

[EE] Evening Poster | A (Atmospheric and Hydrospheric Sciences) | A-AS Atmospheric Sciences, Meteorology & Atmospheric Environment

[A-AS04]Towards integrated understandings of cloud and precipitation processes

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Clouds and precipitation are among the largest uncertainties in weather predictions and climate projections. To overcome this difficulty, substantial progresses are required in understandings of cloud and precipitation processes and their interactions with large-scale environment. Such progresses, however, have been hampered by historical separation of the science community into two, namely, one for clouds and the other for precipitation, despite the fact that clouds and precipitation are inseparable phenomena.

This session aims to integrate various studies of clouds and precipitation across the two communities over different spatial and temporal scales. A particular focus is placed on better understandings of fundamental processes governing the cloud and precipitation phenomena and their multi-scale interactions with environment through dynamical, thermodynamical and radiative processes. A wide variety of studies with theoretical, modeling and observational approaches are solicited in this session to seek a novel way for combining different methodologies to obtain unified, holistic understandings of the cloud and precipitation systems. The solicited area of research includes but is not limited to cloud microphysics, cloud-radiation interaction, convection dynamics, meso-scale phenomena and various multi-scale interactions including tropical aggregation of clouds, by means of a breadth of approaches encompassing in-situ and satellite observations, theoretical process studies and numerical modeling. Through discussion of presented papers, the session is also intended to enhance collaborations among different disciplines and communities for substantially advancing our understandings of cloud and precipitation processes.

[AAS04-P03]Smaller susceptibility of precipitation onset to aerosols in a global cloud-resolving model

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A growing body of evidence proposes that the aerosol indirect forcing, particularly due to the cloud lifetime effect or the second indirect effect, may be substantially smaller than what has been considered. This is largely influenced by uncertainty of the cloud water response to aerosol perturbations, which varies even in sign as reported by recent studies. Given that the cloud water response is largely dictated by the rain formation process and its modulation induced by aerosols, this study investigates how the precipitation onset responds to aerosol perturbations with a combined use of a global cloud-resolving model (NICAM), a global climate model (MIROC) and satellite observations (CloudSat and MODIS). Methodologies recently proposed to diagnose the rain formation process are applied to both the model output and satellite observations to quantify how the precipitation onset is susceptible to aerosol perturbations in the models and the real atmosphere. The methodologies construct the global statistics of the probability of precipitation (POP) as a function of liquid water path (LWP) to

demonstrate how the POP tends to monotonically increase with increasing LWP in the manner that varies systematically with droplet number concentration. This variation is then used to quantify the susceptibility of precipitation onset to perturbed aerosols. The susceptibility thus obtained is compared between the two global models and satellite observations to show that NICAM reproduces the susceptibility well close to what is obtained from satellite observations, in contrast to MIROC that exerts significantly larger susceptibility. This proposes that NICAM represents the aerosol effect on rain formation more realistically than MIROC and other traditional climate models that have been reported to overestimate the susceptibility. Further analysis exploring the microphysical process representations in the two models reveals that the cloud-rain water composition is a key factor that controls the precipitation onset susceptibility and is qualitatively different between the two models. The cloud-rain composition varies in response to aerosol perturbations through auto-conversion and accretion processes, whose relative contributions are in turn largely influenced by the cloud-rain composition. This mutual interplay between the cloud-rain water composition and the process proportion plays a key role in determining the precipitation susceptibility and modulation of cloud water budget in response to aerosol perturbation. This presentation highlights a stark contrast between the two models in representations of these fundamental aspects of the aerosol indirect effect in comparison to satellite observations that provide key constraint on some of these aspects.