Data weighting, and dealing with earthquakes and other non-linear motions

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Material from R. King, T. Herring, M. Floyd (MIT) and S. McClusky (now ANU)
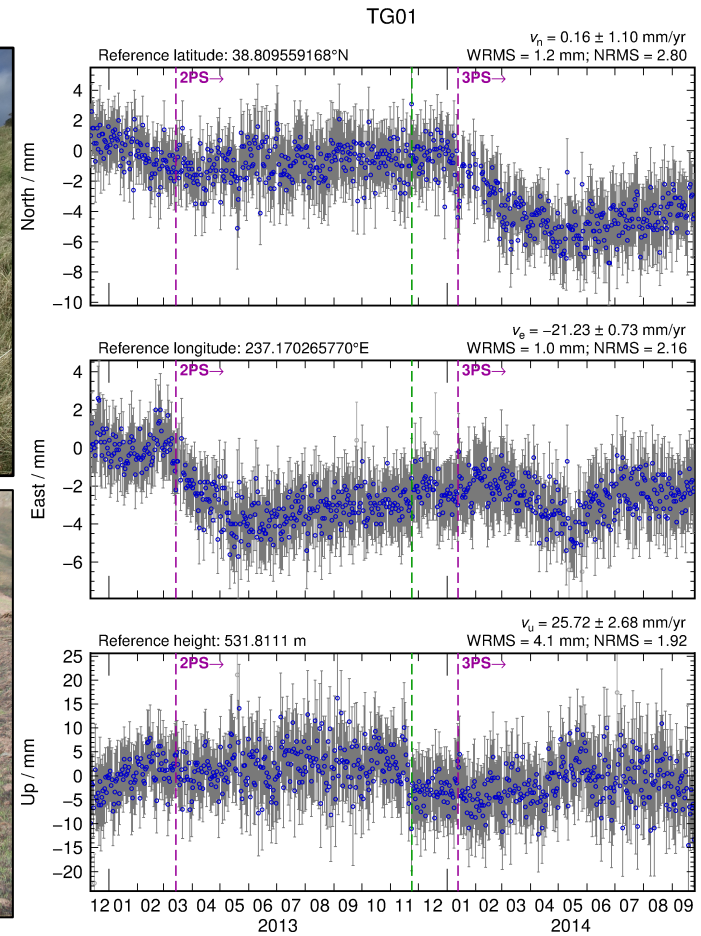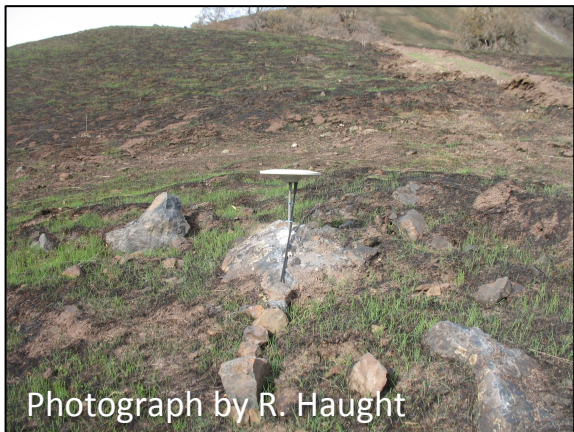
Outline

- Previous lecture showed simple time series models
  - Linear rate
  - Seasonal terms
  - Temporally correlated noise
- Perturbations to such model include
  - Discontinuities due to equipment or environment changes
  - Discontinuities due to earthquakes
  - Non-linear motions due to earthquakes
  - Non-linear motions due to transient events (e.g. volcanic inflation episodes)
- Recommended implementation

Changes to equipment

- Antenna is main concern, although receiver may also affect continuity of calculated position
  - Even antennas of the same model type may not be manufactured within acceptable geodetic tolerance

- stinf_to_rename useful for creating automatic list
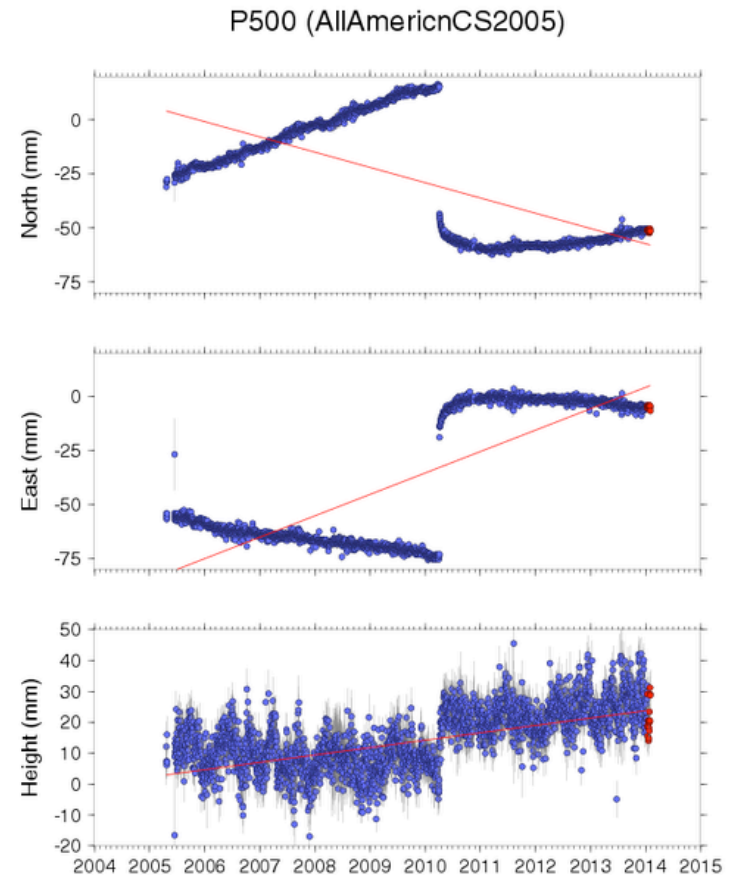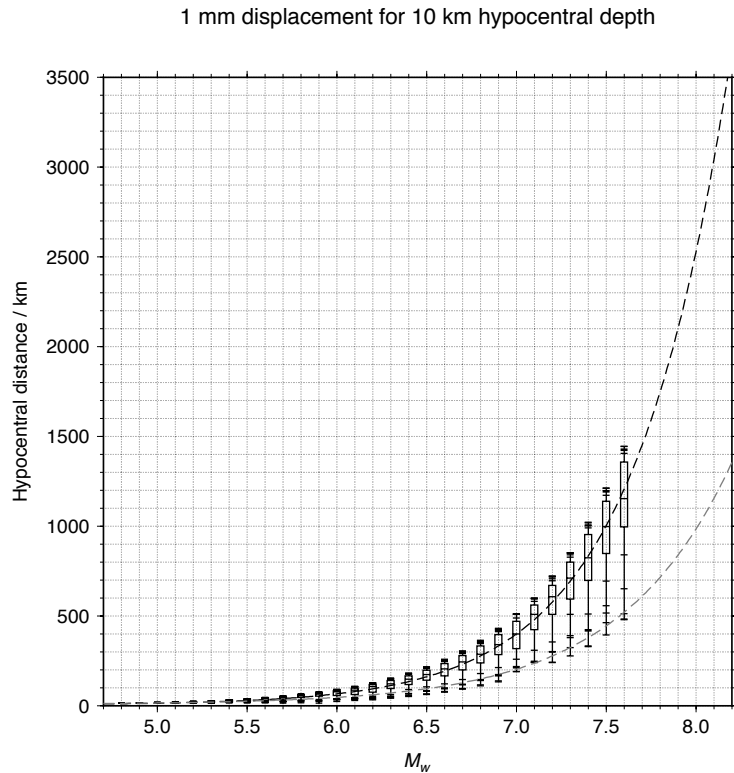
Changes in multipath environment

Photograph by M. Floyd

Photograph by M. Floyd

Photograph by R. Haught

Photograph by R. Haught

Rename scheme

- Rename scheme uses first character of suffix
  - XXXX_GPS → XXXX_2PS → XXXX_3PS → … etc.
- Beyond "9PS", convert to 10th letter of alphabet ("JPS") and beyond
  - … → XXXX_9PS → XXXX_JPS → XXXX_KPS → … etc.
  - But remember "XPS" is a special case for excluding sites from globk runs
- For manual renames (e.g. due to manual inspection rather than known events), use letters in alphabet before "J"
  - XXXX_APS, XXXX_BPS, etc.
  - But remember "GPS" is a special case (the default)

Earthquakes

- Earthquakes occur at known times
- May exhibit more than just discontinuity
- Take care when earthquake occurs in the middle of processing day
  - Some data will fall before and some after ground displacement
  - Time series point on day of earthquake may appear between pre-earthquake and post-earthquake position
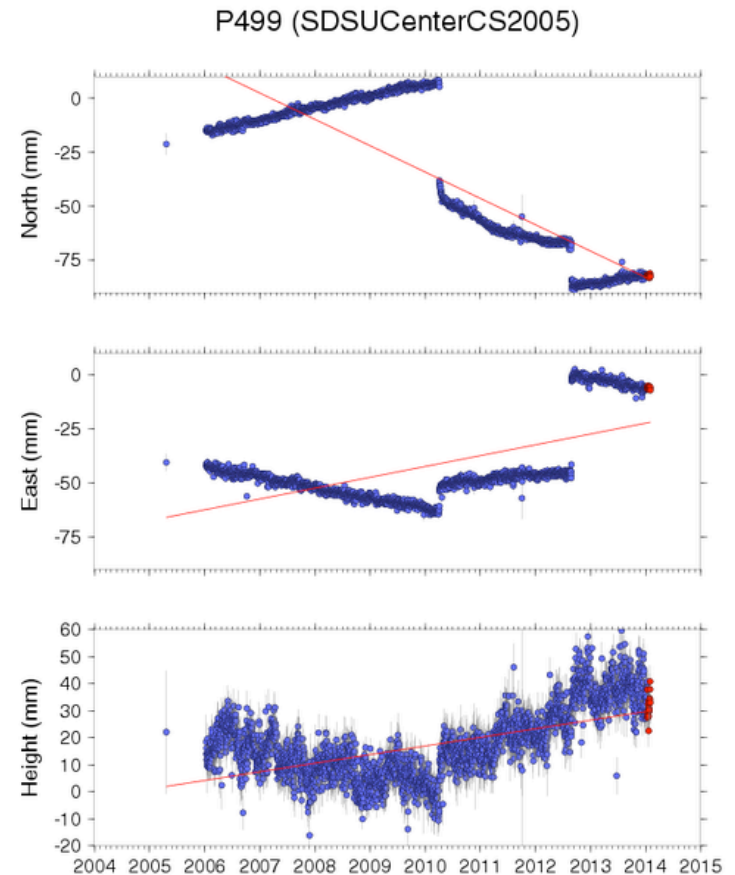

P500 (AllAmericnCS2005)

Radius of influence
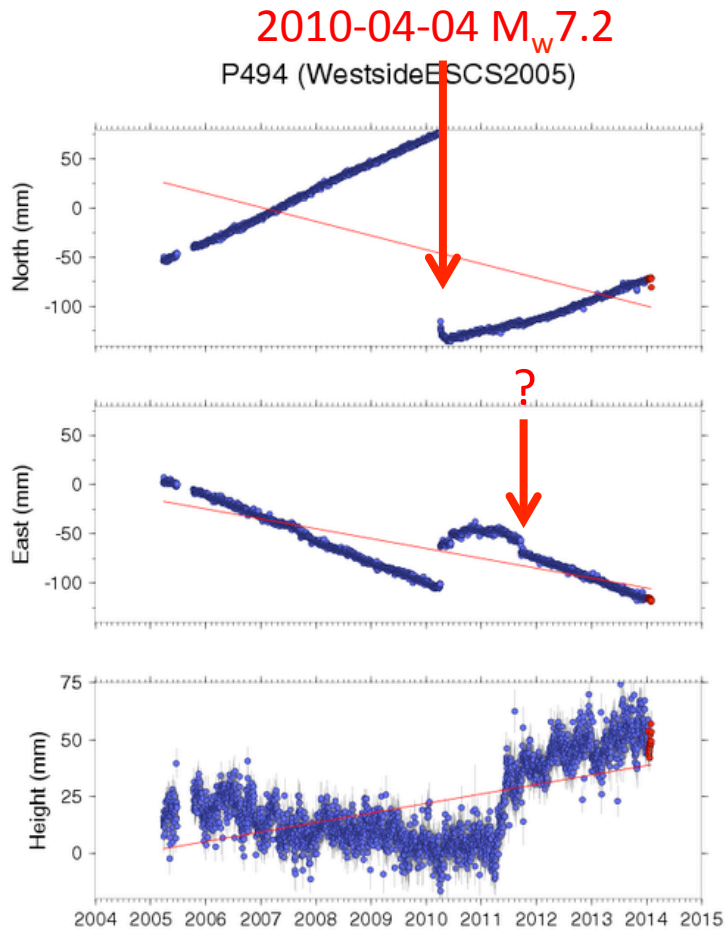
1 mm displacement for 10 km hypocentral depth

- eq_def line in eq-file contains earthquake ID (two characters), location, etc.
  - ID is used to substitute last two characters of 8-character site name, e.g. XXXX_GPS → XXXX_GSN
- sh_makeeqdef will search archives (ANSS ComCat or ISC) to generate eq_def records

Many earthquakes…

- Complications arise in a tectonically active area with multiple events

- Sites may be renamed several times and therefore have various two-character suffixes

- Non-linear motions may be included in apr-file with "EXTENDED" records (see globk help)

P499 (SDSUCenterCS2005)

Undocumented effects

2010-04-04 M$_w$7.2

P494 (WestsideBSCS2005)

- Time series inspection is *very* important to catch undocumented effects

- Insert manually-determined discontinuities using letter for first character of suffix

tsfit

- Time series fitting tool
- Works on ".pos"-files
- As requested, outputs
  - files of residuals to fit (".res"-files)
  - ".vel"-file
  - ".apr"-file
  - Edits ("`rename`"s) file
- Can perform
  - Editing based on maximum sigma (`max_sigma`)
  - Editing based on misfit as a function of sigma (`nsigma`)
  - Estimation of periodic terms
  - Estimation of discontinuities
  - Estimation of post-seismic decays

```
eq_file my_eq_file.eq
periodic 365.2425
periodic 182.62125
max_sigma 0.01 0.01 0.03
nsigma 3
velfile my_vels.vel
out_aprf my_apr.apr
rep_edits my_edits.xcl
resroot my_prefix
```