Objectives
The primary purpose of this cruise is to service three oceanic moorings in the western Pacific Ocean as part of ITOP (Impact of Typhoon on The Western Pacific Ocean) DRI. We service these moorings every ½ year. During this cruise, we will also make observations of background hydrography, bio-chemical properties, and air-sea fluxes.

Shipboard Equipment
Some major equipment is listed as follows.
- Internet Connection
- Standard equipment for mooring deployment and recovery, e.g. Trawl winch, tugger, capstan, …
- Multibeam for bathymetry survey
- Shipboard ADCP
- Revelle deep sonar HDSS
- Met sensors
- Intake sea surface temperature, conductivity
- CTD
- Marine radar if available? (for detecting surface signatures of nonlinear internal waves)
- GPS position and heading

Scientific Activity
1. ATLAS Moorings Service
   We will service three deepwater (~5,500m) ATLAS moorings in the western Pacific. There are 14 underwater temperature sensors and surface meteorological sensors on each mooring. The locations and depths are given in Table 1. The planned transit route is shown in Fig. 1. The mooring configuration is shown in Fig. 2. The moorings are prepared by the Taiwan Ocean Research institute (TORI). Four technicians from TORI will participate the cruise to work with Revelle's resident technicians for the mooring service. Each mooring service is expected to take a whole day, including 4 hrs of recovery and 4 hrs of deployment during the daytime hours.
Figure 1. The overall cruise route, positions of deep-water moorings and CTD stations.

<table>
<thead>
<tr>
<th>Site</th>
<th>Lon</th>
<th>Lat</th>
<th>Nominal Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>127°50.17'E</td>
<td>20°20.84'N</td>
<td>5570m</td>
</tr>
<tr>
<td>A2</td>
<td>123°49.93'E</td>
<td>20°36.37'N</td>
<td>5610m</td>
</tr>
<tr>
<td>A3</td>
<td>126°03.02'E</td>
<td>18°54.14'N</td>
<td>5680m</td>
</tr>
</tbody>
</table>
Figure 2. Schematic diagram and photo of ITOP mooring.

Mooring Recovery
Estimated operation time: 4 hr
- Marine radar searching first and then visual contact of the surface buoy.
- Fire the acoustic release
- Hook and lift the buoy up by A-frame, disconnect the mooring line from the bridle below the buoy.
- Run the wire (approx. 500m) through the winch, stop and detach temperature loggers from mooring wire.
- Run the nylon rope through capstan and relay it in the foldable irony cage, a cage usually holds 3 sections (approx. 1500m).
- Recover the glass floats and acoustic release.

Mooring Deployment
Estimated operation time: 4 hr
- Upload the new wire to the winch and attach to the buoy.
- Lift the buoy by A-frame and deploy into the water.
• Ship steams slowly (2 knots or so) against the ship drift
• Stop the wire (winch) and mount temperature loggers
• Run the nylon rope through capstan from the foldable iron cage. Ropes are deployed in a reversed order as they were recovered.
• Stop at the glass floats and deploy them slowly.
• Hold the mooring line and determine the let-go site and drop the railroad wheel anchor by a tip plate.

All the three moorings, either to be recovered or deployed, have the similar configuration as shown in Fig. 2.

2. PO survey near ITOP mooring A2 (C1-30)

30 CTD stations (C1-30) are selected near the ITOP A2 mooring (shown in Fig. 1 with red circles). At each station, we will conduct a ~1000-m CTD cast. At some CTD stations, water samples will be taken in the upper 200 m. The depth of CTD cast and stations for water samples will be determined once we have the estimate of the time cost for east cast. Roughly, each CTD cast is estimated to take about 40 minutes. The transit between stations is estimated to be 3 hours. Five days is budgeted for this PO survey. Shipboard sensors including Revelle HDSS 140-kHz and 50-kHz sonars, 150kHzADCP, and echo-sounder will be used.

3. Internal tides off Luzon Strait (T1-3):

Three time-series stations (T1-3) are chosen (shown in Fig.1 with star signs). On each station, we will conduct CTD cast every two hours for two days to characterize the internal tides off Luzon Strait. This is best in Oct 3-8 for spring tide in this region. Six days in total for this operation.

4. Biology, Nutrient and Chemistry Study

Water samples taken during the CTD casts will be used to study pico-planktons’ distribution patterns of abundance, pigment content and their enzymatic activity (alkaline phosphatase). Water samples taken from different depths in the upper 200 m will be incubated on deck for alkaline phosphatase activity. Parts of the water samples taken from above procedure will be stored and bring back to land for the measurements of species composition (Flow Cytometry) and pigment analysis (HPLC). Running seawater is needed for 60 minutes for on deck incubation and filtration on each station (Fig. 3)
5. Air-Sea Flux and Radiation Study
Revelle's shipborne meteorological data will be used for the study of air-sea flux and radiations. Extra equipment including solar and long-wave radiation system, eddy covariance system (Fig. 4) and flux measurement cart (Fig. 5) will be installed on the deck and mast. In order to comply the safety guideline of the ship, the installations are to be determined. The discussion with Drew Cole (Resident Technician) is underway.

Figure 3. Configuration of on-deck incubation system

Figure 4. The solar and long-wave radiation system, and eddy covariance system
Detailed Schedule:
9/17-9/18: Loading
09/19 16:00 depart from Keelung
09/21 A1 mooring turn around
09/22 A3 mooring turn around
09/24 A2 mooring turn around
09/25 – 10/01 Spatial CTD and ADCP (red circles)
10/02 - 10/08 T1 – T3 (Stars)
10/09 0800 return to Kaohsiung
10/10: Off Loading

Alternative Activity (Due to Typhoon)
If typhoon occurs before or during the cruise, we will stay or return to Taiwan, or dodge from typhoon. The first priority of this cruise is to service ITOP moorings. If cold wake is present and we have completed the mooring service, we may study the cold wake using shipboard ADCP, CTD, and Revelle HDSS sonar.

This is a crude estimate of schedule for mooring service and CTD casts. The actual schedule will vary depending on the time for mooring deployment. Weather and sea state will be the major factors.