Revisiting the relationship between PRE and ESF with Jicamarca ISR measurements made over the past 2 solar cycles

F. S. Rodrigues[1], J. M. Smith[1,*], B. G. Fejer[2], and M. Milla[3]

1. The University of Texas at Dallas, Richardson, TX, USA

* Now at Texas Instruments, Dallas, TX

2. Utah State University, Logan, UT

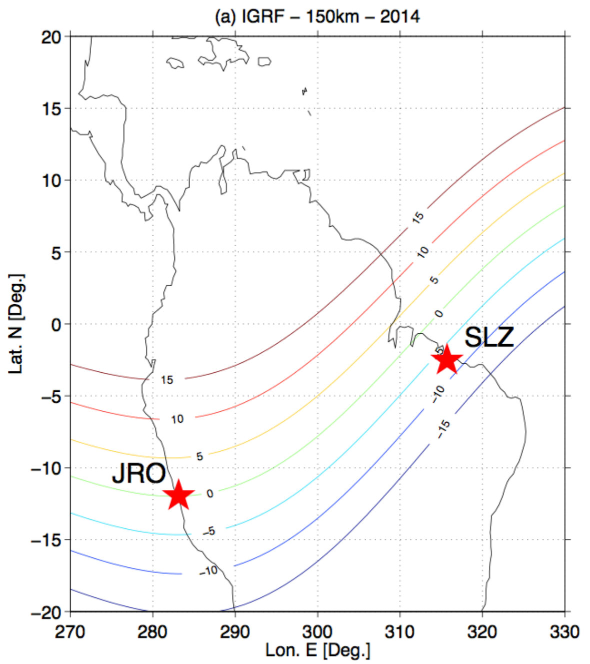
3. Jicamarca Radio Observatory, Lima, Peru

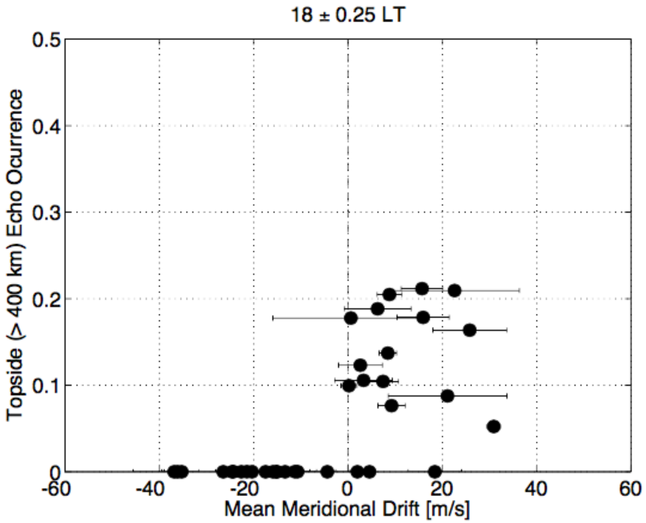
2016 Joint CEDAR-GEM Workshop, Santa Fe – NM, June 19-24, 2016.

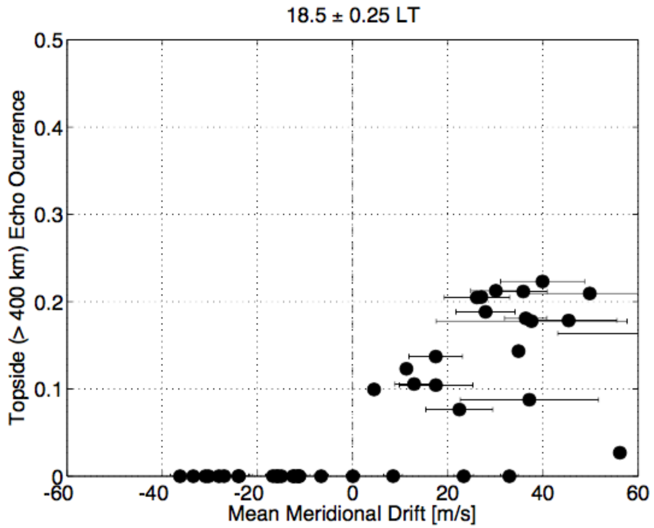
Introduction

- F-region height (controlled by PRE) is recognized as the most important parameter controlling ESF (e.g. Fejer et al., 1999; Basu et al., 1996; Abdu, 2001; Anderson et al., 2004; Retterer and Gentile, 2009, etc.)
- To which extent can ESF be explained by evening vertical drifts alone?
- Follow-up of the study by Fejer *et al.* (1999)
  - Used JRO ISR measurements between 1968 – 1992
  - Considered weak (BT) and strong (BS and TS) ESF
  - Proposed that most of ESF occ. can be explained by the PRE

Motivation

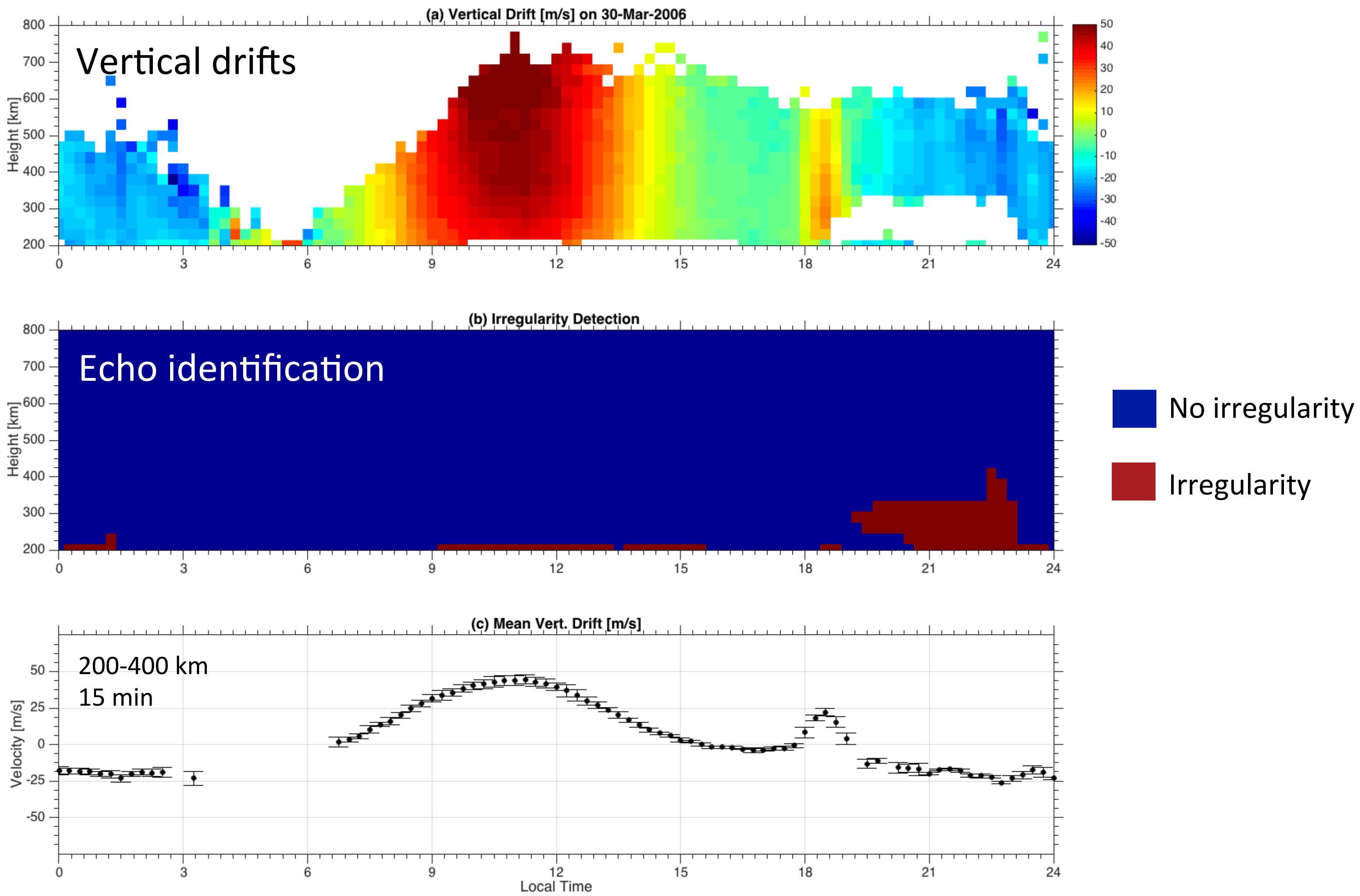






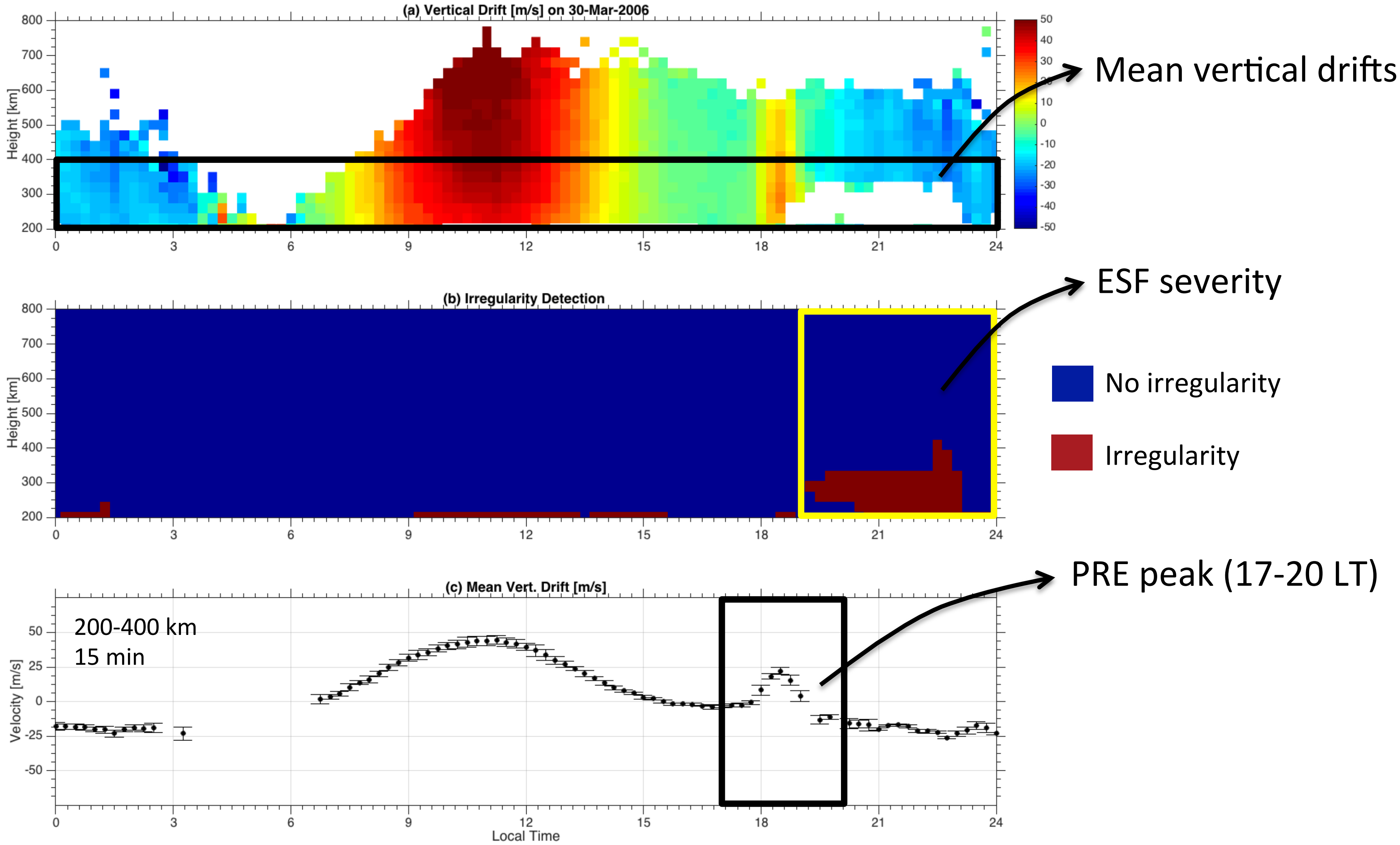
1. Absence of ESF when drifts < ~0 m/s (Smith *et al.*, JGR, 2015)
2. Studies suggesting different threshold values for PRE
3. Higher quality drift measurements started in 1994 (Kudeki *et al.*, 1999)
4. SNR and drifts available: Allows for different metrics for PRE intensity and ESF severity

Analysis



(a) Vertical Drift [m/s] on 30-Mar-2006
Vertical drifts
Height [km]
(b) Irregularity Detection
Echo identification
No irregularity
Irregularity
(c) Mean Vert. Drift [m/s]
200-400 km
15 min
Velocity [m/s]
Local Time

Analysis


(a) Vertical Drift [m/s] on 30-Mar-2006
Height [km]
Mean vertical drifts
(b) Irregularity Detection
ESF severity
No irregularity
Irregularity
(c) Mean Vert. Drift [m/s]
200-400 km
15 min
Velocity [m/s]
Local Time
PRE peak (17-20 LT)

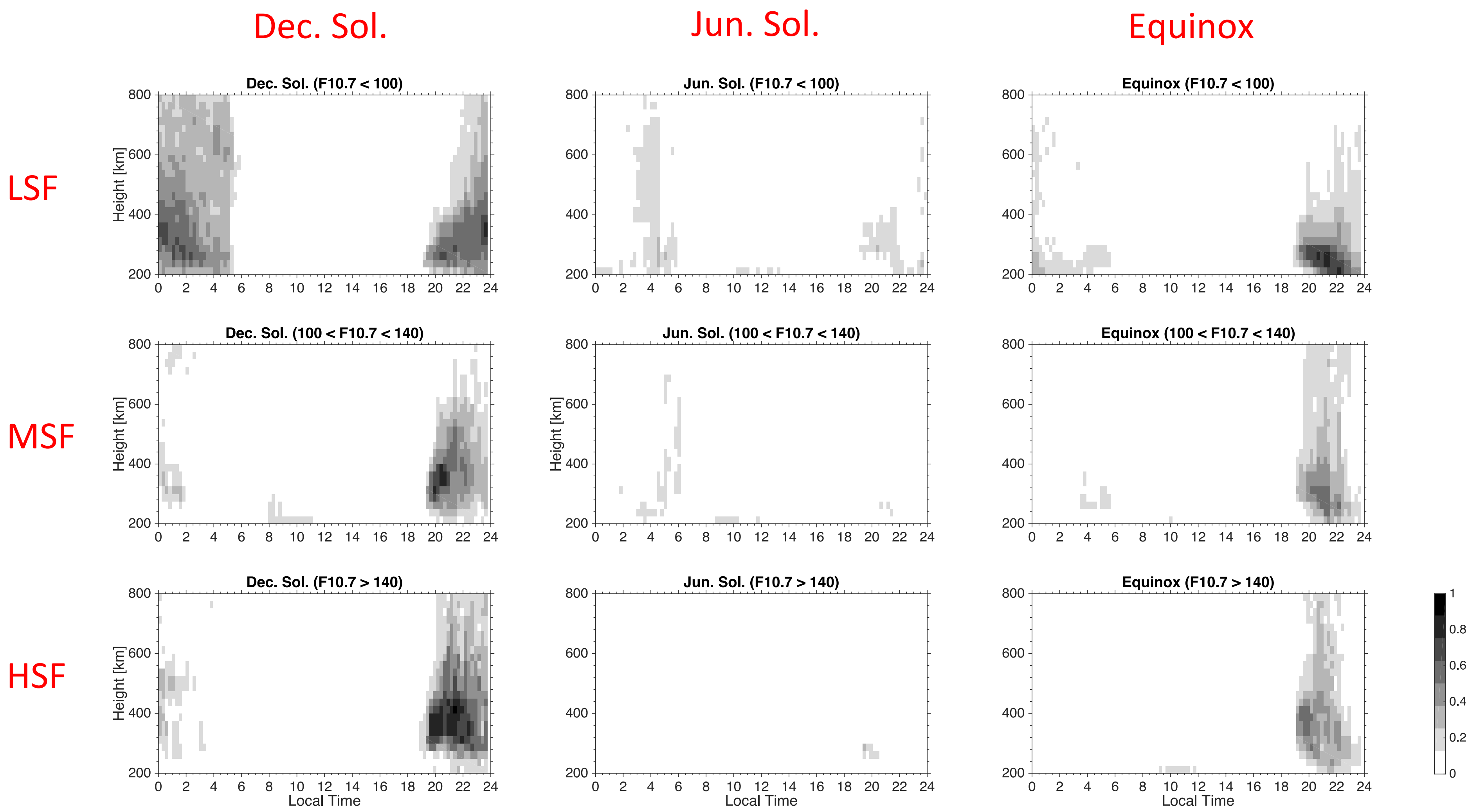
Analysis

- Measurements between 1994 and 2013 (~380 days)

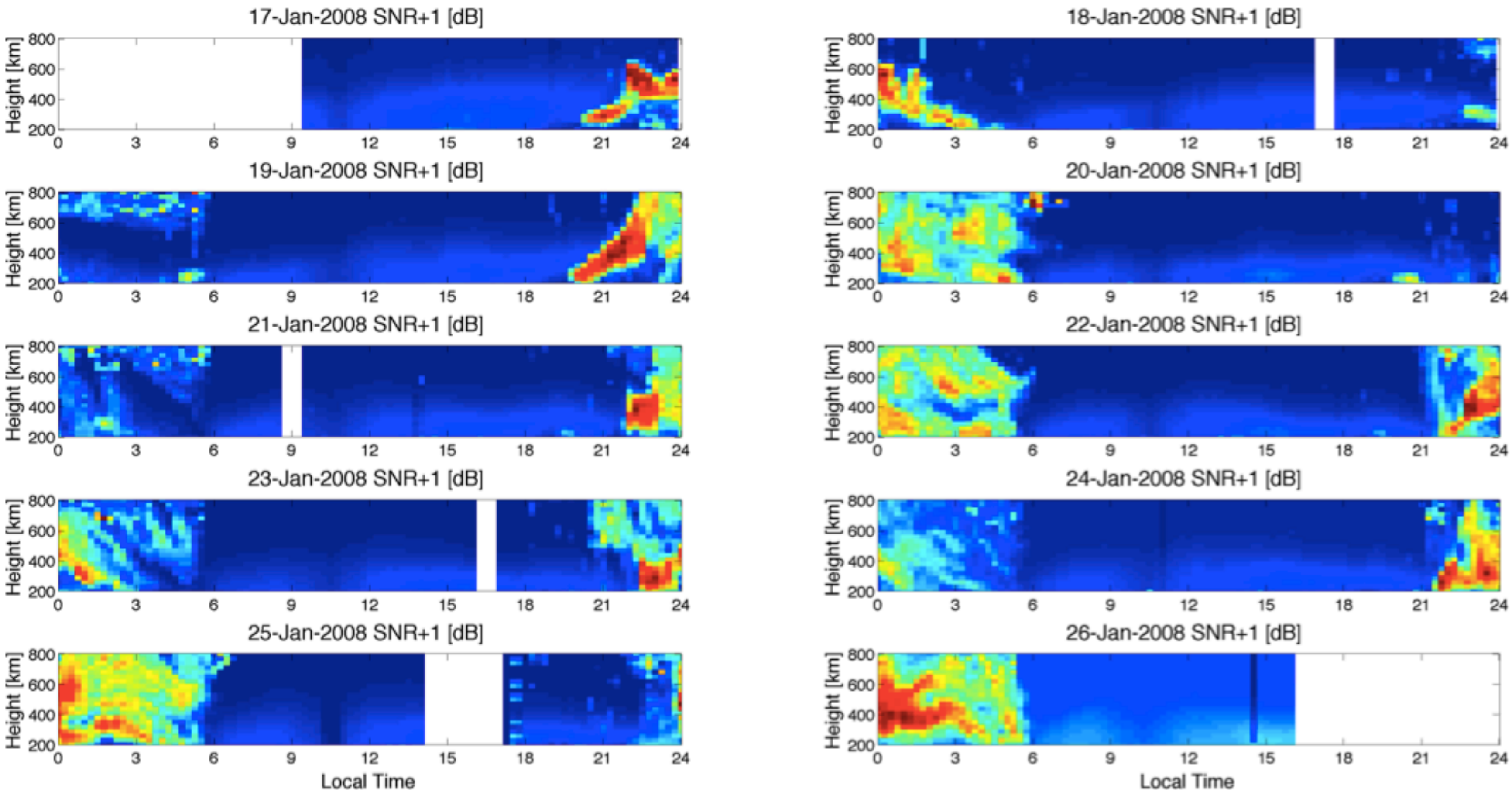
- Climatological analysis:
  - Only quiet-time measurements: Kp + 3 previous values < 4
  - Only drift measurements with error < 2 m/s

- PRE vs ESF analysis:
  - Drift measurements between 1700 and 2000 LT
  - CS measurements between 1900 and 2400 LT

Results: ESF climatology



Results: ESF climatology



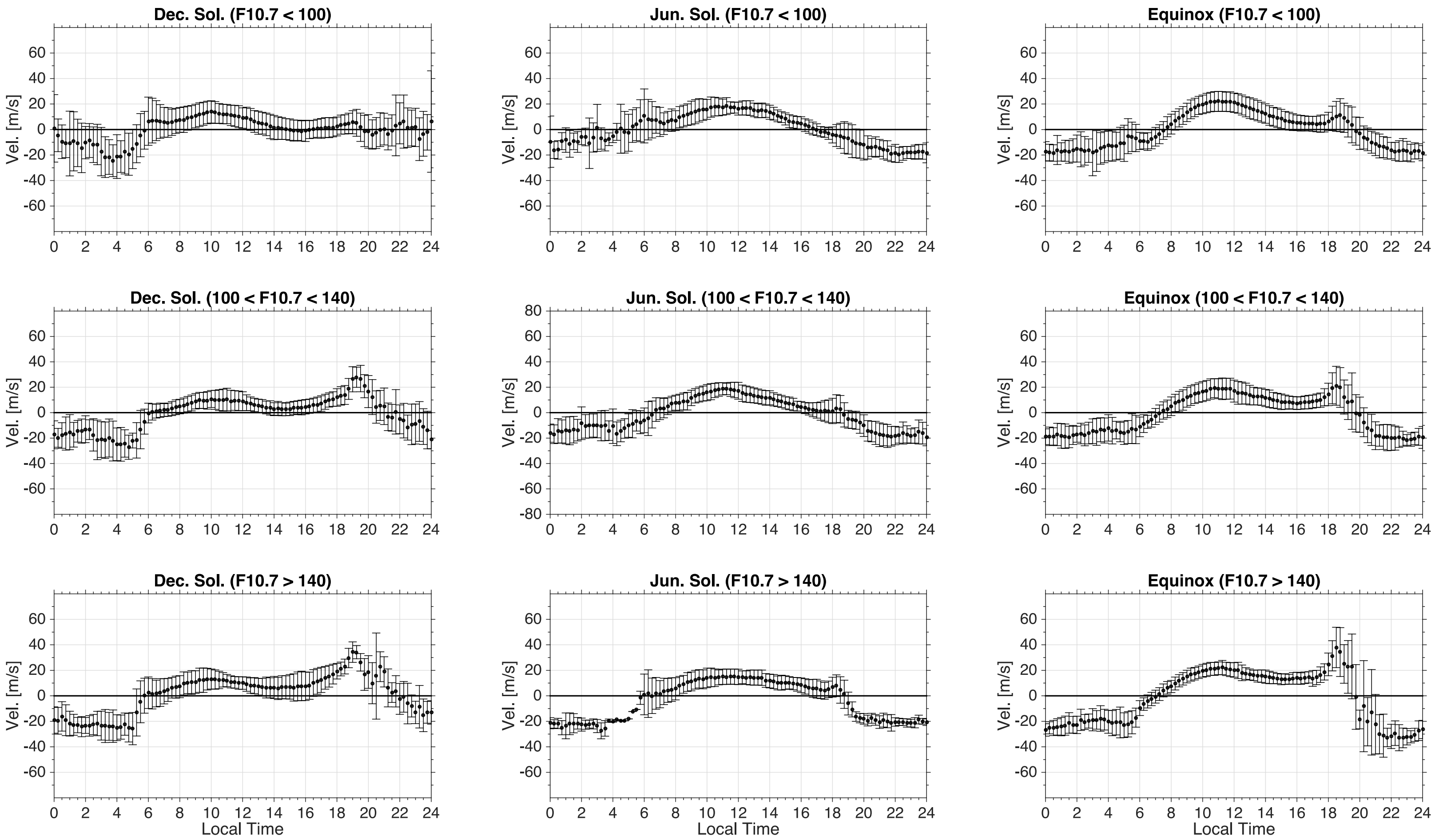
Results: Vertical drift climatology

Dec. Sol. | Jun. Sol. | Equinox

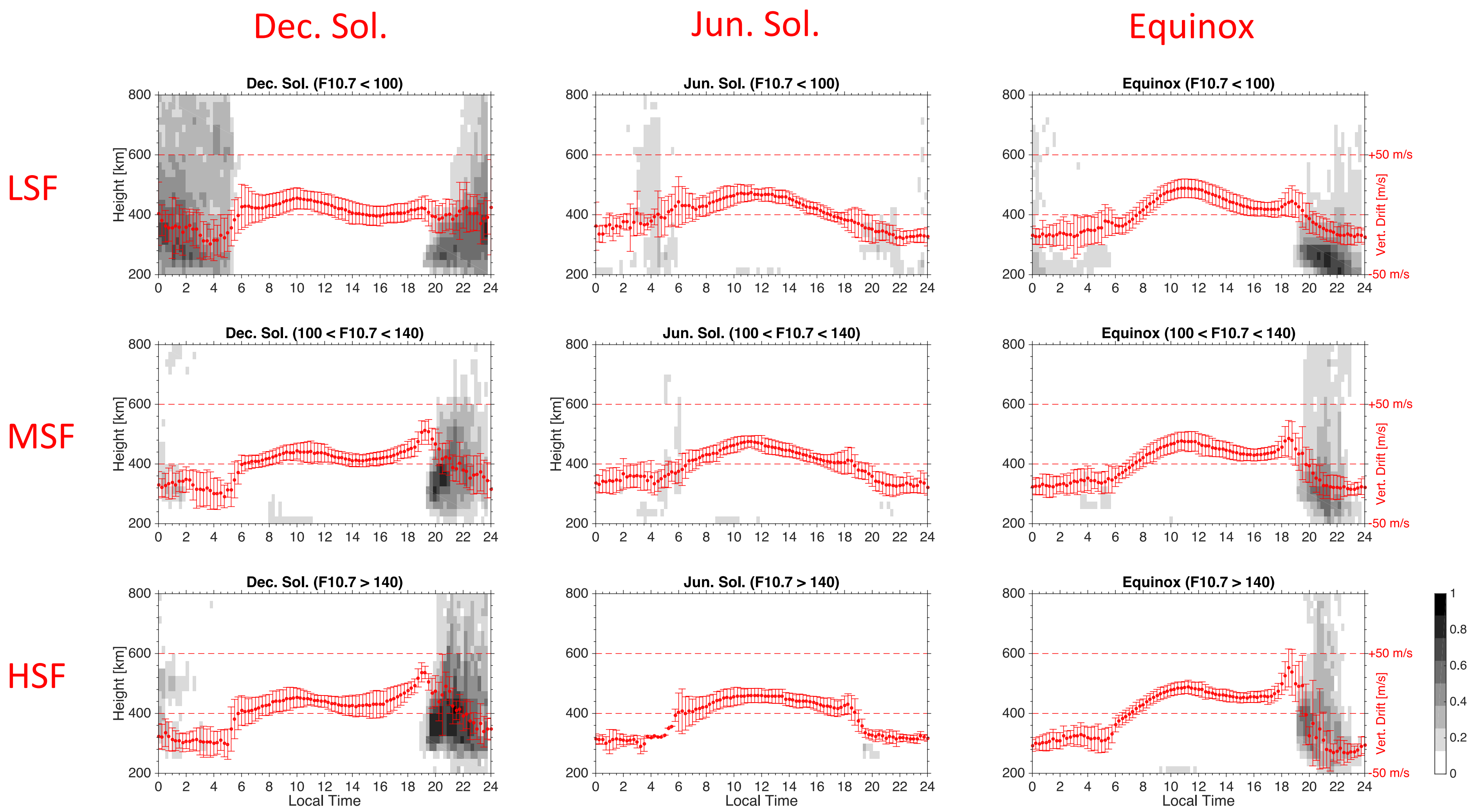
LSF

MSF

HSF



Results: Drift vs ESF climatology



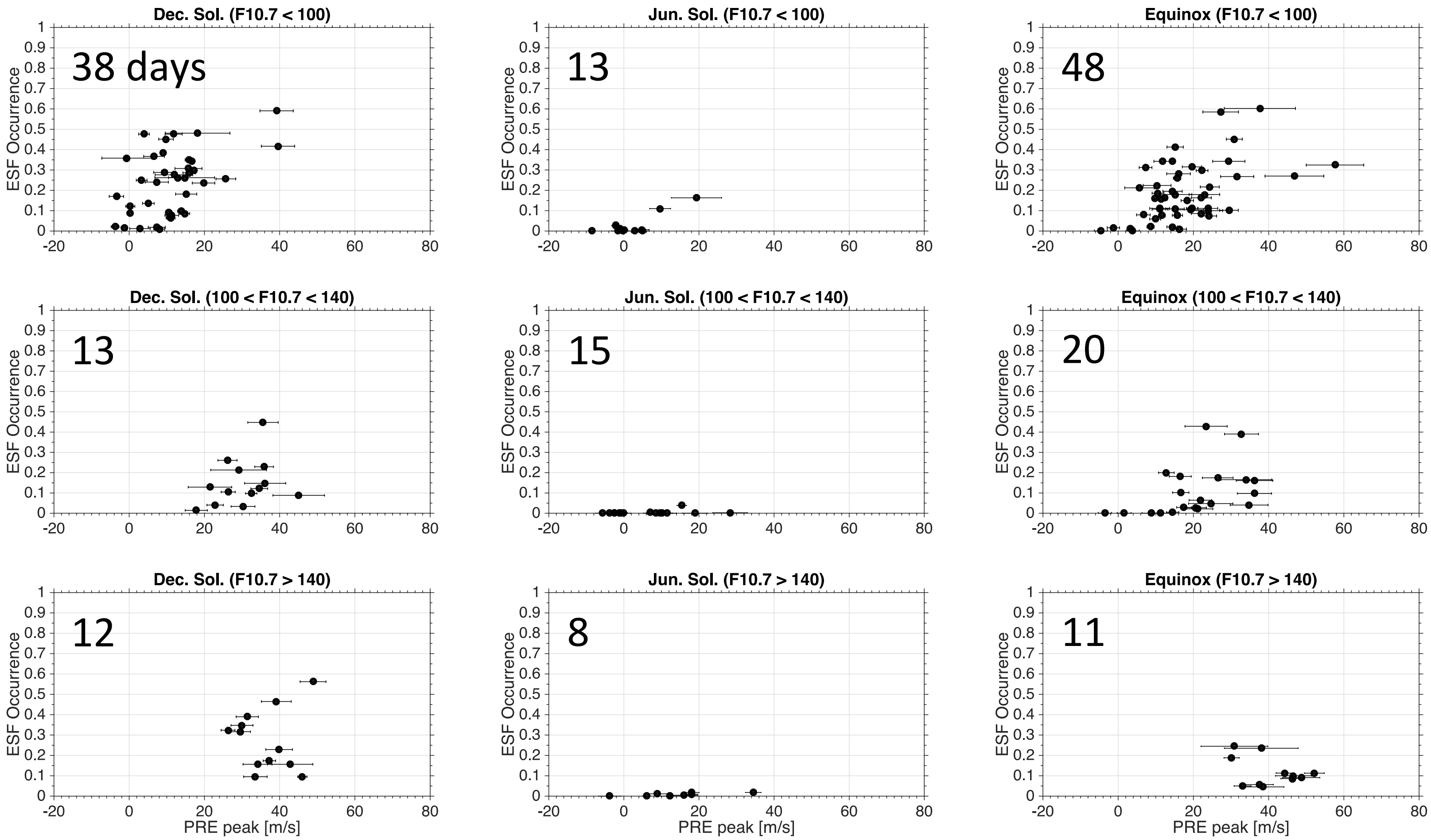
Results: PRE peak versus ESF [200 km and above]

Dec. Sol. | Jun. Sol. | Equinox

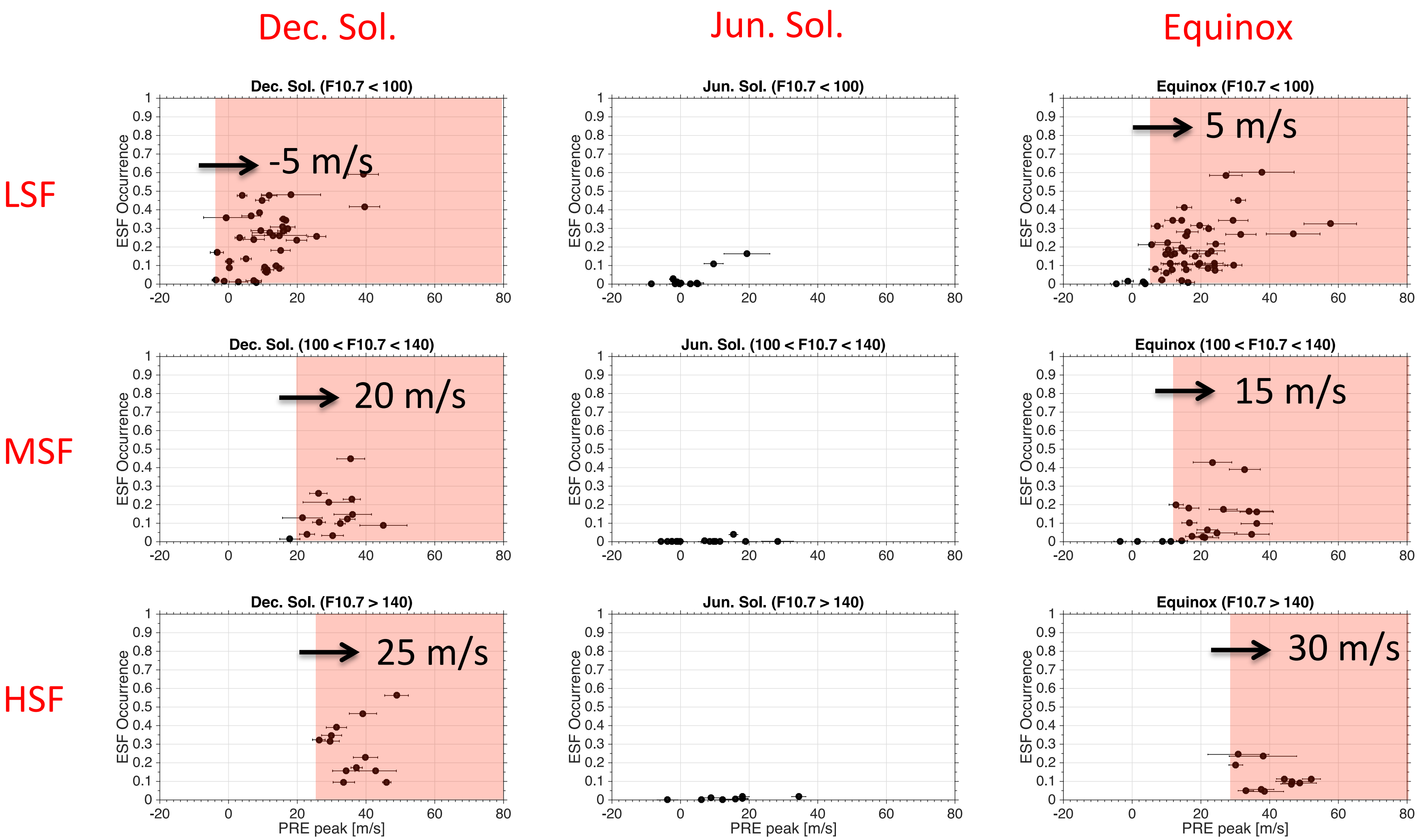
LSF

MSF

HSF



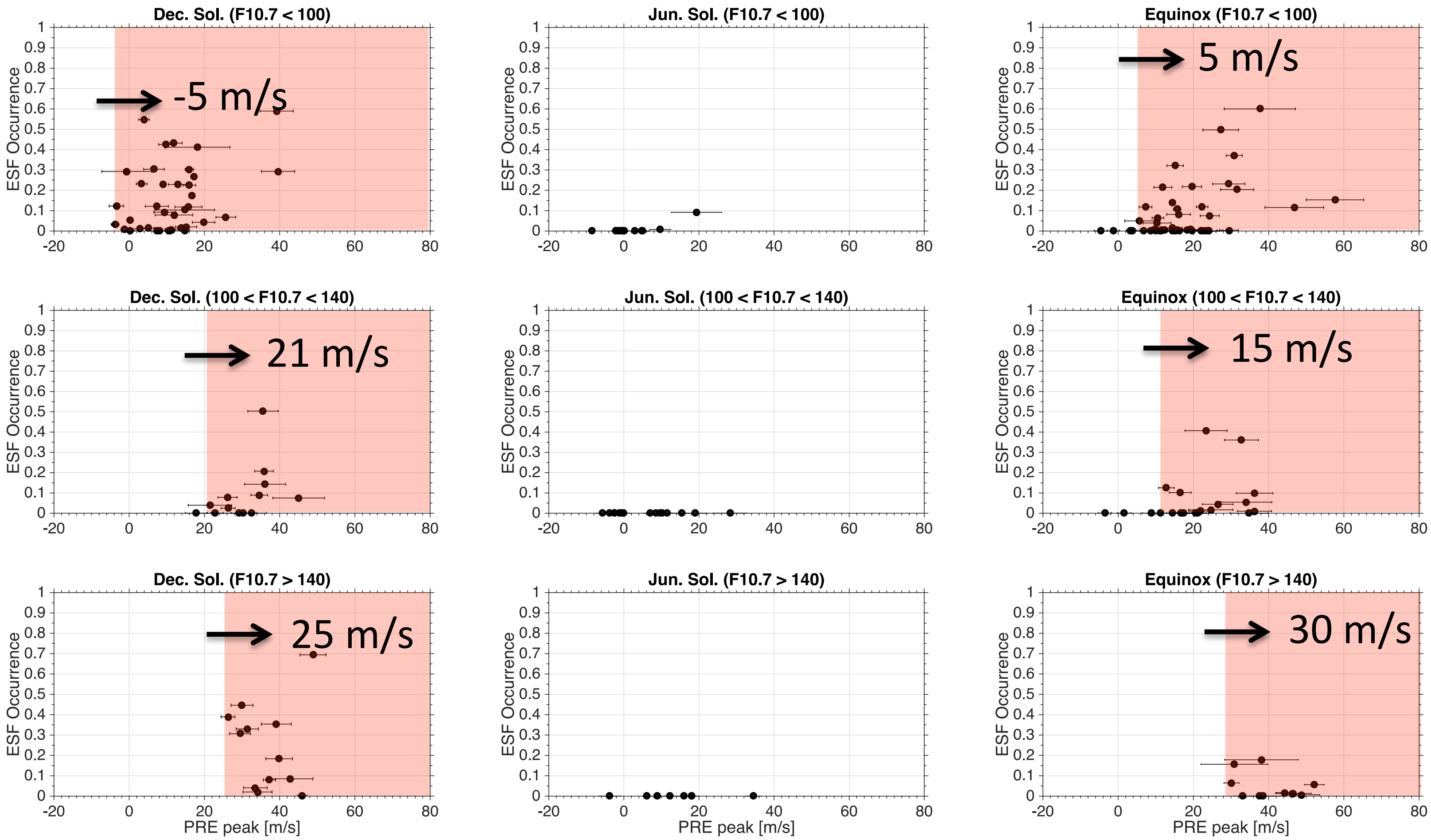
Results: PRE peak versus ESF [200 km and above]



Results: PRE peak versus ESF [400 km and above]

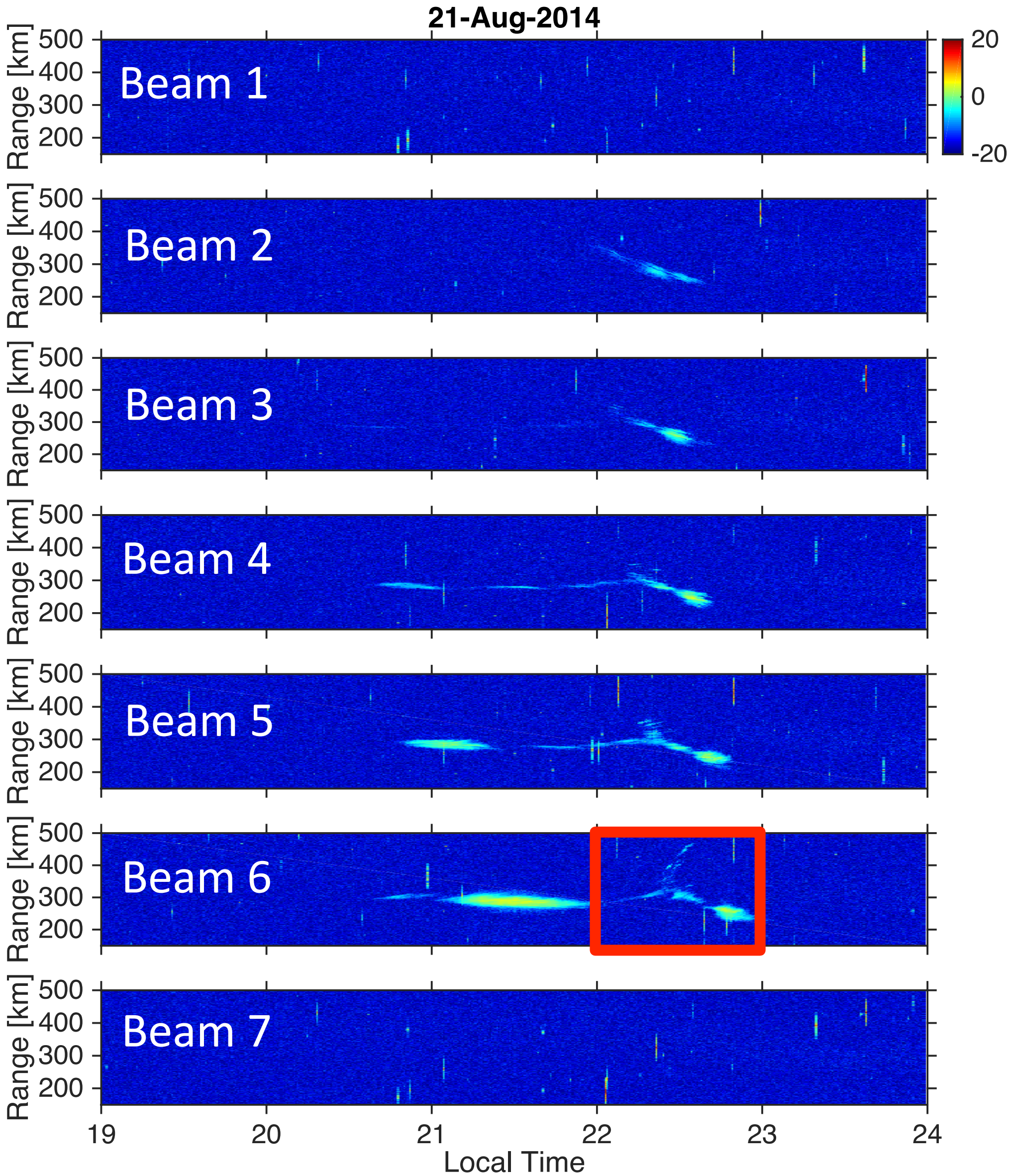
Dec. Sol. | Jun. Sol. | Equinox

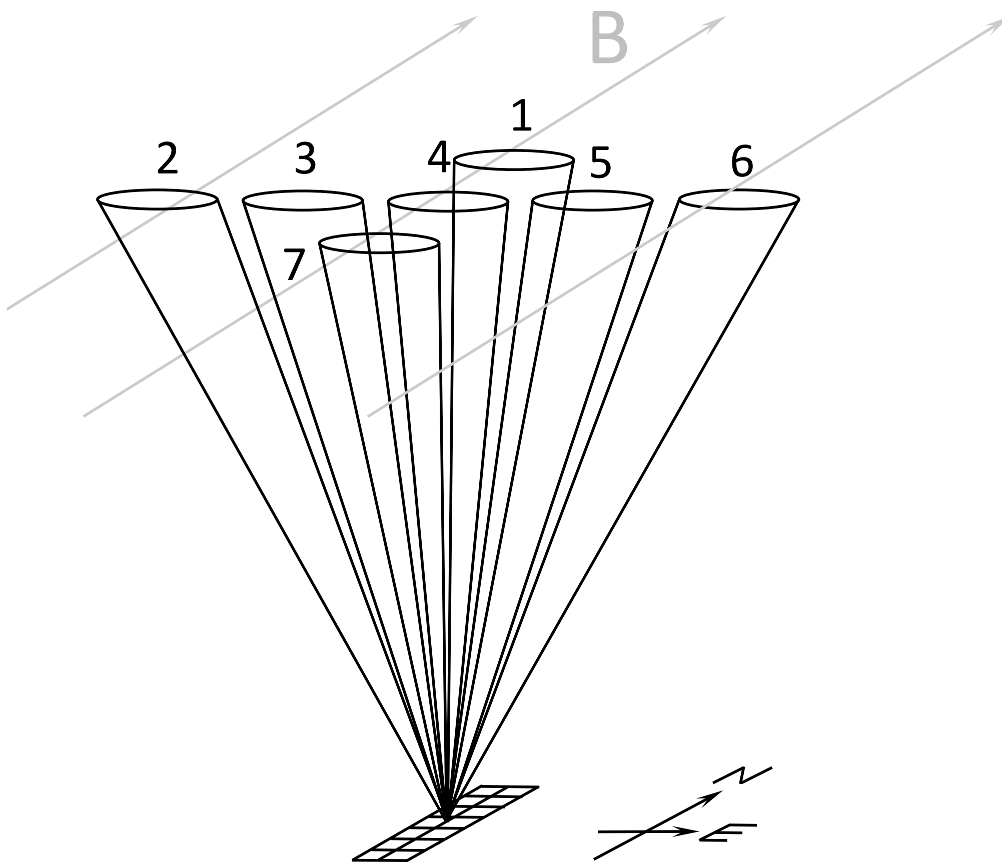
LSF / MSF / HSF



- Fully developed ESF [reaching > 400 km alt.) echoes]

AMISR-14 Observations





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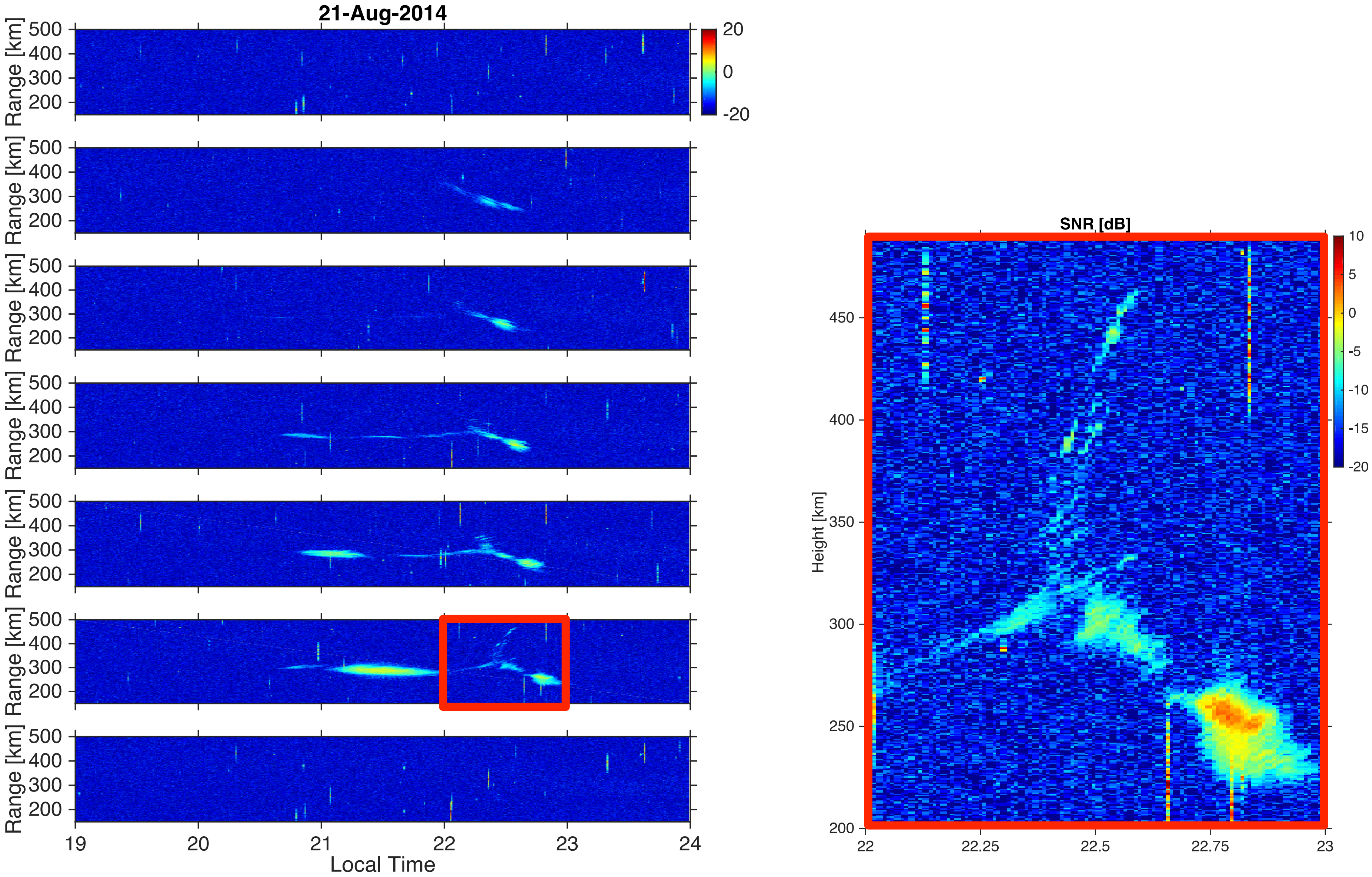

Summary

- In general, the overall behavior of ESF occurrence can be explained by mean vertical drift patterns as shown by Fejer et al. (1999).
- Cases of no topside ESF despite large PRE peaks
- "Threshold PRE" varies with season and solar flux but more measurements are needed to test identified thresholds for MSF and HSF conditions
- We found an higher than expected occurrence rate of post-midnight F-region irregularities during December solstice LSF: SSW