

Working group on Data Assimilation and Numerical Weather Prediction

Attendees

Fiona Smith (Bureau of Meteorology), Andrew Collard (NOAA/NCEP/EMC), Vincent Guidard (Météo-France), Cristina Lupu (ECMWF), Marco Matricardi (ECMWF), Kozo Okamoto (JMA), Bill Bell (Met Office), Reima Eresmaa (ECMWF), Fabien Carminati (Met Office), Indira Rani (NCMRWF, India), Bill Campbell (NRL), Haixia Liu (NOAA/NCEP/EMC), James Jung (CIMSS), Qifeng Lu (CMA/NSMC), Agnes Lim (CIMSS), Thomas August (EUMETSAT), Yanqiu Zhu (NOAA/NCEP/EMC), Ben Johnson (JCSDA), Katrin Lonitz (ECMWF), Sylvain Heilliette (ECCC), Chris Burrows (ECMWF), Ruth Taylor (Met Office), Stefano Migliorini (Met Office), Brett Candy (Met Office), Stu Newman (Met Office), Hyoung-Wook Chun (KIAPS), Olivier Coopmann (Météo-France), Christina Köpken-Watts (DWD), Kristen Bathmann (NOAA/NCEP/EMC), Eunhee Lee (KMA), Chawn Harlow (Met Office), Tom Auligné (JCSDA), Karen St. Germain (NOAA), Mitch Goldberg (NOAA), Chris Barnet (STC), Nadia Fourrié (Météo-France), Olaf Stiller (DWD), Hidehiko Murata (JMA), Jonathan Guerrette (UCAR), Francesca Vittorioso (CNRM), Bruna Barbosa Silveira (Météo-France), Emily Morgan (FNMOC), Robin Faulwetter (DWD), Zhipeng Xian (CAS), Ruoying Yin (CAS), Maziar Bani Shahabadi (ECCC), Christina Stumpf (DWD), Buddhi Prakash Jangid (NCMRWF, India), Magnus Lindskog (SMHI), Zheng Qi Wong (Met.no), Liam Gumley (CIMSS), Ricardo Todling (NASA/GMAO), Dmitry Gayfulin (Roshydromet), David Duncan (ECMWF), Jeon-Ho Kang (KIAPS), Erin Jones (NOAA/NESDIS), Silke May (DWD), David Tobin (CIMSS), In-Hyuk Kwon (KIAPS), Zied Sassi (CNRM), Ming Chen (NOAA/NESDIS), Joel Bedard (ECCC), Stéphane Laroche (ECCC), Bryan Karpowicz (NASA/GMAO), Dirceu Herdies (CPTEC), Maria Toporov (U. Köln), Marc Pondrom (DWD), Lawrence Flynn (NOAA/NESDIS), Mathieu Assery (Météo-France)

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.

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. Those using the SSMIS instrument are making good use of the instrument. No other instrument has comparable upper atmospheric sounding channels and the instrument shows positive impact in FSOI.

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.

Recommendation DA/NWP-3 to the NWP Centres: : Work to assess the impact of the upper atmospheric sounding channels of SSMIS in NWP and determine the information content unique to those channels e.g. via data denial experiments.

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-4 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-5 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 the 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 characterisation of uncertainties and development of 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-6 space agencies: Satellite agencies should work with their primary user communities to assess the limitations in the exploitation of satellite data, and also engage with users less closely connected to their agencies

Recommendation DA/NWP-7 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

Radio Frequency Interference (RFI) has the potential to seriously impact the usefulness of data used for NWP. Instances of RFI should be documented to provide evidence to spectrum managers who try to safeguard the passive bands that the NWP community rely on. Low-level interference that is hard to detect may be particularly difficult to account for.

Action DA/NWP-2 on NWP WG members: Send any evidence of RFI in the observations to Stephen English (stephen.english@ecmwf.int) and Richard Kelley (barometer@verizon.net) and also the results of experiments investigating the effects of RFI on forecast skill.

Stephen and Richard will coordinate the provision of information and results to CGMS.

Action DA/NWP-3 on NWP WG chairs: Discuss with Stephen English (stephen.english@ecmwf.int) and Richard Kelley (barometer@verizon.net) where to collate information on RFI in NWP (e.g. DA/NWP-WG web page).

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 believe 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-4 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-5 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 continues to appreciate the use of the working group mailing list in highlighting problems with operational instruments and members are encouraged to continue to share experiences this way.

Action DA/NWP-6 on Working Group Members: look at the working group website and make suggestions and corrections

Action DA/NWP-7 on Working Group Co-chairs: Review the current mailing list membership and migrate to a new platform (google groups).

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.

Recommendation DA/NWP-8 to Data Providers: Agree standardized procedure for calculation of NEdT estimates for inclusion within BUFR for microwave data.

Action DA/NWP-8 on Working Group Chairs: Clarify with Banghua Yan regarding the status of provision of NEdT estimates in BUFR files for microwave data from NOAA/NESDIS.

The group retained the following two recommendations from previous conferences:

Recommendation DA/NWP-9 to Data providers: Include azimuthal viewing and solar angles as appropriate in BUFR for present and future instruments.

Recommendation DA/NWP-10 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

The switch from Nominal Spectral Resolution (NSR) to Full Spectral Resolution (FSR) CrIS data for the S-NPP satellite has been proposed for 01 April 2020. NOAA-20 data has been available in this format for over a year. Centres are either using FSR in operational assimilation or have strategies to convert between the two formats. NOAA/NESDIS are providing FSR and NSR in parallel, but EUMETSAT currently distribute only the NSR dataset.

Recommendation 11 to EUMETSAT: Communicate when NSR for S-NPP CrIS will be switched off and provide a parallel stream for a short time (a few weeks) to allow users to transition to the new dataset.

Action DA/NWP-9 on Working Group Co-Chairs: Ensure the April 1st 2020 date for the end of NESDIS distribution of S-NPP NSR CrIS data is communicated to the group.

6. PC Compression of Hyperspectral Data

We retained the following recommendations from the last conference:

Recommendation DA/NWP-12 to Data Providers: When using PC compression, noise normalisation should be performed using the full noise covariance matrix.

Recommendation DA/NWP-13 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.

Thomas August (EUMETSAT) confirmed that the IASI PC-compressed data stream will be updated during 2020 to use the full noise covariance matrix, a training data set with updated trace gas events, and an additional 5 vectors derived from the granule (Hybrid PCA). More than 8 weeks notice will be given, as agreed at the last conference.

In addition, EUMETSAT is planning studies on the use of hybrid PCs to prepare for the MTG-IRS user community. MTG-IRS data will be disseminated as hybrid PC Scores.

Recommendation DA/NWP-14 to NWP Centres: All centres should use the IASI Hybrid PC-compressed dataset to ensure they are prepared for MTG-IRS. Users are requested to provide feedback to EUMETSAT on the use of these data.

7. Change management and the NWP community

Unfortunately, despite CGMS agreeing to the recommendations made at the last conference, there were again a number of instances during 2019 where the management of change to the global observing system did not meet the requirements of the NWP and DBNet communities.

Planned changes to the calibration of instruments, in particular to ATMS, were not appropriately notified to the community. In the case of ATMS, notification to the community only occurred only via unofficial channels. The group agreed once again that responsibility for advising the users of

such changes lies with data providers and that they should unambiguously communicate to users using multiple channels when significant changes such as these are to be made.

In the case of the Metop-A IASI non-linearity correction, the WG would like to thank Stephanie Guedj and Dorothee Coppens for their communications about the IASI change, but it is not clear that all users will have been reached by these informal channels. The community was advised of the upcoming change via the EUMETSAT UNS weekly operations bulletin, but the message retained the phrase “The exact time will be provided closer to the event” even on the date of the change, which could have been confusing.

The switch of S-NPP CrIS electronics to the B-side was reported to have been well-communicated to users, but some people were not satisfied with updates regarding when the data would be reinstated.

Recommendation DA/NWP-15 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.

Action DA/NWP-10 on WG co-chairs: Provide feedback to CGMS that significant changes to operational datastreams continue to be inadequately communicated to users.

The group wished to retain the following recommendation, noting that the clear sky radiance products for GOES-16 and GOES-17 are not operational at this time.

Recommendation DA/NWP-16 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. VIIRS/AVHRR Cluster Information

The group was asked by Nigel Atkinson to provide feedback on timeliness requirements for DBNet data for CrIS, following a request by users to add VIIRS sub-pixel cluster information to the datastream. The AAPP VIIRS cluster algorithm for CrIS delays the L1c product by 4 mins; an additional 10 mins is required if MAIA cloud products are produced.

The group agreed that a 4 minute delay was acceptable, but that the additional cloud product was not a requirement.

Recommendation DA/NWP-17 to DBNet providers: Switch on the production of VIIRS cluster information for DBNet for IASI and CrIS.

As the IASI/VIIRS cluster algorithm is available via AAPP, this should now be added to the global data stream.

Action DA/NWP-11 on Andrew Collard: Check with NESDIS-STAR on plans to implement the VIIRS cluster algorithm for global CrIS data dissemination.

9. Bias Correction

The group have agreed to close a number of actions related to bias correction at this conference. There remain a number of open questions regarding the best methods for addressing biases in data for assimilation in limited area models, but no specific items were raised at this meeting.

If any discussion is required or requested before the next conference, a teleconference will be arranged via email amongst working group members.

10. New and future mission evaluation

CMA Satellites

At ITSC-XXI, 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. These data are now available. Initial evaluation has been performed by a group including CMA, ECMWF, the Met Office and U Wisconsin, and the data is considered to be satisfactory for evaluation by the wider NWP community.

Action DA/NWP-12 on Chris Burrows and Qifeng Lu: Seek expressions of interest on coordinating evaluation of GIIRS and HIRAS data.

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-13 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 to support the early morning orbit.

Meteor-M2 IKFS-2

ECMWF have started to evaluate data from the IKFS-2 instrument from the Russian Meteor-M2 satellite. The instrument appears to be performing well, and it is recommended that other centres participate in evaluation studies. There are, however, issues with the timeliness of the delivery of the data, which is currently available via EUMETCast

Recommendation DA/NWP-18 to NWP Centres: Evaluate IKFS-2 data.

Recommendation DA/NWP-19 to Data Providers: In order to facilitate evaluation of new data by NWP centres, aim for distribution in near-real time.

Metop-C

Many centres have begun to use Metop-C data, including ATOVS, IASI and ASCAT. The instruments are reported to be performing well, and quality of the data are comparable to the Metop-A and -B instruments.

Anecdotally, the impact from adding Metop-C on top of the full observing system appears to be rather variable, but the reasons for the mixed results are not understood and are likely to be related to the specifics of thinning algorithms, DA systems and observation errors.

Action DA/NWP-14 on Working Group Chairs: Coordinate collation of information on impact of Metop-C instruments in operational NWP, along with information regarding thinning algorithms and error correlations used and share the collated information with working group members.

IASI-NG

Vincent Guidard reported that Meteo-France have been developing a channel selection for IASI-NG for use by the NWP community, presented at this conference by Francesca Vittorioso.

Impact of DBNet Data

To ensure continuation of the DBNet network, evidence should be provided on the importance of these data on forecast skills. This is expected to be particularly important in regional models. There were several posters at this conference demonstrating the importance of DBNet data (Youngchan Noh: 12p.08, Shuang Xi: 12p.11, David Howard: 1p.03), but more studies and evaluation would be useful.

Recommendation DA/NWP-20 to NWP centres: Produce impact studies for DBNet and low latency data and present results at the [Seventh WMO Workshop on the Impact of Various Observing Systems on NWP](#) in Seoul in May 2020.

Action DA/NWP-15 on Mitch Goldberg: Forward existing studies on the impact of DBNet data to the Working Group.

JPSS Field of View Size Followup

Following the recommendation from this working group on field of view size for JPSS, it was reported that the JPSS team took this recommendation and have studied this further. This is considered to be successful recommendation from NWP working group. The change will probably will not be implemented for CrIS but our views were taken into account for future sounders.

Monitoring

Christina Koepken-Watts (DWD) reported on the monitoring activities of NWP-SAF. Data timeliness and quality plots are provided, along with automated alerts from the ECMWF monitoring system and information about DBNet data provision. In addition there are quality assessments of AMVs, DFS and FSO diagnostics from Meteo-France and a new service providing reports on radiance evaluation for new satellite missions

The NWP-SAF request feedback from users on the current suite of products and ideas for implementation during the next operational phase (CDOP-4). A survey will be circulated in the coming weeks.

The group were able to report that the NWP-SAF monitoring site is in wide and regular use by the community, and new additions to the site are greatly appreciated.

Action DA/NWP-16 on Working Group Chairs: Circulate the NWP-SAF survey on user requirements for monitoring activities

Action DA/NWP-17 on Working Group Members: Complete NWP-SAF survey on user requirements for monitoring activities

Thomas Auligné (JCSDA) reported on work being undertaken to extend a multi-centre FSOI intercomparison study undertaken by the WMO working group on observation impacts into near-real time. This study could be linked into the NWP-SAF website.

Action DA/NWP-18 on Thomas Auligné: Contact Samantha Pullen (samantha.pullen@metoffice.gov.uk) to discuss circulation of FSOI intercomparison study.

Cristina Lupu spoke on behalf of Mohamed Dahoui (ECMWF) about a proposal to provide the community with a list of instrument events (changes to calibration, drop-outs). It could be interesting to add example plots for these events.

Recommendation DA/NWP-21 to NWP-SAF: Share ECMWF instrument event records with the community, together with illustrative monitoring plots where appropriate.

Action DA/NWP-19 on Working Group Co-chairs: Add a link to ECMWF instrument event records to the Working Group web page when such a link is provided by the NWP-SAF.

NWP SAF Cloud and Aerosol Detection Software

The developers of the NWPSAF Cloud and Aerosol Detection Software also looking for user requests for improvements to be included in the next release (next summer) and beyond.

Action DA/NWP-20 on users of the NWPSAF Cloud and Aerosol Software: Provide feedback to Reima Eresmaa (Reima.Eresmaa@ecmwf.int) on requirements for future upgrades.

Instrument Requirements

NOAA does not have a requirement for maximum allowed inter-detector calibration differences. It was noted that EUMETSAT do have such a requirement for the IASI-NG.

Action DA/NWP-21 on Thomas August and Fiona Smith: Determine whether the IASI-NG End Users Requirements Document can be shared. If any questions remain, discuss at ISSWG how to help NOAA formulate a requirement on maximum inter-detector calibration differences.

In addition, it is noted that the Advanced Sounder Working Group made a recommendation at ITSC-20 for a 50mK calibration match between detectors.

Aqua AIRS end-of-life planning

As propellant is finally running low, Aqua is moving out of the A-train and the orbit will drift over the next seven years. From 2022 to 2025 it will move to 15:30 orbit and then to 17:30 in the following year before being deorbited. Current plans are for Aqua to be switched off in October 2022. It is recommended that Aqua is kept alive and providing data throughout the orbital drift phase to evaluate the impact of different orbits (provided AIRS can still be properly calibrated)

Recommendation DA/NWP-22 to NASA and NESDIS: Continue to provide AIRS Aqua data in real-time to NWP centres for as long as calibration of the instrument is possible.

Plans for future NOAA Satellite Constellation

Karen St Germain (NOAA) outlined NOAA's current announcement of opportunity to industry to propose instrumentation for the next generation of meteorological satellites from 2030. Various options are being considered.

Questions arising from the presentation include:

- 1) Disaggregation (flying instruments on different platforms): Which instruments do we require to be flown together?
- 2) Which trade-offs need to be studied? E.g. Spectral bands vs accuracy and resolution (horizontal and vertical); spectral resolution vs spatial resolution vs noise.
- 3) Small satellites vs large buses: IR instruments proposed for small sat platforms tend to not have the 15micron band. Is this acceptable?
- 4) Mission lifetimes: Can we effectively use instruments with shorter lifetimes, say 3 years?
- 5) How should NOAA stagger development of new technologies to get greatest impact out as soon as possible whilst retaining agility?

In addition it was noted that NWP systems are likely to evolve dramatically in the next 10-20 years and evaluation of future systems should take this into account.

Given the limited time for discussion at the meeting, it is proposed that a virtual working group be set up by the Working Group chairs to discuss these proposals and provide feedback.

Action DA/NWP-22 on Karen St. Germain: Send to WG co-chairs the target performance and reference architecture for the Broad Area Announcement to industry for next-gen instrument proposals, including identified areas for potential trade-offs.

Action DA/NWP-23 on Working Group Chairs: Send out an email to the DA/NWP WG members containing supporting documentation from Karen St Germain inviting participation in a working group to make recommendations to NOAA on the proposals for next-generation satellites.

Action DA/NWP-24 on NWP Working Group Members: Respond to the request from Karen St Germain and DA/NWP WG co-chairs to join a working group to provide feedback to NOAA on proposals for next-generation satellites.