On the freshwater content modeling in the Arctic basin: a sensitivity study

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Model and Data uncertainties that change FW balance in numerical experiments

1. Precipitation rate (in summer (10%) and in winter (80-120%), Yang et al. 2005)
2. River runoff (ungauged volume is 30%, increasing trend of 2.9 ± 0.4 km³
3. Pacific water (since 2001 Bering Strait freshwater variability is ~25% of the total annual Arctic river run-off (Woodgate et al. 2006))
4. Ice model (Radiation and Cloudiness)
5. Evaporation
6. Vertical and horizontal diffusion

Coupled Ice-Ocean Model

3D Ocean Circulation Model of ICMMG based on z-level vertical coordinate approach

Ice model-CICE 3.14 (elastic-viscous-plastic)

On the freshwater content modeling


Vertical and horizontal diffusion

Shiklomanov 2010)

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– Salty and warm Atlantic waters in Arctic become colder faster than fresher, therefore their density increases and their position decreases.
– Cold and fresher Arctic waters in Atlantic become warmer faster than saltier, therefore their density decreases and they tend to get upper position.

Vertical Diffusion

• Model uncertainty
  – Constraining by numerical stability
  – Regulate surface salinity minimum, formed by precipitation, river runoff and saltier water
  – Regulate the Atlantic and Pacific water layer thicknesses, their interaction and their involvement into the surface layer processes

Different salinity and temperature vertical diffusion

• Lower A1/A2 ratio causes water to change its temperature faster than its salinity
• Salty and warm Atlantic waters in Arctic become colder faster than fresher, therefore their density increases and their position decreases
• Cold and fresher Arctic waters in Atlantic become warmer faster than saltier, therefore their density decreases and they tend to get upper position

Base model experiment: GSA

Positive anomaly in 1958

Negative anomaly in 1953

GSA reduction: positive anomaly

GSA reduction: negative anomaly

In 1988 the first known GSA was formed in Greenland Sea. During this period the difference between FW volumes reached its maximum. The positive anomaly of precipitation in the GSA formation area, due to warming of Artic waters, seems to be the main reason. Then the change of the sea surface temperature and sea ice extent on the surface caused the Atlantic water mass to increase, dense and cool Arctic waters descend, and the freshwater salinity of the surface layer decreases.