The cross-cutting use of observations needed for climate across the Societal Benefit Areas identified by GEO

Discussion Paper

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GCOS Secretariat

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0. Purpose of this document

0.1 As part of the GEO process, to invite GEO members to consider a structured engagement towards better observations for GEOSS through:

- clear identification of observational needs of all Societal Benefit Areas (SBAs) identified by GEO
- developing an integrated approach, noting the mutually overlapping needs of each of the SBAs
- address Task US-06-01 in the GEO 2007-2009 work plan

0.2 In particular, the document illustrates a perspective from the needs of the Climate SBA in relation to all other SBAs, since geophysical observations required for both climate monitoring and climate research are being used in many application areas outside "climate". This document attempts to demonstrate this, on the basis of the GEOSS 10-year IP Reference Document (GEO, 2005). We hope it raises useful points for discussion, but recognize that it is not a unique perspective.

0.3 This document was presented to the GEO User Interface Committee at its session on 2-3 April 2007 in Geneva. The Committee recommended its wider distribution in the GEO community, including stakeholders from all SBAs, for comment and discussion.

1. The cross-cutting nature of observations

1.1 Task US-06-01 in the GEO 2007-2009 Work Plan demands the following: "Establish a GEO process for identifying critical Earth observation priorities common to many GEOSS societal benefit areas, involving scientific and technical experts, taking account of socio-economic factors, and building on the results of existing systems' requirements development processes." (Associated GEO Committee: User Interface; No lead for this task identified as yet; contributing entities are, e.g.: GTOS (Latham), WWW (Hayes), UNOSAT (Retiere), GCOS (Goodrich))

1.2 One of the 2-year targets for the Climate SBA in GEO (2005) calls for the following: "Coordinate climate sectors and broad user groups to clarify and specify requirements for socio-economic benefit areas (disaster prevention, health, energy, water resources, ecosystem, agriculture, and biodiversity) for climate products and information."

1.3 In the interest of a structured and integrated approach towards better observations for GEOSS, GCOS as a key contributor to the Climate SBA finds that it is necessary to address the nature of observations of geophysical variables (e.g., temperature, precipitation), which are, directly or indirectly, of common interest to most SBAs. These observations are taken *in situ* or by remote sensing, using ground-based, airborne or space-based instruments.

1.4 It is therefore important that the implementation of observing systems to meet the needs of the Climate SBA be carried out in close coordination with those in support of all other SBAs. It is especially important to recognize that, within each of the other SBAs, climate as the record of change, and the history of extreme events, is likely to have an often important bearing on aspects of relevant applications. For example, the Water and Agriculture SBAs are inevitably concerned with changes in precipitation amounts and patterns, and changes in land use.

1.5 GCOS has analyzed, with the assistance of the IPCC, the needs of the UN Climate Change Convention for systematic observation of the climate system, and thus generated a priority list of Essential Climate Variables (ECVs) for which sustained global coverage is believed to be in principle achievable within a decade. ECVs are geophysical variables that span the atmosphere, ocean and land surface and are thus likely to form a major part of the GEOSS purview. In fact, the UNFCCC objectives themselves also effectively concern a wide range of SBAs (e.g., Article 4 of UNFCCC, 1992). Observing the ECVs covers all the needs of the Climate SBA, including a major part of the observation needs of the climate research community. There are of course some additional geophysical and many other variables, which other SBAs have added as their requirements for GEOSS (see GEO (2005)).

1.6 Many observing systems in place to satisfy needs of the Climate SBA have been originally put in place to underpin weather prediction, explaining the particularly marked overlap between the observation needs of the Climate and the Weather SBAs.

1.7 To illustrate the cross-cutting role of climate-relevant observations within GEOSS, Table 1 below lists the ECVs, together with an indication of actual or potential application in other SBAs in mostly (near) real-time use. GEO (2005) provided a basis for Table 1.

Table 1. Cross-cutting (near) real time use of geophysical Essential Climate Variables (ECVs) in Societal Benefit Areas (SBA) other than Climate

SBA / ECV	Weather	Health	Agriculture	Water	Ecosystems	Biodiversity	Disasters	Energy
Atmosphere								
Surface wind speed and direction	X	X	X	X	X	X	X	X
Surface temperature	X	X	X	X	X	X	X	X
Precipitation	X	X	X	X	X	X	X	X
Surface pressure	X							
Surface radiation budget	X	X	X		X	X		X
Surface water vapour	X	X	X	X	X	X		
Earth radiation budget	X							
Upper-air temperature	X							
Upper-air wind speed and direction	X	X					X	
Upper-air water vapour	X							
Cloud properties	X							X
CO_2								
CH_4								
O_3	X	X						
Other greenhouse gases								
Aerosol properties	X	X					X	X

Oceans								
Sea-surface temperature	X		X	X	X			
Sea-surface salinity				X	X			
Sea level				X	X		X	X
Sea state	X				X		X	X
Sea ice	X				X			
Surface current	X	X			X			X
Ocean colour			X	X	X	X		
PCO_2			X	X	X	X		X
Sub-surface temperature	X		X	X	X			
Sub-surface salinity					X			
Sub-surface current					X			X
Sub-surface nutrients			X		X	X		
Sub-surface carbon			X		X	X		X
Sub-surface tracers								
Sub-surface phyto-plankton			X		X	X		
Terrestrial								
River discharge		X		X	X	X	X	X
Water use		X	X	X				
Ground water		X	X	X				
Lake levels	X	X		X	X	X	X	
Snow cover	X			X		X	X	
Glaciers and Ice Caps		X		X		X	X	
Permafrost				X	X	X		
Albedo	X							
Land cover	X	X	X	X	X	X	X	X
fAPAR			X	X	X	X	X	X
LAI	X		X	X	X	X	X	X
Biomass			X	X	X	X	X	X
Fire disturbance	X	X	X		X	X	X	
Soil moisture[1]	X	X	X	X		X	X	

1.8 In addition to the (near) real time use of direct observations or analyzed datasets, Table 2 notes the use of weather forecasts, seasonal-to-interannual forecasts, information on past climate conditions and future climate predictions in other SBAs.

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[1] Note that soil moisture was not listed in GEO (2005) as a required variable by the Climate SBA, but was recognized as an emerging ECV in the GCOS Implementation Plan (GCOS, 2004).

Table 2. Use of weather forecasts, seasonal-to-interannual forecasts and long-term climate predictions in Societal Benefit Areas other than Climate

	Weather	Health	Agriculture	Water	Ecosystems	Biodiversity	Disasters	Energy
Weather forecasts (0-30 days)	X	X	X	X			X	X
Seasonal-to-interannual forecasts (1-12 months)	X	X	X	X			X	X
Climate forecasts (beyond 12 months)	X	X	X	X	X	X	X	X

2. Examples

[SBA communities are invited to amend, and add to these examples]

2.1. Precipitation

Precipitation (frequency, intensity, quantity and type) is a key variable for all SBAs. It varies considerably in space and time and requires a high-density network to observe its variability and extremes on regional scales. Analysis of precipitation variability and change is crucial for the assessment of climate change and of the impact on nature, environment and human society. Changes in timing of precipitation (e.g., seasonality) can have implications for water supplies and agriculture. In particular, knowledge of surface precipitation (rainfall, snowfall) is important for the assessment of global water resources and for better understanding of the interaction between the energy and water cycle, as well as for the assessment of climate impact on ecosystems. Aspects are climate change impact on vegetation, desertification (duration of droughts, shift of climate zones), water resources, river runoff and floods (intensity and duration of extreme events), snow cover and ice sheet balance.

2.2. Sea-surface Temperature

Together with air temperature over land, sea-surface temperature (SST) is a fundamental indicator of the state of the climate system on all time scales. It is also critical for weather forecasting under certain conditions. In warm-water regions (T>26°C), SST appears to be a strong and sensitive factor for the formation of tropical cyclones, and for coral-reef bleaching (T>28°C). SST is directly important for fisheries management, the assessment of recreational opportunities, and the estimation of hazardous material spill impacts. It is also needed in the public health sector, such as for the prediction of invasive species vectors, the general assessment of ecosystem dynamics, and many other marine applications.

2.3. Land cover

Land cover is of direct and indirect importance for many SBAs. Land cover influences climate by modifying water and energy exchanges with the atmosphere, and changes sources and sinks of greenhouse gas and aerosols. Land-cover distributions are linked to the regional climate, so changes in cover can indicate climate change on a regional scale. Land cover and the change of land cover

affect the services provided to human society (e.g., provision of food, fibre, shelter etc.). Changes in land availability for agriculture, forestry as well as urbanization are key factors in sustainable development of many regions, and a major driver of land use conflicts. Land-cover distributions are intrinsically linked to biodiversity, land degradation, and ecosystem functioning and services, demonstrating the fundamental importance of land cover information for society.

3. Conclusions

3.1 Based on the issues raised in this paper, it may be helpful for all involved organizations and observing systems - across all SBAs - to define their observational requirements related to geophysical variables, identify areas of overlap and common interest, and follow a variable-based implementation strategy, with full recognition of the cross-cutting utility of many of the needed observations, networks and systems.

4. References

GEO (2005): *Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan and Reference Document*, GEO-1000R, February 2005, 209pp
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GCOS (2004): *Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC* (GCOS-92, October 2004)
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UNFCCC (1992): United Nations Framework Convention on Climate Change, 9 May 1992
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