Combination of spaceborne sensor(s) and 3-D aerosol models to assess global daily near-surface air quality

M. Kacenelenbogen(1), Jens Redemann(2), Philip Russell(3), Ajith Kaduwela(4), Chenxia Cai(4), Jose-Luis Jimenez(5), Michael Cubison(6), Ruben Delgado(6), Raymond Hoff(7)

(1) NASA Atmospheric Chemistry Program, (2) NASA Ames Research Center, Moffett Field, CA, (3) Bay Area Environmental Research Institute, San Jose, CA, (4) NASA Ames Research Center, Moffett Field, CA, (5) Air Resources Board, California Environmental Protection Agency, (6) Department of Chemistry and Biochemistry, University of Colorado at Boulder, (7) Joint Center for Earth Systems Technology/Geodetic Earth Sciences Technology and University of Maryland, Baltimore County, Baltimore, MD. Contact: jruben@umces.edu

Background

Aerosol and human health

-- Among various, smoke lung and respiratory diseases even premature death.

Satellite’s capability in assessing AOD

POLDER satellite:

- Observation: different viewing geometry (downward, upward)
- Polarization sensitive (upward looking)
- Measurement: aerosol extinction in polarization and matrix index of a 3-4 km layer

GRASP satellite: visible to the polarizing window.

Space-borne sensor

MODIS-AQUA, MODIS-Terra, MODIS-1km.

Why not use CALIPSO for aerosol vertical distribution?

Why not use CALIPSO:

- Too low altitude
- Too wide footprint

Possible sources of CALIPSO extinction underestimation

- Sun glint
- Aerosol variability
- Sun glint

II.2. Weaknesses in current CALIPSO extinction algorithm (V2)

- CALIPSO product product seem to underestimate MODIS AOD (by 75%)
- MODIS AOD could be biased by wrong surface reflectance, cloud contamination...

CALIPSO extinction validation 

August 4, 2007 case.

POLDER satellite:

- Observation: different viewing geometry (downward, upward)
- Polarization sensitive (upward looking)
- Measurement: aerosol extinction in polarization and matrix index of a 3-4 km layer

GRASP satellite: visible to the polarizing window.

Space-borne sensor

MODIS-AQUA, MODIS-Terra, MODIS-1km.

Results From Previous Studies

I. Direct satellite-ground mass comparison

A. NASA airborne field campaigns

Layer identified by CALIPSO using HSRL data.

B. CALIPSO extinction algorithm (V2)

C. POLarization and Directionality of Earth’s Reflectance (POLde)

D. Combination of POLDER and CALIPSO data

- MODIS AOD could be biased by wrong surface reflectance, cloud contamination...

POLDER extinction algorithm (V2)

- Observation: different viewing geometry (downward, upward)
- Polarization sensitive (upward looking)
- Measurement: aerosol extinction in polarization and matrix index of a 3-4 km layer

GRASP satellite: visible to the polarizing window.

Space-borne sensor

MODIS-AQUA, MODIS-Terra, MODIS-1km.

CALIPSO AOD ("CALIPSO_V2.01") still under-estimates MODIS AOD. Best correlation (R=0.6) when AMS PM mass in 6 bin size from 0.01 µm to 3 µm.

References

5. Dr. Jose Jimenez and Dr Ray Cubison.
6. CALIPSO combined PM-2.5 data and ground instrument (min. 40 km away from CALIPSO track).
11. Chenxia Cai and Dr. Jose Jimenez.

Why not use CALIPSO?

- Too low altitude
- Too wide footprint

Possible sources of CALIPSO extinction underestimation

- Sun glint
- Aerosol variability
- Sun glint

II.2. Weaknesses in current CALIPSO extinction algorithm (V2)

- CALIPSO product product seem to underestimate MODIS AOD (by 75%)
- MODIS AOD could be biased by wrong surface reflectance, cloud contamination...

CALIPSO extinction validation 

August 4, 2007 case.

POLDER satellite:

- Observation: different viewing geometry (downward, upward)
- Polarization sensitive (upward looking)
- Measurement: aerosol extinction in polarization and matrix index of a 3-4 km layer

GRASP satellite: visible to the polarizing window.

Space-borne sensor

MODIS-AQUA, MODIS-Terra, MODIS-1km.

References

5. Dr. Jose Jimenez and Dr Ray Cubison.
6. CALIPSO combined PM-2.5 data and ground instrument (min. 40 km away from CALIPSO track).
11. Chenxia Cai and Dr. Jose Jimenez.