Aerosol-induced radiative flux changes in the Pacific Basin troposphere

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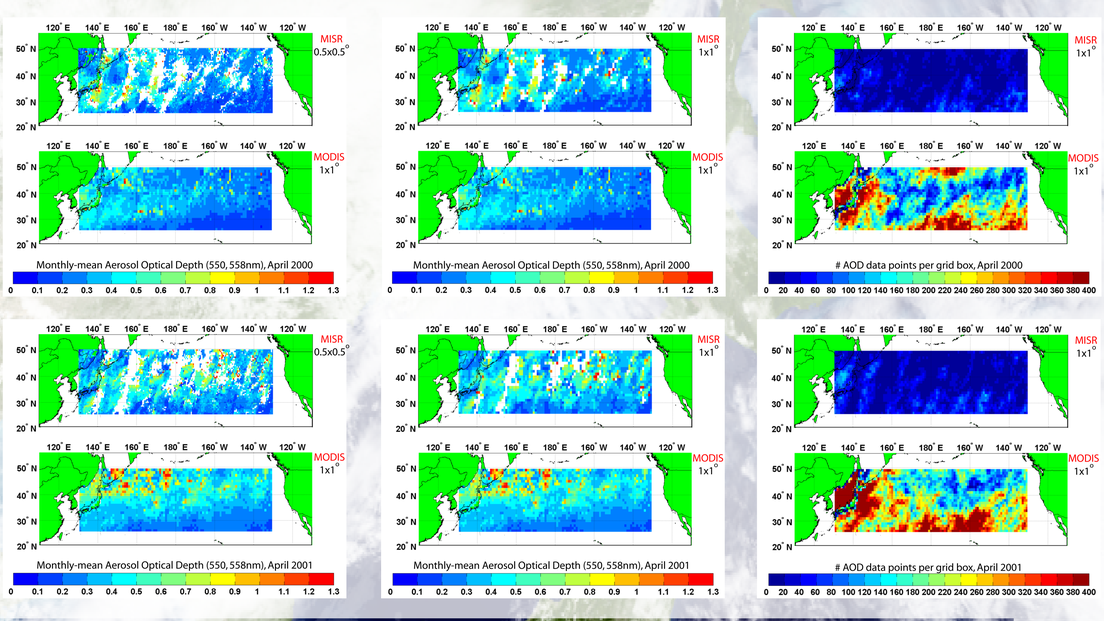
Motivation

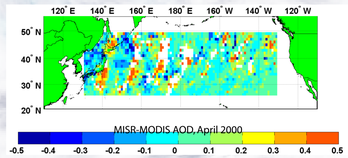
One methodology to calculate the direct aerosol radiative forcing of climate is to use suborbital measurements of aerosol properties to devise a parameterization between column aerosol optical depth and direct aerosol radiative forcing (see Figure 2 below), which can then be applied to satellite-derived maps of aerosol optical depth (AOD). The uncertainties in this method stem from the uncertainty in the accuracy and representativeness of the suborbital and spaceborne measurements of aerosol parameters.

Using previously published aerosol column closure studies conducted during the ACE-Asia field campaign, we have developed a mean model for the vertical structure of aerosol properties in the Asian region during spring of 2001. This model includes the vertical structure of the aerosol single scattering albedo, as well as the wavelength dependence and absolute magnitude of aerosol extinction (Figure 1 below). The model reflects the predominance of pollution-type particles in the lowest 3 km of the atmosphere and the occurrence of large mineral dust particles at altitudes between 4 and 8 km. At a latitude of 35N, the model yields an instantaneous shortwave aerosol forcing of -30 Wm^{-2} per unit aerosol optical depth at the top of the atmosphere and 65 Wm^{-2} at the surface.

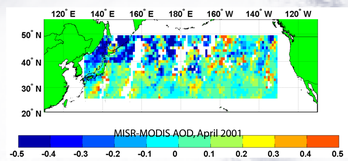
Here, we investigate the consistency between monthly-mean aerosol optical depth fields derived using MODIS-Terra and MISR for the month of April between 2000 and 2004. We compare the monthly mean aerosol optical depth derived by these sensors in the latitude region between 25 and 50N and the longitude region between 130W and 130E. The study area covers almost 5% of the Earth's surface area and is crucial for import climate phenomena. Yet, there are only 4 ground-based AERONET stations (see Figure 3), and only a small number of field campaigns within this region that provide opportunities for satellite sensor validation.



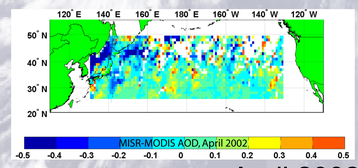
MISR - MODIS



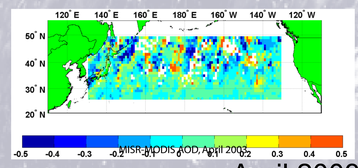
April 2000



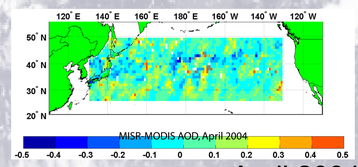
April 2001



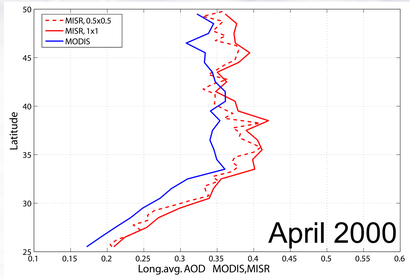
April 2002

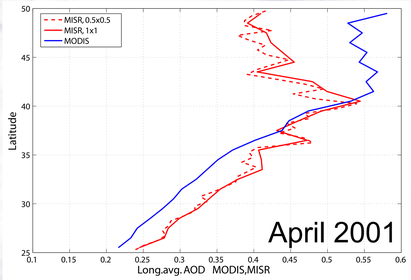


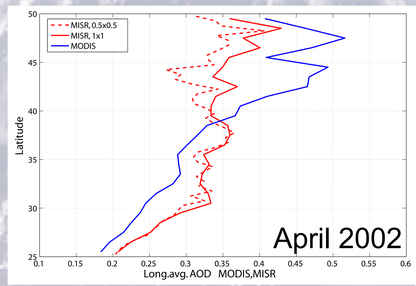
April 2003

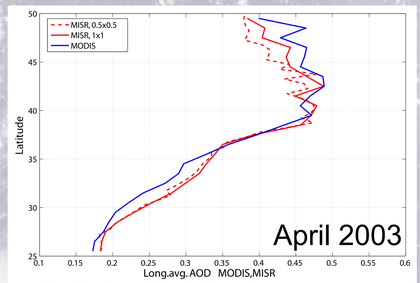


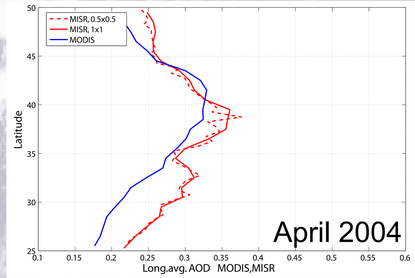
April 2004











Suborbital data

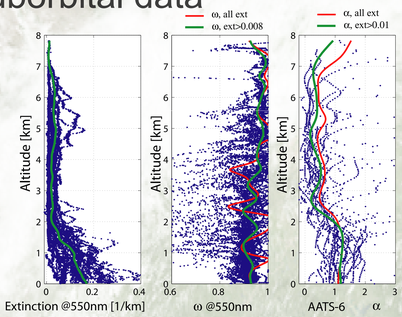


Figure 1. ACE-Asia (NCAR C-130) closure study derived aerosol properties, April 2001

Parameterization

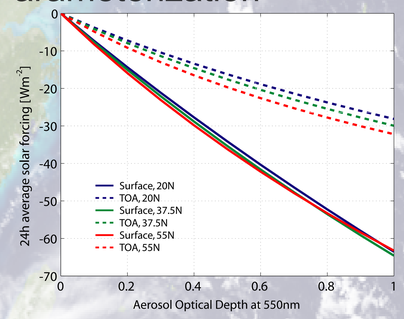


Figure 2. Parameterization of direct aerosol radiative forcing versus midvisible AOD

Conclusions

1) Level-3, monthly-mean AOD maps from MISR and MODIS show significant differences due to different sampling frequency and lack of coincidence.

2) Longitudinally-averaged AOD fields show significant differences, in particular when dust is present.

3) MODIS derived AODs across the Pacific Basin show a generally stronger latitudinal gradient when compared to the MISR AOD data.

4) Possible reasons for the differences in longitudinally-averaged AOD's:

- Transport pattern not strictly W to E
- Differences in cloud screening
- Differences in accuracy of level-2 aerosol data

Validation?

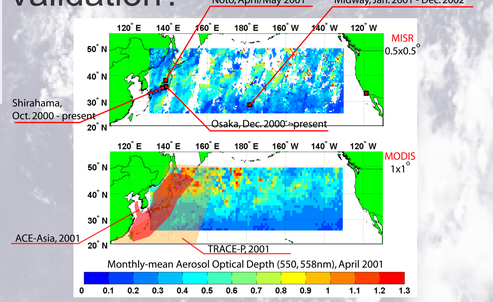


Figure 3. Ground-based (AERONET) validation sites and airborne field campaigns

Nitty-gritty, get-down-on-your-knees-if-you-care, bend-down-really-low, squint-your-eyes kind of details:

1) The MISR AOD data for April of 2000 and 2001 shown here are Collection 3 data, while the data from 2002-2004 are Collection 4. The Collection 3 data are based on Version 15 (or prior) retrieval algorithm results, which are the only retrievals available for these dates at this time. The next generation level-2 retrieval, Version 16, implements a correction to the instrument low-light-level calibration and is expected to decrease the AOD values by 0.025 to 0.04.

2) The MODIS-Terra data shown here are MOD08_M3, Collection 4. The data for April 2004 were created with PGE57, v4.2.1, while the data for 2003 and before were created using earlier versions. Collection 5 data will begin being processed in early 2005.

3) This work was funded in part by NASA grant EOS-IDS-291-07-97-16 and NOAA grant OGP-ACIP/GC03-086.