Decadal variation of the shallow meridional overturning circulation of the Indian Ocean

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Motivation (1):


What about the Indian Ocean?
Motivation (2):

Levitus et al. (2004) upper 300-m Indian Ocean heat content

Why is this >> this?
Motivation (3):

The increasing Indian Ocean SST (NCEP)

The decreasing heat flux (NCEP) into this Ocean

Potential role of ocean circulation?
How do ocean currents regulate upper Indian-Ocean heat content?

- Meridional overturning cells carry warm surface water southward and colder thermocline water northward.
- ITF brings in warmer western Pacific water (not addressed here).
1992-2000 trend of zonal wind from ERS scatterometers (*Lee, 2004 GRL*)

Reflect weakening of the southern cell by nearly 70% of time mean.
Temporal change of N-S Ekman transport as a function of latitude
1993-2000 trend of SSH from TOPEX/Poseidon altimeter (*Lee, 2004 GRL*)

- Increasing east-west SSH difference across the South Indian Ocean suggests less northward flow of colder thermocline water.
- Smaller changes of SSH and wind in the north suggest relatively steady cross-equatorial cell.
Summary

• ERS scatterometers observed weakening southeasterly trade wind over the South Indian Ocean (92-00), indicating less southward export of warm surface water.

• T/P altimeter observed increasing E-W sea level difference across the South Indian Ocean (93-00), suggesting less import of colder subsurface water.

• Indicate a near-decadal slowdown of the southern overturning cell (nearly 70% of time mean), but not the cross-equatorial cell.

Implications to

• heat content: upper-ocean warming, larger in the south;

• climate: manifestation of decadal & longer climate variability?

• observing system: adequate to quantify heat budget?

• biochemistry: potential impact on nutrient supply & CO$_2$ flux.
Zonal section of temperature difference at 10S (97-00 minus 93-96) shows changing zonal tilt of upper thermocline?

Altimeter+in-situ (Josh Willis’ product): clear

in-situ only: not as clear
Current IOGOOS design adequate to monitor SIO decadal variations?

- SIO moorings helpful but too expensive? Boundary arrays feasible?
- ARGO adequate?