Trend and Variability of the Atmospheric Water Vapor: a Mean Sea Level Issue

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The wet tropospheric path delay (dh) is presently the main source of error in the estimation of the mean sea level. This correction on altimetric measurements highly depends on the atmospheric integrated water vapor content (wv) [g/cm²(wv)=0.0064].

Nowadays, water vapor products from microwave radiometers are relatively close but important discrepancies remain. Understanding these differences can help us improve water vapor products and reduce at the same time the error on the mean sea level.

This poster shows the first results of the comparison between AMSR-E, MWR (ENVISAT) and JHR (JASON) water vapor products. AMSR-E products are used as reference. The purpose of this study is to characterize both temporally and spatially the behavior of the discrepancies.

Data and methodology

AMSRe data are produced by Remote Sensing Systems and managed by the NASA Earth Science MARS450E DISCOVER Project and the AMSR-E Science Team. Data are available at www.ress.com. AMSRe data are provided in daily anemous and ascending orbit grids with a resolution of 0.25°.

ENVIsat and JASON 0 datasets are composed of standard 1 Hz along-track products.

Spatial analysis: differences of average water vapor maps

Both AMSR-E, JASON and ENVISAT datasets are transformed into monthly gridded maps of water vapor with a spatial resolution of 3°. For each dataset, only validated measurements are taken. Measured of ENVISAT and JASON which distance to the coast is inferior to 100km are rejected before the construction of the gridded maps. For each mission only bins of 3 degrees with more than 50 measures are kept. Bias are selected such as the spatial coverage of data for both AMSR-E, JASON and ENVISAT maps remains identical at each time.

Results

No difference of the radiometer water vapor trends is statistically different from 0 with a level of significance α=0.05.

The difference of trend between AMSRe and the two other radiometers is statistically different from 0 with a level of significance α=0.05.

The annual cycle is statistically significant, for α=0.05, to explain discrepancies between the AMSRe and the JASON time series.

Seasonality is not statistically significant, for α=0.05, in the modeling of monthly water vapor differences between AMSRe and ENVISAT.

Conclusions and perspectives

Water vapor products from AMSRe, JASON and ENVISAT are qualitatively in good agreements. However, quantitative differences exist between the products both spatially and temporally. For instance, the differences of trend between AMSRe and ENVISAT is 0.005 g/cm²/year which is important in regard to the MSL problematic. Indeed, it represents a difference in the wet tropospheric path delay trend of about 0.32 mm/year, about one tenth of the MSL trend between 1992 and 2011.

Part of the behavior of the discrepancies has been characterized temporally and spatially. For JASON, the discrepancies increase with the water vapor content. Thus, the largest discrepancies concern the tropical regions. These differences fluctuate according to annual cycle. For ENVISAT, the discrepancies are stronger in coastal region of the northern hemisphere. Regionally, the discrepancies follow an annual cycle with a peak in summer. The differences mainly concern low values of water vapor content.

However, the origin of these differences are still under investigation. The aim is to identify specific meteorological and oceanographic conditions that induce important discrepancies in the retrieval of water vapor. Impacts of sea surface temperature, wind speed, dew water, rain rate, or even chlorophyll, and unusual profiles of pressure and temperature are also to be explored. These discrepancies may be related to differences on the instrumental or mission designs and on ground processing (in-flight calibration, retrieval algorithms and editing criteria).

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Venice, Italy - 23-25 September 2011