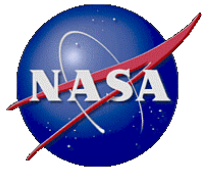


Clouds and dust: CALIPSO observations of transatlantic dust transport

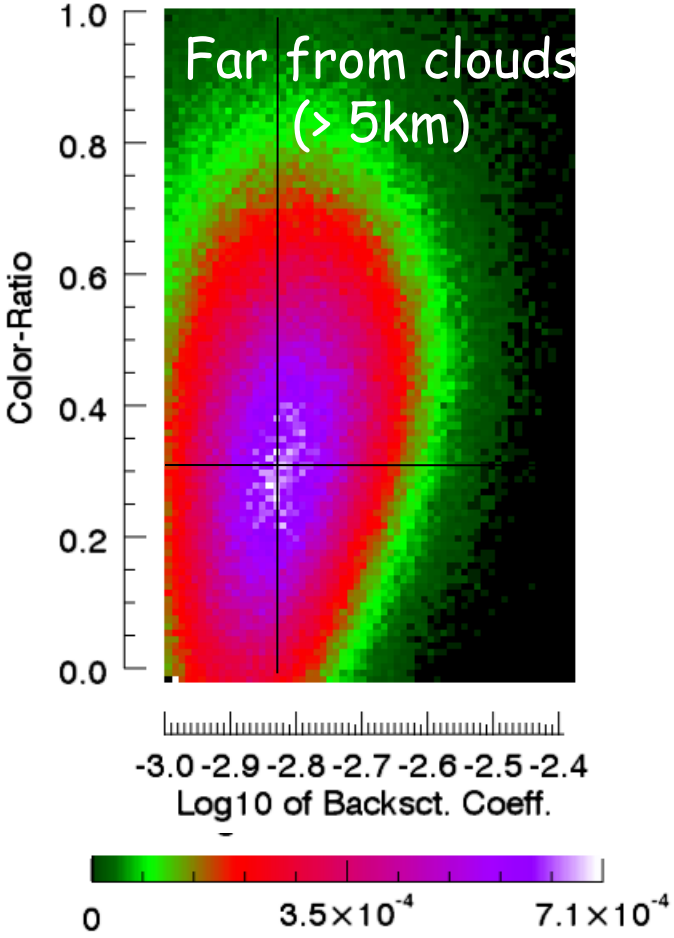
Alexander Marshak (GSFC)

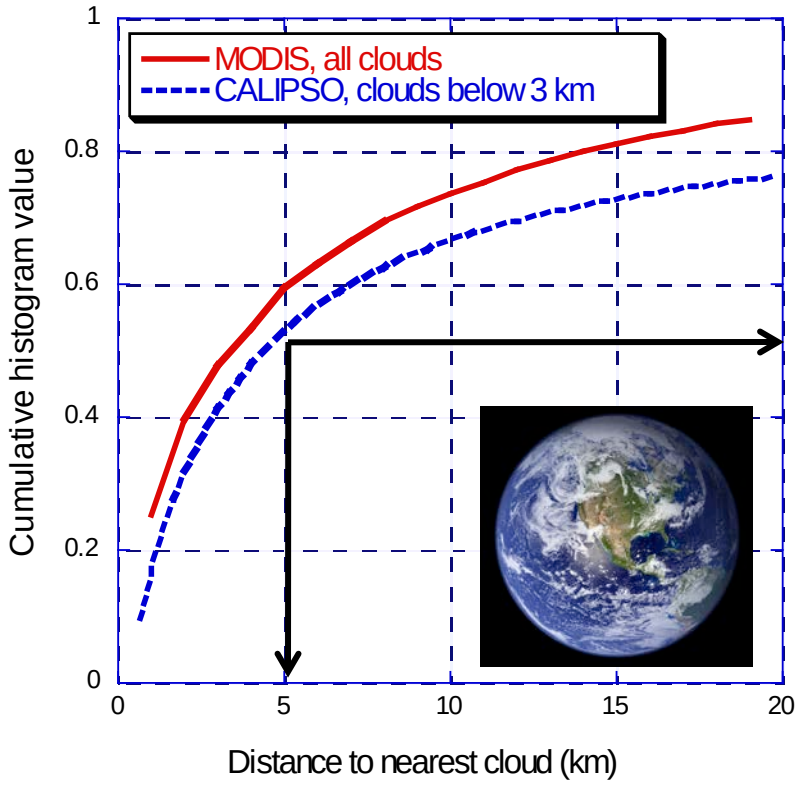
Weidong Yang (USRA), Tamas Varnai (UMBC), Olga Kalashnikova (JPL), Alex Kostinski (Michigan Tech)

CALIPSO

(ColorRatio vs. Backscat close to and far from clouds)

Global night data over ocean



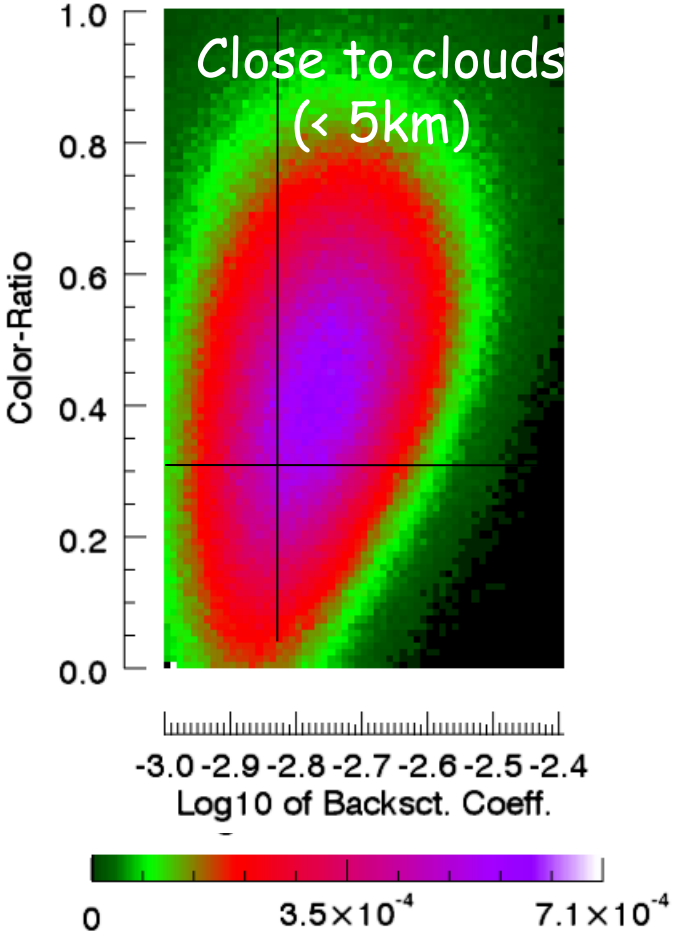


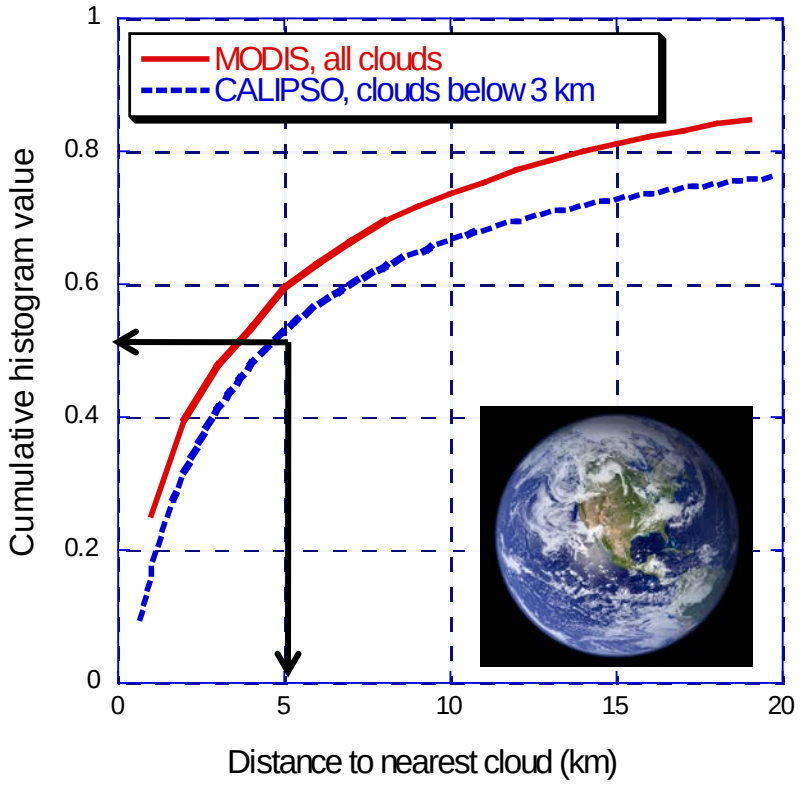
Fraction of cloud-free vertical profiles

CALIPSO

(ColorRatio vs. Backscat close to and far from clouds)

Global night data over ocean





Fraction of cloud-free vertical profiles

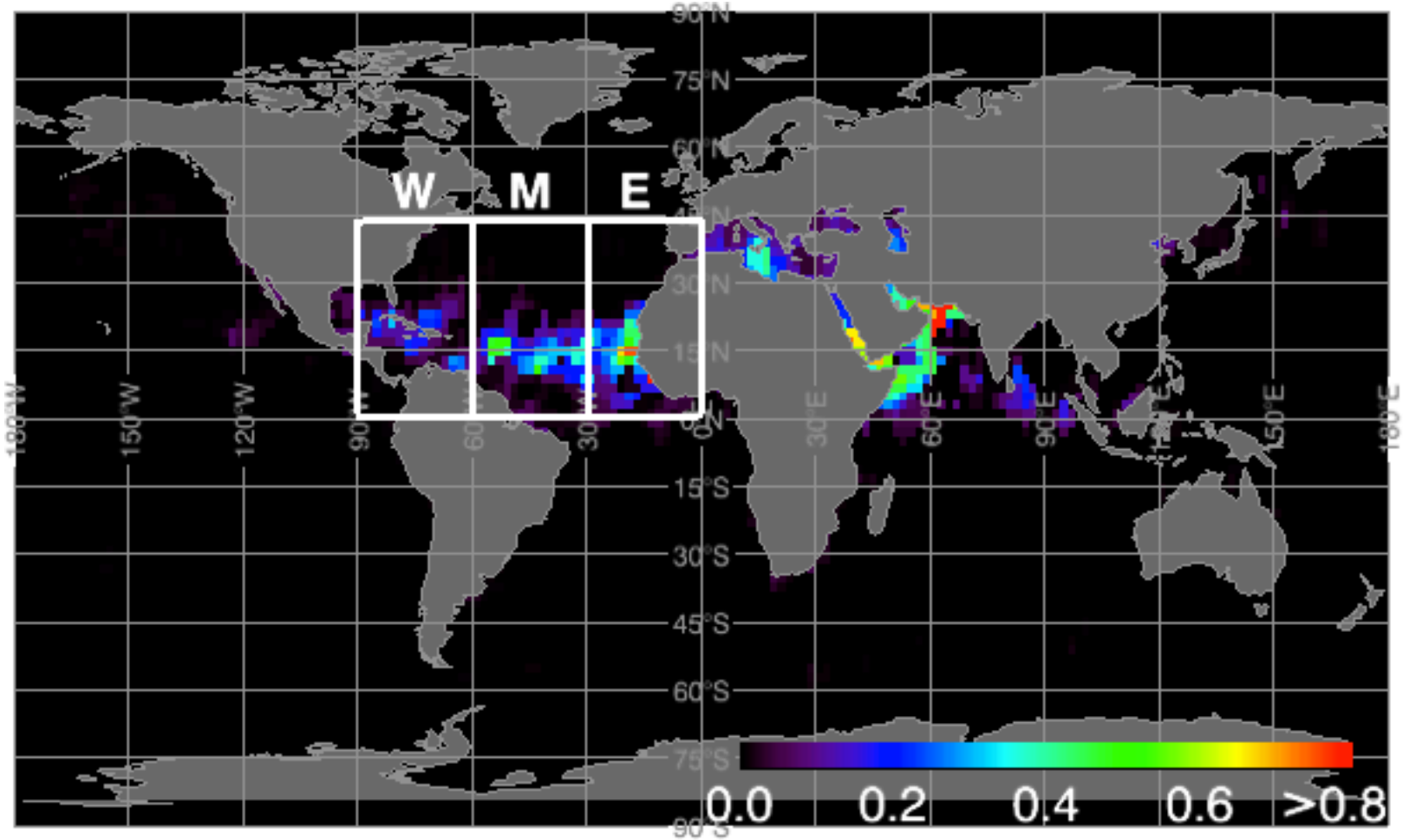
Main Question

How does the hygroscopicity of dust affect its optical properties near clouds?

Hygroscopicity is the particles' ability of taking up water from humid air

Dust is mostly composed of water-insoluble minerals and shows nearly complete hydrophobicity or at least poor hygroscopicity

Area of Interest

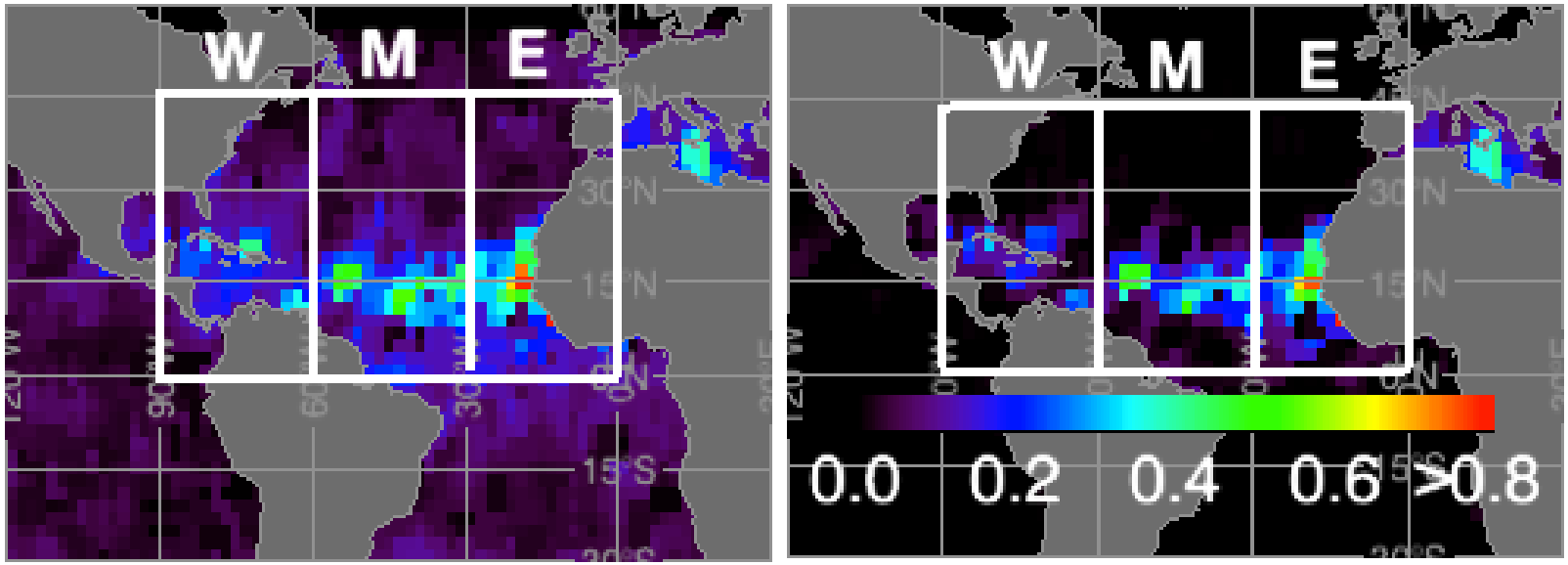


Colors indicate the average nighttime CALIOP Dust Optical Depth (DOD) over oceans for the June 7-July 7, 2007 period.

Area of Interest

AOD

DOD



Colors indicate the average nighttime CALIOP Dust Optical Depth (DOD) over oceans for the June 7-July 7, 2007 period.

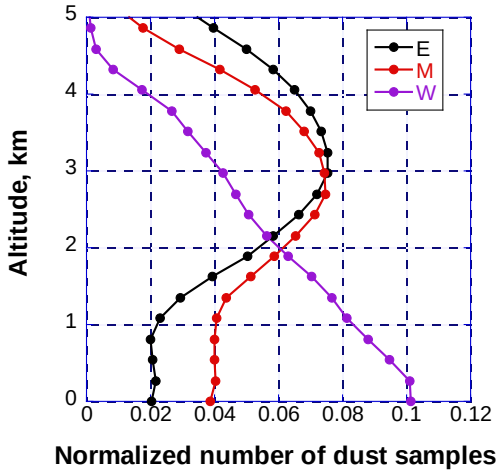
Data

attenuated backscatter coefficient: β'_{532};

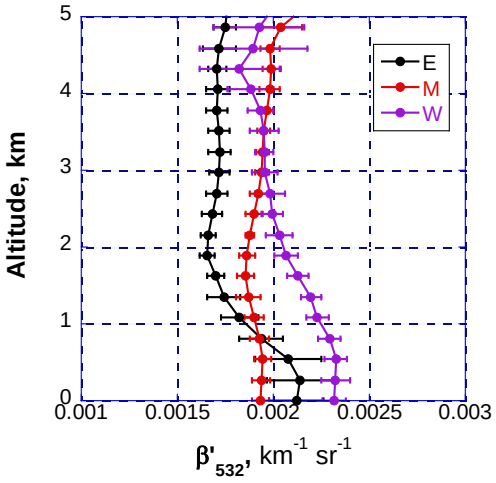
attenuated color ratio: χ' (ratio between β'_{1064} and β'_{532});

depolarization ratio: δ' (ratio between the perpendicular and parallel components of β'_{532})

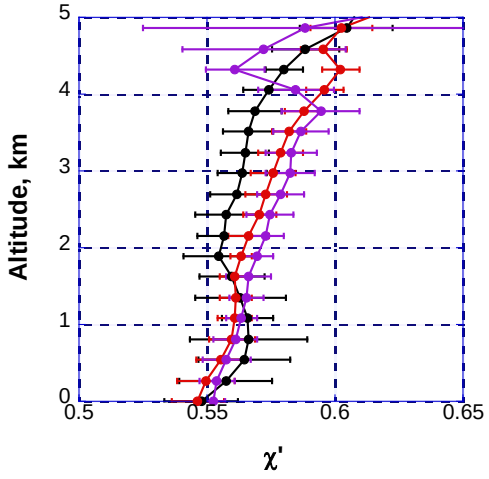
Vertical distribution of dust



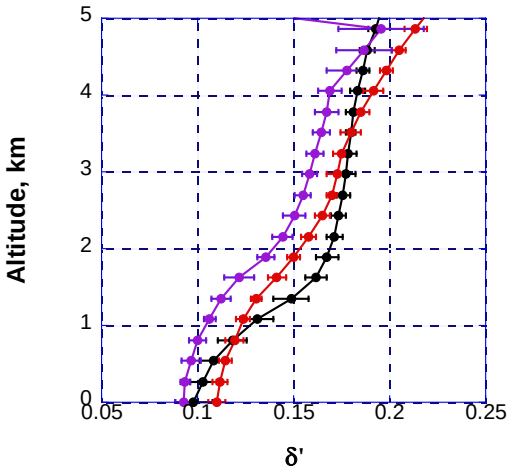
norm. # of samples



backscatter

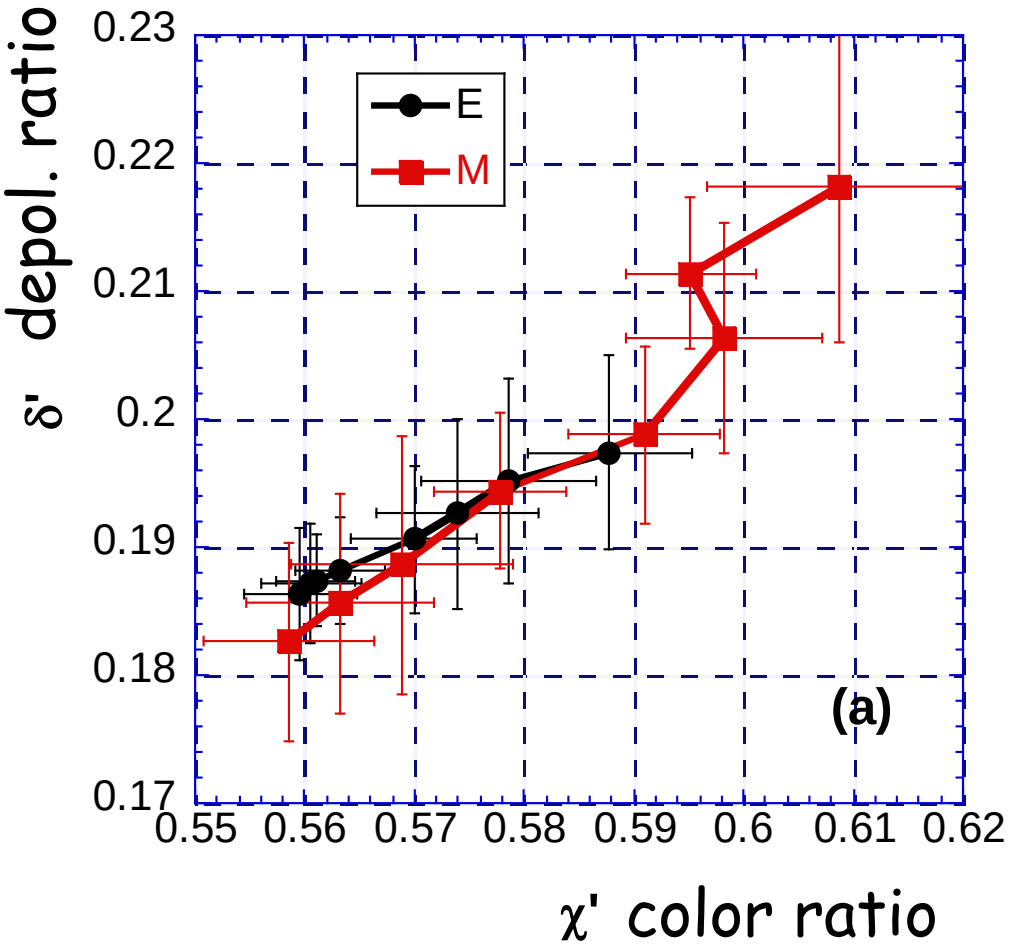


color ratio



depol. ratio

Color ratio vs. depolarization ratio

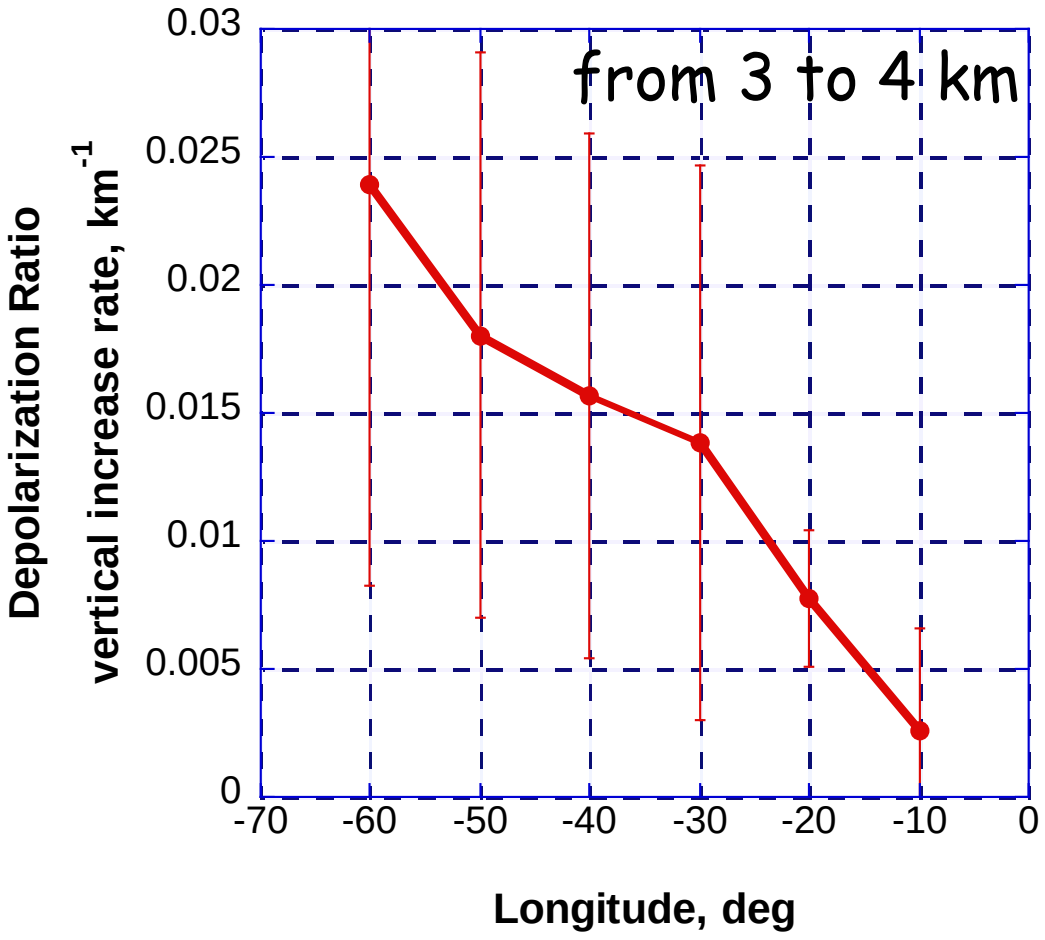


- decrease with altitude in the concentration of non-dust particles mixed in from below

- different fall speeds vertically separating the relatively more spherical dust particles from the least spherical ones (Ginoux, 2003).

- backscatter from larger dust particles can be more depolarized (Mishchenko and Hovenier, 1995).

Depolarization ratio vs. longitude

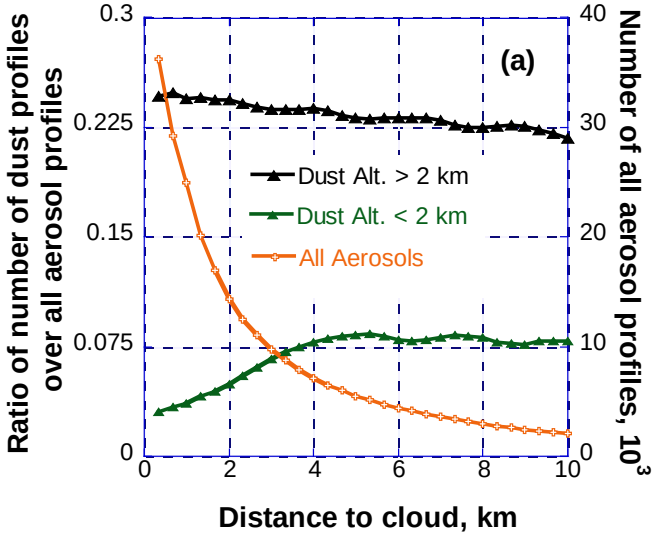


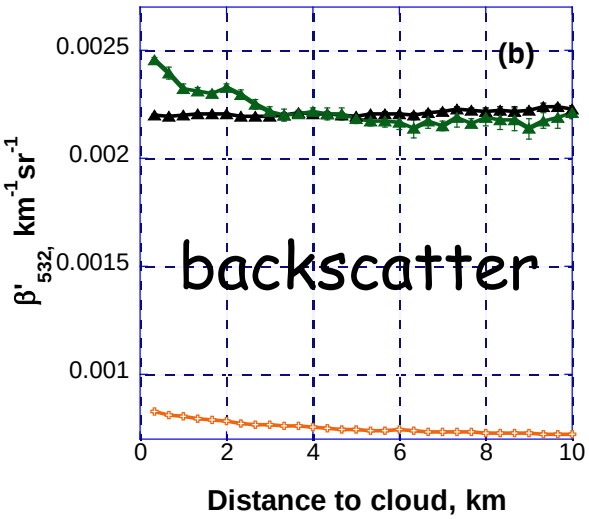
- more and less spherical dust particles getting vertically separated because of their different sedimentation speeds

- particles with irregular shapes have greater cross-sectional areas and drag-coefficients, thus more irregular particles fall slower than more spherical ones

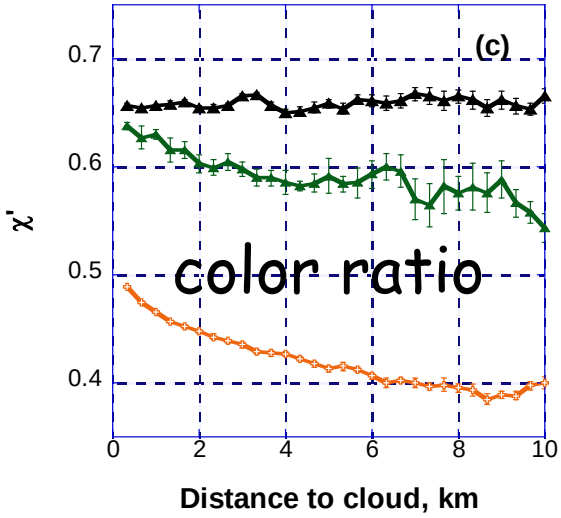
- the upward increase gets stronger westward simply because the sedimentation process has more time to work

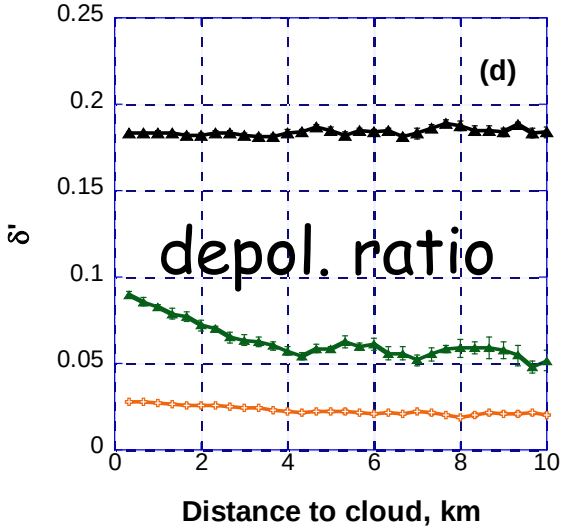
Dust near clouds



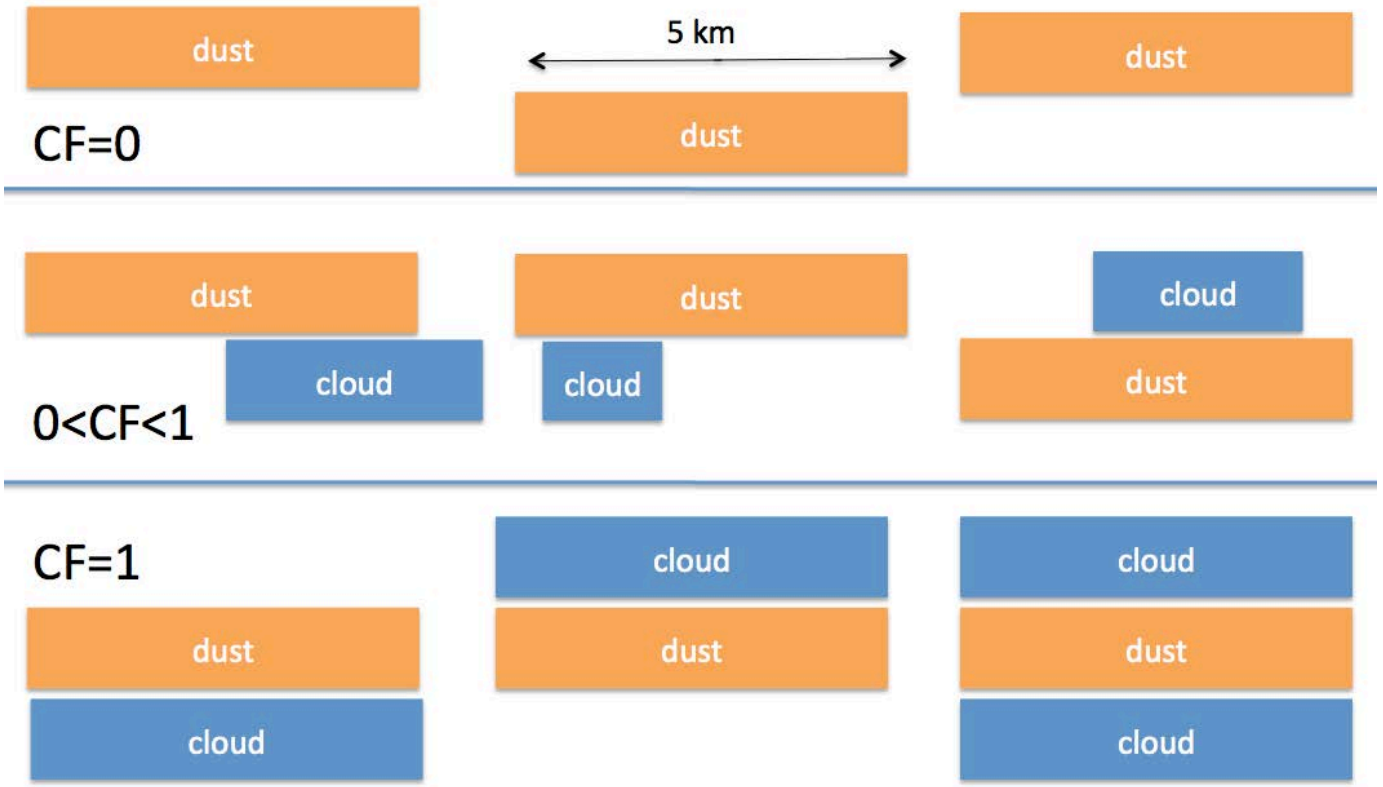


- black: high dust
- green: low dust
- orange: all aerosols



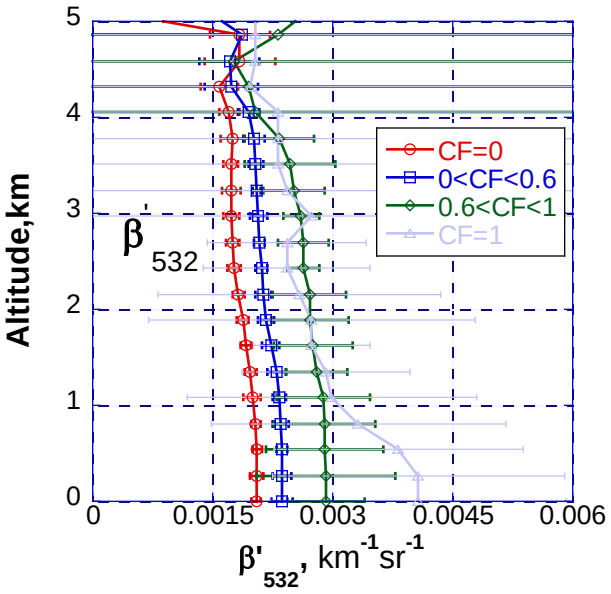


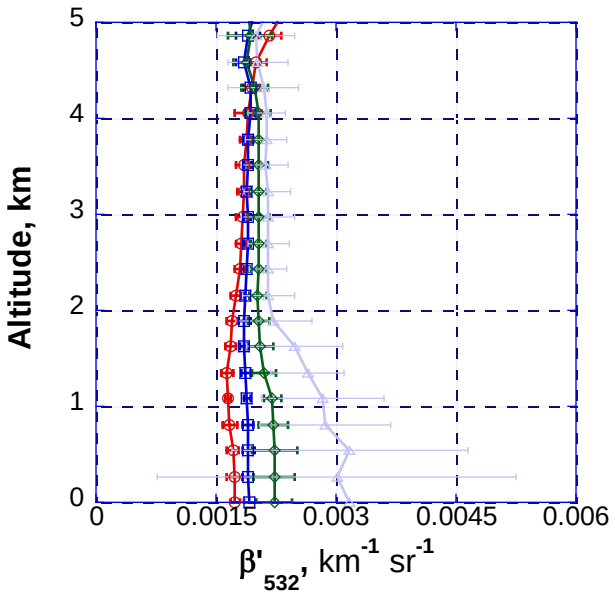
Cloudy vs Clear

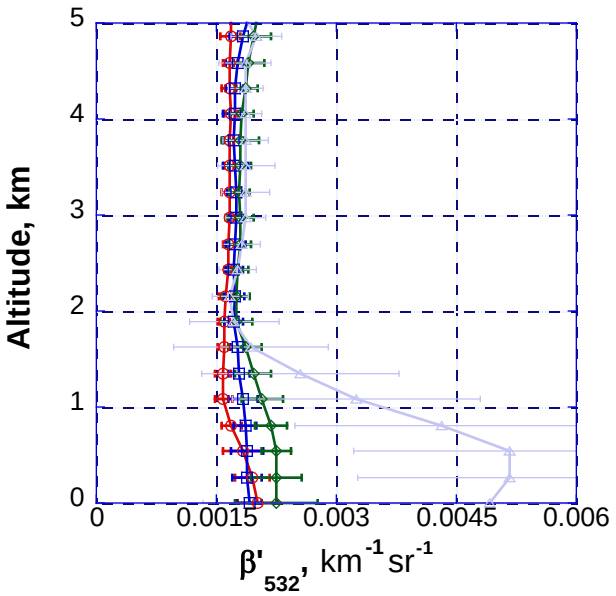


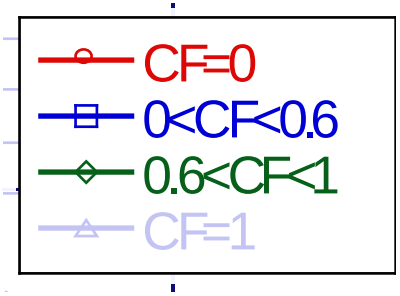
Schematic illustration of Cloud Fraction (CF) definitions for 5 km resolution dust pixels. CF is the fraction of cloudy 0.3 km-resolution pixels in 5 km size areas containing dust

Vertical profile of dust backscatter coeff. @ 532 nm

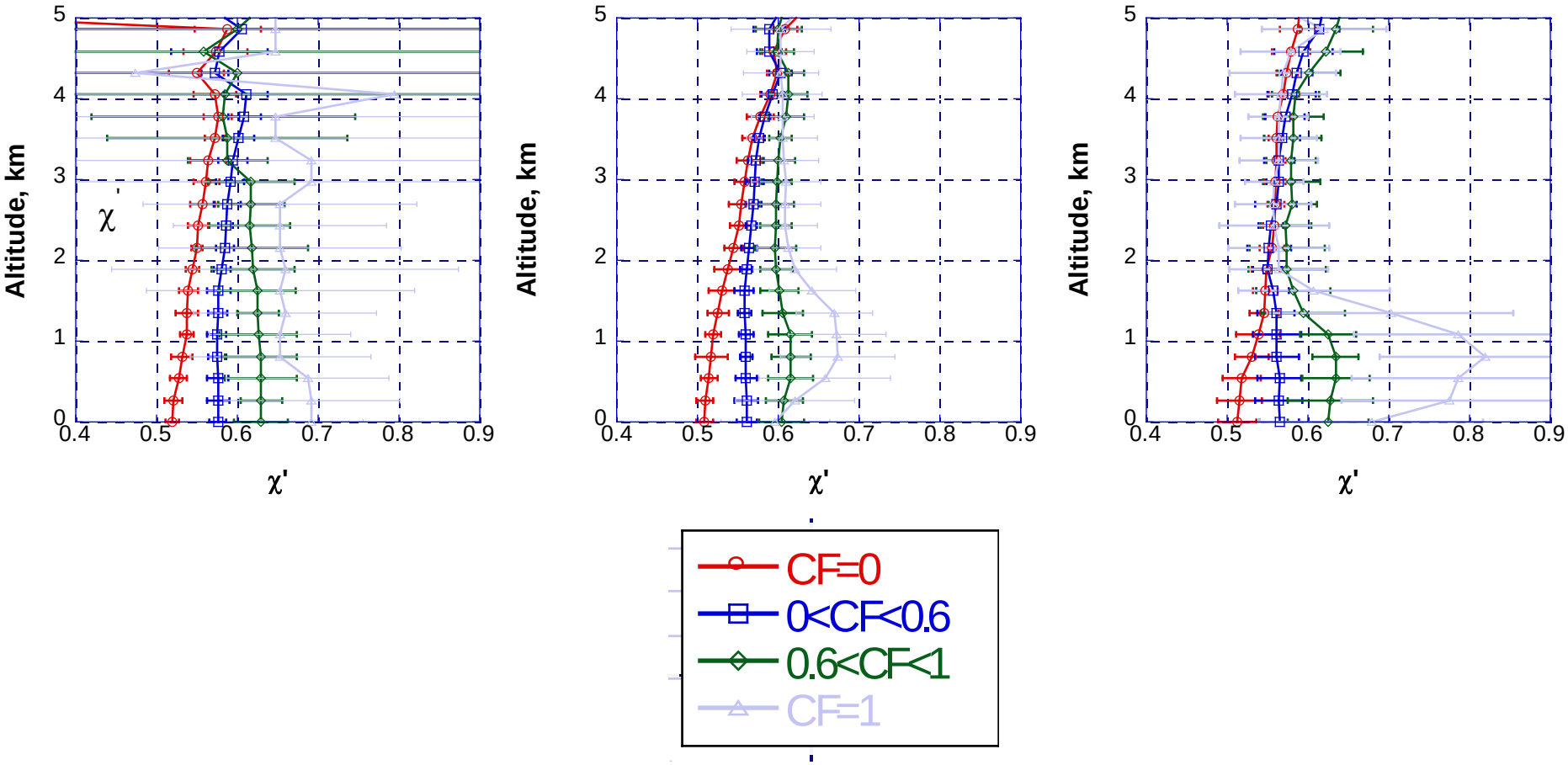




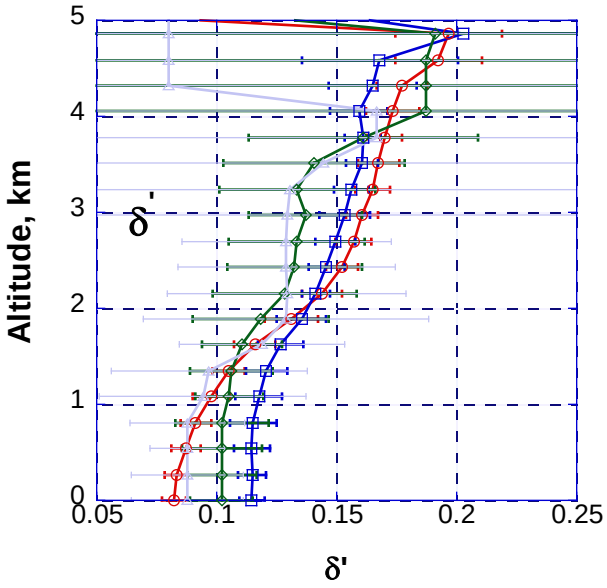


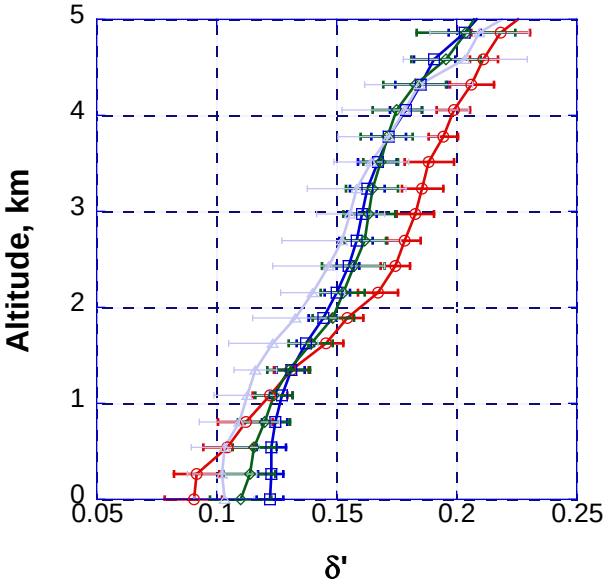


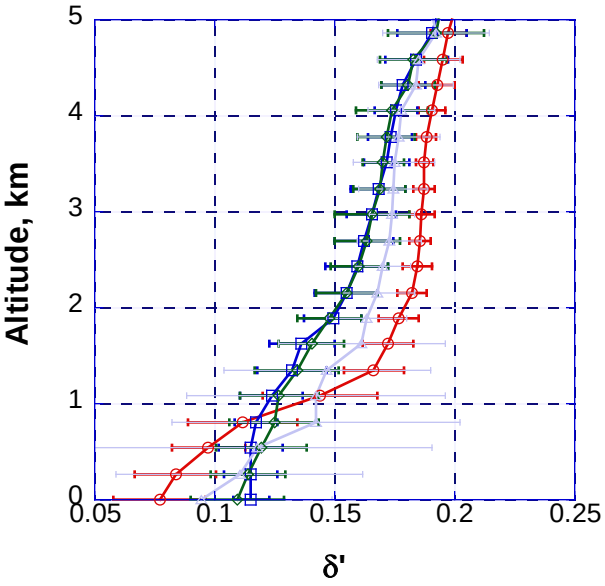
Vertical profile of dust color ratio

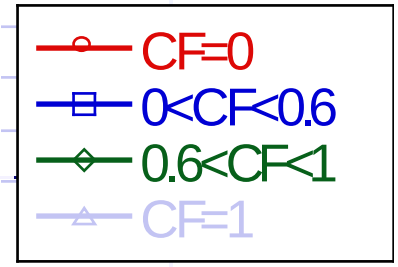


Vertical profile of dust depolarization ratio









Summary

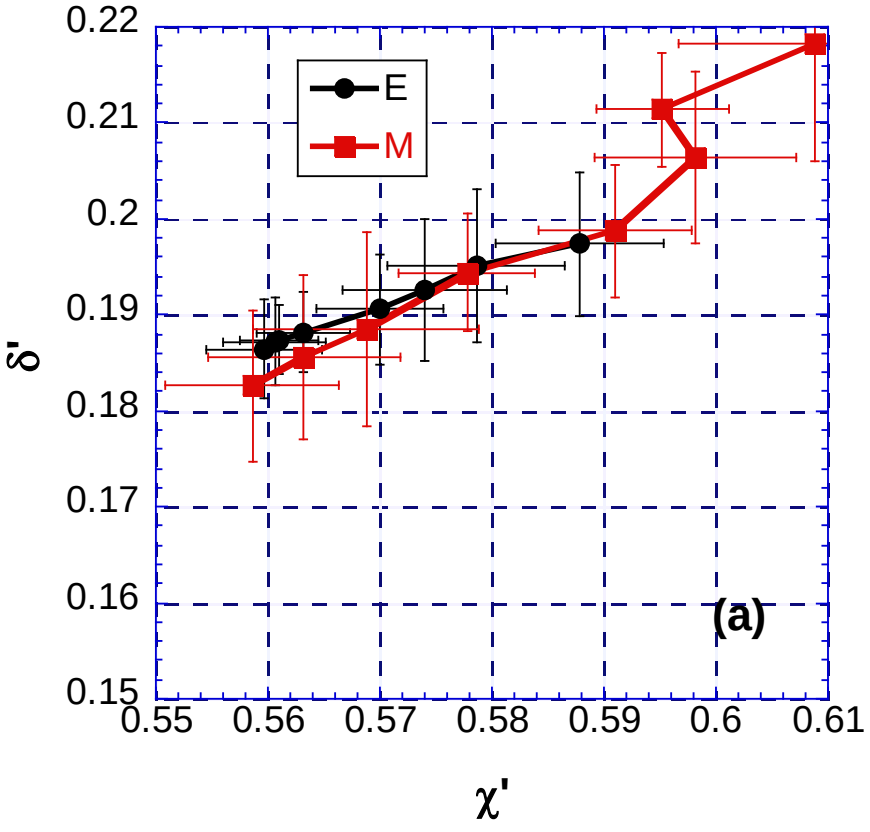
(1) backscatter doesn't change much with altitude in the SAL, while dep. ratio and color ratio increase;

(2) the vertical increase rate of dust depolarization ratio in the SAL increases as plumes move westward;

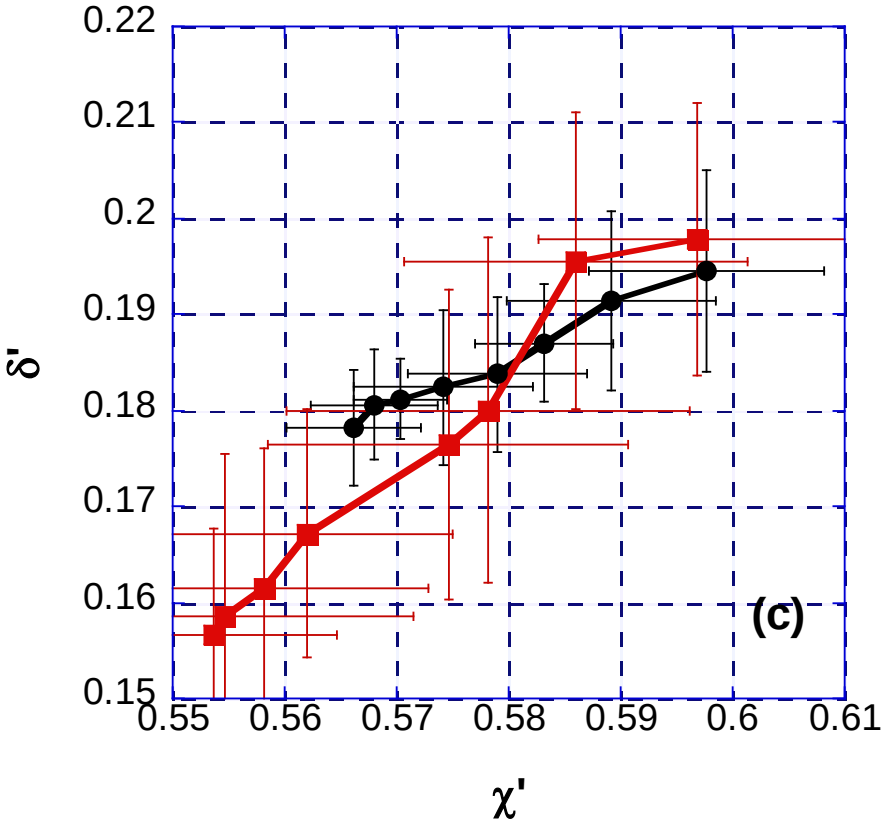
(3) the amount of nearby clouds barely affect the backscatter and color ratio of dust volumes inside of SAL but affect them significantly below the SAL.

(4) an *apparent increase* in depol. ratio near clouds indicates that particles in some dusty volumes become more spherical in the humid air near clouds, and cannot be identified by CALIPSO as dust.

Color ratio vs. depolarization ratio



June 7- July 7, 2007



May 25 - June 25, 2008

Vertical profile of dust # of samples