Satellite Observations of Surface Fronts, Currents and Winds in the Northeast South China Sea

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LONG-TERM GOALS

The long-range goal of this proposal is to improve our understanding of surface currents and fronts in the northeast South China Sea and their influence on acoustic propagation across the shelfbreak in this low-latitude setting. We are using satellite measurements of sea surface temperature, color, height and winds to identify and analyze the regional surface fronts and mesoscale eddy features and collaborate with other ASIAEX investigators to reach this goal.

OBJECTIVES

Relatively little is known about the general circulation and fronts in the northeast South China Sea. Past work suggests a northeastward current over the outer shelf (the South China Sea Warm Current) and a southwestward current over the slope containing Kuroshio water from the Luzon Strait, however, there exist few *in-situ* direct current measurements to support this schematic. AVHRR imagery shows that the Kuroshio can bifurcate in the Luzon Strait, with some of its transport entering the South China Sea west of Taiwan. Wind stress (Farris and Wimbush, 1996) and wind stress curl (Metzger and Hurlburt, 2001) have been shown to be relevant to the penetration of the Kuroshio and subsequent shedding of large mesoscale eddies, which may influence flow over the Chinese continental margin directly.

The Asian Seas International Acoustics EXperiment (ASIAEX) was developed to investigate the propagation of low frequency sound across the shelfbreak in this region. As part of this program, two one-month field studies were conducted, featuring high-resolution SeaSoar/ADCP surveys and moored acoustic and physical oceanographic measurements. One objective of the physical measurements was to observe the current and thermohaline fields near the shelfbreak with sufficient spatial and temporal resolution to help interpret the variability observed in the acoustic data. As part of this latter effort, we are using satellite data to help describe surface features and their evolution during the two field studies. In addition, we propose to use satellite data collected over a three-year span (which includes the two

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14. ABSTRACT
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field studies) to better understand the larger-scale surface variability in the eastern South China Sea on time scales of days to years, and the relationship between this regional variability and that observed in the two smaller-scale shelfbreak field studies.

APPROACH

We began collecting and processing AVHRR, ocean color, and altimeter data for the eastern South China Sea in January 2000, with one objective being to provide early descriptions of the surface features observed in the area of the pilot study (April 2000) to ASIAEX investigators planning the pilot study. The collection of the remote sensing data will continue for two full years (into spring, 2002). Archived data for 1999 will be obtained to complete a three-year plus data set. This time period encompasses the pilot and main (April–May 2001) field studies while allowing annual mean fields to be computed and seasonal and interannual differences to be identified. This will allow the pilot and main field study periods to be placed within the longer-term temporal context. For example, a multi-year mean sea surface height (SSH) field will be computed and used to help isolate mesoscale current features and variability. The locations of fronts and eddies will be analyzed to determine whether the features observed during the two field studies were typical. In 2001–2003, final data processing will be completed and scientific analysis and collaborations with other investigators continued and completed.

WORK COMPLETED

We have acquired and archived a number of satellite-derived data sets for the South China Sea. These data sets include high and low resolution sea surface temperature data from 1990 to present, ocean color images from 1997 to present, scatterometer wind fields from 1999 to present and altimeter sea surface height anomalies from 1993 to present.

RESULTS

Our analysis during this past year has focused on the altimeter sea surface height data. Figure 1 shows the location of TOPEX/Poseidon track 088, which is the descending track closest to the ASIAEX study region just west of the Luzon Strait. This track crosses the region of the large-scale deep-water SeaSoar surveys. Figure 2 is a time/latitude plot of the sea surface height residuals along track 088 for the period January 2000 through May 2001. This figure demonstrates that conditions are considerably different prior to the two field programs in the spring of 2000 and 2001. The positive sea surface height anomaly that appears near 21.5^{o} N in January 2000 indicates the presence of an eddy moving northward during the late winter–early spring. This eddy is also apparent in the SeaSoar measurements made during the pilot study. The large anomaly in the spring of 2000 is in contrast to the lack of an anomaly during the spring of 2001, which indicates the lack of an eddy during the main field study. Preliminary measurements from the main field study have confirmed that conditions indicated by the altimeter were correct.

Although the long time series data along track 088 show that the most dominant signal is the annual signal due to steric changes, an inter-annual signal can also be seen in the data. In the summer/fall of 1996, an anomaly can be seen around 19°N that moves north to about 21°N. Again in summer/fall of 1998, a similar anomaly can be seen. However, this anomaly does not become as intense as the anomaly of 1996. Finally, an intense anomaly can be seen in the summer/fall of 1999 at 20°N.

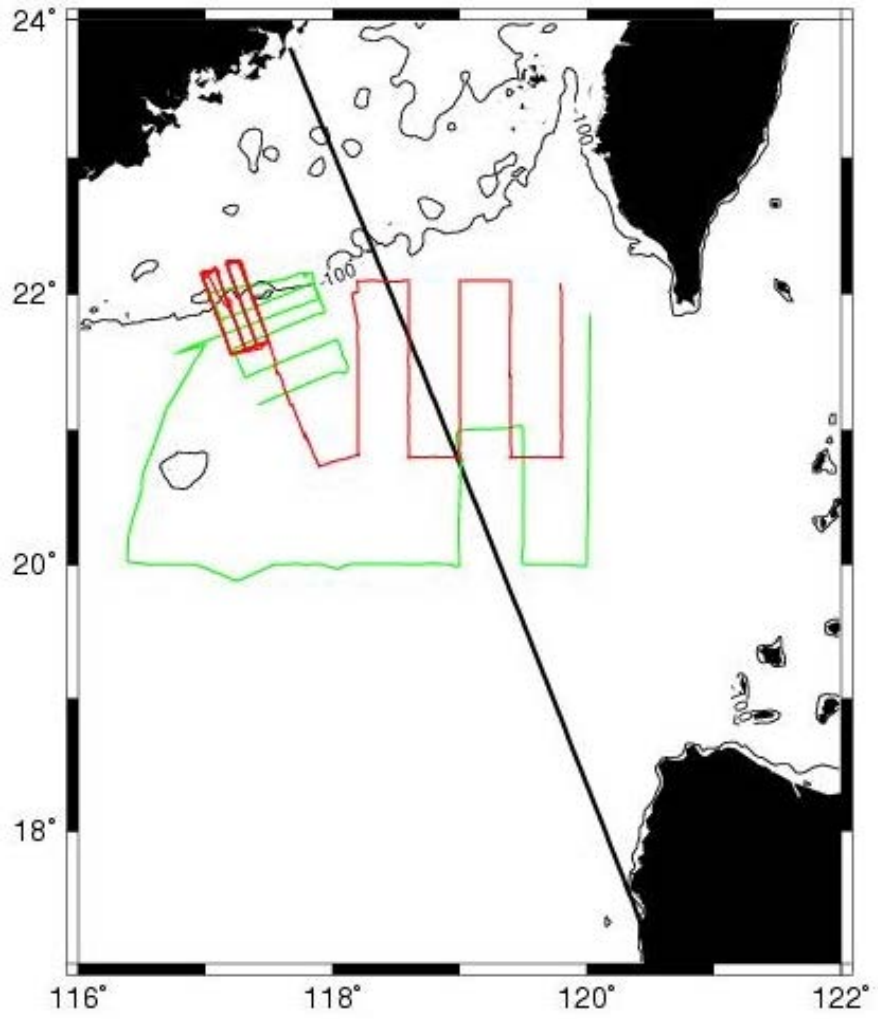

Figure 1. Map showing SeaSoar tracks for the pilot (green) and main (red) field programs relative to TOPEX/Poseidon track 088 (black). The deepwater surveys cross the altimeter subtrack and the shelfbreak surveys are to the west of subtrack.

Wind stress and wind stress curl are thought to play an important role in the intrusion of Kuroshio water into the South China Sea and subsequent eddy formation. We have started analyzing scatterometer wind data to assess the relative strength of the winter monsoons preceding the two field programs.

Although initial results from surface information derived from the passive radiometers such as sea-surface temperature and ocean color did not provide much insight into the temporal evolution of the shelf break front or eddies in the South China Sea, we have begun to look at the statistics of these two fields. There are few individual days with clear views of the Luzon Strait and the South China Sea. However, higher concentrations of chlorophyll in the Luzon Strait between the Philippines and Taiwan may be useful for determining the extent of the intrusion of Kuroshio water into the South China Sea on inter-annual time scales.

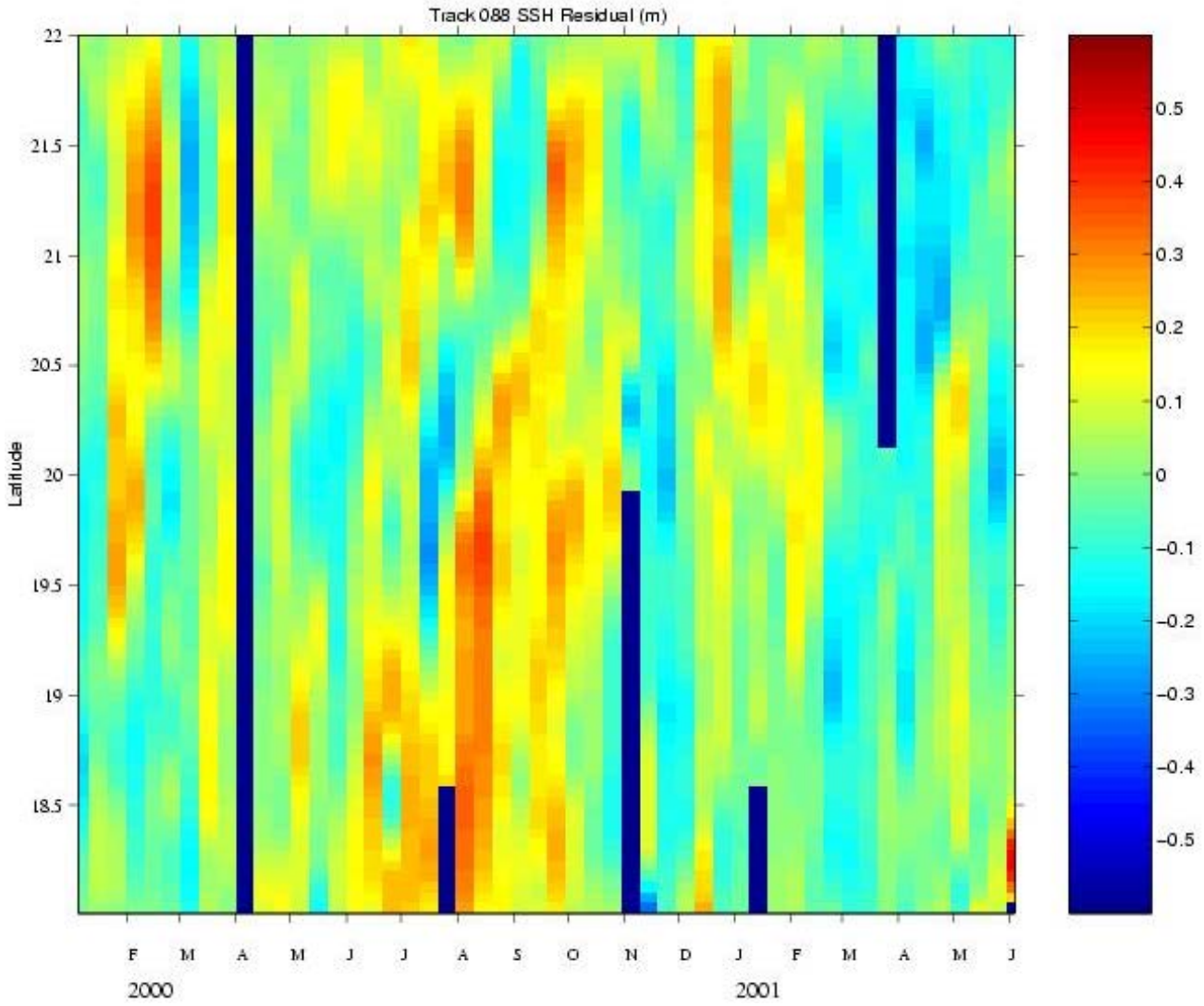

Figure 2. This figure shows the time-latitude plot of TOPEX/Poseidon sea surface height residual along track 088, just east of the South China Sea study area. A positive sea-surface height anomaly indicates the presence of an eddy near 21 ºN during the spring 2000 pilot experiment, while a slightly negative anomaly indicates the absence of an eddy during the 2001 main field program.

IMPACT / APPLICATIONS

There is considerable debate over the frequency and duration of Kuroshio intrusions into the South China Sea. The long-term altimeter and scatterometer data combined with ocean color and sea surface temperature data will enable us to characterize the temporal/spatial behavior and interannual variability of this intrusion and its impact on the general circulation west and south of Taiwan and the shelf-break front.

TRANSITIONS

We have provided remote sensing data to the WHOI and Taiwanese SeaSoar groups in the ASIAEX program to provide broad scale interpretation of their *in-situ* data collected in the 2000 pilot and 2001 field programs.

RELATED PROJECTS

The Asian Seas International Acoustics EXperiment (ASIAEX) was developed to investigate the propagation of low-frequency sound across the shelfbreak in this region. The insights provided by the Taiwanese and WHOI SeaSoar data (G. Gawarkiewicz, personal communication) have been helpful in our analysis of the satellite data. We are working with Gawarkiewicz and other ASIAEX investigators to provide broad-scale analysis to help in the interpretation of the SeaSoar and moored array data collected during the pilot and main studies.

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PUBLICATIONS

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