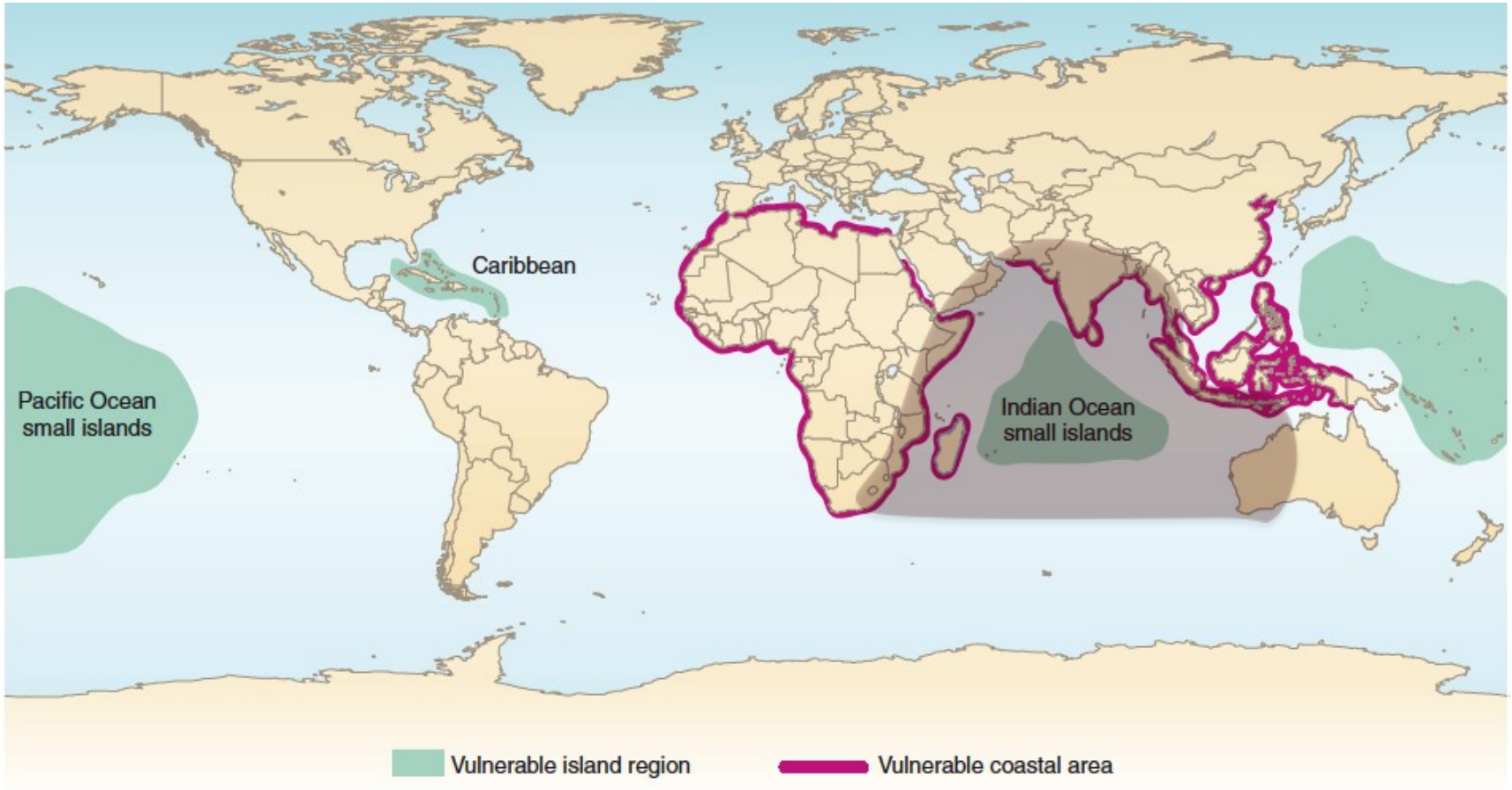
Chp 14: The regional sea-level variability & change

Vulnerable regions to coastal flooding caused by future sea level rise



Nicholls and Cazenave (2010)

Most regions of the Indian Ocean rim are marked as vulnerable areas

However, large uncertainties exist in the projected SLR on regional & local scales, because

(1) different models have different responses to the same external forcing (e.g., solar, volcanoes, GHGs), and

(2) Natural internal variability may dominate external forcing even for multidecadal trend

CESM1 40member-avearge

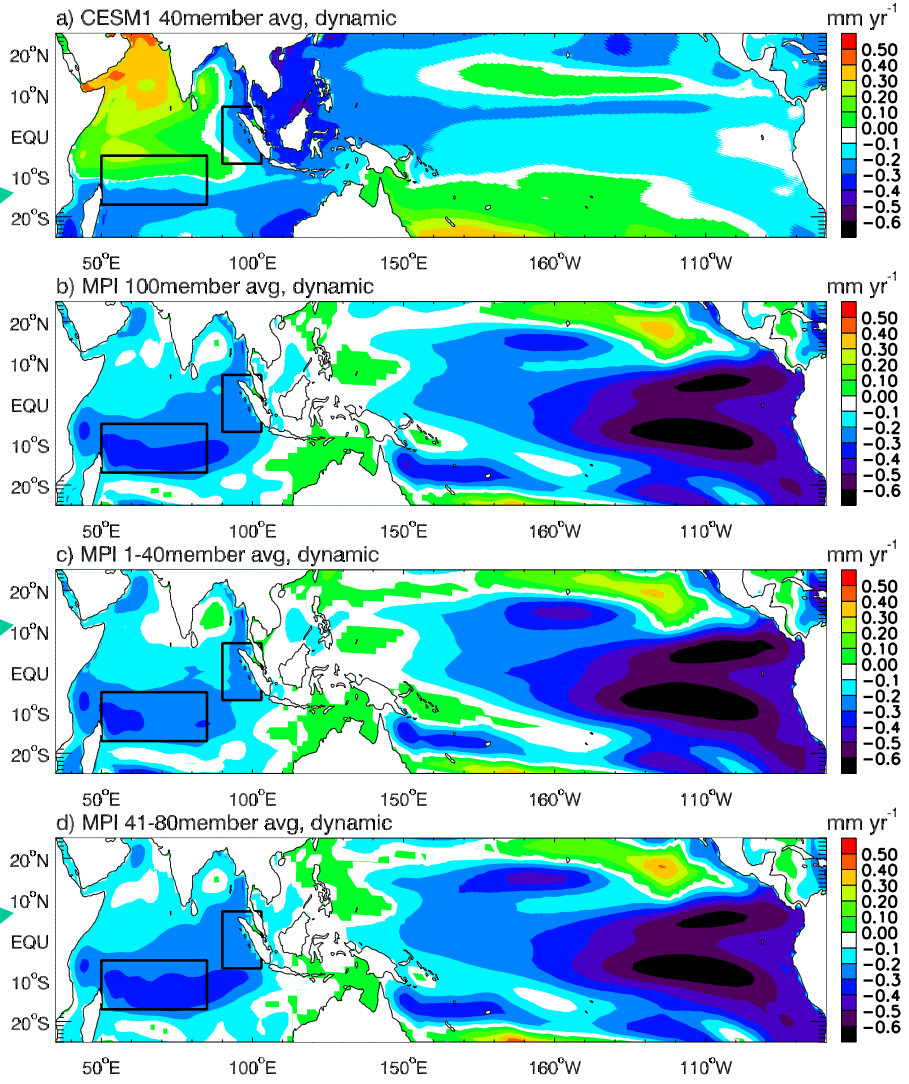
Max-Planck Institute (MPI) 100member avearge

MPI 40member average (1-40)

MPI 40member average (41-80)

Han et al. 2018

Linear trend of sea level for 1958-2005



Natural internal variability may dominate external forcing even for multidecadal trend (On seasonal-to-decadal timescales, natural variability dominates external forcing)

(a) External forcing ~17% (40%) of ORAS4 (SODA) trend over thermoc. Ridge

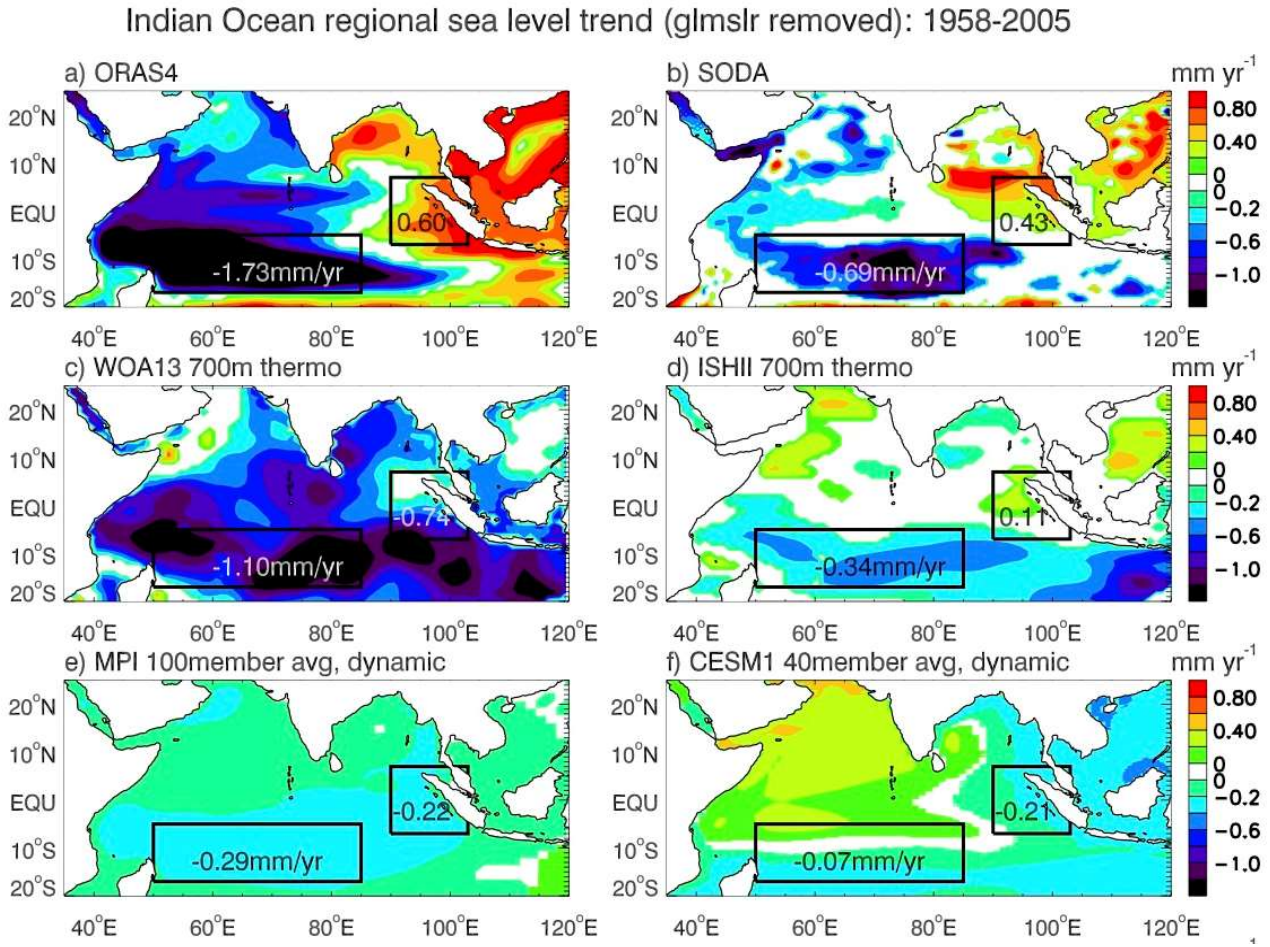
(b)Large uncertainties among datasets;

(c) Tide gauge: only a dozen > 50yrs & only 2 >100yrs

(d) Satellite altimetry: oct 1992-present; short for detecting decadal variability

(e) While thermosteric SL is important, halosteric effect is also large over the eastern IO & BoB, & deep ocean effect can also be important (compare top & middle panels)

(f) Changes in wind-driven ocean circulation is important for causing the uneven pattern

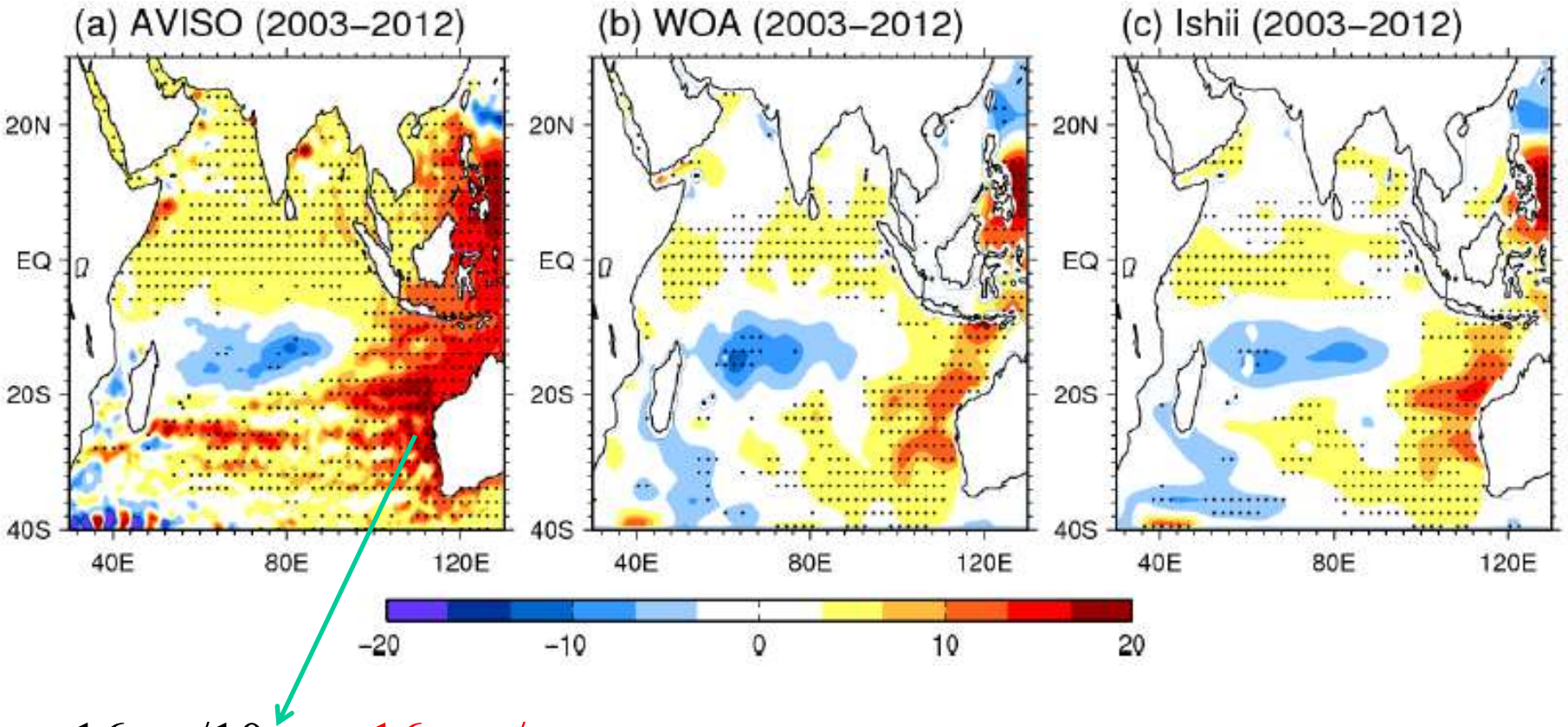


Han et al. 2018

Inter-basin connection with the Pacific: The ITF explains ~2/3 "missing heat" during the recent surface warming hiatus since ~2003; most concentrates on the W. Australian Cost

(Li et al. 2017)

AVISO SSH trend **0-700m thermosteric sea level trend**



16cm/10yr ~ 16mm/yr

Much larger than glm slr ~3mm/yr

To obtain reliable future projections, we need to observe & understand natural internal variability & externally forced signals at both surface and subsurface oceans, and meanwhile improve climate model simulations; There is also a need to inter-calibrate successive satellite missions with the help of in situ data, in order to yield more homogeneous basin-scale products for the key variables.

EOVs:

(1) Direct sea level observations (tide gauge & satellite);
(2) T & S (thermo. & halo. Sea level);
(3) Current (understand regional SLC associated with changes in ocean circulation);
(4) Surface wind (understand regional SLC associated with changes in wind-driven ocean circulation & turbulent heat fluxes)

Actionable recommendations for IndOOS:

(1)Maintain existing tide gauge stations to provide continuous records; add new tide gauges around the thermocline ridge region (e.g., at Agaléga, Rodrigues & St Brandon of Mauritius, "Iles éparses" such as Tromelin, Europa & Juan de Nova);

(2) Maintain the existing RAMA array, particularly the meridional sections at 67° E and 80° E where sea level variability is large over the thermocline ridge region; and the zonal sections at the equator, 2° N and 2° S (IOD wind, subsurface thermal and salinity signals, and current) and all moorings in the eastern equatorial Indian Ocean for temperature and current measurement;

(3)Maintain the Argo network in the entire Indian Ocean to obtain basin-wide estimation of thermosteric and halosteric sea level contributions;

(4) Improve deep ocean observations (e.g., deep ocean moorings and deep Argo) to observe temperature and salinity to assess the effect of deep ocean variability on SLC;

Actionable recommendations for IndOOS: continued

(5) Maintain the IX01 XBT line to sustain the mass and heat transport estimate of the ITF and sea level variability near the west coast of Australia; Maintain the trans-Indian Ocean hydrographic observations along the 32° S line, including the boundary current regions near the Leeuwin and Agulhas currents;

(6) Continue satellite altimetry data (e.g., Jason series), which are essential for providing basin-wide multidecadal records, and satellite missions for measuring vector winds over the ocean surface; the upcoming SWOT mission is important for resolving the small scale sea level variability due to oceanic internal variability; Continue Earth gravity satellite missions such as GRACE and GOCE to better capture the changes of mass distribution in the ocean.