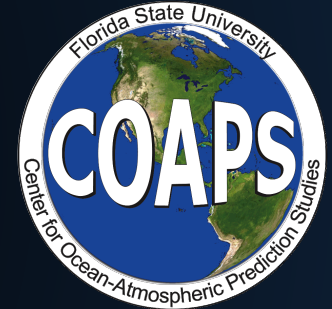


Coastal Upwelling Index Databases Derived from Satellite Winds



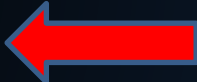


Steve Morey
Center for Ocean – Atmospheric Prediction Studies
The Florida State University

This project was sponsored by the NASA/JPL Ocean Vector Winds Science Team

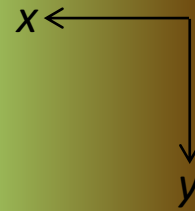
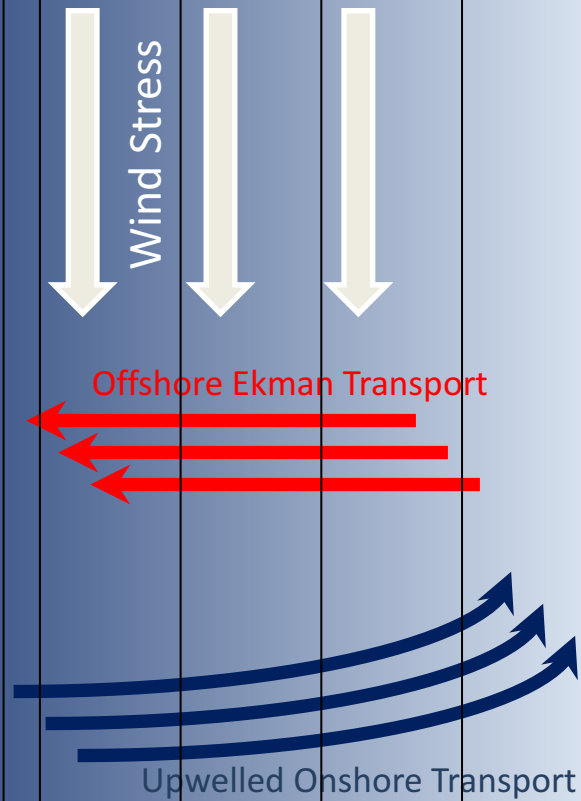
Project Objectives:

- Develop global databases of coastal upwelling indices from satellite scatterometer-derived wind products.
- Develop methods for extending application of upwelling indices to coastal regions with complex shelf geometry.
- Use this global product to examine spatio-temporal variability of upwelling/downwelling over Earth's coastal regions at multiple scales.
- Provide web access to analysis tools and data download

Global Coastal Upwelling Data Products:

- Ekman upwelling indices:
 - CCMP (1.1) 1987-2011
 - QuikSCAT (L2b Swath) 1999-2009
- Daily Climatology (CCMP and QuikSCAT)
- Modified Upwelling Index for better application to complex coastlines
 - Metrics to gauge applicability of the upwelling indices
- Data Products served via THREDDS/OPeNDAP (open access) 
- Web-based GUI for basic analyses  **Now Live**
 - Time series with optional filtering
 - Maps of time-averaged upwelling indices 
 - Maps of upwelling anomalies
 - Upwelling climatology

Classic Ekman Coastal Upwelling



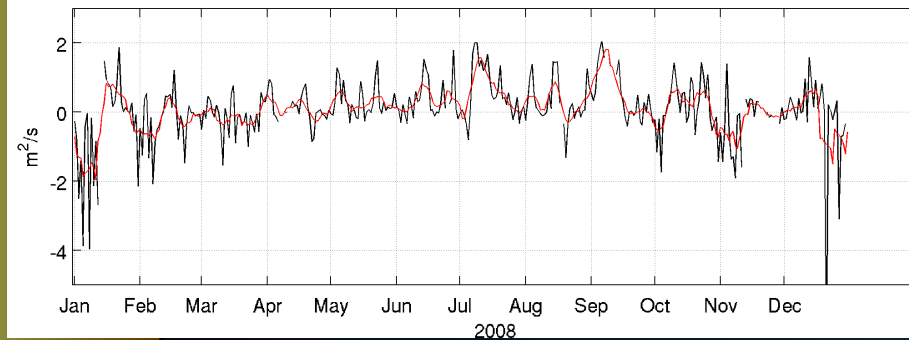
The offshore Ekman transport is

$$S_x = \frac{\tau_y}{\rho_0 f}$$

S_x is used as an upwelling Index

Classic Upwelling Indices from CCMP Winds

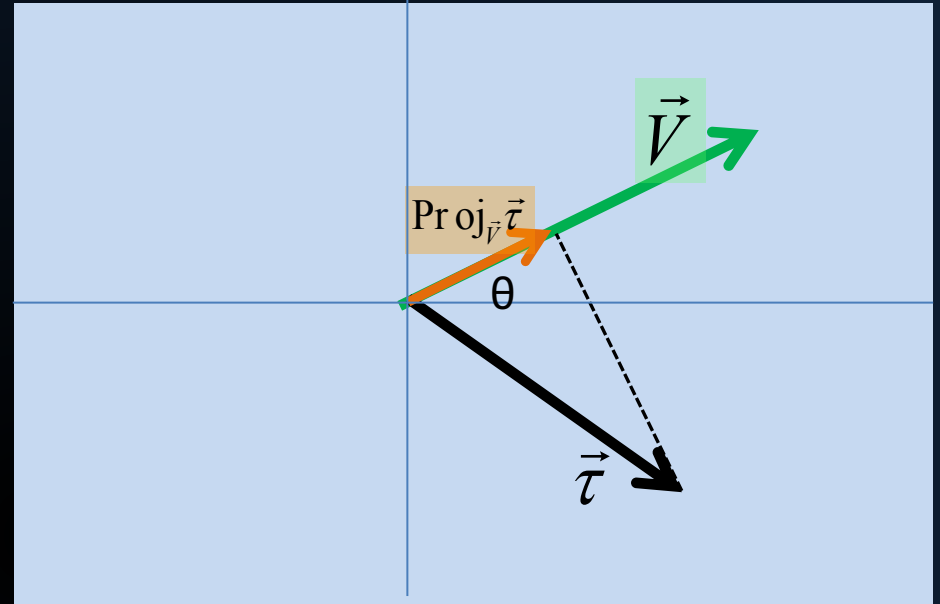
Offshore Ekman transport (m^2/s): 45.0N, 124.9W



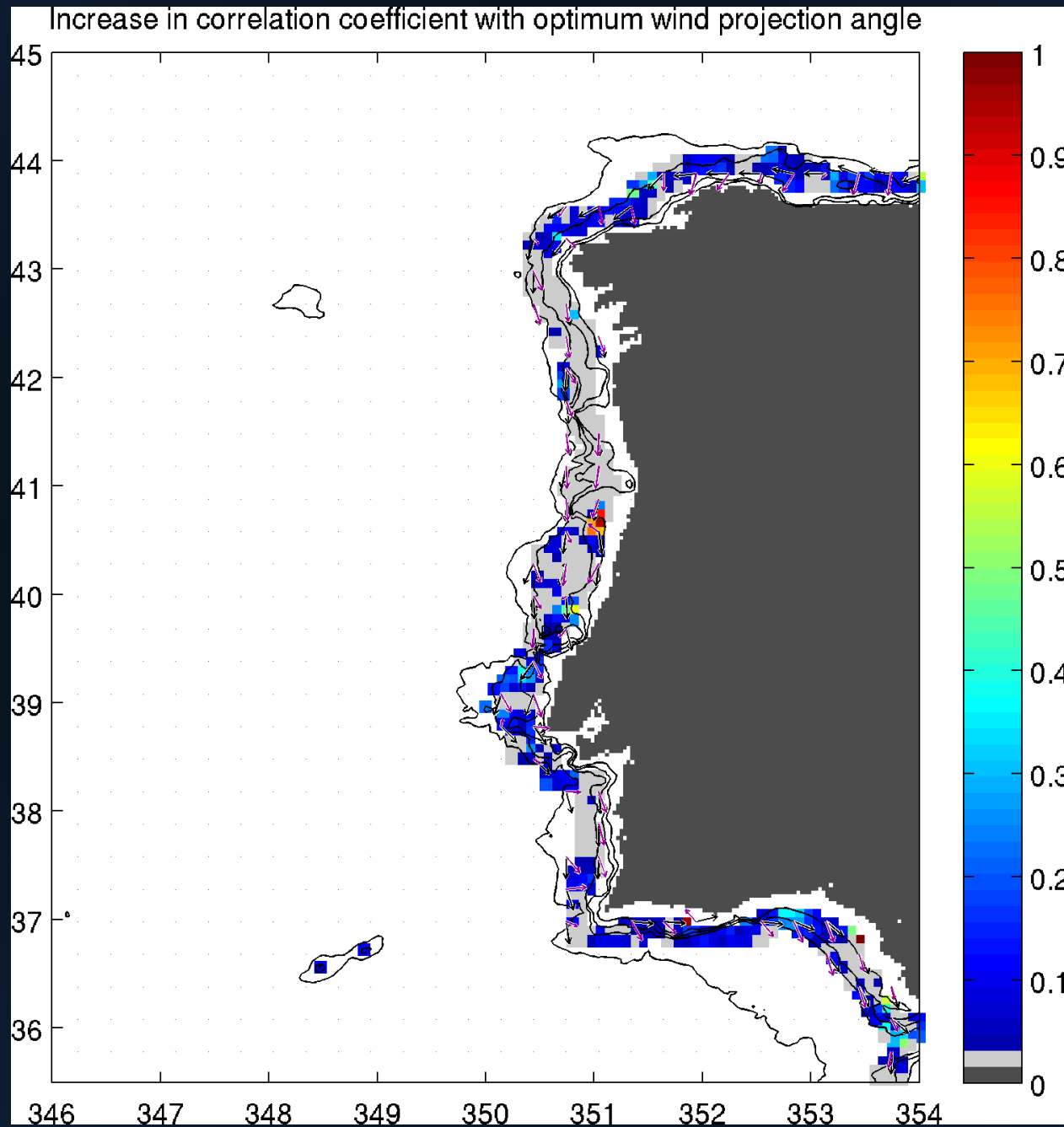
A Modified Upwelling Index

For each coastal point:

1. Project τ onto the vector V rotating through all angles.
2. For each angle, compute correlation between the projected wind stress time series and the near-bottom cross-isobath ocean velocity from a global model (HYCOM).
3. Determine the rotation angle of maximum correlation
4. CCMP wind stress time series are then projected onto the angle of maximum correlation at each grid point to produce modified upwelling indices.

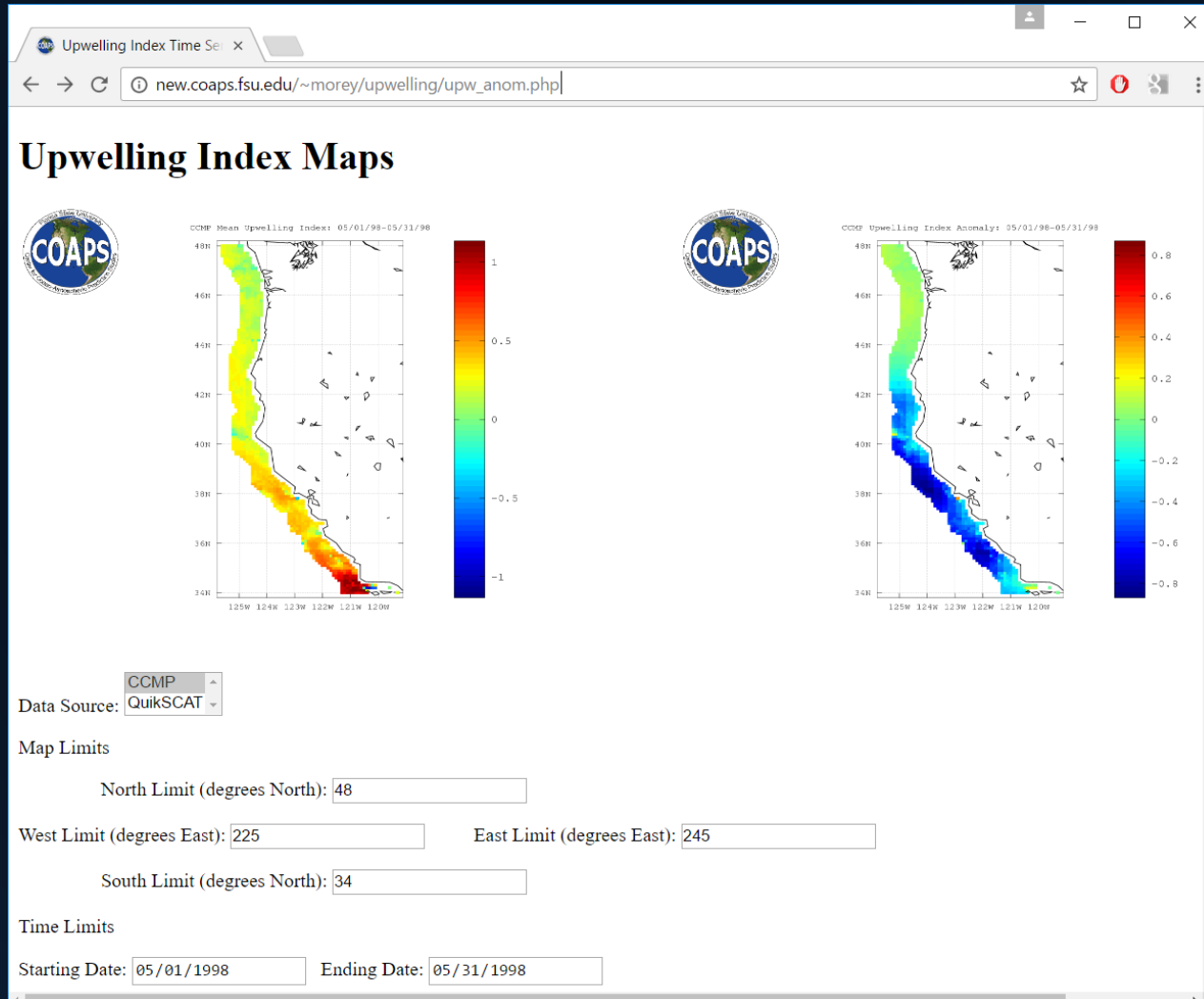


Iberian Peninsula Example

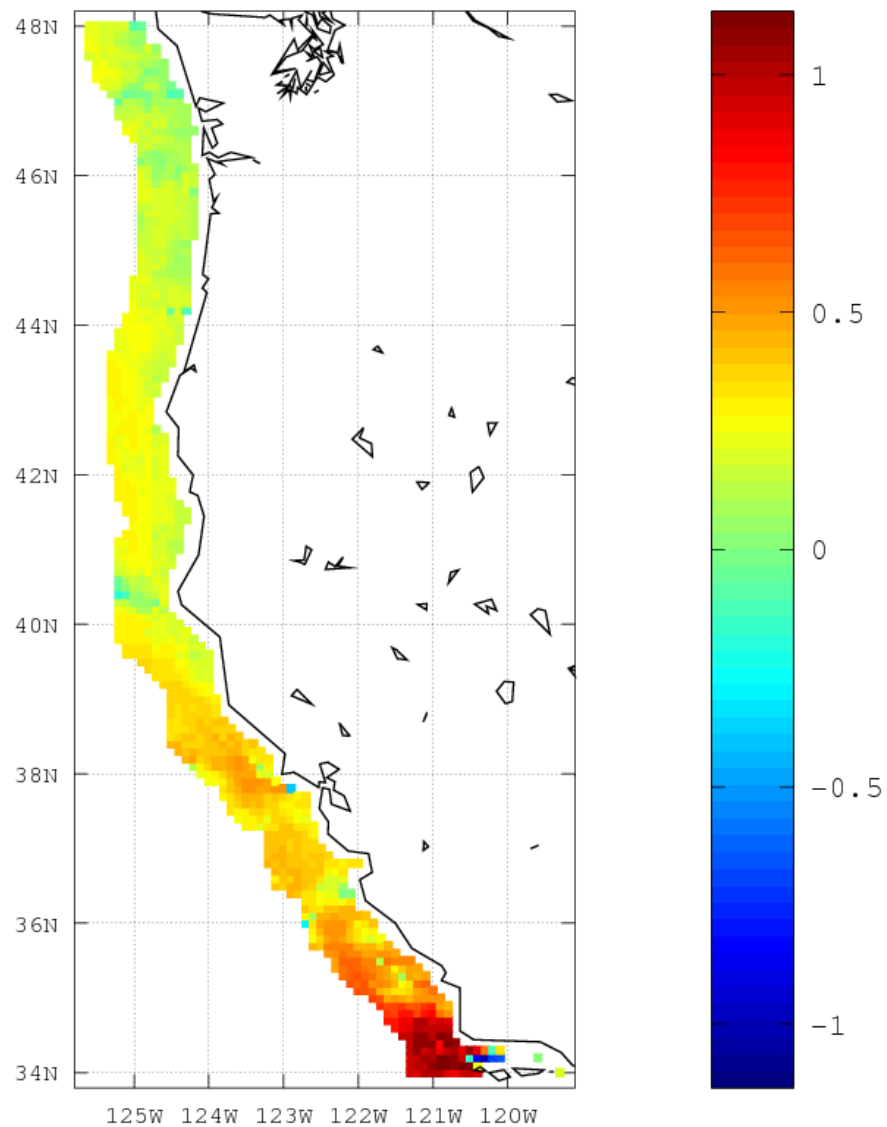


Analysis Tools and Data Downloads available at:

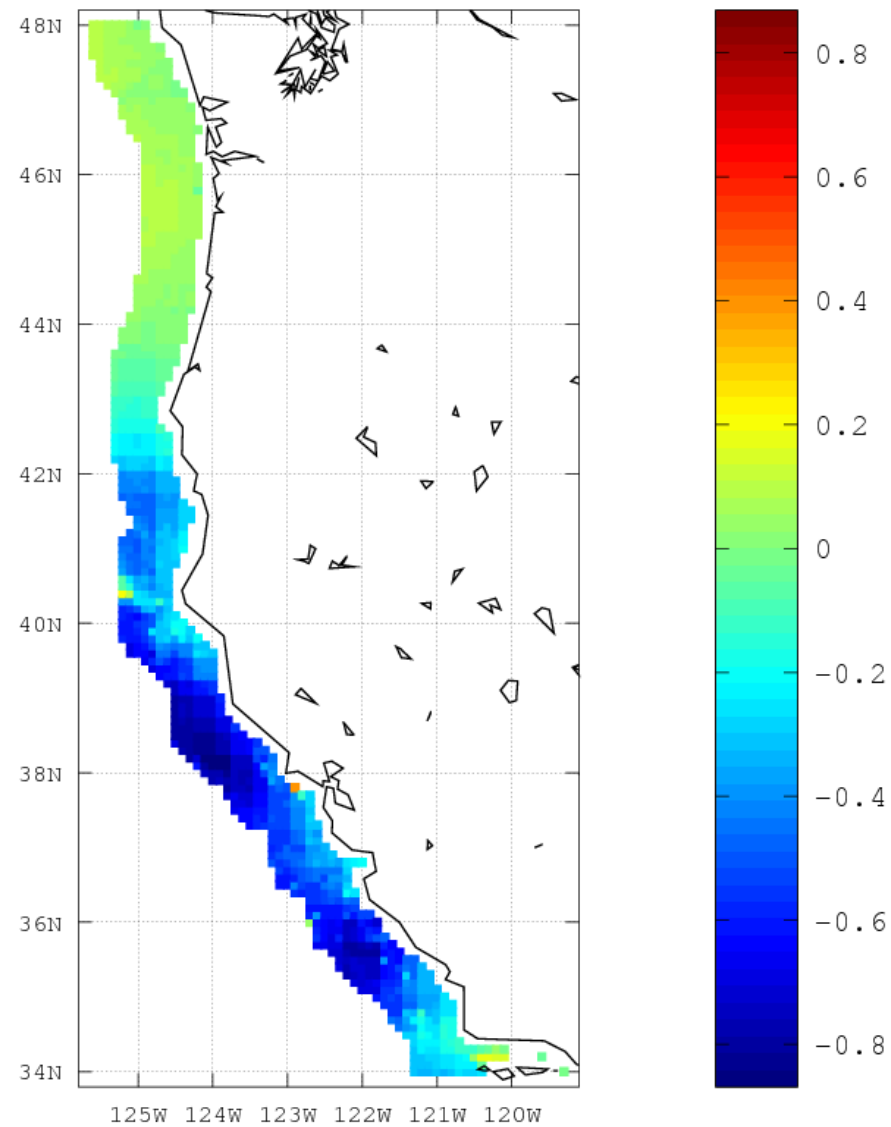
<http://coaps.fsu.edu/scatterometry/derivedProducts/>



CCMP Mean Upwelling Index: 05/01/98-05/31/98



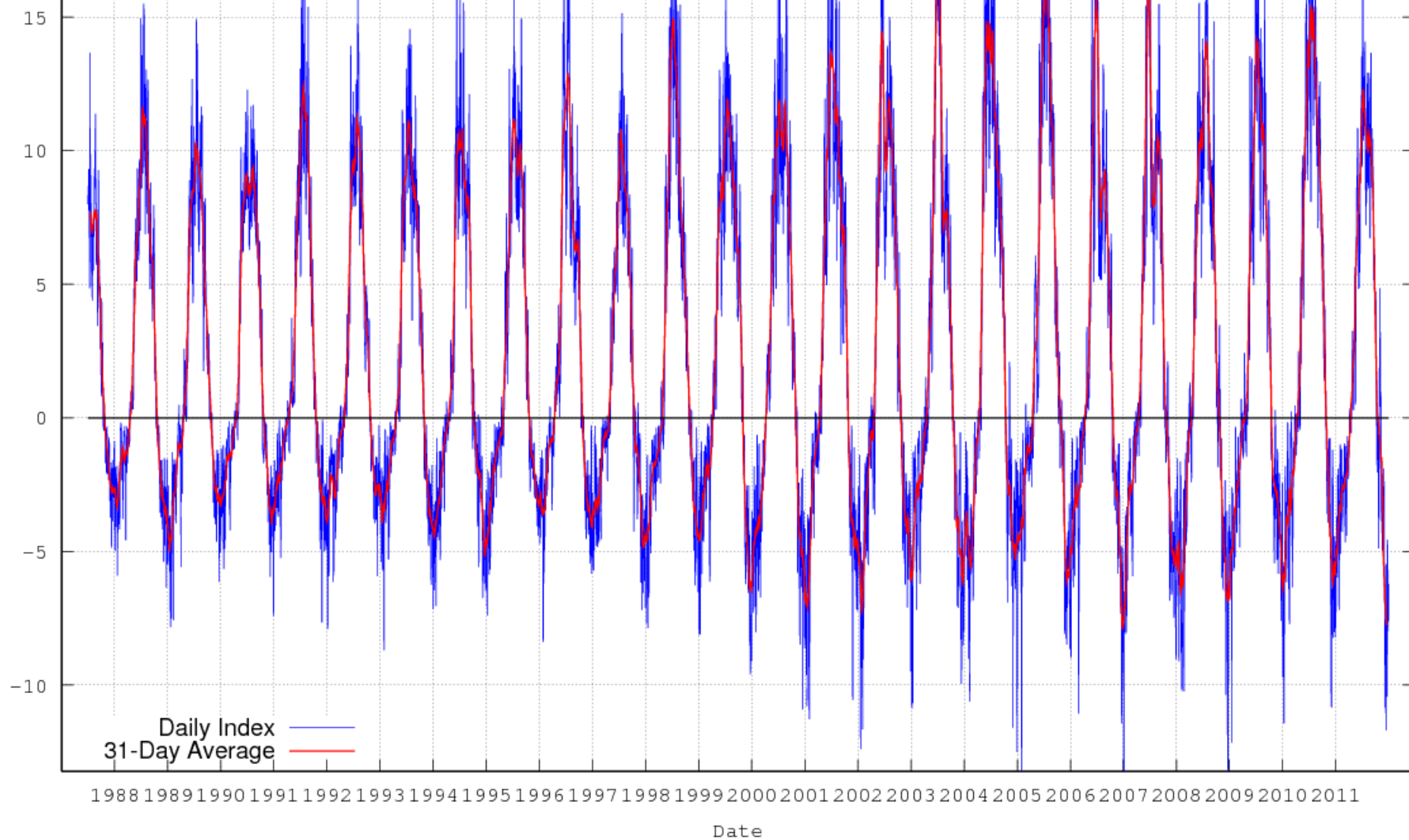
CCMP Upwelling Index Anomaly: 05/01/98-05/31/98

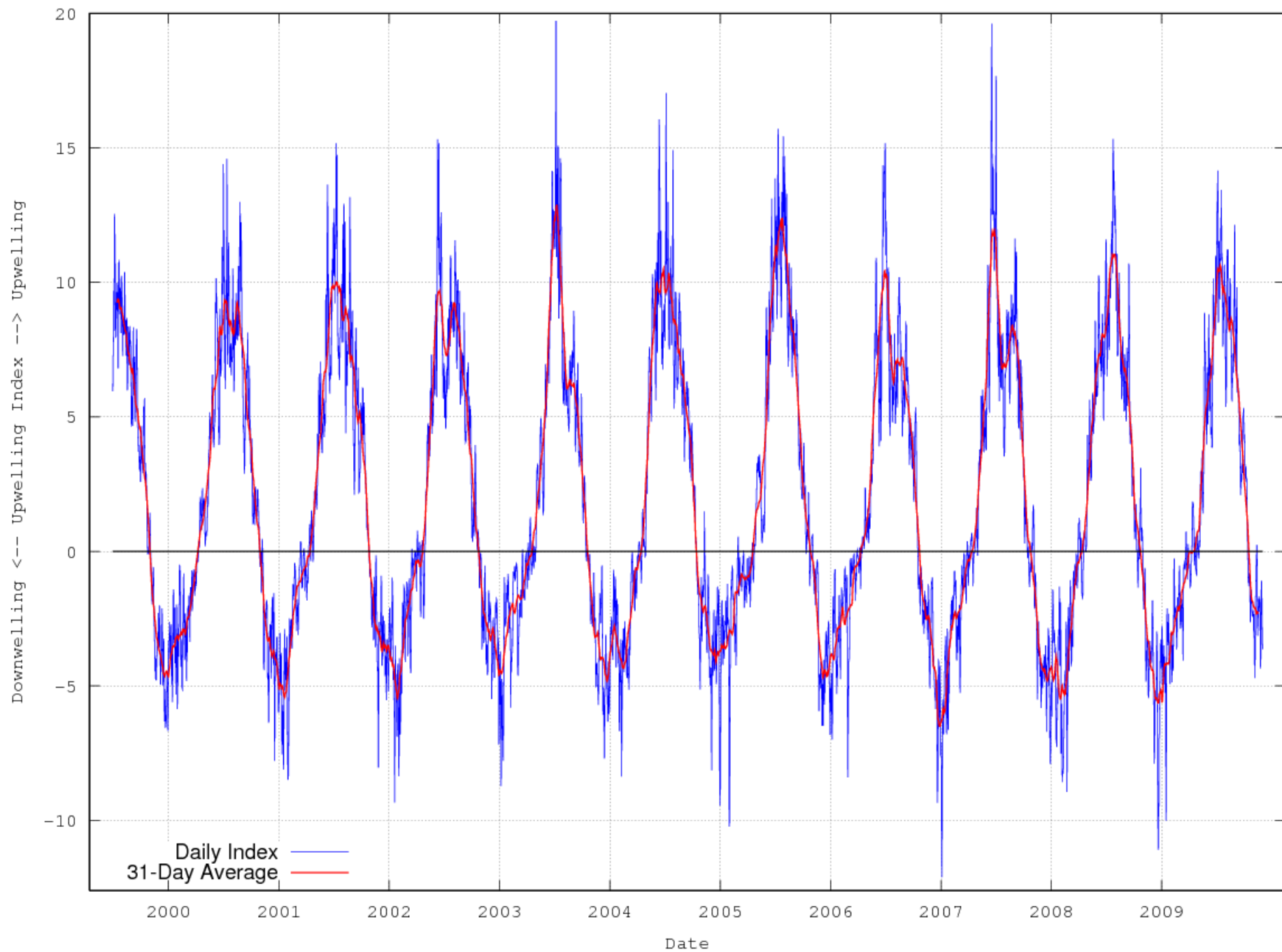


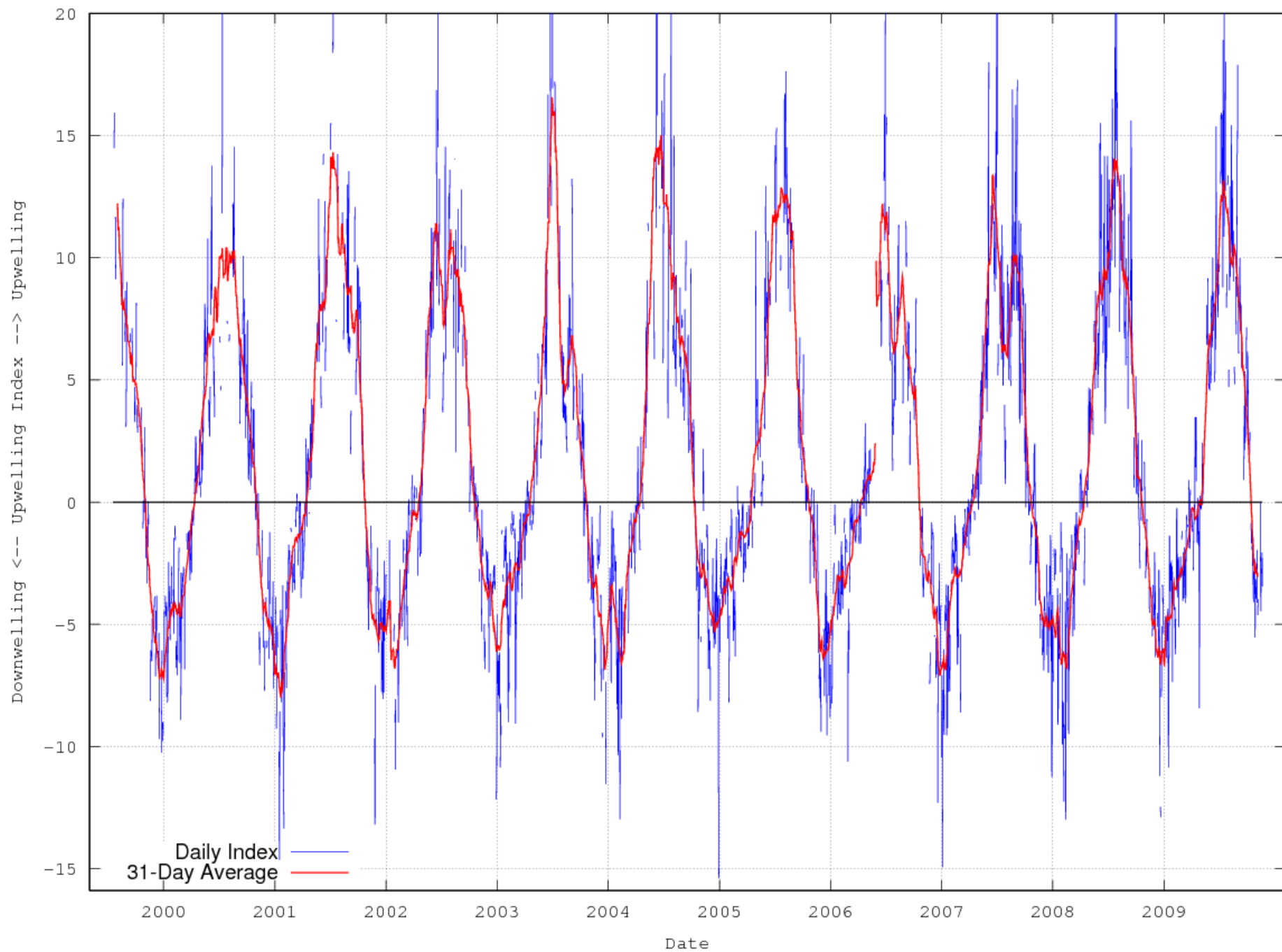


CCMP Upwelling Index: 8°N, 50.9°E

Downwelling <-- Upwelling Index --> Upwelling







THREDDS Data Server for Remote Subsetting of Upwelling Index Databases

OPeNDAP Dataset Query x

Secure | https://tds.coaps.fsu.edu/thredds/dodsC/pub/morey/scat_data/Global_coastal_upwelling_QS.nc.html

Action:

Data URL:

Global Attributes:

history: Created by Steven Morey at FSU/COAPS March 2017.
Upwelling indices computed from QuikSCAT L2B swath data with daily and 50km binning

Variables:

☐ **time: Array of 64 bit Reals [time = 0..3777]**
time:
units: days since 0000-01-01 00:00:0.0
actual_range: 730320, 734097
delta_t: 0000-01-00 00:00:00
long_name: Time

☐ **latitude: Array of 32 bit Reals [locations = 0..509947]**
locations:
actual_range: -84.9, 84.3
coordinate_defines: point
long_name: Latitude
standard_name: latitude
units: degrees_north

☐ **longitude: Array of 32 bit Reals [locations = 0..509947]**
locations:
actual_range: 0.0, 359.9
coordinate_defines: point
long_name: Longitude
standard_name: longitude
units: degrees_east

☐ **upwelling_index: Array of 32 bit Reals [locations = 0..509947][time = 0..3777]**
locations: time:
dataset: Coastal Upwelling Index Computed from QuikSCAT L2B Winds
long_name: upwelling_index
missing_value: 999.0
standard_name: upwelling_index

Next Steps:

- Complete Global Modified Coastal Upwelling Index Database
- Provide Upwelling Index Quality Metrics
- CCMP 2.0 Coastal Upwelling Database
- Combine with SST and Ocean Color

Wintertime
Sea of Okhotsk
Upwelling inferred
from winds and
ocean color

