NDSA MEASUREMENTS BETWEEN TWO LEO SATELLITES IN KU AND K BANDS FOR THE TROPOSPHERIC WATER VAPOR ESTIMATE: PERFORMANCE EVALUATION AT GLOBAL SCALE

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NDSA (Normalized Differential Spectral Absorption) is a differential measurement method to estimate the total content of water vapor (IWV, Integrated Water Vapor) along a tropospheric propagation path between two Low Earth Orbit (LEO) satellites [1].

The NDSA approach is based on the conversion of a spectral parameter called "spectral sensitivity", measured in the Ku/K bands, into the total content of water vapor along the propagation path between the two LEO satellites. To measure the spectral sensitivity it is required that the total attenuations at two relatively close frequencies, symmetrically placed around a reference frequency f_o , are simultaneously estimated.

In [1] we showed the potential of spectral sensitivity to provide direct estimates of integrated water vapor along LEO-LEO tropospheric propagation paths in the 15-25 GHz interval. This analysis was carried out for tangent altitudes (the distance of the path with respect to the Earth) up to 11 km.

In [2] we focused on the measurement accuracy of the spectral sensitivity parameter. Specifically, we examined this accuracy at three different frequencies and for two models of atmospheric structure. We achieved this objective both by providing an approximate theoretical expression, function of main propagation and disturbance parameters, and by developing a simulator based on more detailed atmospheric and disturbance models.

A basic result presented in [2] is that the spectral sensitivity measurement accuracy can be estimated through the theoretical approximation as far as the averaged signal to noise ratio keeps above 20 dB, and that below such level measurements are far from being reliable. This can be considered true as far as the integration time used for measurements keeps smaller than the decorrelation time of the scintillation.

In this work we present the performance evaluation of the NDSA method at global scale assuming a realistic satellite orbital plane with two counter rotating satellite [3]. This configuration allows to generate a lot of rise and set occultation events over many latitute longitude locations. In this way we can simualate many plausible atmospehric profiles all aorund the whole globe.

The results are obtained considering some global atmosheric models (pressure, temperature, water and liquid contents) as well as they are provided by the ECMWF (European Centre for Medium-Range Weather Forecast).
The NDSA simulation tool we developed in this work is based on the result reported in [1], [2] and [4]. It accounts for the main disturbance effects: sicintillation impairments, thermal noise at the receiver and defocusing.
To simulate the microwave propagation in atmosphere we used the MPM93 model accounting for water vapor, oxygen, nitrogen and liqud water extinction effects [5].

For the scintillation impairments in the NDSA simualation tool we assumed both a simplified two parameters model, as well as we proposed in [2] (i.e. an exponential profile of the scintillation amplitude profile and a correlation coefficient between two close tones), and a model where the scintillation amplitude profile is realeted to the profile of the refractive-index structure costant Cn2 [4]. The profile of the refractive-index structure is computed on each sigle atmospheric profile, therefore when we simulate the LEO-LEO set/rise event for a specific atmospehric profile we assume its specif scintillation amplitude profile.

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[3] ACE Scientific Support Study, Final Report, ESA Contract No. 14809/00/NL/MM (2003)

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