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January 3, 2003

International Time Series Science Team
Report for POGO Meeting January 2003

The Time Series Science Team met with POGO sponsorship on February 16-18, 2002 in Honolulu just after the Ocean Sciences meeting and will meet again in February 2003 just before the EGU/EUG/AGU Meeting in Nice. At present Bob Weller (WHOI, USA) and Uwe Send (IFMK, Germany) are co-chairs and members include Philip Boyd (NIWA, New Zealand), Ed Boyle (MIT, USA), Francisco Chavez (MBARI, USA). Tommy Dickey (UCSB, USA), Dave Karl (Hawaii, USA), Tony Knap (BBS, Bermuda), Yoshi Kuroda (JAMSTEC, Japan), Richard Lampitt (SOC, UK), Joao Lorenzetta (INPE, Brazil), Roger Lukas (Hawaii, USA), Mike McPhaden (PMEL, USA), Liliane Merlivat (LODYC, France), Rodrigo Nuñez (SHOA, Chile), John Orcutt (SIO, USA), Svein Osterhus (Bergen, Norway), and Bronte Tilbrook (CSIRO, Australia). The composition of the Science Team reflects the intent that the time series be implemented as multi-disciplinary sampling stations.

The Honolulu meeting was the second meeting of the Science Team and had the specific objectives of laying the foundations for a White Paper, a brochure, and a website, collecting material documenting the diverse and significant uses of time series stations, and advancing the planning for a global array of time series stations. In the time since that meeting activity around the world directed at planning and implementing time series stations has increased tremendously and many of the members have directed their energies to support national and international programs planning and implementing time series stations.

This report is written to update POGO on these activities. There is considerable progress in establishing sites (the lead section below includes summaries of these) and much work being done in which time series are important or to support the development of the global time series array (the next section). An up to date array map showing the status of the array is included. Also included as appendices are the draft of the White Paper and the report from the recent Indian Ocean observing system planning meeting in the Mauritius.

The continuing support and visibility for the effort provided by POGO is critical, and the Time Series Science Team requests the continuation of that support. The summaries provided below do not include all activities but are intended to convey to the POGO membership the type of work underway. If POGO members know of other efforts to plan, implement or maintain time series sites, please email Bob Weller (rweller@whoi.edu) and Uwe Send (usend@ifm.uni-kiel.de) with information.

Specific Sites Recently Implemented or Being Developed

<u>European Programs</u>

In Europe, several projects have been initiated with European Union funding which have to goal of contributing to a global ocean observing system via the establishment of timeseries sites. Of these, the ANIMATE (www.soc.soton.ac.uk/animate) project has begun operation of 3 sites in the eastern

North Atlantic which collect physical and interdisciplinary observations and telemeter part of the data in real time. Recently funded were several projects related to the ASOF program studying fluxes in the arctic/subarctic ocean and which also include various timeseries observing elements, mainly for transports and fluxes of major current systems (asof.npolar.no).

J-PAC

A Japanese (JAMSTEC)-U.S. (WHOI and other institutions) effort is maintaining three time series sites in the northwest Pacific. Their website is http://jpac.whoi.edu/. Multidisciplinary, including physical, optical, nutrient, and biogeochemical, sampling is underway at three mooring sites. Moorings are deployed at sites K1 (50°N, 161°E) , K2 (47°, 160°E), and K3 (39°, 160°E). Turn-around cruises are scheduled for late summer/early fall each year. There is interest in developing a surface mooring, but this location is challenging, with icing and high waves, so technical progress is needed before this is possible.

NOAA OGP (continuation of TAO, PIRATA, addition of surface reference sites)

NOAA's Office of Global Programs provides support for the TAO array, which continues as an international collaboration, and for the PIRATA array, which is a French, Brazilian, and U.S. collaboration. On the TAO array, biogeochemical time series are being collected at two sites. NOAA OGP has also begun support of Surface Reference Stations at extra-tropical locations chosen in concord with the development of the plan for the global array of time series sites. One Surface Reference Station has been deployed off northern Chile under the stratus cloud deck since October 2000 and is serviced annually. Another is being maintained in the Caribbean at 15°N, 51°W. A third is planned for the vicinity of the Hawaiian Ocean Timeseries (HOT) site.

Design of Interdisciplinary Buoy for Bermuda Testbed Mooring and Hawaii Ocean Time Series Hale-ALOHA Mooring (Contributed by TommyDickey)

A new buoy has been designed by UCSB and WHOI under NSF sponsorship. The buoy has several features that will facilitate deployment of interdisciplinary sensors and systems (e.g., atmospheric, chemical, optical sensors, plus telemetry units) and is compact enough to fit in a standard shipping container. The new buoy is now deployed as the surface expression for the Bermuda Testbed Mooring and a similar buoy is scheduled for deployment in 2003 as part of the recently funded NOPP (under NSF management) MOSEAN Hawaii Ocean Time Series Hale-ALOHA Mooring program (contact: tommy.dickey@opl.ucsb.edu). Both of the Bermuda and Hawaii mooring programs are coordinated with the ongoing JGOFS ship-based Bermuda Atlantic Time Series (BATS) and Hawaii Ocean Time-series (HOT) programs (contacts: aknap@bbsr.edu and dkarl@soest.hawaii.edu, respectively). These collective programs welcome international cooperation for instrument testing and science experiments.

Gulf Stream and Kuroshio Mooring Design Effort

In parallel and cooperative efforts, the design for surface moorings to be deployed in the Kuroshio and in the Gulf Stream is being considered by surface mooring groups at the NOAA PMEL and at WHOI. The Kuroshio mooring is motivated in part by the

desire to obtain surface fluxes during the Kuroshio Extension System Study (KESS, A CLIVAR process study) and also by the desire to observe and monitor air-sea interaction in this critical region of the northwest Pacific where large heat loss can accompany cold air outbreaks and where the ocean may influence storm tracks. Japanese investigators also are interested in such a mooring, and the partnership to do the work would likely involve JAMSTEC. The Gulf Stream mooring is motivated by the desire to observe air-sea interaction during a planned CLIVAR study of 18° water formation and by the need to obtain in-situ air-sea flux observations in this critical but sparsely observed region of the North Atlantic, where air-sea exchanges are strong but also spatially variable and difficult to resolve with only Volunteer Observing Ship (VOS) data. WHOI is investigating the design of a surface mooring for a Gulf Stream site, and WHOI and PMEL are exchanging results of their mooring design efforts.

Design for Mooring South of New Zealand

There is interest in deploying a surface mooring at 173.8E, 56.19S. Discussions of the feasibility have been initiated between parties in New Zealand and the U.S. and a design study is to be proposed.

Time Series Science Team and Relevant Activities

Second Meeting

The Time Series Science Team met in Honolulu, 16-18 Feb 2002 (internal usage only, not a report for distribution). The following topics were addressed: requirements and rationales for physical, biological, geochemical, geophysical time series and different missions/objectives; how sites are selected; the need for real-time telemetry vs delayed-mode. In this discussion the strategy of maximizing benefit across disciplines was developed, so that, for example mid-basin sites would be selected based on the biological provinces they occupy, on physical oceanographic value, on what meteorological and air-sea flux regime they characterize, and on their geological (including seismic) merit. The groundwork was done to start to prepare a white paper, brochure, and website. The contribution of timeseries to the global ocean observing system and to "operational" oceanography was discussed as were data policy, quality and management issues. These issues included intercalibration, lessons from ARGO, options for timeseries implementation, required infrastructure, support from operational centers, distributed or centralized data serving, serving near-real time vs delayed data, drafting of data policy. The group discussed defining a "core" set of recommended multidisciplinary measurements, can this be defined, sampling rates, accuracies. Short basin-by-basin summary reviews of status were presented and material from each basin sought for the brochure, white paper, and website..

Climate Science and Observations

In many nations and in the international science community much work is underway to improve understanding of climate variability and change. Time series sites are important elements of the observing plans and will address key issues.

The WMO/UNEP/JSC Ocean Observations Panel for Climate (OOPC) saw the need for time series sites and developed rationales for them. The international CLIVAR

program (through its CLIVAR Ocean Observations Panel (COOP) and in its basin planning and implementation panels also has stated the need for time series sites. CLIVAR implementation is in its early stages, but establishment of long time sites in the ocean basins, some in challenging locations, is important to CLIVAR

International Carbon Cycle Science Plans also identify the need for time series sites, and members of the Time Series Science Team participate in Carbon Cycle planning as they do in CLIVAR planning.

It will be important for members of the Time Series Science Team to also participate in planning for the international Surface Ocean Lower Atmsophere Study (SOLAS).

In the U.S. an extensive review of climate science programs is underway. It is important that this review include the ocean perspective. There is talk of an international ocean observations summit initiated by the White House for summer of 2003.

Capacity Building

The GOOS Capacity Building Panel met in Geneva in June 2002. Bob Weller represented POGO. There was great interest in and support of the POGO fellowship program. With respect to time series, it was noted that the model of partnering institutions to foster technology transfer was a good one if it could be sustained, as time series technology while proven requires expertise developed through hands-on experience. It was also noted that ship time to deploy and service moorings is an issue in some countries and that POGO might help by working toward greater cooperative ship use and availability across nations.

Indian Ocean Workshop (Contributed by Mike McPhaden)

The IOGOOS Meeting (Mauritius, 4-8 November 2002) was hosted by the Mauritius Institute of Oceanography and sponsored by many organizations including IOC/GOOS, the WMO, International CLIVAR, NSF, NOAA, and ONR. The purpose was to advance planning for the development of an Indian Ocean Observing System in both coastal zones and the deep ocean. The coastal zone discussions covered a very broad range of topics (biodiversity, coastal erosion, pollution, sustainable fisheries, etc), while the deep ocean discussions focused primarily on climate issues. The meeting was attended by over 160 participants, many of whom were from the developing rim countries of the region. However, there was also a significant contingent of participants from the US, France, Japan, and Australia.

The deep ocean climate-related part of the meeting emphasized primarily development of in situ capabilities, especially Argo and moored buoys. A lot has happened in the two years since the GOOS meeting in Perth, Australia in November 2000 that has helped to stimulate planning and implementation efforts for these systems. We have a better understanding of modes of climate variability in the Indian Ocean, such as the Indian Ocean dipole and its relation to ENSO. The relationship of SST to subsurface variability in the equatorial and southern Indian Ocean is becoming better defined, and there are also hints of limited skill in predicting intraseasonal rainfall variations over the Indian subcontinent. Observationally, there is now a year's worth of TRITON measurements at 2 sites in the eastern equatorial Indian Ocean, and an exciting year long JAMSTEC subsurface ADCP record from an equatorial deployment. Several nations

have committed to Argo float deployments in the next few years, and many have already been deployed. The Indian Department of Ocean Development is planning to deploy up to 40 moorings in the seas around Indian north of 5°N. They have an engineering effort underway to develop a low cost, expendable surface mooring with a minimal set of surface and subsurface instrumentation for yearlong deployments.

An emerging theme of the moored buoy planning effort is that intraseasonal oscillations (ISOs) should be targeted as the primary phenomenon for study. These oscillations have been referred to as "the building block of the monsoons" because they affect monsoon active/break periods, the number of which determines whether it will be a good or bad monsoon year. Moreover, intraseasonal oscillations, in propagating through the atmosphere into the western Pacific, affect the evolution of El Niño as well as rainfall variability over the western US (even in non-El Niño years). At the conclusion of the meeting, an ad hoc working group of the Tropical Moored Buoy Implementation Panel was formed to further develop and refine implementation strategies.

Real challenges exist in developing an moored buoy array in the Indian Ocean, such as adequacy of shiptime, potential for fishing vandalism, data management, and funding. However, the situation is promising given the level of resource that is beginning to be devoted to observing system development in the region, and the spirit of international cooperation that pervaded the workshop.

U.S. Ocean.US Efforts

In response to a Congressional request that U.S. ocean observing activities be better organized an interagency office, Ocean.US, was established. In March 2002 they held a large workshop to consider U.S. ocean observing needs from the perspective of a diverse group of users (industry, recreational, science, defense, fishing). This workshop largely felt that the blue water observing plans were in good shape and focused on the coastal observing plans. Ocean.US is the mechanism for funding those in the U.S. who participate in the ARGO float program.

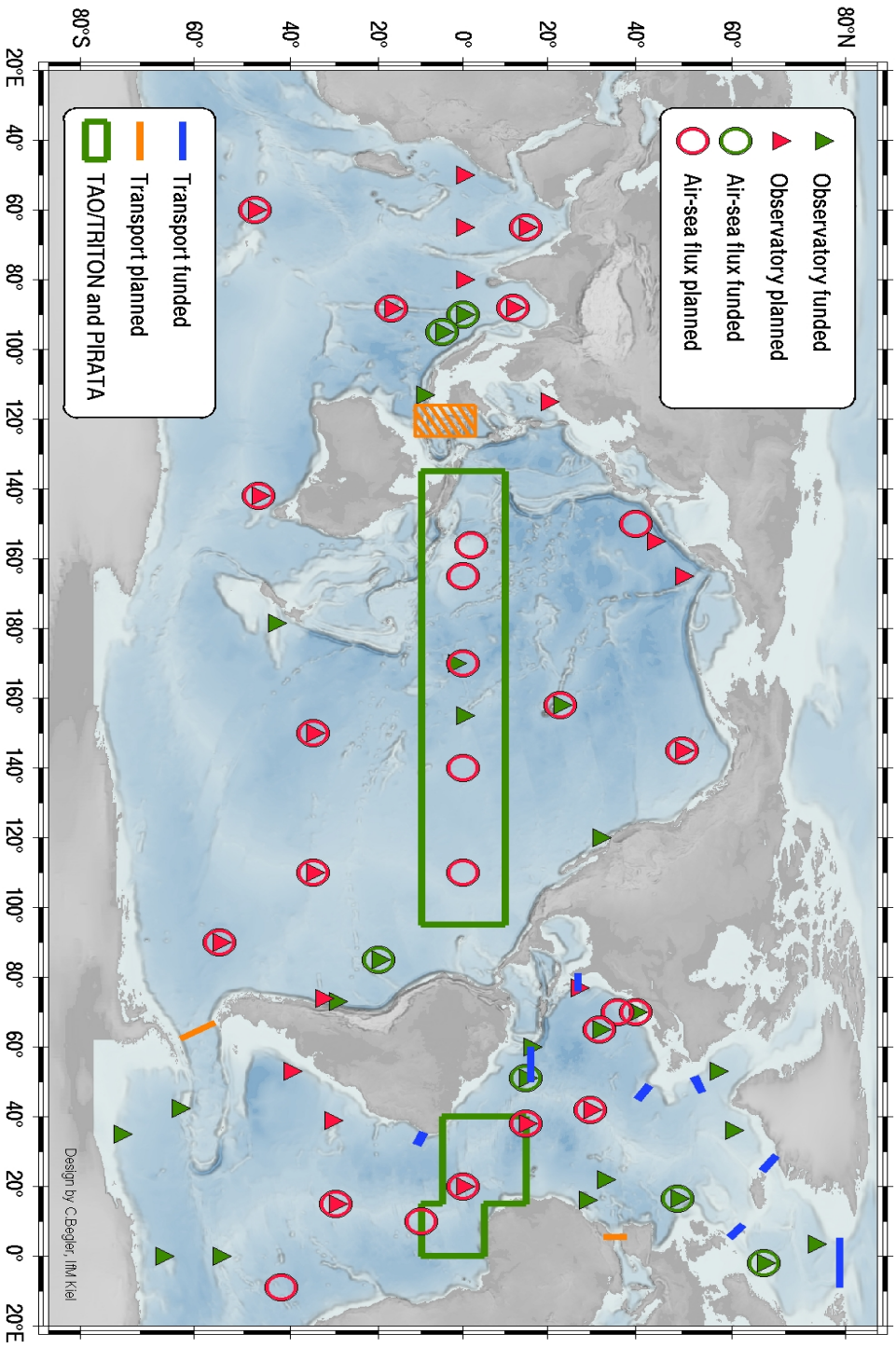
U.S. National Science Foundation's Ocean Observatories Initiative

The U.S. National Science Foundation has proposed a major funding initiative to support ocean observatory infrastructure. Development of this initiative and ongoing planning for it has involved the U.S. National Academy of Science's National Research Council (NRC), the science team DEOS (Dynamics of Earth and Ocean Systems), and many in the community (including many from the Time Series Science Team) and has led to many meetings, workshops, and reports over the last year. Briefly, the initiative would support the infrastructure of three types of observatories: regional observatories relying of cables on the seafloor for power and data communication, deep sea observatories that occupy the seafloor and water column, and coastal ocean observatories. Workshops have been or will soon be held on all three components. An NRC committee is presently reviewing the plans and writing a report. Members of the International Time Series Science Team have been active in all phases of this effort, with participation including team members from outside the U.S.

Third Meeting

The third Time Series Science Team Meeting is now being planned in for Villefranche, France in conjunction with the EGU,EUG, AGU spring meeting.

Figure: Present map of funded/proposed time series sites



Appendix I. Draft Time Series Working Group White Paper
Appendix II Mauritius Meeting Report