

# IGCP 565 Workshop 3 Questions



**How can we bridge the gap in spatial scales between regional/global and point/catchment measurements?**

## **Reference Frame**

- Promote the development of an improved International Terrestrial Reference Frame. Densify network, produce consistent processing of 1000s of station. Use to georeference InSAR etc. (VLBI, SLR, GPS, DORIS)
- Need to improve the observation framework (by developing away to get observations easily and in same reference frame)

## **Modelling**

- Develop a consistent modelling framework for assimilating gravity, surface displacement, and rotation over range of scales in order to solve the problems of variation of observation density in both temporal and spatial resolutions. Community modelling framework for geodesy similar to the surface processes framework was suggested.
- Geodesy is at intersection of many fields (solid earth, tectonics, volcanology, hydrology, oceanography, atmospheric science, geotechnical, etc.). We need to tie geodetic observations to range of physical processes and observations from other fields.

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## **Modelling Continued...**

- Need to better understand the physics of processes and develop modelling techniques to improve smoothing and fill gaps in observation. (For example how to combine the separation of GIA from more recent deformation processes.)
- An earth system approach is needed to understand the physics of several processes which will help tie across the scales of observing systems.
- Need a way to provide uncertainty from models to be able to do data fusion and inversion. (not easy to do). Pin down errors from GLDAS and others.

## **Infrastructure Needs**

- Need observations on the ground as well as space (e.g. water well data, GPS, gravity, moisture, etc.)
- Need to encourage assistance in installing new instrumentation in developing countries (e.g. Africa).
- Encourage collocation of observation platforms to meet science goals and improve sustainability of long term measurements.

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*Developing the Global Geodetic Observing System  
into a Monitoring System for the Global Water Cycle*

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## **Outreach**

- Need to define what we need to do to support hydrology with geodesy. We need to increase interactions and mutual understanding of our science and learn hydrologic jargon.
- The concept of a geodesy center or portal was suggested. E.g. GRACE, IGS and other data. Currently there is no one stop shopping. Need to consider a range of models including GLDAS, WGHM, LaD that have different input data, different conceptualization of model, etc.
- It was suggested to contact the Hydrology Focus Group and CUASHI
- Collaborate with other geodetic groups and plans eg. The Long Range Geodesy Plan (see UNAVCO)

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## **How can we isolate long-term hydrological changes from secular effects due to tectonics, GIA, etc**

- Use hydrologic models to estimate secular effects. Need improved resolution and to be able to separate different hydrologic effects
- GRACE can provide secular in places like Africa where contamination from GIA is not a problem.
- Our understanding of long term hydrological signals is changing (not really secular).
- Establish validation points. E.g absolute gravity in Fennoscandia. Perhaps tie down one point precisely? Would this be useful for GRACE? (see previous question)
- Look at ratio between vertical and gravity changes to resolve mass changes.
- GRACE provides the hydrological storage term.
- International ground water assessment center in Utrecht source of long term secular signal model.

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### **How can we isolate long-term hydrological changes from secular effects due to tectonics, GIA, etc**

- Can compare coherence of tectonic vrs hydrological models at times to help separate sources of deformation. Can use separation of components of deformation (e.g. Horizontal vrs vertical) to test source models.
- Need to promote the acquisition of continuous long term time series. This can be a problem with space systems like GRACE. Need follow on systems and accurate bridging between them. Same for terrestrial. Need to encourage long term funding in a high level document that can be used by agencies.
- Need to encourage more local involvement in on the ground measurements to help ensure long term observations. E.g. In Africa AfricaRef is an African-led effort to establish two stations per country and openly share data from these stations. Also note new AfricaArray project.
- Also need to encourage international sharing of data, a key goal for GEO. The GEO portal a source of data. Governments realizing this is a problem. The ISO standard is accepted in GEO registry and user feedback is requested.
- Capacity building is critical for sustainability.
- Need multiple complementary observations for comparisons. E.G. GPS and GRACE. Greenland example. LiDAR. The more the better. Each has strengths.

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## **How can we improve measurement accuracy and robustness to seasonal and other artefacts?**

- Use combination of techniques, understand multiple processes such as atmospheric pressure loading. Bring the cryosphere into hydrological modelling. Need improved models for Antarctica as well as Greenland.
- Catalogue artefacts in geodetic data. Develop interoperability of observing systems. Develop and implement metadata standards and publish metadata about datasets.
- Not all seasonal effects are sinusoidal. Things vary from year to year. Need to have models that allow for this type of variability (see model section above).

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### **How can we improve infrastructure to build reliable services?**

Need sustained long term funding.

Encourage new observing systems (e.g. DESDynI, GRACE follow on, ICESatII, CryosatII, SWOT, SMAP etc.)

Encourage data sharing (great example is ESA and anticipated Sentinel open data policy). Individually and through groups such as WInSAR. Note the international Charter for InSAR might be built upon for other observations. Note the Supersites effort. Could extend to include hydrology.

Be able to do seasonal predictions for sustainability. E.g. Drought index, early warning for hydrological applications such as disease forecasting and landslide detection. This will help to increase societal relevance. Speak to sponsors and other stake holders with applications of interest to them.

Continued workforce development. Integrate geodesy into hydrological programs.

Multiple use of techniques. For example GPS multipath detection of snow, moisture, and plant growth. Also GPS met.

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## Additional Notes from plenary discussion:

1. Matt Rodell noted that you can get a conservative estimate of the uncertainty in the modeled water storage variations by taking the standard deviation of 4 GLDAS models (NOAH, CLM, VIC, Mosaic)
2. They are working on a 1948-present simulation with a more consistent meteorological forcing (input) dataset, which should enable more reliable assessment of interannual variability.
3. Near-future GLDAS runs with the Catchment land surface model and CLM 3.5, which include groundwater components, will enable better assessment of long term interannual variations and trends. Currently, the dynamic range of the modeled terrestrial water storage is often not large enough to characterize such variations/trends. Another issue is that models will miss trends associated with human impacts, such as groundwater mining, which are not modeled.

## Additional Notes :

For the point validation site(s) consider other areas such as at Wetzel. Want locations where point scales to local/regional so they are representative of larger areas. Not Karst area for example.

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