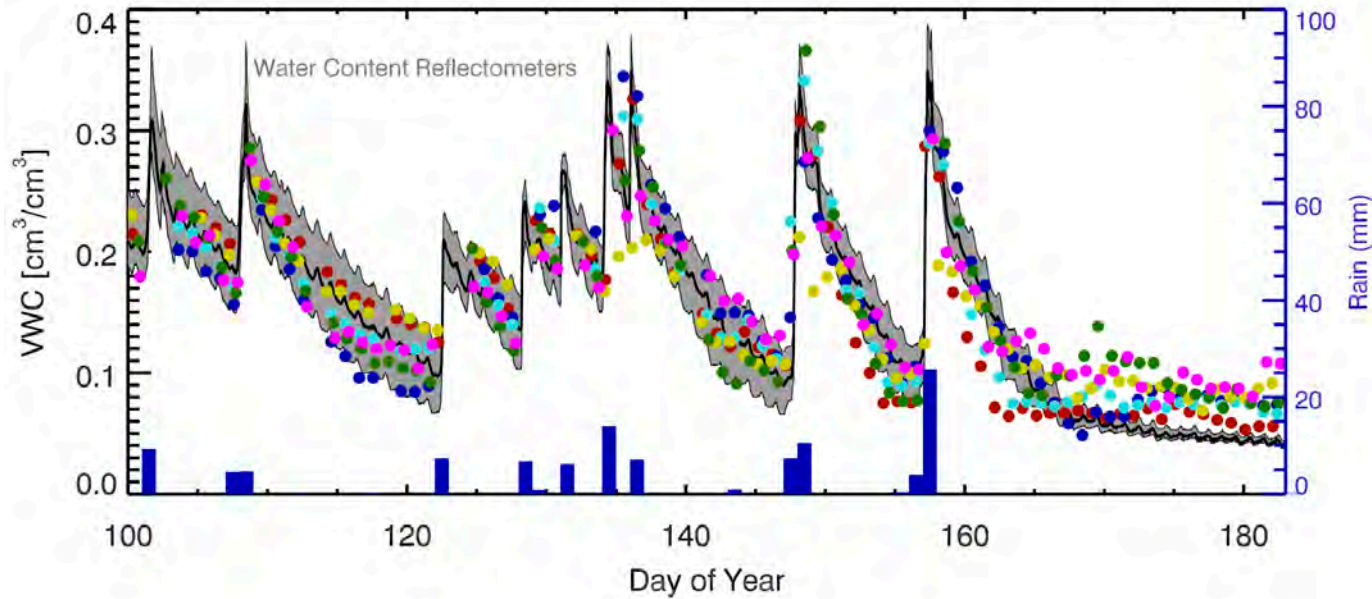


Water Cycle Studies Using GPS Ground Networks

GPS reflections is a new technique that uses data from existing GPS sites to monitor water stored on land in soil, plants, and snow. Water cycle products are derived from the interference between the direct and reflected GPS signals; they represent a region ~25m in radius around the antenna.



GPS site in West Yellowstone, Montana

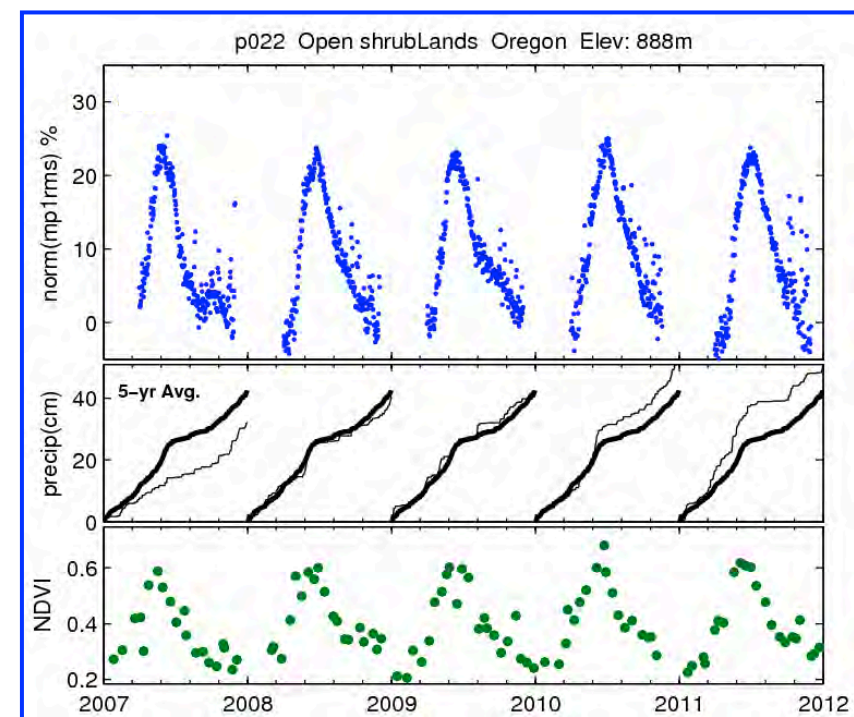
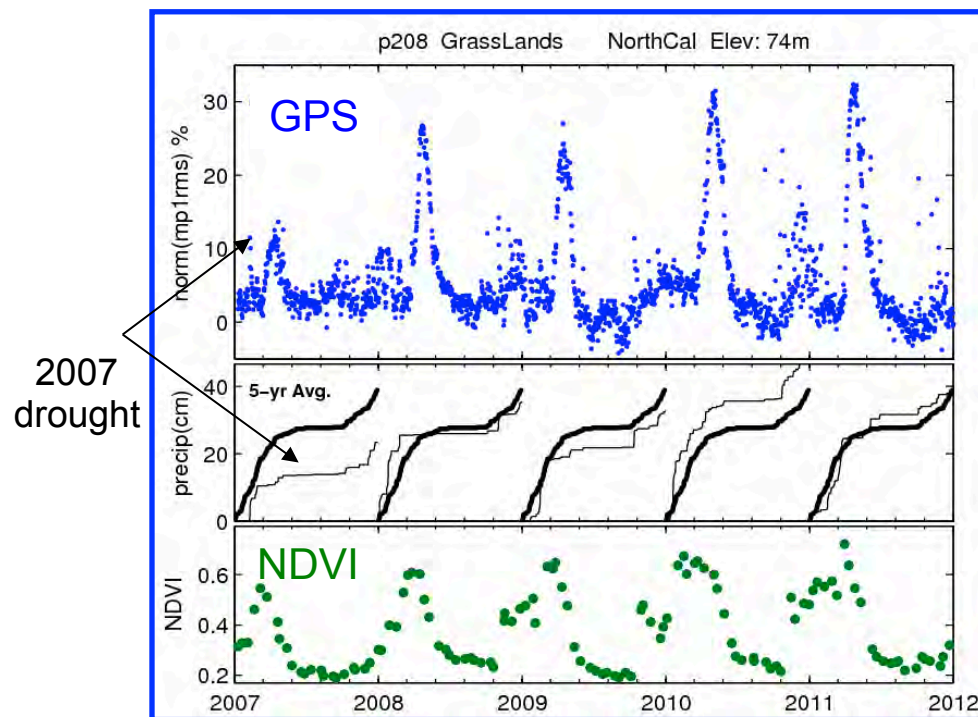
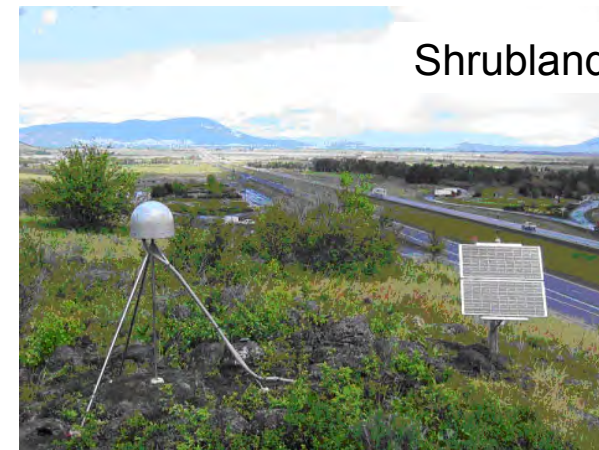


Soil Moisture

Reflected GPS signals (colors represent different GPS satellites) correlate well with *in-situ* sensors (gray region) and rain (blue bars).

Kristine M. Larson (Univ. Colorado, Aero), Eric Small (Univ. Colorado, Geol. Sci.), John Braun (UCAR)

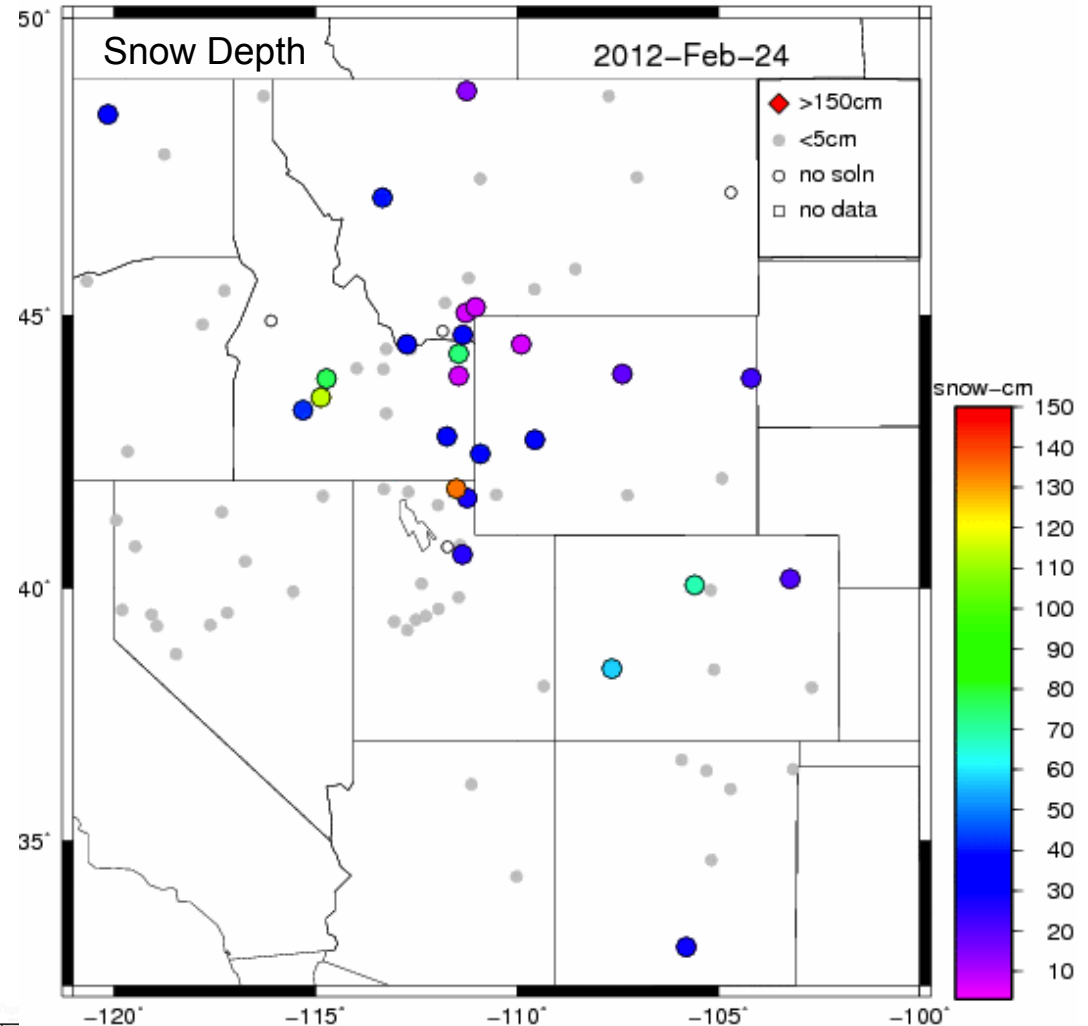
Biomass



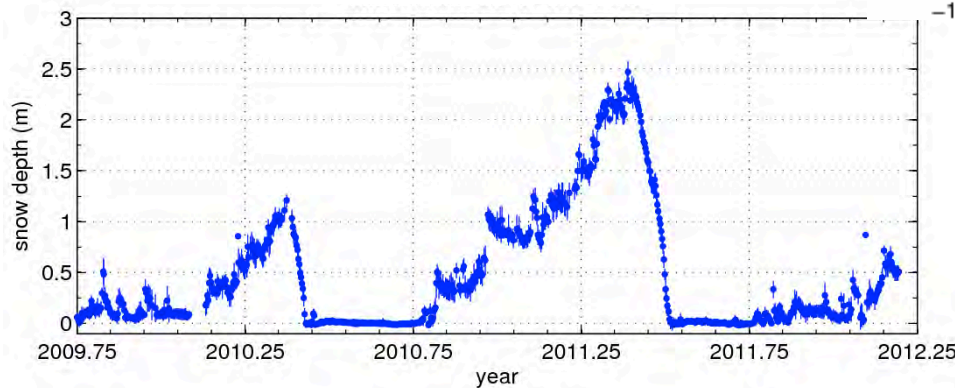
GPS reflections are also sensitive to vegetation water-content, and thus show effects during drought years that are difficult to see in optical remote sensing products such as NDVI. Five-year GPS vegetation water content time series are available for over 500 sites in the western U.S.

Snow

- Snow depth products currently available every day for ~100 sites.
- This analysis is being expanded to GPS sites on the west coast and Alaska.
- Also developing snow water equivalent product for each site.
- Validation activities ongoing with NSIDC, NOAA, and NASA Goddard.
- Reflections research is supported by NSF and NASA.



Snow Depth, Niwot Ridge, Elev 3130 m



GPS reflections can be used to measure snow properties at multiple azimuths in near-real-time.

Last year we had record snow levels in the Rocky Mountains. This year they are the lowest in the past 25 years.