Methods for Examining Deep Soil Mineralogy, Carbon Sequestration, Nutrient Cycling, and Hydraulic Redistribution

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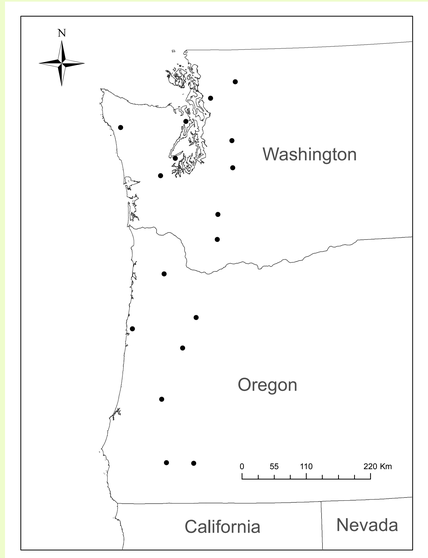
Background

Deep soil (> 1 m) has been under-estimated in the literature, despite large amounts of carbon, nitrogen and other nutrients being stored in these layers. Previous research in the Pacific Northwest has shown that >20% of soil carbon and >30% of soil nitrogen can be found beneath 1 m (James et al. 2014; James et al. *in press*). While much is known about the variety of storage mechanisms for soil carbon, the relative importance of each mechanism across soil types has not been quantified, nor have the differences between surface and deep soil storage within the same pedon.

Forest productivity tends to increase as effective soil depth increases, and Douglas-fir commonly extend roots past 2 m depth. These roots provide direct input of carbon and nitrogen through root exudates and turnover, and provide access to water in deep horizons. During drought and dry summer months, deep roots passively move water to dry surface soil (called hydraulic redistribution), which can extend the growing season and facilitate decomposition of organic matter and release of nutrients.



Methods

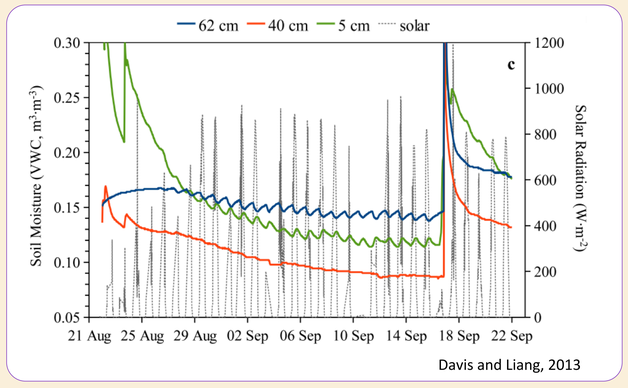
Soil Sampling

- 17 sites excavated between 2 m and 3.5 m depth
- Cover a range of variables in the coastal Pacific Northwest
  - Precipitation
  - Temperature
  - Latitude
  - Parent material
  - Degree of soil development
- At 7 sites, pits dug in one fertilized and one unfertilized plot
- Bulk density and chemical analysis samples taken at the midpoint of depth intervals:
  - 0-10 cm
  - 10-20 cm
  - 20-50 cm
  - 50-100 cm
  - 100-150 cm
  - 150-200 cm
  - 200-250 cm
  - 250-300 cm
  - 300-350 cm
- Forest floor samples taken with 30x30 cm quadrat
  - One fertilized & one unfertilized at 7 sites

Methods (cont'd)

Hydraulic Redistribution

- At 10 sites, soil moisture sensors installed at 4 depths:
  - 10 cm
  - 50 cm
  - 100 cm
  - 200 cm
- Temperature sensor installed at 50 cm
- Data gathered every hour
- Example data:



Research Questions

What mechanisms store carbon in deep soil?

How do storage processes differ between soil types?

What mineralogical properties control storage and release of carbon, nitrogen and other soil nutrients?

How widespread is hydraulic redistribution, and how much water does it translocate?

Citations

Davis, T., Liang, X. 2013. The potential use of soil moisture sensors for observing hydraulic redistribution characteristics. Journal of Water Resource and Hydraulic Engineering 2:3 84-91.

James, J., Devine, W., Harrison, R., Terry, T. 2014. Deep soil carbon: quantification and modeling in subsurface layers. Soil Science Society of America Journal 71:s1-s10.

James, J., Knight, E., Gamba, V., Harrison, R. *in press*. Deep soil: quantification, modeling, and significance of subsurface nitrogen. Forest Ecology and Management.

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NARA Northwest Advanced Renewables Alliance

USDA

NSF

CAFS

Stand Management Cooperative