RECENT RESEARCH ACTIVITIES

Strateole-2 (long-duration balloon flights at the tropical tropopause layer) project

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The tropical tropopause layer (TTL) is a key region of the atmosphere in the tropics as it interfaces the moist, quickly mixed troposphere below with the dry, stratified stratosphere above. The TTL constitutes the gateway for air entering the stratosphere, and the processes occurring in the TTL contribute to setting the composition of the whole stratosphere. Strateole-2 is an international project led by Laboratoire de Météorologie Dynamique (LMD), France [1, 2]. Strateole-2 is aimed at providing observations of the TTL (16-20 km altitudes in the tropics) to better understand dynamical and transport processes in this region. The originality of the project comes from the use of long-duration superpressure (SP) balloons developed by Centre National d'Etudes Spatiales (CNES), France, which are able to fly for several months at targeted altitudes. During the flight campaigns, each balloon is carried by winds and circumnavigate the Earth a few times. By moving with the air along a quasi-Lagrangian trajectory, the SP balloon measurements provide unique data of chemical and physical processes evolving over time in a given air mass. The long duration of the flight is of particular interest for characterizing the dynamics and chemistry of the TTL.

There are, however, difficulties and limitations, since the SP balloons follow trajectories at a constant density level above the cold point tropopause. Complementary observations such as radiosondes (Lagrangian measurements in vertical direction) and the Equatorial Atmosphere Radar (EAR) (Eulerian measurements) at Kototabang, Indonesia (100.3E, 0.2S) are essential to interpret and understand the SP balloon measurements, which provide the information on the local dynamics of the atmosphere (wave field and occurrence of turbulence), and eventually the vertical profile of water vapor or ozone. About the meso-scale dynamics, radar and radiosonde measurements provide complementary information about the vertical structure of the wave field, especially of the large-scale Kelvin waves. Ozone sondes allow to describe the ozone gradients at the height of the SP balloon flights and to characterize the signature of large wave activity. Such observations may prove crucial in order for the Strateole-2 data to be conclusive regarding vertical transport and dehydration issues.

The first Strateole-2 preparatory campaign was conducted in November 2019-February 2020. Eight SP balloons were launched (20 SP balloons will be launched during two main campaigns scheduled in late 2021 and late 2024). SP balloons were launched at the Seychelles islands (55E, 4S) and the quasi-biennial oscillation (QBO) was westerly in this period. So the balloon crosses the Indian Ocean and reaches Indonesia in about one week after launch. (The second passage was two months later, but the dispersion in latitudes of the balloon was quite large.) The EAR was continuously operated in the troposphere/stratosphere standard observation mode with temporal and vertical resolutions of 1 min and 150 m, respectively, in November 19-December 6 to measure the wind field, wave activity and turbulence. In this period, 20 GPS radiosondes with 11 ozone sondes were launched at the EAR site. They bring complementary observations about the temperature and ozone field (mean state and wave activity) as well as about the turbulent regions.

Acknowledgements

The EAR observatory is operated jointly between RISH, Kyoto University and LAPAN, Indonesia. This study is partly supported by JSPS KAKENHI Grant Numbers JP19H01967.

References

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[2] A. Hertzog and F.Vial, A study of the dynamics of the equatorial lower stratosphere by use of ultra-long-duration balloons; Part II. Gravity waves, J. Geophys. Res., 106, 745-761, 2001.