On Interplay of Gravity Waves and Rossby Waves in the Middle Atmosphere

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It has been considered that the material circulation in the middle atmosphere is driven by force due to gravity waves (GWs) and Rossby waves (RWs) originating mainly from the lower atmosphere. However, recent theoretical studies and high-resolution model simulation studies indicate that GWs and RWs interplay and form a hierarchical structure in the middle atmosphere. GWs are spontaneously generated from balanced flows which are sometimes organized as RWs. The generation mechanism is theoretically explained as spontaneous radiation from the imbalance originating from the flow nonlinearity (Plougonven and Zhang, 2014) and/or as radiation by a resonance of GWs with a balanced flow through their time-scale matching (Yasuda et al., 2015a,b). Such spontaneous radiation of GWs mainly occurs in the troposphere and stratosphere where RWs are dominant. In contrast, in the mesosphere where GWs are a main driver of the material circulation, the GW force sometimes makes anomalous potential vorticity gradient and generates RWs (Sato and Nomoto, 2015). Such RWs are likely those frequently observed as quasi-two-day waves and four-day waves in the mesosphere and lower thermosphere region. The interplay of RWs and GWs may be important for teleconnection through the middle atmosphere. We will start a project to promote the integration of the global network observation of MST radars including the PANSY radar in the Antarctic (Sato et al., 2014) and high-resolution general circulation model simulations under the international collaborations, so as to deepen our knowledge and improve understanding of the hierarchical structure of the middle atmosphere and its role on climate through interhemispheric and vertical coupling processes.

Key words: middle atmosphere, gravity waves, Rossby waves, MST radars.

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