

ITSC-21 Working group on Data Assimilation and Numerical Weather Prediction

Attendees

Fiona Smith (Bureau of Meteorology/Met Office), Andrew Collard (NOAA/NCEP/EMC), Roger Randriamampianina (Met Norway), Masahiro Kazumori (JMA), Vincent Guidard (Météo-France), Cristina Lupu (ECMWF), Marco Matricardi (ECMWF), Kozo Okamoto (JMA), Mohamed Dahoui (ECMWF), Bill Bell (Met Office), Patrik Benacek (CHMI), Reima Eresmaa (ECMWF), Fabien Carminati (Met Office), James Cameron (Met Office), Sanjeev Kumar Singh (NCMRWF, India), Awdhesh Sharma (NOAA/NESDIS/OSPO), Indira Rani (NCMRWF, India), Wei Han (CMA), Keyi Chen (ZAP/CAS), Heather Lawrence (ECMWF), Louis Garand (ECCC), Bill Campbell (NRL), Jun Li (CIMSS), Haixia Liu (NOAA/NCEP/EMC), Jérôme Vidot (Météo-France/CMS), Yong Chen (NOAA/NESDIS/STAR), Likun Wang (Univ. of Maryland), Niels Bormann (ECMWF), James Jung (CIMSS), Chu-Yong Chung (KMA), Qifeng Lu (CMA/NSMC), Agnes Lim (CIMSS), Thomas August (EUMETSAT), Yanqiu Zhu (NOAA/NCEP/EMC), Jörg Ackermann (EUMETSAT), Ben Johnson (JCSDA), John Eyre (Met Office), Katrin Lonitz (ECMWF), Will McCarty (NASA GMAO), Dave Santek (CIMSS), Sylvain Heilliette (ECCC), Chris Burrows (ECMWF), Dirceu Herdies (CPTEC), Jin Woo (KMA), Junhyung Heo (KMA), Kirsti Salonen (ECMWF), Nai-Yu Wang (ESSIC/University of Maryland), Meeja Kim (KMA), Qiang Zhao (NOAA/NESDIS/IMSG), Yanqiu Zhu (NOAA/NCEP/EMC), Alan Geer (ECMWF), Pete Weston (ECMWF), Ruth Taylor (Met Office), Stefano Migliorini (Met Office), Brett Candy (Met Office), Tim Hultberg (EUMETSAT), Seon Ki Park (EWHA), Stu Newman (Met Office), Bob Tubbs (Met Office), Bomin Sun (NOAA/NESDIS), Yasutaka Murakami (JMA), Allen Larar (NASA Langley), Jeon-Ho Kang (KIAPS), Hyoung-Wook Chun (KIAPS), Olivier Coopmann (Météo-France), Florian Suzat (Météo-France), Christina Köpken-Watts (DWD), Kristen Bathmann (NOAA/NCEP/EMC), Eunhee Lee (KMA)

0. Scope of the DA/NWP Working Group

The scope of the group with respect to geostationary sounders was discussed. It was decided that it was appropriate to include geostationary sounders (and to some extent imagers) provided the science was within the scope of the conference generally, i.e. it related specifically to passive sounding applications rather than imagery applications (including AMVs).

1. Standing Actions and Recommendations

Action DA/NWP-1 on ITSC Co-chairs: To bring relevant recommendations to the attention of CGMS.

Polar orbiting constellation

Over the years, many observation impact experiments have demonstrated benefits from using MW and IR sounding data from three or more polar orbiting systems in NWP, compared to using data from just two orbits. An even spacing of orbits (early morning, morning, afternoon orbit) ensures most homogeneous coverage, with benefits for forecast impact. The WG strongly supports international cooperation to ensure harmonization of orbits. The group would like to recognise that good work has been done in support of this recommendation already over the last few years. It has been agreed that the Chinese satellite FY3E will be placed in early morning orbit, but for future FY satellites the orbit is not yet confirmed. The working group therefore noted the continuing uncertainty around the presence of sounding instrumentation in the early morning orbit

Recommendation DA/NWP-1 to all relevant space agencies: The constellation of at least three orbits (early morning, morning, and afternoon), each with full sounding capabilities (IR and MW), should be maintained. The overpass times of operational satellites with sounding capability (IR and MW) should be coordinated between agencies to maximize coverage and include a satellite in early morning orbit.

With the discontinuation of the DMSP satellites, the availability of high altitude temperature sounding channels is in doubt. It is therefore recommended that options to continue this capability be explored.

Recommendation DA/NWP-2 to the Satellite Agencies: In support of maintaining a robust global satellite observing system, instrumentation to allow continued sounding of the temperature of the upper stratosphere and mesosphere (as for the SSMIS UAS channels) should be explored.

Cal/val of future instruments

The working group believe that the distribution of test data prior to launch is of such importance that the following recommendations should be repeated to ensure that users have adequate test data to fully prepare for future systems.

Recommendation DA/NWP-3 to Space Agencies: New operational data dissemination infrastructure should be tested at an early stage (well before launch) with simulated data. Furthermore, NWP data has proven to be a critical resource in the Cal/Val process for new instruments.

Recommendation DA/NWP-4 to Space Agencies: There should be open and early access to new satellite data for all NWP centres to help with calibration and validation.

Investment to fully realise potential of new satellites in operational use.

New satellite programmes can cost hundreds of millions of Euros and yet it can take many years to learn to properly exploit the data in numerical weather prediction. Additional investment in operational NWP (which while still expensive is only a few percent of the satellites themselves) therefore represents an efficient path for improving the cost/benefit ratio for satellite observations. This investment should focus on improved computational resources (allowing more sophisticated models to be run and more resources for research); development of new assimilation techniques (many centres are still not running 4D assimilation systems thereby reducing the impact of observations with high temporal frequency) and improvement to the forecast models, as well as methods focused on the particular observations themselves. Investment in operational NWP is preferred as research conducted in this paradigm from the start is more easily transferred to operational status. It is also noted that the larger the number of operational centres able to conduct cutting-edge research, the more likely that breakthroughs will be made in the use of satellite data.

Recommendation DA/NWP-5 to funding bodies of NWP centres and space agencies: Consider, as part of the cost of satellite programmes, providing computational and personnel resources targeted at operational NWP centres to optimise the public's return on investment from these expensive measurement systems.

Radio Frequency Interference

At ITSC-17, an activity was started to collect evidence from existing Radio Frequency Interference (RFI) or research into potential impacts of RFI in NWP systems. A website has been set up for this task (https://groups.ssec.wisc.edu/groups/itwg/nwp/rfi_and_nwp), including examples for Windsat, SMOS, and AMSR-E. We need to be able to document instances of RFI so that evidence can be presented to the relevant national authorities who may be able to remove offending illegal transmissions.

Action DA/NWP-2 on NWP WG members: Send any evidence of RFI to working group chairs for inclusion on the NWP WG RFI web page and forwarding to Jean Pla (jean.pla@cnes.fr) or Richard Kelley (richard.kelley@noaa.gov).

Updated channel characteristics

NWP systems or Simultaneous Nadir Overpass (SNO)-methods have been used to revise channel characteristics such as central pass-band frequencies for microwave instruments or spectral response functions for IR sounders. The group think that it is still useful to collect this information on the channel characteristics web-page of the RT WG, as such updates have been

shown to reduce some airmass-dependent biases and therefore aid the assimilation of the affected data.

Action DA/NWP-3 on NWP WG members: If you have estimates of revised channel characteristics resulting from post-launch diagnostics, please email these to the radiative transfer working group chairs (Benjamin.T.Johnson@noaa.gov & Marco.Matricardi@ecmwf.int)

2. WG support to NWP community

The ITSC NWP WG is recognized as an ideal forum to exchange information and inform/update NWP users about new developments, aided by Wiki-pages and a dedicated email list. For several meetings, the survey on the use of satellite data has been capturing the broad developments in the assimilation of sounder data in NWP, with the results posted on the NWP WG web pages. Ahead of ITSC-21, an extra column has been added to allow centres to link in further information (e.g. regarding blacklisting).

Action DA/NWP-4 on NWP centres: Continue to provide information on instrument channels assimilated and their observation errors for inclusion on the NWP Working Group pages in advance of each conference.

The group was pleased by the increased use of the working group mailing list in highlighting problems with operational instruments and members are encouraged to continue to share experiences this way.

It was pointed out that working group members may not be aware of all the notification services available from data providers. The working group chairs will put this information on the working group webpage.

Action DA/NWP-5 on WG Chairs: Add information on the notification services from operational data agencies to the working group webpage.

3. Provision of BUFR data

At previous meetings, the group made the recommendation (ITSC-XX/DA/NWP-8) to Data Providers to agree a standardized procedure for inclusion of NEdT estimates within BUFR for microwave data.

Since the last meeting, NEDT estimates have been added to the ATOVS BUFR data distributed by EUMETSAT.

However, it remains an issue that the calculation of the NEDT differs between NOAA, EUMETSAT and the Met Office. Jörg Ackermann (EUMETSAT) distributed a report detailing the differences between these approaches. For further progress, working group members should review these approaches and make suggestions as to the preferred method for calculating NeDT.

Action DA/NWP-6 on WG members: Review the summary document on different methods of calculation of NEDT compiled by Jörg Ackermann and feed back to the Working Group Chairs by 1st March 2018.

Recommendation DA/NWP-6 to Data Providers: Agree standardized procedure for calculation of NEDT estimates for inclusion within BUFR for microwave data.

The group retained the following two recommendations from previous conferences:

Recommendation DA/NWP-7 to Data providers: Include azimuthal viewing and solar angles as appropriate in BUFR for present and future instruments.

Recommendation DA/NWP-8 to Space Agencies and data providers: When designing new or modified BUFR formats, please circulate drafts to the NWP community via the NWP Working Group for feedback, prior to submission to WMO.

4. CrIS switch to Full Spectral Resolution data

CrIS data from NOAA-20 will only be distributed as Full Spectral Resolution (FSR) data, but the decision on when to transition the data dissemination for S-NPP from Nominal (NSR) to FSR needs to be made. Every centre will have a different strategy for making this transition, but it was agreed that the optimal strategy to maximise data usage would be for the transition to FSR for S-NPP to occur when centres are ready to start assimilating CrIS from NOAA-20 (and for some centres it may be necessary to switch both to FSR at the same time). Six months from the start of NOAA-20 data dissemination was considered a reasonable timeframe for this.

Recommendation DA/NWP-9 to Data providers: The transition from NSR to FSR for CrIS data from S-NPP should occur no earlier than six months after CrIS NOAA-20 data becomes available.

5. IASI Non-linearity correction

Following the change to non-linearity correction on Metop-B IASI, CNES plan to update the non-linearity correction algorithm for Metop-A IASI at the beginning of February 2018, pending any objections from users.

Nobody in the working group expressed any reasons why the change should not be made to Metop-A IASI.

6. PC Compression of Hyperspectral Data

At the last conference, a recommendation (ITSC-XX/DA/NWP-13) was made to data providers and NWP users to agree a mutually acceptable update strategy for the dissemination of PC products. Thomas August and Tim Hultberg (EUMETSAT) closed the associated action (ITSC-XX/DA/NWP-13) to circulate a proposal for an update strategy, which in brief proposes an 8-week warning plus test data for a change to the eigenvector basis set (without change to number of eigenvectors).

The working group broadly agreed that this strategy is acceptable but ask data providers to note that it is a change that will require activity by NWP Centres, possibly including updating error covariance matrices. Acknowledging that centres do not currently use PC-compressed data streams in operations, a longer lead time is requested for the first of such changes in order to ensure that 8 weeks is indeed an adequate lead time.

We retained the following recommendation from the last conference:

Recommendation DA/NWP-10 to Data Providers: When using PC compression, noise normalisation should be performed using the full noise covariance matrix.

Although the full noise covariance matrix is not currently used for IASI compression, the PC basis vectors are in need of updating and the full matrix could be introduced at the same time. This might be a good test case for trying out the 8-week lead time proposed for a change, assuming centres were able to run near-real-time assimilation experiments of PC-compressed data before the switch to new vectors is made.

The group expressed interest in the work being done at EUMETSAT into Hybrid-PC compression (using a few hundred global PCs with 3 granule-based vectors of the residuals added). The use of such an approach should mitigate the requirement for ad hoc changes to PC basis vectors, and instead a planned annual update could be foreseen.

Recommendation DA/NWP-11 to EUMETSAT: Proceed with work on the use of Hybrid PC compression and investigate practical application of this method, including the incorporation of granule-based vectors in BUFR.

7. Change management and the NWP community

There were a number of instances this year where the management of change to the global observing system did not meet the requirements of the NWP community.

There were two planned changes to the calibration of instruments (ATMS on S-NPP and IASI on MetOp-B) where notification via official services should have been more timely and (where applicable) test data should have been provided. In both of these cases, the calibration changes resulted in changes to instrument biases of several tenths of a Kelvin - enough to potentially impact NWP fields.

The group felt strongly that it should be unambiguously communicated by data providers when a significant change such as these are to be made. This should be done at least 8 weeks before the change and, where possible, test data should be provided. A initial definition of a “significant change” is where the brightness temperature changes in the mean by 0.1K or 20% of NEdT (whichever is smaller).

Recommendation DA/NWP-12 to Data Providers: If a change to data processing results in a change in brightness temperature of 0.1K or 20% of NEdT (whichever is smaller), this should be made clear in notifications to users. These notifications should be made no later than 8 weeks before the change and test data should be provided if possible.

There was also some disappointment in the group on the very short transition (19 days) from GOES-13 to GOES-16, which was considered too short for NWP centres to introduce new instruments and data products (the International Winds Working Group, IWWG, has previously recommended an overlap of not less than 9 months). In addition, some data products (such as the Clear Sky Radiances) will not be available before Spring 2019, resulting in a fifteen month gap in the products.

It was noted that this transition did not follow WMO guidelines for change management and user consultation.

Recommendation DA/NWP-13 to Data Providers: The overlap period where one satellite resource is replacing another should be chosen after consultation with the user community and should follow WMO guidelines.

8. Pre-processing Software

NWPSAF MTG-IRS Pre-Processor (IRSPP)

This software is proposed to be made available in a similar way to AAPP for the polar orbiting sounders. Nigel Atkinson (Met Office) is currently collating a list of requirements for the software. The group had not had time to properly consider this, although one new proposal was made that the package could be configured to automatically download the PC eigenvector basis set required to decode the data if not already available at runtime.

NWPSAF Microwave Imager Pre-Processor (MWIPP)

The NWPSAF are also planning a microwave imager pre-processing package, incorporating features of the current SSMIS-PP Averaging Module and extending to other instruments such as AMSR-2, GMI and the future MWI. A similar request was made for feedback on this proposal.

A suggestion was made that for all-sky assimilation, superobbing is generally onto a fixed (NWP) grid rather than across the scanline. The pre-processor should support averaging onto this kind of grid as well as on the native instrument grid.

Action DA/NWP-7 on WG chairs: Forward Nigel Atkinson's email requesting input on design and features of IRSP and MWIPP to working group members

Action DA/NWP-8 on WG members: Review requirements for IRSP and MWIPP and feed back to Nigel Atkinson and NWP WG co-chairs by 1st March 2018.

9. Provision of collocated imager data from within the footprint of hyperspectral sounders.

Action DA/NWP-16 at ITSC-XX was assigned to Andrew Collard to request information from a VIIRS clustering algorithm to be included in the CrIS BUFR data. While this request was made, progress requires delivery of this algorithm from the AAPP group and this is expected in Spring 2018. This action has been taken up by the Software and Products Working Group.

10. Bias Correction

Constrained bias correction

As part of his studies into constrained bias correction, Wei Han (CMA) is investigating forward model and bias correction uncertainty. To do this he requests that members of the ITWG send him first-guess departures and bias correction values for ATMS and AMSU-A at nadir. A more detailed request for exactly what is required and in what format will be sent to the group.

Action DA/NWP-9 on Wei Han: Distribute a detailed request for data required for his constrained bias-correction study

Action DA/NWP-10 on WG members: Respond to Wei Han's request.

Regional bias correction

At ITSC-XX, interested members of the group met to discuss methods for correcting instrument bias in regional models. The working group expressed a desire to monitor progress that has been made in this area, although there is no scope for an additional meeting at this conference.

Action DA/NWP-11 on Working Group chairs: Circulate request for updated information on regional bias correction methods

Action DA/NWP-12 on WG members: Respond to this request.

Formation of a bias correction sub-group

Other aspects of bias correction were discussed by the group, including the need for better information about RT biases and reinforcement of NWP model bias within VarBC schemes. Extended approaches are needed to handle this. Bias correction schemes for cloudy data are expected to be problematic because in these situations, model biases can be large. The issues are sufficiently numerous and broad that a separate sub-group is proposed.

Action DA/NWP-13 on DA/NWP WG Co-chairs: Organise a meeting of a bias correction sub-group to meet at the next ITSC conference

Adaptive bias correction and quality control

Recent calibration changes have in general been handled well by VarBC, especially combined with VarQC, whilst minimising manual intervention in the data flow.

Recommendation DA/NWP-14 to NWP Centres: Adaptive bias correction schemes are now in wide use and proven to be effective in handling large changes to instrument calibration. Centres should aim to use adaptive bias correction wherever possible.

11. New and future mission evaluation

Evaluation of current and near-to-launch missions

It is desirable for the data quality of new operational instruments to be evaluated directly by the NWP centres. It is noted however, that there are many instruments that are pre-operational (or failed prematurely) for which evaluation by the NWP centres may be less of a priority that could be evaluated by the wider community. With, for example, tools such as the NWPSAF RadSim and NWP fields freely available from the NWP centres, detailed evaluation of instrument performance can be performed without the need to run an NWP model or data assimilation system.

There was some discussion as to whether the data available in NWP centres' archives is sufficient for this. In particular: the temporal frequency of the fields that are archived may need to be increased to allow sufficiently accurate temporal interpolation; and certain necessary information may be missing for scenarios such as convective cloud (although it was also pointed out that this sort of evaluation should probably avoid cloudy regimes).

Recommendation DA/NWP-15 to the research community: The data quality of developmental instruments may be evaluated by the research community, through the use of existing freely available NWP fields and radiance simulators. This is most appropriate where NWP centres are unable to fulfill this rôle and should be done in close collaboration with the NWP community.

Recommendation DA/NWP-16 to NWP centres: Review whether archived NWP output is sufficient for the purpose of evaluating instrument quality without running the NWP model.

The recent GAIA-CLIM project has evaluated several new datasets including FY-3 microwave data and MTVZA, and is considered to have been a very successful collaboration. It is proposed that evaluation of new instruments by NWP centres is carried out in a coordinated and collaborative manner.

Several centres expressed intention to evaluate GIIRS data from FY-4A when made available by CMA. It was proposed that interested centres should therefore coordinate their work.

It was reported that data, including at the interferogram level, could be made available to interested parties during early 2018 for evaluation, though real-time dissemination would take longer. CMA would also be interested for centres to evaluate HIRAS data from FY-3D

Action DA/NWP-14 on Chris Burrows and Qifeng Lu: Seek expressions of interest on coordinating evaluation of GIIRS and HIRAS data once available to the NWP community.

Evaluation of FY-3E data will be critical to support requests for satellites in the early morning orbit, and impact assessments will be sought by CMA.

Action DA/NWP-15 On WG Members: Share impact assessment results for FY-3E with the group and CMA as soon as possible after data becomes available, in particular to provide evidence for support of the early morning orbit.

Support for future research missions

Proposals for new research missions (such as those that may be launched as small satellites or from ISS) often require statements of requirement and evidence of utility in an NWP context, and especially evidence for requirement of near-real time data dissemination which is very costly. However, national NWP centres do not typically have capacity to perform impact studies

for missions that are not secure and may be demonstrators of unproven science. However, collaboration with NWP centers would be beneficial so that results from these assessments are readily translatable when the data are available and of sufficient quality.

Recommendation DA/NWP-17 to proposers of research missions: Promote studies from the research community, in particular non-operational centres that run NWP models, to investigate the utility of non-traditional measurement platforms (e.g. small satellites or observations from ISS). Collaboration with operational NWP centres is encouraged.

At the same time, near-real time data supply does increase likelihood of engagement of operational centres. The group acknowledged that this can sometimes add significant cost to a mission. Such near-real time supply does not, however, have to be at a high reliability level.

Recommendation DA/NWP-18 to proposers of research missions: Near-real time dissemination of data is extremely valuable to engage the operational community in mission evaluation, but high reliability levels (e.g. >95%) do not need to be a requirement at the pre-operational stage or for short-term research missions.

12. Monitoring

An action from ITSC-XX on the definition of a common set of monitoring plots has been dropped, but it was noted at this meeting that the reanalysis community have plans to allow comparison of assimilation systems via the sharing of data in a common format.

The NWPSAF website contains a new page displaying data availability and timeliness, initially from the Met Office and DWD. Working group members are encouraged to visit the page <https://www.nwpsaf.eu/site/monitoring/nrt-availability/data-timeliness/>

It was noted that data timeliness is greatly dependent on the mechanism for data dissemination at different centres. Whilst the NWPSAF website is understandably focussed on the member centres, links can be added to plots from other centres outside of the SAF. In particular it would be of interest to see differences in the timeliness from centres outside the EUMETCast network. It was noted that timeliness constraints can differ markedly based on application - in particular regional models have much tighter requirements for this.

Recommendation DA/NWP-19 to WG members: Consider producing timeliness plots similar to those on the NWPSAF website and where possible request they are linked to for comparison.

Action DA/NWP-16 on NWPSAF: Add links on the NWPSAF data timeliness site to monitoring of DBNet stations' data timeliness.

13. Stratospheric Water Vapour

The question was raised as to whether there is sufficient information available to constrain the stratospheric water vapour in data assimilation, in particular noting the effect of this on heating rates and therefore temperature. It was noted that Aura-MLS would be a good candidate to provide this constraint, and also that this instrument is old and with no replacement planned. It is recommended that studies be conducted to show whether a simple climatological constraint on stratospheric humidity is sufficient for this purpose or whether the assimilation of Aura-MLS data would provide additional information.

Recommendation DA/NWP-20 on NWP Centres: Determine whether existing climatological constraints on stratospheric water amounts are sufficient or whether additional observations (such as the aging Aura-MLS) provide significant information.