Observations for Climate: Satellite Observations for Climate Studies

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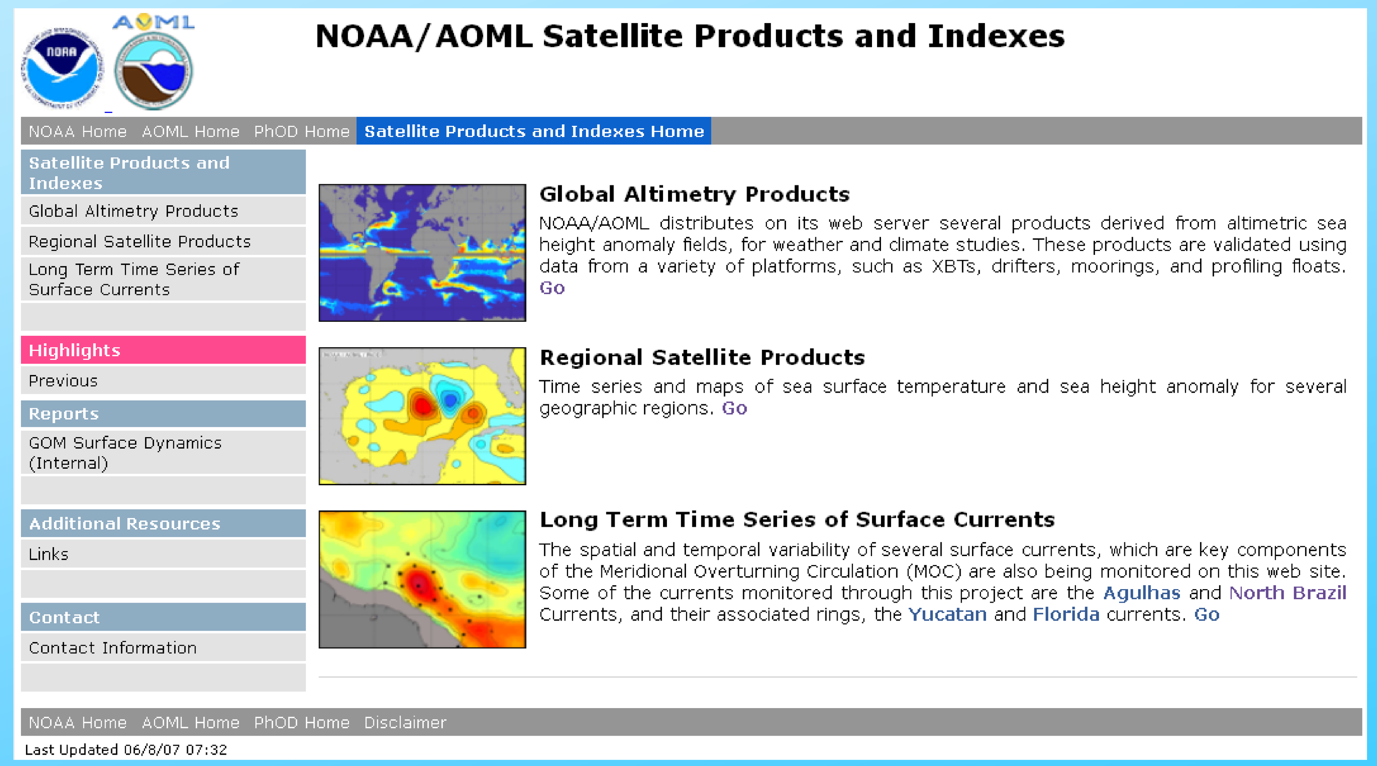
Introduction

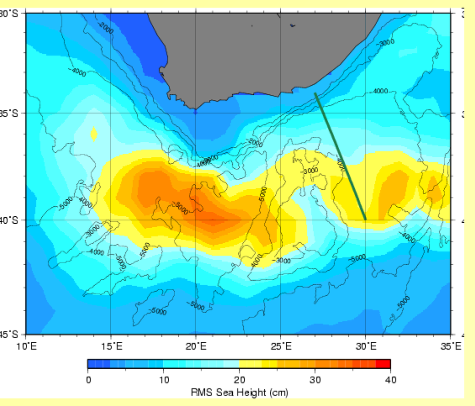
Climate research greatly benefits from satellite observations as a critical tool to assess variability and change, to fill the observational gaps with high-quality, up-to-date and synoptic products. As a component of the Global Climate Observing System (GCOS), satellite observations are part of the Global Earth Observation System of Systems (GEOSS). Sea surface temperature (SST), sea height anomaly (SHA), and ocean currents have been identified by GCOS as essential climate variables for the ocean. These and other satellite-derived products, such as surface currents and tropical cyclone heat potential fields, are used to analyze and monitor the state of the ocean system, to identify the underlying climate processes, and to apply to climate and weather studies. The data used to derive these products come from a wide array of observing platforms, and include datasets such as temperature profiles from Argo floats and expendable bathythermographs (XBTs), and surface currents from drifters. Some of these products and analyses are shown at **www.aoml.noaa.gov/phod/satprod**, and key results are presented here.



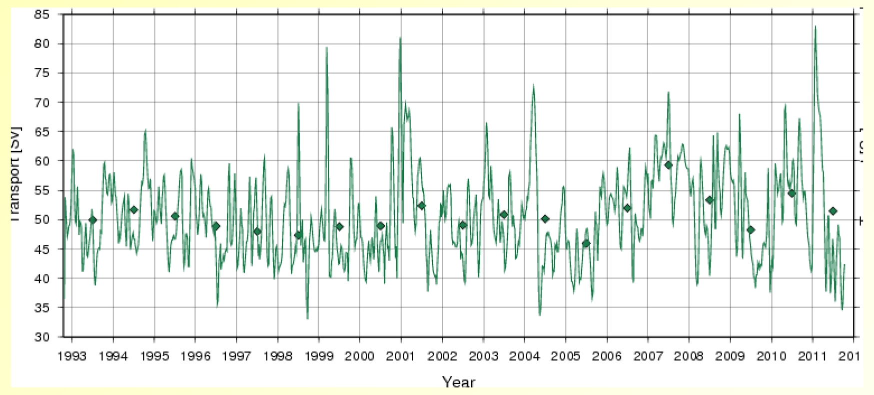
AOML's Satellite Products and Indices web page (**www.aoml.noaa.gov/phod/satprod**)

Transport variations of major ocean currents

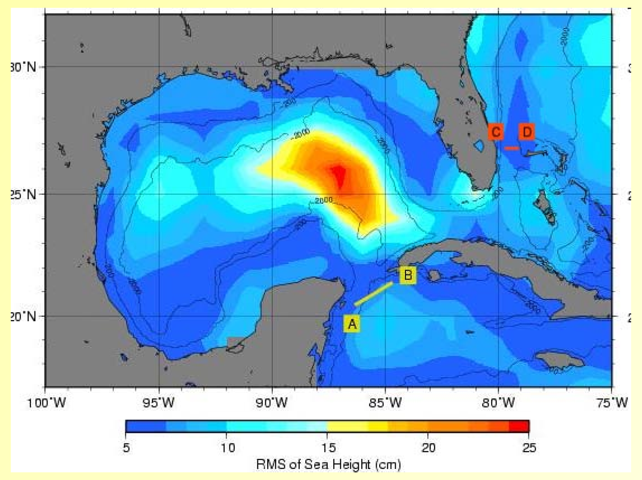
The spatial and temporal variability of several surface currents, which are key components or are related to the Meridional Overturning Circulation (MOC) are monitored on AOML's Satellite Products and Indices web page. One of the goals of this monitoring is to identify cycles in the variability of these currents that could be linked to climate signals. Some of the currents monitored through this project are the Agulhas, Yucatan and Florida currents.



Left: root-mean-square (rms) of sea height over the Agulhas Current retroflection region between November 1992 and December 2004. The bathymetry contours are superimposed. The time-series of geostrophic transport of the Agulhas Current is estimated across a selected transect (green line).



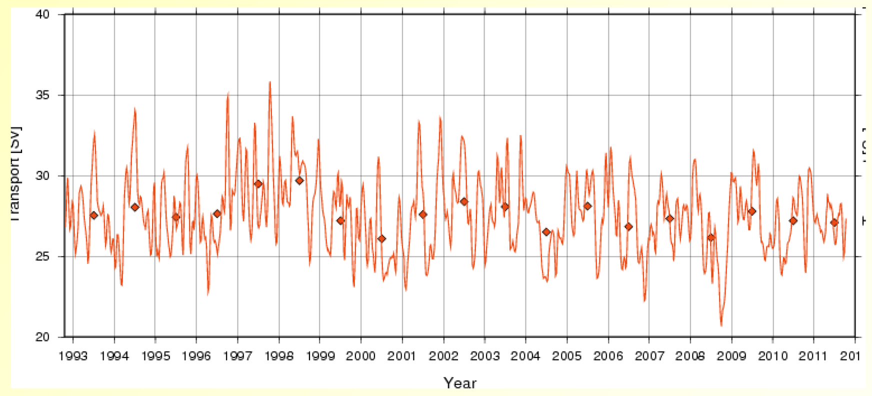
Above: time series of geostrophic transport of the Agulhas Current is produced using a combination of sea height anomaly (SHA) fields from satellite altimetry (AVISO) and climatological data (Levitus). Diamonds indicate the annual mean values.

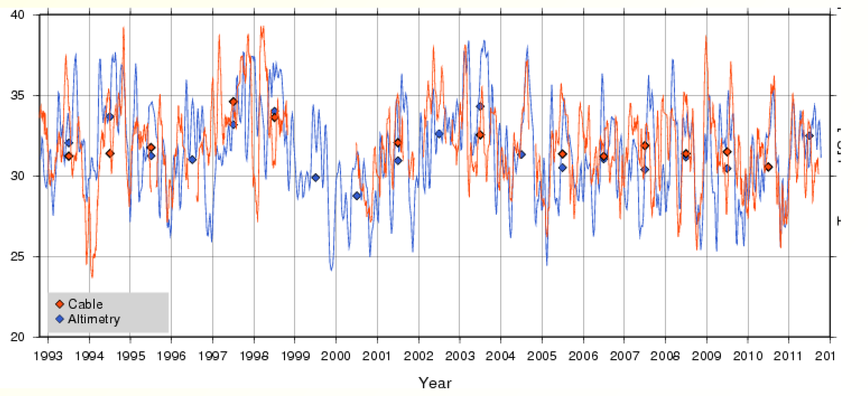


Left: root-mean-square (rms) of sea height over the Gulf of Mexico and the Florida Straits between November 1992 and December 2004. The geostrophic transport time-series is estimated for Yucatan Current (yellow line) and Florida Straits (red line).

Below left: time series of the geostrophic transport of the Yucatan Current is produced using sea height anomaly fields from AVISOand climatological data.

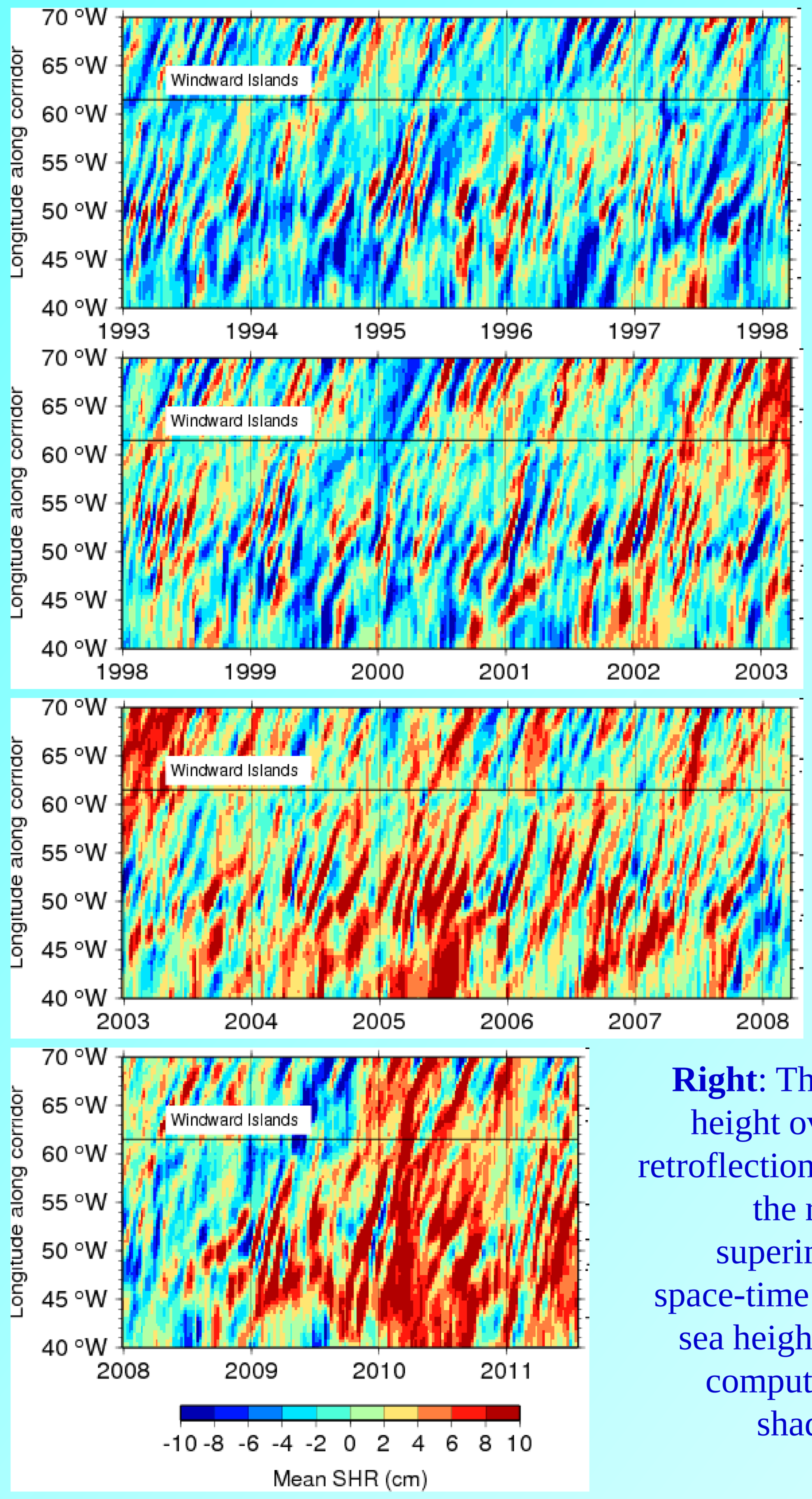
Below right: The altimetry-derived time series of geostrophic transport is compared to the Florida Current Transport Project time series. Both transport time series are estimated at a section across 27°N. Diamonds indicate the anual mean values. No anual mean values are computed for years with less than 10 months of data.





Changes in the Tropical Atlantic

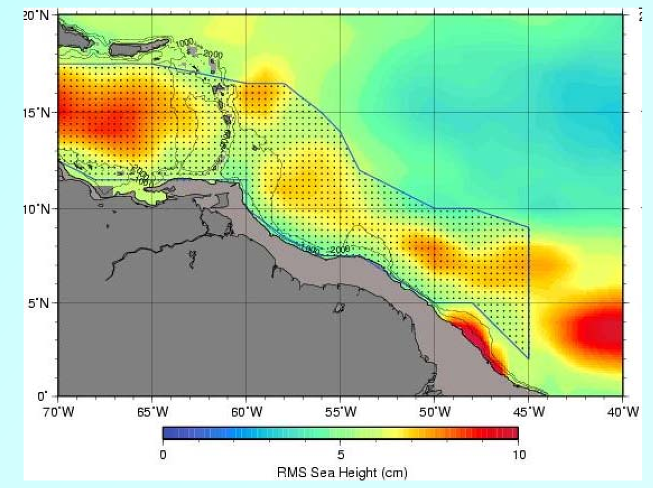
The North Brazil Current (NBC) plays an important role in the Atlantic Meridional Overturning Circulation by periodically shedding rings which transfer water of southern hemisphere origin to the northern hemisphere. In 2010, the NBC demonstrated extremely anomalous conditions with a constant shedding of large rings. Anomalies of this magnitude have not been seen previously in the altimeter time period (1993—present). The interannual variability of the NBC ring shedding deserves further study, particularly how it interacts with the dominant modes of tropical climate variability.



Left: this sea height residual (SHR) space-time diagram provides useful means to identify the motion of the NBC retroflection and the shedding and translation of rings. These anticyclonic warm rings can usually be identified by their large positive SHR values, which appear as red colors in the graphics.

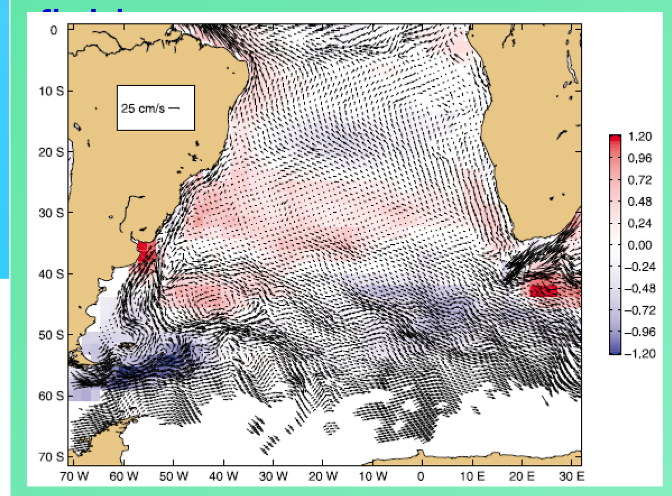
The SHR fields are obtained by removing the anual signal to the sea height anomaly (SHA) fields from AVISO satellite altimetry. Then, mean SHR values are computed for same longitude sections along a corridor (see below) to obtain the space-time dependent SHR dataset. This space-time diagram is updated monthly on NOAA/AOML's web page.

Right: The rms of sea height over the NBC retroflection region with the ring corridor superimposed. The space-time diagrams of sea height residue are computed along the shaded corridor.

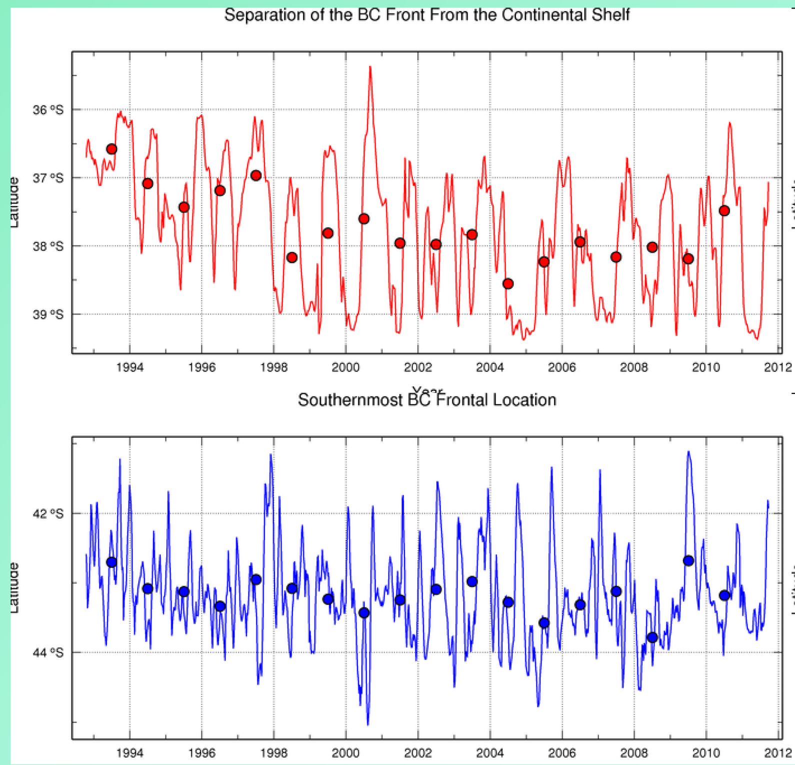


Changes in the South Atlantic

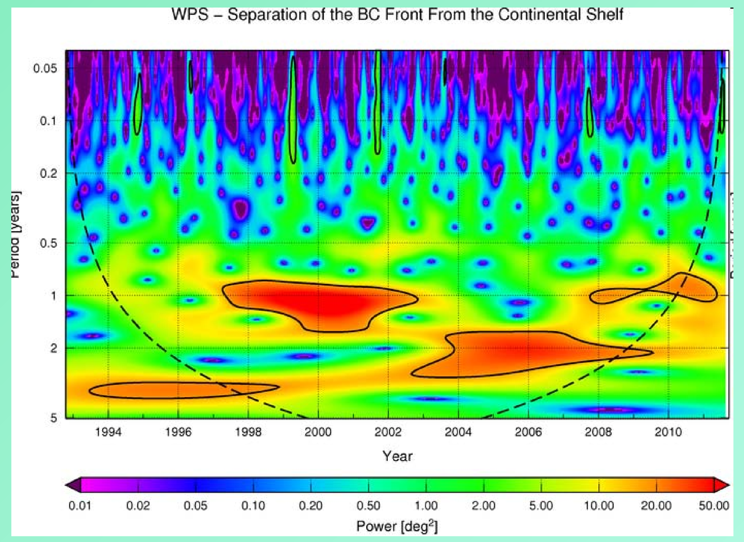
The Brazil Current, the southwest component of the South Atlantic subtropical gyre, is the main conduit of upper ocean waters in the region. The observed low-frequency variability of the Brazil Current front (BCF) using SHA and SST observations during the period 1993-2008 indicates a southward shift of approximately 1.5° of the separation of this current from the continental shelf break. Simulations using synthetic drifters are consistent with the observed southward shift of the BCF. Trends of eddy kinetic energy, SHA, SST and wind stress curl are also in agreement with this variability. Wavelet transform analysis reveals that the separation of the BCF from the continental shelf break also changed from annual to bi-annual during 2003, which could be an indication of an abrupt change in the transport of the Brazil and Malvinas currents or of the local or remote wind fi[...]



Left: Mean surface geostrophic circulation of the South Atlantic derived from a synthesis of surface drifter trajectories, NCEP winds, and AVISO sea level anomalies. Color shading represents sea surface temperature anomaly trend during January 1993 to December 2002 (°C decade−1) from NCEP/NCAR version 2 reanalysis, with nonzero values shown only where the trend significantly exceeds zero. Warming at the Brazil-Malvinas confluence is consistent with a southward shift of the confluence front. From Lumpkin and Garzoli (2011).



Right: Top: time series (after a 28-days running mean) of the latitude of separation of the BC front from the continental shelf, defined as the intersection between the 1000m bathymetry contour and the contour when the 10°C isotherm is 200m deep. Bottom: time series (after a 28-days running mean) of the latitude of the southernmost frontal location defined as the southernmost position of the altimeter-derived 200m contour of the 10°C isotherm.



Left: Wavelet Power Spectrum of the latitude of separation of the BC front from the continental shelf, defined as the intersection between the 1000m bathymetry contour and the contour when the 10°C isotherm is 200m deep. The solid black contour represent the peak-based significance levels, computed at 95%. The dashed curve indicates the cone of influence (COI). Edge effects become important in regions of the wavelet spectrum below the COI.

Right: Trend in the (a and b) zonal and meridional components of the wind stress and (c) of the curl of the wind stress in the decade 1993–2002. Trends are not shown where they are not significantly different from zero. (d) The time series of the maximum of the curl of the wind stress across the basin as a function of time is also shown. White solid curve is the annual and semiannual fit, black dots are the maxima and the straight dashed curve indicates the slope. The trend in zonal wind stress has negative (easterly) values in the region 30°S–45°S, west of about 10°W, indicating weakening of the northern Westerlies and consistent with a southward shift in the maximum wind stress curl. From Lumpkin and Garzoli (2011).