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Title: Atmospheric tides in Earth rotation observed with VLBI

Abstract

The Earth's body is enveloped with fluids represented mostly by the atmosphere and oceans, which force the Earth's rotation vector to alter. On daily and sub-daily time scales, differential gravitational forces of the Moon and Sun govern the regular Earth rotation variations by raising ocean tides. A distinct addition and modulation of these ocean tide effects is provided by atmospheric tides, which result from cyclic absorption of insolation at upper air and boundary layer heating at the Earth's surface. Short period tidal mass variations that are of particular relevance to Earth rotation are those with Sun-locked diurnal S_1 (24 hour) and semidiurnal S_2 (12 hour) periodicities.

Atmospheric tides were discovered first in the variations of the surface pressure field, whose measurements are ingested into weather models along with a presentation of the S_1 and S_2 cycles from remote sensing. The impact of these variations on Earth rotation can be determined from a geophysical modeling perspective by means of an angular momentum approach. In this thesis, the Earth's rotation effects related to atmospheric tides are evaluated in a separate approach based on the VLBI observations. Elucidating the potential reasons for the well-known discrepancies in Earth rotation between these two approaches formulates the core argumentation in this thesis.

Overall, atmospheric tide effects in Earth rotation are detected on the expected level in the analysis of the VLBI observations. The reliability of these signals is confirmed directly through a comparison with geophysical estimates and indirectly validating the obtained high-frequency ocean tide terms against the range of reference solutions. For polar motion, previous studies have documented a significant discrepancy between the geodetic and geophysically derived S_1 terms at the order of 10 μas or large. This difference is mitigated to 5 μas in the present study, yet this value is above the best threefold formal error level in polar motion (2.5 μas) provided by the undertaken VLBI analysis.

In a supplementary study Earth rotation tide models were considered in dependence on the applied corrections to the station VLBI positions due to the loading effects of the fluids as provided by different geophysical models and vice versa. However in both approaches, the parameter estimates based on different geophysical models demonstrate statistically insignificant variations under threefold formal error level.