PUBLICATIONS

Geophysical Research Letters

Supporting Information for

A model-based investigation of the recent rebound of shelf water salinity in the Ross Sea

Jingwei Zhang [1,2], Xuebin Zhang[1], Matt A. King [2,3], Kewei Lyu[4]

[1]Climate Science Centre, CSIRO Environment, Hobart, Australia

[2]School of Geography, Planning, and Spatial Sciences, University of Tasmania, Hobart, Australia

[3]The Australian Centre for Excellence in Antarctic Science, University of Tasmania, Hobart, Australia

[4]State Key Laboratory of Marine Environmental Science, College of Ocean and Earth Sciences, Xiamen University, Xiamen, China

Overview

We present here additional information related to oceanography data, model simulation setup, summary of perturbation experiment settings, and the additional experiment and analysis (Figures S1 to S7).

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3. Figures

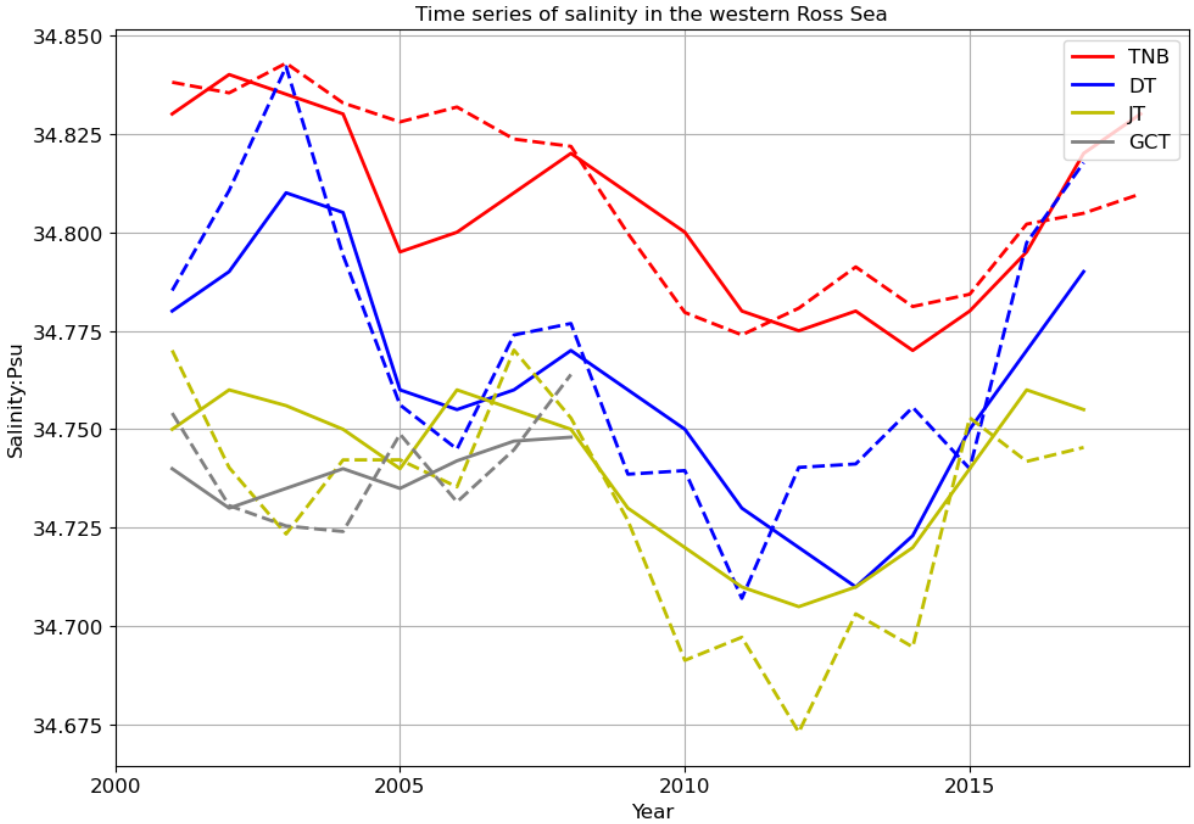


Figure S1 | Comparisons of salinity between model experiments and observations. Time series of averaged DSW salinity measured (solid line) and model-simulated (dashed line) near the seafloor at Terra Nova Bay (TNB, red line), Drygalski Trough mouth (DT, blue line), Joides Trough (JT, yellow line) and Glomar Challenger Trough (GCT, grey line) from 2000 to 2018.

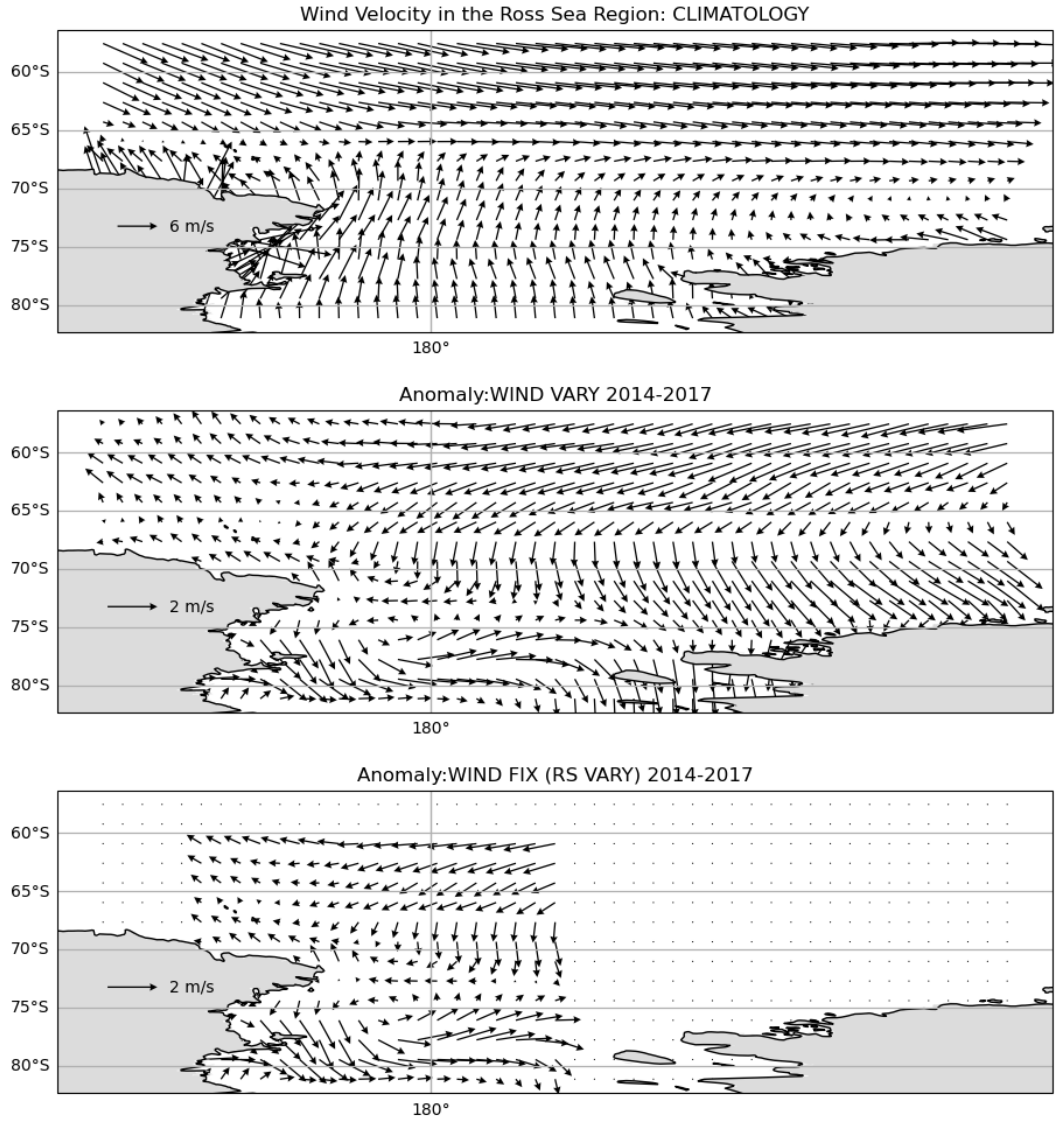


Figure S2 | Interannual variability of winds in the western Ross Sea. The Ross Sea-Only simulation employed a fixed wind forcing and real-time other atmospheric forcing approach for the entire Southern Ocean, except for the western Ross Sea (160ºE-170ºW, 60ºS-80ºS), where real-time wind forcing was implemented.

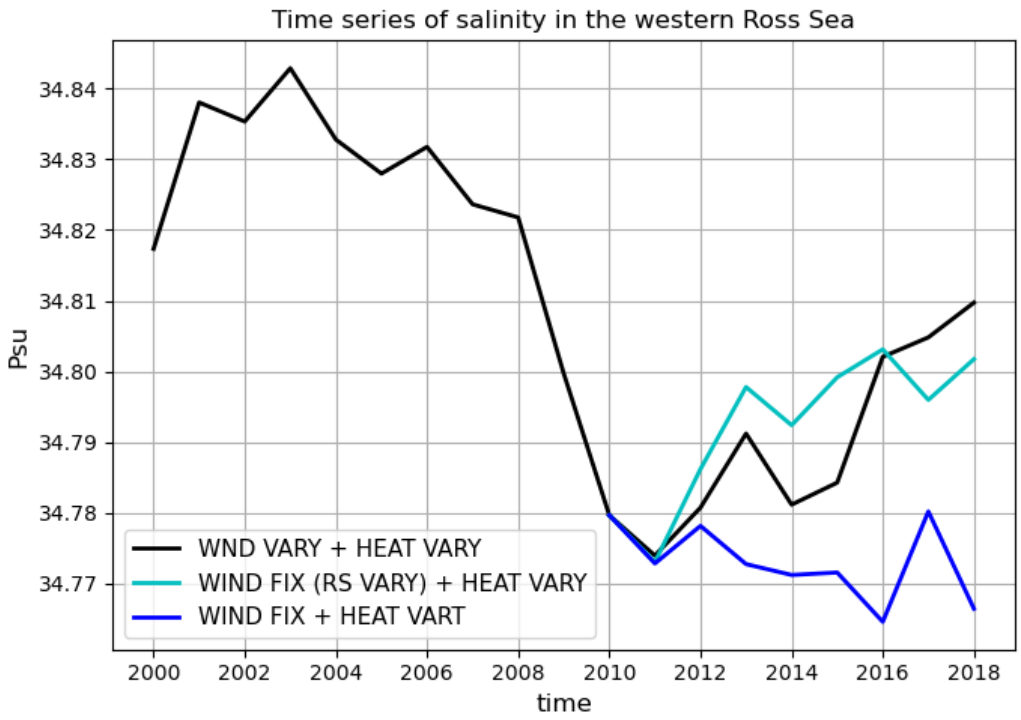


Figure S3 | Simulated DSW salinity from further perturbation experiments Time series of averaged DSW salinity simulated by All Vary (black line) from 2000 to 2018, Wind Fix (Ross Sea Wind Vary) + Heat Vary (cyan line) and Wind Fix + Heat Vary (blue line) from 2010 to 2018 near the seafloor in TNB (details in Supplementary 1.4. Ross Sea-only wind experiment).

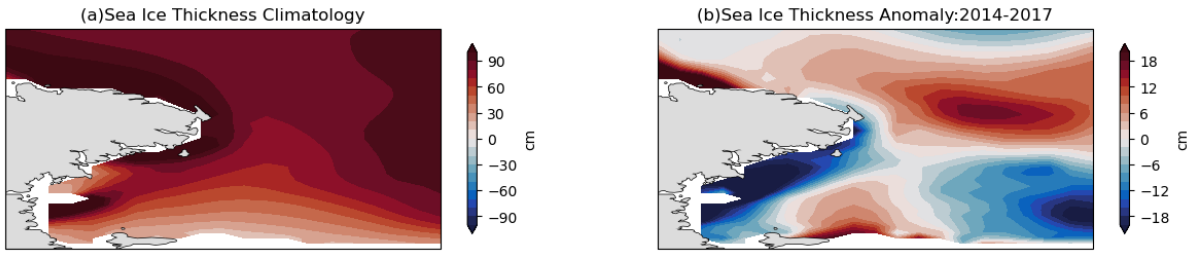


Figure S4 | Sea ice thickness in wind experiment. Climatology (**a,** All-Fixed) and 2014-2017 anomaly (**b,** Wind-Vary minus All-Fixed) of sea ice thickness induced by wind forcing.

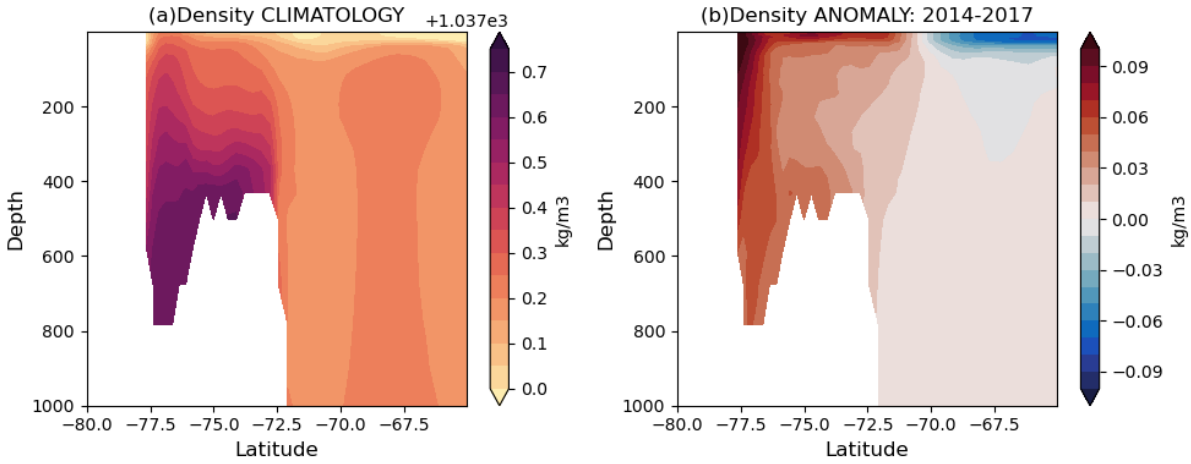


Figure S5 | Density change in surface heat flux experiment. Zonal averaged climatology (**a**, Wind-Vary) and 2014-2017 anomaly (**b**, All-Vary minus Wind-Vary) of ocean density in heat flux experiment.

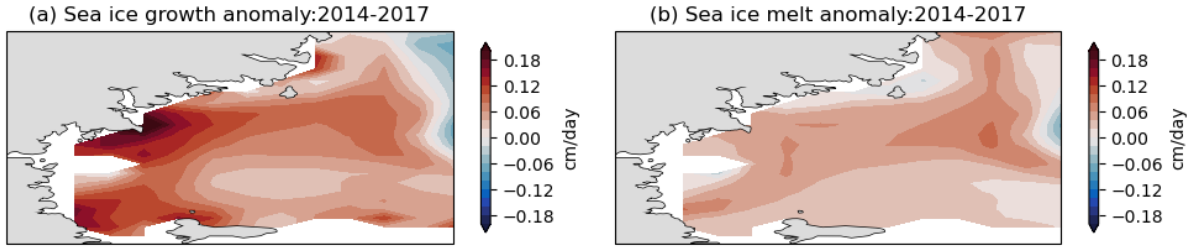
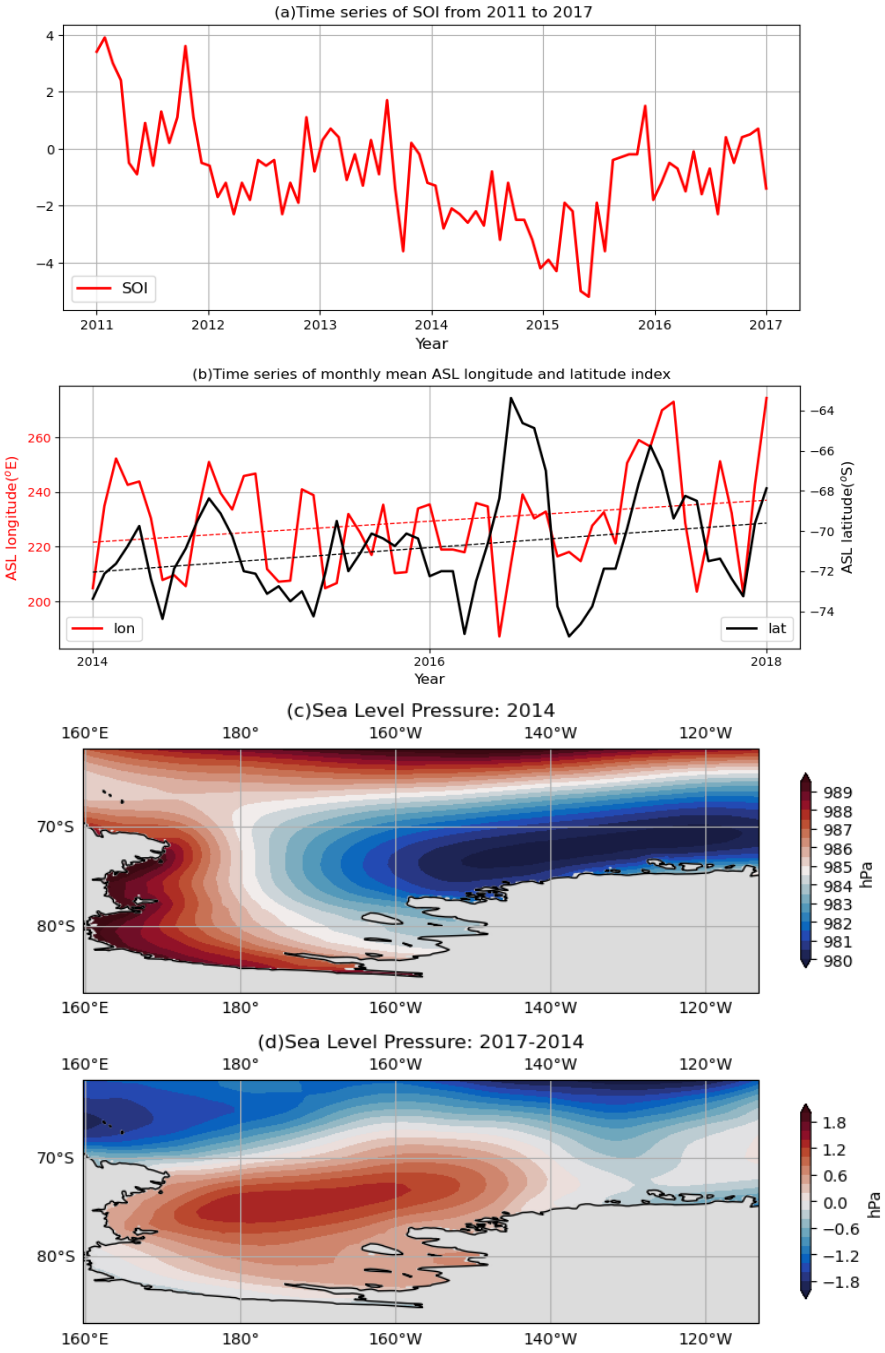


Figure S6 | Sea ice growth and melt in surface heat flux experiment. Averaged sea ice anomalies (All-Vary minus Wind-Vary) in growth (**a**) and melt (**b**) between 2014 to 2017 in heat flux experiment.



77 **Figure S7 | Wind forcing, and surface heat flux driven by climate anomalies**. (**a**) Time
78 series of SOI between 2011 to 2018. The period from 2014-2017 is characterized by negative
79 SOI. (**b**) Time series (solid line) and trends (dashed line) of ASL central latitude (black line)
80 and longitude (red line) from 2014-2018, within the ASL sector (170°E-298° E, 80°S-60° S).
81 Sea level pressure in 2014 (**c**), and anomaly in 2017 (**d**).

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