Solar Spectral Flux Radiometer, SSFR, in ARCTAS:

Instrument Description and Science Goals

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Our primary objective is to support ARCTAS by flying the Solar Spectral Flux Radiometer, SSFR, aboard the P-3 to measure the spectrally resolved solar irradiance in the Arctic. These radiometric observations will be used to answer some of the following questions:

1) Can area-resolved surface albedo over snow covered areas be derived using a technique that was currently developed for land and sea surfaces? How well do our measurements agree with surface and with satellite observations? What is the spatial variability, as seen from an airborne SSFR, and from satellite? What is the dependency on solar zenith angle?
2) Can we relate the aerosol surface forcing as determined by SSFR and the TOA aerosol forcing as determined from satellite over snow and ice covered surfaces?
3) Are SSFR retrievals of cloud optical thickness and effective radius in agreement with satellite retrievals, in particular with MODIS level-2 products?

The Solar Spectral Flux Radiometer (Pilewskie et al., 2003) is a moderate resolution flux (irradiance) spectrometer.

- Wavelength range: 380 nm to 2200 nm
- Spectral resolution: ~ 8-12 nm
- Simultaneous zenith and nadir viewing
- Hemispheric field-of-view
- Accuracy: ~ 3%; Precision: 0.5%
- Measured quantities: Upwelling and down-welling spectral irradiance ($Wm^{-2}nm^{-1}$)
- Derived quantities: Spectral albedo, net flux, flux divergence (absorption), and fractional absorption
- Retrieved quantities: r_e, τ, liquid water path

The SSFR is a well-characterized sensor, having flown in several recent missions including the following: the Southern African Regional Science Initiative (SAFARI), 2000; the Cirrus Regional Study of Tropical Anvils and Cirrus Layers-Florida Area Cirrus Experiment (CRYSTAL-FACE), 2002 – see Schmidt et al., 2007; the ARM Aerosol IOP, 2003; and the International Consortium for Atmospheric Research on Transport and Transformation (ICARTT) 2004, the Gulf of Mexico Atmospheric Composition and Climate Study (GoMACCS) 2006 in Houston; the Intercontinental Chemical Transport Experiment (INTEX-B) in Veracruz and Mexico City, and the Tropical Composition Cloud and Climate Coupling Experiment (TC4) in San Jose, Costa Rica. Among the many platforms that the SSFR has been integrated are the NASA ER-2, the NASA Altus II (UAV), the NASA DC-8, the CIRPAS Twin Otter, the Scaled Composites Proteus, and the Sky Research J-31.

Our first objective is to provide area-resolved spectral surface albedo from airborne measurements. The method has been developed during the INTEX-B field experiment (Coddington et al., 2007). The results of this method have been compared with the MODIS 500 m albedo level 3 product and have been validated with ground-based measurements. Required input to this product will be aerosol optical thickness from, e.g., ground-based sunphotometers at a limited number of surface sites, and in-situ measured aerosol optical properties (single scattering albedo and asymmetry parameter). In addition, we will use aerosol optical thickness retrieved from onboard the same aircraft and/or aerosol extinction profiles measured with a High Resolution Lidar System (HSRL) onboard a second remote sensing platform (B-200). Preferred flight tracks are straight level legs at low altitude under clear-sky conditions or homogeneous cloud conditions. We intend to compare the results to ground-based surface albedo measurements, and to satellite products from MISR and MODIS.

Our second objective is to measure aerosol absorption directly, and to derive single scattering albedo. This important aerosol parameter can directly be compared to airborne or ground-based in situ measurements. This will be an important parameter for satellite aerosol retrievals (e. g., MISR). From aerosol absorption, we will derive aerosol single scattering albedo, and compare with MISR retrievals. Aerosol forcing efficiency will be derived in conjunction with an airborne sunphotometer (AATS-14).

Our third objective is to retrieve cloud optical thickness and effective radius in cases where the aircraft was flying above clouds. We will compare the SSFR retrievals with simultaneous satellite retrievals, in particular MODIS, to improve the MODIS level-2 cloud product over snow/ice surfaces, where a new spectral band combination is going to be tested. Priority for the cloud retrievals will be given to the summer experiment with higher sun angles. For this study, the SSFR area-resolved surface albedo measurements will also be of primary importance. In addition, we will study (a) the impact of aerosol layers above cloud on the retrievals, (b) the impact of aerosols between (broken) clouds on retrievals, and (c) the impact of the high surface albedo and low sun on cloud retrievals, especially when clouds are optically thin.

References:

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