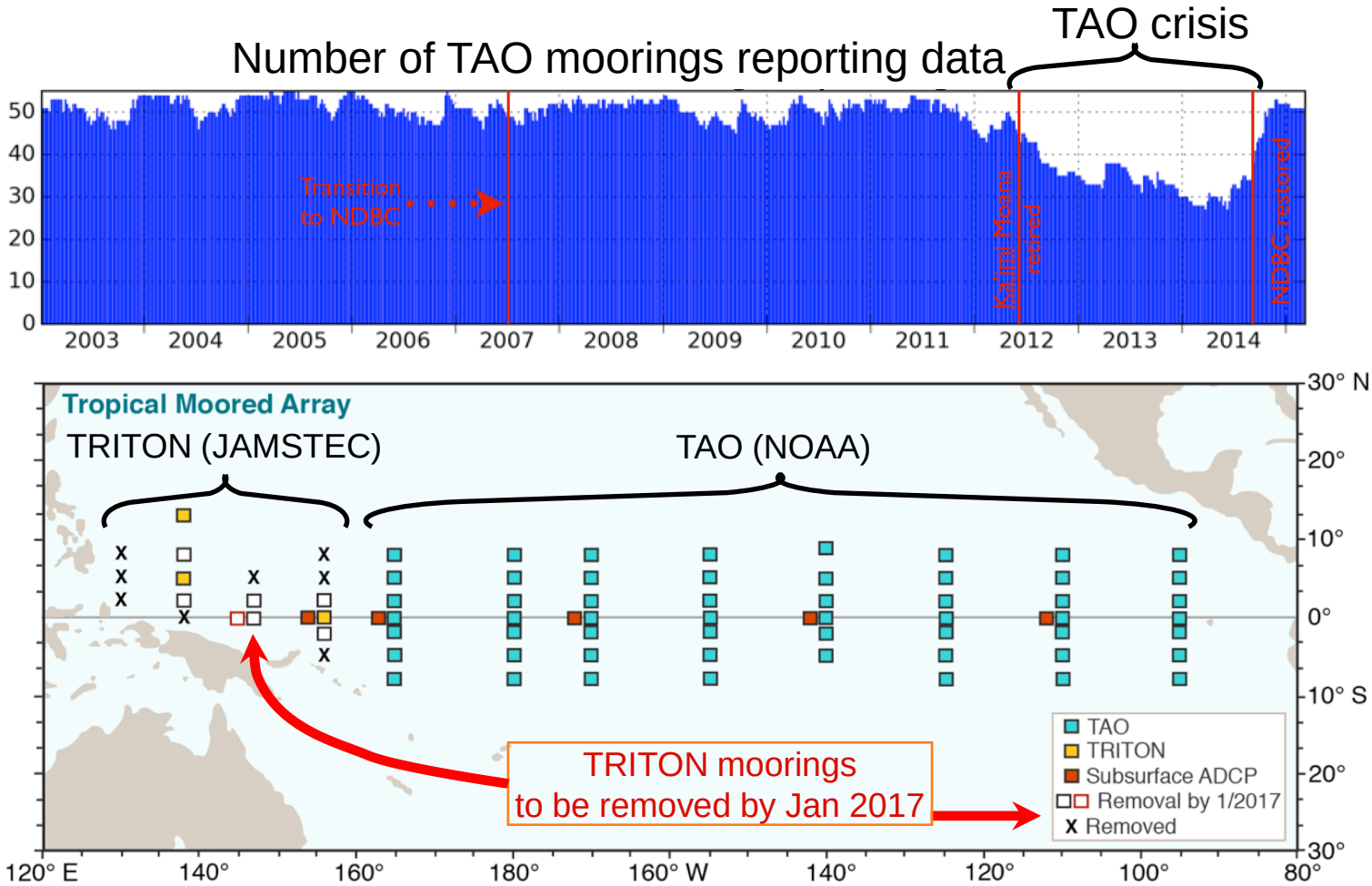
Tropical Pacific Observing System 2020 Update

Tony Lee
On behalf of the TPOS2020 Steering Committee

The TAO Array Crisis started in 2012



Need to re-examine the whole system, much of it designed 3 decades ago, in light of the development of other elements of the observational capabilities (both in-situ & satellites)

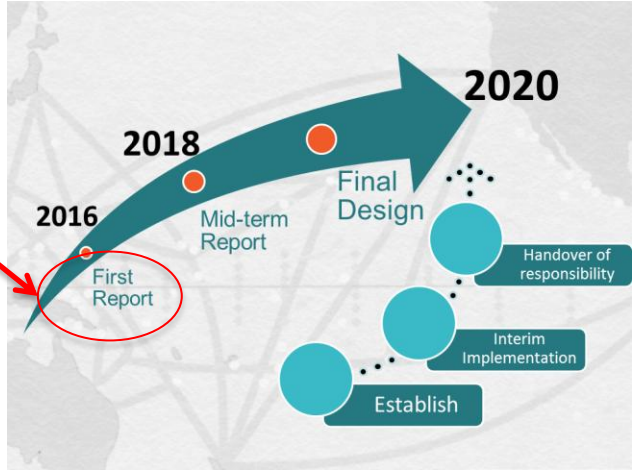
The TPOS 2020 Project (time limited)

- International project under GOOS (Global Ocean Observing System).
- Steering Committee: 15 members from 6 nations; chaired by Billy Kessler (US) and Neville Smith (Australia).
- Task Teams: Backbone System, Planetary Boundary Layer, Modeling & Assimilation, Biogeochemistry, Eastern Boundary, Western Boundary.

Goal: to redesign & enhance TPOS to improve

- monitoring & understanding of tropical Pacific physical & biogeochemical variability, esp. those associated with ENSO.
- predictions of the tropical Pacific coupled O-A system.

TPOS2020 First Report released Aug. 2016 for public review: the SC is addressing the feedbacks.



The TPOS 2020 First report

- Lays out rationales & plans for TPOS2020's first step of the redesign and enhancement.

- To provide sponsors with a means to justify and defend current and future investments in both sustained and experimental observations in the Tropical Pacific.

- Focuses on the fundamental and core contributions to the sustained observing system: the "Backbone system" of TPOS.

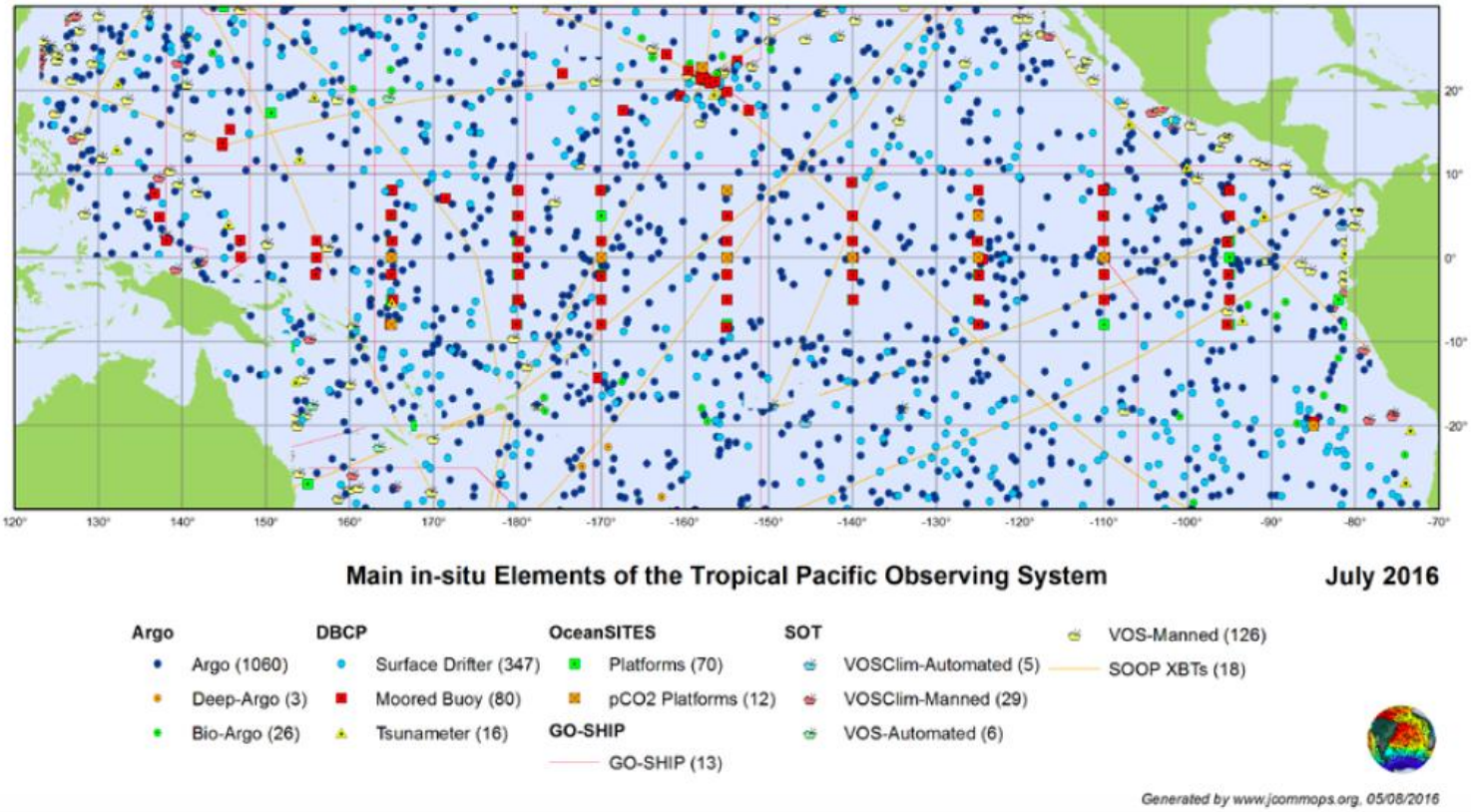
Design Principles

Five key functions of the backbone system:

- Provide data in support of, and to evaluate, validate and initialize, ENSO and other forecasting systems and to foster their advancement.
- Provide observations to quantify the evolving state of the surface and subsurface ocean (on time scales from weekly to interannual and decadal).
- Support integration of satellite and in situ approaches including calibration and validation.
- Advance understanding and modelling of the climate system in the tropical Pacific, including through the provision of observing system infrastructure for process studies.
- Maintain and extend the tropical Pacific climate record.

Table of Content of The TPOS 2020 First report

Current Main In-situ Elements of the TPOS



Regime-based redesign and enhancement of the Tropical Mooring Array (TMA):

- Equatorial regime
- Convective regimes
- Near-surface ocean

Recommendations from #1 to 9 (being refined)

Surface wind

Recommendation 1 A constellation of multi-frequency scatterometer missions and complementary wind speed measurements from microwave sensors. The latter ensure broad-scale, all-weather wind retrievals over the oceans for the next decade and beyond. A variety of orbits are needed for spatial and temporal coverage, including to resolve the diurnal cycle.

- Recommendation 2 In situ vector wind measurements, with particular emphasis on extending the in situ based climate data records, and inter-calibrating different satellite wind sensors both in the equatorial Pacific and in tropical rainy areas.

SST

Recommendation 3 Sustaining satellite measurements of SST, using infrared sensors for higher spatiotemporal sampling; passive microwave sensors filling gaps under clouds; and the diversity of platforms contributing to inter-calibration

- Recommendation 4 Maintenance of the current level of in situ SST observations and improvement of drifter SST quality. Both will to contribute to satellite SST calibration and validation, as well as providing an independent reference dataset for the SST climate record. Specifically target convective and rainy areas for SST ground truth, while keeping SST in situ measurements on moorings in the equatorial region.

SSH

- Recommendation 5 Continuation of the high-precision SSH measurements via the Jason series of satellite altimeters for monitoring large-scale SSH, and the continuing development of wide-swath altimetry technology to measure meso- and submesoscale SSH variations that are particularly energetic in crucial regions including the western boundary.
- Recommendation 6 Maintenance of in situ tide gauge measurements for the calibration and validation of satellite SSH, upgraded with global navigation satellite system referencing, and complemented by sustained temperature and salinity profile measurements.
- Recommendation 7 Continuation of ocean mass measurements to complement satellite SSH and Argo-derived steric height measurements, and in situ bottom pressure sensors to help calibrate and validate satellite-derived estimates.

Precipitation

- Recommendation 8 Continuation and enhancement of international collaboration for precipitation-measuring satellite constellations to sustain the spatiotemporal sampling of precipitation measurements in the tropics.
- Recommendation 9 Continuation of open-ocean in situ precipitation measurements for the calibration and validation of satellite-derived products, especially for de-aliasing diurnal variability and for providing a long-term climate record.

Recommend integrated approaches by satellite, moorings, Argo and others.

Recommendations from #10 to 18 (being refined)

Salinity

Recommendation 10 Synergistic use of satellite and in situ platforms to observe sea surface salinity. Argo provides more accurate measurements on larger space scales; satellite sea surface salinity provides higher spatial resolution, better coverage in marginal seas and better estimates of finer-scale spatial gradients. Tropical mooring measurements provide high-frequency SSS measurements.

Current

Recommendation 11 Continuation of technological developments to measure ocean surface currents remotely, and of in situ measurements of ocean surface currents, particularly near the equator. Provide co-located measurements of wind and surface currents at TMA sites. Maintain the surface drifters from the Global Drifter Program.

Color

Recommendation 12 Continuation of ocean color missions with appropriate overlap to facilitate inter-calibration for measurement consistency. In situ measurements for the calibration and validation of satellite ocean color measurements are required.

Flux

Recommendation 13 Enhancing in situ observations of state variables needed to estimate surface heat and freshwater fluxes in the western Pacific as well as under the South Pacific and Intertropical Convergence Zones in the west, and across the Intertropical Convergence Zone, the cold tongue and the seasonal southern Intertropical Convergence Zone in the east. These will help evaluate and improve atmospheric reanalyses, satellite-based surface flux estimates, and coupled data assimilation systems.

DA

Recommendation 14 Use an integrated combination of fixed-point moorings, profiling floats and lines/sections from ships to meet the sustained requirement for sub-surface temperature and salinity observations. Synthesis through an ocean model-data assimilation system is needed to produce the required gridded fields.

High Reso Obs

Recommendation 15 Enhancing meridional resolution and upper ocean sampling in the equatorial zone and near-surface ocean through a mix of (a) additional moorings near the equator, and additional upper ocean sensors on equatorial moorings with higher vertical resolution in the thermocline and above, and (b) if required, targeted enhancement of Argo profiles in the equatorial zone (approximately doubling density)

Current

Recommendation 16 Maintaining and, potentially, augmenting the sampling range of the Acoustic Doppler Current profilers on the five existing equatorial moorings

Argo

Recommendation 17 Doubling the density of temperature and salinity profile observations through the tropics, beginning with the western Pacific and the equatorial region (Recommendation 15).

DA

Recommendation 18 Coordinated program of model and data assimilation studies to (a) assess analysis products, and their utilization of historical and proposed TPOS data; (b) refine the TPOS design; and (c) identify and address biases in models and analyses, leveraging TPOS sustained and experimental observations.

Actions (targeted implementation in near future) (being refined)

- Action 1. The six former TRITON TMA sites in the western Pacific within 2° S to 2° N should be reoccupied.
- Action 2. Argo deployments should immediately be increased equatorward of 10° in the west (especially outside the TMA-occupied region) to increase subsurface temperature and salinity observations to the required sampling levels.
- Action 3. The Argo profiling density should be doubled over the entire tropical region 10° S-10° N.
- Action 4. Through the TPOS Steering Committee and the Argo Science Team, together test the feasibility of retargeting and optimizing Argo deployment plans for TPOS requirements.
- Action 5. Moorings at 1° S and 1° N at selected longitudes should be added to enhance the resolution of near-equatorial dynamics. Enhancement of instrumentation on all moorings from 2° S and 2° N at these longitudes should be targeted.
- Action 6. Staged reduction of the TMA in the trade wind regions should begin with the outermost sites that are not the focus of regime enhancements.
- Action 7. Efforts to understand the sensitivity and diagnose the impact of TMA air-sea flux variables in weather prediction, atmospheric reanalyses and coupled models should be renewed and coordinated, including through existing activities focused on the impact of observations.
- Action 8. The Transition Group should initiate discussion with TPOS stakeholders on sustainable solutions for the western Pacific and in the eastern region, especially for the needed TMA contributions.
- Action 9. All equatorial mooring sites should be upgraded to mixed layer flux moorings.
- Action 10. Meridional lines of surface flux sites should be extended from the equator to intersect both the South Pacific and Intertropical Convergence Zones in the west, and across the Intertropical Convergence Zone, the cold tongue and the seasonal southern Intertropical Convergence Zone in the east.
- Action 11. Underway pCO2 observations and the present network of moored pCO2 measurements should be maintained and possibly extended.
- Action 12. Through the TPOS Resources Forum, the TPOS Transition Group, and through links to research programs and funders, support should be advocated for Pilot Studies and Process Studies that will contribute to the refinement and evolution of the TPOS Backbone.
- Action 13. In consultation with key stakeholders, including GOOS, JCOMM and WMO/WIGOS, a transition process should be initiated, including the creation of a TPOS 2020 Transition and Implementation Group, for overseeing implementation of TPOS 2020 Recommendations and Actions.

The "Wyrtki Challenge"

- To examine TPOS' ability to close volume, heat, and freshwater budgets of the Tropical Pacific Ocean (introduced in GOV 2015).

- Specific questions to address:
  - Are we missing high-frequency (e.g., sub-monthly) contributions to meridional heat and freshwater fluxes?
  - Are the western-boundary currents and Indonesian throughflow monitored adequately?

- Need GOV & CLIVAR/GSOP groups to perform assessments based on multiple models – tasks to complete before the next OSEVal-TT meeting.

- Groups already signed up: ECCO, Mercator, BlueLink? Others?