

Using Existing GPS Infrastructure to Measure Snow, Soil Moisture, and Vegetation Water Content



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Why Do People Use GPS?



- Personal Navigation
- Fleet Tracking
- Timing
- Surveying
- Farming
- Construction



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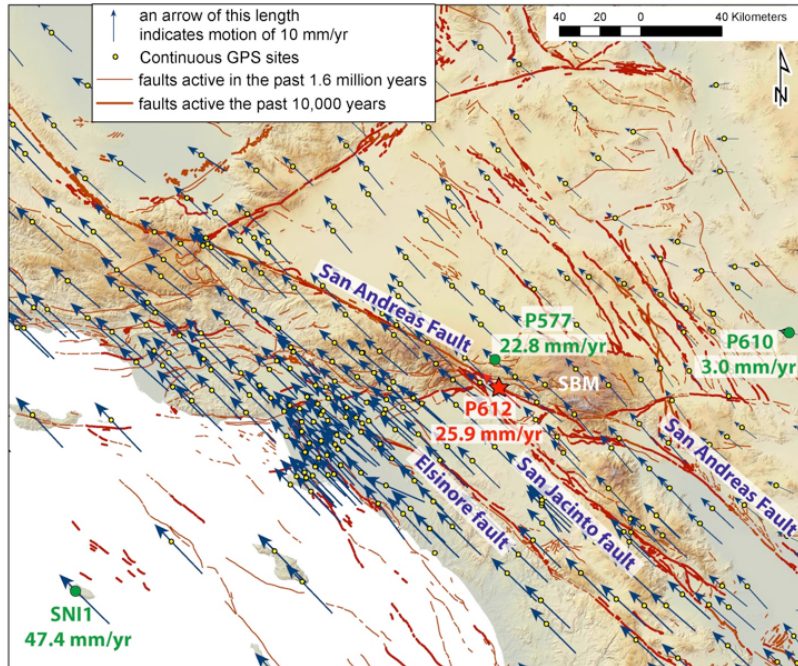


A bulldozer at work with GPS masts on the front blade.

Land surveying, farming, and construction require continuously operating “GPS base stations.”

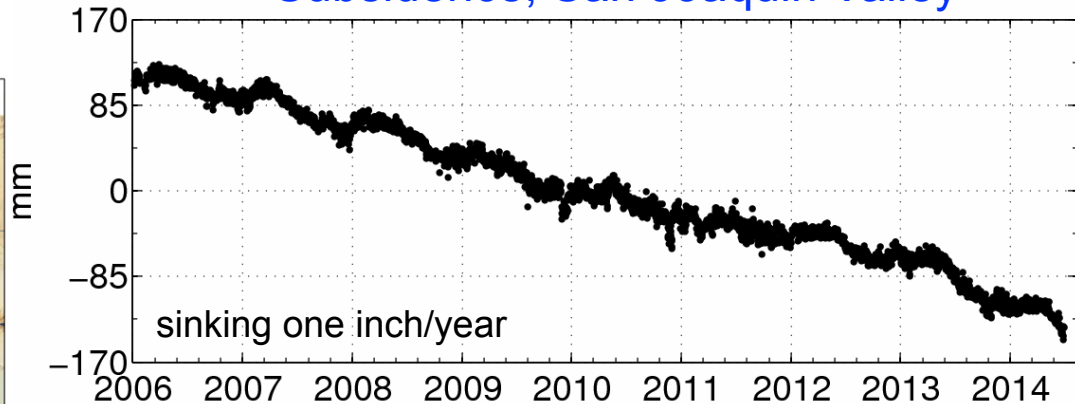
Earth Scientists Use the Same GPS Instruments to Measure Very Small Ground Motions

Tectonics, Southern California

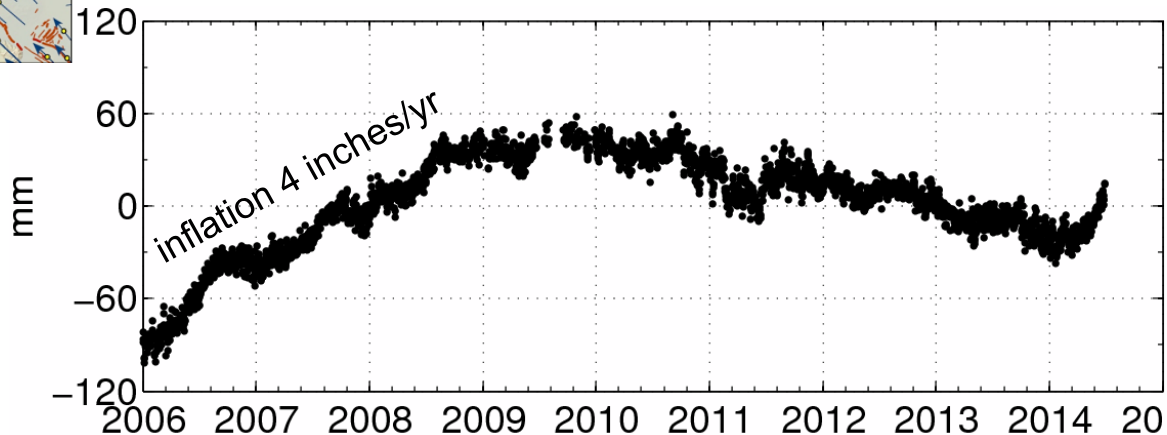


The length of the arrows represent how fast the crust is moving.

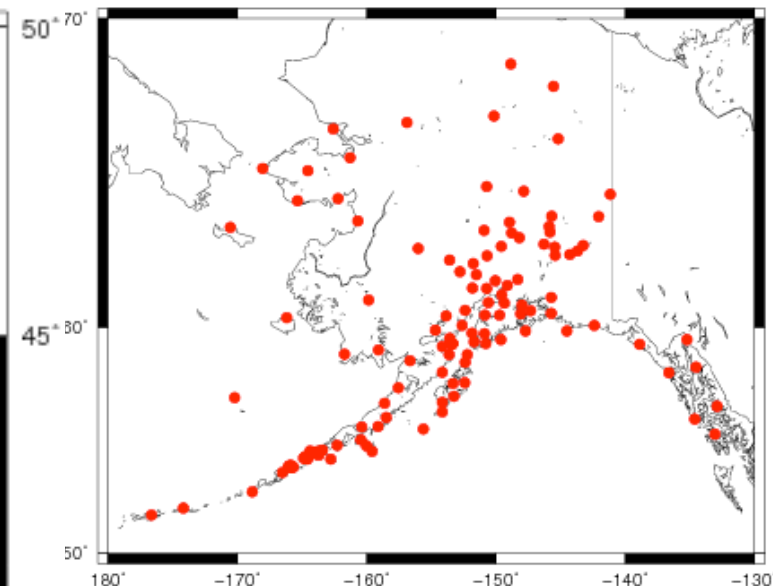
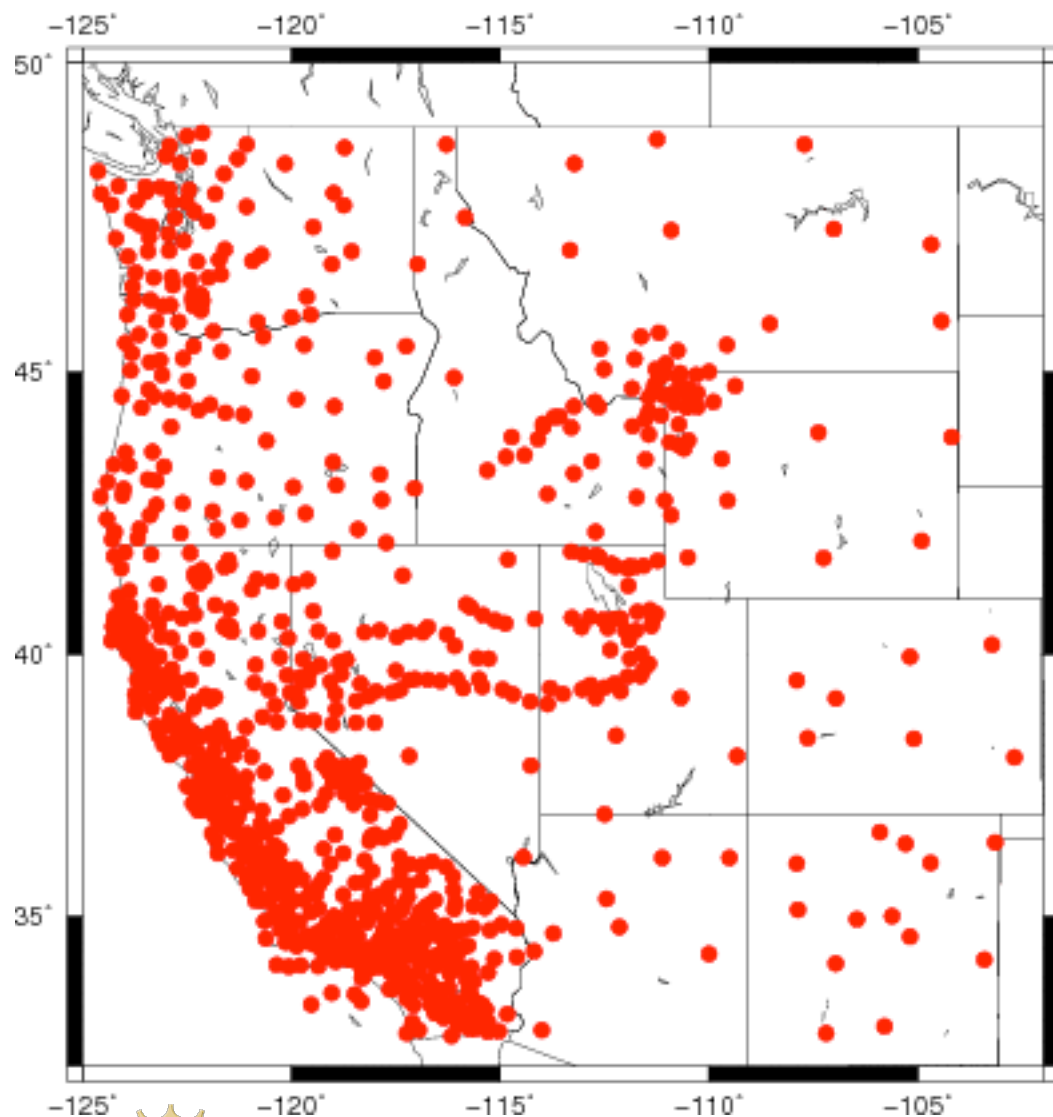
Subsidence, San Joaquin Valley



Inflation of the Yellowstone Caldera



EarthScope Plate Boundary Observatory (PBO)



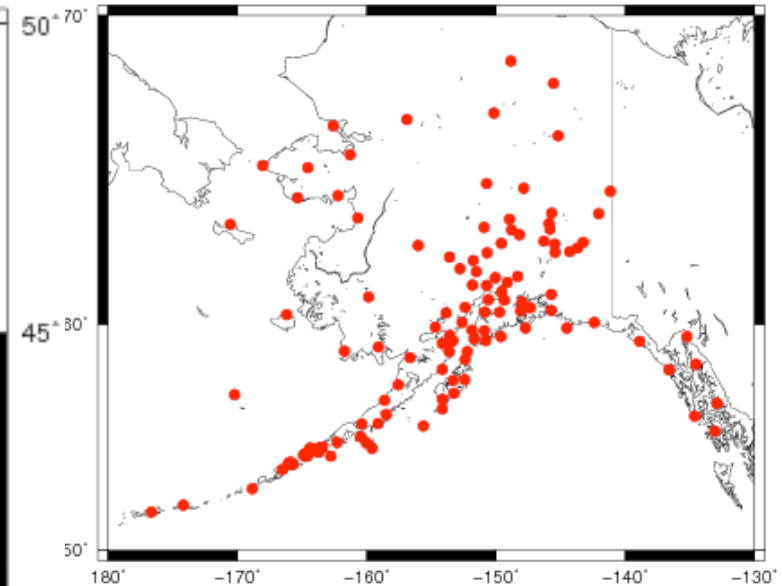
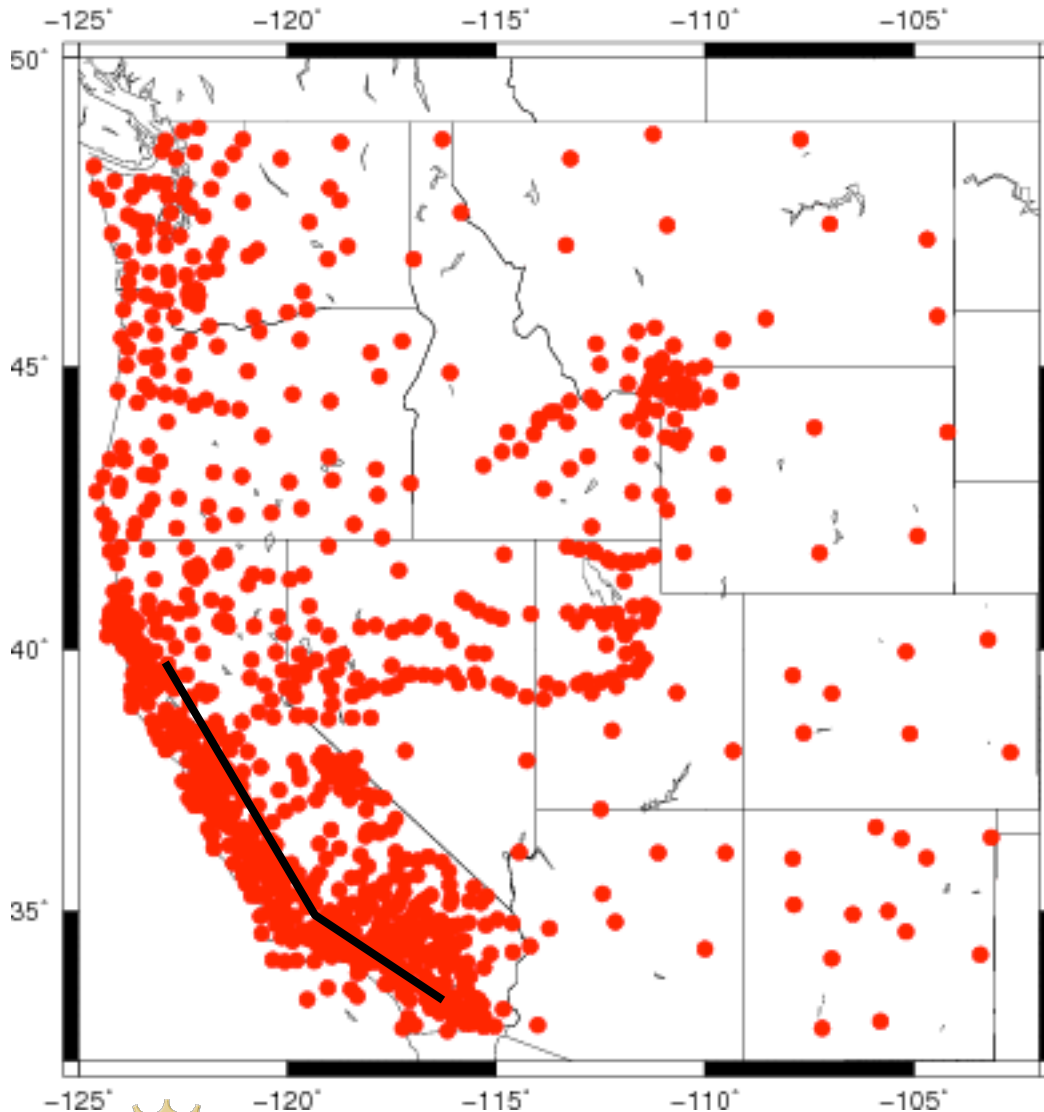
1100 continuously-operating
GPS receivers - deployed to
measure ground motions from
plate tectonics, earthquakes,
and volcanos.

Data are freely available (often
in real-time) and are used by
Earth scientists and surveyors.



PBO data are archived at UNAVCO

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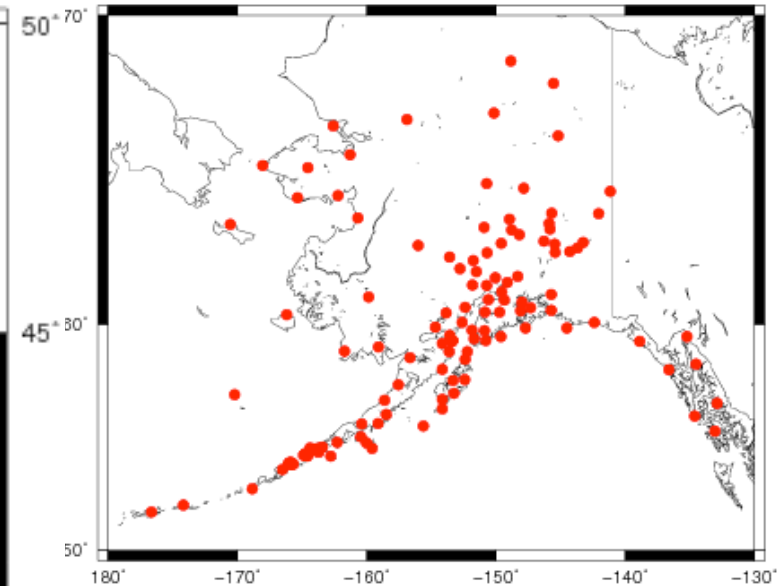
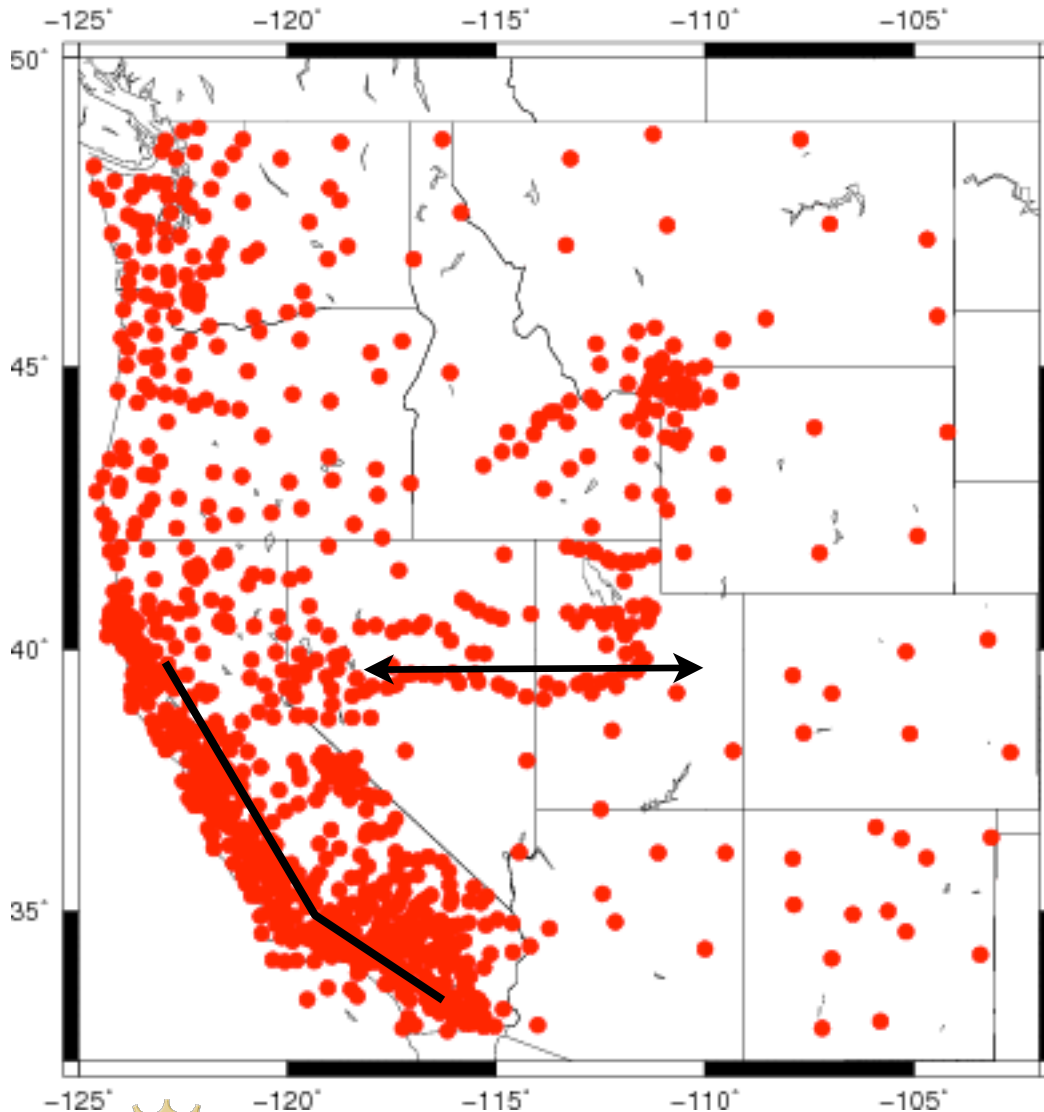
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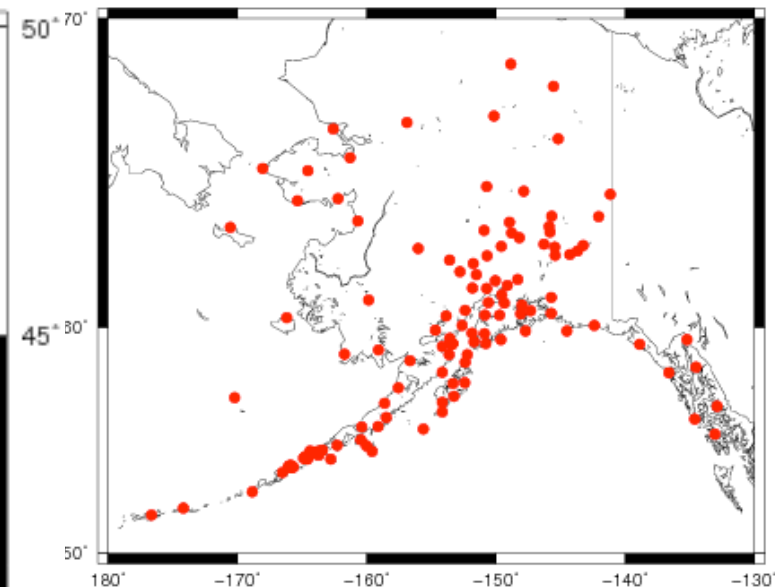
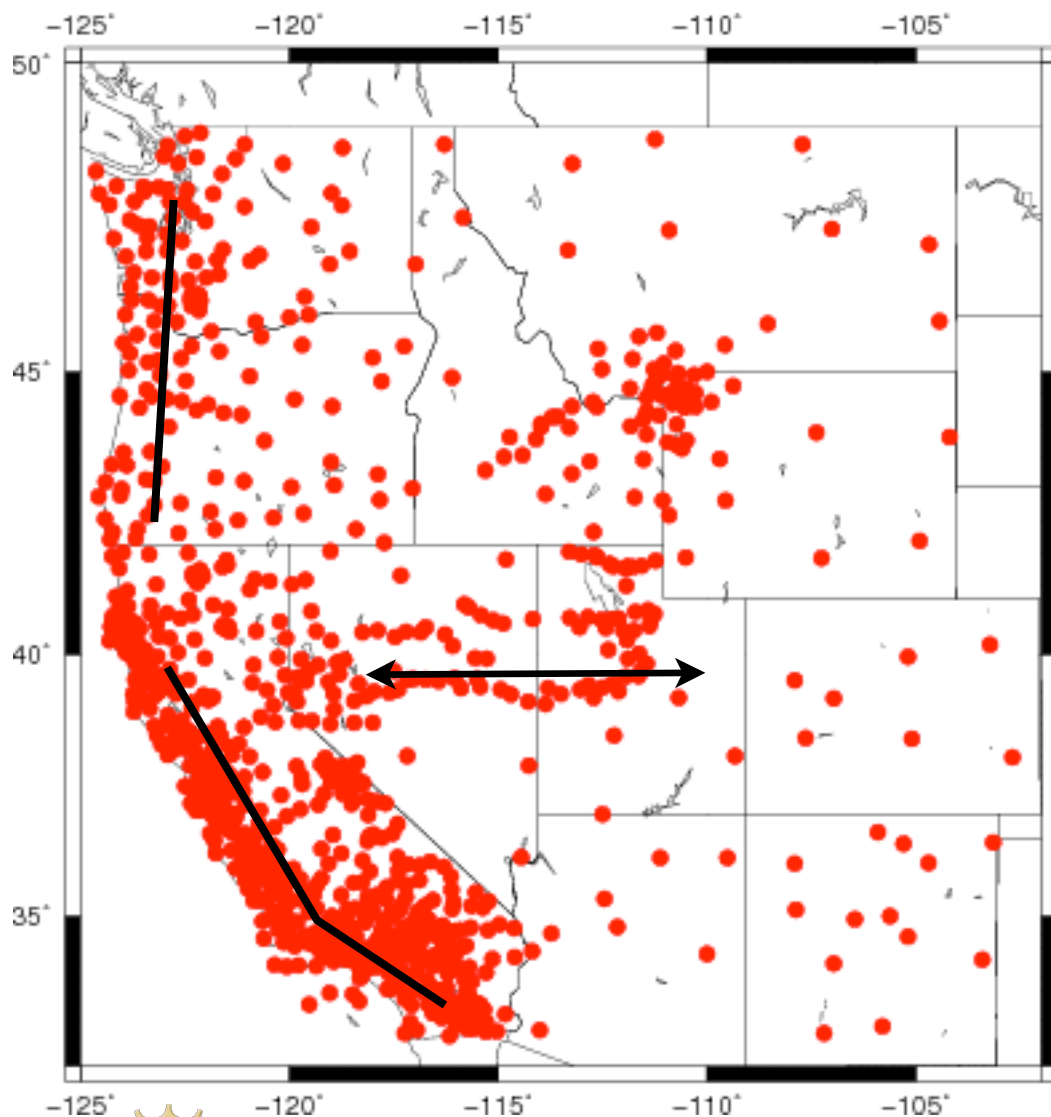
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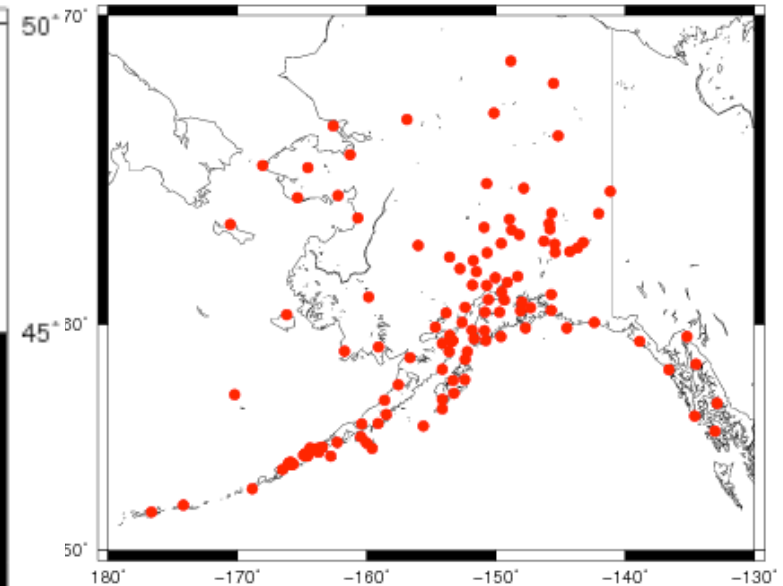
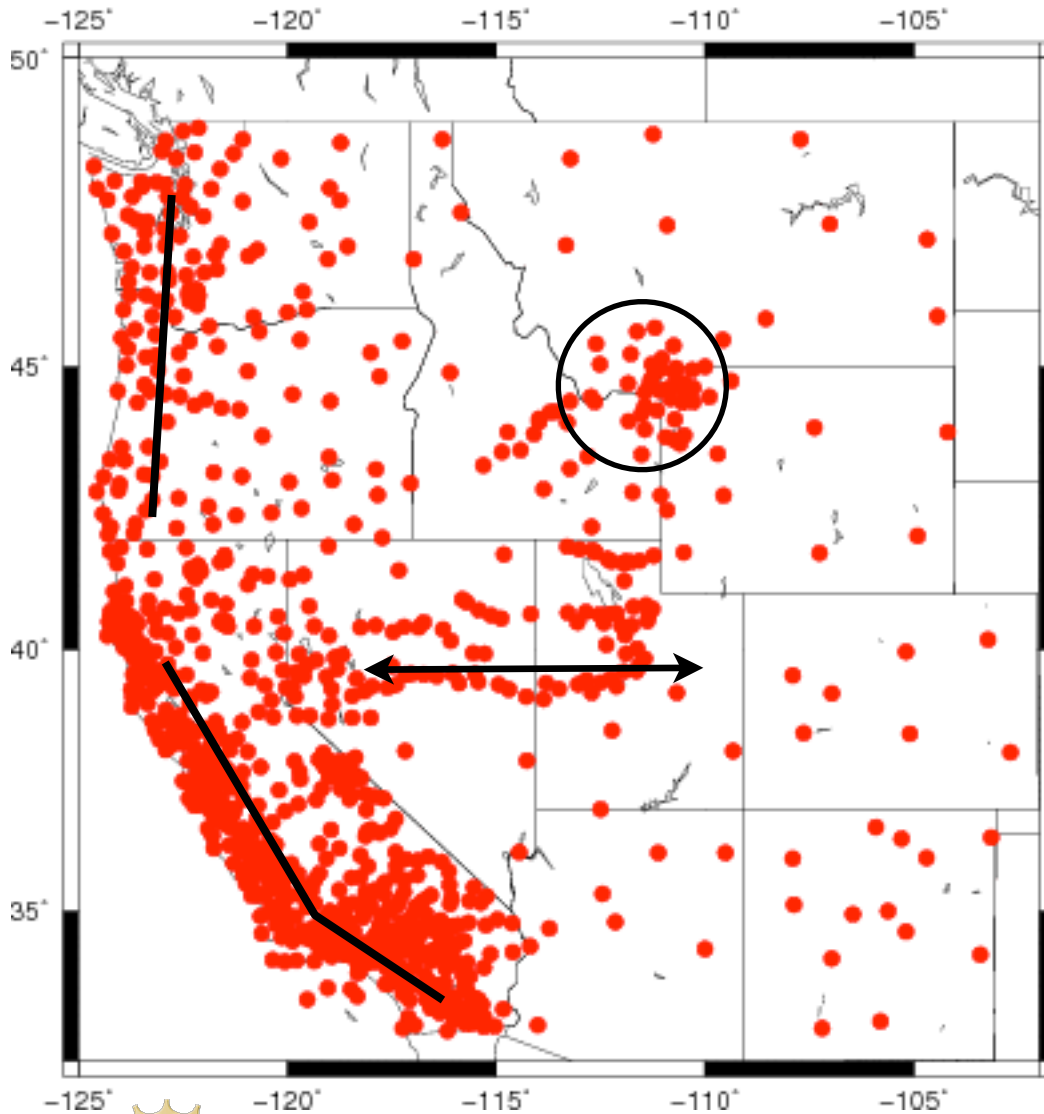
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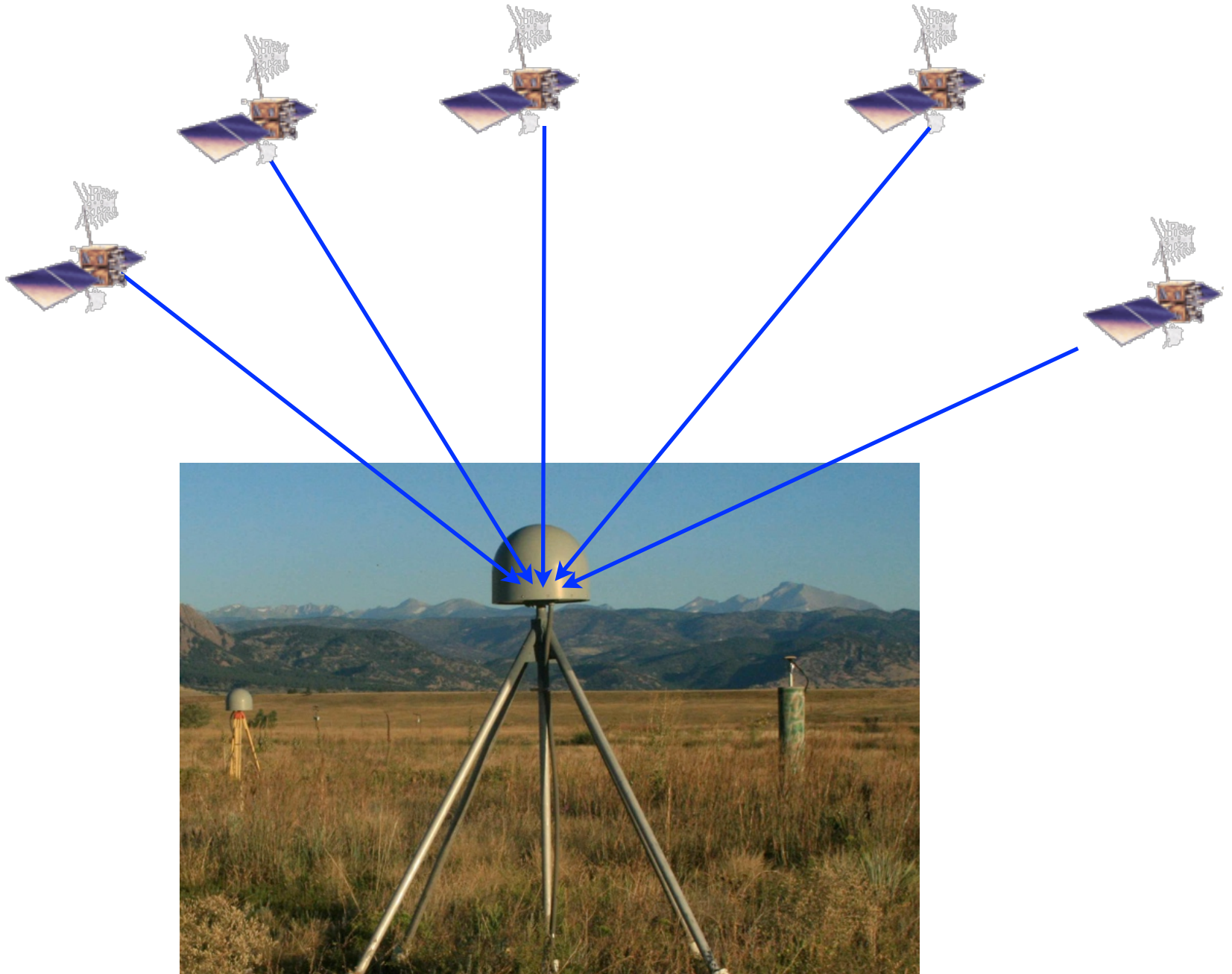


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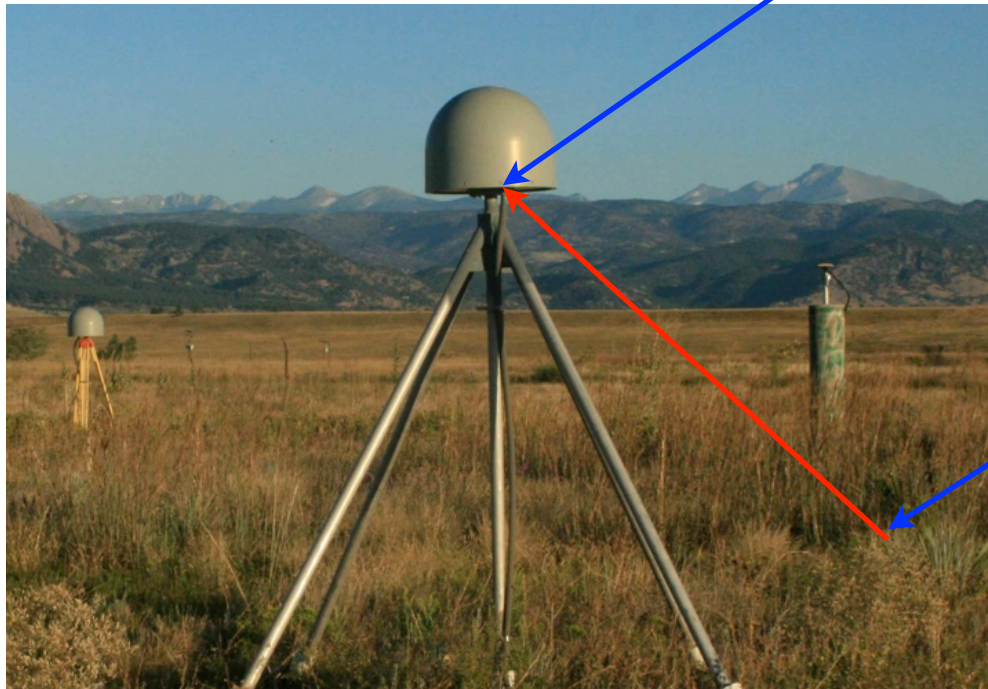
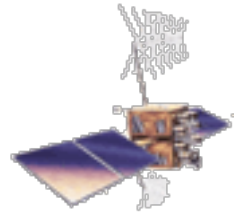
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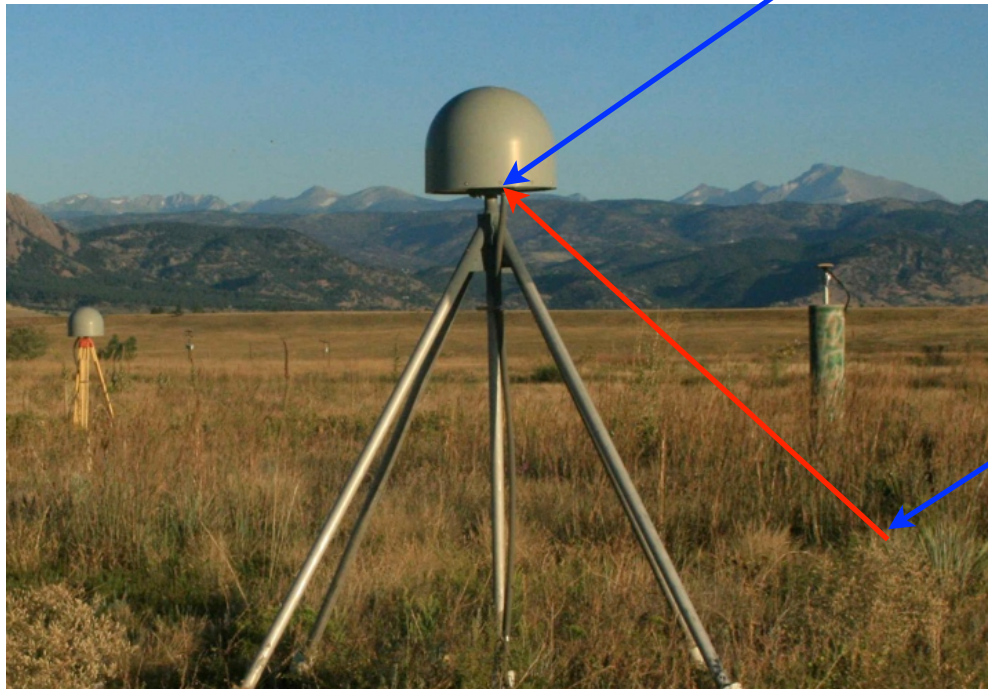
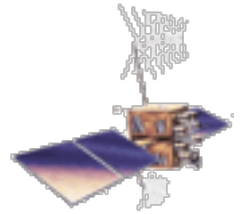
What does a GPS network designed to measure plate motions have to do with water resources?



The signal that reflects can tell you about its surface conditions
Is the soil wet or dry? How much snow is on it? Is the vegetation healthy?

Footprint of the GPS method is ~30 meters by 30 meters.

Measurement can be made hourly.



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PBO H₂O uses GPS data to study the water cycle

Data Products

-  Snow
-  Vegetation
-  Soil Moisture
-  Water Loading

Update 2014-08-16

- We are having difficulties accessing files at the UNAVCO archive. We are working with UNAVCO to solve this problem.
- The U.S. Air Force launched the seventh GPS Block IIF satellite on August 1, 2014, at 11:23 p.m. EDT.
- Please see our [documentation](#) for instructions on downloads.
- [Overview article](#) about our work from EOS. Another longer summary was published this month in InsideGNSS.



 Download all data



PBO H₂O

Using GPS reflection data from NSF's Plate Boundary Observatory (PBO) to study the water cycle



Station SC02 in Friday Harbor, WA



Snow

Snow influences the land-surface water budget. Snow measurements are needed both to study climate and to predict drought, flooding, and water availability.

[View data »](#)



Vegetation

Monitoring changes in vegetation is important for climate and hydrologic modeling applications, validation of satellite estimates of land surface conditions, and testing of ecohydrological hypotheses.

[View data »](#)



Soil Moisture

Soil moisture affects the partitioning of precipitation into runoff, evapotranspiration and deep drainage and the fluxes of energy and carbon between the land surface and atmosphere.

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Water Loading

Regional water storage loads the surface of the Earth. Changes in loading from these reservoirs becomes evident through vertical displacement time series.

[View data »](#)

<http://xenon.colorado.edu/portal>

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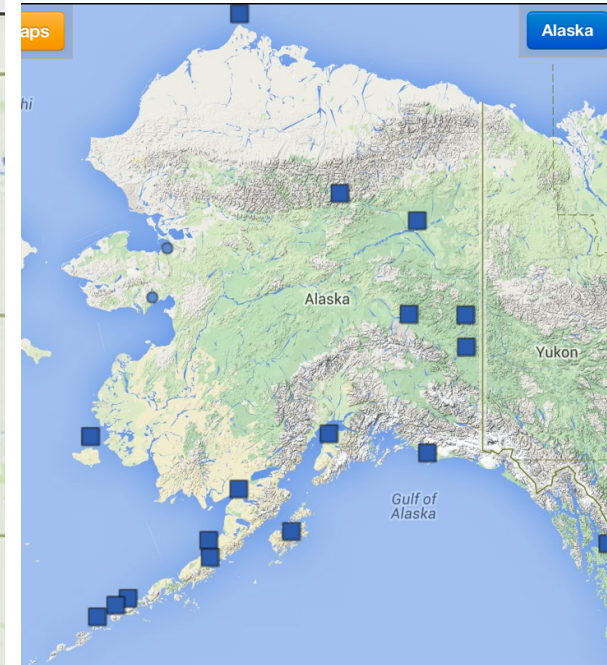
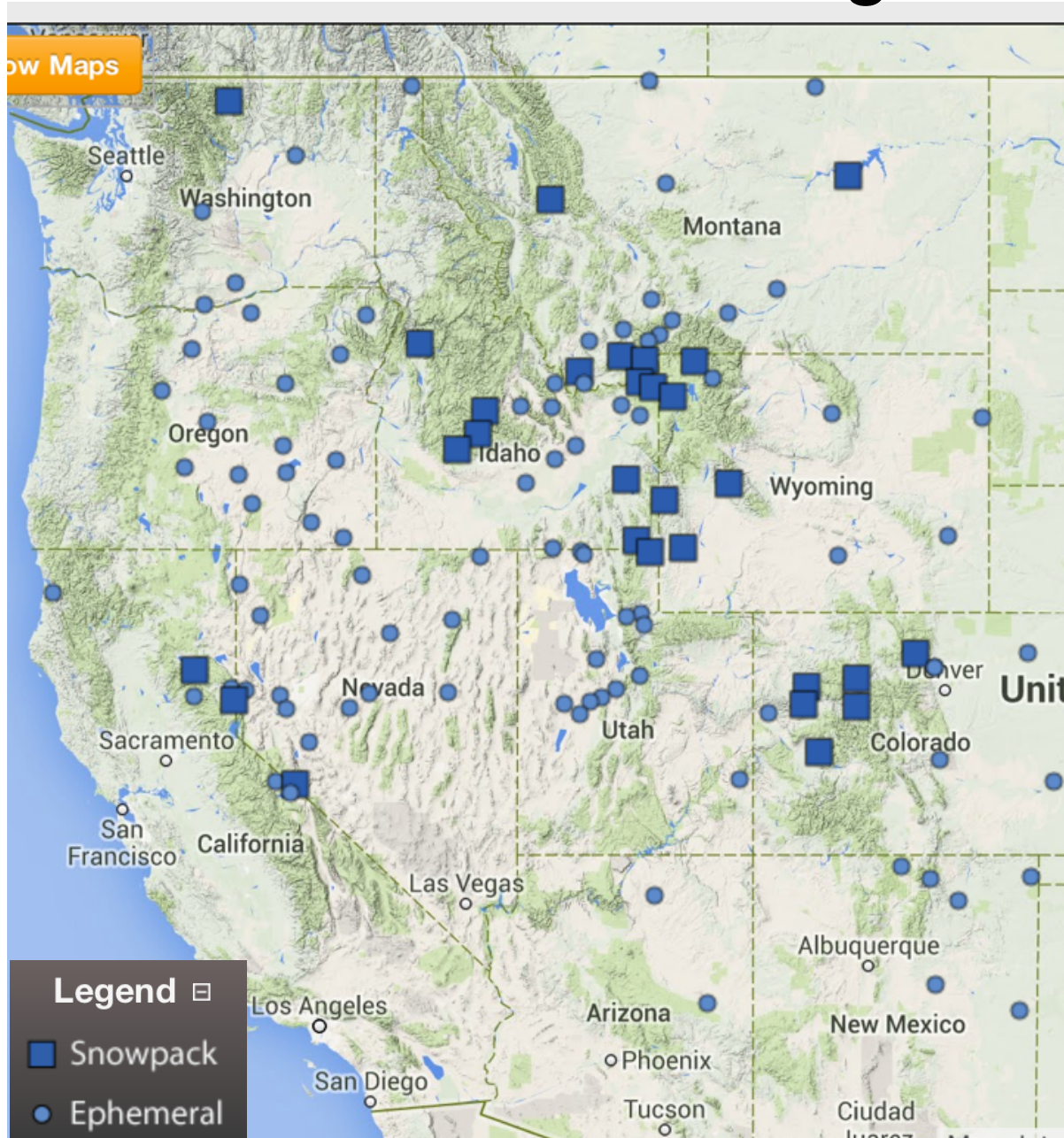
Station SC02 in Friday Harbor, WA



For the Rocky Mountains, PacificNW, a few sites in California, and Alaska, we measure snow in the winter and vegetation growth/soil moisture in the spring/summer/fall.

At remaining sites, we measure soil moisture and vegetation growth all year.

Monitoring Snow

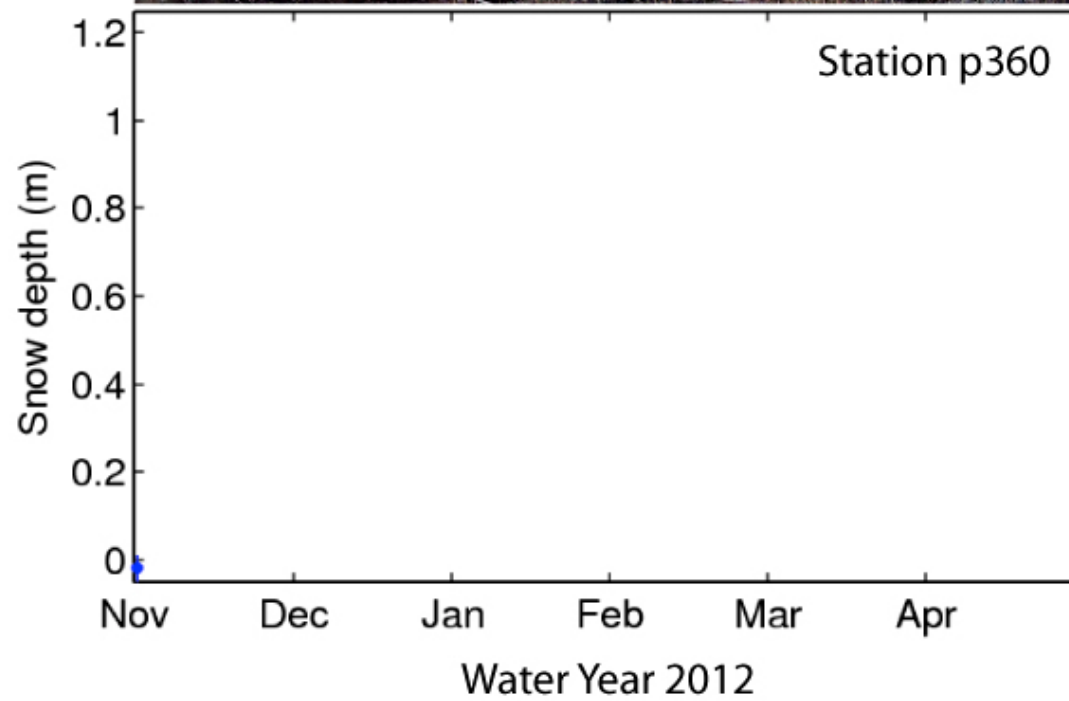


Currently: 160 sites.
Made available every morning.
Snow depth and snow water equivalent.
Note: GPS people avoid forested regions.

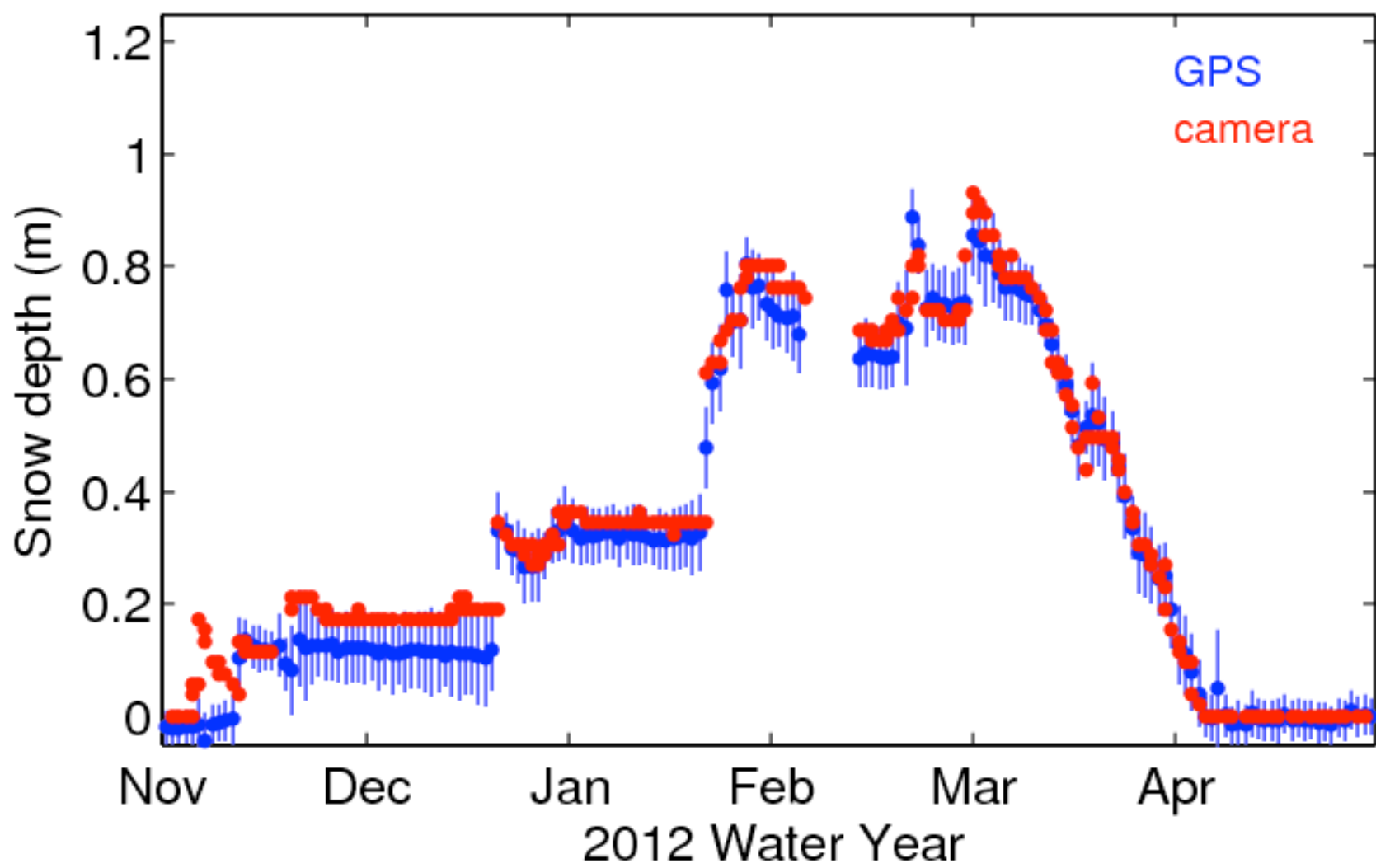


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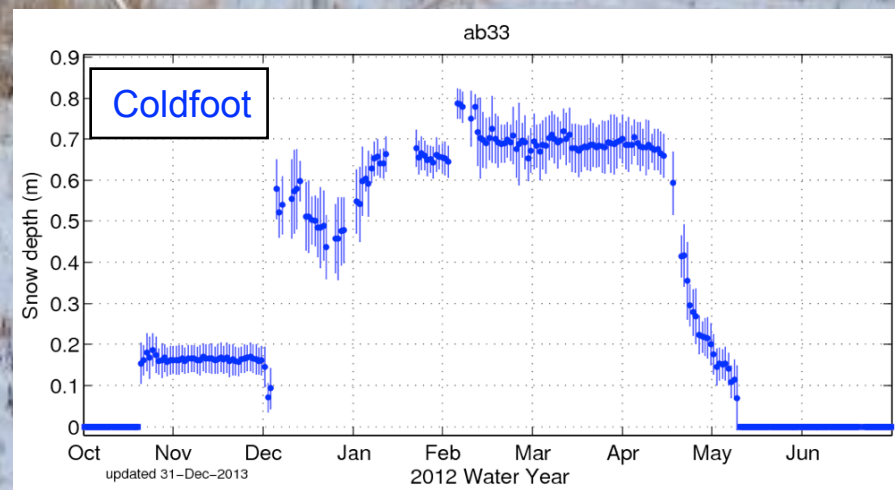
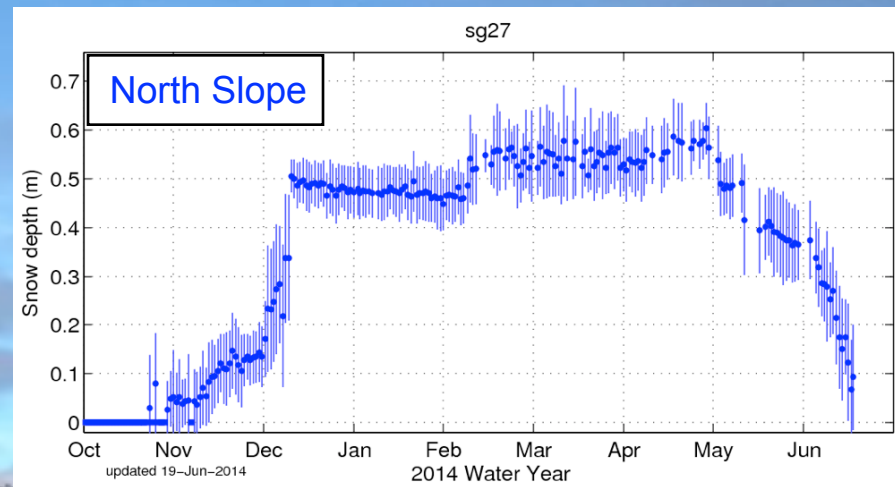
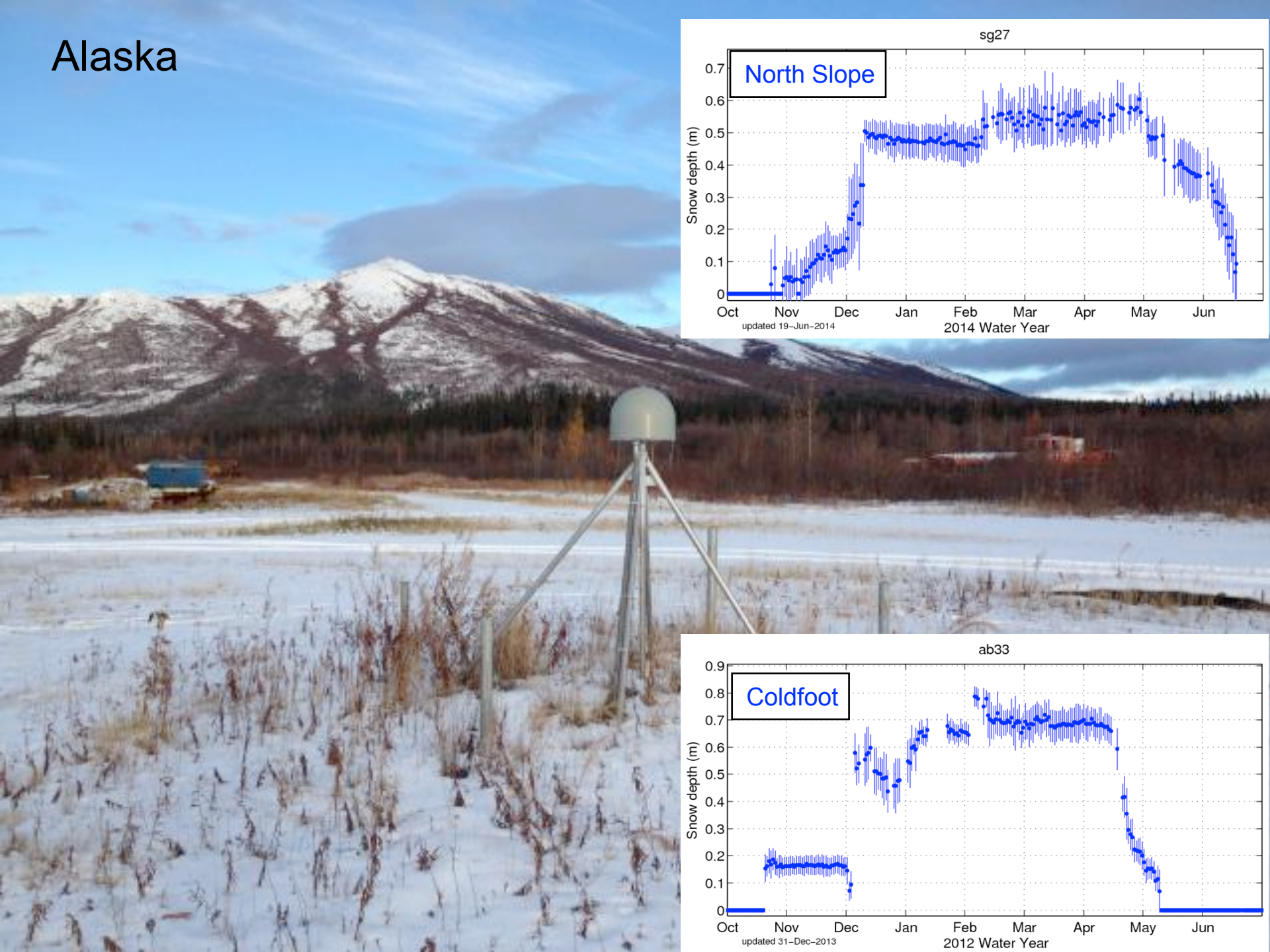




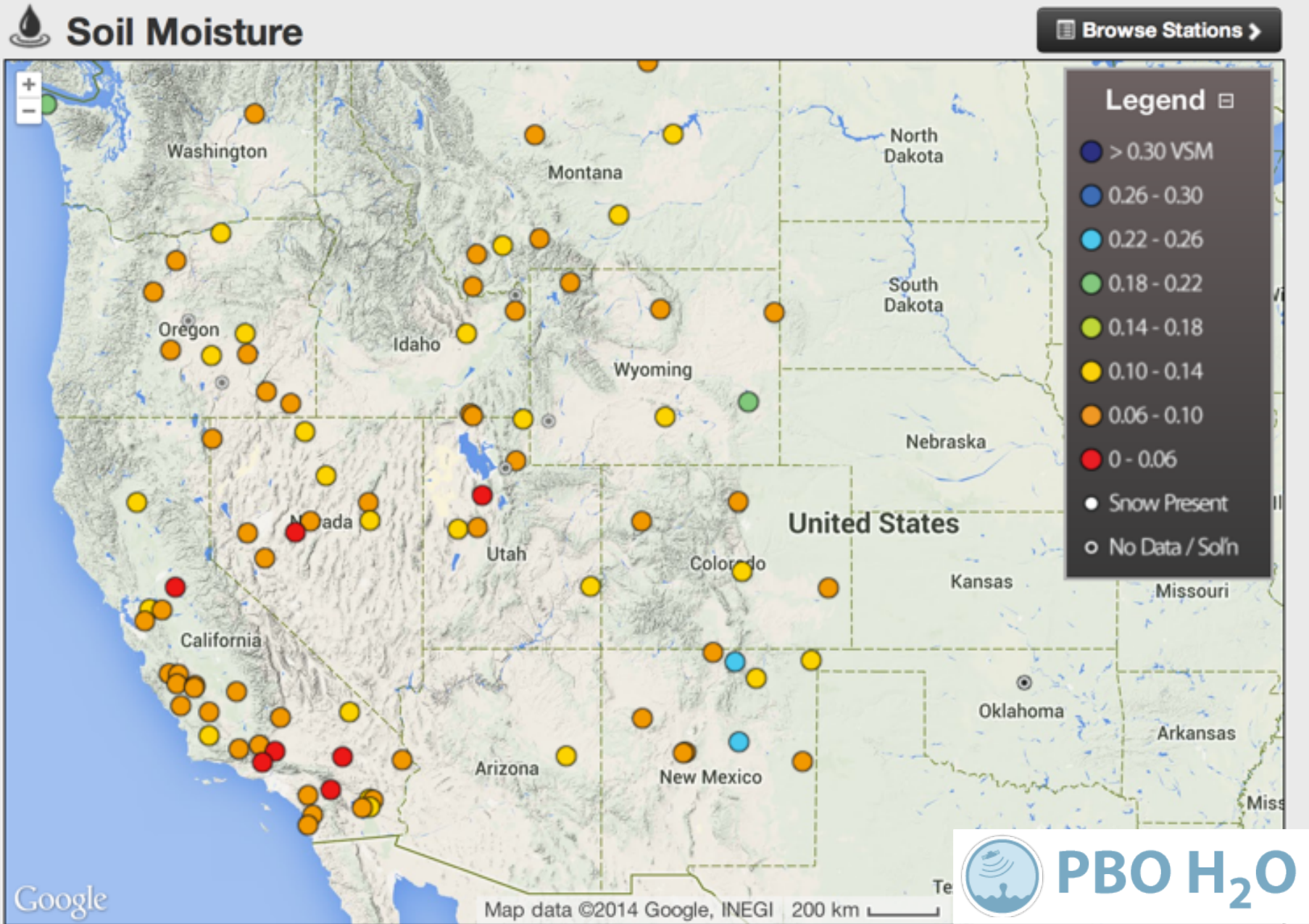
p360



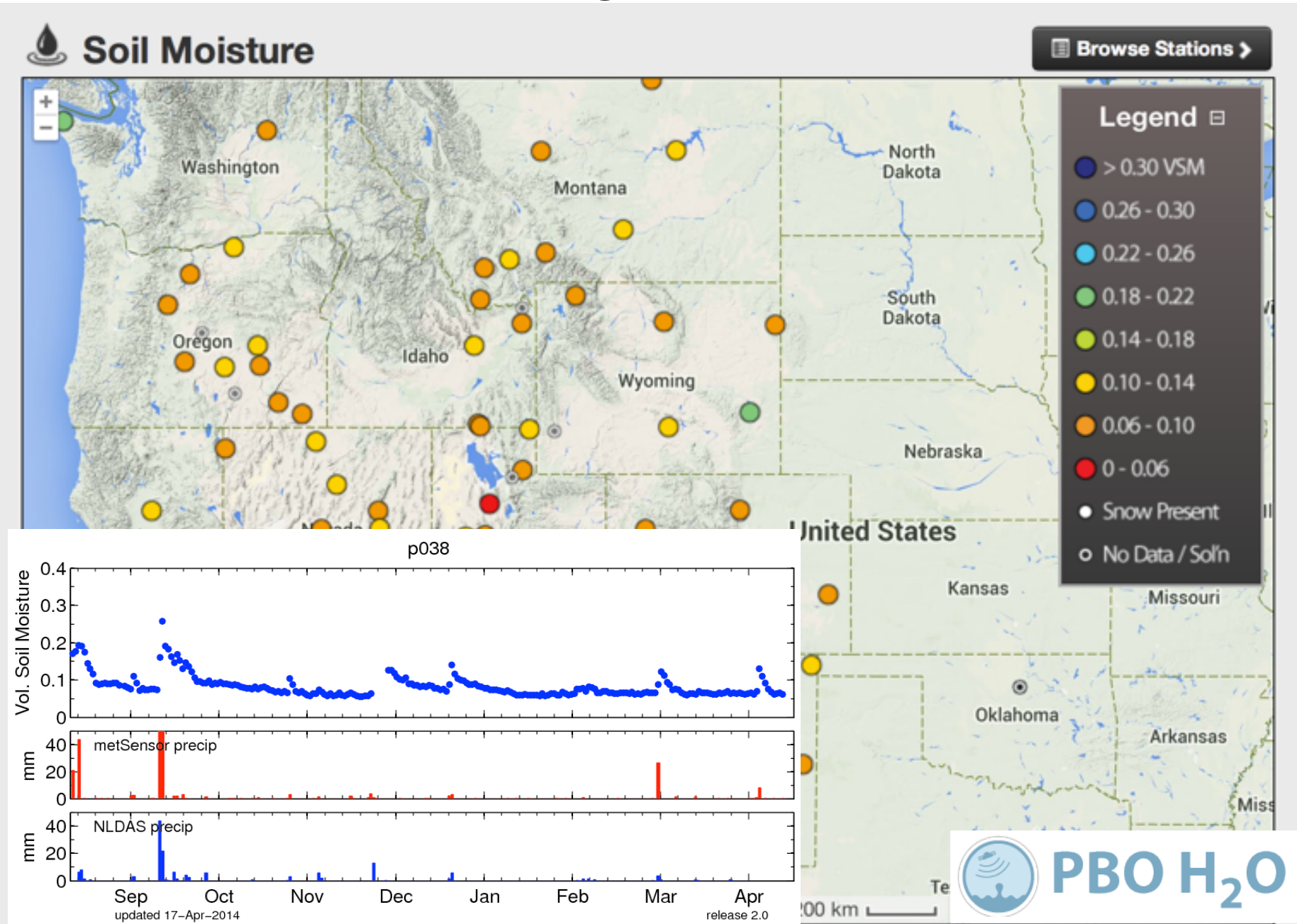
Alaska

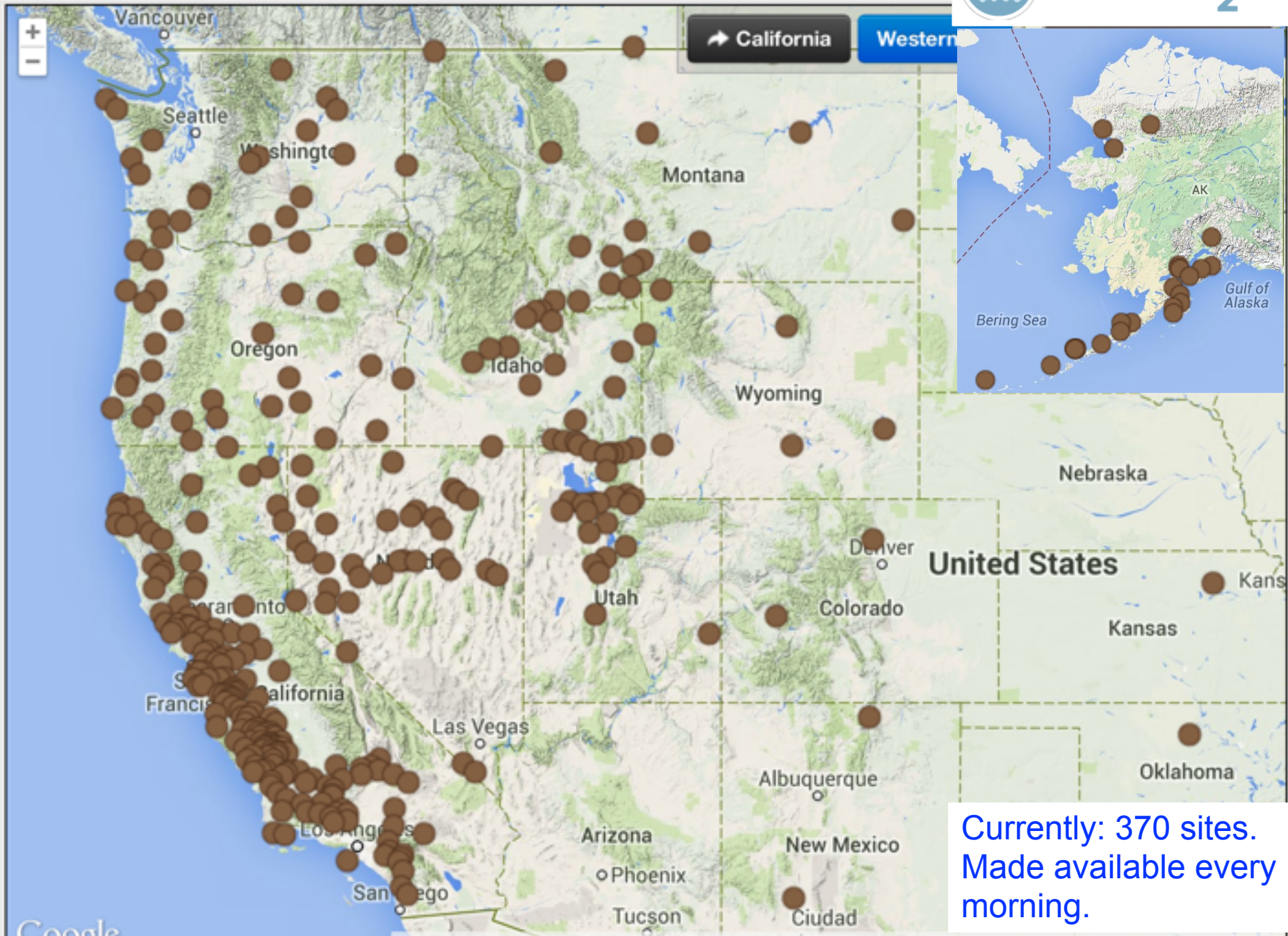


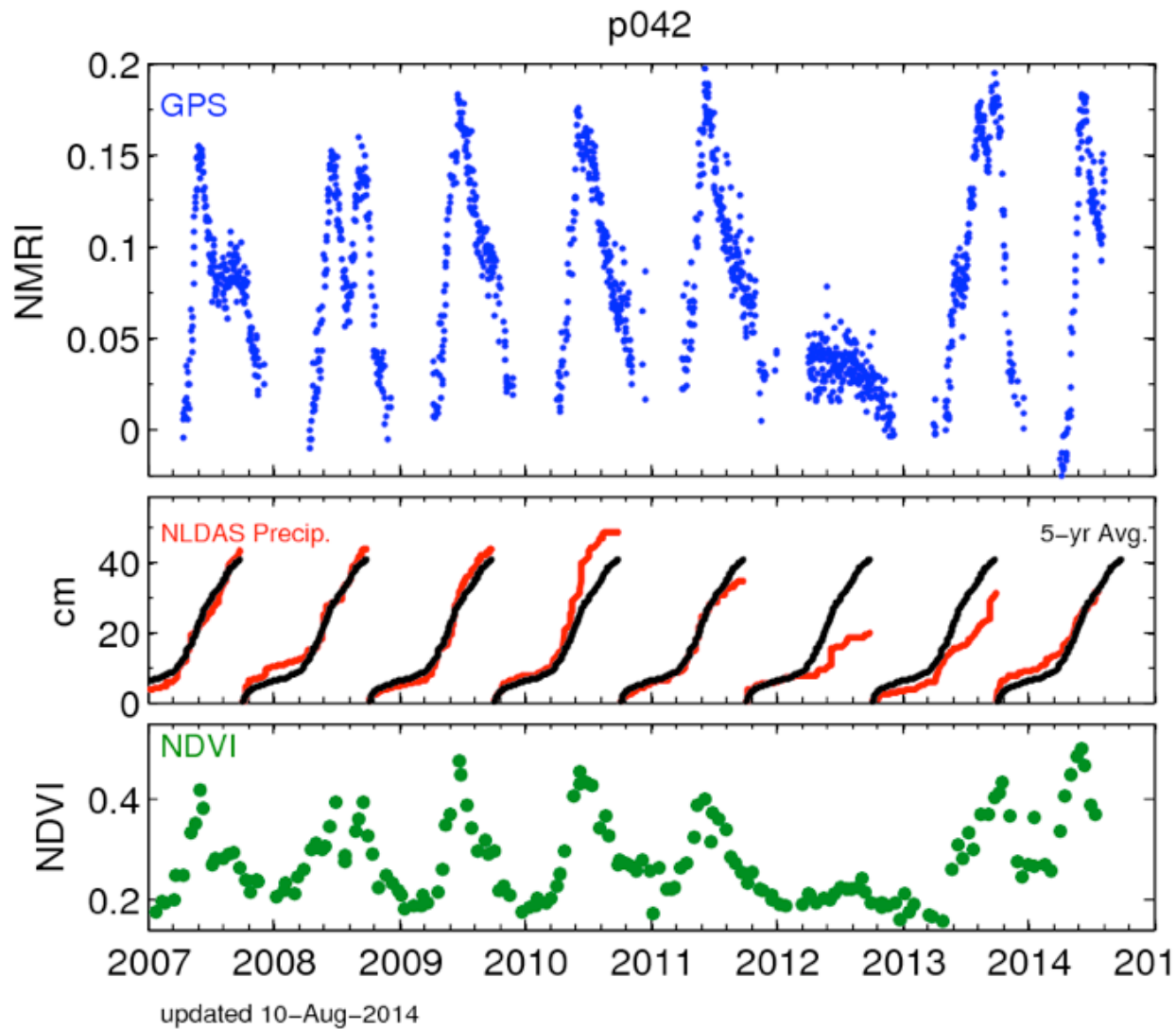
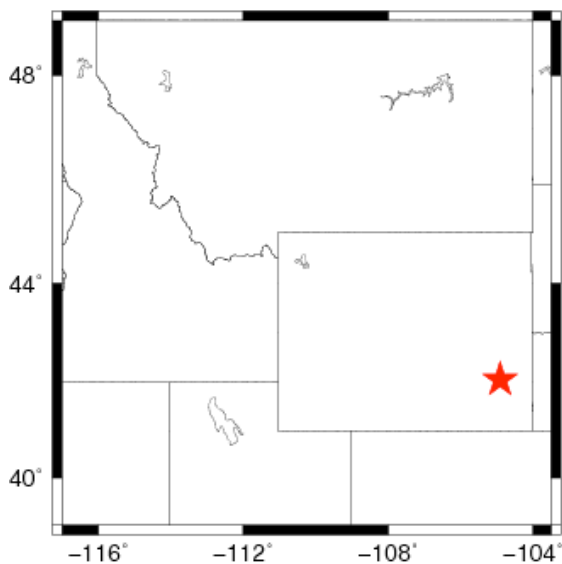
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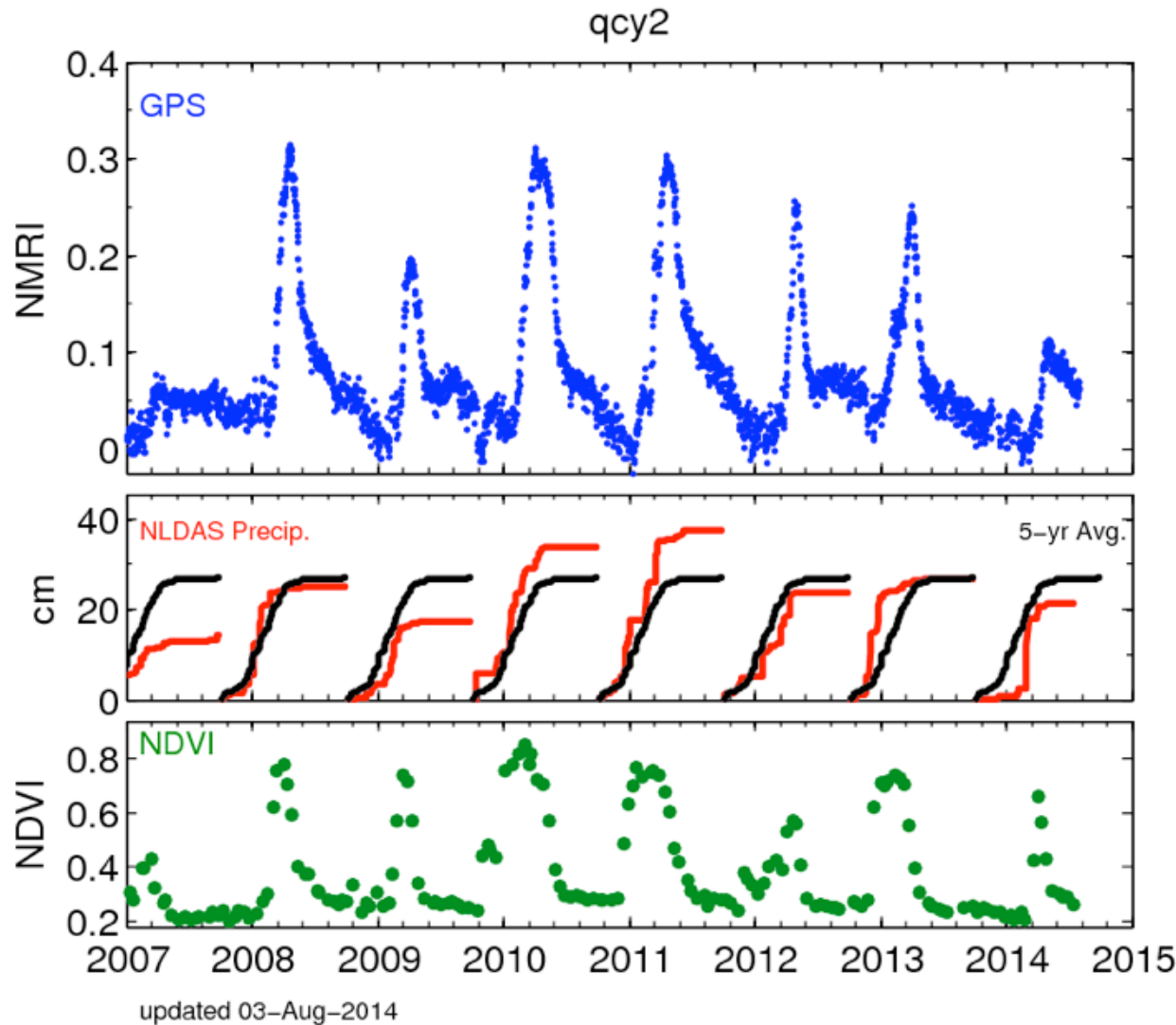
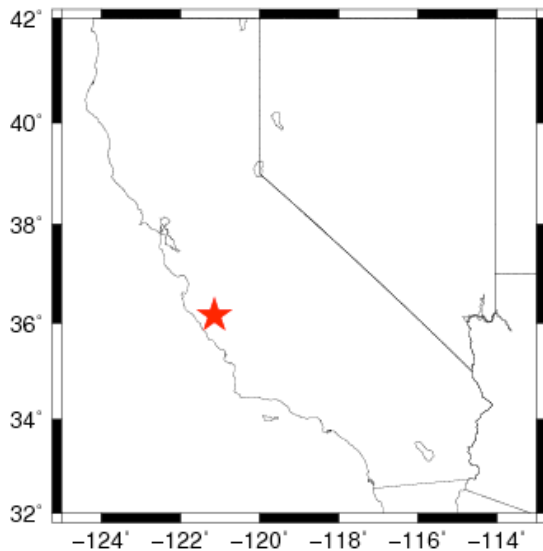
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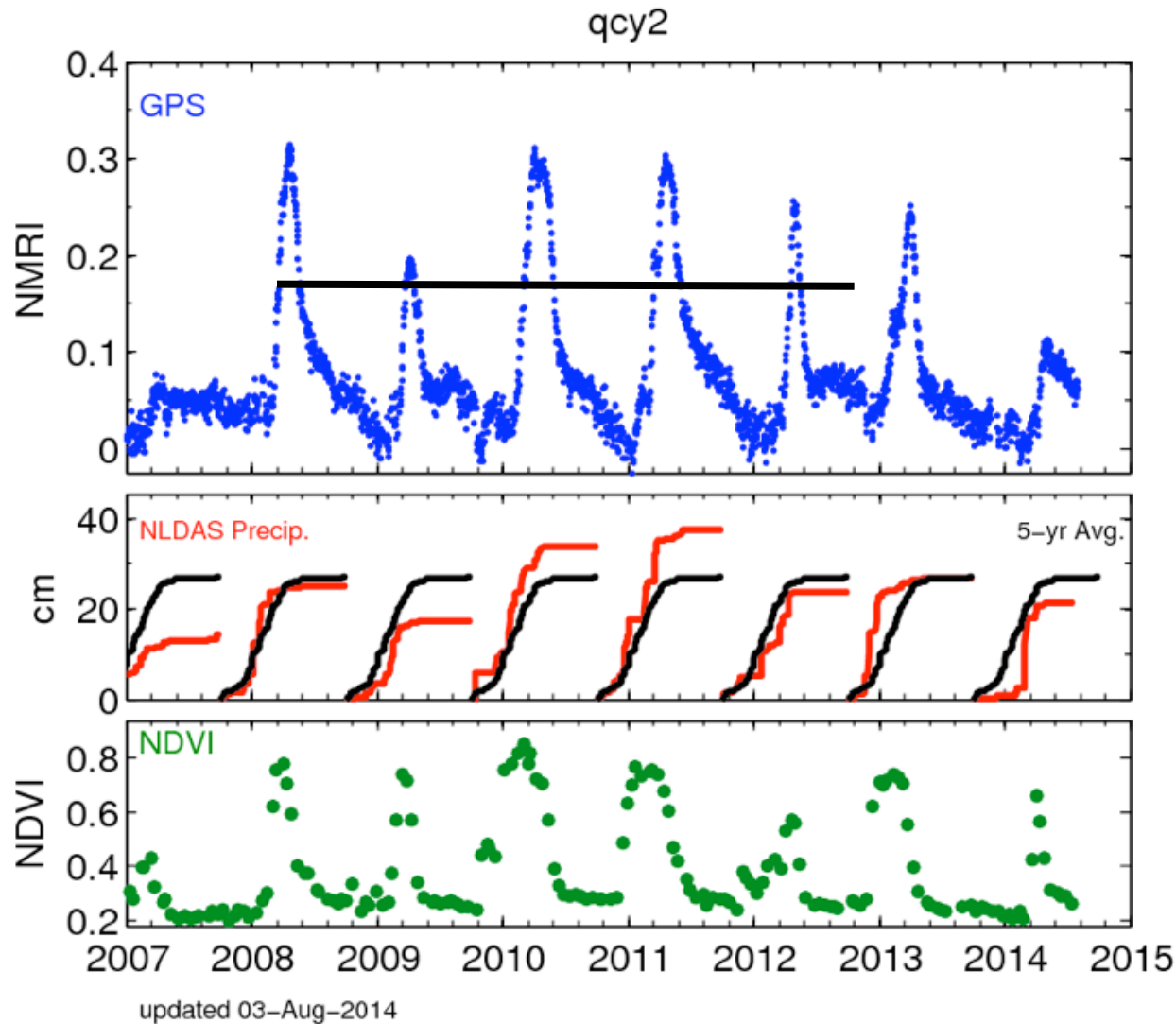
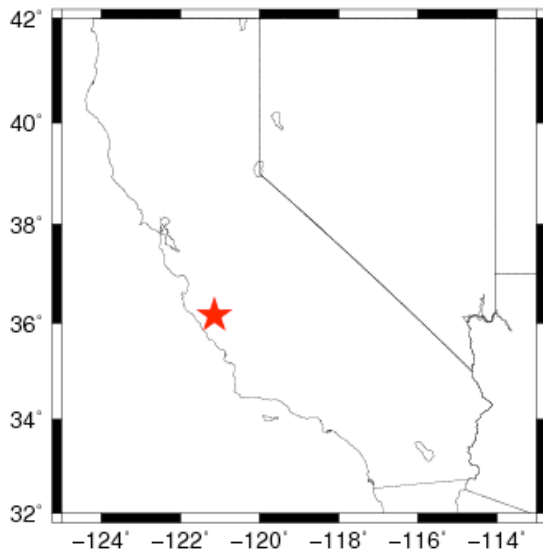




GPS reflections are sensitive to how much water is in plants.
 NDVI data are sensitive to vegetation color/chlorophyll production.

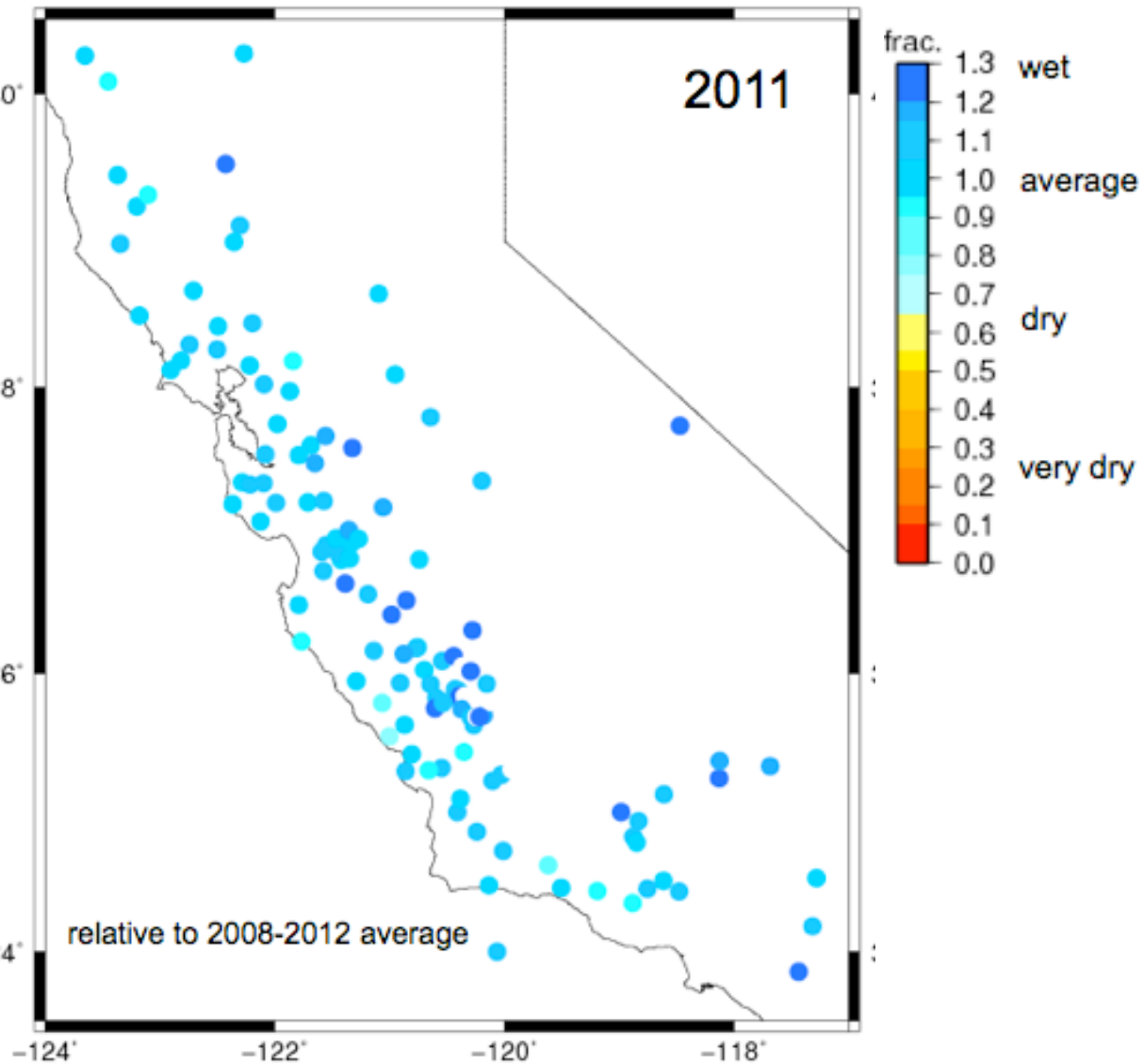


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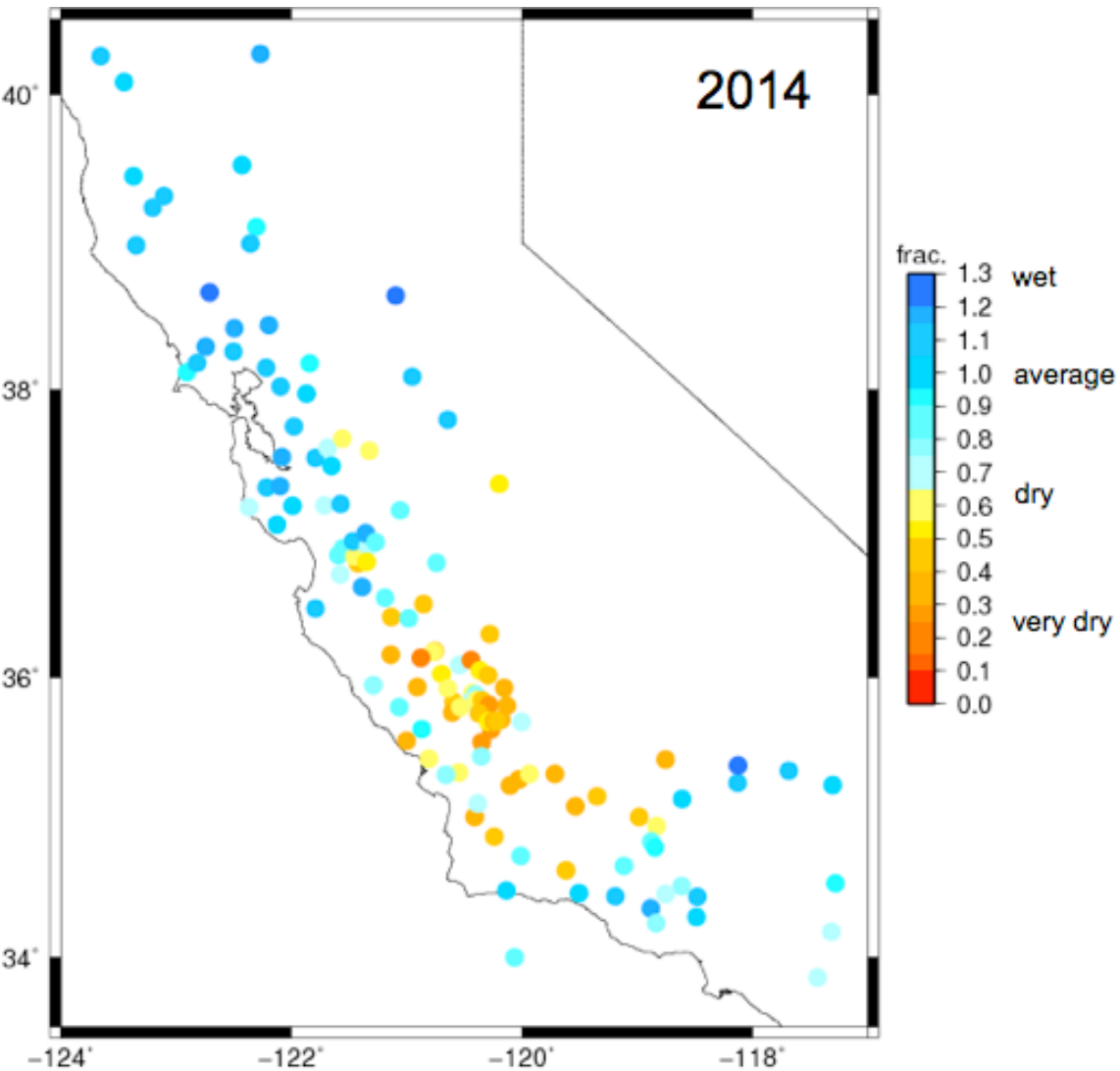
Peak Vegetation Water Content Measured by GPS



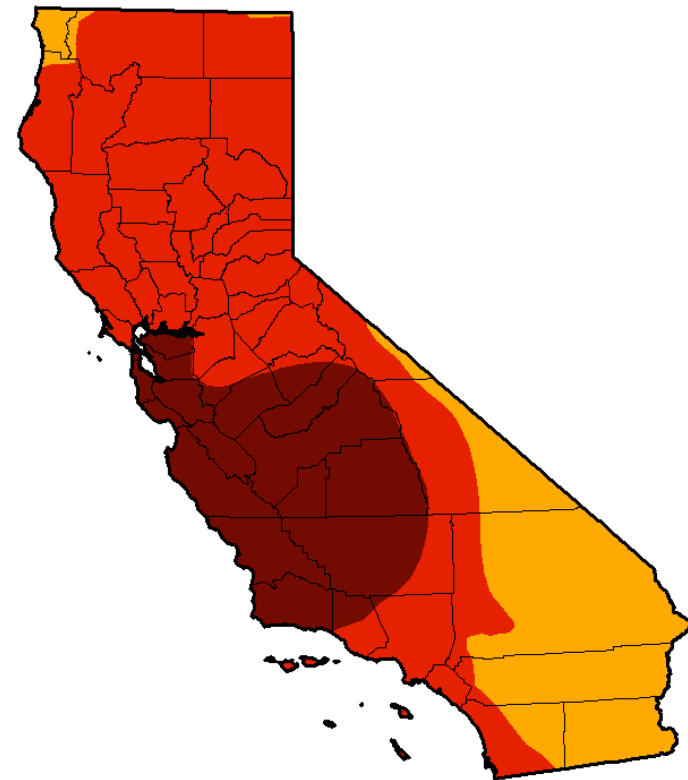
U.S. Drought Monitor May 2011



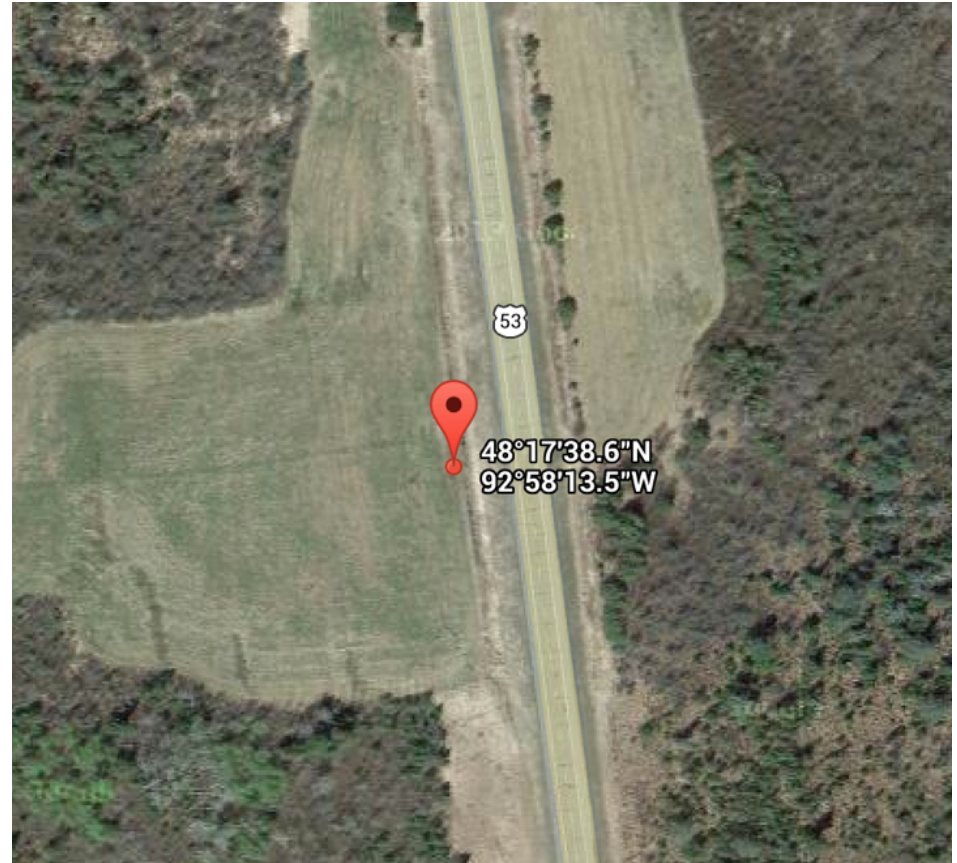
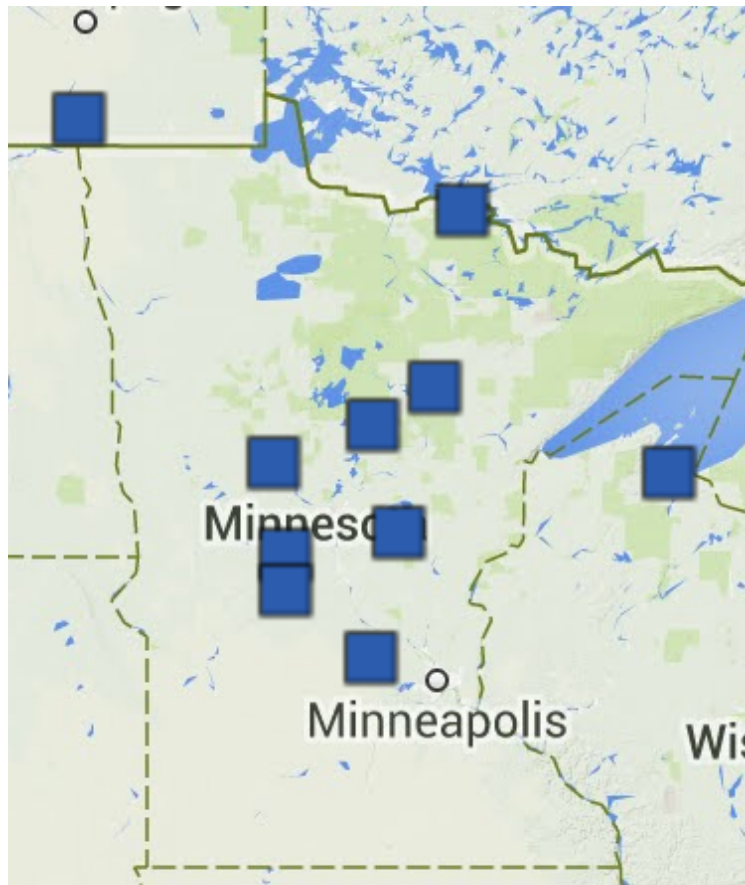
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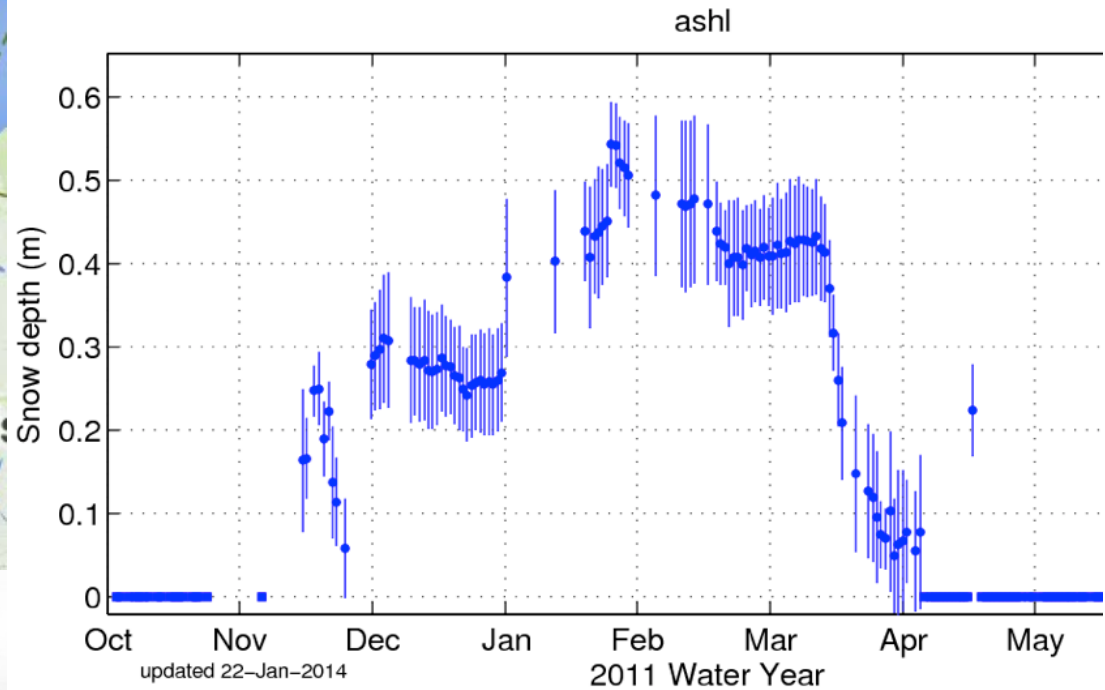
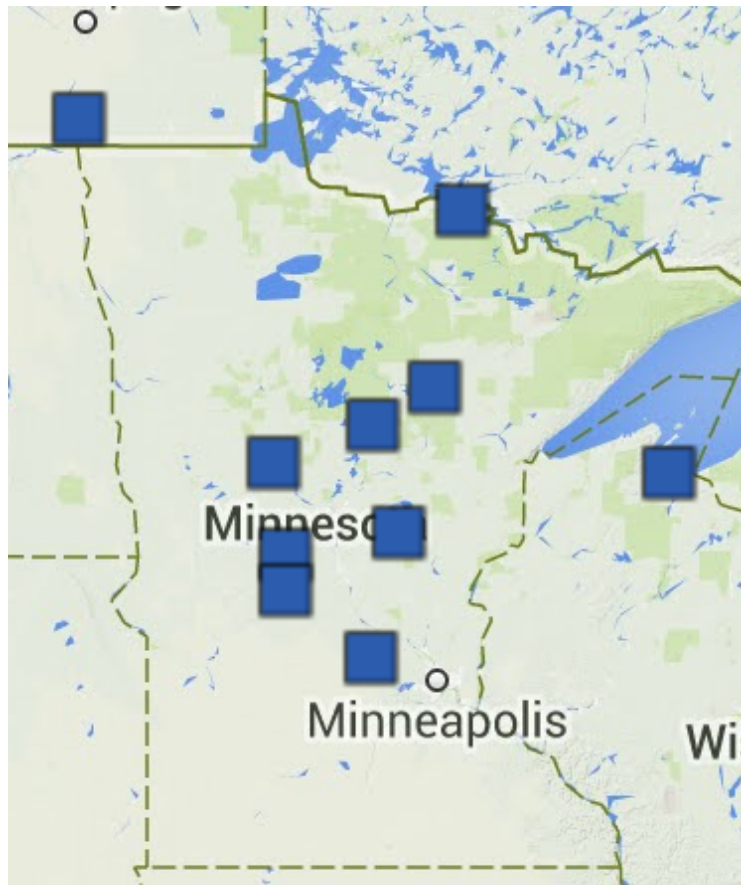


Expanding Beyond PBO



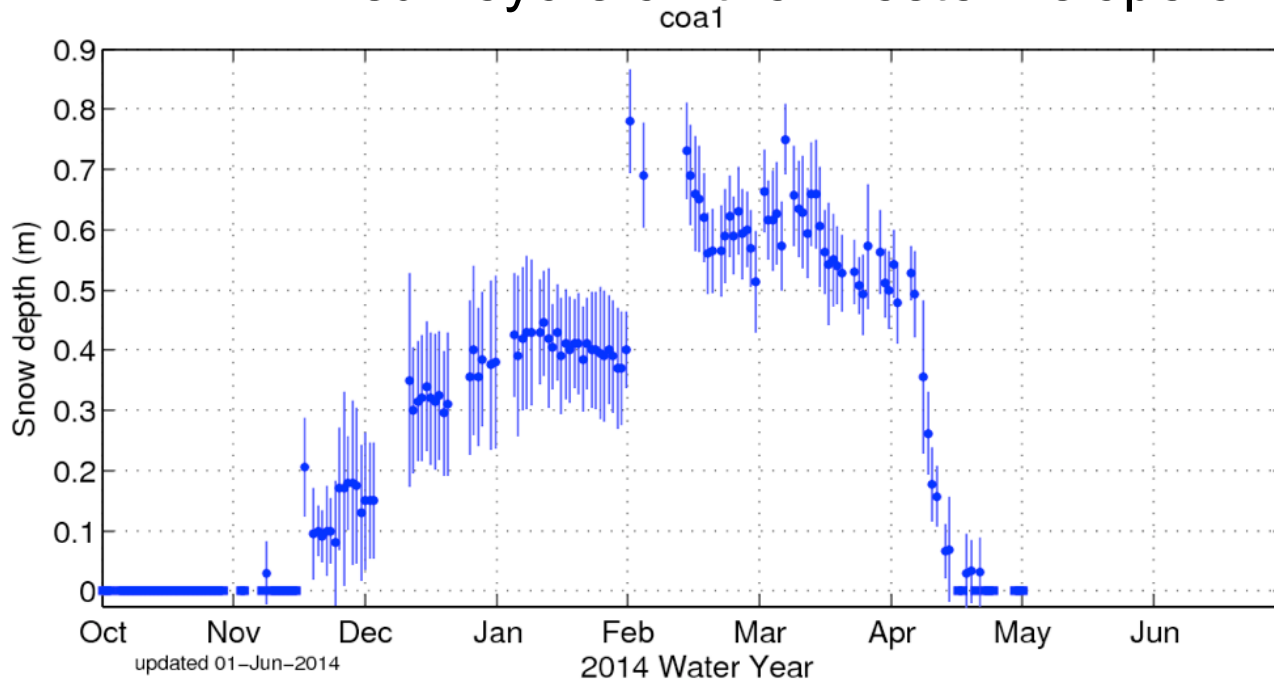
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Expanding Beyond PBO



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We measure snow depth/water equivalent for GPS sites run by surveyors on the western slope of Colorado.



To maintain, perpetuate, and interpret legal records and public information which control land boundaries, property ownership and associated interests for the citizens of Mesa County in order to safeguard real property and promote public welfare.



RTVRN INFO ▾ GNSS DATA ▾ RTVRN WEB SIMS ▾

REAL TIME VIRTUAL REFERENCE NETWORK - RTVRN

Final Remarks

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