Summary

The Pacific Upwelling and Mixing Physics (PUMP) experiment is a process study designed to improve our understanding of the complex of mechanisms that connect the thermocline to the surface in the equatorial Pacific cold tongue. Its goal is to observe and understand the interaction of upwelling and mixing with each other and with the larger-scale equatorial current system. Its premises are, first, that the least understood contributions to the modulation of equatorial SST are upwelling and mixing, and second, that climate-scale ocean models are now ready to exploit realistic vertical exchange processes, but need adequate observational guidance.

The outcome of PUMP will be advancements in our ability to diagnose and model both the mean state of the coupled climate system in the tropics and its interannual and interdecadal variability.

The primary objectives of this program are:

1. To observe and understand the 3D time evolution of the near-equatorial meridional circulation cell under varying winds, sufficiently well to serve (a) as background for the mixing observations in objective 2; (b) as a challenge to model representations.

2. To observe and understand the mixing mechanisms that determine (a) the depth of penetration of wind-input momentum and the factors that cause it to vary; (b) the transmission of surface heat fluxes into the upper thermocline and the maintenance of the thermal structure in the presence of meters per day upwelling.

3. To observe and understand the processes that allow and control exchange across the sharp SST front north of the cold tongue, including both small-scale frontal dynamics and the effects of tropical instability waves.

To achieve these objectives requires a concerted effort with four interlocking components:

1. An integrated reanalysis of historical data should be undertaken with the specific goals of providing both experimental guidance and, by producing uniform data sets, expanding the range of climate states for further model diagnosis.

2. A multi-scale and coordinated modeling effort should be directed toward aiding the observational effort to begin with, and later toward interpreting and parameterizing observational results.

3. An extended (2–3 year) and expanded (2/3 degree spatial resolution) moored observational presence should be established along 140°W spanning the cold tongue to quantify scales of and changes in equatorial velocity and upwelling.

4. Two intensive observation periods to quantify the relative effects of upwelling and mixing within the moored observational array should be targeted to resolve the distinctions between the well-defined periods of Rapid Cooling and Reduced Cooling at 140°W, both on and just off the equator.