A simple linear model for radiative forcing of absorbing aerosol above clouds

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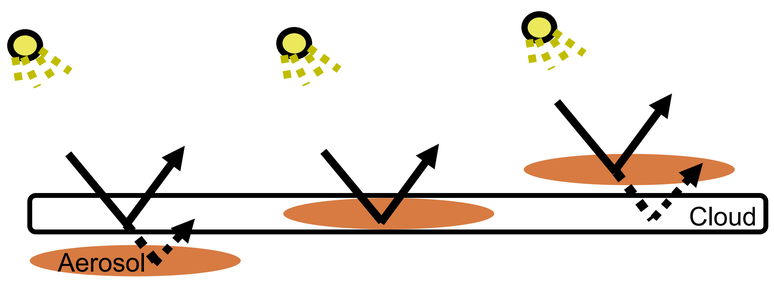
Motivation

Absorbing aerosol in cloudy scenes: effects on atmospheric radiation

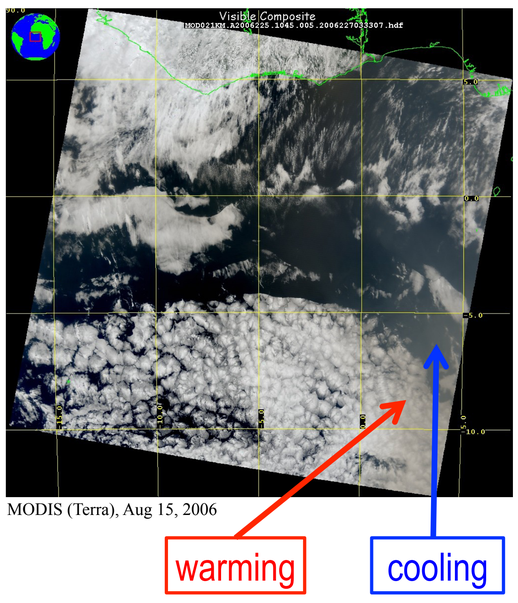


Cloud prevents aerosol-radiation interaction; small <u>negative</u> forcing, i.e. COOLING

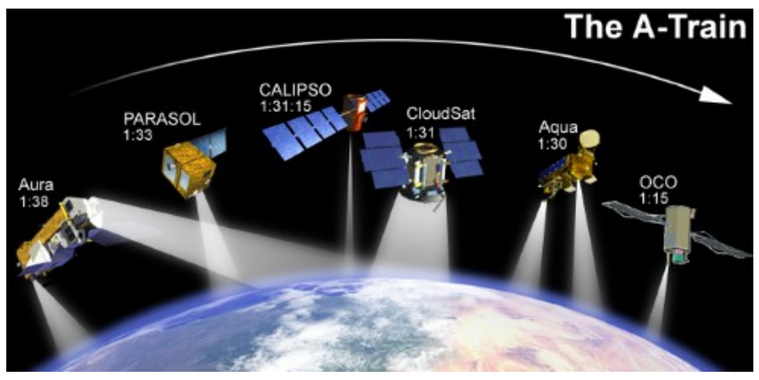
Indirect rather than direct effect through modification of cloud properties

Cloud enhances "surface albedo"; potentially large <u>positive</u> forcing, i.e. WARMING

Satellite observations reveal importance of accounting for aerosol-cloud overlap



Latest generation of satellite platform setups enables quantification



Measurements by instruments of the A-Train constellation yield excellent temporal and spatial coincidence and are thus practical for investigating aerosol-cloud interactions

Methodology

The local-planetary-albedo linear model

$$\alpha \approx a_0 + a_1 \ln(LWP) + a_2 \ln(AOD)$$

Local planetary albedo from CERES instrument on EOS-AQUA, daily values, 0.25°x0.25° re-solution

Cloud liquid water path (g/m²) from AMSR-E instrument on EOS-AQUA, daily values, 0.25°x0.25° resolution

Aerosol optical depth from MODIS instrument on EOS-AQUA, daily values, 1°x1° resolution

Filter for abs. aerosols

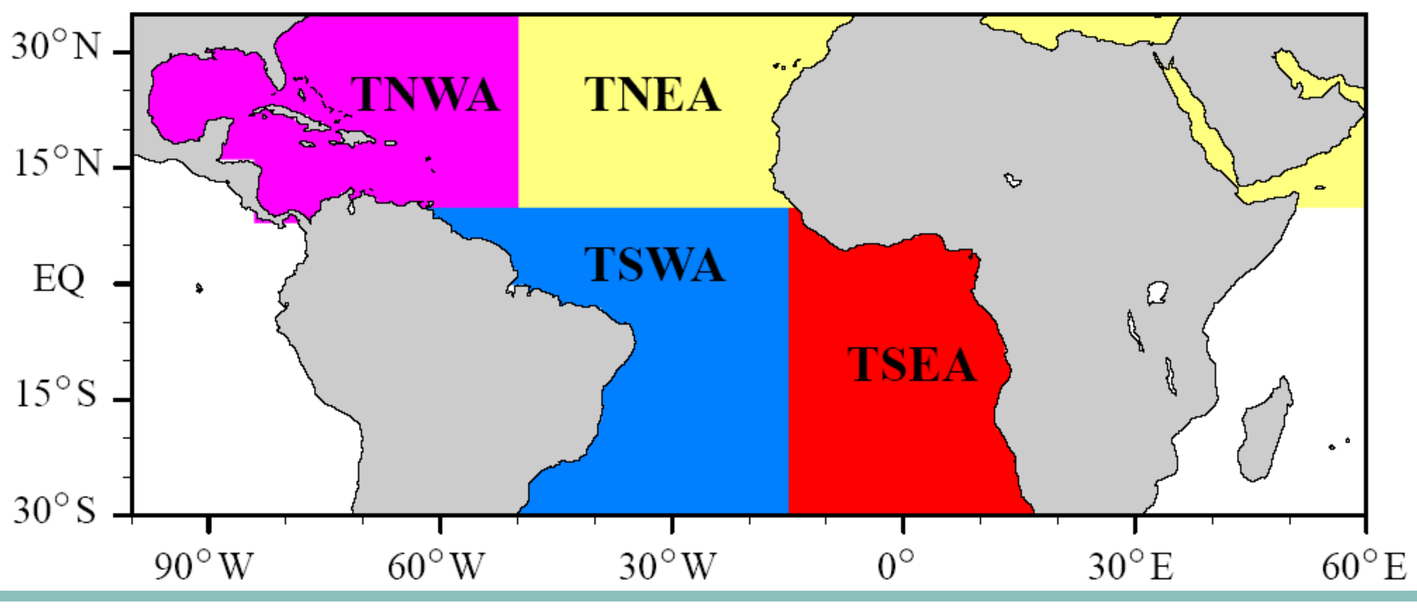
UV-Aerosol Index (UVAI) from OMI instrument on EOS-AURA, daily values, 0.25°x0.25° resolution

UVAI < 0.7 < UVAI

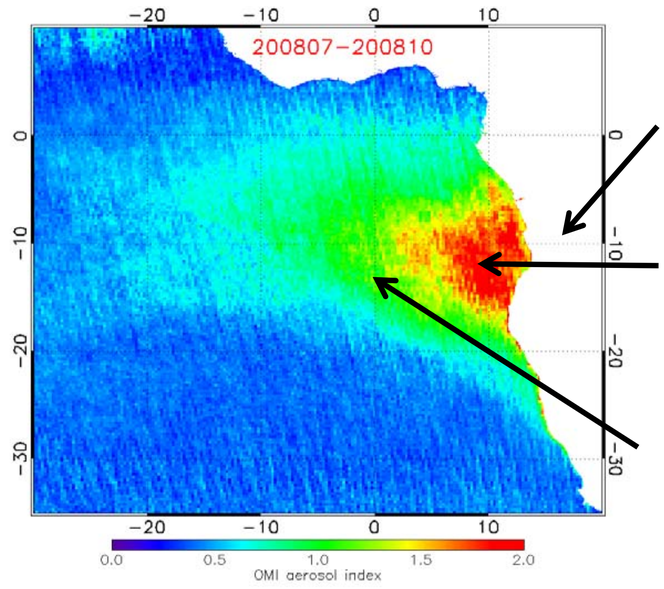
mostly scattering

mostly absorbing

Regions defined for the analysis, data for Jan 2005 - Dec 2007



UV-AI off SW-Africa, July – October 2008



biomass burning region

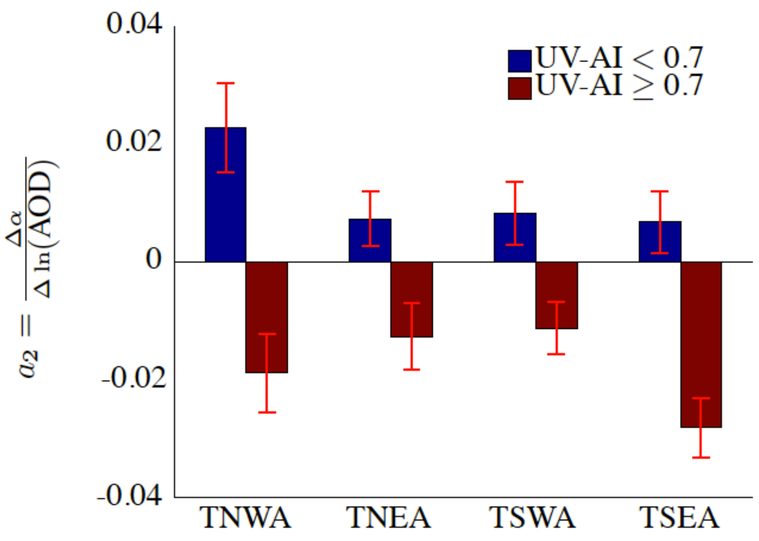
plume advected over stratocu clouds

diluted plume, less clouds

Seethala, C.: Evaluating the state-of-the-art of and Errors in 1D Satellite Cloud Liquid Water Path Retrievals with Large Eddy Simulations and Realistic Radiative Transfer Models, in: Berichte zur Erdsystemforschun, 110, 160 pp., ISSN: 1614-1199, Max-Planck-Institut fuer Meteorologie, 2012.

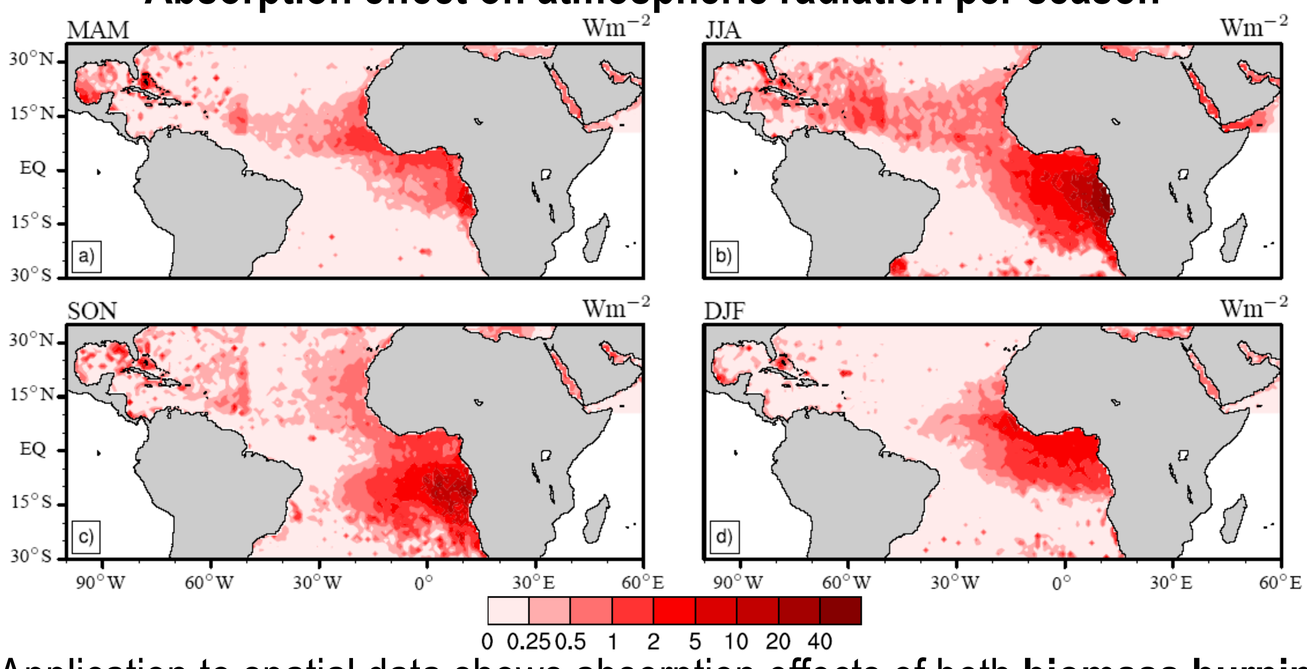
Results

Change of local planetary albedo α with ln(AOD)



The linear model reveals **a reduction of albedo** in cloudy scenes with absorbing aerosols being present

Absorption effect on atmospheric radiation per season



Application to spatial data shows absorption effects of both **biomass burning aerosol** (seasonality !) from SW Africa, as well as **dust aerosol** from N Africa !

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