An Overview of the NASA Atmosphere Observing System Inclined Mission (AOS-I) and the Role of Backscatter Lidar

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NASA has established the Earth System Observatory (ESO) to fulfill the science needs presented in the 2017 Earth Science Decadal Survey, and the Atmosphere Observing System (AOS) is a key component of ESO. The AOS mission will make measurements of aerosols, clouds, convection and precipitation, all of which are designated observables in the decadal survey, to advance our understanding of the processes that drive types of clouds (i.e., low, high, and precipitating), convective vertical motion, air quality, aerosol redistribution, radiative transfer, and the relationships between these processes. By employing a two-orbit architecture, AOS will be able to cover a wide range of temporal and spatial scales, thereby transforming our understanding of this critical part of the Earth System. One of the orbit planes is inclined (AOS-I, 55-degree inclination, 407 km altitude, launch in 2028) with a backscatter lidar called the Atmospheric Lidar Instrument for Clouds and Aerosol Transport (ALICAT), a Ku-band Doppler radar, and two microwave radiometers that provide time delta measurements. The goal of AOS-I is to determine the time-varying processes that control aerosol-convection-precipitation interactions, as well as the diurnal variability of convection, precipitation, high clouds, aerosol emissions, and air quality.

This extended abstract provides (1) an overview of the AOS-I mission, (2) a description of the AOS-I science objectives, and (3) a preview of the critical role ALICAT plays in AOS-I science, applications, and synergy. Based on heritage from the Cloud-Aerosol Transport System (CATS) that operated on the International Space Station (ISS) for 33 months, ALICAT is a high-repetition rate, photon counting backscatter lidar optimized to fit a SmallSat spacecraft bus. In addition to its compact and affordable design, ALICAT will provide vertical profiles of attenuated backscatter and depolarization ratio at two wavelengths (532 and 1064 nm) with better daytime signal-to-noise ratio than previous space-based lidar systems, improving aerosol detection/typing and estimates of aerosol optical properties such as vertical profiles of aerosol extinction coefficient. These ALICAT measurements are critical to: (1) facilitating the first ever space-based synergistic aerosol-convection-precipitation measurements from coincident lidar, Ku-band radar, and microwave radiometers, (2) developing synergy with aerosol measurements from the next generation of Geostationary atmospheric composition and weather satellites, and (3) enabling timely and precise monitoring of the height and vertical distribution of aerosols, which uniquely support applications such as operational hazardous plume monitoring (i.e., volcanic plumes), aerosol modeling, and air quality assessments.