

Remote sensing of clouds with SMART-HALO

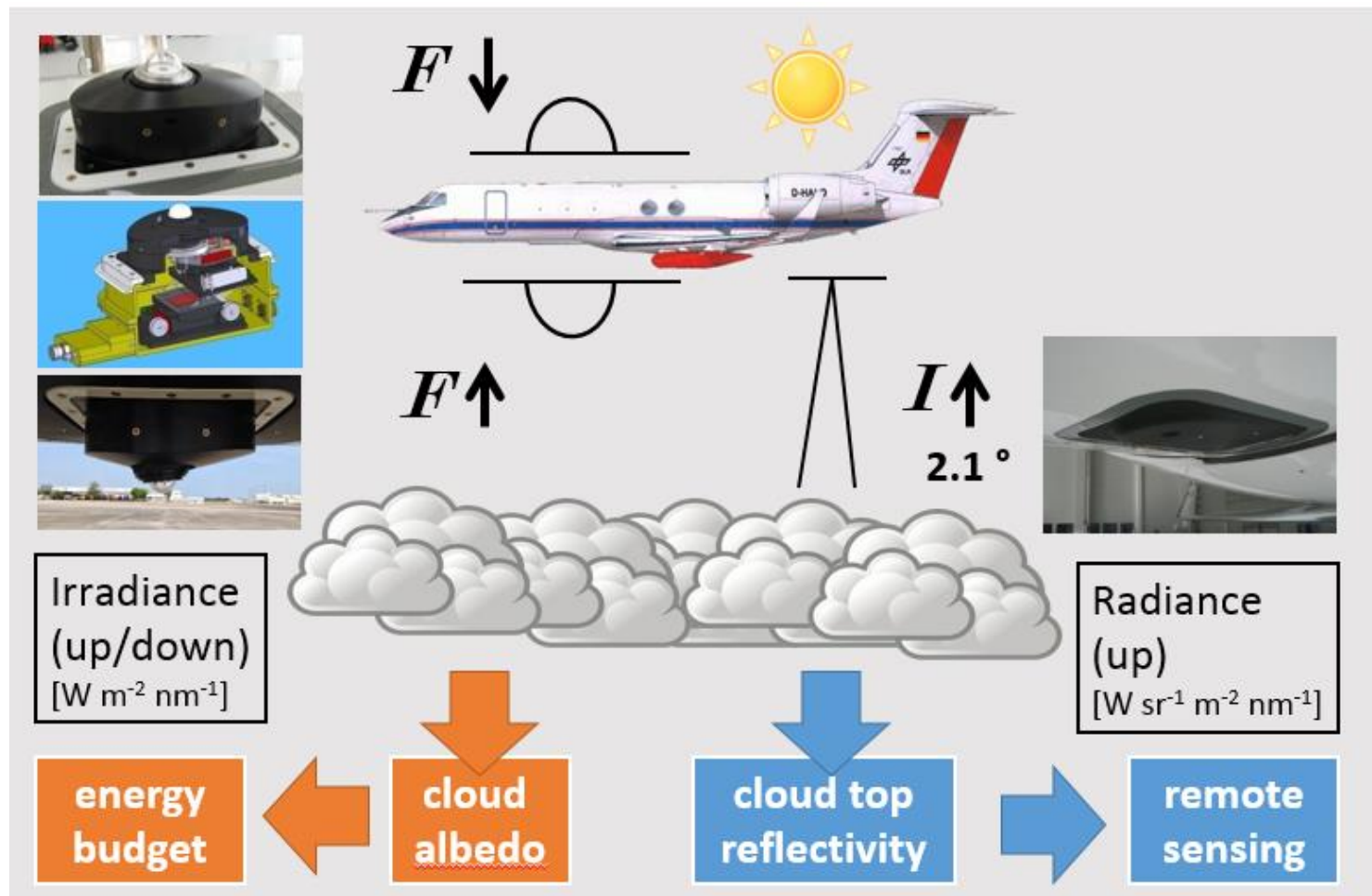


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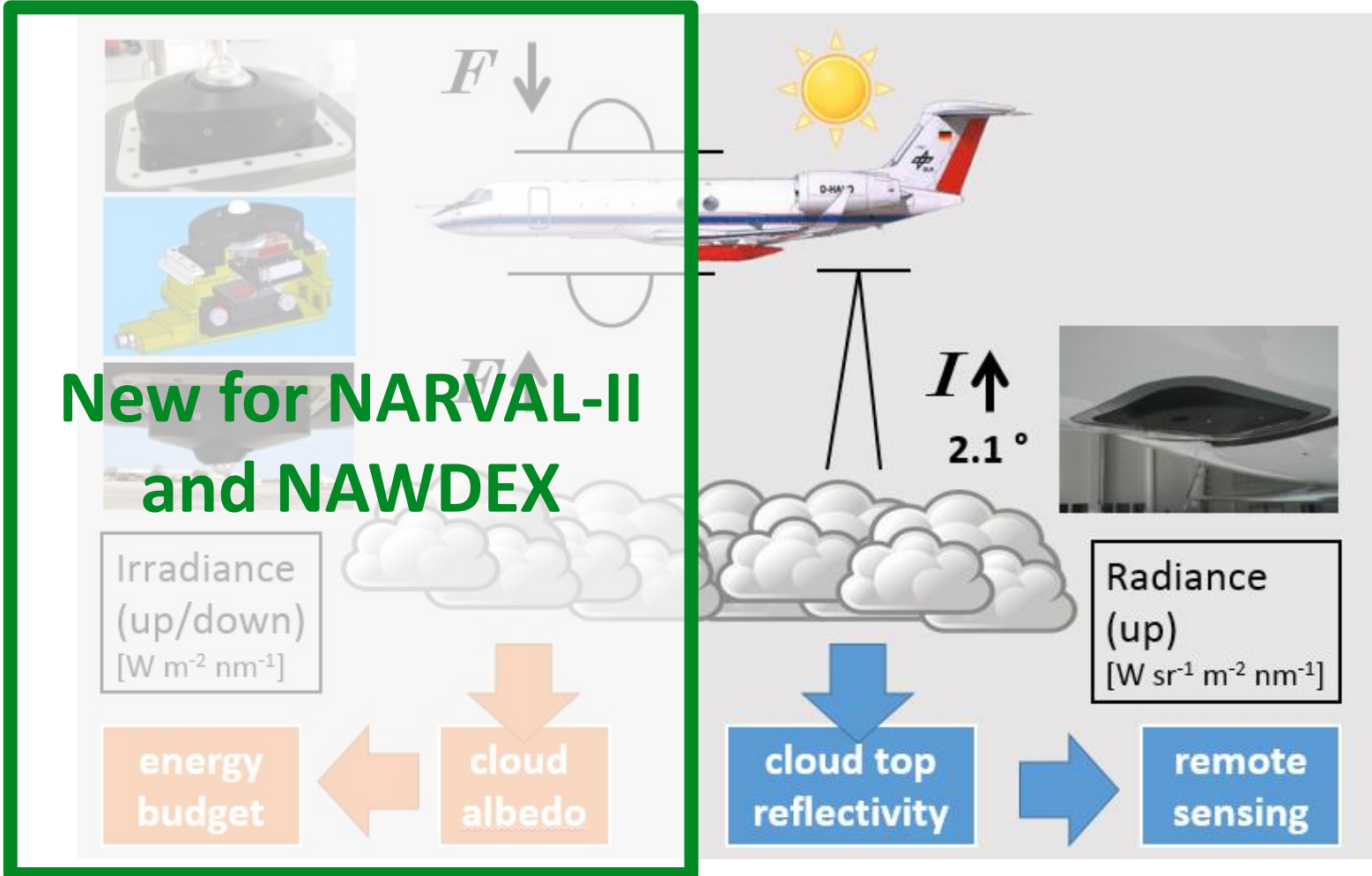
Institute for Meteorology

André Ehrlich, Kevin Wolf,
Frank Werner, Trismono Krisna,
Manfred Wendisch

SMART = (Spectral Modular Airborne Radiation measurement sysTem)



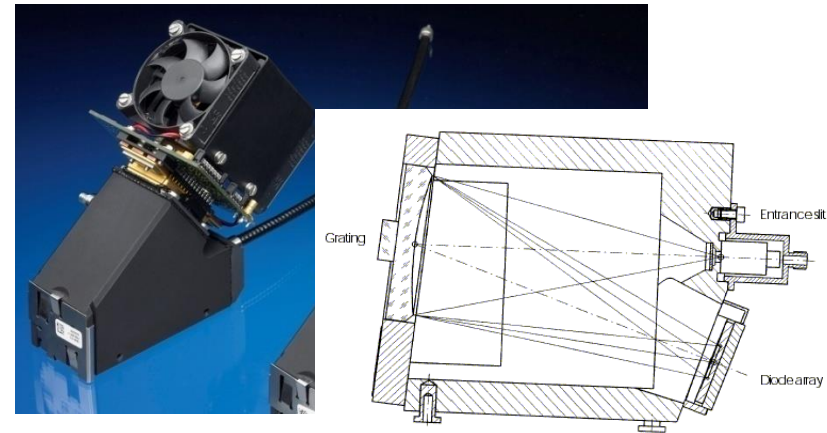
SMART = (Spectral Modular Airborne Radiation measurement sysTem)



Upward / Downward spectral
solar irradiance ($\text{W m}^{-2} \text{nm}^{-1}$)

Zeiss grating spectrometers

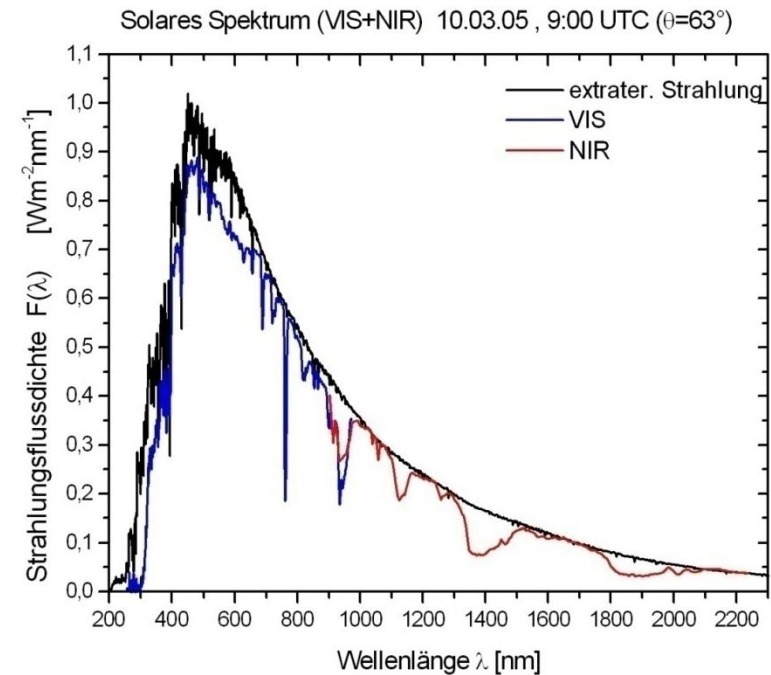
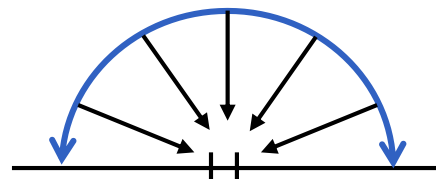
350 – 2200 nm (2-16 nm FWHM)



optical inlet



sampl. frequency
2-5 Hz



Upward spectral solar radiance

$$(W sr^{-1} m^{-2} nm^{-1})$$

Zeiss grating spectrometers

350 – 2200 nm (2-16 nm FWHM)

optical inlet
2.1° FOV

sampl. frequency
2-5 Hz

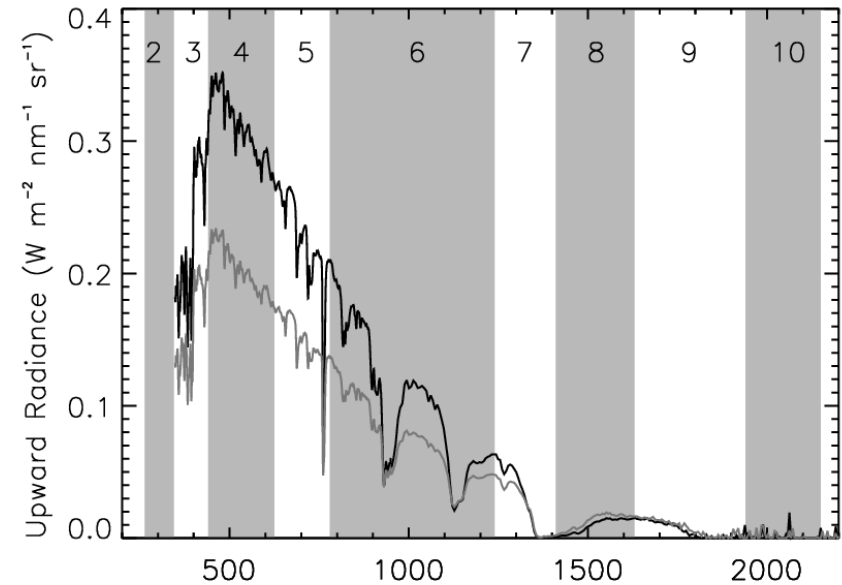
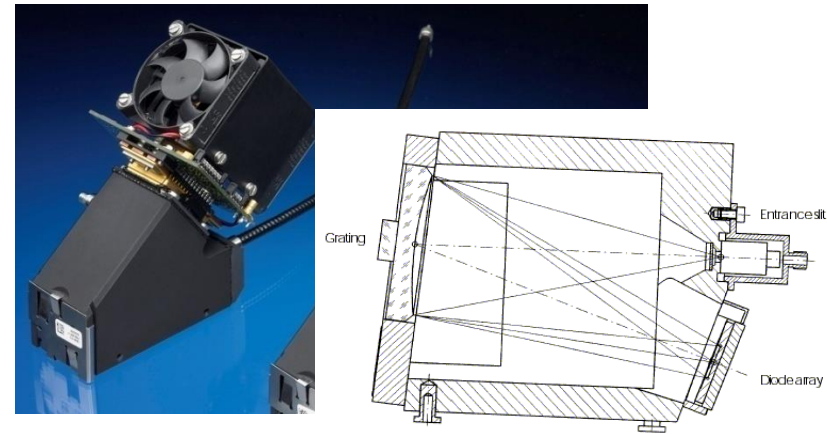
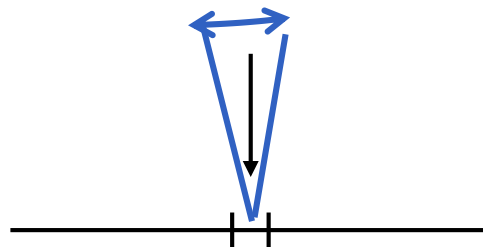


Fig.: Example of measured spectral up-ward radiance (ML-Cirrus). Numbers indicate the overlap of spectral bands in the ECMWF radiation scheme.

- **Cloud Products:**
 - cloud phase
 - optical thickness
 - effective radius

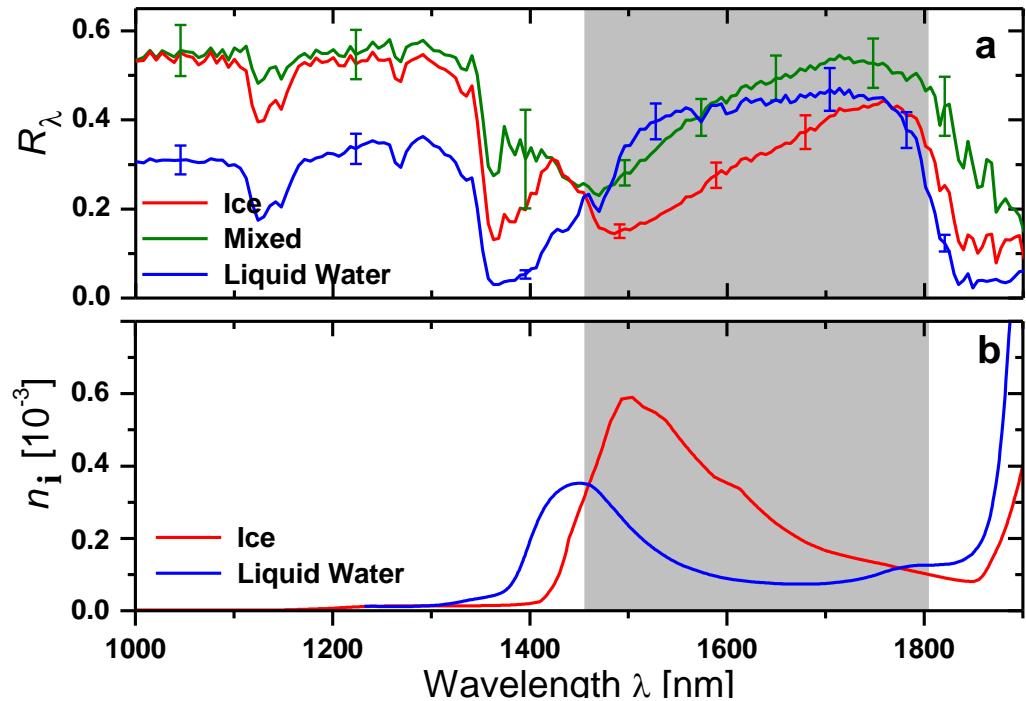
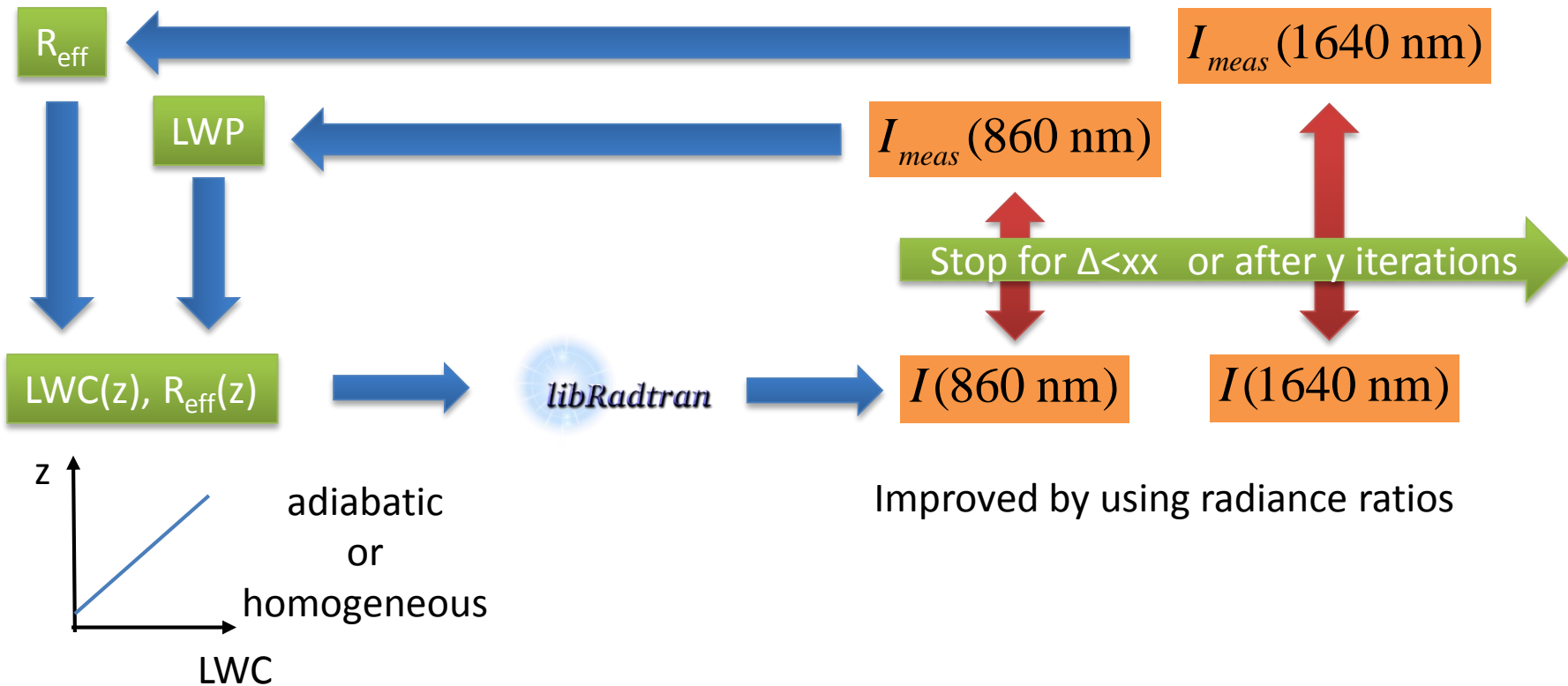


Fig.: Example of measured spectral cloud reflectivity (ASTAR [1]) and refractive index of ice and liquid water.

- **Cloud radiative forcing:**
 - impact of ice formation on cloud radiative forcing
 - statistical approach and radiative transfer simulations

Some preliminary results

Fast iterative cloud retrieval for LWP and R_{eff}



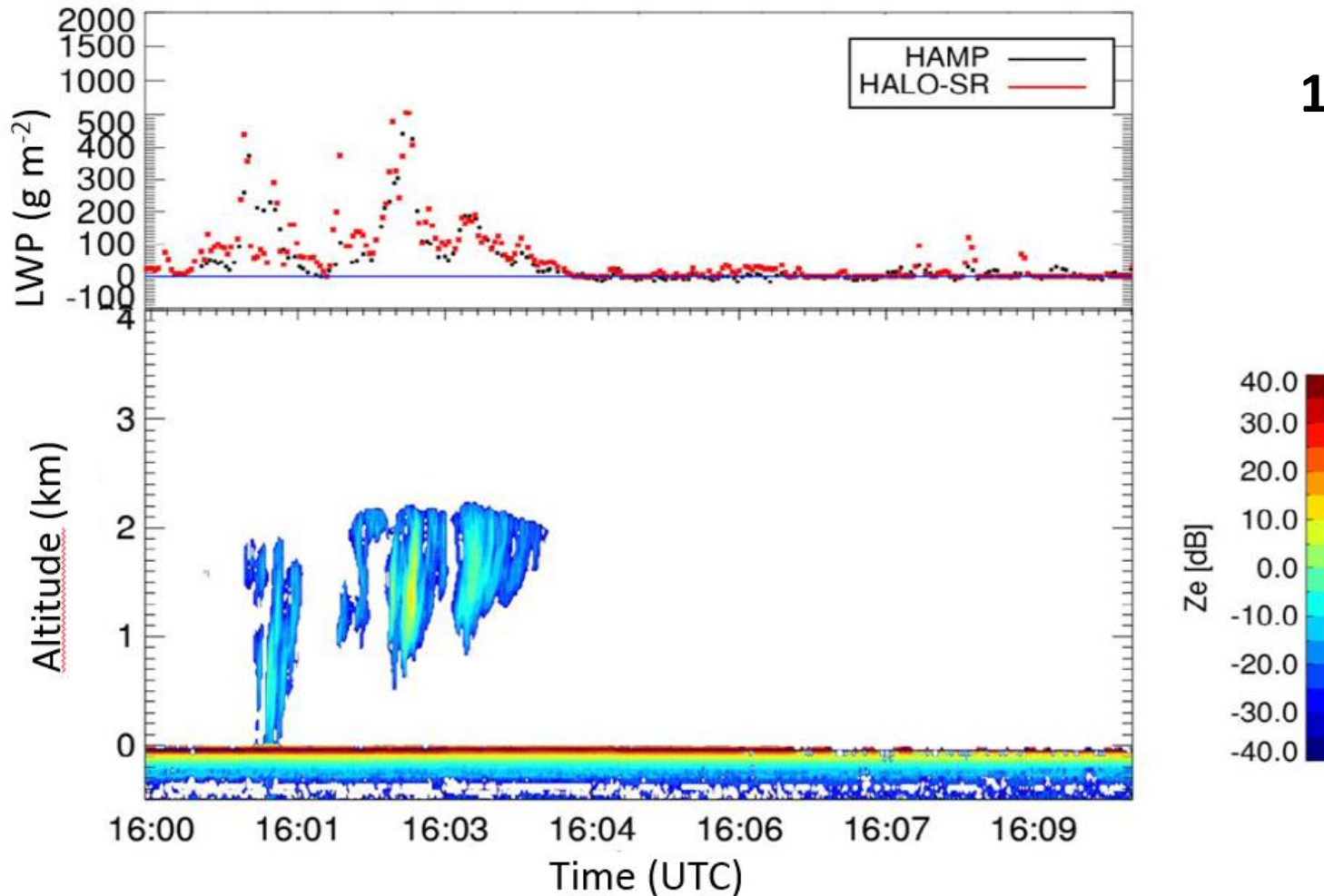
Improved by using radiance ratios

Always considers:

- exact solar zenith angle
- exact flight altitude

NARVAL: Comparison of SMART and HAMP

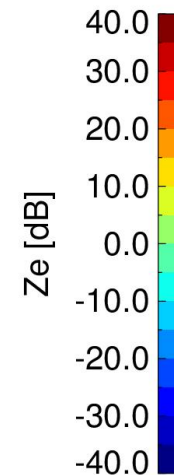
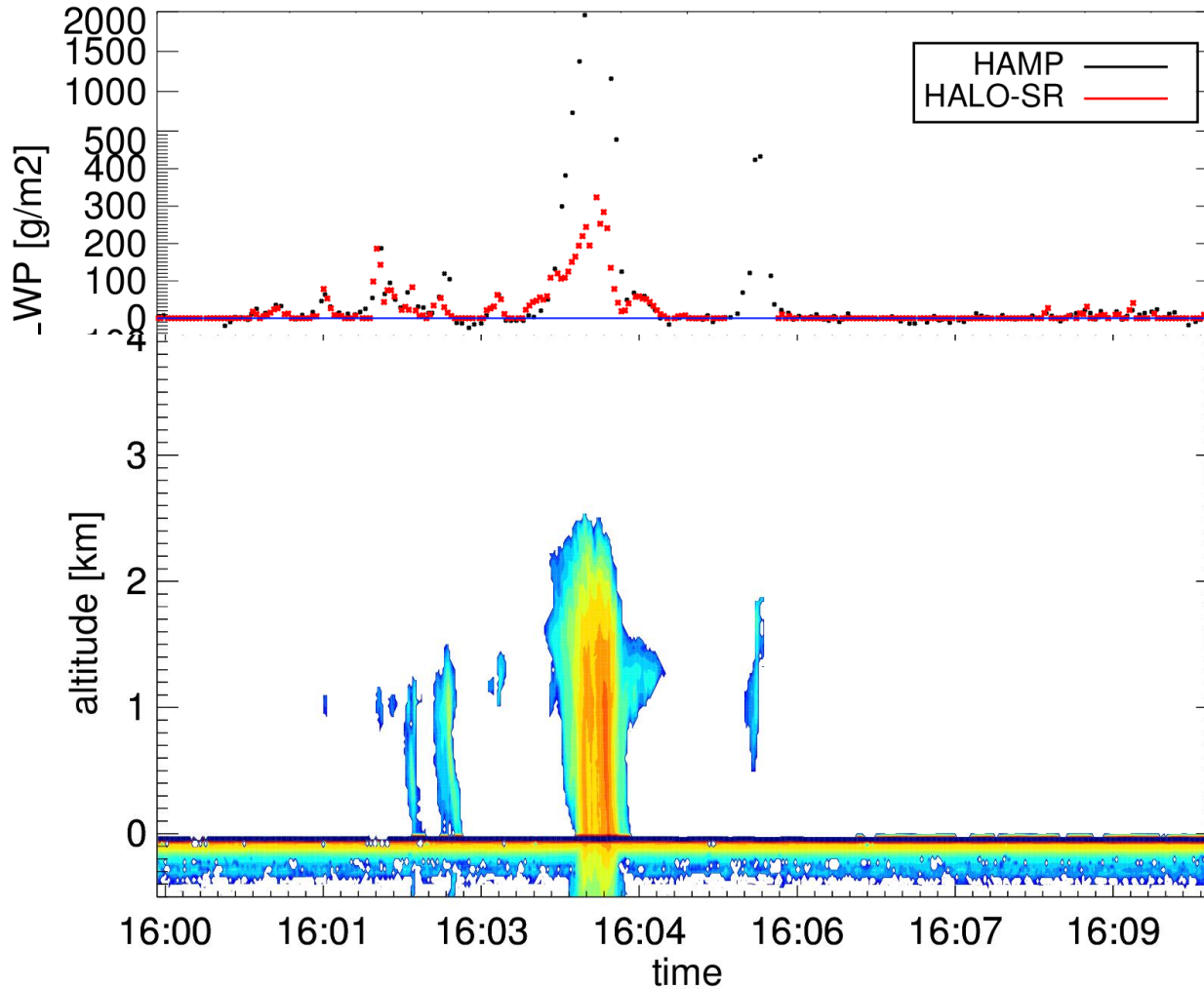
16. 12. 2013



NARVAL: Comparison of SMART and HAMP

12. 12. 2013

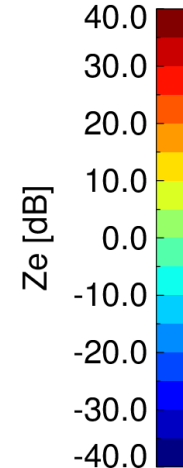
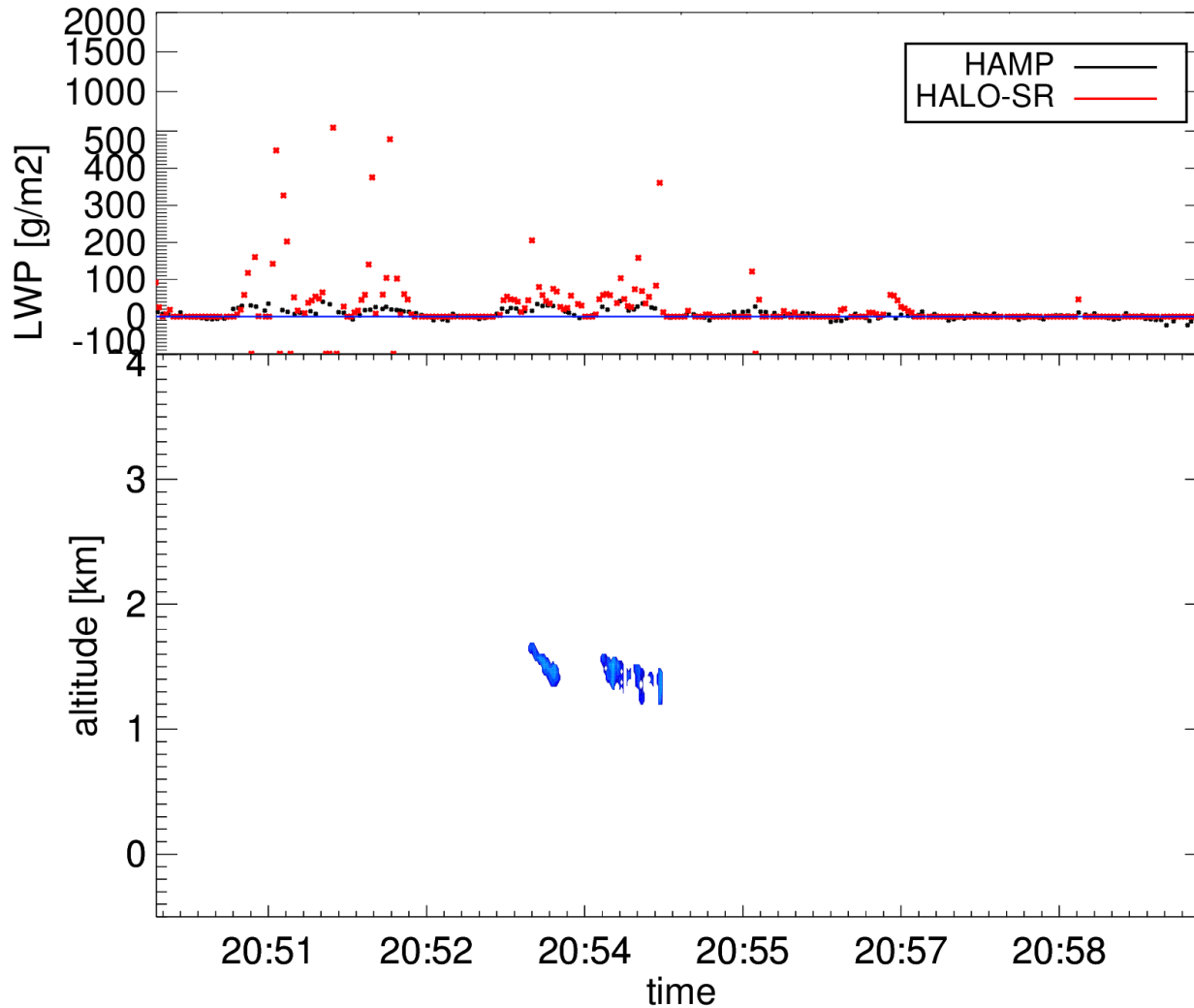
Reff always ~25 um



NARVAL: Comparison of SMART and HAMP

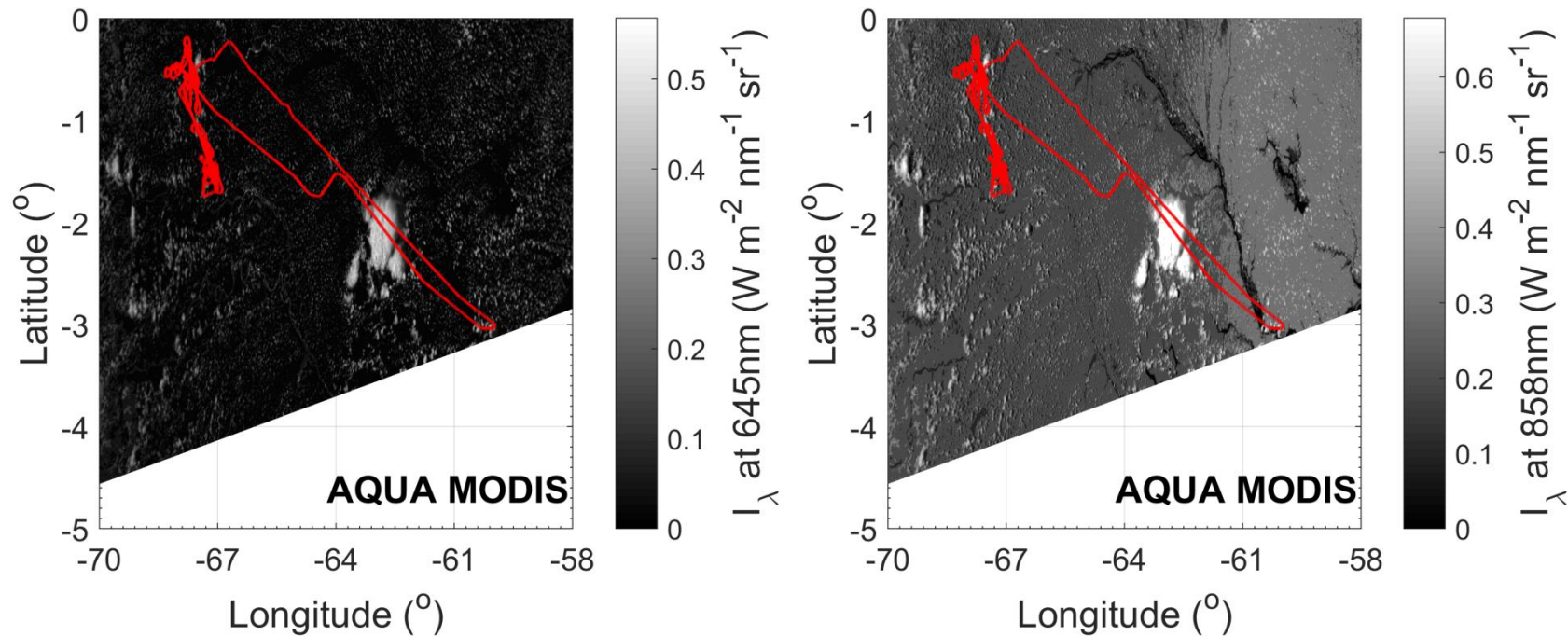
13. 12. 2013

dark / low Sun



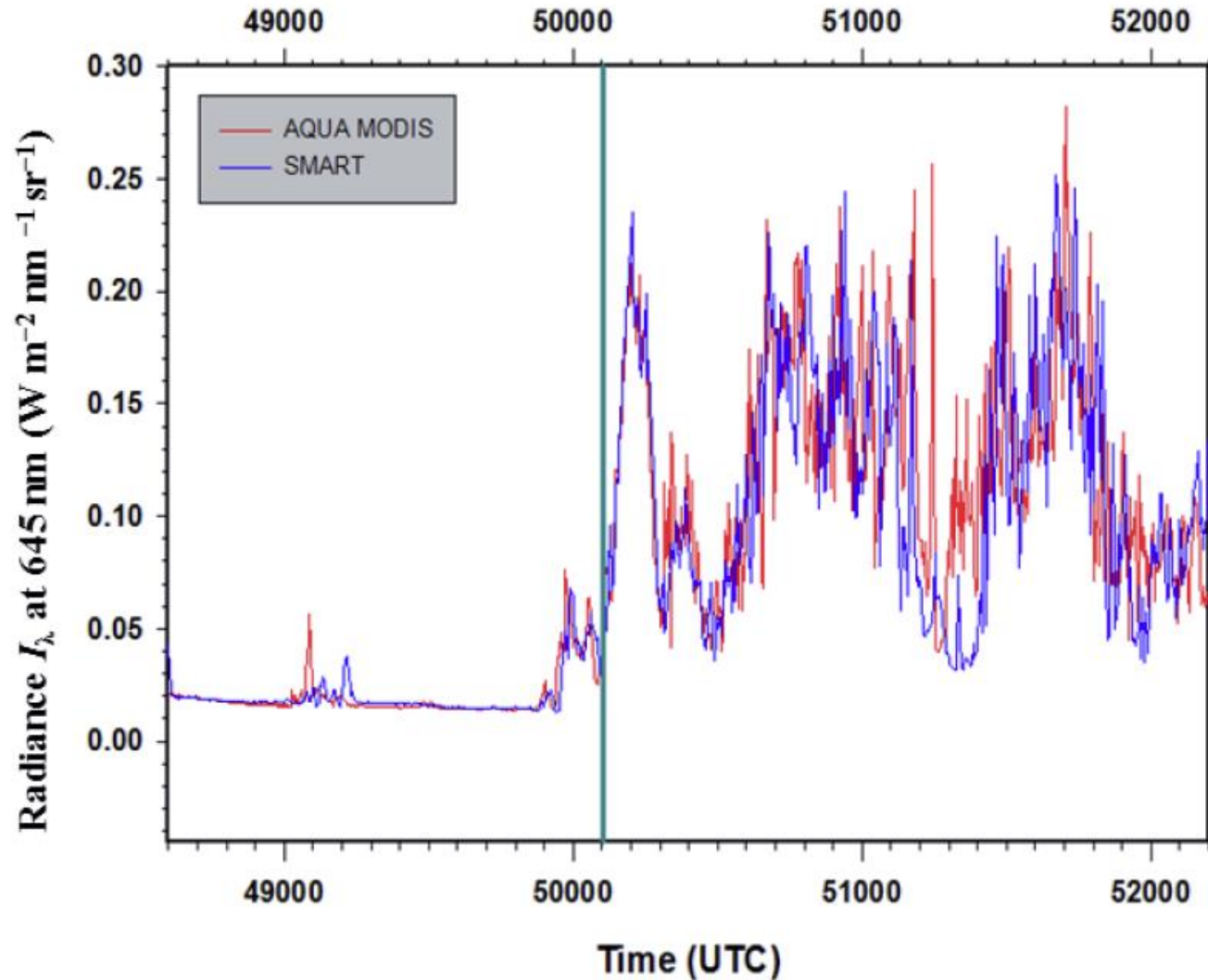
ACRIDICON and ML-Cirrus: Comparison of SMART and MODIS

AQUA-MODIS 28-09-2014 overpass at 17:50 UTC



ML-Cirrus

SMART vs. MODIS/Aqua 13. April 2014



ACRIDICON

SMART vs. MODIS/Aqua 28. Sept. 2014

Fig.: Spectral radiance from SMART and AQUA-MODIS measured above deep convective cloud observed during ACRIDICON.

ACRIDICON

SMART vs. MODIS/Aqua 28. Sept. 2014

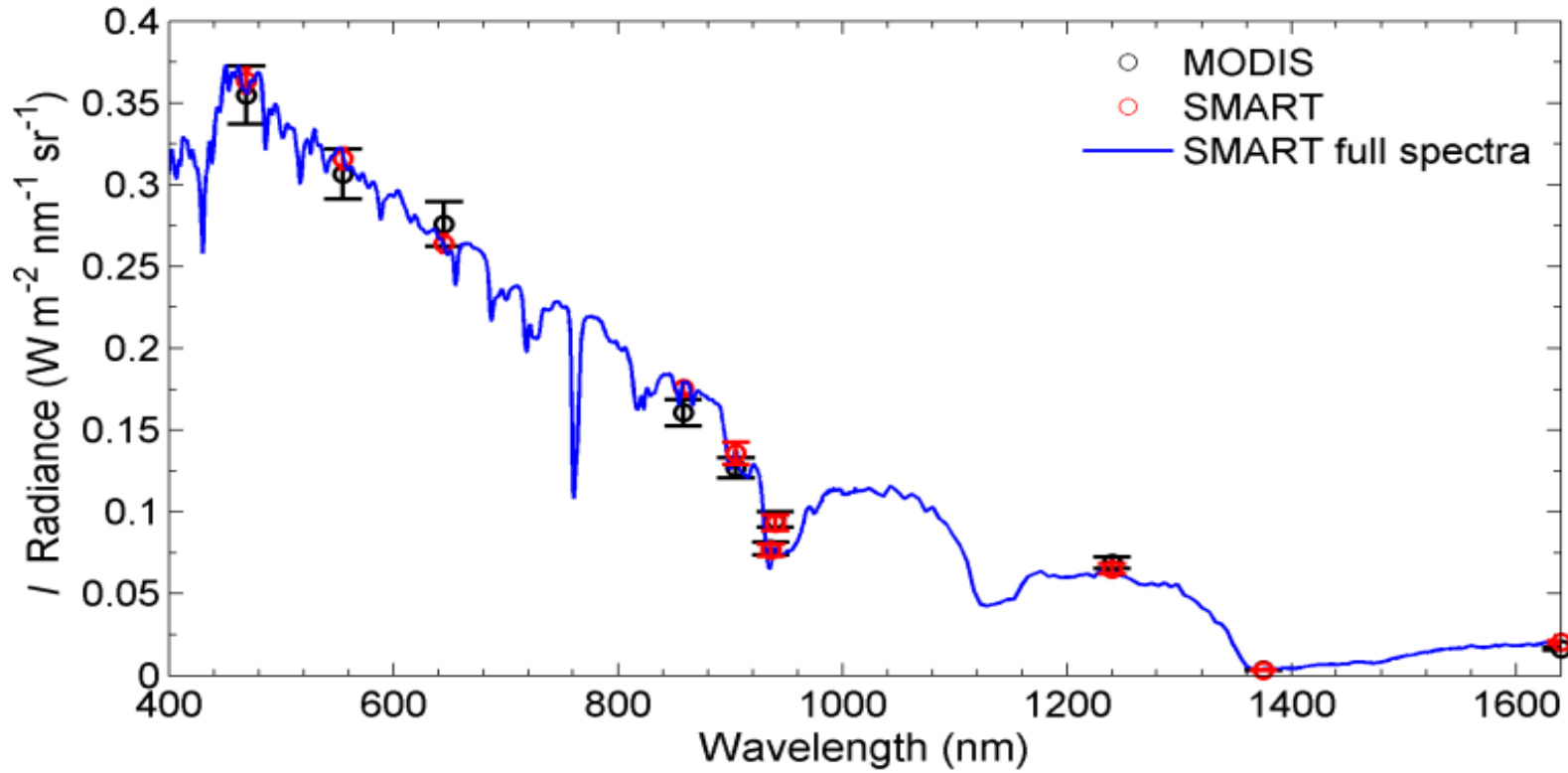
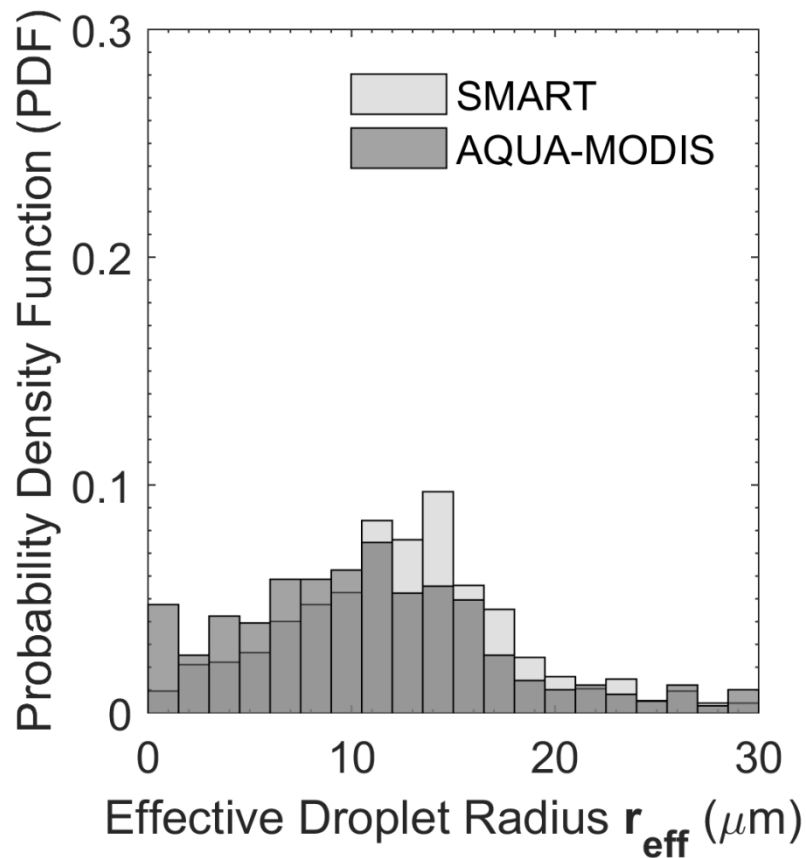
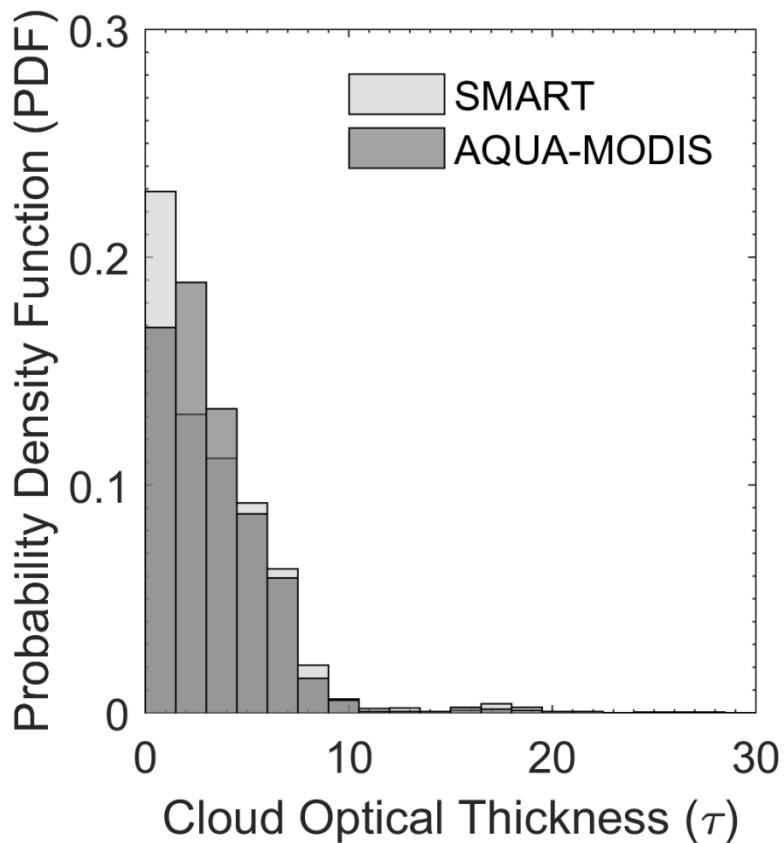


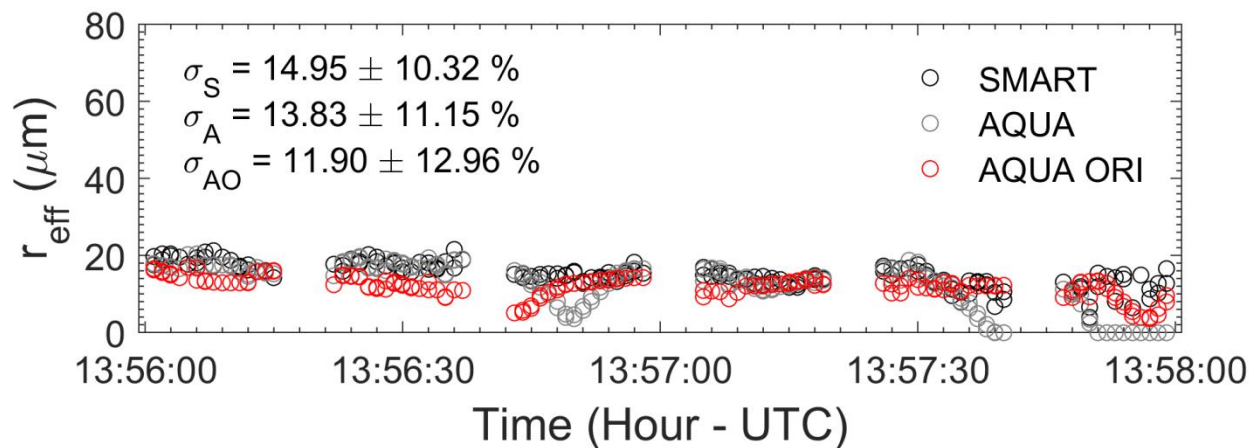
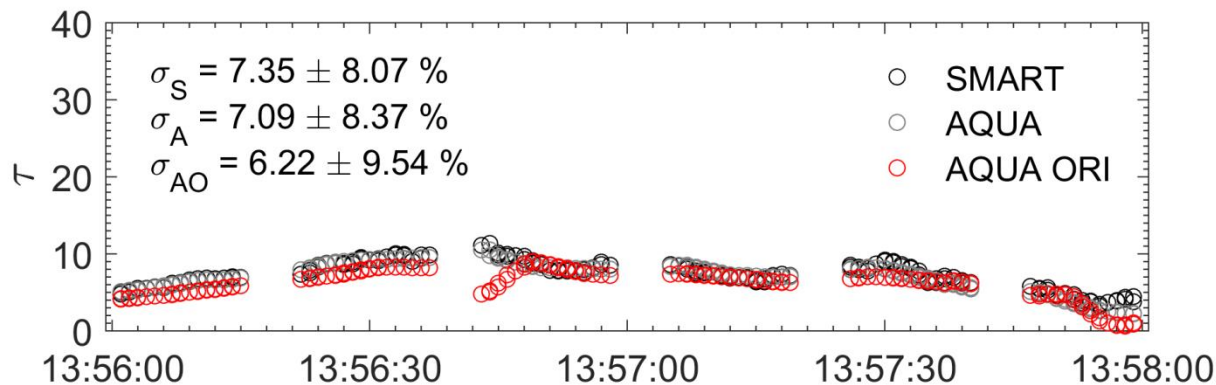
Fig.: Spectral radiance from SMART and AQUA-MODIS measured above deep convective cloud observed during ACRIDICON.

ML-Cirrus



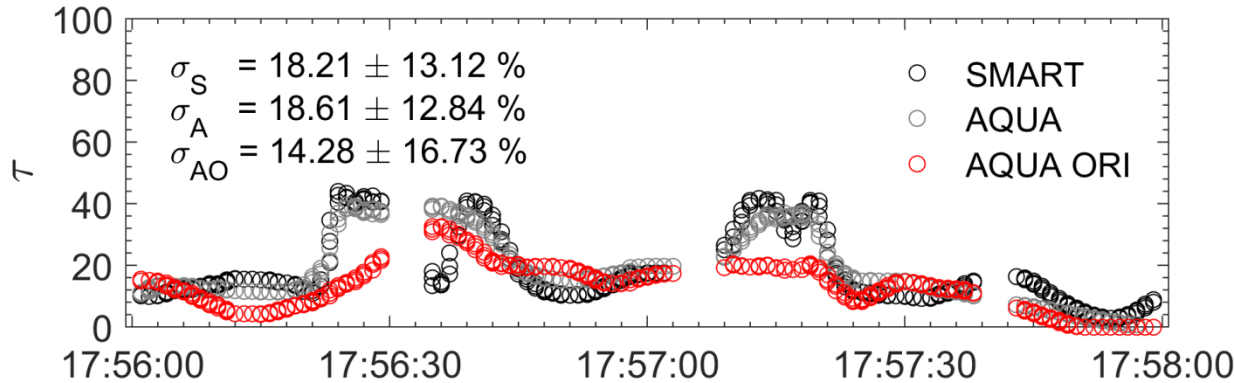
ML-Cirrus

In comparison with MYD02_L6 Cloud Product (See
: *Red Circle*)



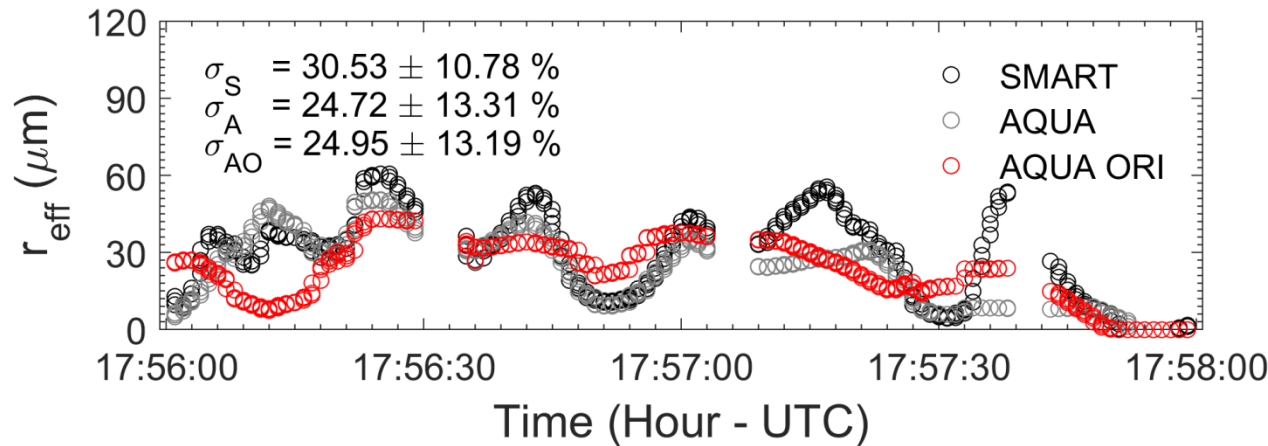
ACRIDICON

In comparison with MYD02_L6 Cloud Product (See : *Red Circle*)



Differences?

- Inhomogeneous clouds?
- Wavelength selection
➔ Information on cloud profile?



**Thank you
for
your attention.**

ML-Cirrus

SMART vs. MODIS/Aqua 13. April 2014

