# How do you like it?

OR

investigate how the spectral shape changes as a function of temperature and assumed composition

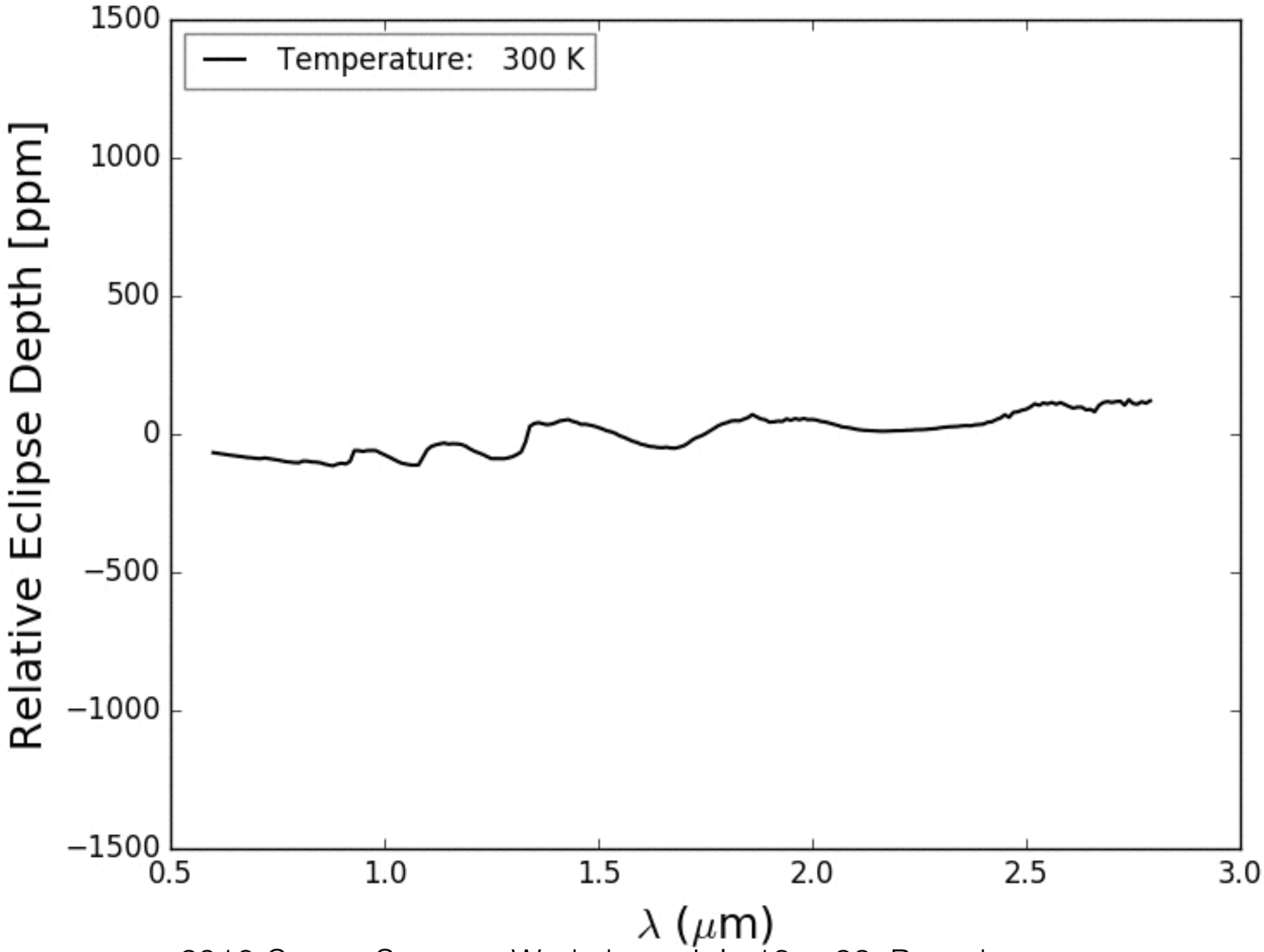
# How do you like it?

- Temperature
- Water
- Molecules

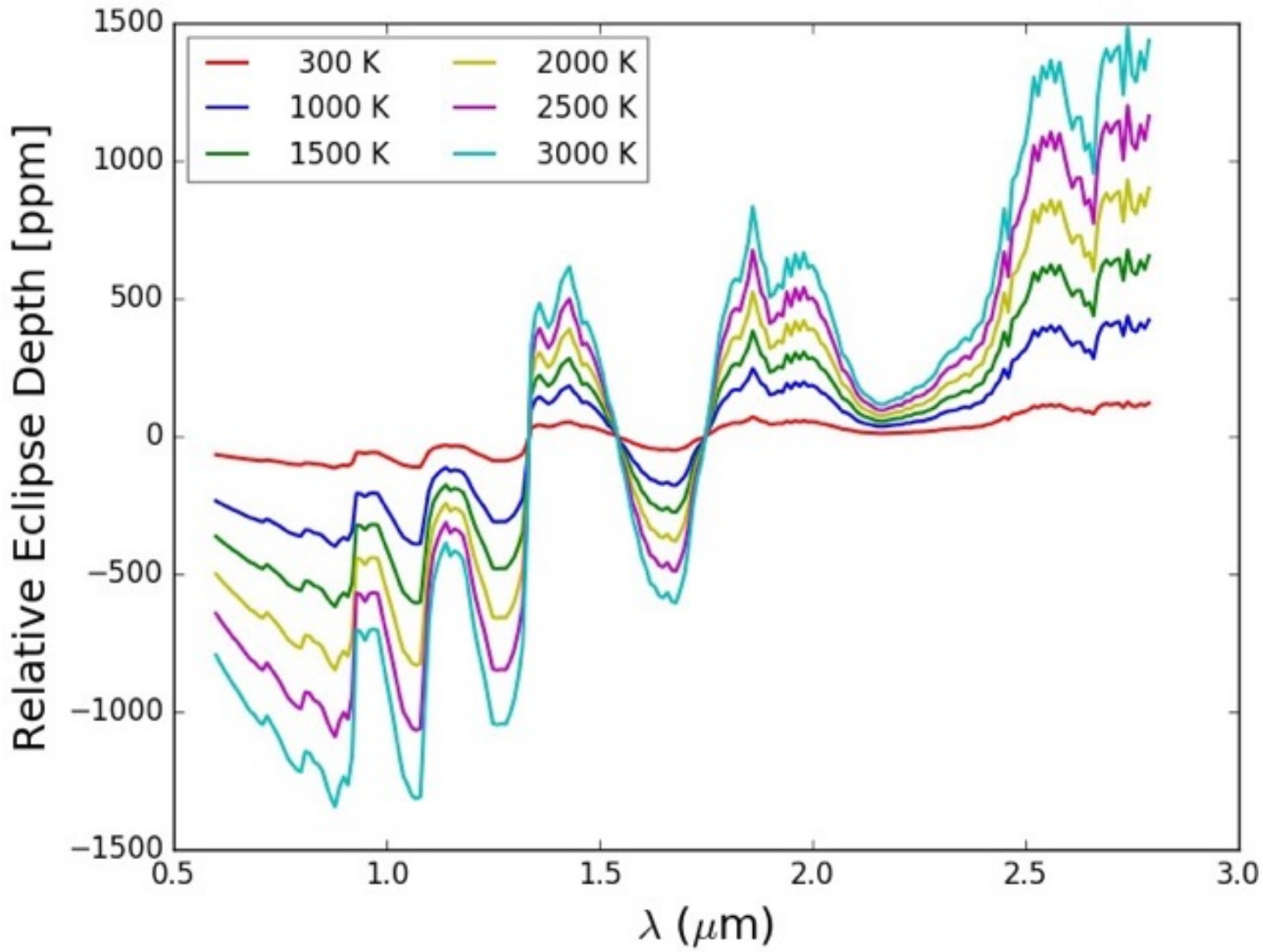
# Dream Team

- Bin Ren - **Johns Hopkins**
- Clara Sousa-Silva - **UCL/MIT**
- Jesse Lopez - **CSUN**
- Lorenzo Pino - **University of Padova**
- Pinghui Huang - **Chinese Academy of Science**
- Jessica Roberts - **University of Colorado**
- Kyle Sheppard - **University of Maryland**

# Spectra like it hot



# Temperature dependence



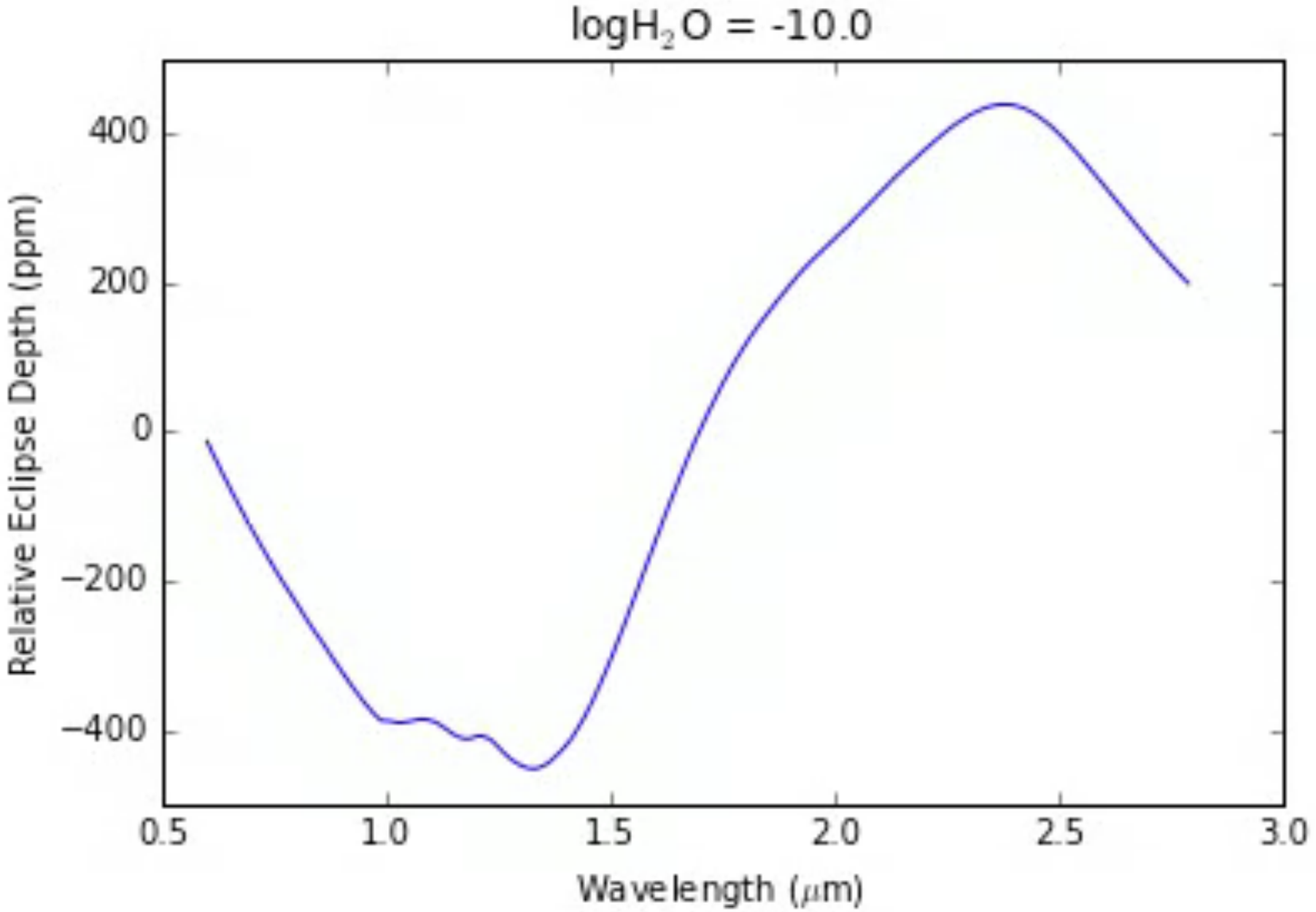

**Absorption During Transit (%):**

$$\frac{10R_p}{R_*^2}\left(\frac{kT_p}{\mu g}\right)$$

$$H = \frac{k_b T}{\mu g}$$

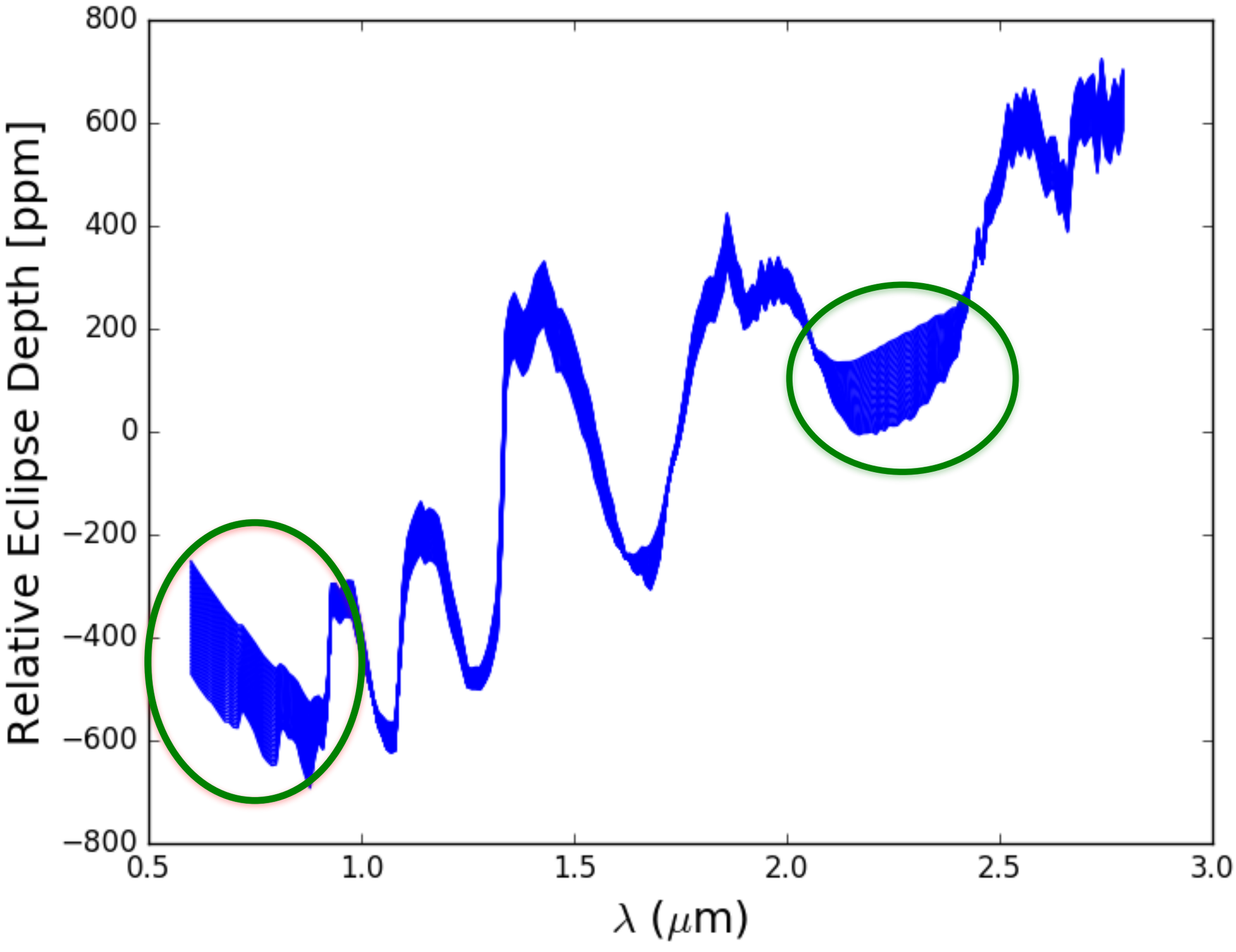
**H.E:** $n(z) = n_0 e^{-z/H}$

# Spectra like it wet

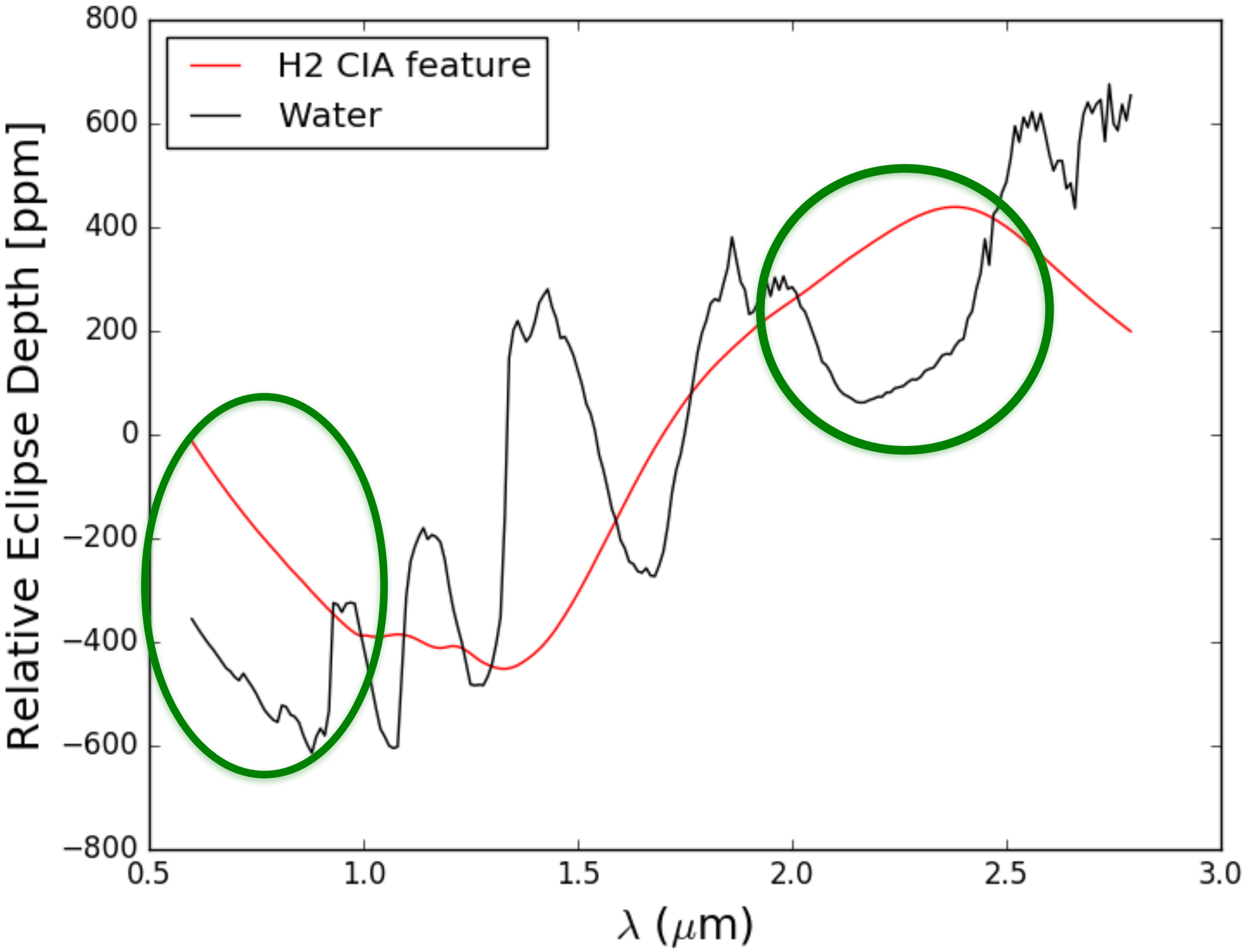



$$H = \frac{k_b T}{\mu g}$$

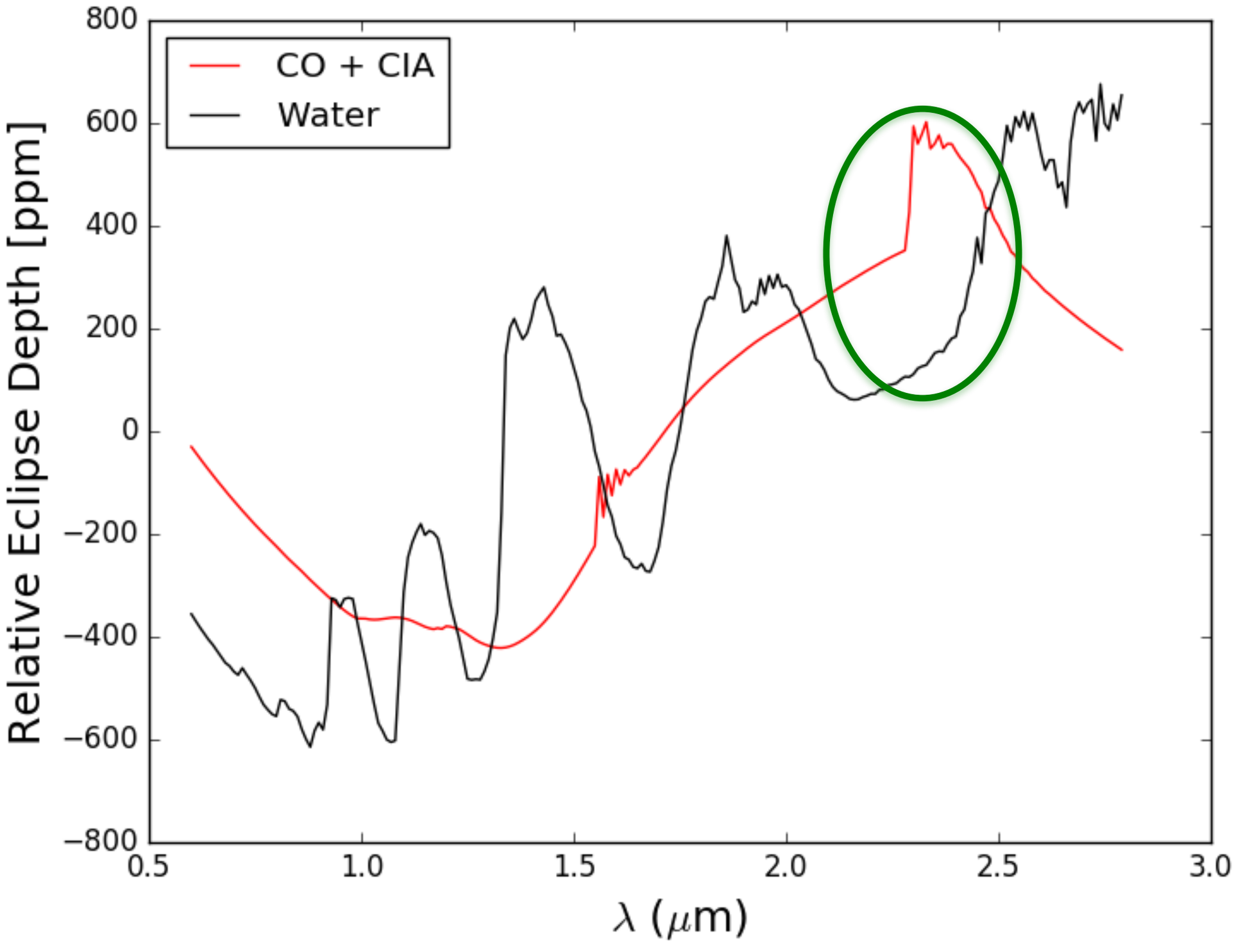
# Sensitivity to $H_2O$ Abundance



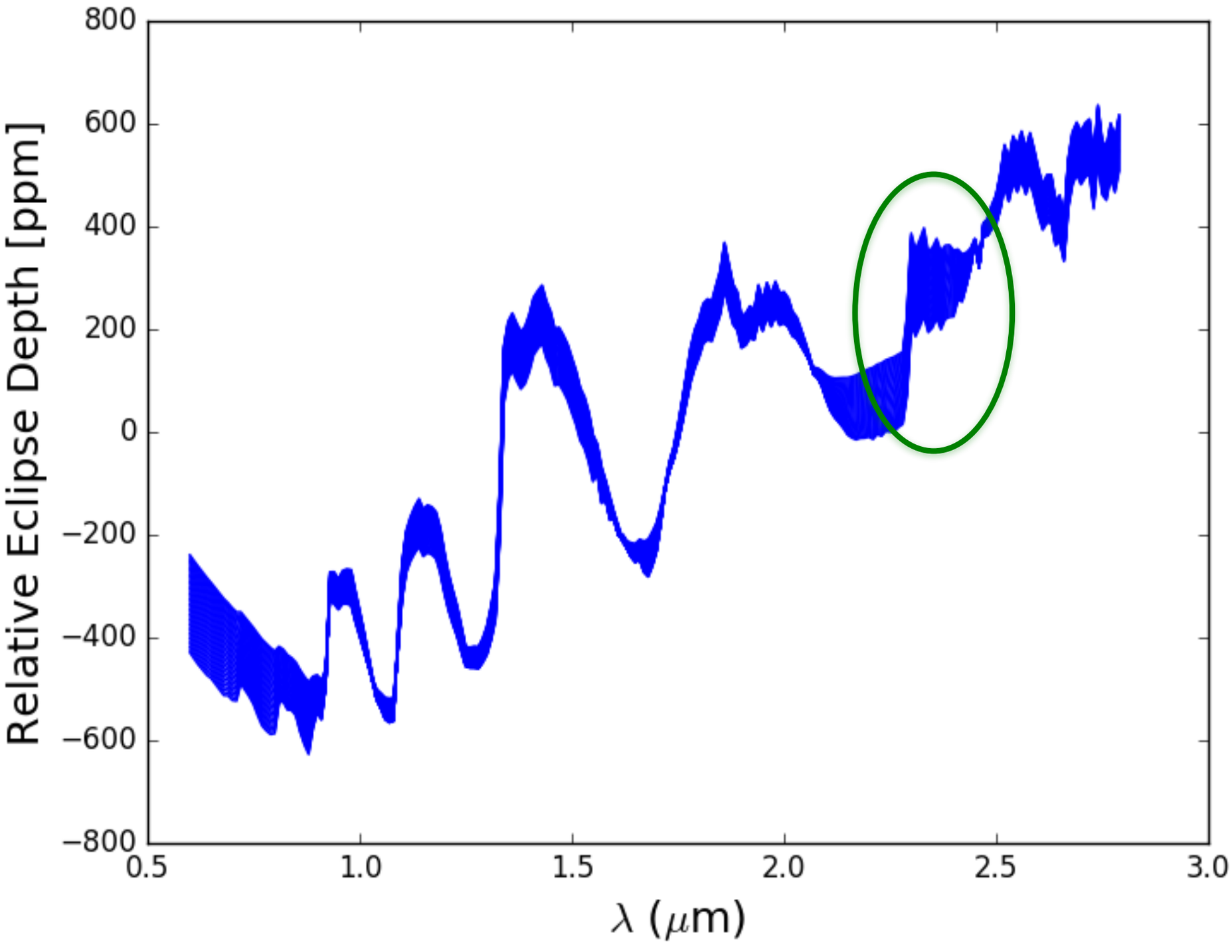
# Sensitivity to $H_2O$ Abundance



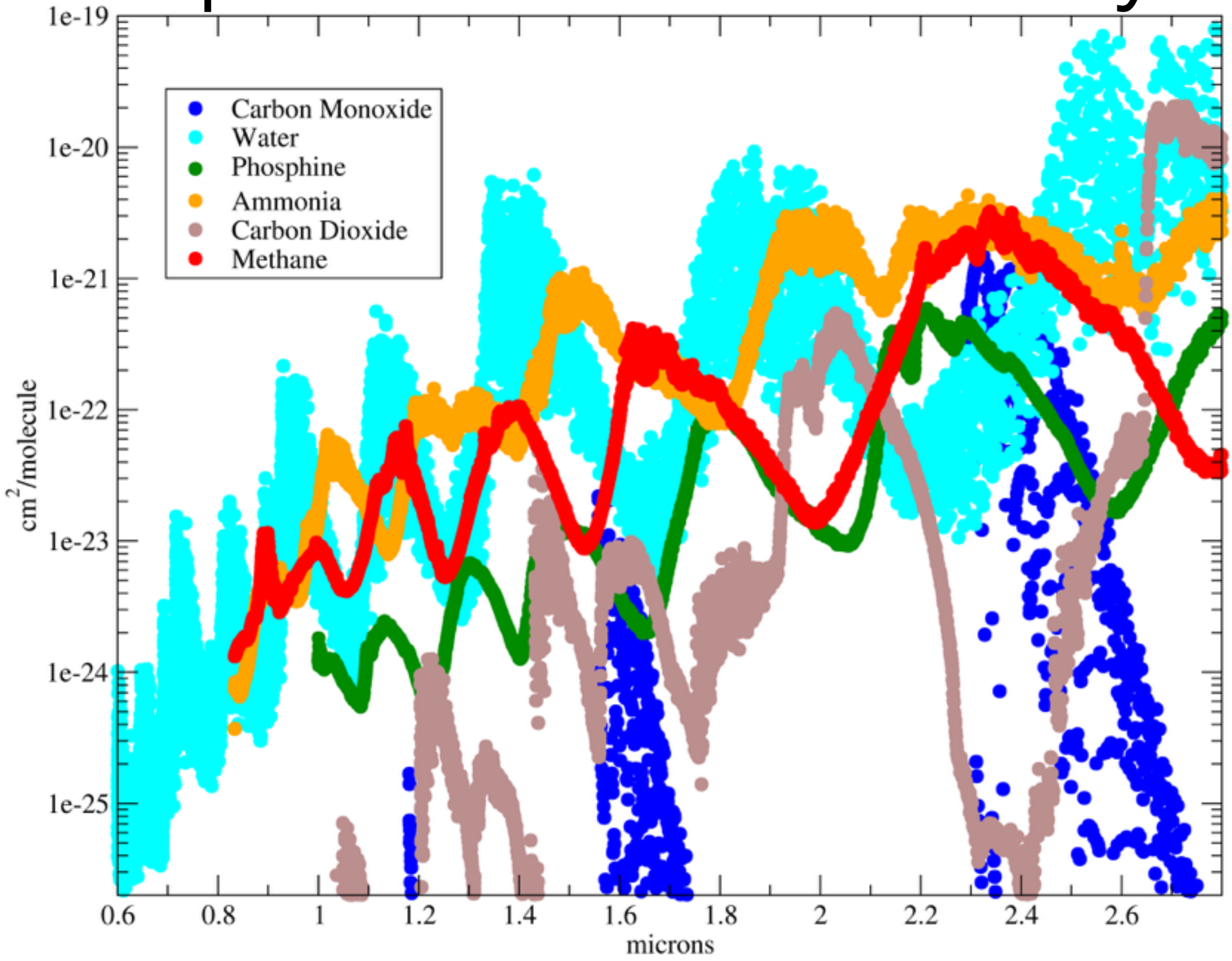
# Sensitivity to $H_2O$ Abundance



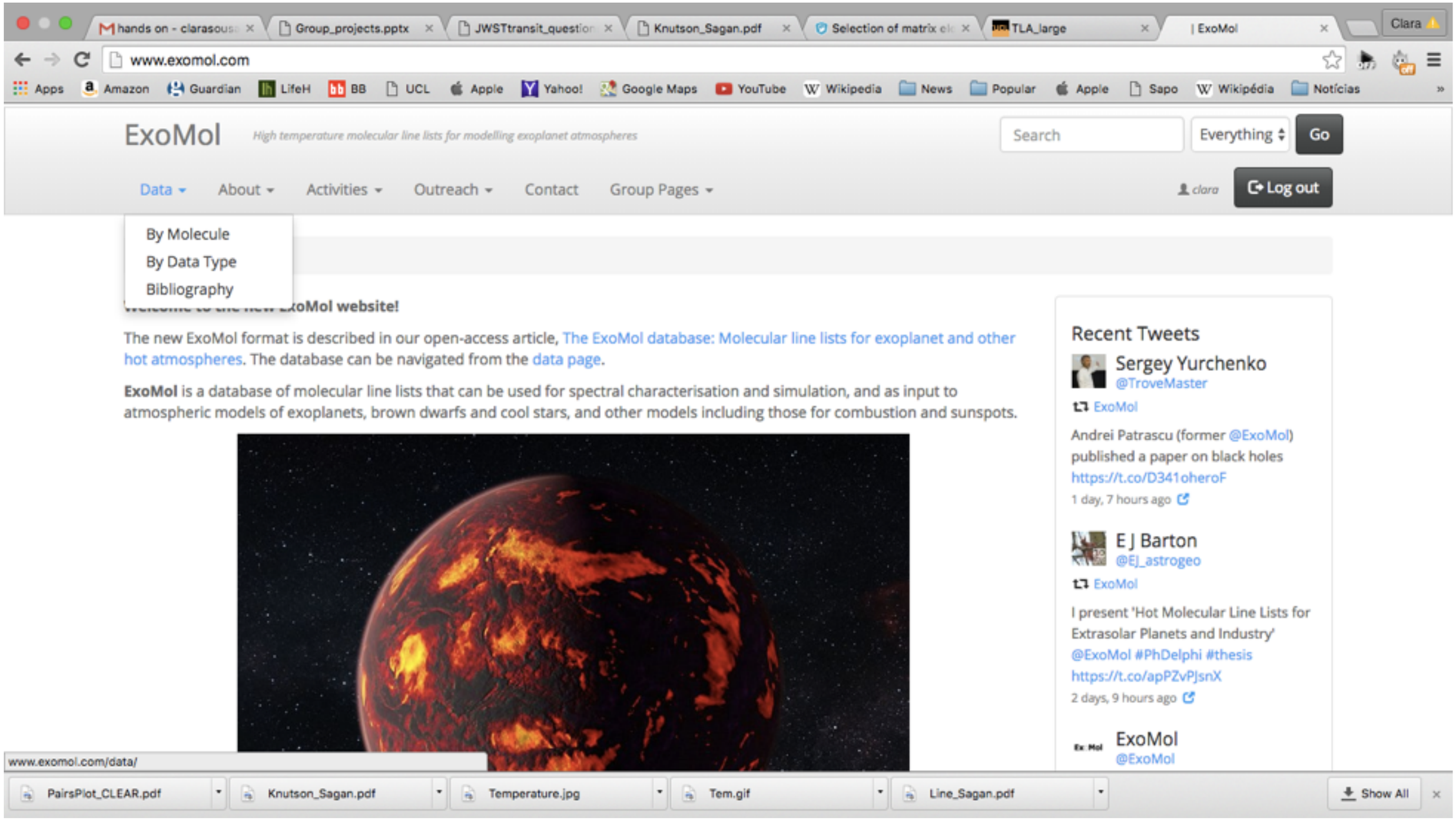
# Sensitivity to $H_2O$ Abundance



# Spectra like it messy



# www.exomol.com

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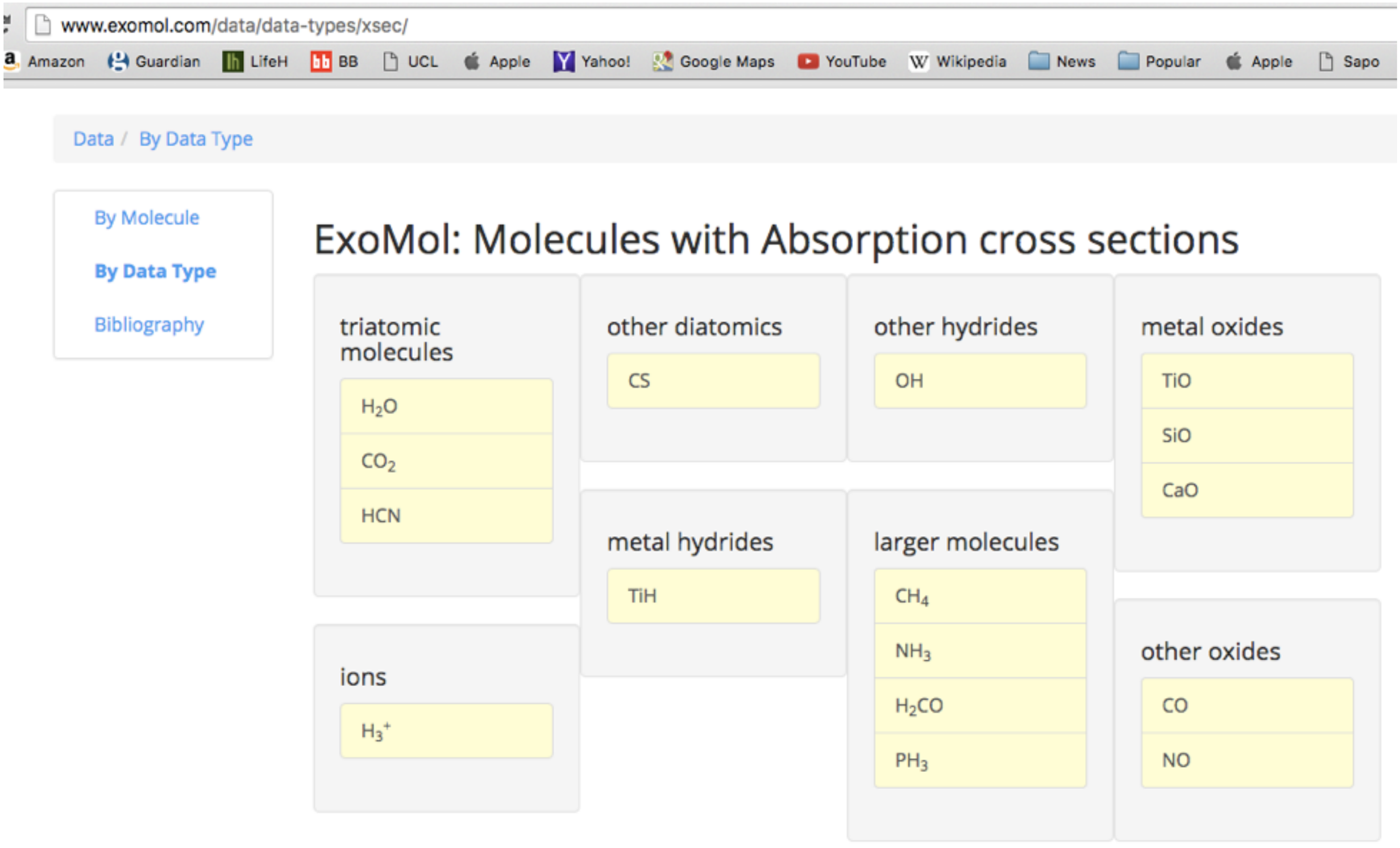
# www.exomol.com



# Cross section data for $^{31}P^{1}H_3$

*Reminder*: the cross sections provided by this page are calculated at **zero-pressure** (*i.e.* Doppler-broadened lines only). If you enter your email address below it will only be used to inform you of fixes to the service in case it fails. Alternatively, please email christian.hill@ucl.ac.uk.

The default format of the .sigma data file is a single column of cross section points (in $cm^2$/molec), one for each wavenumber bin selected, starting at $\nu_{min}$ and spaced by $\Delta\nu$. Select two-column output below if you want each cross section point preceded explicitly by the wavenumber at the centre of the bin it applies to.

**$\Delta\nu$:**

**$\nu_{min}$ (0 - 10000 $cm^{-1}$):**

**$\nu_{max}$ (0 - 10000 $cm^{-1}$):**

**$T$ (296 - 1500 K):**

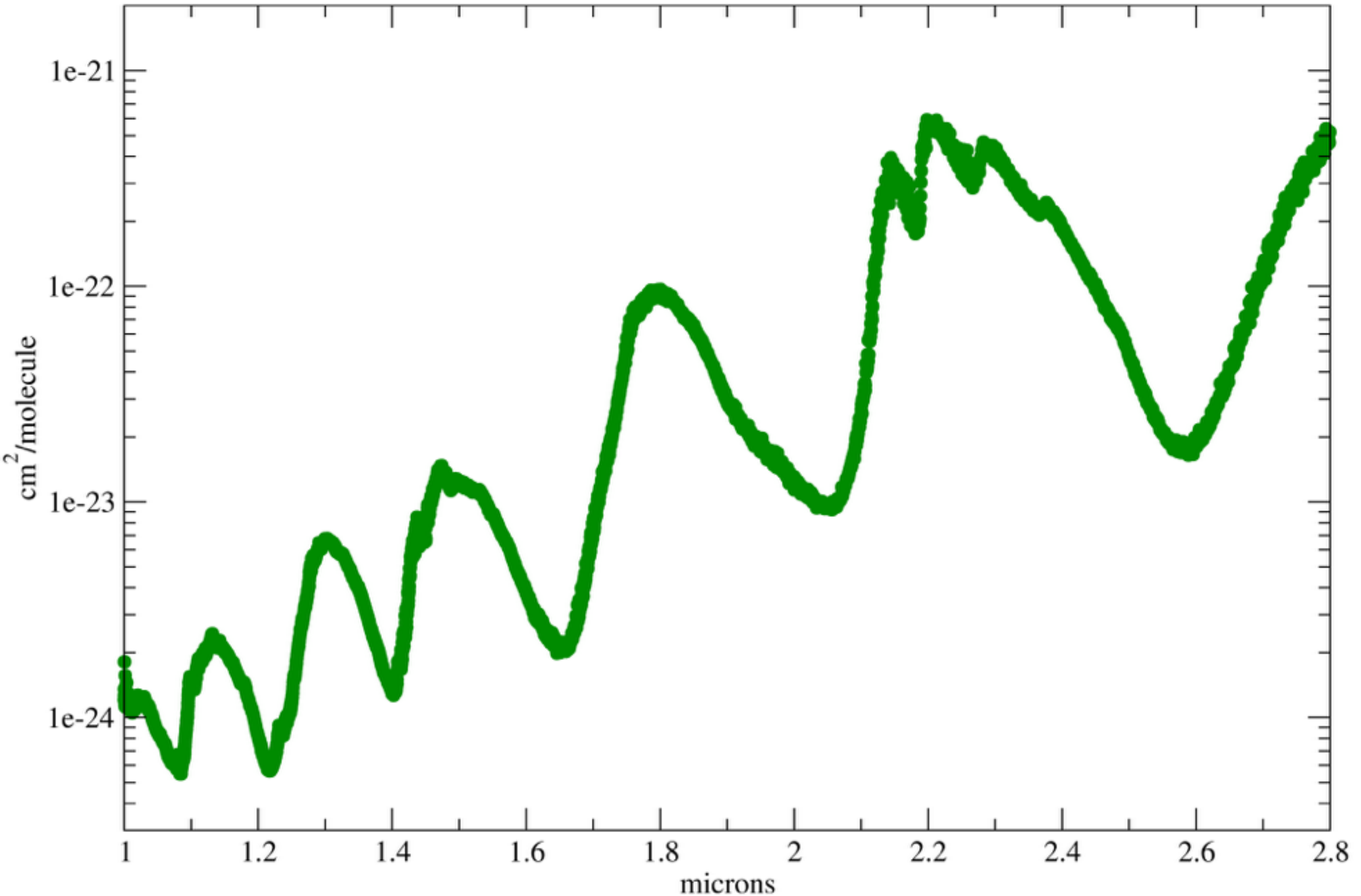
**Two-column output: $\nu$ and $\sigma$:** ☐

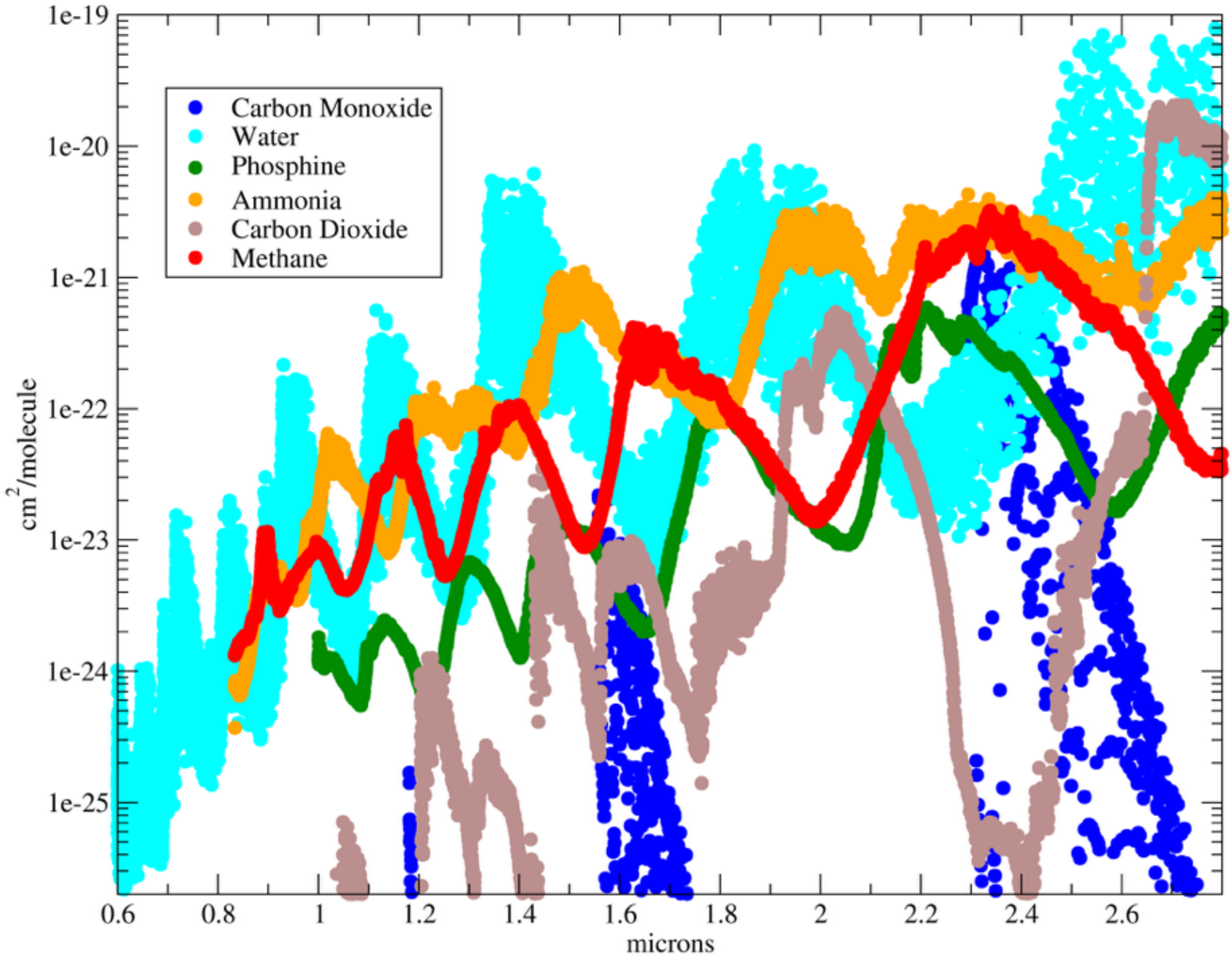
Submit

Online absorption cross section service: this cross section has been generated from data in the SAlTY $PH_3$ calculated line list [Sousa-Silva *et al.* (2015)] for the ExoMol project [Tennyson and Yurchenko (2012)] using the procedure described in [Hill *et al.* (2013)].

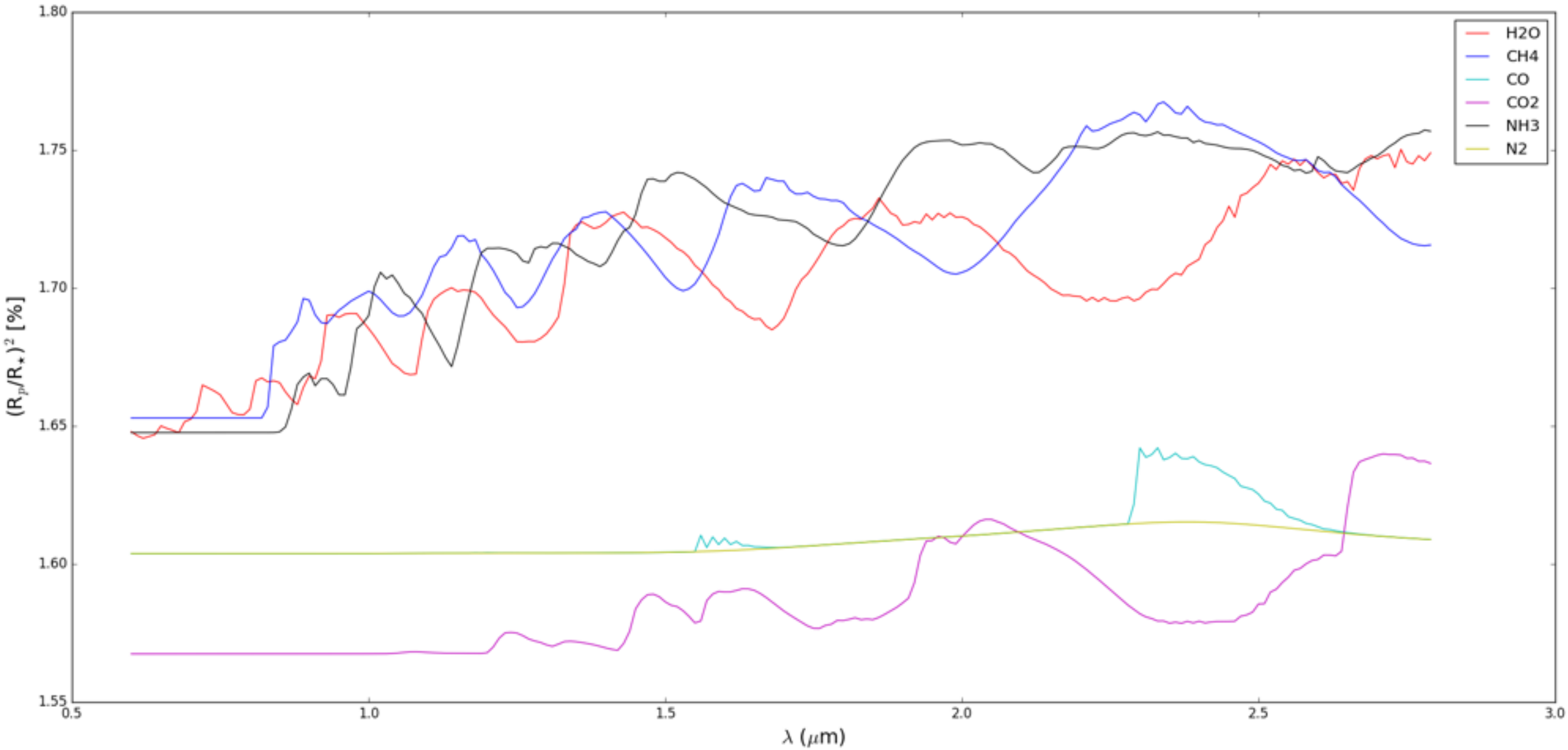
## References

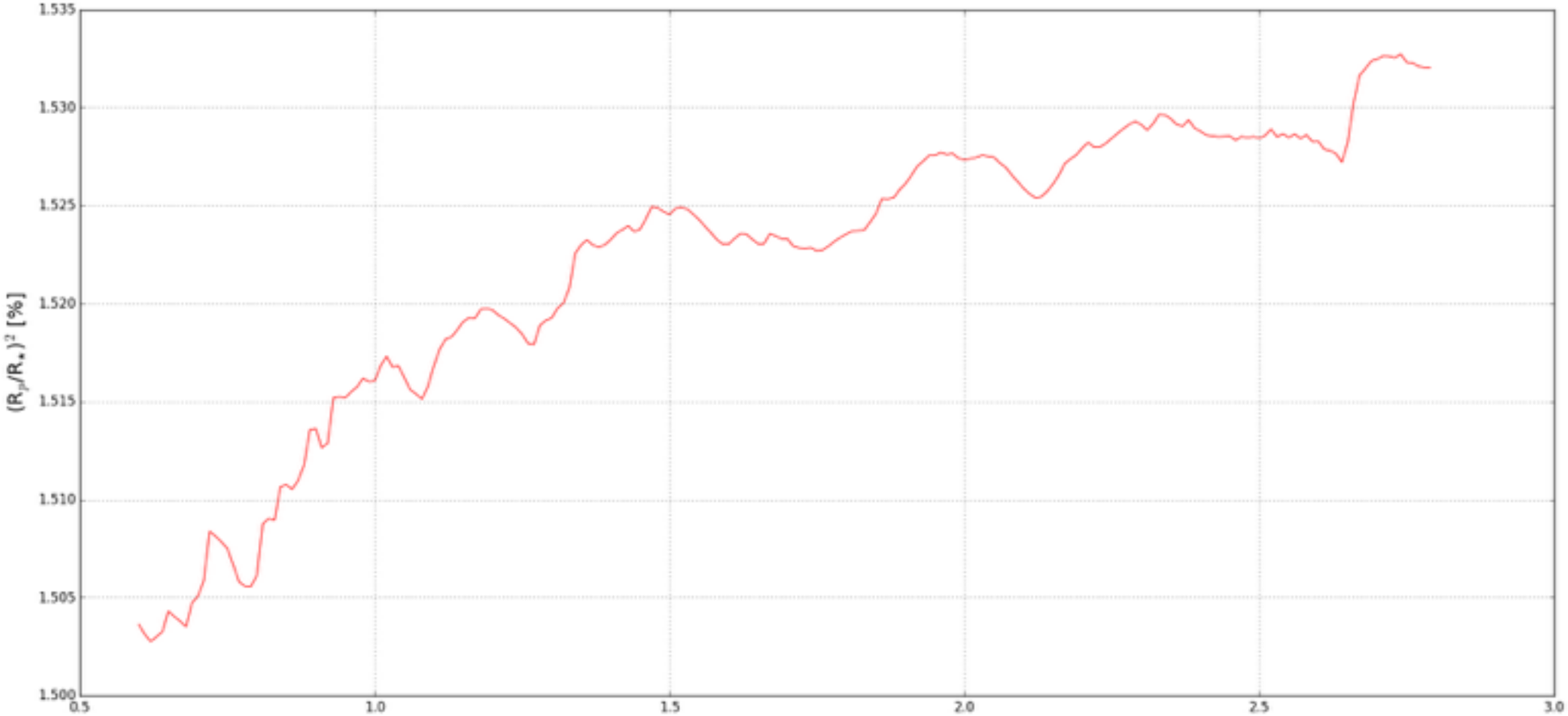

1. C. Hill, S. N. Yurchenko, J. Tennyson, "Temperature-dependent molecular absorption cross sections for exoplanets and other atmospheres", *Icarus* **226**, 1673-1677 (2013). [link to article]
2. C. Sousa-Silva, A. F. Al-Refaie, J. Tennyson and S. N. Yurchenko, "ExoMol line lists VII: The rotation-vibration spectrum of phosphine up to 1500 K", *Monthly Notices of the Royal Astronomical Society* **446**, 2337-2347 (2014). [link to article]

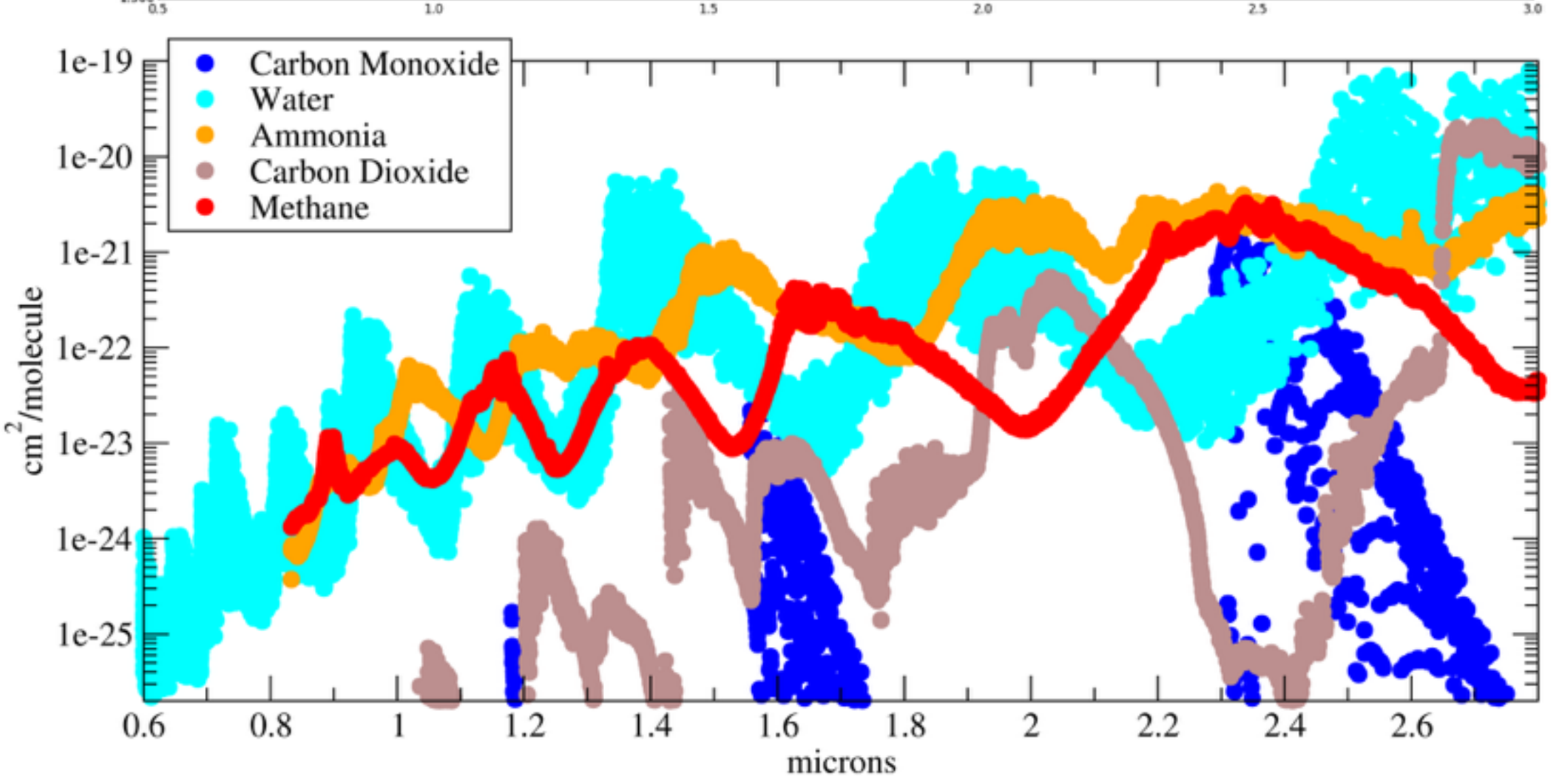

1e-21
1e-22
1e-23
1e-24
cm$^2$/molecule
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
microns


Carbon Monoxide
Water
Phosphine
Ammonia
Carbon Dioxide
Methane
1e-19
1e-20
1e-21
1e-22
1e-23
1e-24
1e-25
cm2/molecule
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
microns

# Atmospheric Composition - Extremes




1.535
1.530
1.525
1.520
1.515
1.510
1.505
1.500
$(R_p/R_*)^2$ [%]
0.5
1.0
1.5
2.0
2.5
3.0


Carbon Monoxide
Water
Ammonia
Carbon Dioxide
Methane
1e-19
1e-20
1e-21
1e-22
1e-23
1e-24
1e-25
cm$^2$/molecule
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
microns

# We hope you liked it

**Take Home Points**

- Spectral features are temperature dependent.
- Higher temperatures -> bigger features (assuming constant composition).
- More water means more water features, but there are negative trade-offs with increasing mean molecular weight.
- Most significant spectral features depend on ratio of molecular abundances.
- Use good molecular data or your model will be wrong.

# We hope you liked it

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