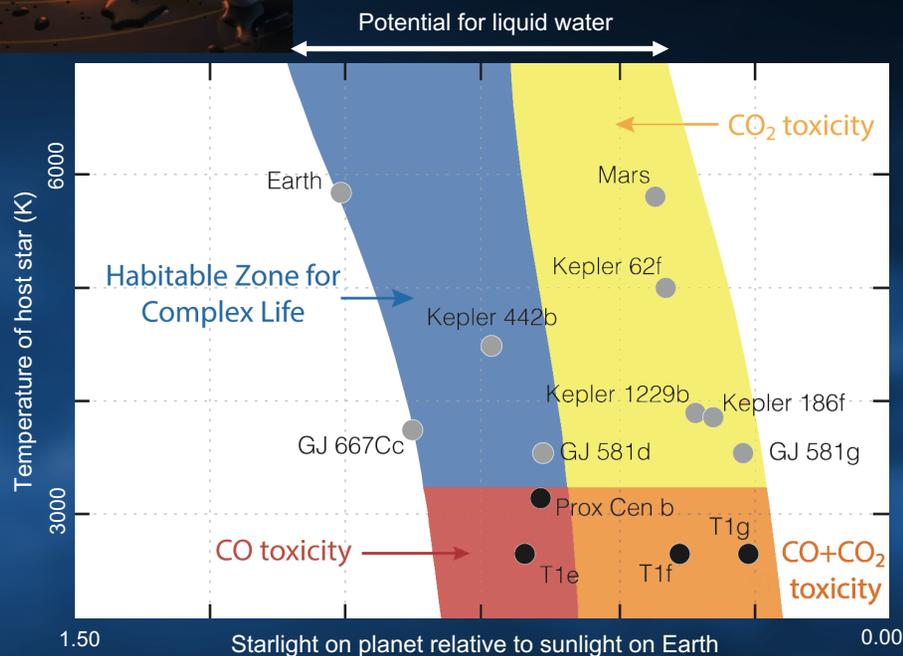


Predicting a Restricted Habitable Zone for Complex Life

Toxic gases may preclude large complex animal life on many exoplanets.



THE HABITABLE ZONE FOR COMPLEX LIFE (blue) is highly restricted relative to the zone defined by the potential for liquid water, due to toxic buildup of CO₂ (yellow), CO (red), or both (orange). This safe zone excludes many potentially water-bearing exoplanets, including Proxima Centauri b and TRAPPIST-1e, f, and g (black dots).

Schwietzman et al. (2019b) *The Astrophysical Journal*, 86, 19, DOI: 10.3847/1538-4357/ab1d52 | TRAPPIST-1 illustration: © R. Hurt/NASA/JPL-Caltech

INNOVATION | The concept of the habitable zone—the range of distances from a host star where liquid water could exist on a planet’s surface—is based on the minimum requirements for a simple microbial biosphere. This study is the first to consider the roles of CO₂ and carbon monoxide (CO) in limiting the planetary environments suitable for animal-like life.

DISCOVERY | Using a suite of models for atmospheric climate and photochemistry, we compared predicted CO₂ and CO levels to known toxicity limits to quantitatively describe a ‘Habitable Zone for Complex Life.’ This zone is less than half the size of the conventional habitable zone for sun-like stars and may be non-existent for the coolest M dwarf stars.

MISSION RELEVANCE | Atmospheric photochemistry and stellar environment are critically important for constraining a planet’s potential to support complex life. Physiological impacts of high CO₂ and CO should be considered in searches for biological complexity beyond our solar system, particularly intelligent life or technosignatures.