Geophysical Research Abstracts
Vol. 16, EGU2014-1492, 2014
EGU General Assembly 2014

KARAT-LAMBDA - frequency dependent ray-traced troposphere delays for space applications

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Space-geodetic microwave techniques work under the assumption that the only dispersive, i.e. frequency dependent delay contribution is caused by the ionosphere. In general, the refractivity, even for the troposphere, is a complex quantity which can be denoted as N = N0 + (N'(f) + i N"(f)) where N0 is a frequency independent term, and N'(f) and N"(f) represent the complex frequency dependence. Thereby, the imaginary part can be used to derive the loss of energy (absorption) and the real part can be assigned to the changes in the propagation velocity (refraction) and thus describes the delay of an electromagnetic wave which propagates through that medium. Although the frequency dependent delay contribution appears to be of small order, one has to consider that signals are propagating through few kilometers of troposphere at high elevations to hundredths of kilometers at low elevations. Therefore, the Kashima Ray-Tracing package (Hobiger et al., 2008) has been modified (and named KARAT-LAMBDA) to enable the consideration of a frequency dependent refractivity. By using this tool, it was studied if and to which extent future space geodetic instruments are affected from dispersive troposphere delays. Moreover, a semi-empirical correction model for the microwave link of the Atomic Clock Ensemble in Space (ACES) has been developed, based on ray-tracing calculations with KARAT-LAMBDA. The proposed model (Hobiger et al., 2013) has been tested with simulated ISS overflights at different potential ACES ground station sites and it could be demonstrated that this model is capable to remove biases and elevation dependent features caused by the dispersive troposphere delay difference between the up-link and down-link.

References:

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