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Jupiter's high-latitude hazes as mapped by JunoCam

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Abstract

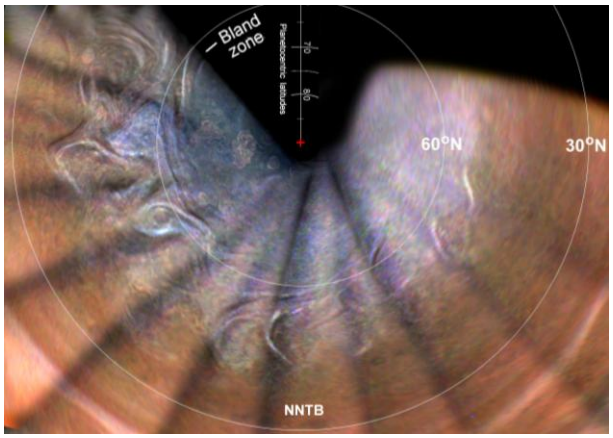
The JunoCam instrument on the Juno spacecraft takes images of Jupiter's polar regions at every perijove and reveals elaborate patterns of haze bands. In visible-colour images, they include white bands, dark brown bands, and 'rainbow bands'. All are seen mainly near the terminator, but brown bands are sometimes also seen under full sunlight. Some of them are also visible in methane-band images (889 nm, detecting reflected sunlight from high-altitude aerosols), but the relationship is complex. In addition to the localised bands, the polar regions are covered with the well-known North and South Polar Hoods (NPH, SPH), which appear bluish (but not noticeably opaque) in JunoCam's visible-colour images, and bright in methane-band images. Here we describe these patterns with particular reference to Perijove 12 (PJ12) on 2018 April 1. These maps show very clearly the high-latitude haze patterns previously seen at lower resolution from Hubble and Cassini and in ground-based infrared images. The main outlines of these haze features can also be detected in the best amateur methane-band images from 2018.

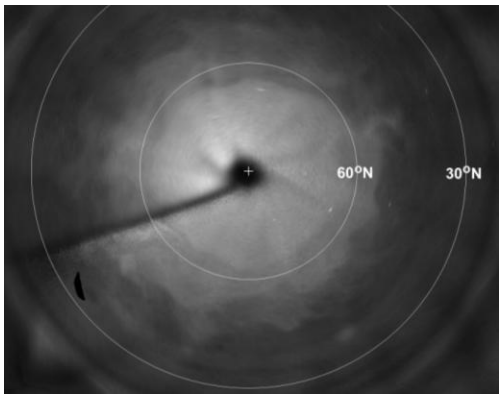
Northern hemisphere

In the north, the most noticeable haze bands are long linear bands in what we call the Bland Zone (roughly lying between two prograde jets at 61 and 66ºN, planetocentric). These were seen at PJ1 [ref.1]; they are slightly oblique, and often consist of adjacent white and brown bands. There are few visible haze bands at higher latitudes, where the NPH is densest. But at <61ºN, there are often conspicuous bands at various angles near the terminator.

PJ12 was special because Juno inbound viewed the planet at higher phase angles than before, and the images showed mainly the high-altitude hazes all across the crescent. Figure 1 is the first detailed map of the northern hazes. The map shows the NPH extending down to the Bland Zone, where the usual linear bands can be seen. From there, similarly bluish-white bands and arcs extend to the south in huge waves and swirls, covering several domains down to ~31ºN (the N2 jet).

Fig.2 is a methane-band map for comparison. It shows multiple edges to the methane-bright NPH, which correspond to waves and swirls in Fig.1.





Figures 1 & 2. Northern hazes: composites of polar projection maps of the PJ12 inbound images, all at high phase angle. **Fig.1** (RGB): The white features are high-altitude hazes. **Fig. 2** (methane band).

South of 61ºN, these hazes do not obviously match the known zonal wind profile, but they may be influenced by it. We suggest that they may arise in the N4 and N5 domains, and spread northwards and southwards until entrained by the next or next-but-

one prograde jet. The N4 and N5 domains are largely filled with 'folded filamentary regions' which generate the most frequent lightning strikes on the planet, and could be generating the hazes.

Southern hemisphere

Fig.3 shows a composite map of south polar haze bands. One conspicuous long haze band has been present in similar position at every perijove since PJ4. This arc-shaped 'Long Band' appears to be structurally related to the pentagon of cyclones that surrounds the south pole [ref.2]. It is often composed of adjacent brown and white bands, the latter often being 'rainbow bands' near the terminator (see below). North of the SPH, narrower bands are often seen in the S5 and S4 domains [not shown here].

Fig.4 is a methane-band map for comparison. It shows the wave system around the edge of the methane-bright SPH (= S6 jet). The Long Band is seen as a boundary within the SPH.

Discussion

The properties of these haze bands are complex. White and brown bands often form tight bundles, and sometimes a band appears white when illuminated from one side and dark when illuminated from the other (i.e., diurnal variation). *White bands* are seen mainly near the terminator, sometimes projecting across it, demonstrating their high altitude [ref.1], above the polar hoods; however they are not always strongly methane-bright. Sometimes they are *'rainbow bands'*, i.e. bright bluish on one side, usually sun-facing (possibly due to wavelength-dependent scattering in the thin outer fringe of the band) and reddish on the other, usually shadowed side (due to any of the following explanations for brown bands).

Brown bands could be explained by some or all of the following hypotheses:

(1) They may be shadows cast by the white bands, with diffusely scattered red light; (2) They may be clear lanes within the diffuse bluish-white polar hoods; (3) They may be bands of brown aerosols;

(4) As brown bands are usually adjacent to white bands, these may be waves of alternating thinner and thicker haze, and/or, waves in which particles are tilted at slightly different angles.

Acknowledgements

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References

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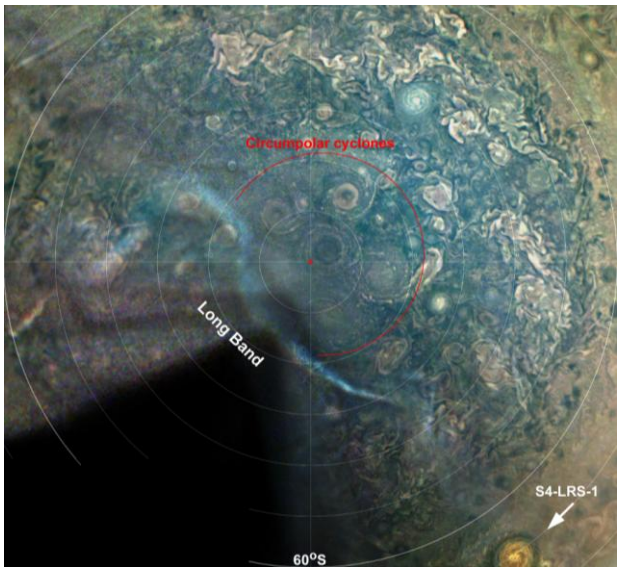

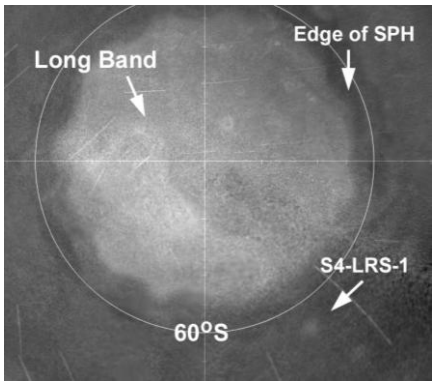

Figures 3 & 4: Composite polar projection maps of the PJ12 images over the south pole and outbound.
Fig.3 (*left*: RGB): In the lower and left-hand sides, it emphasises the regions near the terminator where haze bands (bright or dark) are seen.
Fig.4 (*top right*: methane band).