Hyperspectral Radiometer Measurements During RACORO

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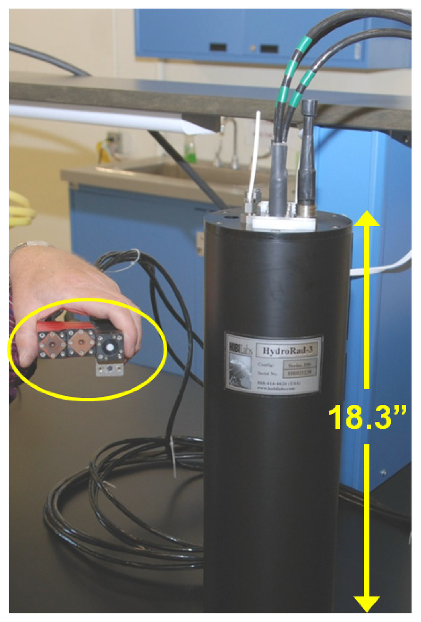
Summary

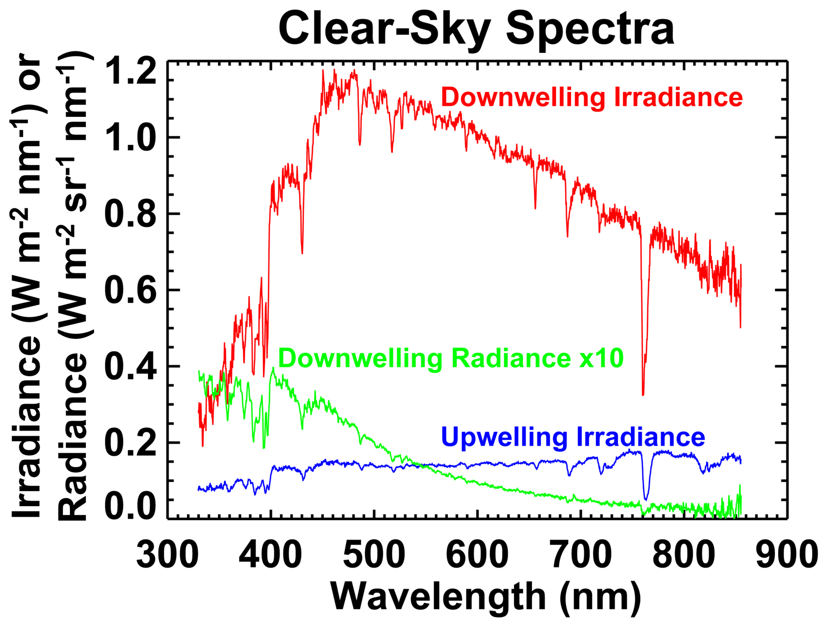
Airborne shortwave hyperspectral irradiance and radiance measurements during the RACORO field program are described, and their use explored for scientific applications such as spectral surface albedo mapping and cloud property retrievals.

1. Shortwave Hyperspectral Measurements

Radiometers flown onboard the Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS) Twin Otter included a HOBI Labs (http://www.hobilabs.com/) Hydrorad-3 series 300 Hyperspectral Radiometer.

- **Simultaneous measurements of upwelling and downwelling irradiances, and radiance (3º field-of-view) either up or downwelling**
- **Wavelength range 350-850 nm at down to 0.3-nm resolution**
- **Fast response: dwell time between 20 and 200 ms**

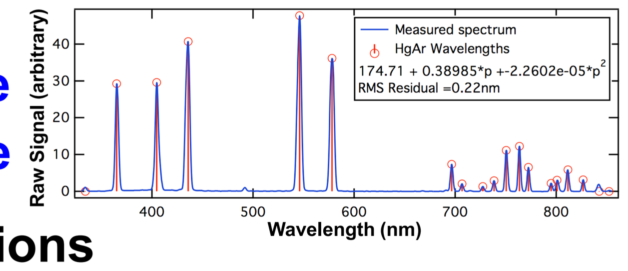




2. Radiometer Calibration and Testing

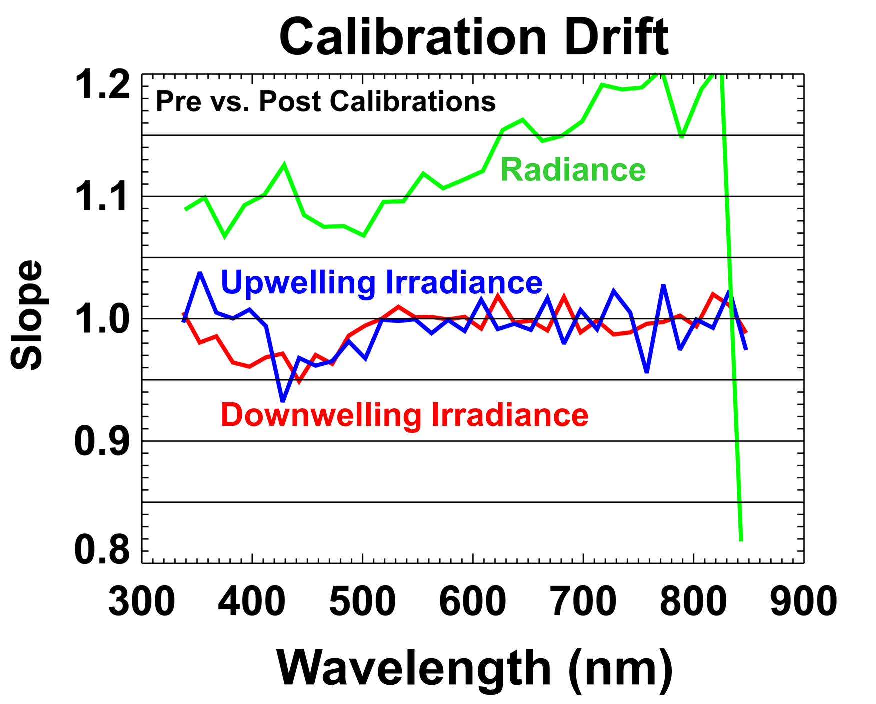
HOBI Labs calibration:

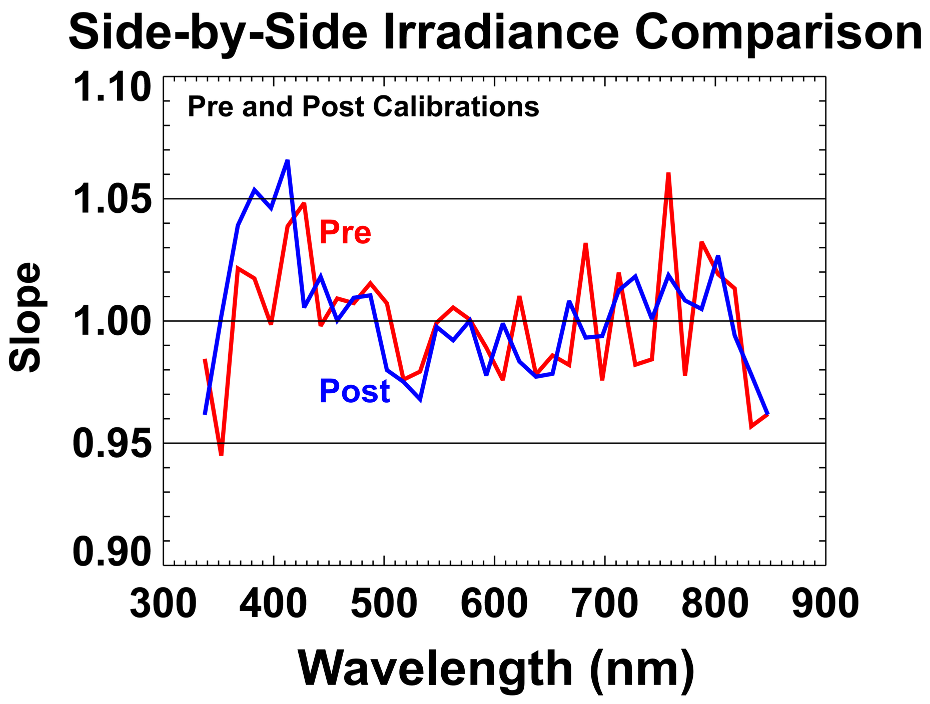
- **Radiometric calibration uses a NIST traceable light source**
- **Wavelength calibration uses a Mercury-Argon light source**



Calibrations examined using pre- and post-campaign calibrations

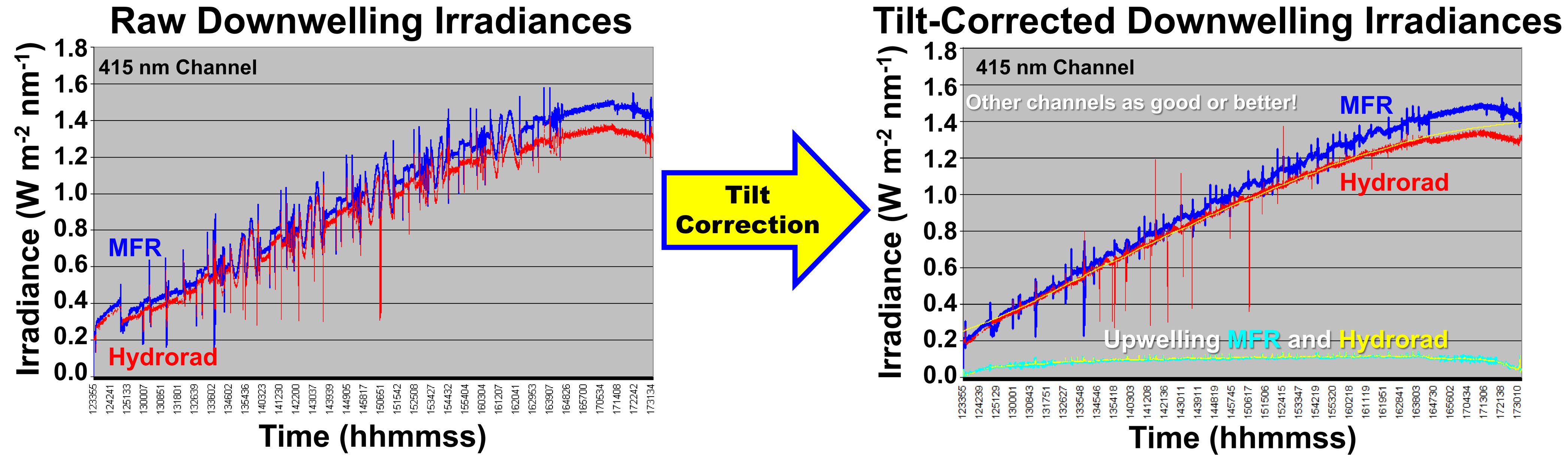
- **Calibration drift**
- **Side-by-side irradiance comparisons**





3. Downwelling Irradiance Tilt Correction

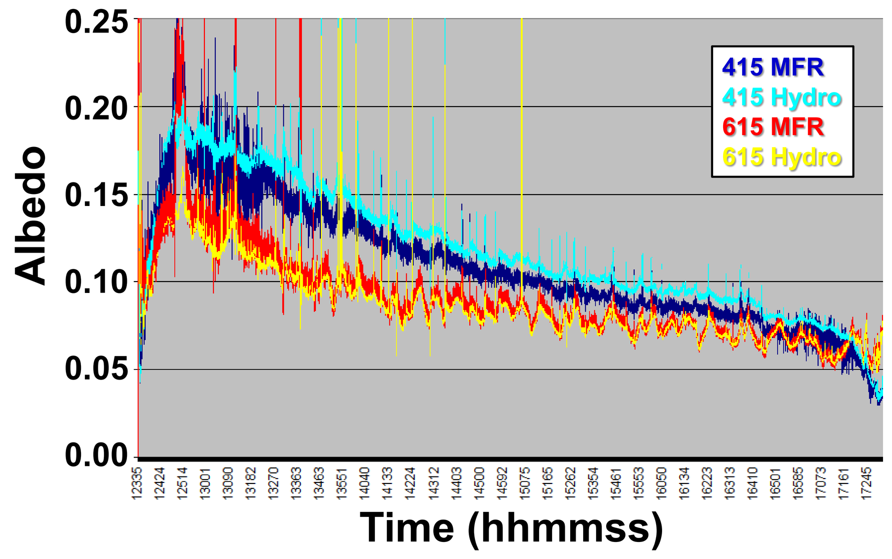
Downwelling irradiances require "leveling" for aircraft attitude to be used in scientific applications. The Long et al. (2010) method, which uses direct and diffuse fluxes from a SPN1 to correct for attitude, was successfully applied to the Hydrorad spectral data.

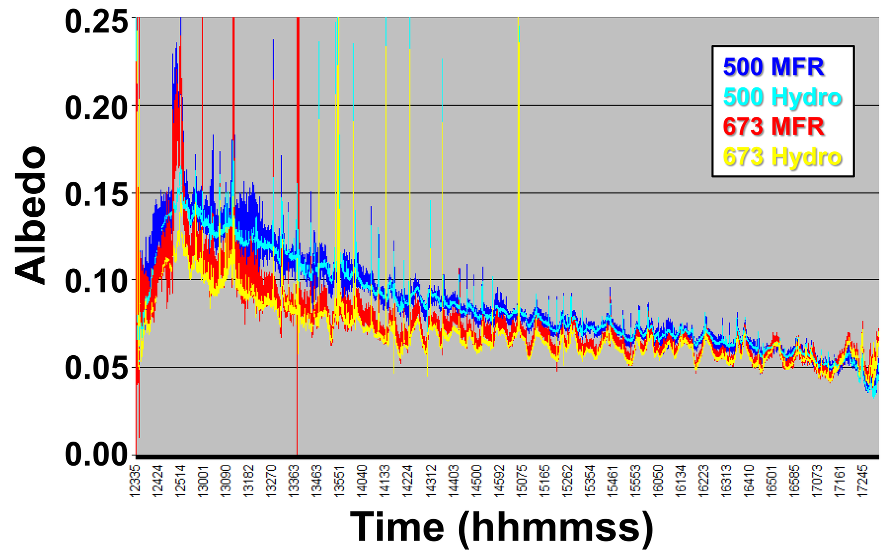


4. Sample Scientific Applications

A. Spectral Surface Albedo

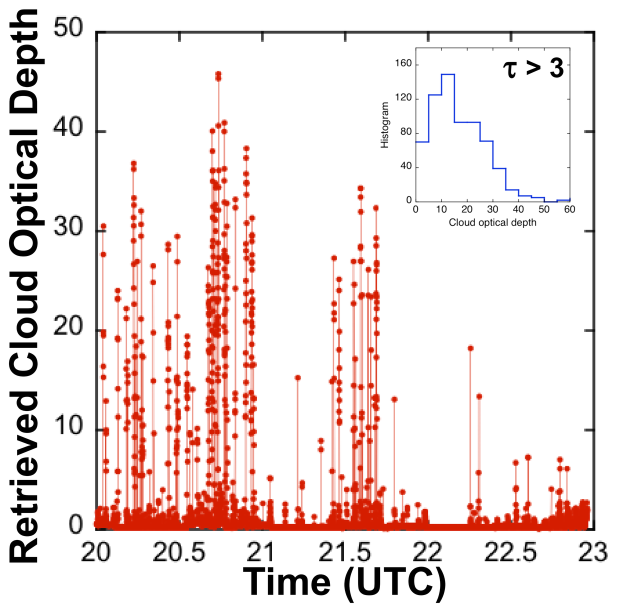
The Hydrorad can provide spectral albedo from 350-850 nm. Below is a comparison of albedos with MFR channels.



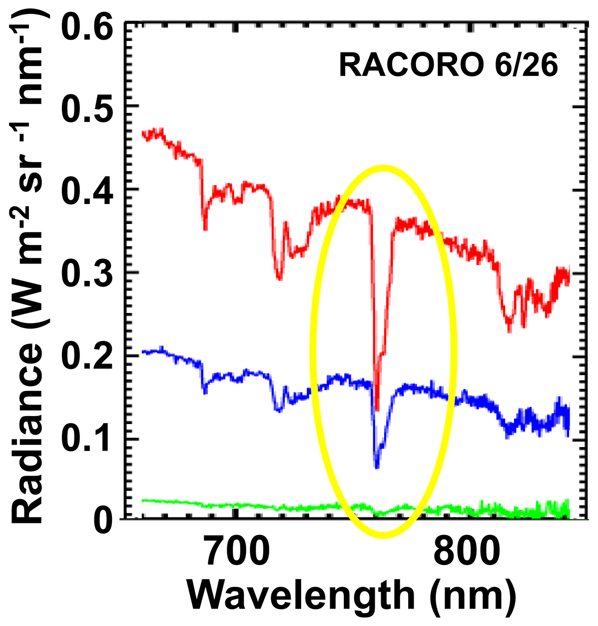


B. Cloud Property Retrievals

Below-cloud legs enable mapping the cloud field optical depth.



Radiances at 440 and 780 nm can be used to retrieve optical depth over vegetated surfaces even for broken cloud fields (Marshak et al., 2004; Chiu et al., 2010). Shown here are retrievals for a cumulus cloud field sampled during the 6/18 RACORO flight, which shows the large degree of variability that can be captured.



Spectral radiances within the Oxygen A-band region (758-778 nm) potentially offer another means to obtain optical depths across the cloud field (e.g., Min and Harrison, 2004).

Contact Information & References

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Chiu, J. C. et al., 2010: Cloud optical depth retrievals from the Aerosol Robotic Network (AERONET) cloud mode observations. *J. Geophys. Res.*, 115, D14202, doi:10.1029/2009JD013121.

Long, C. N. et al., 2010: A Method of Correcting for Tilt from Horizontal in Downwelling Shortwave Irradiance Measurements on Moving Platforms, *The Open Atmospheric Science Journal*, 4, 10.2174/1874282301004010078.

Marshak, A. et al., 2004: The "RED versus NIR" plane to retrieve broken-cloud optical depth from ground-based measurements. *J. Atmos. Sci.*, 61, 1911-1925.

Min, Q., and L. C. Harrison, 2004: Retrieval of Atmospheric Optical Depth Profiles from Downward-Looking High-Resolution O2 A-Band Measurements: Optically Thin Conditions. *J. Atmos. Sci.*, 61, 2469–2477.

Vogelmann, A. M. et al., 2011: RACORO Extended-Term, Aircraft Observations of Boundary Layer Clouds, *Bull. Amer. Meteor. Soc.*, in preparation.