The Arctic Ocean volume and heat transports in 2004-2010

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1. Introduction
Entire Arctic boundary through Bering, Davis, Fram Straits and Barents Sea Opening (BSO) has been monitored since 2004 (fig. 1). Gathering of all the data together allows for a comprehensive estimate of oceanic transports across the Arctic gateways. In this study, we focus on Oct. 2004 - May. 2010 and aim to:
- quantify volume & heat transport variabilities both on seasonal & inter-annual time scale.
- discuss reference values to calculate heat transports.

2. Data
- ~1,000 moored instruments in Davis, Fram, Bering Straits and BSO.
- PIOMAS sea ice thickness & velocity output data.

3. Method
3.1. Monthly TSV fields
- Hourly data are lowpass filtered with a 27 days cutoff Butterworth filter.
- Data gaps are filled by its mean annual cycle.
- Linear interpolation is applied for vertically and horizontally (fig. 2).

3.2. Box inverse model
- Obtain volume conserved velocity fields for 68 consecutive months.
  1. Provide first guesses for each parameter.
     - Ocean circulation, Sea ice (PIOMAS), surface FW input (set 180 mSv).
  2. 1,283 unknowns are derived from 12 constraints.
     - Mass & salt constrains for 5 defined layers & whole layer.
     - Unknowns: Bottom vel., Sea ice vel., Diapycnal vel., Surface FW input.

4. Results
4.1. Volume conserved velocity field
- Initial monthly imbalances are -3.0±2.2 Sv.
- Most of the adjustment happens in the Fram Strait and BSO (fig. 3).
- The velocity field captures major currents across the gateways (fig. 3).

4.2. Volume transport variabilities
- Net transports is almost zero in each month (fig. 4).
- Seasonality (fig. 4, table 1).
  - e.g. strong BSO inflow in winter, strong Bering Strait inflow in summer.

4.3. Heat transport variabilities
- Oceanic plus sea ice heat transport is 180±57 TW (fig. 5).
- Seasonality: ~250 TW in November, ~100 TW in May (fig. 5).
- Inter-annual variability: 196±50 TW in 2004-05, 165±71 TW in 2007-08 (fig. 5).

5. What changes by changing reference temperature?
- Total heat transport does not change (fig. 7).
- Partial temperature transport in the section does change (fig. 7).
  - e.g. WSC: 33±14 TW-eq (1.01±0.18°C), 113±34 TW-eq (-1.8°C).

6. Summary
- Quantification of volume transport variabilities in the four Arctic gateways under mass and salt constrains using box inverse model.
- The oceanic plus sea ice heat transport is 180±57 TW.
- It’s seasonal variability: ~250 TW in Nov., ~100 TW in May (fig. 5).
- It’s inter-annual variability: 196±50 TW in 2004-05, 165±71 TW in 2007-08 (fig. 5).

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