Combination issues and approach at DGFI

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Characteristics of input data (1/2)

- Consistency and homogeneity of input data is required

  -> Implementation of common standards
  for modelling and parameterization (see session 3)

- Reduction of observation data should only be applied, if the errors of reduction are significantly smaller than the observation errors.

- The following parameter types can be distinguished:
  - Parameters that are nearly identical (e.g., EOPs, station velocities, troposphere gradients)
  - Parameters that are **not** identical, but their relationship is known (e.g., coordinates, troposphere zenith delays)
  - Parameters that are unique to one space technique (e.g., quasar coordinates, SLR range biases)

Characteristics of input data (2/2)

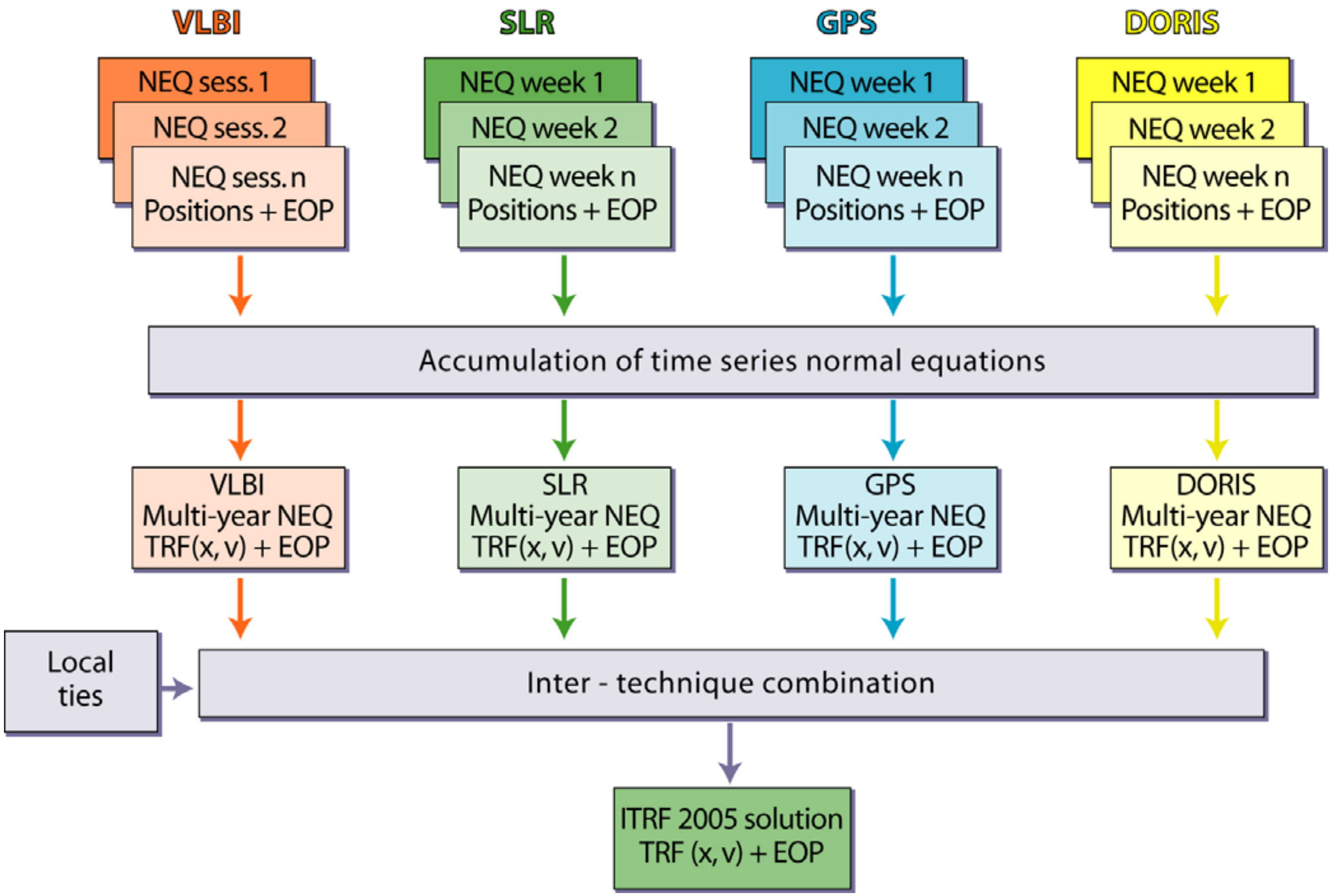
- The input data may be classified as:
  - original observation equations
  - unconstrained normal equations (nearly equivalent to obs. eq.)
  - solutions with removable minimum constraints
  - solutions with „loose“ constraints
  - over-constrained solutions (not suitable for combinations)
- A problem is often the classification of constraints, because:
  - solutions may be **implicitely constrained** by the applied models (e.g., by the used gravity field that fixes the origin)
  - there may be **hidden constraints** (e.g., constraints on reduced parameters such as orbits or troposphere parameters)
  - **loose constraints** may deform results, if applied manifold (e.g., on hundreds of stations)

Combination strategies

- Different levels of combination:
  - observation equations
  - normal equations
  - solutions
- Some remarks related to these levels:
  - The most appropriate approach is the combination of observation equations, but this method is not suitable for a distributed processing as done by the services.
  - The combination on the normal equation level is equivalent to the observation equation approach, if all the used models and required parameters are identically introduced.

Combination methodology at DGFI

- General concept: Combination on the normal equation level
- Software: DGFI Orbit and Geodetic Parameter Estimation Software (DOGS)
- Example: ITRF2005 computation at DGFI



Combination issues (1/3)

- Parameterization of station coordinates
  - ITRF2005: station positions and linear velocities
  - GGOS-D: positions, velocities (and seasonal signals?)
- Example: Position time series derived from GGOS-D data

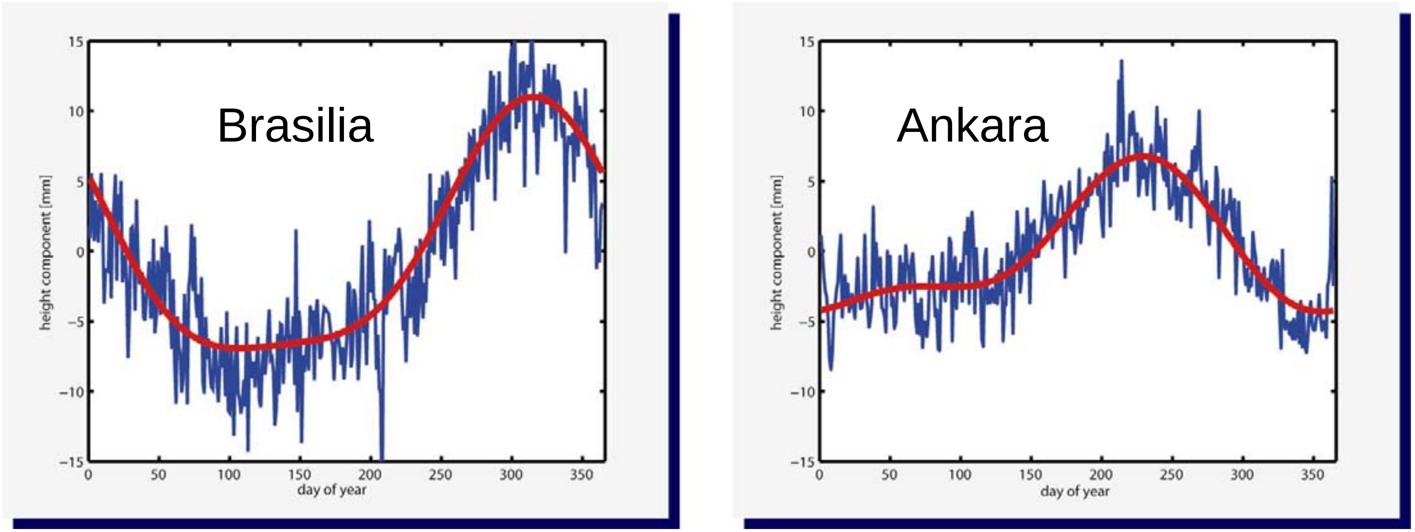
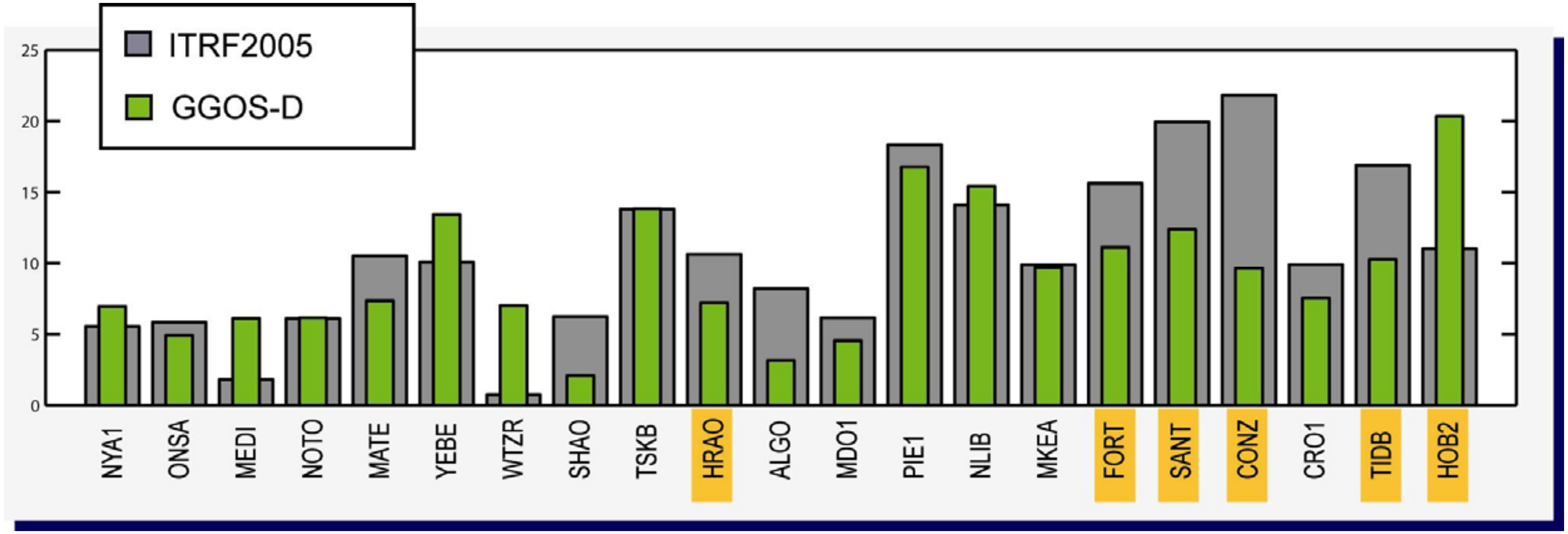


Fig. Mean annual signal in height component approximated by annual and semi-annual sine/cosine functions

Combination issues (2/3)

- Integration of different techniques, e.g.:
  - strategies for the implementation of local ties
  - equating station velocities of co-located instruments
  - common parameters (e.g., EOPs, troposphere parameters)
  - investigations related to ties on satellites
- Example: 3-D differences between local ties and space techniques (GPS-VLBI, ITRF2005 vs. GGOS-D)



Combination issues (3/3)

- Realization of the geodetic datum, e.g.:

  (1) What is the effect of estimating Helmert-transformation parameters within the combination ?

  -> Crust fixed network vs. geocentric datum ?

  (2) How should the kinematic datum be defined ?

  -> NNR NUVEL-1A vs. geodetic models ?

- Recommendations:

  To (1): Network deformations should **not** go into the datum parameters, but into the station coordinates

  To (2): The reference frame should rotate with the present-day physical crust (to ensure consistency between the ITRF and EOP)