IRS2012-221
International Radiation Symposium 2012
Dahlem Cube, Berlin, Germany, 06 – 10 August 2012

Retrieval of Relative Humidity Profiles and its Associated Error from Megha-Tropiques Measurements

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January 18, 2012

Abstract

Water vapor has a great role in the atmosphere dynamics and thermodynamics processes and it is the main greenhouse gas regulating the Earth's climate. Measuring water vapor present important problems which hinder detailed and intensive studies. The water vapor's principal aspect is its strong variability spatio-temporal and passive remote sensing helps measuring vast areas per day; but passive remote sensing obtains indirect measures, yielding to use restitution methods. Regarding detection problems is important to keep in mind the water vapor vertical behavior, near surface the absolute humidity is bigger than in higher altitudes; in consequence, instruments must have an expanded work scale to obtain acceptable precision values for all cases.

The SAPHIR microwave radiometer onboard the recent Megha-Tropiques plateform observes the tropospheric relative humidity with six channels in the strong water vapor absorption band (near183.31, ranging from $\pm$ 0.2 GHz to $\pm$ 11GHz). With respect to MHS and AMSU-B radiometers, this configuration is aimed at providing an improved retrieval of the tropospheric relative humidity. The Megha-Tropiques' tropical orbit is an important advantage with an enhanced sample rate, it allows 3 to 6 observations each day for any point between $23^o S$ and $23^o N$.

In this work we focus on the retrieval of relative humidity profiles distribution given a set of 22 levels of relative humidity obtained by tropical radiosoundings in clear sky scenes and the associated set of simulated satellite brightness temperatures using the RTTOV model. Retrieval of the relative humidity profiles from satellite measurements are commonly based on neural network algorithms (ex: [Aires and Pringent (2001)]). Alternative statistical models exist such as support vector machines (SVM) and additive models (ex: Generalized Additive Model).

A comparison of three models was performed, in equal conditions of input and output data sets, through their statistical values (error variance, correlation coefficient and error mean) obtaining a seven layers profile of relative humidity. The three models show the same behavior with respect to layers, mid-tropospheric layers reach the best statistical values suggesting a model-independent problem. The smallest relative humidity error standard deviation (2.45% from 4^{st} layer) is obtained thanks to an improved version of the SVM while the neural network reveals higher values for almost all layers. GAM model has better results than the neural network for high layers. In a general way, the improved SVM method obtains better results respect to other models.

Finally, the associated error of retrieval is studied through the characterization of the probability density function of the relative humidity at given atmospheric pressure.