TITLE:

Earth Observations for Knowledge and for Development:

The Global Ocean Observing System.

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There are two main drivers for building an integrated observing system of the Planet. The first and more fundamental one is to obtain the knowledge about the natural systems that make life possible on the surface of the planet. The second one is to improve the performance of all the human activities, that impact the natural systems of the planet. Knowledge is connected directly with science, the *understanding* of the systems and their response to the perturbations imposed on them by the development of modern civilization. The use of the new information through applications is related to *development*.

This second aspect of global observations is at the core of "sustainable development". The implementation of sustainable development strategies requires improving the management of human activities and their interaction with the natural environment. This process is science-based and requires of the best technology available.

At least twice during the second half of the XX century, there were initiatives to turn the best technologies of the time to look at our own planet: to discover and conquer the inner space. It is an interesting paradox that in both occasions the political commitment went towards the exploration of outer space. There is no question of the huge benefits that space exploration has provided to humanity, however the reluctance to undertake a major effort to explore and monitor all the planetary systems affecting our environment, stands as a testimony of the limits of our collective foresight.

We urgently need to turn our science and technology inward to look at our own planet. Despite our late reaction, by so doing we shall acquire a wealth of knowledge that can

make our interaction with nature a more knowledgeable, friendly and beneficial to humankind.

The integrated character of the system we are building is essential. We need to integrate across the land, the ocean and the atmosphere, avoiding unnecessary duplications. But most importantly we need to integrate space-based information with improved *in-situ* instrumental networks. The ocean is "opaque" to electromagnetic radiation. Some measurements from space reflect accurately properties from a very thin layer of the ocean the so called "skin", few micrometers thick. Most of the space-based observations of the ocean depend on the extrapolation of the observed surface properties, to the vast volume of the Ocean. This extrapolation is inherently uncertain and inaccurate. We need to observe the ocean directly using the new technologies that are available.

The Intergovernmental Oceanographic Commission (IOC) of UNESCO, as the focal point of the UN for coordinating Ocean Science and the development of Ocean Services, has been engaged in the development of the Global Ocean Observing System, GOOS. The part of GOOS dealing with the physics of the ocean is the *ocean component of the climate observing system* that is responding to call made by the United Nations Framework Convention on Climate Change. We have help to develop a wide scientific consensus of what are the *in situ* and *space based* observations that are needed to start collecting the information to answer the main questions about climate change and climate variability. This consensus is reflected in Figure 1, as a ten year program for the deployment of a minimum system that satisfies the main requirements.

[insert FIGURE 1 near here;1/3 page]

GOOS will enlarge its current scope focused mainly on the dynamics of the ocean, to incorporate the continuous monitoring of the chemical and biological environments of the Ocean especially close to the coasts.

It is important to look at the Earth Observing System in all its dimensions and the economic one is fundamental.

The main feature of global observations is the very large scale at which they are collected. In the oceans, at each spatial and temporal scale there are specific properties that are related to that scale and others that "spill-over" to other scales. In theory, full forecasting capabilities would be available only if all scales are properly sampled. This is a huge technical requirement. In GOOS, what is a local observation collected in the East Coast of North America, becomes a "remote and distant" observation for a forecast in the North Sea, and vice-versa. If one wishes to extend weather forecast in the North America from 6 days to two weeks, information collected in and over the Pacific and Indian Oceans would be needed. A very clear picture of what is happening in and around the Indian sub-continent would be required.

From a practical point of view, there are absolute limits (spatial scale) beyond which appropriability of data from private observation networks face diminishing returns and a point where profitability eventually must break down. Data originating from the local scale,

where from an economic stand point can be considered a “rival good”, start loosing its “rival” character, as they are collected at larger scales, becoming essentially “non-rival goods” at the global scale. The logic of the systems to be studied and analyzed, call for a very open scheme of collecting and integrating the pieces of information into larger and larger pictures (technically “fields”) of known precision and accuracy. This integration is being done in real or almost real-time. The latest piece of information, let us say collected in the last six hours, coming from an isolated place has a larger value that start to diminish as times passes.

Since the potential users of these products come from a wide range of public and private activities, most of them on land, it is necessary to efficiently segment the markets between public and private agents, with the goal of maximizing total economic benefits to society. Although society might wish to directly recover the cost of collecting the data by selling the raw data itself, I am convinced that is the wrong approach. The benefits to society are increased by the free and open exchange of primary data and by allowing the development of a variety of specialist organizations that can tailor their products to the specific needs of their clients. These extra layers of specialists provide extra jobs, generate revenues and taxes and secure efficient servicing of final users. The specialists might as well develop additional observing networks to improve their products, and serve better their clients.

The building of Earth observations until now has been mainly the result from ¨science pushing”. For the completion of this effort, today we need to enlarge the “societal pull”. IOC and others have started to work directly with a variety of private users that are interested in trying the new information in their own daily management operations.

Companies and agencies involved in Energy, Power, Tourism, Building Regulations, Insurance and the Financial sector at large, have all expressed interest in working with us to better specify their needs of information. It is a simple truism that in order to build an observing system useful for a particular industrial application, one needs to know the requirements from that application. Industries are used to deal with risk assessment and liabilities. It is not that we are asking them to finance directly the investment, but we want them to demonstrate the utility of this information to themselves and in doing so help us to reveal the real economic benefits to society involved in earth observations.

Quoting from an internal report of the IOC to the 31st General Conference of UNESCO: *"The long-term challenge […] is to define a global framework in which the development of GOOS as a single, permanent, global, public-oriented service, can be achieved, with the active contribution of different segments of the society, including the private sector. This requires demonstration of the economic benefits of a common shared strategy between the public and private sector, the identification of the public and private services that can be derived and/or shared through a common observing platform and the appropriate segmentation of public and private products and users. Achieving this new vision will require the development, negotiation and adoption of international norms and agreements, especially in the area of data and information exchange and sharing"*.

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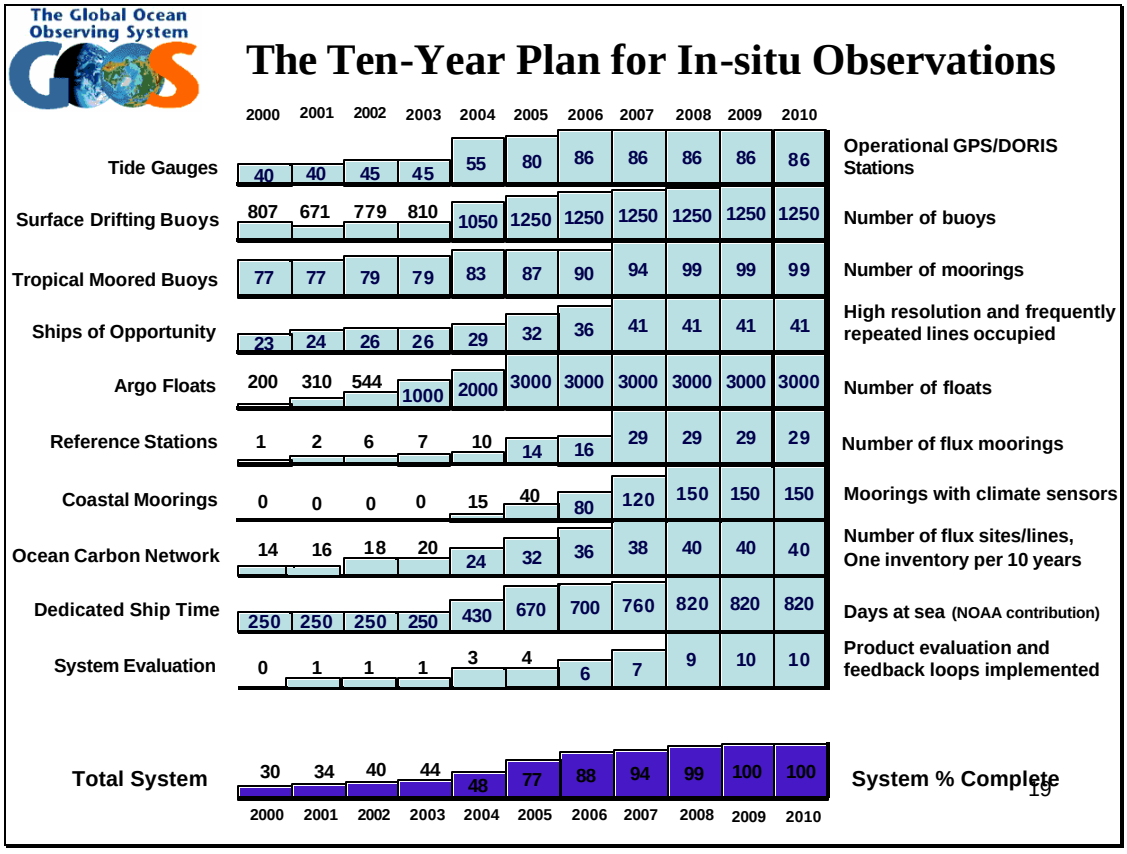
Figure 1


The Global Ocean Observing System
The Ten-Year Plan for In-situ Observations
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Tide Gauges
40 40 45 45 55 80 86 86 86 86 86
Operational GPS/DORIS Stations
Surface Drifting Buoys
807 671 779 810 1050 1250 1250 1250 1250 1250 1250
Number of buoys
Tropical Moored Buoys
77 77 79 79 83 87 90 94 99 99 99
Number of moorings
Ships of Opportunity
23 24 26 26 29 32 36 41 41 41 41
High resolution and frequently repeated lines occupied
Argo Floats
200 310 544 1000 2000 3000 3000 3000 3000 3000 3000
Number of floats
Reference Stations
1 2 6 7 10 14 16 29 29 29 29
Number of flux moorings
Coastal Moorings
0 0 0 0 15 40 80 120 150 150 150
Moorings with climate sensors
Ocean Carbon Network
14 16 18 20 24 32 36 38 40 40 40
Number of flux sites/lines, One inventory per 10 years
Dedicated Ship Time
250 250 250 250 430 670 700 760 820 820 820
Days at sea (NOAA contribution)
System Evaluation
0 1 1 1 3 4 6 7 9 10 10
Product evaluation and feedback loops implemented
Total System
30 34 40 44 48 77 88 94 99 100 100
System % Complete
19
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010