

The Search for a Diurnal Effect in Lunar Hydrogen

Luis Teodoro

BAER, NASA Ames Research Center

David J. Lawrence (JHU/APL)

Vincent R. Eke (Univ. of Durham)

Richard C. Elphic (NASA Ames Research Center)

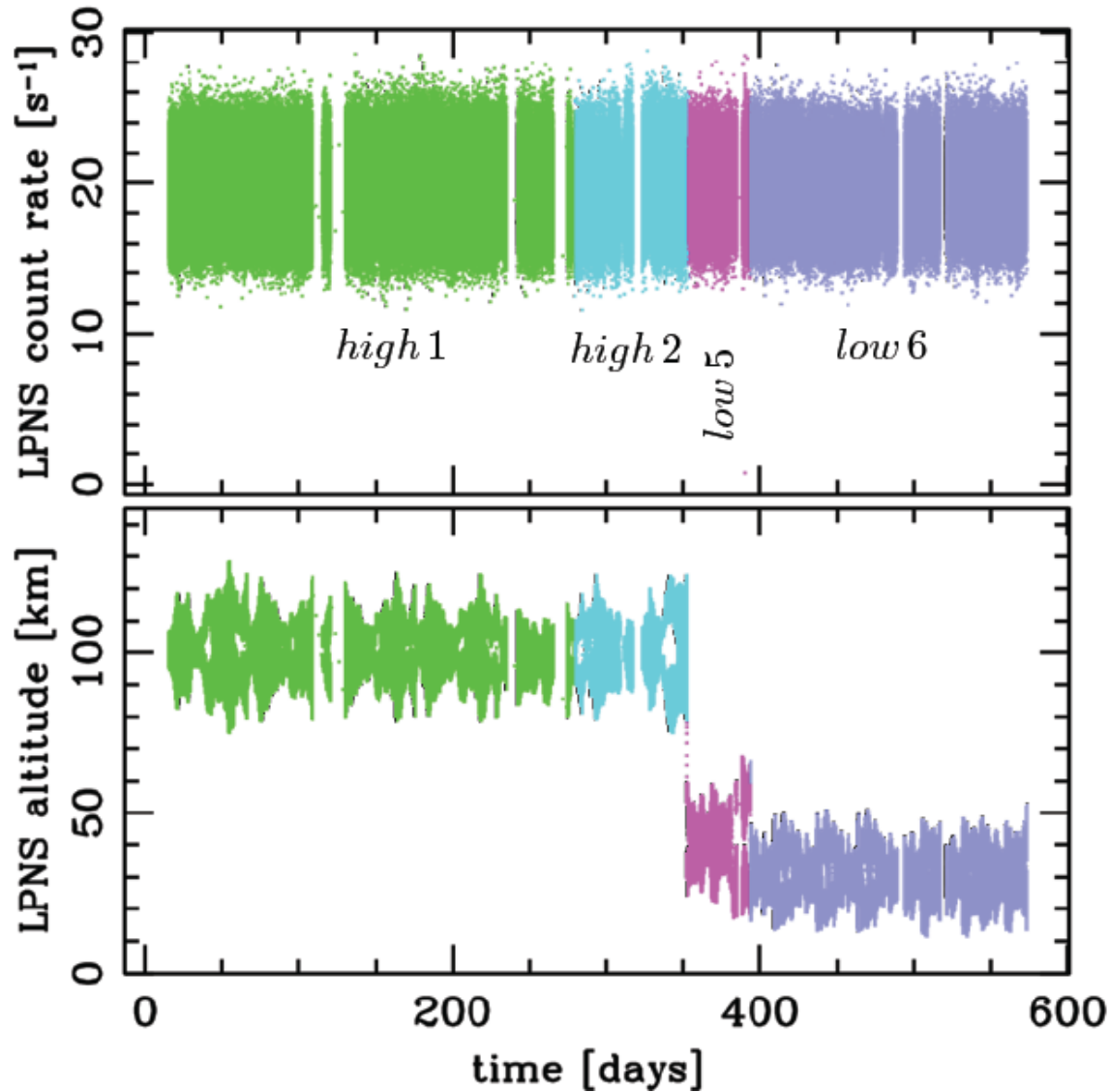
William C. Feldman (Planetary Science Institute)

Sylvestre Maurice (IRAP)

Setting the Scene

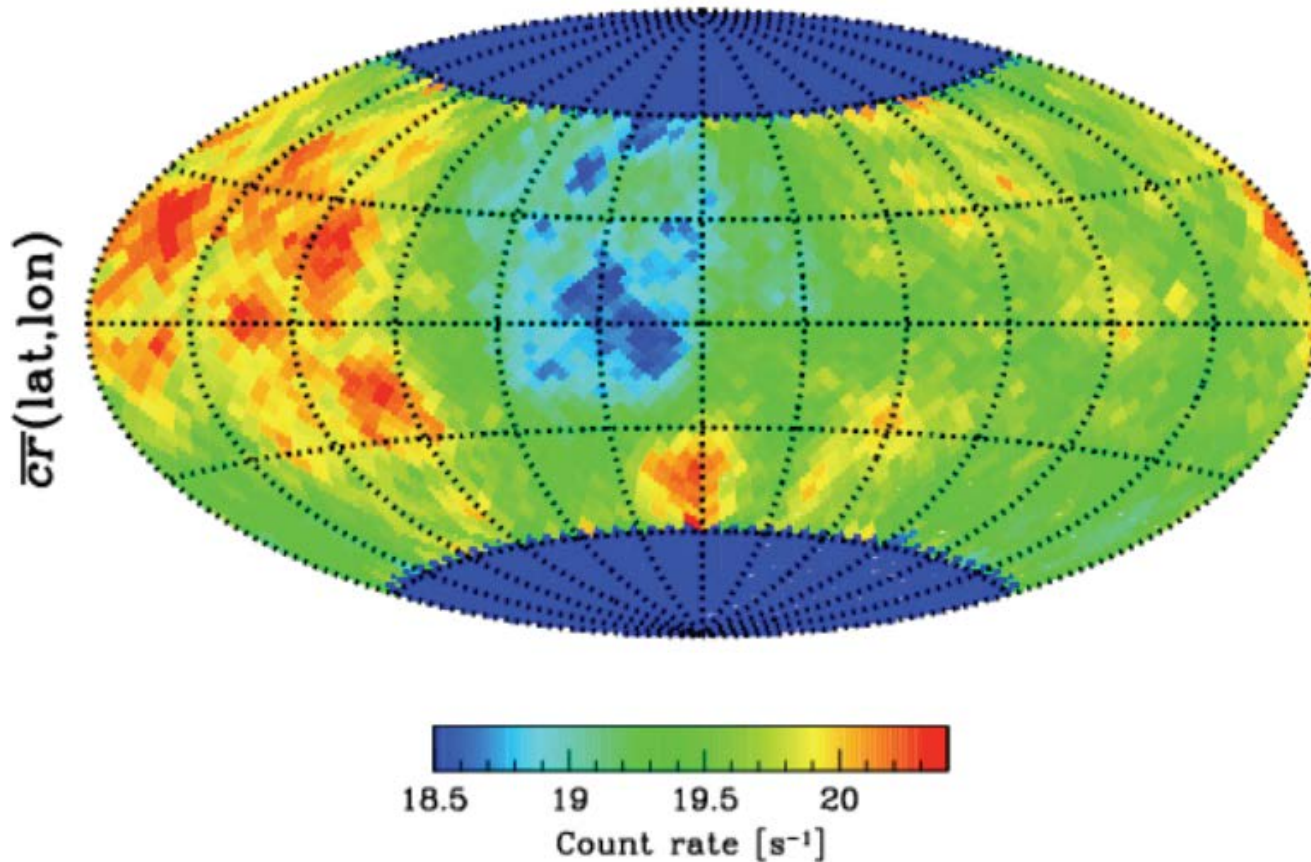
- Lunar diurnal variations of surficial hydrogen have been reported (*Sunshine et al.*, 2009)
- Diurnal count rate variations (~2%) reported with LEND neutron data (*Livengood et al.*, 2013)
 - Interpreted as hydrogen variations.
- Are such variations present in Lunar Prospector (LP) epithermal neutron data?
 - If so, do such variations indicate hydrogen variations?

LP Epithermal Neutron Data



LP count rate $55^{\circ}\text{S} < \text{latitude} < 55^{\circ}\text{N}$

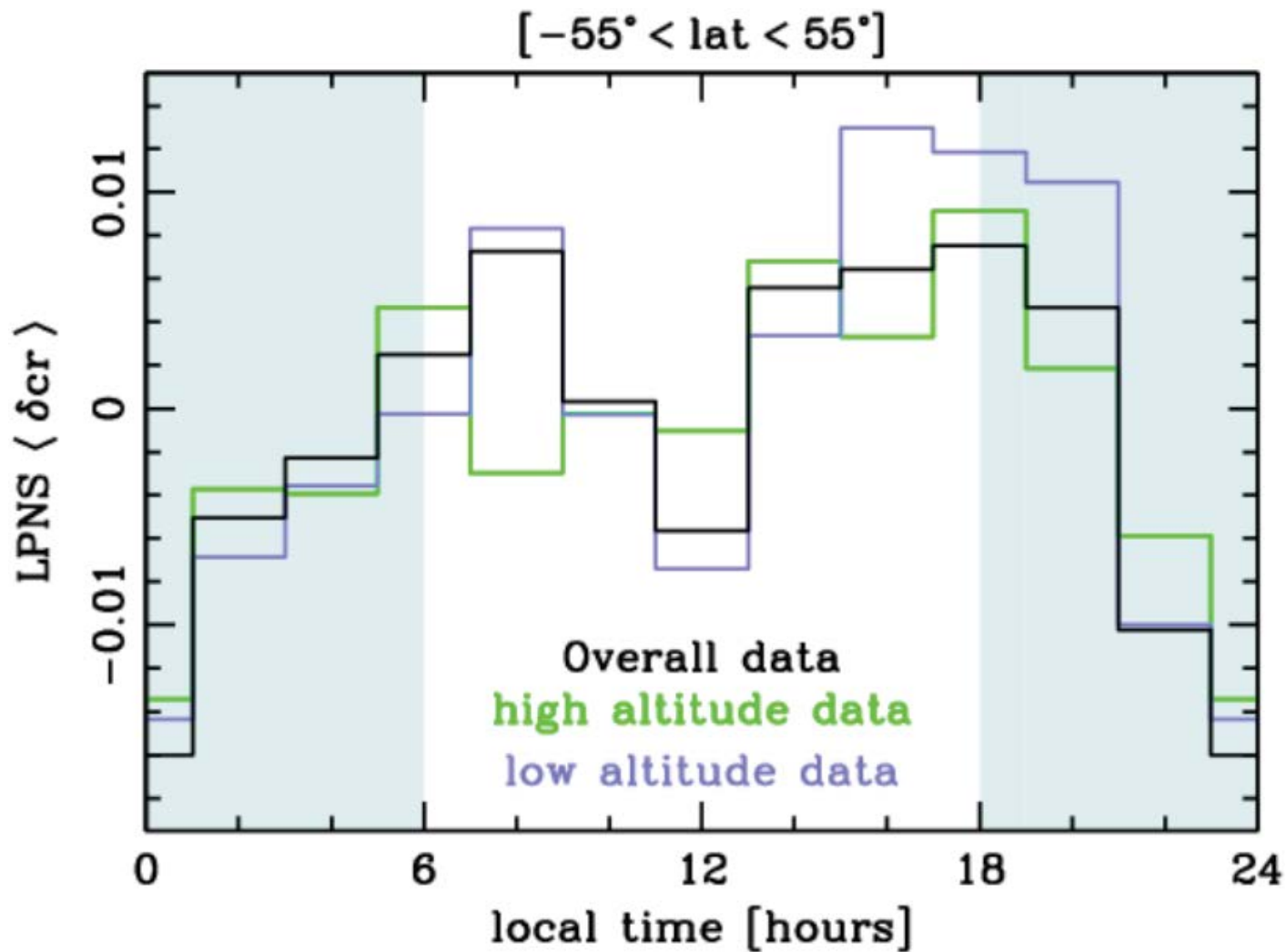
$\overline{(\dots)}$ \equiv average over time



$$\delta cr(\text{lat}, \text{lon}, t) \equiv \frac{cr(\text{lat}, \text{lon}, t)}{\bar{cr}} - 1$$

Counts vs. Local Time

$\langle \dots \rangle \equiv \text{average over (lat, lon)}$

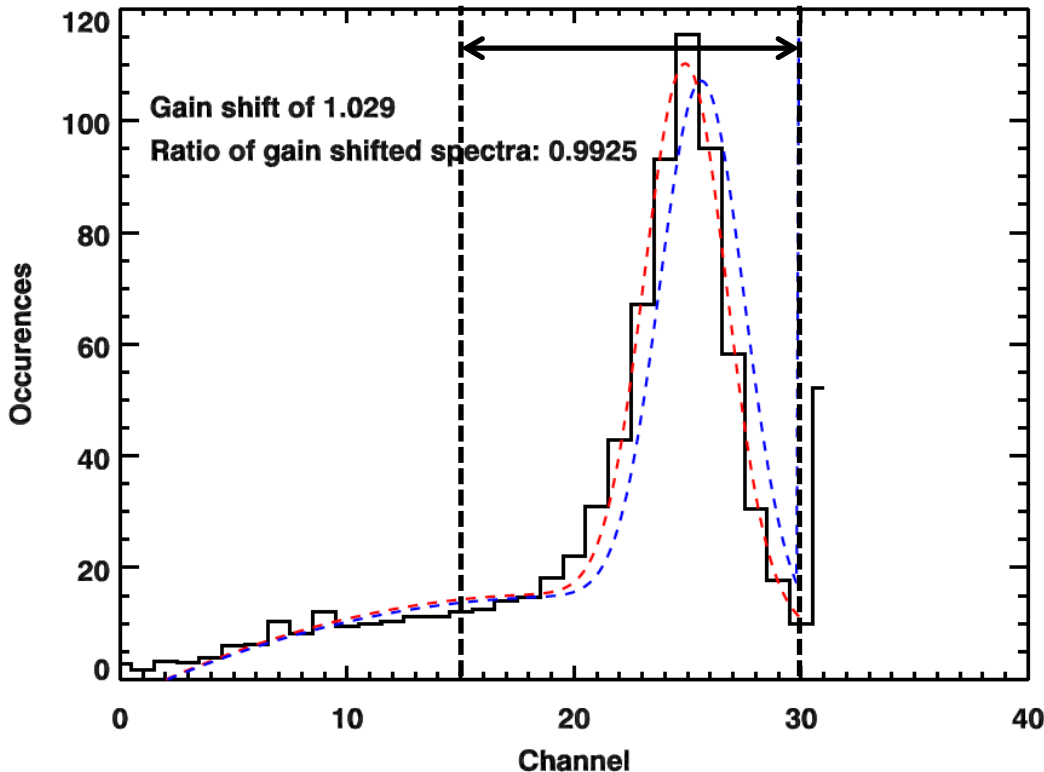


Is the local time variation due to hydrogen?

- Are there systematic non-hydrogen variations related to local time?
- Instrument sensor temperature variations:
 - Can modify count rate by $<2\%$ via sensor gain variations.
- Lunar surface temperature variations:
 - Can modify count rates by few percent.

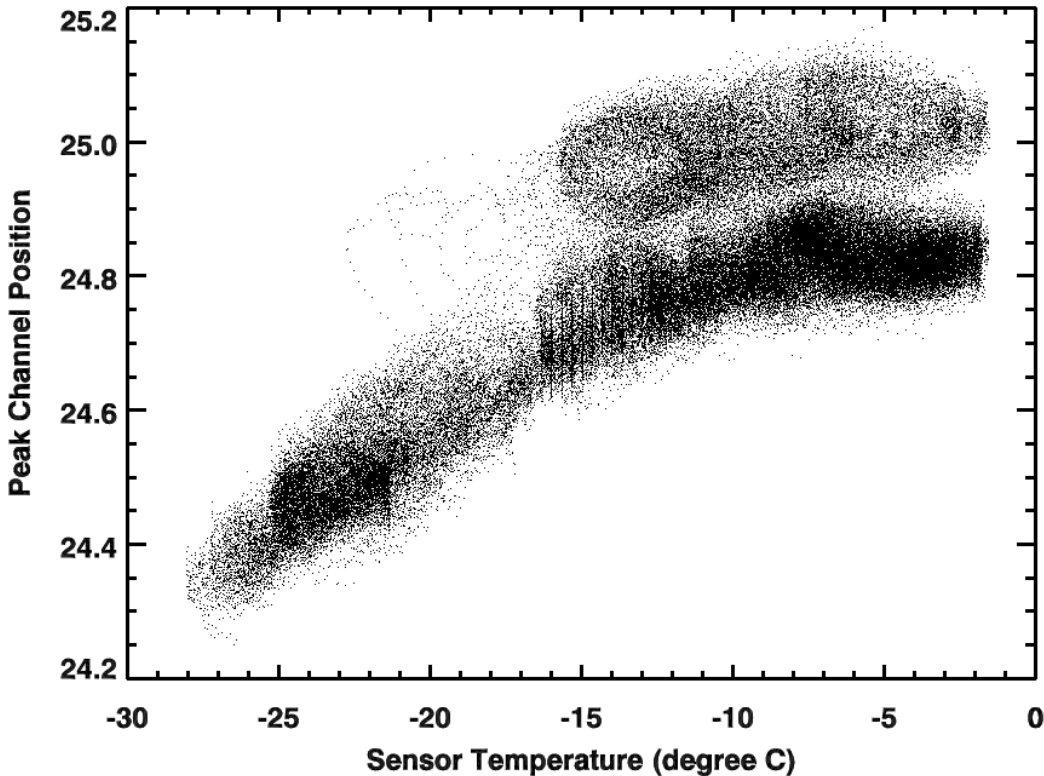
Sensor Energy Spectra

*Epithermal neutron
count rate*



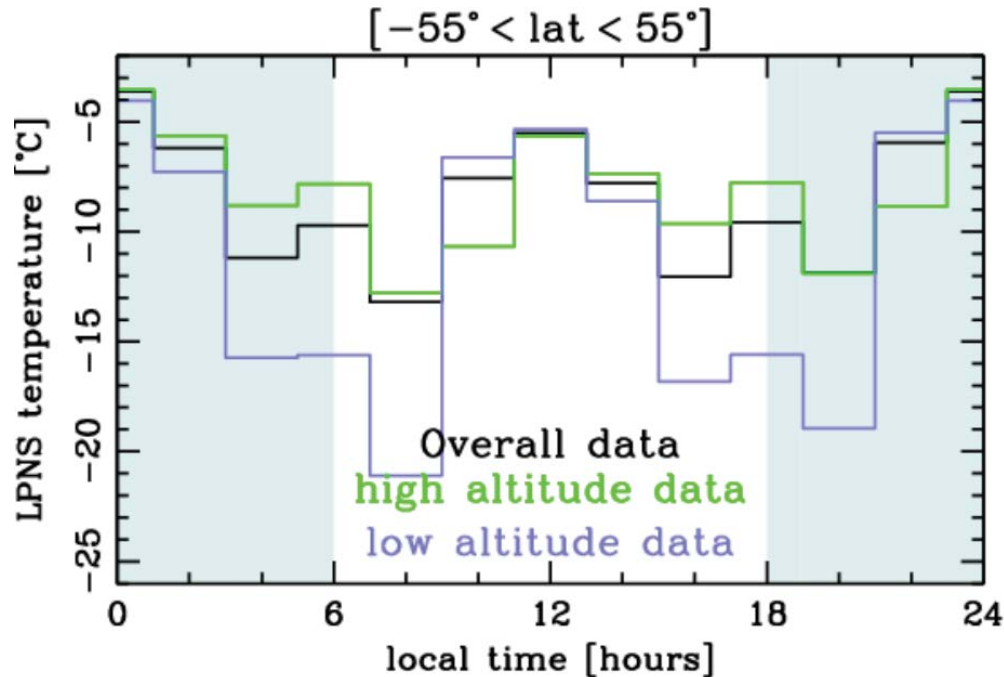
- Count rate measured within fixed channel width.
- Measured count rate decreases when peak shifted to higher channels.

Peak Position vs. Sensor Temperature



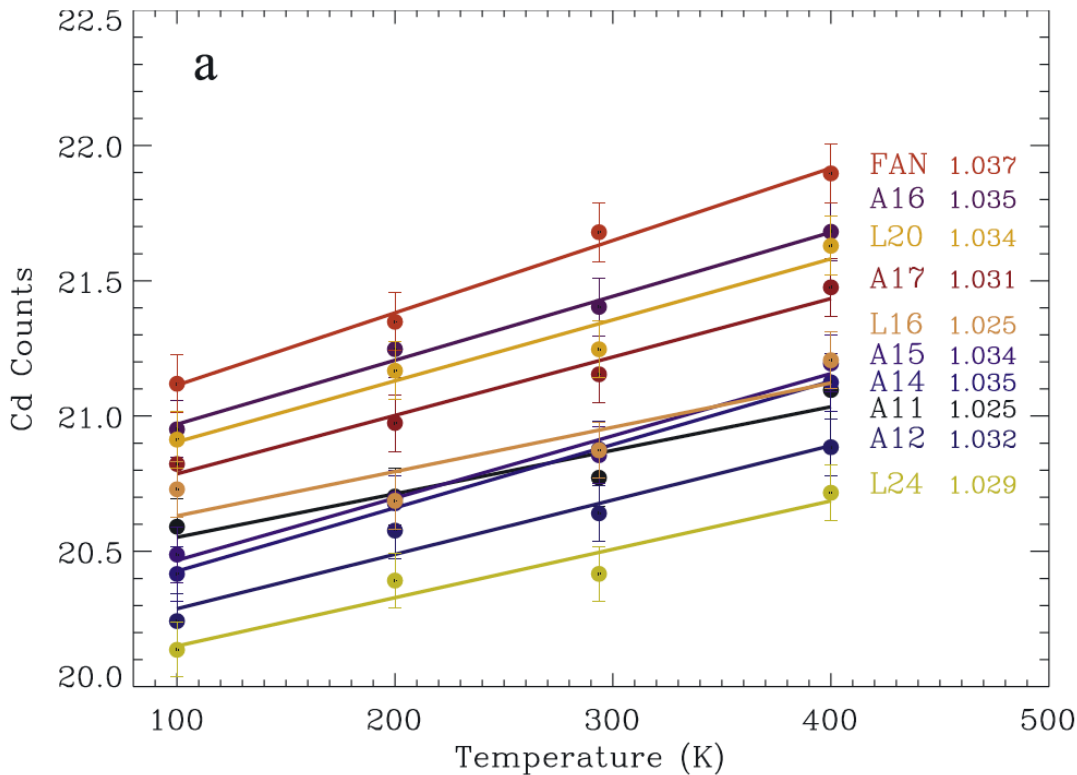
- For low-altitude data, peak position varies with sensor temperature.

Sensor Temperature



- Sensor temperature varies with local time.
 - Anticorrelated with count rate.
- May explain or partially explain local-time count rates.

Surface Temperature



From *Lawrence et al.*, (2006)

- Epithermal neutrons should vary with surface temperature.
 - 2.5 to 3.5% per 300K.
- Negligible for mapped data.
 - May be important for data binned in local time.
- Effect likely muted:
 - Effective neutron depth is 15 to 20 cm (*Little et al.*, 2003).
 - Less day/night temperature variation for wide latitude range.
- May cause <2% count rate variation.

Conclusions

- LP epithermal neutron data show $\sim 2.5\%$ diurnal variation.
 - Local-time dependence is different from LEND data (*Livengood et al., 2013*).
- Sensor temperature correlates with local time and is related to count rate variations.
- Surface temperature may systematically effect count rate.
 - Need to correct with latitude-dependent “neutron effective depth” temperature.
- Corrections in progress.
 - Until corrections completed, no need to invoke diurnal hydrogen variations.