NASA scientist creates expanded list of habitability possibilities for other worlds

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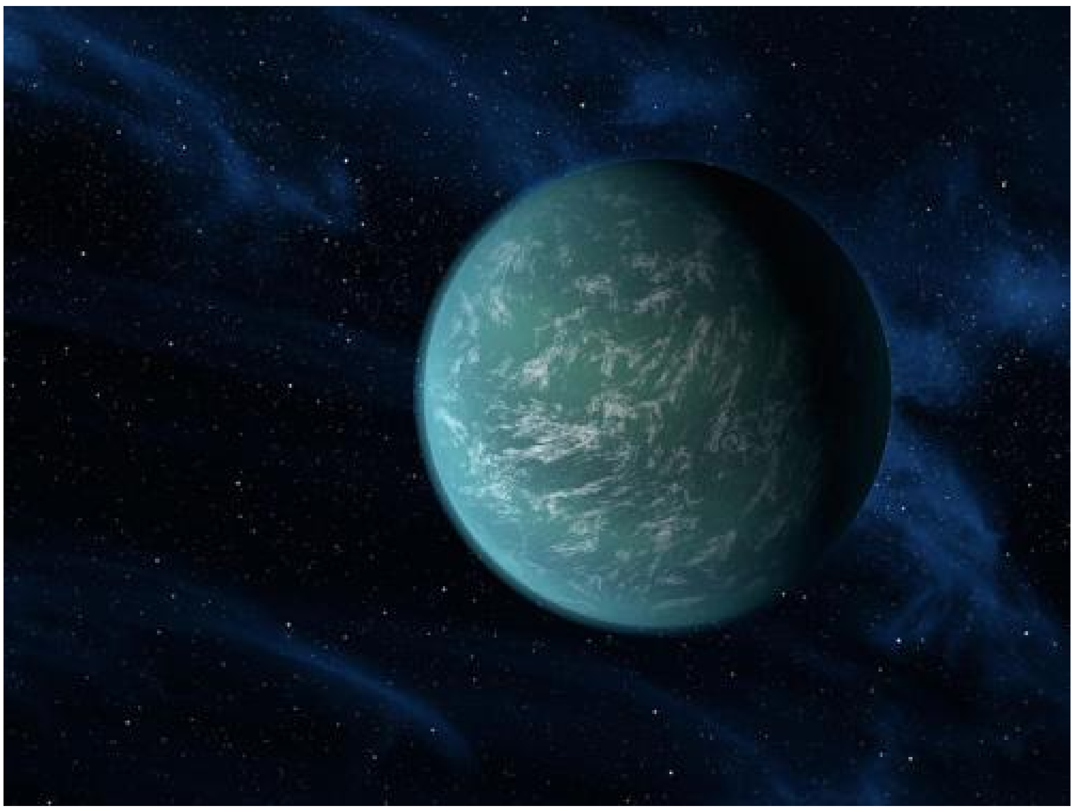

This artist's conception illustrates Kepler-22b, a planet known to comfortably circle in the habitable zone of a sun-like star. Credit: NASA/Ames/JPL-Caltech

(Phys.org) —A NASA scientist based at Ames Research Center has compiled a checklist of habitability possibilities for planets or other bodies in the solar system or beyond. In his paper published in *Proceedings of the National Academy of Sciences*, Christopher McKay outlines ways that life could be possible on other planets, moons, or even other bodies.

Research here on Earth, McKay notes, has led to findings that show that life can exist under what would previously have been considered impossible environmental conditions. Thus, it seems logical that what we define as the conditions possible for life existing in other places should expand as well. Not all life forms need the same requirements as most of the life we see around us, some can survive or even thrive in very extreme conditions.

He notes that some types of microorganisms, for example, have been found to live in environments that are consistently well below freezing or well above the boiling point. Thus, it would not make sense to rule out a planet simply because it's too cold or too hot.

He also notes that not all life forms require as much water as was once thought. Some algae, for instance has been found living inside of rocks, where very, very little water is available. Not unlike the water that is trapped in rocks on the moon, as just one example.

The need for light or some other form of energy source might have been overstated as well. Creatures have been found living in the sea, for example, at depths almost beyond where sunlight can penetrate. Might that mean that some planets have been wrongly excluded as possible life holders, simply because they are too far away from their star? No one knows, but perhaps we should start including more of them on our list of possibilities.

There's also the problem of radiation—too much of course and life should not be able to survive—but what about those microbes that have been found living inside of nuclear reactors? Perhaps we've been too narrowly focused in this respect as well.

And finally, being creatures that need a lot of oxygen to survive, it would seem only natural that we would expect other habitable worlds to have it as well. But research has shown that it too isn't always necessary and is sometimes even fatal to some forms of life, such as a type of bacteria living in soil. Nitrogen, on the other hand seems to be far more critical. Perhaps it should be one of our primary clues.

In short, McKay is reminding us that we maybe ought to be more careful in what we exclude when looking for life elsewhere, perhaps now more so than before as our technology improves to the point where we might finally have what we need to actually prove that life does exist out there, somewhere—even if it's in a form we never might have imagined was possible before.

More information: Requirements and limits for life in the context of exoplanets, Christopher P. McKay, *PNAS*, DOI: 10.1073/pnas.1304212111

Abstract
The requirements for life on Earth, its elemental composition, and its environmental limits provide a way to assess the habitability of exoplanets. Temperature is key both because of its influence on liquid water and because it can be directly estimated from orbital and climate models of exoplanetary systems. Life can grow and reproduce at temperatures as low as −15 °C, and as high as 122 °C. Studies of life in extreme deserts show that on a dry world, even a small amount of rain, fog, snow, and even atmospheric humidity can be adequate for photosynthetic production producing a small but detectable microbial community. Life is able to use light at levels less than 10^{-5} of the solar flux at Earth. UV or ionizing radiation can be tolerated by many microorganisms at very high levels and is unlikely to be life limiting on an exoplanet. Biologically available nitrogen may limit habitability. Levels of O2 over a few percent on an exoplanet would be consistent

with the presence of multicellular organisms and high levels of O_2 on Earth-like worlds indicate oxygenic photosynthesis. Other factors such as pH and salinity are likely to vary and not limit life over an entire planet or moon.

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