

Variety of water planets

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Real necessary and sufficient conditions for life are not well constrained yet. However, terrestrial-life requires existence of liquid water during at least some periods of their life. Therefore, we may consider existence of liquid water as a conventional necessary condition. In the following, we call rocky planets with substantial amount of liquid water on their surface 'water planets.' We discuss possible variety of water planets.

The ice-albedo feedback, which causes the complete freezing, and the runaway greenhouse, which causes the complete evaporation, play important role in determining the existence of liquid water at a given moment. Since both effects are driven by water, abundance of water itself affects the surface environment significantly. Most of the previous studies on the habitable zone implicitly assume an 'ocean' planet that has a large amount of liquid water and covered by oceans like the present Earth. However, there is a possibility of a habitable 'land' planet that is covered by vast dry desert but has locally abundant water. Ancient Mars might be in such a state. The conditions for the existence of liquid water can be different for a less water land planet from that of an ocean planet, because both the ice-albedo feedback and the runaway greenhouse are enhanced by abundant water.