



Evidence for Diurnal Cycling of Surface Hydration Towards the Moon's Mid-Latitudes

To:

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Equatorial Diurnal Neutron Flux Modulation:

Diurnal Surface Hydration or **Regolith Temperature?**

Diurnal Surface Hydration

Livengood et al, 2015

LEND: CSETN and SETN

Dawn H, NIR observations

Regolith Temperature Variation

Teodoro et al., 2014

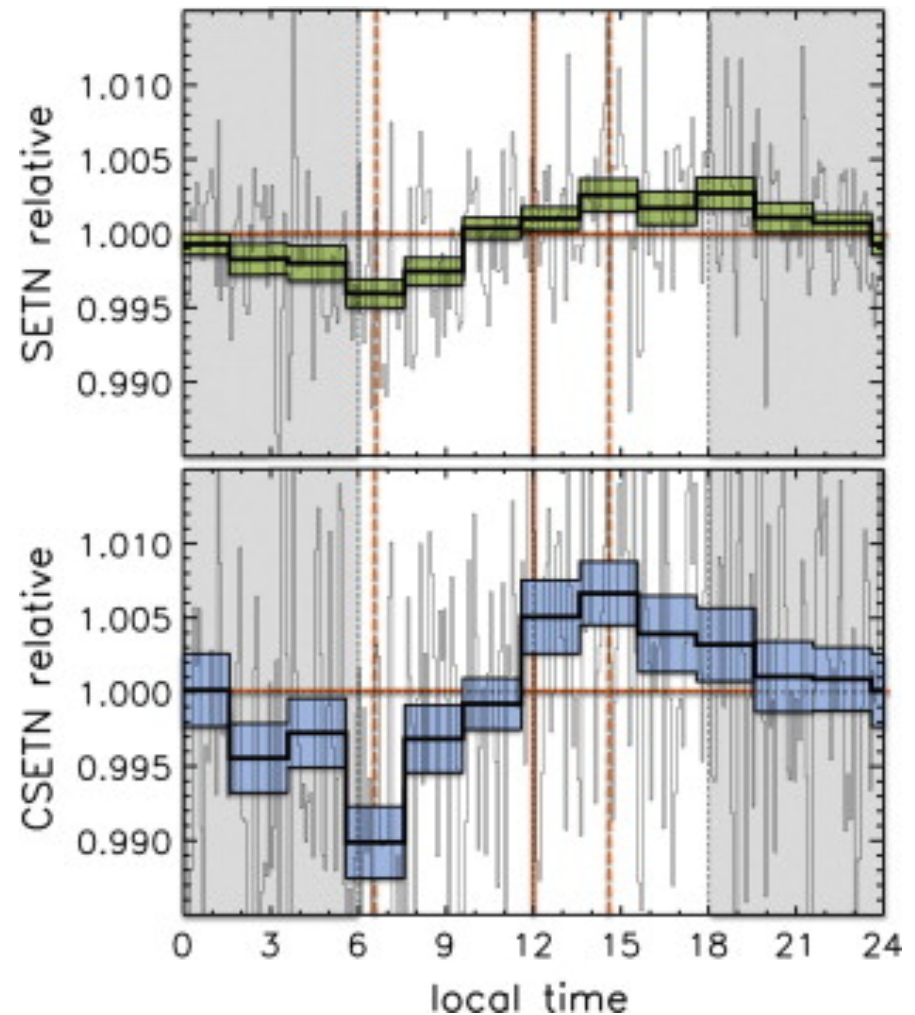
LPNS detected

Neutron Transport Modeling

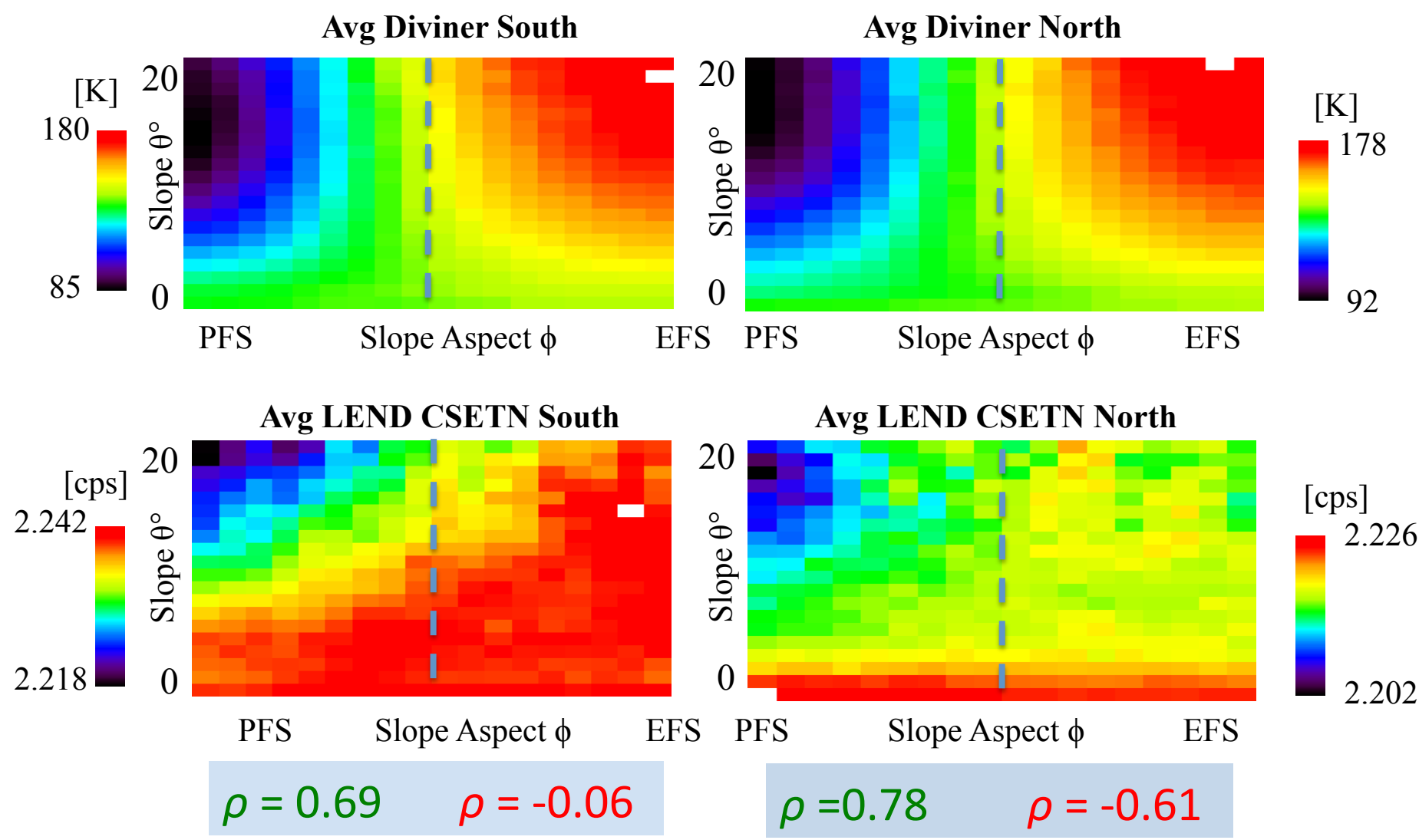
Diviner Temps / Modeling

Evidence for both explanations

LEND Normalized Flux CSETN and SETN

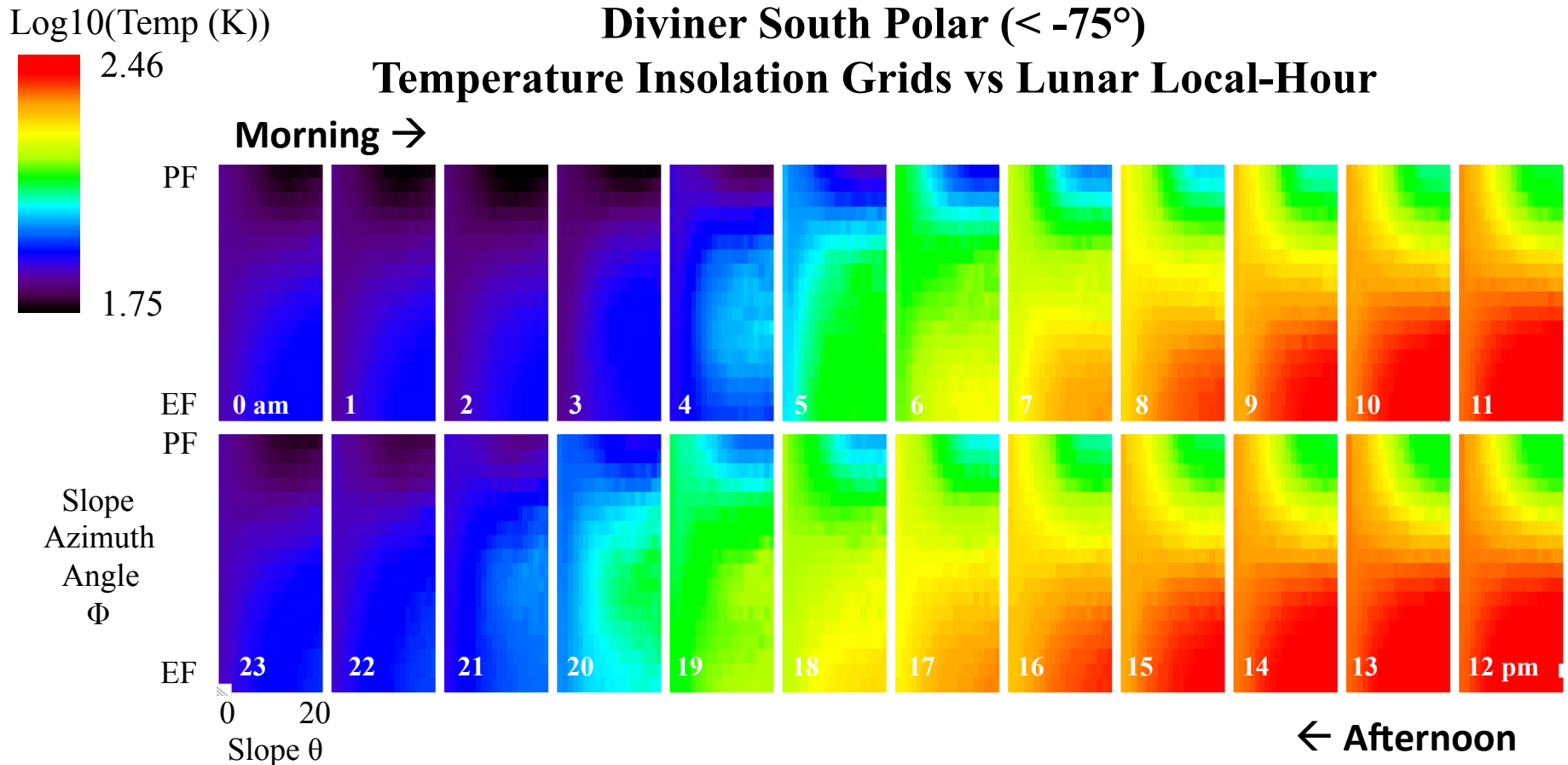


Correlation: LEND CSETN to Diviner Temperature, >75°



→ No evidence – CSETN *n* flux not + correlated to regolith temp → EFS

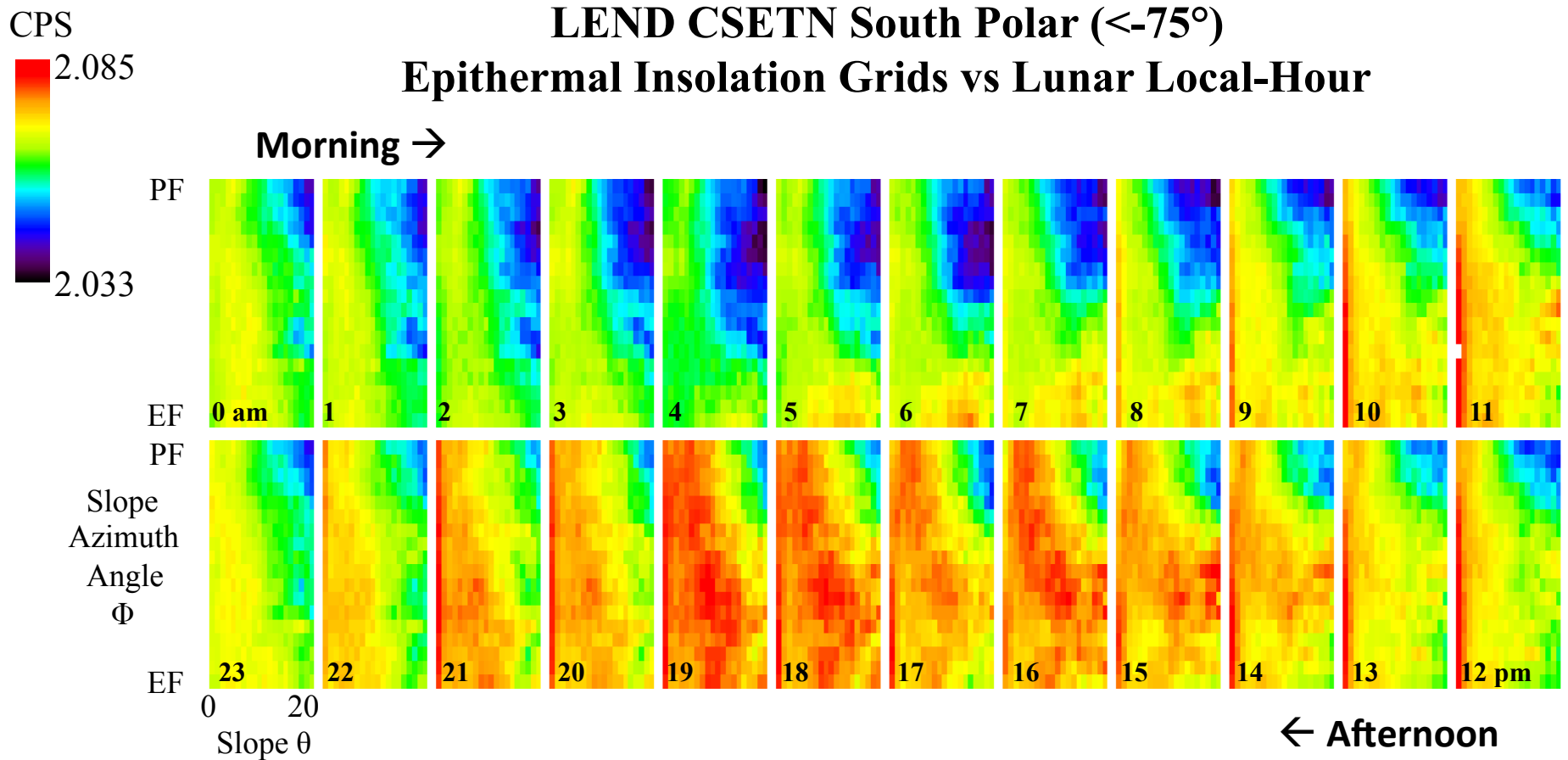
Diurnal Temperature Variation: Diviner vs Local Time, >-75°



- Profiles, **EFS** and **PFS**
- Diurnal power \propto Amplitude(F1)², FFT
- Diurnal power: **EFS**power \gg **PFS**power, 4x
- North equivalent ...

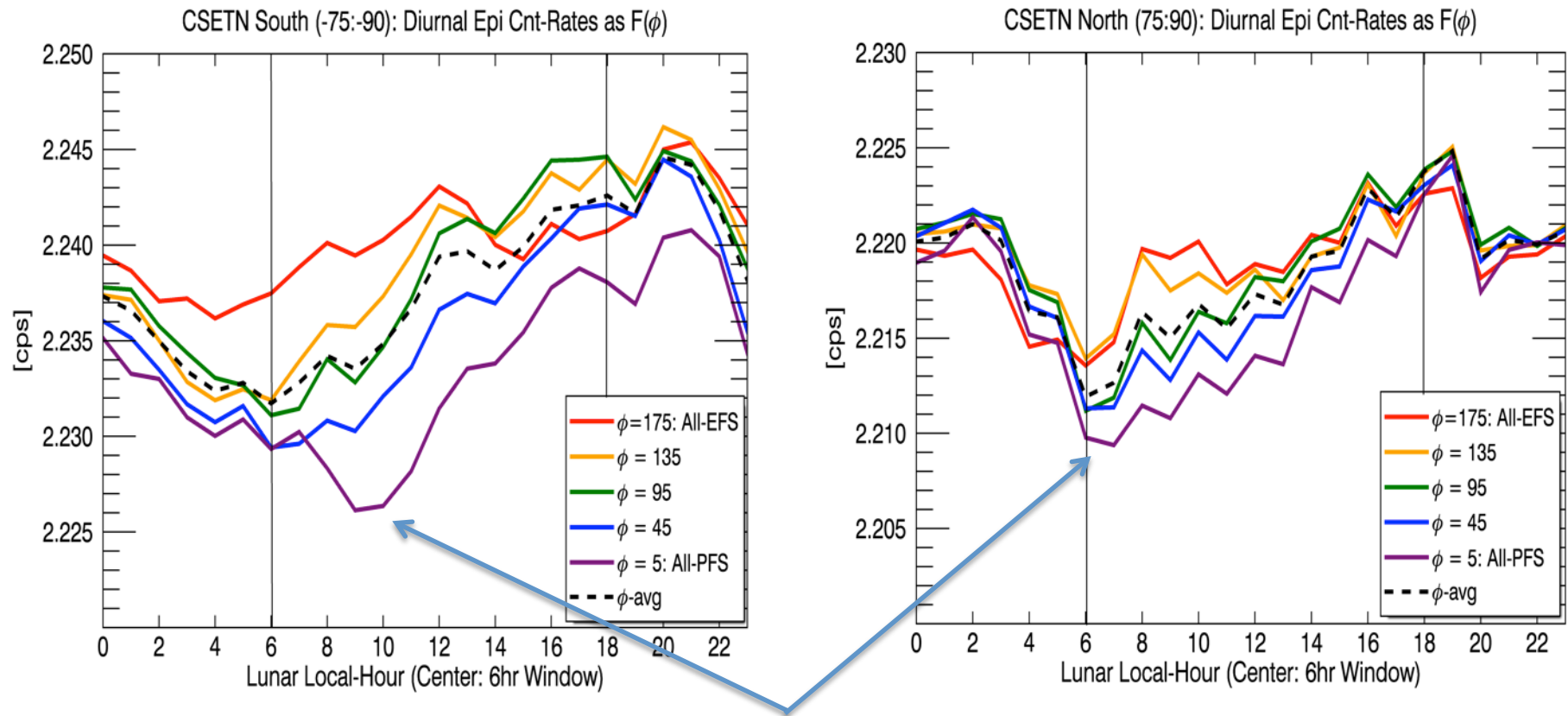
South -75:-90, CSETN Local-Time Observations

- Full Mission, Units (counts/sec)



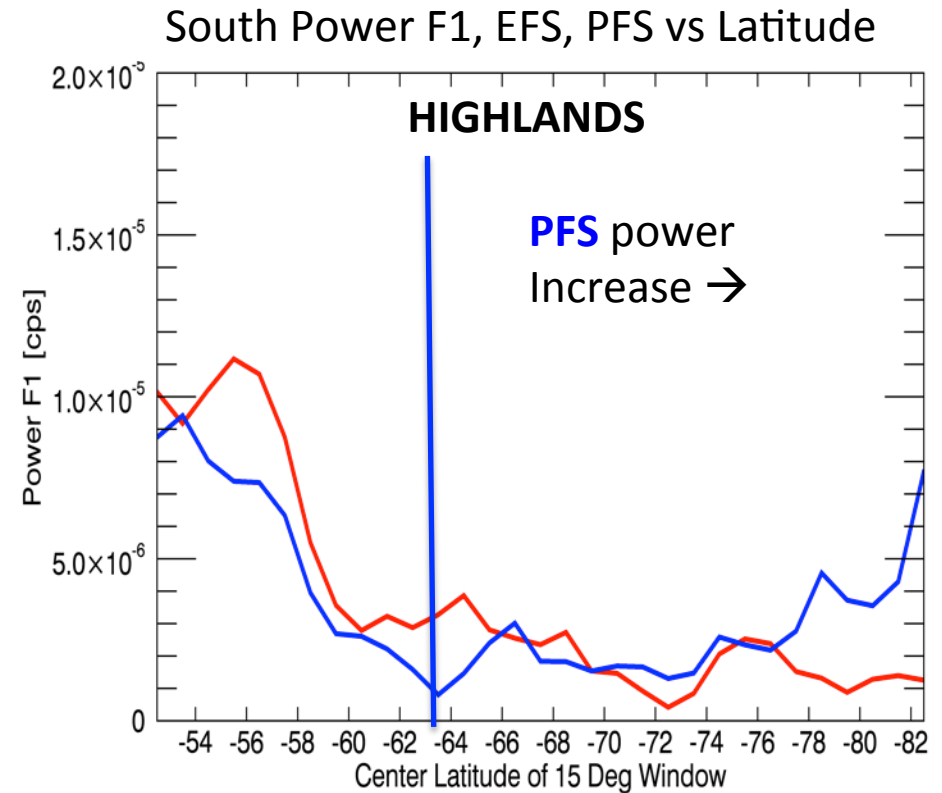
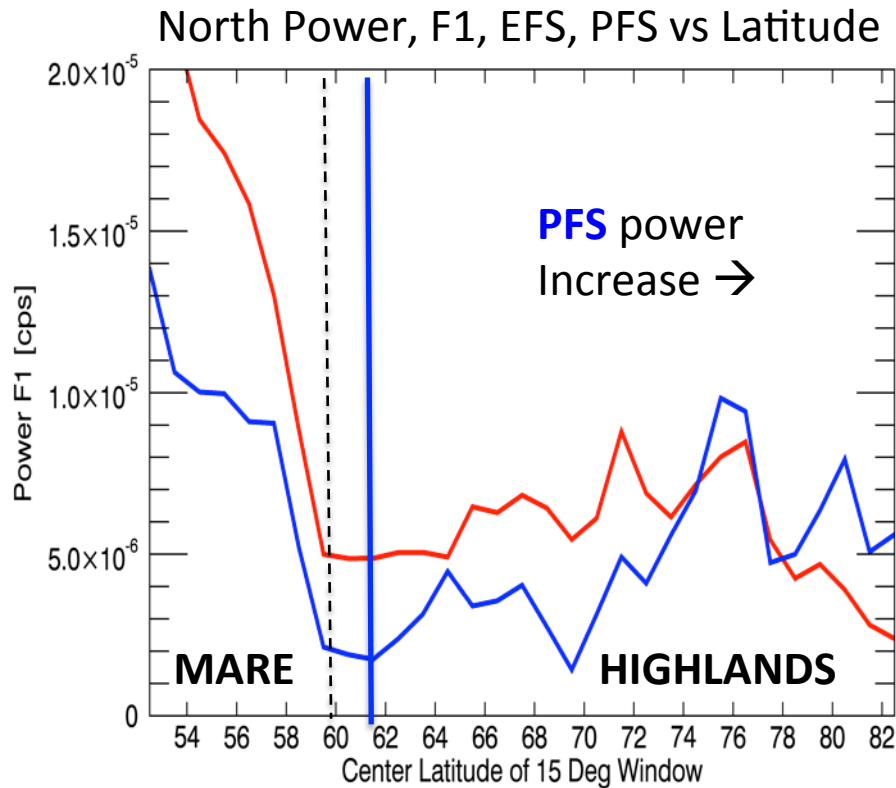
- **PFS**power > **EFS**power → Opposite Regolith Temp Predict
- F-tests of variance(**EFS**, **PFS**) → Significantly different
- North equivalent

North and South (75 to 90)°, Slope Aspect Profiles



- N and S: Insolation dependent response
- Suggests: Cycled H, **0.012% WEH, 12 ppm** → Max at [9,7 am]
- Diurnal power increases **EFS** to **PFS** → Opposite Temp Predict

North, South: EFS vs PFS, 24-hr wavelength power (F1), 45° to 90°



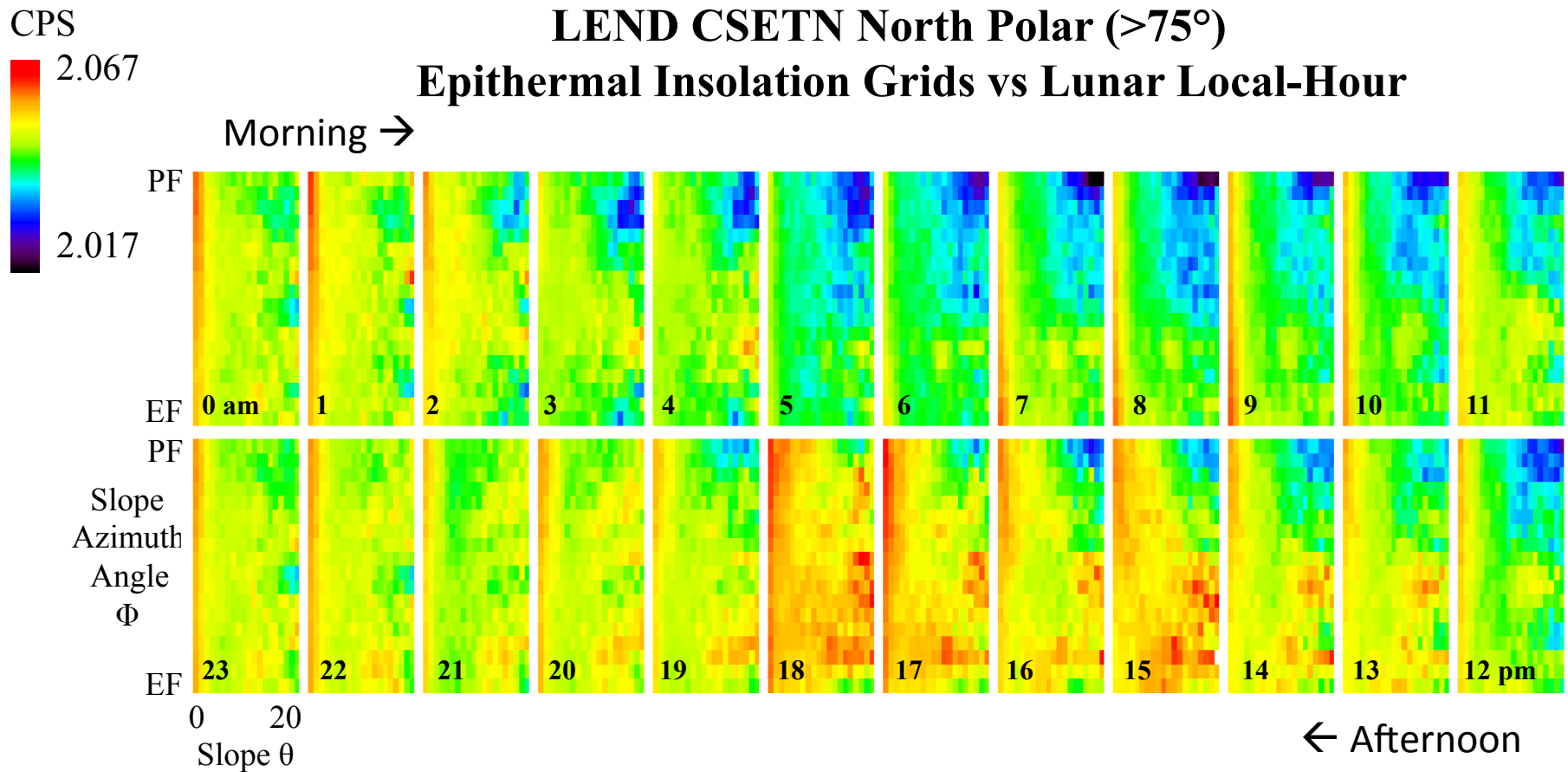
- >±75°, Diurnal Hydration → PFS power < EFS power
- >±63°, Diurnal Hydration → PFS power increase, **opposite temperature**
- <±66° to 74°, Regolith Temperature → EFS power > PFS power, **Mare**
 - EFS power poleward decrease with insolation / temp

Conclusions

1. **Polar Latitudes**, $>\pm 75^\circ$: LRO's LEND, LOLA and Diviner instruments - Suggest hydrogen is being diurnally cycled at the surface.
 - No evidence of regolith temperature, **EFS**
 - **PFS**power > **EFS**power, F-tests significant
 - **Cycled H: [0.012% WEH, 12 ppm] at dawn towards PFS [7 to 9am]**
 - H pumping, (Schorghofer, Aharonson 2014), 110-130 K, Lats, H
2. **Upper Latitudes**, N and S ($>63^\circ$): **PFS**power increases, opposite temps (**EFS**)
 - Suggests diurnally cycled H increase towards pole:
3. **Mid Latitudes**, $\pm(45^\circ < 75^\circ)$: **Regolith temperature** dominates the flux modulation, **EFS**power > **PFS**power, e.g. Mare.
 - Livengood et al., Cycled H concentrations may be overestimated
5. CSETN Fast Neutrons → Shallow depth (top several cm)
6. **Alternative: Regolith Temperature** can't be excluded. **EFS**, **PFS** diurnal power dependence on regolith composition → Thermal waves differ
7. Future: Mid-latitudes: Highlands and Mare, Subsurface thermal modeling

North 75:90, CSETN Insolation Grids vs Local-Time

- Circular Mission Only, Units (counts/sec)



- Morning PFS epithermal suppression towards PFS
- Small daytime epithermal enhancement towards EFS
- **PFS** power > **EFS** power, F1, Opposite Regolith Temp