Breakout Session B1: Mission Requirements

Presentations included the topics: hydrology, ocean dynamics, GIA
Missing topics in the presentations: co- and post-seismic deformation, atmospheric topics, tectonics

Conclusions/recommendations/activities:

1. establish an updated version of the **requirements** table (accuracy, spatial and temporal resolution, time series length) for all applications, that will include 3 numbers: 1. Threshold, 2. Break-through, 3. Target
2. requirements should include **latency** issues
3. table should include **all theme's**: see Prof. Jakob Flury's table
4. **length of the time series** is the most important requirement
5. **advanced Earth system modeling** is required, including issues of separation of signals, de-aliasing, etc.
6. we underline the value of the established requirements in the report of the previous workshop of 2007

From the report of the previous workshop:
For the static gravity field:

Table 3-1: Static gravity field, scientific requirements in preparation for GOCE, from: Rummel (2005).

Static gravity field, scientific requirements in reparation for GOCE					
Application			Accuracy		Spatial resolution
			Geoid [cm]	Gravity [mGal]	Half wavelength D [km]
Solid Earth	Lithosphere/upper mantle density			1-2	100
	Continental lithosphere	Sedimentary		1-2	50-100
		Basins rifts		1-2	20-100
		Tectonic motions		1-2	100-500
	Seismic hazards			1	100
	Ocean lithosphere/asthenosphere			0.5	100-200
Oceanography	Short scale		1-2		100
			0.2		200
	Basin scale		~0.1		1000
Ice sheets	Rock basement			1-5	50-100
	Ice vertical movements		2		100-1000
Geodesy	Levelling by GPS		1		100-1000
	Unified height system		1		100-20000
	INS			~1-5	100-1000
	Orbits			~1-3	100-1000
Sea level change			Many of the above applications, with their specific requirements, are relevant to studies of sea level change.		

For the time variable field:

Table 3-2: Accuracy requirements.

Application	mm_{H_2O}/mon	mm_{H_2O}/yr	smoothing radius (km) ≥ 300	Timescales and Notes
Hydrologic basin total water change	10	20 (10)	400	days to decades
Glacier mass loss		2 (1)	300	seasonal, interannual
Ice sheet mass loss		20 (5)	1,000	
Oceanic gyres spinup or down		4 (1)	700	interannual
Global Sea level rise: thermosteric / eustatic		1 (0.3)	5,000	seasonal, interannual
Glacial Isostatic Adjustment		0.5 (0.1)	1,000	5-10 years

Update of the requirements ('break-through' values) on time-variable gravity:

Application:	Accuracy	Spatial resolution	Time scale Mission length	Temporal resolution	Remarks
Hydrology, ground water	Currently sufficient	0.01 – 250 km	Continuous observations	Down to hours and weeks	Latency: (near-)real-time
Ocean dynamics	Currently sufficient	Down to 200 km	Long time series		
GIA	Currently sufficient	< 200 km	> 15 years	Not critical	
Ice melt	Higher accuracy: mm				
Sea level	Higher accuracy: mm				

Other issues that need to be addressed:

Hydrology:
- isolating individual water storage components: no clue from Grace

Ocean dynamics:
- reduction of aliasing effects
- consistent modeling for separation of processes

Sea level:
- short-term (~10 y) sea level forecasting system

Conclusions/recommendations/activities:

7. establish an updated version of the requirements table (accuracy, spatial and temporal resolution, time series length) for all applications, that will include 3 numbers: 1. Threshold, 2. Break-through, 3. Target
8. requirements should include latency issues
9. table should include: see Jakob's table

10. length of the time series is the most important requirement
11. advanced Earth system modeling is required, including issues of separation of signals, de-aliasing, etc.
12. we underline the value of the established requirements in the report of the previous workshop of 2007

Rodell: Hydrology Mission Requirements for a GRACE-FO

Gravimetry is unique in its ability to monitor water at all levels.
Grace has been very valuable for hydrology.

Mission requirements for hydrology:

1. accuracy: 5-20%, Grace is sufficient
2. product latency: need real-time (on the order of days)
3. spatial resolution: needed scales 0.01 - 2,500 km, Grace too coarse
4. isolating individual water storage components: no clue from Grace
5. temporal resolution: most hydrological processes are on the h – wk timescale

Drivers for mission requirements for a follow-on:

- cost
- technology readiness
- limitations on resolution/accuracy due to aliasing
- cutting edge (space agencies' attitude towards monitoring missions vs new technologies/exciting new missions)

What to be done in the next period/activities:

- show what the benefits on smaller scales actually can be
- what type of products are to be assimilated for (near-)real-time applications

Discussion:

What latency do the hydrologists need? In particular, for operational applications it would be on the order of days. Is it actually feasible to have near real-time gravity data from a satellite mission? Depends on the type of product that is needed for assimilation. What latency could a Grace-FO achieve?

We have to realize that what is a signal for one application, is a nuisance for another. Hydrology, for instance, is a nuisance for GIA.

We have to come up with requirements for combinations of (usually linked) parameters, not for only one parameter.
Many type of missions and sensors contribute to the hydrology problems. On a priority list, where would be a gravity mission?

Dobslaw et al.: Gravity field signatures of ocean dynamics

Requirements for future gravity missions:

- Reduction of aliasing effects from short-term variability: is critical for satgrav accuracy over the oceans
- Continuation of time-series : e.g. inter-annual variations
- Increased spatial resolution: shelf areas and enclosed seas, down to 200 km
- Consistent modeling for separation of processes: OBP trends

Current accuracy is sufficient.

Steffen et al.: GIA requirements for future gravity missions: implications after more than 7 years of Grace data

Longer time spans sharpen uplift structures: The results for PGR are very dependent on the length of the time series of Grace data. For Europe, an analysis of 3 years of Grace data shows a big hydrological signal in Central Europe, while this signature disappears when analyzing 7 years of data.

For present-day GIA in Antarctica a higher resolution than the 400 km of Grace (e.g. go to 200 km) would be necessary in order to be able to discriminate between different ice models. This is relevant also for other causes of ice mass changes, like melt, and therefore also for separation of both signals.

What need to be studied:

- Regional signatures
- Lateral variations in the lithosphere
- Rheological and chemical composition of crust and mantle
- Uplift structures

Recommendations:

1. **Longer time series: > 15 years**
    - Reduce hydrology effect
    - Reduce tidal aliasing and system noise
    - Reduce amount of filtering
2. Higher spatial resolution, 200 km might already help
3. Temporal resolution not critical for GIA

Flury et al.: Time periods, spatial resolution, and accuracy: from geophysical requirements to mission scenarios

Requirements:
More spatial res
More time res
Better accuracy

Length of time series is critical: quick Grace-2, long term funding (missions operations costs)

Enough papers?