

2.3 THE USE OF TOVS/ATOVS IN DATA ASSIMILATION/ NUMERICAL WEATHER PREDICTION (DA/NWP)

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2.3.1 Introduction

There were many substantive presentations at this meeting that indicated very positive results using satellite data from different instruments. The trend towards the use of 1b sounder and imager radiances has continued with most centres now using or preparing to use radiances. OSEs presented at this meeting demonstrate that satellite data has an extremely important impact on weather forecasting and promising new results suggest the potential for future enhancements in the use of satellite sounder and imager data. The microwave data continues to have the largest impact but one centre showed how using a wide diversity of satellite data increased robustness to the loss of any one.

AIRS is now assimilated at three NWP centres and others have plans to exploit AIRS. Most centres have shown a small positive impact arising from a very conservative use of the data. However larger impacts have also been found when more of the data (spatially) has been processed allowing more cloud-free data to be assimilated. As a result new thinned AIRS datasets have been made available by NOAA which should contain more cloud-free data. These are the AIRS warmest FOV dataset in which thinned observations have been selected as the warmest fov in the window region and the AIRS MODIS dataset where the least cloudy FOV has been identified using MODIS cloud flags. A number of presentations were given on fuller use of spectral information (reconstructed radiances, principal components, super-obs). However, the importance of correctly allowing for correlated observation error in so-called reconstructed radiances was also presented.

Initial radiative transfer experiments including the effects of clouds indicate progress has been made towards the potential future assimilation of cloudy radiances. These results indicate that radiative transfer models are now sufficiently accurate to begin the development of theoretically sound assimilation systems for clouds and precipitation. While significant progress has been made, the inclusion of clouds and precipitation remains a very difficult data assimilation problem and a solution should not be expected in the next 5 years.

AMSU-B is assimilated at a majority of NWP Centres and with reports of various levels of positive impacts particularly on the moisture fields and precipitation. This widespread use of the AMSU-B and AIRS data is representative of the general increase in the use of satellite radiance data among the various Centres. Initial work has also begun at a few centres on assimilating the first microwave sounder to use a conical scan geometry and a high noise but oversampling philosophy (SSMIS).

The use of satellite radiances in Limited Area Models continues to progress and there was a significant rise in the number of groups reporting positive impact from ATOVS in regional models. The impact of satellite data in regional/mesoscale (and often for global) data assimilation systems continues to be limited by many factors such as: incomplete use of data over land sea/ice; lateral boundary influences; low model top; background error not adequate for regional/meso scales; inadequacies in the data (e.g. clouds and vertical resolution). The WG recognizes that while significant progress in the use of satellite data in limited area data assimilation has occurred, it is still in the early stages and significant development is still necessary. Note that since the development and use of limited area models is often driven by the expected improvements in QPF and other smaller scale variables, the development of appropriate verification techniques for these models and forecast variables is necessary.

2.3.2 Evaluation and use of TOVS/ATOVS in DA/NWP

The use of satellite data remains very dependent on the monitoring and evaluation procedures for the satellite data. Prior to the use of the data, it is important to diagnose the significant biases between background and radiances (both level 1b and level 1d) which still remain. After implementation, monitoring is necessary to ensure that changes to the data or data assimilation system do not adversely affect the results. Many difficulties have been diagnosed and resolved by monitoring procedures. As more and more Centres get involved in radiance data assimilation, better coordination of the monitoring procedures and more documentation, particularly on the bias correction method should be exchanged between the various data assimilation groups. The WG continues to encourage the development and documentation of monitoring procedures as part of any Centre's analysis procedure and to post monitoring results and documentation on their external Web site. Three more centres have provided monitoring on their Web sites since ITSC-XIII.

The WG acknowledged the continued excellent support to users of AIRS data. The very detailed information distributed and the response to users when possible anomalies are spotted has been very helpful. The WG would like to see support to AIRS as a standard for other missions now and in the future to aspire towards.

Action DA/NWP-1

Mitch Goldberg to enquire (through NESDIS) if the same level of detailed real time information which has been provided for AIRS can be replicated for other instruments and similarly the response to user enquiries.

The WG felt that we do not always know the instrument scientist for each instrument (AIRS, HIRS, AMSU-A, AMSU-B, SSM/I, SSMIS) and requested NESDIS to provide this information.

Action DA/NWP-2

Mitch Goldberg to provide to the ITWG NWP WG a list identifying the most appropriate contact for instrument problems for each instrument.

The WG is not sufficiently aware of existing information on the status of each channel on each instrument and that this information should be linked from the ITWG Web page. Furthermore it would be useful to see what channels the NWP centres considered to not be useable (this can be a larger list than one which is simply instrument problems, e.g. inadequate radiative transfer). The WG members agreed to provide information to a new ITWG Web page and to try to provide updates whenever their usage changed.

Action DA/NWP-3

John Le Marshall with ITWG input to facilitate the establishment of a Web page for instrument status (channel by channel being used where appropriate) and ensure this is linked to the ITWG Web page.

(Post meeting note: an existing page at <http://www.oso.noaa.gov/poesstatus/> exists.)

Action DA/NWP-4

John Le Marshall to ask NWP WG members to provide information to him on their current channel usage for each instrument (used now, used in the past, never used) for input to a summary table which he will put on the ITWG Web page.

The Working Group noted that a new email list server has been established for exchange of information on ATOVS data quality issues and also discussion of other topics relevant to the NWP WG. The address is itwg_nwp@metoffice.gov.uk and the administrator for the list is Stephen English.

The results of the ITWG survey presented at this meeting and reproduced in the Table 2.3-1 below, indicates that the NWP community still has an operational requirement for NOAA/NESDIS ATOVS data processing from level-1b to preprocessed (PP) level-1d radiances, through to retrieved products. The WG again wished to recognise the effort of Tony McNally (ECMWF)) for coordinating the survey and to all centres that responded.

Institute	Retrievals in Global NWP	Retrievals in Regional NWP	Radiances in Global NWP	Radiances in Regional NWP	external WWW DATA MON
<i>Australia</i>	NESDIS		YES-PP (1DVAR)	YES-PP (1DVAR)	YES
<i>Brazil</i>	NESDIS	ICI			NO
<i>Canada</i>			YES-1C (4DVAR)	YES-1C (3DVAR)	YES
<i>Denmark</i>				Yes-1C (3DVAR)	YES
<i>ECMWF</i>			YES-1C (4DVAR)		YES
<i>France</i>			YES-1C (4DVAR)	YES-1C (3DVAR)	YES
<i>Germany</i>	NESDIS				YES
<i>Hungary</i>				YES-1C (3DVAR)	NO
<i>India - IMD</i>		ICI			NO
<i>India - NCMRWF</i>	NESDIS				NO
<i>Japan</i>		NESDIS/JMA	YES-1C (4DVAR)		NO
<i>Korea</i>			YES-PP (3DVAR)		NO
<i>Spain</i>				YES-1C (3DVAR)	NO
<i>Sweden</i>				YES-1C (3DVAR)	NO
<i>UK</i>			YES-1C (3DVAR)	YES-1C (3DVAR)	YES
<i>USA (NCEP)</i>			YES-1C (3D SSI)	YES-1C (3D SSI)	YES
<i>USA (NRL)</i>		NESDIS	YES-1C (3DVAR)		NO

Table 2.3-1. Use of satellite data in operational NWP (ITWG survey of systems at 01 / 05 / 2005).

Notes

- 1) It shows that the NWP community still has operational requirements for all levels of NOAA/NESDIS ATOVS data processing from level-1b radiances to preprocessed radiances (PP), through to retrieved products. However there has been a major move towards direct radiance assimilation (and to 4DVAR).*
- 2) There is still a very limited use of tropospheric data (radiances or retrievals) over land and ice. This is true for microwave and infrared.*
- 3) Many more centres have monitoring information on external Web services (though some are password protected). These are excellent and their use is strongly encouraged.*
- 4) The responses from each NWP centre have provided much more information than is presented here and will be made available in full to all interested parties (hopefully on the ITWG Web site).*

Action DA/NWP-5

DA/NWP Co-Chairs and Tony McNally to provide information from ITWG NWP survey on ITWG Web page.

There continues to be questions raised at this meeting concerning the conversion of antenna temperatures to brightness temperatures for microwave instruments. The WG is concerned that biases are being introduced by the antenna correction and that users may start to use antenna temperature as if they were brightness temperatures. The WG would welcome further studies in this area.

2.3.3 Evaluation and use of AIRS in NWP

The WG agreed NESDIS should be congratulated for past activity in providing AIRS data and be encouraged to continue with the current activity to provide clear fields of view in thinned data sets available to the operational community. The WG discussed options for improved exploitation of AIRS, including new datasets. It was agreed that coordination was necessary in switching from the existing operational dataset to new datasets and that more evaluation of products using MODIS for cloud detection was required. It was also noted that more work is required on developing and testing methods which aim to allow the full spectral information to be used efficiently.

Action DA/NWP-6

Stephen English (Met Office) and Andrew Collard (ECMWF) to coordinate with NOAA the change to warmest fov over the US-Exeter link.

Recommendation DA/NWP-1 to ECMWF/Met Office

ECMWF/Met Office to evaluate AIRS "MODIS" product when it becomes available.

Action DA/NWP-7

Thomas Auligné and Stephen English to present recommendation DA/NWP-1 to ECMWF and Met Office for consideration.

Action DA/NWP-8

John LeMarshall to ask JCSDA to review AIRS 324 channel data set in light of full spectral resolution experiments and recommend any promising additions.

Recommendation DA/NWP-2 to NOAA

Add more MODIS cloud information on AIRS FOVS using existing AIRS BUFR tables rather than additional parameters.

Action DA/NWP-9

John LeMarshall to present recommendation DA/NWP-2 to NOAA, providing full details of what is required in consultation with the WG members.

2.3.4 Forward modelling

The WG welcomed the concept of CRTM where several radiative transfer model options have a common interface. The WG also noted that RTIASI and RTTOV-8 will merge with a common interface in RTTOV-9. The WG encourages developers of RTMs to continue to work towards use of common interfaces wherever possible.

Recommendation DA/NWP-3 to all RT model developers

Where possible use an existing interface (e.g. CRTM, RTTOV) for new models.

Action DA/NWP-10

Stephen English to ask Roger Saunders to communicate recommendation DA/NWP-3 to the wider RT development community.

Recommendation DA/NWP-4 to JCSDA (Paul van Delst) and NWP-SAF (Roger Saunders)

To work towards the same interface for CRTM and RTTOV.

Action DA/NWP-11

Stephen English to present recommendation DA/NWP-4 to the NWP SAF SG.

Action DA/NWP-12

John LeMarshall to present recommendation DA/NWP-4 to the JCSDA SG.

Recommendation DA/NWP-5 to NWP SAF (Stephen English)

To provide information to RTTOV users on sources of emissivity information and emissivity models.

Action DA/NWP-13

Stephen English to discuss with NWP SAF SG whether recommendation DA/NWP-5 can be undertaken by the NWP SAF.

2.3.5 Observing systems and real time access to data

As the use of satellite data matures, the design of observing systems, availability of data, procedures for introducing new data sources and how the data is delivered continue to be major sources of concern for operational NWP Centres. The WG recognizes that the inclusion of NWP early on in the preparation for provision of AIRS data was a positive step, and encourages future satellite programs to have similar programs.

It has been an ongoing concern of the ITWG NWP group that a significant portion of the observations arrive too late for complete inclusion in the data assimilation systems. The operational centres are under pressure to shorten the delivery times of their forecasts to the users and thus are shortening their cut-off times for data delivery. Also, a significant increase in the use of satellite data in limited area systems has been noted. These limited area systems often have shorter time requirements than global systems. Two encouraging advances have been noted. The significant improvement in the delivery time for the NPOESS satellites (20-30min) and the creation of the EUMETSAT EARS system should both allow a significant improvement in the availability of data. The creation of the EARS system has been particularly innovative in providing a low cost system to significantly improve delivery times for the data.

Recommendation DA/NWP-6 to CGMS

Continue to support fast delivery initiatives (EARS, RARS), extending where possible (e.g. Hawaii).

Action DA/NWP-14

Stephen English to communicate recommendation DA/NWP-6 to EUMETSAT and to ask John Eyre to bring it to the attention of WMO and CGMS.

Recommendation DA/NWP-7 to NOAA

To use new global ground stations to mitigate blind orbit problems for NPOESS data.

Action DA/NWP-15

John LeMarshall to present recommendation DA/NWP-7 to NOAA.

The use of research satellites in operational NWP centres has been increasing. The WG strongly welcomed the inclusion of research satellites in the global observing system as a very positive step forward. The availability of research data (e.g., the high spectral resolution data from AIRS) has allowed the NWP centres to develop techniques to use the data more quickly and allowing the monitoring components of the system to feed back to the instrument scientists. However, there continues to be development of satellite programs with no or limited real time access to the data.

The managers of new satellites and satellite programs have often been reluctant to allow outside users to access the data until it has been completely proven. However, NWP centres often have access to data, algorithms and monitoring capabilities which are unavailable to the satellite programs. This makes the NWP centres ideal partners in the initial evaluation process and allows them to begin early development of the infrastructure necessary to use the data.

Recommendation DA/NWP-8 to all satellite agencies

The assimilation community (all major NWP centres) to be part of the cal/val operation for future missions and to receive near real time data before final quality of the data has been established.

Action DA/NWP-16

John LeMarshall and Stephen English to ask ITWG Co-Chairs to ensure recommendation DA/NWP-8 is conveyed to all satellite agencies via appropriate international bodies (e.g. CGMS).

Recommendation DA/NWP-9 to all satellite agencies

While current operational practice and very considerable benefits are based mainly on the use of microwave data and the longwave and midwave IR components of the hyperspectral frequency range, the potential exists for continued gains to be made through additional application of the shortwave IR component of the spectrum. It is recommended that research addressing the problems of solar contamination and surface emissivity be given enhanced emphasis.

Action DA/NWP-17

Stephen English to ask the IASI Sounding Science WG Co-Chairs to note recommendation DA/NWP-9.

The WG welcomed the continuation of the "TOVS" heritage through future missions on METOP, FY-3, NPP and NPOESS. The WG reaffirmed the statement from past meetings that the positive impact of this data on NWP will be largest if satellite agencies choose complimentary overpass times which optimise the data coverage.

The WG is concerned that the instrument specification for ATMS channel noise exceeds current AMSU performance and that the choice of polarisations may not be optimal for sounding the lower troposphere. The WG were keen to do more scientific studies to provide good evidence for the impact of different choices in microwave sounder design on microwave sounder impact in NWP. When these studies are complete, the WG will be in a stronger position to formulate a recommendation to satellite agencies concerning future microwave sounding missions.

Action DA/NWP-18

Nancy Baker to get detailed instrument actual performance figures for ATMS and to then study the relative performance of AMSU-A and ATMS through experiments in the NRL NWP system. Note: JCSDA also plans an OSSE using ATMS this year.

Action DA/NWP-19

Tom Kleespies to repeat Kleespies & Watts MHS study for ATMS compared to AMSU-A.

The WG also noted that the absence of a 6.7 μm channel on VIIRS will prevent a continuation of the MODIS polar atmospheric motion vector product which has been proven to give very positive impact at several centres.

Recommendation DA/NWP-10 to IPO

To add a 6.7 micron water vapour channel to VIIRS.

Action DA/NWP-20

John LeMarshall to present recommendation DA/NWP-10 to the IPO JARG.

The WG discussed data distribution for NPP and METOP products and welcomed the developments for direct broadcast data for both satellites. Whilst the policy for GTS products is clear, the WG needs more information on the policy for distribution of non-GTS products. A specific example is whether the USA can forward METOP non-GTS products to South American countries.

Action DA/NWP-21

John LeMarshall to establish and report to the WG the NPP and METOP non-GTS data distribution policy for countries outside Europe.

Several presentations at ITSC-XIV showed the preparations by satellite agencies and NWP centres for METOP data. The WG considered it important that NWP centres provide input into channel selection for the GTS IASI product and choice of channels etc. for Web based IASI monitoring so that IASI monitoring at different centres can be easily compared.

Action DA/NWP-22

Thomas Auligné to propose and then circulate a monitoring strategy for IASI to be adopted by all NWP centres, to allow easy comparison of monitoring between centres.

Action DA/NWP-23

Stephen English to ask NWP WG members to study the proposal by Andrew Collard for IASI GTS products and provide feedback to Andrew Collard by the end of July 2005 (other IASI GTS questions/comments should be fed to Simon Elliot at EUMETSAT).

During ITSC-XIV NOAA-N was launched. During the meeting it was clarified that NESDIS could provide both NOAA-16 and NOAA-18 in a timely fashion, except when NOAA-16 and NOAA-18 are in conflict when N16 would lose 2 contacts/day because NOAA-18 would be given priority. There are 21 days in conflict, then 23 days out of conflict, then repeat. The data are not lost, just delayed for an orbit.

Recommendation DA/NWP-11 to NWP Centres

NWP centres to provide feedback to NESDIS if NOAA-16 data reception is not acceptable during NOAA-18 commissioning.

Action DA/NWP-24

Stephen English to inform NWP centres of the expected situation for NOAA-16 to NOAA-18 transition and recommendation 14.11.

Recommendation DA/NWP-12 to EUMETSAT

EUMETSAT to provide NOAA-15, NOAA-16, NOAA-17, and NOAA-18 HRPT data as part of EARS where possible.

Action DA/NWP-25

Stephen English to inform EUMETSAT EARS team of recommendation DA/NWP-12.

2.3.6 Other data assimilation issues

The WG welcome the effort of the NWP SAF and ECMWF in particular in organising a bias correction workshop with an open invitation to NWP centres to send observers. This will be held in November 2005 and details can be found at the ECMWF Web site. The WG also said that the bias correction Web based guidance provided by the NWP SAF on its Web site is very helpful.

Action DA/NWP-26

Graeme Kelly to re-advertise details of ECMWF bias correction workshop to ITWG.

Action DA/NWP-27

Stephen English to re-advertise existence of NWP SAF Web based guidance on bias correction on NWP SAF Web page to ITWG and to pass on positive feedback about the Web page to the NWP SAF SG.

The WG noted that considerable progress has been made towards consistent calibration of HIRS in global and direct broadcast data. The effort of CMS Lannion and in particular Pascal Brunel was gratefully acknowledged. The WG requested that NESDIS and CMS confirm whether all possible assistance was being provided from NESDIS to direct broadcast users.

Action DA/NWP-28

Mitch Goldberg to check with CMS (Pascal Brunel) whether NESDIS can provide any information which would allow AAPP processing of HIRS to be even closer to global processing.

The WG noted that re-tuning of AIRS observation errors in combination with a number of other enhancements had a considerable impact e.g., in the NH at JCSDA but little impact at ECMWF. It was agreed we do not know enough about each others observation errors.

Action DA/NWP-29

Stephen English to ask NWP WG members to supply him with information on assumed observation errors for radiance assimilation in order to create a summary Web page for the ITWG NWP WG Web page. This can then be updated as and when necessary.

Action DA/NWP-30

Stephen English to ask NWP WG members to provide him with text (with Web links where appropriate) to describe current techniques used at their centre for estimating observation errors (e.g. Chapnik method).

The WG agreed that there were many ideas and tools but little sharing of information on verification.

Action DA/NWP-31

All WG members to submit information on verification methods (including software tools where available) to Brett Candy, who will create a Web page for the NWP WG Web site.

2.3.7 ITWG NWP WG administration issues

The WG expressed a strong desire to provide a useful Web page under ITWG and noted many items which could or should be provided on it, reflected in many of the actions in this report.

Action DA/NWP-32

Stephen English to get initial information for NWP WG Web page to Leanne Avila.

Action DA/NWP-33

NWP WG Co-Chairs to review the status of the actions and recommendations in September 2005 and at regular intervals before ITSC-XV and email a status report to WG members and ITWG Co-Chairs.