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ultra-Stable Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (5STAR)

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Abstract Text:

The Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (4STAR) combines airborne sun tracking and sky scanning with diffraction spectroscopy to improve knowledge of atmospheric constituents and their links to air pollution and climate. Direct beam hyperspectral measurement of optical depth improves retrievals of gas constituents and determination of aerosol properties. Sky scanning enhances retrievals of aerosol type and size distribution. Hyperspectral cloud-transmitted radiance measurements enable the retrieval of cloud properties from below clouds. These measurements tighten the closure between satellite and ground-based measurements. 4STAR incorporates a modular sun-tracking/ sky-scanning optical head with optical fiber signal transmission to rack mounted spectrometers, permitting miniaturization of the external optical tracking head, and future detector evolution.

4STAR has supported a broad range of flight experiments since it was first flown in 2010. This experience provides the basis for a series of improvements directed toward reducing measurement uncertainty and calibration complexity, and expanding future measurement capabilities, to be incorporated into a new 5STAR instrument. A 9-channel photodiode radiometer with AERONET-matched bandpass filters will be incorporated to improve calibration stability. A wide dynamic range tracking camera will provide a high precision solar position tracking signal as well as an image of sky conditions around the solar axis. An ultrasonic window cleaning system design will be tested. A UV spectrometer tailored for formaldehyde and SO₂ gas retrievals will be added to the spectrometer enclosure. Finally, expansion capability for a 4 channel polarized radiometer to measure the Stokes polarization vector of sky light will be incorporated. This paper presents initial progress on this next-generation 5STAR instrument.

Keywords: atmosphere; climate; pollution; radiometry; technology; hyperspectral; fiber optic, polarimetry

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