MET OFFICE AND ECMWF CONTRIBUTION TO NPP AND NPOESS CAL/VAL EFFORT

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1. Introduction

NPP and NPOESS will provide the next generation of operational microwave and infrared sounding instruments. These have proven to be of immense value to operational weather forecasting through their assimilation in numerical weather prediction (NWP) models. Recent missions such as NOAA-18 (ATOVS), DMSP F-16 (SSMIS) and MetOp (IASI, ATOVS, ASCAT) have demonstrated the value of using NWP models to help interpret observations and diagnose any problems quickly, as part of a wider cal/val process. This is particularly beneficial when more than one NWP centre is involved, as was clearly demonstrated by Newman and Hilton [1], who used data from multiple NWP centres in the context of the MetOp IASI JAIVex cal/val experiment. In this paper we outline the proposed contribution from the Met Office and ECMWF to the NPP and NPOESS cal/val process.

2. The use of NWP in cal/val

The advantage of using NWP is to gain temporal and spatial understanding of biases in measured data globally. NWP errors are generally smooth and so fine-scale changes in (measured minus simulated) radiance fields in time or space are more likely to be the result of observation error, especially if they are reproducible from day to day. This was used very effectively by the SSMIS cal/val team (US DoD, NOAA, Met Office and ECMWF) to diagnose and characterise errors in the SSMIS calibration resulting from solar intrusion events and from reflector emission. This cal/val effort made extensive use of NWP model fields from ECMWF, the Met Office and NCEP. Also the recent characterisation of IASI on MetOp has shown strongly the value of taking NWP fields from more than one NWP centre.

The NWP centres create a three dimensional estimate of the global atmospheric state (the *analysis*) based on all available observations (both earth and space segment). The analysis is a memory of all previous observations projected forward in time using the forecast model, plus the latest observations. The two sources of information, from short range forecasts and new observations, are combined in a statistically optimal way to produce the analysis. The model is projecting forward a previous analysis based on all available observations to the location and time of the new observations. It is not a “model” estimate. The period over which new observations are compared is called the data assimilation window and the previous analysis projected forward by the forecast model is called the *background*.

In any particular analysis most of the information arises from the background (i.e. information retained from previous observations). This means that comparing a new observation type with the background immediately places it in the context of all previous observations and we can see how the fit compares to other similar observation types. We can look for spatial and temporal anomalies (and whether they correlate with any housekeeping data on the spacecraft or instrument, as was done for SSMIS) and we can compare with expected fit in the NWP system.

Whilst the difference between observation and background (hereafter referred to as “O-B”) from NWP systems is a powerful tool the use of the model to project forward in time is more successful for some geophysical variables than others. For mass fields (i.e. temperature and geopotential height) the different NWP systems are very consistent with each other, and the errors and biases are considered to be very small. For example the background field errors projected into radiances for IR or MW temperature sounding channels are around 0.1K, enabling the detection of systematic errors in measured radiances of amplitude 0.3K or greater. For wind fields errors in the background field are in the range 1-2 ms^{-1}. For moisture fields (specific humidity, cloud liquid water, cloud ice, cloud fraction, precipitation rate, precipitation type) and some surface fields (land surface temperature, land emissivity) there can be large inter-model differences. For example, for microwave moisture sounding channels the background errors expressed as radiances are around 2K in clear skies. Nevertheless, errors arising from reflector emission (in the case of a conical scanning microwave imager) can be in the range 5-10K for these channels and hence NWP fields have proven to be very useful in investigating these errors.

Using NWP fields from multiple models can give an indication of the uncertainty on the NWP background and help separate NWP background errors from observation biases, as was done by Newman and Hilton [1].

One final area where NWP centres can contribute is in the development of correction algorithms if systematic errors are discovered during the cal/val investigations. The global and seasonal picture provided through O-B comparisons enables the development of globally effective correction algorithms. NCEP, US DoD agencies, the Met Office and ECMWF have expertise in this area and these groups have forged effective collaborations during previous cal/val programs.

3. Application to NPP and NPOESS

The Met Office and ECMWF will be carrying out the following activities during the cal/val phase of NPP and NPOESS missions:

1) Compare global statistical analyses of O-B for the two NWP centres for ATMS and CrIS.
2) Identify variations of O-B during an orbit, orbit-to-orbit, descending and ascending orbits and how representative biases in Simultaneous Nadir Overpass (SMO) areas are of the full orbit.
3) Examine whether expected differences are consistent with expected errors by comparing with background errors in observation space.
4) Look for spatial or temporal systematic biases e.g. regions of high bias.
5) Compare any biases found with instrument housekeeping data, following the style of analysis seen in Swadley et al. [2].
6) Contribute to the development of correction algorithms if these are necessary to optimise the impact of the data for NWP.

A key tool for the pre-processing of NPP and NPOESS data – prior to its ingestion in NWP – is the ATOVS and AVHRR Pre-processing Package (AAPP), see [3]. AAPP is maintained by the EUMETSAT Satellite Application Facility for NWP (NWP SAF), of which the Met Office is lead institute. The package will be extended to ingest Sensor Data Record data from NPP and NPOESS, to map ATMS to the CrIS field of view and to carry out spatial filtering on ATMS in order to optimise its noise-beamwidth trade-off for NWP (and other) applications. This will be useful for both global data and locally received direct-readout data.

The main benefit of these activities should be to facilitate a rapid implementation of NPP and NPOESS data at all NWP centres.

4. References

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