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The evolution of water on Venus: sources and sinks from the Late Accretion to present-day.

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Understanding the evolution of Venus and how it differs from Earth's remains a major conundrum in planetary sciences. We address this puzzle by investigating the history of water in Venus' atmosphere since its Late Accretion phase up to present-day. Using numerical modelling, we seek to define the consequences of the major sinks and sources of water on surface conditions, how they interact, and how they vary with time. The simulations take into account thermal evolution of Venus, and outgassing from the mantle dynamics 2D/3D code StagYY, and atmospheric escape, including modelling of surface conditions and temperature, using a 1D radiative convective atmosphere model. Here, our main modeling efforts focus on the following aspects:

(i) Late Accretion impacts can deliver volatiles to Venus, erode its atmosphere and melt its surface and mantle. We use new parameterizations to assess the maximum volatile loss and delivery during Late Accretion. We calculated evolutionary pathways throughout this era, estimating the possible composition of the final ~1% of the mass delivered to Venus. We discuss impactor volatile content and the effect of nature (reduced, differentiated, outgassed). We compare the consequences of different Late Accretion scenarios and how we can discriminate between them based on atmosphere evolution.

(ii) We consider the role of post-Late Accretion processes in changing atmospheric composition and study under which conditions present-day observations can be reproduced. We discuss the role of melt production and volcanism, including outgassing, surface-gas chemical equilibria between fresh volcanic material and the atmosphere, and the possible volatile sink induced by recent impact delivery since the time present-day surface of Venus was formed.

(iii) Finally, we discuss the place of the atmosphere itself and feedback processes, such as the role of a climate transition through runaway greenhouse from a more temperate Venus into the arid state we observe at present.