Impact of atmospheric radar and lidar observations on global climate change studies

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Abstract:

One of the most important factors of the climate change is the change of atmospheric minor constituents, such as greenhouse gasses or ozone-depleting substances. These gasses are artificially created around the earth surface due to activity of mankind and diffuse into the earth's atmosphere. Turbulence of various scales plays a very important role in vertical transport of such gasses from the ground into troposphere and stratosphere through turbulent diffusion, or eddy diffusion. However, the details of turbulent diffusive process in the earth's atmosphere is still not understood well.

Atmospheric radar and lidar (laser radar) are active remote sensings transmitting radio wave or laser beam into the atmosphere and receiving backscatters from the atmosphere in order to observe various parameters such as wind velocity, temperature, mixing ration of minor constituents etc. The advantage of such observations is to have capability of profiling atmospheric parameters as a function of height (or range) with relatively short time integration. It is not very difficult to attain height and time resolutions of 100 m and minutes using such techniques.

The MU radar (Middle and Upper atmosphere radar) of RISH (Research Institute for Sustainable Humanosphere), Kyoto University, Japan is the most capable atmospheric radar in the world with 46.5 MHz 1MW output. This radar was built in 1984 mainly for the studies of middle atmosphere (10-100km altitude) and upper atmosphere (100 – 500km) as well as troposphere (up to 15 km), and has been used for atmospheric science, mainly for study of atmospheric dynamics. A collocated atmospheric lidar system with 532 nm 30W output was installed in 2000 mainly for the measurement of temperature above 30 km. This system was upgraded using the Rotational Raman lidar technique developed in GKSS, Germany, under the collaboration with Dr. Andreas Behrent, who visited us as JSPS post-doctoral fellow in 2000 – 2002. The new lidar now can measure temperature, humidity and particle (cloud) properties in the troposphere and lower stratosphere with a high time –height resolution. In the meantime, the MU radar was upgraded with 25 channel digital receiver system with multiple frequencies and this new system has an improved spatial resolution (in height and horizontal scale) by a factor of 5-6. Both of our radar and lidar systems now have a time and height resolution of ten seconds and 10-30 m, and ready to study the complicated turbulent layer structures which is a key phenomenon in order to clarity vertical diffusive process in the atmosphere. An example of combined radar-lidar measurement will be introduced in the talk.

Curriculum Vitae:

Takuji Nakamura is currently an Associate Professor at the Research Institute for Sustainable Humanosphere (RISH), Kyoto University, Japan.

He was born on April, 1961 in Kobe, Japan. He received his B.E., M.E., and PhD. degrees in electronic engineering from Kyoto University in 1984, 1986 and 1992, respectively. He worked for Communication Equipment Works, Mitsubishi Electric Co. between 1986 and 1989. In 1989 he moved back to Kyoto University, as a Research Associate at the Radio Atmospheric Science Center (RASC), and he has remained at Kyoto University since then. He became an Associate Professor of RASC in 1998. He was a visiting professor at the Department of Aerospace Engineering, University of Colorado, USA during 2003.

His major research interests include system design and signal processing of atmospheric radars; radar and optical remote sensing techniques of the atmosphere; dynamics and aeronomy of the earth's atmosphere (including the equatorial atmosphere); and radio scattering mechanisms of meteor phenomena.

He has worked with the MU radar (the middle and upper atmosphere radar, one of the largest atmospheric radars in the world, which is located in Shiga, Japan) since 1986. From the mid-1990s, he extended his work into optical observations (ground-based lidars, CCD imagers) as well as engaging in collaborative observations with radar, optical instruments and satellites. His observational field activity has been in Shigaraki, Shiga, Japan; Java and Sumatra, Indonesia; and Colorado, USA.

He is currently vice-chair of Commision C (the Upper Atmosphere of the Earth and Planets, including Reference Atmospheres) of COSPAR (Committee of Space Research), and a member of AGU, JPGU, IAU, etc.