A New Photochemistry Code for Terrestrial Exoplanet Atmospheres

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Photochemistry Model

- 1-D chemistry-transport equation for 111 molecules and aerosols
- Eddy diffusion
- Chemical kinetics
- Photolysis
- Boundary conditions
  - Atmospheric escape
  - Surface emission
  - Dry deposition velocity
Model Validation

- We simulate the atmospheres of current Earth and Mars.
  - Stratospheric chemistry – Ozone layer formation, NOx and HOx cycles
  - Tropospheric chemistry – OH formation, Steady-state concentration of CH$_4$, NH$_3$, N$_2$O, SO$_2$, H$_2$S, H$_2$SO$_4$

- Mars CO$_2$ atmosphere stabilized by odd hydrogens
A “water world” scenario has been proposed to explain the mass-radius relationship and the flat NIR transmission spectra of GJ 1214b (e.g., Rogers & Seager 2010; Bean et al. 2010).

- H$_2$O is photochemically stable up to 1 Pa.
- Equivalent water loss rate due to H diffusion-limited escape is $5.1 \times 10^{14}$ kg yr$^{-1}$.
- The lifetime for a water layer of 0.1 $M_p$ is 7.5 byr, comparable to the age of the star.