An assessment of Arctic Ocean freshwater content changes from the 1990s to the 2006-2008 period and beyond


SUMMARY

1. Observed increase in liquid freshwater (LFW) reservoir by 20% (+8400±2000 km$^3$), equivalent to annual freshwater export (liquid and ice) from the Arctic.
2. Increase in LFW of 6120 km$^3$ in NAOsIm simulation.
3. Preliminary analysis of observations indicates some decrease and levelling of LFW content from 2008 to 2011.
4. Observed LFW changes primarily due to changes in the mean salinity, and only 1/3 layer thickness (Ekman pumping).
5. Mean salinity changes associated with temporary change in European river water pathways during 1990s.
6. Layer depth / Ekman pumping changes likely regular (c.f. increase in LFW of 6120 km$^3$ in NAOsIm simulation).
7. Changes in freshwater induce regional changes in sea surface dynamic height.

Challenges

- How? (Objective mapping → LFW inventories)
- How? (LFW inventories)
- How? (Area integral)
- How? (Differences between maps / time periods)
- How? (Area integral)
- How? (LFW inventories)
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- How? (Area integral)
- How? (LFW inventories)

Contributors to Changes

- Changes between 1992-1999 and 2006-2008: observed JAS mean salinity between the surface and 34 isohaline (top, left) and the depth of this isohaline (top, right); all-year net thermodynamic ice melt in the simulation (bottom, right) and timeseries of vertical velocity due to Ekman pumping (bottom, left; dotted line) and the displacement of the 34 isohaline (solid line) in the simulation.

Liquid Freshwater Changes upper Arctic Ocean Basins 92-99 to 06-08 (JAS)

- Changes in liquid freshwater inventories in the upper Arctic Ocean basins between JAS 1992-1999 and 2006-2008 (positive=increase) from observations (left) and ice-ocean model simulations (right).
- Liquid freshwater is relative to a salinity of 35. The integral over the region covered by the grid in the left-hand plot is given in bold cyan (water depth more than 500 m and near the prime meridian north of 82’N).

REFERENCES


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How?

1. Liquid freshwater (LFW) from salinity profiles
2. Outlier elimination
3. Objective mapping (Bretherton et al., Böthe et al.)
4. Map of LFW inventories for specified time periods
5. Differences between maps / time periods
6. Area integral → LFW content

Simulated regional mean wind/ice-induced ocean surface stress regional driver of isohaline depth changes.
- Significant ice melt only north of the Bering Strait and on Siberian shelves in simulation.
- Shelves are not important for liquid freshwater storage variability in simulation.
- Changes in freshwater induce regional changes in sea surface dynamic height.

Challenges

- Basis in observational mapping toward end 2000s?
- Influence on ocean circulation in recent two decades?