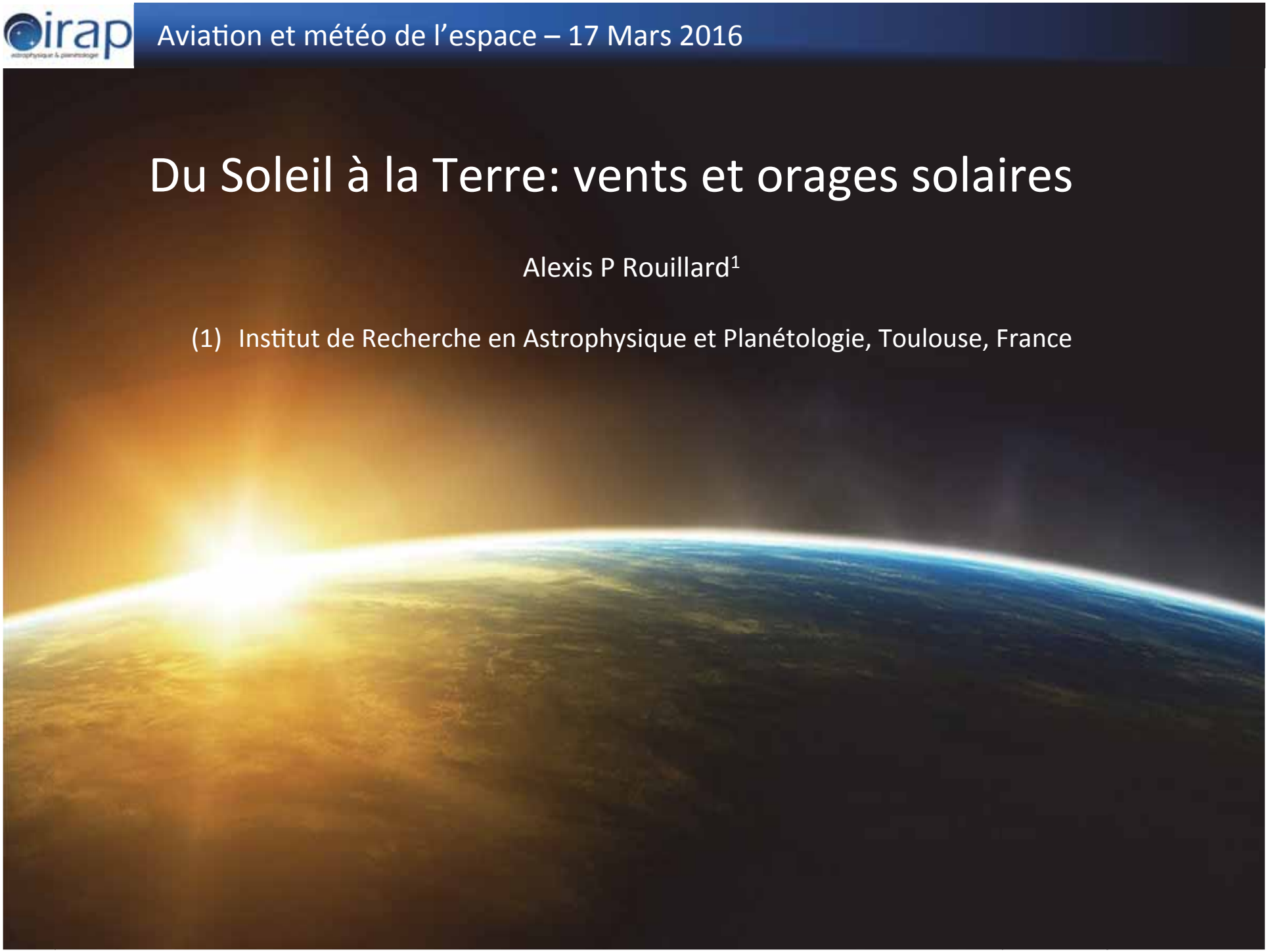
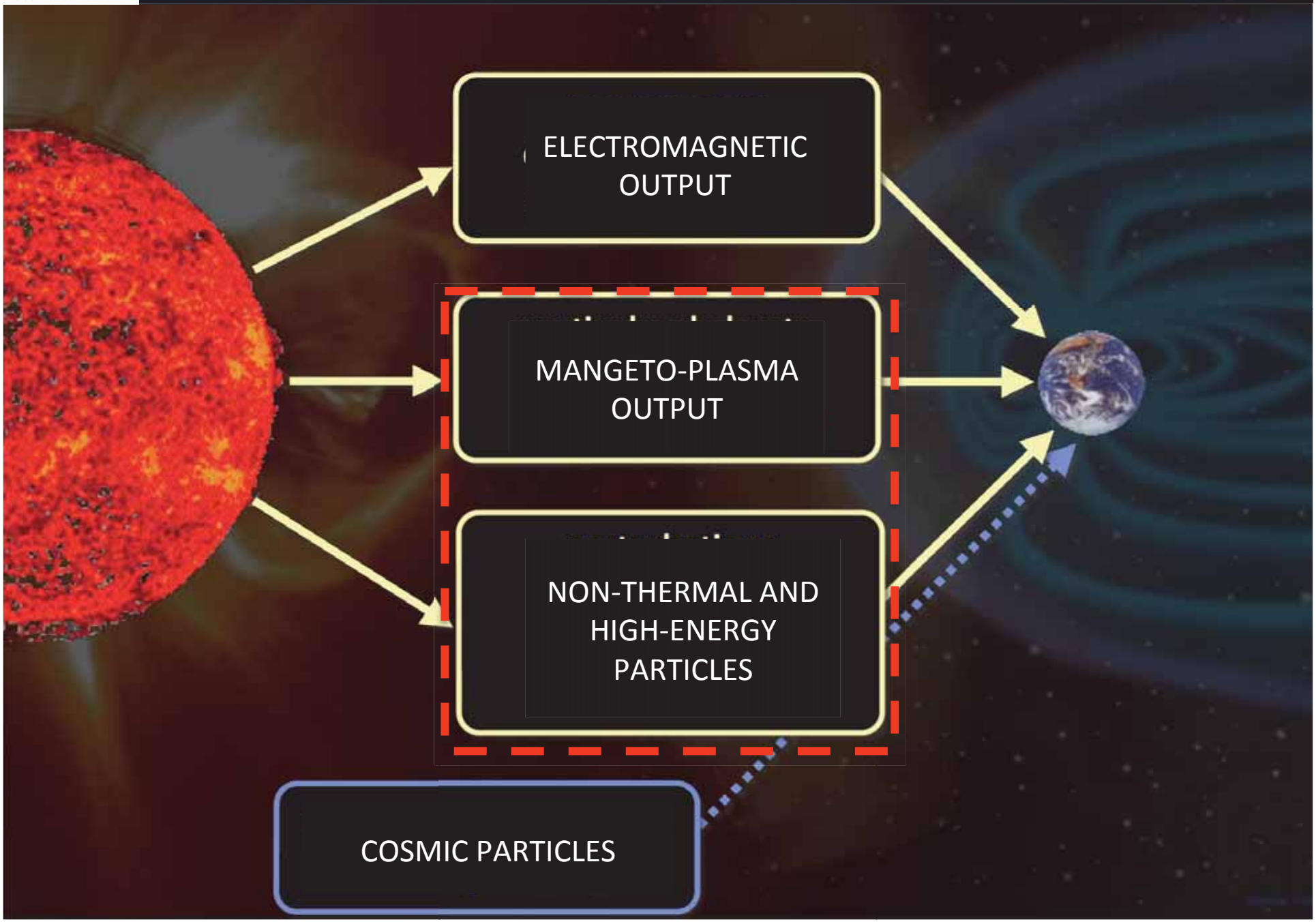
Du Soleil à la Terre: vents et orages solaires

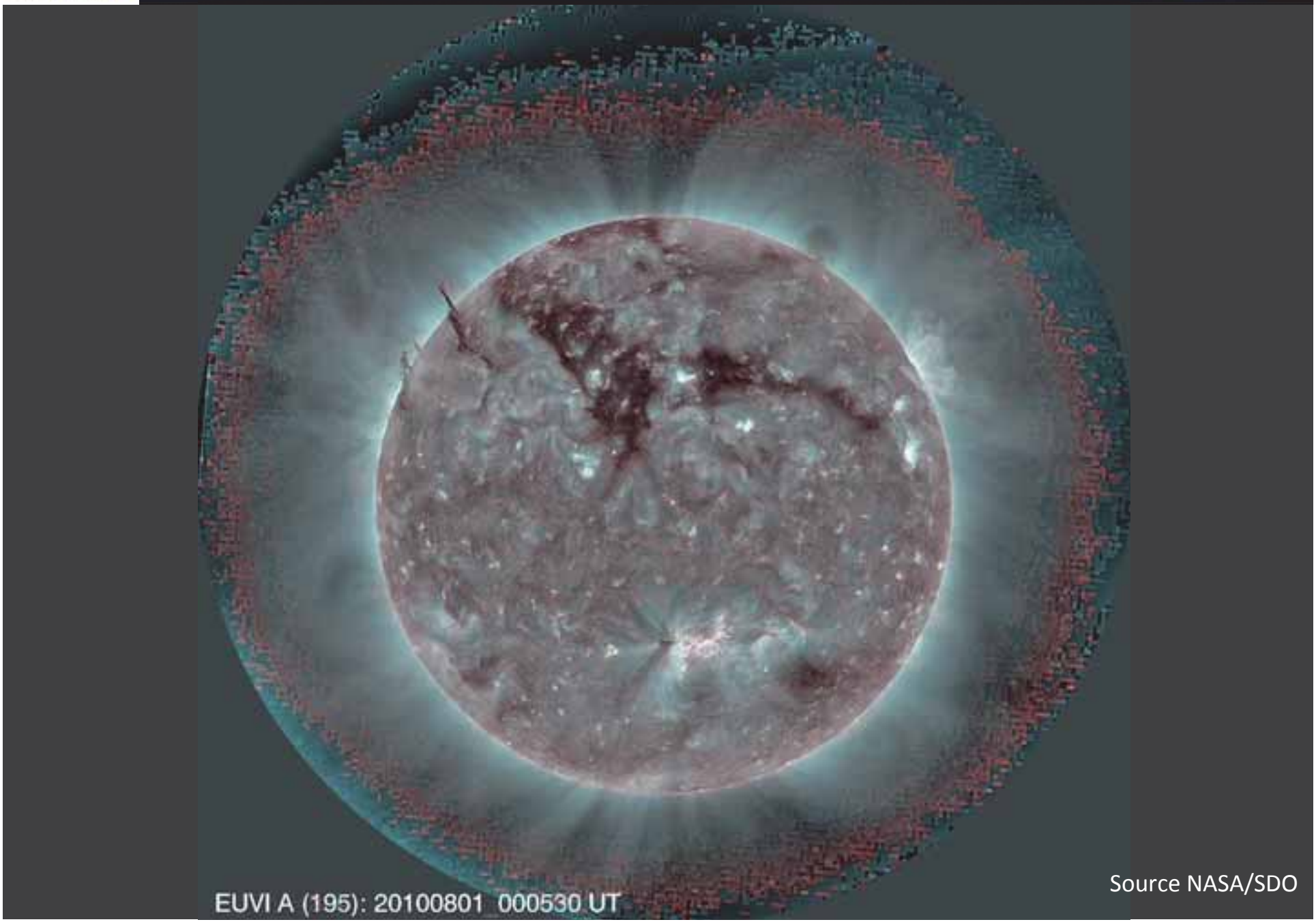
Alexis P Rouillard[1]

(1) Institut de Recherche en Astrophysique et Planétologie, Toulouse, France



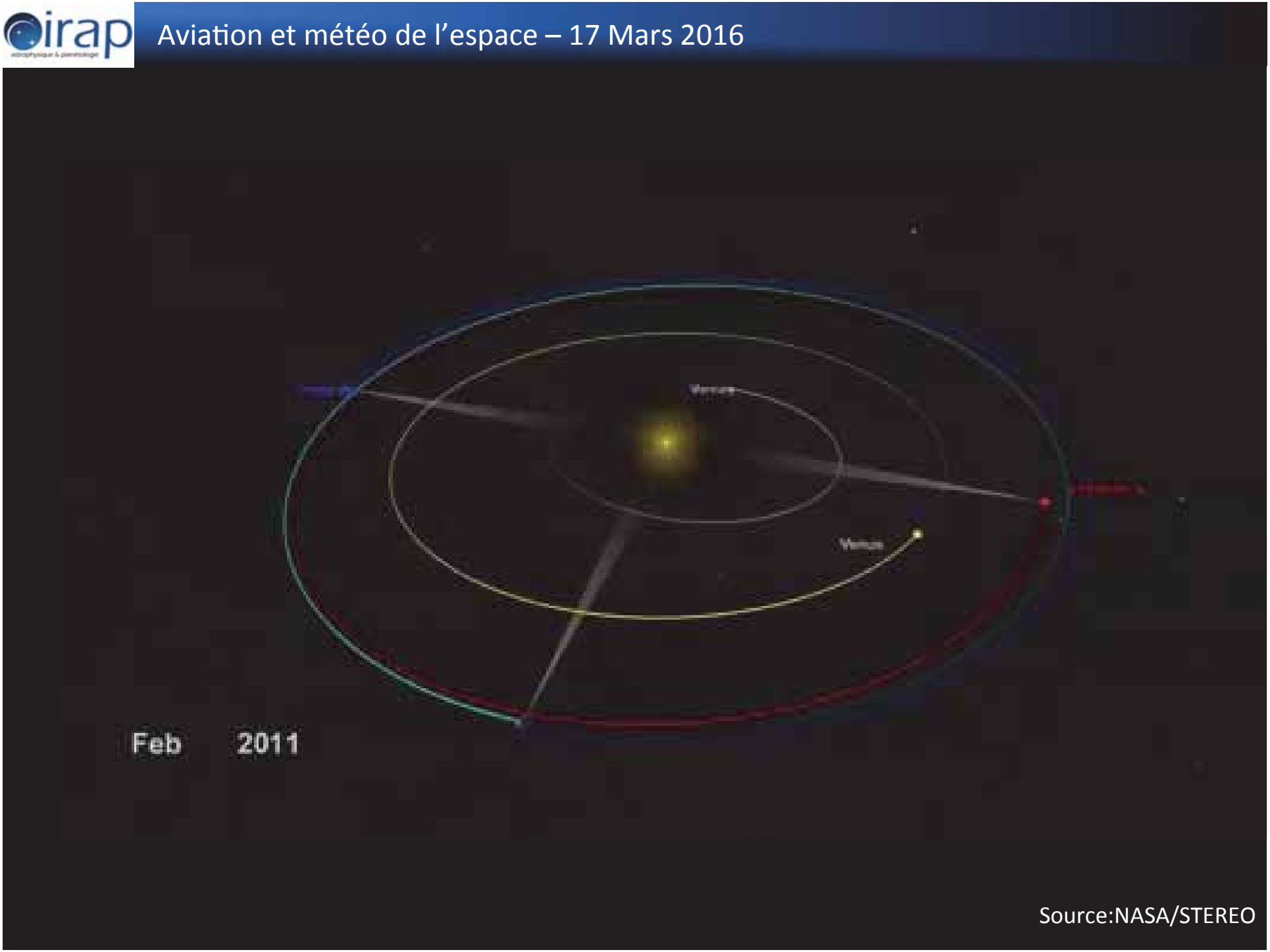

ELECTROMAGNETIC OUTPUT
MANGETO-PLASMA OUTPUT
NON-THERMAL AND HIGH-ENERGY PARTICLES
COSMIC PARTICLES

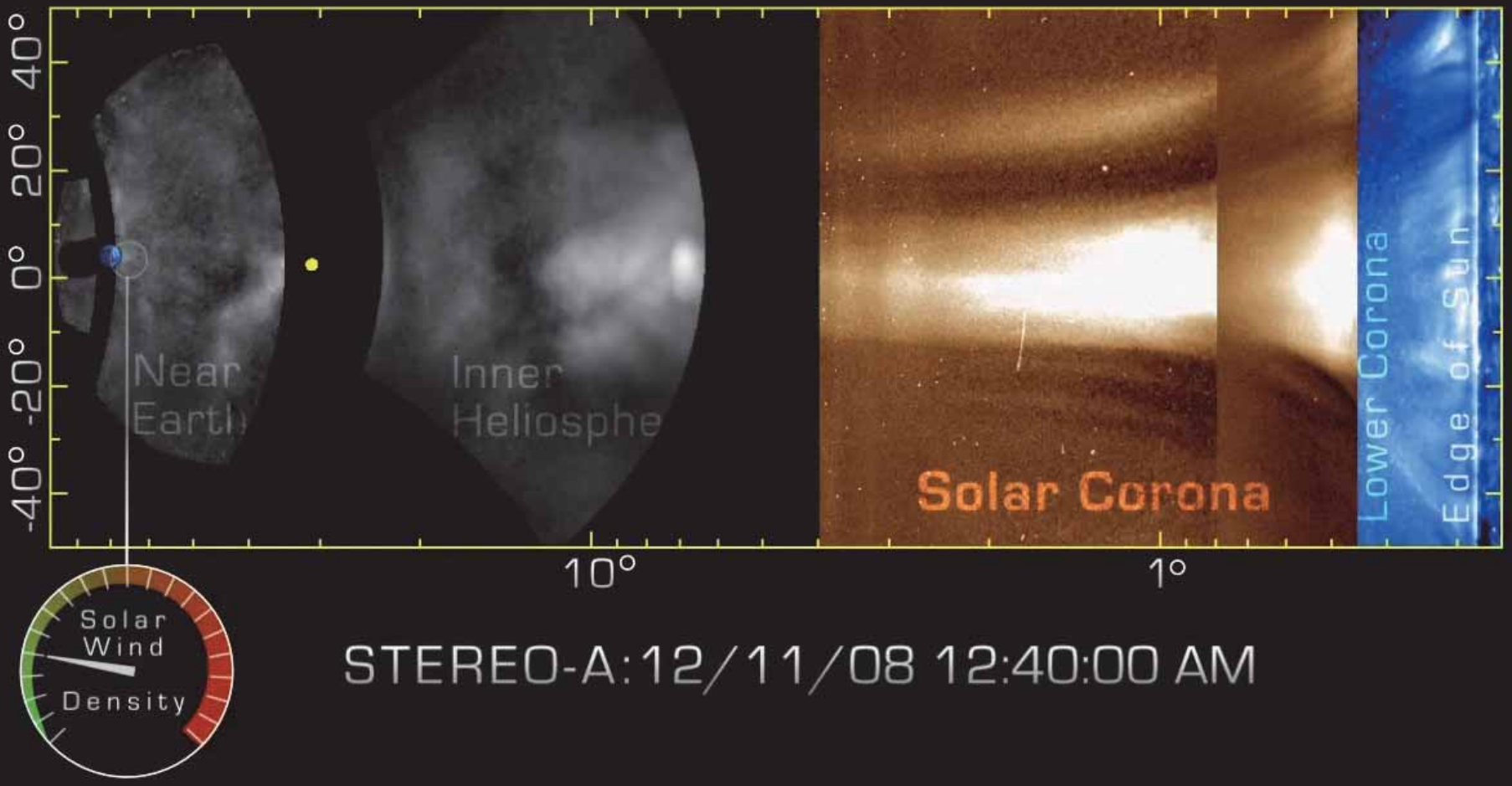
Aviation et météo de l'espace – 17 Mars 2016



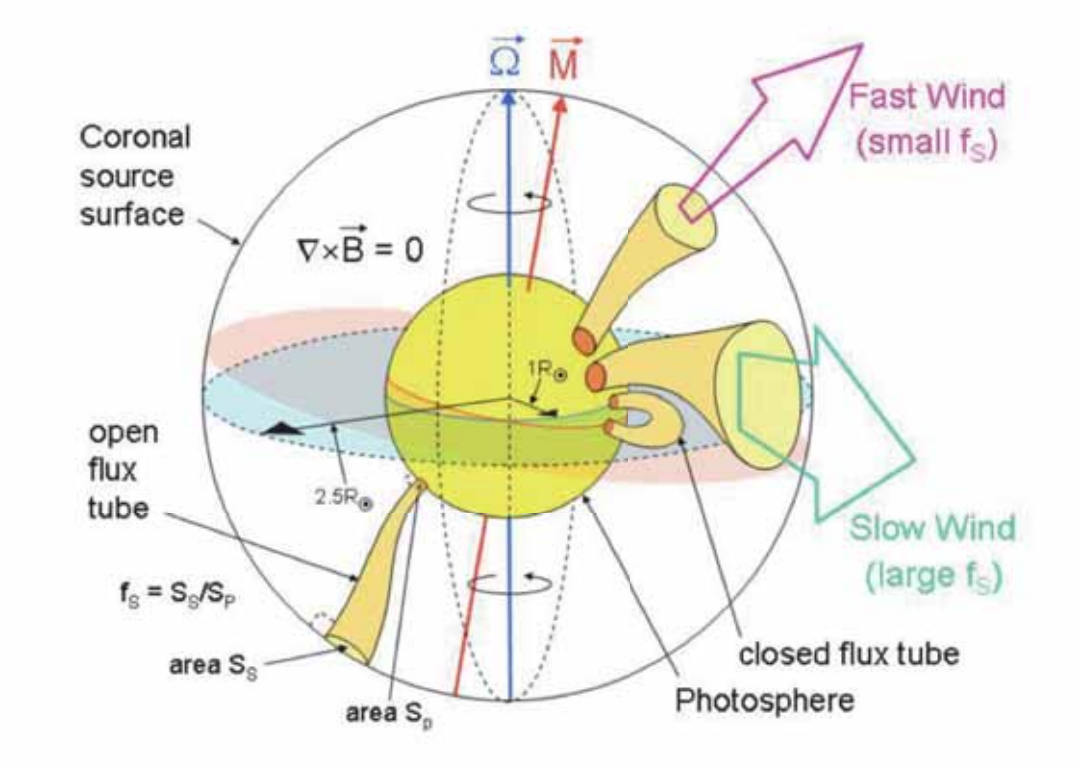
Source NASA/SDO

Aviation et météo de l'espace – 17 Mars 2016

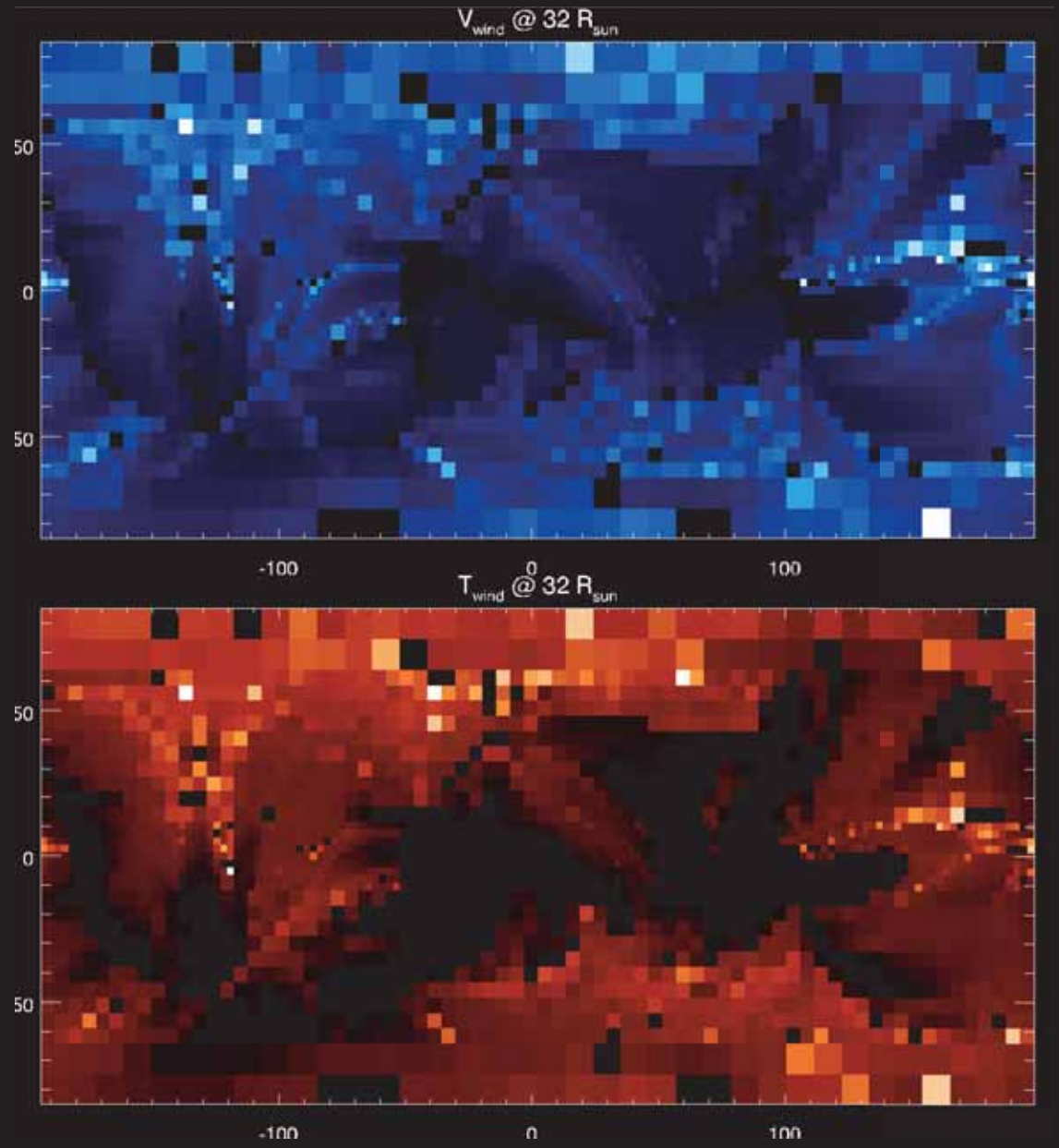

Feb 2011
Source:NASA/STEREO

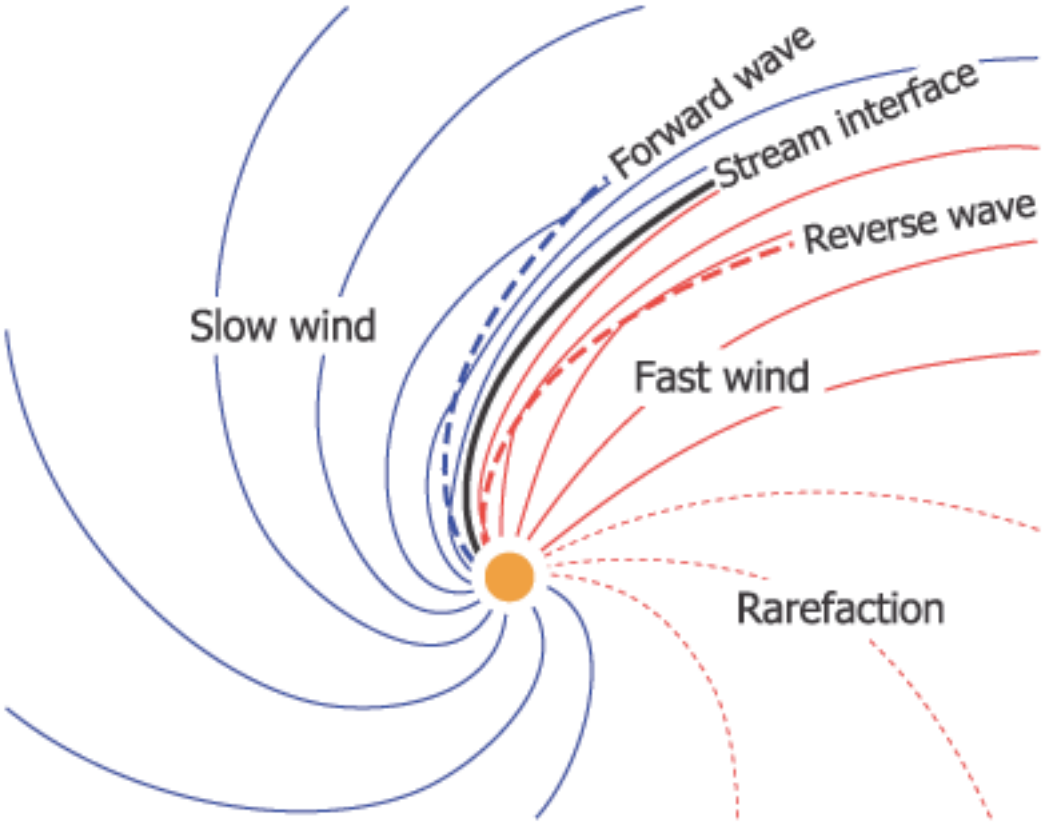


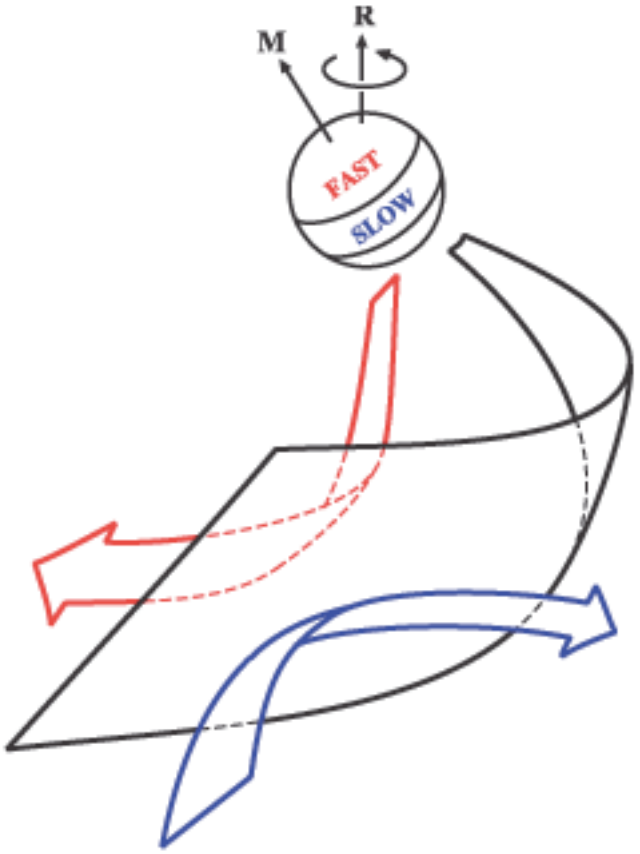
Source: Craig De Forest


Ω M
Fast Wind
(small f_S)
Coronal
source
surface
$\nabla \times \vec{B} = 0$
$1R_\odot$
open
flux
tube
$2.5R_\odot$
Slow Wind
(large f_S)
$f_S = S_S/S_P$
area S_S
area S_p
closed flux tube
Photosphere

Aviation et météo de l'espace – 17 Mars 2016

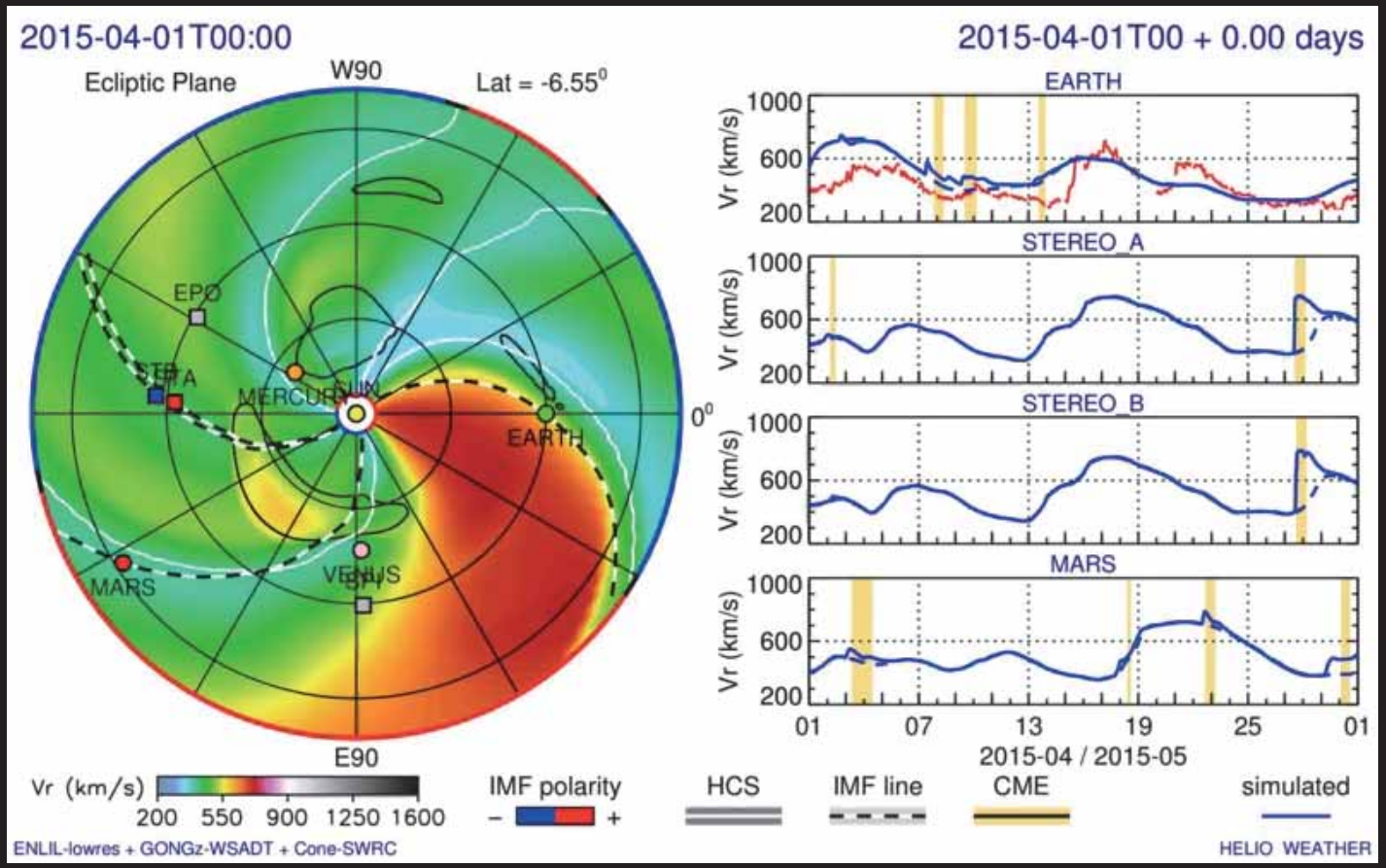






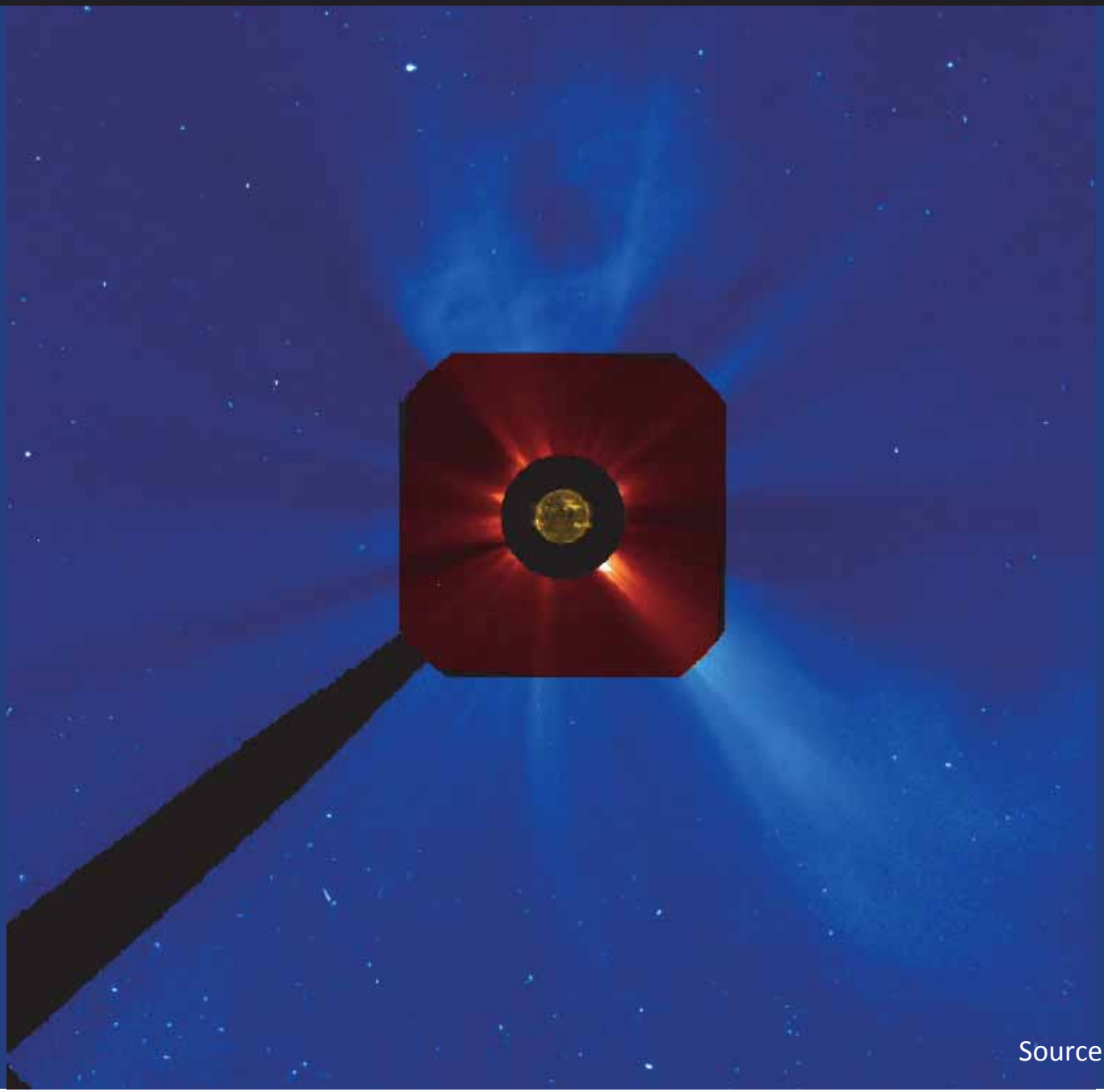
Source: Owens and Forsyth (2014)

MHD models of the solar wind used at SWPC, MET OFFICE

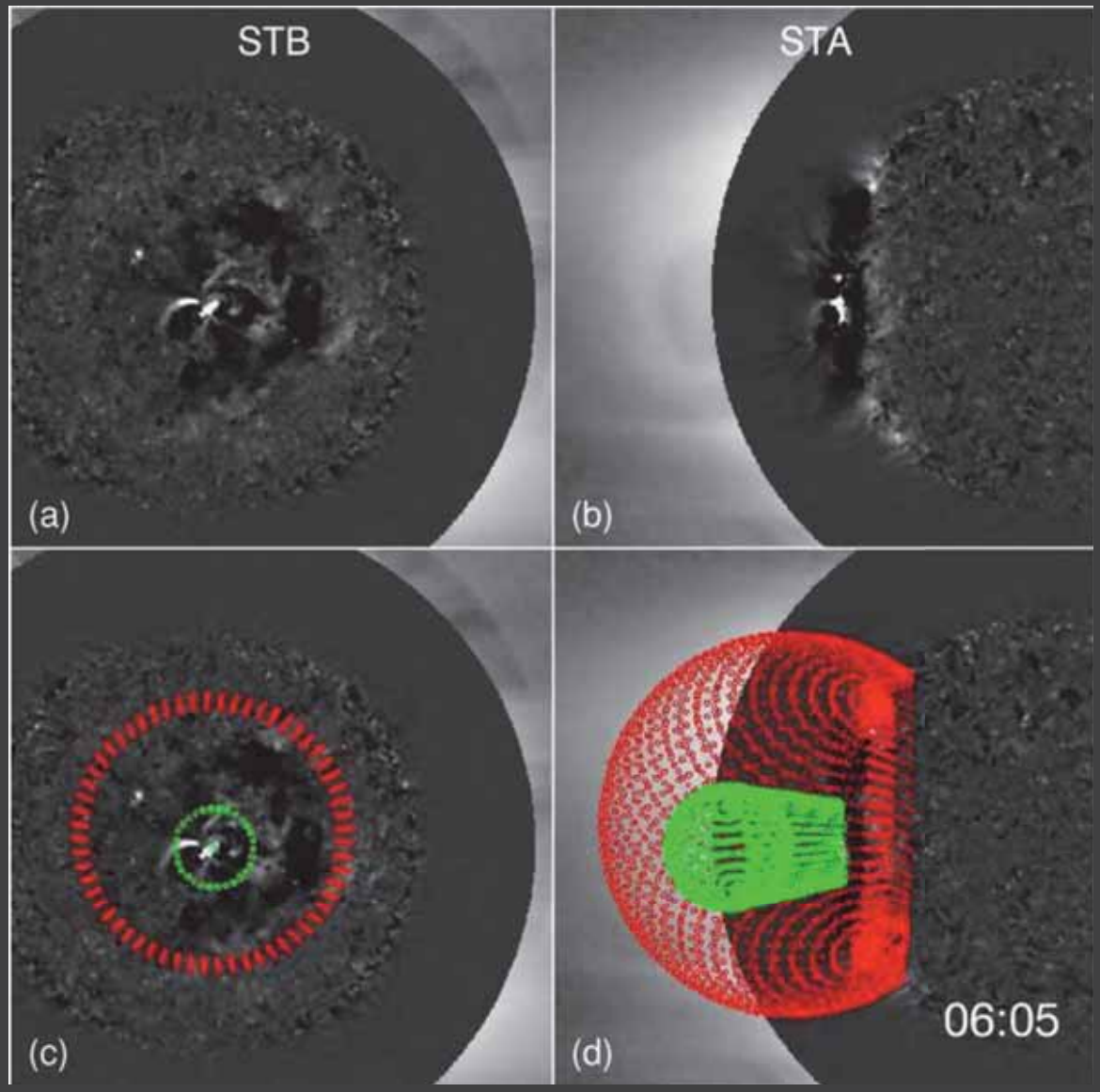


Source: NOAA SWPC

Aviation et météo de l'espace – 17 Mars 2016

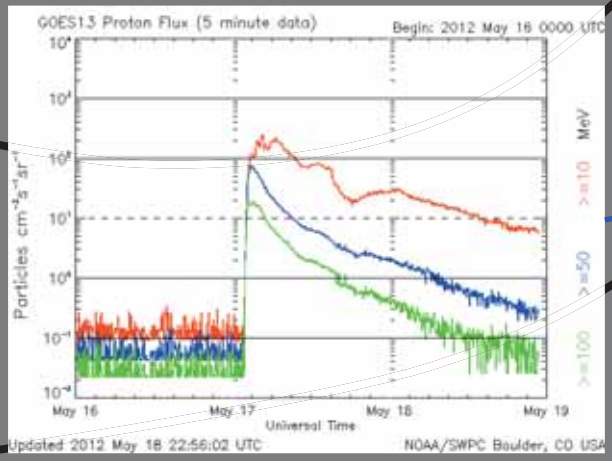


Source: ESA/SOHO



Source: Pastourakos and Vourlidas (2008)

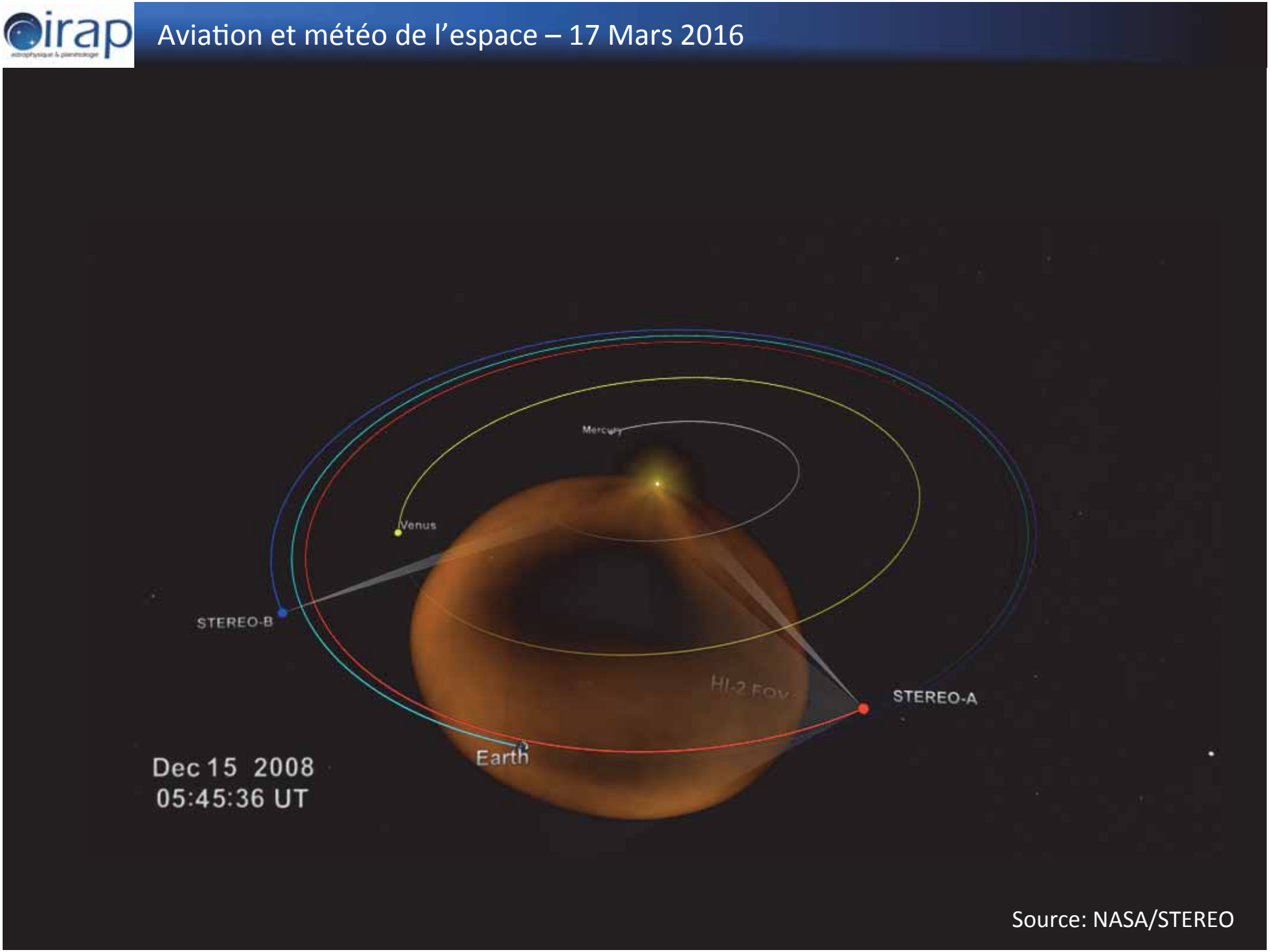
Aviation et météo de l'espace – 17 Mars 2016



Terre

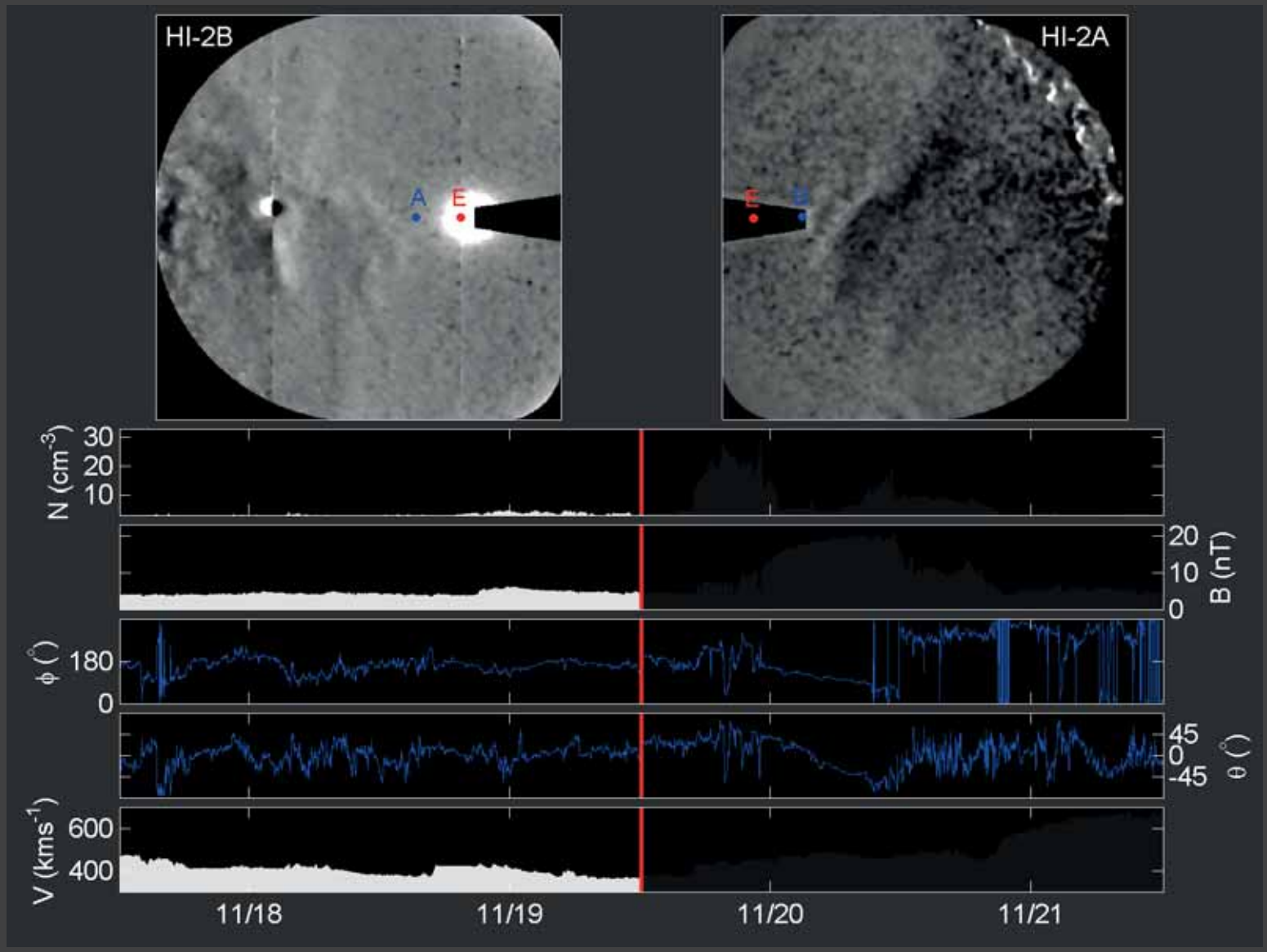
Mars

Aviation et météo de l'espace – 17 Mars 2016



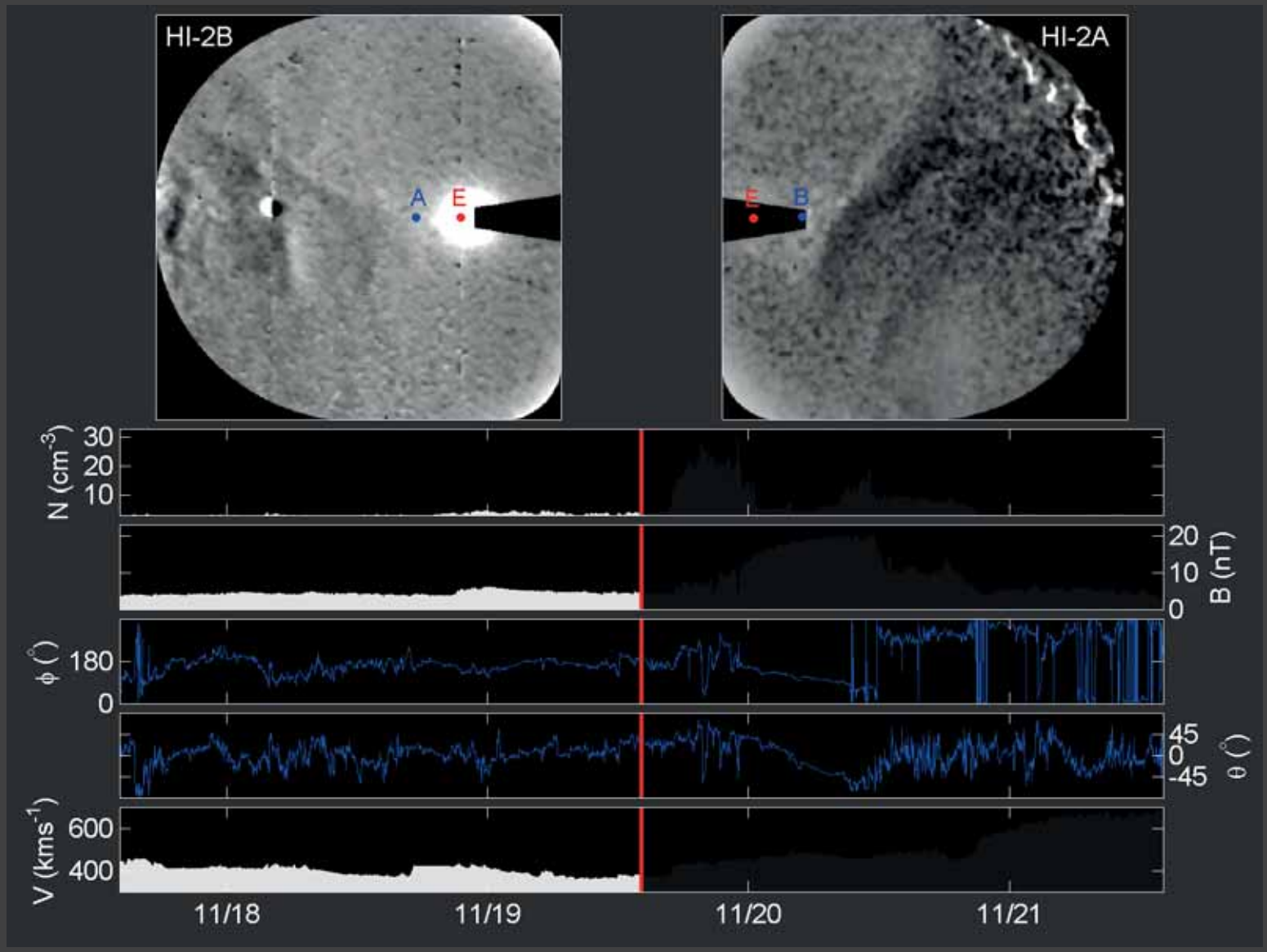
Source: NASA/STEREO

Aviation et météo de l'espace – 17 Mars 2016

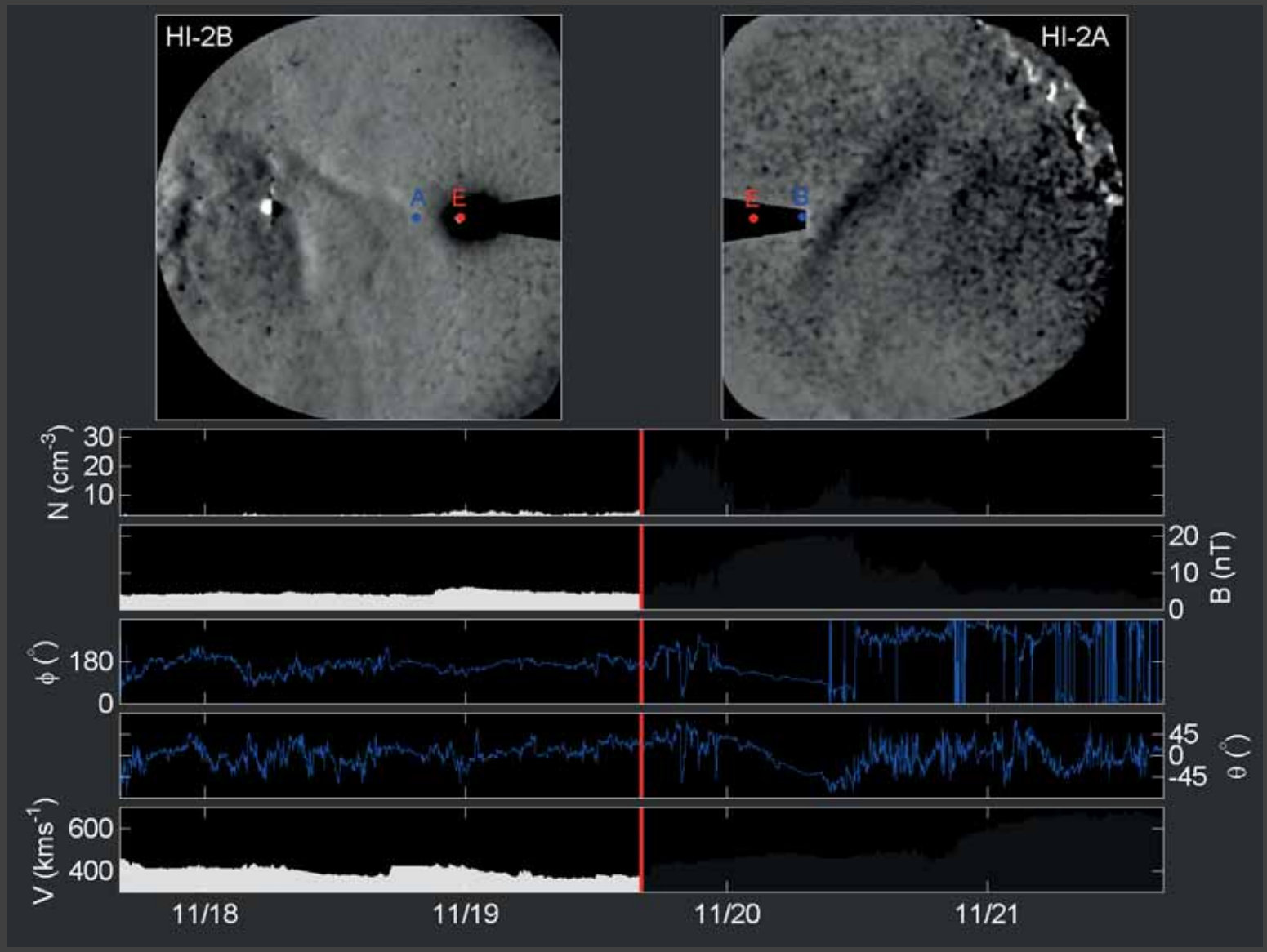


Rouillard et al:, Ap. J. 2010a

Aviation et météo de l'espace – 17 Mars 2016

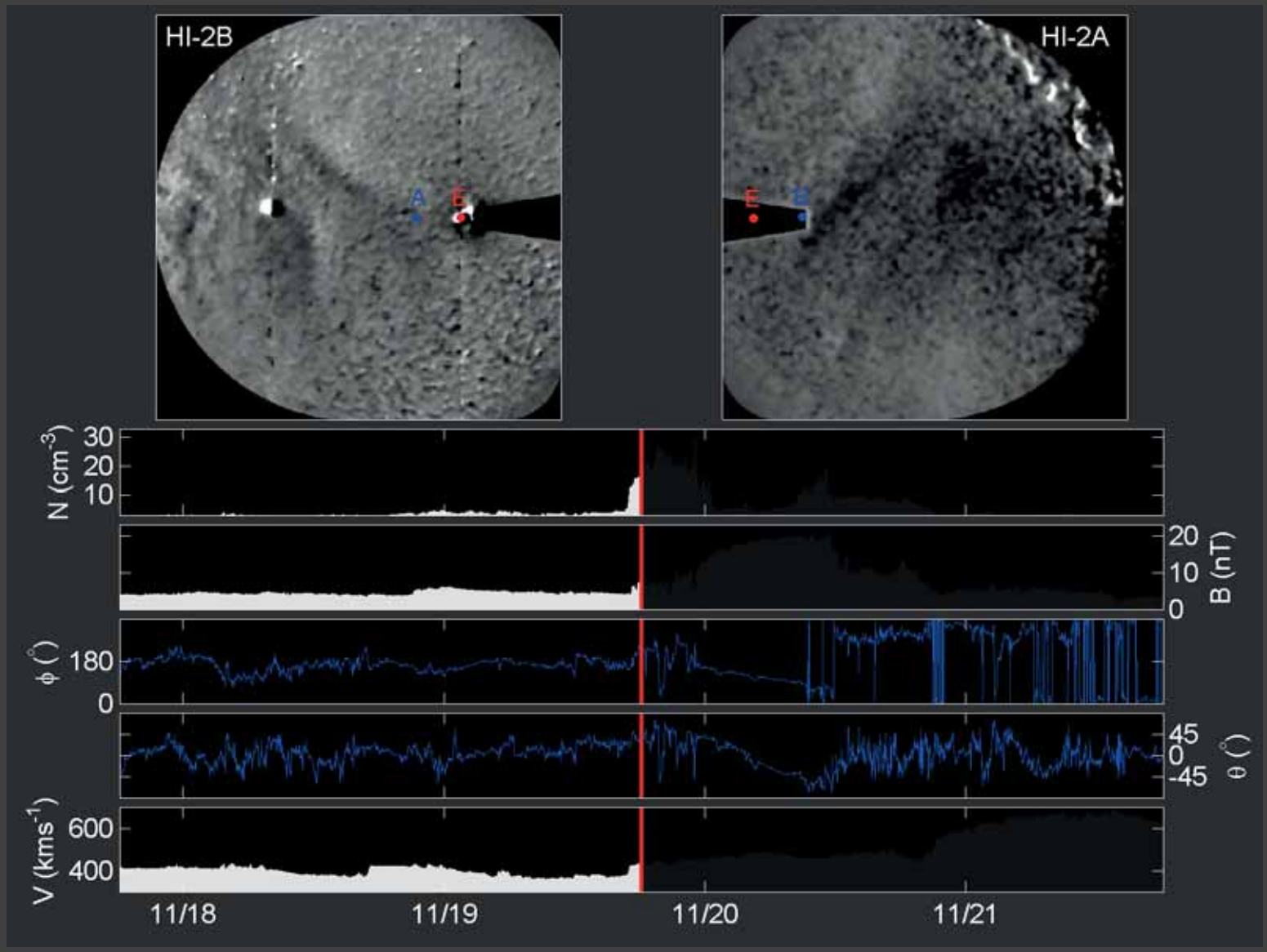


Rouillard et al:, Ap. J. 2010a



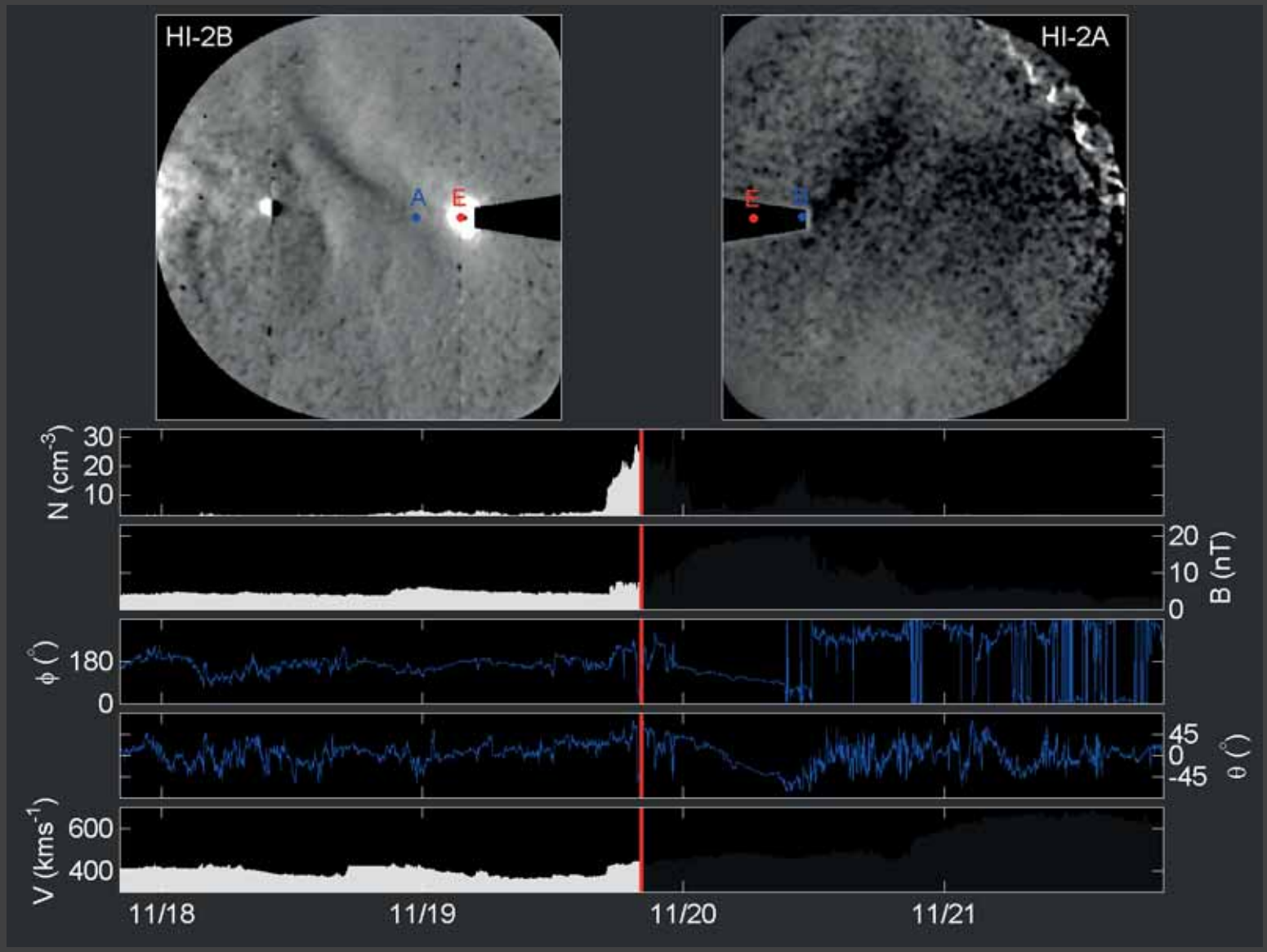
Rouillard et al:, Ap. J. 2010a

Aviation et météo de l'espace – 17 Mars 2016



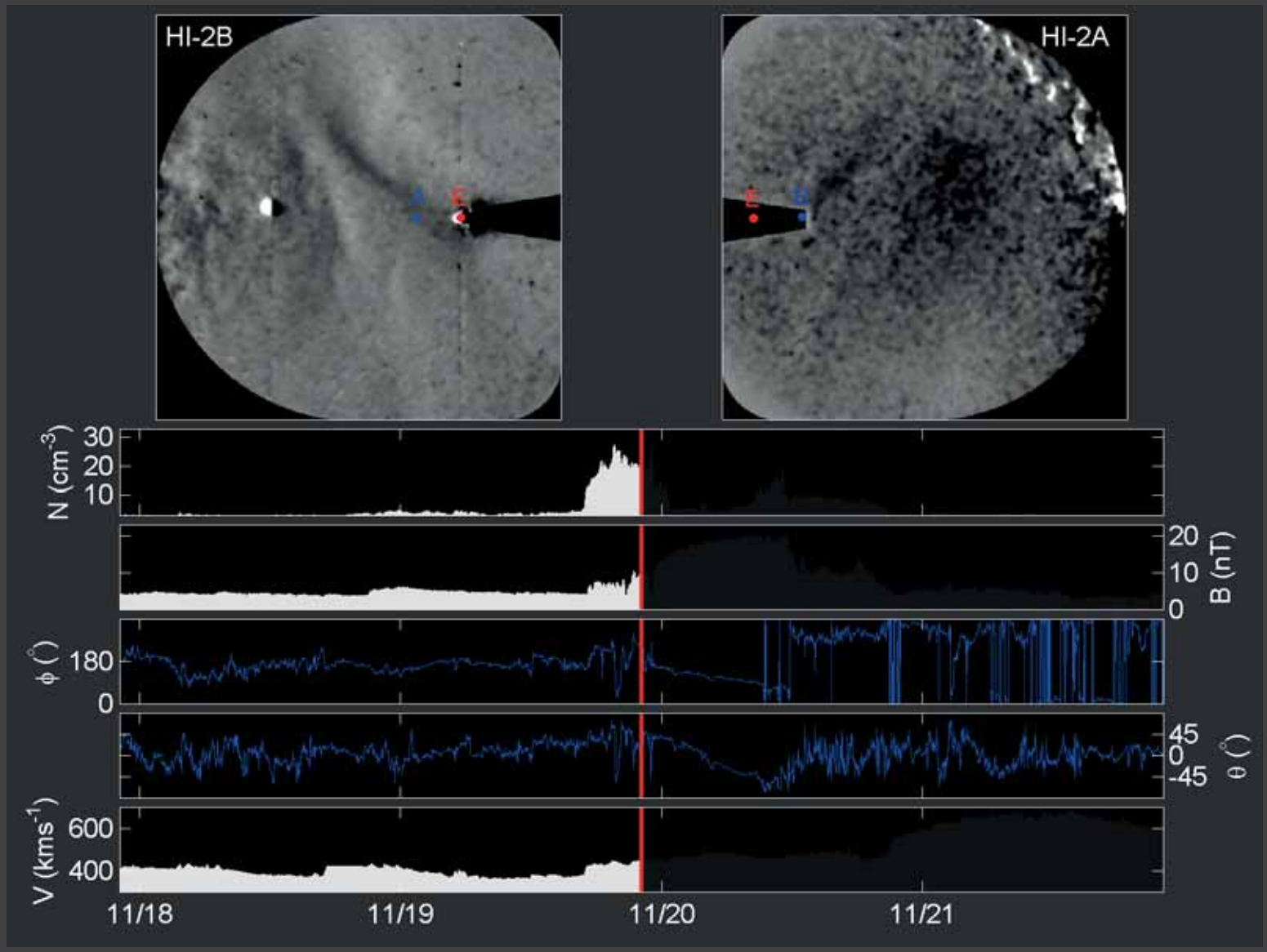
Rouillard et al:, Ap. J. 2010a

Aviation et météo de l'espace – 17 Mars 2016

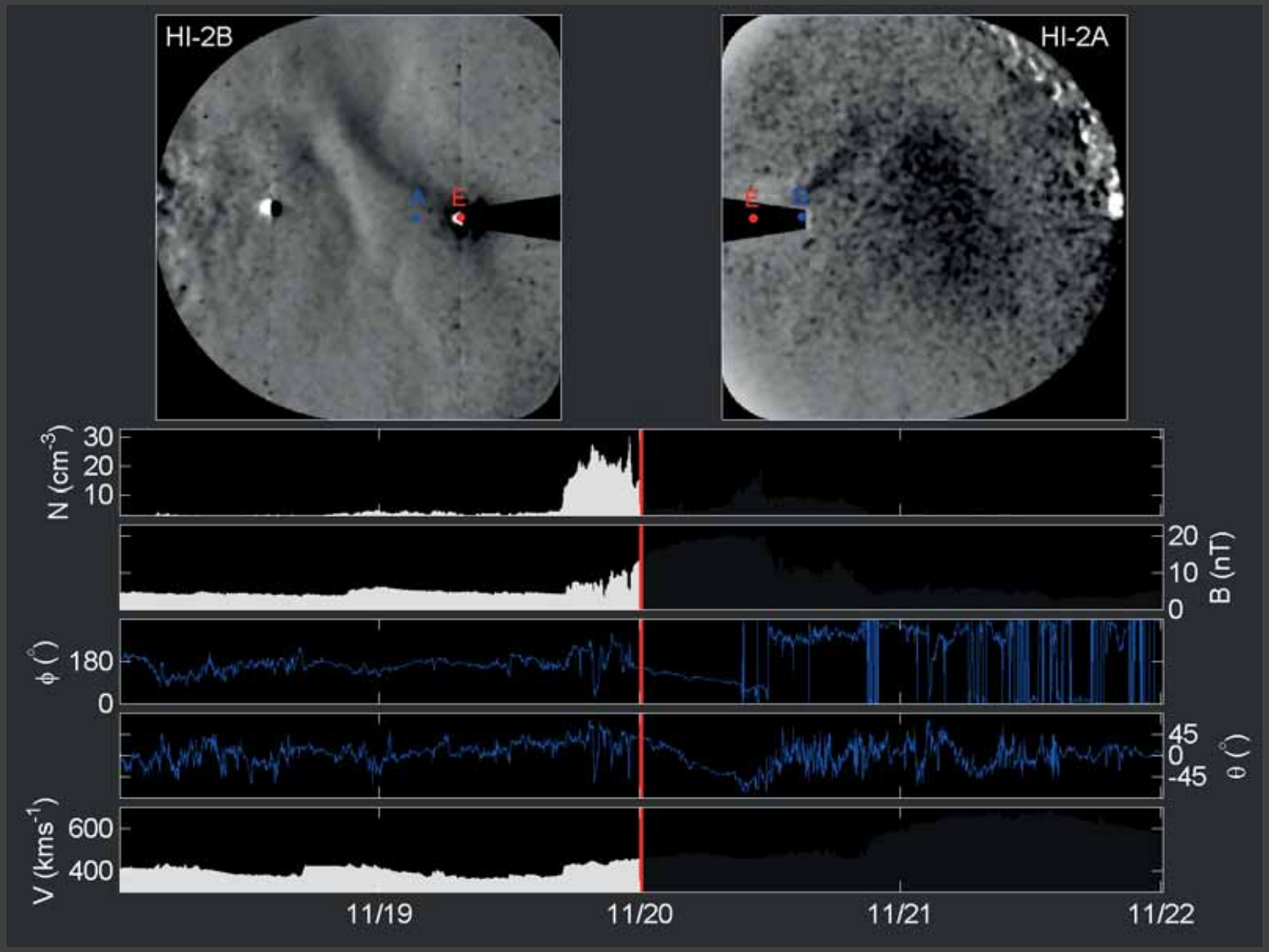


Rouillard et al:, Ap. J. 2010a

Aviation et météo de l'espace – 17 Mars 2016

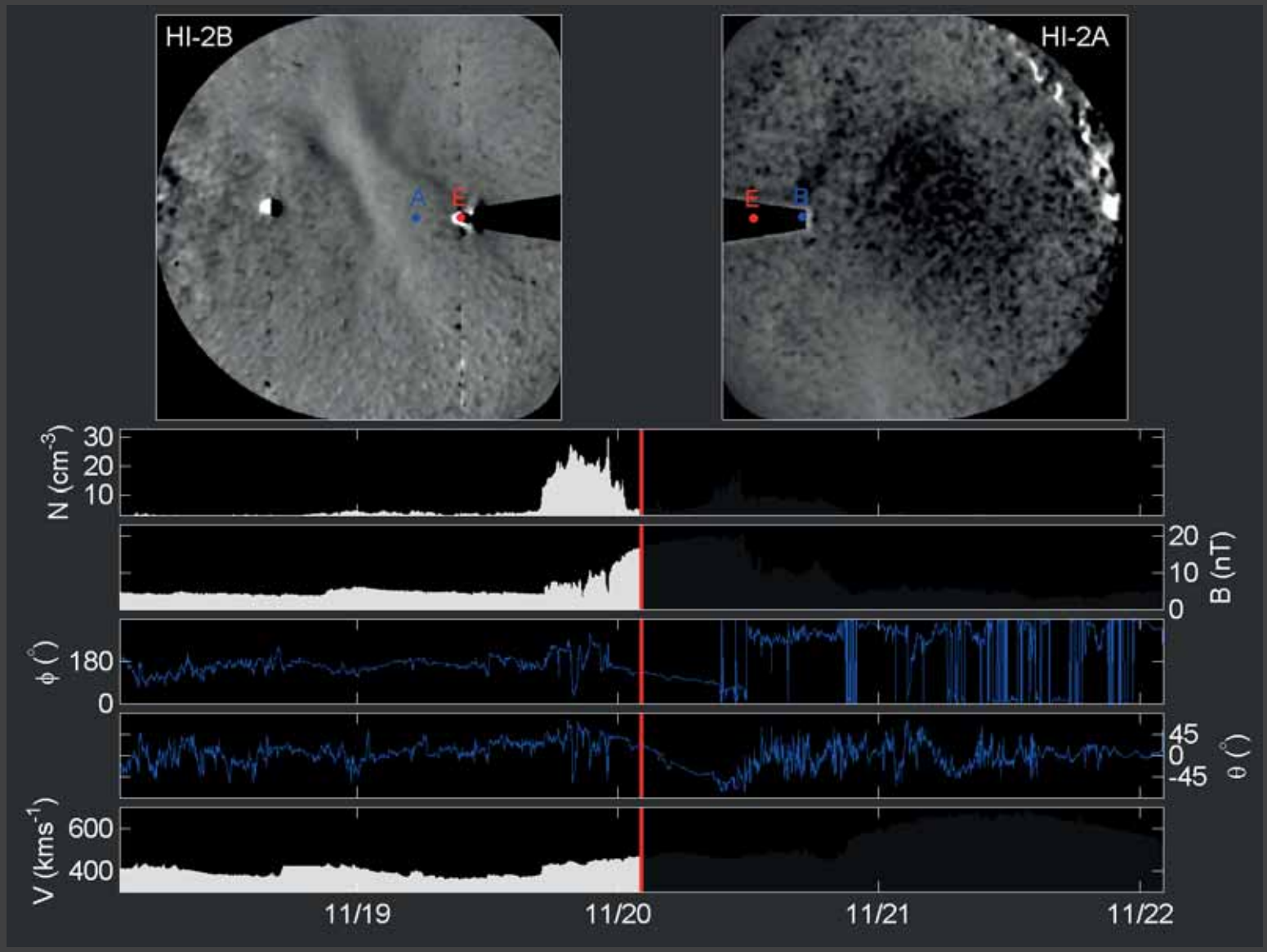


Rouillard et al:, Ap. J. 2010a

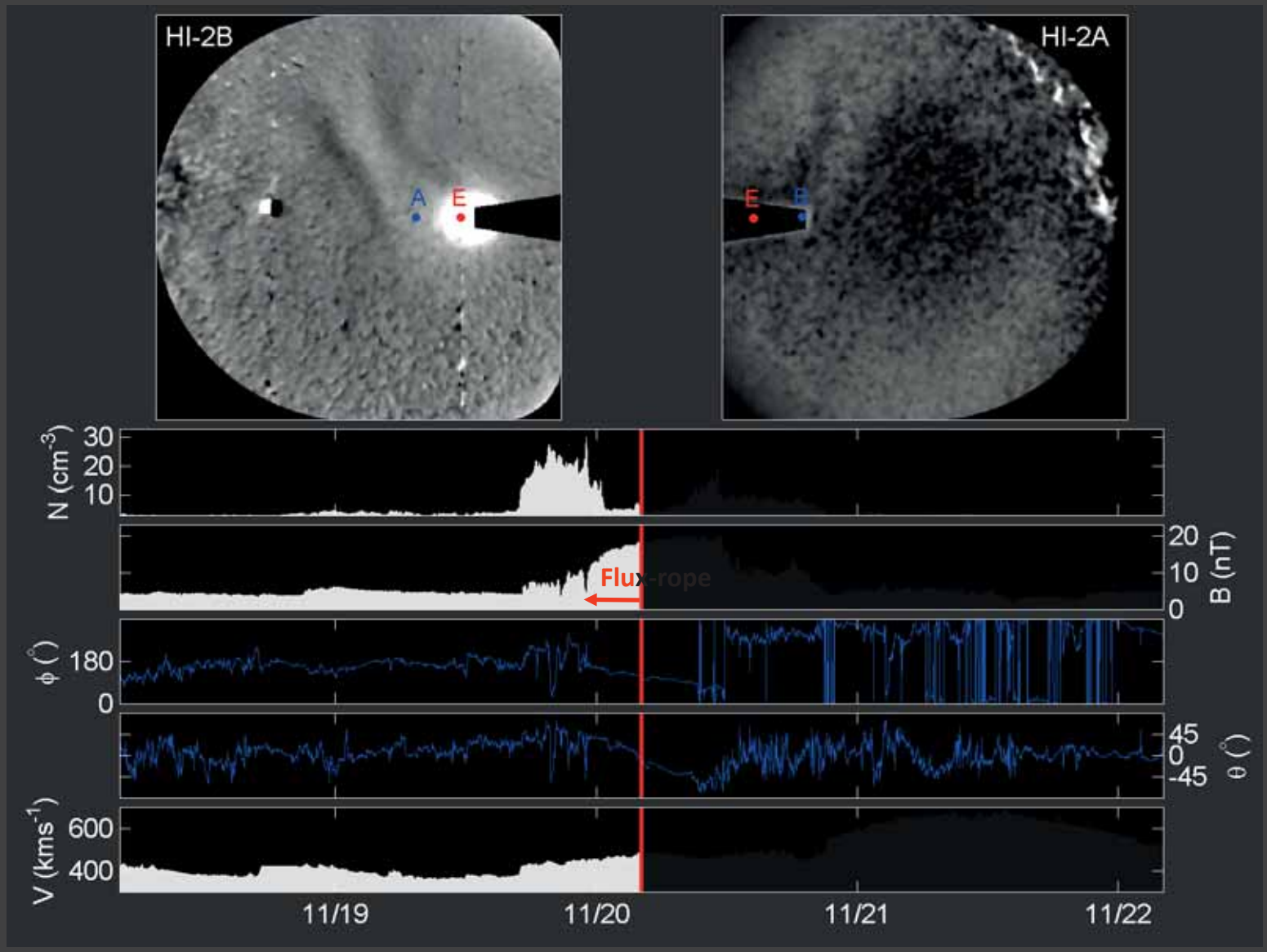


Rouillard et al:, Ap. J. 2010a

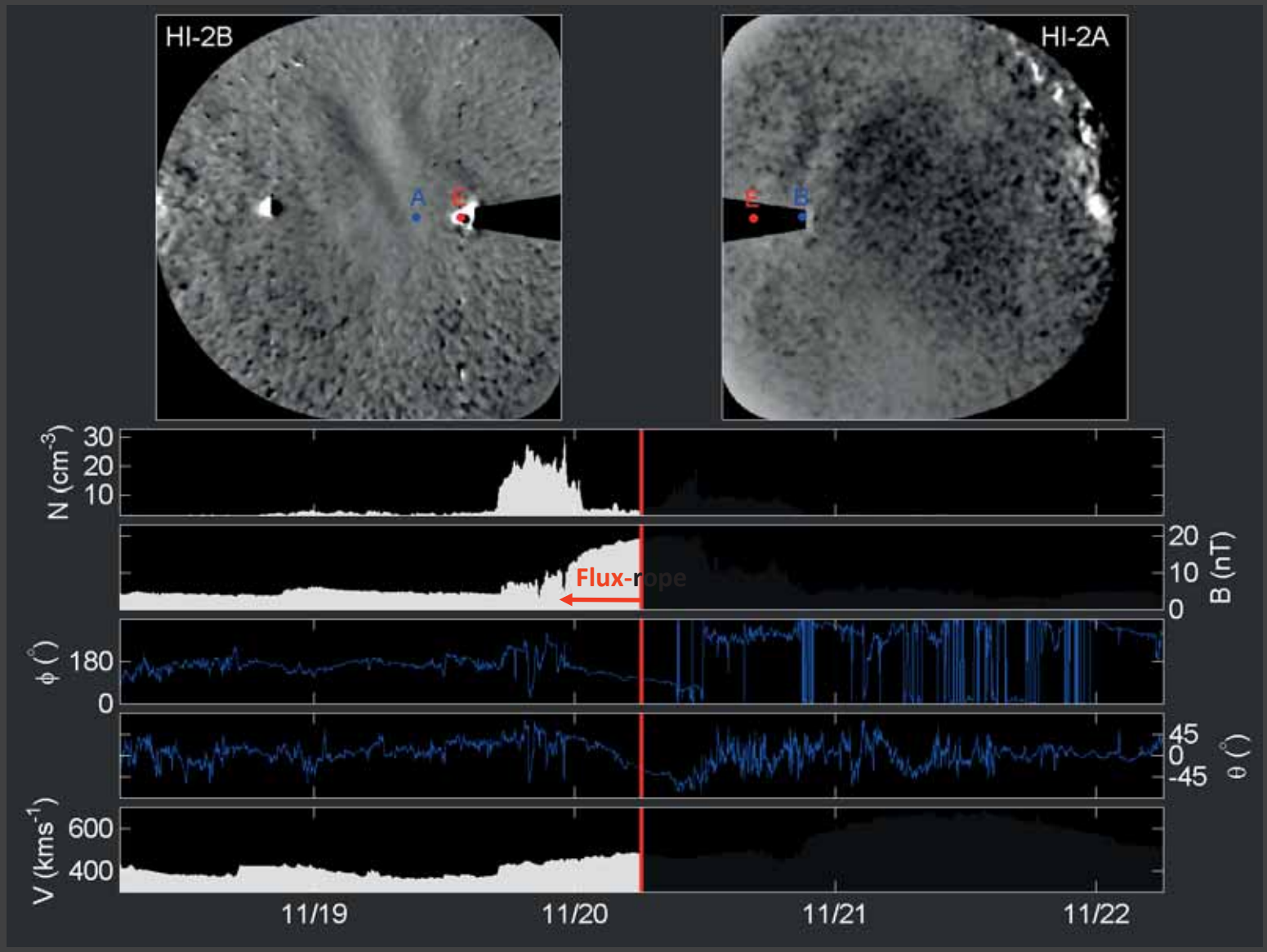
Aviation et météo de l'espace – 17 Mars 2016



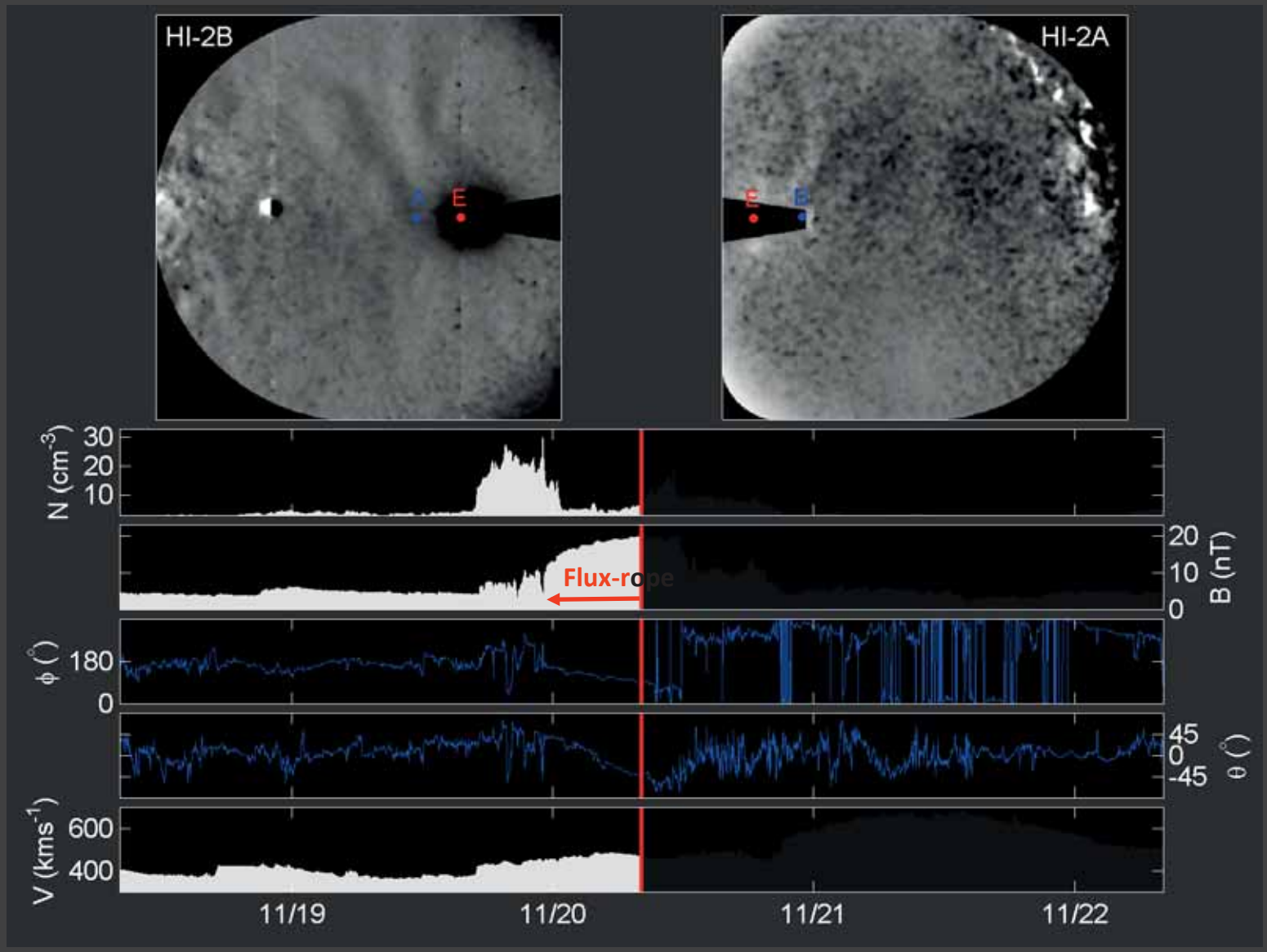
Rouillard et al:, Ap. J. 2010a



Rouillard et al:, Ap. J. 2010a

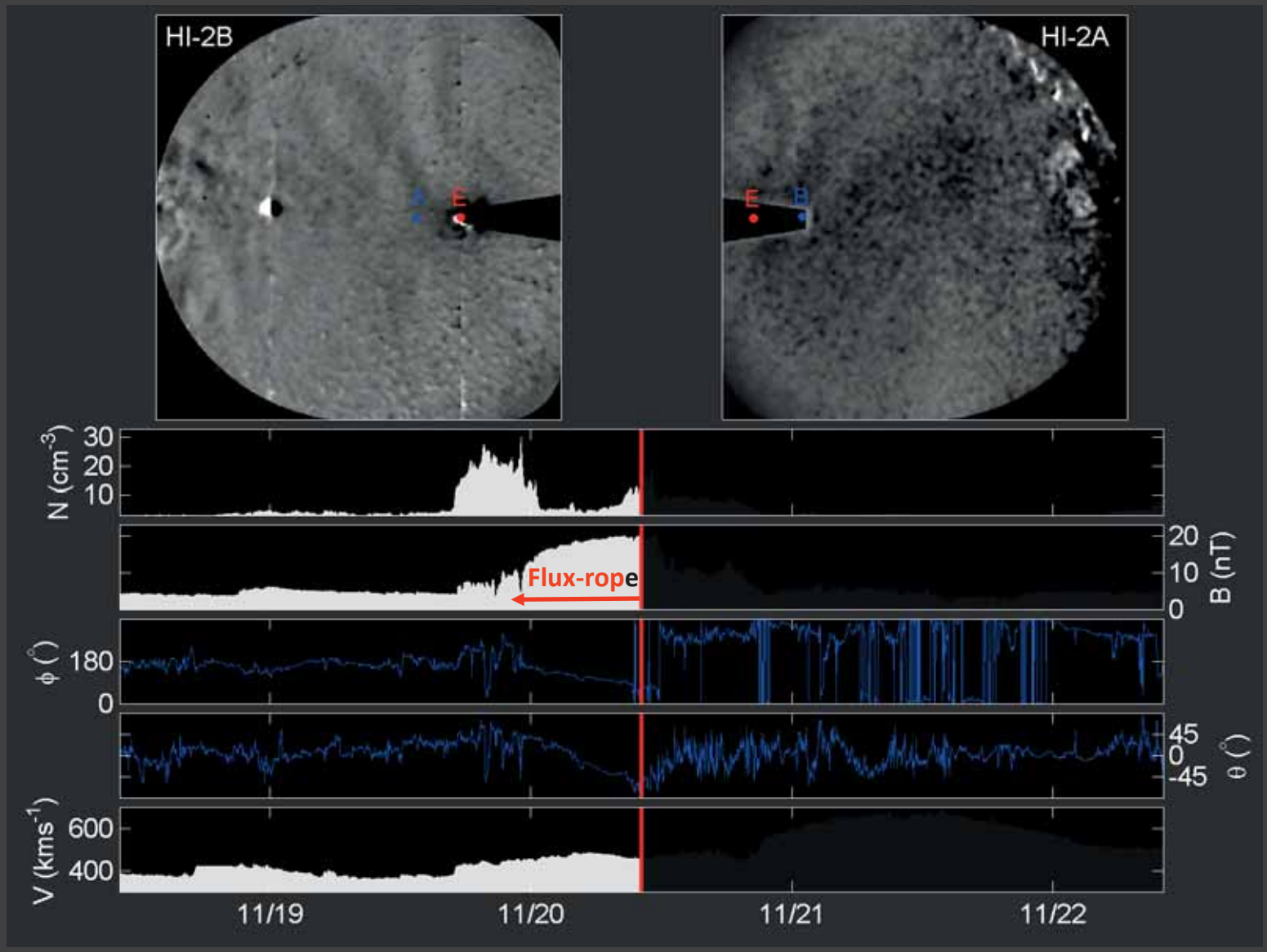


Rouillard et al:, Ap. J. 2010a



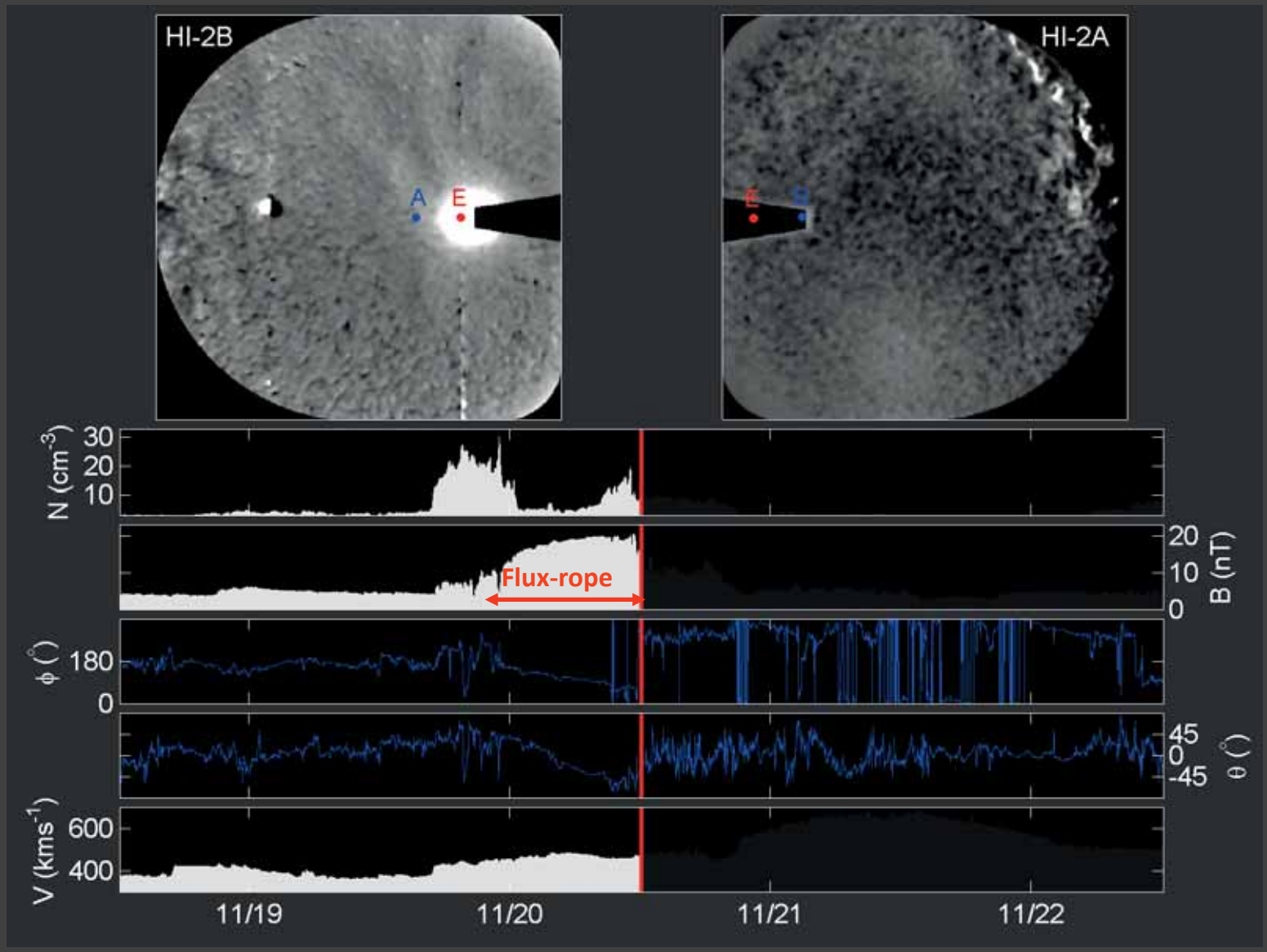
Rouillard et al:, Ap. J. 2010a

Aviation et météo de l'espace – 17 Mars 2016

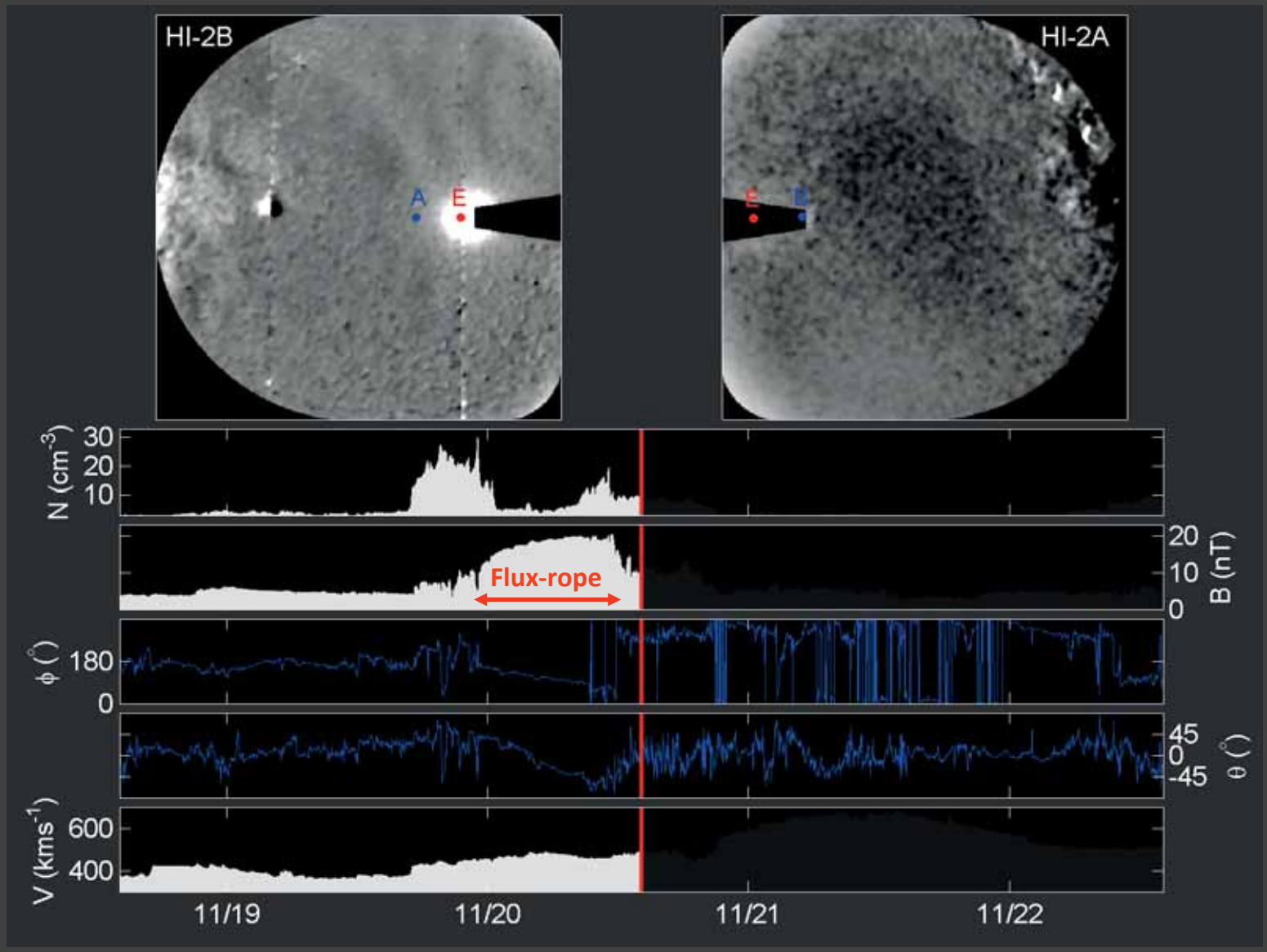


Rouillard et al:, Ap. J. 2010a

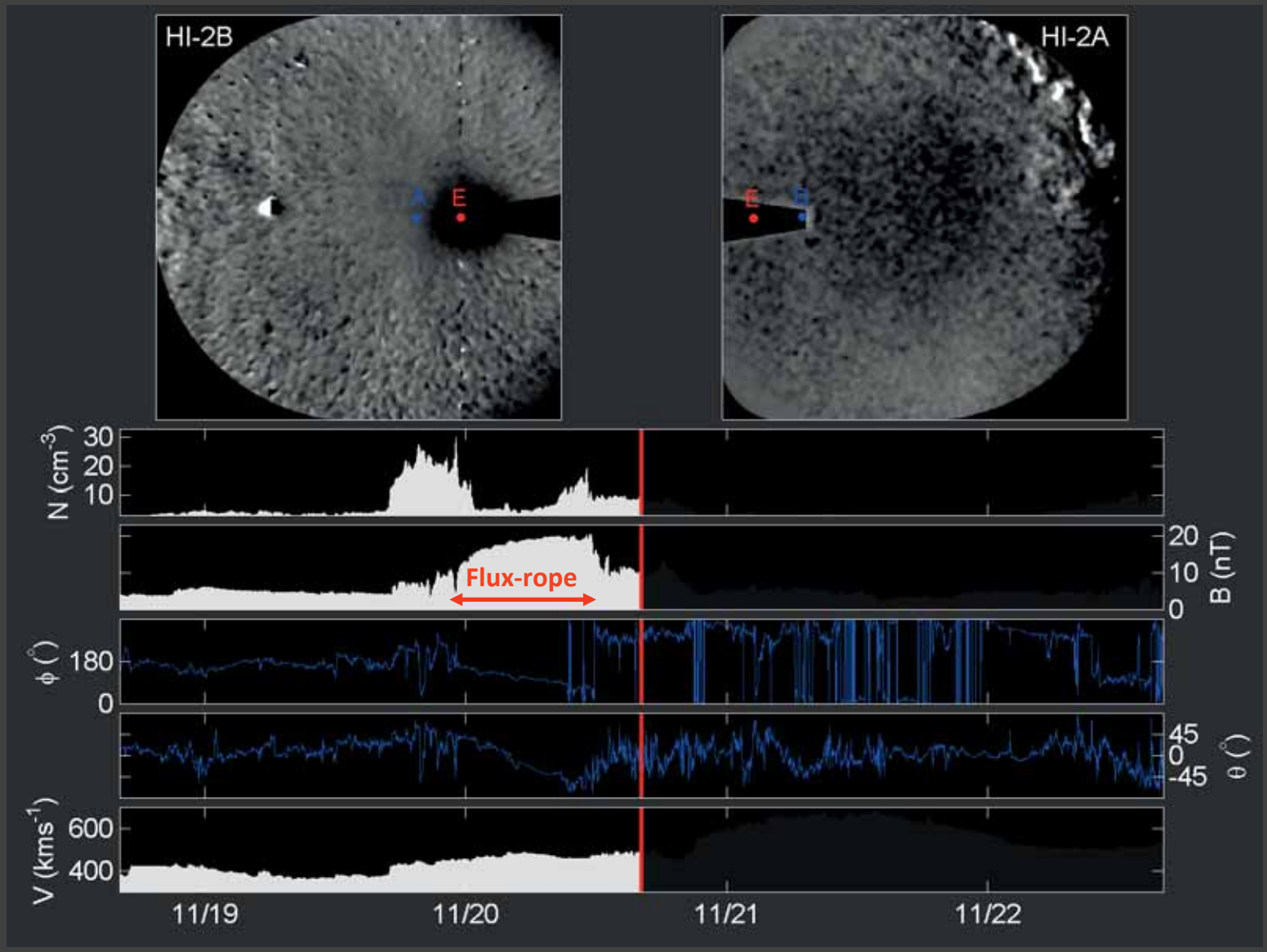
Aviation et météo de l'espace – 17 Mars 2016



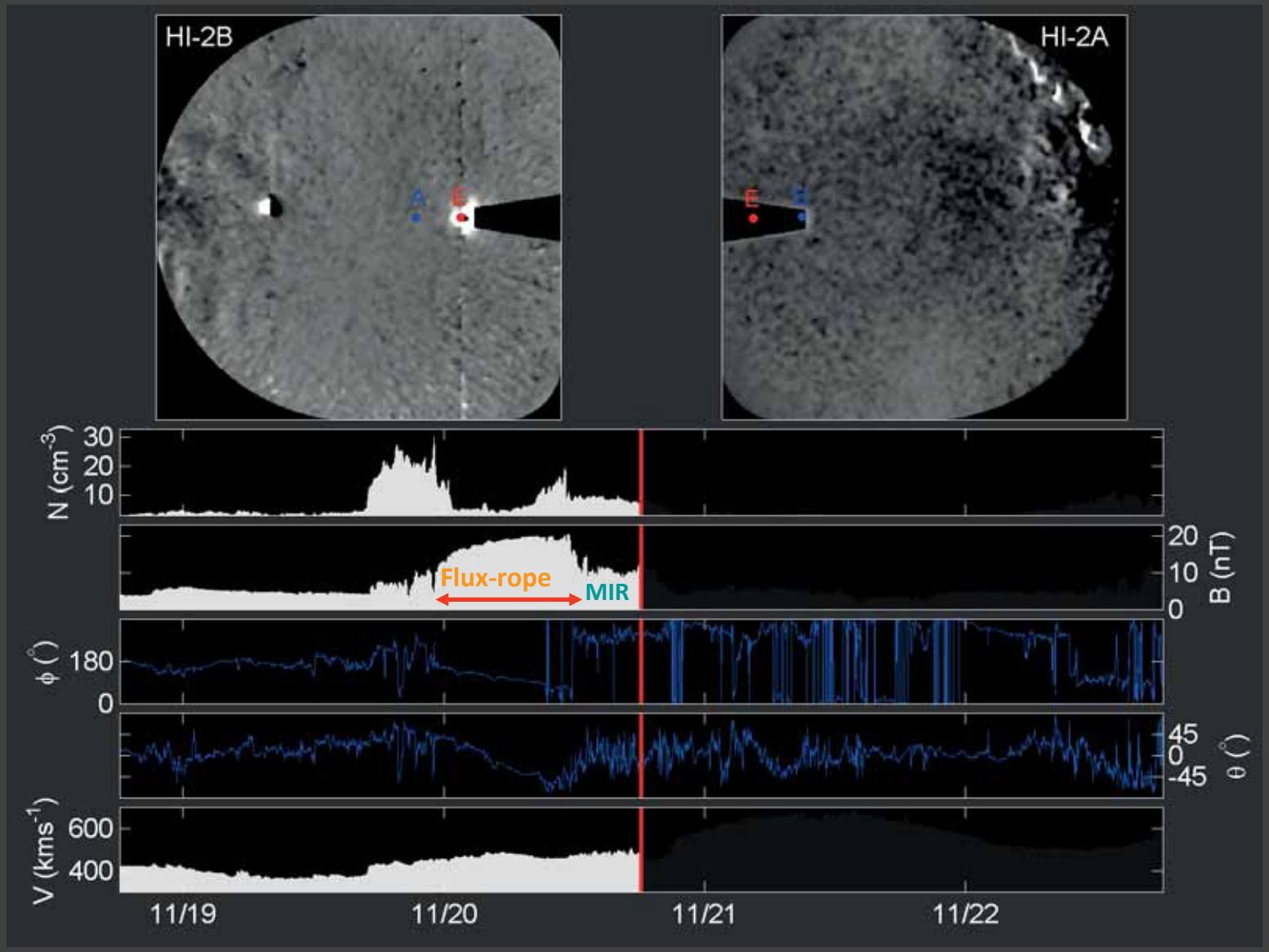
Rouillard et al:, Ap. J. 2010a



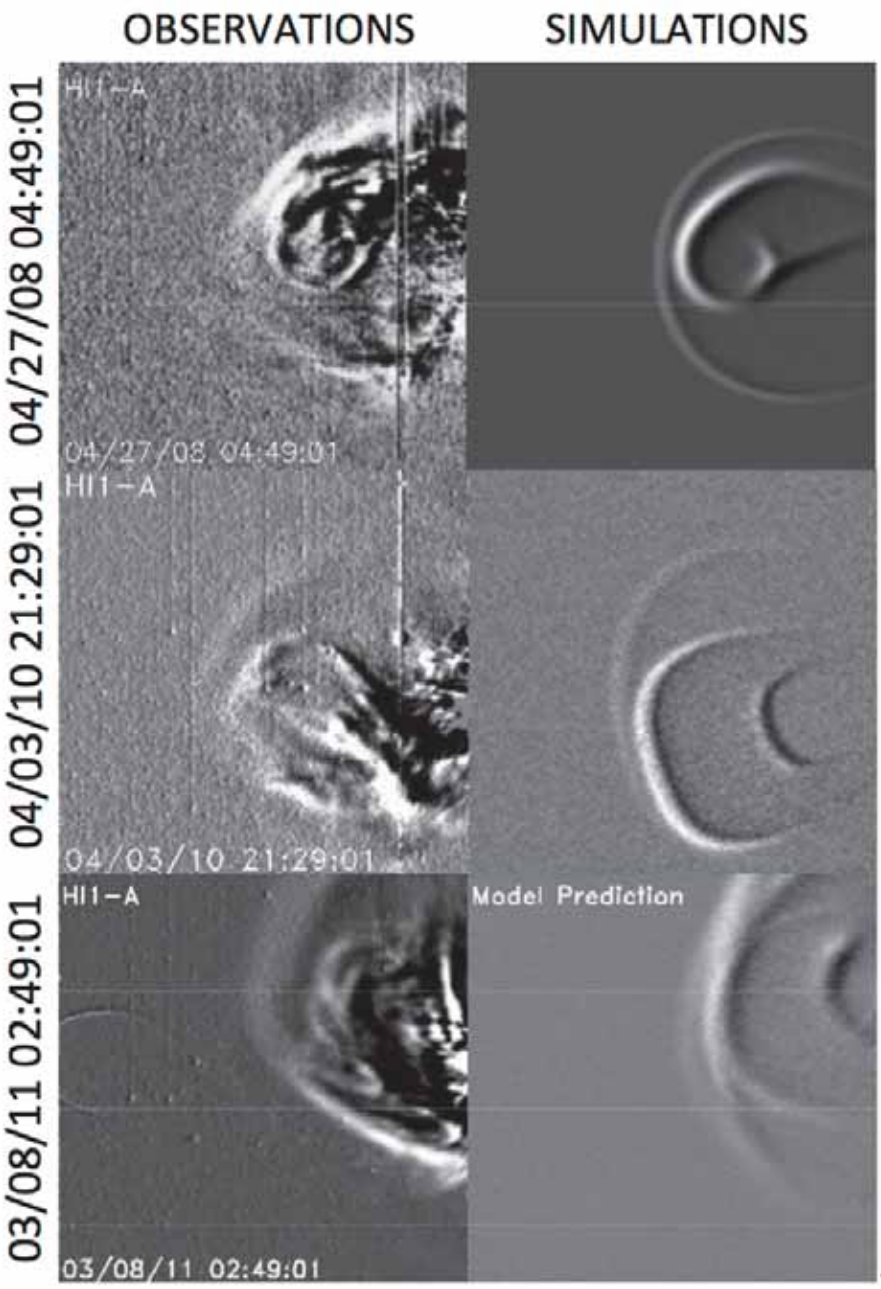
Rouillard et al:, Ap. J. 2010a



Rouillard et al:, Ap. J. 2010a

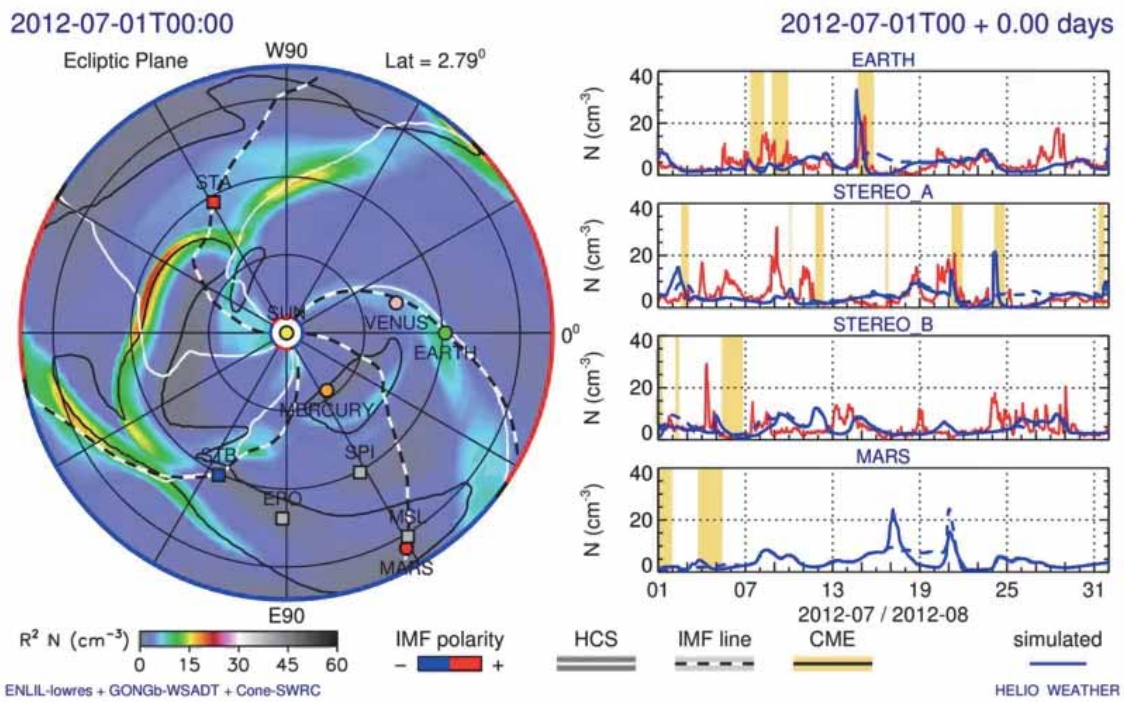


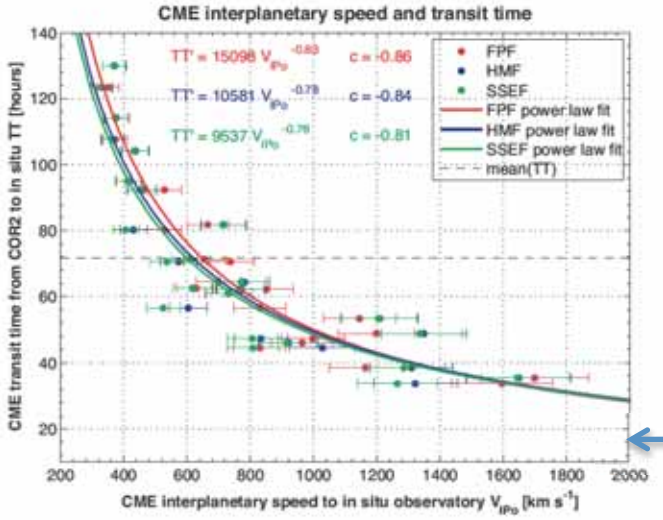
Evidence for reconnection occuring between this CME and IMF (c.f. Ruffenach et al. 2012, thesis at IRAP).



Source: Wood et al. (2009, 2010)

Carrington-like event hit STEREO-A on 2012 July 23!

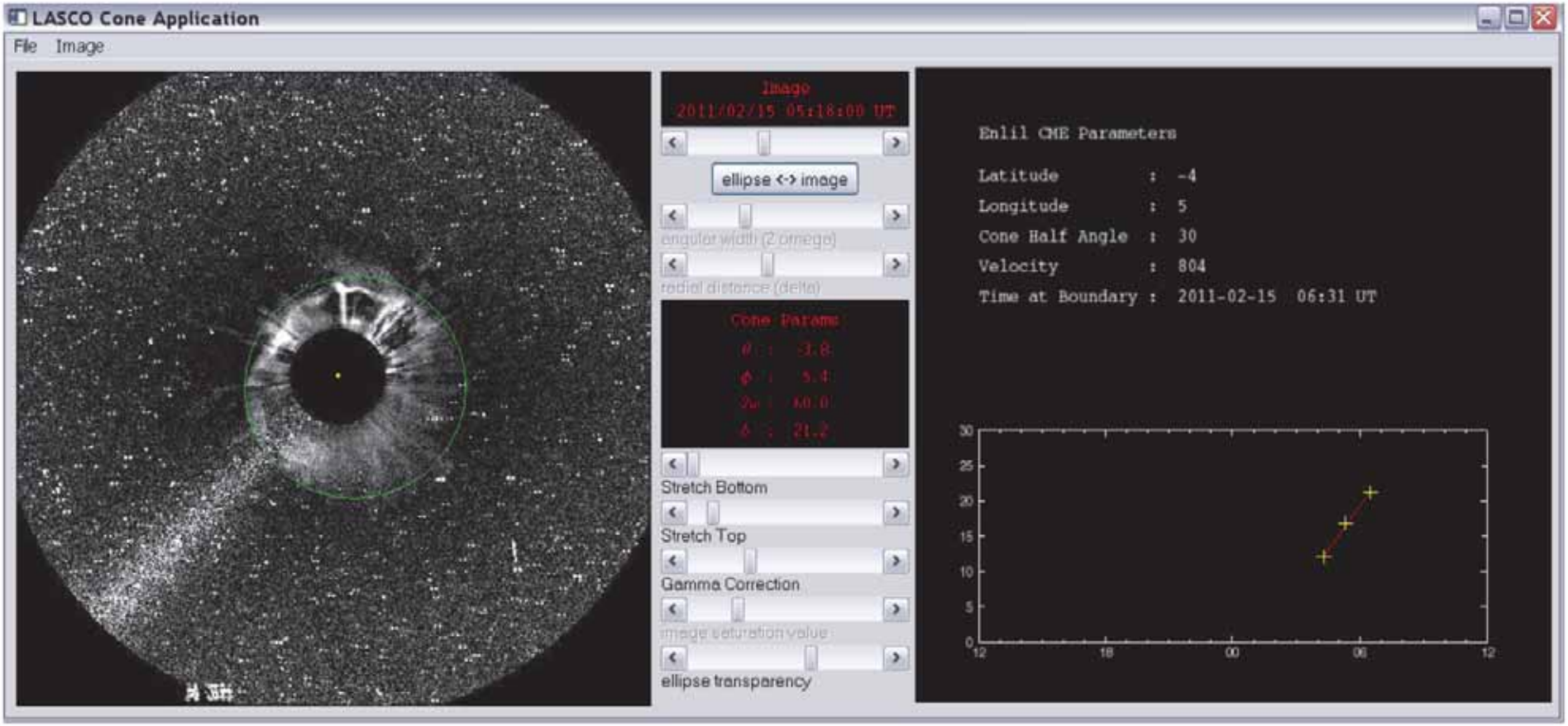




2012 July 23 event
17 hour transit time

Moestl et al. (2014)

Aviation et météo de l'espace – 17 Mars 2016



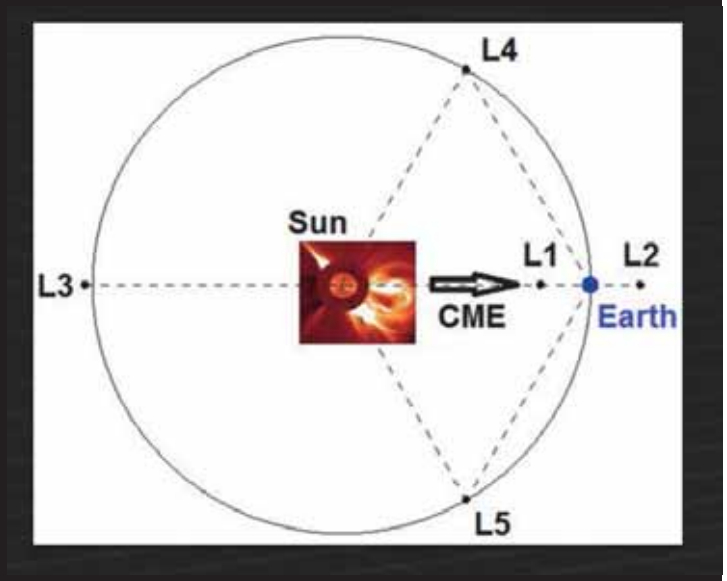
G. Millward, SWPC and University of Colorado

Source: NASA SWPC

An observatory situated at L5 should improve Space-weather forecasting by:

- Removing directional ambiguities

- By providing a near real-time update of the solar storm position



Interesting facts:

- The largest observed flare saturated the GOES detector and was estimated to peak at X28, there is a 10% chance of a flare larger than about X30 to occur in the next 30 years,

- We predict arrival times of CME with an overall uncertainty of 8-10 hours,

- The fastest CME to transit from the Sun to 1AU:

- According to a study by the National Academy of Sciences, the total economic impact could exceed $2 trillion or 20 times greater than the costs of a Hurricane Katrina.

- If that CME had hit Earth, the resulting geomagnetic storm would have registered a Dst of -1200, comparable to the Carrington Event and twice as bad as the March 1989 Quebec blackout."