PUBLS. INST. GEOPHYS. POL. ACAD. SC., D-72 (403), 2008

Editorial Note

Starting with the year 2006, we have been gradually limiting the publication of raw experimental data from the observatories of the Institute of Geophysics. The data will be available on the Institute's webpage.

Along this line, the present issue, with subtitle *Monographic Volume*, is published in place of the former yearbooks entitled: ***Atmospheric Ozone, Solar Radiation, Belsk*** and ***Results of Atmospheric Electricity and Meteorological Observations, S. Kalinowski Geophysical Observatory at Świder.***

We also include reports on other topics dealt with at the Department of Atmospheric Physics, namely the lightning research. The next issues will contain papers with current information about the new developments in measurements, instrumental problems, and data processing relating to the observatories.

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Total Amount of Atmospheric Ozone with the Dobson Spectrophotometer No. 84 at Belsk, Poland, 2006-2007

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Ozone observations have been made by means of Dobson spectrophotometer No. 84 in the Geophysical Observatory at Belsk since March 1963. This publication presents all total ozone values over Belsk in 2006 and 2007. Monthly means based on the daily values of total ozone were obtained according to the recommendations of the WMO. According to the International Ozone Commission of IAMAP and WMO recommendation, new ozone absorption coefficients (Bass-Paur scale) have been used in processing Dobson spectrophotometer total ozone data beginning on 1 January 1992. In June 2005 the instrument No. 84 from Belsk took part in the WMO Intercomparison of Dobson Ozone Spectrophotometer in Hohenpeissenberg, Germany; first set of correction to N-values resulting from the comparison and the wedges recalibration have been applied since 1 July 2005. In Table 1, Table 2, Fig. 1 and Fig. 3 we present monthly means of total ozone [D] and the departures from long-term monthly means (in percent). In Fig. 2 and Fig. 4 we present daily means of total ozone [D] and the departures from long-term daily means.

Table 1

Monthly means of total ozone [D] and the departures (in percent) from long-term monthly means in 2006: 1 – long-term monthly means, 2 – monthly means, 3 – departures

2006	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	340	372	381	386	368	355	339	320	300	287	288	312
2	304	386	386	385	363	336	317	325	270	264	280	260
3	–10.6	3.7	1.3	–0.2	–1.3	–5.3	–9.3	1.2	–10.0	–8.0	–2.8	–16.7

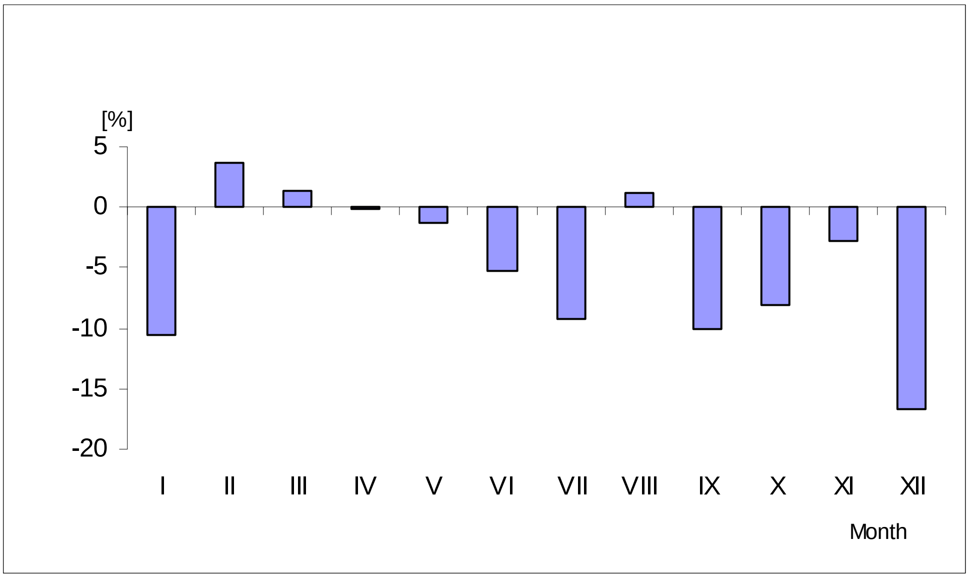

Fig. 1. Monthly means departures (in percent) from 43-year averages of total ozone measurements at Belsk in 2006.

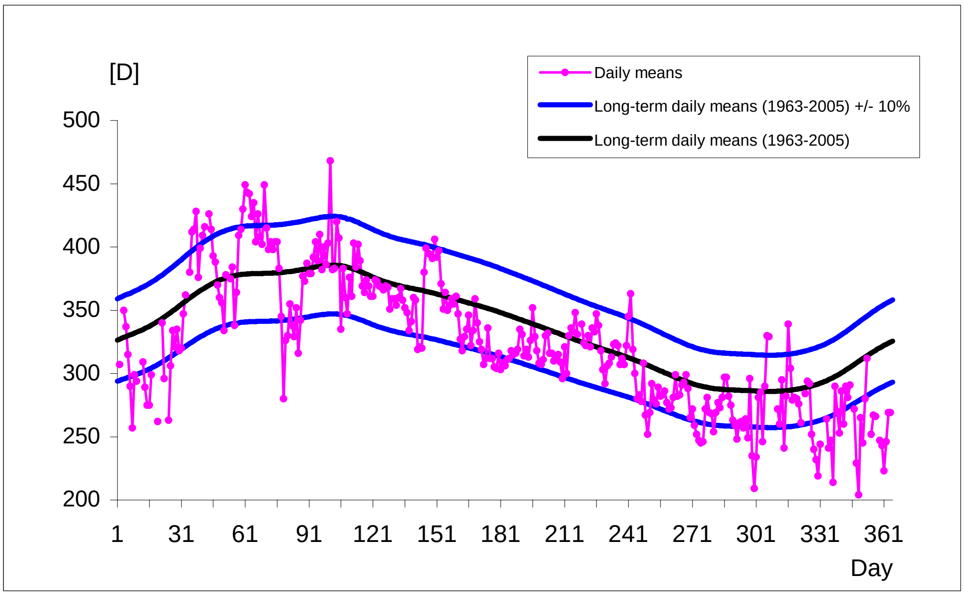

Fig. 2. Time series of the total ozone measurements at Belsk in 2006.

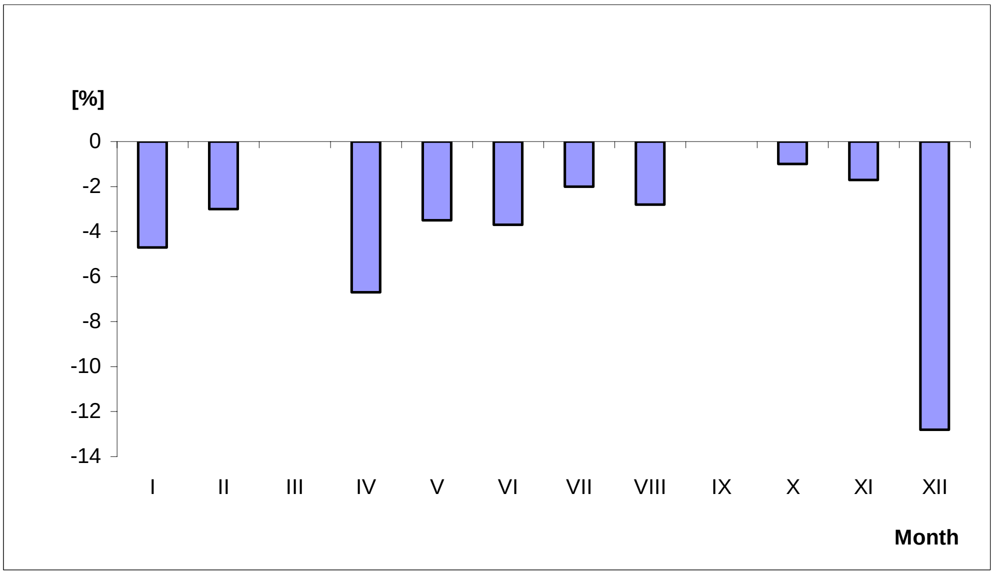

Fig. 3. Monthly means departures (in percent) from 44-year averages of total ozone measurements at Belsk in 2007.

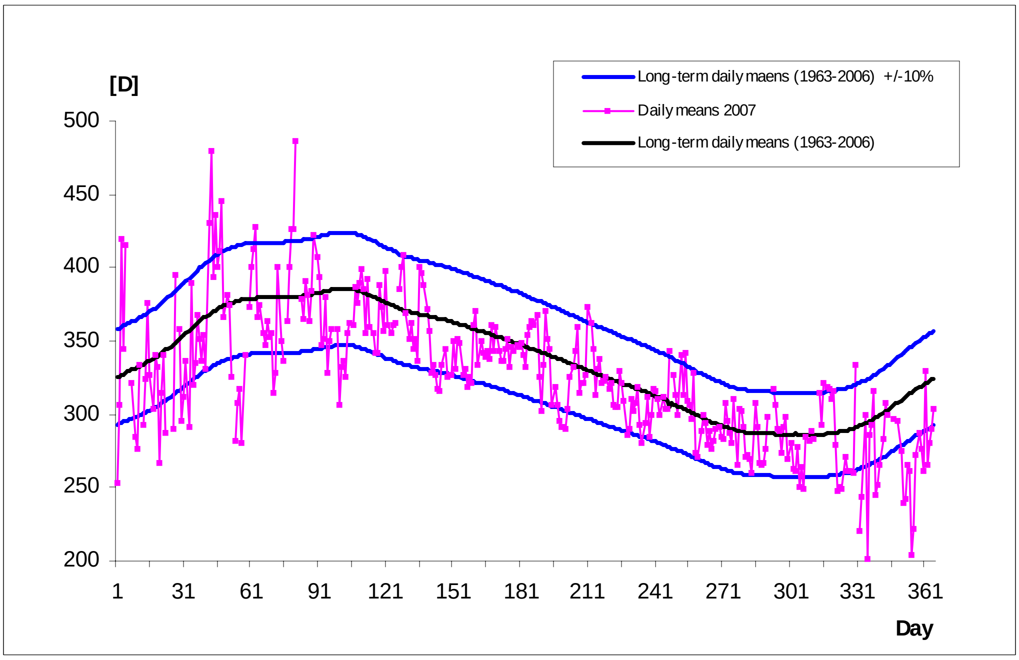

Fig. 4. Time series of the total ozone measurements at Belsk in 2007.

Table 2

Monthly means of total ozone [D] and the departures (in percent) from long-term monthly means in 2007: 1 – long-term monthly means, 2 – monthly means, 3 – departures

2007	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	340	372	381	386	368	355	339	320	300	287	288	312
2	324	361	381	360	356	342	332	311	301	284	283	272
3	–4.7	–3.0	0.0	–6.7	–3.5	–3.7	–2.0	–2.8	0.0	–1.0	–1.7	–12.8

Accepted December 22, 2009

TOTAL AMOUNT OF OZONE

Observations are entered in the column in accordance with the codes explained below:

YY – Greenwich day of the month on which the observation is made.

GG – Time of observation to the nearest hour, Greenwich Mean Time.

μμμ – The relative path-length of sunlight through the ozone layer.

λ – Wavelengths used, reported according to the following code:

0 – wavelengths AD, ordinary setting,
2 – wavelengths CD, ordinary setting,
4 – wavelengths AD, focussed image,
6 – wavelengths CD, focussed image,
9 – wavelengths CD, focussed image with $NiSO_4$ filter.

S – Kind of observation, on sun or sky, reported according to the following code:

0 – on direct sun,
2 – on blue zenith sky – ZB,
3 – on zenith cloud – ZC (uniform stratified of small opacity),
4 – ZC (uniform or moderately variable layer of medium opacity),
5 – ZC (uniform or moderately variable layer of large opacity),
6 – ZC (highly variable opacity, with or without precipitation),
7 – ZC (fog).

ΩΩΩ – Total amount ozone in D (1 dobson = 1 milli atm-centimeter).

YY	GGμμμ	λSΩΩΩ
JANUARY 2006		
02	10388	26310
	10371	26305
	10366	26304
	11364	26310
04	11360	26350
05	10381	26341
	11367	26338
	11358	26334
	11357	26335
	11364	26332
	11372	26333
06	10376	26321
	10364	26313
	11355	26311
	11356	26315
	11366	26312
	12378	26316
07	11353	20284
	11356	20286
	11360	22286
	11364	20290
	12376	20294
08	11356	20258
	11359	22357
	12365	20255
	12370	22258
	12378	20259
09	10375	20298
	10358	20299
	10354	22298
	11348	20301
	11347	20301
	11351	20299
	12361	20299
	12370	20299
10	10362	20299
	10356	22296
	10350	20295
	11345	20300
	11345	20298
	11349	20298
	11352	22289
	11357	20287
	12375	20282
13	11336	26310
	11336	26305
	11343	26309
	12357	26311
14	11333	26288
14	11334	26287
	12346	26291
	12356	26289
15	11330	26277
	11339	26271
	12351	26274
	12359	26278
16	10346	22277
	10337	22274
	10331	20271
	11328	20274
	11326	20279
	11329	22278
	11334	20275
17	11331	26300
	12337	26297
	12344	26300
20	10328	25259
	10319	25258
	11313	25260
	11313	25260
	11321	25267
	12327	25267
	12335	25264
	12343	25264
22	12345	24338
	12354	24341
23	10315	20297
	10306	20294
	11304	22297
	11303	20300
	11302	20294
25	10311	24261
	10306	25258
	11297	25262
	11296	25260
	12312	25271
	12323	25264
26	10311	22310
	10305	22305
	10298	22304
	11292	22310
	12310	22303
27	10304	22329
	10300	20324
	10296	22322
	10292	20327
	11290	22328
	11289	22333
	11289	20338
	11290	20339
	12297	20339
27	12307	20335
28	11286	20317
	11285	20319
	11288	20326
29	11286	26334
	12295	26331
	12300	26340
30	10301	26317
	10289	26317
	10283	26314
	11279	26313
	11278	26317
	12288	26325
	12296	26321
31	10293	26322
	10282	26323
	11276	26323
	11275	26322
	12288	26317
	12294	26312
FEBRUARY 2006		
01	10285	26348
	10277	26340
	11273	26338
	11272	26342
	12292	26362
	12301	26358
02	11269	26361
	11268	26366
	11269	26362
04	11262	26391
	13336	25371
05	11259	22414
	11259	22403
	11263	22409
	12272	22406
	12284	22416
	13302	22415
	13328	22424
	13346	22413
06	10262	25418
	11257	02418
	11255	02421
	13299	22417
07	12277	26425
	12289	26431
08	11249	06386
	11250	26368
	12286	26384
	13295	26374
09	9328	26393
	9305	26407
	9293	25387
	10270	25390
	10253	06409
	11247	06409
	12272	26409
	13285	26401
10	9293	26403
	9277	26402
	10263	06414
	10254	06411
	10248	06410
	11244	06415
	12262	06426
	12274	26412
	13290	26408
	13310	26413
	13335	26421
11	11240	02424
	11241	02422
	11241	02421
13	10237	06436
	11235	06433
	11234	06431
	11235	06431
14	9281	26417
	9266	26409
	10253	06422
	11239	06423
15	10243	06408
	10236	06405
	10231	06402
	11229	06398
	12239	06390
	12243	06393
	12252	06397
	13270	06405
16	11227	06397
	11226	06393
	11228	06394
	12241	06392
	13259	06397
17	9291	26369
	9262	06382
	10227	06378
	11224	06379
	11223	06375
	12235	06375
	12246	05369
	13261	04368
	13281	25372

YY	GGμμμ	λSΩΩΩ
18	11221	02365
	11221	02366
	11223	02362
	12233	02362
	13268	22364
	13275	20358
	13284	22365
	13293	20361
19	13289	25358
20	9258	02341
	9234	02341
	10225	02339
	10220	02337
	10217	02337
	11216	02340
	11216	02339
	12235	05338
	13257	06344
21	10219	06371
	10215	06375
	11213	06376
	12223	06382
	13241	06389
	13253	06392
	13265	26387
	13281	26389
23	9248	06376
	9236	06374
	11208	06369
	13271	22379
	13285	22371
24	9223	02386
	10219	02387
	10212	02389
	10208	02392
	11208	02395
25	11203	00343
	11205	00344
	12209	00348
	12218	00348
	13235	00342
	13256	00341
27	8283	20418
	9250	00413
	9224	00414
	10212	00416
	10204	00421
	11200	00419
	12204	00415
	12219	00412
	13238	00407
28	8262	22423
28	9218	02420
	9213	02420
	10198	02423
	11197	00419
	12208	00422
	12217	00421
	13225	00420
	13236	00422

MARCH 2006

YY	GGμμμ	λSΩΩΩ
01	11195	02434
	11196	02435
	11198	02433
	12204	00435
	12210	02433
	12218	00434
	13228	02434
	13230	00439
02	9227	06455
	11193	02451
	11192	00457
	11192	00458
	11194	00458
	12196	00459
	13238	00455
	13242	00455
	13249	00453
	13260	00454
03	8265	00444
	9238	00445
	10202	00449
	10192	00453
	11191	00457
	12200	00451
	12202	02452
	12211	00451
	14353	20371
	13220	00450
	13236	00452
	13254	00449
04	12200	02455
	13212	02450
	13238	00451
	14262	00447
05	11188	05431
	12191	04431
	12199	06433
	13228	06428
	14261	06429
06	11184	06451
	12188	02450
06	12192	00439
	12197	02444
	12199	00442
	12204	02442
	13214	02441
	13228	02441
07	8292	00410
	8247	00412
	9224	00415
	9201	00409
	10187	00406
	11183	00413
	11183	00416
	12187	00415
	12194	00413
	12199	00411
	13206	00411
	13226	02411
	13231	00404
08	8289	00425
	8256	00425
	8230	00414
	9209	00431
	10184	00433
	11181	00434
	11181	00437
	12193	00446
	12200	00444
	13213	00437
	13237	00435
	14258	00432
09	8259	02427
	10186	00431
	10183	00429
	11179	00398
	12197	02393
	13202	00383
	13220	02387
10	8228	06400
	9209	06404
	9192	06408
	10185	06414
	11177	06403
	11187	06400
	13201	06415
	13211	06414
	14260	06422
11	11176	06450
	12193	04456
	13208	02458
	13226	02462
	14241	02455
11	14254	02447
12	8220	00420
	9206	00420
	9190	00425
	10181	00423
	10176	00425
	11174	00421
13	8259	02418
	9201	00406
	9191	00404
	11172	03409
	13209	05402
14	13190	05399
	13209	05408
	14228	06414
	14241	06419
15	8259	04408
	9189	04410
	10170	00407
	11169	00404
	11169	00406
	12180	00407
	12183	02411
	13193	02415
16	11168	06424
	11170	06423
	12173	06416
	12181	06407
	13189	06402
	13194	06400
	13201	06402
17	13220	06409
	14251	06411
	14258	06412
	14274	06408
18	11165	06379
	11167	06378
	12174	06380
	13189	06388
	13202	06395
	14223	06401
	14260	06407
19	11163	06364
	11164	06362
	13203	04345
	13214	04344
	14241	04348
	14258	05342
20	9173	06289
	11162	02292
	11161	02291
	14259	02293

YY	GGμμμ	λSΩΩΩ
21	7251	06345
	8236	06345
	9187	06346
	10161	63651
	13198	06335
	14223	04334
	14240	02331
22	7260	05326
	8235	04324
	8201	05323
	9187	06330
	10160	06337
	11159	06346
	14241	06351
	14266	06354
23	7234	02367
	8199	02367
	10159	00363
	10158	00363
	11157	00362
	12171	00362
	13180	00364
	13196	00369
	14207	00364
	14235	00355
24	7307	00346
	7258	00349
	7242	00354
	8206	00354
	8190	00351
	9166	00343
	10159	00346
	11156	00339
	11158	00342
	12169	00340
	13177	00337
	14260	02346
25	11157	05330
	12162	05331
	12169	05331
	13183	05335
	13194	05342
	14204	05343
26	12160	07364
	12165	07352
	13177	07362
27	11152	06320
	11153	06321
	11155	02324
	13191	06332
28	7232	00351
	8202	02348
28	8188	00349
	9171	02346
	10156	02347
	10152	00349
	13187	05364
	14232	05364
29	7267	05374
	7148	05385
	8203	05386
	8187	05385
	9170	05386
30	7237	05378
	8189	05380
	9166	06382
	13174	02377
	13182	02381
	14204	02380
	14244	00383
31	7233	06384
	8210	06404
	8186	06399
	9169	06386

APRIL 2006

YY	GGμμμ	λSΩΩΩ
01	10149	06386
	11147	02387
	11147	00388
	11147	00387
	11148	02386
02	12153	05381
	13171	02380
	13188	00382
	14196	00387
	14207	00389
	15253	02381
03	7225	05396
	8171	05400
	12152	00401
	12154	00399
04	8177	05392
	8170	06391
	9164	06394
	10145	06408
	11144	06412
	11144	06407
	11145	06407
	14193	04258
	14218	06426
	15242	06429
	15263	06426
05	7238	06419
05	7213	06401
	7202	06415
	9152	05395
	10147	05388
	10144	05392
	11143	06385
	11443	06379
	12149	05383
	14192	06392
	14197	06393
	14202	06393
	14207	06396
	14211	06400
	15259	06398
06	7203	00412
	8195	00412
	9164	02416
	9162	00427
	13177	05410
	15252	05417
07	6264	00387
	7221	00390
	7202	00390
	8184	00390
	9157	00391
	10141	02386
	13176	04390
	14188	04391
08	12148	00417
	12154	00412
	14199	00402
	14212	00402
	15255	00404
09	11141	06398
	12142	06403
	12152	06395
	13161	06395
	14204	06389
	15231	06383
	15268	06390
10	8186	06389
	8175	06392
	8166	06406
	10142	06406
	10139	06402
	10138	06404
	11138	06405
	12146	06403
	14192	06420
	14195	06417
	14202	06426
	14210	06435
10	14217	06435
11	6260	06484
	7195	06468
	9142	06474
	10142	06478
	13173	06482
	14191	06481
	14212	06471
	15245	06469
	15261	06472
12	6268	05383
	6261	05381
	6252	05380
	7205	06380
	8183	06377
	9150	06381
	9142	06385
	11137	05391
	11137	05393
	13153	05391
	13175	05395
	14186	04398
	14198	04400
	14208	05398
	15235	04406
13	7234	05388
	8157	02386
	9151	00391
	9149	00391
	10140	00393
	11136	05391
	13158	05394
	14192	06392
14	9147	06343
	11135	00431
	12144	00431
	12147	00430
	12148	00435
	14194	00426
	14208	00421
	14212	00423
	15259	00417
	15264	00422
15	6271	06399
	6247	06429
	7211	06411
	7204	06421
	7197	06424
	10134	06409
	10134	06409
	11134	06413
16	10135	06342

YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ
16	10134	05344	23	6256	02393	30	6260	06367	05	7176	00379
	11134	05342		7183	02395		6209	06363		9134	00379
	11134	05349		7161	02395		6203	06367		9129	00380
17	11133	05386		9133	00393		7197	06363		10124	00378
	11134	02393		10129	00393		10125	06373		11123	03377
	11135	02394		11129	00397		10125	06373	0	12128	02376
18	8168	06372		11130	02398		11125	06376		12133	00376
	8160	06372	24	7192	05409					15204	05371
	9149	05372		7182	02420	**MAY 2006**				15219	06377
	9141	06371		8153	05407				07	11124	06375
	10132	02369		11128	06404	01	6216	02363		12125	00379
	11132	02372		13148	02400		6206	02367		12132	00377
	11133	02368		14172	05406		7195	02368		13149	00377
	13159	06366	25	6244	00385		7189	02367		14184	00379
	14178	06373		7198	02384		10126	04365	08	6194	00374
	15216	06371		8145	00398		11126	05366		7170	00375
19	6234	02351		9138	00404		12127	05368		8148	00378
	7224	00358		11129	00402	02	6223	05373		8142	00380
	7196	00355		12131	00402		7169	05373		9129	00382
	7177	00356		14196	04398		8160	05377		10125	00377
	9146	00355	26	9139	00387		11126	05385		10123	00374
	9140	00355		9134	00388		14157	05376		11122	00382
	9138	00356		10130	00389		14171	05378		16261	06375
	10132	00354		10128	00380		15192	05383	09	5261	20357
	14206	05352		10127	00381		15206	05384		6241	00357
	15212	05352		10127	00382		15222	05391		6224	00360
	15262	05351		13153	00375	03	13142	02382		6214	00358
20	13163	02379		14162	00373		13149	02381		6202	00361
	14179	02380		14188	00371		14169	02384		7170	00360
	14191	02382		15201	00370		14184	02387		8152	00360
	14198	02384		15222	00368		15198	02377		8143	00364
	15239	02387		15238	00370		15218	02379		9128	00358
21	6254	00364	27	6241	00373		15239	02376		9125	00363
	7206	00364		8151	00361		15258	02375		10123	00367
	7195	00365		8146	00372	04	6248	00369		10121	00353
	8171	00368		9135	00375		6221	00372		11122	00354
	8160	00366		10128	00378		7192	00371		13145	00359
	8148	00365		11127	00371		7171	00375		13150	00360
	9136	00370		13149	00369		8147	00376		14164	00363
	10132	00370		15201	00371		9136	00378		15185	00359
	12137	00371		15209	00378		9128	00379		15212	00359
	13157	00371		15247	00372		10123	00380		15241	00359
	14173	00372	28	6229	02387		11124	00378		16257	00360
	14192	00373		7204	02386		13147	00380	10	7154	02372
	14204	00369		8147	04383		14164	00379		8151	00370
	15226	00371		11126	00383		14176	00381		9134	00366
	15261	00367		13158	02387		15191	00379		9130	00367
22	11131	04408		14182	00384		15204	00378		9125	00362
	12134	04409		15197	02386		15237	00375		10122	00365
	12137	05409	29	14177	06378		16260	00375		11121	02369
	14174	02411		14183	06378	05	6260	02381		14168	00374
	14189	02408		15211	06369		6214	00373		14173	00373

YY	GGμμμ	λSΩΩΩ
11	6229	00368
	6208	00369
	6192	00366
	7161	00364
	8146	00367
	8140	00370
	9126	00358
	9124	00365
	10121	00368
	11120	02371
	13148	00371
	14180	06365
	15200	06368
12	6238	05360
	8137	02360
	9129	00360
	10120	02360
	10120	00367
	11120	00368
	13134	00364
	15214	00363
	15237	00361
	16250	00360
	16261	00358
13	5264	00368
	6226	00369
	6203	00369
	7158	00370
	8149	00367
	8142	00365
	8134	00367
	9127	00368
	9124	00369
	10122	02362
14	5263	06383
	6208	05375
	6201	06374
	9129	05370
	9127	05372
	9124	05371
	9123	05366
	10121	05375
	10120	05383
15	5263	00370
	6393	00378
	7173	00375
	8141	00366
	9132	00363
	9123	00364
	10121	02361
	10119	00363
	11119	00363
16	6245	00355
	6205	06356
	8140	00363
	10122	05355
17	8137	06364
	9125	05353
	10119	06354
	11118	05356
	15181	04364
18	7164	06359
	8136	06351
	9128	05350
	12222	00346
	15200	06339
	15227	06341
19	9128	05346
	10119	00340
	11118	00353
	11118	00366
	16237	02366
	16253	02360
20	5262	04361
	6225	04364
	6206	04366
	7158	05363
	9129	04376
	10120	03374
21	16238	02363
22	5238	00327
	6214	00331
	6187	00332
	8143	00328
	8137	00325
	9128	00323
	9124	00328
	10118	00328
	11117	00331
	15174	03326
23	5259	00321
	5240	00321
	6193	00324
	7148	00333
	11117	00340
	11118	00333
	14148	00332
	14171	00335
	15189	02332
24	5260	05320
	6210	05323
	9125	05327
	10120	05322
	10117	05327
24	11117	05324
	11117	05326
	13147	05333
	14151	05327
	14159	05337
	15195	05330
	15210	05325
	16231	05335
	16269	05340
25	8144	00392
	8140	00395
	8133	00394
	9126	00390
	9121	00387
	11117	00384
	15184	06389
26	5259	06402
	8131	06409
	8130	06405
	9127	06406
	9120	06417
	10119	06413
	10117	06409
27	12125	05404
	13130	05396
	13138	06394
	14143	06411
	14162	06408
	15181	06405
28	5234	06405
	6203	06401
	7154	06403
	8143	06399
	9123	06401
29	7154	06393
	7149	06405
	14148	05392
	14155	04396
	14158	02403
	14162	00393
	15201	02402
	16228	02396
	16258	02393
30	5235	06417
	6200	06416
	11115	03417
	11115	04413
	11116	05409
	13139	05416
	14145	05418
31	5236	06404
	6189	06398
31	10117	06402
	10116	06401
	14146	02401
	15202	00399
	16244	00400

JUNE 2006

YY	GGμμμ	λSΩΩΩ
01	7172	06407
	8141	05411
	9143	05412
	10116	00410
	10115	00407
	11116	02410
	15197	05405
	15205	00406
	16258	00400
02	6217	00378
	6195	00373
	8141	00379
	9126	00384
03	5233	05354
	6180	05357
	7158	02359
	9120	06360
	10118	06356
04	11117	05376
	14143	06372
	14155	05374
	14158	02372
05	5263	06361
	5241	06355
	10115	06358
	11115	06357
	14148	05357
	14163	06362
06	5271	00361
	5262	00358
	5247	00361
	6204	00363
	6201	00361
	6197	00363
	10115	00359
	10115	00366
	11115	00361
	11115	00360
	13134	00366
	15192	00364
	15208	00363
07	5262	00360
	7159	03359
	9122	05361

YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ
07	10115	06363	13	11114	00338	19	8130	00351	25	5249	00317
	11115	03646		12116	00341		8127	00355		6223	00317
	15184	00367		13127	00345		10115	00353		6201	00317
	15193	00367		14150	00343		10114	00352		6299	00317
	15205	00366		14162	00342		13131	00351		6296	00317
	16228	00366		15182	00343		15175	00341		6185	00317
	16250	00363		16219	00339		16217	00347		7163	00322
08	6298	03358		16248	00337		16231	02346		8132	00325
	7160	03357		16260	00335	20	5306	00330		8130	00324
	11114	03355	14	5261	00335		5250	00332		9118	00328
	14144	02364		6220	00336		6196	00332		10116	00329
	14150	02325		6201	00334		6181	00332		10115	00326
	14161	02347		6181	00336		8139	00335		10114	00330
	16242	05363		7147	00341		8129	00332	26	5235	03323
	16261	06362		8127	00345		9119	00331		8143	00322
09	5236	00366		9121	00347		10115	00330		8132	00324
	6212	00366		9118	00348		11114	00340		9126	00326
	6184	02361		11114	00346		11114	00341		9120	00324
	8135	00372		12121	00351		13130	00339		10117	00325
	9118	02365		14146	00351		14142	00337		10114	00325
	11114	04364		15182	00354		14154	00339		10115	00326
	13127	06365		15203	00356		15171	00335		14139	00322
	16254	05335	15	12116	00351		15201	00330		14144	00320
10	12120	05354		12116	00354		16226	00330		14150	00320
	12122	00357		12122	00356		16259	00327		15203	00321
	14162	02353		13123	00357	21	8140	00330		16227	00318
	15175	00355		13131	00357		8133	00330		16268	00315
	16221	00353		13133	00355		8128	00331	27	9121	00312
11	12120	00336		14154	00360		9123	00328		10117	00310
	13127	00336		14157	00361		9119	00329		10115	00309
	14141	00335	16	7160	00328		10115	00328		11114	00310
	15172	00336		8141	00330		10114	00333		15178	02319
	15200	00334		8133	00330		11114	00335		16218	00320
	16221	00335		8126	00332		12116	00334		16240	00318
12	5260	00322		9122	00333		15200	02335		16266	00318
	6195	00326		10116	00330	22	6193	02317	28	5263	00307
	7162	00326		11114	00327		6173	00317		6215	00310
	7148	00327		12116	00330		8132	02317		6180	00306
	9125	00329		12117	00333		8128	00317		7168	00308
	9121	00330		13131	00338		10114	06316		8129	00317
	10115	00330		14140	00338		12118	04318		10114	00324
	13124	06328		15175	00332		16210	05320		12119	05322
	14140	06329		15201	00334	23	6194	06327		15198	02318
13	5262	00334		16225	00333		7144	05322		16255	02309
	6211	00339		16261	00330		11114	02323	29	7146	00329
	6201	00337	17	13124	06343		12122	04323		9120	05325
	7150	00334		13136	02343		15195	05325		10115	06327
	8141	00334		14160	06341	24	12121	02348		11114	00329
	9124	00335	18	5226	05376		12122	00349		15180	00324
	9120	00337		8130	05370		15172	00346		15202	00320
	9117	00335		10115	02371		15198	00342		16260	00318
	10114	00337	19	7151	00350	25	5261	00315	30	5266	00308

YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ
30	6191	03307	04	15180	00328	09	15178	00344	15	8130	00360
	8138	03309		15200	00326		15192	00342		10119	00365
	11114	05315		16217	00326		16220	00340		10117	00362
	16223	05309		16246	00325		16261	00339		10116	00364
			05	5264	02325	10	5265	00329		11116	00365
	JULY 2006			6231	02323		6194	00335	16	12121	00345
				6206	02324		8143	00343		13127	00339
01	12116	04317		6185	02323		8129	00345		13132	00337
	12119	04319		8141	02325		9123	00348		16237	03329
	13128	05314		8134	02327		10116	00342	17	5260	00326
	14149	05311		9120	02332		10115	00341		6228	00330
	15168	05317		10116	02330		12117	00346		6203	00329
	15199	04317		10115	02330		13138	00341		7168	00332
	16230	03319		12120	06324		15167	00340		8141	00327
	16263	03317		13127	06327	11	8144	03326		9130	00324
02	6224	00313		15199	05321		9126	00327		9126	00325
	6181	00314	06	5260	00319		9120	00327		10116	00328
	7163	00313		6225	00321		10116	00327		11116	00329
	7150	00315		7155	00325		11115	00328		13125	00330
	8137	00318		8141	00321		14163	00323		13132	00331
	8128	00317		8130	00325		15183	00320		14143	00333
	9123	00317		9124	00323		16210	02326		15167	00329
	9119	00319		9120	00324		16240	00320		15184	00328
	10115	00321		10117	00325	12	5259	00322		15212	00326
03	6182	00314		10116	00323		6229	00327	18	5258	00315
	7163	00313		11114	00330		6194	00325		6228	00316
	8136	00316		11114	00329		7168	00327		6202	00316
	8130	00316		12116	00330		8146	00330		7181	00318
	9123	00319		12122	00332		8133	00330		7150	00317
	9118	00319		13125	00331		9127	00332		8140	00317
	10115	00320		14145	00328		10118	00329		9130	00316
	11114	00330	07	5265	00320		14151	00330		9126	00316
	11114	00331		6195	00320		15177	02328		11116	04318
	12117	00325		8137	00325		16252	02328	19	7153	00314
	13126	00329		8128	00320	13	5250	00321		9129	00315
	14141	00327		9124	00323		6210	00322		9126	00316
	15169	00324		9120	00325		6205	00322		10119	00320
	15194	00323		10118	00323		6200	00321		10119	00319
	16261	00320		10115	00325		6196	00322		11117	00318
04	5263	00312		10117	00332		9126	04321		11117	00321
	5249	00313		13134	00335		11115	00323		11117	00320
	6227	00312		13136	00334		11115	00321		15188	02317
	6206	00319		14153	00331		15201	04324		15202	00311
	6194	00314	08	5264	00321	14	14148	06336		16224	00314
	8140	00315		6211	02324		15193	06332		16258	00312
	9123	00319		7150	00329		16234	02330	20	5253	00312
	10115	00317		8131	00334		16249	02331		6219	00315
	10115	00318		11117	00331		16262	02333		6201	00316
	11114	00323		10115	02329	15	6211	06365		7180	00316
	12121	00332	09	13131	02350		7157	00364		8146	00317
	14140	00329		14141	00343		7155	00363		8133	00324
	15165	00330		14161	00344		8131	00360		9128	00326

YY	GGμμμ	λSΩΩΩ
20	10118	00325
	11117	00324
	13127	00333
	15205	04328
21	6220	02337
	6199	02340
	9121	02340
	11117	02336
	13131	04338
	14157	04341
22	12121	06348
	12124	02348
	14141	02349
	14165	02347
	14167	00335
	16234	02334
	16261	02333
23	12120	03325
	12122	03324
	14148	03328
	14165	02328
24	5260	00327
	6221	00328
	6200	00330
	7170	00327
	8138	00326
	9129	00322
	9123	00320
	10119	00327
	12125	00322
	13130	00321
	14164	02327
	15184	02326
25	6252	00311
	6221	00315
	7165	00317
	9132	00318
	9126	00322
	10118	00326
	11118	00328
	14150	04325
	15187	04329
26	5272	00316
	6249	00317
	6210	00317
	6204	00316
	7161	00320
	9123	05318
	11118	00329
	13130	02331
	14155	00332
	15186	06326
27	5268	00320
	5265	00319
	6247	00320
	6217	00323
	6206	00323
	6203	00324
	7186	00325
	8145	00324
	9127	00323
	9126	00324
	10122	00328
	10119	00325
	11119	00324
	11119	00327
	12124	00327
	13130	00326
	13141	00325
	14151	00324
	14160	00325
	15186	00321
	15199	00320
	15222	00320
	16244	00321
	16263	00319
28	6258	00313
	6209	00314
	7190	00317
	8145	00319
	8137	00325
	9129	00316
	10122	00319
	11119	03319
	11119	00321
	15175	05317
29	6255	02301
	6231	02299
	6199	02302
	7179	02306
	9131	05305
	10120	04316
30	14164	05323
	15178	02327
	15205	00323
	16251	00319
31	6266	00302
	7169	00310
	8156	00311
	9135	00311
	9130	00315
	10123	00308
	10121	00314
	14165	04309

AUGUST 2006

YY	GGμμμ	λSΩΩΩ
01	10123	06339
	11120	06343
	11120	06338
	11121	06328
	14156	06332
	15199	06336
	15205	06333
	15211	06332
02	8133	06333
	13135	00348
	14147	00347
	15206	02345
	16239	00338
03	6251	00338
	7291	00341
	7173	00341
	8149	00340
	8132	00340
	8131	02337
	11121	04330
	14168	02336
	15223	06332
	16250	06344
04	7165	06351
	13132	06353
	13142	06362
	14175	06359
	15204	06343
	16274	06362
05	12126	05345
	13141	02342
	14156	02337
	15198	05329
07	8154	05347
	8152	00349
	10125	02352
	10123	00346
	12125	00351
	14175	05343
08	7167	06337
	9133	06340
	11123	02340
	11123	00336
	14151	06334
	16246	05327
09	10126	06328
	11123	06343
	13138	05328
	15220	04330
09	16244	02326
	16275	02329
10	6235	05338
	8148	02339
	8141	05344
	15193	06341
	15202	06342
	16258	06342
11	6249	06323
	6218	06322
	7206	05321
	7194	05321
	7178	05324
	7166	05323
	8145	05325
	9138	05326
	9130	06327
	10125	06337
	11124	06333
	13149	06335
	14166	06334
	14179	06339
12	8161	05344
	8158	00344
	9130	00349
	10129	00347
	10126	00350
	11125	00350
13	6258	05335
	6221	05336
	7191	05330
	8152	06345
	8145	06346
	10127	06350
14	6244	06358
	7167	06361
	9133	06360
	11126	06363
	13141	06361
	14185	05348
	15146	04354
	16273	02352
15	7206	05343
	7191	00344
	7172	00344
	9139	00350
	10130	00350
	10127	00350
	11126	02350
	11126	00348
16	8154	02330
	8149	00326

YY	GGμμμ	λSΩΩΩ
16	9139	00327
	10131	00328
	10128	00327
	11127	00328
	12135	00326
	13139	02329
	14166	00329
	15214	00328
	15232	02325
17	6248	04317
	7174	05317
	9134	00318
	11127	00316
	11128	00311
	12139	00314
	13147	00317
	13158	00312
	14173	00308
	14189	00311
	15248	00307
	15267	00304
18	6558	03300
	7217	00299
	8153	02299
	8147	02298
	9145	00302
	11128	04302
19	6241	06316
	8147	06309
	9144	02315
	10129	06310
20	14171	05306
	14183	05310
	15207	00315
	15236	06307
21	2514	00320
	7218	00318
	7192	00318
	8173	00320
	8151	00323
	9140	00323
	10134	00325
	10130	00327
	11130	00326
	13158	00326
	14171	02326
22	7202	02320
	8170	05322
	11131	05338
	11132	00333
	13159	02341
	15213	02342
23	7204	05337
	9245	05332
	10132	00332
	11131	00332
	12144	02337
	15207	00337
24	7198	02321
	11132	05328
	11134	00336
	14167	05329
	14185	06331
	15231	02327
	15243	00325
25	6299	00312
	6255	00314
	6237	00312
	7207	00317
	8152	02316
	9146	02316
	11133	00321
	11134	00317
	13161	02320
	14170	02319
	15247	06317
26	12138	04320
	12141	02323
	13150	02320
	13157	02321
	14175	02319
	14176	00320
	15239	04324
	15179	00349
27	7230	00309
	7199	02313
	8173	02318
	8158	00318
	9148	00319
28	8164	06322
	13153	05333
	13164	05325
	14214	00328
	15228	02324
	15234	00328
29	6279	06351
	6265	06351
30	6264	06374
	6245	06365
31	7234	05326
	8175	02324
	9147	02330
	10140	00325
	10139	00327
31	11137	05330
	13158	00331
	14204	00327
	14207	00327
	14224	00327

SEPTEMBER 2006

YY	GGμμμ	λSΩΩΩ
01	6255	00305
	7230	00305
	7206	00307
	10142	06306
	10138	06308
	14207	06306
02	11141	02289
	12144	00283
	13163	00288
	14183	00288
	14207	00289
	15233	00289
03	6256	05289
	7248	05288
	7212	05290
	7207	05289
	8166	05290
04	7196	02288
	7193	02288
	9154	02292
	11140	02285
	11141	02285
	13172	06282
05	7253	02313
	7199	06312
	9148	06316
	11141	06320
	15259	06313
06	7199	05278
	11142	00278
	12151	04271
	13167	02275
	13174	00276
	14195	02270
07	6260	06262
	8183	00262
	8172	00262
	9161	00261
	9158	00258
	11143	02263
	11144	00262
	12148	00262
	13176	04263
	14222	02264
08	8196	05272
	10144	06279
	11147	00280
	12148	00278
	14192	06288
	15256	05288
09	12151	01305
	12161	02305
	13168	00301
	13183	00300
	14206	00300
	15254	00296
10	7267	00286
	7259	00285
	7202	00285
	8197	00286
	8171	00287
	11146	05290
11	7253	00282
	7212	00284
	8188	00279
	8172	00281
	9164	00282
	9153	00282
	10149	02281
	11147	00285
	13192	00290
	14211	00288
	14250	02284
	15266	00286
12	7260	00292
	11149	02299
	12166	00297
	13195	00299
	14200	00297
	14225	00296
	14258	00295
	15265	00294
13	7225	00282
	8202	00283
	8182	00289
	9170	00288
	9158	00291
	10151	00291
	11149	00290
	12159	00294
	13185	00294
	14201	00293
	14266	00291
14	7225	00287
	8189	00287
	8176	00288

YY	GGμμμ	λSΩΩΩ
14	9166	00289
	10155	00290
	10150	00292
	11150	00290
	12155	00293
	12161	00294
	13180	00293
	13195	00294
	14205	00292
	14226	00293
	14264	00292
15	7279	00290
	7264	00290
	7210	00290
	8201	00292
	9169	00290
	10154	00293
	10151	00293
	11151	00294
	12169	00298
	13177	00295
	13203	00295
	14239	00296
	14266	00292
16	8202	02292
	8183	00284
	9174	00286
	9158	00285
	10153	00287
	11152	02286
17	12162	03278
	12165	02285
	13210	03277
	14234	03277
	14265	04276
18	8207	04282
	8194	00278
	9177	00281
	9162	00283
	10156	00282
	13177	00284
	14248	02282
	14259	02283
	14262	02282
19	7241	02288
	8209	02287
	10158	02288
	11156	02290
	11157	02290
	14234	05293
20	8218	02303
	8206	05302
20	10160	06308
	10157	02309
	13210	06306
21	7233	00288
	8220	02285
	8187	02295
	9174	02293
	9168	02293
	10164	02291
	10159	00292
	11159	02286
	13194	02287
	13206	02286
	14257	02289
22	7254	00285
	8215	00286
	8197	00291
	9181	00294
	9170	00292
	10162	00294
	12174	00290
	13196	00288
	13205	00289
	14237	00288
	14259	00289
23	10161	02293
	11163	00297
	11166	00296
	12176	00299
	13220	00299
	14248	00300
	14266	00298
24	7259	00297
	8209	00299
	8192	00300
	9177	00302
	10168	00301
	10164	00301
	11163	00299
25	7262	00304
	8227	00305
	8209	00304
	9186	00304
	9177	00305
	10168	00309
	10165	00309
	11165	00309
	13222	00304
	14259	00303
	14266	00303
26	7253	00287
	8232	00286
26	8204	00286
	9186	00292
	9173	00296
	10169	00298
	11166	00305
	13203	00297
	14239	00297
	14278	00299
27	6338	00270
	7264	00269
	8230	00270
	8196	00272
	9175	00273
	10171	00272
	10168	00275
	12179	00273
	13207	00272
	13228	00272
	14255	00272
28	8229	06279
	8211	02279
	8203	02279
	10169	04276
29	7274	00265
	7265	00266
	8214	00266
	8209	00265
	10171	06260
	12186	04263
	13212	02271
	14252	02270
	14270	02268
30	11177	02258
	11177	00260
	12184	00260
	12195	00260
	13214	00260
	13234	00257
	14255	00256

OCTOBER 2006

YY	GGμμμ	λSΩΩΩ
01	7258	05251
	8223	05256
	8208	05253
	9198	05256
	9189	04254
	10179	04257
	10177	05256
	10175	05256
02	7262	05245
	8225	05248
02	8209	05247
	9197	05245
	9186	06255
	12198	06258
	12200	06261
	14268	06252
03	7257	06249
	8238	06252
	8208	06250
	9200	06256
	9198	06232
	9196	06236
	12204	06262
	13210	06258
	13246	06259
	14264	06269
04	9190	06275
	9199	06278
	10179	06280
	10179	06283
	10179	06287
	10178	06284
	12204	06278
	13217	06275
	14290	06270
05	8255	06284
	8230	06285
	9205	06294
	10180	06293
	11181	06289
	12208	06277
	13242	06285
	13256	06289
06	8248	02280
	8242	00278
	9207	00277
	9200	00277
	10186	00277
	11182	00275
	11186	00277
	12193	00275
	12209	00274
	13226	00274
	13262	00273
07	11187	03270
	11289	02275
	12197	04272
	12207	04276
	13220	05282
08	12210	02260
	12217	02259
	13246	02261

YY	GGμμμ	λSΩΩΩ
08	13264	05259
09	8263	06276
	8221	06275
	9210	06275
	9201	06276
	10193	06273
	10189	06272
	11188	06273
	11191	06274
	12205	06275
	13257	06282
	13261	06280
10	8258	00278
	8236	00280
	9214	00282
	9202	00283
	10194	00285
	10191	00284
	11190	00287
	12208	00285
	12225	00286
	13252	00284
	13266	00282
11	8271	05281
	9206	00282
	9204	00281
	10196	00281
	10192	00279
	10192	00280
	11195	00279
	11200	00278
	13234	00277
12	8271	06279
	8265	06282
	9208	05277
	9207	05276
	10194	05281
	10194	05281
	10194	05282
	12205	03291
	12219	03297
	13256	03303
	13267	03306
13	10197	02299
	11198	02300
	11200	02300
	11203	02301
	12210	02301
	12224	02302
	13247	02310
	13264	00301
	13270	02309
14	11201	06305
	11204	06302
	12213	06302
	12232	06301
	13245	06302
	13265	06303
15	8267	06300
	8264	06298
	9215	06284
	9213	06284
	9211	06285
	9208	06279
	10200	06289
	10200	06282
16	8285	22276
	8250	05274
	9212	06277
	11203	06276
	13249	06285
17	8251	06270
	9233	06272
	10211	06274
	10205	06265
	12224	06268
	12237	00270
	12240	02265
	13267	06271
18	8272	00263
	8263	00263
	9232	00263
	9219	00266
	9214	00267
	10208	00266
	10207	00265
	11213	00265
	12226	00264
	12238	00264
	12251	00264
	13367	00263
19	8264	02248
	8248	02250
	9227	02253
	10215	02252
	10214	00259
	10212	02256
	10210	02255
	11211	02257
	11213	02259
20	8262	02264
	8251	02262
	10219	02259
	11215	02266
20	11218	00276
	11219	02274
21	11218	02267
	11228	02267
	12243	02268
	13266	02267
22	8255	00260
	9227	00262
	10221	00263
	10218	00265
	11217	02260
23	9254	05264
	9250	05262
	9236	05263
	10219	05264
	11226	06275
	12234	06277
	12247	06278
	12262	06274
24	8264	06258
	10228	02256
	10222	05257
	11231	06261
25	12250	05293
	12253	02289
	12259	02287
	12263	06295
26	9248	02244
	10227	02241
	11228	02239
	11231	02241
	12263	04239
27	8280	05218
	9270	05214
	9267	05213
	9262	05212
	9257	05213
	9251	05211
	10233	05212
	10233	05213
	11234	04221
	11243	04219
	12253	04222
28	9270	02238
	9251	02238
	10237	02241
	10233	02244
	10233	00246
29	10241	06288
	10240	06283
	10237	06288
30	10243	00289
30	10239	00291
	11239	00291
	11244	00290
	12258	00290
	13347	00282
31	9255	02252
	10249	02250
	10244	04245
	11242	05241
	11244	05243
	11246	05243
	12266	06245

NOVEMBER 2006

YY	GGμμμ	λSΩΩΩ
01	12291	20294
	12299	20290
	12311	20288
02	9262	06331
	10256	06330
03	11251	05334
	12280	02327
	12293	02332
	12313	22327
07	9203	06278
	9302	26265
	9284	26267
	11263	26274
	10263	06281
	11266	26270
	11282	06285
	12294	26269
	12305	26268
	12329	26267
08	9306	24269
	9293	24259
	9287	24256
	9281	24259
	12292	26262
	12340	26255
09	9315	26295
	9297	26295
	11284	22295
	11287	22295
10	10281	22330
	10275	22334
	11279	22345
	11284	20343
	12296	22344
	12326	20352
11	11284	26283
	11294	26281

YY	GGμμμ	λSΩΩΩ
11	12305	26278
	12323	26284
	12352	26285
12	9324	26335
	9310	26331
	10290	26340
	10279	22339
13	10284	26309
	10283	26311
	10283	26319
	11295	26293
	12305	26298
	12326	26305
	12357	26292
14	9338	26283
	9312	26281
	9299	26273
	10290	26279
	11291	26277
	12310	26269
	12336	25275
	12364	26287
15	10295	26280
	10292	26281
	10290	26277
	11290	26281
	12324	26285
	12341	26282
	12370	26283
16	9344	20277
	9324	20282
	10305	20284
	10295	20279
	11294	20281
	12328	20277
	12345	20278
	12379	20279
17	9360	20266
	9325	20272
	10307	20272
	10296	20277
	11305	20277
	12313	20282
	12335	20279
	12349	20280
	12380	20277
18	10312	22265
	10305	22265
	10300	22262
	11301	22259
	11304	22257
	12322	22259
18	12339	22260
	12363	22261
20	9331	25271
	10320	26272
	10309	26282
	10307	26277
	11312	26282
	12334	26297
	12355	26291
21	9326	26294
	12337	26291
	12384	22291
	12398	22298
22	9353	26289
	11318	22291
	11320	20299
	11331	22293
	12345	20292
	12352	22290
	12365	22290
	12384	22287
23	9347	26254
	11317	22252
	12385	26255
	12411	26252
24	9385	26232
	9362	26229
	9341	26233
	10335	25234
	11320	26242
	11322	26244
	12353	26250
	12383	26253
25	11326	22239
	11329	22235
	11339	22230
	11348	22224
26	9396	26216
	9388	26213
	9344	26220
	10334	26222
	10327	26221
	11328	23223
27	9371	20238
	10347	20240
	10333	20245
	11330	20246
	10336	20245
	12357	20248
	12405	22244
30	10358	26265
	10344	25255
30	11340	26262
	11356	26264
	12368	26269
	12418	26270

DECEMBER 2006

YY	GGμμμ	λSΩΩΩ
01	9378	22251
	10360	22244
	10343	22242
	11343	22241
	11368	22240
	12380	22236
	12389	22235
02	11348	22244
	10356	20249
	11362	22244
	11369	20252
	12377	22247
03	11349	25219
	11352	25214
	11358	25215
	11367	25212
	12375	25208
04	12377	20288
	12382	20295
	12392	20291
	12397	22287
05	9383	25271
	10375	25269
06	10366	20252
	11356	20256
	11374	20253
	12384	20250
07	10380	26287
	10372	26285
08	10384	23259
	11379	25260
	13518	22260
09	10387	22289
	10382	20288
	10376	20290
	10371	22291
	10363	22290
	10362	20290
	11364	22294
10	10372	26281
11	10375	26306
	10368	25288
	10366	25302
	11368	26291
	11374	26293
11	11378	25281
13	10378	26267
	10371	26266
	11369	25270
	11374	26275
	11381	26285
14	10379	26230
	11372	26226
	11380	26231
15	10384	23206
	10379	23204
	10374	23206
	10372	24204
	11373	23204
	11378	23204
	11384	23201
	11391	23204
16	11375	20265
	11383	20266
	11394	20265
17	10387	26253
	10381	26241
	10376	26243
	11374	26241
	11375	26239
18	10382	23289
	11374	26276
	11375	26277
	11380	26278
19	10383	26318
	10376	26314
	11377	26310
	11381	26309
	11386	26311
21	10384	26250
	10377	25253
	11375	25253
	11377	25252
	11381	25252
	11387	25250
22	10376	26268
	11375	26265
23	10384	26269
	10381	26266
	10378	26266
	10376	26265
	11375	26264
25	10376	26254
	11374	25246
	11375	22247
	11379	22246
26	10384	25250

YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ
26	10377	25247	28	10379	26245	29	10378	26265	30	10372	22268
	10374	25235		10374	26248		10371	26267		11369	22266
	11374	25240		11372	26249		11371	26273		11371	20270
27	11376	26226		11374	26247		11381	26275		11376	20270
	11380	26224		11383	26243	30	10379	22273		11383	22261
	11389	26218	29	10392	26267		10377	20279			

YY	GGμμμ	λSΩΩΩ
JANUARY 2007		
01	11367	26249
	11378	26257
02	10376	26316
	10366	26299
	11364	26314
	11365	26306
	11379	26304
03	10374	26421
	10367	26417
	11363	26419
	11362	26418
04	11360	26353
	11360	26349
	11368	26342
	12378	26340
	12384	26341
05	11359	26426
	11358	26418
	11361	26416
	12387	26399
08	10378	22327
	10364	20325
	10361	22324
	10353	22322
	11351	22320
	11351	22318
	11355	22315
	11361	22315
09	10382	22293
	10365	20294
	10354	22280
	12374	20271
	12390	20273
10	10372	26276
	10354	26274
	10349	26273
	11346	26275
	11346	26276
	12369	26280
	12384	26277
11	10364	26346
	10354	26330
	10346	26330
	10342	26321
	10344	26333
	11352	26326
	12363	26322
	12385	26323
13	11337	26300
13	11336	25309
	11340	26295
	12358	25288
	12371	26275
14	12348	22330
	12351	20324
	12360	20323
15	10338	26387
	10336	22378
	10332	22379
	11330	22371
	11331	22377
	11336	22375
	12356	24364
16	10347	20325
	10343	22323
	10334	20325
	10332	22329
	11327	20332
	11327	22325
	11328	20327
	11331	22325
	11332	20328
	11336	20323
	12343	20328
	12347	22325
	12354	20330
17	10342	24310
	10331	22315
	10327	24300
	11324	24298
	11324	25300
	12340	26303
	12350	26300
18	11321	26340
19	11321	26333
	11323	26332
20	10319	26270
	10316	26268
	11313	26242
	11315	26267
	11322	26261
	12334	26263
21	9369	22310
	9377	22304
	9345	22304
	10340	22305
	10321	20313
	10318	20315
	10313	20313
22	10318	26348
	10312	26345
22	10309	26347
	11307	26345
	12318	26337
	12327	25330
	12334	22338
	12340	22341
23	10321	26305
	10309	26286
	10306	26280
	11303	26287
	11311	26290
	12323	25284
	12334	25279
26	10311	20286
	10309	22286
	10300	20280
	10297	22283
	11293	20294
	11293	22298
	12304	20299
	12309	22298
	12320	20289
27	10295	26403
	11291	26396
	11292	26387
29	10293	25375
	10286	25348
	11284	22362
	11283	22362
	11283	20357
	11284	22356
	12288	20357
	12291	22356
	12295	20358
	12303	22350
	12307	20359
30	11279	26290
	11281	26289
	12287	26303
	12295	26300
31	11276	26317
	11276	26300
	11277	26308
FEBRUARY 2007		
01	9351	26352
	9320	26343
	10301	26344
	10291	26351
	11273	26330
	11274	26334
01	12281	26325
	12295	26325
	13320	26334
	13364	26323
02	9356	26286
	10271	26297
	11270	26295
	11270	26285
	12277	26288
	12289	26287
	13315	26292
	13353	26291
03	9335	26395
	9300	26387
	10280	26385
	11266	26386
	11266	26390
04	9345	20324
	9332	20316
	9299	22314
	11264	05310
05	9348	25312
	9336	25315
	9319	25316
	9306	22324
	9302	22324
	11260	05339
	11261	02348
	13316	22337
	13341	22341
	13358	25342
06	9340	26366
	9316	26366
	9268	26372
	9288	26358
	11256	26377
	13306	25366
07	11253	05374
	12369	05366
	12287	24350
	13300	22354
	13316	22353
	13334	22351
	13352	22348
08	13304	26345
	13316	25336
	13336	26328
09	9326	26334
	9321	26336
	10265	26344
	10261	06361
	10258	06361

YY	GGμμμ	λSΩΩΩ
09	11249	06358
	11251	06359
	12264	06364
	12272	06363
	13287	26354
	13315	26351
	13346	26360
10	11244	05337
	11244	05331
	11247	05340
	12261	05339
	13296	25321
	13315	25322
	13342	25324
11	9312	26432
	9298	25393
	9281	26410
	10264	25426
	10258	05446
	10244	05448
	11241	05443
	11241	05443
12	9290	25478
	10248	05494
	10241	05499
	11239	05489
	12256	05470
	12265	05479
	13303	25468
	13331	25460
13	12240	07395
	12257	07403
	13283	26384
14	9297	25427
	9276	26418
	10239	06432
	10235	06435
	11232	06431
	11232	06432
	12245	06448
	12250	06449
	13301	26438
15	10238	06403
	10235	06398
	11229	06403
	12244	06407
	12252	06407
	13267	26393
	13282	26396
	13299	26404
16	13259	26408
	13262	06428
16	13282	26396
17	9281	00444
	9261	00445
	9259	02444
	10241	00447
	10236	02440
	10233	02438
	10227	00443
	11224	02437
18	11221	02368
	11221	02369
	12333	02366
	12241	02367
	13264	02371
	13269	22361
	13274	22368
	13278	22363
19	11219	06385
	13269	26389
	13294	26372
20	9271	26380
	9250	06380
	10233	06375
	10225	06377
	10221	06376
	10218	06374
	11216	06375
	12226	06373
	12237	06372
	13255	06374
	13280	26360
21	8288	25312
	9267	22324
	9260	02329
	10223	02323
	10219	02323
	10216	04317
	11214	05315
	12220	05319
	12239	05320
23	8284	00278
	8275	00278
	9257	02281
	10224	00280
	10220	02286
	10214	00284
	11209	00284
	11209	00285
	12215	00285
	12217	02291
	12225	02291
	13236	02292
24	11206	05311
	11209	05313
	12211	05314
	12223	05320
	13247	05322
	13267	25289
25	11205	05320
	11207	05318
	12210	05319
	13243	05320
	13263	05311
	13270	05312
26	8295	26288
	8282	26273
27	10208	06340

MARCH 2007

YY	GGμμμ	λSΩΩΩ
01	9247	05384
	9237	06395
	9226	04381
	9214	05379
	10198	02374
	11196	04369
	11195	06377
	13220	06379
	13230	06375
02	8269	00396
	8262	04393
	9234	02394
	9230	00405
	9215	02400
	10205	02400
	11193	06419
	13245	06408
03	8259	06418
	10203	06413
	10196	06410
	10192	06408
	11191	06416
	11191	06412
04	8261	06439
	8244	06434
	10200	06429
	10199	06428
	11189	06420
	11189	06419
05	9225	02364
	9217	02366
	9209	00373
	10191	03361
	11187	03363
05	11187	03359
	12195	04360
	12204	04362
	13247	05370
	14259	05368
06	8261	04379
	8239	05380
	9211	06384
	9204	06384
	10187	02374
	11185	02373
	12203	06368
	13215	06366
	13244	06366
07	8279	00350
	8256	02346
	8240	00351
	8232	02347
	9222	02347
	10194	02352
	10187	02354
	10184	03353
	11183	02359
	11184	02358
	12204	00358
	13207	02351
	13219	00356
	13246	00360
	14262	02356
	14270	00356
08	9208	03357
	9205	05362
	12185	06347
	12195	05341
	12197	03338
	13203	03336
	13239	05346
	14261	05347
09	8264	06360
	8245	06357
	9219	06352
	9203	06352
	10180	06359
	11179	06355
	12186	06365
	12189	06368
	12197	06370
	13235	06381
	14255	06387
10	11178	02352
	11178	02350
	11179	00353

YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ
10	11180	00354	14	8258	02363	22	8201	06478	28	8193	00360
	12193	05355		9185	04368		9189	05481		9178	02360
	12198	06360		10179	02375		9176	05485		9174	00361
	13202	06361		10175	00378		11159	05485		9164	00363
	13216	06353		10173	02390		11159	02488		10155	00366
	14242	06368		10171	00395		13201	06493		12165	00369
11	8250	05357		11171	02395		14212	06488		13194	00365
	8234	03355		11171	00402	24	11158	02382		14200	00367
	8226	02359		12178	00406		12160	00394	29	7260	00371
	9214	02359		12184	00407		12162	02384		7231	00371
	9206	02355		13196	00407		12168	02380		8195	00375
	9197	00353		13220	00403		13189	00387		8178	00378
	9195	02349		14241	00399		13199	02377		8162	00376
	10186	04345		14262	00393		14215	02374		10154	00382
	10177	06355	15	8260	05356		14258	02371		11150	00386
	11176	06354		8229	06355	25	12160	02355		13176	00396
12	8259	02319		8212	05351		12162	00362		13189	00398
	8246	02316		9201	02353		12168	02360		14239	00392
	8218	00312		9181	02347		12169	00361		15260	00391
	9208	02311		10170	06348		14206	00368	30	7252	00406
	9196	00314		11169	06348		14212	02364		7222	00407
	9193	02308		13193	06349		14237	00369		8200	00409
	10179	00313		13203	06347		14259	00367		9174	00418
	11174	00317		14232	06357	26	7257	00387		9160	00426
	12179	02312		14264	06357		7230	00389		10154	00435
	12180	00315	16	7262	02331		8200	00395		11150	00445
	13199	02311		8255	00334		9169	00393		11186	00433
	13202	00316		9203	02331		9162	00393		14204	00431
	13213	02313		9197	00335		10156	00393		15260	00423
	13223	00315		9188	02335		11155	00394	31	7260	00393
	14234	00310		9183	00338		13187	02388		8203	00403
	14282	00314		10169	06344		13195	00390		9162	00413
	14319	00313		11168	06336		13197	02388		9156	00411
13	8253	02319	18	10172	06360		14221	00390		10150	00413
	8247	00322		10166	06368		14241	02386		10148	00419
	8228	00323	19	7261	06411		15266	00388			
	9201	00324		8239	06405	27	7249	00377		**APRIL 2007**	
	9190	02321		9196	06395		8204	00379			
	9186	00325		9189	06396		8189	00382	01	11147	02391
	10182	00326		11163	06398		9166	00385		11147	02390
	10174	00325		11163	06404		10160	02378		12153	02396
	10173	02322		13190	06396		11153	00382		12154	02396
	11172	00329		13194	06400		11153	00382	02	7263	04349
	12179	00330		13203	06397		12157	00392		7229	04347
	12187	00331	20	10162	07420		13174	00378		8206	05343
	13198	02340		11162	07419		13183	00379		8184	05346
	13206	00337		12165	07429		14203	00380		9156	03350
	14230	02328		12170	07436		14222	00380		10149	05346
	14238	00334		13207	07433	28	7243	00357		11146	03347
	14258	00334	21	7261	07422		7230	02356		13175	04342
	14293	00332		8238	07430		8211	00358		14200	04352
	15338	00330	22	8218	06487		8202	02357		15249	04348

YY	GGμμμ	λSΩΩΩ
02	15260	04346
03	7261	03351
	7240	03352
	8199	03354
	8192	04353
	9165	04347
	10149	04346
	10145	04343
	13186	06359
	15268	06365
04	8189	05392
	9156	02394
	9151	00394
	10147	02390
	10146	00392
	10144	02384
	13160	00384
	14203	00372
	14222	00369
	15259	00368
05	7207	03330
	8191	05326
	10145	03323
	14188	02324
	14192	02323
	14195	02323
	14200	02324
	15259	02328
06	7257	06340
	7232	06345
	7207	06352
	8168	06346
	9159	05348
	9151	06346
	10146	06349
	10143	06351
	10142	06368
	14201	06365
07	10141	04361
	11141	06356
09	8174	06362
	8164	06364
	9155	06360
	9148	06347
	10140	06356
11	7231	05310
	7206	05310
	8163	04303
	9156	05302
	10140	04300
	10138	05302
	11138	05301
11	13172	05307
	14181	06308
	14201	05310
	14216	06306
	15244	06311
	15281	06313
12	6247	00326
	7227	00328
	7193	00329
	8175	00332
	8165	00330
	9151	00329
	9144	00328
	10140	00327
	10137	00333
	12145	00337
	13151	00338
	13164	00338
	14197	00337
	15224	00334
	15264	00332
	15302	00332
13	6251	00337
	7222	00332
	7205	00334
	8168	00333
	8158	00335
	9150	00339
	10140	00341
	10138	00335
	11136	00333
	13174	00340
	14185	00339
	14209	00337
	15225	00336
	15261	00338
	15297	00337
14	6302	00322
	6260	00322
	7214	00323
	8155	00325
	9146	00327
	9142	00325
	10138	00328
15	11137	02352
	13153	02355
	14179	00356
	14196	00356
	15226	00355
	15253	00356
16	6263	03365
	7200	03367
16	8164	02367
	8156	02365
	9142	02365
	11134	02360
	13161	02361
	13169	02363
	14177	02362
	14195	00363
	15222	02359
	15232	02360
	15264	02358
17	6260	00354
	6247	00353
	8172	00358
	8158	00361
	9151	00364
	9145	00360
	10135	00366
	10133	00365
	11133	02361
	13152	00363
	14188	00362
	14204	00364
	15251	00359
18	6242	00371
	11132	05383
	13161	00400
	15215	00391
19	6258	00381
	7187	00382
	8171	00381
	10136	00371
	10132	00373
	10132	00371
20	6263	02389
	6232	02380
	7204	00392
	7198	02387
	7184	02386
	9144	02395
	9239	00402
	9136	02397
	10134	00395
	10133	02388
	14208	00384
	15235	02384
21	11133	00389
	13158	00403
	13162	00403
	14190	00401
	15234	00400
	15268	00399
22	6250	02387
	6226	00382
	7203	00384
	8150	00389
	8148	00386
	9135	00385
	10130	00384
	11130	00384
23	6223	05350
	7188	05349
	11129	06341
	12134	02355
	13157	02356
	14172	02356
	15240	02353
24	7169	06373
	9140	06372
	11128	06393
	11129	06396
	14183	06392
	15204	06396
	15237	06400
	15269	06408
25	6227	00363
	7204	00364
	7187	00362
	8147	00353
	9139	00352
	9136	00355
	11128	00358
	11128	00358
	12141	00359
	14198	04357
26	6248	00356
	7192	00351
	7878	00351
	8150	00364
	8145	00360
	10130	00355
	12130	02359
	14176	04357
	15202	06356
	15237	04363
27	6253	02344
	6215	02343
	8162	02339
	8155	00341
	8152	00341
	9134	00341
	11127	00339
	12133	00343
	14169	00343

YY	GGμμμ	λSΩΩΩ
27	15203	04341
	15253	00341
28	12134	02338
	13140	02341
	14181	05341
	15231	04344
	15253	02348
29	12133	02388
	12134	00392
	12135	00390
	14176	02387
	14190	00389
	15212	00389
	15235	00386
	15251	00384
30	6220	00365
	7195	00366
	8145	00374
	9137	00371
	15226	00378
	15256	00379
	16299	00378
	MAY	**2007**
01	11127	06391
	14164	00417
	14166	00418
	15196	00385
	15200	00386
	15260	00386
02	6243	00357
	6212	00362
	6202	00361
	7163	00365
	8154	00360
	9133	00360
	11124	00363
	13148	02353
	14192	02363
	15247	02358
03	11125	00357
	12129	00360
	14157	00354
	14176	00355
	15201	00352
	15227	00354
	15259	00354
	16303	00352
04	6247	00348
	6215	00350
	7190	00350
04	7164	00358
	8151	00357
	8139	00360
	9135	00361
	9129	00363
	10125	00367
	10123	00366
	12130	00363
	12133	00364
	12139	00368
	13148	00363
	15196	00363
	15214	00360
	15243	00364
	16263	00366
	16305	00364
05	12127	04359
	12130	04358
	13135	04359
	13144	04360
	13154	04359
	14168	04362
	14181	02369
	15198	04366
	15221	04366
	16258	04367
07	6254	06385
	6225	06382
	8144	06382
	9130	00386
	9128	00385
	9127	00385
	11122	02378
	14160	06385
	15207	06380
	16260	06383
08	6260	06389
	6236	06388
	6197	06385
	8144	06401
	11122	02409
	11122	02406
	13150	04410
	14155	04402
	15192	04406
	15205	04404
	16260	05393
09	6237	06400
	9134	06401
	10121	00405
	12127	00412
	12128	00411
09	14178	00407
	15201	00405
10	6249	02369
	7185	03369
	7170	03368
	7158	03364
	15237	06371
	16257	06379
11	6254	02343
	8146	06345
	10122	02353
	10121	02359
	15204	06369
12	5255	02365
	6213	04368
	7155	05350
	8148	05359
	8138	05365
	8134	05353
	10123	06367
	10121	06367
	10120	06366
13	11121	00349
	13139	00345
	13147	00343
	14165	00342
	15197	00341
	15231	02339
14	6249	02351
	6206	02352
	9131	00351
	9125	00351
	11119	00350
	14149	02354
	14156	00352
	16254	04347
15	5255	02333
	6210	02333
	6201	02332
	8143	02336
	9124	05338
	9123	00347
	11119	04333
	14153	06342
	15202	06350
	15235	06352
	16257	06357
16	11119	06406
	11120	06407
	13146	06411
	14151	06404
	15197	06398
16	16191	04389
	16258	02391
17	6241	02392
	6186	02397
	10120	00398
	11119	06397
	12124	00396
18	5260	00381
	6206	00385
	7178	00384
	7157	00384
	9128	00385
	10118	05396
	14147	05397
	15206	00402
	15213	02393
	16260	02397
19	11119	00374
	11119	00373
	12126	00379
	14151	00372
	15192	00368
	15201	02361
	16239	00366
	16259	02358
20	11118	00356
	11119	00358
	12124	00357
	13138	05343
	14160	06345
	15196	06345
	16259	06361
21	5258	02330
	6231	02330
	6222	02330
	6197	02327
	8140	02330
	8133	02330
	9126	02326
	9122	02327
	10118	02326
	11117	02329
	13133	04328
	14163	05328
	15208	05330
22	5265	04333
	6202	04331
	9129	04324
	10117	00332
	10117	00332
	11118	00328
	13135	00337

YY	GGμμμ	λSΩΩΩ
22	14170	00340
	15208	02334
	16228	02333
	16253	02333
23	5243	04325
	6204	04326
	6183	02326
	7150	02321
	8142	02319
	10118	00328
	10118	00326
	11117	00327
	13142	00328
	14152	02327
	14163	00325
	14170	02326
	15184	02327
	16244	02328
	16264	02328
24	5246	00312
	6199	02312
	7170	00311
	7157	00313
	7148	00316
	8136	00316
	9128	00311
	10119	00318
	10117	00313
	12121	00316
	13135	00319
	14169	00321
	15195	00324
	16229	00322
	16257	00323
	16312	00322
25	6213	00311
	7154	00314
	8145	00314
	8133	00314
	9127	00311
	10118	00317
	10116	00321
	14158	00324
	15208	00319
26	5254	00332
	6203	00332
	6192	02332
	7176	00338
	7148	00337
	8138	00336
	9127	00337
	10118	00329
26	10117	02331
27	12119	04335
	13131	04350
	14158	00344
	14164	00343
	15174	00344
	15179	02340
28	6227	00319
	6195	02319
	8132	02323
	9123	00325
	9120	00328
	10119	02324
	10118	02324
	10117	00324
	16218	02341
29	5269	00326
	6208	00326
	6191	00323
	7159	00322
	9128	02324
	10119	02324
	11117	00332
	12118	00330
	14149	00331
	14158	02325
	15191	00323
	15209	02325
	16230	02327
30	5261	06327
	5233	06329
	6207	06332
	7162	05326
	7151	05320
	9127	06325
	9120	06329
31	9122	06351
	10116	06346
	11115	06346
	13138	06352
	14145	06349
	14152	06344
	15187	06346
	15210	06349
	16232	06355
	16260	06358

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YY	GGμμμ	λSΩΩΩ
01	5259	06332
	5236	06339
	6222	06340
01	6185	06332
	7164	06323
	7157	06317
	9127	06319
	10116	05320
	10115	05321
	13138	06341
	16238	06349
	16260	06348
02	6180	06351
03	11116	06332
	12118	06341
	12121	06335
	14147	06350
	14158	06353
	15174	06356
	15203	06353
	16227	06356
	16255	06360
04	7167	06333
	11115	06327
	15195	06327
	15203	06326
	16231	05325
	16261	05327
05	5303	00331
	5255	00335
	6216	00338
	6198	04332
	7162	06340
	10116	06325
	13139	06327
	15205	00326
	16228	05328
	16245	00326
	16263	00324
06	5300	00314
	5251	00315
	6176	00314
	7158	00315
	8130	00315
	9121	00319
	10114	00324
	11115	02324
	14162	04320
	15171	00326
	15187	02333
	16216	02332
07	11115	02326
	11115	00330
	12122	02327
	15197	00324
07	15206	00324
08	5261	02318
	5249	00317
	6207	00316
	6177	00321
	7160	00318
	8141	00310
	8128	00315
	10116	00321
	10115	02322
	13132	00333
	15177	00331
	15203	00327
	16216	02328
	16229	00329
	16249	02329
	16262	00328
09	11114	00361
	11115	00365
	12122	00357
	12123	02356
	15200	06356
10	9123	05364
	9120	05367
	10114	04362
	11114	02369
	11115	02372
	11115	02371
11	6218	00330
	6182	00328
	7148	00329
	8136	00322
	9125	00320
	10116	00328
	11114	00334
	14146	00343
	14157	00341
	15197	00345
	16219	00341
	16247	00338
12	5262	00348
	5248	02341
	6201	00345
	6191	02344
	6186	00347
	7143	00342
	8138	02348
	8135	00348
	9118	00352
	11114	00358
	14139	00353
	15165	00353

YY	GGμμμ	λSΩΩΩ
12	15194	00353
	16220	00349
	16232	02350
	16263	00350
13	5248	00338
	6210	00342
	6182	00344
	7145	00342
	8132	02340
	9124	00340
	9119	00341
	11114	02346
	11114	00345
14	5266	02337
	5254	00336
	6205	00335
	6184	00336
	8135	00339
	8134	02337
	9123	00339
	9120	00340
	11114	00352
	14157	04353
	15185	04353
	15203	04353
15	5253	02336
	5247	00334
	6204	00337
	6177	00338
	8142	00346
	9125	00344
	9124	00348
	10114	00353
	16232	06347
	16248	06352
16	12121	06348
	13123	06327
	13127	05332
	13137	05338
	14142	06321
	15191	06347
	16212	06346
	16239	06346
17	12120	00361
	13123	00361
	14154	00366
	14158	00366
	15202	00360
	16239	00354
	16246	00358
18	6192	05342
	8131	00345
18	10115	05341
	11114	06344
	15163	06348
19	5234	00345
	6203	00347
	6192	02344
	7159	05349
	10115	00364
	11114	00364
	13131	00368
	13132	00369
	15185	00365
	15199	00364
	15203	02359
	15220	00360
	16265	02356
20	5265	00347
	6222	00350
	6197	00350
	7170	00355
	7162	02348
	9122	00340
	9118	00334
	10116	02337
	11114	00337
	11114	00340
	15165	02337
	15201	00341
	16242	00337
	16264	00337
21	5262	02323
	6199	02321
	8129	04327
	9124	04330
	9121	02333
	10114	00336
	13132	00338
	14137	00337
	15187	04325
	16259	06321
22	10117	06347
	10114	06335
	11114	06337
	11114	06330
	15170	06334
	15178	06338
	15188	06330
	16222	06335
	16256	06340
23	6197	02331
	7157	00338
	7150	05348
23	10115	00346
	10115	02348
	10114	00348
24	5257	02359
	5235	00352
	8143	06351
	10117	05349
	11116	00351
	10114	00350
25	6226	02335
	6206	02332
	6202	00330
	6193	00329
	7146	00335
	8141	00334
	9119	00336
	10116	00339
	14147	02328
	15169	00327
	15189	00326
	16232	02325
	16266	00323
26	5268	04327
	6205	05331
	6191	05324
	11114	06338
	11115	06335
	14156	02369
	15191	02365
	16216	02363
	16265	02359
27	7155	00345
	8139	00346
	9118	02353
	11114	00339
	14157	06342
	15201	06338
	16255	06353
28	5261	05348
	6222	05352
	6203	06349
	7145	03356
	8133	03356
	10114	05360
	14146	02341
	15168	04344
	15180	02348
	16230	02348
	16242	02351
29	8141	04343
	8127	00331
	9126	00330
29	11114	00351
	10115	00353
	14158	02355
	15176	02353
	15203	00357
	16223	00356
	16265	02354
30	5263	05352
	6202	05347
	7172	03353
	7156	02355
	7150	00352
	8141	00346
	9125	02344
	10116	03342
	10114	04343

JULY 2007

YY	GGμμμ	λSΩΩΩ
01	5231	00337
	6199	02338
	6186	00342
	8142	00341
	8137	02336
	8129	02338
	9120	02341
	10115	05336
	11114	05337
02	5240	00330
	6200	02328
	6181	00331
	7169	02329
	8140	02332
	8135	00336
	8129	02331
	9121	02330
	10116	02331
	10114	02329
	11114	02330
	15195	04333
	16213	04327
	16259	05327
03	5262	06358
	6226	06360
	9118	06346
	11114	00354
	12117	04347
	16208	05350
	16261	05350
04	5264	05353
	6204	06354

YY	GGμμμ	λSΩΩΩ
04	13135	06364
	14140	06368
05	5268	05368
	6202	06364
	8136	06370
	14148	05355
	15164	06358
06	16252	06362
	16265	06360
07	11115	06349
	14141	06364
	14142	06356
	15189	06376
	15197	06372
	15200	06373
	16254	06365
	16261	06370
08	11116	05325
	12119	05328
	13124	04330
	14156	06321
	15168	00331
	15170	02327
	16207	00326
09	5263	00298
	6226	00298
	6205	00297
	8246	00302
	9124	00303
	11115	00305
	11115	00309
	14156	06308
10	5250	06327
	6221	07332
	6298	06333
	14161	06340
	15182	06339
	16221	06344
	16235	05328
	16260	05321
11	6207	06371
	7171	06369
	9121	06357
	10116	06372
	10115	06363
	11115	06361
	15164	06361
	15197	02372
	16211	02373
	16237	00371
	16260	02369
12	5264	02350
12	7175	00355
	7167	02352
	7163	00352
	8131	00347
	10115	06357
	11115	06354
	15195	06360
	16211	06359
	16239	06360
	16263	04357
13	5262	06355
	6218	04344
	6205	05350
	7166	04346
	9128	06342
	9123	04331
	10118	06336
	10116	05334
	11115	05346
	15184	06345
	15194	06346
	16211	06355
14	5258	05309
	6205	04314
	7161	04311
	8146	06303
	8136	04302
	9127	04297
	10119	04297
	10117	06315
	11116	05319
15	12118	00319
	14164	00318
	15201	00319
	16231	02318
	16237	00318
	16256	00315
	16264	02318
16	5270	00309
	6228	00317
	6205	00314
	7181	00317
	7162	00306
	8140	00306
	8132	00302
	9122	00298
	10118	00304
	10116	00303
	14145	00306
	14148	02303
	14151	00299
	14160	00308
16	15200	02300
	16218	00286
	16224	02299
	16245	02302
	16262	02299
17	5275	00292
	6199	02291
	6193	00295
	7155	02292
	8145	00288
	8138	00293
	9129	00290
	10119	00290
	11116	00289
	12119	00291
	15169	00300
	15186	00300
	15197	02300
	15203	00302
	16246	00299
18	5259	02289
	5254	00290
	6200	00291
	6193	02293
	8147	02295
	14150	06294
	15168	06297
	15177	06300
	16236	06288
19	5269	05290
	6220	05295
	6185	02288
	7152	00292
	8140	00291
	8133	00287
	9121	02286
	10119	02286
	10118	00289
	11116	02291
	12123	04290
	14166	00299
	15205	02293
	16228	02296
	16255	00294
	16259	02292
20	6247	00283
	6211	00285
	8146	04284
	8137	02289
	8135	00287
	10118	00289
	11117	00292
20	14142	00294
	15187	00294
	15193	02293
	15206	00295
	16228	00294
21	10120	06307
	10117	06306
	11117	06302
	11117	06300
	11118	06300
22	11118	02313
	15203	02331
	16251	02332
	16261	02329
23	6223	00324
	7171	02321
	8145	04321
	10121	04324
	11118	05323
	12122	00336
	13133	00337
	14145	00331
	15183	04320
	15205	04320
	16267	04320
24	7156	05329
	9129	05328
	11118	06334
	14144	06343
	15171	04346
	15176	02346
	15201	00345
	15213	02340
	16259	00342
25	6241	06334
	8140	06363
	15212	06362
	15219	06368
	16237	06370
	16262	06367
26	6227	02317
	6213	00318
	7173	00320
	8136	02321
	11118	00315
	11119	02315
	14166	02311
	15180	00308
	15184	02310
	15214	02308
	16225	00307
	16232	02313

YY	GGμμμ	λSΩΩΩ
26	16269	02313
27	6203	02317
	7189	02318
	8154	05315
	9127	05326
	11119	05329
	13136	00334
	15222	06341
28	12121	05315
	12127	05317
	14162	06324
	15175	06329
29	11120	02325
	12124	02329
	15195	02330
	15200	02327
	16270	06328
30	8153	06374
	11120	06364
	13142	06378
	14154	02379
	14164	02376
	15183	02377
	15221	02365
	16263	02366
31	6220	06365
	7172	06362
	9133	06355
	12126	00362
	12127	02359
	15197	06356

AUGUST 2007

YY	GGμμμ	λSΩΩΩ
01	6201	02348
	7189	02349
	7160	00344
	8140	05344
	9132	06344
	10124	00349
	10120	00348
	11120	02344
	11120	00339
	11121	00341
	14163	02337
	15200	02332
	16241	02332
	16282	02334
02	6227	00306
	7182	00307
	8157	00309
	8144	00312
02	9135	00312
	9131	00310
	10124	00315
	11121	00317
	13146	00323
	14157	00323
	15192	02317
	15204	02317
03	5258	06328
	6233	06325
	6214	06323
	7191	06322
	7180	06319
	10123	06339
	10121	06338
	14150	06337
	14152	06338
	15204	06338
	16269	06338
04	6265	05344
	7197	05342
	8154	04342
	8140	05332
	10124	05331
	10122	06335
	10121	06337
05	11123	06314
	12126	06317
	12130	06322
	13139	06320
	14162	06318
	15184	06320
	15225	06325
	16269	06331
06	6264	05317
	6207	02325
	7191	02324
	8147	06314
	9138	05313
	10122	06311
	11122	05310
	15202	05315
	15232	02319
	16275	04316
07	6261	02313
	6222	00315
	7192	00321
	8145	00322
	9134	00325
	11122	00329
	11123	02330
	14161	00331
07	15221	00329
08	6239	03313
	7170	04317
	9136	02314
	10123	04317
	11123	00317
	14161	05319
	15203	06319
	15227	05314
	16261	06320
09	6226	06324
	6209	06319
	8149	06330
	11123	06337
	14176	04319
	15200	05319
	15242	02322
	16269	02323
10	15189	02313
	15207	05307
	16258	02304
	16264	02305
11	9141	06307
	9131	06306
	10128	06306
	10125	06305
	10125	06305
	11124	05298
12	6237	04301
	7208	04308
	7188	04307
	8165	05309
	8144	05301
	9133	04309
	10126	05303
	11125	06306
13	9132	06328
	10128	06331
	10126	06326
	11125	06320
	15200	06332
	15206	06332
	15235	06337
	16256	06330
14	7170	04316
	10126	04316
	11126	00323
	11126	02318
	11126	00317
	13143	00320
	13144	02324
	13149	00328
14	15233	02318
	16278	02319
15	11126	02307
	13146	06304
	14171	02312
	15205	06306
	15257	06305
16	6235	00285
	7201	00286
	7186	02282
	8168	00287
17	16334	26290
18	12135	02313
	13143	00313
	13152	02315
	14167	02317
	14176	02310
	15213	00308
	15227	02309
	16277	02310
19	12132	04307
	14169	05309
	14195	02304
	15200	00299
	15218	02302
	15269	02305
	16276	00302
20	7219	06315
	7205	06319
	12134	05301
	13156	04309
	14171	04306
	15201	04305
	15232	06303
	15264	05308
21	9146	02314
	11130	06317
	13152	02312
	14174	04316
	15205	00324
	15215	02318
	15228	00323
22	6255	00293
	7187	00290
	9145	00294
	9139	00291
	11130	00295
23	6253	00283
	7202	00282
	8151	00280
	9145	00280
	10131	04277

YY	GGμμμ	λSΩΩΩ
23	14189	05282
	15245	00282
	15264	00281
24	8162	06283
	9140	06287
	11132	02288
	11132	00287
	11132	00286
	13162	00305
	14188	00302
	14203	00299
	15245	00302
25	6263	02314
	6238	00303
	7202	00306
	8174	00313
	9149	00311
	10134	00319
	11132	00320
26	6248	06277
	7212	02284
	7204	02285
	8159	02284
	10136	06275
	11133	02282
27	6261	03298
	7208	04298
	8174	04300
	10136	02304
	11134	06306
	13158	02302
	14172	00300
	15276	02292
28	6264	05320
	8180	04316
	9142	02319
	10137	02318
	10137	00315
	10135	00314
	10134	00320
	12140	00315
	12143	00321
	13161	00317
	14203	00316
	15228	00316
	15282	02311
29	7203	02318
	8181	02316
	8165	02314
	12149	05315
	14196	05315
	14203	05313
30	7211	00320
	8177	00312
	8174	00311
	8166	00310
	11136	00305
	11138	00306
	15224	04311
	15255	02313
31	6260	06306
	10138	06291
	11137	06293
	11137	06297
	13163	06296
	14177	06314

SEPTEMBER 2007

YY	GGμμμ	λSΩΩΩ
01	12142	02313
	12144	00313
	14200	04315
	14203	00311
	14224	06314
	15236	06319
02	6265	06302
	7240	06302
	7206	06301
	9157	06298
	10139	02303
03	6265	04304
	6255	00303
	7210	02304
	7200	02303
	8166	02304
	9156	02308
	11139	06308
	13178	06314
	14186	06328
	15234	06326
	15265	06324
04	6269	06343
	9148	06333
	11140	05352
	11141	06349
	12146	05335
	13179	06339
	14204	06346
	14230	06341
	15264	06347
06	6270	06336
	6258	06334
	8182	05325
	8174	05325
06	10142	05319
	10142	05322
	13177	06325
	14191	06327
07	7232	06319
	9161	06307
	9152	05306
	10146	05311
	10144	05314
	11143	06311
	11143	06314
	14226	06317
	15259	06319
08	12148	02298
	13162	02299
	13181	02302
	14235	05305
	15300	02309
09	8182	06342
	8177	06349
	9161	06347
	9155	06332
	10147	06335
10	8194	06319
	9157	06309
	10151	06306
	11146	06315
	11147	06312
	14211	05316
11	11147	06340
	11148	06335
	14224	02342
	14245	02342
	15264	02342
12	11148	06307
	13179	02314
	13187	02311
	14210	02308
	14236	02302
	14255	02308
13	7206	05306
	8201	02306
	8198	00306
	9169	00309
	11149	05307
	11151	05307
	13171	00307
	14256	02305
	15267	02306
14	7253	00295
	8206	00306
	9164	02294
14	9160	00296
	9156	00294
	10152	00293
	11150	00293
	14205	04293
	14213	00301
	14235	00302
	14242	00290
	14257	02298
15	11154	06326
	12156	00334
	12159	00326
	14228	00325
	14248	00328
	14261	00327
16	7260	06280
	7217	06271
	8208	06274
	9171	06296
	10156	06272
	11154	06275
17	7250	00270
	8207	00269
	8177	00270
	9159	00264
	10155	00263
	10154	02266
	11155	00276
	12166	00272
	13191	00274
	14216	00277
	14241	00276
18	8211	02289
	8199	00291
	8187	00289
	9169	00289
	11159	02287
	11155	02285
	12176	00284
	13187	02284
19	8211	02297
	8194	02301
	10161	05300
	11156	00300
	13196	05301
	14216	05302
20	7277	00296
	7249	00291
	8191	00291
	9172	00294
	11157	00294
	12172	00298

YY	GGμμμ	λSΩΩΩ
20	13193	00294
	14230	04283
21	7304	00279
	7229	00280
	8193	00280
	9171	00278
	10159	02278
	11159	02278
	12177	02281
	13202	04280
	14226	03284
	14250	02289
22	7248	02288
	8197	02289
	9178	00287
	9176	02282
	11160	02285
	11162	00291
	11164	00288
23	7258	02275
	9180	02279
	9176	02277
24	7247	00280
	8207	00277
	8189	00280
	9174	00276
	10165	00277
	10162	00284
	11163	02281
	12174	00287
	12182	00282
	13199	00282
	13219	00285
	14235	00285
	14297	00282
25	7237	00292
	8210	00288
	9188	00292
	9175	00293
	11164	02291
	11164	00292
	11660	00292
	13197	00292
	13220	00288
	14254	00287
26	7241	06288
	8215	06288
	8198	06288
	9185	06290
	9177	06288
	11166	06294
	11169	06294
26	13200	06292
	13212	06297
27	8232	06287
	8203	06283
	9180	05286
	10172	04284
	11167	02283
	12177	02283
	13204	02287
	13213	02286
28	8199	06286
	9174	06282
	10170	06281
	10168	06282
	11169	06281
	12195	05282
	13204	05284
29	11170	06303
	11176	00306
	11183	00311
	13200	00309
	13220	00307
	13241	02301
30	7159	06291
	7244	06295
	8209	06292
	9182	05297
	10171	05298

OCTOBER 2007

YY	GGμμμ	λSΩΩΩ
01	7266	00283
	8231	02278
	8210	00288
	9184	00287
	11173	02287
	11174	00288
	12180	00289
	13221	03280
02	7260	06284
	8239	06279
	8205	06278
	9200	06275
	11175	06283
	11177	06280
03	7254	02310
	8228	05312
	9203	05308
	9182	02315
	10181	02314
	10176	02313
	11177	02311
03	11177	00306
	13231	02304
04	7275	02265
	7258	00266
	8213	06268
	10178	05269
	12196	06272
	13222	06277
05	8247	05293
	9208	05293
	10181	04300
	10180	00303
	12209	06310
06	8249	06306
	8214	06306
	9201	06303
	9190	06299
	10183	02302
07	11188	05287
	12196	06292
	13222	02954
08	8262	07264
	10185	06273
	11187	06265
	12207	05267
	12218	02271
	13235	05270
	13268	06276
09	8253	02265
	9210	02265
	10192	02270
	10188	00273
	11188	00274
	12199	00274
	12209	00273
	13234	06276
10	8235	00271
	9216	00269
	9205	00269
	10193	00269
	12208	02266
	12222	02268
	13232	02271
	13238	00266
11	11193	02263
	12202	00262
	12219	02260
	13240	02258
	13260	02258
12	8256	06307
	8241	06309
13	8261	02290
13	8255	02293
	9212	06294
	9210	06296
	9207	06293
	10195	06296
14	8262	00266
	9225	00267
	9213	00267
	10203	02263
15	8251	02266
	9226	02269
	10205	02274
	11200	02268
	11201	00263
	11202	00268
	12211	00266
	12222	00264
	12243	00264
	13256	00266
16	8268	02261
	9212	00258
	11203	02259
	11204	00263
	11209	00274
	12218	00273
	12236	00269
17	8246	02274
	9221	00276
	9218	02275
	10211	00273
	10206	00276
	11206	02279
	12240	00281
	13261	00276
18	10207	06301
	11217	06298
	13269	02297
	16283	00299
20	8262	06322
	9242	06321
	9221	05313
	10213	05317
	10211	04315
21	11214	00310
	11216	00308
	11223	00306
	13273	00305
22	8264	06291
	9248	06280
	9224	06286
	10218	06290
	10216	06293

YY	GGμμμ	λSΩΩΩ
22	11218	06292
	11225	06291
	12230	06289
	13291	06294
23	8260	06286
	9244	06291
	11220	06282
	11223	06288
	12250	06283
	12261	02928
24	9260	02271
	9240	02271
	9232	04270
	10223	02274
	10221	02270
	11222	02274
	11227	00275
25	9256	06284
	9242	06288
	10225	06288
	10224	06293
	11228	06291
	11234	06296
	12243	06300
	12259	06294
26	9262	06296
	9247	06293
	9236	02298
	10129	06298
	11235	06300
27	9263	05270
	9248	05274
	10237	05274
	10252	05269
	10230	05268
	10229	05268
28	11235	05283
	11240	05282
	11247	05278
	12251	05280
	12256	05280
	12259	05279
29	9259	05262
	9247	05261
	10241	02263
	10239	02263
	10236	06263
	10235	06266
	12253	06268
30	9253	06260
	10240	06261
	10238	06260
30	10244	06263
	11248	06265
	12264	06264
31	10242	02276
	10241	00278
	10241	00278
	11245	00278

NOVEMBER 2007

YY	GGμμμ	λSΩΩΩ
01	10244	06254
	10244	06254
02	10249	02263
	10247	02265
	11247	02264
	11248	00260
	11261	00265
	12281	00267
03	11251	05254
	11253	05250
	12269	26253
04	9284	26286
	10261	06284
	10255	06297
05	9303	26289
	11264	06289
	12316	26279
06	10259	06307
	11266	06305
	12281	26292
07	11264	06300
10	9295	26317
	10276	26313
	10272	26313
11	9311	26283
	9294	25292
	10276	26298
	11277	25298
12	9321	26327
	9305	26309
	10290	26315
	10280	26324
	12279	26324
	12310	26331
	12357	26319
13	9319	26324
	9295	26328
	10289	26318
	11283	26313
14	9335	26331
	9299	25341
	10296	25337
14	11303	26313
	12309	26305
	12318	26312
	12330	26318
	12345	26319
	12362	26320
15	10296	26320
	11290	22312
	11294	22314
	11302	20311
	11308	22309
	12312	20310
	12338	20307
	12343	22310
	12357	22307
	12366	20308
16	9356	20311
	9341	20312
	9325	20320
	10301	20322
	11302	22318
	12338	26317
17	10296	26283
	11297	26279
	11299	26277
	11303	26276
18	9350	26246
	10310	26251
	10299	26247
19	9350	26250
	9324	26246
	10310	26255
	10303	26250
	11304	26253
	12327	26254
	12357	26250
	12387	26252
20	11313	25259
	11317	25242
	12357	26247
21	11317	25272
	11333	22272
	12346	22275
	12358	22270
	12401	22267
22	9350	20262
	9333	22260
	10322	22261
	10315	22261
	10313	20258
	11314	22259
	12339	22262
22	12351	20267
	12363	22265
	12370	20270
	12398	22260
23	9382	22258
	9362	22257
	9333	22257
	10324	22256
	10319	20260
	10316	22258
	11317	22263
	11340	22263
	12355	22269
	12368	22266
	12384	22259
25	11324	26264
	11334	26255
	12361	26252
	12416	26270
26	12431	26336
	13465	26333
28	9401	20233
	9369	20225
	9358	20222
	11333	20222
	11349	22219
	12359	22219
29	10344	20230
	10336	20243
	11336	22246
	12366	20249
	12387	20249
	12413	20246
30	12433	26302
	13460	26297

DECEMBER 2007

YY	GGμμμ	λSΩΩΩ
01	11342	26209
	11350	26204
	11361	24201
	12371	25198
02	9370	25279
	10356	22284
	10344	22288
04	10368	26324
	10361	26317
	11353	26313
05	10357	26250
	10352	26242
	11353	26238
	11362	26248

YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ	YY	GGμμμ	λSΩΩΩ
05	11373	26246	13	11369	20298	21	10378	26203	27	10377	22326
	12282	26248		11374	22295		11376	26308		11373	22334
06	10355	25252		11378	20304		11379	26205	28	10383	26264
	11355	25252	15	10389	26301	22	11377	22231		10373	25263
07	10379	26267		10377	26294		11388	22223		11373	25266
	10366	26262		11372	26300		11395	22216		11377	25265
	10359	26261		11373	26301		12402	22219		11383	25258
	11357	26261	16	10378	26276	23	10384	22276	29	10378	22275
	11374	26266		10375	26275		10380	22270		11371	22277
	12289	26284		10374	26275		10377	22271		11371	20278
08	10360	25279		11372	26274		11375	22271		11376	22278
	11361	25284	17	10381	26242	24	10382	26289		11381	20285
	11368	25283		10375	26238		10377	26285	30	10385	26281
	11378	25284		11373	26237		11376	26288		10377	26283
09	11363	26314		11384	26237	25	10376	26282		10371	26293
	11365	26308	18	10383	26245		11375	26272		11371	26295
	11375	26301		10374	26243		11375	26276		11384	26297
	11384	26308		11384	26241		11377	26275	31	10397	26303
10	10380	26302	19	11379	26268	26	10379	26263		10376	25296
	10374	26295		11383	26263		10374	25263		11368	26299
13	10385	20290	20	10377	26260		11374	25256		11371	26303
	10372	20293		11375	26262		11376	25264		11378	26312
	10370	20300		11388	26263	27	10381	22328			

PUBLS. INST. GEOPHYS. POL. ACAD. SC., D-72 (403), 2008

Total Ozone, Sulfur Dioxide and UV-B Radiation Measurements with the Brewer Spectrophotometer No. 64 at Belsk, Poland 2006-2007

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The Brewer spectrophotometer No. 64 has been installed in the Geophysical Observatory of the Polish Academy of Sciences at Belsk in February 1991.

The Brewer spectrophotometer is an optical instrument which measures atmospheric ozone and sulfur dioxide by examining intensities of the attenuated incident solar ultraviolet radiation at five specific wavelengths. The automatic, computer-controlled operation of the instrument allows different types of measurements and calibrations to be made according to an adjustable schedule. The instrument is capable of taking direct sun, zenith sky, UV-B and Umkehr measurements in unattended operation for several days.

Contrary to the total ozone measurements taken with the Dobson instrument, in the case of Brewer spectrophotometer the effect of interfering absorption by SO_2 is accounted for. The daily means of ozone and SO_2 are computed only from observations with standard deviation less than 2.5 D.

Small negative SO_2 amounts may occur in the data. These values reflect the SO_2 measurement uncertainty to which the main contributions are from small errors in the ozone coefficients and wavelength settings. The SO_2 amounts from observations with slant paths greater than three are unreliable.

The Brewer instrument No. 64 contains also the UV-B monitor which enables it to measure spectral irradiance in the region between 290 and 325 nm by monitoring the photon count rate at wavelengths every 0.5 nm. The irradiance at each wavelength is integrated to produce a damaging ultraviolet radiation value (DU) using Diffey erythemal weighting curve instead of the ACGIH-NIOSH erythemal weighting curve used before.

In May 2006 the instrument was calibrated at Lindenberg, Germany, against the transfer standard instrument (Brewer No. 17) by Mr Ken Lamb from International Ozone Services Inc., Canada.

In May 2007 the instrument was calibrated in Hradec Kralowe, Czech Republik, against the transfer standard instrument (Brewer No. 17) by Mr Ken Lamb from International Ozone Services Inc., Canada.

Accepted December 22, 2008

Observations are entered in the column in accordance with the codes explained below:

Day – number of day of the month,

Ozone – total amount of ozone in D (Dobson Units) (zs means zenith sky, ds means direct sun observations),

Dev – standard deviation of ozone measurements,

μ – harmonic mean of the relative slant paths at 22 km for each of the observations used to compute the daily value,

N – number of direct sun or zenith sky observations,

SO_2 – total amount of SO_2 (in milli-atmo-centimeters),

Dev – standard deviation of SO_2 measurements,

UV – daily integral of UV radiation (in J/m^2),

NN – number of damaging UV measurements.

BREWER OBSERVATIONS **JANUARY 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	321.0	ZS	0.9	3.75	2	–	77	9
2	312.4	ZS	1.8	3.66	2	–	85	11
3	363.8	ZS	5.8	3.87	3	–	68	10
4	–	–	–	–	–	–	50	11
5	344.9	ZS	1.6	3.63	4	–	84	10
6	316.2	ZS	5.0	3.73	5	–	79	10
7	308.1	DS	2.7	3.69	15	–0.5	208	10
8	271.3	DS	0.9	3.69	16	0.1	238	10
9	308.4	DS	1.0	3.64	32	–0.5	219	22
10	300.0	DS	0.5	3.77	4	–1.0	77	3
11	279.7	ZS	2.6	3.60	4	–	167	10
12	286.6	ZS	2.6	3.45	3	–	86	11
13	310.1	ZS	1.4	3.73	2	–	86	11
14	292.9	ZS	2.1	3.55	4	–	121	11
15	273.0	ZS	1.7	3.43	5	–	167	11
16	284.5	DS	1.3	3.38	28	0.5	232	23
17	296.6	ZS	5.5	3.35	4	–	126	11
18	–	–	–	–	–	–	101	11
19	341.3	ZS	12.5	3.34	8	–	192	11
20	276.0	DS	8.0	3.37	3	–0.1	262	11
21	–		–	–	–	–	68	11
22	325.7	DS	2.9	3.66	2	–0.6	264	11
23	310.2	DS	4.9	3.32	49	0.4	288	15
24	300.1	DS	1.7	3.20	38	0.1	321	13
25	287.6	DS	1.7	3.13	16	1.1	289	12
26	320.6	DS	2.1	3.20	24	1.6	267	12
27	346.2	DS	1.2	3.17	51	1.3	273	15
28	330.5	DS	4.2	3.11	16	0.1	270	13
29	369.8	ZS	6.9	3.11	14	–	175	14
30	328.9	ZS	4.5	2.95	13	–	206	13
31	336.4	ZS	1.9	3.05	13	–	155	13
	312.2		**3.2**	**3.45**	**14**	**0.2**	**171**	**12**

BREWER OBSERVATIONS **FEBRUARY 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	363.9	ZS	4.6	2.94	16	–	158	13
2	370.1	ZS	1.7	2.77	10	–	120	9
3	364.6	ZS	6.2	2.98	7	–	159	13
4	377.8	DS	1.3	3.64	3	–3.3	208	13
5	399.4	DS	4.0	2.91	24	–0.8	331	13
6	421.9	DS	0.8	2.90	6	–1.4	304	14
7	425.1	ZS	4.1	2.66	10	–	154	14
8	387.7	ZS	2.1	2.61	9	–	161	14
9	412.4	ZS	2.4	2.64	17	–	280	13
10	416.0	ZS	6.2	2.76	16	–	234	14
11	420.6	DS	2.0	2.47	7	1.2	336	14
12	455.7	ZS	2.1	2.58	9	–	201	14
13	430.0	ZS	3.8	2.49	11	–	–	
14	425.3	ZS	4.7	2.54	21	–	287	14
15	391.7	DS	0	2.30	1	0.2	317	15
16	388.7	ZS	4.0	2.48	14	–	164	15
17	366.3	DS	0	2.72	1	0.3	290	15
18	370.5	DS	1.6	2.51	27	0.3	535	15
19	371.5	DS	0	2.73	1	1.5	307	15
20	339.1	DS	4.1	2.44	20	1.5	563	15
21	380.6	ZS	10.1	2.34	17	–	236	15
22	406.9	ZS	1.2	2.39	9	–	160	16
23	363.9	DS	1.3	2.79	13	0.2	579	16
24	414.9	DS	4.1	2.16	19	0.3	597	16
25	350.9	DS	3.0	2.43	57	0.2	805	19
26	376.2	ZS	7.5	2.32	28	–	485	16
27	422.6	DS	6.3	2.28	56	–0.4	714	17
28	422.6	DS	4.8	2.40	49	0.3	651	16
	394.2		**3.4**	**2.61**	**17**	**0.0**	**346**	**15**

BREWER OBSERVATIONS **MARCH 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	438.6	DS	5.5	2.26	34	0.3	642	16
2	464.1	DS	3.5	2.29	23	–1.3	600	16
3	458.0	DS	2.6	2.25	79	–0.1	683	23
4	460.1	DS	3.1	2.52	11	–1.2	476	17
5	432.5	DS	2.8	2.10	23	0.8	682	17
6	448.7	DS	2.5	2.27	7	–2.5	572	17
7	419.5	DS	6.3	2.15	78	1.1	833	21
8	443.4	DS	6.5	2.23	69	–0.4	803	21
9	413.5	DS	22.3	2.13	49	0.3	853	18
10	414.0	ZS	6.2	2.13	35	–	570	17
11	455.1	DS	2.4	2.09	12	0.5	598	17
12	429.8	DS	2.7	2.11	40	–0.3	955	17
13	410.8	DS	3.7	2.13	47	0.7	944	17
14	399.2	DS	1.1	1.96	3	1.5	660	18
15	413.4	DS	1.5	1.77	33	1.0	977	19
16	410.1	ZS	1.9	2.20	14	–	372	17
17	401.7	ZS	2.1	1.92	31	–	534	17
18	391.1	ZS	8.1	1.94	26	–	519	17
19	346.9	DS	4.1	2.17	5	0.8	869	17
20	280.3	DS	2.2	2.28	18	0.4	1640	18
21	328.2	DS	5.6	2.07	3	0.5	1026	20
22	317.6	DS	4.2	1.87	2	1.8	1003	20
23	366.3	DS	5.3	1.88	61	0.8	1525	25
24	345.1	DS	6.8	1.86	92	0.8	1694	21
25	329.0	DS	5.2	1.87	38	1.3	1408	21
26	353.7	ZS	4.8	1.74	20	–	512	21
27	325.4	DS	0.9	1.60	7	0	1310	21
28	352.4	DS	4.0	1.80	48	0.4	1213	24
29	395.4	ZS	3.2	1.76	28	–	573	22
30	382.4	DS	5.9	2.24	17	–0.1	1029	23
31	387.0	DS	0	2.54	1	–0.6	650	23
	394.0		**4.4**	**2.07**	**31**	**0.3**	**862**	**19**

BREWER OBSERVATIONS **APRIL 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	389.0	DS	2.8	1.52	5	1.7	792	22
2	388.1	DS	7.4	1.94	13	0	1197	22
3	399.9	DS	8.3	2.12	16	–0.5	1105	23
4	414.9	ZS	8.6	1.63	23	–	755	22
5	395.8	DS	14.4	1.67	19	–0.2	1006	23
6	414.9	DS	10.5	2.11	17	–0.1	1183	22
7	391.9	DS	2.0	1.81	63	0.3	1483	21
8	414.9	DS	8.8	1.80	52	0.7	1391	23
9	391.2	DS	1.7	1.65	27	1.2	1128	23
10	401.9	ZS	11.6	1.55	9	–	358	22
11	480.8	ZS	6.1	1.55	17	–	581	23
12	397.9	DS	6.6	1.65	12	1.1	1333	22
13	389.5	DS	3.0	1.57	12	1.7	1121	23
14	428.5	DS	3.8	1.93	9	0.5	1070	24
15	398.5	DS	9.4	2.53	7	–0.6	1028	25
16	349.9	DS	2.4	1.60	10	1.3	1157	24
17	402.5	DS	5.0	1.54	7	0.9	1211	24
18	368.4	DS	3.6	1.45	11	0.9	1370	25
19	357.1	DS	2.3	1.71	48	0.6	1930	24
20	371.1	DS	8.0	1.73	28	1.0	1812	25
21	371.2	DS	3.6	1.69	65	0.2	2182	23
22	396.4	DS	8.0	1.61	32	1.3	1491	24
23	402.0	DS	2.6	1.68	48	1.3	1754	24
24	403.9	DS	5.0	1.49	16	1.0	1355	24
25	402.1	DS	7.0	1.53	50	0.8	1896	23
26	379.0	DS	2.6	1.59	76	0.5	2219	27
27	374.0	DS	1.7	1.62	95	0.6	2454	27
28	380.9	DS	3.1	1.64	52	1.6	1830	23
29	376.4	ZS	6.4	1.60	24	–	758	25
30	354.8	DS	2.4	1.52	3	1.6	1030	25
	392.9		**5.6**	**1.70**	**29**	**0.7**	**1333**	**24**

BREWER OBSERVATIONS **MAY 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	385.9	DS	5	1.73	39	0.9	–	–
2	388.4	DS	10.2	1.73	43	0.6	1587	24
3	375.7	DS	3.5	1.59	95	1.0	2191	25
4	379.3	DS	2.8	1.42	55	1.7	2326	29
5	377.3	DS	..6.3	1.45	31	1.9	1538	25
6	376.3	DS	..3.0	1.47	31	1.8	1672	25
7	–	–	–	–	–	–	1766	25
8	–	–	–	–	–	–	–	–
9	–	–	–	–	–	–	–	–
10	–	–	–	–	–	–	–	–
11	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–
13	–	–	–	–	–	–	–	–
14	–	–	–	–	–	–	–	–
15	–	–	–	–	–	–	–	–
16	–	–	–	–	–	–	–	–
17	365.8	DS	5.4	1.50	7	0.8	452	10
18	339.0	DS	6.8	1.30	13	1.0	2425	27
19	347.6	DS	11.5	1.41	18	0.5	2497	26
20	368.1	DS	7.0	1.85	28	0.4	2461	25
21	399.4	DS	12.5	2.24	14	–1.2	1487	27
22	327.1	DS	3.4	1.56	76	0.6	3728	29
23	330.5	DS	7.3	1.74	30	0.7	2537	26
24	327.9	DS	5.2	1.40	31	1.3	2376	26
25	383.6	DS	6.9	1.52	20	1.1	2138	25
26	409.3	DS	8.5	1.63	10	0.3	1909	27
27	396.2	DS	4.6	1.71	30	0.2	2205	27
28	415.7	DS	8.0	1.86	17	–0.2	1686	27
29	390.5	DS	2.9	2.03	9	–0.1	1765	27
30	407.1	ZS	45	1.37	31	–	1916	25
31	395.8	DS	4.2	1.74	13	0.4	1817	28
	375.5		**8.1**	**1.63**	**31**	**0.7**	**2023**	**25**

BREWER OBSERVATIONS **JUNE 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	408.5	DS	2.3	1.74	19	–0.1	2047	27
2	377.9	DS	7.4	1.80	43	0.1	2337	25
3	362.7	DS	1.8	1.67	11	0.5	1943	26
4	387.5	ZS	13.2	1.38	29	–	1399	26
5	353.4	DS	2.7	1.89	11	–0.1	1656	27
6	362.7	DS	1.7	1.60	25	0.2	2852	24
7	364.9	DS	3.4	1.89	28	0.2	2700	25
8	356.4	DS	3.0	1.67	36	0.4	3254	22
9	367.5	DS	2.8	1.70	20	0	2514	27
10	360.6	DS	5.7	1.81	36	0.1	3313	27
11	333.8	DS	2.4	1.63	52	0.2	3854	27
12	329.3	DS	3.5	1.79	41	0.3	3617	25
13	335.2	DS	2.5	1.51	84	0.5	4038	31
14	341.4	DS	5.6	1.65	54	0.4	3449	26
15	344.9	DS	5.7	1.50	47	0.8	3181	23
16	329.0	DS	2.5	1.51	68	0.4	3740	31
17	336.2	DS	2.3	1.85	21	1.2	1767	27
18	365.3	DS	10.8	1.59	9	0.5	2439	27
19	351.5	DS	7.0	1.69	42	0.1	3170	25
20	331.2	DS	2.6	1.46	97	0.8	4092	29
21	330.5	DS	4.8	1.43	84	0.8	3666	29
22	315.6	DS	1.8	1.50	25	0.5	3067	27
23	324.4	DS	2.4	1.46	23	0.3	3128	27
24	330.9	DS	8.2	1.69	53	0	3877	27
25	321.0	DS	2.5	1.55	85	0.7	4030	31
26	320.0	DS	2.0	1.48	91	0.5	3824	32
27	312.7	DS	3.2	1.55	61	0.4	4025	28
28	311.8	DS	3.4	1.73	55	0.3	3631	29
29	325.5	DS	11.6	2.20	9	0.5	3056	26
30	315.3	DS	4.9	1.78	46	–0.1	3294	27
	343.6		**4.5**	**1.66**	**44**	**0.4**	**3099**	**27**

BREWER OBSERVATIONS **JULY 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	320.9	DS	2.0	1.60	63	–0.2	3754	27
2	319.5	DS	1.7	1.52	84	0.2	4311	29
3	319.1	DS	2.3	1.54	104	1.4	4249	26
4	318.4	DS	5.5	1.56	74	0.7	4117	29
5	325.0	DS	2.8	1.58	63	0.3	3852	24
6	324.8	DS	1.6	1.47	96	0.5	3909	30
7	324.5	DS	3.0	1.54	81	0.5	3750	28
8	326.7	DS	2.1	1.67	66	0.4	3737	27
9	338.0	DS	1.8	1.68	54	0.5	3027	26
10	337.3	DS	3.6	1.47	87	0.4	3379	31
11	321.5	DS	2.0	1.47	62	0.6	3237	30
12	325.3	DS	2.0	1.51	70	0.5	3379	27
13	319.1	DS	2.1	1.67	38	0.7	3213	27
14	315.9	DS	5.9	2.77	6	–0.4	1198	27
15	368.3	DS	7.1	1.71	28	–0.2	2770	26
16	335.8	DS	4.1	1.58	41	0.1	3701	27
17	326.2	DS	1.9	1.49	99	0.1	3932	29
18	315.1	DS	2.0	1.73	70	0.4	3501	32
19	312.6	DS	3.1	1.66	48	0.2	3731	27
20	322.4	DS	5.4	1.48	101	0.1	3815	29
21	331.6	DS	3.7	1.50	36	1.0	2901	27
22	329.0	DS	2.1	1.71	44	0.4	3097	26
23	324.5	DS	3.4	1.57	57	0	3288	26
24	323.7	DS	2.5	1.44	82	0.3	3471	30
25	321.1	DS	2.8	1.71	65	0.1	3506	31
26	325.7	DS	5.2	1.73	43	0	3158	26
27	322.5	DS	2.0	1.61	55	0.2	3591	27
28	313.5	DS	1.4	1.57	79	0.3	3657	26
29	312.4	DS	5.1	1.71	44	0.5	2996	26
30	323.8	DS	4.0	1.86	19	0.4	2669	26
31	309.8	DS	2.8	1.50	62	0.4	3241	20
	324.3		**3.1**	**1.63**	**62**	**0.3**	**3424**	**27**

BREWER OBSERVATIONS **AUGUST 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	330.0	ZS	4.5	1.55	23	–	1329	26
2	334.9	DS	10.1	2.23	11	–0.1	1909	26
3	337.1	DS	2.4	1.59	47	0.5	2859	26
4	340.3	ZS	5.2	1.67	10	–	676	25
5	334.8	DS	2.1	1.76	13	0.3	2107	24
6	341.1	ZS	7.8	1.37	25	–	1240	24
7	342.6	DS	2.4	1.59	24	0.1	2349	24
8	330.6	DS	1.9	1.60	19	0.2	2162	25
9	329.3	DS	2.0	1.88	12	0	1629	25
10	330.4	DS	1.2	1.69	3	0.2	1560	25
11	326.3	DS	0.9	1.56	15	0.7	1715	25
12	343.5	DS	1.5	1.58	28	0.5	2446	25
13	338.6	DS	10.1	2.03	5	0.8	1299	25
14	345.4	DS	1.9	2.05	13	1.1	967	24
15	348.5	DS	1.1	1.57	17	0.5	2168	25
16	326.2	DS	1.7	1.67	41	0.3	2726	23
17	313.2	DS	1.8	1.62	45	0.5	2791	24
18	297.3	DS	1.2	1.69	17	0.6	1573	25
19	301.9	DS	1.1	2.14	15	–0.1	2222	25
20	302.2	DS	3.1	2.16	15	1.1	1525	24
21	321.0	DS	2.6	1.65	46	0.5	2358	24
22	330.9	DS	4.8	2.10	21	0.1	2000	25
23	332.4	DS	3.8	2.06	13	0.1	1669	25
24	323.2	DS	3.7	2.39	11	0.5	1667	25
25	316.6	DS	1.6	1.79	33	0.7	2217	25
26	318.8	DS	3.6	1.84	14	0.8	1832	25
27	318.3	DS	4.8	1.98	30	0.4	2199	24
28	323.4	DS	8.0	2.14	15	0.3	1588	23
29	341.5	ZS	5.3	1.61	26	–	779	23
30	363.1	ZS	5.3	1.64	15	–	542	23
31	327.7	DS	4.4	1.89	5	0.9	1745	23
	329.4		**3.6**	**1.81**	**20**	**0.4**	**1802**	**25**

BREWER OBSERVATIONS **SEPTEMBER 2006**								
Day	Ozone		dev	μ	N	SO2	UVB	NN
1	305.8	DS	1.9	2.26	14	0.3	1185	21
2	285.9	DS	4.0	1.87	22	0.3	2066	23
3	290.0	DS	5.9	2.03	12	1.3	1258	23
4	280.3	DS	1.0	2.79	2	0.4	2249	21
5	307.0	DS	7.6	1.84	2	0.3	1083	23
6	276.1	DS	1.5	1.90	22	0.8	2086	23
7	262.0	DS	3.2	1.79	44	0.3	2149	23
8	280.8	DS	10.3	1.85	9	1.2	1691	23
9	304.2	DS	6.0	2.07	35	0.4	1854	23
10	286.0	DS	1.5	2.00	26	0.7	1755	23
11	285.5	DS	3.1	2.01	59	0.8	1992	25
12	296.4	DS	1.1	1.91	45	1.2	1846	22
13	290.6	DS	2.8	1.88	85	0.5	1859	24
14	292.8	DS	2.3	1.91	87	0.4	1797	23
15	295.4	DS	2.4	1.91	69	1.0	1742	22
16	285.6	DS	1.4	1.82	42	0.9	1720	21
17	286.0	DS	1.3	1.90	42	0.3	1723	20
18	282.0	DS	1.6	1.81	48	0.7	1639	22
19	286.3	DS	3.4	1.75	23	1.1	1288	21
20	300.0	DS	2.3	2.03	11	0.5	1177	21
21	291.0	DS	1.4	2.25	32	0.1	1655	25
22	290.5	DS	1.9	2.01	55	1.0	1564	19
23	297.1	DS	3.5	2.06	69	0.8	1491	22
24	301.6	DS	1.0	2.08	75	0.5	1338	22
25	306.5	DS	1.5	1.95	77	0.8	1303	21
26	293.7	DS	2.6	2.00	76	0.9	1324	22
27	275.9	DS	1.4	1.99	69	0.8	1341	20
28	269.3	DS	4.2	2.07	15	1.7	773	17
29	270.0	DS	2.9	2.42	28	0.7	1250	17
30	261.6	DS	1.5	2.17	63	0.4	1423	19
	287.9		**2.9**	**2.01**	**42**	**0.7**	**1587**	**22**

BREWER OBSERVATIONS **OCTOBER 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	263.7	DS	2.2	2.00	18	2.1	991	17
2	260.3	DS	1.1	2.26	8	1.3	779	17
3	245.5	ZS	7.2	2.17	27	–	775	17
4	262.7	ZS	1.5	2.14	24	–	415	17
5	285.9	ZS	4.4	2.01	23	–	665	17
6	277.7	DS	1.8	2.15	37	0.9	1101	17
7	275.1	DS	6.3	2.38	18	0.4	939	16
8	268.7	DS	3.3	2.07	13	0.6	1042	17
9	275.9	DS	0	2.55	1	0.6	664	16
10	287.5	DS	2.0	2.27	77	0.6	981	21
11	281.0	DS	3.6	2.29	36	0.2	971	16
12	291.0	DS	6.0	2.25	34	1.2	789	16
13	301.9	DS	1.8	2.29	33	1.6	711	15
14	294.1	ZS	3.1	2.26	7	–	175	15
15	277.1	ZS	2.0	2.21	22	–	413	15
16	277.6	DS	0.8	3.03	8	0.2	582	16
17	270.0	DS	0.7	2.66	11	0.5	595	15
18	268.0	DS	1.2	2.40	65	0.8	830	19
19	263.5	DS	7.0	2.53	38	0.9	781	15
20	275.9	DS	2.6	2.46	34	0.7	667	16
21	273.1	DS	4.2	2.46	33	0.9	672	15
22	267.6	DS	5.0	2.49	33	0.3	697	15
23	273.3	DS	1.3	2.25	7	0.3	431	15
24	259.5	DS	1.1	2.48	11	0.3	407	15
25	295.5	DS	0.9	2.81	3	0.5	267	15
26	250.9	DS	2.7	2.64	34	0.7	665	15
27	235.0	DS	2.2	2.72	28	0.5	352	6
28	245.2	DS	3.3	2.93	18	0.2	624	14
29	257.4	ZS	9.0	2.75	7	–	144	13
30	293.7	DS	2.7	2.77	67	0.2	527	20
31	256.7	DS	5.3	2.75	21	1.0	448	14
	271.3		**3.1**	**2.43**	**26**	**0.7**	**648**	**16**

BREWER OBSERVATIONS **NOVEMBER 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	296.4	DS	1.9	3.06	8	0	292	13
2	325.2	ZS	1.7	2.64	10	–	194	14
3	345.3	DS	1.5	2.88	18	–0.1	312	13
4	327.3	ZS	0	3.19	1	–	119	14
5	294.3	ZS	4.4	2.71	4	–	114	13
6	293.5	ZS	1.4	2.74	6	–	114	13
7	274.2	ZS	2.4	2.79	12	–	230	14
8	277.8	DS	1.7	2.97	15	0.4	314	13
9	302.0	DS	0.3	2.84	2	0.2	194	13
10	–	–	–	–	–	–	261	14
11	302.2	ZS	3.6	2.97	9	–	180	13
12	347.1	DS	3.9	3.53	4	–1.6	188	13
13	331.3	DS	0	2.88	1	0.5	212	12
14	294.6	ZS	1.2	3.10	9	–	187	12
15	281.7	ZS	3.3	3.10	6	–	115	11
16	284.2	DS	1.5	3.23	49	0.2	284	16
17	283.8	DS	1.1	3.18	43	0.7	274	15
18	275.0	DS	0.7	3.11	11	0.6	246	11
19	292.6	ZS	1.8	3.23	5	–	107	11
20	296.3	DS	3.1	3.33	3	–0.1	170	11
21	293.4	ZS	5.5	3.43	6	–	131	11
22	305.7	DS	2.5	3.33	10	0.1	170	11
23	271.3	DS	0.8	3.17	4	2.0	164	11
24	235.9	ZS	4.1	3.27	4	–	133	11
25	250.9	DS	2.6	3.47	20	0.1	253	11
26	246.3	DS	1.0	3.48	20	0.5	227	11
27	250.9	DS	1.5	3.46	36	0.7	218	13
28	271.8	ZS	3.6	3.48	3	–	137	11
29	253.6	ZS	3.2	3.50	5	–	113	11
30	271.6	ZS	0.9	3.42	2	–	115	11
	288.8		**2.1**	**3.15**	**11**	**0.3**	**192**	**12**

BREWER OBSERVATIONS **DECEMBER 2006**

Day	Ozone		dev	μ	N	SO2	UVB	NN
..1	260.0	DS	2.7	3.59	16	1.6	208	10
..2	258.5	DS	2.2	3.64	17	0.6	197	10
..3	248.9	DS	2.5	3.64	13	0.2	188	11
..4	299.2	DS	2.7	3.78	4	–0.6	133	10
..5	277.5	ZS	1.1	3.57	3	–	108	10
..6	256.6	DS	1.4	3.69	30	0.1	195	14
..7	290.0	ZS	0	3.63	1	–	90	9
..8	280.8	DS	0	3.93	1	–0.4	141	10
..9	296.0	DS	1.2	3.73	12	–0.4	154	10
10	–	–	–	–	–	–	333	10
11	316.5	ZS	0	3.66	1	–	111	9
12	–	–	–	–	–	–	41	9
13	267.9	ZS	4.5	3.71	3	–	60	10
14	213.9	ZS	0.9	3.78	2	–	104	9
15	234.8	DS	0.6	3.82	12	0.3	190	9
16	274.0	DS	3.2	3.83	11	–0.1	158	9
17	239.7	ZS	3.2	3.87	3	–	112	10
18	289.7	ZS	3.5	3.82	3	–	78	9
19	323.9	ZS	0	3.88	1	–	67	9
20	–	–	–	–	–	–	31	9
21	241.2	ZS	8.7	3.87	4	–	111	9
22	–	–	–	–	–	–	33	9
23	–	–	–	–	–	–	62	10
24	–	–	–	–	–	–	42	10
25	264.9	DS	0.7	3.86	5	–0.3	157	9
26	–	–	–	–	–	–	149	10
27	–	–	–	–	–	–	47	9
28	248.8	ZS	0	3.72	1	–	69	10
29	264.9	ZS	5.7	3.79	3	–	84	9
30	287.8	DS	4.4	3.80	12	–0.1	151	9
31	276.2	DS	3.4	3.75	6	–0.3	140	9
	272.7		**2.4**	**3.69**	**8**	**0.1**	**111**	**10**

BREWER OBSERVATIONS **JANUARY 2007**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	277.3	ZS	4.3	3.70	4	–	67	9
2	323.4	DS	0	3.66	1	–0.5	79	10
3	–	–	–	–	–	–	48	9
4	372.3	ZS	2.5	3.68	3	–	64	10
5	412.6	ZS	0	3.65	1	–	45	7
6	340.4	ZS	0.8	3.63	2	–	45	10
7	355.9	ZS	0	3.79	1	–	31	10
8	336.1	DS	5.4	3.61	11	–0.5	141	10
9	290.8	DS	5.7	3.58	11	0.4	156	10
10	301	ZS	2.4	3.59	10	–	81	10
11	347.7	DS	0	3.42	1	–0.8	104	11
12	–	–	–	–	–	–	46	11
13	293	DS	2.7	3.56	3	–0.2	147	11
14	327.9	DS	1.2	3.65	2	–0.9	75	11
15	391.2	DS	1.5	3.41	10	–2.5	129	11
16	332.9	DS	1.9	3.42	30	–0.2	157	13
17	318.3	DS	3.4	3.31	5	0.1	140	11
18	364.1	ZS	3.6	3.41	2	–	75	11
19	355.7	ZS	1.1	3.29	5	–	81	12
20	287.3	DS	0.7	3.34	2	0.6	139	12
21	323.2	DS	3.3	3.28	14	–	206	11
22	353.2	DS	0.8	3.37	3	–0.7	154	11
23	319.5	ZS	3.2	3.28	13	–	165	11
24	322.7	ZS	3	3.16	11	–	102	11
25	359.3	ZS	2.5	3.11	6	–	164	11
26	313.5	DS	2.4	3.11	38	0.7	335	13
27	420.5	DS	3	3.27	7	–3.0	191	11
28	370.7	ZS	1.9	3.07	15	–	182	13
29	396.9	DS	2.1	3.10	14	–1.0	255	12
30	320.9	ZS	6.2	3.03	17	–	186	12
31	321.1	ZS	4	2.95	12	–	113	13
	339.6		**2.4**	**3.39**	**9**	**–0.6**	**126**	**11**

BREWER OBSERVATIONS **FEBRUARY 2007**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	359.3	ZS	8.7	2.93	15	–	168	13
2	310.4	ZS	1.4	2.92	21	–	268	13
3	413.9	ZS	2.2	2.77	12	–	143	13
4	329.3	DS	4.6	2.86	22	0.4	312	14
5	341.8	DS	4.2	2.91	5	0.1	253	13
6	393.2	ZS	1.8	2.68	12	–	117	13
7	373.3	DS	3	2.95	8	0.5	225	14
8	–	–	–	–	–	–	108	14
9	361.8	ZS	2.6	2.71	21	–	228	13
10	330.9	DS	2.4	2.63	3	1.9	344	14
11	441.7	DS	6.5	2.51	11	0.6	324	13
12	486.6	ZS	6.7	2.63	15	–	215	14
13	391.8	ZS	10.4	2.58	15	–	199	14
14	430.7	ZS	7.3	2.47	9	–	167	13
15	404	ZS	5.5	2.53	19	–	200	14
16	436.9	ZS	12.4	2.41	19	–	225	14
17	441.9	DS	4	2.61	34	–1.2	390	15
18	375.5	DS	5.2	2.59	34	0.5	460	15
19	381.2	ZS	8.8	2.38	16	–	113	15
20	377.8	ZS	3.9	2.43	26	–	239	15
21	329.9	DS	2.1	2.42	22	0.7	545	16
22	361.5	ZS	5.6	2.48	9	–	142	15
23	294.1	DS	6.8	2.96	6	1.8	916	18
24	312.5	DS	1.1	2.36	3	2.5	616	15
25	325.4	ZS	2.4	2.42	37	–	476	15
26	321.9	ZS	11.7	2.61	15	–	276	16
27	331.6	DS	0	2.13	1	1.1	367	16
28	338.7	ZS	9.6	2.25	21	–	233	15
	370.3		**5.2**	**2.60**	**16**	**0.8**	**295**	**14**

BREWER OBSERVATIONS **MARCH 2007**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	382.4	DS	5.1	2.05	3	1.1	471	16
2	410.0	DS	5.2	2.39	13	0.3	450	15
3	415.2	DS	2.6	2.51	4	0.2	296	16
4	417.2	ZS	1.5	2.15	5	–	127	16
5	374.7	DS	2.3	2.20	31	0.6	687	16
6	378.0	DS	3.4	2.15	17	0.6	616	16
7	357.6	DS	3.0	2.26	41	1.0	778	17
8	347.9	DS	5.3	2.08	6	1.7	485	17
9	362.9	DS	0	1.85	1	0.7	457	17
10	357.2	DS	2.1	1.94	23	1.3	738	17
11	359.2	DS	2.2	2.06	12	1.1	671	17
12	317.8	DS	1.8	2.09	82	0.7	1157	22
13	332.4	DS	4.3	2.09	83	0.6	1126	22
14	393.8	DS	22.8	2.07	60	0.7	856	21
15	350.0	DS	2.4	2. 03	6	0.9	730	17
16	338.4	DS	2.1	2.20	31	1.4	821	18
17	422.5	DS	3.3	2.84	2	–2.0	248	17
18	379.5	ZS	3.9	1.82	30	–	451	17
19	395.3	DS	1.8	1.79	5	1.2	565	17
20	410.4	ZS	8.5	1.77	13	–	209	17
21	428.7	ZS	8.1	2.10	9	–	163	18
22	487.0	DS	3.6	1.95	7	–0.5	582	20
23	426.4	ZS	5.2	1.98	9	–	179	21
24	386.3	DS	3.4	1.94	47	0.8	1080	20
25	364.7	DS	4.9	1.94	62	0.9	1162	22
26	394.4	DS	2.1	1.93	90	0.4	1167	24
27	382.8	DS	2.2	1.85	83	0.7	1283	23
28	363.8	DS	4.1	1.81	57	1.6	1133	20
29	384.1	DS	9.6	1.87	96	1.0	1265	28
30	431.2	DS	11.1	1.78	86	1.1	1062	24
31	412.2	DS	3.3	1.82	56	0.9	1192	20
	385.9		**4.6**	**2.04**	**35**	**0.7**	**716**	**19**

BREWER OBSERVATIONS **APRIL 2007**								
Day	Ozone		dev	μ	N	SO2	UVB	NN
1	385.7	DS	5.4	1.66	29	1.5	943	22
2	352.8	DS	4.9	1.86	46	0.7	1436	23
3	351.5	DS	5.9	1.76	32	1.8	1262	23
4	383.9	DS	13.3	1.86	27	0.7	1381	23
5	327.3	DS	5.6	1.93	39	0.9	1704	22
6	356.8	ZS	8.0	1.68	38	–	1004	23
7	369.5	ZS	5.5	1.62	33	–	678	22
8	361.6	DS	3.3	1.59	6	1.4	1103	23
9	348.2	ZS	4.2	1.66	25	–	595	24
10	399.7	DS	0	1.95	1	1.5	605	23
11	304.5	DS	2.5	1.60	13	1.1	1896	23
12	334.5	DS	3.8	1.74	96	0.6	2265	26
13	339.9	DS	1.8	1.71	97	0.6	2247	29
14	331.4	DS	3.3	1.73	64	0.5	2347	21
15	355.7	DS	3.3	1.74	75	0.5	2228	26
16	362.6	DS	2.1	1.71	68	0.7	2167	25
17	364.5	DS	3.4	1.65	90	1.0	2158	25
18	378.9	DS	10.2	1.90	19	0.6	1373	25
19	375.8	DS	9.1	1.91	26	0.9	1697	24
20	396.3	DS	4.0	1.75	43	1.0	1805	27
21	397.1	DS	2.7	1.64	38	0.9	2099	24
22	382.0	DS	5.0	1.60	98	0.8	2374	26
23	354.0	DS	3.2	1.67	52	0.7	2191	25
24	372.7	DS	8.7	1.58	3	1.8	1224	25
25	365.3	DS	1.9	1.59	97	0.7	2409	26
26	354.9	DS	1.8	1.65	71	0.7	2381	26
27	341.0	DS	1.1	1.63	63	1.0	2481	27
28	336.8	DS	1.5	1.65	37	1.2	2353	25
29	375.6	DS	15.6	1.73	49	0.9	2305	25
30	374.1	DS	3.6	1.73	55	0.8	2215	31
	361.2		**4.8**	**2.04**	**35**	**0.7**	**1764**	**25**

BREWER OBSERVATIONS **MAY 2007**								
Day	Ozone		dev	μ	N	SO2	UVB	NN
1	383.8	DS	8.1	1.92	28	1	1565	24
2	355.6	DS	4.8	1.67	56	1.1	2747	24
3	349.3	DS	6.0	1.71	51	0.6	2968	22
4	359.3	DS	3.1	1.56	107	0.4	2900	29
5	362.3	DS	1.6	1.61	49	0.4	2726	25
6	341.5	DS	0	3.33	1	1.1	710	25
7	370.2	DS	6.1	1.27	12	1.3	2065	25
8	393.8	DS	3.4	1.69	7	1.3	1737	25
9	392.7	DS	2.8	1.45	16	1.2	1642	26
10	–		–	–	–	–	–	–
11	–		–	–	–	–	–	–
12	–		–	–	–	–	–	–
13	–		–	–	–	–	–	–
14	–		–	–	–	–	–	–
15	–		–	–	–	–	–	–
16	–		–	–	–	–	–	–
17	–		–	–	–	–	–	–
18	–		–	–	–	–	–	–
19	–		–	–	–	–	–	–
20	–		–	–	–	–	–	–
21	–		–	–	–	–	–	–
22	330.5	DS	4.5	1.47	42	–0.1	1408	15
23	324.3	DS	4.2	1.58	88	0.3	–	–
24	314.4	DS	3.8	1.51	106	0.4	3696	29
25	313.2	DS	4.3	1.40	85	0.6	3462	31
26	328.0	DS	2.0	1.59	34	1.2	2200	23
27	333.5	DS	2.6	1.63	40	0.7	2925	26
28	320.1	DS	3.6	1.48	81	0.6	3431	33
29	322.6	DS	2.9	1.55	84	0.7	3509	31
30	320.0	DS	3.4	1.72	5	1.2	1581	27
31	347.1	ZS	4.6	1.22	27	–	1047	27
	345.4		**3.8**	**1.5**	**48**	**0.8**	**2351**	**26**

BREWER OBSERVATIONS **JUNE 2007**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	324.4	DS	2.1	1.24	10	–0,3	2304	26
2	348.1	ZS	10.6	1.49	24	–	866	26
3	344.4	ZS	5.9	1.50	30	–	1392	27
4	315.0	DS	0.7	2.62	7	0.9	1319	27
5	324.8	DS	4.9	2.25	20	1.0	2116	24
6	314.7	DS	3.3	1.68	38	1.5	3289	27
7	319.1	DS	1.4	1.64	54	1.0	3913	27
8	318.2	DS	5.1	1.57	71	0.5	3781	26
9	347.8	DS	5.9	1.50	34	0.6	2594	27
10	368.8	DS	7.8	1.23	16	0.5	2296	26
11	329.5	DS	5.4	1.48	93	0.3	3886	34
12	347.1	DS	2.0	1.57	124	0	3700	35
13	337.5	DS	1.8	1.58	63	1.4	2582	32
14	338.8	DS	4.7	1.54	56	0.6	3320	30
15	345.3	DS	4.9	1.43	60	0.5	3154	30
16	341.4	DS	3.8	1.69	28	0.4	2645	27
17	350.5	DS	8.0	1.61	58	0.4	3472	26
18	335.6	DS	4.6	1.45	20	1.0	1959	27
19	348.8	DS	6.4	1.92	40	0.4	2626	28
20	340.3	DS	7.0	1.61	64	0.7	1976	26
21	323.5	DS	2.7	1.49	55	0.6	3712	23
22	331.2	ZS	6.7	1.43	39	–	1123	27
23	338.6	DS	8.2	1.57	25	0.7	2718	27
24	341.6	DS	6.3	1.66	43	0.4	3525	32
25	325.8	DS	5.0	1.71	50	0.5	3334	27
26	341.4	DS	20.4	1.81	23	0.9	1748	27
27	336.4	DS	5.5	1.68	29	0.7	3044	27
28	345.6	DS	4.0	1.71	25	0.7	2956	26
29	350.0	DS	1.9	1.57	27	0.5	2727	27
30	341.5	DS	3.5	1.40	18	1.8	2728	27
	337.2		**5.4**	**1.62**	**41**	**0.7**	**2694**	**28**

BREWER OBSERVATIONS **JULY 2007**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	335.8	DS	4.4	1.67	25	0.4	3105	27
2	327.8	DS	2.3	1.52	40	0.9	3338	26
3	342.0	DS	3.9	1.48	16	0.2	2400	27
4	333.4	DS	0	2.65	1	1.1	931	27
5	354.1	DS	3.9	1.75	3	0.6	1415	27
6	358.2	ZS	16.6	1.44	12	–	529	26
7	363.2	ZS	5.1	1.44	27	–	1450	26
8	318.5	DS	1.9	1.85	8	0.4	2634	27
9	296.8	DS	2.4	1.66	54	0.7	3618	29
10	332.1	ZS	6.5	1.49	8	–	883	19
11	358.9	DS	3.2	1.85	27	0.9	1867	25
12	354.1	DS	0.4	1.53	2	1.0	1465	18
13	330.3	DS	1.5	1.67	3	1.2	1879	22
14	303.1	DS	2.9	1.71	15	0.7	2874	22
15	313.1	DS	1.2	1.79	24	0.8	–	–
16	295.5	DS	3.7	1.39	69	1.0	3967	29
17	290.6	DS	2.5	1.67	106	1.1	4083	40
18	286.8	DS	1.4	1.80	15	1.3	1274	23
19	286.1	DS	2.6	1.62	39	0.6	3562	27
20	284.5	DS	4.2	1.52	39	0.8	3679	22
21	299.0	DS	1.0	1.75	13	–0.2	3427	21
22	–	–	–	–	–	–	3508	23
23	326.4	DS	5.6	1.64	46	1.0	3354	23
24	330.8	DS	14	1.80	16	0.8	2106	22
25	368.4	ZS	9.3	1.18	22	–	784	21
26	307.1	DS	2.5	1.70	36	0.7	3308	23
27	320.2	DS	6.6	1.58	32	1.3	2393	26
28	313.7	DS	2.3	1.49	20	0.8	2644	26
29	317.4	DS	2.6	1.46	11	0.5	2859	26
30	365.4	DS	7.5	1.91	12	0.4	1077	26
31	347.1	DS	2.6	2.11	3	–0.1	1608	23
	322.5		**7.5**	**1.68**	**25**	**0.8**	**2401**	**25**

BREWER OBSERVATIONS **AUGUST 2007**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	335.3	DS	7.5	1.46	27	0.8	2799	26
2	312.2	DS	2.8	1.58	68	1.1	3236	25
3	315.7	DS	7.5	1.37	2	1.1	1416	24
4	334.4	DS	1.3	1.57	18	0.6	1937	24
5	323.4	ZS	3.1	1.53	51	–	1831	24
6	306.9	DS	5.1	1.91	16	0.6	2167	24
7	320.0	DS	3.6	1.71	47	1.3	2895	24
8	311.6	DS	2.0	1.57	28	1.2	2563	24
9	312.2	DS	2.9	2.11	10	0.5	1042	24
10	300.7	DS	2.0	2.14	11	1.0	2322	48
11	303.9	DS	3.9	1.71	12	0.4	1742	24
12	297.6	DS	1.8	1.62	20	0.6	3602	48
13	316.1	DS	2.4	1.51	2	1.4	1179	24
14	312.8	DS	2.2	1.54	45	1.0	1155	11
15	303.7	DS	3.6	1.72	48	0.9	2587	25
16	278.6	DS	2.4	1.68	47	0.8	–	–
17	287.5	DS	5.9	1.48	16	0.5	2545	24
18	305.0	DS	2.6	1.77	38	0.9	–	–
19	300.2	DS	1.8	1.78	39	1.2	2478	24
20	300.9	DS	1.5	1.93	14	1.1	1828	24
21	307.9	DS	8.6	1.84	31	0.7	2084	24
22	286.1	DS	2.6	1.62	44	0.6	2209	25
23	275.6	DS	2.1	1.75	39	0.9	2420	24
24	288.1	DS	9.0	1.84	33	0.7	2400	24
25	307.7	DS	7.2	1.85	36	1.2	2270	24
26	269.4	DS	2.8	1.74	11	1.1	2312	25
27	293.0	DS	2.8	1.95	24	0.8	1913	24
28	312.5	DS	3.3	1.89	29	1.0	2221	23
29	310.7	DS	1.7	1.98	34	0.8	1995	22
30	313.4	DS	6.1	1.92	20	1.2	2079	23
31	302.2	ZS	4.5	1.78	16	–	1208	22
	304.7		**3.8**	**1.74**	**28**	**0.9**	**2153**	**25**

BREWER OBSERVATIONS **SEPTEMBER 2007**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	313.0	DS	1.2	1.56	5	1.2	1301	22
2	293.7	DS	2.3	1.50	4	0.6	1663	23
3	303.0	DS	3.5	2.00	19	0.8	1518	22
4	333.6	DS	2.7	1.49	7	0.9	1041	22
5	351.5	ZS	8.7	1.84	15	–	307	22
6	317.6	DS	3.7	1.49	3	1.7	912	22
7	311.3	DS	1.5	2.14	2	1.0	756	22
8	304.6	DS	1.8	1.81	37	0.7	1910	22
9	330.8	DS	0.6	2.36	2	0.3	889	22
10	315.1	DS	2.4	1.51	4	1.1	1025	22
11	336.5	DS	1.3	2.43	5	0.1	1081	22
12	309.9	DS	2.1	2.08	6	0.5	1374	22
13	304.2	DS	1.6	2.13	11	0.6	1495	22
14	294.7	DS	1.8	1.90	31	1.0	1776	21
15	316.6	DS	6.7	2.08	15	0.7	1294	21
16	272.6	DS	1.7	2.05	15	0.7	1331	20
17	268.0	DS	1.8	1.94	42	1.5	1844	20
18	287.1	DS	1.7	1.83	37	0.9	1488	20
19	299.6	DS	2.6	1.93	14	1.2	1336	20
20	294.8	DS	4.0	1.95	31	1.2	1344	20
21	284.4	DS	1.3	2.00	49	1.5	1573	19
22	288.5	DS	3.6	1.99	47	1.4	1515	17
23	281.2	DS	3.4	2.02	49	1.0	1343	17
24	281.1	DS	1.0	2.04	48	1.1	1423	17
25	286.7	DS	0.7	2.31	16	0.9	754	11
26	291.2	ZS	2.1	2.00	27	–	380	17
27	280.9	DS	1.3	1.97	25	2.2	1096	17
28	283.9	DS	1.4	1.78	17	1.1	805	17
29	312.5	DS	4.1	2.14	41	0.8	1131	17
30	306.0	DS	8.7	2.14	34	0.9	969	17
	301.8		**2.7**	**1.95**	**22**	**1.0**	**1222**	**20**

BREWER OBSERVATIONS **OCTOBER 2007**								
Day	Ozone		dev	μ	N	SO2	UVB	NN
1	283.6	DS	2.2	2.23	20	1.1	1153	17
2	275.8	DS	1.6	1.80	2	2.0	608	15
3	309.8	DS	5.2	2.26	9	0.7	692	17
4	270.7	DS	0.6	2.62	8	1.3	762	17
5	296.1	DS	1.4	1.94	7	2.1	677	17
6	284.0	DS	0.8	2.36	7	0.7	615	16
7	294.0	DS	4.5	2.49	12	1.0	766	17
8	266.3	DS	0.2	2.14	2	1.2	554	16
9	270.6	DS	1.5	2.33	20	0.8	868	16
10	268.7	DS	1.6	2.32	35	1.4	915	16
11	260.3	DS	2.0	2.28	19	1.5	731	15
12	309.6	ZS	2.4	2.21	27	–	208	15
13	302.9	DS	3.6	2.85	8	0.5	581	15
14	267.4	DS	1.6	2.48	23	0.7	842	15
15	267.5	DS	1.2	2.40	40	1.6	835	15
16	268.0	DS	2.9	2.45	34	0.9	779	15
17	278.6	DS	2.1	2.43	36	1.3	706	15
18	301.9	DS	2.4	2.84	4	0.5	353	14
19	339.7	ZS	1.7	2.39	24	–	241	15
20	323.3	DS	3.3	2.56	10	0.8	456	15
21	310.6	DS	3.7	2.50	36	0.8	613	15
22	282.3	DS	2.6	2.66	3	1.1	345	15
23	288.5	ZS	2.5	2.50	24	–	157	15
24	272.3	DS	2.2	2.58	20	1.5	500	15
25	296.5	ZS	3.4	2.58	27	–	208	14
26	292.1	DS	0	3.22	1	–0.4	274	14
27	282.0	DS	1.7	2.36	10	1.3	432	14
28	287.7	ZS	2.9	2.64	27	–	199	14
29	274.0	ZS	1.3	3.31	4	–	407	14
30	266.5	ZS	3.2	2.68	27	–	252	14
31	278.5	DS	3.2	2.47	7	1.1	364	13
	286.1		**2.2**	**2.48**	**17**	**1.1**	**551**	**15**

BREWER OBSERVATIONS **NOVEMBER 2007**

Day	Ozone		dev	μ	N	SO2	UVB	NN
1	244.2	ZS	5.0	2.72	21	–	274	13
2	269.6	DS	1.2	2.93	7	0.1	374	13
3	265.4	DS	2.6	3.28	10	–0.1	315	13
4	296.4	DS	1.9	3.05	5	–0.1	251	13
5	293.5	ZS	3.3	2.79	15	–	226	13
6	301.9	DS	0	2.98	1	0.8	201	13
7	303.6	ZS	2.5	3.03	10	–	186	13
8	282.5	ZS	7.2	2.91	4	–	117	13
9	256.5	ZS	0	2.84	1	–	70	13
10	334.8	DS	3.2	3.76	3	–2.4	183	13
11	314.1	DS	2.1	3.38	3	–1.6	215	13
12	340.0	ZS	2.7	3.00	8	–	113	12
13	344.0	ZS	2.4	3.01	8	–	105	12
14	335.9	ZS	1.2	2.99	12	–	146	12
15	321.5	DS	0.9	3.29	9	–0.1	174	12
16	333.5	DS	3.5	3.31	16	–1	219	12
17	297.8	ZS	4.2	3.07	11	–	158	11
18	263.4	ZS	1.5	3.03	4	–	147	11
19	261.7	ZS	3.8	3.25	8	–	123	11
20	255.4	ZS	7.6	3.32	8	–	175	11
21	286.6	DS	1.7	3.67	7	–0.5	181	11
22	275.8	DS	1.7	3.51	25	0.4	216	11
23	273.6	DS	3.7	3.40	26	2.0	209	11
24	247.0	ZS	3.2	3.38	4	–	71	11
25	271.3	ZS	8.5	3.46	2	–	80	11
26	344.4	ZS	0	3.52	1	–	55	11
27	362.5	ZS	1.0	3.58	2	–	65	11
28	235.9	DS	2.1	3.62	12	0.1	230	11
29	264.1	DS	1.1	3.59	16	0.7	199	11
30	301.5	ZS	5.2	3.41	3	–	55	11
	292.6		**2.8**	**3.24**	**9**	**–0.1**	**171**	**12**

BREWER OBSERVATIONS **DECEMBER 2007**

Day	Ozone		dev	µ	N	SO2	UVB	NN
1	201.6	ZS	1.9	3.47	3	–	156	10
2	310.8	DS	1.3	3.54	6	–0.4	114	10
3	–	–	–	–	–	–	57	10
4	–	–	–	–	–	–	40	10
5	–	–	–	–	–	–	79	10
6	252.8	ZS	12.5	3.75	4	–	79	11
7	290.1	ZS	0	3.57	1	–	66	10
8	314.1	DS	2.1	3.82	5	–2.9	116	10
9	333.4	DS	0	4.05	1	–4	72	10
10	–	–	–	–	–	–	39	10
11	–	–	–	–	–	–	27	9
12	–	–	–	–	–	–	24	9
13	317.4	DS	1.6	3.90	27	–1.8	120	13
14	–	–	–	–	–	–	46	9
15	–	–	–	–	–	–	55	9
16	295.8	DS	0.2	4.10	3	–1.7	73	9
17	–	–	–	–	–	–	73	9
18	227.1	ZS	0	3.89	1	–	36	9
19	–	–	–	–	–	–	39	9
20	257.5	ZS	0	3.91	1	–	29	9
21	189.4	ZS	1.6	3.77	2	–	47	9
22	246.5	DS	0.7	3.93	8	–0.2	132	9
23	294.2	DS	3	3.91	14	–0.8	116	9
24	–	–	–	–	–	–	23	9
25	–	–	–	–	–	–	33	9
26	298.8	DS	1.0	4.02	6	–1.2	98	9
27	353.2	DS	4.4	4.04	5	–4.4	74	9
28	298.0	DS	1.5	3.75	3	–1.0	110	9
29	303.9	DS	2.2	3.94	18	–1.2	125	9
30	300.7	ZS	3.7	3.72	2	–	62	9
31	322.6	ZS	0	3.86	1	–	70	9
	284.6		**2.0**	**3.84**	**6**	**–1.8**	**72**	**10**

PUBLS. INST. GEOPHYS. POL. ACAD. SC., D-72 (403), 2008

Variability of Aerosols Forcing on the Surface UV Radiation: Analysis of Data Taken at Belsk, Poland, in Spring 2007

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Abstract

Potential impact of the atmospheric aerosol on surface UV radiation is presented. Sun-photometer data collected at Belsk in the period March 27 – April 19, 2007, as well as satellite data, were used to estimate the UV irradiance response to the aerosols optical depth (AOD) changes during smoke/dust event and advection of the clear Atlantic air mass. The mean attenuation of the erythemally weighted surface UV irradiance due to smoke was ~3% in the case of sun-photometer data and ~7% in the case of satellite data, whereas ~10% increase relative to the overall mean UV level was estimated during the clear Atlantic air episode.

It seems that the satellite observations can provide accurate estimate of the aerosol optical depths for "clear" air masses and when the AOD exhibits small intraday variations. It was also found that extrapolation of satellite data to UV range leads to an overestimation of AODs.

1. Introduction

Aerosols are being recognized as a major factor determining climate. In recent years, increased interest has been noted on studies of the aerosol properties in the ultraviolet (UV) range when it was established that the aerosols could significantly affect the intensity of UV radiation at the ground-level and play a more important role in attenuating UV irradiances than has been recognized previously. The observed ozone depletion at high and mid-latitudes triggered attention to the related increase of the UV radiation at the Earth's surface. Many other factors, such as cloud cover and aerosol load of the atmosphere may also influence the UV radiation interfering with the ozone related changes (Bais *et al.* 2006). These factors sometimes could act synergistically rather than independently, posing challenging task related to description of expected range of the UV response to changes in one UV forcing factor.

Influence of atmospheric aerosol on solar UV radiation was recognized by Liu *et al.* (1991). Attenuation of the UV radiation depends on aerosol optical properties which are determined by aerosol microphysical structure and concentration. Temporary changes of the aerosol optical properties depend on the source of aerosol origin and transformation processes during the advection of aerosols. The variability of aerosols is rather wide and the life-time in the atmosphere is rather small comparing to other UV radiative forcing agents like ozone. For example, aerosol optical depth (AOD) can change more than two or three times in a few days. In some cases, changes of surface UV radiation induced by aerosol are comparable to that induced by ozone (Zerefos 1997, Krzyścin and Puchalski 1998). Jarosławski and Krzyścin (2005) reported that AOD at 320 nm in Belsk, Poland, has a decreasing tendency since the early 1990s, inducing an increase in surface UV irradiance of about 4%, that is comparable with the total ozone forcing on UV radiation in that period. Modeling of aerosol influence on surface UV radiation is rather difficult in global scale. Many studies revealed the strong influence of variations in the aerosol properties on long- and short-term variations in surface UV radiation (Chubarova *et al.* 2002, Arola *et al.* 2003, Kambezidis *et al.* 2005, Meloni *et al.* 2005).

Precise modeling of attenuation of UV radiation by aerosols is rather difficult and requires wavelength dependent aerosol radiative properties like AOD and total content of other forcing agents being input to radiative transfer models. On the basis of statistical analyses of UV data collected at Belsk (52^{o}N, 21^{o}E), Poland, Krzyścin (2004) introduced Radiation Amplification Factor (RAF) due to aerosol to describe aerosol impact on UV radiation. Modeling of aerosol radiative forcing by means of RAF requires information about aerosol optical depth at a certain UV wavelength. The measurements of aerosol optical thickness in the UV range (around 320 nm) are relatively rare and short (Cheymol and de Backer 2003, Groebner 2004, Jarosławski *et al.* 2003). This is caused by the difficulties connected with the measurement itself, relatively low signal level, necessity of knowledge of total ozone content at the time and place of measurement, large variability of signal intensity within the range of UV wavelengths. Only the world-wide sun-photometric network, AERosol Observing NETwork (AERONET), performs regular measurements of aerosol properties including AOD at 340 nm since the late 1990s (Holben *et al.* 1998).

Analyses of past, present, and future variations of the aerosols properties in the UV become one of the important pending problems. It becomes evident that more specific knowledge of aerosol characteristics in the UV range and their effects on the ground-level UV radiation lead to improved accuracy in the UV climatology modeling, proper scaling of the measured UV spectra, and reliable UV Index forecasting.

2. Observatory and Instrumentation

The Central Geophysical Observatory of the Institute of Geophysics, Polish Academy of Sciences, at Belsk is located in a rural site about 50 km SSW of Warsaw. It is surrounded by orchards and larch forest. A nearby village is located about 2 km from the observatory and a distance to nearby small town Grójec is about 10 km. Thus, Belsk observatory could be qualified as a background station weakly affected by large local pollutions. Measurements of atmospheric aerosol by means of sun-photometers and lidar as well as in-situ techniques are performed at Belsk. Various standard meteorological observations are also carried out, complementarily to aerosol measurements. In this work we examine sun-photometer data obtained by CIMEL instrument at the Belsk observatory and satellite data from MODIS instrument on Aqua and Terra satellite platform.

Belsk's CIMEL CE-318 sun-photometer, instrument #318, is part of AERONET network. The photometer contains two collimators and detectors mounted on sun tracker and an electronic module containing control unit and real time acquisition system. Collected data are transmitted via satellite to AERONET centre. The instrument uses two detection systems for registration of sun and sky radiances. A UV enhanced silicon detector is used for sun radiance measurements at 340, 380, 440, 500, 670, 870, 938 and 1020 nm. The other silicon detector is used for sky radiance registration. The sky radiance measurements are taken at 440, 670, 870 and 1020 nm by means of almucantar and principal plane scans. Direct sun measurements are used to determine aerosol optical depths at selected wavelengths, Angström exponent, and columnar water vapour concentration. Dubovik's numerical procedure (Dubovik and King 2000) is applied to the almucantar scans providing microphysical and radiative properties of the aerosol: aerosol particle size distribution, refractive index, single scattering albedo, and asymmetry factor.

Moderate Resolution Imaging Spectroradiometer (MODIS) is a main instrument onboard Earth Observing System (EOS) Terra and Aqua satellites. Both are polar-orbiting satellites; they repeat orbit every 16 days. MODIS instrument performs measurements of solar and earth thermal radiation from about 0.41 to 14 μm (Salomonson 1989). Seven channels from 0.47 to 2.1 μm are used in the atmospheric retrievals. MODIS uses predefined aerosol microphysical properties and look-up tables to estimate aerosol radiative properties over land and ocean, respectively. In this work (next subsection) we convert AODs by MODIS originally measured at 470 and 660 nm to AOD in the UV range.

2.1 Retrieval of AOD in UV range

Estimation of aerosol optical thickness in the UV is typically taken by the extrapolation of optical thicknesses from the visible range of wavelengths by the so-called Angström coefficient (Angström 1929). However, this extrapolation can lead to overestimation of AOD in the UV range. The reason is a dependence of Angström coefficient on wavelength. It decreases towards the shorter wavelengths (Jarosławski *et al.* 2003) and could be even negative for very short UV-B wavelengths. Another way to estimate AOD in UV range is to calculate aerosol optical properties using measured aerosol microphysical properties and Mie light scattering theory. This method provides good agreement with direct sun measurements (Pietruczuk and Jarosławski 2007). In this work we examine aerosol optical properties in the UV range that are directly measured by CIMEL sun-photometer at Belsk and inferred from the satellite observations at visible wavelengths.

Figure 1 shows a scatter plot of AOD at 340 nm measured by CIMEL sun-photometer versus that extrapolated from CIMEL AODs in the visible range using Angström exponent calculated between 440 and 870 nm wavelengths. A sample of about 70 simultaneous CIMEL AOD measurements taken in 2006 was examined. High correlation between measured and extrapolated data is found but the extrapolated AODs are in the mean ~13% larger than those from the direct CIMEL observations in UV. Figure 1 illustrates that the extrapolation method induces substantial overestimation. Figure 2 shows scatter plot of AOD at 340 nm measured directly by CIMEL versus that extrapolated from AODs measured by MODIS at 440 and 870 nm. Lower correlation coefficient is found between direct measurements and UV extrapolated satellite data. Extrapolated satellite data are about 37% larger than those from CIMEL measurements at 340 nm.

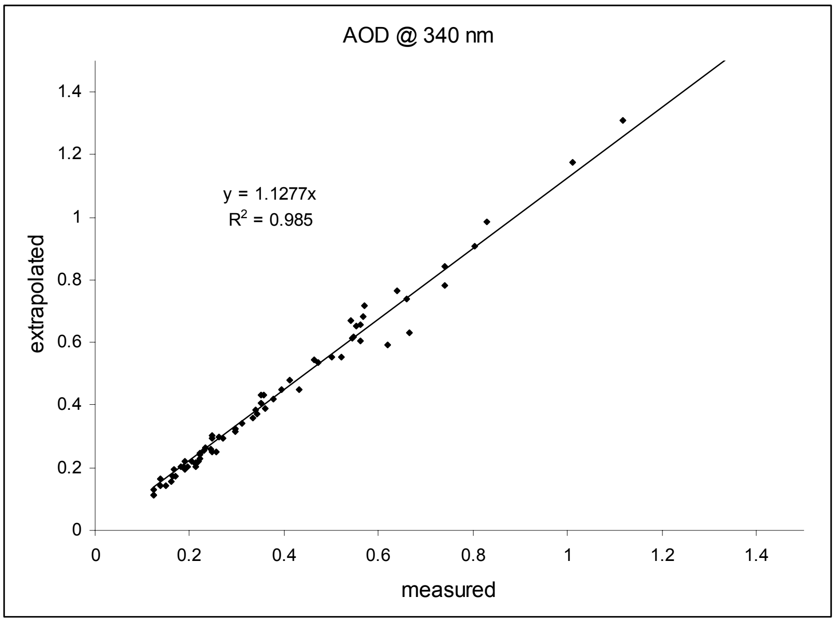

Fig. 1. Correlation between AOD at 340 nm directly measured by CIMEL sun-photometer and extrapolated from CIMEL measurements in visible range.

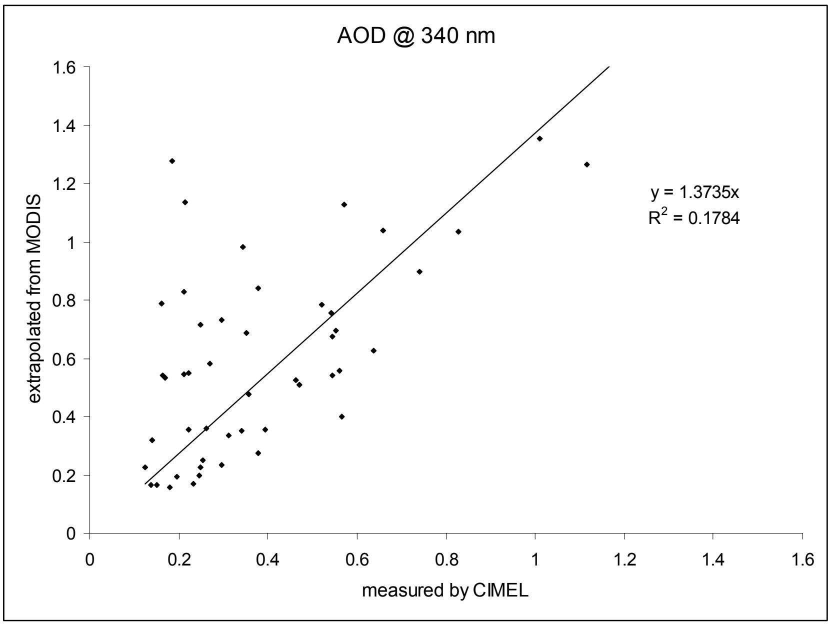

Fig. 2. Correlation between AOD at 340 nm directly measured by CIMEL and AOD extrapolated from MODIS measurements.

3. Synoptic Situation

In this work we analyze optical properties of aerosol measured during dust/smoke events and "clear air mass" event. Moreover, variability of aerosol forcing on surface UV during these events is discussed. Aerosol type and its origin site were determined by the backward trajectories analysis and aerosol diagnostic models. In back trajectory analysis we used HYSPLIT model (Draxler 1998). HYSPLIT is freely available at NOAA Air Resources Laboratory web pages, http://www.arl.noaa.gov/. The DREAM dust transport model (Nickovic 2001) and NAAPS (Navy Aerosol Analysis and Prediction System) prediction system were used to distinguish aerosol type and its loading. Results of DREAM dust model, like dust load and dust optical depths, are available on-line at Barcelona Supercomputing Center web pages, http://www.bsc.es/projects/earthscience/DREAM/. NAAPS results are available on-line at Naval Research Laboratory/Monterey Aerosol Page, http://www.nrlmry.navy.mil/aerosol/. NAAPS provides maps of surface concentration and optical depths of dust, smoke and sulfate aerosol.

Seasonal forest, grass and peat-bog fires are a main source of smoke aerosol in Eastern Europe. Such fires took place mainly in the Eastern Ukraine, Western Russia and Belarus. This spring (end of March 2007), large numbers of fires took place at the border between the Ukraine and Russia. Figure 3 shows fire activity in Eastern Europe at the end of March 2007 detected by MODIS instrument at Aqua and Terra satellite platform. MODIS fire products (Justice *et al*. 2002) are distributed by the University of Maryland, Fire Information for Resource Management System (FIRMS), are available on-line, http://maps.geog.umd.edu.

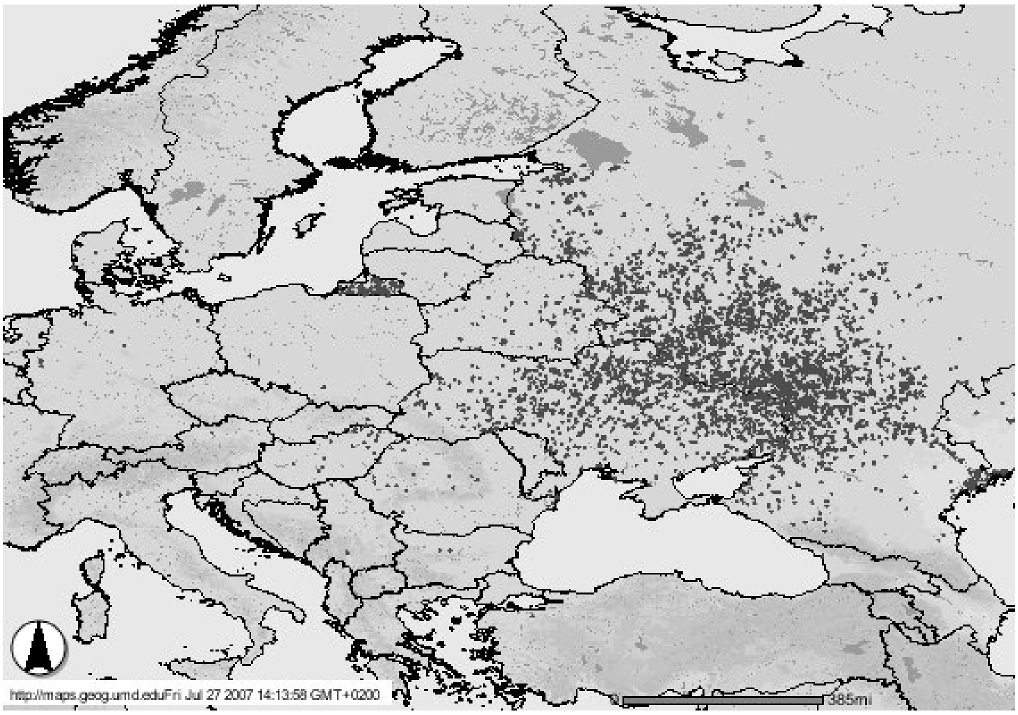

Fig. 3. Fires (dark dots) between 20 and 25 March 2007, provided by FIRMS system.

Biomass burning products were redistributed over Europe by the large-scale atmospheric circulation. Smoke plume was detected by lidar and sun-photometric stations in Minsk, Belarus and Belsk, Poland (Pietruczuk and Chaikovsky 2007). The smoke was transported mainly in the boundary layer but it was also injected into the free troposphere. The smoke layer was detected up to 3 km height. Smoke aerosol is dominated by fine particles which correspond to large values of Angström exponent. The presence of smoke over central Poland was predicted by NAAPS system for the whole period between 24 March and 04 April. Figure 4 shows a sample of vertical distribution of fine and coarse aerosol mode concentration measured 30 March. It is clearly seen that fine mode aerosol dominates the layer up to 2 km which is over a typical height of the boundary layer. This profile was derived from simultaneous lidar and sun-photometric measurements in Belsk.

Dust transported from Sahara to Europe is mainly observed in the Mediterranean region (Balis *et al*. 2006, Lyamani *et al*. 2005, Mona *et al*. 2006) but it affects Eastern

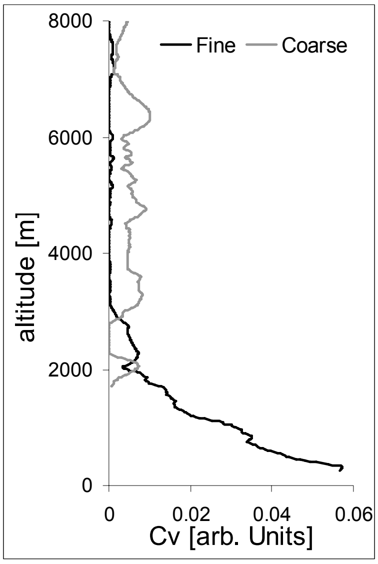

Fig. 4. Vertical profile of fine and coarse mode concentration derived from lidar measurements taken in Belsk, Poland, on 30 March 2007.

and Central Europe several times per year. Such events were detected and studied by lidar networks covering the whole continent (Ansmann *et al.* 2003) and by a single lidar station as well (Kardas *et al.* 2006). Almost the whole Europe was affected by large dust event at the end of March 2007. Transport of dust from Northern Africa over the Middle East towards Eastern Europe is clearly seen from DREAM model output (Fig. 5). The dust plume was followed by the smoke event (Fig. 6). Dust episodes were identified by the models on 23, 26/27 and 30/31 March 2007. Models' estimates are in good agreement with lidar measurements performed at Belsk (Pietruczuk and Chaikovsky 2007). The back trajectory analysis shows that during dust events the air masses present at high altitudes were advected from Northern Africa but at lower altitudes the air masses have their origin in the Eastern Ukraine, a source region of smoke (see Fig. 7a). In those cases the dust layer was lying over the smoke layer. During dust episodes aerosol was dominated by coarse particles, which corresponds to low values of Angström exponent.

At the beginning of April 2007, when fire activity was decreasing, the air circulation changed and the clear air mass from Atlantic Ocean appeared over Poland. These air masses were not affected by industrial areas, which is confirmed by the back trajectory analysis (Fig. 7b). During "clear air mass" event, extremely low values of AOD and extremely high values of meteorological visibility were registered at Belsk. These conditions lasted up to 12 April 2007. Later there was a small dust event but low values of AOD were still registered. Unfortunately, at the beginning of that event the sky was partially covered by clouds and sun-photometric observations up to 13 April were not performed.

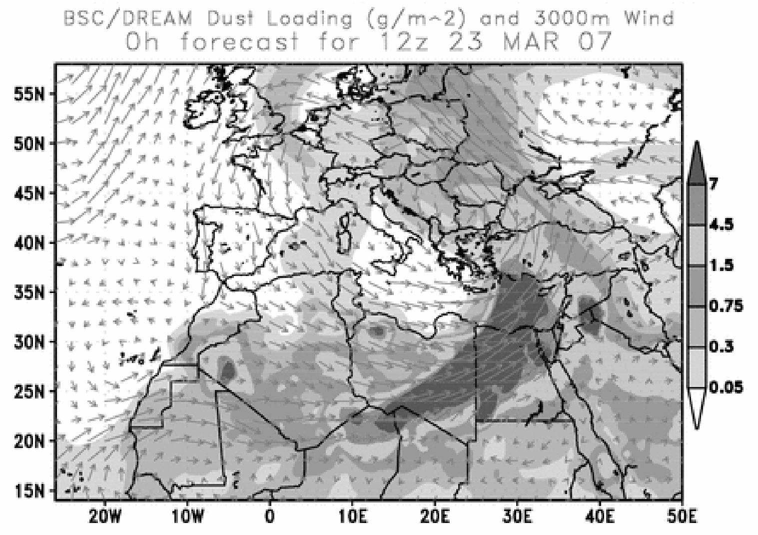

Fig. 5. Dust load over whole Europe on 23 March 2007, provided by DREAM model.

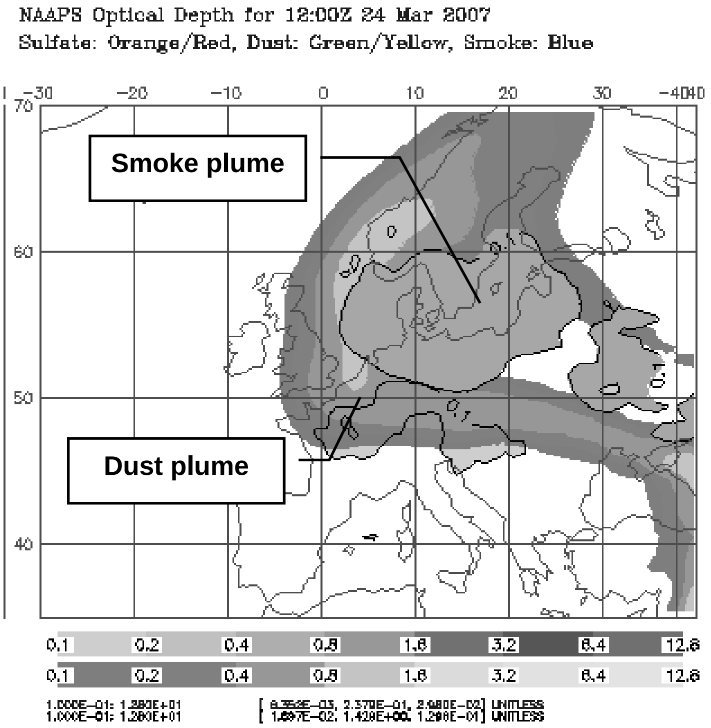

Fig. 6. Dust plume followed by smoke on 24 March 2007, provided by NAAPS system.

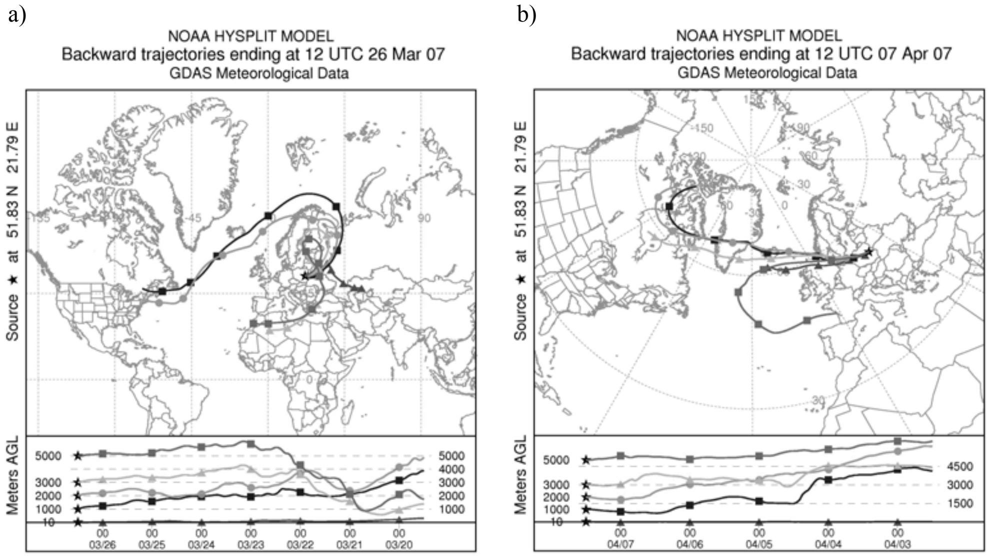

Fig. 7. HYSPLIT back trajectory analysis: (a) dust episode, 26 March 2007, (b) “clear air mass” episode, 07 April 2007.

4. Results and Discussion

Aerosol optical depths at 340 nm derived from direct CIMEL measurements and extrapolated from MODIS retrievals are shown in Fig. 8. It is shown that AOD exceeds the mean value (dashed line) during aerosol load events. The mean value is exceeded about twice on 28 March and up to four times during the 01/02 April event. Episode of the clear Atlantic air mass, from 4 to 12 April, was characterized by the AOD values about twice smaller than the overall mean value. Large variability of AOD in different timescale is also shown in Fig. 8. Long-term variability is probably due to advection of different types of aerosol with different particle concentrations. Diurnal variability of the aerosol properties seems to be strongly affected by conversion processes of aerosol. It should be mentioned that the diurnal variability of aerosol, clearly seen in CIMEL AOD time series, is not available from MODIS data because the satellite overpasses happen at most twice a day whereas CIMEL measures continuously throughout the whole day if weather conditions permit.

Large variability of aerosol properties is also seen at time series of Angström exponent (Fig. 9). Values of the parameter vary from about 0.6 during dust events up to 1.9 during smoke events. During “clear air mass” episode, the Angström exponent measured by CIMEL varies around its long-term mean value but pertaining values taken from MODIS retrievals are much higher and comparable to that measured during the smoke event. This difference could influence estimation of AOD in UV range taken from the MODIS extrapolation from AODs in visible range.

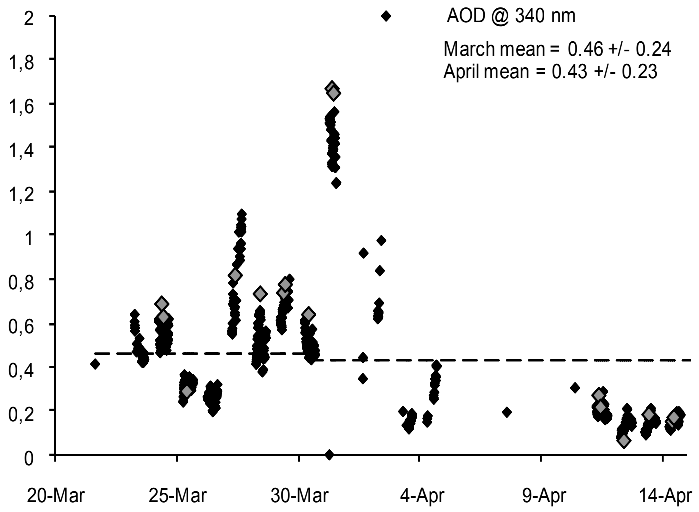

Fig. 8. Aerosol optical depth at 340 nm measured by CIMEL sun-photometer at Belsk (black diamonds) and extrapolated from MODIS retrievals (gray diamonds).

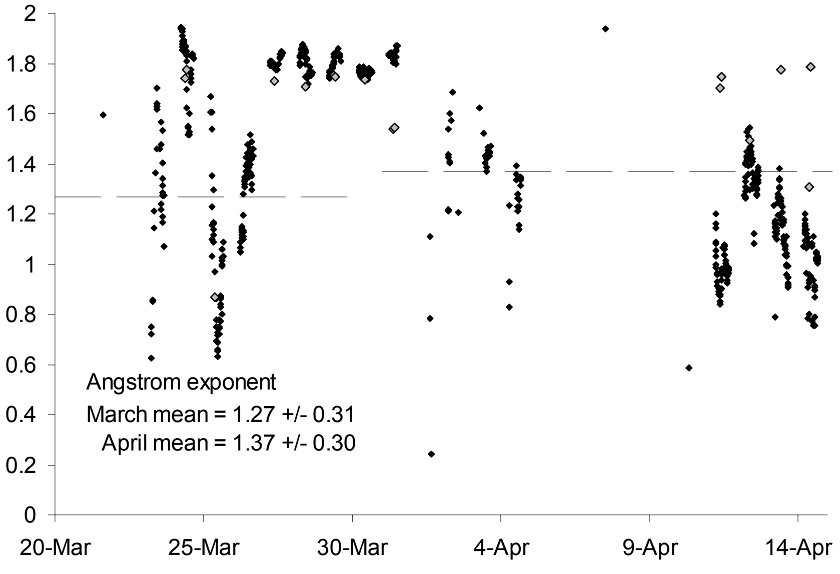

Fig. 9. Angstrom exponent taken from CIMEL measurements at Belsk, 440-870 nm (black diamonds) and MODIS retrievals, 470-670 nm (gray diamonds).

The value of Angström exponent is determined by the aerosol microphysical structure. The aerosol microphysical structure is determined by source of origin and conversion processes during advection and in situ processes (e.g., humidification).

Large values of the parameter are typical for aerosol dominated by fine mode fraction, like smoke, and small values are specific for the aerosol dominated by coarse fraction, like dust.

The back trajectory analysis shows that during days when the Angström exponent was extremely low, 23 and 26 March as well as after 14 April, the air mass at altitudes of about 3000 to 5000 m was advected from Saharan region; see for example Fig. 7a. During episodes when the Angström exponent was extremely high, air mass was advected only from regions of biomass burning. A dust layer over the smoke layer was detected on 30 and 31 March but the dust AOD was much smaller than the smoke AOD see the aerosol concentration profile in Fig. 4. During those days, the columnar properties of the aerosol were typical for the smoke aerosol being dominated by fine mode fraction of the aerosol size distribution. Mean values of aerosol optical properties characteristic for each type of episode are listed in Table 1. Period from 24 March to 4 April was qualified as a smoke event except of 26 March, which was described as a dust event. The period from 5 to 13 April was qualified as a “clear air mass” event.

Table 1

Mean values of aerosol optical properties by aerosol class directly measured by CIMEL and MODIS sun-photometer (AOD at 340 nm) and extrapolated from CIMEL and MODIS visible measurements (Angström exp.) in the period March/April 2007

Aerosol Class	AOD at 340 nm		Angström exp.	
	CIMEL	MODIS	CIMEL	MODIS
Smoke	0.68±0.01	1.00±0.10	1.75±0.01	1.68±0.05
Dust	0.30±0.01	0.28	1.12±0.03	0.87
“clear” air mass	0.16±0.01	0.18±0.06	1.13±0.03	1.67±0.06

We applied the aerosol RAF concept (Krzyścin 2004) to determine the variability of relative clear-sky UV irradiance for cases with different aerosol types. The aerosol RAF follows the power law formula used by Booth (1994) to describe total ozone effects on surface UV radiation. The aerosol RAF is defined by the following formula:

$$\frac{UV}{UV^*} = \left(\frac{\tau^*}{\tau}\right)^{RAF}, \tag{1}$$

where UV denotes the surface erythemally weighted UV irradiance under clear-sky conditions, τ is the actual AOD in UV range, τ^* denotes the overall mean AOD, UV^* represents the clear-sky erythemally weighted UV irradiance calculated from a radiative transfer model with actual total ozone and AOD = τ^*. The aerosol RAF is rather independent of solar zenith angle and equal to about 0.1 for AOD at 320 nm (Krzyścin 2004).

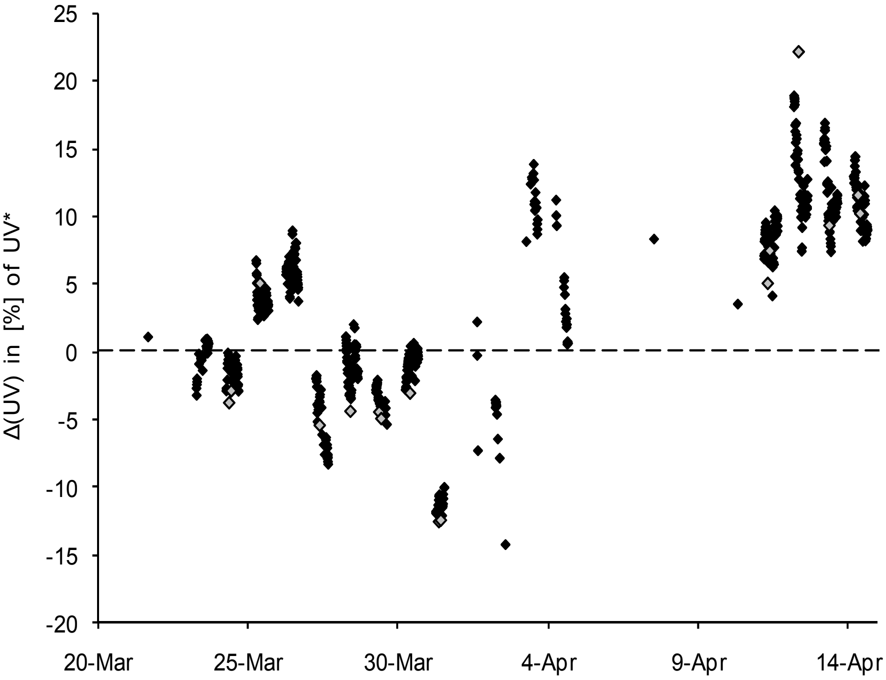

Fig. 10. UV response of changes in aerosol optical depth derived from CIMEL observations at Belsk (black diamonds) and the site MODIS overpasses (gray diamonds) in the period March/April 2007.

Figure 10 shows series of model (1) calculated surface *UV* level relative to the hypothetical UV^* for clear-sky conditions at Belsk with actual total ozone and overall mean aerosol properties. Our previous studies show that mean values of AOD registered in Belsk at 320 and 340 nm are comparable (Pietruczuk and Jarosławski 2007). Thus, the aerosol RAF constants calculated at 320 nm and 340 nm are equivalent. Drawing Fig. 10 we used formula (1) with RAF = 0.1 and the AOD series at 340 nm shown in Fig. 8. It is seen that the AOD variability induces large variations of the surface UV irradiance. In the case of MODIS retrievals, the variability is from −12.7% up to 22.1% and in case of CIMEL data from −14.2% up to 18.8%. Erythemally weighted surface UV irradiances during the smoke episodes were a few percents smaller than the overall mean. The value is around −3% in the case of CIMEL data and around −7% in the case of MODIS data. Dust episodes yield an increase of ~4% in cases of both instruments. Advection of clear Atlantic air masses enhances erythemally weighted UV irradiances of ~10% relative to the overall mean for both instruments. Mean values of aerosol influence on surface UV radiation are summarized in Table 2.

Table 2

Mean values of the UV response of changes in aerosol optical depth derived from CIMEL observations at Belsk and the site MODIS overpasses in the period March/April 2007

Aerosol Class	Δ(UV) in [%] of UV*	
	CIMEL	MODIS
Smoke	−3.1±1.7	−6.9±1.8
Dust	4.5.±1.1	4.9
“clear” air mass	11.0±1.4	10.4±3.7

Figure 10 and Table 2 show that the mean aerosols effects on erythemally weighted surface UV irradiation by the CIMEL are smaller than that by the MODIS retrieval during smoke event and comparable during “clear air mass” and smoke episode. This is due to various spectrophotometers used, different methodologies for estimation of AOD in UV range, and specific time schedule for measurements. MODIS measures at most twice a day whereas CIMEL measures all day if clear Sun is present. Thus, MODIS provides temporary values of AOD around noon, which could be extreme or no representative for the whole day. CIMEL is able to monitor diurnal changes of AOD. Disagreement in case of large AODs (smoke event) is also possible as a result of extrapolation to AOD at 340 nm based on MODIS Angström coefficient derived from AOD at visible wavelengths. Such an algorithm leads to an overestimation of AOD as it was previously discussed in Section 2.

5. Conclusions

During dust/smoke events, large variations of AOD due to long- and short-term changes in aerosols inflow or transformation of aerosol size spectrum were registered by the CIMEL instrument. Variability of aerosol properties induces large variability of erythemally weighted surface UV irradiation. The extreme values of potential influence of changes of AODs on erythemally weighted UV surface radiation at Belsk were −15% during smoke and +20% during clean air mass event. Mean values are from around −7% up to 11% , respectively.

It seems that the satellite observations can provide accurate estimate of the aerosol optical depths for “clear” air masses and when the AOD exhibits small intraday variations. In case of large variations of aerosol optical properties and large values of AOD, extrapolation of MODIS data to UV range overestimates AODs. Moreover, the MODIS observations are not able to provide diurnal variability of AOD, thus the mean AOD may be not representative for the whole day. However, in first approximation, AODs from MODIS follow the pattern of daily changes of AOD directly measured by CIMEL sun-photometer. Thus, it seems that the MODIS retrieval of aerosol data provides valuable input data for diagnostic model dealing with long-term changes in surface UV.

During dust/smoke events, large variations of AOD due to long- and short-term changes in aerosols inflow or transformation of aerosol size spectrum were registered by CIMEL instrument. Variability of aerosol properties induces large variability of aerosol forcing on surface UV radiation

Acknowledgements. This work was partially supported by the State Inspector for Environment Protection, Poland under grant No. 26/2006/F and Scientific Network – "Satellite Geophysics". The author would like to acknowledge Barcelona Supercomputing Center for providing DREAM model results, Naval Research Laboratory for providing NAAPS results and MODIS team for aerosol and fire products.

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Accepted: November 3, 2008

PUBLS. INST. GEOPHYS. POL. ACAD. SC., D-72 (403), 2008

Ultraviolet Radiation Measurements at Belsk Geophysical Observatory in 2006 and 2007

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Measurements of erythemally weighted solar radiation in UV-B range, as well as sunshine duration, were continued in the years 2006 and 2007. The results of measurements were used to calculate diurnal doses of UV-B radiation and UV index which indicates maximum power of UV-B radiation registered during each day. Measurements of solar radiation in UV range have been performed in Belsk Geophysical Observatory by means of Robertson-Berger (R-B) instrument since 1976 to 1994, and then continued by means of UV-biometers manufactured by Solar Light Co., Philadelphia, USA, since 1993. One year of simultaneous measurements of solar radiation by means of Robertson-Berger (R-B) and Solar Light (SL) instrument was necessary to provide continuous and homogeneous record of UV-B radiation. Usage of two UV-biometers (Solar Light 501A model) at Belsk allows to secure continuity of data series when instruments are calibrated and serviced.

Measurements performed in 2006 and 2007 are summarized in Tables 1 and 2. Diurnal doses are expressed in MEDs. One MED (minimal erythermal dose) is equal to 209.88 J/m^2 of erythemally weighted solar radiation. The tables also contain values of UV index, which is a daily maximum value UV flux (in watts per square meter) multiplied by 40. Its values range from 0 to 16.

Tables 3 and 4 present mean and extreme values for each month in 2006 and 2007. Columns from 2 to 4 contain mean, maximum and minimum values of UV radiation daily doses. Column 5 presents the mean values of UV index, column 6 the sunshine duration, column 7 the ozone content, and column 8 the mean value of UV radiation between 1976 and 2006. Column 9 presents the difference between UV radiation in 2007 and the long-term mean.

Data for the year 2007 were analyzed in greater detail.

Figure 1 shows monthly means of diurnal doses of UV-B radiation with standard deviation referred to long-term mean and extreme values for each month. Figure 2 shows differences between long-term mean and the UV-B radiation, ozone content and sunshine duration recorded in 2007.

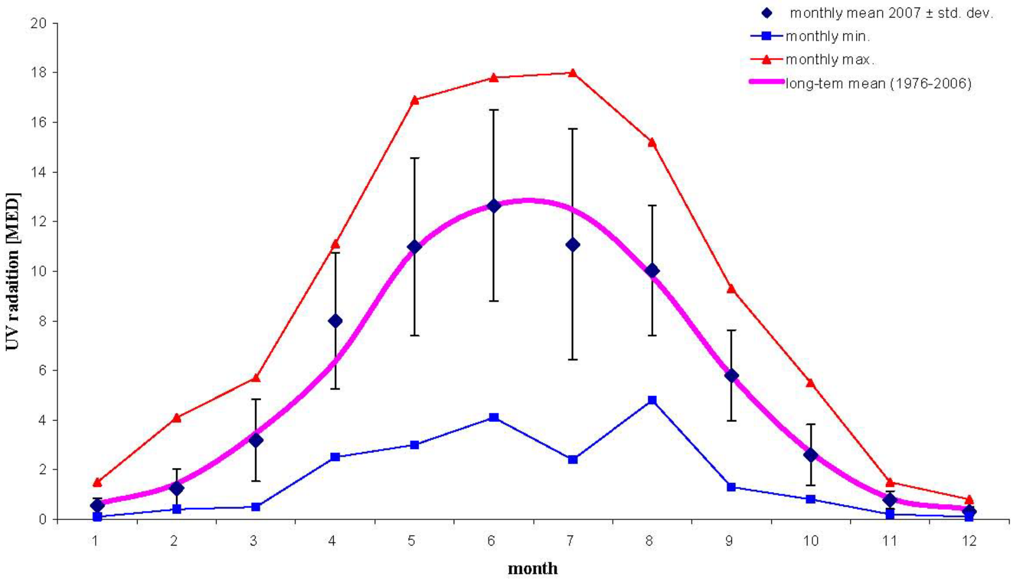

Fig. 1. Monthly means of UV radiation and extreme values in 2007.

The lack of UV-B radiation was registered during winter, early autumn and early spring. Maximum deviation from the long-term mean is 24% in December. In July, UV radiation was 11% lower than the long-term mean. The UV radiation larger than long term mean values by 26% was registered in April. It is clearly seen in Fig. 2 that the lack of UV radiation correlates with the lack of sunshine duration. It is caused by increased cloud cover reducing the solar radiation that reaches the Earth's surface. The lack of solar radiation and the sunshine duration greater than the mean value was observed during March 2007. Such a situation was caused by long-range transport of biomass burning products from western Ukraine and eastern Russia (Pietruczuk and Chaikovsky 2008). Smoke aerosol from fires in this region was transported over Central and East Europe reducing solar radiation. This kind of aerosol effectively scatters UV radiation because of its microphysical structure in which the fine mode is dominant.

Mean UV indexes for each month of 2007 and standard deviation as well as extreme values are shown in Fig. 3. The largest values of UV index were registered during summer season, which are obviously connected with small solar zenith angles. However, large UV indexes were measured in May 2007. The largest value (7.2) was registered on 9 July 2007.

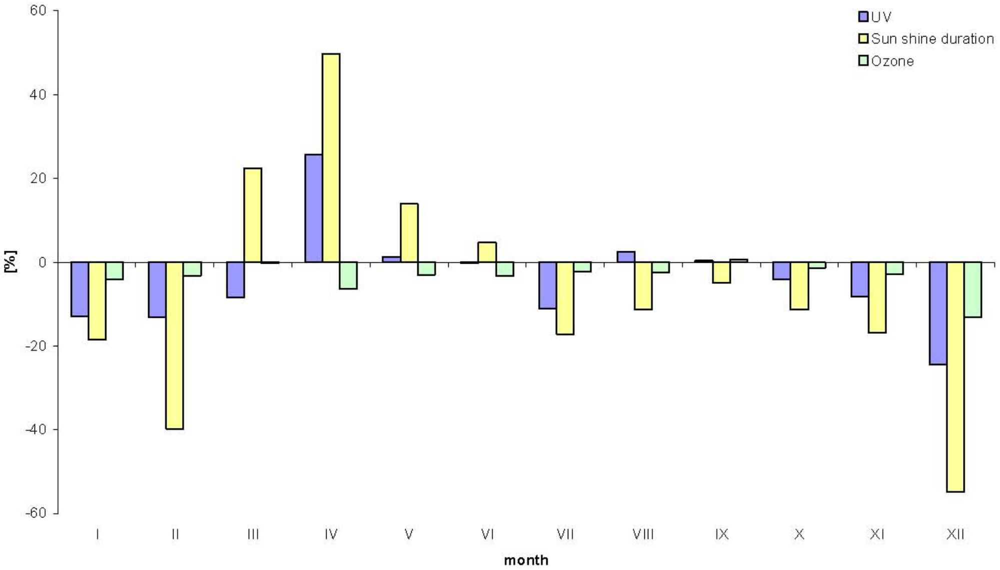

Fig. 2. Differences between long-term mean and monthly means of the UV radiation, sunshine duration and ozone concentration in 2007.

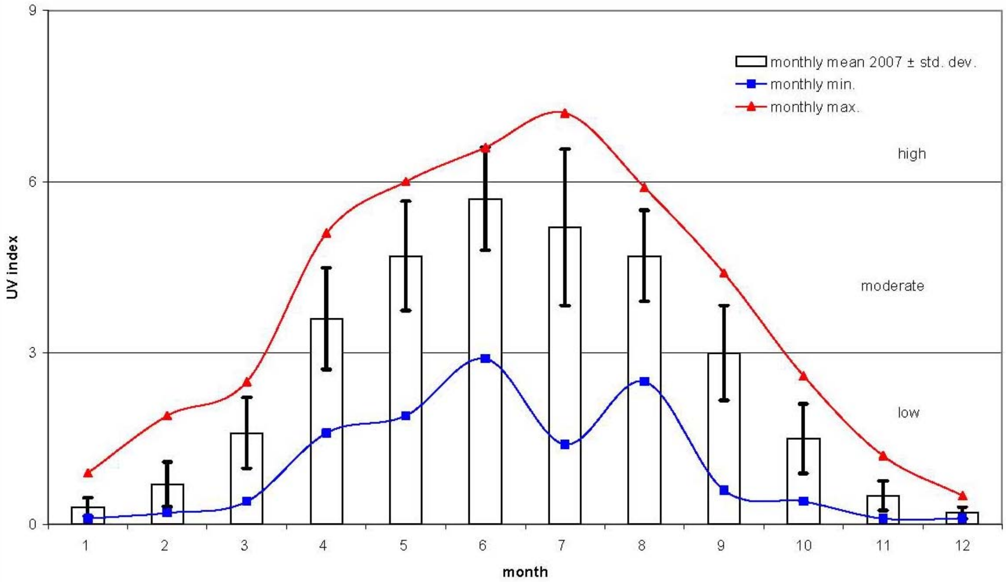

Fig. 3. Monthly mean of UV index and extreme values in 2007.

Figure 4 shows the number of days with UV index larger than 6.5, which is equivalent to 2.8 MED per hour. The number of days with high UV index, larger than

6.5, in June 2007 is smaller than in previous years although in July it is comparable with other years.

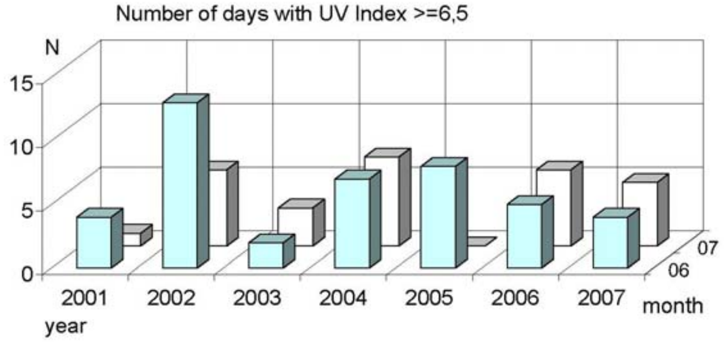

Fig. 4. Number of days with UV index larger than 6.5.

The Belsk ultraviolet radiation data for the years 2006 and 2007 are the last data printed in the year-book form. Data for next years will be available through the Internet at http://www.igf.edu.pl/.

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Accepted November 3, 2008

Table 1

Daily doses of UV-B and UV index, Belsk 2006

Month	I		II		III	
Day	UV-B [MED]	Index UV	UV-B [MED]	Index UV	UV-B [MED]	Index UV
1	0.3	0.2	0.6	0.4	2.7	1.3
2	0.3	0.2	0.5	0.3	2.6	1.3
3	0.3	0.2	0.6	0.6	2.9	1.4
4	0.2	0.2	0.9	0.6	2.2	1.2
5	0.3	0.2	1.4	0.8	3.0	1.5
6	0.3	0.2	1.2	0.6	2.7	1.5
7	1.0	0.5	0.6	0.4	3.6	1.6
8	1.1	0.6	0.6	0.4	3.4	1.6
9	1.0	0.5	1.1	0.6	3.8	1.7
10	1.0	0.5	1.0	0.5	2.5	1.2
11	0.8	0.4	1.4	0.9	2.6	1.5
12	0.4	0.3	0.8	0.4	4.2	1.9
13	0.4	0.2	0.9	0.5	4.1	1.9
14	0.5	0.3	1.3	0.8	2.8	1.5
15	0.8	0.4	1.3	1.0	4.3	2.2
16	1.1	0.6	0.8	0.6	1.6	0.8
17	0.5	0.3	1.3	0.8	2.3	1.2
18	0.4	0.3	2.4	1.2	2.3	1.2
19	0.9	0.5	1.4	0.9	3.9	2.5
20	1.2	0.6	2.5	1.5	7.4	4.2
21	0.3	0.1	1.1	0.9	4.8	2.8
22	1.2	0.6	0.6	0.3	4.5	2.2
23	1.3	0.6	2.5	1.2	7.0	3.1
24	1.4	0.8	2.6	1.4	7.9	3.3
25	1.3	0.8	3.6	1.7	6.5	3.0
26	1.2	0.6	2.0	1.3	2.3	1.3
27	1.3	0.6	3.1	1.4	5.9	3.7
28	1.2	0.8	2.8	1.3	5.8	3.1
29	0.8	0.4			2.5	1.4
30	0.9	0.5			4.6	3.0
31	0.6	0.3			2.8	1.5
Mean	0.78	0.4	1.46	0.8	3.85	2.0
Dev	26%		1%		11%	

Month	IV		V		VI	
Day	UV-B [MED]	Index UV	UV-B [MED]	Index UV	UV-B [MED]	Index UV
1	3.9	2.9	9.1	4.2	10.2	5.2
2	5.3	3.2	7.1	2.6	11.7	5.4
3	5.0	3.0	10.2	4.4	9.5	4.2
4	3.2	2.0	10.8	4.0	7.2	5.0
5	4.6	2.5	6.9	2.5	8.5	5.3
6	5.2	2.8	7.2	3.1	14.2	6.3
7	6.9	2.9	7.9	3.2	12.7	5.9
8	6.3	2.6	9.1	3.9	15.2	5.8
9	5.3	2.7	13.6	5.1	12.1	5.6
10	1.5	0.8	11.5	5.1	14.5	6.5
11	2.4	1.2	11.4	5.0	17.8	6.7
12	5.9	3.1	11.9	4.8	16.1	6.7
13	5.2	2.6	12.4	4.7	18.5	6.3
14	5.1	3.7	8.6	5.2	15.0	6.5
15	4.5	2.0	14.0	5.4	14.7	5.9
16	5.2	3.8	8.0	4.6	16.8	5.8
17	5.5	3.6	8.8	4.7	8.0	3.7
18	6.5	3.9	11.2	5.8	11.1	5.7
19	9.1	4.0	11.7	5.6	14.6	6.0
20	8.3	3.7	11.5	5.6	18.2	6.1
21	10.1	4.0	6.5	3.7	16.3	5.8
22	6.8	3.0	17.3	6.5	12.8	6.1
23	8.0	3.2	12.3	6.0	14.3	6.7
24	6.8	3.3	10.9	5.1	16.8	6.1
25	8.6	3.4	10.4	5.3	18.1	6.1
26	10.0	3.9	8.3	5.0	16.9	6.0
27	11.3	4.3	9.9	5.1	17.7	6.3
28	8.3	3.3	6.6	4.6	15.8	6.1
29	3.7	2.3	8.0	5.3	14.9	6.2
30	4.6	2.7	8.8	5.1	14.2	5.4
31			8.6	37		
Mean	6.10	3.0	10.02	4.7	14.15	5.8
Dev	-4%		-8%		12%	

Month	VII		VIII		IX	
Day	UV-B [MED]	Index UV	UV-B [MED]	Index UV	UV-B [MED]	Index UV
1	16.5	6.8	5.6	3.2	5.7	3.2
2	19.5	6.7	8.3	4.2	9.1	4.3
3	19.4	6.6	12.5	5.3	5.4	2.7
4	18.8	6.7	3.1	1.3	7.9	5.0
5	17.2	5.9	9.7	5.6	5.2	3.9
6	17.4	6.1	5.4	3.1	9.8	4.8
7	16.6	5.8	11.2	5.5	9.8	4.4
8	16.1	5.7	9.8	5.3	6.9	4.4
9	13.0	5.3	7.3	5.9	8.4	4.0
10	15.0	5.4	6.5	4.2	8.5	4.1
11	14.0	5.4	7.5	3.1	8.8	3.9
12	15.3	5.9	11.1	5.0	8.3	3.6
13	13.7	6.1	5.6	4.6	8.4	3.6
14	5.0	2.6	4.2	2.0	8.2	3.4
15	13.6	5.8	10.0	5.0	7.9	3.3
16	17.0	6.3	12.3	5.1	7.9	3.4
17	17.9	6.1	12.5	5.1	7.9	3.3
18	15.9	6.5	7.0	4.7	7.4	3.2
19	16.7	6.5	9.5	5.3	5.8	3.0
20	17.1	6.1	6.7	3.1	4.8	2.9
21	12.8	5.0	10.8	5.2	7.5	3.4
22	13.5	5.5	9.1	5.1	7.0	3.2
23	14.6	5.7	7.6	4.8	6.8	2.9
24	15.4	5.7	8.1	4.0	6.0	2.7
25	15.3	5.8	9.8	4.2	5.9	2.6
26	14.1	5.7	8.3	4.0	6.0	2.6
27	16.1	5.8	9.4	4.4	6.0	2.7
28	16.7	5.9	6.7	4.3	3.3	2.3
29	13.3	5.7	3.6	1.8	5.5	2.6
30	11.7	5.3	2.2	1.2	6.5	2.9
31	14.9	5.6	7.2	4.3		
Mean	15.29	5.8	8.02	4.2	7.09	3.4
Dev	24%		-19%		24%	

Month	X		XI		XII	
Day	UV-B [MED]	Index UV	UV-B [MED]	Index UV	UV-B [MED]	Index UV
1	4.4	2.7	1.3	1.1	0.9	0.5
2	3.6	1.5	0.8	0.5	0.9	0.5
3	3.2	1.7	1.3	0.8	0.9	0.4
4	2.0	1.3	0.5	0.4	0.5	0.3
5	2.8	1.9	0.5	0.3	0.4	0.3
6	5.1	2.5	0.5	0.3	0.9	0.5
7	4.2	2.3	1.0	0.5	0.3	0.2
8	4.5	2.5	1.4	0.9	0.6	0.3
9	2.9	1.4	0.8	0.8	0.6	0.4
10	4.4	2.0	1.1	0.6	0.1	0.1
11	4.3	2.2	0.8	0.5	0.4	0.3
12	3.4	1.7	0.8	0.6	0.2	0.1
13	3.0	1.5	0.8	0.5	0.2	0.2
14	0.8	0.4	0.8	0.5	0.4	0.3
15	2.0	1.5	0.4	0.3	0.9	0.5
16	2.6	1.5	1.3	0.6	0.8	0.4
17	2.7	1.5	1.2	0.6	0.4	0.3
18	3.8	1.8	1.1	0.6	0.3	0.3
19	3.6	1.7	0.4	0.3	0.3	0.1
20	3.1	1.5	0.8	0.5	0.1	0.1
21	3.0	1.5	0.5	0.3	0.5	0.3
22	3.1	1.6	0.8	0.4	0.1	0.1
23	1.9	1.1	0.6	0.6	02	0.2
24	1.8	1.5	0.6	0.4	0.2	0.1
25	1.2	1.0	1.1	0.6	0.6	0.4
26	3.0	1.5	1.0	0.5	0.6	0.3
27	2.7	1.4	1.0	0.5	0.2	0.2
28	2.7	1.5	0.5	0.3	0.3	0.2
29	0.6	0.5	0.5	0.3	0.3	0.2
30	2.4	1.2	0.4	0.4	0.6	0.4
31	2.0	1.2			0.5	0.4
Mean	2.93	1.6	0.82	0.5	0.46	0.3
Dev	9%		-4%		12%	

Table 2

Daily doses of UV-B and UV index, Belsk 2007

Month	I		II		III	
Day	UV-B [MED]	UV Index	UV-B [MED]	UV Index	UV-B [MED]	UV Index
1	0.3	0.3	0.6	0.5	1.8	1.5
2	0.4	0.3	1.2	0.6	1.9	1.2
3	0.2	0.1	0.6	0.5	1.3	1.1
4	0.2	0.2	1.4	0.8	0.5	0.5
5	0.2	0.2	1.1	0.6	3.0	1.5
6	0.2	0.1	0.5	0.4	2.7	1.5
7	0.1	0.1	1.0	0.5	3.4	1.6
8	0.6	0.3	0.4	0.3	2.2	1.3
9	0.6	0.4	1.0	0.6	1.9	1.6
10	0.3	0.2	1.4	0.9	3.3	1.7
11	0.4	0.3	1.3	0.6	2.8	2.0
12	0.2	0.2	0.9	0.4	5.3	2.4
13	0.6	0.4	0.8	0.5	5.1	2.3
14	0.4	0.4	0.6	0.4	3.8	1.7
15	0.5	0.3	0.9	0.5	3.4	1.9
16	0.6	0.4	1.0	0.5	3.9	2.3
17	0.6	0.4	1.6	0.9	1.1	0.6
18	0.3	0.2	1.9	1.0	1.9	1.5
19	0.4	0.3	0.4	0.3	2.5	1.4
20	0.6	0.4	1.0	0.4	0.9	0.6
21	0.9	0.5	2.5	1.3	0.8	0.6
22	0.6	0.4	0.5	0.2	2.5	1.8
23	0.8	0.5	4.1	1.9	0.8	0.4
24	0.4	0.2	2.7	1.3	4.8	2.0
25	0.8	0.4	2.0	1.1	5.2	2.3
26	1.5	0.9	1.2	0.8	5.3	2.3
27	0.8	0.5	1.5	1.5	5.7	2.5
28	0.8	0.4	1.0	0.6	5.1	2.3
29	1.1	0.6			5.7	2.5
30	0.8	0.5			4.7	1.9
31	0.4	0.3			5.3	2.2
Mean	0.54	0.3	1.25	0.7	3.18	1.6
Dev	-13%		-13%		-8%	

Month	IV		V		VI	
Day	UV-B [MED]	UV Index	UV-B [MED]	UV Index	UV-B [MED]	UV Index
1	4.2	1.8	8.1	3.8	10.4	5.0
2	6.1	2.8	12.5	4.6	4.1	2.9
3	5.5	2.6	13.7	5.0	5.7	5.6
4	6.6	3.2	13.2	4.8	5.7	3.8
5	7.7	3.8	12.3	4.8	10.7	6.6
6	4.6	3.3	3.0	1.9	15.4	6.0
7	3.0	1.9	9.6	4.4	17.5	6.2
8	5.2	3.7	7.1	4.6	16.9	6.1
9	2.5	1.6	8.1	5.0	11.4	5.5
10	2.7	1.7	6.2	3.2	10.3	5.8
11	8.8	3.9	9.5	5.0	17.8	6.2
12	10.3	4.1	9.6	5.0	17.0	5.8
13	10.2	4.0	13.6	5.6	11.8	5.3
14	10.7	4.2	13.3	5.0	14.9	5.4
15	10.1	4.0	11.3	5.3	13.9	5.6
16	9.8	3.9	4.0	2.7	12.3	5.7
17	9.7	3.8	8.9	4.7	16.7	6.2
18	6.0	4.0	10.7	5.0	9.3	5.6
19	8.4	4.3	14.0	4.8	12.2	5.8
20	8.6	3.7	14.0	5.2	16.6	6.2
21	9.7	3.9	12.3	4.4	17.0	6.2
22	10.8	4.1	12.1	4.7	5.1	3.1
23	9.6	4.1	13.9	5.1	12.2	6.5
24	5.4	2.6	16.9	6.0	16.3	6.5
25	11.0	4.2	15.9	5.8	15.9	6.3
26	10.8	4.2	10.2	5.3	9.0	5.9
27	11.1	4.3	12.7	5.2	14.2	6.6
28	10.2	4.2	15.5	5.8	13.2	5.9
29	10.9	4.5	16.1	5.9	13.3	6.3
30	9.9	5.1	7.4	3.1	12.5	6.1
31			4.7	3.1		
Mean	8.00	3.6	10.98	4.7	12.64	5.7
Dev	26%		1%		0%	

Month	VII		VIII		IX	
Day	UV-B [MED]	UV Index	UV-B [MED]	UV Index	UV-B [MED]	UV Index
1	14.3	6.2	13.5	5.6	6.2	4.0
2	15.2	5.9	15.2	5.6	7.7	4.4
3	10.4	6.5	5.6	3.6	7.1	3.4
4	4.0	2.4	9.1	4.1	4.8	2.2
5	7.0	3.8	8.3	3.9	1.3	0.6
6	2.4	1.4	9.4	4.7	4.1	2.4
7	5.9	4.7	13.6	5.3	3.4	2.5
8	12.6	6.5	11.4	5.5	9.3	4.1
9	16.5	7.2	4.8	2.5	4.2	4.1
10	3.9	2.6	6.0	4.3	5.1	3.2
11	8.4	3.9	8.3	5.4	4.6	3.3
12	9.1	3.8	8.9	4.7	5.8	3.7
13	8.9	5.3	5.8	3.2	7.0	3.7
14	12.4	6.0	12.4	5.5	8.3	3.8
15	16.6	5.8	12.5	5.3	5.8	3.1
16	18.0	6.5	14.7	5.9	6.3	2.9
17	18.0	6.3	11.6	5.1	8.8	3.8
18	5.9	3.4	11.8	5.1	6.9	3.1
19	17.2	6.7	11.5	4.6	6.0	3.4
20	17.7	6.3	8.2	4.5	6.9	3.3
21	11.3	5.9	9.7	5.2	7.3	3.2
22	11.6	5.8	10.4	5.4	7.2	3.1
23	15.5	5.7	11.3	5.2	6.3	2.9
24	10.0	5.4	11.1	5.3	6.8	3.0
25	5.0	4.7	10.4	4.5	6.3	2.7
26	16.1	6.3	11.0	5.2	1.7	0.9
27	11.2	5.7	10.1	4.8	5.1	2.6
28	12.8	5.4	10.4	4.6	3.9	2.6
29	13.3	5.9	9.3	4.3	5.4	2.5
30	5.7	4.4	9.0	4.6	4.4	2.4
31	6.7	5.0	5.5	3.0		
Mean	11.08	5.2	10.03	4.7	5.80	3.0
Dev	-11%		2%		0%	

Month	X		XI		XII	
Day	UV-B [MED]	UV Index	UV-B [MED]	UV Index	UV-B [MED]	UV Index
1	5.5	2.6	1.3	0.9	0.8	0.5
2	2.8	1.8	1.5	1.2	0.5	0.4
3	3.3	2.3	1.5	1.2	0.2	0.2
4	3.6	1.8	1.2	0.9	0.2	0.2
5	3.1	2.3	1.0	0.5	0.3	0.2
6	2.9	2.4	1.0	0.5	0.3	0.3
7	3.6	2.2	0.8	0.8	0.3	0.2
8	2.7	1.6	0.5	0.3	0.5	0.3
9	4.4	2.4	0.3	0.3	0.3	0.2
10	4.4	2.2	0.8	0.5	0.2	0.1
11	3.6	2.0	1.0	0.5	0.1	0.1
12	1.0	0.9	0.5	0.3	0.1	0.1
13	2.6	1.7	0.4	0.5	0.5	0.3
14	3.9	2.0	0.6	0.4	0.2	0.2
15	4.1	1.9	0.8	0.5	0.2	0.2
16	3.7	1.8	1.0	0.5	0.3	0.3
17	3.3	1.6	0.8	0.4	0.3	0.2
18	1.6	1.4	0.6	0.5	0.2	0.1
19	1.1	0.8	0.5	0.3	0.2	0.2
20	2.0	1.4	0.8	0.4	0.1	0.1
21	2.9	1.4	0.9	0.5	0.2	0.1
22	1.5	1.1	1.0	0.5	0.6	0.4
23	0.8	0.4	1.0	0.5	0.5	0.3
24	2.4	1.3	0.3	0.2	0.1	0.1
25	1.0	0.5	0.3	0.3	0.1	0.1
26	1.3	0.9	0.3	0.1	0.4	0.3
27	1.9	1.2	0.3	0.2	0.3	0.2
28	0.9	0.5	1.1	0.6	0.5	0.3
29	1.8	1.2	1.0	0.5	0.6	0.3
30	1.1	0.8	0.2	0.2	0.3	0.2
31	1.6	1.2			0.3	0.3
Mean	2.59	1.5	0.78	0.5	0.31	0.2
Dev	-4%		-8%		-24%	

Table 3

Mean daily values for each month in 2006

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	UV-B	UV-B	UV-B	Index	G	G/Go	US	OZON	UV-B/G	UV-B	d [%]
2006:	[MED]	[MED]	[MED]	UV	[MJ/m^2]		[HOUR]	[D]		76-05	
M	mean	min.	max.	mean	mean	mean	mean	mean	mean	mean	
1	0.78	0.2	1.4	0.4	3.18	0.38	1.7	305	0.25	0.62	26
2	1.46	0.5	3.6	0.8	5.29	0.38	1.7	386	0.28	1.44	1
3	3.85	1.6	7.9	2.0	10.43	0.49	3.2	386	0.37	3.46	11
4	6.10	1.5	11.3	3.0	14.49	0.47	5.1	389	0.42	6.38	-4
5	10.02	6.5	17.3	4.7	19.63	0.52	6.9	363	0.51	10.87	-8
6	14.15	7.2	18.5	5.8	23.48	0.57	9.0	336	0.60	12.61	12
7	15.29	5.0	19.5	5.8	25.65	0.64	11.9	317	0.60	12.38	24
8	8.02	2.2	12.5	4.2	13.57	0.40	4.5	325	0.59	9.85	-19
9	7.09	3.3	9.8	3.4	14.14	0.56	6.9	281	0.50	5.73	24
10	2.93	0.6	5.1	1.6	7.04	0.43	3.5	264	0.42	2.69	9
11	0.82	0.4	1.4	0.5	2.87	0.30	1.4	282	0.29	0.85	-4
12	0.46	0.1	0.9	0.3	2.04	0.30	1.3	260	0.23	0.41	12

Table 4

Mean daily values for each month in 2007

	UV-B	UV-B	UV-B	UV	SSD	OZONE	UV-B	Diff. [%]
				Index			1976-06	
2007:	[MED]	[MED]	[MED]		[HOUR]	[D]	[MED]	
M	mean	min.	max.	mean	mean	mean	mean	
1	0.54	0.1	1.5	0.3	1.2	324	0.62	-13
2	1.25	0.4	4.1	0.7	1.3	361	1.44	-13
3	3.18	0.5	5.7	1.6	4.3	381	3.47	-8
4	8.00	2.5	11.1	3.6	7.8	360	6.37	26
5	10.98	3.0	16.9	4.7	8.2	356	10.84	1
6	12.64	4.1	17.8	5.7	8.1	342	12.66	0
7	11.08	2.4	18.0	5.2	6.4	332	12.47	-11
8	10.03	4.8	15.2	4.7	6.4	311	9.79	2
9	5.80	1.3	9.3	3.0	4.6	301	5.78	0
10	2.59	0.8	5.5	1.5	3.0	284	2.70	-4
11	0.78	0.2	1.5	0.5	1.2	283	0.85	-8
12	0.31	0.1	0.8	0.2	0.4	272	0.41	-24

PUBLS. INST. GEOPHYS. POL. ACAD. SC., D-72 (403), 2008

Global Solar Radiation and Direct Aerosol Forcing at Belsk, Poland

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Abstract

A comparison of global solar radiation fluxes at the bottom of the atmosphere and Direct Aerosol Radiative Forcing (DARF) values determined by two different methods is presented. Analysis of data covers the period from 2002 to 2005. Global solar radiation fluxes and DARF obtained at the Geophysical Observatory at Belsk by means of CM11 pyranometer are compared with fluxes and DARF calculated for Belsk AERONET station by radiation transfer model. Aerosol microphysical properties retrieved from almucantar measurements taken by Cimel CE318A Sun-sky scanning radiometer are used in the radiation transfer model. The analysis of fluxes of global solar radiation at the bottom of the atmosphere indicates that the average difference between data taken by the two methods is about 2%. Besides, 95% of cases are within 10% interval of differences, and 84% of cases are within 5%. In the case of DARF, the agreement of results taken by the two methods is much worse. The average percentage difference between DARF values calculated on the basis of measurements taken by the two methods is about 20%. Besides, only 20% of cases are within 10% interval of differences and 29% of cases are within 20%. In both cases, values obtained from pyranometric measurements are lower than the values from radiometric measurements.

1. Introduction

Aerosol particles have been recognized recently as one of the more important factors forming climate of the Earth. They modify the radiation balance of the Earth-atmosphere system directly, reflecting and absorbing solar radiation (Charlson *et al.* 1987, Ackerman 2000) as well as the Earth thermal (infrared) radiation (Vogelmann *et al.* 2003). Aerosols affect climate also acting as condensation nuclei in the process of clouds formation (Twomey 1959) which have a large influence on planetary albedo. Influence of aerosols on the Earth's climate is commonly described by Aerosol Radiative Forcing parameter which is a difference between fluxes of solar radiation with and without the presence of aerosol in a column of the atmosphere.

The goal of this study was to make a comparison of solar radiation at the ground and Direct Aerosol Radiative Forcing (DARF) measured directly by pyranometer and calculated from radiative transfer model and aerosol microphysical parameters. Measurements were performed in the Geophysical Observatory at Belsk, Poland.

2. Site Description and Instrumentation

Geophysical Observatory at Belsk (51°50'N, 20°47'E) is located in central Poland about 50 km south of Warsaw, the nearest big city. The distance to the nearest industrial region (Silesia) exceeds 200 km (south-west direction). Therefore, the observatory may be considered as a background station.

The downward global radiant flux, in the spectral range from 300 to 2800 nm, was measured by the Kipp and Zonen pyranometer CM11. The data averaged over 5-minute time intervals were used in this study. Aerosol microphysical and optical properties were evaluated from measurements made by collocated CIMEL Sun-sky radiometer, which is part of AERONET network (Holben *et al.* 1998). We used level 2.0 of version 2 inversion products (Version 2 Inversion Products Description, http://aeronet.gsfc.nasa.gov/). Version 2 of AERONET inversion product contains aerosol microphysical properties and radiative fluxes at the top and bottom of the atmosphere, as well as direct aerosol radiative forcing values. Those solar radiation fluxes were calculated on the basis of aerosol microphysical properties derived from the direct and diffuse radiation measured by CIMEL radiometer and radiative transfer model (Dubovik and King 2000).

The direct Aerosol Radiative Forcing (according to AERONET) is defined by:

$$\Delta F = F_{A\downarrow}^{p} - F_{0\downarrow}^{r} \tag{1}$$

where ΔF is the DARF [W/m^2], $F_{A\downarrow}^{p}$ is the value of downwelling solar flux [W/m^2] in case of aerosol presence, and $F_{0\downarrow}^{r}$ is the value of downwelling solar flux [W/m^2] for the aerosol-free case. The solar flux for aerosol-free case was taken from AERONET inversions. Flux in the case of aerosol presence was directly measured by pyranometer or taken from AERONET inversions.

3. Results and Discussion

3.1 Downwelling flux

A comparison of solar flux at the bottom of the atmosphere measured by means of a pyranometer and that computed from CIMEL measurements is shown in Fig. 1. The presented data set contains 792 pairs of measurements collected from 01 May 2002 to 28 January 2006. The number of data pairs is limited by the number of CIMEL almucantar scans.

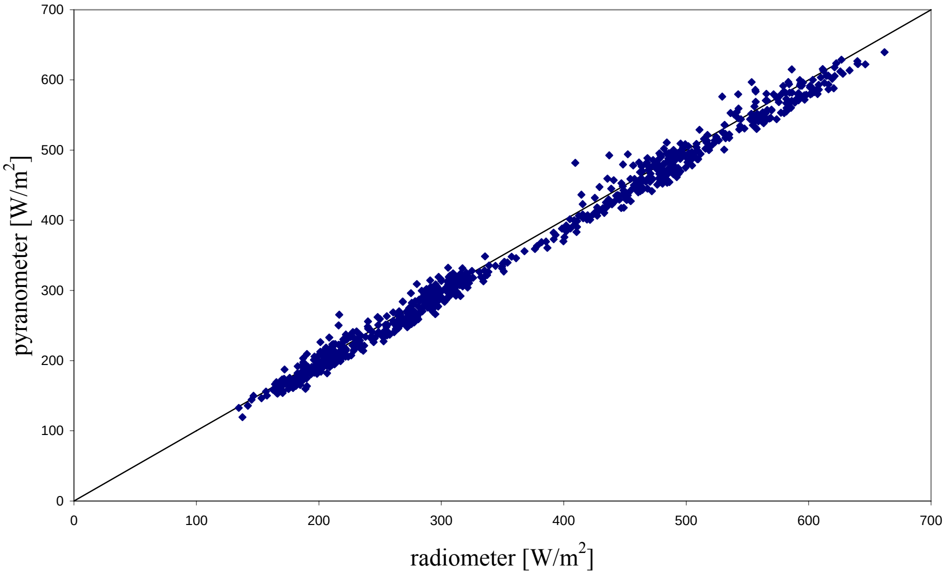

Fig. 1. Scatter plot of solar fluxes at the bottom of the atmosphere measured by pyranometer and derived from CIMEL almucantar inversions.

Table 1 presents squares of correlation coefficients and slopes of regression lines for the whole set of data and for the data taken at successive years. The presented values of slopes indicate that the values of downwelling solar fluxes measured by pyranometer are mostly less than those calculated from almucantar retrievals and provided by AERONET team. The largest differences are observed in 2002.

Table 1

Slopes and correlation coefficients

Year	2002-2005	2002	2003	2004	2005
Slope	0.9864	0.9620	0.9990	0.9915	0.9923
Square of correlation coefficient	0.9918	0.9958	0.9705	0.9926	0.9916

Table 2 presents values of average percentage differences between analyzed total solar fluxes and their standard deviations for the successive years of the analyzed period. The difference within the whole analyzed period is 2% with 4% standard deviation.

Table 2

Differences between the analyzed total solar fluxes

Year	2002	2003	2004	2005
Average percentage difference	2.9%	4.7%	0.9%	2.0%
Standard deviation of differences	3.5%	4.4%	4.0%	4.1%

3.2 Direct aerosol radiative forcing

Comparison of direct aerosol radiative forcing at the bottom of the atmosphere taken from measurements and calculations based on almucantar retrievals for the whole period is shown in Fig. 2. Regression line fitted to the pairs of points in this figure has a slope of –0.90 and a square of correlation coefficient is 0.63. So, the DARF values measured by means of pyranometric method are smaller on the average than those retrieved from almucantar scans.

The average value of DARF for Belsk obtained by means of pyranometric method is –37.3 W/m^2, while that calculated from AERONET retrievals is 30.5 W/m^2. The difference in absolute values of these averages expressed in percentage is about 20%. The square of correlation coefficient value of 0.63 indicates correlation between the two parameters but it is much weaker than in the case of solar fluxes.

Figure 3 presents differences in DARF values obtained by means of the two methods as a function of DARF taken by means of radiometric method. The largest differences occur for the smallest values of DARF where errors of solar fluxes measurements are largest.

4. Summary

In the case of solar radiant flux, the agreement of results obtained by pyranometer and radiometer is quite good. The average difference of 2% which reveals during the data analysis lies within the range of errors connected only with the pyranometer used for measurements. The accuracy of data calculated from radiometric measurements is difficult to estimate. In particular, relatively high errors may occur in situations of low aerosol optical depths, high solar zenith angles or a decrease of angular coverage of scattering in the sky radiance (Dubovik *et al.* 2000).

In the case of DARF, the discrepancy of results obtained by the two methods is much higher. The agreement is better for the values of DARF larger than 60 W/m^2.

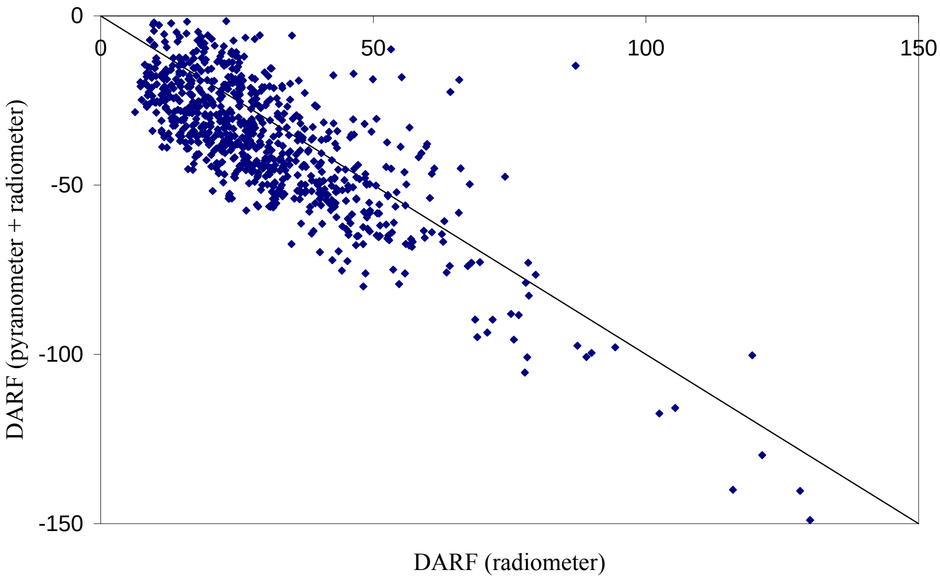

Fig. 2. Comparison of DARF values at the bottom of the atmosphere derived from almucantar retrievals and pyranometric measurements.

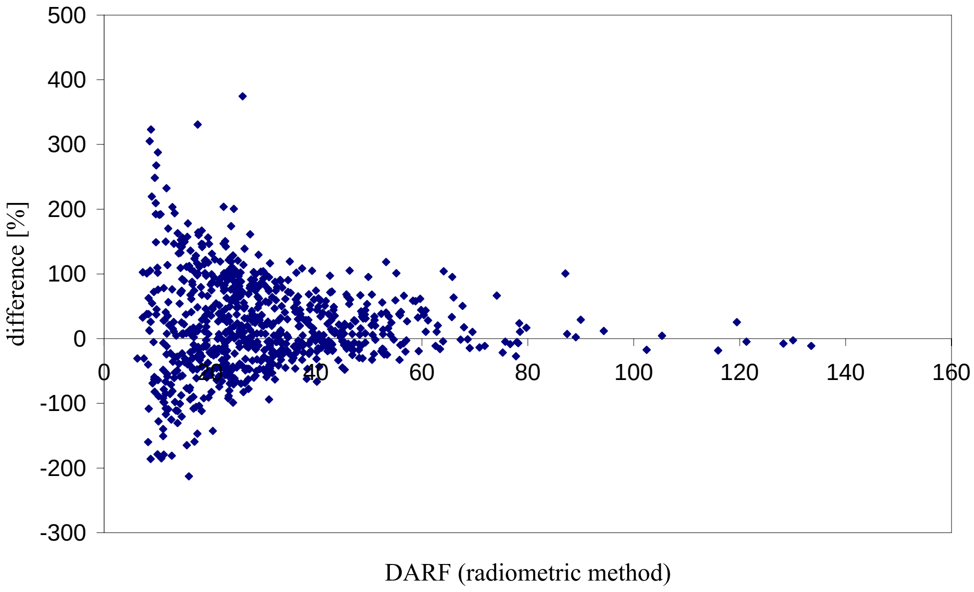

Fig. 3. Differences of DARF values obtained by the two methods as a function of DARF obtained by radiometric method.

5. Acknowledgment

The authors thank Brent N. Holben, the Principal Investigator, and all members of his group, for establishing and maintaining the Belsk site, as well as for the data processing.

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Accepted: November 3, 2008

PUBLS. INST. GEOPHYS. POL. ACAD. SC., D-72 (403), 2008

Lidar Observations of Stratospheric Aerosol over Belsk Geophysical Observatory in 1996-2006

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Abstract

Results of over 10 years of lidar measurements of stratospheric aerosol at 532 nm wavelength have been analysed. Averaged stratospheric aerosol optical depths and selected profiles of scattering ratio versus altitude are presented. Their analysis in relation to historical results of several authors in the sixties, seventies and eighties of the last century is made. It has been found that in the years 1996-2006 the stratosphere underwent a cleaning process, manifesting itself by decreasing aerosol optical depth, down to a level of about 0.002, that is, to the aerosol background level typical of the period before the Pinatubo eruption in 1991.

1. Introduction

The presence of aerosol in the stratosphere was postulated for the first time in 1927 by Gruner and Kleinert (1927). This postulate was confirmed experimentally by Junge (1961), Fiocco and Grams (1964), Grams and Fiocco (1967) as well as Castelman *et al.* (1973). The aerosol layer discovered at that time in the stratosphere, at an altitude of about 20 km, was named “Junge layer”. The main sources supplying aerosol to the stratosphere are the most powerful volcanic eruptions, which deliver volcanic ash, sulfur dioxide and water vapour to the altitudes above tropopause. Such powerful eruptions occur once per several years, and each time the aerosol level in the stratosphere rapidly increases after such an eruption, and then, after some alterations and falling out – reduces to a certain background level that remains stable until a next eruption. Lidar sampling makes it possible, under some assumptions, to determine vertical profiles of aerosol scattering coefficients as well as aerosol optical depths of the stratosphere. On this basis it is possible, under some limitations, to estimate sizes of aerosol particles and their concentration.

2. Basic Formulas

A convenient form of presenting results of lidar sampling of the stratosphere is the use of a parameter called scattering ratio (SCR), which is a measure of the ratio of total to molecular scattering at fixed wavelength λ (Russel *et al.* 1976),

$$SCR(z) = \frac{\beta_2(z) + \beta_1(z)}{\beta_2(z)} = 1 + \frac{\beta_1(z)}{\beta_2(z)}$$

where $\beta_1(\lambda, z)$ [$\mathrm{m^{-1}sr^{-1}}$] is the backscattering coefficient of aerosol, $\beta_2(\lambda, z)$ [$\mathrm{m^{-1}sr^{-1}}$] is the backscattering coefficient of air molecules, z is the distance from a lidar.

The profile of backscattering coefficient in the stratosphere at a fixed wavelength can be determined from lidar signal profile $U(z)$ on the basis of the following formula (Puchalski 1999):

$$\beta_1(z) = \frac{U(z)\exp[A(z)]}{\dfrac{U(z_0)}{\beta_1(z_0) + \beta_2(z_0)} + 2S_1 \int\limits_{z_0}^{z} U(r)\exp[A(r)]dr} - \beta_2(z)$$

where:

$$A(z) = 2(S_1 - S_2)\int\limits_{z_0}^{z} \beta_2(r)dr$$

S_1 and S_2 are aerosol and air molecules lidar ratios, respectively, and z_0 is the distance to the upper boundary of the sampling layer. The profile of $\beta_2(\lambda, z)$ coefficient depends on the air density and can be determined from a model of the atmosphere, or a Raman lidar sampling. In this study, $\beta_2(\lambda, z)$ was determined from the standard model of the atmosphere (Bielenkii *et al.* 1987).

3. Optical Properties of Atmospheric Aerosol

Figure 1 shows a plot of maximum values of $\beta_1(z)/\beta_2(z)$ = SCR(z) − 1 in the stratosphere at λ_1 = 694.3 nm as a function of time interval between Mt. Agung 1963 and Mt. Fuego 1974 volcano eruptions. The graph has been plotted on the basis of results of measurements collected from the literature (Russel *et al.* 1976).

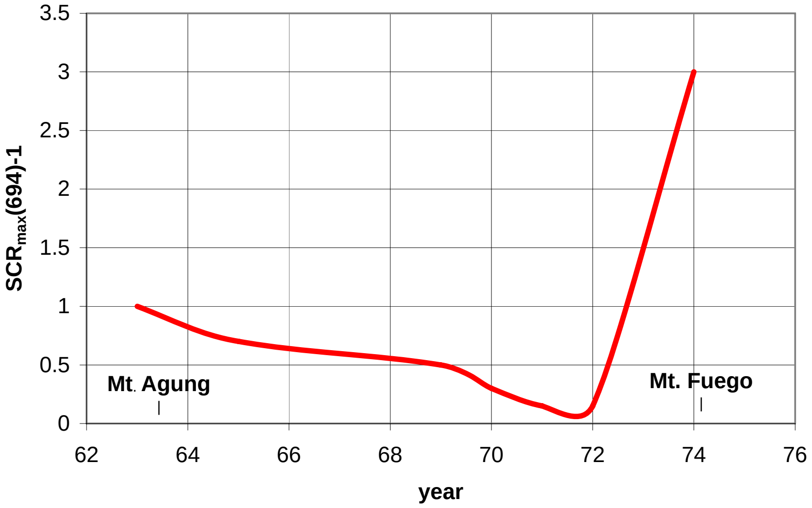

Fig. 1. A plot of $[\beta_1(z)/\beta_2(z)]$max = SCR$_{max}$–1 for the stratosphere at λ_1 = 694.3 nm between Mt. Agung and Mt. Fuego eruptions.

Figure 2 presents relations between scattering ratio SCR(532) at λ_2 = 532 nm and atmospheric extinction, expressed by volume scattering coefficient α_1 (532), for different altitudes H in the atmosphere. As can be seen, considerable differences of extinction coefficients may occur at different altitudes despite of the same value of SCR. So, the presentation of results of lidar sampling in the form of SCR(H) reveals and exposes fine changes in aerosol extinction in the upper layers of the atmosphere and therefore is very suitable for investigation of the stratosphere.

Figure 3 presents plots of ratios of scattering ratios QSCR for the three most often used lidar wavelengths: λ_1 = 694.3 nm, λ_2 = 532 nm and λ_3 = 1064 nm as a function of SCR(λ_2 = 532 nm), and for the three models of atmospheric aerosol (expressed by three values (−1, 0, +1) of exponent m in Angstrom formula). These plots enable to estimate the dependence of SCR on wavelength, and then to link the results of sampling performed nowadays at 532 and 1064 nm with historical results performed mainly at 694.3 nm. As the stratospheric aerosol has features close to the specific aerosol (Table 1) (Valero *et al.* 1992), the differences between SCR(λ_2 = 532nm) and SCR(λ_1 = 694.3 nm), as can be seen from Fig. 3, are not large and linking the results of sampling performed nowadays, mainly at λ_2, with historical results performed at λ_1 is possible.

Identifying optical objects detected by lidar in the atmosphere, as shown by experience, is not a simple question (Puchalski 2006). Procedure of screening clouds and layers that are not aerosol requires detailed knowledge of physical and morphological properties of different optically active objects present in the atmosphere. In Table 1 characteristic values of optical objects investigated by lidar, set up on the basis of results of investigations accessible in the literature and the authors' investigations (Puchalski 2006), are collected. This enables preliminary identification of these objects.

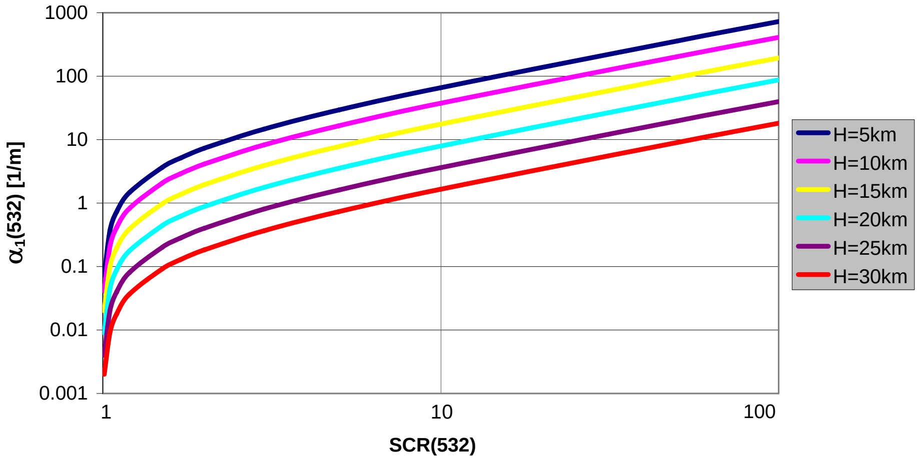

Fig. 2. Relation between atmospheric extinction, expressed by volume scattering coefficient of aerosol $\alpha_1(\lambda_2 = 532$ nm), and SCR(λ_2) for various altitudes *H* in the atmosphere.

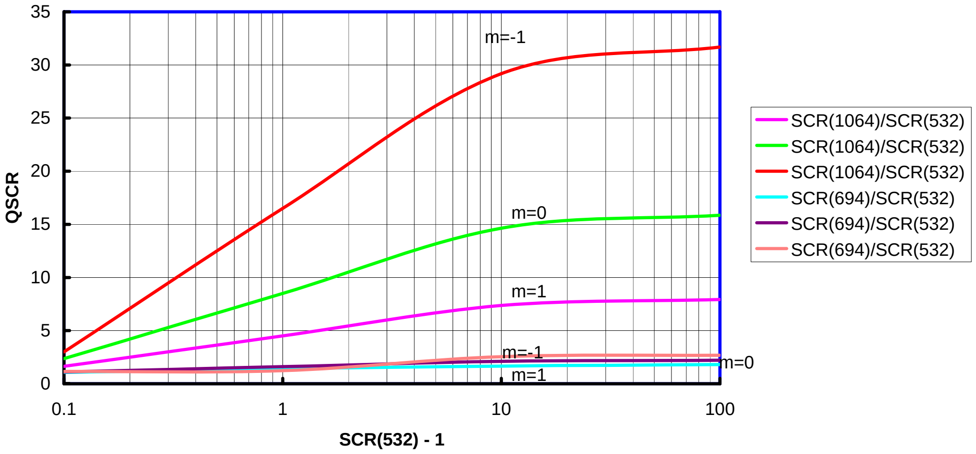

Fig. 3. Plots of dependences of scattering ratios QSCR on SCR($\lambda_2 = 532$nm), for wavelengts most often used in lidar investigations of the stratosphere, and for three models of atmospheric aerosol expressed by exponents *m* in the Angstrom formula.

4. Lidar Observations at Belsk

Since 1996, lidar samplings of the stratosphere have been made at Belsk Geophysical Observatory with scheduled frequency of one sampling a month on the average. Prac-

Table 1

Typical features of optical objects in the atmosphere detected by lidar at λ_2 = 532 nm (green channel) and λ_3 = 1064 nm (red channel)

Optical object	a	$m_{2,3}$	$\alpha_1(\lambda_2)$	$\tau(\lambda_2)$
1. Molecular background	< 1 nm	4.0	< 10 m^{-1}	< 0.08
2. Aerosol background	0.5-5.0 μm	0	< 50 m^{-1}	< 0.05
3. Continental aerosol	0.05-10 μm	1.3±0.6	0.05-0.5 km^{-1}	0.05-0.8
4. Marine aerosol	0.1-20 μm	0.5-1.0	0.08-0.8 km^{-1}	0.05-0.7
5. Specific aerosol	0.7-1.5 μm	−1.5-0.5	0.01-0.04 km^{-1}	0.01-0.04
6. Unformed clouds	0.5-5 μm	0.2-0.7	0.2-0.8 km^{-1}	≤ 1
7. Formed clouds	5-40 μm	0	5-100 km^{-1}	> 1

a = radius of aerosol particle, $m_{2,3}$ = Angstrom exponent, α_1 = aerosol extinction coefficient, τ = optical depth of the object.

tically, the frequency of measurements depends on weather conditions and technical abilities of lidar, which is a prototype device, currently subject to continuous improvement and development. For example, in 2004 there were no samplings of the stratosphere at all because of the instrument's reconstruction.

This study is based on results of lidar samplings of the stratosphere carried out in 1996-2007 at Belsk Geophysical Observatory by the Long Range Lidar (Puchalski 2003). 279 lidar profiles have been analyzed, and, after screening procedure (elimination of results which did not meet the required conditions as to the altitude range or signal quality), 140 profiles have been selected. These profiles were subject to further processing: conversion, integration and matching, which resulted in getting 80 profiles of SCR(H) for maximum attainable altitude range. At the same time, optical depths of 10 to 30 km altitude range layers were determined for each of these 80 profiles. Values of SCR(H) were calculated for a sample of 400 m depth and were obtained by averaging in the range of altitude H = ±200 m.

Figure 4 presents annually averaged aerosol optical depths of the stratosphere for the successive years of the analysed period.

The values in the years 2005-2006 (AOD > 0.010) can be considered as large, taking into account the lack of giant volcano eruptions since 1991 ("post Pinatubo" period), and, on the other hand, the values obtained in 2001, 2002 and 2003 confirm that the stratosphere after the Pinatubo eruption had already came to the state of aerosol background level with optical depth of about 0.002-0.003. This may be a real effect, but also a result of a little number of lidar samplings made last years. It should be assumed that aerosol in the stratosphere is not distributed uniformly. There are thin aerosol clouds present in the aerosol background, which, while moving in the stratosphere, can be observed as an increased level of aerosol while present in the field of view of lidar. This may result in increased value of averaged optical depths of the stratosphere if the number of samplings is too little.

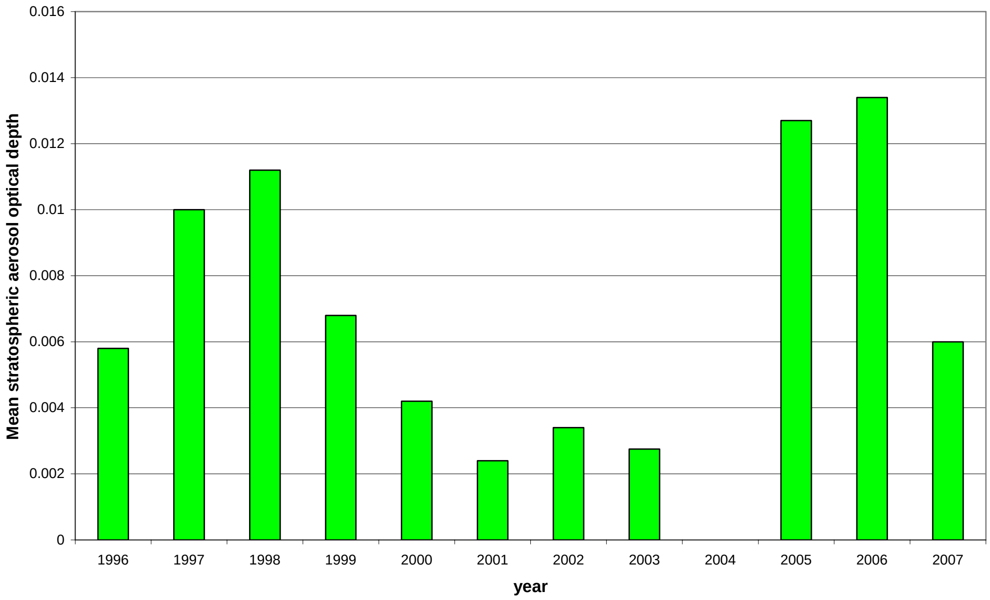

Fig. 4. Annually averaged optical depths of the stratosphere determined from lidar samplings carried out at Belsk in 1996-2007 at 532 nm wavelength.

During the last several years, the maximum optical depth of the stratosphere was observed in 1992, about a year after the Pinatubo eruption on the Philippines (Ansmann 1994). That time, the optical depth of the stratosphere at 532 nm reached 0.120 over Europe (Jager *et al.* 1994), and 0.060 over Japan (Shibata *et al.* 1994), while over Hawaii it was 0.200 (Barnes *et al.* 1994). An analysis of historical data indicates that the level of aerosol background in the stratosphere for periods preceding big volcano eruptions, expressed in optical depth, was of the order of 0.002-0.003. Before the El Chichon eruption (1982) it got a value of 0.0024, while before the Pinatubo eruption (1991) it was 0.003 (Barnes *et al.* 1994). Historical data obtained for the undisturbed stratosphere in the sixties and seventies of the preceding century indicate that, on the average, the aerosol level at altitudes of 30-35 km is very low (SCR < 1.05), then increases with lowering the altitude to about 20 km (SCR = 1.15-1.5), and decreases towards the tropopause (SCR = 1.1-1.3) (Russell *et al.* 1976).

Analysis of 80 vertical profiles of SCR(H) for the stratosphere leads to the conclusion that data obtained for Belsk are in agreement with historical data. Values of SCR(20 km) obtained for all typical profiles are within the range from 1.05 to 1.50, the aerosol background for the stratosphere expressed in SCR values is of the order of 1.05-1.15, while expressed in optical depth is of the order of 0.002-0.003.

Figure 5 shows typical profiles of SCR(H) for the stratosphere undisturbed and loaded with a great amount of aerosol. Profiles dated 18.01.2001, 13.05.2001 and

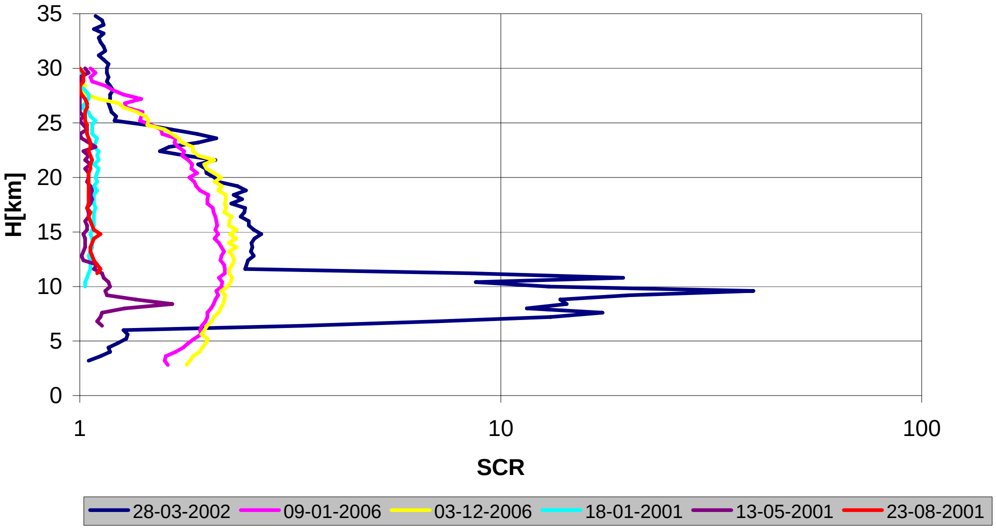

Fig. 5. Examples of SCR(H) profiles for undisturbed, clear stratosphere (18.01.2001, 13.05.2001, 23.08.2001) and for the stratosphere with heavy aerosol load (28.03.2002, 9.01.2006, 03.12.2006).

03.12.2001 are, both from the point of view of morphology and value of SCR(20 km) (lower than 1.15), typical of undisturbed stratosphere with aerosol of the background level.

Three interesting cases of untypical aerosol extinction profiles in the atmosphere have occurred. The first, obtained from sampling made on 28.03.2002, reveals the presence of a large cloud (SCR ≈ 20) in the upper troposphere, at the altitude from 5 to 12 km, joined with an optically active layer (SCR ≈ 2.5) at the altitude from 12 to 25 km. Analysis of parameters of the cloud on the basis of Fig. 2 and Table 1 leads to the conclusion that it is an aerosol cloud, located partly in the upper troposphere which penetrated through the tropopause and increased the level of aerosol background in the stratosphere up to about 25 km. The rest of the three interesting cases are samplings made on 09.03.2006 and 03.12.2006. Very untypical aerosol extinction profiles were obtained from them, exhibiting a lack of influence of the tropopause layer, with values of $SCR_{max} \approx 2.3$ within the 10 to 15 km range of altitude, considerably exceeding the level of aerosol background.

A positive valuation of lidar signal quality as well as the method of numerical analysis and assumptions that were made, is corroborated by SCR(H) profiles of aerosol background of undisturbed atmosphere, for which, within the range of altitude from 10 to 30 km, stable levels of aerosol background expressed by SCR(H) ≈ 1.05 were obtained.

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Accepted: November 3, 2008

PUBLS. INST. GEOPHYS. POL. ACAD. SC., D-72 (403), 2008

Atmospheric Electricity Research at the Institute of Geophysics in the Years 2006-2007

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Through the years 2006-2007, the atmospheric electricity observations in the range of fair weather electricity on the background of the supplementary recordings were continued.

At the Geophysical Observatory at Świder (52.07°N, 21.16°E) the measurements included: atmospheric electric field, electrical conductivity of both polarities, vertical current density, aerosol concentration, radioactive and chemical pollution, as well as meteorological observations of temperature, humidity, precipitation, wind, and cloudiness. The yearbook for the year 2005 was the last printed edition of the results of atmospheric electricity measurements at Świder. We decided to make our data available only through the internet, and limit the printed version to short reports on the recent developments.

At the Arctic Station Hornsund (72°N, 15.5°E), the measurements included: atmospheric electric field, meteorological data from automatic station Vaisalla, and ground-based geomagnetic and ionospheric recordings.

Sensors, their installation, the recording instruments and methods used at Świder have been described in detail by Kubicki (2006).

The electric field strength was measured by radioactive collector with a heated insulator. The collector is connected to electrometer with a very high input resistance of 10^{14} Ohm. The electric conductivity of the air is measured by a standard Gardien condenser. The mobility of condenser is 2.6 cm^2/Vs.

The design of the electric field meter used at Hornsund was updated and new improvements were described by Berlinski *et al*. (2007), published in the Proceedings of the13-th ICAE Conference, Beijing 2007.

The new version of rotating dipole field mill was constructed with special DC motor and radio transmission measurement signal used for monitoring electric field in the range from DC to 1 Hz and the intensity up to 10 kV/m. The meter consists of two main parts: the sensor head with transmitter and the receiver. Hourly mean values of electric field E_z, electric conductivity λ, and aerosol concentration Z are prepared for internet exchange.

Figure 1 shows the long-term variations of E_z, λ and Z at Świder from 1958 to 2007. The yearly mean values for the last two years are, respectively, 241 V/m, 21×10^{-16} $\mathrm{Ohm^{-1}m^{-1}}$, and 16500 $\mathrm{cm^{-3}}$ for 2006; and 216 V/m, 27×10^{-16} $\mathrm{Ohm^{-1}m^{-1}}$, and 12400 $\mathrm{cm^{-3}}$ for 2007.

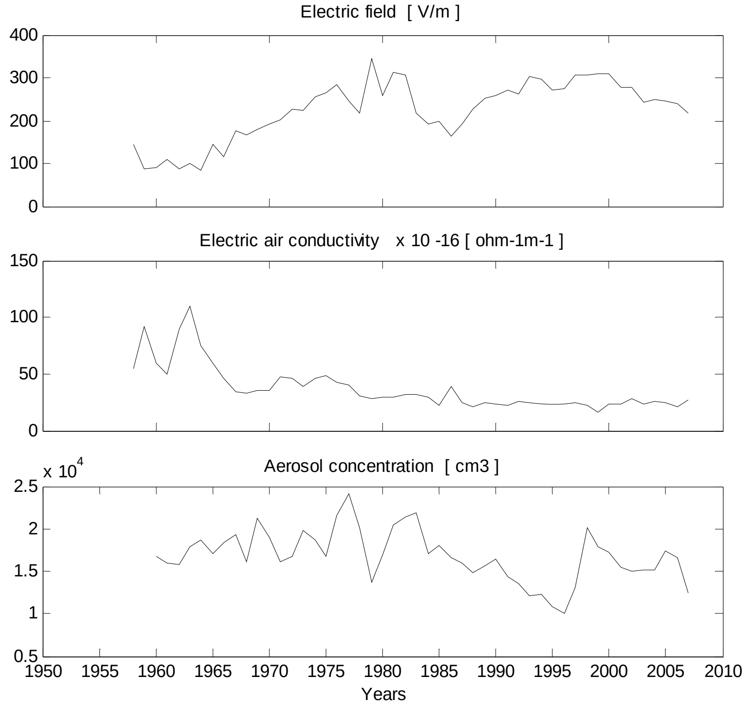

Fig. 1. Long-term variations of the electric field, electric conductivity of air and aerosol concentration at Świder Observatory.

The measurement results are used in studies of the atmospheric electricity response to local, regional and global environment changes of natural and artificial, i.e., man-made origin. In the years 2006 and 2007, our study was directed toward observation of some global electric current circuit changes that were associated with the supplementary lightning activity data, and on the search for and examination of the distinct response of the electric parameters in the lower atmosphere to the solar wind-magnetosphere–ionosphere changes, as observed at Hornsund and Świder.

Large deflections of E_z and J_z have been recorded at fair weather conditions at Hornsund during magnetic substorms and magnetic storms. The amplitude and sign of these departures were much larger than the average values for the corresponding day period observed at quiet magnetic state. They appear to depend on development stage of the storm and on site situation against the ionosphere potential patterns aligned to the position of the Sun. A new oscillatory feature of the E_z response to the substorm main phase was recorded. The E_z response to magnetic storm, never reported before in the middle latitudes, was observed in a number of cases at Świder (Fig. 2), most often during the main phase of magnetic storms. It is characteristic that

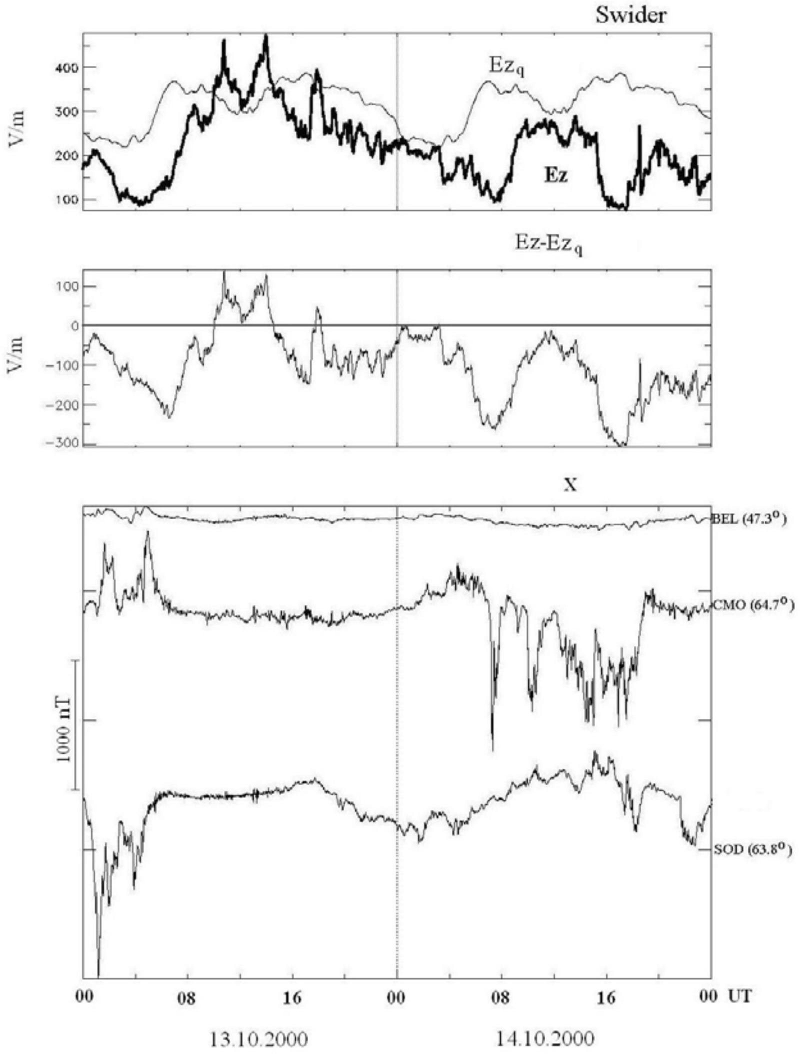

Fig. 2. The E_z variations at Świder during strong magnetic storm, 13-14 October 2000.

the E_z response effects appear then during the day, when no magnetic activity is noticed in a broad range in low and middle latitudes, while on the other hemisphere, at night, large substorms often occur in Alaska. The large amplitudes of the observed E_z responses, sustaining for a long time, are striking.

These findings are bringing new interesting information which seems to be very important in studies of the lower atmosphere couplings with solar wind changes. The results obtained in collaboration with the Earth's Institute of the Russian Academy of Sciences and the Uppsala University were presented on 13-th International Atmospheric Electricity Conference ICAE in Beijing and published in Proceedings of this Conference in 2007.

The seasonal and daily variations in E_z, λ, and Z were examined in detail on the basis of meteorological data. Some characteristic features of the behavior of these parameters were discussed in respect to local and global effects. The variations of the values recorded in 2006 and 2007 appear to have the shape similar to those for previous long term mean changes. Their analysis was published by Kubicki *et al*. (2007). The data on mean changes of these parameters in 2006 and 2007, including the mean yearly values for previous long term changes are available at www.igf.edu.pl

In January 2007 the new VLF (300 Hz – 50 kHz) recording system was installed and put in operation at Świder as an element of international AWESOME (**A**tmospheric **W**eather **E**lectromagnetic **S**ystem for **O**bservation **M**odeling and **E**ducation)

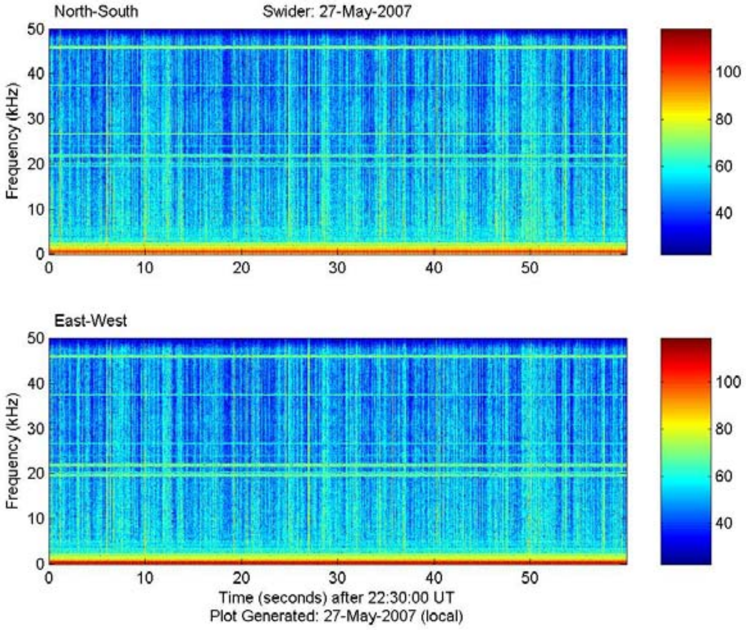

Fig. 3. VLF data spectrogram.

net of Stanford University (USA). The AWESOME system consists of VLF/ELF antenna, preamplifier box, and a line receiver. The data obtained at Świder have been used in studies of Earth's lightning discharge activity, local ionospheric disturbances and magnetospheric activity. An example of VLF spectrogram is shown in Fig. 3. The detailed information on AWESOME net is accessible at www. star-stanford.edu.

Relationships between the daily changes of global lightning discharge activity and the corresponding E_z variations recorded at Świder were investigated in 2007 on the basis of the Schumann resonance recordings made at Chylaty station of the Jagiellonian University in Kraków. The new method of decomposition of resonance signals was applied. The method is based on the spectral analysis of magnetic components Bx and By of Schumann resonance field observed within the 40-60 Hz frequency range. The analysis of the obtained results was published by Nieckarz (2007).

The case of a deep anomaly of E_z at Świder related to the strong Carpathian earthquake was reconsidered on the background of the updated new cases reported in world literature. The E_z anomaly was observed from 04:00 to 16:00 UT of 30.08.1986 before this earthquake (origin time 21:28 UT). The discussion in collaboration with the Institute of the Earth's Physics in Moscow was published by Nikiforova *et al.* (2007).

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Accepted: November 3, 2008

PUBLS. INST. GEOPHYS. POL. ACAD. SC., D-72 (403), 2008

Lightning Research Activities in the Institute of Geophysics, Polish Academy of Sciences, in the Years 2006-2007

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Warsaw atmospheric electricity group continues its many-year activity in the field of thunderstorm electricity observations and lightning research (Piotr Baranski: baranski@igf.edu.pl). Our measuring site with electric field sensors of different type, i.e., low frequency (LF) antennas and Maxwell current flat antennae, used for recent lightning recordings, is located on the roof of the building the Institute in Warsaw (λ = 20.94ºE, φ = 52.245ºN). The view on the installation of these sensors is in Figs. 1 and 2.

The main objectives of our electric field change measurements (ΔE) carried out during lightning cloud-to-ground (CG) or intracloud (IC) discharge events are:

- obtaining–in the form of digital files–return stroke (RS) waveform signatures with high time resolution (25 MHz sampling of ΔE records),
- determining the main time parameters, i.e., the rise time (t_r) and the decay time (t_d) of all collected RS waveform signatures,
- denoting characteristic signal features that occurred during the rising and decaying phases of particular RS waveforms, i.e., the "γ-peaks", slow and fast front for the rise stage and secondary or subsidiary peaks for the decay stage,
- comparing the obtained time characteristics of particular RS waveforms with the ones delivered by the SAFIR/PERUN lightning detection network system in Poland as CG lightning flash detection data.

Some results of examination of ΔE signatures of the first and subsequent return strokes recorded during different types of CG flashes which occurred in the monitored area 100×100 km around Warsaw in the summer 2005 thunderstorms were presented

Fig. 1. The measuring site used for lightning event observations in Warsaw. [a] – the flat-plate antenna with frequency band 20 Hz ÷ 1.3 MHz and based on charge amplifier AD 711 having feedback time constant $\tau = 5$ ms; [b] – the Maxwell current flat antennae delivering the pulse of electric field change in the time domain, i.e. ($\partial E/\partial t$), for the displacement current component of lightning flash events to be detected in the range of about 50 km from our measuring point and recorded by our data acquisition system. This system consists of 2-channel A/D PC 12-bit card having on its board a 64 MB memory buffer in each channel and triggered by the amplitude level of ($\partial E/\partial t$) signal, and the GPS time module unit giving the same time stamping 0.1 ms as the one used by the SAFIR/PERUN lightning detection network in Poland.

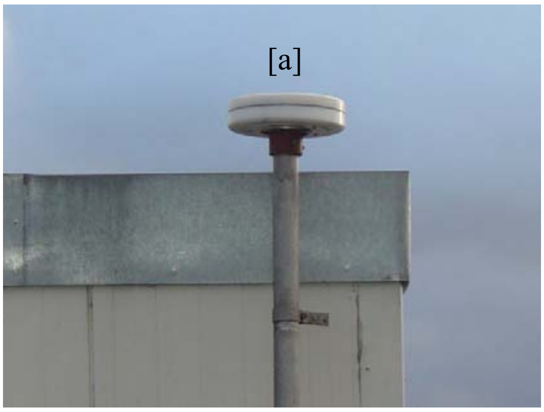

Fig. 2. The same as in Fig. 1, but with second LF antenna labeled [a] which is the PAD 04 unit with charge amplifier AD 825 (the same as that used by the SAFIR/PERUN system for CG flash discrimination) and having frequency band from 300 Hz to 3 MHz, and feedback time constant $\tau = 6.7$ ms.

at the First COST P18 Symposium which was hold on 2-3 April 2006 in Vienna (Barański and Loboda 2006). Details of this presentation are still available on www site (http://www.costp18-lightning.org/). On the other hand, during thunderstorm season in 2006 we collected additionally several cases of CG flash events with their electric field signatures containing the continuing current (CC) component. These observations have been examined to obtain the short-time Fourier transform (STFT) spectra of special spikes, the so-called M-components, appearing sometimes during CC stages of CG flashes. Our results were presented during the 13-th ICAE in Beijing, China (Barański *et al*. 2007) and one example of them is shown in Fig. 3.

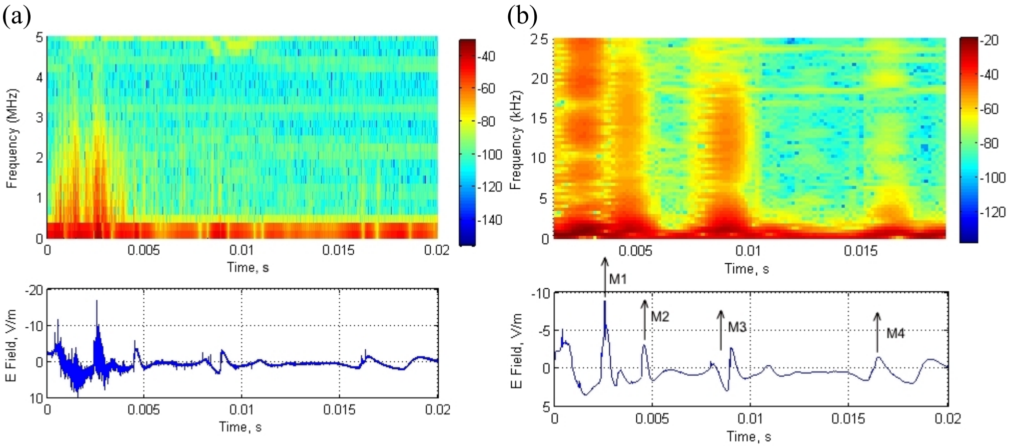

Fig. 3. Spectrograms and waveforms of electric field changes associated with the CC stage for (a) a wide frequency band which enables discrimination of the very fast spikes superimposed on the slow electric field change, and (b) a narrow frequency band which enables a better discrimination of their M-components. The colour scale of spectrograms amplitude is in dB units.

Although the CC changes are not as frequent components of CG flashes as for example the RS ones, the possible application of their dynamic spectra properties for CC detection and location by network lightning systems could be a considerable progress in lightning protection against their powerful and harmful effects on our ground objects or forests. We think that further extension and more detailed examination of dynamic spectra of the CC electric field changes and other important components of CG or IC lightning discharges would be useful in a search for some new detection algorithm procedures to be applied in computer processing.

The previous valuable recordings of the rarely occurring bipolar flashes during summer thunderstorms near Warsaw were reported and published in Barański (2006).

In 2007 we started our special research project entitled "Multiple cloud-to-ground lightning flashes – their development, parameters, hazard for people and risk of damages" in the frame of the COST P18 program in cooperation with Warsaw University of Technology, Institute of Meteorology and Water Management and Space

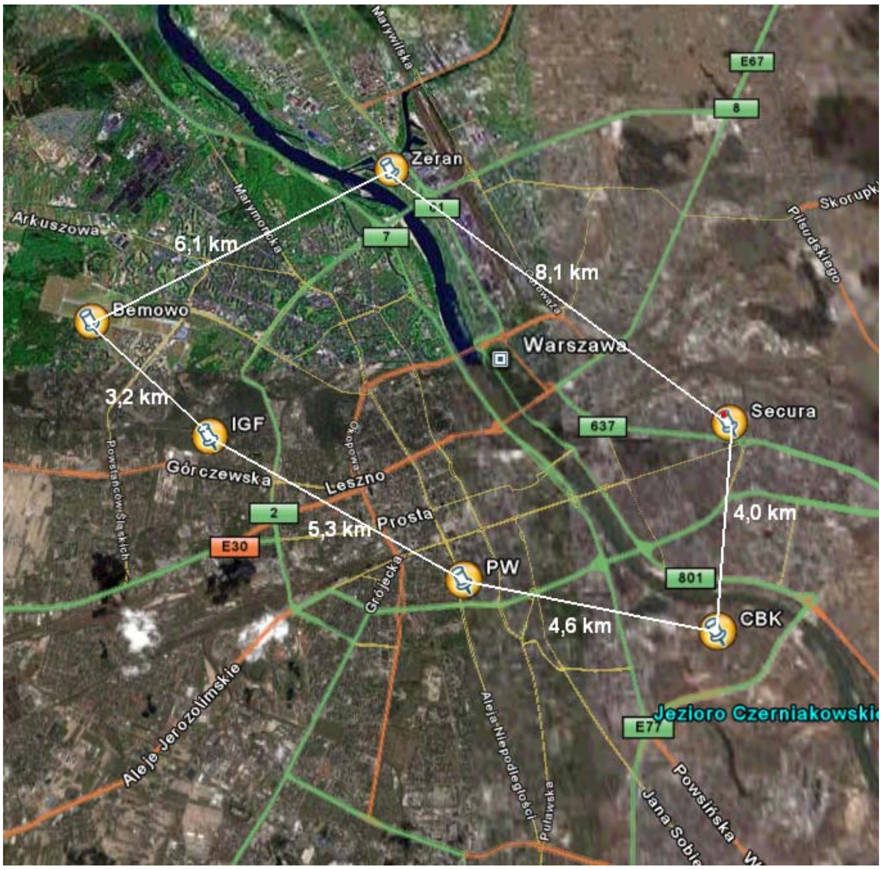

Fig. 4. Space configuration of the LLDS network in Warsaw with six measuring stations denoted by Zeran, Secura, CBK, PW, IGF and Bemowo.

Research Centre of the Polish Academy of Sciences. The preliminary task of that project is the design, construction and operation of the complementary local lightning detection system (LLDS) in the region of Warsaw as an additional source for validation and extension of data on multiple CG lightning flashes detected by the SAFIR/PERUN lightning detection system and eventually by the CELDN or the LINET data recorded from the Warsaw region. The LLDS network will consist of six stations installed in Warsaw area (see Fig. 4) and equipped with: electric field changes receiving antenna of frequency band up to 100 kHz, GPS time synchronization clock, pretriggered A/D converter, and individual memory storage bank. The central analyzer with personal computer will be used for post processing of stored data from all simultaneously working antennas. The fast speed movie digital cameras (PHANTOM VRIMIRO 4) will be applied for records of lightning development images in selected regions of horizon containing tall structures. The main field measurement campaign is planned to be done in the spring and summer of 2009. We intend to extend the range of the collected data on relations between CG discharges (including multiple strokes) and the SAFIR/PERUN lightning detections, and meteorological radar observations, with different PPI and VCUT scans of those parts of the thundercloud precipitation shafts which may be involved in lightning flash initiation, aiming to get better knowledge on multiple discharge origin and its time and space development. Comparative examinations of the LLDS and the SAFIR/PERUN (and the CELDN/LINET) data are expected to verify the quality of lightning data available now over Warsaw from different location systems as well to enrich multiple lightning flash studies in the region of Warsaw.

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Accepted: November 3, 2008