Action Items Finished from Last Summit

- **Letter on US fleet concerns (by Renellys Perez and Peter Ortner)**

- **Letter on developing a mechanism to promote sustainability of ocean observing systems (by POS members)**

- **International Quality Controlled Ocean Database (IQuOD) update**

- **US CLIVAR continues to support OpenAD development, which is an important tool for ocean data assimilation community (ECCO aims to transition from TAF to OpenAD in the next 5 years)**

- **WG on Arctic climate change and mid-latitude interactions (by X. Zhang and J. Cohen)**

- **WG on global warming hiatus and deep ocean warming (by P. Heimbach and X.H. Yan)**

POS Panel Summary and Plan

- **Joint POS/PSMI Session on TPOS 2020**
- **Sustaining Ocean Observing Systems**
- **Syntheses of Climate Parameters**
- **Understanding of Climate Variations and Impacts**
- **Joint POS/PPAI Session on Predictability of Coastal/Shelf Systems**
- **Action Items**

Joint POS/PSMI Session on TPOS 2020

- **Keep long climate record to understand climate change and decadal variability**
- **Assess the impacts of diminishing TRITON by 2017 (e.g., developing OSSE's, who would be impacted, science-based needs, etc.) and how to replace with new technology**
- **TAO data is crucial in constraining and validating surface flux products (winds, heat fluxes and E-P)**
- **Need velocity and wind observations in the off-equatorial region [10-15N 10-15S] to identify changes in ENSO dynamics (e.g. precursors)**

Joint POS/PSMI Session on TPOS 2020

- **Need salinity/temperature under ITCZ and SPCZ**
- **Need rain gauges (e.g., acoustic hydrophones) in the ITCZ regions**
- **Enhance vertical resolution to resolve mixed layer**
- **Add biogeochemical (Chl, CO2, 02, pH, etc), cytometers, and isotopic measurements (on moorings and via ARGO floats)**
- **No compelling reason to move moorings - best to leave moorings in place and augment the array with new technology**
- **The mooring array and Argo need to be coordinated**
- **US CLIVAR should support the re-evaluation of the system**

Sustaining Ocean Observing Systems

- **Current observing systems for climate include:**
- **in situ: TPOS, RAMA, PIRATA, Argo, XBT, Volunteer Observing Ships, OceanSites stations, GO-SHIP, other repeat hydrography, AMOC array, coastal observing systems (NDBC buoys), sea level network, monitored cables, Global drifter program, Fluxes**
- **remote satellite: SST, SSS, SSH, winds, ocean color, etc.**

Each is a vital cog in the understanding of short-term through decadal climate processes via direct data diagnostics and model validation and improvement

- **They lead to important secondary products: OI analyses, assimilated model output, reanalyses, L3 and L4 satellite products, OSCAR, derived Fluxes**

Sustaining Ocean Observing Systems

New technolgoies are continually being developed and should be evaluated to determine how they can be best exploited while maintaing the existing network.

Deep Argo, which is only funded as a pilot, is a priority for building and sustaining into a global array for improving estimates of total heat content in the ocean

Understanding who develops, governs, and runs tropical arrays (and other OOS's) and fulfilling our obligations for joint support is vital for sustaining them and exploiting their potential in climate monitoring and forecasting

Sustaining Ocean Observing Systems

Need to find mechanisms for making these arrays more sustainable in the fluctuating budget processes, e.g., via partnerships with other countries

These systems require constant attention to data management, distribution, and quality control, otherwise the data stream will become irrelevant

Sustaining Ocean Observing Systems

GO-SHIP is a thriving enterprise and it provides additional benefits besides benchmark high-quality top-to-bottom deep-ocean hydrography, e.g., validating and deploying Argo, piggyback experimentation, student development.
US CLIVAR should fully support this activity and create a framework for external review and publicity of data and results.

US CLIVAR should endorse an Aquarius follow-on for the global water cycle studies
US CLIVAR should support completing the RAMA Array
Need continuing funding for Indian Ocean flux mooring because of its value in validation and model improvement

Syntheses of Climate Parameters

- More Buoy eddy covariance flux measurements (gold standard for validation of flux products) needed in remote places like Southern Ocean
- Need scatterometer for winds, fluxes, etc., for climate observations, hurricane studies and synoptic observations
- More surface observations are needed to resolve E-P uncertainties and SSS drift
- New "Argo - surface temperature and salinity" needed to resolve diurnal cycle
- Need to exploit and QC the TSG sampling from ship
- Ensemble mean of multiple ocean reanalyses should be created and distributed, since it reduces uncertainties and is promising in monitoring interannual variability and trend

Understanding of Climate Variations and Impacts

ENSO:

- ENSO provides dominant source for skillful seasonal climate prediction over global land.
- Need better resolved models to properly simulate teleconnections and ENSO dynamics (e.g., WWB and spatial structure of ENSO diversity)
- Precursors that lead to both growing and damping events, and associated phyiscal mechanisms, need to be better identified for different types of events

Pacific Decadal variability (e.g. IPO,PDO & NPGO) and ENSO:

Need to explore the hypothesis that meridional modes (MM) dynamics interacts with ENSO on interannual to decadal timescales

Need to develop diagnostics to compare the mechanisms that energize tropical variance across climate models (e.g. active feedbacks and relevant stochastic forcings).

Understanding of Climate Variations and Impacts

Blob

- Need to develop better understanding of the mechanisms that led to the persistent nature and extreme temperature of the Blob as well as its impacts on the ecosystem and relation to North American climate
- Need for diagnosing ocean hindcast with observed fluxes as forcing
- Need for diagnosing atmospheric hindcast with SST duing blob period as forcing
- Need to eexplore potential influence of extreme SST associated with the Blob on the predictability of the coupled system

Understanding of Climate Variations and Impacts

AMOC/AMO

US AMOC science team, through many observational programs (OSNAP, RAPID-MOCHA, MOVE, SAMOC, SAMBA), has quantified and improved our understanding of AMOC transport, spatial cohernecy and its temporal variability.

These efforts need to be sustained to obtain reccords that are relevant for climate studies.

The new community effort through AtlantOS, an international (European-led) program designed to organize the somewhat fragmented Atlantic observational efforts currently does not have a US agency representation.
AtlantOS is potentially a good opportunity for US-CLIVAR (via AMOC working group) to get involved with trans-Atlantic collaborations

Understanding of Climate Variations and Impacts

MJO/Indian Ocean

Many ongoing/planned field programs to understand air-sea interaction (monsoon, MJO) in the Indian Ocean.

Improving Monsoon and MJO prediction skill is critical.

Need new observations and modeling efforts in the northern Bay of Bengal, Maritime Continent, and northern Arabian Sea region. Sustained observations are necessary to reduce model biases and improve satellite products (e.g. flux moorings).

Understanding of Climate Variations and Impacts

Arctic Climate

- The goal is to understand the very different response of Arctic and Antarctic sea ice trends in recent years
- Need to better understand feedbacks through modeling studies combined data diagnostics of unique events like the winter of 2013-14

Southern Ocean

Southern Ocean accounts for much of the CO2 and heat uptake, yet is poorly modeled and poorly observed. Southern Ocean winds in climate models are particularly problematic, with maximum wind stress at the wrong latitude which impacts carbon uptake.

Need direct observations of fluxes (heat and momentum, FW), winds,

Joint POS/PPAI Session on Predictability of Coastal/Shelf Systems

CLIVAR has a great opportunity to develop an application in developing the framework for forecasting ecosystems.

Need to identify the predictable components of the physical system from the CLIVAR side and work with biologists to identify the ways in which biology can respond. Leverage existing international marine ecosystem organizations like PICES and ICES.

EXAMPLES

- **Forecasting ENSO impacts on coastal systems,** applied to the California Current and Alaska Gyre ecosystems.
- **Decadal predictions in Upwelling Systems**, monitoring changes in large-scale subsurface water masses that feed the upwelling regions (e.g. oxygen and nutrient contents that impact hypoxia and productivity)
- **Intra-American Seas might be another target area due to the increased interest by CLIVAR**

Action Items and Future Plan for POS Panel

- **Talk with NOAA Fisheries leaders about the way CLIVAR could interact with managers in developing ecosystem forecast framework**
- **Contribute to the Development of a Straw Man for TPOS 2020 in an explicit diagram**
- **Evaluate sustainability of OOS's by developing a mechanism to help promote them (e.g., ongoing evaluations, strategic plans)**
- **Foster the creation of a working group, intra-agency science team, or a panel on climate impacts on ecosystems and biogeochemistry, possibly focusing on coastal regions**
- **Discuss the AtlantOS situation with the IAG**
- **Discuss US participation in the IIOE-2**