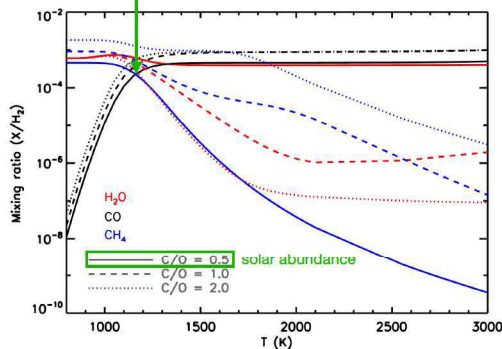


What are the chemical trends with temperature?

transition between CO and CH₄ as dominant carbon carrier at 1200 K (at P=1 bar)
 $\text{CH}_4 + \text{H}_2\text{O} \rightleftharpoons \text{CO} + 3\text{H}_2$
 Is this transition pressure-dependent?

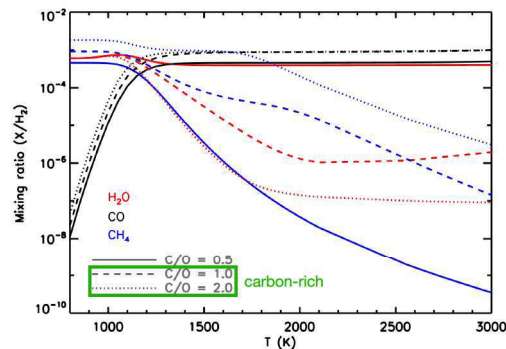


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Madhusudhan (2012, ApJ, 758, 36)

What are the chemical trends with temperature?

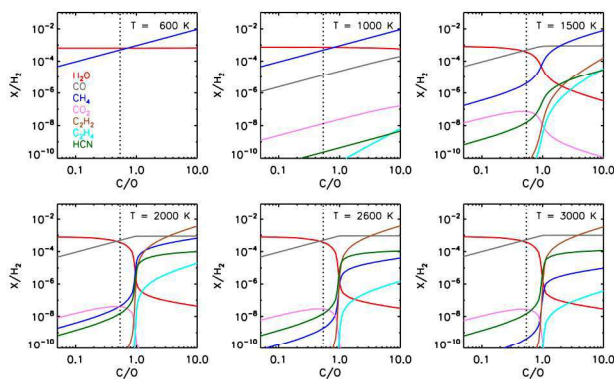
As the conditions become more carbon-rich, notice how methane becomes more abundant and water becomes less abundant.



8

Madhusudhan (2012, ApJ, 758, 36)

What are the chemical trends with carbon-to-oxygen ratio (C/O)?

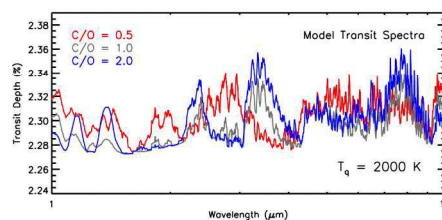


H₂-dominated atmospheres: Carbon-rich atmospheres are water-poor and methane-rich

9

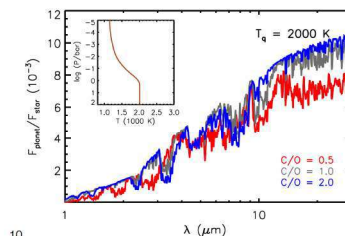
Madhusudhan (2012, ApJ, 758, 36)

Strong variations of chemical abundances with C/O imply that the corresponding spectra differ strongly as well



Madhusudhan (2012, ApJ, 758, 36)

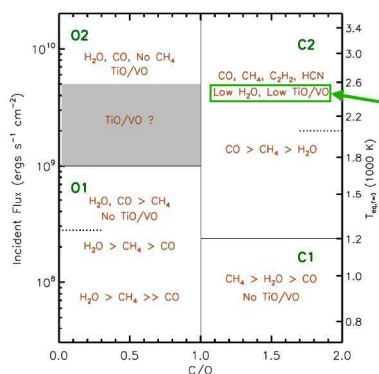
This is an interesting paper to review for your seminar talk!



10

λ (μm)

Strong variations of chemical abundances with C/O: chemical classification scheme

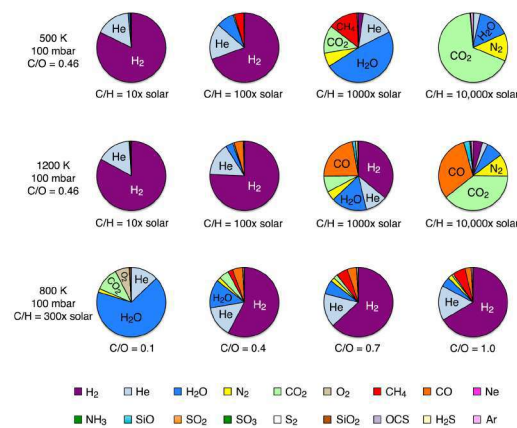


Prediction: Carbon-rich atmospheres are both water-poor and have low abundances of titanium oxide and vanadium oxide, since the oxygen is mostly locked up in carbon monoxide!

11

Madhusudhan (2012, ApJ, 758, 36)

Another exoplanet example: mini Neptunes (or sub-Neptunes)



12

Moses et al. (2013, ApJ, 777, 34)