

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

Web site: <http://cimss.ssec.wisc.edu/itwg/nwp/>

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2.3.1 Introduction

As in previous ITSC meetings, there were many substantive presentations at this meeting that indicated very positive results using satellite radiance data from many different instruments. This meeting concentrated on the use of the new data from the IASI instrument, the use of the new unified preprocessor for the SSMIS data and the use of cloudy radiances in NWP. Several operational centres showed quite positive results incorporating the long wave channels from the IASI instruments into their operational systems. The moisture channels appear to be more difficult to use with at least two centres reporting difficulty using some of the moisture channels. One center demonstrated problems using moisture channels with the adjoint sensitivity technique. The difficulties encountered may be because of correlated errors in the observational or representativeness error. It appears that it will be difficult to get useful information from the IASI shortwave channels because of the relatively large observational errors.

Results from the Unified Pre-Processor (UPP) applied to the SSMIS data were also presented. Pre-processing of the data was necessary because of several instrument problems for both F16 and F17. Use of the UPP data rather than the raw data appears to have made the temperature sounding channels useful for NWP. Additional enhancements to the UPP were discussed among attendees during the meeting.

Initial radiative transfer experiments including the effects of clouds indicate further 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 developments will be ongoing over at least the next five years.

Finally, the working group discussed making the NWP working group, NWP working group e-mail list and web pages more useful for the NWP community. Several recommendations about enhancements were made.

2.3.2 Evaluation and use of satellite radiance data in DA/NWP

A major justification for the development and launch of the TOVS/ATOVS instruments is their use in NWP. For that reason, improving the availability, quality, monitoring and use of the data is very important. The working group has noted several important developments since the last meeting. However, it was also noted by the working group that each satellite program has its own priorities and ways of doing things. Thus, many problems solved for one program come back in other programs. For that reason, it is important to continue to

encourage the satellite agencies to develop their programs in a way that provides maximum benefit.

The working group was encouraged to see the progress on a unified pre-processor for the SSMIS. The groups involved (NRL/Monterrey, Met Office, NESDIS) are to be complemented on their progress. Impacts from using the F16 unified preprocessor data within NWP models were shown and were encouraging. The availability of the F17 data was discussed. DMSP F17 raw data is flowing to NESDIS. Processing through UPP can commence after flight software modification is completed. Distribution of data in BUFR format should start within a month.

Action DA/NWP-1

When DMSP F17 data and also when UPP version 3 becomes available, Nancy Baker will notify users via the ITWG_NWP mailing list.

Several lessons were learned from the SSMIS experience. It was noted that the instrument problems overwhelmed the signal and required one to dig down deeply into instrument properties. As a result, it was concluded that it is critical that 1) instruments be characterized very well before launch and 2) that NWP requirements be fully taken into account in the design process. Several NWP centers got involved to make the data useful and they should be commended for their initiative and perseverance.

Recommendation DA/NWP-1 to all satellite agencies

Operational NWP centers should be part of the early cal/val operation for future missions and should receive near real time data before final quality of the data has been established.

The NPP/NPOESS system is at the stage where the cal/val procedures are being established. At this meeting, members of the IPO were present (a list of acronyms is provided in section 2.3.4). Discussions were directed toward ensuring the NWP centres are involved in the cal/val process and that the data flow and format are in place prior to the launch of the first instrument.

Action DA/NWP-2

In order to set up a list of international partners for cal/val of NPP/NPOESS instruments, members of the NWP WG will communicate their interest to the NWP WG Co-Chairs. The Co-Chairs will send this list to Karen Saint-Germain within the next week because in two weeks there is a peer review cal/val committee meeting. It should be noted that additions to the list at a later time are possible.

Action DA/NWP-3

Sid Boukabara to coordinate NPP/NPOESS data formats and information exchange (BUFR file content, line shapes, APCs, etc...) with ITWG WG.

The NWP WG expressed concerns about direct readout access through IPOPP because of the restrictions to IPO sanctioned components. Therefore, if IPOPP does not meet the requirements, then it was suggested that the NWP SAF software (to Level 1b) address the shortfalls.

The status of replacement for CMIS/NPOESS was also presented. Karen Saint-Germain announced that the government will lead the building of the initial MIS (Microwave Imager Sounder) unit. The Washington DC NRL laboratory was selected for this task. It is expected that follow-on units will be built by the private sector. The current baseline design includes AMSR-E, Windsat, SSM/I like capabilities, and SSMIS LAS (Low Atmospheric Sounding channels). Applications include soil moisture, polarimetric winds over water bodies, surface imagery, and lower atmospheric sounding.

The timely delivery of data remains a concern of the NWP working group. The timeliness requirements for the global models have tightened in some centres and for regional applications, the delivery of the data in time for use remains a challenge. The use of the RARS system has made quick delivery of data for the regional systems significantly better. The use of the Svalbard ground station has improved the delivery of the operational data stream for NOAA-18 and METOP.

Recommendation DA/NWP-2 to EUMETSAT and NESDIS

Delivery time is critical for NWP centers to enable the data to be used for nowcasting and short-range forecasts. Delays in ground-processing of observations prohibit the fulfillment of the strict data delivery requirements. The routing of data through the Svalbard station has been very beneficial for NOAA-18 and METOP. The WG recommends that EUMETSAT and NESDIS explore the possibility of sending the other still operating NOAA satellites (i.e., NOAA-15, 16, 17) through the Svalbard ground station. It is recognized that this is not trivial and may be costly and that the outcome may depend on a cost/benefit analysis.

Recommendation DA/NWP-3 to WMO

Continue to support fast delivery initiatives (RARS), extending where possible. However, the working group believes that the system should continue to be low-cost. Extension of RARS towards complete global coverage is encouraged until the point is reached where further improvements are no longer cost effective.

RARS distribution of Level 1B versus 1C data was discussed. Antenna Pattern Correction (APC) is at issue for some NWP centers. Current RARS system uses AAPP software to perform the APC. However, some centers use a different APC that is applied on the Level 1B NESDIS operational data stream. Hence for consistency, these centers would rather obtain RARS Level 1B data to be able to use the APC. The WG did not reach a consensus on preferring Level 1B or 1C.

A full orbit of HIRS data is needed for the operational calibration implying that the RARS data would not be distributed until one full orbit has been received. This would delay the distribution of all data (including AMSU) by at least ½ hour. The group felt that the HIRS calibration issue does not warrant a delay in the distribution of both AMSU and HIRS data.

Recommendation DA/NWP-4 to EUMETSAT and IPO

The short operational delivery time of NPOESS data to NWP centers is an extremely attractive component of the system design. The Safety Net (NPOESS ground receiving system) is expected to be online with NPOESS satellite C2 in 2016. While the NPOESS delivery will be greatly improved, the METOP delivery will be substantially slower. The working group recommends the satellite agencies make every effort to improve the operational delivery of the METOP data. This includes

the possibility of the Antarctic ground station, and the possibility for post-METOP-C satellites using the Safety Net ground system.

There was considerable discussion concerning the EUMETSAT plan to distribute IASI principal components (PCAs) rather than the individual channels.

Recommendation DA/NWP-5 to EUMETSAT

EUMETSAT is considering the distribution of PCAs (up to 300-400 PCAs) over EUMETCast instead of the full set of channels to save bandwidth. However, some selected users may still be able to receive the full channel information. The NWP WG recommends that both the new data formats and the full set of channels be distributed for a six month testing period. A final decision on the way forward should be made after the evaluation of the testing.

Action DA/NWP-4

European NWP WG members to discuss Recommendation DA/NWP-5 with their EUMETSAT OPS WG representatives.

The members of the NWP WG have found that intercomparisons between the various centres to be quite useful. The IASI instrument was thought to be a good opportunity for this intercomparison.

Recommendation DA/NWP-6 to NWP WG members

At the ITSC-15, it was recommended that a 15 IASI channel data set be used for near real time intercomparisons between different NWP centers. However, it was later noticed that only a few of the chosen 15 channels were included in either the EUMETSAT GTS data set (~300 channels) or the NESDIS (~600) data set. The working group reiterates the desirability of the intercomparison exercise.

Action DA/NWP-5

Fiona Hilton to select a new set (< 20) of IASI channels for intercomparison purposes. Fiona to give instructions on basic breakdown (e.g., clear, land, etc...) of profile types and the statistical variables (e.g., mean, standard deviation, histograms, diffusion diagram...) presented. It would be best if common formats were used but this is considered to be of lower priority. Links to the results will be put on the ITWG web site.

Action DA/NWP-6

Lars Fiedler (EUMETSAT) to put their IASI monitoring on their external web site.

The use of off-diagonal terms for the observation error covariance matrix (R) was briefly discussed. However, estimating the terms remains a difficulty requiring further research. Note that for the IASI instrument, the EUMETSAT archive contains estimates of the instrument (only) covariance matrix including apodization effects. However, representativeness errors are state dependent.

The reevaluation of the choice of AIRS channels (in reference to the ~300 channel set available on the GTS) was brought up. This may be a good idea but would imply significant adjustments to the processing and assimilation procedures at the operational centers. Most operational centers are moving on to newer instruments requiring urgent attention.

It is noted that the only planned GEO orbit high resolution IR sounders are the IRS on MTG and an instrument on FY4. We also note that the microwave plans are significantly behind.

Recommendation DA/NWP-7 to satellite agencies and WMO

The geostationary orbit is ideal for observing the rapidly changing components of the atmospheric and surface fields. The WG recommends the use of this orbit with high spectral resolution IR and/or microwave sounder/imager instruments. Ideally if both are possible the microwave and IR instruments should observe the same portion of the atmosphere at the same time.

2.3.3 Working group support for NWP community

The large number of instruments and agencies supplying data to the NWP community makes the use of the data a challenge. For this reason, the working group has formulated several recommendations and action items intended to improve the efficiency of the development.

Recommendation DA/NWP-8 to satellite agencies

The working group feels that the amount of information about current and future satellite systems and advanced notification of changes could be improved. Better communication is necessary for planning, preparation, and execution by the NWP community.

Action DA/NWP-7

NWP WG members to locate relevant satellite agency URLs and contact points where information can be found. The information will be obtained from space agencies through NWP WG members listed below.

Members to send URLs and contact points to Co-Chairs who will then put them on the ITWG web site. Chairs will then communicate with space agency contacts so that the ITWG_NWP mailing list can be added to their mailing list.

Action DA/NWP-7a

Fiona Hilton (UK MO) responsible for obtaining the information for EUMETSAT.

Action DA/NWP-7b

Peiming Dong (CAMS) responsible for obtaining the information for CMA.

Action DA/NWP-7c

Clemence Pierangelo (CNES) responsible for obtaining the information from CNES (www.smsc.cnes.fr).

Action DA/NWP-7d

Kozo Okamoto (JMA) responsible for obtaining the information from JAXA and JMA.

Action DA/NWP-7e

Min-Jeong Kim (NESDIS JCSDA) responsible for obtaining the information from KMA.

Action DA/NWP-7f

Alexander Uspensky (SRC Planeta) responsible for obtaining the information from ROSCOSMOS and ROSHYDROMET.

Action DA/NWP-7g

Godelieve Deblonde (EC) responsible for obtaining the information from the CSA.

Action DA/NEWP-7h

John Derber (NCEP) responsible for obtaining the information from NESDIS.

Action DA/NWP-7i

Karen Saint-Germain (IPO) responsible for obtaining the information from NPP/NPOESS.

Action DA/NWP-7j

Nancy Baker (US Navy NRL) responsible for obtaining the information from DMSP.

Action DA/NWP-7k

Dirceu Herdies (INPE/CPTEC) responsible for obtaining the information from INPE.

Volunteers are still needed for India, NASA, and RARS.

The availability of real time information on the status of the various instruments and platforms, while greatly improved, still is an area of concern for the working group. Since the data is distributed from a variety of agencies located around the world to all NWP centers, it is difficult to create a single distribution paradigm.

Action DA/NWP-8

Fiona Hilton to gather together information regarding what level of information messaging (METOP) is required by NWP centers and forward this information to EUMETSAT.

The ITWG NWP working group web pages and email list could be useful for the distribution of information among the NWP centres. The working group has noted that the contents and capabilities of these web pages have not kept up. A series of recommendations and action items were formulated to make better use of the web pages and email list.

Recommendation DA/NWP-9 to ITWG CIMSS web site webmaster

It is recommended that WIKI capability be set up on the ITWG CIMSS web site (under the supervision of the Co-Chairs).

Action DA/NWP-9

NWP WG chairs to provide survey template (start with what Tony McNally has used so far) to be put on ITWG WIKI page and allow updating as operational systems change. NWP WG chairs remind NWP centers to update the table through ITWG_NWP mailing list every six months and before next ITSC meeting.

Action DA/NWP-10

All members of the ITWG NWP working group to examine mailing list for missing relevant e-mail addresses. WG Co-Chairs to maintain and update the email list.

Action DA/NWP-11

NWP WG Co-Chairs to ask developers of software packages to announce new software releases on ITWG NWP mailing list. Specifically, the following software packages have been identified: CRTM, RTTOV, IPOPP, AAPP, and NWP SAF news.

Action DA/NWP-12

NWP WG Co-Chairs to review the status of the actions and recommendations at regular intervals and email a status report to WG members and ITWG Co-Chairs via the ITWG_NWP mailing list.

Action DA/NWP-13

NWP WG Co-Chairs to solicit ideas through NWP WG mailing list for WG topics prior to ITSC-17.

The challenges with the assimilation of radiance data in regional models were briefly discussed. It was noted that recommendations on the issue of bias correction can be found in the proceedings of the bias correction workshop held at ECWMF in 2005. The group noted that this was a large and a very complex problem and may benefit by more in depth discussion. This could be addressed in a regional satellite data assimilation workshop.

Action DA/NWP-14

The NWP WG will set up an email distribution list for those interested in regional satellite DA and the list will be sent to the ITWG_NWP mailing list.

A subgroup interested in regional satellite data assimilation was identified at the meeting consisting of M. Uddstrom, J. Derber, G. Deblonde, B. Harris, F. Hilton, R. Randriamampianina, T. Montmerle, B. Candy, K. Okamoto, N. Baker, S. English, R. Hess, and B. Yan.

A previous action item several ITSC meetings ago covered a single observation comparison between different NWP centers. Sue Ballard set up the comparison. It was noted that this is something that should be revisited since the use of data and background errors (e.g., flow-dependent) have changed substantially.

Action DA/NWP-15

Brett Candy and Roger Randriamampianina will work together to design single observation experiments in a global and regional model setting and the results will be accessible though the ITWG web site.

The format of the ITSC meeting was discussed and several options were discussed with the ITWG Co-Chair (S. English). It was suggested that if there are split sessions that a participant in each session be identified to write and present a comprehensive summary of the session to the full ITSC audience.

Action DA/NWP-16

As recommendations 2, 3, 4, and 7 (see above) do not have associated action items, the working group co-chairs will bring these to the attention of the relevant bodies.

2.3.4 List of Acronyms

AAPP: ATOVS and AVHRR Pre-processing Package

APC: Antenna Pattern Correction

BUFR: Binary Universal Form for the Representation of meteorological data

CAMS: Chinese Academy of Meteorological Sciences

CIMSS: Cooperative Institute for Meteorological Satellite Studies (University of Wisconsin-Madison)
CNES: Centre National D'Etudes Spatiales (France)
CRTM: Community Radiative Transfer Model
CSA: Canadian Space Agency
DA: Data Assimilation
DMSP: Defense Meteorological Satellites Program
EC: Environment Canada
EUMETSAT: European Organization for the exploitation of meteorological satellites
FY-4: Geostationary satellite from China
GTS: Global Telecommunications System
INPE: Instituto Nacional de Pesquisas Espaciais (Brazil)
ITSC: International TOVS Study Conference
IPOPP: International Polar Orbit Processing Package
IPO: Integrated Program Office
IRS: Infrared Sounder
ITWG: International TOVS Working Group
JAXA: Japan Aerospace Exploration Agency
JCSDA: Joint Center for Satellite Data Assimilation
JMA: Japan Meteorological Agency
KMA: Korean Meteorological Administration
MTG: Meteosat Third Generation
NCEP: National Centers for Environmental Prediction
NESDIS: National Environmental Satellites, Data, and Information Service
NPP: NPOESS Preparatory Project
NRL: Naval Research Laboratory
NPOESS: National Polar-orbiting Operational Environmental Satellite System
OPS: Operations
RARS: Regional ATOVS Retransmission Services
RTTOV: Radiative Transfer for TOVS
SAF: Satellite Application Facility
SMSC: Site des Missions Scientifiques du CNES
SRC Planeta: Scientific and Research Centre on Space Hydrometeorology "PLANETA"
Russian state organization established since 1974
UK MO: United Kingdom Met Office
UPP: Unified Pre-processor (SSMIS)
WG: Working Group