University of Colorado Boulder
LASP

Composition and physical properties of ATAL and NATAL

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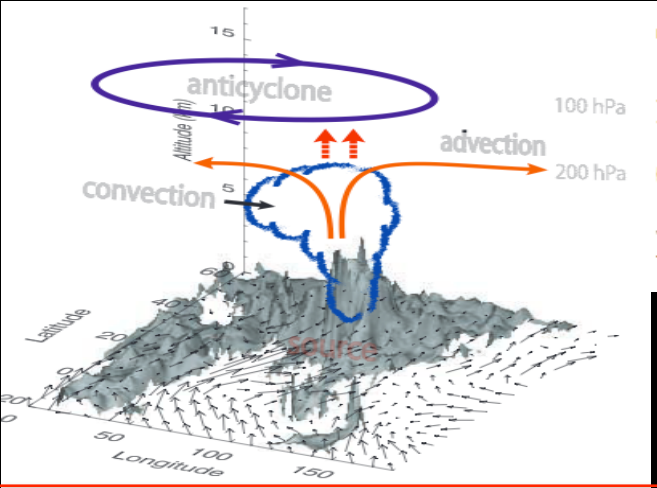
Brian Toon, Ryan Neely, Bengt Martinsson, Carl Brenninkmeijer

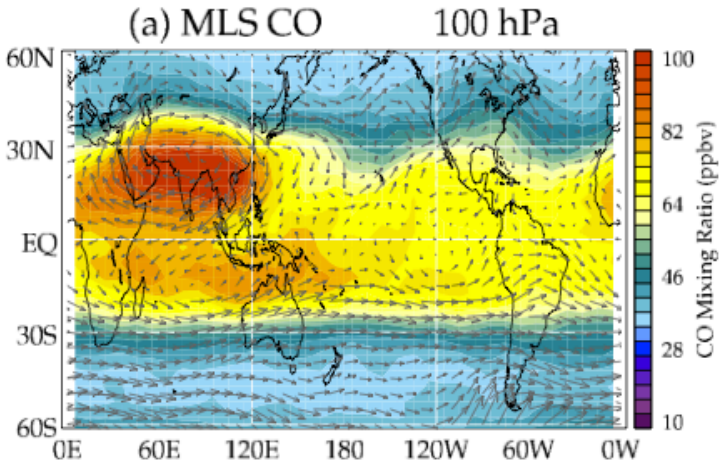
July.20.2015

Briefly review: previous studies show pathway from Trop to Stratosphere, i.e. Asian summer monsoon



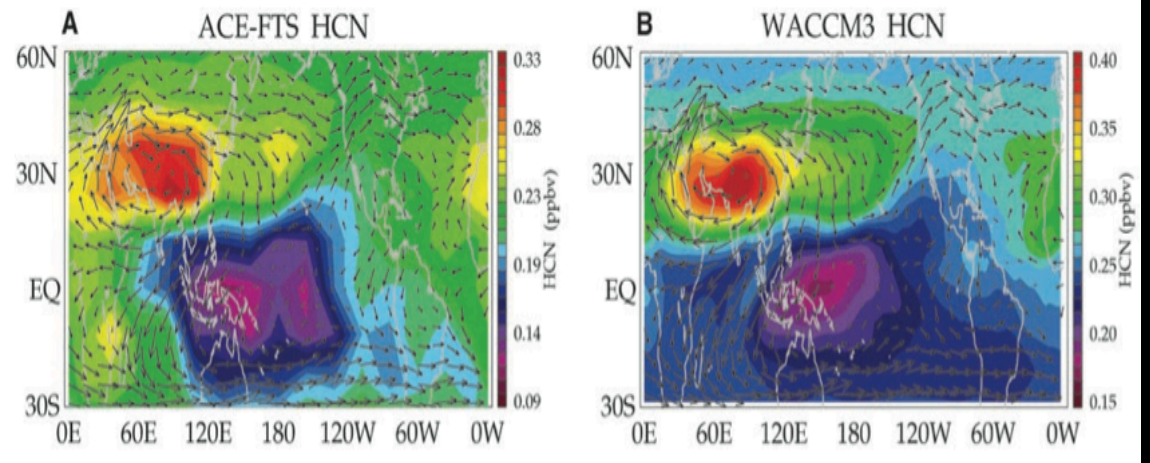
Transport pathways of carbon monoxide in the Asian summer monsoon diagnosed from Model of Ozone and Related Tracers (MOZART)

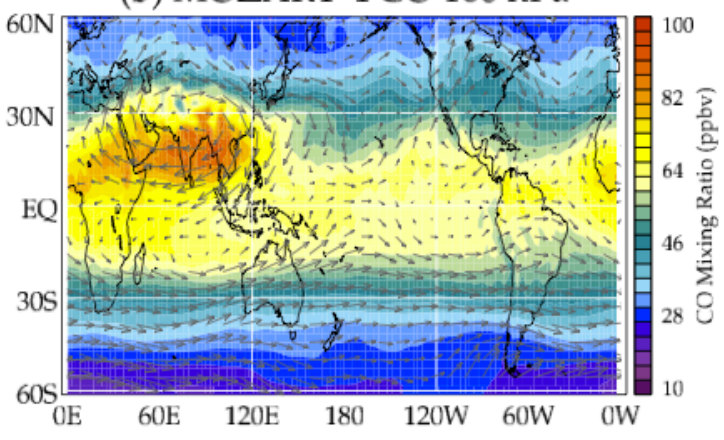
Mijeong Park,[1] William J. Randel,[1] Louisa K. Emmons,[1] and Nathaniel J. Livesey[2]



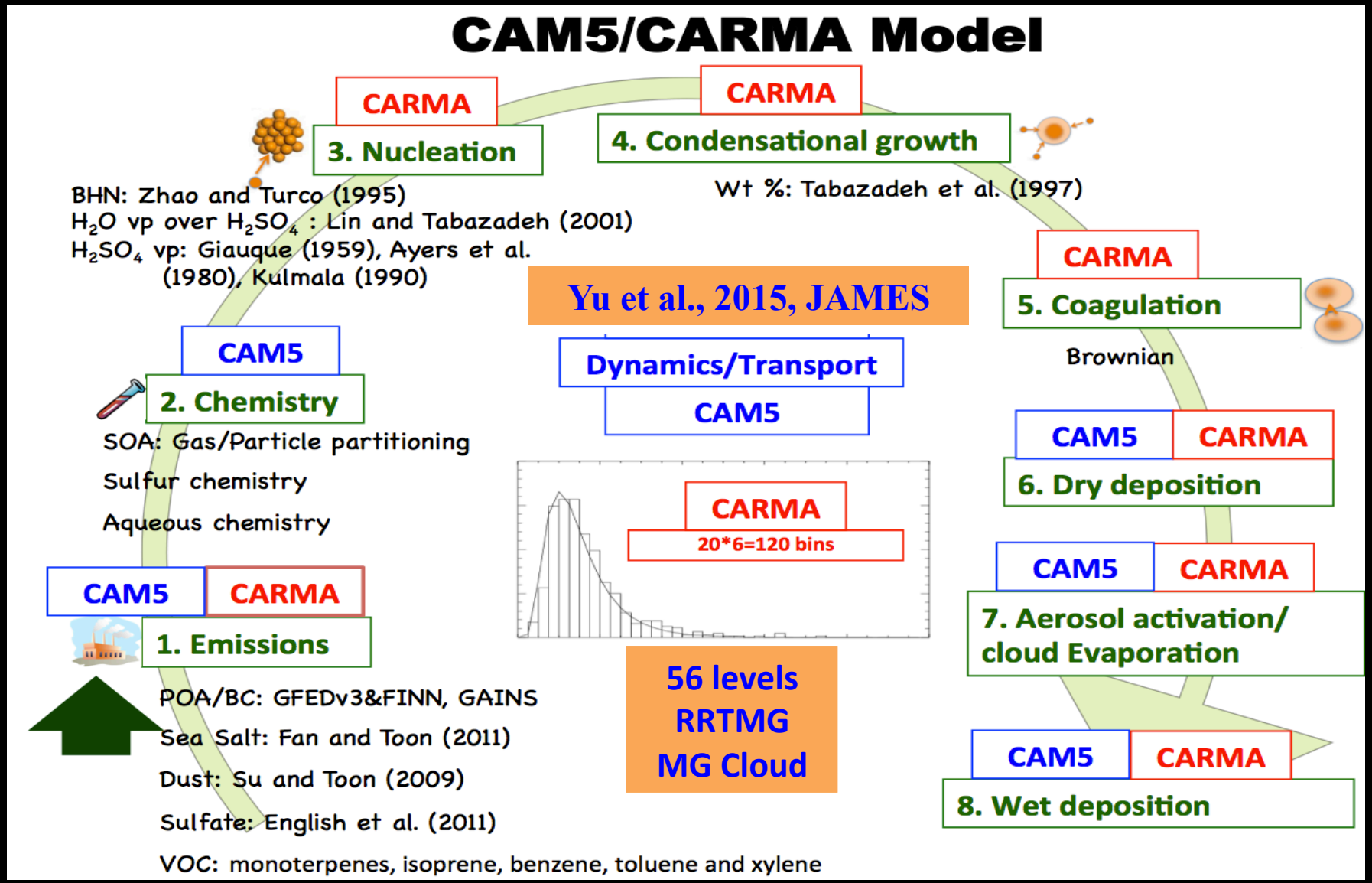
Asian Monsoon Transport of Pollution to the Stratosphere

William J. Randel,[1]* Mijeong Park,[1] Louisa Emmons,[1] Doug Kinnison,[1] Peter Bernath,[2,3] Kaley A. Walker,[4,3] Chris Boone,[3] Hugh Pumphrey[5]



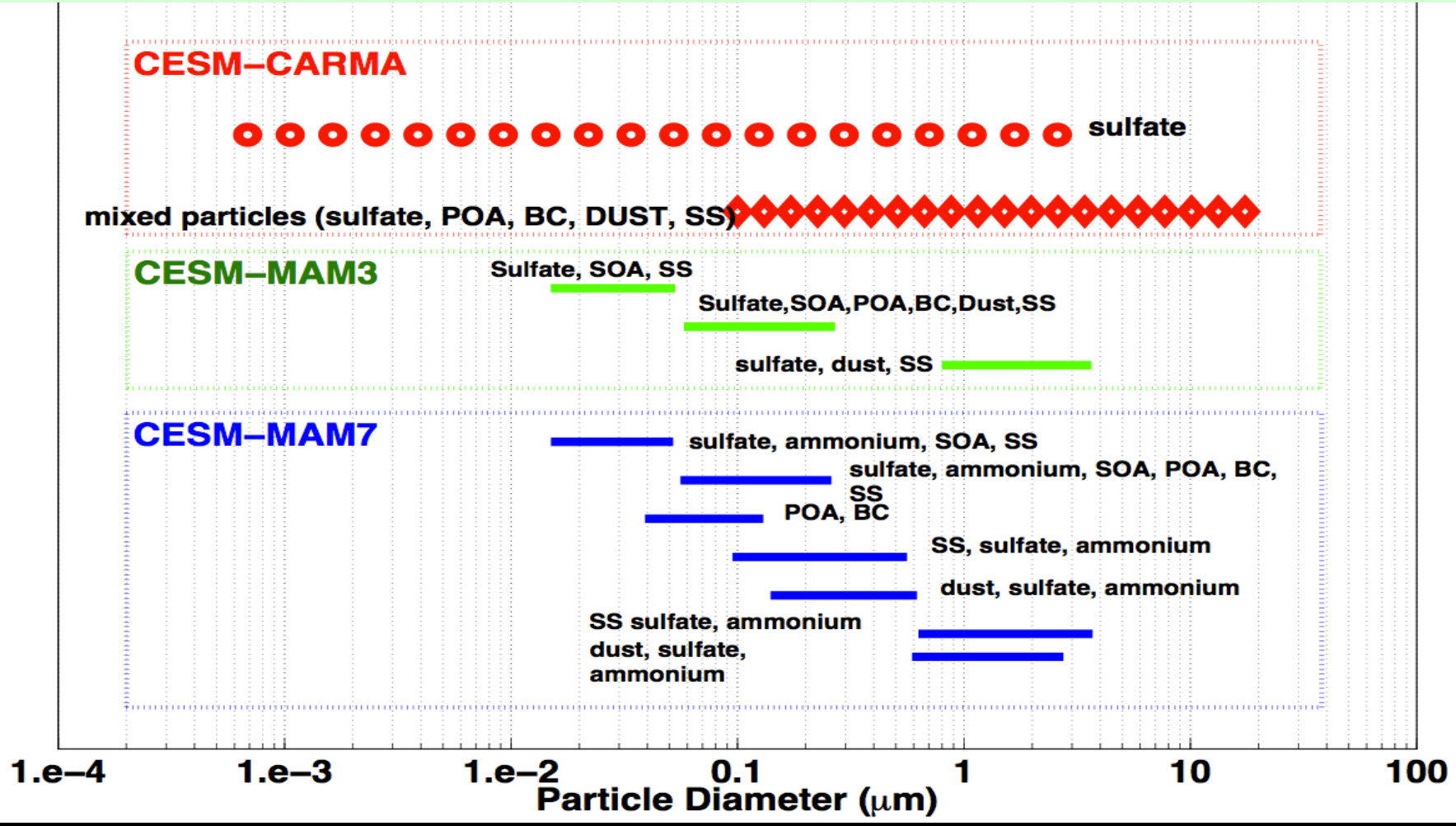


We are using a sectional aerosol model

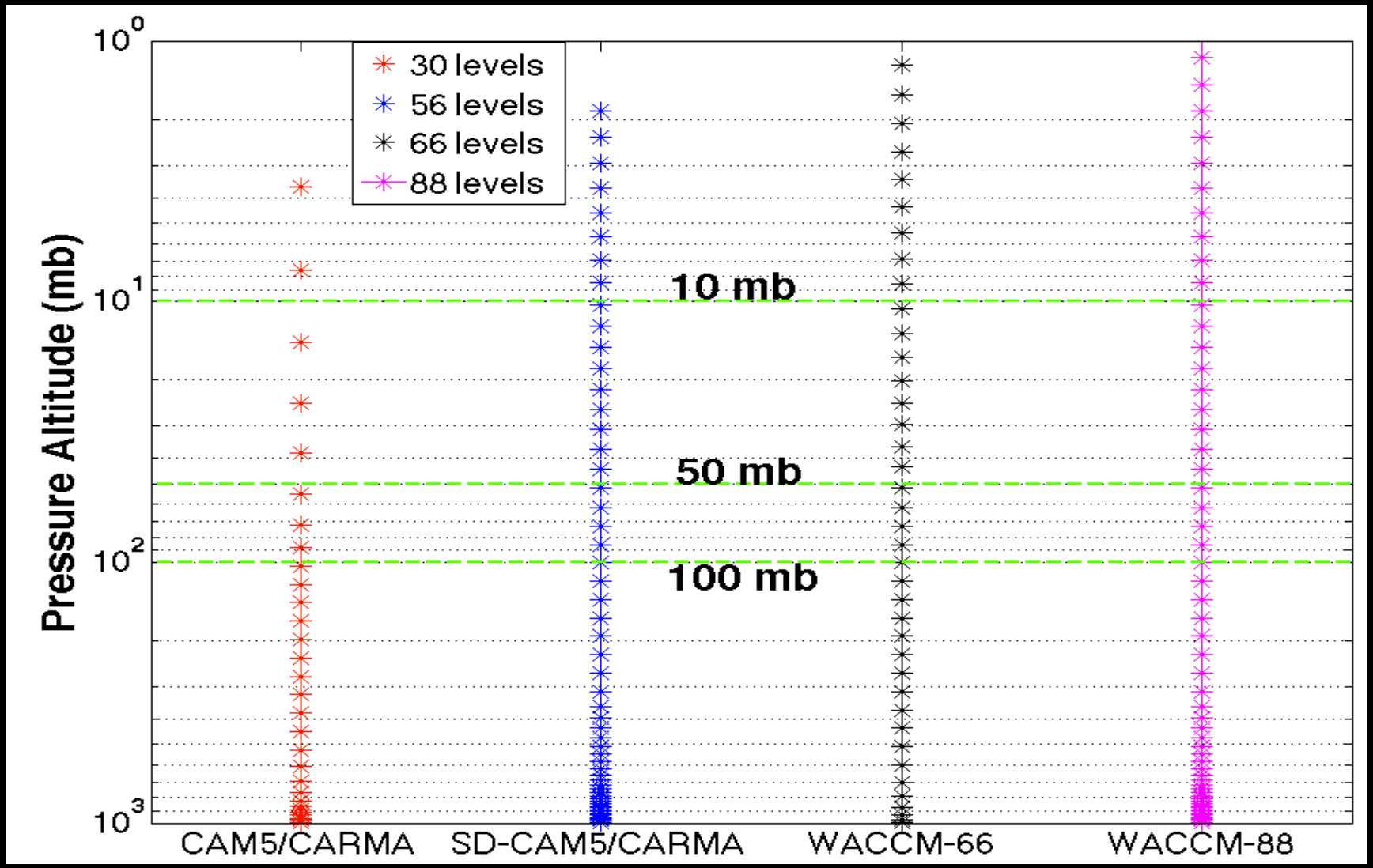


CARMA has broader size distribution compared with modal aerosol schemes

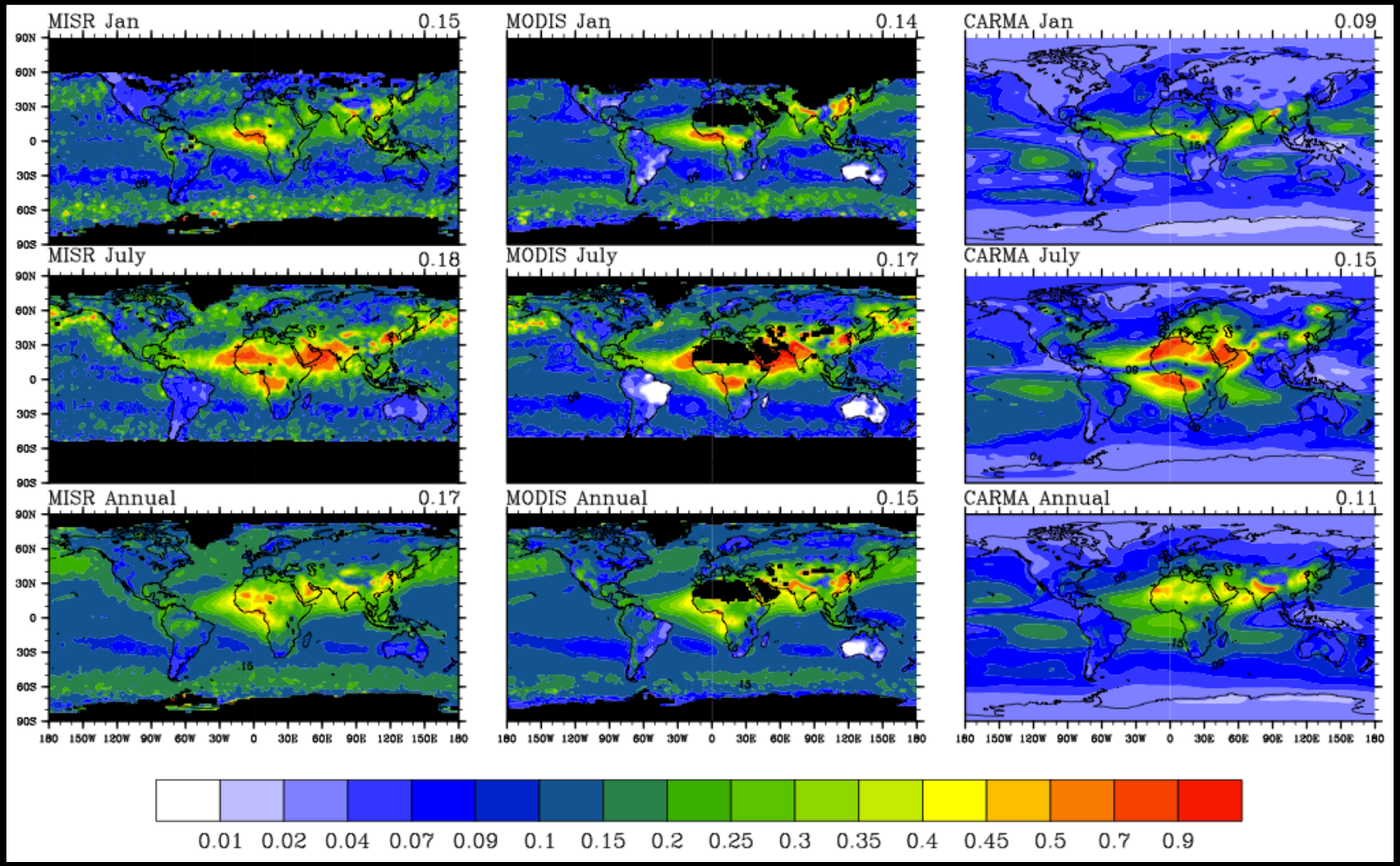
POA includes biomass burning organics, anthropogenic organics, marine organics and biological particles.



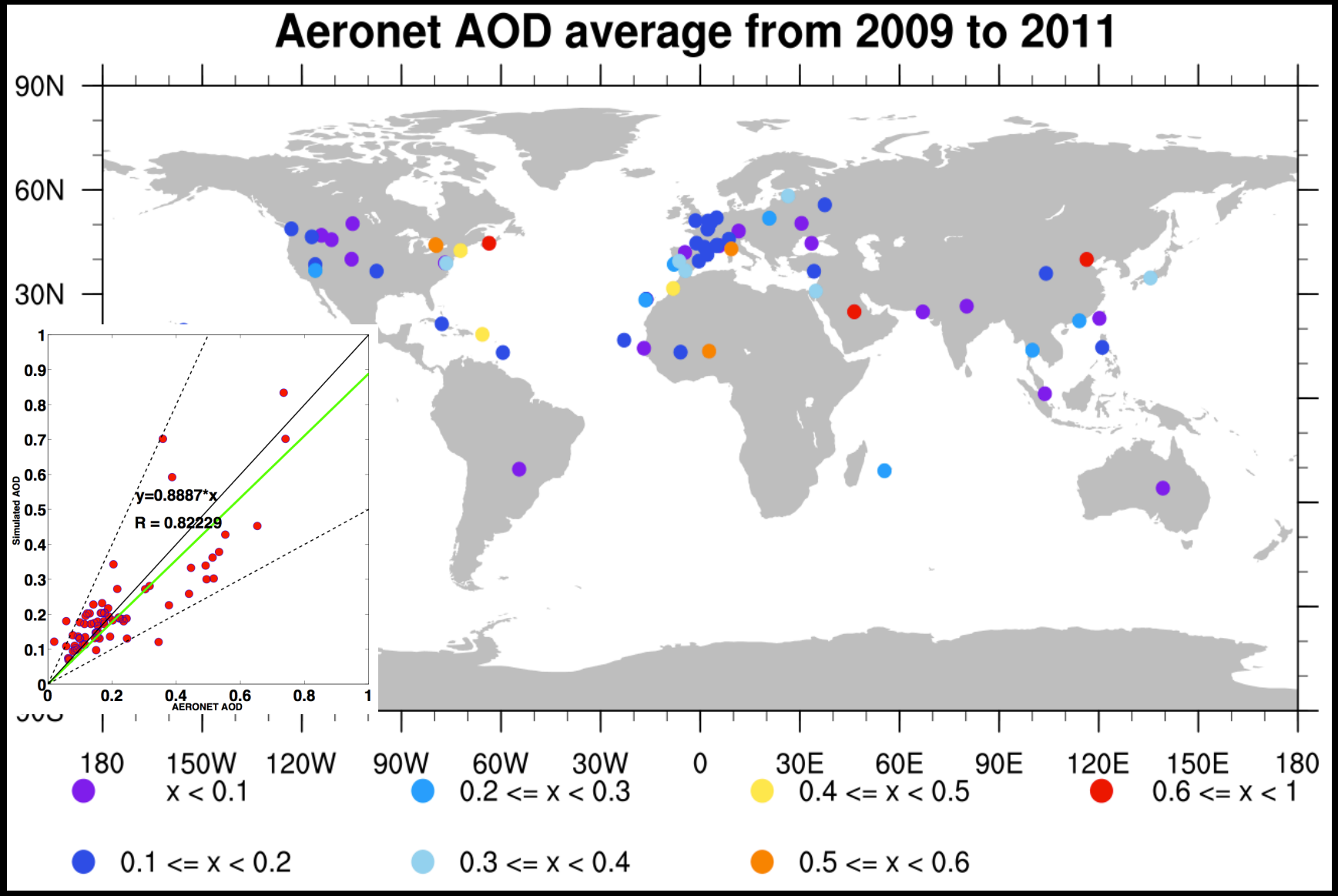
56-level CAM5/CARMA has similar vertical resolution around UTLS compared with WACCM



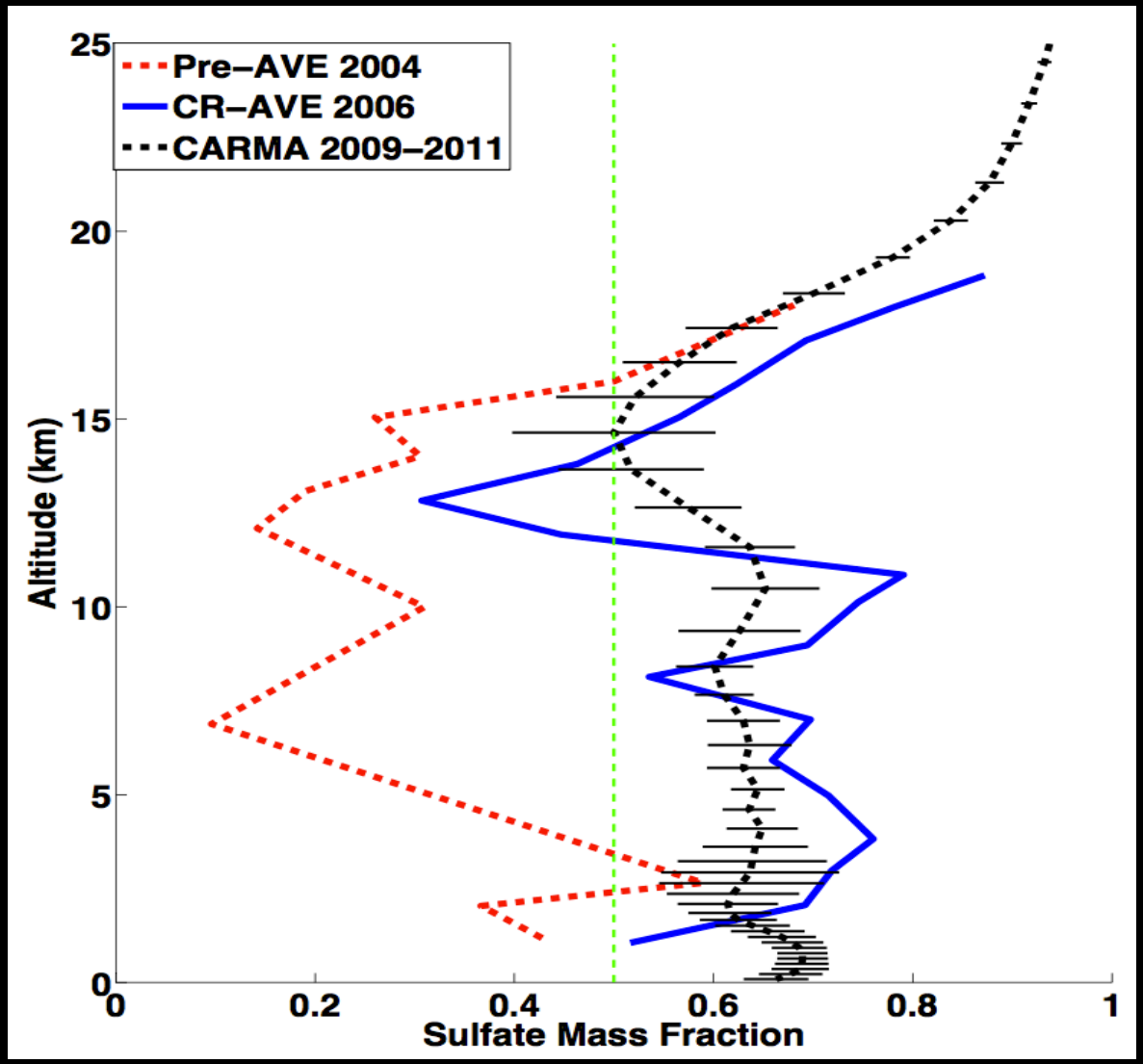
CARMA captures Global AOD distribution, while underestimates AOD over ocean

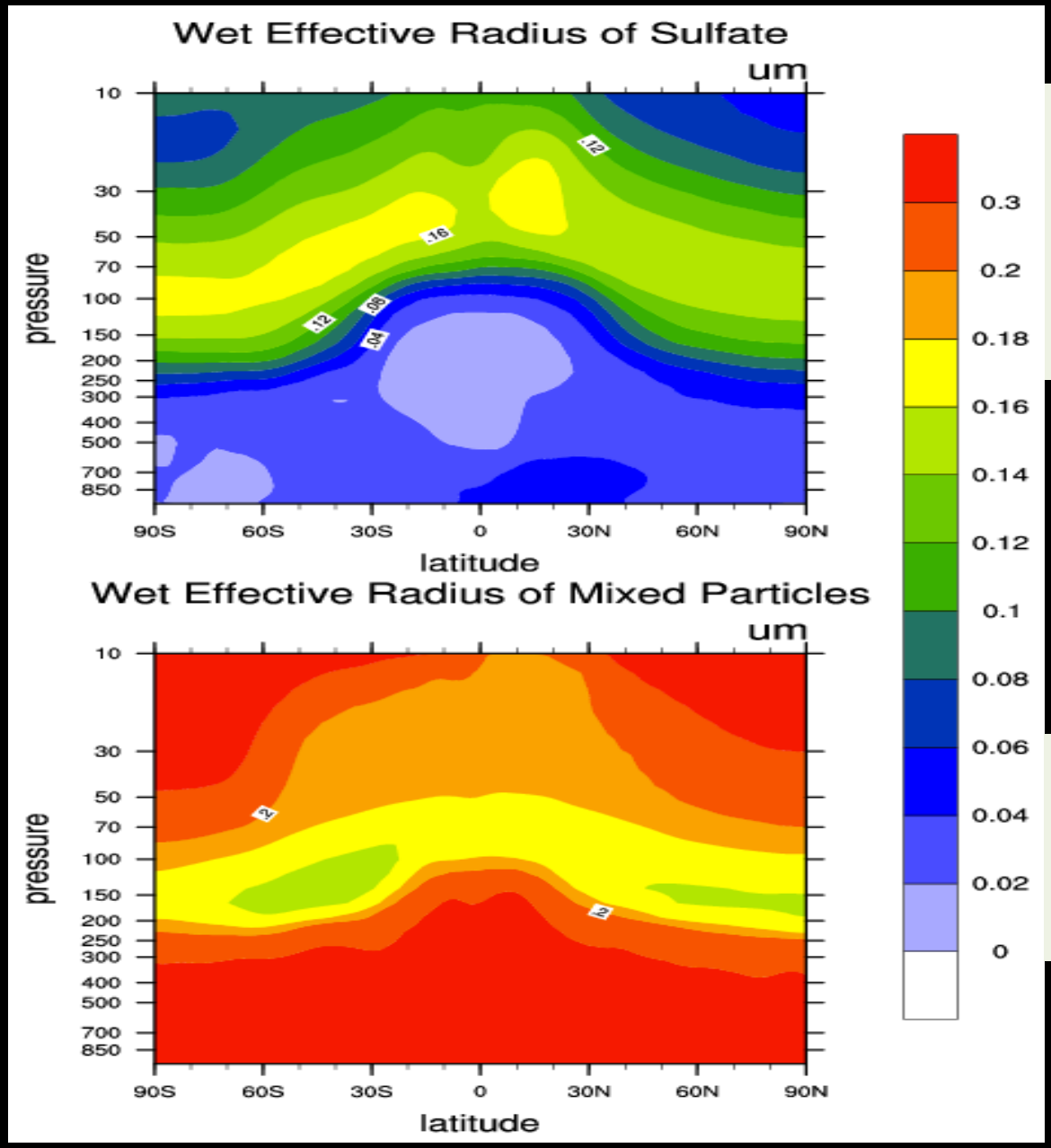


Model captures 89% of AeroNet AOD on average



OC is about equal to sulfate mass at TTL, as simulated and observed



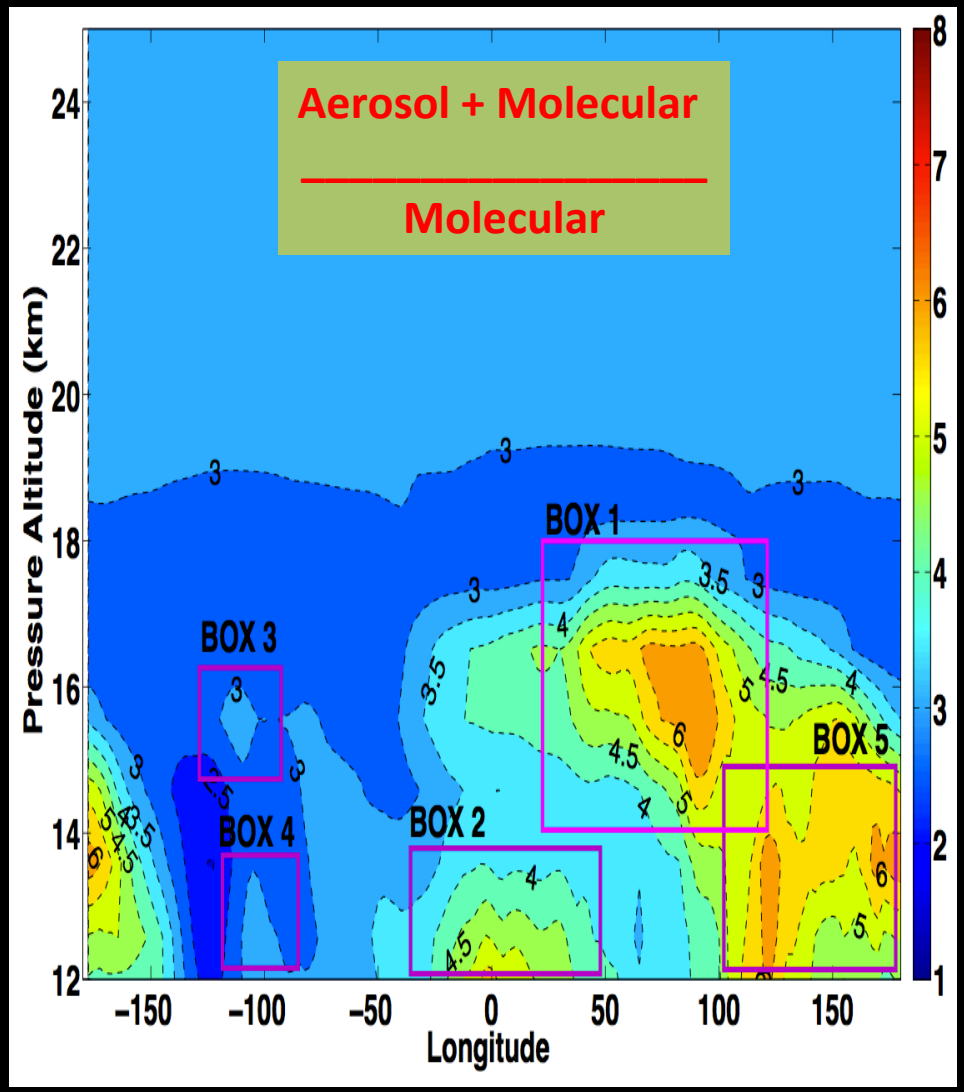


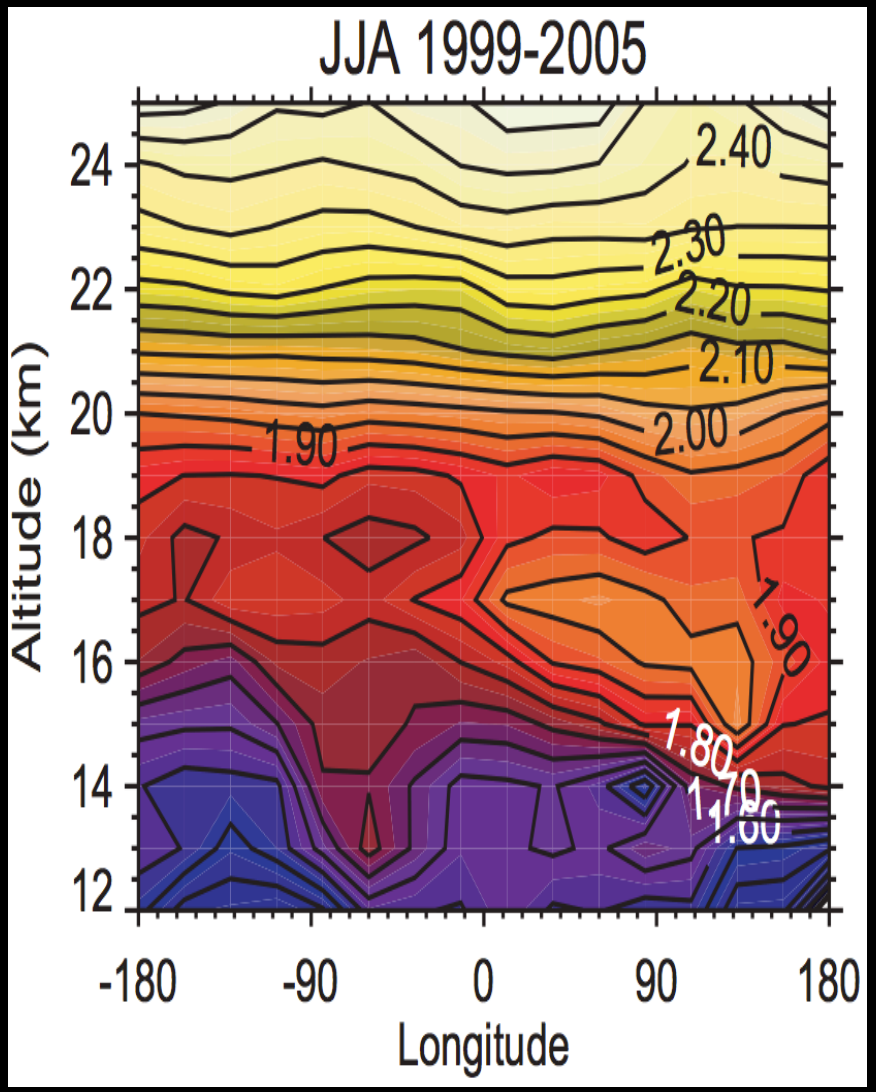
Sulfate effective radius is between 0.1 to 0.18 um in stratosphere

Mixed particles effective radius at UTLS is 0.16 um

Simulated Extinction Ratio is larger than observation by a factor of 2-3

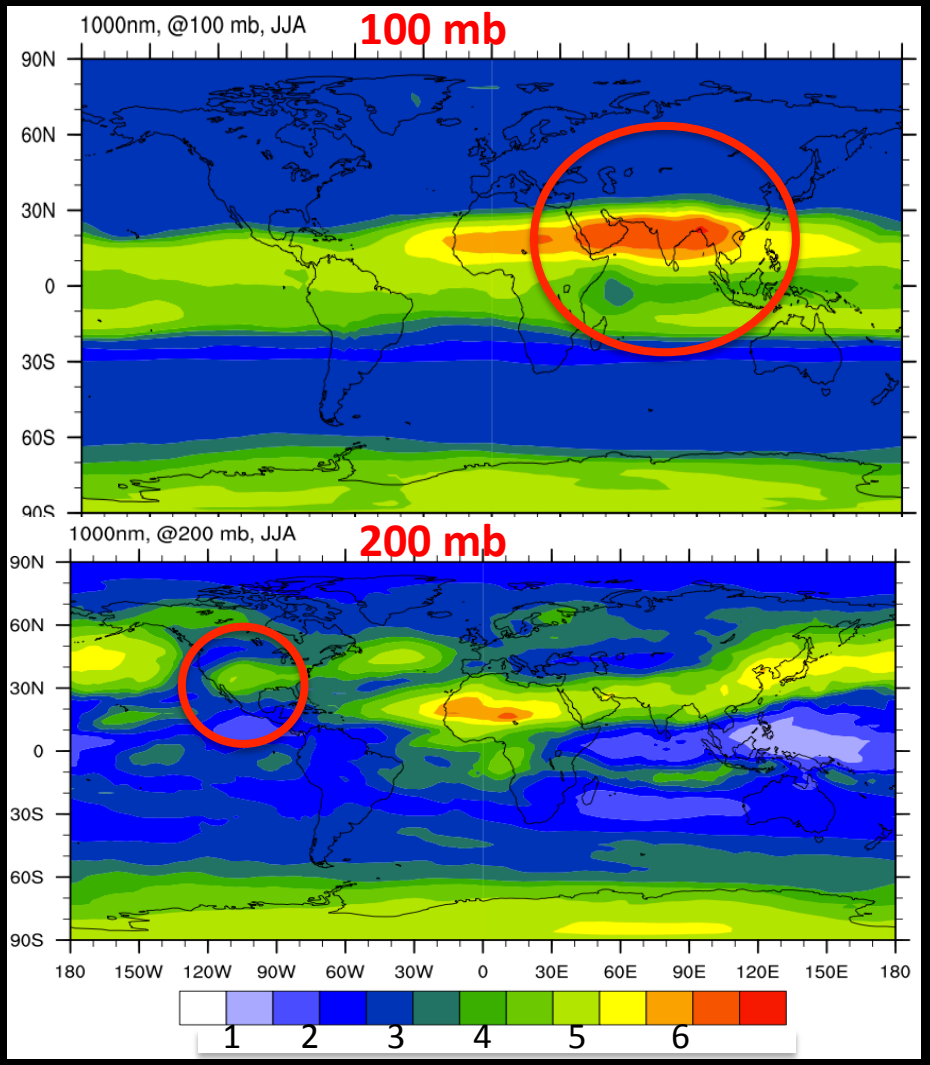
Vernier et al.. 2013, ACP

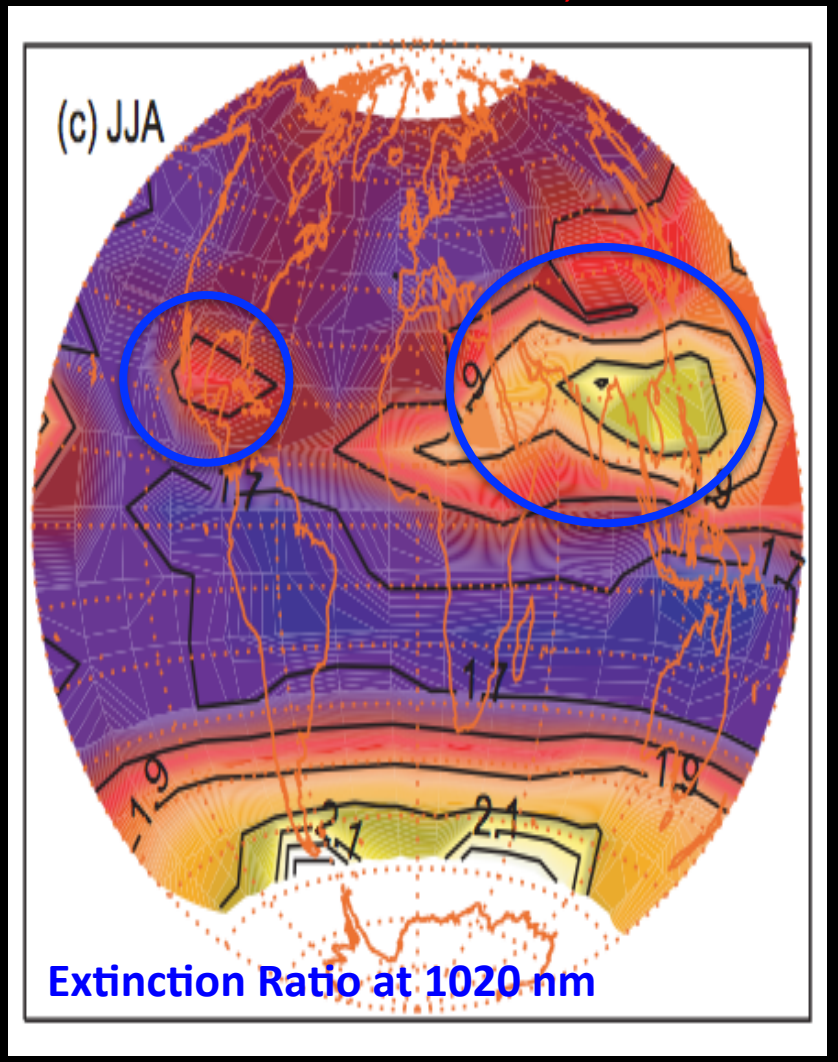




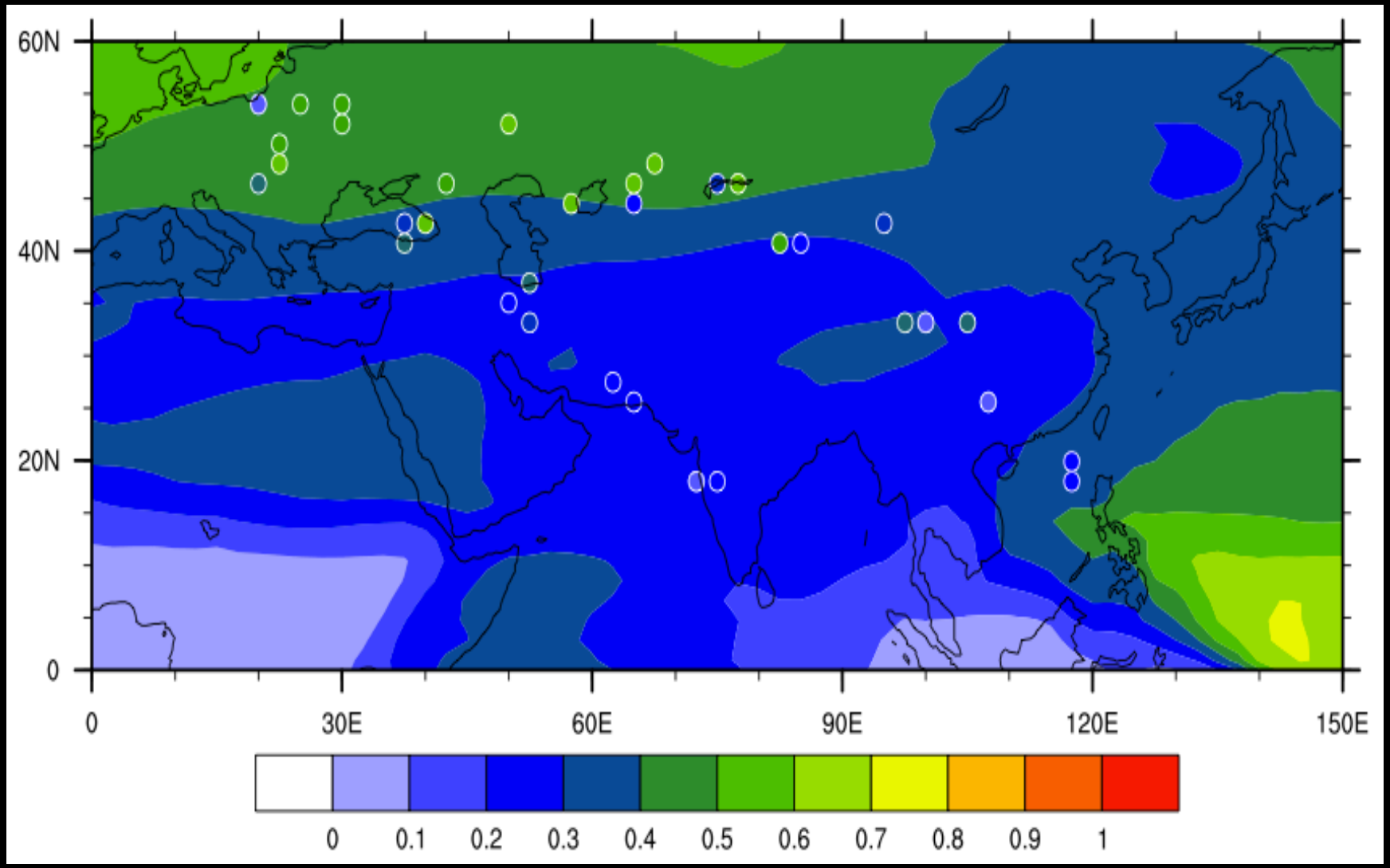
CARMA extinction ratio has maximum in ATAL and NATAL

Vernier et al.. 2013, ACP

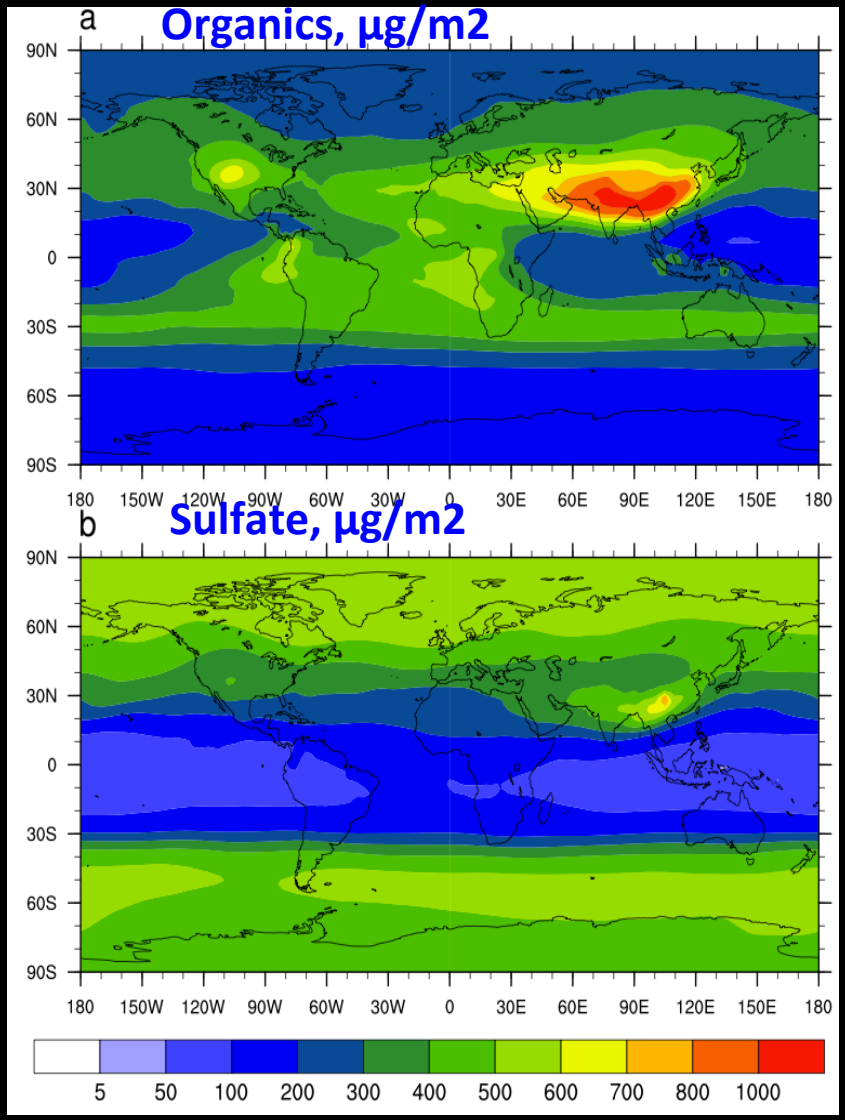


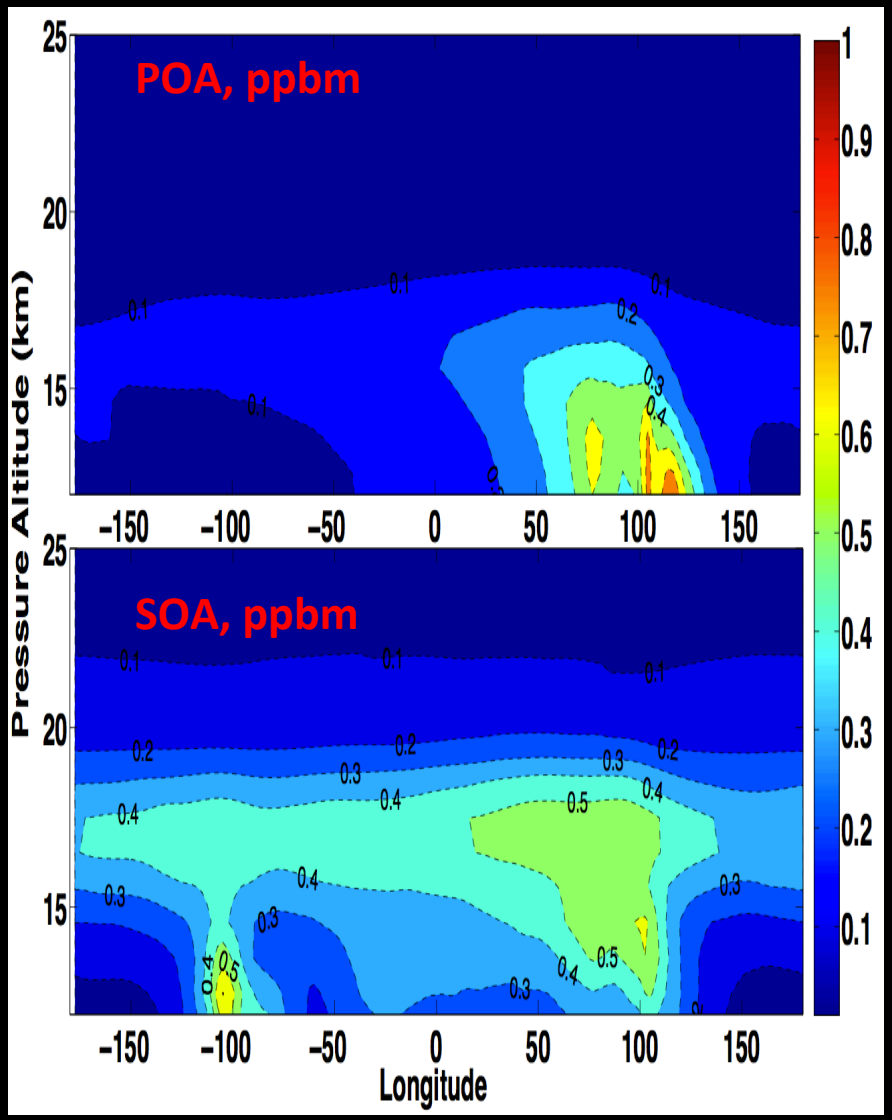


High latitude gradient of Organics/Sulfate mass ratio is simulated and observed

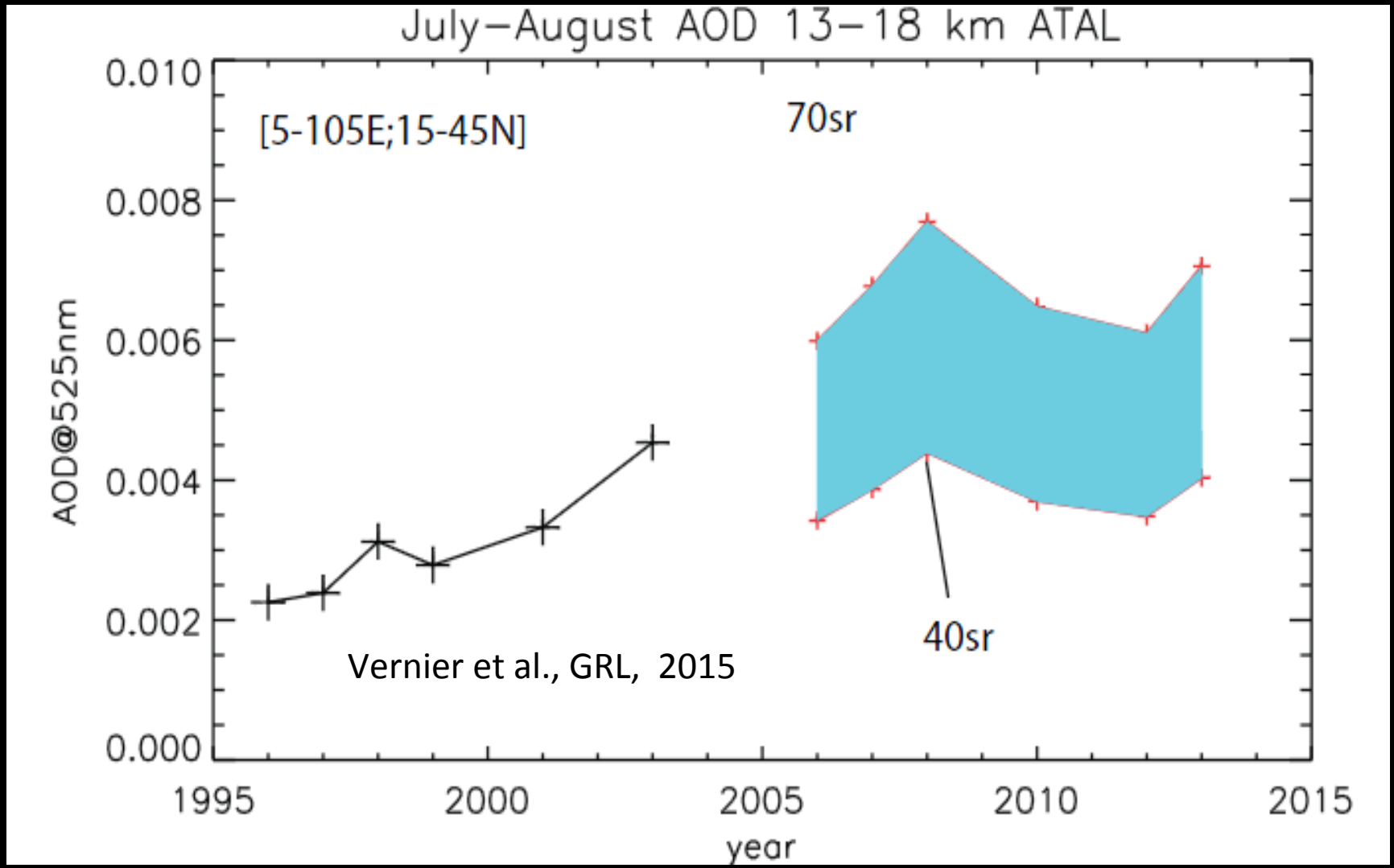


ATAL is POA and sulfate; NATAL is mostly SOA and sulfate



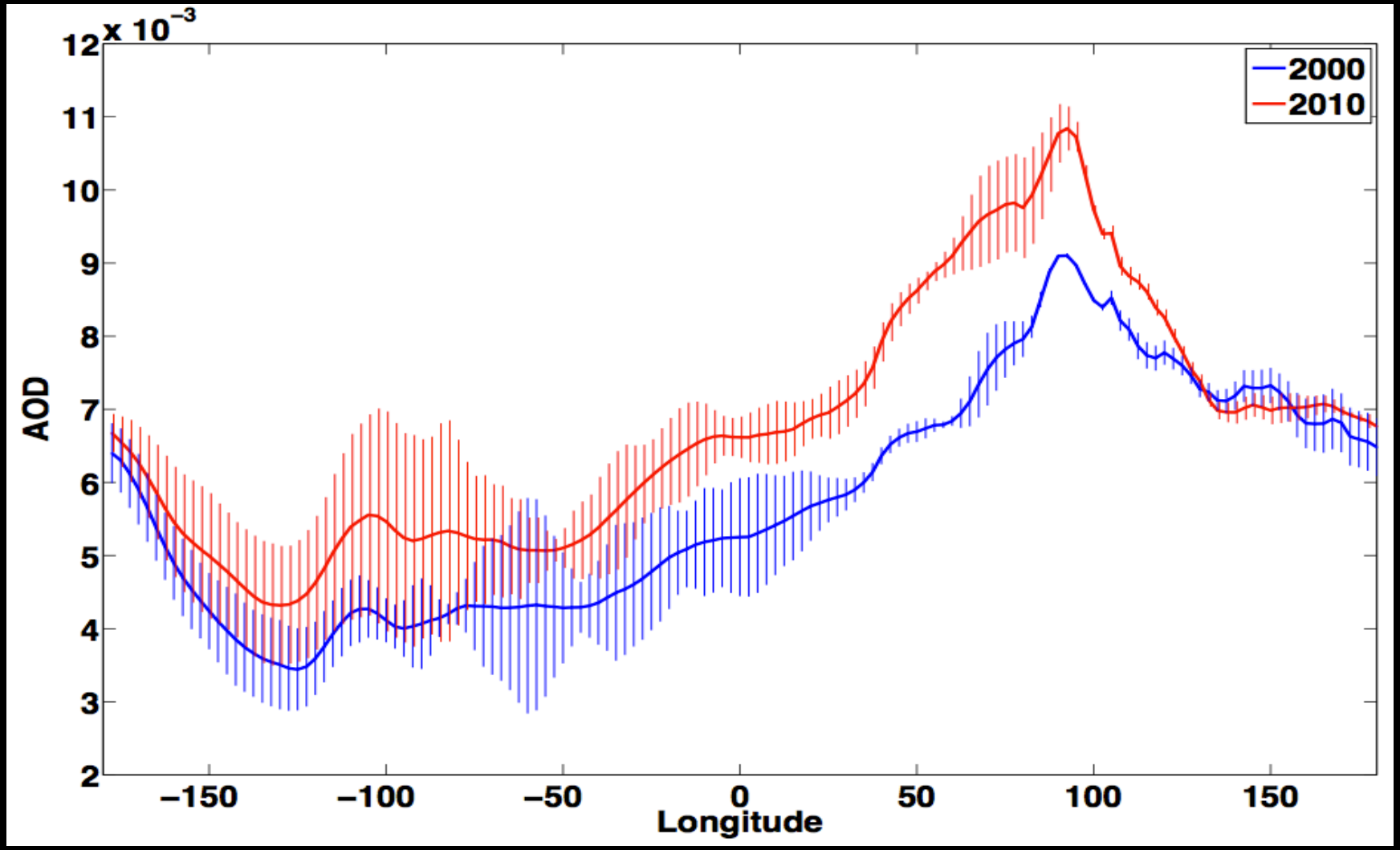


Observations suggest optical depth of ATAL increased in last decade



Vernier et al., GRL, 2015

Optical depth changed from 2000-2010 due to changing emissions of sulfate and organics



Summary

- CARMA is a sectional aerosol model and documented in Yu et al. [2015, *JAMES*]
- At UTLS, organics is about equal to sulfate mass;
- At UTLS, aerosol effective radius is 0.1-0.2 μm;
- ATAL and NATAL is simulated in CARMA;
- The intensity of ATAL is overestimated by a factor of three;
- ATAL is mainly composed of sulfate, SOA and POA;
- NATAL is mainly composed of sulfate and SOA;
- Asian anthropogenic emission may explain observed intensity trend of ATAL;

AGU PUBLICATIONS

Yu et al., 2015a, JAMES

Journal of Advances in Modeling Earth Systems

RESEARCH ARTICLE

10.1002/2014MS000421

Key Points:
- A sectional aerosol model has been developed and coupled with the community earth system model
- Model performance is evaluated by comparing simulations with multiple data sets

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Evaluations of tropospheric aerosol properties simulated by the community earth system model with a sectional aerosol microphysics scheme

CARMA

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[1]Department of Atmospheric and Oceanic Sciences, University of Colorado, Boulder, Colorado, USA, [2]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, Colorado, USA, [3]National Center for Atmospheric Research, Boulder, Colorado, USA, [4]Now at College of Global Change and Earth System Science, Beijing Normal University, Beijing, China, [5]National Centre for Atmospheric Science and Institute of Climate and Atmospheric Science, School of the Earth and Environment, University of Leeds, Leeds, UK

AGU PUBLICATIONS

Yu et al., 2015b, GRL

Geophysical Research Letters

RESEARCH LETTER

10.1002/2015GL063181

Key Points:
- The Asian Tropopause Aerosol Layer is composed of sulfate, primary organics, and secondary organics
- The North American Tropospheric Aerosol Layer is mostly composed of sulfate and secondary organics
- Aerosol Optical Depth of Asian Tropopause Aerosol Layer increases by 0.002 from 2000 to 2010

Composition and physical properties of the Asian Tropopause Aerosol Layer and the North American Tropospheric Aerosol Layer

ATAL

Pengfei Yu[1,2], Owen B. Toon[1,2], Ryan R. Neely[3,4,5], Bengt G. Martinsson[6], and Carl A. M. Brenninkmeijer[7]

[1]Department of Atmospheric and Oceanic Sciences, University of Colorado Boulder, Boulder, Colorado, USA, [2]Laboratory for Atmospheric and Space Physics, University of Colorado Boulder, Boulder, Colorado, USA, [3]National Centre for Atmospheric Science and the Institute of Climate and Atmospheric Science, University of Leeds, Leeds, UK, [4]Atmospheric Chemistry Division, National Center for Atmospheric Research, Boulder, Colorado, USA, [5]CIRES, University of Colorado Boulder, Boulder, Colorado, USA, [6]Division of Nuclear Physics, Lund University, Lund, Sweden, [7]Air Chemistry Division, Max Planck Institute for Chemistry (Otto Hahn Institute), Mainz, Germany

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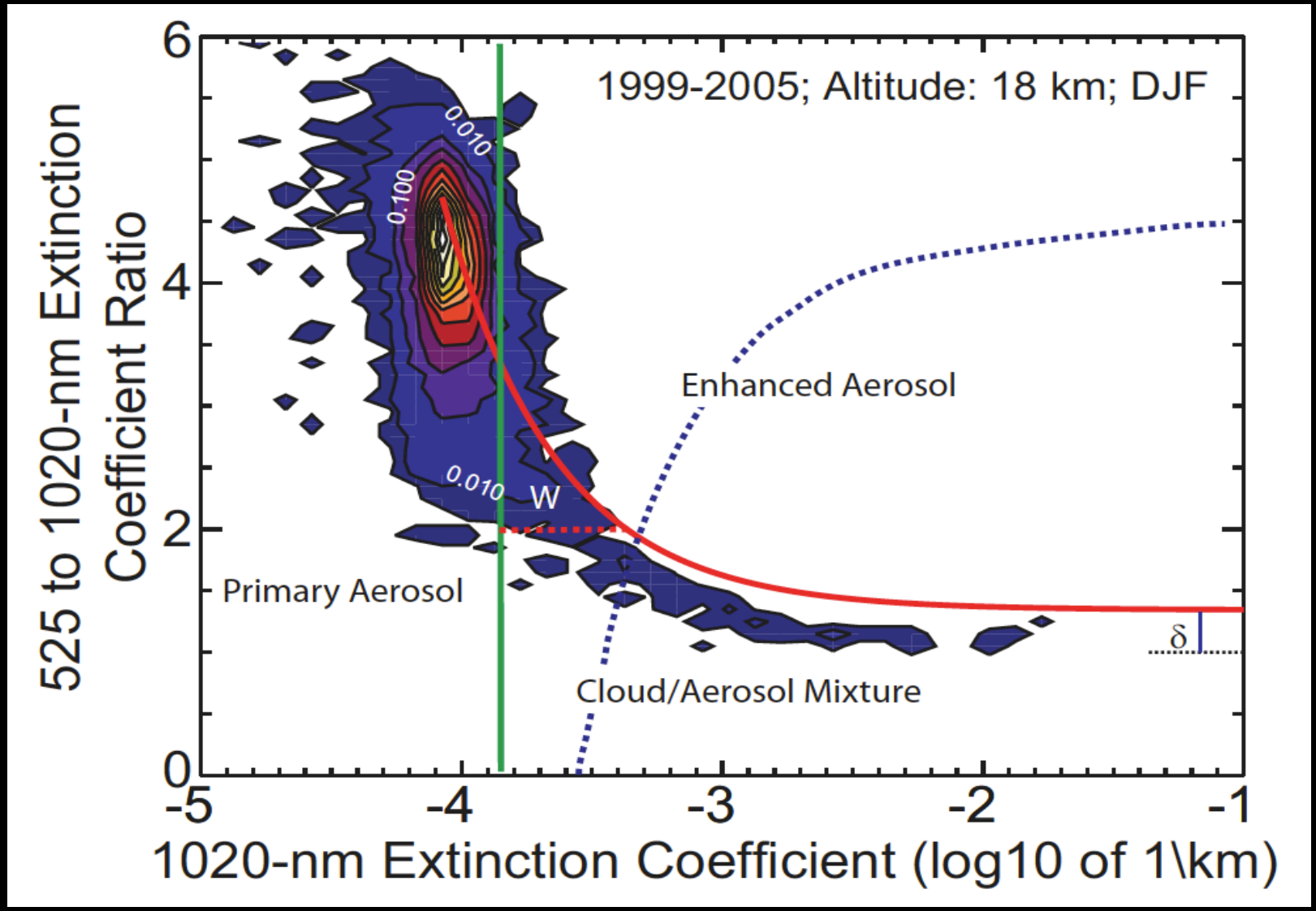
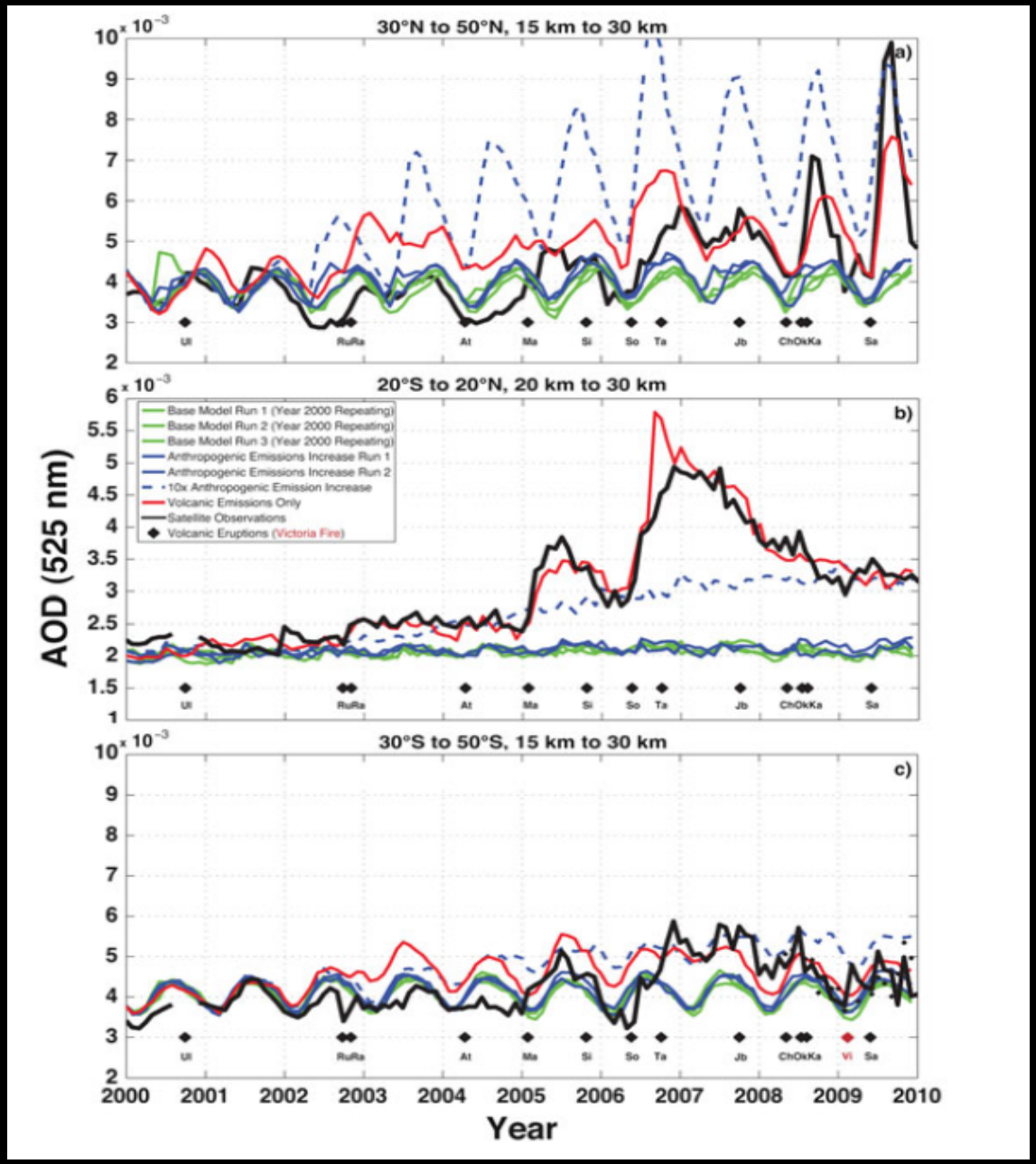
SAGE II retrieval filter by Vernier et al. [2013]





We care about the impact of emissions on stratospheric aerosols because it may explain part of "warming hiatus"

Neely et al., GRL, 2013

OC is about equal to sulfate mass at TTL, as simulated and observed