

ICI Atmospheric Profiles Over Rondonia Using HSB Data Emulated From AIRS Information

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Abstract

It was analyzed the performance of the Inversion Coupled with Imager (ICI) software over the Amazon region, with set up for AMSU/NOAA-16 channels but using information from AQUA sounding system (AMSU and AIRS). AIRS channels were used to recovering the absence of HSB data, whose behavior should be similar to AMSU-B. The HSB brightness temperature in clear sky conditions was simulated by a linear combination of AIRS channels sensitive to water vapor band. The selected AIRS channels were the five best correlated with HSB (183 GHz) in a set of 3000 pixels distributed over oceanic areas for one training day (August 31, 2002). The simulated HSB data together with AMSU-A/AQUA information were used to recover vertical profiles of temperature and moisture, using ICI with two data bases: a) TIGR climatological profiles; b) CLASS1 Brazilian climatological profiles. The retrievals obtained over the Amazon region suggest that temperature profiles inferred by ICI with the TIGR and CLASS1, and using only the microwave channels, are close to radiosonde “ground truth”. The use of CLASS1 improves the results for moisture profile when compared with TIGR, particularly within low troposphere.

Atmospheric Profiles

Recent efforts have been concentrated on the development of sensors with high spectral resolution. The AIRS (Advanced InfraRed Sensor), with 2378 channels, is the first operational instrument with these characteristics. AIRS sensor was launched onboard EOS-PM (AQUA) satellite in May 2002, together with microwave units AMSU-A and HSB (Humidity Sensor for Brazil). The AQUA mission provides a unique opportunity for selecting proper channels in different atmospheric conditions as well as for improving the “state of the art” in retrieval techniques. Different selection methods and retrieval techniques are still in development for information content of AIRS (Goldberg et al. 2003 and 2004, McMillin 2004). The HSB was similar to AMSU-B sensor but exhibited improved technical performance (Lambrigsten and Calheiros 2003). Unfortunately, it is no more in operation since the last quarter of 2002 and the AQUA sounding system is limited to AIRS and AMSU-A information. Nevertheless, the enormous flux of AIRS data suggests the possibility of partially recovering HSB information in clear-sky conditions, through emulation of its spectral behaviour by AIRS channels located in water vapour absorption bands. Present work explores this possibility, seeking for AIRS channels (or combinations of them) which provide the best simulation of HSB brightness

temperatures for channels centred at 183 GHz. In addition, it is expected to contribute to a better understanding of the AIRS information content, which in turn may be useful to improve retrievals of water vapor profiles.

The datasets used in this work correspond to period of the Dry-to-Wet LBA experiment (August 31 to October 31, 2002) that include: 1) ATOVS/NOAA-16 data; 2) AIRS-AMSU-HSB/AQUA data; 3) radiosondes and 4) ICI retrievals over three LBA sites (Gujará-Mirim, Porto Velho e Ouro Preto). It is important to note that eventual substitution of HSB by AIRS data is possible only for cloud-free pixels, since AIRS channels are located at infrared spectrum. Consequently, a previous cloud masking process was applied before starting AIRS channel selection. The Figure 1 shows the localization of three validation sites over the Amazon region.

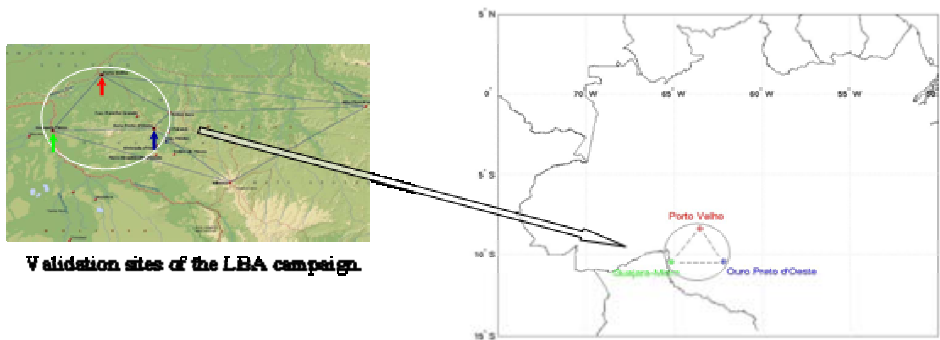


Fig. 1 – Validation sites of the LBA campaign.

The starting point for analysis was the detection of AIRS channels highly correlated with those of HSB. Linear correlation coefficient was assessed for radiances of each AIRS channel, related to each one of the four HSB channels. A number of $N_p = 3000$ cloud-free pixels provided the cases for correlation assessment. When ordering AIRS channels by their higher-valued correlation with an HSB channel, it was observed that water vapor Jacobians of those channels showed fair similarity with the corresponding HSB channel. The regression model was built and the coefficients were assessed for the training day August 31, 2002 and the Figure 2 shows the 3000 cloud-free pixels used. The results were used for simulation of HSB channels during the whole time interval and comparison with actual (observed) HSB data. Finally, the simulated HSB data together with AMSU-A/AQUA information were used to recover vertical profiles of temperature and moisture, using ICI with two first-guess data bases: a) TIGR climatological profiles (Lavanant et al., 1997); b) CLASS1 Brazilian climatological profiles (Macedo, 2003).

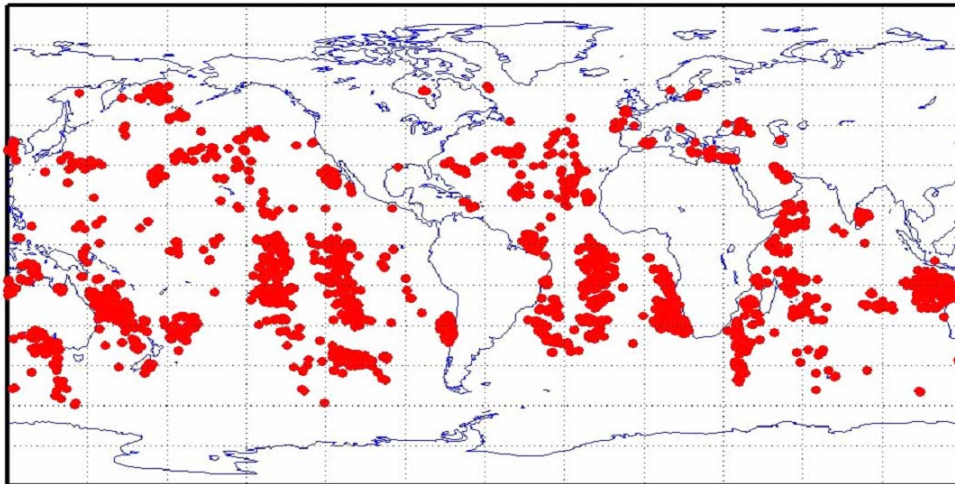


Fig 2 - The 3000 cloud-free pixels used for the training day August 31, 2002.

Results

The operational ICI-3 in dynamic mode (first guess NWP/CPTEC data) presented better performance because it used all ATOVS data. However, the retrievals obtained over the Amazon region (Figure 3) suggest that temperature profiles inferred by ICI with the TIGR and CLASS1, and using only the microwave channels, are close to radiosonde “ground truth”. The use of CLASS1 improves the results for moisture profile when compared with TIGR, particularly within low troposphere. It is important to note that there are differences between NOAA-16, AQUA and the radiosondes schedules. This fact could influence on the quality of the results, mainly near the surface.

Conclusion

The AMSU + HSB (simulated) AQUA data yield proper profiles for temperature, in the “static” ICI mode of operation. The use of CLASS1 improves the results for moisture profile when compared with TIGR, particularly within low troposphere. Moreover, it will be appropriated to include typical profiles of the Amazonia occidental region in CLASS1 dataset to obtain still better results.

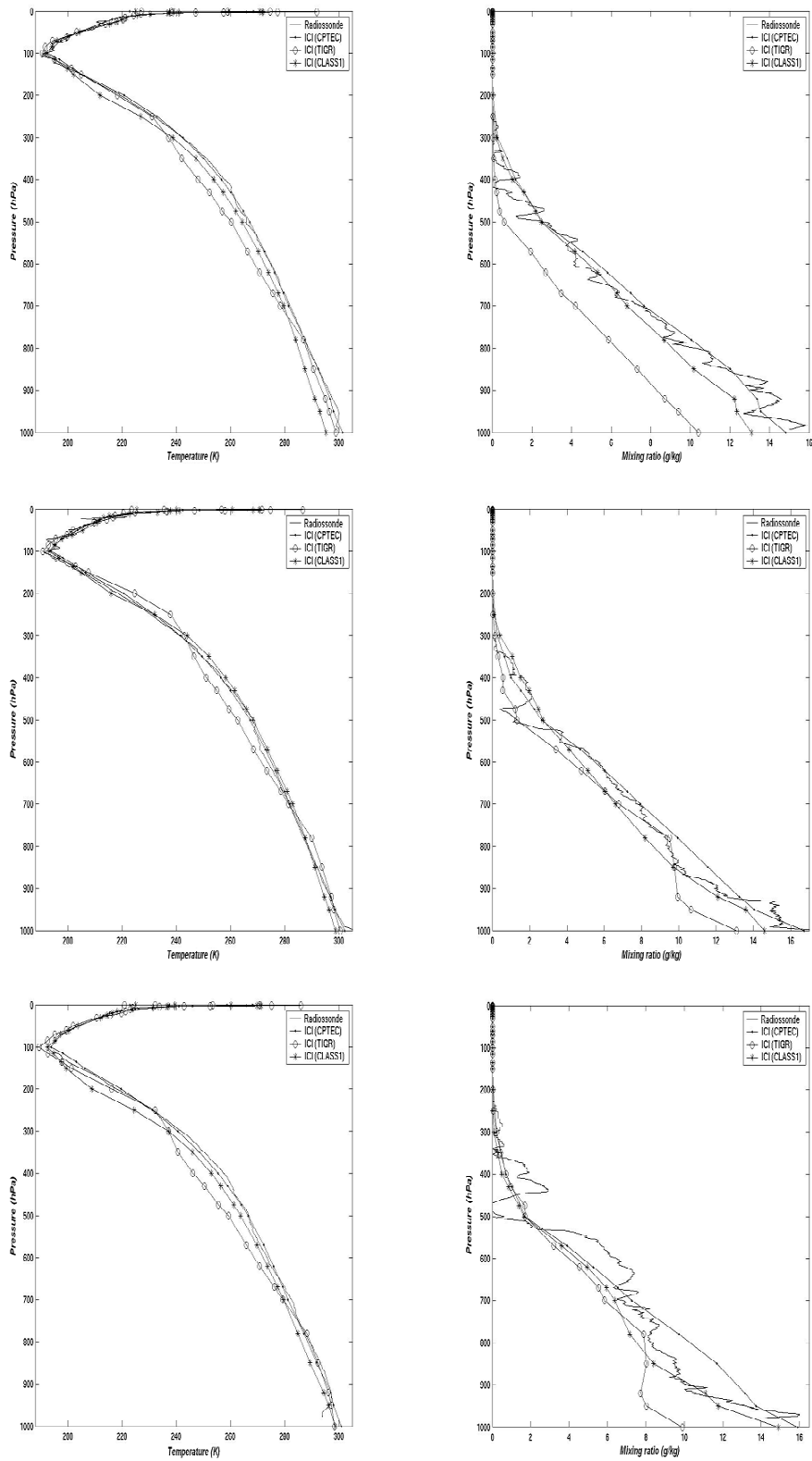


Fig. 3 - Temperature (left) and Mixing ratio (right) profiles over three LBA sites: Guajará-Mirim, Porto velho and Ouro Preto d'Oeste.

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References

- Goldberg, M.D., Qu, Y., McMillin, L.M., Wolf, W., Zhou, L. and Divakarla, M. 2003. AIRS near-real-time products and algorithms in support of numerical weather prediction. *IEEE Transactions on Geoscience and Remote Sensing*, **2**, 379-389.
- Goldberg, M.D., Zhu, L., Wolf, W. 2004. Applications of Principal Component Analysis (PCA) to AIRS data. *Proceedings of the 13th Conference on Satellite Meteorology and Oceanography, Norfolk, USA, 20-23 September*, edited by American Meteorological Society, paper 1.15.
- Lambriksen, B.H. and Calheiros, R. V. 2003. The humidity sounder for Brazil – An international partnership. *IEEE Transactions on Geoscience and Remote Sensing*, **2**, 352-361.
- Lavanant, L.; Brunel, P.; Rochard, G.; Labrot, T.; Pochic, D. 1997. Current Status for the ICI Retrieval Scheme. In: International TOVS Study Conference, 9. (ITSC), 20-26 February, Igls, Austria. *Proceedings of the Ninth International TOVS Study Conference*, Igls: ITSC.
- Macedo, S. R. 2003. *Um estudo das sondagens do ICI (Inversion Coupled Imager) mediante o processamento de perfis atmosféricos brasileiros*. 2003. 109 p. Dissertação (Mestrado em Meteorologia) – Instituto Nacional de Pesquisas Espaciais, São José dos Campos.
- McMillin, L.M., Super Channels for AIRS retrievals. 2004. *Proceedings of the 13th Conference on Satellite Meteorology and Oceanography, Norfolk, USA, 20-23 September 2004*, edited by American Meteorological Society, paper 6.6.