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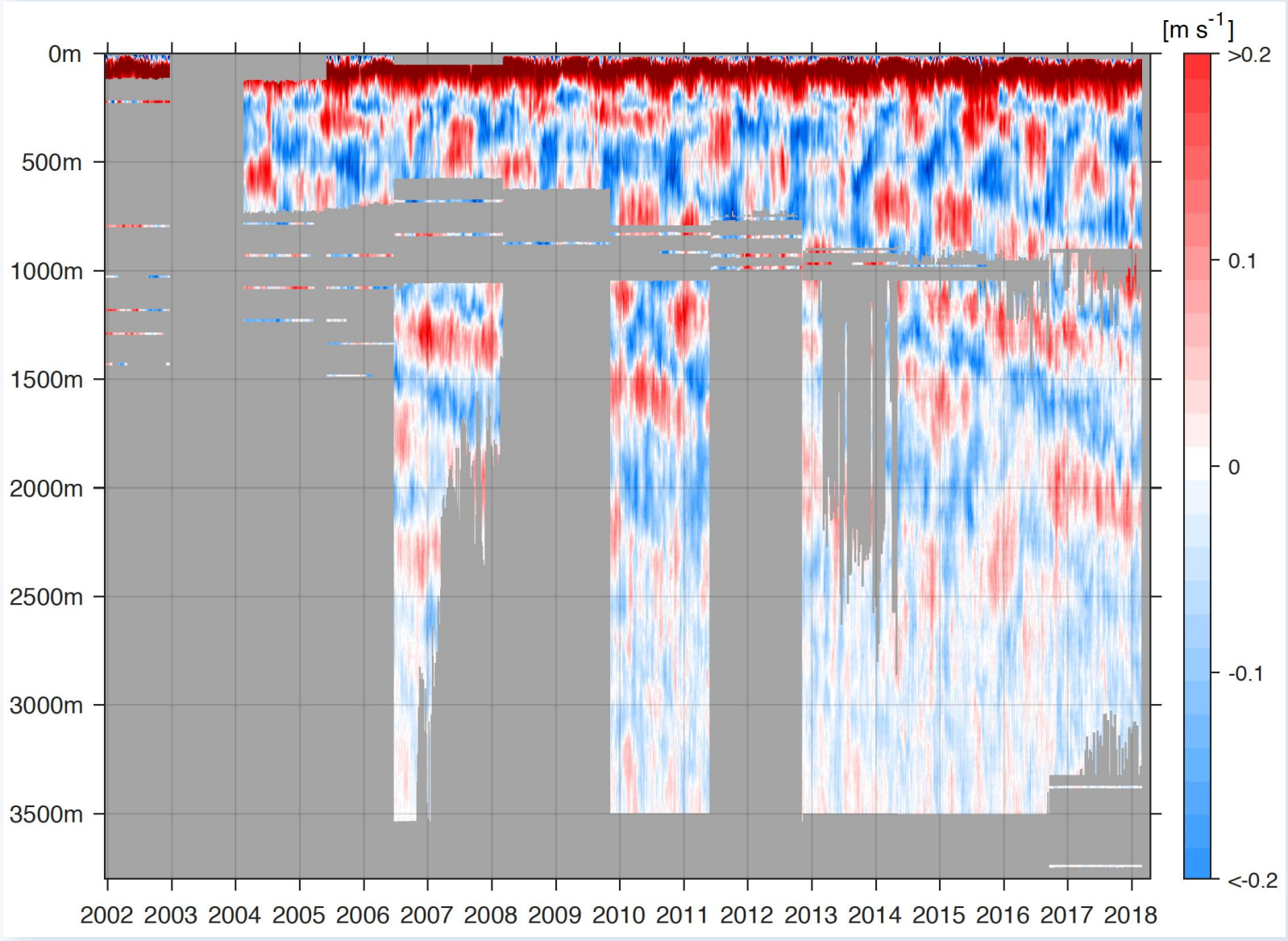
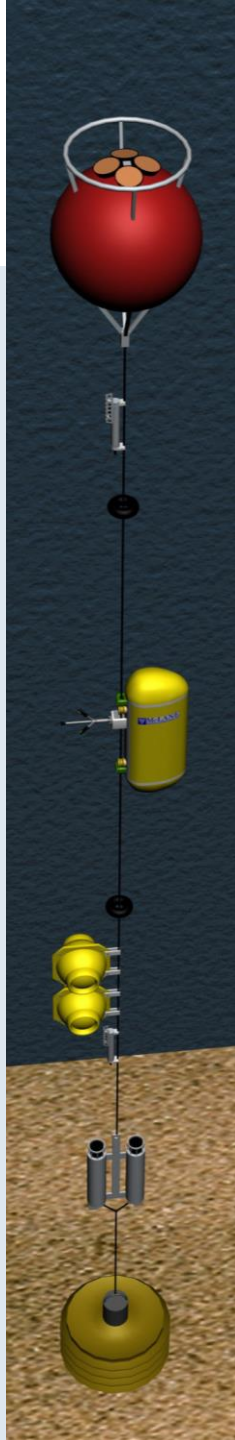
[4] Woods Hole Oceanographic Institution, USA

# Equatorial Deep Jets in the Atlantic Ocean studied by observations and ocean general circulation models

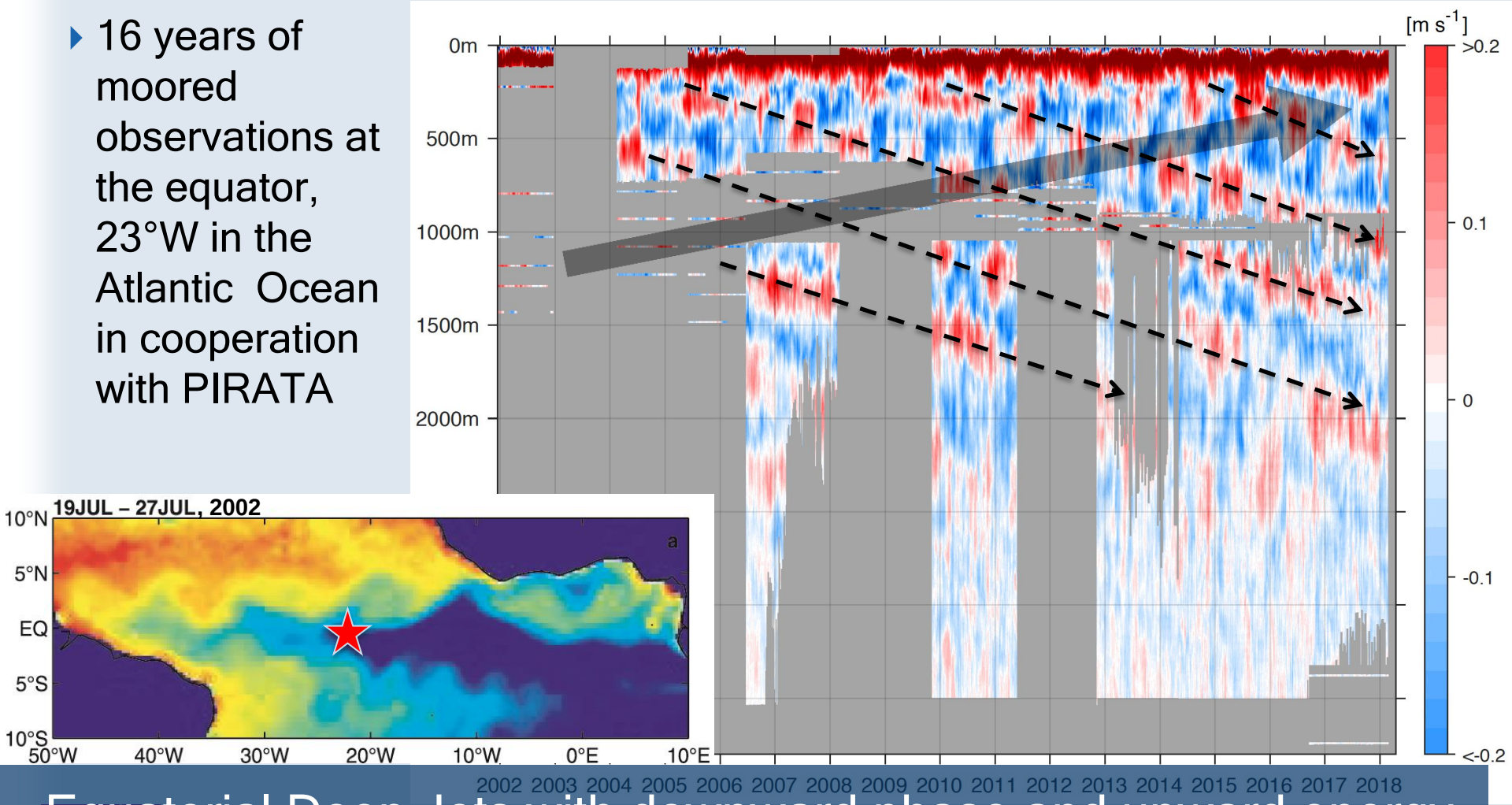
# Zonal Velocity in the Central Equatorial Atlantic



# 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

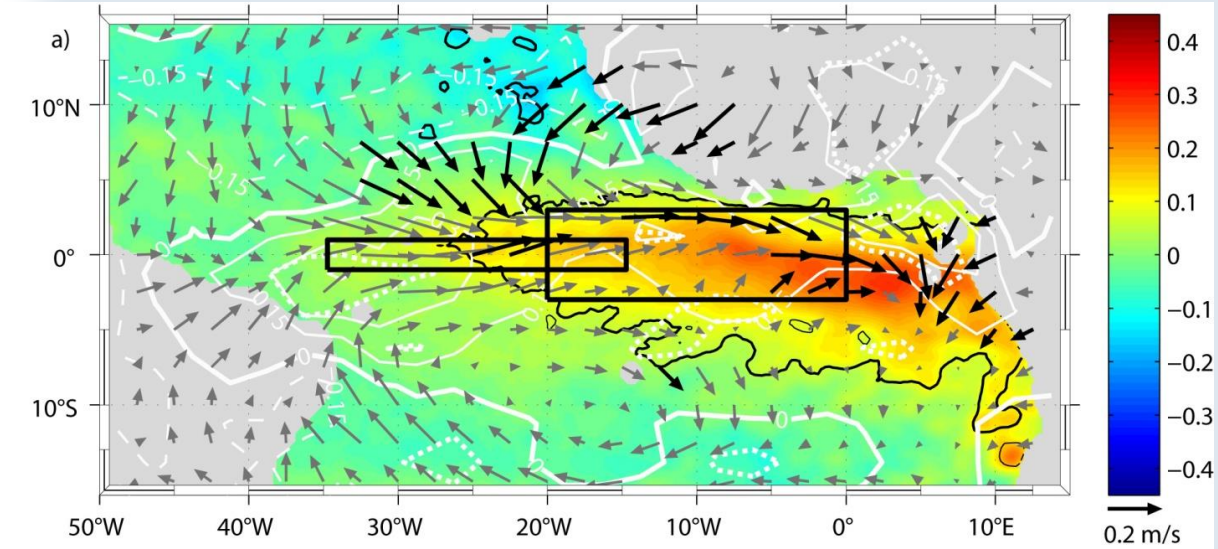


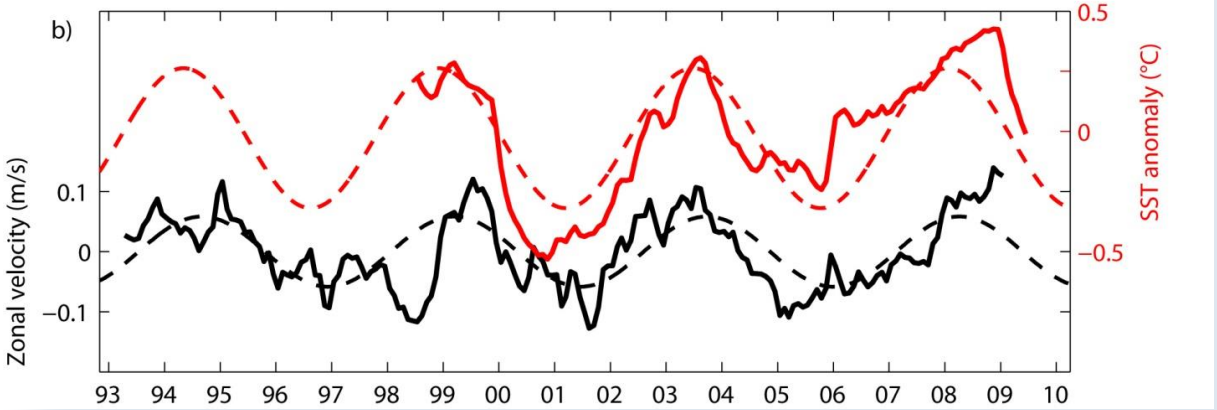

Equatorial Deep Jets with downward phase and upward energy propagation (Johnson and Zhang 2003, Bunge et al. 2008)

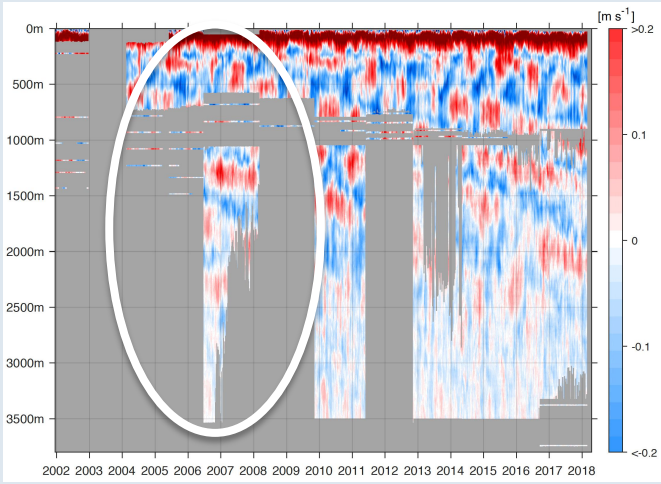
# Role of Equatorial Deep Jets (EDJ)

Brandt et al. (2011):

- uses mooring data until 2009 at 23°W



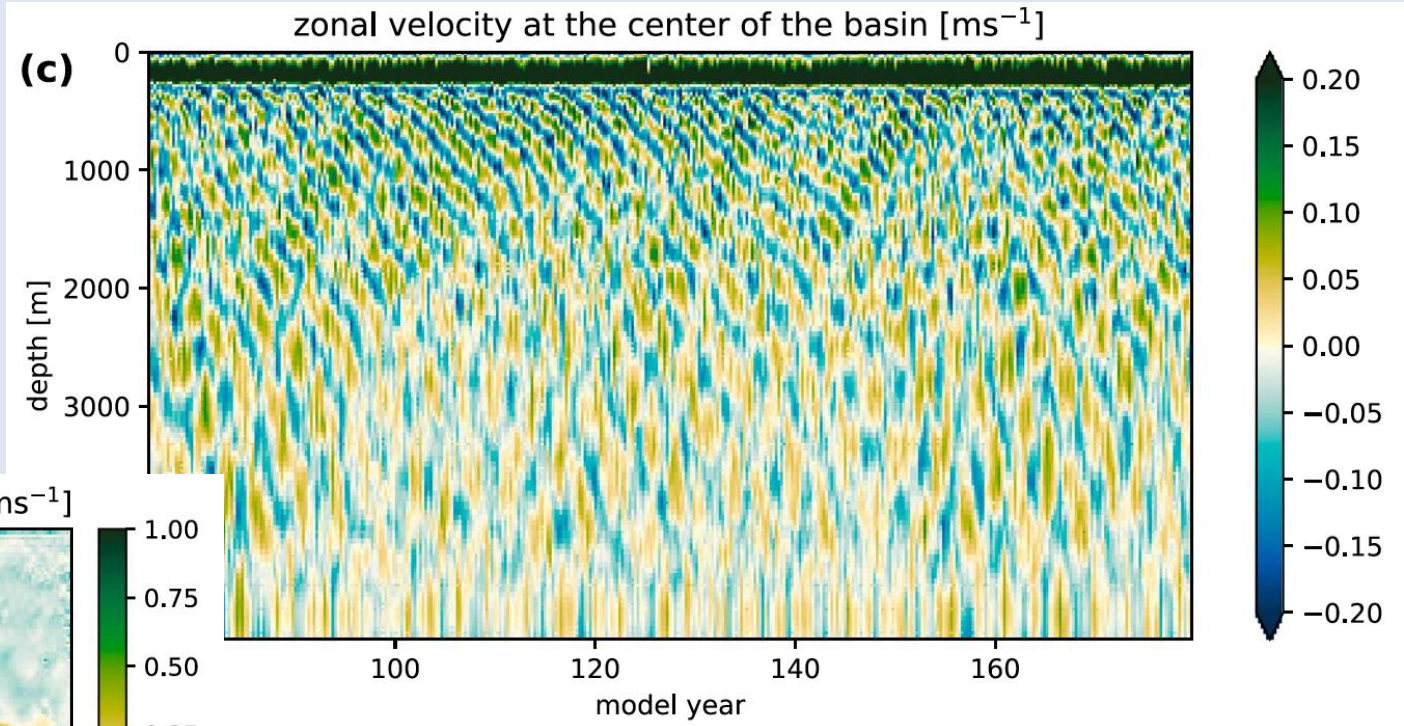



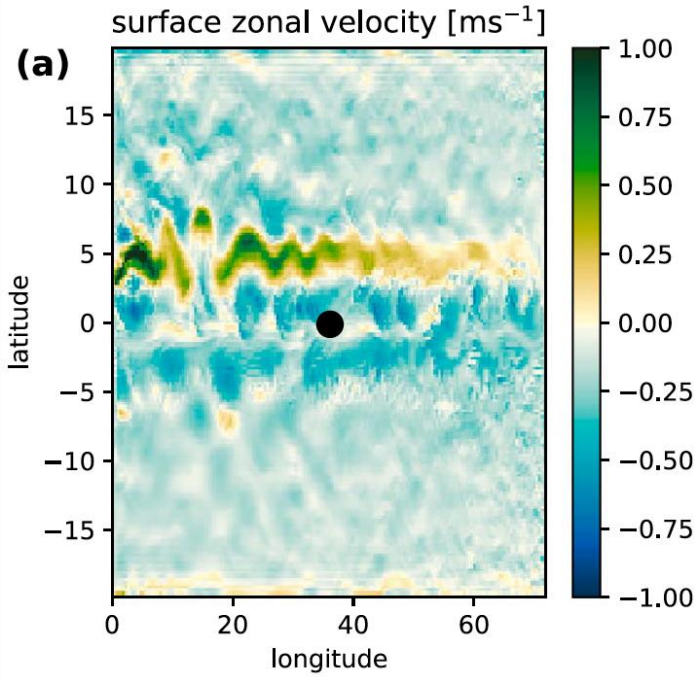




- suggested EDJ impact on equatorial zonal surface velocity and SST
- enhanced climate predictability in the Atlantic sector

# EDJ Simulations

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



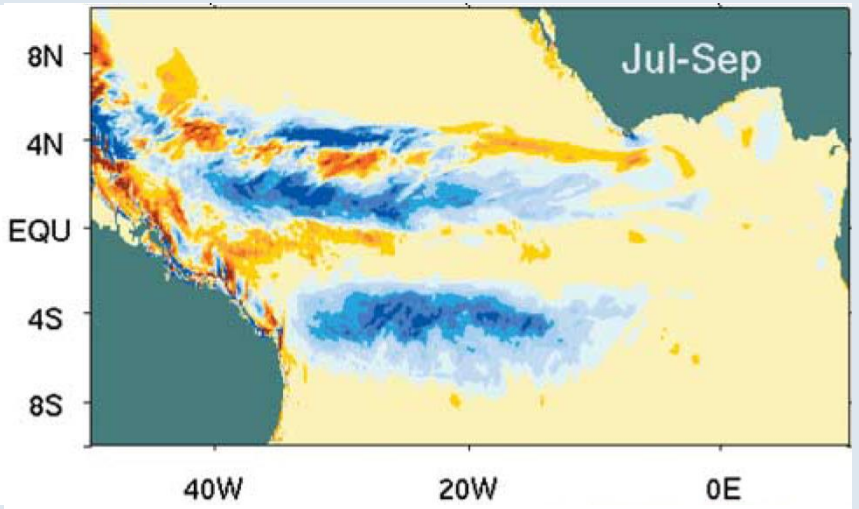



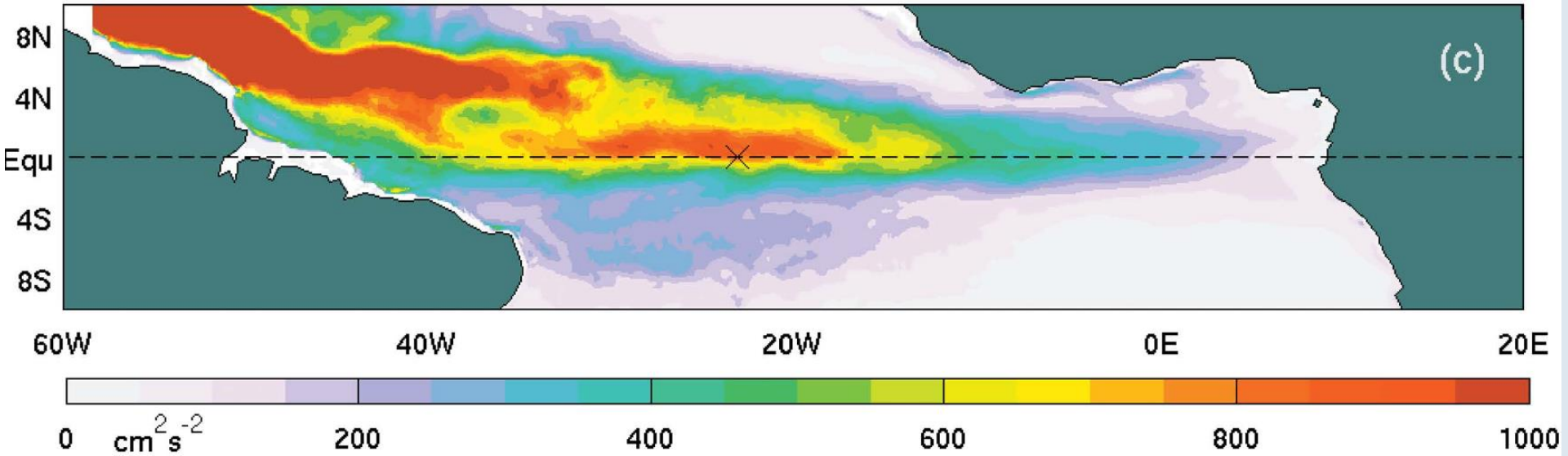

- Model represents equatorial box forced with steady, zonally uniform wind stress
- Produces mean circulation with EUC, NECC, and SEC
- Flow instabilities generates TIWs and finally regular oscillations of EDJs

# Generation of TIWs

von Schuckmann et al. (2008)

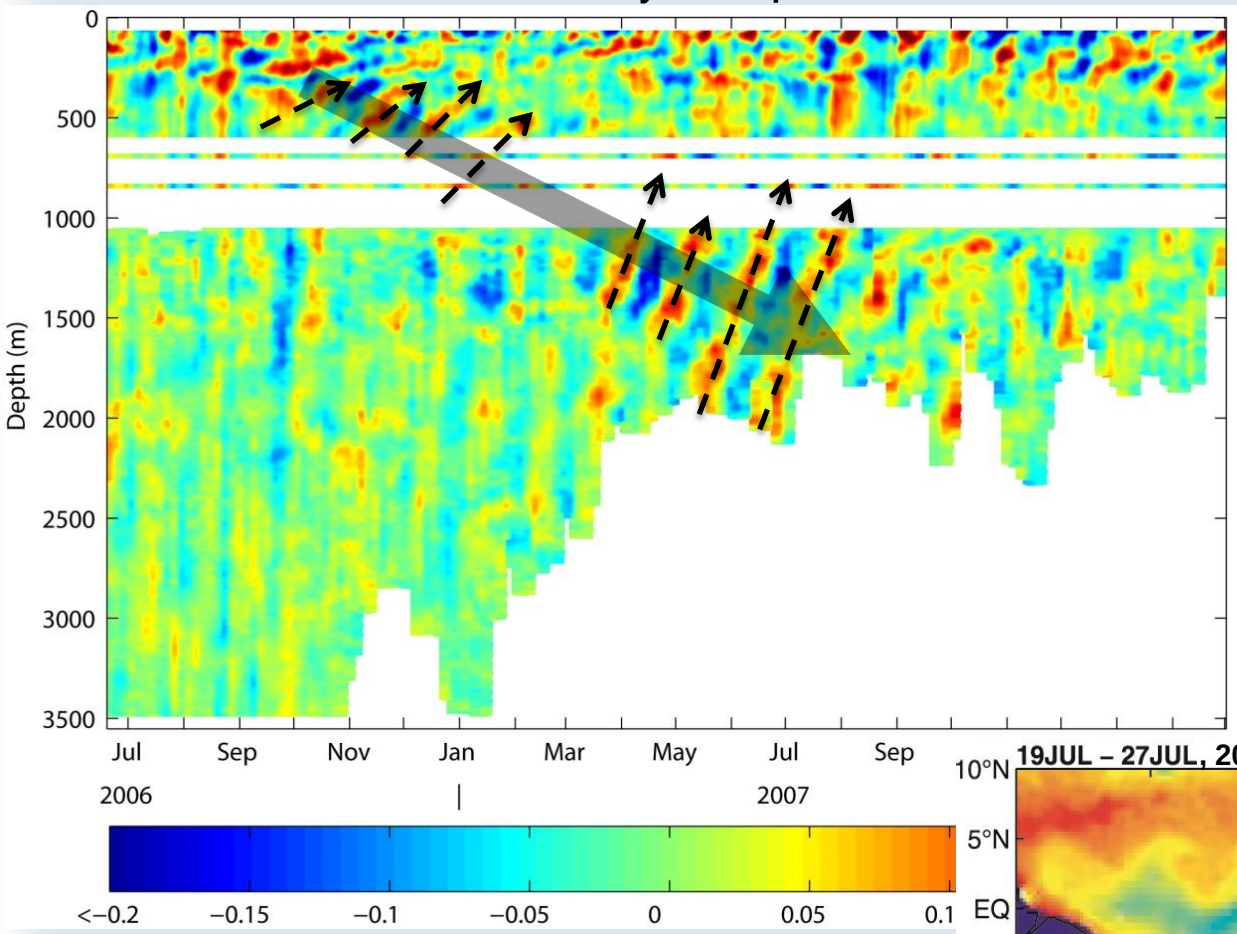
- Barotropic instability (right) dominant process generating eddy kinetic energy (bottom)
- Baroclinic instability contributes
- Boreal summer maximum



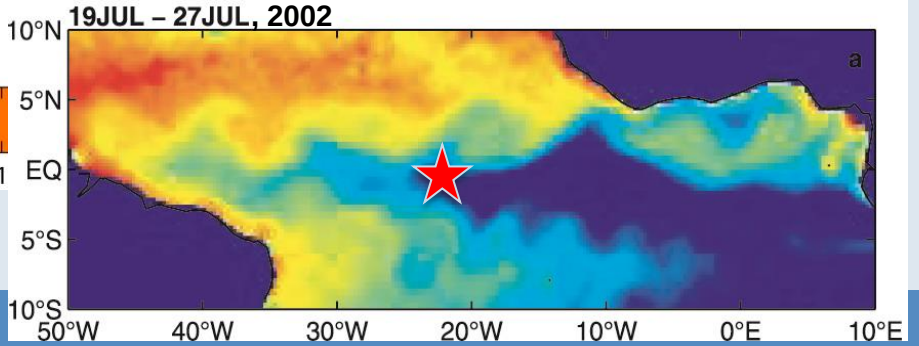



# Tropical Instability Waves

Meridional velocity at equator, 23°W



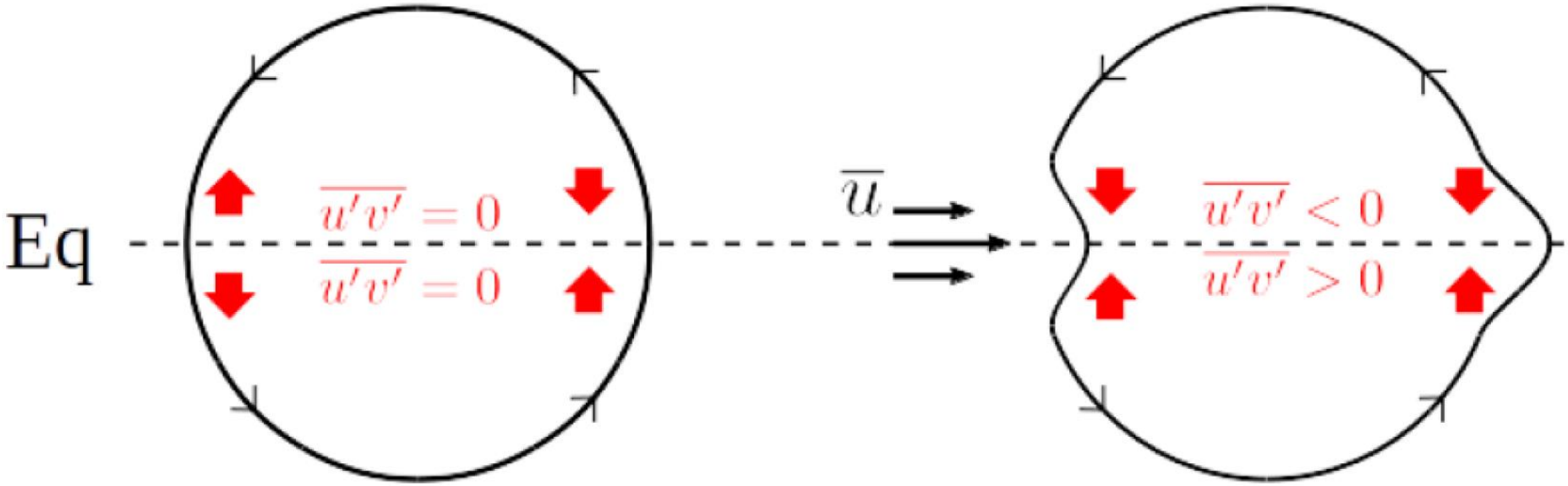

- Monthly period waves generated near the surface by flow instabilities
- Upward phase downward energy propagation along equatorial beams mostly as Yanai waves (Tuchen et al., 2018, submitted)




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 maintain the jet



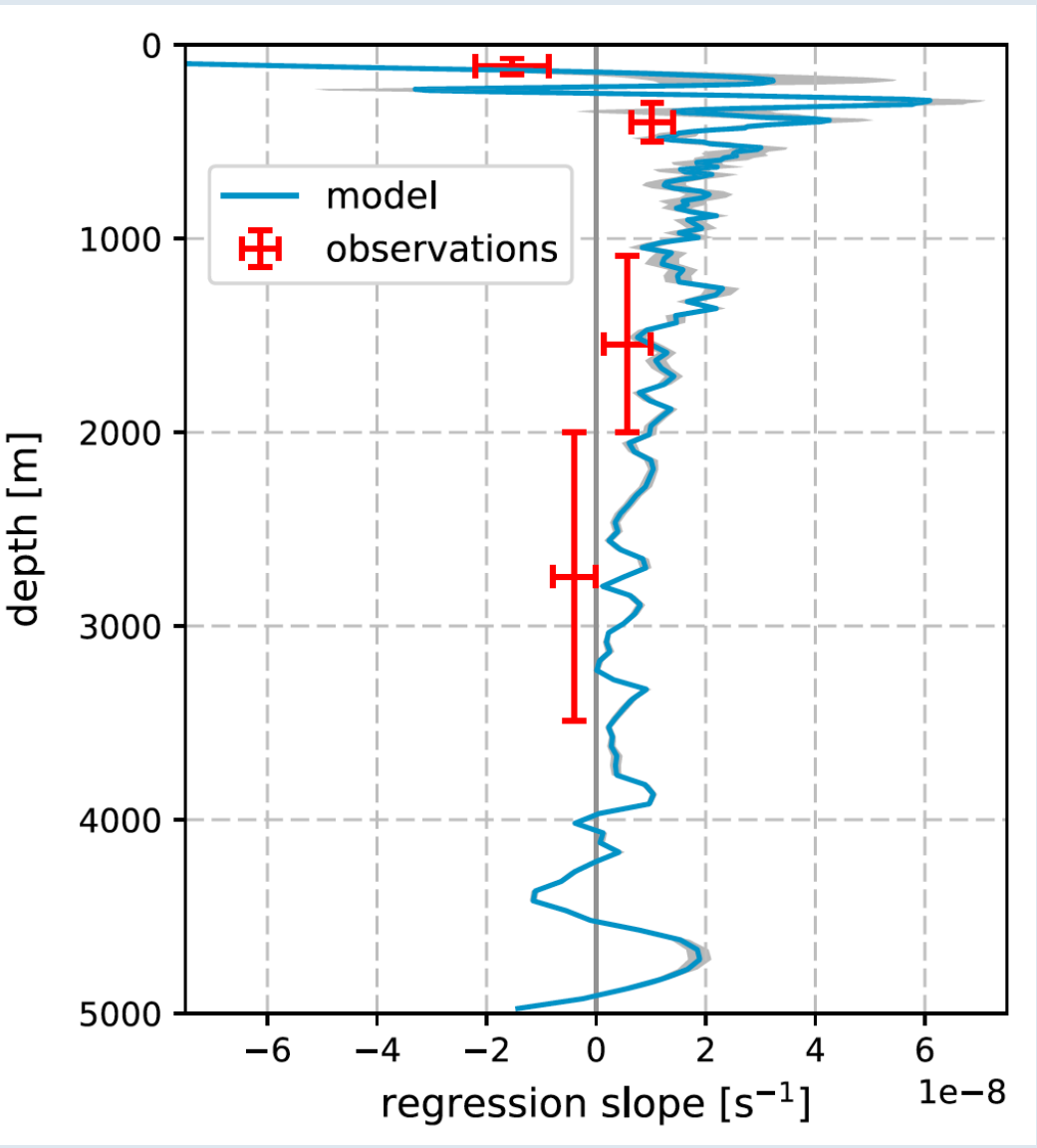

Analogous mechanism by which storm systems in the atmosphere act to maintain the atmospheric jet stream

# Maintenance of Equatorial Ocean Currents

- Dominant balance at the e

$$\frac{\partial \bar{u}}{\partial t} \approx -\frac{\partial \left(\overline{v'u'}\right)}{\partial y} - \frac{1}{r_0}\frac{\partial \bar{p}}{\partial x} - r\bar{u}$$

- describes linear wave pro
  maintenance and dissipati
- Regression of the converg
  intraseasonal zonal mome
  equatorial zonal velocity
- Positive regression slope
  fluxed into the slowly varyi



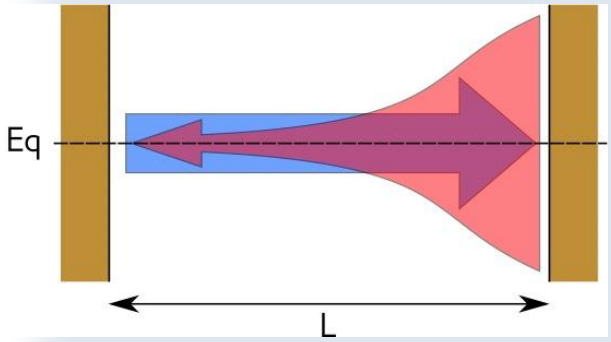

Christian-Albrechts-Universität zu Kiel

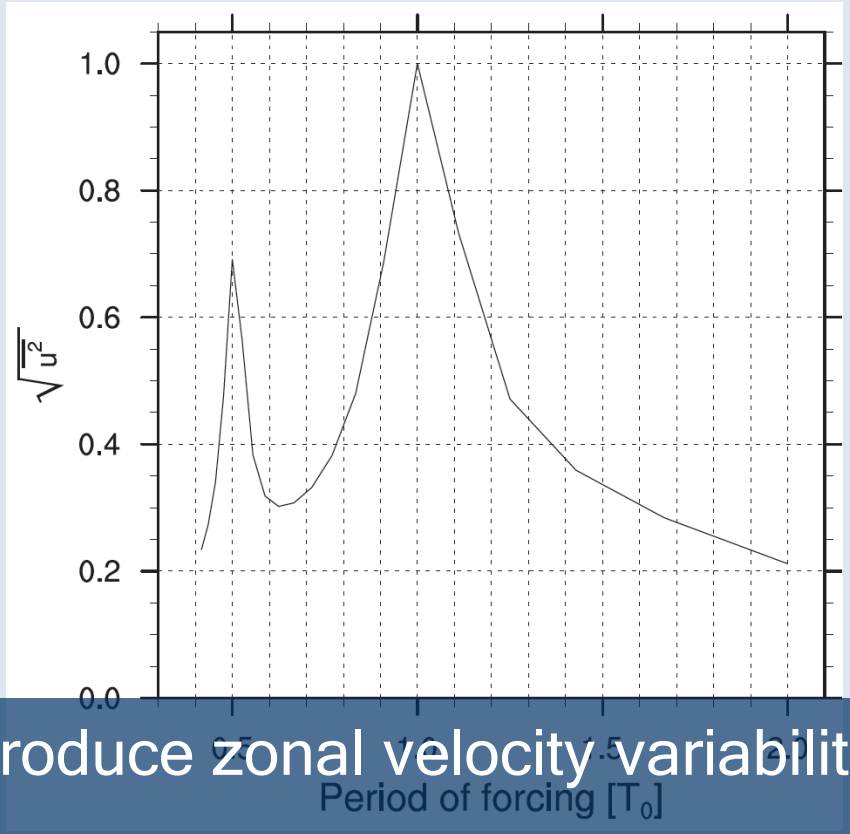
# Resonant Equatorial Basin Modes

Greatbatch et al. (2012)

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

$$T_0 = \frac{4L}{c_{gw}}$$

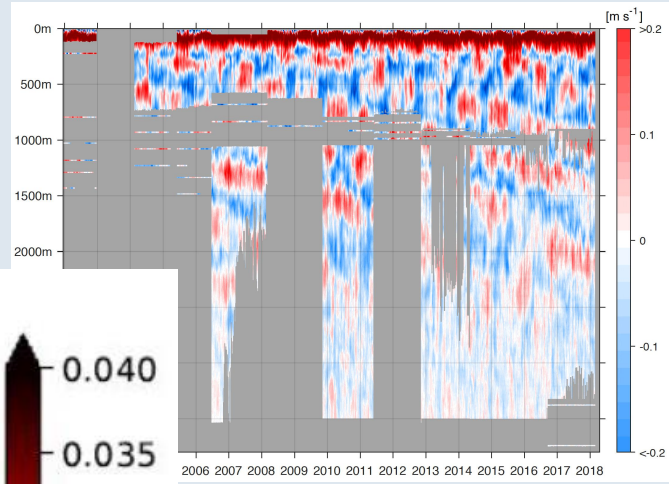


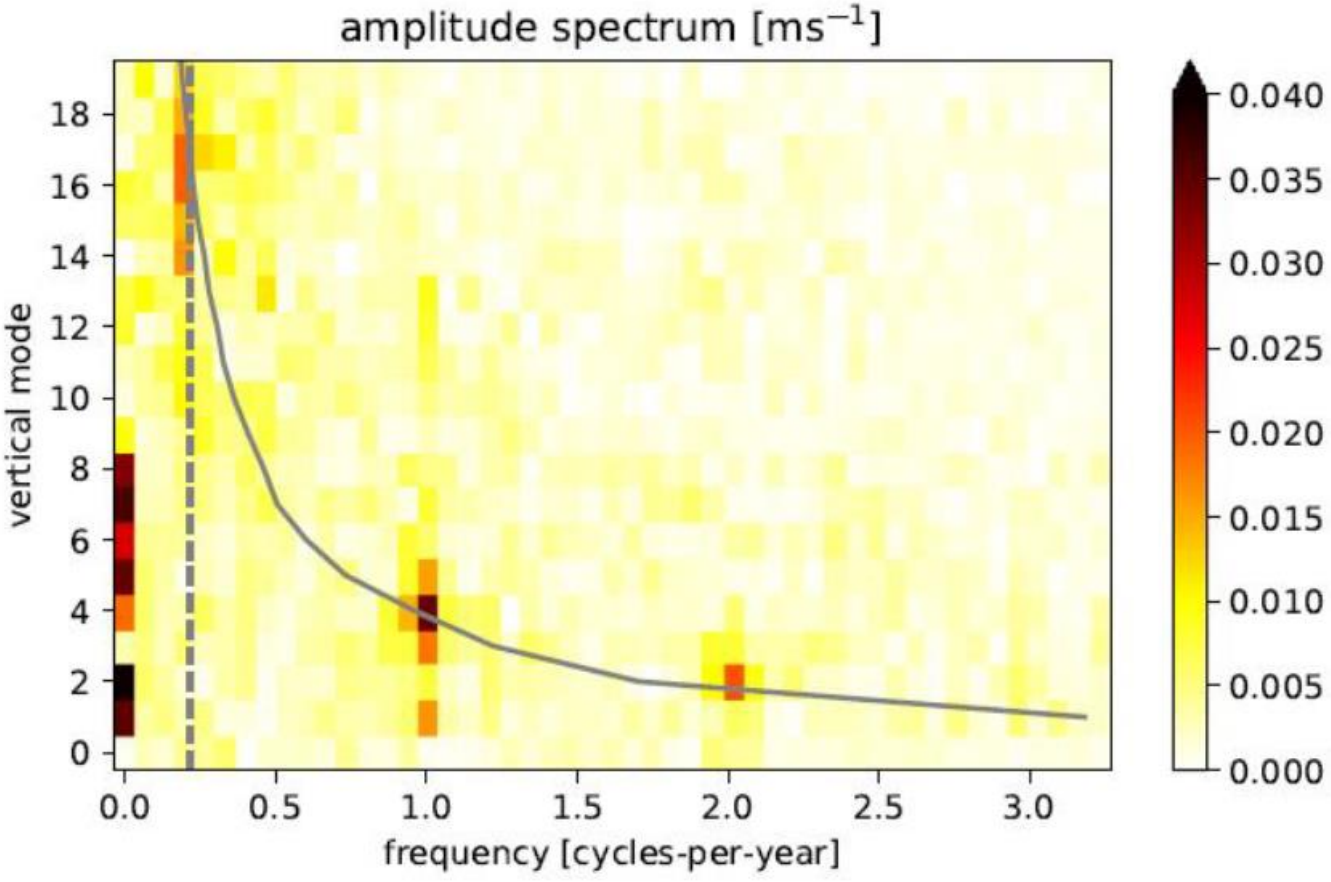




Only weak forcing required to produce zonal velocity variability at resonance period.

# Resonant Equatorial Basin Modes

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

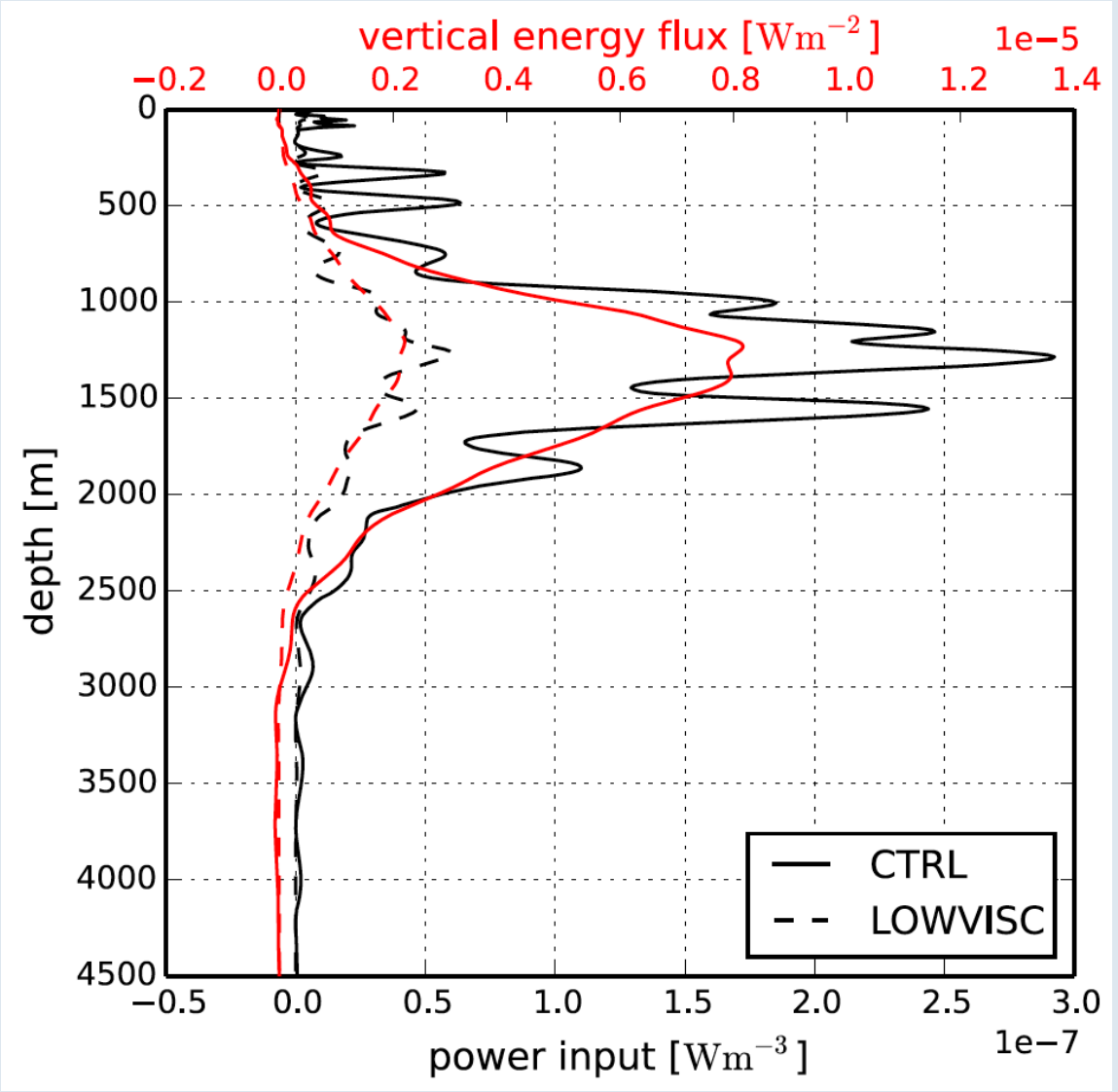


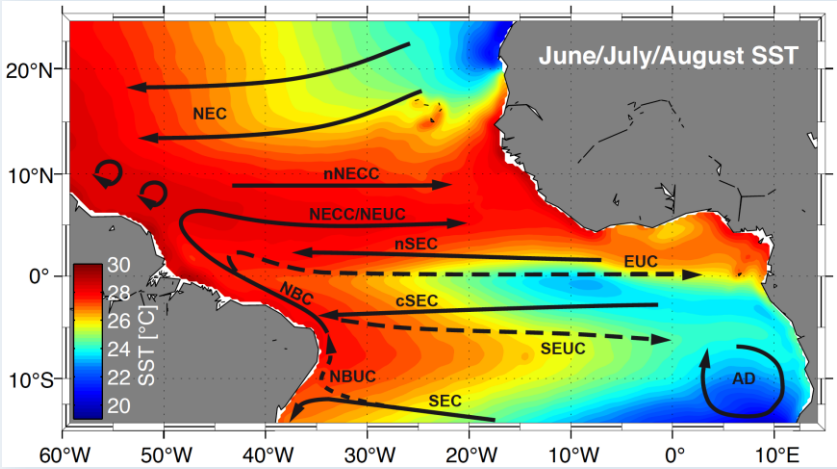

- Energy is found at basin mode characteristic
- Regular EDJ oscillations at period of 4.5 years

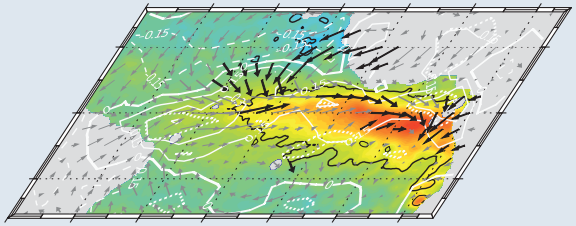
# Vertical Structure of Power Input

- 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

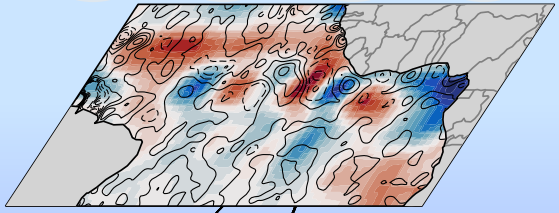


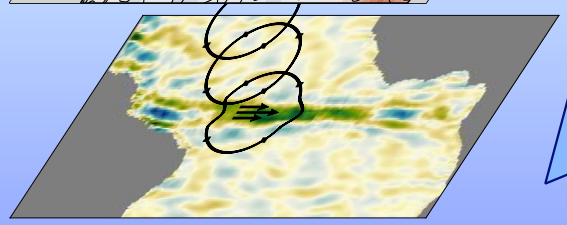
climate predictability

mean wind-driven circulation

tropical instability waves



interannual surface variability



deep intra-seasonal variability

equatorial deep jets