



The Met Office (U.K.) status report to 17th N. America-Europe Data Exchange Meeting at Dorval, Canada 26-28 May 2004

Roger Saunders, NWP/SA, Met Office, Exeter, EX1 3PB, U.K.

1.0 Introduction

This report describes changes to the use of U.S. satellite and in-situ data in the Met Office NWP models and other forecasting systems since the last Data Exchange Meeting in May 2003. Changes to the Met Office NWP models and assimilation systems are now regularly documented in the NWP gazette which is available on line at: http://www.metoffice.com/research/nwp/publications/nwp_gazette/. There are also technical reports on NWP available at: <http://www.metoffice.com/research/nwp/publications/papers/index.html>

The relocation of the Met Office headquarters building from Bracknell to Exeter (~200km to the south west) was successfully completed on time. The new building was completed in December 2003 at which time the majority of the staff had relocated. More than 70% of the staff moved to Exeter. All of the links to Washington, Dorval and European Met Services are now established at Exeter rather than Bracknell. The new site can be viewed at: <http://www.metoffice.com/corporate/relocation/> .

The NWP models were successfully ported to the new NEC SX-6 computers and operations began on the new machines on 27 April 2004. The old Cray T3Es are now being disposed of.

1.1 Model and assimilation changes

There have been no changes to the global model, a 1:50hr data cut off is used. An ensemble forecasting system is planned with 16 members out to T+72hr at 80km resolution. The new Eurolam model with a 20km grid has become operational on 23 March 2004 and is run 4 times a day with forecasts out to T+48hr. It is planned to make the products more widely available to customers in late 2004.

Due to the relocation of the Met Office there have been no major changes in the data assimilation or data usage over the past year but there is a new package of satellite data changes planned for late May 2004 which is described below. A summary of the observations used in the global model is given in Table 1. Work on 4D-Var at the Met Office has continued and an initial implementation is being planned within the next six months for the global model and during 2005 for the Eurolam model.

1.2 ATOVS radiances

The brightness temperatures (BTs) in the Level 1B ATOVS datasets (HIRS, AMSU-A and AMSU-B) from NOAA-15,16 and 17 mapped to the HIRS fovs, are continuously monitored by comparing with calculated BTs from the 6 hour global forecast. The link to the monitoring plots has changed and can now be viewed at: <http://www.metoffice.com/research/nwp/satellite/radiance/atovs/main.html> . Feedback on these plots is welcomed to nwpsaf@metoffice.com. Monitoring of the instrument housekeeping parameters also continues for AMSU-A and AMSU-B on all 3 NOAA platforms.

Observation group	Observation Sub-group	Items used	Daily extracted	% used in assimilation
Ground-based vertical profiles	TEMP	T, V, RH processed to model layer average	1200	97
	PILOT PROFILER	As TEMP, but V only As TEMP, but V only	900 3200	90 75
Satellite-based vertical profiles	ATOVS NOAA-15/16 AIRS, AMSU-A AQUA	Radiances directly assimilated with channel selection dependent on surface instrument and cloudiness	430000 (AIRS not included)	3 (AIRS not included)
Aircraft	<i>Manual</i> AIREPS	T, V as reported with duplicate checking and blacklist	25000	21
	<i>Automated</i> ACARS/AMDAR/A SDAR		120000	60
Satellite atmospheric motion vectors	GOES 10,12 SATOB Meteosat 5, 7 BUFR GOES 9 SATOB	High resolution IR winds IR, VIS and WV winds IR, VIS and WV winds	110000	10
			190000	5
			4000	55
Satellite-based surface winds	SSMI-13,15	In-house 1DVAR wind-speed retrieval NESDIS retrieval of ambiguous winds. Ambiguity removal in 3DVAR.	3000000	1
	Seawinds		1800000	1.5
Ground-based surface	Land SYNOP SHIP BUOY	Pressure only (processed to model surface) Pressure and wind Pressure	30000	80
			6000	90, 95
			9500	75

Table 1. Observations assimilated into global model.

The Met Office generates Level 1C ATOVS datasets (i.e. geolocated brightness temperatures), which are passed to ECMWF, DWD and MétéoFrance and are potentially available to other European NWP Centres. The generation of level 1C NOAA-16 AVHRR parameters on the HIRS fields of view is also operational and provided to ECMWF. The ATOVS level 1C data are pre-processed to level 1D (i.e. brightness temperatures of all ATOVS channels mapped on to the HIRS grid) which are then used in the Met Office global NWP models and also passed to the Bureau of Meteorology in Melbourne. There are still significant delays in the global ATOVS 1B files at some periods of the day due to the 'blind orbit' delays. To investigate the impact of the ATOVS data delays on the NWP forecasts a data impact experiment was run where all the late data was included in the main forecast run. The results showed with our 1:50 hr cut-off that significant improvements in the forecasts over both the Northern and Southern Hemispheres were seen by including the late data even though an update run is used for the next cycle of the data assimilation which includes these data. The results are available from the following link: http://www.ecmwf.int/newsevents/meetings/workshops/2003/9th_Meteorological_Operational_Systems/presentations/Saunders.pdf This underlines the importance of receiving the ATOVS data in a more timely manner for operational NWP.

To mitigate the data delays the Met Office is also processing the level 1A data received from the EUMETSAT EARS system, which currently comprises of

downloaded ATOVS from 9 stations using AAPP. Routine monitoring of the differences between the EARS data and the global 1B ATOVS data is carried out. These data are now assimilated in the global and EUROLAM models due to their much improved timeliness which fills gaps over the Atlantic Ocean due to the late arrival of ATOVS data from NESDIS.

The ATOVS data from NOAA-17 was no longer assimilated after October 2003 due to the failure of AMSU-A1 on that platform. As a result to improve the robustness of the satellite data provision the AMSU-A data from Aqua has been introduced from 25 May 2004. Although the Aqua platform is in an orbit similar to NOAA-16 it can sometimes provide AMSU-A data before the NOAA-16 data resulting in positive forecast impacts.

A new radiance bias correction, expanding the use of both IR and microwave data over land/ice, has also been implemented on 25 May 2004.

A project has commenced to prepare for the assimilation of METOP data, initially ATOVS and ASCAT but with plans to also quickly exploit the data from the IASI and GRAS instruments.

1.3 Advanced infra-red sounders (AIRS)

The Met Office continues to provide monitoring statistics of the AIRS 324 channel radiances + AMSU-A on Aqua in near real time on the web at: <http://www.metoffice.com/research/nwp/satellite/infrared/sounders/airs/index.html> (userid: airspage; password: &Graces). Assimilation experiments to assess the forecast impacts with the AIRS data have shown positive results in both hemisphere and as a result AIRS radiances from a subset of ~80 channels are now used operationally in the global model. This is a conservative use of AIRS data and it is planned to gradually use more of the data to increase the impact.

1.4 SSM/I & SSMIS

Orbit-by-orbit brightness temperatures are received from F-13, F-14 and F-15 in near real-time from NESDIS. These data are passed to ECMWF where they are BUFR-encoded and returned to Exeter for onward transmission to other European centres.

The brightness temperatures are processed through a 1D-Var analysis which provides retrieved total column water vapour, surface wind speed and cloud liquid water path. Surface wind speeds from both F13 and F15 continue to be assimilated. Experiments are continuing with assimilating the total column water vapour and recent results have shown some positive benefits.

It is planned to process SSMIS radiances as soon as they become available for comparison with the NWP model and ultimately to assimilate these radiances with a common processing software with ATOVS. It is frustrating how long it is taking for the SSMIS radiances to be released which we are now expecting within a few weeks.

1.5 Scatterometers

Seawinds observations are received from NESDIS and since 11 Dec 2002. The directionally ambiguous winds have been assimilated in the global model with the ambiguities being removed with the 3DVAR scheme. Under the NWP SAF, monitoring of Seawinds is reported at: http://www-nwp/research/interproj/nwpsaf/scatter_report/index.html

ESA have introduced a revised processing scheme for the ERS Scatterometer which can compensate for the satellite's yaw-steering problem. ERS-2 scatterometer data have been available on the GTS again since October 2003; validation has shown the recent ERS-2 scatterometer winds to be of at least the same quality as that prior to the gyro failure in February 2001. ERS winds are being monitored but there are no plans to assimilate these data at present.

1.6 Altimeters and in-situ ocean data

The Met Office receives altimeter data products twice a week from the DUACS/SSALTO centre in Toulouse and assimilates them into the FOAM models, which are run daily in the operational suite. Altimeter data are available from the US Navy on a daily basis and we plan to investigate them when resources allow.

1.7 SST products

Retrieved AVHRR SSTs obtained from NESDIS in SATOB format are used in the operational global SST analysis. In addition data at 1° resolution and twice weekly data at 0.5° resolution are being delivered to the Met Office and a system has been developed to replace the SATOB data with the 0.5°/1° data in the near future.

NOAA-16+17 SSTs are retrieved from locally-received AVHRR data (covering N. Atlantic) for assimilation in the mesoscale model's SST analysis. It is planned to replace this with a product from the Ocean Sea-Ice SAF in the near future.

AATSR top of atmosphere brightness temperatures and SSTs from ENVISAT are received from ESA in near real time. It is planned to use these data for both NWP and climate model SST analyses. The skin SSTs are accurate to 0.3 K. A monitoring web page for AATSR SSTs is at:

<http://www.metoffice.com/research/nwp/satellite/infrared/aatsr/index.html>

with user id: aatsruser, password: sst4you .

1.8 Snow and Sea-ice products

The NESDIS Interactive Snow and Ice Mapping System data were used to compare with the global model N. Hemisphere diagnosed snow and ice fields from June 2002. A report is available on the comparisons at:

http://www.metoffice.com/research/nwp/publications/papers/technical_reports/2003/FRTR416/FRTR416.pdf

Longer term plans are to assimilate these data into a surface analysis.

The NCEP sea-ice analysis continues to be used operationally in the global NWP systems.

1.9 Cloud-tracked winds

GOES IR winds (thinned to one per 2 deg box) continue to be assimilated and monitored. The details of the current use of the winds in the global model are at:

http://www.metoffice.com/research/interproj/nwpsaf/satwind_report/ukmodel.html

The monitoring results are at:

http://www.metoffice.com/research/interproj/nwpsaf/satwind_report/index.html

The GOES-10/12 SATOB and BUFR winds, MODIS Aqua and Terra polar winds are all being monitored. We are running forecast impact experiments with the GOES BUFR and MODIS winds processed at NESDIS. The latter are showing positive

impacts. We require any improvements implemented for the NESDIS MODIS winds be made available without delay. We are also keen to see the NESDIS winds available on the GTS as soon as possible, at least by early next year. We also use the JMA GOES-9 winds in place of the GMS-5 winds.

A new superobbing scheme has been developed by a visiting scientist from CIMSS as a potential improvement to the use of thinning for dealing with the high density satwind data-sets. Data assimilation trials are underway.

1.10 Polar and Geostationary Imagery

Forecasters make use of the images on the NOAA PSB polar WEFAX product internet site. We are still working with NESDIS to add the overpass times to the image products so that the forecasters know the valid time of each overpass. NOAA GAC polar composites are also copied once or twice a day to Exeter as a backup to the products on the internet.

The generation of products from the new MSG (Meteosat-8) satellite has begun. Images are received from the DVB broadcast system and processed in real time to provide clear sky radiances and cloud top height for the nowcasting systems. Volcanic ash and fog imagery are also produced.

1.11 Profiler data

The U.S. profiler data continue to be assimilated in 3D-Var. More data will be used when 4D-Var becomes available later this year. The European profiler data are monitored and a report is issued quarterly. Currently about 30 of the European stations are assimilated based on their monitoring statistics. The wind profiles from the weather radars are also now being assimilated.

1.12 Ozonesonde Ascents

The Met Office has been launching ozonesondes from Lerwick once a week (normally Wednesday at 12Z) and the ascents are encoded into BUFR and put out on the GTS in near real time. They are also stored in the NILU archive in Norway.

1.13 NWP Satellite Application Facility

The NWP Satellite Application Facility (SAF) reached the end of its 5 year development phase in February 2004. A 3 year initial operational phase has now begun. Activities include:

- Maintaining and developing AAPP software for processing of ATOVS data.
- Maintaining and developing the fast RT model RTTOV.
- Producing cloud track winds monitoring reports from several NWP centres.
- NWP monitoring of scatterometer winds.
- NWP monitoring of ATOVS radiances.
- Developing NWP interface software for METOP sensor radiances.

For more details the NWP SAF web site is at:

<http://www.metoffice.com/research/interproj/nwpsaf/index.html>

1.14 GRAS Satellite Application Facility

The GRAS (GNSS Receiver for Atmospheric Sounding) Satellite Application Facility (SAF) reached the end of its 5-year development phase in April 2004. A 3-year Extension Phase has now begun. Met Office activities include:

- Specification of Level 2 data formats for NRT & offline dissemination to users
- Developing ROPP (Radio Occultation Processing Package) software for the pre-processing of GRAS and other radio occultation mission (CHAMP, COSMIC, etc) data.
- Developing NWP interface software for the assimilation of RO data
- Monitoring of GRAS sounding products.

For more details the GRAS SAF web site is at:

http://web.dmi.dk/pub/GRAS_SAF/