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# Evolution of the Atmosphere and Climate of Venus

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## Abstract

We will review the evolution of the atmosphere and climate of Venus, with a focus on the apparent divergence from early more Earth-like conditions. We will examine what constraints can be put on the nature and timing of this divergence, and in particular on the history and role of water in affecting the evolution of Venus.

Venus, in comparison with Earth, is strikingly dry. As our understanding of terrestrial planet evolution has increased, the importance of water abundance as a substance controlling many evolutionary factors has become increasingly clear. This is true of biological evolution, as the presence of liquid water is widely regarded as the key to the possibility of finding "life as we know it" on other worlds. It is also true of geological and climatic evolution. Water is among the most important climatically active atmospheric gasses on the terrestrial planets. It is also a controlling variable for tectonic style and geologic processes, as well as a mediator of surface-atmosphere chemical reactions.

First, we will discuss what is known about the accretion process, the initial conditions of a primordial Venusian atmosphere, and how the differing history of late large impacts (lack of a moon-forming impact, or combination of large impacts that largely cancelled angular momentum) may have affected these initial conditions.

Then we will review what is known about atmospheric loss processes and in particular the constraints on loss of water over time. The current state of modeling of the runaway or moist greenhouse will be reviewed, in the context of recent work trying to establish theoretical limits for the inner radius of the circumstellar habitable zone and its movement with stellar evolution.

The coupling between of geological and tectonic evolution and the atmosphere and climate will be reviewed, including climate feedbacks, which are operating today, depending on the level of current geological activity.

Finally we will discuss the prospects for improving constraints on the atmospheric and climatic evolution of Venus with measurements made by future missions.