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Contents

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Abstract

In cooperation with the Laboratoire de Météorologie Dynamique at Palaiseau, France, a set of TOVS observations from 58 NOAA-11 orbits in the period 14 September until 3 October 1992 over Europe has been processed with the 3I system.

The resulting retrievals have been compared with collocated radiosondes extracted from the operational database at KNMI for the same period. The collocation criteria (less than 3 hours time difference and a maximum distance of 50 km) resulted in a statistical dataset with about 100 or more items in each of the considered sub-cases: clear-cloudy, day-night and their combinations.

Apart from results for the layer mean virtual temperatures, we also obtained statistics for the stability index and for the total water vapour content. Finally error correlation matrices for the thickness errors in the various layers have been computed.

1. Introduction

During the past years a number of projects have been undertaken in various research institutes as well as weather services to use the sounding observations from operational satellites. These efforts resulted in a number of different schemes for the retrieval of atmospheric parameters from the observed radiances through the inversion of the radiative transfer equation.

One of these schemes, the 3I system developped by the Atmospheric Radiance Analysis group of the Laboratoire de Météorologie Dynamique in Palaiseau, France, has been implemented at KNMI. This system, based on the first version of the 3I database (TIGR, TOVS Initial Guess Retrieval), is available for routine use since early 1991. Since that time a number of (limited) validation studies have been undertaken, all showing rather poor results when compared with operational radiosonde observations over the European continent.

Therefore it was decided to set up a validation study, using the latest version of the TIGR database (TIGR-2), which has been entirely created from scratch, starting from a dataset of around 150,000 radiosonde profiles worldwide. After careful screening a database of some 1800 profiles resulted, covering evenly the "atmospheric feature space", as far as possible. With the 3I system based on this new atmospheric dataset, a validation study has been undertaken for satellite data covering a three week period in September-October 1992. This period has deliberately been chosen for easy availability of the necessary satellite and other data. The weather situation over Europe during that period covered a wide range of synoptic situations and was fairly mobile.

As the retrievals will eventually be used in a numerical weather forecasting context at KNMI, in this validation study much attention has been given to the statistical properties (biases, standard deviations and error correlations) of the retrievals. Impact experiments in the HIRLAM model (High Resolution Limited Area Model) as implemented at KNMI are foreseen for the near future. The results of the present study, aiming at the knowledge and possible understanding of the error characteristics of such retrievals, are presented in this report.

It is worth noting at this point that the 3I system has been used in an "as is" form, available at the computer system of the ARA/LMD group, except for changes in the front-end input modules which had to cope with the format of the data as transferred from KNMI to the computer-system. This version of 3I -apart from minor corrections- differs from the currently semi-operational version at KNMI only in the version of the atmospheric database: at KNMI TIGR-1 is in use, whereas at LMD the newer TIGR-2 is the current version.

The results of the 3I-inversion of TOVS radiances into atmospheric parameters for 58 orbits of the NOAA-11 satellite have been compared with radiosonde ascents over Europe. Various statistics have been obtained and are presented in table-form below.

2. Available data.

Satellite data have been obtained from the HRPT receiving station at KNMI for the period 14 September until 4 October 1992. For the period 22 September until 4 October (with the exception of 28 September) forecasts of the operational limited-area weather prediction model of KNMI (LAM) have been obtained for guidance in the first guess selection.

Therefore the satellite dataset has been split in 2 subsets: a set of 28 satellite orbits for the period 14 - 21 September and 28 September (called "Period 1) and a set of 30 orbits for the period 22 September until 4 October, excluding 28 September (called: "Period 2).

Both subsets have been processed with the 3I retrieval method, using version 2 of the TIGR database of atmospheric profiles. Thus three sets of atmospheric retrievals were generated:

both subsets were processed without the use of forecast data in the first guess selection;

the subset for Period 2 was also processed using the available LAM data in the first guess selection.

Standard radiosonde reports have been extracted and decoded from the operational observations database at KNMI.

Note that in this setup we have not made comparisons between the results of TIGR-1 retrievals vs. TIGR-2 retrievals.

3. Comparisons made

In this report only thicknesses of a number of standard layers are considered compatible with the weighting functions of the TOVS channels, for meteorological reasons dividing the near surface layer into 2 sub-layers:

1000-850, 850-700, 700-500, 500-300 and 300-100 hPa

Furthermore the total precipitable water in the entire column from the surface to 300 hPa has been compared between the radiosonde data and the retrievals, as well as the stability index, defined as the difference of the virtual temperature for the 500 - 300 hPa layer and the virtual temperature for the 1000 - 700 hPa layer.

In the computation of the statistics only those cases were taken into account for which:

a. the time difference between the satellite observation and the radiosonde ascent was less than **3 hours**

b. the 3I result closest to the radiosonde was within a **50 km** distance

c. the surface pressure of the radiosonde ascent was above 900 hPa

d. the mean surface pressure for the 3I result was above 950 hPa

The latter two restrictions are based on the radiative transfer characteristics of some of the TOVS/HIRS channels, which start acting as window channels rather than sounding channels over elevated terrain.

Note in passing that the applied restrictions imply that only retrievals over land have been considered. Due to the horizontal variability both in surface characteristics and in the planetary boundary layer, we therefore expect that the comparison results for the lowest layers will be relatively poor, and that the same kind of study over sea (were enough radiosondes available over the sea) would display substantially better statistical results.

In order to study a possible difference between day and night cases (day being defined as **satellite overpasses between 6.00 and 18.00** and night as **satellite overpasses after 18.00 and before 6.00 GMT**) the available dataset has also been split for day- and night-cases. We also distinguished between cloudy and clear cases.

To gain insight into possible compensating biases and/or errors between the lower and the upper troposphere, error correlations between all considered layers have been computed.
An inventory of the available data for Period 1 cases is given in Annex 1, whereas Annex 2 summarizes the available data for Period 2.

4. Intercomparison results.

The results of all intercomparisons are given in tables I through XVIII below. Each table contains the statistics for three cases: overall statistics including all available items for that table, the day-only results and the night-only results.

Three sets of results are presented:

a. results for Period 1, processed without the use of forecast data (14 - 21 September, plus 28 September; 28 orbits of which 14 during daytime and 14 during nighttime)
Tables I through III give the statistical results and tables X through XII summarize the errorcorrelations.

b. results for Period 2, processed without the use of forecast data (22 - 27 September and 29 September - 4 October; 30 orbits of which 12 during daytime and 18 during nighttime)
Tables IV through VI give the statistical overview, whereas tables XII through XV display the error correlations for this period.

c. results for Period 2, processed with the use of forecast data in the first guess selection

(22 - 27 September and 29 September - 4 October; 30 orbits of which 12 during daytime and 18 during nighttime)
Tables VII through IX present the statistical results and tables XV through XVIII show the error correlations.

Statistical significance

The number of items involved in each of the statistical results is indicated in the tables. As can be seen from these numbers, the number of items is largely sufficient to make the results significant, except for the night data under clear conditions. There we consider the number of realizations too small for the results to be significant.

Statistical values

Mean data as presented are taken over the radiosonde dataset, whereas the bias data are defined as radiosonde - retrieval and standard deviation is defined in the usual way:

$$mean = \frac{1}{N} \sum_{1}^{N} (obs_{RS})$$

$$bias = \frac{1}{N} \sum_{1}^{N} (obs_{RS} - obs_{sat})$$

$$std.dev = \sqrt{\frac{1}{N} \sum_{1}^{N} (obs_{RS} - obs_{sat} - bias)^2}$$

$$N = number\ of\ items$$

Temperature

Where applicable, the statistics have been computed for the layer thicknesses (reported in the radiosonde messages and computed in the retrieval system) and have been converted to their equivalent values in layer-mean virtual temperatures using standard conversion formulae.

Stability index

This index, which is one of the possible measures for correctness of the shape of the retrieval, is defined as the difference:

$$T_{5/3} - T_{10/7}$$

where $T_{5/3}$ is the mean virtual temperature for the layer 500 - 300 hPa and $T_{10/7}$ the mean virtual temperature for the layer 1000 - 700 hPa. Negative biases indicate that the retrieved profile is less stable than the radiosonde profile, with positive biases indicating that the retrieved profile is more stable than the radiosonde profile.

Precipitable water

This result is obtained by integrating the water vapour content of the profile (radiosonde as well as retrieval) from the surface to the top of the profile. Only those collocations are considered for which the top of the radiosonde profile is above the 300 hPa level.

Error correlations

Correlations between the errors in the thicknesses for the considered atmospheric layers have been obtained using standard formulae. Only those collocations for which both errors were within the two-sigma band for their respective layers have been used, thus suppressing probably erroneous data.

5. Discussion

Cloud detection

Analyzing the distribution of the number of clear versus cloudy retrievals during daytime and nighttime (cf. column "Number of items" in tables I ./. III), it is evident that the cloud detection algorithm in the 3I system has a tendency to overestimate cloudiness during the night. It is difficult to assess the exact cause for this phenomenon, neither is it clear in which sense this will influence the outcome of the intercomparisons. It is quite possible that the "low cloud at night" test in the 3I-system, which is rather severe, is at the heart of this problem and needs some careful re-consideration, taking the effects of nocturnal inversionson the radiation into account.

As already mentioned above the statistics for the clear/night cases is based on a very limited number of realizations and therefore will not be considered in the rest of the discussion.

Retrievals without forecast usage

Comparing the results for the two periods processed without forecast data (tables I ./. III for period 1 and tables IV ./. VI for period 2) one can conclude that within the limits of accuracy both periods display very similar results (excluding the clear/night cases).
When a separation is made between the day- and night-time retrievals it is evident that the nighttime retrievals for the near-surface layers (1000-850 and 850-700 hPa; tables I and III) generally underestimate the layer mean temperature by around 1.5 K. This result is illustrated by a warm retrieval for the 1000-850 hPa layer under clear/day conditions (tables II and V) and by a cold retrieval for the 1000-850 hPa layer and - at a slightly smaller extent - for the 850-700 hPa layer under cloudy conditions (tables III and VI). The warm retrievals for the 1000-850 hPa under clear day conditions put emphasis on the importance of a correct recognition of the

radiative temperature, along with the other physical parameters concerning the earth surface.

This different behaviour during day and night is probably also linked with the physics of the near-surface layer under clear sky conditions: the very surface is heated during daytime resulting in generally high values for the temperature of the ground relative to the overlying air. During night on the other hand strong cooling of the ground results in an air temperature well above the (radiation) temperature of the ground. Since the ground-temperature is the driving term in the radiative transfer equation, the difference in the biases under clear conditions for day and night cases is -at least qualitatively- a well-understood phenomenon.

The cold near-surface retrievals under cloudy conditions are indicative of the problems involved in retrieving the proper shape (inversions etc.) of the temperature profile within and around clouds.

Standard deviations are generally quite similar for all cases within the accuracy of the radiance observations and the accuracy of the radiative transfer computations.

The error correlations (tables X ./. XV) suggest a near significant correlation of errors in the two lower layers (1000-850 and 850-700 hPa) as must be expected from the characteristics of the HIRS sounding channels for this part of the troposphere.

There is also an indication of a near significant anti-correlation of the errors for the layers around the tropopause (500-300 hPa and 300-100 hPa). This reflects the fact that the sounding channels for the upper troposphere and lower stratosphere are not well-suited to resolve the structure around the tropopause.

Under cloudy conditions (tables XII and XV) a weak correlation of errors for the layers 850-700 and 700-500 hPa can be observed. This can be understood from the radiative transport aspects concerning the "surface properties" of cloud-tops.

The results for the stability index show that the 3I retrievals have a tendency to slightly overestimate this temperature difference under clear/day conditions and to slightly underestimate this parameter under all other conditions. It must be borne in mind however, that the biases observed are well within the bandwidth of the standard deviations and are therefore hardly significant.

The weak biases (relative to the standard deviations) of the integrated water vapour content show a tendency of the 3I retrievals to underestimate the water vapour content under clear conditions and to retrieve a little more water vapour under cloudy conditions than is given in the radiosonde observations. The standard deviations of this parameter (around 25% of the mean content) are fully in line with the severe problems in general to observe atmospheric water vapour accurately.

Retrievals with and without forecast usage (Period 2).

Before going into details on the statistical aspects of this part of the study, it is worth mentioning that the use of forecast data also seems to work as a kind of filter to the number of retrievals passing the various consistency checks. This is hardly detectable from the tables (VII through IX, as compared to tables IV ./. VI), but is obvious from the direct processing output. Not only are the retrievals limited to the area covered by the forecast data, but the selection of the first guess profile is also more stringent, without however leading to significantly better statistical results (see below). As discussed later in this report, this effect may be due to the limitation of the forecast data to parameters describing the atmospheric boundary layer.

The impact of the use of forecast data in the selection of the first guess profile is most clearly displayed in the cloudy retrievals (tables VI and IX). The bias in the lowest layer (1000-850 hPa) is markedly reduced, at the expense however of increasing the biases in all other layers. The standard deviations for all layers on the other hand are hardly influenced (within the accuracy limits).

This effect must be the consequence of the choice of the forecast parameters. Except for the temperature at 700 hPa and the geopotential height of that level, all parameters describe aspects of the planetary boundary layer:

- pressure and temperature of the surface
- temperature at 2 m height
- temperature and geopotential heights of the 1000 and 850 hPa levels

From these elements in the 3I first-guess selection algorithm use is made of the surface pressure and surface temperature as well as one of the temperatures at standard levels in such a way that the first level above the actual surface pressure is used. In view of the poor resolution of the sounding instruments for the lower troposphere, this is an understandable choice, constraining the selection of possible atmospheric states as initial guess by adding physical information on the state of the boundary layer to the selection process. From the results it is clear that this choice indeed has favorable aspects, at least under cloudy conditions.

In the clear cases, on the other hand, there is also a tendency to slightly reduce the biases in the lowest layer, without appreciable changes in the biases for the other layers. For these cases the standard deviations for all layers stay the same or are slightly reduced, relative to the no-forecast results (Note the clear/night results for the lower troposphere displaying a different behaviour, but this may well be due to the low number of items in this situation, making the statistics unreliable).

The results for the precipitable water content show no significant (within the accuracy) differences from the use of forecast data, except for the cloudy retrievals. Here the biases are reduced whereas the standard deviations are slightly larger when using forecasts.

The largest impact of the use of forecast data in the first guess selection is observed in the error correlations (tables XIII ./. XV and XVI ./. XVIII).

For the clear retrievals the correlations between the errors for the lowest layers is markedly reduced. On the other hand the correlations of errors in the top two layers, spanning the tropopause, is increased in this situation.

A different situation occurs for the cloudy retrievals. Here again the error correlations between the 1000-850 and 850-700 hPa layers are slightly reduced. The same effect is to a lesser extent, also observed for the correlations of errors in the retrievals for the 700-500 and 500-300 hPa layers. The error correlations between all other layers are increased.

6. Conclusions and recommendations.

Results of a verification study of satellite retrievals using the 3I-version 2 system against operational radiosonde observations over Europe have been presented for a three week period in September - October 1992.

In general the statistical results are in line with the findings of other groups (see e.g. the results of the principally different 1D-VAR method reported in ECMWF Technical Memorandum No. 187, 1992) and with the limits of the inherent errors of the satellite and radiosonde instruments. Also the current knowledge and modelling of the radiative transfer processes in the atmosphere gives error bounds of the same order (see e.g. Luther et al., 1988).

The study reveals some remarkable points on the 3I preprocessing, especially the cloud detection scheme: the ratio of scenes identified as clear vs. the number of cloudy spots is markedly different for the day- and night situations. This implies that the cloud detection algorithm as currently implemented, should be critically reviewed, possibly including more detailed instrumentation like AVHRR.

Another point of concern are the findings for the impact of forecast data in the first guess selection. In the current implementation only forecast data for the lowest atmospheric layers are used, when available. In our study we found that indeed the results for the planetary boundary layer show a positive influence of this source of information on the actual physical state of the lower troposphere. The negative influence on the retrievals for higher atmospheric layers requires however that the choice of forecast data used in the first guess selection be critically reviewed and that other possibilities of conveying information on the physical state of the whole atmosphere at the time of satellite observation to the retrieval system be considered. It must be borne in mind however, that the current 3I system (version 2) without forecast data already performs quite well and that the use of forecast information should help selecting the initial guess profile from among a database of atmospheric situations, rather than just replace it.

A possible solution to this problem, that needs however careful study and extensive redesign of parts of the 3I retrieval software, could be to select the initial guess profile from the TIGR dataset by comparison with profiles taken from a model forecast at the time of satellite overpass. In this way the physical information contained in the model is used to constrain the first guess selection, without conveying the "model's climate" to the resulting retrievals, rather than the real atmospheric climate. This could be called a "weak model-coupling" as compared to a "strong model-coupling" when the model profiles are directly used as the first guess. Preparations for such a cooperative study between LMD and KNMI will soon be started.

As mentioned in the introduction, a separate step in the validation of satellite retrievals is their inclusion in the data-assimilation section of a numerical weather prediction system, aiming at the evaluation of the impact of such data inclusion on the forecast quality. For KNMI's HIRLAM model this step will be started in the near future.

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Table I

Period: 14/09 until 21/09 and 28/09 (28 orbits, 14 day and 14 night)
Forecast data: none

All cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	342	1356	3.12	13.17	0.7	2.8
850-700 hPa	440	1572	3.08	10.98	0.5	1.9
700-500 hPa	444	2602	5.34	11.84	0.5	1.2
500-300 hPa	460	3620	2.10	25.94	0.1	1.7
300-100 hPa	427	7054	-16.39	30.43	-0.5	0.9
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.77	-0.03	0.45		
Stability index (K)		-38.5	-0.3	3.1		

Day cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	250	1356	1.38	12.59	0.3	2.6
850-700 hPa	310	1571	1.47	10.42	0.3	1.8
700-500 hPa	316	2600	4.55	11.53	0.5	1.2
500-300 hPa	321	3615	1.53	24.21	0.1	1.6
300-100 hPa	308	7058	-14.50	30.43	-0.5	0.9
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.75	-0.02	0.43		
Stability index (K)		-38.7	0.0	3.0		

Night cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	90	1357	7.42	13.43	1.6	2.8
850-700 hPa	126	1573	7.13	10.58	1.3	1.9
700-500 hPa	124	2607	6.63	11.97	0.7	1.2
500-300 hPa	134	3629	3.08	28.34	0.2	1.9
300-100 hPa	119	7045	-21.40	29.61	-0.7	0.9
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.80	-0.04	0.53		
Stability index (K)		-38.2	-1.2	3.0		

Table II

Period: 14/09 until 21/09 and 28/09 (28 orbits, 14 day and 14 night)
Forecast data: none

CLEAR RETRIEVALS ONLY

All cases	Number of	Thickness			Temperature	
	items	mean	bias	std dev	bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	152	1364	-2.78	10.56	-0.6	2.2
850-700 hPa	184	1579	-0.30	9.51	-0.1	1.7
700-500 hPa	183	2612	7.47	10.40	0.8	1.1
500-300 hPa	183	3626	11.03	18.04	0.7	1.2
300-100 hPa	166	7045	-20.62	25.89	-0.6	0.8

Precipitable water	mean	bias	std dev
surface - 300 hPa (cm)	1.70	0.11	0.38
Stability index (K)	-39.5	1.0	2.3

Day cases	Number of	Thickness			Temperature	
	items	mean	bias	std dev	bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	137	1365	-3.16	9.91	-0.7	2.1
850-700 hPa	168	1580	-0.72	9.58	-0.1	1.7
700-500 hPa	167	2614	7.25	10.09	0.7	1.0
500-300 hPa	165	3624	9.42	17.08	0.6	1.1
300-100 hPa	153	7039	-20.59	26.24	-0.6	0.8

Precipitable water	mean	bias	std dev
surface - 300 hPa (cm)	1.73	0.11	0.37
Stability index (K)	-39.7	0.9	2.1

Night cases	Number of	Thickness			Temperature	
	items	mean	bias	std dev	bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	12	1349	2.73	11.69	0.6	2.5
850-700 hPa	16	1565	4.08	7.46	0.7	1.3
700-500 hPa	16	2589	9.75	12.96	1.0	1.3
500-300 hPa	15	3616	11.84	31.5	0.8	2.1
300-100 hPa	13	7110	-20.97	21.28	-0.7	0.7

Precipitable water	mean	bias	std dev
surface - 300 hPa (cm)	1.49	0.07	0.56
Stability index (K)	-37.8	-0.3	3.1

Table III

Period: 14/09 until 21/09 and 28/09 (28 orbits, 14 day and 14 night)
Forecast data: none

CLOUDY RETRIEVALS ONLY

All cases	Number of items	Thickness mean	bias	std dev	Temperature bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	185	1350	8.08	11.21	1.7	2.4
850-700 hPa	266	1566	6.02	10.7	1.1	1.9
700-500 hPa	267	2594	3.85	12.1	0.4	1.2
500-300 hPa	280	3612	-5.38	27.28	-0.4	1.8
300-100 hPa	262	7066	-11.71	30.83	-0.4	1.0
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.81	-0.12	0.46		
Stability index (K)		-37.8	-1.4	2.9		

Day cases	Number of items	Thickness mean	bias	std dev	Temperature bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	105	1343	8.63	8.96	1.8	1.9
850-700 hPa	149	1560	4.73	10.35	0.8	1.8
700-500 hPa	152	2584	2.18	11.67	0.2	1.2
500-300 hPa	149	3597	-11.06	23.24	-0.7	1.6
300-100 hPa	154	7083	-5.87	30.59	-0.2	1.0
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.77	-0.16	0.42		
Stability index (K)		-37.5	-1.7	2.7		

Night cases	Number of items	Thickness mean	bias	std dev	Temperature bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	80	1357	8.14	13.44	1.7	2.8
850-700 hPa	115	1573	7.36	10.76	1.3	1.9
700-500 hPa	114	2608	5.86	12.16	0.6	1.2
500-300 hPa	124	3630	2.56	27.61	0.2	1.8
300-100 hPa	111	7042	-21.62	30.33	-0.7	0.9
Precipitable water		mean	bias	std dev		
surface - 300hPa (cm)		1.84	-0.06	0.52		
Stability index (K)		-38.2	-1.3	3.0		

Table IV

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: none

All cases	Number of items	Thickness mean	bias	std dev	Temperature bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	277	1348	5.64	12.23	1.2	2.6
850-700 hPa	382	1563	3.27	9.53	0.6	1.7
700-500 hPa	383	2593	5.40	11.91	0.5	1.2
500-300 hPa	396	3611	3.94	19.61	0.3	1.3
300-100 hPa	372	7013	-20.21	31.50	-0.6	1.0
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.67	-0.03	0.46		
Stability index (K)		-37.5	-0.5	2.5		

Day cases	Number of items	Thickness mean	bias	std dev	Temperature bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	167	1351	2.76	12.86	0.6	2.7
850-700 hPa	222	1568	1.23	9.57	0.2	1.7
700-500 hPa	218	2599	4.35	11.70	0.4	1.2
500-300 hPa	221	3617	4.99	18.88	0.3	1.3
300-100 hPa	211	7015	-23.00	31.07	-0.7	1.0
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.72	0.01	0.48		
Stability index (K)		-37.8	0.0	2.5		

Night cases	Number of items	Thickness mean	bias	std dev	Temperature bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	99	1343	8.82	8.21	1.9	1.7
850-700 hPa	154	1557	5.50	8.33	1.0	1.5
700-500 hPa	164	2585	6.67	11.95	0.7	1.2
500-300 hPa	171	3603	3.21	19.39	0.2	1.3
300-100 hPa	161	7011	-16.57	31.69	-0.5	1.0
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.62	-0.09	0.42		
Stability index (K)		-37.0	-1.0	1.9		

Table V

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: none

CLEAR RETRIEVALS ONLY

All cases	Number of items	Thickness mean	bias	std dev	Temperature bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	101	1350	-1.38	10.66	-0.3	2.2
850-700 hPa	128	1567	-0.35	8.08	-0.1	1.4
700-500 hPa	127	2602	5.98	11.65	0.6	1.2
500-300 hPa	127	3613	6.11	18.55	0.4	1.2
300-100 hPa	122	7019	-23.42	30.46	-0.7	0.9
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.50	0.19	0.33		
Stability index (K)		-37.5	0.6	2.2		

Day cases	Number of items	Thickness mean	bias	std dev	Temperature bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	92	1353	-2.19	10.47	-0.5	2.2
850-700 hPa	116	1570	-1.00	7.82	-0.2	1.4
700-500 hPa	116	2607	5.39	12.08	0.5	1.2
500-300 hPa	115	3618	6.08	18.64	0.4	1.2
300-100 hPa	109	7013	-24.28	30.77	-0.8	1.0
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.55	0.20	0.33		
Stability index (K)		-37.9	0.8	2.1		

Night cases	Number of items	Thickness mean	bias	std dev	Temperature bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	8	1321	5.10	7.93	1.1	1.7
850-700 hPa	10	1532	3.56	6.42	0.6	1.1
700-500 hPa	12	2542	8.85	10.45	0.9	1.1
500-300 hPa	12	3560	6.42	17.59	0.4	1.2
300-100 hPa	13	7068	-16.26	26.66	-0.5	0.8
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.89	-0.24	0.51		
Stability index (K)		-34.9	-0.8	1.1		

Table VI

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: none

CLOUDY RETRIEVALS ONLY

All cases	Number of	Thickness			Temperature	
	items	mean	bias	std dev	bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	173	1346	8.95	10.44	1.9	2.2
850-700 hPa	259	1560	5.36	9.35	0.9	1.6
700-500 hPa	264	2589	5.48	11.93	0.6	1.2
500-300 hPa	272	3607	1.85	19.71	0.1	1.3
300-100 hPa	257	7014	-18.30	31.83	-0.6	1.0
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.75	-0.14	0.45		
Stability index (K)		-37.4	-1.0	2.3		

Day cases	Number of	Thickness			Temperature	
	items	mean	bias	std dev	bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	76	1348	8.54	12.03	1.8	2.5
850-700 hPa	109	1562	4.58	10.00	0.8	1.8
700-500 hPa	106	2591	3.24	11.02	0.3	1.1
500-300 hPa	106	3613	2.02	17.57	0.1	1.2
300-100 hPa	103	7025	-20.83	29.28	-0.6	0.9
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.89	-0.24	0.51		
Stability index (K)		-37.6	-0.9	2.5		

Night cases	Number of	Thickness			Temperature	
	items	mean	bias	std dev	bias	std dev
Layer		m	m	m	K	K
1000-850 hPa	92	1345	9.05	8.06	1.9	1.7
850-700 hPa	147	1559	5.61	8.62	1.0	1.5
700-500 hPa	155	2588	6.57	12.01	0.7	1.2
500-300 hPa	161	3606	3.19	19.59	0.2	1.3
300-100 hPa	154	7007	-16.60	33.32	-0.5	1.0
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.66	-0.10	0.43		
Stability index (K)		-37.2	-1.0	1.9		

Table VII

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: LAM output

All cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	158	1354	-1.45	12.32	-0.3	2.6
850-700 hPa	223	1572	4.45	10.95	0.8	1.9
700-500 hPa	206	2608	13.99	15.37	1.4	1.6
500-300 hPa	211	3625	13.60	21.43	0.9	1.4
300-100 hPa	174	7010	-30.94	29.14	-1.0	0.9

Precipitable water	mean	bias	std dev
surface - 300 hPa (cm)	1.85	0.08	0.52
Stability index (K)	-37.8	0.8	2.5

Day cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	100	1353	-2.23	12.34	-0.5	2.6
850-700 hPa	142	1573	1.95	11.29	0.3	2.0
700-500 hPa	137	2608	11.18	16.14	1.1	1.6
500-300 hPa	137	3626	11.83	21.35	0.8	1.4
300-100 hPa	114	7011	-30.07	29.45	-0.9	0.9

Precipitable water	mean	bias	std dev
surface - 300 hPa (cm)	1.80	0.15	0.55
Stability index (K)	-37.9	0.8	2.6

Night cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	55	1354	-0.62	10.95	-0.1	2.3
850-700 hPa	75	1570	7.69	8.12	1.4	1.4
700-500 hPa	58	2608	16.49	10.41	1.7	1.1
500-300 hPa	72	3622	15.97	20.79	1.1	1.4
300-100 hPa	59	7009	-31.84	28.08	-1.0	0.9

Precipitable water	mean	bias	std dev
surface - 300 hPa (cm)	1.92	-0.01	0.46
Stability index (K)	-37.7	0.9	2.0

Table VIII

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: LAM output

CLEAR RETRIEVALS ONLY

All cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	51	1356	-3.29	11.72	-0.7	2.5
850-700 hPa	75	1578	-2.75	9.5	-0.5	1.7
700-500 hPa	76	2613	4.99	17.48	0.5	1.8
500-300 hPa	71	3636	6.38	19.01	0.4	1.3
300-100 hPa	63	6991	-20.36	28.39	-0.6	0.9
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.68	0.23	0.44		
Stability index (K)		-37.7	1.0	2.4		

Day cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	45	1356	-4.59	11.09	-1.0	2.3
850-700 hPa	69	1578	-3.38	9.24	-0.6	1.6
700-500 hPa	70	2613	4.71	17.83	0.5	1.8
500-300 hPa	65	3634	5.46	18.57	0.4	1.2
300-100 hPa	57	6989	-19.70	26.92	-0.6	0.8
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.62	0.28	0.38		
Stability index (K)		-37.9	1.1	2.4		

Night cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	6	1359	6.49	11.68	1.4	2.5
850-700 hPa	6	1577	4.42	9.43	0.8	1.7
700-500 hPa	6	2613	8.23	12.3	0.8	1.2
500-300 hPa	6	3655	16.44	20.8	1.1	1.4
300-100 hPa	6	6977	-36.61	50.84	-1.1	1.6
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.91	-0.04	0.41		
Stability index (K)		-36.8	0.1	2.1		

Table IX

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: LAM output

CLOUDY RETRIEVALS ONLY

All cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	106	1352	-0.53	12.05	-0.1	2.5
850-700 hPa	141	1569	7.48	8.76	1.3	1.5
700-500 hPa	108	2605	15.36	9.34	1.6	0.9
500-300 hPa	137	3619	15.93	21.2	1.1	1.4
300-100 hPa	108	7024	-34.90	26.88	-1.1	0.8
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.93	-0.02	0.51		
Stability index (K)		-37.9	0.6	2.4		

Day cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	55	1351	0.29	12.49	0.1	2.6
850-700 hPa	74	1568	7.39	9.64	1.3	1.7
700-500 hPa	57	2502	13.83	8.95	1.4	0.9
500-300 hPa	71	3619	15.93	21.57	1.1	1.4
300-100 hPa	54	7040	-36.82	27.12	-1.1	0.8
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.93	0.04	0.62		
Stability index (K)		-37.9	0.2	2.7		

Night cases	Number of items	Thickness mean	Thickness bias	Thickness std dev	Temperature bias	Temperature std dev
Layer		m	m	m	K	K
1000-850 hPa	49	1353	-1.50	10.53	-0.3	2.2
850-700 hPa	69	1569	7.98	7.93	1.4	1.4
700-500 hPa	51	2608	17.17	9.62	1.7	1.0
500-300 hPa	66	3619	15.93	20.79	1.1	1.4
300-100 hPa	54	7009	-32.98	26.5	-1.0	0.8
Precipitable water		mean	bias	std dev		
surface - 300 hPa (cm)		1.92	-0.01	0.46		
Stability index (K)		-37.8	1.0	2.0		

Table X

Period: 14/09 until 21/09 and 28/09 (28 orbits, 14 day and 14 night)
Forecast data: none

Error correlations

All cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.57	-0.01	-0.40	0.22
850-700	0.57	1.00	0.24	-0.27	0.08
700-500	-0.01	0.24	1.00	0.19	-0.33
500-300	-0.40	-0.27	0.19	1.00	-0.57
300-100	0.22	0.08	-0.33	-0.57	1.00

Day cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.58	-0.01	-0.43	0.18
850-700	0.58	1.00	0.25	-0.24	0.06
700-500	-0.01	0.25	1.00	0.21	-0.32
500-300	-0.43	-0.24	0.21	1.00	-0.52
300-100	0.18	0.06	-0.32	-0.52	1.00

Night cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.39	-0.22	-0.46	0.39
850-700	0.39	1.00	0.04	-0.40	0.17
700-500	-0.22	0.04	1.00	0.16	-0.40
500-300	-0.46	-0.40	0.16	1.00	-0.61
300-100	0.39	0.17	-0.40	-0.61	1.00

Table XI

Period: 14/09 until 21/09 and 28/09 (28 orbits, 14 day and 14 night)
Forecast data: none

Error correlations

CLEAR RETRIEVALS ONLY

All cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.52	0.14	-0.23	0.05
850-700	0.52	1.00	0.19	0.04	0.04
700-500	0.14	0.19	1.00	0.08	-0.28
500-300	-0.23	0.04	0.08	1.00	-0.42
300-100	0.05	0.04	-0.28	-0.42	1.00

Day cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.47	0.10	-0.16	0.01
850-700	0.47	1.00	0.19	0.07	0.02
700-500	0.10	0.19	1.00	0.14	-0.28
500-300	-0.16	0.07	0.14	1.00	-0.42
300-100	0.01	0.02	-0.28	-0.42	1.00

Night cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.68	0.32	-0.22	0.02
850-700	0.68	1.00	0.08	-0.63	0.27
700-500	0.32	0.08	1.00	-0.20	-0.28
500-300	-0.22	-0.63	-0.20	1.00	-0.69
300-100	0.02	0.27	-0.28	-0.69	1.00

Table XII

Period: 14/09 until 21/09 and 28/09 (28 orbits, 14 day and 14 night)
Forecast data: none

Error correlations

CLOUDY RETRIEVALS ONLY

All cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.41	-0.01	-0.38	0.23
850-700	0.41	1.00	0.32	-0.29	0.03
700-500	-0.01	0.32	1.00	0.07	-0.31
500-300	-0.38	-0.29	0.07	1.00	-0.58
300-100	0.23	0.03	-0.31	-0.58	1.00

Day cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.55	0.16	-0.27	0.06
850-700	0.55	1.00	0.47	-0.26	0.00
700-500	0.16	0.47	1.00	0.02	-0.22
500-300	-0.27	-0.26	0.02	1.00	-0.49
300-100	0.06	0.00	-0.22	-0.49	1.00

Night cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.36	-0.24	-0.50	0.43
850-700	0.36	1.00	0.08	-0.38	0.17
700-500	-0.24	0.08	1.00	0.14	-0.39
500-300	-0.50	-0.38	0.14	1.00	-0.60
300-100	0.43	0.17	-0.39	-0.60	1.00

Table XIII

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: none

Error correlations

All cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.56	-0.03	-0.29	0.19
850-700	0.56	1.00	0.30	-0.13	0.00
700-500	-0.03	0.30	1.00	0.31	-0.29
500-300	-0.29	-0.13	0.31	1.00	-0.50
300-100	0.19	0.00	-0.29	-0.50	1.00

Day cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.55	-0.16	-0.34	0.19
850-700	0.55	1.00	0.28	-0.19	0.05
700-500	-0.16	0.28	1.00	0.30	-0.23
500-300	-0.34	-0.19	0.30	1.00	-0.50
300-100	0.19	0.05	-0.23	-0.50	1.00

Night cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.46	0.14	-0.19	0.02
850-700	0.46	1.00	0.33	0.04	-0.15
700-500	0.14	0.33	1.00	0.34	-0.40
500-300	-0.19	0.04	0.34	1.00	-0.47
300-100	0.02	-0.15	-0.40	-0.47	1.00

Table XIV

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: none

Error correlations

CLEAR RETRIEVALS ONLY

All cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.49	-0.01	-0.28	0.23
850-700	0.49	1.00	0.40	-0.05	-0.07
700-500	-0.01	0.40	1.00	0.32	-0.15
500-300	-0.28	-0.05	0.32	1.00	-0.51
300-100	0.23	-0.07	-0.15	-0.51	1.00

Day cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.48	-0.03	-0.33	0.22
850-700	0.48	1.00	0.35	-0.03	-0.11
700-500	-0.03	0.35	1.00	0.32	-0.17
500-300	-0.03	-0.03	0.32	1.00	-0.56
300-100	0.22	-0.11	-0.17	-0.56	1.00

Night cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	-0.12	0.06	0.58	-0.01
850-700	-0.12	1.00	0.01	-0.12	0.52
700-500	0.06	-0.01	1.00	0.37	-0.18
500-300	0.58	-0.12	0.37	1.00	-0.05
300-100	-0.01	0.52	-0.18	-0.05	1.00

Table XV

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: none

Error correlations

CLOUDY RETRIEVALS ONLY

All cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.50	-0.03	-0.30	0.12
850-700	0.50	1.00	0.35	-0.11	-0.08
700-500	-0.03	0.35	1.00	0.29	-0.37
500-300	-0.30	-0.11	0.29	1.00	-0.48
300-100	0.12	-0.08	-0.37	-0.48	1.00

Day cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.51	-0.14	-0.31	0.15
850-700	0.51	1.00	0.35	-0.33	0.09
700-500	-0.14	0.35	1.00	0.24	-0.33
500-300	-0.31	-0.33	0.24	1.00	-0.40
300-100	0.15	0.09	-0.33	-0.40	1.00

Night cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.47	0.13	-0.24	-0.02
850-700	0.47	1.00	0.33	0.01	-0.26
700-500	0.13	0.33	1.00	0.34	-0.43
500-300	-0.24	0.01	0.34	1.00	-0.51
300-100	-0.02	-0.26	-0.43	-0.51	1.00

Table XVI

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: LAM output

Error correlations

All cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.32	-0.09	-0.28	0.24
850-700	0.32	1.00	0.55	0.06	-0.25
700-500	-0.09	0.55	1.00	0.27	-0.34
500-300	-0.28	0.06	0.27	1.00	-0.58
300-100	0.24	-0.25	-0.34	-0.58	1.00

Day cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.36	-0.05	-0.26	0.28
850-700	0.36	1.00	0.56	0.04	-0.21
700-500	-0.05	0.56	1.00	0.24	-0.25
500-300	-0.26	0.04	0.24	1.00	-0.60
300-100	0.28	-0.21	-0.25	-0.60	1.00

Night cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.30	-0.43	-0.37	0.31
850-700	0.30	1.00	0.24	0.03	-0.30
700-500	-0.43	0.24	1.00	0.41	-0.71
500-300	-0.37	0.03	0.41	1.00	-0.52
300-100	0.31	-0.30	-0.71	-0.52	1.00

Table XVII

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: LAM output

Error correlations

CLEAR RETRIEVALS ONLY

All cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.18	-0.43	-0.40	0.34
850-700	0.18	1.00	0.42	0.15	-0.05
700-500	-0.43	0.42	1.00	0.29	-0.16
500-300	-0.40	0.15	0.29	1.00	-0.70
300-100	0.34	-0.05	-0.16	-0.70	1.00

Day cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.10	-0.45	-0.50	0.38
850-700	0.10	1.00	0.41	0.07	-0.10
700-500	-0.45	0.41	1.00	0.24	-0.15
500-300	-0.50	0.07	0.24	1.00	-0.69
300-100	0.38	-0.10	-0.15	-0.69	1.00

Night cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.19	-0.64	-0.44	0.82
850-700	0.19	1.00	0.53	0.57	-0.28
700-500	-0.64	0.53	1.00	0.86	-0.91
500-300	-0.44	0.57	0.86	1.00	-0.84
300-100	0.82	-0.28	-0.91	-0.84	1.00

Table XVIII

Period: 22/09 until 03/10 except 28/09 (30 orbits, 12 day and 18 night)
Forecast data: LAM output

Error correlations

CLOUDY RETRIEVALS ONLY

All cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.38	-0.13	-0.23	0.22
850-700	0.38	1.00	0.44	-0.16	-0.22
700-500	-0.13	0.44	1.00	0.22	-0.42
500-300	-0.23	-0.16	0.22	1.00	-0.48
300-100	0.22	-0.22	-0.42	-0.48	1.00

Day cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.39	0.13	-0.15	0.14
850-700	0.39	1.00	0.59	-0.24	-0.20
700-500	0.13	0.59	1.00	0.11	-0.20
500-300	-0.15	-0.24	0.11	1.00	-0.45
300-100	0.14	-0.20	-0.20	-0.45	1.00

Night cases

Layer	1000-850	850-700	700-500	500-300	300-100
1000-850	1.00	0.38	-0.29	-0.35	0.30
850-700	0.38	1.00	0.14	-0.05	-0.25
700-500	-0.29	0.14	1.00	0.37	-0.66
500-300	-0.35	-0.05	0.37	1.00	-0.53
300-100	0.30	-0.25	-0.66	-0.53	1.00

ANNEX 1:

Information on orbits in Period 1

In this Annex an overview is presented of the NOAA-11 orbits available in the dataset and evaluated without the use of forecast data (for use in the 3I initial guess selection).

For each orbit the revolution number, the initial date/time (in the form YYMMDD/HHMM) are listed, along with the date/time of the radiosonde-file with which the retrieved results have been compared, given a time window of up to 3 hours.

The -manually performed- check on the overall quality of the satellite radiance data is reflected in the columns labelled "Skipped lines HIRS MSU". The data reception problems -due for instance to obstructions in the reception path- have been dealt with by suppressing the HIRS-lines concerned. Another reason for skipping a few HIRS-lines at the start and/or the end of the received data, stems from the 3I interpolation step, which signals HIRS points lying outside the area of available MSU data points. (N.B.: only interpolation is acceptable, not extrapolation of MSU radiances to the centers of HIRS spots).

Finally, on one occasion, (orbit 20573) erroneous positional information, probably also due to data reception problems in a near-horizon situation, necessitated the suppression of a few MSU lines (and correspondingly HIRS-lines).

Table I

Inventory of orbits without forecast usage.

Orbitnr NOAA-11	Date/time orbit	Skipped lines HIRS	MSU	Date/Time radiosonde
20470	920914/0453	1,0		92091406
20475	920914/1304	0,6		92091412
20476	920914/1444			92091412
20483	920915/0300	0,7		92091500
20484	920915/0441	3,1		92091506
20489	920915/1253	1,0		92091512
20490	920915/1432	3,2		92091512
20497	920916/0248	3,1		92091600
20498	920916/0429	2,2		92091606
20499	920916/0610	0,10		92091606
20531	920918/1217	41,0		92091812
20532	920918/1358	3,0		92091812
20539	920919/0212	69,0		92091900
20540	920919/0353	2,2		92091906
20545	920919/1206	33,0		92091912
20546	920919/1344	1,2		92091912
20553	920920/0200	65,3		92092000
20554	920920/0340	1,3		92092006
20560	920920/1334			92092012
20561	920920/1514	1,3		92092018
20567	920921/0148	3,61		92092100
20568	920921/0329	3,1		92092106
20573	920921/1142	19,9	0,2	92092112
20575	920921/1502	3,2		92092118
20666	920928/0204	65,5		92092800
20667	920928/0346	3,1		92092806
20672	920928/1158	23,2		92092812
20673	920928/1341	2,0		92092812

ANNEX 2:

Information on orbits in Period 2

In this Annex an overview is presented of the NOAA-11 orbits available in the dataset which have been evaluated both with and without the use of forecast data (for use in the 31 initial guess selection).

For each orbit the revolution number, the initial date/time (in the form YYMMDD/HHMM) and the forecast times (in the format $YYMMDDH_1H_1/H_2H_2$) are listed, along with the date/time of the radiosonde-file with which the retrieved results have been compared, given a time window of up to 3 hours.

The outcome of the manually performed check on the overall quality of the satellite radiance data is reflected in the columns labelled "Skipped lines HIRS MSU". For further explanation of this quality control step see Annex 1.

Those orbits for which all satellite data were outside the area of the LAM-model are not shown in this overview.

Table II

Inventory of orbits with forecast usage.

Orbitnr NOAA-11	Date/time orbit	Date/time forecast	Skipped lines HIRS	MSU	Date/Time radiosonde
20582	920922/0316	92092200/06	2,2		92092206
20583	920922/0457	92092200/06	1,0		92092206
20588	920922/1309	92092212/18	2,0		92092212
20589	920922/1450	92092212/18	1,0		92092212
20596	920923/0304	92092300/06	1,3		92092306
20597	920923/0445	92092300/06	3,0		92092306
20602	920923/1257	92092312/18	2,1		92092312
20603	920923/1437	92092312/18	2,7		92092312
20610	920924/0252	92092400/06	3,1		92092400
20611	920924/0433	92092400/06	2,2		92092406
20632	920925/1556	92092512/18	1,0		92092518
20638	920926/0228	92092600/06	0,4		92092600
20639	920926/0409	92092600/06	3,1		92092606
20645	920926/1405	92092612/18	1,1		92092612
20652	920927/0217	92092700/06	62,0		92092700
20653	920927/0357	92092700/06	2,6		92092706
20659	920927/1354	92092712/18	3,3		92092712
20688	920929/1507	92092912/18	2,3		92092918
20694	920930/0141	92093000/06	61,4		92093000
20702	920930/1456	92093012/18	2,0		92093012
20708	921001/0129	92100100/06	3,50		92100100
20709	921001/0309	92100100/06	0,7		92100106
20710	921001/0450	92100100/06	3,4		92100106
20715	921001/1301	92100112/18	2,1		92100112
20716	921001/1443	92100112/18	2,15		92100112
20723	921002/0257	92100200/06	2,2		92100200
20724	921002/0438	92100200/06	1,3		92100206
20729	921002/1251	92100112/18	33,2		92100212
20737	921003/0245	92100300/06	1,3		92100300
20738	921003/0426	92100300/06	0,3		92100306