Spatial distributions of height-integrated conductance & FACs during substorms

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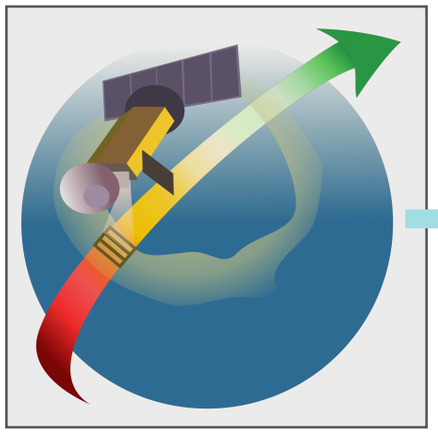
UNIVERSITY OF LEICESTER

DMSP/SSUSI + AMPERE: energy, flux & FACs

DMSP across polar cap F16, F17, F18



Electron precipitation: LBH-long vs LBH-short auroral emissions

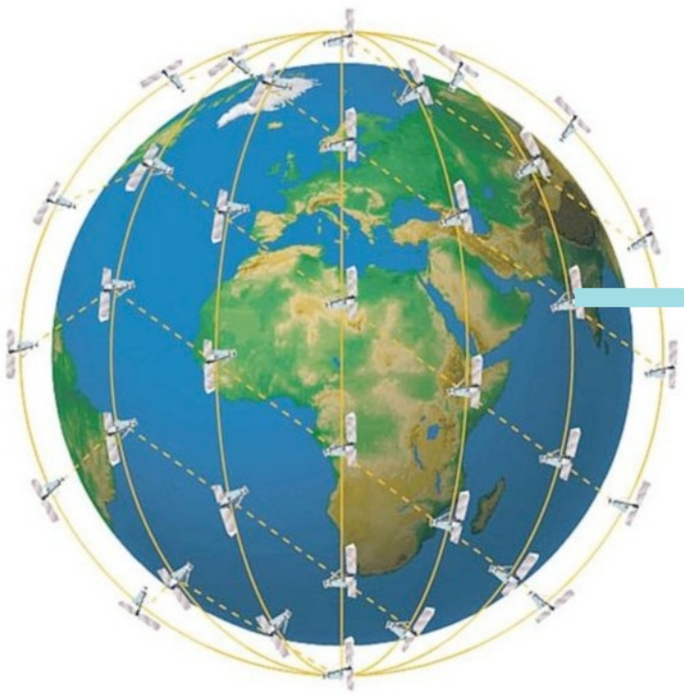
Mean energy
E_0

Mean energy flux
Q

$$\Sigma_P = \frac{40\bar{E}}{16 + \bar{E}^2}\,\Phi_E{}^{1/2}$$

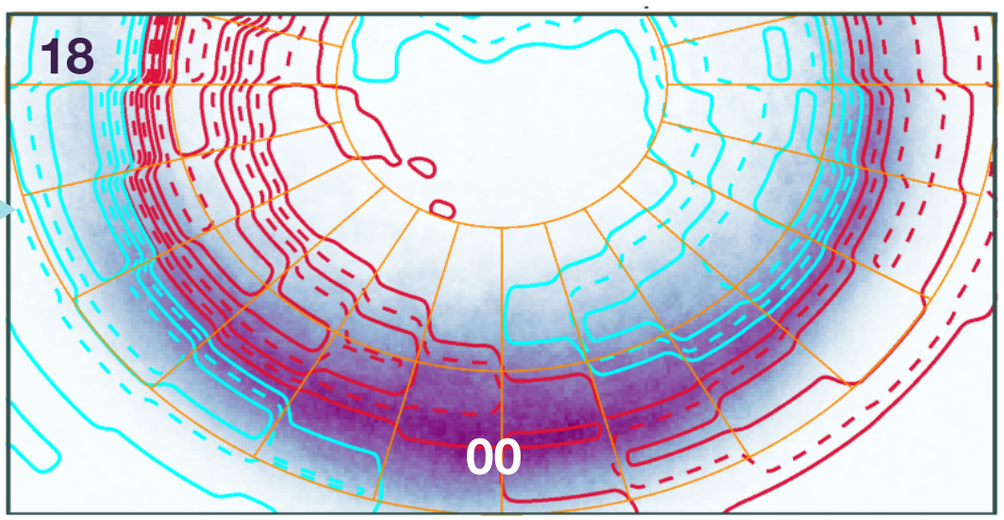
$$\frac{\Sigma_H}{\Sigma_P} = 0.45(\bar{E})^{0.85}$$

Robinson+ 1987



Credit: ICC

Nightside MLT-Mlat grids

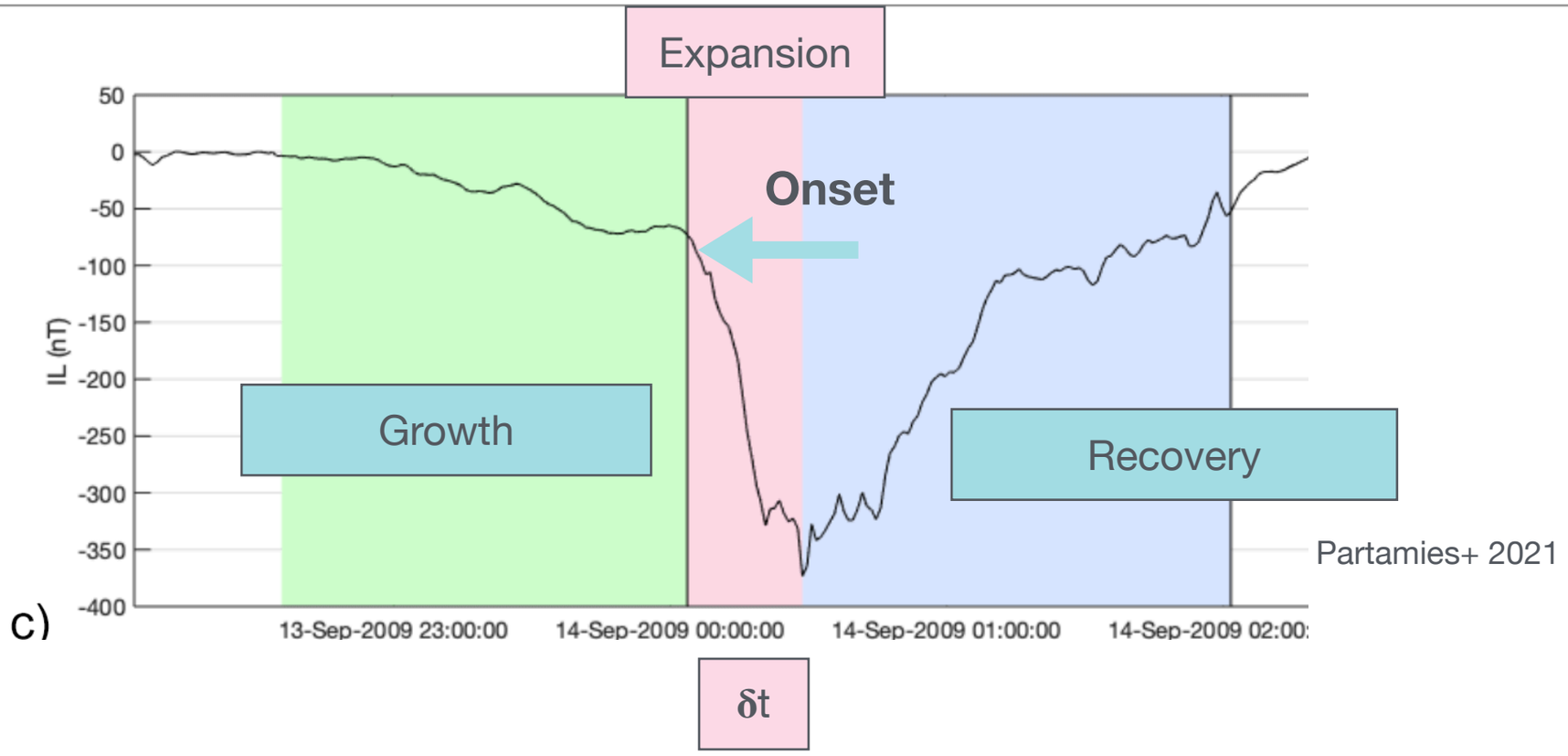


Σ_P, up FAC, down FAC

Advantage: large spatial areas

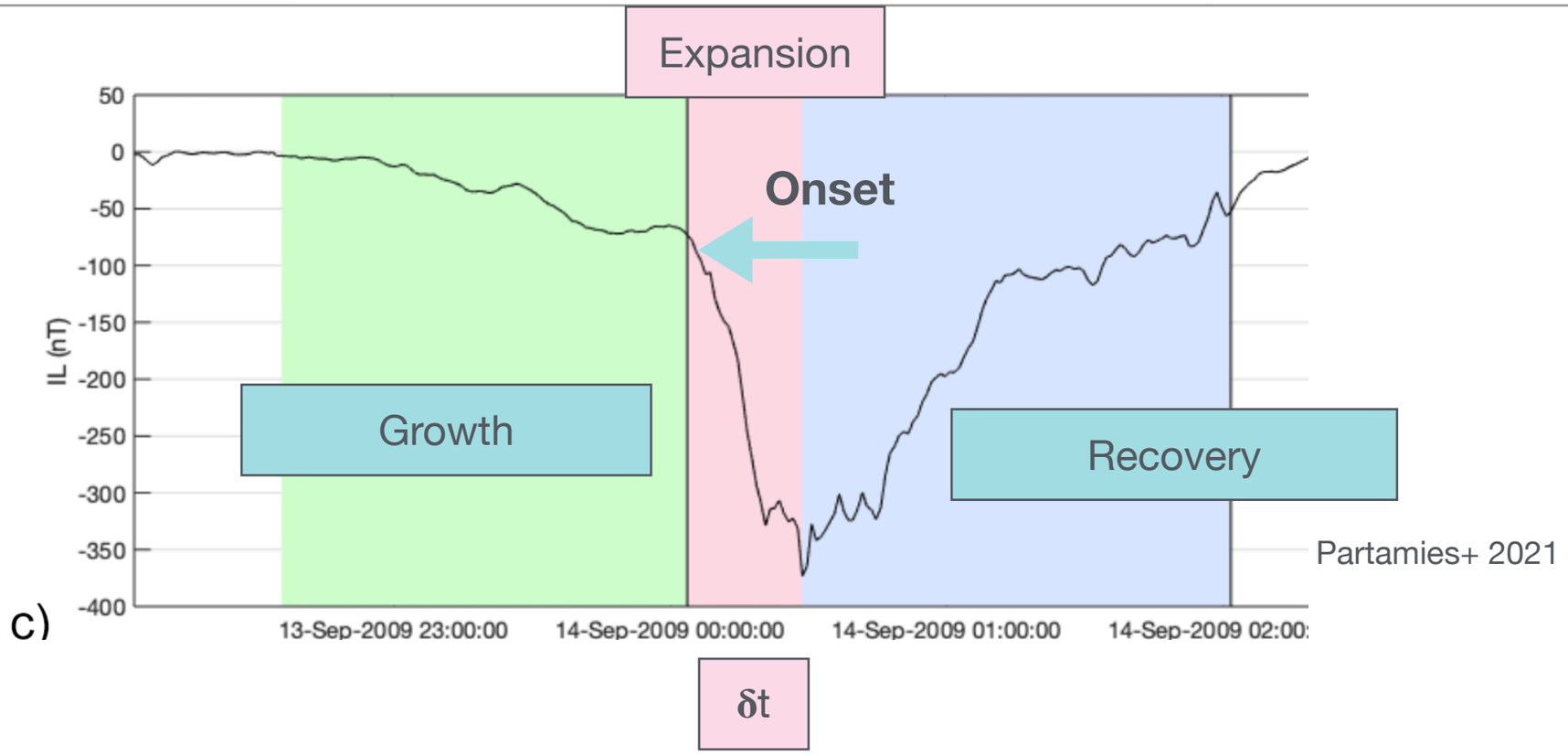
Substorms superposed epoch time grid

Magnetometer trace



Partamies+ 2021

Substorms superposed epoch time grid



Magnetometer trace

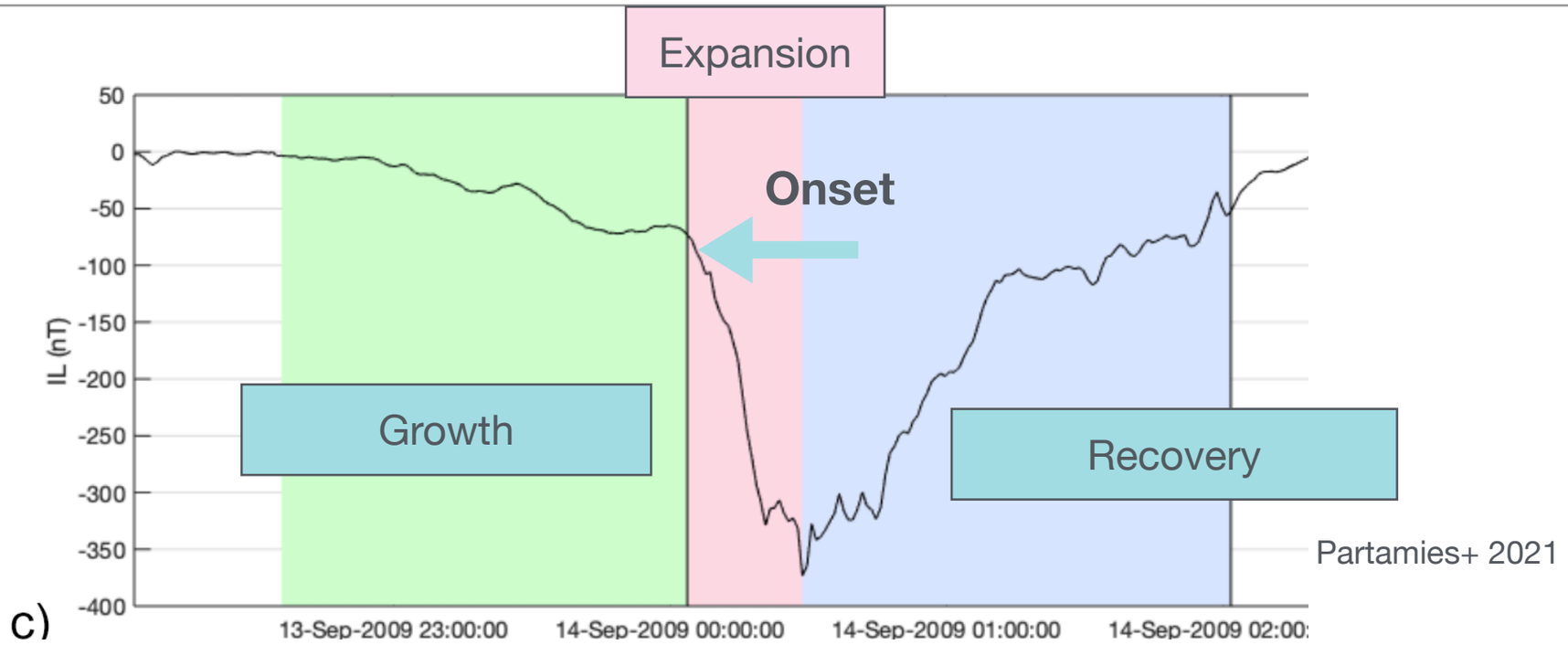
Partamies+ 2021

SOPHIE substorm list Forsyth+ 2015

SSUSI data set & AMPERE data set In SH

Split by magnetic latitude of onset

Substorms superposed epoch time grid



Magnetometer trace

Partamies+ 2021

δt

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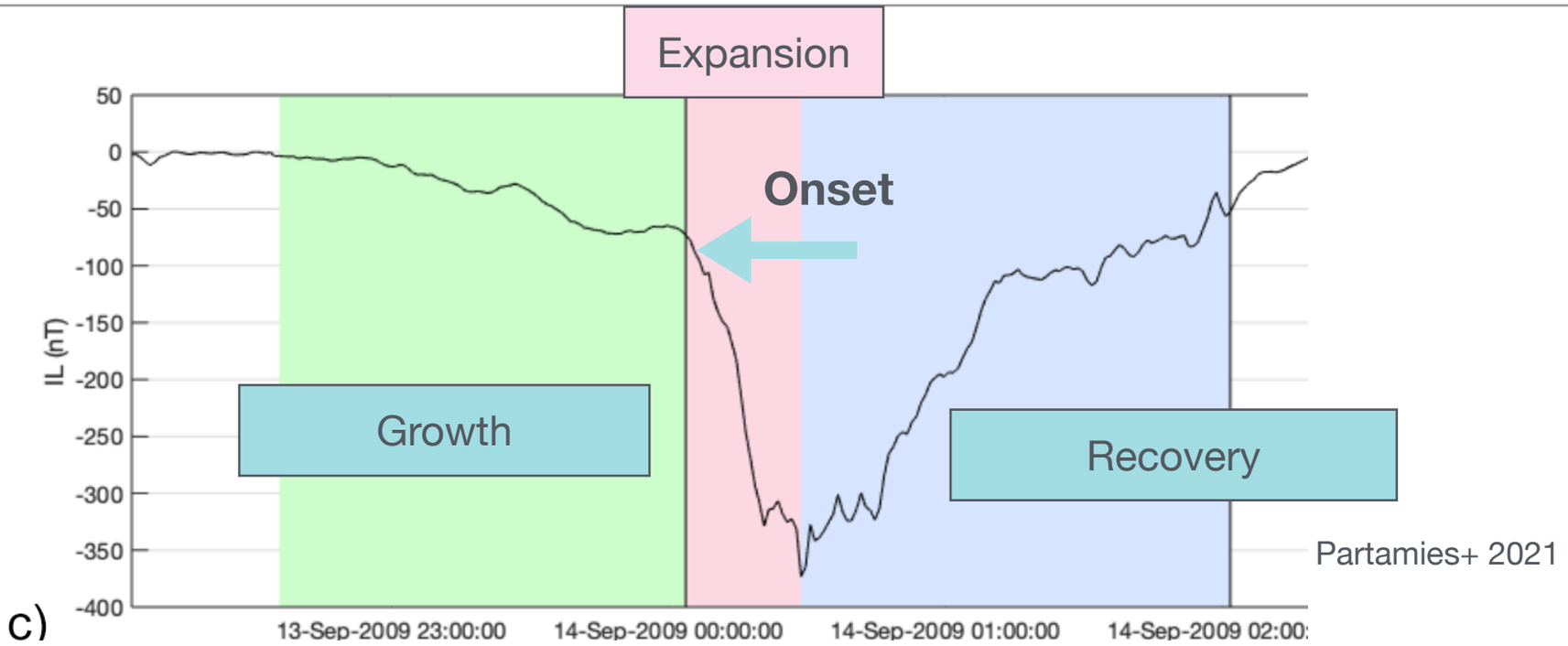
SSUSI data set & AMPERE data set In SH

Split by magnetic latitude of onset

0.25 δt steps

Substorms superposed epoch time grid



Magnetometer trace

Partamies+ 2021

δt

SOPHIE substorm list Forsyth+ 2015

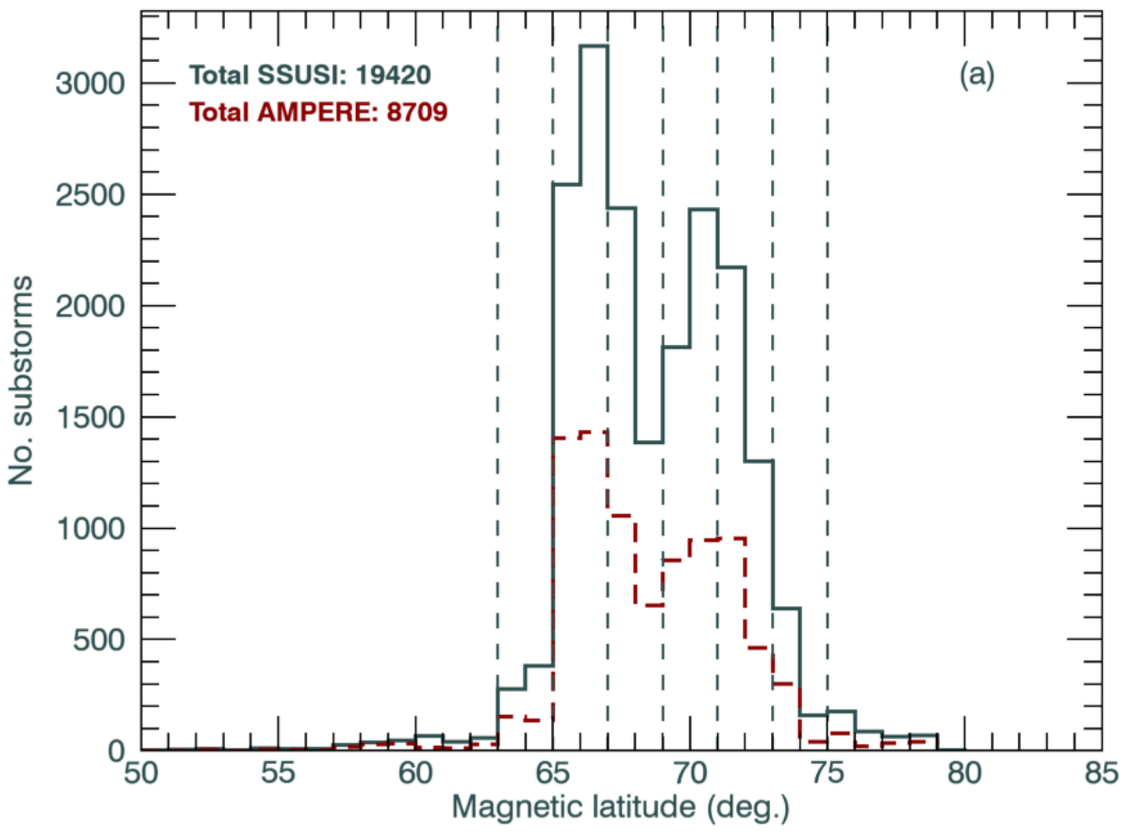
SSUSI data set & AMPERE data set In SH

Split by magnetic latitude of onset

0.25 δt steps

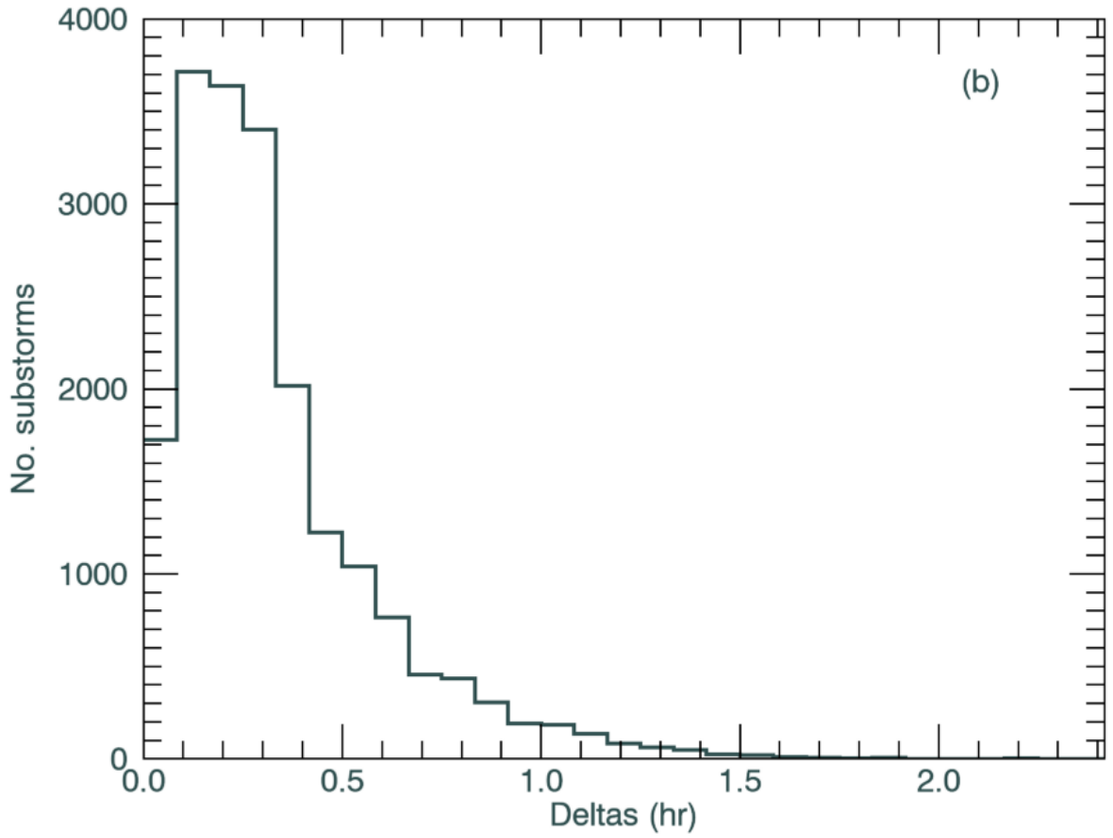
Time series of mean energy, energy flux, conductance, FACs

The data sets: auroral emissions, FACs, substorms



DMSP/SSUSI list
AMPERE list

Bins from magnetic latitudes:
50° - 63°, 63° - 65°, 65° - 67°,
67° - 69°, 69° - 71°, 71° - 90°



SOPHIE substorm list
Forsyth+ 2015

Modal δt = 0.15 hr or 9 min

Variable grid: -2δt to +4δt, 0.25δt steps

-1.00 δt, Σ_P

-0.75 δt, Σ_P

-0.50 δt, Σ_P

-0.25 δt, Σ_P

Σ_P (mho)

10.00 9.00 8.00 7.00 6.00 5.00 4.00 3.00

Difference from previous time step

Increase, **decrease**

-16.00 -32.00 -48.00 -64.00 -80.00

Onset

0.00 δt, Σ_P

0.25 δt, Σ_P

0.50 δt, Σ_P

0.75 δt, Σ_P

10.00 9.00 8.00 7.00 6.00 5.00 4.00 3.00 2.00 1.00 0.00

80.00 64.00 48.00 32.00 16.00 0.00 16.00 32.00 48.00 64.00 80.00

(%)

1.00 δt, Σ_P

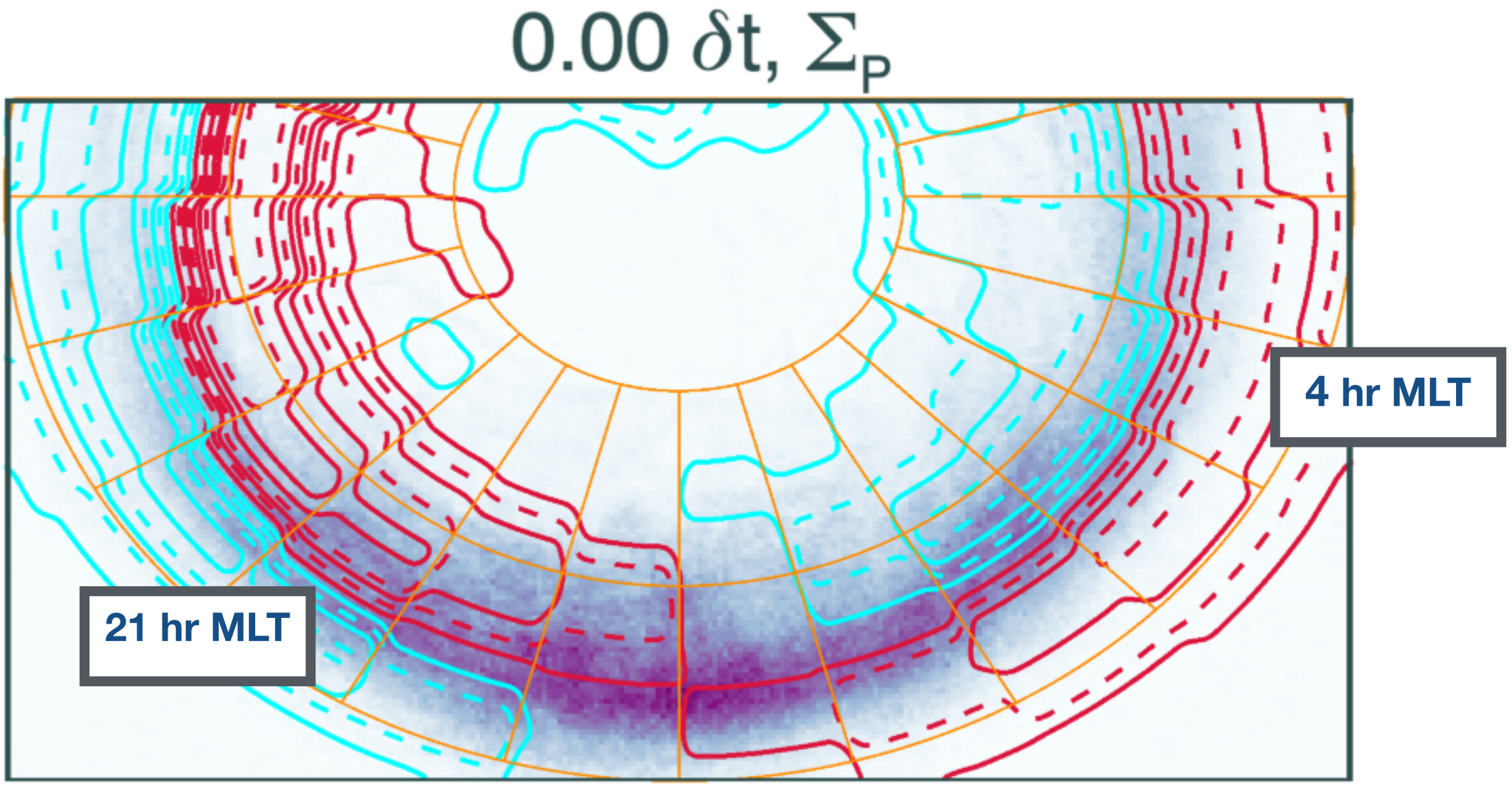
1.25 δt, Σ_P

1.50 δt, Σ_P

1.75 δt, Σ_P

Variable time grid: 63° - 65°

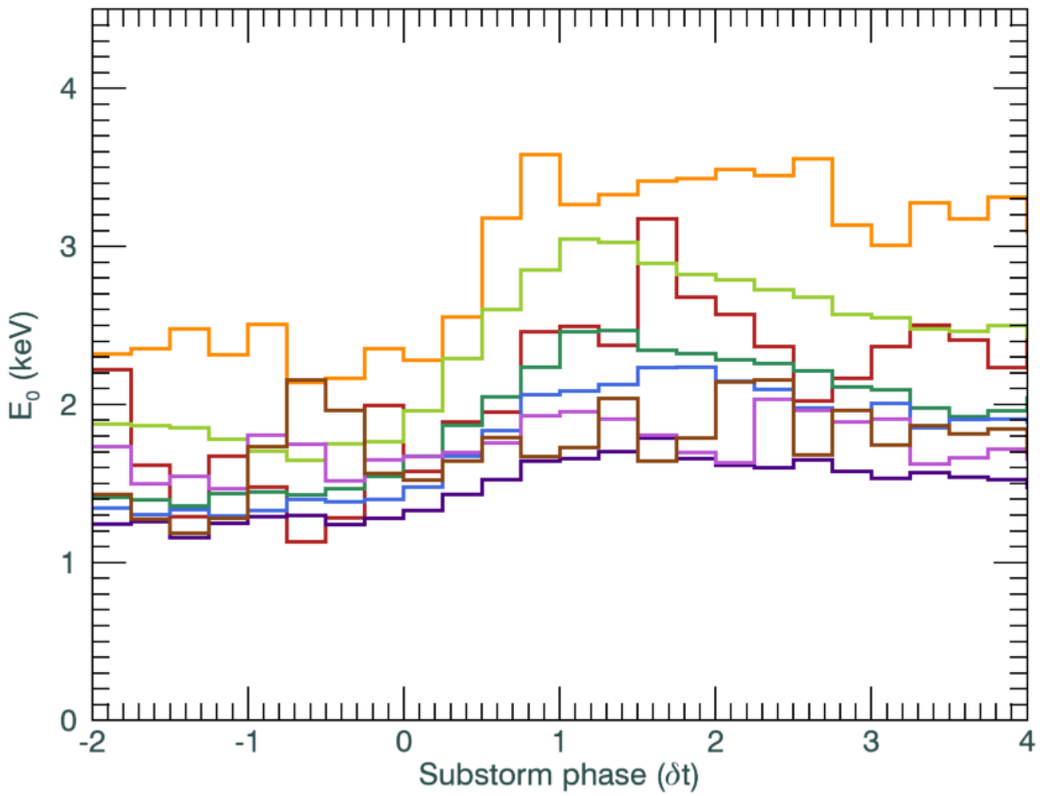
SSUSI parameters: 21 hr to 4 hr MLT, 10° to 35° co-latitude



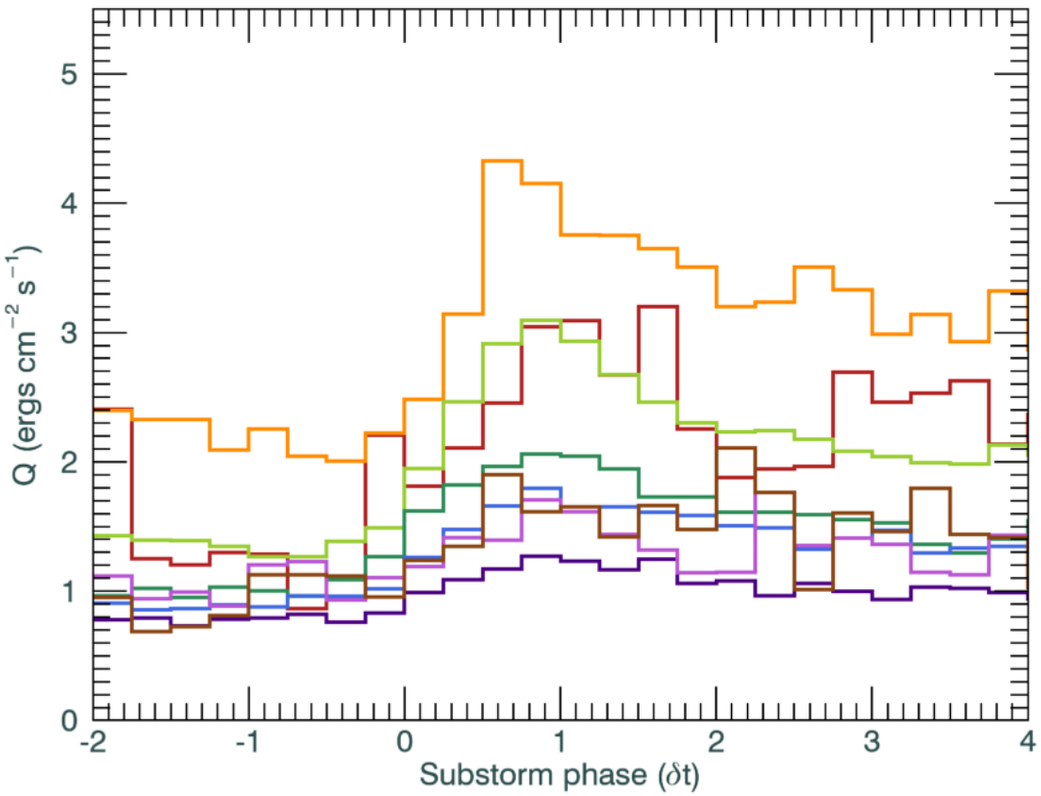
- M.Lat. = 50° - 63°
- M.Lat. = 63° - 65°
- M.Lat. = 65° - 67°
- M.Lat. = 67° - 69°
- M.Lat. = 69° - 71°
- M.Lat. = 71° - 73°
- M.Lat. = 73° - 75°
- M.Lat. = 75° - 90°

Variable time grid, by magnetic latitude

Mean energy, E_0



Mean energy flux, Q



Broadly ordered by magnetic latitude

Mag. lats largest values, largest change: 63° - 65°

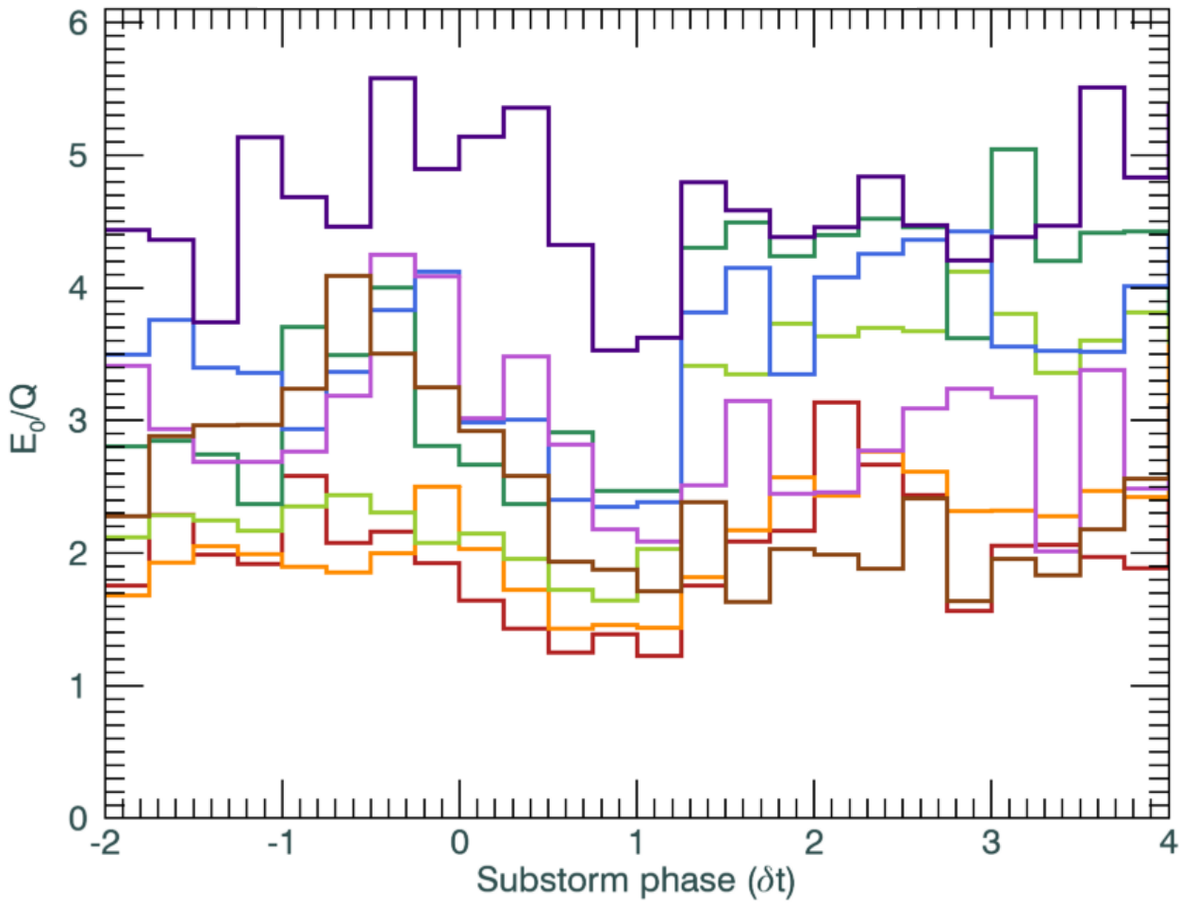
Peak ~< 1.25 δt after onset

Lower latitude onsets - longer duration

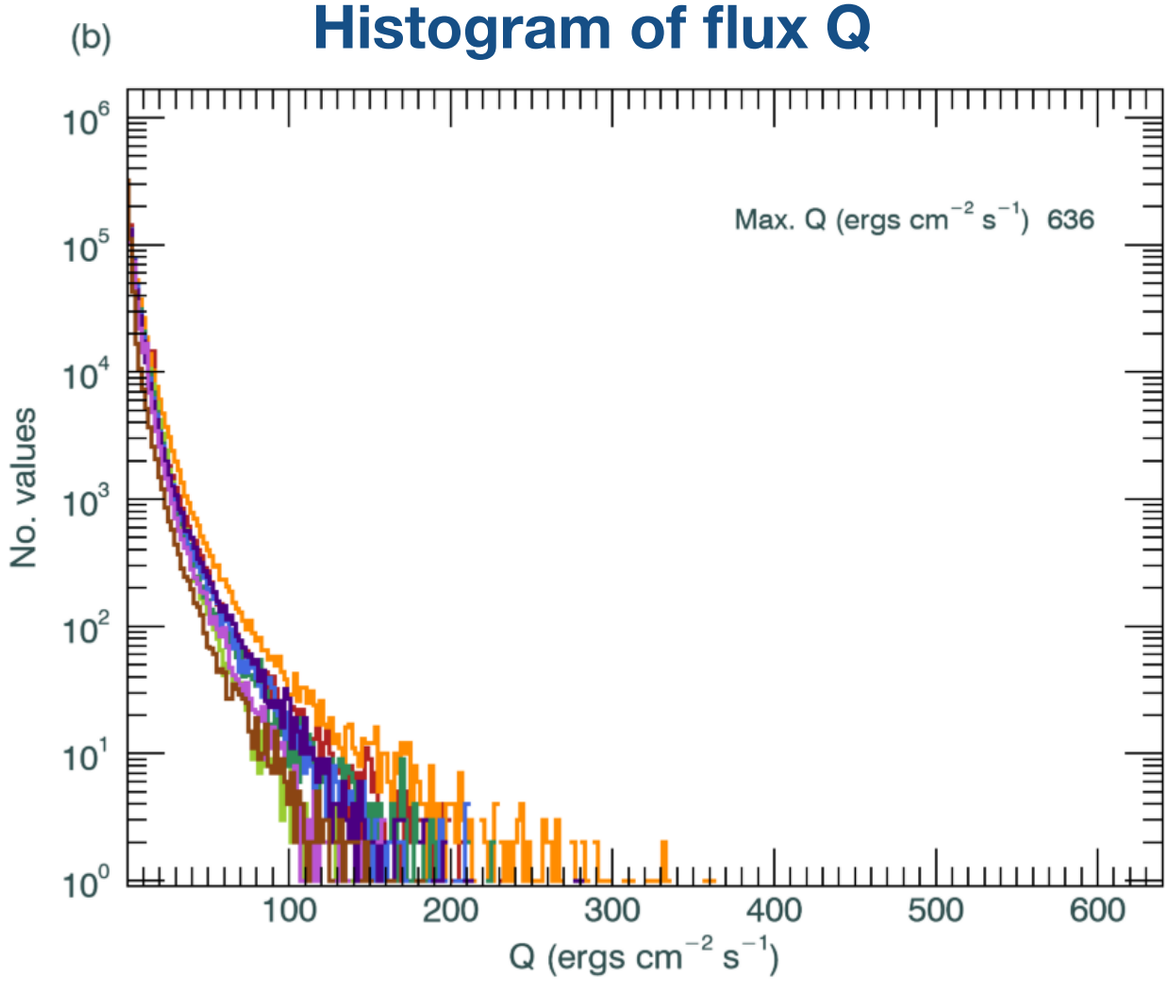
- M.Lat. = 50° - 63°
- M.Lat. = 63° - 65°
- M.Lat. = 65° - 67°
- M.Lat. = 67° - 69°
- M.Lat. = 69° - 71°
- M.Lat. = 71° - 73°
- M.Lat. = 73° - 75°
- M.Lat. = 75° - 90°

Variable time grid, by magnetic latitude

E_0/Q



Histogram of flux Q

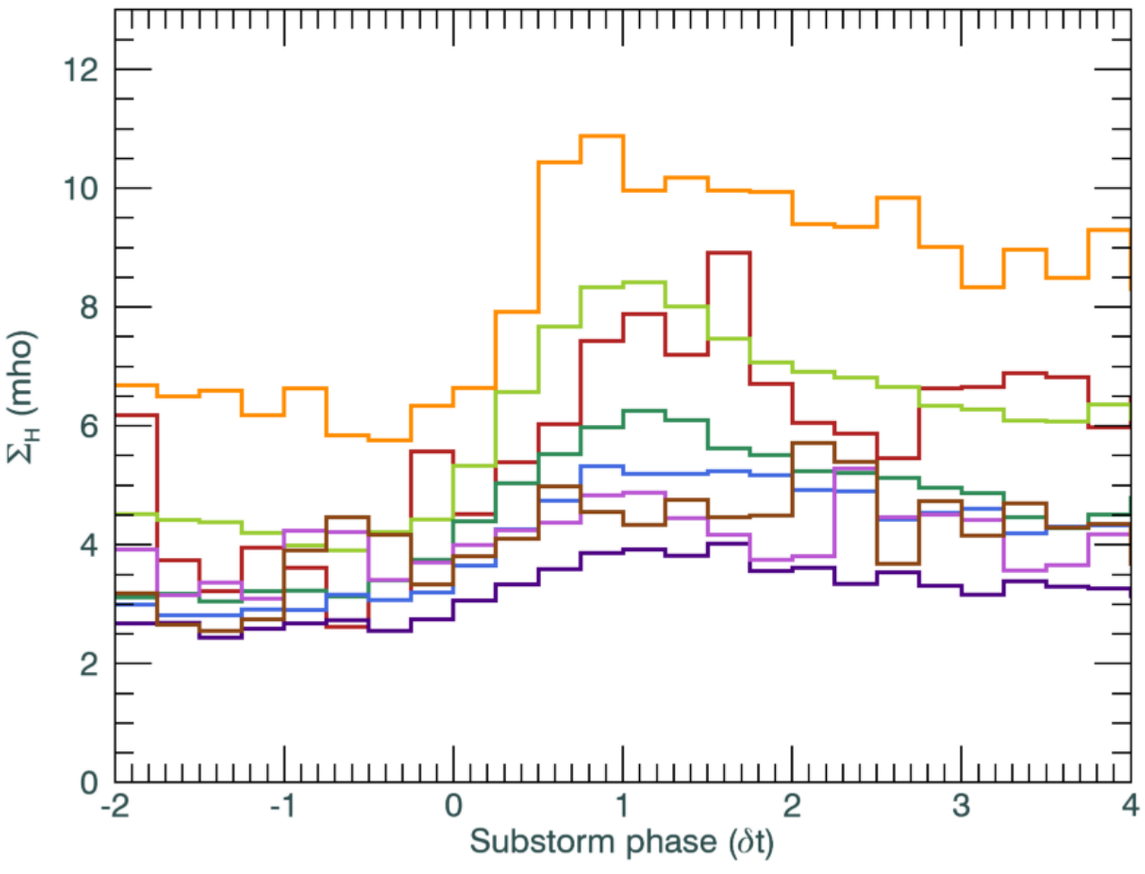


Increase in flux Q driving change in ratio

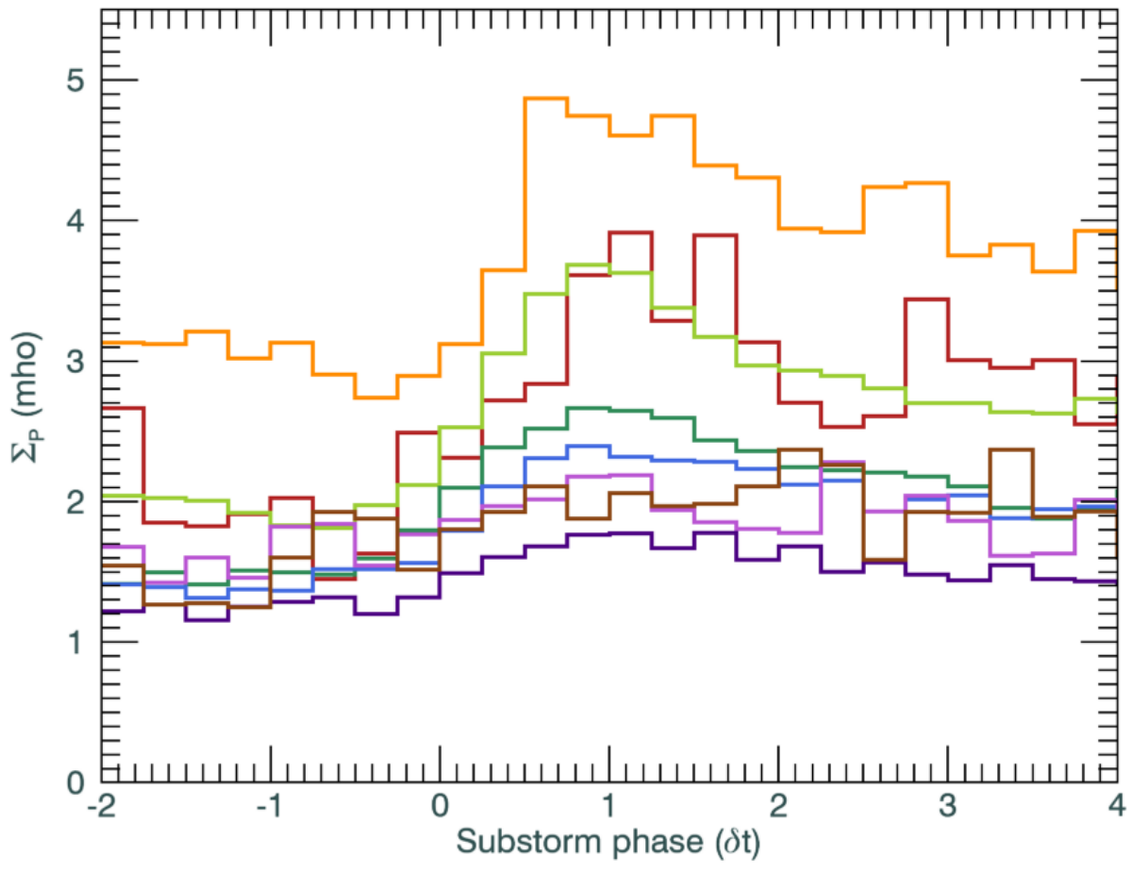
- M.Lat. = 50° - 63°
- M.Lat. = 63° - 65°
- M.Lat. = 65° - 67°
- M.Lat. = 67° - 69°
- M.Lat. = 69° - 71°
- M.Lat. = 71° - 73°
- M.Lat. = 73° - 75°
- M.Lat. = 75° - 90°

Variable time grid, by magnetic latitude

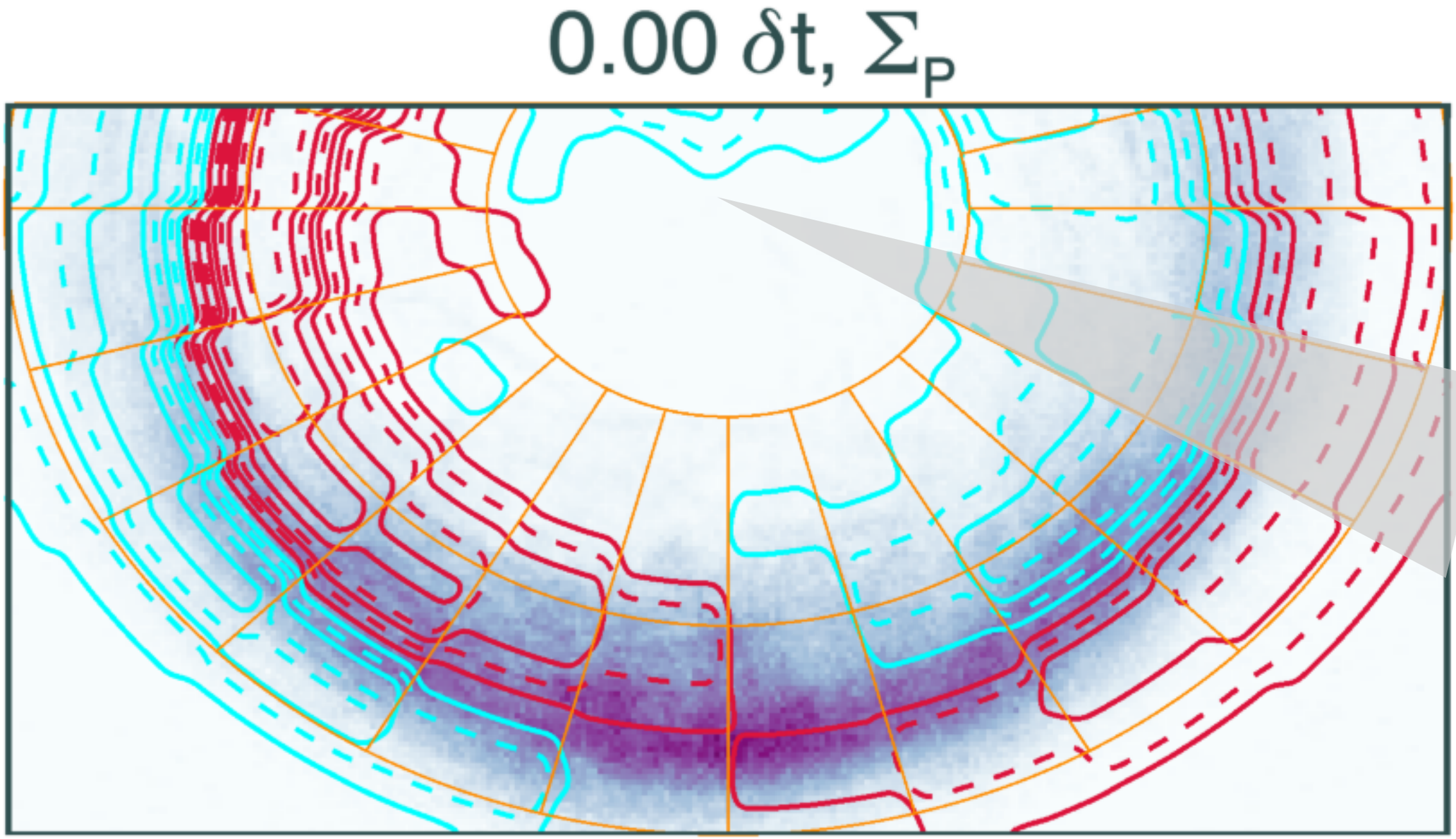
Σ_H



Σ_p



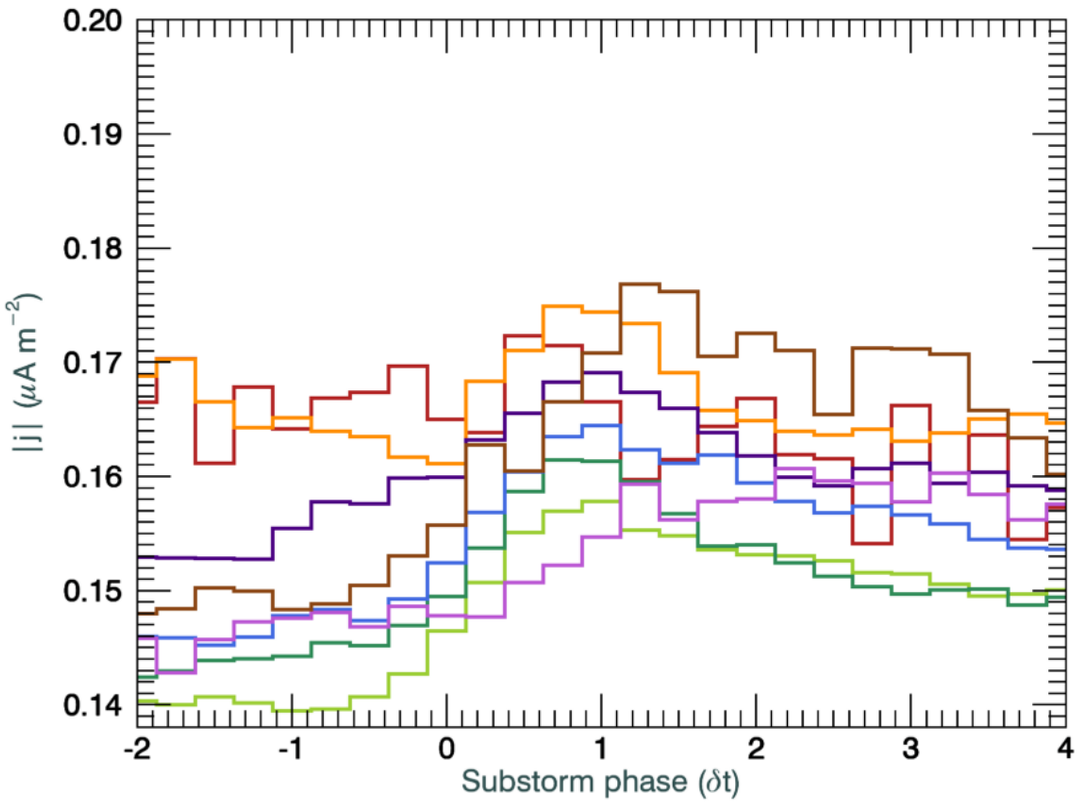
FACs: 4 hr to 5 hr MLT



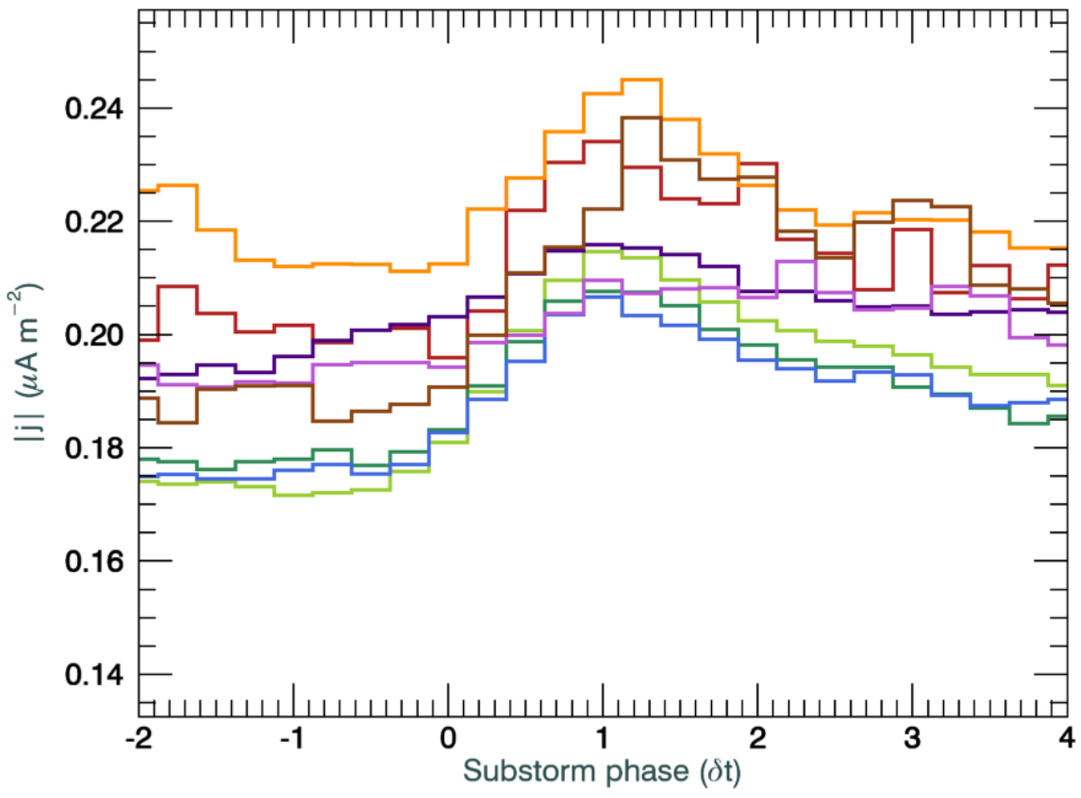
- M.Lat. = 50° - 63°
- M.Lat. = 63° - 65°
- M.Lat. = 65° - 67°
- M.Lat. = 67° - 69°
- M.Lat. = 69° - 71°
- M.Lat. = 71° - 73°
- M.Lat. = 73° - 75°
- M.Lat. = 75° - 90°

Variable time grid, by magnetic latitude

FACs - up (R2)



FACs - down (R1)



Mean up FACs (R2) ~ordered by magnetic latitude, highest bin exception

Mean down FACs (R1) ordered by magnetic latitude

Lowest onset substorms give highest FAC j, behaviour over substorm clearer

Peak ~< 1.25 δt after onset cf. SSUSI results

Similar recovery time for majority of onset latitudes

Summary & Conclusions

- Height-integrated conductances & FACs by substorm phase & magnetic latitude of onset
- Time grid based on expansion phase
- Carter+ 2020: https://doi.org/10.1029/2020JA028121
- Carter+ 2022 in prep
- Statistical maps may be useful for primers for global M-I-T models: testing
    - Disadvantage: not height resolved
    - Benefits: large spatial regions ~simultaneously
- Energies, fluxes, conductances, and FACs
        - ~ordered by magnetic latitude, lowest = largest values
- Largest energies, fluxes, conductances and FACs for magnetic latitudes 63°-65°
    - Optimal onset latitude
    - Brightest longest duration aurora -> largest conductances -> consistent with literature