

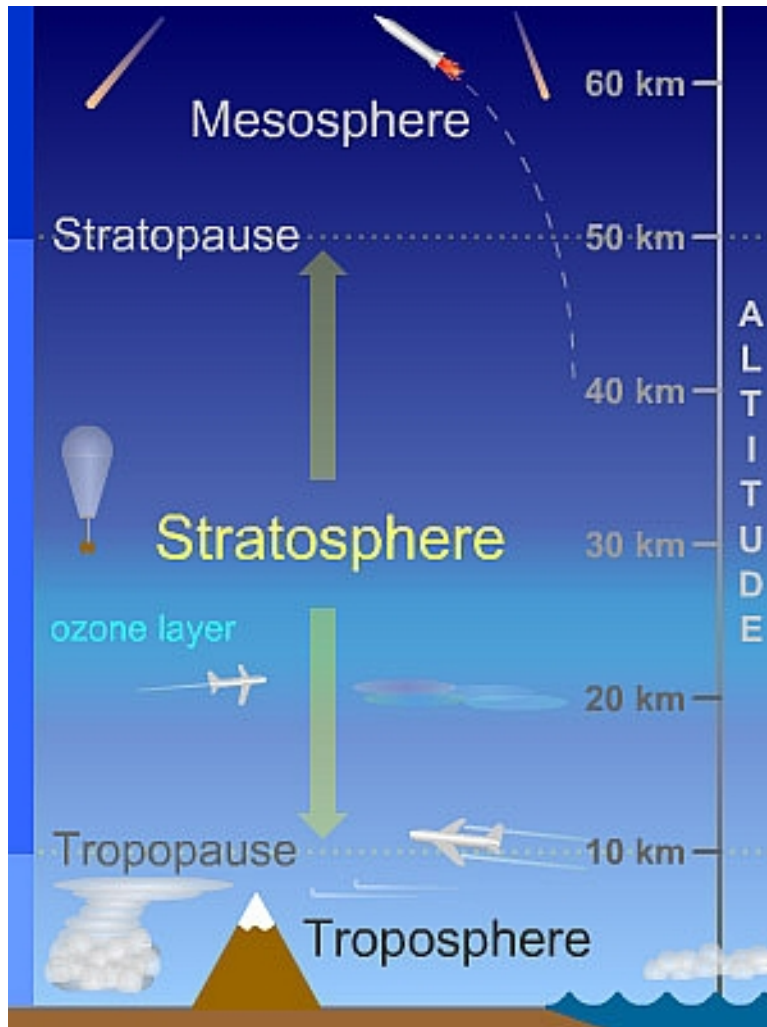
Simulating Climate Change in the Stratosphere

Presented by Pu Lin

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The stratosphere: A unique component of the climate system

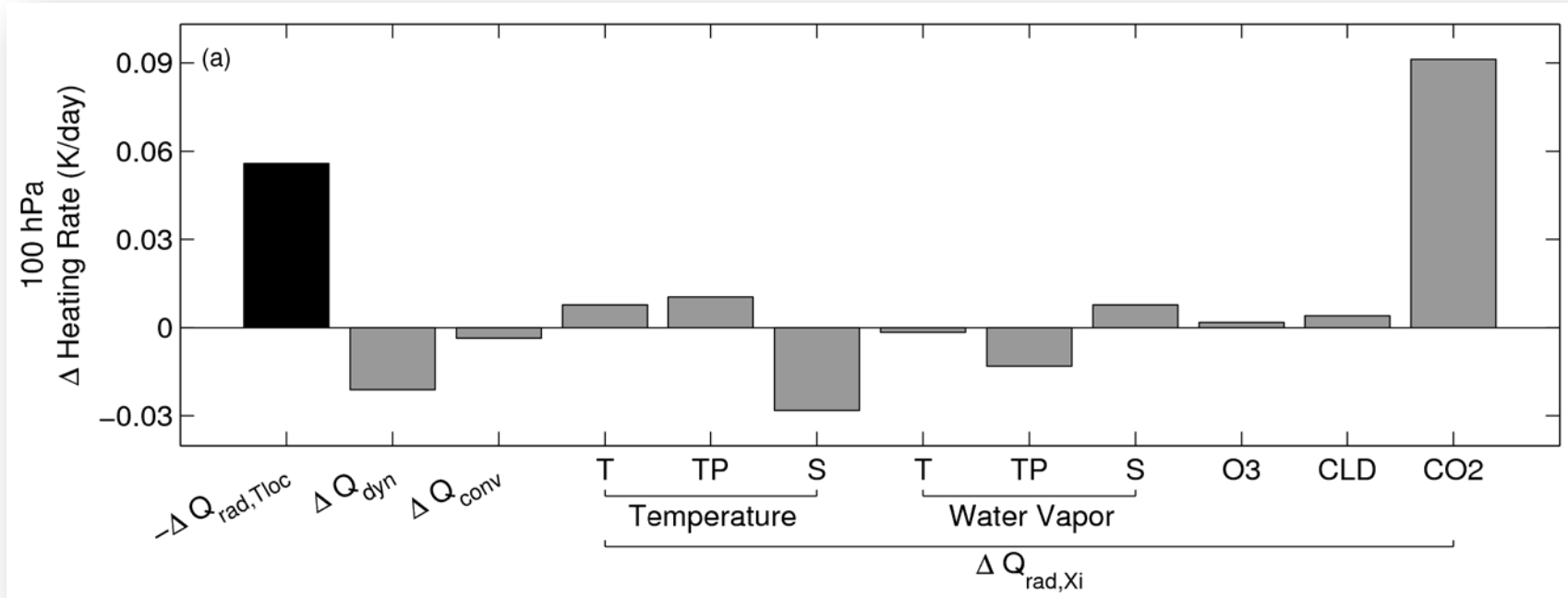


Credit: UCAR

- Additional validation for basic theories.
- Significant influence on weather and climate in the troposphere and at the surface.
 - Radiation balance is sensitive to changes in trace gases such as ozone and stratospheric water vapor.
 - Dynamical coupling between the stratosphere and the troposphere.
 - Composition changes from stratosphere-troposphere exchange.

Tropical tropopause warming : Insights from heat budget analysis

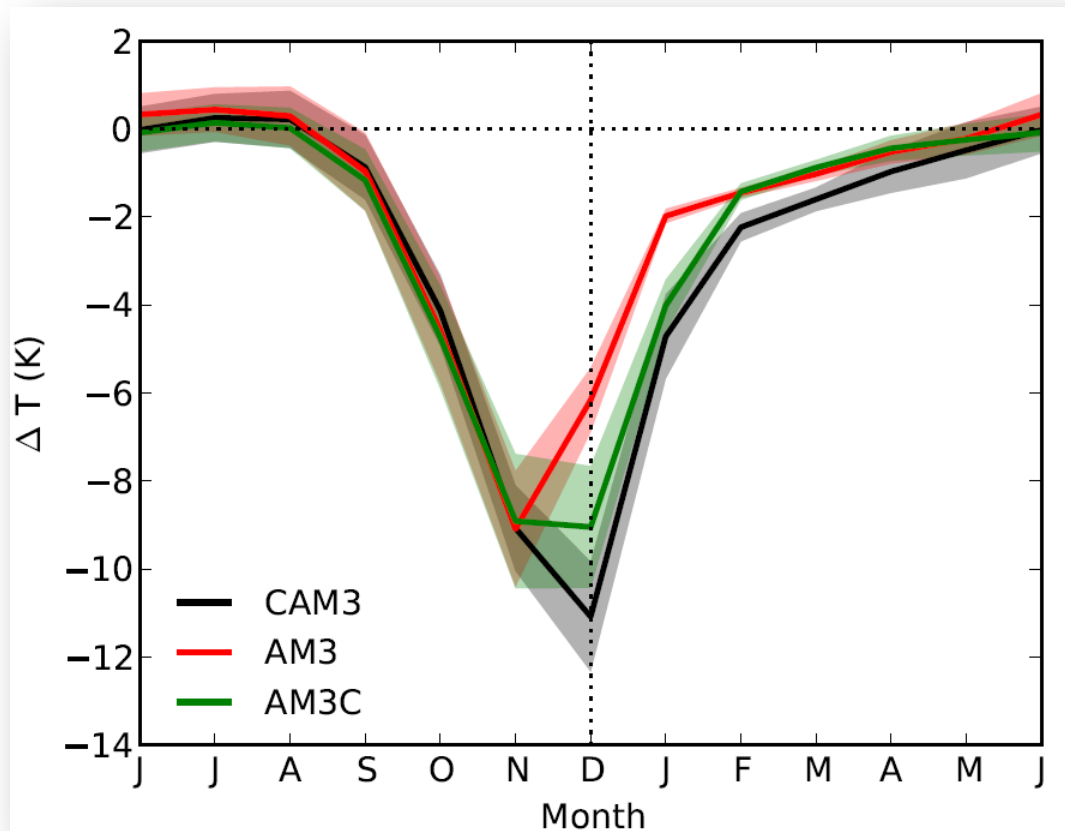
Changes in the Heating Rate at the tropical tropopause from 4xCO2



- GFDL AM3 is capable of simulating the relevant dynamic, radiative, chemical and thermodynamic processes.
- A detailed heat budget is achieved by combining GCM output and the corresponding off-line radiative transfer model.
- A quantitative investigation of the mechanisms.

Response to Ozone Depletion: Role of the Zonal Wind Climatology

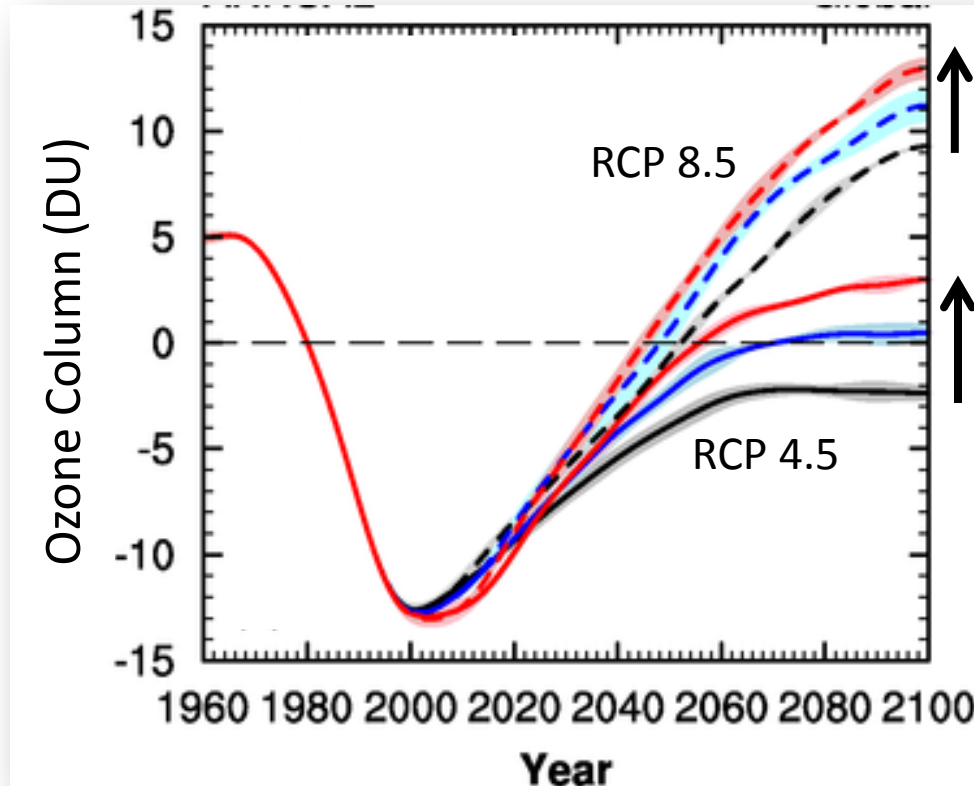
ΔT at 60°S-90°S 100 hPa as ozone depletes from 1960 level to 2000 level



Delayed southern polar vortex breakdown, a common model bias, implies an overestimation of the response to ozone depletion.

Stratospheric ozone recovery: Elevated volcanic aerosols increase ozone in a low halogen world

Global mean annual mean stratospheric ozone column relative to 1980



Medium volcanic aerosols
Low volcanic aerosols
Background aerosols

- Volcanic aerosols induce uncertainties in future stratospheric ozone projections and expected recovery dates.
- Accurate representation of stratospheric aerosols is necessary.

Summary

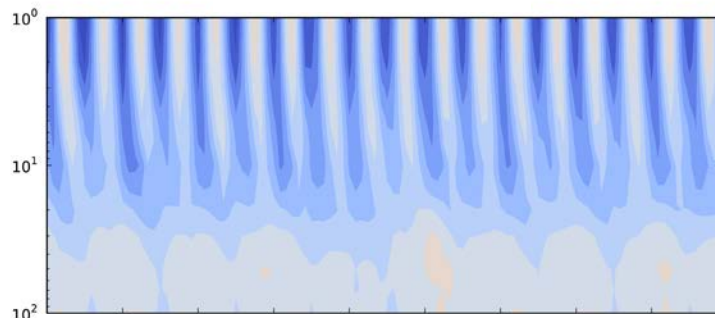
- GFDL models are capable of simulating the essential radiative, dynamic and chemical processes in the stratosphere.
- Heat budget analysis reveals that the direct radiative effect of CO₂ increase is a major contributor to the tropical tropopause warming.
- The simulated response to ozone depletion depends on the zonal wind climatology.
- Future projections of ozone is modulated by volcanic aerosols.

Future outlook:

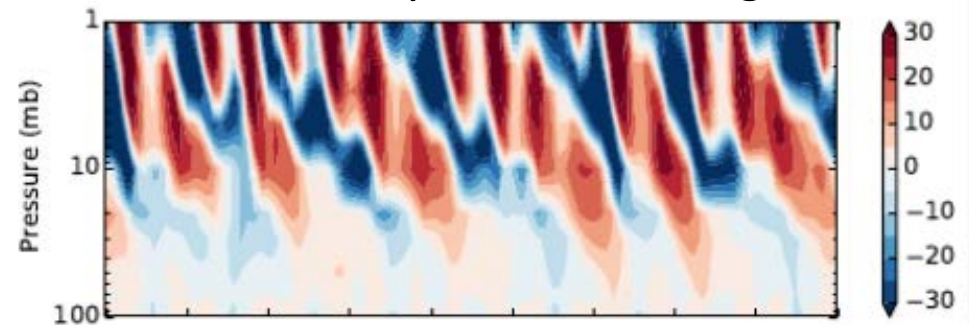
High resolution, non-hydrostatic simulations open new doors

Equatorial zonal wind simulated with different model configurations

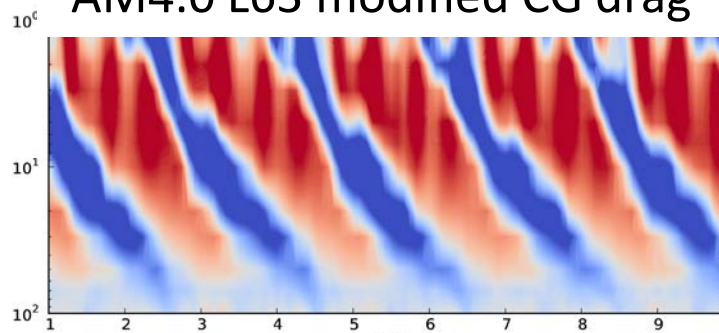
AM4.0 L33



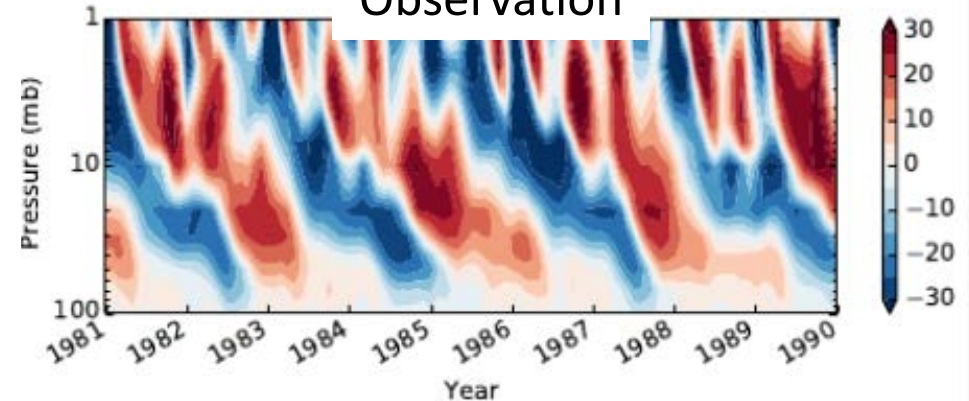
L71, non-hydro, no CG drag



AM4.0 L63 modified CG drag



Observation



Courtesy of Lucas Harris