Impact of the Barrier Layer on the variability of the Southeastern Arabian sea

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Introduction: Seasonal variability of the southeastern Arabian Sea

Precipitation monsoon onset

Spring SST warming

Barrier Layer

Rao and Sivakumar, 1999
Shenoi et al., 1999
Durand et al., 2004

Explore and quantify this hypothesis with a coupled model
1. Model components:  *No flux correction*
   - **AGCM** (*MPI, Germany*): ECHAM4 (T106L19)
   - **OGCM** (*LODYC, France*): OPA8 (ORCA2: 2° x 0.5°~2°, L31)
   - **Coupler** (*CERFACS, France*): OASIS2

2. European collaborators:
   - **LODYC**: OPA group
   - **INGV (Italy)**: Antonio Navarra’s group
   - **MPI**: ECHAM model group
   - **CERFACS**: OASIS coupler group
   - **PRISM project group**

3. Reference experiment: we keep 100 years from 21 to 120
Monsoon onset in the SE Arabian Sea

Model

REF: Precip, May

May

Latitude

Longitude (mm/day): Min= 0.01, Max= 14.10, Int= 2.00

CMA


May

Latitude

Longitude (mm/day): Min= 0.0, Max= 14.17, Int= 2.00

TMI

REF: CMAP (1979-2002) Precip, June

June

Latitude

Longitude (mm/day): Min= 0.0, Max= 20.42, Int= 2.00


June

Latitude

Longitude (mm/day): Min= 0.0, Max= 132.00, Int= 2.00


July

Latitude

Longitude (mm/day): Min= 0.0, Max= 136.80, Int= 2.00
Spring variability of the SST: mini-warm pool formation

Joseph, 1990
Rao and Sivakumar, 1999
Seasonal Variability : OK
Model Bias : ~1°C

Spring warming : Feb ⇒ May OK
How to explain the spring warming?

1) heat fluxes
   • Shenoi et al. 1999
   • Sengupta et al. 2002

Problems:
   early SST warming
   late SST decrease

2) Barrier layer
   • Shenoi et al. 1999
   • Durand et al. 2004

Less Solar heat flux
Smaller thermal inertia
weak or positive entrainment
BL formation mechanism

1) Downwelling
   • Bruce 1994, 1998
   • Shankar et Shetye 1997

2) Imput of fresh water
   • Shetye et al. 1991
   • Rao et Sivakumar 2003
A perturbation experiment

Suppress, in the SE Arabian Sea, the salt impact on the vertical stratification which controls the depth of the mixed layer

• Reference (yr 21⇒120) :
  with active salinity in the vertical stratification
• Perturbation (yr 21⇒120) :
  without active salinity in the vertical stratification
REF - PERTURB
yr 21⇒120

REF: +0.6°C in Apr

REF: +3mm/d in May
REF:
Warmer in April
More precipitation from April to July

REF:
earlier monsoon onset (15 days)
Conclusion

Significant impact of the Barrier Layer in the SE Arabian Sea

+0.6°C in Apr
+3mm/d in May
earlier monsoon onset (15 days)

Remaining Questions

- Impact of the Ocean resolution
  - better ocean circulation in the SouthEast Arabian Sea
  - thinner salinity stratification
- Impact on the onset of the monsoon => interannual variability