Baroclinic life-cycles from GPS radio-occultation measurements

Robin PILCH KEDZIERSKI [1], Katja MATTHES [1,2], Karl BUMKE [1]

[1] *GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany*

[2] *Faculty of Mathematics and Natural Sciences, Christian-Albrechts Universität zu Kiel, Kiel, Germany*

Baroclinic waves and their embedded cyclones-anticyclones are the major driver of extratropical weather. The evolution of these systems and their structures can be generalized into life-cycles of growth and decay or breaking. While observational studies usually focus on individual extratropical cyclones or wave packets, the theoretical approach with idealized life-cycle experiments or two-layer models is rather done from a planetary-scale perspective (e.g. with wavenumber 6).

Typical baroclinic life-cycle diagnostics tend to focus on the surface (SLP maps), troposphere (longitude-height cross-sections of wind fields, PV, isentropes...) and the tropopause (potential temperature of the 2PVU surface), including the calculation of fluxes and the energy balance associated to the baroclinic waves at those levels. However, it is known that the sharp gradients occurring within the tropopause region are not properly captured in models and (re)analyses due to their insufficient vertical resolution, thus making the modeled/analysed tropopause fields less reliable. In addition, only recently attention is being drawn to the role of the lower stratosphere in the development of baroclinic waves.

In this study we diagnose the temperature signal of baroclinic life-cycles throughout the troposphere, UTLS and stratosphere by direct use of observations. We use high resolution GPS radio-occultation measurements from different satellite missions gridded at 5x5 degree, together with a wavenumber-frequency domain filtering method to extract the planetary-scale temperature signals from individual planetary wavenumbers (from 1 to 10). After calculating the envelope, zonally constrained wave packets are obtained. We complement the observational data with pressure and wind fields from ERA-Interim. Such an approach tries to bridge the gap between observational and theoretical studies, as well as showing the UTLS structures of the baroclinic waves at unprecedented vertical resolution.

We will disclose the co-amplification of the tropospheric and lower-stratospheric temperature signals of the baroclinic wave (which only happens for intermediate wavenumbers ~4-8), as well as the correlations of their zonal structures. We also obtained daily 3D snapshots of the wave's structures and evolution over time, which display important phase and latitude displacements around the tropopause. Our results agree with theory and earlier observational studies, and show new features of the baroclinic waves through the UTLS which are valuable for the understanding of stratosphere-troposphere interactions.

Key words: baroclinic life-cycles, stratosphere-troposphere interactions