Disaster Mitigation Applications of Terrestrial GNSS

Dr. Angelyn Moore
Jet Propulsion Laboratory, California Institute of Technology
15 November 2017

©2017 California Institute of Technology. Government sponsorship acknowledged.

Typical western U.S. ground GPS station as installed by geodetic community

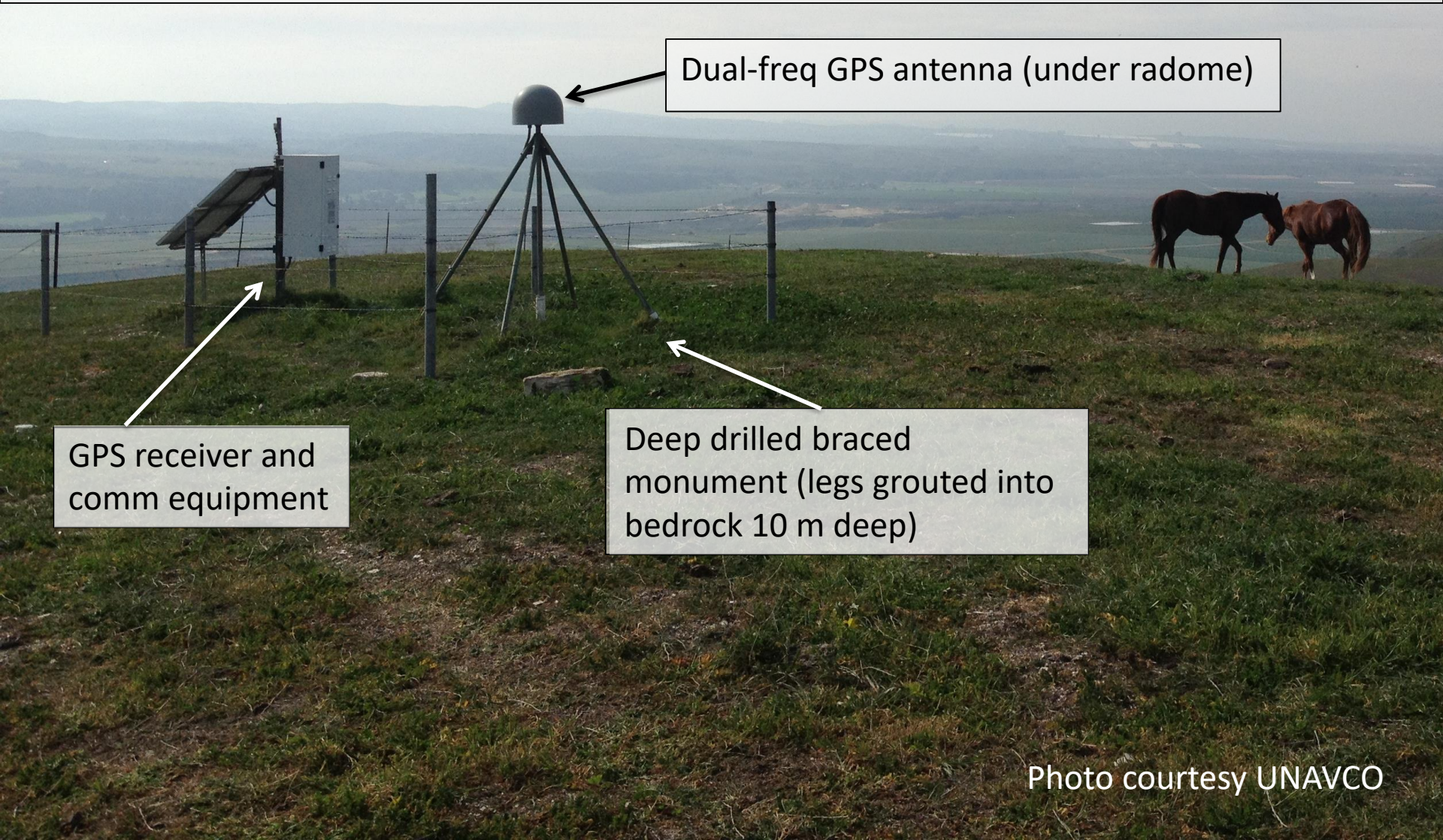
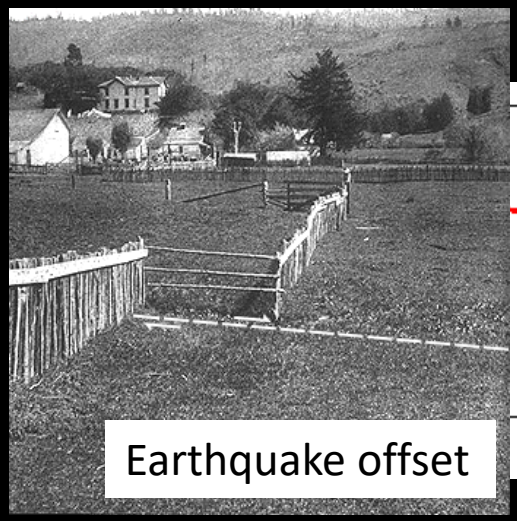
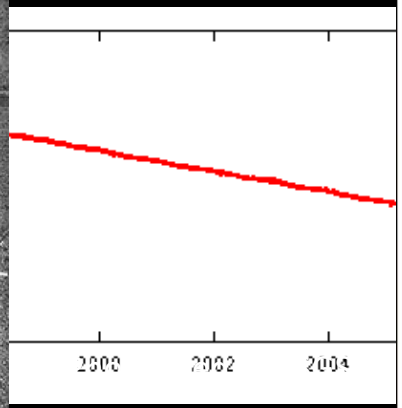


Photo courtesy UNAVCO

Ground GPS reveals motion between and during earthquakes

JPLM East Coordinate

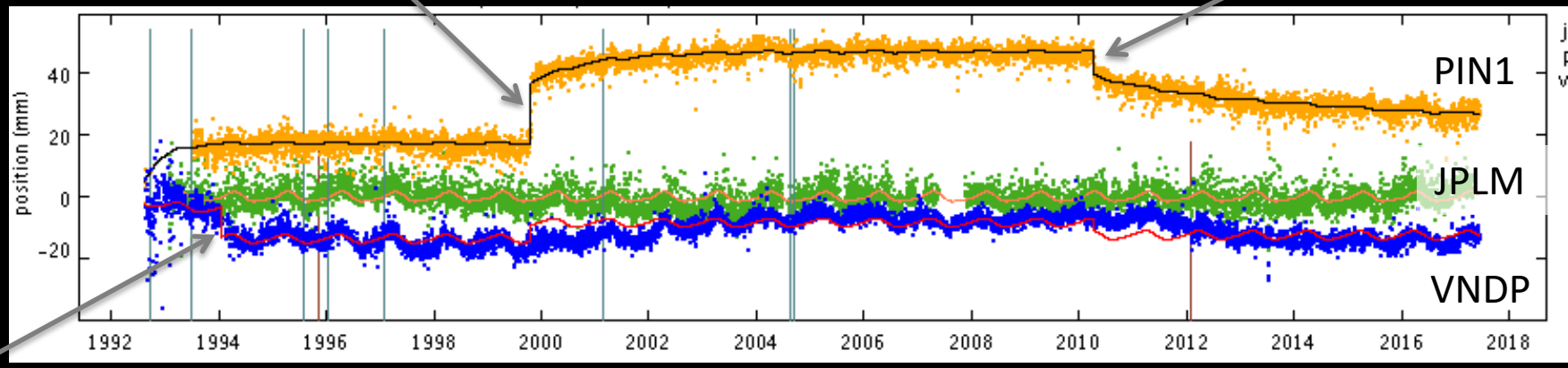




1999 Hector Mine

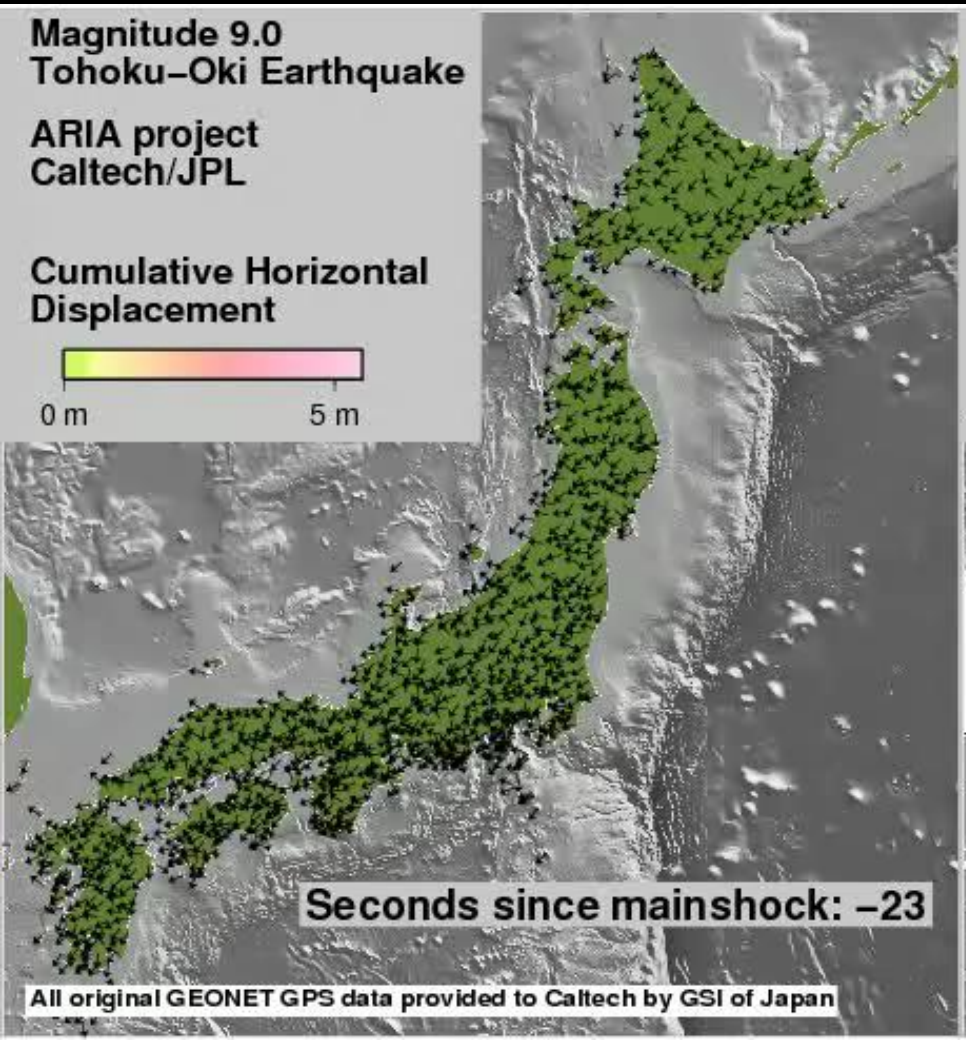
2010 El Mayor-Cucapah

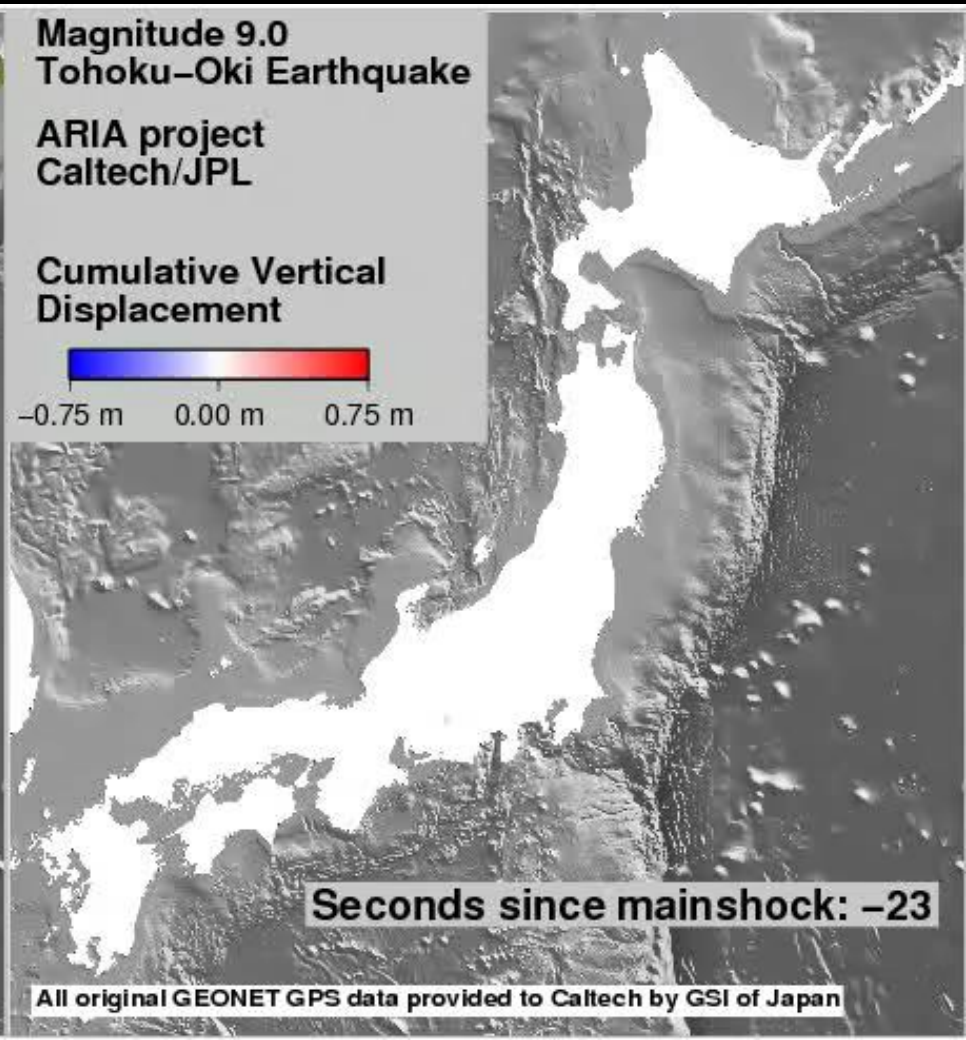
North Coordinate (detrended)



1994 Northridge earthquake

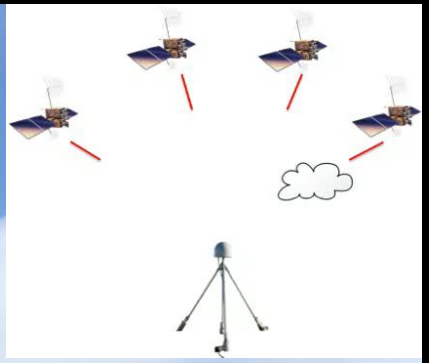
GPS can also measure the movement during an earthquake

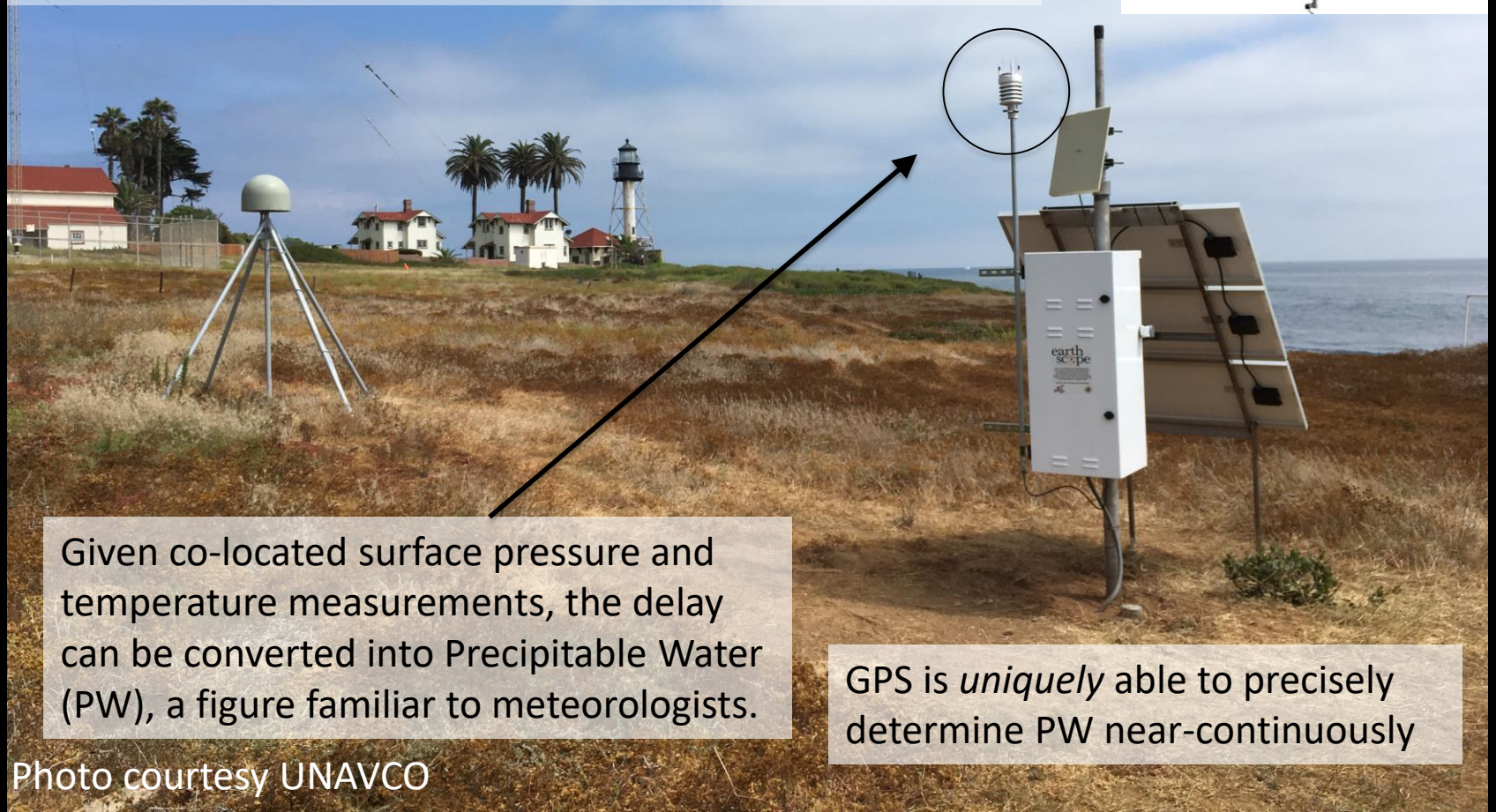




Ground GPS meteorology

Because GPS is a time-of-flight technique, when we estimate the station's position, we <u>automatically</u> also estimate the amount of delay due to water vapor.





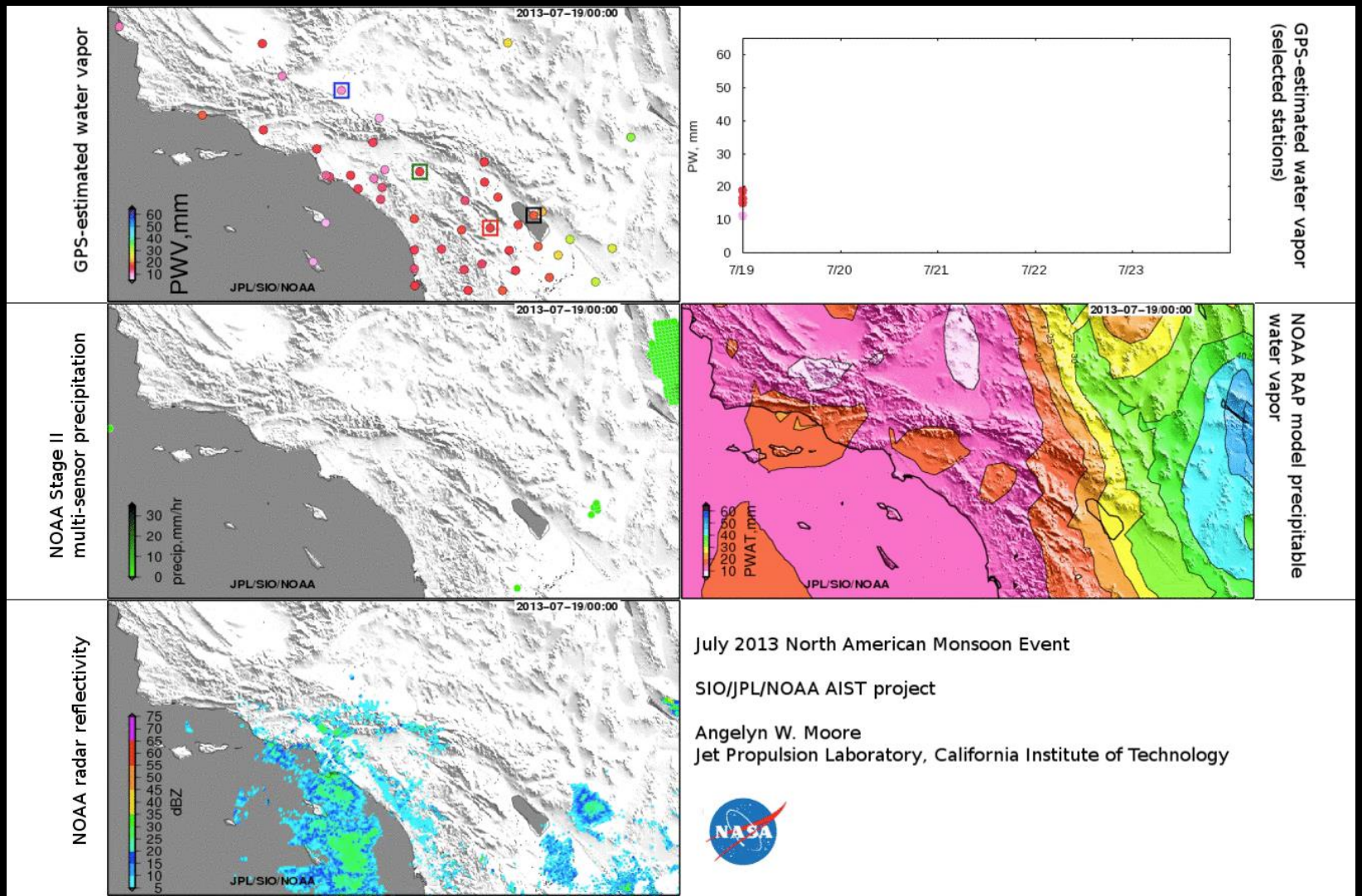
Given co-located surface pressure and temperature measurements, the delay can be converted into Precipitable Water (PW), a figure familiar to meteorologists.

GPS is *uniquely* able to precisely determine PW near-continuously

Photo courtesy UNAVCO

Ground GPS Meteorology

Uniquely able to precisely determine Precipitable Water Vapor near-continuously



Ground GPS meteorology

Photo credit: A. Tardy, NWS

R. Munroe (NWS) consults GPS PW at the National Weather Service LA/Oxnard forecast during developing storms.
Photo courtesy J. Laber, NWS

GPS Interferometric Reflectometry (GPS-IR) detects changes in snow, soil moisture, and vegetation

We use the interference pattern created by the direct and reflected signal power to infer changes in the reflecting surface

Photo courtesy UNAVCO

GPS-IR detects changes in snow, soil moisture, and vegetation

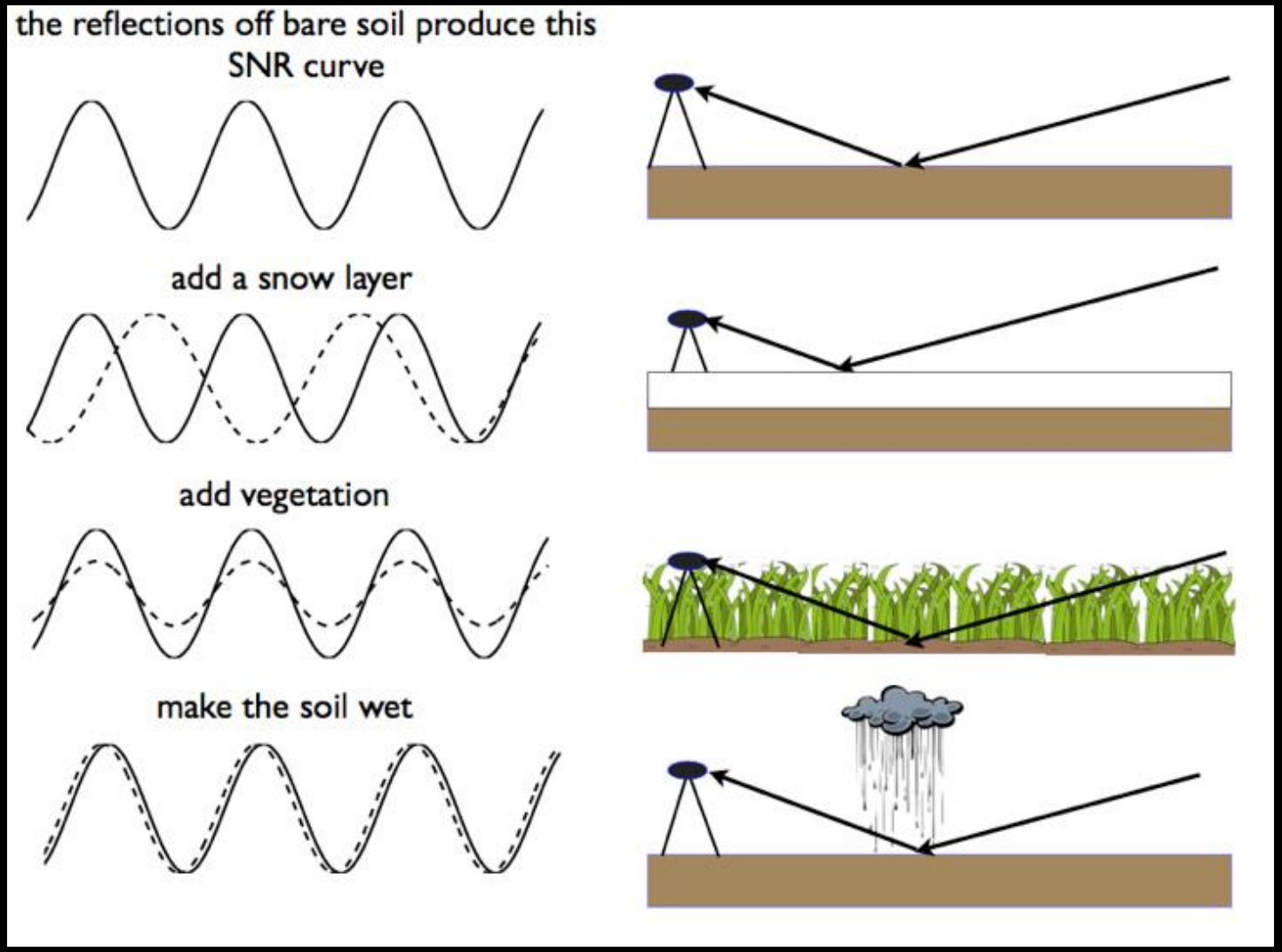
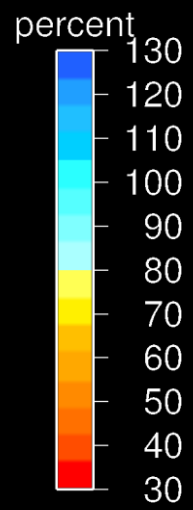
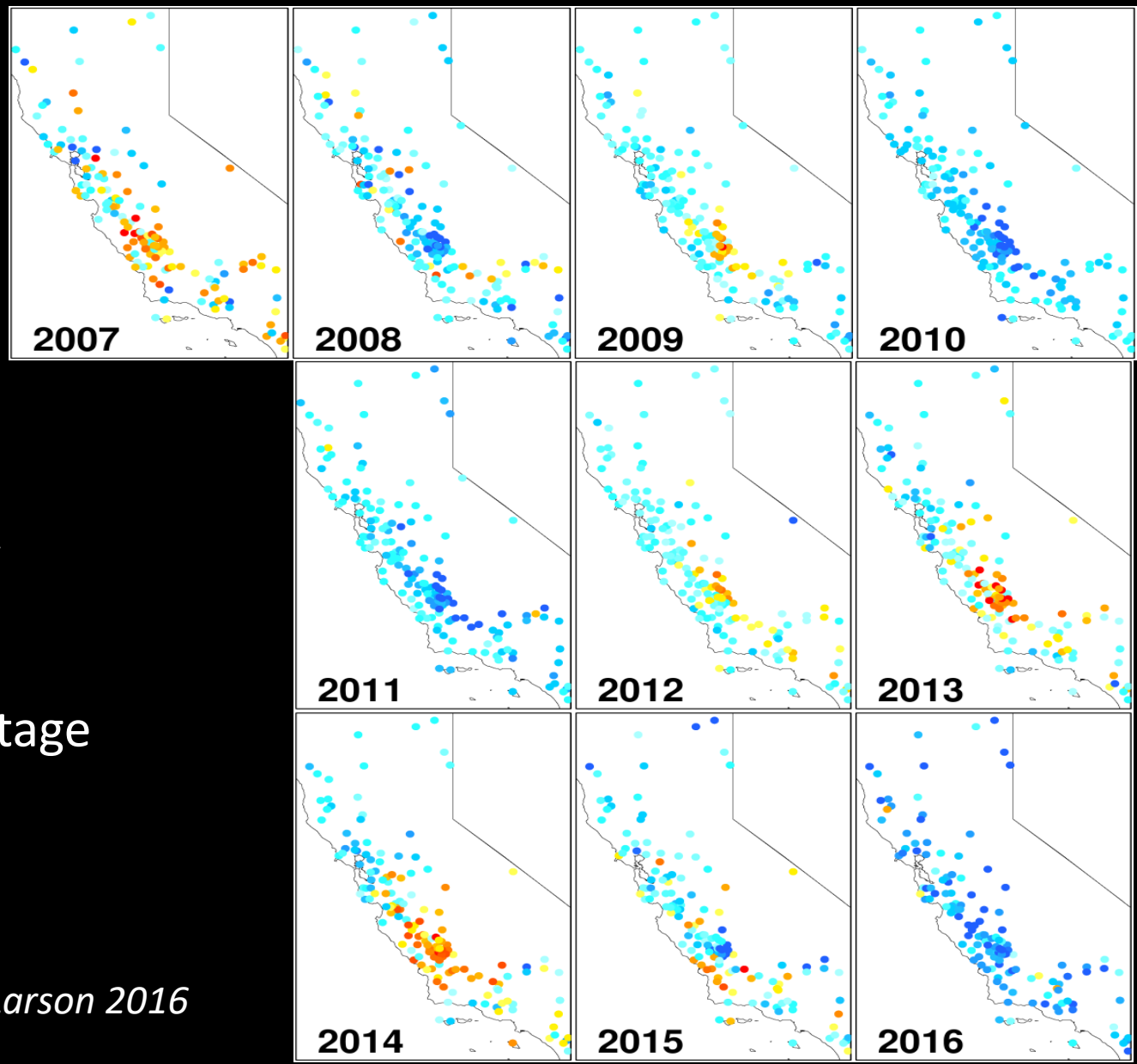


Illustration courtesy K. Larson

GPS-IR vegetation index reveals California droughts (2007, 2012-2015)

Blue is dense vegetation (compared to a multi-year average); red is sparse

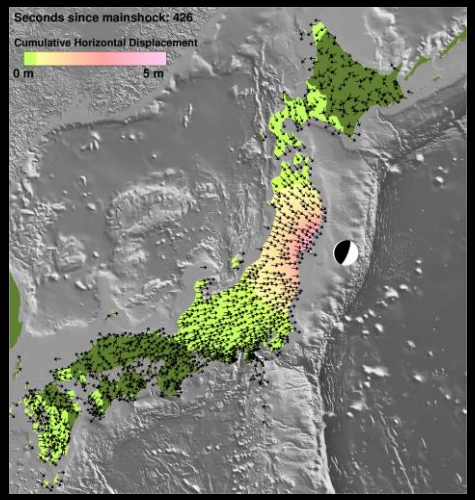




Peak annual GPS-IR vegetation water content (health), reported as percentage of the 2008-2012 average

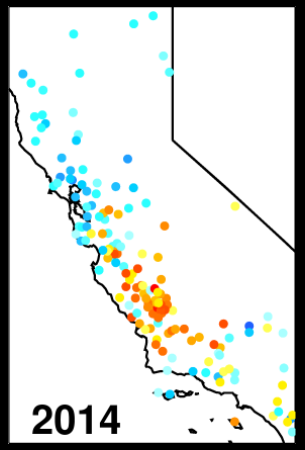
After Larson 2016

(Some) Disaster Mitigation Applications of Terrestrial GNSS



Tectonics

Meteorology



Hydrology