The Use of Space Weather Forecasts and Reports by Flight Projects at JPL - a personal view*

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* This does not represent a comprehensive review of all JPL operations.

Routine Operations at JPL

No standardized process for factoring SWx information into flight project operations.

Mission Controllers monitor SWx conditions and forecasts at their discretion.

Information is provided via notifications from SWPC or SWRC.

Challenge for Deep Space Missions

No ability to predict or measure flux of solar energetic particle events (SEP events).

- CME is a crude proxy for possible SEP.

- CME itself doesn't affect deep space s/c.

Operations "Philosophy" towards SWx monitoring

Spacecraft tolerate a high SEP flux,
so SWx-prompted actions are only appropriate if:

(1) Flux is known to be much higher than design flux
- **but we can't measure flux heading toward s/c;**
- **Outer planet s/c are designed for large 1 AU SEP, so will tolerate fluxes attenuated by distance from Sun.**

(2) Entry into safe mode would impact critical operations (e.g. arrival at Mars)
- **false positive SWx threat is acceptable in this situation.**

(3) Hardware vulnerabilities discovered during flight can only be mitigated by actions in response to SWx.
- **need in-situ detection, or must accept false positives.**

SWx effects on Deep Space Radio Signals

Measurements:

Doppler (s/c velocity)

Range (s/c position)

Intervening CME -> noisy measurement -> failed solution.

CME Alert confirms SWx explanation.

May cause Earth targeting error for Sample Return Mission; see Morabito et al. 2011, "The effects of earthward directed interplanetary coronal mass ejections on near-Earth S band signal links"

SWx effects on Deep Space Radio Signals

Communications:

Issues are chiefly

- **Solar Conjunction,**
- **Large Geomagnetic Storms**
  - **denser ionosphere**
  - **interplanetary CME plasma**

Otherwise, CMEs are not a problem for communications.

JPL POCs for SWx effects on Deep Space Radio Signals

David (Dave) Morabito

Francis (Jim) Taylor

Shyamkumar (Shyam) Bhaskaran

Next Mars Arrivals -

- **Insight (5/5/18 launch, 11/26/2018 arrival)**
- **Mars2020 (7/16/2020 launch, 2/14/2021 arrival)**

How will we know what is happening at Mars?

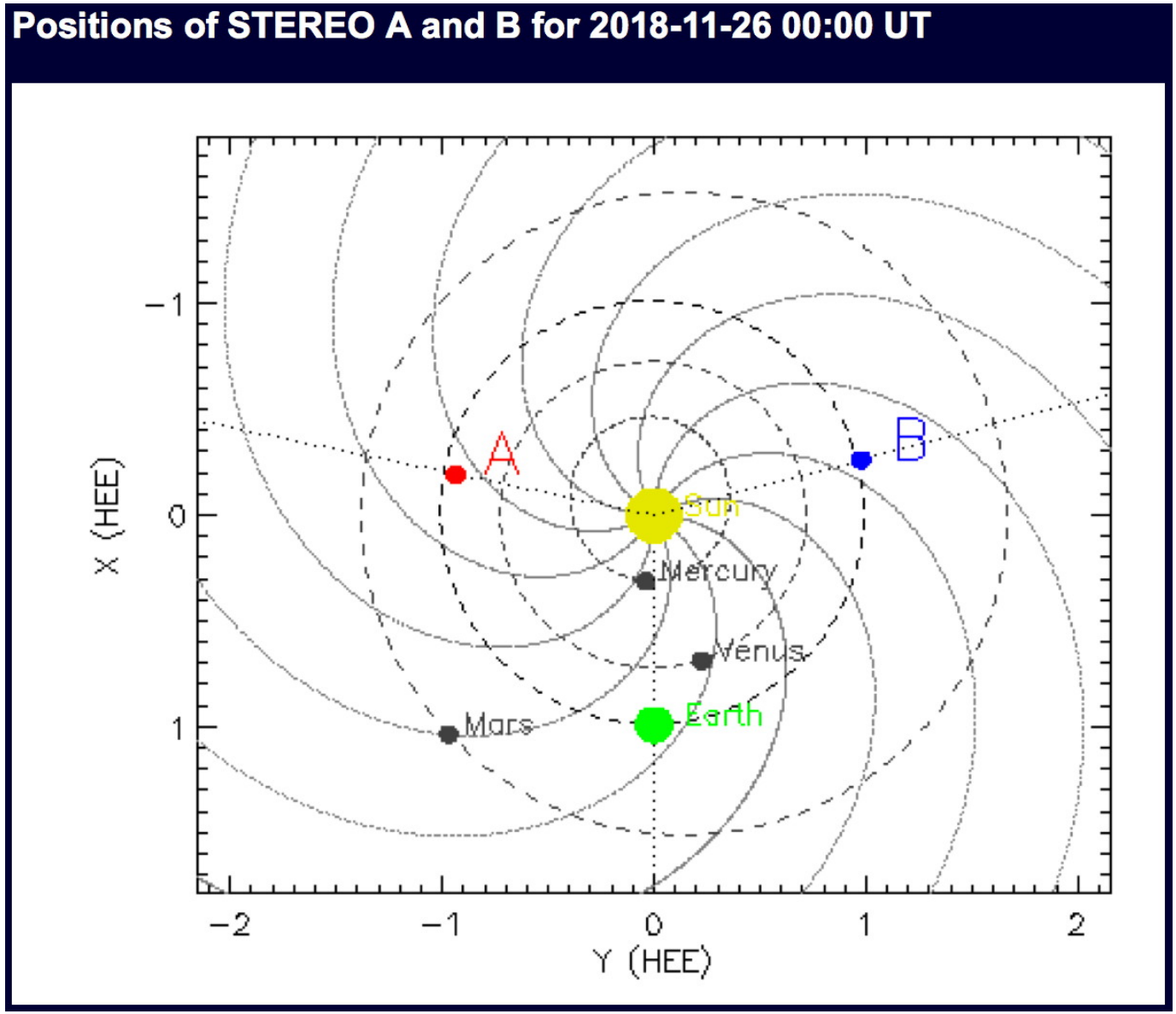
MRO SEU data (qualitative, delayed)

MAVEN or MEX for in-situ indication of SEP?

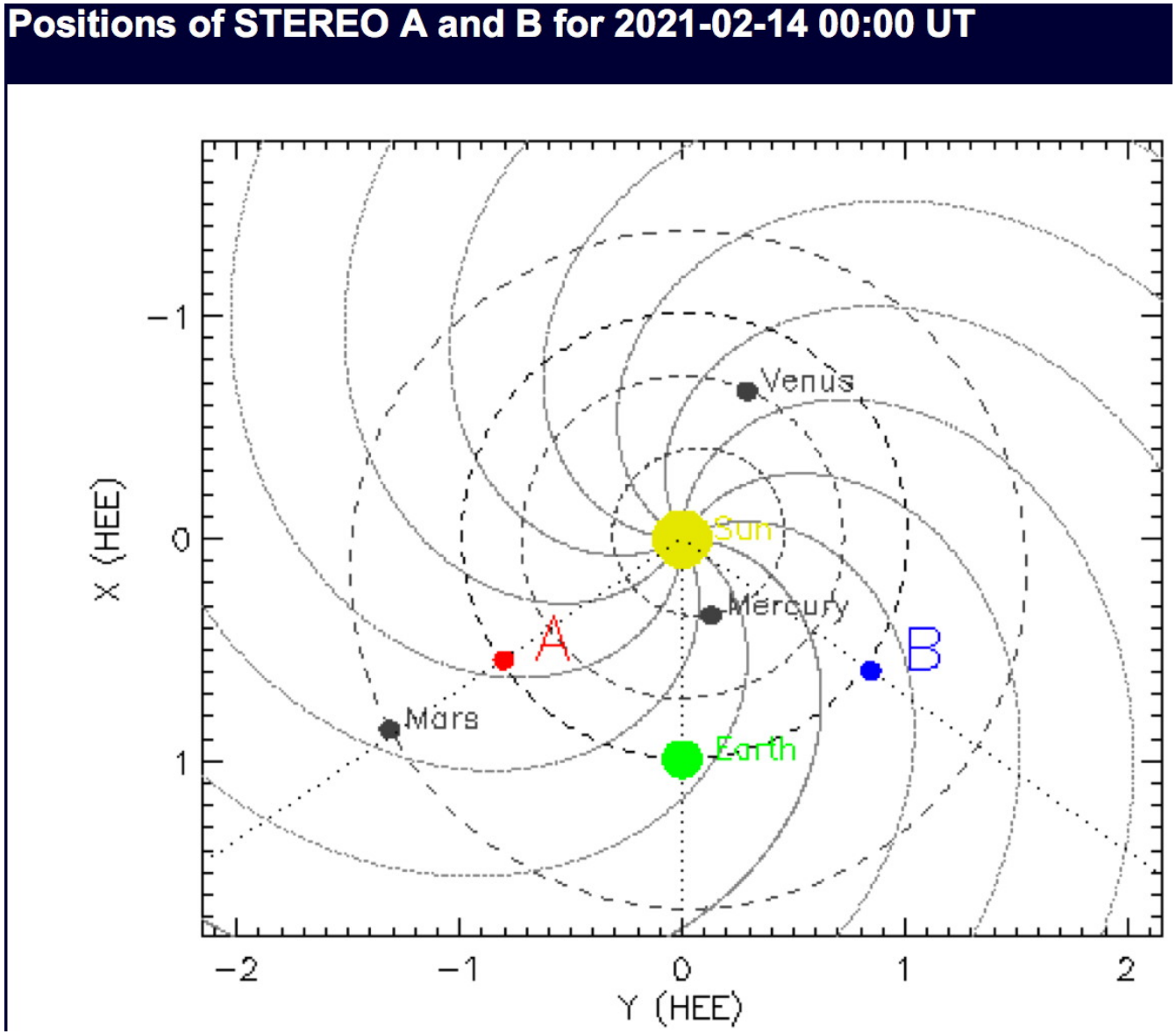
Can STEREO help?

http://stereo-ssc.nascom.nasa.gov/cgi-bin/make_where_gif

Insight arrival on 11/26/2018:



M2020 arrival on 02/14/2021:



We'll need:

Parker Spiral estimates;

STEREO-A SEP proton flux in real-time.

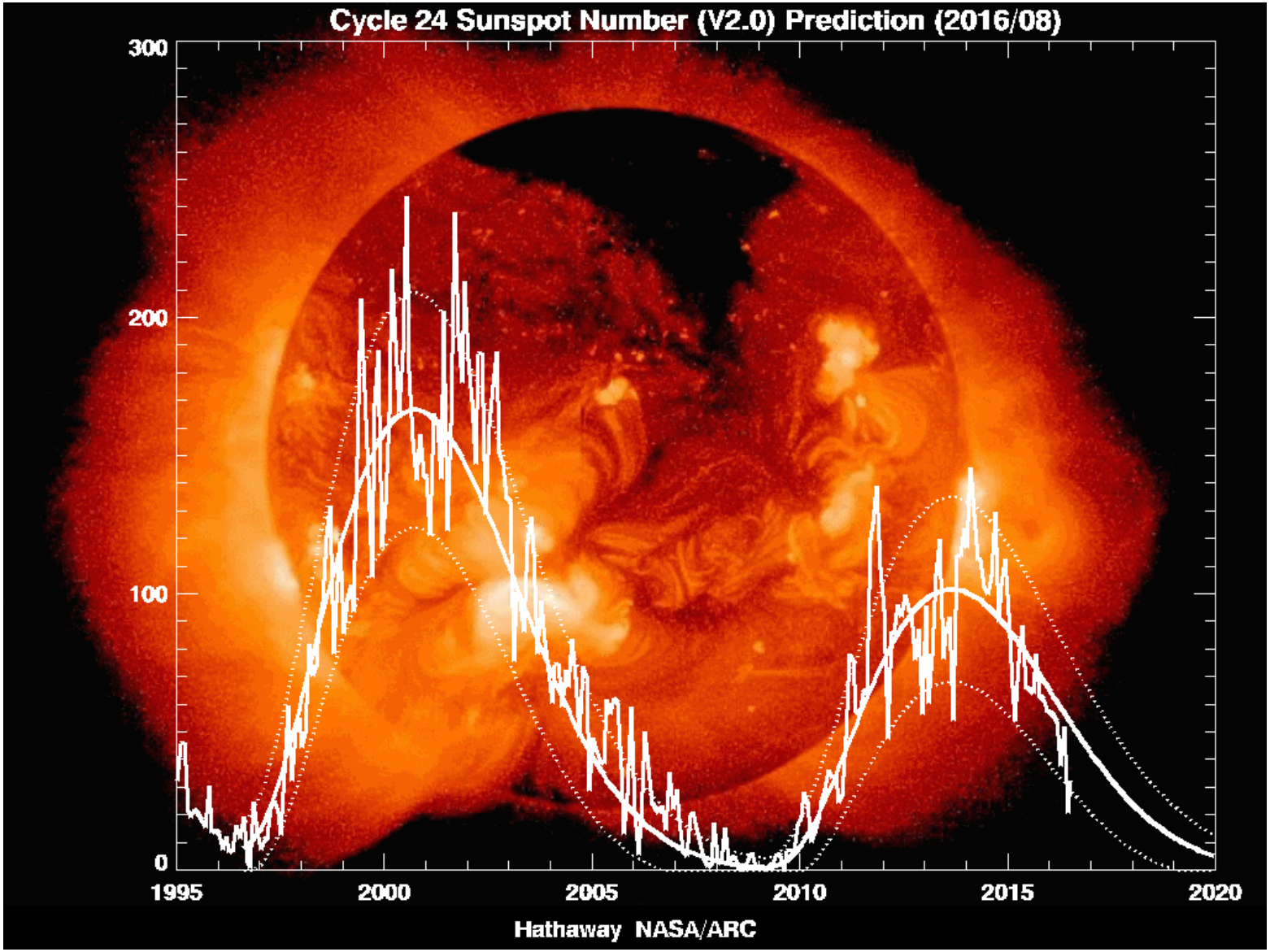
Request to iSWA:

Reformat STEREO energetic proton data to look like GOES format –

- **Integral spectrum**
- **Same x-y scales**

Develop MAVEN and MEX as SWx stations.

But maybe there won't be any solar activity…



Questions, comments…?