CLU­STERS OF CYCLONES ENCIRCLING JUPITER’S POLES

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NASA’s Juno spacecrafthas been operating at Jupiter, in a 53-day polar orbits, since 5 July 2016. The Juno mission has been planned to give a complete survey of the planet from the magnetosphere to the interior. In order to achieve its goals, the Juno spacecraft has a high-inclination orbit, passing from pole to equator to pole in about two hours and, when itpasses close to the planet, the remote sensing instruments can be commanded to sound the planet’s polar regions. From that unique vantage point, JIRAM, the Jupiter InfraRed Auroral Mapper, and JunoCamobtained unprecedented views of Jupiter’s polar regions. JIRAM is an infrared imager suitable for atmospheric mapping and JunoCam is a visible camera.During the first five flybys of the mission the two instruments were able to give a full coverage of both Jupiter polar regions. Flybys took place on 28 August 2016, on 11 December 2016, on 2 February. 2018, and on 27 March 2017 (no remote-sensing observations were collected during perijove 2 and JIRAM did not operate during December flyby).

The atmospheric structure in Jupiter’s polar regions is very different from the well-known axisymmetric banding of alternating belts and zones at lower latitudes. Cyclones, as opposed to anticyclones, were expected in the polar regions but their stable appearance, close clustering and symmetry around each of the poles was unexpected.

From the infrared images, the Northern Polar Cyclone (NPC) appears to have a diameter of approximately 4,000 km and to be offset, relatively to the geographic North Pole, by about 0.5°. It is surrounded by eight circumpolar cyclones in a double-squared geometrical pattern. Counting alternating cyclones, four are centred at about 83.3°N while the other four at about 82.5°N. The two squares are angularly shifted between them by about 45°±2°, forming a “ditetragonal” shape. All cyclones have similar dimensions with diameters ranging from 4,000 to 4,600 km. The four cyclones furthest from the NPC have broad cloud-covered inner regions with sharp oblate boundaries. The four cyclones interspersed between them have more diverse and irregular inner regions, with very small-scale cloud textures; some of them appear chaotic and turbulent. Images reveal the presence of a chaotic zone between the NPC and the eight surrounding circumpolar cyclones, within which there is a largely continuous westward (clockwise) flow at ~86ºN; poleward of this, the eastward (counter clockwise) flow of the NPC begins. This chaotic zone appears to contain turbulent small-scale cloud textures and a few small anticyclonic vortices.

Differently from the North, the Southern Polar Cyclone (SPC) is surrounded by five large cyclones in a quasi-pentagonal pattern. They are of similar size, but generally bigger than the northern circumpolar cyclones with diameters ranging between 5,600 km and 7,000 km. The southern cyclones present a range of morphologies, although the differences are much less distinct than in the north. In particular, some of them display a quasi-laminar circulation: the SPC and two adjacent circumpolar cyclones have cloud spirals converging to the centre, while the other three circumpolar cyclones appear to be significantly turbulent along their spiral cloud branches. The SPC has an offset of about 1.5° relative to the geographical South Pole position and the angular distance between two adjacent circumpolar cyclones is not as regular as in the north, it varies from 65° to 80° relative to the centre of rotation of the SPC. In most cases, the cyclones are essentially in contact if one includes the spiral arms that extend beyond the core. In some cases, a single cloud streak connects the outer spiral arms of adjacent cyclones and can be seen to be continuously stretched.

Regions that are relatively bright in the JunoCam visible images are cool and dark in the JIRAM thermal infrared images and viceversa. Thus, the visibly bright discrete features in the JunoCam images correspond to high-altitude clouds, while the general darker background corresponds to a deeper cloud deck. On the other hand, as the JIRAM thermal radiance is primarily governed by cloud opacity, regions that appear warm can be interpreted as relatively clear of clouds, allowing radiance from deeper, warmer regions to be detected and regions that appear cold are cloudier. Then, the amount of radiation measured by JIRAM can be quantified as the “brightness temperature” of planet varying, in the polar regions between 190K and 260 K (-83°C and -13°C).

More on Adriani et al., 2018, Clusters of cyclones encircling Jupiter’s poles, Nature vol. 555, pages 216-219, doi:10.1038/nature25491.