Working group on Data Assimilation and Numerical Weather Prediction

Attendees

Fiona Smith (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), Javier Andrey Andres (Météo-France), Fabien Carminati (Met Office), Stephen Macpherson (Environment Canada), James Cameron (Met Office), Rory Gray (Met Office), Tiger Yang (NOAA/NESDIS/STAR), Sanjeev Kumar Singh (NCMRWF, India), Awdhesh Sharma (NOAA/NESDIS/OSPO), Indira Rani (NCMRWF, India), Tanya Maurer (NRL), Wei Han (CMA), Keyi Chen (ZAP/CAS), Heather Lawrence (ECMWF), Simon Pellerin (Environment Canada/MSC), Louis Garand (Environment Canada/MSC), Takumu Egawa (JMA), Bill Campbell (NRL), Robin Faulwetter (DWD), Olaf Stiller (DWD), Jun Li (CIMSS), Joe Predina (Logistikos), Pei Wang (CIMSS), Jinlong Li (CIMSS), Haixia Liu (NOAA/NCEP/EMC), Jérôme Vidot (Météo-France/CMS), Yong Chen (NOAA/NESDIS/STAR), Likun Wang (Univ. of Maryland), Yong Han (NOAA/NESDIS/STAR), Niels Bormann (ECMWF), Yi Song (NOAA/NESDIS/STAR), Xin Jin (NOAA/NESDIS/STAR), James Jung (CIMSS), Xiaoyan Zhang (NOAA/NCEP/EMC), Chu-Yong Chung (KMA), Eunhee Lee (KMA), Qifeng Lu (CMA/NSMC), Agnes Lim (CIMSS), Thomas August (EUMETSAT), Yanqiu Zhu (NOAA/NCEP/EMC), Pascal Brunel (Météo-France), Jörg Ackermann (EUMETSAT)

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. Recently it has been agreed that the Chinese satellite FY3E will be placed in early morning orbit, but for future FY satellites the orbit has not yet been decided. 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.

Also, whilst SSMI/S is recognised as an instrument that provides alternative sounding capability, the launch of F20 is still uncertain. F20 would help with gap mitigation, and the WG recommends that F20 should be flown.

Recommendation DA/NWP-2 to the Defense Meteorological Satellite Program: In support of maintaining a robust global satellite observing system, SSMI/S on F20 should be flown, preferably in an early morning orbit.

Cal/val of future instruments

The working group feel 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 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 programs 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 programs, 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 noted that it would be useful to collect this information at a central location, as such updates have been shown to reduce some airmass-dependent biases and therefore aid the assimilation of the affected data. The channel characteristics web-page of the RT WG seems a logical place for this, and Paul van Delst agreed to include such information.

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 Paul van Delst (paul.vandelst@noaa.gov).

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-20, the survey has been further enhanced to include more instruments and details on channel selection etc.

During the meeting the WG discussed enhancing the content of the survey further to include channel blacklisting information.

Action DA/NWP-4 on WG co-chairs: Enhance NWP instrument usage survey to include template where centres can add information on channel 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.

Increased use of the NWP WG email list was discussed during the meeting. There have been several recent examples of channels dropping out or instruments exhibiting unusual performance in NWP models, where information has been shared only between individual centres. In the past, the NWP WG email list was used to discuss data usage or to alert the community of data problems. However, the group agreed that there should be a new mailing list specifically for these issues, as in many centres there may be other people who do not attend ITSC that are involved in instrument monitoring who it would be useful to include.

There was a feeling among the group that people were reluctant to immediately spread news of anomalies because the first thought is always that it is likely to be a specific problem in their own system which may not be of interest to others. The consistent availability of monitoring reports from other centres would help to identify such problems (see discussion below). However , it was agreed that it would be better to raise the alarm sooner rather than later, even if it turned out to be a model issue. Guidance will be provided on what the address should be used for. If people are unsure about emailing personally, questions can be addressed to the co-chairs who can then forward the message on to others. A list of names subscribed to the mailing list will be made available on the DA/NWP working group website so that everyone knows who the recipients are.

Action DA/NWP-6 on WG co-chairs: Set up new mailing list for communicating potential instrument anomalies.

Recommendation DA/NWP-6 to NWP WG members: Use the new instrument anomaly mailing list to alert other centres to potential data problems or changes in channel usage as soon as they arise.

Several working group members expressed frustration that monitoring plots from different centres were often insufficient to help with diagnosing instrument/model issues that affect radiance assimilation. It was noted that most centres' monitoring pages are linked from the

NWP-SAF website, but that the plots available varied considerably, and some websites require password access.

The group discussed putting together a proposal for a consistent set of monitoring plots (c.f. paper by Tom Auligne and Fiona Hilton in 2006 which proposed plots for IASI monitoring) to aid diagnosis of issues. The document should propose channel subsets for monitoring and a list of the type of plots that should be produced. The list should be prioritised so that centres that do not have the scope to produce the full range of plots do produce the highest priority ones.

Action DA/NWP-7 on WG co-chairs: Add link to NWP-SAF website on NWP instrument monitoring to the WG webpages

Action DA/NWP-8 on WG members: Ensure their centre's monitoring sites are on the NWP-SAF website. Email NWP-SAF helpdesk if not to ask for it to be added.

Action DA/NWP-9 on WG co-chairs: Coordinate a group to define a set of monitoring plots that each centre should endeavour to provide with public access. Circulate the proposal to the NWP working group

Recommendation DA/NWP-7 to NWP WG members: Update monitoring websites as soon as possible to include the plots requested in the monitoring proposal.

3. Provision of BUFR data

At the last meeting, the group made the following recommendation:

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

This time we noted that this recommendation is part of the CGMS HLPP. It did not seem that much progress had been made in this area. The primary purpose of such data is for use in physical error models (e.g. talk by Hyoung-Wook Chun this conference), such that temporal variation of noise characteristics can be taken account of during assimilation. This information is available currently for ATMS.

It was noted that the provision of this information for other sensors would require modification of the BUFR tables.

A further issue regards the method of calculation of the NEDT. Jörg Ackermann reported significant differences between NEDT reported by NOAA and by EUMETSAT. This is not just a simple offset but channel-dependent. The NOAA algorithm includes orbital variability but EUMETSAT takes account only of variability of warm target calibration counts. There have also been recent changes at NOAA to use the Allan variance. It is unclear which measure is more

useful to users. The Allan variance does not include gain variability in the calculation as this can theoretically be accounted for separately.

Action DA/NWP-10 on Jörg Ackermann: Collate information regarding different algorithms used by data providers for calculating NEDT.

Action DA/NWP-11 on WG members who belong to member states of EUMETSAT: Request provision of NEDT in BUFR products for microwave sounders via EUMETSAT science working group.

The group retained the following two recommendations from the previous conference:

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.

CrIS Full Spectral Resolution BUFR data is available for users to test. Centres are encouraged to download test datasets as soon as possible so that the format can be confirmed.

Action DA/NWP-12 on NWP Centres: Contact Tom King (thomas.s.king@noaa.gov) to acquire CrIS FSR data, and confirm with him that it is acceptable.

4. Microwave Sounding Data

Striping on ATMS

NESDIS would like ATMS radiance products with striping effects mitigated to be tested by NWP centres. JMA tested the destriped ATMS data provided by Fuzhong Weng and found that observation first-guess departure histograms are good and noise is improved spatially. JMA would now like to have near-real-time data to do a forecast impact experiment. (Met Office, NCEP, ECMWF, NRL, DWD also expressed interest)

Recommendation DA/NWP-11 on NWP Centres: Evaluate the de-striped ATMS radiances made available by Fuzhong Weng and report back to NOAA and the NWP Working Group, both on initial investigations with the sample dataset and on OSEs when a parallel data stream becomes available.

5. Hyperspectral Infrared Sounders

Efficient Dissemination of Hyperspectral Radiances

For future hyperspectral sounders (particularly geostationary imagers such as MTG-IRS) it will be challenging to losslessly disseminate all data. Several items in the CGMS HLPP relate to prescribing appropriate PC compression methods for hyperspectral data dissemination.

At the previous conference, the working group discussed the possibility for a two-stream dissemination approach, where a low data volume stream suitable for operational assimilation would be provided with high reliability, and timeliness, combined with a lossless full resolution dataset (which can be used for research purposes) with reduced reliability and timeliness constraints. There was a recommendation for this to be discussed further, but there has been no progress since last meeting.

The following recommendations, which relate to CGMS HLPP items on PC compression are retained by the working group.

Recommendation DA/NWP-12 to data providers: If PC compression is used to disseminate hyperspectral IR observations, a conservative approach should be taken in order to mitigate information loss (e.g., by retaining as many principal components as possible).

Recommendation DA/NWP-13 to data providers and NWP users: A mutually acceptable update strategy should be devised and documented for the dissemination of PC products.

At the last conference, the following actions were placed that were not completed before this conference. They are retained (and renumbered):

Action DA/NWP-13 on EUMETSAT: Circulate a proposal on update strategy for IASI PC basis vectors, including consideration of the length of the notice period, to the working group.

Action DA/NWP-14 on NWP WG Members: Provide feedback on the above proposal.

No plan was circulated before the meeting. However, at this meeting, Thomas August confirmed that a change in basis vectors would constitute a “business as usual” type change, which would involve a minimum 4 week notice period (in practice 6-8 weeks + test data). A change in the number of vectors (or other more radical change) would be considered a larger change that would require more notice, and a period of parallel dissemination with specific users asked to act as beta testers, then a trial phase for all users. Registered users will be notified directly in either case.

The working group discussed whether this strategy is acceptable. It was agreed that it was very difficult to determine whether 4 weeks would be sufficient when centres currently do not use PC-compressed IASI operationally. For example, for centres assimilating PC scores, changes to RT coefficients or modified QC might be required. It is also not clear how such updates would be initiated - by users or by EUMETSAT (likely to be a combination of the two).

For example, would an update be initiated immediately after a few outlier spectra are identified? Given the lack of clarity the working group retains the above two actions.

However, acknowledging that we need to make more use of the data in order to be able to test the proposed update strategy, the following recommendation is made:

Recommendation DA/NWP-14 to NWP Centres: Monitor Reconstructed Radiances in parallel to operations so that the PC update strategy can be properly tested.

We also add the following recommendation:

Recommendation DA/NWP-15 on Data Providers: When using PC compression, noise normalisation should be performed using the full noise covariance matrix.

CrIS

The community is encouraged to investigate the use of high-spectral resolution CrIS data, including unapodised radiances.

Recommendation DA/NWP-16 on NWP Centres: Consider carrying out studies to evaluate the use of unapodised CrIS radiances, and/or to use the full spectral resolution apodised data combined with a full noise error covariance matrix.

However, software changes by the data provider are required with unapodised data to reduce the effects of spectral ringing. Users should wait until that change has been made to the data processing chain before trying to use unapodised CrIS data.

The following open action from the previous meeting is retained (but with a change of actionee), as there is still interest, particularly given the imminent arrival of CrIS FSR.

Action DA/NWP-15 on Reima Eresmaa: Organise through the NWP working group a six-monthly telecon to update on progress and any new findings regarding assimilation of CrIS.

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

The sub-pixel information from imagers that is reported with hyperspectral radiance BUFR data varies from instrument to instrument. It is suggested that a common form of colocated imager data be provided for AIRS, IASI, CrIS and other operational hyperspectral IR sounders and that the AVHRR clustering algorithm currently used for IASI is preferred.

The clustering algorithm provides the mean and standard deviation of radiances within the IASI field-of-view for each AVHRR channel (up to 7 clusters). In addition a percentage cloud fraction

derived from AVHRR cloud flags is provided. Note that the ISSWG is also currently addressing this issue for IASI-NG (from 2020).

The product provided should be able to be supported by direct readout packages.

Points to note: The IASI clustering algorithm operates simultaneously on the AVHRR footprints that fall into all 4 FOVs in a FOR. For CrIS, this would mean operating over 9 FOVs, for IASI-NG over 16.
The current processing of VIIRS cloud data within the CrIS field of view requires the data to be present within ten minutes of the CrIS acquisition, otherwise the cloud flag is missing. Is this a suitable strategy for the cluster analysis?
The latest version of AAPP can perform geolocation matches between VIIRS and CrIS and also contains the required clustering algorithm.

Recommendation DA/NWP-17 to Data providers: Use the AVHRR cluster algorithm available in AAPP for all hyperspectral sounders.

Action DA/NWP-16 on Andrew Collard: Request that the AVHRR/IASI clustering algorithm is implemented at NOAA/NESDIS/STAR for CrIS and AIRS data.

There has been discussion in the IASI user community on including more detailed information on the distribution of imager radiances within the IASI-NG sounder field of view.

Recommendation DA/NWP-18 to data providers: Consider including a map of the sub-pixel information derived from imager pixels within hyperspectral sounder FOVs, should bandwidth allow.

Reduced Field of View Size for Hyperspectral Sounders

It has been suggested that it is possible to reduce the field-of-view size from 14km to 7km for CrIS on JPSS-3, while keeping the sampling frequency the same (ie, resulting in sampling that is not spatially continuous). This will result in approximately a doubling of NEdT for the CrIS radiances. The advantage would be potentially a greater number of clear and/or homogeneous fields of view.

It has long been recognized that there is a tradeoff in instrument performance between field-of-view size, spectral resolution and instrument noise, but that opinion remains divided on the optimal solution.

It was noted that there have been a number of studies on clear-sky yield as a function of instrument field of view size and that a review of these studies would be desirable (known papers include the present study by Likun Wang using CrIS/VIIRS; a 2010 study by Lydie Lavanant using IASI/AVHRR; a 2007 study by Krijger et al. using MODIS). However, the effect

of these changes and the associated noise increase on forecast model performance has not been extensively studied. It is very hard to reach consensus on this issue without this additional information (and it was also noted that even full assimilation studies are limited because of the difficulty in anticipating the data assimilation systems in the coming decades).

Finally, it was noted that these issues are moot if sampling is frequent enough to allow observation averaging or super-obbing.

Recommendation DA/NWP-19 to funding bodies: Provide finances for specific projects to look at the impact of data assimilation/forecast systems on the trade-off between field-of-view size, spectral resolution and instrument noise.

Action DA/NWP-17 on Bill Bell (Met Office) to collate the available studies that have been performed on the increased yield and coordinate investigations into the impact of reduced field-of-view size combined with increased noise on model performance with an aim to inform decisions for the JPSS-3 CrIS.

Action DA/NWP-18 on Working Group Members: Please e-mail Bill Bell (william.bell@metoffice.gov.uk) if you have something to contribute to the FOV studies.

Action DA/NWP-19 on Likun Wang (U. Maryland): to circulate information on the study he performed on the VIIRS cloud mask.

6. Bias Correction

On Friday evening, a sub-group met to discuss bias correction in regional models.
Present: Fiona Smith (Met Office), Robin Faulwetter (DWD), Stephen Macpherson (Environment Canada), Masahiro Kazumori (JMA), Chu-Yong Chung (KMA), Wei Han (CMA), Eunhee Lee (KMA), Inchul Shin (KMA), James Juno (CIMSS), Agnes Lim (CIMSS), Indira Rani (NCMRWF), Vincent Guidard (Météo-France), A.K. Sharma (NOAA/NESDIS), Bill Campbell (NRL), Patrik Benacek (CHMI), Tom Auligné (JCSDA), Andrew Collard (NOAA/NCEP/EMC), Pei Wang (CIMSS), Nancy Baker (NRL), James Cameron (UKMO), Sanjeev Kumar Singh (NCMRWF), Xiaoyan Zhang (NCEP), Kozo Okamoto (JMA), Roger Randriamampianina (Met Norway).

The group effectively conducted the survey on bias correction strategies recommended at the previous ITSC during the meeting. The results are included in the table below

Centre	**Global model available?**	**Strategy**
Met Norway	Yes	AROME uses VarBC, assimilating ATOVS and IASI. 24-hr cycling of coefficients.

DWD	Yes	Global bias correction scheme is a dynamically-updated off-line Harris and Kelly (HK) -like scheme. No radiances yet in the assimilation model, but plans to assimilate cloud-affected radiances in regional ETKF.
Environment Canada	Yes (same model top)	Global model runs dynamically-updated off-line HK scheme. All radiances in global model are used also in regional, using global BC coeffs.
JMA	Yes	Global uses VarBC. Mesoscale model imports global coeffs.
KMA	Yes	Global uses static HK. Regional model imports the global coefficients. LAM does not assimilate satellite data.
CMA	Yes	No satellite data yet assimilated, GEO CSR will be added using bias corrections derived in the mesoscale model itself.
NCEP	Yes (global model stratosphere blended on)	Regional model runs VarBC separate from global model. Wide domain.
NCMRWF	Yes	Global model uses VarBC Regional model does not yet assimilate satellite data, but it is planned to use VarBC in IMDAA reanalysis, which will begin soon.
Météo-France	Yes	Global uses VarBC. Regional model uses imported coefficients from the global. Due to the particularly low model top, the predictors needed to be adapted in the global model. The exception is High-Res SEVIRI, for which VarBC is used in AROME.
NRL	Yes	Global uses VarBC Current 3D-Var regional model uses a HK-like scheme. New 4D-Var to use global coefficients. Hard to

		spin up regional coeffs as may need to be done at short notice over a very small domain.
CHMI	No	3D-Var with 6-hour assimilation windows and VarBC. Starting to assimilate MSG. 24-hour cycling of coefficients
Met Office	Yes	Global currently static HK, but moving to VarBC. Regional model currently uses global coeffs. Future strategy is not yet set. AMSU-B is sometimes spun up from the UKV.
CIMSS	No	WRF, uses input from GSI coeffs (VarBC global)

Main Issues

1. Where centres use coefficients from a global model for bias correction in a regional model, mismatches in
    a. Model top and
    b. Vertical layering

    can mean that coefficients do not perform well in the regional model.
2. If you do not have a global model you do not have the possibility to use global coeffs anyway. It can be particularly hard to spin up bias corrections because of extremely variable observation coverage.
3. Small domain size and short assimilation window length are the main issues for very limited area models. In the case of VarBC, 24-hour cycling with separate coefficients for each assimilation cycle is often required. There is a trade-off between requirements for fast adaptation rate and stable VarBC performance.
4. Bias correction of all-sky radiances is of particular interest to some members of group.

The group did not feel that an intercomparison exercise would be easy to achieve. The group recommends that studies in this area are carried out and experiences shared. It would be particularly useful to have studies that compared the bias corrections derived from global models with those derived from LAMs to understand their differing properties.

Recommendation DA/NWP-20 on Working Group members: To submit abstracts to the next ITSC on the topic of bias correction in regional models and bias correction of all-sky radiances.

At the last conference there was an action (DA/NWP-17) on Wei Han to evaluate whether the information on the RT group website is sufficient to provide radiometric uncertainty information needed for a study to constrain biases to realistic levels. Wei Han said that it was not sufficient, but that he would still like to attempt such a study.

Action DA/NWP-20 on Wei Han: Detail what information is required on radiometric and forward model uncertainty to constrain bias corrections, and circulate to the working group along with a proposal for how they would be used.

7. Use of correlated errors for data assimilation

There has been significant progress in the use of correlated observation error covariance matrices for NWP in recent years. Most progress has been made in the use of matrices diagnosed using the Desroziers technique or Hollingsworth-Lönnberg. One of the main drawbacks of these methods is that they have many assumptions built into them that are frequently violated, and the output matrices often require inflation before they can be used without causing significant degradation.

The working group noted a new line of work presented at this conference (5.04 Hyoung-Wook Chun) using a physical approach to estimate correlated errors. The group would like to encourage further work in this area. Parts of the physical model are easier to estimate than others; in particular understanding the random component of line-by-line RT errors and representivity errors require further study.

Recommendation DA/NWP-21 to NWP Centres: Consider studies into the use of physical methods as well as diagnostic methods to characterise observational uncertainties, including their correlations, to improve the assimilation of satellite radiances.

8. Direct Broadcast

Action DA/NWP-21 on WG co-chairs: Define a superset of channels for hyperspectral IR instruments that are required for monitoring and assimilation at NWP centres to define minimum channel distribution through DBNet and send to ITSC chairs.

9. Other items from the CGMS HLPP

CGMS Recommendation 1.1.2: Support satellite impact studies including regional verification

We note that many satellite impact studies are performed at NWP centres, and there were many papers at this conference on this topic. Several centres reported on the assimilation in regional models, though verification schemes for regional models are often designed to verify local weather rather than upper air performance, and satellite data impacts may be hard to demonstrate.

CGMS Recommendation 1.1.3: Facilitate the evolution of research short-term missions to an operational status

NWP Centres are keen to use all sources of data in their models, but note that there is significant work required to prepare assimilation systems for new data, and that if the research mission is short-lived there is a risk that this work is wasted. In summary, NWP centres perform work in this area as appropriate.

CGMS Recommendation 3.7.3: Perform validation and intercomparison of LBL models/spectroscopy

The working group strongly supports work in this area, as good RT is fundamental for assimilation of sounding data. The group are particularly interested in studies that provide information on uncertainty estimates, particularly in correlated error structures and the separation of bias and random error, that can be used for physical error estimation for data assimilation.

CGMS Recommendation 3.8.2: Conduct studies to investigate the technical feasibility to reduce FOV size for microwave sounders to keep in line with the spatial resolution expected for future global NWP models.

The group discussed this briefly, and the main consensus was that footprint size is less of an issue than noise. For ATMS, most centres average the footprints to 3.3 degree resolution to reduce the noise.

We noted that a previous version of HLPP did have a recommendation regarding instrument noise for microwave sounders, but it seems to have been dropped in this latest version.

Recommendation DA/NWP-22 to ITSC co-chairs: Request changes to CGMS HLPP to include a recommendation on investigating methods for reducing microwave sounder instrument noise without increasing the footprint size.