

Application for Consent to Conduct Marine Scientific Research  
in Japan

Date: 18 December 2009

Revised 1/7/10

Revised: 1/28/2010

Revised: 5/8/10

Re: State Department #2009-131

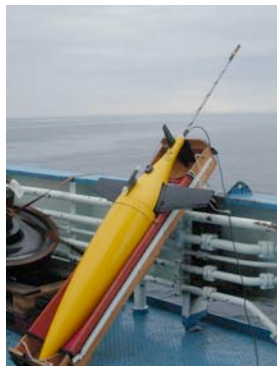
1. General Information

1.1 Project name and/or #:	<b>Impact of Typhoons on the Pacific: Glider Operations and Internal Waves in Straits</b>
1.2 Undertaking institution:	Scripps Institution of Oceanography
Name:	Elizabeth Brenner/Rose Dufour
Address:	University of California 9602 La Jolla Shores Drive, La Jolla, CA 92037 858-534-2841 shipsked@ucsd.edu
Name of Director:	Dr. Tony Haymet
1.3 Government Agency Responsible for Supervising the Project:	
Name	Dr. Terri Paluszkiwicz
Address	U.S. Office of Naval Research 875 North Randolph Street, Suit 1425 Arlington, VA 22203-1995
1.4 Scientist in charge of the project:	
Name:	Dr. Craig M. Lee (POC for shipboard operations). See attached list for individual project contacts. Louis St. Laurent (WHOI, Principal Investigator) Luc Rainville (APL-UW, Principal Investigator) Steve Jayne (WHOI, Principal Investigator) Elizabeth Douglas (WHOI, postdoctoral investigator) Ken Decoteau (WHOI, technician, glider pilot) 3 Graduate students (1 WHOI, 1 NSYSU, 1 University of Colorado) 6 person biogeochemical sampling group (National Taiwan Univ) To be determined APL-UW personnel
Address:	Applied Physics Laboratory University of Washington 1013 NE 40th St Seattle, WA 98105-6698 USA
Telephone:	+1-206-685-7656
Telex:	
Telefax:	+1-206-543-6785
E-mail Address:	craig@apl.washington.edu
1.5 Scientist(s) from Japan involved in the planning of the project:	
None yet identified, but have long-term collaboration with:	
Name(s): Not available	Dr. Tetsuo Nakazawa
Address:	Typhoon Research Department Meteorological Research Institute, Tsukuba, Japan

2. Description of Project (Attach additional pages as necessary)

2.1 Nature and objectives of the project:
<p>ITOP aims to study the ocean response to typhoons in the western Pacific Ocean. Understanding the impact of such strong storms on the ocean will help improve track and intensity forecasts and thus benefit those living in areas subject to typhoons. The primary focus of the experiment is to improve our understanding of the cooling of the upper ocean associated with the passage of a typhoon ("cold wake"). In particular, we seek to (1) measure the formation and evolution of the cold wake via air-deployed oceanographic instruments and ship surveys, and (2) get a detailed description of the atmospheric forcing on the ocean, by measuring the atmospheric conditions before, during, and after the storm.</p> <p>This project will employ long-range, autonomous gliders to sample areas that have a high probability of being subjected to typhoons. Eight gliders will be deployed between June and September from the R/V <i>Roger Revelle</i> at locations within the operating region (please see attached chart) and will then occupy surveys designed to sample typhoons. Gliders may be deployed from multiple cruises. Gliders will be recovered in October/November at the end of the experiment.</p> <p>Because typhoon paths are impossible to predict, it is not possible to specify the deployment, recovery or survey locations in advance of the actual field program. We will deploy between zero and eight gliders, depending on conditions, and all vehicles will remain within the operating area specified in the attached chart, excluding the territorial waters of Japan, Philippines and Taiwan. Neither ship tracks or glider tracks are plotted on this chart, as it is impossible to specify them in advance- they will be determined by whatever typhoons occur between June and November 2010. If desired, 3-4 times per day the gliders can report their positions via email to whatever authority the government of Japan specifies.</p> <p>Seagliders are small, reusable, long-range (3000 – 4000 km) autonomous underwater vehicles designed to glide from the ocean surface to as deep as 1000 m and back while collecting profiles of temperature, salinity, dissolved oxygen concentration and optical properties. Gliders steer through the water by controlling attitude (pitch and roll) and can thus navigate between waypoints to execute survey patterns; or they hold station while profiling and collect Eulerian time series as a 'virtual mooring'. Mission durations depend largely on ambient stratification and profile depth, but for this application should be approximately 6 months. Gliders are commanded remotely and</p>

report their measurements via Iridium satellite telephone at the conclusion of each dive. The vehicles also archive all data to onboard storage for delayed mode transmission or post-recovery interrogation. They use GPS navigation at the sea surface to dead reckon toward commanded targets by assimilation with a Kalman filter or through other algorithms. Navigation and knowledge of vehicle buoyancy and pitch angle allows estimation of depth-averaged current and suitably energetic vertical velocity fluctuations. Sensor suites include pressure, temperature, conductivity, Doppler sonar, dissolved oxygen, chlorophyll fluorometer, and optical backscatter. Gliders have been deployed and recovered from a wide range of platforms including small rubber boats, chartered fishing vessels and large research ships. Because the vehicles are relatively small and light, special handling gear is not required and field teams typically consist of one or, at most, two individuals. In more remote regions, we have also had significant success training local collaborators to handle field operations, eliminating the need to send highly-trained personnel from our laboratories.



Seaglider photos. The Iridium/GPS antenna sits at the end of the long tail. Sensors are carried in the two narrow, cylindrical housings in the top aft region of the glider.

ITOP aims to study the ocean response to typhoons in the western Pacific Ocean. Understanding the impact of such strong storms on the ocean will help improve track and intensity forecasts and thus benefit those living in areas subject to typhoons. The primary focus of the experiment is to improve our understanding of the cooling of the upper ocean associated with the passage of a typhoon ("cold wake"). In particular, we seek to (1) measure the formation and evolution of the cold wake via air-deployed oceanographic instruments and ship surveys, and (2) get a detailed description of the atmospheric forcing on the ocean, by measuring the atmospheric conditions before, during, and after the storm. ITOP ship operations will focus on sampling of typhoon-generated cold wakes and servicing two surface moorings.

ITOP also include a biogeochemical component motivated by recent research that has shown that typhoons can stimulate marked cooling of the sea surface and result in phytoplankton blooms along the path of the typhoon and in adjacent areas. Previous studies of typhoon events have largely been based on satellite remote sensing data, but it can be difficult to obtain clear ocean color images due to extensive cloud cover. In situ field observations on the effects of typhoons on biological processes are rare, and their collective effects on ocean biogeochemistry, especially carbon export flux, are still poorly understood. Most importantly, the flux of particulate organic carbon (POC) from the euphotic zone is unknown because typhoons form in remote parts of the open ocean, and their paths are difficult to predict. ITOP will collect hydrographic information, DIC, pCO<sub>2</sub> and POC flux data after the passage of a typhoon to provide new insight on this potentially important process.

IWISE\* is focused on the oceanographic response to sea straits to tidal forcing. Luzon Strait has been selected as the focus area because of the large tidal currents in the area which generate large amplitude internal waves. These internal waves, with ranges up to 150m are a prominent feature of the South China Sea and readily visible in remote sensing images. The waves have been intensively studied in recent years, especially to the west of the strait where their amplitude and nonlinear behavior is greatly modified due to effects of the decreasing water depth. Of particular interest in this project is measurement of the internal waves over an extended period to see how modulation of the Kuroshio affects the generation. The efforts planned for 2010 include instrument testing and collection of measurements to inform planning for the primary field program in 2011.

\*Not to be carried out in Japan EEZ

A variety of distinct seagoing operations associated with the two projects have specific objectives that are described below. The timing of these operations is planned to be highly flexible to accommodate ITOP's need to sample shortly after the passage of strong typhoons. All operations will occur within the 14 August – 23 October window, but because operations must be scheduled around the top priority of sampling a typhoon, it is not possible to predict the dates of the various cruises. The distinct components, along with the number of operating days assigned to each one, are:

1. ITOP cold wake surveys and instrument recovery (42 days, possibly in multiple segments)
2. IWISE mooring deployments and surveys (29 days)\*

\*Not carried out in Japanese waters.

## ITOP COLD WAKE SURVEYS AND INSTRUMENT RECOVERY

### Objectives

Cold wake cruise objectives include:

- Document evolution of the cold wake generated by a passing typhoon.
- Recover instruments that were deployed by aircraft in front of the moving typhoon. In the event that no aircraft is available we will use R/V Roger Revelle to deploy instruments after the passing typhoon and then recover at a later date.
- Biogeochemical sampling of cold wakes

The cold wake will be sampled by a combination of ship-based surveys, a short-endurance autonomous glider and 4-8 long-endurance gliders that will be deployed on the cold wake sampling cruises and retrieved by the mooring recovery cruises

scheduled for 25 October – 24 November 2010 (covered under a separate MSR State Dept. File #2009-131GOJ approval No. 928). Fig. 2 provides examples of the kinds of surveys that might be executed.

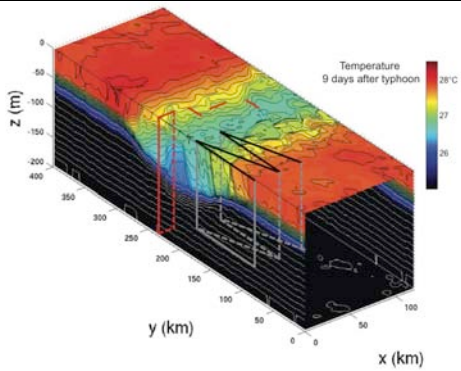


Figure 2. Example of ship (black) and glider (red) tracks during the wake sampling experiment. Colors indicate the temperature of the water column 9 days after the passage of a typhoon in a numerical simulation run by Baylor Fox-Kemper (Colorado University). Four 90-km transects are shown for the ship (black zig-zag), and the tracks of 4 gliders, each covering 15 km are shown.

#### 2.2 Relevant previous or future research cruises:

1. 21 March – 1 April 2010, R/V *Revelle* (PI: Ren-Chieh Lien): Mooring service cruise.
  2. 24 July – 12 August 2010, R/V *Revelle* (PI: Hans Graber): ASIS/EASI deployment cruise. Moorings deployed in international waters (no clearance requested here). Clearance for gliders deployed on this cruise requested under State Dept. File #2009-131 approved by GOJ #928 18 March 2010
- 25 October – 24 November 2010, R/V *Revelle* (PI: Ren-Chieh Lien and Hans Graber): Mooring, ASIS/EASI and (glider recovery cruise. approved by GOJ #928 18 March 2010)

#### 2.3 Previously published research data relating to the project:

None

#### 3. Methods and Means to be Used

Deployments may take place in the Taiwanese, Philippine or Japanese EEZs' or within international waters. Glider-based survey operations could take place in any of these EEZs, as might recoveries. We respectfully seek permission for R/V *Roger Revelle* to enter the EEZs to deploy and recover gliders and to collect a small number of CTD profiles for the purpose of calibrating glider sensors, and for **gliders** to sample within the EEZs (in the area marked on the chart). Dates will extend from 11 June – 24 November, 2010.

#### 3.1 Particulars of vessel:

Name:	R/V <i>Roger Revelle</i>
Nationality (Flag state):	USA Flag
Owner:	U.S. Navy
Operator:	University of California, San Diego, Scripps Institution of Oceanography
Overall length (meters):	84 m. [275']
Maximum draught (meters):	17
Displacement/Gross tonnage:	3,180 long tons
Propulsion:	Tow 3000 hp Propulsion General Electric Bow Thruster: 1180 hp Azimuthing jet Tyupe Elliot Gill Model 50T 35 Propulsors: Two 3000 hp Z-Drives Lips Type FS 2500-450/1510BO
Cruising & Maximum speed:	12 knots
Call sign:	KAOU
Method and capability of communication (including emergency frequencies):	Email, master@rv-revelle.ucsd.edu Inmarsat-B, Telephone, Indian, 011-873-336780030 Alternate, 011-873-336780020 Fax, Primary, 011-873-336780031 Alternate, 011-873-336780021 Telex, Primary, 336780033 (AnsBk=KAOU) Alternate, 336780022 (AnsBk=KAOU) Inmarsat-C, 436780010 Radio, Vessels guard standard GMDSS frequencies for calling, distress and dissemination of marine safety information. MMSI #, 367800100 SELCAL #, 71410 Telex, Primary, 336780033 (AnsBk=KAOU) Alternate, 336780022 (AnsBk=KAOU) Inmarsat-C, 436780010 Radio, Vessels guard standard GMDSS frequencies for calling, distress and dissemination of marine safety information. MMSI #, 367800100 SELCAL #, 71410
Name of master:	Tom Desjardins
Number of crew:	22
Number of scientists on board:	No more than 37

#### 3.2 Aircraft or other craft to be used in the project:

Yes, but filed under separate MSR

3.3 Particulars of methods and scientific instruments		
Types of samples and data	Methods to be used	Instruments to be used
T, S, chlorophyll fluorometer, light attenuation (660nm), CDOM fluorescence, dissolved oxygen profiles	Shipboard CTD profiling	Seabird CTD and rosette
Water velocity profiles	Ship-based surveys	Shipboard Hydrographic Doppler Sonar (ADCP), GPS, GPS attitude and Lowered ADCP (LADCP) mounted on CTD package.
Meteorological variables (e.g. wind speed, heat flux, air temperature, etc)	Ship-based surveys	Shipboard meteorological sensors
T, S, dissolved oxygen, chlorophyll fluorescence, blue/red light backscatter, water velocity shear	Glider-based surveys	Autonomous gliders (Seaglider, please see paragraph above)
Underway (UW) multibeam	Swath mapping	Simrad 12khz
UW Mags	Magnetometer deployment	Marine Magnetics total field gradiometer
UW Gravity	Gravimeter	Bell Gravimeter
T, S profiles	Synoptic, ship-based surveys with profiling instrument	OceanSciences Underway CTD (UWCTD)
T, S, dissolved oxygen, chlorophyll fluorescence, blue/red light backscatter, water velocity shear, microstructure	Glider-based surveys	Autonomous gliders Seagliders and Slocum gliders
Microstructure, T, S	Surveys using tethered microstructure profiler	Rockland Scientific VMP-500
T, S, velocity	Subsurface mooring with profiling instrument	ADCP (velocity), MacLane Moored Profiler
Ocean temperature, salinity, oxygen, gas tension, radiance, velocity, sound level, chlorophyll fluorescence, optical backscatter, pressure, ocean surface winds, ocean surface pressure	May be deployed from ship	***ADIOS and SVP Surface drifters These are drogued surface drifters that are deployed within a specially reinforced cardboard and wood deployment box. A more detailed description of the drifters can be found at the manufacturer's website ( <a href="http://www.pacificbyte.com">http://www.pacificbyte.com</a> ).
Ocean temperature, salinity, oxygen, gas tension, radiance, velocity, sound level, chlorophyll fluorescence, optical backscatter, pressure, ocean surface winds, ocean surface pressure	May be deployed from ship	***EM-APEX Floats Manufactured by Teledyne Webb research ( <a href="http://www.webbresearch.com/apex.aspx">http://www.webbresearch.com/apex.aspx</a> ). They are 16.5 cm in diameter, 130 cm long (not incl. 70 cm antenna) and weigh 26-28 kg. They present the following substances to the environment: delrin, PVC, epoxy paint and filler, aluminum, anodized aluminum, nylon, O-ring grease, agar and fiberglass. They are otherwise a closed, sealed system with no chemical emissions.
Ocean temperature, salinity, oxygen, gas tension, radiance, velocity, sound level, chlorophyll fluorescence, optical backscatter, pressure, ocean surface winds, ocean surface pressure	May be deployed from ship	***Lagrangian Floats  The floats are 1.5 m long, 26 cm in diameter, with a drogue that extends to 2-m diameter when open. They weigh 49-50 kg. Floats present the following substances to the environment: Steel, Stainless steel, brass, delrin, PVC, epoxy paint and filler, aluminum, anodized aluminum, nylon, acoustic potting compound, wire insulation, O-ring grease, carbon fiber, fiberglass, glass, and nylon sailcloth. They are otherwise a closed, sealed system with no chemical emissions. All Lagrangian floats will be recovered. More information at <a href="http://rod.and.washington.edu/~dasaro/FloatTech/floats.html">http://rod.and.washington.edu/~dasaro/FloatTech/floats.html</a>

- \*\*\*In the event that no aircraft is available we will use R/V Roger Revelle to deploy these instruments after the passing typhoon and then recover at a later date;

\*Indicate type and specification of instruments (e.g. length and number of cables towed)

### Equipment to be deployed and used from the ship during cold wake surveys

The cold wake surveys will employ:

- Underway CTD (Ocean Science) will be used to conduct quasi-synoptic surveys of cold wake evolution.
- Microstructure profiler (Rockland Scientific VMP-500) will provide measurements of mixing within the wake across selected sections.
- Slocum glider (Teledyne Webb Research) will be deployed shortly after arriving to occupy sections across the wake. This glider will be recovered by Revelle after approximately 3 weeks of operation.
- Seagliders (4 to 8; APL/UW) will also be deployed on arrival. Seagliders will sample wake evolution from deployment until pickup sometime during the 25 October – 24 November 2010 mooring recovery cruises.
- Biogeochemical measurements using Revelle's CTD and rosette. Measurements will include: Nutrients (N, P, Si etc.), POC, PN, PIC, POC flux and chlorophyll, underway PCO<sub>2</sub>, pH, TA, DIC and primary production.
- Revelle's CTD system.
- Revelle's Hydrographic Doppler Survey System (HDSS).
- Revelle's multi-beam system.

### Personnel roster

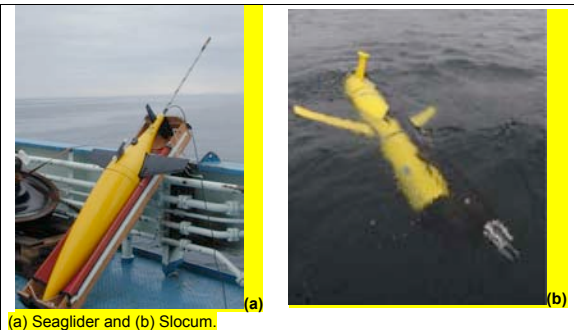
- Louis St. Laurent (WHOI, Principal Investigator)
- Luc Rainville (APL-UW, Principal Investigator)
- Steve Jayne (WHOI, Principal Investigator)
- Elizabeth Douglas (WHOI, postdoctoral investigator)
- Ken Decoteau (WHOI, technician, glider pilot)
- 3 Graduate students (1 WHOI, 1 NSYSU, 1 University of Colorado)
- 6 person biogeochemical sampling group (National Taiwan Univ)
- To be determined APL-UW personnel

### 3.3 Particulars of methods and scientific instruments

Here we provide details on some of the less common instrument systems.

#### SEAGLIDER

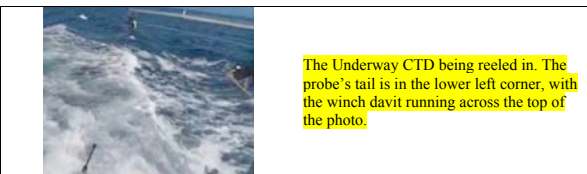
(Clearance already requested under State Dept. File #2009-131 and approved by GOJ No. 928)  
 Seagliders and Slocums are small, reusable, long-range autonomous underwater vehicles designed to glide from the ocean surface to as deep as 1000 m (Seaglider) or 200m (Slocum) and back while collecting profiles of temperature, salinity, dissolved oxygen concentration, optical properties and turbulence (microstructure). Gliders steer through the water by controlling attitude (pitch and roll) and can thus navigate between waypoints to execute survey patterns; or they hold station while profiling and collect Eulerian time series as a 'virtual mooring'. Mission durations depend largely on ambient stratification and profile depth, but for this application should be approximately 6 months (Seaglider) or 1 month (Slocum). Gliders are commanded remotely and report their measurements via Iridium satellite telephone at the conclusion of each dive. The vehicles also archive all data to onboard storage for delayed mode transmission or post-recovery interrogation. They use GPS navigation at the sea surface to dead reckon toward commanded targets by assimilation with a Kalman filter or though other algorithms. Navigation and knowledge of vehicle buoyancy and pitch angle allows estimation of depth-averaged current and suitably energetic vertical velocity fluctuations. Sensor suites include pressure, temperature, conductivity, Doppler sonar, dissolved oxygen, chlorophyll fluorometer, and optical backscatter. Gliders have been deployed and recovered from a wide range of platforms including small rubber boats, chartered fishing vessels and large research ships. Because the vehicles are relatively small and light, special handling gear is not required and field teams typically consist of one or, at most, two individuals. In more remote regions, we have also had significant success training local collaborators to handle field operations, eliminating the need to send highly-trained personnel from our laboratories.



(a) Seaglider and (b) Slocum.

#### UNDERWAY CTD

This UWCTD is a light-weight T-S probe tethered to a thin spectra line. The probe can be dropped from a ship moving as fast as 20 knots. The probe free-falls, collecting a profile of temperature and salinity (maximum depth depends on ship speed). At the end of it's profile, the probe is reeled back in using a fast winch. Data are downloaded and the probe's line spool rewound to prepare for another cast.



The Underway CTD being reeled in. The probe's tail is in the lower left corner, with the winch davit running across the top of the photo.

#### ROCKLAND SCIENTIFIC VMP-500 MICROSTRUCTURE PROFILER

The VMP-500 is a tethered microstructure profiler capable of collecting data to depths of 500 m. Profiling is executed from a slow-moving vessel. The profiler carries FP07 fast-response thermistors and SPM-38 shear probes.



The Rockland VMP-500 microstructure profiler.

#### REVELLE HYDROGRAPHIC DOPPLER SONAR SYSTEM

The R/V *Roger Revelle* is equipped with a Hydrographic Doppler Sonar (HDS) System which provides estimates of:

- Absolute ocean velocity
- Ocean shear

- Acoustic scattering intensity
- Scattering intensity gradient (plankton layering)

The system consists of two 4-beam Doppler sonars and assorted support sensors:

- The “Deep Sonar” operates at 44 kHz and can profile depths in excess of 1 km in favorable conditions. Depth resolution is 12 m.
- The “High Resolution Sonar” operates in a band near 140 kHz, profiling with 4m resolution to depth of 150-350m, depending on weather and bio-scattering conditions. Individual sonar returns (echos) are recorded at 2s intervals.

Both sonars are configured in the conventional 4-beam Janus geometry. In plan, the beams are oriented 45° relative to the fore/aft axis of the ship’s hull. The depression angle of each beam relative to horizontal is 60°.

The HDSS sonars transmit through a protective polyethylene “window” mounted flush with the ships’s hull. They are similar in principle to the commercial instruments found on many research vessels. The HDSS sonar beam patterns are significantly narrower than those of most commercial systems.

Each sonar transmits a coded acoustic pulse at 2-s intervals. The sound scatters from plankton drifting in the water column. From the Doppler shift of the return echo, the relative speed between the ship and the water can be inferred. GPS, along with a variety of other support sensors, is used to infer the absolute ocean velocity.

This equipment is permanently mounted on the R/V *Roger Revelle*. More information can be found at: <http://opgl.ucsd.edu/HDSS/RevMan7July2009sm.pdf>

3.4 Indicate whether harmful substances will be used:  
No harmful substances to be used.

3.5 Indicate whether drilling will be carried out:  
No drilling to be conducted.

3.6 Indicate whether explosives will be used (Type and trade name, Chemical content, Depth of trade class and stowage, Size, Depth of detonation, Frequency of detonation, and Position in latitude and longitude):  
No explosives will be used.

3.7 Indicate whether the project involves catching, taking, or exploration of marine animal and plants:  
No marine animal or plant interactions.

N.B. When the research project involves catching, taking or exploration of marine animals and/or plants in the exclusive economic zone of Japan, a separate approval from the Ministry of Agriculture, Forestry, and Fisheries of Japan under the Law on the Exercise of Sovereign Rights Concerning Fisheries in the Exclusive Economic Zone shall also be necessary. Applicants may submit the application form provided in Annex II through diplomatic channels. Catching and taking of marine animals and/or plants in the territorial Sea of Japan is generally prohibited by the Law for Regulation for Fishing Operation of Foreign Nationals and shall not be approved.

4. Installations and Equipment

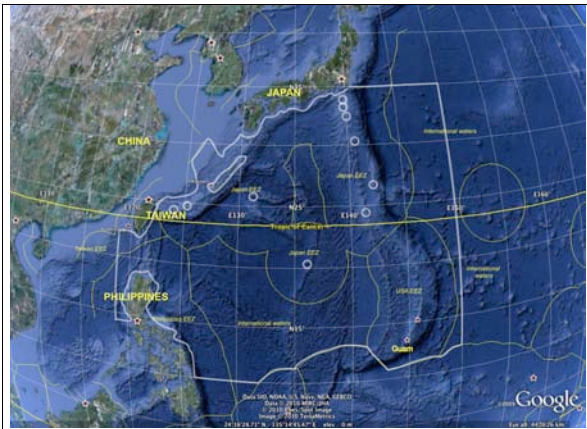
Gliders will operate autonomously (without the presence of the ship) between 11 June – 24 November, 2010. We request permission for them to sample within the EEZs of Taiwan, Japan and the Philippines during this period.

5. Geographical Areas

5.1 Indicate geographical areas in which the project is to be conducted (with reference in latitude and longitude):  
Please see chart below. Because typhoon paths are impossible to predict, it is not possible to specify the deployment, recovery or survey locations in advance of the actual field program. We will deploy between zero and eight gliders, depending on conditions, and all vehicles will remain within the operating area specified in the attached chart, excluding the territorial waters of Japan, Philippines and Taiwan. Neither ship tracks or glider tracks are plotted on this chart, as it is impossible to specify them in advance- they will be determined by whatever typhoons occur between June and November 2010. If desired, 3-4 times per day the gliders can report their positions via email to whatever authority the government of Japan specifies.  
  
Because we cannot make accurate predictions of typhoon timing and tracks, we must instead specify a broad area where typhoon surveys might occur. All operations detailed below will be confined to the region inside 10° N – 35° N and 120° E – 150° E, delineated by the thick grey line in Fig. 3. This area includes regions inside the EEZ’s of Taiwan, Japan and the Philippines, but excludes territorial waters (waters within 12 nm of the Philippine and Japanese coasts and 24 nm of the Taiwanese coast). Ship-based surveys, glider tracks and instrument recovery efforts will be restricted to the specified region.

5.2 Attach chart(s) at an appropriate scale showing the geographical areas of the intended work and, as far as practicable, the positions of intended stations, the tracks of survey lines, and the locations of installations and equipment.

Request permission to operate gliders and collect CTD and shipboard ADCP profiles within the region specified on the attached chart. All vehicles will remain within the operating area specified in the attached chart, excluding the territorial waters of Japan, Philippines and Taiwan. Neither ship tracks or glider tracks are plotted on this chart, as it is impossible to specify them in advance- they will be determined by whatever typhoons occur between June and November 2010. If desired, 3-4 times per day the gliders can report their positions via email to whatever authority the government of Japan specifies.



Map updated 2/17/10  
 The ITOP sampling area. Because we cannot predict where and when typhoons will occur, ITOP float deployments and cold-wake surveys might take place in the region between 10°-35°N and 120°-150°E (excluding territorial waters.), indicated by the white box. Maritime boundaries are shown in yellow. (From Google Maps).

## 6. Dates

6.1 Expected dates of first entry into and final departure from the research area of the research vessel:

R/V *Roger Revelle* First entry 11 June 2010  
 R/V *Roger Revelle* departs region 24 November 2010\*  
 \*Glanders are anticipated to be in the area until 24 November 2010.

ITOP Multiple entries possible between safe dates of 14 August – 23 October 2010. Due to the uncertainties involved in sampling typhoons, it is not possible to specify exact dates of entries and departures in advance.  
 Glanders are anticipated to be in the area until 24 November 2010 (see request and authorization covered under a separate MSR State Dept. File #2009-131 approval # First North America No. 928).

**Proposed Time of Multiple Entries**

R/V *Roger Revelle* cruises that take place between 24 July – 23 October 2010 will be scheduled in response to passing typhoons, so it is not possible to specify dates in advance.

Glanders (8 gliders total) will conduct surveys from 11 June – 24 November 2010. However, it is impossible to specify the timing of glider surveys in advance- timing will be determined by whatever typhoons occur between June and November 2010. If desired, 3-4 times per day the gliders can report their positions via email to whatever authority the government of Japan specifies.

**Timeline for ITOP**

This cruise will take place in a 71-day period shared by (IWISE)\* and by ITOP (Impact of Typhoon on the Ocean in the Pacific). Cruise duration will be 42 days, and may be broken into multiple legs that may not be contiguous. Exact timing and structure of this cruise will be governed by the timing and nature of typhoons that occur during the 71-day period under consideration in the clearance request.

Although it is not possible to specify an exact timetable for this cruise, if we assume that the 41 days are used in a single block, and example operations schedule might be:

Days 1 – 3 The vessel gets underway and steams to north or south of the wake.  
 Days 4 – 18 Arrive at cold wake, deploy gliders, and conduct survey using ship-deployed underway CTD and microstructure profiling. Recovery of air-deployed instruments is done on an opportunistic basis. The Slocum glider will be recovered at the end of this period. Seaglanders will remain in the water, to be recovered at the end of the ITOP program during the mooring recovery cruise.  
 Days 19 – 21 Return to port.  
 Day 22 Offload personnel and some equipment. Personnel for the recovery leg will board the ship and depart soon after.  
 Days 23-41 Chase and recover drifting instruments that were air-dropped into the typhoon earlier in the experiment.

This is only an example schedule- the actual schedule will almost certainly differ. Steaming time to and from the cold wake is dependent on the actual distance from the originating port, and on weather and sea-state conditions during the transit. There will likely be a need to stop survey activities to avoid other typhoons influencing the survey area subsequent to targeted typhoon of interest. These conditions may both subtract from the survey time, and delay the return of the ship to port.

\*IWISE not conducted in Japan EEZ

6.2 Indicated if multiple entry is expected: yes

## 7. Port Calls

7.1 Dates and names of intended ports of call:
None in Japan.
Potentially port calls in Kao-hsiung and Keelung, Taiwan

N.B. A separate request should be submitted by Note Verbales for intended port calls by public vessels.

Jardine, Matheson & Co  
13/14F, No. 50 Hsin Sten South Road, Sec.1  
Taipei, P.O. Box 81  
Taiwan

Tel: 886-2 23931177  
Fax: 886-2 23920435  
Gen Email: [operation.tpe@jm.com.tw](mailto:operation.tpe@jm.com.tw)

## 8. Participation

8.1 Extent to which Japanese scientists or officials will be enabled to participate or to be represented in the research project:
Participation by Japanese colleagues encouraged.

8.2 Proposed dates and ports for embarkation / disembarkation:
R/V <i>Roger Revelle</i> will operate from Kao-hsiung, Taiwan, Multiple embarkations /debarations, beginning 11 June 2010 and ending 24 November 2010.

## 9. Access to data, samples and research results

9.1 Expected dates of submission to the Ministry of Foreign Affairs of Japan of preliminary reports and data which should include the expected dates of submission of the final results:
No more than 30 days from the end date of the cruise.

9.2 Proposed means for access by Japanese scientists or officials to samples:
CD or DVD provided, with further access to the data via internet download or CD/DVD on request.

9.3 Proposed means to provide Japan with assessment of data, samples and research results or provide assistance in their assessment or interpretation:
Participation in international data analysis workshops and science symposia during the analysis phase of the project.

9.4 Proposed means of making results internationally available:
Publication in scientific journals and reports.