Variability of the Subantarctic Mode Water volume in the South Indian Ocean during 2004-2018

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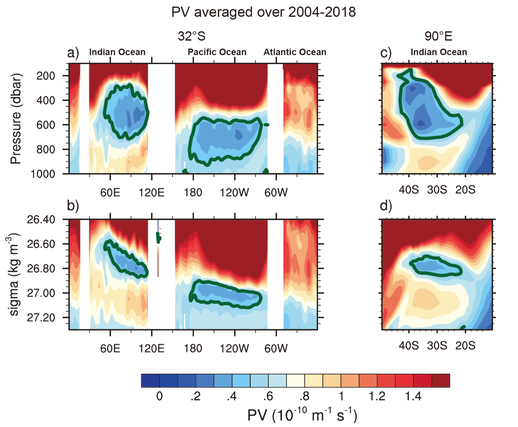
Introduction

Subantarctic Mode water (SAMW) : water mass with vertically homogenous physical properties (temperature and salinity) that covers a large horizontal area in the southern hemisphere.

In the **South Indian Ocean (SIO),** the SAMW displays a high sensitivity to climate change. This study investigates the layer dependence of the SAMW volume variation in the SIO and its associated atmospheric forcing based on **Argo** observations.

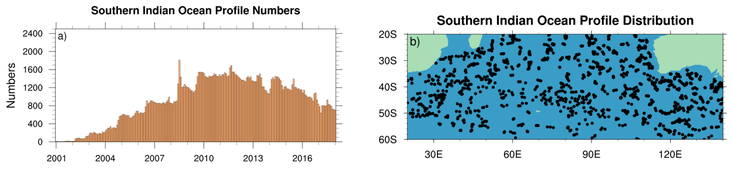


The SAMW exists mainly in the Indian and Pacific Oceans, with only a very small amount observed in the Atlantic Ocean. In each ocean basin, the denser SAMW is confined to the east, i.e., the SAMW density increases from west to east starting at 60°E in the SIO.

Data and methods

Data source:

- Temperature and salinity profiles from the **Argo** data from **JAMSTEC** during **2004-2018**. Region is restricted to **20°E-140°E** and **20°S-60°S**.



- Heat fluxes and wind from ERA-Interim.

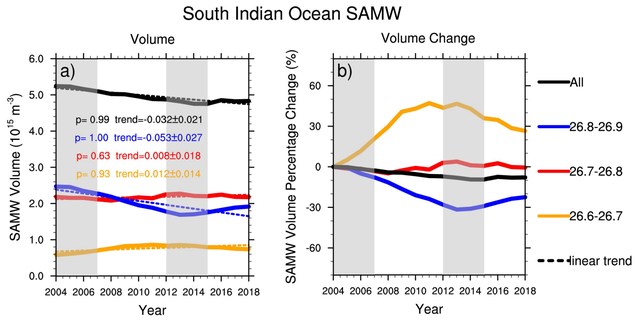
SAMW definition:

- 100 m -1000 m
- Pv<=0.5x10^{-10} m^{-1} s^{-1} $PV = \frac{f}{\rho}\frac{d\rho}{dz}$
- 26.6 kg m^{-3} ≤ σ≤26.9 kg m^{-3}

SAMW density classes:

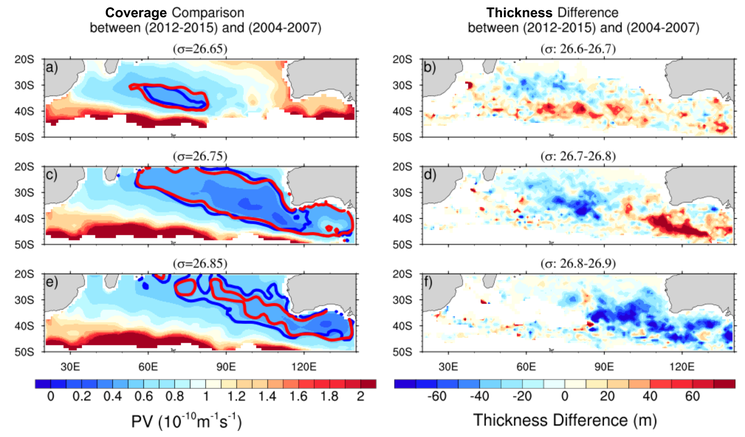
	Light SAMW	Medium SAMW	Dense SAMW
Density range	26.6<σ≤26.7	26.7<σ≤26.8	26.8<σ≤26.9

The SAMW volume change



- During 2004-2018, the total SAMW volume **decreases** by 0.032±0.021×10^{15} m^3 year^{-1}. The percentage of this volume decreases by ~10% from 2004 to 2018.
- The **dense SAMW** experiences a **decreasing** trend of 0.053±0.027 ×10^{15} m^3 year^{-1} from 2004 to 2018, while the **medium and light SAMW increase** by 0.008 ±0.018×10^{15} m^3 year^{-1} and 0.012±0.014×10^{15} m^3 year^{-1}, respectively.

The SAMW spatial distribution

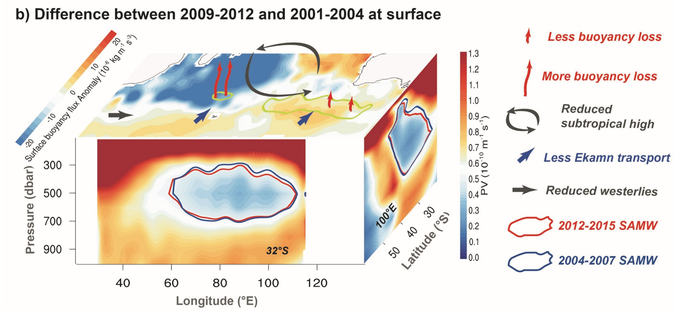


Red (the second period): 2012-2015
Blue (the first period): 2004-2007

From the first to the second period:

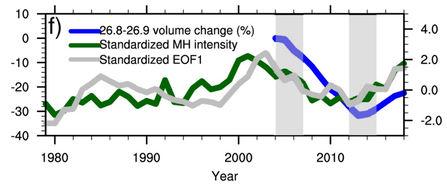
- The **light SAMW expands**, and its **thickness increases** by more than 50 m.
- The **medium SAMW** show a **dipole pattern** both for its spatial coverage and thickness, which decrease in the lower latitudes and increase in the higher latitudes.
- The coverage of the **dense SAMW** does **not change** much at higher latitudes; however, it **decreases** at lower latitudes. The **thickness decreases** by more than 60 m.

The SAMW volume change mechanism



- The weakening of the **Mascarene High** and **westerly winds** in the SIO **reduces** the evaporation-precipitation, surface heat flux (the **buoyancy loss**) and **Ekman pumping** and **shoals the mixed layer** southwest of Australia, which leads to a volume decrease at 26.8-26.9 kg m^{-3} in approximately 3 years. West of 90°E, the parameters exhibit the opposite change, leading to a volume increase at 26.6-26.8 kg m^{-3}.

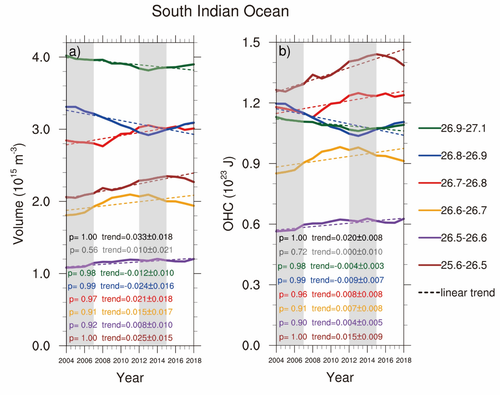
Surface buoyancy flux, Ekman pumping and 10 m winds (JAS) MVEOF 1



- The distinct weakening of the Mascarene High (MH) during 2000-2018 leads to changes in the SAMW volume with a lag time of ~3 years.

Conclusion and discussion

- Argo data reveal a Subantarctic Mode Water volume loss in the SIO over the period 2004-2018.
- Most of the volume loss occurs in the density range of 26.8-26.9 kg m^{-3}, while a volume increase occurs at 26.6-26.8 kg m^{-3}.
- Changes in the SAMW volume are controlled by surface forcing, which is closely related to the Mascarene High variation.



The increasing ocean heat content in the SIO is dominated by an increasing volume of water that is lighter than the SAMW (less than 26.8 kg m^{-3}), and thus, the decreasing volume of the dense SAMW partially offsets the increase in the total SIO OHC.

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