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CHASER: An Innovative Satellite Mission Concept to Measure the Effects of Aerosols on Clouds and Climate

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The formation of cloud droplets on aerosol particles, technically known as the activation of cloud condensation nuclei (CCN), is the fundamental process driving the interactions of aerosols with clouds and precipitation. Knowledge of these interactions is foundational to our understanding of weather and climate. The Intergovernmental Panel on Climate Change (IPCC) and the Decadal Survey (NRC 2007) indicate that the uncertainty in how clouds adjust to aerosol perturbations dominates the uncertainty in the overall quantification of the radiative forcing attributable to human activities. The Clouds, Hazards, and Aerosols Survey for Earth Researchers (CHASER) mission concept responds to the IPCC and Decadal Survey concerns by studying the activation of CCN and their interactions with clouds and storms.

CHASER proposes to revolutionize our understanding of the interactions of aerosols with clouds by making the first global measurements of the fundamental physical entity linking them: activated cloud condensation nuclei.

The CHASER mission was conceptualized to measure all quantities necessary for determining the interactions of aerosols with clouds and storms. Measurements by current satellites allow the determination of crude profiles of cloud particle size but not of the activated CCN that seed them. CHASER uses a new technique (Freud et al. 2011; Rosenfeld et al. 2012) and high-heritage instruments to produce the first global maps of activated CCN and the properties of the clouds associated with them. CHASER measures the CCN concentration and cloud thermodynamic forcing simultaneously, allowing their effects to be distinguished. Changes in the behavior of a group of weather systems in which only one of the quantities varies (a partial derivative of the intensity with the desirable quantity) allow the determination of each effect statistically.

The high uncertainties of current climate predictions limit their much-needed use in decision-making. CHASER mitigates this problem by establishing a Data Application Center for conducting social science research focused on understanding the best ways to use, transfer, and communicate mission data to decision-makers. The CHASER Data Application Center supports the visions of the National Research Council and the Decadal Survey for an integrated program of observations from space that secures practical benefits for humankind by developing data products for assessing risks due to severe weather and climate change.