A Generalized Magnetospheric Disturbance Index

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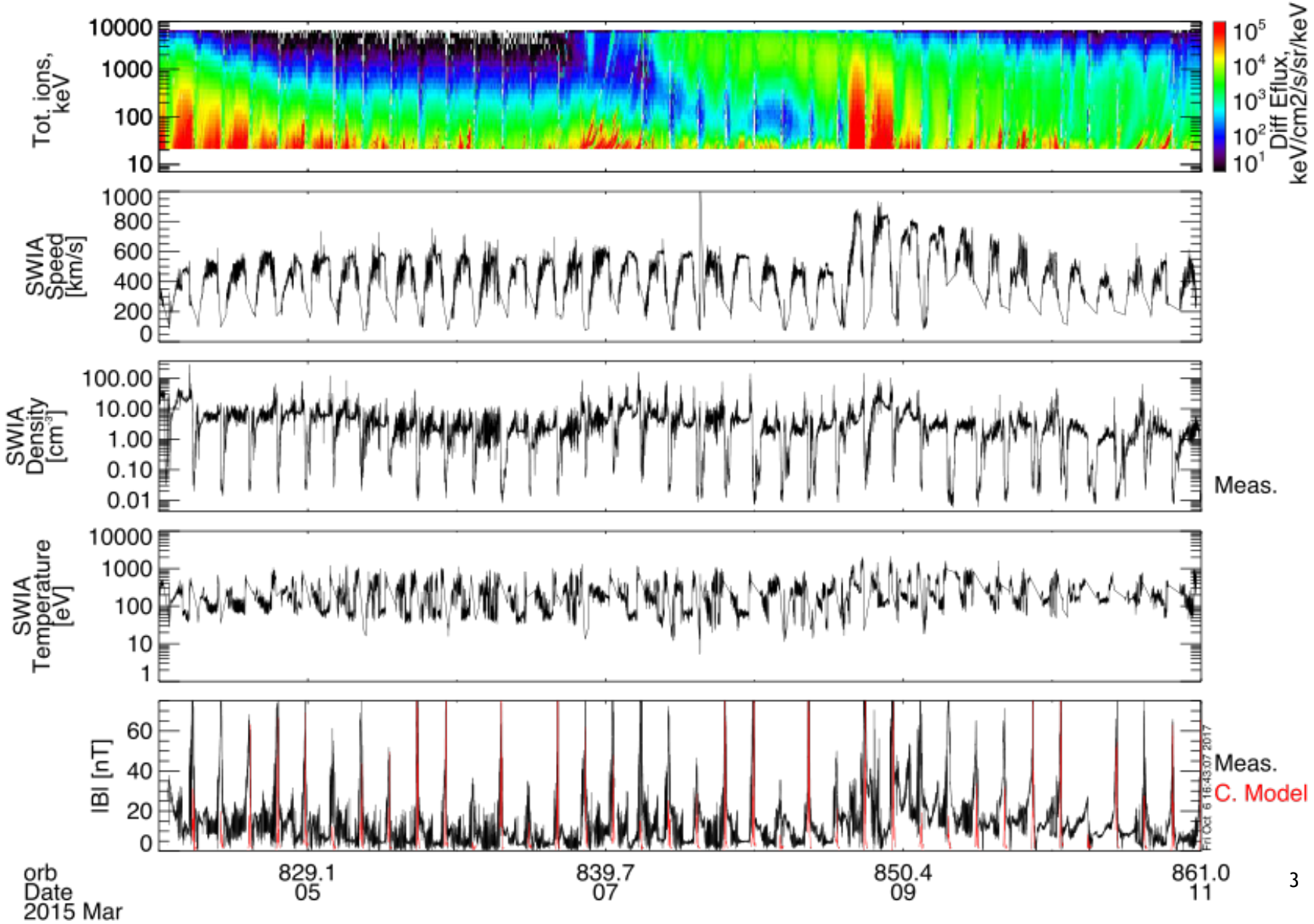
Jacob Gruesbeck
(jacob.r.gruesbeck@nasa.gov)
and Jared Espley

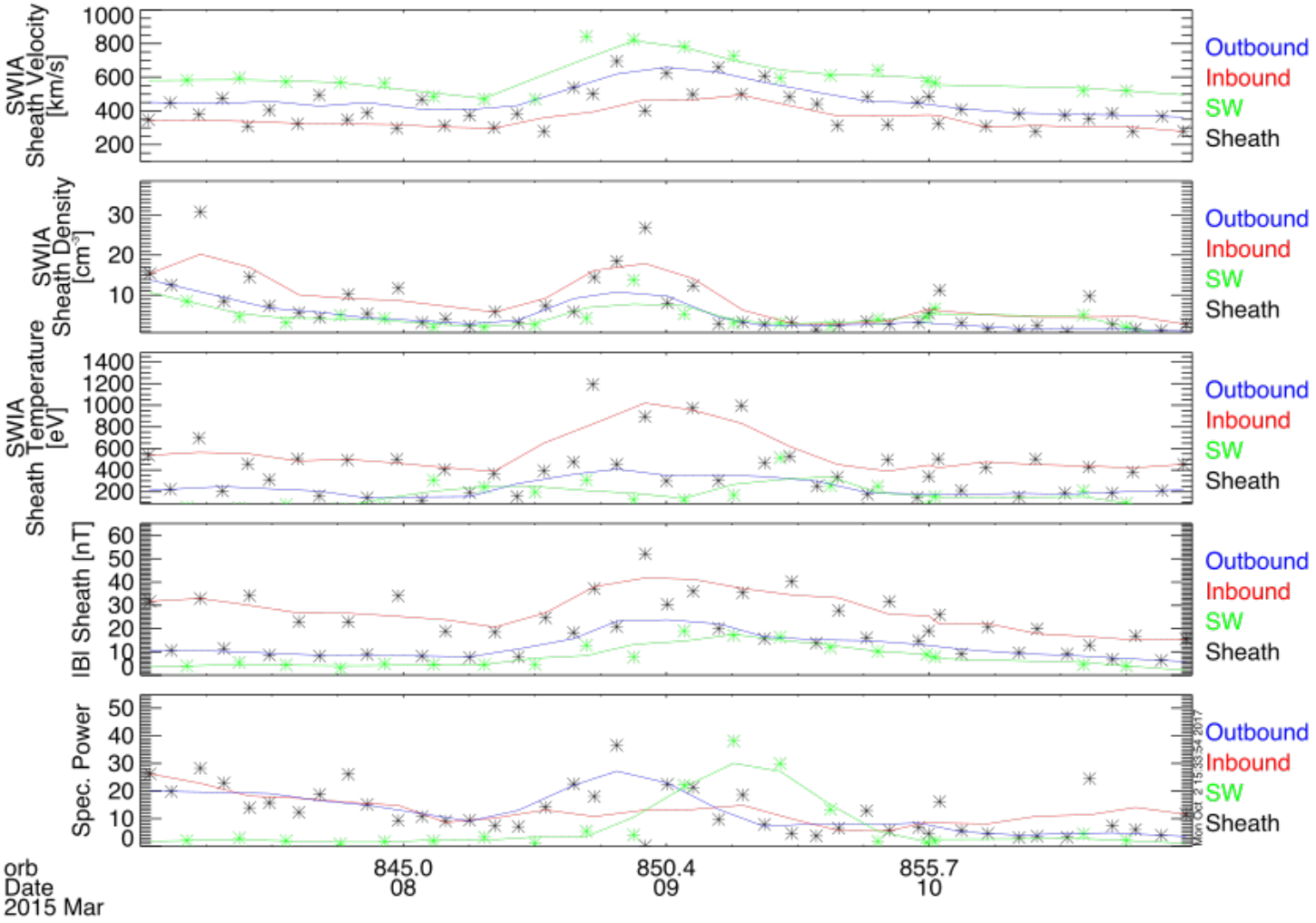
Background

- MAVEN's primary mission goal of addressing atmospheric loss
  - Can look at individual case studies of the effects of space weather events
  - Correlating strength of disturbance to loss tends to use qualitative descriptions
- Mars' hybrid magnetosphere causes a unique problem
  - To say something about how disturbed a magnetosphere is requires a statement of what a quiet period looks like
  - At Mars, the baseline is constantly moving

March 8, 2015 ICME Event



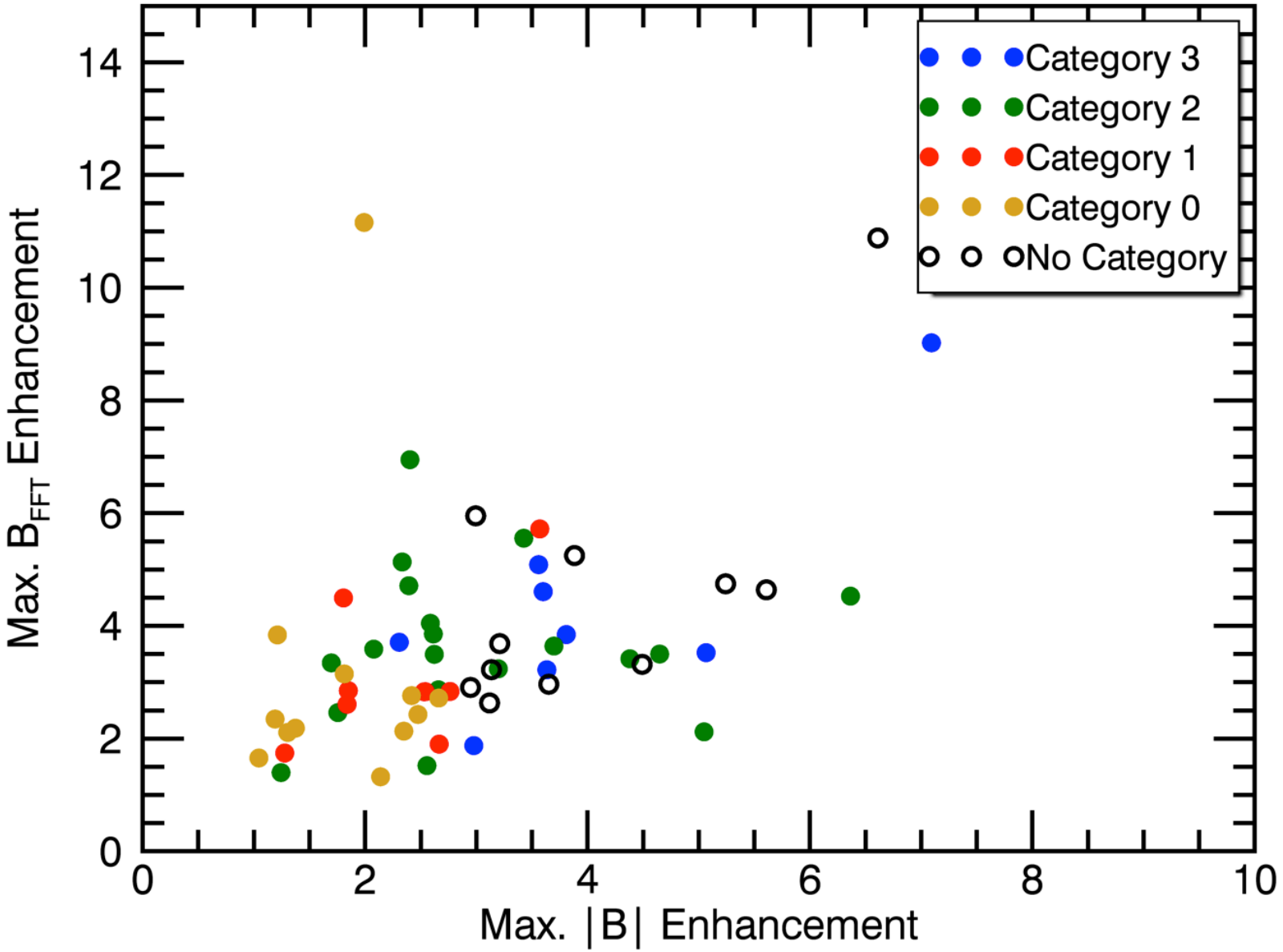
March 8, 2015 Event Averages



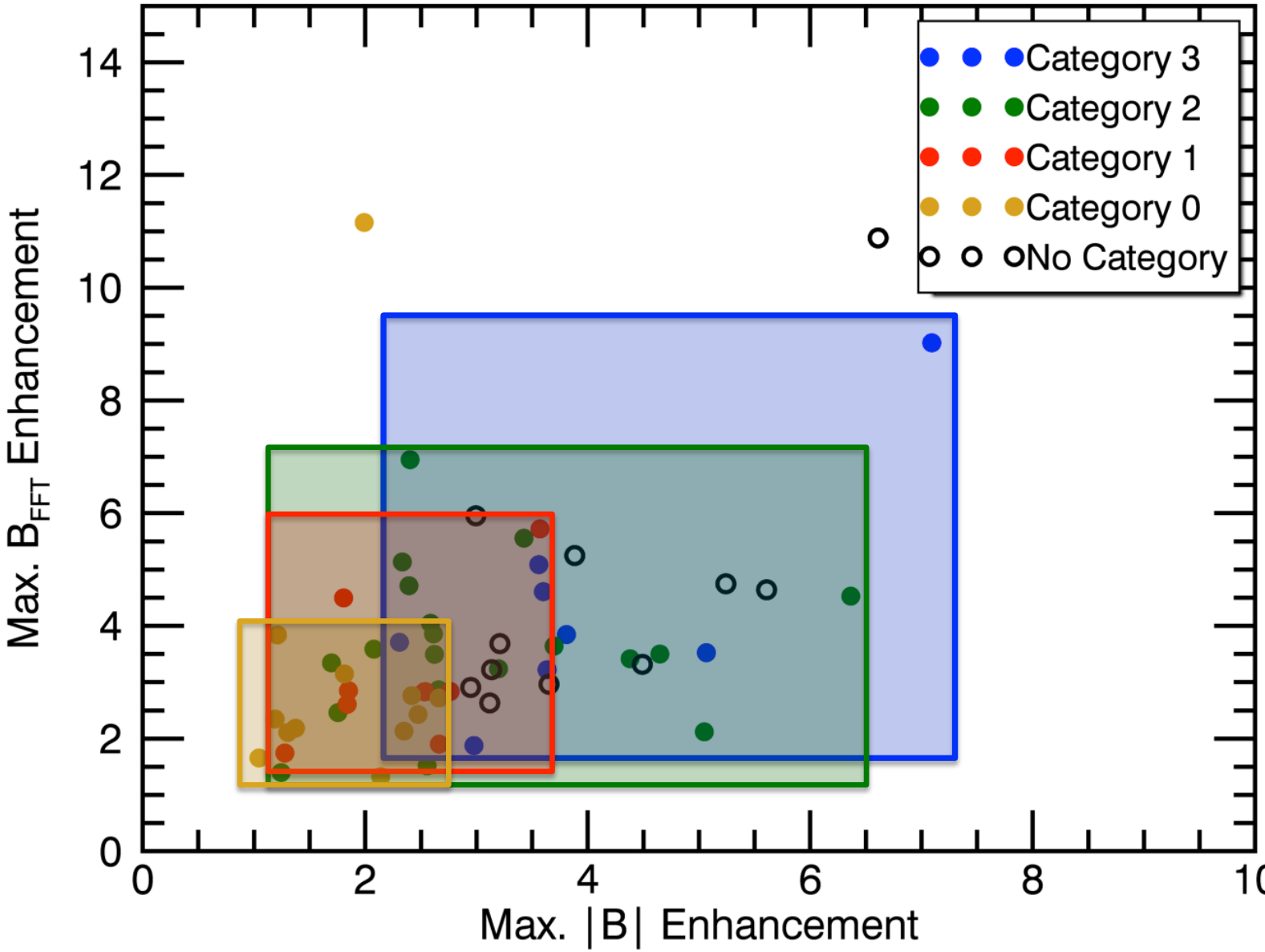
A proposed Magnetospheric Disturbance Index (MDI)

- As an initial task, we start with two parameters that are most evident in all event periods
  - |B| enhancement
  - B waviness − quantified as the integrated power from an FFT around the proton cyclotron frequency
- Normalize the sheath observation of these two quantities by observations prior to the event
- Compute MDI by the summation of the two enhancements

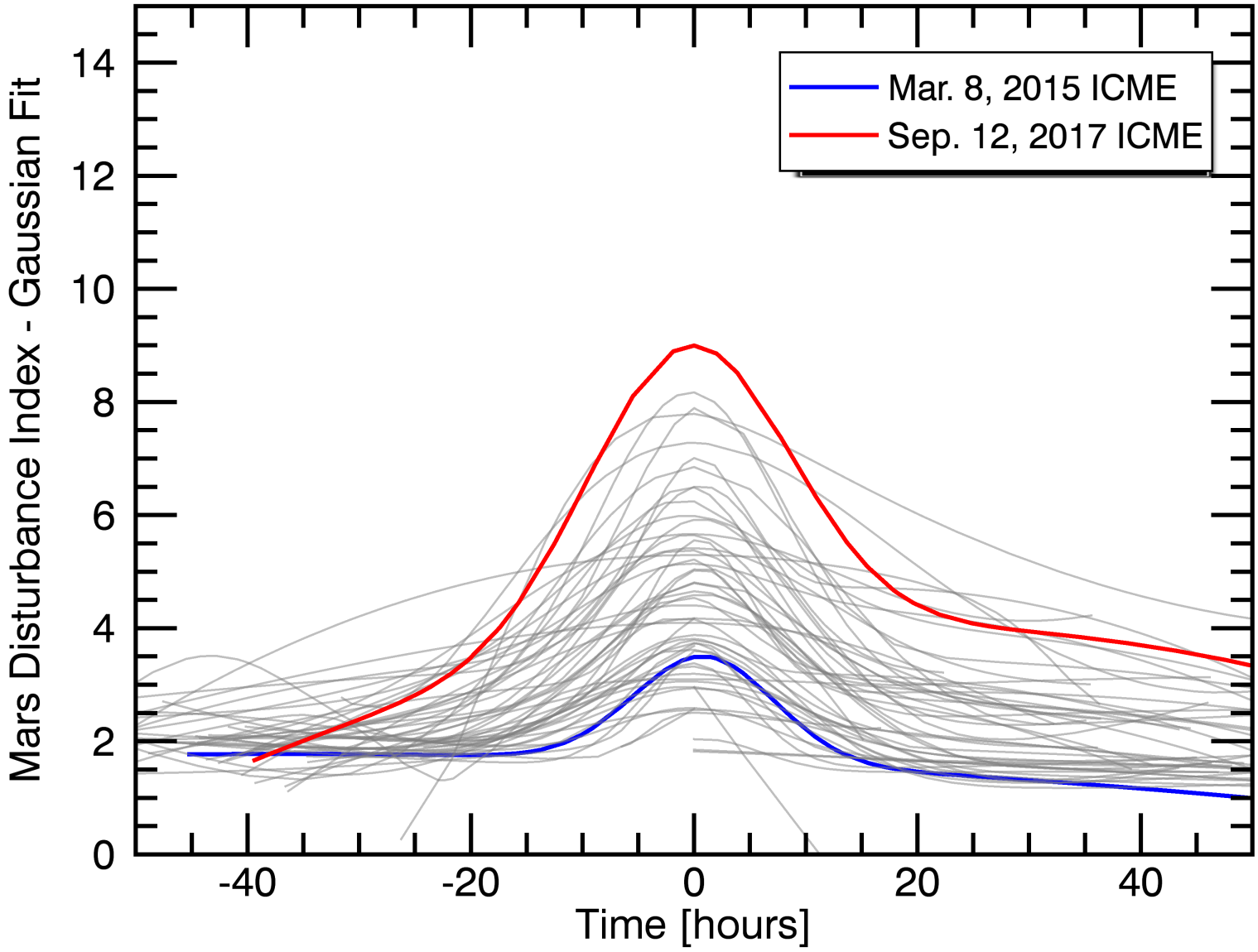
The ingredients of MDI



The ingredients of MDI



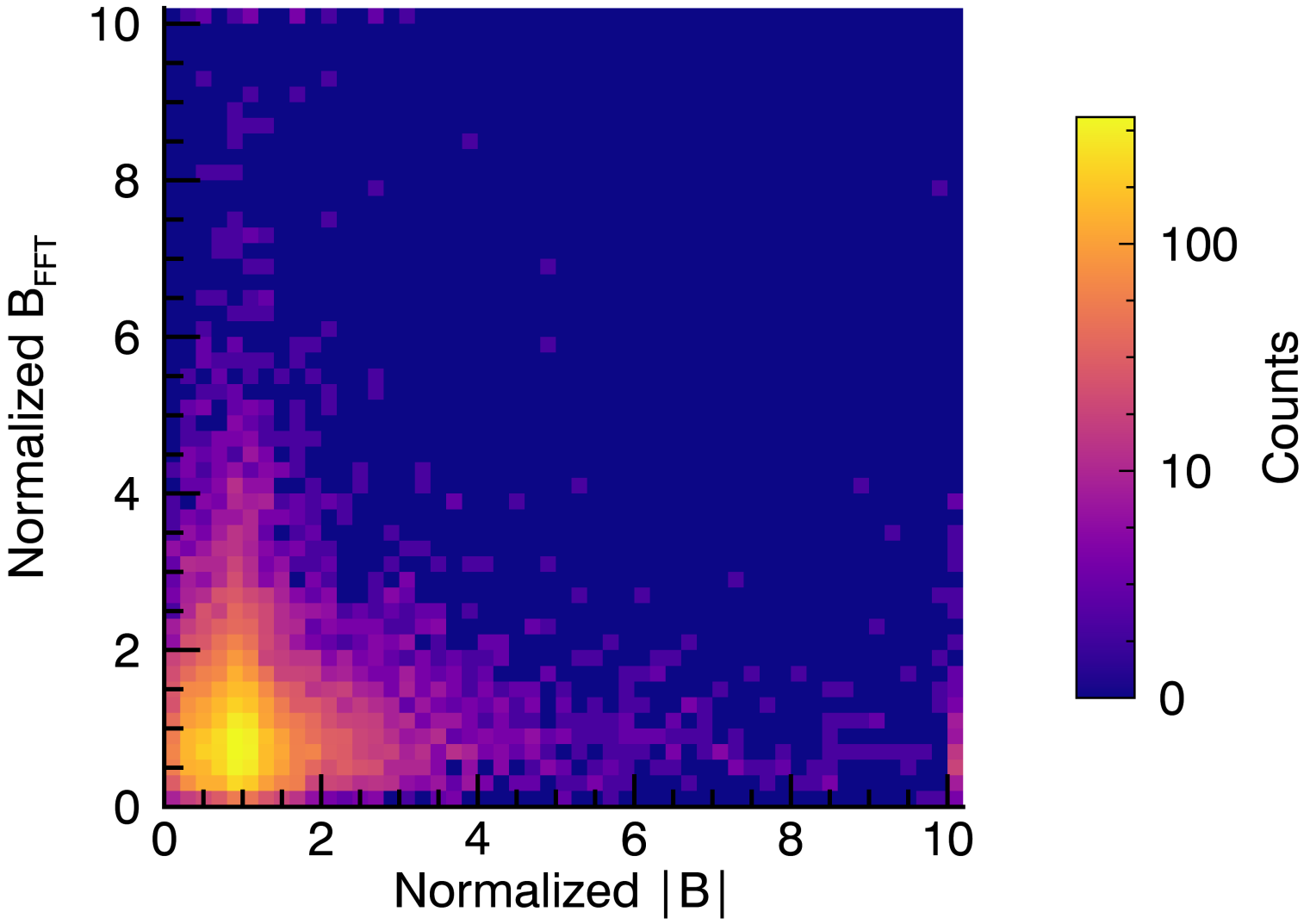
How disturbed did Mars become?



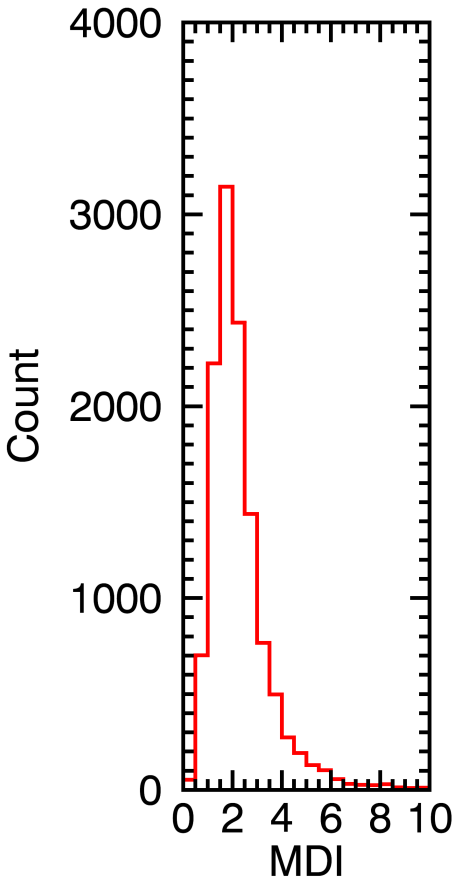
Automating MDI

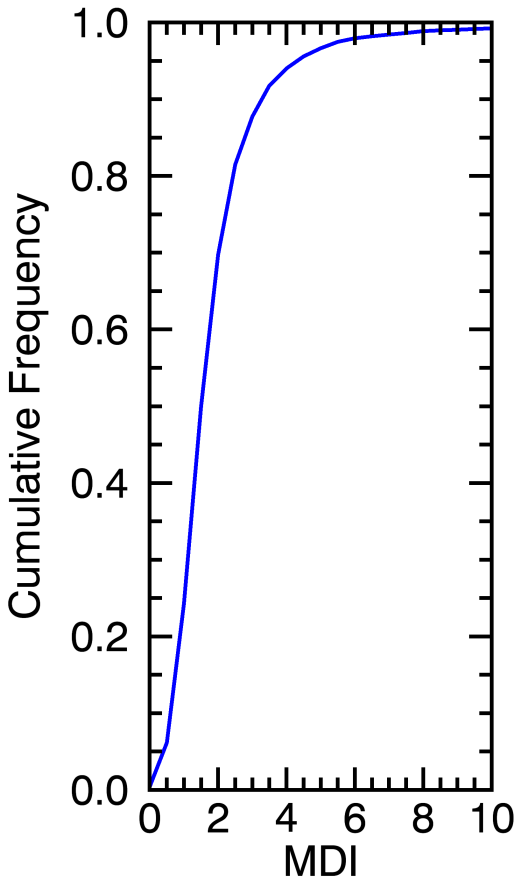
- MDI has been calculated using hand curated events
  - Storm periods picked out
  - Quiet time period to normalize by
  - Sheath periods to average
- Not scalable!
- First attempt at automating requires
  - Algorithm to select sheath events
  - Normalize each period by the 3 previous orbit periods. Not the same metric as before

MDI of the MAVEN Mission v0.1

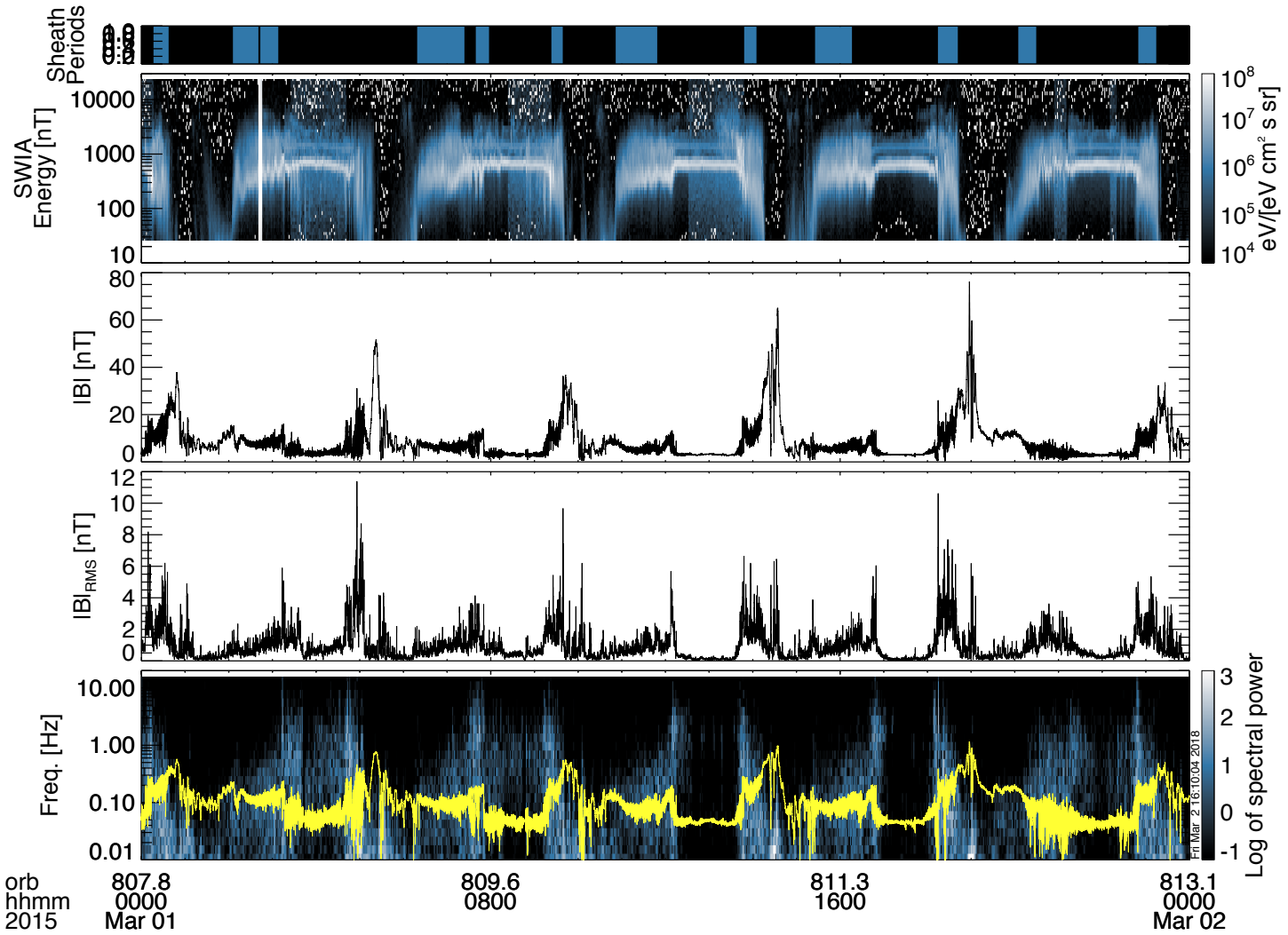


MDI of the MAVEN Mission v0.1

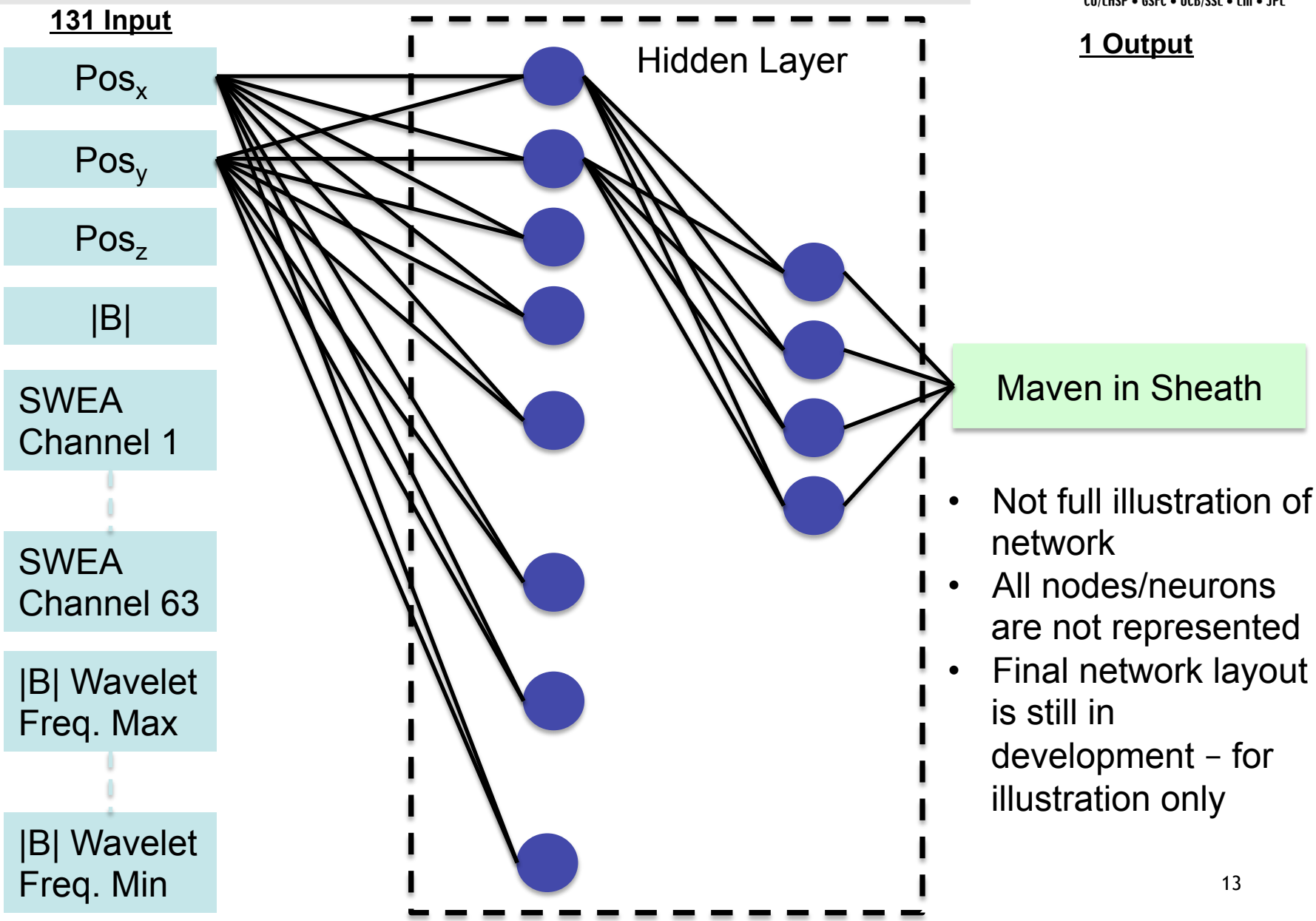




MDI can be better!

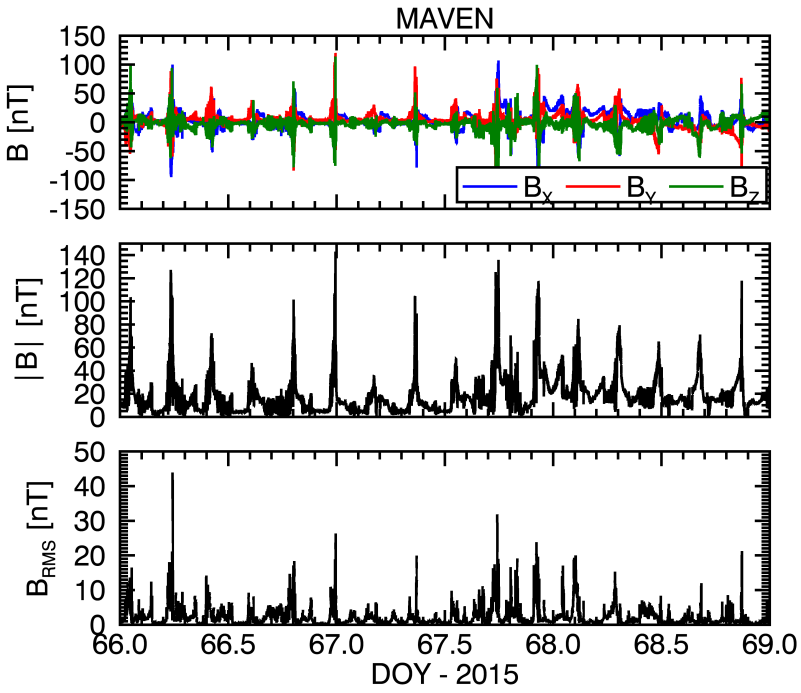


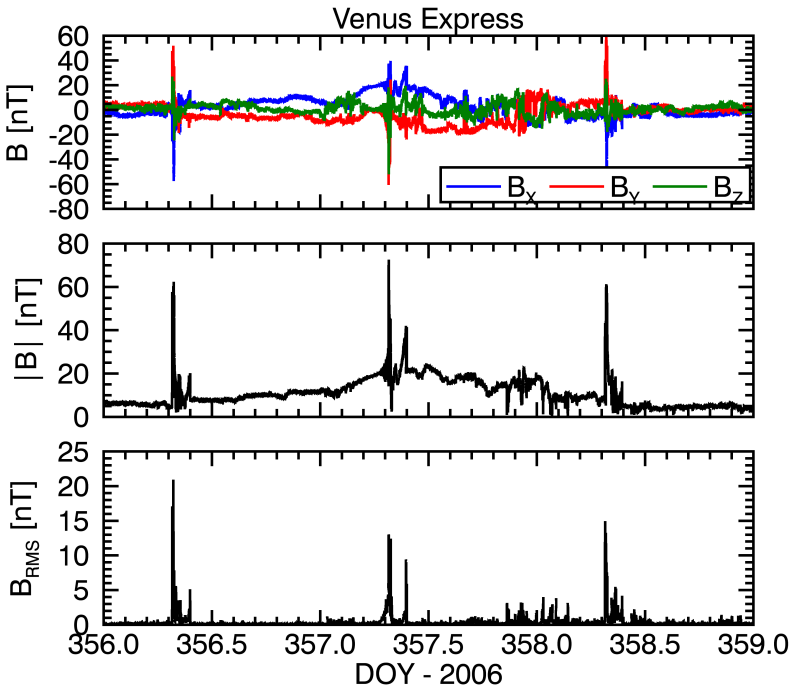
A Neural Network to Find the Sheath



- Not full illustration of network
- All nodes/neurons are not represented
- Final network layout is still in development – for illustration only

Comparison to Venus





Summary

- Have presented an initial magnetospheric disturbance index (MDI) for Mars
  - Based on increase of amplitude and variability of B in magnetosheath
- Based on MDI, disturbances driven by SIRs and ICMEs while MAVEN has been at planet have been similar in strength and duration
- Attempted to automate the calculation, to process entire missions of data
- Venus Express data shows similar response in magnetosphere to space weather
  - Implies applicability to other unmagnetized bodies.