SAMUM I: Preliminary Results of the Regional Dust Model for May, 2006 (Project #3)

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Introduction

The project SAharan Mineral dUst experiMent (SAMUM) aims at clarifying the uncertainties in radiative properties of Saharan dust to quantify its radiative forcing. The SAMUM I field campaign took place in Morocco during May and June 2006. The experiments comprised surface and airborne measurements determining the optical, physico-chemical, and morphological properties of Saharan dust near the source region.
Within the framework of SAMUM a new regional model system was developed for simulations of emission, transport, deposition, and radiative effects of Saharan dust aerosol. Once the model system will have been extensively evaluated with the measurements from the field campaign, it will provide additional information for the evaluation of the field experiment results, help to extrapolate the findings to larger regions, and allow estimation of radiative effects and feedbacks on atmospheric dynamic and the hydrological cycle.

The model performance has been already tested in a near-source study for a dust event in the Bodélé depression (Chad) in March 2005 during the field experiment BoDEx (Tegen et al., 2006) and in two far-field case studies for Saharan dust outbreaks directed to Europe in August and October 2001 (Heinold et al., in press, Helmert et al., submitted). Here, preliminary model results for the SAMUM1 field period are presented for May 2006. The modeled dust load is evaluated by comparisons with already available satellite, lidar profiles from the European Aerosol Research Lidar Network (EARLINET) and sunphotometer measurements at Aerosol Robotic Network (AERONET) stations.

Model setup

The first model simulation of the period of the field experiment was carried out without including any updated information on dust optical properties (e.g. particle size, SSA) from the measurements, which were not yet available. Initial comparisons of the preliminary results with the field measurements will indicate the needs for improvements in model parameterization.

Model domain

- **SAMUM I:** 510×377/40 grid points/layers, 14 km horizontal resolution, lower left corner: 3.47°N/18.09°W (Fig. 1, blue)

Modeled period

- May 9 - June 14, 2006

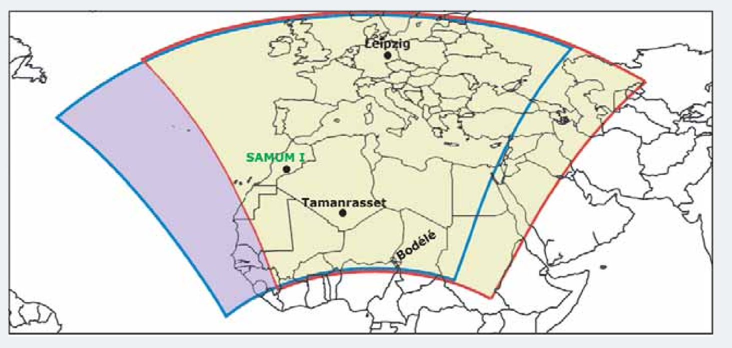

Fig. 1. Model domains (SAMUM I, blue and preliminary far field case, yellow) and SAMUM observation site.

Dust aerosol

- Transportation of the modeled dust as dynamic tracer in 5 independent size classes (0.1 µm - 24 µm)
- Removal of dust from the atmosphere by dry and wet deposition

Optical properties

- Prior to the availability of measured dust optical properties, a mineral composition of 2% hematite and 98% kaolinite was assumed (using results from lab. measurements, Sokolik and Toon, 1999).
- Dust radiative feedback on atmospheric dynamics is included.

Table 1. Mean single scattering albedo ω_0 of continental aerosol used for the different radiation bands of LM in comparison with Mie derived ω_0 depending on dust effective radius r_e . (Helmert et al., submitted).

	Effective radius r_e (µm)				
Spectral band (µm)	**0.17**	**0.5**	**1.5**	**4.6**	**13.8**
0.245–0.7	0.960	0.901	0.793	0.685	0.606
0.7–1.53	0.992	0.995	0.981	0.952	0.883
1.53–4.642	0.824	0.952	0.970	0.921	0.849
4.642–8.333	0.006	0.087	0.317	0.471	0.483
8.333–9.009, 10.309–12.5	0.003	0.058	0.358	0.520	0.543
9.009–10.309	0.006	0.105	0.421	0.569	0.631
12.5–20.0	0.000	0.010	0.165	0.442	0.543
20.0–104.515	0.000	0.004	0.083	0.408	0.496

SAMUM I: First model results

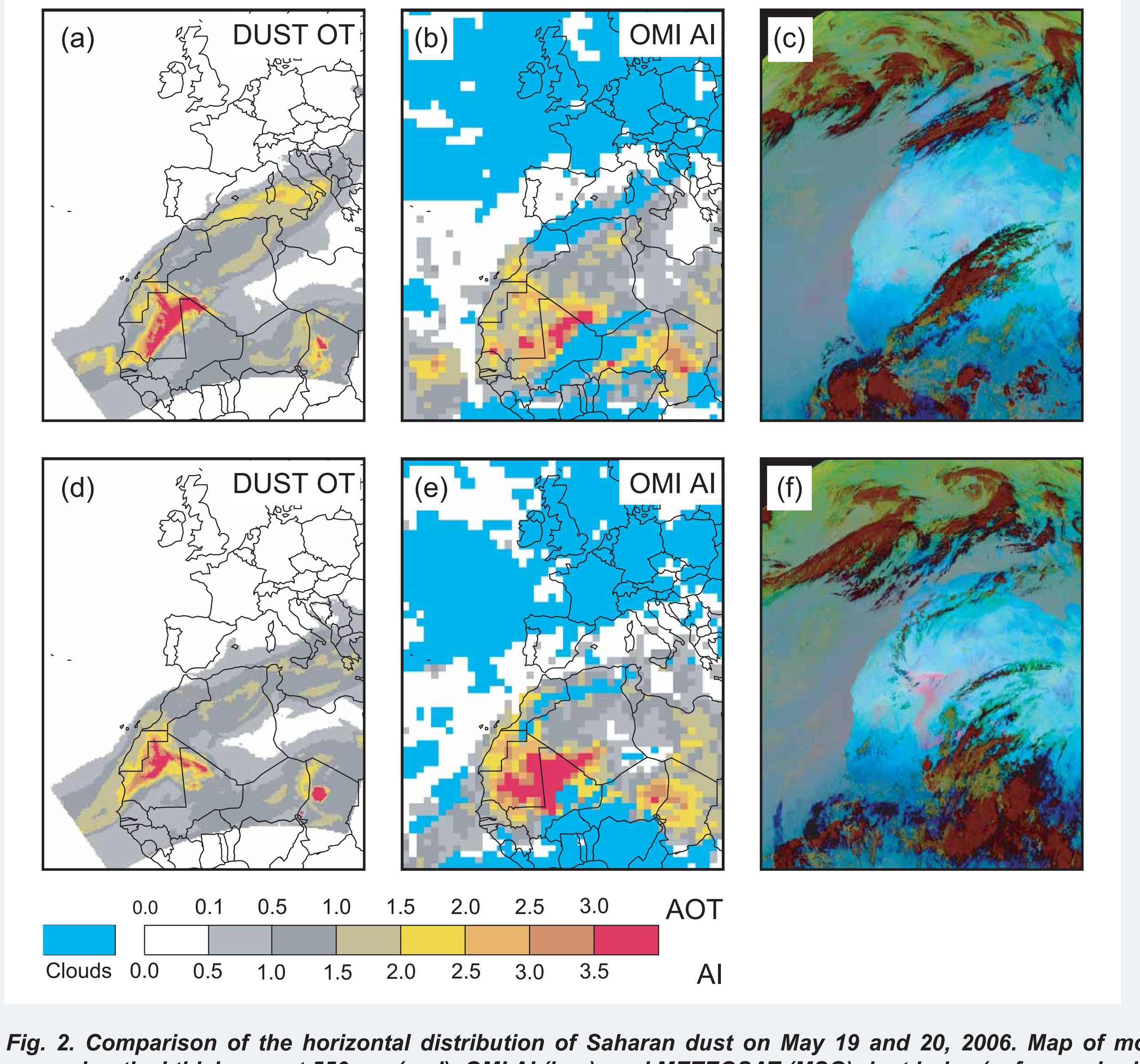

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Fig. 2. Comparison of the horizontal distribution of Saharan dust on May 19 and 20, 2006. Map of model-derived dust aerosol optical thickness at 550 nm (a, d), OMI AI (b, e), and METEOSAT (MSG) dust index (c, f; no color bar). Note that the color bar describes different units.

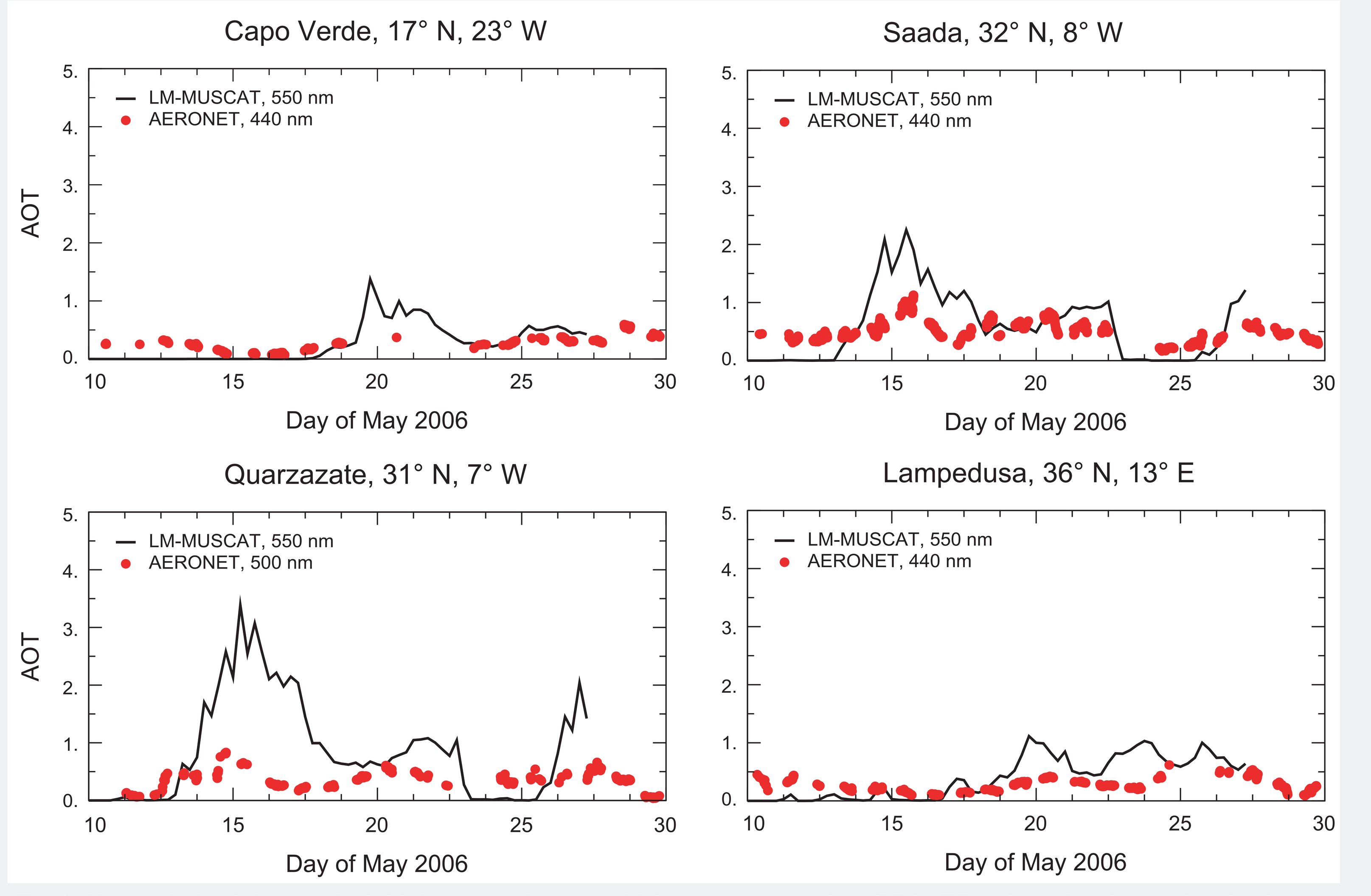

Fig. 3. Model-derived dust optical thickness and optical thickness provided by AERONET at Capo Verde and Saada, Quarzazate, and Lampedusa on May 10 - 30, 2006. While the model simulates background dust optical thicknesses and the temporal evolution reasonably well, near-source dust OTs at Quarzazate are strongly overestimated for peak events by the model.

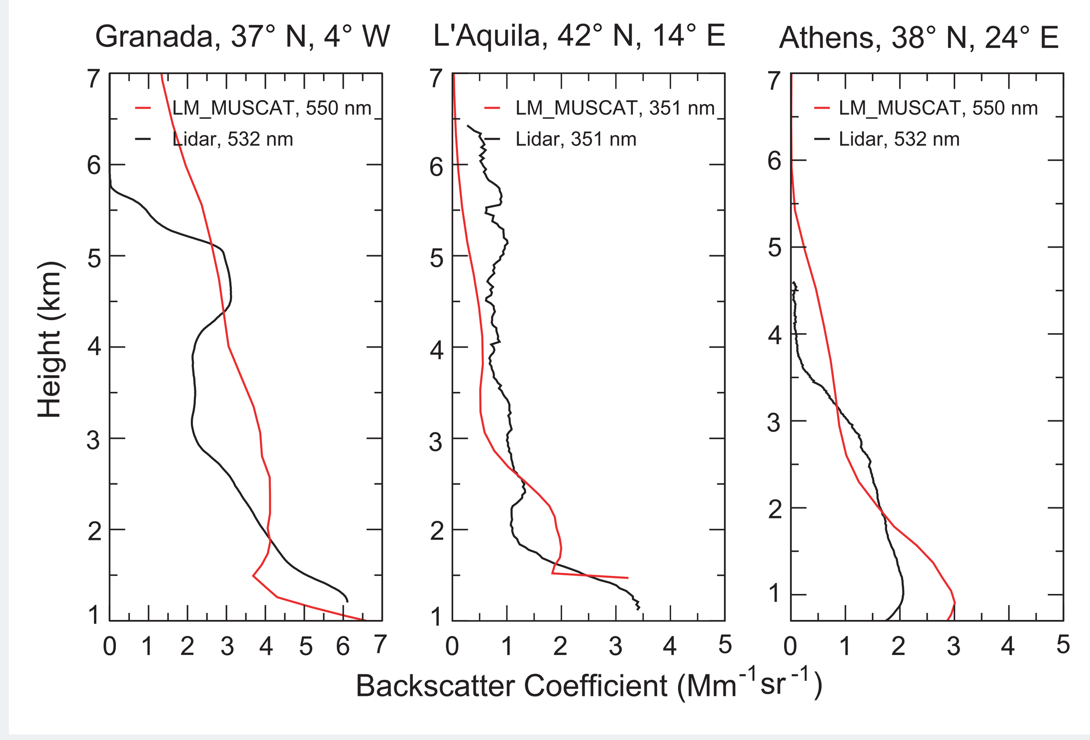

Fig. 4. Vertical distribution of Saharan dust backscatter coefficient above the EARLINET sites Granada on May 15 (12:15 UTC), L'Aquila on May 18 (21:15 UTC) and Athens on May 21 (12:50 UTC). Comparison of modeled profiles (red line) with lidar data (black line). The vertical distribution for dust travelling to Europe during the SAMUM1 period is reproduced reasonably well by the model.

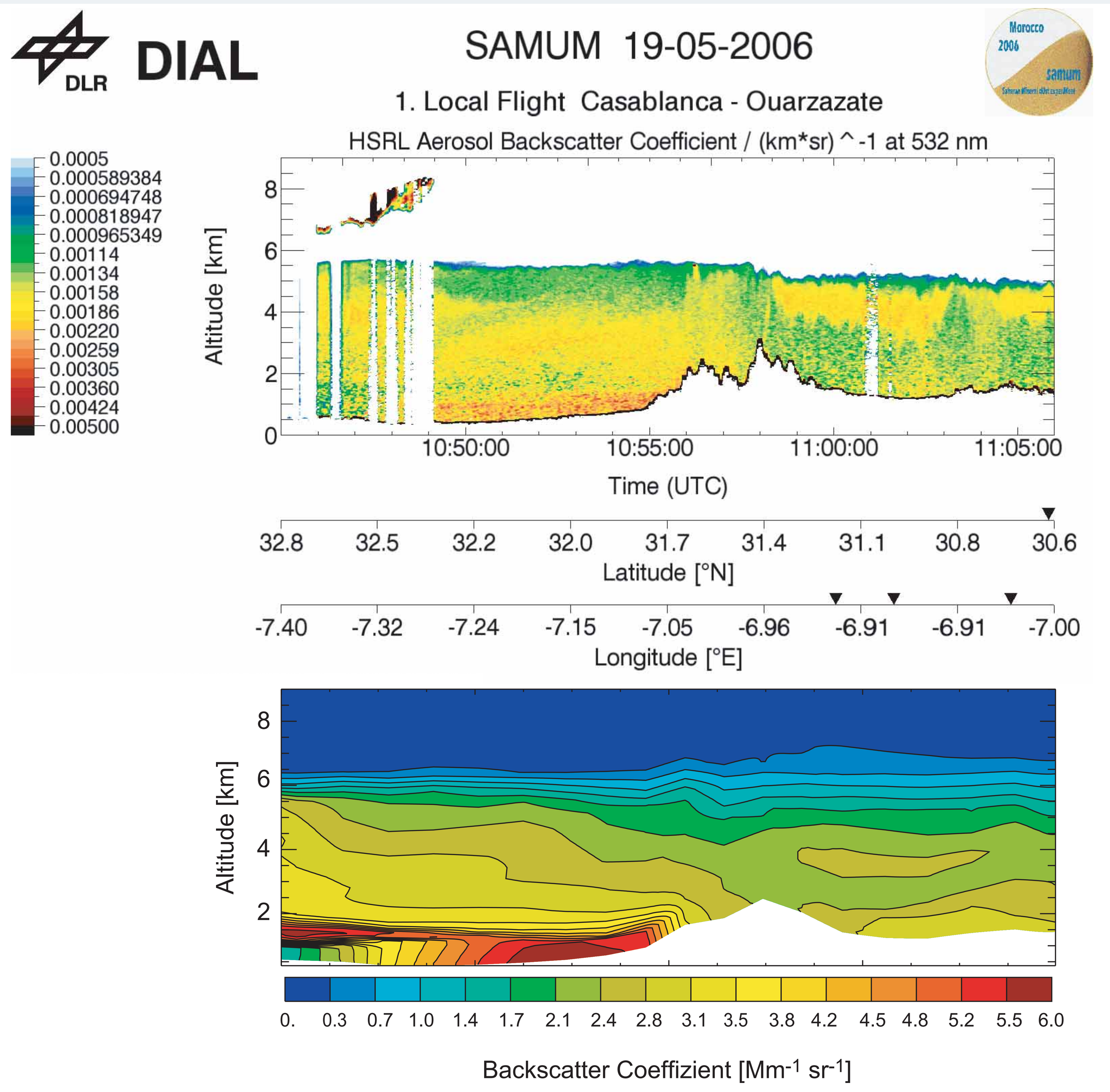

Fig. 5. Vertical distribution of Saharan dust backscatter coefficient during the Falcon flight from Casablanca to Quarzazate on May 19, 2006 (#060519a, 10:35-12:10 UTC). Lidar data from flight measurements (top) and model-derived backscatter coefficient (bottom).

Outlook

The first regional modeling results from a preliminary simulation for the SAMUM I period show reasonable agreement with satellite, lidar, and sunphotometer observations. Still, there are discrepancies especially with respect to overestimated near-source dust optical thicknesses and backscatter coefficients. These are possibly related to shortcomings of the description of the dust particle size distribution in the model or to over-predicted dust emissions close to the field sites.

As the analysis of observed data progresses, the model system will be extensively evaluated and refined. The model system will be used to accompany the analysis of the results from the field campaign by providing 3D fields of size-resolved dust distribution and optical properties for a realistic estimation of dust radiative effects and feedbacks.

References

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