

Working group on Data Assimilation and Numerical Weather Prediction

The Working Group meeting was held on 10th May 2025. The attendees are listed in Appendix 1.

1. Actions from the previous meeting

The status of the actions from the previous conference can be found on the DA/NWP website: <https://itwg.ssec.wisc.edu/nwp/action-item-status/>

Most actions were completed and standing actions can be seen in Appendix 2. The following actions were still outstanding.

Action DA/NWP 24-4 on WG co-chairs: Organise a task team to perform experiments to establish the impact of data latency (esp. DBNet data) in both global and local assimilation systems. Status closed - see follow up action.

Action DA/NWP 24-6 on WG Members: Share impact assessment results for FY-3E with the working group, NOAA and CMA as soon as possible in particular to provide evidence for support of the early morning orbit. Still interested in this e.g. online reports, presentations. Status open - review at intermediate online meeting in 2026.

Regarding DA/NWP 24.4 It is recognised that the WMO DBNet Coordination group and all contributing stations provide a dedicated service to provide data with a high timeliness. This is especially important for NWP applications that have a short cutoff time. Support for this is expressed and to aid the work of the DBNet system this action will continue. As a first step statistics of data use will be assembled by the WG and further discussion on additional assessments will be discussed at an online meeting

ACTION DA/NWP 25-1 on WG co-chairs: To organise an online meeting within 2025 to discuss with WG members the approach to assess and provide feedback on DBNet. Prior to the meeting gather statistics of usage via email.

Regarding DA/NWP 24.6 the WG is aware of several studies carried out to assess the impact of the early morning data from FY3E showing very good impact focusing

mostly on MWHS-2. Further studies are still encouraged to support possible future discussions on orbit configurations relevant to the global observing system. It was noted that the international uptake of MWHS-2 data was greatly helped through the provision of this data in BUFR format. Other centres would like to include HIRAS in this way. See Standing Recommendation 11 discussed later in the Report.

2. CGMS HLPP

Relevant parts of the CGMS High Level Priority Plan (HLPP) were reviewed and discussed.

2.1 Concerning Principal Component Scores representation of hyperspectral radiances

4.2.6 Establish together with the user community a commonly agreed approach for retrieval of Principal Component scores and associated parameters from hyperspectral infrared data, minimizing information loss including the mutually acceptable update strategy for the principal component basis and to implement such an approach in a coordinated manner.

The WG was pleased to see that following on from the initial work at EUMETSAT several other centres are adopting the approach of global plus local PC scores (discussed at ITSC-21 Hultberg et al.) for dissemination of data from existing and planned hyperspectral instruments. NASA will do this for CrIS data as presented at this conference. In addition, it was mentioned that JMA is open to explore using this approach for the forthcoming Himawari GHMS instrument. There may be circumstances where data providers cannot adopt a common approach. In this case we recommend detailed technical documentation available to users to ensure optimum uptake of the datasets.

Most centres present currently pursue the approach to assimilate reconstructed radiances from the PC scores, rather than using PC scores directly.

2.2 Concerning NWP specific needs for radiative transfer developments

4.6.3 Through coordination between IPWG, ITWG and ICWG, continue to improve microwave radiative transfer models to include complex surfaces (e.g., snow, desert, etc.) and scattering atmospheres (e.g., frozen hydrometeors) to support improved algorithm development for current and future sensors.

Feedback from the WG members suggests that there is not a single key issue affecting all centres, however ongoing strands of development need further improvements for the following areas: modelling the solar component of the short-wave IR; visible reflectance simulations in the presence of both cloud and aerosol; ability to simulate fully polarized radiances over complex surfaces e.g. snow and sea-ice. Coordination of discussions and developments between the listed working groups should include the IEWSG.

ACTION DA/NWP 25-2: to Chris Burrows: to pass on his short wave IR results to the RT group.

2.3 Concerning trade off studies for IR instrument properties

4.7.2 Conduct trade-off studies regarding the benefits of spectral, radiometric, and spatial resolution of infrared sounders, taking into account aspects such as scene inhomogeneity and uncertainties in spectroscopy

The WG is not aware of any new studies addressing these questions since papers published by Wang around 2017. It is noted that many of the forthcoming and planned hyperspectral sounders in geo orbit share similar resolution characteristics. This may be beneficial for user uptake and also suggests that for the foreseeable future these issues are of reduced concern for operational NWP.

2.4 Concerning AI technologies

4.9 Identify AI/ML technologies for applying to the product processing and data management infrastructure and develop best practices

There are a wide range of active developments being pursued in the context of applying AI for satellite data assimilation. These include AI based components integrated within traditional NWP DA systems, e.g. adjoint estimation, bias correction, radiative transfer, estimation of radiative properties for complex surfaces, monitoring. Other developments focus on AI to replace the analysis or forecast model components of NWP as well as a direct forecast from observations including radiances. From the perspective of NWP there is at the time of the conference no clear preferred methodology among the range of activities and approaches.

3 User Led Items

3.1 Status of WIS2.0

A short update on the status of WIS2.0 was given by Simon Elliot. WIS2.0 is scheduled to replace the GTS as the main data transmission mechanism by 2030. Currently there are already over 70 countries disseminating a range of observational data from both satellite and conventional instruments via this route. Simon invited the WG to actively explore this new data route and provide any feedback, especially in case of difficulties with the initial access. Simon offered to answer upcoming questions.

ACTION DA/NWP 25-3: to WG Members: to report back to their respective technical departments regarding this ongoing transition to WIS2.0, in order to ensure a smooth transition in satellite data reception.

3.2 EUMETSAT NWP SAF - possibilities for future evolution of services

The NWP SAF service relevant to use of satellite sounder data were presented to the WG, inviting feedback for future improvements. RTTOV is in operational and research use at many centres world wide. The specifics of the further evolution of RTTOV were not discussed (this being covered in the RT WG). Regarding the use of PC-RTTOV it was highlighted that the processing package IRSPP contains an option to convert the MTG-IRS disseminated PCA scores into the PC basis used within PC-RTTOV. However, the centres represented at the meeting plan to convert from PC space to reconstructed radiances for assimilation. Consequently at this time there was no specific need expressed for further development of PC-RTTOV. There is support within the WG for producing a forward model based on Machine Learning, this approach is likely to be of interest to communities beyond NWP. However, it was noted that for application in most current DA approaches the accurate representation of Jacobians are also required. Several centres are actively using the 1D-Var package for both training, retrievals and also extending it to add transformed retrieval capability.

The range of instruments covered in the portfolio of pre-processing packages such as AAPP, IRSPP, etc., was considered comprehensive with no obvious gap. However, in terms of general functionality an option to resample IASI-NG to IASI spectral resolution would be considered useful to help NWP centres make a rapid transition to IASI-NG already before system updates allowing the exploitation of the full new capabilities are achieved. Also a superobbing option for hyperspectral data was mentioned.

The NWP-SAF near real time monitoring activities for data reception and data quality were presented and discussed. The availability of such monitoring statistics was mentioned as useful, especially for those centres who run limited area models, as monitoring instrument quality is challenging with only small regional statistical samples.

Concerning provision of diverse atmospheric profile datasets, there was general support

that these datasets are very useful for a range of activities. The provision of such profiles from different NWP systems was considered beneficial. Rather than providing very large datasets aimed at ML developments, there was interest in providing a software package to perform such diverse sampling.

ACTION DA/NWP 25-4 to WG co-chairs: To present this feedback to the NWPSAF project team as input to their planning activities

3.3 Meta Data for ML as output from Pre-Processing Packages

This discussion was raised by the Products WG. During the discussion a few useful parameters were mentioned. For example: instrument temperature, satellite orbital angle, determination of land or sea in field of view (either based on observations or from ancillary data). Such parameters are also of interest in the context of “classical” DA schemes. The range of parameters may evolve as research into ML methods progress and it was recognised that we should review this at the next meeting.

3.4 Changes to Satellite Constellations

The retirement of NOAA-15, 18 & 19 on June 26th 2025 marks the end of data transmission from the POES series of operational satellites. This series of satellites has provided excellent timely data underpinning the quality of NWP forecasts world wide for many years. The WG recognises that this was only possible through the dedicated work from the many experts involved.

In terms of upcoming instruments the WG was pleased to see the plans for more hyperspectral infrared geostationary sounders in space. In particular, talks have been given concerning the planned GHMS (JMA), GXS (NOAA), GEOHIS (KMA) sounders to complement the existing GIIRS (CMA) and the upcoming IRS (Eumetsat). In view of the exciting research and operational possibilities offered by continuous coverage the WG recommends that space agencies continue their efforts to launch hyperspectral sounders in order to achieve a complete geostationary ring.

Recommendation DA/NWP-25-1: to space agencies and CGMS: Continue their efforts to launch hyperspectral sounders in geostationary orbit in order to achieve continuous coverage in the geostationary ring.

Recommendation DA/NWP-25-2: to NOAA to continue plans for GXS such that there is not a hemispheric gap in hyperspectral sounding from GEO orbit over the Americas.

Regarding the emergence of constellations of small satellites and CubeSats currently

carrying microwave instruments, the multitude of orbits will greatly enhance the temporal coverage of these important data. Several presentations on evaluation of the new MWR onboard the AWS satellite confirmed the high quality of this new instrument, and consequently tests are underway for assimilation of this precursor to the proposed EPS-Sterna constellation. The WG discussion highlighted the importance of a stable calibration system, as well as low instrument noise, for operational use of radiometer data.

It was also noted that operational experience with the 118 GHz band present or planned for several instruments on small satellites is currently limited. Available studies suggest that the 50-60 GHz band provides lower instrument noise and a cleaner temperature signal (less affected by presence of hydrometeors) than the 118 GHz band.

Recommendation DA/NWP 25-3 to NWP centres: perform studies to investigate the operational use and impact of the 118 GHz band.

Aspects of small satellite missions, including those from commercial providers, have already been discussed at previous WG meetings. In view of the increasing numbers of small satellite constellations it was decided to incorporate the following previous recommendations (DA/NWP 2022/1, DA/NWP 2022/2, DA/NWP 24-2, DA/NWP 24-4, DA/NWP 24-5) as the following standing WG recommendations: **9-13**. These recommendations cover aspects such as calibration stability, instrument noise, satellite lifetime, dissemination data formats and the requirement for sufficient meta data, and should help to facilitate greater uptake of these datasets by NWP centres.

4. Working Group Matters

The group website, which can be found here: <https://itwg.ssec.wisc.edu/nwp/>, has recently been refreshed and we extend our thanks to Leanne Avila for help during the transition to using the new website creation software. WG members are encouraged to visit the site and make any suggestions for improvements (see WG standing action 5).

The NWP survey continues to be a useful source of information for other centres as well as DBNet, etc. WG co-chairs encourage all centres to make regular updates as their use of satellite sounders evolves. The status of data usage at the time of ITSC-25 will be saved from the survey at the end of June 2025. This snap shot of the survey will then be made available from the WG web pages.

Standing actions and recommendations were reviewed and amended. These are listed in Appendix 2 & 3.

Appendix 1: List of Participants

Tomoya Uraza , Ashish Routray , B R R Hari Prasad Kottu , Prashant Kumar , Indira Rani , Magnus Lindskog , Stephanie Guedj , John P George , Zheng Qi Wang , Sumit Kumar , Sreerekha Thonipparambil , Mary Borderies , Olivier Audouin , Suryakanti Dutta , Sujata Pattanayak , Srinivas Desamsetti , Ryan Honeyager , Guillaume Deschamps , Dorothee Coppens , Simon Elliott , Fiona Smith , David Duncan , Dirceu Herdies , Thomas Buey , Swapn Mallick , Hyeyoung Kim , Nahidul Samrat , Christina Köpken-Watts , Chris Burrows , Ethel Villeneuve , Mohamed Dahoui , Niels Bormann , Ahreum Lee , Cristina Lupu , Young-Jun Cho , Young-Chan Noh , Hidehiko Murata , Roger Randriamampianina , Erik Dedding , Isabel Monteiro , Hyoung-Wook Chun , Na-Mi Lee , Brett Candy , Stefano Migliorini , Kozo Okamoto , Zaizhong Ma , Maria Eugenia Dillon , Benjamin Ruston

Appendix 2: DA/NWP Working Group Standing Actions

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

Action DA/NWP- Standing 2 on DA/NWP WG members: Send any evidence of RFI to co-chairs of the RFI Technical SubGroup

Action DA/NWP- Standing 3 on DA/NWP WG members: If you have estimates of revised channel characteristics resulting from post-launch diagnostics, please email these to brett.candy@metoffice.gov.uk & radiative transfer working group chairs (Benjamin.T.Johnson@noaa.gov & vito.galligani@cima.fcen.uba.ar).

Action DA/NWP- Standing 4 on NWP centres: Continue to provide information on instrument channels assimilated and their observation errors via the working group survey spreadsheet in advance of each conference.

Action DA/NWP- Standing 5 on DA/NWP WG Members: Make suggestions and corrections to the DA/NWP Working Group website

Appendix 3: DA/NWP Working Group Standing Recommendations

Recommendation DA/NWP-Standing 1 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 (for example comparable to SSMIS

UAS channels or limb sounding) should be explored.

Recommendation DA/NWP-Standing 2 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.

Recommendation DA/NWP-Standing 3 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.

Recommendation DA/NWP-Standing 4 to Data Providers: When using PC compression, noise normalisation should be performed using the full noise covariance matrix.

Recommendation DA/NWP-Standing 5 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.

Recommendation DA/NWP-Standing 6 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.

Recommendation DA/NWP - Standing 7 to Data Providers: Provide NedT estimates for inclusion within BUFR for microwave data.

Recommendation DA/NWP - Standing 8 to Data Providers: Develop and maintain public instrument status monitoring web pages; Suggestions for useful diagnostics on the monitoring of instrument health is compiled in

https://itwg.ssec.wisc.edu/nwp/wp-content/uploads/sites/5/2025/04/Instrument_performance_monitoring_apr2025.pdf

Recommendation DA/NWP - Standing 9 to CGMS: Communicate to satellite data providers that the stability and consistency of bias and noise for individual passive radiometer instruments within a constellation of small/CubeSats are very important for implementation. Consistency between instruments within the constellation is also critical.

Recommendation DA/NWP- Standing 10 to CGMS: Communicate to satellite data providers that given Standing Recommendation DA/NWP 9, the requirement from NWP Centres for single instrument longevity within any constellation of small/CubeSats should be a threshold of 3 years post-commissioning (below which many centres will not use the data) and an objective of 5 years (where most NWP centres will aim to use the data). If the overall mission is of long duration, the threshold for an individual satellite could be lowered to 2 years post-commissioning.

Recommendation DA/NWP - Standing 11 to CGMS and data providers: Radiance data from new satellite instruments should be disseminated using WMO pre-approved BUFR sequences, consistent with other similar data types where possible.

Recommendation DA/NWP - Standing 12 to WMO: Continue to engage with commercial satellite providers to convey NWP requirements via industry days etc.

Recommendation DA/NWP - Standing 13 on CGMS and WMO members: When commercial satellite data is purchased, ensure that the necessary data and meta-data, e.g. spectral

response functions, that are required to make use of the data in applications are provided to users as early as possible.