

Analysis of proton spectra combining ECT/HOPE and RBSPICE/TOF_xPH-TOF_xE and interesting spectra

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Topics

1. Comparison between ECT/HOPE and RBSPICE proton observations
2. Suggested Algorithm to adaptively match spectra
3. Specific examples of the effectiveness of the algorithm
4. Mission wide study of modification factor called “HOPEMOD factor”
5. Identification of interesting spectra throughout the mission
6. Conclusions and questions

HOPE vs RBSPICE data

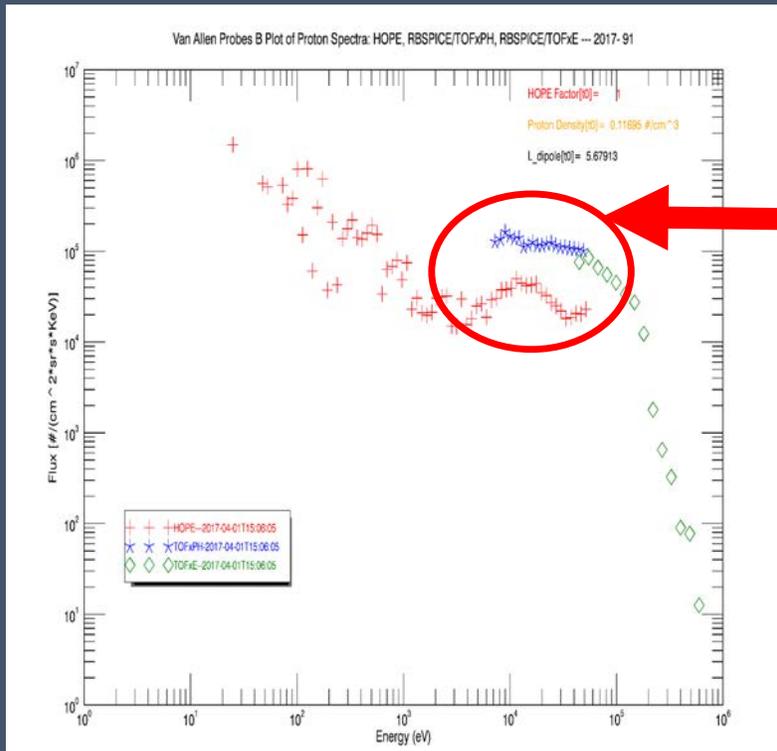
HOPE energy channels provide observation of proton spectra with 72 energy channels from 25 eV to 52 KeV.

RBSPICE has two specific data products used in this analysis

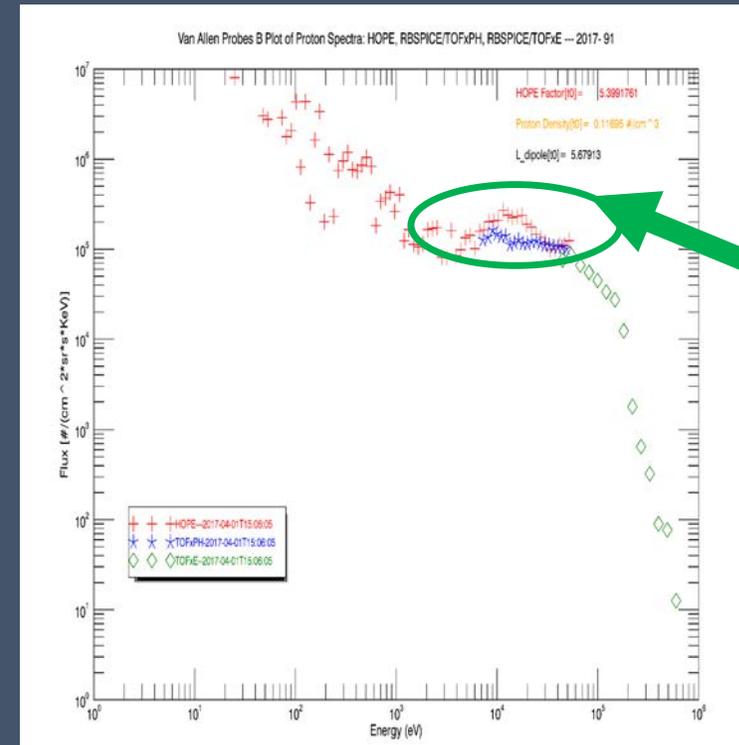
RBSPICE/TOF_xPH protons has 20 energy channels from 7 KeV to 49 KeV.

RBSPICE/TOF_xE protons has 14 energy channels from 45 KeV to 600 KeV

The overlap of HOPE and RBSPICE energy channels occurs between the upper HOPE proton energy channels and the RBSPICE/TOF_xPH proton energy channels and the bottom two energy channels of the RBSPICE/TOF_xE proton product. The proton spectra taken for specific times showing the disconnect between the HOPE and RBSPICE proton flux.



Mismatch between HOPE and RBSPICE proton observations in the spectra



Use of a multiplicative factor allows the HOPE proton flux to be lifted such that the spectra blends without as large of a mismatch in the observations.

Adaptive algorithm to Match HOPE and RBSPICE proton spectra

Algorithm to modify the Omni Flux from HOPE and RBSPICE so spectrum are “aligned”

A simple algorithm for spin by spin match of the proton spectra between the HOPE OMNI upper energy channels and the TOFxpH upper energy channels. This provides a spin by spin direct observation of the necessary changes required to match the spectra and get a reasonable agreement between the two data sets.

Simple algorithm which works most of the time $R_E > 3.5$ and somewhat when $R_E < 3.5$ (Note that the TOFxpH data lower energy channels suffer from contamination due to accidentals from high density plasma in the plasmopause, this can be noticed when the lowest HOPE flux is exceptionally high and the low end of the RBSPICE TOFxpH flux becomes significantly higher than the HOPE data)

Calculate average OMNI flux of the top 3 HOPE energy channels minus 1, i.e.

$$E_{\text{mid}_{68}} = 32724.5 \pm 2454.34 \text{ eV}; E_{\text{mid}_{69}} = 38130.1 \pm 2859.76 \text{ eV}; E_{\text{mid}_{70}} = 44428.7 \pm 3332.15 \text{ eV}$$

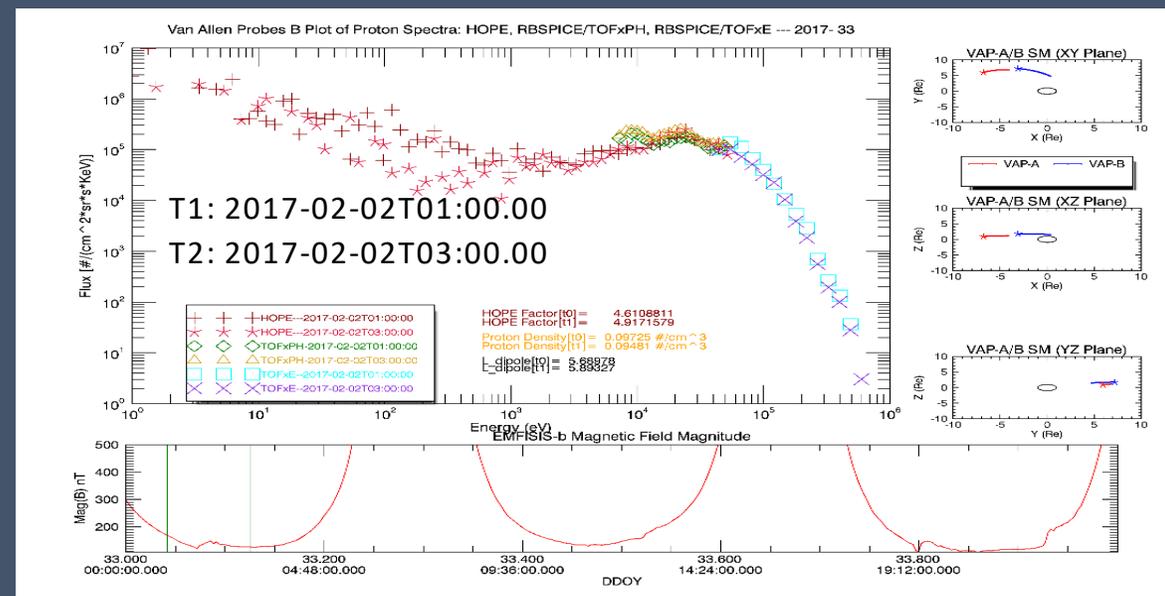
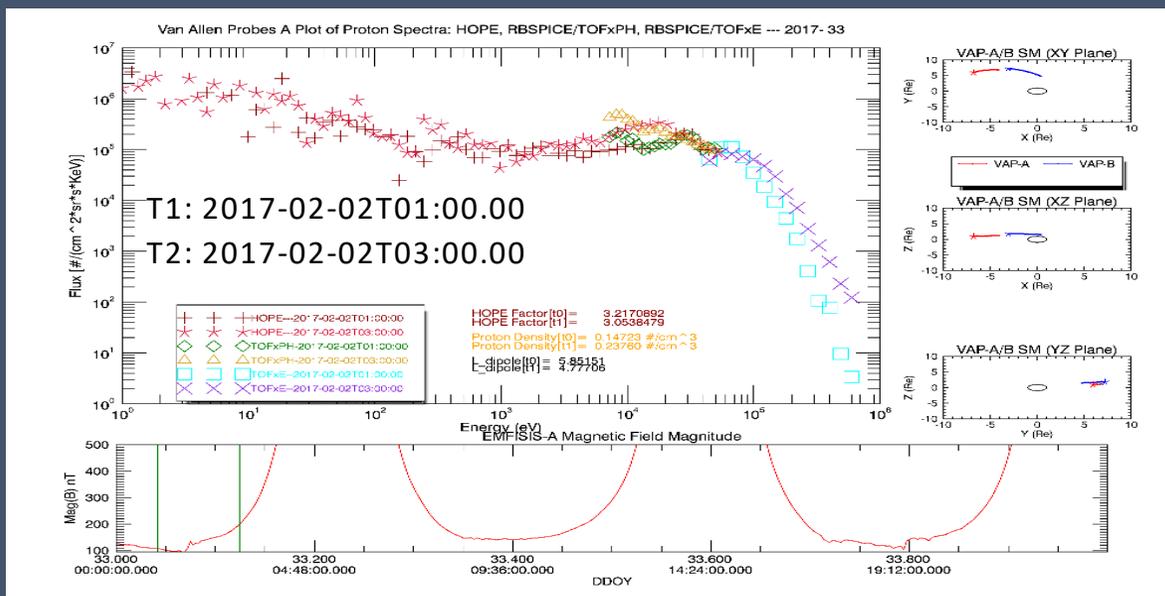
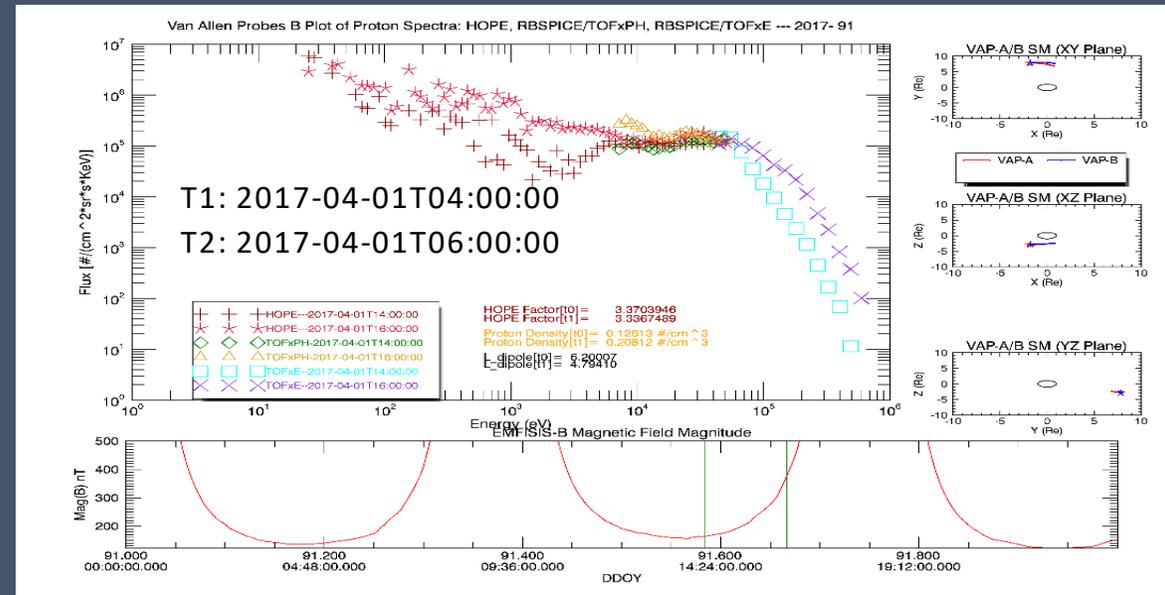
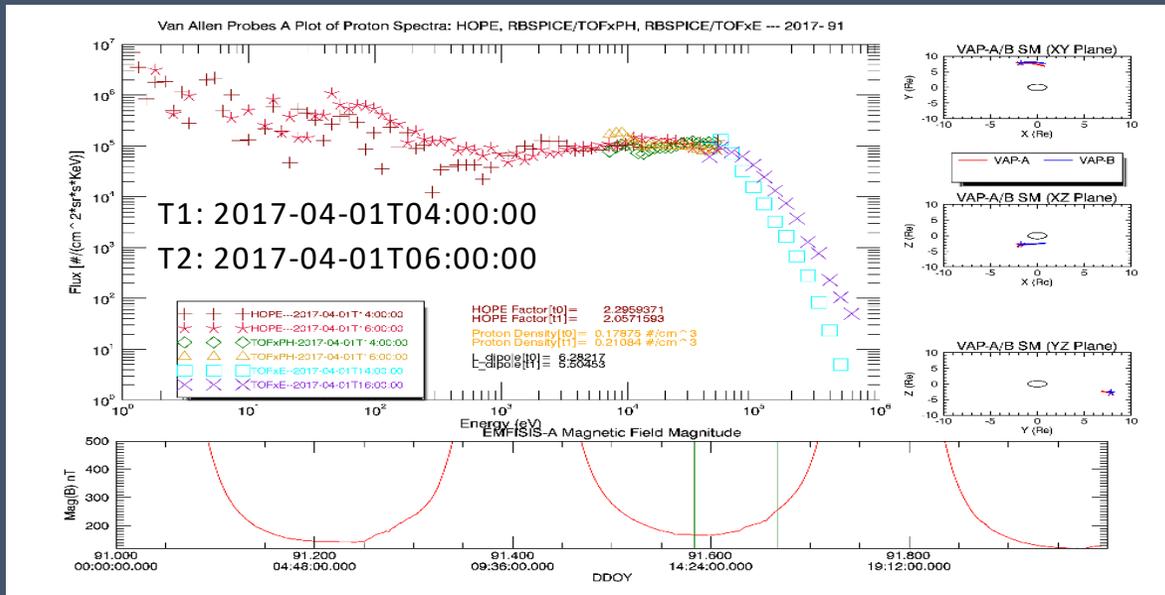
Calculate average ONNI flux of the top 3 RBSPICE/TOFxpH_H_HELT energy channels minus 2, i.e.

$$E_{\text{mid}_{15}} = 32873.0 \pm 3266.84 \text{ eV}; E_{\text{mid}_{16}} = 36310.6 \pm 3608.46 \text{ eV}; E_{\text{mid}_{17}} = 40107.7 \pm 3985.81 \text{ eV}$$

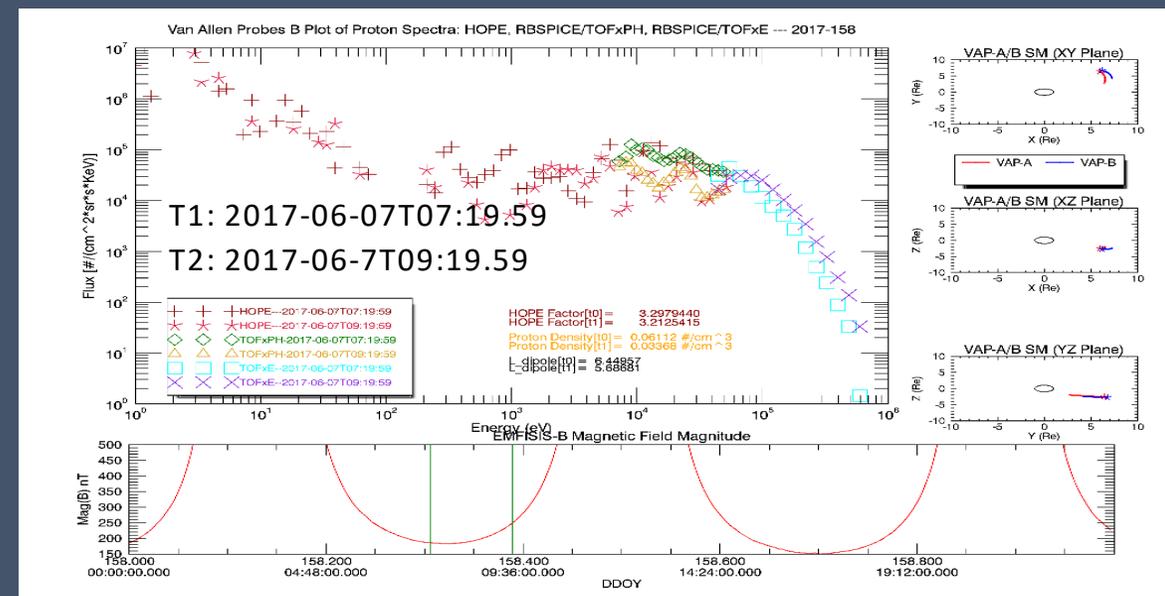
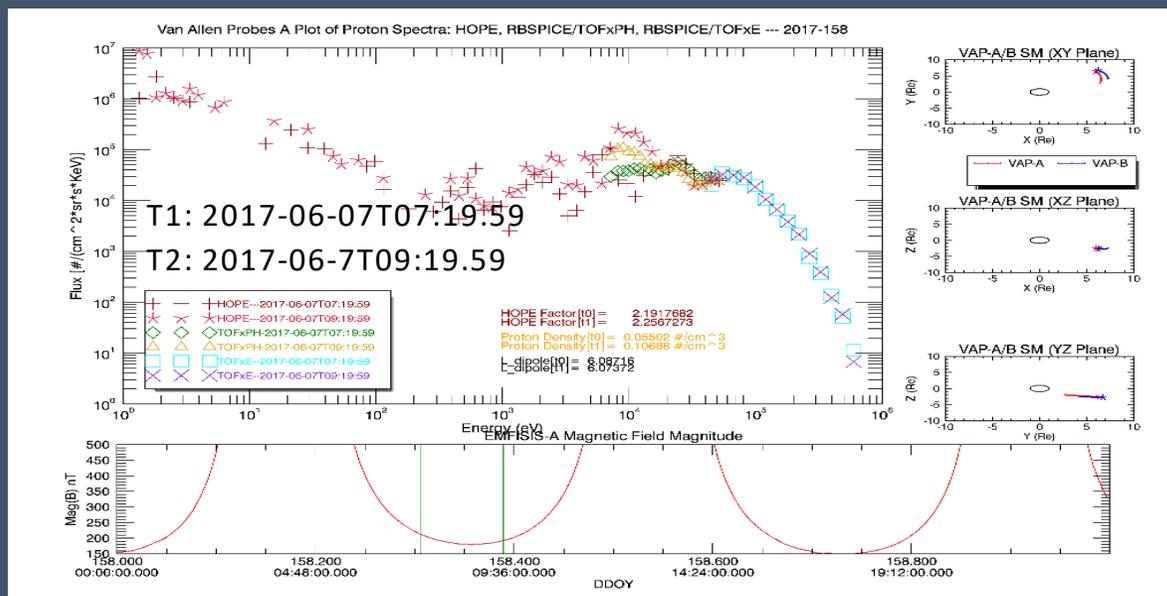
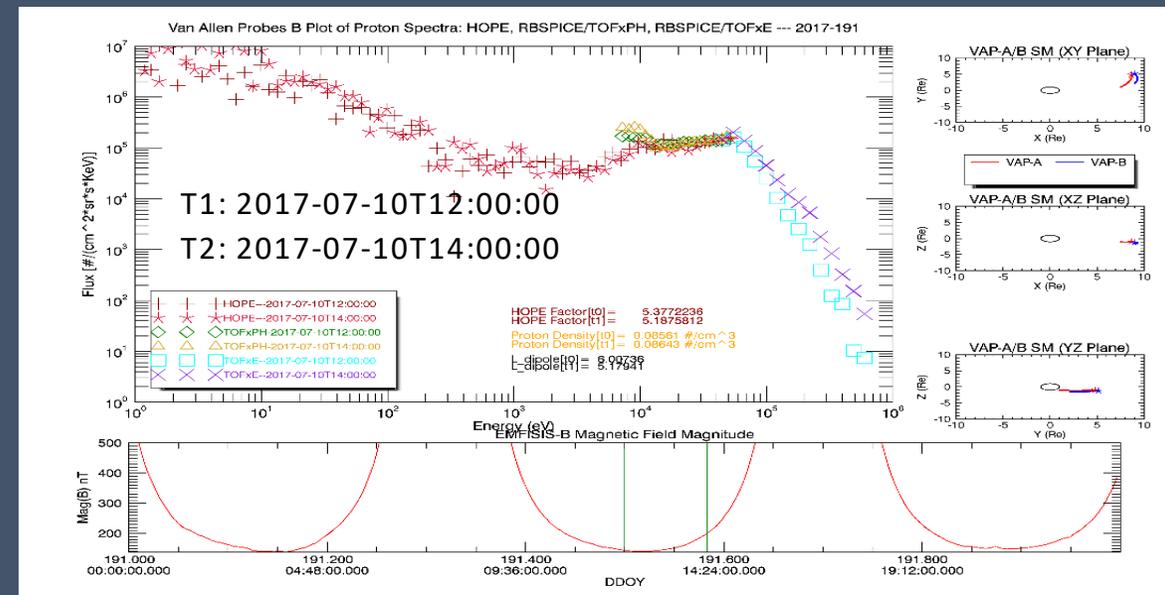
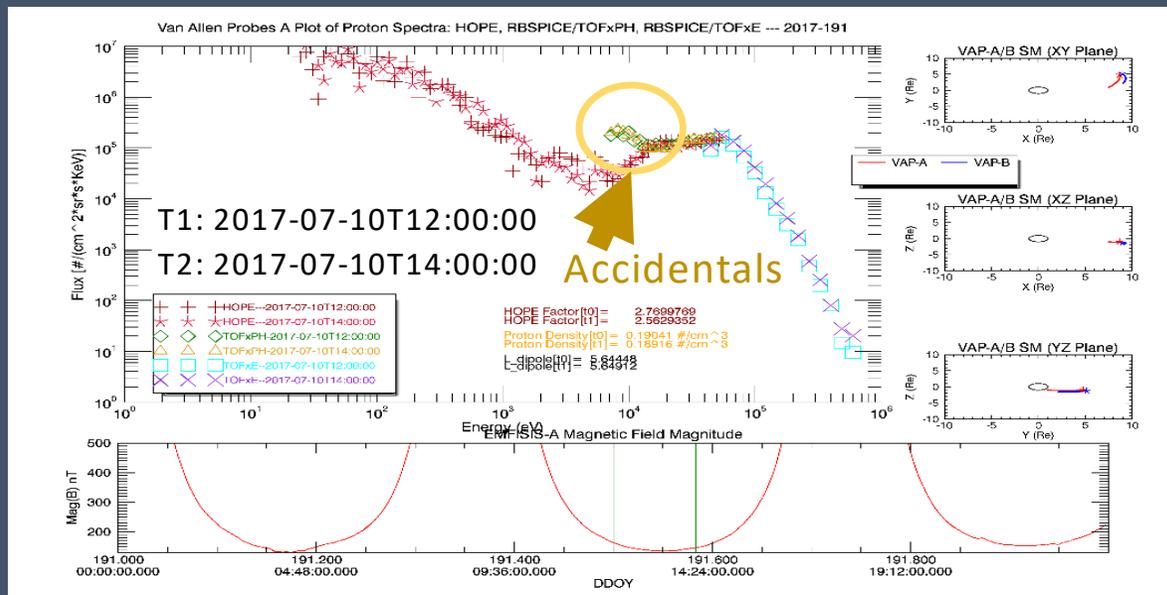
Calculate the ratio of TOFxpH to HOPE, i.e. $r = \langle f_{\text{tofxpH}} \rangle / \langle f_{\text{HOPE}} \rangle$ assuming the slight mismatch of energies passbands is a second order effect that doesn't significantly effect this calculation and exists within the statistical Poisson error bars.

Multiply the HOPE ONNI Flux matrix by R – this is identified in plots as the HOPEMOD factor.

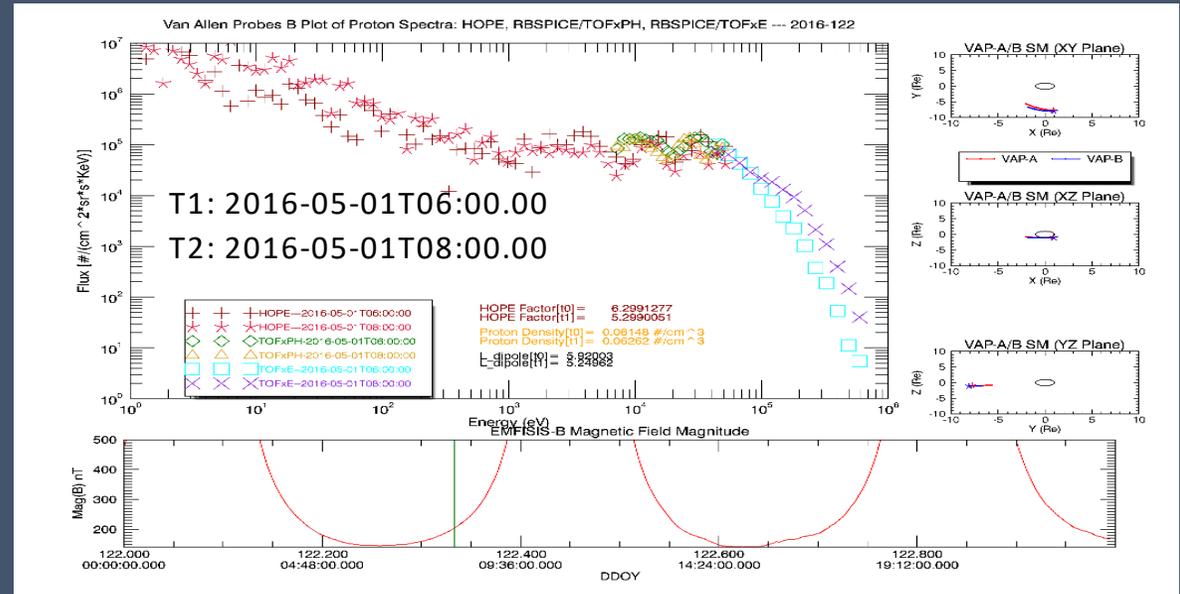
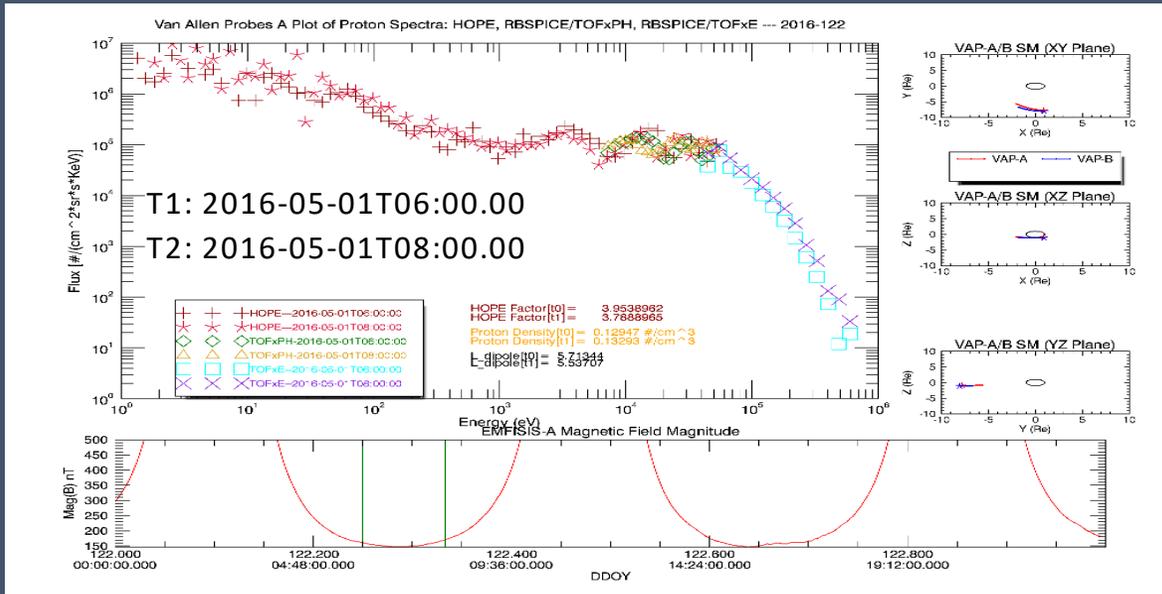
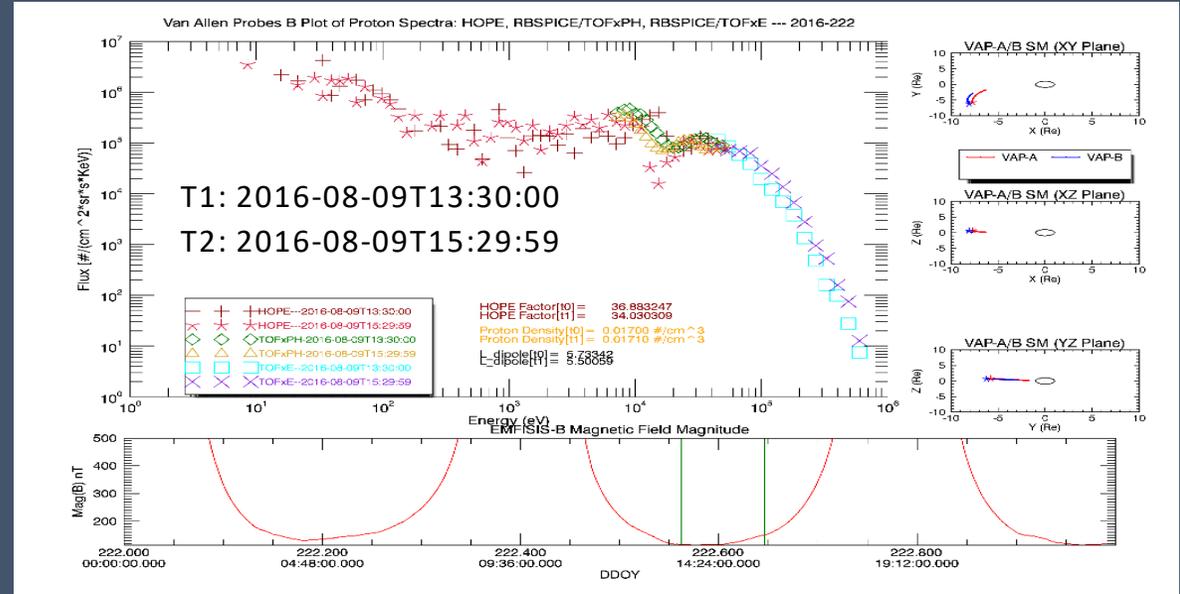
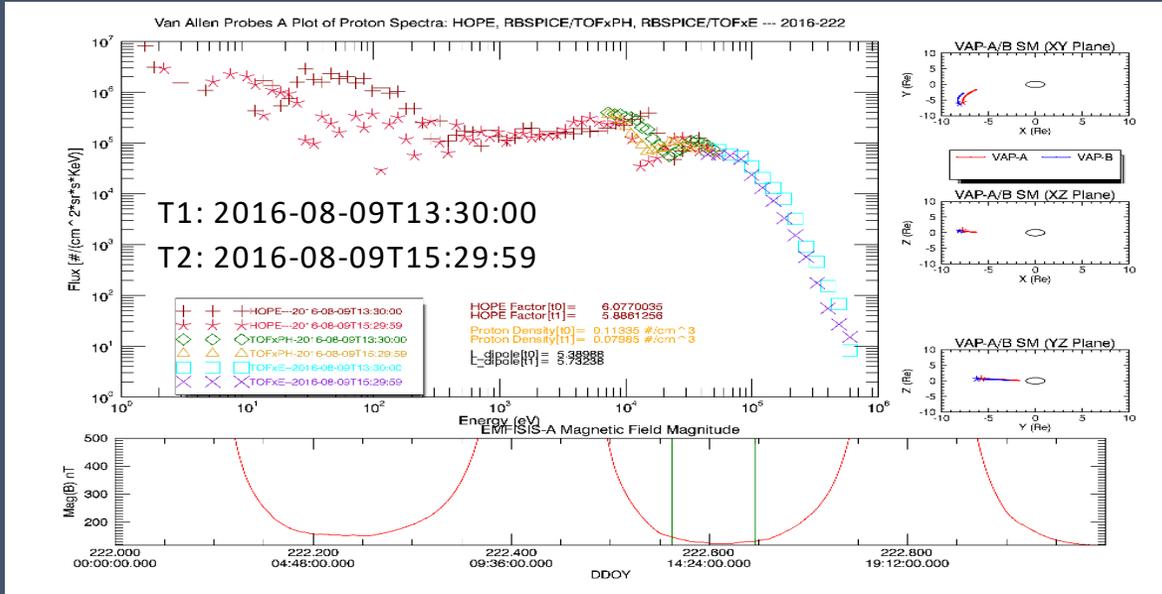
Individual Examples of HOPEMOD Factor: MLT=Dusk



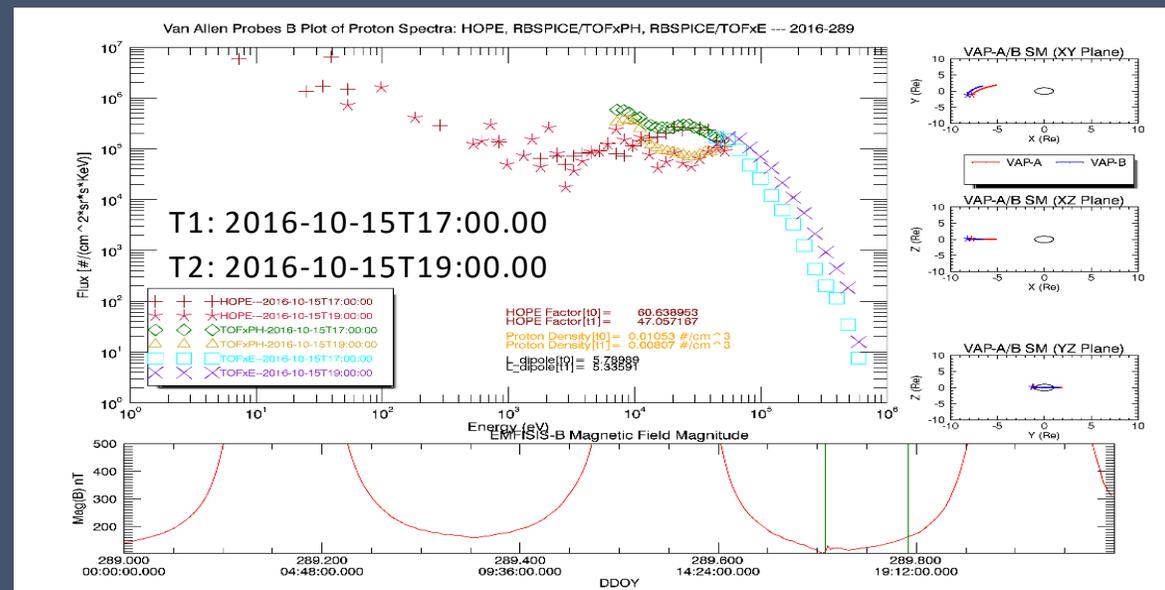
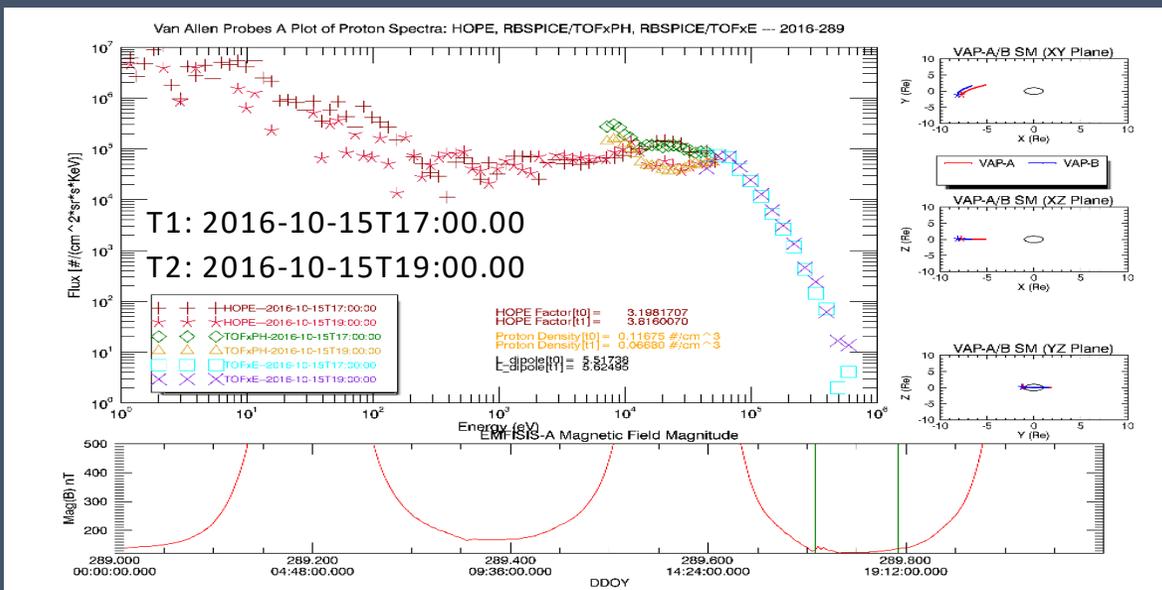
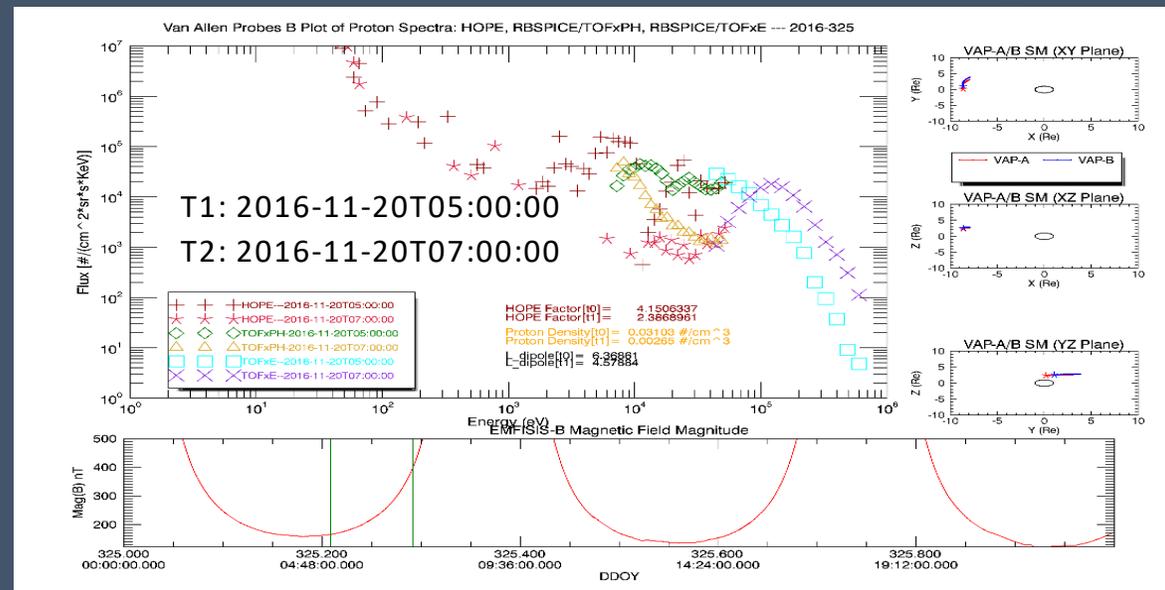
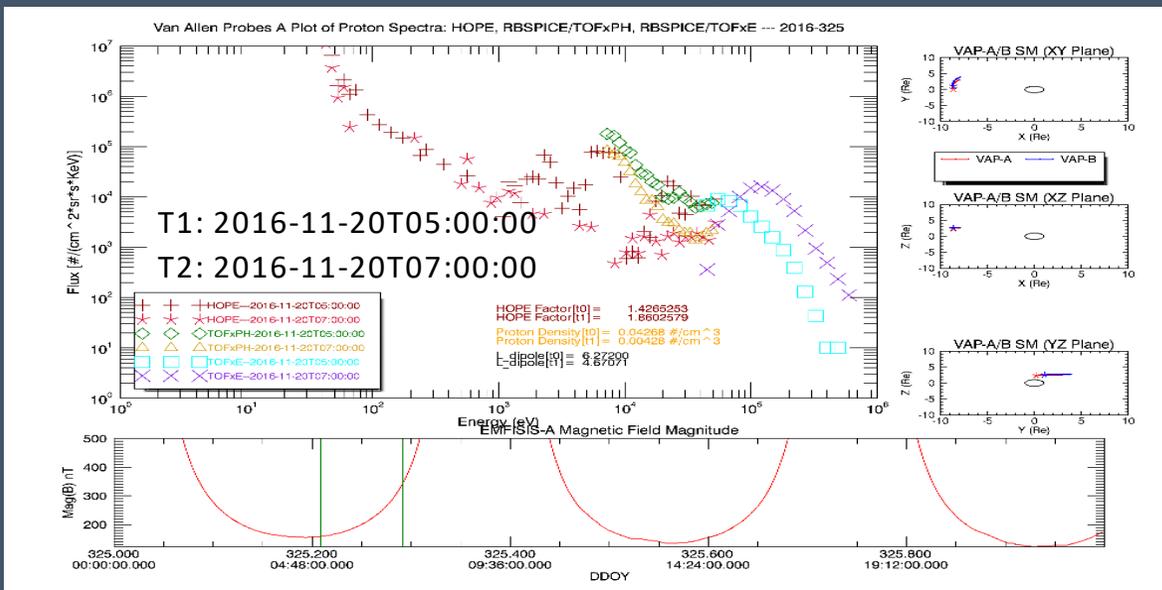
Individual Examples of HOPEMOD Factor: MLT=noon



Individual Examples of HOPEMOD Factor: MLT=Dawn

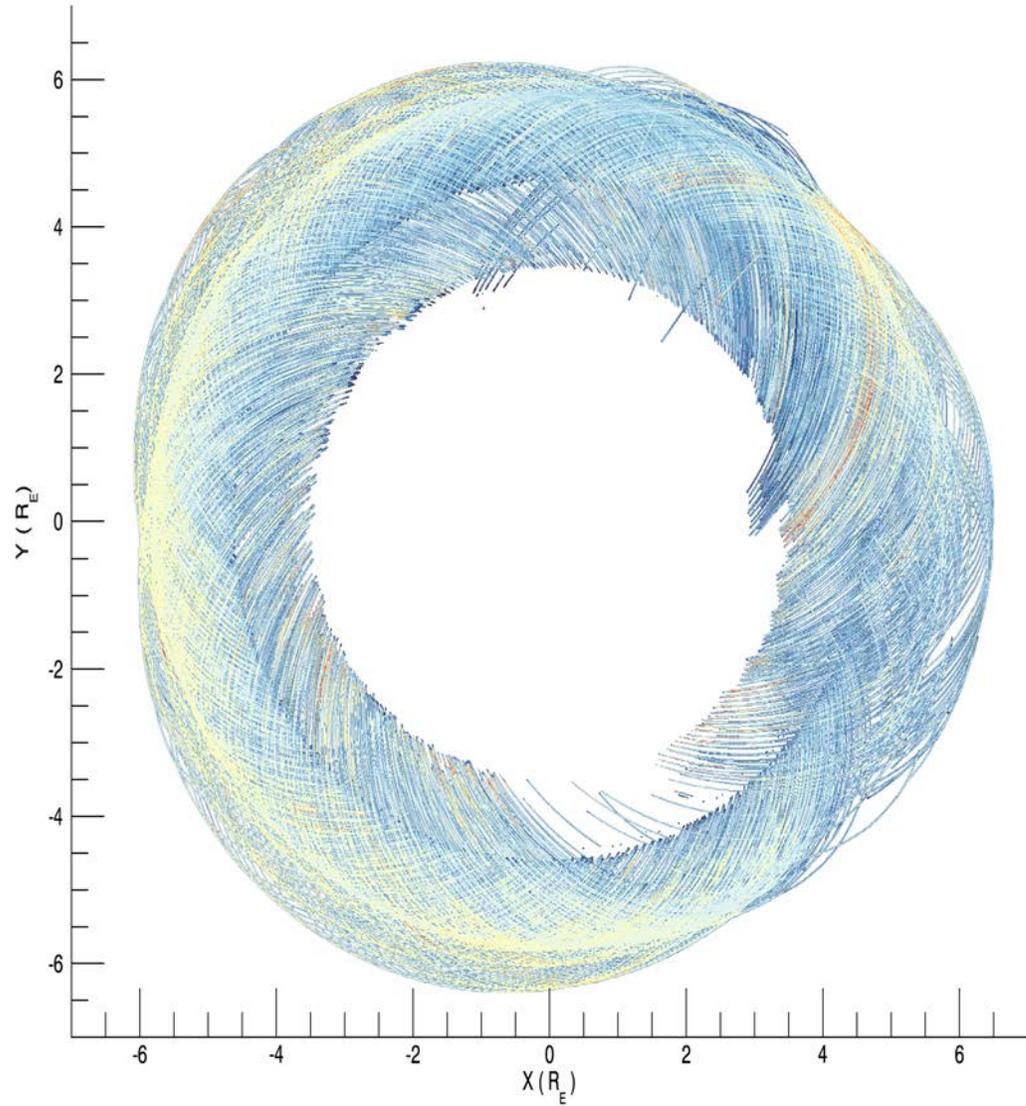


Individual Examples of HOPEMOD Factor: MLT=Midnight

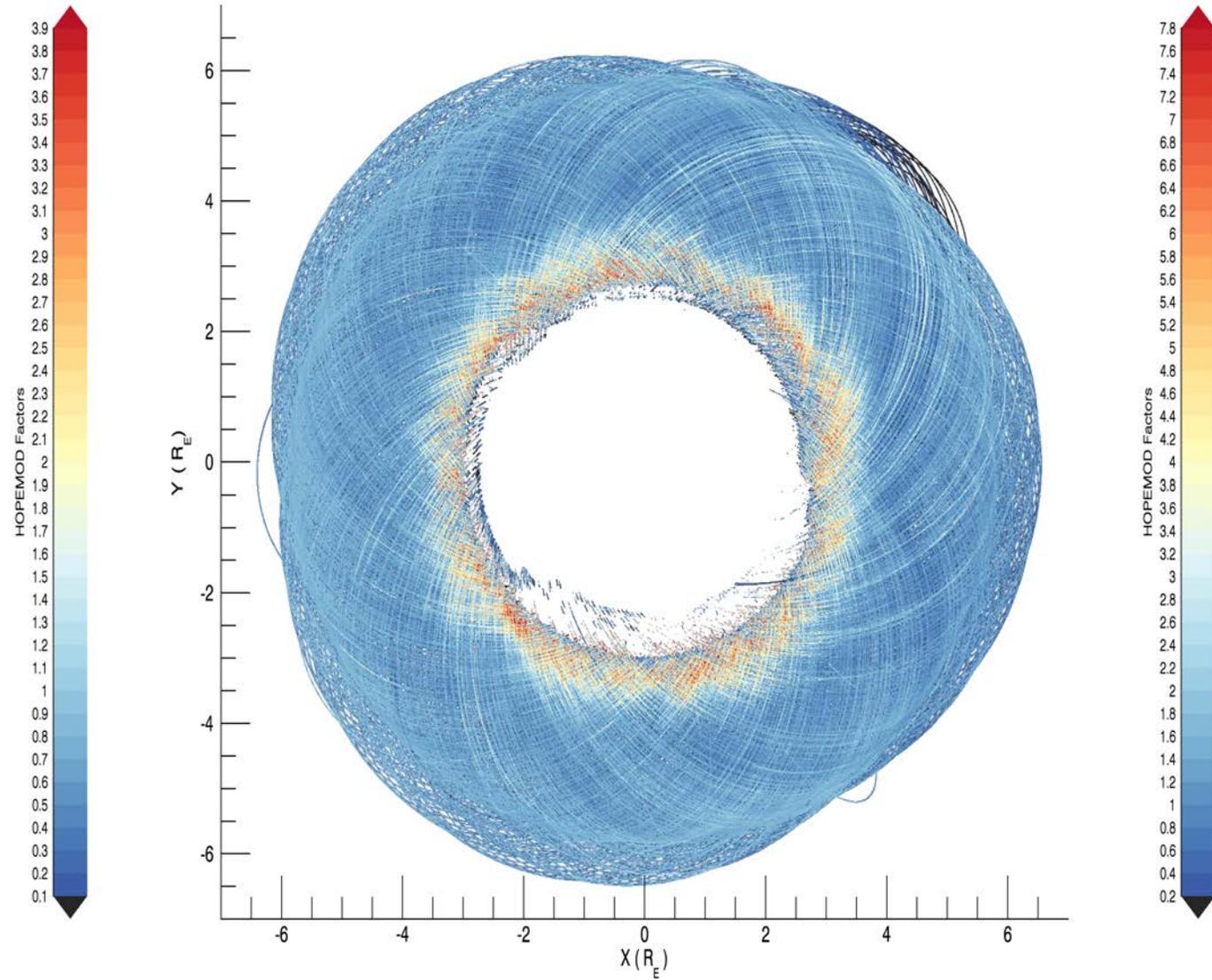


Mission wide overview of HOPEMOD Factor by L vs MLT: 2013-2014

RBSP-A HOPE Modification Factor Contour Plot 2013 to 2014

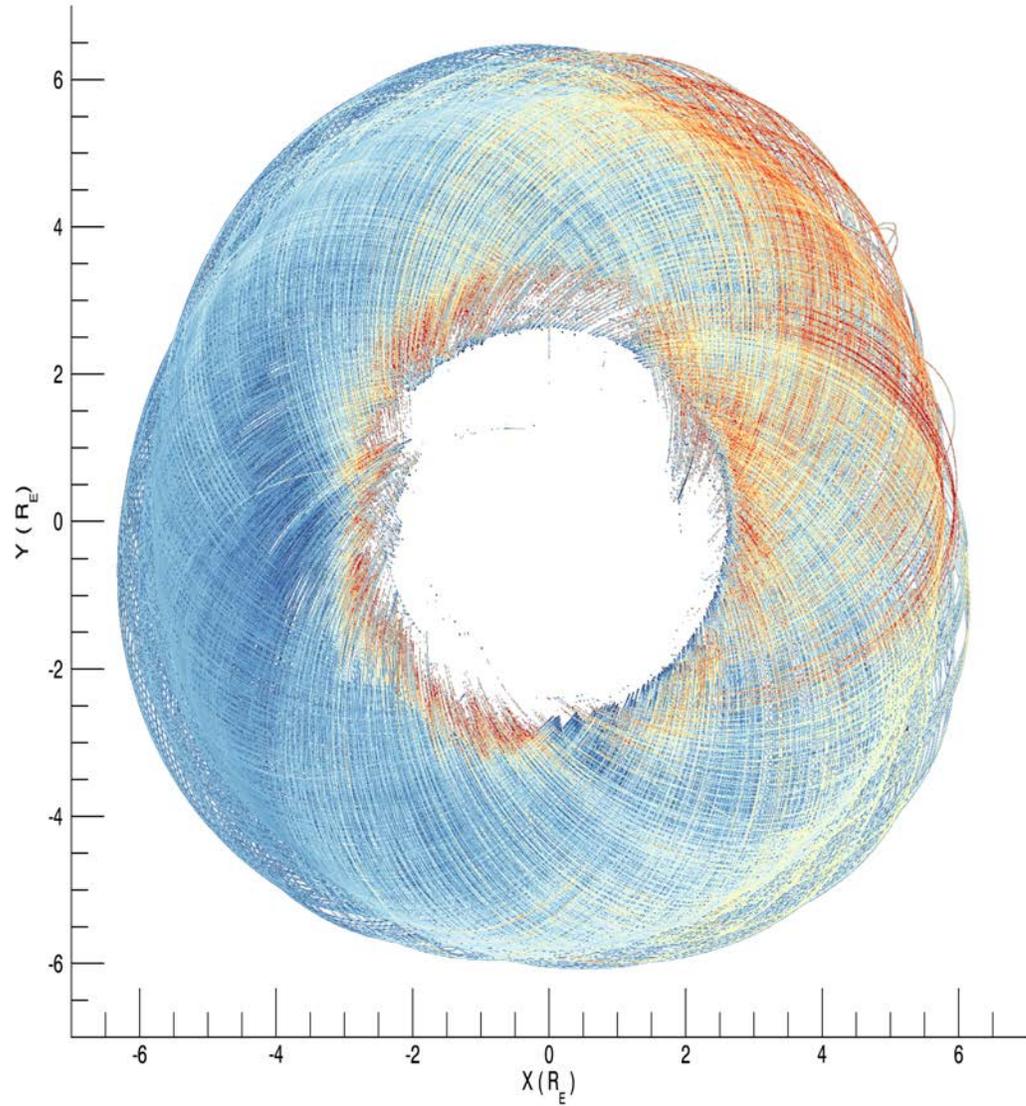


RBSP-B HOPE Modification Factor Contour Plot 2013 to 2014

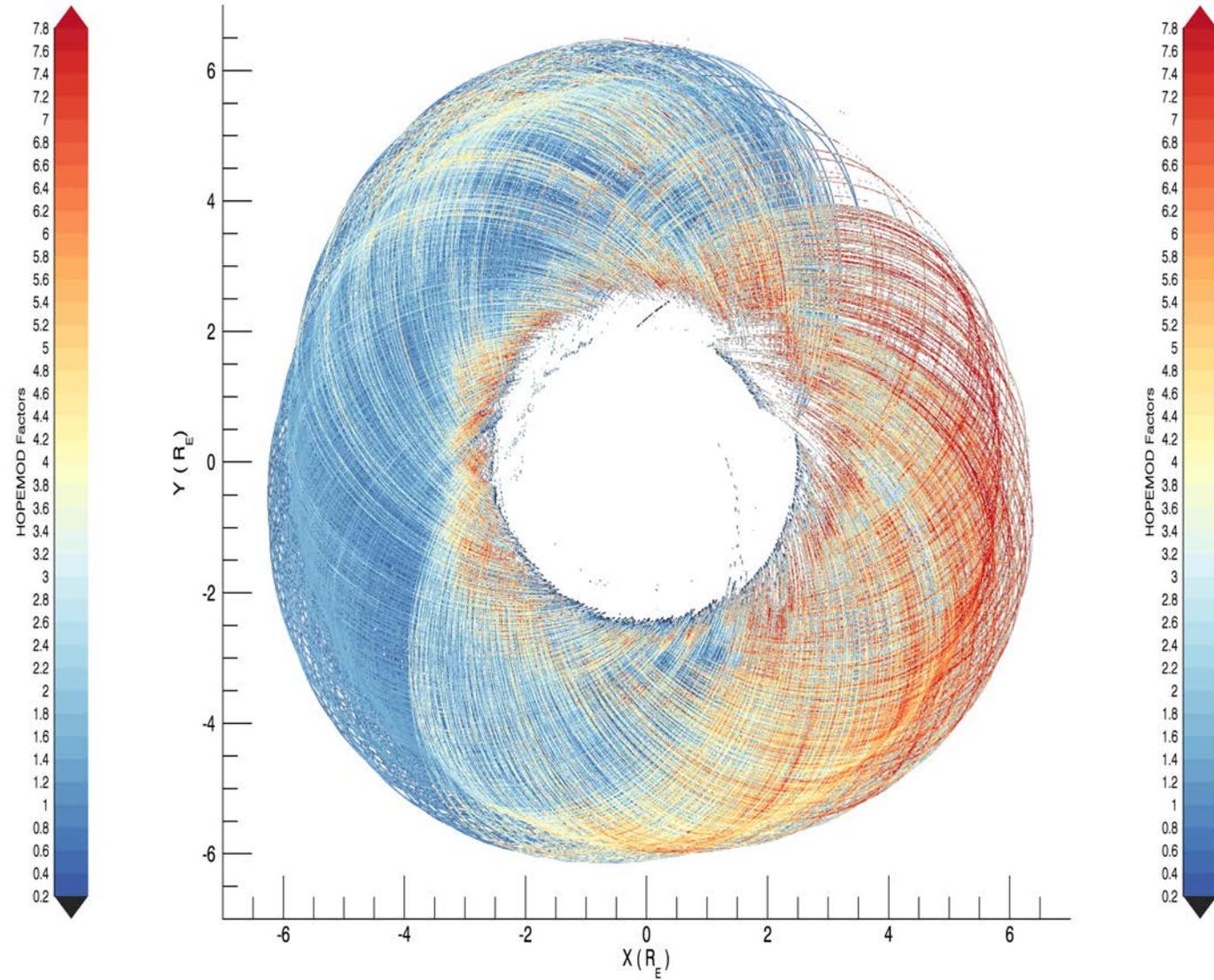


Mission wide overview of HOPEMOD Factor by L vs MLT: 2015-2016

RBSP-A HOPE Modification Factor Contour Plot 2015 to 2016

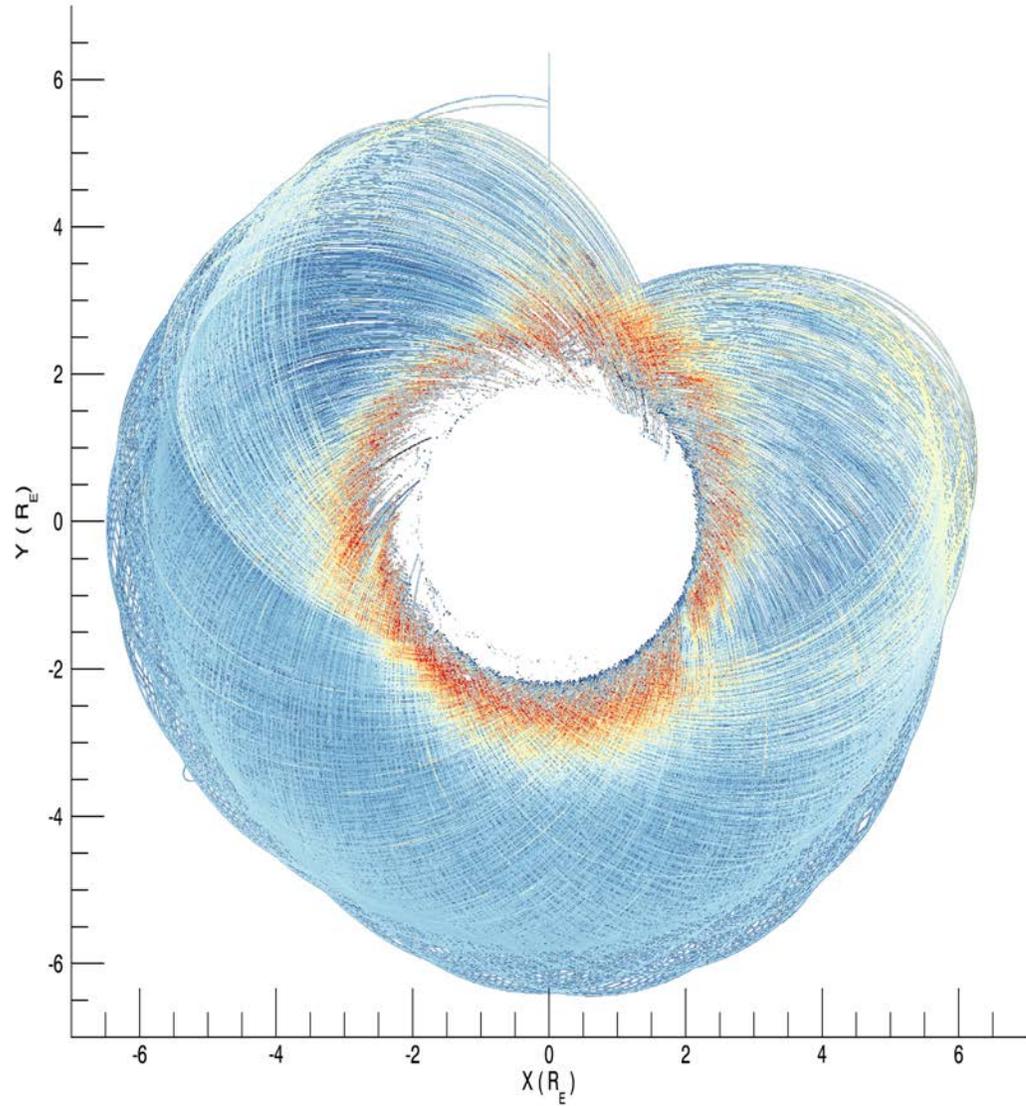


RBSP-B HOPE Modification Factor Contour Plot 2015 to 2016

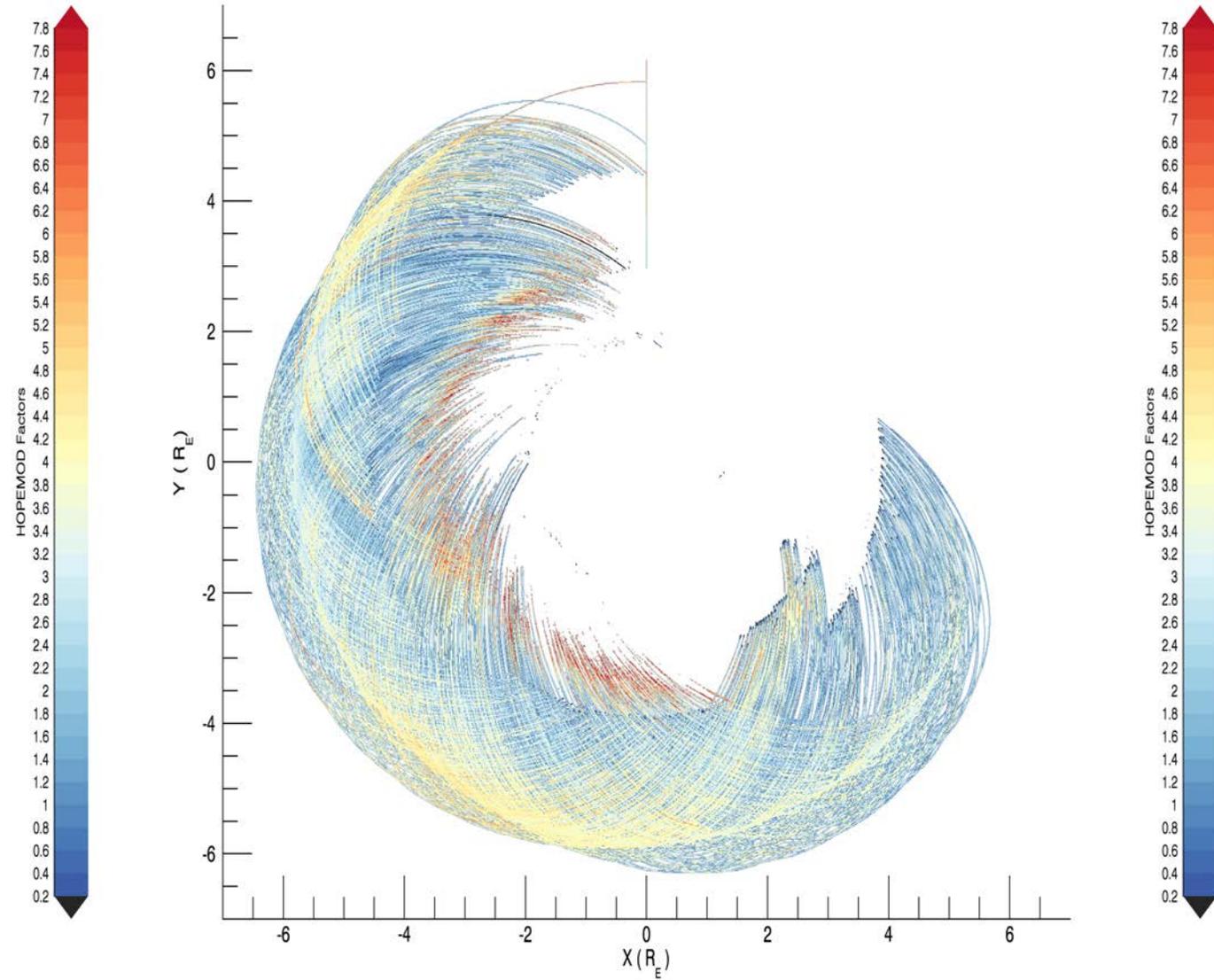


Mission wide overview of HOPEMOD Factor by L vs MLT: 2017-2018

RBSP-A HOPE Modification Factor Contour Plot 2017 to 2018

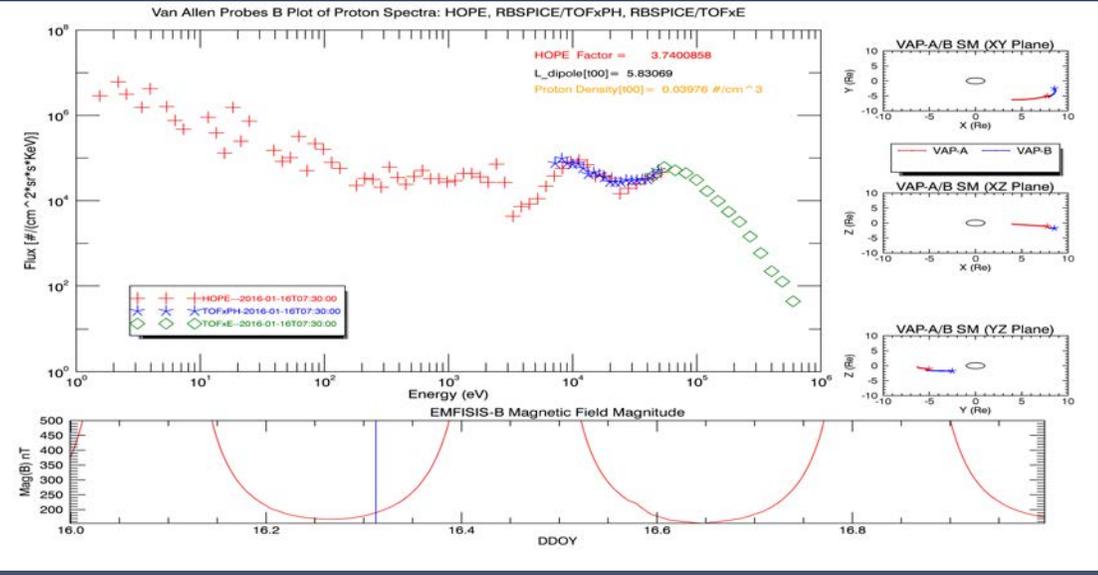
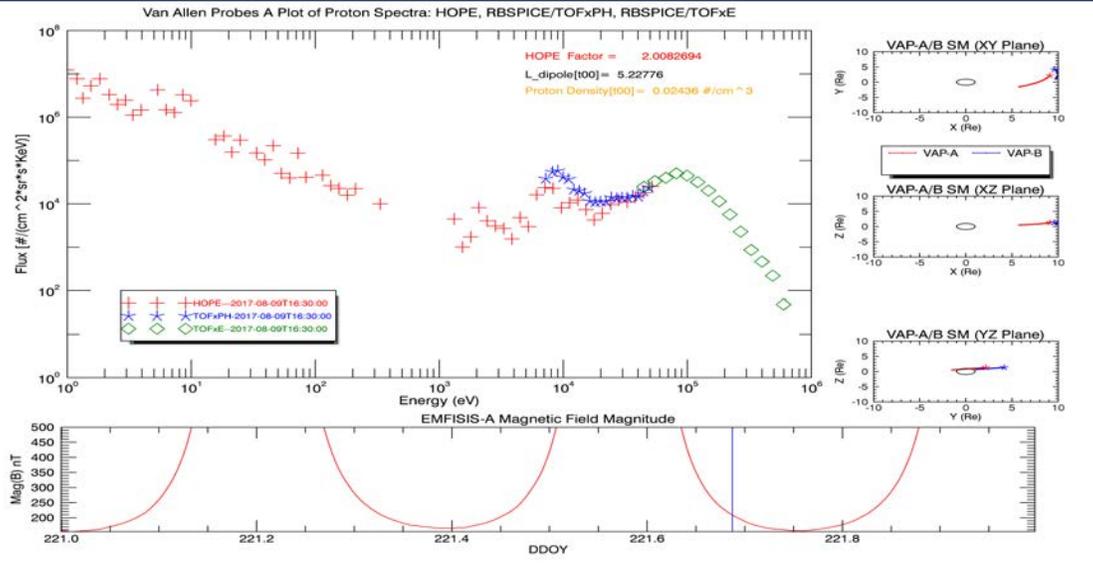
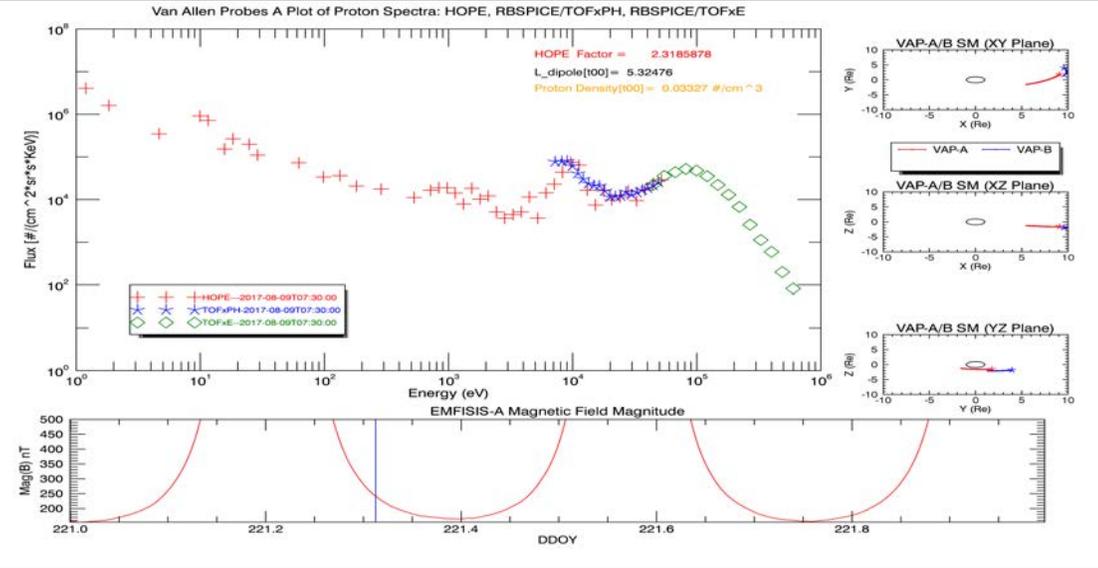
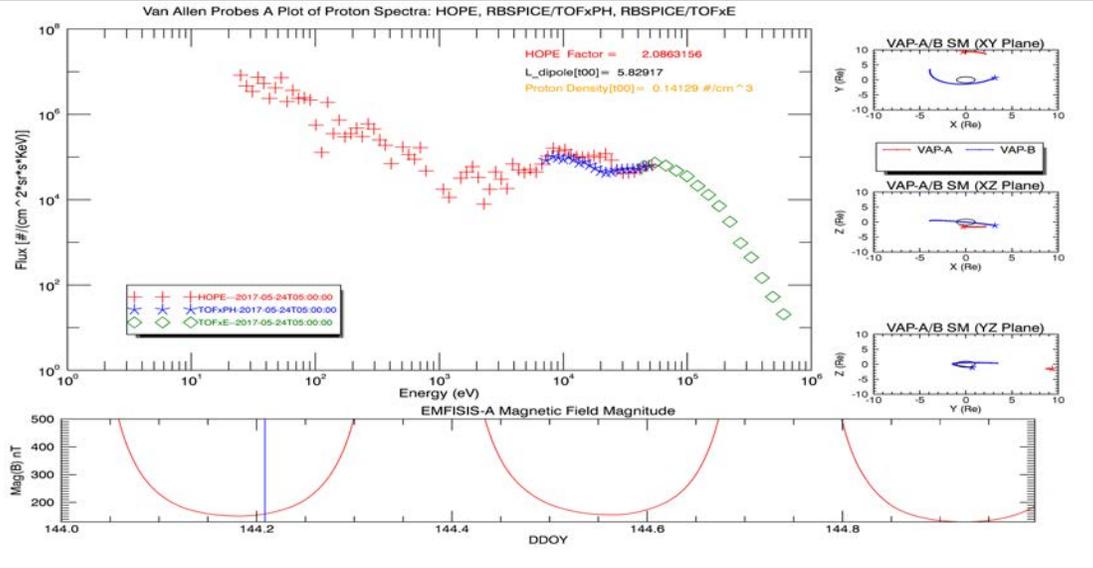


RBSP-B HOPE Modification Factor Contour Plot 2017 to 2018

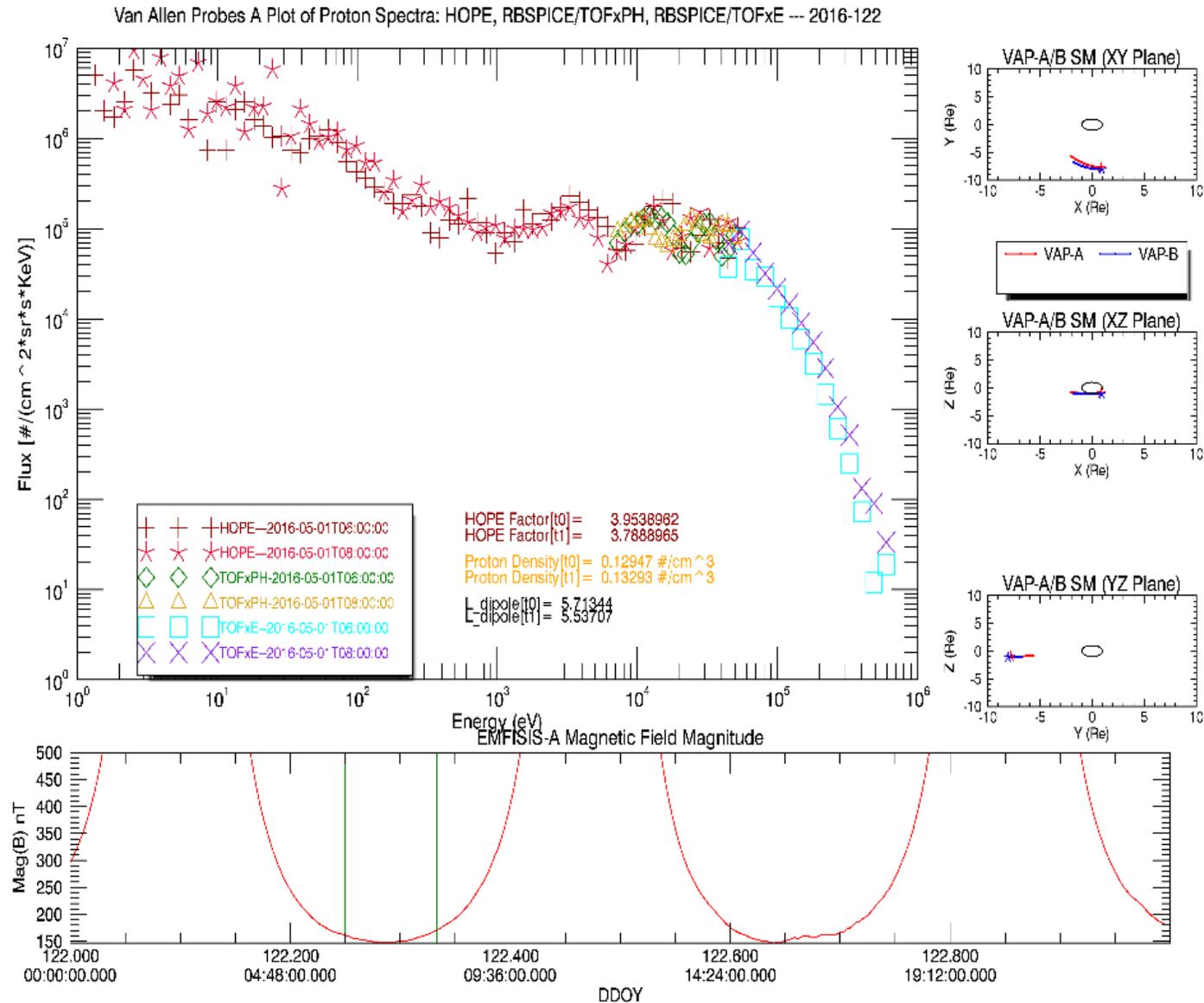


Interesting Spectra observed during this study

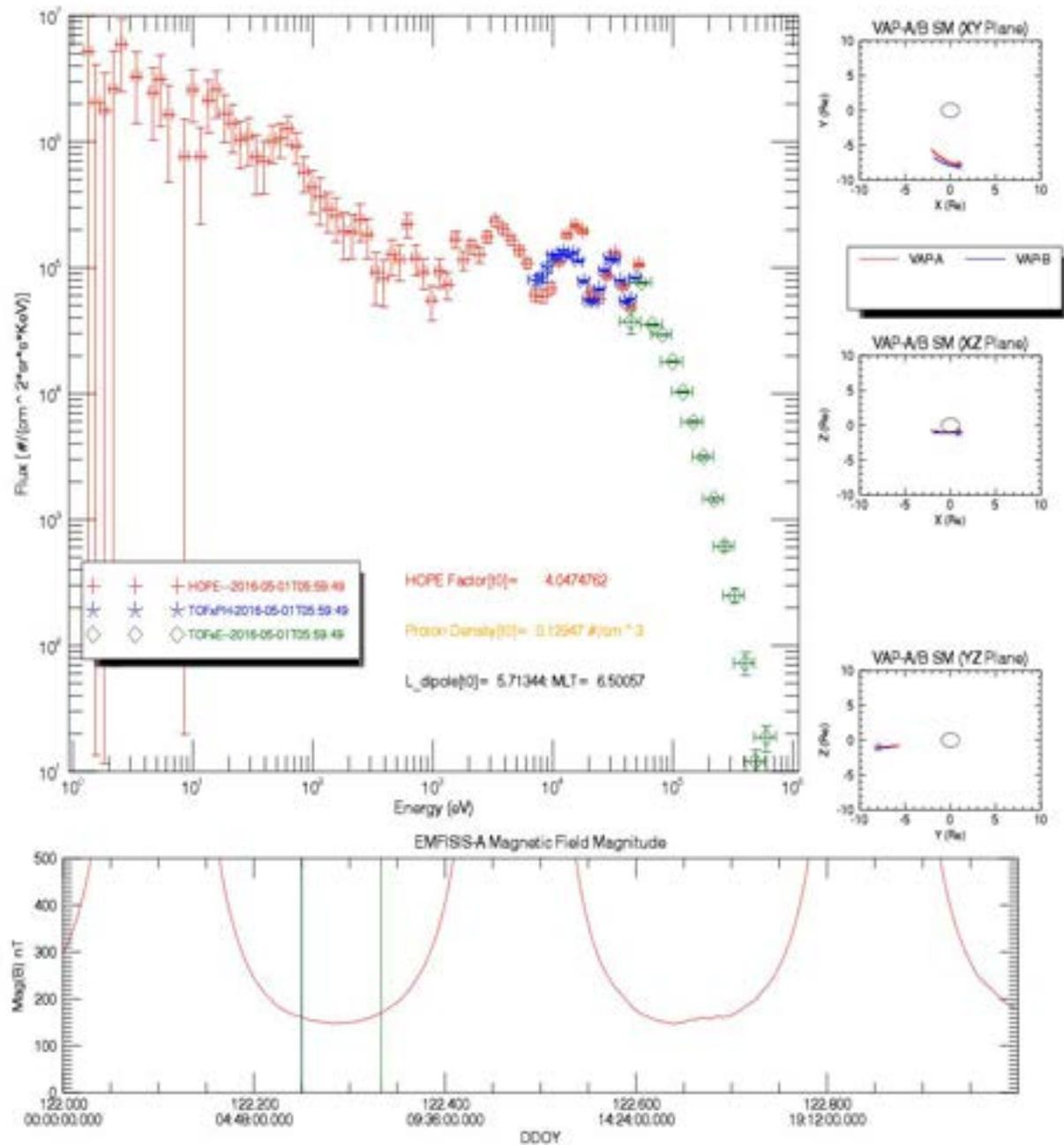
Double Peak bump on tail – is this real?



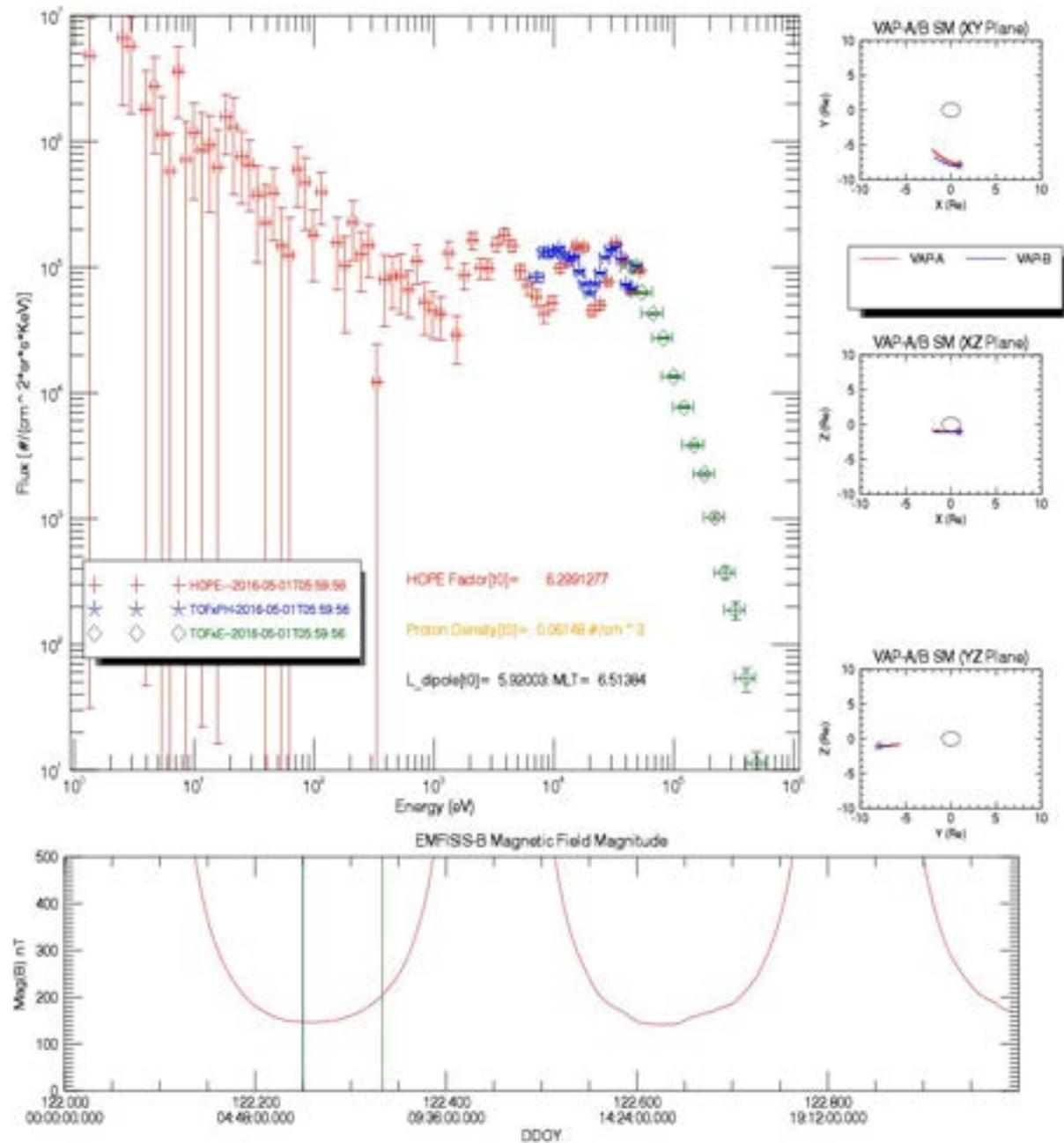
Interesting Spectra observed during this study Or this spectra with three peaks?

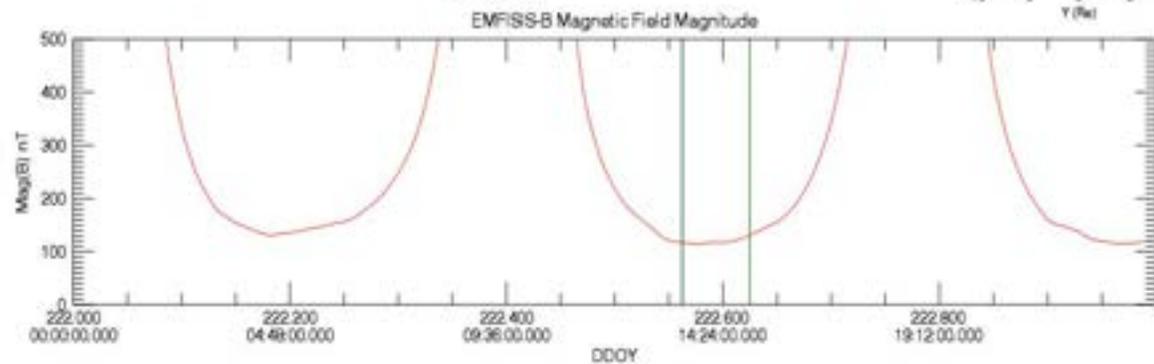
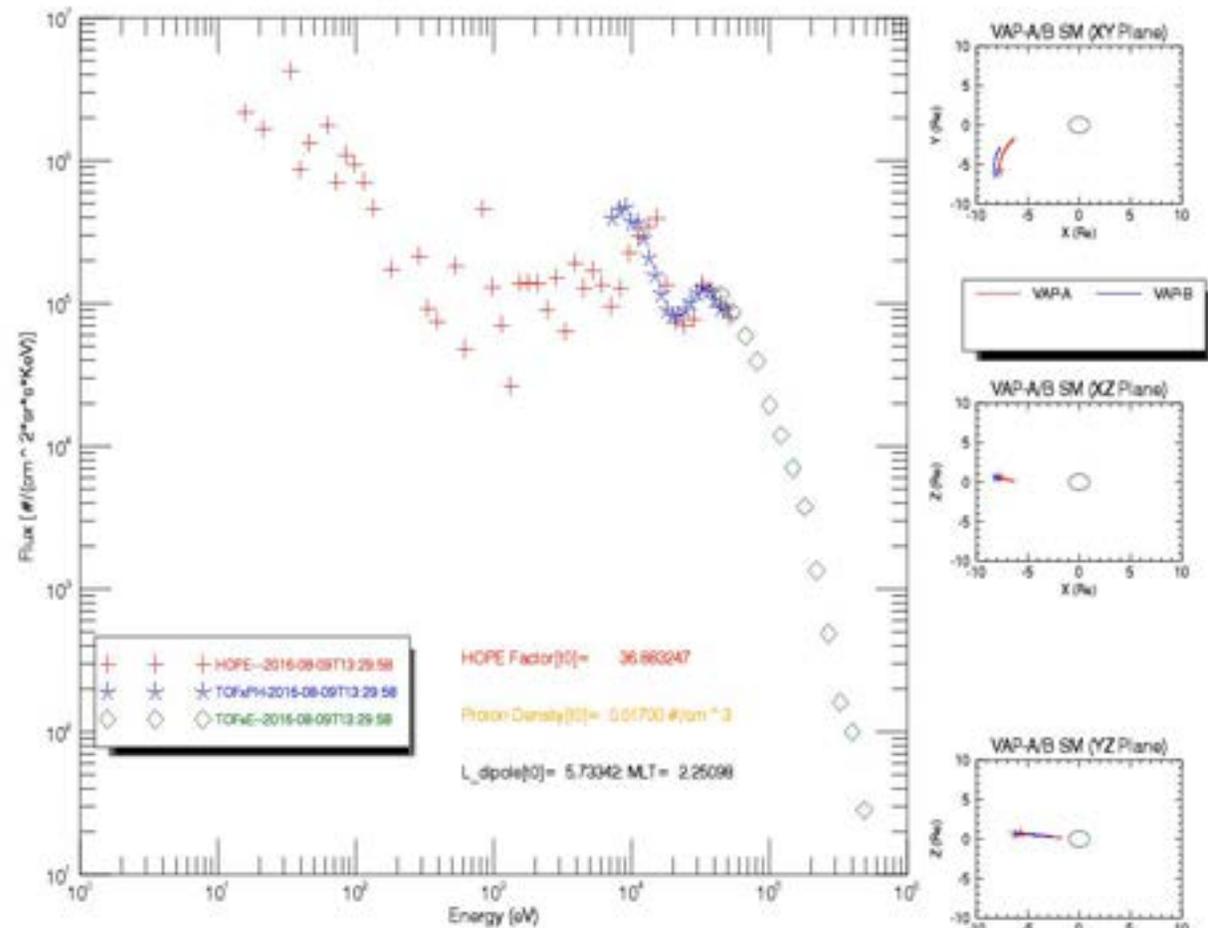
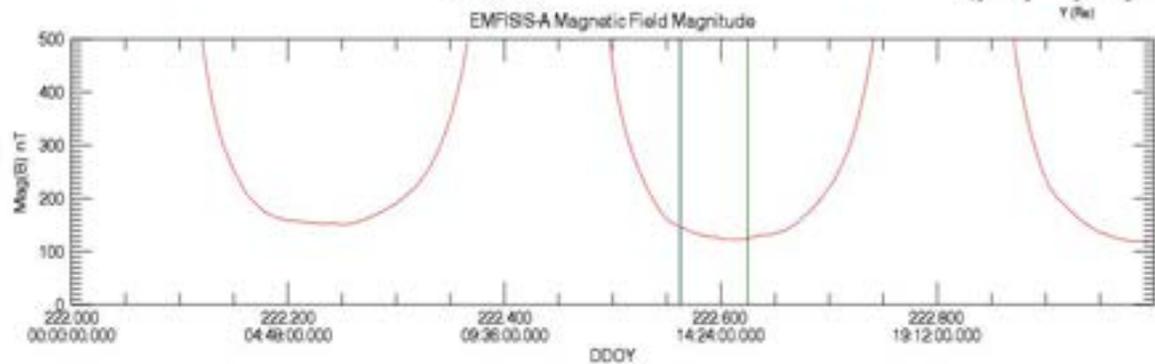
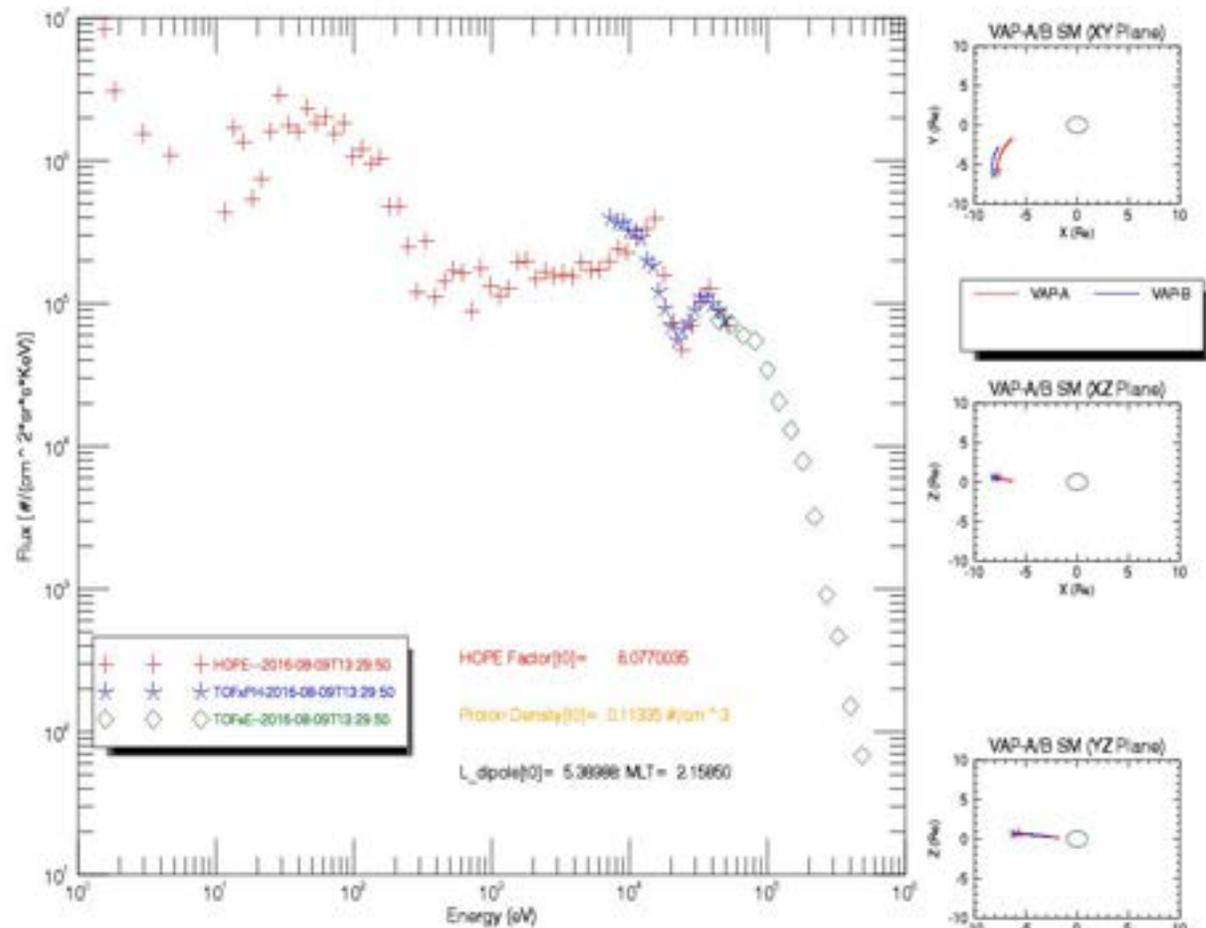


Van Allen Probes A Plot of Proton Spectra: HOPE, RBSPICE/TOFPH, RBSPICE/TOFxE — 2016-122



Van Allen Probes B Plot of Proton Spectra: HOPE, RBSPICE/TOFPH, RBSPICE/TOFxE — 2016-122





Study Conclusions:

1. HOPEMOD Factor varies with mission years and shows the changes of calibration that occurred throughout the Mission for the HOPE instrument
2. HOPEMOD Factor varies with L and MLT although this variation has no clear functional form
3. HOPEMOD Factor values as spacecraft are getting near perigee increase dramatically sometimes as much as a factor of 100
4. Very interesting double bump (+) on tail distributions were observed during this study. The question to ask and is the subject of further study by the RBSPICE team is whether these distributions are correct observations of the actual energetic particle distribution
 1. if so where is this found
 2. under what conditions leads to this distribution
 3. finally is this a stable distribution
5. It is 4 AM and I'm going to bed!!! – any questions 😊