Interhemispheric Coupling Study by Observations and Modelling (ICSOM)

Kaoru Sato and ICSOM team members
[1]*Department of Earth and Planetary Science, The University of Tokyo*

Recent observational and modelling studies suggest that the Northern and Southern Hemispheres of the earth atmosphere are potentially coupled by the Lagrangian mean flow in the mesosphere modulated by waves interacting with the mean flow. However, observations of modulated wave and flow fields which are need for quantitative understanding of the interhemispheric coupling are not sufficient. Simultaneous observations of gravity waves at various locations are most important because they are a main driver of the Lagrangian mean flow in the mesosphere. With the start of the full system observation by the PANSY radar in the Antarctic in March 2015, a global mesosphere-stratosphere-troposphere (MST) radar network covering from the Arctic to the Antarctic has been realized.

The MST radars are able to observe wind vectors with fine temporal and vertical resolutions including vertical wind components in the troposphere, stratosphere and mesosphere, although an observational gap of the middle and upper stratosphere remains. Thus, the characteristics of small-scale or short-period wave motions including gravity waves and the momentum fluxes associated with these waves can be estimated with a good accuracy. In addition, recent high-resolution general circulation models enable an explicit simulation of gravity waves under ideal and/or climatological boundary conditions and allow us to examine the momentum budget in the MST region including gravity waves, although their resolution is currently not sufficient to resolve the entire gravity wave spectrum. Real atmosphere simulations utilizing such high-resolution models are still a challenge for the MST region. However, if such real atmosphere simulations are successful, they will help quantitative interpretation of the dynamical fields observed by the MST radar network, and the observations will provide invaluable validation data for the model improvement. Therefore it is proposed to examine the interhemispheric coupling of the earth atmosphere through a combination of simultaneous observations by networking the radars over the world and high-resolution model simulations of the observed atmosphere.

The first research target of ICSOM is the interhemispheric coupling initiated from a sudden stratospheric warming (SSW) in the Arctic. An observation window is 15-31 January, 2016. Statistics indicates that the SSW, an extreme event in the stratosphere, occurs in winter twice per three years in the Arctic on average. Roughly speaking, the prediction of SSW is possible five days before the onset. Following the prediction made on 10-20 January, 2016, MST radar observations will start at all sites. Observations will be necessary over at least ten successive days starting three days before the SSW onset, considering the time lag of the Antarctic atmosphere response to the SSW. Even in the case of no SSW during the observation window, simultaneous observations will still be beneficial: If another extreme event of vortex intensification (VI) is predicted, we will perform coordinated observations in a similar way. If normal condition of polar vortex is expected, we will perform continuous observations over about seven days to obtain reference data which can be compared with future successful SSW observations. Simultaneous observations for the troposphere and lower stratosphere in addition to mesospheric observations will also be important so as to distinguish the modulation of gravity wave characteristics by the SSW from that originating from the gravity wave source variation. Complementary observations utilizing MF and meteor radars, lidars, imagers and radiosondes will also be performed. High resolution satellite observations covering the whole stratosphere are included for the analysis as well.

Simulation of high-resolution general circulation models covering the MST region will be made using super computers. Initial conditions for the model simulation will be made based on global analysis data covering the mesosphere such as MERRA. Regional models or models having a stretched grid configuration will also be used for simulations with finer resolutions.

This international research collaboration, which more than 30 scientists from eight countries participate in, is supposed to be placed as a project for ROSMIC of SCOSTEP. Currently, the PANSY radar at Syowa Station in the Antarctic (Japan), a Summer-Mesosphere ST radar at Davis Station in the Antarctic (Australia), the Jicamarca radar in Peru (Peru), the equatorial atmosphere radar in Indonesia (Japan), the MU radar in Japan (Japan), and MAARCY in Norway (Germany) will be operated as the global network of MST radars.