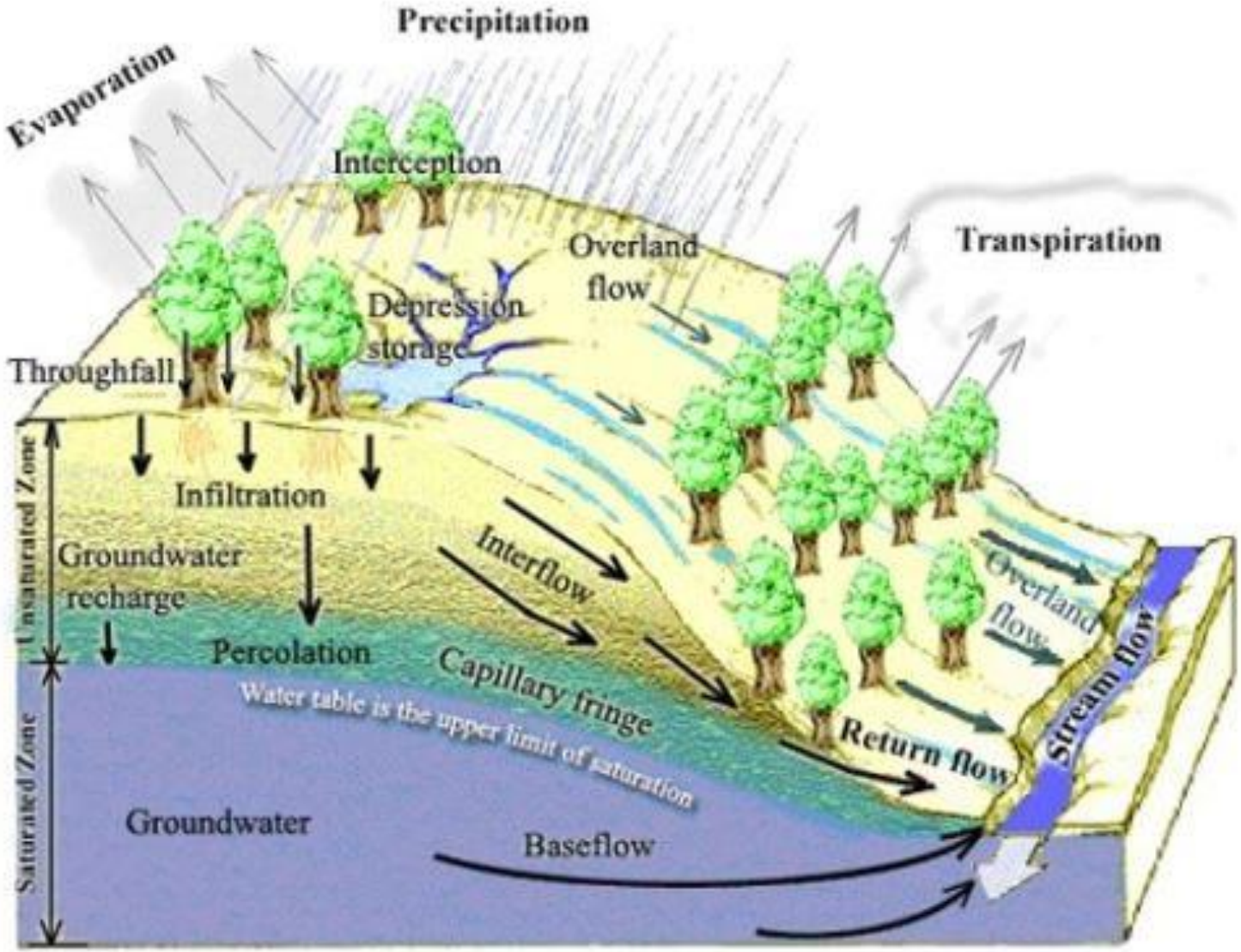
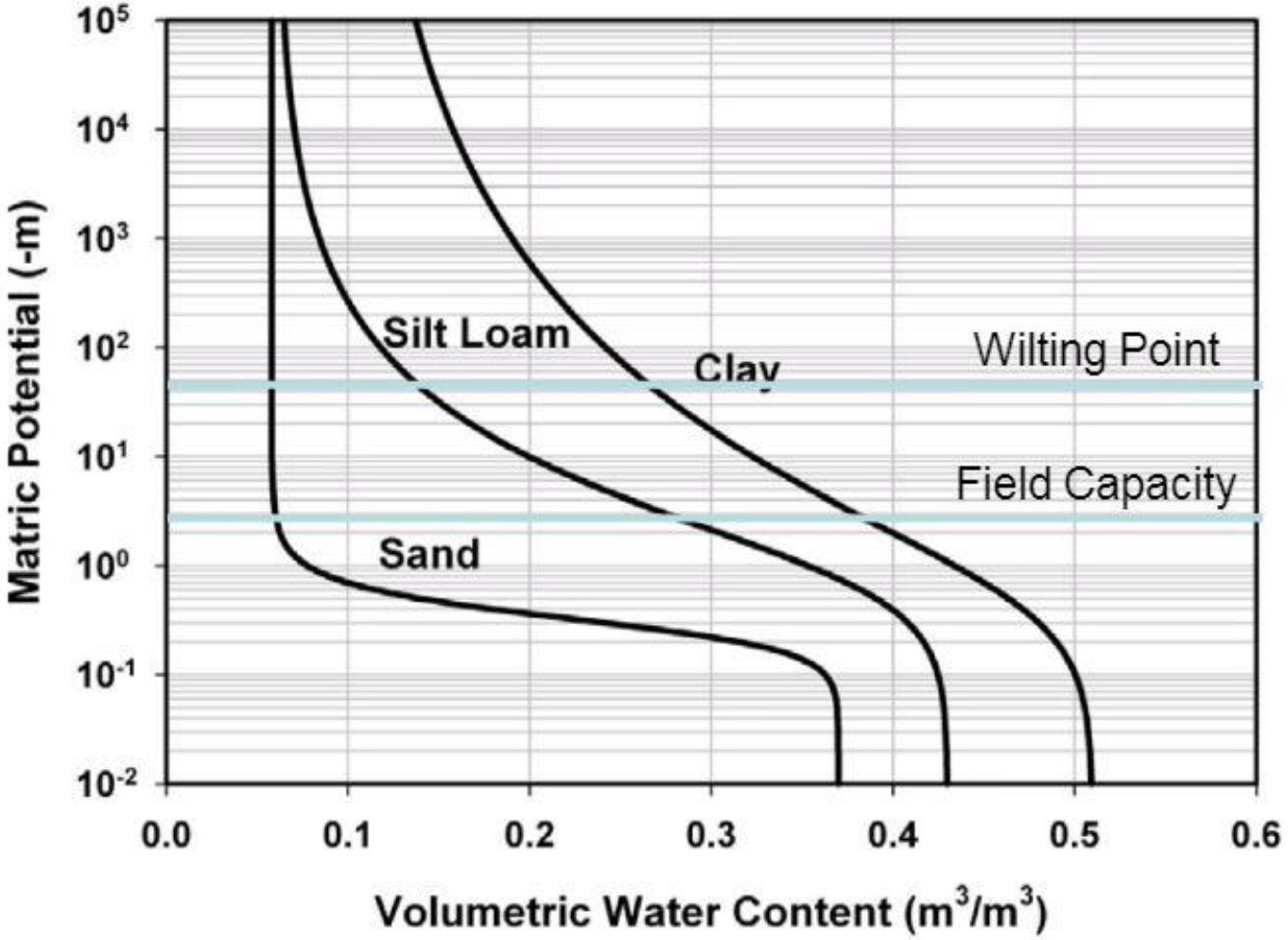
MATLAB processing techniques for soil moisture and matric potential data

John Shuler
Boise State University
GEOS597
12/5/2016

Soil is a main driver of precipitation routing



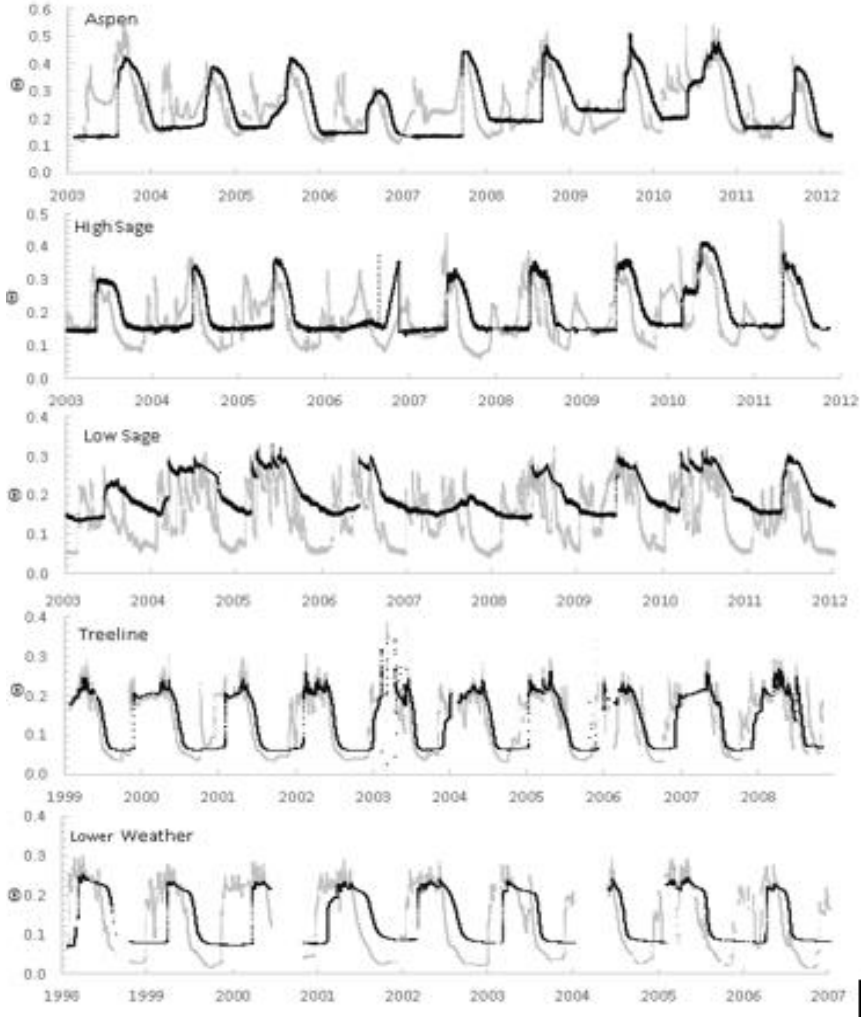
Soil moisture and tension are common parameters of interest

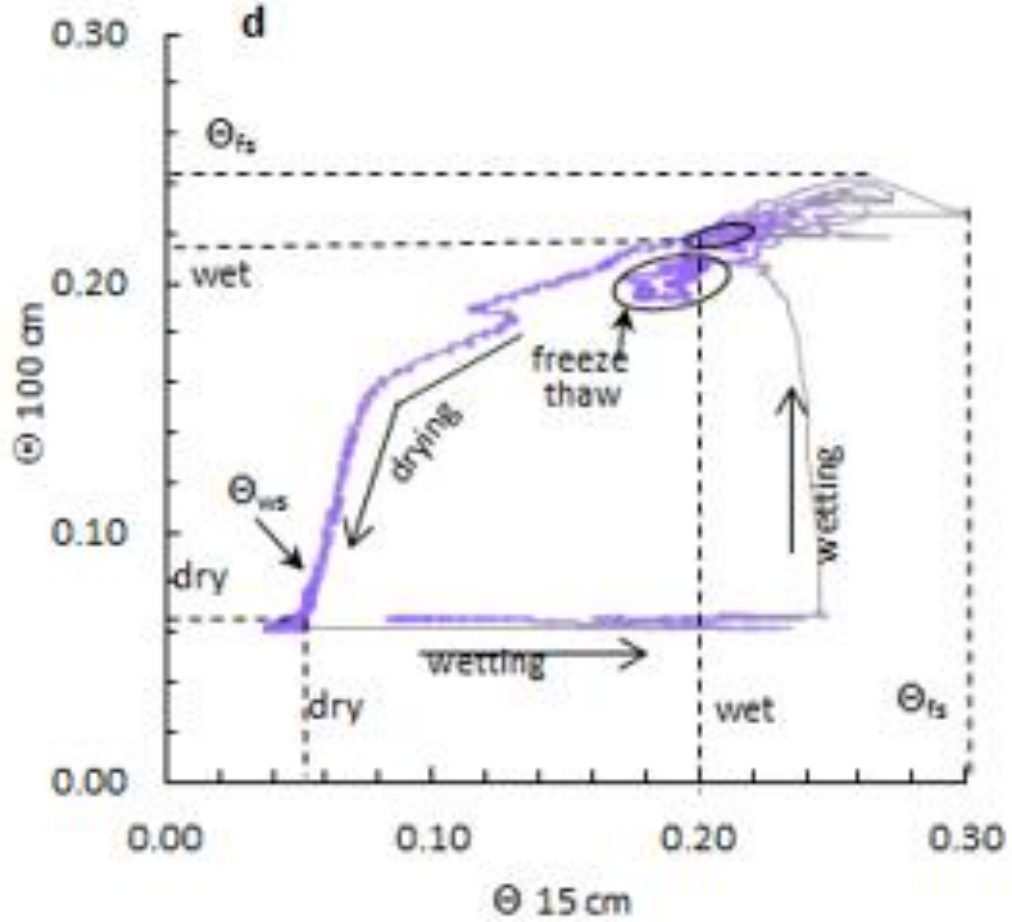


- Characteristic curves reveal soil properties

[*Hillel*, 1998]

Soil properties can be inferred from in situ time series data



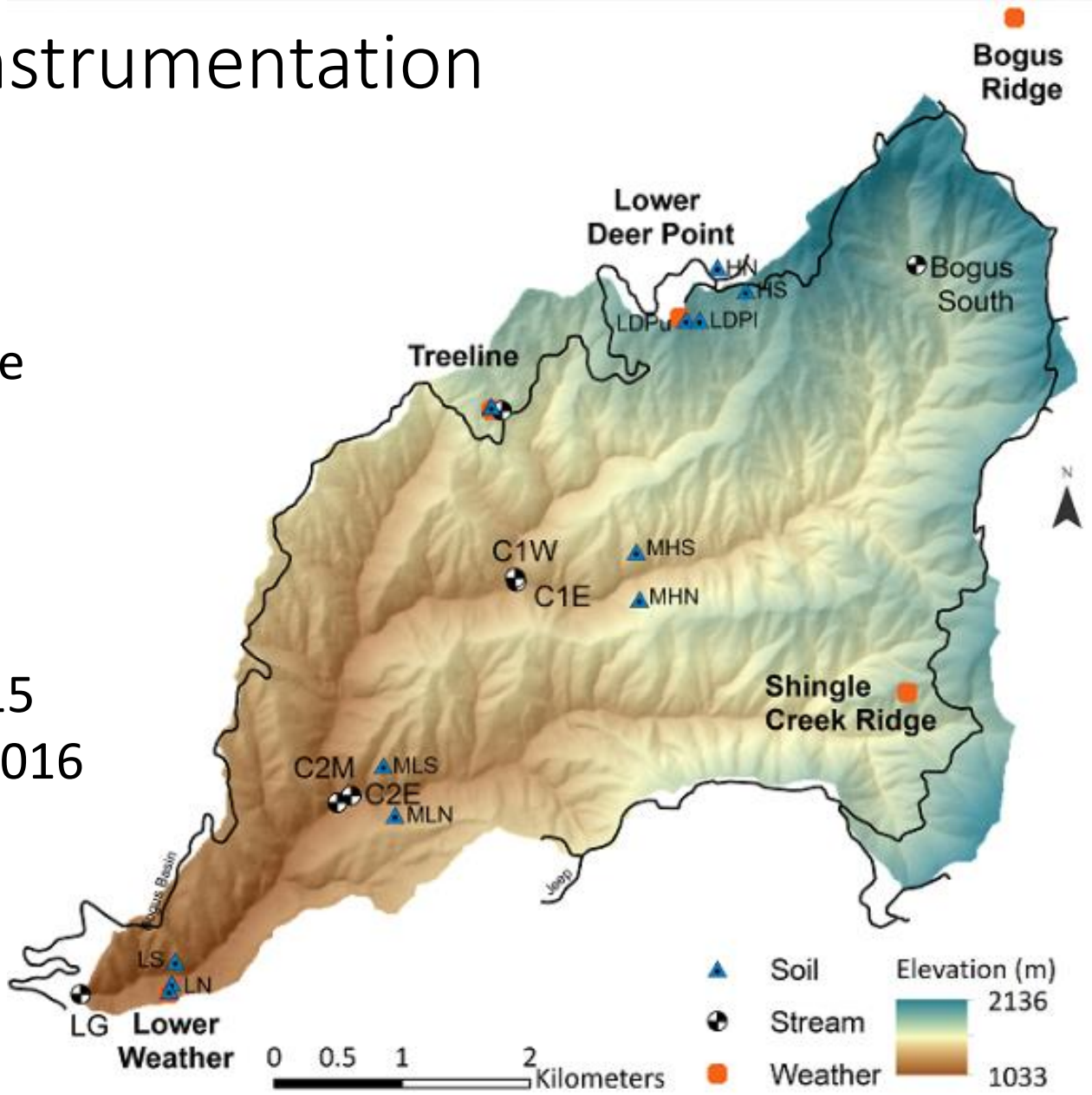


[*Chandler et al.*, 2016]

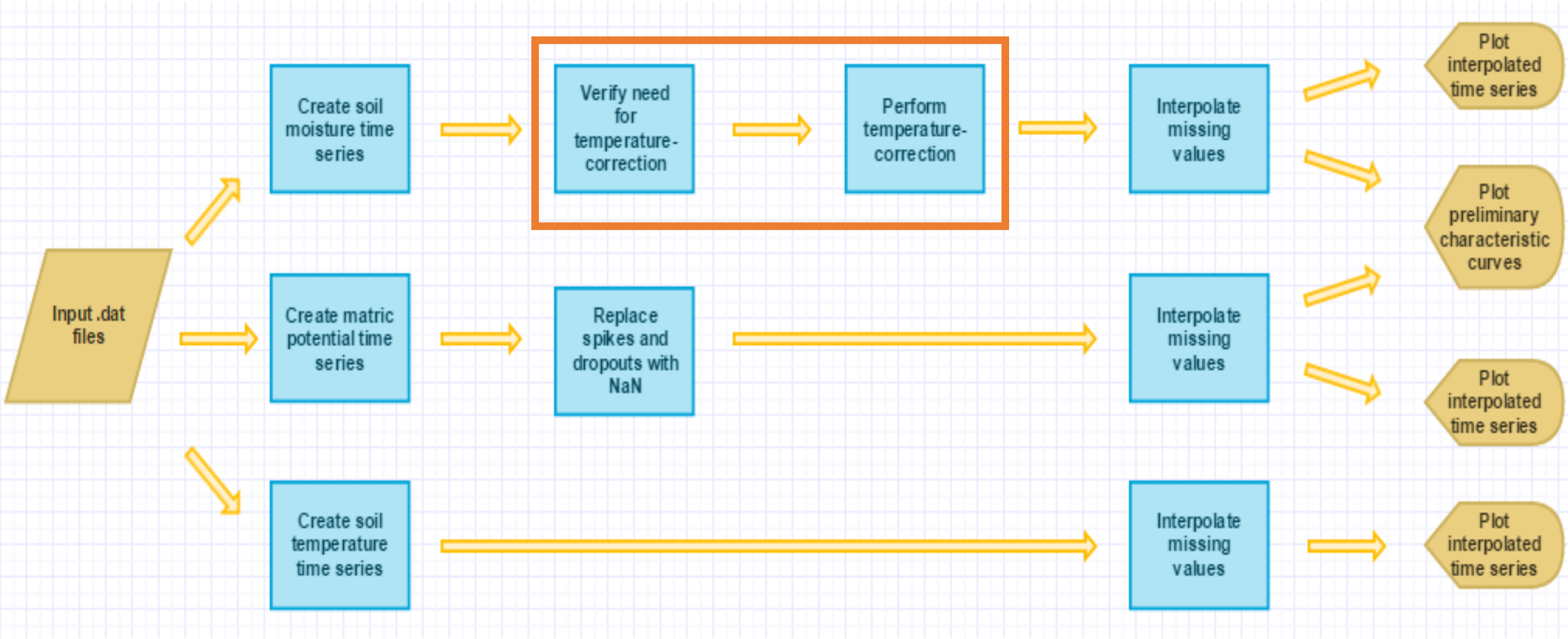
DCEW Study Site and Instrumentation

Data Con 1 East Soil Profile:

- 5 moisture sensors (also measure temperature)
- 4 matric potential sensors
- Measurements collected every 15 minutes from 5/12/16 to 9/30/2016



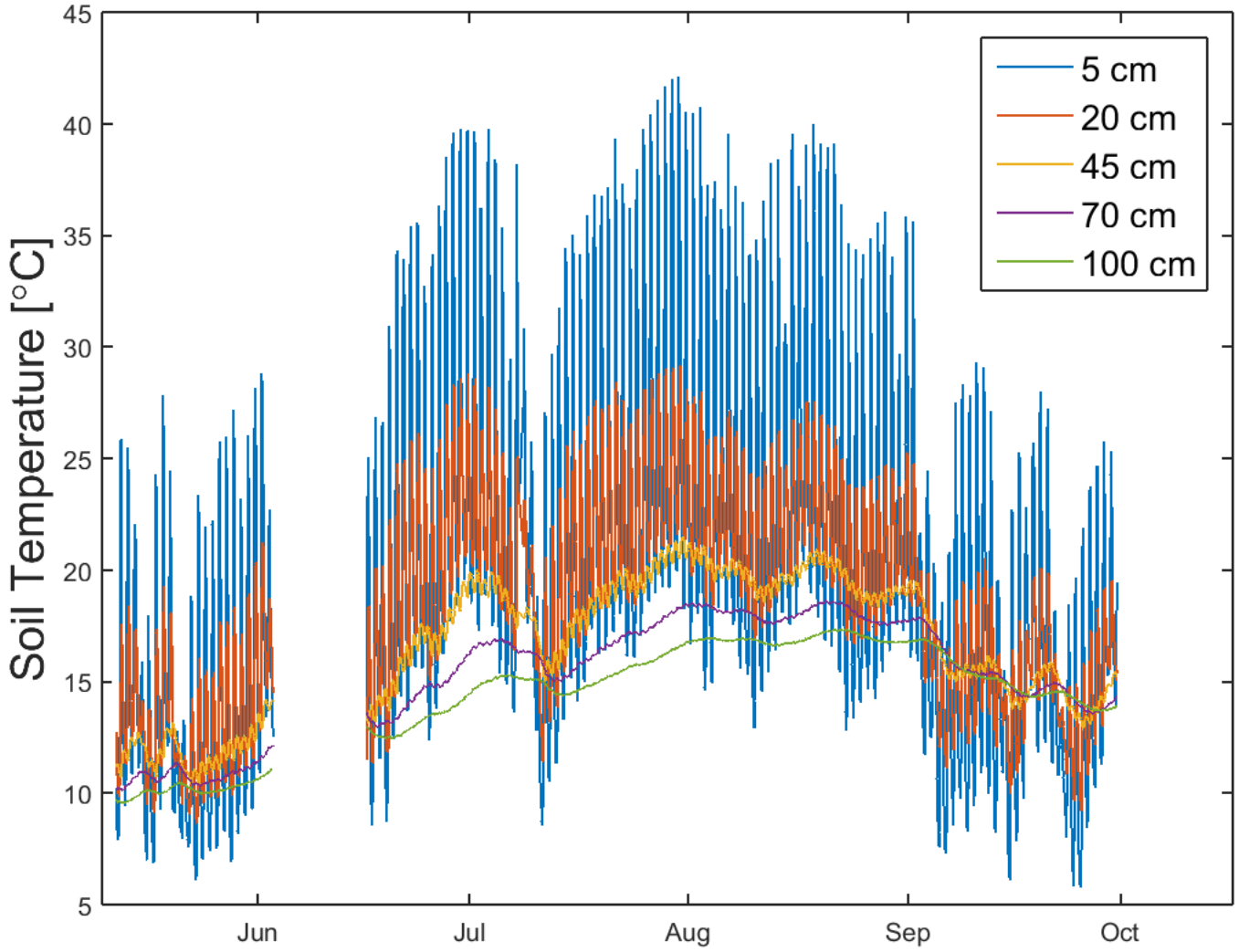
Workflow Chart



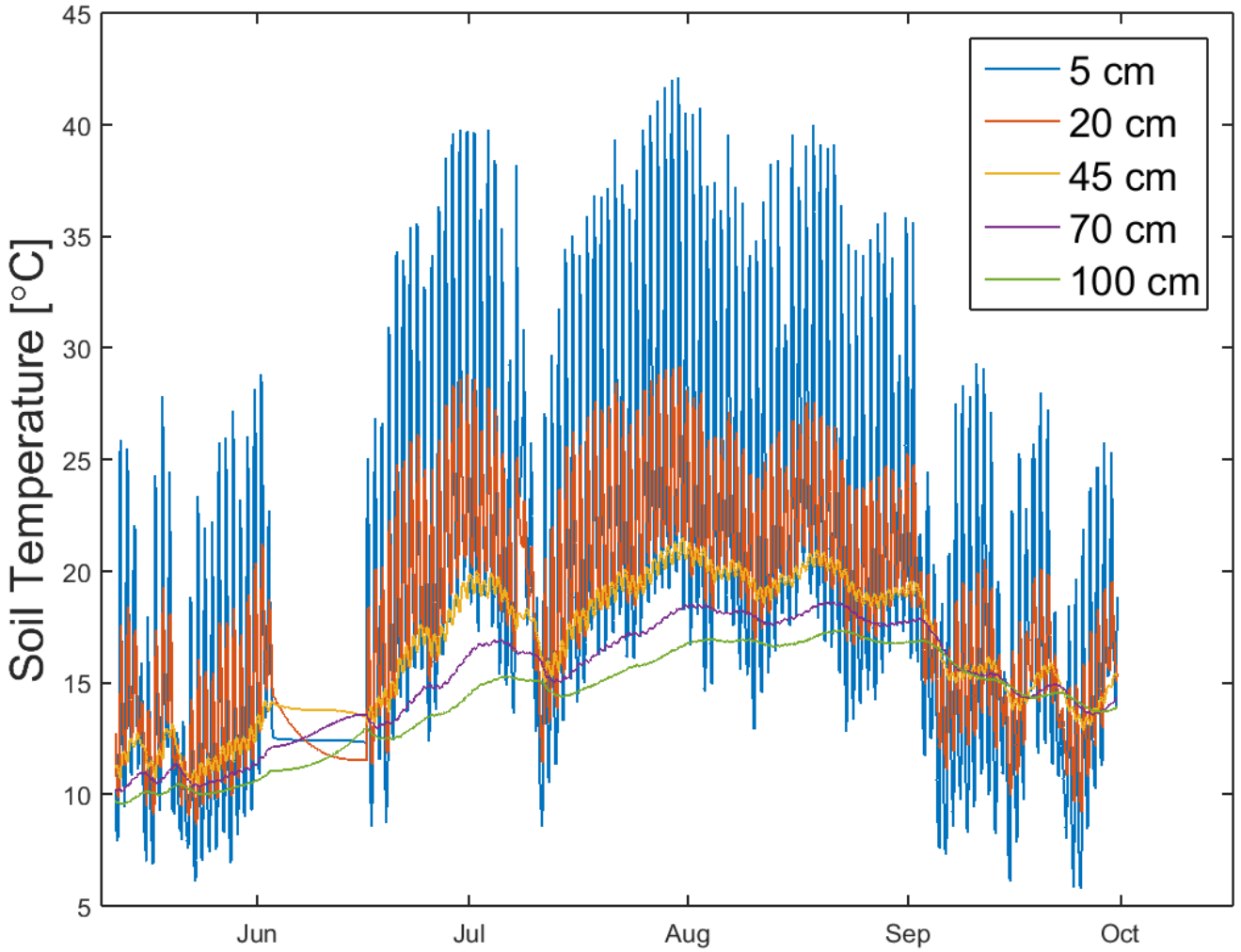
Raw soil temperature data

Issues:

- Data gap in early June



Processed soil temperature time series

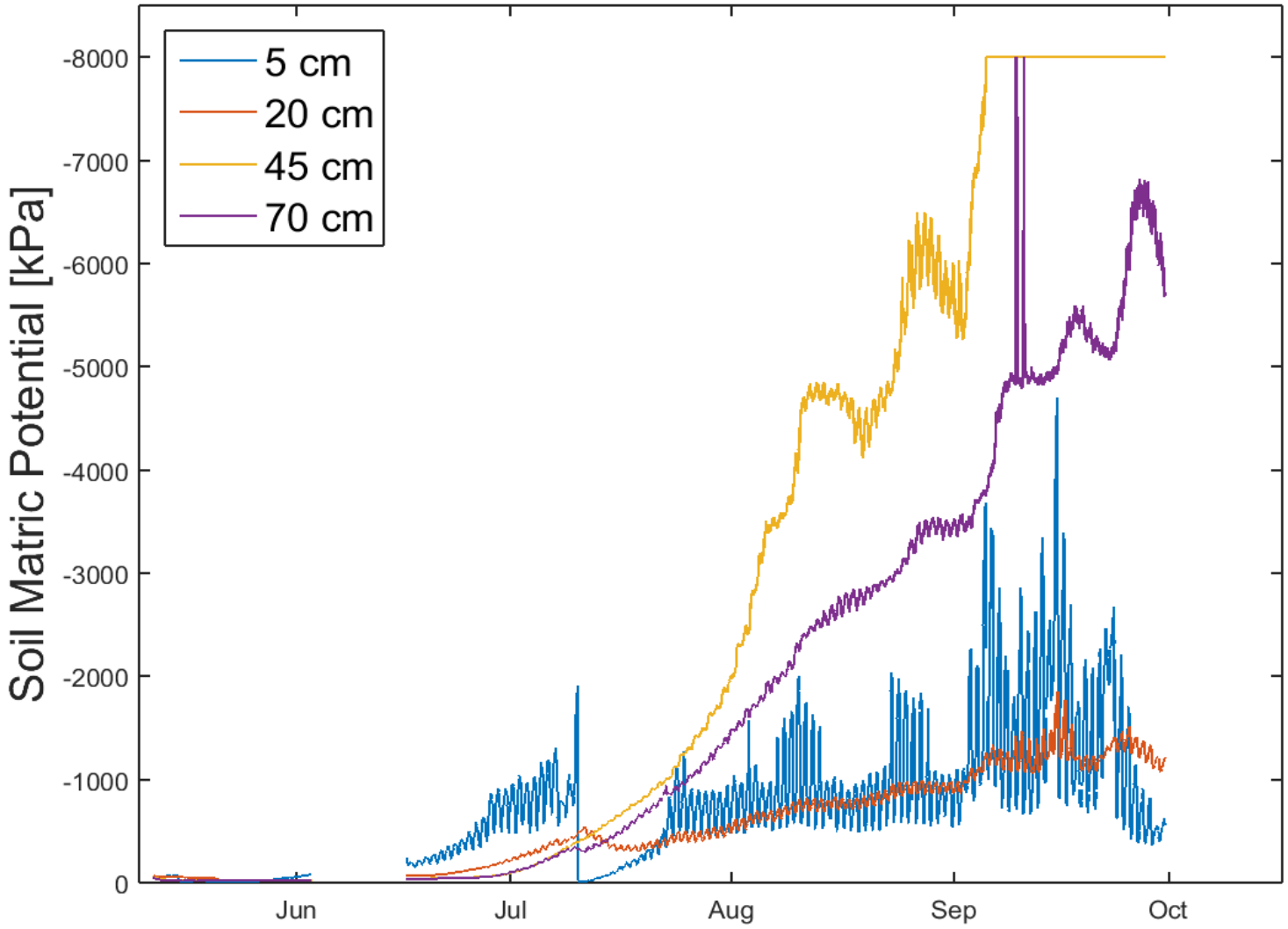



```
tempInt = zeros(length(dateVecNew),5);
for i = 1:5;
    tempInt(:,i) = interp1(dateVec, pit1Temp(:,i),
 dateVecNew, 'pchip');
end
```

Raw matric potential data

Issues

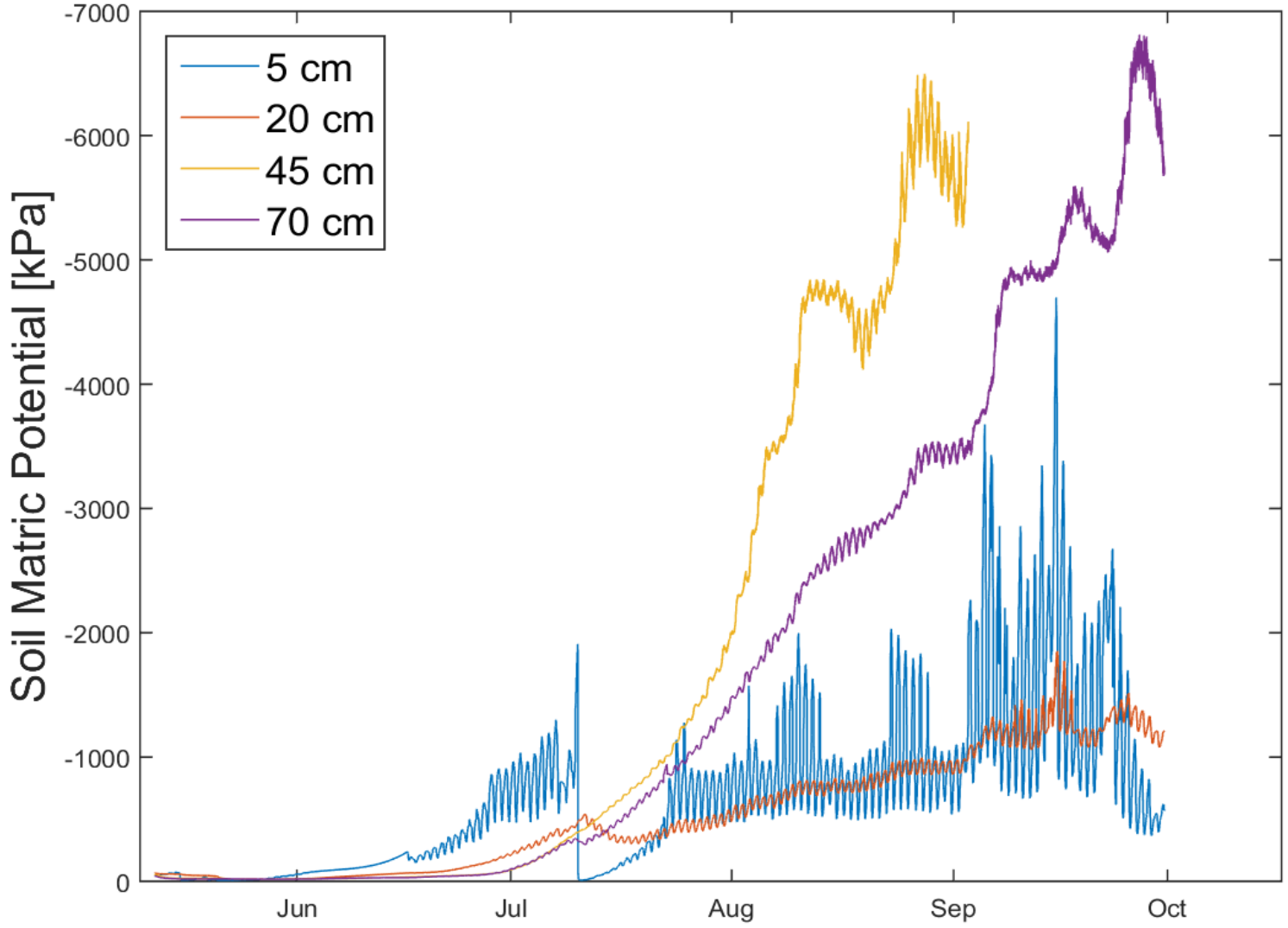
- Spikes and dropouts
- Data gap in early June
- Diurnal fluctuations



Processed matric potential time series

```
pit1Tension(pit1Tension<-7998) = NaN;
pit1Tension(10197:10222,4) = NaN;
pit1Tension(10293:10317,4) = NaN;
```

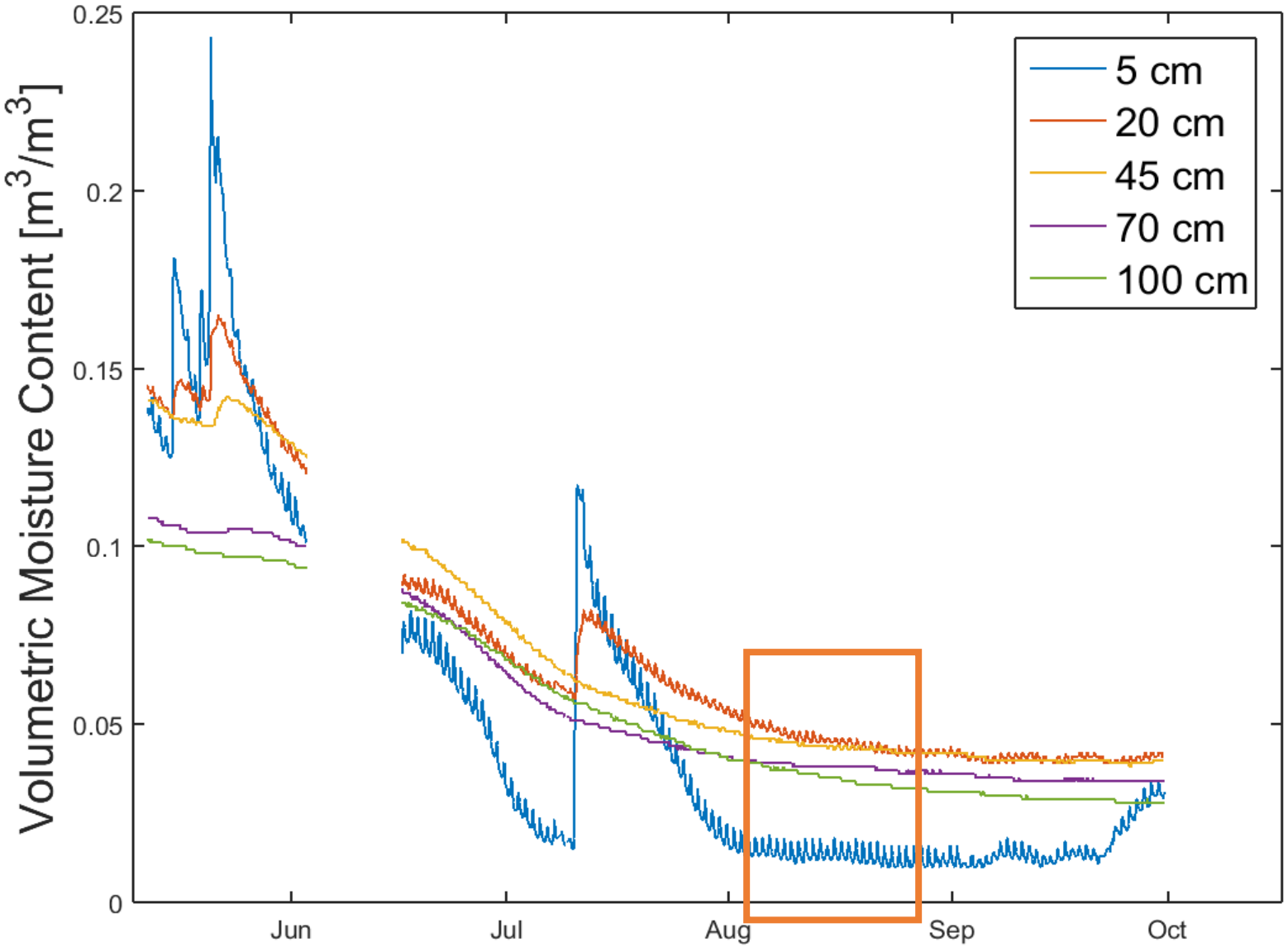
Processing ignores diurnal fluctuations (for now)



Raw soil moisture data

Issues:

- Data gap in early June
- Diurnal fluctuations in shallow sensors

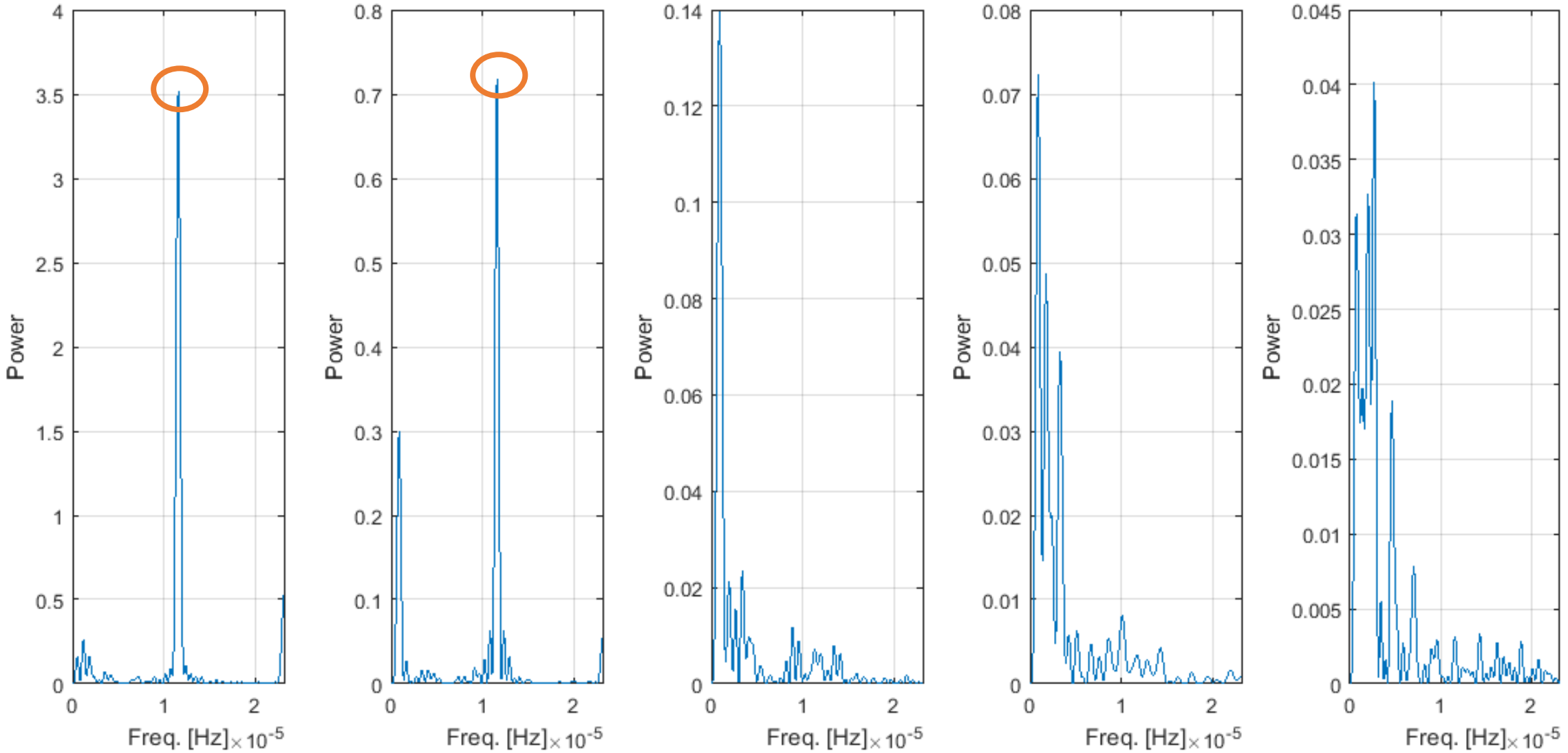


Code for periodogram of data subset

```
fs = 1/(15*60);                % sampling frequency in Hz
N = length(pit1Moisture)-1;
nfft = 2^nextpow2(N);
subset = pit1Moisture(8000:10000,1:5);

figure;
for i = 1:5;
    A = detrend(subset(:,i),'constant');
    B = detrend((A),'linear');
    [Pxx,f] = periodogram(B,[],nfft,fs);
    subplot(1,5,i)
    plot(f,Pxx);
    grid on;
    xlabel('Freq. [Hz]');
    xlim([0 1/(12*3600)])
    ylabel('Power')
end
```

Is temperature-correction of VMC data justified by periodicity?

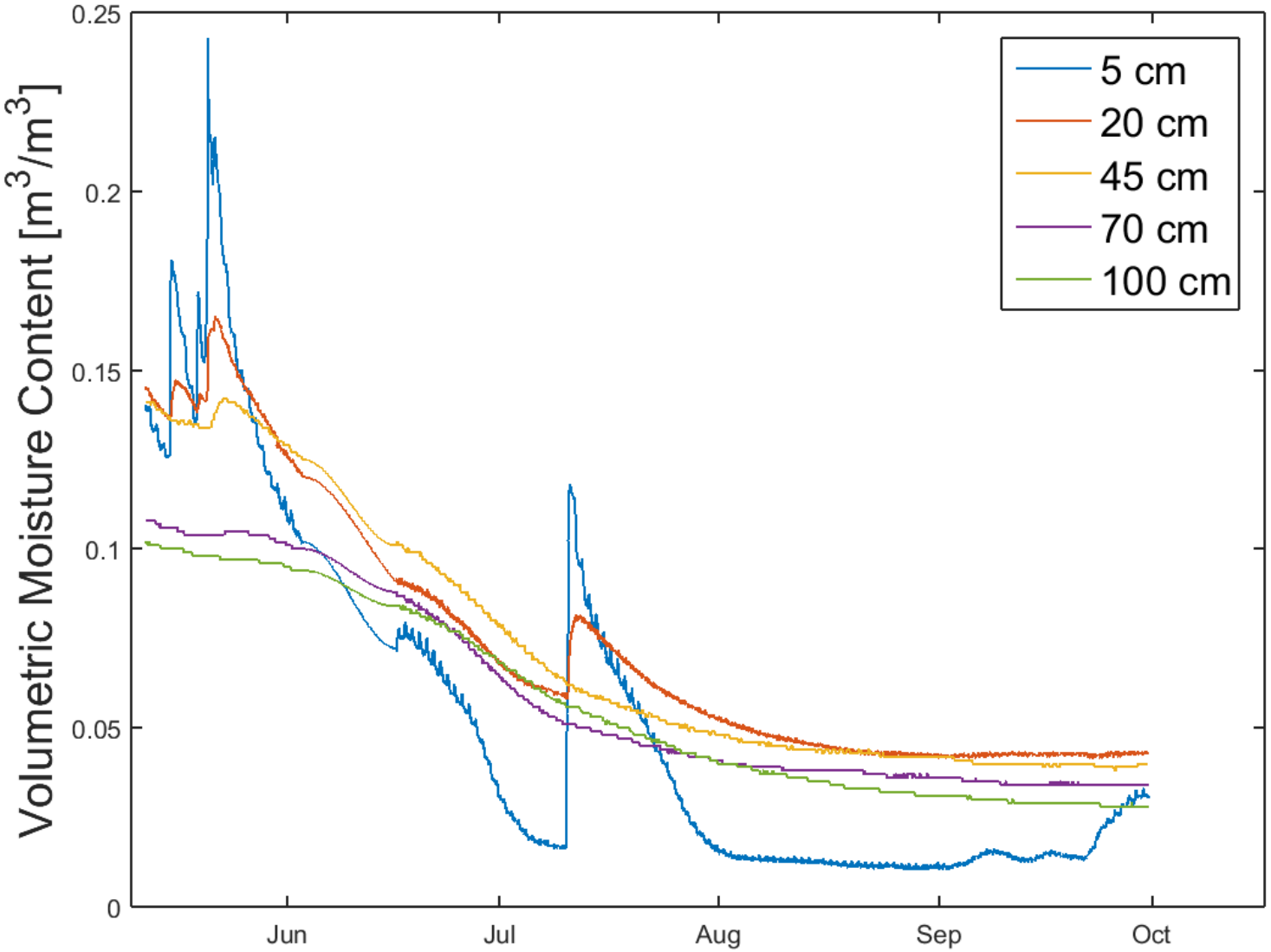


Temperature correction a la *Cobbs and Campbell*, 2007

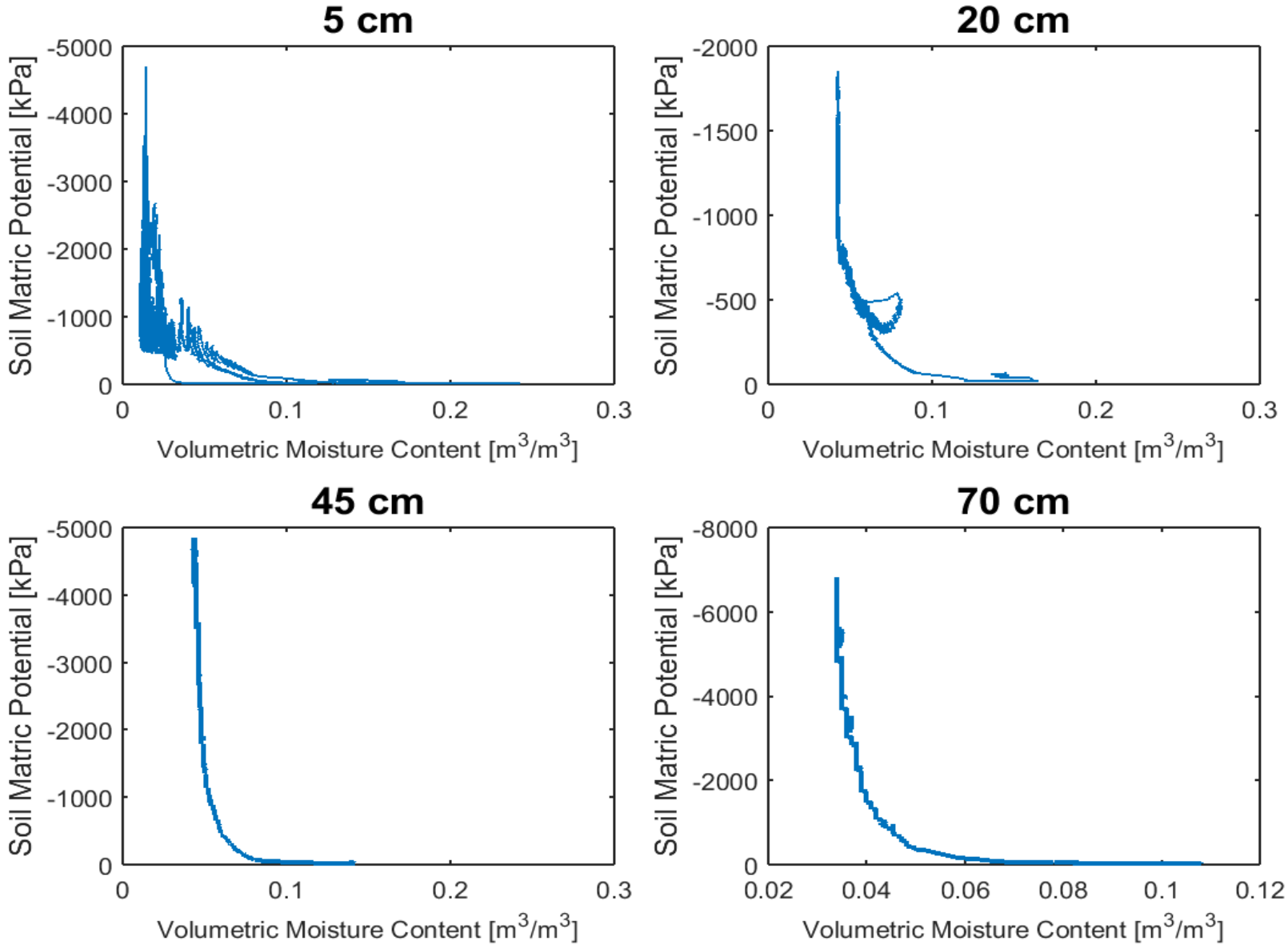
- Method requires manual selection of 3 rain-free, 24-hour periods
- Temperature correction equation uses multiple linear regression
- Coefficients for MLR produced by the Matlab **regress()** function:

```
X = [ones(size(VMCmeasured)) VMCmeasured temp VMCmeasured.*temp];
b = regress(VMCint,X);
```

Processed soil moisture data



Incomplete Characteristic Curves



To-Do List for Future John

- Continue data collection to improve characteristic curves
- Explore periodicity of matric potential data
  - Use low-pass filter to correct for temperature?
- Relate moisture and matric potential to stable isotope data

References

Chandler, D., M. Seyfried, J. McNamara (2016), Inference of Soil Hydrologic Parameters from Electronic Soil Moisture Records. In review for Hydrologic Processes

Cobos, D. and C. Campbell, (2007) Correcting temperature sensitivity of ECH2O soil moisture sensors, Decagon Devices, Pullman, WA

Hillel, D. (1998) Environmental Soil Physics: Fundamentals, Applications, and Environmental Considerations, 1st Edition, Academic Press, Cambridge, MA

Lu, M., J. Kapilaratne and I. Kaihotsu (2015), A data-driven method to remove temperature effects in TDR-measured soil water content at a Mongolian site. Hydrological Research Letters, 9(1), 8–13 DOI: 10.3178/hrl.9.8