### Course Name: Tropical Oceanography

**Target audience:** Postgraduate and final year undergraduate students (3 credits; Elective Course; New Course)

**Key competencies:** Able to describe physical processes of tropical ocean and its relation to nutrient dynamics and ocean productivity. Develop skills in analysing seawater properties and critically evaluate the connection of oceanographic features of upwelling and biogeochemistry knowledge. Able to articulate scientific arguments and communicate professionally in addressing the adaptation strategies related to climate change issues.

**Course developers:** Mohd Fadzil Akhir, Ong Meng Chuan, Fatin Izzati Minhat, Nur Hidayah Roseli

**Course contents:** Tropical Oceanography. Physical Processes. Tropical Ocean and Climate Change. Ocean Productivity. Marine Pollution. Geological Oceanography. Major Geological Events. Paleoceanography.

**Marine Coastal and Delta Sustainability** 

Envision Marine Future

Erasmus+ Programme

for Southeast Asia

**Teaching methodologies:** Lectures, presentations, discussion, problem-based learning

Form of control: Test, report, assignment, final examination



Envision Marine Future



Marine Coastal and Delta Sustainability for Southeast Asia



# 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 <sup>1</sup>/<sub>2</sub> 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

YouTube MY 



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

Conductivity and Temperature sensors are under this guard; internal Pressure sensor is at bottom of housing

sensor is an

auxiliary sensor on this CTD package

Cage

Pump to provide constant flow through sensors

### Terminology: Gradients/ '-cline'

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

Thermocline Halocline Density

- temperature
- salinity

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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

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



EGO meeting and International Glider Workshop, May 21-23, 2019, Rutgers University, New Jersey

#### jcomm 🖢 🔊 **ICOMMOPS : DISTRIBUTE METADATA AND MONITOR THE NETWORK**

THE OWNER WHEN

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)

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What can we do with it?





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



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.

\*The European Commission's support for the production of this publication does not constitute an endorsement of the contents, which reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein 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 = 23252), while (b) is the dataset which present both temperature-salinity data (n = 6797). 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



