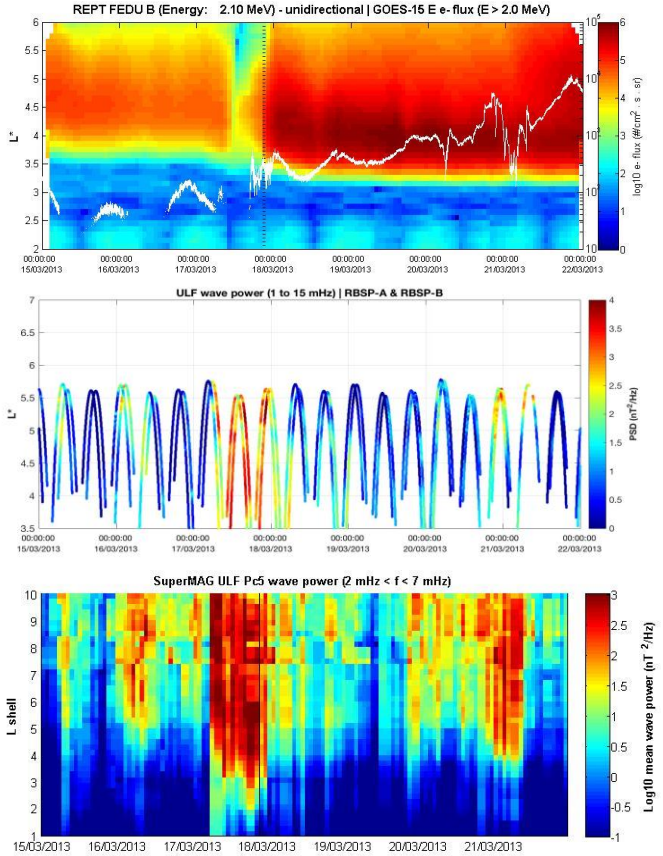
‘Storm-time estimates of radial diffusion from ground- and space-based measurements’

Georgiou, M., Rae, I. J., Daglis, I. A., Sandhu, J. K., Forsyth, C., Zesta, E., Sibeck, D. G., Mann, I. R., and Balasis, G.

Chapman Conference on ‘Particle Dynamics in the Earth’s Radiation Belts’
Cascais, 4 March 2018

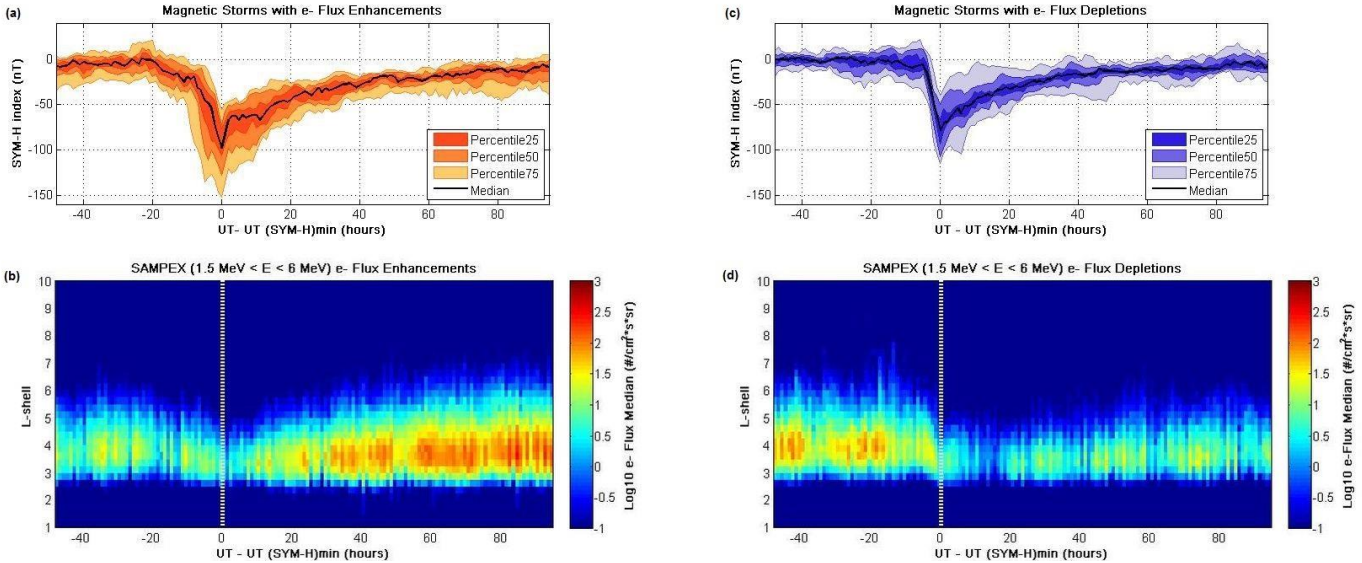


Does radial diffusion lead to energization?

- MeV electron fluxes during 2013 Saint Patrick's day storm show **abrupt localized acceleration** in the outer belt [Baker+ 2014]
- **Enhanced ULF wave activity** observed during the main phase by Van Allen Probes as well as on the ground [Katsavrias+ 2015]
- **Radial diffusion coefficients by global MHD model** improved radial diffusion simulations compared to coefficients parameterized by geomagnetic activity indices [Li+ 2017]

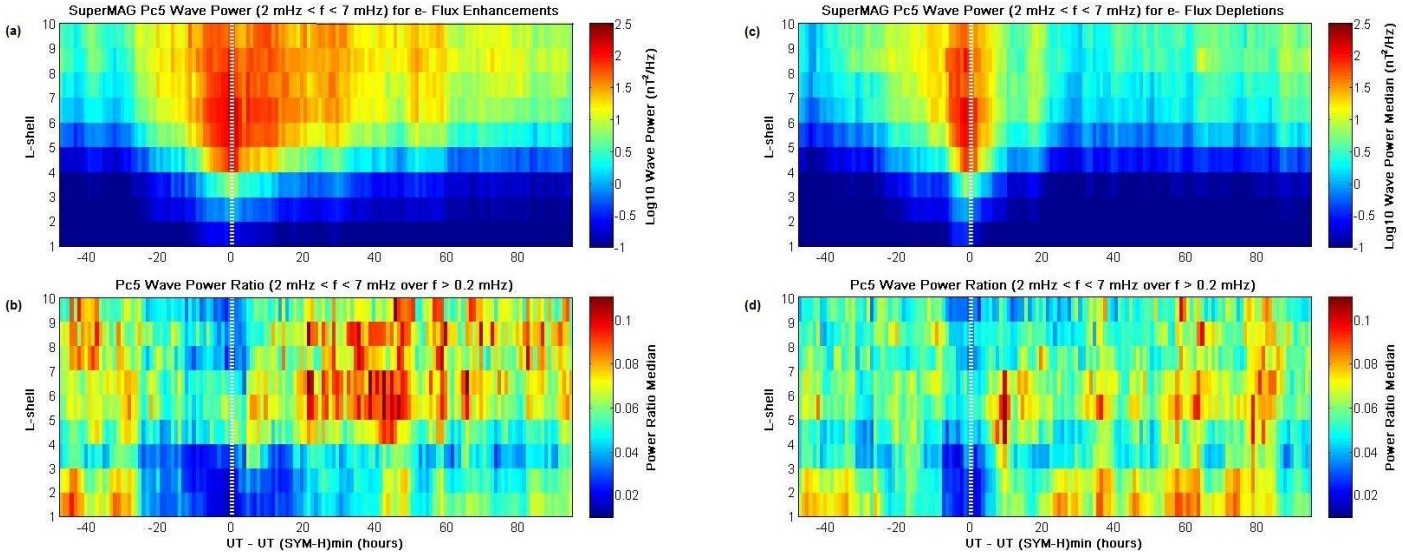
Properties of ULF waves to determine DLL_B and DLL_E

- The **radial profile** of ULF wave activity: radial diffusion coefficients explicitly dependent on L-shell
- Distinct from the azimuthal mode structure of waves is the **azimuthal occurrence** of wave power

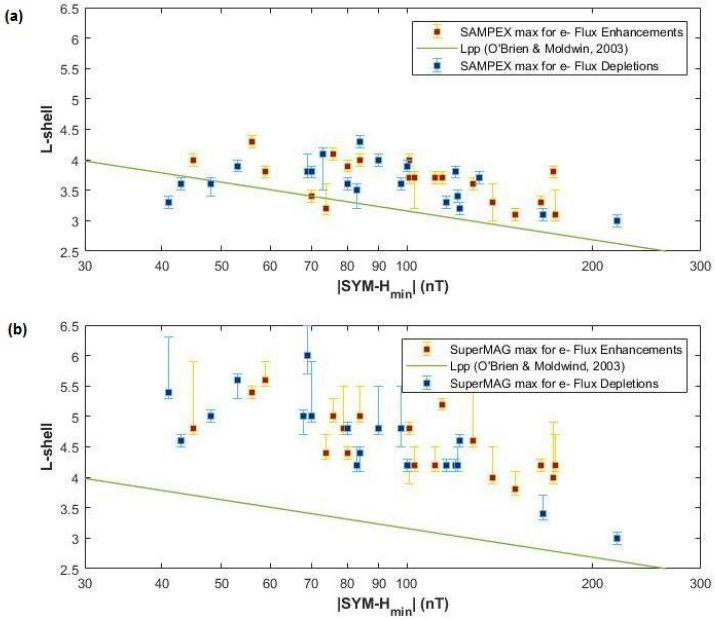


Pc5 wave power versus L-shell

- **Wave activity persisted** up to ~62 hours during storms that resulted in electron flux enhancements [O'Brien+ 2001 & 2003]
- Remarkable penetration of Pc5 wave **power down to L-shells < 3** during the main phase
- **Narrow-band waves suppressed in the main phase** or masked by broadband Pc5 wave activity.



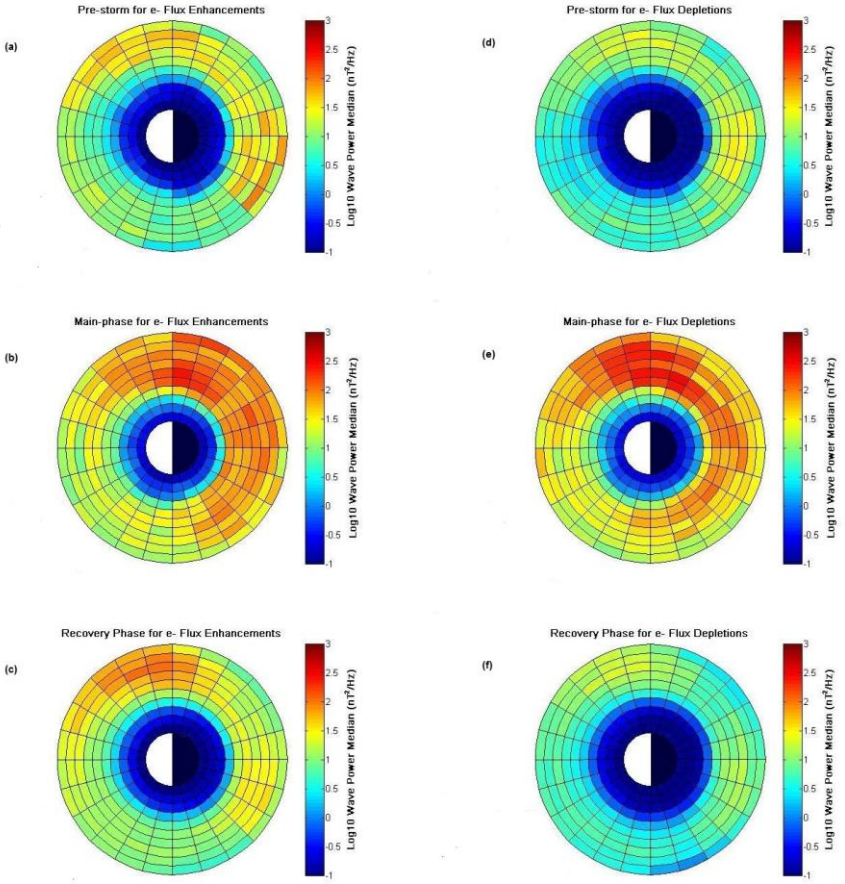
Earthward penetration of wave power



- Response of electron fluxes was proportional to minimum SYM-H (**Spearman's R = 0.46**) [Tverskaya+ 2003]
- Intensity of each storm related to depth of Pc5 wave power penetration (**Spearman's R = 0.54**)

Pc5 wave power versus L-shell and MLT

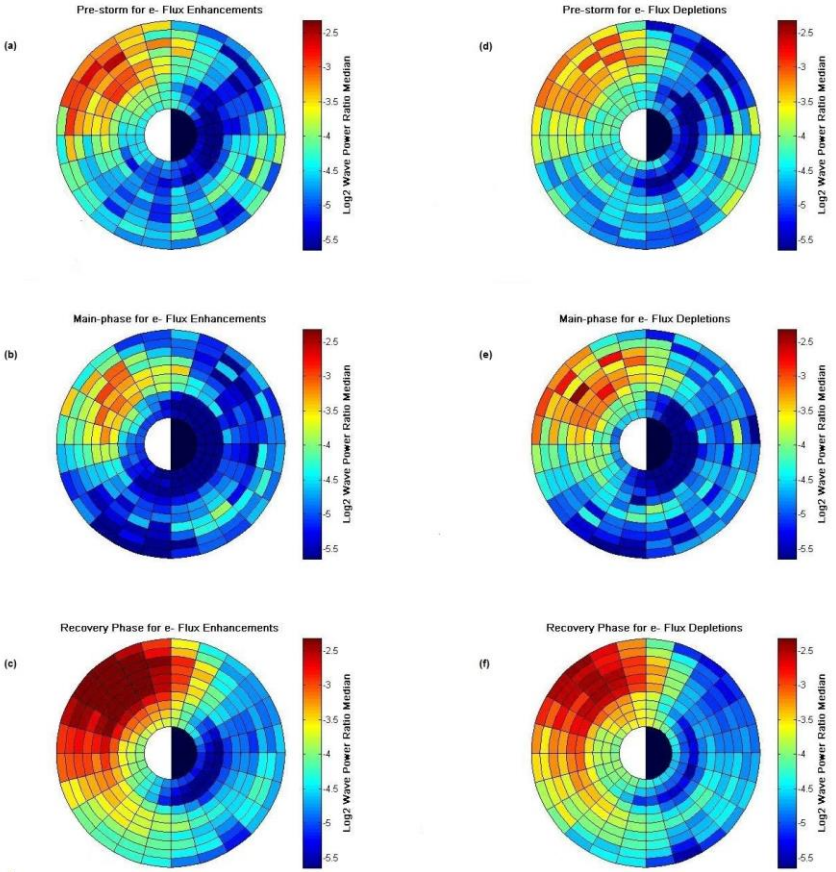
- Broadband wave power concentrated in the **nightside (21:00 - 01:00 MLT)** and **dawn sector(04:00 – 09:00 MLT)**
- **Pc5 wave activity concentrated in the main phase** of both sets of storms and higher in the dawn sector for storms leading to losses
- **Gradual decay towards low L-shells** (external source in the solar wind). Storm-time waves generated by injected ions.



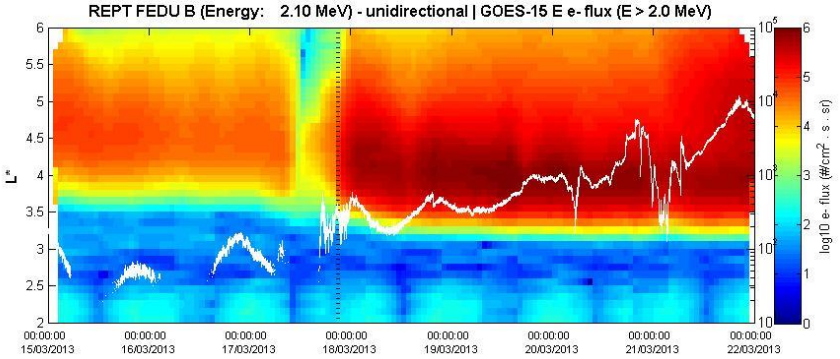
Narrow-band power versus L-shell and MLT

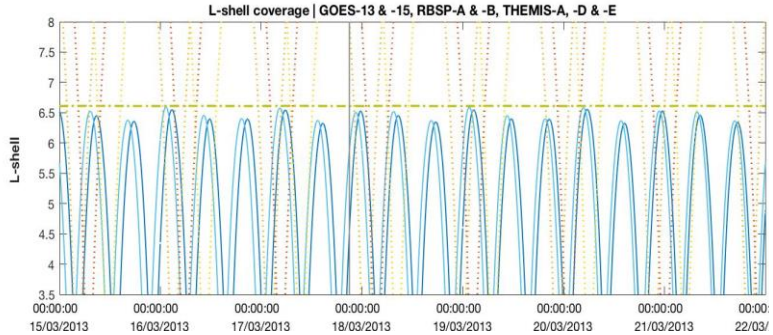
- **Coherent Pc5 wave activity enhanced in the morning sector** (06:00 – 12:00 MLT) in all phases
- Generation mechanism related to **velocity shear** between solar wind and magnetopause.
- Pc5 wave activity is **concentrated in the recovery phase of both** sets of storms and particularly higher in the morning sector of storms producing relativistic electrons.

Georgiou et al. (submitted to JGR)



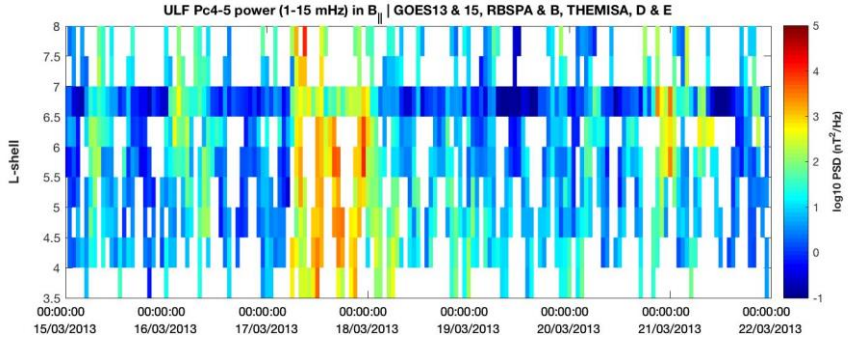
Case study of 2013 Saint Patrick's day storm





Multi-spacecraft Pc5 wave power from:

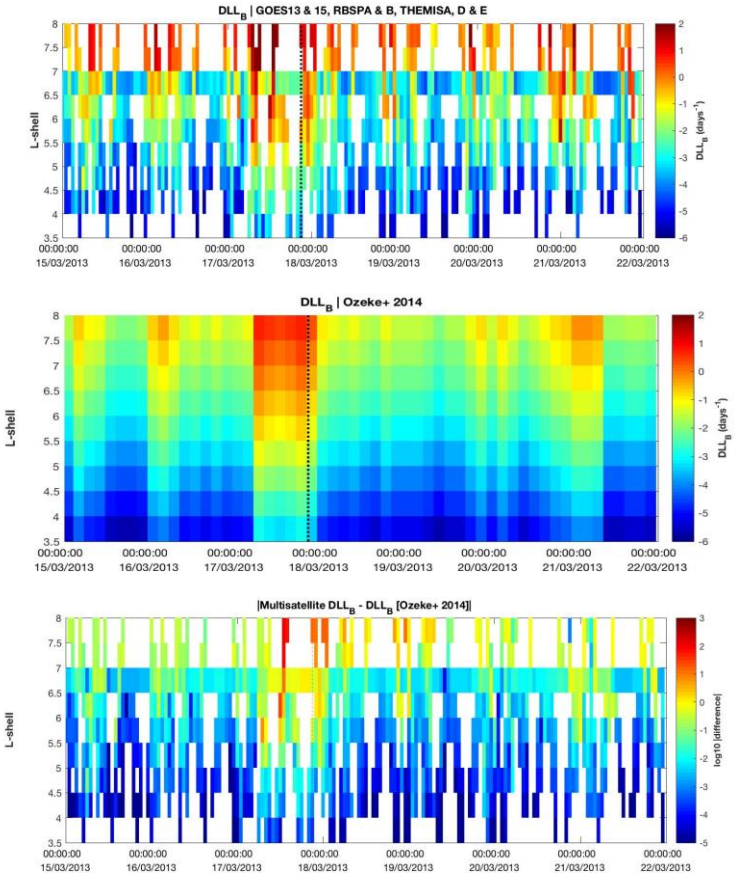
- Van Allen Probes EMFISIS data (4-sec)
- GOES-13 & -15 magnetometer data (.512-sec)
- THEMIS A, D & E FGM data (3-sec)



To determine transport rates

- **Radial and azimuthal extent**, properties of ULF waves required to quantitatively determine the transport coefficients necessary to model interactions between waves and energetic particles

- Coefficients parametrized by a global geomagnetic **overestimate and other times underestimate** activity index transport rates at different regions and storm periods.



Thank you!

This research has been funded in part by
the NERC Highlight Topic Grant #NE/P01738X/1 (Rad-Sat Project)