Indo-Pacific Inter-basin Exchange
Centre for Southern Hemisphere Oceans Research Science Seminar 2019
Bernadette Sloyan and Beatriz Peña Molino
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Project Team
Motivation
Indo-Pacific Inter-basin Exchange

As water from the Pacific warm pool (red region) flows to the Indian Ocean it is cooled by ocean and atmospheric processes (arrows with changing red shade) and by forcing form the Indian ocean (black wave arrow).

Sea identified; Halmahera Sea HS, Lifamatola Passage LP, Ceram Sea CS.
Ocean Surface Boundary Forcing
Modification of the incoming Pacific waters is thought to be the result of mixing induced by several ocean processes: (1) dissipation of powerful tidal currents (2) Ekman pumping and (3) fluxes across the ocean-atmosphere boundary.

These processes produce a unique Indonesian stratification and vertical temperature and salinity gradients.
Building International Links

Detecting change in the Indonesian Sea

Research Collaboration: USA, Australia – CSHOR, and IMOS, China
MINTIE: Measurements and Modeling of the Indonesian Throughflow - new insights into a key interocean connection

Seminars and visit with Dr Dongliang Yuan, Institute of Oceanology, Chinese Academy of Sciences (IOCAS)

Dr Bernadette Sloyan member of the Scientific Advisory Committee
High-Resolution Earth System Prediction (iHESP) – a research partnership among the Qingdao National Laboratory for Marine Science and Technology (QNLTM), Texas A&M University (TAMU) and the National Center for Atmospheric Research (NCAR)
Science Achievements
Multiple scales associated with the ITF:

- Interannual: ENSO and IOD
- Seasonal (Monsoon)
- Intraseasonal (Kelvin Waves, MJO)
- Tidal
The seasonal drivers of the ITF

- The monsoon system
- Some (but not all) seasonal drivers of the ITF:
  - Local drivers:
    - Convergence/divergence of Banda sea
    - Ekman flow
  - Remote drivers:
    - Winds over the Indian ocean (Kelvin waves at the outflow passages)
    - Winds over the tropical Pacific (changes in sea level)

→ What about the transformation?
Seasonal Cycle influence on surface properties

Black line = mixed layer, Blue line = wind stress curl (positive values = divergence/shallower thermocline/pycnocline and negative values = convergence/deeper thermocline/pycnocline)

- Black line = mixed layer
- Blue line = wind stress
- Orange line = wind stress curl (positive values = divergence/shallower thermocline/pycnocline and negative values = convergence/deeper thermocline/pycnocline)
And why Timor...

INSTANT data showed larger transports than previously estimated, accounting for 50% of the total outflow.

Heavily instrumented moorings: much better resolution of the flow.

First reliable salinity measurements.
The seasonal cycle in Timor has an amplitude of nearly 6 Sv (almost half the amplitude of the total mean ITF).

The seasonality is driven by the deep (<600m) flow, and associated with the passing of the biannual Kelvin wave.

The cycle maxima results from increased near-surface flow (Banda Sea divergence), and unblocked deep flow.
Altimetry: X-track (along-track sea level anomalies for coastal applications) AVISO product. Fit seasonal cycle and filter to reduce noise. Then calculate seasonal anomalies of the surface geostrophic velocity.

Weakest ITF during NWM / Strongest ITF during SEM

As the core of the ITF strengthens it separates from the coast

Shelf circulation has opposite phase to flow through deep passage

But why is the geostrophic flow in phase with the winds, but out of phase with the shelf?
The timing and phase of the near surface flow is not unique to this location (only the inertial overshoot is)
Is it remote or locally driven?

The seasonal transport is dominated by the remote forcing, driving maximum transport during May-June. The local forcing tends to oppose the remote response.
Heat transport doubles when correlations between transport and temperature are largest.
Salinity is much more complex (and uncertain...)

SALINITY anomaly
(during transport max: April-June)

SALINITY anomaly
(during transport min: August-October)
Not a passive conduit

Salinity maximum of the Pacific waters is eroded during transit via:

-mixing due to dissipation of internal tides
-transformation due to surface fluxes
-and Ekman driven convergence/divergence

(Sprintall et al, 2014)
What’s the origin of the waters feeding Timor?
TS-variability in the pathways, or modulation of the mixing?
Outlook for 2019-2020
2019-2020 Planned Research

- Combining models and obs to understand local vs remote forcing of the ITF and connectivity of the western route to Banda Sea.
- Use obs to characterize the interannual variability (INSTANT vs IMOS)
- Tidal mixing included in high resolution models
- Preparation and participation in international field program

MINTIE: Measurements and Modeling of the Indonesian Throughflow

- use models to guide best location of moorings
- build CSHOR-IMOS mooring
- purchase CSHOR floats
- participate in voyage planning
- voyage date yet to be confirmed, requesting June-July 2020
Thank you