UNIVERSITÄT LEIPZIG

Impact of surface albedo on atmospheric solar radiative forcing – results of SAMUM 2

Stefan Bauer #(1), Eike Bierwirth (2), Bernd Heinold (3), Manfred Wendisch (1)

(1) University of Leipzig, 04103 Leipzig, Germany
(2) Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, Colorado, USA
(3) Leibniz Institute for Tropospheric Research, 04318 Leipzig, Germany

(#) Corresponding author. Email: mail@bauerstefan.com

1. Introduction

Airborne and groundbased measurements of radiance and irradiance for:

- iteration of surface albedo from measurements of upwelling irradiance
- comparison with radiance/irradiance calculated by the 1D radiative transfer simulation model DISORT 2 (libRadtran software package, Mayer and Kylling, 2005)
- investigating the impact of surface albedo on the radiative forcing after long range transport of Saharan dust and biomass burning smoke

2. Instrumentation

Instrument	Measured Quantity	Wavelength Range
	Airborne (Falcon/DLR)[1]	
VIS/NIR Spectrometer	Upwelling Radiance/Irradiance	0.3 – 2.2 µm (spectral)
	Groundbased[2]	
VIS/NIR Spectrometer	Downwelling Radiance/Irradiance	0.3 – 2.2 µm (spectral)
Pyrgeometer	Downwelling Irradiance	4 – 42 µm (broadband)

1: SMART-Albedometer (Spectral Modular Airborne Radiation Measurement System)
2: CORAS (Compact Radiation Measurement System)

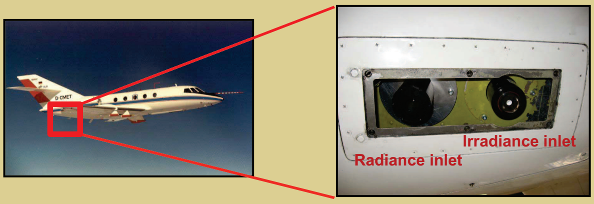


Fig 1: left photograph: Research aircraft Falcon from the German Aerospace Center (DLR) in Oberpfaffenhofen. The inlets were installed in the backward frame of the aircraft. Right photograph: On the left side the radiance inlet, on the right side the irradiance inlet.

3. Measurements SAMUM II

- **SA**haran **M**ineral d**U**st experi**M**ent
- January/February 2008
- Cape Verde Islands
- 9 flights with airborne measurements of upwelling radiance and irradiance
  - various airborne measurements over the Atlantic Ocean, over land (Senegal) and over/around the Cape Verde Islands
- measurements of spectral upwelling radiance/irradiance above different layers (Saharan dust, biomass burning smoke, clouds)

Fig 2: Flight 29 January 2008: Cape Verde to Senegal. Different surface albedos (water and land). Mixture of high loads of biomass burning smoke and Saharan dust.

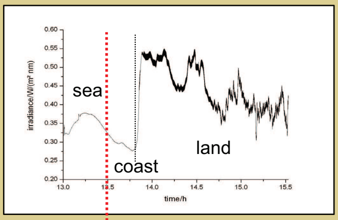


Fig 3: Upwelling irradiance at flight altitude at 532 nm on 29 January 2008. Lower values and smoother shape of irradiance over the sea due to a lower and more homogeneous surface albedo compared to the land surface.

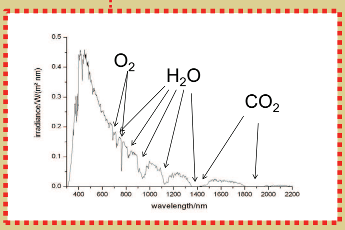


Fig 4: Spectral upwelling irradiance at 13:30 UTC on 29 January 2008 over the sea. Absorption bands of atmospheric gases: O_2, H_20 and CO_2 are labeled.

4. Simulation and solar radiative forcing

As a measure of the impact of dust and biomass burning smoke on the solar radiation budget the solar radiative forcing has to be determined. To calculate the radiative forcing at the top of atmosphere during the flight on 29 January 2008 the following steps have been applied:

a. Determination of **surface albedo** by iterative algorithm (Wendisch et al., 2004):

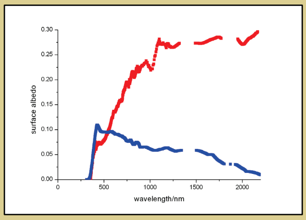


Fig 5: Iterated spectral surface albedo of the sea (blue line) and of the land (red line). The maximum of the water surface albedo at 470 nm in the blue spectral range and a lower surface albedo to the near infrared range. The land albedo shows an increasing surface albedo to the near infrared.

b. Simulation of the upwelling irradiance with the 1D radiative transfer simulation model DISORT 2 (libRadtran software package, Mayer and Kylling, 2005) and comparison with the measured upwelling irradiance. **Input**: meteorological profiles, aerosol properties (AOD derived from airborne LIDAR measurements (DLR) and AOD from groundbased sun photometer (University of Munich)), surface albedo.

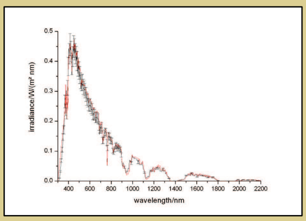


Fig 6: Comparison of measurements (black line) and resulting calculation (red line) with libRadtran and the iterated sea surface albedo at 13:30 UTC on 29 January 2008.

c. Due to the consistency of measured and calculated data the upwelling and downwelling irradiance at the top of atmosphere for a clear case (without any aerosol) and with the aerosol input was calculated and the solar radiative forcing was determined.

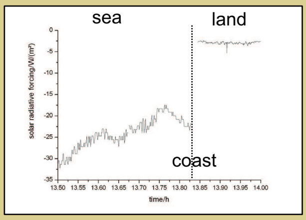
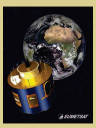


Fig 7: Solar radiative forcing before and after the sea-land transition. The dominant effect on solar radiative forcing is the surface albedo. Lower surface albedo over the sea leads to negative forcing of -32 to -18 W/m² while higher surface albedo over land leads to a forcing between -2 and -5 W/m² and therefore to less cooling than over the sea.

5. Outlook



- comparison of radiance by airborne measurements and MSG measurements
- radiance – irradiance conversion of MSG data and comparison with airborne measurements
- comparison of radiance/irradiance with those calculated by combined dust and radiation models
- use broadband (solar and thermal infrared) additionally to the spectral (solar) irradiance measurements performed on the ground and measured from aircraft in combination with respective 1D radiative transfer simulations to evaluate the **net radiative forcing** (broadband and spectral) of the dust layer in its temporal development throughout the measurement campaign

References

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