The future of Jupiter-like planets around Sun-like AGB stars: first steps

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Take-home message

If a Jupiter-like planet stays at ~5 AU during the stellar evolution phases, it will warm up to T ≥ 600 K due to the high luminosity of the AGB star. The deep atmosphere retains its high H_2O and CH_4 abundance, but several species (incl. CO, CO_2, HCN) become enhanced.

Why?

After the **Main sequence (MS)**, solar-type stars will evolve through the giant branches, including the **Asymptotic Giant Branch (AGB)**. The **luminosity** will increase by **orders of magnitude** and this will affect orbiting planets.

How?

We simulate the 1D **temperature structure** with petitCODE [1] and 1D atmospheric **chemical composition** [2] of a gaseous Jupiter-like planet at 5 AU.

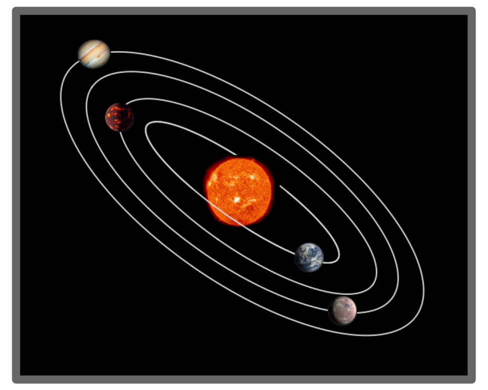
Our results are in agreement with [3], which matches observed abundance of CO in Jupiter's deep atmosphere.

Main sequence

$L \sim 1\ L_\odot$

$R \sim 1\ R_\odot$

$T_{eff} \sim 5700$ K

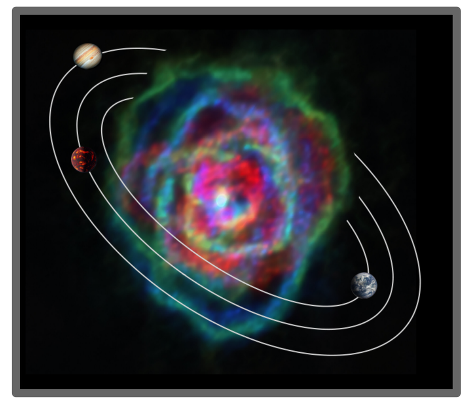


Asymptotic Giant Branch

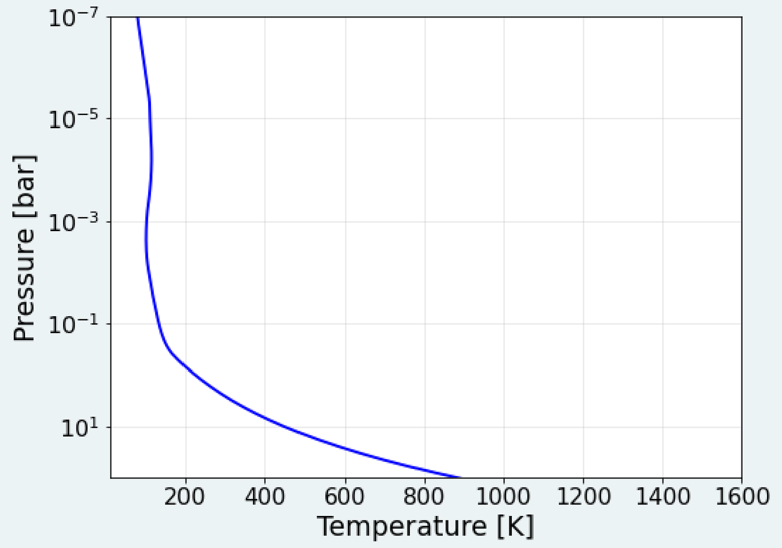
$L \sim 10^3\ L_\odot$

$R \sim 100\ R_\odot$

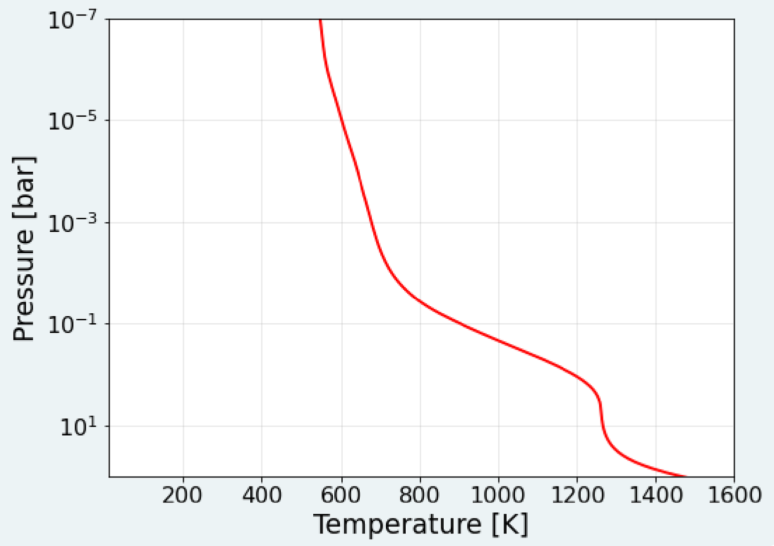
$T_{eff} \sim 4000$ K

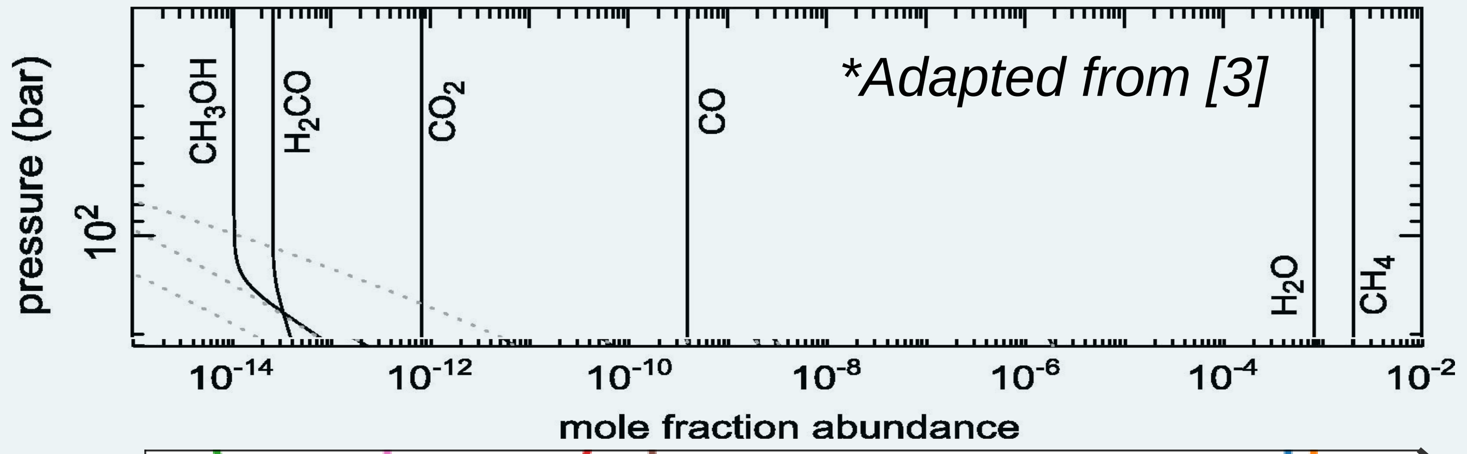


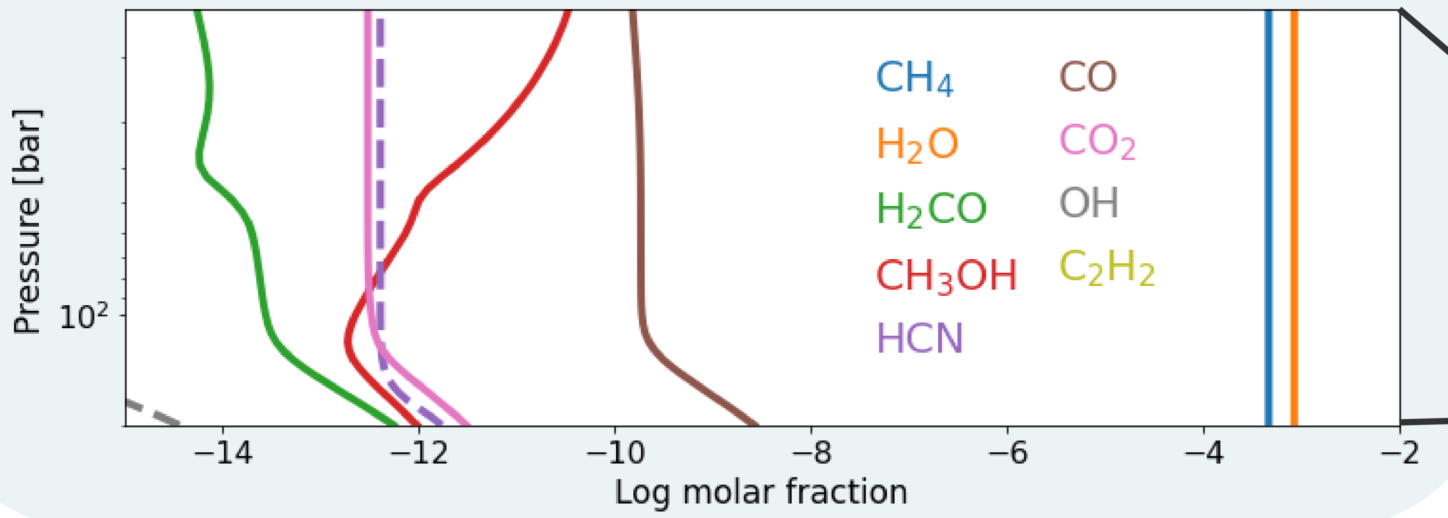
At a distance of 5 AU, the temperatures are < 200 K below 1 bar

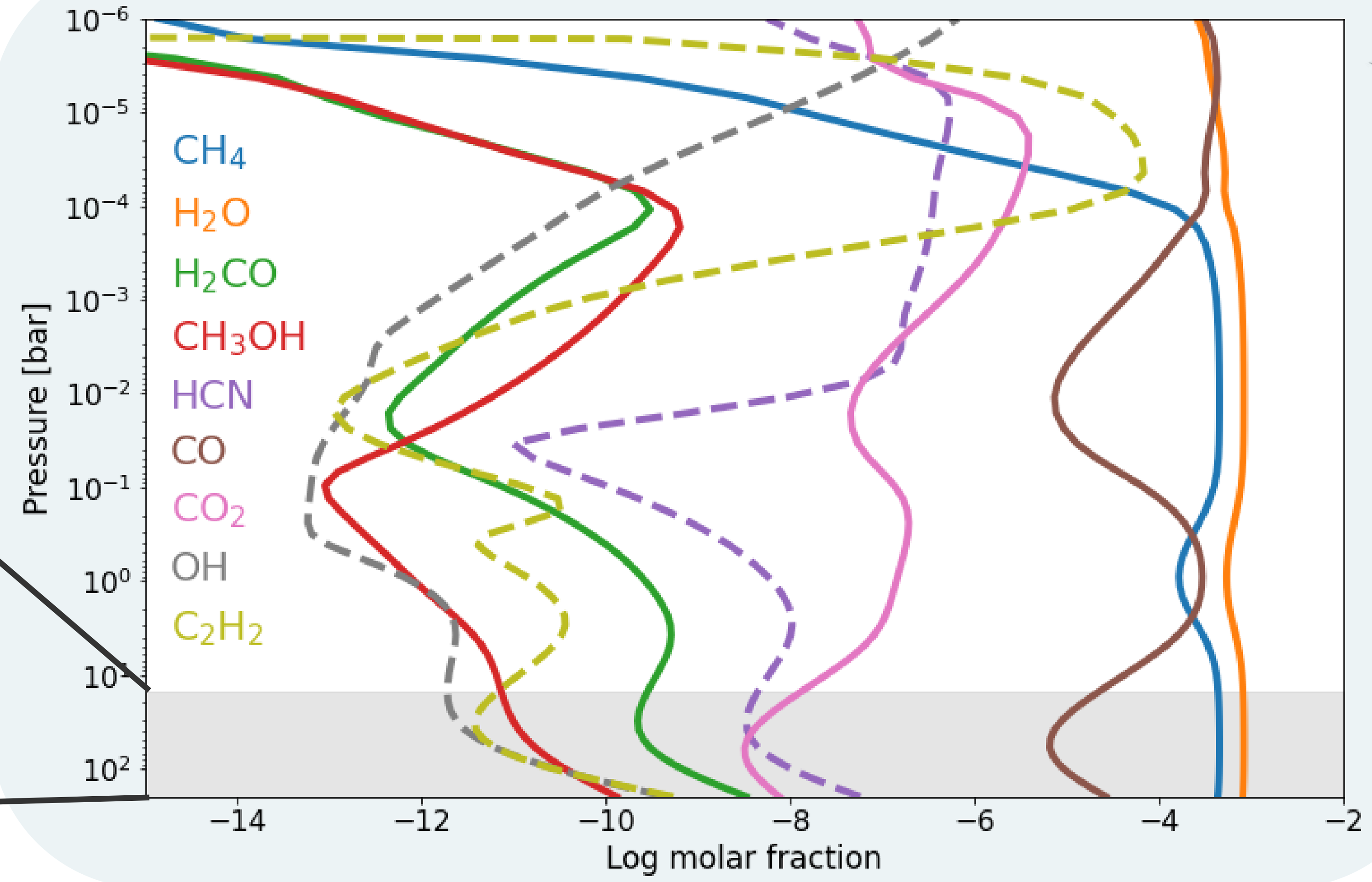


Because L increases, temperatures reach ~600 K in the upper layers









«When simulating the AGB star planet, we can increase the pressure range.»

- CH_4, H_2O (& H_2) remain dominant
- CO becomes a prominent constituent
- HCN and C_2H_2 become non-negligible

The road ahead...

Do these planets lose their atmospheres by hydrodynamical escape?

How does the 3D general circulation pattern change?

What kind of interaction is there with the strong stellar AGB wind?

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References

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[2] Agúndez M., Parmentier V., Venot O., Hersant F., Selsis F., 2014a, A&A, 564, 73
[3] Visscher, C., Moses, J. I., & Saslow, S. A. 2010, Icarus, 209, 602

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