

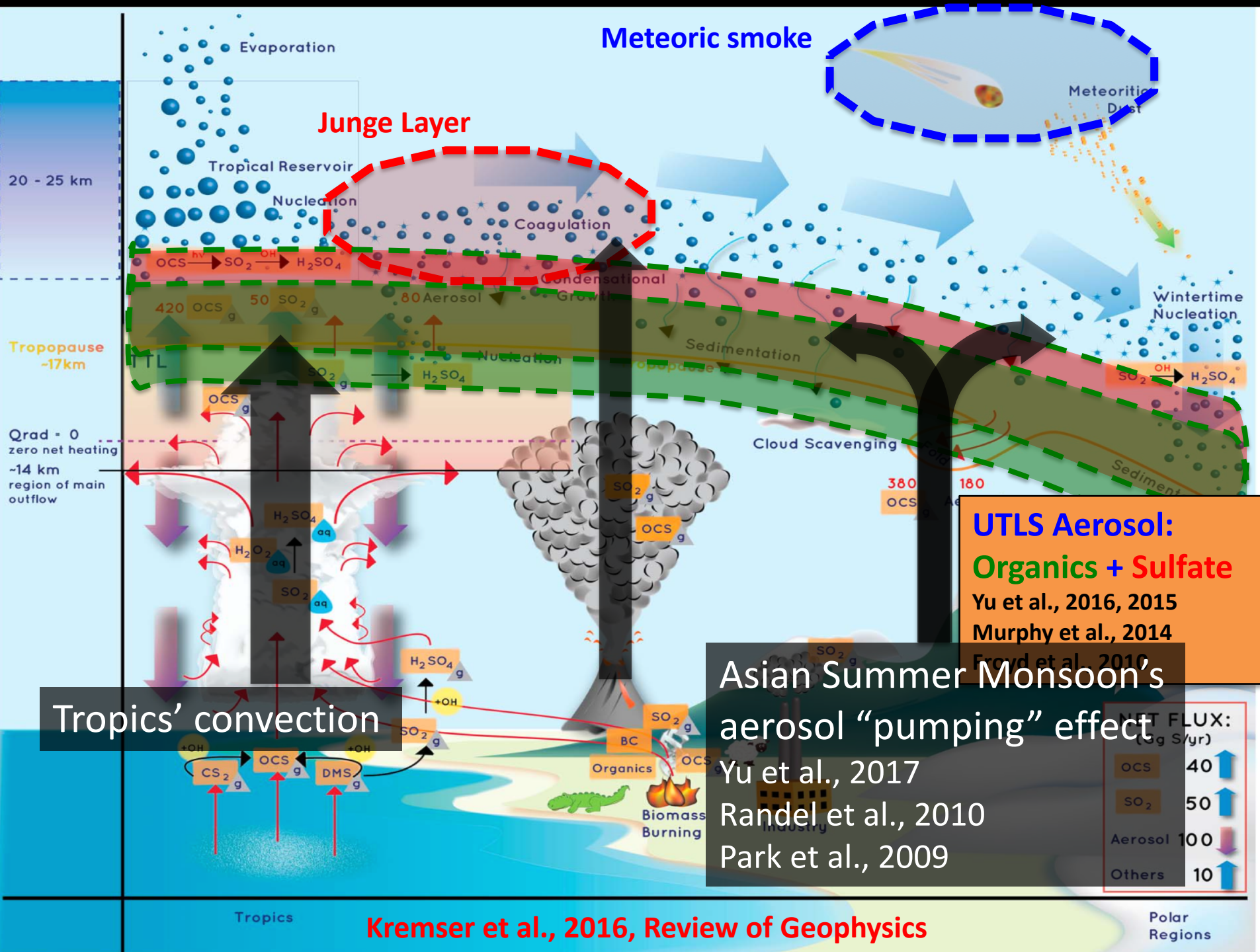


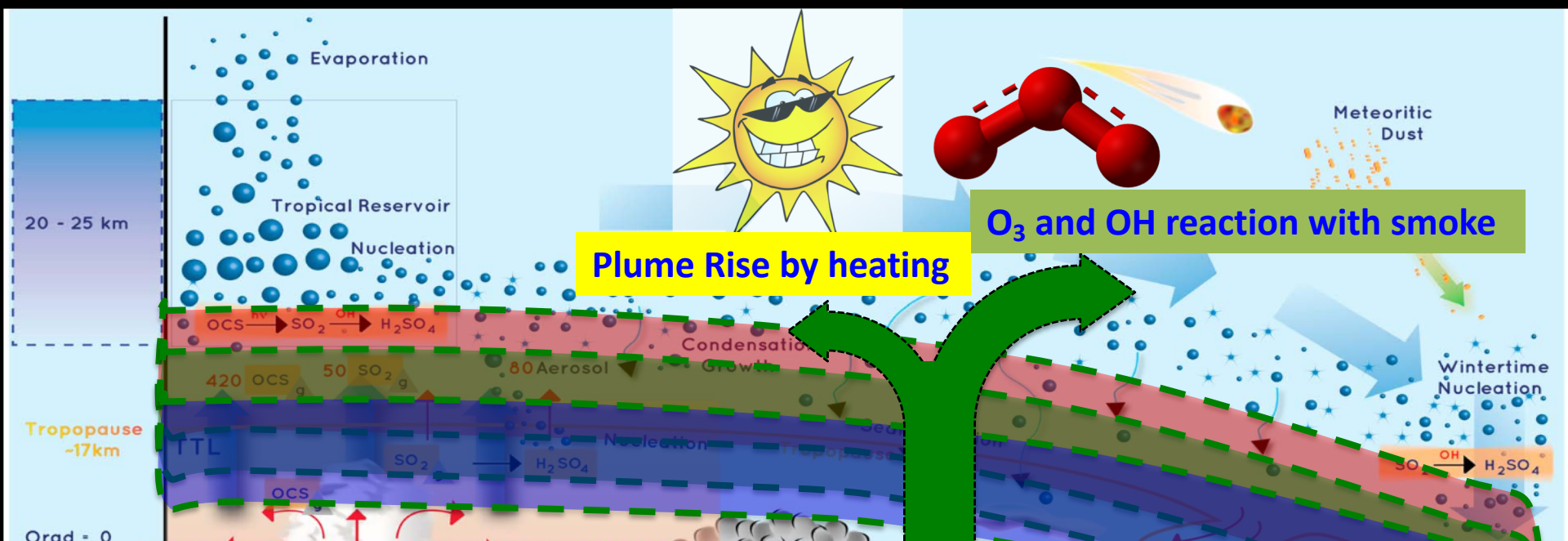
# Modeling Stratospheric Aerosols: Background and Smoke

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4<sup>th</sup> ACAM Meeting, June.28.2019, Bangi, Malaysia





Plume Rise by heating

O<sub>3</sub> and OH reaction with smoke

- For the first time, smoke plume Self-Rising is clearly observed
- Evidence of smoke's photolysis in stratosphere
- Smoke heats local stratosphere

Nitrate aerosol

Smoke review

NET FLUX: (Gg S/yr)	
OCS	40 ↑
SO <sub>2</sub>	50 ↑
Aerosol	100 ↓
Others	10 ↑



Nuclear Winter



Regional nuclear war ---> global impacts



# We use a **Sectional** Aerosol Model coupled with a climate model (CESM-CARMA)



Laboratory for Atmospheric and Space Physics  
University of Colorado Boulder



## CAM5/CARMA Model



CARMA

CARMA

3. Nucleation

4. Condensational growth

BHN: Zhao and Turco (1995)  
 $H_2O$  vp over  $H_2SO_4$ : Lin and Tabazadeh (2001)  
 $H_2SO_4$  vp: Giauque (1959), Ayers et al. (1980), Kulmala (1990)

Wt %: Tabazadeh et al. (1997)

CAM5

2. Chemistry

SOA: Gas/Particle partitioning  
 Sulfur chemistry  
 Aqueous chemistry

1.9°x2.5° resolution

Dynamics/Transport

CAM5

5. Coagulation

Brownian

CAM5

CARMA

6. Dry deposition

CAM5

CARMA

7. Aerosol activation/  
cloud Evaporation

CAM5

CARMA

8. Wet deposition

CAM5

CARMA

1. Emissions

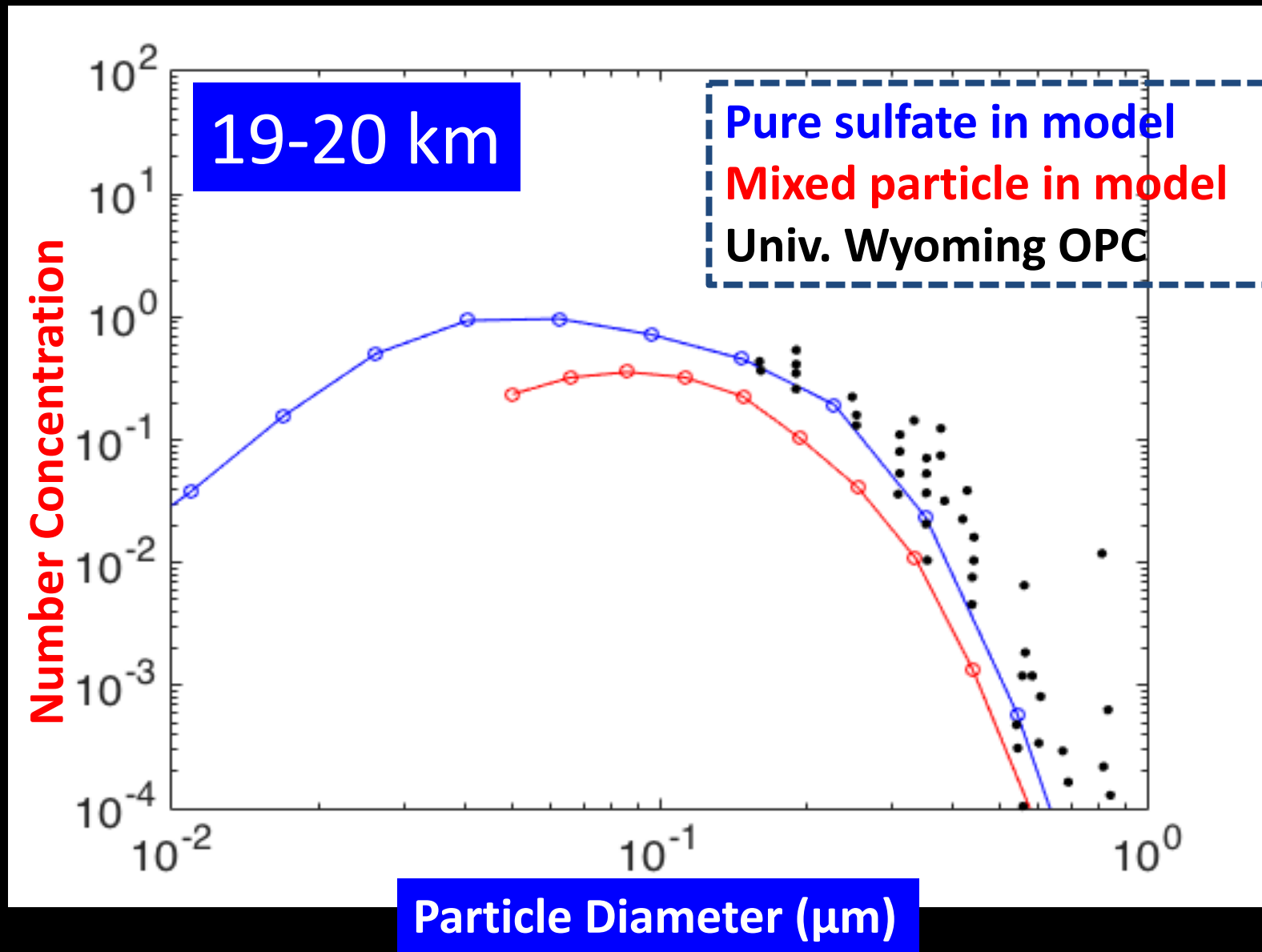
POA/BC: GFEDv3&FINN, G...  
 Sea Salt: Fan and Toon (20...  
 Dust: Su and Toon (2009)  
 Sulfate: English et al. (2011)  
 VOC: monoterpenes, isoprene, benzene, toluene and xylene



Pengfei Yu et al., 2015  
 Chuck Bardeen et al., 2013  
 Brian Toon et al., 1988

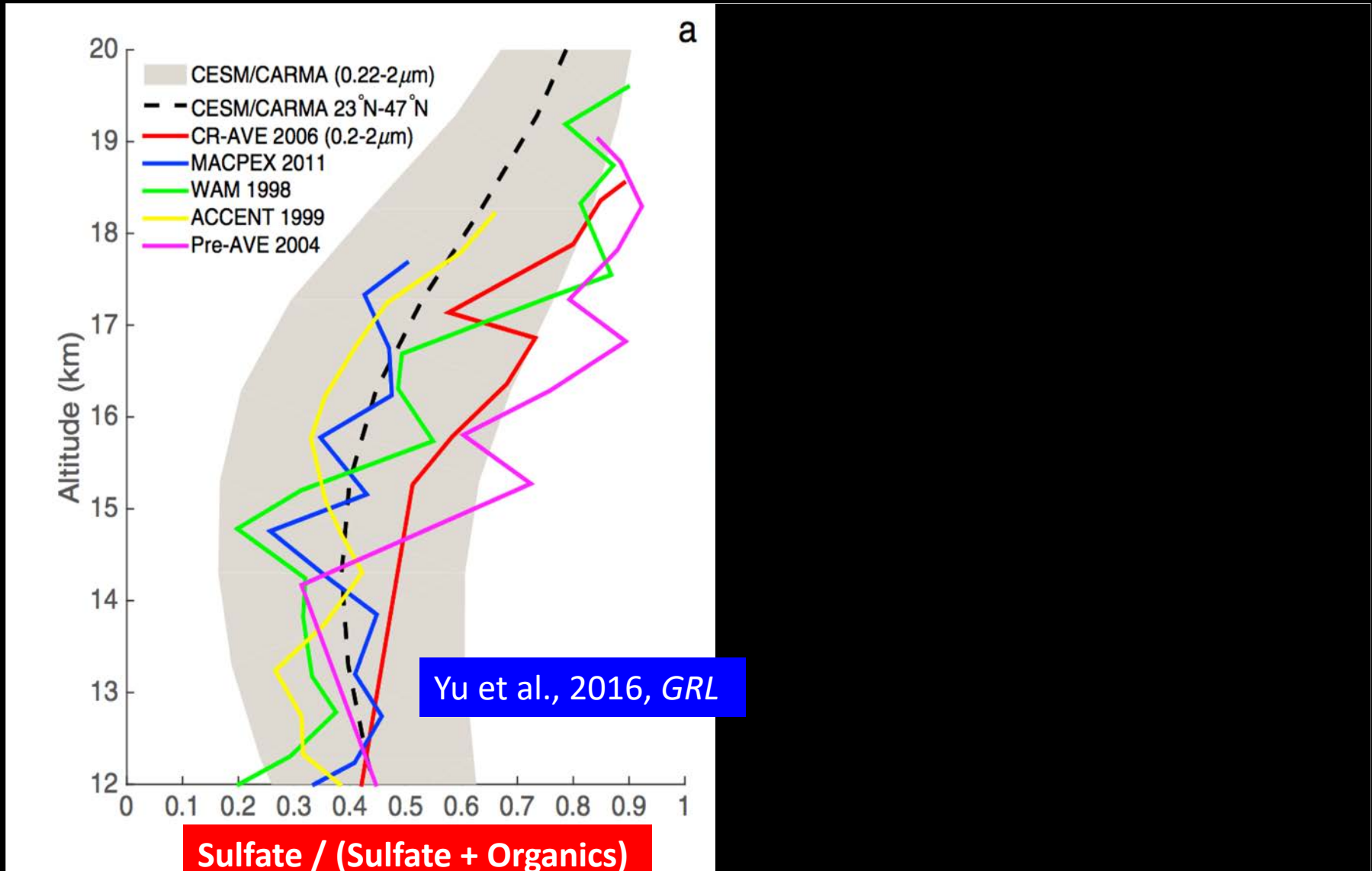


# Background at 20 km: pure sulfate dominates



# Background in UTLs:

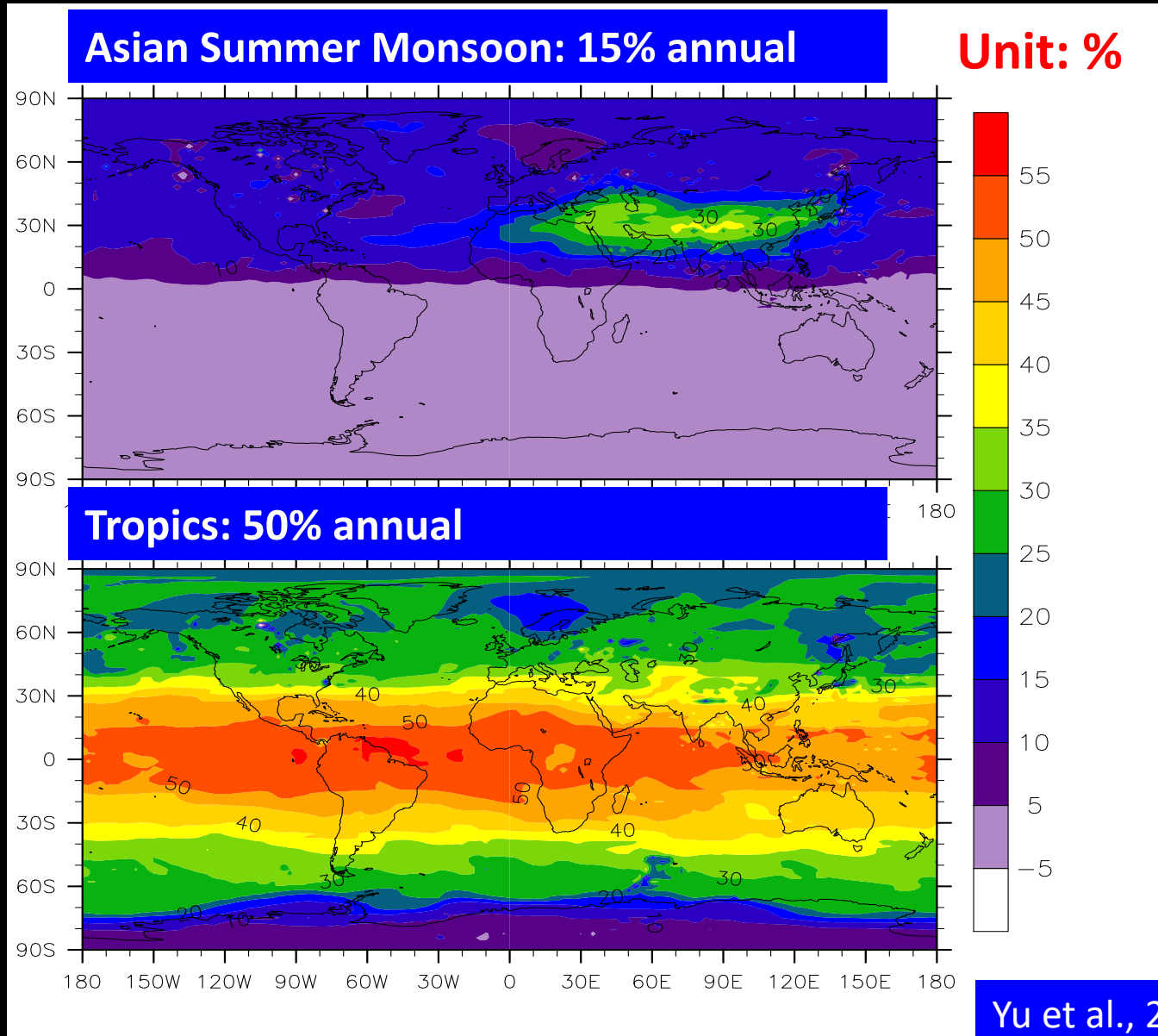
Organics and Sulfate's concentrations are comparable



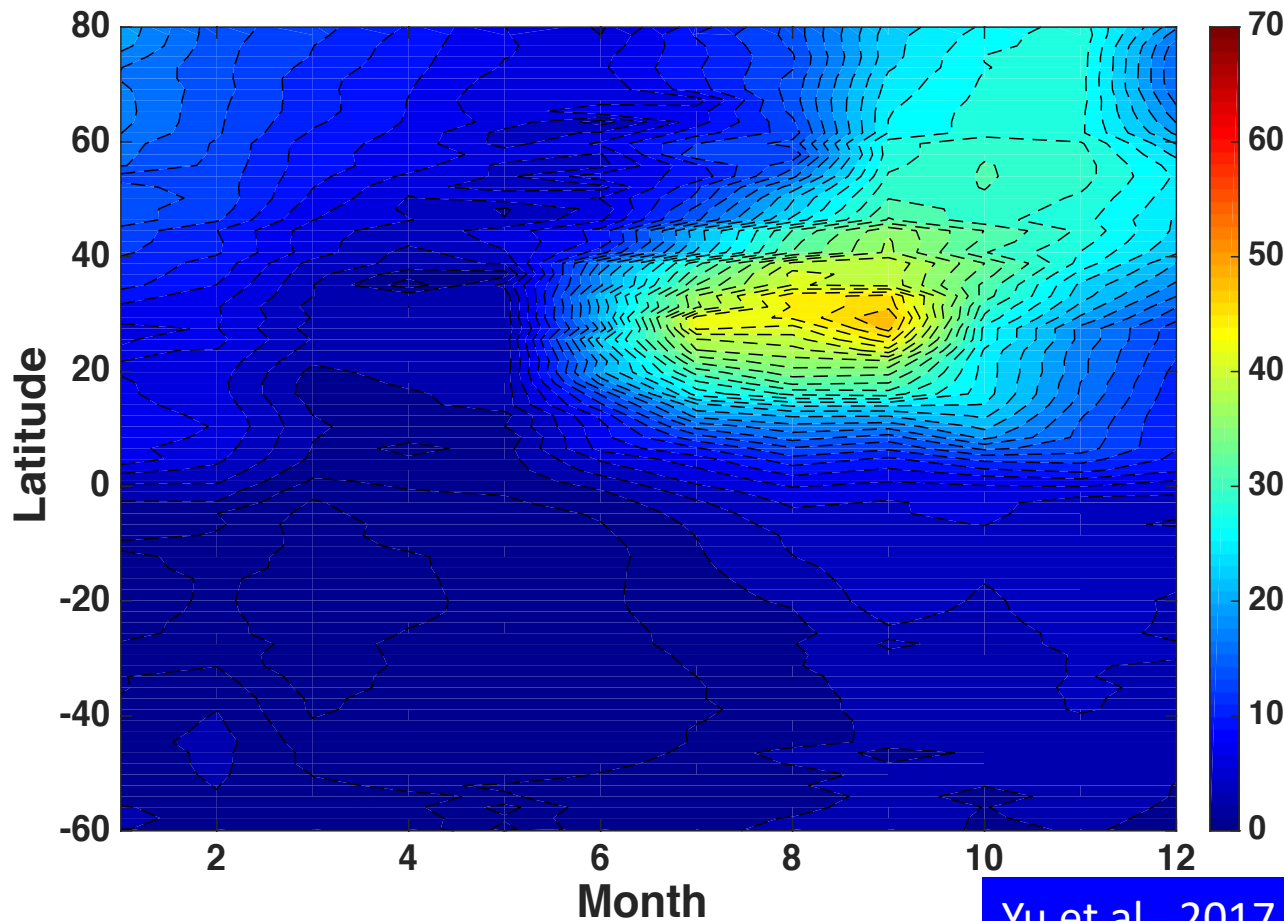




# ASM contributes 15% to stratospheric aerosol; Tropics contributes ~50%

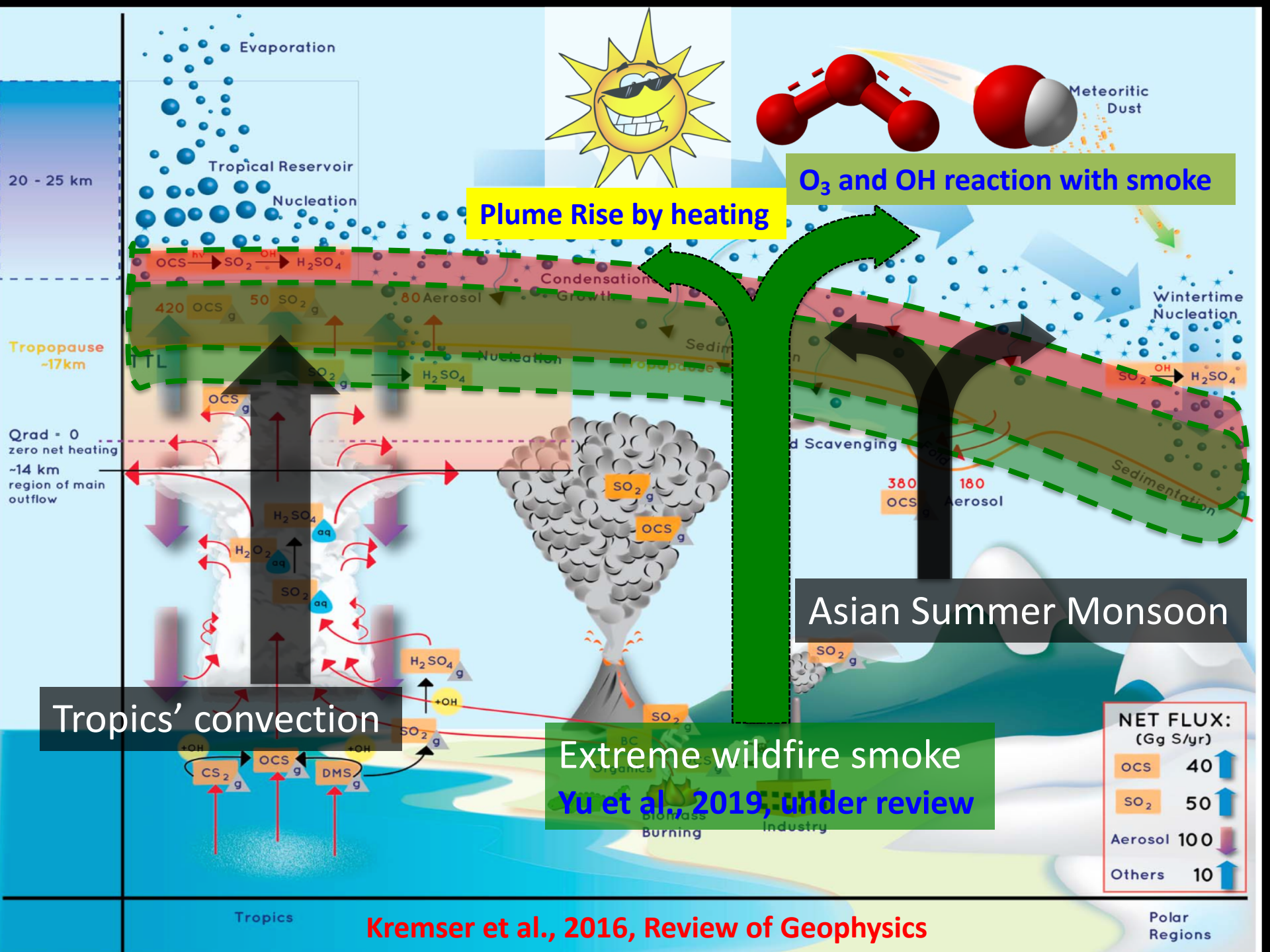


After pumped into the stratosphere,  
aerosols are transported polewards



Unit: %

Yu et al., 2017



Evaporation

Tropical Reservoir

Nucleation

Plume Rise by heating

O<sub>3</sub> and OH reaction with smoke

20 - 25 km

Tropopause -17km

Grad = 0 zero net heating -14 km region of main outflow

Tropics' convection

Asian Summer Monsoon

Extreme wildfire smoke  
Yu et al., 2019, under review

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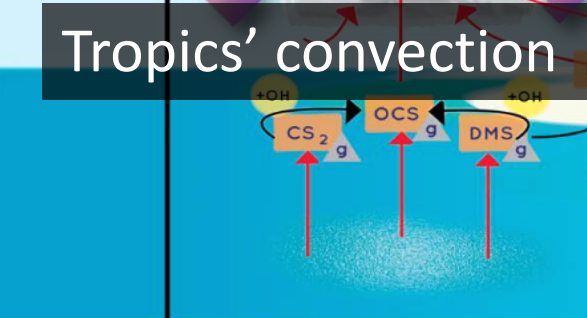
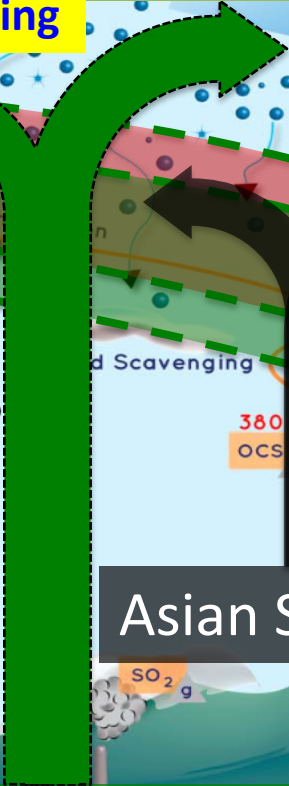
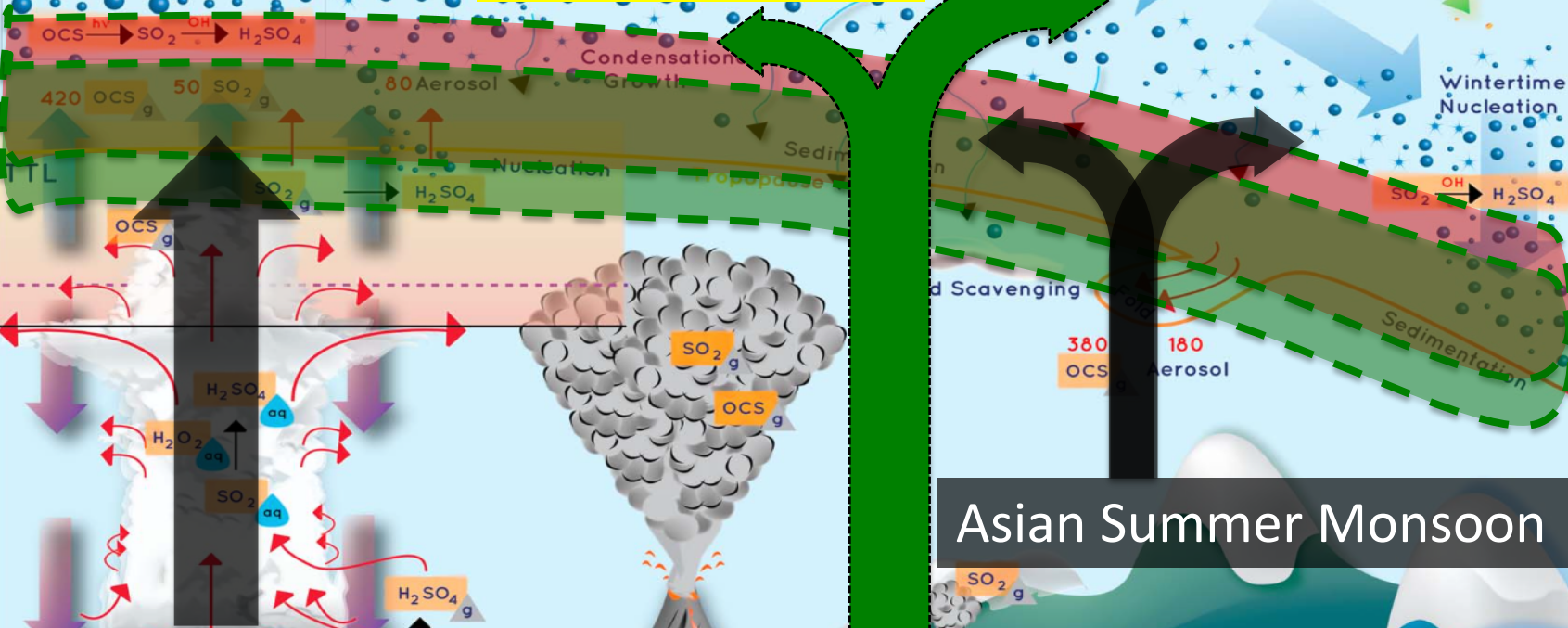
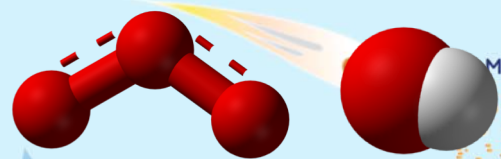
Tropics

Kremser et al., 2016, Review of Geophysics

Polar Regions

Wintertime Nucleation

Meteoritic Dust



biomass Burning Industry



# 2017 British Columbia Event is Large

