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Issues related to the computation of atmospheric angular momentum functions

Michael Schindelegger (1), Johannes Böhm (1), David Salstein (2), and Harald Schuh (1)
(1) Vienna University of Technology, Vienna, Austria, (2) Atmospheric and Environmental Research, Inc., Lexington, U.S.A.

Atmosphere-induced variations in Earth rotation are routinely inferred from variations of atmospheric angular momentum (AAM) functions, which can be estimated from the standard analysis fields produced by different meteorological centers. Within the project GGOS Atmosphere, we use 6-hourly operational analysis data of the European Centre for Medium-Range Weather Forecasts (ECMWF). From these data, the AAM functions can be split up into the effects of mass distribution, an integral over the density distribution (mass or pressure term) and the relative motion field, namely the wind term, an integral over the atmospheric wind field. Mass and wind terms can be determined following various calculation methods. In detail, three-dimensional integration over height or pressure increments in the vertical is applicable for both mass and motion terms, whereas a two-dimensional integration over surface pressure values is possible for the mass term only. In the latter method, the use of atmospheric surface pressure provides an estimate of all the atmospheric mass compressed into a very thin layer at the Earth's surface, but the effects of this approximation ignore the variability of density with height as well as non hydrostatic effects. In order to assess the accuracy of the excitation terms, we compare the AAM functions from these methods – also addressing the differences between the ECMWF series and the solutions calculated from the U.S. National Centers for Environmental Prediction (NCEP) analysis.
Additionally, the time varying differences between the pressure terms from the rigorous three-dimensional integration and from the simplified, two-dimensional integration are investigated. In all three differential AAM components we find significant annual signals, which, if expressed on the level of Earth rotation parameters, correspond to polar motion variations of several milliarcseconds and LOD changes of a few microseconds. We examine the possible relation of these annual AAM anomalies with the variation of the center of mass of the atmosphere, which also has a strong seasonal component.