

Retrieving Daytime Desert Dust and Volcanic Ash Layer Heights

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AIRS STM
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UMBC Physics/JCET

Omar Torres

NASA Goddard, Greenbelt, Maryland

Gareth Thomas

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Don Grainger

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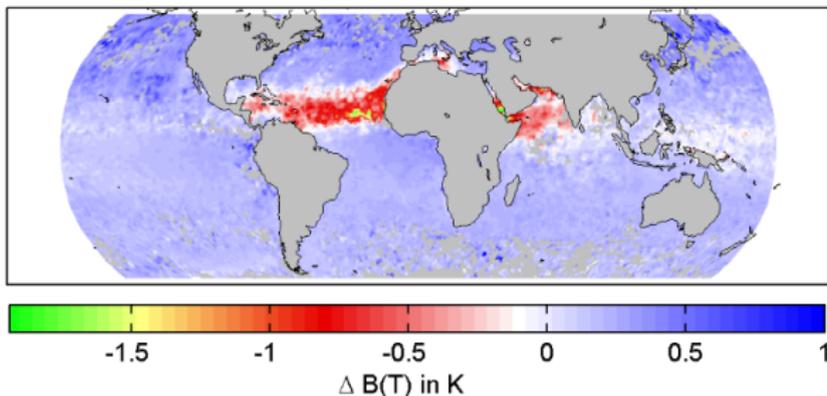
University of Oxford, Oxford, England

Adam Robinson

Radiation Oncology and Molecular Radiation Sciences

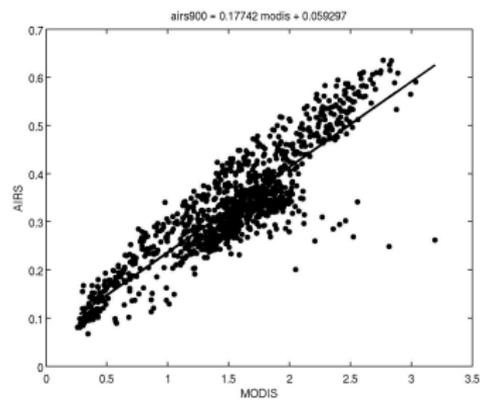
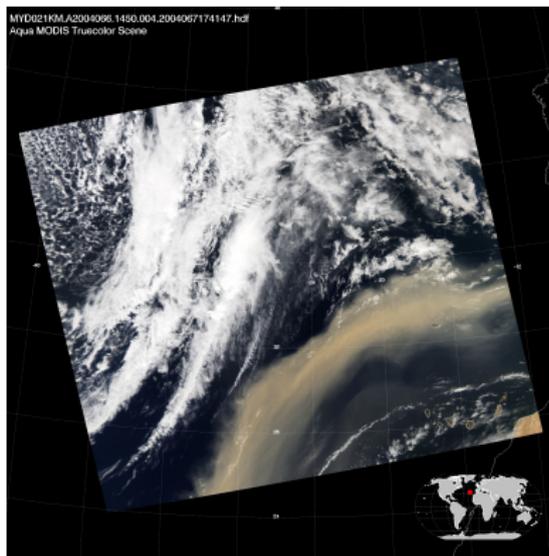
Johns Hopkins Hospital, Baltimore MD

"About 15% AIRS observations in certain regions can be dust contaminated seasonally eg Atlantic during hurricane season, Pacific in spring time"

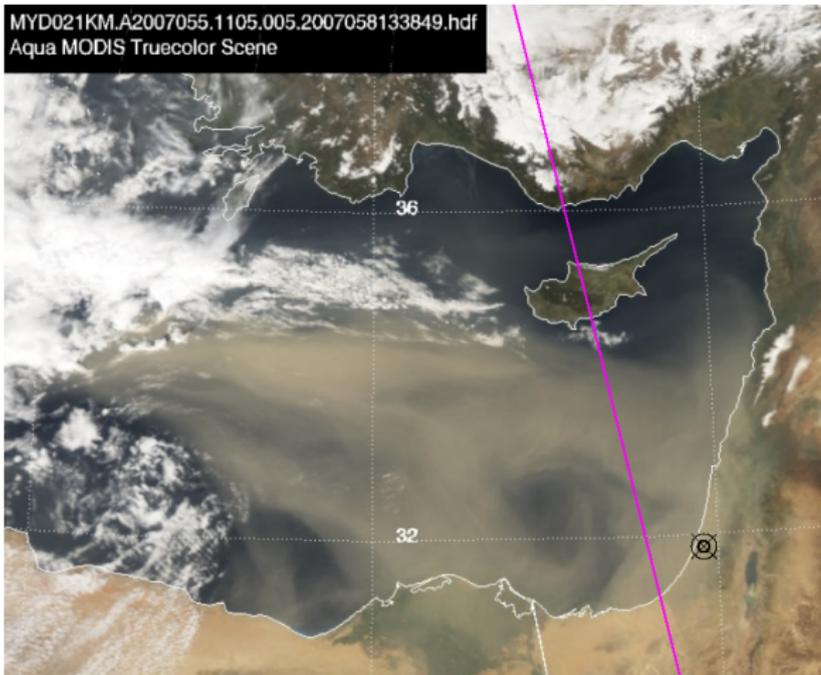


- Effects of dust/ash on AIRS radiances are combination of amount and dust layer height (and size, species)
- **Can fit data assuming dust at any height : (low z, large OD) vs (high z, small OD)**
- Our RT code assumes scattering effects are small (single scattering albedo $\omega \ll 1$); works best in Thermal Infrared (not reliable in SWIR)
- Climatological aerosol heights will always yield an OD estimate, but most likely incorrect (current databases do not distinguish between smoke or dust)
- Using χ^2_{min} can work, but need accurate scattering models/ scattering parameters else the individual pixel results are "noisy" (χ^2 computed over handful of channels in TIR)
- **When dust layer heights are correct (eg validated by Calipso) we find MODIS 550 nm OD / AIRS 900 cm^{-1} OD ~ 4**

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Placed AIRS dust at 600 mb; **AIRS : MODIS \simeq 5**



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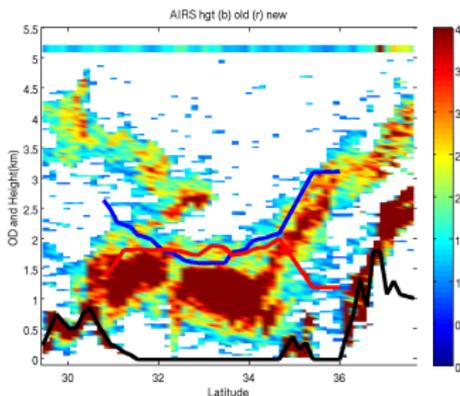
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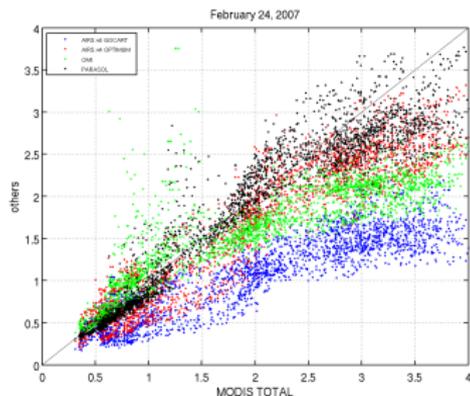
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(L) Height vs Calipso



(R) OD comparisons



Black = PARASOL

Green = OMI

Red = AIRS with height retrieval

Blue = AIRS with GOCART climatology

- Use this constraint in daytime MODIS/AIRS synergy to retrieve height
- Once height is obtained, can retrieve accurate OD
- Sunlint regions : fill in 550 nm OD using 2d interpolation
- Night time : use χ_{min}^2 from selected TIR channels

- Wrapper Code subsets dust flagged FOVS in a granule (rtp file, ECMWF geophysical fields)
- Needs to loop over heights 1.5 km : 0.5 km : 6 km
 - For all subsetted dust FOVS, push out each height retrieval to a processor
 - For each H_n we get Newton-Raphson based $OD(z)$ estimate for all dust FOVS (as well as $\chi^2(z)$)
 - UMBC has 8 cpus/node
- Gathers together $OD(lat, lon, z)$ for each dust FOV
- **If daytime**
 - Loads in MODIS L2 data, interpolates across sunglint regions
 - Looks for height which gives closest $OD_{MODIS}/OD_{AIRS} = 4$
- **For both day and night**
 - Find height based on minimum $\chi^2(z)$
 - Use GOCART climatological height (varies with month, lat, lon)

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- current code does extra step, rederiving OD for MODIS/AIRS synergy and χ^2_{min} ; plan to remove that in the future
- about 20 mins for very dusty granule (~ 3000 fovs)

- **Climatological Height, and OD retrieval** - very reliable, not accurate
- **χ^2 Height, and OD retrieval** - "needs work", better than climatology
- **MODIS/AIRS Height, and OD retrieval** - optimal (daytime)

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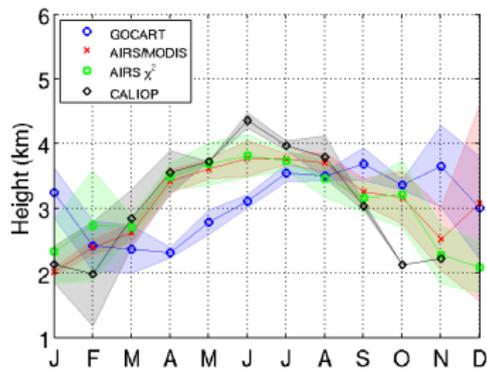
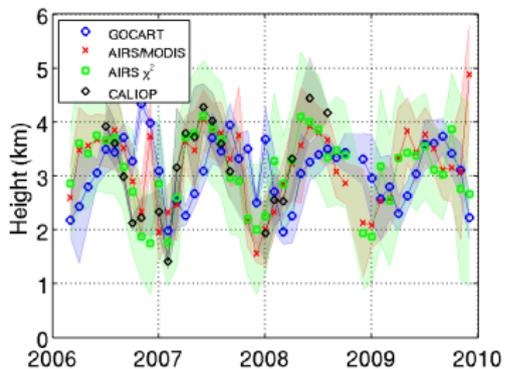
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- Have June 2006 - Dec 2008 Calipso aerosol centroid heights
- Ran above retrieval, gathered results for various geographical regions
- Compared AIRS/MODIS synergy, AIRS χ^2 , GOCART climatology vs Calipso
- Works quite well over water, problems(?) over land
- Climatology not so good over Pacific/land, phase shift over Atlantic

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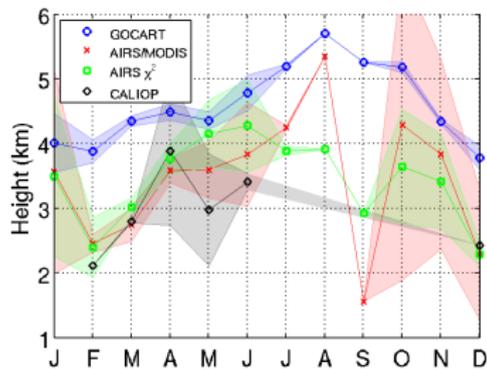
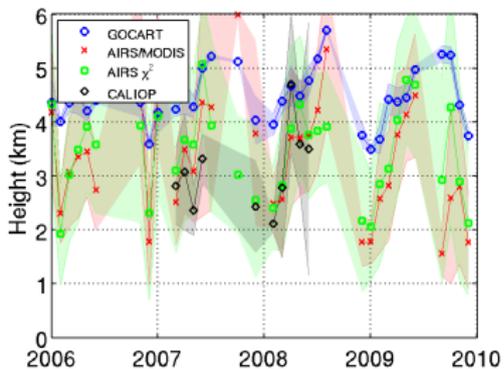
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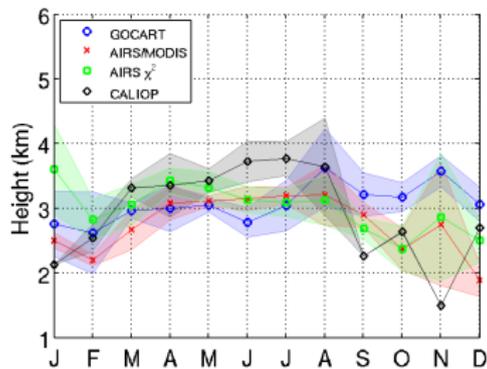
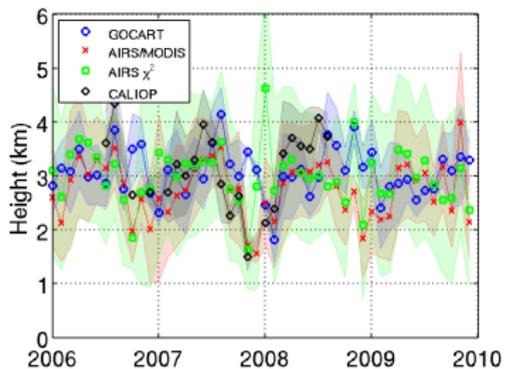
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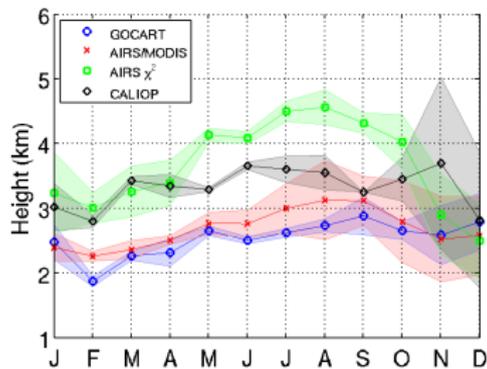
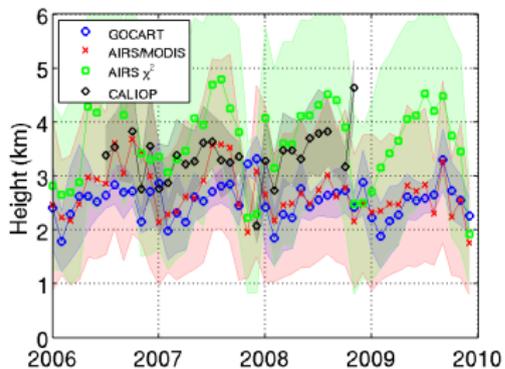
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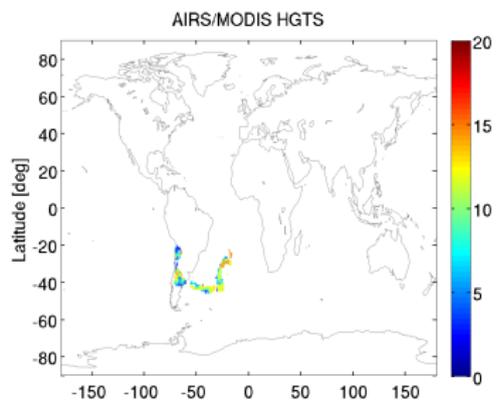
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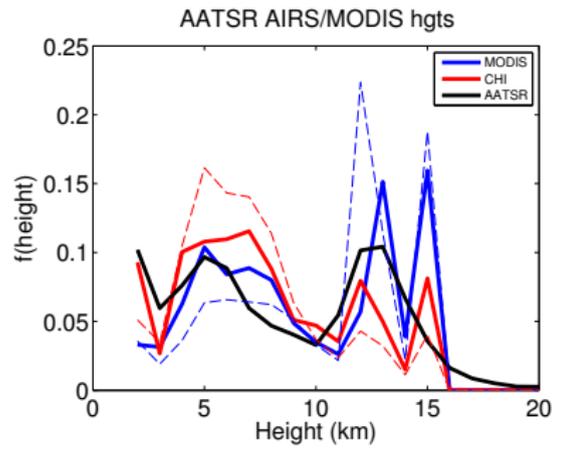
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- Puyehue erupted June 5 - June 20, 2011
- Ash circumnavigated Southern Hemisphere in about 10 days
- Calipso turned off (solar flare event)
- Gareth Thomas/Don Grainger (RAL and Oxford) have AATSR height retrievals, closer to S. America
- Different orbits, so had to compare pdfs of retrieved heights
- Works quite well!

(L) AIRS heights



(R) Height comparisons



- Algorithm to obtain daytime dust/volcanic ash plume heights using MODIS synergy
- Have "improved" χ^2_{min} retrieval for night-time heights
- From height retrieval, can get OD retrieval
- Having determined the above, fix dust height/amount, surface emissivity and next step is to solve for **geophysical state $T(z), WV(z), O_3(z), stemp$ using OE**

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