Internship Master 2 (6 months)

Title: Temperature and salinity contributions to sea level change since 2005

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Subject:
Planet Earth is experiencing a positive energy imbalance at the top of the atmosphere, where more energy is entering the Earth-atmosphere system than is leaving. This positive imbalance is known as global warming. The global ocean has absorbed ~90% of this excess energy, leading to global ocean warming and sea level rise, with a range of consequences for human society and marine ecosystems. Satellite altimetry data show that global mean sea level has been rising at a rate of 4.0 +/- 0.4 mm/year since 2015. However, this rise is not uniform and presents large regional variability. Understanding the cause of this regional variability is of great importance for potential future socio-economic impacts.

The figure shows the regional sea level trends derived from satellite altimetry for 2005-2014 (left panel) and 2014-2023 (right panel). We can clearly see that sea level is not rising uniformly in both plots, with regions experiencing a linear rise three times greater than the global mean trend. Furthermore, the spatial patterns are not the same over the two periods, suggesting that climate modes of variability leaves imprint in regional sea level trends. It is well established that these regional patterns are driven by steric sea level trends (i.e. density changes induced by temperature and salinity). If the temperature changes in the upper ocean are well documented due to a good coverage of in situ data, the salinity contributions remain uncertain mainly due to the lack of in situ data. Recently, with the deployment of Argo floats, we have the opportunity to investigate both contributions (temperature and salinity) to regional sea level trends inferred from satellite altimetry data, which is the main purpose of the internship.

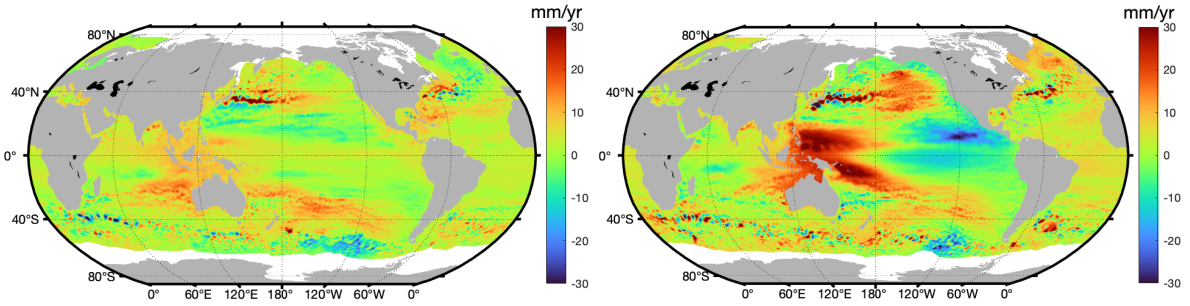


Figure: Regional sea level trends from satellite altimetry computed over 2005-2014 (left panel) and 2014-2023 (right panel). Values are in mm/yr.

Method:

The contribution of temperature and salinity to regional sea level trends will be investigated using available Argo-based gridded products from the Scripps Institute of Oceanography, IFREMER/LOPS, MetOffice and JAMSTEC. Steric sea level trends will be compared with altimetry-based sea level trends since 2005, when the Argo network reaches its near global coverage. The above analysis will be complemented with surface atmospheric forcing, such as wind stress and air-sea heat and freshwater fluxes, to investigate possible causes of identified temperature and salinity changes to regional sea level trends observed from satellite altimetry data. For this purpose, the selected student will make use of available atmospheric reanalysis output from ERA5, NCEP2 and JRA-55.

References:

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Roemmich, D., and J. Gilson (2009), The 2004-2008 mean and annual cycle of temperature, salinity and steric height in the global ocean from the Argo program, Prog. Oceanogr., 82, 81–100, doi:10.1016/j.pocean.2009.03.004.

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WCRP Global Sea Level Budget Group: Global sea-level budget 1993–present, Earth Syst. Sci. Data, 10, 1551–1590, https://doi.org/10.5194/essd-10-1551-2018, 2018.