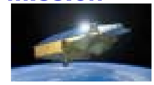
Feasibility of an accurate wet tropospheric correction for the CRYOSAT mission



Franck MERCIER and Estelle OBLIGIS

ABSTRACT

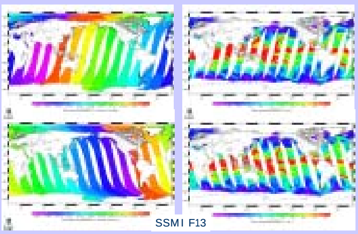
The main objective of the European satellite CRYOSAT is the observation of the polar ice. For this reason, and on the contrary to ocean altimetry missions, it is not equipped with a microwave radiometer, i.e. a instrument that provides the wet tropospheric correction.

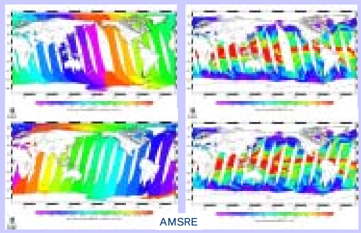
In order to exploit the CRYOSAT measurements on a global scale, i.e. to use measurements over ocean to retrieve the sea surface height, an accurate wet tropospheric correction is required. For the time being, it is planned to use the model-derived correction provided by the European Center for Medium Range Weather Forecasts (used as a backup on the usual ocean altimetry missions), which is known reliable at large scale, but insufficient to catch small atmospheric humidity structures.

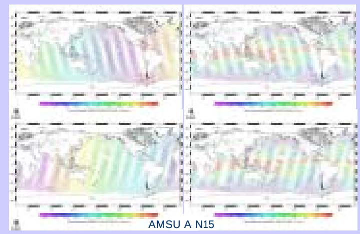
The actual resolutions of the model are 0.5 degree in space and 6 hours in time, so they are not always/everywhere adapted for the atmospheric humidity scales that may be shorter than half a degree/ 1 hour.

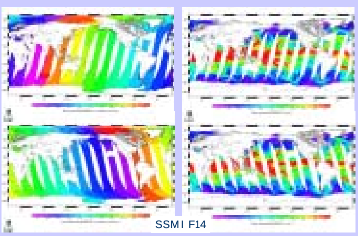
In this context, the objective of this study is to evaluate the feasibility and the potential benefit of using existent water vapor measurements provided by other in-flight microwave radiometers to build an accurate wet tropospheric correction. First results are based on the global combination of different available data sources: SSM/I, TMI, AMSR-E, AMSU. In this first step, we analyzed the spatio-temporal cover of the different satellites, and quantify the benefit with respect to the ECMWF model.

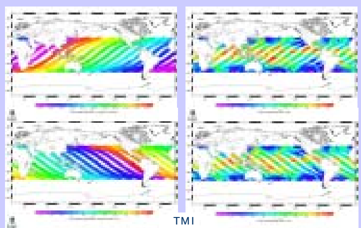
Data availability and coverage : example for one given day (11/11/2006)

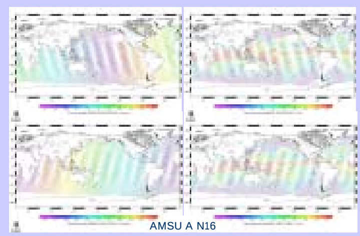










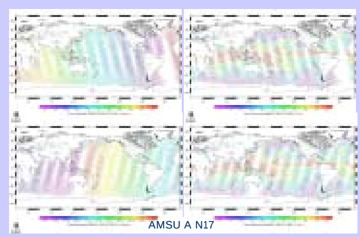


SSMI (onboard DMSP F13 and F14), AMSRE and TMI integrated atmospheric water vapor content data are distributed by Remote Sensing Systems (F. Wenz, http://www.ssmi.com) on the basis of a daily set of two 0.25°x0.25° grids for ascending and descending tracks, together with the corresponding grids of acquisition time.

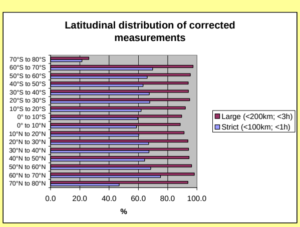
Only one day of data is shown here. However, the study presented below has been performed over 35 days (i.e. one ENVISAT cycle).

AMSU-A (onboard NOAA-15, 16 and 17) integrated water vapor content data are distributed by CIRA (Cooperative Institute for Research in the Atmosphere, Colorado State University (http://amsu.cira.colostate.edu/) on the basis of elementary ascending and descending swaths files. Each swath is a succession of pixels for which the position of the center is given together with the time of measurement and the vapor content.

We arranged the AMSU-A data set in order to create 0.25°x0.25° regular grids for ascending and descending tracks (similar to SSMI grids) in a very crude way: no spatial interpolation is performed and no information relative to the coverage of each pixel is introduced. This raw processing explains the dotted aspect of the AMSU-A figures with respect to SSMI, TMI and AMSRE ones.



Preliminary results



For each and every point of ENVISAT cycle 52 (09/10/2006 to 12/11/2006), we simply explored the data grids presented above in order to find the closest values in time and space according to 2 sets of criteria:

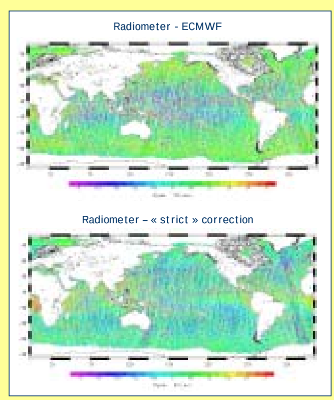
- « **strict** » co-localisation:
  - distance < 100km and delay < 1h
- « **large** » co-localisation:
  - distance < 200km and delay < 3h

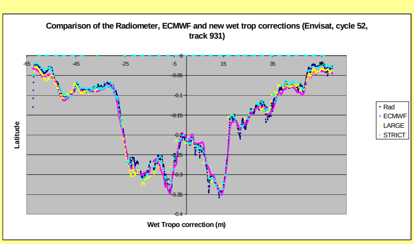
On average, we found matching water vapor data for 64.0% of the ENVISAT data points with the « strict » criteria and 93.4% with the « large » criteria. The latitudinal distribution of these results is presented on the left figure.

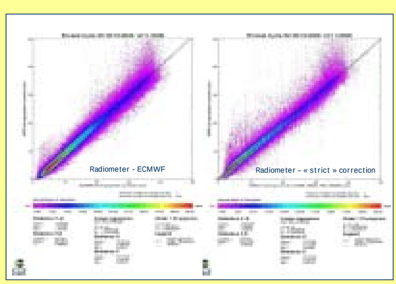
The objective of the study is to evaluate the feasibility of a wet tropospheric correction that would be more accurate than the correction derived from the ECMWF model.

Therefore, we performed several comparisons between the radiometer, the ECMWF correction and a correction simply and empirically derived from the water vapor content by multiplying it with a constant factor:

1. *maps of (rad - ECMWF) and (rad – « strict ») differences*: the 2nd map appears more homogeneous than the (rad – ECMWF) map. However, larger differences are observed in the gulf of Guinea and in the eastern equatorial Pacific ocean. Elongated patterns in the middle of the Atlantic and south of Tasmania probably show a problem with one instrument.
2. *scatter plots of these differences*: statistics are rather equivalent. Nevertheless, the central part of the cloud appears thinner in the (rad-strict) plot.
3. *along track profile of these corrections*: we clearly see that the « strict » correction is, when available, closer from the radiometer than the ECMWF correction. The « large » correction is often not accurate enough.







Conclusion

These preliminary results are promising: it appears feasible to compute an accurate wet tropospheric correction directly from microwave imager data.

The various treatments applied in this study are very basic. There are few doubts that more sophisticated processings (intercalibration of the instruments, objective analysis, signal processing, accurate transition from water vapor content to wet tropo correction ...) will significantly enhance these results.

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