DANISH METEOROLOGICAL INSTITUTE

ÄÄÄÄ **TECHNICAL REPORT - ONLINE** ÄÄÄÄÄ

98-19

Quality and availability of AMIS data for the growing seasons of 1997 and 1998

Anna Hilden
Jakob Hansen

DMI
COPENHAGEN 1998

ISSN: 1399 - 1388

List of contents

1 Introduction

1.1 The project

This report presents an evaluation of the data quality and accessibility of the DMI (Danish Meteorological Institute) AgroMeteorological Information System, AMIS, for the growing seasons of 1997 and 1998. The investigation was carried out at DMI as part of a joint project on IT and decision support systems in agriculture, "Informatik og Beslutningsstøttesystemer i Jordbruget" (INF96-1), having participants from Danish agricultural organizations, and funded by the Danish Ministry of Food, Agriculture and Fishery.

1.2 The report

The report is organized as follows:

Chapter 2 contains a brief description of the AMIS system and database. In Chapter 3 we summarize the statistics on the availability of AMIS data. Chapter 4 deals with the evaluation of interpolated AMIS observational data, and Chapter 5 presents verification results for the AMIS forecast fields.

Appendices A, B and C contain the most important results of each investigation in tabulated form; these are occasionally referred to in the text.

1.3 Abbreviations

Throughout the report and in the appendices we use the following abbreviations for meteorological quality measures:

E	Error
ME	Mean error
MAE	Mean absolute error
RMSE	Root-mean-square error
HR	Hit rate (percent correct)
HKSI	Hanssen-Kuipers' skill index ([1])
SSPER	Skill score based on persistence
SSCLI	Skill score based on climatology

2 The AMIS system

2.1 General

AMIS, the DMI AgroMeteorological Information System, provides farmers and other users within the agricultural community with local meteorological data on a real-time basis. The system was introduced in April, 1997, and is under continuous development with respect to data quality and content.

2.2 The database

The heart of the system is a database of meteorological observations and forecasts interpolated to an approximately 10 by 10 kilometer geographical grid covering Danish land area. There are 632 AMIS points, or 'squares', in all (fig. 2.1). The database is part of (and up to now indeed identical to) the so-called SAFE (SemiAutomatic Forecasting Environment) database [2].

Table 2.1 lists the observation (**AMO**) and forecast (**AMF**) parameters contained in the database in 1997 and 1998. For each weather parameter the table shows the corresponding observation or forecast times, two constants specifying the interpolation method (power and cut-off radius, see below), the approximate number of data points entering the interpolation, and a short verbal description.

Except for **24HPEV**, the observation data are interpolated from measured values from some 70 SYNOP and automatic climatological stations (fig. 2.2.a-b). Not all stations measure precipitation amount, and only 19 stations measure global radiation. **24HGLR** was included in the database from April 1, 1998.

The **2MTX**, **2MTN** and **10MFX** forecast fields are prepared from point forecasts for the same set of stations; the point forecasts in turn are produced using statistical interpretation of weather model data from the ECMWF (European Centre for Medium Range Weather Forecasts) global forecast model.

24HPEV observation and forecast fields are interpolated analyses and forecasts from the DMI evaporation-prediction system, which is run for all Danish SYNOP stations [3 and 4].

24HAT forecasts are raw ECMWF model forecasts, interpolated to the AMIS grid.

Interpolation is distance weighted with weights proportional to d^r, where d is distance and r is a parameter dependent (negative) power. A parameter dependent cut-off radius limits the number of data points influencing each interpolated value.

Figure 2.1:
The 632 AMIS 10 by 10 kilometer 'squares'.

Table 2.1.:
*Observation (**AMO**) and forecast (**AMF**) parameters contained in the database in 1997 and 1998.*
Figure 2.2.a:
SYNOP stations.

Figure 2.2.b:
Automatic climatological stations.

Figure 2.1 AMIS grid

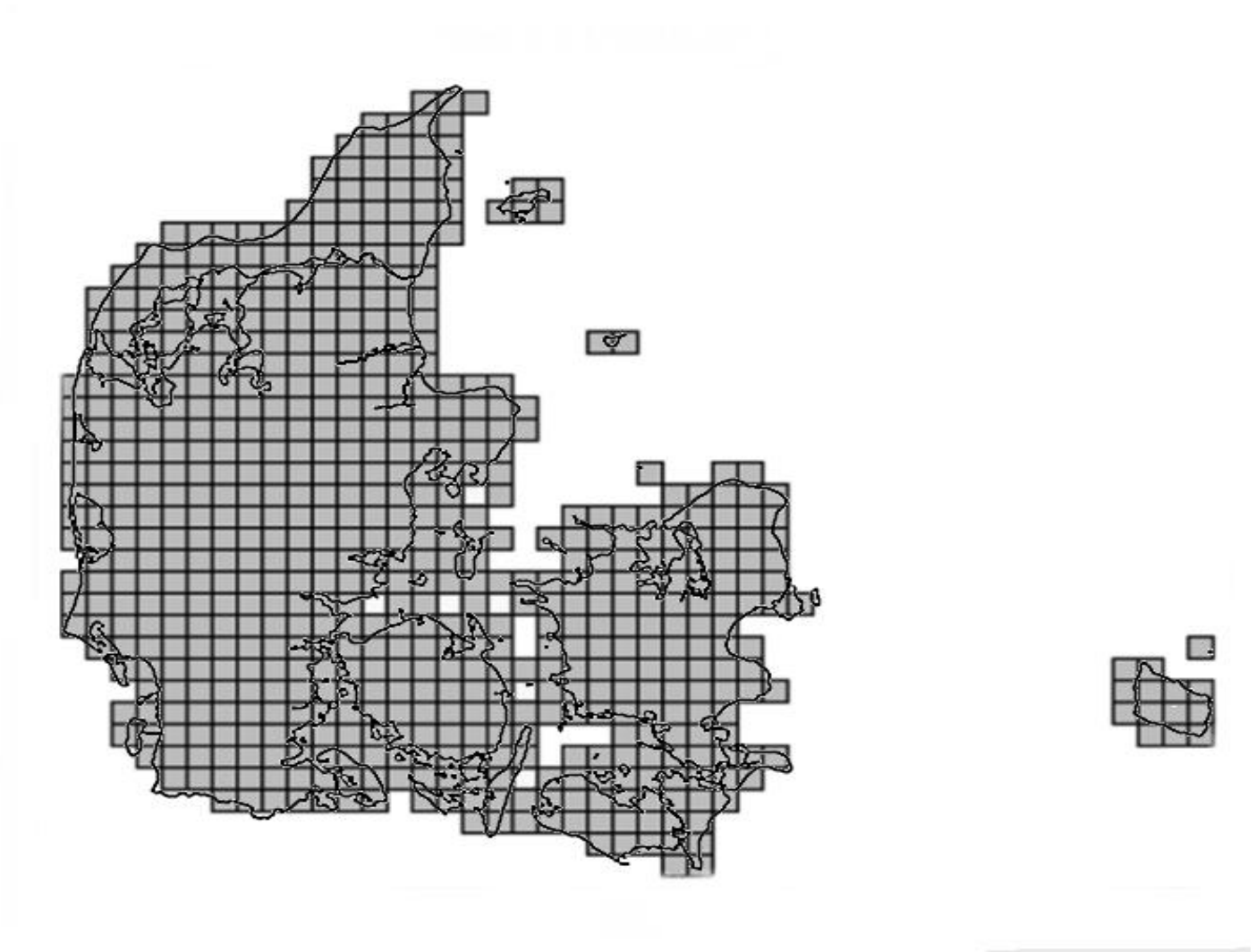


Table 2.1 AMIS weather parameters 1997 / 1998

	Para-meter	Time	No. of stations (approx.)	Interpolation radius (km)	Interpolation power	Description
A M O	**2MT**	00,03,06,09,12, 15,18,21 UTC	72 / 73	150 / 100	-2.0 / -1.7	Temperature 2 m above ground (degrees Celsius)
	2MRH	00,03,06,09,12, 15,18,21 UTC	72 / 73	150 / 100	-2.0 / -1.7	Relative humidity 2 m above ground (percent)
	10MFF	00,03,06,09,12, 15,18,21 UTC	72 / 73	150 / 100	-2.0 / -1.3	Wind speed 10 m above ground (m/s)
	24HAT	06-06 UTC	31 / 33	150 / 100	-2.0 / -1.4	24 hours' accumulated precipitation (mm)
	24HPEV	06-06 UTC	38 / 38	150 / 80	-1.0 / -1.4	24 hours' accumulated potential evaporation (mm)
	24HGLR	06-06 UTC	- / 19	- / 100	- / -2.3	24 hours' accumulated radiation (MJ/m^2)
A M F	**2MTX**	Day 0,1,2,3,4,5	71 / 71	150 / 70	-5.0 / -2.2	Maximum day temperature 2 m above ground (degrees Celsius)
	2MTN	Day 0,1,2,3,4,5	71 / 71	150 / 70	-1.5 / -2.2	Minimum night temperature 2 m above ground (degrees Celsius)
	10MFX	Day 0,1,2,3,4,5	71 / 71	150 / 50	-2.0 / -3.8	24 hour maximum wind speed 10 m above ground (m/s)
	24HAT	Day 0,1,2,3,4,5	288 / 288	150 / 60	-2.0 / -2.3	24 hours' accumulated precipitation (mm)
	24HPEV	Day 0,1,2,3,4,5	38 / 38	150 / 80	-1.0 / -1.4	24 hours' accumulated potential evaporation (mm)

Figure 2.2.a SYNOP stations

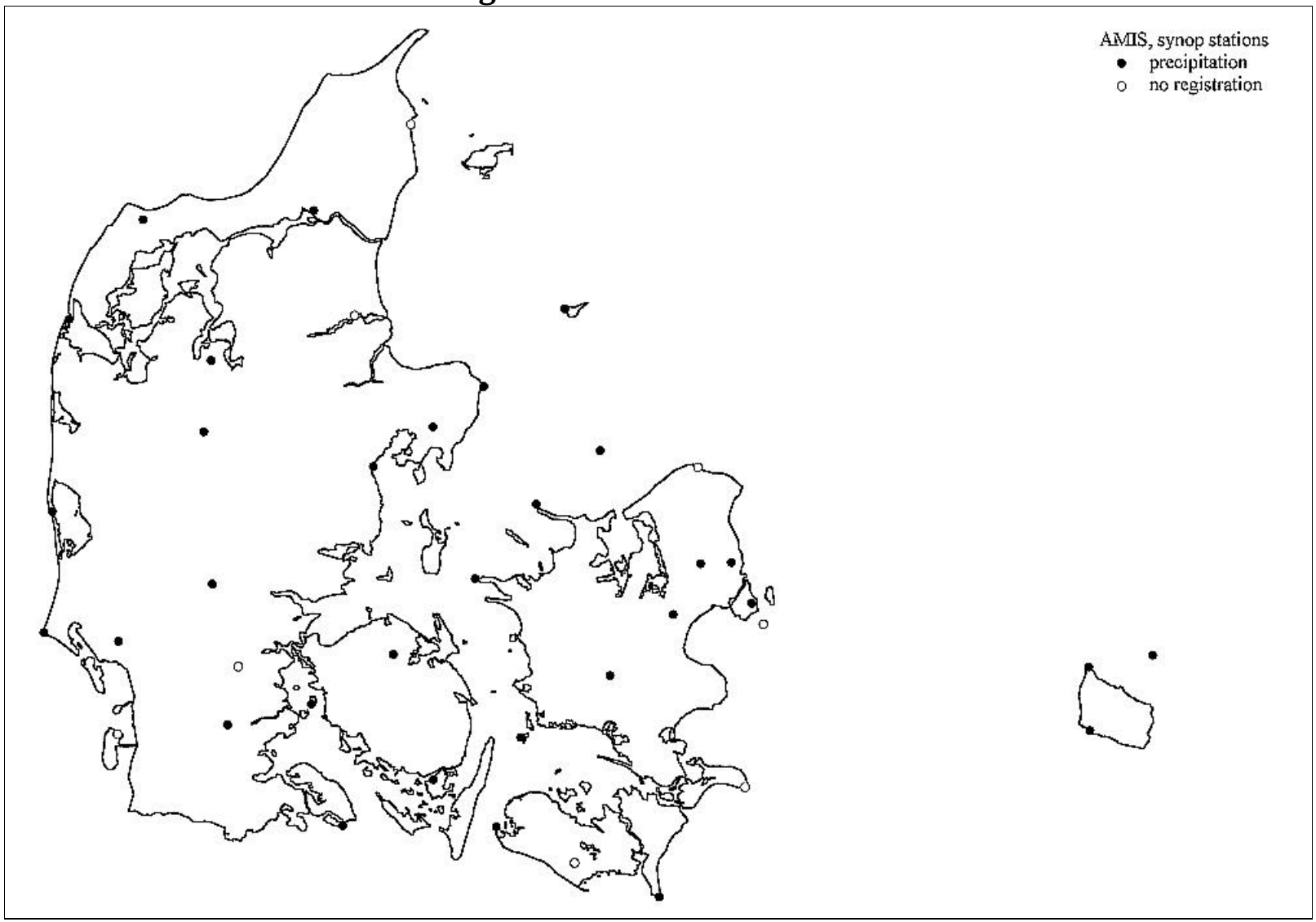
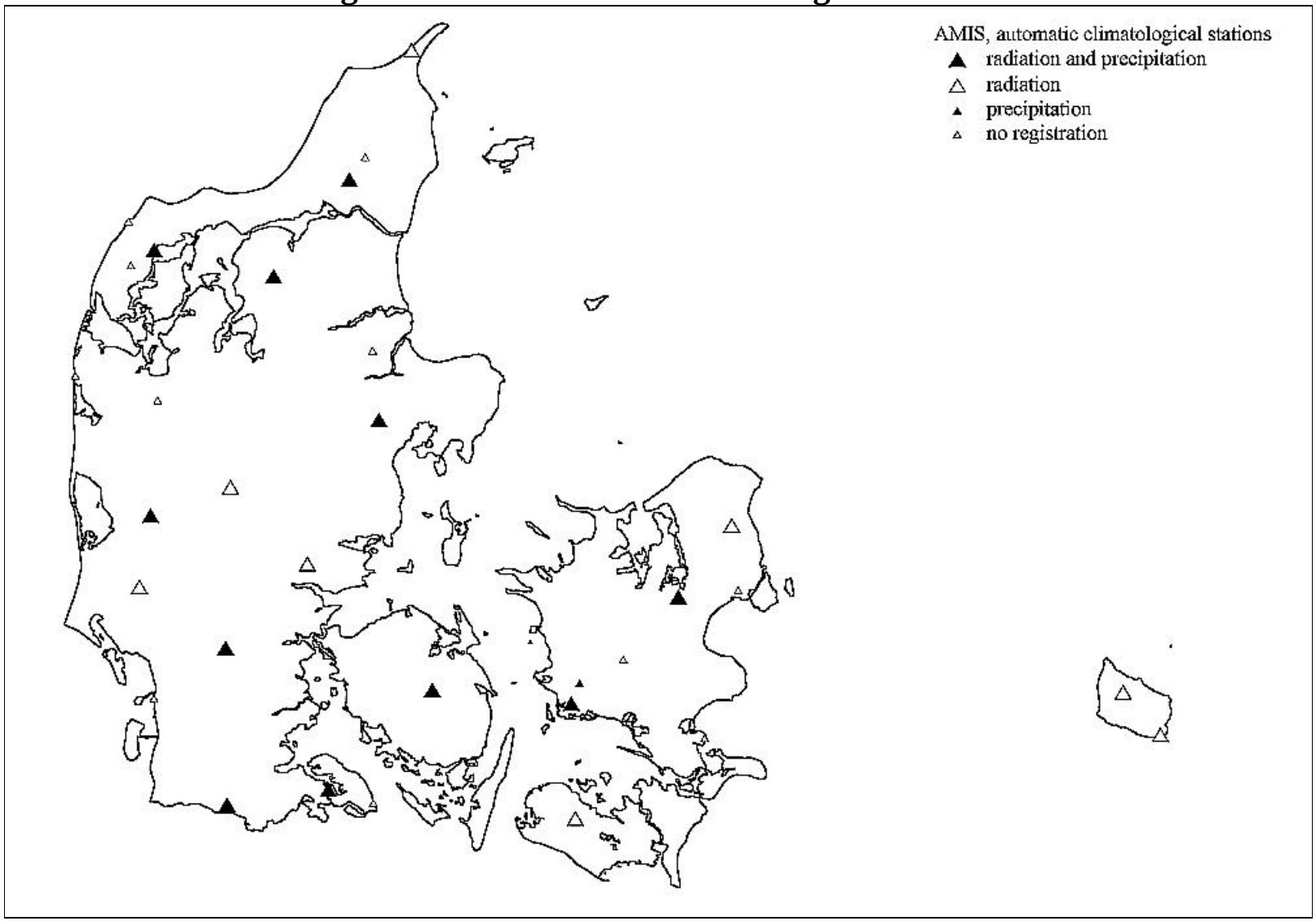


Figure 2.2.b Automatic climatological stations



3 Availability

3.1 Observation data

Table 3.1 summarizes the availability of AMIS observation data fields for each month of the growing seasons of 1997 and 1998. Numbers for **2MT**, **2MRH** and **10MFF** are shown for observation hours 00 and 12 UTC only. Here and elsewhere in this report, the period covered by the statistics starts by April 17, 1997, the day AMIS became operational.

For most parameters and months the **AMO** availability is between 90 and 100 percent. The lowest numbers are found in July, 1997, where (on the 27th) a lightning stroke hitting DMI caused considerable loss of observational data.

If at any specific hour there are AMIS grid points having no raw data points within the cutoff radius, interpolated data values for these grid points cannot be determined. The data coverage of a single AMIS field may thus be lower than 100 %.

Tables A.1 of Appendix A show the minimum, maximum and mean percentage of good data values of available fields for the same parameters, periods and observation hours as above. The data coverage is above 98 % in all cases, except for **24HPEV**, where, as a result of a human error, input data for the island of Bornholm were consistently missing up to June 15, 1998.

3.2 Forecast data

Table 3.2 shows the availability of forecast data fields for all parameters and selected forecast days. All numbers are in the interval 90 to 100 percent.

The percentage of good data values of available **AMF** fields is above 98 % for all parameters and forecast lengths (Appendix A, Table A.2).

Table 3.1:

Availability of observation data fields, percent.

Table 3.2:

Availability of forecast data fields, percent.

Availability percentage

Table 3.1 Observation data

		UTC	Apr	May	Jun	Jul	Aug	Sep	All
	2MT	00	92,9	100,0	100,0	93,5	96,8	100,0	97,6
1		12	92,9	96,8	100,0	90,3	100,0	96,7	96,4
9	**2MRH**	00	92,9	96,8	100,0	90,3	87,1	100,0	94,6
9		12	92,9	96,8	100,0	90,3	100,0	96,7	96,4
7	**10MFF**	00	92,9	100,0	100,0	93,5	96,8	100,0	97,6
		12	92,9	96,8	100,0	90,3	100,0	96,7	96,4
	24HAT	06	85,7	100,0	100,0	90,3	100,0	100,0	97,0
	24HPEV	06	92,9	100,0	90,0	80,6	96,8	90,0	91,6
	2MT	00	100.0	100.0	100.0	100.0	96.8	100.0	99.5
1		12	100.0	100.0	100.0	100.0	100.0	100.0	100.0
9	**2MRH**	00	100.0	100.0	100.0	100.0	100.0	100.0	100.0
9		12	100.0	100.0	100.0	100.0	100.0	100.0	100.0
8	**10MFF**	00	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		12	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	24HAT	06	100.0	100.0	100.0	100.0	100.0	96.7	99.5
	24HPEV	06	93.3	93.5	86.7	100.0	96.8	100.0	95.1

Table 3.2 Forecast data

		Day	Apr	May	Jun	Jul	Aug	Sep	All
1997	2MTX	0	92,9	100,0	83,3	93,5	100,0	96,7	94,6
		3	92,9	100,0	83,3	93,5	100,0	96,7	94,6
		5	92,9	100,0	70,0	90,3	100,0	93,3	91,0
	2MTN	0	92,9	100,0	83,3	93,5	100,0	96,7	94,6
		3	92,9	100,0	83,3	93,5	100,0	96,7	94,6
		5	92,9	100,0	70,0	90,3	100,0	93,3	91,0
	24HAT	0	92,9	100,0	100,0	100,0	100,0	100,0	99,4
		3	92,9	100,0	93,3	100,0	100,0	100,0	98,2
		5	92,9	100,0	90,0	100,0	96,8	100,0	97,0
	24HPEV	0	92,9	100,0	93,3	96,8	100,0	93,3	96,4
		3	92,9	100,0	93,3	96,8	100,0	93,3	96,4
		5	92,9	100,0	93,3	96,8	100,0	93,3	96,4
	10MFX	0	92,9	100,0	83,3	93,5	100,0	96,7	94,6
		3	92,9	100,0	83,3	93,5	100,0	96,7	94,6
		5	92,9	100,0	70,0	90,3	100,0	93,3	91,0
1998	2MTX	0	100.0	96.8	100.0	100.0	96.8	100.0	98.9
		3	100.0	96.8	100.0	100.0	96.8	100.0	98.9
		5	100.0	93.5	100.0	100.0	93.5	96.7	97.3
	2MTN	0	100.0	96.8	100.0	100.0	96.8	100.0	98.9
		3	100.0	96.8	100.0	100.0	96.8	100.0	98.9
		5	100.0	93.5	100.0	100.0	93.5	100.0	97.8
	24HAT	0	100.0	100.0	100.0	100.0	100.0	96.7	99.5
		3	100.0	96.8	100.0	100.0	96.8	100.0	98.9
		5	100.0	96.8	100.0	100.0	96.8	100.0	98.9
	24HPEV	0	96.7	100.0	100.0	93.5	93.5	100.0	97.3
		3	100.0	100.0	100.0	96.8	96.8	100.0	98.9
		5	100.0	100.0	100.0	96.8	96.8	100.0	98.9
	10MFX	0	96.7	96.8	100.0	90.3	96.8	96.7	96.2
		3	100.0	96.8	100.0	100.0	96.8	100.0	98.9
		5	100.0	93.5	100.0	100.0	93.5	100.0	97.8

4 Evaluation of the gridding method

4.1 Procedure

4.1.1 Data

The gridding method was evaluated for the following observed parameters: **2MT**, **2MRH**, **10MFF**, **24HAT** and (for 1998) **24HGLR**.

To obtain independent data for the evaluation of **2MT**, **2MRH** and **10MFF**, we selected 17 SYNOP- and automatic climatological stations and compared observations from these with pseudo-AMIS data, produced by re-running the interpolation with one station left out. The **24HGLR** fields were evaluated in the same way, using all 19 stations reporting global radiation. For **24HAT** we compared AMIS values with independent observations from a number of manual climatological stations, 19 in 1997, 16 in 1998.

We evaluated daily values of **24HAT** and **24HGLR** and values from 00 and 12 UTC of the other parameters. For **2MT** and **24HAT** we looked at monthly sums as well.

4.1.2 Verification methods

For each parameter and observation hour and for each station we computed monthly values of **ME**, **MAE**, **RMSE**, **HR** and **HKSI**. For monthly sums we investigated the time series directly.

The limits used for computing **HR** and **HKSI** are as follows:

2MT	2 ^{o}C
2MRH	10 %
10MFF	2 m/s
24HAT	the intervals 0-0.1, 0.1-2, 2-6, 6-10, >10 mm
24HGLR	2 MJ/m^2

HR for **24HAT** was computed as the percentage of AMIS values belonging to the same interval as the point value; for the rest of the parameters it is the percentage of AMIS values within the given limit from the observation.

4.2 Results

4.2.1 Temperature

Figures 4.1 a-b show **ME**, **MAE** and **HR** for **2MT** at 00 and 12 UTC for each month of the two growing seasons, averaged over all verification points.

The **ME** curve for 00 UTC shows a positive bias of around half a degree for all months; for 12 UTC the bias is small. **MAE** values are around 1 ^{o}C for both observation hours. The hit rates are between 80 and 100 percent for most months.

In Appendix B the station minimum, maximum and average values of all scores are

tabulated for each month. The **HKSI** values show that the interpolation has positive skill compared to chance for all stations and months, except for July 1997, where **HKSI** is negative for at least one station.

In Figure 4.1.c monthly sums of interpolated and observed temperature have been plotted, averaged over the stations, (note that the sums for April 1997 do not cover the whole month, cf. Section 3.1). The sums fit well, with a small positive overall bias. For individual stations and months (Appendix B) the errors range from -30 to +36 degree days; the average error in degree days per month was 7.6 in 1997, 6.9 in 1998

Figures 4.1.d-e show maps of the **ME** at 00 and 12 UTC at individual stations averaged over each of the two growing seasons. The figures reveal a clear geographical pattern in the interpolation errors: At 00 UTC temperature is being over-estimated at inland sites and under-estimated at the coast, whilst the opposite is the case at 12 UTC. This indicates that one might be able to improve the quality of AMIS data by using a gridding method which takes land-sea differences into account. It is planned in 1999 to investigate the possibility of using analyses and short-term forecasts from the HIRLAM model, DMI's operational high-resolution atmospheric model, for this purpose.

4.2.2 Relative humidity

Selected verification measures for **2MRH** are displayed in Figures 4.2.a-b (analogous to Figures 4.1.a-b). For 00 UTC the quality is quite good: **HR** is above 80 percent for all months, and the **MAE** is around 4 percent. The results are somewhat poorer for 12 UTC, with hit rates down to 70 percent and **MAE** values near 8 percent in some months of 1997. The bias is below 2 degrees by absolute value for both times and all months.

The comprehensive results (Appendix B) show a large spread in the scores for individual stations. In fact, for every month except one, there is some stations for which the interpolation skill, as measured by **HKSI**, is negative. It turns out that most of the bad extremes, in **HKSI** as well as in the other measures, come from a few verification points having a large bias throughout the seasons; this is probably due to station characteristics.

4.2.3 Wind speed

Figures 4.3.a-b (analogous to Figures 4.1.a-b) show verification results for **10MFF**. The interpolated wind speeds are good for all months and both observation hours, with **HR** of 70-90 percent and **MAE** around 1.2 m/s. At 00 UTC there is a small, positive bias of 0.3 - 0.5 m/s; at 12 UTC the bias is virtually zero, except for a few months of 1998.

The tables in Appendix B show some spread in the scores among the 17 stations. **ME** and **MAE** reach 3.5 m/s by absolute value for one station in August 1998, 00 UTC. The **HKSI** shows a large, positive skill compared to chance for nearly all stations and months.

4.2.4 Precipitation

For **24HAT** (Figure 4.4.a, analogous to Figures 4.1.a-b) the results are only reasonable, with **HR** of 55-80 percent and **MAE** between 0.5 and 1.6 mm. The results for 1997 are better than those for 1998. The **ME** is negative for nearly all months, greatest by absolute value in July 1997 (0.3 mm).

There is some spread in the scores for individual stations (Appendix B). For every month there are stations showing a positive bias as well as stations where it is negative. **HKSI** is positive for all stations and months.

Tables 4.1 a-b are contingency tables for measured versus interpolated **24HAT** values for 1997 and 1998, all stations and months (the precipitation intervals of this table are narrower than the five categories used for computing **HR** and **HKSI**, cf. 4.1.2). The cases are only very roughly concentrated along the diagonal; specifically, there is a large number of correctly interpolated dry cases. Most of the off-diagonal cases are dry cases where the AMIS field had precipitation of a few mm. This is a natural consequence of the interpolation procedure, which smoothes out local variation in the precipitation field; it is reflected in the distributions of AMIS and observed values, the former being flatter than the latter (top row and leftmost column).

Figure 4.4.b shows monthly sums of precipitation, interpolated and measured, averaged over the stations (note, once again, that the data for April 1997 cover some two weeks only). The general negative bias is apparent; averaged over all stations and months it amounts to 4.6 mm per month for 1997, 1.5 mm for 1998.

4.2.5 Global radiation

Summary results for global radiation, **24HGLR**, is shown in Figure 4.5.a (1998 only, otherwise analogous to Figures 4.1.a-b). The interpolated values are correct within 2 MJ/m^2 in 60 - 75 percent of cases in each month; the hit rates are lowest around midsummer when the radiation level is highest. **MAE** values range from 1.3 to 2.3 MJ/m^2, **ME** is between 0 and 0.5 MJ/ m^2.

There is some variation in the scores from station to station (Appendix B). The largest differences - and the largest errors - are found in July, where one station has a **MAE** of 5.2 MJ/m^2. **HKSI** is positive for nearly all stations and months.

Figure 4.1.a:
*Monthly values of **HR** (2 and 4 ^{o}C intervals, percent), **ME** and **MAE** (^{o}C) for 2MT at 00 UTC.*

Figure 4.1.b:
Same as Figure 4.2.1.a, but for 12 UTC.

Figure 4.1.c:
Station averaged monthly sums of temperature, interpolated and observed (degree days).

Figure 4.1.d
*Maps of the temperature **ME** at 00 and 12 UTC at individual stations averaged over 1997.*

Figure 4.1.e
*Maps of the temperature **ME** at 00 and 12 UTC at individual stations averaged over 1998.*

Figure 4.2.a:
*Monthly values of **HR** (intervals of 10 % RH, percent), **ME** and **MAE** (% RH) for **2MRH** at 00 UTC.*

Figure 4.2.b:
Same as Figure 4.2.a, but for 12 UTC.

Figure 4.3.a:
*Monthly values of **HR** (4 m/s intervals, percent), **ME** and **MAE** (m/s) for **10MFF** at 00 UTC.*

Figure 4.3.b:
Same as Figure 4.3.a, but for 12 UTC.

Figure 4.4.a:
*Monthly values of **HR** (five intervals, percent), **ME** and **MAE** (mm) for **24HAT**.*

Figure 4.4.b:
Station averaged monthly sums of precipitation, interpolated and observed (mm).

Table 4.1.a:
*Contingency table for 1997, **24HAT,** all stations.*

Table 4.1.b:
*Contingency table for 1998, **24HAT,** all stations.*

Figure 4.5:
*Monthly values of **HR** (2 MJ/m^2 intervals, percent), **ME** and **MAE** (MJ/m^2) for **24HGLR** at 06 UTC (1998 only).*

Temperature

Fig. 4.1.a

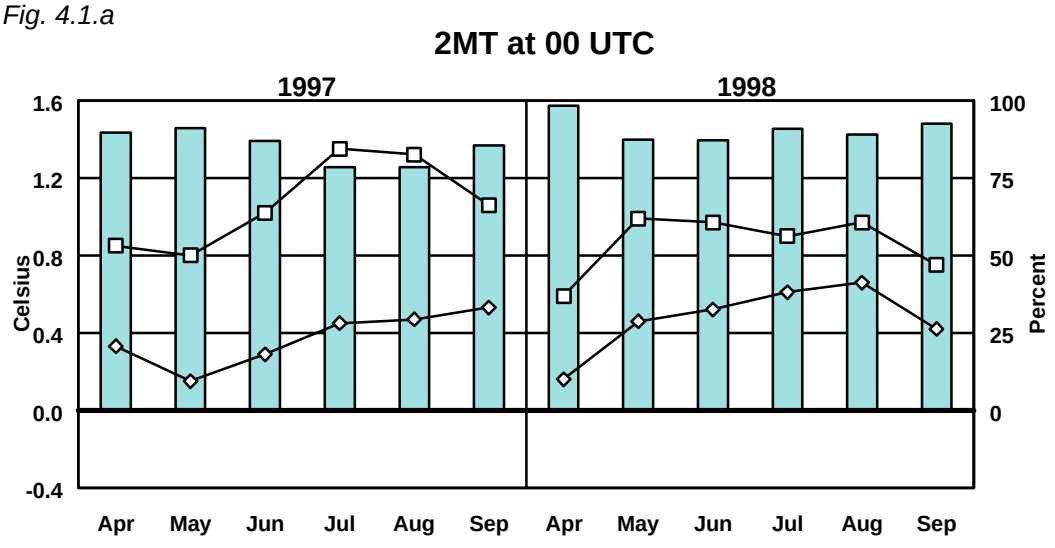


Fig. 4.1.b

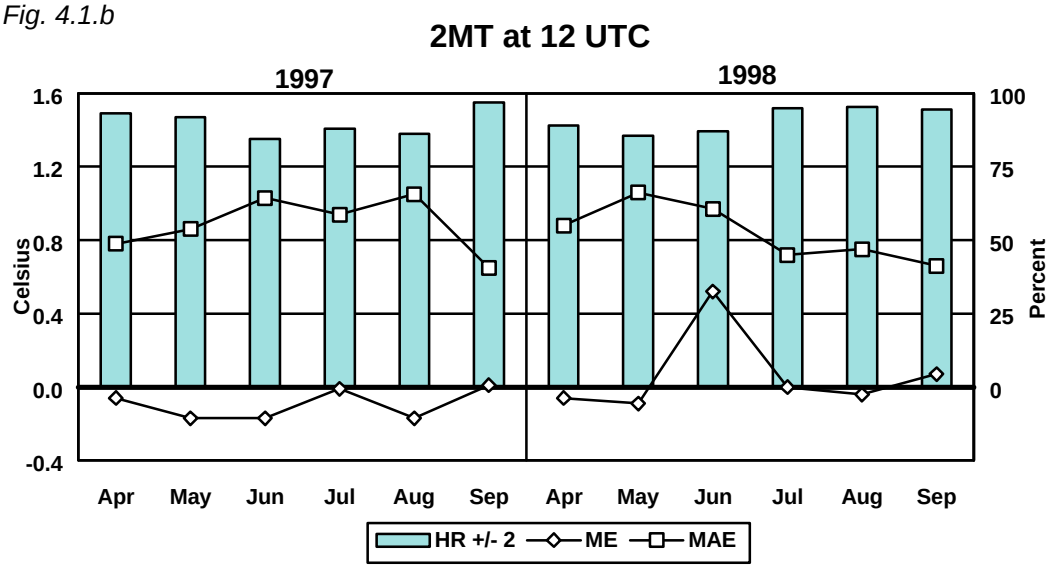
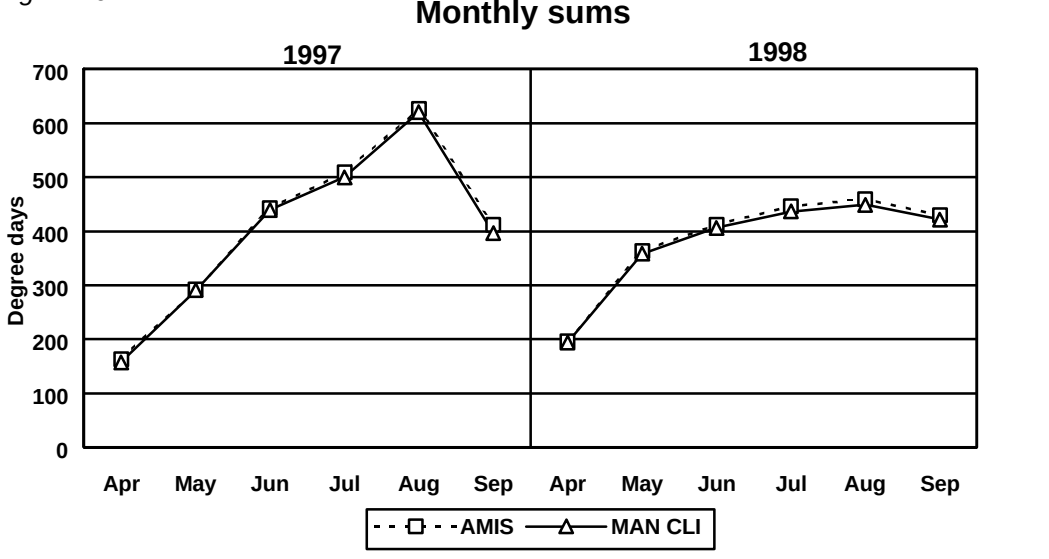


Fig. 4.1.c



Temperature mean error

Fig. 4.1.d

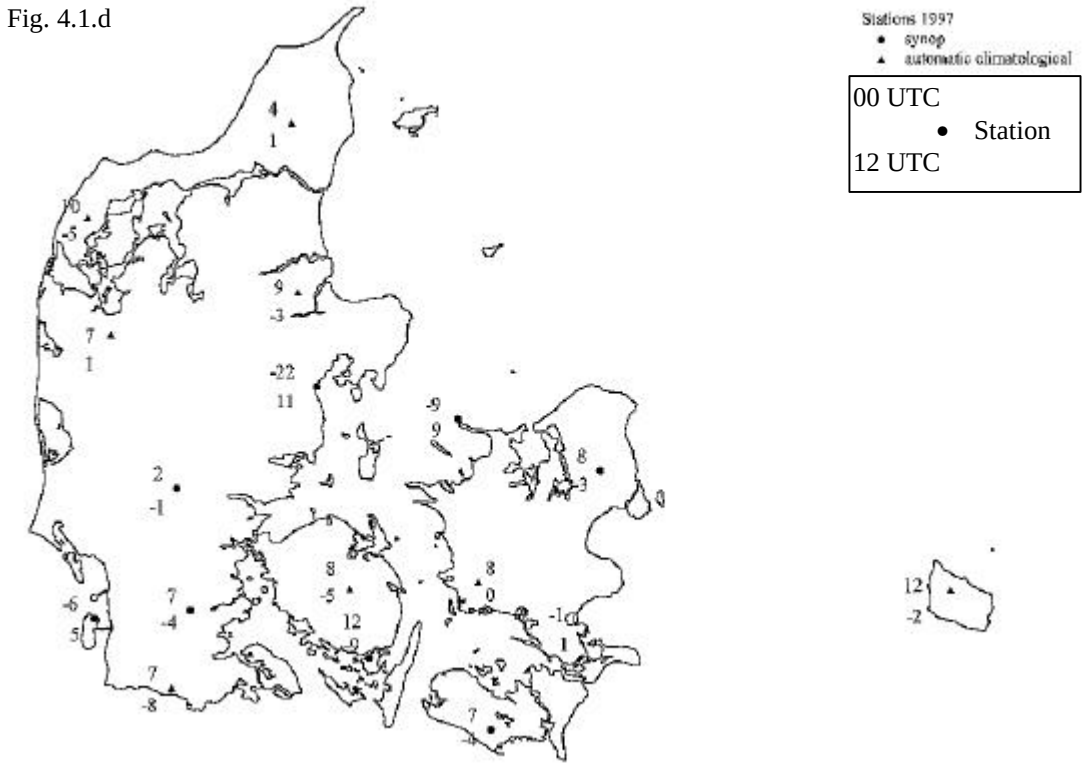
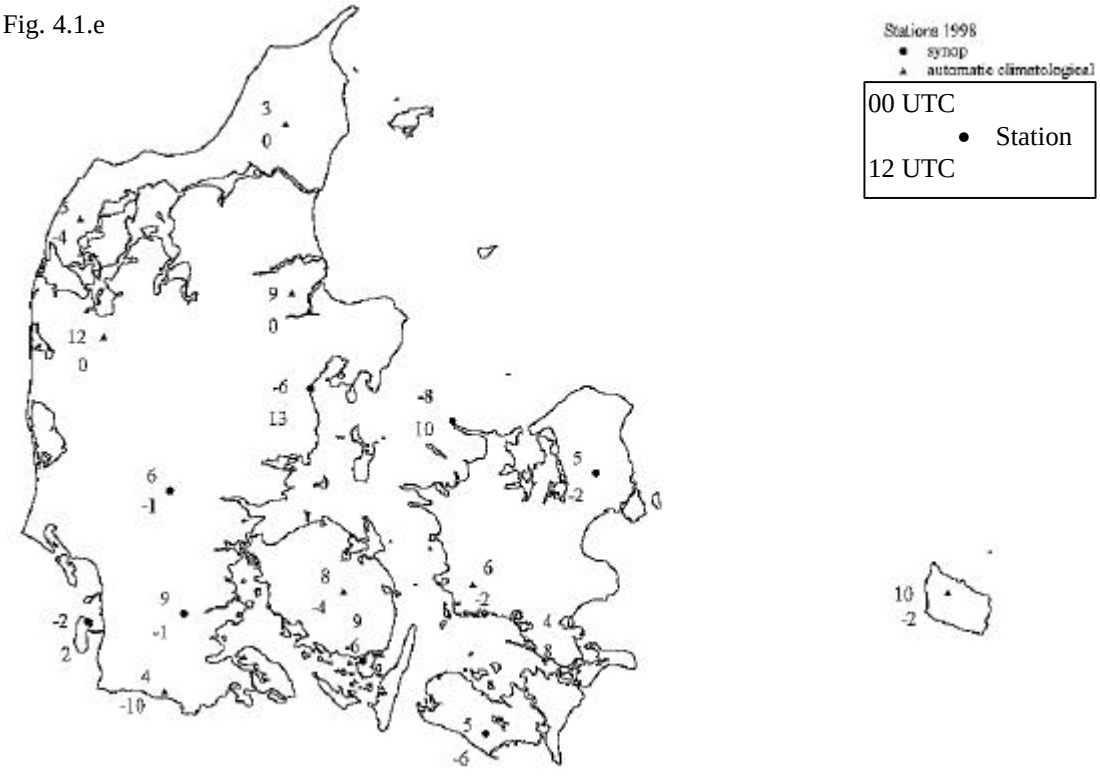


Fig. 4.1.e



Relative humidity

Fig. 4.2.a

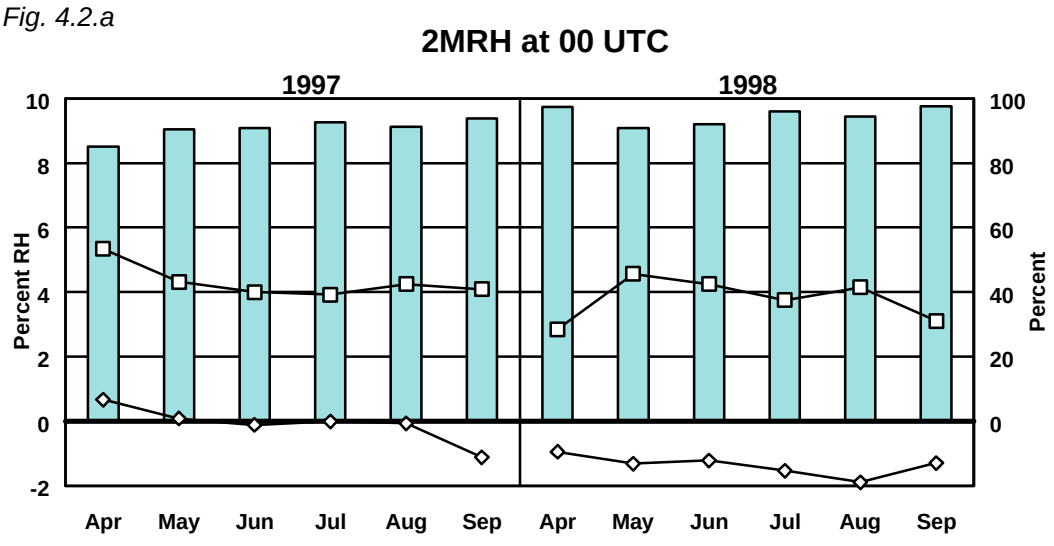
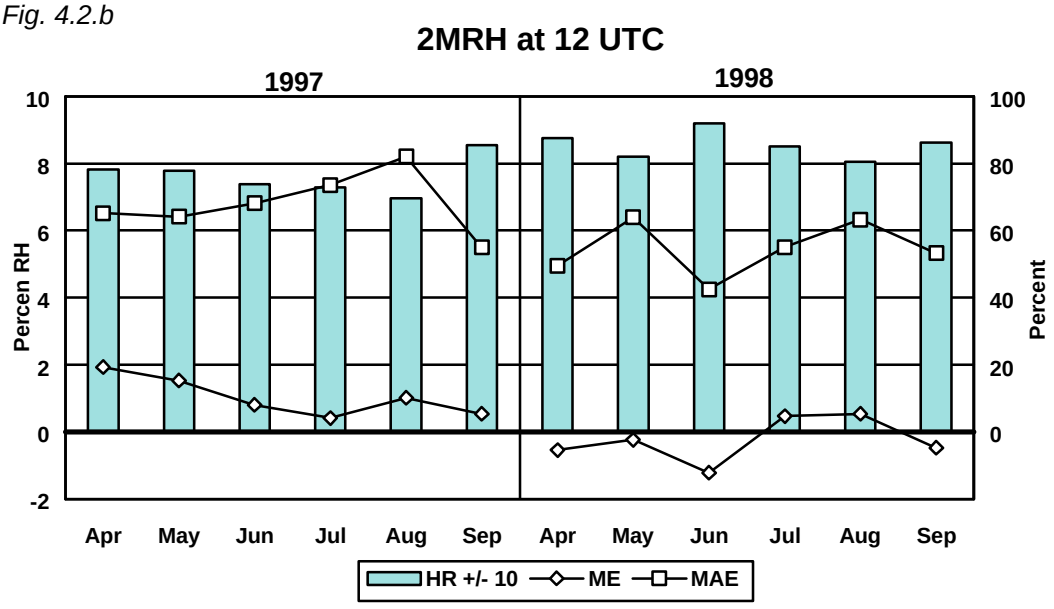


Fig. 4.2.b



Wind speed

Fig. 4.3.a

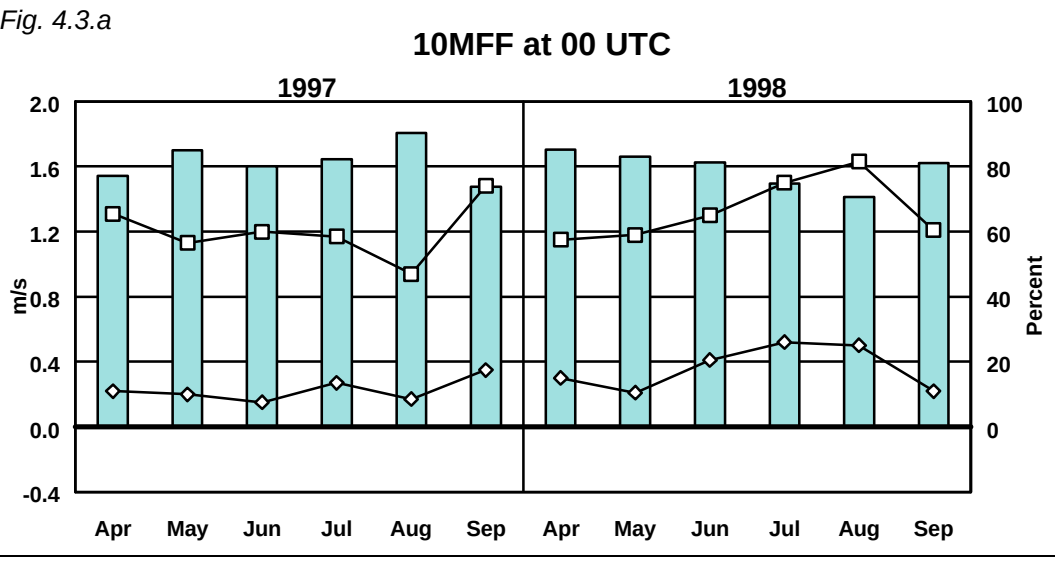
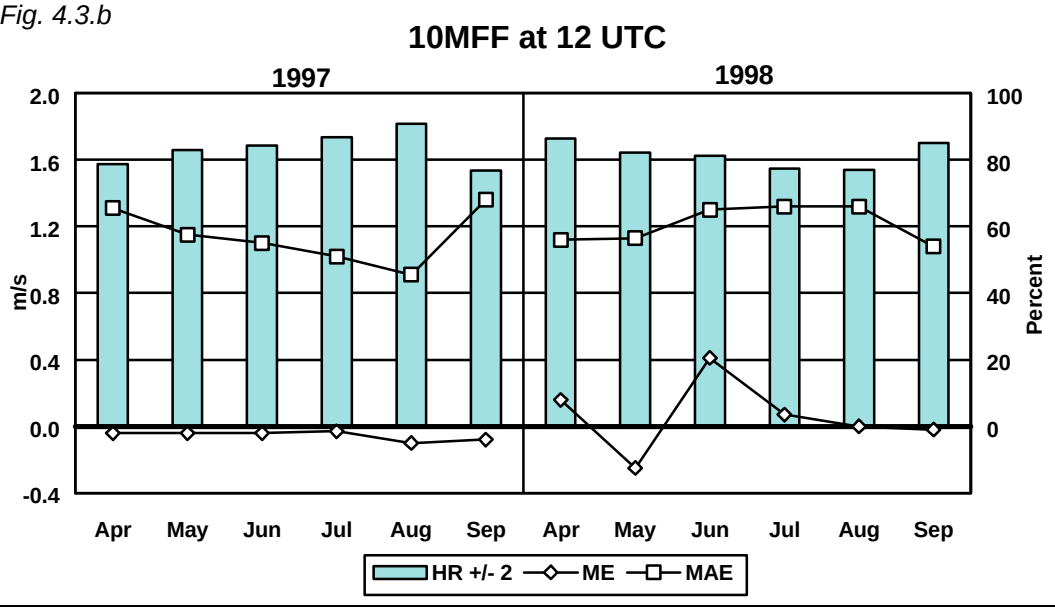


Fig. 4.3.b



Precipitation

Fig. 4.4.a

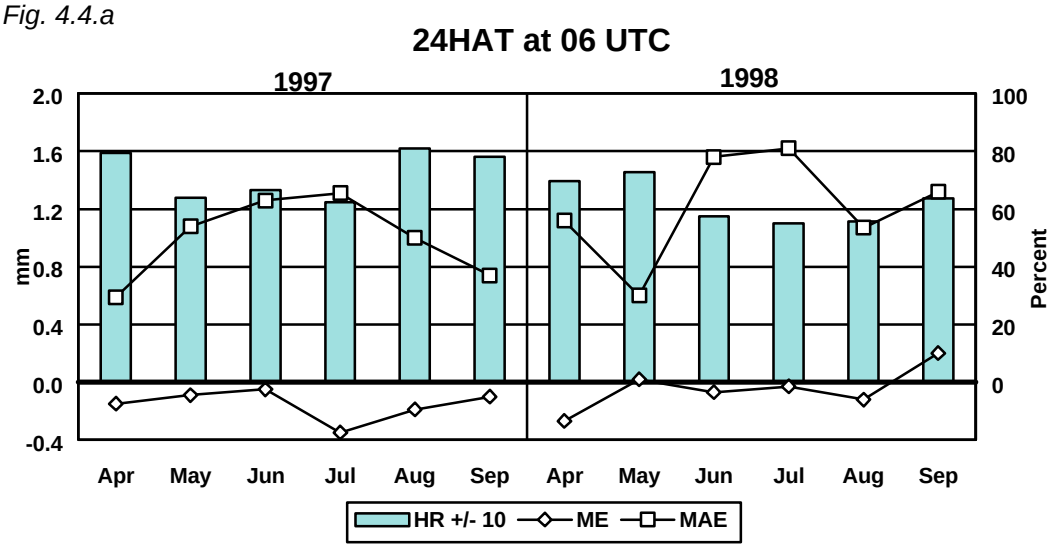
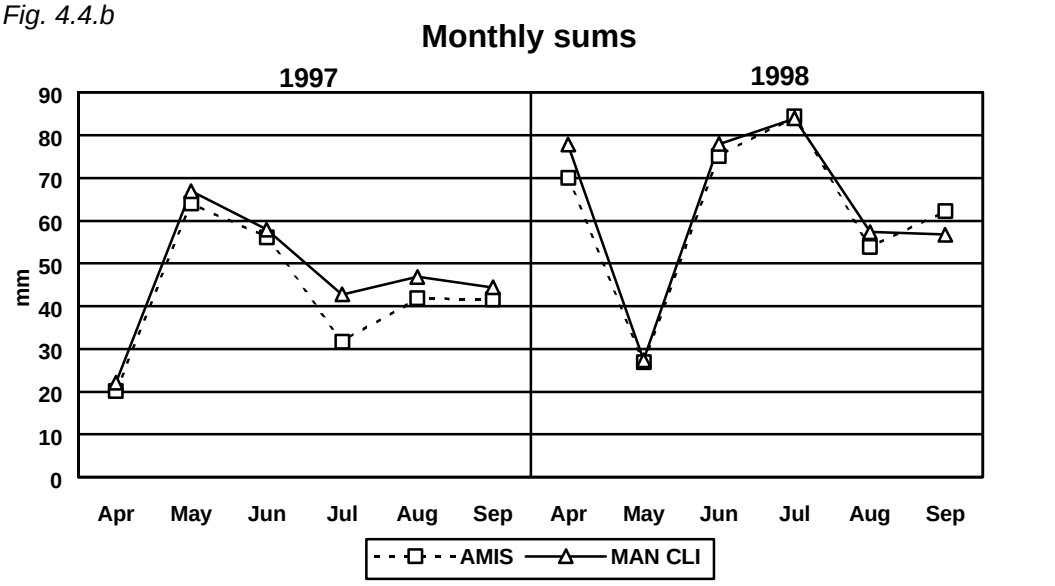


Fig. 4.4.b



Precipitation
Contingency tables

Table 4.1.a

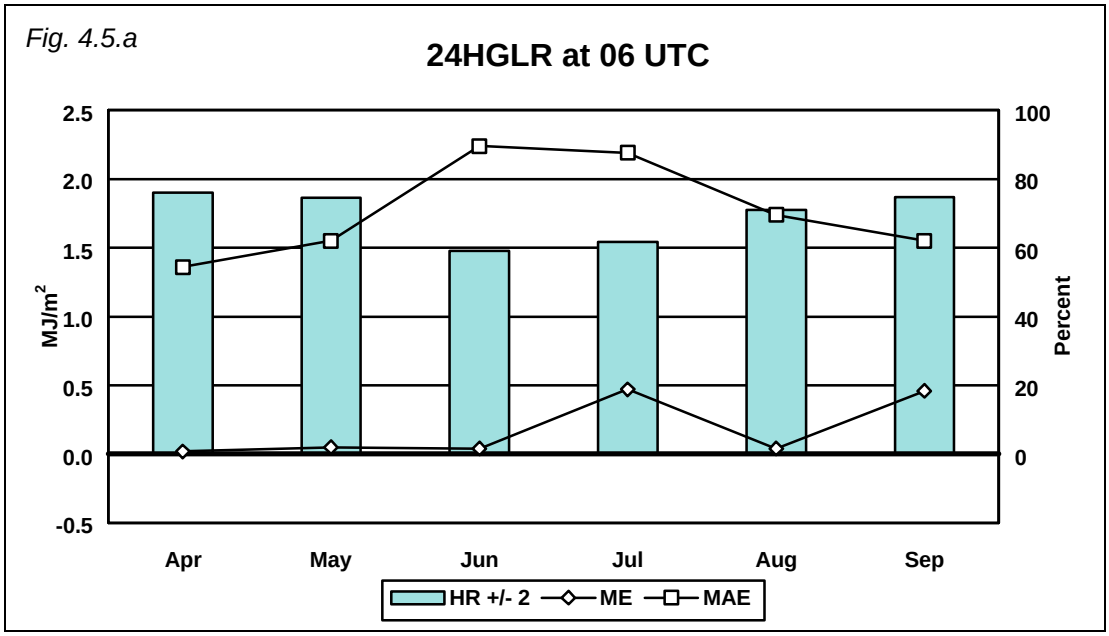
3,096	Measured	1,990	498	193	109	88	62	39	30	25	18	13	31
Interpolated	**1997**	0-0,1	0,1-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-99
1,689	0-0,1	1,600	76	5	4	1	-	-	-	1	-	-	2
785	0,1-2	345	318	77	20	5	7	6	1	1	1	1	3
223	2-4	34	67	58	27	18	7	1	4	4	1	-	2
128	4-6	4	21	36	30	19	7	2	5	-	2	-	2
98	6-8	1	7	12	17	28	17	4	3	3	2	3	1
58	8-10	2	4	-	5	7	12	11	9	4	-	2	2
36	10-12	1	2	2	-	4	9	7	2	3	3	1	2
39	12-14	2	-	1	5	2	2	6	4	3	6	3	5
16	14-16	-	1	1	-	4	-	2	2	2	1	2	1
4	16-18	-	1	-	-	-	-	-	-	2	1	-	-
5	18-20	-	-	-	1	-	1	-	-	-	-	-	3
15	20-99	1	1	1	-	-	-	-	-	2	1	1	8

Table 4.1.b

2867	Measured	1,413	657	293	195	98	75	31	25	19	21	6	34
Interpolated	**1998**	0-0,1	0,1-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-99
972	0-0,1	914	55	1	1	-	1	-	-	-	-	-	-
1,077	0,1-2	466	452	113	26	12	2	2	1	2	-	-	1
331	2-4	21	101	111	65	19	8	1	2	1	-	-	2
213	4-6	5	35	51	63	26	20	3	4	2	2	-	2
95	6-8	1	7	13	26	19	13	7	4	1	2	1	1
63	8-10	4	4	3	8	13	13	7	5	2	3	1	-
38	10-12	-	-	-	3	4	7	9	2	5	4	-	4
18	12-14	-	-	-	-	3	7	-	3	-	3	1	1
13	14-16	-	1	-	1	1	1	-	2	-	2	-	5
14	16-18	1	1	1	-	-	-	1	1	2	-	-	7
12	18-20	-	-	-	1	-	1	-	-	1	1	2	6
21	20-99	1	1	-	1	1	2	1	1	3	4	1	5

Global radiation

Fig. 4.5.a



5 Evaluation of forecast quality

5.1 Procedure

5.1.1 Data

Forecast quality was evaluated for the **AMF** parameters **2MTX**, **2MTN** and **24HAT** for forecast days 0, 3 and 5.

As verifying observations we used measurements from manual climatological stations, (19 and 16 in 1997 and 1998, resptively). These stations report maximum and minimum temperature and accumulated precipitation for the 24 hours ending at 8 o'clock Danish local time. In the summer period this is 06 UTC, so we actually have the values for the standard meteorological day, 06-06 UTC. It is considered of minor importance that the reported extreme temperatures are for the whole 24 hour period, whilst the forecast **2MTX** and **2MTN** are for day and night hours, respectively.

5.1.2 Verification methods

For each parameter and forecast day and for each station we computed monthly values of **ME**, **MAE**, **RMSE**, **HR**, **HKSI, SSPER** and **SSCLI**.

The following limits are used for computing **HR** and **HKSI**:

2MTX	2 and 4 ^{o}C	(**HKSI** for 2 ^{o}C only)
2MTN	2 and 4 ^{o}C	(**HKSI** for 2 ^{o}C only)
24HAT	the intervals 0-0.1, 0.1-2, 2-6, 6-10, >10 mm	

As in the **AMO** evaluation, **HR** for the temperature variables was computed as the percentage of forecasts deviating less than 2, resp. 4 degrees from the observation; for **24HAT** it is based on the five intervals.

SSPER measures the skill relative to a reference forecast identical to yesterday's observed value; **SSCLI** measures the skill relative to a forecast identical to the montly mean value. The scores are computed as 1 - **MAE**/**MAE**$_{ref}$, where **MAE**$_{ref}$ is the mean absolute error of the reference forecast.

5.2 Results

5.2.1 Maximum temperature

Figures 5.1.a-c show **ME**, **MAE** and **HR** for **2MTX**, day 0, 3 and 5, for each month, averaged over all climatological stations. At day 0 there is a clear negative bias of between -0.5 and -2 ^{o}C for all months, largest in 1998. **MAE** values are correspondingly quite high, about 2 ^{o}C. The hit rates are low, around 55-60 percent for most months, for a tolerance of 2 ^{o}C, but high, above 90 percent, for a tolerance of 4 ^{o}C. This pattern is present for day 3 and 5 as well, growing worse with forecast length. The day 5 forecasts for 1998 are better than those for 1997.

The scores for each station (not presented here) show that the bias is negative for nearly all stations and months. Most likely, the primary cause of the negative bias is the fact that

the variable being predicted by the underlying statistical interpretation system (see 2.2) is in fact not daily maximum temperature, but rather the highest of regularly (hourly or three-hourly) reported temperature values. As a result of an error, the statistical interpretation system was inactive in 1998, not adjusting to the actual error levels; the explanation thus holds for 1997 only. It is planned to change the system to use reported extreme temperatures from summer 1999.

In Figure 5.1.d the three skill scores are displayed for each forecast day for 1997 and 1998. Skill relative to climatology and relative to chance (**SSCLI** and **HKSI**) decrease with forecast length for both years, as might be expected. Climatology actually beats the AMIS forecast for day 5 - and in 1998 for day 3 as well; this is presumably because of the large bias of the forecast. Bias probably also explains the fact that skill relative to persistence (**SSPER**) decreases from day 3 to day 5. The skill scores are generally higher for 1997 than for 1998.

5.2.2 Minimum temperature

ME, **MAE** and **HR** for **2MTN** are displayed in Figures 5.2.a-c for days 0, 3 and 5. In 1997, the day 0 forecasts were of about the same quality as the maximum temperature forecasts for day 0, with a general positive bias of about 1 ^{o}C and **MAE** values of 1.5 - 2 ^{o}C. In 1998 they were better, hitting within 2 ^{o}C from the observed in 75 - 80 percent of cases, and having smaller errors. The quality goes down with forecast length, but also for day 3 and 5 the 1998 forecasts are better than those from 1997.

Analogously to what was noted concerning maximum temperature, the positive **ME** at day 0 for 1997 might be explained by the fact that the statistical interpretation system underlying AMIS predicts the lowest temperature reported at regular observing hours, not the measured minimum temperature.

The skill plots (Figure 5.2.d) are very similar to those for maximum temperature. Contrary to what was the case for maximum temperature, the skill scores for 1998 are higher than those for 1997.

5.2.3 Precipitation

Figures 5.3.a-c show **ME**, **MAE** and **HR** for **24HAT**, forecast days 0, 3 and 5. At day 0 the **MAE** is around 2 mm and the **ME** between 0 and 1 mm for most months. **HR** values are around 60% for 1997, but below 40% for most months of 1998. The quality decreases with forecast length for both years, hit rates dropping to 20-50 % on day 5. The forecast quality was generally poorer in 1998 than in 1997.

From contingency tables (not shown here) it is apparent that a major problem with the **24HAT** forecasts is that precipitation is forecast much too frequently for dry days. This was the case more often in 1998 than in 1997.

All three skill measures (Figures 5.3.d) decrease with forecast length. For **SSPER** this is contrary to what might be expected; one important reason, as judged from contingency tables for persistence forecasts (not shown here), is that the persistence forecasts capture the dry days better than the forecasts.

Skill levels are lower for 1998 than for 1997. Values of **SSCLI** (and for 1998 **SSPER**) are negative for days 3 and 5; this indicates that one would actually be better off using climatology rather than the AMIS values for longer forecast lengths, at least to the extent

that the **MAE** is an appropriate quality measure (it should of course be noted that 'climatology' in this case is the monthly data mean, and so is not independent of the verifyng data).

Figure 5.1.a:
*Monthly values of **HR** (2 and 4 ^{o}C intervals, percent), **ME** and **MAE** (^{o}C) for **2MTX**, day 0.*

Figure 5.1.b:
Same as Figure 5.2.1.a, but for day 3.

Figure 5.1.c:
Same as Figure 5.2.1.a, but for day 5.

Figure 5.1.d:
***SSCLI**, **SSPER** and **HKSI** for **2MTX**, averaged over stations and months, for days 0, 3 and 5.*

Figure 5.2.a:
*Monthly values of **HR** (2 and 4 ^{o}C intervals, percent), **ME** and **MAE** (^{o}C) for **2MTN**, day 0.*

Figure 5.2.b:
Same as Figure 5.2.2.a, but for day 3.

Figure 5.2.c:
Same as Figure 5.2.2.a, but for day 5.

Figure 5.2.d:
***SSCLI**, **SSPER** and **HKSI** for **2MTN**, averaged over stations and months, for days 0, 3 and 5.*

Figure 5.3.a:
*Monthly values of **HR** (five intervals, percent), **ME** and **MAE** (mm) for **24HAT**, day 0.*

Figure 5.3.b:
Same as Figure 5.2.3.a, but for day 3.

Figure 5.3.c:
Same as Figure 5.2.3.a, but for day 5.

Figure 5.3.d:
***SSCLI**, **SSPER** and **HKSI** for **24HAT**, averaged over stations and months, for days 0, 3 and 5.*

Maximum temperature

Fig. 5.1.a

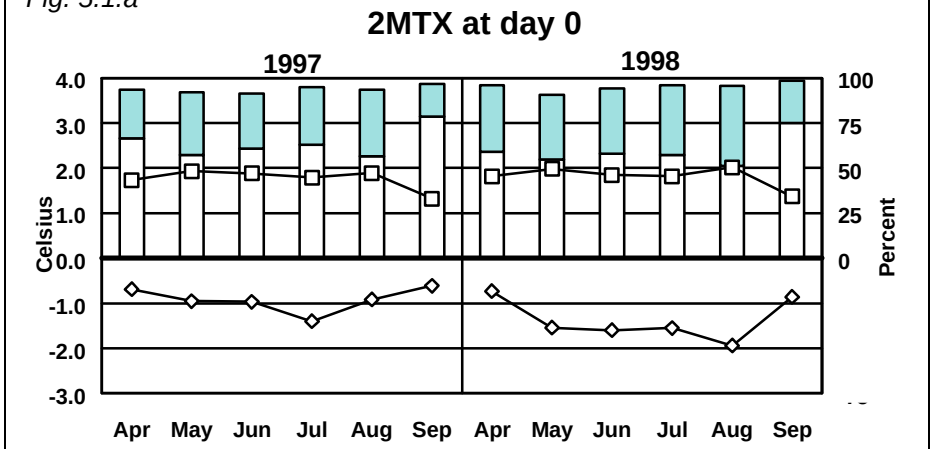


Fig. 5.1.b

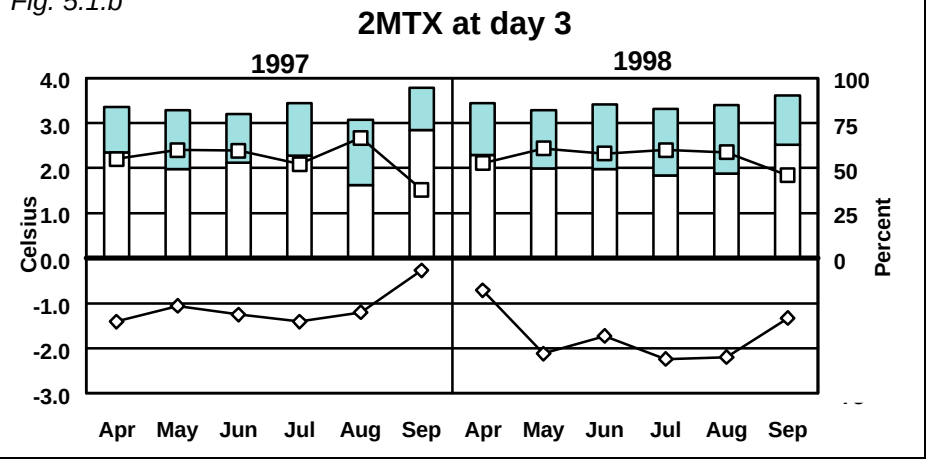


Fig. 5.1.c

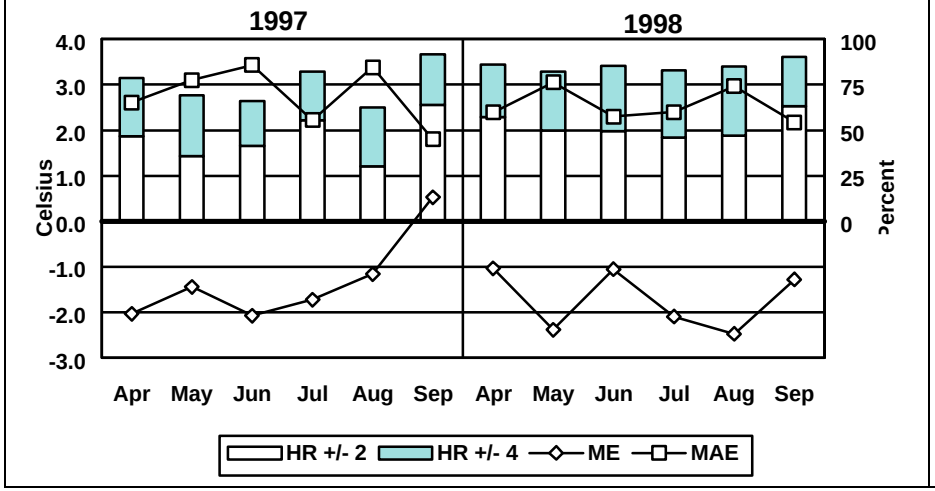
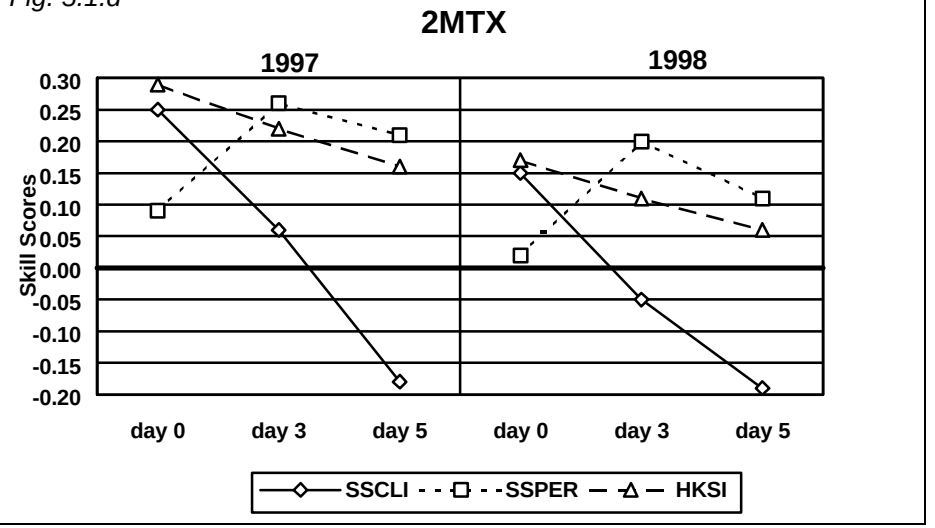


Fig. 5.1.d



Minimum temperature

Fig. 5.2.a

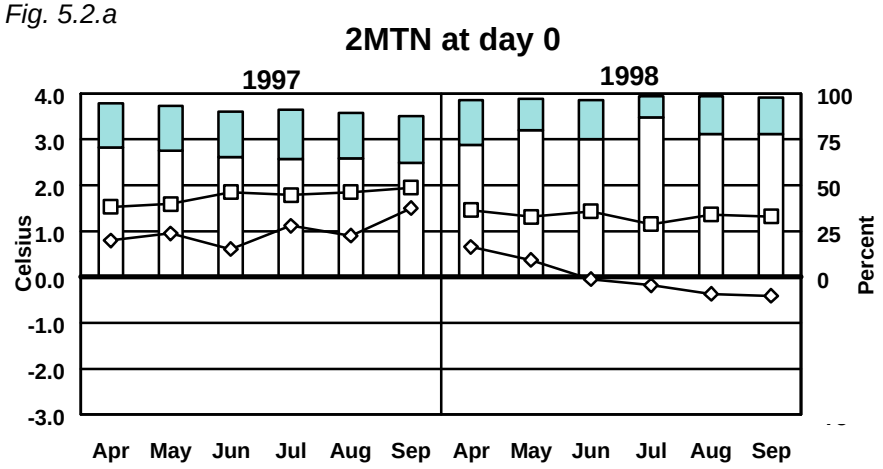


Fig. 5.2.b

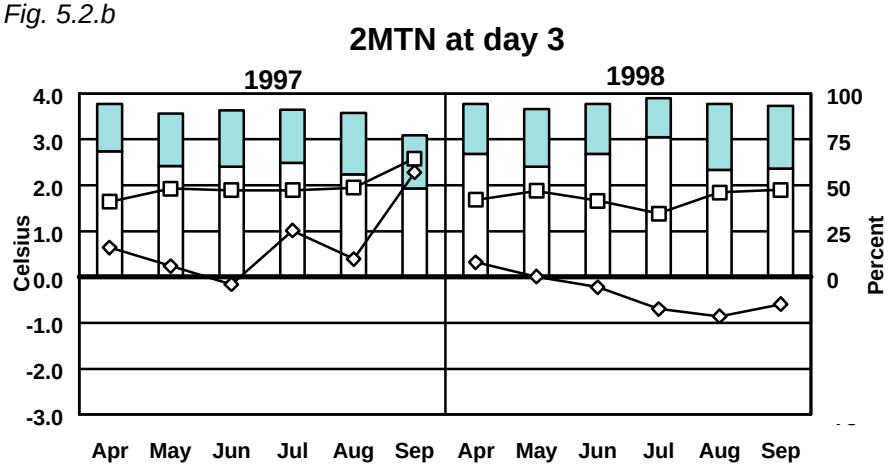


Fig. 5.2.c

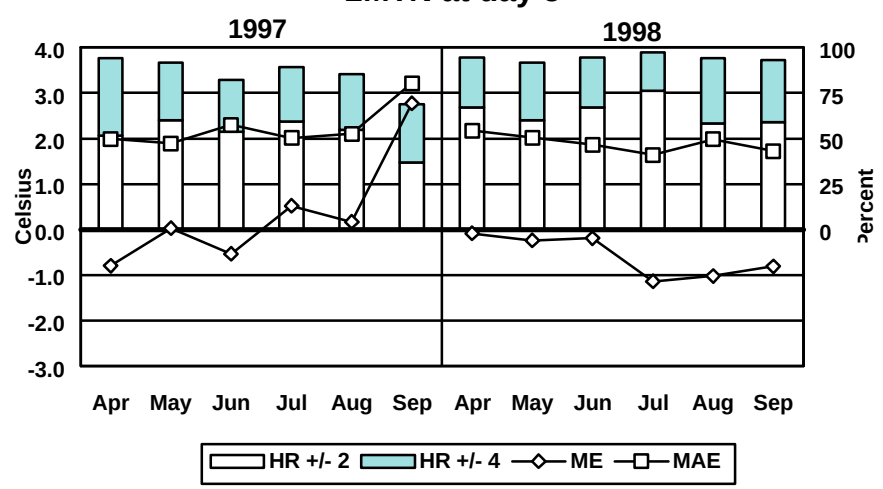
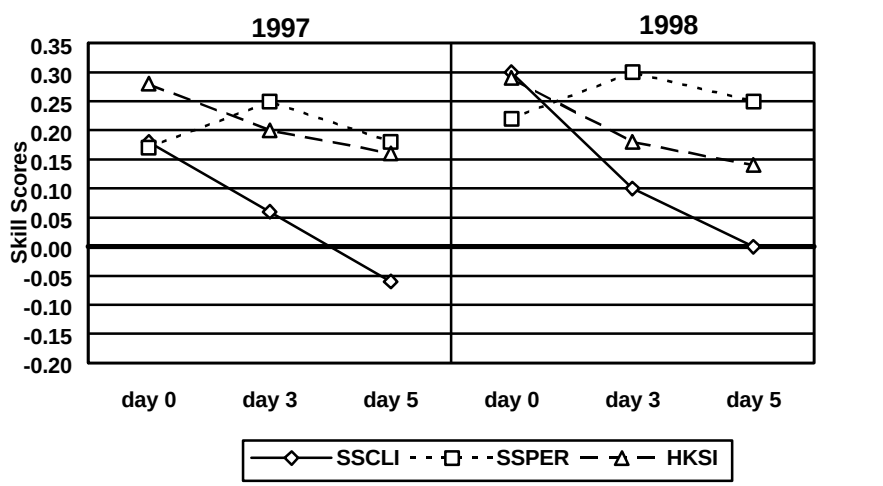


Fig. 5.2.d



Precipitation

Fig. 5.3.a

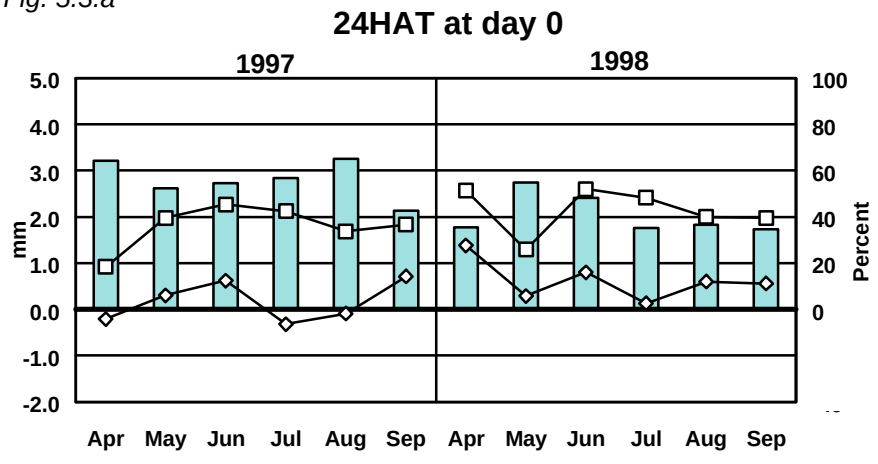


Fig. 5.3.b

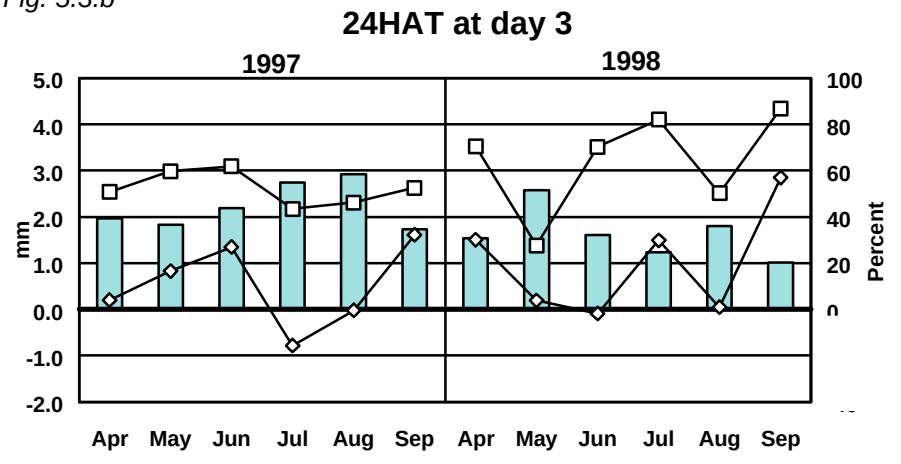


Fig. 5.3.c

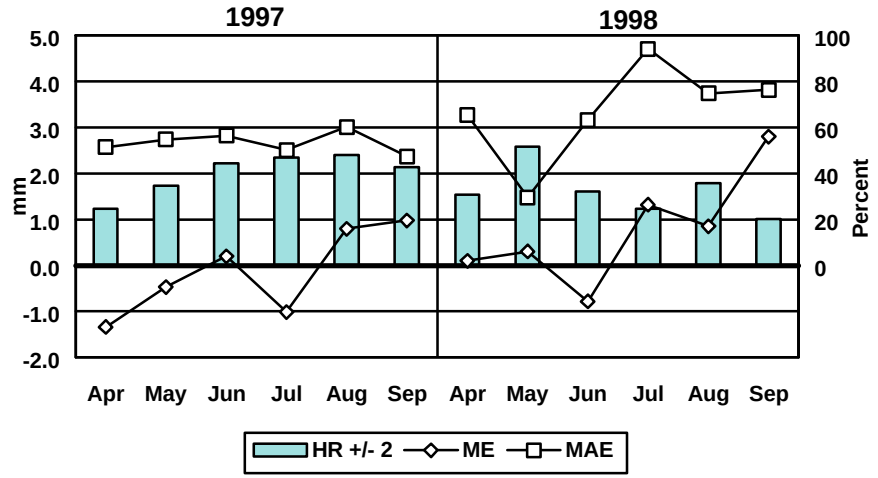
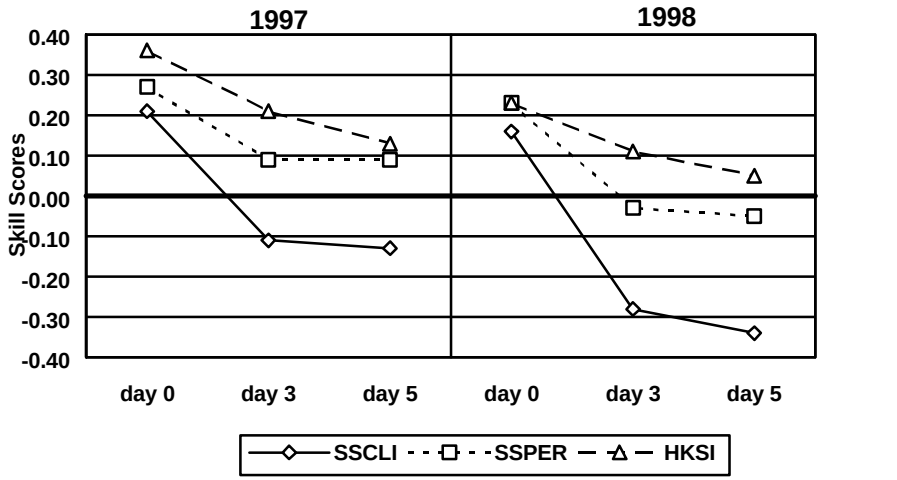


Fig. 5.3.d



6 Conclusions

The present investigation has shown that the observation and forecast data of the **AMIS** system have been of good, expectable quality in the growing seasons of 1997 and 1998, as measured by general meteorological standards. Availability has been high as well, and better in 1998 than in the year before. Some important problem areas have emerged, however:

- **AMO** fields of 24-hour precipitation tend to be too smooth, not reflecting the fine-scale spatial structure of actual precipitation fields;
- **AMO** temperature fields display consistent bias patterns, almost certainly due to land-sea differences not being taken into account by the interpolation scheme;
- **AMF** values of extreme temperature are biased, possibly as a result of the underlying statistical interpretation method;
- The quality of **AMF** precipitation fields is less than satisfactory;
- Further improvement of data availability is desirable.

A number of operational changes and further off-line investigations have been planned for 1999 with the purpose of alleviating some of these problems:

New sub-projects of the present on IT and agriculture (Section 1.1) will address the possibility of improving the gridding methods for observed precipitation, temperature and humidity. For precipitation, alternative interpolation techniques such as kriging will be tried out; for the other parameters we will investigate the possibility of utilizing analyses and short-term forecast fields from the DMI high-resolution forecast model, HIRLAM.

In Summer, 1999, a change will be made in the operational system which will hopefully reduce the bias problems of the **AMF** temperatures.

An upgrade of the operational system is expected to improve the data availability from April, 1999.

7 References

[1] Hanssen, A.W., and W.J.A. Kuipers: *On the relationship between the frequency of rain and various meteorological parameters*. De Bilt, KNMI, Mededelingen en Verhandelingen, **81,** 1965.

[2] Hilden, A: *SAFE-databasen - en beskrivelse af systemet. Udgave 1B.* DMI, November 1997.

[3] Christensen, O.B., and B. H. Sass: *A description of the DMI evaporation forecast model*. DMI technical report 94-3, DMI 1994.

[4] Christensen, O.B.: *Changes to the DMI evaporation-prediction system in 1996*. DMI technical report 96-7, DMI 1996.

Appendix A - Availability

Availability of AMIS fields (percent) and percentage of good data values in available fields (monthly minimum, maximum and mean).

A.1: Observations

A.2: Forecasts

A.1 Observations

2MT at 00 UTC

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	93.5	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	97.6	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	99.5	100.0	100.0	100.0

2MT at 12 UTC

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	90.3	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	96.4	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	100.0	100.0	100.0	100.0

2MRH at 00 UTC

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	90.3	100.0	100.0	100.0
	Aug	87.1	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	94.6	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	100.0	100.0	100.0	100.0

2MRH at 12 UTC

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	90.3	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	96.4	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	100.0	100.0	100.0	100.0

10MFF at 00 UTC

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	93.5	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	97.6	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	100.0	99.8	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	100.0	99.8	100.0	100.0

10MFF at 12 UTC

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	90.3	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	96.4	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	100.0	100.0	100.0	100.0

24HAT at 06 UTC

		% avail.	min. % good	max. % good	mean % good
1997	Apr	85.7	99.7	100.0	100.0
	May	100.0	99.7	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	90.3	99.8	100.0	100.0
	Aug	100.0	98.6	100.0	99.9
	Sep	100.0	99.8	100.0	100.0
	All	97.0	98.6	100.0	100.0
1998	Apr	100.0	99.5	100.0	100.0
	May	100.0	99.7	100.0	100.0
	Jun	100.0	99.7	100.0	100.0
	Jul	100.0	98.1	100.0	99.9
	Aug	100.0	99.8	100.0	100.0
	Sep	96.7	99.8	100.0	100.0
	All	99.5	98.1	100.0	100.0

24HPEV at 06 UTC

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	97.8	97.8	97.8
	May	100.0	97.8	97.8	97.8
	Jun	90.0	97.8	97.8	97.8
	Jul	80.6	97.8	97.8	97.8
	Aug	96.8	97.8	97.8	97.8
	Sep	90.0	97.8	97.8	97.8
	All	91.6	97.8	97.8	97.8
1998	Apr	93.3	97.8	97.8	97.8
	May	93.5	97.6	97.8	97.8
	Jun	86.7	97.8	100.0	98.7
	Jul	100.0	99.8	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	95.1	97.6	100.0	99.1

A.2 Forecasts

2MTX at day 0

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	83.3	100.0	100.0	100.0
	Jul	93.5	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	94.6	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	98.9	100.0	100.0	100.0

2MTN at day 0

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	83.3	100.0	100.0	100.0
	Jul	93.5	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	94.6	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	98.9	100.0	100.0	100.0

2MTX at day 3

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	83.3	100.0	100.0	100.0
	Jul	93.5	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	94.6	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	98.9	100.0	100.0	100.0

2MTN at day 3

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	83.3	100.0	100.0	100.0
	Jul	93.5	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	94.6	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	98.9	100.0	100.0	100.0

2MTX at day 5

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	70.0	100.0	100.0	100.0
	Jul	90.3	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	93.3	100.0	100.0	100.0
	All	91.0	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	93.5	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	93.5	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	97.3	100.0	100.0	100.0

2MTN at day 5

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	70.0	100.0	100.0	100.0
	Jul	90.3	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	93.3	100.0	100.0	100.0
	All	91.0	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	93.5	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	93.5	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	97.8	100.0	100.0	100.0

24HPEV at day 0

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	93.3	100.0	100.0	100.0
	Jul	96.8	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	93.3	100.0	100.0	100.0
	All	96.4	100.0	100.0	100.0
1998	Apr	96.7	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	93.5	100.0	100.0	100.0
	Aug	93.5	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	97.3	100.0	100.0	100.0

24HAT at day 0

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	99.4	100.0	100.0	100.0
1998	Apr	100.0	99.5	100.0	100.0
	May	100.0	99.7	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	99.4	100.0	100.0
	All	99.5	99.4	100.0	100.0

24HPEV at day 3

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	93.3	100.0	100.0	100.0
	Jul	96.8	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	93.3	100.0	100.0	100.0
	All	96.4	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	96.8	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	98.9	100.0	100.0	100.0

24HAT at day 3

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	93.3	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	98.2	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	96.8	99.2	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	96.8	99.8	100.0	100.0
	Sep	100.0	98.1	100.0	99.9
	All	98.9	98.1	100.0	100.0

24HPEV at day 5

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	93.3	100.0	100.0	100.0
	Jul	96.8	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	93.3	100.0	100.0	100.0
	All	96.4	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	96.8	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	98.9	100.0	100.0	100.0

24HAT at day 5

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	90.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	97.0	100.0	100.0	100.0
1998	Apr	100.0	99.7	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	98.7	100.0	99.9
	Jul	100.0	99.8	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	98.9	98.7	100.0	100.0

10MFX at day 0

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	83.3	100.0	100.0	100.0
	Jul	93.5	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	94.6	100.0	100.0	100.0
1998	Apr	96.7	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	90.3	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	96.2	100.0	100.0	100.0

10MFX at day 3

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	83.3	100.0	100.0	100.0
	Jul	93.5	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	96.7	100.0	100.0	100.0
	All	94.6	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	96.8	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	96.8	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	98.9	100.0	100.0	100.0

10MFX at day 5

		% avail.	min. % good	max. % good	mean % good
1997	Apr	92.9	100.0	100.0	100.0
	May	100.0	100.0	100.0	100.0
	Jun	70.0	100.0	100.0	100.0
	Jul	90.3	100.0	100.0	100.0
	Aug	100.0	100.0	100.0	100.0
	Sep	93.3	100.0	100.0	100.0
	All	91.0	100.0	100.0	100.0
1998	Apr	100.0	100.0	100.0	100.0
	May	93.5	100.0	100.0	100.0
	Jun	100.0	100.0	100.0	100.0
	Jul	100.0	100.0	100.0	100.0
	Aug	93.5	100.0	100.0	100.0
	Sep	100.0	100.0	100.0	100.0
	All	97.8	100.0	100.0	100.0

Appendix B - Gridding method

Monthly minimum, maximum and mean values of quality measures.

Units:	**ME**, **MAE**, **RMSE**:	**2MT**:	^{o}C
		2MRH:	%
		10MFF:	m/s
		24HAT:	mm
		24HGLR:	MJ/m^2
	HR:		%
	HKSI:		1

2MT at 00 UTC

			ME	MAE	RMSE	HR 2	HR 1	HKSI
		Apr	-1.47	0.40	0.63	76.7	46.7	0.34
		May	-1.70	0.32	0.40	63.3	36.7	0.15
	M	Jun	-2.13	0.61	0.80	63.3	20.0	0.11
	I	Jul	-3.20	0.69	0.82	26.7	10.0	-0.08
	N	Aug	-2.97	0.76	1.00	33.3	10.0	0.00
		Sep	-1.52	0.37	0.55	73.3	23.3	0.21
		All	-2.16	0.66	0.88	56.7	27.2	0.21
		Apr	0.94	1.47	1.84	100.0	90.0	0.78
		May	0.82	1.70	2.03	100.0	96.7	0.81
1	M	Jun	1.40	2.13	2.51	100.0	76.7	0.69
9	A	Jul	1.66	3.20	3.50	100.0	80.0	0.36
9	X	Aug	2.15	3.04	3.44	93.3	67.9	0.65
7		Sep	1.50	1.52	1.98	100.0	90.0	0.88
		All	1.18	2.18	2.63	97.2	76.1	0.67
		Apr	0.33	0.85	1.13	89.6	68.8	0.59
	M	May	0.15	0.80	1.03	91.1	72.0	0.54
	E	Jun	0.29	1.02	1.30	87.0	60.6	0.42
	A	Jul	0.45	1.35	1.62	78.4	44.2	0.20
	N	Aug	0.47	1.32	1.60	78.5	46.5	0.36
		Sep	0.53	1.06	1.37	85.4	57.9	0.44
		All	0.37	1.07	1.38	85.0	58.4	0.49
		Apr	-0.46	0.36	0.49	93.3	56.7	0.52
		May	-1.43	0.63	0.72	67.9	32.3	0.11
	M	Jun	-1.13	0.63	0.81	66.7	26.7	0.03
	I	Jul	-1.11	0.44	0.57	80.6	19.4	0.10
	N	Aug	-1.13	0.44	0.58	74.2	25.8	0.07
		Sep	-0.70	0.38	0.60	76.7	30.0	0.07
		All	-0.83	0.58	0.79	82.5	38.8	0.31
		Apr	0.71	1.02	1.26	100.0	93.3	0.92
		May	1.33	1.43	1.90	100.0	83.9	0.58
1	M	Jun	1.51	1.51	1.71	96.7	83.3	0.63
9	A	Jul	1.51	1.51	1.69	100.0	90.3	0.87
9	X	Aug	1.50	1.50	1.70	100.0	93.5	0.76
8		Sep	1.56	1.56	1.77	100.0	93.3	0.74
		All	1.24	1.30	1.51	97.8	84.2	0.68
		Apr	0.16	0.59	0.77	98.2	82.7	0.72
	M	May	0.46	0.99	1.26	87.4	60.0	0.39
	E	Jun	0.52	0.97	1.24	87.1	62.1	0.40
	A	Jul	0.61	0.90	1.12	90.9	63.8	0.44
	N	Aug	0.66	0.97	1.20	88.9	60.8	0.43
		Sep	0.42	0.75	1.05	92.5	76.0	0.51
		All	0.48	0.86	1.13	90.9	67.5	0.52

2MT at 12 UTC

			ME	MAE	RMSE	HR 2	HR 1	HKSI
		Apr	-0.83	0.32	0.48	77.8	44.4	0.29
		May	-0.85	0.40	0.51	72.4	34.5	0.18
	M	Jun	-1.06	0.57	0.73	58.6	37.9	0.03
	I	Jul	-0.91	0.49	0.66	64.3	21.7	0.06
	N	Aug	-1.91	0.46	0.56	41.9	19.4	0.06
		Sep	-1.08	0.35	0.44	79.3	37.9	0.14
		All	-0.94	0.55	0.72	70.9	44.5	0.37
		Apr	1.38	1.38	1.84	100.0	96.3	0.83
1		May	1.68	1.74	2.32	100.0	93.3	0.68
9	**M**	Jun	1.31	1.74	2.16	100.0	86.2	0.80
9	**A**	Jul	1.21	1.54	1.84	100.0	89.3	0.73
7	**X**	Aug	2.52	2.59	3.06	100.0	93.5	0.82
		Sep	0.64	1.24	1.45	100.0	96.4	0.85
		All	1.12	1.41	1.95	99.4	87.4	0.73
		Apr	-0.06	0.78	1.04	93.2	72.9	0.52
	M	May	-0.17	0.86	1.11	91.9	69.5	0.50
	E	Jun	-0.17	1.03	1.29	84.5	61.8	0.47
	A	Jul	-0.01	0.94	1.21	87.9	64.9	0.46
	N	Aug	-0.17	1.05	1.29	86.2	60.2	0.46
		Sep	0.01	0.65	0.82	97.0	78.2	0.58
		All	-0.10	0.88	1.17	90.1	67.9	0.56
		Apr	-0.99	0.51	0.62	66.7	36.7	0.22
		May	-1.36	0.54	0.70	50.0	32.3	0.05
	M	Jun	-1.13	0.63	0.81	66.7	26.7	0.03
	I	Jul	-1.16	0.39	0.59	76.7	48.4	0.35
	N	Aug	-0.94	0.41	0.52	87.1	48.4	0.29
		Sep	-0.34	0.33	0.48	72.4	48.3	0.27
		All	-1.00	0.50	0.68	71.2	48.6	0.33
		Apr	1.19	1.75	2.35	100.0	90.0	0.83
1		May	1.82	2.04	2.61	100.0	90.3	0.74
9	**M**	Jun	1.51	1.51	1.71	96.7	83.3	0.63
9	**A**	Jul	1.33	1.34	1.89	100.0	93.5	0.77
8	**X**	Aug	1.19	1.37	1.98	100.0	93.5	0.90
		Sep	1.34	1.37	1.79	100.0	96.7	0.82
		All	1.32	1.46	1.99	99.5	90.7	0.75
		Apr	-0.06	0.88	1.15	89.0	68.8	0.54
	M	May	-0.09	1.06	1.38	85.5	61.8	0.45
	E	Jun	0.52	0.97	1.24	87.1	62.1	0.40
	A	Jul	0.00	0.72	0.95	94.9	76.6	0.58
	N	Aug	-0.04	0.75	0.96	95.4	73.4	0.50
		Sep	0.07	0.66	0.87	94.5	78.3	0.61
		All	-0.03	0.82	1.09	91.8	71.9	0.56

2MRH at 00 UTC

			ME	MAE	RMSE	HR 10	HKSI
1997	MIN	Apr	-7.23	2.56	3.79	13.3	-0.14
		May	-4.84	1.59	2.07	26.7	-0.07
		Jun	-4.15	2.23	2.94	26.7	-0.04
		Jul	-4.23	1.63	2.29	30.0	-0.20
		Aug	-3.75	2.02	3.04	20.0	-0.08
		Sep	-5.31	1.74	2.44	46.7	-0.12
		All	-4.12	1.97	2.97	27.2	-0.06
	MAX	Apr	15.55	15.55	16.68	100.0	0.53
		May	14.38	14.38	15.66	100.0	0.51
		Jun	14.82	14.82	16.47	100.0	0.51
		Jul	17.55	17.55	19.88	100.0	0.42
		Aug	16.77	16.77	18.23	100.0	0.54
		Sep	11.28	11.28	11.82	100.0	0.45
		All	15.06	15.06	16.64	98.3	0.39
	MEAN	Apr	0.67	5.34	6.80	85.1	0.22
		May	0.08	4.32	5.33	90.4	0.18
		Jun	-0.12	4.00	5.24	90.9	0.30
		Jul	-0.01	3.92	4.90	92.7	0.12
		Aug	-0.07	4.25	5.35	91.3	0.17
		Sep	-1.12	4.09	4.92	93.7	0.16
		All	-0.10	4.33	5.54	90.7	0.20
1998	MIN	Apr	-4.17	0.78	1.10	80.0	-0.1
		May	-6.38	2.00	2.79	25.0	0.0
		Jun	-5.85	2.08	2.52	28.6	0.0
		Jul	-6.03	1.34	1.63	50.0	-0.3
		Aug	-7.34	1.87	2.43	54.8	-0.3
		Sep	-4.89	1.48	1.90	73.3	-0.3
		All	-5.34	1.83	2.51	52.5	-0.1
	MAX	Apr	5.61	5.61	6.83	100.0	0.8
		May	14.85	14.85	16.29	100.0	0.4
		Jun	12.77	12.77	13.86	100.0	0.6
		Jul	10.66	10.66	11.13	100.0	0.5
		Aug	9.99	9.99	10.40	100.0	0.4
		Sep	8.91	8.91	9.32	100.0	0.4
		All	10.39	10.39	11.62	100.0	0.4
	MEAN	Apr	-0.95	2.85	3.58	97.3	0.3
		May	-1.32	4.57	5.62	90.8	0.2
		Jun	-1.22	4.25	5.23	92.0	0.2
		Jul	-1.53	3.75	4.31	95.9	0.1
		Aug	-1.89	4.15	4.73	94.4	0.0
		Sep	-1.30	3.11	3.82	97.6	0.1
		All	-1.38	3.78	4.68	94.7	0.2

2MRH at 12 UTC

			ME	MAE	RMSE	HR 10	HKSI
		Apr	-9.47	3.73	5.00	51.9	0.02
		May	-11.50	4.15	5.25	44.4	-0.01
	M	Jun	-9.91	4.26	5.91	51.7	-0.01
	I	Jul	-8.25	4.21	5.60	53.6	-0.06
	N	Aug	-13.15	4.25	4.65	33.3	-0.09
		Sep	-10.31	3.03	3.72	51.7	-0.10
		All	-9.94	4.62	5.97	52.1	0.01
		Apr	7.82	9.98	14.84	96.3	0.54
1		May	9.02	11.57	13.50	96.7	0.36
9	M	Jun	7.35	9.97	11.96	90.0	0.39
9	A	Jul	7.13	10.41	11.77	96.4	0.34
7	X	Aug	11.49	14.55	17.02	100.0	0.35
		Sep	6.87	10.76	12.13	100.0	0.45
		All	6.83	10.57	12.44	91.9	0.31
		Apr	1.93	6.52	8.59	78.2	0.26
	M	May	1.53	6.41	8.02	77.9	0.19
	E	Jun	0.80	6.81	8.62	73.9	0.18
	A	Jul	0.41	7.36	8.94	72.9	0.10
	N	Aug	1.01	8.21	9.96	69.6	0.10
		Sep	0.54	5.50	6.90	85.4	0.20
		All	1.03	6.81	8.71	76.3	0.18
		Apr	-9.83	3.06	3.95	53.3	-0.1
		May	-16.74	3.40	4.45	25.8	-0.1
	M	Jun	-5.85	2.08	2.52	28.6	0.0
	I	Jul	-11.39	2.90	4.21	38.7	0.0
	N	Aug	-14.69	3.93	4.86	19.4	-0.1
		Sep	-9.07	3.32	4.14	63.3	-0.1
		All	-12.48	3.90	5.59	39.9	0.0
		Apr	4.94	10.21	12.35	96.7	0.6
1		May	5.12	16.91	18.65	96.8	0.4
9	M	Jun	12.77	12.77	13.86	100.0	0.6
9	A	Jul	7.57	11.39	12.82	96.8	0.5
8	X	Aug	8.08	14.69	15.95	93.5	0.4
		Sep	6.38	9.26	10.04	100.0	0.4
		All	5.67	12.60	14.33	94.5	0.4
		Apr	-0.54	4.95	6.53	87.6	0.2
	M	May	-0.24	6.39	7.83	82.1	0.2
	E	Jun	-1.22	4.25	5.23	92.0	0.2
	A	Jul	0.47	5.51	6.72	85.1	0.2
	N	Aug	0.54	6.33	7.66	80.4	0.2
		Sep	-0.47	5.33	6.78	86.2	0.2
		All	-0.01	5.69	7.18	84.0	0.2

10MFF at 00 UTC

			ME	MAE	RMSE	HR 4	HKSI
1997	MIN	Apr	-2.28	0.63	0.99	36.7	0.02
		May	-1.70	0.62	0.75	60.0	0.38
		Jun	-1.77	0.56	0.69	55.2	0.25
		Jul	-1.78	0.52	0.65	53.3	0.00
		Aug	-1.62	0.38	0.56	66.7	-0.10
		Sep	-2.82	0.66	0.83	33.3	0.17
		All	-1.93	0.59	0.84	56.7	0.28
	MAX	Apr	2.34	2.35	2.74	96.7	0.90
		May	1.59	1.77	2.17	100.0	0.95
		Jun	1.96	1.97	2.46	100.0	0.87
		Jul	1.88	1.88	2.21	100.0	0.95
		Aug	1.35	1.68	1.89	100.0	0.98
		Sep	2.69	2.92	3.62	96.7	0.94
		All	1.83	1.98	2.46	96.7	0.88
	MEAN	Apr	0.22	1.31	1.61	77.1	0.64
		May	0.20	1.13	1.41	85.0	0.67
		Jun	0.15	1.20	1.51	80.1	0.58
		Jul	0.27	1.17	1.46	82.2	0.48
		Aug	0.17	0.94	1.14	90.4	0.55
		Sep	0.35	1.48	1.84	73.9	0.61
		All	0.23	1.20	1.53	81.4	0.63
1998	MIN	Apr	-1.61	0.55	0.72	33.3	0.1
		May	-2.06	0.57	0.73	54.8	0.2
		Jun	-2.39	0.67	0.81	46.7	0.2
		Jul	-2.85	0.63	0.85	35.5	0.2
		Aug	-3.49	0.55	0.71	25.8	-0.2
		Sep	-1.97	0.51	0.66	50.0	0.1
		All	-2.27	0.61	0.80	49.7	0.1
	MAX	Apr	1.86	3.08	3.66	100.0	0.9
		May	1.77	2.13	2.80	100.0	1.0
		Jun	2.36	2.58	3.18	100.0	0.9
		Jul	2.57	3.17	3.68	100.0	1.0
		Aug	2.93	3.52	3.90	100.0	0.7
		Sep	1.76	2.30	4.27	100.0	0.9
		All	2.08	2.44	3.04	98.9	0.8
	MEAN	Apr	0.30	1.15	1.41	85.1	0.6
		May	0.21	1.18	1.45	83.1	0.6
		Jun	0.41	1.30	1.60	81.2	0.7
		Jul	0.52	1.50	1.80	74.7	0.6
		Aug	0.50	1.63	1.86	70.6	0.5
		Sep	0.22	1.21	1.57	81.1	0.7
		All	0.35	1.32	1.65	79.4	0.6

10MFF at 12 UTC

			ME	MAE	RMSE	HR 4	HKSI
1997	MIN	Apr	-2.09	0.76	0.95	51.9	0.16
		May	-1.77	0.71	0.86	56.7	0.17
		Jun	-1.79	0.65	0.80	41.4	0.04
		Jul	-1.44	0.65	0.86	64.3	0.15
		Aug	-1.24	0.65	0.83	80.6	0.27
		Sep	-1.77	0.89	1.06	41.4	0.31
		All	-1.65	0.78	1.02	58.0	0.28
	MAX	Apr	2.05	2.20	2.78	96.3	0.73
		May	1.67	1.81	2.17	100.0	0.72
		Jun	1.83	1.89	2.14	100.0	0.89
		Jul	1.48	1.71	2.05	100.0	0.81
		Aug	1.08	1.29	1.67	100.0	0.80
		Sep	2.45	2.49	2.99	100.0	0.70
		All	1.75	1.83	2.20	97.1	0.68
	MEAN	Apr	-0.04	1.31	1.68	78.6	0.52
		May	-0.04	1.15	1.44	83.0	0.51
		Jun	-0.04	1.10	1.37	84.3	0.52
		Jul	-0.03	1.02	1.30	86.8	0.49
		Aug	-0.10	0.91	1.16	90.8	0.53
		Sep	-0.08	1.36	1.73	76.8	0.53
		All	-0.06	1.14	1.48	83.5	0.52
1998	MIN	Apr	-1.29	0.56	0.76	41.2	0.2
		May	-2.22	0.64	0.84	41.9	0.0
		Jun	-2.39	0.67	0.81	46.7	0.2
		Jul	-1.98	0.68	0.90	29.0	-0.2
		Aug	-2.22	0.58	0.68	32.3	0.0
		Sep	-2.10	0.54	0.69	50.0	0.2
		All	-1.91	0.69	0.89	53.0	0.2
	MAX	Apr	2.70	3.60	4.50	100.0	0.9
		May	1.59	2.29	2.60	100.0	0.7
		Jun	2.36	2.58	3.18	100.0	0.9
		Jul	2.77	2.79	3.20	96.8	0.6
		Aug	2.67	2.67	2.89	100.0	0.8
		Sep	1.88	2.19	2.61	100.0	0.9
		All	2.04	2.09	2.43	98.4	0.7
	MEAN	Apr	0.16	1.12	1.42	86.5	0.5
		May	-0.25	1.13	1.42	82.2	0.5
		Jun	0.41	1.30	1.60	81.2	0.7
		Jul	0.07	1.32	1.65	77.3	0.4
		Aug	0.00	1.32	1.57	76.9	0.5
		Sep	-0.02	1.08	1.35	85.0	0.6
		All	-0.03	1.18	1.51	81.8	0.5

24HAT at 06 UTC

			ME	MAE	RMSE	HR	HKSI
1997	MIN	Apr	-0.68	0.15	0.34	0.6	0.40
		May	-0.90	0.49	0.81	0.5	0.28
		Jun	-0.80	0.37	0.76	0.6	0.34
		Jul	-2.07	0.54	1.07	0.5	0.09
		Aug	-1.46	0.52	1.32	0.7	0.38
		Sep	-1.99	0.30	0.61	0.6	0.43
		All	-0.96	0.72	1.71	0.6	0.47
	MAX	Apr	0.71	1.16	2.30	1.0	1.00
		May	1.38	3.13	7.44	0.8	0.72
		Jun	1.09	2.70	5.33	0.8	0.71
		Jul	0.89	2.99	8.77	0.9	0.71
		Aug	0.56	2.58	9.29	0.9	0.93
		Sep	0.41	2.00	6.25	0.9	0.88
		All	0.27	1.80	5.12	0.8	0.67
	MEAN	Apr	-0.15	0.59	1.22	0.8	0.68
		May	-0.09	1.08	2.20	0.6	0.53
		Jun	-0.05	1.26	2.72	0.7	0.51
		Jul	-0.35	1.31	3.30	0.6	0.41
		Aug	-0.19	1.00	3.29	0.8	0.64
		Sep	-0.10	0.74	1.69	0.8	0.66
		All	-0.15	1.04	2.90	0.7	0.56
1998	MIN	Apr	-0.79	0.65	1.17	0.6	0.42
		May	-0.60	0.29	0.75	0.6	0.35
		Jun	-1.64	0.82	1.55	0.4	0.26
		Jul	-2.26	0.81	1.31	0.4	0.24
		Aug	-2.11	0.58	0.95	0.3	0.07
		Sep	-0.82	0.58	0.97	0.4	0.22
		All	-0.88	0.86	1.68	0.5	0.39
	MAX	Apr	0.48	2.08	6.11	0.9	0.82
		May	0.66	1.22	2.95	0.9	0.74
		Jun	1.06	2.49	7.29	0.8	0.72
		Jul	1.02	3.29	8.78	0.7	0.55
		Aug	0.82	2.44	7.75	0.7	0.66
		Sep	1.16	2.27	7.60	0.8	0.81
		All	0.40	1.66	4.70	0.7	0.64
	MEAN	Apr	-0.27	1.12	2.19	0.7	0.59
		May	0.02	0.60	1.36	0.7	0.57
		Jun	-0.07	1.56	3.51	0.6	0.45
		Jul	-0.03	1.62	3.39	0.6	0.42
		Aug	-0.12	1.07	2.10	0.6	0.40
		Sep	0.20	1.32	3.08	0.6	0.52
		All	-0.05	1.21	2.96	0.6	0.50

24HGLR at 06 UTC

			ME	MAE	RMSE	HR 2	HR 1	HKSI
1998	MIN	Apr	1.40	2.78	3.48	93.1	75.9	0.63
		May	1.40	2.90	3.78	96.8	64.5	0.61
		Jun	2.77	4.74	12.48	83.3	50.0	0.47
		Jul	4.26	5.18	6.44	86.7	56.7	0.57
		Aug	2.58	4.22	5.85	89.3	66.7	0.67
		Sep	3.09	3.75	7.24	92.6	68.0	0.62
		All	2.40	3.33	4.79	80.0	52.3	0.47
	MAX	Apr	-1.25	0.75	0.99	41.4	27.6	0.21
		May	-1.02	0.94	1.36	45.2	25.8	0.10
		Jun	-2.86	1.38	1.77	38.1	19.0	0.01
		Jul	-3.60	1.14	1.44	16.7	10.0	-0.04
		Aug	-2.54	1.00	1.26	16.7	6.7	-0.02
		Sep	-0.75	0.95	1.26	37.0	18.5	0.21
		All	-1.58	1.27	1.62	36.4	23.3	0.16
	MEAN	Apr	0.02	1.36	1.78	76.0	51.8	0.41
		May	0.05	1.55	2.09	74.6	45.7	0.37
		Jun	0.04	2.24	3.30	59.2	34.1	0.26
		Jul	0.47	2.19	2.81	61.7	34.9	0.28
		Aug	0.04	1.74	2.46	71.0	46.0	0.37
		Sep	0.46	1.55	2.24	74.7	50.6	0.42
		All	0.18	1.76	2.60	69.7	44.0	0.37

Appendix C - Forecast quality

Monthly minimum, maximum and mean values of quality measures for days 0, 3 and 5.

Units:	**ME**, **MAE**, **RMSE**:	**2MTX**, **2MTN**:	^{o}C
		24HAT:	mm
	HR:		%
	HKSI:		1

2MTX at day 0

			ME	MAE	RMSE	HR 2	HR 4	SS CLI	SS PER	HKSI
		Apr	-2.28	1.28	1.61	42.9	71.4	-0.16	-0.51	-0.06
		May	-2.77	1.37	1.62	23.3	73.3	-0.14	-0.24	-0.04
	M	Jun	-2.47	1.15	1.46	34.6	73.1	-0.19	-0.28	-0.10
	I	Jul	-2.54	0.96	1.16	28.6	78.6	-0.71	-0.65	-0.14
	N	Aug	-2.16	1.27	1.55	32.3	80.6	-0.21	-0.65	-0.04
		Sep	-1.96	0.95	1.19	51.7	82.8	-0.21	-0.52	0.10
		All	-2.01	1.29	1.62	44.3	83.5	-0.09	-0.26	0.10
		Apr	1.18	2.48	3.30	85.7	100.0	0.44	0.25	0.60
		May	1.06	2.86	3.39	80.0	100.0	0.54	0.50	0.52
1	**M**	Jun	0.40	2.79	3.46	88.5	100.0	0.50	0.43	0.45
9	**A**	Jul	-0.21	2.76	3.34	92.9	100.0	0.48	0.48	0.45
9	**X**	Aug	1.13	2.52	2.98	80.6	100.0	0.49	0.27	0.38
7		Sep	0.82	2.06	2.47	93.1	100.0	0.58	0.52	0.58
		All	0.17	2.43	2.97	79.7	98.7	0.46	0.35	0.44
		Apr	-0.69	1.73	2.13	66.7	93.6	0.19	0.04	0.27
	M	May	-0.95	1.93	2.30	57.4	92.3	0.32	0.17	0.19
	E	Jun	-0.97	1.88	2.28	60.6	91.3	0.22	0.15	0.21
	A	Jul	-1.40	1.79	2.11	63.1	94.8	-0.02	-0.08	0.09
	N	Aug	-0.92	1.89	2.24	56.7	93.5	0.24	-0.11	0.18
		Sep	-0.61	1.32	1.71	78.6	96.7	0.37	0.18	0.38
		All	-0.90	1.74	2.15	64.2	93.9	0.25	0.09	0.29
		Apr	-1.60	1.38	1.67	40.0	90.0	0.07	-0.03	-0.01
		May	-2.51	1.50	1.88	40.0	70.0	-0.06	-0.42	-0.04
	M	Jun	-2.68	1.09	1.38	20.0	83.3	-1.28	-1.24	-0.16
	I	Jul	-2.91	1.11	1.31	19.4	87.1	-0.78	-0.48	-0.09
	N	Aug	-3.40	1.05	1.51	6.7	86.7	-1.29	-1.24	-0.20
		Sep	-1.84	1.04	1.18	53.3	90.0	-0.28	-1.08	-0.06
		All	-2.35	1.28	1.63	35.9	89.0	-0.40	-0.53	0.03
		Apr	-0.01	2.20	2.54	73.3	100.0	0.52	0.35	0.34
		May	-0.45	2.70	3.15	73.3	100.0	0.42	0.21	0.27
1	**M**	Jun	-0.64	2.71	3.01	83.3	100.0	0.46	0.54	0.34
9	**A**	Jul	-0.46	2.91	3.04	90.3	100.0	0.47	0.51	0.43
9	**X**	Aug	-0.93	3.40	3.48	83.3	100.0	0.38	0.30	0.44
8		Sep	0.17	1.91	2.30	96.7	100.0	0.45	0.31	0.59
		All	-0.54	2.47	2.77	80.7	98.9	0.41	0.34	0.34
		Apr	-0.73	1.82	2.14	59.0	95.8	0.33	0.15	0.17
	M	May	-1.54	1.98	2.36	54.7	90.6	0.25	0.01	0.12
	E	Jun	-1.60	1.85	2.16	58.0	94.4	-0.04	0.05	0.09
	A	Jul	-1.55	1.82	2.13	57.2	95.9	0.07	0.13	0.08
	N	Aug	-1.94	2.02	2.29	51.1	95.6	-0.21	-0.30	0.04
		Sep	-0.86	1.37	1.66	75.1	98.4	0.23	-0.16	0.20
		All	-1.35	1.81	2.15	58.8	95.2	0.15	0.02	0.17

2MTX at day 3

			ME	MAE	RMSE	HR 2	HR 4	SS CLI	SS PER	HKSI
1997	MIN	Apr	-3.65	1.16	1.44	27.3	63.6	-0.71	-0.18	-0.11
		May	-3.37	1.72	2.19	26.7	56.7	-0.24	0.17	-0.14
		Jun	-2.75	1.49	1.85	33.3	59.3	-0.24	0.01	-0.17
		Jul	-2.71	1.09	1.39	25.0	57.1	-0.83	-0.40	-0.10
		Aug	-2.62	1.78	2.37	23.3	60.0	-0.54	-0.34	-0.13
		Sep	-1.66	1.15	1.52	58.6	86.2	-0.03	-0.09	0.07
		All	-2.29	1.59	2.10	40.0	65.2	-0.26	-0.02	0.11
	MAX	Apr	1.04	3.65	4.65	81.8	100.0	0.50	0.60	0.38
		May	0.97	3.71	4.41	73.3	93.3	0.42	0.56	0.26
		Jun	0.19	3.52	4.40	74.1	100.0	0.29	0.45	0.30
		Jul	-0.10	3.28	3.84	85.7	100.0	0.19	0.47	0.42
		Aug	0.89	3.41	3.90	63.3	96.7	0.29	0.39	0.23
		Sep	0.66	1.92	2.41	86.2	100.0	0.50	0.46	0.49
		All	0.01	3.07	3.81	68.8	94.8	0.22	0.38	0.32
	MEAN	Apr	-1.41	2.20	2.88	58.6	83.9	-0.04	0.26	0.15
		May	-1.06	2.40	2.97	49.5	82.1	0.15	0.41	0.10
		Jun	-1.25	2.39	3.00	52.9	80.1	0.02	0.26	0.11
		Jul	-1.41	2.09	2.56	56.7	85.9	-0.18	0.15	0.10
		Aug	-1.20	2.67	3.16	40.5	76.8	-0.07	0.04	0.02
		Sep	-0.27	1.52	1.99	71.1	94.6	0.29	0.26	0.31
		All	-1.02	2.20	2.79	54.8	84.3	0.06	0.26	0.22
1998	MIN	Apr	-1.78	1.86	2.38	46.7	80.0	0.05	0.09	0.00
		May	-3.21	1.62	2.29	30.0	63.3	-0.36	0.25	-0.08
		Jun	-3.21	1.39	1.81	23.3	70.0	-1.33	-1.39	-0.19
		Jul	-4.01	1.64	2.02	9.7	54.8	-1.46	-0.66	-0.18
		Aug	-4.08	1.53	2.04	13.3	40.0	-1.76	-1.29	-0.17
		Sep	-2.65	1.42	2.01	43.3	80.0	-0.59	-0.38	-0.16
		All	-3.02	1.79	2.31	29.3	68.5	-0.79	-0.36	-0.01
	MAX	Apr	0.38	2.38	3.07	70.0	90.0	0.36	0.45	0.37
		May	-1.24	3.38	4.27	73.3	93.3	0.34	0.66	0.24
		Jun	-0.66	3.36	3.62	76.7	100.0	0.10	0.32	0.22
		Jul	-1.15	4.01	4.30	71.0	96.8	0.30	0.43	0.10
		Aug	-0.96	4.08	4.33	73.3	100.0	0.28	0.41	0.24
		Sep	-0.05	2.65	3.22	80.0	96.7	0.23	0.36	0.42
		All	-0.81	3.15	3.60	66.9	91.7	0.27	0.40	0.22
	MEAN	Apr	-0.71	2.11	2.68	57.3	86.0	0.22	0.29	0.14
		May	-2.12	2.44	3.05	49.7	82.0	0.08	0.46	0.06
		Jun	-1.73	2.32	2.76	49.6	85.3	-0.30	-0.02	0.01
		Jul	-2.24	2.40	2.86	46.0	82.8	-0.22	0.11	-0.02
		Aug	-2.20	2.35	2.77	46.9	84.9	-0.42	-0.15	-0.01
		Sep	-1.33	1.84	2.39	63.1	90.2	-0.04	0.11	0.12
		All	-1.69	2.24	2.78	52.3	85.1	-0.05	0.20	0.11

2MTX at day 5

			ME	MAE	RMSE	HR 2	HR 4	SS CLI	SS PER	HKSI
1997	MIN	Apr	-4.15	1.23	1.59	11.1	44.4	-0.90	-0.02	-0.19
		May	-3.45	2.42	3.20	23.3	53.3	-0.50	0.07	-0.21
		Jun	-3.77	2.08	2.72	20.0	52.0	-0.80	-0.13	-0.08
		Jul	-3.20	1.23	1.54	25.9	55.6	-1.17	-0.29	-0.10
		Aug	-2.59	2.24	2.78	10.7	32.1	-0.76	-0.36	-0.13
		Sep	-1.26	1.25	1.58	46.4	82.1	-0.19	0.08	-0.02
		All	-2.37	2.08	2.75	32.0	59.9	-0.51	-0.03	0.07
	MAX	Apr	-0.06	4.18	5.14	88.9	100.0	0.45	0.64	0.26
		May	0.76	4.01	4.55	53.3	83.3	0.10	0.45	0.13
		Jun	-0.48	4.76	6.19	60.0	84.0	-0.17	0.27	0.25
		Jul	0.04	3.37	4.16	85.2	100.0	0.03	0.43	0.25
		Aug	0.94	4.65	5.03	57.1	82.1	0.04	0.34	0.22
		Sep	1.71	2.46	3.22	78.6	100.0	0.41	0.54	0.41
		All	-0.07	3.62	4.55	57.5	86.4	-0.04	0.32	0.25
	MEAN	Apr	-2.03	2.61	3.14	46.5	78.6	-0.24	0.33	0.04
		May	-1.44	3.10	3.75	35.6	69.3	-0.10	0.31	-0.02
		Jun	-2.07	3.43	4.44	41.3	66.0	-0.41	0.09	0.07
		Jul	-1.72	2.22	2.75	55.3	82.1	-0.25	0.25	0.08
		Aug	-1.16	3.38	3.98	30.3	62.6	-0.34	-0.01	0.01
		Sep	0.53	1.80	2.28	63.8	91.7	0.16	0.30	0.19
		All	-1.16	2.75	3.51	45.6	75.0	-0.18	0.21	0.16
1998	MIN	Apr	-2.27	1.67	2.13	46.7	80.0	-0.21	-0.12	-0.10
		May	-3.56	2.30	2.68	30.0	63.3	-0.46	0.04	-0.15
		Jun	-2.59	1.53	1.95	23.3	70.0	-1.04	-0.22	-0.12
		Jul	-3.44	1.66	1.93	9.7	54.8	-1.11	-0.31	-0.14
		Aug	-4.15	2.26	2.89	13.3	40.0	-1.73	-1.20	-0.22
		Sep	-2.44	1.83	2.11	43.3	80.0	-0.76	-0.48	-0.13
		All	-2.81	2.16	2.67	29.3	68.5	-0.69	-0.28	-0.01
	MAX	Apr	0.23	3.20	3.92	70.0	90.0	0.39	0.46	0.26
		May	-1.26	4.18	5.11	73.3	93.3	0.12	0.47	0.19
		Jun	0.30	2.94	3.62	76.7	100.0	0.04	0.30	0.23
		Jul	-0.90	3.44	3.89	71.0	96.8	0.21	0.46	0.20
		Aug	-1.17	4.16	4.67	73.3	100.0	-0.18	0.18	0.07
		Sep	-0.05	2.67	3.25	80.0	96.7	0.04	0.16	0.12
		All	-0.64	3.15	3.75	66.9	91.7	0.07	0.32	0.14
	MEAN	Apr	-1.03	2.39	2.97	57.3	86.0	0.13	0.14	0.05
		May	-2.38	3.05	3.62	49.7	82.0	-0.15	0.30	-0.02
		Jun	-1.05	2.30	2.79	49.6	85.3	-0.27	0.13	0.05
		Jul	-2.09	2.40	2.91	46.0	82.8	-0.22	0.20	0.01
		Aug	-2.47	2.97	3.53	46.9	84.9	-0.77	-0.32	-0.06
		Sep	-1.28	2.17	2.60	63.1	90.2	-0.22	-0.09	-0.01
		All	-1.70	2.57	3.14	52.3	85.1	-0.19	0.11	0.06

2MTN at day 0

			ME	MAE	RMSE	HR 2	HR 4	SS CLI	SS PER	HKSI
1997	MIN	Apr	-0.17	0.82	1.00	42.9	78.6	0.05	-0.24	0.02
		May	-0.39	1.05	1.46	40.0	80.0	-0.04	-0.10	-0.02
		Jun	-0.73	1.30	1.62	50.0	73.1	-0.02	-0.01	0.00
		Jul	-1.00	1.17	1.42	42.9	67.9	-0.65	-0.45	-0.07
		Aug	-1.71	1.06	1.21	35.5	58.1	-0.50	-0.31	-0.07
		Sep	0.27	1.32	1.76	34.5	65.5	-0.12	-0.33	0.04
		All	-0.66	1.31	1.66	45.6	73.4	-0.05	-0.08	0.16
	MAX	Apr	2.34	2.44	3.23	100.0	100.0	0.63	0.61	0.58
		May	2.53	2.83	3.44	83.3	100.0	0.40	0.38	0.45
		Jun	1.88	2.60	3.51	84.6	100.0	0.34	0.44	0.36
		Jul	2.64	2.81	3.63	82.1	100.0	0.24	0.45	0.35
		Aug	3.10	3.24	3.81	93.5	100.0	0.34	0.37	0.36
		Sep	3.17	3.39	4.01	75.9	100.0	0.49	0.46	0.46
		All	2.55	2.81	3.55	79.7	98.1	0.34	0.40	0.42
	MEAN	Apr	0.80	1.53	1.95	70.7	94.7	0.37	0.38	0.29
		May	0.95	1.59	2.05	68.9	93.3	0.18	0.20	0.26
		Jun	0.61	1.85	2.42	65.5	90.3	0.18	0.24	0.16
		Jul	1.12	1.79	2.23	64.3	91.3	-0.08	0.01	0.11
		Aug	0.90	1.85	2.23	64.5	89.5	0.01	0.02	0.13
		Sep	1.50	1.95	2.46	62.2	87.8	0.30	0.19	0.23
		All	1.01	1.79	2.28	65.2	90.7	0.18	0.17	0.28
1998	MIN	Apr	0.08	1.08	1.41	53.3	86.7	0.26	-0.64	0.11
		May	-0.23	0.90	1.19	63.3	83.3	0.18	-0.33	0.11
		Jun	-0.88	1.24	1.47	60.0	86.7	-0.11	-0.01	0.05
		Jul	-1.26	0.88	1.10	67.7	93.5	0.07	0.01	0.06
		Aug	-1.25	1.10	1.35	63.3	93.3	-0.19	-0.32	-0.06
		Sep	-1.44	0.97	1.23	53.3	93.3	-0.06	-0.18	-0.08
		All	-0.48	1.13	1.46	65.2	89.5	0.15	-0.01	0.21
	MAX	Apr	1.63	1.84	2.30	83.3	100.0	0.52	0.31	0.42
		May	1.76	2.05	2.63	93.3	100.0	0.57	0.43	0.55
		Jun	1.16	1.79	2.38	90.0	100.0	0.34	0.49	0.39
		Jul	1.11	1.59	2.17	96.8	100.0	0.45	0.52	0.50
		Aug	1.37	1.71	2.37	90.0	100.0	0.42	0.43	0.38
		Sep	0.79	1.93	2.22	90.0	100.0	0.52	0.36	0.48
		All	1.12	1.74	2.34	85.6	100.0	0.40	0.35	0.41
	MEAN	Apr	0.66	1.46	1.84	72.1	96.5	0.39	0.03	0.26
		May	0.37	1.31	1.67	79.9	97.1	0.35	0.25	0.33
		Jun	-0.05	1.43	1.80	75.0	96.4	0.15	0.30	0.18
		Jul	-0.18	1.15	1.45	86.9	98.4	0.23	0.32	0.22
		Aug	-0.37	1.36	1.68	77.8	98.7	0.23	0.20	0.19
		Sep	-0.41	1.32	1.66	78.0	97.8	0.28	0.15	0.24
		All	0.01	1.34	1.70	78.1	97.6	0.30	0.22	0.29

2MTN at day 3

			ME	MAE	RMSE	HR 2	HR 4	SS CLI	SS PER	HKSI
1997	MIN	Apr	-0.16	0.83	1.04	36.4	72.7	0.08	0.25	-0.13
		May	-1.21	1.37	1.71	46.7	73.3	-0.20	0.17	-0.04
		Jun	-1.62	1.34	1.78	40.7	81.5	-0.08	0.27	0.00
		Jul	-1.09	0.98	1.21	39.3	60.7	-0.47	-0.24	-0.16
		Aug	-2.31	1.17	1.46	36.7	70.0	-0.38	-0.22	-0.10
		Sep	1.25	1.67	2.15	34.5	58.6	-0.26	-0.16	-0.06
		All	-0.92	1.56	1.98	45.8	73.5	-0.08	0.18	0.09
	MAX	Apr	2.39	2.80	3.47	90.9	100.0	0.56	0.64	0.44
		May	1.74	2.84	3.63	76.7	100.0	0.15	0.41	0.28
		Jun	1.09	2.42	3.27	74.1	96.3	0.42	0.54	0.31
		Jul	2.79	3.06	3.74	89.3	100.0	0.27	0.50	0.31
		Aug	2.63	2.86	3.38	80.0	100.0	0.19	0.39	0.25
		Sep	3.54	3.79	4.74	69.0	96.6	0.36	0.22	0.29
		All	2.28	2.88	3.71	69.7	94.8	0.17	0.36	0.31
	MEAN	Apr	0.64	1.64	1.98	68.4	94.4	0.33	0.49	0.15
		May	0.24	1.93	2.45	60.5	89.1	0.01	0.32	0.08
		Jun	-0.16	1.89	2.41	60.0	91.0	0.15	0.42	0.13
		Jul	1.01	1.89	2.30	62.1	91.1	-0.13	0.11	0.03
		Aug	0.39	1.95	2.36	55.8	89.5	-0.06	0.19	0.09
		Sep	2.28	2.58	3.19	48.4	77.1	0.07	-0.01	0.11
		All	0.75	2.03	2.56	57.7	87.7	0.06	0.25	0.20
1998	MIN	Apr	-0.24	1.10	1.33	46.7	80.0	0.03	0.14	-0.04
		May	-0.88	1.10	1.37	46.7	76.7	-0.07	0.20	-0.04
		Jun	-1.49	1.00	1.37	50.0	86.7	-0.41	0.02	-0.07
		Jul	-1.69	1.03	1.24	51.6	90.3	-0.53	-0.17	-0.09
		Aug	-1.70	1.29	1.59	46.7	83.3	-0.40	-0.27	-0.03
		Sep	-1.33	1.20	1.44	33.3	73.3	-0.28	0.02	-0.14
		All	-1.14	1.32	1.68	53.0	85.6	-0.15	0.09	0.08
	MAX	Apr	1.00	2.39	2.88	90.0	100.0	0.49	0.48	0.44
		May	1.23	2.52	3.04	83.3	100.0	0.25	0.51	0.46
		Jun	0.59	2.09	2.80	86.7	100.0	0.24	0.46	0.42
		Jul	-0.07	1.84	2.20	93.5	100.0	0.30	0.57	0.28
		Aug	0.36	2.23	2.73	80.0	100.0	0.18	0.44	0.19
		Sep	0.07	2.70	3.13	90.0	100.0	0.17	0.40	0.22
		All	0.45	2.12	2.71	77.9	98.9	0.19	0.37	0.30
	MEAN	Apr	0.32	1.68	2.06	67.1	94.4	0.30	0.35	0.17
		May	0.01	1.88	2.30	60.2	91.7	0.09	0.34	0.13
		Jun	-0.22	1.66	2.10	67.0	94.4	0.02	0.34	0.11
		Jul	-0.70	1.38	1.70	76.0	97.5	0.05	0.35	0.11
		Aug	-0.86	1.84	2.23	58.2	94.2	-0.03	0.12	0.06
		Sep	-0.59	1.90	2.28	59.1	93.1	-0.01	0.24	0.04
		All	-0.31	1.72	2.14	64.7	94.2	0.10	0.30	0.18

2MTN at day 5

			ME	MAE	RMSE	HR 2	HR 4	SS CLI	SS PER	HKSI
		Apr	-1.71	1.01	1.17	11.1	77.8	-0.21	-0.07	-0.33
		May	-1.37	1.30	1.72	43.3	76.7	-0.22	0.19	-0.12
	M	Jun	-1.92	1.64	2.02	40.0	68.0	-0.19	-0.07	-0.07
	I	Jul	-1.68	0.88	1.18	33.3	70.4	-0.59	-0.11	-0.17
	N	Aug	-2.30	1.26	1.69	32.1	60.7	-0.72	-0.44	-0.15
		Sep	1.61	2.18	2.67	25.0	53.6	-0.50	-0.32	-0.11
		All	-1.12	1.71	2.19	40.8	70.1	-0.23	0.03	0.08
		Apr	1.01	3.02	3.44	88.9	100.0	0.48	0.62	0.29
1		May	1.58	2.60	3.29	86.7	100.0	0.19	0.50	0.38
9	M	Jun	0.72	2.78	3.75	76.0	96.0	0.08	0.32	0.29
9	A	Jul	2.29	2.89	3.79	85.2	100.0	0.17	0.39	0.46
7	X	Aug	2.36	3.19	3.65	78.6	96.4	0.25	0.47	0.19
		Sep	3.90	4.23	5.03	46.4	89.3	0.08	0.12	0.11
		All	1.98	2.93	3.75	68.7	92.5	0.06	0.27	0.28
		Apr	-0.79	1.99	2.29	51.6	94.2	0.18	0.33	0.04
	M	May	0.03	1.89	2.33	60.2	91.8	0.02	0.38	0.06
	E	Jun	-0.53	2.30	2.91	53.8	82.3	-0.02	0.15	0.11
	A	Jul	0.52	2.01	2.47	59.5	89.1	-0.21	0.10	0.02
	N	Aug	0.17	2.10	2.58	54.9	85.5	-0.15	0.19	0.05
		Sep	2.77	3.21	3.89	36.7	68.7	-0.16	-0.05	0.00
		All	0.53	2.29	2.89	52.9	84.0	-0.06	0.18	0.16
		Apr	-0.93	1.83	2.16	46.7	80.0	0.00	0.01	-0.09
		May	-1.27	1.18	1.44	46.7	76.7	-0.22	0.15	-0.13
	M	Jun	-1.32	1.49	1.79	50.0	86.7	-0.48	-0.06	-0.15
	I	Jul	-2.19	1.22	1.63	51.6	90.3	-0.89	-0.36	-0.16
	N	Aug	-1.82	1.34	1.73	46.7	83.3	-0.69	-0.35	-0.16
		Sep	-1.65	0.95	1.20	33.3	73.3	-0.29	0.23	-0.12
		All	-1.32	1.48	1.81	53.0	85.6	-0.22	0.12	0.08
		Apr	0.83	2.55	3.04	90.0	100.0	0.19	0.32	0.14
1		May	0.79	2.65	3.04	83.3	100.0	0.31	0.51	0.39
9	M	Jun	0.74	2.35	3.08	86.7	100.0	0.09	0.38	0.35
9	A	Jul	-0.44	2.27	2.53	93.5	100.0	0.24	0.46	0.27
8	X	Aug	0.00	2.44	2.86	80.0	100.0	0.12	0.30	0.16
		Sep	-0.19	2.44	2.89	90.0	100.0	0.32	0.58	0.30
		All	0.24	2.23	2.75	77.9	98.9	0.11	0.35	0.25
		Apr	-0.08	2.17	2.60	67.1	94.4	0.10	0.21	0.04
	M	May	-0.24	2.02	2.39	60.2	91.7	0.01	0.31	0.04
	E	Jun	-0.19	1.86	2.30	67.0	94.4	-0.10	0.17	0.06
	A	Jul	-1.14	1.64	2.00	76.0	97.5	-0.13	0.17	0.09
	N	Aug	-1.02	1.98	2.39	58.2	94.2	-0.11	0.03	0.03
		Sep	-0.81	1.72	2.08	59.1	93.1	0.09	0.45	0.09
		All	-0.56	1.91	2.33	64.7	94.2	0.00	0.25	0.14

24HAT at day 0

			ME	MAE	RMSE	HR	SS CLI	SS PER	HKSI
		Apr	-1.26	0.51	0.95	42.9	-0.07	0.29	0.15
		May	-0.89	1.29	2.55	33.3	0.01	0.14	0.12
	M	Jun	-0.72	0.89	2.89	43.3	-0.63	-0.67	0.19
	I	Jul	-2.39	0.82	1.63	41.9	-0.20	-0.53	0.13
	N	Aug	-1.24	0.53	1.55	58.1	-0.13	-0.28	-0.11
		Sep	-2.83	0.98	1.70	23.3	-2.90	-2.42	0.01
		All	-1.00	1.40	3.12	47.6	0.04	0.11	0.29
		Apr	0.85	1.51	3.08	85.7	0.66	0.77	0.82
1		May	1.12	2.87	5.22	60.0	0.52	0.61	0.53
9	M	Jun	2.79	3.77	8.09	66.7	0.41	0.47	0.50
9	A	Jul	1.16	3.52	9.96	71.0	0.47	0.49	0.43
7	X	Aug	0.86	3.35	10.74	77.4	0.69	0.71	0.60
		Sep	2.51	3.72	8.50	56.7	0.43	0.40	0.39
		All	0.86	2.25	6.13	58.4	0.31	0.40	0.42
		Apr	-0.21	0.92	1.85	64.3	0.47	0.61	0.49
	M	May	0.30	1.98	3.80	52.3	0.29	0.41	0.38
	E	Jun	0.62	2.27	4.76	54.6	0.09	0.04	0.35
	A	Jul	-0.32	2.12	4.76	56.9	0.18	0.13	0.31
	N	Aug	-0.09	1.69	4.68	65.0	0.30	0.36	0.39
		Sep	0.71	1.83	3.51	42.5	-0.42	-0.42	0.24
		All	0.20	1.89	4.45	54.9	0.21	0.27	0.36
		Apr	-0.26	1.29	1.80	23.3	-0.99	-0.47	0.04
		May	-0.56	0.57	1.07	38.7	-1.68	-1.46	0.00
	M	Jun	-1.20	1.53	2.73	30.0	-0.14	-1.22	0.13
	I	Jul	-1.75	1.65	2.65	22.6	-0.22	-0.09	-0.03
	N	Aug	-1.05	1.37	2.31	16.1	-0.57	-0.62	-0.06
		Sep	-0.97	1.17	2.46	17.4	-0.17	-0.34	0.01
		All	0.05	1.61	2.83	35.2	0.01	0.04	0.16
		Apr	2.73	3.80	6.82	46.7	0.43	0.53	0.29
1		May	1.62	2.27	4.63	67.7	0.44	0.48	0.52
9	M	Jun	1.90	3.69	8.14	56.7	0.55	0.58	0.43
9	A	Jul	1.05	4.22	9.26	54.8	0.52	0.57	0.40
8	X	Aug	1.93	2.99	6.91	48.4	0.50	0.53	0.33
		Sep	1.19	3.92	8.83	46.4	0.58	0.47	0.40
		All	1.29	2.62	5.38	44.5	0.31	0.42	0.29
		Apr	1.38	2.57	3.87	35.5	0.06	0.23	0.18
	M	May	0.29	1.29	2.52	54.8	-0.13	-0.05	0.26
	E	Jun	0.80	2.60	4.69	48.1	0.15	0.13	0.32
	A	Jul	0.13	2.41	4.23	35.1	0.17	0.33	0.15
	N	Aug	0.60	2.00	3.55	36.7	0.07	0.12	0.19
		Sep	0.56	1.98	4.04	34.5	0.21	0.13	0.21
		All	0.63	2.14	4.04	40.9	0.16	0.23	0.23

24HAT at day 3

			ME	MAE	RMSE	HR	SS CLI	SS PER	HKSI
1997	MIN	Apr	-1.06	1.04	1.56	18.2	-0.86	-1.61	-0.07
		May	-0.42	2.03	3.56	23.3	-0.53	-0.14	-0.07
		Jun	0.05	2.21	3.59	30.0	-1.89	-1.42	-0.02
		Jul	-2.30	1.01	2.29	41.4	-0.76	-0.20	-0.02
		Aug	-1.53	1.38	2.97	45.2	-1.18	-0.42	-0.13
		Sep	-2.08	1.25	2.18	20.0	-5.49	-2.04	-0.09
		All	-0.24	2.01	4.23	38.5	-0.27	-0.06	0.09
	MAX	Apr	1.90	4.58	6.61	72.7	0.19	0.52	0.68
		May	2.06	4.15	6.87	50.0	0.31	0.52	0.34
		Jun	3.00	4.34	7.39	56.7	0.18	0.13	0.45
		Jul	1.03	3.97	10.08	75.9	0.49	0.52	0.52
		Aug	1.28	3.47	12.10	71.0	0.47	0.44	0.61
		Sep	4.59	5.66	9.96	56.7	0.38	0.48	0.40
		All	1.08	3.07	7.67	52.8	0.06	0.22	0.29
	MEAN	Apr	0.20	2.54	4.13	39.3	-0.42	-0.17	0.26
		May	0.83	2.99	5.33	36.7	-0.09	0.19	0.13
		Jun	1.35	3.09	5.30	43.9	-0.27	-0.22	0.24
		Jul	-0.78	2.17	4.94	54.8	0.14	0.27	0.23
		Aug	-0.02	2.31	6.01	58.4	0.01	0.11	0.22
		Sep	1.61	2.63	5.46	34.6	-1.11	-0.39	0.14
		All	0.57	2.64	5.63	45.0	-0.11	0.09	0.21
1998	MIN	Apr	0.33	2.47	4.23	16.7	-1.31	-0.87	-0.06
		May	-0.70	0.80	1.84	30.0	-2.02	-0.71	-0.19
		Jun	-1.80	2.50	4.05	20.0	-0.62	-0.49	-0.07
		Jul	-0.65	2.92	4.59	19.4	-1.01	-0.42	-0.05
		Aug	-1.75	1.75	3.67	28.6	-0.57	-0.16	-0.02
		Sep	1.02	3.49	5.49	6.9	-3.42	-3.44	-0.14
		All	0.30	2.84	4.80	25.6	-0.63	-0.24	0.03
	MAX	Apr	2.62	4.39	6.95	46.7	0.25	0.39	0.30
		May	1.41	2.14	5.31	70.0	0.37	0.50	0.56
		Jun	1.29	4.96	9.72	50.0	0.14	0.32	0.28
		Jul	3.01	6.03	11.20	32.3	0.09	0.27	0.18
		Aug	1.52	3.97	9.50	46.7	0.21	0.53	0.26
		Sep	4.17	6.80	11.89	39.3	-0.11	-0.01	0.30
		All	1.70	3.74	7.15	39.1	-0.08	0.14	0.19
	MEAN	Apr	1.51	3.53	5.49	30.8	-0.29	-0.10	0.10
		May	0.19	1.38	2.83	51.7	-0.25	0.13	0.20
		Jun	-0.09	3.51	6.04	32.3	-0.15	-0.05	0.06
		Jul	1.49	4.10	6.67	24.7	-0.44	-0.07	0.05
		Aug	0.05	2.51	5.16	35.9	-0.12	0.25	0.12
		Sep	2.85	4.34	7.60	20.1	-0.86	-0.76	0.05
		All	0.99	3.22	5.95	32.6	-0.28	-0.03	0.11

24HAT at day 5

			ME	MAE	RMSE	HR	SS CLI	SS PER	HKSI
1997	MIN	Apr	-2.89	1.05	1.55	11.1	-1.00	0.05	-0.15
		May	-1.38	1.68	3.07	20.0	-0.49	-0.33	-0.13
		Jun	-1.22	1.05	1.74	34.5	-0.53	-0.69	-0.05
		Jul	-2.88	0.74	1.59	27.6	-0.42	-0.24	-0.08
		Aug	-0.44	2.19	5.26	30.0	-1.35	-0.58	-0.18
		Sep	-2.84	0.93	1.50	23.3	-4.54	-0.51	-0.13
		All	-1.01	2.04	4.55	32.7	-0.44	-0.12	0.04
	MAX	Apr	-0.32	4.51	7.26	44.4	-0.05	0.50	0.29
		May	0.41	3.65	5.95	53.3	0.33	0.37	0.38
		Jun	1.99	4.06	7.62	58.6	0.22	0.19	0.34
		Jul	0.50	6.77	11.22	72.4	0.32	0.54	0.44
		Aug	2.21	4.82	13.65	70.0	0.27	0.23	0.56
		Sep	3.94	5.84	9.69	63.3	0.32	0.53	0.51
		All	0.81	3.48	7.39	52.2	0.06	0.30	0.23
	MEAN	Apr	-1.34	2.57	4.17	24.7	-0.45	0.34	0.03
		May	-0.47	2.74	4.73	34.6	0.01	-0.07	0.05
		Jun	0.20	2.82	5.24	44.5	-0.10	-0.22	0.18
		Jul	-1.01	2.51	5.39	46.8	0.07	0.24	0.08
		Aug	0.80	3.01	7.14	47.9	-0.30	-0.02	0.10
		Sep	0.98	2.37	4.25	42.7	-0.81	0.17	0.23
		All	0.02	2.68	5.62	42.0	-0.13	0.09	0.13
1998	MIN	Apr	-0.81	2.16	3.40	16.7	-0.87	-0.33	-0.24
		May	-0.35	0.65	1.05	30.0	-1.09	-0.47	-0.22
		Jun	-2.12	2.01	3.62	20.0	-0.41	-0.34	-0.15
		Jul	-0.08	3.44	5.50	19.4	-1.35	-0.53	-0.12
		Aug	-1.11	2.90	4.44	28.6	-1.48	-0.74	-0.23
		Sep	1.25	2.79	3.96	6.9	-2.63	-2.04	-0.09
		All	0.04	2.86	5.01	25.6	-0.74	-0.34	-0.03
	MAX	Apr	1.39	4.60	7.66	46.7	0.16	0.36	0.17
		May	1.18	2.62	5.12	70.0	0.50	0.35	0.40
		Jun	0.53	4.67	10.33	50.0	0.19	0.20	0.26
		Jul	2.68	7.39	11.97	32.3	0.00	0.25	0.14
		Aug	2.01	5.38	10.38	46.7	-0.03	0.29	0.17
		Sep	4.35	5.53	8.81	39.3	0.03	0.27	0.30
		All	1.34	4.07	7.18	39.1	-0.04	0.18	0.11
	MEAN	Apr	0.10	3.27	5.45	30.8	-0.18	0.06	0.02
		May	0.30	1.48	2.66	51.7	-0.30	-0.01	0.11
		Jun	-0.78	3.16	5.56	32.3	-0.02	-0.01	0.05
		Jul	1.32	4.71	7.28	24.7	-0.65	-0.10	0.03
		Aug	0.85	3.74	6.28	35.9	-0.72	-0.15	-0.06
		Sep	2.80	3.82	6.05	20.1	-0.63	-0.32	0.10
		All	0.75	3.35	5.84	32.6	-0.34	-0.05	0.05