The Arctic Ocean

Not a textbook sea

Photo: T. Juul-Pedersen
Arctic Ocean Geography

Surrounded by land

- only 3 openings
- Large river influence
  - 9000 km³/yr
Arctic Ocean Geography

Large shelves

- 50% of the total area is shallower than 250 m
- extending up to 1200 km from the coast
- Comprise oceanographically distinct coastal seas

Barents Sea
Kara Sea
Laptev Sea
East Siberian Sea
Chukchi Sea
Beaufort Sea
Chukchi Sea
Arctic Ocean Geography

2 deep basins

- Waters up to 450 years old (compared to 30 in the North Atlantic & 1500 in the North Pacific)
Arctic Ocean Circulation

Inflows
- Atlantic: warm and salty
- Pacific: cold and fresh

Outflows
Mostly shallow
Arctic Ocean Circulation

Surface currents
Arctic Ocean Circulation
Surface currents
Arctic Ocean Circulation
Arctic Oscillation

“an atmospheric circulation pattern in which the atmospheric pressure over the polar regions varies in opposition with that over middle latitudes... on time scales ranging from weeks to decades” (NSDIC)

Positive phase: Pressure low in the Arctic & high at mid-latitudes.

Negative phase: Pressure high in the Arctic & low at mid-latitudes.

J. Wallace
Arctic Ocean Circulation

Arctic Oscillation

Positive phase:
• Pressure low in the Arctic & high at mid-latitudes
• Stronger polar vortex
• More water exits through the Archipelago

Negative phase:
• Pressure high in the Arctic & low at mid-latitudes
• Weaker polar vortex
• More water exits through Fram Strait

Arctic Council, 2001
Arctic Ocean Circulation
Deep water formation
Arctic Ocean Circulation

Deep water formation

Cooling

Sea-ice formation

Brine rejection

Warm, salty Atlantic water

Sea-ice export

Cold, very salty Greenland Sea

Deep Water

Nordic Seas
Arctic Ocean Circulation

Shelf water formation

Sea-ice formation in flaw leads

Requires local excess ice formation over melt

Brine rejection

Fresh Polar Mixed Layer water

Cold, salty intermediate water
Arctic Ocean Circulation

Deep waters

Aagaard et al., 1985
Arctic Ocean Circulation
Deep waters

Jones et al., 1995
Arctic Ocean Water Masses

Salinity (PSU)

Pressure, dbar

Temperature, °C

Canada Basin

Nansen Basin
Arctic Ocean Water Masses

Density: $\sigma_T = (\rho - 1)1000$

Rudels et al., 2004
Intro to Arctic Marine Biogeochemistry

[Graph showing temperature, pressure, salinity, nitrate, silicate, and dissolved oxygen levels in the Nansen and Canada Basins.]

- Temperature, °C
  - Range: -3 to 2
  - Scale: 0 to 40

- Pressure, dbar
  - Range: 0 to 4000
  - Scale: 0 to 3500

- Salinity (PSU)
  - Range: 32 to 36
  - Scale: 0 to 36

- Nitrate and Silicate, μmol/kg
  - Range: 0 to 35
  - Scale: 0 to 35

- Dissolved Oxygen, μmol/kg
  - Range: 240 to 380
  - Scale: 240 to 380

Legend:
- Nansen Basin
- Canada Basin

Data points indicate variations in biogeochemical properties across different depths and locations in the Arctic Marine ecosystem.