

WORLD METEOROLOGICAL ORGANIZATION

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**COMPOSITE OBSERVING SYSTEM FOR THE
NORTH ATLANTIC (COSNA)**

SCIENTIFIC EVALUATION GROUP (SEG)

TWELFTH SESSION

ECMWF, READING, UK, 21-22 MAY 2002



FINAL REPORT

DISCLAIMER

WMO General Regulations 42 and 43

Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case if a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent, and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

EXECUTIVE SUMMARY

The twelfth COSNA Scientific Evaluation Group (SEG) meeting was held in at the ECMWF in Reading, UK from 21 to 22 May 2002. The major issues reviewed by the meeting were: COSNA observing systems and monitoring activities, EUCOS studies and field experiments, impact studies carried out by ECMWF, DWD, the Met Office, HIRLAM, METEO-FRANCE, NCEP and future CGC and SEG. In summarizing the monitoring results, the meeting noted with appreciation that the observational data available in the COSNA area in general continued to be of high quality. The meeting addressed the performance of some new and emerging systems.

- (i) The European profilers provide in general good data at high temporal resolution but require careful quality monitoring for use in NWP. Information on any change in the system characteristics at each platform is required by the users.
- (ii) The aerosonde demonstration in March 2002 off the Iberian Peninsula was troubled by poor weather conditions, was limited in time (less than two weeks) and provided little data for impact studies.
- (iii) A further increase in the availability of AMDAR data was noted. The observations are in general of good quality, but a conflict in the temperature bias between the radiosondes and the AMDAR profiles was reported. Data from the humidity sensors are expected to become available later in 2003.
- (iv) The operators of observing systems and organisers of field experiments need to ensure that the information on data availability is passed to the users (examples are the US winter storm programme, the aerosonde demonstration, the introduction of new ASAP units.)
- (v) Information on data quality should be made more readily accessible to the users. It was suggested to use the Internet for the exchange of such information.

The meeting was informed on the results of the current impact studies. Plans for the future studies were also presented. It noted that financial constraints and the emergence of new technologies require and justify a careful re-design of the regional and global observing systems. In particular the high quality observations from aircrafts should together with the radiosonde network provide a well-balanced surface based observing system for vertical atmospheric profiles. New technologies also provide the means for taking observations on request, i.e. for observation targeting. It, therefore, reiterated that future impact studies and the coordination of these studies will be important to allow the managers of observing systems to design their networks in an optimal way. Another challenge for data impact studies will be the exploitation of new satellite data like SCAT winds and future systems, e.g. WINDSCAT/CORIOLIS and others. The meeting was also updated on the current status of activities to merge the CGC and SEG with EUCOS. It noted that the global aspect of the SEG may find a new home under the umbrella of WMO/CBS and appropriate proposals will be discussed during the upcoming session of CBS-Ext. in December 2002.

1. ORGANIZATION OF THE MEETING

1.1 Opening of the session

The session was opened at 1000 hrs on Monday, 21 May 2002 at the European Centre for Medium Range Weather Forecasts (ECMWF), Reading, UK, by Dr David Burridge, the Director of ECMWF. He welcomed participants and underlined the major goals of SEG which was created as an interest group of NWP centres focussing on data impact studies and providing them with an informal forum for exchanging ideas and comparing notes on the use of data from developing and new observing systems in NWP. This group has very much retained its informal character and has produced over the years many results in its field including organisation of two well-known workshops on data impact studies. He recalled that there are now concrete plans to merge the CGC and SEG activities with EUCOS while the global aspect of the SEG may find a new home under the umbrella of WMO/CBS. It is highly desirable that the work of the SEG continues. Financial constraints and the emergence of new technologies require and justify a careful re-design of the regional and global observing systems. In particular the high quality observations from aircrafts should together with the radiosonde network provide a well-balanced surface based observing system for vertical atmospheric profiles. New technologies also provide the means for taking observations on request, i.e. for observation targeting. Future impact studies and the coordination of these studies will be important to allow the managers of observing systems to design their networks in an optimal way. Another challenge for data impact studies will be the exploitation of new satellite data like SCAT winds and future systems, e.g. WINDSCAT/CORIOLIS. Following the recent launch of AIRS, ECMWF together with other NWP centres will work on the use of these data together with information from Aqua and the next DMSP satellites which have and will carry additional AMSU type instruments.

In conclusion he wished participants every success in the deliberations of the meeting.

1.2 Adoption of the agenda

The agenda for the meeting as adopted, together with the list of participants, are given as Annex I and II respectively.

1.3 Working arrangements

The session agreed on the working hours and noted that the report would be compiled and produced by the WMO Secretariat after the meeting.

2. REPORT OF THE CHAIRMAN

The chairman of SEG, Dr Horst Böttger gave a brief summary of the activities relating to the work of the SEG since its last session (May, 2001). In particular these included participation in a meeting of the CBS Expert Team on Observational Data Requirements and Redesign of the GOS (ET-ODRRGOS), Geneva, 28 January - 1 February 2002 attended also by representatives of EUCOS and NAOS. The meeting stressed the importance of observational data impact studies to be carried out at the regional and global level and made suggestions for future studies, including in particular, the determination of the appropriate balance between conventional radiosonde observations and AMDAR, and the development of observation targeting strategies. The Expert Team noted that efficient and timely exchange of information on NWP studies is imperative for the evolution of the GOS and recommended that this be facilitated by the convening of regular workshops.

The liaison has been maintained with EUCOS which had become operational in January 2002 and is now managed by the Met Office. EUCOS conducted a demonstration of Aerosonde flights out of Portugal in March from which data were made available on the GTS. Some related impact studies may be carried out this year.

SEG chair also participated in the CGC-XII (Hamburg, 29-31 August 2001) and CGC Management Group meeting, which was held in Geneva in March 2002, where in particular the plans

for the future of CGC and SEG were discussed. The Group re-iterated the view of the CGC that, following the closure of CGC and the SEG, it would be desirable for the activities of the SEG to be carried out within the framework of CBS. It was noted with appreciation that the ET-ODRRGOS had indicated that it was prepared to take on the task of Impact Study monitoring, promotion and coordination. In this respect the Expert Team had stressed the importance of regularly held workshops and had set up an ad hoc organising committee for the next such workshop to be held in 2003 or 2004. The Group was also informed that a proposal be submitted by the WMO Secretariat via RA-VI to CBS to take over the SEG activities. Specific proposals to that extent will be submitted to CGC-XIII by the CGC Chairman.

3. COSNA OBSERVING SYSTEMS AND MONITORING ACTIVITIES

3.1 The 2001 consolidated monitoring report

The chairman of SEG informed the meeting that the 2001 consolidated monitoring report was prepared by Mr Bernd Richter (Germany) and presented at the twelfth session of CGC (Hamburg, 29 - 31 August 2001). CGC noted that observational data available from the North Atlantic area continued to be generally of high quality. Their availability, however, was variable due to routine operational and /or telecommunication problems and the natural variability of mobile platforms such as ships and aircraft actually operating in the region. The detailed conclusions from the review are contained in CGC-XII final report which available on the WMO Web at: <http://www.wmo.ch/web/www/OSY/reports/CGC-XII-final-report.pdf> Finally, the SEG suggested to task Mr Bernd Richter to prepare the consolidated monitoring report for the year 2002 comprising essential COSNA components with particular emphasis on drifting buoys, E-ASAP and E-AMDAR performance.

3.2 Review of Monitoring Results

A summary of the monitoring results related to COSNA as presented at the meeting by ECMWF, the Met Office and Météo-France is given below.

3.2.1 ECMWF

Mr Garcia-Mendez presented a summary of ECMWF monitoring statistics.

COSNA Monitoring at ECMWF

- Surface data
 - ✓ The problem of the height catalogue: Two examples shown comparing monitoring results from ECMWF and the Met Office. The examples show how different the height catalogue can be in some occasions.
 - ✓ The main problem with the Synop data is related to the pressure biased stations. That is the case also for Drifters and Ships
 - ✓ Problems related to the Drifters are
 - Wrong positions. Normally the wrong positions show up in the statistics as gross errors
 - Sudden deterioration
- Sondes
 - ✓ The number of reports received from the COSNA area is similar to the previous year at 00 and 12 UTC and reduced at 18 UTC.
 - ✓ No relevant problems related to the quality of observations
 - ✓ ASAP number of reports is still showing a decreasing trend in the last two years.
 - ✓ The quality of ASAP data has continued to be good and is fully comparable to land-based stations

□ Aircrafts

- ✓ Since the end of January 2002 the percentage of used data has increase from 35 to 65% (Amdar) and from 40 to 75% (Acars)
- ✓ The quality of observations has continued to be good
- ✓ The so-called -9 degrees problem with Acars is still there. 55 Acars are always reporting always -9 C. All of them are in the blacklist.
- ✓ The number of used ascent and descent observations from E_AMDAR has increased dramatically at Frankfurt and Heathrow compared to one year ago. The data quality looks better also.

□ AMV

- ✓ ECMWF has continued providing monthly statistics to the Met Office SAF web site. Apart from the density plots with statistics stratified in NH, Tropics and SH and coloured charts showing the speed bias and std for different channels and layers ECMWF is now providing charts for the vector difference rms and normalized VRMS with respect to the observed wind speed

3.2.2 The Met Office

Dr Bruce Macpherson presented a review of monitoring activities carried out by the Met Office.

Marine data

From the UK Met Office's latest 6-monthly Marine Monitoring Report for WMO (July-December 2001). The number of marine surface pressure reports increased slightly to 1,943,000 (or ~10,700 per day); the reports coming from 6421 ships, 658 drifting buoys and 653 automatic platforms (e.g. moored buoys). The number of "suspect" marine platforms for pressure remained similar to the previous year at 125; with 133 reporting suspect winds and 145 reporting suspect SSTs.

The number of drifting buoys reporting in the COSNA area (10N-80N, 0W-85W) has remained fairly steady over the last year, although there have been a large number of buoy failures and buoys ashore recently, resulting in only 74 buoys reporting more than one pressure observation in April 2002, compared to 87 in April 2001; and the number of buoys reporting both wind speed and direction dropped slightly from 24 to 22. The quality of the UK marine data remained high. In March 2002, only 1.5% of pressure reports from the 25 UK drifting buoys were rejected.

Sonde data

The number of ASAP ships reporting in the COSNA area increased slightly to 13 in April 2002, although the total number of observations of temperatures/winds at 500 hPa fell slightly, to 241/223 in April 2002, from 286/263 in April 2001. There were more reports during September and October 2001 during the E-ASAP trial, in which 12 ASAP ships took part - the maximum number was 349 temperatures (and 304 winds) in October.

Since August 1999, the winds received from Sal Island, Cape Verde (08594) have shown a 10 degree direction bias against the Met Office Global Model and they remain on our reject list.

Recent changes to the UK sonde station network:

Upper air observations from Boulmer (03240) ceased on 14 February 2002, but a new station at Albermarle (03238) began reporting on 1 March 2002. Upper Air observations from Woodvale (03317) ceased on 18 February 2002. From 1 April 2002, the main UK sonde network (7 stations) stopped doing soundings at 18Z (to reduce costs) - all now report at 00Z, 06Z and 12Z. There continue to be occasional ascents from the 'supplementary' network. In all, 16 UK sonde stations reported a total of 714 ascents in April 2002, compared with 13

stations reporting a total of 934 ascents in March 2001. The quality of the reports remains good.

Since December 2000, several US sondes have exhibited a bias in their 300 hPa wind speed of ~3 m/s, due to problems with their wind-finding systems, and the winds from 9 US stations continue to be rejected from the Met Office Global Model.

In September 2001, NASA made dropsonde observations of tropical storms (as part of CAMEX4) over the Western N Atlantic - we received and assimilated ~300 observations from 6 to 25 September.

Profiler data

In May 2002 the assimilation of wind profilers from Japan was included in the Met Office Global Model, in addition to those from the USA and Europe. Currently, 22 out of 25 of the Japanese profilers are used, along with all 33 from the USA and 20 out of the 29 received from Europe (including 9 out of 10 Swedish VAD profilers). Wind profiler reports are thinned in time to one report per hour.

The quality of the 4 UK boundary-layer profilers and the profilers at Aberystwyth, Cabauw, Lindenberg and Vienna also remains good. But the problems with the winds from the profiler at Kiruna (02043) continue, with bias in wind direction and speed. The winds from the profiler at La Ferte Vidame (07112) show a small speed bias, but currently not large enough for it to be rejected. The other French, some of the Austrian, and the Italian profilers exhibit larger o-b mean/rms values and they are rejected.

The quality of the Swedish VAD profilers is generally good, except for Lulea (02092) whose reports show a large speed bias. The winds from the Dublin weather radar (03969) remain generally poor and are being rejected along with those from Shannon (03962).

Aircraft data

Aircraft data volume has continued to increase over the last year, except for a short spell after the terrorist attacks in the USA on 11 Sep 2001. The coverage over the North Atlantic seems to have been slightly reduced in April 2002 compared to April 2001. There were more reports from the busy routes 40N-60N, but fewer reports from further south and north.

The total number of active European AMDAR aircraft has risen from 176 in March 2001 to 243 in April 2002 (comprising 61 SAS, 31 BA, 87 LH, 61 AF and 3 KLM), producing ~23,000 reports per day. In September 2001, as part of the E-AMDAR Optimisation Plan, Lufthansa started a selection system to "target" certain airports. This reduced the total number of Lufthansa reports by 1/3. Air France and SAS operate similar flight selection systems, and AF started to produce descent data from targetted airports from 1 October 2001. The number of ASDAR units reporting in March 2002 had decreased to 5, from 10 in March 2001. Generally, the quality of the AMDAR/ASDAR data has remained high, although temperature observations from a few aircraft have shown a bias of around +2 degrees C and have been rejected.

Approximately 70% of all AMDAR/ACARS data are thinned out and excluded from our assimilation, mostly over the USA and Europe, particularly over airports.

Some out-of-date North Atlantic AIREPs have occasionally been received and assimilated in the Met Office models, because the date is not included in each AIREP report (only in the bulletin). To try to reduce the impact of any such erroneous data, the quality control of AIREPs was tightened in December 2001.

ADS aircraft reports will be assimilated again soon, following a 2-year break due to poor quality B777 data.

Satellite winds

There has again been no change in the operational use of satellite-derived atmospheric motion winds over the past year. The quality of the winds has changed little, although from 14 May 2001 ~8% of high level GOESAMW data have been flagged by the background quality control check, due to the reinstatement of very fast winds at NESDIS.

SSM/I 10m wind speed data over the sea from the 2 DMSP satellites continues to be assimilated, after thinning down to ~1.3% (greatest thinning in the northern hemisphere).

Satellite soundings

The NOAA-15 and NOAA-16 ATOVS radiances continue to be assimilated at the Met Office, after selective thinning to ~5%. Although, no NOAA-15 data was assimilated from 10 April to 7 May 2002 due to the failure of AMSU-A channel 11.

3.2.2 Météo-France

Dr Jean Pailleux presented a summary of monitoring activities on COSNA carried out by Météo-France.

The aerosonde data provided by the EUCOS experiment (March 2002) have been monitored. The amount of data was less than expected. No quality problem has been detected.

The US and European profilers have been examined in details in order to determine what data can be used in routine in the ARPEGE operational assimilation. The quality varies a lot in time and also from one profiler to another. However most of the profiler data are likely to be introduced operationally in 2002.

Some French radiosonde stations have been affected occasionally by bad instruments leading to a completely wrong temperature profile.

The problems affecting NOAA15 (HIRS instrument, and, more recently AMSU11) have been monitored through the usual tools. The HIRS instrument has not been used for months, and it is not planned to use it again.

4. EUCOS

4.1 Status of EUCOS

Mr Bruce Truscott, EUCOS Technical Coordinator informed the meeting

The EUMETNET Composite Observing System Programme (EUCOS) was originally established with the following broad objective:

"...to improve the quality and make more cost-effective the numerical and general forecast at European scale. To this end, the density of measurements should be considered and determined in relation to the data-sparse areas surrounding the territory of EUMETNET Members, including the Mediterranean and Baltic seas and the Oceans."

The EUCOS Implementation Programme (1999-2001) has provided recommendations to EUMETNET Members concerning the design and formation of an operational EUCOS network. These recommendations now form the basis for the EUCOS Operational Programme (2002/2006), which has been tasked with establishing and operating the EUCOS network starting on 1 January 2003 and planning its future evolution.

Network evolution will be led by an ongoing EUCOS Studies Programme, which will further refine the current network design. The Studies Programme Plan includes proposals for further OSEs/OSSEs, technology demonstrations, network studies etc., aimed at achieving a better understanding of the ways in which the major components of EUCOS should evolve in the future. The intention is to build ; upon and extend previous work initiated by EUCOS.

It is the intention to link the proposals to those in other relevant programmes, e.g. the COSNA SEG, SRNWP etc.

4.2 EUCOS observation studies and field experiments

Mr Bruce Truscott presented review of EUCOS observation studies and field experiments. The EUCOS Operational Programme which includes a Studies Programme which through OSEs and OSSEs will address the testing of new observing techniques to aid network design. The observing system experiments will, if agreed, assess the value of targeted observations, the use of profile data over the North Atlantic and the Mediterranean, the benefit of high frequency AMDAR profiles, the optimum density of drifting buoys, the evolution of the EUCOS territorial upper-air and surface network. A special programme MEDEX will evaluate and identify the observation issues related to high impact weather prediction in the Mediterranean.

Summary of discussions (COSNA monitoring)

The meeting noted with appreciation that the observational data available in the COSNA area in general continued to be of high quality. The meeting addressed the performance of some new and emerging systems.

- (i) The European profilers provide in general good data at high temporal resolution but require careful quality monitoring for use in NWP. Information on any change in the system characteristics at each platform is required by the users.
- (ii) The aerosonde demonstration in March 2002 off the Iberian Peninsula was troubled by poor weather conditions, was limited in time (less than two weeks) and provided little data for impact studies.
- (iii) A further increase in the availability of AMDAR data was noted. The observations are in general of good quality, but a conflict in the temperature bias between the radiosondes and the AMDAR profiles was reported. Data from the humidity sensors are expected to become available later in 2003.
- (iv) The operators of observing systems and organisers of field experiments need to ensure that the information on data availability is passed to the users (examples are the US winter storm programme, the aerosonde demonstration, the introduction of new ASAP units.)
- (v) Information on data quality should be made more readily accessible to the users. It was suggested to use the Internet for the exchange of such information.

5. IMPACT STUDIES

5.1 Review of impact studies

5.1.1 ECMWF(2)

Dr Erik Andersson presented the results from three studies related to observations reported with a high frequency in time:

- (i) hourly surface pressure;

- (ii) hourly vertical wind profiles from European profiler network;
- (iii) temperature and wind measurements taken during aircraft ascent and descent over North America and Europe.

The impact of hourly surface pressure and also wind observations (SYNOP, SHIP and DRIBU) has been evaluated in the context of ECMWF's operational 4D-Var data assimilation system. The study period was 1-31 May 2001. The globally available observations from the main synoptic hours at 00, 06, 12 and 18 UTC were used in the experiments. Only the data from the intermediate hours were excluded. The hourly surface observations are found to have a positive impact in the short-range forecast in those areas where such data are available (i.e. the North Atlantic and the southern oceans where other data are relatively sparse). The global exchange of all hourly surface observations for use in a 4D-Var system appears to be beneficial for NWP.

The impact of observations from the European profiler network was tested during the period 1-31 May 2001. Only platforms producing consistently high quality data were used in the experiment. Only some marginal impact from the extra data was found. Operational use of the data was implemented at ECMWF in April 2002 but constant monitoring of the quality of the observations is required.

Vertical profile data from aircraft were denied over North America and Europe for the periods 1-31 January 2001 and 1-31 July 2001. All aircraft data (T, U, V) between the ground and 350 hPa were excluded from 25-60N, 120-75W and 35-75N, 12.5W-42.5E. The impact of the wind and temperature profiles from the aircraft observations taken during ascent and descent can be detected in the increment field of geopotential height in the free atmosphere. Forecast errors are reduced over North America, the North Atlantic and Europe. The signal propagates eastward with forecast time and is clearly visible out to Day 5 of the forecast and beyond. The atmospheric profiles from aircraft appear to have a significant impact on the 4D-Var data assimilation resulting in improvements of the short and medium range forecast over North America, the North Atlantic and Europe. The results support the expansion of the coverage of aircraft observations including the observations taken during ascent and descent from other parts of the globe.

Mr Jean-Noel Thepaut reported on the results of satellite-related impact studies Four Observing System Experiments (OSEs) have been performed. The goal was to respectively evaluate the impact of water vapour Clear Sky Radiances (CSR) from Meteosat-7, GOME/SBUV ozone products, Quikscat surface winds and MODIS polar Atmospheric Motion Vectors in the ECMWF assimilation system. The first three OSEs have been motivated by plans for operational implementation, the last one being performed in the context of a collaboration between CIMSS and ECMWF.

The assimilation of Geostationary WV CSR from Met-7 has shown that adjustments of humidity fields were made in areas of model deficiencies. A better fit to other water vapour satellite data was observed (HIRS-12 and AMSU-B) as well as an improved fit to tropical PILOT observations. The impact on scores was neutral to slightly positive.

The assimilation of ozone columns from GOME and ozone profiles from SBUV shows an improvement of the total column ozone field in the ECMWF model. The large scale structure of stratospheric ozone is also improved. Problems remain with the specification of the ozone background errors used in the assimilation and in particular the vertical distribution of the total column increments in the vertical. The experiments also show a potential of 4D-Var to extract wind information from the ozone tracer.

The preoperational assimilation experiments of Quikscat surface winds (thinned at 50 km and rainflag quality controlled) has shown several cases of large tropical tracking and surface wind improvement. An improved fit to independent ERS-2 surface winds was also observed. The rain contamination remains an issue since a lot of data cannot be used in crucial areas. Overall the assimilation of Quikscat has a significantly positive impact in the southern hemisphere.

Three weeks of assimilation of experimental MODIS polar atmospheric motion vectors has been performed in the 3D-VAR configuration of the ECMWF system. With a tight quality control on model orography, the assimilation of these data shows a slightly improved fit to the PILOT data in the area, a dramatic improvement of scores over North Pole, which remains substantial over Northern Hemisphere.

5.1.2 Deutscher Wetterdienst

Dr Alexander Cress provided a summary of impact studies carried out by DWD.

The past year was predominated by the migration of our global and local assimilation and forecast system from the old Cray T3E to the new IBM RS/6000SP computer system, including a substantial change in our data base system. With the new computer system we are now able to run a 3-hourly data assimilation cycle with a time window of +/- 1.5 hours. An impact study comparing the 3 -hourly cycle to the former 6-hourly cycle has been performed. The new data base system has enabled DWD to use additional aircraft data (ACARS) in our data assimilation. The impact of the additional ACARS has been studied. In addition, a set of data denial experiments has been performed to study the impact of various components of the surface observation network on the performance of the DWD's global weather prediction system for a time period in summer 2001. Another OSE has been conducted to estimate the impact of PAOB data on the forecast quality of the Southern Hemisphere.

3-hourly data assimilation cycle on the new IBM system

The DWD, like many other NWV centers, use optimal interpolation schemes to produce global analyses at 00, 06, 12 and 18 UTC, using observations in a window of +/- 3 hours around these analysis times. In cases of fast moving storms, the observation window is too large, leading to strong "smearing out" of information and thus to erroneous forecasts. By reducing the observation window from +/- 3 hours to +/- 1.5 hours the temporal interpolation errors will be reduced, but unfortunately not all available observations will be used at the four analysis times. With the new IBM RS/6000SP computer system the DWD's global data assimilation is able to use a 3-hourly assimilation cycle producing analyses at 00, 03, 06, 09, 12, 15, 18, 21 UTC. The observation window is +/- 1.5 hours around the analysis times. Due to the four additional analyses, all available observations are used. Particularly, more synop-, aircraft-, and satellite data are processed.

An impact experiment covering one month has been performed to investigate the influence of the new 3-h data assimilation cycle on the NWV system's forecast quality. Overall, an increase in forecast quality over all areas can be demonstrated. The benefit is greatest on the Southern Hemisphere and over Europe. It is noteworthy, that the number of extremely erroneous forecasts in the experiment decreases substantially.

Additional aircraft data

Due to a new data base system at the DWD, additional aircraft data (ACARs) can be used within the data assimilation system. The ACARs consists of data from the ascent and descent phases of the aircraft as well as of flight level data. The amount of usable aircraft data has almost doubled with the inclusion of the additional ACAR data.

An impact study can be used to deduce the positive benefit of the new aircraft data over Europe and the Northern Hemisphere. The benefit is highest over Europe, due to the fact that the new aircraft data are concentrated mainly over the U.S.

Surface observations

In addition to several OSE's for a winter period, several impact studies for a summer period were conducted, in which the following surface observations were excluded from the routine assimilation and forecast system:

- Ship observations
- Buoy observations
- Synop, ship and buoy observations

All OSE's were run for the period of 10 July to 31 July 2001, using the DWD's 4th generation Global-Modell (GME).

The following results have been obtained:

- Withholding all surface observations (synop, ship, buoys) results in a large deterioration of the forecast quality.
- Benefit is higher in the Southern Hemisphere and Tropics than in the Northern Hemisphere.
- Impact of ships or buoys alone is less but noticeable
- As opposed to winter cases, benefit of buoys are slightly higher than ships in the Northern Hemisphere.
- Benefit of buoys is slightly greater than that of ships in the Southern Hemisphere.
- Neither ship or buoy observations had any impact in the Tropics.
- In individual cases, ships or buoys have a significant impact on the forecast quality for Europe and the whole Northern Hemisphere.
- Overall, the impact for the summer period is less than for the winter period.

PAOB observations

The Australian Bureau of Meteorology prepares manual analysis of mean sea level pressure over Southern Hemisphere twice a day, based on satellite imagery, ship and buoy reports and synoptic observations. A set of point estimates of mean sea level pressure, called PAOB's is made from these manual analyses.

An impact experiment has been performed using not only the standard observational data but also the PAOB observations in the Southern Hemisphere, covering the period from 20. March to 10 April 2002. Using PAOB observations results in a substantial increase in forecast quality for the Southern Hemisphere.

5.1.3 The Met Office

An overview of impact studies carried by the Met Office was presented by Mr Richard Dumelow.

Improvements in the processing of satellite data

The following three changes in the processing of satellite data were made to operations on 17th October 2001.

Increased use of ATOVS over sea ice

The emissivity of sea ice was previously set at a constant 0.92 where the fraction of a grid box containing sea ice (the sea ice fraction) was greater than 20%. The emissivity from sea ice is now variable and depends upon the sea ice fraction, taken from the NCEP sea ice analysis, and the sea ice type. The sea ice type is defined as 'new' or 'multi-year'. Recently formed or 'new' sea ice has different emission properties to older or 'multi-year' ice which tends to be covered in snow. This operational change resulted in an improved fit to radiances at T+6 over the ocean near sea ice and over sea ice. The impact on RMS scores was neutral in the Northern Hemisphere, but slightly positive in the Southern Hemisphere where RMS height errors fell by 1-2% at and below 500 hPa at all forecast ranges up to 6-days.

Increased use of ATOVS data in cloudy conditions

There are good reasons to observe cloudy regions of the atmosphere. It has been found that model background errors are systematically higher in cloudy areas, and also these regions are most likely to be more 'sensitive' to synoptic development. Thus the ATOVS thinning algorithm was modified so that observations taken in cloudy conditions were preferentially selected if possible. The observations are selected in regions where the microwave sounder detected no cloud, but the infra-red sounder did. Such regions tend to contain cloud with ice or small water droplets, but not large water droplets or precipitation. This modification resulted in a much improved fit to radiances at T+6, and a reduction in RMS height errors of 2-3 % at T+24 and T+48 in the Southern Hemisphere, and a 1-2 % reduction in the Northern Hemisphere.

Doubling of observation errors for AMV data

A doubling of the observation errors for AMV reports brings the observation errors used by the Met Office in line with those used by other Centres.

Impact of observations on mesoscale model forecasts of precipitation

A case selection technique has been used to pick out cases where observations assimilated over a 6-hour period produced significant improvements in the skill of short-range forecasts of precipitation produced by the mesoscale model. Cases were chosen from periods April 2000 to October 2000 and July 2001 to January 2002. It was found that the analysis from the Moisture Observation Processing System (MOPS) produced noticeable impact on the largest number of occasions. Surface, aircraft and radiosonde observations provided benefit on approximately an equal number of occasions.

The Impact of Data from E-ASAP on NWP

The E-ASAP field experiment took place in September and October 2001 as part of the EUCOS Studies Program. During the experiment, extra ASAP reports were taken over the North Atlantic and the Azores radiosonde reported four times a day. On average, about 6 extra observations were made over the North Atlantic at any particular time. An Observing System Experiment was run using the Met Office global model to assess the impact of the data. The overall impact of the extra data on the mean scores was neutral, although two cases were found where the RMS scores of the T+96 forecast versus European sondes were noticeably improved. The small impact is probably due to the low number of reports being available at a time when prevalent synoptic conditions over the North Atlantic were anti-cyclonic.

Global data denial experiments

Global data denial experiments have been performed to assess the overall performance of the Met Office data assimilation scheme. Using July 2001 data, runs have been performed in which the following data types were denied: radiosonde, aircraft, surface, satellite radiances, atmospheric motion vectors, and all satellite data. Additional runs denying the surface observation types SYNOP, buoys, ships and all marine (buoys plus ships) were also run. Initial analysis of the results suggests:

- Satellite data are the most important source for forecasting geopotential height in the Northern Hemisphere, Tropics and Southern Hemisphere.
- Sonde data provide the most important source of information for forecasting wind in the Northern Hemisphere, but satellite data are the most important source in the Tropics and Southern Hemisphere.
- Aircraft data are as important as sonde data for geopotential height forecasts in the Northern Hemisphere at T+144.
- In the Southern Hemisphere, AMV data have most impact when satellite radiance data are not available.

- Surface pressure observations are essential for MSLP forecasts, but there may be significant redundancy in the network, particularly in the Northern Hemisphere.

5.1.4 HIRLAM

Dr Xiang-Yu Huang presented a summary of impact studies carried out by HIRLAM.

ATOVS AMSU-A

The HIRLAM 3D-Var system is currently set up for assimilation of AMSU-A channels over ocean only, after a bias correction, a deep cloud check and a thinning to a minimum distance of 150 km. Different approaches have been tried for selecting the observation error covariance matrix R, both diagonal or non-diagonal.

There have been a number of intensive impact studies. An overview is given in Table 1.

Table 1: Overview of impact studies

Period	Model	Data source	Analysis	Other information
Dec 1999	SMHI 44 km	ECMWF global archive BUFR data	3 h	Diagonal R(Cloud mask bug)
1-6 May 2000	SMHI 22 km BALTEX	ECMWF global archive BUFR data	3 h	(Cloud mask bug)
Feb 2000	DNMI 50 km	DNMI Oslo antenna, NOAA-15 only	6 h	Non diagonal R
21 May - 7 June 2001	DNMI 50 km	DNMI Oslo antenna, NOAA-15 only	6 h	Non diagonal R
Dec 2001	DMI-G 0.45	DMI Denmark and Greenland antennae	3 h	Non diagonal R
Jan 2002	DMI-G 0.45	DMI Denmark and Greenland antennae	3 h	Revised non-diagonal R
Fe, Mar, Apr, 2002	DMI-G 0.45	DMI Denmark and Greenland antennae	3 h	Revised non-diagonal R

Some of the impact studies are done with an operational environment using ECMWF forecast boundaries, using ATOVS data down-linked from the satellite at local antennae and processed with AAPP in near-real-time. The coverage of these data is limited by the view of the local antennae. Other studies are done offline and use archived ATOVS BUFR data from the ECMWF MARS archive and ECMWF analyses as lateral boundaries. The coverage of these data is not limited by the view of the local antennae, and by the timeliness constraints in an online run, and thus have a better data coverage.

The December 1999 run covered a period when several strong storms hit Europe. The average statistics shows a slight positive impact of using AMSU-A data for this period. Closer examination of the time series of the scores, revealed that most of the impact seen came from one single event, which was on the 27th when the storm hit France.

The May 2000 run gave a neutral impact of the AMSU data, which may be due to the bugs in the assimilation code that was used.

The February 2000 and May 2001 experiments showed a positive impact from AMSU-A data. For the February experiment most of the impact was found over the North-Atlantic ocean. Only a slight impact was seen when validating against the whole EWGLAM radiosonde dataset (which is biased towards continental Europe), but when validating against three ocean radiosonde stations in the North Atlantic, the impact was much more significant. This was not seen in the May 2001 experiment, but here the impact using the whole EWGLAM dataset was bigger.

The December 2001 run gave a neutral impact of the AMSU-A data. The run seemed to be influenced by a non-optimal choice of observation error covariance matrix. A non-diagonal R was used, and later an adjustment was made where correlations between some of the channels were set to zero. A revised setup with this adjusted R was run for January 2002, and this resulted in a positive impact from AMSU-A data.

The most recent DMI experiments were performed with a modified diagonal R. There were clear positive impact of ATOVS AMSU-A data in March and April. The observation verification results for April 2002 are summarized in Figure 1 (see Annex III).

Ongoing work with ATOVS data in HIRLAM includes taking HIRS moisture channels into use and the use of observations over sea ice. There are also plans on developing use of AMSU-B moisture data.

GPS-ZTD

The basic quantity measured by the ground-based GPS system is the slantwise delay of the GPS radio-signal between the GPS satellites and GPS ground stations. A number (5-10) of such slantwise delay measurements are mapped into a Zenith Total Delay (ZTD). Provided independent measurements of surface pressure are available at the GPS ground station, a further pre-processing into the Zenith Wet Delay by subtraction of the Zenith Hydrostatic Delay can be carried out. The wet delay can be further pre-processed to Integrated Water Vapour (IWV). We have chosen to assimilate the Zenith Total Delay (ZTD). Other optional variables also exist in the HIRLAM 3DVAR. Observational errors for ZTD are estimated and tuned. A bias reduction is applied before 3DVAR.

Both at SMHI and at DMI, impact studies have been performed using the 3DVAR system for a two-week period, 9-23 June 2000.

The DMI observation verification indicated a neutral impact over the period. However, for the case of 9-11 June 2000, it is clear that forecasts based on analyses including GPS-ZTD data have a higher skill in predicting significant precipitation, using the high resolution rainguage data over France.

The SMHI results indicate significant precipitation forecast differences, but it was not possible to judge from the available radar verification data whether one forecast was better than the other.

Future work include developments of improved bias reduction schemes, developments of models for the horizontal and temporal correlation of the observation errors, possible utilisation of slant atmospheric delays, data impact studies over longer time periods and using a 4DVAR setup.

SSM/I

A series of experiments was done at DMI for the period from the 25th of November to the 4th of December 1999 with 3 hour assimilation cycles. ECMWF analyses (from 00 and 12 UTC) and 6 hour forecasts (valid at 06 and 18 UTC) were used as boundaries with a boundary update period of 6 hours. The SSM/I data encoded in BUFR are received from NOAA/NESDIS by ftp. The data are typically available with a delay of three hours. Three experiments were made: a control run with conventional observations, a run with IWV observations from the SSM/I 1D-VAR output and a run with wind squared observations from the SSM/I 1D-VAR output.

The analyses and forecasts were verified against observations. The overall verification scores do not change very much when including the SSM/I data.

The main priorities are to develop a screening procedure for the 1D-VAR output and to recalculate brightness temperature biases and observation errors. We are in the process of making new set-up based on data from January 2002. The fact that the data is received with a delay of three hours needs to be addressed. Various options for running re-assimilation will be investigated.

SeaWinds scatterometer data

The SeaWinds scatterometer instrument is currently flown on the QuikScat polar orbit (100 minutes/orbit) satellite. The data coverage is over ocean only, and the HIRLAM area of interest passes through the orbit plane at approx. 0600 and 1800 hrs (Z). The highest resolution is 25 km, and the data delay is 3 hours (by ftp from NOAA/NESDIS). The observation parameter is the 10 m wind vector. Unfortunately, since each QuikScat wind observation consists of up to 4 possible wind solutions, it becomes necessary to use model wind to choose the correct wind solution. The observations are also sensitive to precipitation. Recently, parallel runs were performed at DMI showing minor positive impact from the data.

The plan is to have HIRLAM 3D-VAR capable of assimilating QuikScat by June 2002. The first test version featured: NOAA/NESDIS QuikScat BUFR read directly, QuikScat data stored in FORTRAN modules, KNMI rain flag algorithm used, 25 km QuikScat analyzed using DAR method (using either: 1) Wind speed and direction, 2) wind speed only or ignoring the observation.), FGAT and VarQC (not tested), simplified calculation of 10 m model wind ("forward model").

Doppler radar wind

Doppler radar data impact has been investigated and reported. The data were collected from the Swedish radar network and used in the form of VAD and radial wind super observations. A 10-day period, 1-10 Dec 1999, was selected. This period is characterized by the "Danish Storm".

The observation fit statistics reveals a high quality of the radar data and reasonably tuned error statistics. The observation verification scores indicate improved forecasts of winds and temperature in the low and middle troposphere. The improvements are similar when using radar data as VAD wind profiles or as radial wind super observations.

Future work include more extensive parallel data assimilation experiments, further tuning of error statistics and quality control, and preparation for handling velocity ambiguities.

SYNOP cloud and precipitation

A nudging scheme has been developed for assimilating cloud- and precipitation data into HIRLAM. The information appears to be of great value since the focus of short range forecast is on predicting local weather parameters, e.g. precipitation, cloud cover and temperature. The assimilation acts on top of an already existing analysis for other parameters based on HIRLAM 3DVAR. The first tests on 3-D forecast cases indicate a good skill of the assimilation method. The mean absolute error and bias in cloud forecasts are reduced due to the nudging.

Continuous 3-D tests including objective verification will be carried out at DMI in the future to further diagnose benefits and problems associated with the **nudging scheme**.

5.1.5 METEO-FRANCE

Dr Jean Pailleux presented a summary of impact studies carried out by Météo-France. When preparing the operational use of some data sets, two observing system experiments have been carried out, one on the profiler data (both US and Europe), and one on the raw ATOVS radiances. Several experiments have been performed, generally on recent periods which are 2 to 3 week long.

They have been run with the operational assimilation and forecasting systems (4D-VAR). A significant impact of profilers is found over Europe and North America. The use of raw radiances has also a positive impact with respect to the use of processed radiances (which are currently in operations), except over Europe, and mainly in the Southern hemisphere.

In order to evaluate the impact of tropical radiosondes, an impact study has been carried out on a 3-week period of June 2000, in which all the TEMP and PILOT messages have been removed in the tropical belt (20N-20S). This is one of the basic OSEs recommended by WMO. The study has been done with a uniform T199/31L version of the global model ARPEGE. A 6h-cycling 3D-VAR has been used for the assimilation, where the analysis increments are computed at T127. Analysis differences are generally small, except in the Australia – Indonesia area where they are bigger all the time (half of the removed radiosondes are in this area). 96h ARPEGE forecasts have been run every day from 00UTC and intercompared. On one or two occasions, initial differences are growing and propagating up to 50 or 60 degrees of latitude, at 72 or 96h range.

5.1.6 NCEP (including reports on NAOS and THORPEX)

Dr Stephen Lord informed the meeting on the results of impact studies carried out at NCEP regarding contributions of wind profiler and MDCRS (aircraft) ascent and descent profiles to the accuracy of 0-12 hour forecasts. A short test over three weeks in May 2002 was carried out with the Rapid Update Cycle (RUC-20) denying the wind profiler data. Preliminary results show that the loss of profiler data give a worse fit of the analysis to radiosonde data which carries through into the 12 hour forecast. The tests with the denial of the aircraft ascent and descent data were underway.

NAOS and THORPEX updates

The NAOS activities in the US are now focussing on the development and testing of meso-scale observing systems for supporting high impact weather event prediction. The Science and Technology Planning includes studies of the observing system requirements and the utilisation of new platforms and technologies such as dual polarization or phased array radar, the NPOESS system, GOES-R and unmanned aerial vehicles (aerosondes).

THORPEX is a 5-10 year research programme with a goal of improving NWP weather forecast for the 0-14 day lead time. A detailed research plan is being drafted for presentations to WWRP and WGNE in November 2002.

5.2 Review of impact studies initiated by the ET on ODRRGOS

Dr Paul Menzel, Chairman of the CBS/OPAG/IOS ET on ODRRGOS informed the meeting on the status of impact studies, initiated by the ET. The SEG recalled that the ET-ODRRGOS suggested seven OSEs for consideration by NWP centres and asked the OSE/OSSE rapporteurs to engage as many as possible in this work. They include studying the:

- Impact of hourly SYNOPs ;
- Impact of denial of radiosonde data globally above the tropopause ;
- Information content of the Siberian radiosonde network and its changes during last decades ;
- Impact of AMDAR data over Africa through data denial in a 4D-Var analysis and forecasting system ;
- Impact of tropical radiosonde data ;
- Impact of three LEO AMSU-like sounders, and
- Impact of AIRS data.

The upcoming ET-ODRRGOS meeting (Oxford, UK, 1-5 July 2002) will specifically address the results of the above studies.

6. FUTURE OF CGC AND SEG

Magne Lystad, Chairman of CGC, informed the meeting of the CGC Management Group decision to propose to CGC at the session in August 2003 to take a decision on the integration of COSNA in EUCOS and to transfer the CGC activities to EUMETNET. As far as the SEG activities were concerned, CGC had taken the view that it would be desirable for these activities to be carried out within the framework of WMO/CBS. The OPAG-IOS with the Expert Team on Observational Data Requirements and the Redesign of the GOS and the two rapporteurs on global and regional NWP impact studies was considered to provide the organisational structure to take on the task of impact study monitoring, promotion and co-ordination. Assuming an agreement of CBS in December 2002 to take over the SEG activities, the CGC at its session in August was expected to take the decision in principle to disband the SEG as from 1 January 2003.

Andrew Lorenc informed the meeting of the view of WGNE that the SEG had fulfilled an important role in soliciting and undertaking global data and regional impact studies with a view towards the re-design and the development of the global observing system. WGNE has no intention to take on such routine activities and fully supports the idea to let the CBS take over this function when the SEG ceases to exist.

Jean Pailleux, in his capacity as the CBS/OPAG rapporteur on global NWP studies, noted the importance of OSEs and OSSEs for the redesign and development of the observing system. Regular workshops are an important forum for the monitoring of the progress with NWP impact studies and for the exchange of the results and views amongst the parties involved, including the managers and operators of the observing systems. Jean Pailleux noted the past difficulties in organising such workshops on NWP studies with limited resources and therefore welcomed the decision of the OPAG-IOS Expert Team to set up an ad hoc working group for the organisation of the next workshop.

Paul Menzel, Chairman of the OPAG/IOS ET on ODRRGOS, noted the importance of the work of the SEG and expressed his expectations that the ET will benefit from future NWP impact studies. The ET will be prepared to co-sponsor future workshops and participate actively in the organisation of such events on approximately a tri-annual cycle. He did not see a need for any SEG type meeting in the interim period. The SEG members, however, expressed the view that the annual meetings of the SEG had been an important aspect of the work, it had contributed significantly towards a co-ordination of the NWP impact study work between the members and had been instrumental in following up the progress of work.

The Chairman of the SEG in his summary concluded that the data monitoring and NWP impact study activities of the SEG had provided an important contribution towards the work of the CGC in monitoring and developing the COSNA. Through the organisation of the two workshops on the impact of observations on global and regional NWP, both co-sponsored by the WMO, the SEG had raised the awareness for the need of such work on a global scale. Horst Böttger welcomed the intention of the CBS/OPAG-IOS ET to organise future workshops. He also noted with appreciation that the CGC and the WMO Secretariat may provide the funding for the next workshop in early 2004. Horst Böttger expressed his concern that there are no plans for regular, i.e. annual meetings of the key contributors towards the NWP impact study work. The CBS/OPAG rapporteurs are expected to follow the work and keep in touch with the various contributors. As voiced strongly by the SEG it was felt that the composition of a successor institution to the SEG would be desirable. Both CGC and the OPAG-IOS ET are expected to address this issue further in their forthcoming meetings in July and August 2002.

7. FUTURE WORK PROGRAMME

7.1 Planned impact studies

ECMWF proposals

Conventional data

- Surface pressure/winds (in response to EUMETSAT request and EUCOS)
- Surface pressure data only (in view of future re-analyses)
- Targeted observations (THORPEX, when available)
- Driftsondes, aerosondes - if available in quantity
- AMDAR expansion (EUCOS)

Satellite data

- AMSU-B
- AIRS
- Meteosat-5 and GOES WV-channel
- more on MODIS AMVs
- SSM/I
- ENVISAT ozone retrievals
- MSG (later)

Most of these OSEs are likely to be run with the operational 4D-Var at T511/T159, over selected one-month periods (tbd).

DWD proposals

- Use of scatterometer data (QuickScat)
- Tests with wind profiler data in LM and GME
- Use of GPS IWV data in LM humidity analysis
- 1-dvar of satellite data
- change from OI analysis towards 3-dvar analysis

The Met Office proposals

Plans for OSEs

- Global model OSEs, all observation types
- SE Asia - radiosonde (for Expert Team)
- Global model cases, all observation types
- EUCOS Studies Programme - OSEs

Satellite data

- Introduce new radiative transfer model for ATOVS and SSM/I (RTTOV-7) and change Met Office 1D-Var to 43 levels
- Introduce variable land surface emissivity for AMSU and analyse land surface emissivity in 1D-Var to allow more data to be used over land
- Add cloud liquid water analysis to ATOVS 1D-Var
- Improve consistency between F13 and F15 SSM/I processing
- Improve use of AMSU window channels and SSM/I water vapour burden for low level humidity
- New bias correction scheme (model based predictions, variational analysis of coefficients)
- Assimilation of AMSU-B in the mesoscale model

- Replace NOAA-15 with NOAA-17
- Process AMSU-A and HSB from Aqua
- Introduce SSMIS
- Introduce QuikSCAT
- Monitoring the radiances from AIRS + running assimilation trials.

METEO-FRANCE proposals

- EUCOS studies programme support
- AMDAR OSE over Africa
- High resolution cloud drift winds from Meteosat
- QuikSCAT
- AIRS
- MSG
- Use of locally received satellite data at Lannion

NCEP proposals

- Use of AIRS
- Use of AMSU on Aqua satellite
- Total column water vapour from GPS
- Radio winds and Doppler radar winds.

7.2 EUCOS requirements

- Justification for AMDAR programme
- Justification for growth of ASAP
- Definition of the surface synoptic network

7.3 DATE AND VENUE OF NEXT MEETING

Should CGC decide on a continuation of SEG for a further year, the next meeting will be held at ECMWF in spring 2003.

7.4 CLOSURE OF THE MEETING

Following appreciation expressed to the participants for their contributions and cooperation during the meeting, the Chairman of SEG closed the session at 14.15hrs on Tuesday, 15 May 2001.

SEG-XII

**ECMWF
Shinfield Park, Reading/Berkshire, UK**

21-22 May 2002

AGENDA

1. ORGANISATION OF THE MEETING

- 1.1 Opening
- 1.2 Adoption of the agenda
- 1.3 Working arrangements

2. REPORT OF THE CHAIRMAN

3. COSNA OBSERVING SYSTEMS AND MONITORING ACTIVITIES

- 3.1 The 2001 consolidated monitoring report
- 3.2 Review of monitoring results (ECMWF, the Met Office, METEO-FRANCE)

4. EUCOS

- 4.1 Status of EUCOS
- 4.2 EUCOS observation studies and field experiments

5. IMPACT STUDIES

- 5.1 Review of impact studies
 - ECMWF(2)
 - Deutscher Wetterdienst
 - the Met Office
 - HIRLAM
 - METEO-FRANCE
 - NCEP (including reports on NAOS and THORPEX)
- 5.2 Review of impact studies initiated by the ET on ODRRGOS

6. FUTURE OF CGC AND SEG

7. FUTURE WORK PROGRAMME

- 7.1 Planned impact studies
- 7.2 EUCOS requirements

8. DATE AND VENUE OF NEXT MEETING

9. CLOSURE OF THE MEETING

SEG-XII**ECMWF****Shinfield Park, Reading/Berks., UK****21-22 May 2002****PARTICIPANTS**

ANDERSSON, Erik European Centre for Medium-Range Weather Forecasts (ECMWF) Shinfield Park Reading/Berks. RG2 9AX United Kingdom	Tel.: (+44 118) 949 9627 Fax: (+44 118) 986 9450 Email: E.Andersson@ecmwf.int
BÖTTGER, Horst European Centre for Medium-Range Weather Forecasts (ECMWF) Shinfield Park Reading/Berks. RG2 9AX United Kingdom	Tel.: (+44 118) 949 9060 Fax: (+44 118) 986 9450 Email: h.bottger@ecmwf.int
BADER, Michael The Met Office London Road Bracknell/Berks. RG12 2SZ United Kingdom	Tel.: (+44 134) 4856 424 Fax: (+44 134) 4854 026 Email: mike.bader@metoffice.com
CRESS, Alexander Deutscher Wetterdienst Kaiserleistr. 42 D-63067 Offenbach Germany	Tel.: (+49 69) 8062 2716 Fax: (+49 69) 8062 3687 Email: alexander.cress@dwd.de
DUMELow, Richard The Met Office London Road Bracknell/Berks. RG12 2SZ United Kingdom	Tel.: (+44 134) 4854 489 Fax: (+44 134) 4854 026 Email: richard.dumelow@metoffice.com
GARCIA-MENDEZ, Antonio European Centre for Medium-Range Weather Forecasts (ECMWF) Shinfield Park Reading/Berks. RG2 9AX United Kingdom	Tel.: (+44 118) 949 9424 Fax: (+44 118) 986 9450 Email: a.garcia@ecmwf.int

HUANG, Xiang-Yu
Danish Meteorological Institute
Lyngbyvej 100
2100 Copenhagen
Denmark

Tel.: (+45 39) 157 423
Fax: (+45 39) 271 080 / 157 460
Email: xvh@dmi.dk

KARPOV, Alexander
W M O
7 bis avenue de la Paix
CP2300
CH-1211 Geneve 2
Switzerland

Tel.: (+41 022) 730 8222
Fax: (+41 022) 730 8021
Email: Karpov_A@gateway.wmo.ch

LORENC, Andrew
The Met Office
London Road
Bracknell/Berks. RG12 2SZ
United Kingdom

Tel.: (+44 134) 485 6227
Fax: (+44 134) 485 4026
Email: Andrew.Lorenc@metoffice.com

LORD, Stephen
DOC/NOAA/National Weather Service
National Centers for Environmental Prediction
W/NP2x1, WWB, Room 207
5200 Auth Road
Camp Springs
MD 20746-4304
USA

Tel.: (+1 301) 763 8000, ext. 7202
Fax: (+1 301) 763 8545
Email: Stephen.Lord@noaa.gov

LYSTAD, Magne
Det Norske Meteorologiske Institutt
P.O.Box 43, Blindern
0313 Oslo 3
Norway

Tel.: (+47 22) 963 323
Fax: (+47 22) 963 050
Email: magne.lystad@met.no

MACPHERSON, Bruce
The Met Office
London Road
Bracknell/Berks. RG12 2SZ
United Kingdom

Tel.: (+44 134) 485 6490
Fax: (+44 134) 485 4026
Email: bruce.macpherson@metoffice.com

MENZEL, Paul
Chief Scientist
NOAA/NESDIS/ORA
University of Wisconsin
1225 West Dayton Street
Madison
Wisconsin 53706
USA

Tel.: (+1 608) 263 4930
Fax: (+1 608) 262 5974
Email: paul.menzel@ssec.wisc.edu

PAILLEUX, Jean
Meteo-France (CNRM/GMAP)
42 Av. G. Coriolis
31057 Toulouse Cedex
France

Tel.: (+33 5) 6107 8452
Fax: (+33 5) 6107 8453
Email: jean-pailleux@meteo.fr

SIMMONS, Adrian
European Centre for Medium-Range
Weather Forecasts (ECMWF)
Shinfield Park
Reading/Berks. RG2 9AX
United Kingdom

Tel.: (+44 118) 949 9700
Fax: (+44 118) 986 9450
Email: A.Simmons@ecmwf.int

STEINHORST, Gerhard
Deutscher Wetterdienst
Kaiserleistr. 42
D-63067 Offenbach
Germany

Tel.: (+49 69) 8062 2688
Fax: (+49 69) 8062 3687
Email: gerhard.steinhorst@dwd.de

THEPAUT, Jean-Noel
European Centre for Medium-Range
Weather Forecasts (ECMWF)
Shinfield Park
Reading/Berks. RG2 9AX
United Kingdom

Tel.: (+44 118) 949 9621
Fax: (+44 118) 986 9450
Email: jean-noel.thepaut@ecmwf.int

TRUSCOTT, Bruce
EUCOS Technical Coordinator
The Met Office
London Road
Bracknell/Berks. RG12 2SZ
United Kingdom

Tel.: (+44 134) 485 5881
Fax: (+44 134) 485 5897
Email: Bruce.Truscott@metoffice.com

Figure 1.

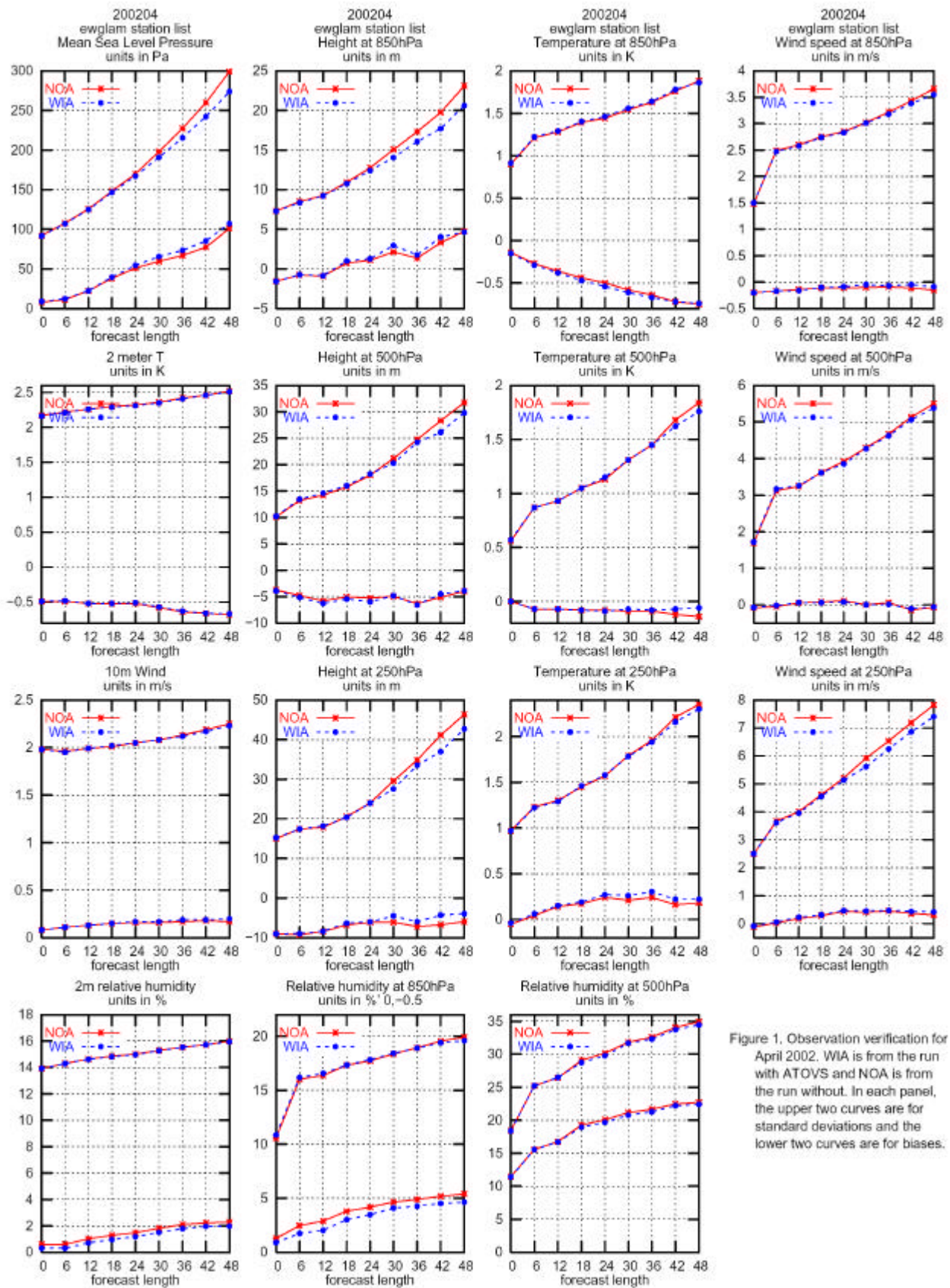


Figure 1. Observation verification for April 2002. WIA is from the run with ATOVS and NOAA is from the run without. In each panel, the upper two curves are for standard deviations and the lower two curves are for biases.