Sensitivity of AOT calculation to relative humidity

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HTAP meeting
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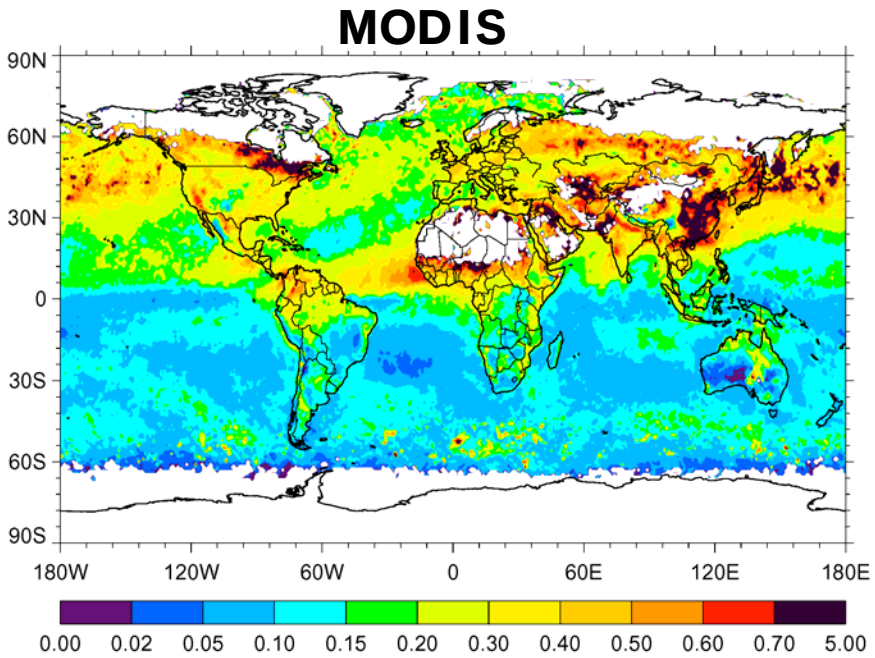
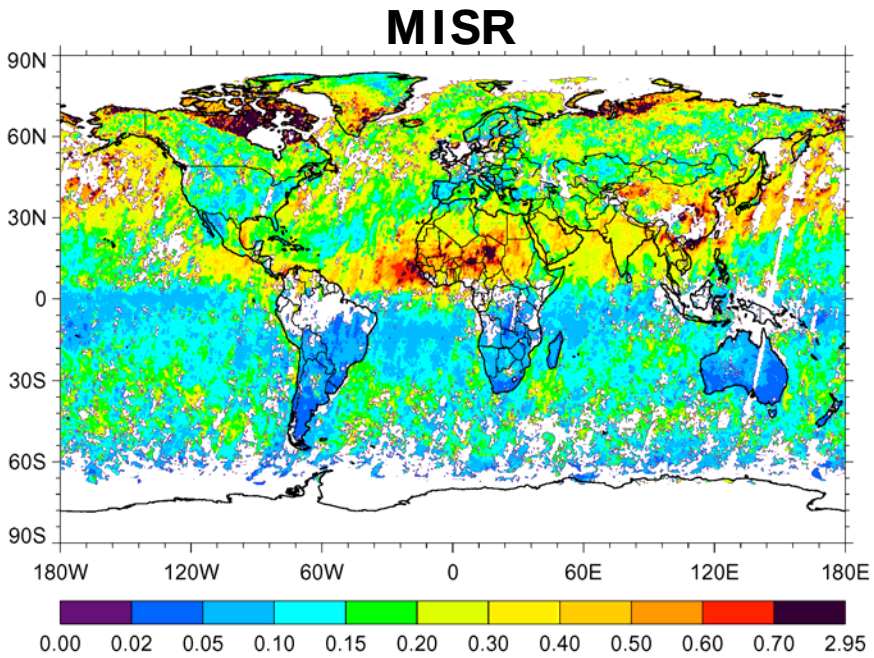
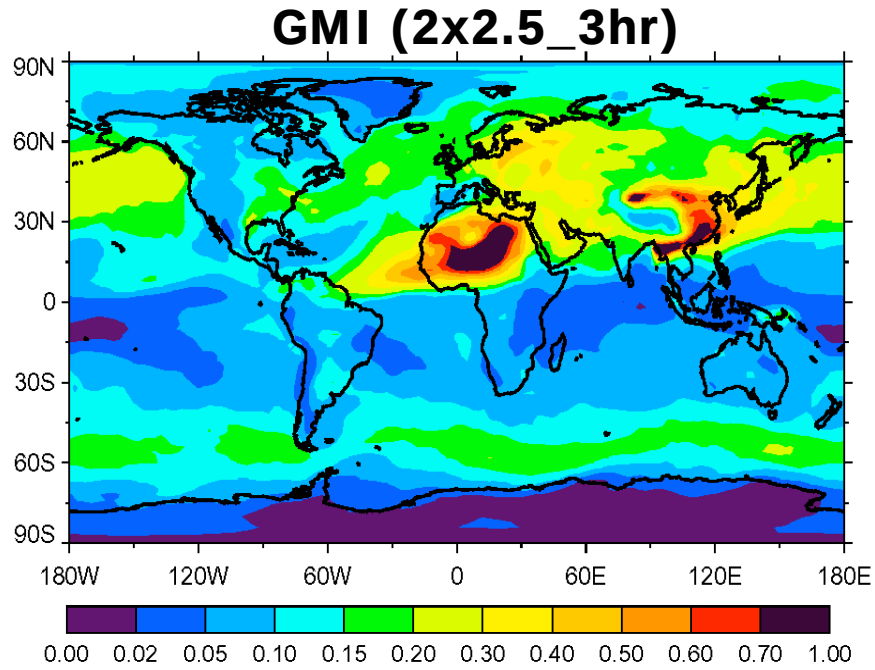


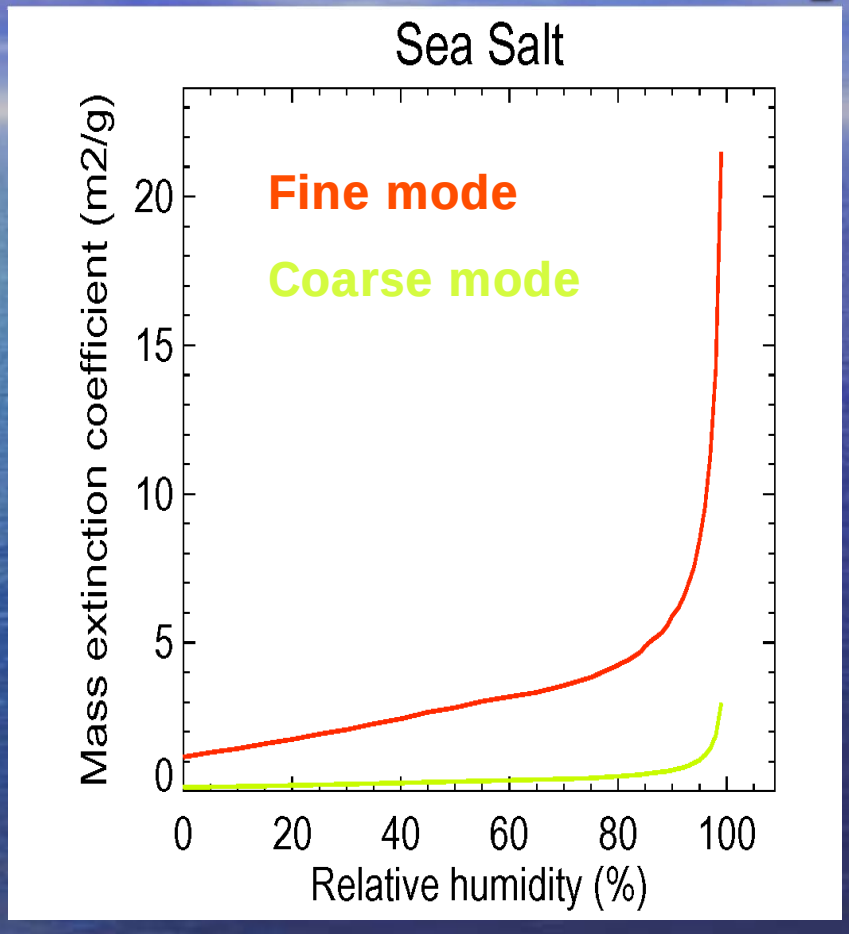




AOT (550 nm) at April 2001

GMI: Global Modeling Initiative, an off-line model driven by GEOS-4 assimilation meteorological data at 2° latitude x 2.5° longitude and 3-hr time interval

Mass Extinction Efficient (MEE) vs Relative Humidity (RH)



AOT = dry_mass x MEE (RH)

Motivation

- A small change in RH creates very large uncertainty in MEE
- Support inter-model comparison

Kinne et al., 2003

ECHAM4	GOCART	MIRAGE	GISS	Sprintars	Grantour	ULAQ
3.8 x 3.8	2.0 x 2.5	2.8 x 2.8	4.0 x 5.0	1.1 x 1.1	5.6 x 5.6	10 x 22.5

Textor et al., 2006

16 models, 2 close to 1 x 1, 11 to 2 x 2.5, 2 to 4 x 5, and 1 to 10 x 22.5

Kinne et al., 2006

20 models, 1 close to 1 x 1, 13 to 2 x 2.5, 4 to 4 x 5, and 1 to 10 x 22.5

Schulz et al., 2006

9 models, 1 close to 1 x 1, 7 to 2 x 2.5, 1 to 4 x 5, and 1 to 10 x 22.5

HTAP (*jüelich*)

12 models, 3 close to 1 x 1, 6 to 2 x 2.5, 3 to 4 x 5

Goal

- What is the AOT variation in terms of RH variation due to using different model spatial resolution or using GCM meteorological field averaged over different time interval?
- Where and when is the AOT most sensitive to changes in RH?

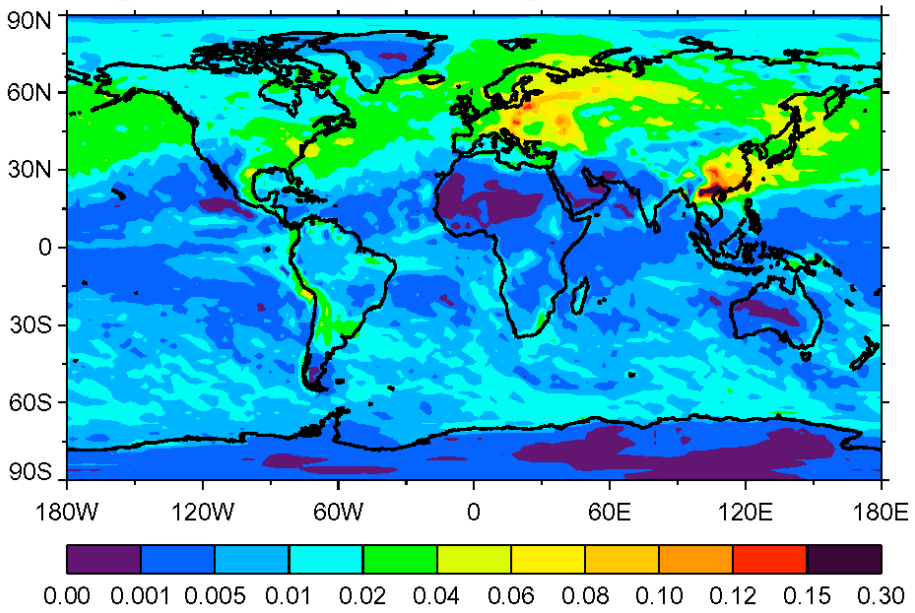
Approach

- Base case (2x2.5_3hr):
  2° (latitude) x 2.5° (longitude),
  3 hour averaged RH
- Control cases:
  - 1 ° x1.25 °, 3 hours (1x1.25_3hr)
  - 2 ° x2.5 ° , 6 hours (2x2.5_6hr)

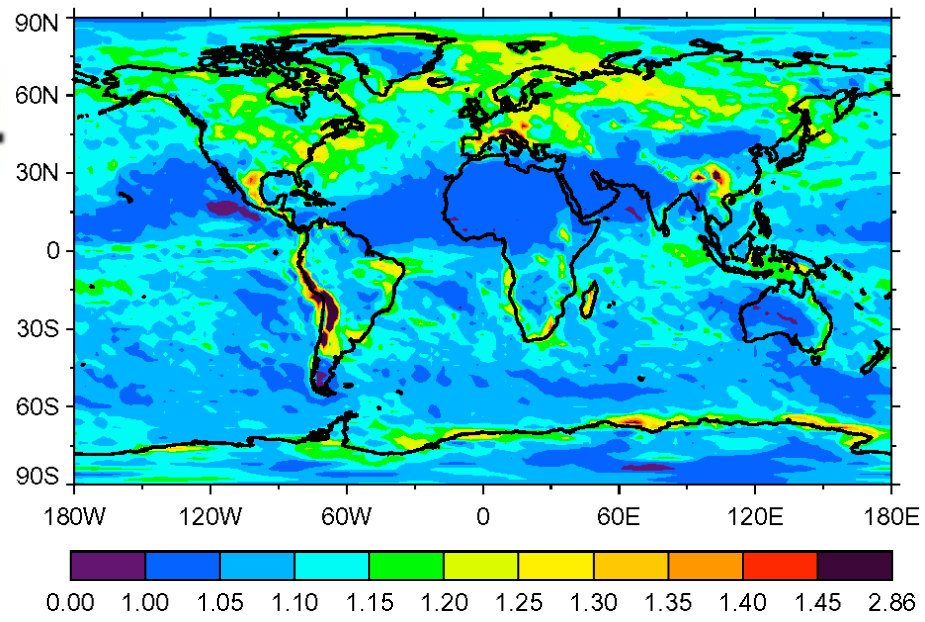
AOT(1x1.25_3hr) vs AOT(2x2.5_3hr)

Absolute Difference

- High difference occurs over :
  1. high hygroscopic aerosol areas;
  2. surface escarpment;
  3. land-ocean boundary.

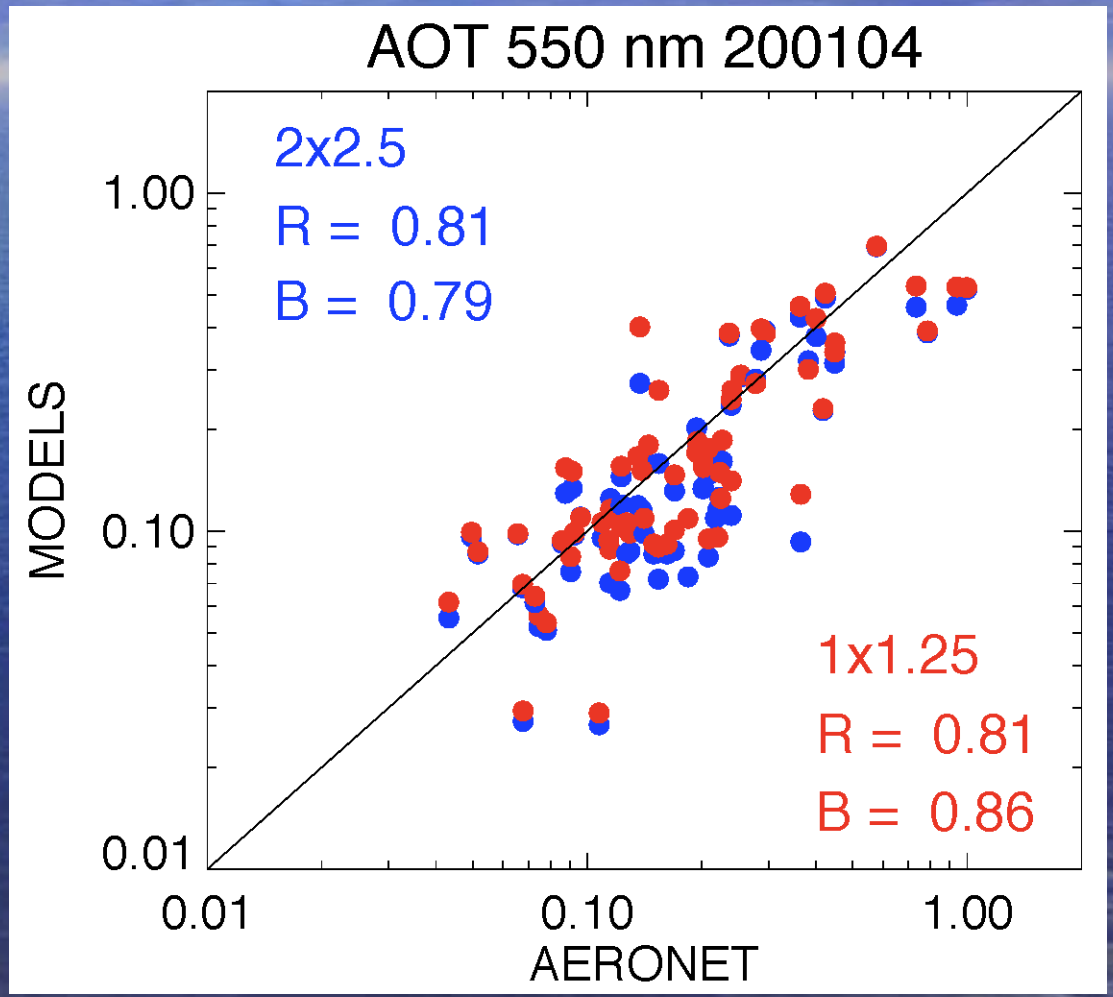


Relative Difference



Comparison of AOT between model and observation

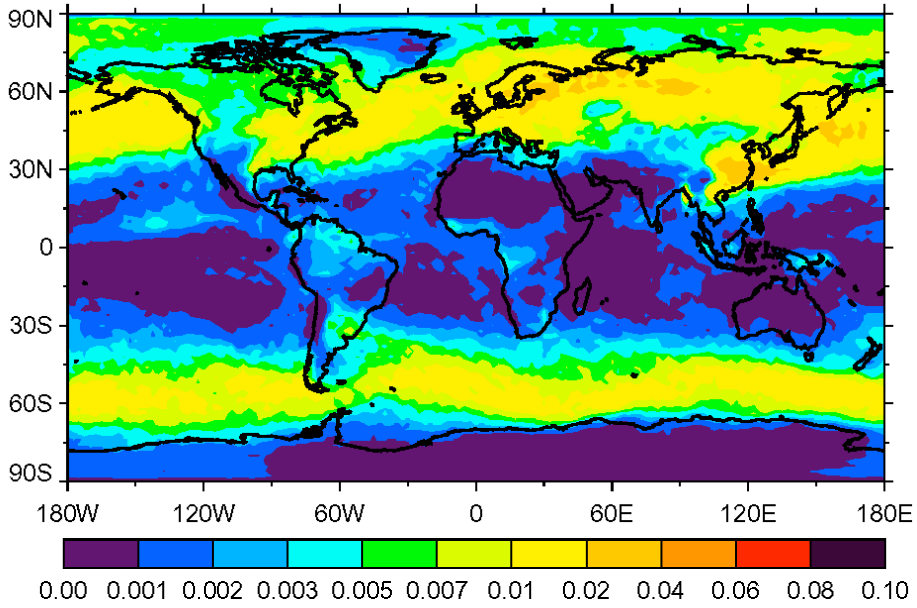
- GMI AOT(1x1.25_3hr) is closer to AOT(AERONET) than that of GMI AOT(2x2.5_3hr)



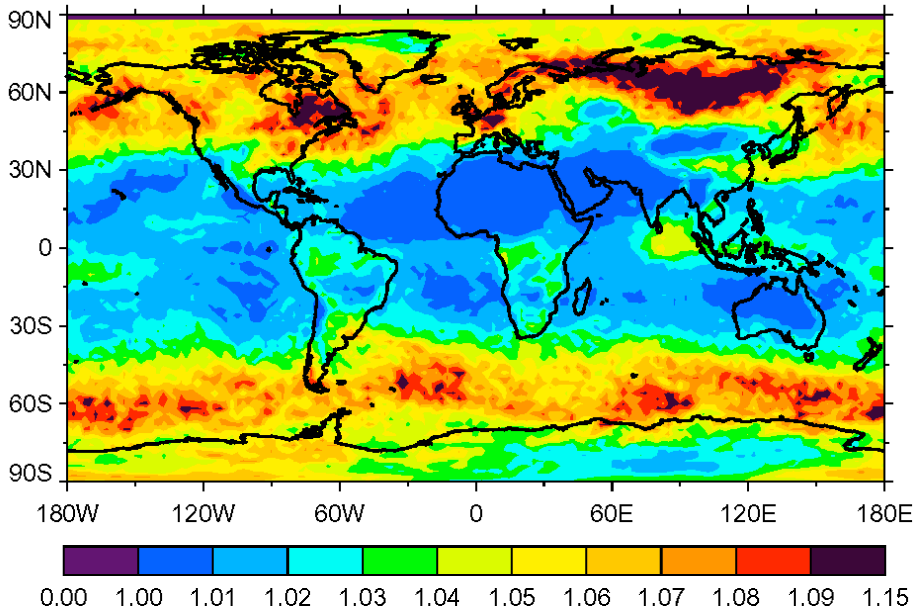
AOT(2x2.5_3hr) vs AOT(2x2.5_6hr)

- High difference occurs over middle latitudes

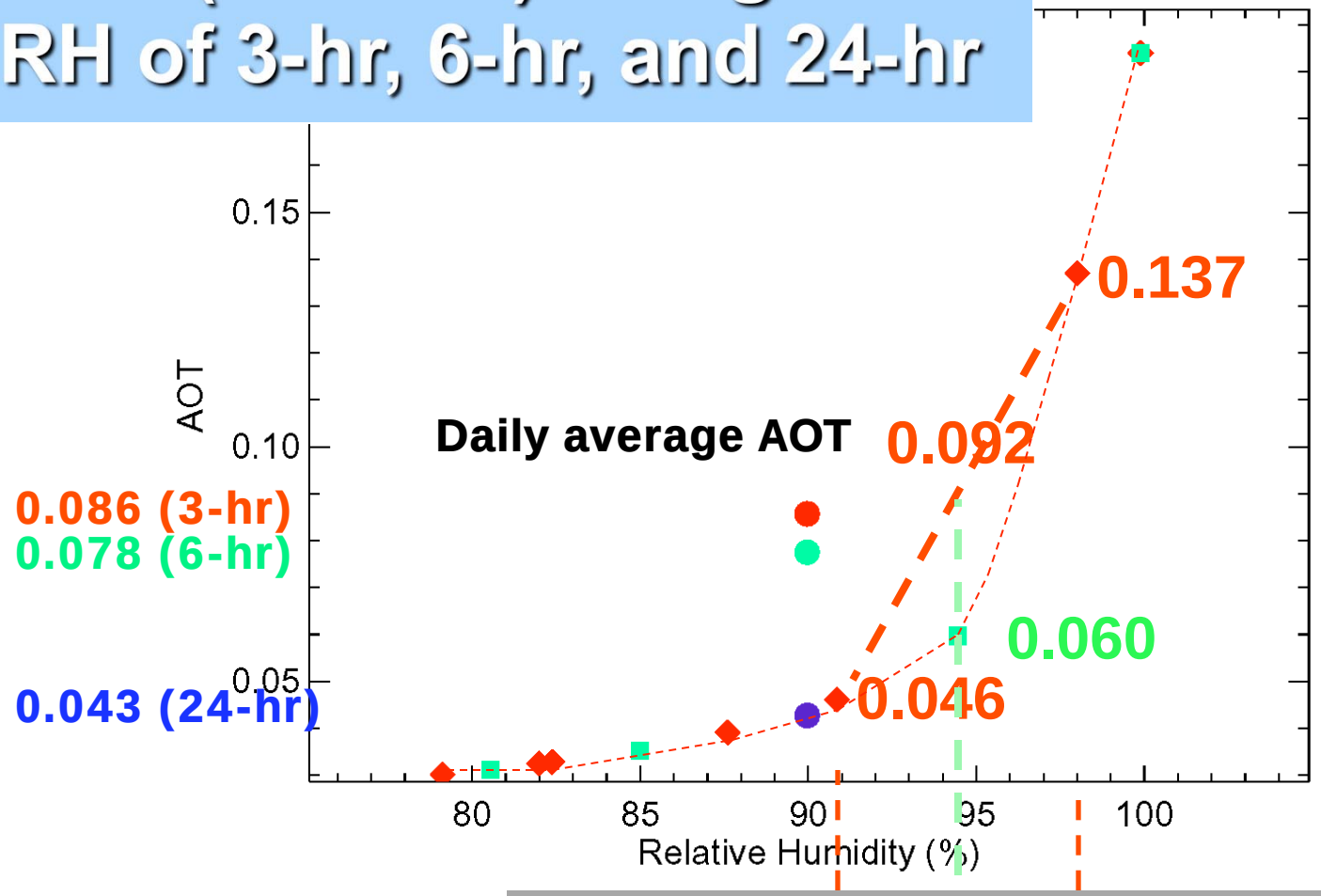
Absolute Difference



Relative Difference



AOT (sea salt) using mean RH of 3-hr, 6-hr, and 24-hr

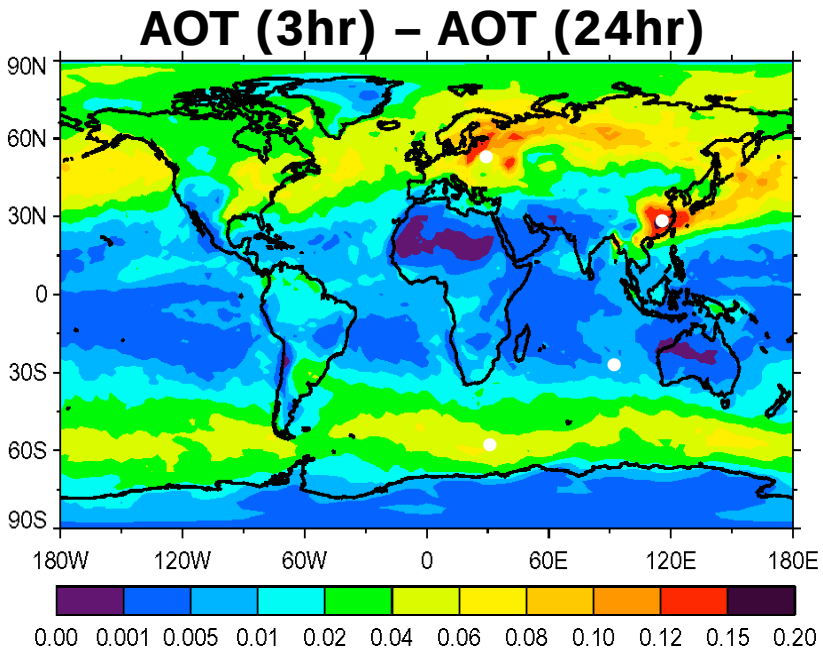


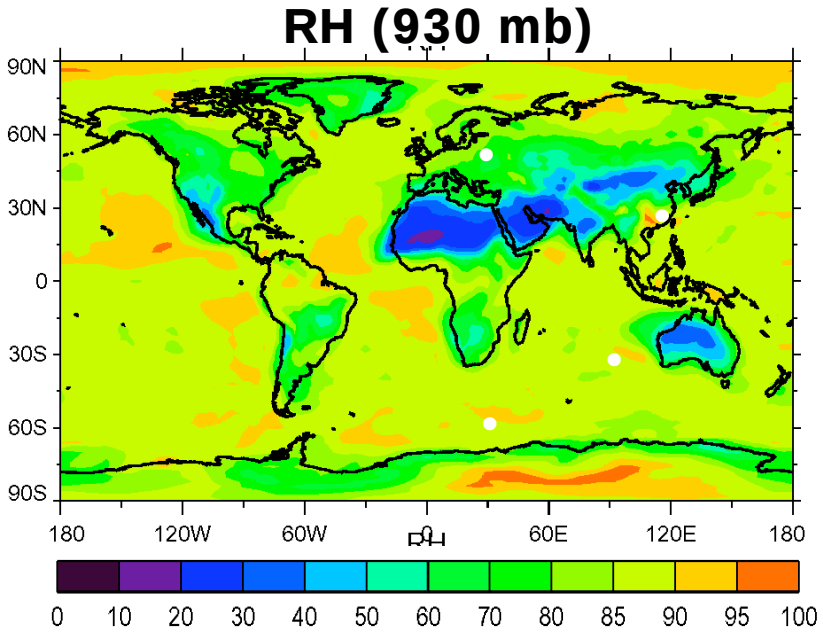
Calculate AOT first and then average > average RH first and then calculate AOT

April 1, 2001

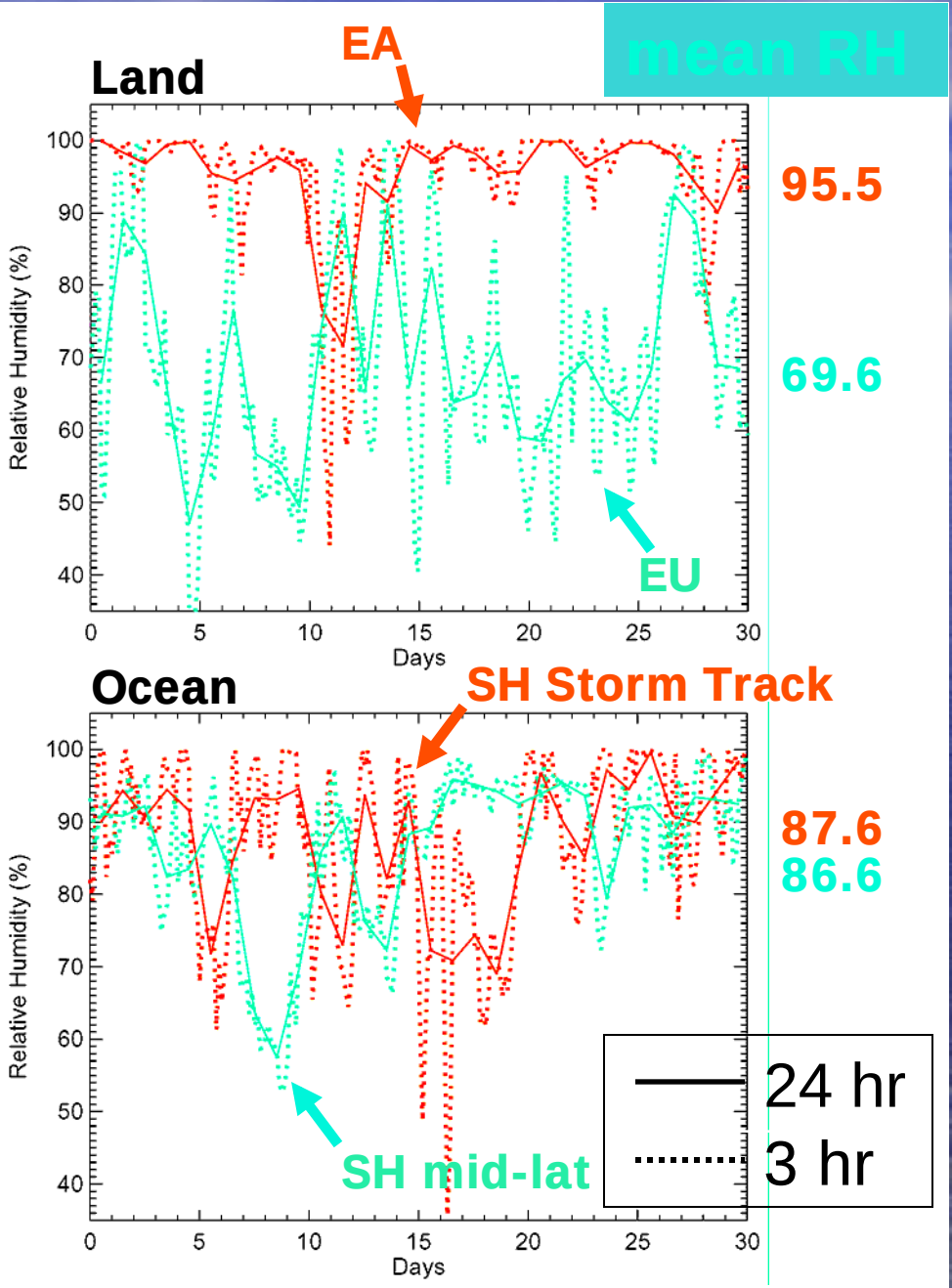
at 30E, 60S

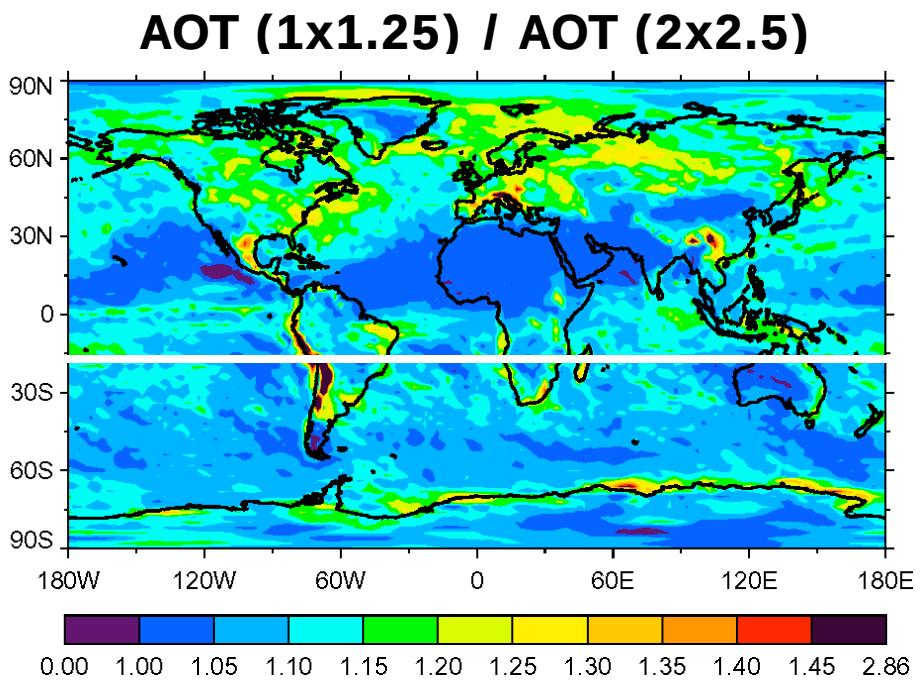
April 2001



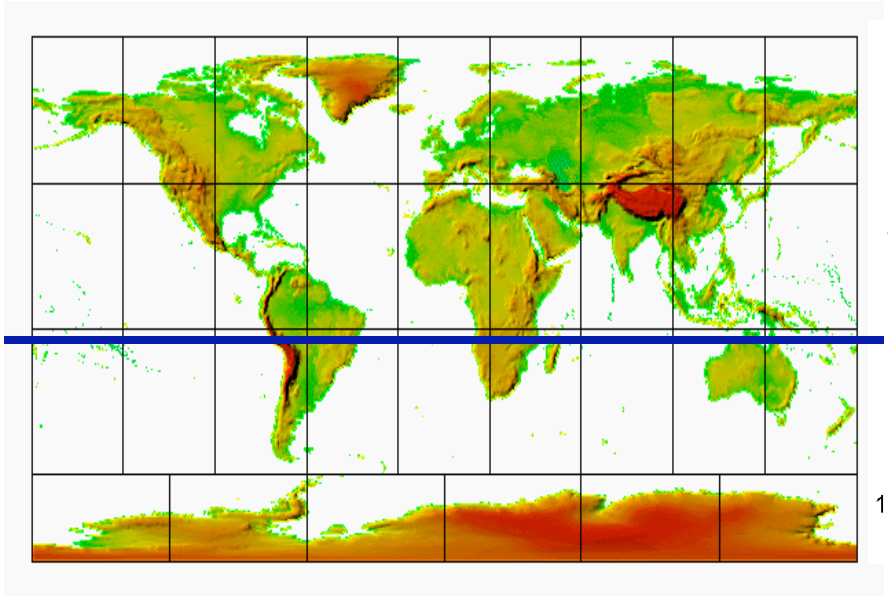


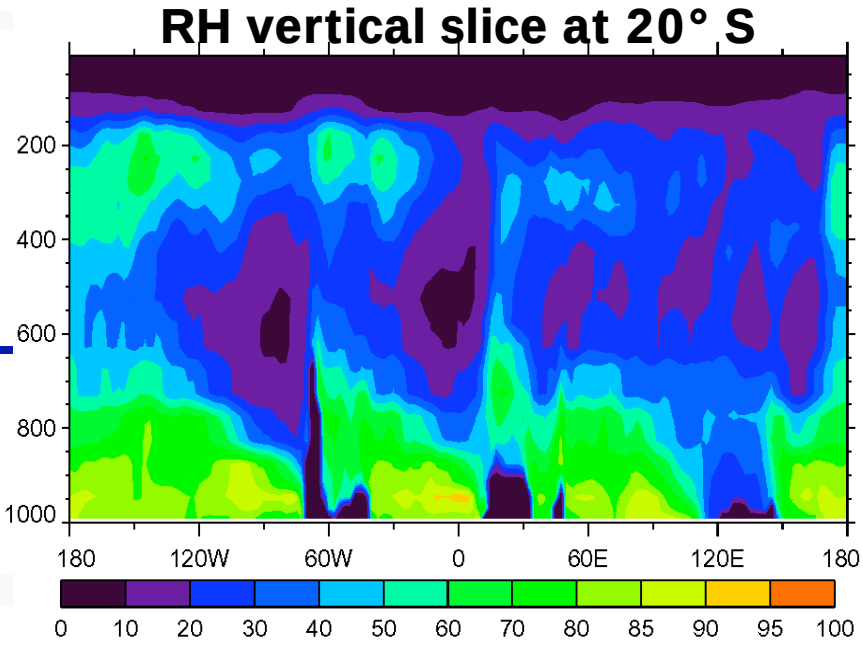
mean RH





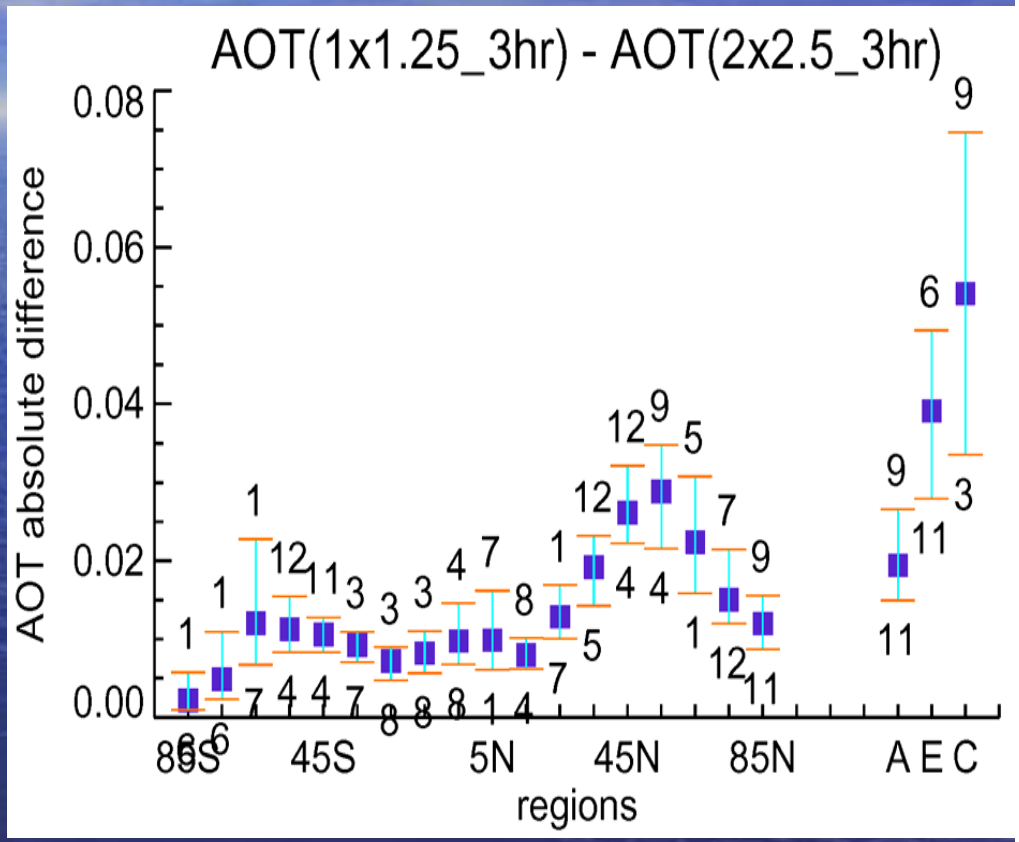
Look at Mountain Andes and Southern Africa !!!





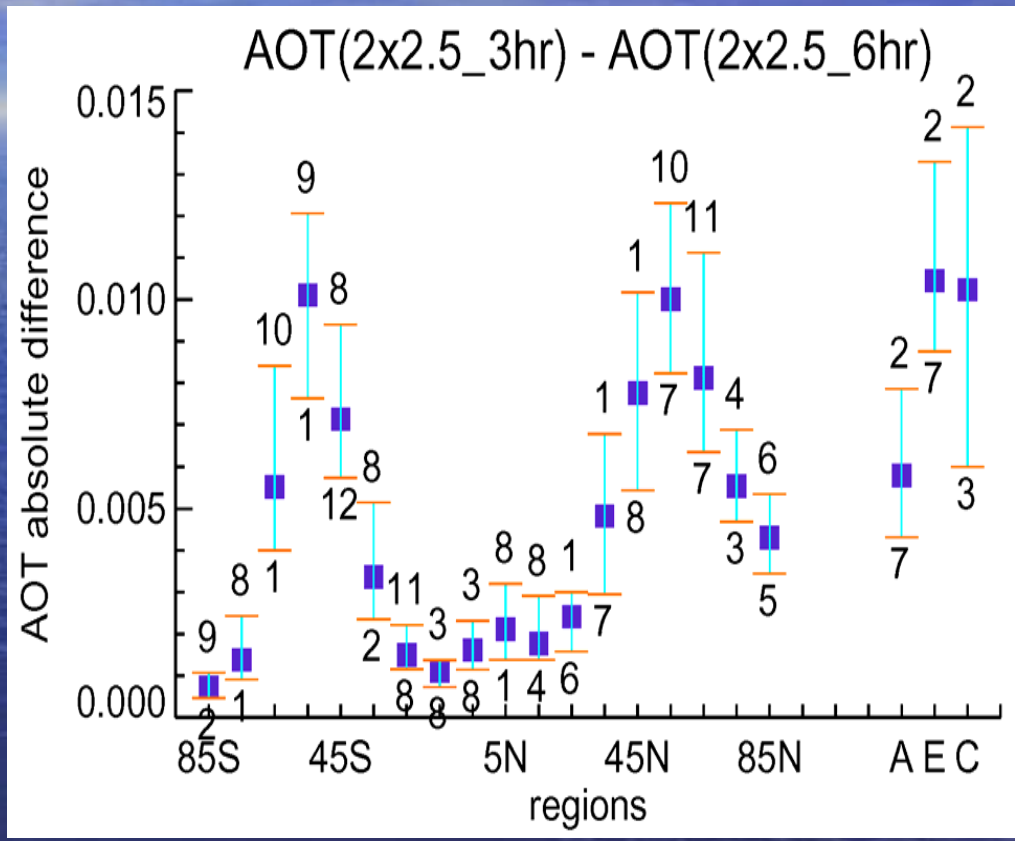
Where and When is the AOT most sensitive to changes in RH?

- Middle Northern Hemisphere
- No apparent time pattern



Where and When

- Middle Northern and Southern Hemisphere
- Southern Hemisphere: Aug - Oct
- Northern Hemisphere: Oct - Apr



Relative change in TOA direct radiative effect (DRE) due to RH at 1x1.25 vs 2x2.5 resolution

Ocean global DRE: MODIS/GOCART/GMI(2x2.5)/GMI(1x1.25)
(Wm^{-2}) -5.9 / -4.1 / -4.8 / -5.3

Land global DRE: MO_MI_GO/GOCART/GMI(2x2.5)/GMI(1x1.25)
(Wm^{-2}) -4.4 / -4.1 / -4.0 / -4.5

Yu et al., 2006 (ACP)

Relative change in TOA direct radiative effect (DRE) due to RH averaged over 3-hr vs 6-hr

Ocean	6	5	2	6
Land	6	6	3	4
	2	1	1	2
	3	1	1	3
	2	2	1	2
		2	1	1
		6	Global mean	3
		5		3

Ocean global DRE: MODIS/GOCART/GMI(3hr)/GMI(6hr)
(Wm^{-2}) -5.9 / -4.1 / -4.8 / -4.7

Land global DRE: MO_MI_GO/GOCART/GMI(3hr)/GMI(6hr)
(Wm^{-2}) -4.4 / -4.1 / -4.0 / -3.9

Yu et al., 2006 (ACP)

Conclusions

- Global AOT is increased by using RH at higher model spatial resolutions, as well as by using mean RH at shorter periods.

- There are two RH features (mean and variability) which influence the AOT change when resolution changes.

Conclusions

- Global AOT is 11% higher by using RH in spatial resolution 1 ° by 1.25 ° instead of 2° by 2.5 °. Accordingly, the TOA DRE increases by 10% and 14% over ocean and land respectively.

- The AOT is most sensitive to middle NH and surface escarpment regions when RH spatial resolution doubles. No apparent time pattern is found.

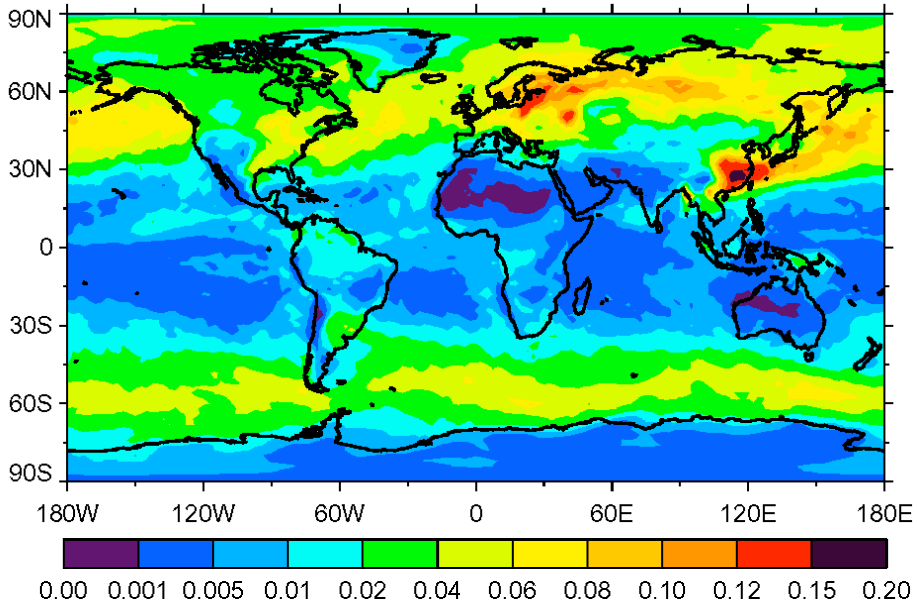
Conclusions

- 4% higher global AOT is derived from using mean RH over 3-hr period instead of 6-hr period and the corresponding TOA DRE is 3% higher globally.

- The AOT is most sensitive to middle latitudes of both hemispheres. The maximum AOT change occurs during August-October in the SH and October-April in the NH.

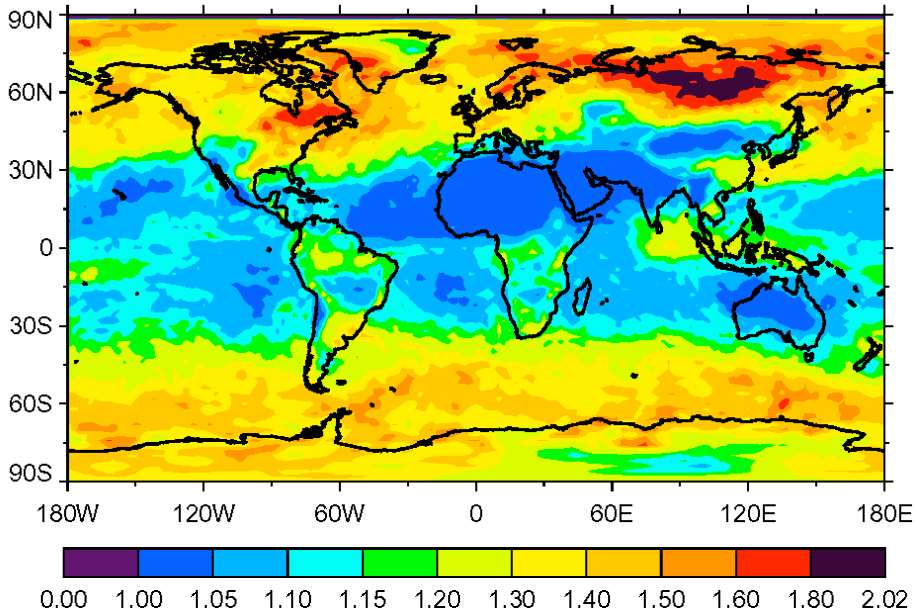
AOT(2x2.5_3hr) vs AOT(2x2.5_24hr)

Absolute Difference

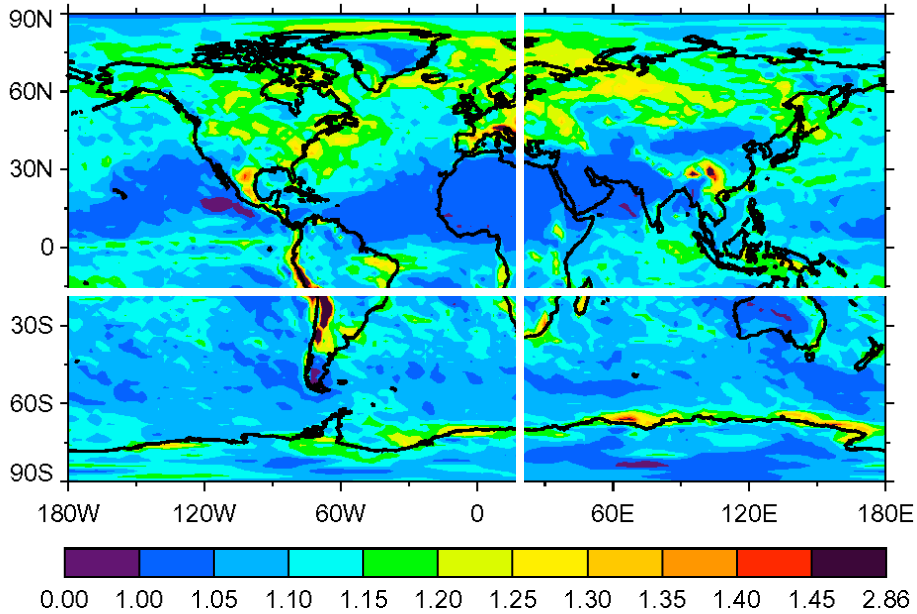


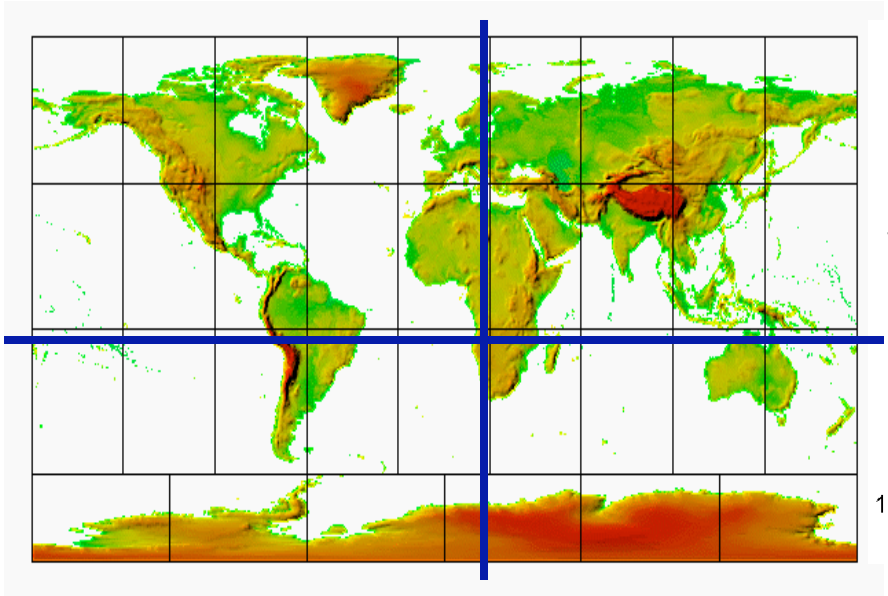
- High difference occurs over middle latitudes

Relative Difference

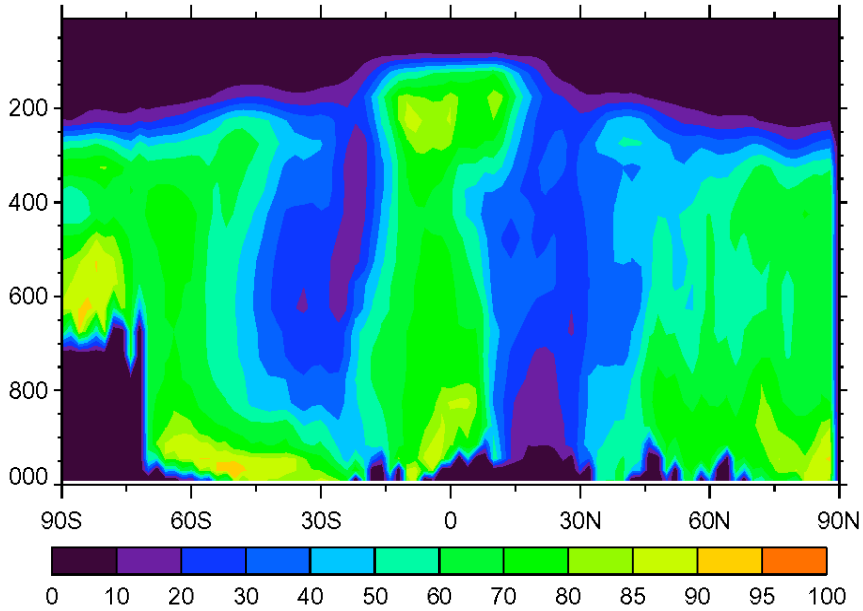


AOT (1x1.25) / AOT (2x2.5)





RH vertical slice at 15° E



RH vertical slice at 20° S