

## Jupiter's north polar region from Pioneer 11 to Juno

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### Summary

Jupiter's north polar region has been thoroughly mapped by images from Juno since 2016 [1]. We now look back at the map of the north polar region obtained by Cassini in 2000 [2], and the very first images of it by Pioneer 11 in 1974 [3], to see whether they recorded any of the features that are now familiar, and whether any changes can be inferred.

### 1. Data sources

*Pioneer 11*: High-quality prints in [3] and original NASA prints: images D1 and D4. An approximate latitude grid was superimposed by reference to [3]. Latitudes and pole position may be uncertain by a few degrees.

*Cassini*: North polar map in colour: PIA07783 [2].

*Juno*: JunoCam images are assembled and transformed into polar projection maps by algorithms specially created by G.E. These are then merged manually to create a polar projection map for each perijove.

### 2. The N4 and N5 domains

*Juno & Cassini*: Dynamical domains are defined between the permanent prograde (eastward) jets [4]. The N4 and N5 domains (47–64°N)\* appear chaotic, being mostly filled with irregular stormy cyclonic patches called folded filamentary regions (FFRs). However, animated maps from Cassini images [2] showed all the jets, and JunoCam has shown far more detail [ref.1, & reports on each perijove at: [https://www.britastro.org/section\\_front/15](https://www.britastro.org/section_front/15)].

*Pioneer 11*: There is a narrow, largely featureless zone at ~52°N or 55°N, in the anticyclonic side of the N4 domain. No such zone is present in the Juno maps, so there has been a systematic change in the behaviour of this domain.

\*(Latitudes in the text are planetographic.)

### 3. The N6 domain and Bland Zone

*Juno & Cassini*: This is a visually bland region at ~63 to 67–68°N, approximately between the two northernmost prograde jets at 64 and 68°N. Sometimes a sector of it appears disrupted, but otherwise it has been a permanent feature since Cassini.

*Pioneer 11*: The Bland Zone is only doubtfully visible in the Pioneer images, but this may be because Pioneer happened to view a disrupted sector as Juno sometimes does.

### 4. The Circumpolar Cyclones (CPCs)

*Juno*: JunoCam's first images revealed clusters of large spiral cyclones at each pole [1]. At the north pole they form an octagon, centred on a ninth cyclone now in darkness [5]. Due to Juno's orbit, it takes four orbits to image the whole octagon illuminated. Nevertheless, it is evident that the pattern has not changed nor moved greatly [6].

*Cassini*: The polar map shows a ring of white, roughly circular patches at 83–85°N, similar to the present octagon. This may well be the same octagon.

*Pioneer 11*: North of the Bland Zone, image D1 shows some resolved FFRs and numerous smaller light patches, like the Juno maps; and closest to the pole, at the terminator, are two roughly circular light patches at ~82.5°N, which are likely to be two of the CPCs.

### 5. Conclusions

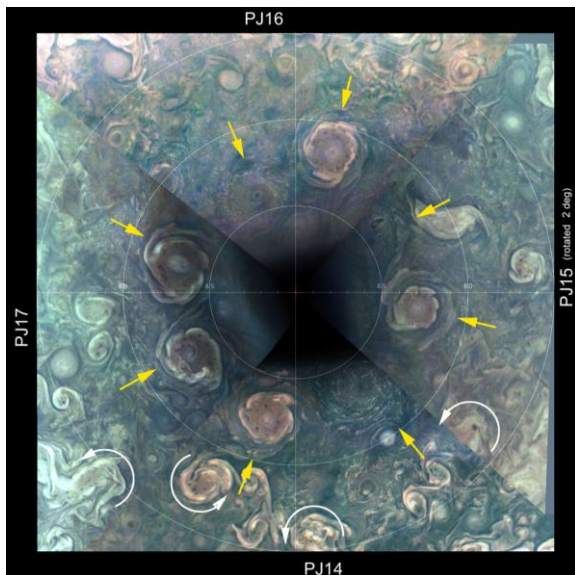
While the latitudes of the high-latitude jets have not shown definite variations since Voyager in 1979, the patterns of features in the N4 to N6 domains have shown some changes. The Bland Zone has existed at least since 2000, but its presence in 1974 was unclear. The cluster of northern CPCs has been largely unchanged from 2016 to 2018, and probably also existed in 2000. The Pioneer 11 image is consistent with similar CPCs existing in 1974.

## Acknowledgements

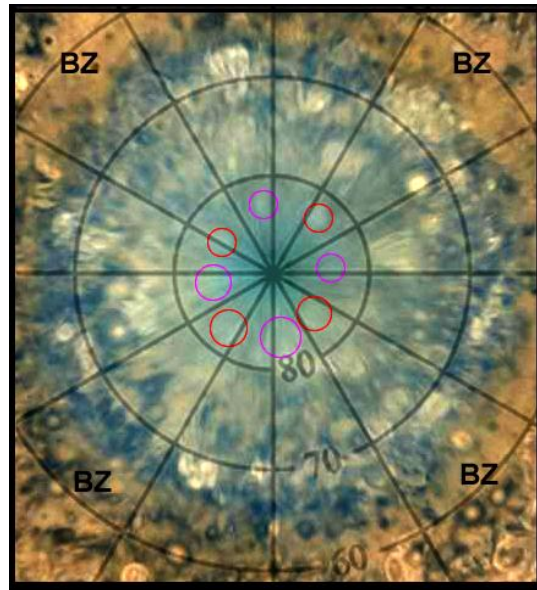
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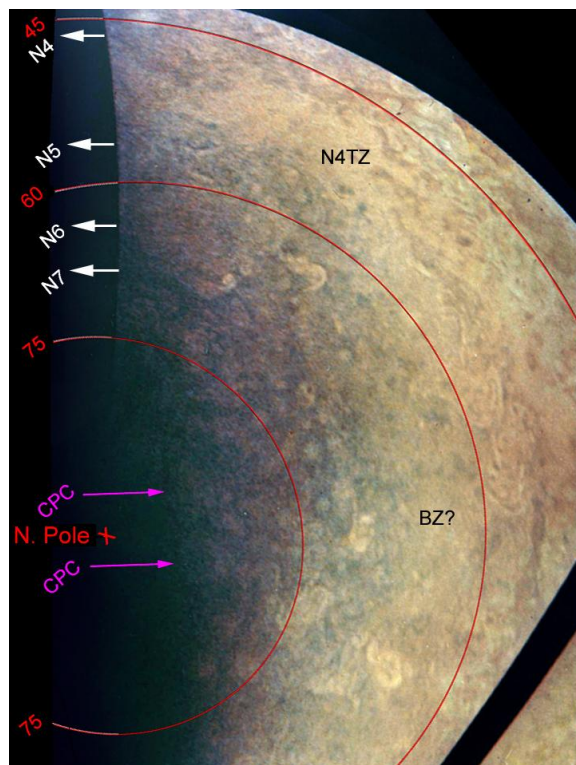
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**Figure 1.** JunoCam north polar map, assembled from perijoves 14-17. Yellow arrows indicate the 8 CPCs. White arrows indicate sense of cyclonic circulation of some FFRs.



**Figure 2.** Cassini north polar map (Credit: NASA/JPL/Cassini imaging team: PIA07783), contrast-enhanced. Planetocentric latitude grid. BZ = Bland Zone. Coloured circles mark probable CPCs.



**Figure 3.** Pioneer 11 image D1. Approx. planetographic latitude grid. Jets N4 to N7 are marked. BZ? = Bland Zone.