Quasi-Stationary Temperature Structure in the Upper Troposphere over the Tropical Indian Ocean Inferred from RO Data

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Vertical fine structure of the tropical circulation in the upper troposphere was analyzed with using the dry temperature data obtained by Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) Global Positioning System Radio Occultation (GPS-RO). The data have very high vertical resolution and global coverage. One-year record during 2007 was utilized to detect statically stable layers in the upper troposphere. A quasi-stationary local shallow statically stable layer, separated from the stratosphere, is detected over the equatorial western Indian Ocean in the upper troposphere during the boreal summer. Statically stable layer has an inclination from the horizontal surface; the position of the maximum stability shifts eastward with increasing height. The stable layer consists of a warm anomaly above and a cold anomaly below. The magnitude of the stability has a maximum at the equator, while it has wide meridional extent and has tilted structure that the center shifts northward with height. Similar layers with less intensity are observed in the northern winter, whereas they are hardly seen in the equinox seasons.

A statistical study was conducted with the 23-year records of objective reanalysis data (ERA-40) at several standard pressure levels. The temperature structure consistent with the COSMIC results during 2007 is obtained statistically in the boreal summer. The local maximum is located at 100 hPa over the western Indian Ocean. It should be stressed that the place is not only meridional but zonally maximum. there. The center of the maximum tilts eastward with increasing height between 150 and 70 hPa. The anomaly of the geopotential height, which is hydrostatically connected to the temperature, has the minimum at 150 hPa. This low height anomaly is in the westernmost at 150 hPa and moves eastward with the vertical distance from the surface.

The position of the low height anomaly is at the western edge of the easterly jet at the equator. The height anomaly in the western equatorial Indian Ocean has negative correlation with the height of Tibetan high center and positive correlation with the zonal wind component of the monsoonal easterly jet in the subtropics.

We discussed what induces these anomalies in the equatorial Indian Ocean. If we presume the Asian monsoon circulation as a linear response for the off-equatorial heating, we can account for the meridional maximum (minimum) of the temperature (geopotential height) just on the equator as a Rossby response to the west of the forcing. Though it is rather difficult to explain the zonal maximum (minimum), we may interpret it as a finite amplitude response. To explain the inclination of the statically stable layer, we propose two hypotheses: 1)vertically propagating Kelvin wave which has stationary shape in the monsoonal easterly contributes, and 2)the monsoon circulation has its own structure with zonally tilted shape.