Equatorial Deep Jets in the Atlantic Ocean studied by observations and ocean general circulation models
Zonal Velocity in the Central Equatorial Atlantic
Zonal Velocity in the Central Equatorial Atlantic

- 16 years of moored observations at the equator, 23°W in the Atlantic Ocean in cooperation with PIRATA

Equatorial Deep Jets with downward phase and upward energy propagation (Johnson and Zhang 2003, Bunge et al. 2008)
Brandt et al. (2011):

- uses mooring data until 2009 at 23°W
- suggested EDJ impact on equatorial zonal surface velocity and SST
- enhanced climate predictability in the Atlantic sector
EDJ Simulations

- Idealized simulations with good representation of EDJs (Greatbatch et al. 2018)

- Model represents equatorial box forced with steady, zonally uniform wind stress

- Produces mean circulation with EUC, NECC, and SEC

- Flow instabilities generates TIWs and finally regular oscillations of EDJs
von Schuckmann et al. (2008)

- Barotropic instability (right) dominant process generating eddy kinetic energy (bottom)
- Baroclinic instability contributes
- Boreal summer maximum
Tropical Instability Waves

- Monthly period waves generated near the surface by flow instabilities
- Upward phase downward energy propagation along equatorial beams mostly as Yanai waves (Tuchen et al., 2018, submitted)

Grodsky et al., 2005
Maintenance Mechanism

- A circular wave of large meridional scale (intraseasonal Yanai or short Rossby wave)
- Interacts with a small meridional scale equatorial jet to produce a momentum flux that maintains the jet

Analogous mechanism by which storm systems in the atmosphere act to maintain the atmospheric jet stream
Maintenance of Equatorial Ocean Currents

- Dominant balance at the equator without wind forcing:
  \[ \frac{\bar{u}}{t} = \left( \frac{v' u'}{y} \right) + \frac{1}{0} \frac{\bar{p}}{x} - r \bar{u} \]

- describes linear wave propagation, maintenance and dissipation.

- Regression of the convergence of the intraseasonal zonal momentum flux on the slowly varying equatorial zonal velocity

- Positive regression slope indicates that momentum is being fluxed into the slowly varying zonal jets.
Greatbatch et al. (2012)

- Reduced gravity model forced with oscillatory zonal wind stress produces enhanced velocity variability at resonance period:

\[ T_0 = \frac{4L}{C_{gw}} \]

Only weak forcing required to produce zonal velocity variability at resonance period.
Resonant Equatorial Basin Modes

- Decomposition of moored zonal velocities into vertical mode-frequency space (Greatbatch et al. 2018)

- Energy is found at basin mode characteristic

- Regular EDJ oscillations at period of 4.5 years
By fitting a multi-mode reduced gravity model to observations, basin wide EDJ structures as well as power input into the EDJs and vertical energy flux can be reconstructed (Claus et al. 2016).

Power input is dominantly balanced by dissipation.
Mechanisms & Processes

- Mean wind-driven circulation
- Tropical instability waves
- Deep intra-seasonal variability
- Interannual surface variability
- Equatorial deep jets
- Climate predictability