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WG: Towards a consistent set of parameters for the definition of a new GRS

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Current status of the GRS

- GRS80 is the conventional global reference system
- It is 42 years old (data and knowledge of the 1970ies)
- Pre-GPS era

- Permanent tide systems were not an important issue at that time
  - They are not treated at all in GRS80

- In 2015, a conventional new value for W_0 (gravity potential of mean sea level) was adopted by IAG.
  - Main purpose: Definition of the IHRS (International Height Reference System)
  - In GRS80, W_0 was a derived quantity
  - Terrestrial time is not defined on this new value (neither on the one of GRS80)

Discrepancies

- Over time, this lead to discrepancies in various applications in geodesy and related sciences
  (see presentation of D. Angermann)

- IERS conventions introduced new constants. Especially for:
  - Geocentric Gravitational Constant (GM)
  - Dynamic form factor J2 (flattening)
  - Semi-major axis a
  - Normal potential W_0

- Many of these constants can be “observed” by space techniques
  - Monitoring of temporal changes (long-term, seasonal)

- Inconsistent treatment of Permanent Tide

Goals of the WG

- Define a consistent set of parameters and formulas for a new GRS
- Proper treatment of the permanent tide
- taking into account relativistic effects
- Study the necessity of replacing GRS80 as the conventional system
- Study the necessity to designate a conventional global gravity field model
  - Satellite only?
  - combined?

Definition of GRS

- 4 independent parameters
  - W_0 (mean sea level)
  - J2 (“flattening”)
  - GM
  - ω (Earth rotation)
- All other parameters are derived quantities
  - especially semi-major axis a
- Zero-tide as the conventional tidal system
  - Transformations to tide-free and mean-tide have to be provided
- Time dependency
  - All parameters are time-dependent
  - Rigorous treatment would be too difficult and too confusing
  - Designation of a reference epoch
    - For now: 2010.0 (Epoch of adopted value of W_0)

Calculation of the parameters

- formulas for derived parameters are known
  - Moritz (GRS80)
  - Groten (2004)
  - newer works
    - permanent tide
    - relativistic effects

- Nice works by I. Oshchepkov

- Should we calculate a consistent set of parameters?
  - In my opinion: Yes
  - We should know the “best estimate” values

Replacement of GRS80?

- Should we replace GRS80 as the conventional system?
- Basically yes:
  - Consistent treatment of datasets (especially in their combination)
  - Parameters are more consistent with the “real” System Earth
  - Consistent use of numerical standards in all products
- But there are some severe disadvantages as well:
  - Danger of confusion
  - Changes in many software packages and applications
  - Change of conventions and standards (not only in Geodesy)
  - All datasets change
    - ellipsoidal coordinates and heights
    - gravity anomalies
    - geoid models (mean sea surface)
    - ...

What happens if we stay with GRS80?

- In principle, we can stay with GRS80.
- We will have to live with all the inconsistencies that exist
- It is illusional to think that all users will change immediately to a new GRS as soon as it is published
- In any case, GRS80 will still be around for a long time (decades?)

- This means, we have to provide transformation methods and parameters for all quantities between GRS80 and a new GRS and probably other systems using other defining parameters (IERS conventions, EGM2008, ...)

Recommendations

- Calculate a consistent set of parameters for a new GRS based on current available data and observations
- Provide transformation methods from/to GRS80
- Check the willingness of users to adopt a new GRS
- (Perhaps) Adopt the new GRS

- In any case:
- Clear documentation of applied standards and conventions for each existing dataset

Questions

- Additional arguments for a new GRS ?
- Arguments against the introduction of a new GRS and for staying with GRS80?
- Do we need a conventional Earth gravity model?

- **Thank you for your attention**