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DRAFT

Report of C-GOOS Chlorophyll Pilot Project Pre-Planning Meeting INCOIS, Hyderabad, India, January 21-22 2006

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Chair, GOOS Scientific Steering Committee

BACKGROUND

The GOOS Coastal Panel has recommended that GOOS Regional Alliances come forward with proposals for Pilot Projects for Coastal GOOS. In this context, Coastal GOOS includes non-physical variables measured in the open ocean. The GSC-8 meeting in Melbourne (Feb. 2005) suggested that estimates of chlorophyll *a* obtained from satellite ocean colour observations might make a good candidate for a GOOS pilot study. The aim would be to provide to a web server, regular ocean chlorophyll *a* images and associated products (daily, weekly or bi-weekly, depending upon each region's needs and conditions).

Concept

Ocean Colour, remotely sensed by satellite, provides a means of getting regular (sometimes daily) estimates of chlorophyll *a* and phytoplankton biomass at very low cost. These can revolutionise our ability to forecast harmful algal blooms (red tides) and can aid in fishing operations, fisheries management, and coastal zone management, *inter alia*. The time series generated by years of such observations have already led to explanations of haddock and shrimp recruitment fluctuations in the Northwest Atlantic. Thus there is great potential for other archives of satellite images of ocean colour to provide similar benefits elsewhere. It is therefore proposed that a few regions (such as the ones suggested below) form parts of a GOOS pilot study to make operational ocean colour observations on a regular basis in support of local and regional needs. Each region would need to have its own operation funded. GOOS has only limited funds to act as seed money and to link the regional databases, but would be able to help raise funds through being part of the GOOS pilot study network. It is envisaged that this would be a partnership between GOOS, POGO and the IOCCG, with the IOCCG providing the scientific and technical expertise. It is anticipated that the GEO, POGO, SCOR and IOC (?), could assist with the capacity building needed for the pilot study, and with the co-ordination. The study would also be aimed at contributing to the GEOSS.

A series of linked projects would provide a valuable comparison amongst different types of ecological environment (up welling regions, western boundary current areas, sub-Arctic and coastal seas). It would probably be of interest to the IOCCP (International Ocean Carbon Coordinating Project) and the IODE (data management) might be able to help in linking data centres together in providing regular ocean chlorophyll images of each region. POGO might be able to assist in capacity building and linking with leading oceanographic laboratories, and with advice on *in situ* measurements and calibration.

POGO

POGO has an important capacity building initiative in ocean observations: the Nippon Foundation – POGO Visiting Professorship Programme. Under this programme, Dr. Trevor Platt and a team of experts assembled by him spent several months in India in 2004-2005, training some 25 scientists from India, Thailand, Vietnam and Tanzania on analysis and interpretation of ocean-colour and on applications of the data for marine-ecosystem and climate-change related problems. The motivation for this initiative was regional capacity building and the development of a cadre of capable professionals to carry out such analyses into the future. The pilot project draws on human resources developed under this programme for the creation and development of an Antares-like network in the Indian Ocean region, and in South East Asia. Four of the NF-POGO participants (one Indian, one Tanzanian, one Thai and one Vietnamese) have been directly involved from the beginning in the development of the pilot study, and all of them attended the start-up meeting in Hyderabad.

POGO has, through its São Paulo Declaration, drawn attention to the observational gaps in the oceans of the Southern Hemisphere. POGO and its member institutions have taken several actions to fill the observational gaps, for example through the BEAGLE 2003 circumpolar expedition, organised by JAMSTEC (Japan) with international participation. Furthermore, POGO has a long-standing commitment to promoting biological observations in the ocean (the POGO Biology Report; give web reference). POGO also has a strong track record in capacity building activities in ocean observations. The POGO objectives of promoting ocean observations in the Southern Hemisphere, of promoting biological observations and building capacity in ocean observations all come together in the development of the Chlorophyll Pilot Study.

IOCCG

IOCCG, along with POGO, has helped establish and maintain Antares. The proposed pilot study meets one of the goals of IOCCG, which is to promote the use of ocean-colour data world wide. More generally, IOCCG is also committed to increasing the quality of ocean-colour data and to building capacity in this area.

GEO

POGO, IOC and GOOS are identified as the lead agencies in a work packet related to Ecosystems Societal Benefit Area in the GEO Work Plan for 2006 (Version 2):

> *EC-06-07: Build upon existing initiatives (e.g. ANTARES in South America for oceans and GOFC-GOLD regional networks for terrestrial domains) to develop a global network of organization-networks for ecosystems, and coordinate workshops to strengthen observing capacity in developing countries.*

THE RATIONALE FOR A CHLOROPHYLL PILOT STUDY

Chlorophyll concentration, as revealed by remote sending using visible spectral radiometry (ocean colour), represents the autotrophic biomass of the ocean ecosystem. Therefore, it is arguably the single most important property of the ocean ecosystem that we would like to know on synoptic scales. Moreover, ocean-colour remote sensing provides our only window into the marine ecosystem on these scales. Chlorophyll concentration has been identified by GOOS Report No. 148 (Table 1.2) among the 12 most important properties to be measured in a global observing system. Furthermore, the proposed pilot study will also deliver satellite-based observations of three other basic variables identified in the GOOS Report No. 148: suspended sediment load, attenuation coefficient of light in the water, and sea-surface temperature. Chlorophyll appears under Societal Goals and Relevant Products in Table 1.1 of the same Implementation Strategy, and in Table 1.3 as an essential Observational Requirement.

Moreover, a preliminary chlorophyll network (Antares) has been identified specifically in the GEO documentation (GEO WorkPlan for 2006, Version 2) as the kind of programme that is highly relevant to the GEO objectives and also structured in a way that can best serve the objectives of GEO. Promoting Antares and extending Antares-like networks into other parts of the developing world responds to the GEO recognition of the need to build capacity in Earth observations in general, and ocean observations in particular.

Advantages of a Network

The GEO Work Plan Version 2 stresses the value of networking to achieve the goals of GEOSS. Specifically, a networked series of regional pilot studies is envisaged, using common equipment and methodologies. This will avoid redundant duplication of software engineering, hardware sourcing, and protocol design for *in situ* observations aimed at ground truth. It will also promote sharing of existing infrastructure, including equipment, computer facilities. It will further facilitate inter-regional comparison of experiences, mutual help. In short, a networked pilot study would have the most cost-effective, most efficient structure providing the highest potential for enhancement through synergy. It is envisaged that this would also form a pilot study for the Global Coastal Network proposed in GOOS-148-COOP.

STRUCTURE OF THE PROPOSED NETWORK

Regions: Indian Ocean, SE Asia and China, South America (ANTARES), N. Atlantic, Benguela Region.
Duration of pilot project: Two phases of 5 years each.

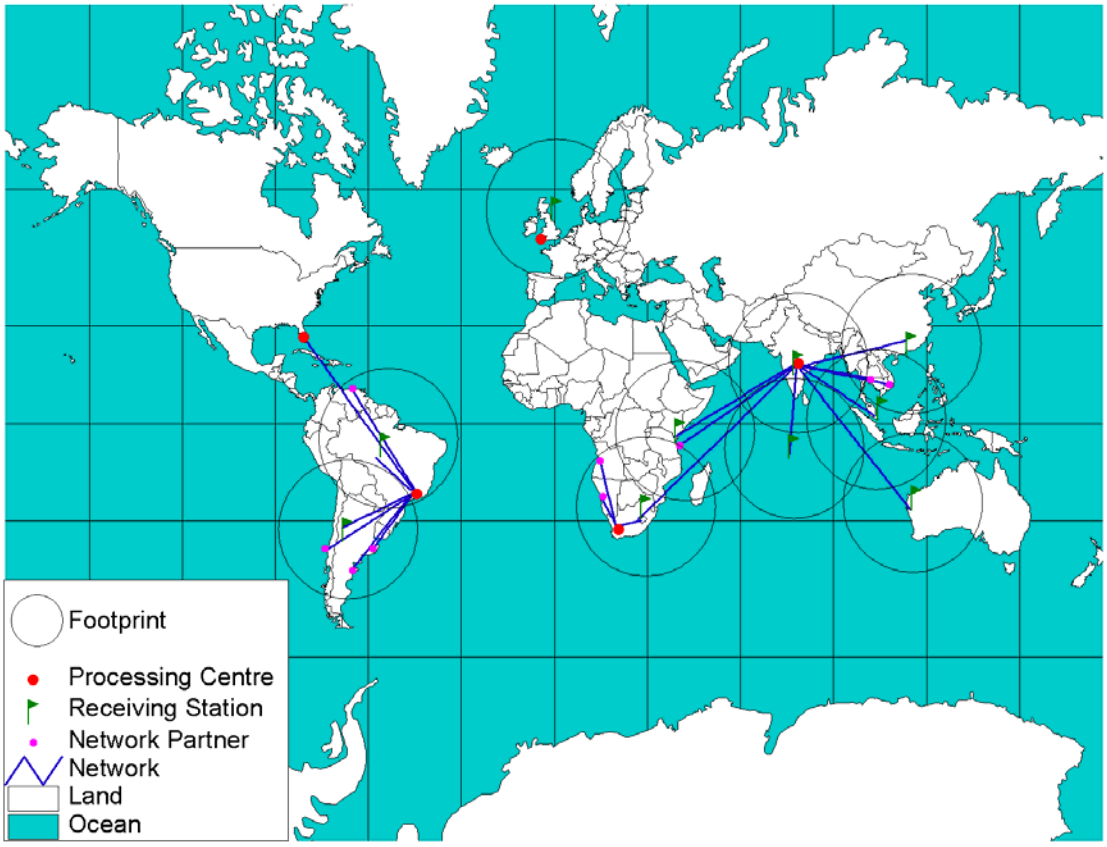
The network will have two technical components, one for satellite data and the other for related *in situ* time series observations to provide regional calibrations for the satellite data and to extend the observations to other variables not directly observable through satellites.

a) Satellite observation network

For satellite data to be made available in near real time for each region, it is recommended that data receiving capability is available in each region and that data processing is undertaken by a regional expert centre. Centres with sufficient expertise already exist for each of the regions in this pilot project, although the technical capacity of some regions will require strengthening (see regional descriptions). Another advantage of establishing regional capability for data retrieval and processing is that it will facilitate integration into the observing system of regionally relevant ocean colour data from future satellite missions by space agencies in, for example, India, China and Brazil. We anticipate this being trialled in phase II of the pilot project.

The map shows the proposed regional networks that will form the pilot project: NE Atlantic, Benguela (SE Atlantic), South America (Antares network), Indian Ocean and SE Asia. The satellite receiving stations will provide live data streams to the regional processing centres. The regional processing centres will then provide near-real time data products to regional partners and regional partners will in turn provide in situ validation measurements to the processing centres. The footprint of each receiving station is shown for an X-band antenna, required for MODIS data reception (radius of 2500 km). The proposed Indian Ocean array of antennae would give nearly complete coverage for this ocean basin. Several sea surface satellite data products of this sort are already being delivered almost routinely at three major centres of the proposed pilot study (Plymouth, Hyderabad, and Cape Town). A well established network for dissemination of data products and collection of in situ validation data already exists through the Antares network in South America.

Regional Elements of Proposed Network (for each region)



b) *In situ* network

It is recommended that the design of the *in situ* network should take into account issues related to different time and space scales that are intrinsic to the space and *in situ* observations. Since the pixel size of satellite observations is several orders of magnitude greater than that the space scales associated with typical *in situ* observations, direct comparisons between *in situ* and satellite observations are fraught with difficulties. Similar problems are caused by mismatches in the temporal scales of measurements. An extended *in situ* sampling programme, that incorporates measurements of atmospheric and oceanic optical properties, in addition to basic biological variables such as chlorophyll-a, will facilitate to break down the inter-calibration analysis into a number of steps that would help isolate the sources of differences between satellite and *in situ* observations (such as problems with atmospheric correction algorithms, sub-pixel variability, and limitations of chlorophyll retrieval algorithms).

A full-fledged bio-optical *in situ* observation programme would include measurements of water-leaving radiances and aerosol optical properties, profiles of in-water optical properties, spectral inherent optical properties of constituents of sea water, in addition to measurements of phytoplankton pigments, suspended sediments, temperature, and dissolved organic matter.

In establishing an *in situ* time series programme, we have to recognise that manpower and ship time requirements are likely to be considerable and should be accounted for appropriately in the regional budgets.

Note that not all members of the *in situ* time-series network need be full-fledged bio-optical time series sites. Scaled down versions that measure subsets of variables (such as pigment concentrations and inherent optical properties) would also serve a very useful purpose.

Management structure

The pilot project should be managed by a Project Coordinator, hosted by one of the network partners. Each of the regions will need part-time regional coordinator who will facilitate the partnership in each region. Regional user advisory groups will provide feedback on the service to the regional coordinator. Multi-regional expert groups, with representatives from each region, will deal with technical issues related to computing, satellite products and *in situ* measurements. Oversight of the project will be via an internal project management group and external steering committee, comprising representatives of sponsoring organisations and ocean colour experts.

The Way forward

A workshop/meeting will be needed to carry out these recommendations as modified by the GOOS Scientific Steering Committee and endorsed by the I-GOOS Board. This will be needed in the period mid - 2006 to early 2007. Plymouth Marine Laboratory has offered to host this meeting as it has the necessary facilities. It is recommended that the proposed meeting should have 3 components:

1. **Full-fledged co-ordination** meeting (ca. 15 representative PI's from all the proposed regions).
   Purpose: to recommend detailed mechanisms for practical operation of the chlorophyll network.

2. **Analytical cross-calibration workshop**
   Purpose: to ground truth satellite chlorophyll by measuring chlorophyll in water samples (in parallel) (ca. 10 experts from all regions).

3. **Satellite processing technical inter-comparison and capacity building workshop** (in parallel) (ca. 10 specialists from all regions).
   Purpose: to decide on technical specifications for products and recommend software for general use on network.

We request $50k from GEO towards the costs of this workshop, will seek to find the balance of funds from other sources.

TP, NHM, JGF
22.01.05

Appendix 1: Attendees of pre-planning meeting

Canada
Trevor Platt, Bedford Institute of Oceanography (chair)

Southern Africa
John Field, University of Cape Town
Lesley Staegemann, Benguela Current Large Marine Ecosystems, South Africa

South America: Antares
Vivian Lutz, INIDEP, Argentina
Milton Kampel, INPE, Brazil

Indian Ocean
T. Srinivas, INCOIS, India
R.S. Mohindra, INCOIOS, India
Phan Min Thu, Institute of Oceanography, Vietnam
Suryan Saramul, Chulalongkom University, Thailand
Margareth Kyewalyanga, Institute of Marine Science, Univ. of Dar es Salaam, Tanzania

UK
Nick Hardman-Mountford, PML/CASIX, UK
Nick Owens, PML, UK

From POGO
Jan de Leeuw, RNIOZ, the Netherlands
Shubha Sathyendranath, POGO Secretariat

Appendix 2: Agenda of pre-planning meeting

1. The requirements of Coastal GOOS
2. The advantages of chlorophyll time series
3. The example of eastern Canada
4. The example of Latin America (Antares)
5. The technical requirements for chlorophyll imagery
6. The value of a related *in situ* bio-optical programme
7. The candidate regions for initiation of new time series
8. What can be achieved through a network of time series
9. Organisational and funding requirements
10. The way ahead.

Appendix 3: Regional details and costing (omitted in this version)