GNSS H2O: Expanding Reflection Research to the Global GNSS Network For Measuring the Water Cycle

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How to get noticed at IGS workshop

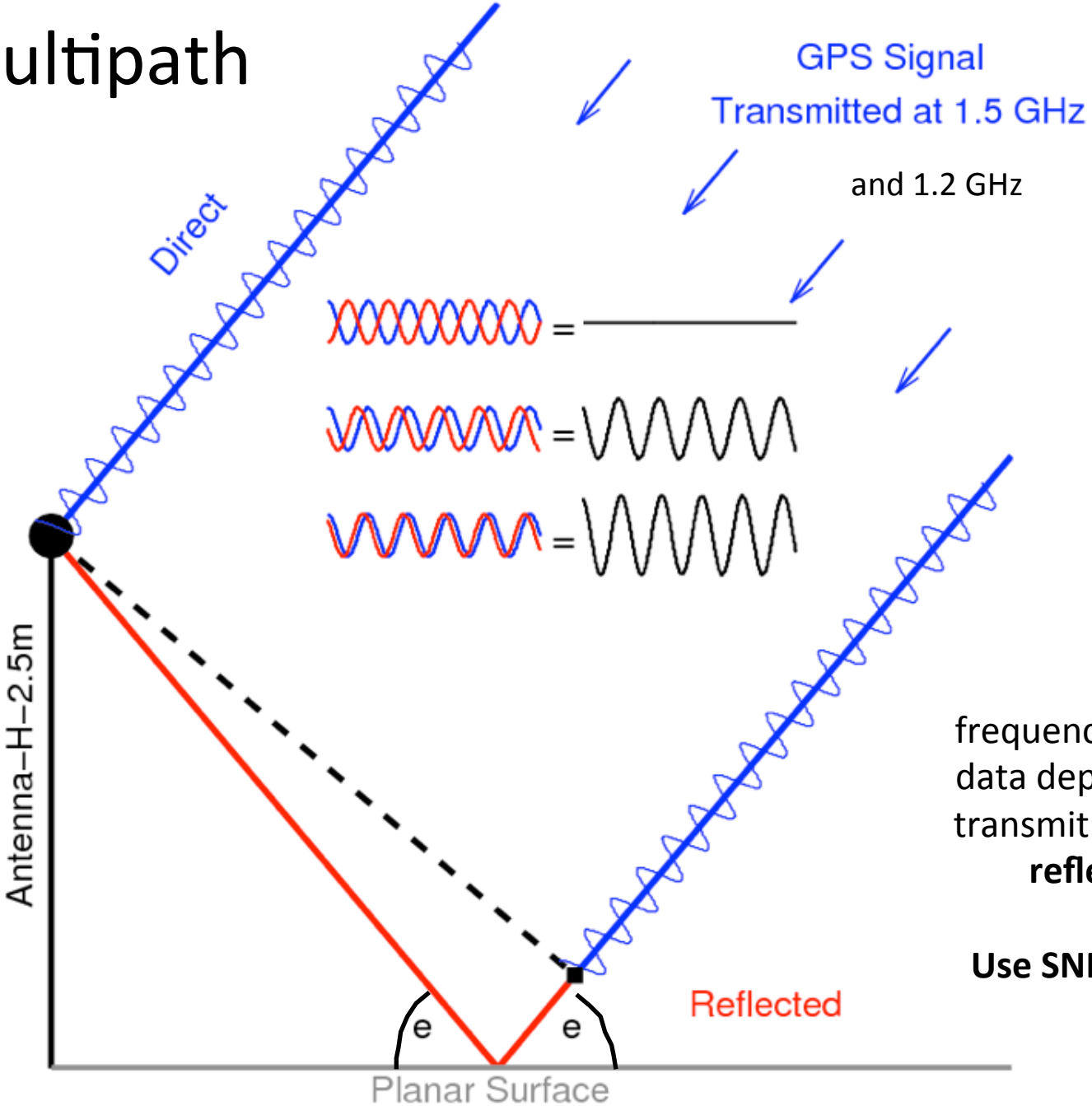
A) Give a great presentation
B) Ask insightful questions
C) Take a bad fall on workshop harbor cruise, require medical attention.

5 out of 5 doctors recommend A or B over C.

Outline

- Multipath
- PBO H2O
- Ground-based reflectometry
  - Snow
  - Soil Moisture
  - Vegetation Water Content
- GNSS H2O

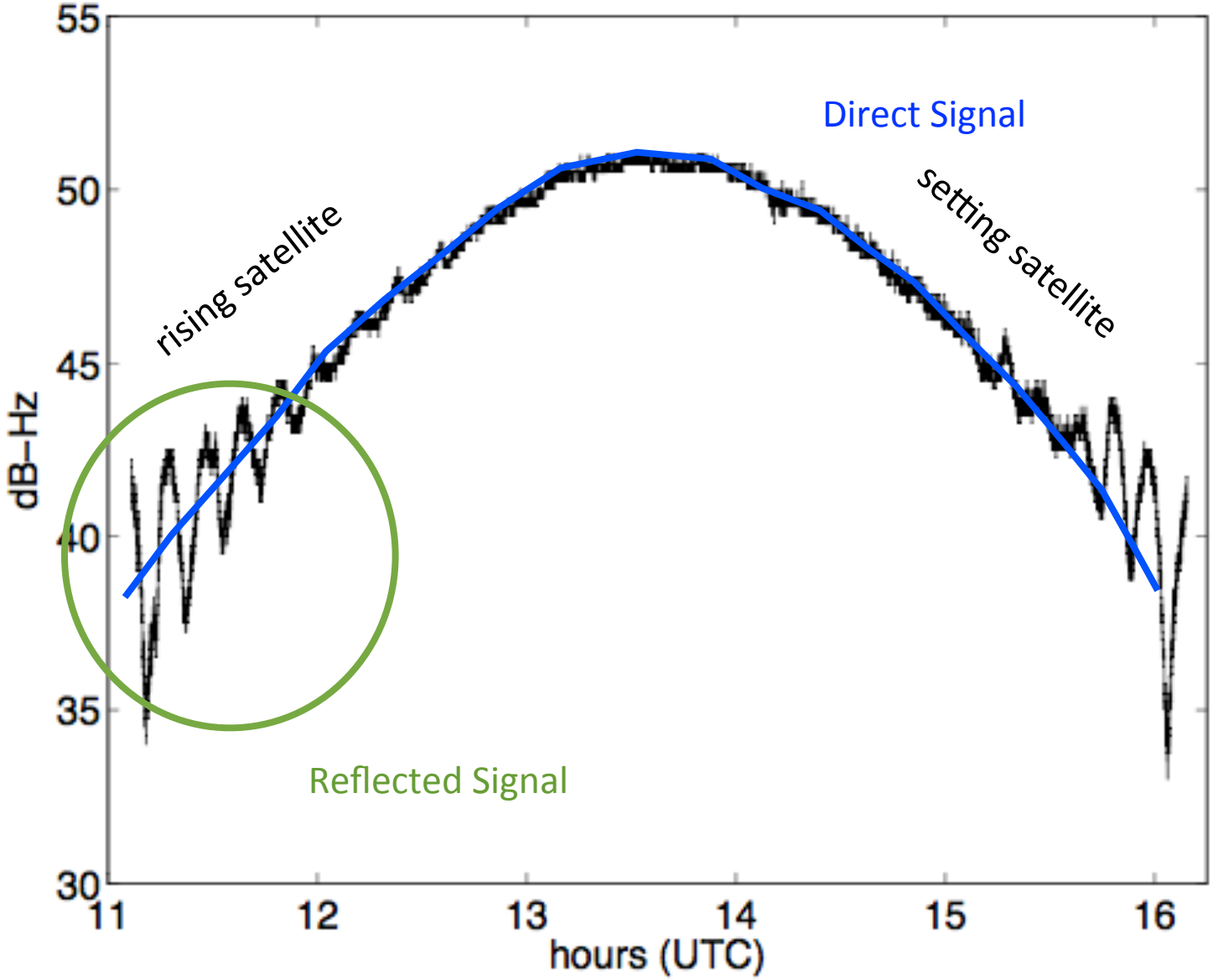
Multipath



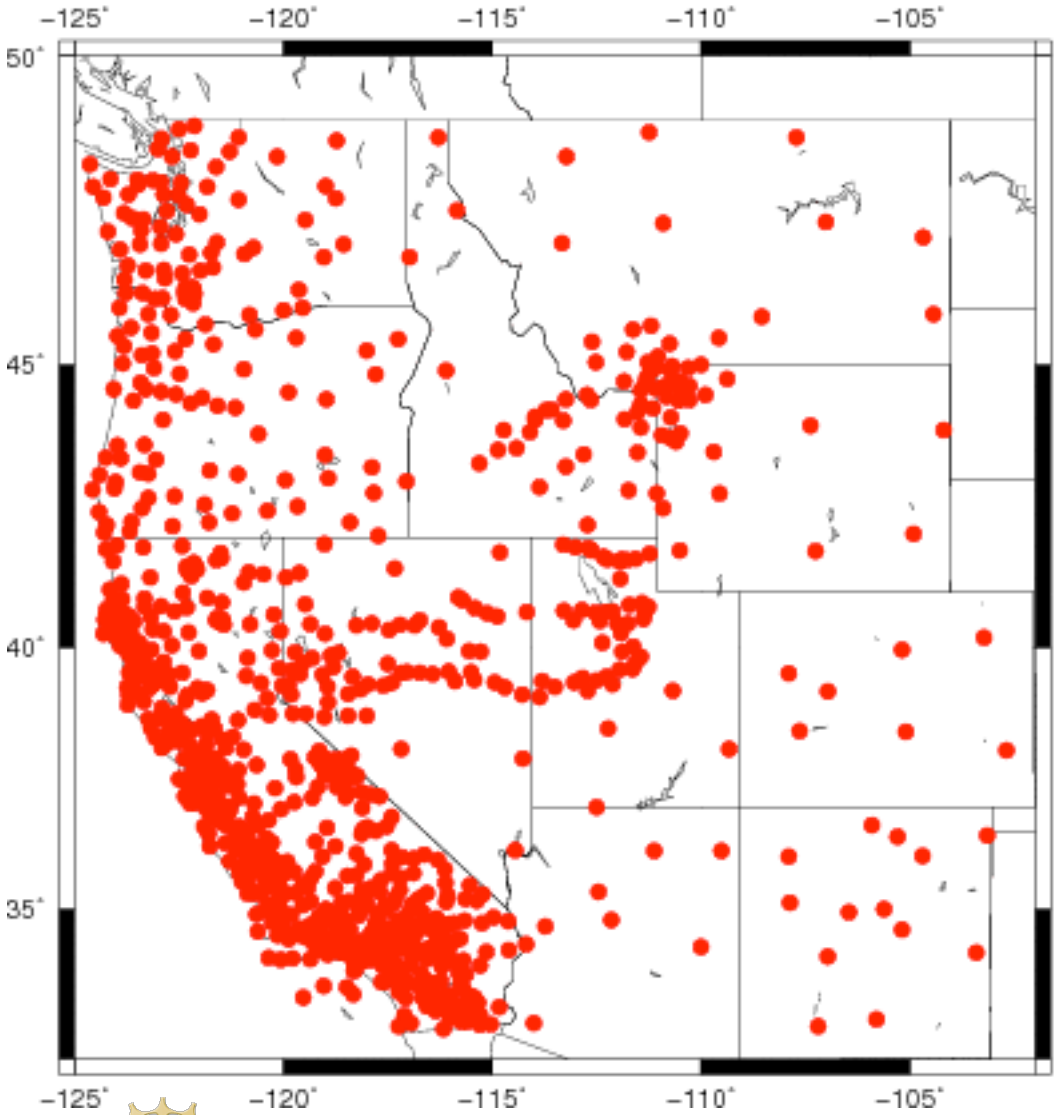
frequency of signal strength data depends on **H**, the GPS transmit **frequency**, and the **reflecting medium**

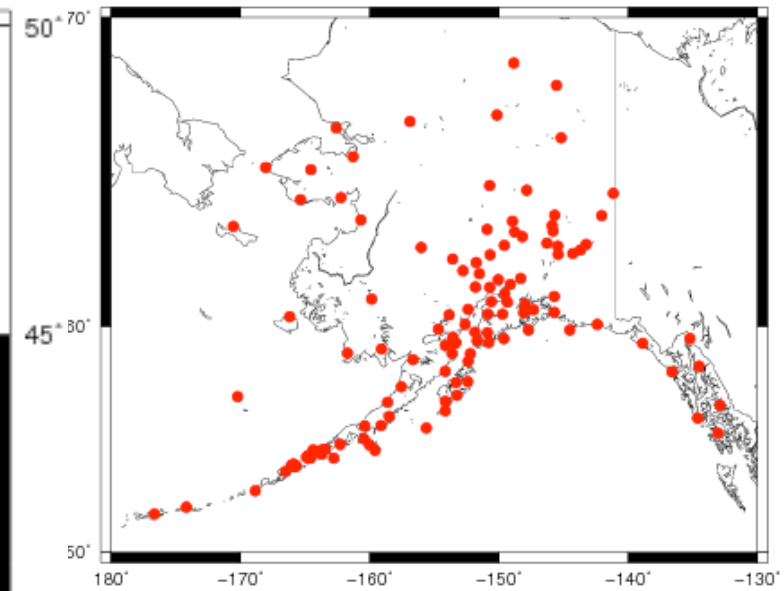
Use SNR data for GPS L2C

How do we do this with GPS receivers?



EarthScope Plate Boundary Observatory (PBO)





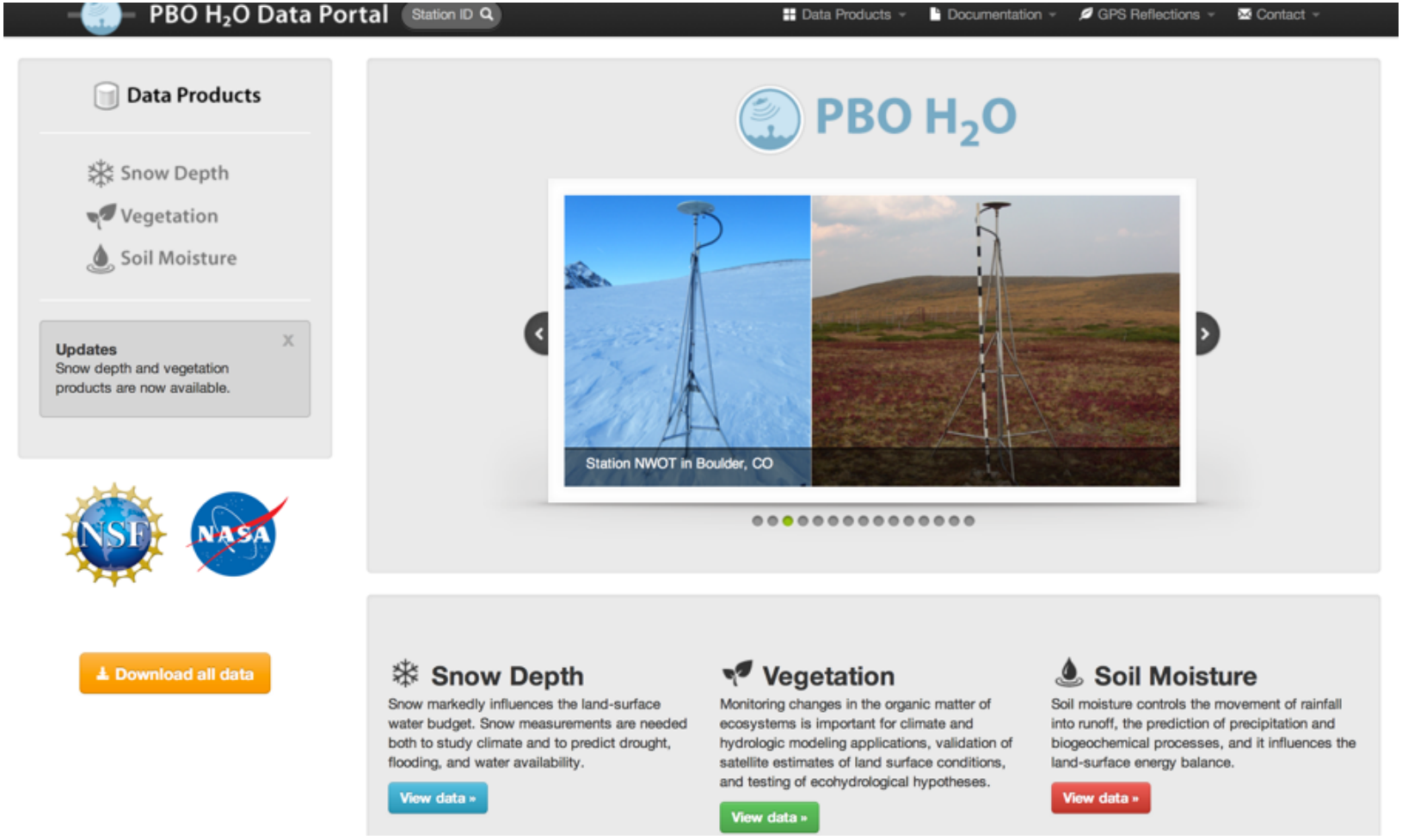
1100 continuously-operating GPS receivers - deployed to measure ground motions from plate tectonics, earthquakes, and volcanos.

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

PBO data are archived at UNAVCO

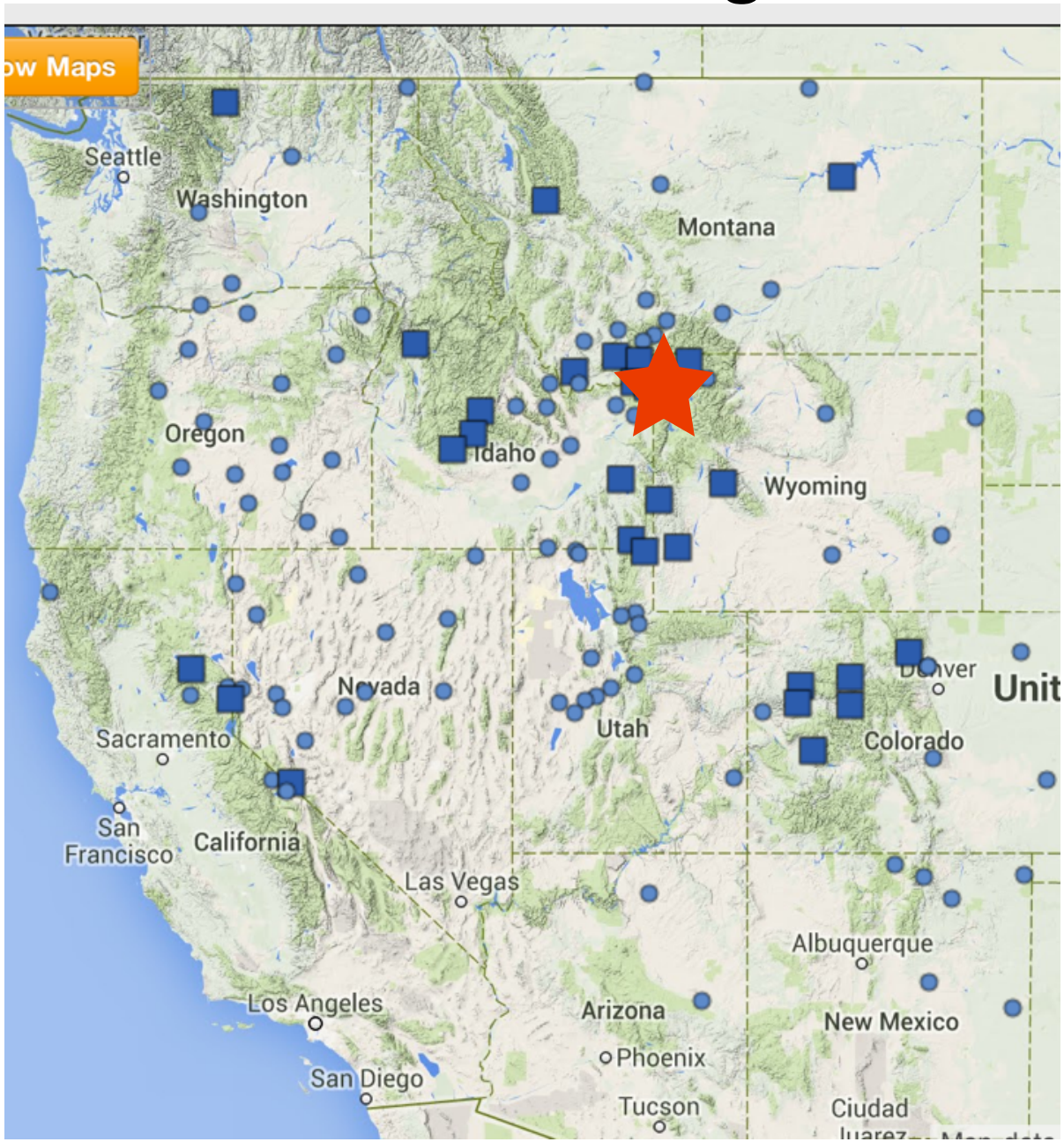
PBO H_2O

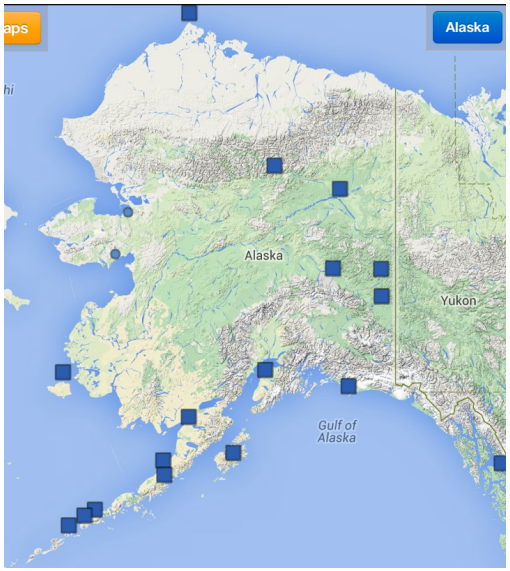
Using GPS reflection data from NSF's Plate Boundary Observatory (PBO) to study the water cycle

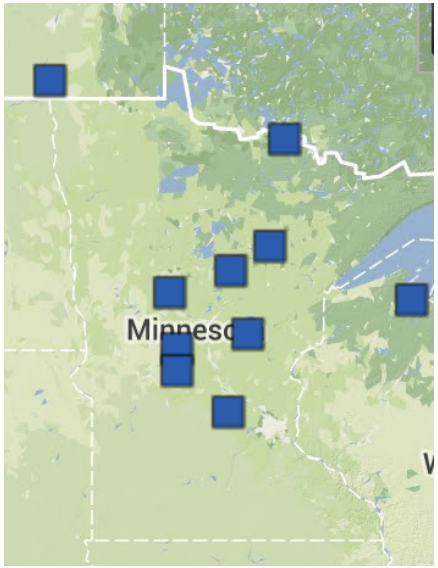


http://xenon.colorado.edu/portal

Measuring Snow

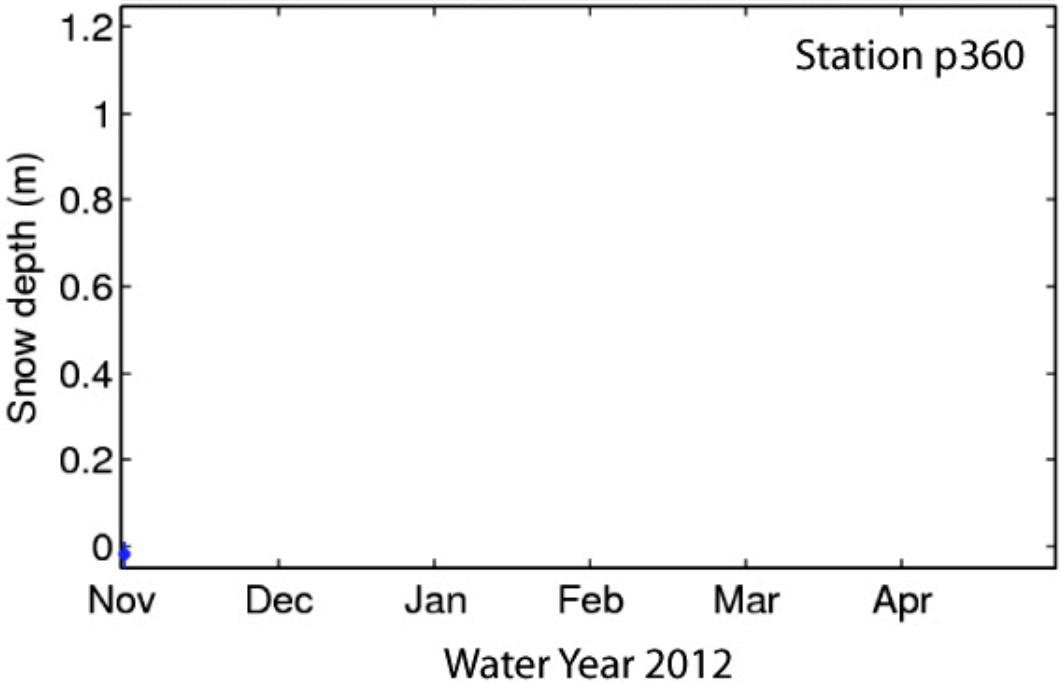


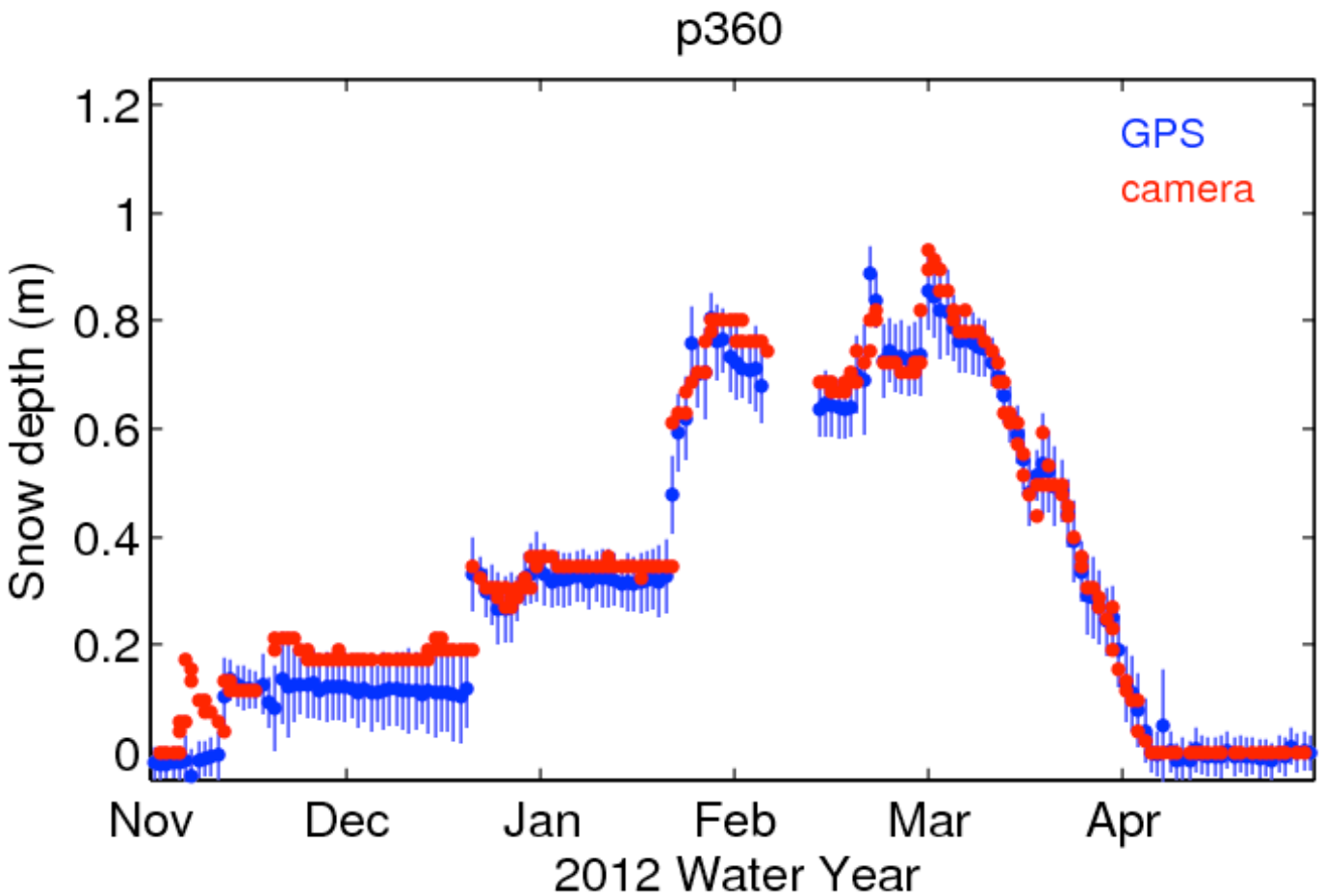




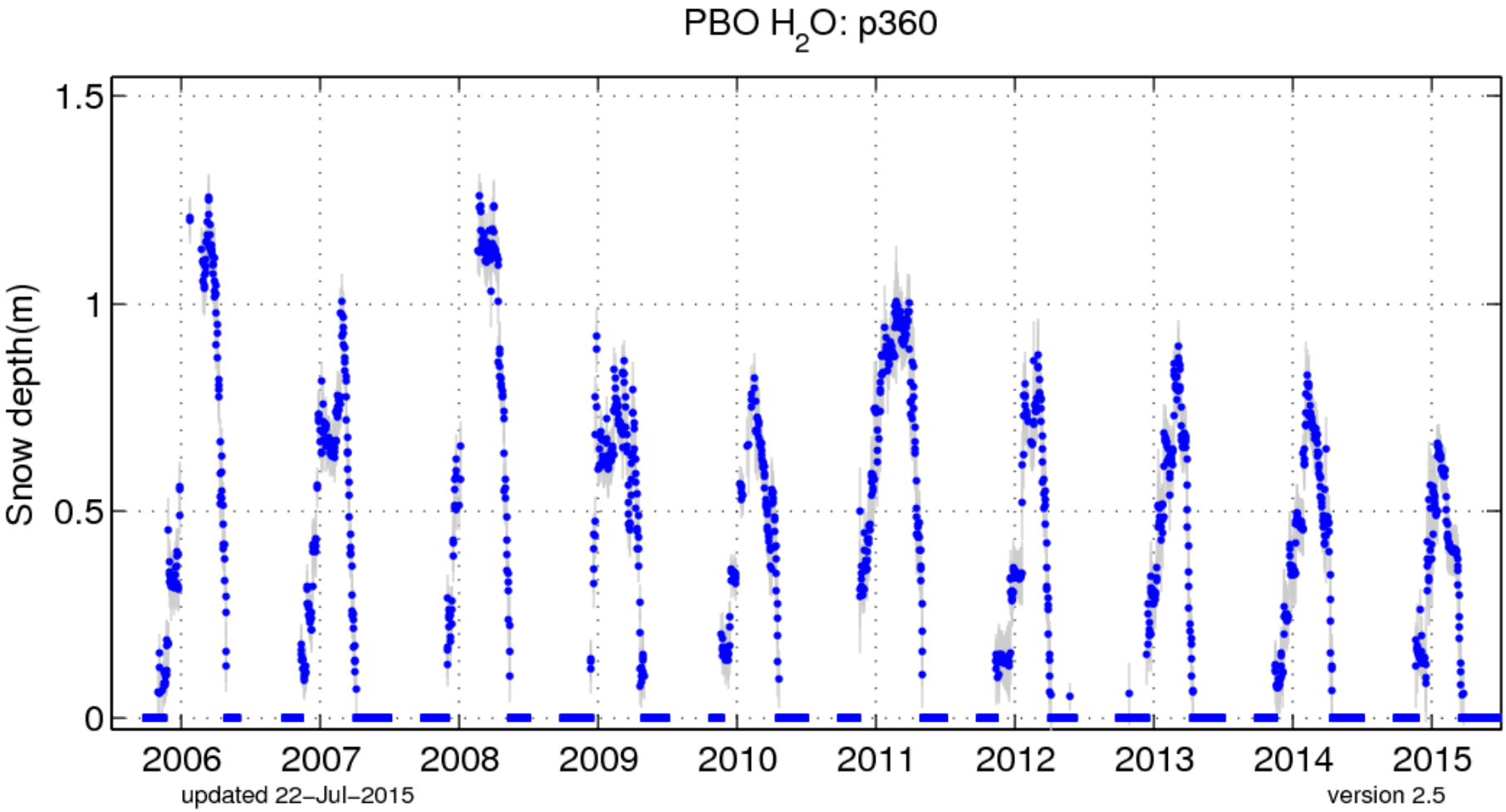
PBO H_2O

Installed a camera to take a picture of this stick every day


Station p360
Snow depth (m)
1.2
1
0.8
0.6
0.4
0.2
0
Nov
Dec
Jan
Feb
Mar
Apr
Water Year 2012

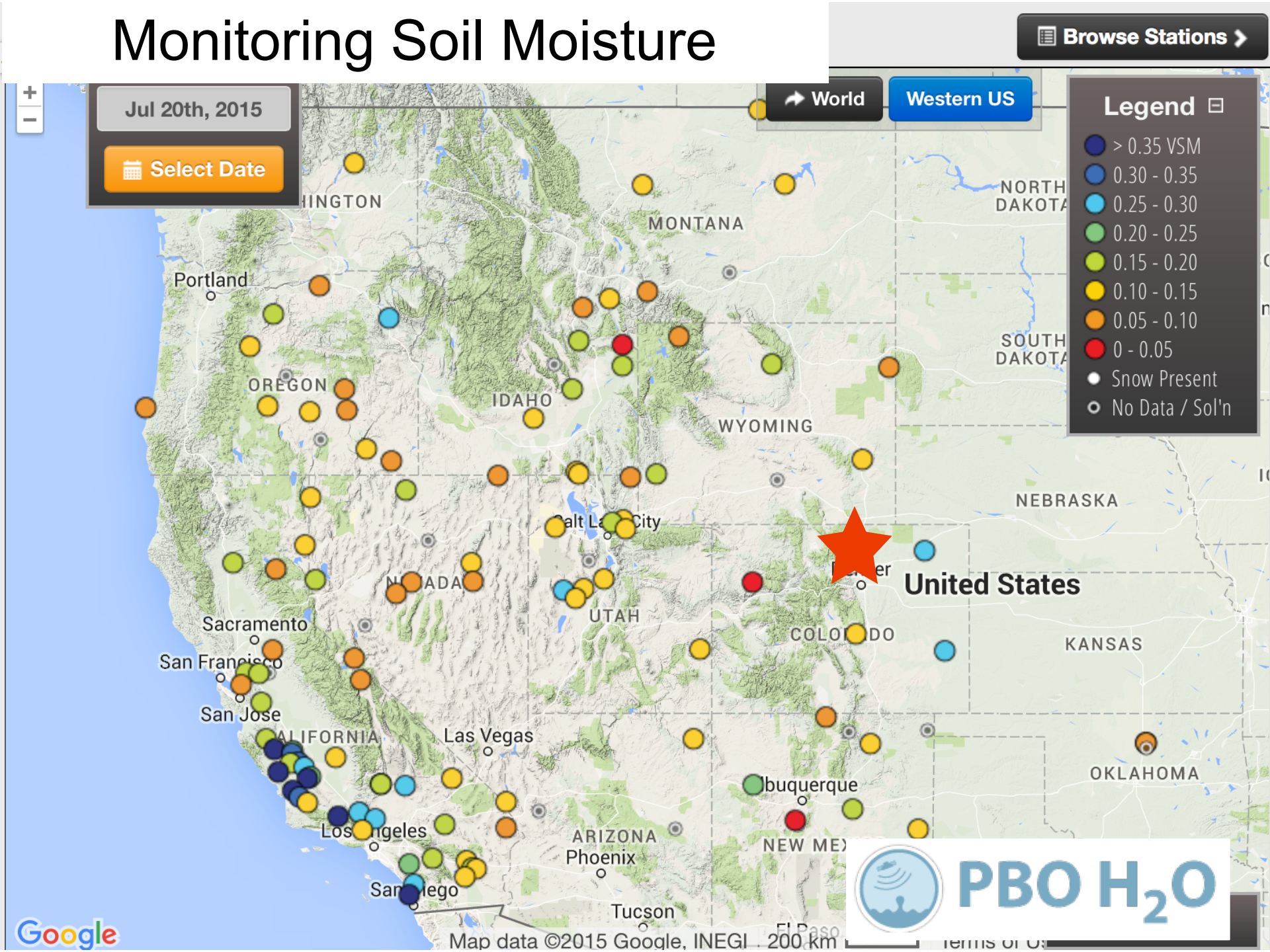

p360
GPS
camera
Snow depth (m)
1.2
1
0.8
0.6
0.4
0.2
0
Nov
Dec
Jan
Feb
Mar
Apr
2012 Water Year

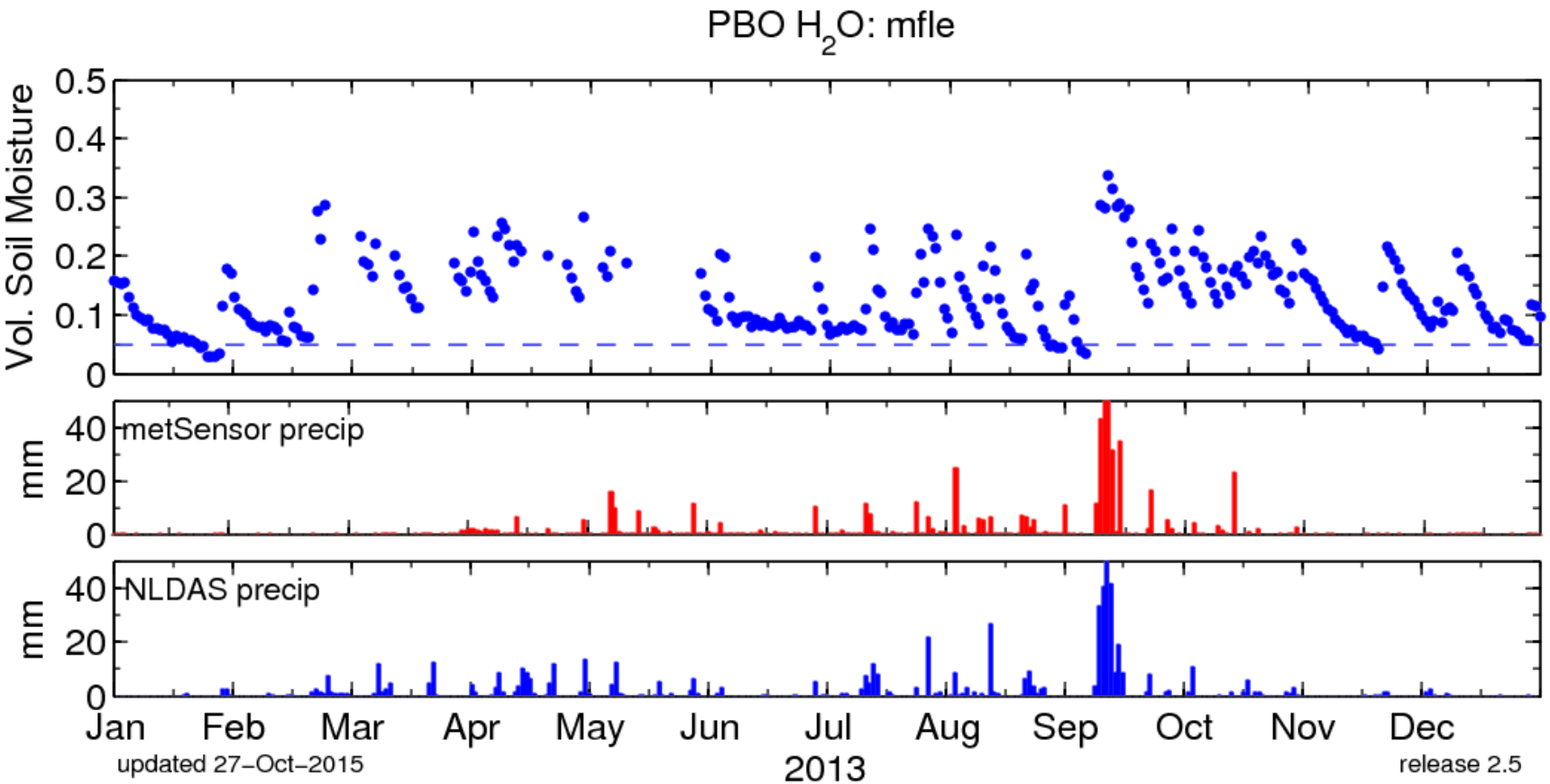
Snow Climatology



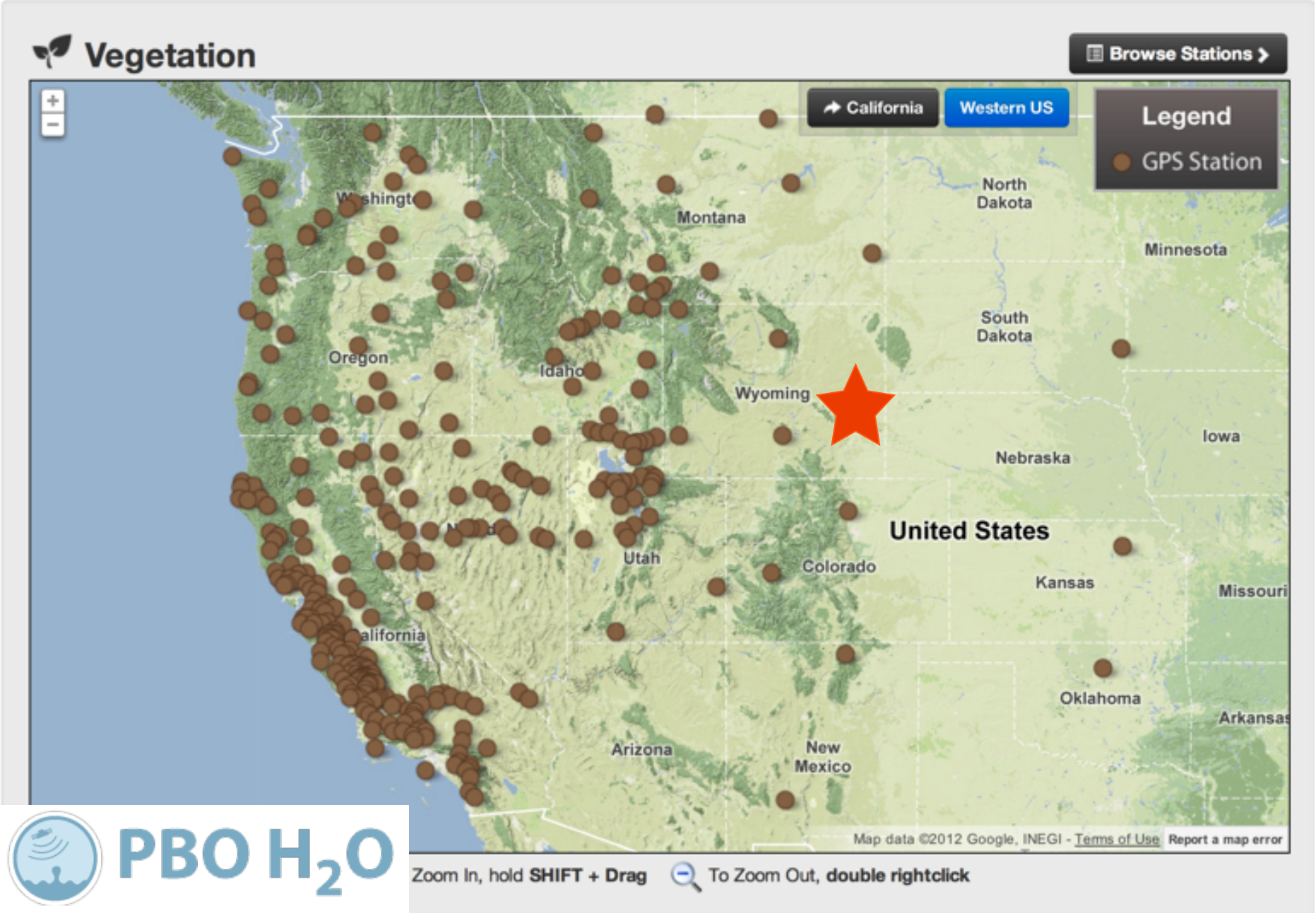
- Also provide a SWE product for GPS stations near SNOTEL sites
- Recently extended analysis to L1 SNR – lower quality but more satellites

Monitoring Soil Moisture

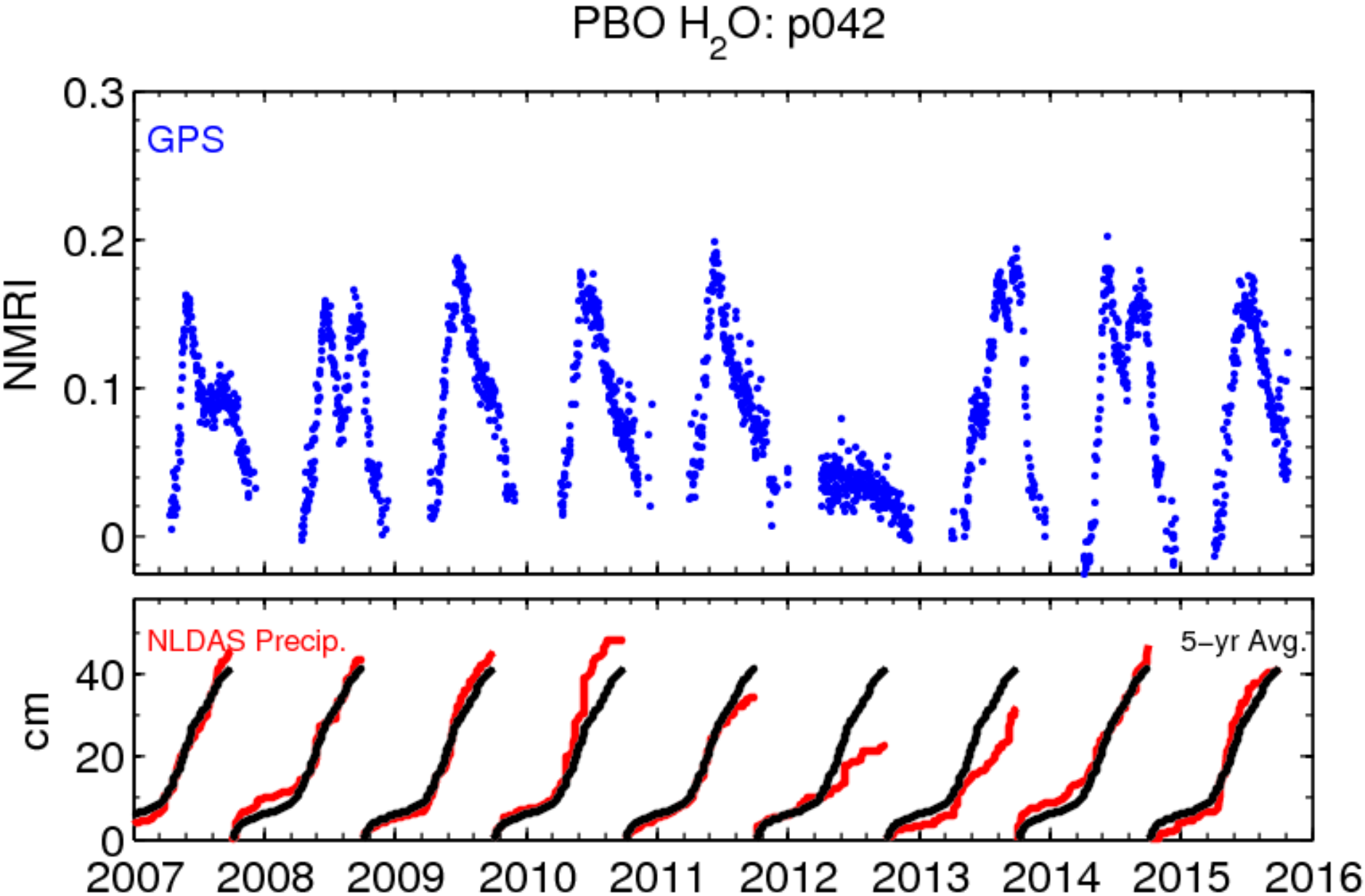



PBO H2O: mfle
Vol. Soil Moisture
0.5
0.4
0.3
0.2
0.1
0
metSensor precip
mm
40
20
0
NLDAS precip
mm
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
updated 27–Oct–2015
2013
release 2.5

Monitoring Vegetation Water Content

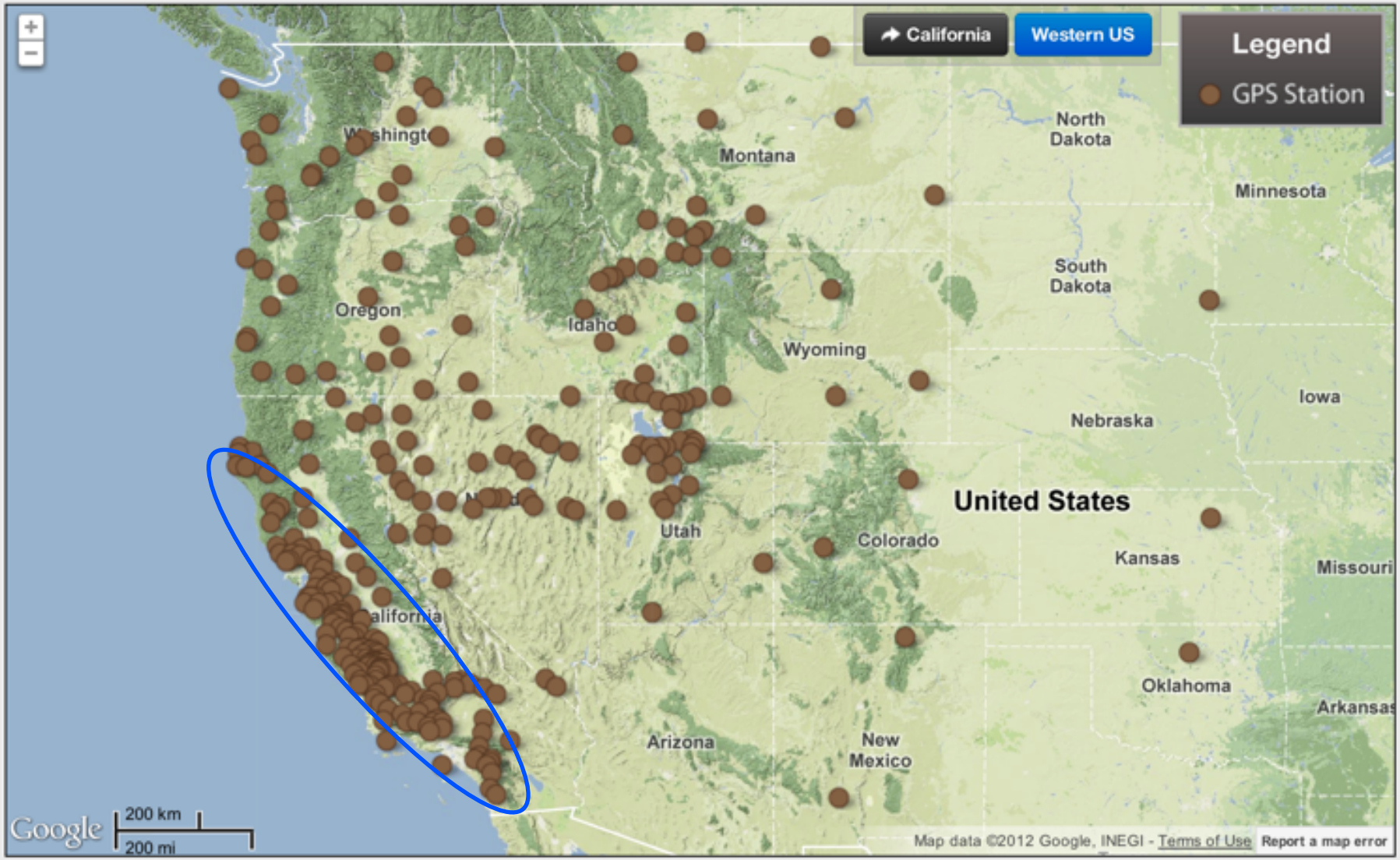


PBO H_2O


PBO H2O: p042
GPS
NMRI
0.3
0.2
0.1
0
NLDAS Precip.
5–yr Avg.
cm
40
20
0
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

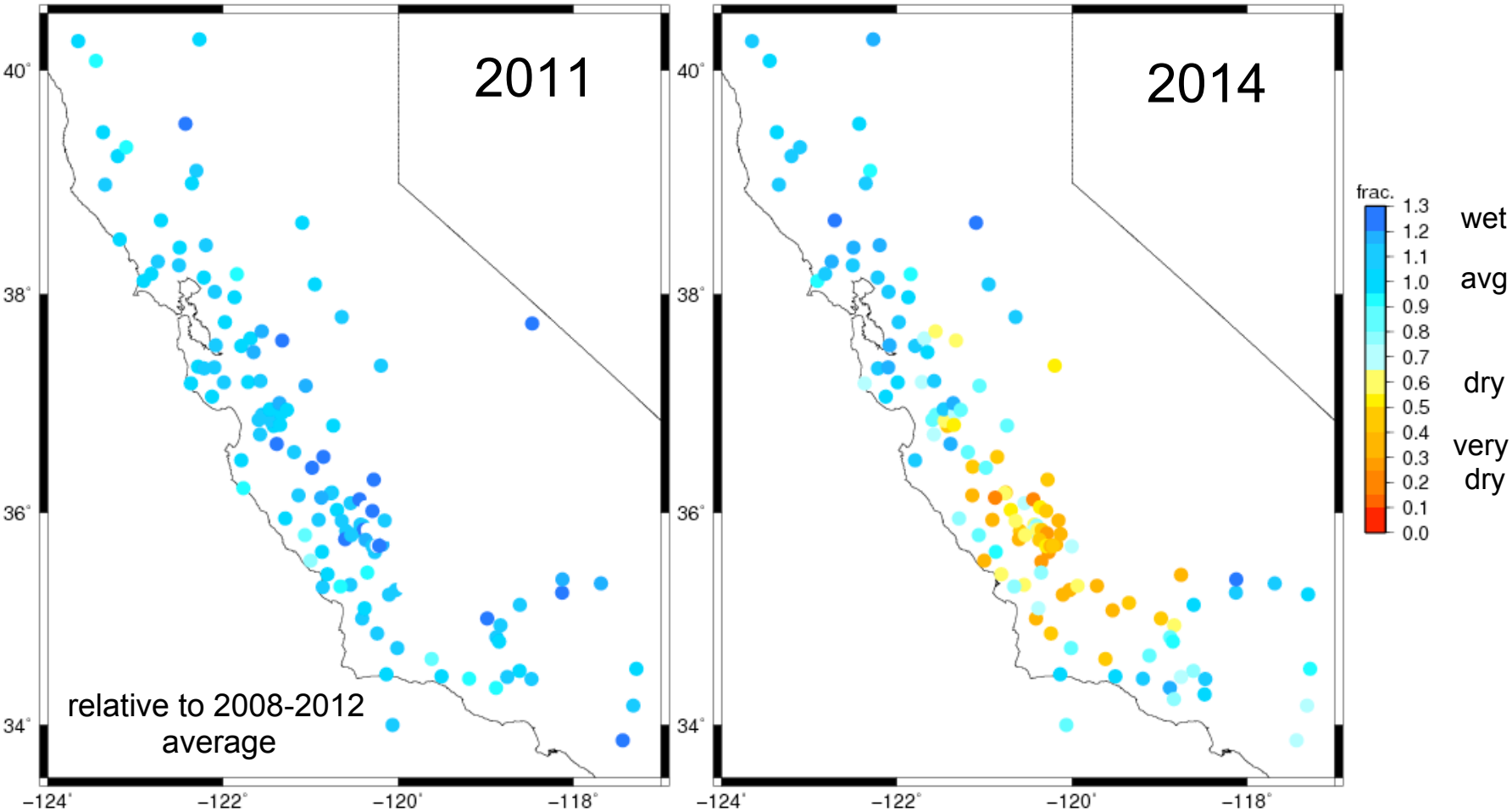
Vegetation

Browse Stations

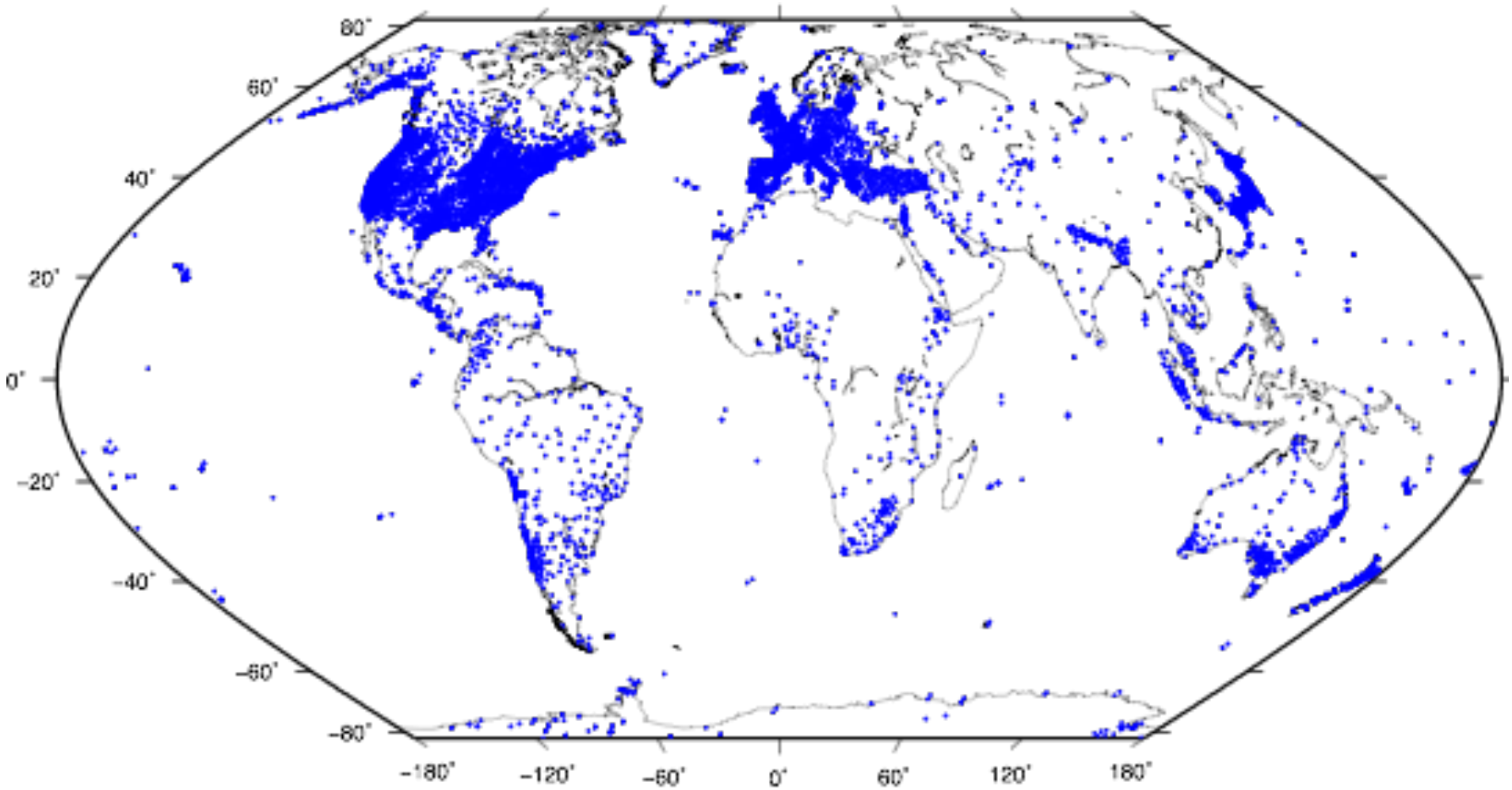


To Zoom In, hold **SHIFT + Drag** To Zoom Out, **double rightclick**

Peak Vegetation Water Content

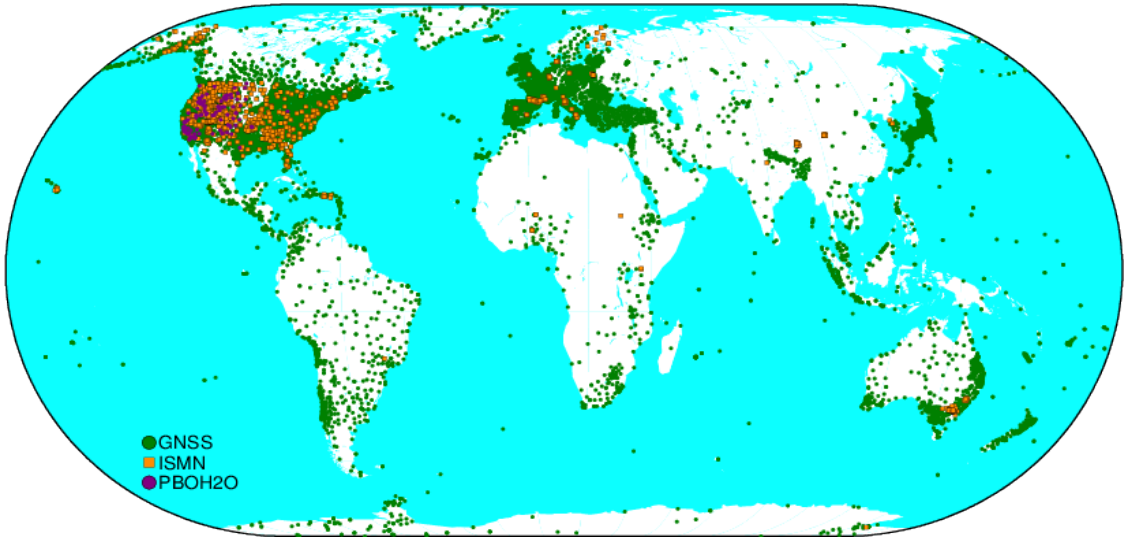


Going Global: Automating Data Ingestion to bring in diverse GPS Networks



Coming Soon: GNSS H2O

Motivation: New Climate Records

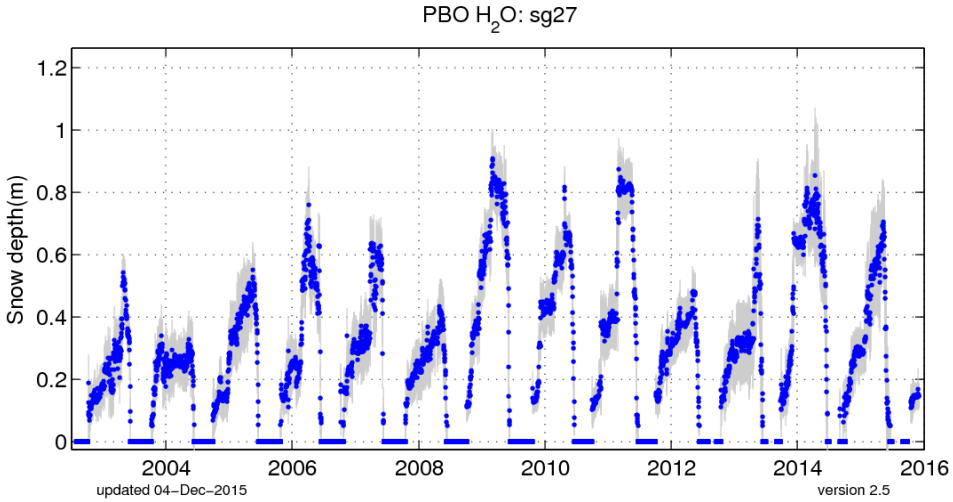


Public GNSS sites

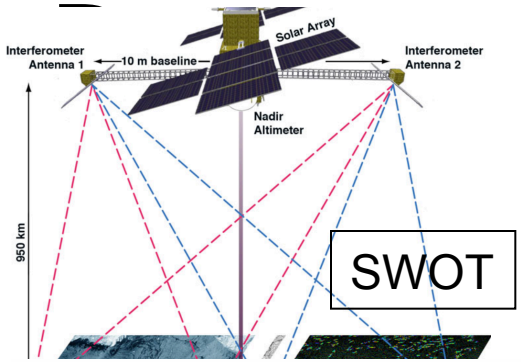
PBO H2O pilot project

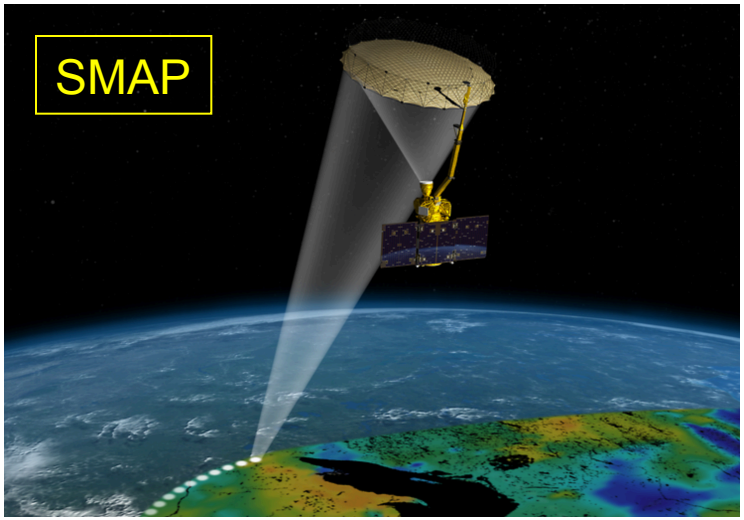
International Soil Moisture Network

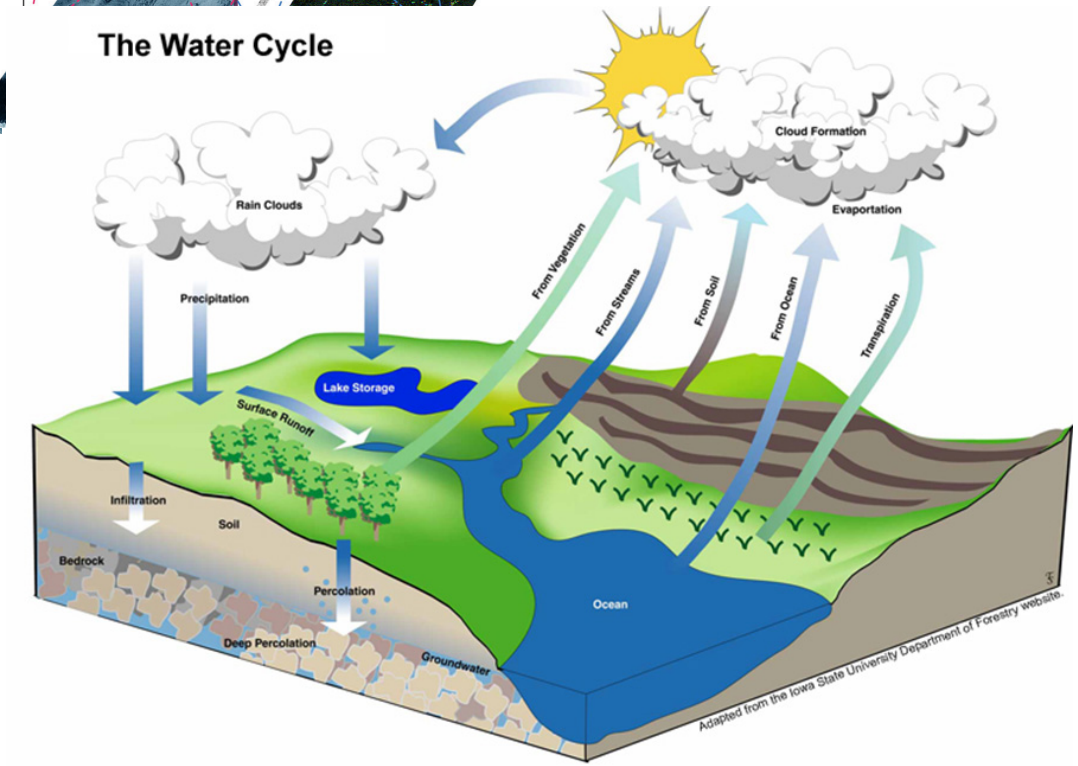
Goal: provide access to thousands of inexpensive GNSS environmental sensors on a global scale, providing long time-scale records for climate studies.



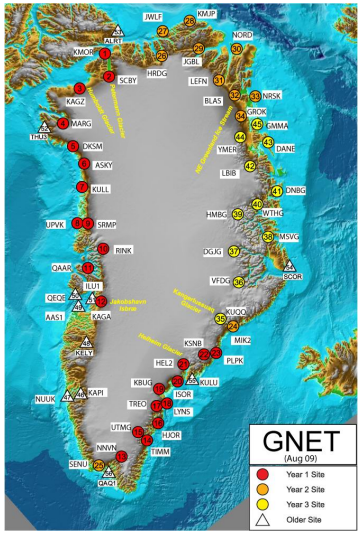
Motivation: Satellite Validation







Upcoming IT Challenges

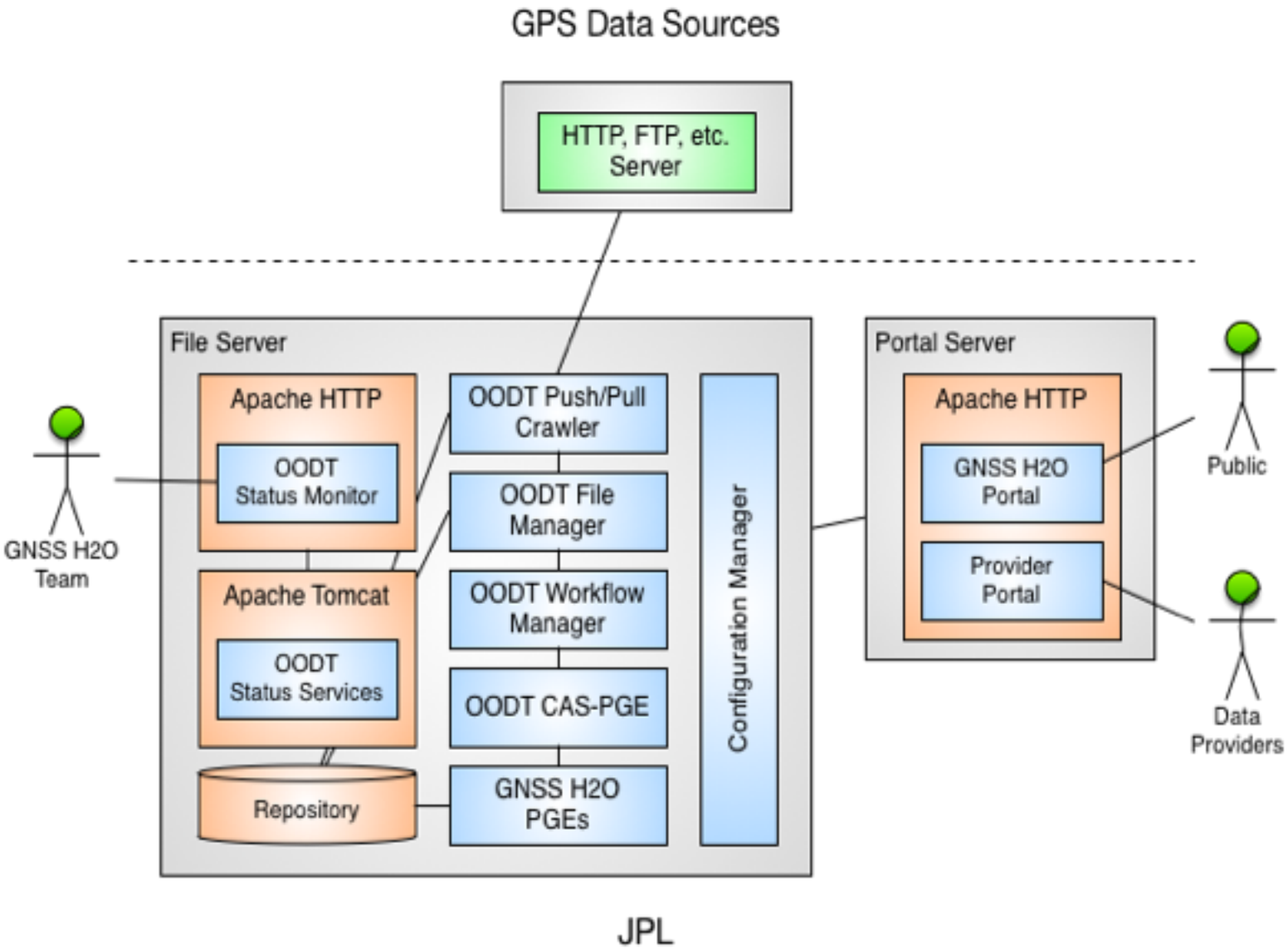


The global GNSS network consists of more than 12,000 stations operated by hundreds of different agencies at a variety of scales (global, regional).

No one archive has all GNSS data. Data formats are well defined, but require that operators use special options when making those data files to be useful for reflection applications.

We need a metadata system that operates in both directions – ingesting data from these networks and communicating to those operators what is needed for a proper GNSS reflection site.

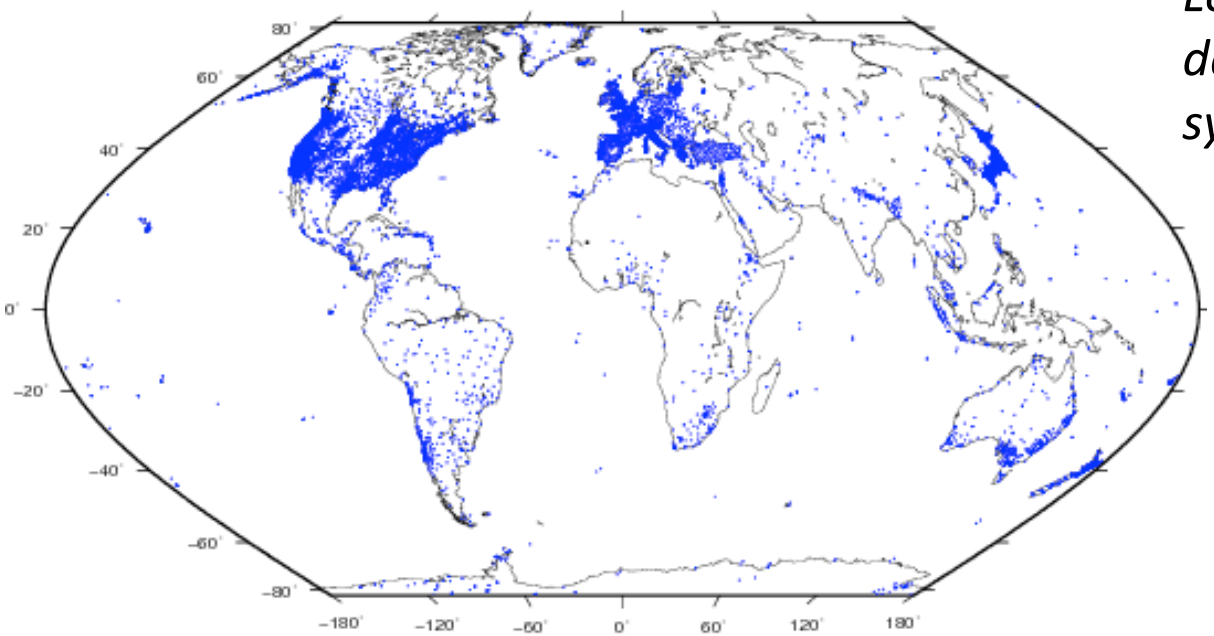
GNSS H_2O System Architecture



Funded by NASA Advanced Information System Technologies Program.
OODT - Object Oriented Data Technology

Summary

- PBO H_2O is now one of the largest soil moisture networks in the world; it also provides snow depth (170) and vegetation (370) information in near real time.
- GNSS H_2O will provide a global dataset of *in situ* climate data and satellite validation data.
- GNSS H_2O will expand PBO H_2O, professionalizing the code so that it can operated with many networks and users. An automatic station evaluator will also be developed.



- *Looking for global network data to test GNSS H_2O system.*

Funding for developing the GNSS H_2O comes from NASA AIST. PBO H_2O was developed with assistance from NSF and NASA.