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The interior-atmosphere coupling of rocky worlds

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Earth has been the only known habitable world and thus used as a reference to understand habitability. The origin of life on Earth is not yet clearly understood, but known traces are up-to the Archean (☐ 3.5Ga, Ga-billion years). Earth had water and continents from the Hadean Earth (> 4.0Ga), which had different atmospheric conditions compared to the Archean Earth. Similarly, the current state and composition of atmosphere does not represent its future state. Climate changes are partly attributed to feedback mechanism between the internal processes and the atmosphere. And as such, each atmospheric state is depictive of an instance a long a trajectory path of a coupled evolution of Earth system. Venus was thought to be habitable until into the 1960s, when its surface was observed to be oven-hot with surface pressure a hundred times that of Earth. Why and when the evolutionary paths of Venus and Earth, which are similarly sized and should have similar internal compositions, started to diverge? Moreover, known exoplanets, planets and moons have very different geophysical characteristic from Earth. This implies exotic life might vary substantially from what we know. As a result, understanding evolution of rocky planets, that is their interior structure, atmospheres and climate regardless of their habitability is of great importance. In this work we study the relation between a rocky planet's internal properties and its observable surface and atmosphere properties over time. We explore the different convection regimes (stagnant lid, episodic-lid and tectonic), studying the relation between a planet's viscous state, its interior composition and structure. Focusing on the effects of mantle convection on volatile recycling processes such as CO2 outgassing that influence the atmospheric state and climatic conditions over time. The computed models are then used to compute observables, that ultimately can be tested with observations.