Issues in aerosol-cloud-climate interaction: Needs for future satellite mission

*Kentaroh Suzuki[1]

1. Atmosphere and Ocean Research Institute, University of Tokyo

The aerosol forcing is the largest source of uncertainty in determining climate forcing that drives global climate change. The aerosol forcing consists of the so-called direct (aerosol-radiation interaction) and indirect (aerosol-cloud interaction) effects, both of which are subject to significant uncertainty. This uncertainty arises from our lack of understanding on key processes that govern interactions between aerosol, cloud and climate. Precipitation, among those processes, is central to the aerosol-cloud-climate interaction through its effect of depleting both clouds and aerosols. The aerosol-induced precipitation change influences the cloud lifetime and amount, whereas the precipitation change also modulates the wet removal of aerosols. This underscores a fundamental role of precipitation in shaping the aerosol-cloud-climate interaction. Recent advance in satellite observations by multiple sensors and platforms enabled us to observationally diagnose the precipitation processes on the global scale particularly, which also offers a process-level constraint on model representation of the processes. Such a “bottom-up” model constraint, however, turned out to be inconsistent with “top-down” energy balance requirement on model performance, exposing error compensations in state-of-the-art climate models at a fundamental level. This proposes that there is still a gap in our understanding of the aerosol-cloud-climate processes that hampers their reliable modeling. This presentation discusses what is required to observe in future satellite missions for filling the gap in understanding and modeling the aerosol-cloud-climate interaction. In particular, observational needs for aerosol, cloud and precipitation will be argued to better quantify aerosol-induced climate forcing in the context of recent Aerosol-Cloud-Convection-Precipitation (A-CCP) discussion emerging from the US Decadal Survey and multiple community efforts for process-oriented model diagnostics in an attempt to advance climate modeling.

Keywords: Aerosol, Cloud and precipitation, Climate modeling, Satellite observation