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T Farm Interim Surface Barrier Vadose Zone Monitoring FY08 Fourth-Quarter Status Report

Z. F. Zhang C. E. Strickland

September 2008

Pacific Northwest
NATIONAL LABORATORY

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Richland, Washington 99352

Executive Summary

This report briefly summarizes the system status and monitoring results of Nests A, B, C and D and the Meteorological Station in the T Tank Farm from July to September, 2008. All the sensors except the two drain gauges were functional.

Acronyms and Abbreviations

CP	Capacitance Probe
FY	Fiscal Year
HDU	Heat-Dissipation Unit
HMS	Hanford Meteorological Station
NP	Neutron Probe
PNNL	Pacific Northwest National Laboratory

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1.0 Introduction

This report briefly summarizes the system status and monitoring results of Nests A, B, C and D and the Meteorological Station in the T Tank Farm from July to September, 2008. For the reason of comparison, the data from October 2007 to June 2008 are also shown in the figures.

The layout of the instrument Nests and a detailed analysis of the FY07 data were summarized in the FY07 annual report (PNNL-17306, Zhang et al. 2008). Nests C and D reside under the surface barrier, Nest B near the edge of the barrier, and Nest A outside the barrier. For detailed description of the design of the monitoring system, please refer to the "T Tank Farm Interim Surface Barrier Demonstration – Vadose Zone Monitoring Plan" (PNNL-16538, Zhang et al. 2007).

The primary variables monitored include

- soil-water content measurements by the capacitance probes (CPs),
- normalized neutron counts (as a reflection of soil water content) by a neutron probe (NP)
- soil-water pressure measurements by the heat dissipation units (HDUs),
- soil-water flux measurements by the drain gauges

The secondary variables monitored include

- soil temperature measured by HDUs
- air temperature and precipitation from the T Farm Meteorological Station
- temperature within the datalogger enclosures
- battery voltages

To check the system's functionality, measured air temperature, temperature within the datalogger enclosures, and precipitation were compared with those from the Hanford Meteorological Station (HMS).

2.0 Results

This section summarizes the monitoring results of both the primary and secondary variables.

2.1 Primary Variables

The primary variables include soil moisture content from the capacitance probes, neutron probe measurements, soil water pressure head from HDUs, and soil water flux measurements by the drain gauges.

Table 1. Dynamics of soil-water content (θ) using the capacitance probes and sensor performance from July to September 2008

Nest	Depth (m)	θ Dynamics	Sensor Functionality	Performance within the Indicated Range?
A†	0.6	Stable	Functional but results are suspicious	Yes
	0.9	Stable		
	1.3	Stable		
	1.8	Stable		
	2.3	Stable		
B	0.6	Stable	Normal	Yes
	0.9	Stable	Normal	Yes
	1.3	Stable	Normal	Yes
	1.8	Stable	Normal	Yes
	2.3	Stable	Normal	Yes
C††	0.6	Stable	Normal	Yes
	0.9	Stable	Normal	Yes
	1.3	Stable	Normal	Yes
	1.8	Stable	Normal	Yes
	2.3	Stable	Normal	Yes
D††	0.6	Stable	Normal	Yes
	0.9	Stable	Normal after late August	Yes after late August
	1.3	Stable	Normal	Yes
	1.8	Stable	Normal	Yes
	2.3	Stable	Normal	Yes

† From January 31 to August 7, 2008, this CP was not functional due to ponding water found in the access tube. A replacement in late May failed also. The most recent repair occurred on August 7, 2008.
††The sensors in Nests C and D were hooked up for logging on May 3, 2008.

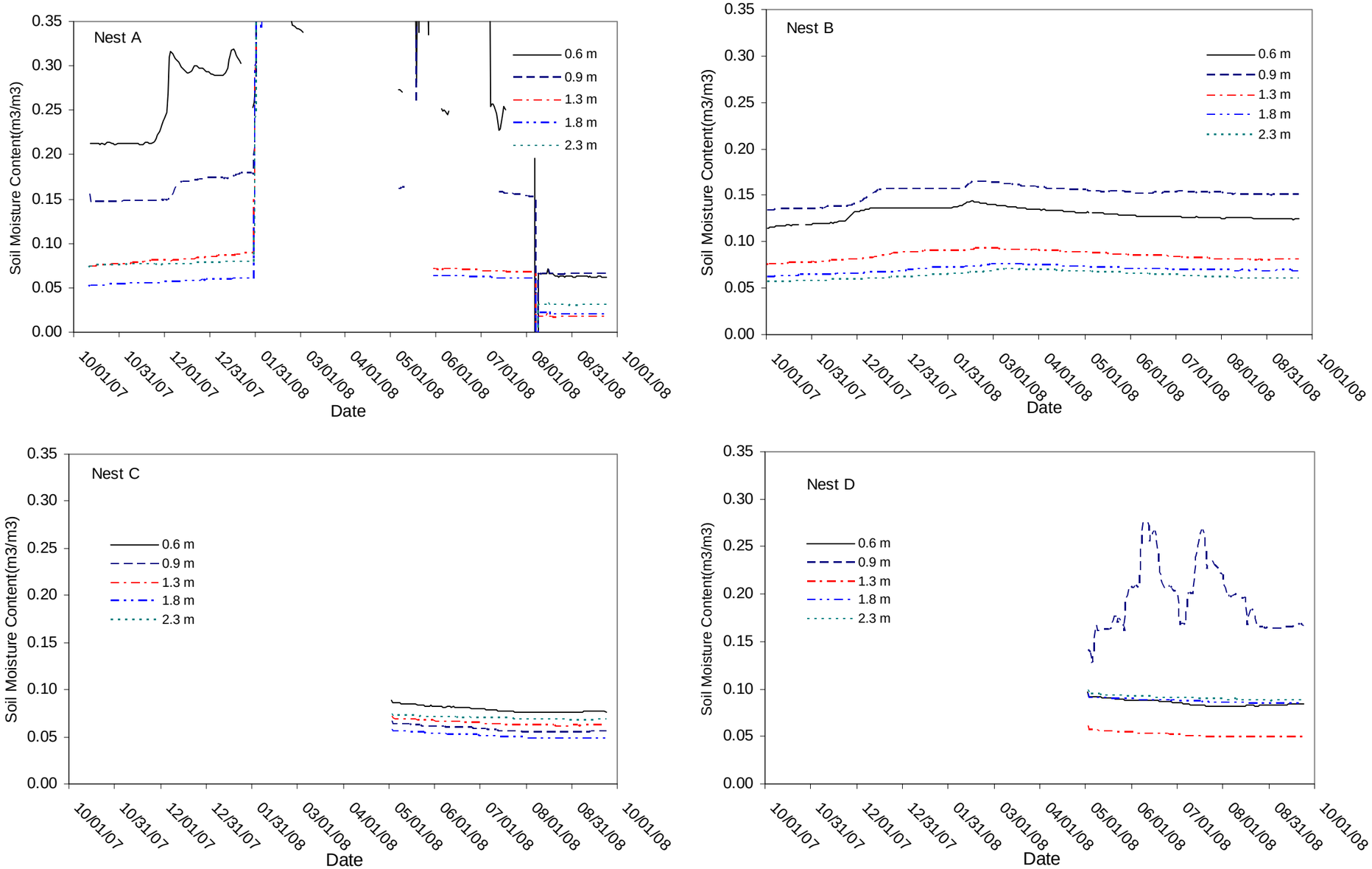

Figure 1. Daily average soil water content at five depths measured using the capacitance probes.

2.1.1 Capacitance Probes

Soil water condition changes and CP-sensor performance from July to September, 2008, are summarized in Table 1. The temporal variations of CP-measured water contents in FY08 are shown in Figure 1. During this period, the CPs in Nests B, C and D were functional. The CP in Nest A was not functional through this period. Repairs the March and May were not successful due to the lack of appropriate tool. A third repair was conducted on August 7 by reusing the sensors from the CPs that might have been damaged. Hence, the data after August 7 were suspicious although the probe was functional. The Nest D CP sensor at 0.9-m depth was noisy from May to August. This might be due to bad wire connection. A repairing in August removed the noise.

2.1.2 Heat Capacitance Units

Soil water condition and HDU-sensor performance from July to September 2008 are summarized in Table 2. The temporal variations of HDU-measured water pressure heads in FY08 are shown in Figure 2. All the HDUs were functional during this period.

Table 2. Dynamics of soil-water pressure head (ψ) from the heat dissipation units and sensor performance from July to September 2008

Nest	Depth (m)	ψ Dynamics	Sensor Functionality	Performance within the Indicated Range?
A	1	Decreasing	Normal	Yes
	2	Decreasing	Normal	Yes
	5	Stable	Normal	Yes
	10	Stable	Normal	Yes
B	1	Decreasing	Normal	Yes
	2	Decreasing	Normal	Yes
	5	Stable	Normal	Yes
	10	Stable	Normal	Yes
C[†]	1	Decreasing	Normal	Yes
	2	Decreasing	Normal	Yes
	5	Decreasing	Normal	Yes
	10	Increasing	Normal	Yes
D[†]	1	Decreasing	Normal	Yes
	2	Decreasing	Normal	Yes
	5	Decreasing	Normal	Yes
	10	Increasing	Normal	Yes

[†] The sensors in Nests C and D were hooked up for logging on May 3, 2008.

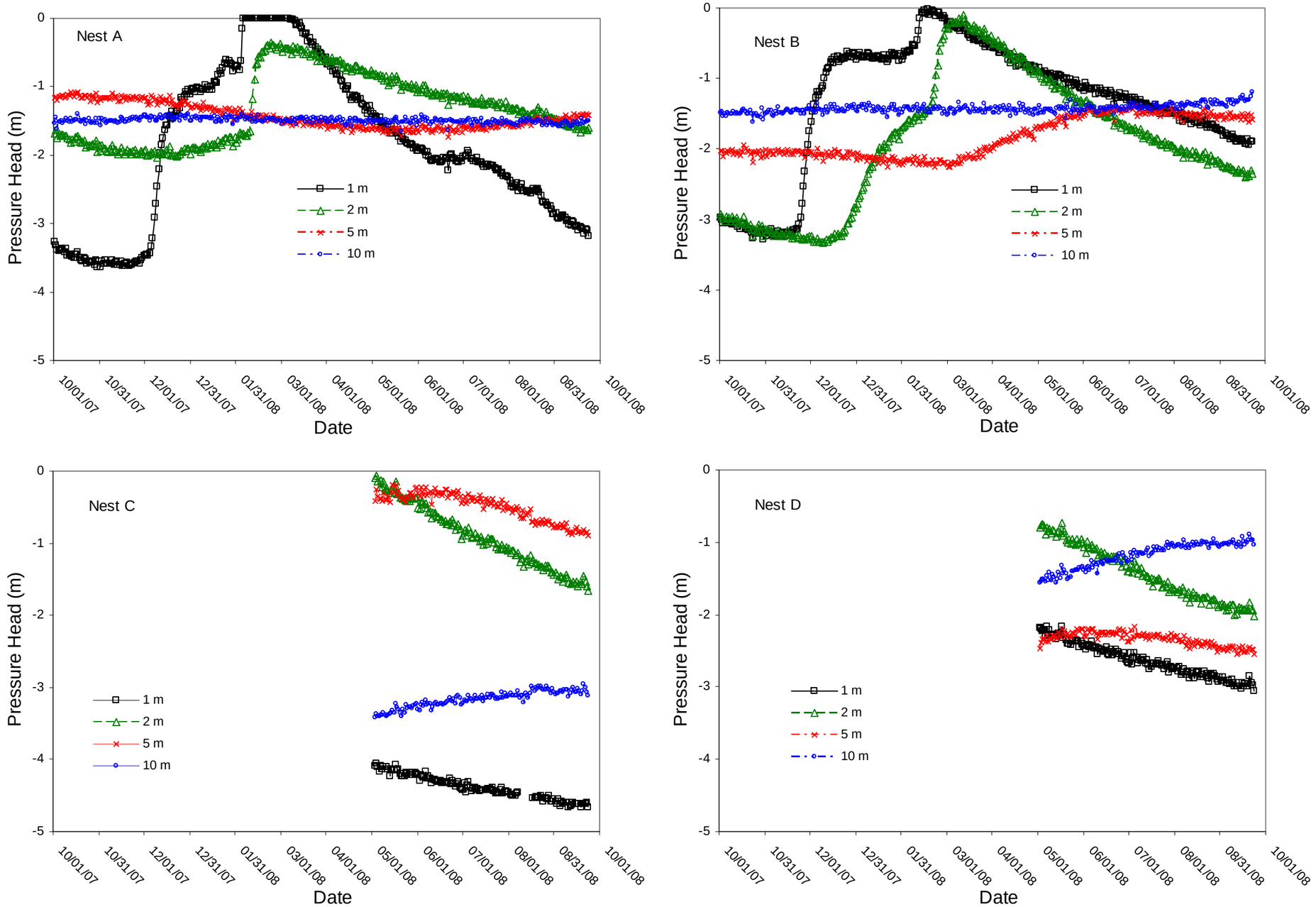

Figure 2. Daily average soil water pressure at different depths measured using the heat dissipation units.

2.1.3 Neutron Probe Measurements

The neutron loggings and the NP performance in FY08 are summarized in Table 3. The profiles of normalized neutron counts are shown in Figure 3. Anomalous data were found occasionally when the observations of different dates were compared. Obvious typos (e.g., the NP counts were off by ~1000) in data were corrected (Table 4). Many observations of the Nest B logging on 4/9/08 were problematic and hence a re-logging was taken on 5/25/08.

Table 3. Neutron moisture logging data

Nest	Date	NP Logged?	Performance within the Indicated Range?	Any Anomalous data?	Depths that anomalous data were found (m/ft)
A	10/12/2007	Yes	Yes	No	-
	1/16/2008	Yes	Yes	Yes	0.6/2
	4/9/2008	Yes	Yes	Yes	8.2/27
	7/30/2008	Yes	Yes	No	-
B	10/12/2007	Yes	Yes	No	-
	1/16/2008	No	-	-	-
	4/9/2008	Yes	Yes	Yes	3.4/11, 8.8/29, 9.1/30, 10.7/35, 14.9/49
	5/25/08	Yes	Yes	No	-
	7/30/2008	Yes	Yes	No	-
C	10/12/2007	Yes	Yes	No	-
	1/16/2008	Yes	Yes	No	-
	4/9/2008	Yes	Yes	No	-
	7/30/2008	Yes	Yes	No	-
D	10/12/2007	Yes	Yes	No	-
	1/16/2008	Yes	Yes	Yes	5.8/19, 7.0/23
	4/9/2008	Yes	Yes	No	-
	7/30/2008	Yes	Yes	No	-

Table 4. Corrections Made to the Neutron moisture logging data

Nest	Date	Depth (m/ft)	Suspected Reading	Previous two readings	Corrected Reading
A	1/16/2008	0.6/2	5907	3052, 2813	2907
A	4/9/2008	8.2/27	3318	2327, 2382	2318
D	1/16	5.8/19	2426	3534, 3406	3426
D	1/16	7.0/23	3780	2663, 2782	2780

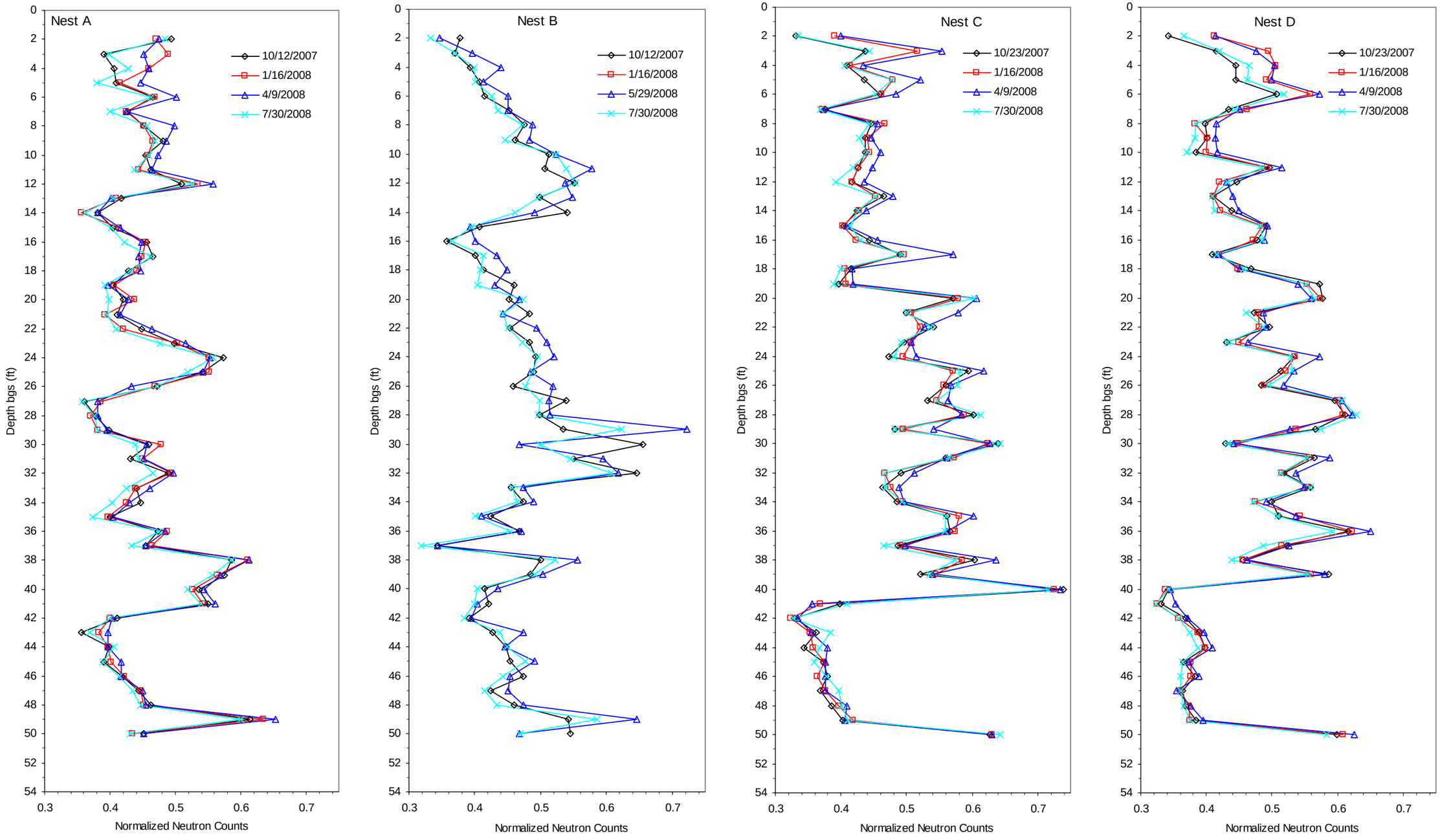

Figure 3. Normalized neutron counts at different depths measured using neutron probes (The logging on 4/9/2008 for Nest B was not considered because of numerous anomalous data).

2.1.4 Soil Water Flux

Neither of the two drain gauges detected any drainage.

2.2 Secondary Variables

The secondary variables include soil temperature, air temperature, precipitation, and battery voltage. These variables do not reflect any soil water condition but are used for other purposes. Soil temperature is used to correct any temperature impacts on the HDUs. The weather data are for the local climatic conditions. These data are also used to examine system functionality.

Table 5. Soil temperature (T) variation using the heat dissipation units from July to September 2008

Nest	Depth (m)	T Dynamics	Sensor Functionality	Performance within the Indicated Range?
A	1	Decreasing	Normal	Yes
	2	Increasing-Decreasing	Normal	Yes
	5	Increasing	Normal	Yes
	10	Stable	Normal	Yes
B	1	Decreasing	Normal	Yes
	2	Increasing-Decreasing	Normal	Yes
	5	Increasing	Normal	Yes
	10	Stable	Normal	Yes
C	1	Decreasing	Normal	Yes
	2	Increasing-Stable	Normal	Yes
	5	Increasing	Normal	Yes
	10	Stable	Normal	Yes
D	1	Decreasing	Normal	Yes
	2	Increasing-Stable	Normal	Yes
	5	Increasing	Normal	Yes
	10	Stable	Normal	Yes

2.2.1 Soil Temperature

The HDU performance from July to September 2008 are summarized in Table 5. The soil temperature variations for all the sensors in FY08 are shown in Figure 4.

- All the HDU sensors were in normal function
- The measured soil temperature from Nests A and B were very similar to those a year ago. The curves for Nests C and D were similar to the corresponding portions in the plots for Nests A and B.

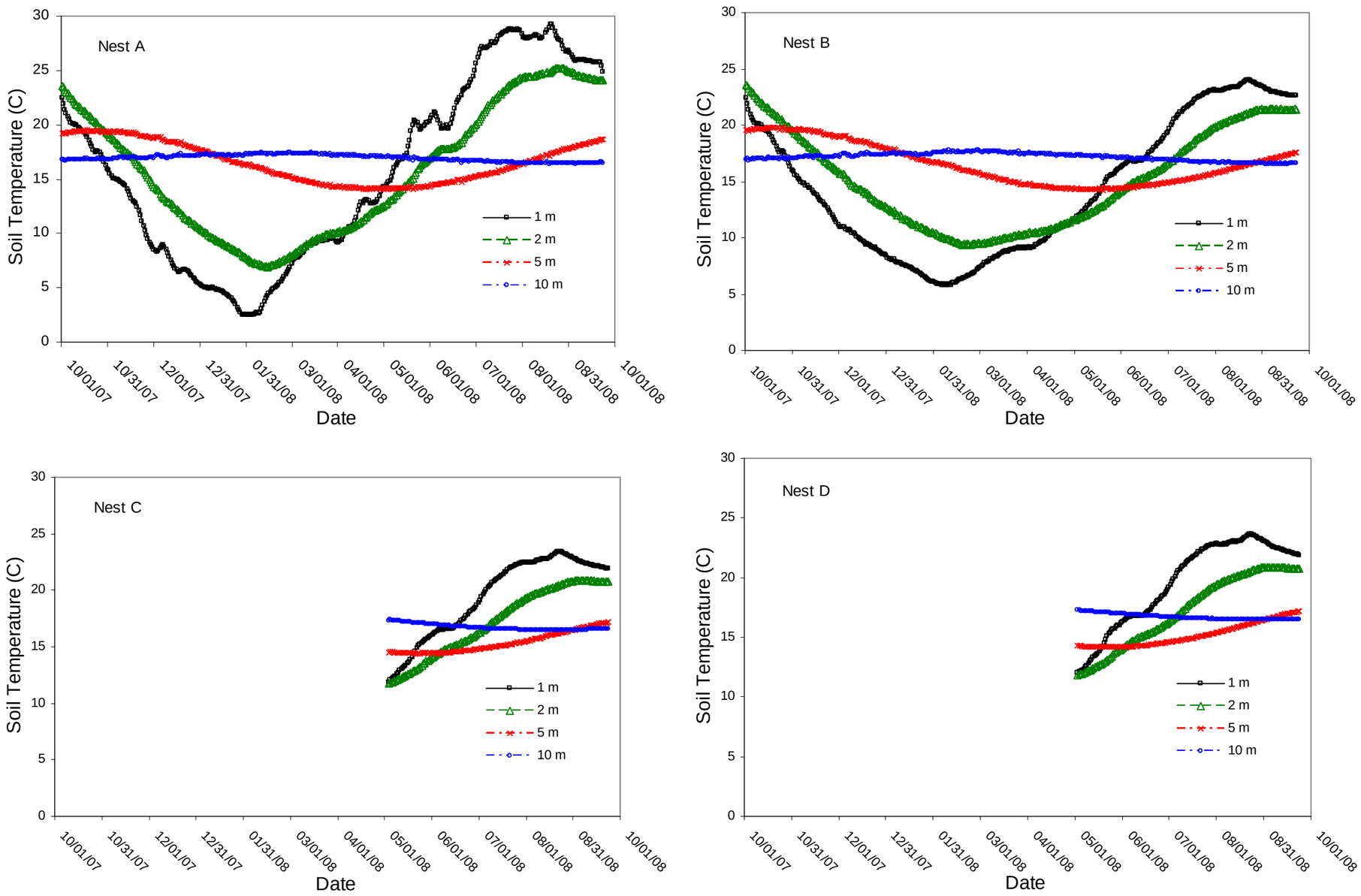

Figure 4. Daily average soil temperature at different depths measured using the heat dissipation units.

2.2.2 Air Temperature

The measured daily average air temperature outside of the fence of T Farm, the reference temperature of the dataloggers in Nests A, B, C and D, and the air temperature from the Hanford Meteorological Station (HMS) in FY08 are plotted in Figure 5. They all are in good agreement.

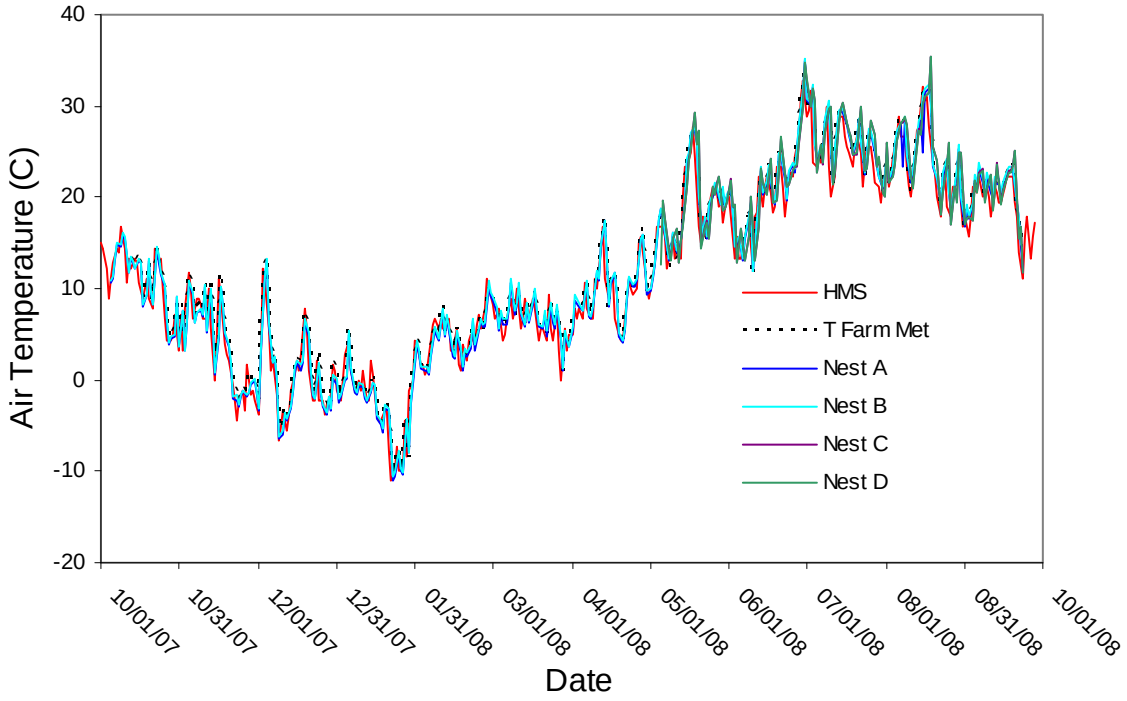

Figure 5. Daily average air temperature.

2.2.3 Precipitation

The FY-to-date cumulative precipitation measured outside of the fence of T Farm and that from the HMS are plotted in Figure 6. The FY08 cumulative precipitation in the T Farm were significantly (30%) less than the HMS measurements. There may be multiple causes to the differences. The T Farm rain gauge is not heated and hence it may underestimate snow amount. The calibration coefficient may have changed during the course of the observation. It is also possible that the actual precipitation at the T Farm was different from that at the HMS. Further investigation will be conducted.

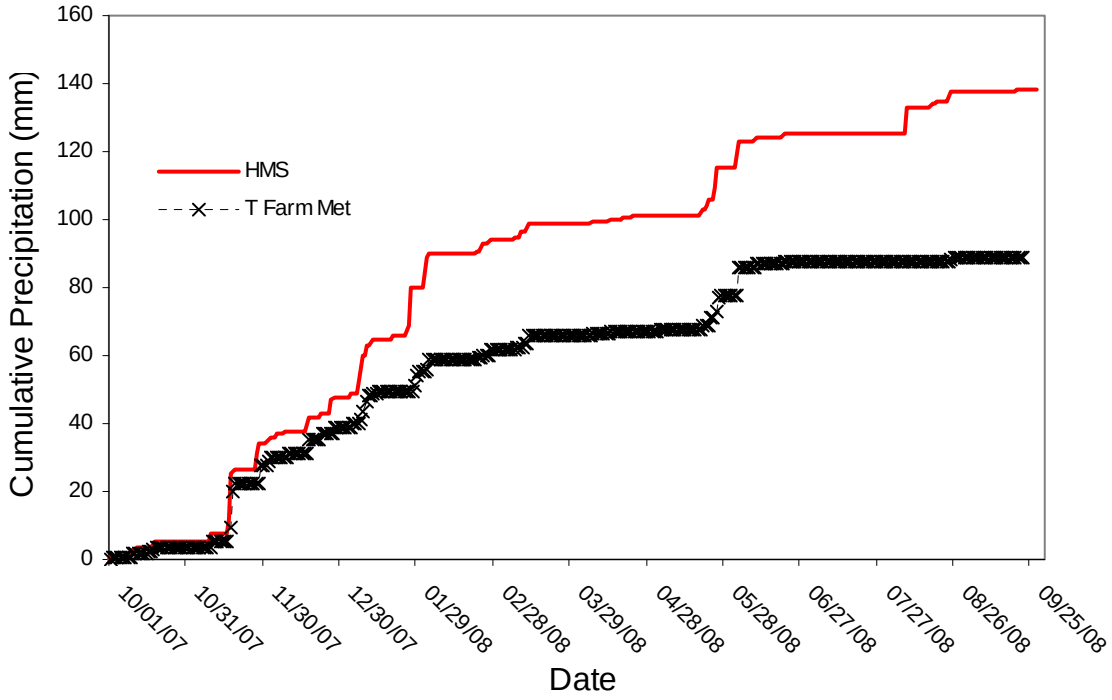

Figure 6. FY-to-date Cumulative precipitation at the T Farm and the HMS.

2.2.4 Battery Voltage

A battery is used for each of the instrument nests and the meteorological station. Each battery is recharged by a connected solar panel. Battery voltage larger than 12V is required to provide sufficient power to the instrument. The variations in battery voltages in Nests A, B, C and D and the T Farm Met station are plotted in Figure 7. For all three batteries, the minimum voltage was no less than 12.5V, which indicates sufficient power to the instruments.

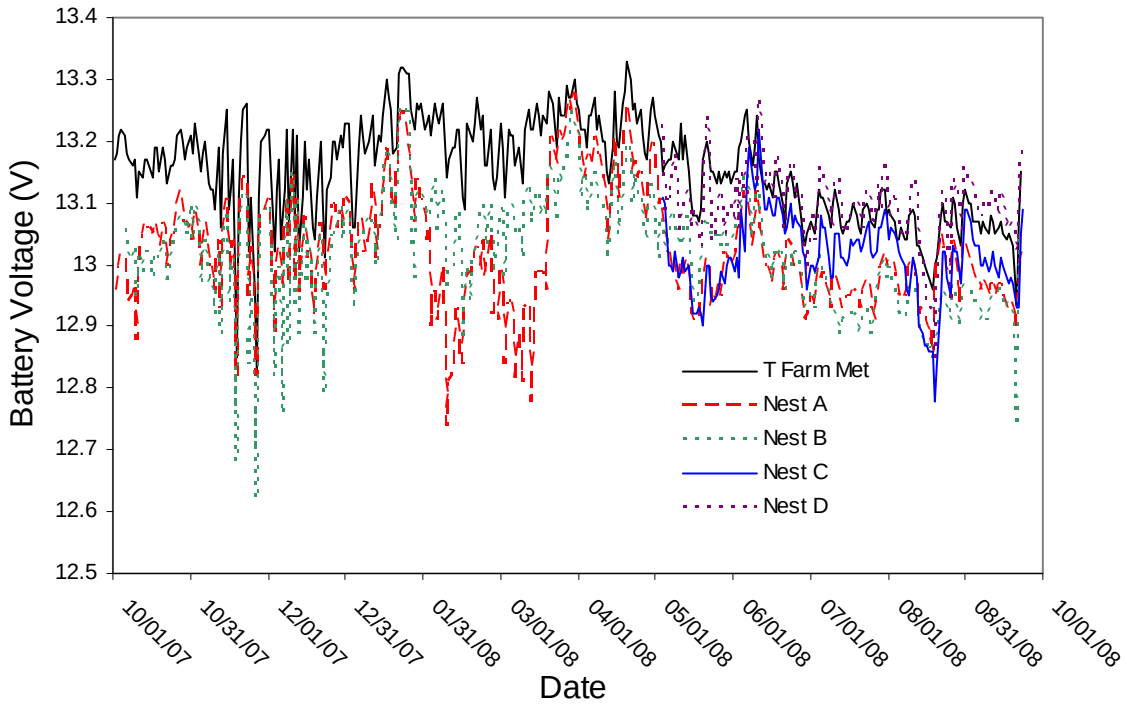

Figure 7. Daily average battery voltage.

References

Zhang ZF, JM Keller, and CE Strickland. 2007. T Tank Farm Interim Surface Barrier Demonstration – Vadose Zone Monitoring Plan. PNNL-16538, Pacific Northwest National Laboratory, Richland WA.

Zhang ZF, CE Strickland, and JM Keller. 2008. T Tank Farm Interim Surface Barrier Demonstration – Vadose Zone Monitoring FY07 Report. PNNL-17306, Pacific Northwest National Laboratory, Richland WA.

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