Geophysical Research Abstracts
Vol. 13, EGU2011-6522, 2011
EGU General Assembly 2011

Sub-daily excitation of Earth rotation by atmospheric tides

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Sub-daily signals in atmospheric excitation of Earth rotation are usually investigated with atmospheric angular momentum (AAM) functions that are estimated from the operational analysis fields of Numerical Weather Models. The temporal resolution of these data is typically six hours, limiting the spectral resolution of polar motion and LOD variations in the semi-diurnal band. In this study, though, we use the so-called delayed cut-off stream of the European Centre for Medium-Range Weather Forecasts (ECMWF) to determine three-hourly AAM functions for the time span July 2004 to July 2010 to aid in the analysis of sub-daily signals. The resulting amplitudes and phases in the diurnal and semi-diurnal equatorial and axial excitation spectra are generally below 2 μas and 4 μs, but they fit well to the estimates from the corresponding six-hourly AAM record based on data from the U.S. National Centers for Environmental Prediction (NCEP). The three-hourly data, however, allow a more detailed insight into the atmospheric state and circulation, causing the well-observed semi-diurnal (S_2) signals in Earth rotation. Both for the AAM functions, and for the original meteorological data, a phase-shift of $\pm\pi$ prevails between the S_2 pressure signal and the resulting S_2 wind tide, leading to a distinct counteraction of pressure and wind terms in the excitation spectra. This finding is in agreement with the theoretical work on atmospheric tides by Chapman and Lindzen (1970) and others.