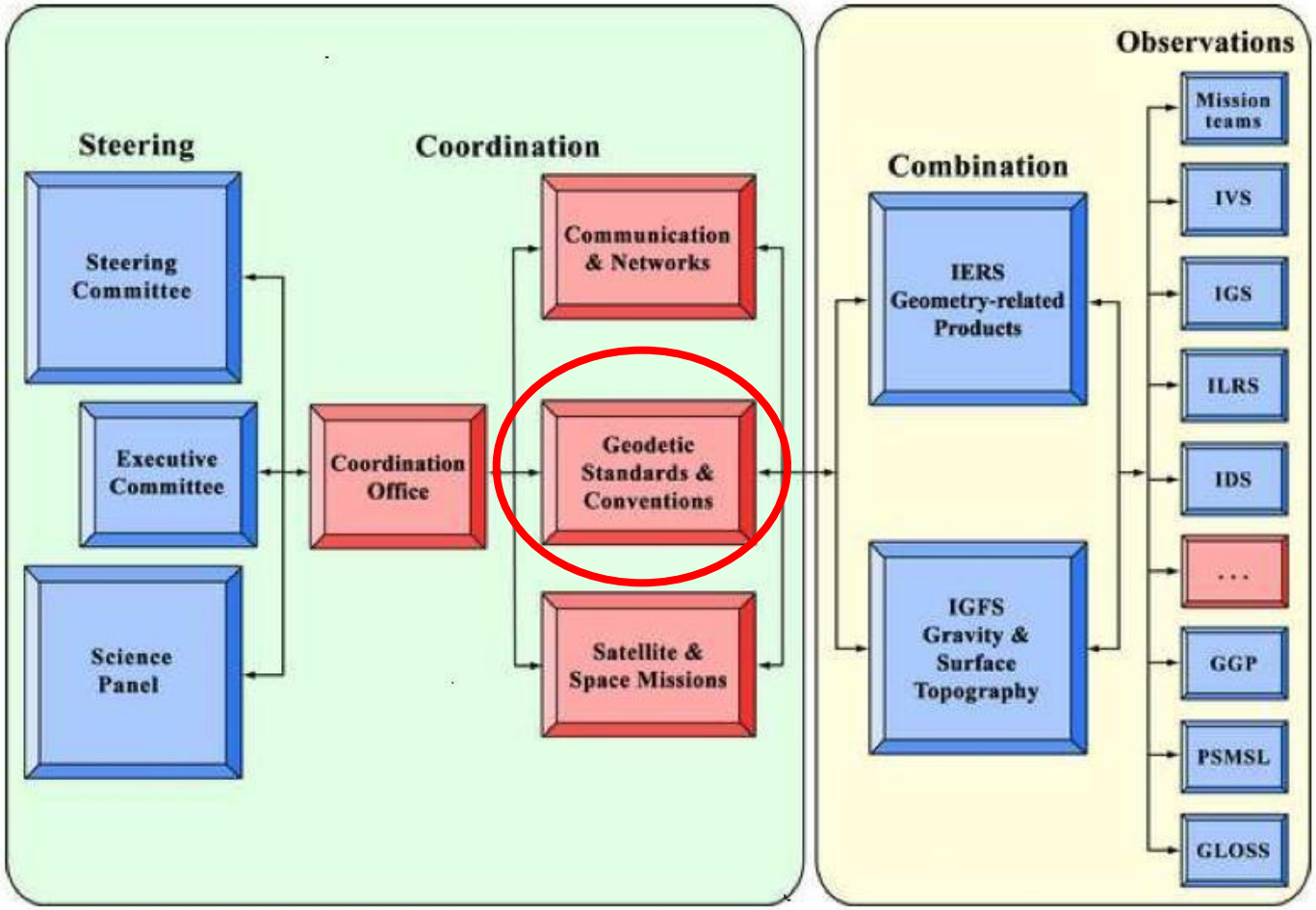
GGOS Bureau for Standards and Conventions

D. Angermann [1], and GGOS-BSC-Team [1, 2]

[1] Deutsches Geodätisches Forschungsinstitut (DGFI), Munich

[2] Institut für Astronomische und Physikalische Geodäsie (IAPG), TU München

GGOS Structure



GGOS, 2008

GGOS Bureau for Standards and Conventions (BSC)

- The BSC has been established in 2009 and is operated by DGFI and IAPG, TU München
- Director: D. Angermann (successor of U. Hugentobler since April 2011)
- Secretary (deputy director): T. Gruber
- BSC-Team:
  - Geometry, TRF: U. Hugentobler, P. Steigenberger
  - Earth Orientation, CRF: M. Gerstl, R. Heinkelmann
  - Gravity: J. Bouman
  - Vertical reference systems: L. Sanchez
- Associated: J. Ihde (BKG)
  J. Kusche (Uni Bonn)
- Representation of all IAG Services needs to be established

Motivation and tasks of the BSC

- For the generation of highly accurate GGOS products **consistency** among the data sets from the different space geodetic observation techniques is of **crucial importance**.
- The analysis of the precise geodetic observations shall be based on the definition of **common standards** and a **unique representation and parameterization** of the relevant quantities.
- Major tasks of the BSC are
  - to **keep track of the strict observance** of adopted geodetic standards and conventions in the generation of geometric and gravimetric products issued by the IAG Services,
  - to **review, examine and evaluate** all standards, constants, resolutions and conventions adopted by IAG,
  - to **identify gaps, inconsistencies and deficiencies** in standards and conventions and to initiate steps to close them,
  - to **propagate** geodetic standards and conventions to the wider scientific community and promote their use.

Terrestrial reference frame, modeling issues …

Conventional modeling of station positions (IERS Conventions):

- The general model connects the **instantaneous position x(t)** of a point at epoch t, and a **regularized position X_R (t)**

$$X(t) = X_R(t) + \sum \Delta X_i(t)$$

- The current ITRF model is **linear**, i.e., a position at a reference epoch to and a constant velocity (V). The regularized station position (X_R) at an epoch t is expressed as:

$$X_R(t) = X_o + V(t - t_o)$$

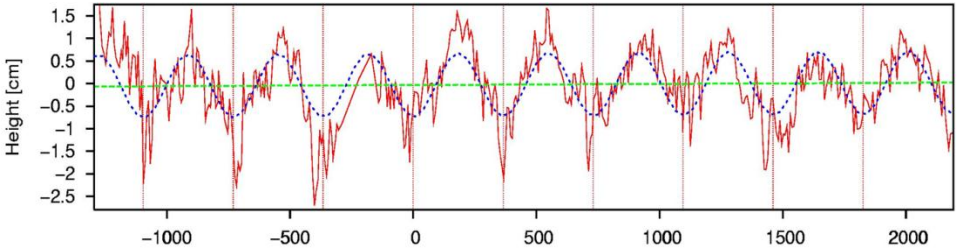
The terms $\sum \Delta X_i(t)$ and their impact on TRF and other GGOS products are discussed in the following

Correction models $\sum \Delta X_i(t)$ for data reduction

- Conventional models (IERS Conventions 2010)
  - Solid Earth Tides
  - Pole Tide
  - Tidal Loading
    - ocean tidal loading (FES2004, EOT08a, ...)
    - atmospheric S1/S2
- Technique-specific correction models (IAG Services)
  - propagation corrections
  - antenna effects
  - …
- Non-conventional displacements of reference markers
  - non-tidal loading (atmospheric pressure and hydrological)
  - post-seismic displacements
  - other secular, episodic or seasonal variations

Discussion

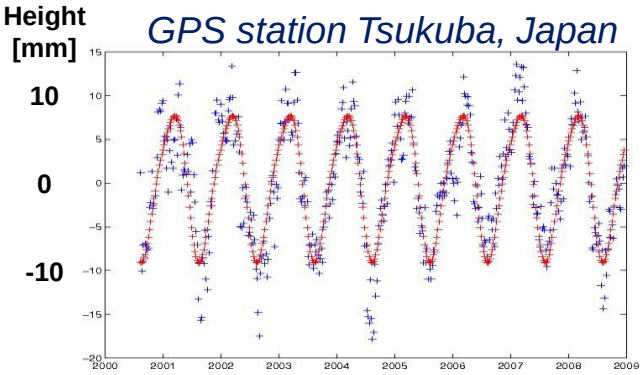
- Consequences of the conventional approach
  - Non-tidal loading and other environmental effects are not considered
  - TRF results do not represent the “real” station motions



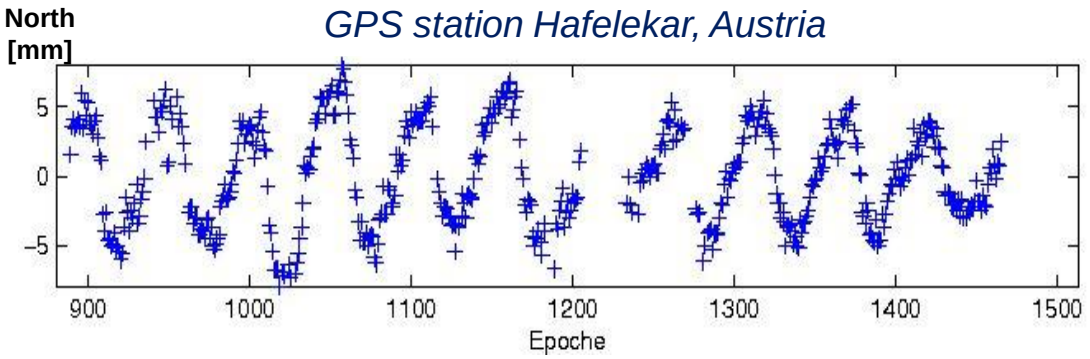
Position time series for GPS station Irkutsk, Siberia

- The observed non-linear station motions can often rather well be explained by geophysical models (e.g., atmospheric pressure and/or hydrological loading), but many stations are also influenced by local effects

GPS station Tsukuba, Japan



GPS station Hafelekar, Austria



Non-tidal displacements in data reductions

- If atmospheric pressure and hydrological loading models are applied, seasonal position variations are reduced for many stations
- However, there are big challenges for an operational implementation, e.g.,:
  - Such models are less accurate than space geodetic observations
  - Discrepancies of several mm between different models do exist
  - It is difficult to account for local environmental effects
  - Models must be free of tidal effects and long-term biases
- Thus, at this time it is **not recommended** by the IERS conventions to include such modeling in operational solutions that support geodetic products
- Continued research efforts in these fields are strongly encouraged
- Models of non-tidal station displacements (including documentation) shall be made available to the user community through the GGFC

Requirements for TRF and other GGOS products

- A fundamental requirement is the definition of common standards and conventions and a consistent modeling and parameterization for the processing of the different space geodetic observations.
- These standards and conventions have to be applied by all analysis centers that are supporting IERS and GGOS products.
- The users of such products must exactly know, whereupon they refer to; i.e. the terms $\sum \Delta X_i (t)$ must be clearly and unambiguously defined.
- An appropriate handling of non-tidal station displacements is essential to satisfy the GGOS accuracy requirements.
- A high long-term stability is crucial for monitoring Global Change phenomena (e.g., sea level rise); thus model changes require a consistent reprocessing of the full observation time series.

Recommendations

(1) The operational data analysis of the space geodetic observations that support GGOS products shall be based on common standards and conventions and a consistent modeling and parameterization.

(2) A clear and unambiguous documentation of the GGOS products is essential and shall be made available to the user community. The BSC will provide recommendations/suggestions for such a documentation.

(3) Further research efforts (e.g., regarding modeling of non-tidal displacements) are strongly encouraged. It is recommended that the GGFC should make available models of non-tidal station displacements, together with all necessary supporting information and implementation documentation.