RECENT RESEARCH ACTIVITIES

Long-term Observations of Mesosphere and Lower Thermosphere (MLT) Dynamics with Meteor and Medium-frequency (MF) Radars in Indonesia

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Based on its temperature profile, the atmosphere can be separated into the troposphere (surface to 10–15 km altitude), stratosphere (10–50 km), mesosphere (50–90 km), and thermosphere (90–1,000 km), with the region above 60 km being partially ionized owing to absorption of solar radiation. The lower atmosphere is involved in various meteorological phenomena, including atmosphere–land–ocean interactions and anthropogenic effects, and global warming occurs primarily in the troposphere. Conversely, the thermosphere is the region most affected by solar activity, including 11-year solar variations and abrupt flare events. The region spanning altitudes of 60–150 km is referred to as the mesosphere–lower thermosphere (MLT); this region acts as an interface between the atmosphere near the earth's surface and interplanetary space. Moreover, a prominent change in the dominant physical and photochemical processes occurs in the MLT region, making this region of particular interest in terms of atmospheric dynamics.

We observed atmospheric dynamics in the MLT region during 1977–1990 at Shigaraki using a meteor radar, which determines wind velocity at altitudes of 80–110 km and with temporal and spatial resolutions of 1 h and 2 km, respectively. A group at the University of Adelaide in Australia operates a medium-frequency (MF) radar to observe MLT dynamics, located at conjugate point relative to the equator. We have been continuing a collaborative study with this group to investigate the behavior of atmospheric waves, atmospheric diurnal and semidiurnal tides, planetary waves, and atmospheric gravity waves. Our results demonstrate similarities and hemispheric differences in the seasonal variations of wave activity.

Radar observations have been expanded toward the tropics. In close collaboration with the Indonesian Institute of Aeronautics and Space (LAPAN), we installed meteor radars at Koto Tabang (western Sumatra), Jakarta (western Jawa), and Biak (Papua) and MF radars at Pameungpeuk (western Jawa) and Pontianak (west Kalimantan) (Fig. 1). The University of Adelaide group has operated MF radars on Christmas Island and helped to establish a number of MLT radars in India, China, and the eastern Pacific.

We used long-term continuous radar observations in 1990-2013 to analyze the characteristics of MLT dynamics. Our results demonstrate that the zonal wind exhibits a semiannual oscillation (SAO) and a westward maximum in March–April that is enhanced considerably every two or years. This peculiar phenomenon appears to be related to dynamical forcing due to breaking of atmospheric waves, tides, gravity waves, or Kelvin waves. The mean meridional wind is characterized by an annual oscillation (AO) with air flow from summer to winter hemispheres. A long-term trend in the meridional winds is also apparent and appears to be more dominant in summer at a particular station in India. However, radar results from Indonesia suggest a decadal oscillation of the meridional winds; such long-term variations may be induced by global warming and/or solar variations.

The MF/meteor radar data have been archived in a database at RISH and are available for use by any research community that may be interested in studying equatorial atmospheric dynamics.

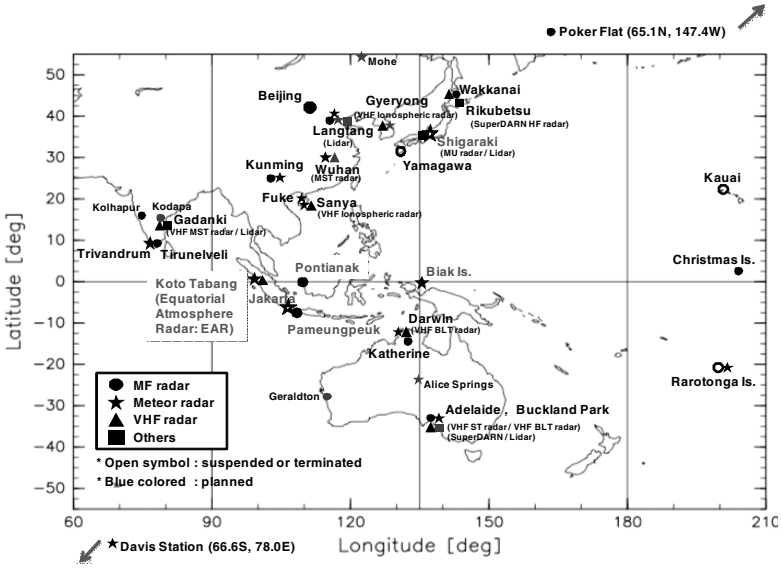

Figure 1. MLT radar network in the Asia–Oceania region