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Submission ID #: 61172
Scriptwriter Name: Bridget Colvin
Project Page Link: https://www.jove.com/account/file-uploader?src=18657508

Title: Investigating the Relationship between Sea Surface Chlorophyll and Major Features of the South China Sea with Satellite Information

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Author Questionnaire

1. Microscopy: Does your protocol involve video microscopy, such as filming a complex dissection or microinjection technique? **N**

2. Software: Does the part of your protocol being filmed demonstrate software usage? **Y**

3. Filming location: Will the filming need to take place in multiple locations (greater than walking distance)? **N**

NOTE: Authors may have used a script draft for filming

Introduction

1. Introductory Interview Statements

REQUIRED:

1.1. **Yuntao Wang**: Satellite observations offer a great approach for investigating the features of major marine parameters, including sea surface chlorophyll, temperature, and height, and factors derived from these parameters, such as fronts **[1]**

1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

REQUIRED:

1.2. **Yi Yu**: This protocol uses satellite observations to describe major parameters and their relationships. Here we use satellite datasets from 2002-2007 to describe surface features of the South China Sea **[1]**.

1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

OPTIONAL:

1.3. **Huan-Huan Chen**: Chlorophyll observations are used as an indicator of ocean production. Factors related to chlorophyll variability can be investigated using monthly averaged time series **[1]**.

1.3.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

OPTIONAL:

1.4. **Hao-Ran Zhang**: This method can also be applied to other global oceans and can be helpful for understanding marine dynamics and ecosystems **[1]**.

1.4.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

OPTIONAL:

1.5. **Rui Tang**: This step-by-step procedure for acquiring the satellite data of different parameters can be used to measure spatial and temporal variabilities and to determine interrelationships between different factors **[1]**.

Commented [BC1]: Authors: Rui Tang will be introduced with this statement and does not need to be introduced with a separate statement.

1.5.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

OPTIONAL:

1.6. **Huan-Huan Chen**: The spatial and temporal variabilities are obtained using the empirical orthogonal function and the interrelationships can be calculated using their correlation coefficients **[1]**.

1.6.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

Protocol

2. Sea Surface Temperature (SST) and Chlorophyll (CHL) Dataset Acquisition

2.1. For sea surface temperature and sea surface chlorophyll data acquisition, download a dataset of satellite observations from MODIS-Aqua, for which the spatial resolution of both datasets is roughly 4.5 kilometers at daily intervals **[1-TXT]**.

2.1.1. WIDE: Talent downloading dataset **TEXT: http://podaac-tools.jpl.nasa.gov/**

2.2. Store the downloaded satellite files in the 'Data' folder and structure the directory of folders as shown **[1]**.

2.2.1. SCREEN: screenshot_1: 00:01-00:16 *Video Editor: please speed up*

2.3. Add the path of the toolbox for NetCDF file in MATLAB and select **Add with subfolders** to enclose the paths of the **scripts** folder. The path for all of the required directories of the data and functions will appear in the MATLAB search path **[1]**.

2.3.1. SCREEN: screenshot_1: 00:17-00:35 *Video Editor: can speed up*

2.4. Then load the sea surface temperature data into the analysis software **[1-TXT]**.

2.4.1. SCREEN: screenshot_2 **TEXT: *e.g.*, here data for January 1st and 2nd 2003 will be obtained as SST variable** *Video Editor: please emphasize SST value on right side of frame when mentioned.*

3. Sea Level Anomaly (SLA), Wind Speed, and Topography Dataset Acquisition

3.1. For sea level anomaly dataset acquisition, download daily sea level anomaly data with a 25-kilometer spatial resolution from the same time frame **[1-TXT]** and enter the command to load the single-day sea level anomaly data **[2]**.

3.1.1. WIDE: Talent downloading data, with monitor visible in frame. **TEXT: https://marine.copernicus.eu/**

3.1.2. SCREEN: screenshot_3 *Video Editor: please emphasize SLA value on right side of frame when mentioned.*

3.2. To obtain the wind speed data, download the wind data from the same time period from an ERA-Interim reanalysis product and enter the command to read the one-month wind data. The obtained **u**, **v**, and **time** variables represent the zonal and meridional speeds and the corresponding time, respectively **[1-TXT]**.

3.2.1. SCREEN: screenshot_4 **TEXT: https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era-interim** *Video Editor: please emphasize u, v, and time values on right side of frame when mentioned*

3.3. To access the topography dataset, download the high-resolution topography data from the National Centers for Environmental Information website and enter the command to load the topography data into the analysis software. The **XX**, **YY**, and **ZZ** variables indicate the latitude, longitude, and corresponding depth, respectively **[1-TXT]**.

3.3.1. SCREEN: screenshot_5 **TEXT: https://maps.ngdc.noaa.gov/viewers/wcs-client/** *Video Editor: please emphasize XX, YY and ZZ values on right side of frame when mentioned*

4. Data Preprocessing

4.1. Due to the large cloud coverage in the sea surface temperature and sea surface chlorophyll data **[1]**, use the command to replace original data with the 3-day average data **[2]**.

Commented [BC2]: Authors: Since this script is a "how to", the narrative text needs to explain to viewers what actions to perform, so the "use the command" text is necessary.

4.1.1. WIDE: Talent at computer, entering command(s)

4.1.2. SCREEN: screenshot_6 *Video Editor: please emphasize CHL_3d and SST_3d values on right side of frame when mentioned*

4.2. Because the spatial resolution is not consistent for different datasets, enter the command to interpolate the sea surface temperature and sea surface chlorophyll data into a spatial grid that is the same as the wind and sea level anomaly spatial grid **[1]**.

4.2.1. SCREEN: screenshot_7 *Video Editor: please emphasize Chl and T values on right side of frame when mentioned*

4.3. Enter the command as indicated to calculate the wind stress and wind stress curl **[1]**.

4.3.1. SCREEN: screenshot_8 *Video Editor: please emphasize Curl value on right side of frame when mentioned*

4.4. To calculate the monthly sea surface temperature, wind, and sea level anomaly time series as 30-day averages in each pixel, enter the command as indicated **[1]**.

4.4.1. SCREEN: screenshot_9 *Video Editor: please emphasize CHL_mon and T_mon* *values on right side of frame when mentioned*

5. SST Front Detection

5.1. For spatial smoothing, enter the command **[1]** to run the script to smooth the three-day averaged sea surface temperature data in each pixel **[2]**.

5.1.1. WIDE: Talent entering command, with monitor visible in frame
5.1.2. SCREEN: screenshot_10 *Video Editor: please emphasize T_smooth value on right side of frame when mentioned*

5.2. To determine the sea surface temperature gradient, enter the command to run the script to calculate the zonal and meridional sea surface temperature gradients as the sea surface temperature difference between the nearest two pixels divided by the corresponding distance **[1]**.

5.2.1. SCREEN: screenshot_11 *Video Editor: please emphasize G, Gx and Gy values on right side of frame*

5.3. To identify a front by testing the value of the sea surface temperature gradient, label the pixel as a potential frontal pixel if the value is larger than a designated threshold **[1-TXT]**.

5.3.1. SCREEN: screenshot_12 *Video Editor: please emphasize Front value on right side of frame when mentioned*

5.4. To calculate the monthly frontal probability of observing a front take place for a specific time span, enter the command **[1]**.

5.4.1. SCREEN: screenshot_13 *Video Editor: please emphasize FP value on right side of frame when mentioned*

6. Spatial and Temporal Variability and Intercorrelation

6.1. Ro load the monthly data for analysis data, enter the commands **[1]** and apply an empirical orthogonal function to describe the spatial and temporal variabilities of the different parameters **[2]**.

6.1.1. WIDE: Talent at computer, entering command(s), with monitor visible in frame
6.1.2. SCREEN: screenshot_14 *Video Editor: please emphasize CHL_mon value on right side of frame when mentioned*

6.2. The program will calculate the magnitude, eigenvalues, and amplitude of the empirical orthogonal functions for the dataset **[1]**.

6.2.1. SCREEN: screenshot_14 *Video Editor: please emphasize Mag, Eig, and Amp values on right side of frame when mentioned*

6.3. To determine the correlation at the seasonal scale, enter the command to calculate the correlations between two factors using their time series at each pixel **[1]**.

6.3.1. SCREEN: screenshot_15 *Video Editor: please emphasize rr value on right side of frame*

6.4. Then enter the command to calculate the correlations between the monthly anomalies of the sea surface chlorophyll and other factors **[1]**.

6.4.1. SCREEN: screenshot_16 *Video Editor: please emphasize rr_rm value on right side of frame*

7. Data Display

7.1. To display the satellite information, enter the command to run the script **[1]** to generate a showcase of satellite information, including the sea surface chlorophyll, temperature, and wind, and sea level anomaly and frontal distribution **[2]**.

7.1.1. WIDE: Talent entering command, with monitor visible in frame
7.1.2. SCREEN: screenshot_17

7.2. Enter the command to display the empirical orthogonal function result **[1]**.

7.2.1. SCREEN: screenshot_18

7.3. Then enter the command as indicated to calculate the relationship between the chlorophyll and other factors at seasonal and anomalous fields **[1]**.

7.3.1. SCREEN: screenshot_19

Results

8. Results: Representative South China Sea (SCS) Surface CHL Analyses

8.1. The topography has a prominent impact on the spatial distribution of sea surface chlorophyll **[1]**, with high sea surface chlorophyll mainly distributed along the coast of the South China Sea, where the topography is shallow **[2]**.

8.1.1. LAB MEDIA: Figure 4A *Video Editor: please emphasize dark red signal*
8.1.2. LAB MEDIA: Figure 1E *Video Editor: please emphasize dark red signal*

8.2. Wind is also influenced by orography, with the lee side of mountains characterized by weak wind **[1]** and a prominent wind stress curl identified southwest of the South China Sea **[2]**.

8.2.1. LAB MEDIA: Figure 4C *Video Editor: please emphasize blue and red signal*
8.2.2. LAB MEDIA: Figure 4C *Video Editor: please emphasize blue*

8.3. The thresholds applied here effectively capture the location of the front **[1]** and ensure the depiction of the boundaries of entire water masses **[2]**.

8.3.1. LAB MEDIA: Figures 3A and 3B *Video Editor: please emphasize Figure 3A, 3B*
8.3.2. LAB MEDIA: Figures 3B and 3C *Video Editor: please emphasize Figure 3C*

8.4. In this analysis, empirical orthogonal function 1 captured a large variance in the northern section of the South China Sea **[1]**.

8.4.1. LAB MEDIA: Figure 5A

8.5. The corresponding monthly average of the time series **[1]** showed that the sea surface chlorophyll was elevated during the winter **[2]** and depressed during the summer **[3]**.

8.5.1. LAB MEDIA: Figure 5C
8.5.2. LAB MEDIA: Figure 5C *Video Editor: please emphasize data line from J to first M*
8.5.3. LAB MEDIA: Figure 5C *Video Editor: please emphasize data line from second M to S*

8.6. The region next to the southwest coast was characterized by a weak magnitude and the corresponding variability was mainly captured by empirical orthogonal function 2 **[1]**.

8.6.1. LAB MEDIA: Figure 5B *Video Editor: please emphasize red signal*

8.7. Sea surface chlorophyll values were high in the summer **[1]** and low in the winter **[2]**, which was mainly out of phase compared to the northern region **[3]**.

8.7.1. LAB MEDIA: Figure 5D *Video Editor: please emphasize data line from second J to S*
8.7.2. LAB MEDIA: Figure 5D *Video Editor: please emphasize data line from first J to M*
8.7.3. LAB MEDIA: Figure 5D *Video Editor: if possible, please superimpose Figure 5C data over Figure 5D data to emphasize out phase data between two regions*

8.8. Indeed, the monthly time series for the empirical orthogonal functions demonstrated clear seasonal variability **[1]**, with empirical orthogonal function 2 leading empirical orthogonal function 1 by approximately 4 months **[2]**.

8.8.1. LAB MEDIA: Figure 5E
8.8.2. LAB MEDIA: Figure 5E *Video Editor: please emphasize blue data line locates to the left of the black line*

8.9. The correlations between the chlorophyll and other factors represents the interrelationships of the factors **[1]**.

8.9.1. LAB MEDIA: Figure 8

8.10. For example, in this analysis, the sea surface temperature is negatively correlated with the chlorophyll **[1]**, while the wind stress is positively correlated with the chlorophyll **[2]**. Thus, a high chlorophyll was associated with a low temperature and strong wind for these data **[3]**.

8.10.1. LAB MEDIA: Figure 8A *Video Editor: please emphasize blue data*
8.10.2. LAB MEDIA: Figure 8B *Video Editor: please emphasize red data*
8.10.3. LAB MEDIA: Figure 8A and 8B

Conclusion

9. Conclusion Interview Statements

9.1. **Huan-Huan Chen**: Identification of the variability of between ocean parameters and investigation of their relationships with chlorophyll are critically important data for ocean dynamic and marine ecosystem studies **[1]**.

9.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera (6.2., 7.3.)

9.2. **Rui Tang**: High chlorophyll is usually associated with fronts. Modify the threshold of the front detection to allow validation of the fronts as necessary to facilitate comparisons with in situ observations **[1]**.

9.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

9.3. **Yuntao Wang**: Satellite observations can be used to accurately describe spatial distributions and temporal variabilities in ocean surface features. As satellite resolutions improve, more detailed features can potentially be identified and investigated **[1]**.