U.S. CLIVAR SSC Assessment of the Pacific Upwelling and Mixing Physics experiment (PUMP)

Based on input and discussion at the SSC-12 Meeting
February 2005

After reviewing this material the overall reaction of the SSC was quite positive in support of PUMP. This is a resource-intensive effort directed at a problem of first order significance for interannual climate studies. It is directly responsive to CLIVAR objectives.

Feasibility: The project technical aspects as sketched out in the science and implementation plan seem feasible. In particular, the upwelling component seems quite feasible. Mixing estimation is higher risk science, but the panel felt that the plan was at the stage where the details, as described in individual science proposals, were needed for further evaluation. It is anticipated that the more detailed plans and links between the mixing observations and modeling will be considered further as planning for PUMP goes forward.

Applicability/Importance: The project directly addresses an aspect of tropical air-sea interaction that has been identified in many studies as representing one of the most critical unknown aspects of the tropical coupled system. Mixing and entrainment processes play a first order role in maintaining the SST field. Errors in these processes have been identified as a major source of errors in ocean and coupled general circulation models.

In considering the applicability of the observation strategy to the science several issues were raised in panel discussion:

1) Narrow geographical scope (140W) of experiment relative to phenomenon. We know that the cold tongue really operates as a whole and indeed, the seasonal cold tongue develops from the coast of South America and progresses westward through air-sea interaction. Two questions arise: is this the best location for a geographically focused effort? and, Will a geographically focused effort tell us about mixing processes over a sufficiently large part of the ocean? In addressing the first question, the only two choices are at 140W and 110W because they are the two locations where there is history and this is an issue. Kessler argues for 140W because of the importance of air-sea interaction and diapycnal mixing, as well as the history of turbulence experiments at this location. Kessler points out that the vertical scale of processes is larger at 140W making sampling a bit easier. There are drifting mixing instruments, which might be added or applied that may spread the results 125w-175w (where there is an SST gradient). These are issues that would need to be addressed in a proposal.

2) Brief, less than month-long temporal sampling of the IOPs. The IOPs will sample the cold tongue cooling transition. Their limited temporal span leaves them susceptible to sampling biases associated with Tropical Instability Waves. The strength of the background SST gradient will be much reduced during an El Nino year, thus altering the usefulness of the observations.

3) Limited information about interactions with the atmosphere. A strength of the plan is the effort to constrain surface heat flux terms. We know that the whole atmospheric planetary boundary layer is responding to the changes in the SST field and in particular movements of the SST front. The plan does not contain a mechanism for tracking these changes. There was some discussion of the extent to which some coordination with other activities could beef up this aspect of the experiment.

4) A third year of deployment for the moored array is noted in the plan as a cost effective extension. It would be helpful if the reasons for this extension were clarified and a clearer position for advocacy (or not) was stated.

5) In contrast to previous equatorial mixing studies, the PUMP filed plan will provide, by the moored array and other sampling, a rich contextual setting for the mixing and subsequent parameterization studies. It will be critical as detailed planning goes forward for the mixing studies to be carefully conceived and well integrated into the overall observation and analysis strategies.

Responsiveness to CLIVAR objectives. Developing improved understanding of air-sea interaction in the cold tongue region of the tropical Pacific is a central CLIVAR issue.

Timeline. It may be that the timeline of the study is somewhat compressed. Time will be required to obtain and process mooring data and to put that data in the context of other data sets (e.g. remote sensing). The agencies should take account of the need for an 2-3 year analysis period (and budget corresponding funds) following the in-water phase of the experiment. The SSC notes the potential conflicting requests for resources, including the request here for ship time for three ships, among several experimental activities. Our general comment to the agencies and PIs is to note that there may be a need to adjust the timing of experiments.

Data Synthesis/assimilation. A strength of this proposal is the tight coordination with ocean modeling. The science plan notes inadequacies in our current understanding of mixing processes. It is evident that the science has not matured to the stage at which PUMP can provide observations that will distinguish between competing hypotheses. Rather, the experiment is more of a mapping expedition. This situation has the disadvantage that it is possible that when additional understanding of mixing and entrainment processes develop we may discover additional factors that should be observed. Asking the same question slightly differently, what assurance do we have that this experiment will lead to a parameterization that's better than what we currently have? This remains a concern of the SSC.

Resource issues

As noted above, this is a resource-intensive proposal. The SSC notes that other experimental programs including a Carbon initiative is interested in a similar location and may be amenable to sharing resources, thus reducing the cost of this project.