A CATALOG OF STELLAR EVOLUTION PROFILES AND THE EFFECTS OF VARIABLE COMPOSITION ON HABITABLE SYSTEMS. Amanda Truitt[1], Patrick A. Young[1], Alex Spacek[1], Luke Probst[1], and Jeremy Dietrich[2], [1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287, [2]Department of Astronomy, Harvard University, Cambridge, MA, 02183

Introduction: One of the fundamental reasons for planet searches, and indeed one of the central motivations in the field of astronomy, is the eventual discovery of life on a planet outside our solar system. Though stellar evolution is not the only component to consider when working to understand planetary habitability, it is nonetheless one of the most important and physically well-understood factors. It plays a huge role in creating a "habitable" environment by providing energy to orbiting planets. Current astrophysical research into the habitability of exoplanets focuses mostly on the concept of the classical "habitable zone" (HZ), the range of distances from a star over which liquid water could exist on a planet's surface [1]. The location of the HZ is determined on the stellar side primarily by the host star's luminosity and secondarily by its spectral characteristics. These properties serve as boundary conditions for a planetary atmosphere calculation that predicts a planet's surface temperature, and therefore the possibility for stable liquid water. Evaluating the availability of water on the surface of a terrestrial planet requires understanding the link between the important stellar parameters and the circumstellar environment.

Research Summary: We are working to understand how stars of different mass and composition evolve, and how stellar evolution directly influences the location of the HZ around a star. We have created an extensive grid of stellar evolution models for Sun-like stars with variable compositions; we present models for stars of mass 0.5-1.2 $M_\odot$ at scaled metallicities of 0.1-1.5 $Z_\odot$ and O/Fe values of 0.44-2.28 $O/Fe_\odot$. We have included a spread in oxygen values because it is important to understand how the abundance of an *individual element* present in a star, and not just the *total scaled metallicity*, can affect a star's evolutionary lifetime. Metallicity (Z) refers to the abundance of elements heavier than hydrogen and helium. In practice, it is usually only the iron abundance that is measured for many stars, and the rest of the elements are assumed to scale in the same fractions present in the Sun. This is nearly a universal practice in stellar modeling, although the abundance ratios in real stars have been shown to vary substantially. Indeed, the spread in oxygen values we use reflects actual variations in the abundances that have been directly observed in nearby Sun-like stars [2], [3], [4], [5], [6], [7]. We have calculated the time dependent evolution of HZ boundaries for each stellar evolution track based on stellar mass, effective temperature, and luminosity parameterizations. The rate of change of stellar surface quantities and the surrounding HZ position are strong functions of all three quantities explored. We also provide the range of orbits that remain continuously habitable, or habitable for at least 2 Gyr.

The time dependent evolution of HZ boundaries are calculated for each stellar evolution track, using the prescriptions of [8] and [9], which follow from [10]. Our results show that the detailed chemical characterization of exoplanet host stars *and* a consideration of their evolutionary history are necessary to assess the likelihood that a planet discovered in the HZ of a particular star has had sufficient time to develop a biosphere capable of producing detectable biosignatures. Our catalog of stellar evolution models is designed for use by the astrobiology and exoplanet communities to efficiently characterize the time evolution of host stars and their HZs for planetary candidates of interest. Because it is now estimated that more than 20% of Sun-like stars may host a planet in the HZ [11], [12], [13], it is more essential than ever to develop a better understanding of what determines the true habitability of a planet. We will explain how stellar evolution has refined our understanding of a star's HZ, how these regions co-evolve with their parent star over time, and how utilizing this knowledge will apply directly to the search for habitable Earth-like planets in the future.

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