Variability of near-inertial waves in the lower stratosphere from balloon observations and the ECMWF (re)analyses

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Near-inertial waves (NIWs) with intrinsic frequency close to the local Coriolis parameter $f$ constitute a striking component of the kinetic energy spectrum in both the atmosphere and the ocean. However, contrary to the oceanic case, the strong and variable background atmospheric winds tend to shift the frequency of the waves (Doppler effect). As a consequence, atmospheric NIWs cannot generally be observed directly as a kinetic energy peak at ground-based frequency $f$ but are instead diagnosed indirectly (e.g. using the polarisation and dispersion relations). This complication does not appear when analyzing quasi-lagrangian observations from superpressure balloons (SPB), which drift together with the flow and are thus exempt from Doppler shift. Past SPB observations in the lower stratosphere have revealed the magnitude of the kinetic energy peak associated with NIWs and it was recently shown that state-of-the-art reanalyses partly represent this feature.

In this presentation, we will investigate the variability of NIWs using ECMWF (re)analysis products (the operational analysis and ERA5) and balloon observations from recent CNES campaigns (2005, 2010 and 2019-2020) at various latitudes ranging from the equator to the pole (and hence different inertial frequencies). As in Podglajen et al. (2020), NIWs are extracted from the (re)analyses by computing Lagrangian trajectories using the analyzed wind and temperature fields. We will illustrate the remarkable realism of model NIWs, both statistically and for specific case studies. Then, we will characterize the geographic and seasonal variability of NIW properties. In light of those results, possible factors influencing the near-inertial energy peak (horizontal wave propagation, refraction near critical levels, tide interactions) and the parallel with the oceanic situation will be discussed, as well as the ability of the model and data assimilation system to simulate them.

Reference: