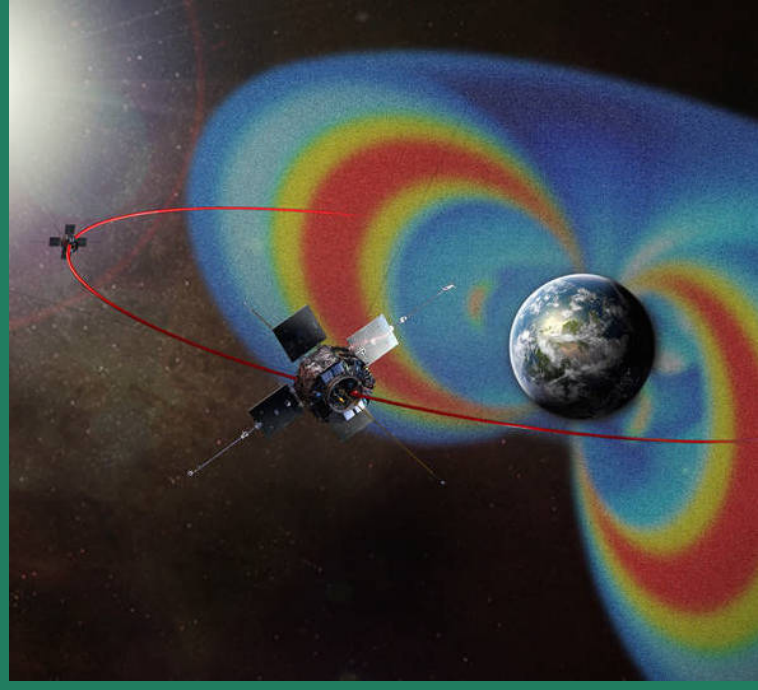




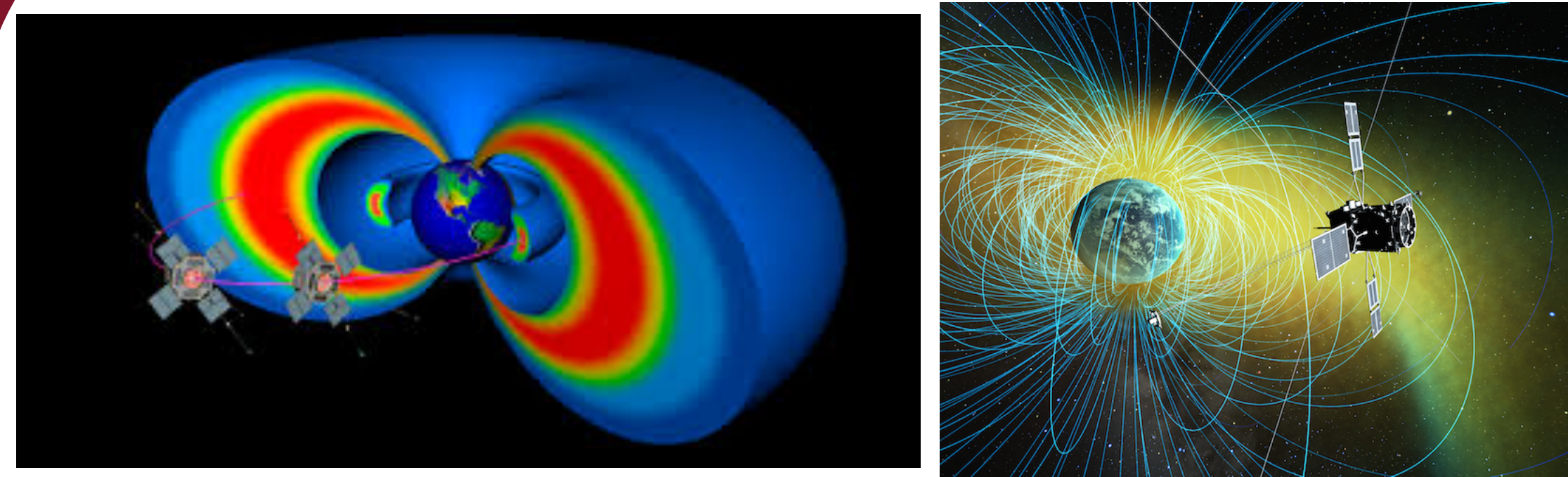
Analysis of data from a series of Van Allen Probes and ARASE satellite conjunctions to determine the spatial scale of magnetospheric wave modes and their effects on radiation belt particles



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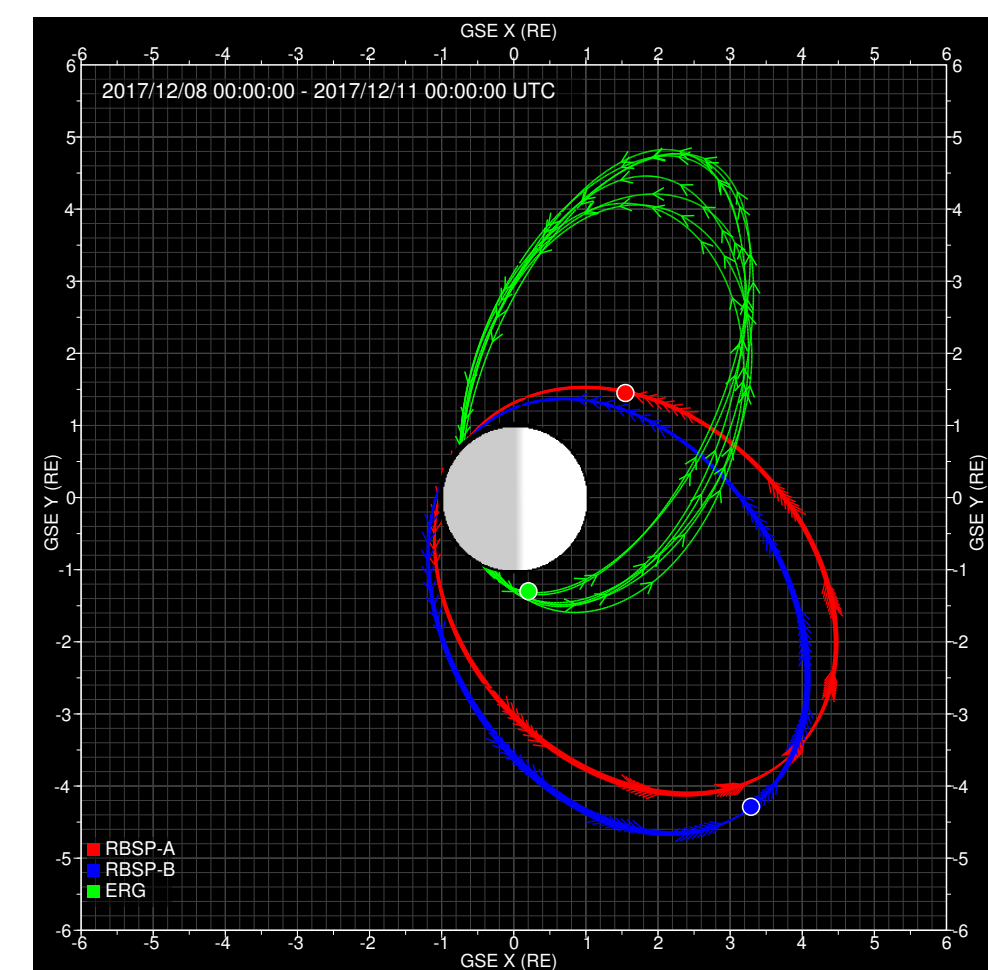
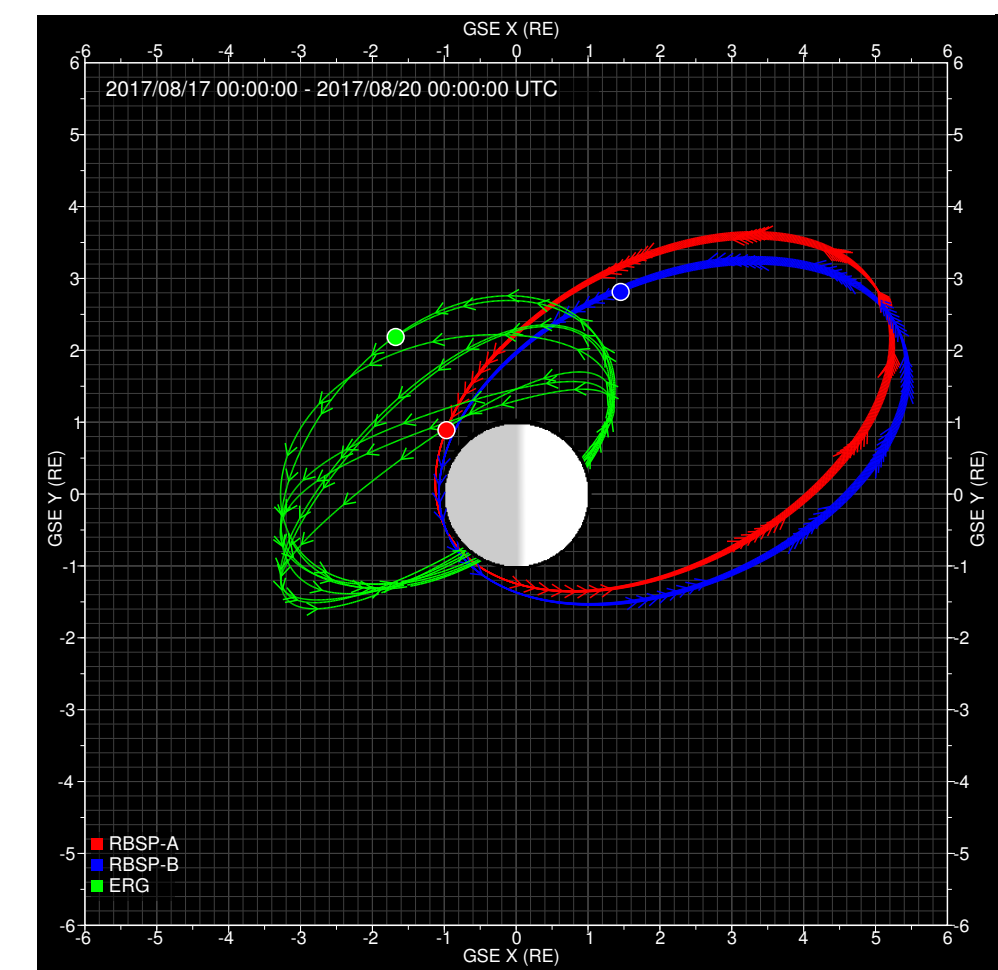
Background and motivation



RBSP – twin spacecraft launched 30 August 2012 into elliptical orbit, apogee 30000 km and perigee 618 km – very nearly equatorial

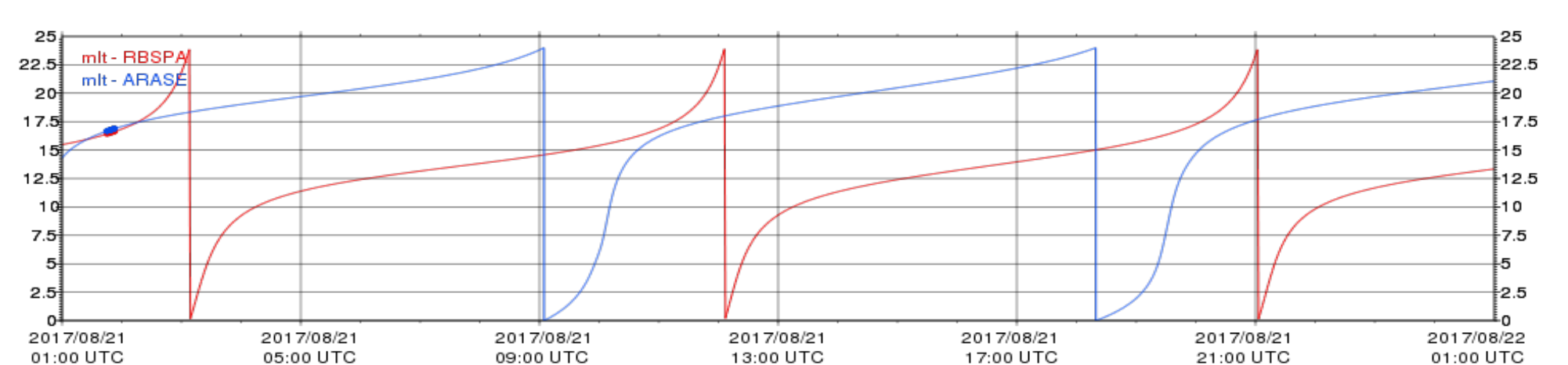
ARASE – launched 20 December 2016 into elliptical orbit with apogee 32000 km and perigee 460 km – but highly inclined

These two experiments provide a unique opportunity to examine the spatial scales of various inner magnetospheric wave modes, their properties and propagation, and their effects on particles, especially given ARASE's high inclination and the presumed equatorial source of certain modes.



- August 19-21, 2017 orbits
- Conjunctions are in dusk sector at low L-shell
- Expect fewer waves, but still some plasmaspheric hiss, whistler

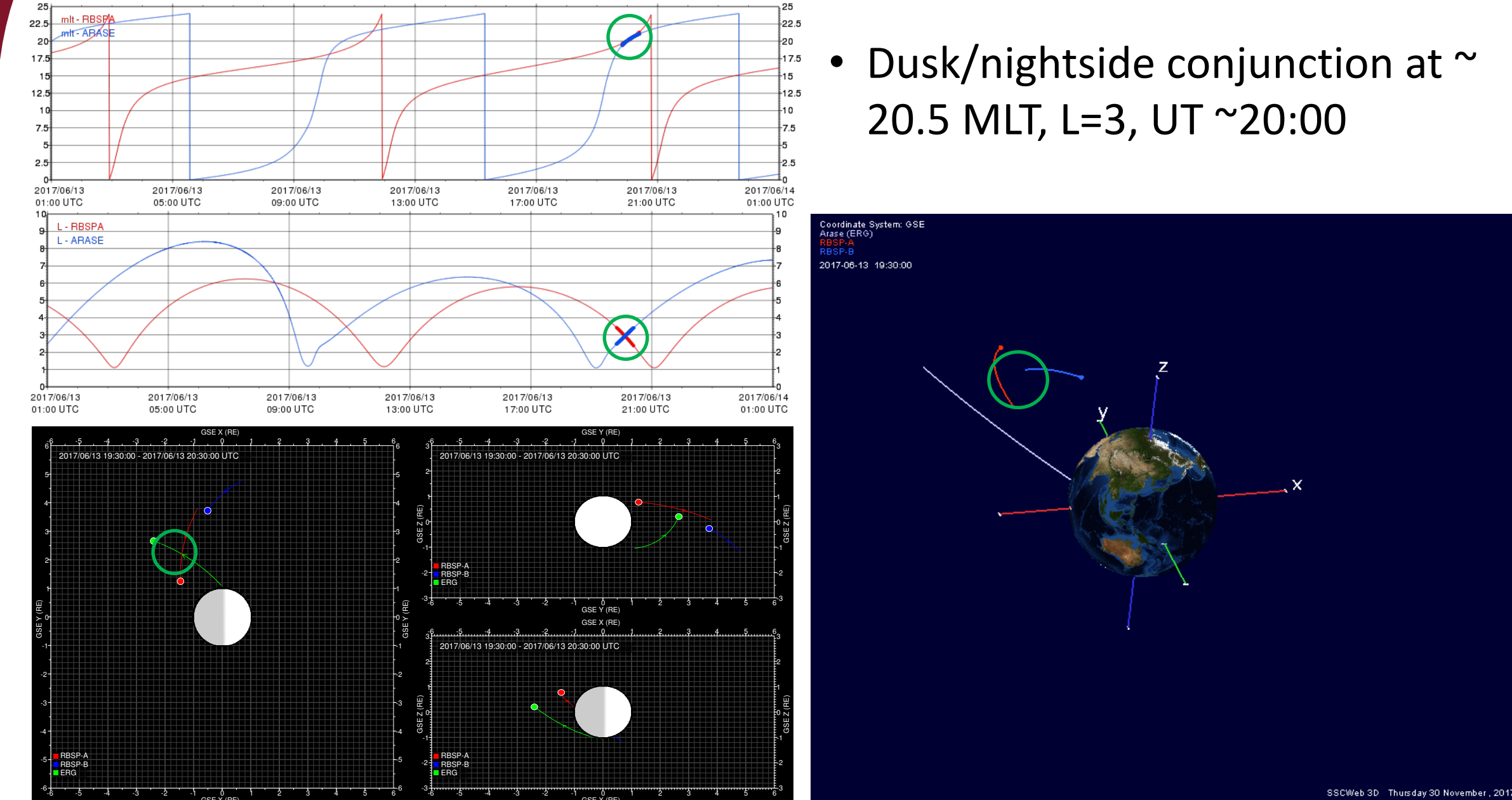
- December 18-20, 2017 orbits
- Conjunctions are in day sector at slightly higher L-shell
- Expect more waves, including chorus, plasmaspheric hiss, whistler



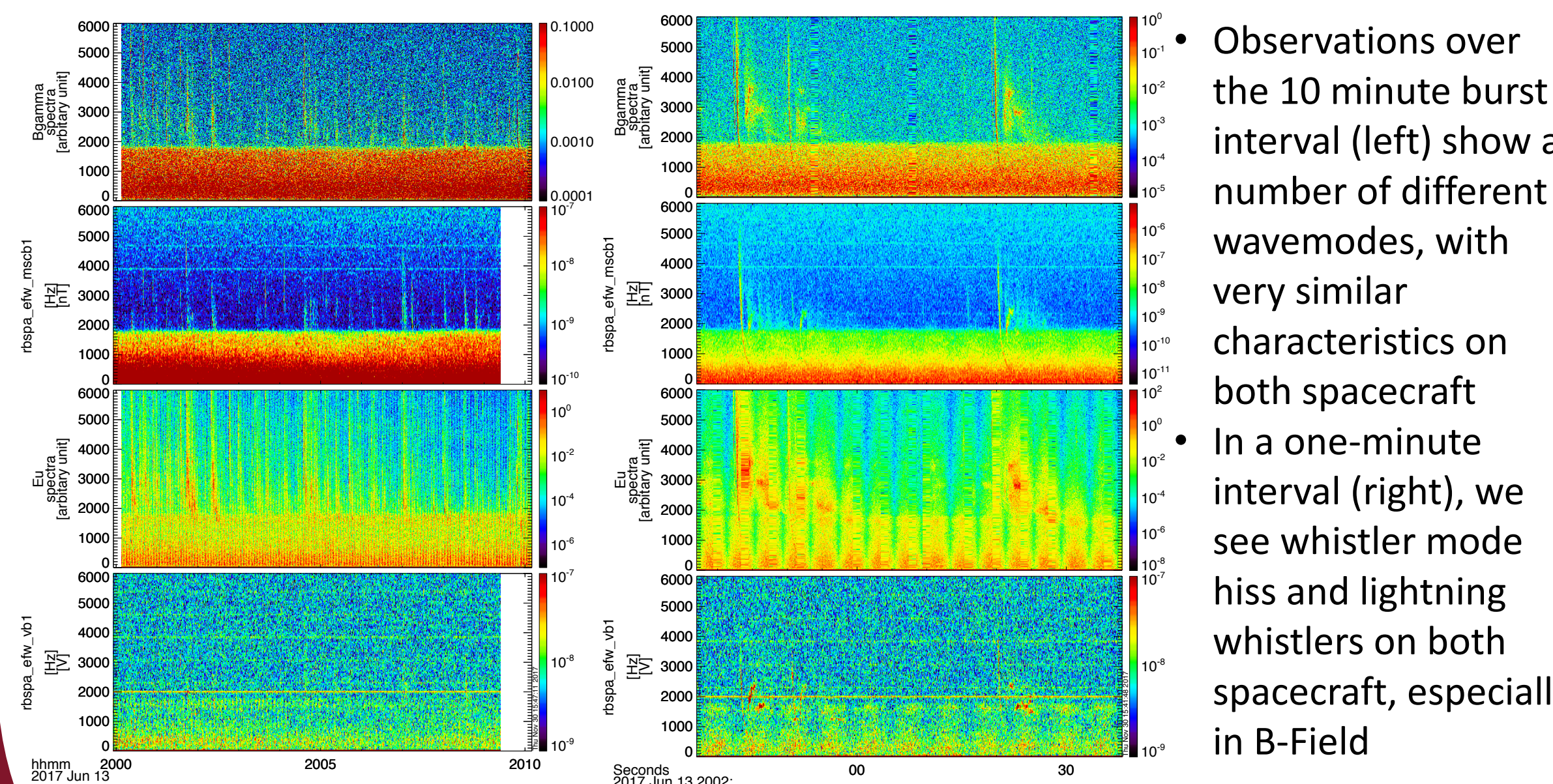
- We use the conjunction finder on APL's RBSP Gateway site to determine upcoming conjunctions
- The EFW team then collaborates with ARASE and RBSP EMFISIS to determine times for burst collection, uploads the commands to the satellite to record the data and downloads the data when it is collected
- Using this process we have identified >100 collections over the last 9 months
- For almost all of these conjunctions we and ARASE have collected data and gotten it to the ground for analysis
- ARASE is still calibrating their data, but we have calibrated spectral data for both E and B fields from ARASE, and EFW and EMFISIS data as well as particle data from RBSP and uncalibrated particle data from ARASE

Events 1 and 2 – lightning whistlers observed on both spacecraft

Conjunction #1 – June 13, 2017

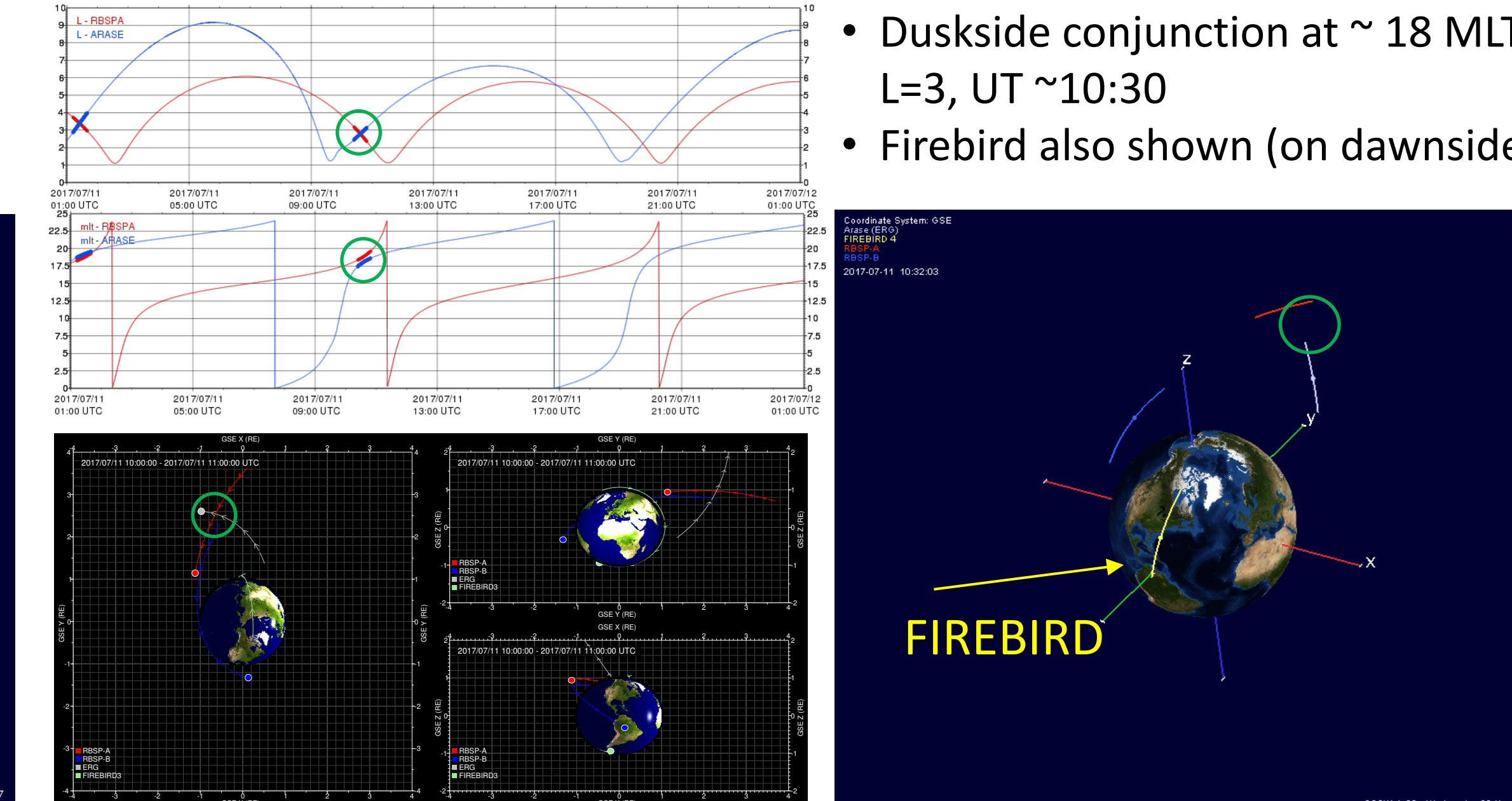


- Dusk/nightside conjunction at ~ 20.5 MLT, L=3, UT ~20:00

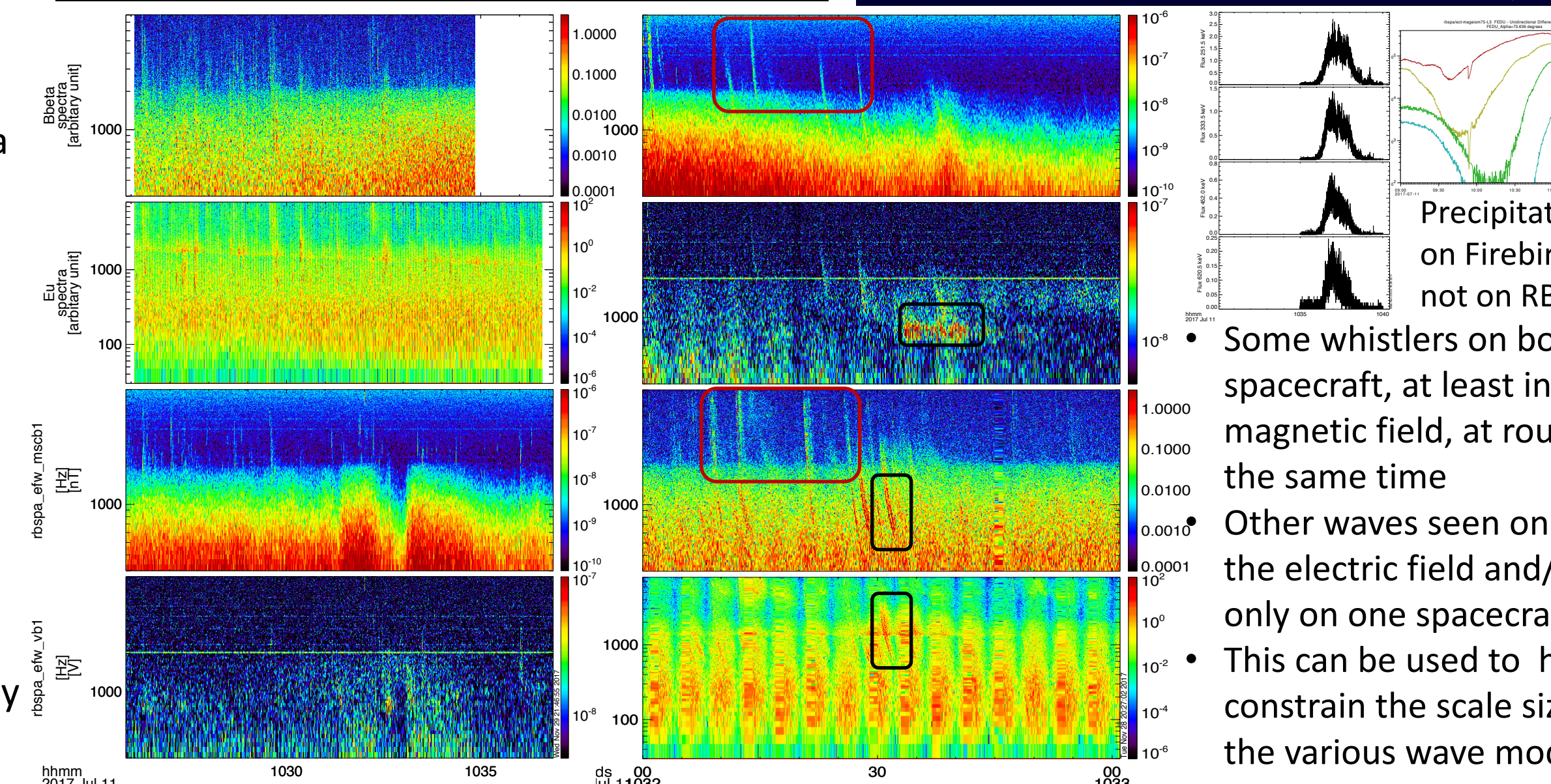


- Observations over the 10 minute burst interval (left) show a number of different wavemodes, with very similar characteristics on both spacecraft
- In a one-minute interval (right), we see whistler mode hiss and lightning whistlers on both spacecraft, especially in B-Field

Conjunction #2 – July 11, 2017



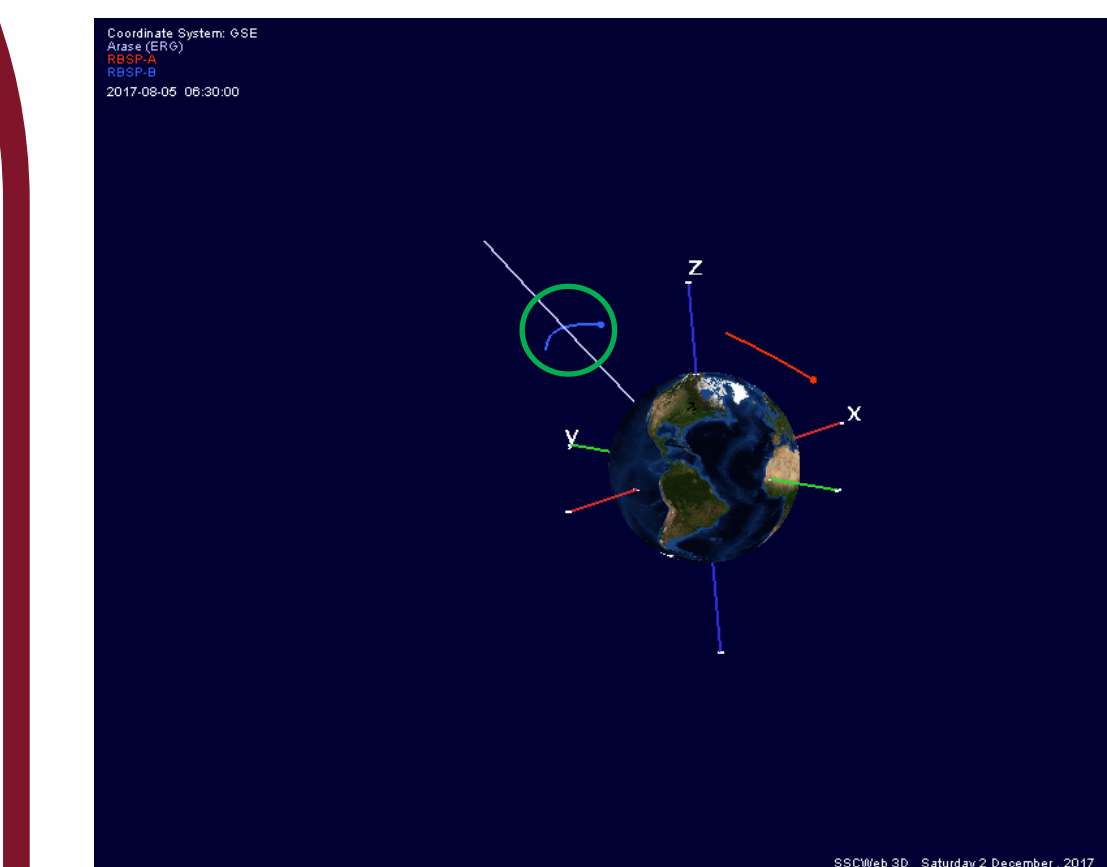
- Duskside conjunction at ~ 18 MLT, L=3, UT ~10:30
- Firebird also shown (on dawnside)



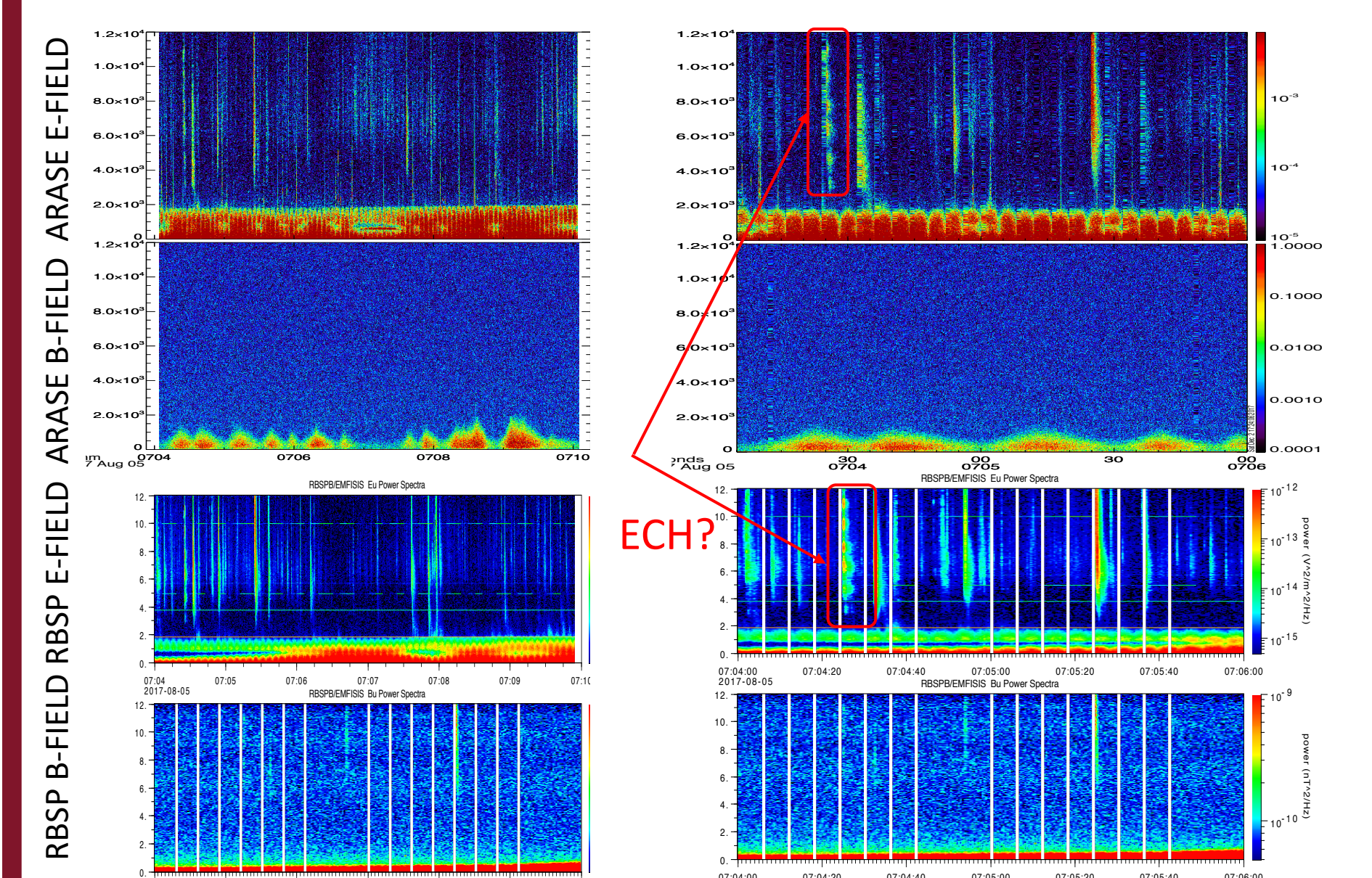
- Some whistlers on both spacecraft, at least in the magnetic field, at roughly the same time
- Other waves seen only in the electric field and/or only on one spacecraft
- This can be used to help constrain the scale sizes of the various wave modes

Event 3 – ECH?

Conjunction #3 – August 5, 2017



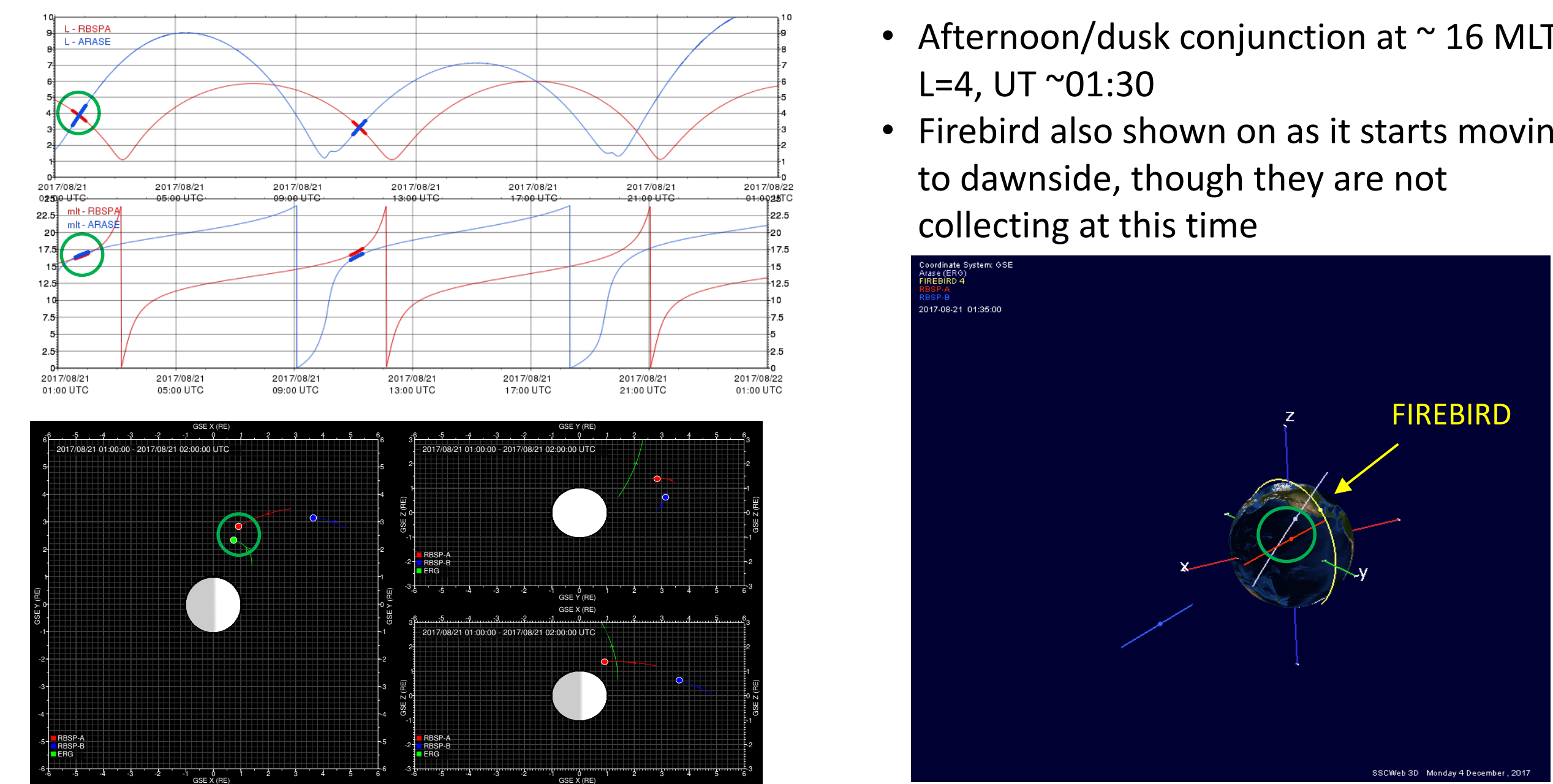
- Duskside conjunction at ~ 17.5 MLT, L=3.5, UT ~7:00
- Relatively close conjunction, with both satellites at similar inclination, Mlat diff =4.8 deg



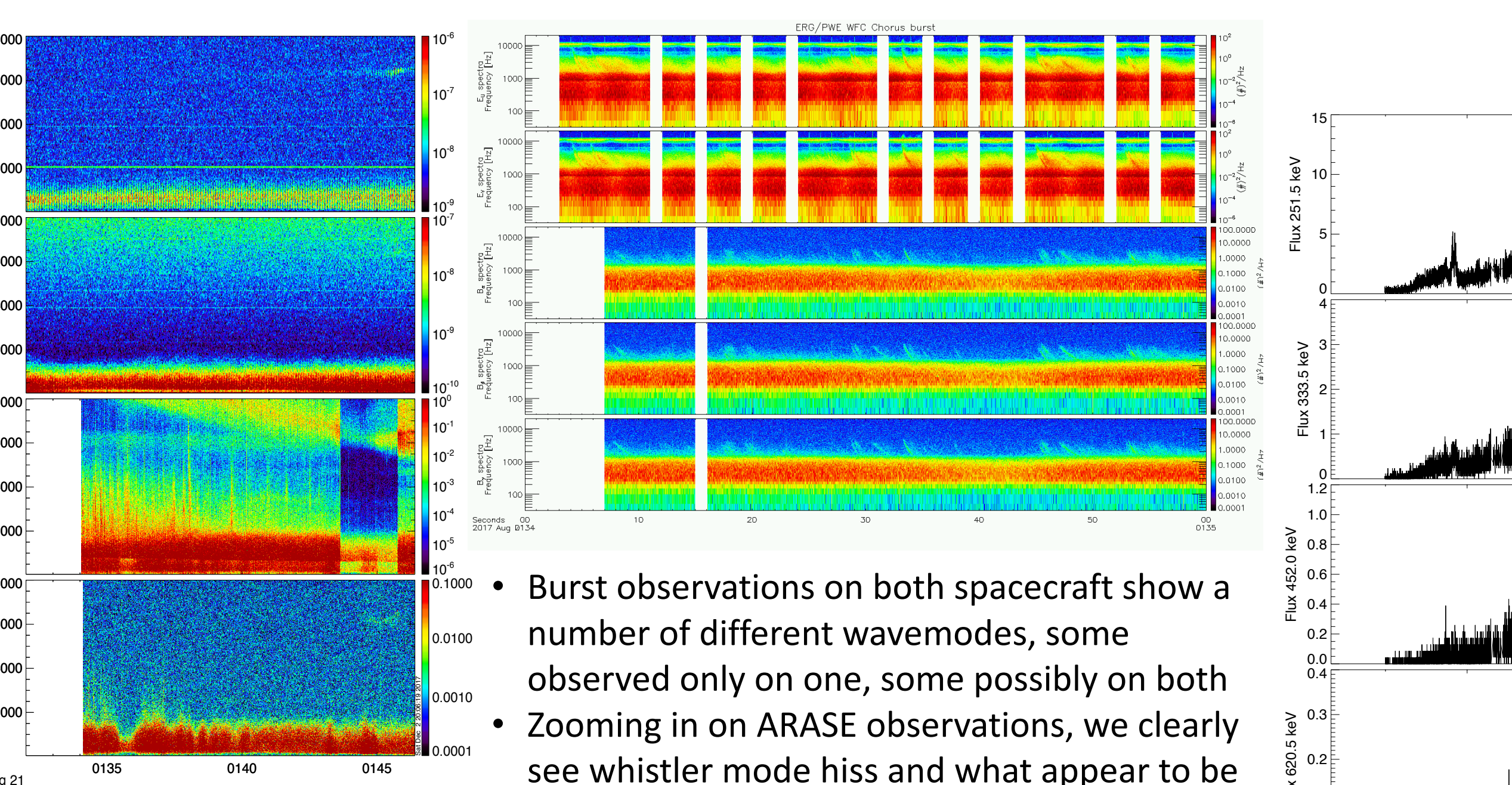
- Multiple waves observed on both RB and ARASE
- Zooming in (right) we see hiss and lightning again, also possibly ECH

Event 4 – correlated hiss waves, and possible chorus elements

Conjunction Event #4 – August 21, 2017

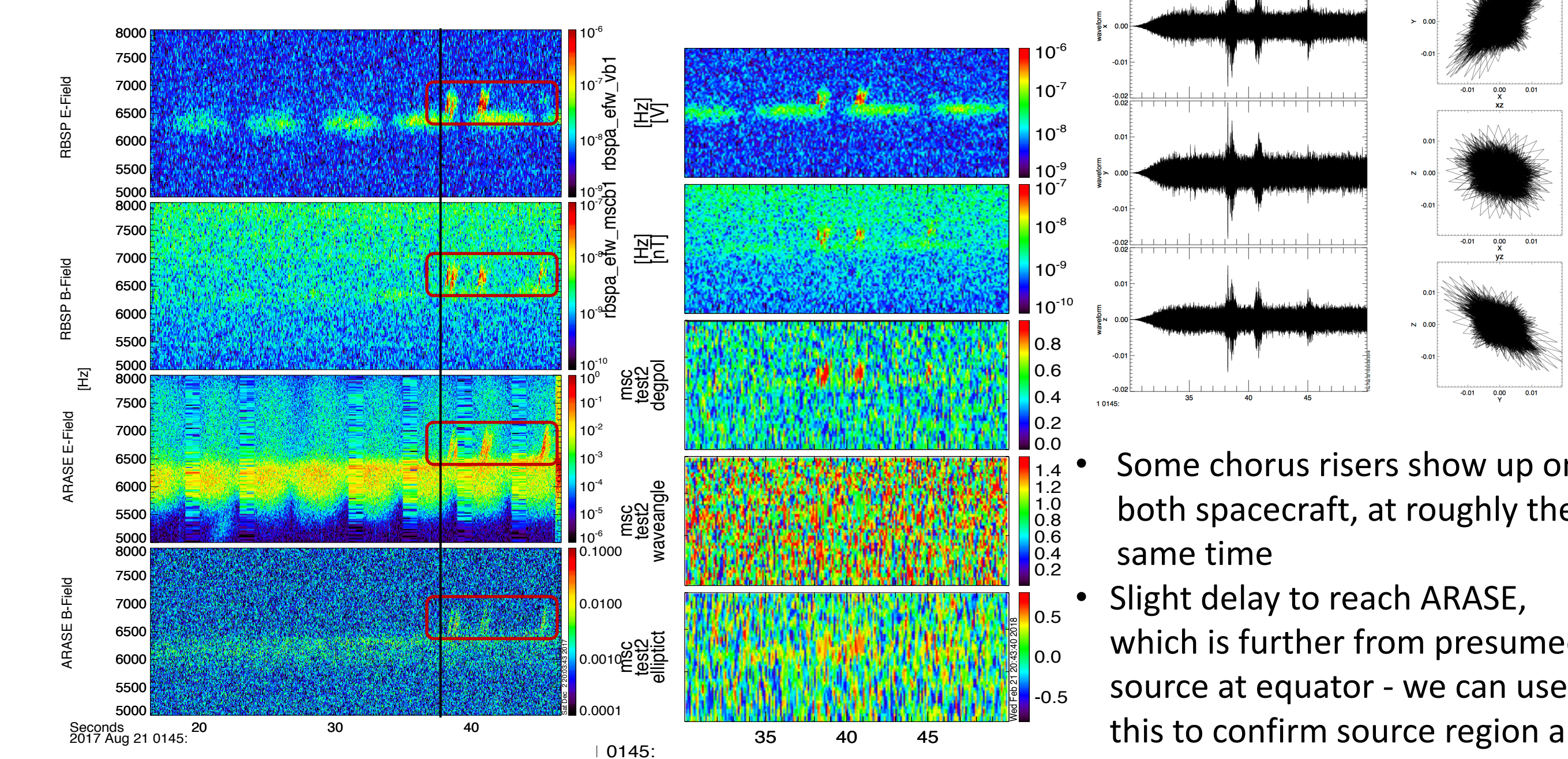


- Afternoon/dusk conjunction at ~ 16 MLT, L=4, UT ~01:30
- Firebird also shown on as it starts moving to dawnside, though they are not collecting at this time



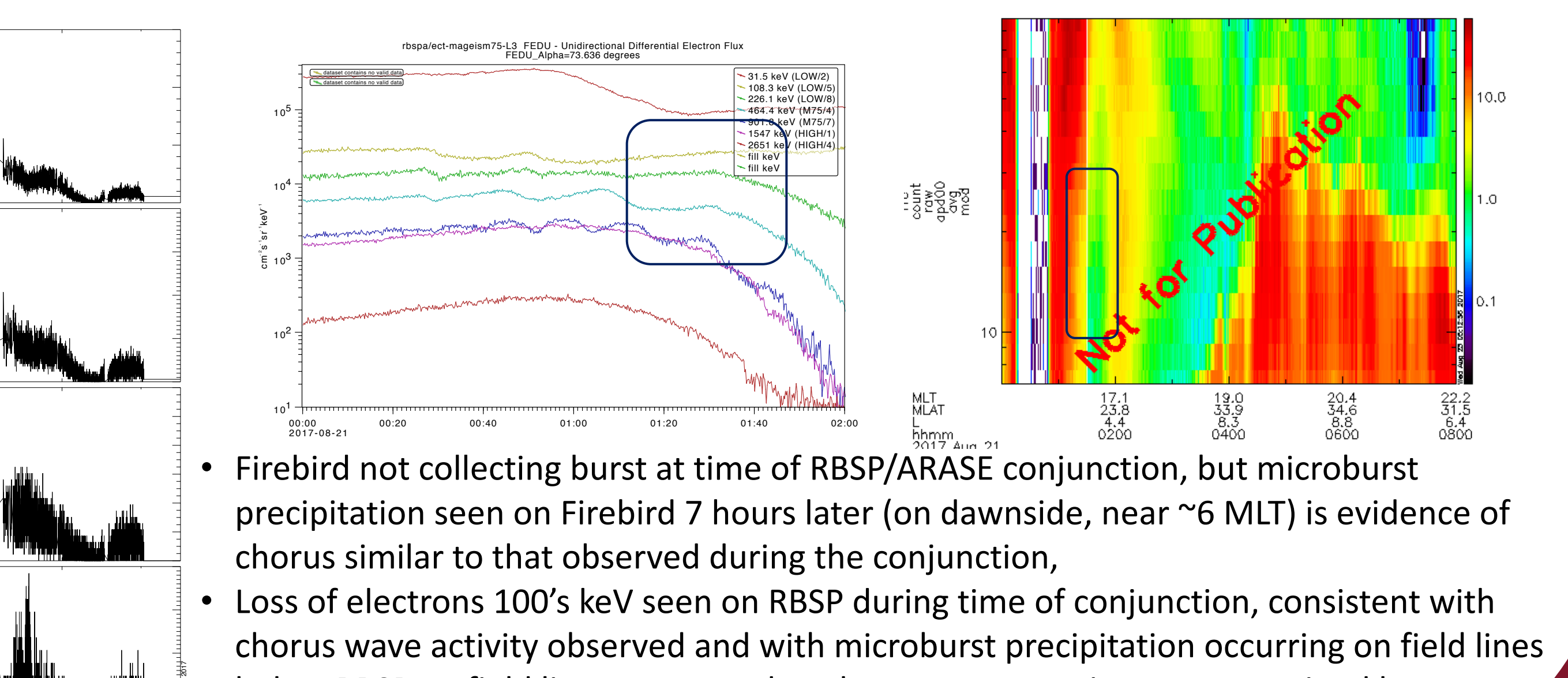
- Burst observations on both spacecraft show a number of different wavemodes, some observed only on one, some possibly on both
- Zooming in on ARASE observations, we clearly see whistler mode hiss and what appear to be lightning whistlers

Electromagnetic chorus waves on RBSP and ARASE



- Some chorus risers show up on both spacecraft, at roughly the same time
- Slight delay to reach ARASE, which is further from presumed source at equator - we can use this to confirm source region and study propagation of individual chorus elements

Firebird observations, particles on RBSP and ARASE



- Firebird not collecting burst at time of RBSP/ARASE conjunction, but microburst precipitation seen on Firebird 7 hours later (on dawnside, near ~6 MLT) is evidence of chorus similar to that observed during the conjunction,
- Loss of electrons 100's keV seen on RBSP during time of conjunction, consistent with chorus wave activity observed and with microburst precipitation occurring on field lines below RBSP on field lines connected to chorus source region, as constrained by Breneman et al. 2017, DOI: 10.1002/2017GL075001
- ARASE preliminary spectral plots may indicate loss in this energy range

Conclusions and future work

- A series of conjunctions between ARASE and RBSP in the inner magnetosphere have been identified, and burst data has been collected and brought to ground from both spacecraft
- These conjunctions provide the opportunity to constrain and/or confirm the source regions of different magnetospheric wave modes, particularly given the different inclinations of the spacecraft
- These waves are known to drive particle acceleration, transport and loss in the magnetosphere including relativistic radiation belt electrons
- Coincident observations of whistler mode hiss, chorus, ECH and lightning whistlers during these conjunctions help constrain the source region and propagation characteristics of these waves
- Calibrated waveform and particle data from ARASE are coming, and will be used for more sophisticated analysis of the properties of these waves