Comparative visibility of planetary auroral radio emissions and implications for the search for exoplanets

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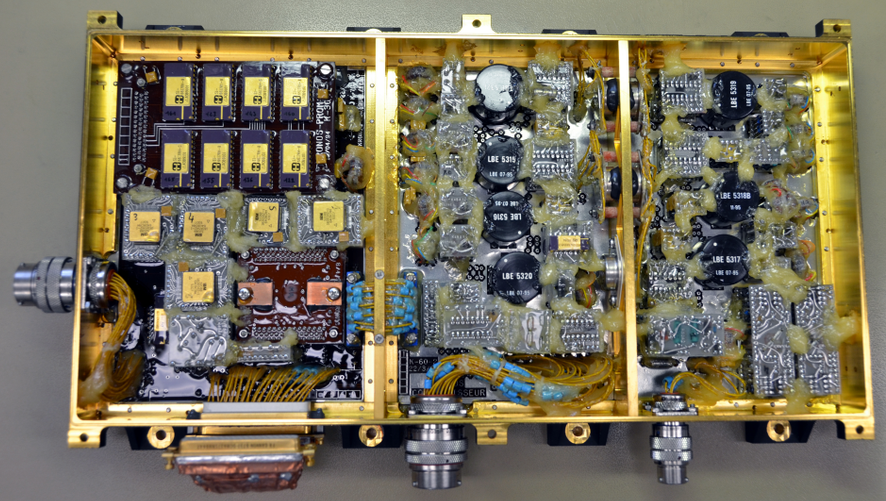
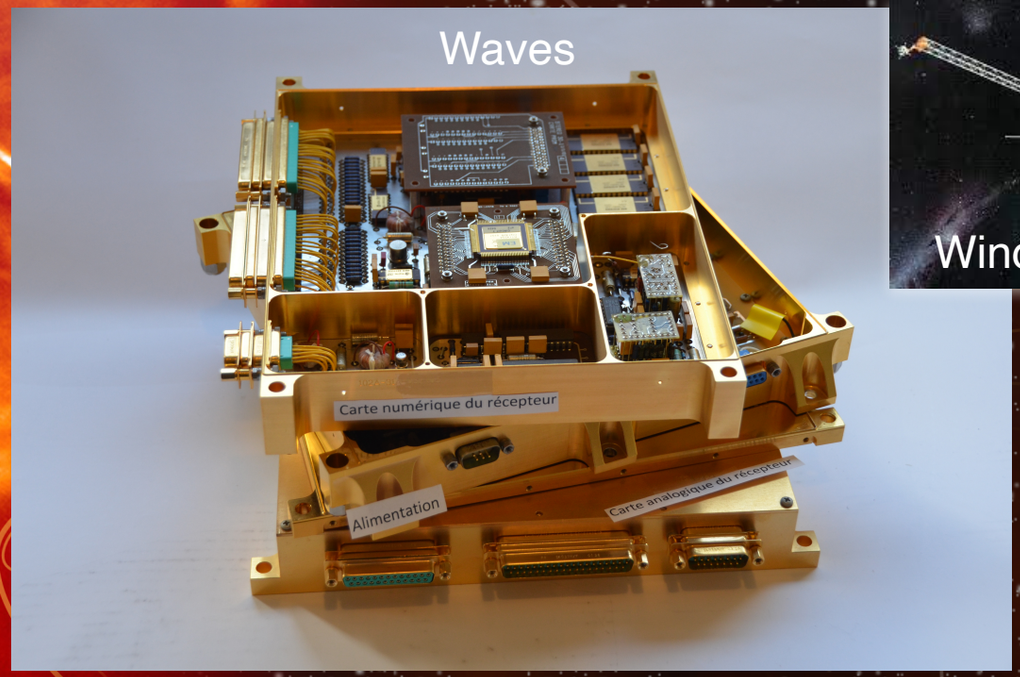
with thanks to : P. Zarka, B. Cecconi, K. Issautier, X. Bonnin

PNST Marseille, 10 janvier 2024

High Frequency Receiver



Cassini 2004-2017



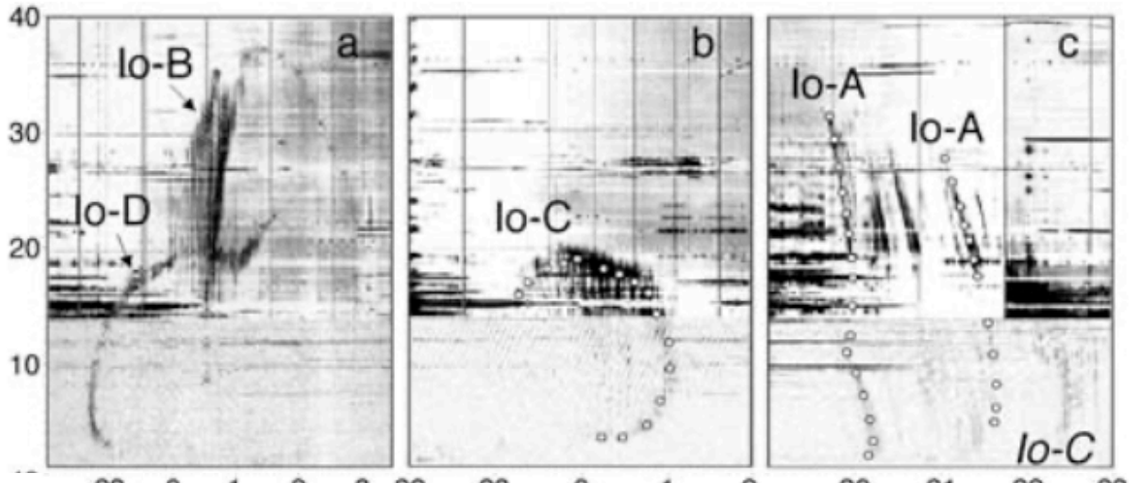
Wind >1993

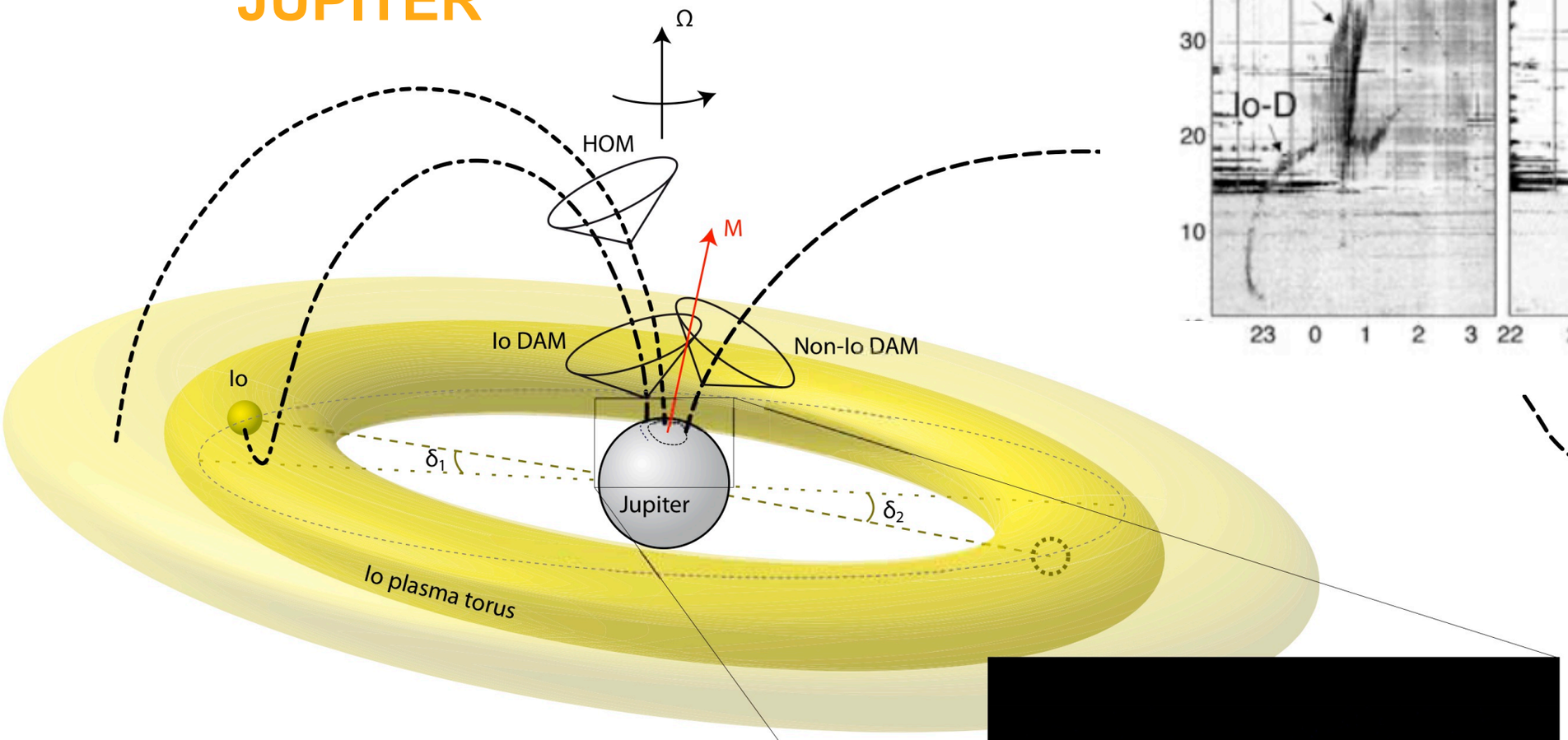
Juno >2016

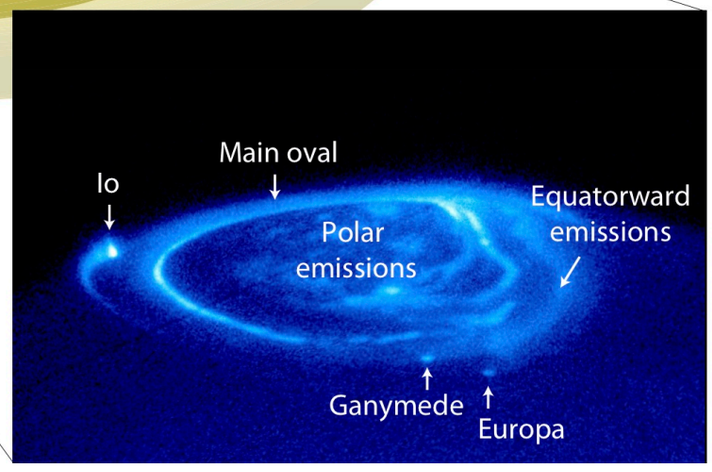
Réseau
Décamétrique
de Nançay >1978

Radio-active planets in the solar system

(Queinnec & Zarka, 2001)







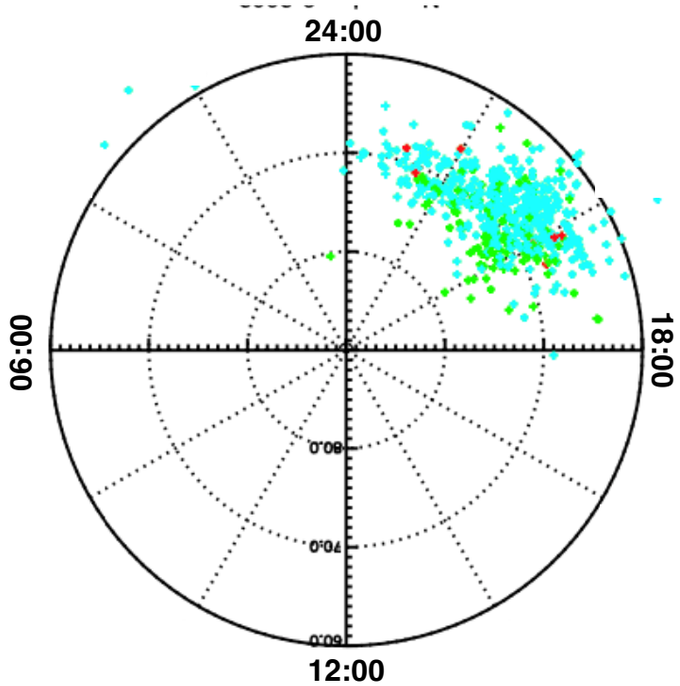
(Cecconi et al., 2012)

- Auroral radio emissions produced by the Cyclotron Maser Instability (CMI)
- $f \sim f_{ce}$, correlation with atmospheric aurorae etc.
- Inhomogeneous radiosources + strongly beamed

Radio-active planets in the solar system

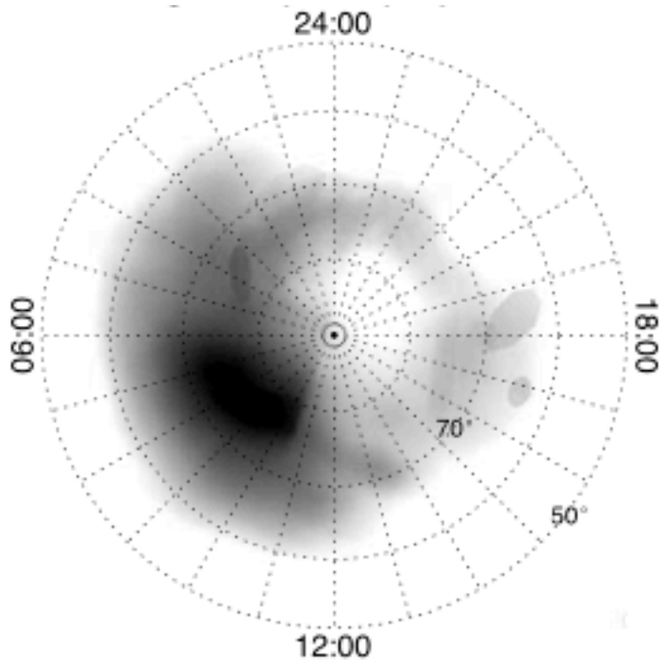
EARTH (AKR)

(Mutel et al., 2004)



organized by
Local Time

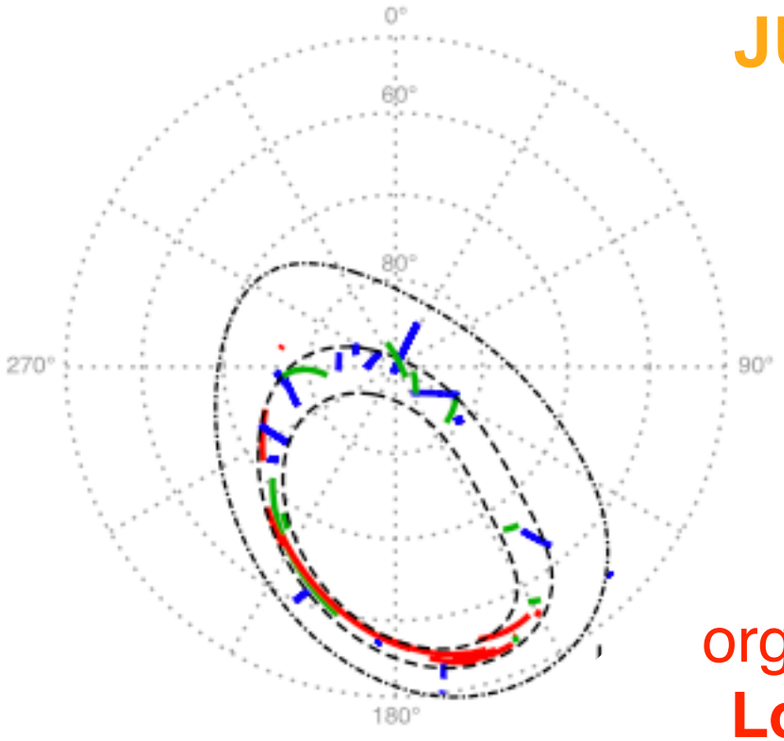
SATURN (SKR)



(Lamy et al., 2009)

JUPITER

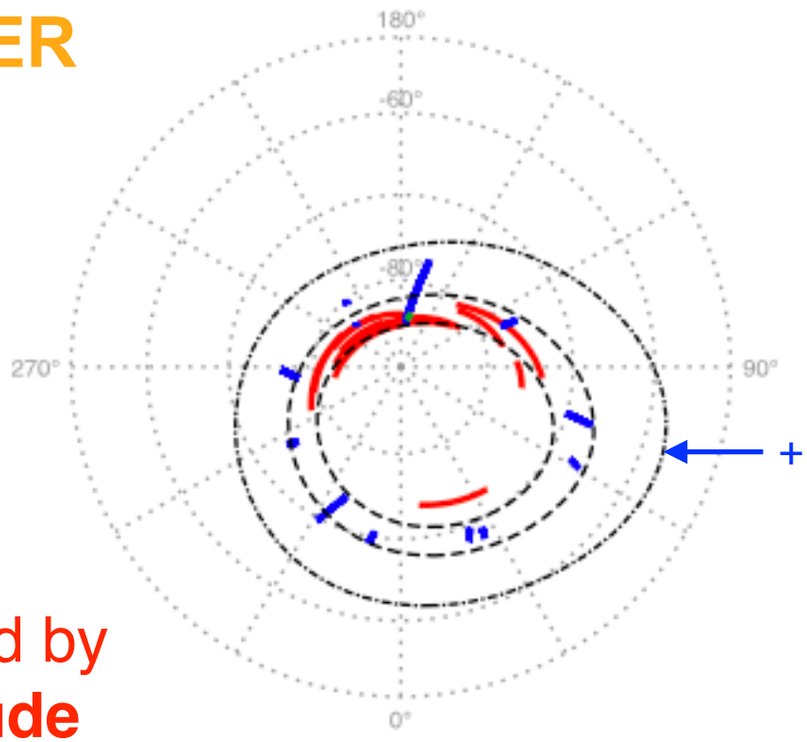
(Louis et al., 2017)



Northern hemisphere

DAM
HOM
bKOM

organized by
Longitude



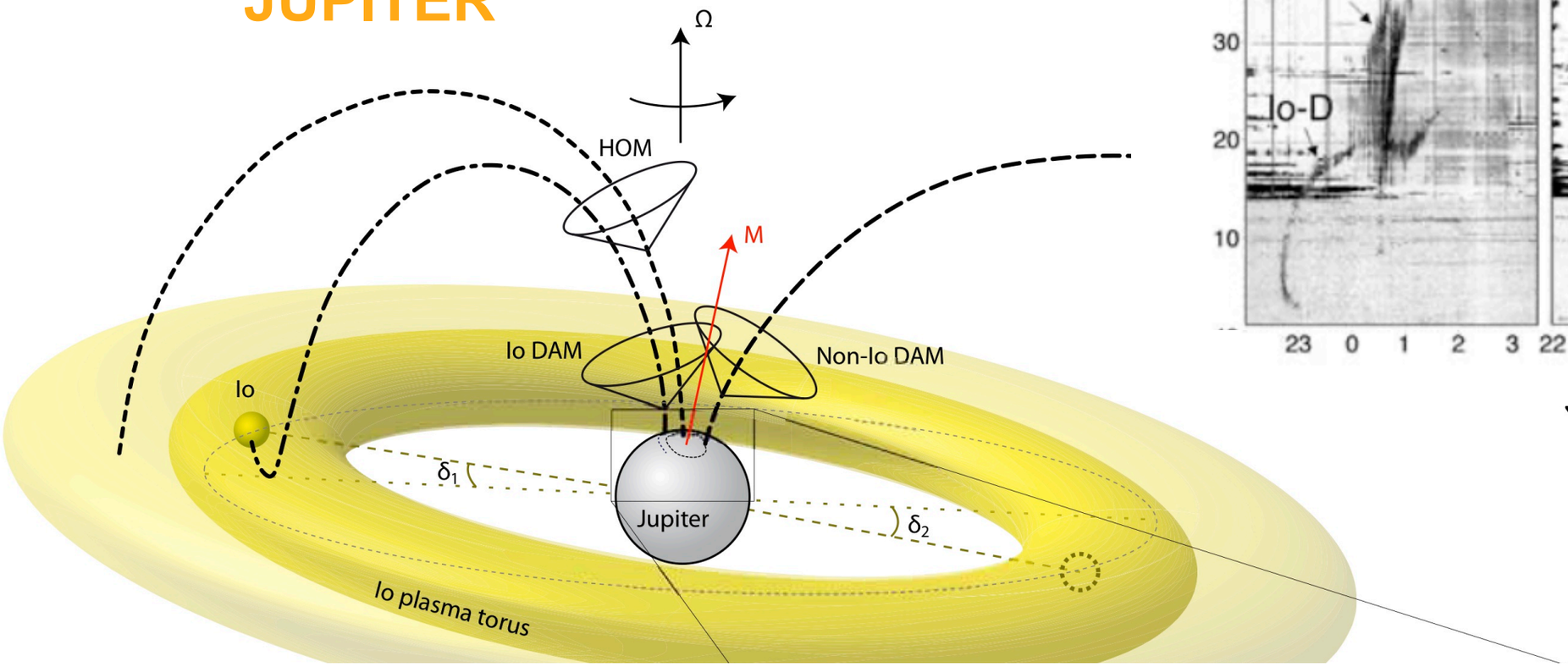
+ Io/Eu/Gan-DAM

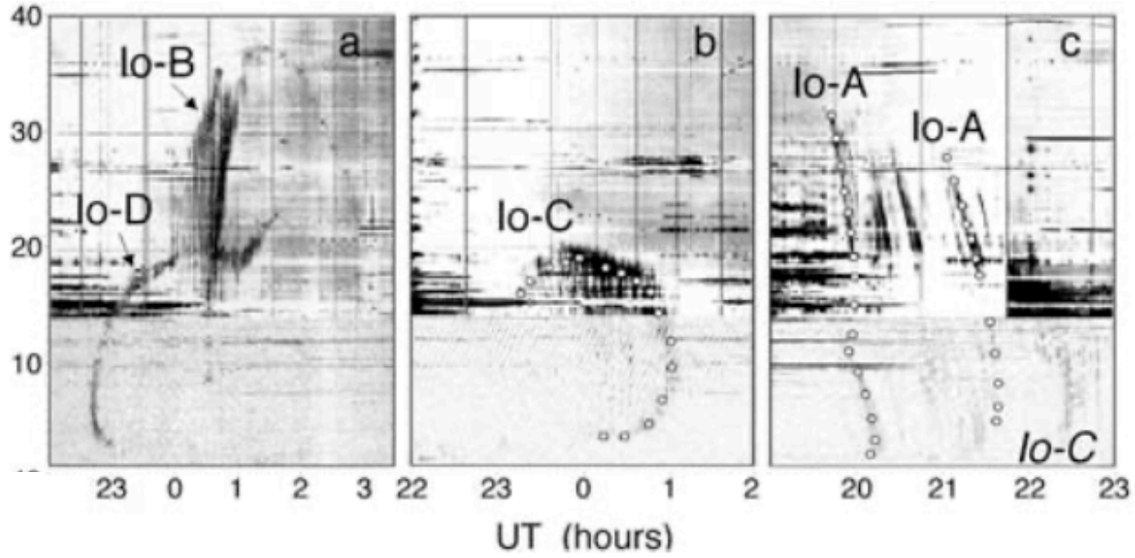
Southern hemisphere

Radio-active planets in the solar system

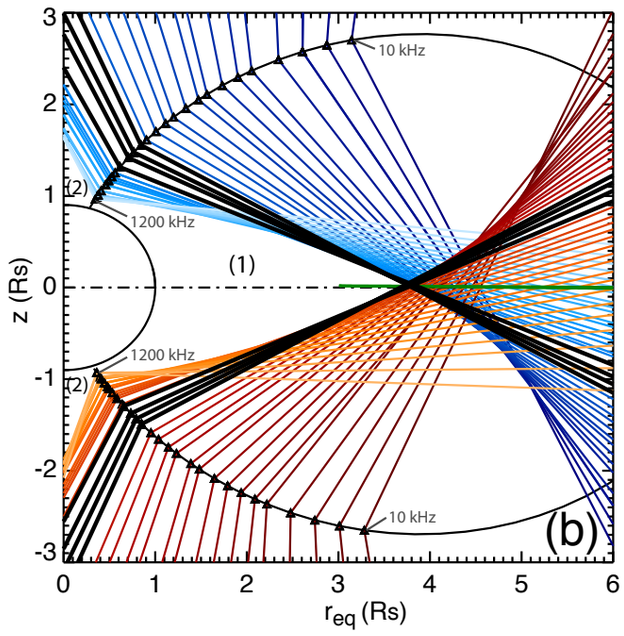
(Queinnec & Zarka, 2001)

JUPITER

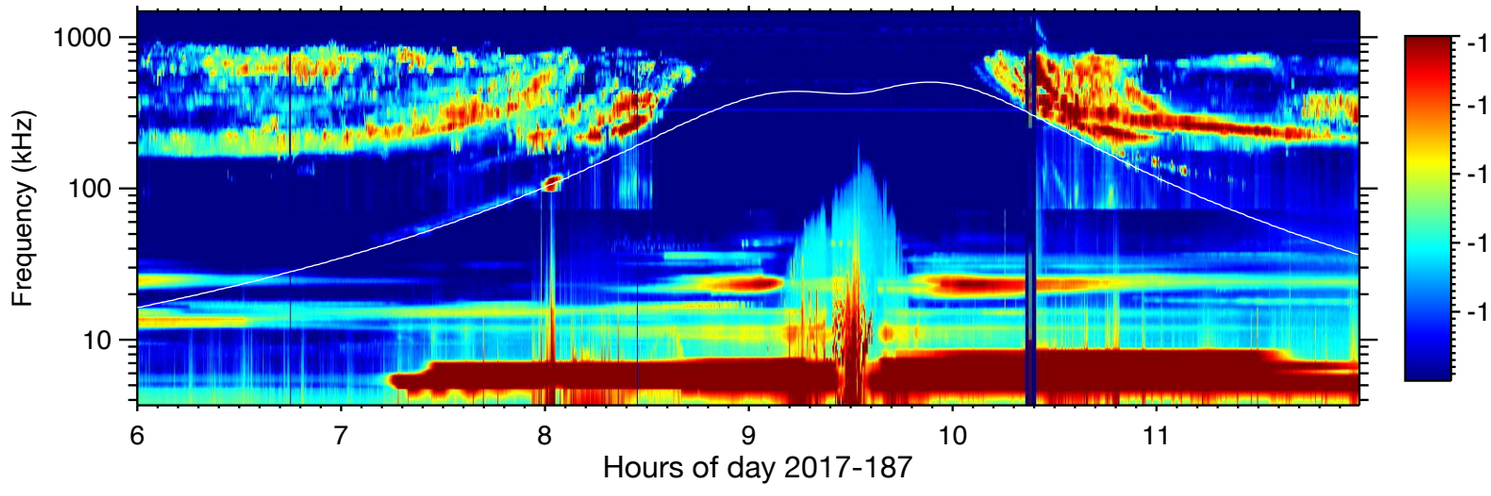




SATURN

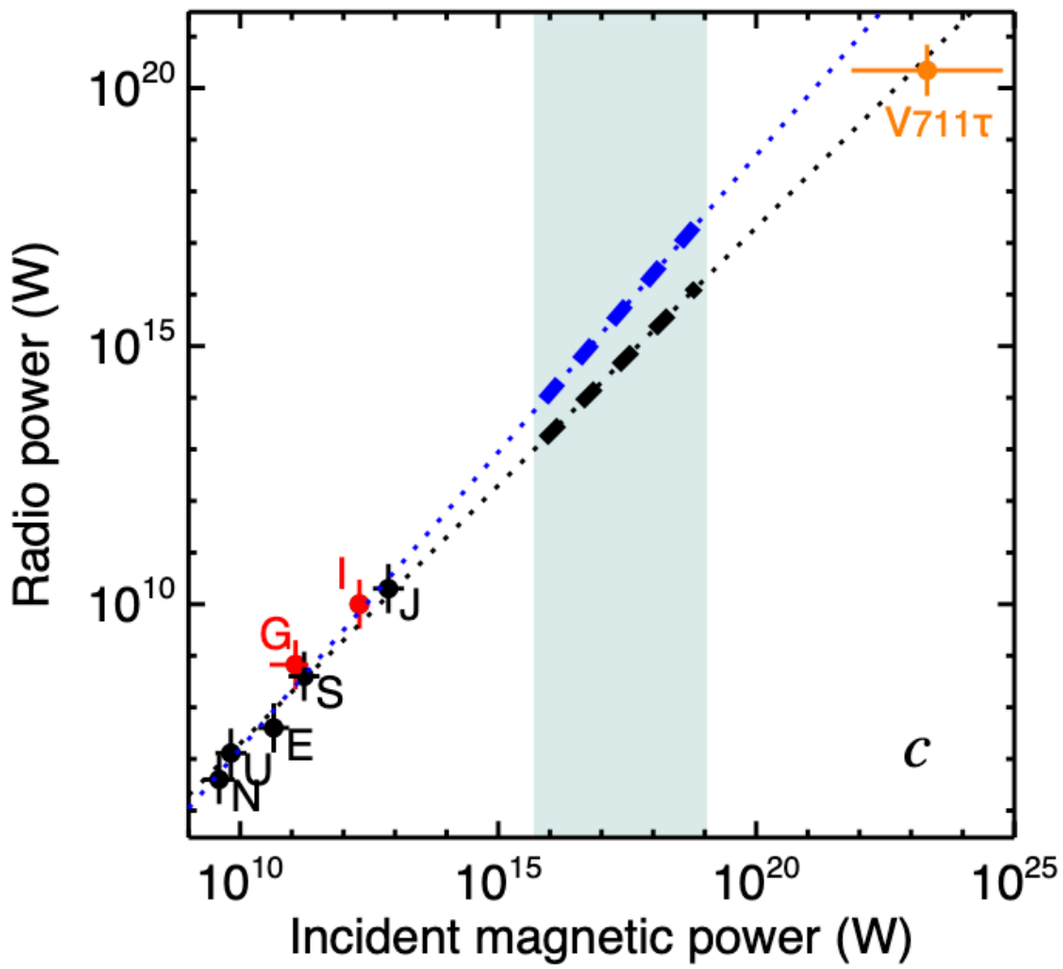


(Lamy et al., 2008)



- Inhomogeneous radiosources + strongly beamed **=> strong visibility effects**

Radio-active planets in the solar system … and beyond ?

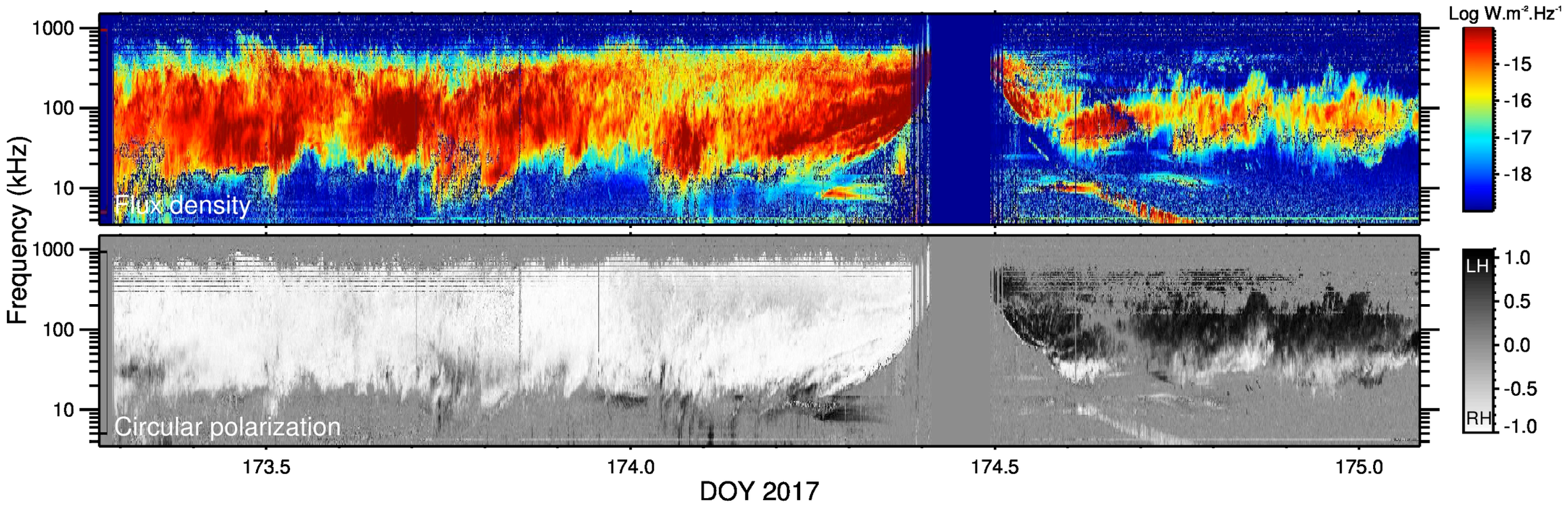


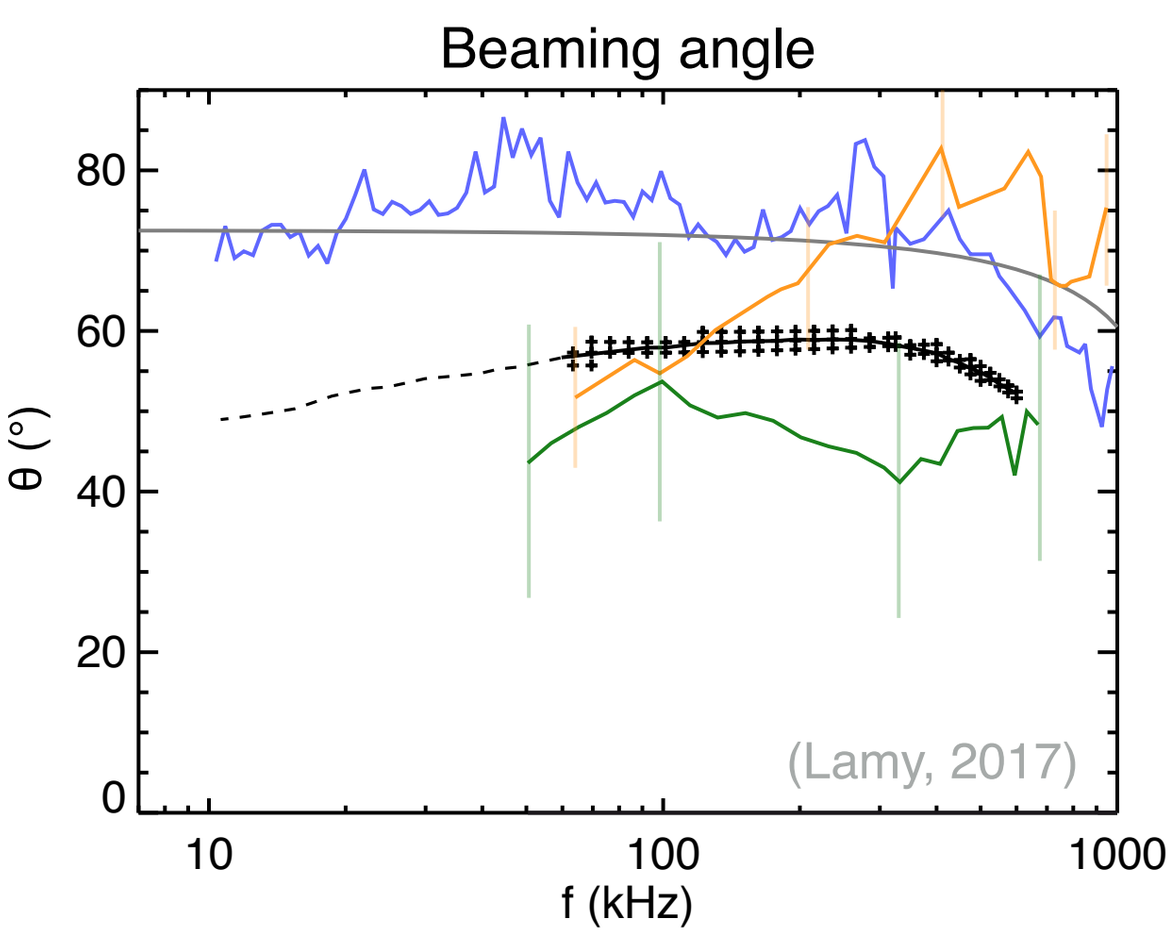
(Zarka et al., 2018)

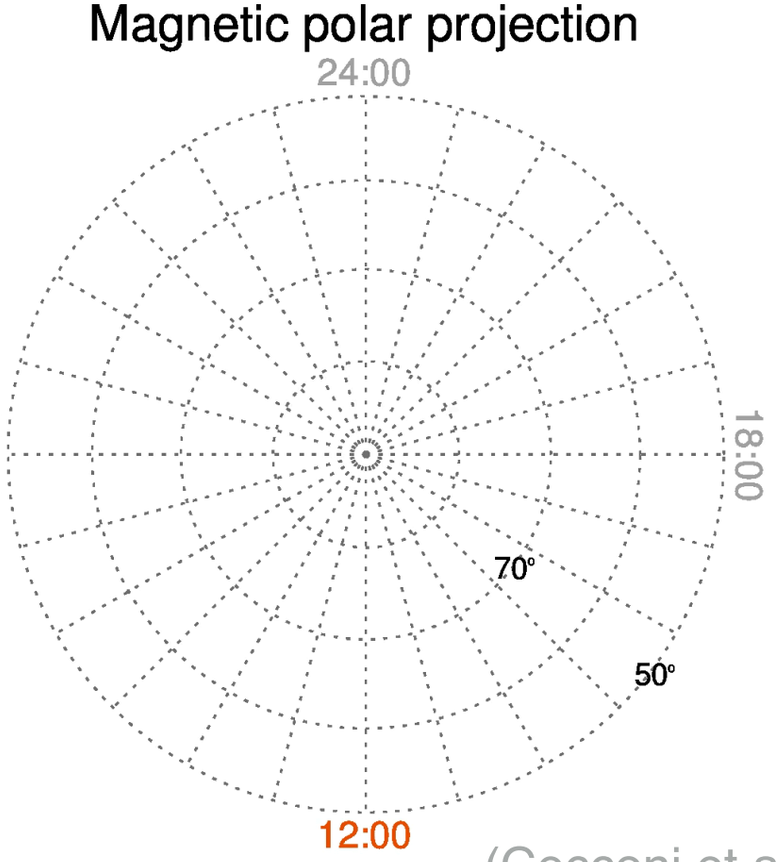
- Long-lasting search for exoplanets with predictions laws
=> First detections in progress (Perez-Torres et al., 2022, Callingham et al., 2023, Tasse et al., 2024)

- Figure of merit used to identify best candidats <u>do not</u> account for visibility (Griessmeier et al., 2017, Livret blanc SKA-France, 2019)

Characterizing the radio auroral visibility





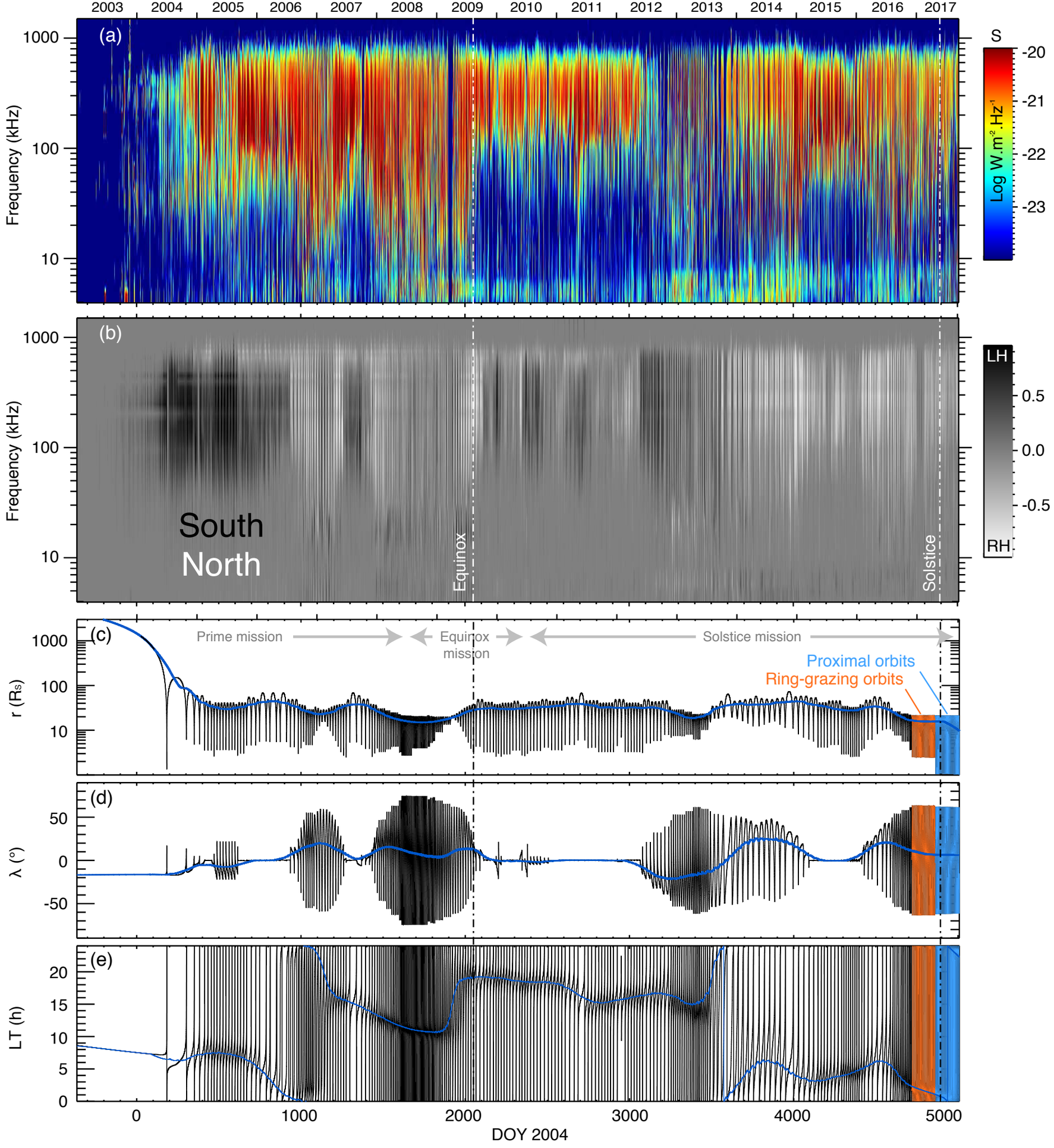


Data selection:

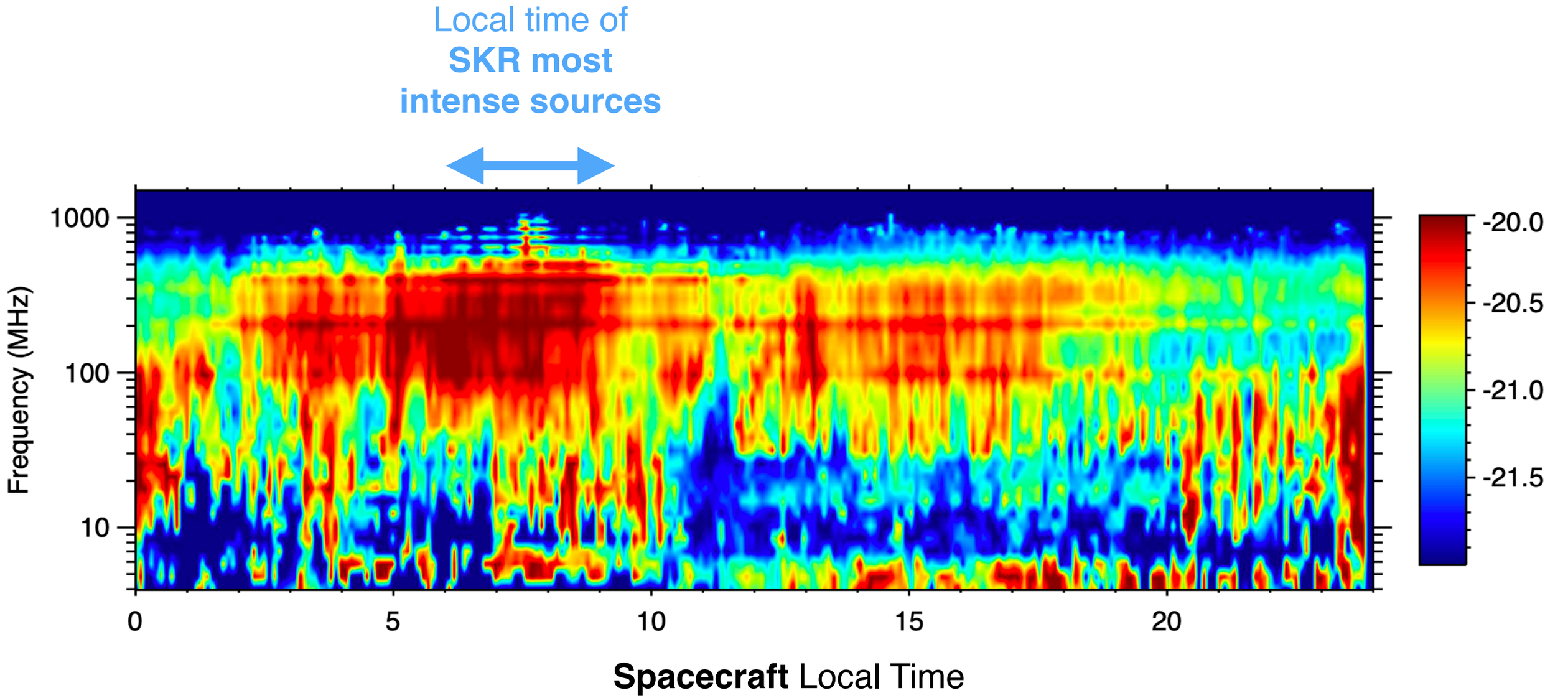
No data

(Cecconi et al., 2009, Lamy et al., 2009,2011,2013,2018)

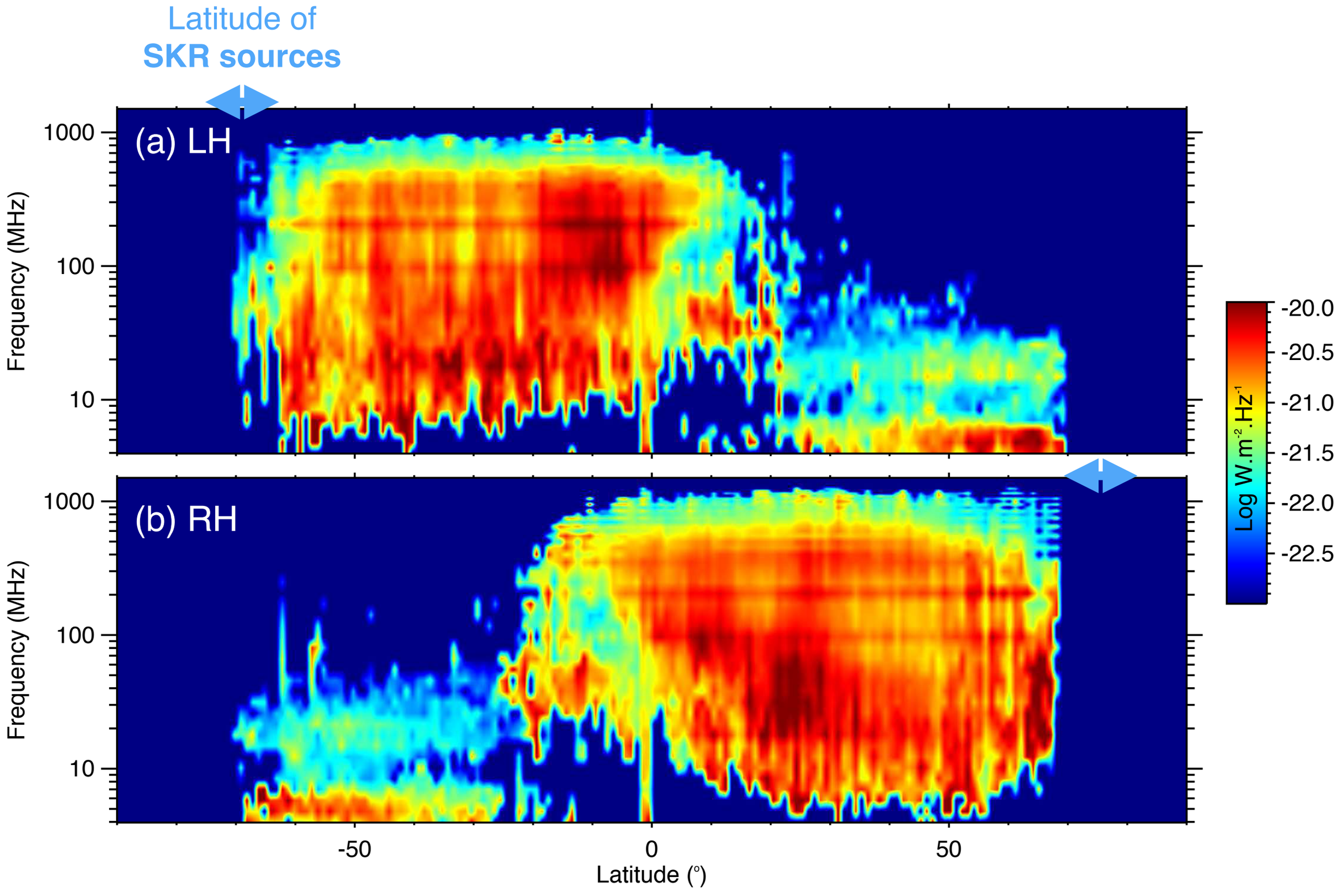
Saturn


2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
(a)
Frequency (kHz)
1000
100
10
S
-20
-21
-22
-23
Log W.m-2.Hz-1
(b)
South
North
Equinox
Solstice
LH
RH
0.5
0.0
-0.5
(c)
Prime mission
Equinox mission
Solstice mission
Proximal orbits
Ring-grazing orbits
r (Rs)
(d)
λ (°)
50
0
-50
(e)
LT (h)
20
15
10
5
0
0
1000
2000
3000
4000
5000
DOY 2004

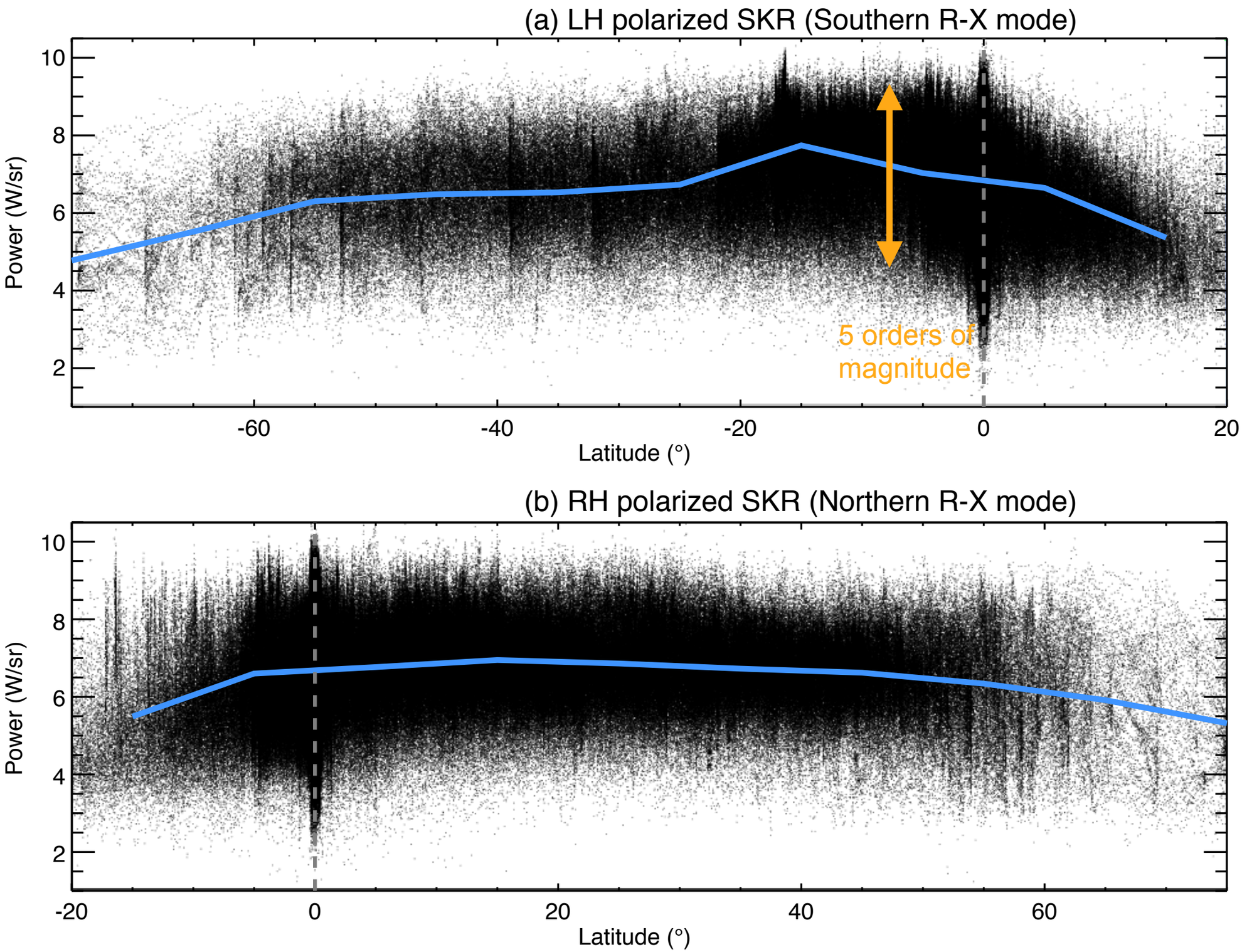
Saturn : visibility in local time



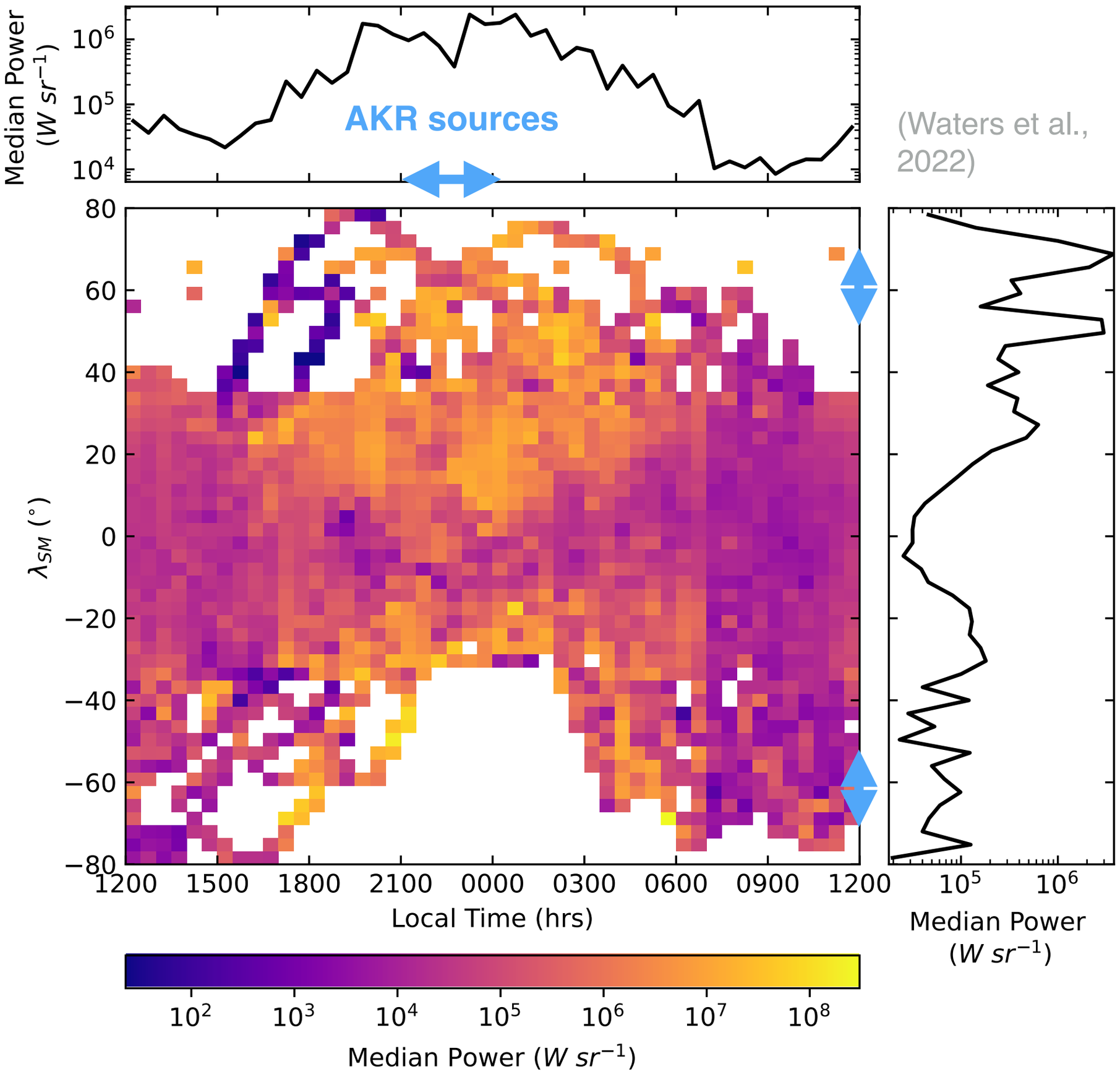
Saturn : visibility in latitude



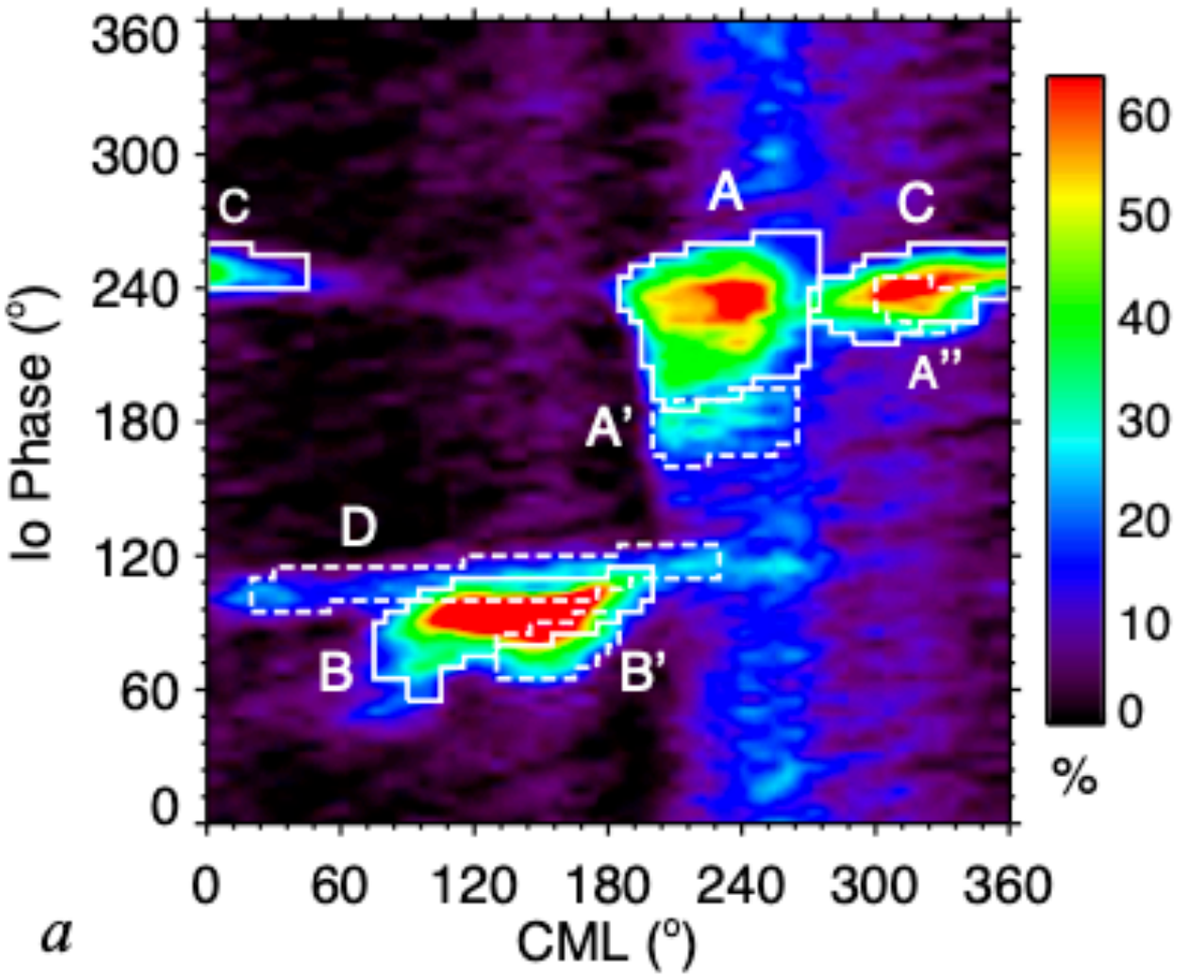
Saturn : visibility in latitude

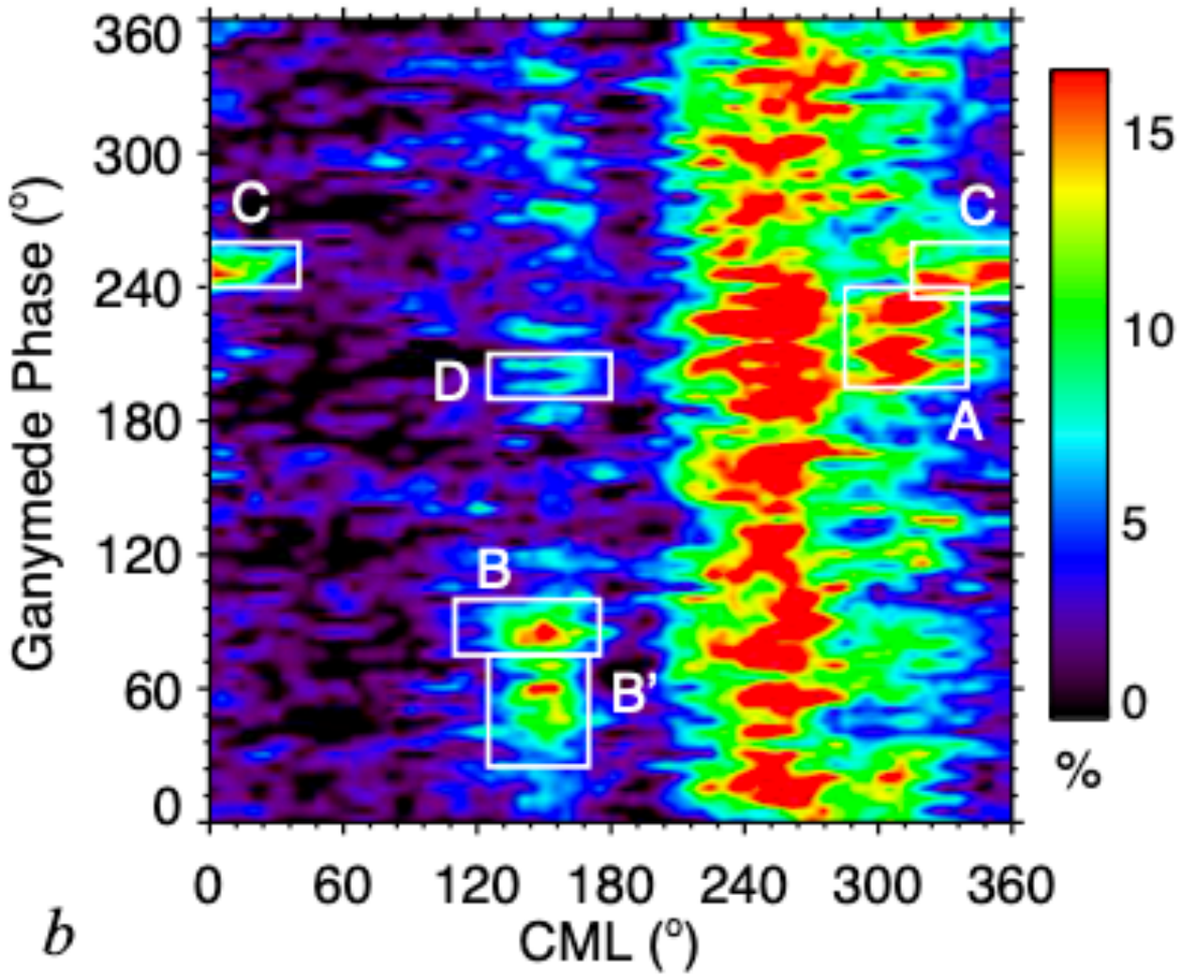


Earth : visibility in local time and latitude



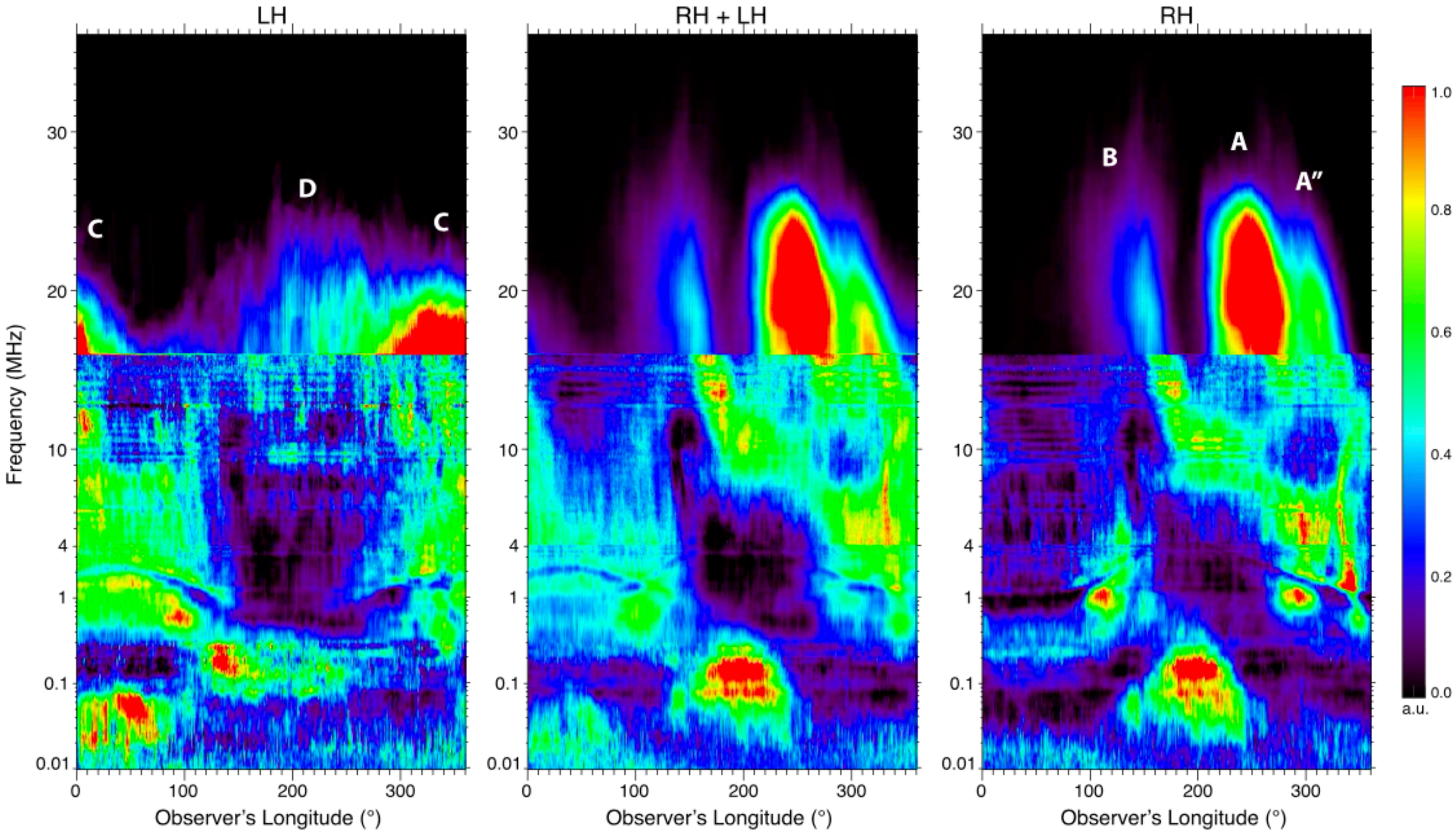
Jupiter : visibility in longitude





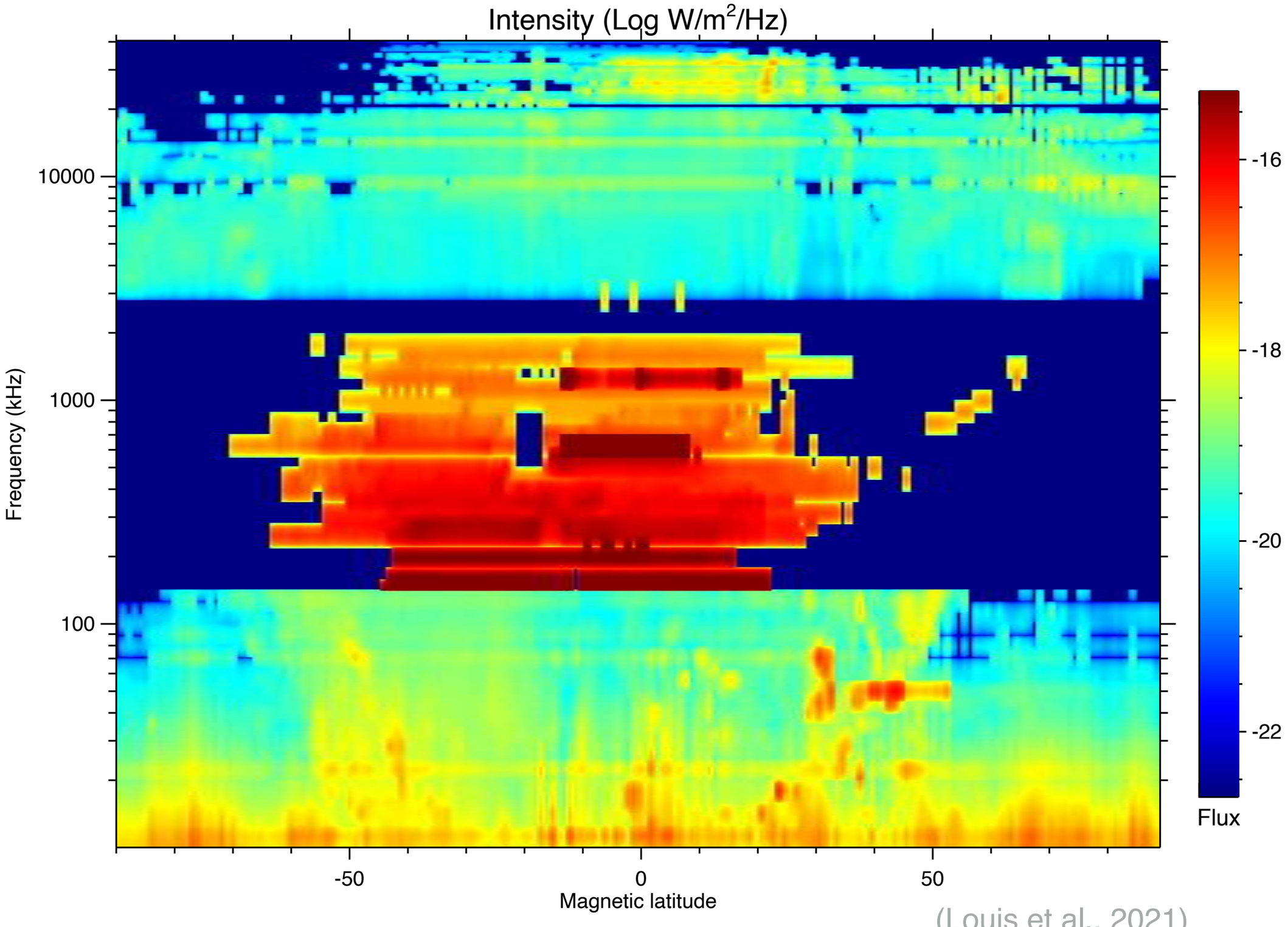
(Marques et al., 2017, Zarka et al., 2018, Jâcome et al., 2022)

Jupiter : visibility in longitude



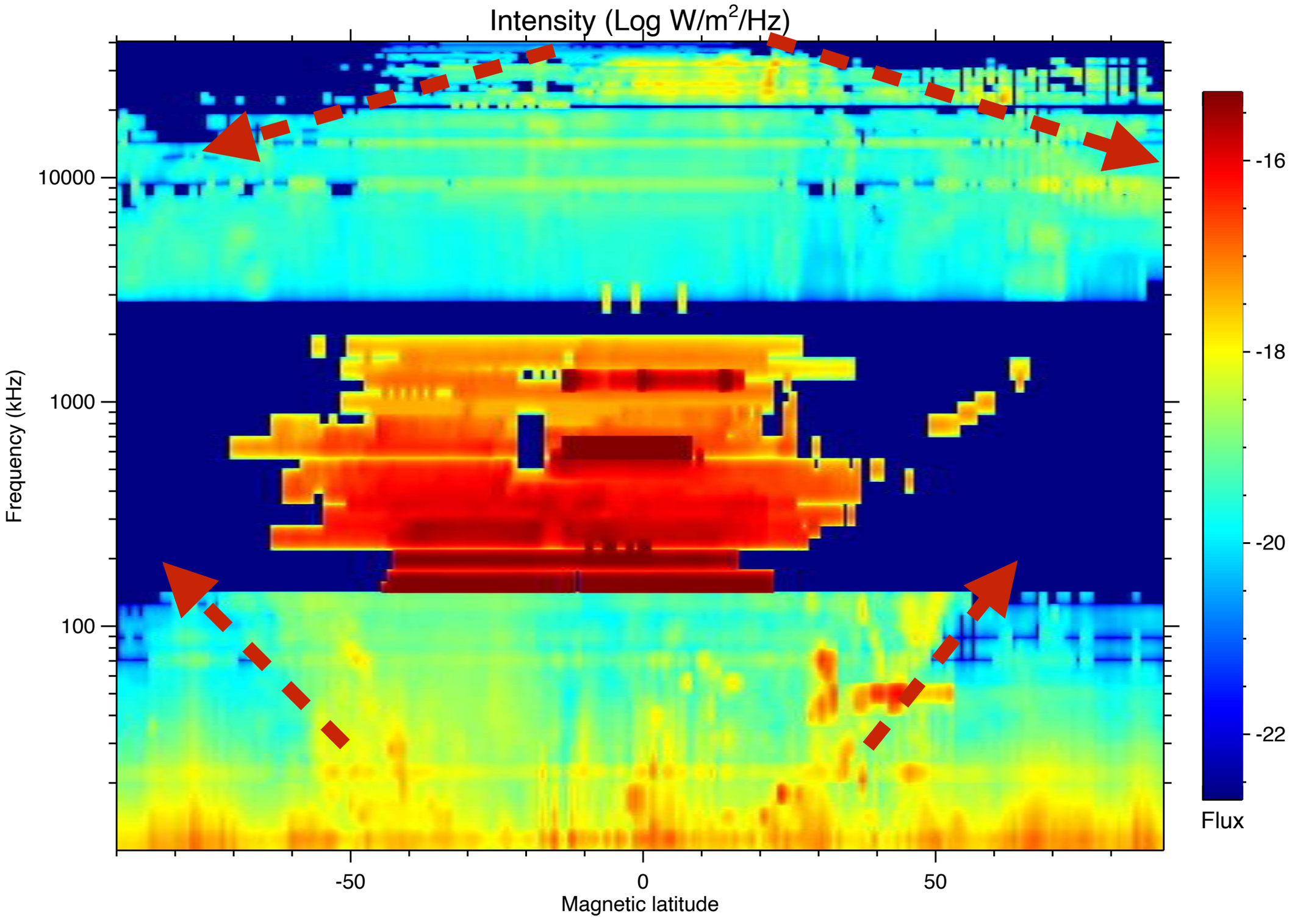
(Zarka et al., 2021)

Jupiter : visibility in latitude

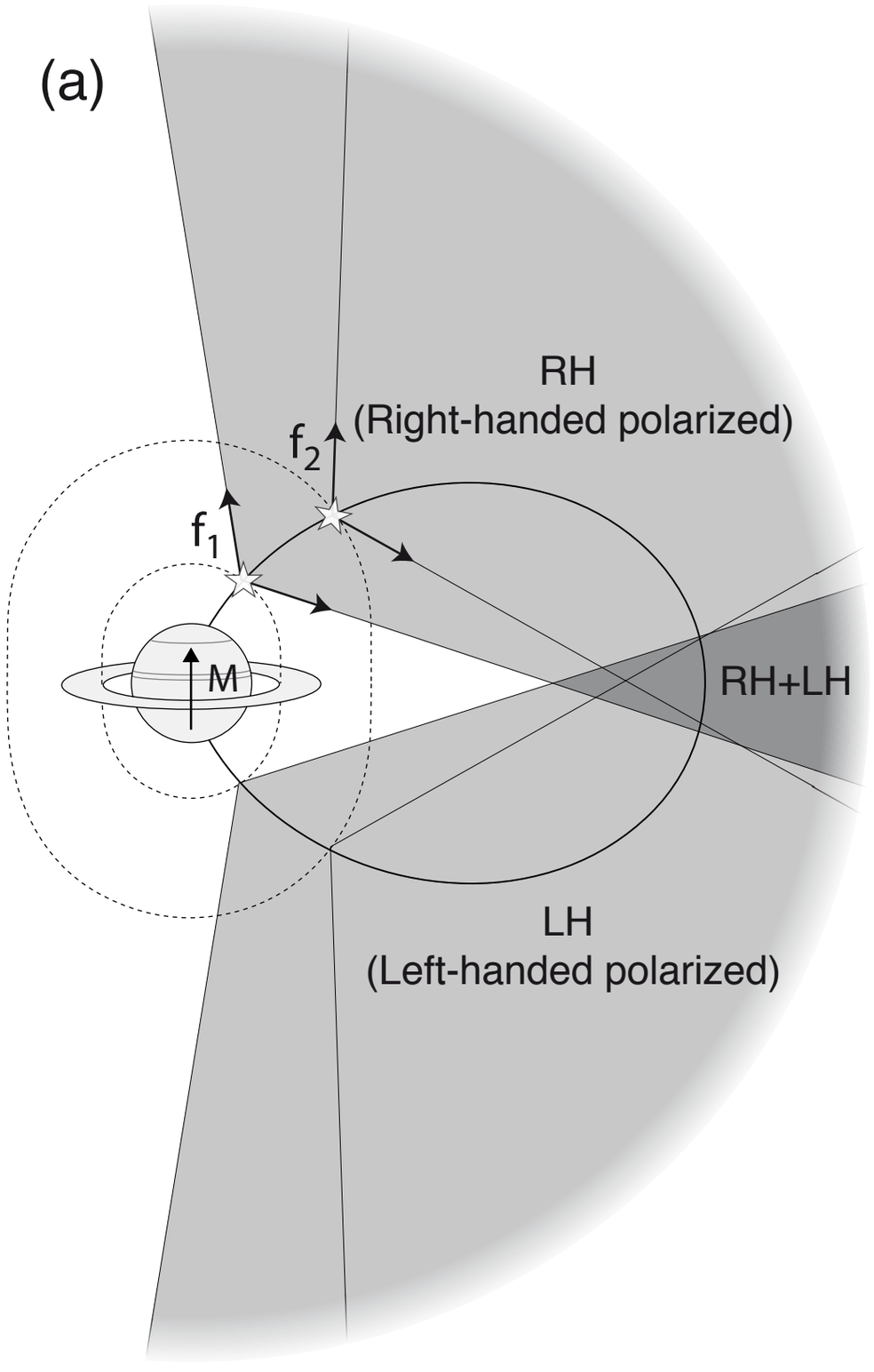


(Louis et al., 2021)

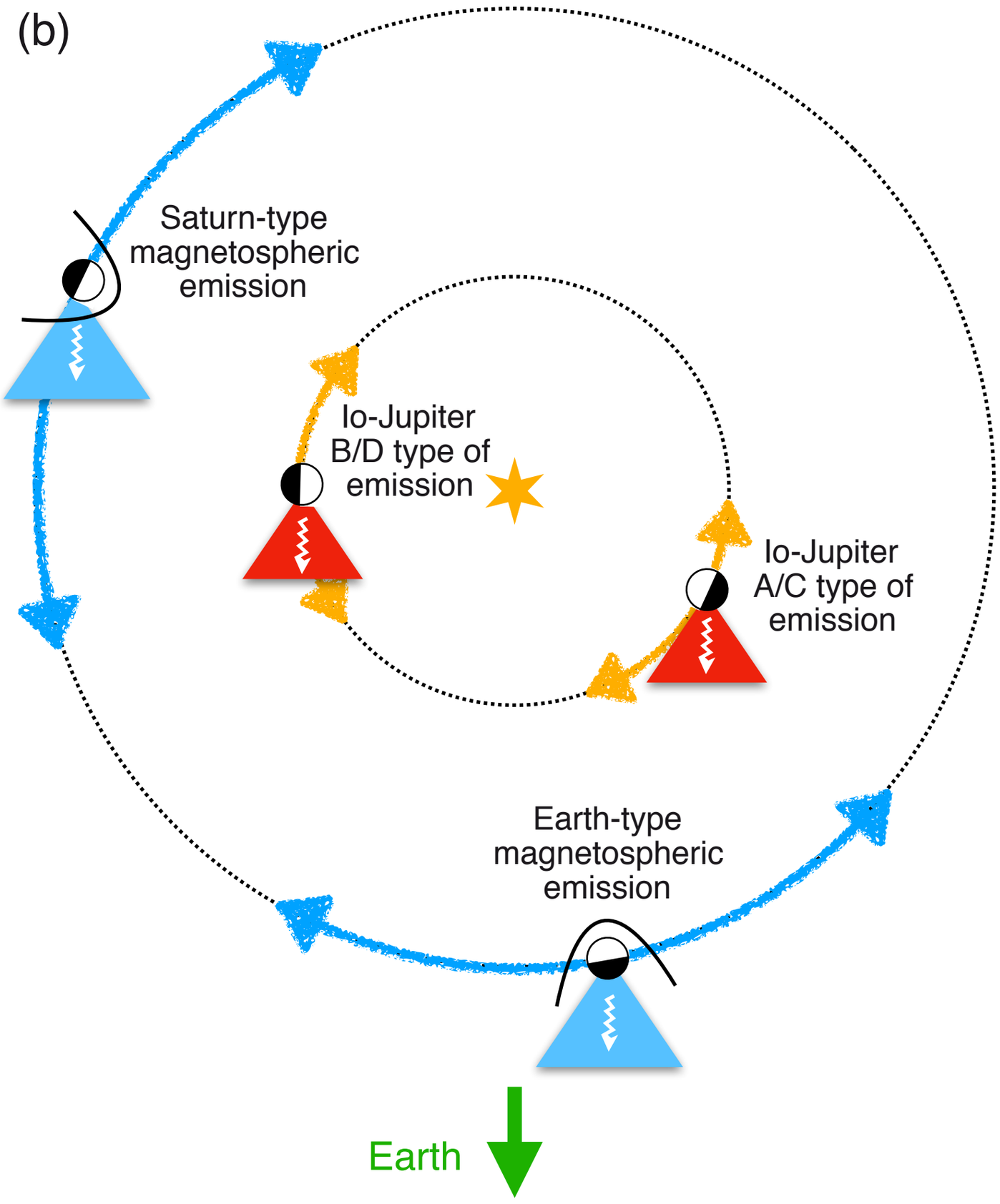
Jupiter : visibility in latitude

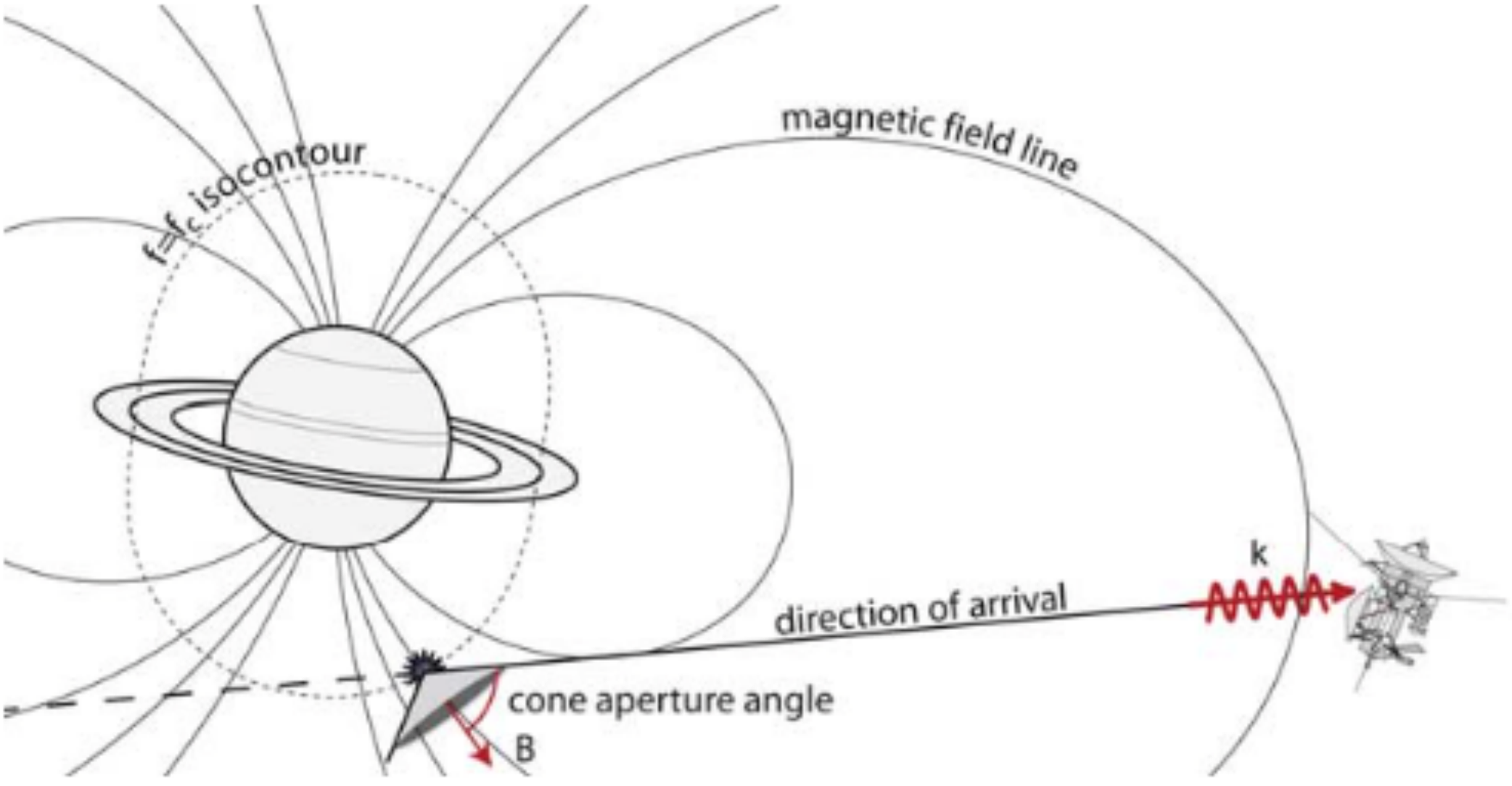


Implications for exoplanets



(Lamy, Louis, Waters, Planet. Radio Em. IX, 2023)




magnetic field line
f=fc isocontour
k
direction of arrival
cone aperture angle
B