INSTITUTE OF OCEANOGRAPHY AND ENVIRONMENT
Envision Marine Future
Marine Coastal and Delta Sustainability for Southeast Asia
Co-funded by the Erasmus+ Programme of the European Union

2.0 Physical Properties of Sea Water

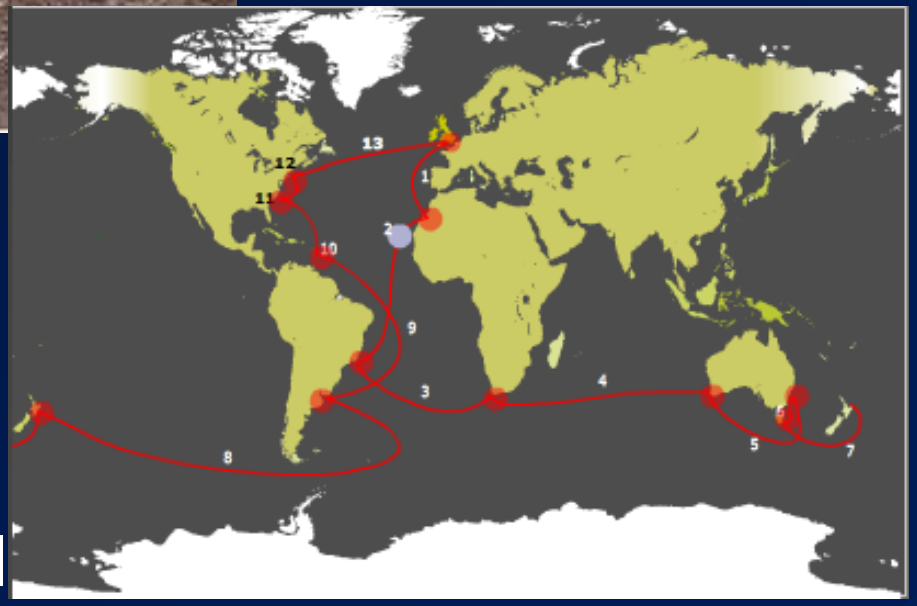
2.1 Temperature: in situ and potential Temperature
2.2 Salinity: Conductivity
2.3 Depth: Pressure
2.4 Density: Sigma

Objectives

- Understand the vertical and horizontal distribution of ocean waters and how it changes
- Explore the importance of T-S in oceanography research

HMS Challenger, 1872

- 127,500kms
- 3 ½ years
- 20years to compile data of 50 volumes books



RV Discovery - UMT

Explored the southern South China Sea

Physical properties of sea water

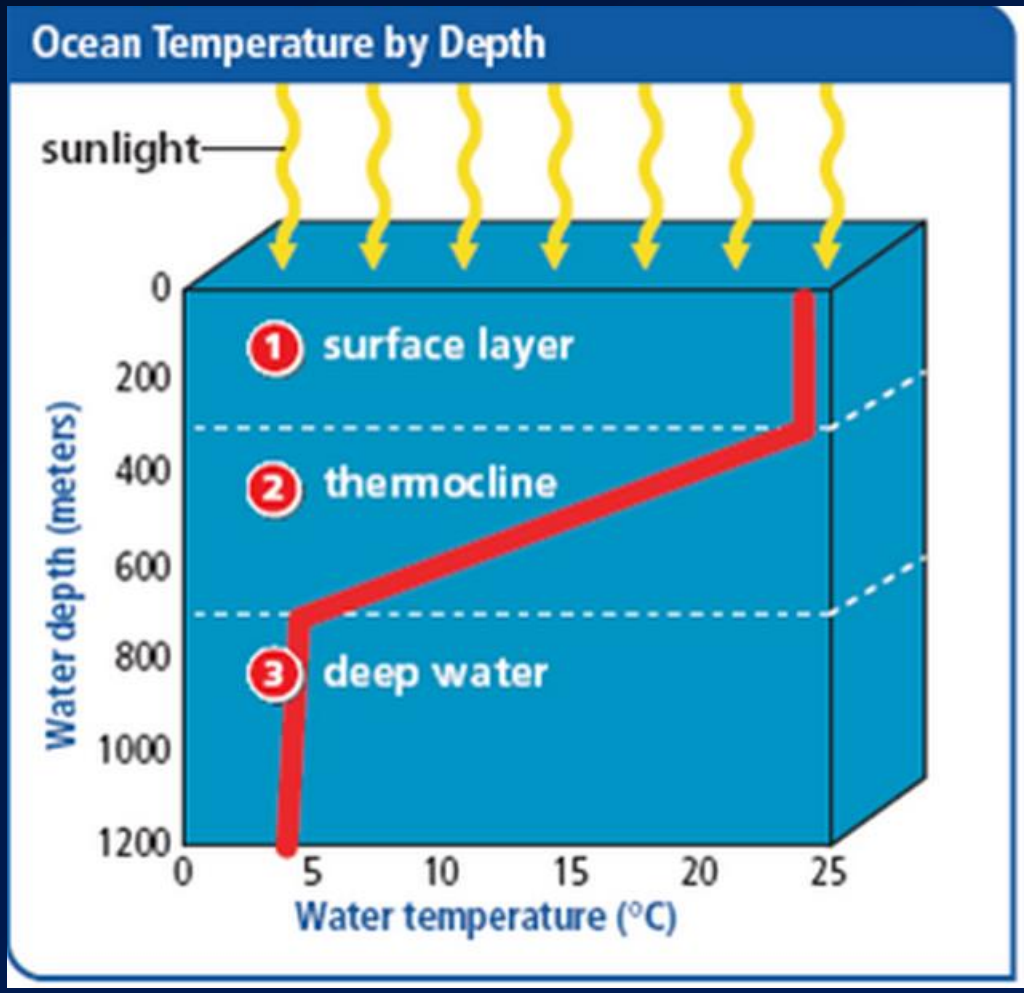
Primary properties we need to look at are the following as they define the circulation and mixing of different waters

Temperature: in situ and potential Temperature
Salinity: Conductivity
Depth: Pressure
Density: Sigma-t, specific volume anomaly

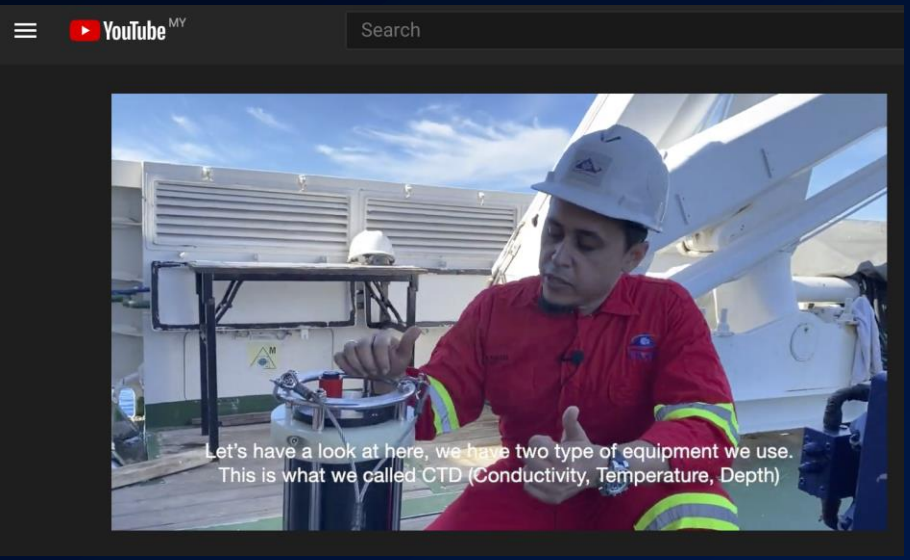
Temperature

The ocean can be divided into three vertical zones, depending on temperature:

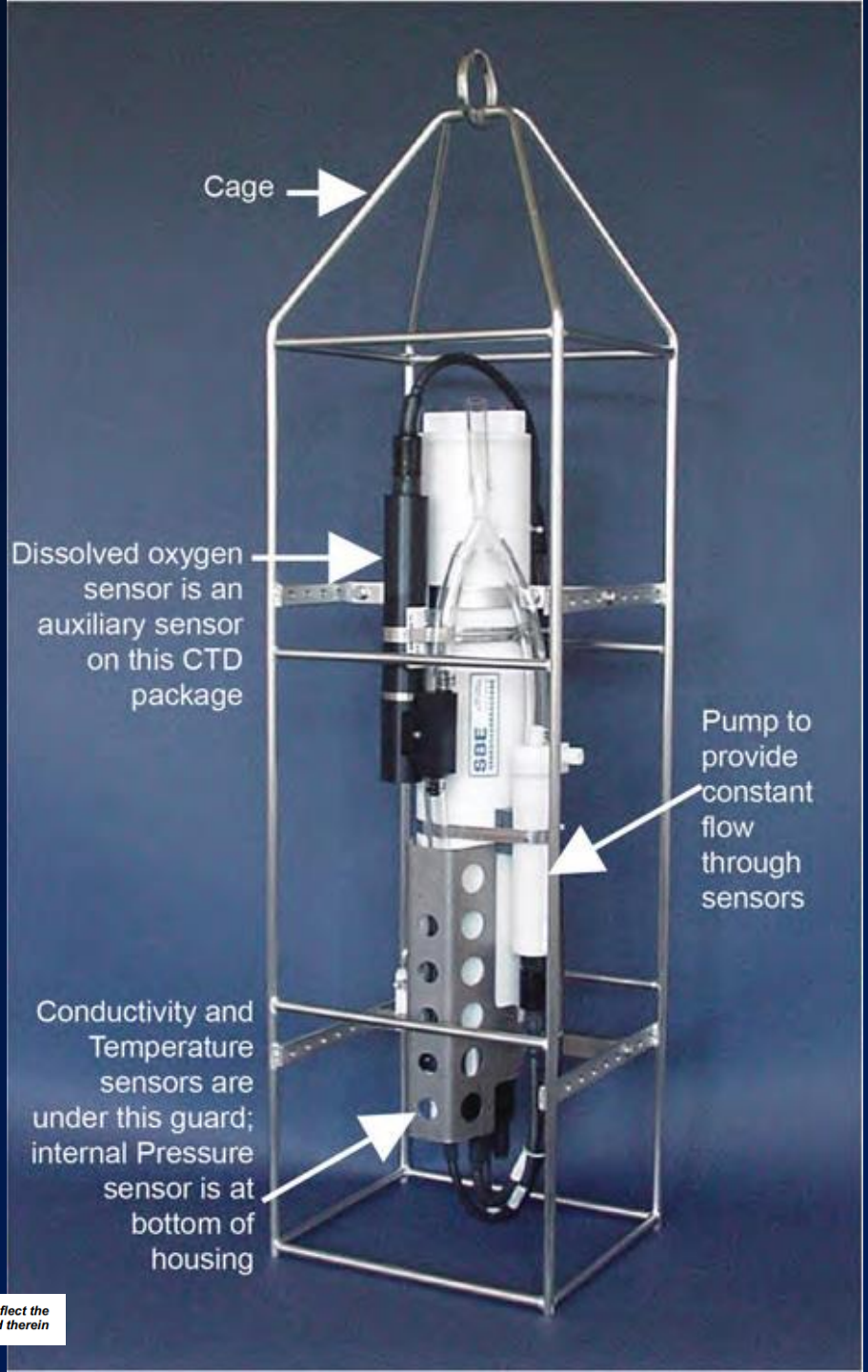
- The top layer is the surface layer, or mixed layer. This layer is influenced by solar energy, wind and rain.
- The second layer is the thermocline. Here, the water temperature drops as the depth increases.
- The third layer is the deep-water layer. Water temperature in this zone decreases slowly as depth increases. Water temperature in the deepest parts of the ocean averages about 2° Celsius.



CTD Equipment:
Conductivity, temperature and depth



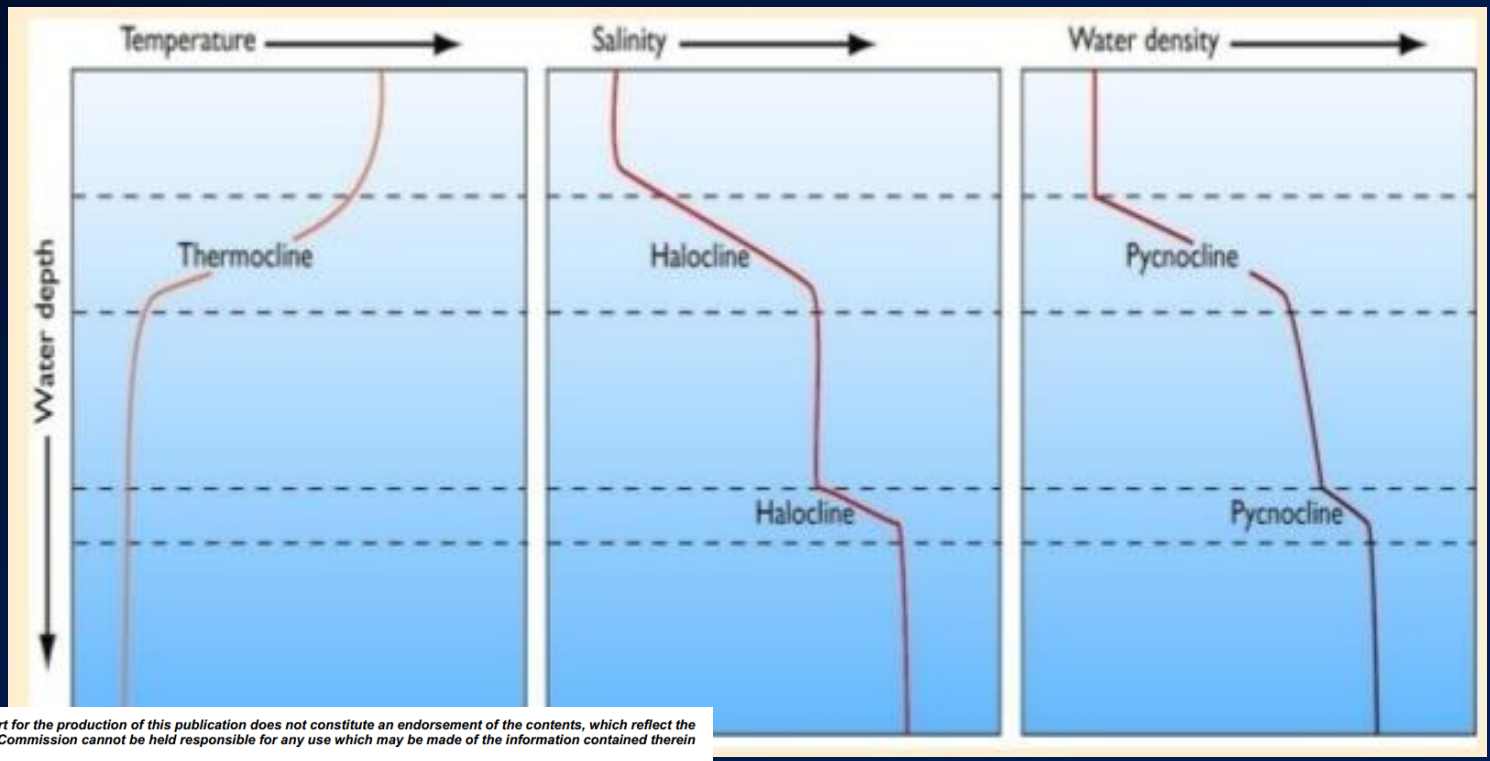
https://www.youtube.com/watch?v=rJGrDoR9NVM



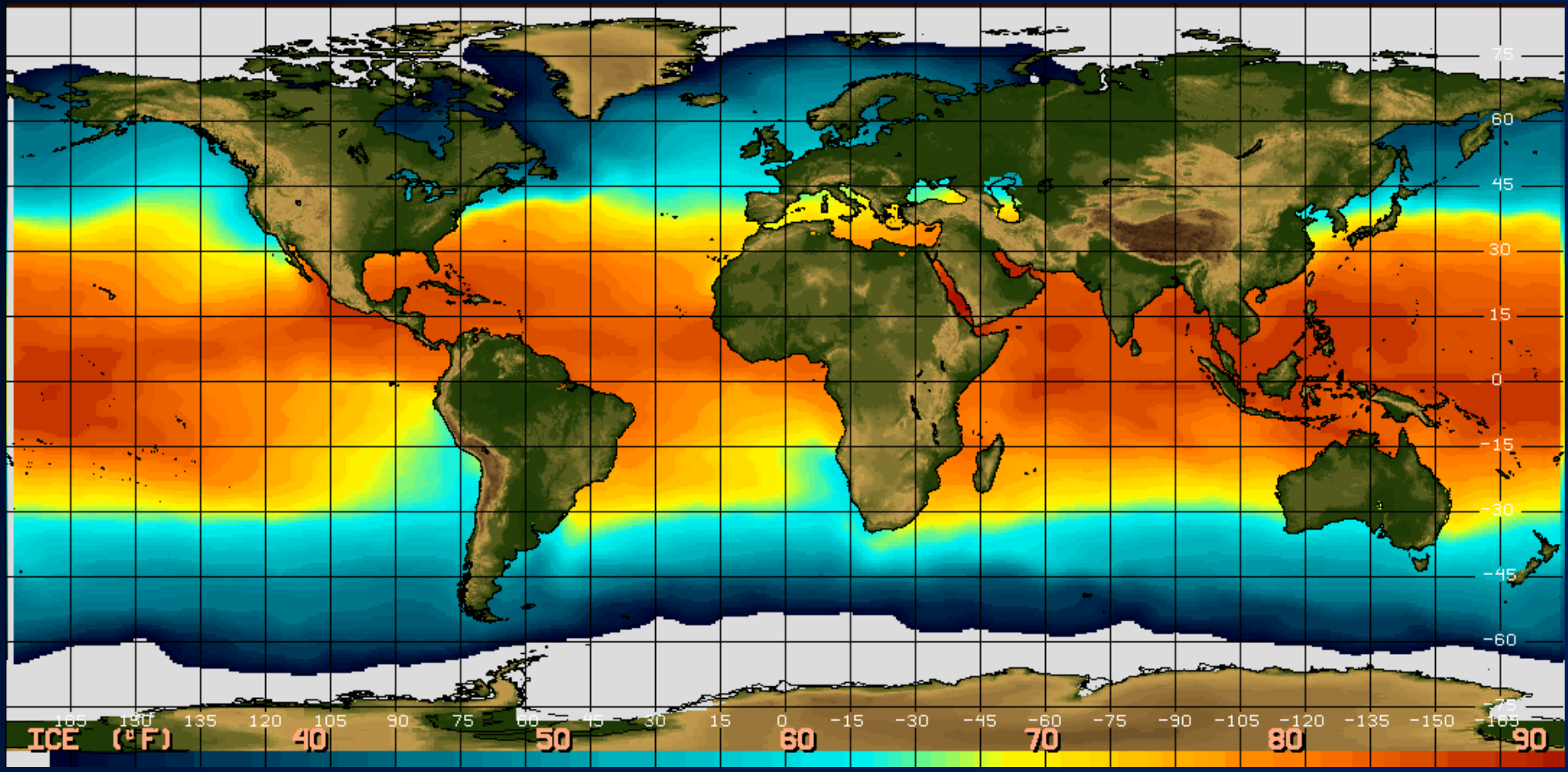
Terminology: Gradients/ '-cline'

Remember that thermocline refers to a 'gradient' where characteristic changes rapidly with depth

Thermocline - temperature
Halocline - salinity
Density - pycnocline

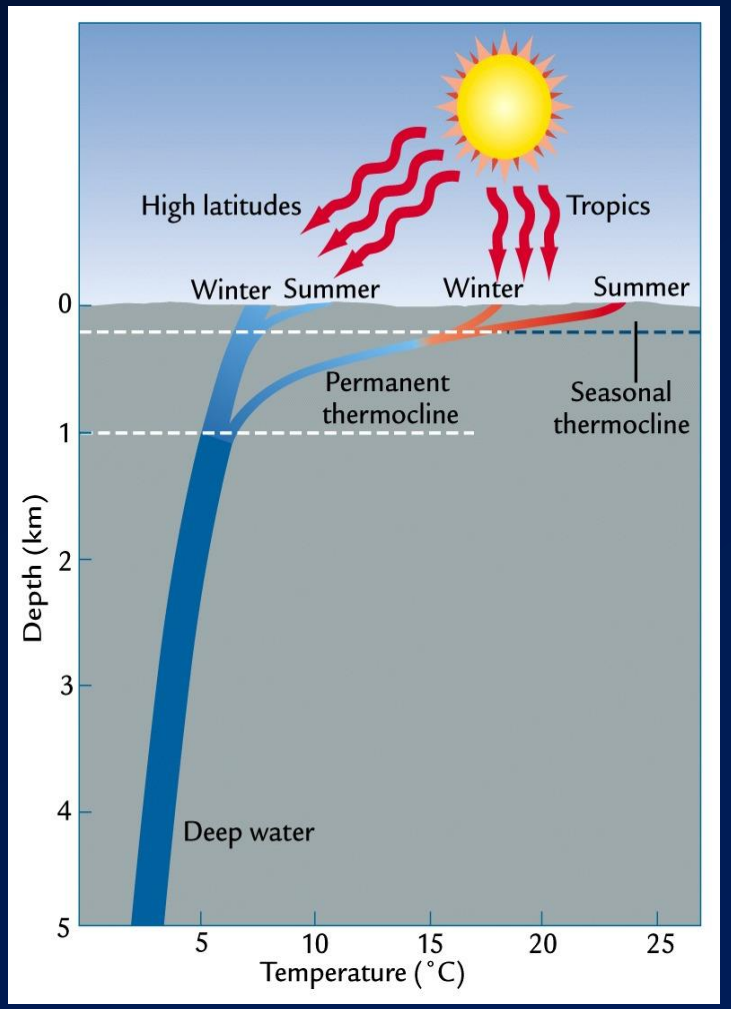


Surface Temperature

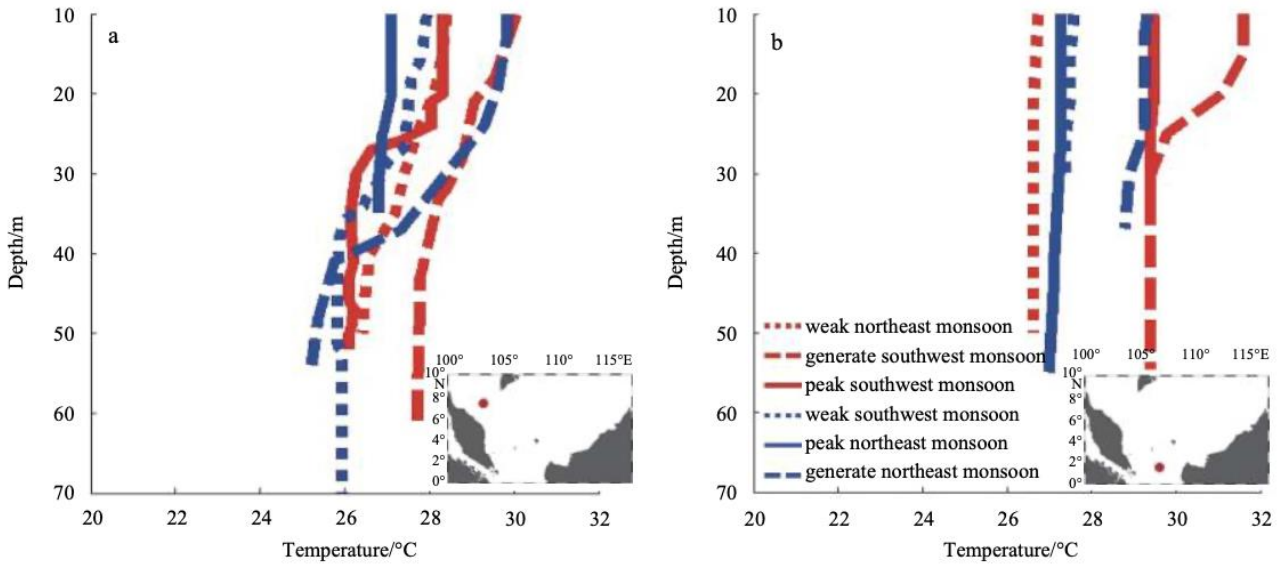


Vertical Structure of Ocean

- Surface Waters – well mixed
  - Wind, waves and currents
  - ~ Constant T and S, low density
  - Waves, surface currents, tides
- Pycnocline or Thermocline- Intermediate Waters (300-1000 m)
  - rapid decrease in temperature with depth
  - Stronger, shallower at low latitudes
  - Barriers to mixing, biological migration
- Deep Waters-
  - Cold, high density water below 1000m
  - Contains ~80% of all ocean water
  - Deep ocean currents



Vertical Structure in shallow sea



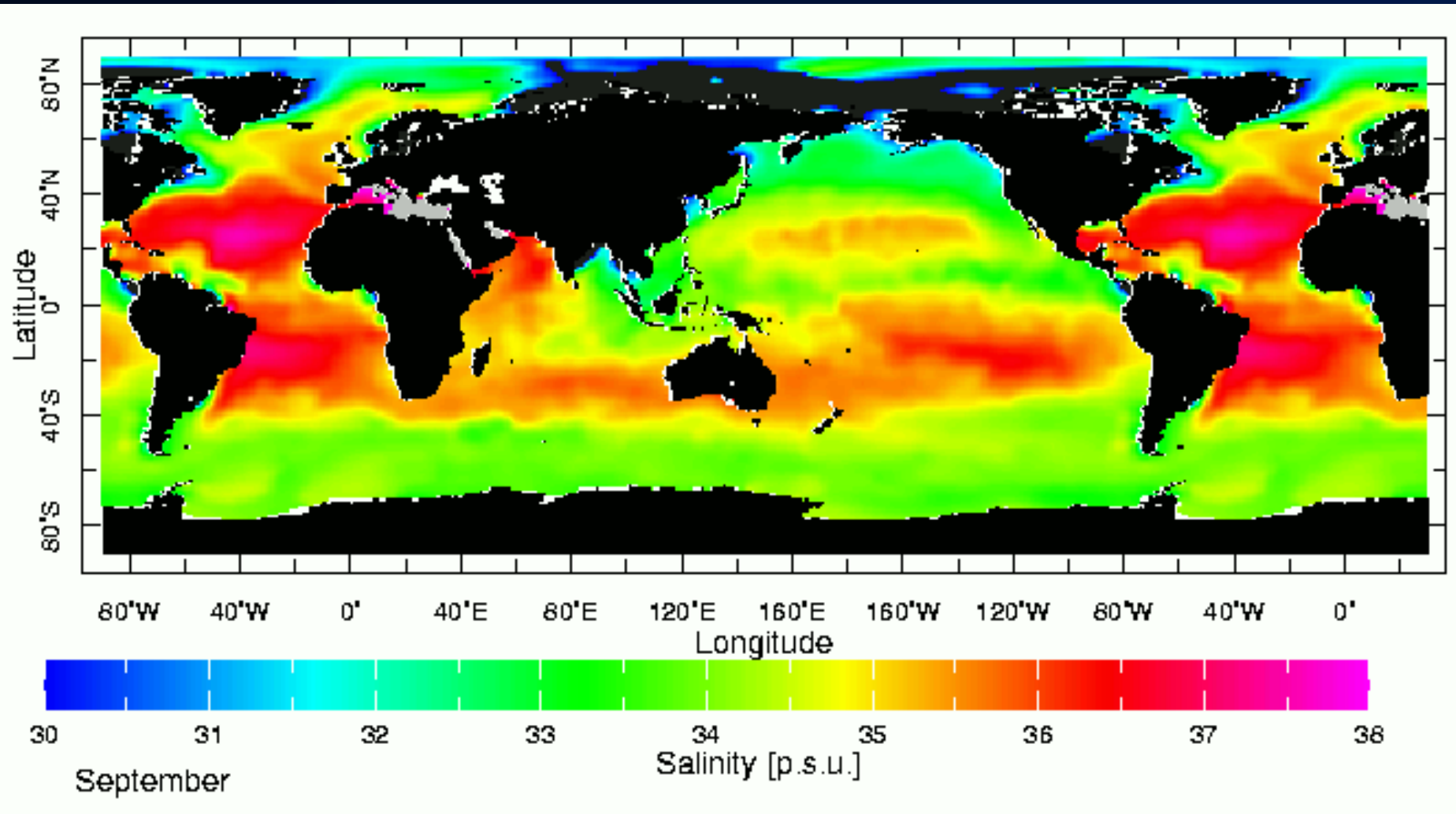
Data taken from South China Sea (Terengganu waters) - WOD (Johari and Akhir, 2019)

Temperature can change through:

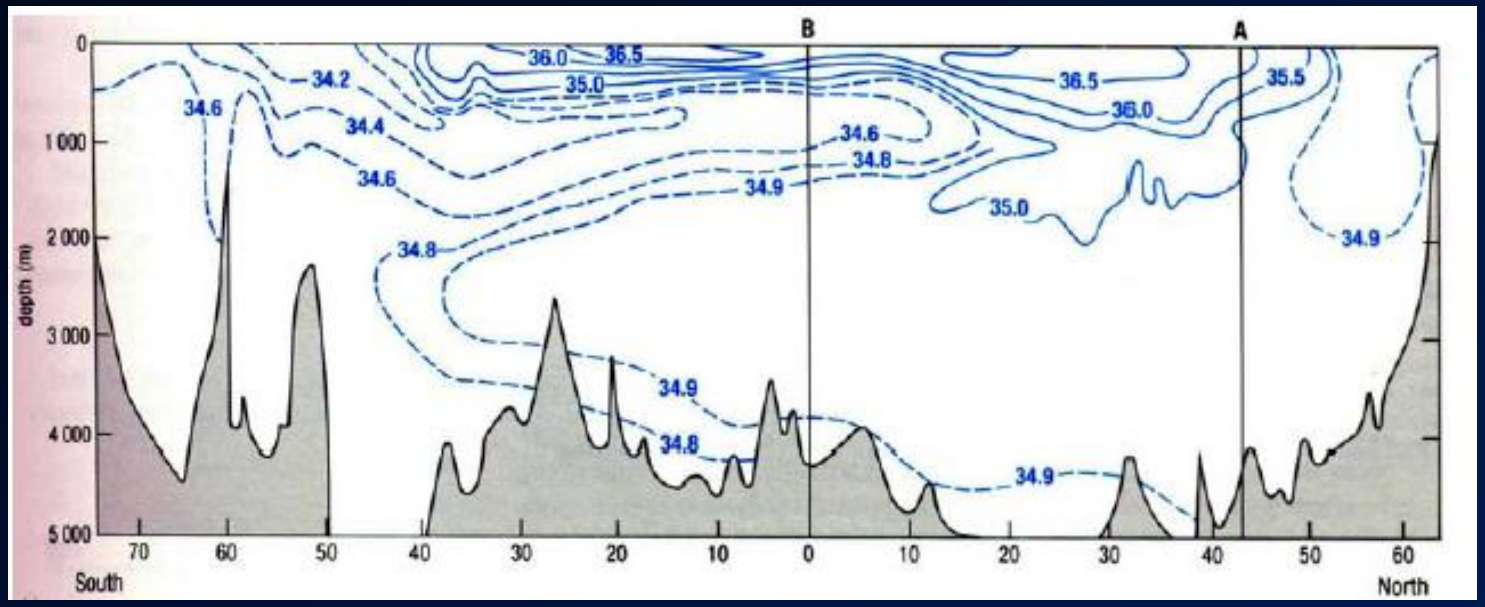
- Heat input/loss at the surface
- Mixing with other waters
- With increasing pressure
- Friction (usually negligible)

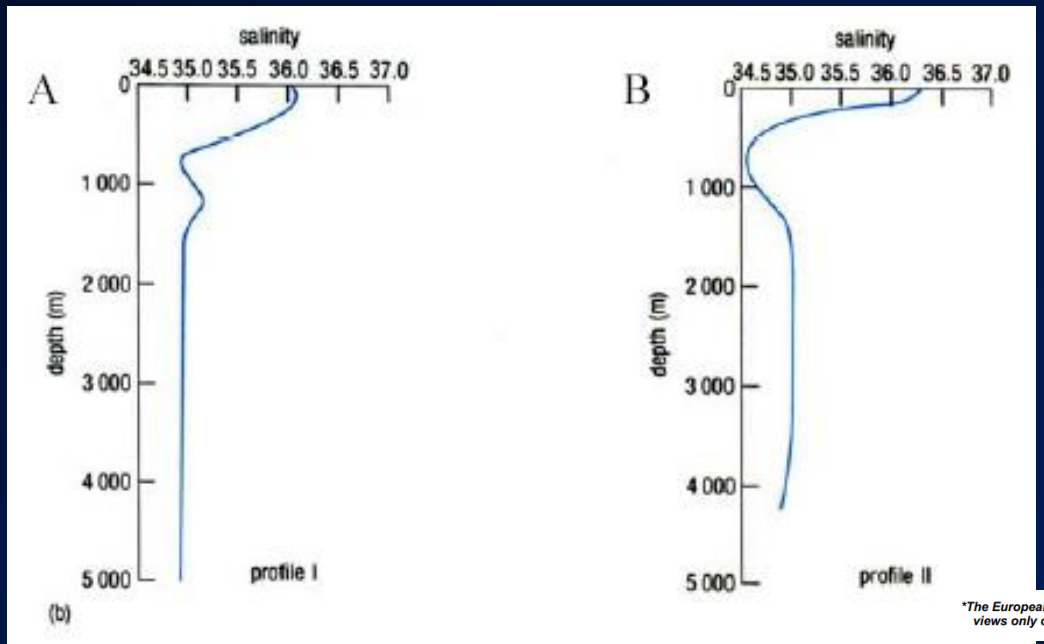
Influences density, heat exchange

Surface Salinity

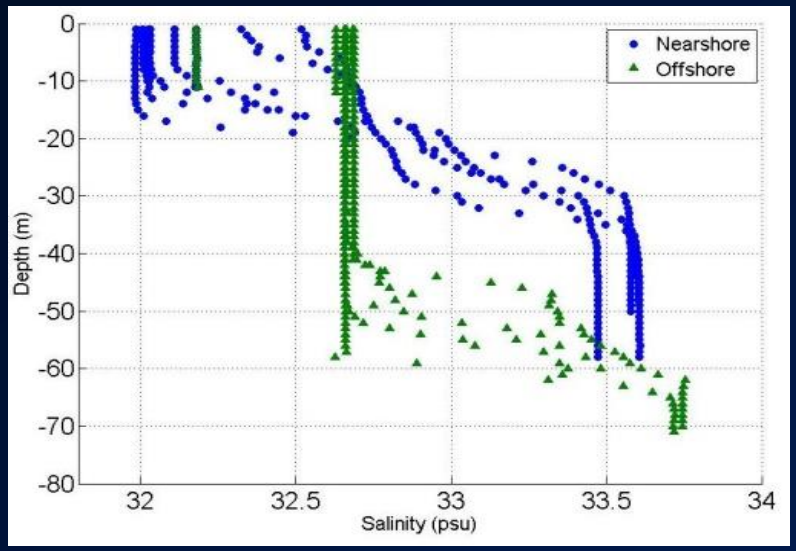


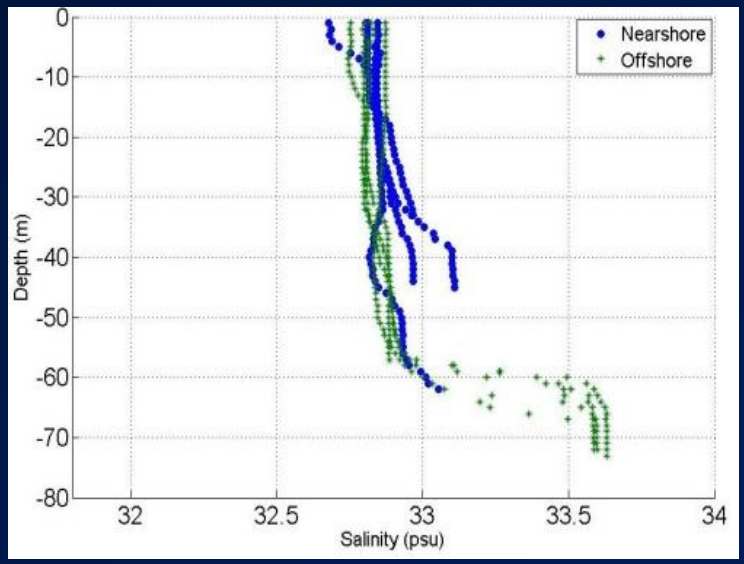
Vertical Structure of Ocean - salinity





Vertical Structure in shallow sea





Data taken from South China Sea (Terengganu waters)

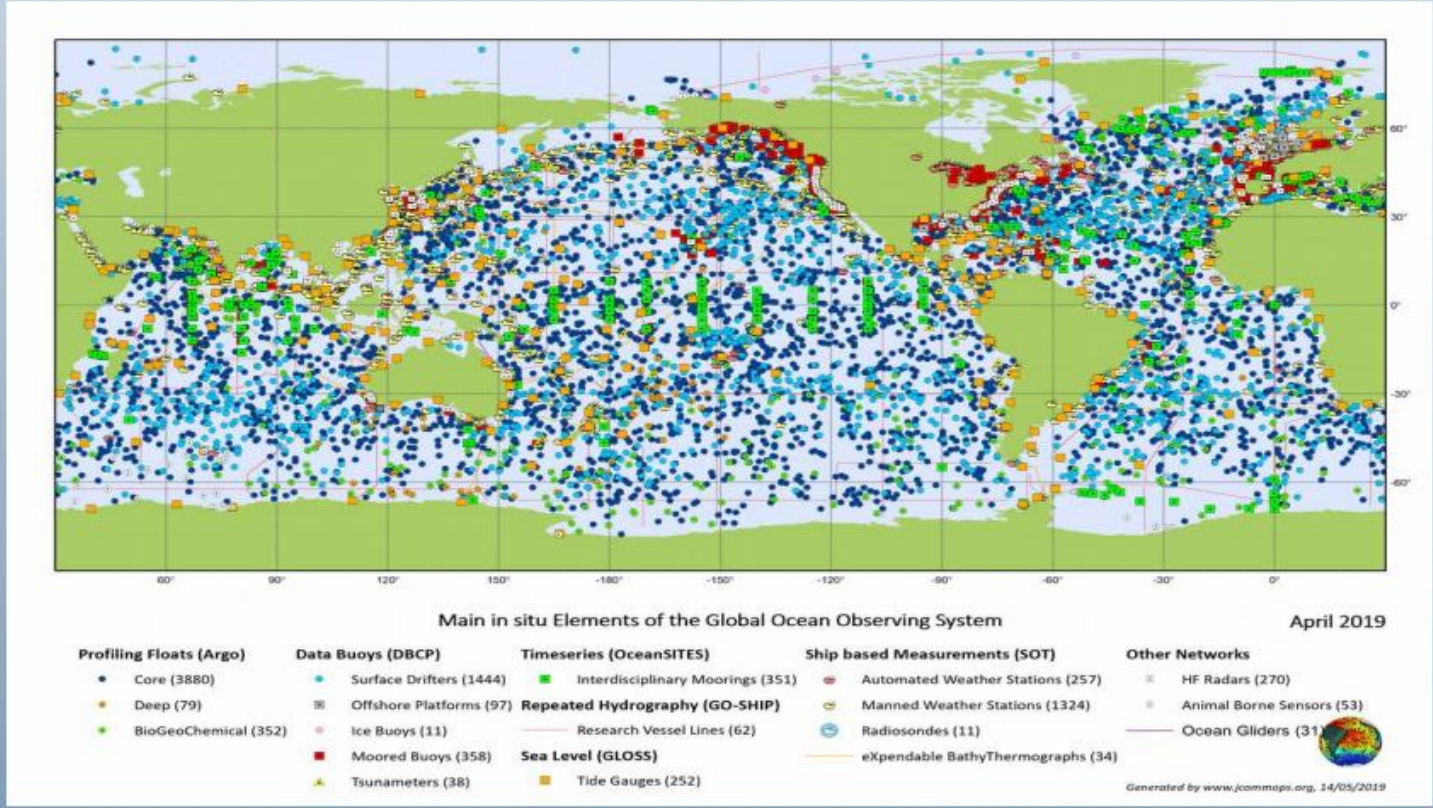
Salinity can change through:

- Evaporation/precipitation at the sea surface
- Ice formation
- Freshwater inputs (rivers, groundwater)
- Mixing with other waters

Influences density, freezing point, ice formation

JCOMMOPS: FOCAL POINT FOR TECHNICAL COORDINATION

Implementation, Data/Metadata exchange, Monitoring



JCOMMOPS : DISTRIBUTE METADATA AND MONITOR THE NETWORK

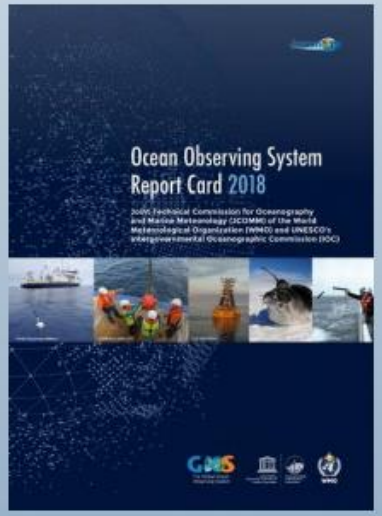
What can we do with it?

- Monthly authoritative status maps

(www.jcommops.org/map)

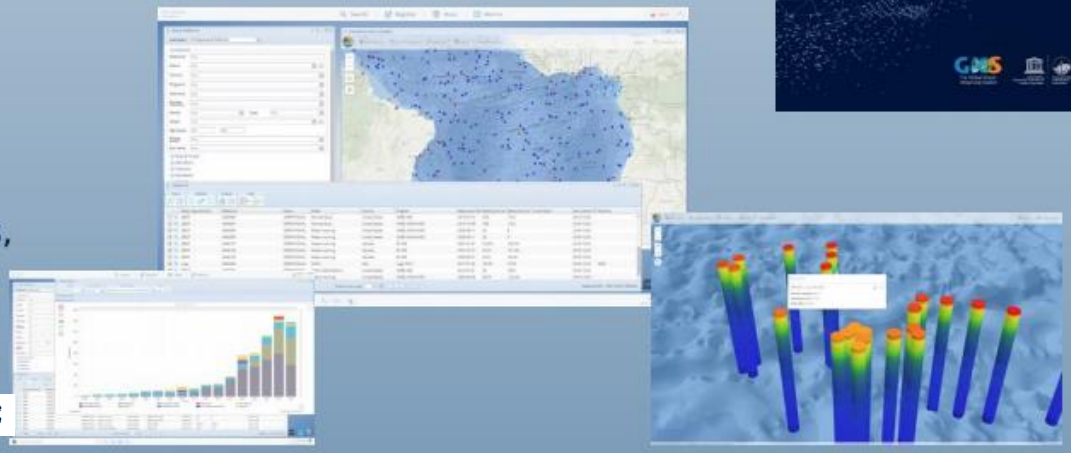
- Annual JCOMM Report Card to inform ocean observing stakeholders, society and decision-makers about the status and value of the GOOS

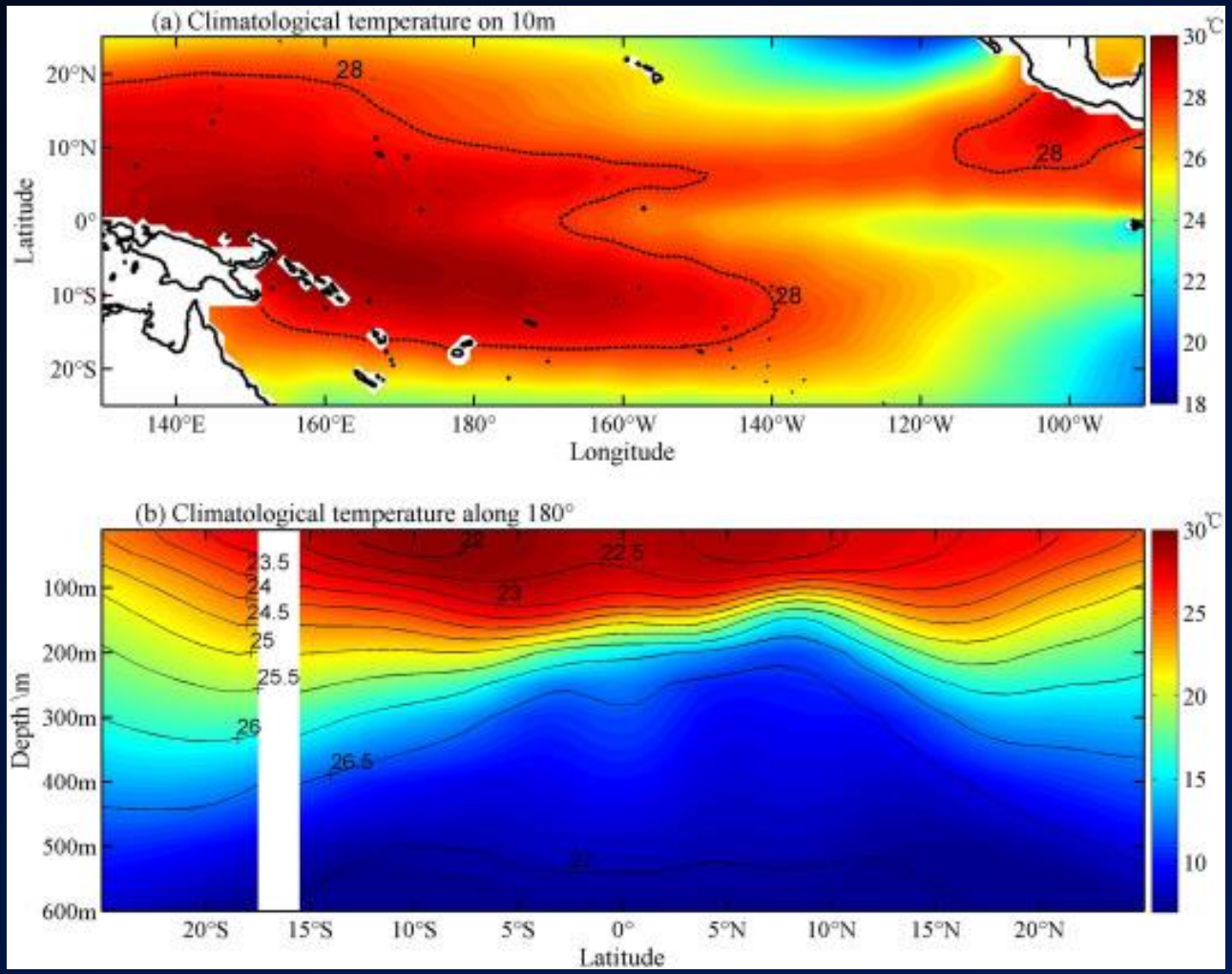
(www.jcommops.org/reportcard)



- Web application to make query, maps, graphs, stats, 3D data visualization

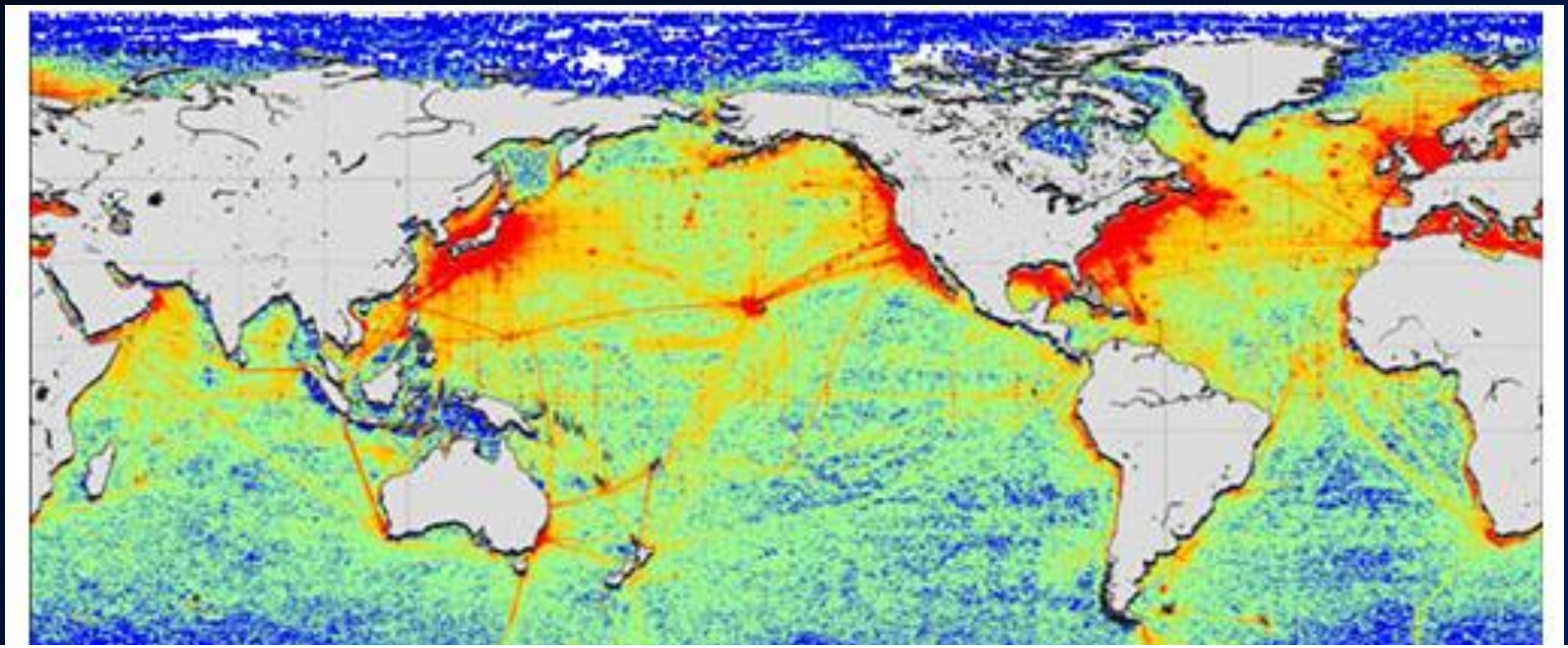
(www.jcommops.org)





Climatological mean temperature on 10 m level (a) and along 180° meridional section (b) in the tropical Pacific derived from gridded Argo data (2001–2017). The dashed contour in (a) denotes the isotherm of 28 °C, and solid contours in (b) denote isopycnals.

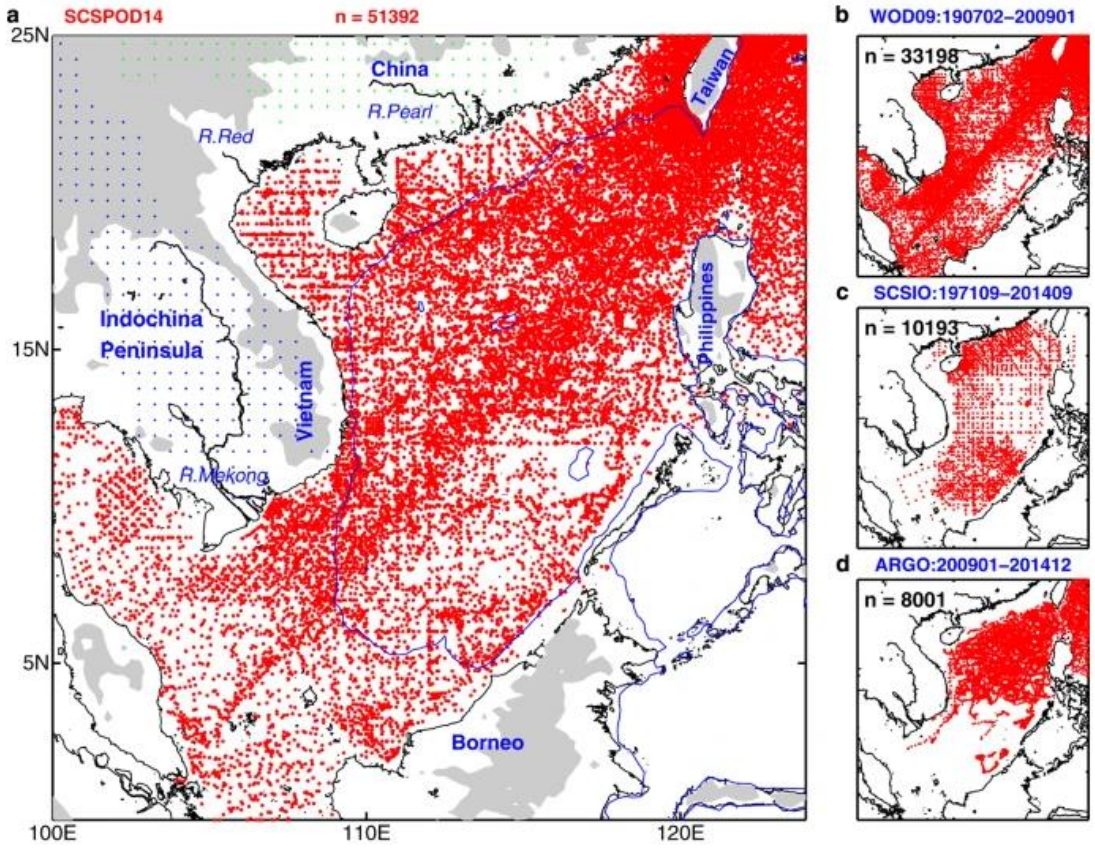
WORLD OCEAN DATABASE (WOD)



- **The WOD is the largest available, online, free ocean database**
  - Data range from >200 years old to stations within the past few years
  - Constantly updated, includes a synchronizing option
  - In-situ only, no remote sensing
  - No instrumental time-series - e.g. tide gauge, current meter
  - About 30 parameters
  - 12 types, depending on measurement methods - ship stations, drifters, diving pinnipeds, etc.
  - Uses cruise/station/depth/date/time paradigm for data organization
  - Includes quality flags for all measurements

WOD in South China Sea

Figure 2: Hydrographic stations.



Geographical distribution of hydrographic (temperature and salinity) stations in the South China Sea: (**a**) the merged dataset (SCSPOD14), (**b**) the World Ocean Database 2009 (WOD09), (**c**) South China Sea Institute of Oceanology (SCSIO), and (**d**) Argo profiling floats. The number of profiles (**N**) is shown at the top of each panel.

Zheng Lili, Wang Dongxiao, Chen Ju, et al. 2016. SCSPOD14, a South China Sea physical oceanographic dataset derived from in situ measurements during 1919-2014. Scientific Data, 3: 160029, doi: 10.1038/sdata.2016.29

WOD in Southern South China Sea

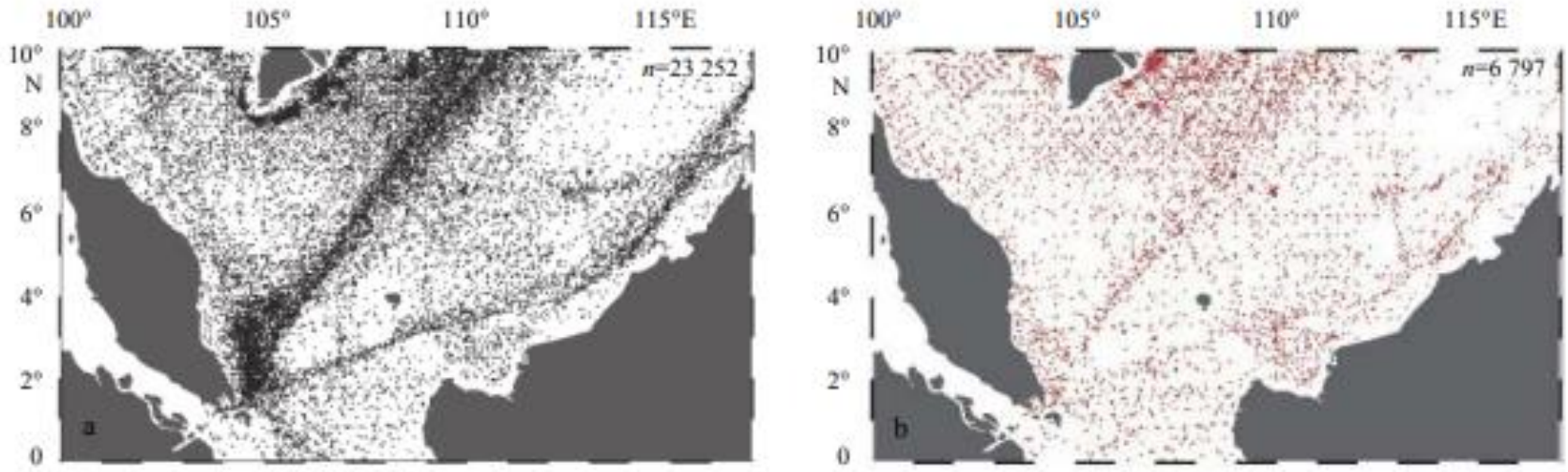


Fig. 2. Distribution of datasets present in SSCS (a, $n = 23\,252$), while (b) is the dataset which present both temperature–salinity data ($n = 6\,797$). Datasets compactness is high in particular region such as in east coast of Johor, Vietnam tip and across the SSCS.

Johari Afifi et al. *Acta Oceanol. Sin.*, 2019, Vol. 38, No. 1, P. 38–47

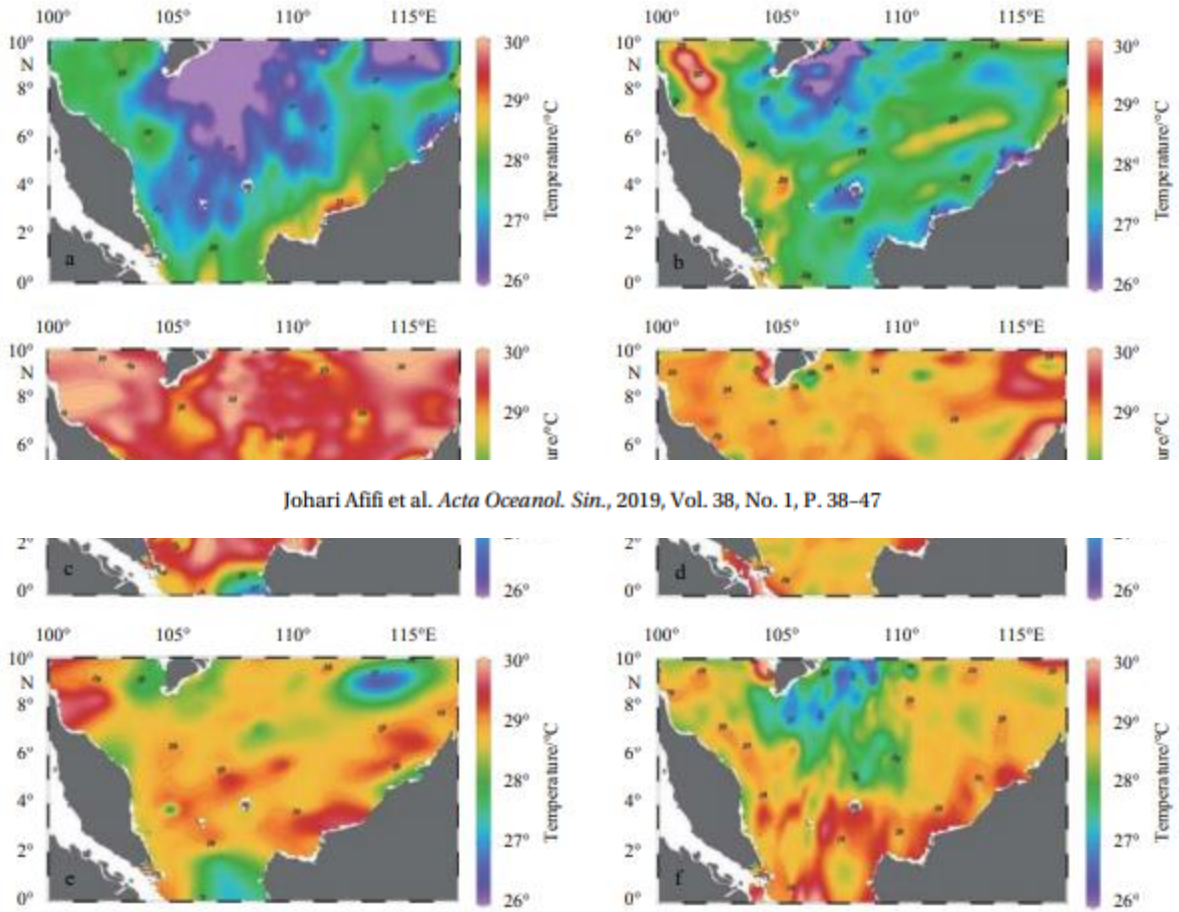


Fig. 9. Upper layer temperature contour plot in SSCS according to seasonality. a. Peak northeast monsoon, b. weak northeast monsoon, c. generate southwest monsoon, d. peak southwest monsoon, e. weak southwest monsoon, and f. generate northeast monsoon.