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Assessment of the accuracy of (re)analyses in the equatorial lower stratosphere

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Trajectory calculations with meteorological analyses are a common tool for transport and dehydration studies in the tropical Upper Troposphere-Lower Stratosphere. If uncertainties in analyses are a known source of errors in those studies, it is generally difficult to quantify their effect. We propose here to use an independent (not assimilated), high quality meteorological dataset collected at low latitudes during a long-duration stratospheric balloon campaign to assess the accuracy of horizontal winds and temperature in the ECMWF operational analysis and ERA interim reanalysis, as well as in MERRA reanalysis. This campaign, named PreConcordiasi, took place in February-March 2010, and the superpressure balloons achieved circumterrestrial flights at 19 km altitude within 10° of the equator.

Whereas analyses and observations were in fairly good agreement during parts of the flights, we have also found periods of strong (> 10 m/s) and long-standing (about 1 month) disagreements in horizontal winds. Specific investigation shows these disagreements to be associated with the misrepresentation of large-scale equatorial Kelvin and Yanai wave packets in the analyses. Comparisons between the actual balloon trajectories and the trajectories computed with the analysed winds shows that the above wind errors can produce errors in simulated trajectories that reach 4,000 km after 5 days.

Last, we have examined potential causes for these large errors in the (re)analyses. The vertical resolution of the models was found to be an important factor, as some of the large-scale waves observed by the balloons were close to their breaking level and thus had small vertical wavelengths (less than 5 km). However, the main factor at stake appears to be the distribution of observations: during the PreConcordiasi campaign, wind errors in the (re)analyses exhibit a clear longitudinal structure, with RMS twice larger over the poorly observed regions of the Indian Ocean than over the Maritime Continent or South America. Interestingly, this structure is mirror to the structure of analysis increments, which peaked where observations were available for assimilation (Maritime Continent and South America).