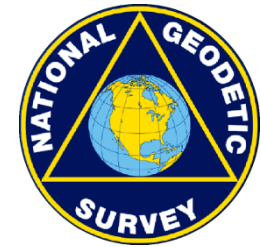


Status of the current multi-year CORS solution--ITRF2008P(NGS)

- why reprocess?
- quality of reprocessed NGS orbits and TRF
- obtaining ITRF2008P(NGS)—P is for “provisional”
- assessment of ITRF2008P(NGS) velocity field
- estimated impact on users of CORS in switch to ITRF2008(NGS)



by
J. Griffiths



with contributions from
**M. Cline, R.L. Dulaney, S. Hilla, W.G. Kass, J. Ray,
J.R. Rohde, G. Sella, T. Soler and R. Snay**

Why Reprocess?

- generate fully consistent orbits, EOPs and global station coordinates using latest models and methods—existing history is inadequate for modern realizations of TRFs
 - absolute antenna calibrations
 - satellite transmitting and ground receiving antennas
 - most significant change
 - new network design—added redundancy
 - Delaunay triangulation over global sites and CORS backbone
 - tie remaining CORS to backbone as stars
 - IERS 2003 Conventions generally implemented
 - updated model for station displacements due to ocean tidal loading
 - updated models for troposphere propagation delays
 - use current frame; first attempt to obtain a full history of products in a fully consistent framework
- contribute NGS reprocessed orbits, EOPs and global SINEX files to International GNSS Service (IGS) repro1 campaign
- generate ITRF2008(NGS) CORS coordinates and velocities in global framework using new orbits, EOPs and global station coords

Contributors to IGS repro1 campaign

- **all IGS Final-product Analysis Centers:**

- COD/AIUB – Switzerland
- EMR/NRCan – Canada
- ESA/ESOC – Germany
- GFZ – Potsdam, Germany
- JPL – USA
- MIT – USA
- NGS/NOAA – USA
- SIO – USA

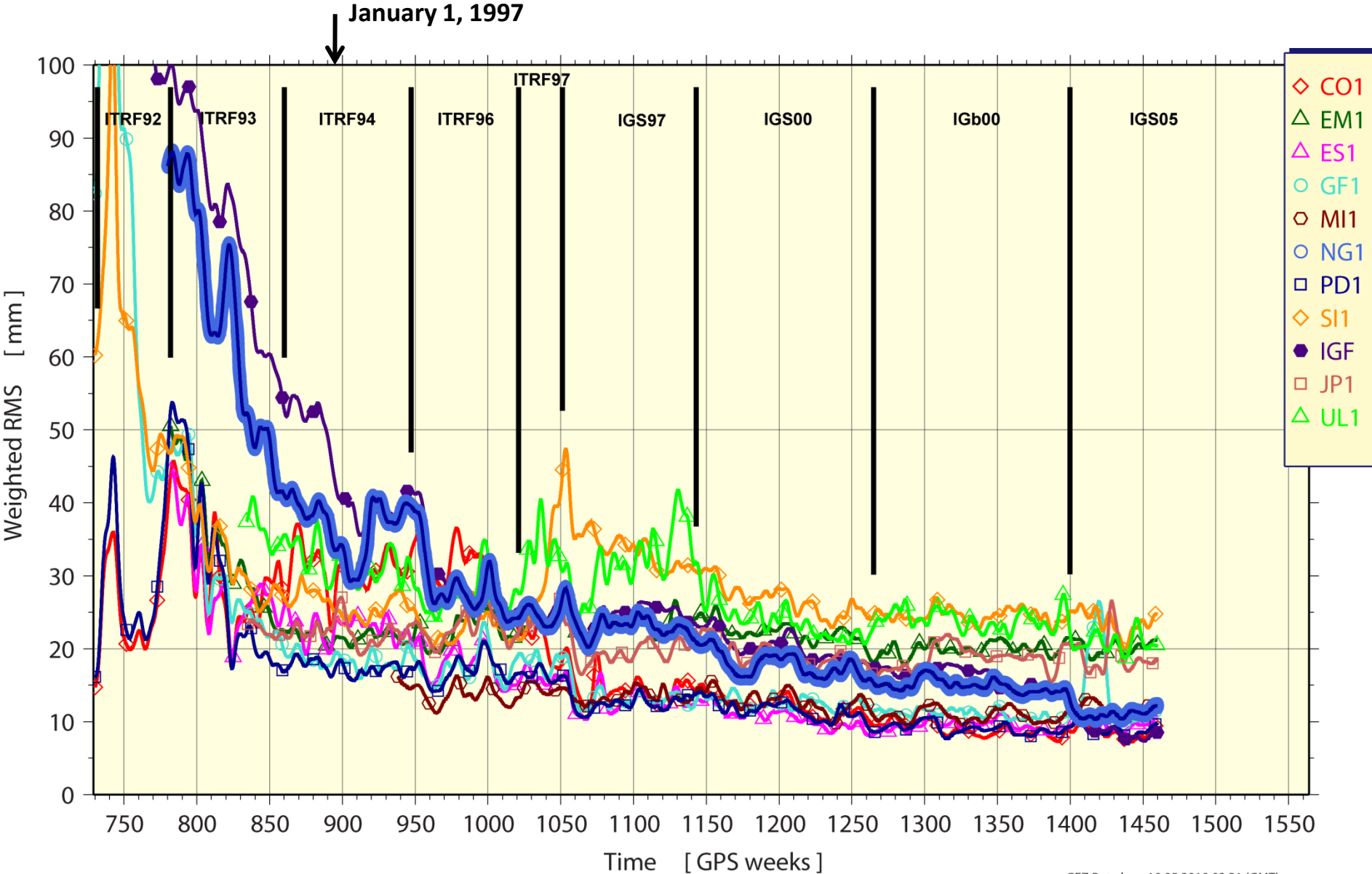
- **plus 2 reprocessing Centers**

- PDR – Potsdam/Dresden Reprocessing, Germany
- ULR – University of La Rochelle TIGA (tide gauges), France

- **plus 1 Center contributing to TRF only:**

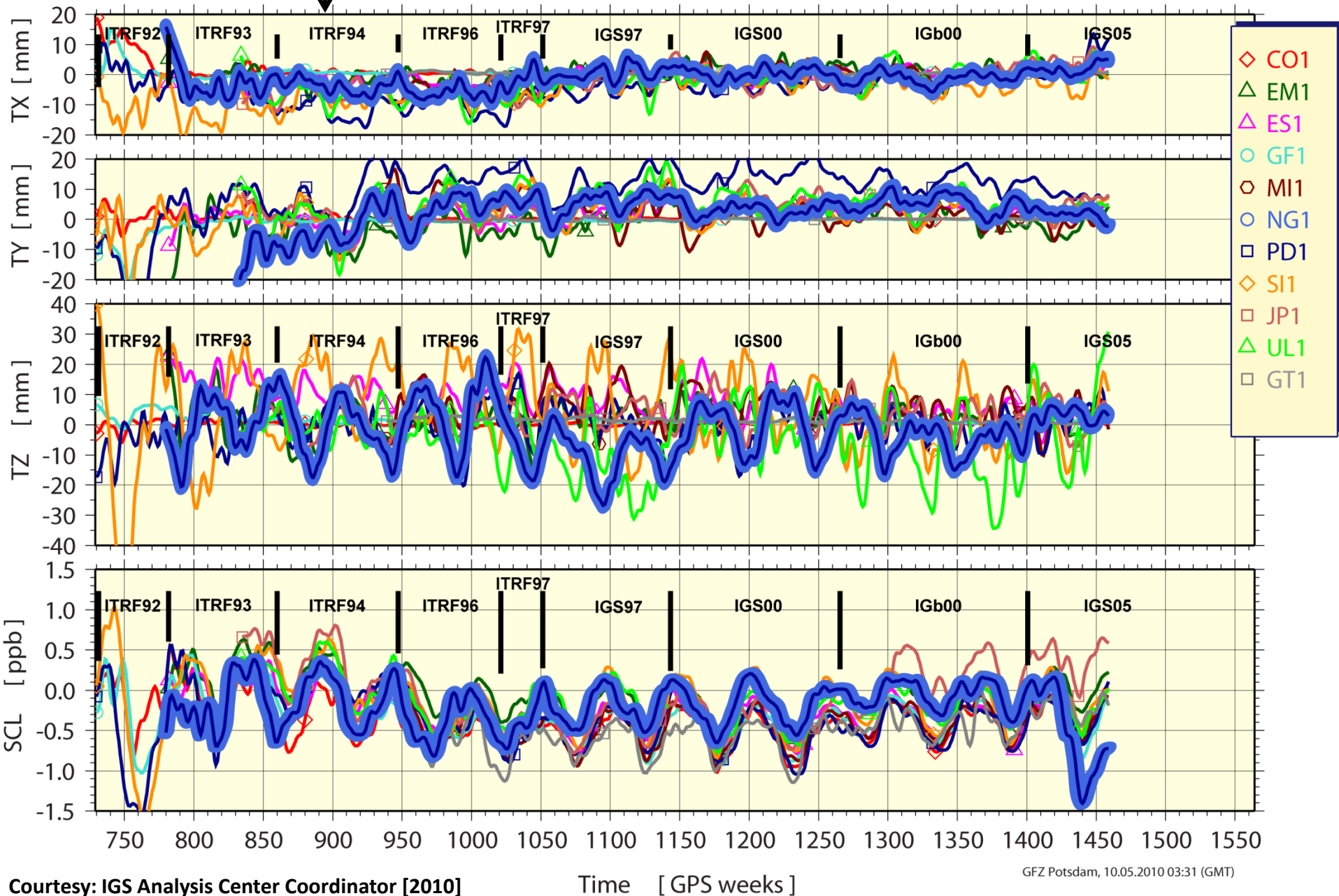
- GFT/GFZ TIGA – Potsdam, Germany

Quality of Orbits: WRMS of AC Orbits (w.r.t. IG1)



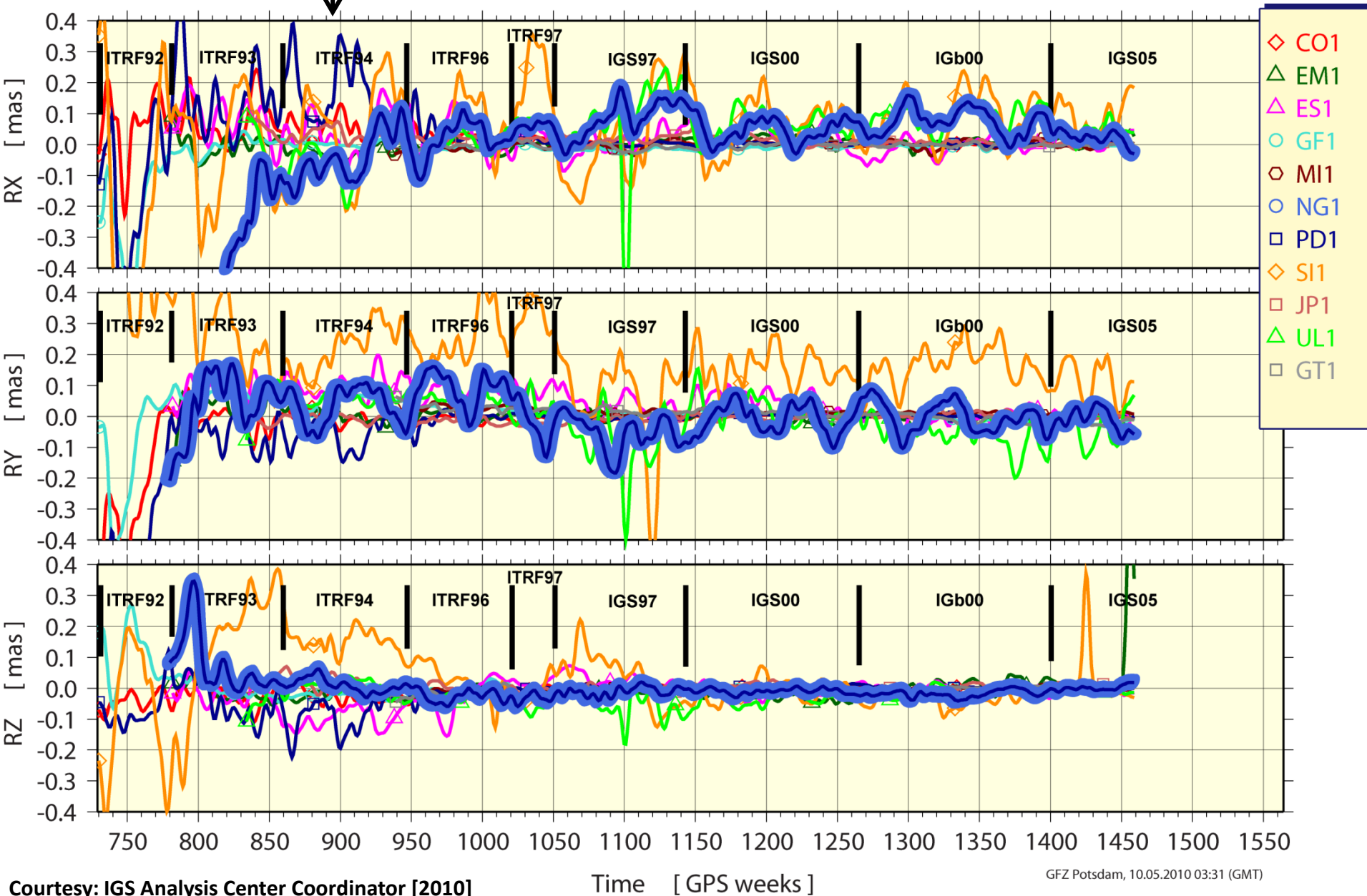
Quality of framework: Geocenter & Scale (w.r.t. IG1)

January 1, 1997



Quality of framework: Orientation (w.r.t. IG1)

January 1, 1997

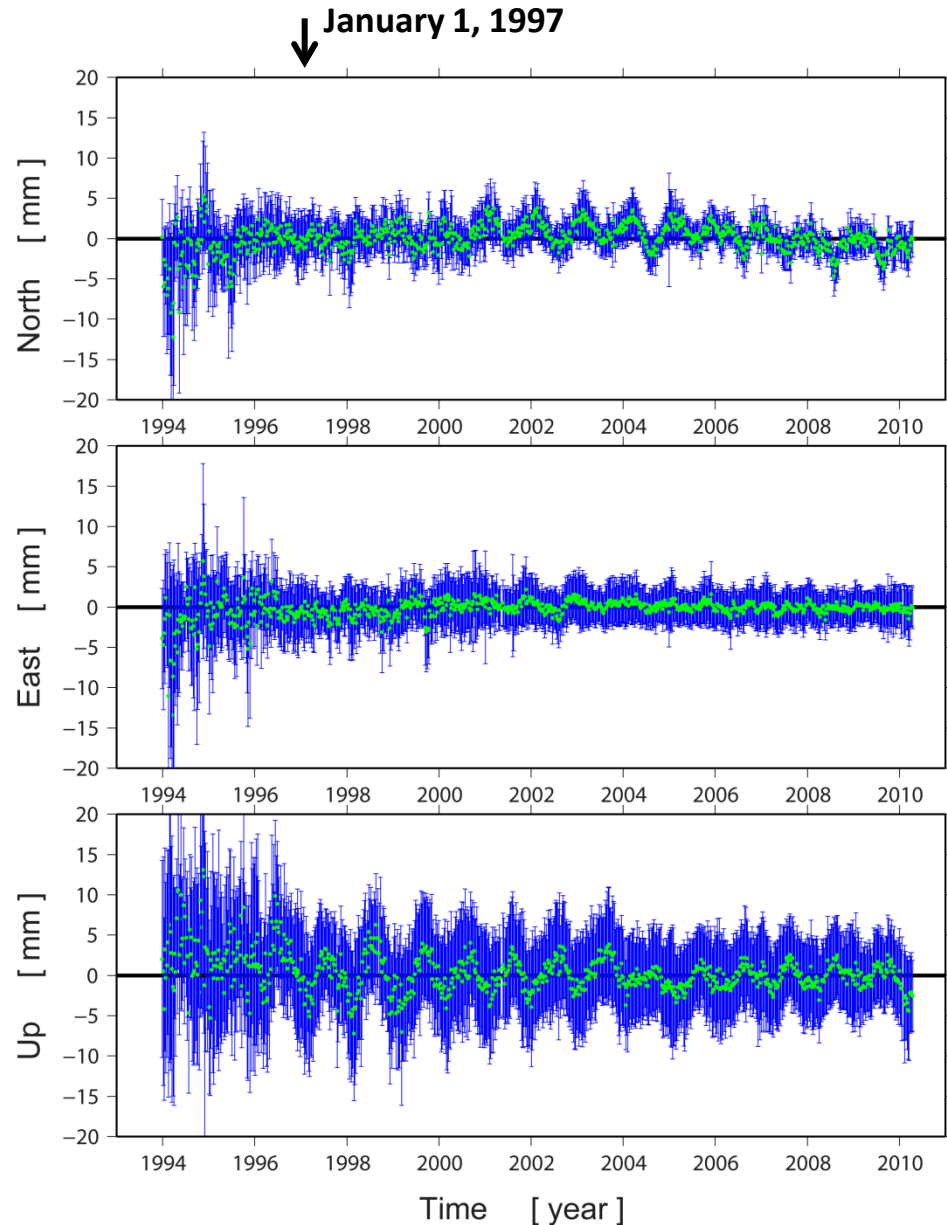
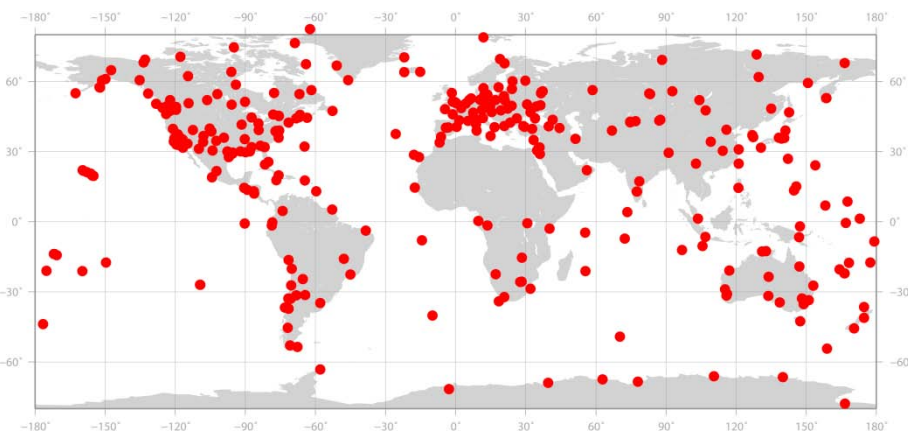


How is ITRF2008P(NGS) obtained?

- CORS RINEX observations processed in global framework using NGS reprocessed orbits, EOPs and global station coordinates
- resulting in full history of weekly SINEX files containing X,Y,Z positions and full variance-covariance information
- use CATREF software from Institut Géographique National (IGN) to stack weekly CORS SINEX files in three steps:
 - step 1: attenuate aliasing effects caused by local non-linear motions
 - sub-network of ~35 sites chosen for their global distribution, long time-series and small/negligible non-linear motions
 - obtain “unscented” weekly Helmert parameters over sub-network
 - weekly scale changes are assumed to be zero
 - step 2: impose “unscented” Helmert parameters on whole network & stack
 - step 3: obtain ITRF2008P(NGS)—i.e., align “unscented” stacked TRF to ITRF2008P via GPS sites common to both SNXs
 - more details of procedure at <http://beta.ngs.noaa.gov/myear/>
- in stacking, undocumented positional discontinuities are detected using SIGSEG [Vitti, 2009] and Change-point Analysis [Taylor, 2000]

Stability of ITRF2008P(NGS)

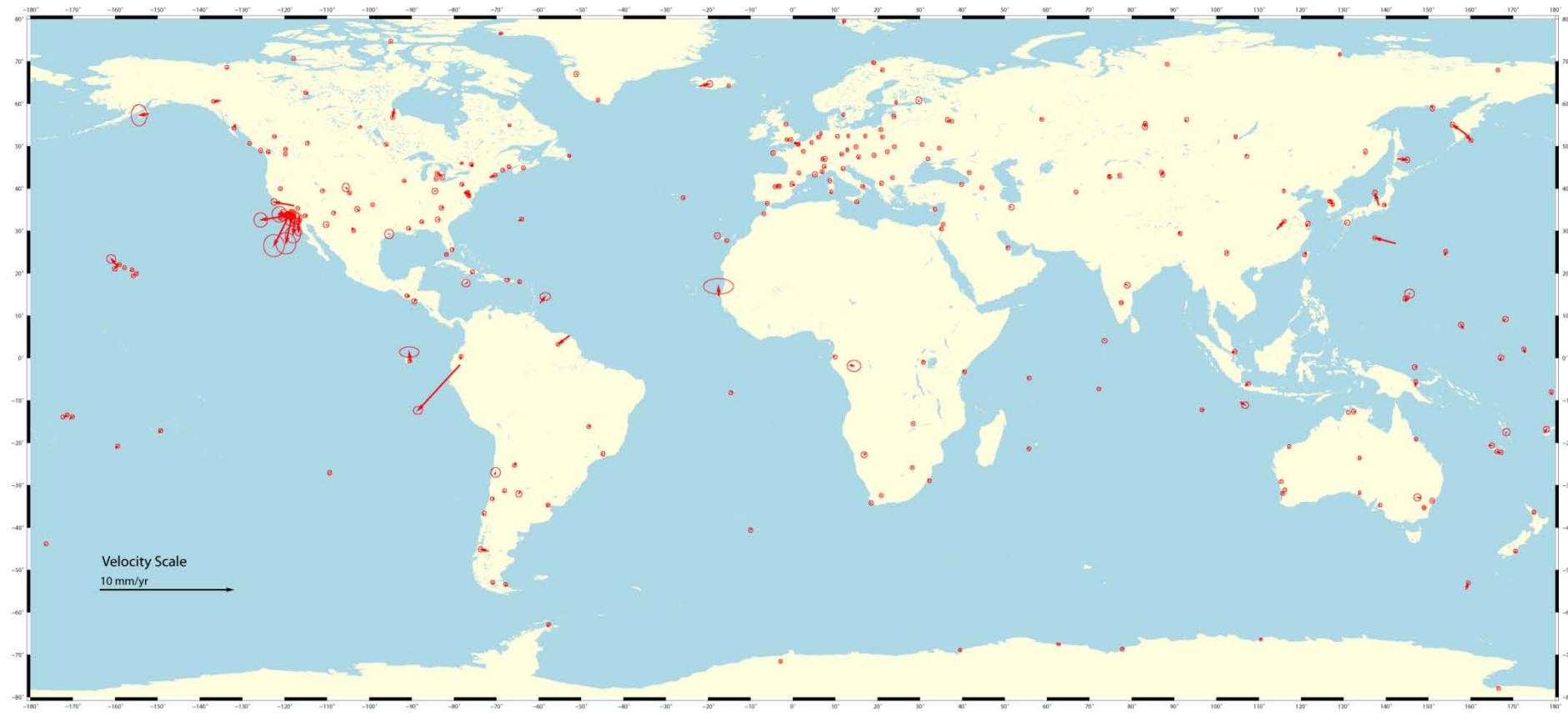
- weighted average of coordinate residuals taken over ITRF2008P sites shown in map below
- amplitude of annual signal:
 - ~3 to 5 mm in vertical
 - <3 mm in N-S
 - ~0 mm in E-W
- early years are noisy, but overall stability quite good



Assessment of Horizontal Velocities:

ITRF2008P - ITRF2008P(NGS)

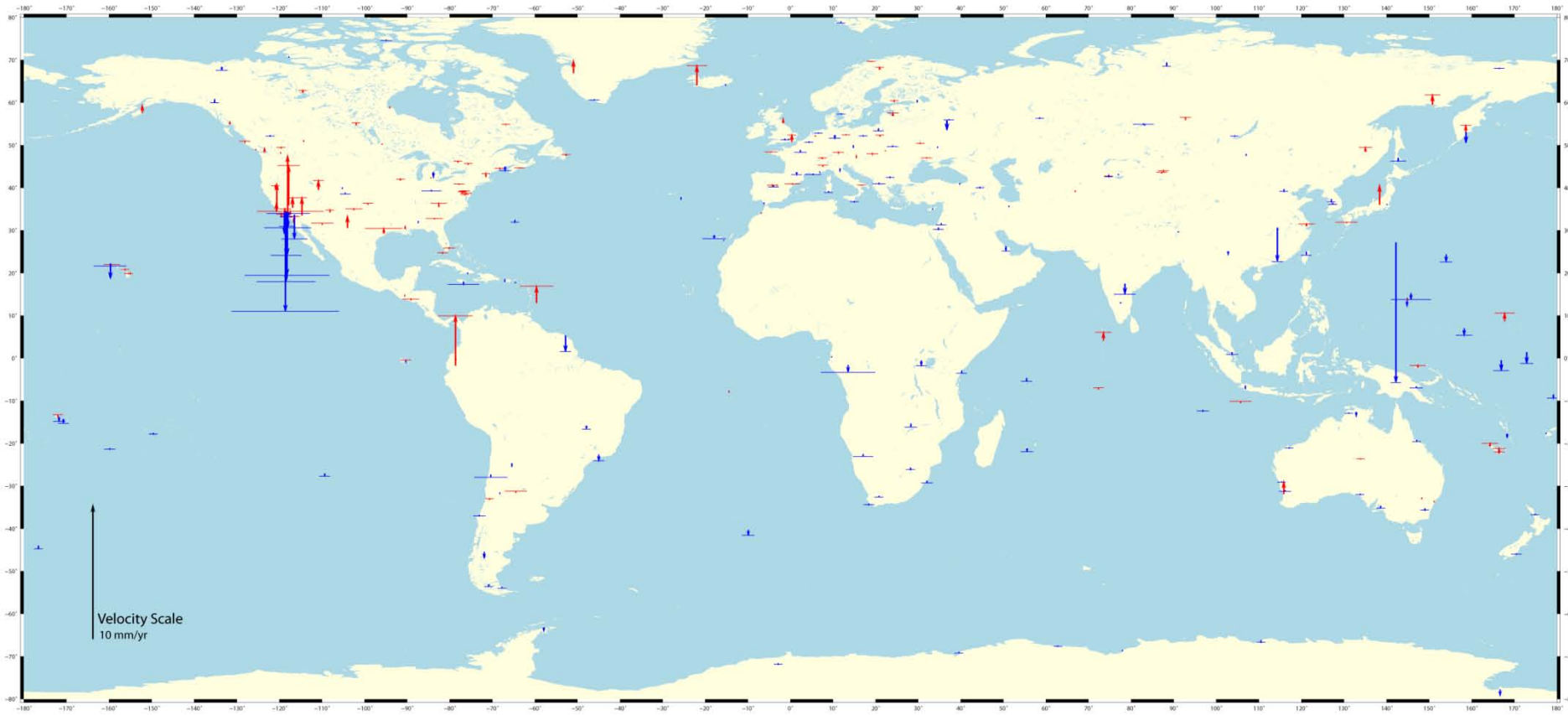
- good agreement between ITRF and CORS solution
- a few sites in western U.S. with large (up to 0.4 cm/yr) horizontal differences



Assessment of Vertical Velocities:

ITRF2008P - ITRF2008P(NGS)

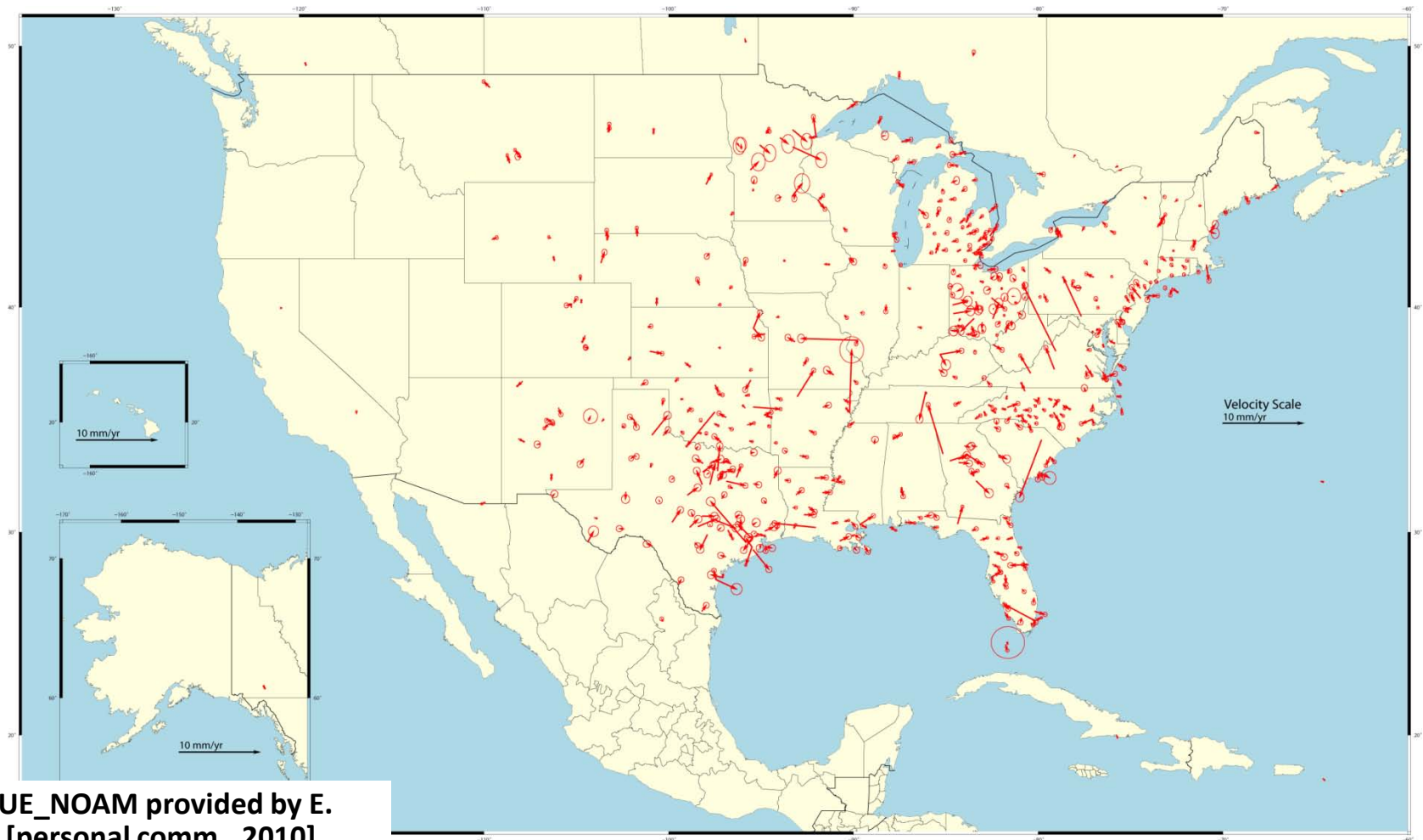
- **good agreement for most sites**
 - sites with large (up to 0.4 cm/yr) horiz. differences also have large vert. differences
- **overall good agreement with ITRF2008P**
 - assess specific cases of large velocity differences
 - consider not using sites with large velocity differences for final alignment



More on Velocities (1/2):

ITRF2008P(NGS) – [PURDUE_NOAM]_{aligned to ITRF2008}

- most differences in horizontal velocities < 5 mm/yr
- few sites have significant velocity differences, presumably caused by applying different sets of discontinuities

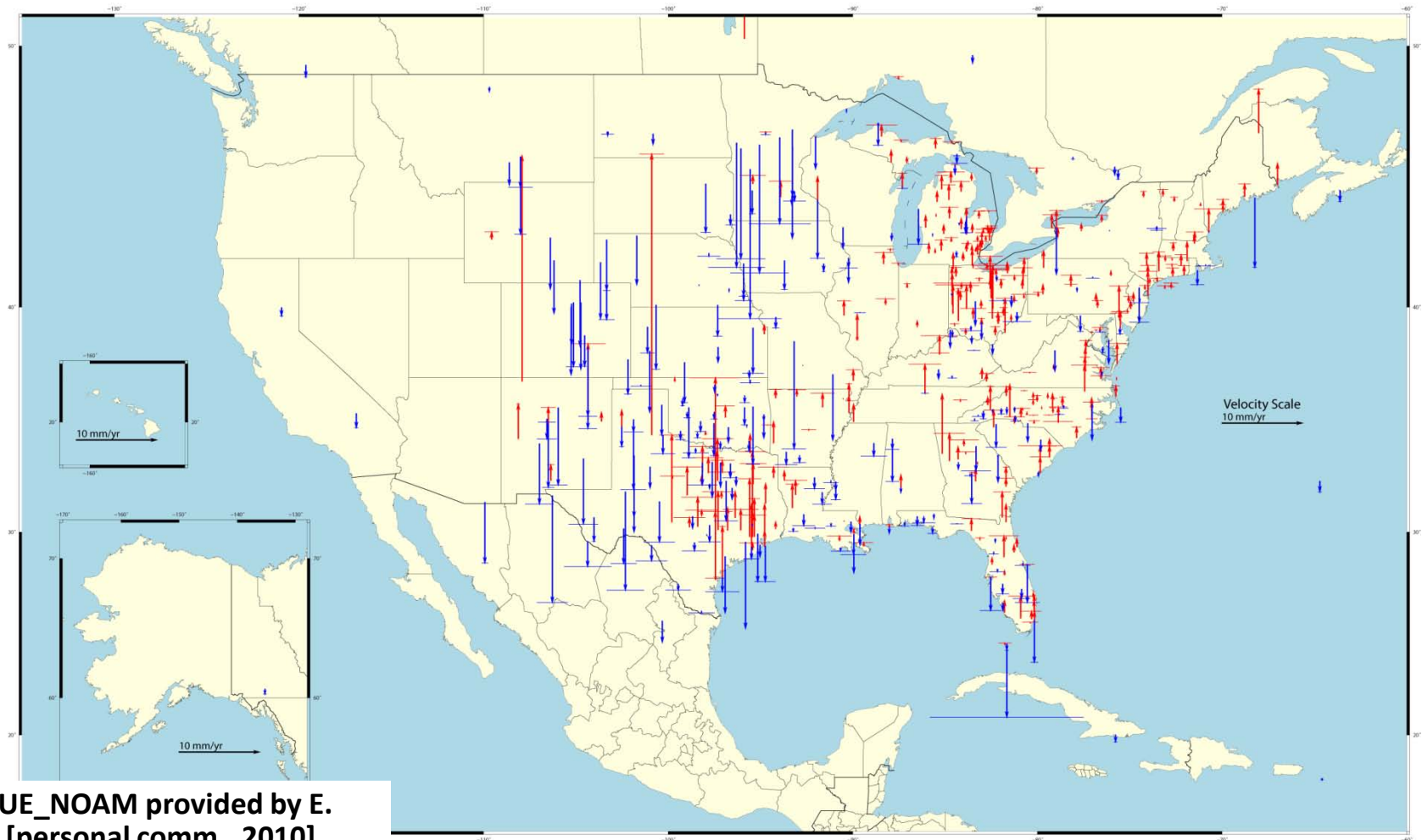


PURDUE_NOAM provided by E. Calais [personal comm., 2010]

More on Velocities (2/2):

ITRF2008P(NGS) – [PURDUE_NOAM]_{aligned to ITRF2008}

- most differences in vertical velocities < 10 mm/yr
- NOTE: a comparison with NRCan solution [M. Craymer] in Great Lakes region shows negligible velocity differences

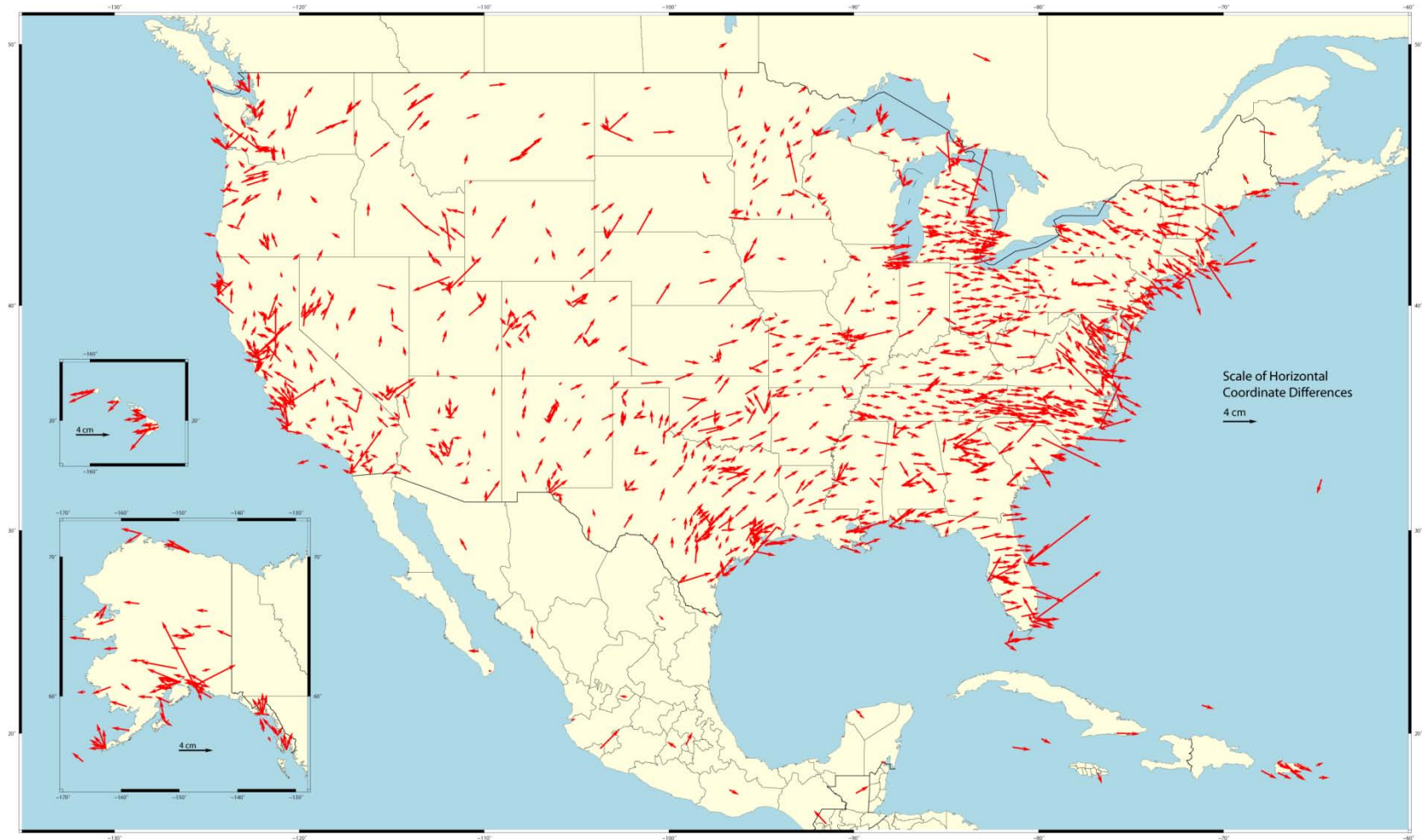


PURDUE_NOAM provided by E. Calais [personal comm., 2010]

Impact on CORS Users: Change in Horizontal Coordinates

ITRF2008P(NGS) – [ITRF2000(NGS)]_{transformed to ITRF2008P @ 2010.00}

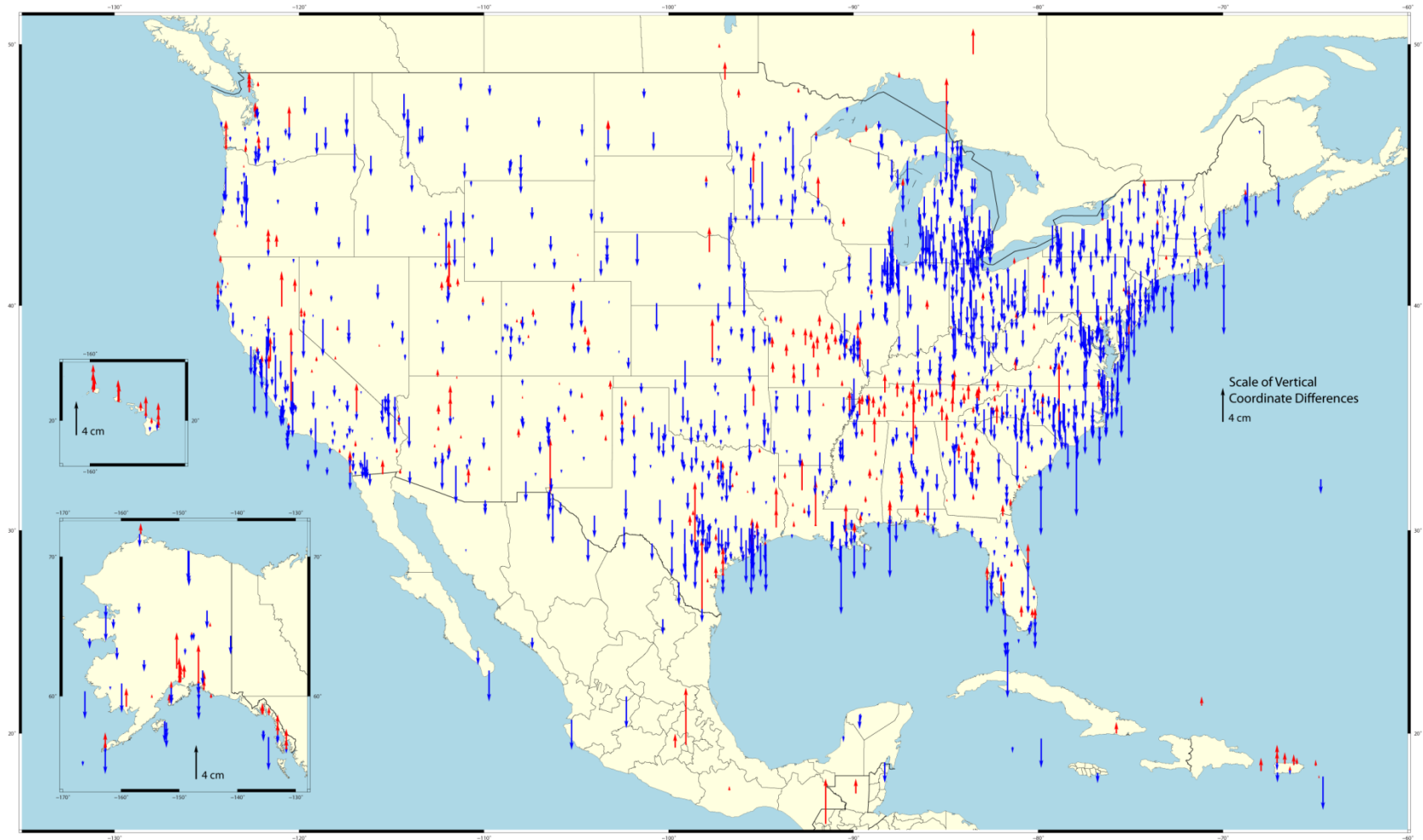
- **average horizontal coordinate differences = 1.0 cm (± 1.5 cm)**
 - sigmas in NGS submission to ITRF2000 indicates ~ 4 cm error @ 2010.00
 - probably mostly caused by prescribing velocities using HTDP and NUVEL-1A
 - random part should be caused by to change to absolute antenna calibrations



Impact on CORS Users: Change in Vertical Coordinates

$\text{ITRF2008P(NGS)} - [\text{ITRF2000(NGS)}]_{\text{transformed to ITRF2008P @ 2010.00}}$

- **average vertical coordinate differences = -1.1 cm (± 2.6 cm)**
 - mostly caused by assuming $V_u = 0$ in ITRF2000(NGS)
 - again, a random part caused by switch to absolute antenna calibrations



Conclusions

- 1st reprocessing of global and CORS GPS data collected since 1994 is complete
- Overall good agreement with sites common to ITRF2008P
 - for final version, need to address cases where velocity differences are large
 - review discontinuity list
 - perhaps use a subset of sites for alignment—e.g., do not use sites with large (~1 cm) velocity differences for alignment
- Good agreement with sites common to PURDUE_NOAM.SNX and with NRCan in Great Lakes region
- Average coordinate offsets of ~ 1 cm will be experienced by most users when evaluating observations at 2010.00
- Users must prepare for change from relative to absolute antenna calibrations, which causes site-specific position changes up to a few cm
- ITRF2008(NGS) expected to be complete by mid 2010
 - target date for implementing solution into NGS operations (e.g., OPUS) is late 2010 / early 2011