Radiative Constraints in Tropical Upper Troposphere and Lower Stratosphere

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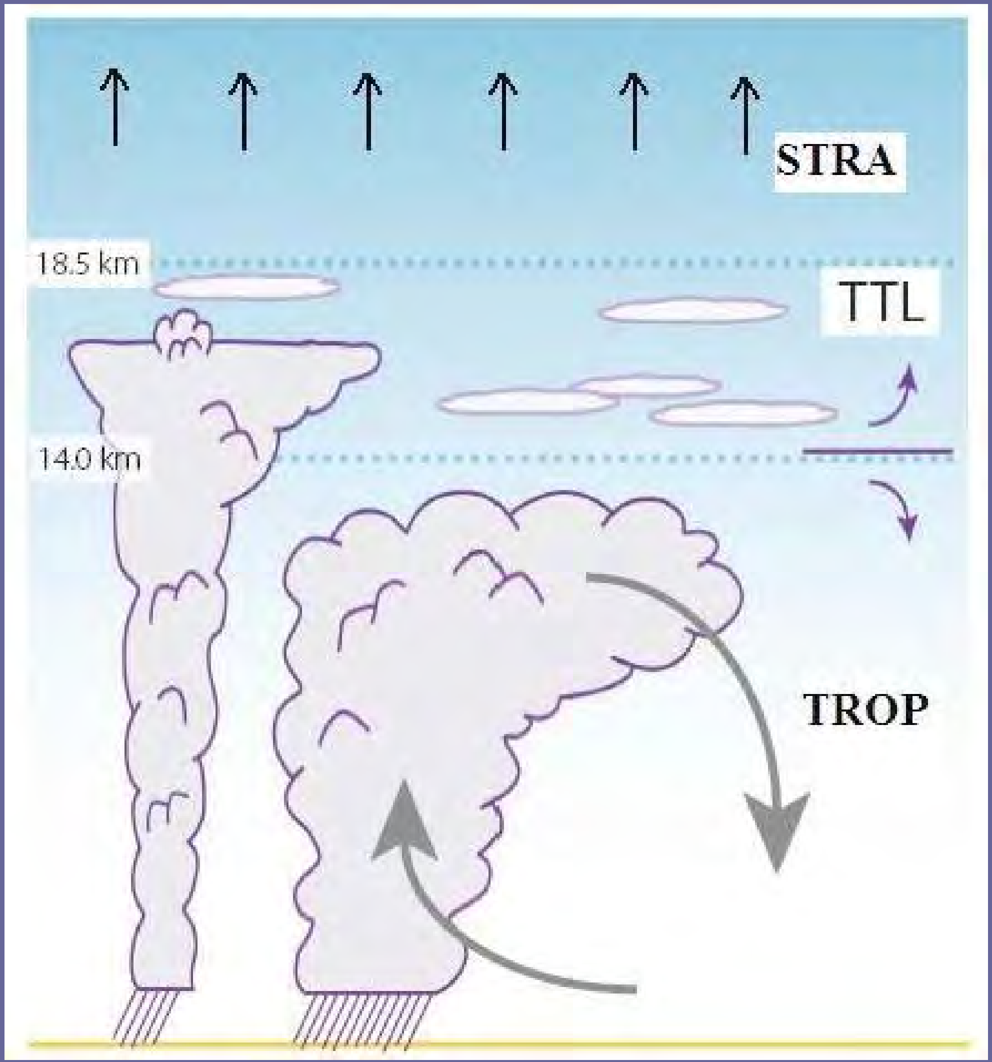
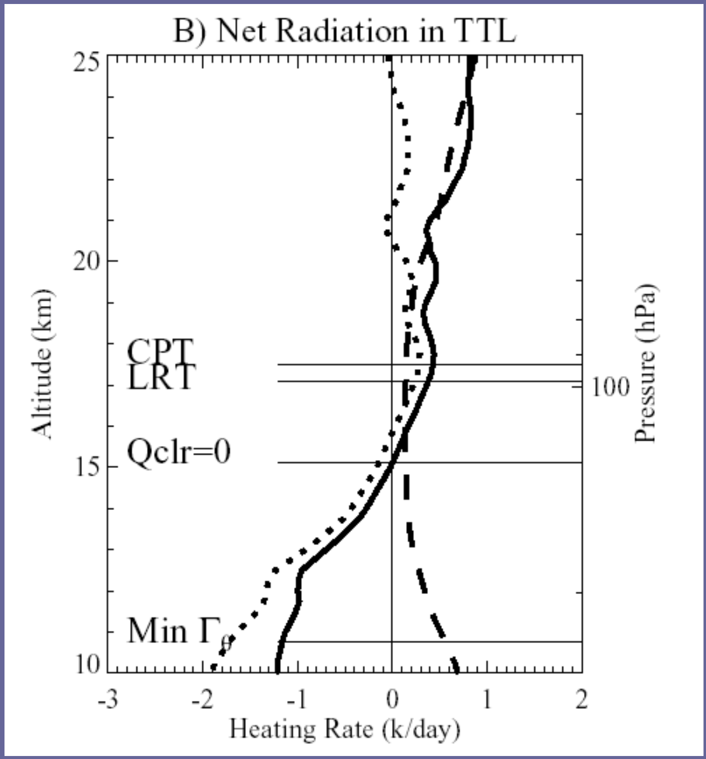
Role of Radiative Heating Rate in Tropical UTLS



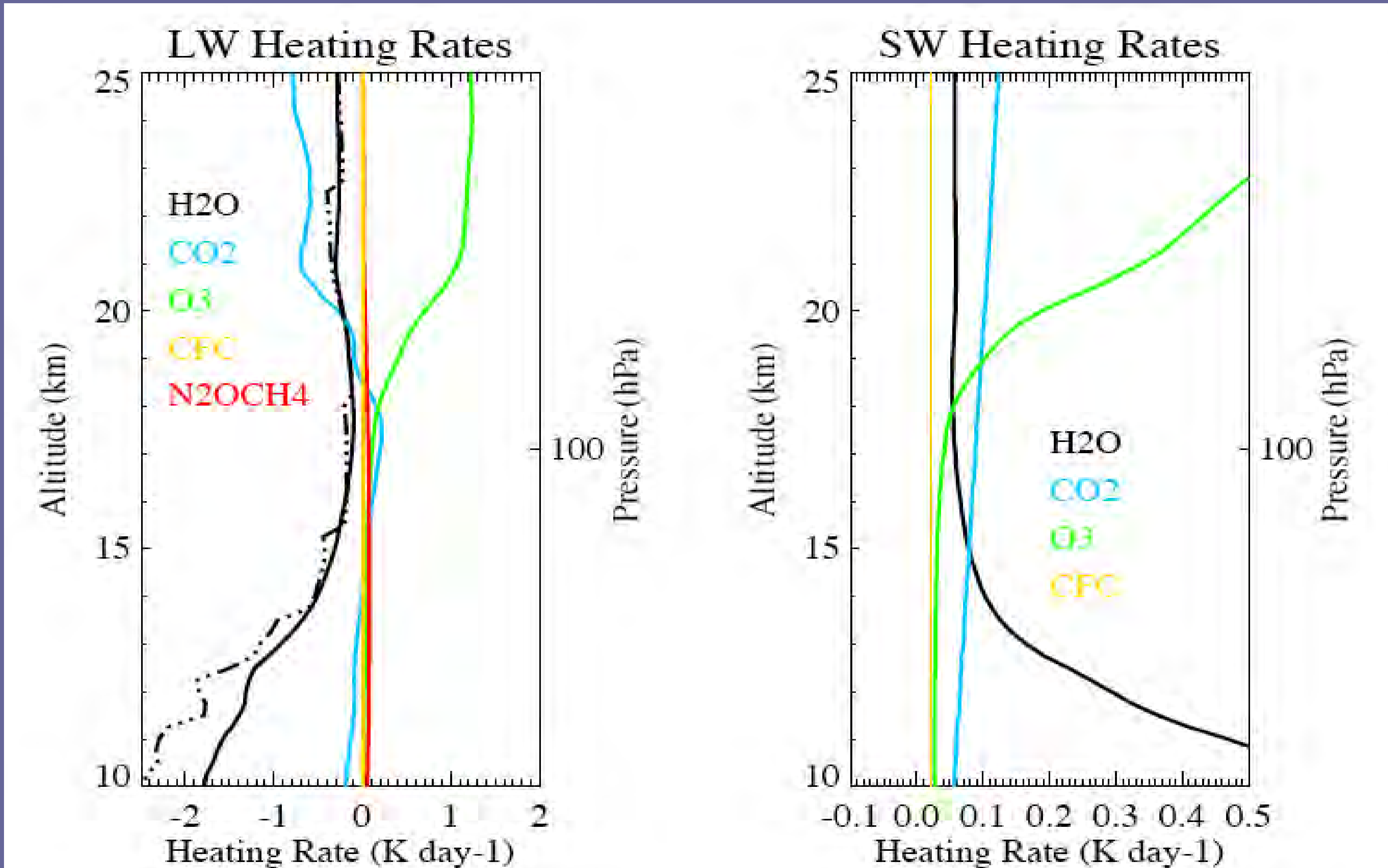


Gettelman et al. (2004)

$$\overline{w} * \frac{\overline{T}}{\overline{\theta}} \frac{\partial \overline{\theta}}{\partial z} \approx \overline{Q}_R, > 15\ km$$

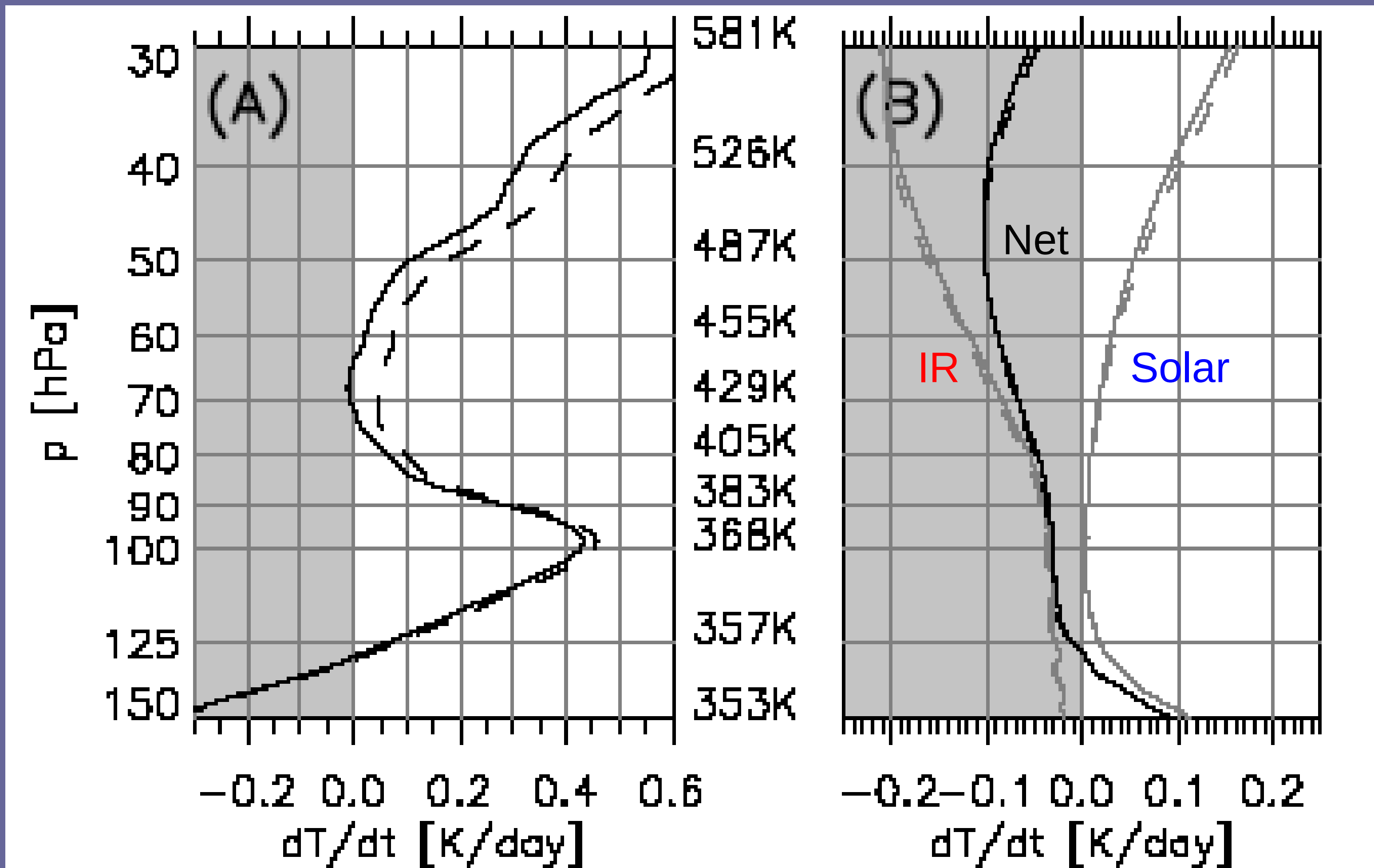
Radiative heating rates in UTLS provide a critical constraint on the troposphere-to-stratosphere transport (Fueglistaler et al. 2009).

Radiative Budget in UTLS: Gas Contributions



Gettelman et al. (2004)

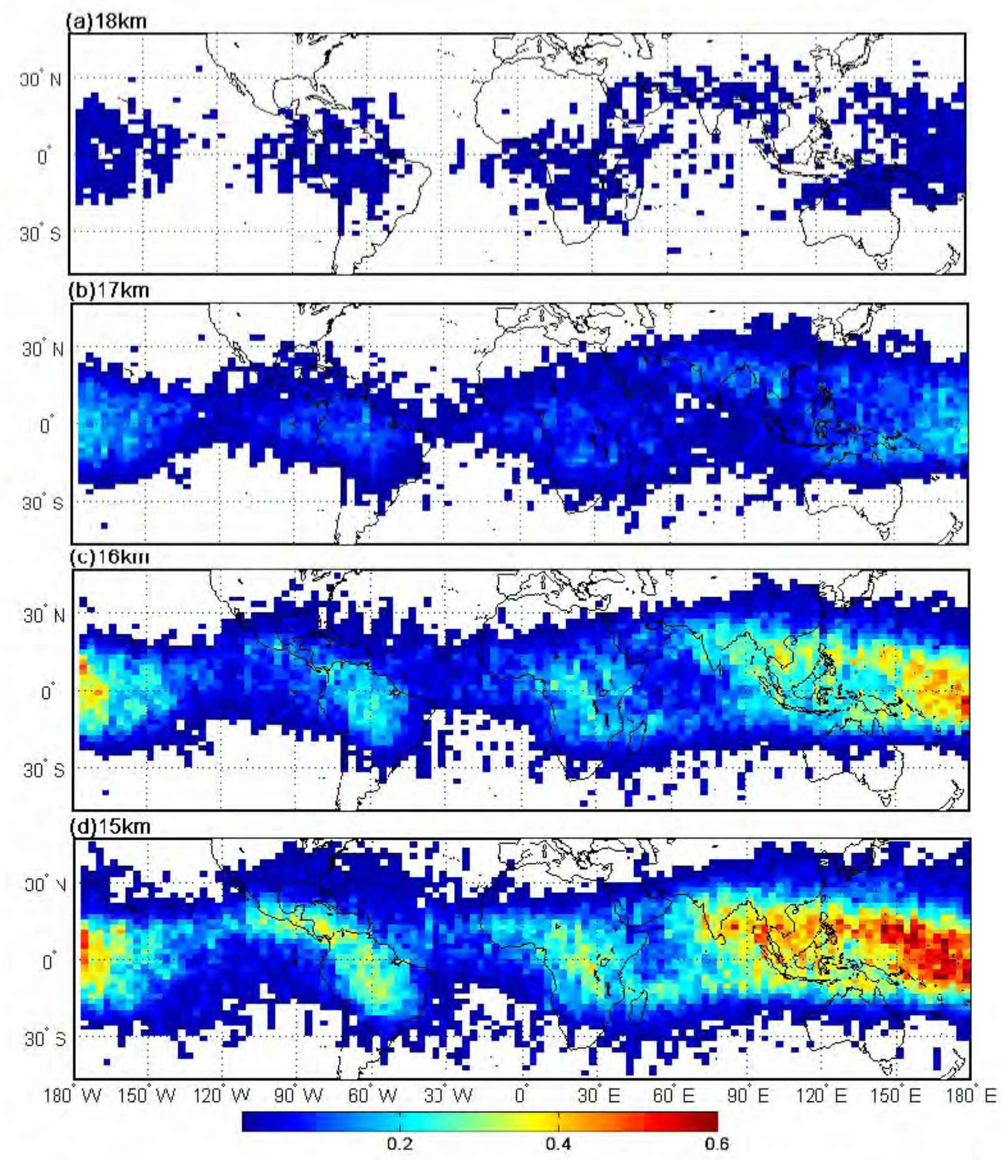
Radiative Budget in UTLS: Cloud Impacts



Radiative heatng rates at the ARM Manus site in 2000. (a) Annual mean with O_3 from Java (solid) and Fiji (dashed); (b) difference between all sky and clear sky.

Fueglistaler and Fu (2006)

Cloud Fraction from CALIPSO Lidar Obs.

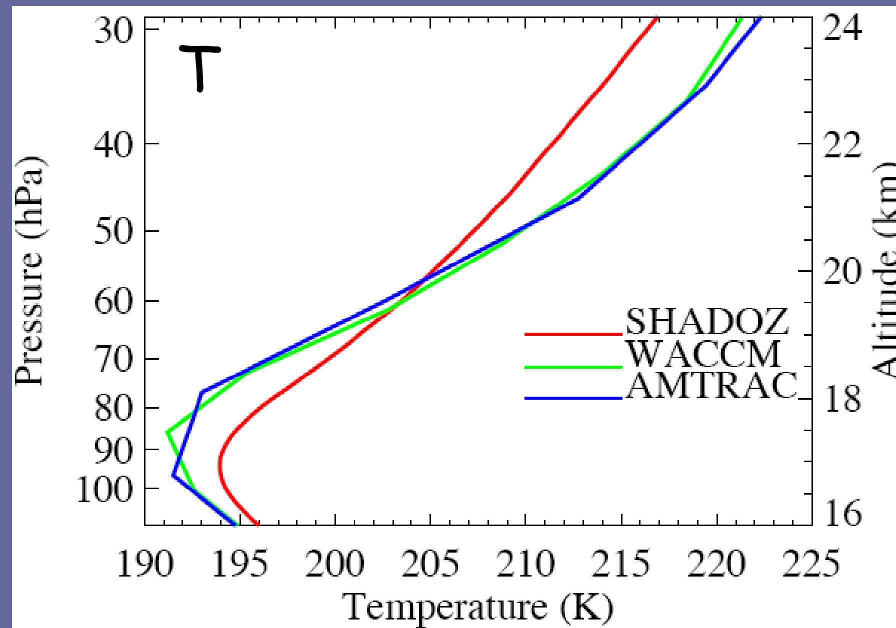


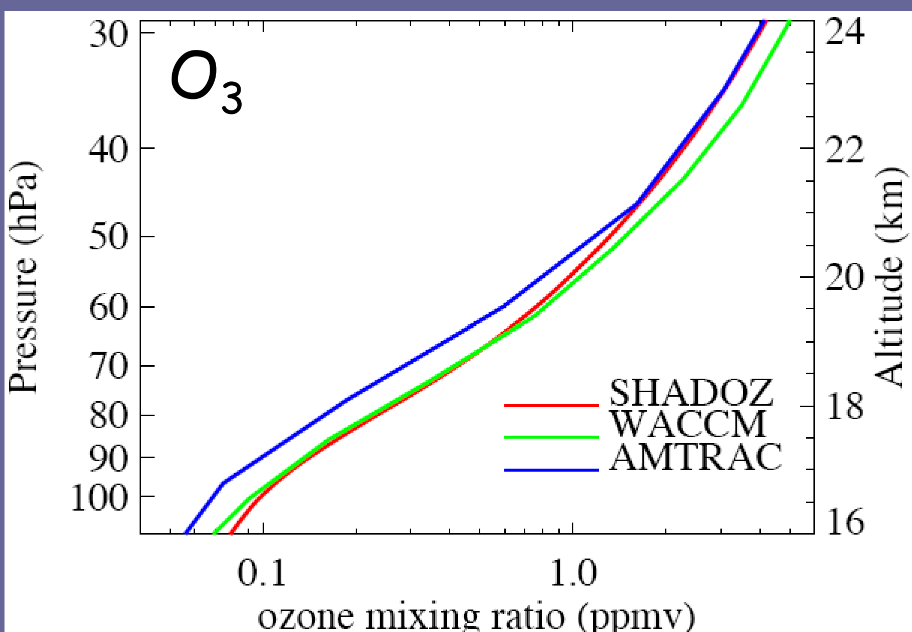
Fu et al. (2007, GRL)

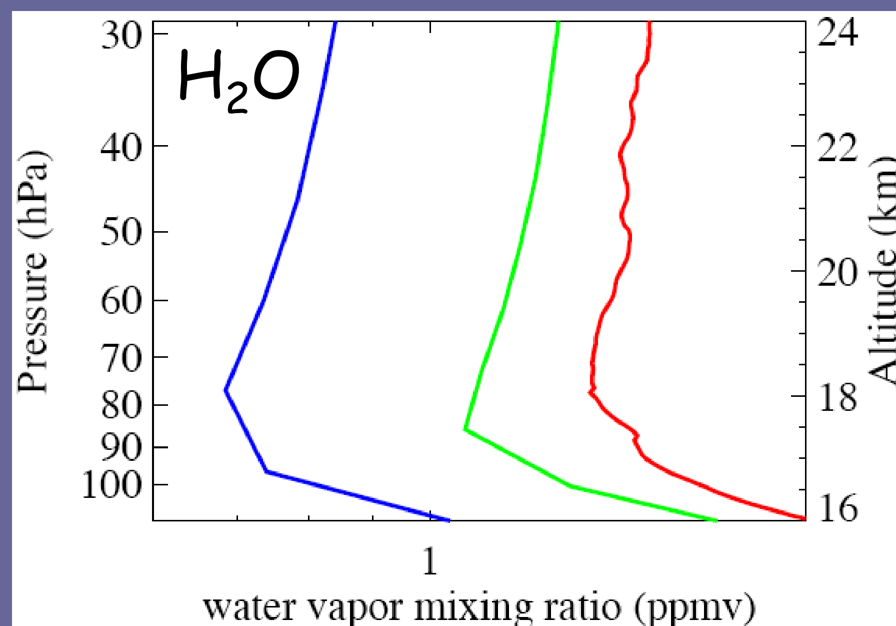
Accurate Quantification of Q_R in Tropical UTLS

- Reliably observed profiles of T, H_2O, and O_3
- Observed cloud fields including thin and subvisible cirrus clouds
- Accurate radiative transfer models (e.g., with 2σ errors smaller than about 0.02 K/day in the tropical tropopause layer).

Comparisons of T, O_3, and H_2O Profiles between Models and Observations





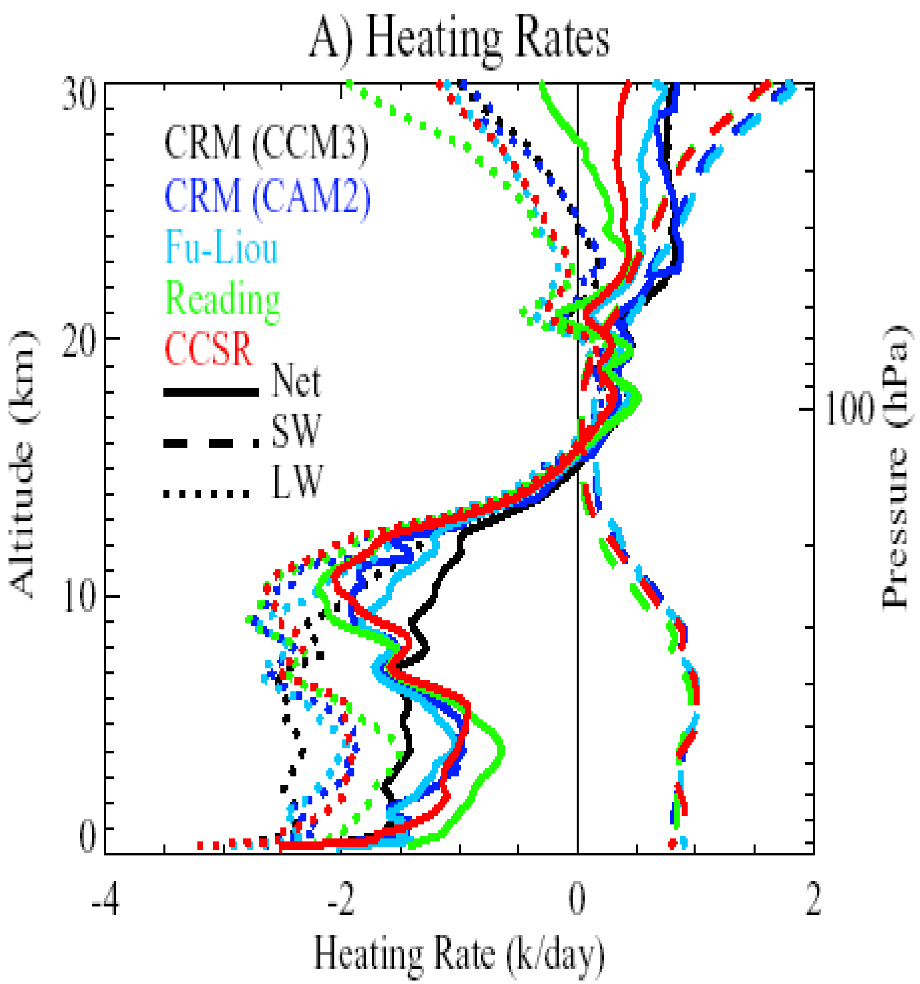


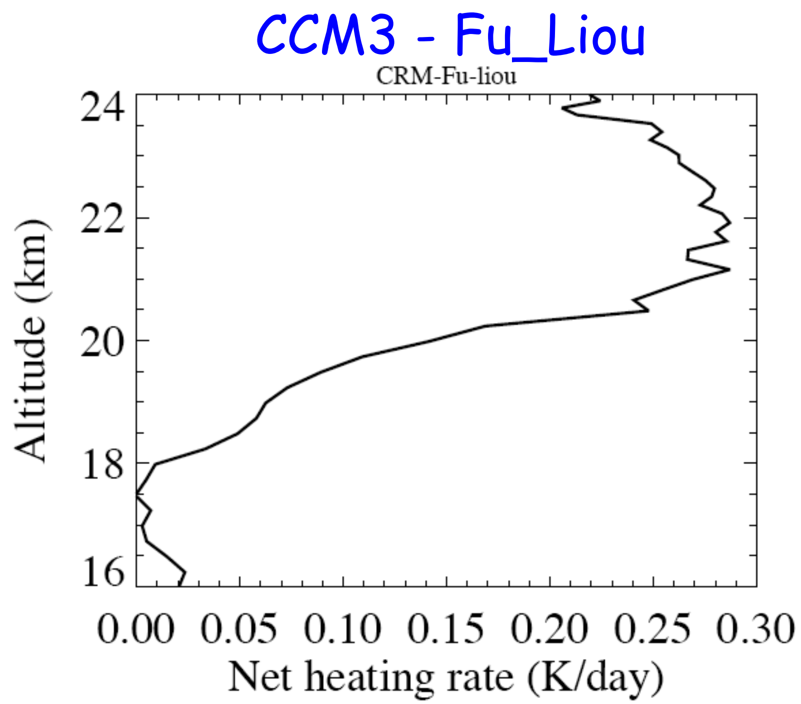
Comparison of Annual Mean Upward Mass Fluxes ($kgm^{-2}day^{-1}$) in the Lower Stratosphere between Two GCMs & Observations

	Observations	NCAR/WACCM	GFDL/AMTRAC
30-40 mb (22-24 km)	1.13 ± 0.40	1.37	1.18
50-70 mb (18.5-20.5km)	0.89 ± 0.48	1.97	1.95

Yang & Fu et al. (2008)

Radiative Heating rate in tropical atmosphere





Gettelman et al. (2004)

Radiative Energy Balance in the Tropical Tropopause Layer: An Investigation with ARM Data

PI: Qiang Fu
Collaborator: Jennifer Comstock

- Generate a cirrus microphysics data product by developing an algorithm combining the ARM Micropulse Lidar and MMCR observations.

- Quantify the TTL radiative energy budget by accurately considering the effects of clouds, especially thin cirrus clouds.

- Understand a) the GCM simulated cold bias in TTL; b) cloud-climate feedbacks related to changes in tropical anvil cloud top heights; c) the air vertical transport in the TTL