Vertical Datum Standardisation

Joint Working Group JWG 0.1.1 of

GGOS Theme 1: Unified Global Height System
IAG Commission 1: Reference Frames
IAG Commission 2: Gravity Field
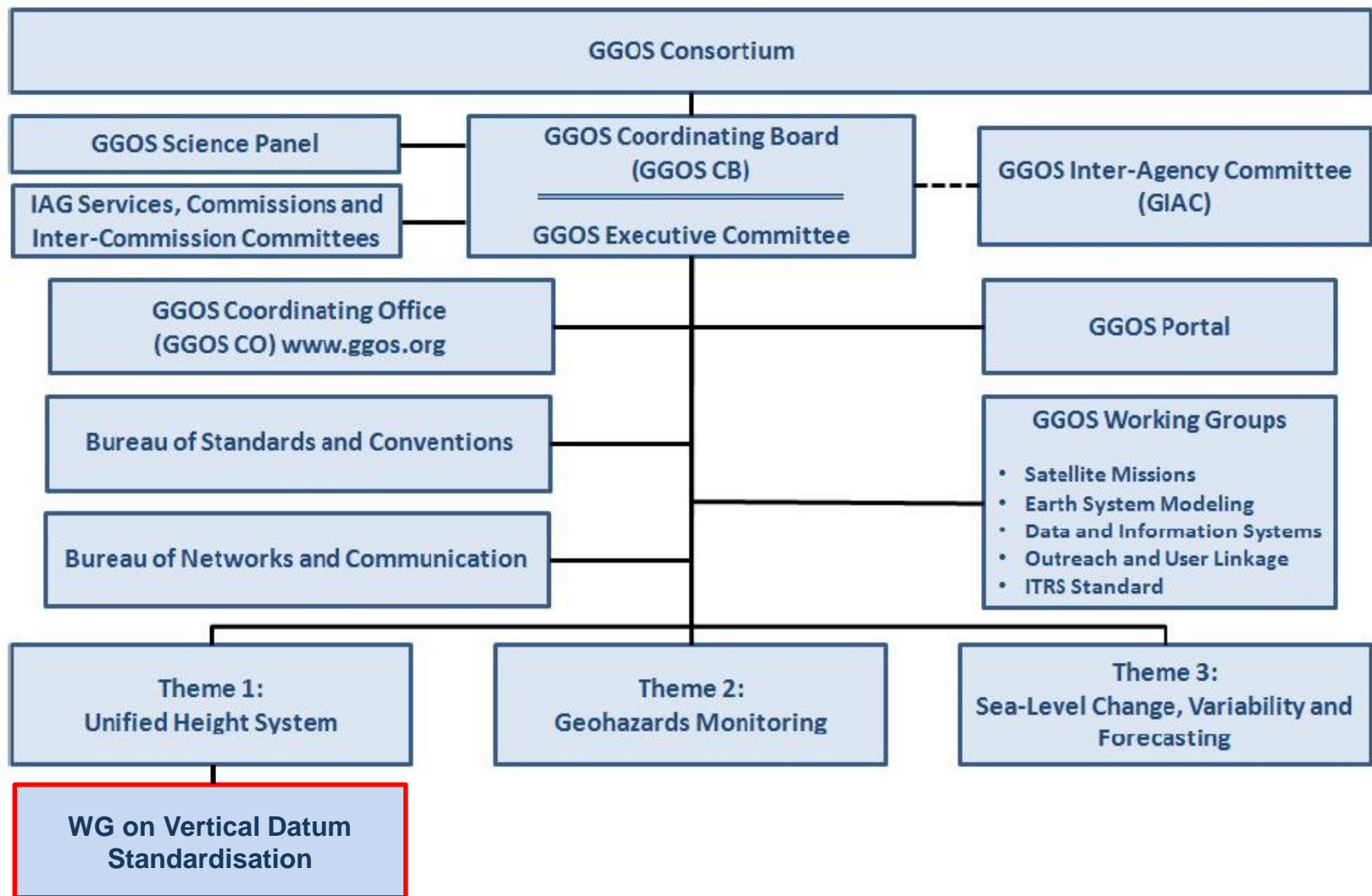**International Gravity Field Service**

Splinter Meeting @ GGHS 2012, October 11, 2012

Agenda
- Introduction to the WG
- The global reference level
- Local/regional realisation of the global reference level
- Website

A Unified Height System: a GGOS challenge

Global vertical reference system: definition and realisation

(IAG-ICP1.2: Vertical Reference Frames, Ihde et al. 2007)

Consistent modelling of geometric and physical parameters, i.e.

$h = H^N + \zeta\ (\approx H + N)$ in a global frame with high accuracy ($< 10^{-9}$)

Geometrical Component

Coordinates:

$h\ (t), dh/dt$

Definition:
ITRS + Level ellipsoid ($h_0 = 0$)
    a. (a, J2, ω, GM) or
    b. (W_0, J2, ω, GM)

Realisation:
    1. Related to the ITRS (ITRF)
    2. Conventional ellipsoid

Conventions:
    IERS Conventions

Ellipsoid constants, W_0, U_0 values, reference tide system have to be aligned to the physical conventions!

Physical Component

Coord.: Potential differences

$-\Delta W_P(t) = W_0(t) - W_P(t); d\Delta W_P/dt$

Definition:

$W_0 =$ *const.* (as a convention)

Realisation:

    1. Selection of a global W_0 value
    2. Determination of the local $W_{0,j}$ values
    3. Connection of $W_{0,j}$ with W_0
    4. Geometrical representation of W_0 and $W_{0,j}$ (i.e. geoid comp.)
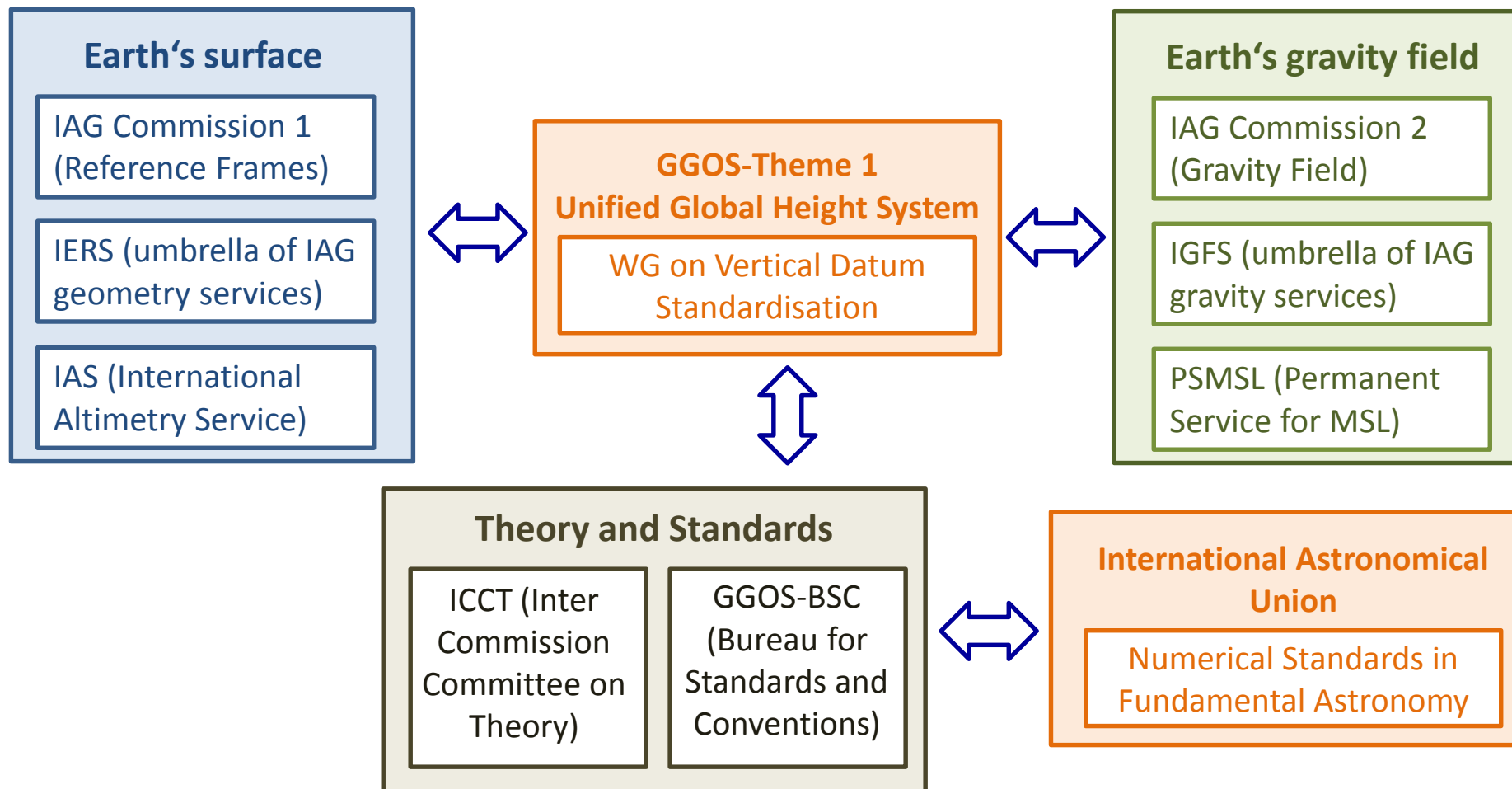   5. Potential differences into physical heights (H or H^N)

Zero tide system

01: Refinement of standards and conventions for the definition and realisation of a Global Unified Height System: identification of missing or out-dated standards and conventions necessary for the global height system realisation.

02: Divulgation and integration of the global height system standards and conventions within the IAG components (Commissions, Services, GGOS): disagreements with the existing standards and conventions of other IAG components shall be analysed and the corresponding updates (modifications) shall be implemented in order to achieve a homogenous set of common numerical standards, models, and procedures.

03: Establishment of a global vertical reference level: to make a recommendation about the W_0 value to be adopted as the conventional reference level for the Unified Global Height System. This W_0 value must also be promoted as a defining parameter for the computation of an improved mean Earth ellipsoid and as a reference value for the computation of the constant L_G within the IERS conventions. **A formal recommendation about the W_0 value to be adopted within IAG is a responsibility of the GGOS Working Group on "Vertical Datum Standardisation",** which is a joint initiative of GGOS Theme 1, IAG Commissions 1 and 2 and the International Gravity Field Service.

Interaction with other IAG/GGOS components

Earth's surface

- IAG Commission 1 (Reference Frames)
- IERS (umbrella of IAG geometry services)
- IAS (International Altimetry Service)

GGOS-Theme 1 Unified Global Height System

- WG on Vertical Datum Standardisation

Earth's gravity field

- IAG Commission 2 (Gravity Field)
- IGFS (umbrella of IAG gravity services)
- PSMSL (Permanent Service for MSL)

Theory and Standards

- ICCT (Inter Commission Committee on Theory)
- GGOS-BSC (Bureau for Standards and Conventions)

International Astronomical Union

- Numerical Standards in Fundamental Astronomy

One year ago:

- Three very close W_0 estimations (~0,2 m²s⁻²): Čunderlik et al., Dayoub et al., Sánchez et al. (computations started in 2005)
- One W_0 estimation far away (~2 m²s⁻²): Burša et al. (computations from 1999 thru 2011 produce the same value)

Today:

- Burša et al. estimation came close to the others.
- IERS includes the "old" Burša value, but this value has not been formally adopted or recommended by the IAG (nor IUGG).

What to do?

- To keep the IERS value, although it differs about ~2 m²s⁻² from the recent estimations?
- To recommend a (new) "best present estimate" for W_0?

If "a best present estimate" shall be recommended:
- should it be an agreement between (signed by) the four groups? (Čunderlik et al., Dayoub et al., Sánchez et al., Burša et al.)
- or should each group make an individual recommendation? If yes, who shall make the decision about the "best estimation"?

How shall the "agreed upon" recommendation be supported?
- a common position paper describing models and methods applied in the individual estimations?
- or individual papers (per group) and then a short common summary?

What about a WG (common) contribution for the GGHS2012 Proceedings?

Planned activities by the individual groups to refine their estimations: (still open questions)

- Combination of a "geodetic" sea surface model and an "oceanographic" DOT-model to reproduce a sea surface closer to an equipotential surface (geoid);
- Integration of polar regions on the Earth's surface representation;
- Differences between W_0 values obtained from a long-term mean sea surface model and yearly mean sea surface models;
- A formal procedure for the error propagation analysis.

Local/regional realisation of the global reference level

Possible strategy: Combination of geometric and physical heights?

Ellipsoidal heights:
- GNSS (mainly on land);
- Satellite altimetry (on oceans);
- Scanning geodetic techniques (SRTM, InSar, Lidar, etc.)
- …

Physical heights:
- Spirit levelling + gravity reductions
- Oceanic levelling (steric and geostrophic)
- …

(Quasi)Geoid models:
- Global gravity models + terrestrial (airborne, marine) gravity data.

Combination of geometric and physical heights

- Usage of different ellipsoid parameters
- Heights (h, H, N) in different tide systems
- Mixture of orthometric hypothesis (heights and geoids)
- Omission of levelling error accumulation
- Different reference epochs (unknown dH/dt)
- Different reductions (Earth-, ocean-, atmospheric tides, ocean and atmospheric loading, post-glacial rebound, etc.)
- Not appropriate error propagation analysis in the combination of satellite and terrestrial gravity data.
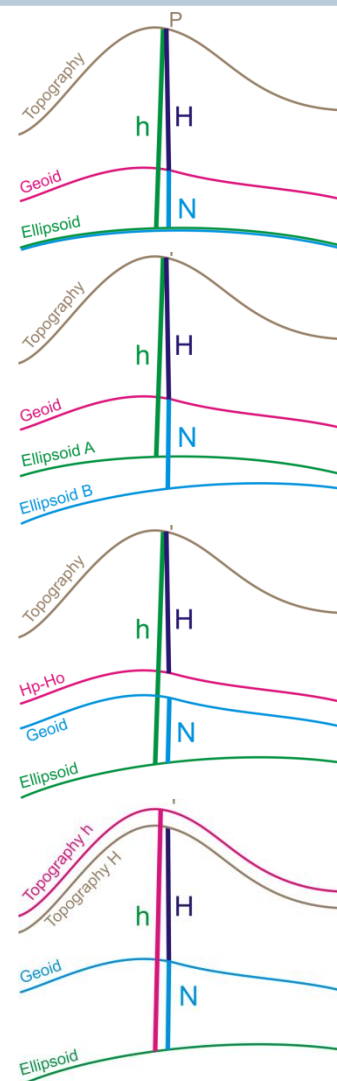
Combination of geometric and physical heights

- Ellipsoidal heights follow the IERS Conventions. Are there similar conventions for physical heights and geoid modelling?
- Taking into account (and advantage of) the experience of colleagues working on
  - regional vertical datum unification,
  - evaluation of global gravity models,
  - modernisation of height systems

  can our WG try to outline the basic standards to be followed by the three coordinates (h, H, N) to guarantee a consistent combination?
- How do you want to contribute to this topic?

At present:
- Terms of reference of the WG (objectives, plan of activities members)
- ICP1.2 Documents (Conventions, presentations, reports, meeting summaries, etc.)

What else?
- Terms of reference for GGOS Theme 1? (They are missing in the GGOS web page).
- A list of references with recent "vertical datum"-related publications?
- Symposium presentations of the WG members?
- ….?