The Sensitivity of Regional Coupled Ocean-Atmosphere Simulations over the Intra-Americas Seas to the Prescribed Bathymetry

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AWP interannual variability and modulation of Atlantic TC activity (Observations)

Large Interannual variations of the warm pool

Modulates Atlantic tropical cyclone activity

Modulates CONUS hydroclimate (not shown)
The area of the Atlantic Warm Pool in CMIP5 models

There is also diversity in the magnitude of the cold bias displayed by CMIP5 models.
A large disparity in flow and heat transport through the Yucatan Channel

**SODA**
SD = 4.42
MN = 23.96

**GFDL-ESM2G**
SD = 3.09
MN = 15.85

**CCSM4**
SD = 1.53
MN = 31.72

**SODAv2.2.4**
POP, horizontal res. 0.25°x0.40°, 40 vertical levels (Carton et al., 2008)

**CCSM4**
Ocean: POP2 with modifications, horizontal res. 1.125° in longitude, 0.27°-0.64° variable in latitude, 60 vertical levels (Danabasoglu et al., 2012)

Atmosphere: CAM4, horizontal res. 0.9°x1.25°, 27 vertical levels (Neale et al. 2013)

**GFDL-ESM2G**
Ocean: GOLD, 1° tripolar 360x210L63, (Hallberg and Adcroft, 2009; Dunne et al., 2012)

Atmosphere: 2.5° x 2.0°, 24 vertical levels (Dunne et al. 2013)
Regional climate model experiments

• Two identical RCM’s run independently for 32 years at 15km grid resolution forced by ocean (SODA v2) and atmospheric (NCEP R2) reanalysis.

• RCM: Regional Spectral Model coupled to ROMS

• RCM1: Run with fine scale bathymetry from ETOPO5

• RCM2: Run with coarser bathymetry (smoothed version of the above)
Fine bathymetry

Coarse bathymetry

Fine-Coarse (difference) bathymetry
RCM1 integration with finer bathymetry warms the SST in the Gulf of Mexico and along the Gulf Stream.
The RCM1 integration (with finer bathymetry) raises the heat content in the IAS and the surface ocean currents are stronger relative to RCM2.
The RCM1 integration (with finer bathymetry) raises the heat content in the IAS and the surface ocean currents are stronger relative to RCM2.
Volume Transport (Sv) through Yucatan Channel in RCM1 and RCM2

**Monthly mean Volume Flux (Sv) through Yucatan Channel**

Maxima and minima observed over time (1980-2010) with mean and standard deviation values for RCM1 and RCM2.

**Observed transport in Yucatan Channel**

Mean transport values of 23.06 Sv (Oct 2009 - May 2011) and 26.2 Sv (May 2010 - Jul 2013).

From Candela et al. 2003 and Athie et al. 2015.
Heat Transport (Sv) through Yucatan Channel in RCM1 and RCM2
Conclusions

- The cold bias of the Atlantic warm pool in CMIP5 models is significant—the area is underestimated by over 200% in majority of models!
- Two of the CMIP5 models show large differences in the transport through Yucatan Channel; the one with the higher transport displayed larger AWP than with the lower transport but yet both displayed cold SST bias in the IAS region.
- The RCM experiments with different bathymetry confirmed that transport through Yucatan Channel does affect the SST and heat content of the IAS.
- The transport through the Yucatan Channel can be modulated by bathymetry because it dictates the potential vorticity through changes to depth of the water column—you don’t even preserve the large-scale forcing transport (SODA transport is comparable to RCM1 but RCM2 is way too less).
- Improving transport through YC will not necessarily fix all problems of bias in IAS but we are looking at a tractable problem.