



Tracking solar wind structures from the Sun through to the orbit of Mars

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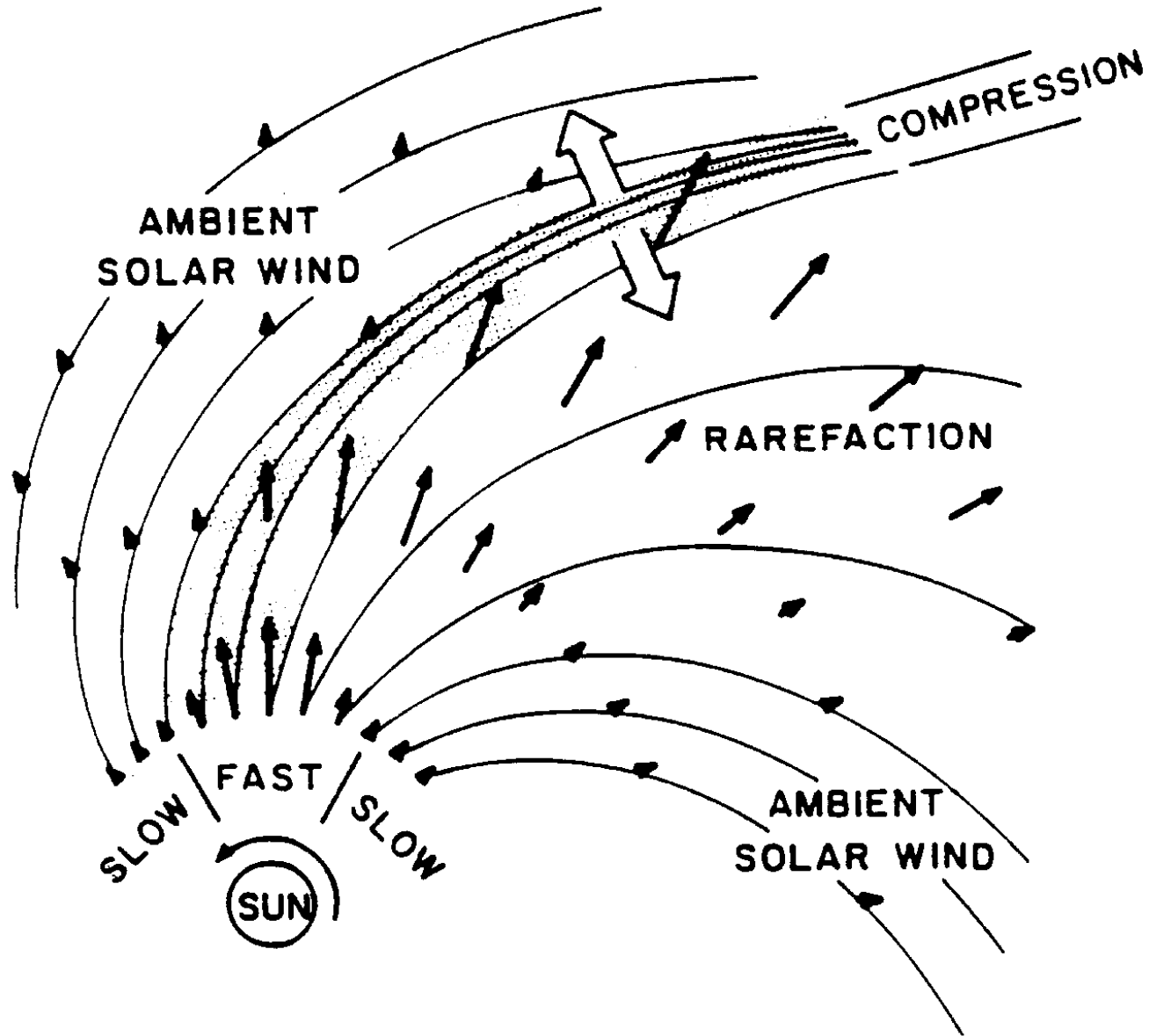
Outline

- What are we tracking?
- How do we do it?
- Observations
- The STEREO side
- Conclusions
- Further Work

What are we tracking?

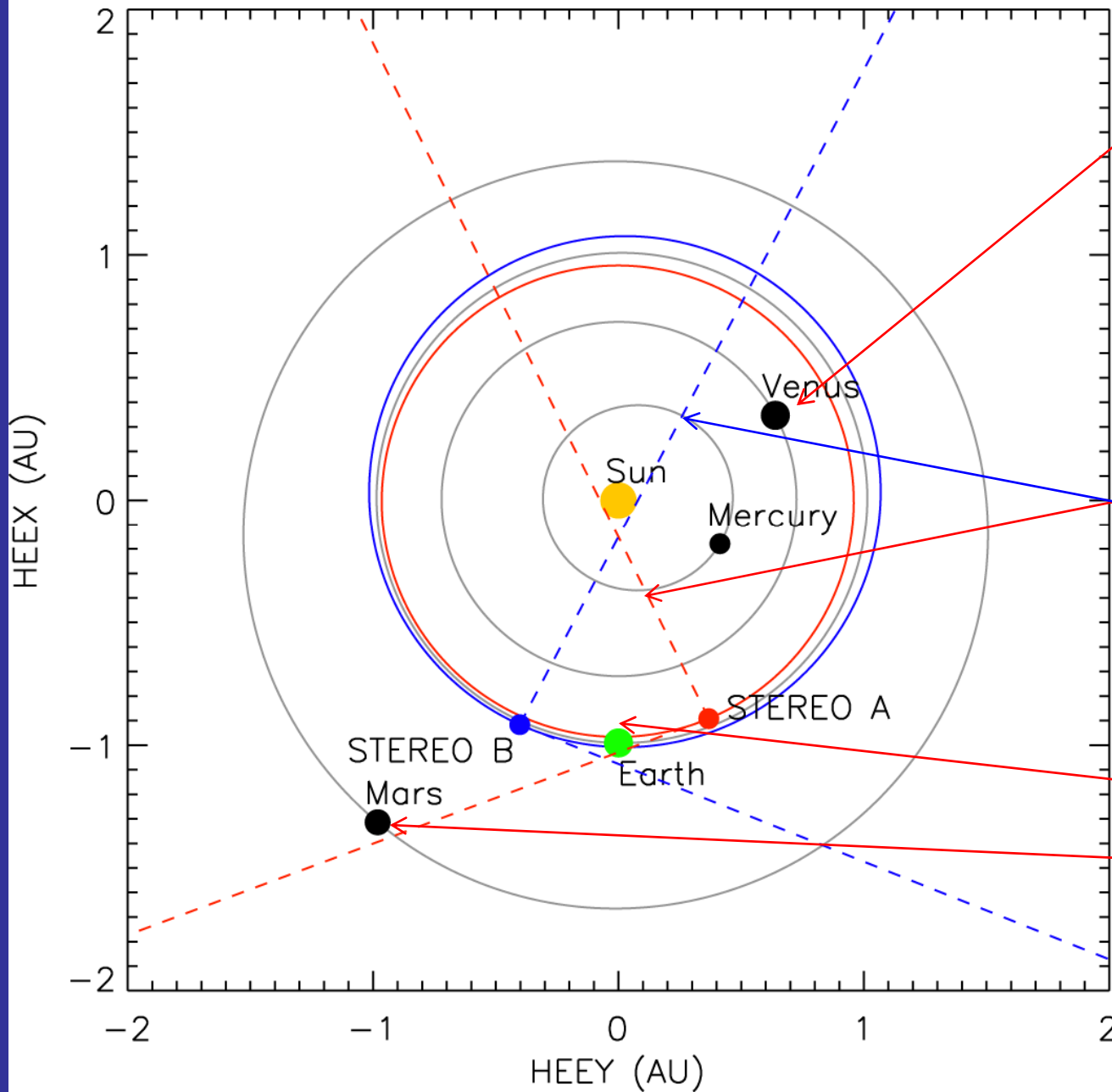
- Solar wind is very complex. Many different types of structures visible in solar wind.
- Different types of structure have different particle/magnetic signatures.
- They could have different effects on planetary magnetospheres/ionospheres.
- This study limited to Interaction Regions (SIRs and CIRs)

COROTATING FLOW (INERTIAL FRAME)



From Pizzo,
1978.

2008-03-01T00:00



Venus Express

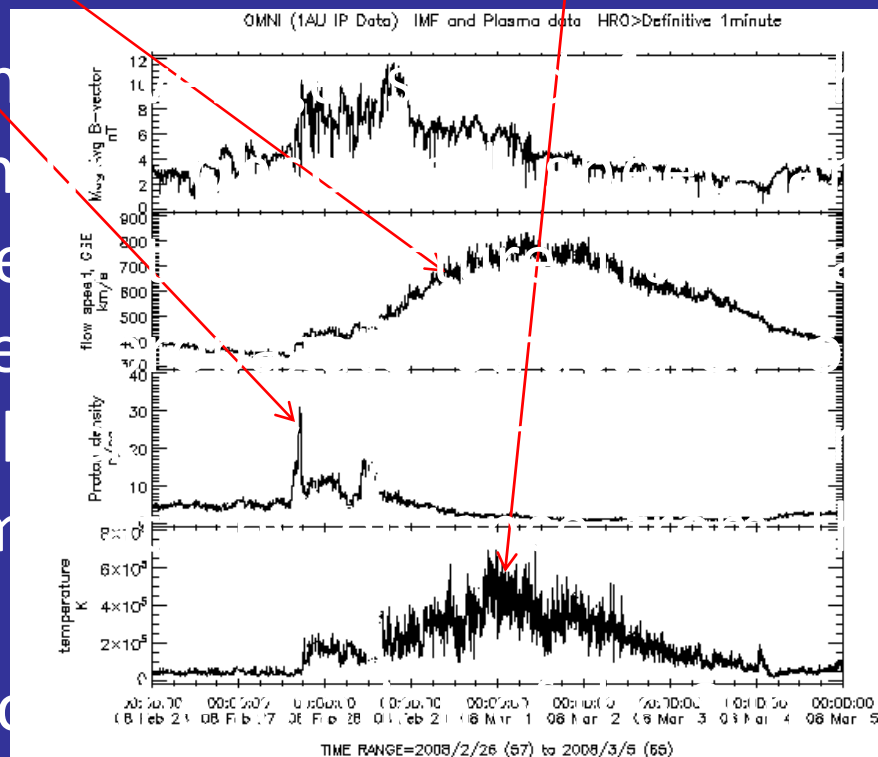
STEREO/HI fields of view

ACE

Mars Express

So how did we use all this information?

- First observe signatures in ACE plasma and magnetometer data. Here we are looking for a density enhancement followed by a temperature enhancement and velocity enhancement.
- Then we calculate the maximum and minimum values and assume this is the speed of the disturbance.
- This allows us to then calculate the arrival time radially (or calculate the distance from the Sun) and calculate an arrival time at Earth.
- Finally we add a time from the Sun to Earth.

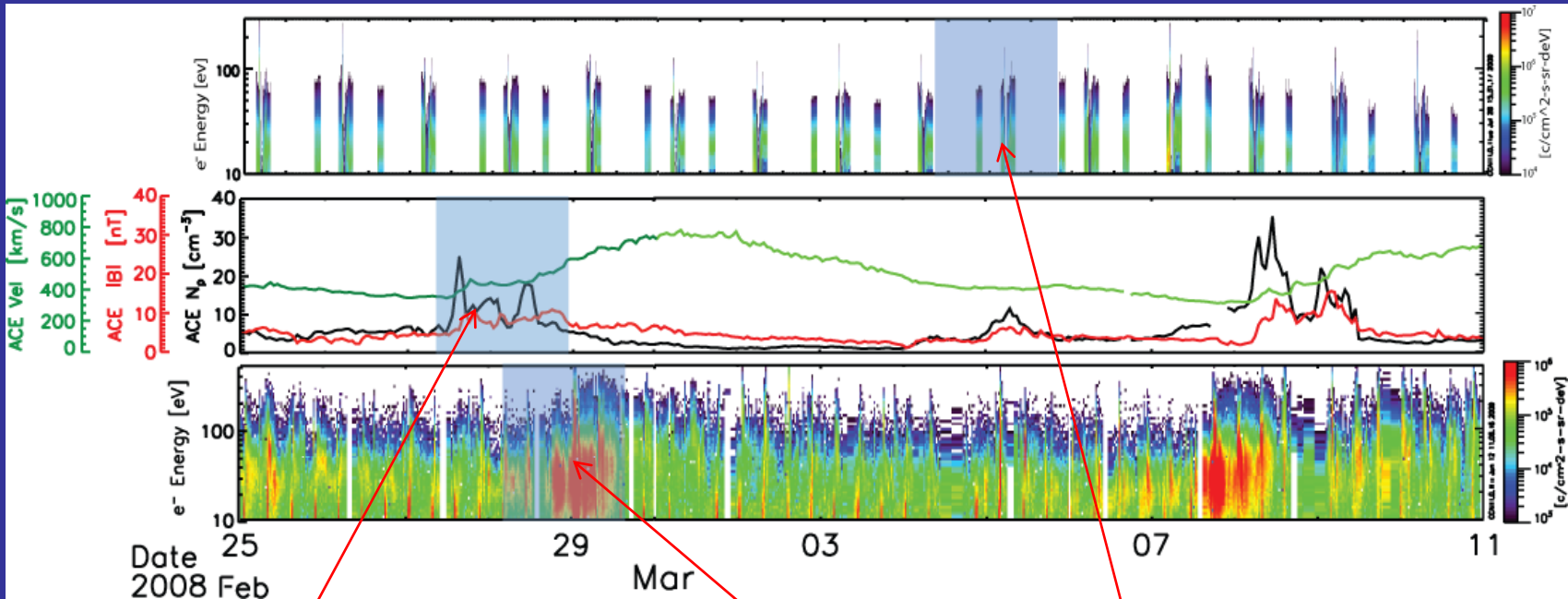


So how did we use all this information?

- So to calculate the arrival time at other planetary bodies once we have a propagation speed, V_r , location and time we use this equation.

$$\Delta t = \frac{r_x}{V_r} + \frac{\beta}{\omega_{sun}}$$

Here r_x is the difference in radial distance between 2 objects in the solar system, β is the separation angle between the 2 objects and ω_{sun} is the rotation rate of the sun.



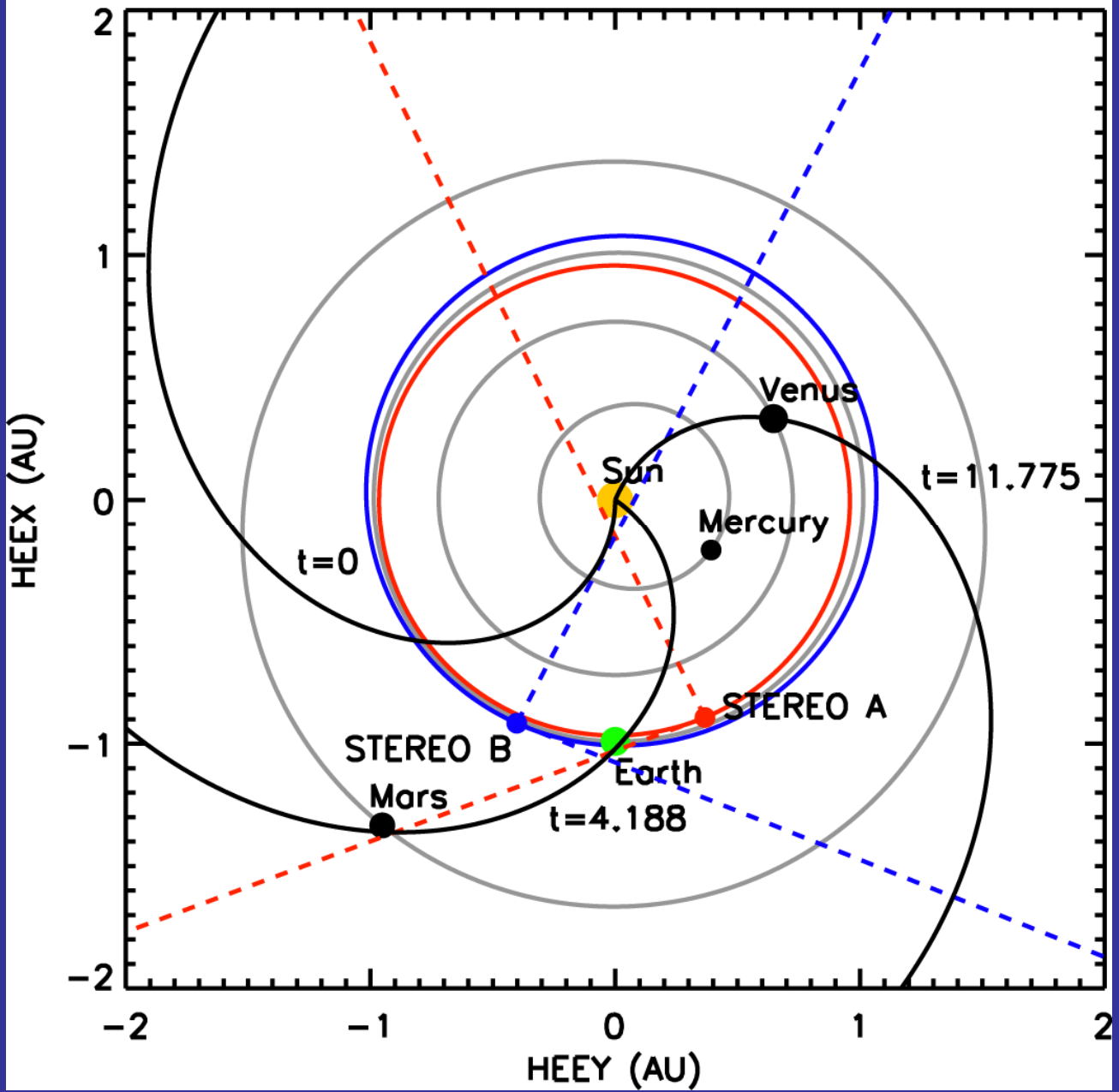
Arrival observed at ACE

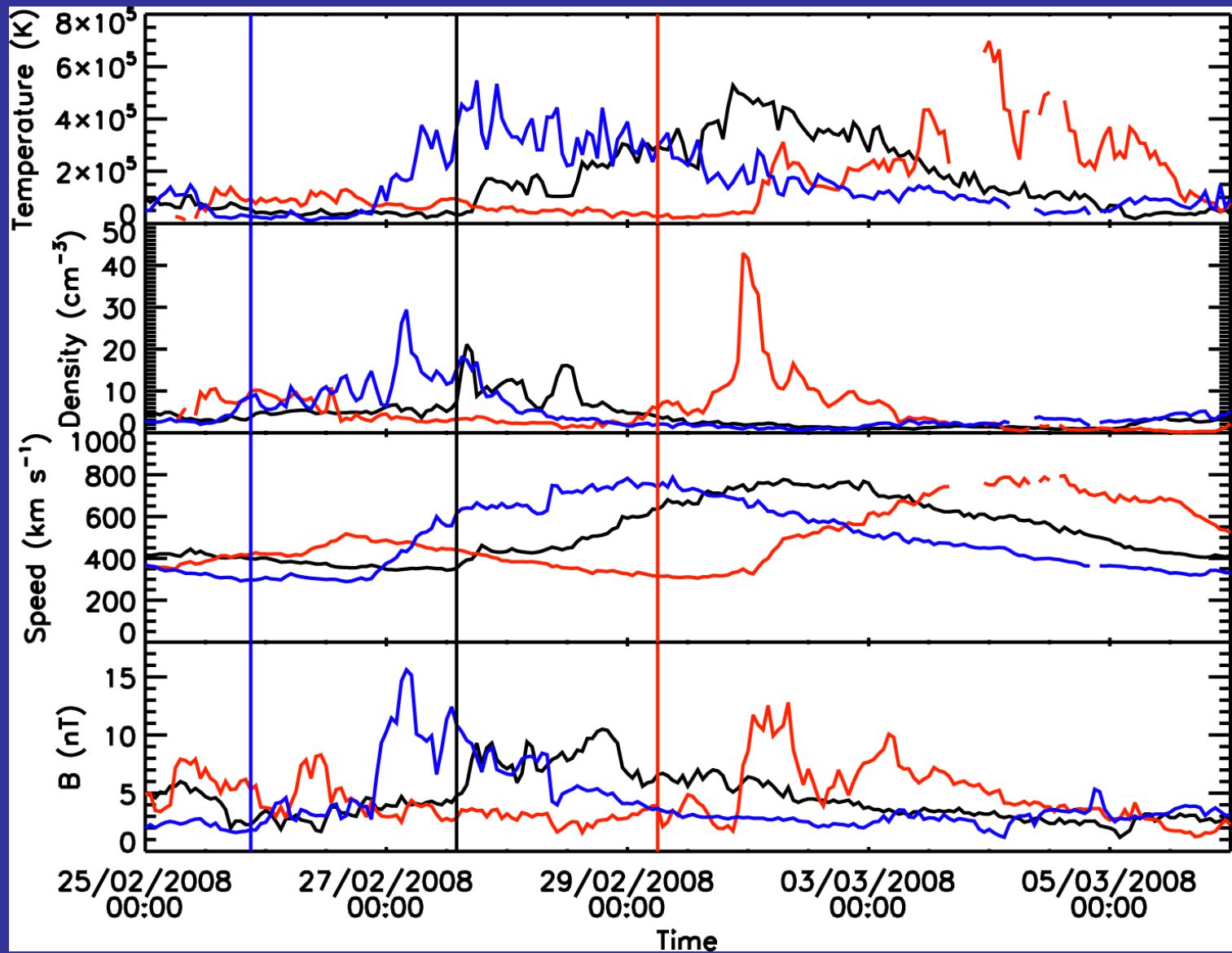
Then calculated to arrive at Mars Express...

... And Venus Express

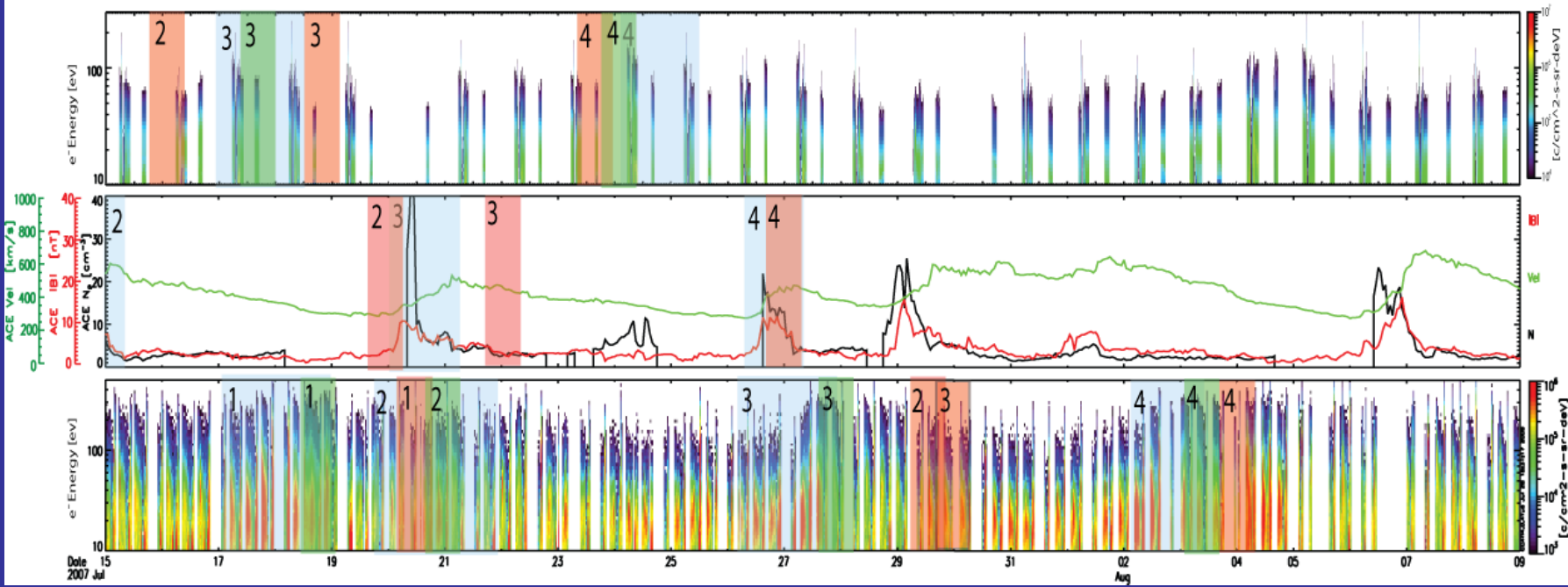
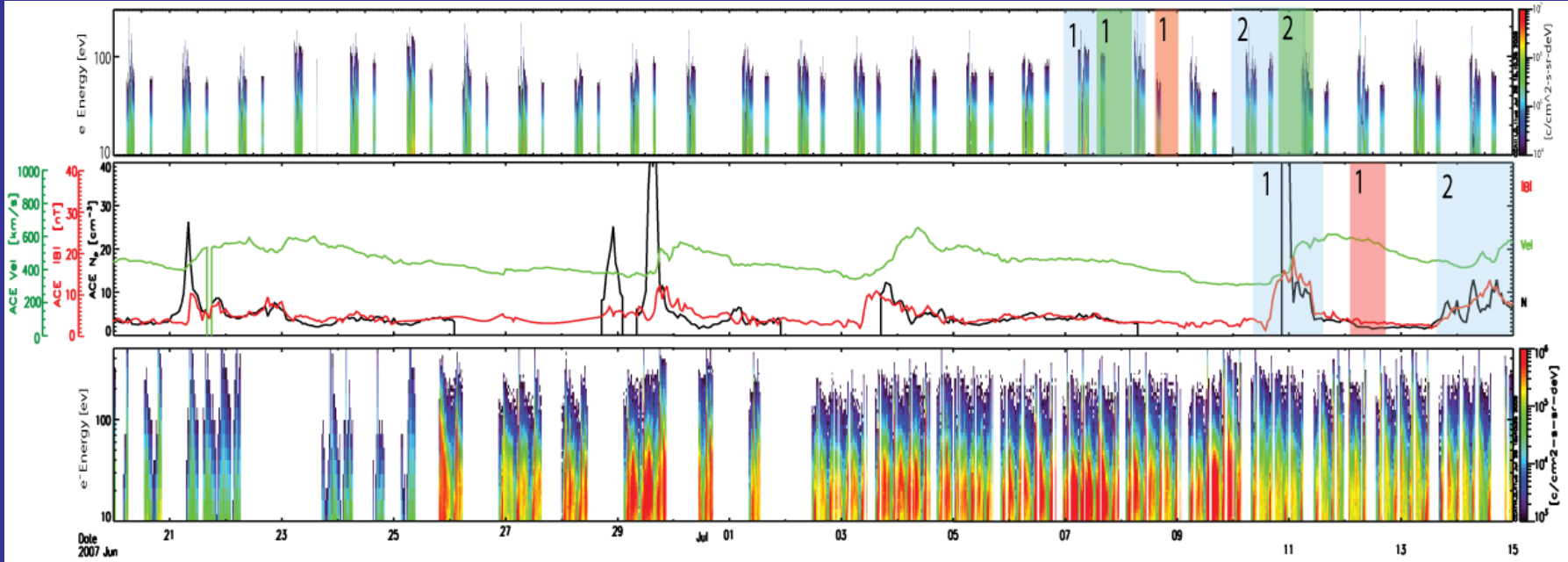
Unfortunately Venus Express data is patchy so exact arrival time is hard to observe.

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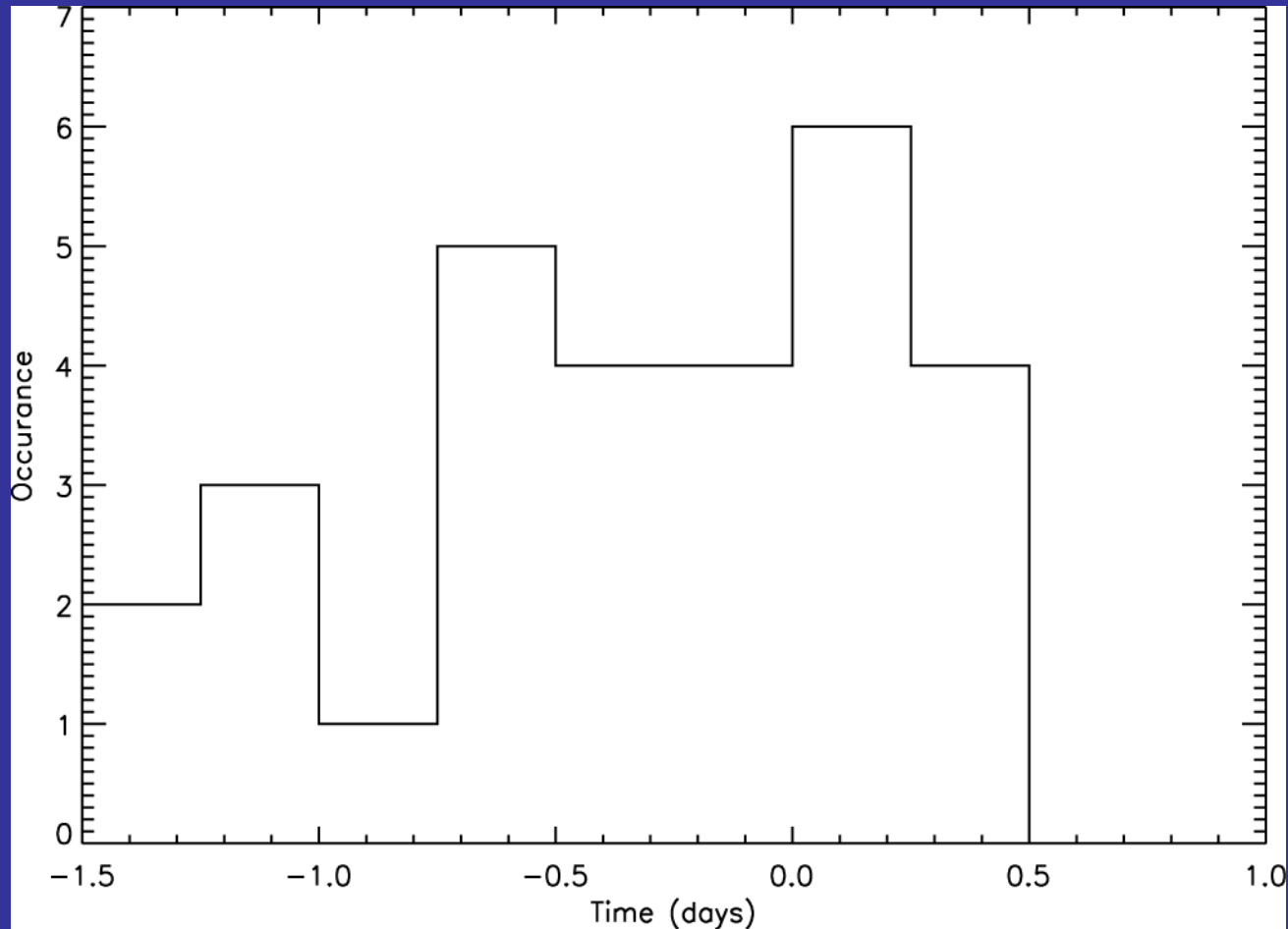


Black line is ACE, Red is STEREO A, Blue is STEREO B



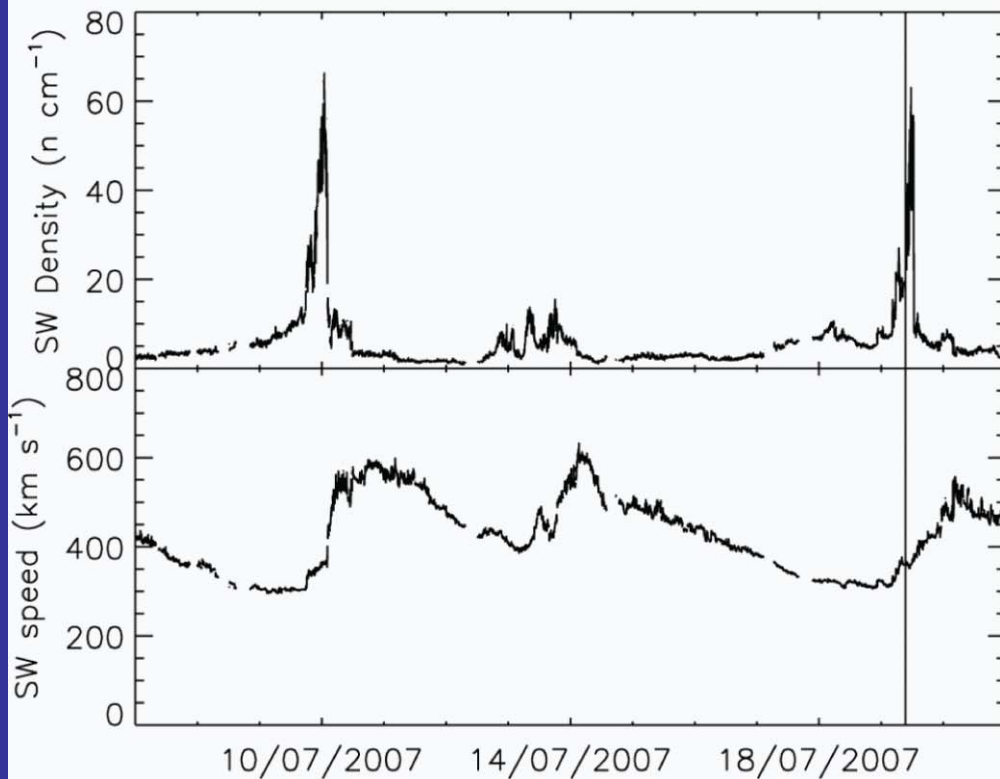
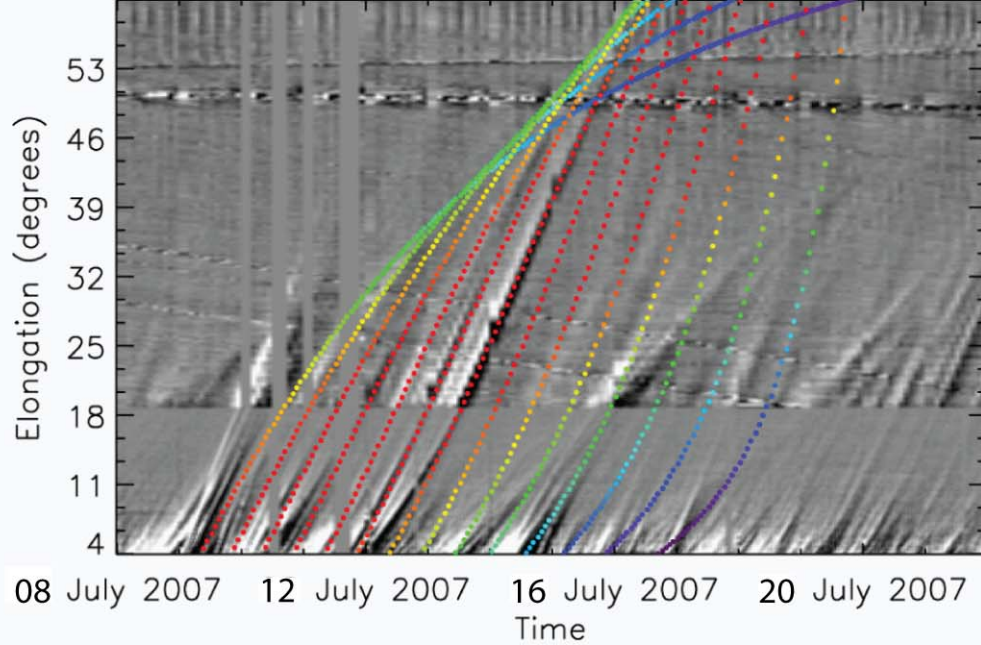
- Having found a total of 29 events and calculated arrival times at Mars Express and Venus Express we then compared these calculations with observations.

Occurrence distribution of the difference between arrival calculated from ACE observations and MEX observations



The STEREO side

- We have also calculated arrival times using STEREO/HI observations and found, in general, the predicted time of arrival at Mars was off by a larger margin.
- Further work is investigating why this is the case



Conclusions

- Using ACE observations we are able to track SIRs (or CIRs) through the inner heliosphere and predict their arrival at the inner planets and other spacecraft within the solar system.
- This should also be possible with observations from STEREO/HI but doesn't always work
- Investigations continuing along these lines.