Range-imaging observation of turbulence in the tropical tropopause layer by the Equatorial Atmosphere Radar

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Observations of temperature, winds, and atmospheric trace gases suggest that the transition from the troposphere to the stratosphere occurs in a layer, rather than at a sharp tropopause. In the tropics, this layer is often called the tropical tropopause layer (TTL). TTL has a bottom at 150 hPa, 355 K, 14 km (pressure, potential temperature, and altitude) and has a top at 70 hPa, 425 K, 18.5 km. TTL acts in many ways as a gate to the stratosphere, and understanding all relevant processes is of great importance for reliable predictions of future climate [1]. The 47-MHz atmospheric radar referred to as the Equatorial Atmosphere Radar (EAR) has been operated at Sumatra island, Indonesia (0.2°S, 100.32°E), and has revealed features of turbulence in TTL, which is expected to contribute airmass mixing there [2, 3]. In December 2009, we carried out the observation campaign named Cloud experiment by Lidar and the Equatorial Atmosphere Radar (CLEAR). During CLEAR campaign, the EAR was operated with a frequency-domain interferometric imaging (FII) mode to observe fine time and altitude variations of turbulence. On pulse-to-pulse basis, the EAR changed transmitted frequencies from 46.5 to 47.5 MHz with 250 kHz spacing. Using phase difference of received signals caused by transmitted frequency difference and location of turbulence, altitudes of enhanced turbulence were determined. Figure shows an example of range-imaging result in TTL. Wavy echoes with a period of about 7 minutes show presence of shear instability, which causes airmass mixing. Previous study has shown that shear instability frequently occurs around the tropopause due to large wind shear [3], and the wavy echoes as shown in the Figure further provide detailed information on observed scales of shear instability in TTL.

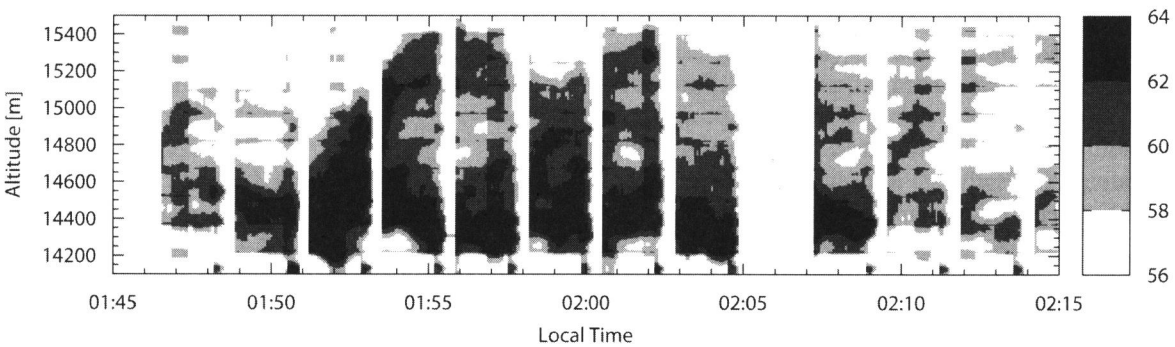

Figure. Time-altitude plot of brightness observed by FII the mode of the EAR.

Acknowledgements

We thank Dr. Tomoaki Mega of RISH for his great contribution in FII data analysis.

References

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