THE QUEST FOR VENUS' LOST WATER. G. A. Collinson[1], J. Grebowsky[1], R. Frahm[2], A. Glocer[1],S. Barabash[3], Y. Futaana[3],

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Introduction: Discovering what processes govern the evolution of atmospheres, and specifically the loss of planetary water and oxygen are key to determining what makes planets habitable, and is a driving science objective behind recent missions including the NASA Mars Atmosphere and Volatile Evolution (MAVEN) mission, the ESA Mars Express, and the ESA Venus Express. Of all other planets, Venus is in many respects the most Earth-like. Its atmosphere however is incredibly dry, with four to five orders of magnitude less water than Earth (De Bergh, et al., 1991). The high deuterium-to-hydrogen ratio (McElroy, et al., 1969; Donahue, et al., 1982; De Bergh, et al., 1991) is indicative this was not always the case, and that Venus once had a substantial quantity of water (Donahue, et al., 1992; Hartle, et al., 1996; Donahue, 1999), possibly even forming Earth-like oceans (Svedhem, et al., 2007). Although it is thought that Venus lost much of its water early in its history (Kulikov, et al., 2006), one of the major early discoveries of the ESA Venus Express (Svedhem, et al., 2009) mission was that the primary ion species escaping down the comet-like plasma tail were H+ and O+ ions in a water-like stoichiometric ratio of 2:1. Thus, regardless of the original water inventory, atmospheric escape mechanisms at Venus today appear to be far more effective at driving water and oxygen loss than at nearby Earth, with a comparable size and gravity.

Orbiter-based in-situ particle and fields measurements are a crucial tool for the exploration and understanding of Venus. Unlike landers and aerial platforms, orbiters offer long duration observations covering the entire planet, and particle and fields instrument packages thus flew on Mariner, Venera, Pioneer Venus Orbiter, and most recently Venus Express. However, despite large existing datasets, many mysteries remain that are crucial to understanding the evolution of the atmosphere and water on Venus that can only be solved with particle and fields instruments, but cannot be answered due to limitations in past sensors on these missions. We outline some of these key questions, and discuss the measurements needed to obtain closure on the scientific mystery of what happened to Venus' water, and how we may use Venus as a natural laboratory for understanding planetary habitability of Earth-like planets around distant suns.

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