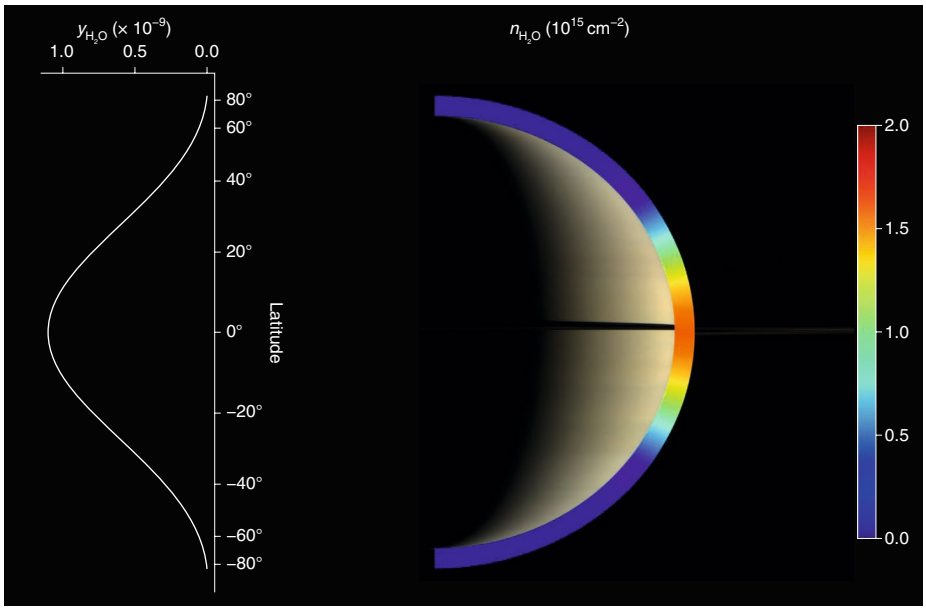
GIANT PLANETS

The Saturn–Enceladus watery link

Astron. Astrophys. (in the press); preprint available at https://arxiv.org/abs/1908.07399



Credit: ESO

Water has been detected in the upper atmosphere of all giant planets in our Solar System. Such water must be exogenous and not endogenous, because any upwelling water from the interior would condense at the tropopause cold trap. Usually, it is assumed that the main water-bearers are oxygen-rich interplanetary dust particles or comet impacts (like the 1994 Shoemaker–Levy 9 impact for Jupiter). However, neither of these scenarios fits the observations of Saturn's water.

After Cassini discovered Enceladus's plumes from its interior ocean, it has been suggested that this moon is a source of Saturn's stratospheric water. Indeed, Herschel data identified a torus of water vapour at Enceladus's orbit, which presumably expands through the Kronian system (P. Hartogh et al. *Astron. Astrophys.* **532**, L2; 2011). However, all of the observations of water on Saturn have been disk averages and so do not allow a direct determination of its origin.

Thibault Cavalié and colleagues analyse spatially resolved data of Saturn's disk taken by Herschel and employ thermal and radiative transfer models to interpret the observations. They find that the water distribution is not uniform in latitude, but rather it peaks at the equator with values of 1.1 parts per billion and decreases poleward following a Gaussian-shaped trend with a full-width at half-maximum of ~25° (pictured, where y_{H_2O} is the mole fraction and n_{H_2O} is the column density). Both this distribution and the measured abundances demonstrate that Enceladus's torus is the main source of water in the stratosphere of Saturn. Any meridionally uniform source, like interplanetary dust particles, is at least one order of magnitude fainter.

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Published online: 26 September 2019
https://doi.org/10.1038/s41550-019-0912-y