

Dynamical analysis of extreme tropopause folding events in the coastal region of Antarctica

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Rapid and deep descent in the tropopause (the so-called tropopause folding; TF) is often observed in the extratropics. Previous studies examined the global distribution of frequency of TF events using reanalysis data [e.g., Škerlak et al., 2015]. They showed that the frequency of deep TF is maximized along the coast of Antarctica. However, the dynamics of TF in the Antarctic region have not yet been studied adequately. In the present study, the extreme TF in the Antarctic are examined using state-of-art reanalysis data to clarify the uniqueness of TF in the Antarctic.

Extreme TF events were defined as time periods during which the deviation of the dynamical tropopause height from 30 days running mean is negatively large. Fluctuations associated with the synoptic-scale eddies are extracted with a high-pass filter with a cut-off period of 10 days. Composite analyses of the extreme TF events at Syowa Station are performed.

When the negative anomaly of tropopause height is maximized, the significant downwelling is observed at the location of the extreme TF. From the analyses using Q-vector in the quasi-geostrophic equation, it is found that the divergence of the Q-vector is observed to the north of Syowa Station. The distribution of Q-vector is explained by the local westerly jet and strengthening of the frontal structure associated with a synoptic low-pressure system extending west-east centered at 70°S over Antarctica and a high-pressure system.

The synoptic low-pressure system extending east-west centered at 70°S over Antarctica is discussed based on ray tracing theory under the WKB approximation. The low-pressure system extends northeast-southwest from 24 hours before the lowest tropopause is observed, which means that this system has a southward group velocity. From the ray tracing theory, the meridional wavenumber increases with southward propagation of the wave packet since a strong meridional PV gradient associated with radiative cooling along the coast of Antarctica. Then, the meridional scale of the system becomes small. As a result, the westerly jet and frontal structure are enhanced along the coast of Antarctica. Then, the strong downward flow is located to the south of the entrance of the westerly jet. And thus, it is considered that the frequent occurrence of extreme TF along the coast of Antarctica is mainly due to the enhanced downwelling associated with shrinkage of the synoptic low-pressure system in the meridional direction.

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