Chapter SD10:
Decadal variability and predictability

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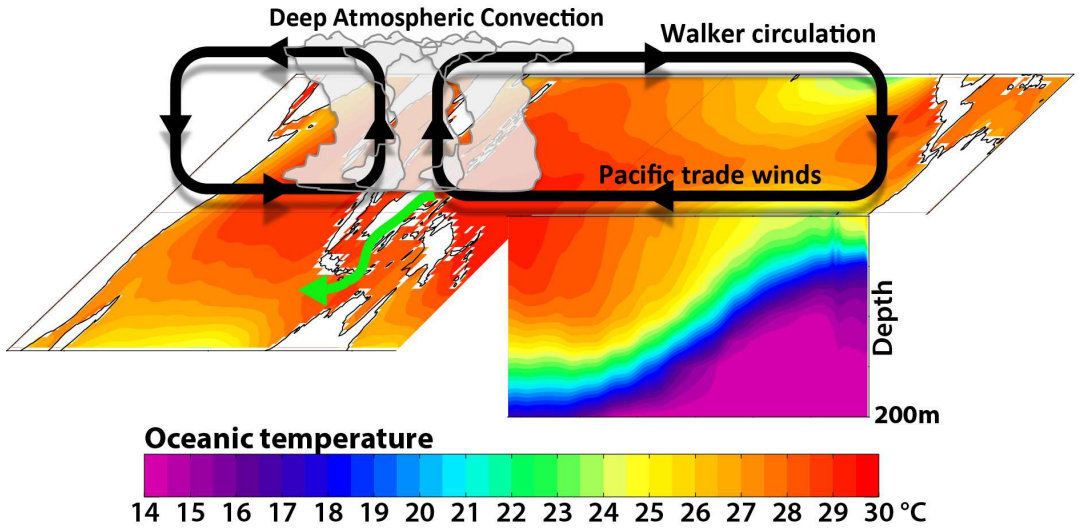
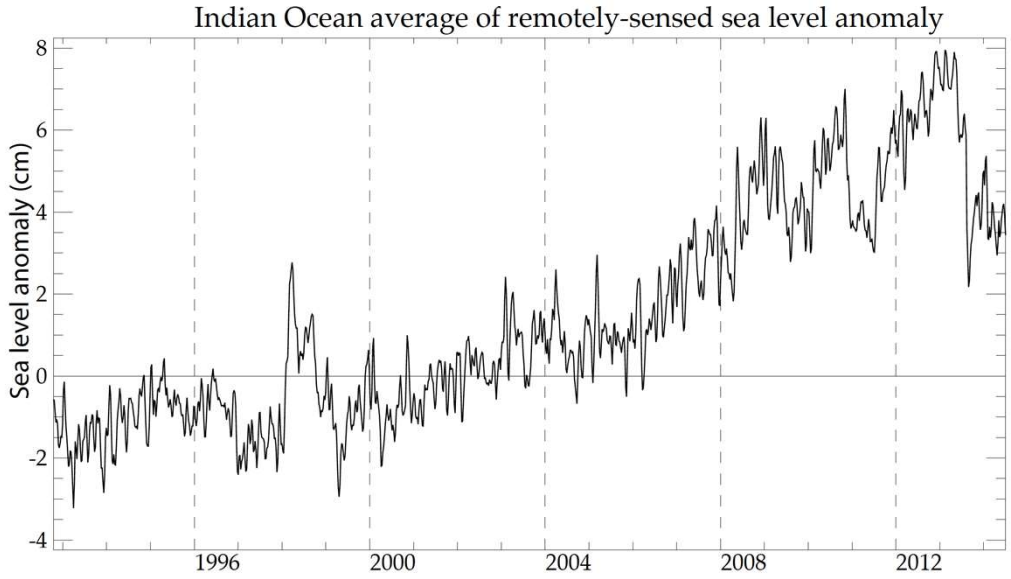
Hiatus heat into the Indian Ocean

Reduced rate of GMST increase: IPO- **(e.g. Meehl et al. 2011; Kosaka and Xie 2013; England et al. 2014)**
Increased heat transfer to the Indian Ocean **(e.g. Lee et al. 2015; Nieves et al. 2015; Liu et al. 2016)**
Strong sea-level rise in the Northern IO **(Thompson et al. 2016; Srinivasu et al. 2017)**

(Vialard, 2015)

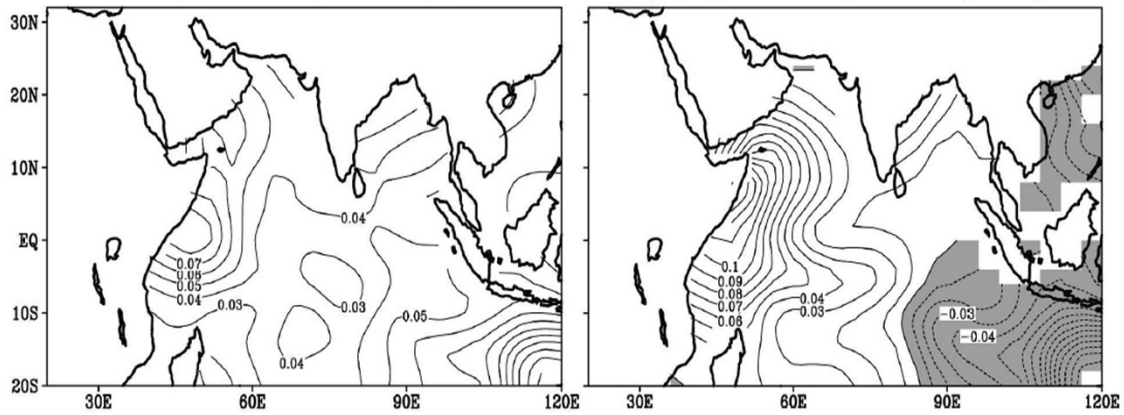




Indian ocean decadal variability

Any internal decadal variability in the Indian Ocean?
Unlike Pacific (IPO) and Atlantic (AMO), no clearly-established mode in IO (Han et al. 2014)

EOF1 (37%) & 2 (14%) of Indian Ocean decadal SST



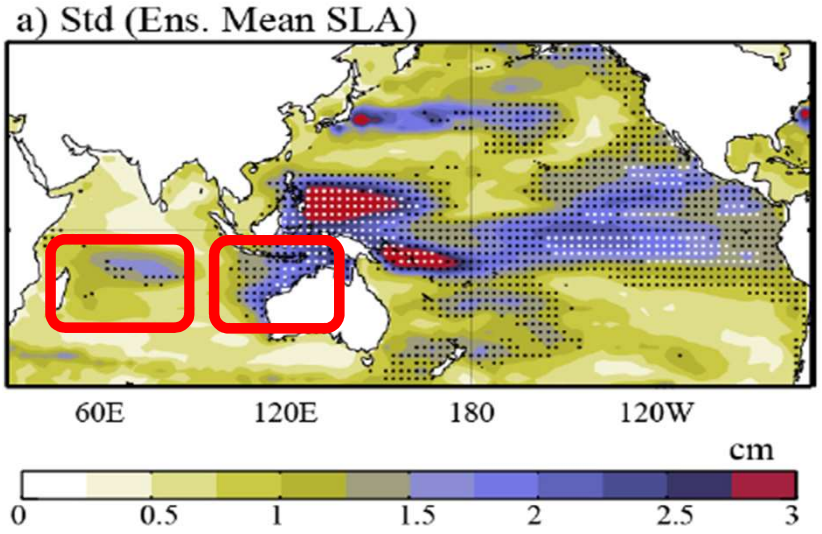
(Tozuka et al. 2007)

Uniform warming linked to IPO (e.g. Tozuka et al. 2007; Dong et al. 2016)

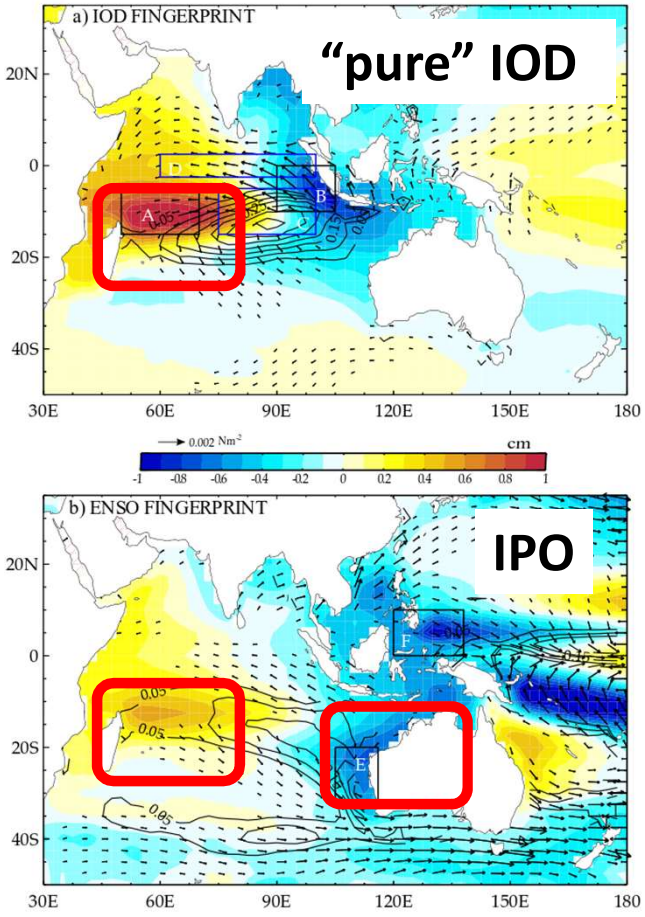
Decadal IOD modulation, independent from ENSO ? (e.g. Tozuka et al. 2007; Ashok et al. 2004)

Indian Ocean Decadal variability

Sea-level decadal variability less constrained than in Pacific

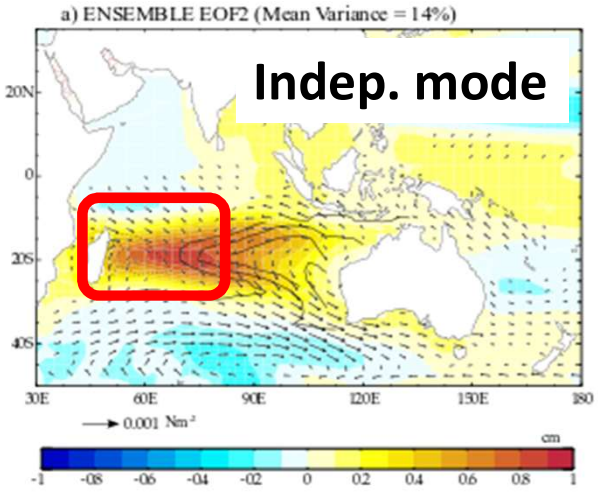


Nidheesh et al. 2017



Consensus modes of decadal sea-level from 26 CMIP5 models

Nidheesh et al. in prep



Linked to Mascarene high fluctuations?

Scientific questions

- How and why does the ITF vary at decadal timescales?
- Are the decadal IOD & IPO independent?
- Interactions between Indian Ocean decadal variability and climate change (aliasing ?; projection of climate change on decadal modes?)
- Is there an Indian Ocean intrinsic mode of decadal variability in the South-Western Tropical IO, mechanisms & relation to other modes of variability?
- (Biogeochemistry and ecological consequences (cf PDO)?)

Summary of reviewer comments

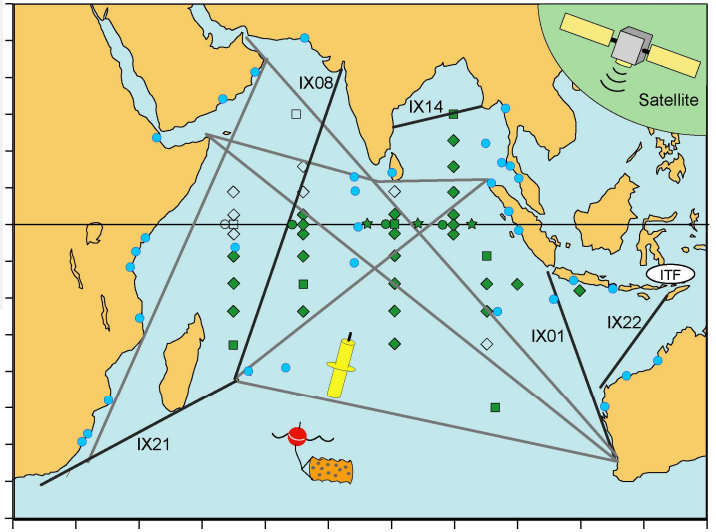
- Clarification: chapter 10 about natural variability.
- IX01 fortnightly: monthly not enough
- Surface drifters important for long term SST, wind record
- For long timescales, tide gauge needs to be updated for land motion
- Missing: predictability; monsoon; salinity
- Say more about paleo-date
- Role of mixing/wind/ ITF for decadal heat storage changes.

EOVs

Sustained basin-scale observations over several decades, at least ~monthly resolution:

1. ITF mass, heat & freshwater transport
2. SST with emphasis on eastern equatorial IO (IOD)
3. Consistent, multi-decadal ocean surface wind stress vector (central equatorial and southern-tropical Indian Ocean emphasis)
4. Sea-level and upper ocean heat content:
   a. southern tropical Indian Ocean (west coast of Australia, southwestern tropical Indian Ocean)
   b. northern tropical Indian ocean (recent, unprecedented sea level rise)
5. Volume and heat transports:
   a. CEC (incl. Somali current), transport
   b. across 32°S (incl.the Agulhas and Leeuwin currents).
6. Net surface heat flux

Actionable recommendations



a. Maintain IX01 XBT line: transport at throughflow exit and region of strong decadal sea-level signal off the west coast of Australia. Experimental glider doubling. (1 and 4)
b. Complete and maintain RAMA: key for IOD; inter-calibration of successive satellite missions (2-6)
c. Maintain Indian Ocean Argo (4 and 5)
d. Continuous satellite record; intercalibration for basin-scale long wind and SST records incl. in rainy/cloudy regions (2 and 3)
e. Maintain tide gauge network and ensure accessibility (4)
f. Paleo-proxies for long SST records (IOD east pole) & sea-level near the west coast of Australia (e.g. Zinke et al. 2015), Chagos archipelago and Mascarene Islands (4).