

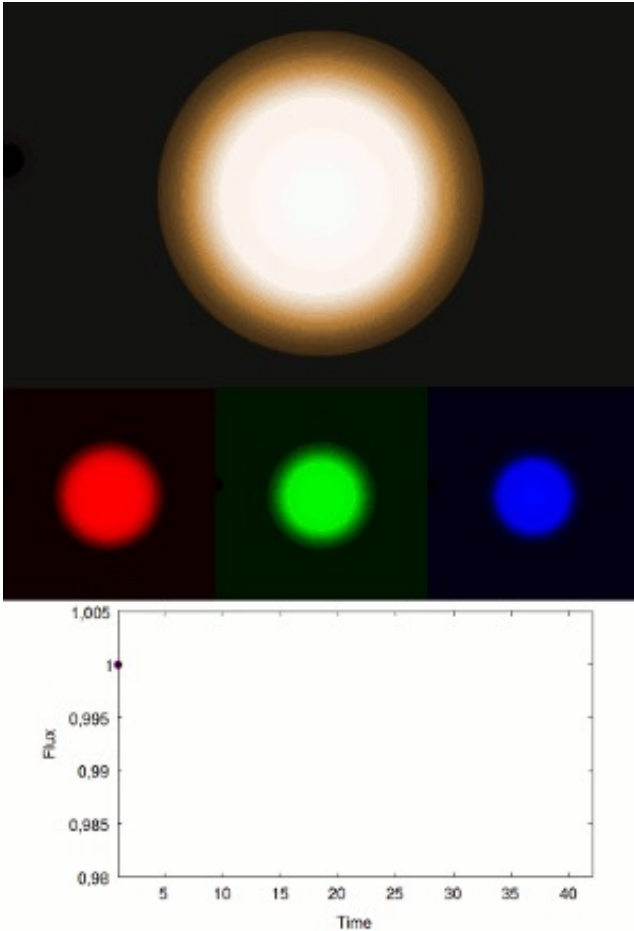


# Quantifying the Ability of JWST to Detect Biosignatures.

Great Lakes Exoplanet Area Meeting 2022

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JWST allows us to discover the gases in the atmospheres of transiting planets



The purpose of this research:

1. Exploring the detectability of JWST for gases in the Trappist-1e's potential atmosphere
2. Find a method that quantifies the detectability of JWST for biosignatures composed of multiple gases



Exoplanet data are from

<https://exoplanetarchive.ipac.caltech.edu/>

The open-source libraries used in the process

*PICASO*



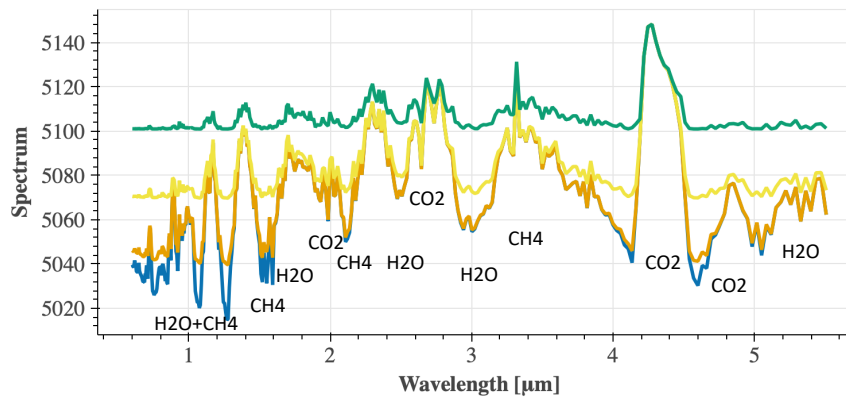
*PandExo*





# Transmission Spectrum

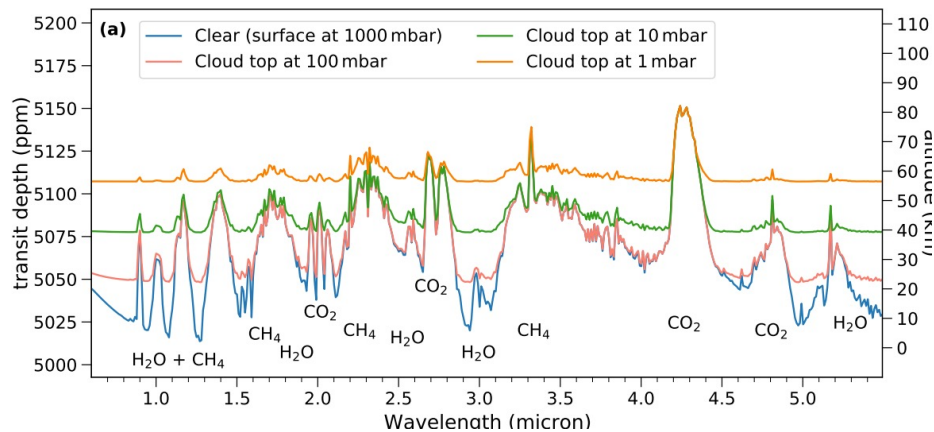
## Modern Earth



Data similarity

> 95%

Spectrum generated by *PICASO*

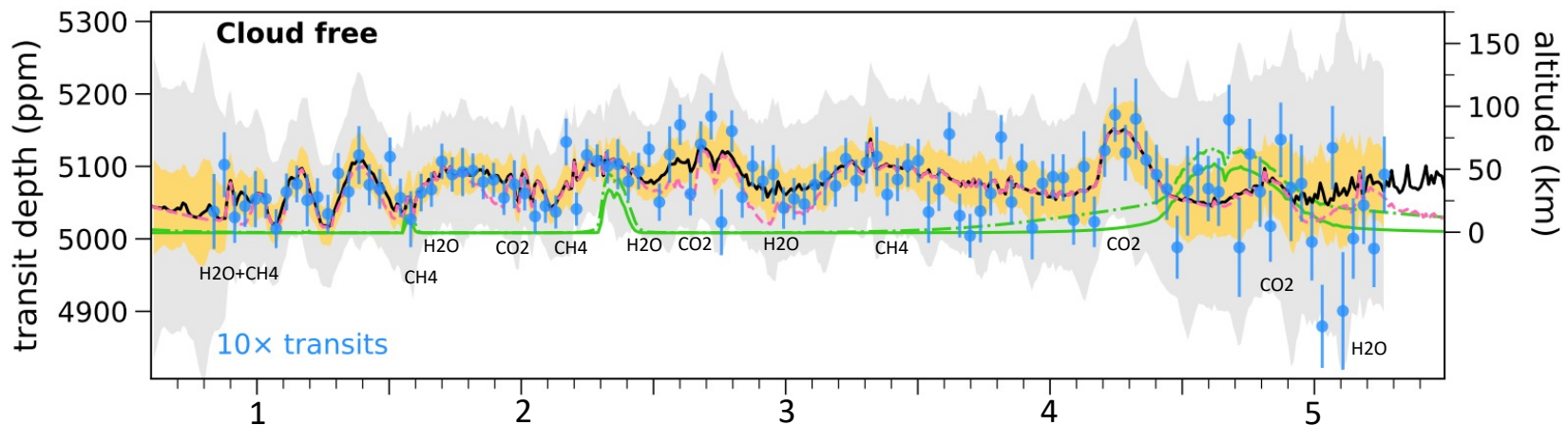
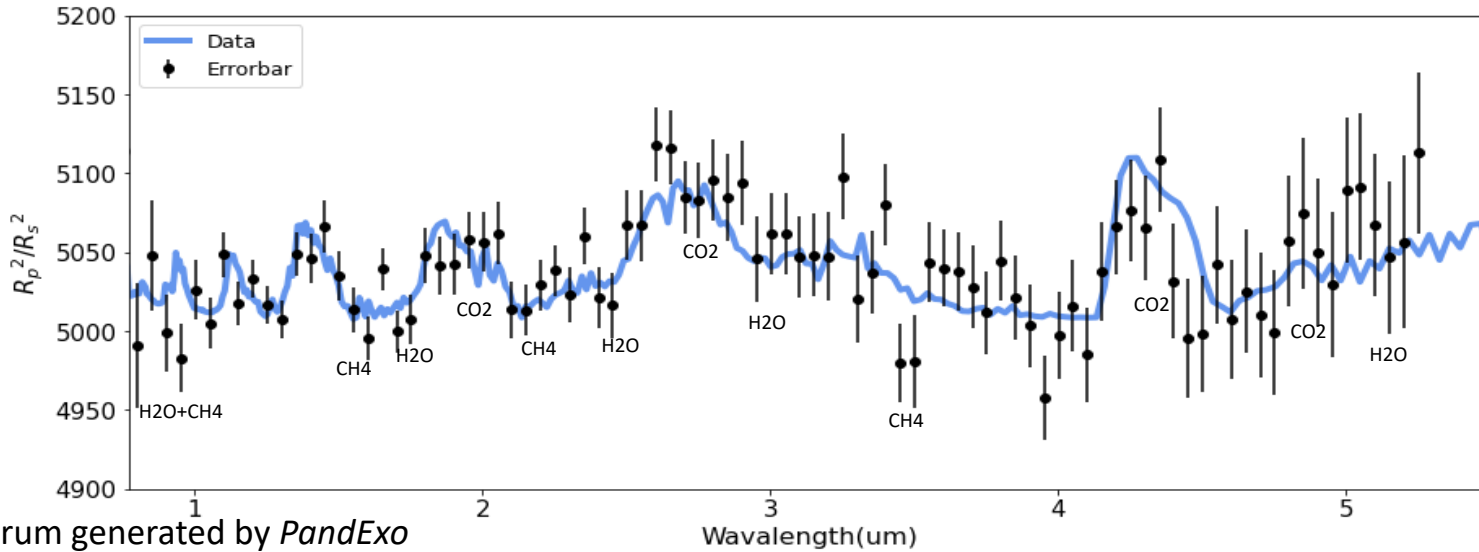


Mikal-Evans, T., 2022.



# Simulated Data of JWST

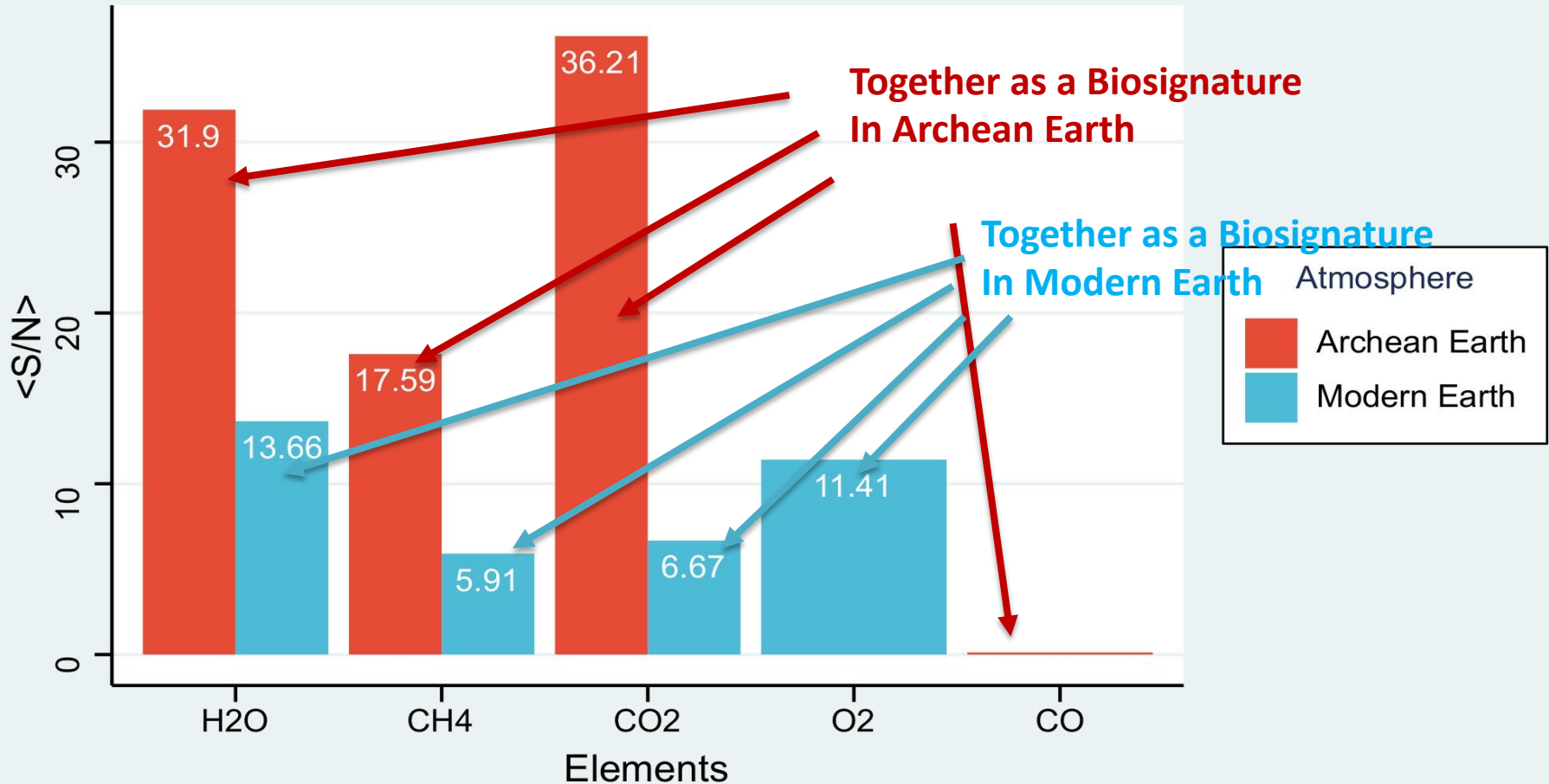
## Modern Earth





## Detectability of Gases

Molecular observability comparison



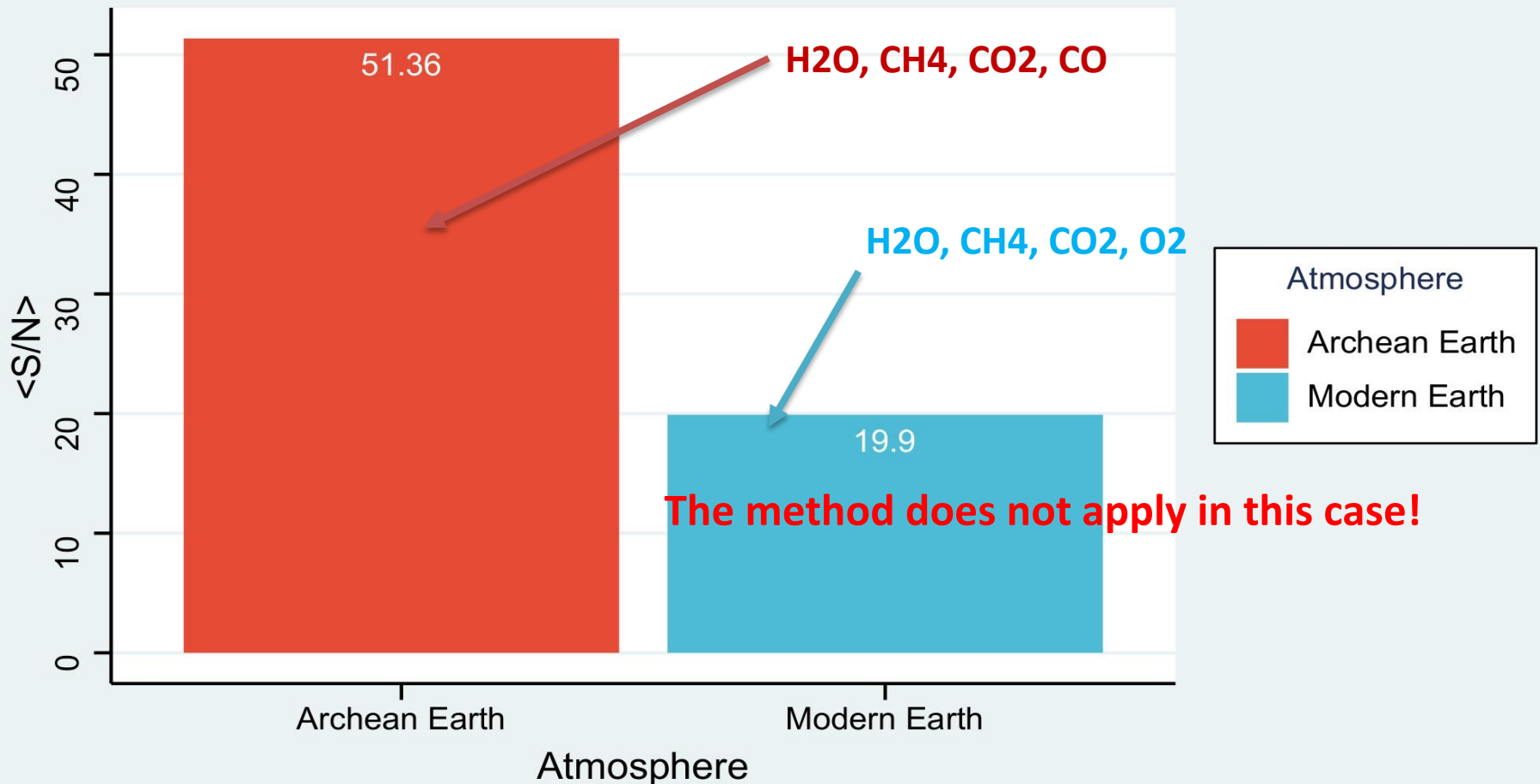
Method for finding the feature wavelength(Phillips, et al. 2021. )

The detectability of biosignature gases in Archean Earth is higher than in Modern Earth except for CO.



## Detectability of Biosignature

Comparison of the Observability of Trappise-1e Under Different Atmospheres



How to find the detectability of a biosignature composed of multiple gases?





## Detectability of Biosignature

We proposed an equation that can quantify the detectability of biosignatures.

$$< S/N >_{total} = \left( \prod_{i=1}^n < S/N >_{gas\ i} \right)^{\frac{1}{n}}$$

For Archean Earth, the total  $<S/N>$  of  $CO_2 + CH_4 + H_2O + CO$ :

$$\begin{aligned} < S/N >_{total} &= (< S/N >_{CO_2} \cdot < S/N >_{CH_4} \cdot < S/N >_{H_2O} \cdot < S/N >_{CO})^{1/4} \\ &= 7.03 \end{aligned}$$

For Modern Earth, the total  $<S/N>$  of  $CO_2 + CH_4 + H_2O + O_2$ :

$$\begin{aligned} < S/N >_{total} &= (< S/N >_{CO_2} \cdot < S/N >_{CH_4} \cdot < S/N >_{H_2O} \cdot < S/N >_{O_2})^{1/4} \\ &= 8.85 \end{aligned}$$



# Conclusion

Our results show that JWST can detect some biosignatures in the TRAPPIST-1e potential atmosphere.

We found a method that quantifies the detectability of JWST for biosignatures composed of multiple gases.



# Report Over

# THANK YOU!

Huihao Zhang

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