

# Physical Essential Ocean Variables and their Links to Biology and Biogeochemistry

Mark A. Bourassa

With input from OOPC  
and many others



# Whose EOVs?

## ➤ IOOS Physical Variables:

- **salinity, temperature**, bathymetry, **sea level**, surface waves, **surface (vector) currents**, **ice concentration**, surface heat flux, bottom characteristics
- **IOOS Meteorological variables are covered by GCOS**

## ➤ GOOS Physical Variables:

- Based on GCOS Ocean variables

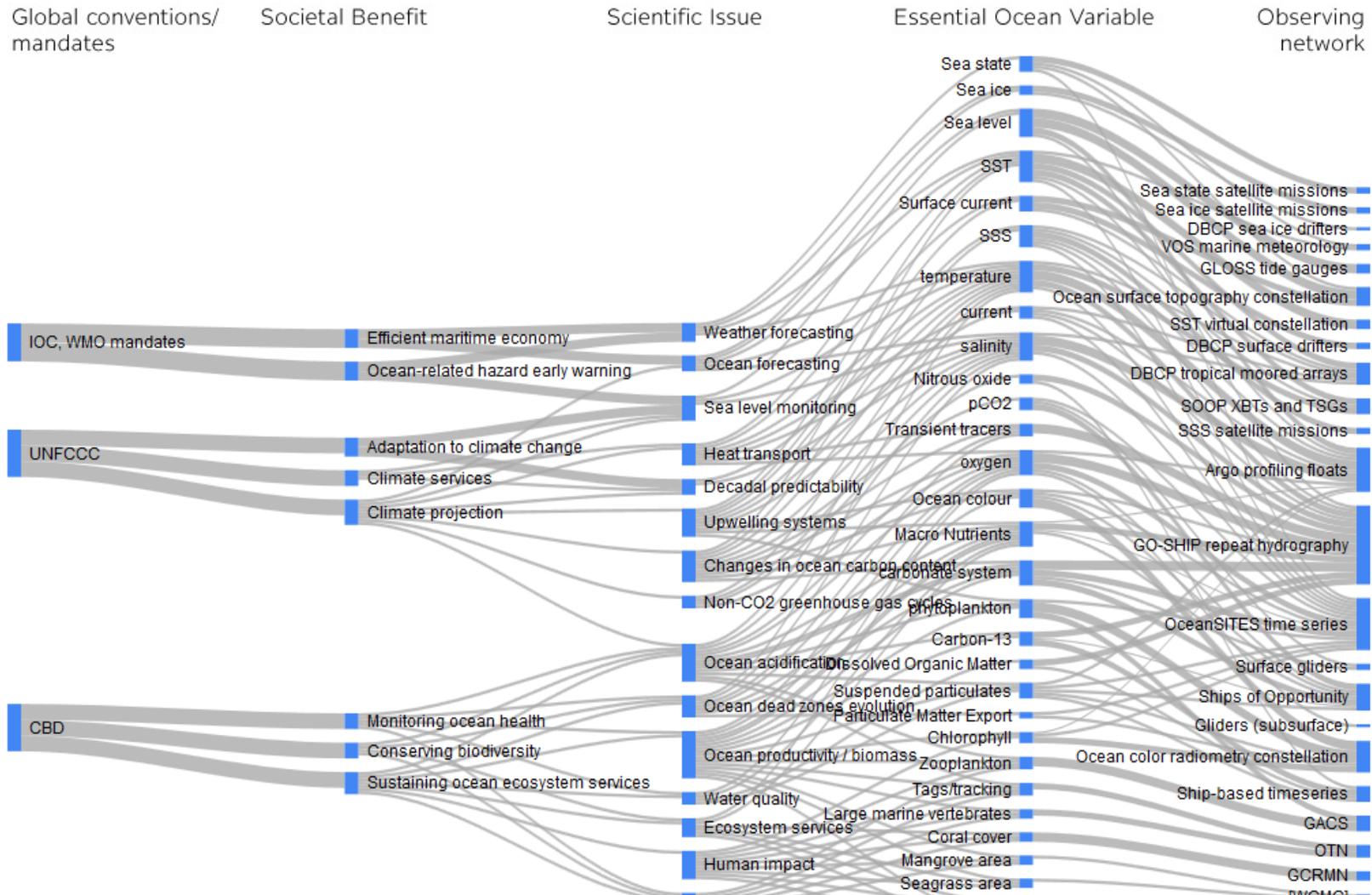
## ➤ Related GCOS Physical Variables:

- Surface: **Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current**, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton.
- Subsurface: **Temperature, Salinity**, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers

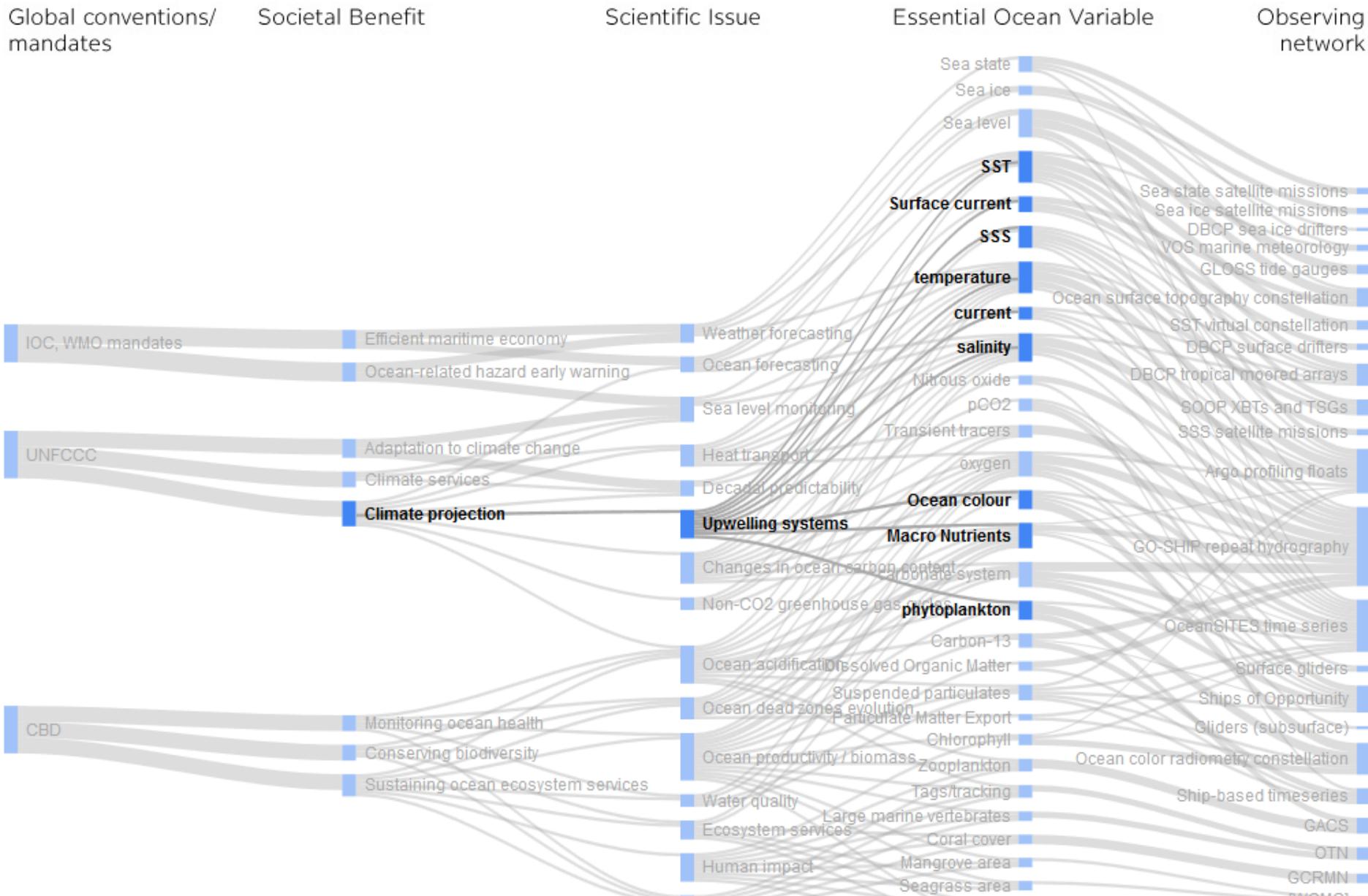
# GOOS Strategic Mapping



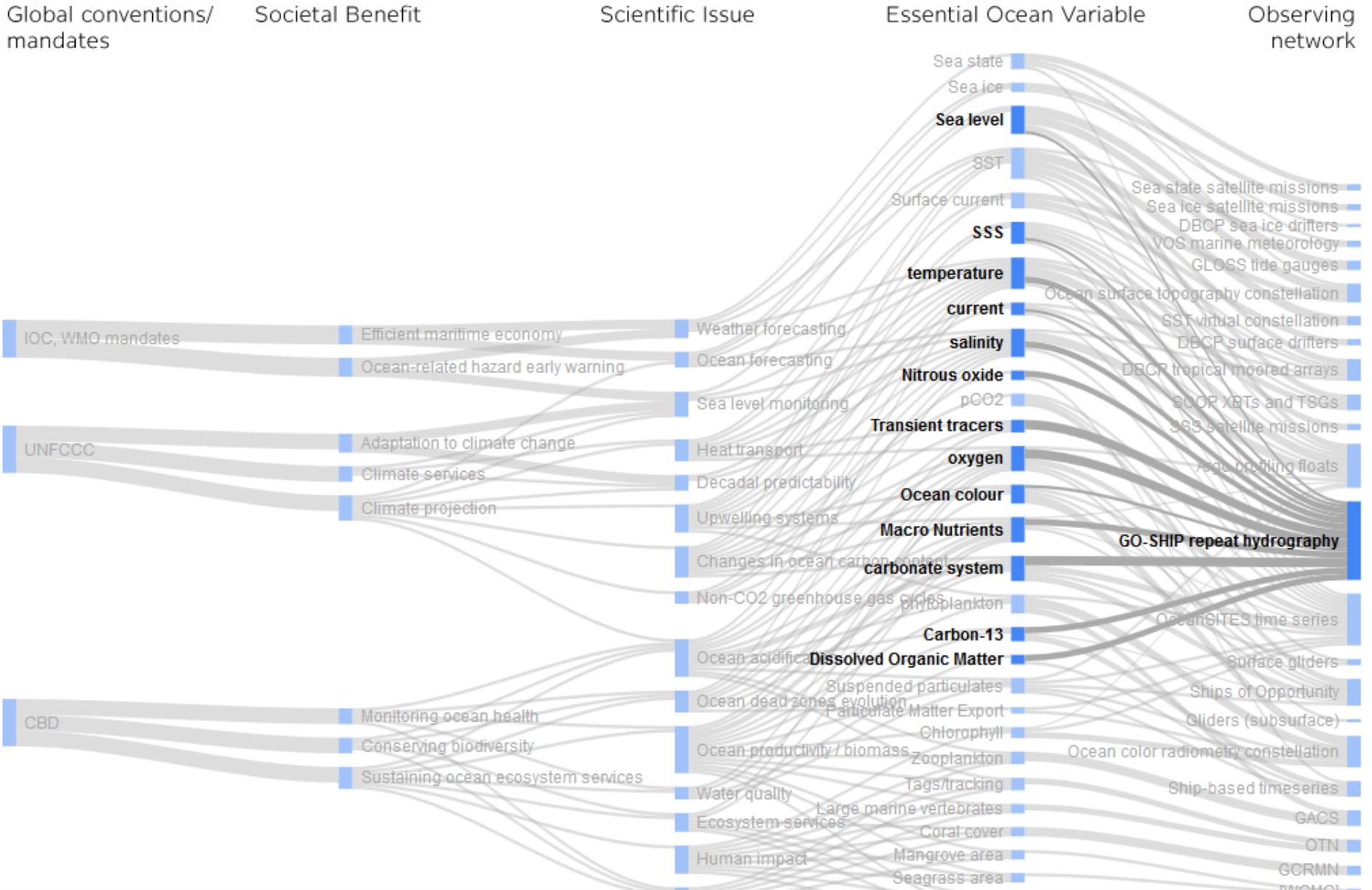
➤ <http://lists-ioc-goos.org/goos-strategic-mapping-graphic>



# Links from Applications to EOVs

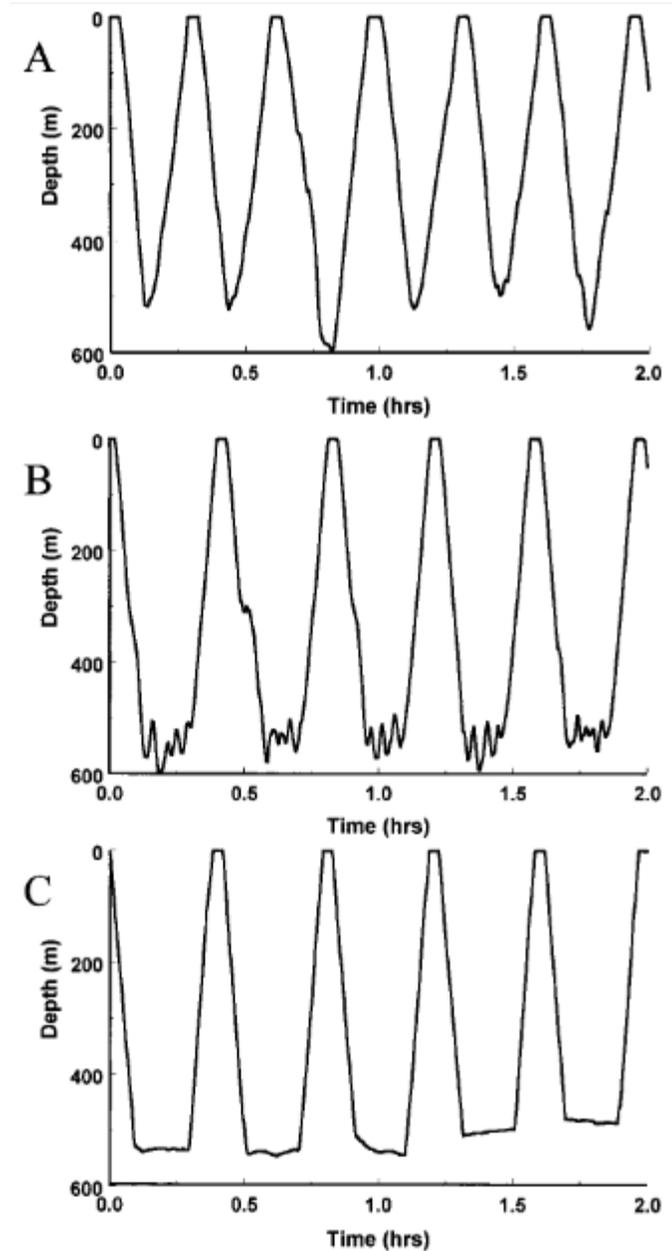


# Observation Network Link to ECV



# Salinity

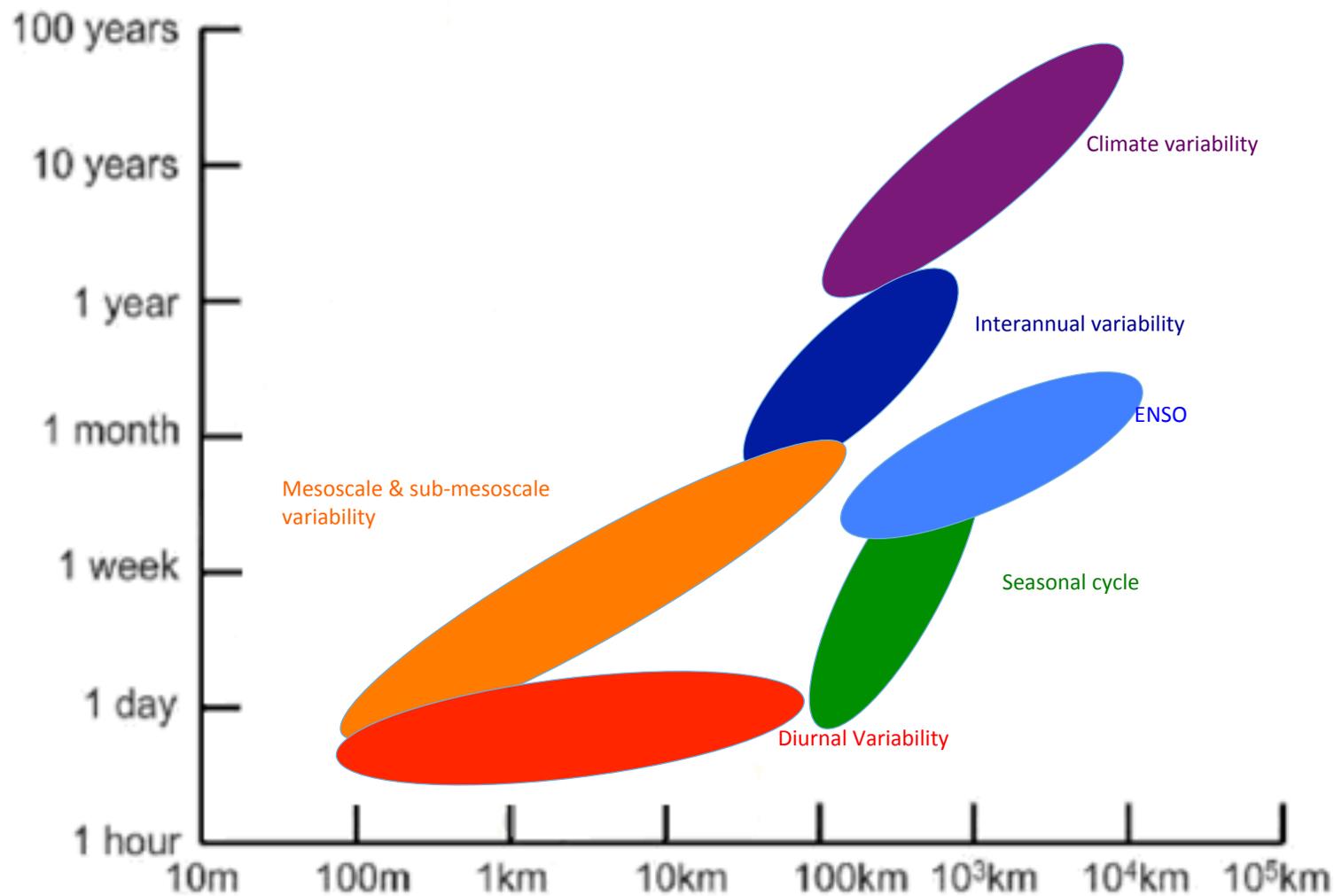
- Salinity modifies buoyancy of water
  - Vertical and horizontal transport
- Some organisms are sensitive to salinity
- Salinity influences chemical processes (e.g., weathering of oil)
- Measurements from pinnipeds can be also used to determine activities of the animal



# Temperature

- Temperature is an indication of energy
- Influences the amount of energy organisms have to spend to keep their bodies in a preferred temperature range
- Modifies the rate of chemical and biological reactions
- Some fish have preferred temperature ranges, and if they can be tracked they can be used to identify the locations of isotherms
- Surface temperature can also be used to identify upwelling regions and some ocean eddies

# Surface Temperature Processes

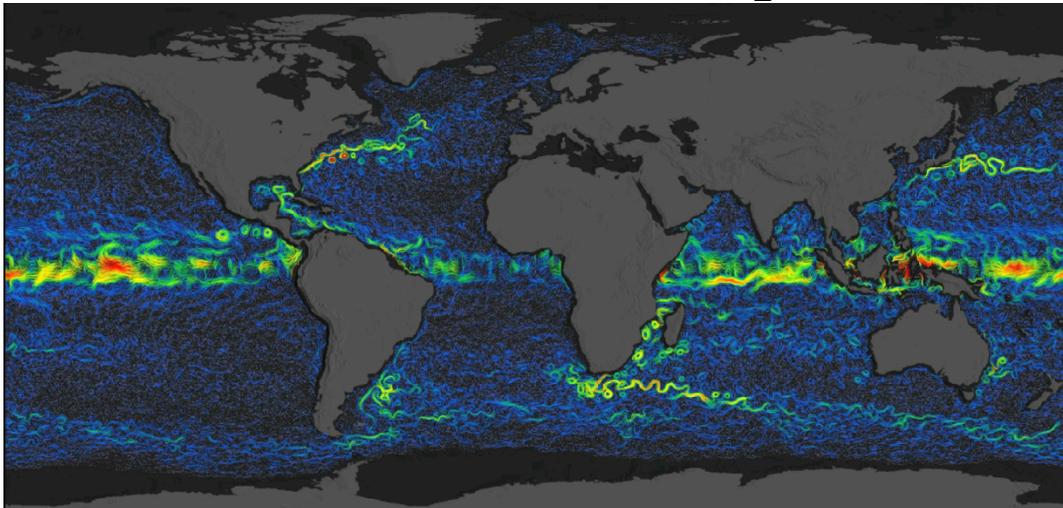


# Sea Level

- Sea level anomalies influence currents and transport
- Changing sea level modifies
  - The solar energy reaching the ocean bottom or reefs.
  - Shoreline characteristics
  - Wetlands and river/ocean interactions,
  - Salinity and temperature of water trapped by reefs
  - Interaction with bottom topography

# Surface Vector Currents

- Surface vector currents are influenced by
  - Sea Level anomalies (geostrophic component)
  - Surface vector wind (stress): Ekman component
  - Surface Waves and Bathymetry: Stokes Drift
  - Rotation of the Earth: Inertial oscillations
- Currents are strongly linked to
  - Transport (energy, nutrients, plants, larva, pollution)
  - vertical mixing ( $\text{CO}_2$  and nutrient fluxes),

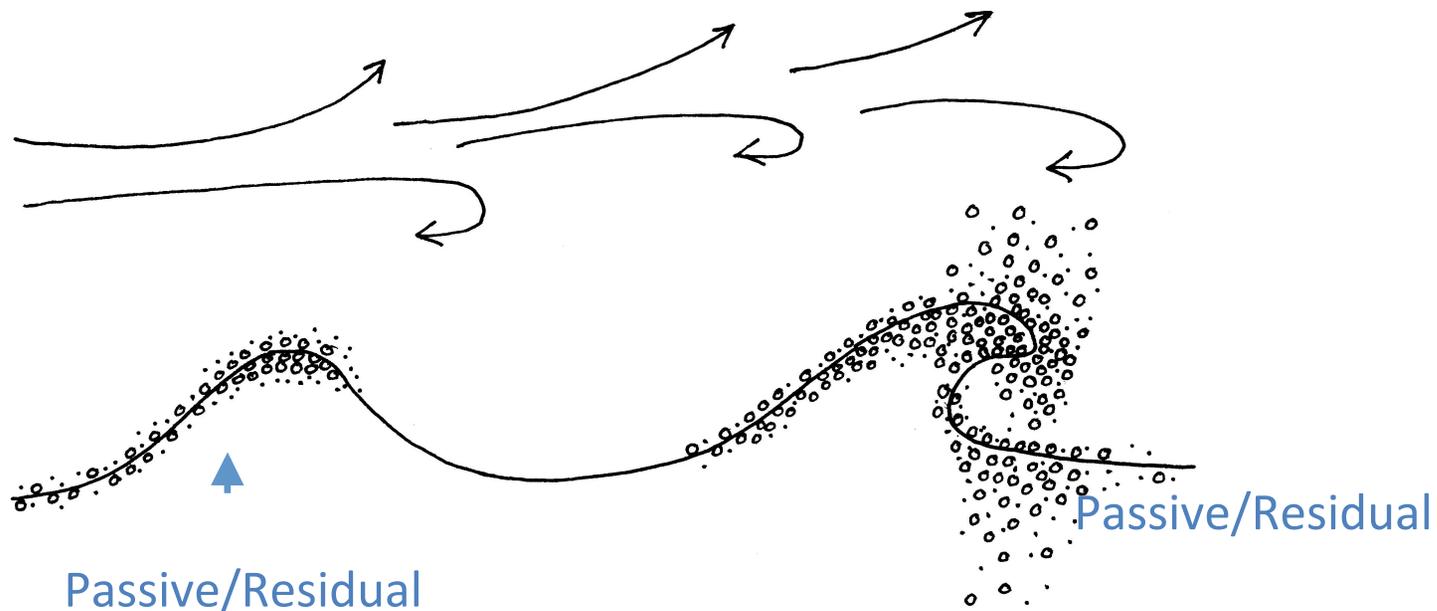


# Bathymetry

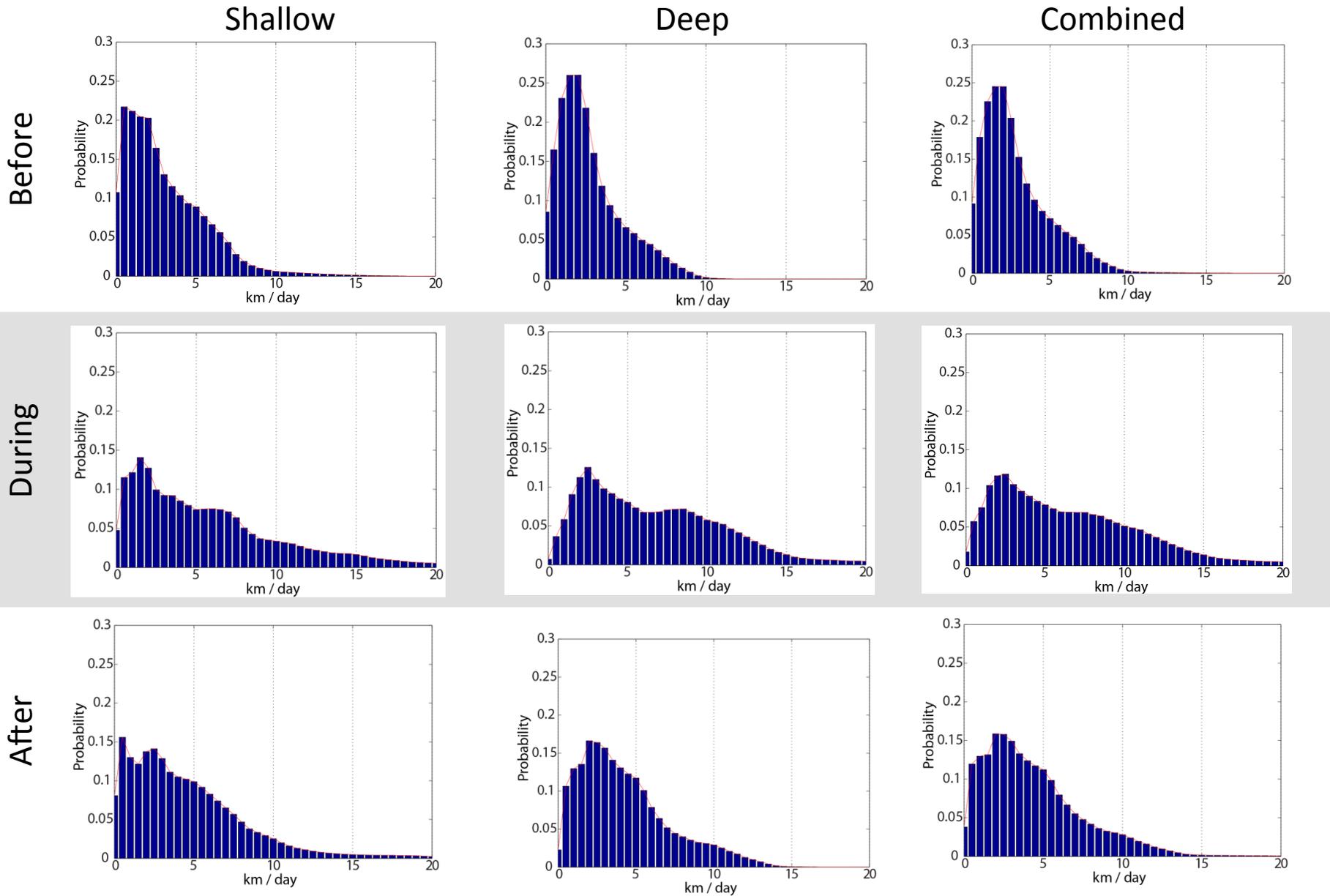
- Bathymetry modifies currents and waves
- Can strongly influence coastal upwelling
  - Linked to vertical transport, and
  - Nutrients

# Surface Waves

- Surface waves: wave height, wave period, wave direction
- Waves modify the surface current (relatively more important on shelves)
- Breaking waves create submerged bubbles and greatly enhance some gas fluxes
- Waves can help bring organisms on and off the shore
- Waves can stir up sediment in shallower water



# Stokes Drift during H. Alex



# Ice Concentration

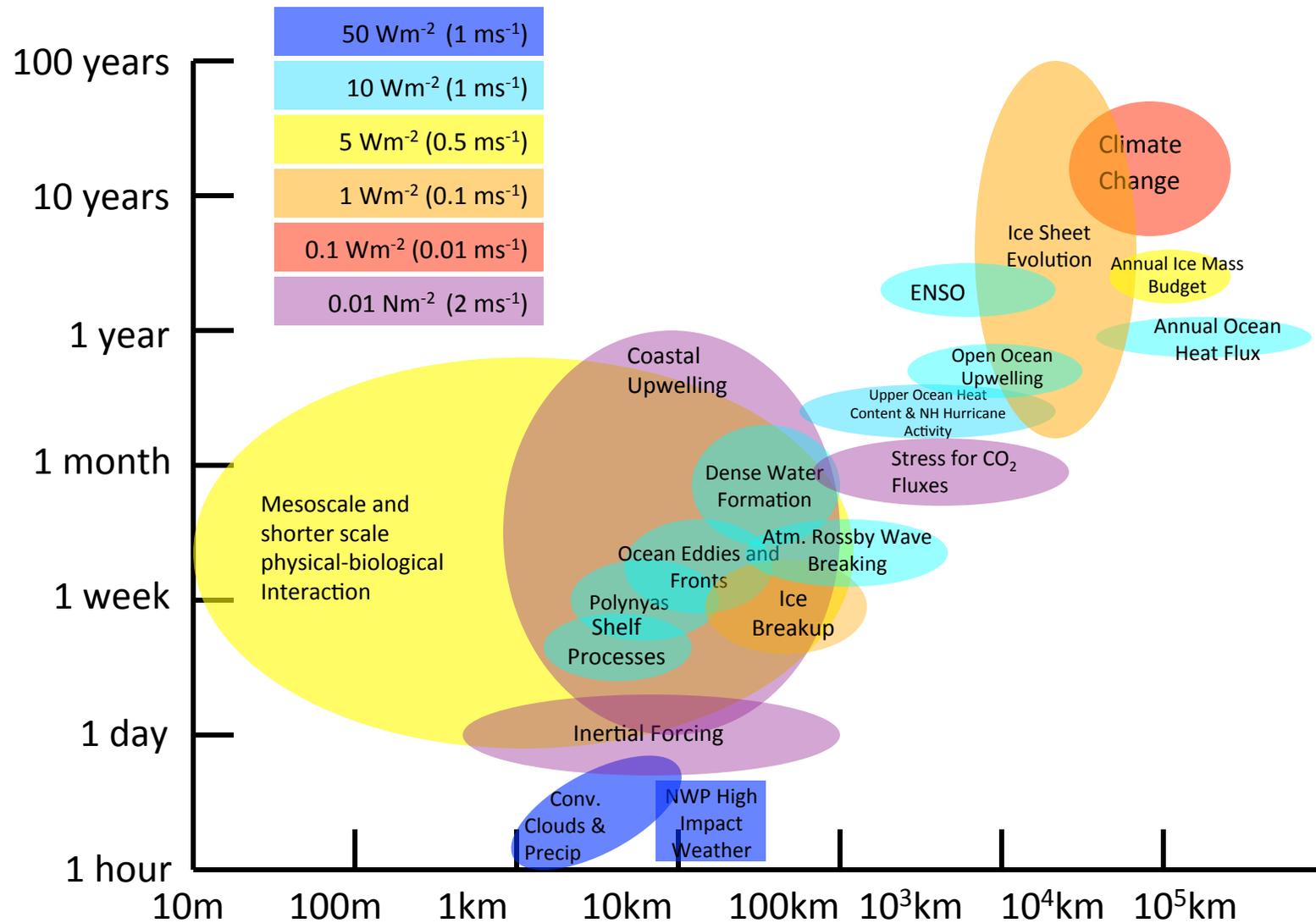
- Sea ice concentration distinguishes solid ice, marginal ice, and open ocean
- The ice edge has been associated with deep convection and strong upwelling.
- The upwelled water can carry nutrients and can be rich in CO<sub>2</sub>
- The nutrient rich water serves as a habitat for many sea organisms and creatures
- Melting ice and aging ice change the nearby salinity
- Ice ponds and leads have a huge impact on the energy budget

# Bottom Characteristics

- With currents and winds influences upwelling
- A source for nutrients
- Bottom roughness influences bottom mixing and currents
  - Which can in turn influence transport of larva and pollution

# Flux (and Wind Accuracies)

## Desired for Various Applications



# Summary

- We know there are many connections between physical EOVS and biogeochemical and biological ECVs
- We are starting to articulate these connections, but have more work to do
- GOOS physical and biogeochemical panels have
  - Recognized the need (as has GOOS leadership), and
  - Are trying to move forward
- We plan on having some of this in place for the next GCOS Implementation Plan

