PEPS

Chemistry, Condensation & Clouds in Substellar Atmospheres

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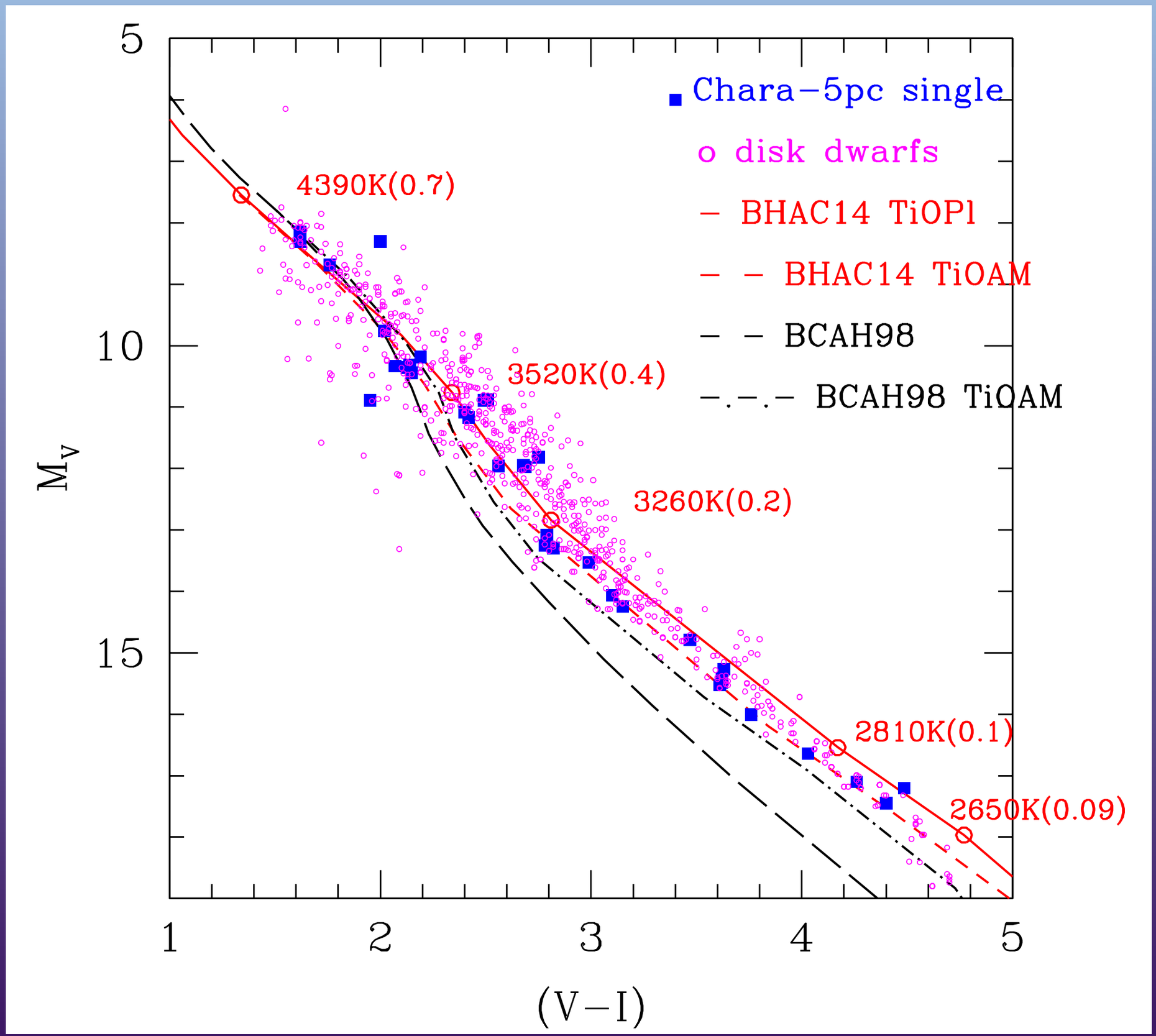
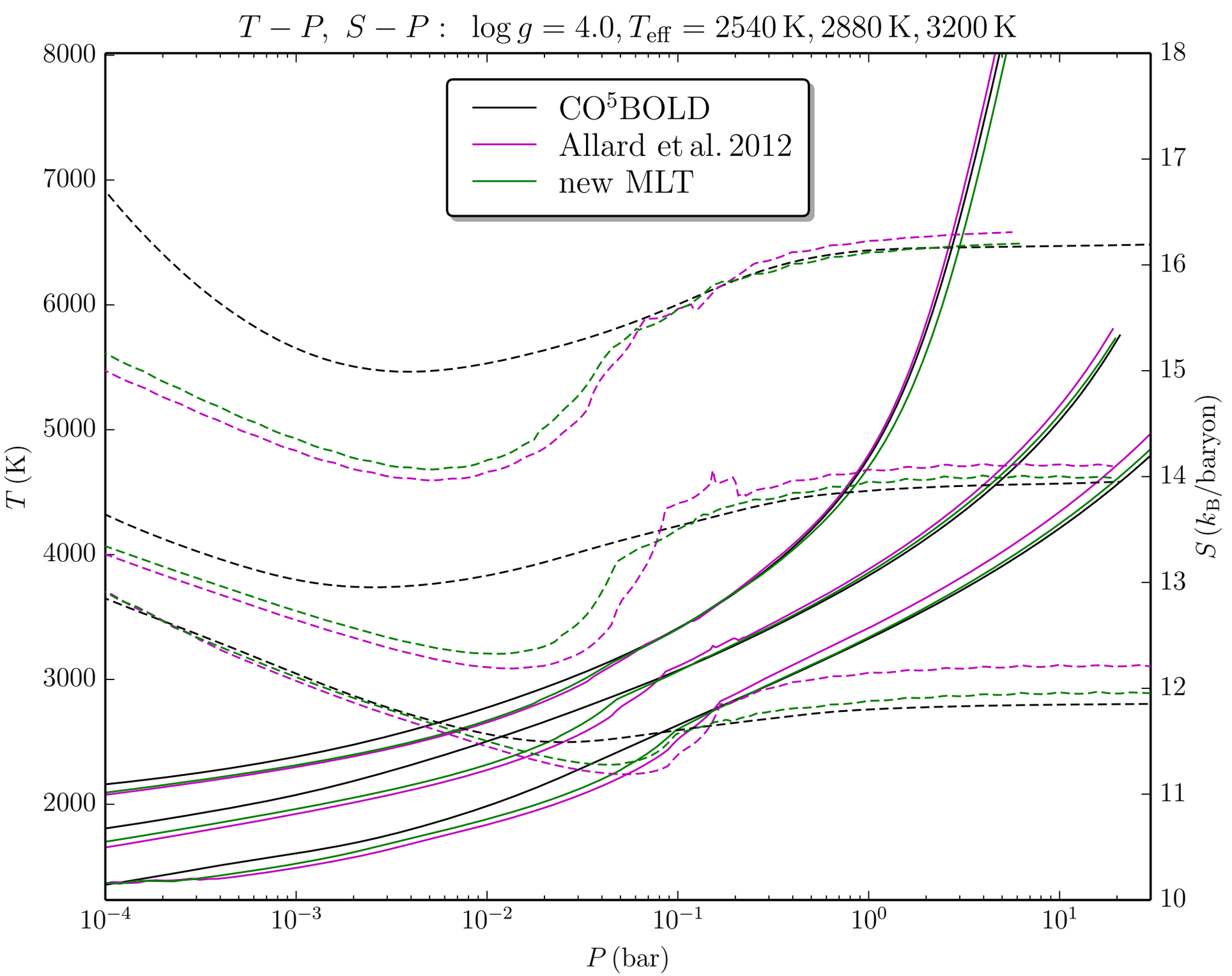
Model atmospheres — connecting physics to observables



Baraffe et al. 2015

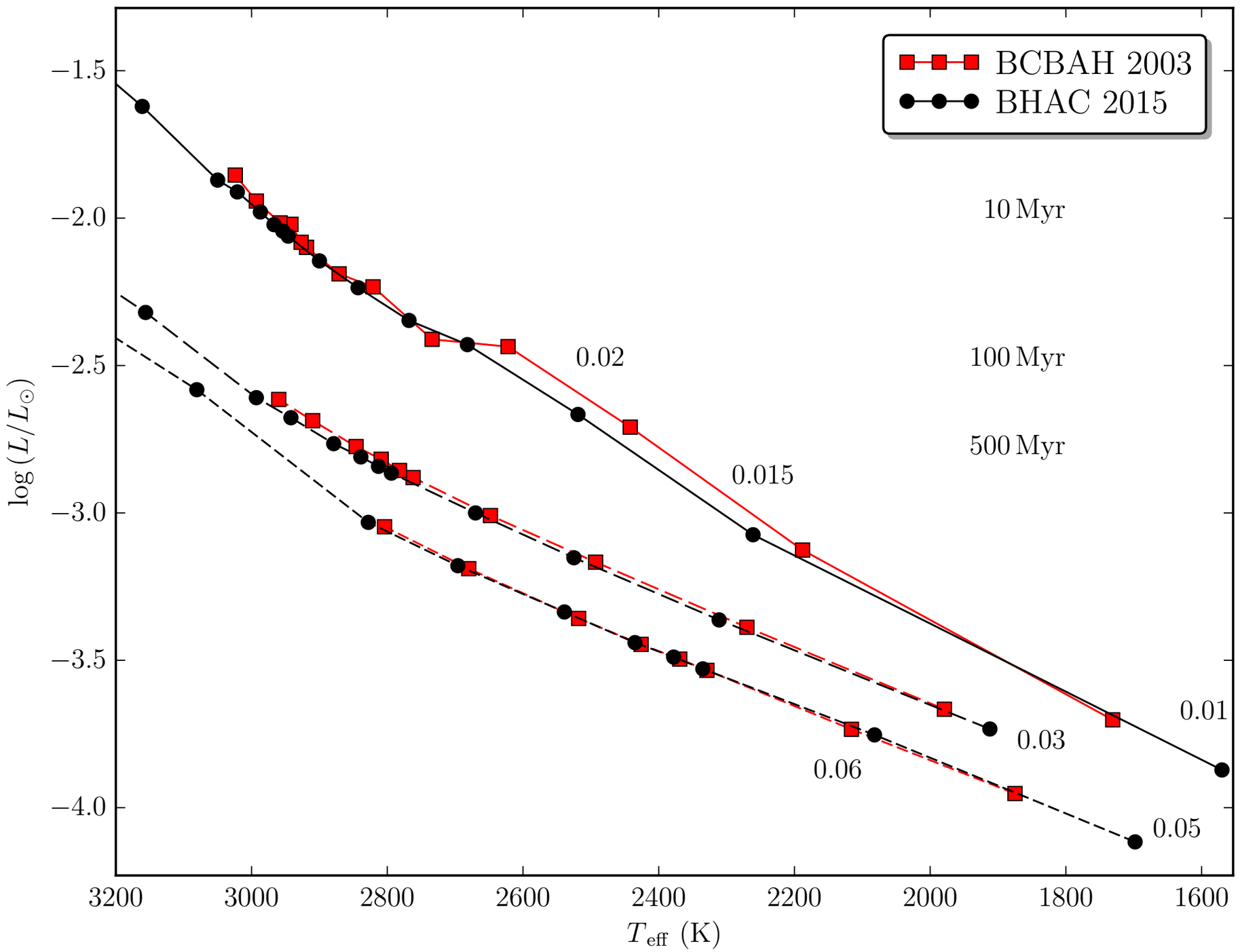
Modelling convection — calibration of MLT



radiative hydrodynamic models calibrate temperature gradient and convective flux

convective structure defines deep thermal profile → boundary condition for evolution!

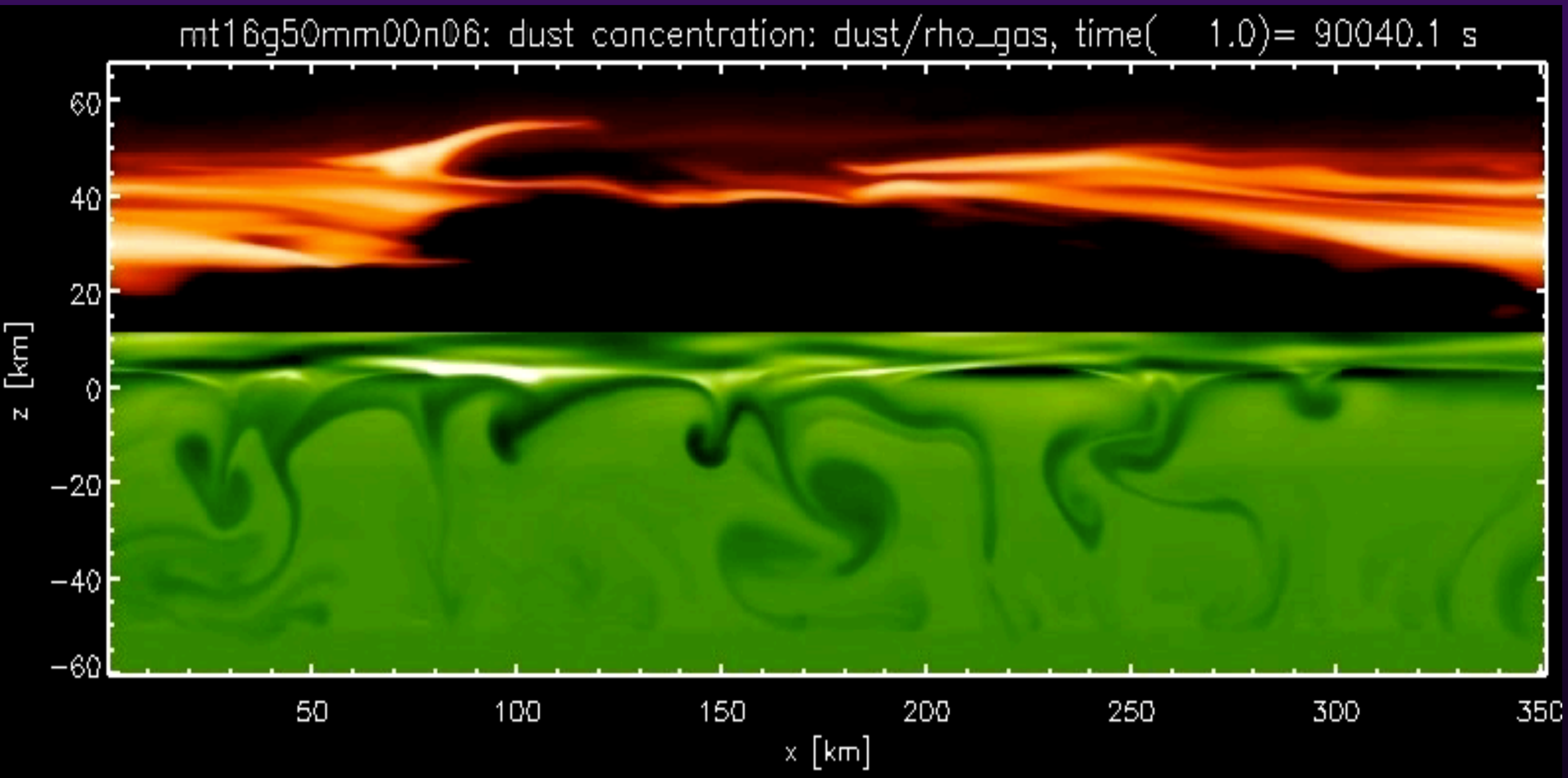
Model atmospheres — boundary condition for evolution



cooling rates are significantly affected by photospheric opacity

consistent treatment of interior and atmospheric modelling essential

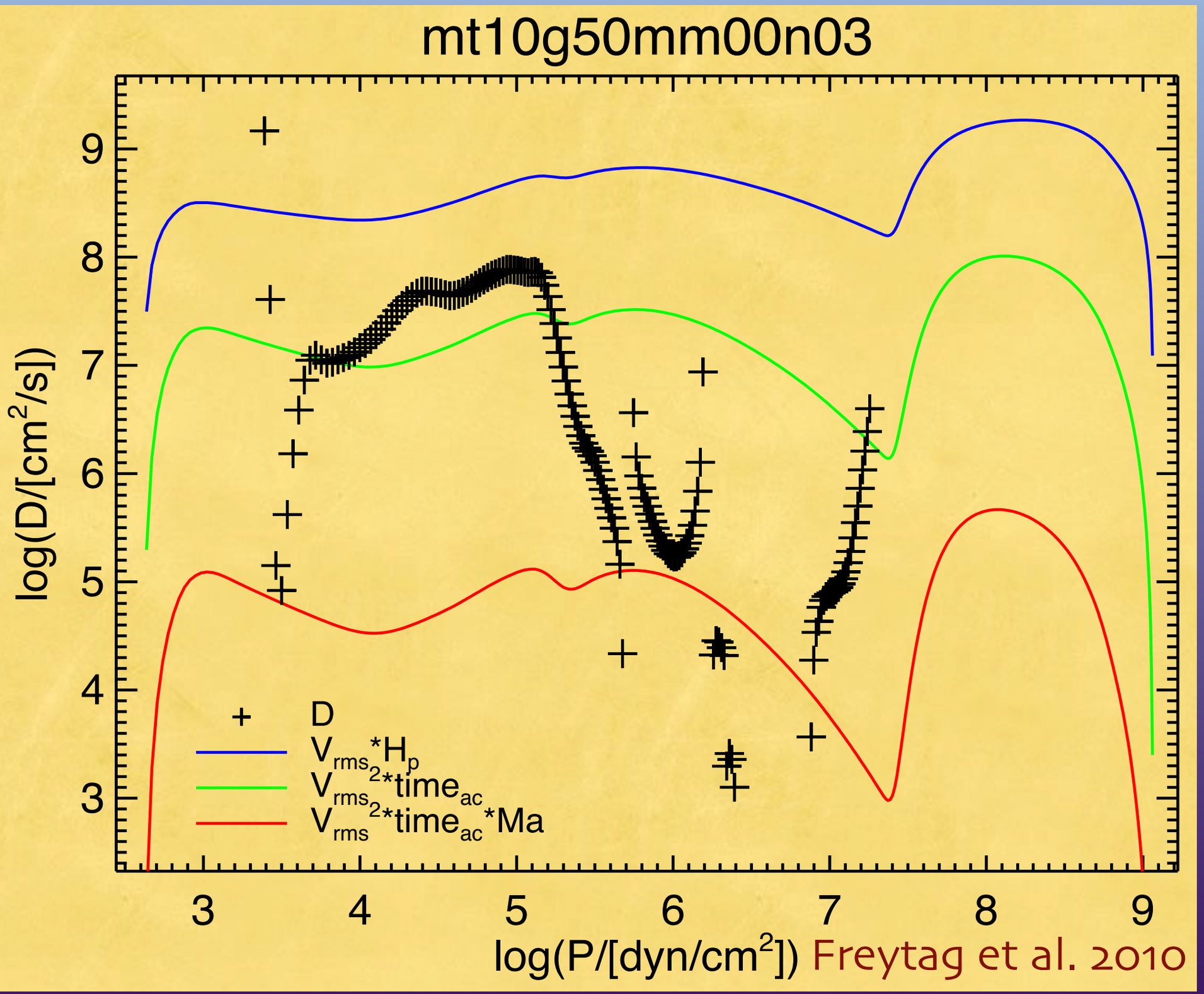
Baraffe et al. 2015



CO5BOLD 2D-Hydrodynamic Simulation of 1600 K L dwarf atmosphere
with Forsterite (Mg_2SiO_4) cloud model

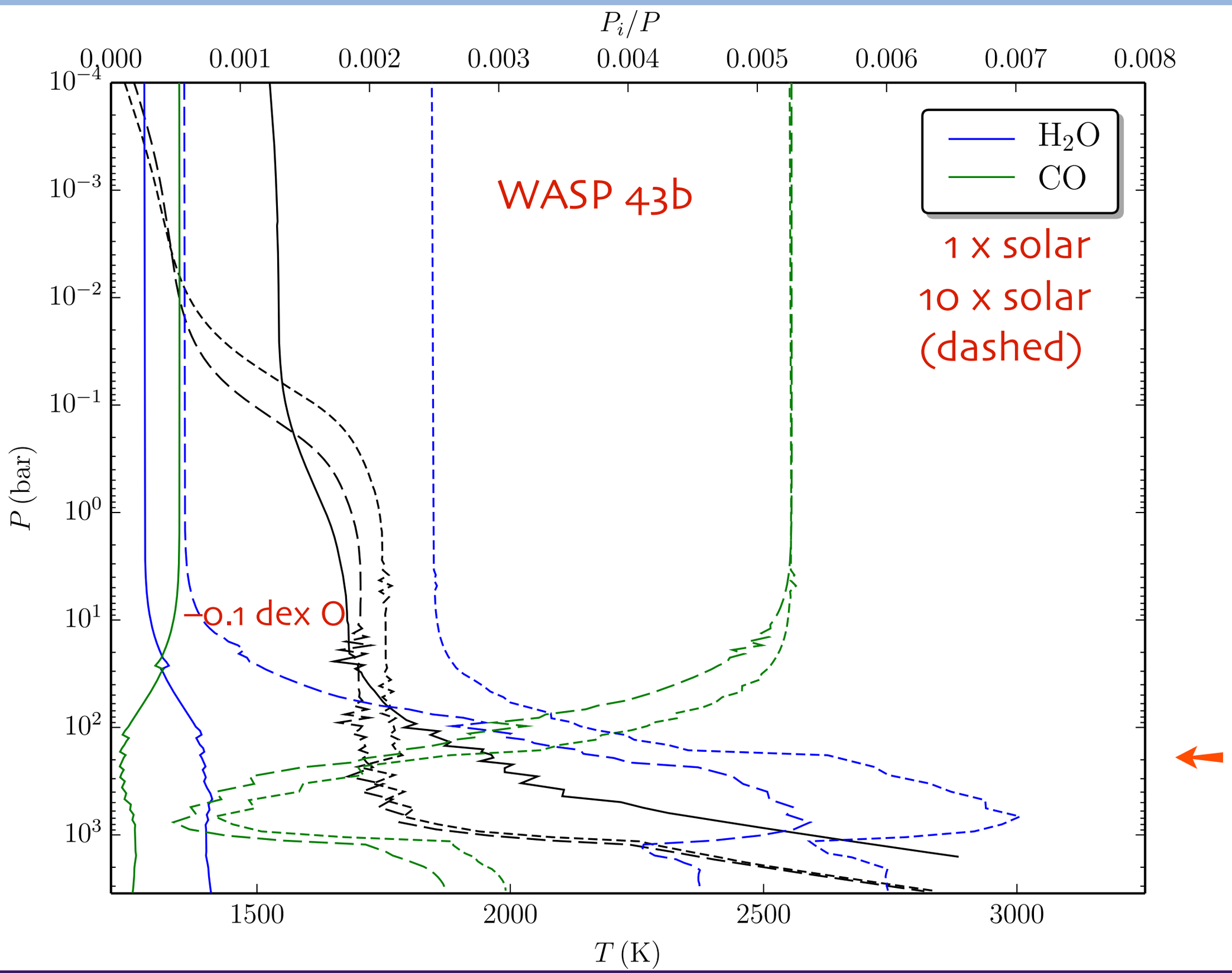
Freytag et al. 2010

Mixing and Diffusion - a closer Look



convective overshoot and gravity wave excitation dominant in brown dwarfs

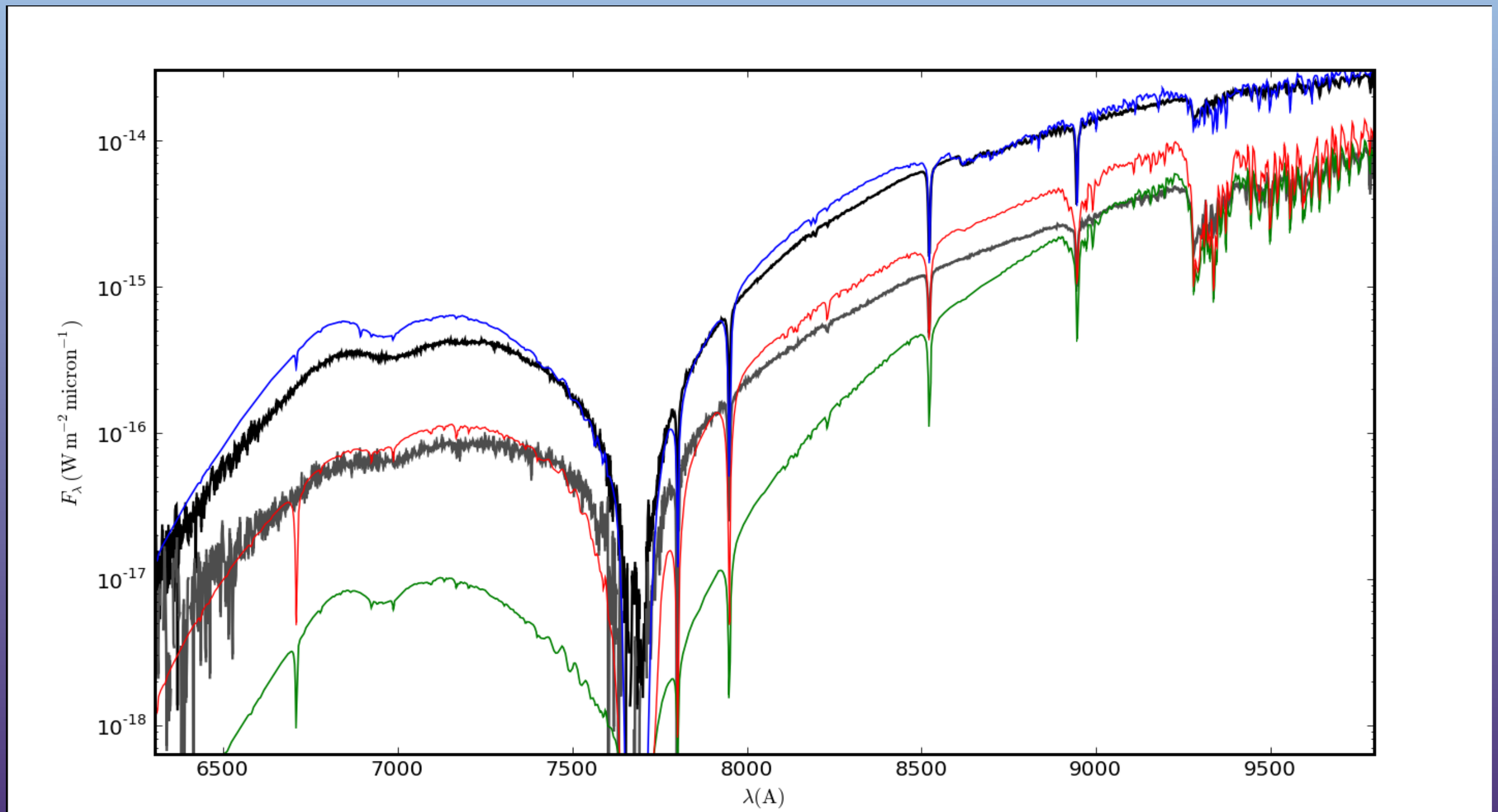
Clouds affect carbon/oxygen chemistry



sequestration of oxygen in deep silicate clouds!

— cf. also talk by T. Kopytova

Condensation

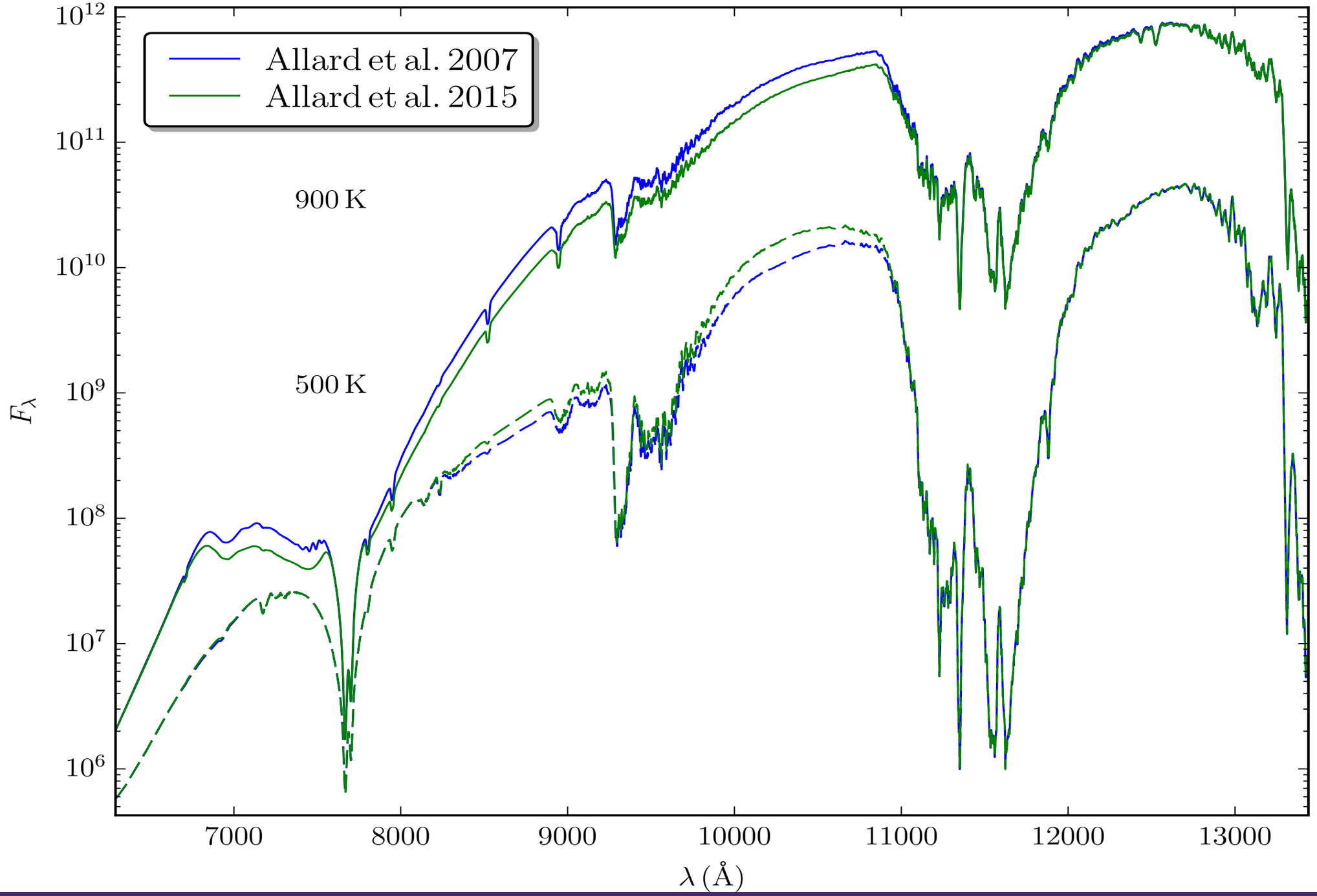


- cloud opacity changes spectral energy distribution

King et al. 2010

- depletion changes gas phase composition → changes spectra as well

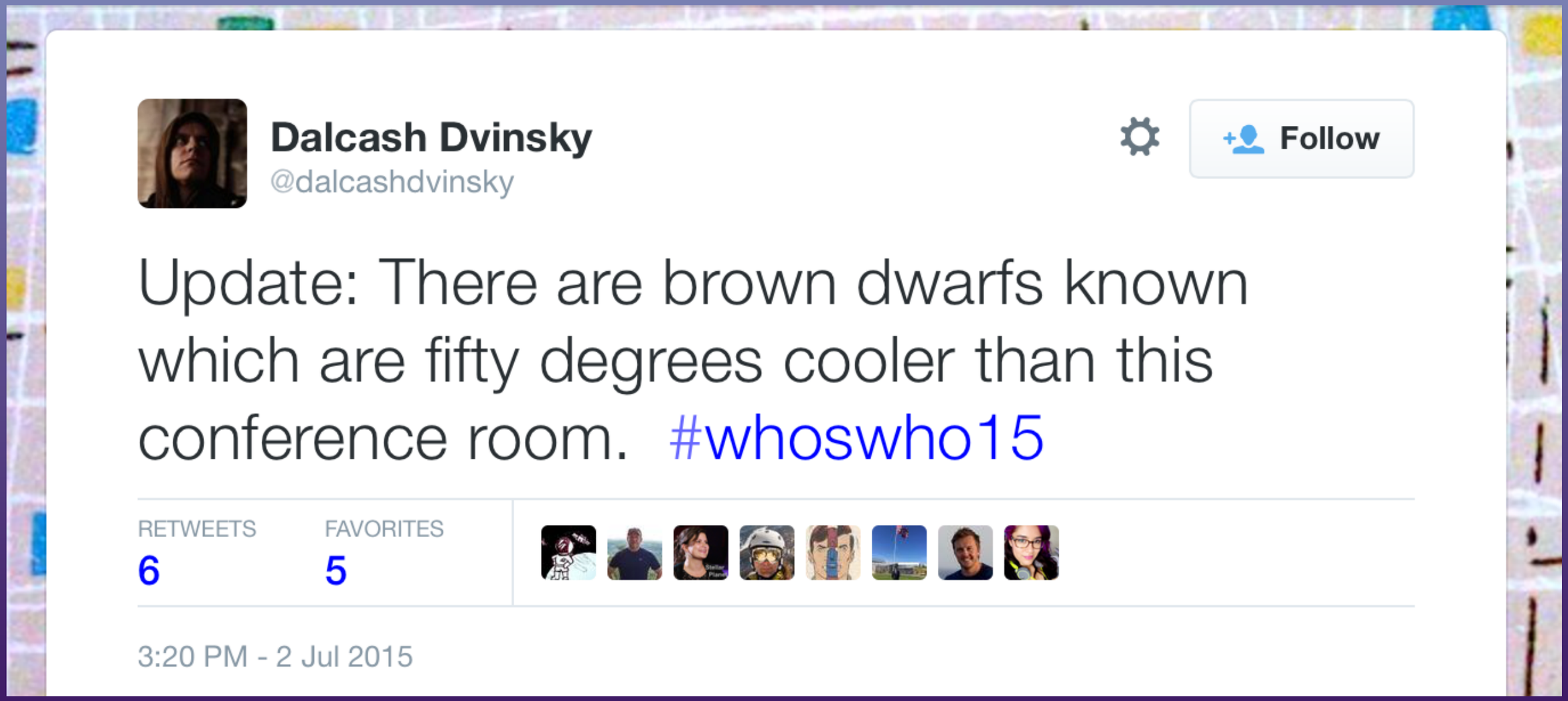
Condensation



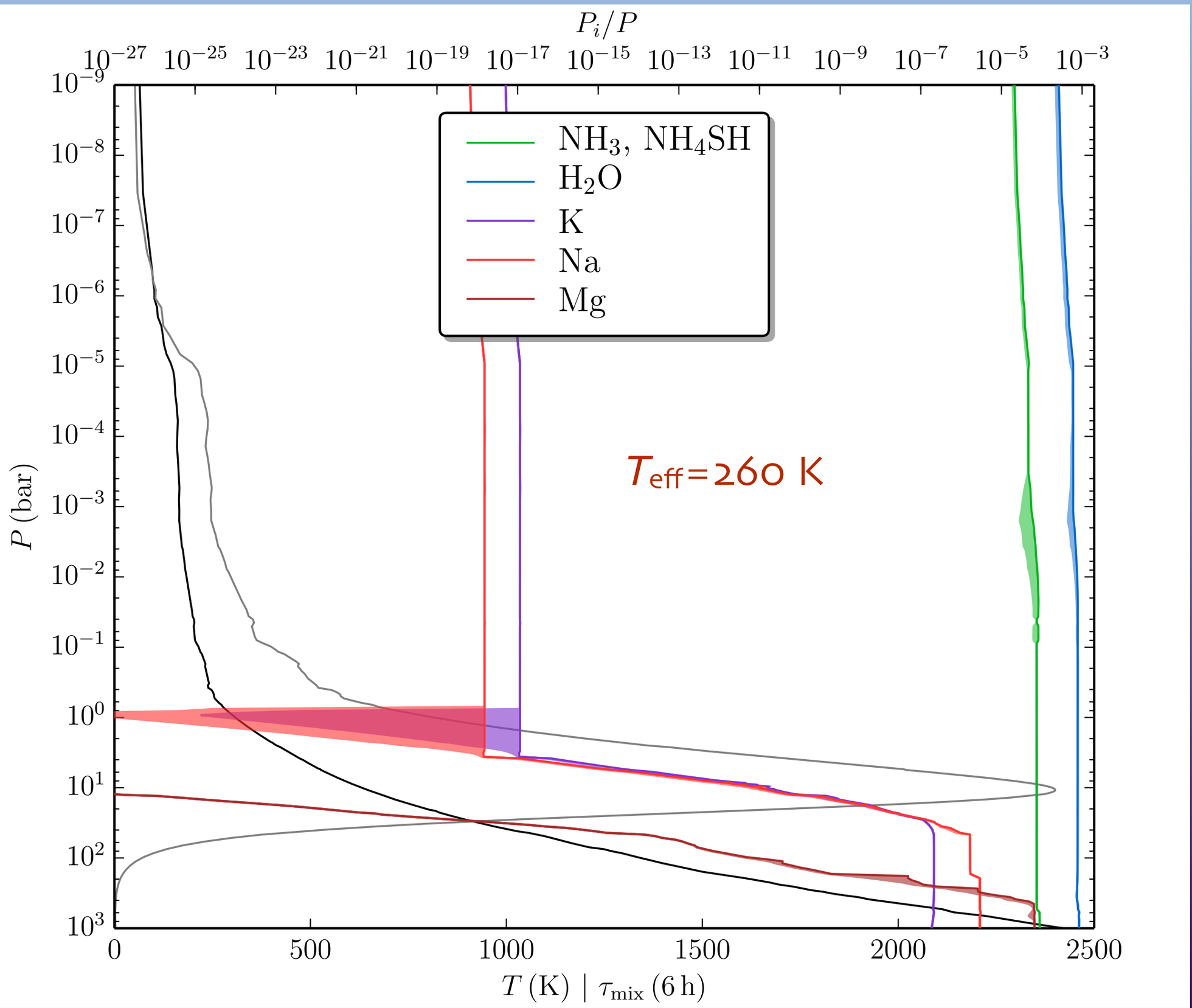
- depletion and accurate broadening theory important
  - Allard et al. in prep. & poster

Clouds in Brown Dwarfs and Planets

- with T and Y dwarfs, getting into the domain of sulphide, halide, and ultimately water ice clouds (Morley et al. 2012, 2014…)



Clouds in Brown Dwarfs and Planets



WISE 0855-0714

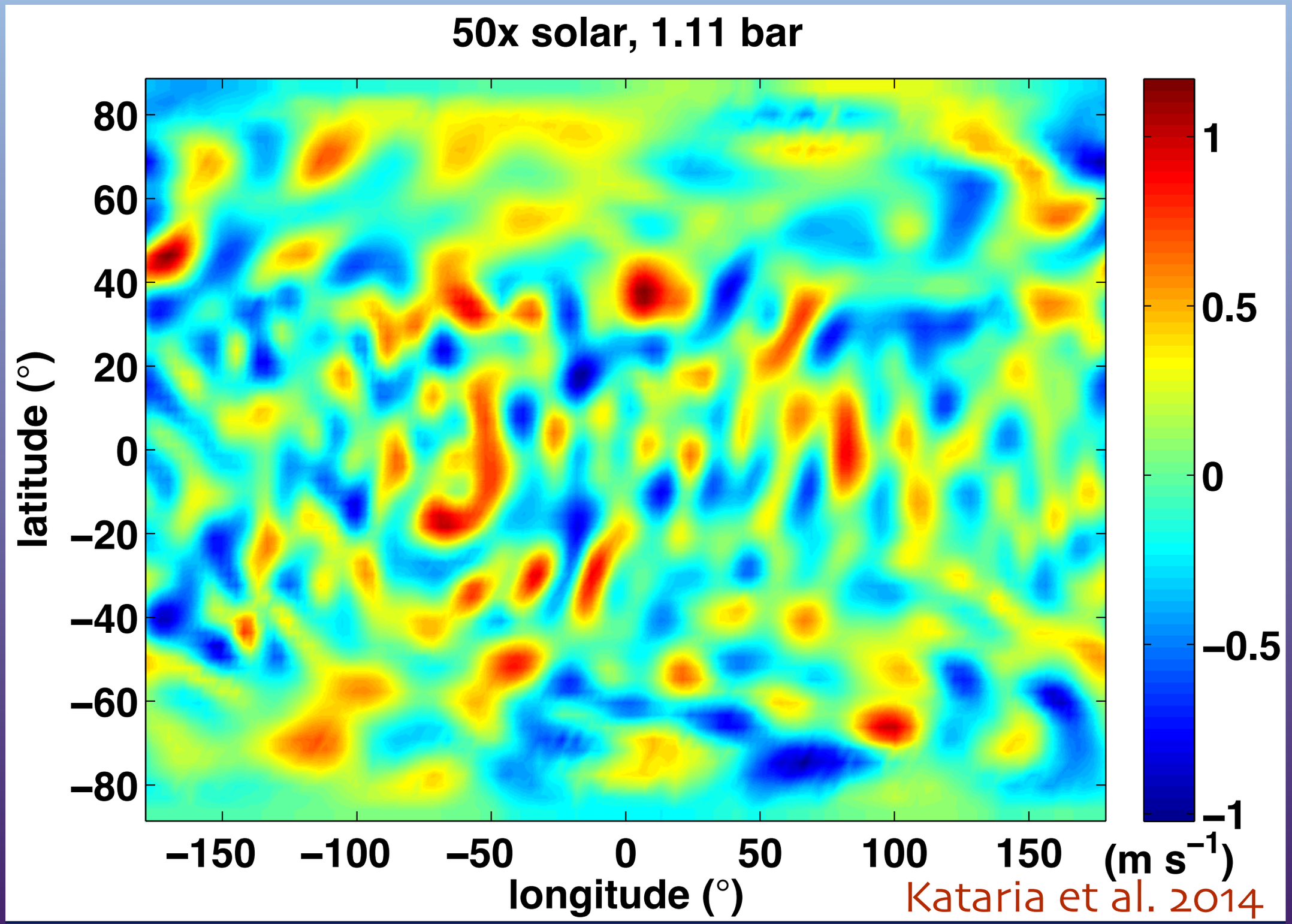
Beamín et al. 2014, poster by H. Boffin

water ice, ammonium hydrosulphide clouds

quenching of CO, NH_3 in non-CE (cf. Visscher et al. 2010)

deep silicate clouds

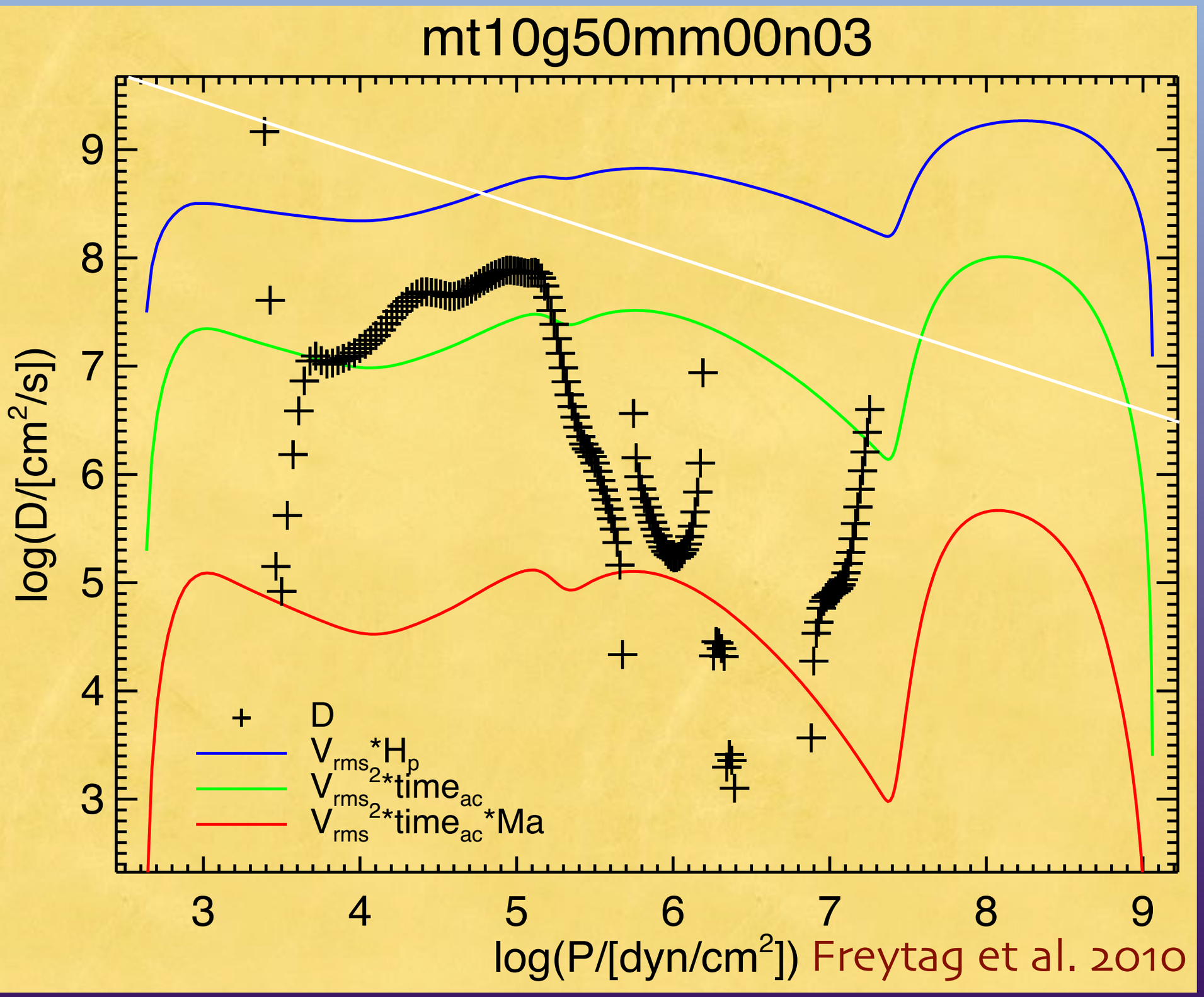
Exoplanets — Irradiation and Circulation



Kataria et al. 2014 GJ 1214b

- General Circulation models predict vertical wind components

Mixing and Diffusion - a closer Look

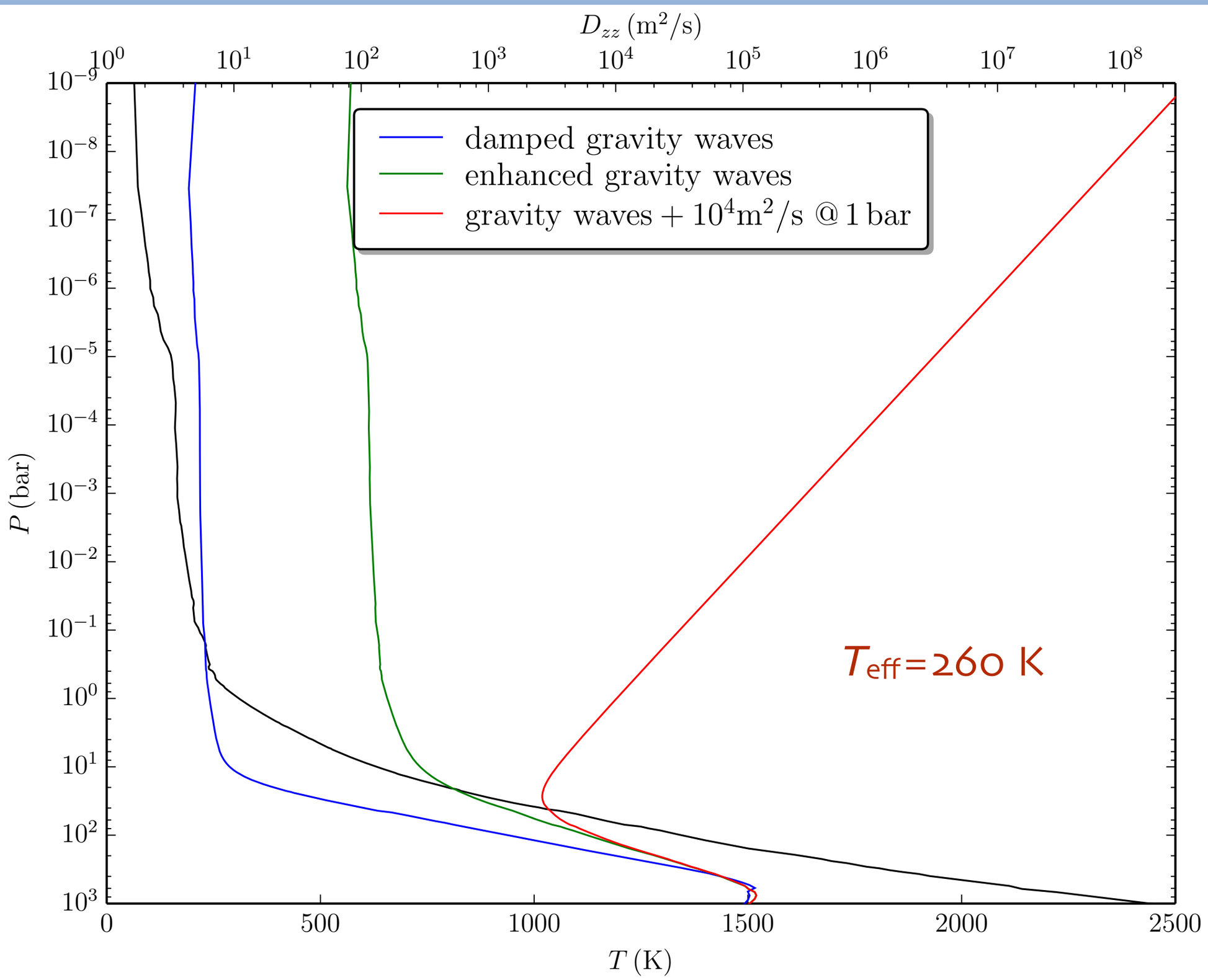


convective overshoot and gravity wave excitation dominant in brown dwarfs — but in planets too inefficient (Schwarzschild boundary @ $\tau \approx 100$

→

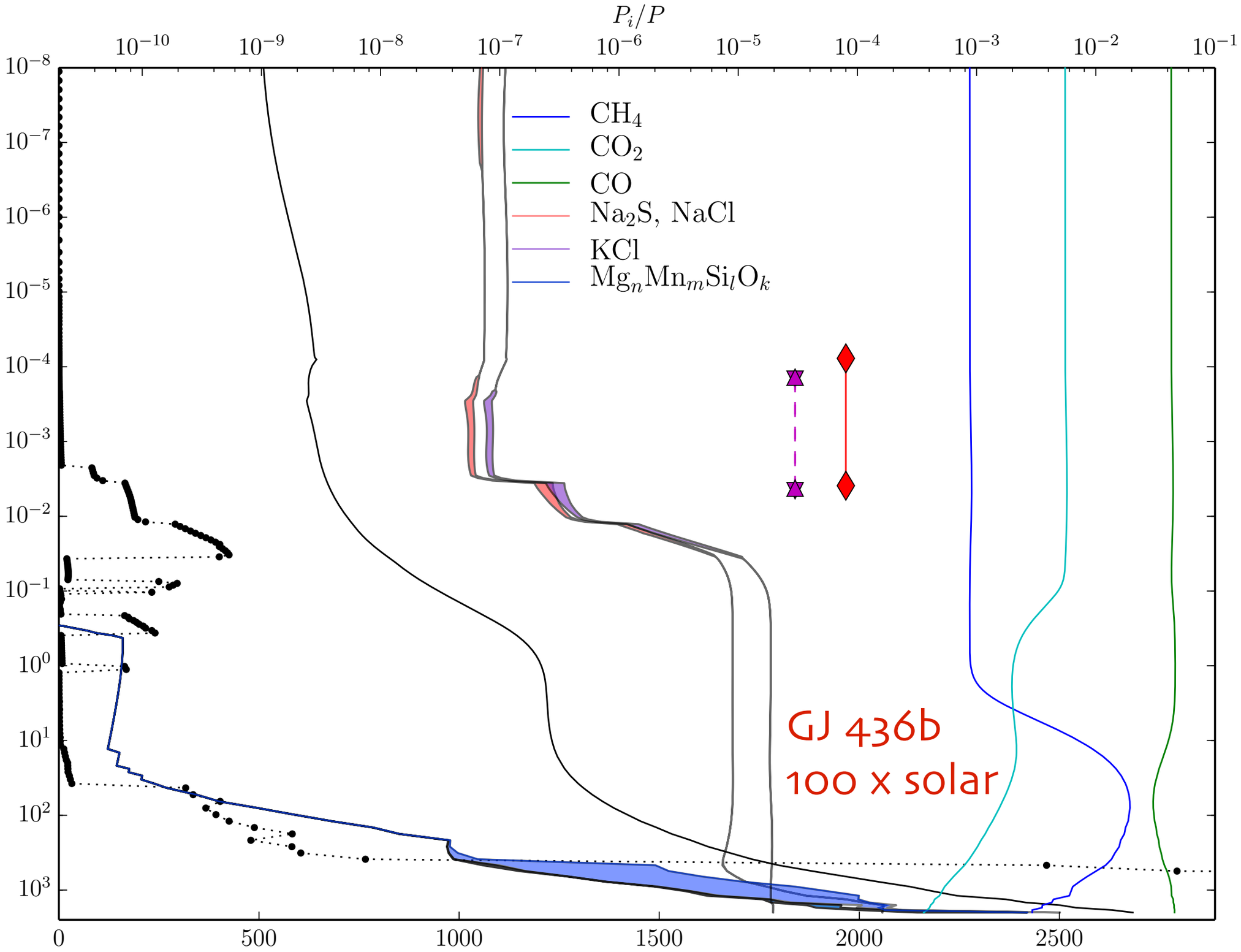
global circulation important!

Clouds in Brown Dwarfs and Planets



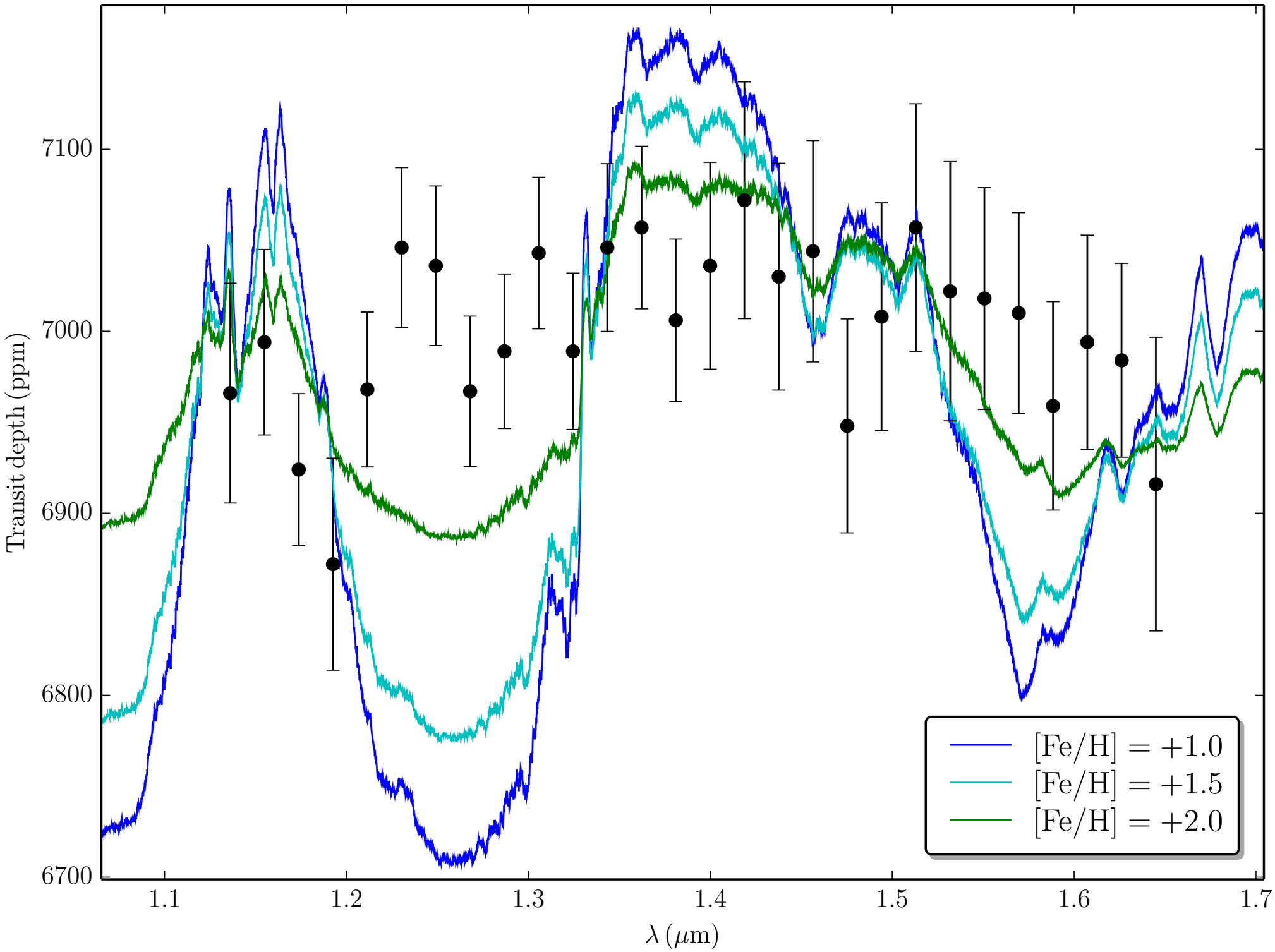
modelling mixing based on extrapolation of RHD simulations + GCM models (Parmentier et al. Kataria et al.)

Clouds in hot Neptunes and super-Earths



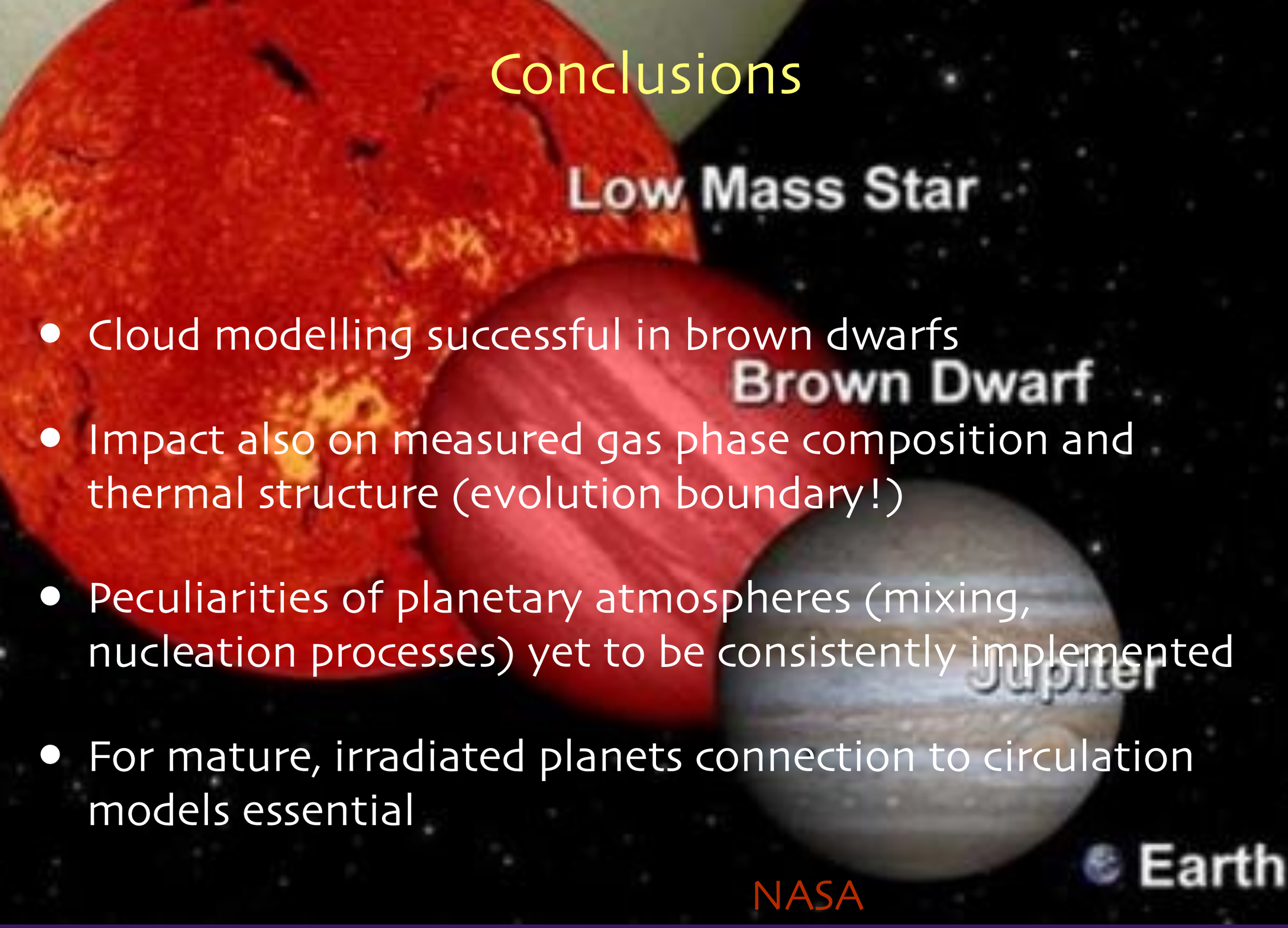
Clouds in hot Neptunes and super-Earths

GJ 436b transit models and WFC3 observations (Knutson et al. 2014)



Conclusions

- Cloud modelling successful in brown dwarfs
- Impact also on measured gas phase composition and thermal structure (evolution boundary!)
- Peculiarities of planetary atmospheres (mixing, nucleation processes) yet to be consistently implemented
- For mature, irradiated planets connection to circulation models essential



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