

# Occurrence of ECH waves in Jovian magnetosphere: comparison with Earth and Saturn

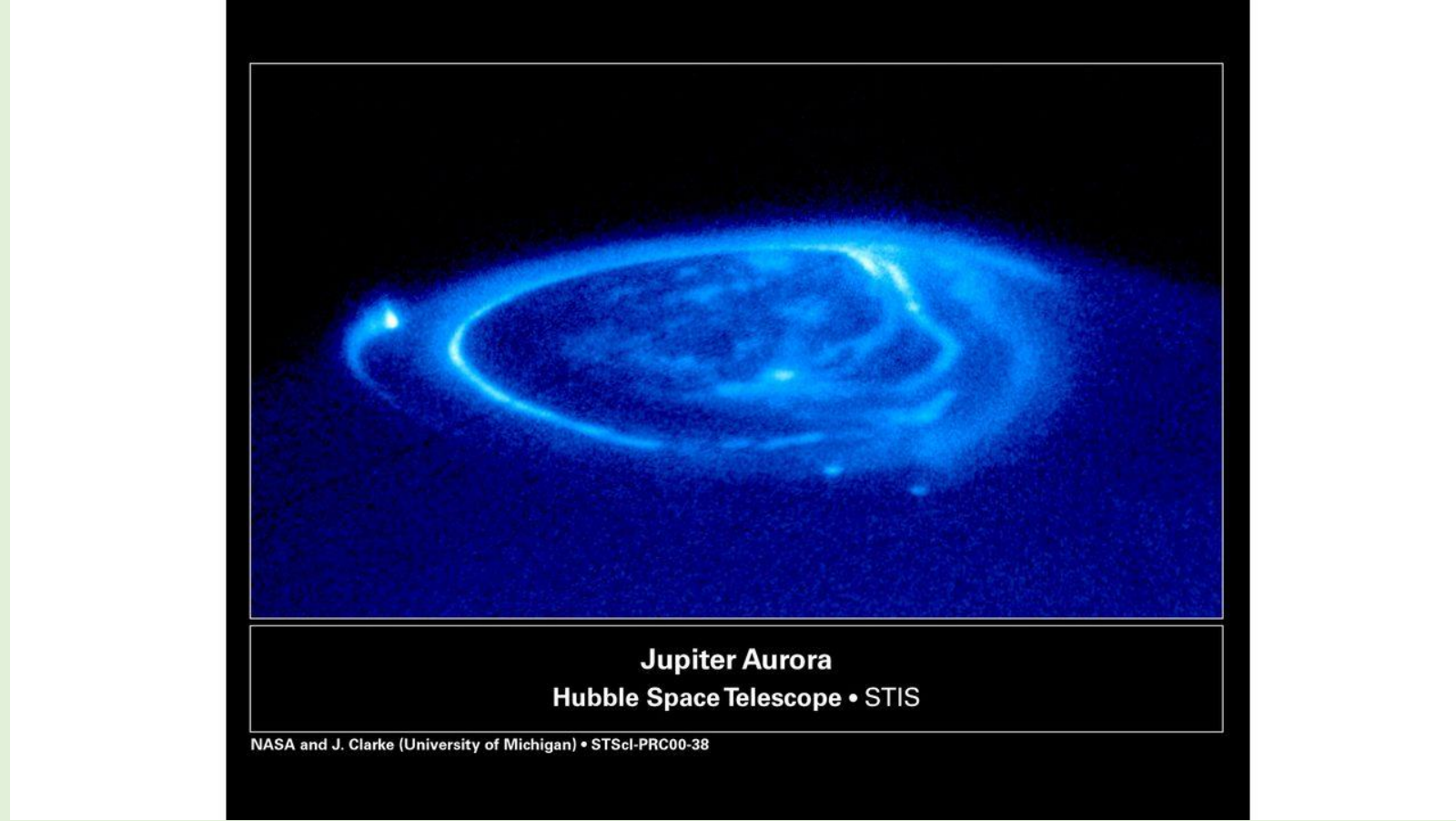
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## Electron Cyclotron Harmonic (ECH) (aka electron Bernstein) wave.

- Narrow band waves with frequencies in between harmonics of electron cyclotron frequency.
- Predominantly electrostatic.
- Tend to occur with distinct banded structure.
- Propagates nearly perpendicular to the background magnetic field.

## Persistent diffuse aurora at Jupiter (Hubble image)



ECH and chorus waves can accelerate magnetospheric electrons causing diffuse aurora.

Statistical distributions of chorus and ECH are needed to understand the nature of the Jovian diffuse aurora.

- Chorus distribution (Li et al., 2020) is available.
- ECH distribution is still needed. Current study is aimed at achieving that goal.

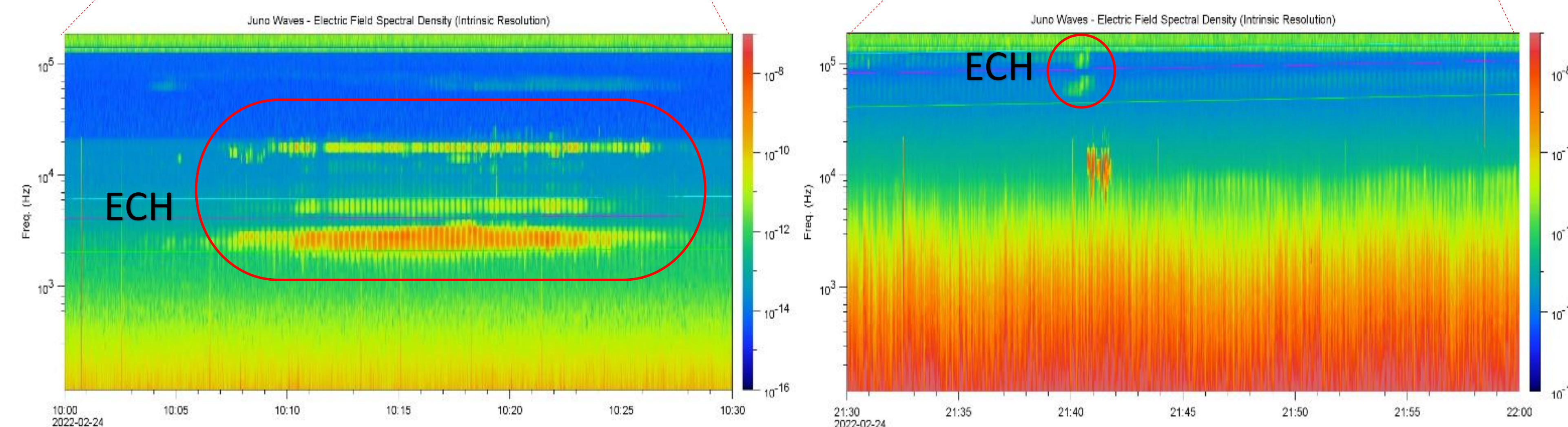
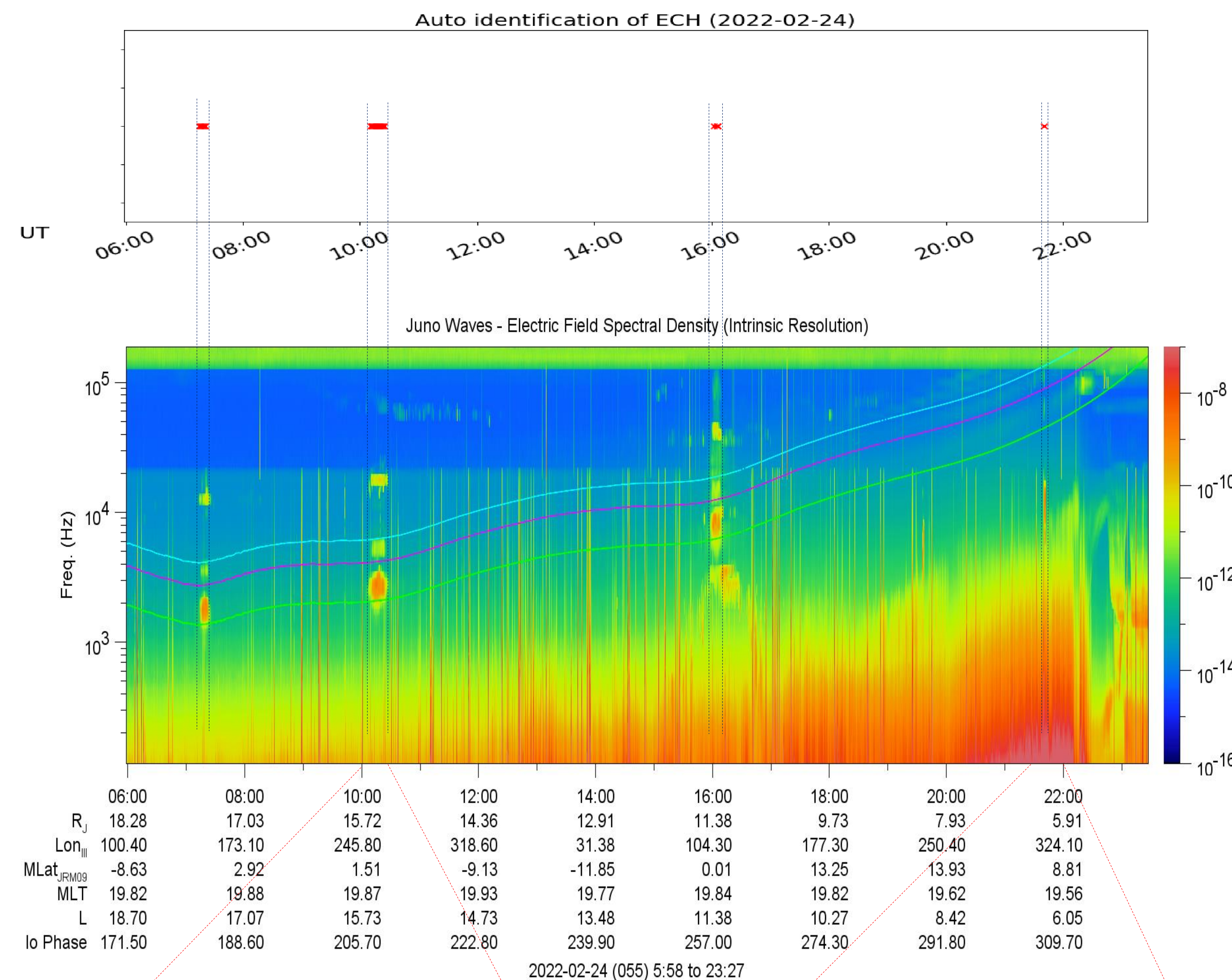
## Identification of ECH waves

- Banded structures in electric field (Juno-Waves instrument) measurements in between the Electron cyclotron harmonics (Juno-FGM instrument).
- Absence of corresponding structures in magnetic field (Juno-Waves instrument) measurements.
- Perpendicular direction of propagation (Barbosa et al., 1980).

## Challenges (w.r.t Juno instruments)

- Determination of a reasonable threshold for electric field strength. Need an adaptable threshold due to changing background.
- Resolution of electric field data reduces at higher frequencies.
- Magnetic field data is only available up to 20 kHz.
- Ideally wave normal angle needs to be measured to determine perpendicular propagation. This is not possible with the current instrumentation on Juno.

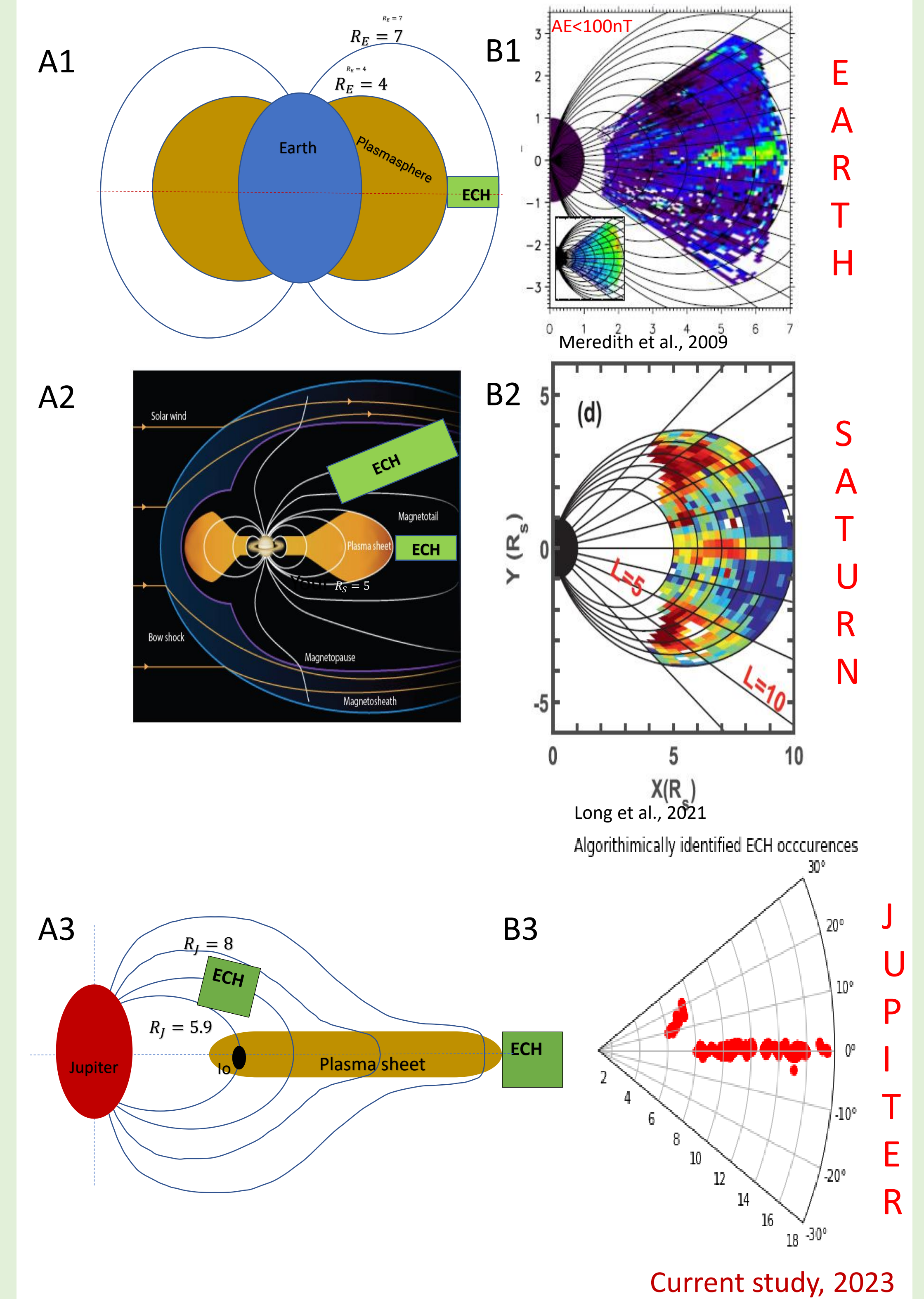
## An example output of ECH wave detection algorithm



Center panel shows the power spectral density of electric field measured by Juno on February 24, 2022. Top panel shows the times when our algorithm detected ECH waves. Bottom panel is the zoomed in view of two of the time intervals that included ECH waves.

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## Regions of ECH occurrence in different planetary magnetospheres.



## Summary

- Two distinct regions of ECH waves are present in Saturn and Jupiter.
- ECH waves occur in regions, where  $1 < \frac{f_p}{f_c} < 4$ . ( $f_p$  = electron plasma frequency,  $f_c$  = electron cyclotron frequency)
- Seen in the equatorial regions outside the high density plasmasphere / plasma torus.
- Seen also at intermediate latitude in the magnetospheres, where plasma is confined in a thin disc near centrifugal equator.

## Future work

- Calculate the intensity of ECH bands.
- Visualization of ECH intensity with respect to various magnetospheric parameters.
- Estimation of the direction of polarization of electric vector.

References: Li: doi:10.1029/2020GL088198; Barbosa:doi:10.1029/JA085iA12p06729; Meredith: doi:10.1029/2009JA014230; Long: doi:10.1029/2020JE006800