SKOLE6626

Måleserier i tid og rom

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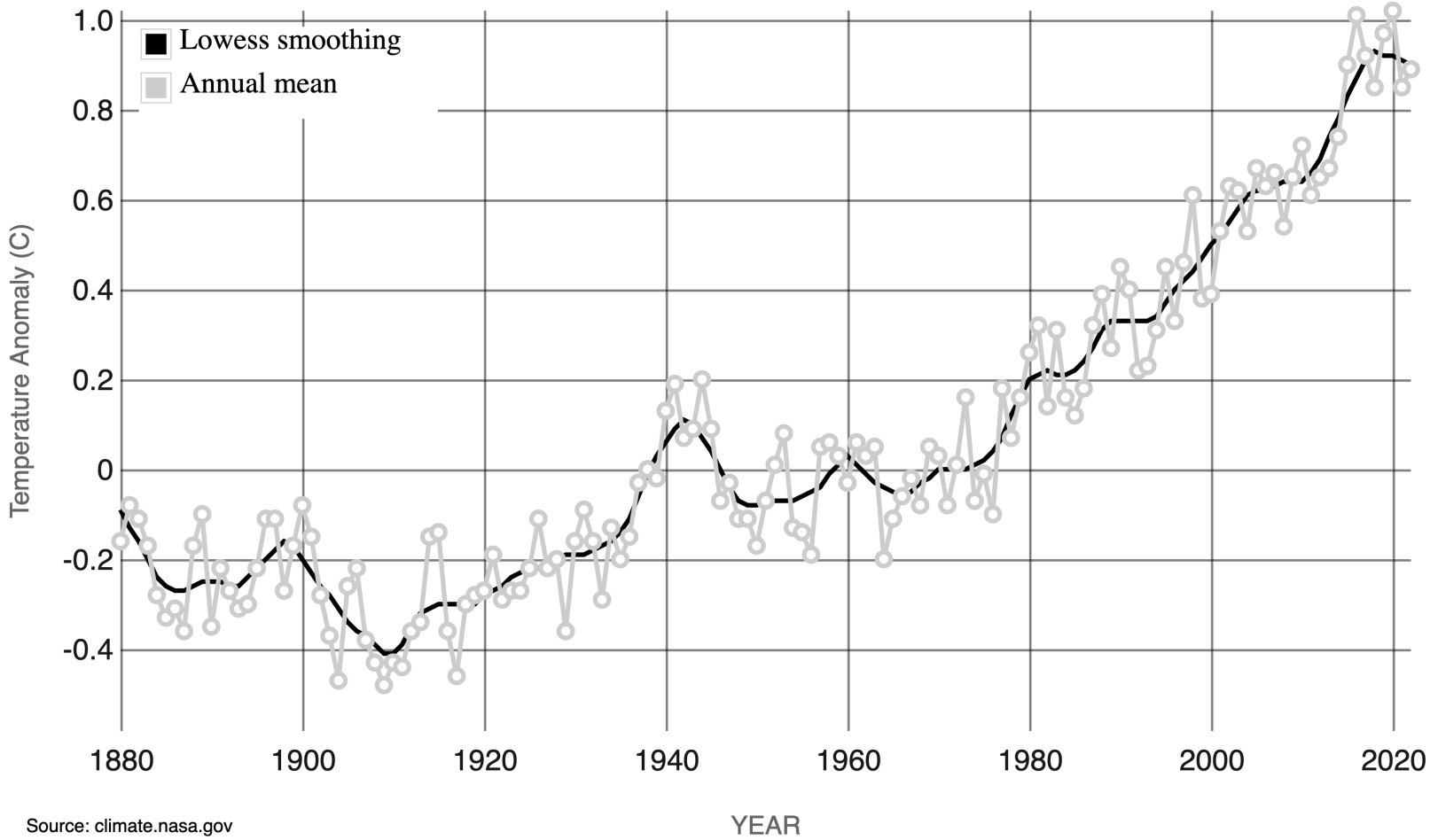
The future of the ocean?

1. Climate change
2. Biodiveristy

Global Temperatures are increasing



Source: climate.nasa.gov

https://climate.nasa.gov/vital-signs/global-temperature/

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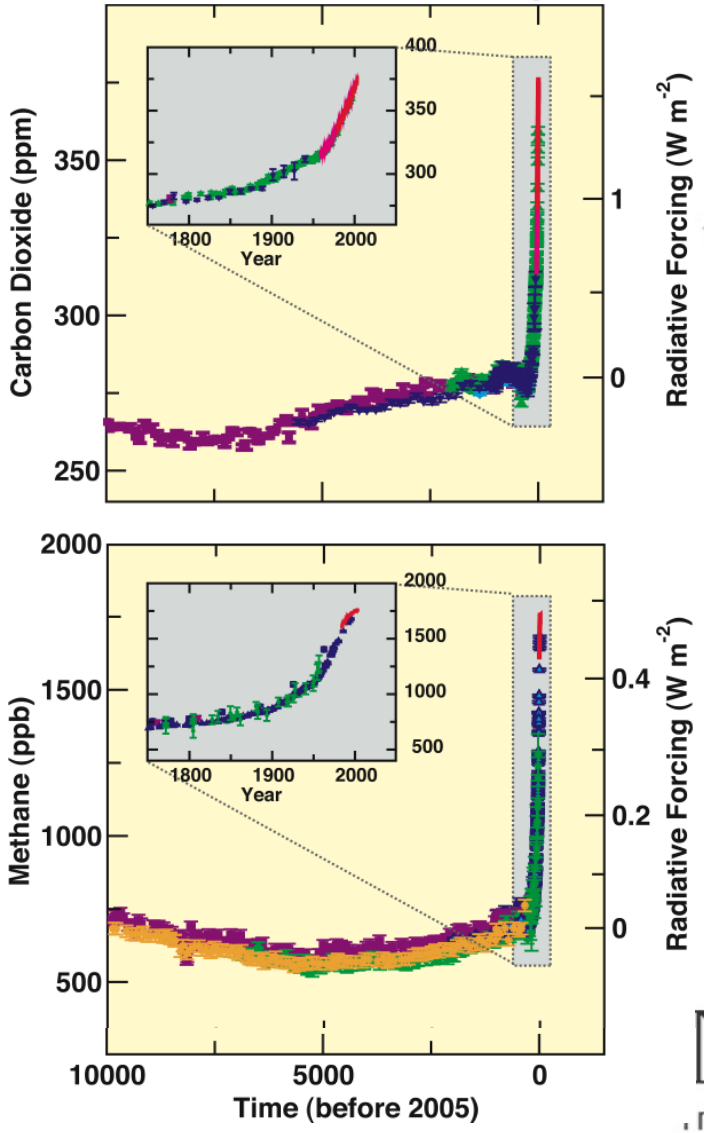
Greenhouse gas concentrations

Compared to natural changes over the past 10,000 years, the spike in concentrations of CO_2 & CH_4 in the past 250 years is extraordinary.

Humans are responsible for the recent dramatic increase emissions. Fossil CO_2 & CH_4 lack carbon-14, and the observed drop in atmospheric C-14 is measurable.



(IPCC AR4 WG1, 2007)

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Oceanography

- Physical
  - The atmosphere
  - Air/sea interface
  - Water column
  - Physical properties of seawater
- Biological
- Geological
- Chemical

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What is Physical Oceanography?

A knowledge of the circulation of the oceans; a systematic quantitative description of the character of the ocean waters and of their movements

1). A description of the temperature, salinity, and density patterns in the ocean, including their variability.
2). The three dimensional water movement (the circulation: currents and vertical movements; also, waves and tides).
3). The transfer of mass, energy, and momentum between the ocean and the atmosphere.
4). The mechanisms of these properties and processes.

Simply:

- What temperature is the water?
- What salinity is the water?
- Where is the water going?
- Why is that?

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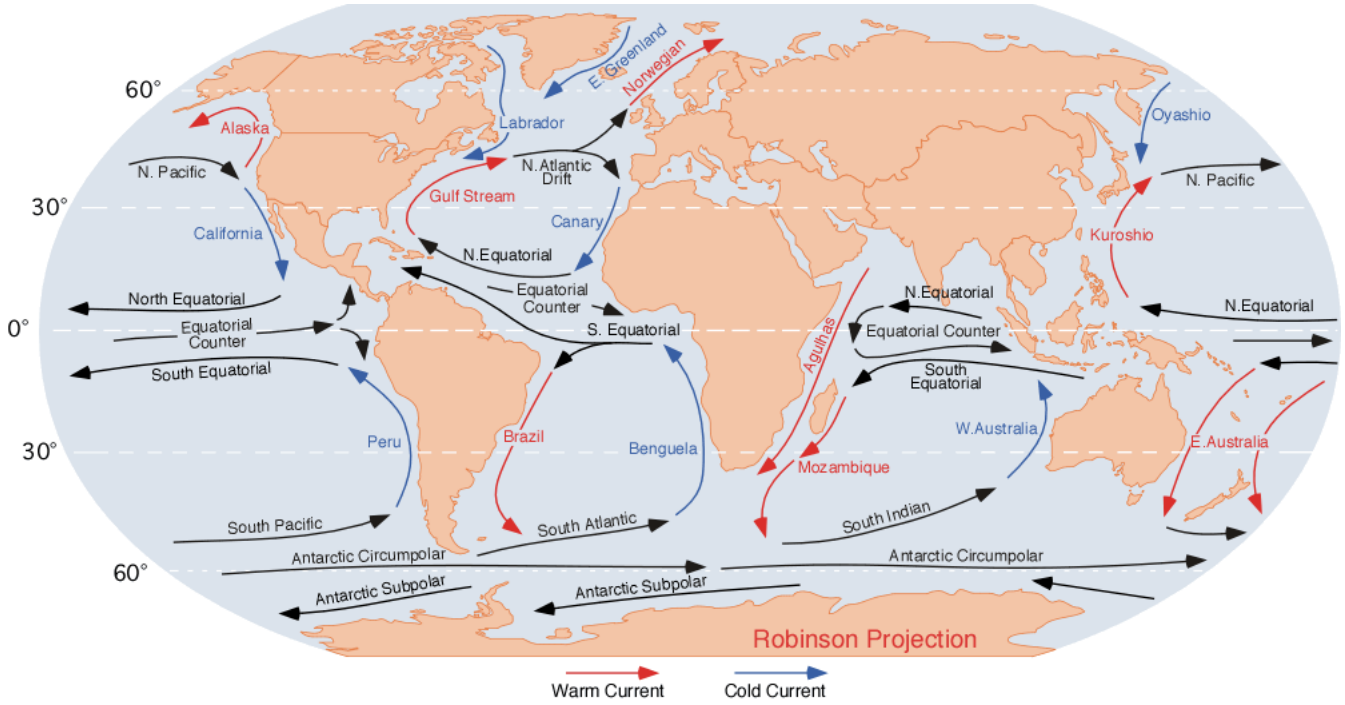
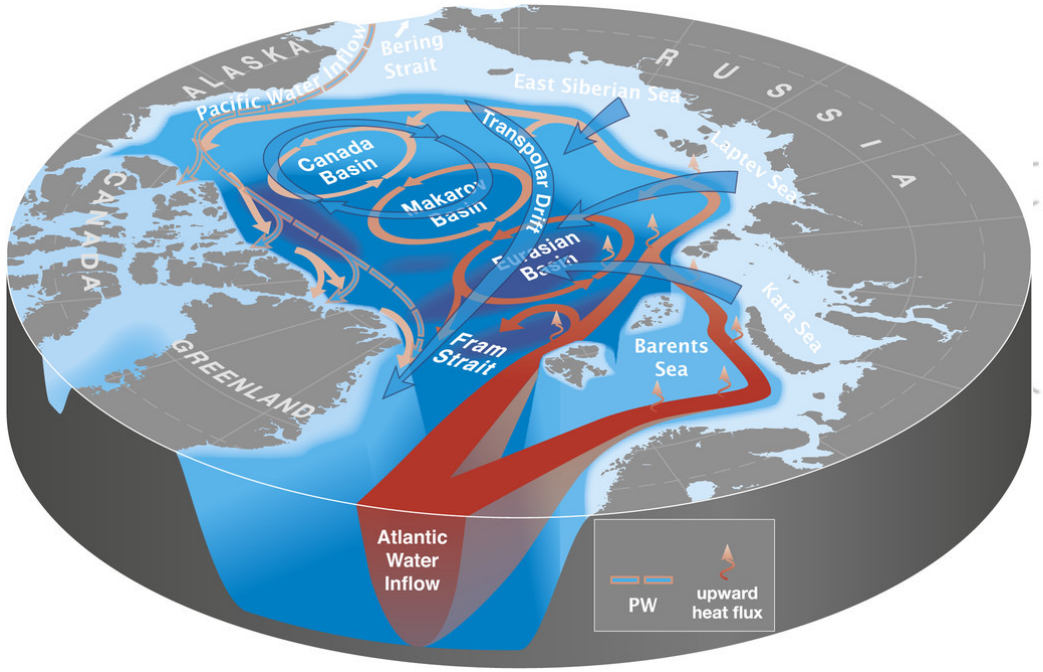
Ocean circulation





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Biological oceanography
Primary production

The study of life in the oceans - the distribution, abundance, and production of marine species along with the processes that govern species' spread and development.

- Converting CO_2 to O_2 and C
- Coupling between atmosphere and ocean
- Energy for biological system

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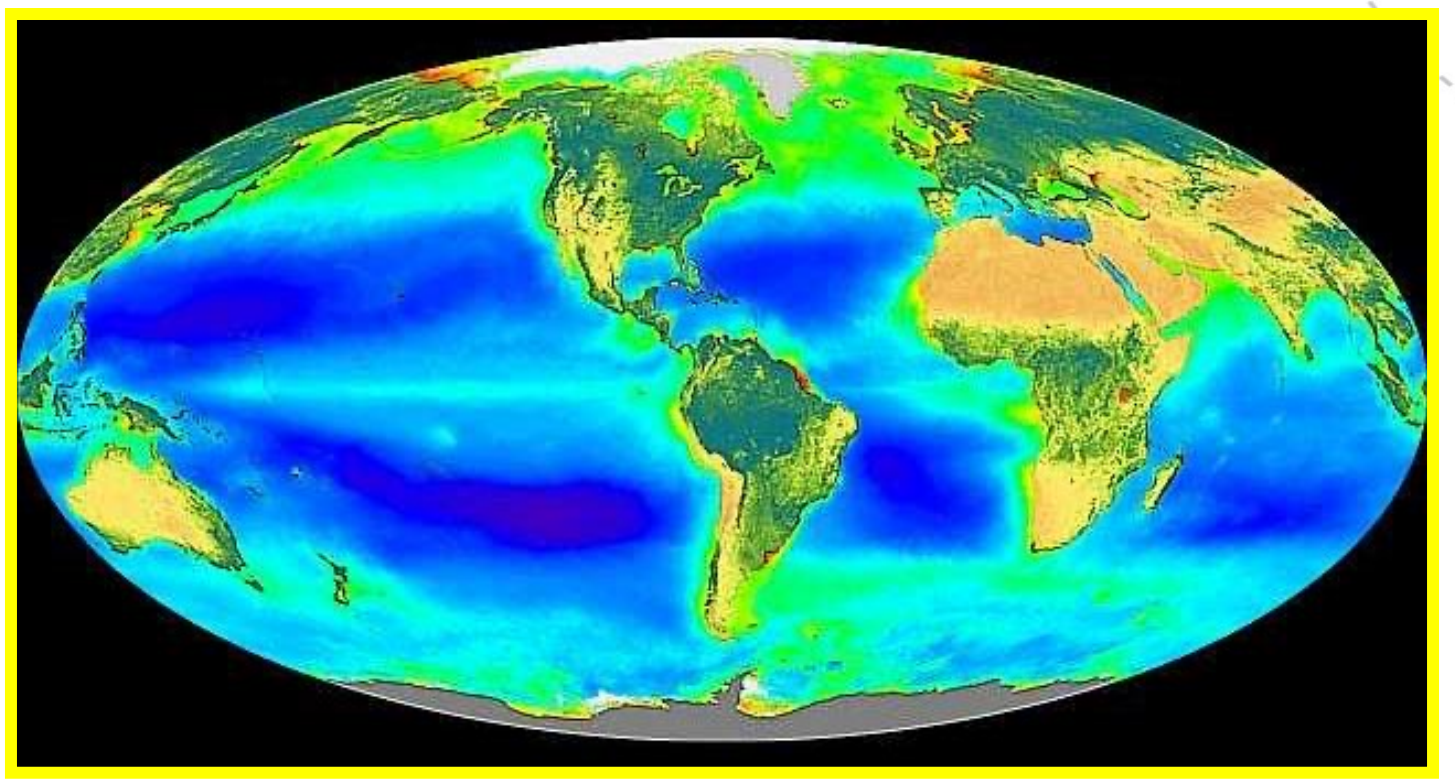
Surface distribution of chlorophyll *a* using SeaWiFS data sets: Note physical forcing effects: Coastal, Equator, North Atlantic



SeaWiFS Team/GSFC/NASA

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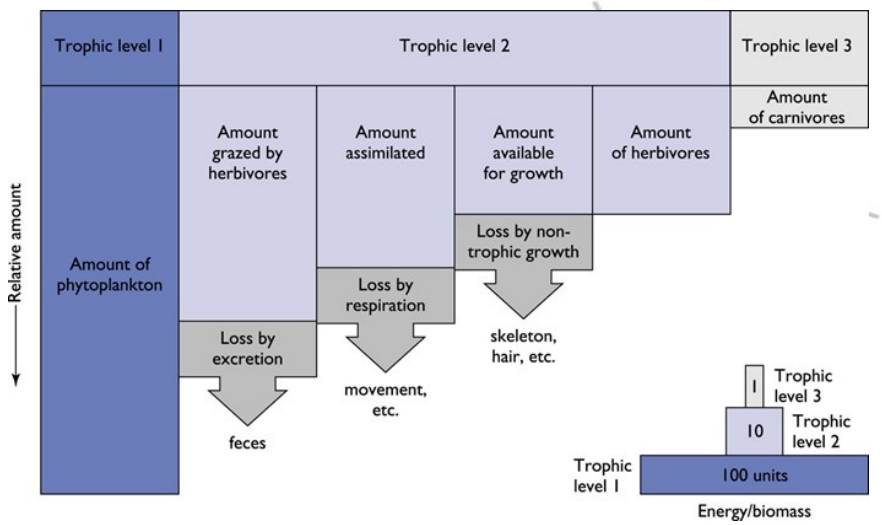
We depend on phytoplankton

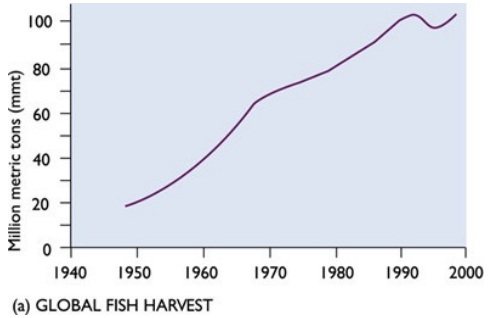
Phytoplankton is at the base of the marine and human food web. They bind CO_2 and produce 50% of the worlds oxygen.

Primary production is an important indicator of primary production.

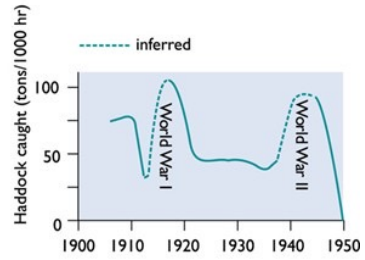
Knowledge gap. Need to know more about dynamics in the water column.

Source: An Introduction to The Worlds Oceans, K.A Sverdrup et al.





(a) GLOBAL FISH HARVEST



(b) HADDOCK CATCH IN NORTH SEA

[redacted] PhD Candidate Trygve Olav Fossum

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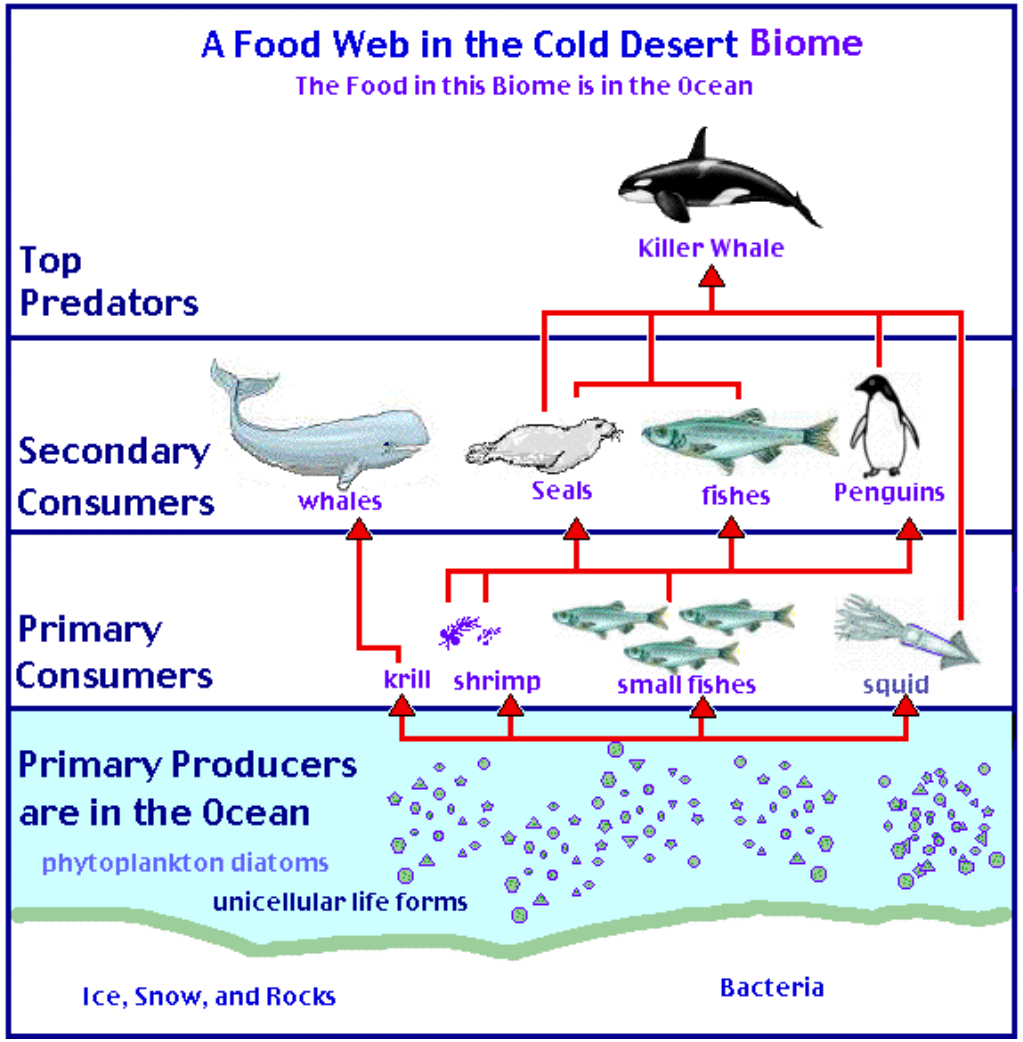

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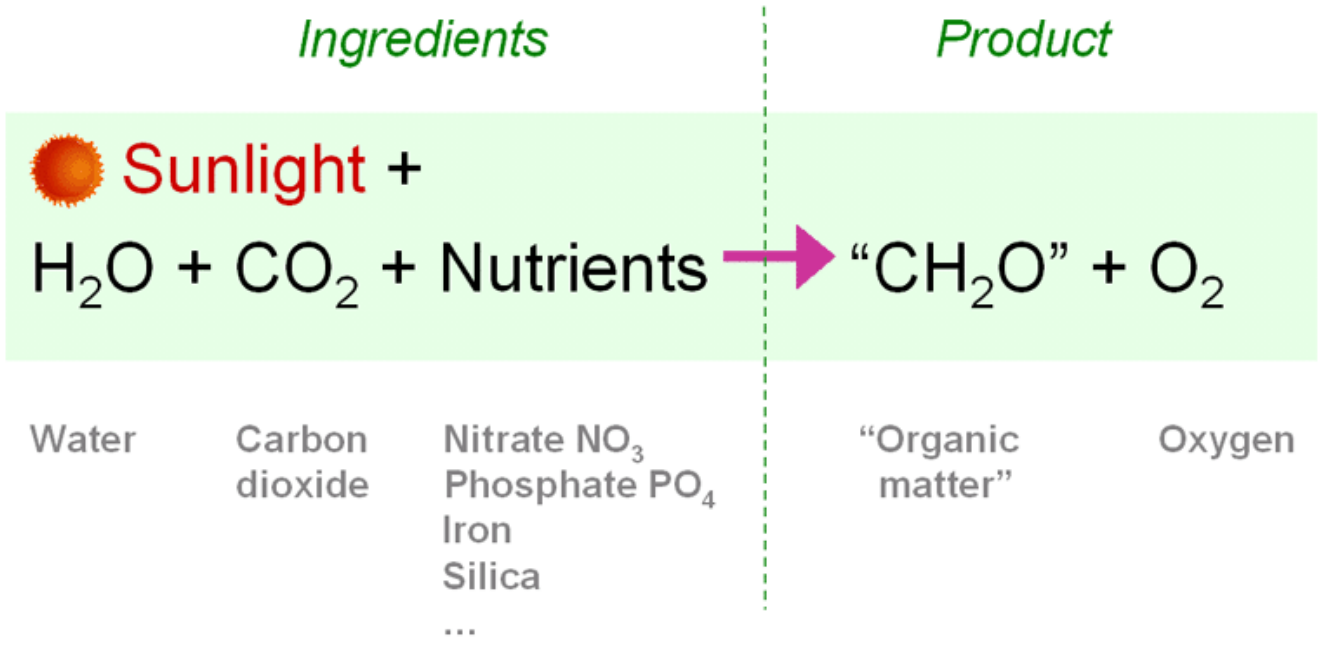
Photosynthesis



Earthguide http://earthguide.ucsd.edu
Memorie Yasuda

Same rule applies to marine life that applies to terrestrial life.

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Nutrient Limitation

- Elements in short supply are limiting to photosynthesis.
  - **Nitrate**
  - **Phosphate**
  - **Silica**
  - **Iron**

  • Silicon is important for the growth of diatoms.

  • Iron is required for photosynthetic electron transport and the synthesis of chlorophyll.

- Nutrient profiles generally increase with depth. Concentrations may be below detection in surface waters, especially in the open ocean.

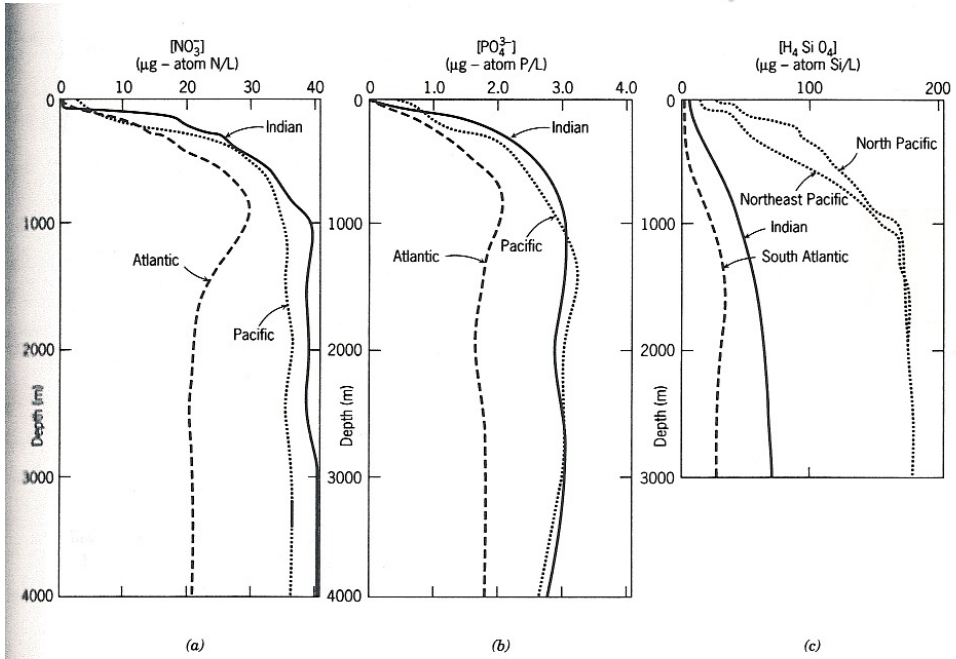

FIGURE 10.1. Vertical distribution of (*a*) nitrate, (*b*) phosphate, and (*c*) dissolved silicon in the Atlantic, Pacific, and Indian oceans. Note that 1 µg-atom/L is equivalent to 1 µ*M*. Thus 1 µg-atom NO_3-N/L is equivalent to 1µmol of dissolved nitrogen (in the form of NO_3^-) per liter of seawater. *Source:* From *The Oceans,* H. U. Sverdrup, M. W. Johnson, and R. H. Fleming, copyright © 1941 by Prentice Hall, Inc., Englewood Cliffs, New Jersey, p. 242. Reprinted by permission. See Sverdrup et al. (1942) for data sources.

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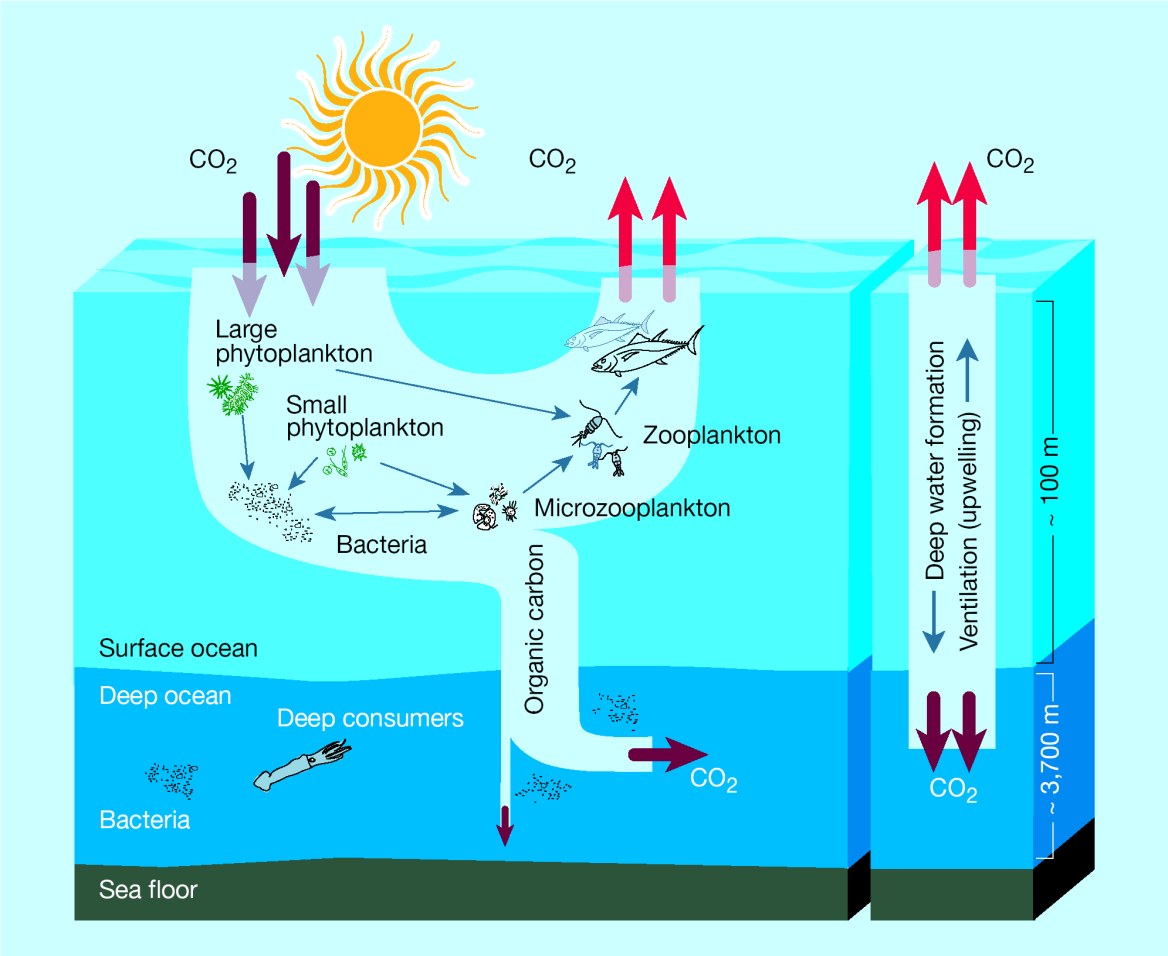
Nearly all of the sinking particulate organic matter is converted back to CO_2 through respiration in the deep ocean. Photosynthesis followed by a) the transport of carbon into the deep ocean and b) the respiration of the majority of this carbon, is called the "*biological pump*".

Sequestration of Atmospheric Carbon



The biological pump is an important mechanism for removing fossil fuel CO_2 from the atmosphere into the ocean

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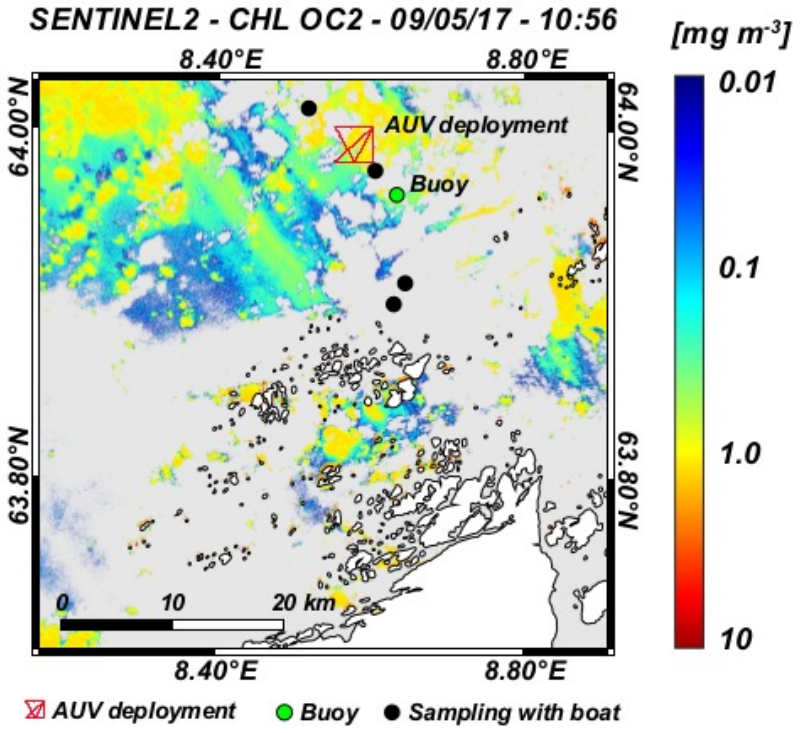
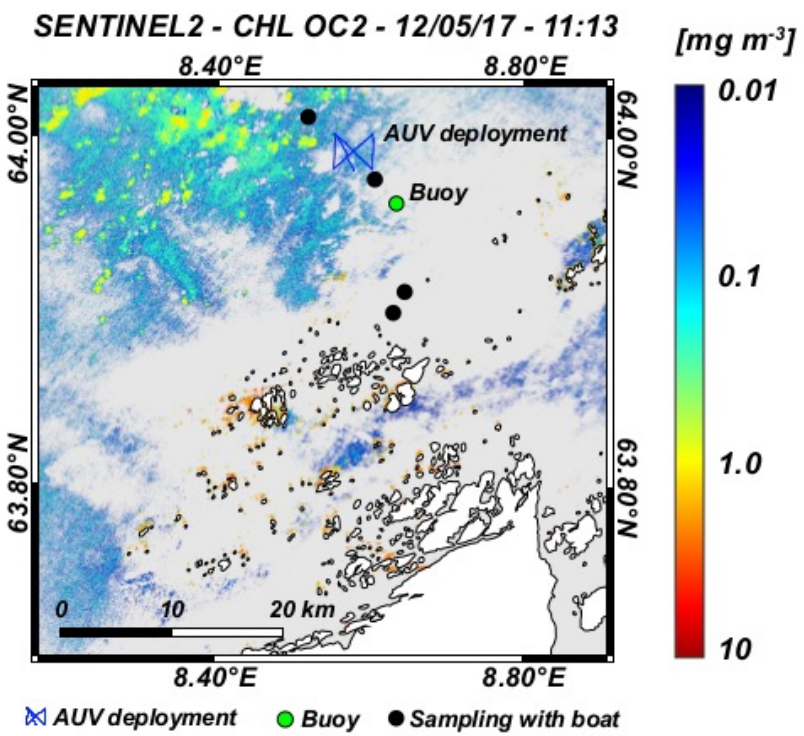
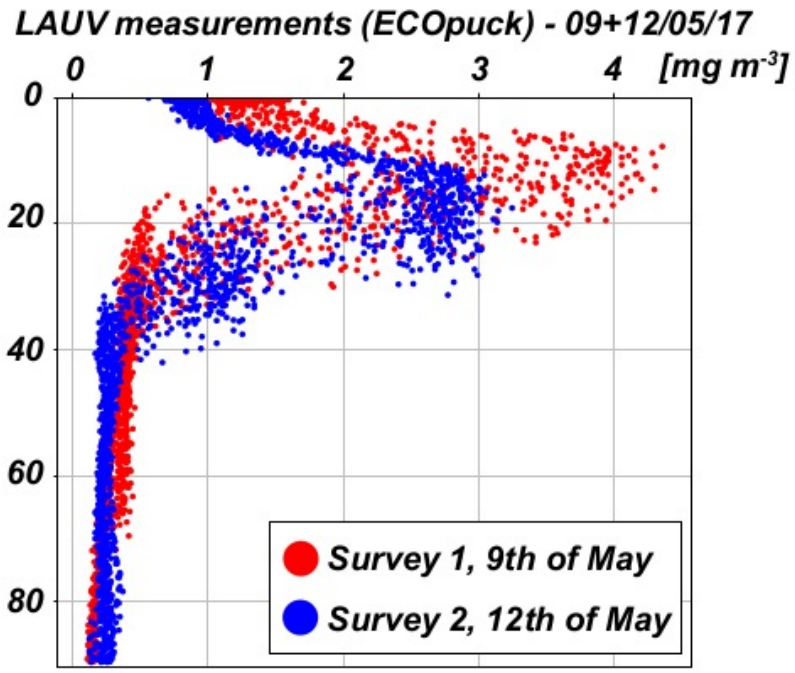
Chl *a* - Covering the gaps

Comparing remote sensing satellite chlorophyll a concentration with AUV data.







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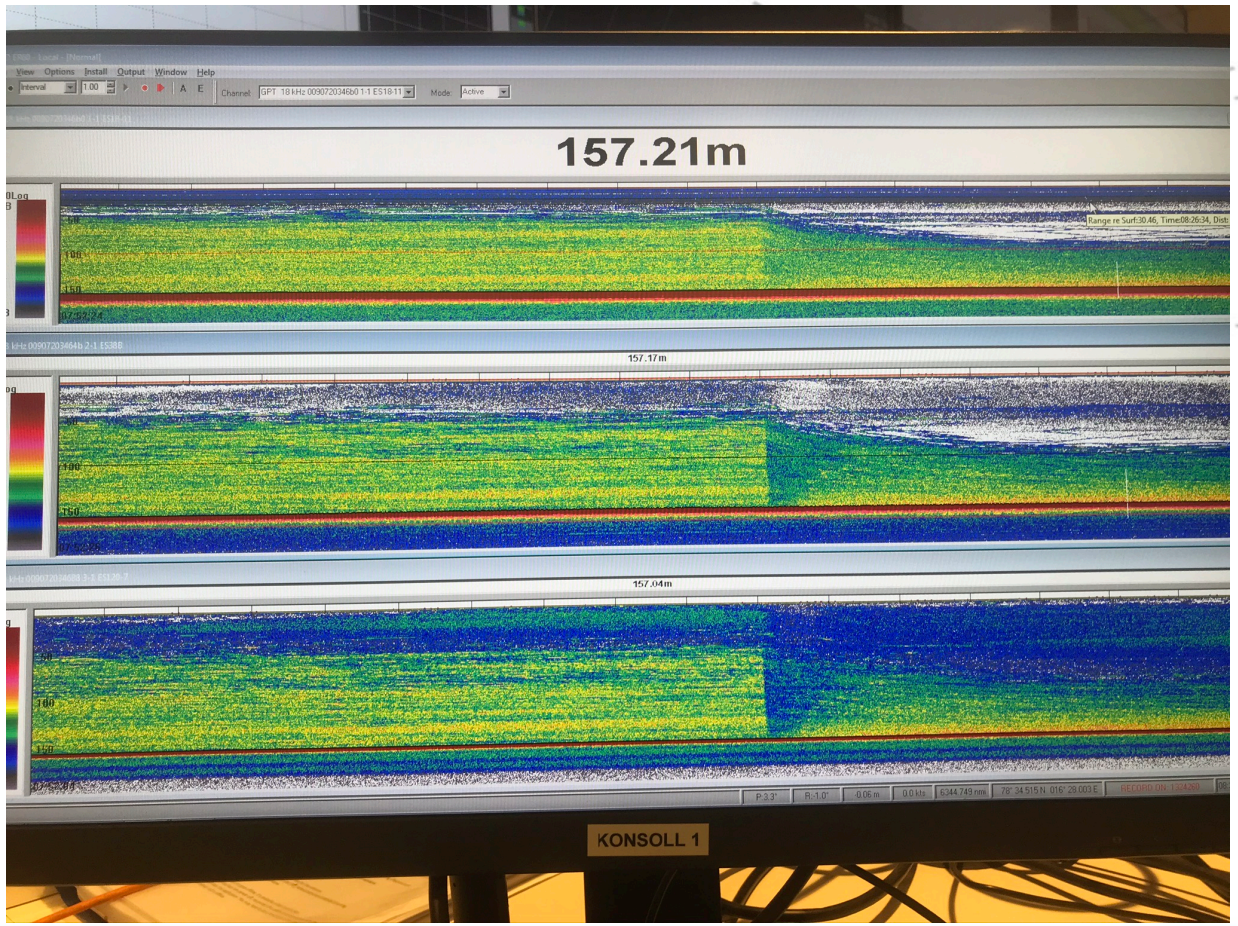
Use of an Autonomous Surface Vehicle reveals small-scale diel vertical migrations of zooplankton and susceptibility to light pollution under low solar irradiance

- An ASV fitted with a hyperspectral irradiance sensor and an acoustic profiler, detected the behavior of zooplankton in unpolluted light in the Arctic polar night
- Compared the results with that from a light-polluted environment close to our research vessels.
- Zooplankton community is intimately connected to the ambient light regime and performs synchronized diel vertical migrations in the upper 30m.
- The vast majority of the pelagic community exhibits a strong light-escape response in the presence of artificial light, observed down to 100 m.



The challenge of ocean sampling

If I were to choose a single phrase to characterize the first century of modern oceanography, it would be a ***century of under sampling***.

Walter Munk

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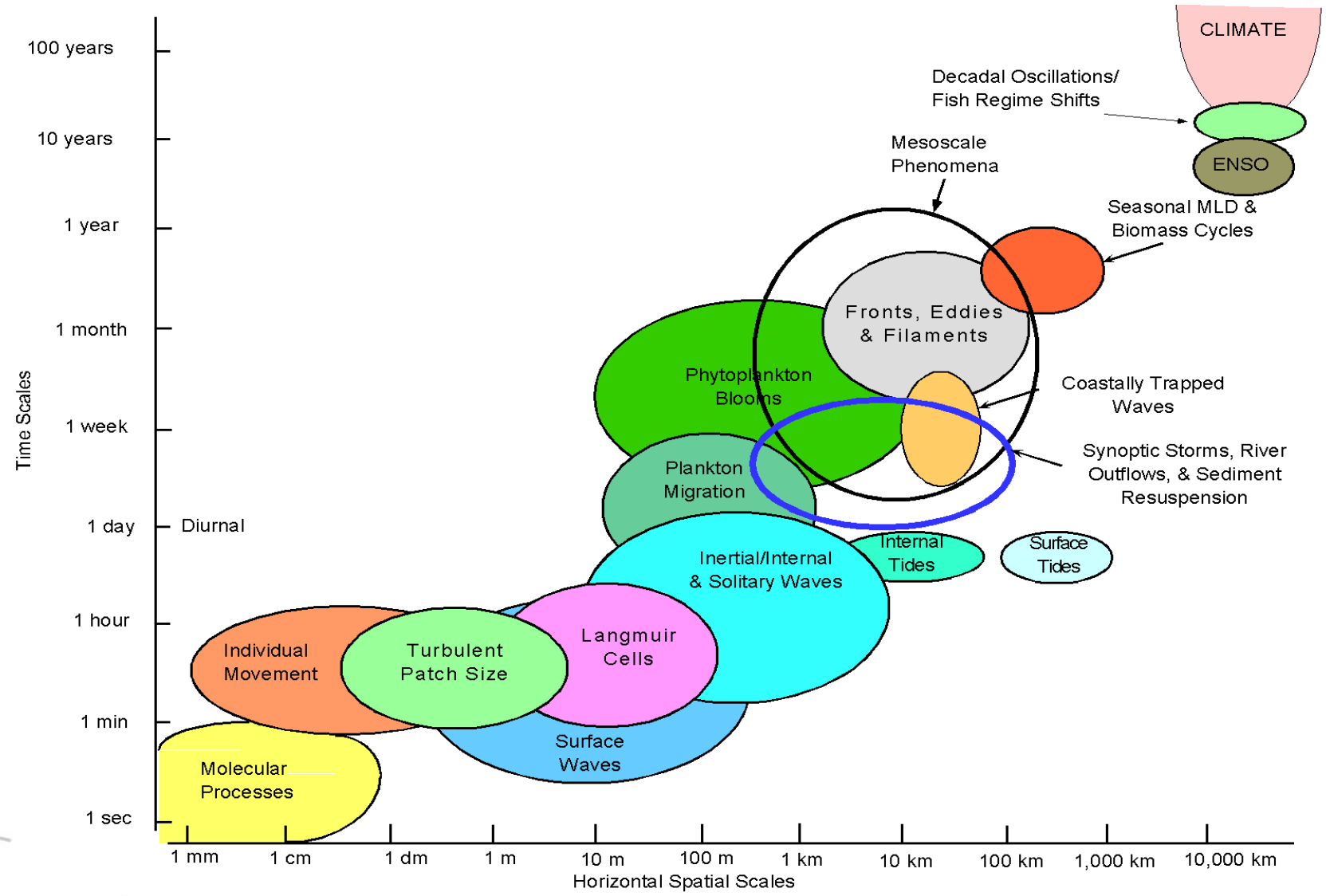
Dynamic processes in the ocean taking place in spatial and temporal domains



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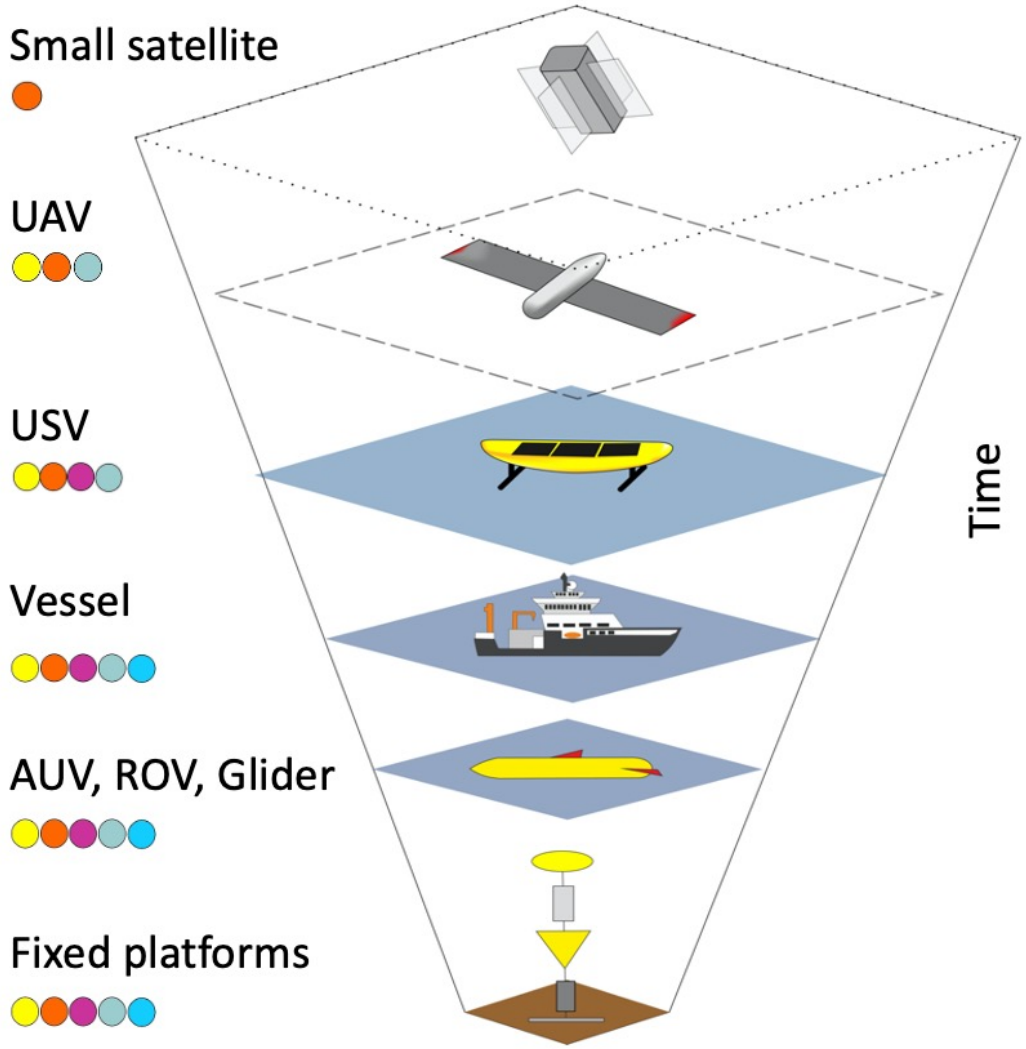
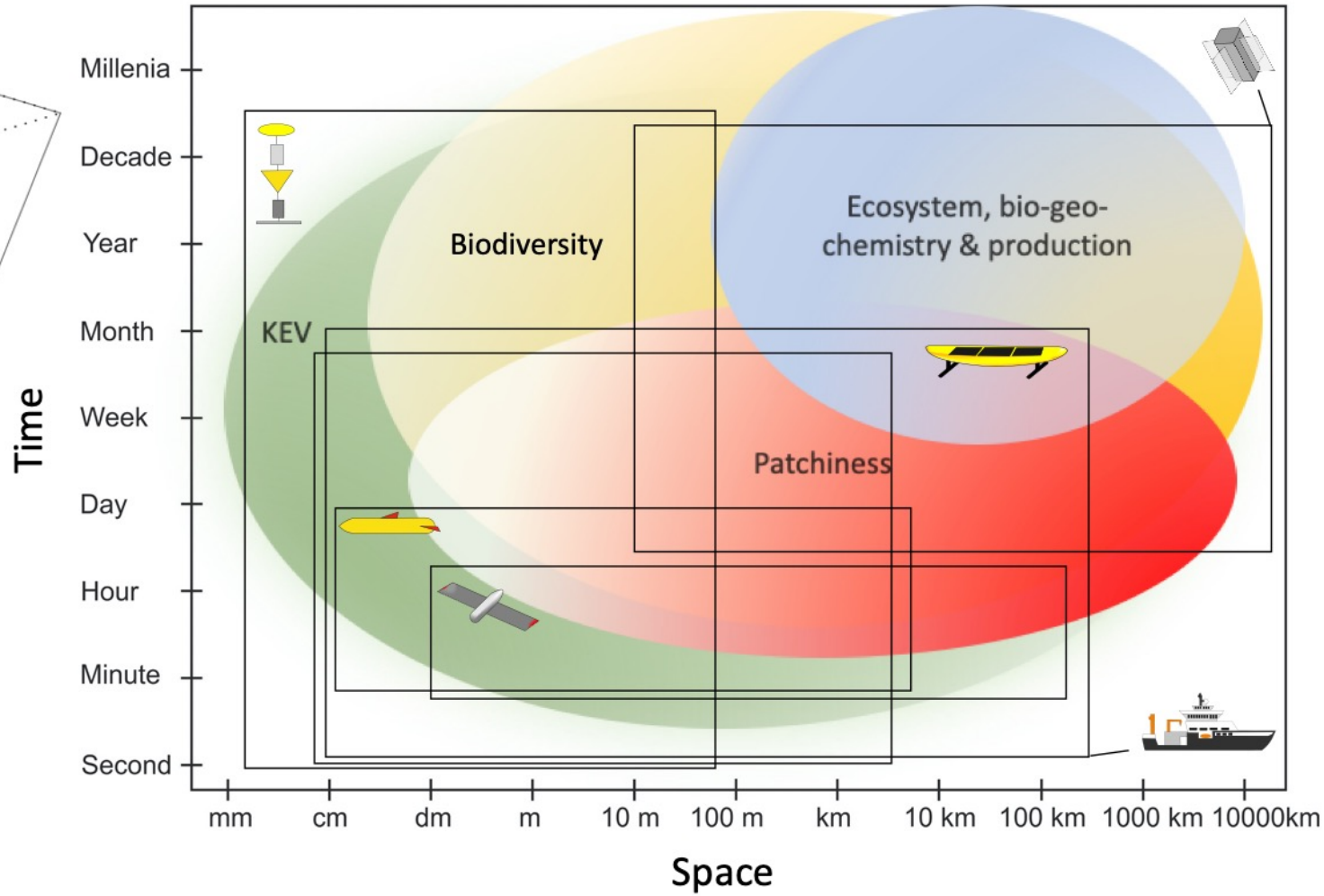
The observational pyramid for marine ecosystem science

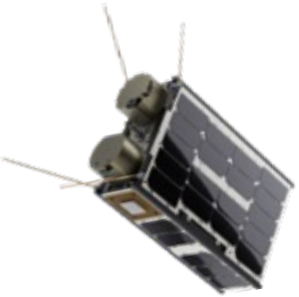




Sensors: Light sensors | Optical sensors/ imaging | Acoustics sensors | Electro-chemical sensors | *In situ* biological sampling

Technology platforms, Ny-Ålesund AMOS OP

Space:
1 customized small satellites with Hyperspectral Imaging (2022)



Air:
Minicruiser fixed-wing UAV
Octo copter

Sea surface:
Teisten boat
Polarcircle boat

USV – Otter
USV - Apherusa

Underwater:
1 ROV Blueye
LAUV Harald
LAUV Roald
Sampler

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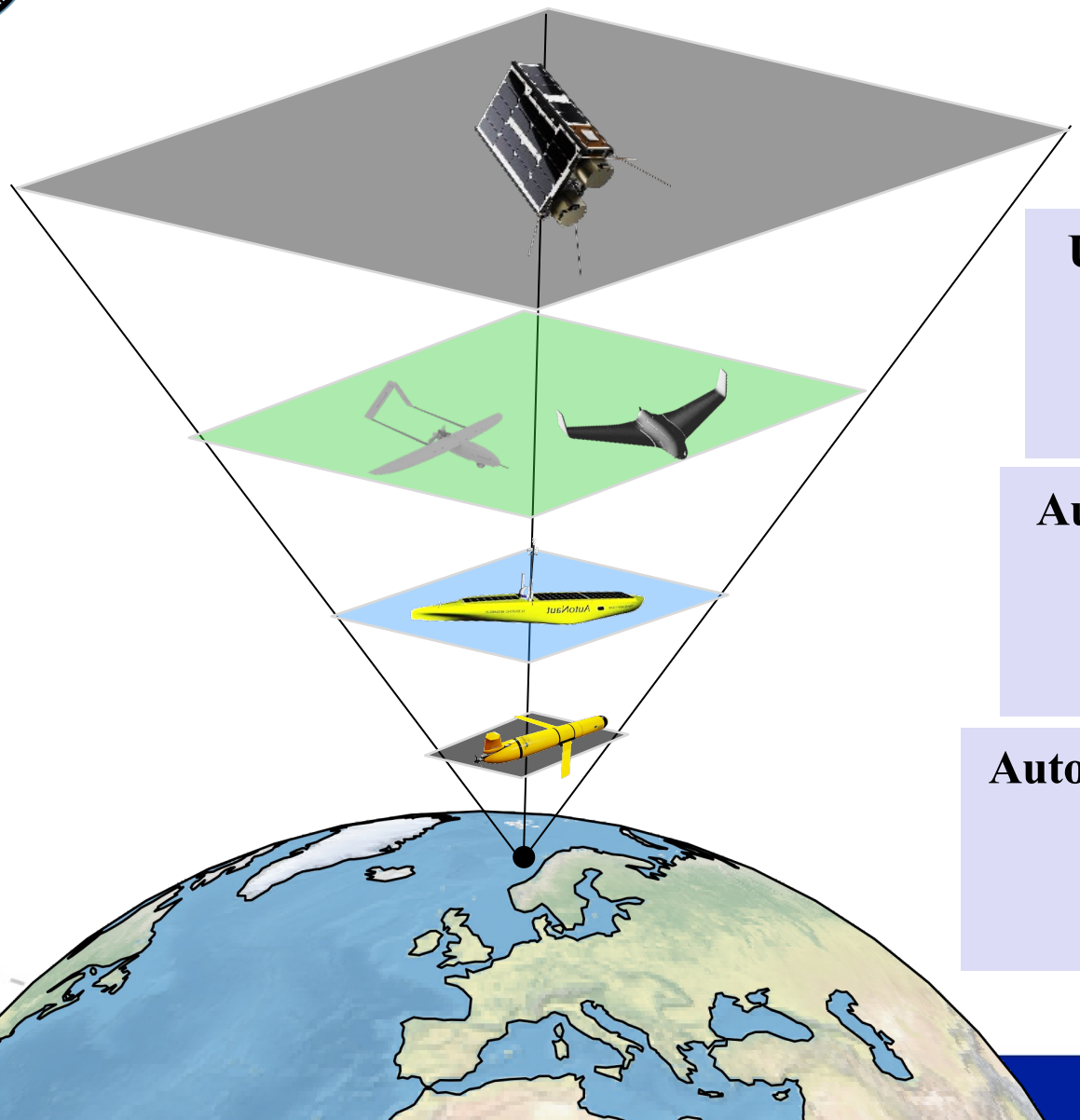
HYPSO
NANOAVIONICS
NTNU SMALLSAT
NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY
SPEED
0
KM/H
ALTITUDE
-0.0
KM
STAGE 1 TELEMETRY
STARTUP
LIFTOFF
MAX-Q
MECO
BOOSTBACK
FAIRING
T+ 00:00:01
TRANSPORTER 3



Small Satellites
Optical remote sensing
Area: <100 km×100 km
Speed: 7.7 km/s

Unmanned Aerial Vehicle (UAV)
Optical remote sensing
Area: <50 km×50 km
Speed: 10-50 m/s

Autonomous Surface Vehicle (ASV)
In-situ measurements
Area: <10 km×10 km
Speed: < 5 m/s

Autonomous Underwater Vehicle (AUV)
In-situ measurements
Area: <5 km×5 km
Speed: 2 m/s

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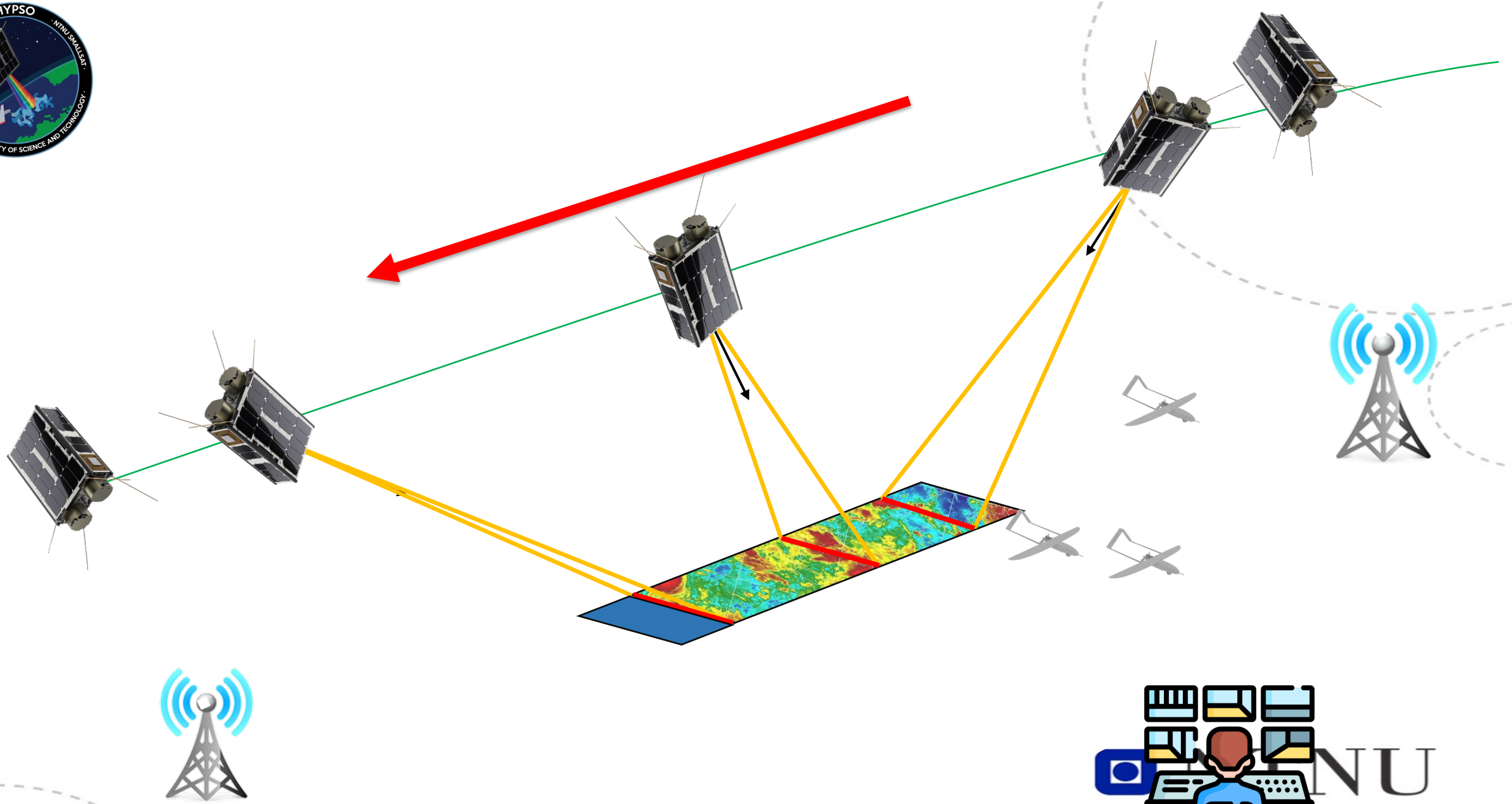
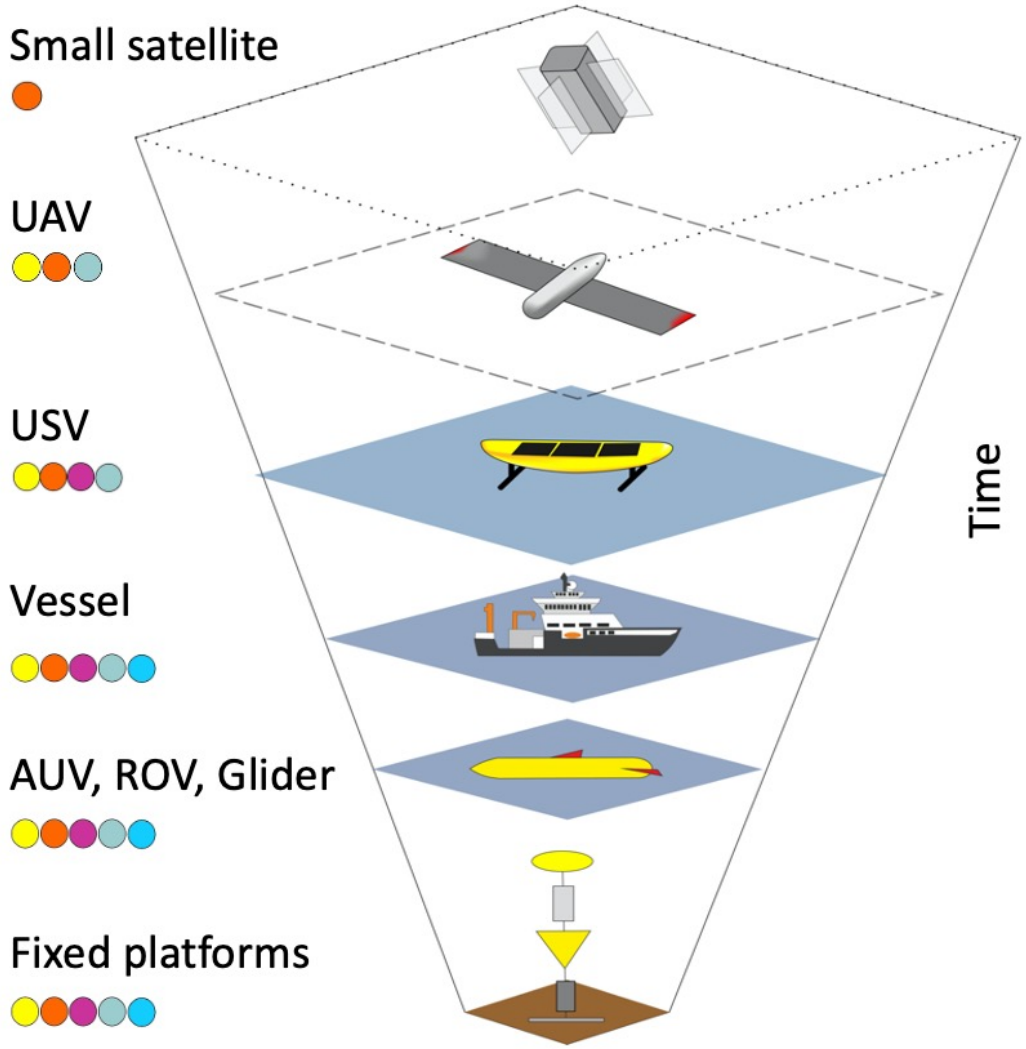
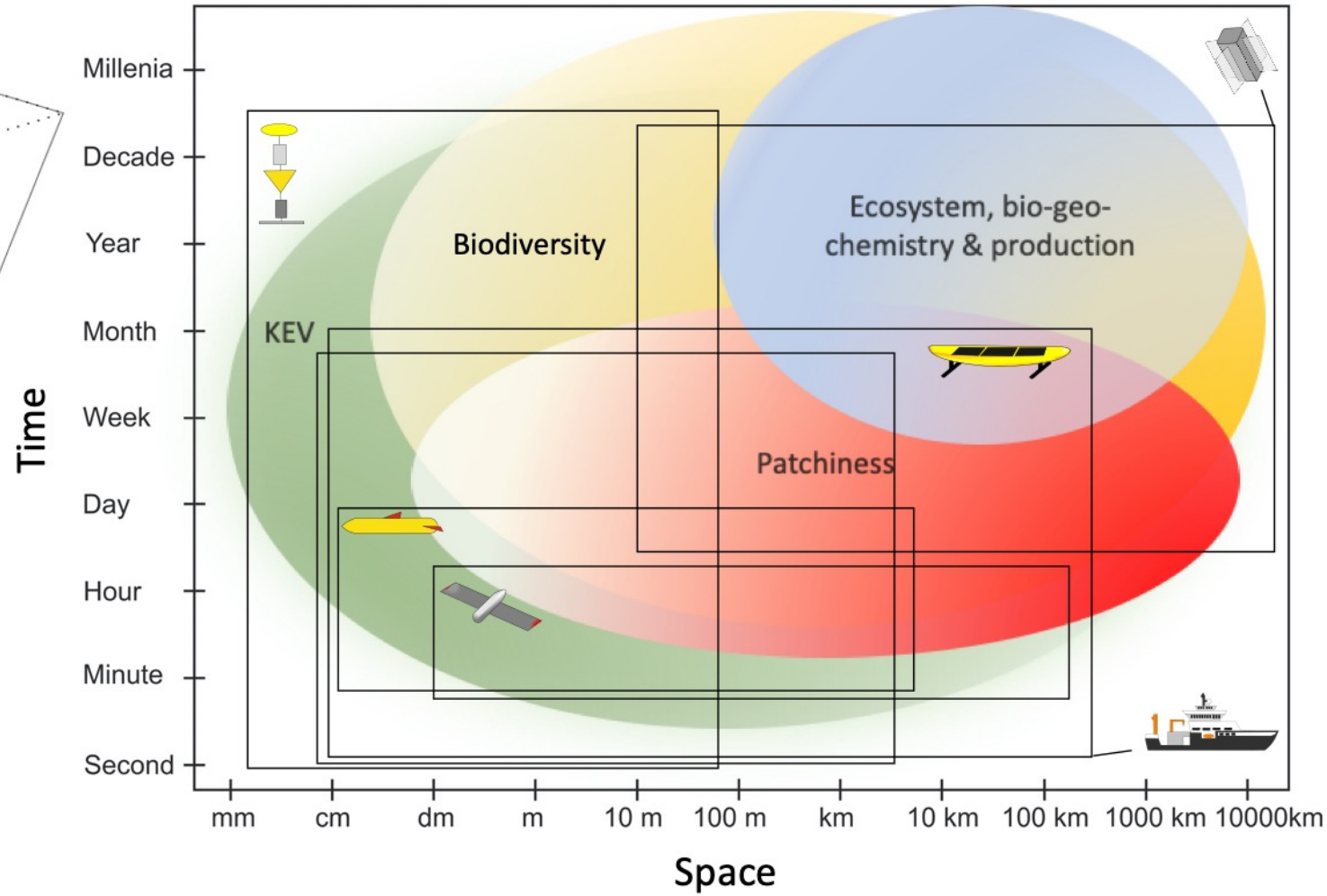


24/05 ++


Nordvest-Spitsbergen
nasjonalpark
Ny-Ålesund
Spitsbergen

The observational pyramid for marine ecosystem science





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