

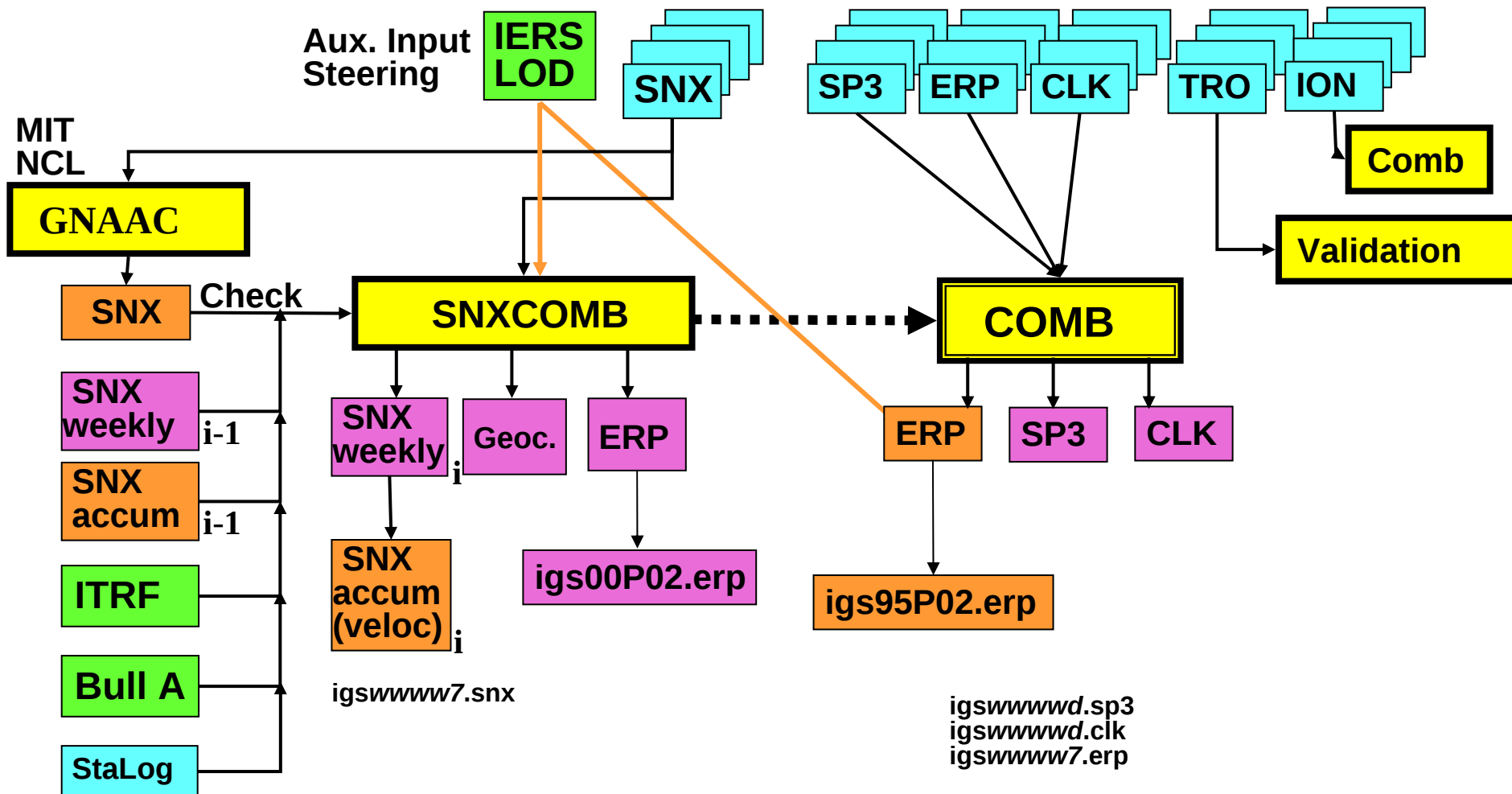


IGS Products

Generation of AC products and Combination



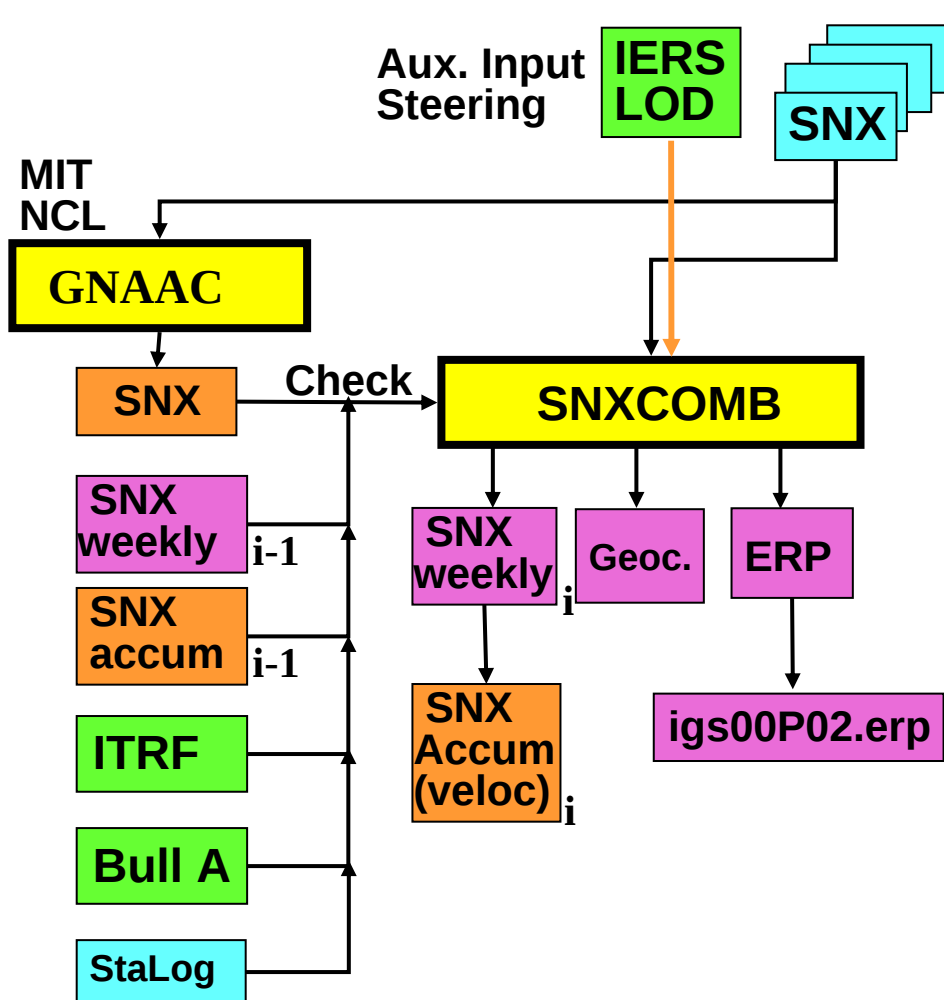
Combination of Final Products - Overview



(: IGS core products)



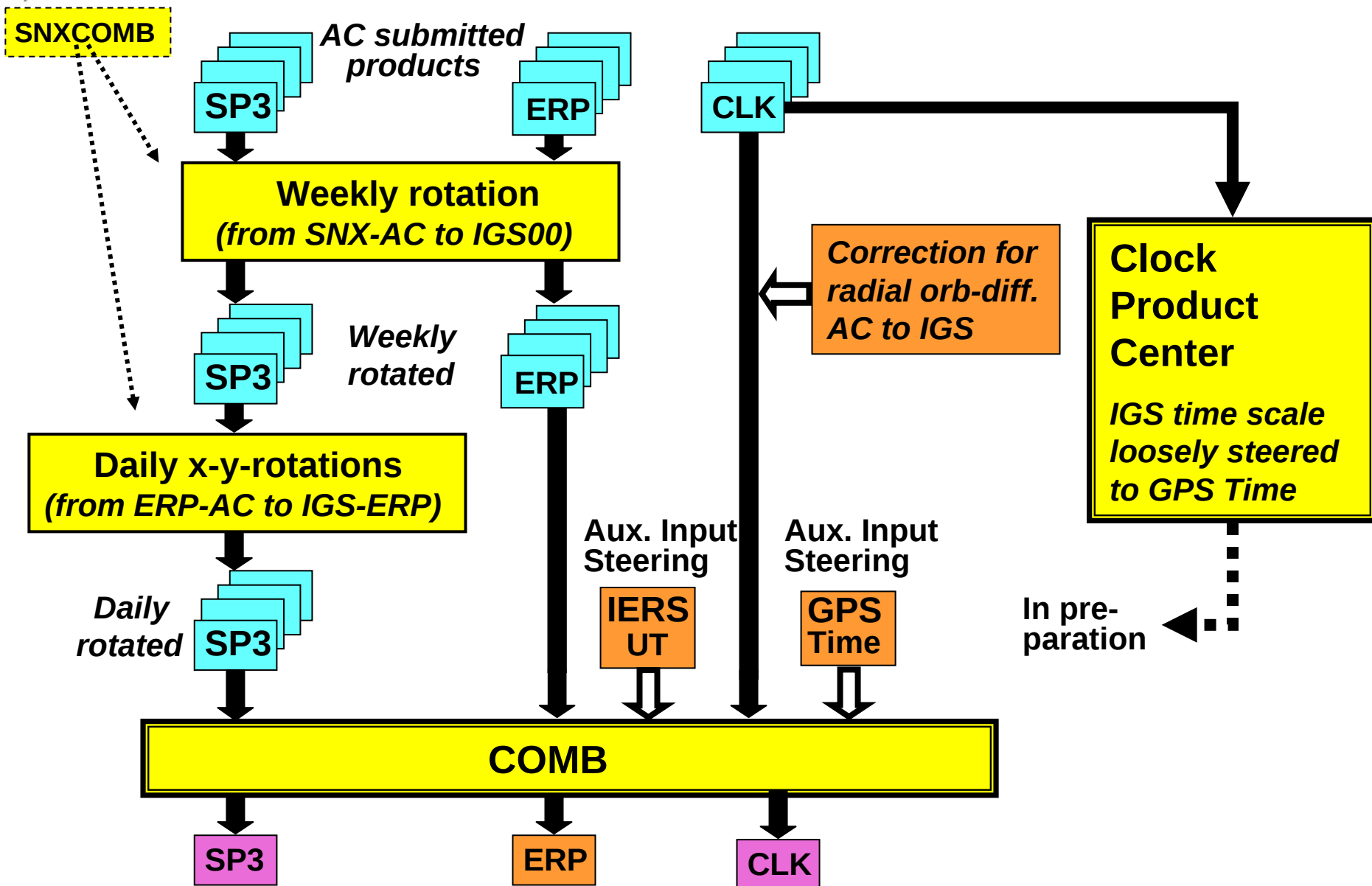
Combination of Station Coordinates & ERP's



- **Combination:**
 - Rigorous combination using all the available covariance information provided by the ACs
 - Steering to LOD from Bulletin A
 - Outliers detection/rejection process
 - Weekly products
 - Cumulative Product (Updated weekly)
- **Internal Quality Control uses:**
 - Pairwise AC comparison
 - Previous week & Cumulative solutions
 - GNAACs' (MIT,NCL) independently determined weekly combinations.
 - Time series Analysis
- **External Quality Control uses:**
 - ITRF2000 (coordinates)
 - Bulletin A (ERP's).



Combination of Satellite Orbits & Clocks





AC Product Generation

(not identical for all ACs; filter technique use different approach)

1 SINEX (final parameters: STA, ERP, GEOC, SATANT)

- Generation of NEQ
- Generation of SINEX
 - ◆ remove all additional parameters (orbits, trop)
 - [PROBLEM !: various parameterizations & arc length; implicitly still in the product]
 - ◆ add (inner) constraints (rotation into ITRF)
 - ◆ report ALL constraints in SINEX (removable)
- Generate AC STA-ERP-SOLUTION (add to SINEX)

2,3 Orbits, Clocks *(varies from AC o AC)*

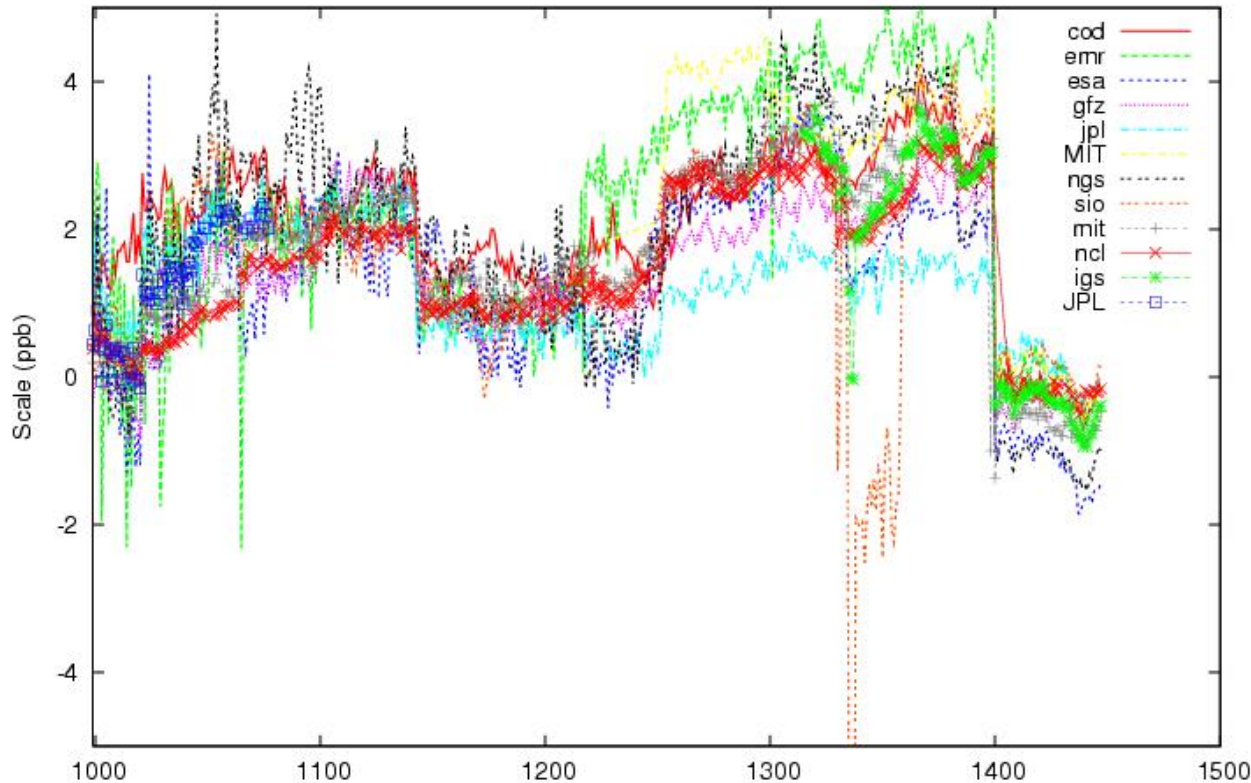
- Generate new ORBIT-SOLUTION by fixing STA-ERP-SOLUTION
- Generate new CLOCKS by fixing STA-ERP- & ORBIT-SOLUTION
(Shift before the STA-ERP- SOLUTION best to ITRF geocenter, to get clocks which provides PPP-STA in ITRF)

For UAW discussion only SINEX is of interest!!



Problems: Example -Time Series of RF scale

AC weekly scale to ITRF



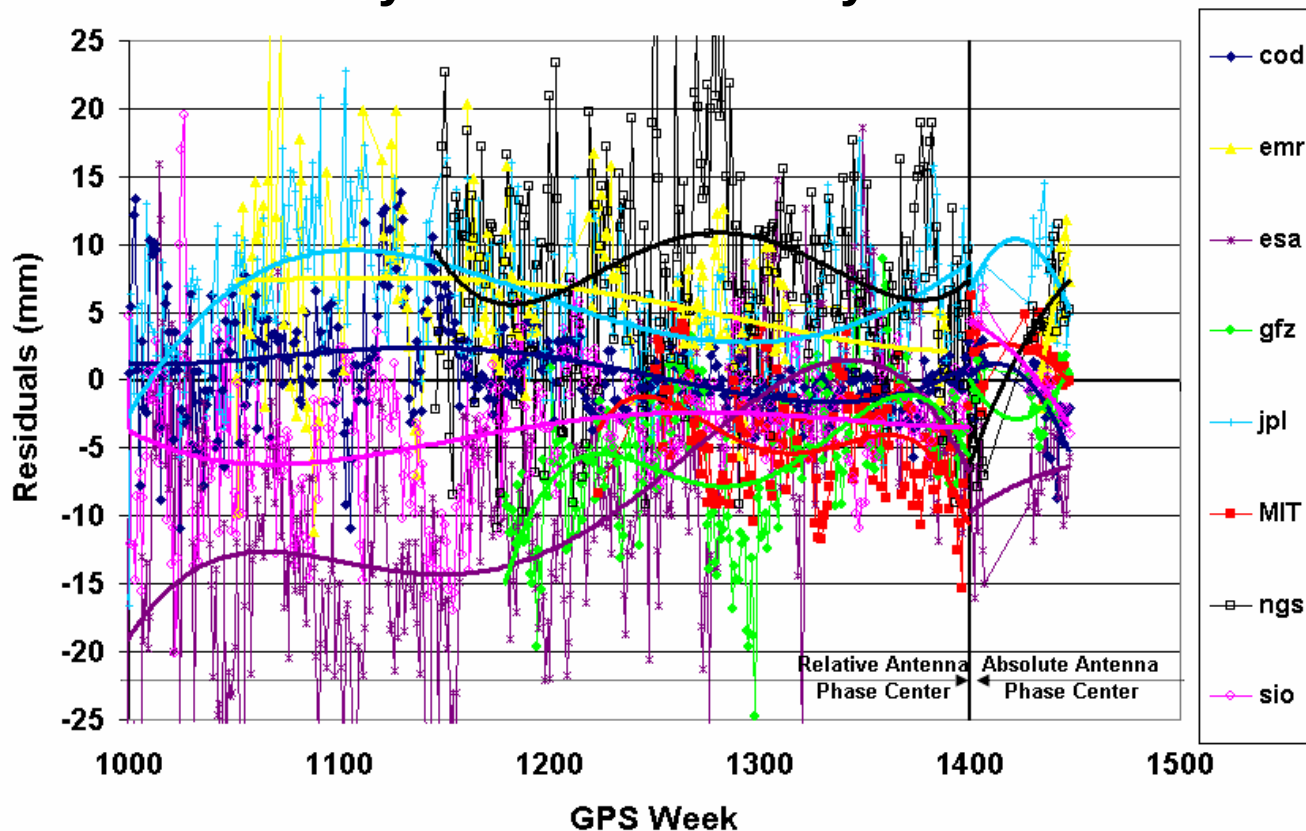
- Jumps at all ACs if new ITRF or general new models**
- Jumps at individual ACs caused by individual changes (e.g. Cut-off)**



Problems: Example –Seasonal effects

Weekly Height Residuals at HRAO (example)

IGS Weekly minus AC Weekly



Systematic effects
btw. ACs
(biases & seasonal)

Hori.: 1-2 mm

Vert.: 5-10 mm

Missing ACs may
generate artificial
jumps in IGS time
series

Note : Smooth lines (1000-1399 / 1400-1447) are 4th / 2nd
order polynomial fit on the residuals time series.



Standards and Models (1/5)

- **The ACs follow mainly the IERS Conventions 2003.
Only deviations will be discussed here**
- **Magnitudes on biases etc. will be discussed in Session 2**

Antenna models

Effects

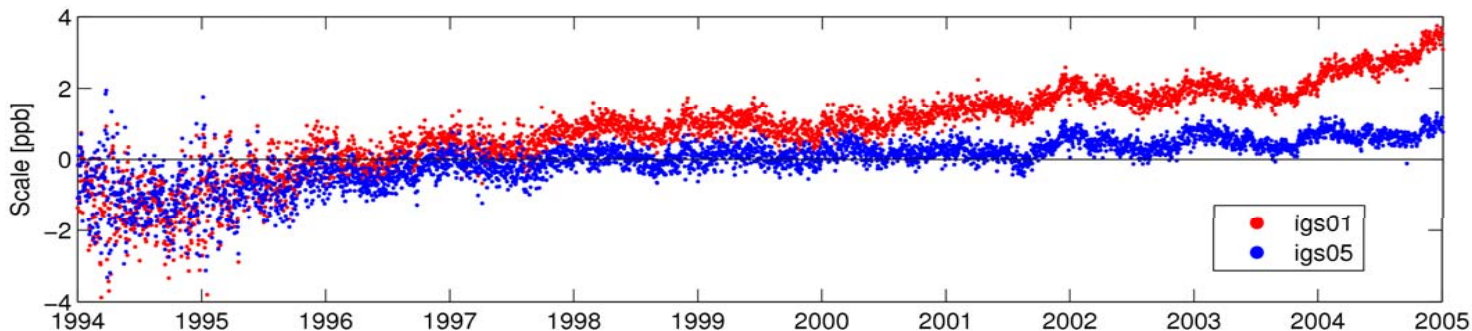
- ◆ strongly affects network scale, scale-rate & deformations
(satellite antenna z-offset error: 1 m $\rightarrow$ 50 mm height bias;
Changing satellite constellation $\rightarrow$ scale rate errors and velocity distortions [Cardellach et.al 2007; Ge et al. 2005])
- ◆ radome effects can be quite large, but are often uncalibrated
- ◆ local site surveys should use consistent antenna models

Mitigation of IGS inconsistency:

- ◆ Use of standard model (igs05_wxxxx.ant)

Mitigation of biases to other techniques:

- ◆ Comparison of different calibrations (robot, chamber, LEOs)



Steigenberger, et al.

Second order ionosphere effects

Effects

- ◆ neglected effects can distort frame & orbits & clocks (esp)

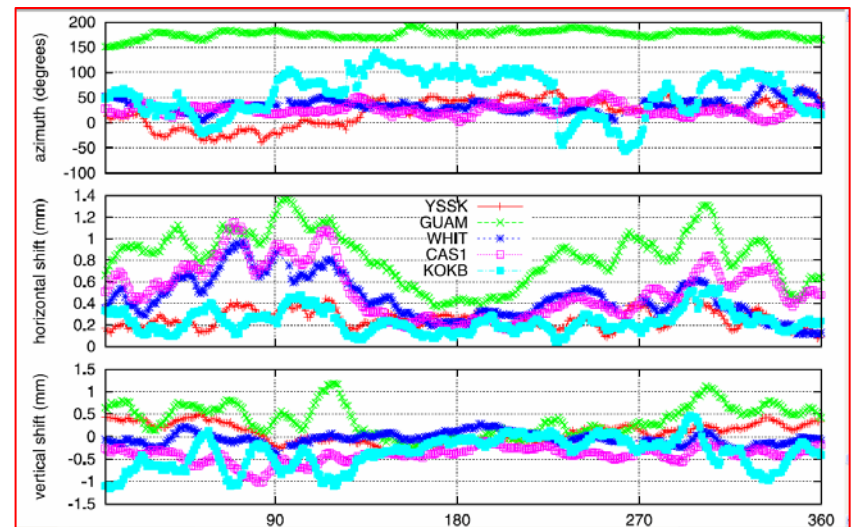
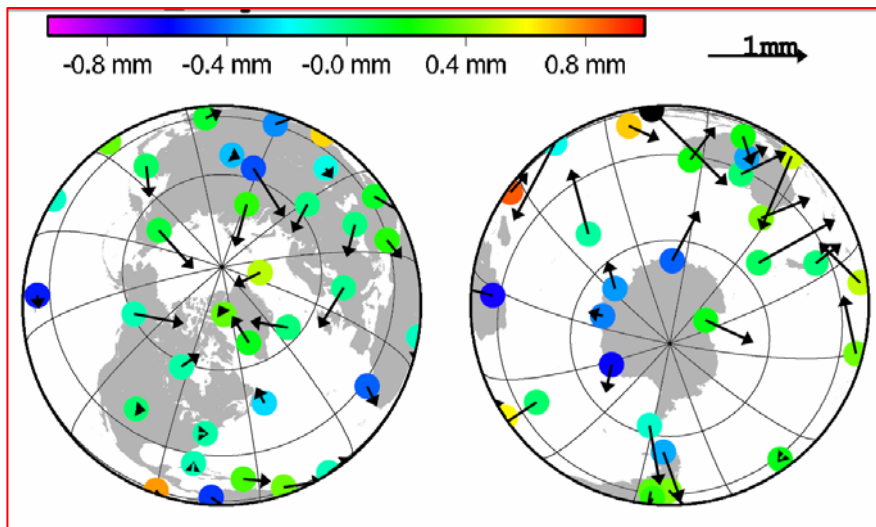
(Impact on receiver positions $< \sim 1$ mm (latitude & time dependent)

Effects on satellite clocks (1 cm) and orbits (few mm) are larger.

[Hernandez, et al. 2007, Steigenberger, et al., 2006 ; Fritsche et al., 2005]

Mitigation of IGS inconsistency:

- ◆ Use of standard model under discussion



Hernandez, et al. 2007



Standards and Models (4/5)

Solar Radiation Pressure (SRP) ; Shadow handling (penumbra, Moon shadow) and Albedo

● Effects

- ◆ approaches differ among Analysis Centers
- ◆ SRP models (parametrization) strongly affect geocenter & LOD estimates (esp)

● Mitigation of IGS inconsistency:

- ◆ Unification not feasible at present

Ocean tidal loading

(hardisp.f, sub-daily CMC also corrected by hardisp.f)

● ACs use FES2004 (one AC FES2002)

- ◆ Not all have implemented hardisp.f so far

● Mitigation of IGS inconsistency:

- ◆ Final unifications needed



Standards and Models (5/5)

Troposphere: initials, mapping functions, gradients

● Effects

- ◆ influence on station position (esp. heights → scale)
- ◆ nearly all ACs use GPT, Saastamoinen, GMF and no a priori gradients

	Bias (up to)	Seasonal (& daily) variations
Mapping:	10 mm; NMF to VMF1	10 mm ; NMF to GMF
Initials:	6mm; SSL to ECMWF	10 mm; SSL to GPT (6 mm in situ)

● Mitigation of IGS inconsistency:

- ◆ Use of standard model is in progress (GPT, GMT)
- ◆ If better models have to be introduced (VMF1, initials from NWM) this should be done consistently among the ACs

Not modeled so far:

- Atmo loading
- Hydrological loading



Data handling

Elevation and weighting

- **Cut-off: 3 to 15 deg (most ACs ~10 deg)**
- **Elevation dependent weighting (all ACs but 2; not identical)**
- **Effects**
 - ◆ **Station height and RF scale; trop estimates**
- **Mitigation of IGS inconsistency**
 - ◆ **Standardization of cut-off and weighting (to the degree possible)**



Parameterization

Orbit Parameterization

- At the moment not planned to be part of SINEX and details are not discussed here (*SRP was already mentioned before*)
 - ◆ Arc length 1 to 3 days (overlapping 3d-arcs) and constraints

Troposphere Parameterization

- NEQ and Filter
- Linear polynomials or piece wise constants; differences for gradients
- Intervals: 1 or 2 hours or continuous (filter)

EOP Parameterization

- Offset and rate per day (with entries at 12 UT)
- Two parameters at 00 and 24 UT with linear trend (day by day)
- Linear polynomial for a week (with entries at 00 UT)

Interpolation of initials

- Linear or higher polynomial



Future - Reprocessing

Models, parameterization, etc. for Repro

- **Most is standardized**
 - **First reprocessing will**
 - ◆ not use 2nd order iono corrections,
 - ◆ not use Numerical Weather Models for trop mapping and initials
 - ◆ be based on non-optimal Antex
 - **Still some AC dependent issues which will cause differences in the solutions**
(e.g. cut-off & weighting, trop modeling & parameterization, orbit constraints, ...)
- These will still cause biases to the other services

Set of submissions

- **Not all IGS ACs join the reprocessing (plus additional ACs for repro)**
- **That may give a jump between repro and forward processing**
(as long as each AC has its own biases and seasonal effects)