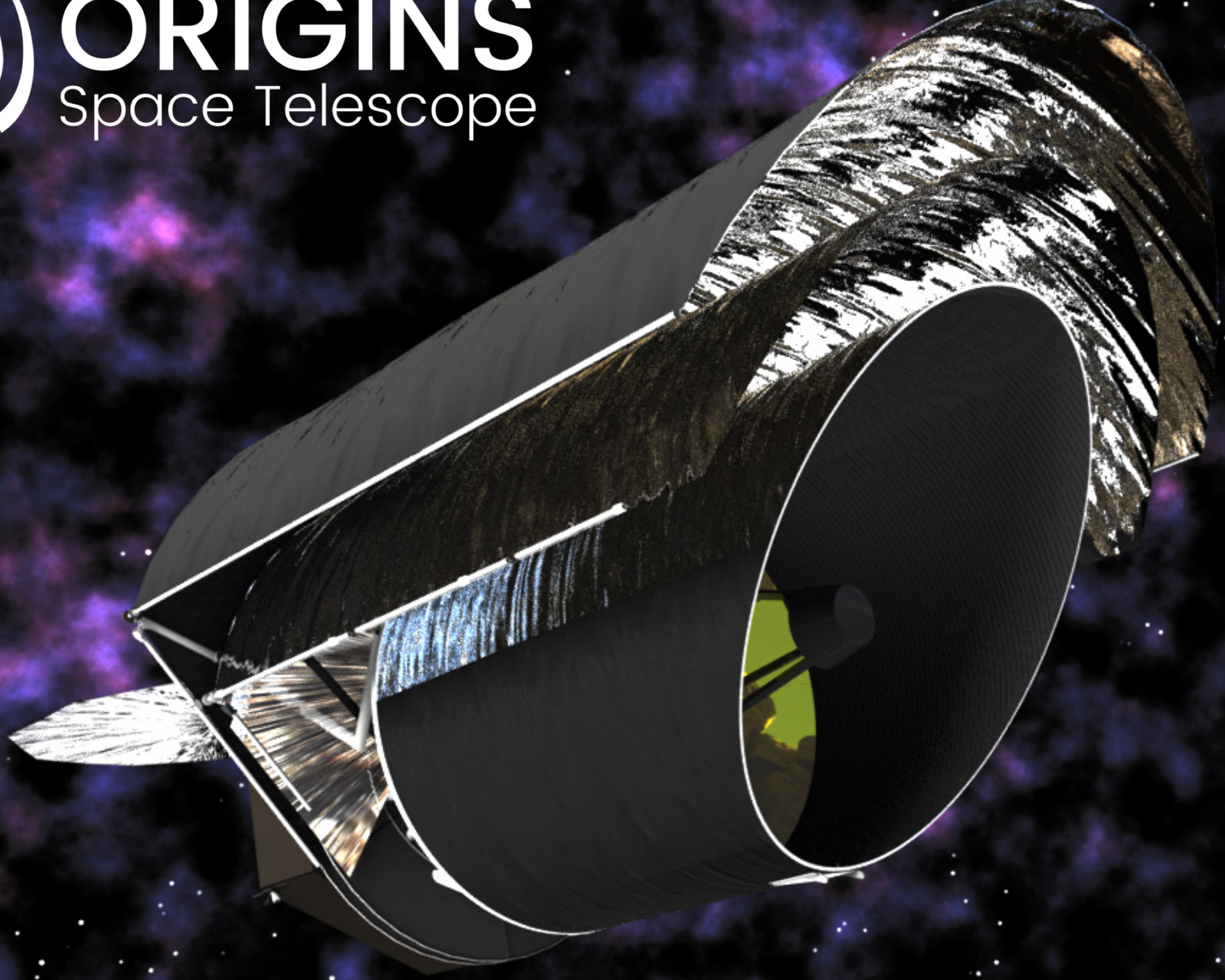
ORIGINS
Space Telescope



- Spitzer-like architecture
- Minimal deployments
- JWST sized (~25 m^2, 5.9 m)
- Cold (~4.5 K)
- Mid-to-Far IR (3-300+ µm)
- Sun-Earth L2 orbit
- 5 year primary mission
- Community selected science programs (~50%)

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Origins Exoplanets Working Group, + Origins STDT

SCIENCE DRIVERS FOR MISSION DESIGN

HOW DOES THE UNIVERSE WORK?

How do galaxies form stars, make metals, and grow their central supermassive black holes from reionization to today?

Using sensitive spectroscopic capabilities of a cold telescope in the infrared, Origins will measure properties of star-formation and growing black holes in galaxies across all epochs in the Universe.

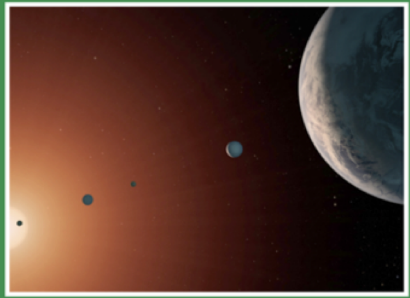
HOW DID WE GET HERE?

How do the conditions for habitability develop during the process of planet formation?

With sensitive and high-resolution far-IR spectroscopy Origins will illuminate the path of water and its abundance to determine the availability of water for habitable planets.

ARE WE ALONE?

Do planets orbiting M-dwarf stars support life?



By obtaining precise mid-infrared transmission and emission spectra, Origins will assess the habitability of nearby exoplanets and search for signs of life.

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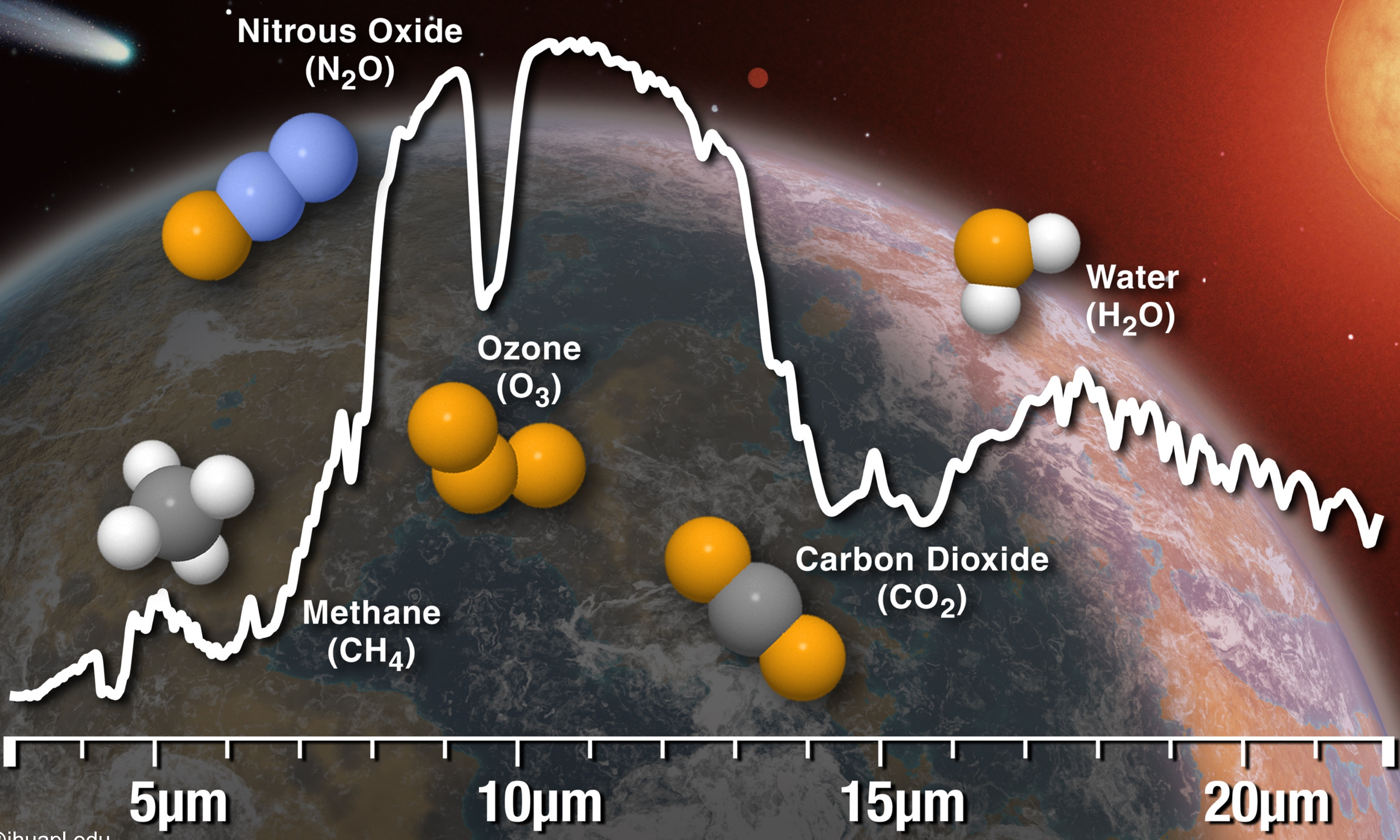
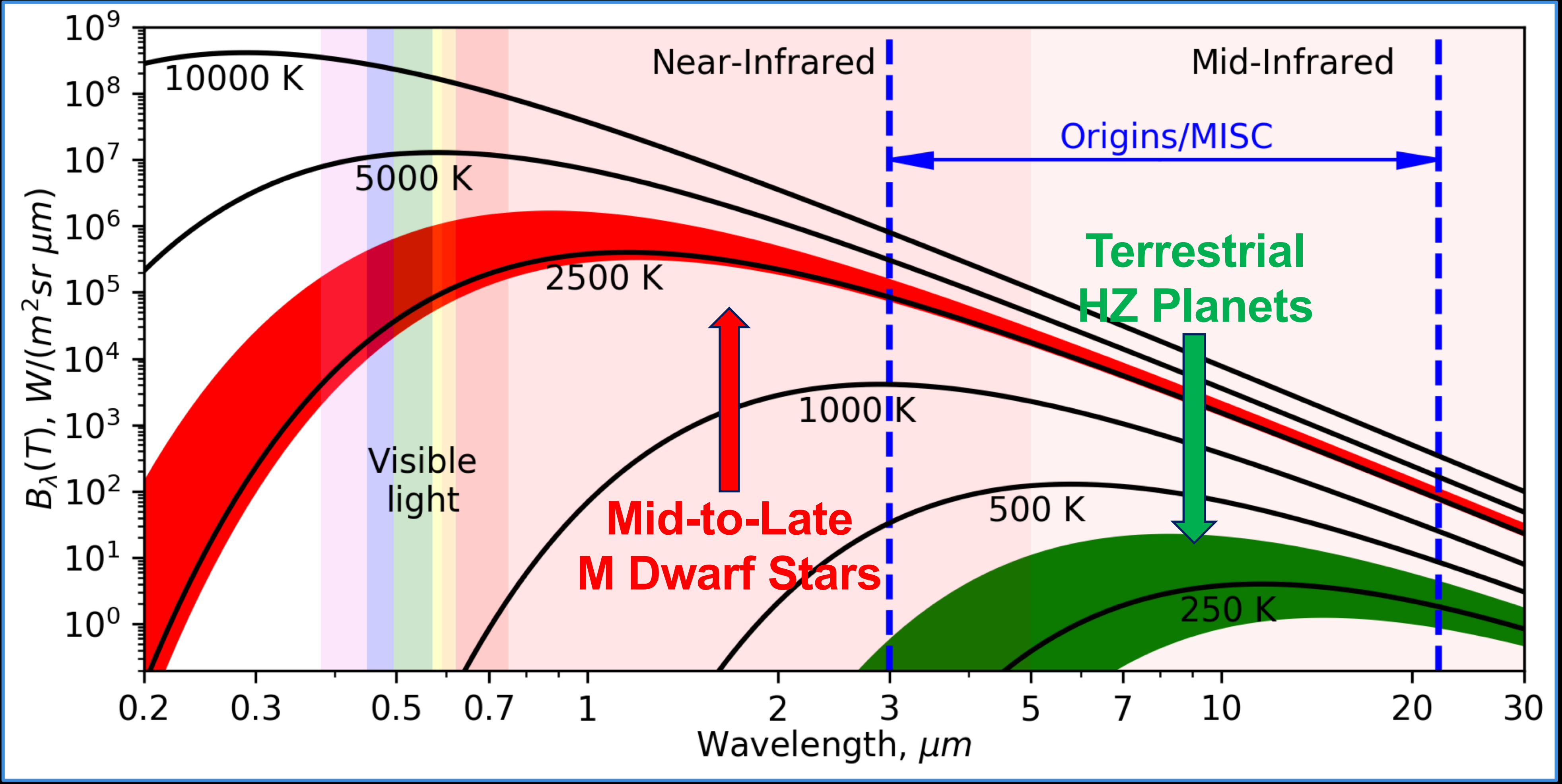


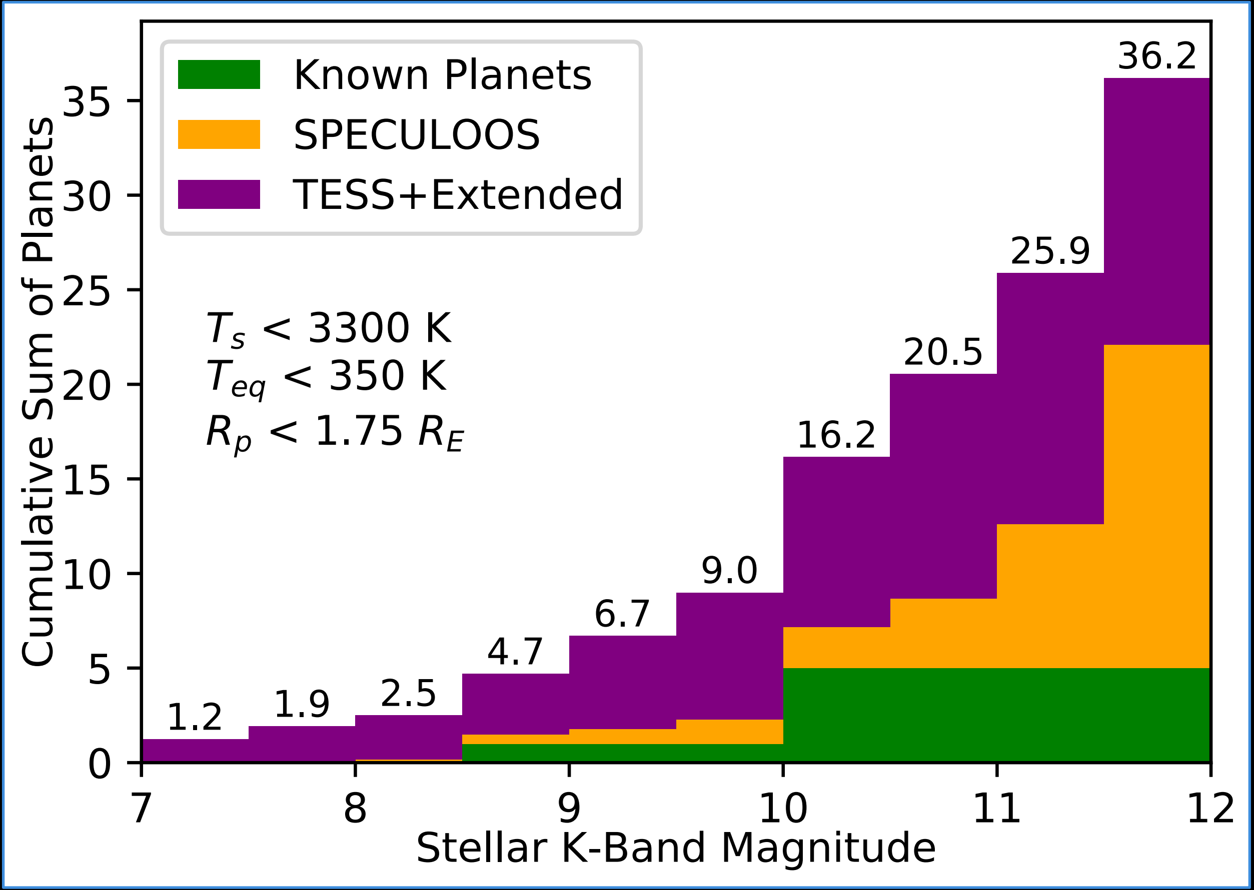
The *Origins* Opportunity Is The Mid-IR



- Planet-star contrast ratio always improves at longer wavelengths
- Overall SNR falls off at >22 μm
- HZ SNR sweet spot is 7 – 15 μm

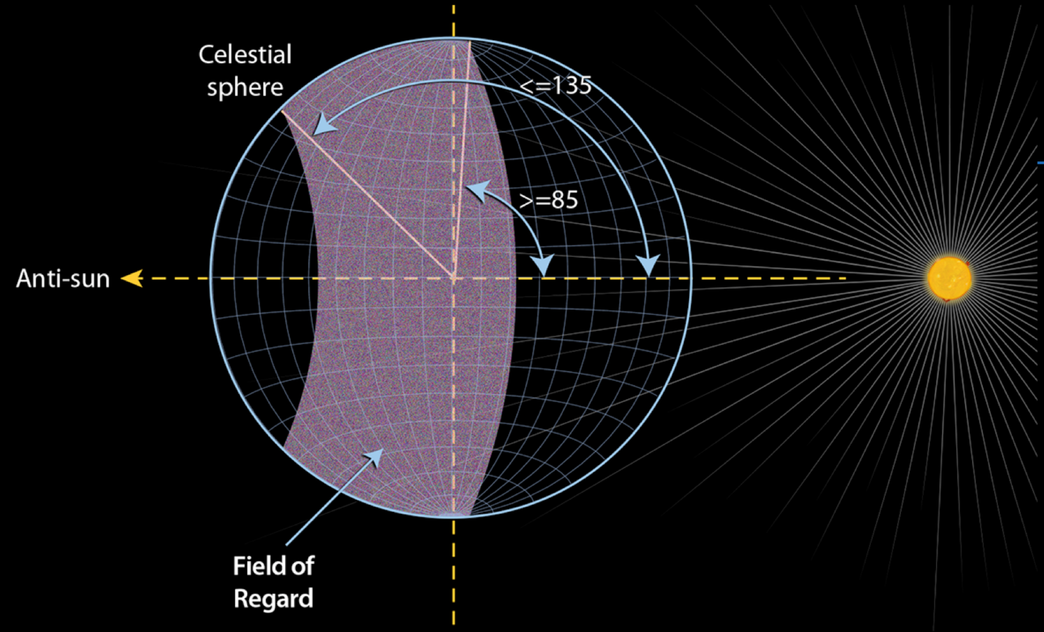
Expected Yields of Temperate M-Dwarf Planets

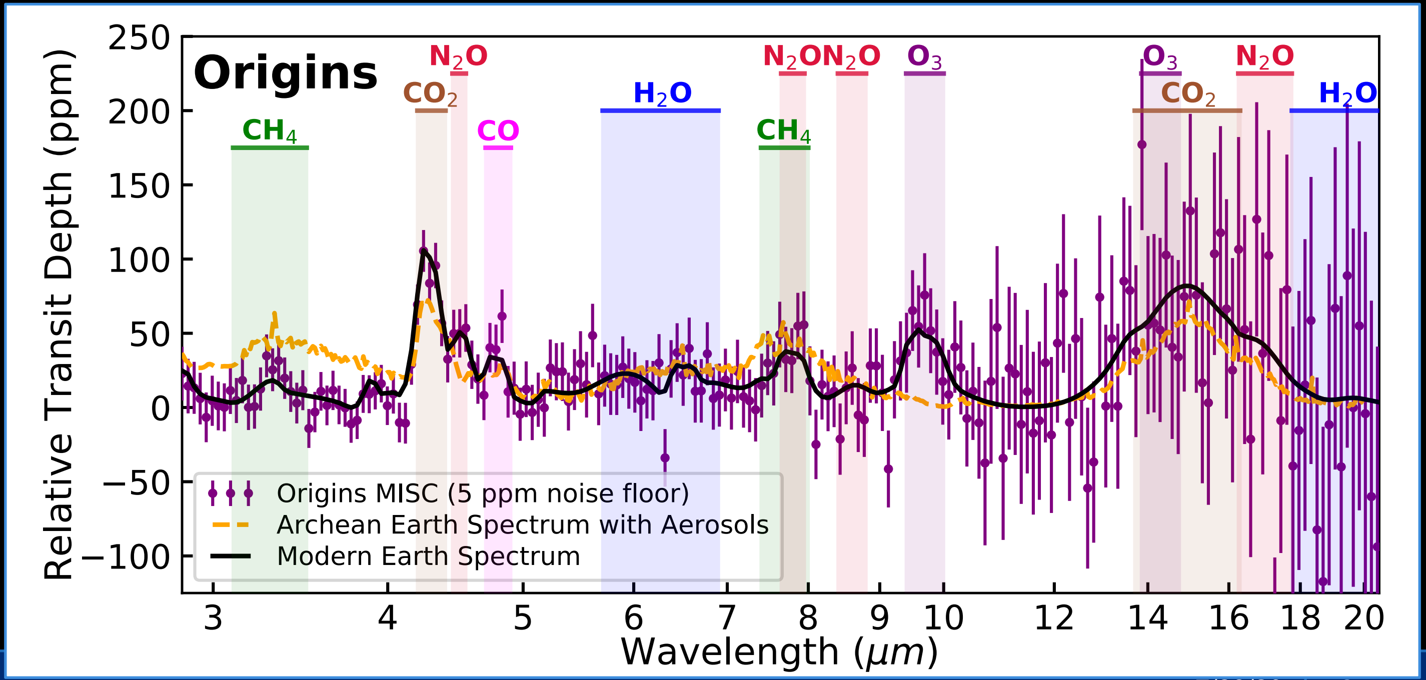
- TESS is expected to discover **43±7** temperate, terrestrial exoplanets (Barclay et al. 2018),
- SPECULOOS is expected to identify **14±5** temperate, terrestrial planets orbiting late M to early L dwarfs (Delrez et al., 2018)
- All target planets will have known masses and radii, some with initial JWST reconnaissance
- Target stars as faint as K=11.5



Origins Requirements

- Large field of regard
  - More transits per year
- Simultaneous wavelength coverage
  - 3 – 20 µm
  - Key spectral signatures
  - H_2O, CO_2, O_3, CH_4, N_2O, etc.
- Instrument designed specifically for high-precision time-series observations
  - Higher throughput
  - Lower noise floor





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Comparison Between *Origins* and *JWST*

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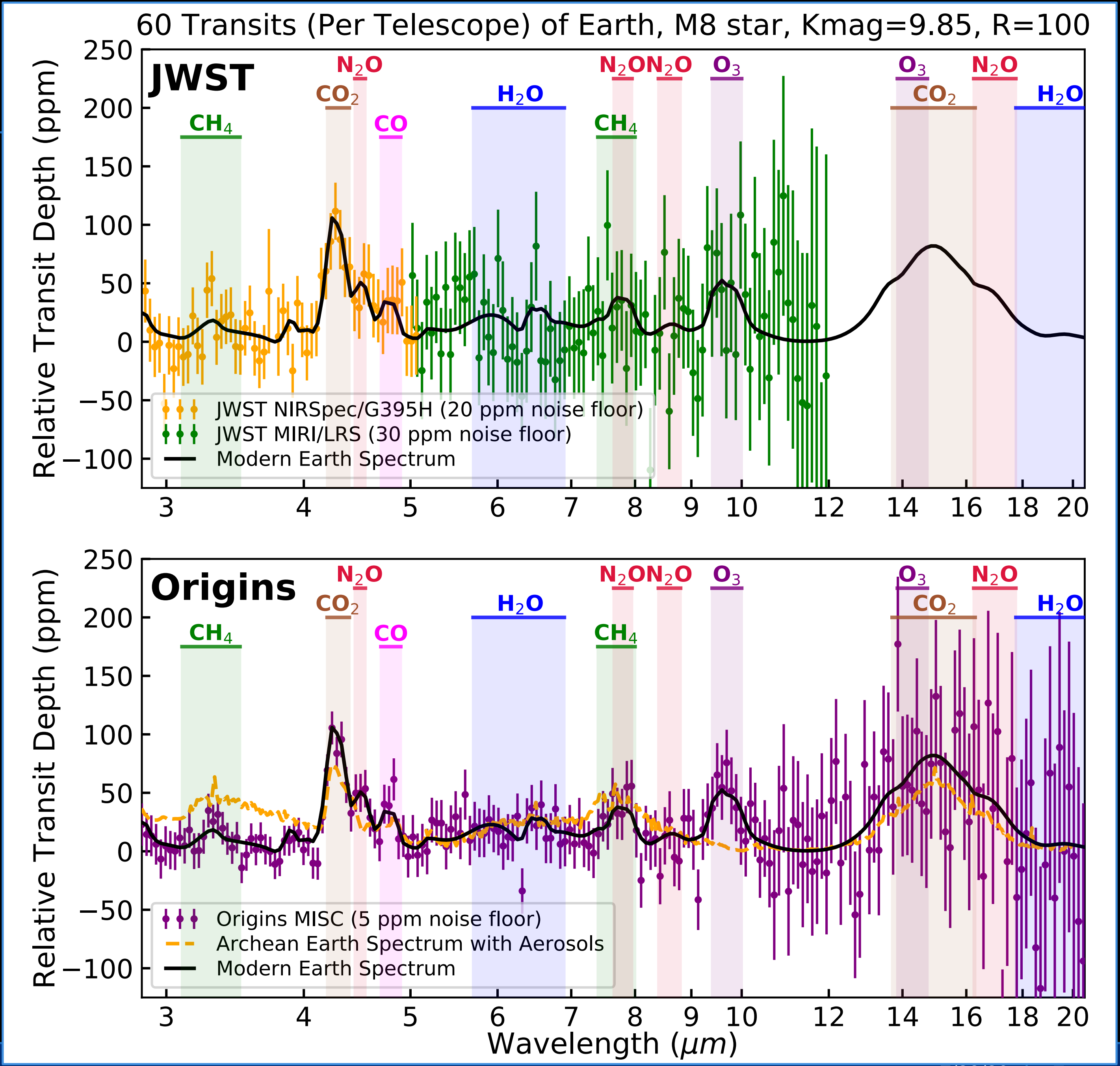

Origins will use a multi-tiered observing strategy to search for life

Tier 3
Search for biosignatures (O_3+N_2O, O_3+CH_4) with additional transits of temperate worlds

Tier 2
Eclipse observations of clear **M-dwarf planets** to determine if they are temperate

Tier 1
Transit observations of **M- and K-dwarf planets** to determine which planets have tenuous, clear or cloudy atmospheres

Number of planets in a 4000-hr program with *Origins*

Tier	# of Planets	Median observation	Total hrs
1	28	8 transits	896
2	17	15 eclipses	1020
3	10	52 transits	2080

Pre-select terrestrial M-dwarf planets based on M_p, R_p and T_{eq}, relatively rank based on suitability for detailed atmospheric characterization (e.g., Cowan et al. 2015; Zellem et al. 2017; Goyal et al. 2018; Kempton et al. 2018; Morgan et al. 2018).

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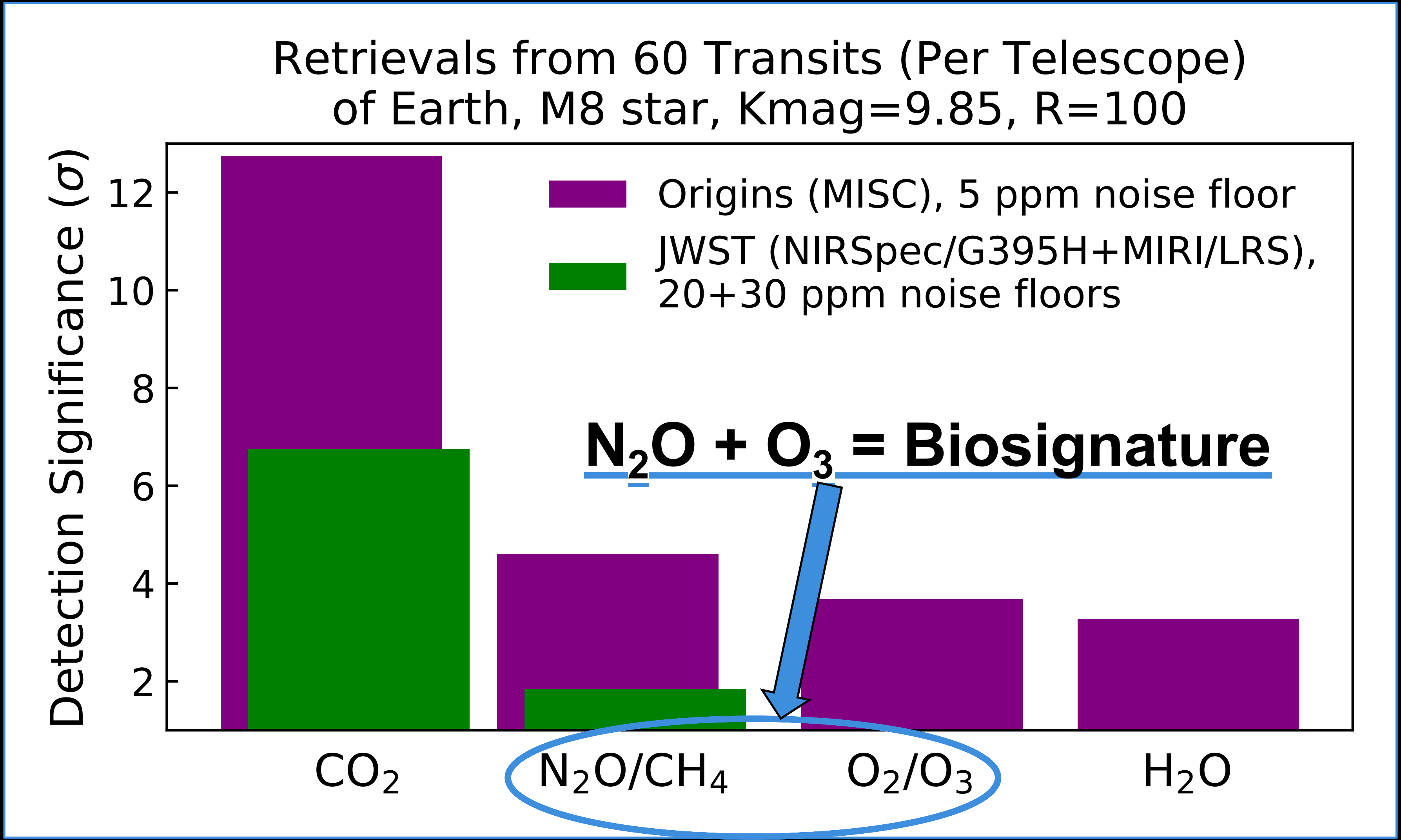

Takeaway Points

- *Origins* will assess the habitability of exoplanets transiting nearby M-dwarf stars
- All planets will have known masses, radii, and densities
- Mid-IR is excellent for detecting habitability indicators and biosignatures