Variability in the South Atlantic Circulation

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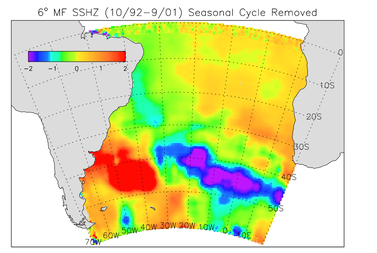
Part 2: Interannual Variability
EOF and PEP (CCA) Analises

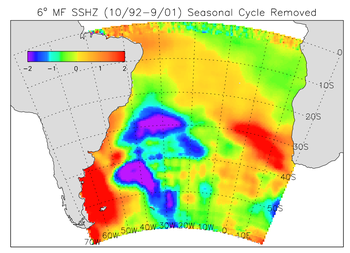
EOF's of SSH, SSHZ, CURL and SLP

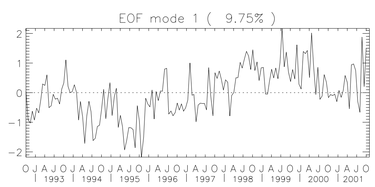
We extend the work of Witter and Gordon (1999, JGR, 104, 20,927-20948), who analyzed 4 1/2 years of T/P data in the South Atlantic. Their basin-scale first EOF was interpreted to represent a slowing of the Subtropical Gyre between the 1993-1995 period (stronger) and the 1996-1997 period (more sluggish). Here we use 9-years of data (T/P and ERS), with 6-degree smoothing in space and both monthly and yearly means. We also use Principal Estimator Patterns (PEP) to relate the SSH to wind stress curl and sea level pressure. The temporal means for all variables are removed over the same period of the T/P data and the annual cycles are removed.

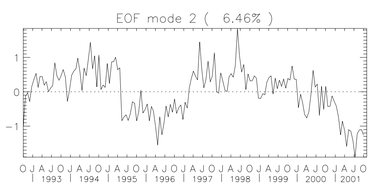
Witter and Gordon also removed zonal mean SSH from their fields to remove some of the seasonal heating and steric changes in SSH. We remove the spatial mean from each 35-day data set (T/P and ERS) before combining them in the gridding process (successive corrections). This removes some of the seasonal steric effect. To the right are the first 2 EOFs of the monthly non-seasonal SSHZ (zonal means removed from each field) and SSH (no zonal means removed). The basic patterns are similar and we work with SSH. Geostrophic currents are calculated from the height field and superimposed on them. Below are the first two EOFs of SLP, CURL and SSH, calculated from yearly means to bring out the interannual variability. There is a strong similarity of all three variables, with high pressure and positive wind stress curl over anticylonic flow (as expected for Ekman pumping). The first two EOF's appear somewhat in quadrature, describing a rough "cycle" with a time scale of about 10 years.

SSHZ

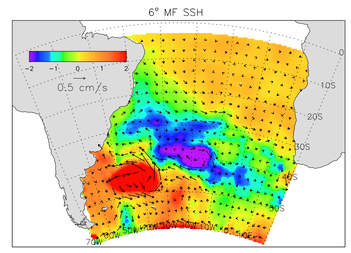


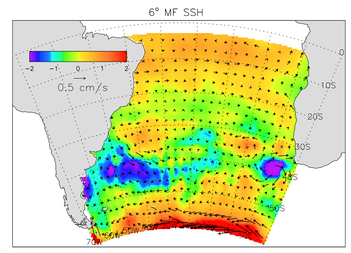


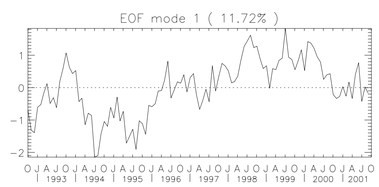


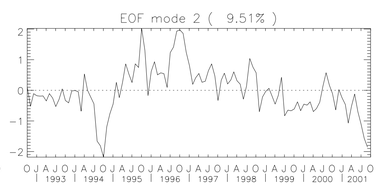


SSH

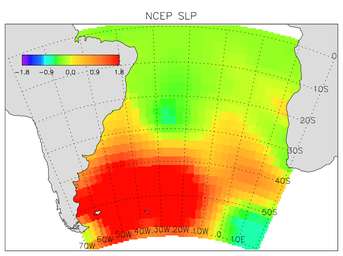


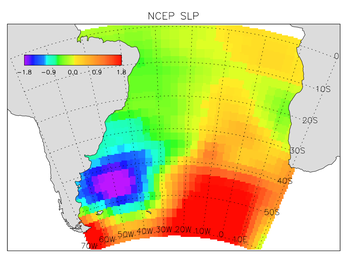


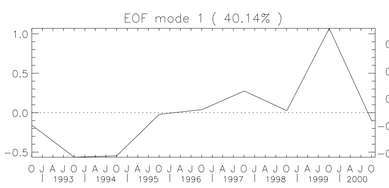


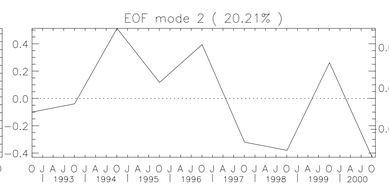


SLP

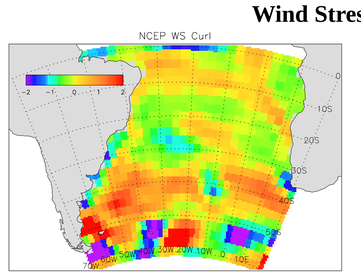


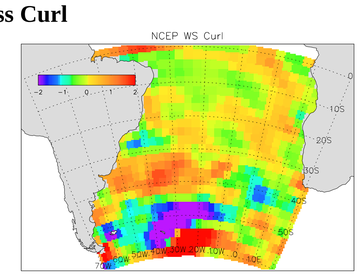


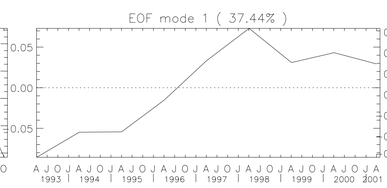


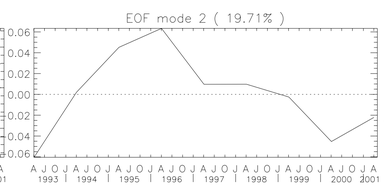


Wind Stress Curl

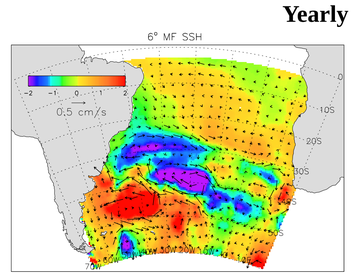


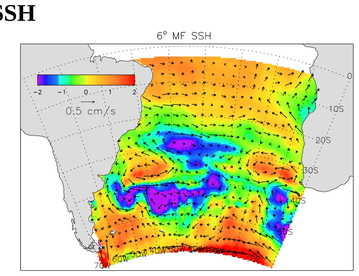


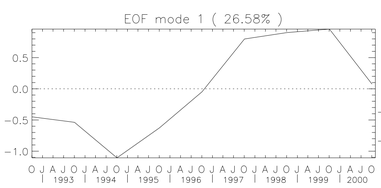


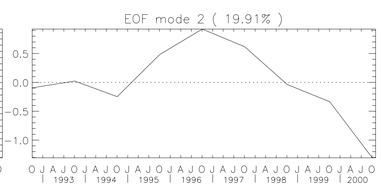


Yearly SSH









PEPs of Curl and SSH - Decadal Change

The first two PEPs linking SSH and Wind Stress Curl are shown to the right. These two modes explain approximately 45% of the variance in each field. If monthly fields are used, the spatial patterns are very similar but the two modes explain only 6% of the SSH variance, showing that much of the monthly variance is intrannual in scale. Positive curl is found over the anomalous heights. The time series appear to confirm the basin-scale slowing of the mid-latitude gyre between 30-40S during 1997-2001 and an increase in anticyclonic flow in the region between 40-50S, 30W-60W. These two modes are used to reconstruct the yearly mean fields to show the gradual transition associated with the pair of "time-locked" signals (imediately to the right). The shift in circulation is brought out most clearly by forming mean fields for 10/92-9/96 and 10/97-9/00, corresponding roughly to the periods before and after the strong 1997-1998 El Nino. The reconstructed field for 2001, however, shows a continued change in the fields, not a switch to a persistent alternname mode or "regime".

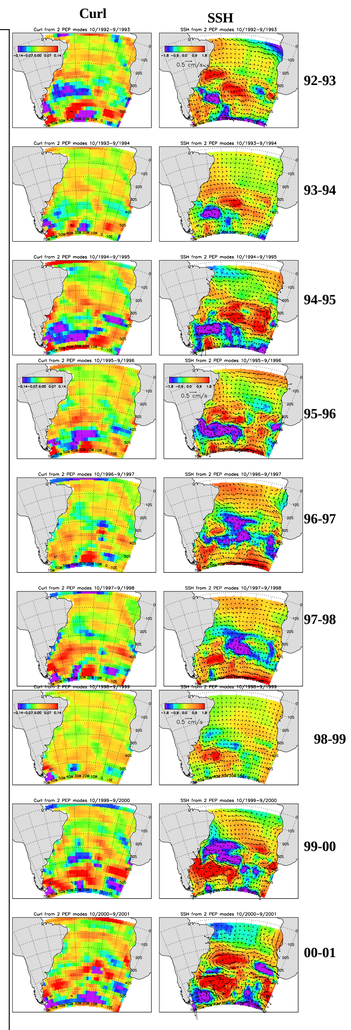
Conclusions

*** The long time series of altimeter data allows us to define decadal-scale changes in circulation at the 1-2 cm level.**

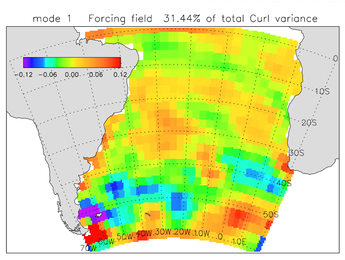
*** The primary mode of interannual variability is similar to that found by Witter and Gordon and is correlated with patterns in both wind stress curl and SLP. It represents a decrease in (strictly speaking, surface) transport in the mid-latitude gyre (30-40S) .**

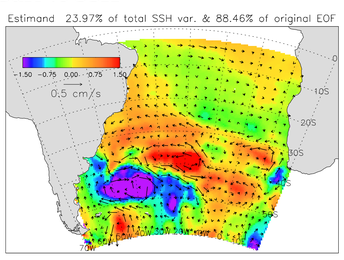
*** Reconstructed fields of Curl and SSH show the spatial nature of these changing fields to be more complex than just a change in the gyre.**

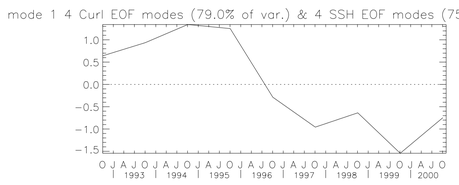
Reconstructed Curl and SSH Yearly Mean Fields



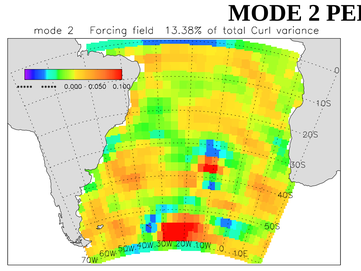
MODE 1 PEP: Curl vs SSH

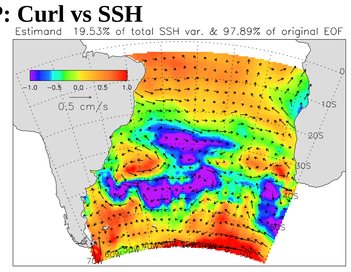


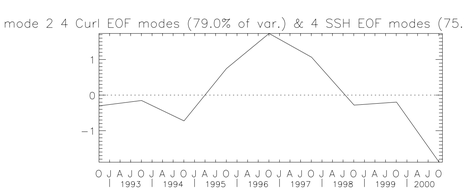




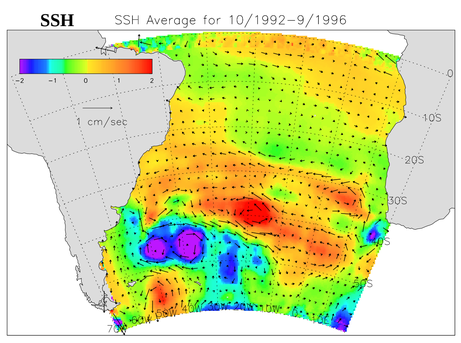
MODE 2 PEP: Curl vs SSH

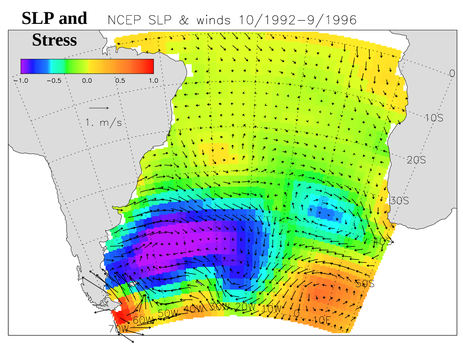


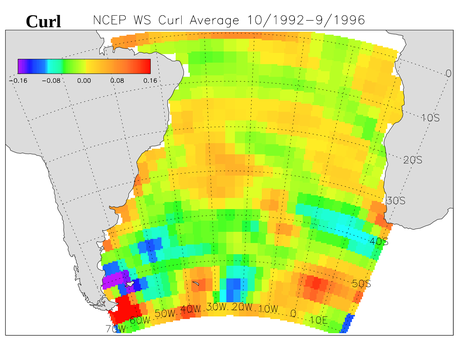


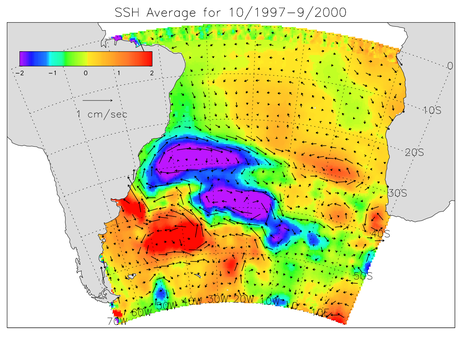


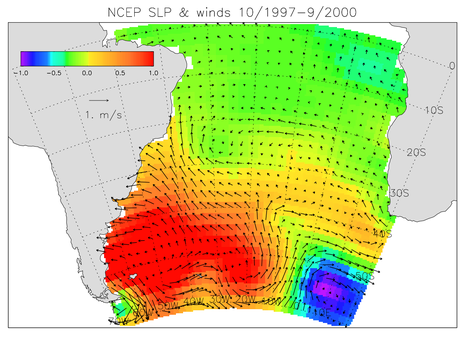
Temporal Means during 10/92-9/96 (top) and 10/97-9/2000 (bottom)

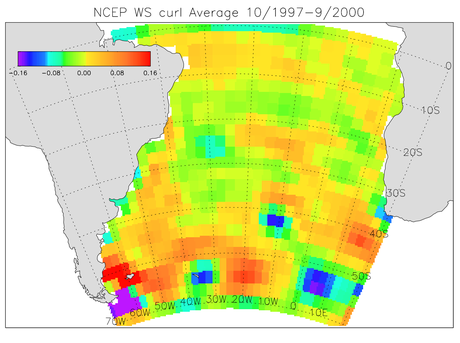












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