July, 2015

This slide set is provided as a general set of PowerPoint slides, with basic TPOS 2020 information, including impetus, project structure, guiding scientific questions and general project management overview.

This is a resource for you to present standard information, but is not likely to be in the order in which you would like to present. Please modify, rearrange, and enhance for your own presentation needs.

If there are specific areas of information that you think should be added or addressed, please email info@tpos2020.org.
The Tropical Pacific Observing System (TPOS) 2020 Project

Steering Committee Members

* **Billy Kessler** (Co-Chair)(NOAA/PMEL, USA)
* **Neville Smith** (Co-Chair)(retired, BOM, Australia)

* Ken Ando (JAMSTEC, Japan)
* Dake Chen (SIO, China)
* Sophie Cravatte (IRD, France)
* Tom Farrar (WHOI, USA)
* Harry Hendon (BOM, Australia)
* Dong-Chull Jeon (KIOST, Korea)
* Arun Kumar (NCEP, USA)

* Bill Large (NCAR, USA)
* Yukio Masumoto (U. Tokyo, Japan)
* Dean Roemmich (Scripps, USA)
* Pete Strutton (U. Tasmania, Australia)
* Ken Takahashi (IGP, Peru)
* Weidong Yu (FIO, China)
**ENSO Drove the Original Observing System**

- El Niño of 1982-83 – and the failure to recognize it until very late – was the impetus for the TOGA observing system.

- Original TAO designed to detect equatorial waves, then the key issue for diagnosis and prediction.

- TOGA observations led to an explosion of ideas in the 80s-90s that established our understanding of ENSO as an intrinsically coupled oscillation.

- Now, those issues are well understood, and we face a different set of problems.

*Figure 2. In situ components of the Tropical Ocean Global Atmosphere (TOGA) observing system at (top) the start of TOGA in January 1985 and (bottom) the end of TOGA in December 1994. Color coding indicates the moorings (red symbols), drifting buoys (orange arrows, one for approximately every 10 drifters), ship-of-opportunity lines (blue), and tide gauges (yellow). After McPhaden et al., 1998*
ENSO Diversity Presents New Challenges

- Today’s observing and forecast systems must adapt to today’s issues
- The lessons of the past 3 decades is ENSO diversity
- The potential for future surprises is high

- Our foremost goal remains to improve the ENSO forecasts, and thus increase seasonal prediction skill
The Tropical Pacific Observing System grew to include many platforms, and was a template for other basins.
The TAO/TRITON System is Vulnerable

Number of TAO moorings reporting data

Transition to NDBC
Ka‘ihi Moana retired
NDBC restored

TPOS Workshop, January, 2014

TRITON stations marked by an ‘X’ have already been removed.

TPOS 2020 is taking the opening created by the crisis of the TAO/TRITON array as an opportunity to rethink and reframe a better, more robust TPOS.
TPOS 2020 Workshop

27-30 January, 2014, Scripps Institution of Oceanography, La Jolla USA

• Review of observing system requirements and implementation
• Presentations on status of all aspects of system
• Presentations on potential new science and contributions
• 14 White Papers produced by 114 Authors

Chaired by: David Anderson and Toshio Suga
Report: Published April 2014 (www.ioc-goos.org/tpos2020)
The Workshop appointed a Steering Committee

First meeting: 6-9 October 2014, hosted by KIOST in Seoul, Korea

Results:

Task Teams and Working Groups appointed, defined:

- Backbone Observing System
- Modeling and Data Assimilation
- Biogeochemistry
- Planetary Boundary Layers
- Eastern Tropical Pacific
- Working Group on the western tropical Pacific
- Subgroup for Time-Series climate record

The SC at KIOST during the first SC meeting in October, 2014.

SC is composed of 15 members from 6 nations
TPOS 2020 Governance and Project Structure

* This role is currently being explored and developed
** This Task Team and its role are still under consideration
TPOS Executive

Still in the formational process, RF Co-chair remains to be identified

Composed of Steering Committee Co-Chairs, Resource Forum Co-Chairs, and the International Coordinator
Backbone Task Team
Co-chaired by Sophie Cravatte (Centre IRD de Noumea) and Susan Wijffels (CSIRO)

**Project Function:**
Through an integrated approach the Backbone TPOS will achieve its objectives through a combination of in situ and remote sensing approaches, augmented as appropriate with advice from models and data assimilation. Sampling for the Backbone has as its goal to:

(a) Observe and quantify the state of the ocean, on time scales from weekly to interannual/decadal;
(b) Provide data in support of, and to validate and improve, forecasting systems;
(c) Support calibration and validation of satellite measurements;
(d) Advance understanding of the climate system in the tropical Pacific, including through the provision of observing system infrastructure for process studies; and
(e) Maintenance and, as appropriate, extension of the tropical Pacific climate record.

**Plan is due July 2016 based on recommendations from the other Task Teams**
Planetary Boundary Layer Task Team  
Co-chaired by Tom Farrar (WHOI) and Meghan Cronin(NOAA/PMEL)

Project Function:
The Planetary Boundary Layer Task Team will tackle their objectives through ocean surface and near-surface process studies. The role of this task team is to identify which observing system requirements are best met via a sustained observing effort (>5 years) and which can be addressed with specific short-term process campaigns.

(a) Formulate strategy and sampling requirements to estimate air-sea fluxes over short (hourly) time scales across key ocean and climate regimes  
(b) Develop recommendations about needed boundary layer measurements including spatial and temporal sampling requirements, particularly to resolve the diurnal cycle  
(c) Consider a subset of regimes where direct eddy-correlation approaches might be used  
(d) Liaise with existing and developing ocean satellite and modelling community on efficiently meeting their present and future requirements for ocean surface data  
(e) Engage biogeochemical and ecosystem experts to ensure the needs of key gas exchange calculations are met.

Point of Contact:  
Associate Project Manager, Lucia Upchurch -> lucia.upchurch@noaa.gov
Biogeochemistry Task Team
Co-chaired by Pete Strutton (Univ. of Tasmania) and Adrienne Sutton (NOAA/PMEL)

Project Function:
The Biogeochemistry task team will evaluate and recommend the most promising foci for observation. The team will begin with carbon biogeochemistry as its core scientific concern. The team will consider primary productivity but not higher trophic levels.

(a) Develop strategies and design plans for the biogeochemical contributions
(b) Provide guidance to the Backbone TT for biogeochemical requirements needed in the redesigned TPOS
(c) Determine the temporal and spatial scales required for the observing system
(d) Provide a prioritized list of variables that will be measured as part of the BGC observing network
(e) Guide the implementation of BGC observations and evaluate new technologies and required process studies

Point of Contact:
Associate Project Manager, Ana Lara-Lopez -> Ana.Lara@utas.edu.au
Eastern Pacific Task Team
Co-chaired by Ken Takahashi (Instituto Geofísico del Perú) and Billy Kessler (interim co-chair)(NOAA/PMEL)

Project Function:
The Eastern Pacific Task Team will define observations necessary to the backbone observing system, as well as facilitate capacity building for improved sustained observing capability and facilitate the development of a regional research project that guides the sustained observing system.

(a) Determine the observational requirements, including time and space scales that should be resolved.
(b) Develop observational strategies and design plans for the region.
(c) Provide guidance as required to the Backbone Observing System Task Team and, as required, other Task Teams on strategies and plans for the region.
(d) Foster interaction and collaboration between the TPOS and other international programs that have an observational focus in the tropical eastern Pacific boundary region.
(e) Provide guidance on implementation and explore potential opportunities to collaborate with regional institutions for the implementation and maintenance of TPOS and its national components, and to evolve process-oriented boundary measurements towards a sustained system.
Modelling and Data Assimilation Task Team
Co-chaired by Arun Kumar (NOAA/NCEP)

Project Function:
The Modelling and Data Assimilation task team will evaluate the bias and errors in current models to develop a strategy to assimilate key observations to improve models and forecast capabilities.

(a) Evaluate key observations needed, time-scale and spatial coverage needed

Opportunities identified:
(a) A workshop on systematic errors in tropical models and prediction systems
(b) OSE workshop for improved understanding of sensitivity

Point of Contact:
Associate Project Manager, Hannah Dean-> hdean@oceanleadership.org
Sub-Projects and Working Groups

Sub-Project:
Western Boundary Region

Writing team to develop regional project plan (drawing on national/regional activities/plans). Potential future task team.

Working Group:
Time-Series Contributions to the Climate Record in TPOS

In TPOS 2020, we are considering fixed-point measurements that are contributions within an integrated system, including the tropical moored buoy array system.
There will be a criteria test at 110W, the group will interact with OOPC/OceanSITE, and will work to identify highest ranking sites and further locations.

www.tpos2020.org
TPOS 2020 Goals

• To redesign and refine the T.P.O.S. to observe ENSO and advance understanding of its causes,

• To determine the most efficient and effective observational solutions to support prediction systems for ocean, weather and climate services,

• To advance understanding of the tropical Pacific physical and biogeochemical variability and predictability.

TPOS 2020 will provide evidence-based, vetted advice pointing to an intelligent evolution of the observing system.
Guiding Principles

• Do not repeat the mistake of changing observing systems without adequate overlap and evaluation.

• Advance by observing the mechanisms connecting the equatorial thermocline and the free atmosphere. Challenge and guide model improvement.

• Foster a diverse-platform observing system to adequately sample ENSO’s rich multi-scale variability. Integrate tools that did not exist when TAO was designed: Satellites, Argo, new autonomous samplers…

• Beyond its monitoring capability, TPOS should serve as the backbone for essential ancillary and process studies (allowing others to propose and participate).
Follow the Project

• Email: info@tpos.org
• Website: www.tpos2020.org
• Twitter: @tpos2020
• Monthly Status Report: Mail list and Website Accessible
Additional Science Slides
TPOS Robustness has a physical component: Diversity of ENSO

The overall story is surprises.
Expect more …

**Lessons:**
1. Do not focus only on the challenges of today; tomorrow’s will be different.

   Focus on observing the physical processes that drive the tropical climate.

2. Build a robust TPOS. Multiple missions, multiple platforms, multiple sources of support. (ENSO is multi-scale)

3. Maintain and build long time series to detect and describe surprises, and climate trends.

**Niño 3.4 SST**

- Quasi-regular oscillations of the 1960s-70s
- El Niño dominance and 2 very strong events of the 1980s-90s
- “Central Pacific” or “Modoki” El Niños (and large mean changes)
It’s not just El Niño

The atmosphere is sensitive to changes in tropical heating, creating many kinds of tropical disturbances that radiate to North America.

One example is the Madden-Julian Oscillation, which powers heavy rain events on the west coast (“Pineapple Express”).

Radiating phenomena like this are common to all the tropical oceans.

Typical winter tropical Pacific anomalies preceding heavy West Coast precipitation events

→ 7-10 days before event

→ 3-5 days before event

→ Precipitation event
The Bjerknes feedback: Fundamental Coupling

Positive feedbacks couple thermocline slope, SST, zonal winds.

The coupling depends on communication links:
- between the thermocline and the surface
- between the free atmosphere and the surface stress/fluxes
(The above is glib and vague about how these links operate ... and so are models)
How does the thermocline communicate with the atmosphere?

The diurnal cycle is surprisingly important ... and its effect depends on background conditions. Can we teach this to models?

Turbulent dissipation during 10 days of 1991
White = Mixed layer
Red = Turbulent ε
TIWE (Lien)

- Much of the work of heat and momentum transmission to the thermocline is accomplished by the diurnal cycle.
- The diurnal warm layer is now thought to be a major factor in developing MJO events.
Boundary regions (western and eastern) will require specific attention:

Examples of issues in the Eastern Pacific (1/2)

Moorings in the Eastern Pacific are important for monitoring and provide continuous climate records in the most dynamic region in the Pacific and are of particular interest to western South America, but are the most vulnerable to vandalism.

Additionally, substantial data exists from western South America but is not available in a timely fashion (in contrast to TAO/TRITON, Argo, etc.).

It is highly desirable to operationally include these observations into TPOS.
Boundary regions (western and eastern) will require specific attention:

Examples of issues in the Eastern Pacific (2/2)

- Predictive skill beyond 3 months continues to be low in the Eastern Pacific.
- Model biases are likely a dominant factor, but need data and process understanding to improve them.

Long-standing and generalized biases in the eastern Pacific are the warm SST bias and the double ITCZ syndrome.

* 120E-80W, normalized by tropical means
The need for multiple platforms

Argo can be used to detect Kelvin waves and their impact on ocean temperature at the Peruvian coast – particularly valuable as the TAO array has been subject to high levels of vandalism in critical regions.

(figure from K. Takahashi)
Models remain a weakness of ENSO prediction

TPOS 2020 will not itself build models, but much of the impact of TPOS data is through models:

Analyses and reanalyses that synthesize diverse data sources, in situ and satellite.

Bad (biased) models can degrade TPOS data products.

One example where models need observational guidance:
The diurnal cycle is surprisingly important for the transmission of surface fluxes to the subsurface ocean. Heat and momentum are communicated downwards via mixing produced by afternoon heating/stratification. Models without these processes have cooler SST and weaker thermoclines (persistent biases).

Diurnal cycle composite at 2°N, 140°W.

Wind and current vectors, temperature shading.

Afternoon trapping, then downward propagation of $T$ and $u$ (and implied mixing) into the evening.

TPOS 2020 will support limited-term process studies to support model development.
CO₂ monitoring will be a key part of the new TPOS

Monthly SST, Winds and fCO₂ from the Equatorial Pacific

30-year record of monthly mean SST and surface ocean fCO₂
6°N - 10°S, 85°W - 165°E

Monthly dots:
• El Niño
• La Niña
• Neutral

Outgassing decreases during El Niños, but a regime change occurred after 1998:
Overall increase, but smaller ENSO signal.

TPOS 2020 will integrate CO₂ monitoring as part of the backbone observing system
How can we best use evidence-based system design, and how can we measure our success?

OSEs: “Many lives of an observation”
- Calibration of Satellite retrievals
- Model development, tuning, initialization, verification
- Trend detection
- Underpin evolving climatologies
- Process diagnosis

A typical OSE that tests only the initialization step is not a full evaluation, and the results depend on the particular model and its biases.

How can TPOS use OSEs to assess array configurations?

Data-based objective techniques to integrate global high-horizontal-resolution satellite data (SST, SSH) with sparse in situ profiles?

“Armor3D”: Satellites provide mesoscale, in situ tunes for vertical structure and large-scale.
New Platforms for Intermittent and Sustained Observations

Spray Glider Dive
- 3 km
- 20 cm/s (3-5 hr)
- Descend to 1,000 m and drift at this depth
- Subsurface layer
- Surface layer
- 1000 m
- 2000 m
- Descend to 2,000 m every 10 days and then rise to the surface measuring temperature and salinity

Saildrone, Surface Mets, up to 200 lb payload capacity

Wave Glider

Argo Global Array

Next generation buoys
Additional Project Mgmt Slides
Project Management “Lite”

• “Lite” Project Management
  • Enough documentation to properly manage, but not too much
  • Highlight:
    • Objectives and breakdown of work
    • Schedules and deliverable
    • Cross-dependencies and risks

• Distributed project management support
  • Washington, D.C. (USA)
  • Seattle, Washington (USA)
  • Hobart, Tasmania (Australia)
Distributed Project Office

Project Execution
• Scope Management
• Resource Management

Project Management
• Schedule Management
• Change Control Management
• Risk and Opportunity Management
• Effort and resource Tracking
• Engagement Action Plan Management
• Communication Management
  • Work Breakdown Structure (WBS)
  • Integrated Master Schedule (IMS)
  • Monthly Status Report (MSR)
  • Annual Work Plan (AWP)
This workflow will be modified in project year 2: Oct. 2015-Sept. 2016