Monitoring of the temporal evolution of water vapor in the stratosphere of Jupiter with the Odin space telescope between 2002 and 2019

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In July 1994, comet Shoemaker-Levy 9 collided with Jupiter. This has introduced new chemical species into Jupiter’s atmosphere, notably H₂O. We observed the disk-averaged emission H₂O in Jupiter’s stratosphere at 556.936 GHz between 2002 and 2019 with the Odin space telescope with the initial goal of better constraining vertical eddy mixing (Kzz) in the layers probed by our observations (0.2-5 mbar).

The Odin observations show a decrease of about 40% of the line emission from 2002 to 2019. We analyzed these observations by combining a 1D photochemical model with a radiative transfer model to constrain the vertical eddy diffusion Kzz in the stratosphere of Jupiter. We were able to reproduce this decrease by modifying a well-established Kzz profile, in the 0.2 mbar to 5 mbar pressure range. However, the Kzz obtained is incompatible with observations of the main hydrocarbons. We found that even if we increase locally the initial abundances of H₂O and CO at impact, the photochemical conversion of H₂O and CO to CO₂ does not allow us to find the observed decrease of the H₂O emission line over time, suggesting that there is another loss mechanism. We propose that auroral chemistry, not accounted for in our model, as a promising candidate to explain the loss of H₂O seen by Odin. Modeling the temporal evolution of the chemical species deposited by comet SL9 in the atmosphere of Jupiter with a 2D photochemical model would be the next step in this study.