Ongoing developments on the use of microwave sounders and imagers at Météo-France

Louis-François MEUNIER, Philippe CHAMBON, Jean-François MAHFOUF
CNRM/GAME, Météo-France and CNRS, 42 av Coriolis, 31057 Toulouse, France;
Email: louis-francois.meunier@meteo.fr

The Arpège global prediction system – Current observation usage

The Arpège global system:

- Spectral model with variable resolution: T798C2.4L70 (from 10 km over France to 60 km over New-Zealand)
- Incremental 4D-Var with 6-h window – 2 outer loops
- Variational bias correction scheme for satellite data
- Background error variances and covariances from an Ensemble Data Assimilation system (low resolution 4D-Var)

MW observation usage in Arpège 4D-var:

- Satellite data are by far the more numerous (see Fig. 2). However, on a per observation basis, conventional data have an important impact.
- Even though microwave radiances are few compared to IR hypersectral data, their impact on the analyses quality is high (see Fig. 1).

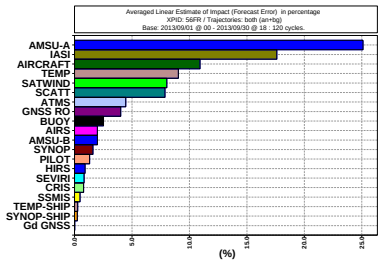

Figure 1: Forecast sensitivity to observations for each observation type.

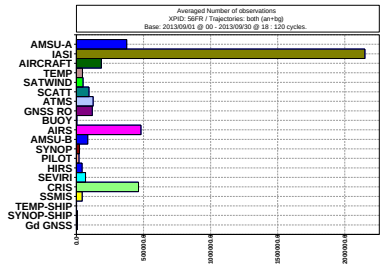

Figure 2: Number of observations for each observation type.

Use of ATMS data

- Raw ATMS data are averaged into pseudo observations on a 3x3 grid
- Averaged ATMS radiances are assimilated in a very similar manner than AMSU data
- The emissivity retrieval (see [Karbou et al., 2006]) is used over land and sea-ice
- The availability of channels from 23GHz to 183GHz allows to compute a variety of diagnosis in order to identify and remove cloudy and rainy scenes (see Fig. 3)

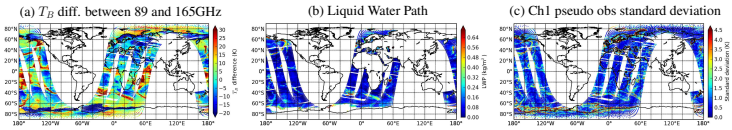

Figure 3: ATMS observation based diagnosis used in operations on 1st January 2014 at 00 UTC.

Assimilation of SSMI/S sounding channels

The assimilation of SSMI/S sounding channels has been attempted in 2013. SSMI/S sounding channels were treated in a similar way than AMSU-A/MHS channels. Unfortunately, the impact on forecast scores was neutral and/or not significant. Several shortcomings have been identified and are currently under being dealt with:

- DMSP-F16 radiances show degraded first guess departure statistics compared to other SSMI/S data. It will be excluded in our experimental set-up.
- DMSP-F18 radiances show a significant ascending/descending bias (especially for temperature sounding channels). The cosine of solar zenith angle will be considered as an additional predictor of the variational bias correction scheme. (see Fig. 4).
- The thinning of SSMI/S data will be lowered to 1.25°(like any other microwave instrument).
- For humidity channels, the emissivity retrieval over sea-ice will be re-tunned in order to take into account SSMI/S high viewing angle.

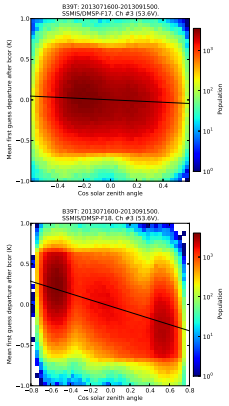

Figure 4: First guess departures as a function of the cosine of solar zenith angle for SSMI/S Ch. 3 aboard DMSP-F17 (top) and DMSP-F18 (bottom).

Impact of Megha-Tropiques/SAPHIR data

- All 6 SAPHIR channels are used with a variational bias correction.
- SAPHIR has no window channel so the lowest peaking sounding channel is used for cloud/rain clearing (during this check a constant bias correction is applied in order to avoid interactions with VarBC)
- Data are also assimilated over land. The AMSU-B/MHS emissivity atlas at 89Ghz is used to prescribe the surface emissivity.
- An assimilation experiment has been run between 15th June 2012 and 10th August 2012 (see [Chambon et al., 2014])
- When SAPHIR data are assimilated, observation statistics are significantly improved even for other instruments like MHS or infrared sounders (see Fig. 5).
- As can be seen in Fig. 6, forecast scores are improved with respect to a reference experiment excluding SAPHIR.

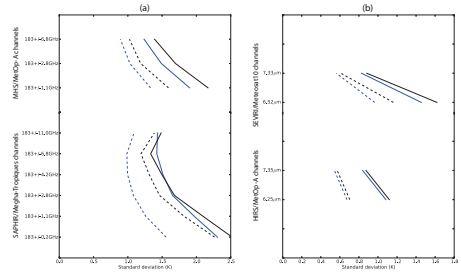

Figure 5: Observation statistics over the tropical region between 15/06/2012 and 10/08/2012. Plain/Dashed lines show the observation minus guess/analysis standard deviation. When SAPHIR data are assimilated statistics are plotted in blue. (a) Microwave sensors. (b) Infrared sensors.

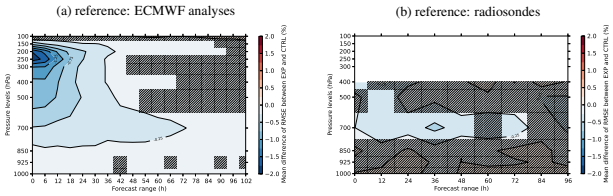

Figure 6: Difference of relative humidity RMSE between experiments with and without SAPHIR data assimilated (from 15/06/2012 to 10/08/2012). Negative values show a positive impact. Grey zones indicates that scores are not significant at the 99% level of confidence.

[Chambon et al., 2014] Chambon, P., Meunier, L.-F., Guillaume, F., Piriou, J.-M., Roca, R., and Mahfouf, J.-F. (2014). Investigating the impact of the water vapour sounding observations from SAPHIR on board Megha-Tropiques into the ARPEGE global model. *To be submitted to Quarterly Journal of the Royal Meteorological Society*.

[Karbou et al., 2006] Karbou, F., Gérard, E., and Rabier, F. (2006). Microwave land emissivity and skin temperature for AMSU-A and -B assimilation over land. *Quarterly Journal of the Royal Meteorological Society*, 132(620):2333–2355.

Perspectives

- Preparatory studies towards the assimilation of rainy microwave radiances in regional models (J. Guerbette, PhD student)
- Potential use of AMSR-2 and GMI radiances (in clear-sky conditions)