

## Quarterly reports of the E-AMDAR Quality Evaluation Centre on AMDAR data

**2000-II**

Report number 3      26 September 2000

Period: 1 APRIL 2000 – 30 JUNE 2000

KNMI  
Wilhelminalaan 10  
NL-3732 GK De Bilt  
The Netherlands



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## 1) Introduction

AMDAR offers the potential for a large increase in upper air wind and temperature data, observed for use as input for models. To improve the usefulness of these data, quality evaluation is essential in combination with appropriate impact studies. Today the E-AMDAR fleet will number approximately 353 assigned aircraft, 80% of which will fly predominantly European routes and the remainder long haul. All E-AMDAR data for evaluation will be made available on the GTS with in near real time performances. ***It should be noted that not all identified aircraft are fully operational at present*** (operational on July, 1<sup>st</sup>: 114).

The purpose of this report is to provide statistical information on the quality, quantity and availability of aircraft reports made available from all Participating Members. The information will be used for further impact studies and feed back to the E-AMDAR operators to improve the quality of the E-AMDAR observing system.

The Quality Evaluation Centre has monitored AMDAR reports received at KNMI since September 17<sup>th</sup> 1999. The aim of the monitoring process is to detect and identify any incorrectness or anomalies of the data or transmission within 24 hours and to instigate fault correction procedures. Such a process is vital for maintaining data quality and credibility at the required level. The monitoring of the observations covers data availability, receipt delays, reporting frequency and checks on the consistency and quality of the meteorological data.

The EUMETNET Council agreed in September 1998 that the UK Meteorological Office (UKMO) would be the Responsible Member for the E-AMDAR Programme. The Programme Manager is Mr Bruce Truscott. The appointed Technical Co-ordinator, Mr Stewart Taylor, will ensure that any faults identified are investigated and rectified in a timely manner. All irregularities on E-AMDAR data will be reported to the Programme Manager.

***Observations period:*** The coverage of the data used for the statistical analysis for AMDAR reporting aircraft is the period April 1<sup>st</sup>, 2000, 00:00 UTC to June 30<sup>th</sup>, 2000, 24:00 UTC (2000Q2).

## 2) Operational AMDAR units

Data from 75 activated AMDAR units producing **FM 42-IX AMDAR** code were received and analysed at KNMI HQ in De Bilt during the stated period. Data were received from 36 AMDAR units producing the **BUFR AMDAR** code as well.

Starting May 15<sup>th</sup> a BUFR AMDAR decoding module was implemented to provide the QEvC database with AMDAR data. After some first tests and upgrades of this module, on June 6<sup>th</sup> the BUFR decoding system was fully operational and all BUFR AMDAR data is evaluated from that day on as well. The figures in annex I give a clear impression of the significant increase of the data evaluated by QEvC. Not only the increased number of aircraft, but also BUFR AMDAR bulletins contain significant more data due to a higher time resolution of the observations.

From three activated aircraft no data was received. Due to financial constraints KNMI has arranged with KLM to restrict the production of AMDAR reports from KLM aircraft.

Notice that a number of aircraft only report during the ascending phase.

For a list of reporting aircraft and their identifiers, see table 1.

### 3) List of outstanding issues

- a) In the previous quarterly report a number of issues concerning errors in the FM 42-IX AMDAR code bulletins were presented. All these errors were seen during this quarter as well. In the examples below a short summary is presented of these errors. See for more details the quarterly report 2000Q01.

```
AMDAR 2915
/// EU4444 5939N 01755E 1517 F-002 PS060 229/002=
/// EU4444 5939N 01755E 1517 F-001 PS059 260/005=
ASC EU4444 5939N 01755E 1517 F001 PS054 288/005=
ASC EU4444 5939N 01755E 1517 F004 PS048 278/008= A
```

```
AMDAR 2915
/// EU4444 5939N 01755E 1517 F-002 PS060 229/002=
/// EU4444 5939N 01755E 1517 F-001 PS059 260/005=
ASC EU4444 5939N 01755E 1517 F001 PS054 288/005=
ASC EU4444 5939N 01755E 1517 F004 PS048 278/008= A=
```

errors:

[1]  $i_p i_p i_p = ///$ ; defined values: LVR, LVW, ASC, DES and UNS

[2]  $S_h h_1 h_1 h_1 = F-002$ ;  $S_h$ : Sign of pressure altitude (code table 3738): If aircraft is below "Standard Datum Plane",  $S_h = A$  in stead of F. Minus signs should not be used.

[3] Obscure end-of-bulletin characters, A or A=

[4] Identical bulletins are transmitted twice, both with different end-of-bulletin characters

date: 29 June 2000

Example 1

```
AMDAR 2908
LVR EU0985 5604N 01441W 0900 F350 MS535 143/024 TB0 S011=
LVR EU0985 5603N 01305W 0907 F350 MS557 151/016 TB0 S011=
LVR EU0985 5601N 01126W 0914 F350 MS550 217/002 TB0 S011=
LVR EU0985 5601N 00946W 0921 F350 MS557 345/003 TB0 S011=
LVR EU0985 5604N 00807W 0928 F350 MS547 352/013 TB' S011=
LVR EU0985 5606N 00627W 0935 F355 MS537 331/014 TB0 S011=
LVR EU0985 5606N 00446W 0942 F360 MS512 326/018 TB0 S011=
LVR EU0985 5606N 00304W 0949 F370 MS485 315/023 TB0 S011=
LVR EU0985 5604N 00122W 0956 F370 MS482 318/023 TB0 S011=
LVR EU0985 5601N 00020E 1003 F370 MS467 322/017 TB0 S011
333 F000 VG000= A=
```

errors:

[5]  $TB B_A = TB'$ ; accent sign not allowed. Turbulence indicator  $B_A = 0, 1, 2$  or  $3$  (code table 0302)

[6] Obscure end-of-bulletin characters, A or A=

date: 29 June 2000

Example 2

```

AMDAR 2912
ASC EU4587 6020N 01105E 1227 F009 PS157 348/001 TBO S011=
ASC EU4587 6020N 01106E 1227 F012 PS150 011/000 TBO S011=
ASC EU4587 6020N 01106E 1227 F015 PS142 007/001 TBO S011=
ASC EU4587 6020N 01106E 1227 F017 PS137 041/004 TBO S011=
ASC EU4587 6021N 01106E 1227 F020 PS125 034/005 TBO S011=
ASC EU4587 6021N 01106E 1227 F023 PS117 350/003 TBO S011=
ASC EU4587 6021N 01107E 1227 F026 PS112 350/008 TBO S011=
/// EU4587 6022N 01107E 1228 F029 PS102 296/004 TBO S111=
/// EU4587 6022N 01107E 1228 F029 PS100 354/005 TBO S111=
/// EU4587 6022N 01107E 1228 F032 PS092 343/009 TBO S111
333 F))) VG))) =

```

errors:

[7]  $i_p i_p i_p = ///$ ; defined values: LVR, LVW, ASC, DES and UNS

[8]  $F h_a h_a h_a = F))) VG)))$ . Pressure altitude and maximum derived equivalent vertical gust should be presented in numbers only.

date: 29 June 2000

### Example 3

- b) Starting May, 15<sup>th</sup> all BUFR AMDAR reports are evaluated as well. BUFR encoded AMDAR data are decoded into a database format similar to the format obtained from the FM42-IX AMDAR bulletins to have comparable data. After testing several international available decoding packages it was found that not all of these packages would give the same results. Some package was not up-to-date, *i.e.* did not fulfil to the current specifications. The more important issue is the differences, which were found caused by different resolutions of the variables, related to the BUFR tables declared in the software programmes or compilers. For practical reasons it will be helpful when a standard viewer should become available to present on a user-friendly manner the complete content of AMDAR BUFR messages.
- c) To prevent the storage of identical reports (like with example 1), each report is checked with reports which are already stored in the database. Starting this quarter timestamp (resolution: 1 minute), position (resolution: 0.01°) or height (resolution: 10 m) are used for comparison and data are discarded and not stored in the database in those cases where all those parameters were identical to those, already stored in the database. However it was found that for a large number of flights observations were continued after landing and a dense set of *identical surface measurements* was disseminated. To be able to discard these data the restriction of identical time stamps was discarded after June 6<sup>th</sup>. From that day on all data having identical positions (latitude/longitude and altitude, using the maximum of available precision) are indicated as "double" to be disregarded and only one observation of this set is evaluated.
- d) An FM42-IX AMDAR code change is implemented officially by WMO on 3 May 2000 by extending the GGgg group with the day number to become YYGGgg. The addition of the day number will help to prevent the rejection of reports. Without the YY (day) the GGgg (hour/minute) will be interpreted as belonging to the day, indicated section 1 of the bulletin (AMDAR YYGG). Reports, within the bulletin, referring to hours from the previous day will be indicated as "to early" and disregarded (*e.g.* see example 2 of 2000Q01). During this quarter, however, in none of the received FM12 AMDAR bulletins this code change was found
- e) Occasionally, the altitude information in the reports from the BUFR encoded bulletins is incorrect. In stead of values just below MSL, these reports present values of about 22 km or more. The explanation is that under certain circumstances negative values of the altitude are calculated near the ground by using the Standard-Atmosphere with MSL = 1013.2 hPa, which can not be presented in the code format used on board appropriately.

The onboard software adds to the negative value of the altitude the fixed positive value of 73000 feet and transmits the result to the ground system. As a consequence the observed variables differs significantly from the background value representative for this high altitude affecting the statistical analyses as a result. These differences are most significant for temperature. The technical co-ordinator is informed that this issue will be solved in the 3rd quarter of 2000. A set of typical examples is given in the table below (the variable *Temperature [background]* is based on the model value for the given altitude):

AIRCRAFT	Day	Time (UTC)	Altitude (m)	Temperature [observed] (°C)	Temperature [background] (°C)	Temperature difference (°C)
EU0041	2000.06.25	12.23	22230	301.2	216.5	84.7
EU0043	2000.06.19	08.50	22210	299.9	220.9	79.0
EU0047	2000.06.19	14.55	22220	305.4	221.0	84.4
EU0050	2000.06.01	20.59	22120	293.8	216.0	77.8
EU0052	2000.06.01	07.37	22210	287.5	219.7	67.8
EU0106	2000.06.17	09.42	22210	301.2	216.6	84.6
EU0154	2000.06.14	16.34	22220	301.7	217.0	84.7
EU0158	2000.06.17	16.16	22210	298.7	218.1	80.6
EU0167	2000.06.14	20.42	22220	293.2	219.5	73.7
EU0185	2000.06.17	12.07	22220	294.7	219.5	75.2
EU0301	2000.06.20	21.05	22180	299.2	218.3	80.9
EU0303	2000.06.01	21.21	22180	290.0	218.4	71.6
EU0307	2000.05.22	14.27	22180	287.3	221.1	66.2
EU0311	2000.06.22	13.42	22220	299.4	216.1	83.3
EU0313	2000.06.22	09.51	22220	298.4	215.7	82.7
EU0316	2000.06.19	14.43	22230	298.7	217.6	81.1
EU0359	2000.06.20	16.25	22240	296.9	218.1	78.8
EU0711	2000.05.31	05.48	22210	282.8	221.3	61.5
EU0802	2000.06.20	11.37	22180	298.7	218.8	79.9
EU0875	2000.05.31	10.01	22210	297.8	215.8	82.0
EU1234	2000.06.02	11.43	22150	289.3	218.2	71.1
EU1547	2000.06.16	14.43	22180	288.7	221.8	66.9
EU1863	2000.06.04	06.58	22180	295.3	216.0	79.3
EU2189	2000.06.02	09.58	22210	296.3	215.0	81.3
EU2301	2000.06.17	18.32	22210	294.7	221.1	73.6
EU2559	2000.06.25	09.09	22230	298.2	216.8	81.4
EU3000	2000.06.18	10.35	22170	293.9	220.7	73.2
EU3421	2000.06.26	15.49	22200	289.7	221.7	68.0

#### 4) Monitoring results

##### a) Data Availability

AMDAR reports are received via the different collecting centres with ground based receiving stations and consequently through GTS. Some aircraft fly "long haul" routes and where no ground station coverage available, send AMDAR data via satellite communications systems. The total number of FM42-IX AMDAR coded reports received daily was on average 8081, an increase of 11% with respect to the previous quarter. The average number of BUFR encoded AMDAR reports, received daily after May 15<sup>th</sup> was 5127, 39% of the total daily amount on average. An overview for all aircraft involved is presented in table 2. At the end of this table also a list of aircraft is presented for which more than one percent of the observations took more than two hours to arrive at the QEvC.

## **b) Data coverage**

Aircraft carrying the AMDAR units fly prominently within Europe. BUFR encoded AMDAR are evaluated from May 15<sup>th</sup> on, with evaluation of the complete set of tables inside the bulletins from June 6<sup>th</sup>. Since aircraft generating these BUFR AMDAR reports produce more frequently observations, the total daily number of AMDAR reports evaluated by the QEvC increased significantly. To demonstrate this increase in annex 1 figures are shown presenting the EU AMDAR coverage on 17 April 2000 with FM42-IX AMDAR observations only (9004 reports within 24H) and on 30 June 2000 with both FM42-IX and BUFR AMDAR observations (23146 reports within 24H). To get a brief impression of the EU AMDAR coverage of the Atlantic two more figures are in this annex as well.

## **c) Data Timeliness**

The delay between observation and reception at the GTS nodes should be small. During the period, 98,2 % of all reports was received within one hour of observation time and 99,3 % within 2 hours from observation. With respect to the previous quarter a slight decrease is found, caused by the introduction of the BUFR AMDAR data. The delay of reports from BUFR AMDAR bulletins is significant larger than from FM42-X AMDAR bulletins (see table 1 for details)

## **d) Frequency of reporting AMDAR observations**

During level flight at cruising height the reporting frequency of AMDAR reports is expected to be one report per 7 minutes or 10 minutes depending on the Aircraft software. During the ascent or descent phase reports should be generated more frequently with the higher frequency applying to the lower part of the atmosphere.

This reporting frequency is checked for each aircraft by taking samples every day (if available). Statistics are compiled by calculating the average time between reports during level flight at cruising heights. For the ascent and descent phases the average pressure difference is calculated from the first 10 reports on ascent and the first 10 reports below 3500 feet (approximately 890 hPa) on descent. These pressure differences for ascent and descent are obtained from the reported height differences and by using the ICAO standard atmosphere (1 hPa equals approximately 29 feet in the layer from 1000-900 hPa). Most of the aircraft operate within Europe and within relatively short travel distance. As a consequence data obtained from E-AMDAR reports at cruising heights is significant less than e.g. for data from ASDAR units during Atlantic flights. It is recommended to investigate in more detail this issue as an impact study.

## **e) Data quality evaluation**

Every day quality control procedures are performed. By comparing the meteorological and positional information supplied by the AMDAR units with a reference background, suspect reports are selected and presented. FM42-IX and BUFR encoded AMDAR bulletins passing through the KNMI MSS are analysed for statistical evaluation purposes. Heavily corrupted reports and reports without any positional information, are stored apart and kept outside further evaluation.

The differences between observations and model-forecast fields from the HIRLAM-3 1-level-global-forecast-model are used for analysing the quality of AMDAR reports. These differences between the values from the observation and the model background (indicated by "O-B") are calculated for the levels from 950 to 400 hPa (ascent/descent levels) and for 350 to 150 hPa (cruise levels). Average values and standard deviations of the calculated differences for temperature, wind speed and wind direction are derived for all reports from any AMDAR unit separately and by taking into account time and place/position. For the evaluation process the

most actual output from the HIRLAM model is used as reference. Note that this model has a 3 hours update interval. Consequently quality evaluation is performed every 3 hours. From this evaluation process AMDAR units are selected as an entry for identifying as a suspect report in case of overriding the stated criteria. As a result from this evaluation process a daily report is generated for direct transmission by e-mail to the E-AMDAR technical co-ordinator and all E-AMDAR operators. With the exception of rejected reports and observations outside the HIRLAM area, all data is evaluated. For practical reasons, the daily reports present only those aircraft with identifiers starting with 'EU' (E-AMDAR) or ending on 'Z' (ASDAR).

### Criteria

The critical (absolute) margins used for selecting entries are:

- Air Temperature:  $|T_A(O)-T_A(B)| \geq 0,5 \text{ } ^\circ\text{C} \text{ (} 0,5 \text{ K)}$
- Wind speed:  $|f(O)-f(B)| \geq 2,0 \text{ m/s (4 Knots)}$
- Wind direction:  $|d(O)-d(B)| \geq 20 \text{ Degrees}$

No criterion is stated concerning standard deviations.

The Obs-Background mean temperature differences vary between  $-0.7^\circ\text{C}$  and  $+1.3^\circ\text{C}$ . Aircraft with a mean difference, typically larger than expected are: EU0592, EU0807 and EU6321. No aircraft exceeded the stated mean wind speed and wind direction differences. In annex 2 two figures are shown, presenting the frequency distribution of both mean O-B temperature differences and wind speed differences as found for the set of aircraft. In four cases unexpected temperature differences were observed:

AIRCRAFT	Day	Time (UTC)	Latitude	Longitude	Altitude (m)	Temperature [observed] ( $^\circ\text{C}$ )	Temperature [background] ( $^\circ\text{C}$ )	Temperature difference ( $^\circ\text{C}$ )
EU0022	2000.05.20	18.55	42.29	26.10	3470	214.5	270.7	-56.2
EU1234	2000.05.28	15.30	18.69	11.05	1400	274.0	305.0	-31.0
EU1456	2000.05.23	13.48	48.19	2.32	240	263.5	290.3	-26.8
EU2845	2000.06.26	18.59	44.09	-3.03	10660	238.7	220.3	18.4

At the end of the quarter (starting 26<sup>th</sup> June) aircraft EU0123 demonstrated significant drift in the temperature bias. For that reason EU0123 was switched off on July 4<sup>th</sup>.

## f) Results (tables)

In the tables 4 to 6 attached to this report all AMDAR units (reporting FM-42 coded AMDAR data) are presented together with the observed total of average differences and standard deviations. All these tables are divided in two lists, one for the DES/ASC phase and the other for the cruise level phase. No statistics are presented for the UNS phase (unstable) or with  $i_p i_p = '///'$ .

## 5) Outstanding identified anomalies.

The identified anomalies are to be considered by the Responsible Members. Reports from published detailed investigations on these issues will be summarised in the following quarterly report. Typical problems/faults (apart from routine maintenance) are presented in table 3 (information provided by the appointed Technical Co-ordinator of the E-AMDAR Programme).

## 6) Solutions and actions taken from the previous period.

Any outstanding issue from previous reports are listed in paragraph 3.

## 7) Summary

1. Timeliness and data quality: Timeliness is comparable to ASDAR data. The number of anomalies is very low with respect to the total number of reports (97,2% within 45 min).
2. The number of aircraft reporting AMDAR was 111.
3. Since reports are generated automatically, in general data is error free at the reception site.
4. Significant temperature, wind speed or wind direction anomalies were not found, except for the issues stated under par. 3.e and 4.e. Anomalies of 0.5 °C and 0.3 m/s are typical.

## 8) Special case study

In Annex II of this report two figures are presented to indicate the frequency distribution of the mean O-B differences for temperature and wind speed for the set of observing aircraft (N=111). Obviously these differences (average over this quarter) vary with approx. 1 °C and 0.5 m/s.

**Table 1, *List of operational AMDAR units***

(A: activated, D: deactivated during this quarter)

<b>Identifier</b>	<b>Identifier</b>	<b>Identifier</b>	<b>Identifier</b>
EU0002	EU0254	EU1001	EU4589
EU0003	EU0263	EU1002	EU4756
EU0005	EU0299	EU1222	EU4896
EU0008	EU0301	EU1234 A	EU4956
EU0021	EU0303	EU1456	EU5175
EU0022	EU0307	EU1495	EU5191
EU0041	EU0311	EU1532	EU5218
EU0043	EU0313	EU1547 A	EU5245
EU0045	EU0316	EU1567	EU5591
EU0047	EU0319	EU1593	EU5593
EU0049	EU0324	EU1688	EU6321
EU0050	EU0332	EU1692	EU6524
EU0051	EU0359	EU1698	EU6723
EU0052	EU0367	EU1863 A	EU6821
EU0054	EU0372 A	EU1929	EU7866
EU0055	EU0432	EU2043	
EU0059	EU0456	EU2189 A	
EU0061	EU0458	EU2301 A	
EU0072	EU0475	EU2389	
EU0081	EU0476	EU2547	
EU0082	EU0482	EU2559 A	
EU0088	EU0568	EU2590	
EU0106	EU0592	EU2618	
EU0109	EU0711	EU3000 A	
EU0123	EU0802 A	EU3257 A	
EU0124	EU0807	EU3421 A	
EU0154	EU0826	EU2845	
EU0158	EU0875 A	EU4333	
EU0167	EU0921 A	EU4426	
EU0185	EU0934	EU4444	
EU0204	EU0947	EU4519	
EU0234	EU0961	EU4529	
EU0245 D	EU0985	EU4587	

**Table 2, *Quantity and Timeliness of AMDAR Reports***

<b>Summary</b>	
Number of days in this period	91
Number of aircraft reporting FM42 AMDAR	75
Number of aircraft reporting BUFR AMDAR	36
Number of E-AMDAR activated aircraft	114
Total number of observations evaluated during the period	971214 (13208/day, after May 15 <sup>th</sup> )
Average daily number of aircraft reporting FM42 AMDAR	60 (77% of activated aircraft)
Average daily number of aircraft reporting BUFR AMDAR, starting 15-MAY-2000	26 (73% of activated aircraft)
Percentage of data available within 60 minutes is	98.2%
Percentage of data available within 120 minutes is	99.3%
Average reports per day, per reporting aircraft is	119

<b>Legend</b>	
AIRCRAFT	Aircraft identifier
Total No of Reports	Number of reports received by E-AMDAR Quality Centre, exclusive of erroneous data.
Days of Reports	Number of days reports were received from aircraft by QEvC
Actual/possible	Ratio of Number of days aircraft reported/ maximum possible days in %
Average reports/day	Average number of reports per day of report from each aircraft
0 – 45	percentage of total reports received within 45 minutes of observation time
0 – 60	percentage of total reports received within 60 minutes of observation time
0 – 120	percentage of total reports received within 120 minutes of observation time

<b>AIRCRAFT</b>	<b>Total No of Reports</b>	<b>Days of Reports</b>	<b>Actual/possible</b>	<b>Average reports/day</b>	<b>0–45 min</b>	<b>0–60 min</b>	<b>0–120 min</b>
EU0002	5313	38	41.8%	140	100.0%	100.0%	100.0%
EU0003	5079	54	59.3%	94	92.3%	96.1%	99.9%
EU0005	9858	87	95.6%	113	100.0%	100.0%	100.0%
EU0008	5832	54	59.3%	108	89.9%	96.3%	99.3%
EU0021	11946	87	95.6%	137	99.8%	99.8%	100.0%
EU0022	14443	82	90.1%	176	99.9%	100.0%	100.0%
EU0041	7580	37	40.7%	205	96.5%	98.0%	99.3%
EU0043	7442	39	42.9%	191	94.7%	95.4%	96.8%
EU0045	7228	70	76.9%	103	92.4%	96.3%	100.0%
EU0047	7583	39	42.9%	194	98.0%	98.8%	99.3%
EU0049	12946	87	95.6%	149	99.6%	99.6%	100.0%
EU0050	8433	39	42.9%	216	95.2%	95.9%	96.7%

<b>AIRCRAFT</b>	<b>Total No of Reports</b>	<b>Days of Reports</b>	<b>Actual/ possible</b>	<b>Average reports/ day</b>	<b>0–45 min</b>	<b>0–60 min</b>	<b>0–120 min</b>
EU0051	9709	86	94.5%	113	100.0%	100.0%	100.0%
EU0052	5558	35	38.5%	159	95.8%	96.7%	99.2%
EU0054	7700	73	80.2%	105	100.0%	100.0%	100.0%
EU0055	13771	88	96.7%	156	99.4%	99.7%	100.0%
EU0059	2573	25	27.5%	103	96.2%	97.5%	97.8%
EU0061	667	20	22.0%	33	91.3%	96.6%	98.4%
EU0072	8944	81	89.0%	110	99.7%	99.7%	100.0%
EU0081	13303	73	80.2%	182	99.9%	99.9%	100.0%
EU0082	13621	86	94.5%	158	99.6%	99.6%	99.8%
EU0088	16639	91	100.0%	183	99.9%	100.0%	100.0%
EU0106	6766	38	41.8%	178	98.4%	99.1%	99.2%
EU0109	15716	89	97.8%	177	99.9%	99.9%	100.0%
EU0123	9260	80	87.9%	116	93.8%	96.8%	99.7%
EU0124	12679	84	92.3%	151	99.5%	99.5%	100.0%
EU0154	8133	37	40.7%	220	94.6%	95.6%	97.4%
EU0158	9025	39	42.9%	231	97.4%	98.0%	99.5%
EU0167	7411	38	41.8%	195	94.0%	94.3%	95.7%
EU0185	7742	39	42.9%	199	96.3%	97.3%	98.2%
EU0204	10347	71	78.0%	146	99.6%	99.7%	100.0%
EU0234	10658	73	80.2%	146	99.7%	99.7%	99.7%
EU0245	5744	56	61.5%	103	100.0%	100.0%	100.0%
EU0254	11360	89	97.8%	128	99.6%	99.6%	99.8%
EU0263	9407	82	90.1%	115	100.0%	100.0%	100.0%
EU0299	14299	89	97.8%	161	99.5%	99.5%	99.7%
EU0301	3627	33	36.3%	110	91.4%	92.1%	93.9%
EU0303	5884	36	39.6%	163	97.9%	98.6%	98.9%
EU0307	6573	39	42.9%	169	93.4%	94.8%	95.7%
EU0311	6531	31	34.1%	211	92.4%	93.1%	94.2%
EU0313	6232	30	33.0%	208	94.1%	94.8%	95.4%
EU0316	3934	35	38.5%	112	91.4%	92.5%	95.5%
EU0319	2690	32	35.2%	84	97.9%	99.1%	99.6%
EU0324	8070	79	86.8%	102	99.6%	99.7%	100.0%
EU0332	8748	67	73.6%	131	99.6%	99.6%	100.0%
EU0359	6095	38	41.8%	160	97.3%	97.9%	99.7%
EU0367	11995	84	92.3%	143	99.4%	99.4%	99.8%
EU0372	4578	38	41.8%	120	99.6%	99.8%	100.0%
EU0432	11867	86	94.5%	138	99.3%	99.3%	99.5%
EU0456	9177	38	41.8%	242	94.9%	95.2%	96.8%
EU0458	8345	38	41.8%	220	94.8%	94.9%	95.1%
EU0475	8407	81	89.0%	104	100.0%	100.0%	100.0%

<b>AIRCRAFT</b>	<b>Total No of Reports</b>	<b>Days of Reports</b>	<b>Actual/ possible</b>	<b>Average reports/ day</b>	<b>0–45 min</b>	<b>0–60 min</b>	<b>0–120 min</b>
EU0476	9447	38	41.8%	249	95.7%	95.8%	96.9%
EU0482	9368	76	83.5%	123	99.9%	99.9%	99.9%
EU0568	10592	75	82.4%	141	99.2%	99.2%	99.7%
EU0592	13430	82	90.1%	164	99.9%	100.0%	100.0%
EU0711	8151	38	41.8%	215	98.2%	98.3%	99.0%
EU0802	6611	32	35.2%	207	98.0%	98.6%	99.9%
EU0807	11034	88	96.7%	125	99.8%	99.8%	100.0%
EU0826	11105	77	84.6%	144	99.7%	100.0%	100.0%
EU0875	8767	39	42.9%	225	94.2%	94.9%	95.8%
EU0921	8333	39	42.9%	214	94.9%	95.7%	96.7%
EU0934	3535	41	45.1%	86	93.4%	96.8%	98.6%
EU0947	8433	84	92.3%	100	93.4%	97.3%	99.2%
EU0961	6952	64	70.3%	109	92.6%	97.1%	99.5%
EU0985	8506	70	76.9%	122	93.5%	98.0%	99.5%
EU1001	14315	89	97.8%	161	100.0%	100.0%	100.0%
EU1002	7982	66	72.5%	121	90.3%	95.9%	99.5%
EU1222	7776	71	78.0%	110	90.1%	95.6%	99.5%
EU1234	7724	38	41.8%	203	95.4%	95.7%	95.9%
EU1456	13341	81	89.0%	165	100.0%	100.0%	100.0%
EU1495	10066	79	86.8%	127	90.9%	95.8%	99.6%
EU1532	10024	69	75.8%	145	99.5%	99.7%	100.0%
EU1547	7259	36	39.6%	202	98.1%	98.5%	99.9%
EU1567	11778	80	87.9%	147	99.7%	99.7%	100.0%
EU1593	4488	57	62.6%	79	91.8%	97.2%	99.7%
EU1688	11191	89	97.8%	126	99.9%	100.0%	100.0%
EU1692	10638	88	96.7%	121	99.9%	99.9%	100.0%
EU1698	12030	81	89.0%	149	99.1%	99.1%	99.8%
EU1863	6860	38	41.8%	181	94.6%	96.0%	96.5%
EU1929	10361	78	85.7%	133	99.5%	99.5%	99.8%
EU2043	13140	89	97.8%	148	99.5%	99.6%	99.8%
EU2189	7781	36	39.6%	216	93.3%	94.1%	94.8%
EU2301	6511	33	36.3%	197	91.7%	94.0%	95.0%
EU2389	5797	33	36.3%	176	99.6%	99.6%	100.0%
EU2547	6537	63	69.2%	104	93.3%	96.7%	99.8%
EU2559	6673	37	40.7%	180	98.7%	99.2%	99.6%
EU2590	15251	53	58.2%	288	88.7%	94.5%	99.9%
EU2618	13181	47	51.6%	280	89.7%	94.8%	100.0%
EU2845	11346	88	96.7%	129	99.8%	99.9%	100.0%
EU3000	7018	15	16.5%	468	95.3%	95.4%	96.0%
EU3257	2308	9	9.9%	256	97.2%	97.2%	100.0%

AIRCRAFT	Total No of Reports	Days of Reports	Actual/possible	Average reports/day	0–45 min	0–60 min	0–120 min
EU3421	4382	10	11.0%	438	99.1%	100.0%	100.0%
EU4333	16876	58	63.7%	291	89.1%	94.8%	99.9%
EU4426	14730	88	96.7%	167	100.0%	100.0%	100.0%
EU4444	17564	52	57.1%	338	88.9%	95.0%	99.8%
EU4519	14075	46	50.5%	306	88.6%	93.6%	99.9%
EU4529	10123	84	92.3%	121	100.0%	100.0%	100.0%
EU4587	10203	88	96.7%	116	100.0%	100.0%	100.0%
EU4589	646	15	16.5%	43	100.0%	100.0%	100.0%
EU4756	1368	28	30.8%	49	100.0%	100.0%	100.0%
EU5175	3753	85	93.4%	44	100.0%	100.0%	100.0%
EU5191	3274	85	93.4%	39	100.0%	100.0%	100.0%
EU5218	14785	81	89.0%	183	99.8%	99.8%	100.0%
EU5245	3711	82	90.1%	45	100.0%	100.0%	100.0%
EU5591	13891	79	86.8%	176	99.8%	99.8%	100.0%
EU6321	2860	67	73.6%	43	100.0%	100.0%	100.0%
EU6524	1405	40	44.0%	35	100.0%	100.0%	100.0%
EU6723	10931	88	96.7%	124	100.0%	100.0%	100.0%
EU6821	2155	45	49.5%	48	100.0%	100.0%	100.0%
EU7866	11374	87	95.6%	131	99.8%	99.8%	100.0%

- From 24 aircraft more than one percent of the received data had a delay after observation for more than two hours:

Identifier	Identifier	Identifier	Identifier	Identifier
EU0043	EU0167	EU0311	EU0476	EU1863
EU0050	EU0185	EU0313	EU0875	EU2189
EU0059	EU0301	EU0316	EU0921	EU2301
EU0061	EU0303	EU0456	EU0934	EU3000
EU0154	EU0307	EU0458	EU1234	

- From 33 aircraft, data was received encoded in BUFR AMDAR (see par. 3). BUFR encoded bulletins are evaluated as from May 15<sup>th</sup>.
- No data was received from (see par. 2) :

Identifier	Identifier
EU4896	EU5593
EU4956	

**Table 3, Description and number of errors**

**Aircrafts deactivated due to temperature anomalies:**

- EU0123: Warm temperature bias (5 to 9 °C) since 25/26 June. Switched off 4<sup>th</sup> July.

**No reports received although expected:**

- EU0002: no reports till 10-may-2000 due to long period of maintenance. No reports 18-29 June. DMU replaced June, 23<sup>rd</sup>.
- EU0003: no reports until 7-april-2000. Data processing problems; resolved 6-april-2000. No reports 1-8 June. System reactivated by operator. No reports 24-30 June
- EU0008: no reports 1-20 June major maintenance, reactivated June, 21<sup>st</sup>
- EU0022: no reports 10-16 May. Problems with on-board clock (1 day out).
- EU0045: no reports 1-8 June. System reactivated by operator.
- EU0054: no reports 10-24 April. Clock problems on aircraft.
- EU0059: no reports 13-26 June. Major maintenance.
- EU0061: no reports 13-30 June. Major maintenance.
- EU0123: no reports 11-20 June. System reactivated by operator.
- EU0204: no reports 9-15 April due to ACARS problems; reset April, 16<sup>th</sup>.
- EU0245: no reports since June, 1<sup>st</sup>. Aircraft no longer operating - sold by operator. Awaiting notification of replacement AMDAR unit.
- EU0332: no reports 1-15 May due to ACARS problems; reset May, 16<sup>th</sup>
- EU0482: no reports 5-18 June. System reactivated by operator.
- EU0568: no reports 12-27 May. New DMU fitted to aircraft.
- EU0802: no reports 16-20 May
- EU0826: no reports 16-26 June. Major maintenance.
- EU0934: no reports till May, 18<sup>th</sup> due to major refit to aircraft.
- EU0961: no reports 10-16 May. System reactivated by operator
- EU0985: no reports 1-11 May. System reactivated by operator.
- EU1002: no reports 23-31 May
- EU1222: no reports 10-18 April. System reactivated by operator on April, 17<sup>th</sup>
- EU1456: no reports 23-30 June. Major maintenance.
- EU1532: no reports 9-30 June. Major maintenance (due back 9<sup>th</sup> July 2000).
- EU1567: no reports 2-10 April. System reactivated by operator.
- EU1593: no reports 28 May-8 June, 11-20 June. System reactivated by operator.
- EU1698: no reports 28-31 May
- EU1929: no reports 22 April-3 May
- EU2389: no reports 14 April-15 May due to ACARS problems; reset May 16<sup>th</sup>. No reports 1-19 June. DMU failure, software reloaded June, 19<sup>th</sup>
- EU2547: no reports 1-8 June. System reactivated by operator.
- EU2590: no reports 26 May-30 June. Software problems - changes to ACMS software being implemented.
- EU2618: no reports until April, 8<sup>th</sup>. System reactivated by operator on April, 7<sup>th</sup>. No reports 27 May-30 June. Software problems - changes to ACMS software being implemented.
- EU4333: no reports 31 May-30 June. Software problems - changes to ACMS software being implemented.
- EU4444: no reports 27 May-30 June. Software problems - changes to ACMS software being implemented.

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- EU4519: no reports 24 May–30 June . Software problems - changes to ACMS software being implemented.
  - EU5218: no reports 24 April–3 May
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#### **Specific problems:**

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- The following aircraft failed to report due to a software problems: EU2590, EU2618, EU4333, EU4444, EU4519
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#### **Ground stations issues and other problems:**

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- SAS ACMS Datalink failure 2<sup>nd</sup> April
  - SAS ACMS Datalink failure 11–12<sup>nd</sup> June
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#### **Activated and deactivated aircraft:**

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- EU0372: activated by operator on May, 18<sup>th</sup>
  - EU0802: activated by operator on April, 10<sup>th</sup> (BUFR format)
  - EU0875: activated by operator on April, 10<sup>th</sup> (BUFR format)
  - EU0921: activated by operator on April, 17<sup>th</sup> (BUFR format)
  - EU1234: activated by operator on April, 19<sup>th</sup> (BUFR format)
  - EU1547: activated by operator on April, 19<sup>th</sup> (BUFR format)
  - EU1863: activated by operator on April, 27<sup>th</sup> (BUFR format)
  - EU2189: activated by operator on May, 11<sup>th</sup> (BUFR format)
  - EU2301: activated by operator on May, 11<sup>th</sup> (BUFR format)
  - EU2559: activated by operator on May, 11<sup>th</sup> (BUFR format)
  - EU3000: activated by operator on June, 15<sup>th</sup> (BUFR format)
  - EU3257: activated by operator on June, 21<sup>st</sup> (BUFR format)
  - EU3421: activated by operator on June, 21<sup>st</sup> (BUFR format)
  - EU0245: deactivated by operator June 2<sup>nd</sup>
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(information provided by the appointed Technical Co-ordinator of the E-AMDAR Programme; more details to be inserted in the following Quarterly reports)

## Tables 4 to 6, *Evaluation results*

Presented values: Observation minus Reference (Model values), O–B.

All statistics are evaluated separately for two datasets:

- 1) Data from Ascent/Decent ( $i_p i_p i_p = \text{ASC}$  or  $\text{DES}$ )
- 2) Cruise level, level flight at cruising height ( $i_p i_p i_p = \text{LVR}$  or  $\text{LVW}$ )

Notes:

- Data with  $i_p i_p i_p = \text{UNS}$  or  $///$  is not evaluated.
- AMDAR aircraft produce much more reports during Ascent/Decent than during Cruise level.
- O–B values larger than the stated criterion are presented in **bold**.
- Temperatures are in °C, wind speed in m/s and wind direction in degrees.
- The total number of reported observations in the table 4 to 6 differs from the total number in table 2. The main reason is that within table two data are presented from observations world wide, whereas in the tables 4 to 6 data are presented which were evaluated with using the HIRLAM model as reference. Since this model is a limited area model, only those data were evaluated which were observed within the HIRLAM area (roughly Europe, Northern Africa and the North Atlantic, see Annex 1 - Figure 3) and within the three hours time-window around main and intermediate hours (eight times a day). Other reasons for this difference are incorrect encoding (e.g.  $i_p i_p i_p$ ), cases with identical reports (only one is used) or in case of incomplete bulletins.
- Notice that a number of aircraft only report during the ascending phase.

### Legends

Number of Reports	Actual number of reports used for calculation of values
Observed Mean	Average value of the parameter for relevant phase in units of °C (for temperature), m/s (wind speed) or degrees (wind direction)
Observed SD	Standard Deviation of observed parameter
Obs–Backgrnd Mean	Average value of calculated differences (observed parameter minus model output value)
Obs–Backgrnd SD	Standard Deviation of calculated differences (observed parameter minus model output value)

a) Tabel 4, *Temperature (°C)*

2000-II T AIR-CRAFT	Temperature Cruise level in °C					Temperature Ascent & Descent in °C				
	Number of Reports	Observed		Obs-backgrnd		Number of Reports	Observed		Obs-backgrnd	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
EU0002						4460	-8.3	16.7	-0.1	0.9
EU0003	3020	-49.6	9.2	-0.3	1.6	1391	-1.1	12.3	-0.1	1.2
EU0005	2663	-49.4	10.5	-0.2	1.6	5541	3.5	13.4	-0.2	1.2
EU0008	3674	-50.1	8.3	-0.3	1.6	1452	0.2	12.5	-0.1	1.0
EU0021	1826	-46.4	12.8	-0.1	1.1	7548	-2.8	11.6	0.0	1.1
EU0022	3303	-50.7	10.6	0.0	1.9	8658	3.2	12.4	-0.2	1.2
EU0041	489	-42.0	16.5	1.1	1.7	7091	-1.0	17.0	0.7	3.6
EU0043	338	-42.1	14.9	0.7	1.2	7104	-1.4	18.1	0.3	2.8
EU0045	4549	-49.2	9.0	-0.3	1.5	1893	-1.4	12.4	-0.2	1.0
EU0047	273	-38.6	17.0	0.6	1.2	7310	-1.7	18.4	0.4	3.9
EU0049						10894	-11.0	17.8	-0.2	1.0
EU0050	510	-41.2	17.2	-0.3	1.2	7923	-0.9	16.2	-0.4	3.1
EU0051	2382	-49.0	10.9	-0.3	1.2	5677	2.3	13.3	-0.4	1.2
EU0052	247	-42.5	16.0	-0.5	1.1	5311	-3.9	19.3	-0.4	3.4
EU0054	2011	-49.9	10.3	-0.4	1.2	4401	3.2	13.1	-0.4	1.2
EU0055						11756	-13.3	19.2	0.1	1.2
EU0059	126	-39.4	16.4	-0.4	1.3	2447	-2.2	15.6	-0.2	3.6
EU0061	116	-41.0	20.2	-0.3	1.1	551	1.7	11.9	-0.3	2.1
EU0072	2385	-49.5	9.8	0.1	2.0	5013	2.9	13.0	0.0	1.3
EU0081	2651	-48.8	12.2	0.2	1.9	8321	4.2	12.3	0.1	1.2
EU0082						11682	-13.5	19.4	0.3	1.0
EU0088	2860	-48.2	11.7	0.6	1.7	10700	3.9	12.1	0.1	1.2
EU0106	382	-41.6	14.3	-0.3	1.2	6384	-1.1	17.6	-0.2	3.6
EU0109	3356	-50.0	12.0	-0.2	2.1	9633	3.0	12.1	-0.1	1.2
EU0123	5872	-49.2	8.9	0.4	2.9	2268	-0.2	12.3	0.1	2.0
EU0124						10744	-11.2	18.0	0.1	1.0
EU0154	336	-37.1	21.4	0.2	1.3	7797	-0.7	16.6	0.0	3.7
EU0158	345	-36.1	18.9	0.9	3.4	8680	0.0	15.4	0.5	2.7
EU0167	363	-36.7	18.1	0.2	0.9	7048	-2.5	19.0	0.3	3.0
EU0185	522	-40.5	13.9	0.4	1.2	7220	0.7	16.2	0.3	2.8
EU0204	2421	-51.2	10.1	0.3	1.4	5939	4.2	12.3	0.2	1.2
EU0234						8999	-10.4	17.6	-0.1	1.0
EU0245	1962	-53.2	8.3	-0.1	1.4	2917	3.0	14.1	-0.1	1.4
EU0254	6024	-48.8	8.7	0.2	1.6	4034	7.9	13.2	0.1	1.2
EU0263	4900	-49.4	8.3	-0.1	1.6	3449	7.6	13.0	0.0	1.3
EU0299						12370	-13.6	19.2	0.0	1.0
EU0301	151	-38.6	20.6	0.7	1.1	3476	-1.0	18.2	0.4	3.0

2000-II T AIR-CRAFT	Temperature Cruise level in °C					Temperature Ascent & Descent in °C				
	Number of Reports	Observed		Obs-backgrnd		Number of Reports	Observed		Obs-backgrnd	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
EU0303	365	-44.4	13.6	-0.4	1.3	5519	-0.6	17.3	-0.4	3.0
EU0307	422	-43.3	14.6	-0.3	1.3	6151	-1.2	16.3	-0.4	3.3
EU0311	406	-40.2	14.7	0.4	1.2	6125	0.6	16.7	0.3	3.5
EU0313	347	-41.5	13.8	0.5	3.7	5885	-0.2	18.0	0.4	3.8
EU0316	149	-41.2	14.4	1.0	1.2	3785	-10.9	23.7	0.8	3.6
EU0319	212	-45.2	14.2	0.0	1.3	2478	0.3	17.1	0.1	3.1
EU0324	3102	-52.9	8.1	-0.3	1.2	3712	4.1	14.0	-0.2	1.4
EU0332	4624	-48.8	8.5	-0.2	1.6	3180	7.5	13.6	-0.1	1.1
EU0359	374	-37.9	17.8	0.6	1.3	5721	1.0	15.5	0.6	3.1
EU0367						10147	-11.2	17.4	-0.2	1.0
EU0372	2479	-47.3	9.0	-0.2	1.5	1588	10.3	13.6	0.0	1.2
EU0432						9950	-10.8	17.8	-0.1	1.0
EU0456	253	-28.3	22.8	0.5	1.1	8924	-1.7	16.4	0.5	1.2
EU0458	184	-27.7	21.7	0.4	1.9	8161	-1.8	16.8	0.3	1.1
EU0475	3688	-51.7	7.5	0.1	1.3	3389	4.1	13.8	0.2	1.4
EU0476	200	-30.3	20.0	0.2	1.4	9247	-2.7	17.3	0.2	1.3
EU0482	4806	-49.4	8.0	-0.2	1.5	3518	7.0	13.2	0.0	1.2
EU0568						8836	-10.5	18.1	0.3	1.1
EU0592	3182	-49.6	9.6	1.3	1.3	7671	6.0	12.3	0.6	1.3
EU0711	175	-28.0	21.0	-0.1	1.0	7976	-1.8	16.8	0.1	1.8
EU0802	387	-38.8	16.8	0.8	3.5	6224	0.7	15.9	0.4	3.0
EU0807	3552	-46.8	8.9	1.3	1.5	5709	3.6	13.8	0.6	1.5
EU0826						9336	-11.9	18.1	0.0	1.2
EU0875	486	-39.8	15.6	0.8	1.2	8281	0.9	16.5	0.7	3.1
EU0921	362	-39.8	15.7	-0.1	3.7	7971	-1.6	17.5	-0.4	3.5
EU0934	2360	-48.8	8.5	-0.3	1.6	842	0.4	11.7	-0.4	1.1
EU0947	5214	-47.8	10.0	-0.5	1.6	2192	-0.3	12.2	-0.3	1.1
EU0961	4279	-47.0	9.6	0.3	1.6	1837	-2.1	12.3	0.1	1.1
EU0985	5231	-49.8	8.3	-0.4	1.6	2254	-0.2	12.4	-0.3	1.1
EU1001						12231	-14.0	19.3	-0.1	1.0
EU1002	4804	-48.4	9.1	-0.1	1.7	2055	-1.6	12.1	0.0	1.2
EU1222	4556	-48.9	9.2	-0.4	1.6	2113	-0.4	12.1	-0.1	1.2
EU1234	412	-40.7	19.4	-0.5	1.3	7312	-1.1	16.8	-0.3	4.1
EU1456						10576	-9.4	18.1	-0.4	1.1
EU1495	6219	-49.4	9.0	-0.4	1.6	2525	-1.1	11.9	-0.1	1.2
EU1532						8471	-13.3	17.9	-0.2	1.0
EU1547	363	-41.4	15.9	-0.2	1.0	6896	-1.7	17.0	-0.2	3.4
EU1567						9988	-10.1	17.7	0.1	1.0
EU1593	2427	-50.9	7.6	-0.4	1.6	1421	-3.4	11.8	-0.1	1.2
EU1688	3433	-48.5	9.3	-0.4	1.1	5940	2.0	13.6	-0.3	1.2

2000-II T AIR-CRAFT	Temperature Cruise level in °C					Temperature Ascent & Descent in °C				
	Number of Reports	Observed		Obs-backgrnd		Number of Reports	Observed		Obs-backgrnd	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
EU1692	3475	-48.8	8.8	-0.1	1.1	5458	2.1	14.0	-0.3	1.3
EU1698						10116	-11.8	18.3	0.1	1.0
EU1863	318	-39.9	16.8	-0.4	1.1	6542	-2.2	17.3	-0.3	4.0
EU1929	6715	-45.6	9.4	0.0	1.6	2474	5.7	12.7	-0.1	1.0
EU2043	8588	-46.2	9.1	0.2	1.7	3144	6.5	12.3	0.0	1.0
EU2189	386	-39.1	15.8	0.6	1.0	7395	-0.7	16.7	0.4	3.9
EU2301	371	-38.4	20.3	0.8	1.2	6140	-0.6	16.7	0.3	3.0
EU2389	824	-45.2	11.9	-0.4	1.1	3833	0.2	12.1	-0.4	1.1
EU2547	4084	-48.8	8.7	0.0	1.5	1712	-1.1	12.3	0.0	1.2
EU2559	355	-41.2	16.7	0.6	1.6	6318	-1.4	16.6	0.4	2.4
EU2590	1284	-37.6	6.2	-0.2	0.8	13921	-7.8	14.8	-0.1	1.2
EU2618	1101	-38.6	7.0	0.0	0.9	11981	-6.9	14.6	-0.3	1.2
EU2845	3644	-48.4	9.0	-0.1	1.2	5868	2.1	13.7	-0.4	1.2
EU3000	292	-41.7	13.0	-0.5	1.2	6726	-1.5	18.0	-0.4	2.6
EU3257	91	-40.4	13.4	-0.3	1.2	2217	-1.5	16.8	-0.4	3.3
EU3421	113	-38.0	13.9	1.2	1.0	4269	-3.3	17.8	0.8	3.3
EU4333	1409	-37.6	6.5	0.1	0.9	15356	-7.4	15.0	-0.1	1.2
EU4426	2407	-46.8	12.1	-0.4	1.1	8868	0.2	11.7	-0.3	1.1
EU4444	1146	-45.5	10.9	-0.4	1.0	15893	-8.0	15.4	-0.4	1.2
EU4519	914	-44.5	10.4	0.0	1.1	12754	-7.1	15.3	-0.1	1.2
EU4529	3328	-48.9	8.7	-0.3	1.1	5137	2.1	13.6	-0.3	1.3
EU4587	3054	-48.7	9.6	-0.2	1.1	5520	1.6	13.5	-0.3	1.2
EU4589	130	-43.9	10.8	0.2	2.4	348	9.7	10.2	0.2	1.1
EU4756	284	-42.8	13.1	0.2	1.4	799	9.5	9.1	0.3	1.3
EU5175	728	-43.2	13.2	0.0	1.6	2147	11.6	8.8	0.2	1.4
EU5191	631	-43.4	12.2	0.0	1.5	1836	12.0	8.9	0.4	1.3
EU5218	2308	-45.8	12.1	0.0	1.1	9645	3.0	11.9	-0.2	1.2
EU5245	657	-44.2	11.7	0.0	1.3	2171	12.7	8.9	0.3	1.3
EU5591	2277	-46.3	12.7	-0.2	1.0	8413	1.0	11.6	-0.3	1.1
EU6321	462	-41.5	13.6	0.3	1.4	1693	12.9	9.0	1.0	1.3
EU6524	345	-45.4	10.1	0.5	1.2	796	-3.3	11.9	0.4	1.1
EU6723	3304	-48.4	9.4	-0.2	1.1	5780	2.3	13.4	-0.2	1.3
EU6821	445	-44.0	12.4	-0.1	7.8	1120	12.5	9.9	0.2	1.4
EU7866	3582	-48.0	9.3	0.0	1.0	5949	2.6	13.7	-0.3	1.2

b) Tabel 5, *Wind Speed (m/s)*

2000-II FF AIRCRAFT	Wind Speed Cruise level in m/s					Wind Speed Ascent & Descent in m/s				
	Number of Reports	Observed		Obs-backgrnd		Number of Reports	Observed		Obs-backgrnd	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
EU0002	0					4460	12.4	8.8	0.1	2.2
EU0003	3020	23.8	13.8	0.1	13.8	1391	10.9	7.5	0.0	2.1
EU0005	2663	20.4	12.0	0.1	12.0	5541	8.3	6.2	0.0	2.2
EU0008	3674	22.7	13.3	0.1	13.3	1452	8.8	5.9	0.0	1.9
EU0021	1826	20.2	12.3	0.2	12.3	7548	10.1	7.0	0.0	2.2
EU0022	3303	19.3	11.8	0.1	11.8	8658	8.5	6.0	0.0	2.0
EU0041	489	23.2	11.8	0.1	11.8	7091	11.7	8.3	0.0	2.0
EU0043	338	20.0	11.6	0.0	11.6	7104	10.6	7.7	0.1	2.1
EU0045	4549	23.0	13.9	0.0	13.9	1893	9.8	7.0	0.3	1.9
EU0047	273	20.0	10.5	0.1	10.5	7310	11.1	7.7	0.0	2.0
EU0049	0					10894	12.5	9.5	0.2	2.5
EU0050	510	19.9	11.4	-0.1	11.4	7923	10.6	7.6	0.1	2.3
EU0051	2382	19.9	11.6	0.3	11.6	5677	8.8	6.2	0.1	2.3
EU0052	247	20.5	11.3	0.2	11.3	5311	12.1	7.8	0.3	2.3
EU0054	2011	20.6	10.8	0.0	10.8	4401	8.0	5.9	0.1	2.2
EU0055	0					11756	14.0	10.2	0.3	2.6
EU0059	126	21.7	12.0	-0.1	12.0	2447	12.1	7.5	0.5	2.1
EU0061	116	22.3	12.5	0.4	12.5	551	9.3	6.3	0.3	2.4
EU0072	2385	20.1	11.9	0.1	11.9	5013	8.5	6.7	0.0	2.2
EU0081	2651	19.4	11.7	0.1	11.7	8321	9.1	6.4	-0.1	2.0
EU0082	0					11682	14.0	10.4	0.0	2.5
EU0088	2860	21.4	12.1	0.3	12.1	10700	8.8	6.4	0.0	2.2
EU0106	382	19.2	12.6	-0.2	12.6	6384	10.4	7.4	0.1	2.1
EU0109	3356	18.7	11.3	0.0	11.3	9633	9.0	6.5	-0.1	2.1
EU0123	5872	20.2	13.2	0.1	13.2	2268	10.2	6.7	0.2	2.0
EU0124	0					10744	12.9	9.6	0.1	2.4
EU0154	336	18.3	11.2	0.2	11.2	7797	10.7	7.7	0.3	2.2
EU0158	345	19.8	11.0	0.0	11.0	8680	11.5	8.0	0.2	2.1
EU0167	363	18.6	11.4	0.1	11.4	7048	11.0	7.8	0.2	2.1
EU0185	522	22.1	11.3	0.3	11.3	7220	10.8	7.7	0.2	2.1
EU0204	2421	20.3	12.0	0.4	12.0	5939	8.6	6.3	0.2	2.1
EU0234	0					8999	12.5	9.6	0.2	2.3
EU0245	1962	18.3	11.5	0.2	11.5	2917	8.5	6.4	0.4	2.3
EU0254	6024	24.1	14.8	0.1	14.8	4034	8.8	6.4	-0.1	2.2
EU0263	4900	23.5	14.8	0.1	14.8	3449	8.5	6.7	-0.2	2.2
EU0299	0					12370	13.9	10.1	0.1	2.6
EU0301	151	21.0	11.0	0.1	11.0	3476	11.2	7.6	0.3	2.1

2000-II FF AIRCRAFT	Wind Speed Cruise level in m/s					Wind Speed Ascent & Descent in m/s				
	Number of Reports	Observed		Obs-backgrnd		Number of Reports	Observed		Obs-backgrnd	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
EU0303	365	21.9	12.2	-0.1	12.2	5519	10.9	8.2	0.5	2.3
EU0307	422	22.0	11.7	0.0	11.7	6151	10.9	8.1	0.2	2.2
EU0311	406	21.4	13.4	0.2	13.4	6125	10.4	7.8	0.1	2.1
EU0313	347	22.3	12.1	-0.1	12.1	5885	10.3	7.0	0.1	2.1
EU0316	149	19.5	11.2	0.2	11.2	3785	14.4	10.6	0.1	2.2
EU0319	212	18.9	10.8	-0.3	10.8	2478	9.9	8.1	0.2	1.9
EU0324	3102	19.5	11.9	0.1	11.9	3712	8.5	6.7	0.3	2.3
EU0332	4624	25.1	14.8	0.1	14.8	3180	8.8	6.2	-0.1	2.3
EU0359	374	18.7	10.7	-0.3	10.7	5721	10.9	7.2	0.1	2.2
EU0367	0					10147	13.4	9.9	0.1	2.4
EU0372	2479	25.2	13.8	0.1	13.8	1588	9.1	6.3	-0.3	2.3
EU0432	0					9950	12.6	9.8	0.0	2.4
EU0456	253	20.7	11.6	-0.3	11.6	8924	12.8	8.1	0.2	2.2
EU0458	184	19.8	12.6	-0.4	12.6	8161	11.7	7.7	0.0	2.1
EU0475	3688	20.2	11.0	0.2	11.0	3389	8.3	6.3	0.3	2.4
EU0476	200	20.3	12.3	-0.4	12.3	9247	12.3	8.4	0.3	2.2
EU0482	4806	25.7	15.1	0.0	15.1	3518	8.6	6.6	-0.1	2.2
EU0568	0					8836	13.4	10.2	0.2	2.4
EU0592	3182	21.3	12.6	0.4	12.6	7671	8.6	6.3	0.2	2.1
EU0711	175	19.8	10.0	-0.3	10.0	7976	12.0	8.5	0.1	2.1
EU0802	387	18.1	11.7	0.1	11.7	6224	11.2	7.6	0.2	2.1
EU0807	3552	21.4	12.9	0.3	12.9	5709	8.6	6.4	0.2	2.3
EU0826	0					9336	13.0	9.4	0.0	2.5
EU0875	486	19.5	11.6	0.1	11.6	8281	10.4	7.3	0.2	2.1
EU0921	362	19.9	11.5	0.0	11.5	7971	11.0	8.1	0.3	2.4
EU0934	2360	16.4	11.2	0.1	11.2	842	12.2	7.7	0.3	2.0
EU0947	5214	22.5	13.8	0.0	13.8	2192	9.7	7.2	0.0	2.1
EU0961	4279	23.3	14.2	0.0	14.2	1837	9.9	7.2	0.1	2.0
EU0985	5231	23.5	14.5	0.0	14.5	2254	11.4	6.7	0.1	2.0
EU1001	0					12231	13.8	10.3	0.0	2.6
EU1002	4804	25.5	15.3	0.0	15.3	2055	12.2	7.6	0.0	2.1
EU1222	4556	24.5	14.6	0.0	14.6	2113	11.7	7.7	0.0	2.0
EU1234	412	21.9	11.4	0.3	11.4	7312	10.4	7.3	0.3	2.2
EU1456	0					10576	12.3	9.3	0.2	2.7
EU1495	6219	25.7	15.2	0.1	15.2	2525	12.4	8.1	0.0	2.2
EU1532	0					8471	13.2	10.1	0.1	2.5
EU1547	363	20.7	13.0	0.1	13.0	6896	11.5	8.0	0.2	2.1
EU1567	0					9988	13.7	10.4	0.0	2.6
EU1593	2427	23.7	14.6	0.0	14.6	1421	10.8	7.2	0.2	2.2
EU1688	3433	21.6	12.9	0.3	12.9	5940	8.9	6.7	0.1	2.5

2000-II FF AIRCRAFT	Wind Speed Cruise level in m/s					Wind Speed Ascent & Descent in m/s				
	Number of Reports	Observed		Obs-backgrnd		Number of Reports	Observed		Obs-backgrnd	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
EU1692	3475	21.6	13.1	0.3	13.1	5458	8.8	6.5	0.2	2.5
EU1698	0					10116	12.2	9.1	0.0	2.4
EU1863	318	20.2	11.4	0.3	11.4	6542	11.1	8.5	0.3	2.2
EU1929	6715	20.7	14.1	0.0	14.1	2474	8.6	6.7	-0.1	2.2
EU2043	8588	20.6	14.2	0.0	14.2	3144	8.0	6.1	-0.1	2.2
EU2189	386	20.4	11.1	0.4	11.1	7395	10.6	7.6	0.2	2.2
EU2301	371	19.9	11.7	0.2	11.7	6140	11.0	8.0	0.1	2.0
EU2389	824	22.1	10.9	0.3	10.9	3833	8.6	5.5	0.0	2.1
EU2547	4084	22.0	12.6	0.1	12.6	1712	8.4	6.2	0.0	2.0
EU2559	355	20.8	12.0	-0.1	12.0	6318	11.2	7.8	0.2	2.0
EU2590	1284	19.5	10.9	0.2	10.9	13921	10.2	7.6	0.1	2.4
EU2618	1101	17.8	11.5	0.0	11.5	11981	9.6	7.3	0.0	2.2
EU2845	3644	20.9	12.3	0.2	12.3	5868	8.9	6.7	0.1	2.4
EU3000	292	24.2	12.0	0.2	12.0	6726	11.0	8.2	0.3	2.4
EU3257	91	23.4	11.2	0.3	11.2	2217	11.6	7.5	0.2	2.2
EU3421	113	22.9	9.9	0.2	9.9	4269	13.7	9.1	-0.2	2.3
EU4333	1409	17.7	9.9	0.0	9.9	15356	9.8	7.2	-0.1	2.4
EU4426	2407	22.0	13.2	0.2	13.2	8868	9.4	6.6	-0.2	2.3
EU4444	1146	18.7	11.4	0.0	11.4	15893	11.4	8.1	0.1	2.4
EU4519	914	19.1	10.7	0.2	10.7	12754	10.9	8.1	0.2	2.3
EU4529	3328	22.2	12.8	0.2	12.8	5137	8.9	6.5	0.1	2.3
EU4587	3054	21.8	12.2	0.2	12.2	5520	8.7	6.5	0.0	2.4
EU4589	130	13.0	9.7	0.1	9.7	348	7.0	4.4	-0.3	1.9
EU4756	284	18.2	12.2	-0.1	12.2	799	7.7	4.5	-0.3	2.3
EU5175	728	17.2	14.1	0.2	14.1	2147	7.1	4.6	-0.4	2.3
EU5191	631	13.1	11.5	0.0	11.5	1836	6.6	4.2	-0.4	2.2
EU5218	2308	22.2	12.9	0.2	12.9	9645	8.7	6.3	0.0	2.2
EU5245	657	13.8	11.0	0.0	11.0	2171	7.4	4.8	-0.4	2.0
EU5591	2277	21.4	13.4	0.3	13.4	8413	8.9	6.3	0.0	2.2
EU6321	462	15.9	11.6	0.1	11.6	1693	7.1	4.6	-0.3	2.2
EU6524	345	21.7	12.1	0.7	12.1	796	9.3	7.5	-0.4	2.6
EU6723	3304	21.1	11.9	0.2	11.9	5780	8.7	6.5	0.1	2.3
EU6821	445	16.2	12.3	0.1	12.3	1120	6.8	4.6	-0.2	2.2
EU7866	3582	21.6	12.5	0.2	12.5	5949	8.9	6.6	0.2	2.5

c) Tabel 6, *Wind direction (deg)*

2000-II DD	Wind Direction Cruise level in degrees					Wind Direction Ascent & Descent in degrees					
	AIRCRAFT	Number of Reports	Observed		Obs-backgrnd		Number of Reports	Observed		Obs-backgrnd	
			Mean	SD	Mean	SD		Mean	SD	Mean	SD
	EU0002						4460			14	21
	EU0003	3020		5	12	1391			13	24	
	EU0005	2663		9	14	5541			19	29	
	EU0008	3674		6	13	1452			13	27	
	EU0021	1826		8	13	7548			16	25	
	EU0022	3303		9	14	8658			17	23	
	EU0041	489		8	15	7091			14	22	
	EU0043	338		8	11	7104			16	26	
	EU0045	4549		5	12	1893			13	24	
	EU0047	273		8	16	7310			14	20	
	EU0049					10894			15	22	
	EU0050	510		10	18	7923			15	22	
	EU0051	2382		9	14	5677			17	25	
	EU0052	247		9	13	5311			15	21	
	EU0054	2011		8	13	4401			19	29	
	EU0055					11756			13	21	
	EU0059	126		8	14	2447			13	19	
	EU0061	116		8	11	551			15	23	
	EU0072	2385		9	15	5013			19	28	
	EU0081	2651		9	13	8321			16	22	
	EU0082					11682			12	19	
	EU0088	2860		7	12	10700			17	24	
	EU0106	382		9	14	6384			16	25	
	EU0109	3356		9	15	9633			17	23	
	EU0123	5872		7	14	2268			11	23	
	EU0124					10744			14	21	
	EU0154	336		8	10	7797			16	22	
	EU0158	345		9	16	8680			14	22	
	EU0167	363		8	15	7048			13	19	
	EU0185	522		8	15	7220			14	22	
	EU0204	2421		9	14	5939			17	24	
	EU0234					8999			14	22	
	EU0245	1962		11	18	2917			20	29	
	EU0254	6024		5	11	4034			8	22	
	EU0263	4900		5	13	3449			9	28	
	EU0299					12370			14	21	
	EU0301	151		8	14	3476			13	19	
	EU0303	365		10	20	5519			15	22	

2000-II DD AIRCRAFT	Wind Direction Cruise level in degrees					Wind Direction Ascent & Descent in degrees				
	Number of Reports	Observed		Obs-backgrnd		Number of Reports	Observed		Obs-backgrnd	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
EU0307	422			8	13	6151			17	24
EU0311	406			9	15	6125			16	24
EU0313	347			7	11	5885			16	23
EU0316	149			10	18	3785			11	18
EU0319	212			8	15	2478			14	23
EU0324	3102			9	14	3712			19	27
EU0332	4624			5	12	3180			8	26
EU0359	374			10	19	5721			13	19
EU0367						10147			14	23
EU0372	2479			5	11	1588			7	24
EU0432						9950			15	23
EU0456	253			8	16	8924			11	17
EU0458	184			9	18	8161			12	17
EU0475	3688			8	13	3389			19	28
EU0476	200			9	16	9247			12	17
EU0482	4806			5	12	3518			8	26
EU0568						8836			13	21
EU0592	3182			9	14	7671			18	26
EU0711	175			8	10	7976			12	17
EU0802	387			10	17	6224			13	20
EU0807	3552			9	15	5709			19	29
EU0826						9336			13	21
EU0875	486			9	17	8281			15	22
EU0921	362			11	19	7971			17	25
EU0934	2360			7	12	842			8	16
EU0947	5214			6	14	2192			14	23
EU0961	4279			5	11	1837			14	22
EU0985	5231			6	14	2254			9	20
EU1001						12231			14	21
EU1002	4804			6	13	2055			9	24
EU1222	4556			6	11	2113			9	23
EU1234	412			7	13	7312			17	26
EU1456						10576			16	24
EU1495	6219			6	13	2525			7	18
EU1532						8471			14	22
EU1547	363			7	13	6896			13	18
EU1567						9988			14	22
EU1593	2427			6	10	1421			15	28
EU1688	3433			9	15	5940			21	30
EU1692	3475			8	14	5458			20	30

2000-II DD AIRCRAFT	Wind Direction Cruise level in degrees					Wind Direction Ascent & Descent in degrees				
	Number of Reports	Observed		Obs-backgrnd		Number of Reports	Observed		Obs-backgrnd	
		Mean	SD	Mean	SD		Mean	SD	Mean	SD
EU1698						10116			14	22
EU1863	318			8	10	6542			17	25
EU1929	6715			3	10	2474			5	20
EU2043	8588			3	12	3144			5	19
EU2189	386			8	15	7395			16	21
EU2301	371			8	19	6140			14	21
EU2389	824			7	11	3833			18	26
EU2547	4084			5	12	1712			16	26
EU2559	355			8	15	6318			13	21
EU2590	1284			8	13	13921			19	27
EU2618	1101			11	15	11981			18	25
EU2845	3644			8	14	5868			20	30
EU3000	292			7	9	6726			17	26
EU3257	91			8	18	2217			14	19
EU3421	113			4	5	4269			12	22
EU4333	1409			11	16	15356			19	27
EU4426	2407			8	15	8868			19	27
EU4444	1146			9	15	15893			17	24
EU4519	914			9	14	12754			18	25
EU4529	3328			8	14	5137			18	26
EU4587	3054			9	14	5520			19	28
EU4589	130			1	3	348			11	25
EU4756	284			1	9	799			13	24
EU5175	728			1	7	2147			11	22
EU5191	631			1	10	1836			14	27
EU5218	2308			8	12	9645			19	27
EU5245	657			1	10	2171			13	27
EU5591	2277			9	16	8413			20	28
EU6321	462			2	16	1693			12	23
EU6524	345			8	12	796			17	25
EU6723	3304			8	12	5780			19	28
EU6821	445			1	7	1120			12	32
EU7866	3582			8	13	5949			21	32

Annex I. Amdar Observations on 17 april 2000 and on 30 juni 2000.

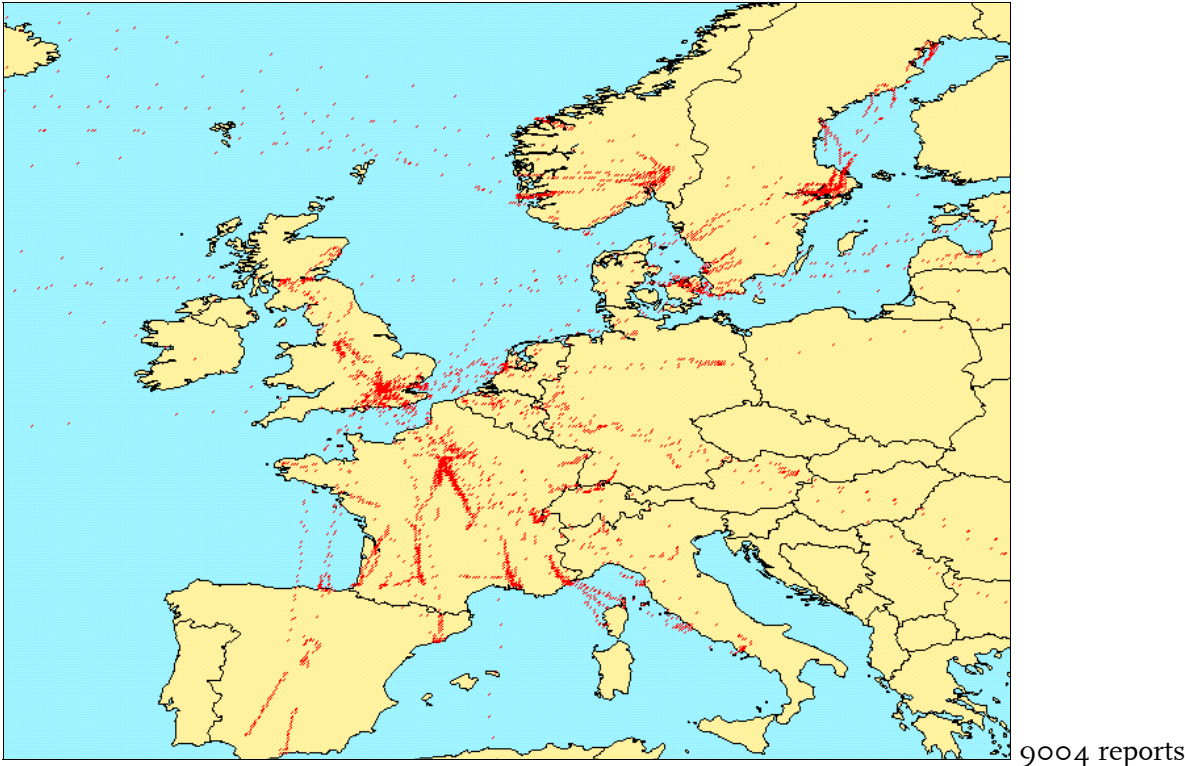


Fig. 1 In this map all (FM42 coded only) EU AMDAR observation locations are presented, for 17 April 2000 and zoomed in over Europe.

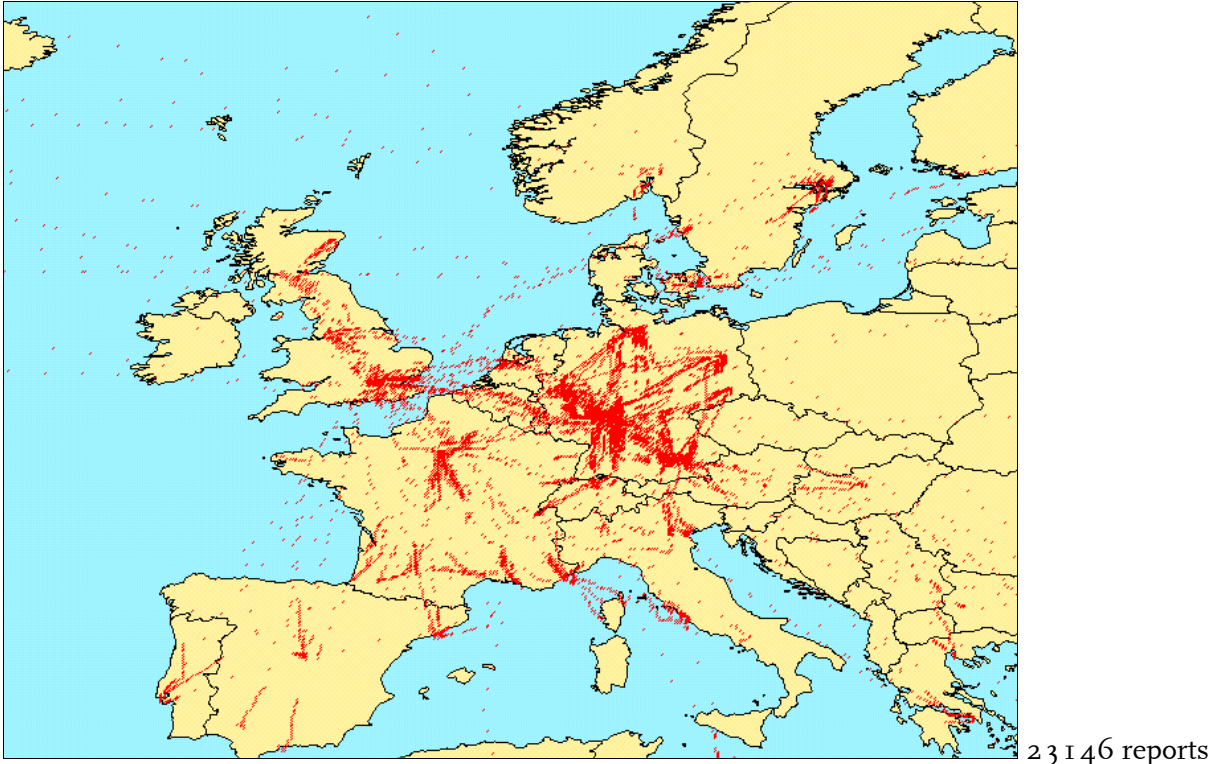


Fig. 2 The same figure, but for 30 June 2000, with both FM42 and BUFR AMDAR observations presented. Note the significant increase

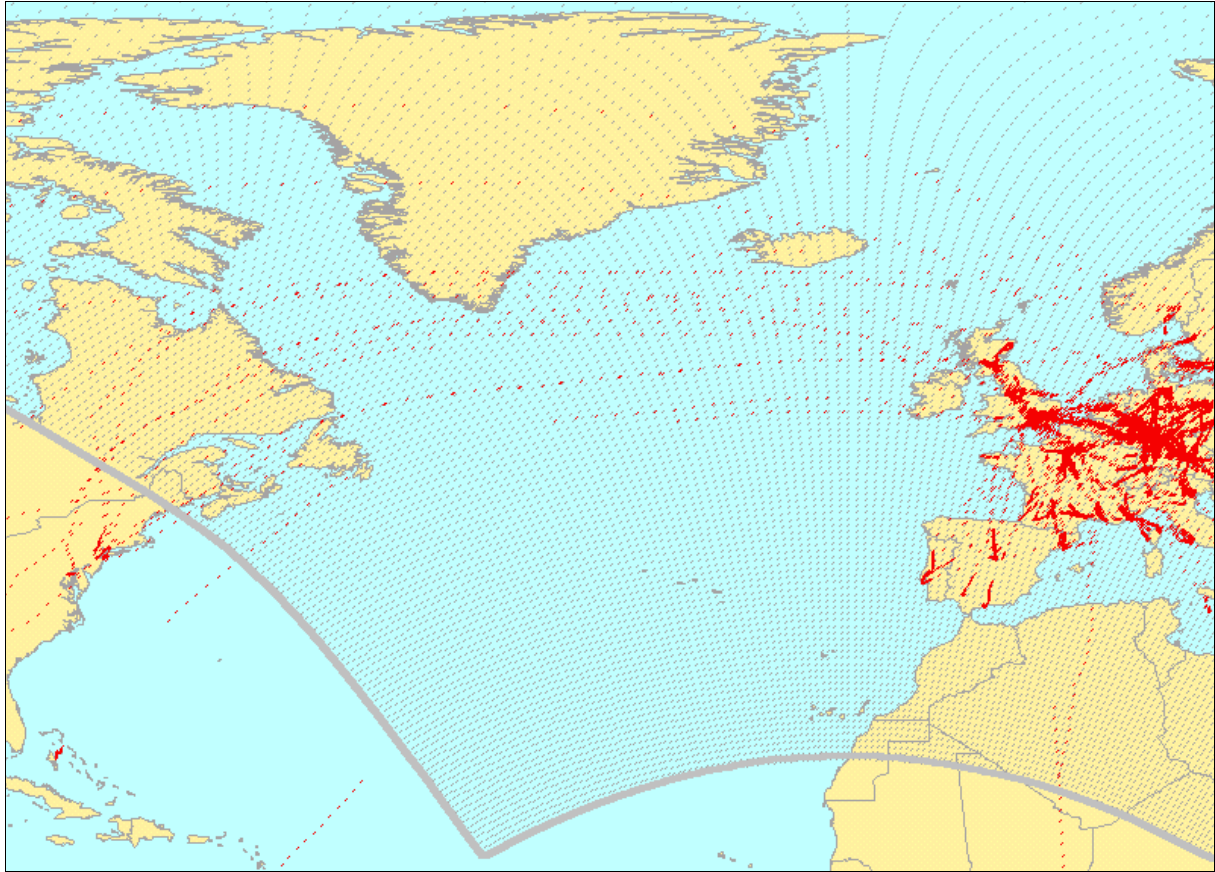


Fig. 3 All FM42 and BUFR AMDAR observations location for 30 June 2000. In this figure the HIRLAM area used for the evaluation purposes is indicated

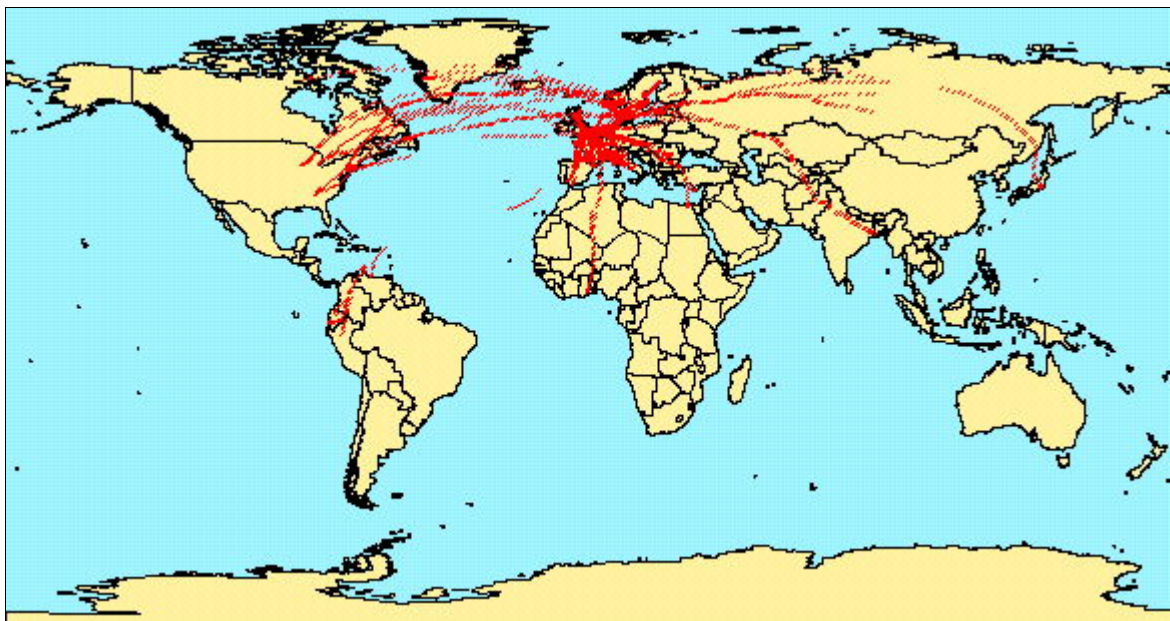


Fig. 4 In this map all (FM42 coded only) EU AMDAR observation locations are presented, for 17 April 2000 and worldwide.

## Annex II. Frequency distribution of mean temperature and mean wind speed differences.

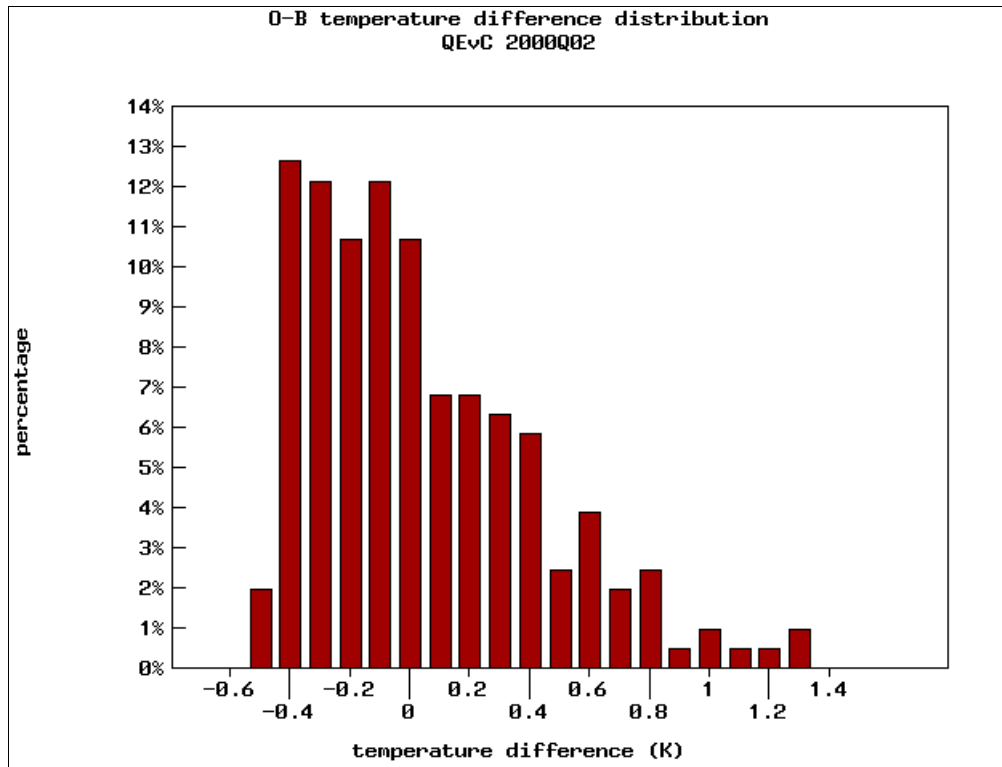


Fig. 5 Frequency distribution of the mean temperature difference (OBS-Background) for the number of aircraft reporting AMDAR reports ( $N=111$ ).

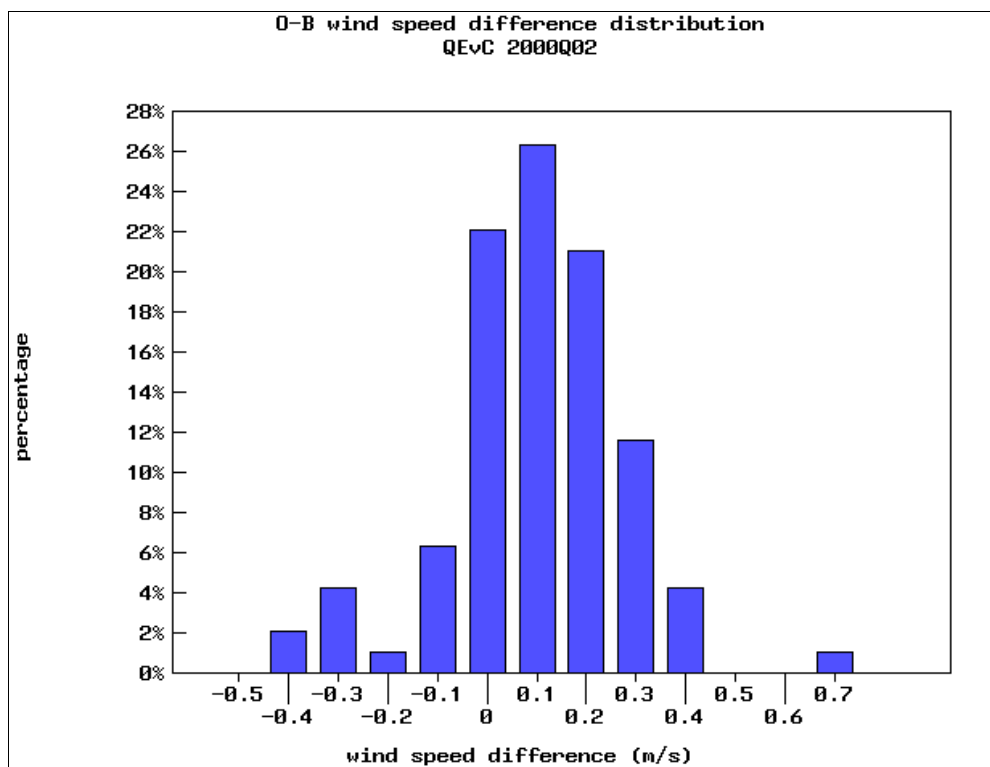


Fig. 6. Frequency distribution of the mean wind speed difference (OBS-Background) for the number of aircraft reporting AMDAR reports ( $N=111$ ).