March 10, 2008: Data Exercise 3; equatorial mechanisms for IO variability

- Discussion: proxy indices of Indian Ocean Dipole events
- Kelvin waves: anatomy and observations
- Ekman transports

*Does the IOD exhibit decadal variability? What mechanisms could lead to this?*
My results: (M-O ave anom difference)

Charles et al. (2003)
Can we do better?

Evans and Kaplan (2008)
Kelvin wave theory

Kelvin waves (Hollton 1992)

Consequence of
- North-south pressure gradient force balanced by Coriolis force
- East-west pressure gradient force on equator balanced by gravity.

Initial perturbation
Restoring forces: Coriolis force changes sign at equator (N-S)
Gravity (E-W)

- Eastward propagation only
- Propagation speed $c \approx \sqrt{gH} \approx 30-100 \text{ cm/s}$
- Physics of equatorial wave guide
Kelvin waves: observations

Five-Day Zonal Wind and 20°C Isotherm Depth 2°S to 2°N Average

Zonal Wind Anomalies (m s⁻¹)  20°C Isotherm Depth Anomalies (m)
Kelvin waves: observations

TAO/TRITON 5-Day Mean Temperatures (°C)
Ending on March 9 2008 2°S to 2°N Average

140°E 160°E 180° 160°W 140°W 120°W 100°W

Depth (m)

Means

Anomalies

Depth (m)
Ekman effects:

Ekman transport: mean flow in a layer is perpendicular to the direction of wind stress.

Coastal upwelling: Ekman transport away from shore causes cooler waters from below to replace advected surface waters.

Equatorial upwelling: Ekman transport on either side of the equator creates a surface divergence, cooler waters upwell to replace warmer surface waters.
Ekman effects: observations

TAO/TRITON SST (°C) and Winds (m s⁻¹)

Means

Anomalies

Five-Day Mean Ending on March 9 2008
Summary

- There is decadal variability in the Indian Ocean, both in historical records and proxy data for the mid-19th c. to present. There doesn't seem to be a distinct periodicity. Longer data series are available in the Indian Ocean basin, but maybe not in the right places for proxying the IOD.

- Equatorial Kelvin waves provide a mechanism by which wind-driven ocean anomalies are translated into ocean circulation anomalies via Ekman divergence anomalies. Since there's a propagation time for the induced waves, there may be predictability.
References

- Evans, M.N. and A. Kaplan, 2008: Coral-based, multiproxy, multicentury, ensemble climate field reconstructions of Pacific basin sea surface temperatures, NOAA/METEO-FRANCE Workshop on ENSO reconstruction for the last 500 years, Moorea, French Polynesia, April 2-4.