IGS Activities for Improving its Contribution to ITRF

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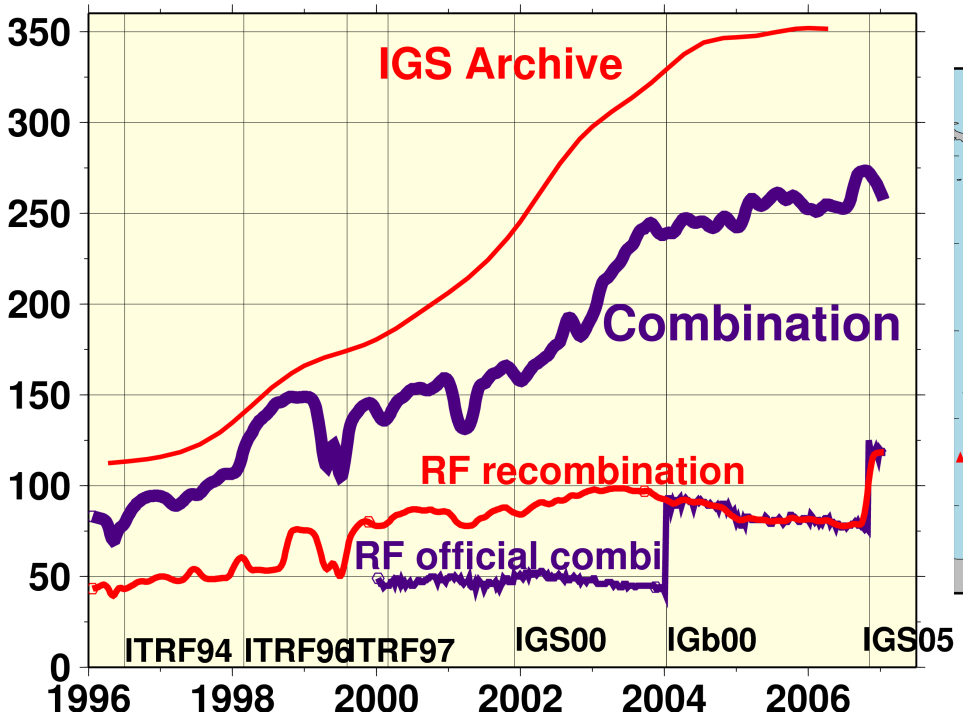
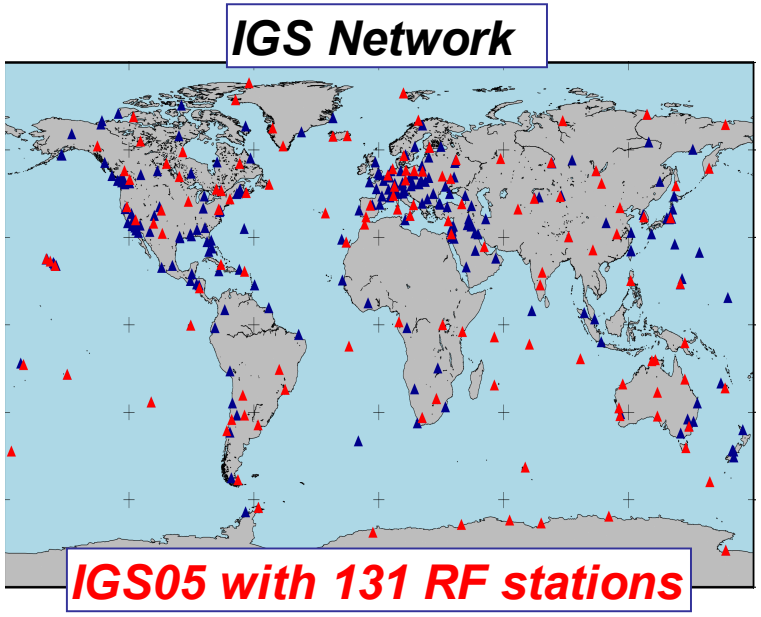
Contents

- History of IGS products
- Present status
- Aspects of the planned IGS reprocessing

IGS contribution to ITRF2005

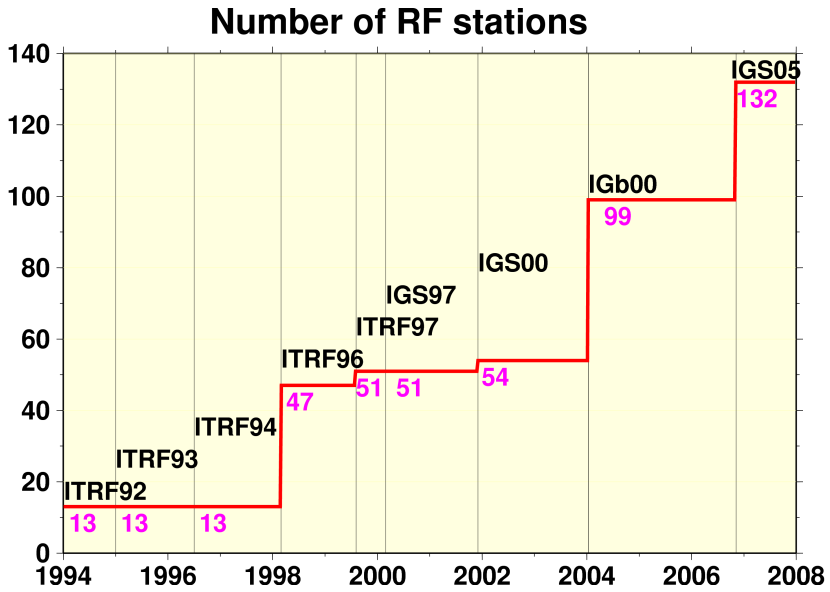
- *Products*
  - SINEX files since 1996/021 (week 838)
    - ERPs included since 1999/157 (week 1013)
  - [Clock files (for PPP) since 2000/310 (week 1087)]
- *Number of stations in IGS Combination*



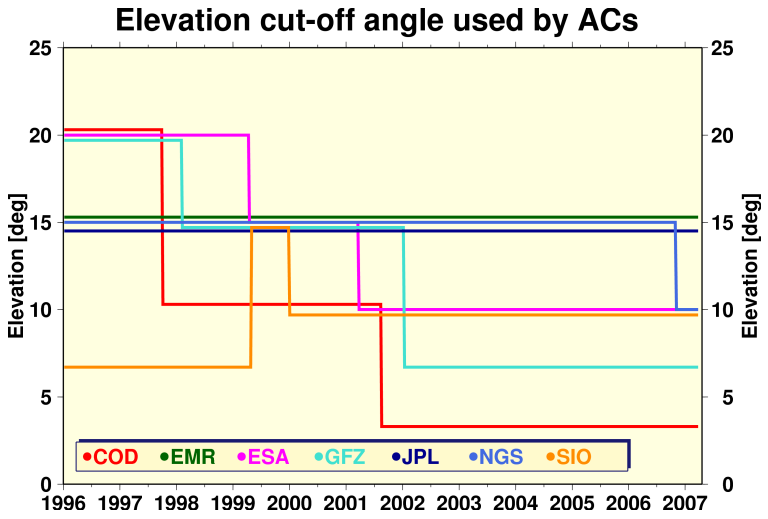


History of IGS Products

Reference Frames



Changes at ACs: e.g.

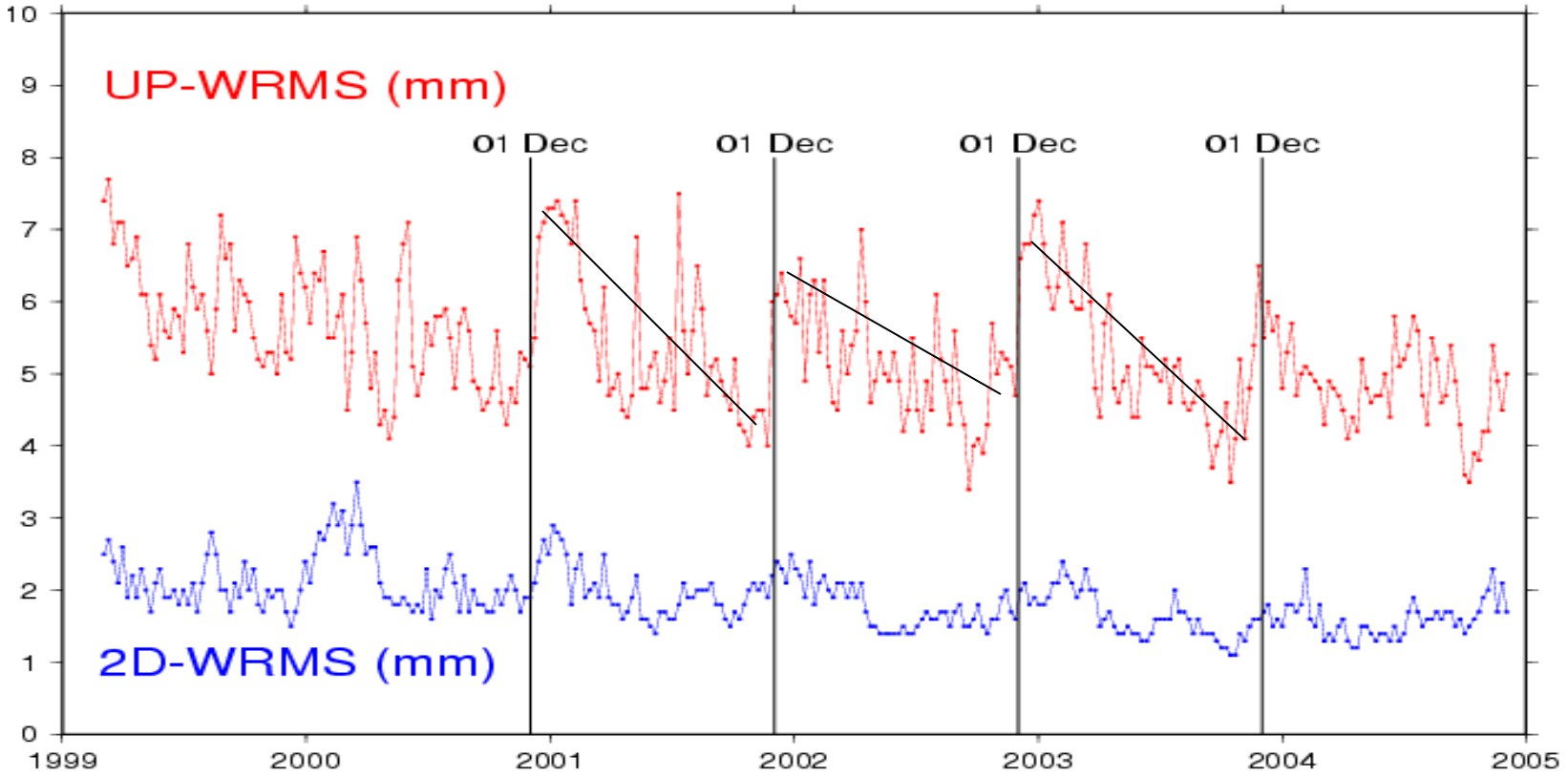


- Trop mapping & initials
- Ocean loading models
- Arc length
- …

Periodicities in IGS time series

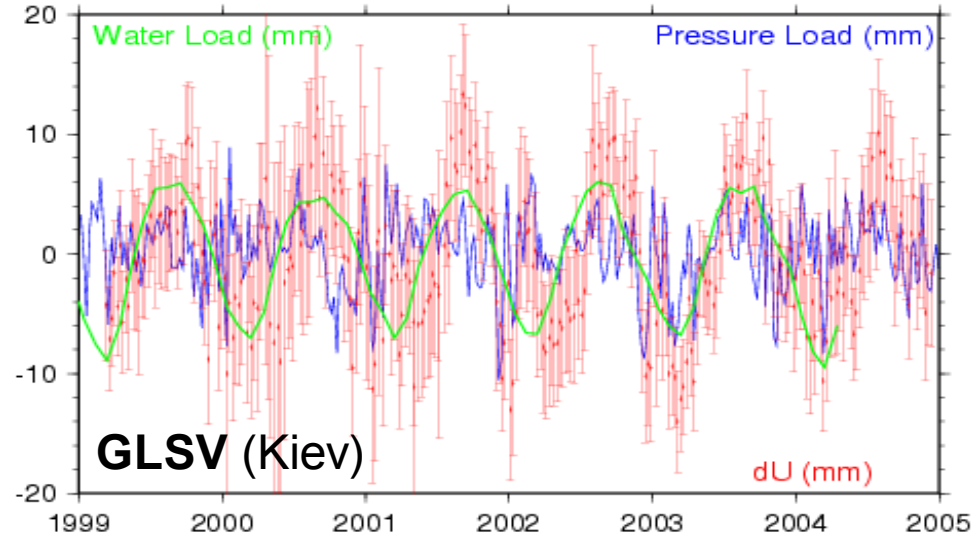
Periodicities in IGS time series (1/2)

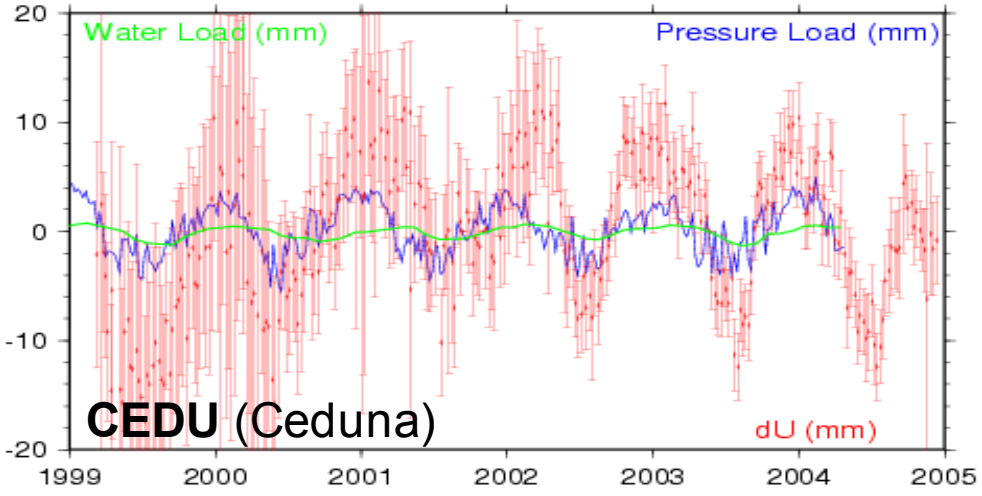
- IGS weekly versus long-term frame



Periodicities in IGS time series (2/2)

- *Seasonal effects*





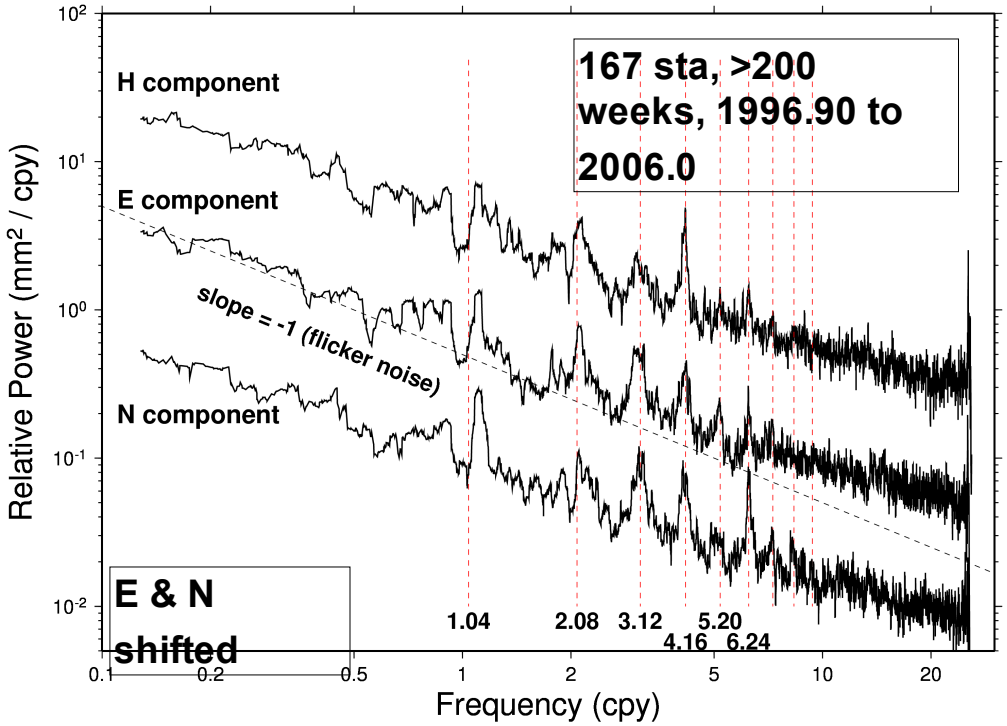
- Environmental problems:
  - Antenna snow accumulation
  - Vegetation
  - …
- Geophysical Signals
  - Atm Pressure loading
  - Water load

Effects can be applied also “afterwards”
(even if not optimal)

(No atm loading models exist that handle dynamic inverted barometer effects for periods less that a few weeks)

Anomalous Harmonics in Spectra of GPS Position Estimates

- ***Stacked periodograms*** **of non-linear position residuals**



(Ray et al. Submitted to GPS Solutions)

Annual & semiannual removed
Harmonics of 1.04 cpy (351d)

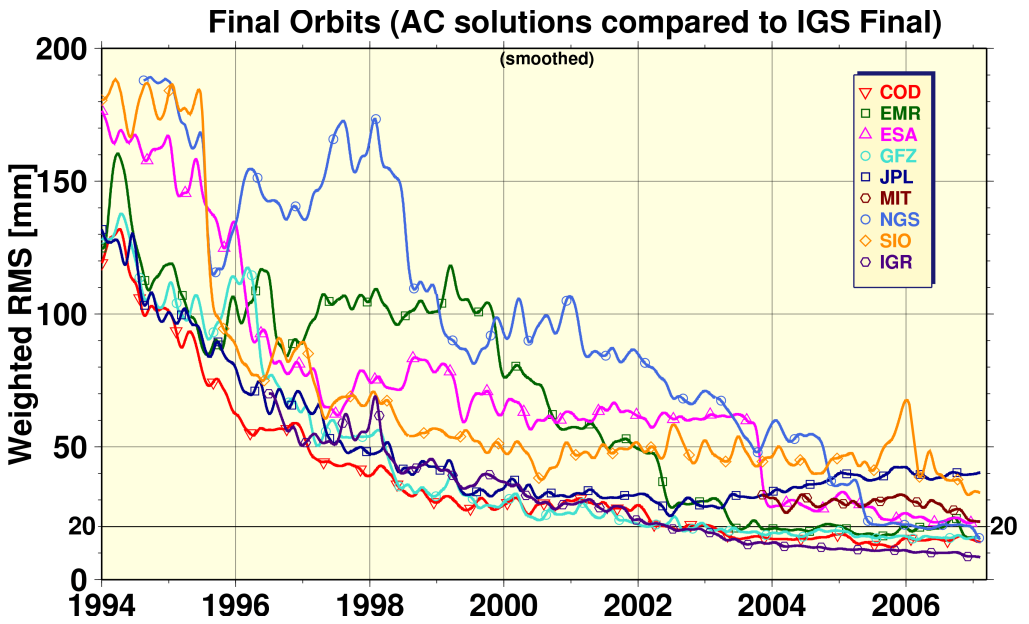
- No confirmation of those anomalous harmonics in corresponding results from VLBI, SLR or loading models.
- Orbital plane relative to sun: period of 351.4 d (Draconic year)
  (Ref. U. Hugentobler: Effects on geocenter estimates have same period)

Expected Improvements by IGS Reprocessing

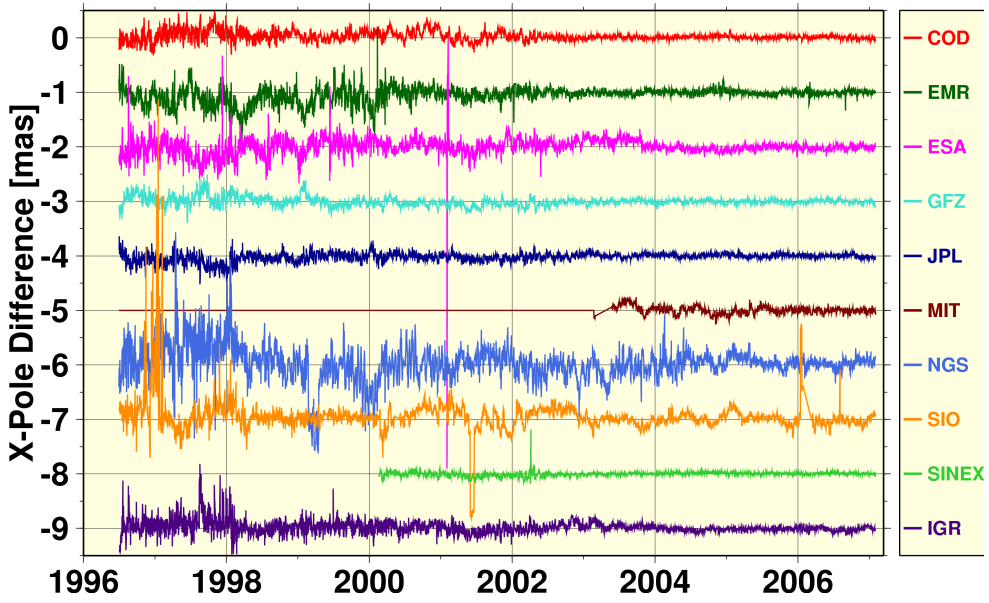
Quality of orbits and ERP

- **IGS Final Orbits**

  Significant improvements by many ACs during last 3 years

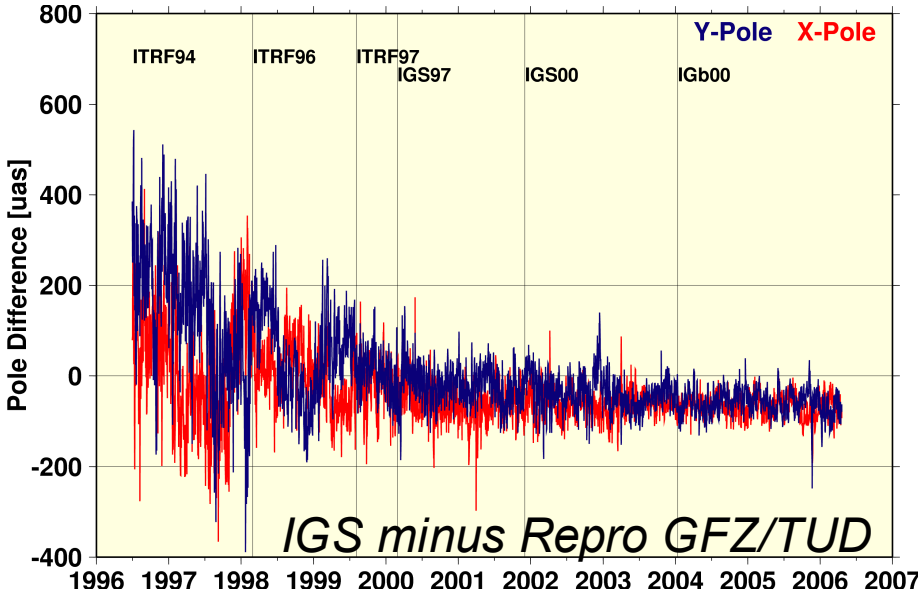


- **IGS Final ERP**



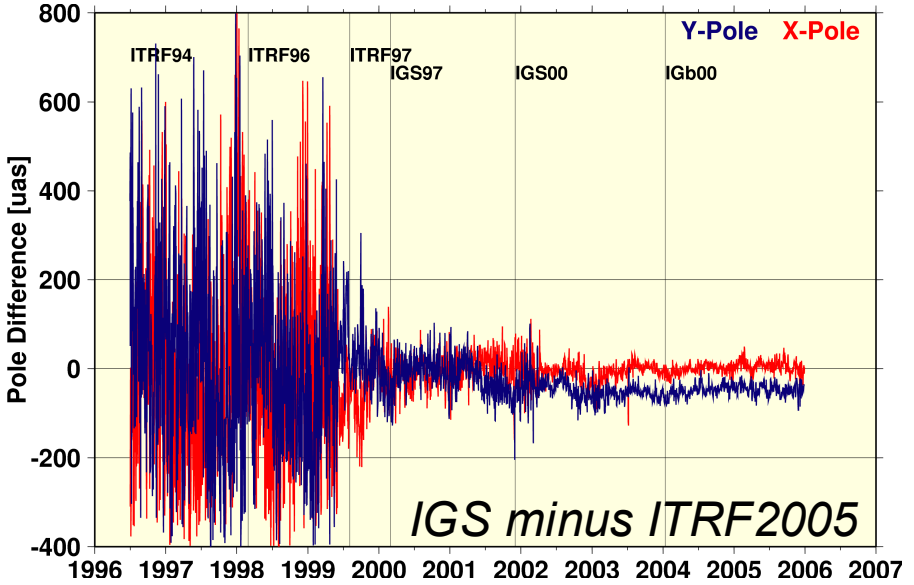
Prolongation of ERP series

- *Reprocessing GFZ/TUD*

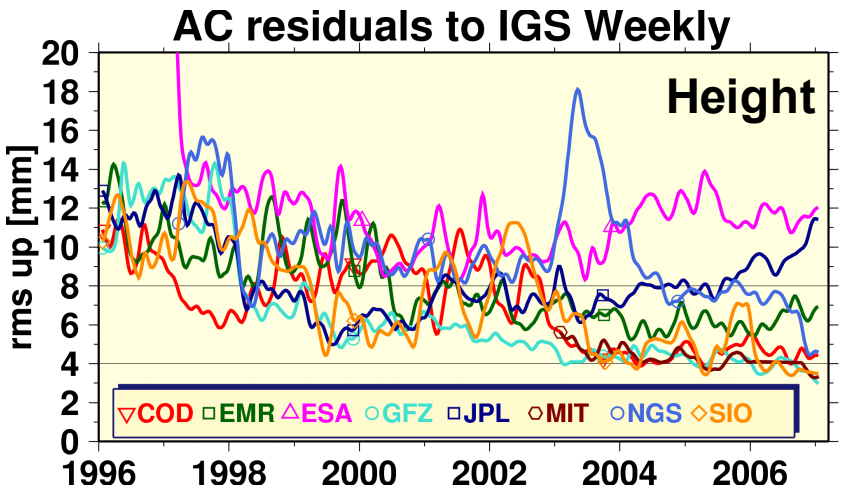


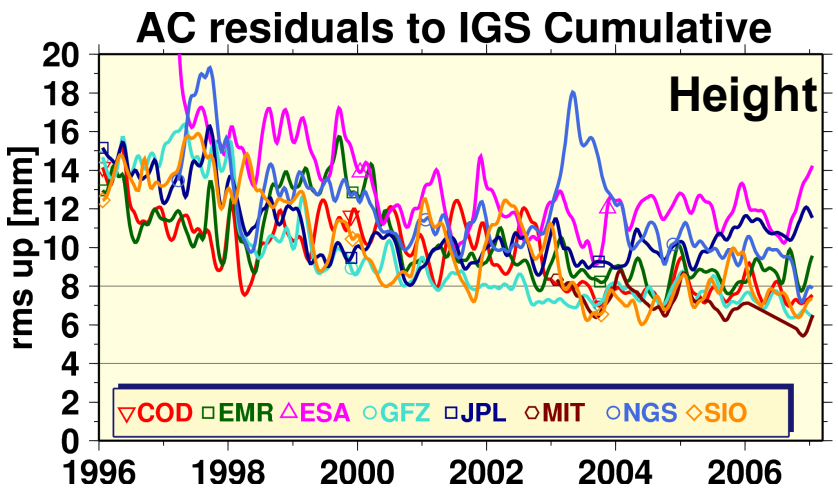
- *IGS contribution to ITRF2005*

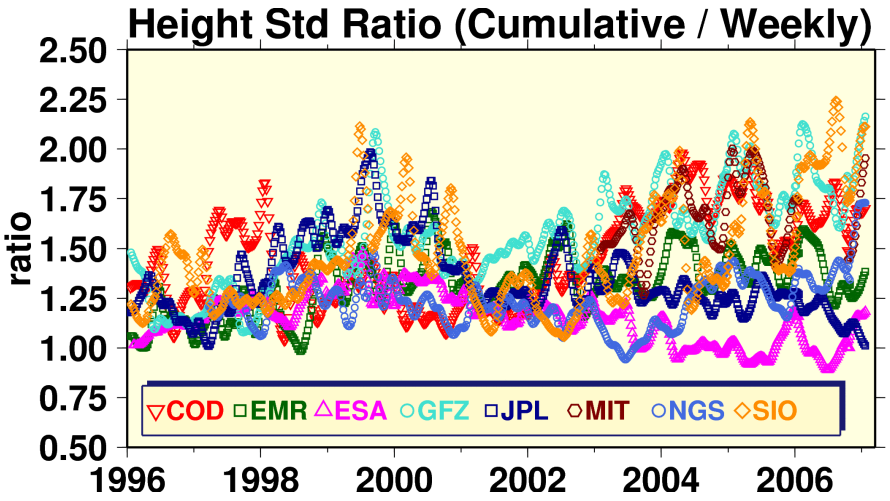
(from 1999/06/06)



Quality of station coordinates





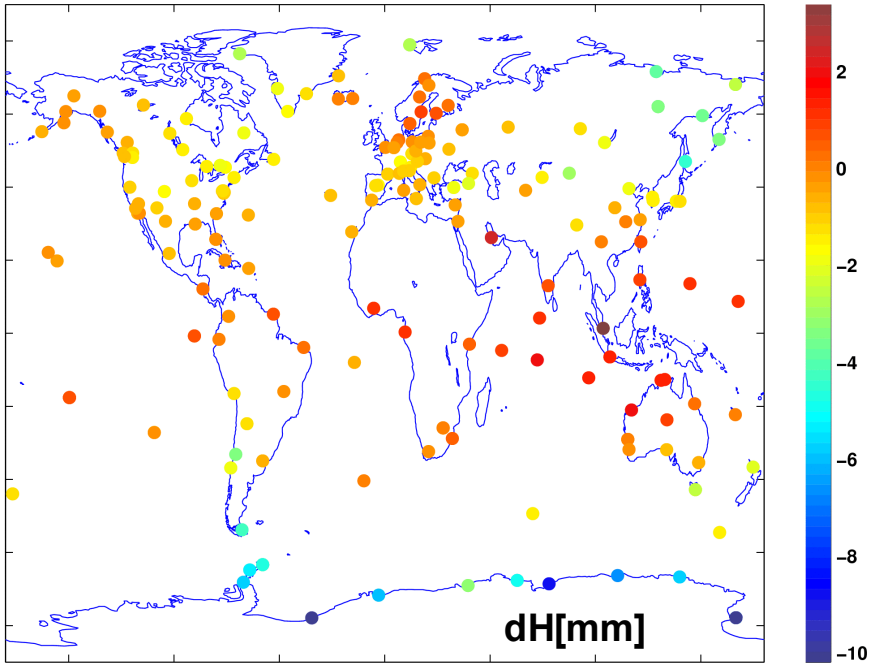


- Ratio is increasing slowly with time.
- Likely caused by improved weekly AC consistency
- Non-random, non-linear effects may account for ~40% of the medium to long term variations

Improvements in modeling (1/2)

- *Ocean loading model FES2004 is applied by all ACs*
- *New troposphere mapping functions*
  - *Reduction of height biases*

NMF ⟷ VMF1



- GFZ/TUD Reprocessing 1994-2005
- Constant a priori Pressure&Temperature

  - ***Reduction of seasonal variations***

NMF ⟷ GMF

Peak to peak variation of up to 10 mm between both models

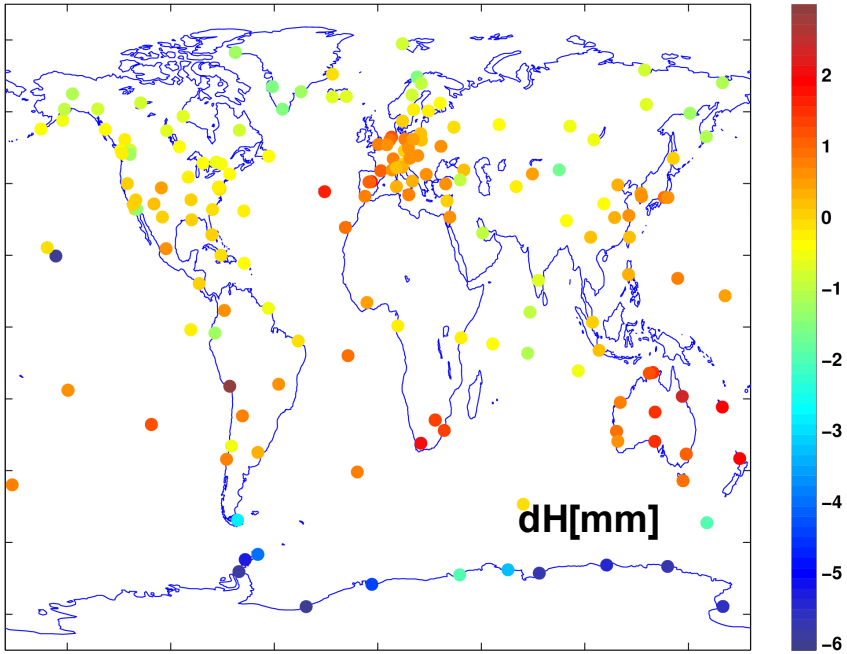
GMF is used by IGS (Global Mapping Funct.)
(J. Böhm, et al., GRL, 2006)

Improvements in modeling (2/2)

Better Troposphere initials - Pressure & Temperature

- Reduction of height biases

  Const. a priories ⟷ ECMWF data



GFZ/TUD Repro 94-05
- both with VMF1
- gridded ECMWF [J Böhm]

- *Reduction of seasonal variations & daily fluctuations*

Effects of few mm

if not precise pressure is used

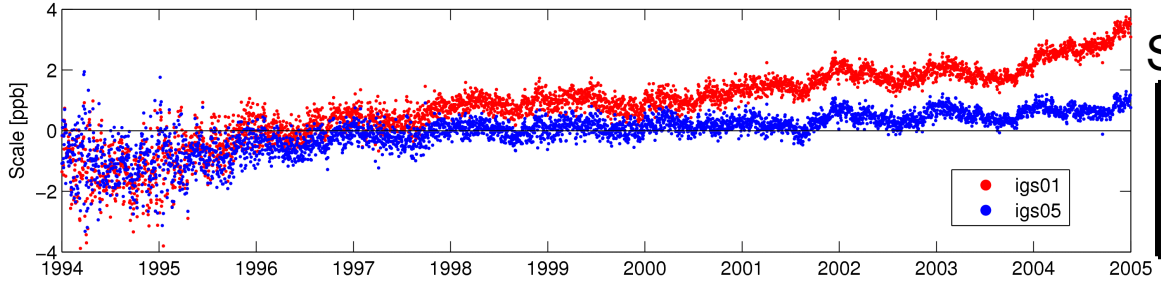
(Tregoning & Herring, 2006)

GPT is used by IGS
(Global Press&Temp)
(J.Böhm et al. JoG 2007)

New Absolute Antenna Model

- *Reduction of trop bias to VLBI*
- *Reduction of bias in scale rate and scale*

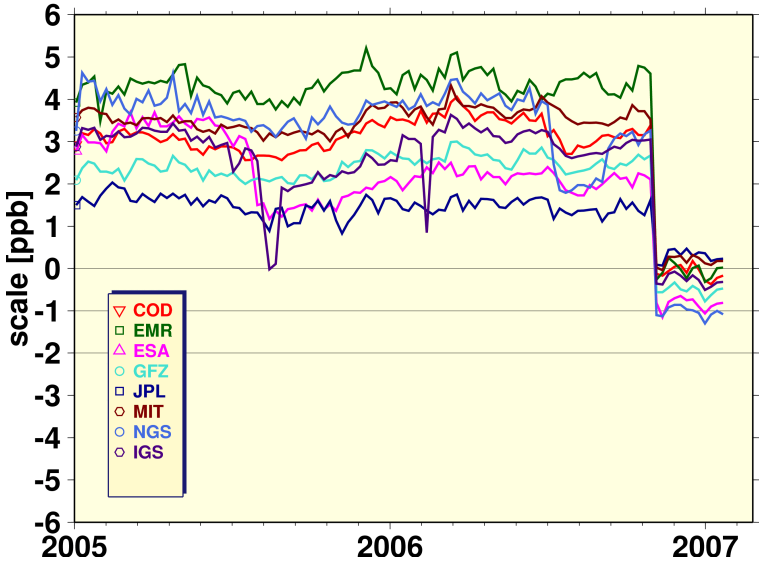
- *Scale rate caused bv inconsistent satellite ant-offsets*



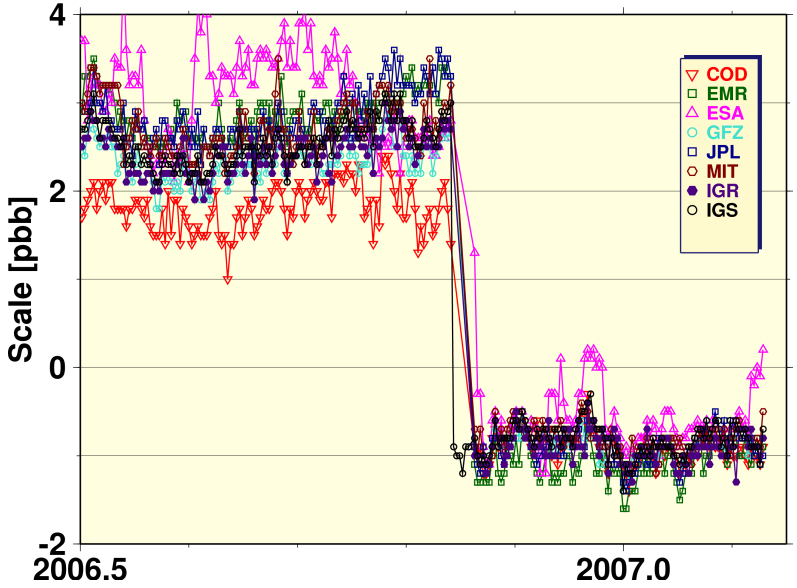
Scale rate (ppb/y) to RF:

	IGb00	IGS05
Ant rela	0.35	0.24
Ant abs	0.15	0.04

- *SINEX combination*



- *PPP solutions*



Analysis & Combination Centers

- *Reprocessing ACs and Product combination*
  - Independent Software

AC	Software	Comment
EMR	Gipsy	UD / Kalman
ESA	NAPEOS	UD / LS
GFZ	EPOS	UD / LS
NGS	Page5	DD / LS
SIO	GAMIT	DD / LS
PDR	Bernese	DD / LS

UD = Undiff.; DD= Dou. Diff.; LS= Least Squ.

Cen	Combi
EMR	SINEX
NCL	SINEX
GFZ	SP3,CLK

Summary (1/2)

- *IGS reprocessing will benefit from*
  - AC's software improvements
  - Improved models (Absolute antenna models, Ocean loading, Troposphere - GMF,GPT, …)
  - Improved history of hard- & firmware problems, earth quakes, …
    (→ Official table of discontinuities)
  - Completion of IGS data archives
- *Problems, which will not be solved by the reprocessing*
  - Data problems
    - Multipath
    - Environment (snow, vegetation)
- *Not considered in the first run*
  - Higher order ionospheric effects
  - Numerical weather models for trop mapping and initials
  - Atmospheric and hydrological loading effects

Summary (2/2)

- *Problems in first run of Reprocessing*
  - SatAnt-Offsets were estimated fixing IGb00
  - IGS05 was generated by using statistics of station height differences (relative to absolute ANTEX). No optimal solution for all sites.
  - Iterative improvement needed
- *Reprocessing will provide a new set of satellite antenna offsets*
  - Higher consistency with RF scale (rates)
  - Self-consistent RF solution for next ITRF combination
- *Reprocessing will provide*
  - Weekly SINEX files including ERP back to 1994
    - New ERP for 1994 to 1999
  - Orbits & clocks with high consistency back to 1994
    - Enabling PPP before 2000

Thank you

for your attention