Jupiter in 2020: Report no.4: Part III

Stationary waves revealed by methane images of the Equatorial Zone

John Rogers (BAA), 2020 July 29

The most remarkable and unexpected discovery of this apparition is a series of waves within the EZ that are not moving with System I (the great equatorial current) but are stationary in System III – unlike anything previously seen in the EZ.

These waves are latitudinal undulations of the boundary at ~3ºS between the methane-bright, visibly ochre EB and the methane-dark, visibly white EZ(S). They were first noticed in May in a restricted longitude sector. They were most evident in the high-quality methane images by Chris Go, but also detectable in images by some other observers (Figure 19).

The well-defined waves were in a limited sector from L3 ~ 160-240, with a wavelength of about 20 deg. In some places the N edge of the methane-bright strip also has waves that parallel those on the S edge, so the whole strip is undulating. I have measured the longitudes of the wave-crests in images from April 22 to June 2 (Figures 19 & 20). When plotted in System I, the wave-train as a whole, and the individual waves, were obviously moving very rapidly, DL1 ~ -7 to -8 deg/day – i.e. with System II or III. Plotting in System III showed that they were stationary, DL3 = +1 (±2) deg/month. (In contrast, the blue arrow on the images indicates a methane-bright spot in the EZ that is stationary in System I, at L1=56. It is not visible in RGB but lies on the ochre EB.)

There were four principal waves, with lower-amplitude extensions of the wave-train sometimes detectable just p. and f., and a few isolated fluctuations at other longitudes. Similar waves can be seen in some methane images as far back as 2020 Feb. but have not yet been measured. This same boundary was present in methane images in summer 2019 but without such prominent wave structure.

A similar wave-train is still present in the same L3 range in July. These waves are likewise near-stationary in System II or III, not System I (Figures 21 & 22), despite some changes in their appearance. Again there is a small methane-bright spot on the equator which provides an internal control as it is fixed in System I (L1=150) . (Conjunction with this spot may be the reason for the largest discrepancy in the chart, a shift of a very methane-dark streak within the wave pattern by 8 degrees in L3.) At the time of writing, similar waves are also visible near the GRS, but much less regular.

The waves are not visible in RGB images (see the direct comparison in Part II Figure 8, & Anim-D). They lie along the interface between the ochre EB and the white EZ(S), which shows small-scale mixtures of streaks; there are often blue-grey streaks on and around the interface, including along some of the waves, but they do not systematically coincide with the waves.

Discussion

There are no visible features in or near the EZ that might be forcing these waves:

--The SEB is all quiet along here;

--The GRS is on the opposite side of the planet;

--The NEBn AWOs are in the same longitude sector, but not aligned with the EZ waves;

--Methane-dark waves developed on the northern NEB in this sector, but not until mid-May, and they were not seen adjacent to the EZ waves.

Various other phenomena might be suspected as relevant but they lack any evidence of a connection:

--The only previous suggestion of features within the EZ moving with System III was for ‘thermal waves’, some 30 years ago, but they seem likely to have been low-resolution spillover from the methane-dark thermal waves that we have subsequently recognised on the NEB [discussed in Ref.5], and although genuine spillover from NEB thermal waves may sometimes occur, our methane images show no evidence for it in 2020.

--System III is the reference frame of Jupiter's magnetic field and Juno discovered an anomalous equatorial 'magnetic pole' that maps to the southern EZ [ref.6], but it is near L3=90, far away from our waves.

--The SEBn jet had undulations with 20-deg wavelength in Cassini movies [Ref.7], but those waves moved with System I (apparently in register with the NEBs dark formations) so cannot be relevant.

We may hope that concurrent professional infrared observations in 2020, and further analysis of Juno magnetic maps, may give some clue as to the nature of these remarkable waves.

References

5. Rogers JH, Akutsu T, & Orton GS (2004). 'Jupiter in 2000/2001: Part II: Infrared and ultraviolet wavelengths: A review of multispectral imaging of the jovian atmosphere.' JBAA 114 (no.6), 313-330.

6. Connerney JEP et 11 al. (2018) 'A new model of Jupiter's magnetic field from Juno's first nine orbits.' Geophys.Res.Lett. 45, 2590-2596.

7. Simon-Miller AA, Rogers JH, Gierasch PJ, Choi D, Allison MD, Adamoli G, Mettig H-J (2012). 'Longitudinal variation and waves in Jupiter's south equatorial wind jet.' Icarus 218, 817–830 [doi:10.1016/j.icarus.2012.01.022]

Figures for Part III:

Figure 19: *[on next page]*.

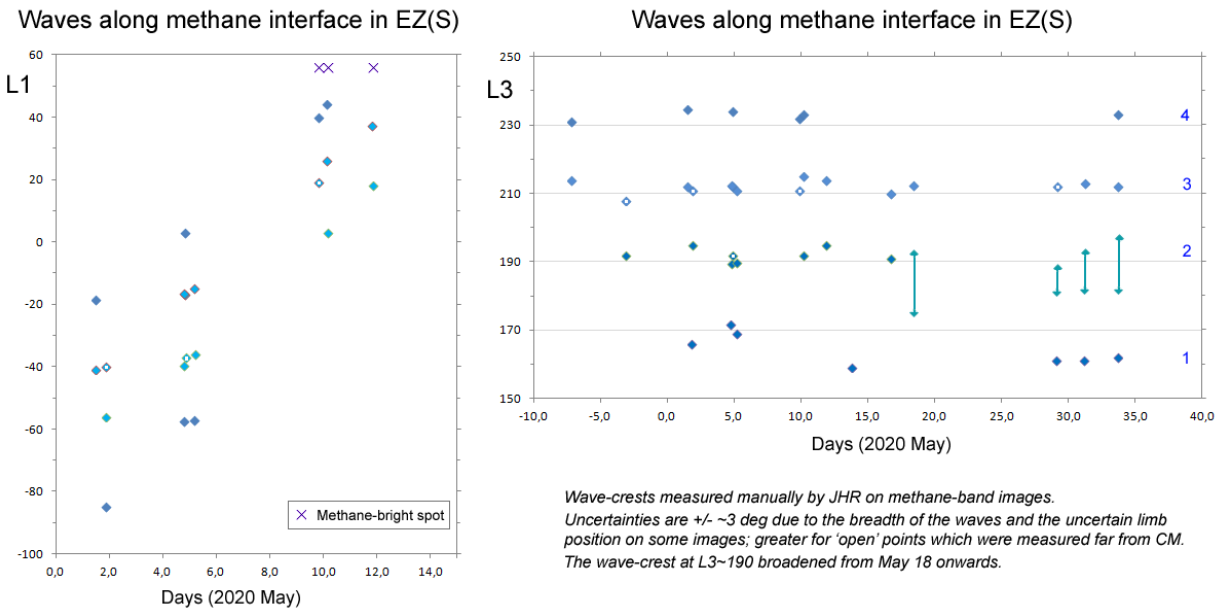

Figure 20. Chart of longitude vs time for the wave crests in 2020 May (left, in L1; right, in L3).

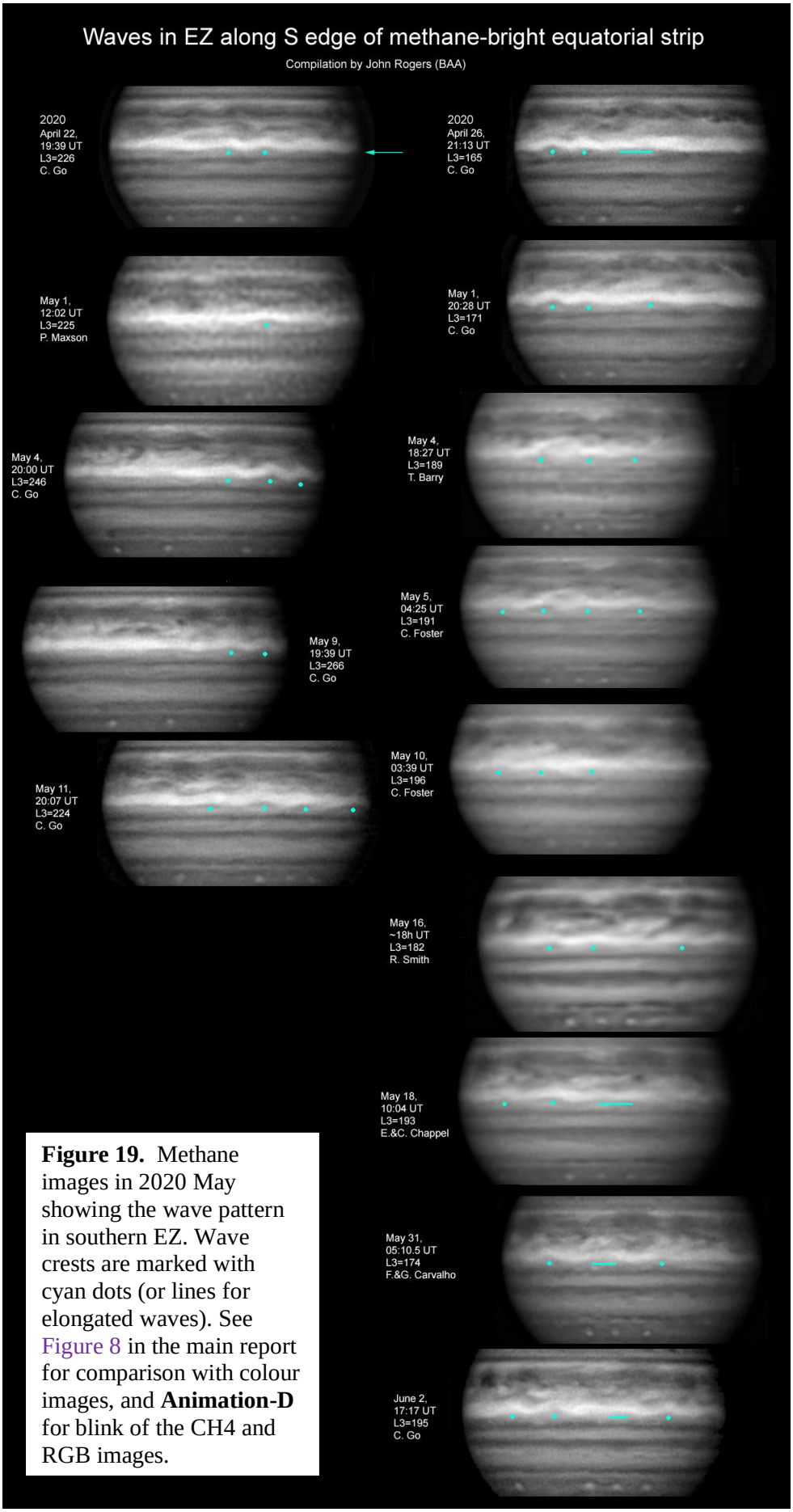

Figure 19. Methane images in 2020 May showing the wave pattern in southern EZ. Wave crests are marked with cyan dots (or lines for elongated waves). See Figure 8 in the main report for comparison with colour images, and **Animation-D** for blink of the CH4 and RGB images.

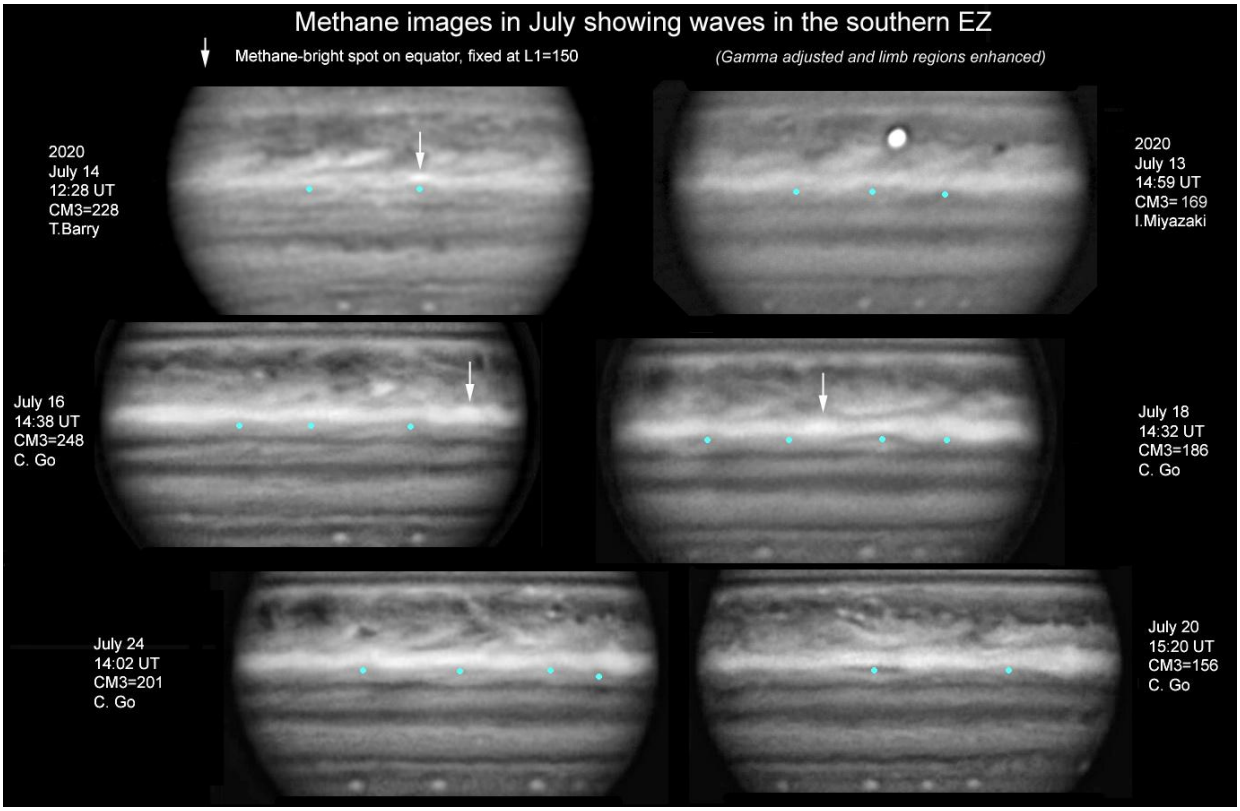

Figure 21. Methane images in 2020 July showing the wave pattern in southern EZ. Wave crests are marked with cyan dots.

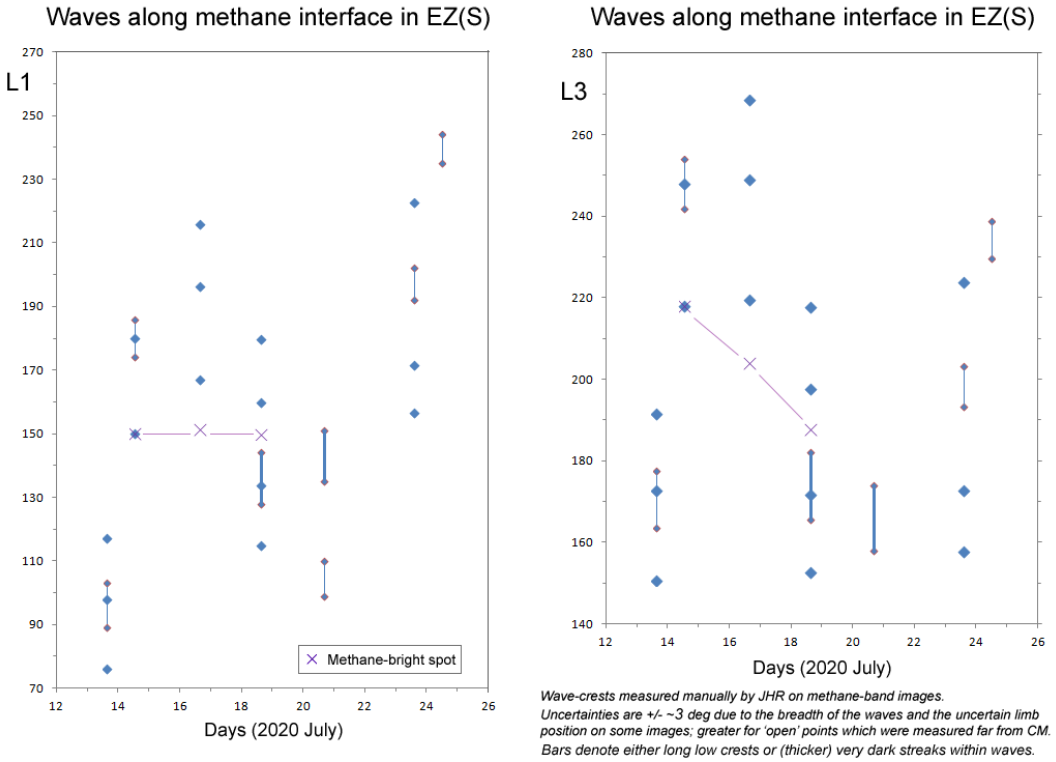

Figure 22. Chart of longitude vs time for the wave crests in 2020 July (left, in L1; right, in L3).