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A long-term study of the Jovian equatorial atmosphere at the upper troposphere-lower stratosphere from HST observations in the 890-nm methane absorption band

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Despite the obvious differences among Jupiter, Saturn and Earth, there are some remarkably similar phenomena occurring on all three planets. One of them is the observed equatorial stratospheric oscillation of temperatures and zonal winds that on Earth is called the Quasi-Biennial Oscillation (QBO) and that was discovered on wind fields measured from meteorological balloons **[1]**. On Jupiter, a similar phenomenon was discovered in 1991 from observations of a cycle of temperatures in the equatorial stratosphere that oscillated with a periodicity of about 4 years **[2]**, and was named the quasi-quadrennial oscillation due to its similarity with the QBO. This phenomenon was later shown to be irregularly affected by the development of large convective outbreaks outside the Equator changing the cadence of the regular cycle modifying the period of the oscillation from 3.9 to 5.7 years **[3]**. In Saturn, a similar oscillation of equatorial temperatures in the stratosphere was discovered with Cassini data **[4-5]** and was accompanied by the presence of an elevated narrow equatorial jet traced in the motions of the upper atmosphere equatorial hazes **[6]**. The Jupiter Equatorial Stratospheric Oscillation (JESO) represents an oscillation of temperatures that propagates downwards in time at pressure levels of 0.1-40 mbar and is confined between the North and South Equatorial Belts. Temperatures oscillate from having a local maximum at the equator and local minimum at ±14º latitude to the opposite situation. Because of the thermal wind relation, changes in temperatures should produce changes in stratospheric winds, but because this occurs at the equator, where Coriolis forces becomes negligible, the exact relation between meridional gradients of temperature and vertical wind shears requires the use of modified thermal wind equations that are untested with observational data **[7]**. Numerical modelling of JESO, and comparisons with Earth meteorology, suggest that gravity waves produced from convection at the troposphere are likely the major contributors to generating the JESO **[8-9]**. Recently, an intense narrow equatorial jet at stratospheric levels (200-50 mbar), close but below those most affected by the JESO changes in temperatures, has been discovered in analysis of James Webb Space Telescope (JWST) images **[10]** (data from July 2022 obtained as part of the Early Release Science Program 1373). This jet mimics the behaviour of the elevated equatorial narrow jet in Saturn **[5]**. The new jovian jet is confined at ±3º of the equator and it could represent a deep counterpart of the JESO phenomena, thus being a key part of the relation between the troposphere and stratosphere.

The lack of further JWST observations equivalent to those obtained in 2022, and the suspected temporal variability of the stratospheric jet, directed our interest to observations obtained by the Hubble Space Telescope (HST) at the strong methane absorption band at 890 nm (filter FQ889N), which are sensitive to the upper aerosols in the atmosphere at levels of around 200-300 mbar below those observed with the JWST. HST images of Jupiter at this wavelength have remained mostly unused in the past to measure winds in the planet due to the lower contrast of the images and the lower image quality than in filters sensitive to deeper levels in the troposphere. We have analysed HST images in this wavelength between 2015 and 2022 to retrieve zonal winds in the equatorial region and study potential variabilities in zonal jets, optical opacities and hazes altitudes. In this talk, we will present a thorough survey of zonal winds and clouds opacity and altitude results together with a close comparison with JWST data in 2022 and the published studies of the thermal aspects of the JESO [e.g. **11**] that will enable us to understand in more detail the troposphere-stratosphere connection.

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