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Comparison of ECMWF analysis fields and station observations of barometric tides in the context of sub-daily excitation of Earth rotation

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Thermally-driven oscillations of atmospheric surface pressure and three-dimensional wind velocities at diurnal (S1) and semi-diurnal (S2) frequencies account for small fluctuations in all three components of the Earth's rotation vector. The impact of such atmospheric tides on polar motion and changes in length-of-day, which is far below that of daily and sub-daily ocean tides, can be estimated from the gridded output of numerical weather models by computing so-called atmospheric angular momentum (AAM) functions. Yet, previous findings concerning the exact amplitude and phase values of S1/S2 excitation signals in AAM disagree significantly, indicating a low reliability of meteorological analysis fields at short periods. Moreover, the analyses in earlier studies were generally based on a temporal resolution of not less than six hours, limiting the local estimation of the S2 wave specifically. Here we address the accuracy and utility of different three-hourly surface pressure data from the European Centre for Medium-Range Weather Forecasts (ECMWF) for the purpose of high-frequency Earth rotation studies. In detail, the diurnal and semi-diurnal gridded pressure tide signals are extracted from multi-year records of ECMWF short-term forecasts and so-called delayed cut-off analysis fields, before comparing them to 'ground truth' barometric observations at selected continental or oceanic stations. A brief statistical evaluation allows identifying those pressure grids fitting best to the original barometric observations. Preliminary results for this study are obtained by performing variance analyses at a set of 25 oceanic islands, which correspond to that of Ray (1998). Within this intercomparison, special attention is paid to the representation of local semi-diurnal barometric residuals, which are obtained after removing the primary S2 signal associated with a westward-propagating wavenumber-2 mode. Due to the globally symmetric structure of such a wavenumber-2 component, its effect on Earth rotation vanishes, whereas the barometric residuals prove to be very much indicative of the amplitude and phase values of atmosphere-induced tidal variations of polar motion and changes in length-of-day.