Southeast Asian Fisheries Development Council
Training Department

The 66th Short-term Training Course for University Students

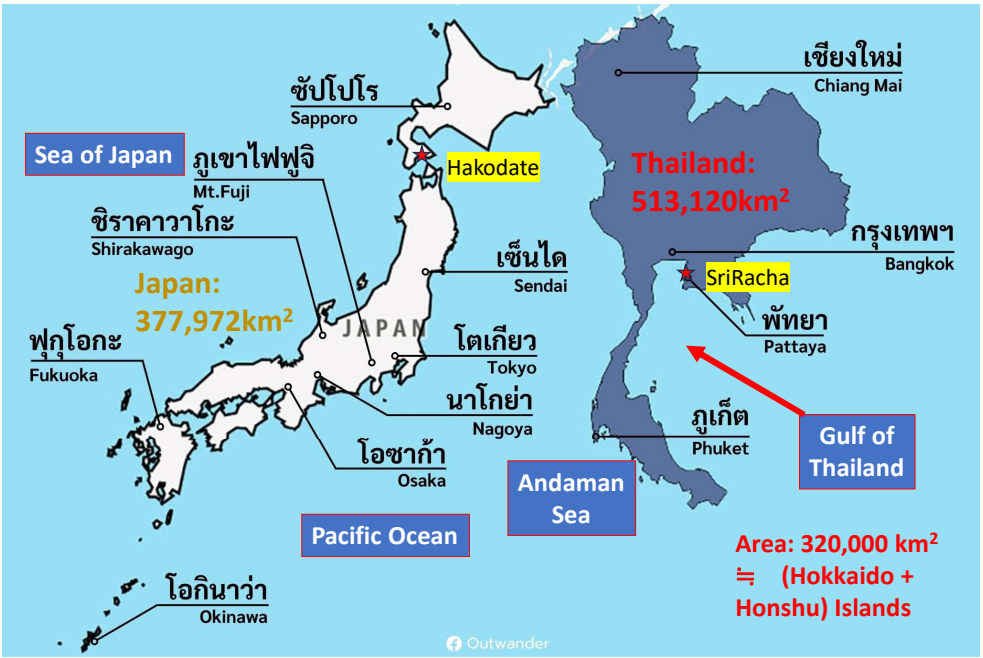
"Ecosystem-Based Fisheries for Sustainable Fisheries Resources Management"

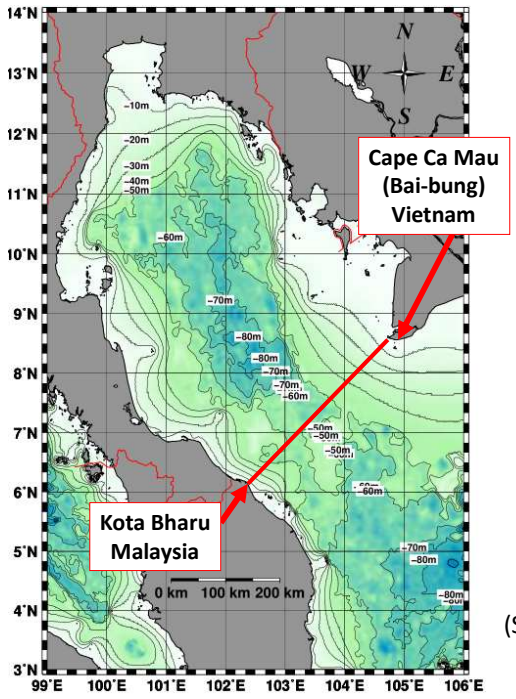
Hokkaido University
Fisheries

Oceanography in the Gulf of Thailand

Hiroji Onishi

19th of May 2026, 15:00~16:00
h.onishi0923@gmail.com





Gulf of Thailand

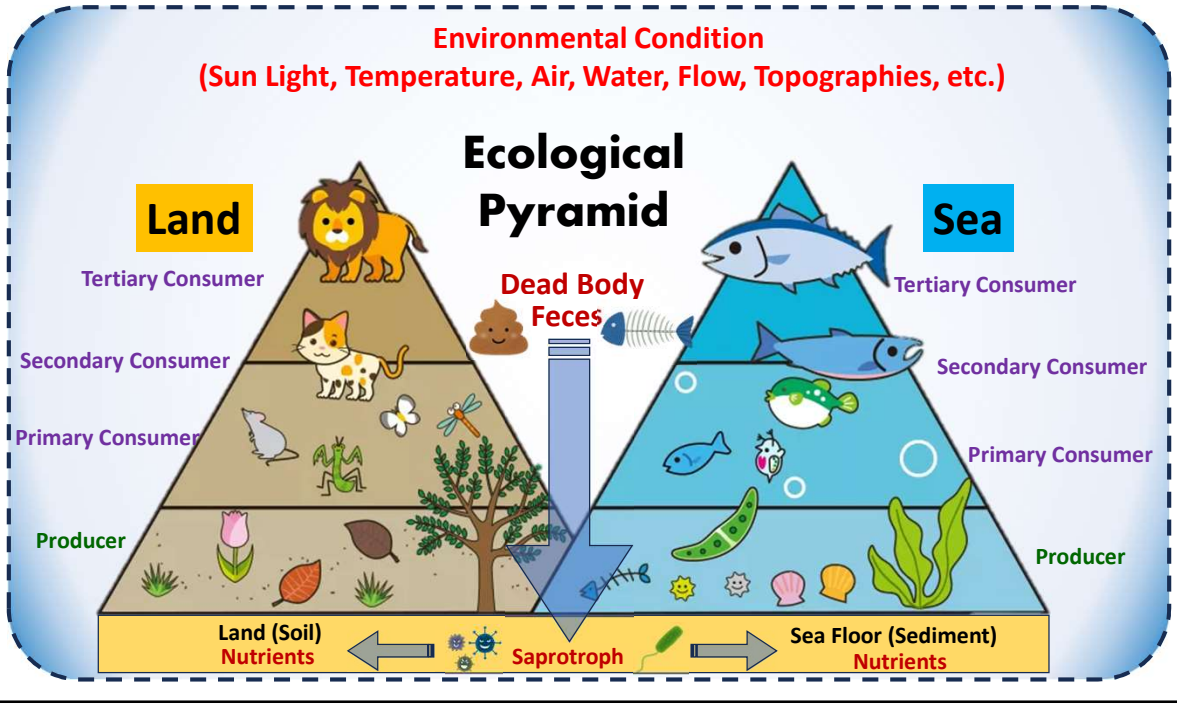
Many Tourist Spots

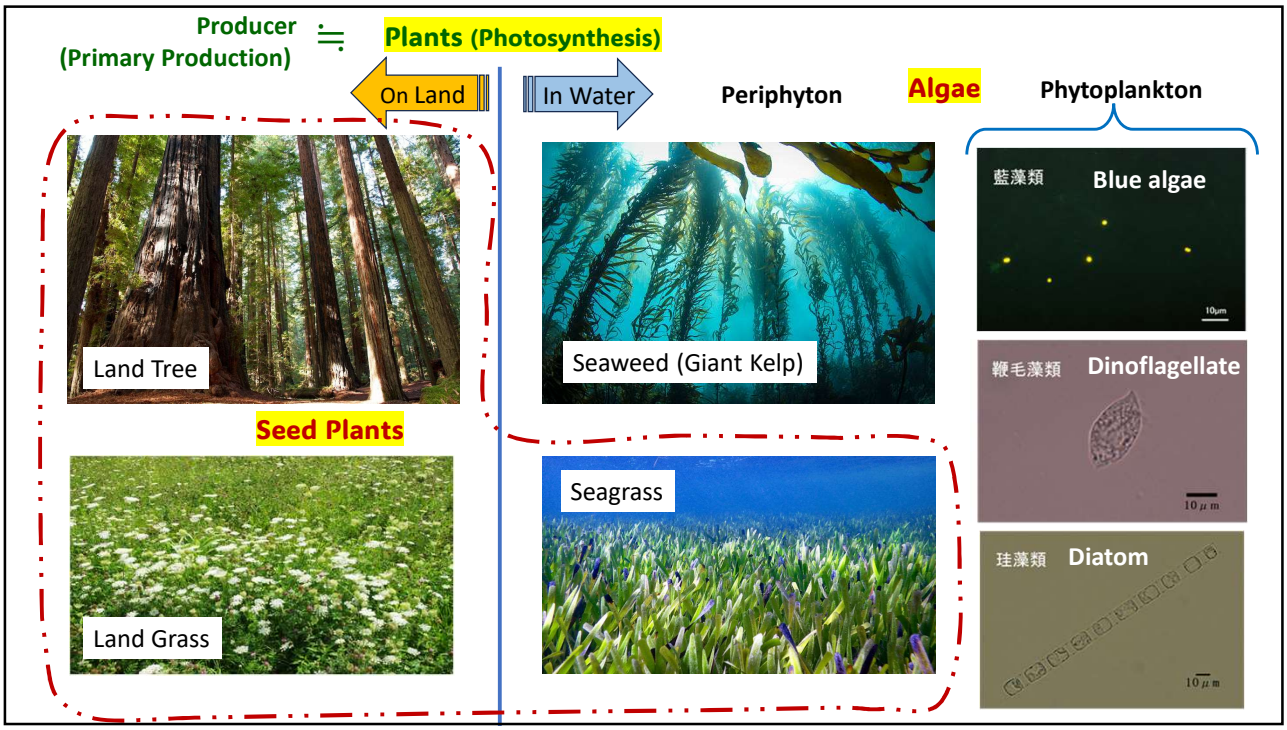
Many Fishing Products

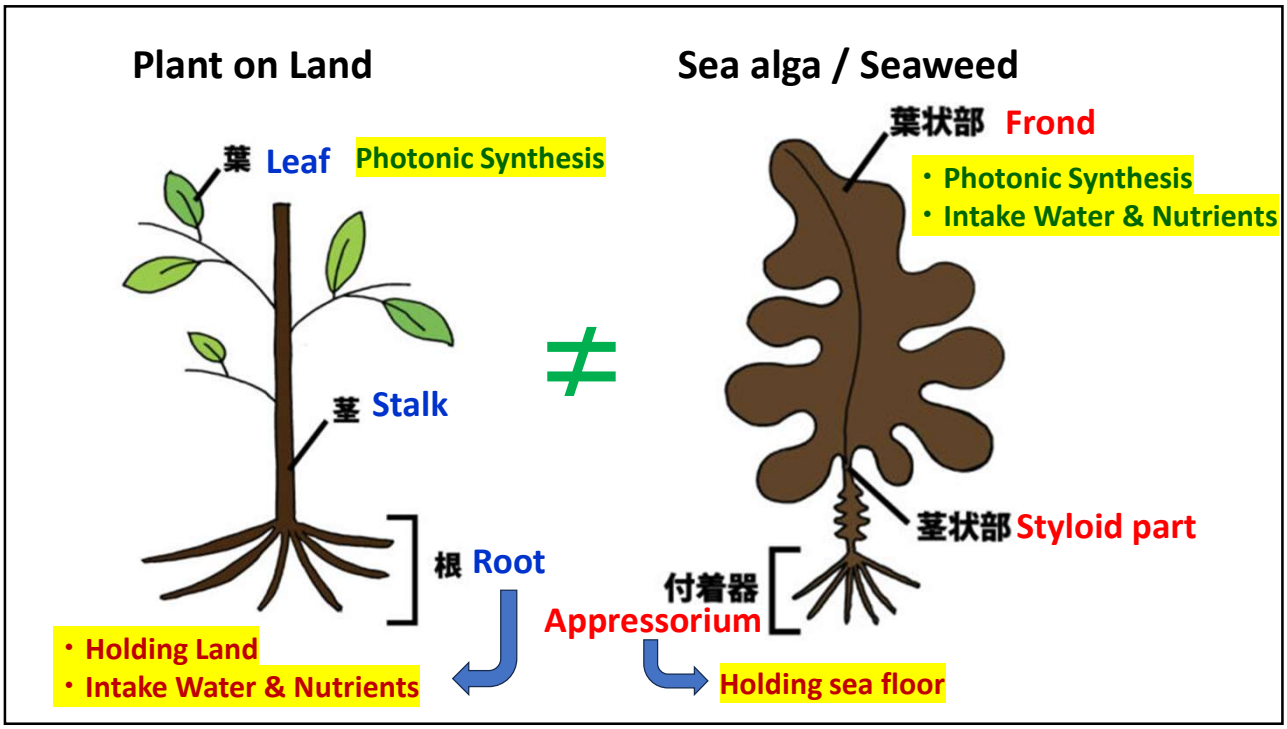
Geographical Feature

Area: 320,000 km^2
Length: 800 km
Width: 560 km
Max. Depth: 85 m
Ave. Depth: 58 m
Water Vol.: 12,510 km^3
(Stansfield & Garrett 1997)

Gulf of Thailand ⇔ South China Sea



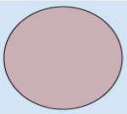

Producer
(Primary Production)
Plants (Photosynthesis)
On Land
In Water
Periphyton
Algae
Phytoplankton
Land Tree
Seaweed (Giant Kelp)
藍藻類 Blue algae
Seed Plants
鞭毛藻類 Dinoflagellate
Seagrass
Land Grass
珪藻類 Diatom


Plant on Land
Sea alga / Seaweed
葉 Leaf
Photonic Synthesis
葉状部 Frond
・Photonic Synthesis
・Intake Water & Nutrients
≠
茎 Stalk
茎状部 Styloid part
根 Root
付着器
Appressorium
・Holding Land
・Intake Water & Nutrients
Holding sea floor

Why the phytoplankton is so small ?

Phytoplankton

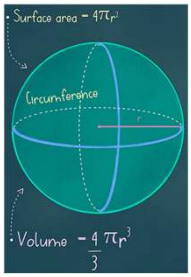
Area-to-Volume ratios

Relative Size			
Radius [L: unit]	1	2	4
Area [L^2: $unit^2$]	$1^2 = 1$	$2^2 = 4$	$4^2 = 16$
Volume [L^3: $unit^3$]	$1^3 = 1$	$2^3 = 8$	$4^3 = 64$
Area / Volume	1/1 = 1	4/8 = 1/2	16/64 = 1/4
Conclusions	1. Most area per unit volume 2. Most drag per unit volume 3. Slowest rate of settling	←	Least area per unit volume Least drag per unit volume Fastest rate of settling

To keep staying in surface layer
Large surface area par unit volume

Sink Slower

Sink Faster



Sphere's Projected Area $=\pi r^2$

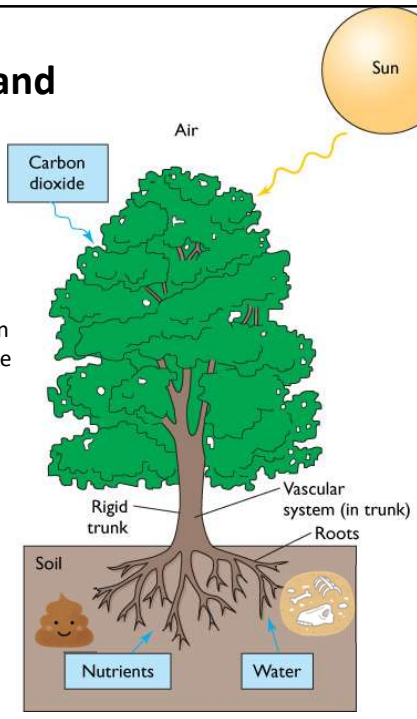
Surface Area $=4 \times \pi r^2$

Volume $=4/3 \times \pi r^3$ (≈Mass) when same density

Plant on Land

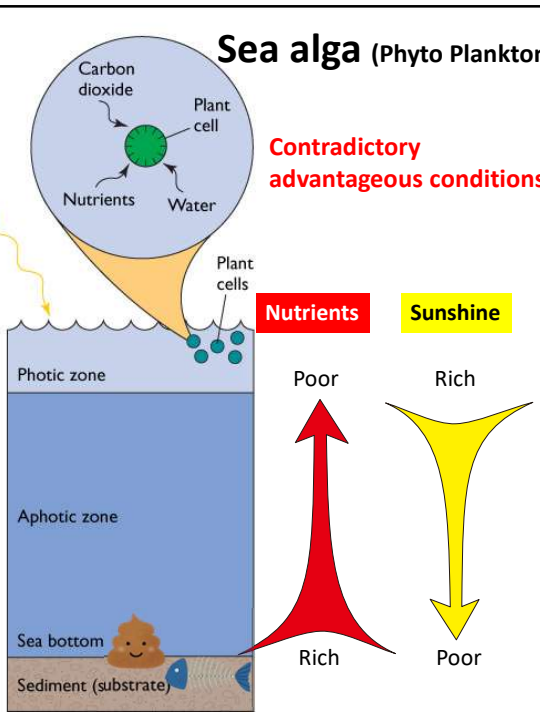
Tall tree can take a lot of Sunshine on the reaves, and take Nutrients (water) from its root.

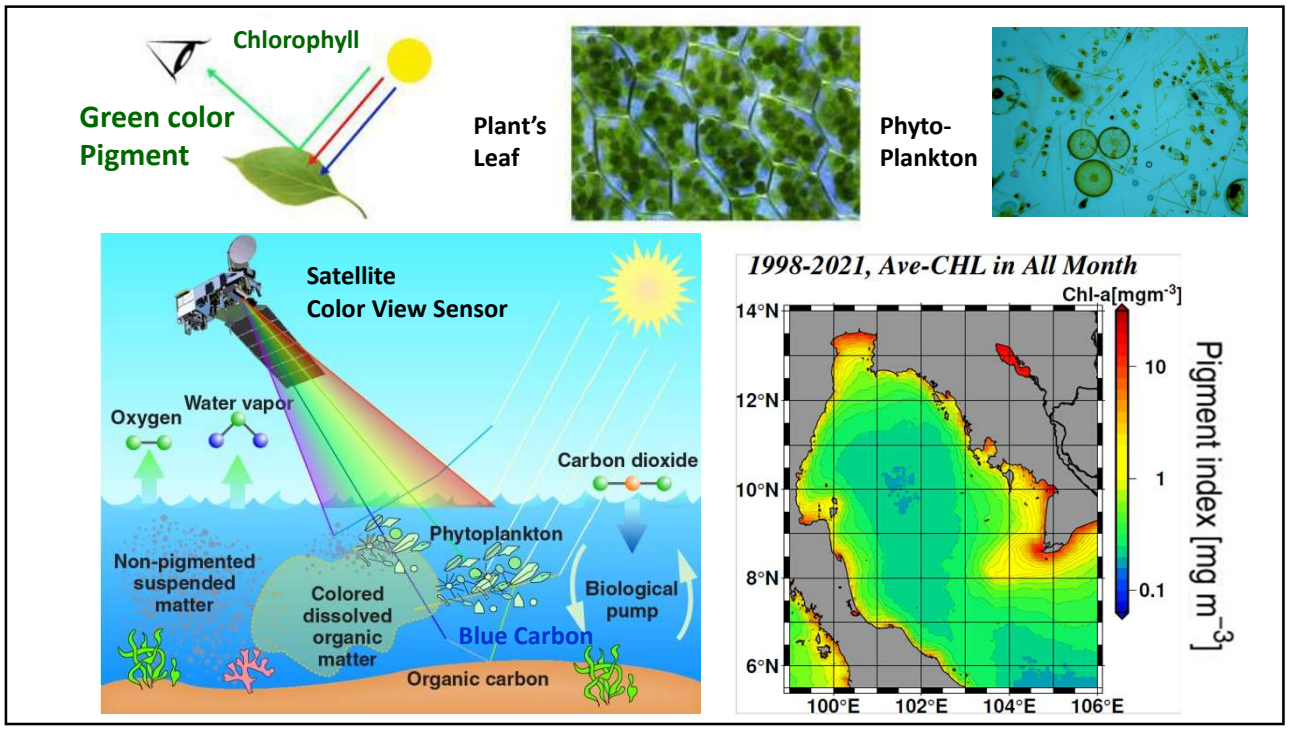
Easy to make photosynthesis

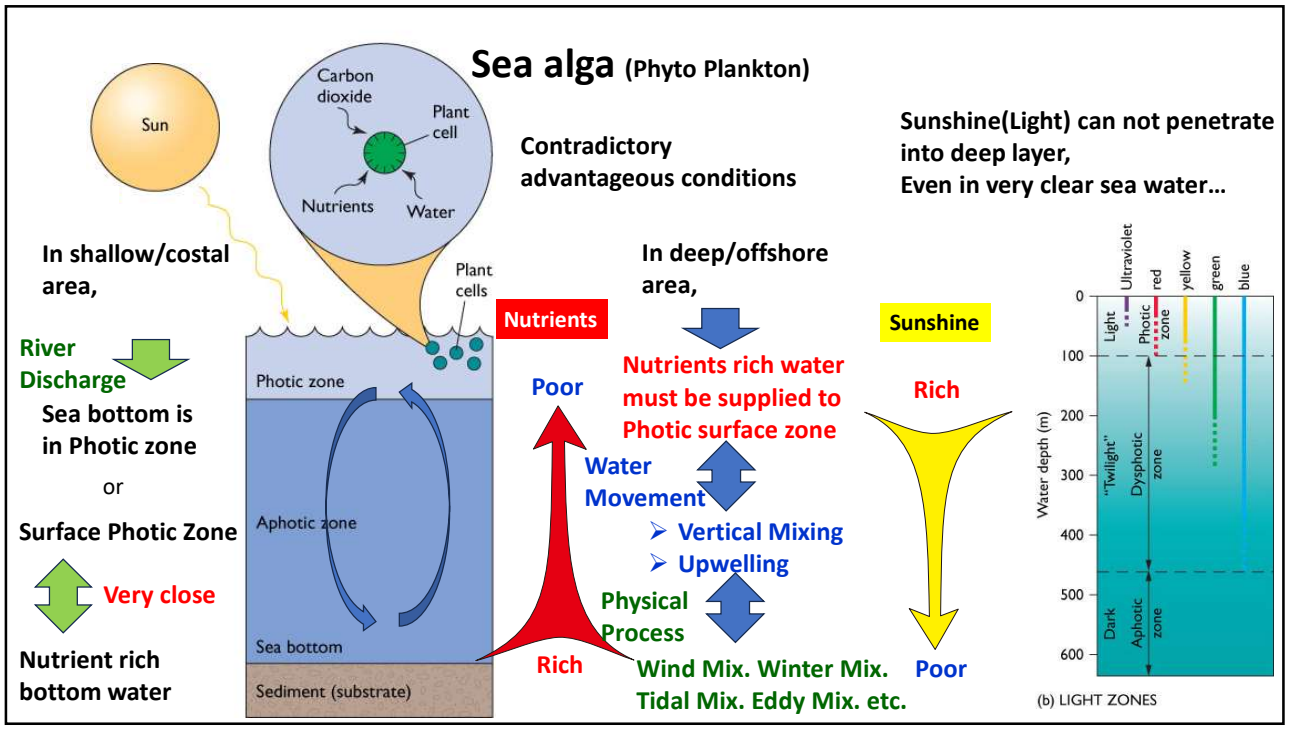


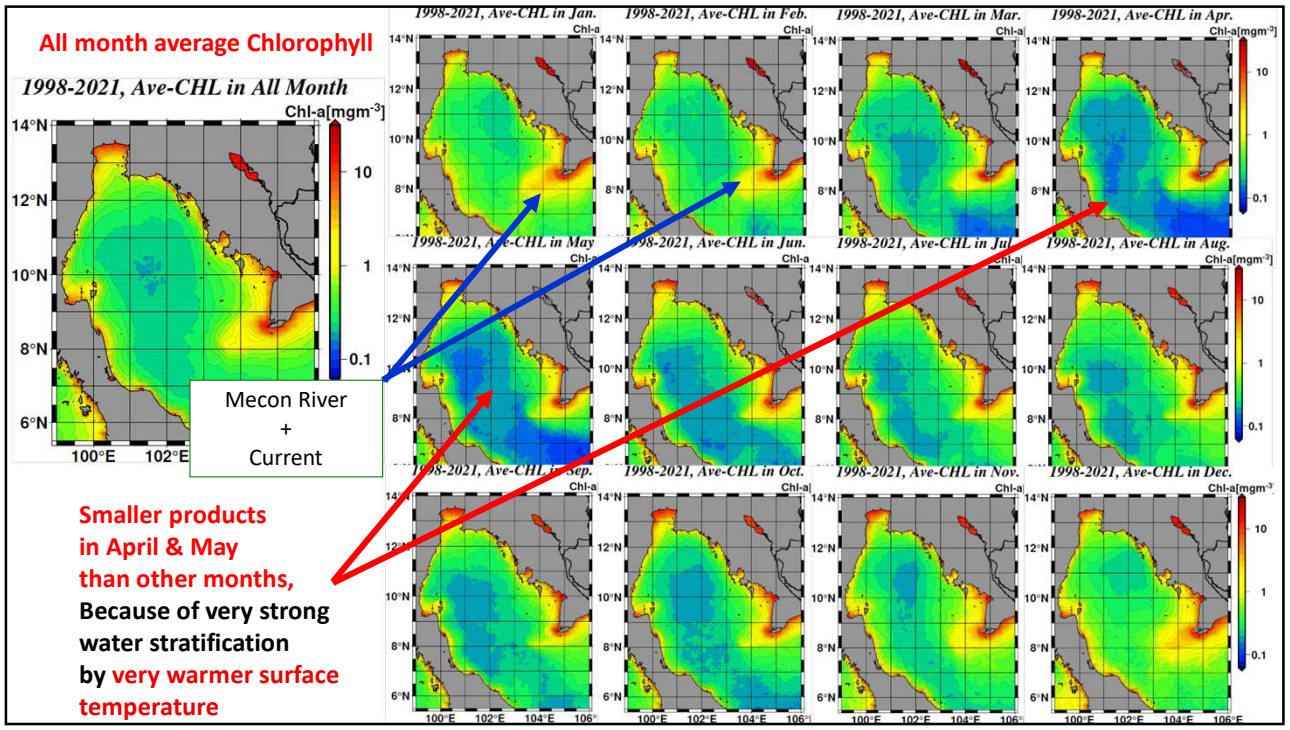
Sea alga (Phyto Plankton)

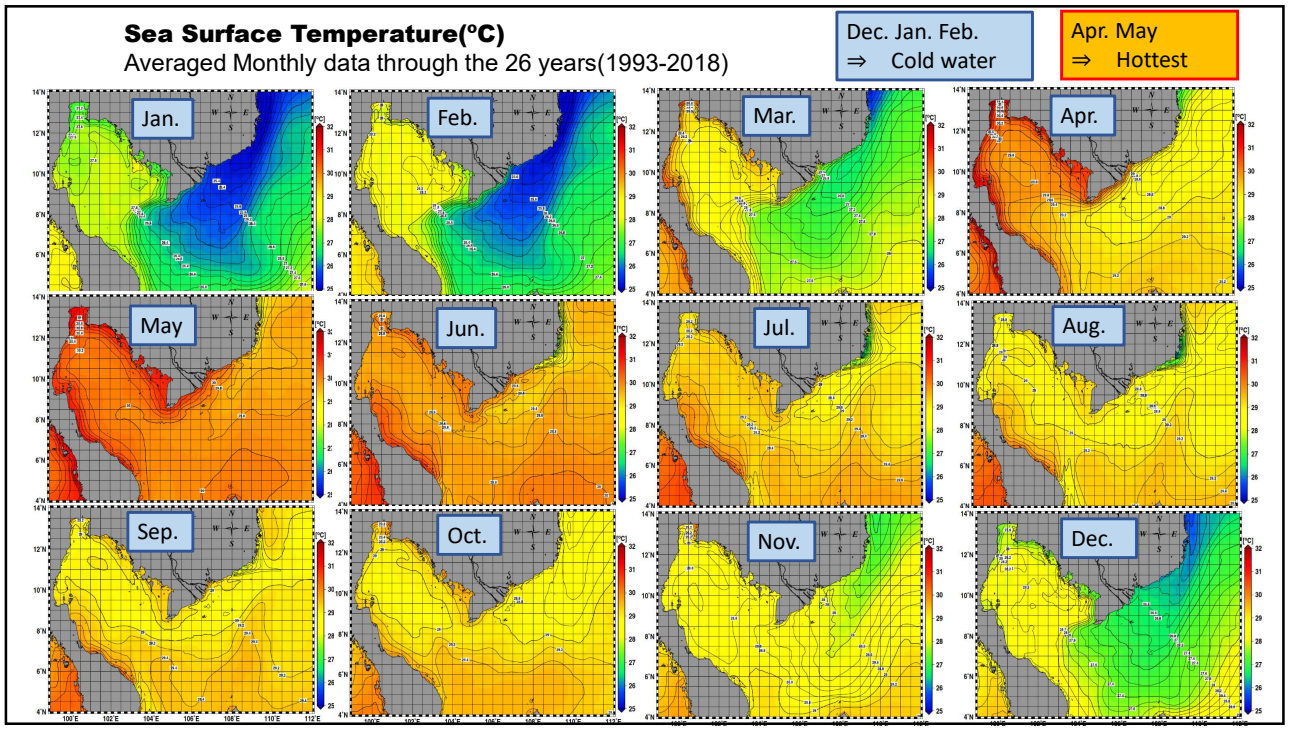
Contradictory advantageous conditions

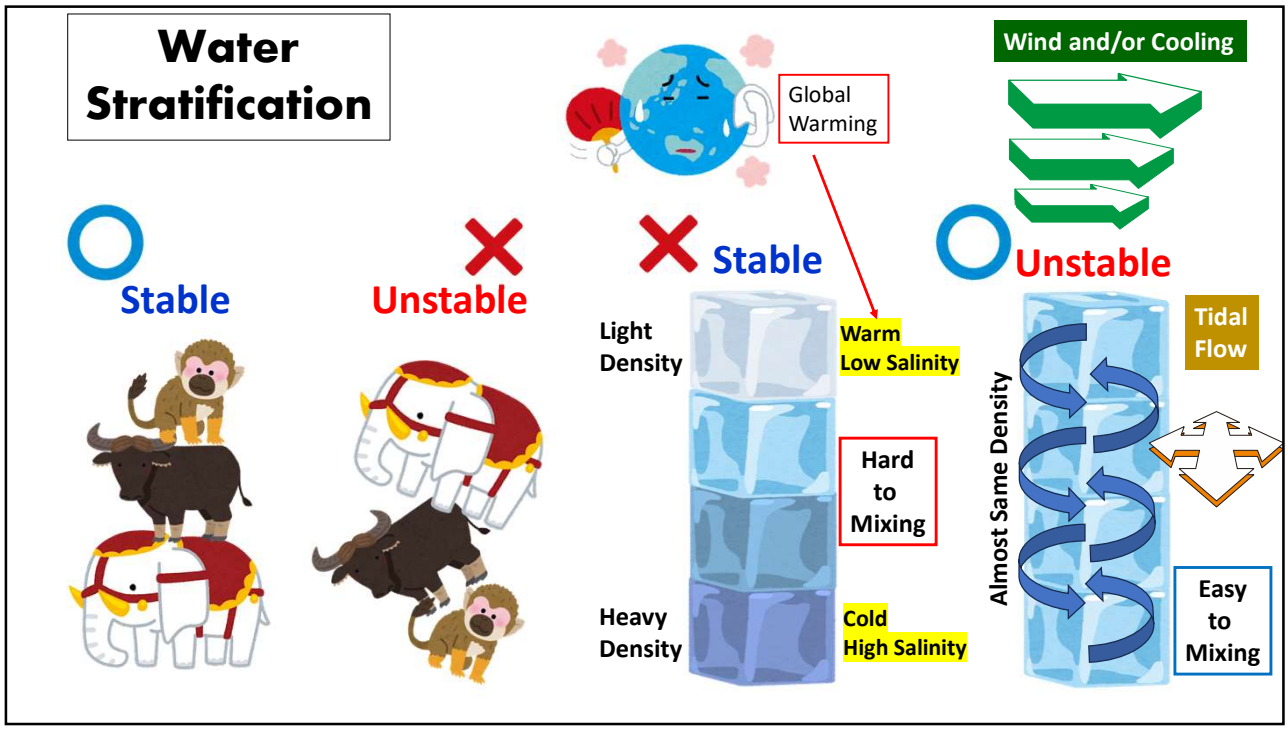



Chlorophyll
Green color
Pigment
Plant's
Leaf
Phyto-
Plankton
Satellite
Color View Sensor
Oxygen
Water vapor
Carbon dioxide
Phytoplankton
Non-pigmented
suspended
matter
Colored
dissolved
organic
matter
Biological
pump
Blue Carbon
Organic carbon
1998-2021, Ave-CHL in All Month
Chl-a[mgm-3]
14°N
12°N
10°N
8°N
6°N
100°E
102°E
104°E
106°E
10
1
0.1
Pigment index [mg m-3]


Sea alga (Phyto Plankton)
Sun
Carbon
dioxide
Plant
cell
Nutrients
Water
Plant
cells
Contradictory
advantageous conditions
Sunshine(Light) can not penetrate
into deep layer,
Even in very clear sea water…
In shallow/costal
area,
River
Discharge
Sea bottom is
in Photic zone
or
Surface Photic Zone
Very close
Nutrient rich
bottom water
Photic zone
Aphotic zone
Sea bottom
Sediment (substrate)
Nutrients
Poor
Rich
In deep/offshore
area,
Nutrients rich water
must be supplied to
Photic surface zone
Water
Movement
Vertical Mixing
Upwelling
Physical
Process
Wind Mix. Winter Mix.
Tidal Mix. Eddy Mix. etc.
Sunshine
Rich
Poor
Ultraviolet
red
yellow
green
blue
Light
Photic
zone
"Twilight"
Dysphotic
zone
Dark
Aphotic
zone
Water depth (m)
0
100
200
300
400
500
600
(b) LIGHT ZONES


All month average Chlorophyll
1998-2021, Ave-CHL in All Month
Chl-a[mgm-3]
Mecon River
+
Current
1998-2021, Ave-CHL in Jan.
1998-2021, Ave-CHL in Feb.
1998-2021, Ave-CHL in Mar.
1998-2021, Ave-CHL in Apr.
1998-2021, Ave-CHL in May
1998-2021, Ave-CHL in Jun.
1998-2021, Ave-CHL in Jul.
1998-2021, Ave-CHL in Aug.
1998-2021, Ave-CHL in Sep.
1998-2021, Ave-CHL in Oct.
1998-2021, Ave-CHL in Nov.
1998-2021, Ave-CHL in Dec.
Smaller products
in April & May
than other months,
Because of very strong
water stratification
by very warmer surface
temperature


Sea Surface Temperature(°C)
Averaged Monthly data through the 26 years(1993-2018)
Dec. Jan. Feb.
⇒ Cold water
Apr. May
⇒ Hottest
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.



For sustainable primary production (Phytoplankton growth), we must think….

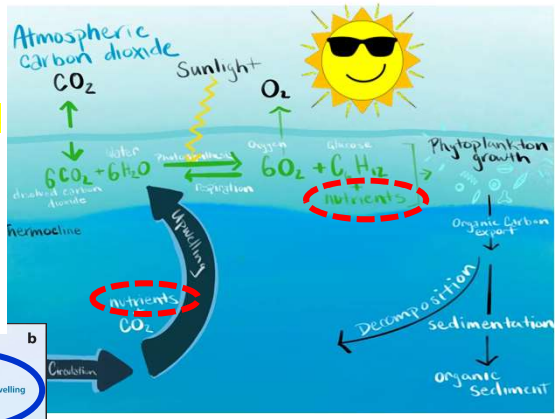
- Sun Energy ⇒ ….Maybe too much in Thailand
- $CO_2 + H_2O$ ⇒ … Enough in sea water

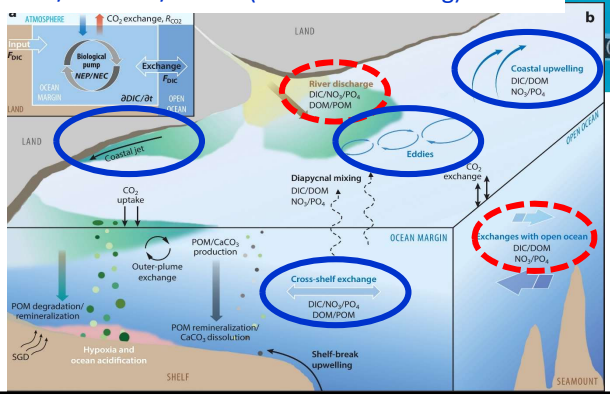
} Photonic Synthesis

- Nutrients Supply …. Only slightly controllable by human

⇒Water moving

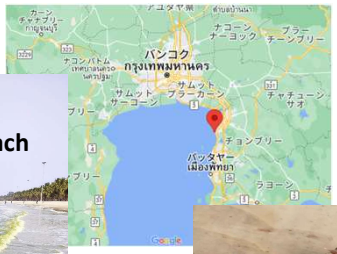
- ☐ River discharge (Human effects on Land)
- ☐ Water stratification (Mixing)
- ☐ Upwelling (Vertical moving)
- ☐ Tides/Currents/Eddies (Horizontal moving)





If we fail in control nutrients supply…

If we fail in control nutrients supply…



[More deformed fish found in Kok, Sai, Mekong and Ruak rivers 2026]

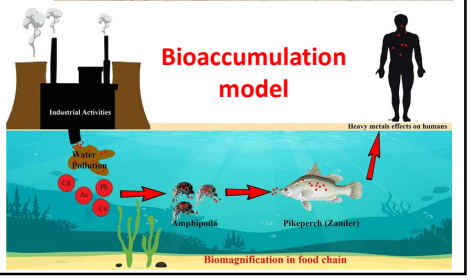
Polluted Mekong: Rare Earth Mining’s by Myanmar Toxic Impact

Too heavy
Blue-Green algae bloom

In Japan, there were disease caused by environmental contamination
(4 Big Pollution Diseases)

- Itai-Itai Disease: 1910-
- Minamata Disease: 1956-
- Yokkaichi Asthma : 1961-
- Niigata Minamata Disease:1965-

Water pollution
-> Polluted Plankton
-> Polluted Fish
-> Human Disease



Bioaccumulation model

In Japanese dictum,
「過ぎたるは、およばざるが如し」
Sugitaruha, Oyobazaruga, gotoshi

“Too much is as bad as too little.”

In Thai,
ノックナイムハムライテンポートワ
นกน้อยทำรังแต่พอตัว
“Little bird makes small nest”

Too clear sea water (poor nutrients) , it is difficult to keep a productive ecosystem

Too much nutrients (overweight condition), it is difficult to keep a healthy ecosystem

My Lecture Title of Today is…..

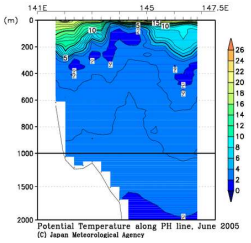
Oceanography

in the Gulf of Thailand

What is “Oceanography” ?

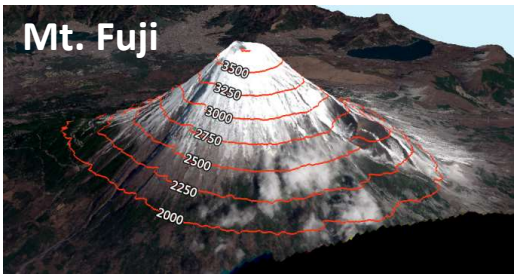
In other word “Marine Science”

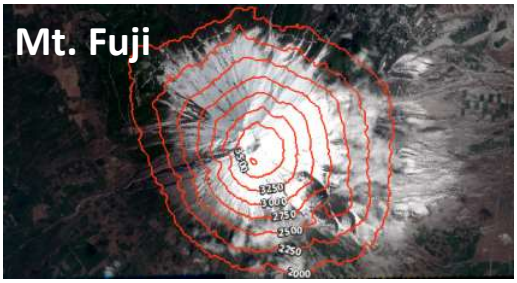
“Oceanography” = “Ocean” + “Graph”



Drawing illustration of the Ocean, That means to understand the Ocean condition.

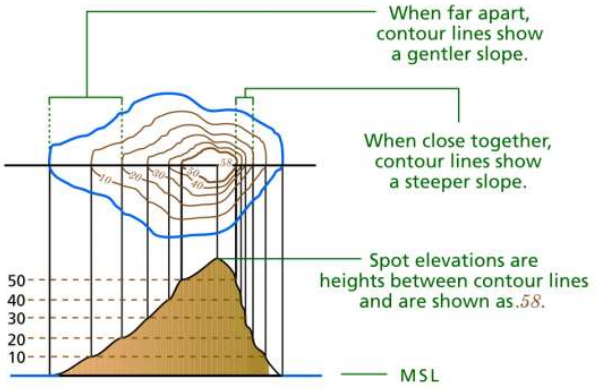
To understand about water distribution in the Gulf of Thailand,
Let’s draw contour lines of water temperature…

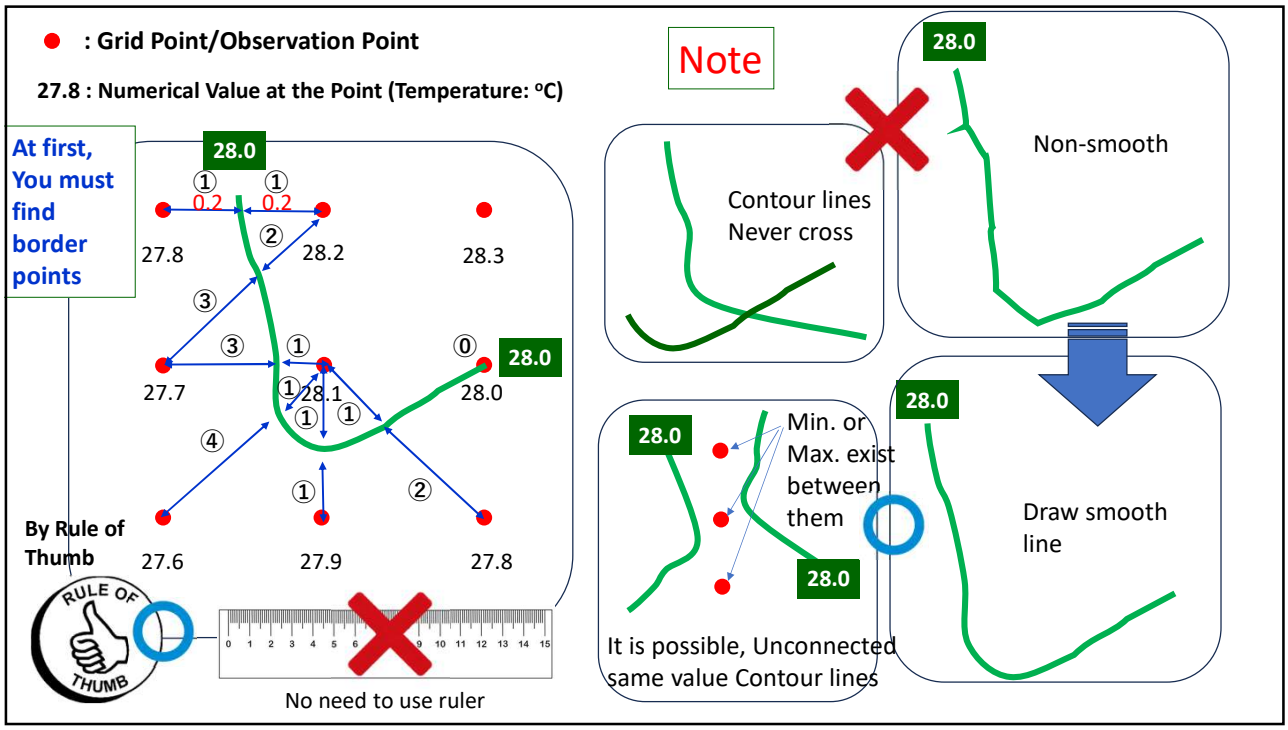


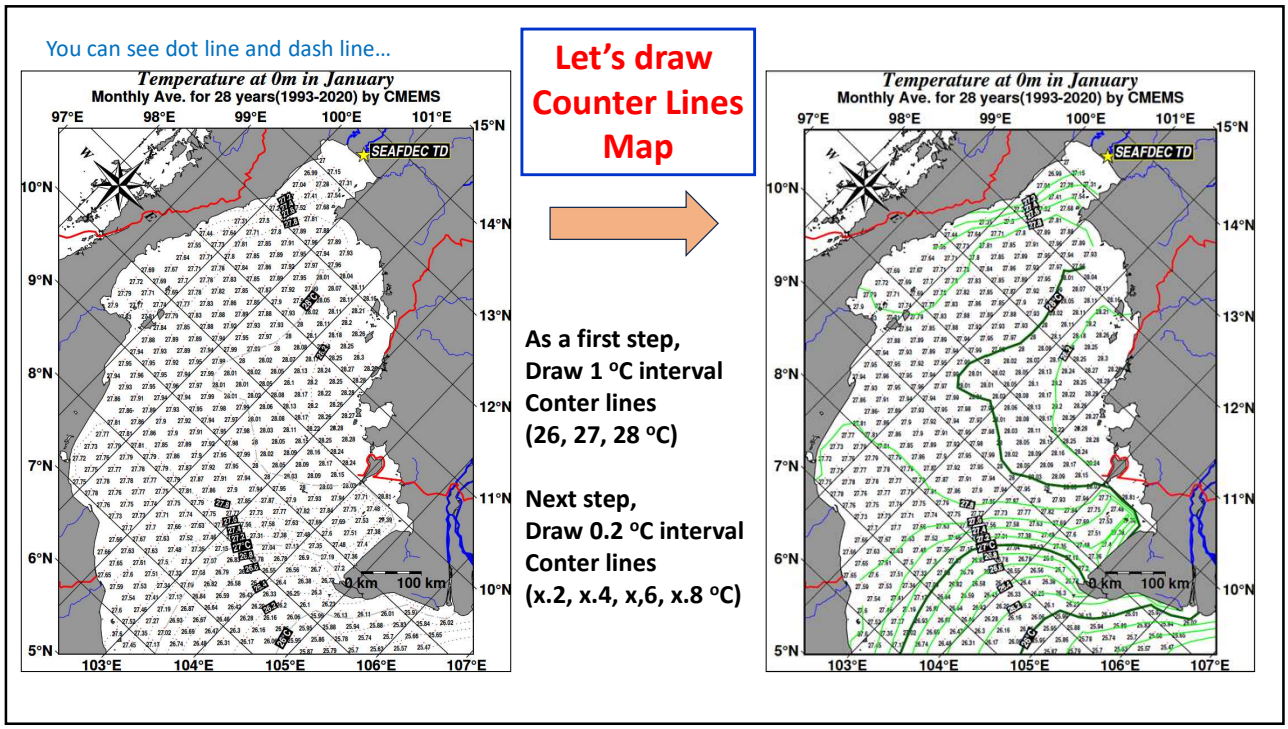


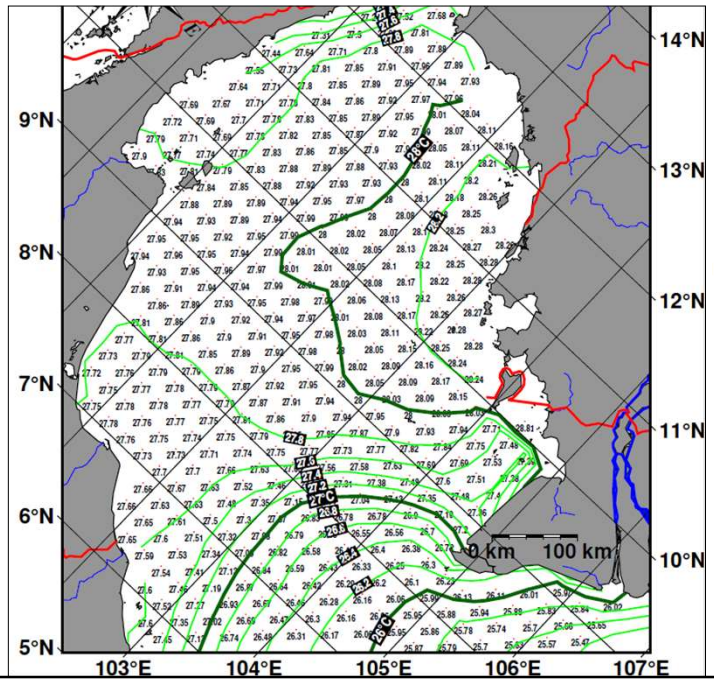
Contour Line:
a line drawn on a map connecting points of equal height

On Temperature map ⇒ Equal Temperature
On Salinity map ⇒ Equal Salinity
Close together Contour lines ⇒ Front area

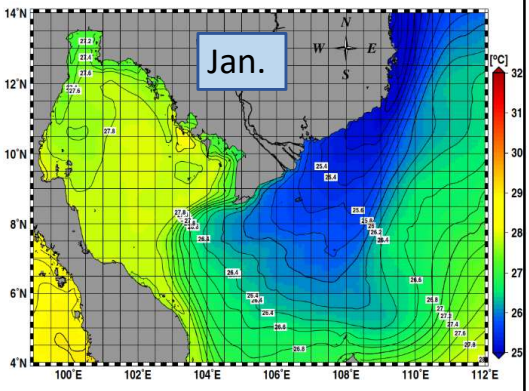



: Grid Point/Observation Point
27.8 : Numerical Value at the Point (Temperature: ºC)
At first, You must find border points
28.0
0.2
0.2
27.8
28.2
28.3
27.7
28.1
28.0
28.0
27.6
27.9
27.8
By Rule of Thumb
RULE OF THUMB
No need to use ruler
Note
Contour lines Never cross
Non-smooth
28.0
28.0
28.0
Min. or Max. exist between them
It is possible, Unconnected same value Contour lines
28.0
Draw smooth line


You can see dot line and dash line…
Temperature at 0m in January
Monthly Ave. for 28 years(1993-2020) by CMEMS
SEAFDEC TD
Let's draw Counter Lines Map
As a first step, Draw 1 ºC interval Conter lines (26, 27, 28 ºC)
Next step, Draw 0.2 ºC interval Conter lines (x.2, x.4, x,6, x.8 ºC)
Temperature at 0m in January
Monthly Ave. for 28 years(1993-2020) by CMEMS
SEAFDEC TD

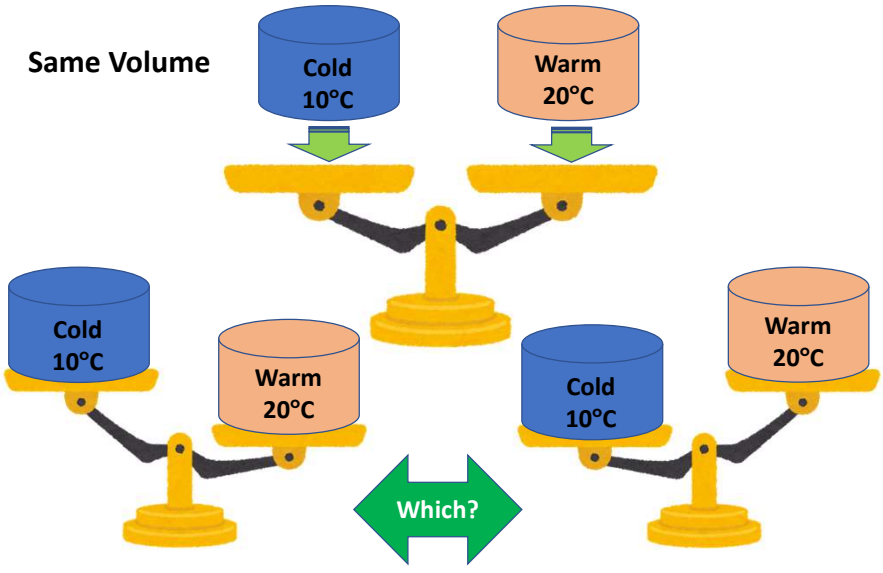


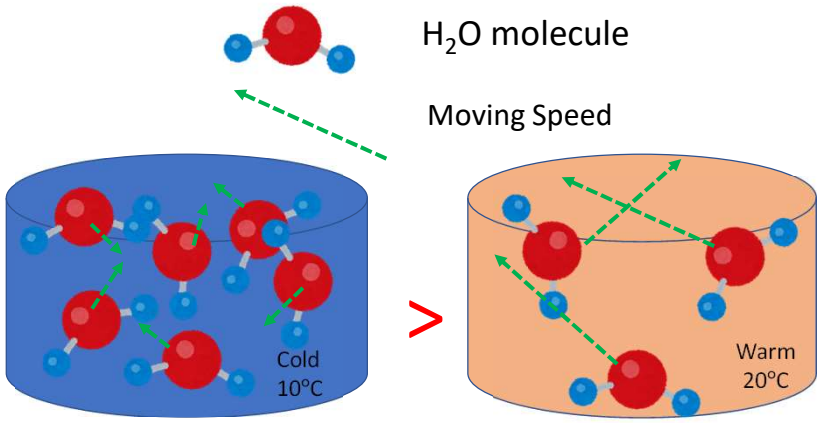
Sea Surface Temperature(°C)
Averaged Monthly data through the 28 years(1993-2020), by CMES



Sea Surface Temperature(°C)
Averaged Monthly data through the 26 years(1993-2018)

Question 1 **Which is heavier, Same Volume Cold water or Warm water ?**





Molecules: Low speed moving
Spans between molecules is narrow
High content of molecules
⇒
High Density
⇒
Heavy Weight/Volume

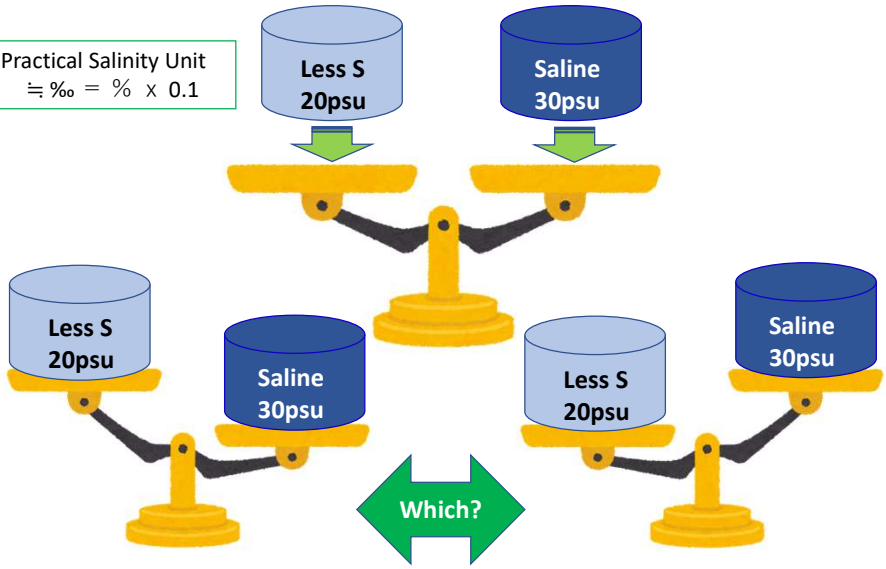
Molecules: High speed moving
Spans between molecules is wide
Low contest of molecules
⇒
Low Density
⇒
Light Weight/Volume

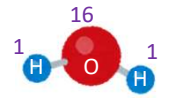
Question 2

Which is heavier, Sama Volume Less-saline water or Saline water ?

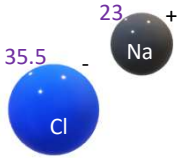
Saline: Higher salinity contents

psu: Practical Salinity Unit
≒ ‰ = % x 0.1



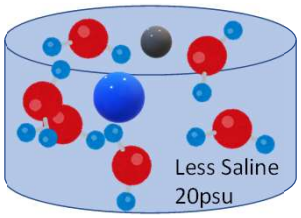


H_2O molar weight: 1 x 2 + 16 = 18

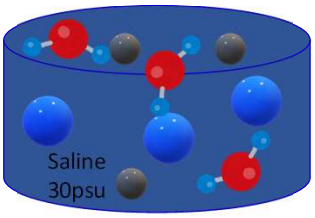


NaCl molar weight: 23 + 35.5 = 58.5

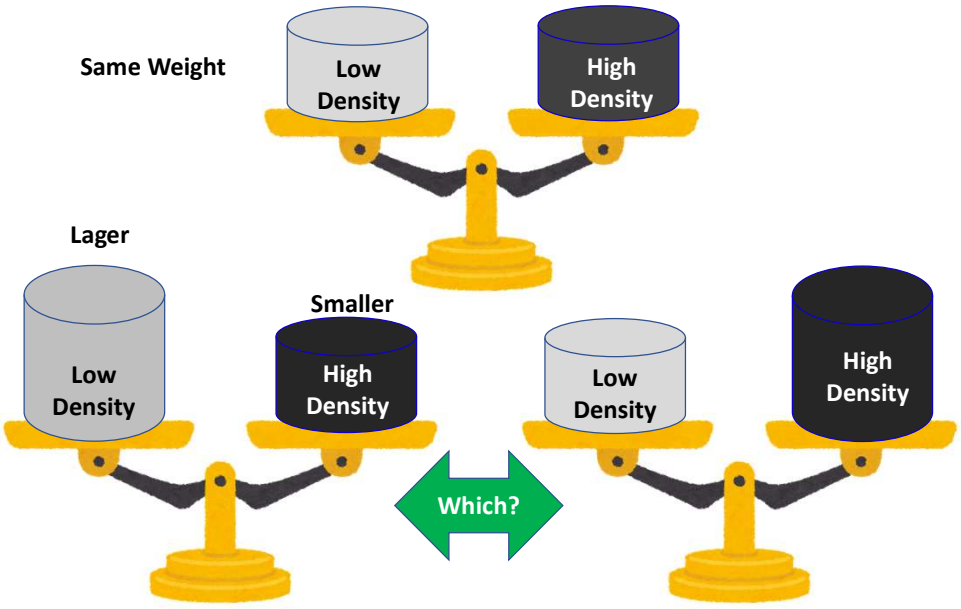
Less Saline water



Saline water

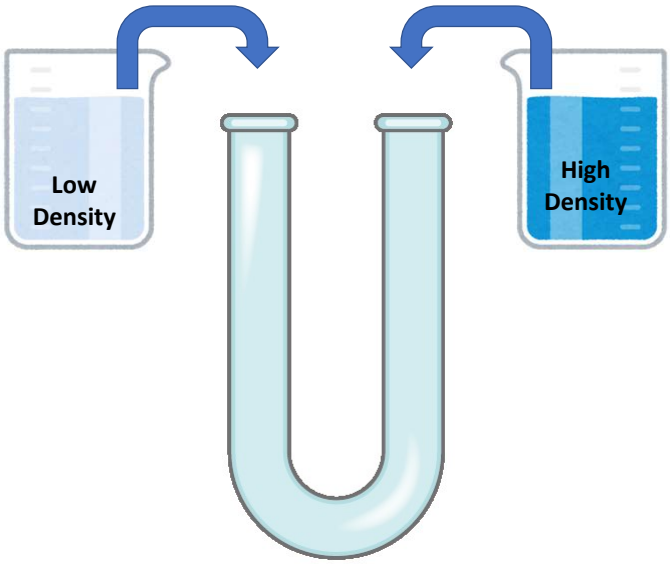


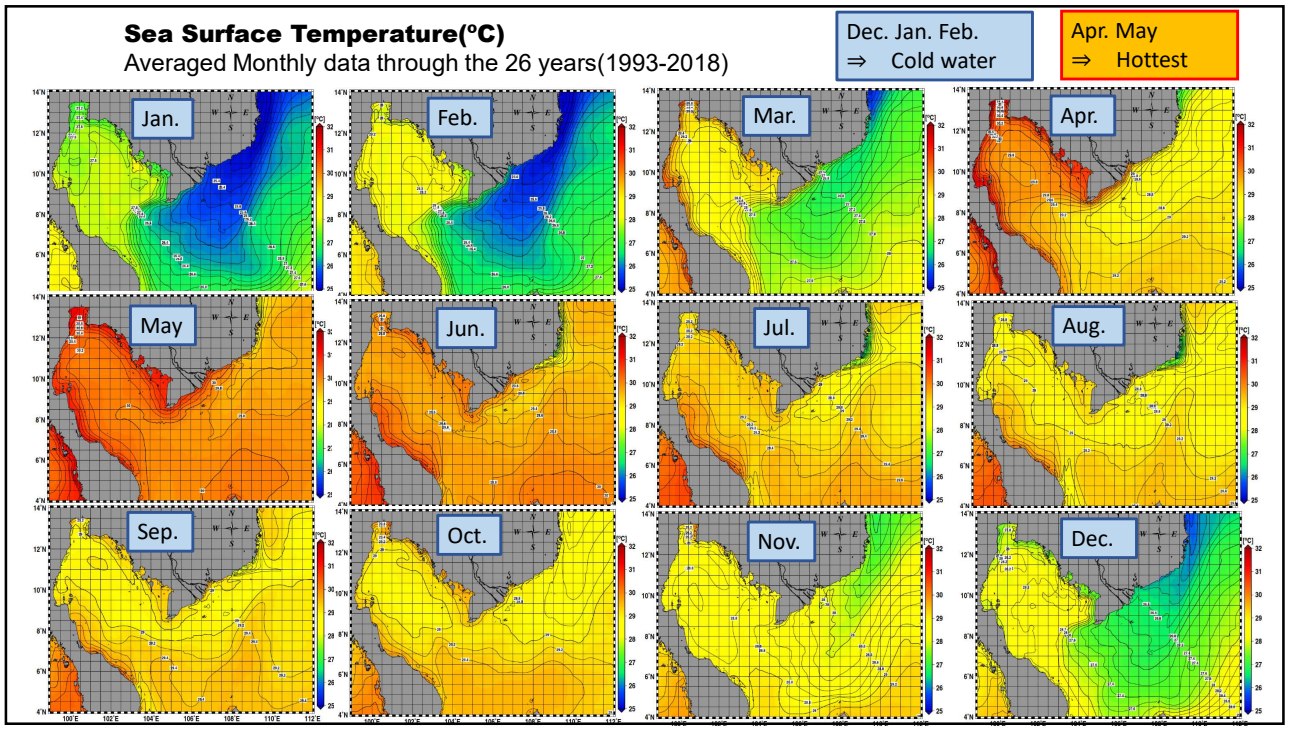
Question 3 Which is larger, Same Weight Low-density water or High-density water?

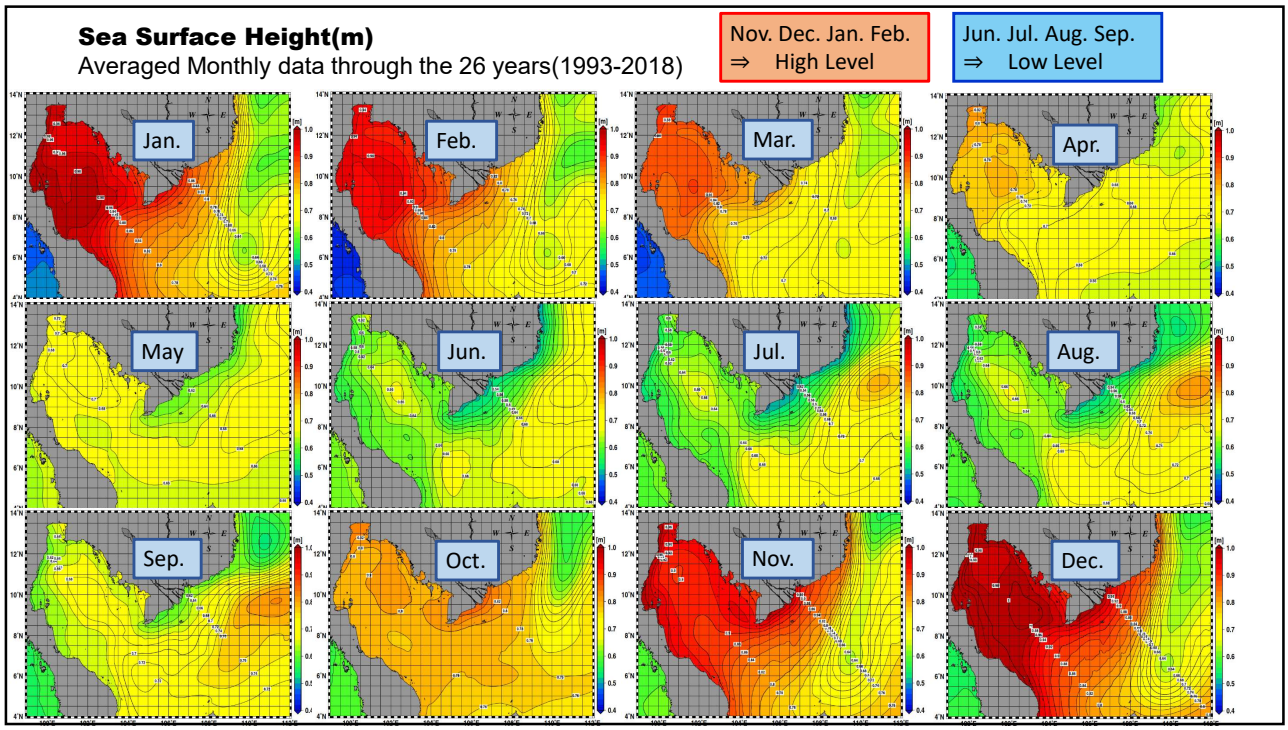


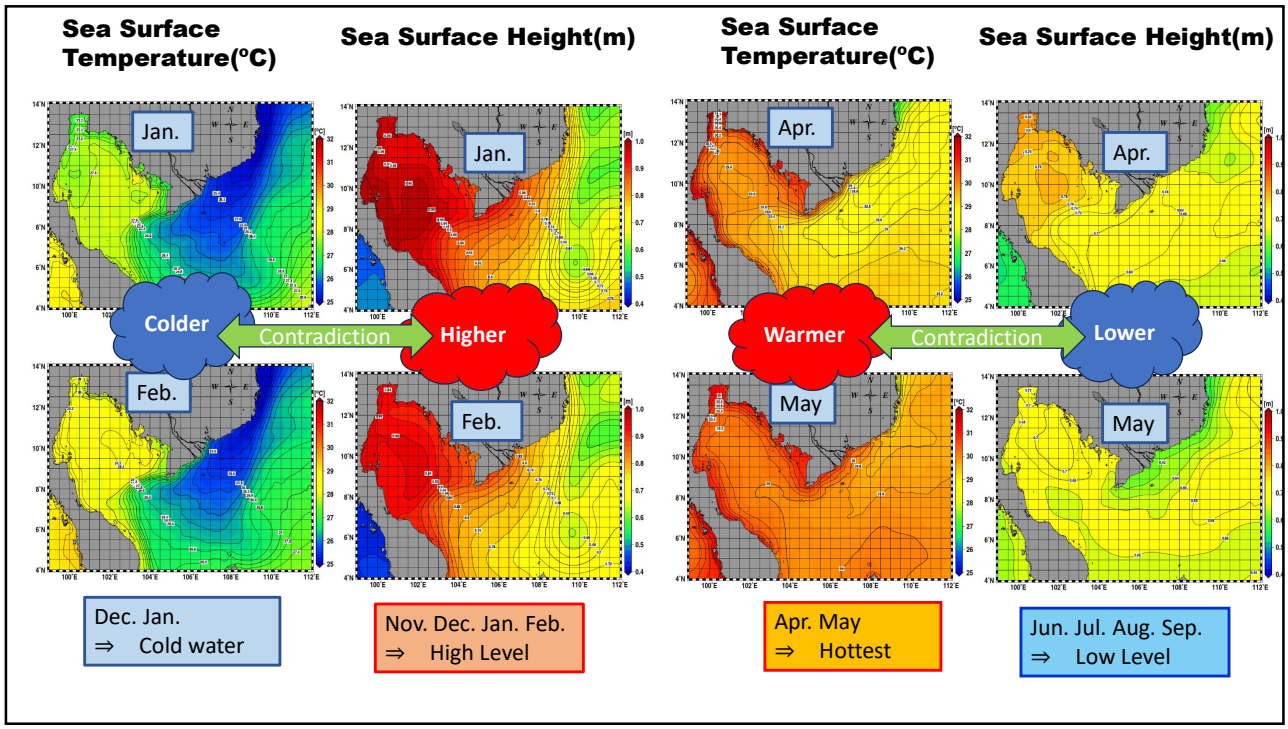
Question 4

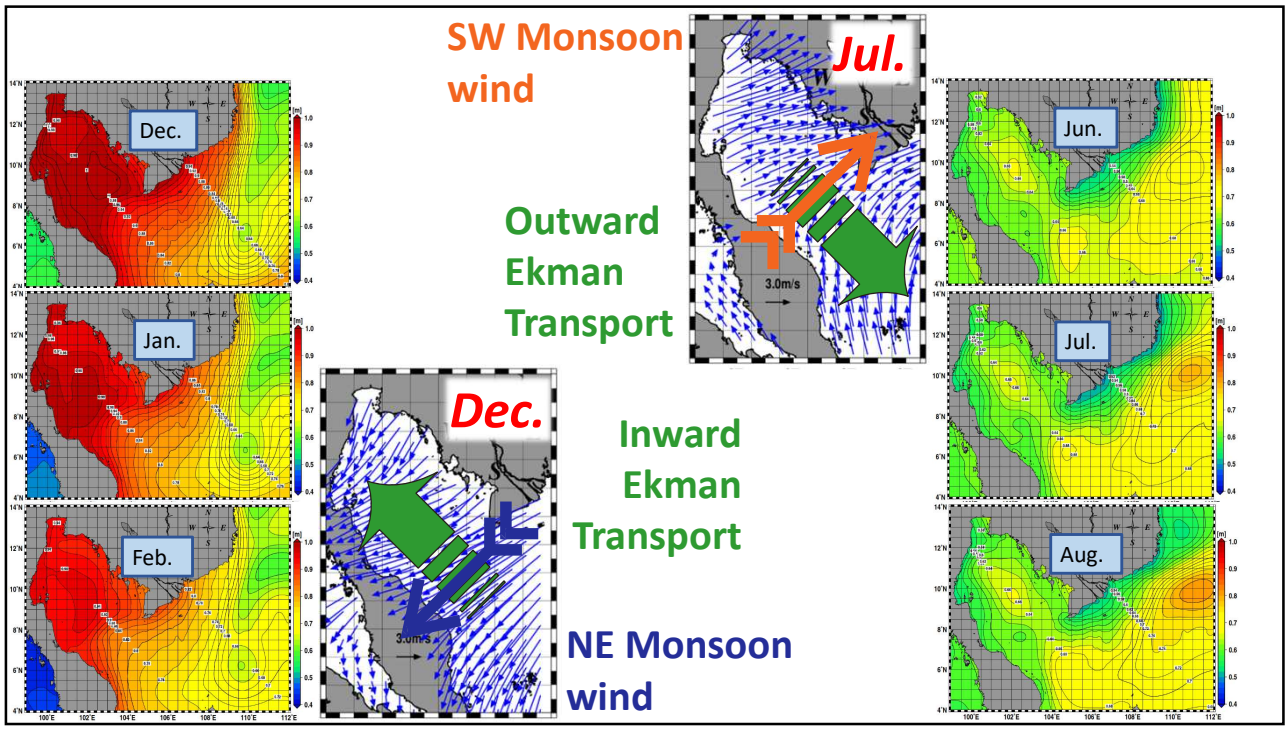
Which is taller, Low-density water or High-density water in a U-tube, when they balanced in the tube ?






Sea Surface Height(m)
Averaged Monthly data through the 26 years(1993-2018)
Nov. Dec. Jan. Feb.
⇒ High Level
Jun. Jul. Aug. Sep.
⇒ Low Level
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.

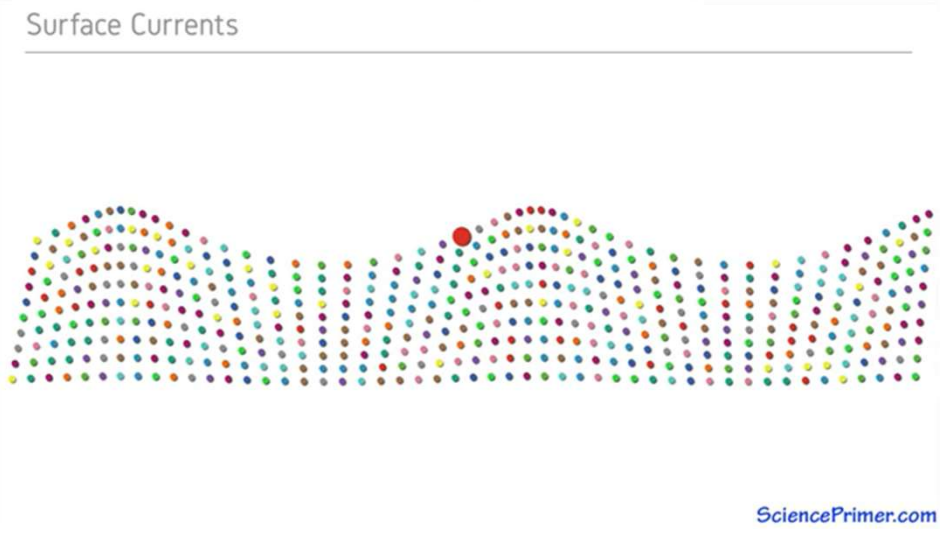

Sea Surface Temperature(°C)
Sea Surface Height(m)
Sea Surface Temperature(°C)
Sea Surface Height(m)
Jan.
Jan.
Apr.
Apr.
Colder
Contradiction
Higher
Warmer
Contradiction
Lower
Feb.
Feb.
May
May
Dec. Jan.
⇒ Cold water
Nov. Dec. Jan. Feb.
⇒ High Level
Apr. May
⇒ Hottest
Jun. Jul. Aug. Sep.
⇒ Low Level

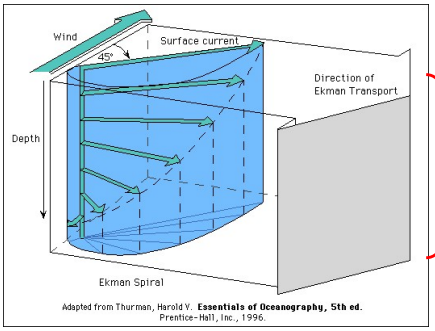


What is "Ekman Transport"

https://youtu.be/KBKmKI3tl4Q

Vagn Walfrid Ekman (1874-1954) was a Swedish oceanographer. In 1905, Ekman published his theory of the Ekman spiral which explains the phenomenon in terms of the balance between frictional effects in the ocean and the Coriolis force, which arises from moving objects in a rotating environment, like planetary rotation.





Directory
Wind effect
to surface
current
system
⇒
Ekman Layer

About 10-100m
Thickness

Current
Direction
changed by
depth.
It looks like a
SPIRAL
STAIRS
⇒
Ekman Spiral

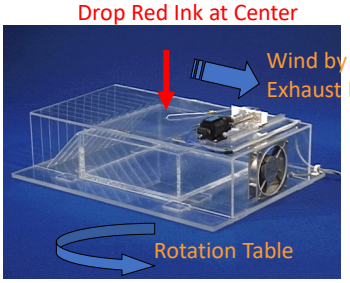
Experiment Equipment

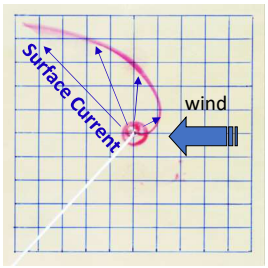
Result (Top View)

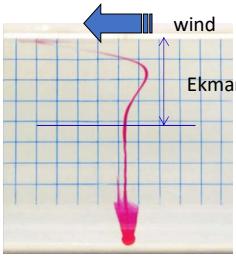
Result (Side View)

Drop Red Ink at Center

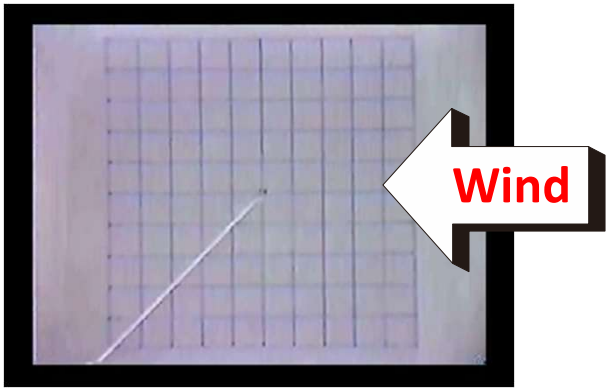
Square
Water
Tank

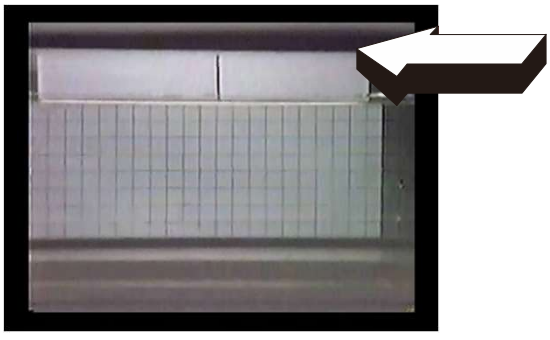






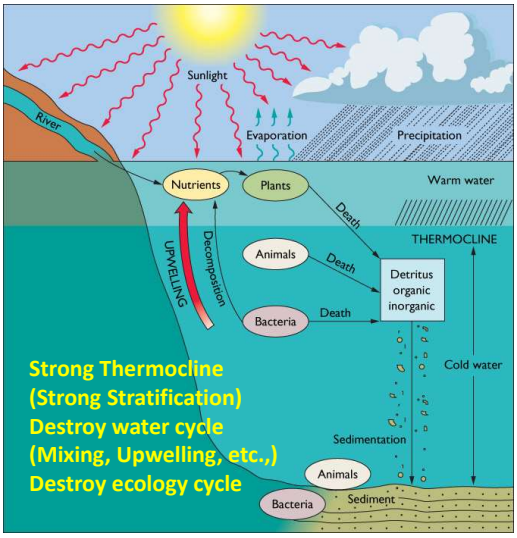
Ekman Spiral (Top View)



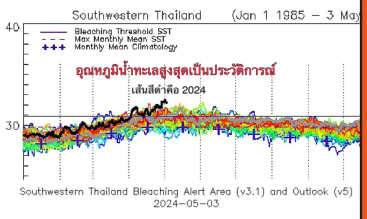


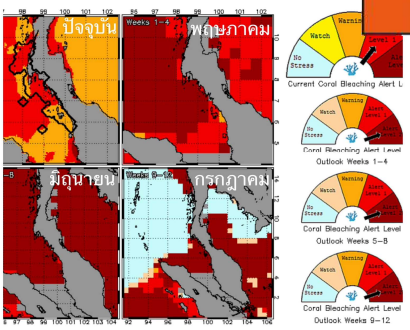
Ekman Spiral (Side View)

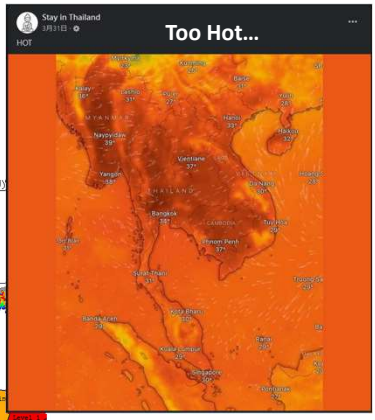
Healthy ecology cycle….will be destroyed by too warmer surface water, too much nutrients.



Strong Thermocline
(Strong Stratification)
Destroy water cycle
(Mixing, Upwelling, etc.,)
Destroy ecology cycle







Coral bleaching
Alert level
Over 32°C sea water

By Global warming… ⇒ Sea water level is rising …

Thailand will melt?

Flooding in Bangkok at High Tide (2021 Nov.)

Bangkok will must go back to Ayuttaya?

In 2005, Capital city of MYANMAR, has moved from Yangon to Nay Pyi Taw.

Most of reasons…
Military government…

One of reasons…
High tide disaster of Cyclone

In 2024,
Capital city of Indonesia, Jakarta will move to East Kalimantan.

A lot of area of Jakarta, is under 0m height

Jakarta, 2007 Feb.

Summary of my lecture

- In the sea, Phyto Plankton is in contradictory advantageous conditions (Surface: rich Sunshine ⇔ Deep: rich Nutrients).
- Water movement (Mixing, Upwelling, Tide, Eddy, River Discharge, etc.) must be need to solve this contradictory condition.

◆ Too warmer surface condition, Too strong water stratification,
⇒ Stop water mixing, Stop nutrient supply, Stop primary production
⇒ Water level: rise, Flooding risk: higher (NE monsoon season)

◆ Too much nutrient supply by river discharge from human effects
⇒ Too heavy bloom, Red tide, Blue-Green Algae, etc. ….