“Uncertainty in climate sensitivity: Cloud adjustment and feedback”

Youichi KAMAE
Assistant Professor, Faculty of Life and Environmental Sciences
University of Tsukuba

During the recent decades, uncertainty range of climate sensitivity (CS), determined as global-mean surface temperature increase in response to doubling of CO2 concentration, has not been reduced efficiently despite improving the quality of clim ate model projections. Literatures revealed that it is essential how to determine radiative forcing and climate feedback for decomposing sources of uncertainty in CS. It is also commonly known that an instantaneous CO2 forcing can lead to fast responses in stratosphere and troposphere (e.g. vertical profiles of temperature, humidity, cloud and circulation) which results in a rapid perturbation in radiative balance at the top of the atmosphere. Atmospheric processes associated with the tropospheric adjustment including slowdown of hydrological cycle were suggested to be important for projections of global and regional climate changes including monsoons.

In addition, cloud feedback that is essential for uncertainty in CS shows an apparent land-sea contrast. Physically-robust positive cloud feedback found over tropical land contributes to anomalous land warming even if the imposed radiative forcing is spatially uniform. As for the oceanic clouds, tropical low-cloud and middle-cloud are suggested to be essential for CS spread among climate models. Here a systematic modeling framework was applied to decompose structural and parametric uncertainties in CS. Model-parameter sensitivity found in perturbed parameter ensembles reveals that the lower tropospheric mixing intensity can explain drying of the boundary layer in a warming climate. As a result, extremely-high CS (e.g. 6-10 K) can be constrained by the observed intensity in lower tropospheric mixing. However, a large spread is also found in middle cloud feedback, resulting in a large uncertainty in CS. A combination of different observational metrics is needed for more effective constraint of CS uncertainty.

In this talk, the recent progresses in understanding of sources of CS uncertainty will be introduced. The effectiveness and limitation of a linear forcing-adjustment-feedback concept are also discussed. The systematic frameworks including structural and parametric uncertainties will contribute to dispel the clouds of uncertainty in CS.