

Products produced under direction of AC Coordinator: Processes, accuracies and quality control

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Contents

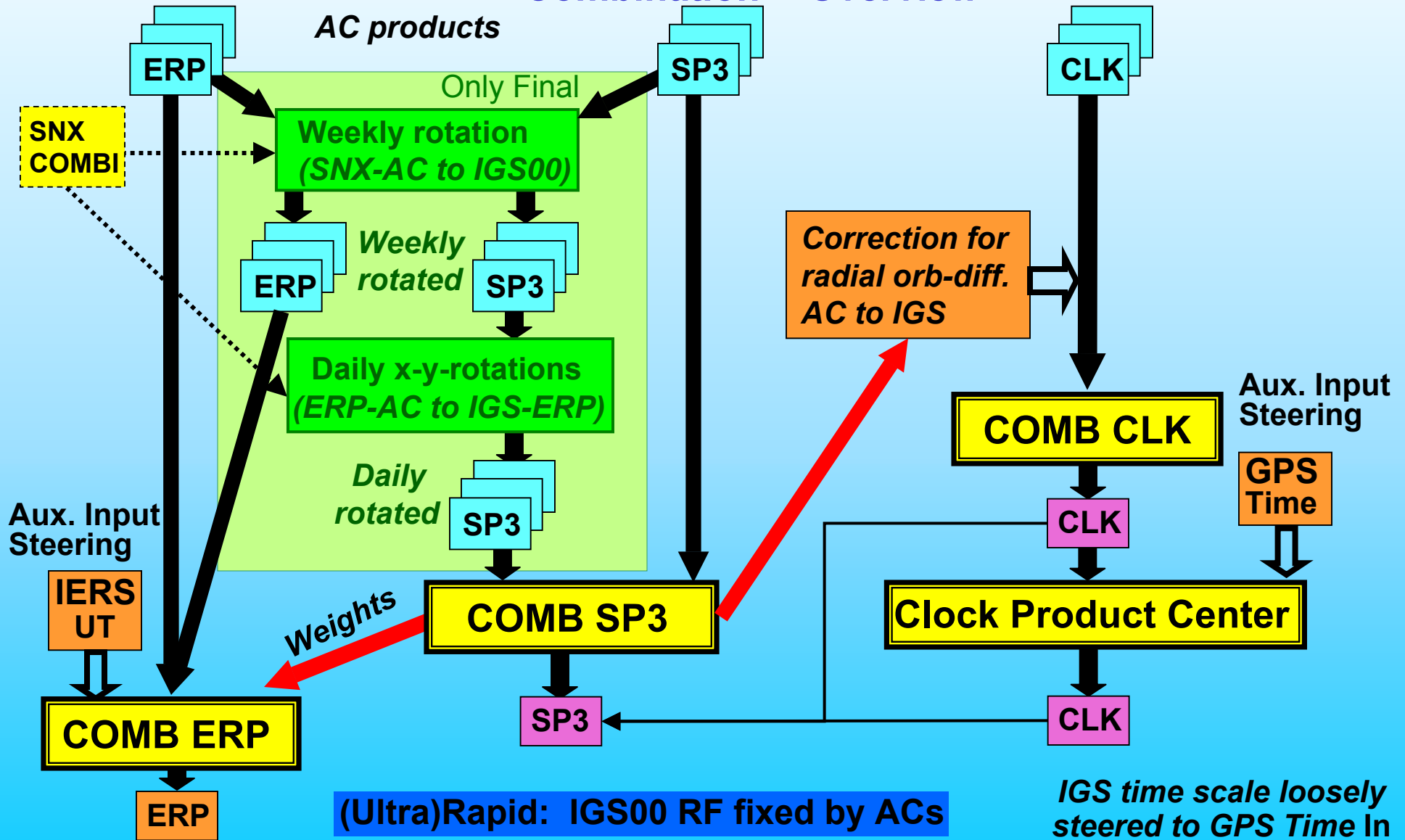
- 1. Overview about combination processes for Orbits, Clocks, ERPs
(background for discussion on IGS integrity)**
- 2. Summary on accuracy and consistency**
- 3. Discussion on existing and possible quality control**

Bern, March 2004

Satellite Orbits, ERPs & Clocks



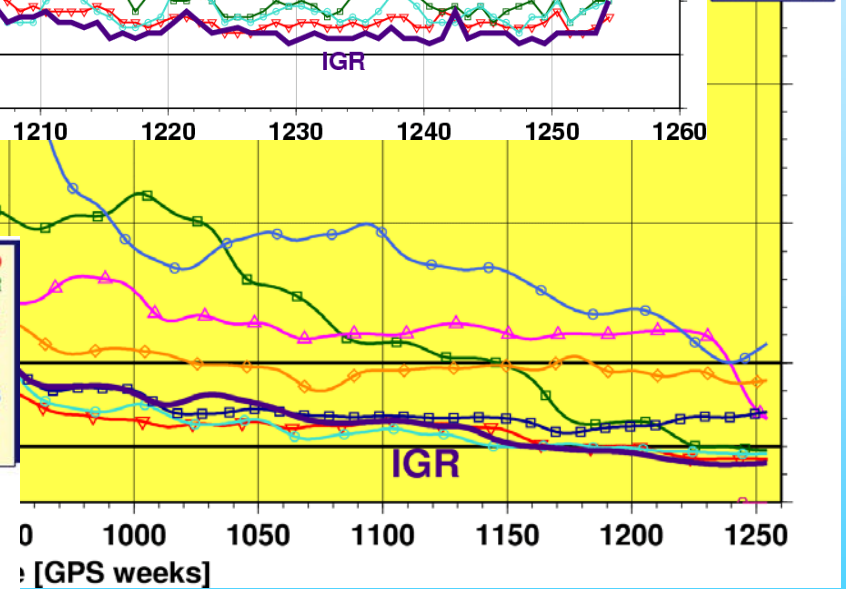
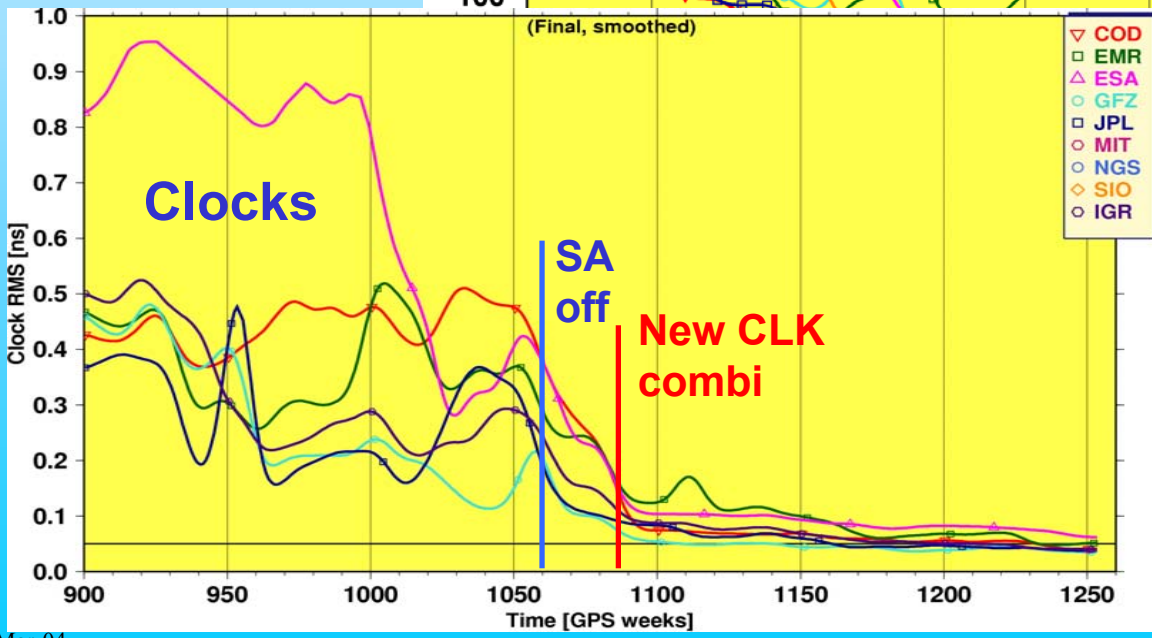
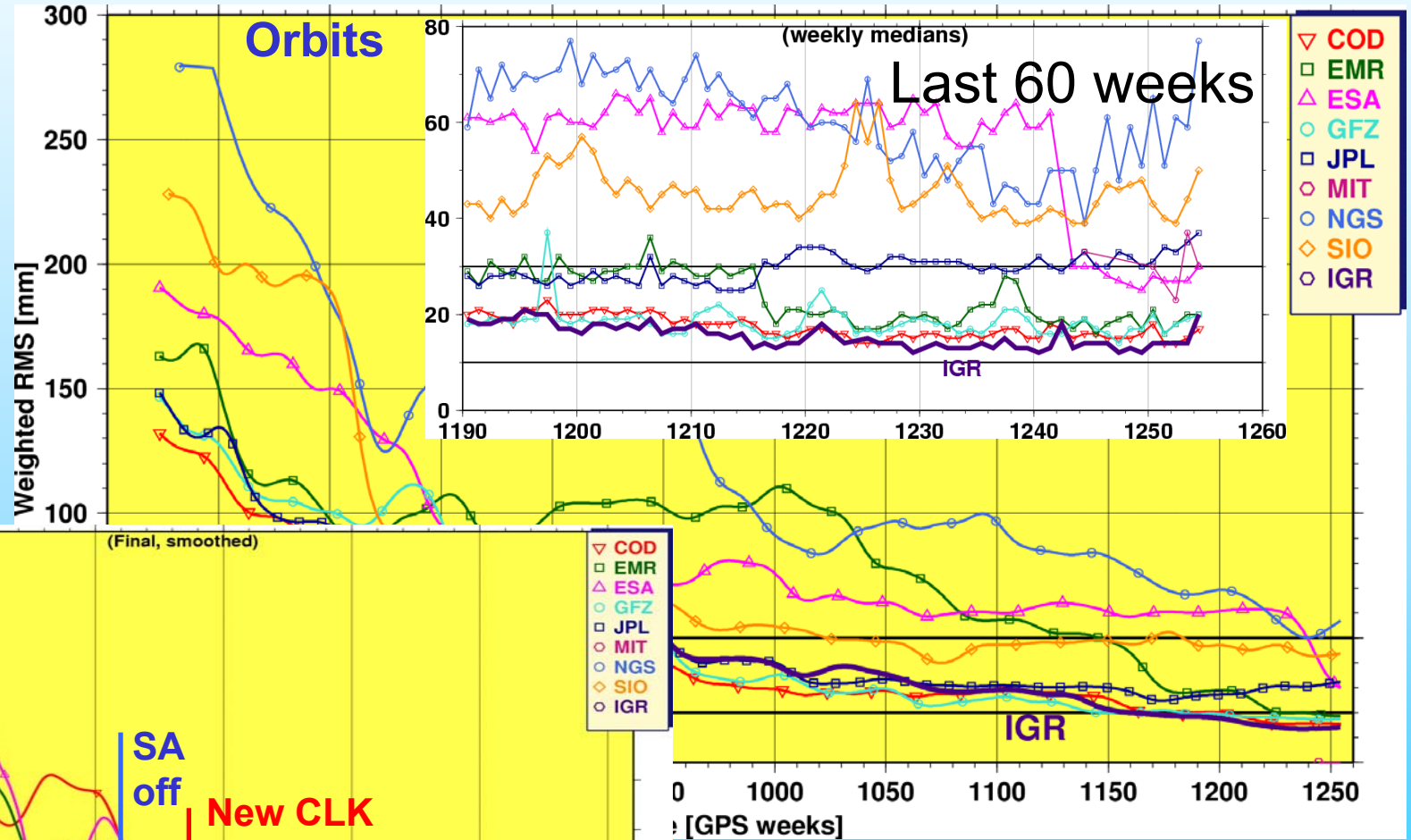
Combination -- Overview



Final Satellite Orbits&Clocks



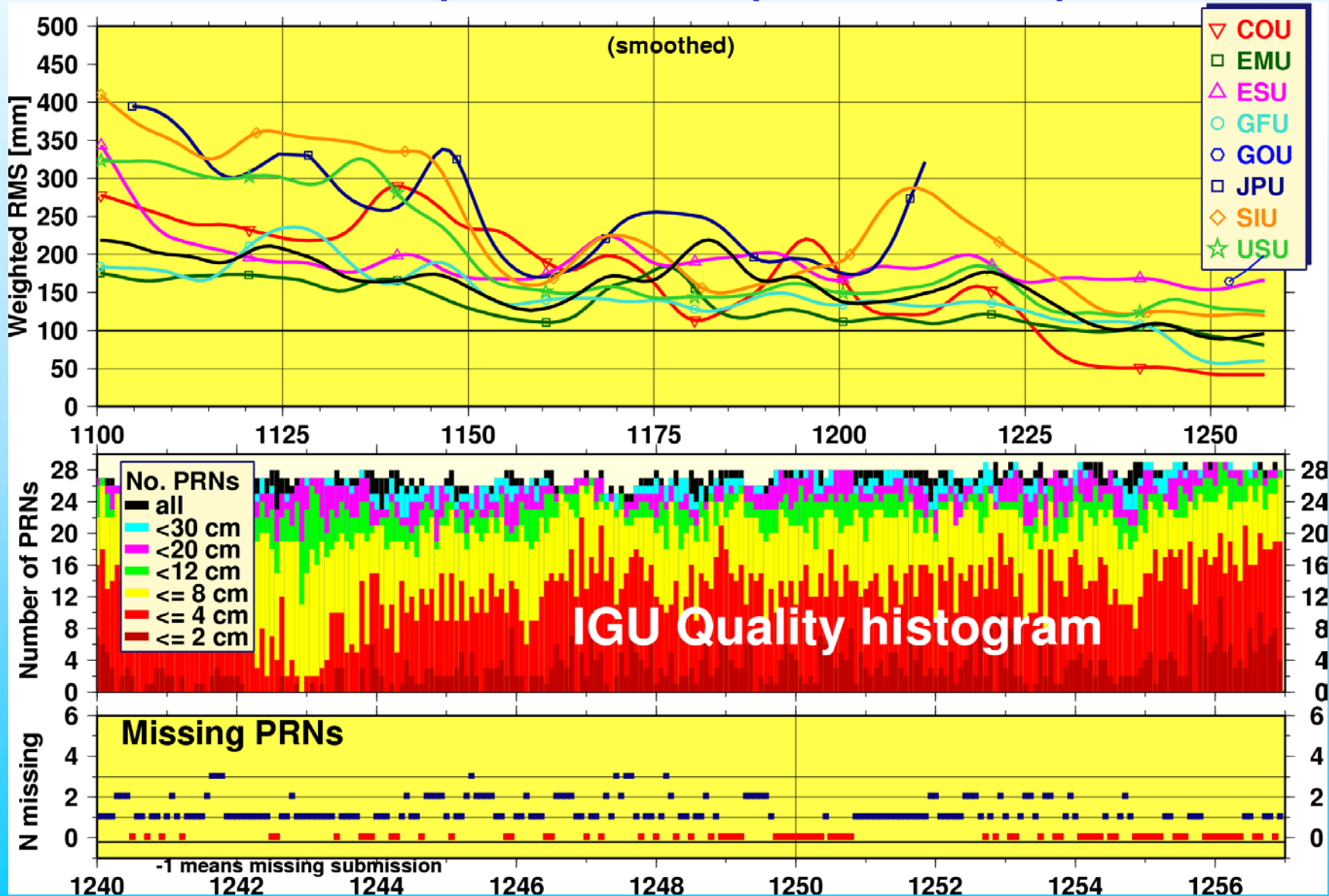
Comparison of
AC Final
orbits&clocks
to IGS Final



Ultra Rapid Predictions



AC Ultra orbit predictions compared to IGS Rapid



X&Y Pole and LOD Residuals Time Series

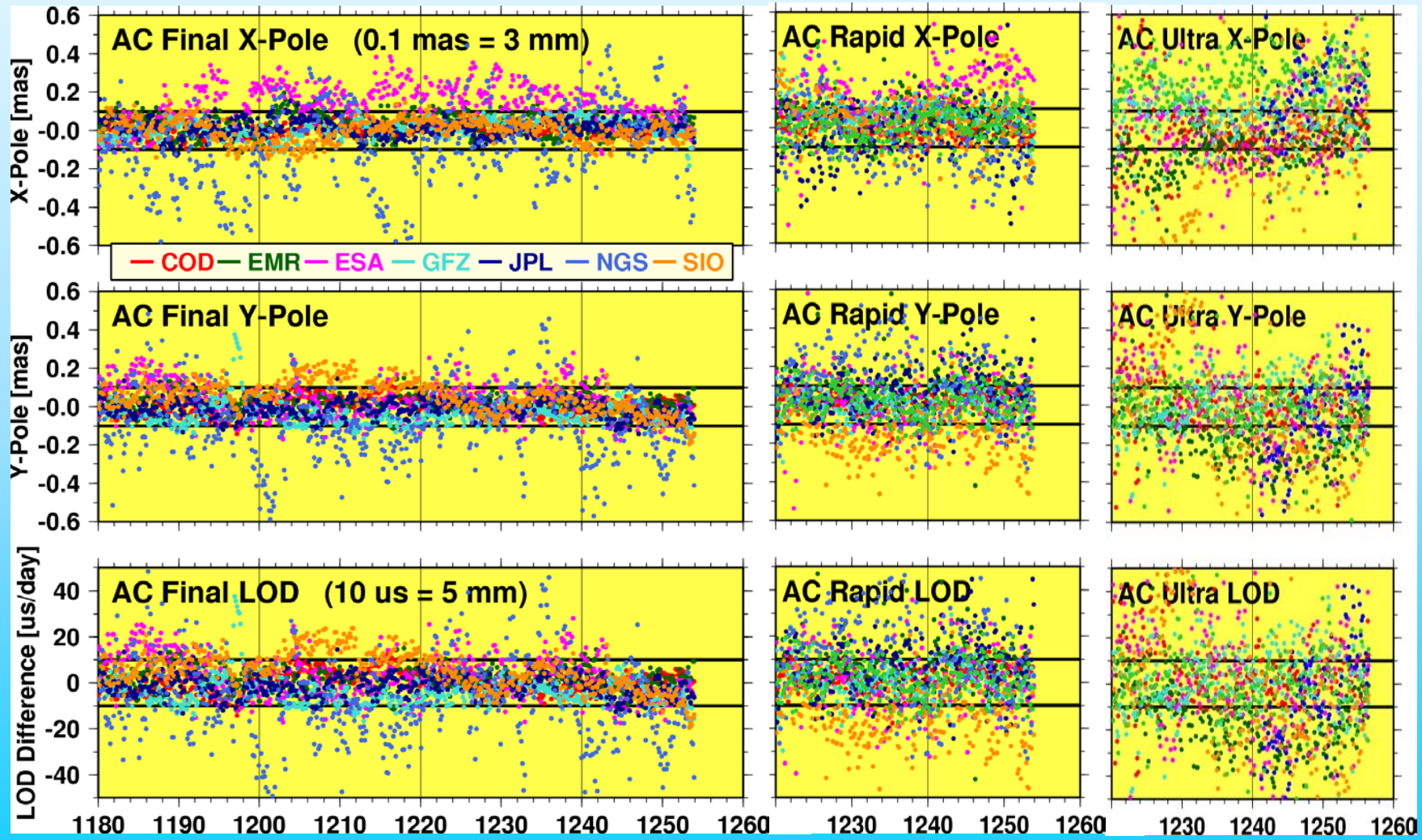


Comparison of AC ERP to IGS Combination

Final

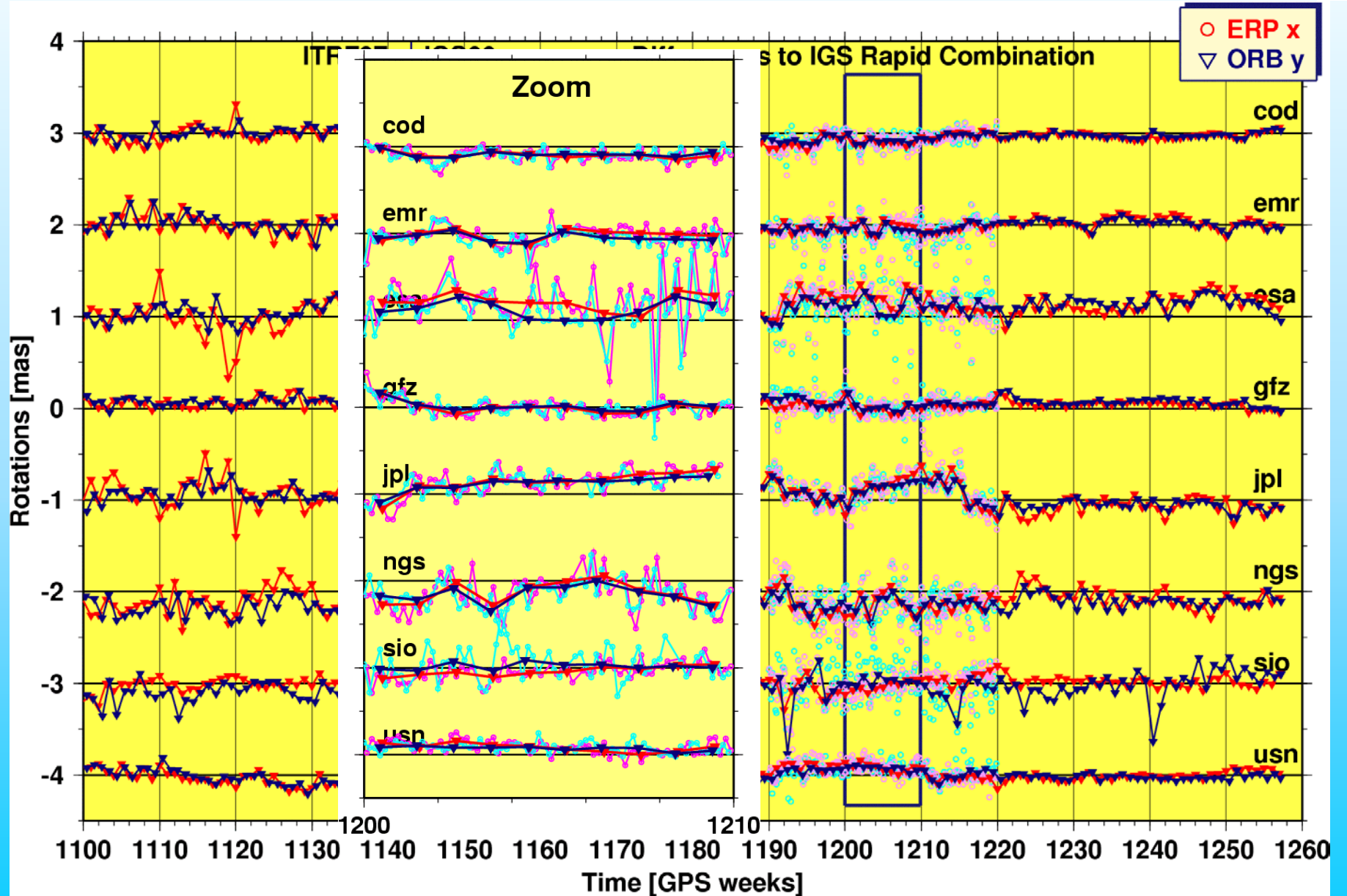
Rapid

Ultra

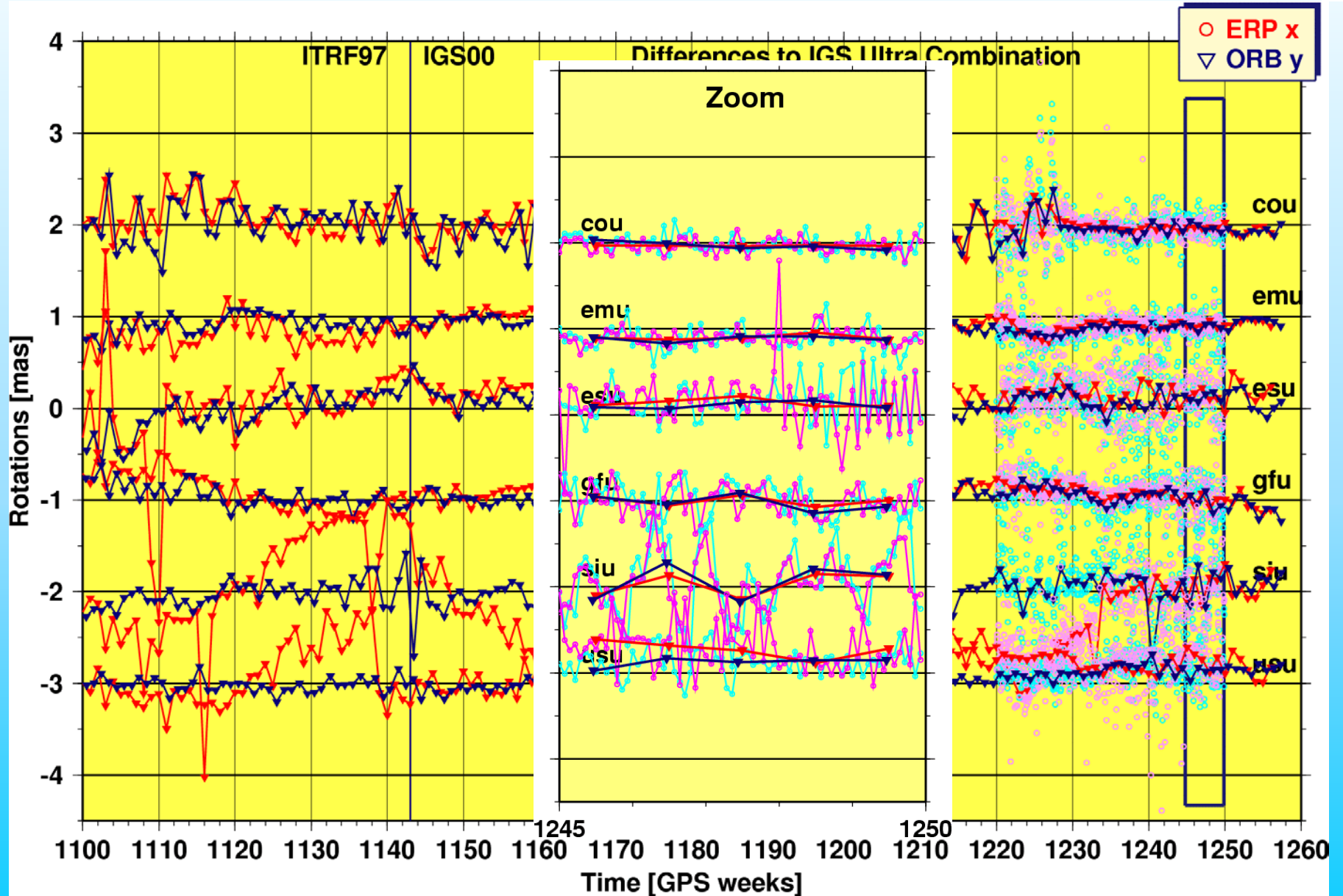


- **Consistency between the various products is a first measure for quality and integrity**
- **Consistency**
 - **between same products of all ACs (Reports)**
 - **between the product lines (Final,Rapid,Ultra)**
 - **between diff. products, e.g. orbits and ERPs**

Consistency / Rapid Orbit to ERP



Consistency / Ultra Orbit to ERP

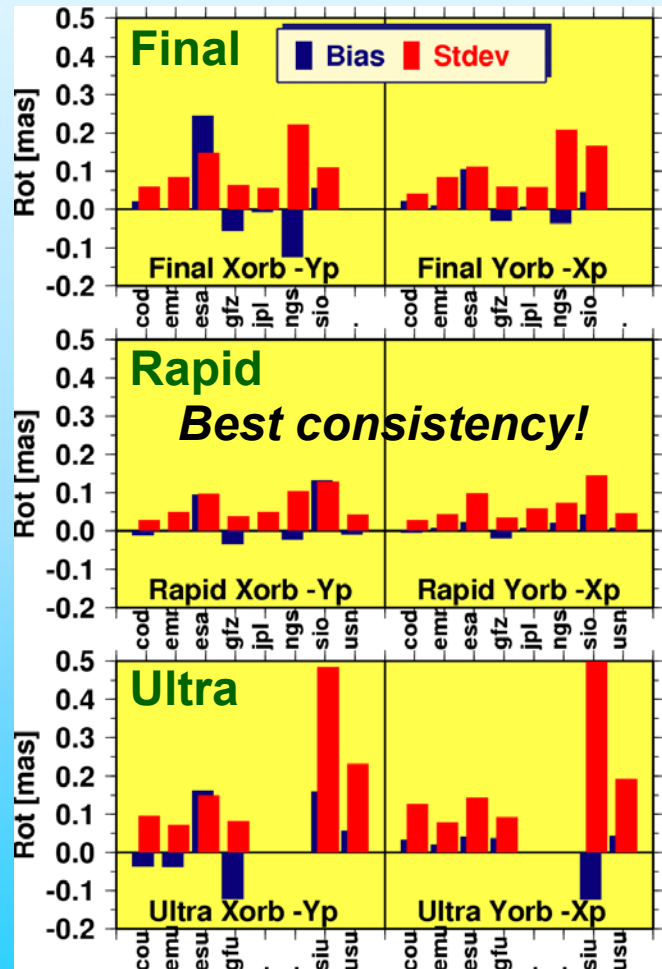


Consistency / Summary



Orbits to ERPs

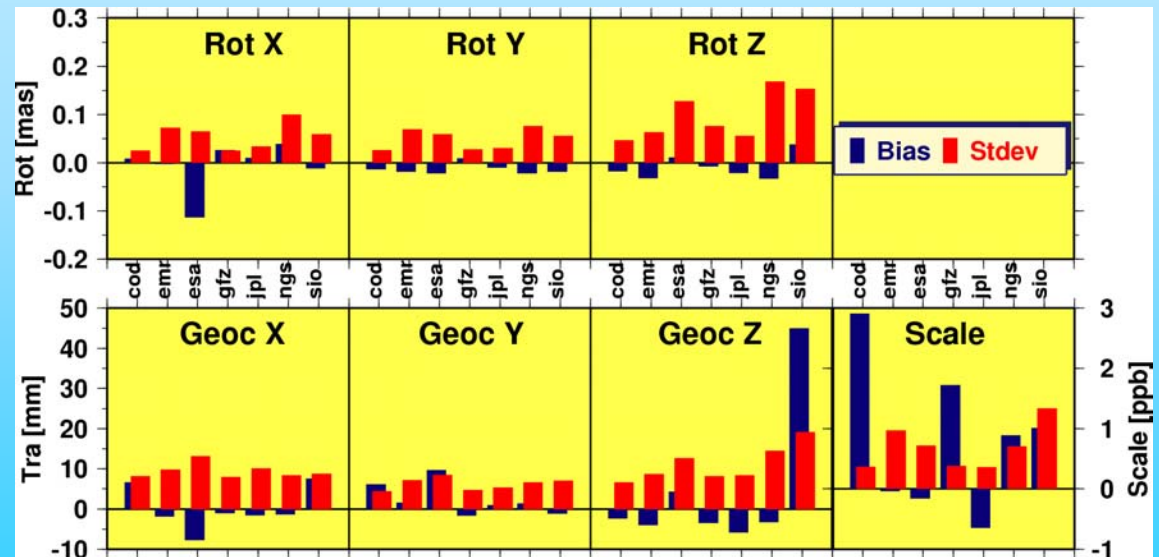
(Diff: $[ORB_{AC} - ORB_{COMB}] - [ERP_{AC} - ERP_{COMB}]$)



Orbits and Station coordinates (Finals) Helmert transformations

(Diff: $[ORB_{AC} \text{ to } ORB_{COMB}] - [SNX_{AC} \text{ to } SNX_{COMB}]$)

SNX_{COMB} is CoM corrected



Quality, Reliability, Integrity



Basis:- Quality of the stations in IGS network (stable RF)
- Quality of AC products (best and consistent models)

1. Avoiding single point of failure

- Assurance of RINEX data availability
 - Redundant GDC & redundant data submissions to GDC
- Assurance of AC product availability at Combi Center
 - Submission to 2 different servers (ACC, GDC)
- Back-up Combi Center

2. Assurance of combined product generation

- Account for all possibilities of corrupted inputs, formats, data, ...

3. Assurance of product consistency and quality

- btw. all AC submission within one product line (Final, Rapid, Ultra)
- between the product lines
(consistencies down to mm-level may be important)

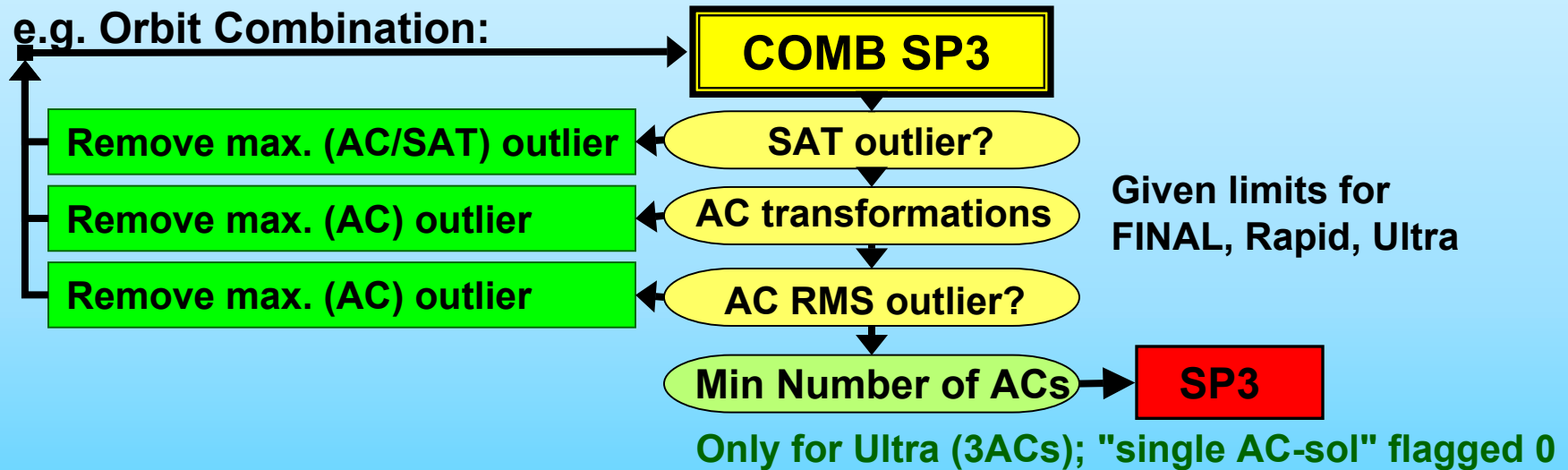
4. Assurance of the long-term stability and the alignment to ITRF

3. Assurance of product consistency and quality

"On-line quality check" : Checks during combination

1. Tracking the consistency between AC submissions

- detect and remove bad contributions (fit, rotations)
- feed-back to ACs; avoid "jumps" by changing number of ACs



- Error codes for all products (flagged if no check possible)

2. Precise Navigation: Check of orbits&clocks for 3 stations (*not in Ultra*)

3. Finals only: - Long-arc orbit check

- Cross-check of ERP_{SNX} to EPR_{ORB}



"On-line quality check" : Checks during combination (continued)

4. (Planned)

PrecisePointPositioning (PPP) with IGS SP3 and IGS Clocks

- Repeatability of station solutions (quality of orbit & clocks)
(for clock quality only differences; not Time and Frequency)
- Realization of RefFrame (ITRF, IGS00) by IGS customers
- Monitoring of PPP results (Helmert transform., bias in East !)

Remark:

CoM : Center of Mass

PPP in Rapid : Orbit(CoM) & Clocks (ITRF) \longrightarrow Stations (ITRF)

PPP in Final : Orbit(CoM) & Clocks (CoM) \longrightarrow Stations (CoM)

\downarrow
ITRF

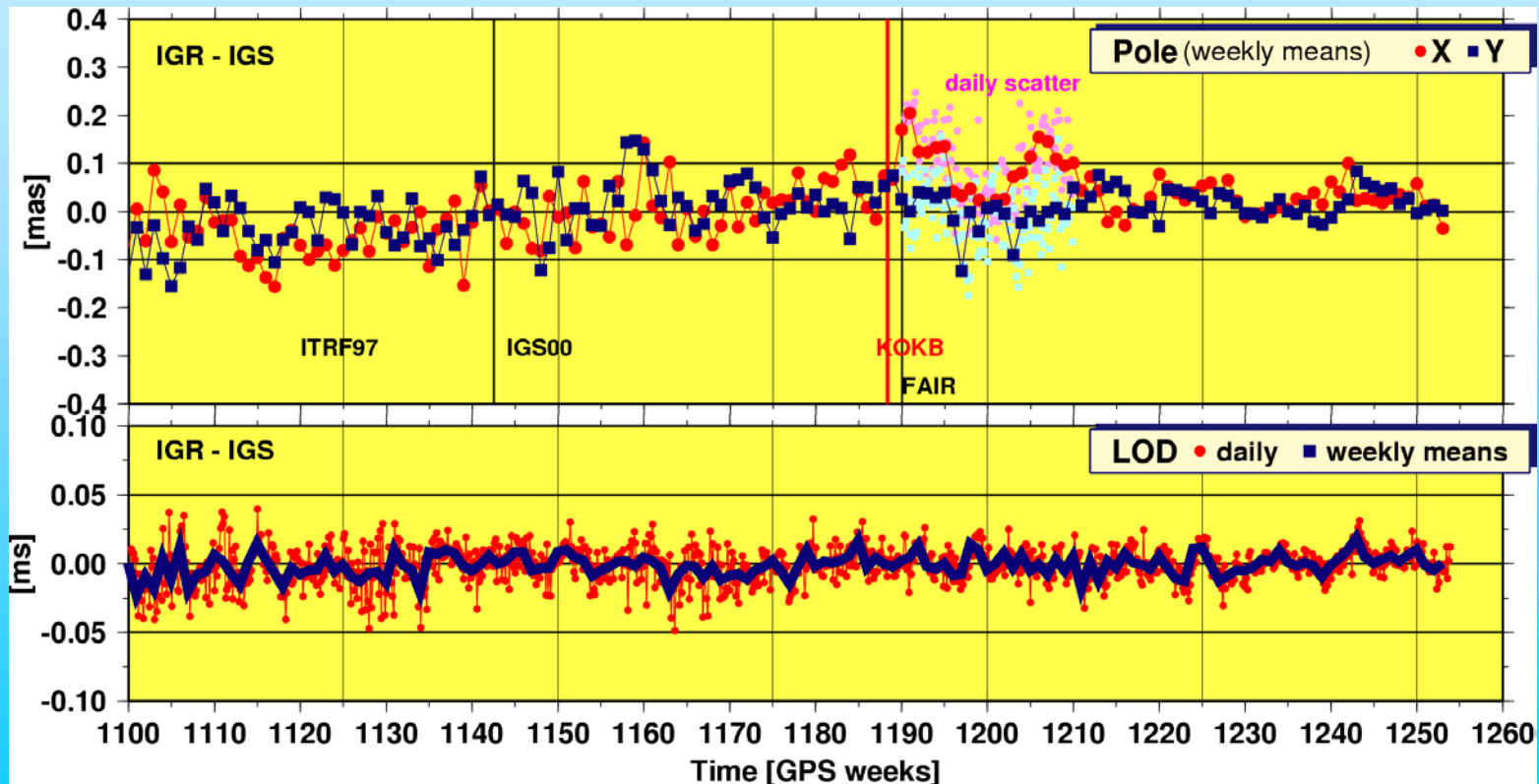
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ITRF

3. Assurance of product consistency and quality (continued)

"Off-line quality check" :

- Tracking the consistency between product lines
 - Rapid to Final (after 2 weeks)
 - Ultra to Rapid (after 1 day)

ERP - Comparison of IGS Rapid to IGS Final

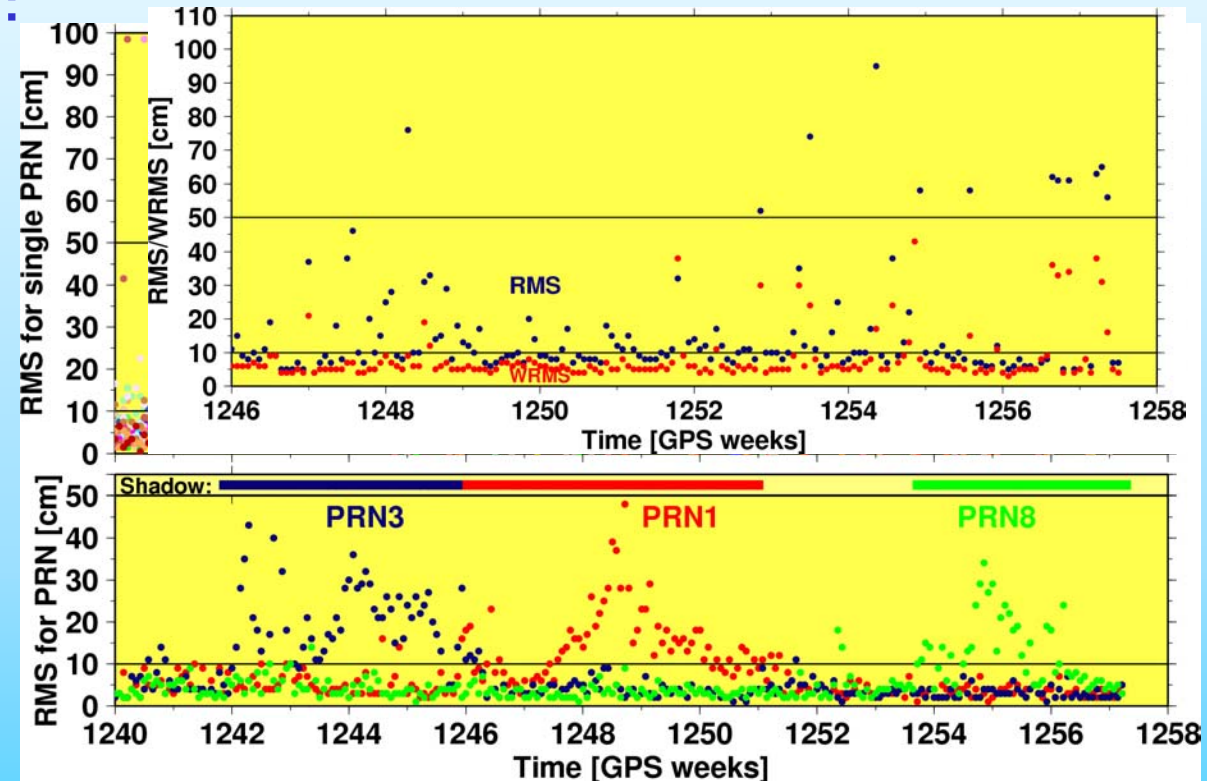


Assurance of product consistency and quality (continued)

"Off-line quality check" :

- Ultra predictions to Rapid

Comparison of all single PRN cases to IGS Rapid



- Special Problems for Ultras:
 - Maneuvers (are unpredictable) or bad behaving satellites (rely on NANUs to flag orbits in SP3c?!)
- *Real-time monitoring*

- **IGS Products**
 - **Quality of cm (orbits, clocks) & mm level (ERPs, Sta)**
 - **Checks of consistency & integrity have to be performed for that level**

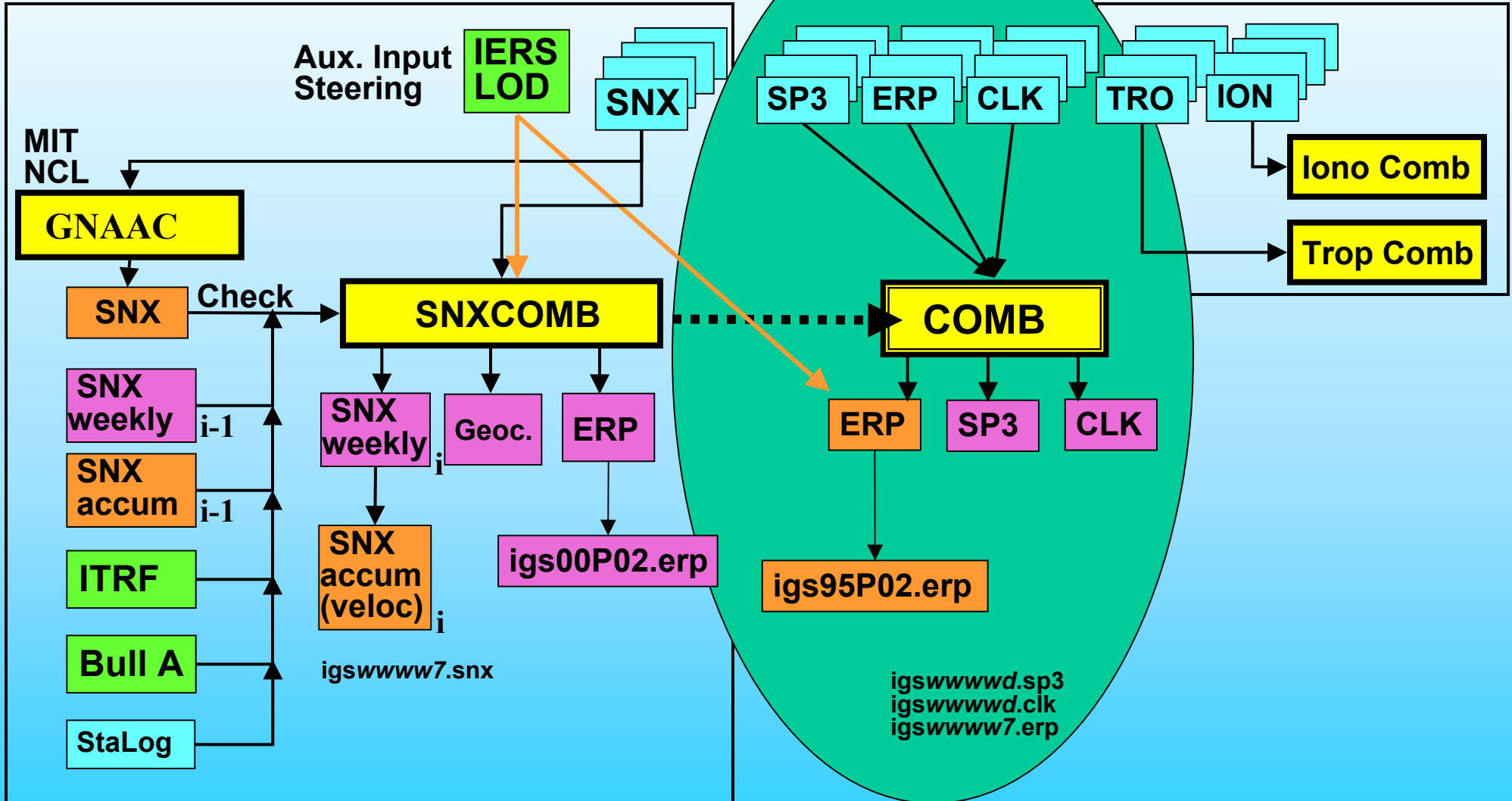
- **Of basic and growing importance is the quality in the long-term realization of the ITRF (mm-accuracy). Here some efforts are needed.**

- **IGS Products are already checked for internal consistency**
 - **during its generation, and**
 - **with some delay between different products lines.**

This has to be improved, and more checks should lead to automated warnings and feed-backs.

- **The growing importance of the ultra rapid predictions requires better integrity checks,**
 - **which can only partly be fulfilled in the existing framework,**
 - **here a combination with real-time procedures have to be developed.**

Combination of Final Products - Overview

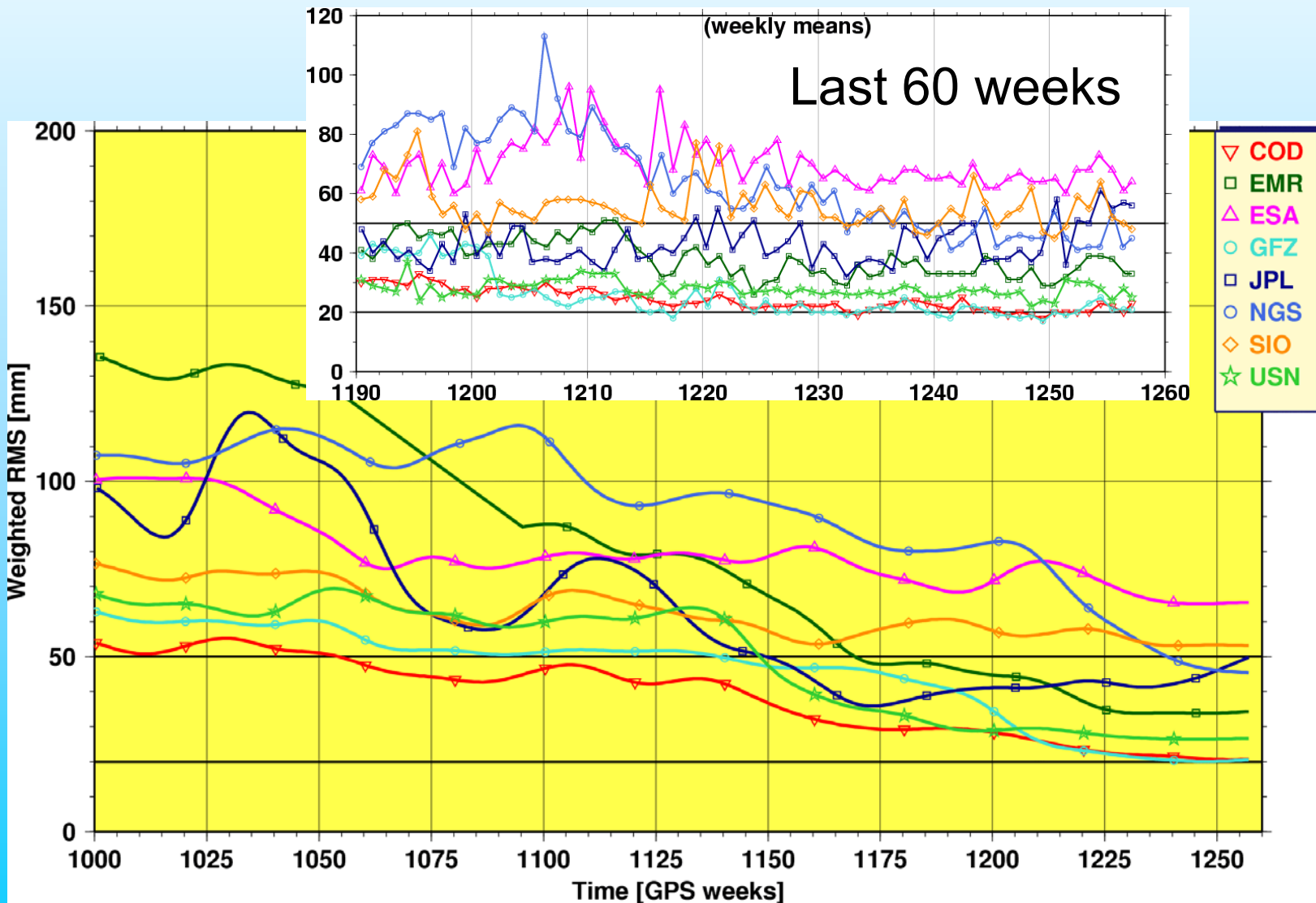


(: IGS core products)

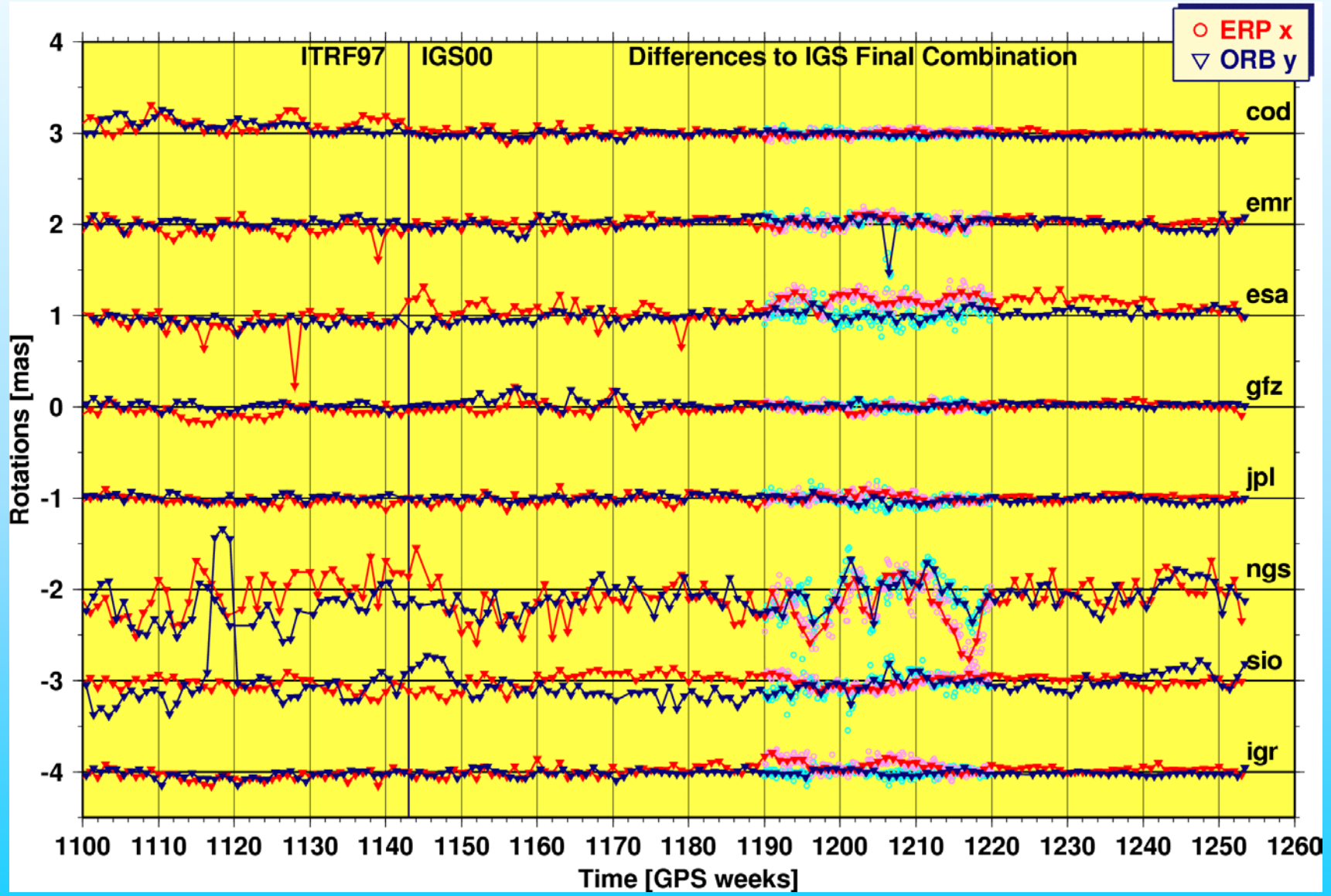
IGS Rapid Orbits



Comparison of AC Rapid orbits to combined IGS Rapid



Consistency / Final Orbit-ERP



Integrity:

- Assurance of the existence of the product
- and the quality, reliability of the product

- Consistency between the various products is a first measure for quality and integrity
- Consistency
 - between same products of all ACs (Reports)
 - between the product lines (Final,Rapid,Ultra)
 - between diff. products, e.g. orbits and ERPs

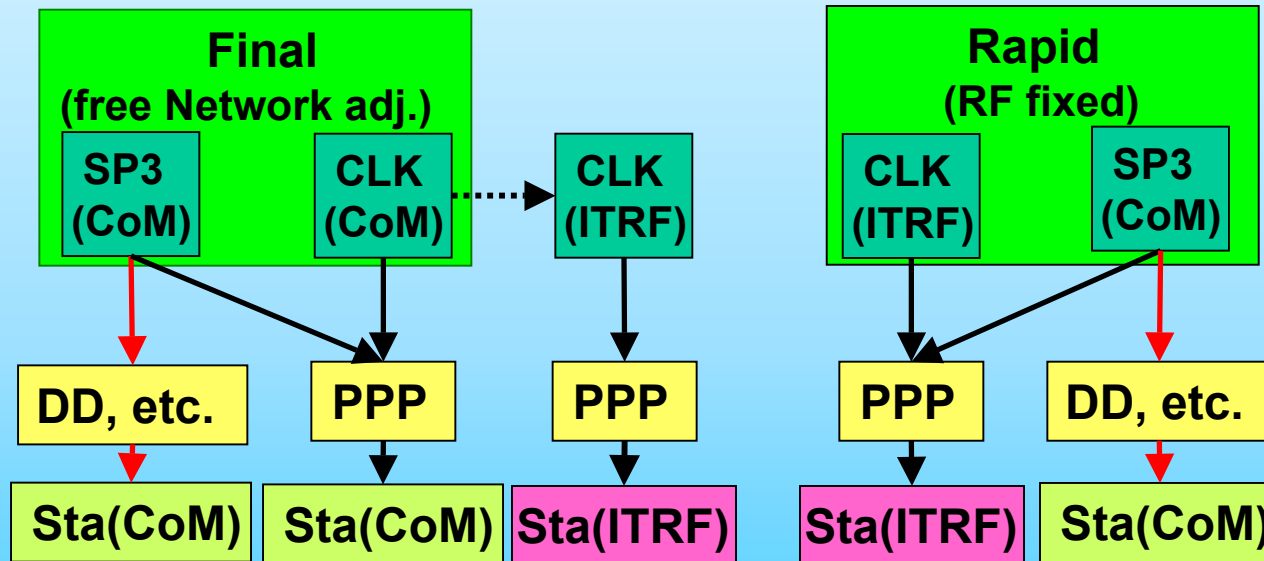
RF realization using IGS (e. PPP)



4. (Planned)

PrecisePointPositioning (PPP) with IGS SP3 and IGS Clocks

- Repeatability of station solutions (quality of orbit & clocks)
(for clock quality only differences; not Time and Frequency)
- Realization of RefFrame (ITRF,IGS00) by IGS customers



SP3 are given in Center of Mass (CoM), CoM moves with a few cm wrt to RefFrame Center (CoN) (is monitored).

- Monitoring of PPP results (Helmert transformation, bias in East !)