The Chemistry of Hot Jupiters and Neptunes

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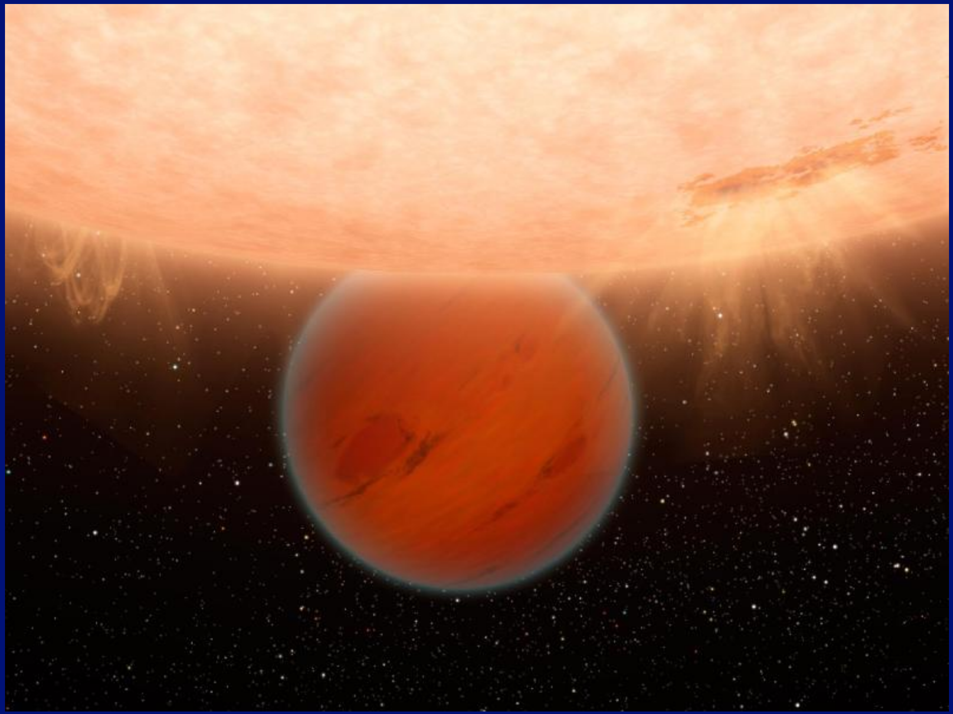
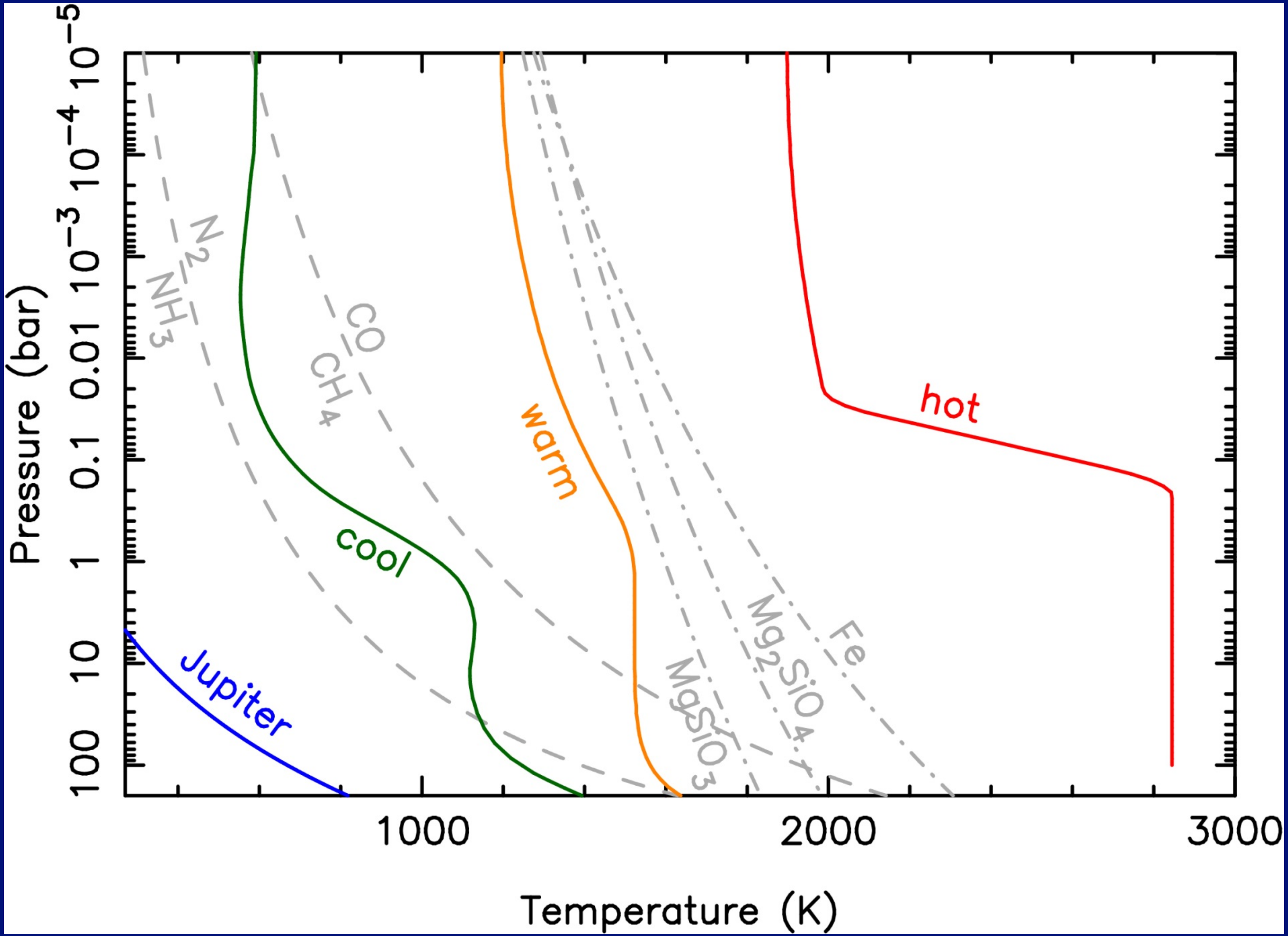


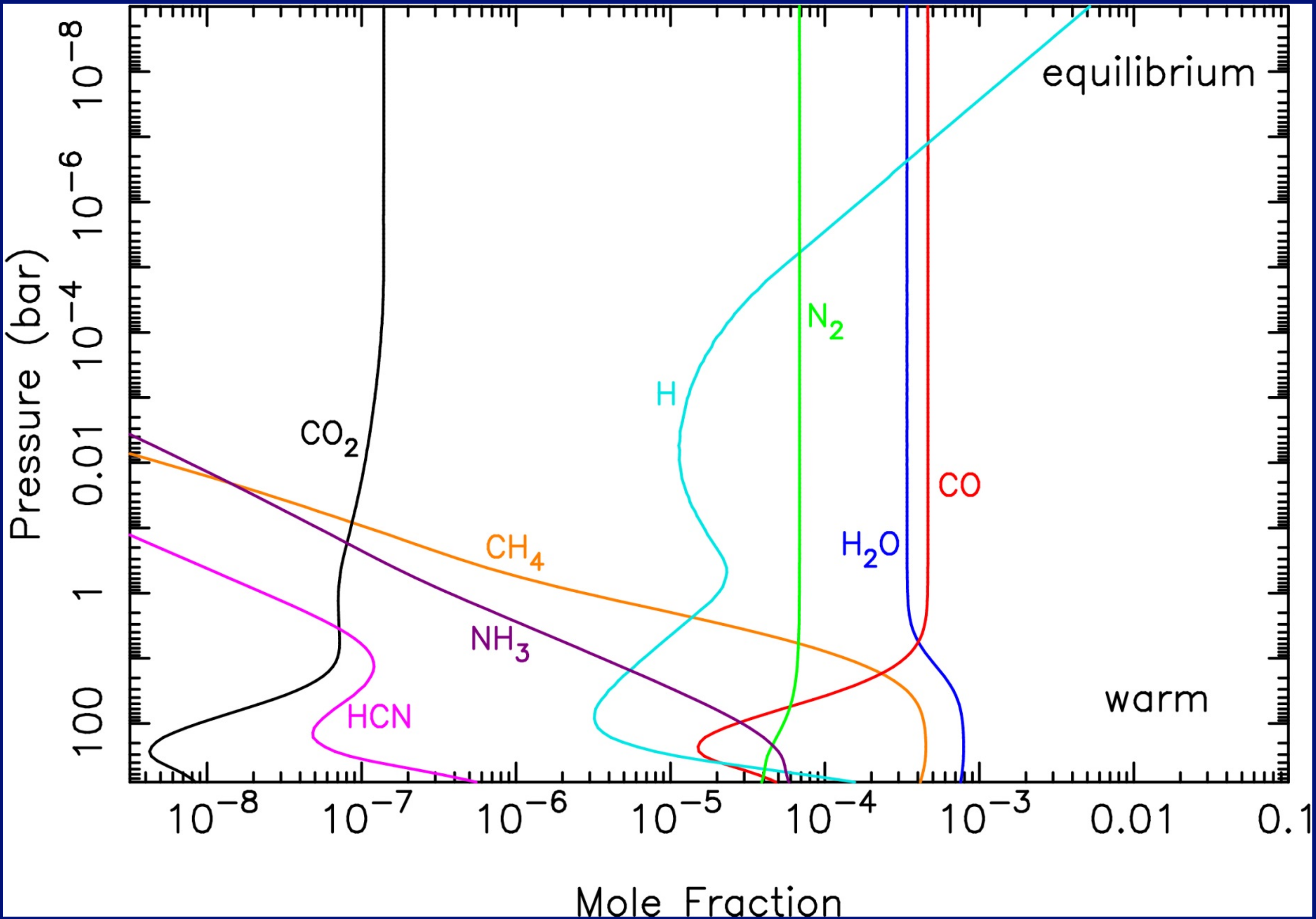
Image Credit: NASA/JPL-Caltech

AGU Chapman Conference on Planetary Atmospheres, 25 June 2013

Exoplanet Chemistry: Temperature Matters

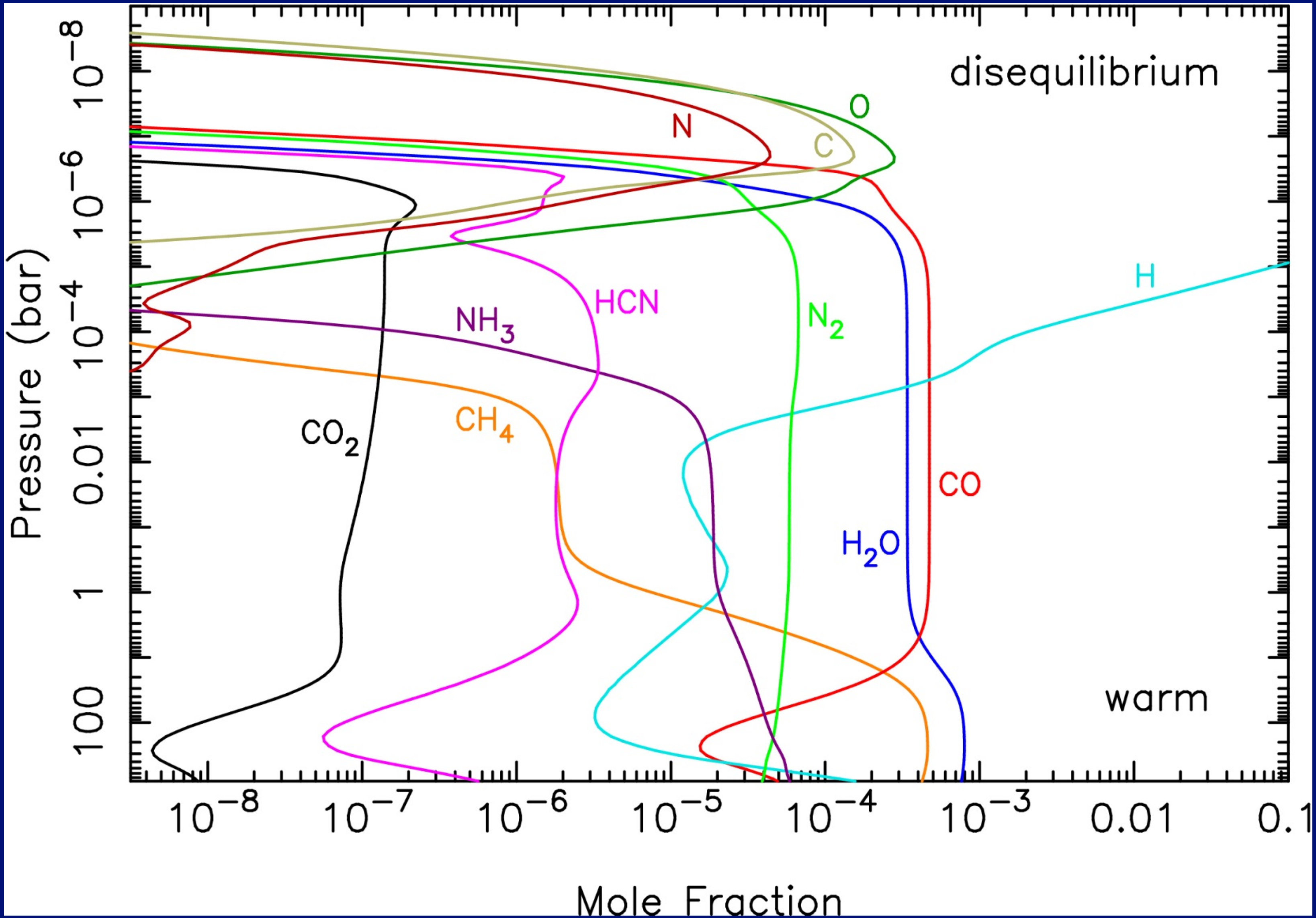


Equilibrium Chemistry: "Warm" Giant



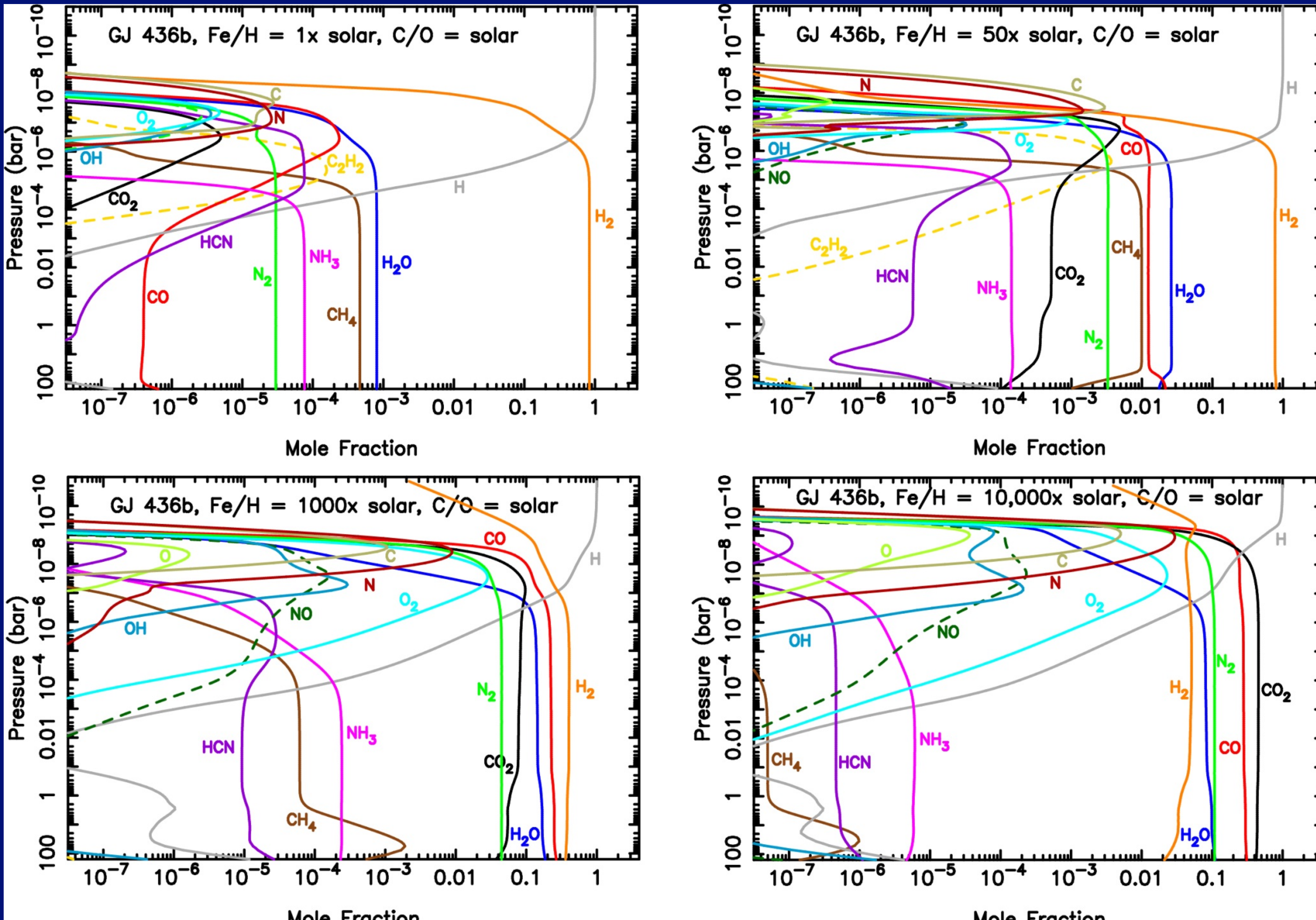
from Moses (2013), Phil. Trans. Roy. Soc. A, submitted

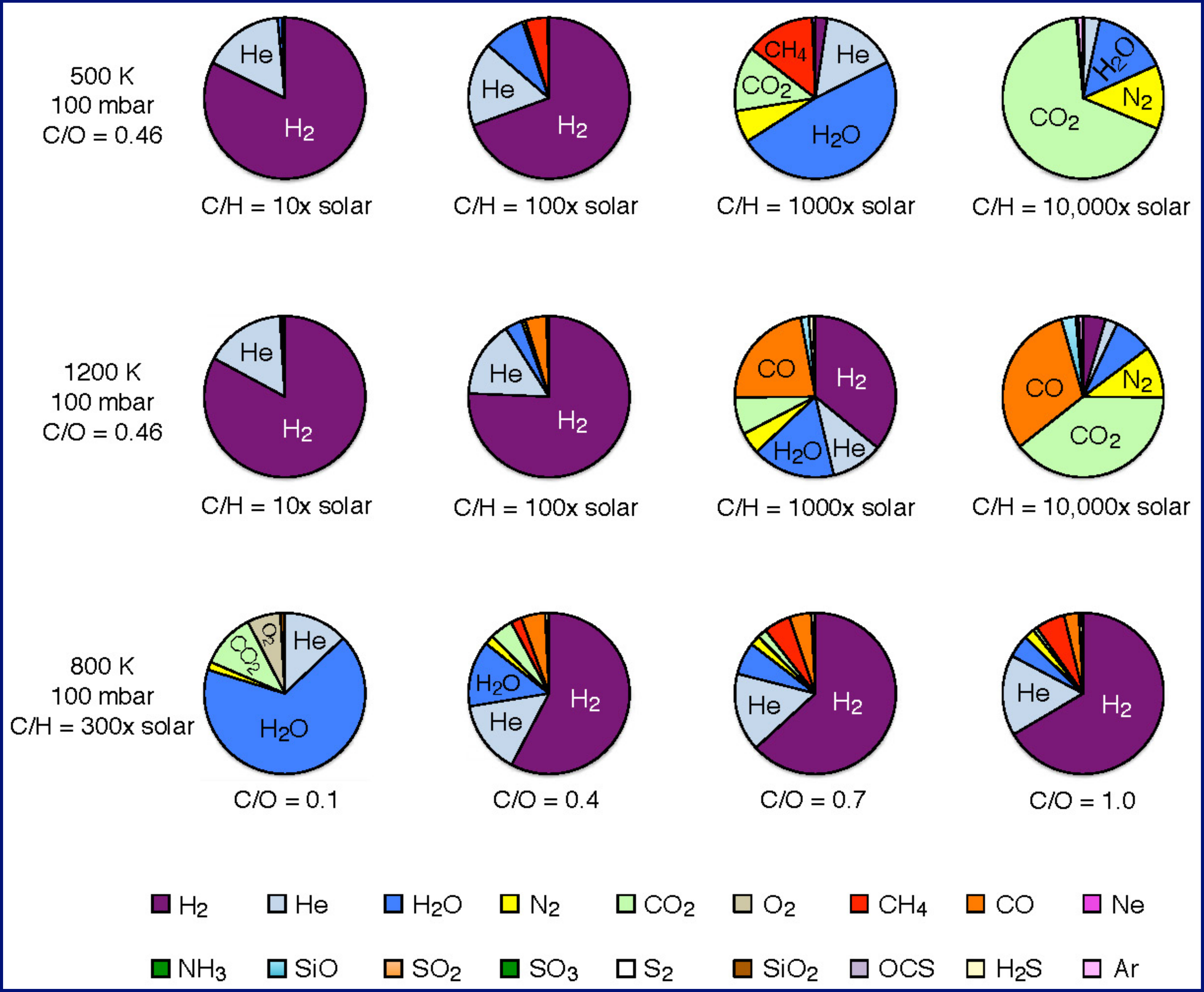
Kinetics/Transport: "Warm" Giant



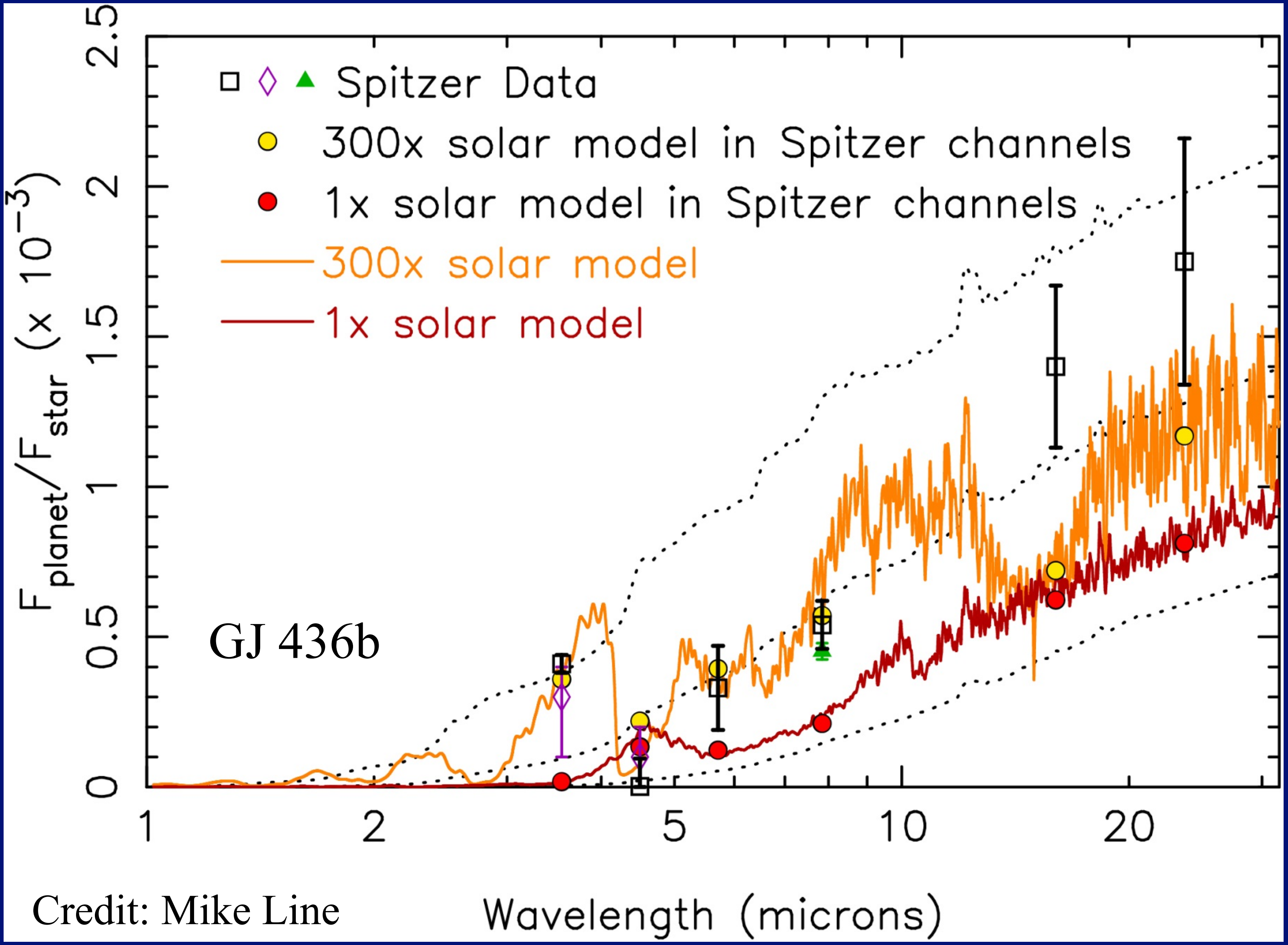
from Moses (2013), Phil. Trans. Roy. Soc. A, submitted

Exoplanet Chemistry: Metallicity Matters



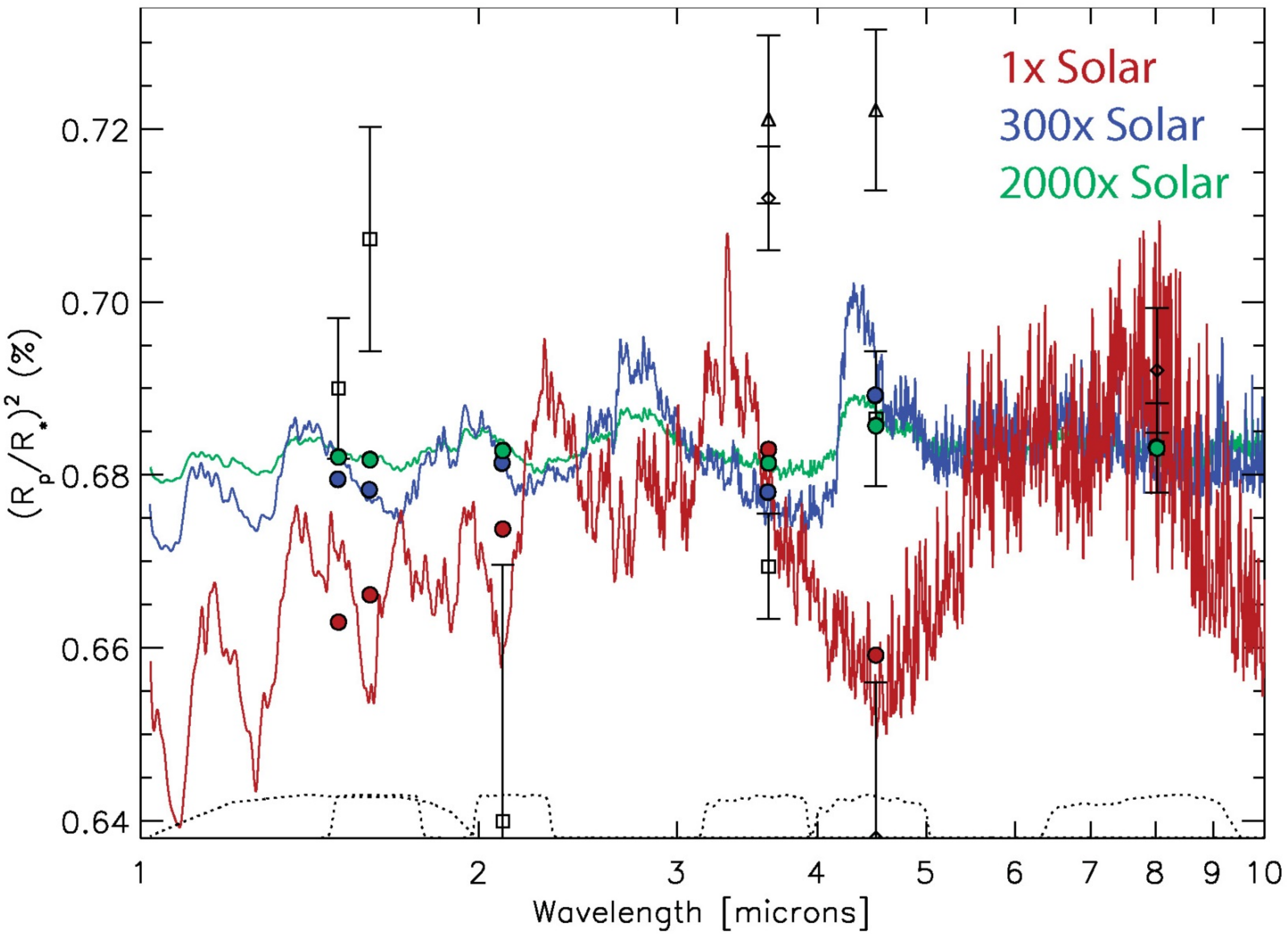

500 K
100 mbar
C/O = 0.46
C/H = 10x solar
C/H = 100x solar
C/H = 1000x solar
C/H = 10,000x solar
1200 K
100 mbar
C/O = 0.46
C/H = 10x solar
C/H = 100x solar
C/H = 1000x solar
C/H = 10,000x solar
800 K
100 mbar
C/H = 300x solar
C/O = 0.1
C/O = 0.4
C/O = 0.7
C/O = 1.0
H2
He
H2O
N2
CO2
O2
CH4
CO
Ne
NH3
SiO
SO2
SO3
S2
SiO2
OCS
H2S
Ar

Exoplanet Chemistry: Metallicity Matters



from Moses et al. (2013), ApJ, submitted

Exoplanet Chemistry: Metallicity Matters



Credit: Mike Line

from Moses et al. (2013), ApJ, submitted

Consequences of Disequilibrium Chemistry

- Depends on temperature: On warmer giant exoplanets, increased CH_4, NH_3, HCN, C_2H_2 due to quenching, but CO, H_2O, CO_2 remain close to equilibrium (except at high alt)
- On cooler giant exoplanets, transport-induced quenching increases the abundance of CO and NH_3 over equilibrium, but CH_4 and H_2O unaffected; greater photochemical production of complex hydrocarbons and nitriles
- Depends on metallicity: For carbon species, at very high metallicities, CO_2 favored; at moderate-to-low metallicities, CO favored at high *T* and CH_4 at low *T*. Water prominent throughout and not destroyed; can be dominant. **Hot Neptunes may have diverse and exotic atmospheric compositions**!!
- Observational consequences in transit and eclipse spectra, especially in adding opacity to water windows in eclipse data; transit data very sensitive to metallicity