Title: Upgrade of the NASA 4STAR (Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research) to its Full Science Capability of Sun-Sky-Cloud-Trace Gas Spectrometry in Airborne Science Deployments
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Abstract: The objectives of this task in the AITT (Airborne Instrument Technology Transition) Program are to (1) upgrade the NASA 4STAR (Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research) instrument to its full science capability of measuring (a) direct-beam sun transmission to derive aerosol optical depth spectra, (b) sky radiance vs scattering angle to retrieve aerosol absorption and type (via complex refractive index spectra, shape, and mode-resolved size distribution), (c) zenith radiance for cloud properties, and (d) hyperspectral signals for trace gas retrievals, and (2) demonstrate its suitability for deployment in challenging NASA airborne multi-instrument campaigns. 4STAR combines airborne sun tracking, sky scanning, and zenith pointing with diffraction spectroscopy to improve knowledge of atmospheric constituents and their links to air pollution, radiant energy budgets (hence climate), and remote measurements of Earth's surfaces. 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. 4STAR measurements are intended to tighten the closure between satellite and ground-based measurements. 4STAR incorporates a modular sun-tracking/sky-scanning optical head with fiber optic signal transmission to rack mounted spectrometers, permitting miniaturization of the external optical head, and future detector evolution. 4STAR test flights, as well as science flights in the 2012-13 TCAP (Two-Column Aerosol Project) and 2013 SEAC4RS (Studies of Emissions and Atmospheric Composition, Clouds and Climate Coupling by Regional Surveys) have demonstrated that the following are essential for 4STAR to achieve its full science potential: (1) Calibration stability for both direct-beam irradiance and sky radiance, (2) Improved light collection and usage, and (3) Improved flight operability and reliability. A particular challenge for the AITT-4STAR project has been conducting it simultaneously with preparations for, and execution of, ARISE (Arctic Radiation - IceBridge Sea&Ice Experiment), a NASA airborne science deployment (unplanned when AITT-4STAR was selected for funding) in which 4STAR will deploy to Thule, Greenland, and Fairbanks, Alaska, on the NASA C-130. This presentation describes progress to date in accomplishing AITT-4STAR goals, and plans for project completion.