

Plasma interaction at Io and Europa

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Tidal Heating:

Lessons from Io and the Jovian System

Thursday, Oct 18 2018

1. Jupiter's Magnetosphere
2. Moon-Magnetosphere Plasma Interaction
3. Precipitation, Sputtering, and Space Weathering
4. Signatures of Plumes
5. Magnetic Fields

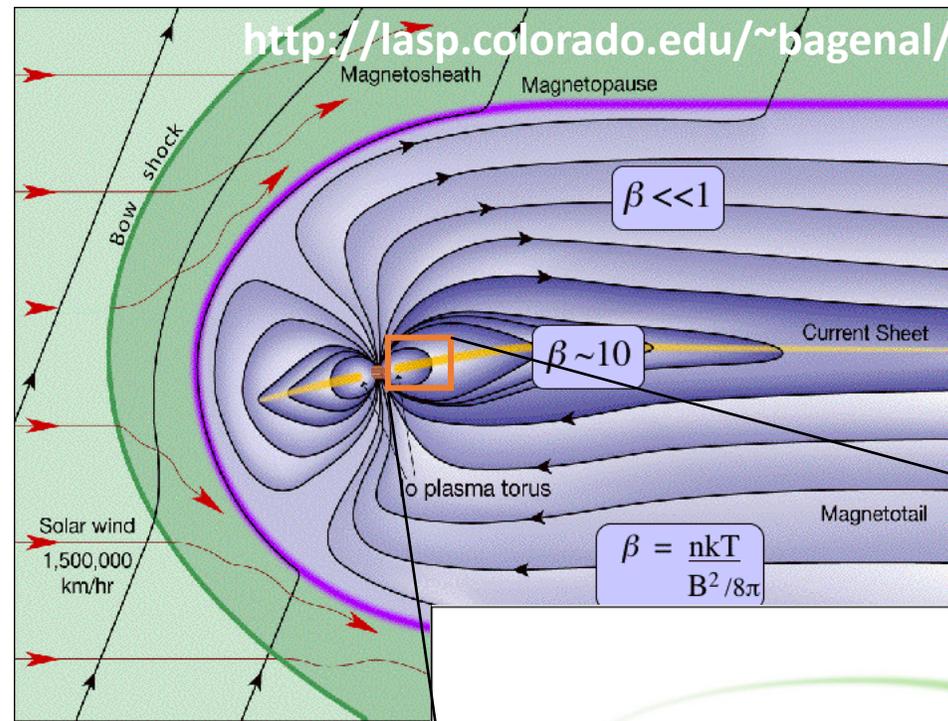
Giant planet magnetospheres

The magnetospheres of Jupiter and Saturn are...

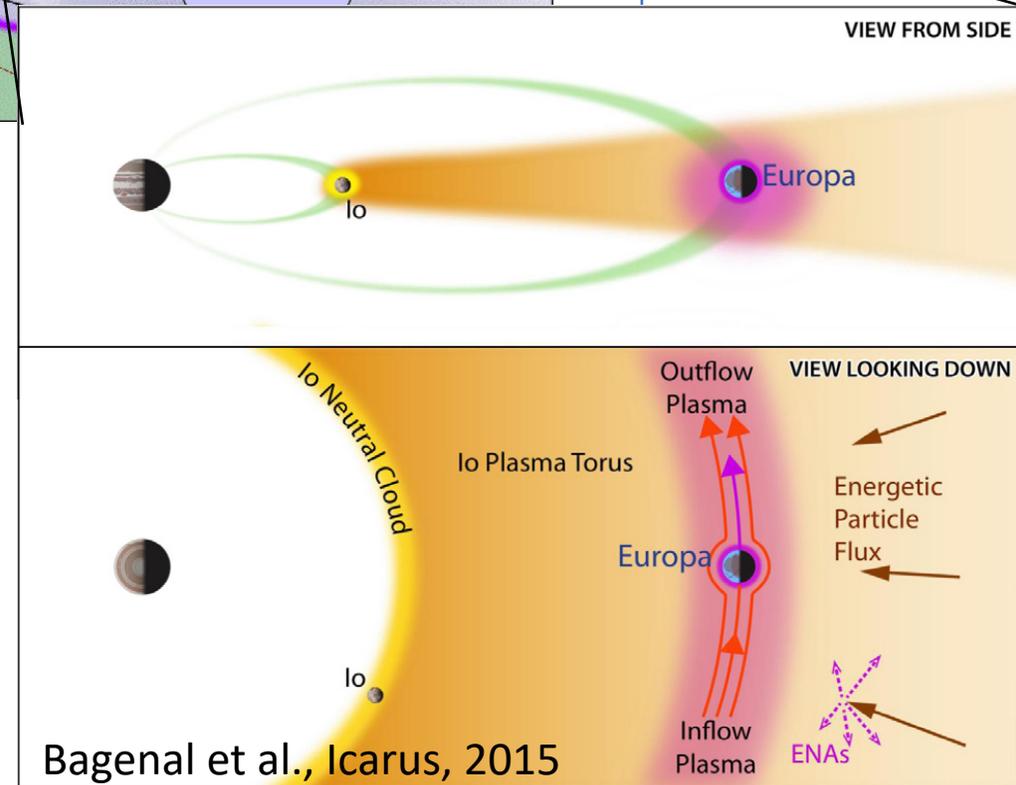
- Extremely **large**
- Dominated by **rotation (~10 hrs)**
- **Weakly** influenced by the solar wind

At Io and Europa (inside of 10 R_J):

- Magnetospheric magnetic field is
 - VERY STRONG! (Io: ~1800 nT, Europa: ~400 nT)
 - *Mostly* southward.
- Io's volcanos are the major plasma source for the whole magnetosphere!
 - 1 ton of plasma every second generated from the Io neutral cloud.



~ 100 R_J
~ 7,000,000 km!

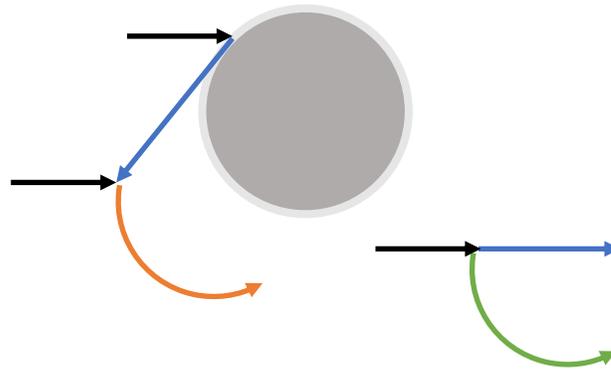
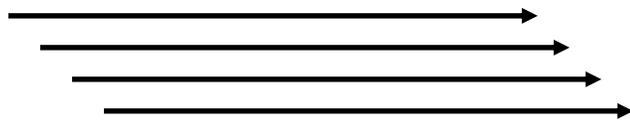


Moon-magnetosphere plasma interactions

Sputtering:

Magnetospheric ions liberate neutrals, feed a tenuous atmosphere. [Cassidy et al. 2013, Vorburger & Wurz 2018]

magnetospheric plasma



Ionization:

Electrons & photons ionize neutrals, populating the ionosphere.

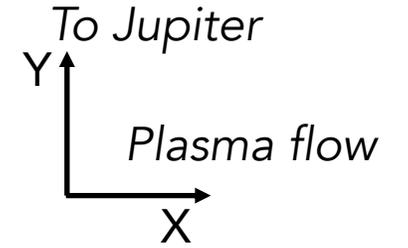
$\otimes \mathbf{B}_J$



$$\mathbf{E} = -\mathbf{u}_{\text{plasma}} \times \mathbf{B}_J$$

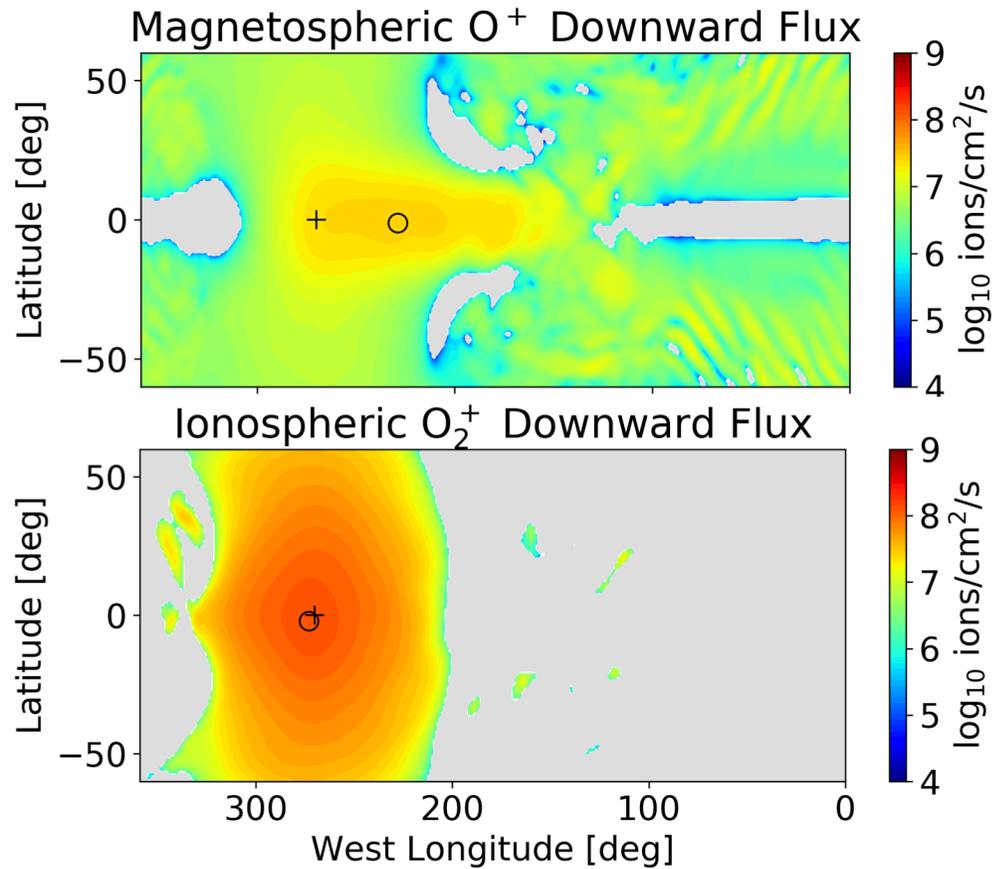
Pick-up:

Magnetospheric ions charge-exchange with neutrals, creating fast neutrals and picked-up ions.



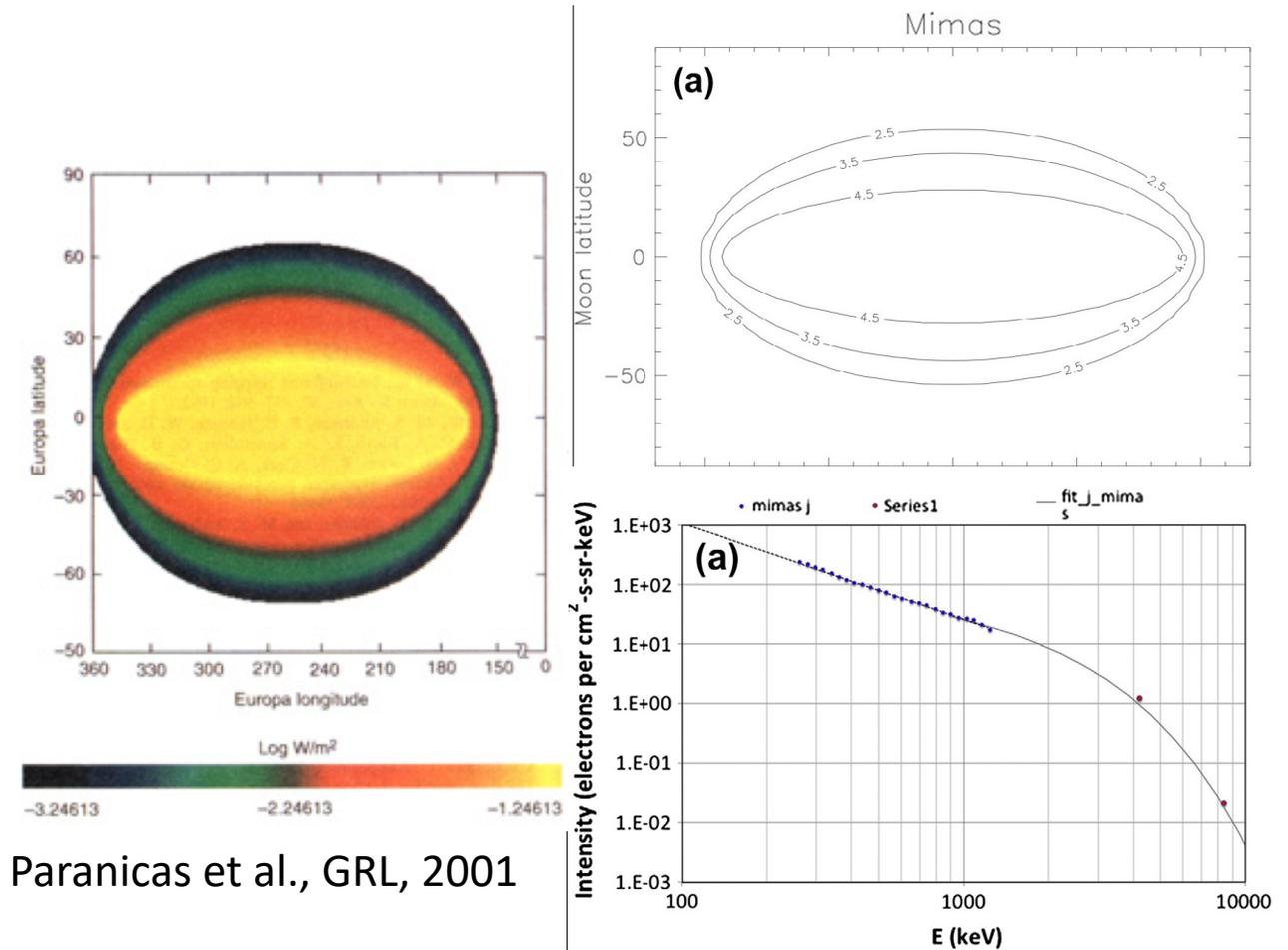
Precipitation, Sputtering, Space Weathering

Thermal Plasma (<100 eV)



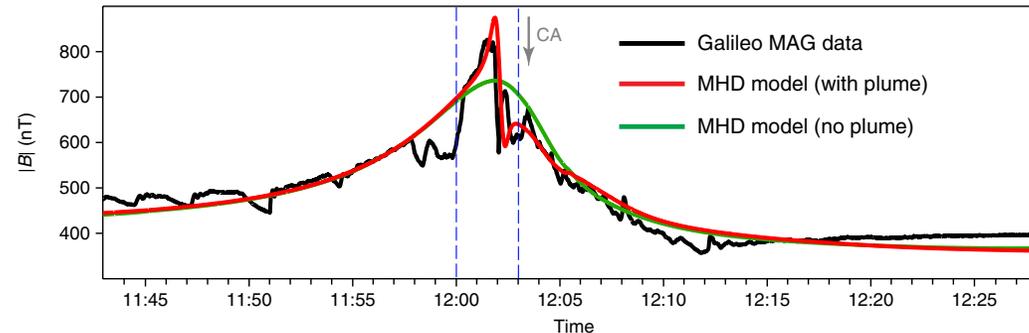
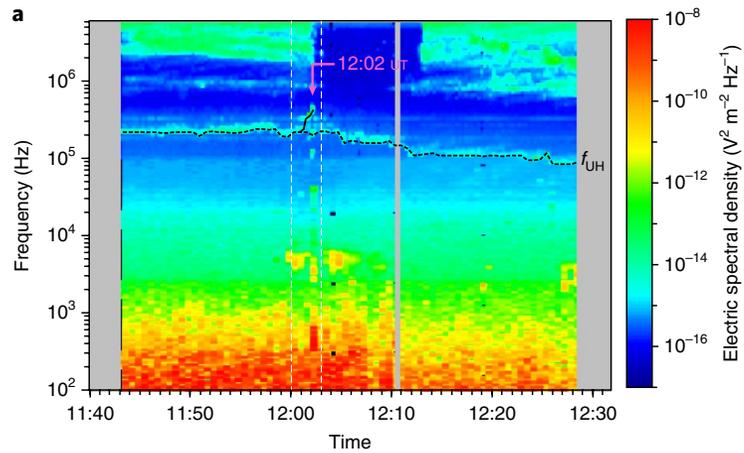
(Please see also my poster!)

Suprathermal plasma



Signatures of Plumes

Jia et al., Nature Ast., 2018



$X (R_E)$	-3.7	-3.0	-2.2	-1.4	-0.5	0.4	1.2	2.1	3.0
$Y (R_E)$	2.4	1.5	0.7	-0.2	-1.1	-1.9	-2.7	-3.5	-4.3
$Z (R_E)$	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
$R (R_E)$	4.5	3.3	2.3	1.4	1.2	1.9	3.0	4.1	5.2

Blöcker et al., JGR-SP, 2016

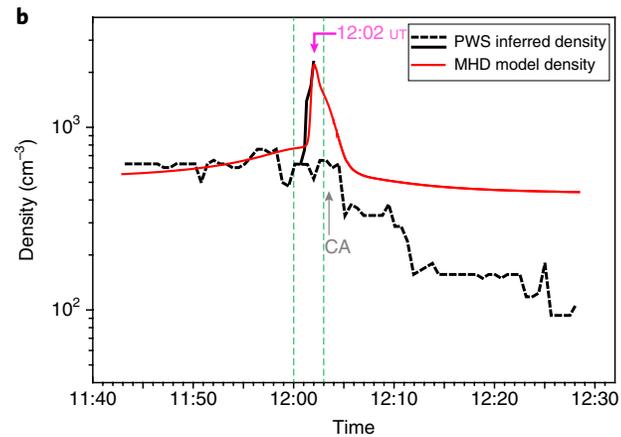
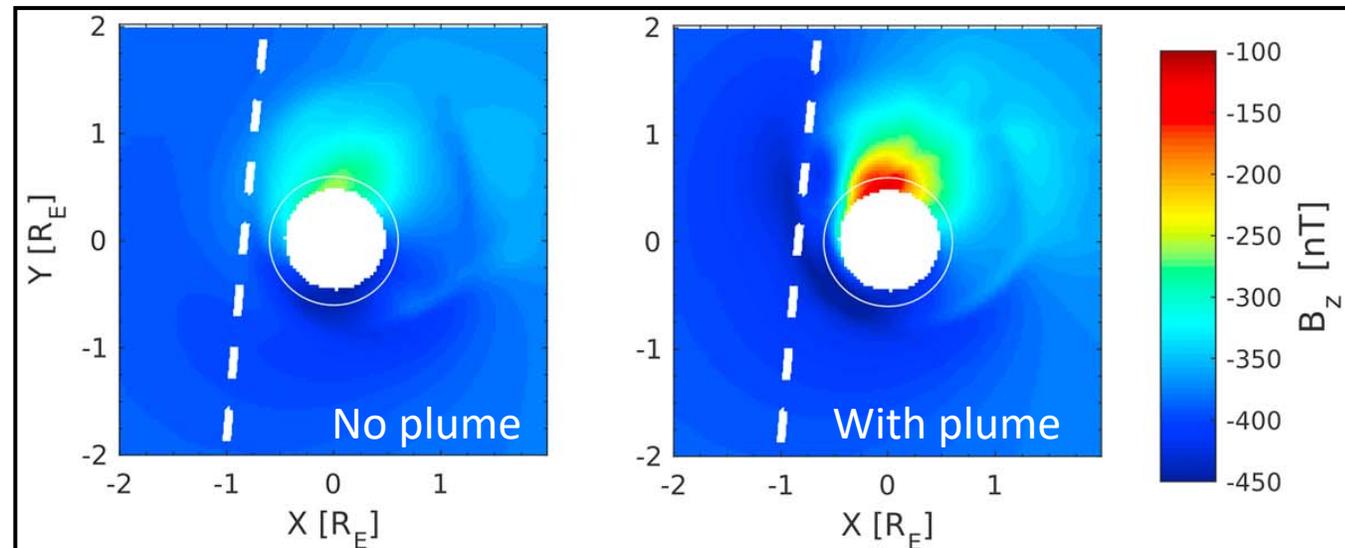
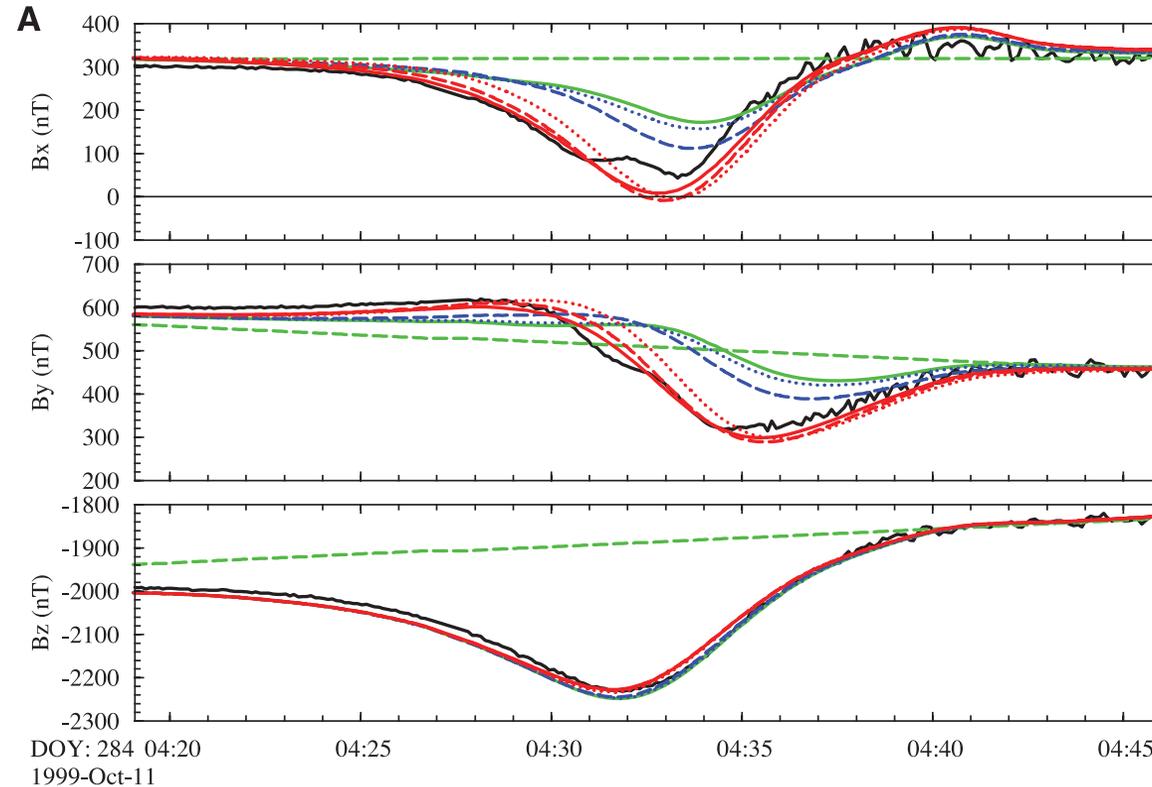


Fig. 2 | Galileo plasma wave data and derived plasma density for the



Magnetic Fields

I24 magnetic field observed and modeled

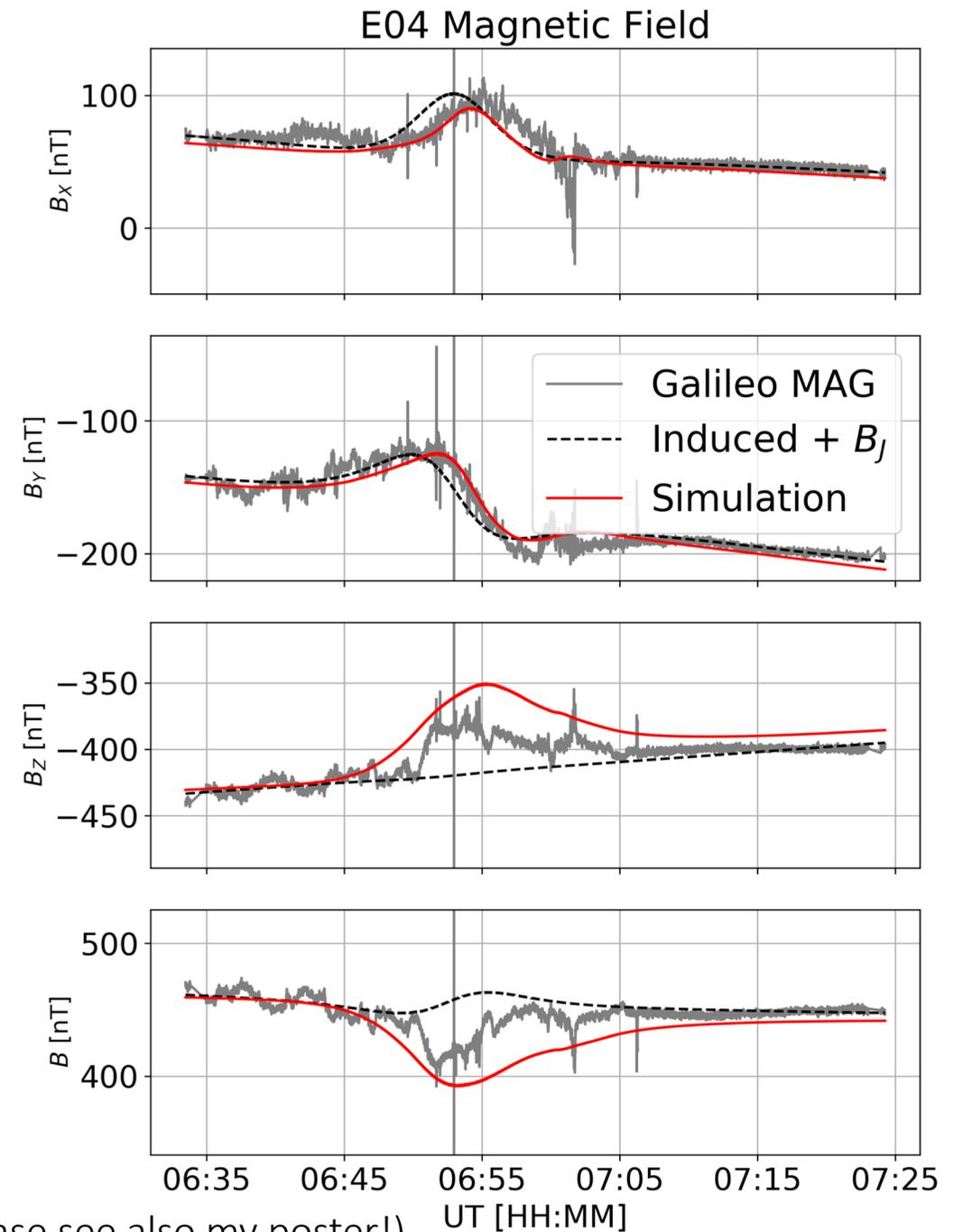


Khurana et al., Science, 2011

Jovian background, No induction

Warm solid mantle

Various asthenospheres



(Please see also my poster!)