Updates on all-sky radiance assimilation at ECMWF

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1. Extension to 150 GHz and 166 GHz channels

The all-sky assimilation of microwave radiances has been extended to 150 GHz, v/h-polarised from SSMIS-F17 and 166 GHz, v/h-polarised from GMI between 45°S and 45°N for the current operational IFS cycle 46R1. Besides reducing a dry bias in the lower atmosphere, wind and humidity forecast scores have been improved up to day 5.

![Image](https://example.com/image1)

2. Water vapour correction to all-sky observation error model

This asymmetry can be improved through: (C37), which seemed to assign smaller errors under dry conditions. Assigned observation errors depend on the calculation of cloud amount in the humidity background error model in IFS cycle 43R3. Part of the MW drying is caused by the all-sky assimilation of microwave radiances over ocean. Here, the drying effect has been attributed to an asymmetry inside the all-sky observation error model for microwave radiances over ocean. Since Bormann et al. (2011, doi:10.1002/qj.833) we have known that interchannel error correlations are much larger in cloudy situations than in clear-skies, but all-sky assimilation has not yet taken this into account. To combine all-sky observations, a bin approach is proposed. An error covariance matrix is fitted to the lookup table of the misfit to observations.

![Image](https://example.com/image2)

3. Adaptive inter-channel observation error covariances for all-sky microwave

Since Bormann et al. (2011, doi:10.1002/qj.833) we have known that interchannel error correlations are much larger in cloudy situations than in clear-skies, but all-sky assimilation has not yet taken this into account. To combine all-sky observation error with inter-channel error correlations, a bin approach is proposed. An error covariance matrix is fitted to the background departures in a large number of bins defined by the symmetric cloud amount (C37) and the total column water vapour amount (to provide higher representation errors in tropical convection compared to midlatitude frontal systems). This approach is currently in testing.

![Image](https://example.com/image3)

4. All-sky infrared water vapour sounding channels on IASI

All-sky infrared assimilation is now a viable operational possibility. The quality of agreement between simulated and observed all-sky IASI radiances is now very good, making use of RTTOV with the Chou-scaling scattering approximation, multiple independent columns (the “streams” approach) and the recently updated Baran ice cloud optical properties. Experiments assimilating 7 IASI upper-tropospheric water vapour sounding channels in all-sky conditions showed similar NWP performance to clear-sky assimilation in the midlatitudes but improved performance in the tropics. A major part of getting this to work was a new observation error model combining inter-channel error correlation, error inflation in the presence of cloud, and variational quality control (VarQC).

![Image](https://example.com/image4)

5. Improved macro- and micro-physical assumptions for RTTOV-SCATT

Key to getting a good fit between simulated and observed all-sky microwave radiances is to choose appropriate microphysical and macrophysical assumptions (Geer and Baordo, 2014, doi:10.5194/amt-7-1839-2014). Recently, 3360 new combinations of micro- and macro-physical assumptions have been explored. The skewness of the FG departures provides a cost function by which to measure the fit to observations.

![Image](https://example.com/image5)

6. All-sky AMSU-A (5p.02)

Moving the assimilation of AMSU-A from the clear-sky system to the all-sky system has been investigated. The latest results show that the all-sky AMSU-A assimilation performs slightly better than clear-sky in the extra-tropics but worse than clear-sky in the tropics. It is hoped that, with a few more improvements, all-sky AMSU-A will soon be suitable for operational implementation.

![Image](https://example.com/image6)

7. Liquid Water Permittivity (5p.08)

The effect of different liquid water permittivity models are studied by using the all-sky assimilation framework of the IFS. Overall, the permittivity model by Rosenkranz (2015) has been chosen to replace Liebe (1989).

![Image](https://example.com/image7)

Conclusions and status

1. 150 GHz and 166 GHz channels have been operational assimilated in all-sky conditions since June 2019.
2. The water vapour correction reduces the drying effect by about 10%, but it requires maintenance of a TCWV retrieval. We need to decide if the maintenance overhead is worthwhile.
3. All-sky microwave error covariance modelling brings small benefits to medium-range scores but slight degradations in background fits to other observations.
4. Operational implementation of all-sky IR assimilation is worthwhile but it awaits a decision on whether we will assimilate reconstructed radiances in future.
5. Improved microphysical and macrophysical assumptions will be submitted for the next available operational cycle.
6. AMSU-A all-sky is close to being operationally viable.