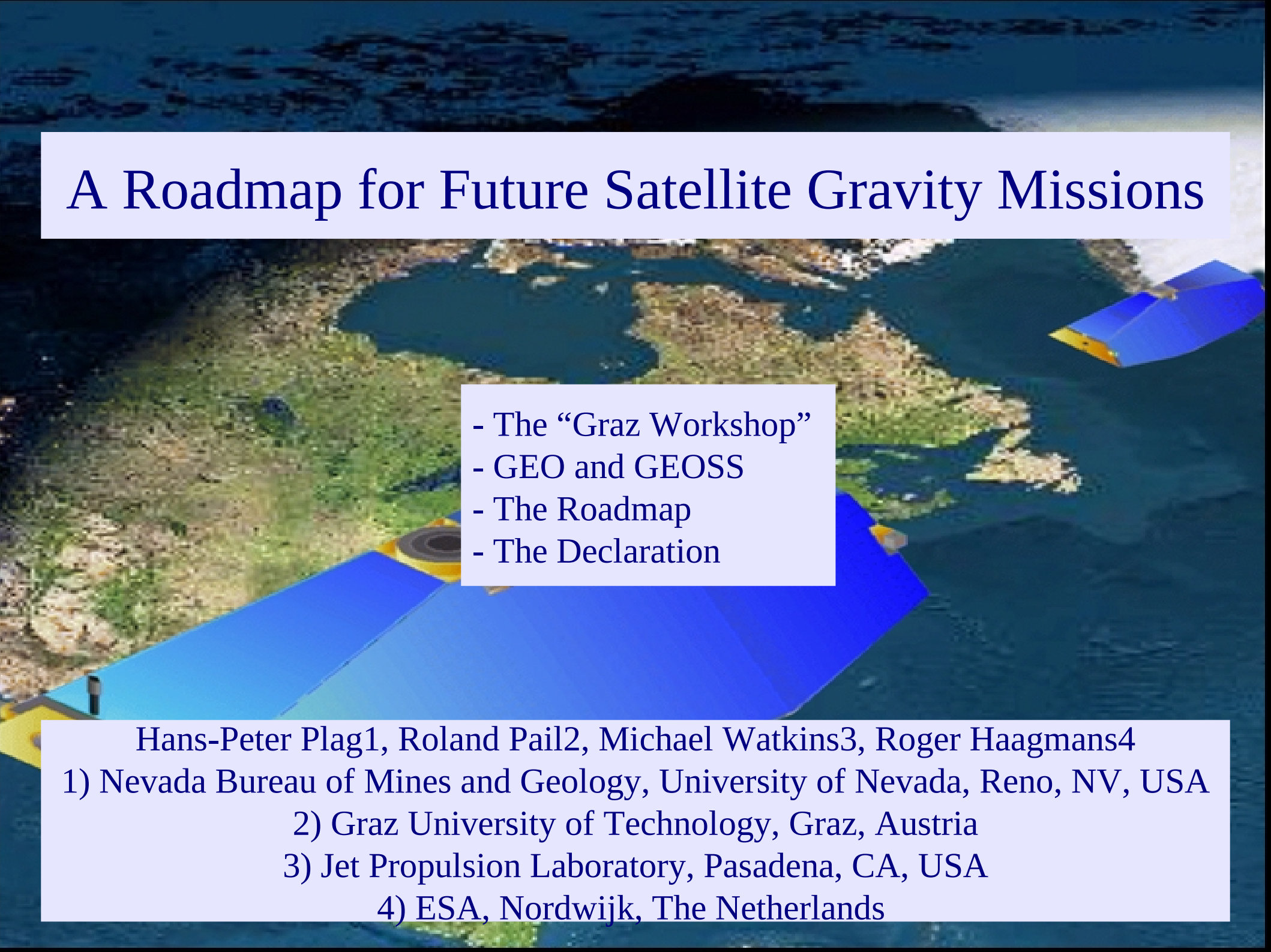
A Roadmap for Future Satellite Gravity Missions



- The “Graz Workshop”
- GEO and GEOSS
- The Roadmap
- The Declaration

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The Workshop

Towards a Roadmap for Future Satellite Gravity Missions
September 30 - October 2, 2009, Graz, Austria

GROUP ON EARTH OBSERVATIONS

Objectives of the workshop: The workshop aimed at bringing together stakeholders in satellite gravity missions in order to establis[illegible] future gravity satellite missions that would outline the sensor developments, mission concept [illegible]ments, and mission implementation, and that would be consistent with anticipations of the ma[illegible] with the needs of key user groups (such as [illegible]

In 2007, an international workshop on *The Future of Satellite Gravimetry* was held (see the Workshop Report) and attended by about 50 leading scientists representing relevant fields of science and technology. The participants agreed on a set of recommendations, which provided the starting point for the roadmap.

http://www.iag-ggos.org/workshops/Graz

The Workshop

Towards a Roadmap for Future Satellite Gravity Missions
September 30 - October 2, 2009, Graz, Austria

GROUP ON EARTH OBSERVATIONS

Output: [illegible] produce a roadmap document that could be submitted to the [illegible] endorsement and also to the CEOS Plenary and SIT for [illegible] anticipated output of the Workshop included:

- Roadmap for future satellite gravity missions;
- Workshop report on the Workshop Web page;
- Summary report in *Episodes*;
- A thematic issue of *Physics and Chemistry of the Earth*.

http://www.iag-ggos.org/workshops/Graz

The Workshop

- 55 participants from eleven countries and three continents
- European dominance
- Outputs produced:
  - roadmap (*)
  - declaration (*)
  - draft recommendations
  - one-page stories (*)

(*) Input to GEO Plenary

Experimental aspects of the Workshop:

- bring GEO and GEOSS to a science&technology community;
- create a forum for the discussion of user groups with data providers;
- produce output of value for GEO
- create channels for S&T communities to make their results better known to decision makers

http://www.iag-ggos.org/workshops/Graz

GROUP ON EARTH OBSERVATIONS

GEO, the Group on Earth Observations

An Intergovernmental group with 80 Members and 57 Participating Organizations

U.S. Department of State, Washington DC
July 31, 2003

GROUP ON EARTH OBSERVATIONS

What is GEO?

- launched in response to calls for action by the 2002 World Summit on Sustainable Development and by the G8 (Group of Eight) leading industrialized countries
- voluntary partnership of governments and international organizations
  - 79 member governments + EC
  - 57 Participating Organizations (PO)
- provides a framework within which these partners can develop new projects and coordinate their strategies and investments
- charged with developing GEOSS

GROUP ON EARTH OBSERVATIONS

What is GEOSS?

- the Global Earth Observation System of Systems
- an integrating infrastructure for Earth observing and information systems to support informed decision making for society
- 10-year implementation plan
- 2015: Global, Coordinated, Comprehensive and Sustained System of Observing Systems

GROUP ON EARTH OBSERVATIONS

GEOSS: A Global, Coordinated, Comprehensive and Sustained System of Observing Systems

Roadmap: Towards Future Satellite Gravity Missions

Contents:

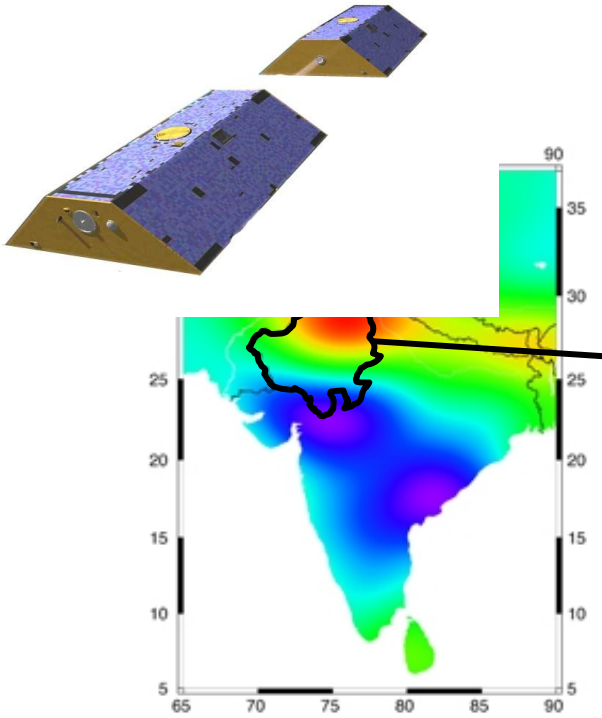
Roadmap: Towards Future Satellite Gravity Missions

Satellite gravity missions are a unique observational system for monitoring mass redistribution in the complete Earth system – no other sensors could do the same.

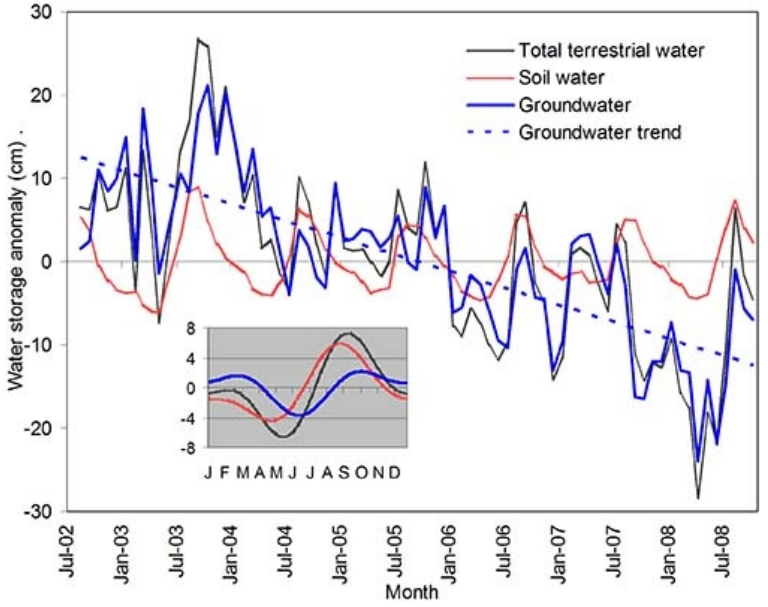
GRACE Quantifies Massive Depletion of Groundwater in NW India

The water table is declining at an average rate of 33 cm/yr

GRACE is unique among Earth observing missions in its ability to monitor variations in all water stored on land, down to the deepest aquifers.



Trends in groundwater storage during 2002-08, with increases in blue and decreases in red. The study region is outlined.



Time series of total water from GRACE, simulated soil water, and estimated groundwater, as equivalent layers of water (cm) averaged over the region. The mean rate of groundwater depletion is 4 cm/yr. Inset: Seasonal cycle.

During the study period, 2002-08, 109 km³ of groundwater was lost from the states of Rajasthan, Punjab, and Haryana; triple the capacity of Lake Mead

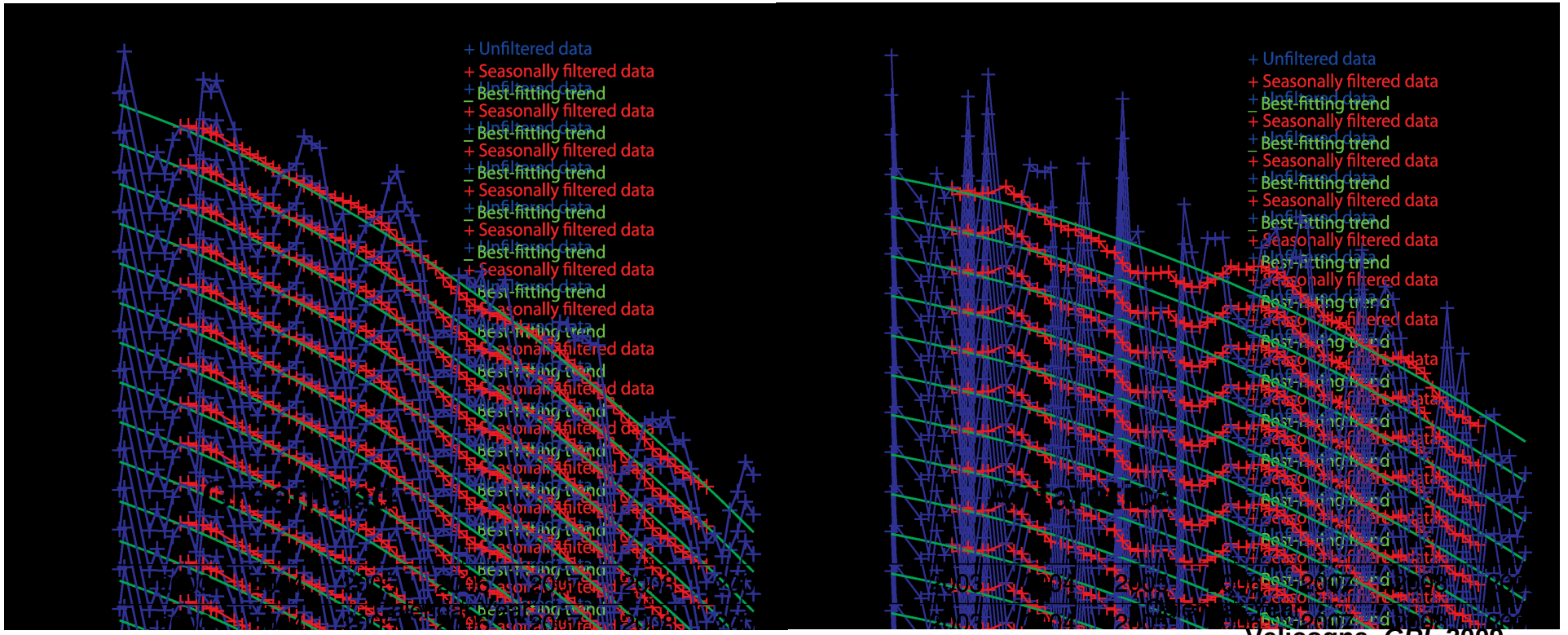
Rodell, Velicogna, and Famiglietti, *Nature*, 2009

GRACE Detects Accelerated Ice Mass Loss in Greenland and Antarctica

During the period of April 2002 to February 2009 the mass loss of the polar ice sheets was not constant but increased with time, implying that the ice sheets' contribution to sea level rise was increasing.

Greenland:
- mass loss increased from 137 Gt/yr in 2002–2003 to 286 Gt/yr in 2007–2009
- acceleration of -30 ± 11 Gt/yr^2 in 2002–2009.

Antarctica:
- mass loss increased from 104 Gt/yr in 2002–2006 to 246 Gt/yr in 2006–2009
- acceleration of -26 ± 14 Gt/yr^2 in 2002–2009.



Velicogna, *GRL*,2009

Roadmap: Towards Future Satellite Gravity Missions

STRATEGIC TARGET

A multi-decade, continuous series of space-based observations of changes in the Earth's gravity field begun with the GRACE mission, and leading, before 2020, to satellite systems capable of global determination of changes in the Earth's gravity field from global down to regional spatial scales and on time scales of two weeks or shorter, as a contribution to an integrated, sustained operational observing system for mass redistribution, global change, and natural hazards, and in support of global water management, the understanding of climate variations, and the characterization and early detection of natural hazards.

Roadmap: Towards Future Satellite Gravity Missions

THE WAY FORWARD: THE MAP

Activity 1: Science developments

1.1 Identifying the guiding science questions and application
1.2 Consolidating and reviewing user and mission requirements
1.3 Meeting the scientific challenges on the road to future gravity missions

Activity 2: Technological developments

2.1 Short-term developments
2.2 Medium-term developments
2.3 Long-term developments

Activity 3: Mission implementation

3.1 Facilitate the international co-ordination of science and technology activities
3.2 Develop a proposal for a virtual constellation for mass redistribution
3.3 Inter-agency coordination
3.4 Agency plans including operation

Activity 4: Processing, modeling and applications

4.1 Processing
4.2 Geophysical modeling
4.3 Supporting science and societal applications through a dedicated service

Declaration

Towards a Service for the Water Cycle

Noticing that

one billion people *are currently without sufficient access to clean* ***drinking water****;*

according to the 2nd UN Water Assessment Report, this deficit is a result of ***governance problems*** *and poorly informed decision-making;*

demand for water resources is rising *due to increased water usage for potable consumption, energy production, irrigation for agriculture purposes, industrial and urban uses, while climate change is locally to regionally impacting water resources through increased frequencies and magnitudes of droughts and floods;*

a better understanding of the water cycle on regional to global scales is critical for managing water resources in a sustainable manner;

Physical water scarcity Economic water scarcity

Source: International Water Management Institute

Declaration

Towards a Service for the Water Cycle

...

and recognizing that

*the **GRACE** satellite gravity mission has **demonstrated the ability to measure mass redistribution in the water cycle**, exemplified most recently by the detection of a decline in the water table in northwestern India between 2002 and 2008 of about 33 cm/yr due to groundwater withdrawals for irrigation; also exemplified by measurement of net decreases in the masses of ice stored in Greenland, certain regions of Antarctica, and Alaskan glaciers over the same time period;*

...

Declaration

Towards a Service for the Water Cycle

...

the Participants of the Workshop on a Roadmap for Future Satellite Gravity Missions declare that

*a **long and uninterrupted series of satellite gravity missions** with accuracies and resolutions at least as good as GRACE's is a **crucial element** of an observation system to adequately monitor the global water cycle and to improve our understanding of the processes and consequences of change;*

*such a **series of satellite gravity missions** would provide the **basis for a global service to inform decision makers** in a timely manner about ongoing and forecasted changes in the water cycle related to droughts, groundwater depletion, sea level changes, and other potential impacts of climate change.*

...

Towards a Service for the Water Cycle

...

Furthermore, the Participants of the Workshop have ***agreed on a roadmap towards future satellite gravity missions*** *and, with this declaration, bring this roadmap to the attention of the GEO Plenary, the governments of the GEO Member Countries, and the Participating Organizations in GEO in* ***an effort to initiate international action for the implementation of this roadmap****, for the benefit of science and society in support of a sustainable and peaceful development. The participants declare their support for this action.*

Post-Workshop Activities

Post-Workshop Goals:

- bring the roadmap to the attention of the GEO Plenary;
- a major international effort to implement the roadmap, i.e.
  * facilitate the science and technology development;
  * realize the missions.

Actions after the Workshop:

GEO Plenary, November 17-18, 2009, Washington DC: Distribution of Declaration and Roadmap

Co-located GEO Exhibition:

- GGOS booth: Slide show on GRACE
- Distribution on one-page stories
  - Groundwater level in Northwestern India
  - Accelerated ice loss in Greenland and Antarctica (also for STC booth)
  - GRACE and water storage in East Afrcia
  - Arctic Ocean Circulation
  - Ocean mass exchanges

Workshop publications:

- resolutions, report, summary, special issue in preparation

Longer-Term Perspective

Related Goals:

- Outreach to other disciplines to increase usage/benefits;
- Contact CEOS and GEO Water and Climate Tasks to increase support for roadmap
- UNFCCC: gravity/mass redistribution as a key climate variable

Important events in 2010:

- Ministerial Summit on Earth Observations. November 2010 in China;
- GEO Plenary, November 2010, China ...

Community Input needed sometime next year:

- Material for compeling examples that show the benefits of GRACE/gravity