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Characterization of South polar-winds in Neptune's atmosphere from ALMA observations

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Measurements of winds in Neptune's stratosphere obtained by ALMA Doppler spectroscopy in 2016 by [1] have shown that stratospheric zonal winds at a pressure level of 1 mbar (-180 m/s) appear to be less intense, by a factor of two, than tropospheric winds based on cloud tracking at 1 bar from Voyager observations (-400 m/s). These data also indicate a reversal of the circulation, from retrograde to prograde, at high southern latitudes. However, the spatial resolution of these data was insufficient for a detailed characterization of the high-latitude circulation.

We present here higher spatial resolution ALMA maps of CO and HCN emission lines towards Neptune's limb to measure their Doppler shifts and derive a map of zonal winds in its stratosphere. Our observations - carried out in March-April 2025 - used the ALMA interferometer to map the CO(3-2) and HCN(5-4) rotational lines in Neptune's atmosphere at 345.796 and 354.505 GHz, respectively. These measurements were obtained using around 44 antennas of the 12m array, with an angular resolution of ~0.19'', allowing the mapping of around 12x12 independent pixels on the planetary disk (2.21").

We will present the analysis of these observations, which will include maps of the planet's zonal wind after subtraction of the planet's solid rotation, and compare these results with earlier measurements of the Doppler wind in Neptune's atmosphere [1]. Particular attention will be paid to the South Pole region, whose resolution will be improved by a factor of 2 compared with the observations of [1]. This growing ensemble of ALMA datasets opens the door to the long-term monitoring of the seasonal stability and potential variations of Neptune's stratospheric wind patterns.

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References

[1] Carrion-Gonzalez et al. 2023 A&A 674, L3