An International Science Perspective on an Earth Observation System

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From the perspective of the international scientific research community, a coherent strategy for a global Earth Observation System must be built around a small set of high priority measurements that reflect our current scientific understanding of the global environment, its natural variability, and the effects of human-driven changes to it. Such an Observation System must be (i) focused and limited enough to be achievable and sustainable; (ii) consistent globally across all nations and regions with data available to all; (iii) continuous through time so as to avoid any gaps; (iv) established as soon as possible (every year's delay represents a year of data that can never be measured); (v) flexible enough to accomodate advancing scientific understanding; and (vi) linked to paleo-data to give a long-time perspective.

Of the hundreds or thousands of observations that could be made, how can a limited number be rationally chosen? One of the most powerful approaches is to base the strategy on the 'Achilles heels of the Earth System', those aspects of the global environment for which human activities can trigger abrupt and/or potentially irreversible changes. Examples include the rapid development of the ozone hole over Antarctica (although this is probably reversible) and the potential shut-down of the Gulf Stream in the North Atlantic. Many of the plausible abrupt changes that would have devastating consequences for modern society have occurred in Earth's past and could conceivably be triggered by human activities. A recent synthesis undertaken by the International Geosphere-Biosphere Programme (IGBP: www.igbp.kva.se) outlines the nature of these abrupt changes, our current understanding of the processes that lie behind them and the magnitudes and rates of human-driven changes

that are now impacting on Earth's environment at the global scale. This work contributes to the scientific basis on which an observation system can be built.

The global carbon cycle is an excellent example of an Earth System process of considerable concern. At present only half of the carbon dioxide emitted by fossil fuel combustion and deforestation remains in the atmosphere; the other half is absorbed by the ocean and by vegetation/soils. Thus, the Earth's environment currently provides a 'free service' by sequestering carbon and thus limiting the amount of climate change that would otherwise result from greenhouse gas emissions. However, the capability of oceans and land to absorb carbon dioxide is not indefinite or limitless. Simulations by Earth System models suggest that the ocean and land sinks for carbon will weaken during the second half of this century; in fact, the land sink may disappear altogether and could become a net source of carbon to the atmosphere. Thus, without sharp reductions in carbon dioxide emissions over the next few decades, the rate of global warming could surge later this century, an abrupt change with far-reaching consequences.

Observations of the global carbon cycle are clearly needed to identify sources and sinks and elucidate further their behaviour, to test the accuracy of simulation models and, importantly, to provide early warning of major changes in the behaviour of the carbon cycle. International collaboration among space agencies, in situ observation systems and the scientific research community via the Integrated Global Observation Strategy Partnership (IGOS-P: www.igospartners.org) is already meeting this challenge through the development of the Integrated Global Carbon Observation strategy (IGCO). The IGCO has distilled out of the hundreds of possible measurements related to the carbon cycle the 10 highest priority observations which together form a coherent, effective carbon observation system.

From the outset the IGCO has been developed in close collaboration with the scientific research community through joint workshops, cross-representation on panels and committees, and interlinked plans and strategies. International research on the carbon cycle is coordinated throughly the newly formed Global Carbon Project (GCP: www.globalcarbonproject.org), which is co-sponsored by four global change research programmes[1], including both the IGBP and the World Climate Research Programme (WCRP). The overarching goal of the Global Carbon Project is to develop a comprehensive, policy-relevant understanding of the global carbon cycle, encompassing its natural and human dimensions and their interactions. A global observation system for the carbon cycle is fundamentally important to achieve this goal.

The theme of close collaboration between the scientific research and observation communities is relevant for the entire range of Earth observations. Global change research is greatly enhanced by reliable, globally consistent observations of Earth; the design of an Earth Observation System benefits greatly from a strong scientific underpinning provided by the research community. The partnership between the observation and research communities is essential to provide all nations with the knowledge base required to deal with global change.

[1]The four international programmes that comprise the Earth System Science Partnership (ESSP) are DIVERSITAS (an international programme of biodiversity science); IGBP (International Geosphere-Biosphere Programme); IHDP (International Human Dimensions Programme on Global Environmental Change); and WCRP (World Climate Research Programme)