1) Variability in the tropical Atlantic:

- Spectral peaks at annual and semi-annual, and 120-day periods associated with 4th, 2nd and 1st baroclinic modes
- Peaks correspond to resonant basin modes, composed of equatorial Kelvin and Rossby waves, as well as coastally trapped waves[1]

2) Reduced gravity simulations of the tropical Atlantic:

- To study the intra-seasonal variability in particular, reduced gravity model (RGM) simulations are used:
  \[ v_1 = \alpha \phi_1 \quad \phi_1'' = -\gamma_1 \phi_1 \]
  \[ \gamma_1 = \frac{f^2}{c_1^2} = \frac{1}{h} \]
- The model is run separately for the first five baroclinic modes (\(c_1=0.47\) m/s, \(c_2=1.32\) m/s, \(c_3=0.94\) m/s, \(c_4=0.74\) m/s, \(c_5=0.57\) m/s), forced with interannually varying wind stress from NCEP (1990-2014)
- To allow for comparison of model and observations, the model output is fitted to AVISO sea level anomaly (SLA)[2]

3) Comparison of reduced gravity simulations with AVISO SLA:

- Dominance of the annual and semi-annual cycle, well reproduced by the RGM (Fig. 3 and Fig.4)
- In AVISO, presence of continuous and recurrent eastward propagations[3], with the intra-seasonal climatology representing ~25% of the seasonal cycle amplitude (Fig. 5)
- Only ~50% of the intra-seasonal signal amplitude is reproduced by the RGM, however the phase-lock of the propagations appears to be consistent

4a) Basin mode of the 1st baroclinic mode

- Basin-wide structure of SLA associated with the 1st baroclinic mode with variability detectable as far as 10°
- Consistent pattern in the RGM, although with considerable lower amplitude
- Mode 1 in the RGM simulations explains most of the structure seen in the “full” model

4b) Equatorial wave analysis

- Averaged over the equatorial belt (5°S-5°N), zonal wavenumber-frequency diagrams of SLA exhibit spectral peaks near the theoretical dispersion curves of the first baroclinic mode equatorial Kelvin and Rossby waves
- In the RGM, total energy is lower, however there is considerable energy in the mixed Rossby-gravity wave range

5) Summary and outlook

- Intra-seasonal SLA variability in the tropical Atlantic is essentially wind-driven, as it can be reproduced by reduced gravity simulations, although with weaker amplitudes
- Possible reasons for discrepancies to be tested:
  - Bad choice / spatial variability of phase speeds, which leads to the missing of resonance to a periodic forcing
  - Uncaptured (i.e. non-linear) effects of the North Equatorial Counter Current (NECC) on westwards propagating Rossby waves at ~4°N (Fig. 8)

References:


[2] The altimeter products were produced by Saudi-Osco and distributed by Aviso, with support from One Ocean (http://www.aviso.altimeter.fr/iscoo/)