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### OBSERVED SEASONAL VARIATION OF THE ARCTIC OCEAN HEAT AND FRESH WATER BUDGETS

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The Arctic Ocean has been accumulating fresh water (FW) over last decades [Rabe et al. 2014 GRL], which has a potential impact on deep water formation in the high latitude North Atlantic. In order to observe oceanic heat and FW exchanges between the Arctic and surrounding seas, five research groups in the world maintain the Arctic boundary mooring observation lines in Davis Strait, Fram Strait, Barents sea opening (BSO) and Bering Strait over many years.

Tsubouchi et al. [2012 JGR] is the first study to estimate a synoptic view of pan-Arctic heat and FW transports in summer 2005 using box inverse model. Followed by Tsubouchi et al. [2012], this study aims to establish an "observation based" full annual cycle of pan-Arctic boundary transports from September 2005 to September 2006. The oceanic transports are estimated based on 135 moored instruments across the pan-Arctic boundary. Sea ice transports are estimated based on PIOMAS data [Zhang and Rothrock, 2003 JGR]. Monthly initial net volume transport is  $-0.3 \pm 2.9$  (Sv), and that of FW imbalance is  $19 \pm 81$  (mSv). 12 months volume and salt conserved velocity fields are generated using box-inverse model. The obtained volume transports are reasonable both in magnitude and variation across the four Arctic gateways:  $-1.6 \pm 0.7$  (Sv) in Davis Strait,  $-1.0 \pm 1.0$  (Sv) in Fram Strait,  $1.8 \pm 1.2$  (Sv) in BSO and  $0.7 \pm 0.6$  (Sv) in Bering Strait. Sea ice volume transport is  $-58 \pm 37$  (mSv). The associated oceanic and sea ice heat transports are  $142 \pm 43$  (TW) and  $23 \pm 15$  (TW), respectively. The associated oceanic and sea ice FW transports are  $149 \pm 55$  (mSv) and  $48 \pm 31$  (mSv), respectively.

This study also aims to address important questions to design future sustained pan-Arctic observation lines quantifying the uncertainties associated with the results. The specific questions are: (1) Does current configuration of pan-Arctic mooring array monitor the major oceanic heat and FW exchanges between the Arctic Ocean and surrounding Oceans? (2) Where is the most efficient place to add additional instruments to increase the accuracy of measurements?