**Advance: Research required!**

- **Pilot studies** enhance TPOS capability
- **Process studies** to understand phenomena
- **Modeling studies** add value to observations, assess their impact

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**Table 1. Metrics used to describe the edge of the Western Pacific Warm Pool and their advantages and disadvantages.**

- **Warm Pool**
  - **Edge metric**
  - **Advantages**
    - SST threshold (28–30°C)
      - Important for atmospheric response, e.g. convection, tropical cyclones, intraseasonal variability including WWBs.
      - Satellite and in-situ data products readily available.
    - Strongly affected by background warming.
    - Inconsistent thresholds between models.
    - Higher SST isotherms not always present.
    - Decouples from other definitions in extreme events and at high-frequency time scales (such as diurnal cycle).
  - **Disadvantages**
    - SST threshold (34.2 to 35.2)
      - More closely representative of dynamical edge.
      - Same as above.
      - Limited data availability, though new satellite products (SMOS & Aquarius) now available.
  - **Maximum SSS gradient**
    - Insensitive to background state.
    - Representative of dynamical edge.
    - Limited data availability.
    - Noisy and may be contaminated by high-frequency variability.
  - **Isotherm fit to SSS gradient**
    - As above.
    - Useful for model intercomparison.
    - Isotherm needs to be revised with background warming.
  - **Density threshold** (not common)
    - Combines temperature and salinity changes.
    - Incorporates disadvantages of both temperature and salinity.
  - **Convergence using hypothetical drifters**
    - Representative of ‘dynamical edge’.
    - Can use dynamic height, or satellite mean sea level as proxy.
    - Need to compute hypothetical drifters.
    - May not converge in models due to the high sensitivity to background mean state.
    - Limited observations and reliance on combined satellite estimates.
  - **Chl-a**
    - Sharp front.
    - Limited to satellite record.
    - May decouple from physical parameters.
  - **Nitrate/pCO2**
    - Usually tracks the frontal zone.
    - Limited observations.
    - May decouple from physical parameters.

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**Figure 1.**

*Figures show schematic of the WPWM mean state and changes for El Niño conditions (inset). The front at the east edge of the warm pool interacts with the atmosphere, especially during the onset of El Niño. The diurnal cycle can be an important mechanism allowing downward propagation of heat and momentum fluxes.*

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**Critical processes in the east include the stratus/cold tongue front/ITCZ system and coastal upwelling.**

---

**The 30-year record of surface pCO2 shows strong annual, interannual and decadal variability of CO2 fluxes in the east Pacific cold tongue.**

---

**Equatorial upwelling is fundamental but poorly known; its modeling is uncertain.**

---

**Low-latitude western boundary currents and the Indonesian Throughflow are principal conduits of tropical-subtropical interaction.**

---

**Barrier layers in the west Pacific warm pool affect the penetration of momentum fluxes.**

---

**Advance:** Research required!
1.1.1 Pilot projects & process studies [action 14]

| TRF-2 Response | a) Noted [or Agreed] the importance of pilot projects and process studies; and 
|                | b) Agreed to advocate for and, as appropriate support such initiatives. |

TRF-2 Response

The Resources Forum noted the pilot projects and process studies that will contribute to the refinement and evolution of the TPOS Backbone. The Western Boundary Current [6.1.1] and Eastern Pacific [6.1.2] Pilot programs were highlighted as priorities [Drafting note: The SC believes all the proposed studies and pilot programmes are important; 6.1.1 and 6.1.2 are critical.]

There are multiple points of common interest with existing (e.g. NPOCE, SPICE, YMC) and planned activities. TPOS 2020 will actively promote the value of such projects/studies for the long-term design and sustainability of the TPOS and may return to the idea of an overarching coordination in the 2nd Report.

[Note: Add in references to specific interests in the projects/studies.]

**Action 14** Through the TPOS 2020 Resources Forum, the TPOS 2020 Transition and Implementation Group and links to research programs and funders, support should be advocated for Pilot and Process Studies that will contribute to the refinement and evolution of the TPOS Backbone.
Pilot Studies (6.1)

A “Pilot” is a small-scale preliminary activity/study designed to evaluate feasibility, cost, risks and sampling strategy ahead of a full-scale campaign.

6.1.1 Observing Western Boundary Current systems
6.1.2 Eastern Pacific equatorial-coastal waveguide and upwelling system
6.1.3 Determining the critical time and space scales for biogeochemistry in TPOS
6.1.4 Direct measurements of air-sea fluxes, waves and role in air-sea interaction
6.1.5 Pilot climate observing station at Clipperton Island for the study of East Pacific ITCZ
6.1.6 Assessing the impact of changes in the TPOS backbone
6.1.7 Comparison of analyses and utilization of TPOS observations
Process Studies (6.2)

A “Process Study” for research experiments, usually with a phenomenological focus, where the outcomes are scientific and the outputs might include improved knowledge, parameterizations and techniques. The results of a Process Study might point to future sustained observations or refinement of the Backbone sampling.

The Process Studies in section 6.2 have been chosen to focus on phenomena that are central to Pacific climate, but where too little is known to design a sampling strategy, or where the need for sustained observations has not been demonstrated.

6.2.1 Pacific Upwelling and Mixing Physics (PUMP)

6.2.2 Air-sea interaction at the northern edge of the warm pool

6.2.3 Air-sea interaction at the eastern edge of the warm pool

6.2.4 East Pacific ITCZ/Warm Pool/Cold Tongue/Stratus system
1.1.1 Pilot projects & process studies [action 14]

1st Report Reference: Chapters 6 and 10; Action 14.

TRF-2 Response

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**Action 14** Through the TPOS 2020 Resources Forum, the TPOS 2020 Transition and Implementation Group and links to research programs and funders, support should be advocated for Pilot and Process Studies that will contribute to the refinement and evolution of the TPOS Backbone.
Pilot Studies

6.1.1 Observing Western Boundary Current systems:
Low-latitude western boundary currents and the Indonesian Throughflow are principal conduits of tropical-subtropical interaction.

Several pilots by different agencies are now being done or have been done. The aim of the pilot here would be to develop an overall strategy.

6.1.2 Eastern Pacific equatorial-coastal waveguide and upwelling system

Develop monitoring system for Peru coastal upwelling. Non-local influences and consequences.
6.1.3 Determining the critical time and space scales for biogeochemistry in TPOS

The 30-year record of surface $pCO_2$ shows strong annual, interannual and decadal variability of CO$_2$ fluxes in the east Pacific cold tongue.

Long history (opportunistic sampling), but scales are not fully known. Needed to devise monitoring strategy.

6.1.4 Direct measurements of air-sea fluxes, waves and role in air-sea interaction

Special relevance to development of coupled models and assimilation systems

6.1.5 Pilot climate observing station at Clipperton Island for the study of East Pacific ITCZ

Small, flat island under eastern ITCZ. Location for atmospheric observations: ITCZ convection.

6.1.6 Assessing the impact of changes in the TPOS backbone

OSEs, OSSEs, DFS, FSOI, etc to assess impact of proposed changes to the backbone

6.1.7 Comparison of analyses and utilization of TPOS observations

Ingestion and impact of in situ and satellite TPOS data by forecast centers
(6.1.5 Pilot climate observing station at Clipperton Island for the study of East Pacific ITCZ)
6.2.1 Pacific Upwelling and Mixing Physics (PUMP)

Mean zonal current (colors) and salinity (white contours) at 140°W (sketch of w)
6.2.2 Air-sea interaction at the northern edge of the warm pool

Schematic of the meridional cross-section of BSISV. The variability and processes below the sea surface have not as yet been fully investigated (modified from Kemball-Cook and Wang, 2001).
6.2.3 Air-sea interaction at the eastern edge of the warm pool

The front at the east edge of the warm pool interacts with the atmosphere, especially during the onset of El Niño.
6.2.4 East Pacific ITCZ/Warm Pool/Cold Tongue/Stratus system

Critical processes in the east include the stratus/cold tongue front/ITCZ system.

This could be seen as several (unconnected) studies, or joined in a large effort that would be on the scale of TOGA-COARE.