Drift of Arctic Freshwater System in CESM initialized Decadal Prediction

Tarun Verma

Wilbert Weijer, Jiaxu Zhang, Milena Veneziani

Los Alamos NATIONAL LABORATORY EST. 1943

Steve Yeager, Gokhan Danabasoglu

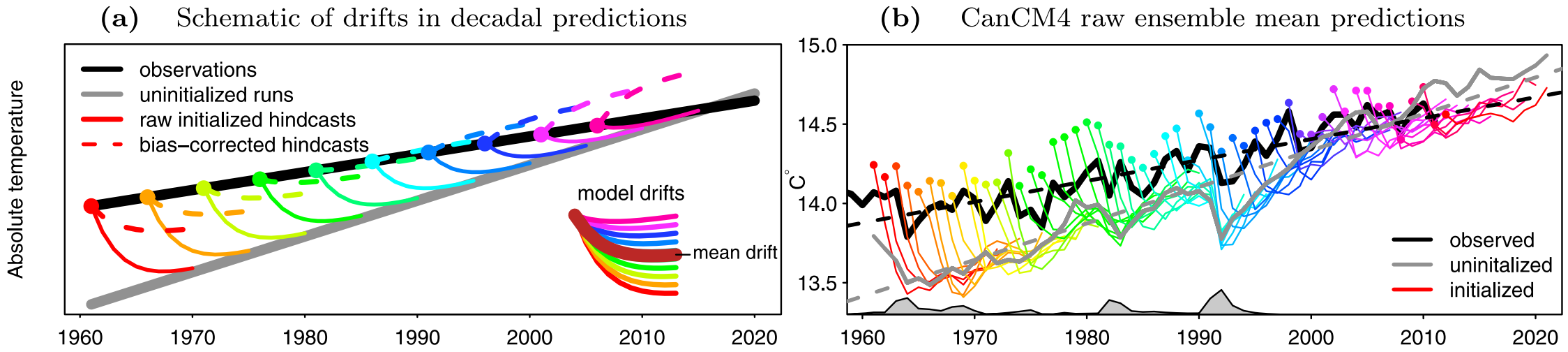
National Center for Atmospheric Research, Boulder, CO

CESM Initialized Decadal Prediction System

Yeager et al. 2018

	CCSM4-DP	**CESM-DPLE**
Model	CCSM4	**CESM1.1**
atm	CAM4 (FV 1°, 26 levels)	**CAM5** (FV 1°, **30 levels**)
ocn	POP2 (1°, 60 levels)	POP2 (1°, 60 levels) **with BGC**
ice	CICE4 (1°)	CICE4 (1°)
lnd	CLM4	CLM4
UI ensemble	6-member CCSM4 twentieth-century ensemble (Meehl et al. 2012)	**40-member CESM twentieth-century Large Ensemble** (Kay et al. 2015)
Forcing		
through 2005	CMIP5 historical	CMIP5 historical
from 2006 onward	CMIP5 representative concentration pathway (RCP) 4.5	CMIP5 **RCP 8.5**
Initialization		
method	Full field	Full field
atm	UI	UI
ocn	CORE-forced FOSI	**CORE*-forced FOSI**
ice	CORE-forced FOSI	**CORE*-forced FOSI**
lnd	UI	UI
Ensembles		
Ensemble size	10	**40**
Start dates	Annual; 1 Jan 1955–2014 (*N* = 60)	Annual; **1 Nov 1954–2015 (*N* = 62)**
Ensemble generation	Variable Jan start days and round-off perturbation of atm initial conditions	Round-off perturbation of atm initial conditions
Simulation length	120 months	122 months

Model Drift in (full field) Initialized Predictions

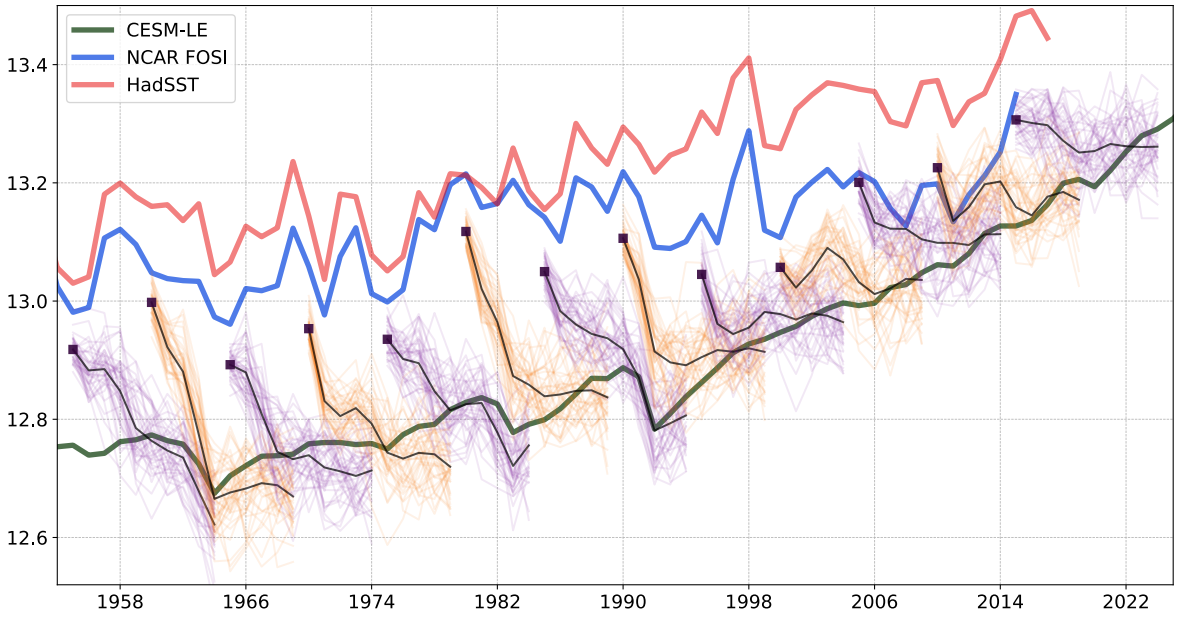


Kharin et al. 2012

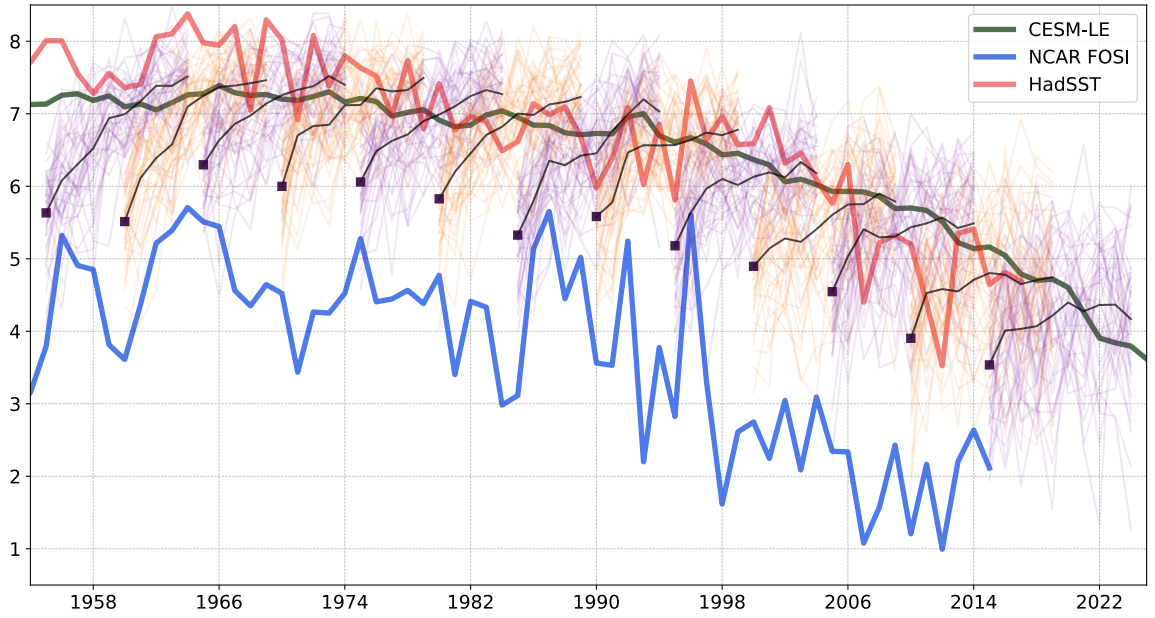
- Mismatch in initial and model mean state often leads predictions to drift
- Systematic nature of the drift allows a posteriori statistical correction

Examples of Drift in CESM-DPLE

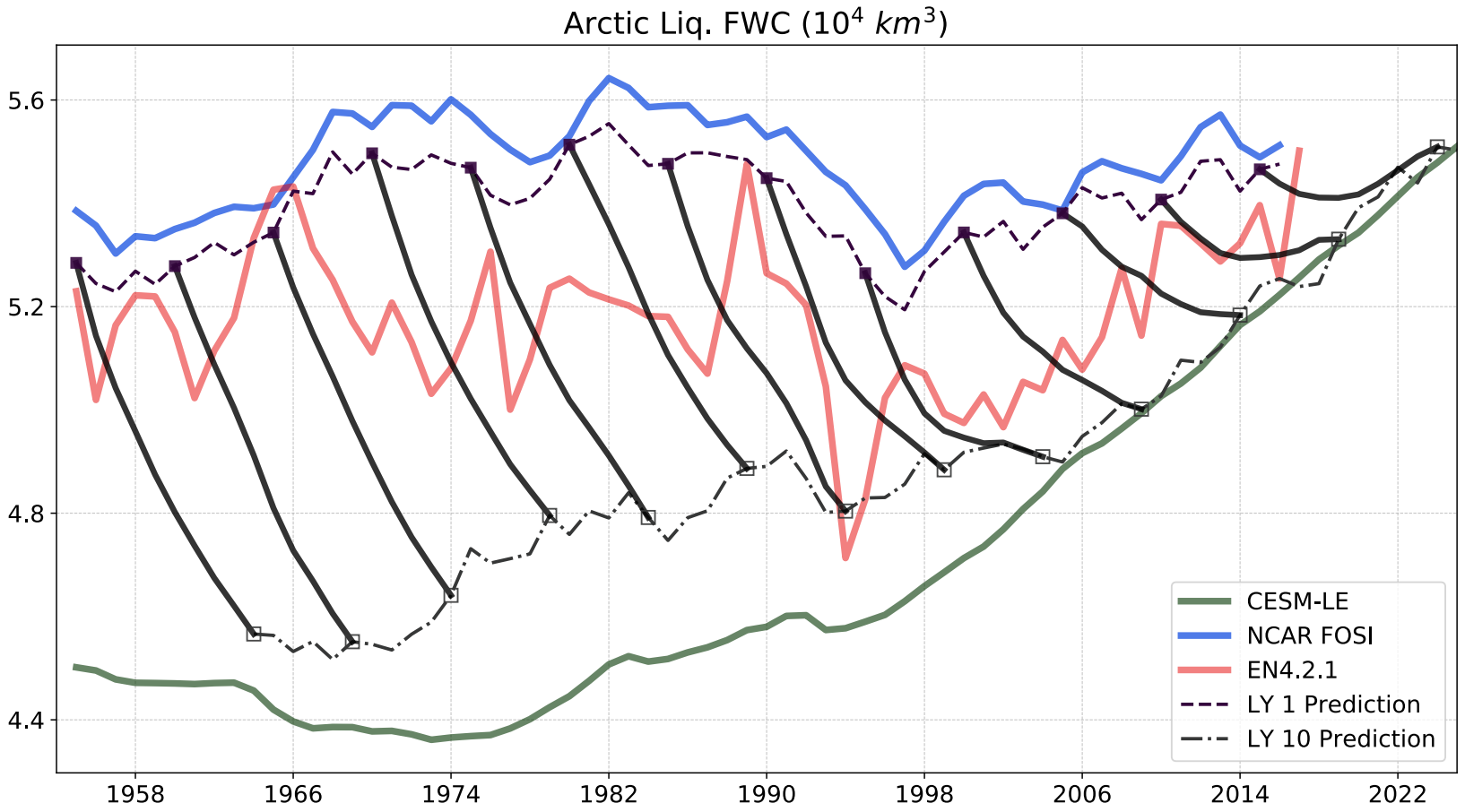
Global Mean SST



Sep. NH Sea ice extent

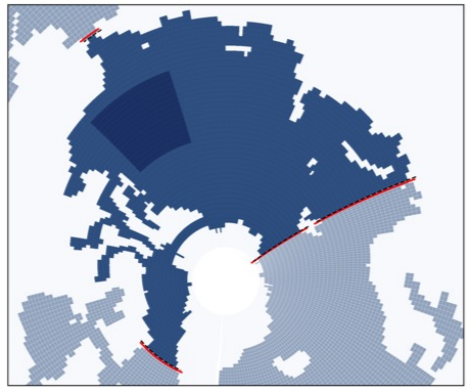


Drift in Arctic Liq. Freshwater Content



$$FWC_{liq} = -\int_0^{z_{ref}} \frac{S - S_{ref}}{S_{ref}} dz$$

$S_{ref} = 34.8$

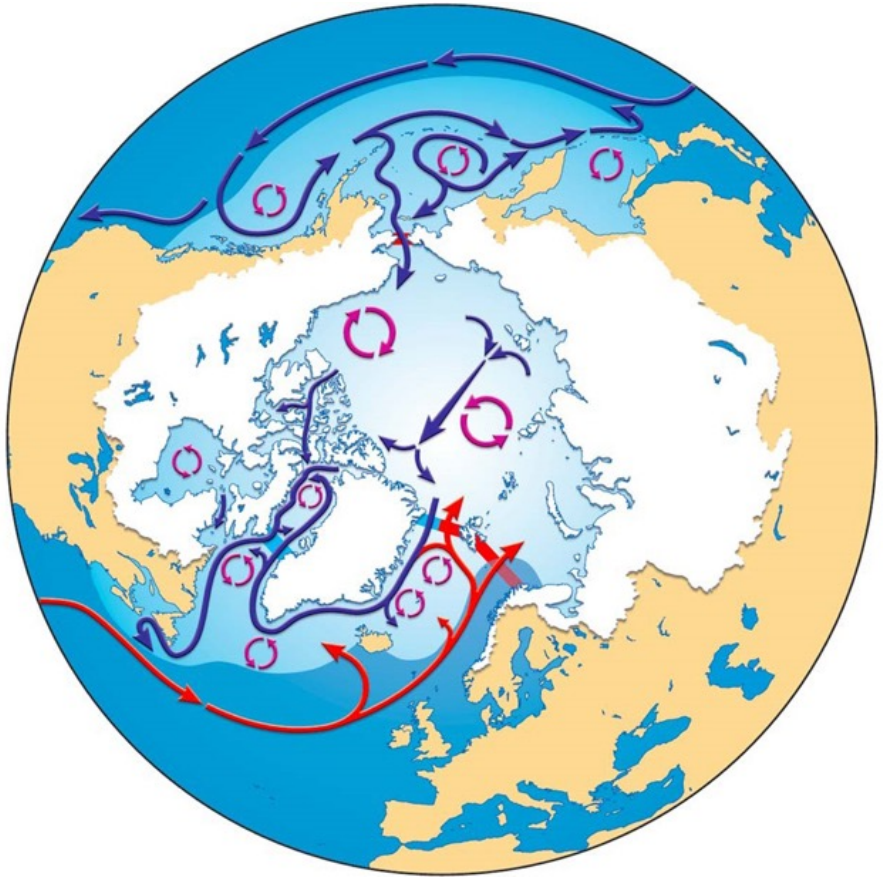


Domain & Gateways

- An opportunity to study the coupled model's behavior in getting rid of excess freshwater from the Arctic.

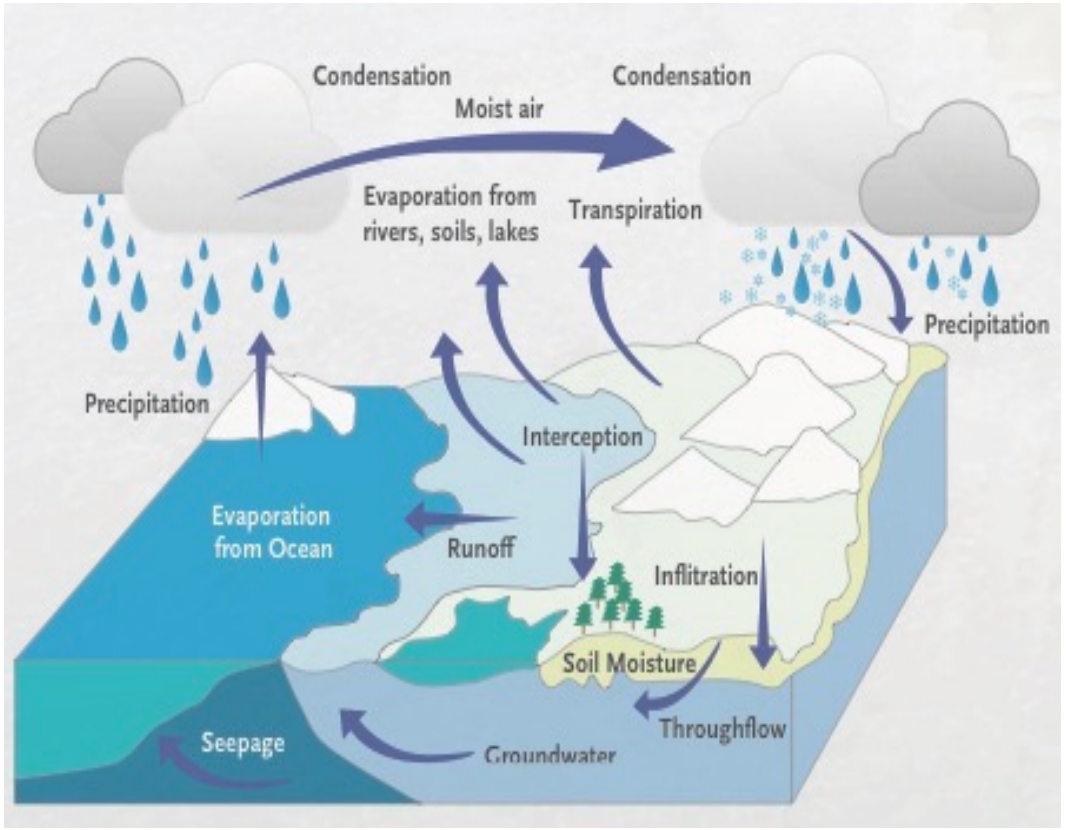
Arctic Freshwater System

Ocean Gateways



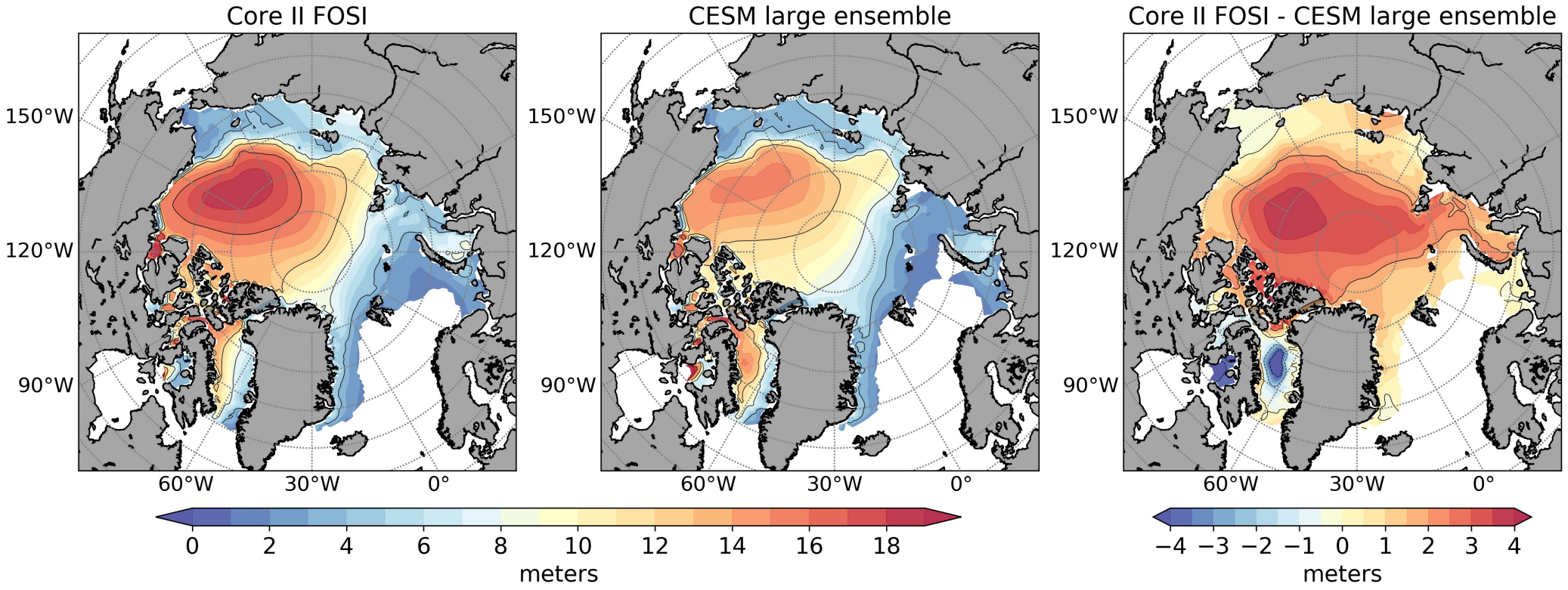
Prowse et al. 2015

Surface Processes

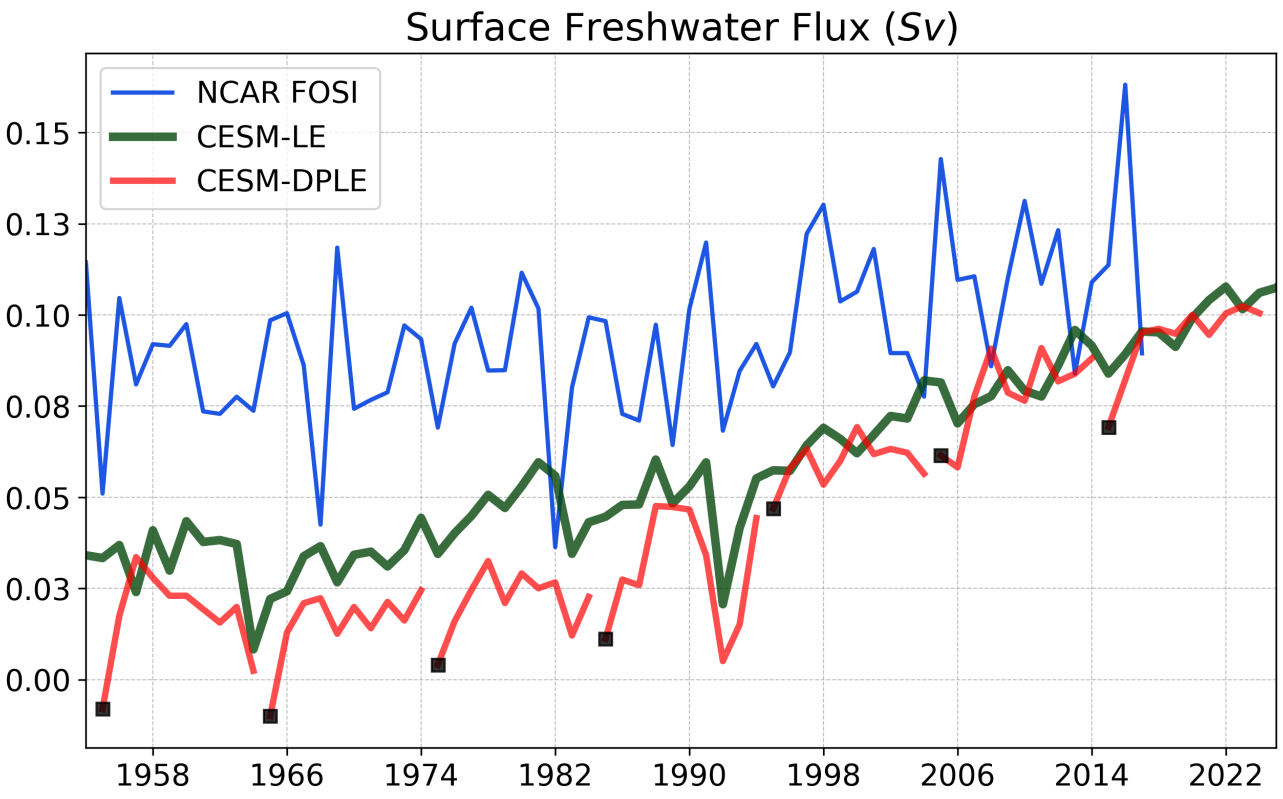


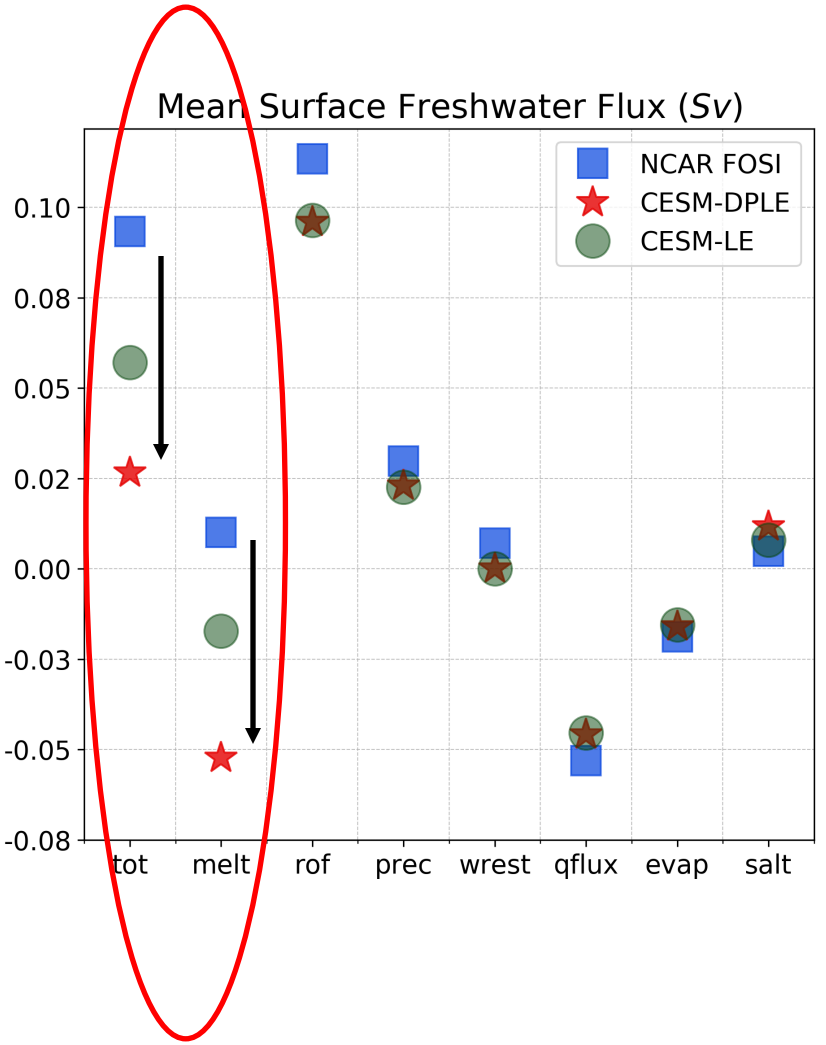
WCRP/CliC 2016

Core II* FOSI is fresher than CESM-LE (1954-2015)



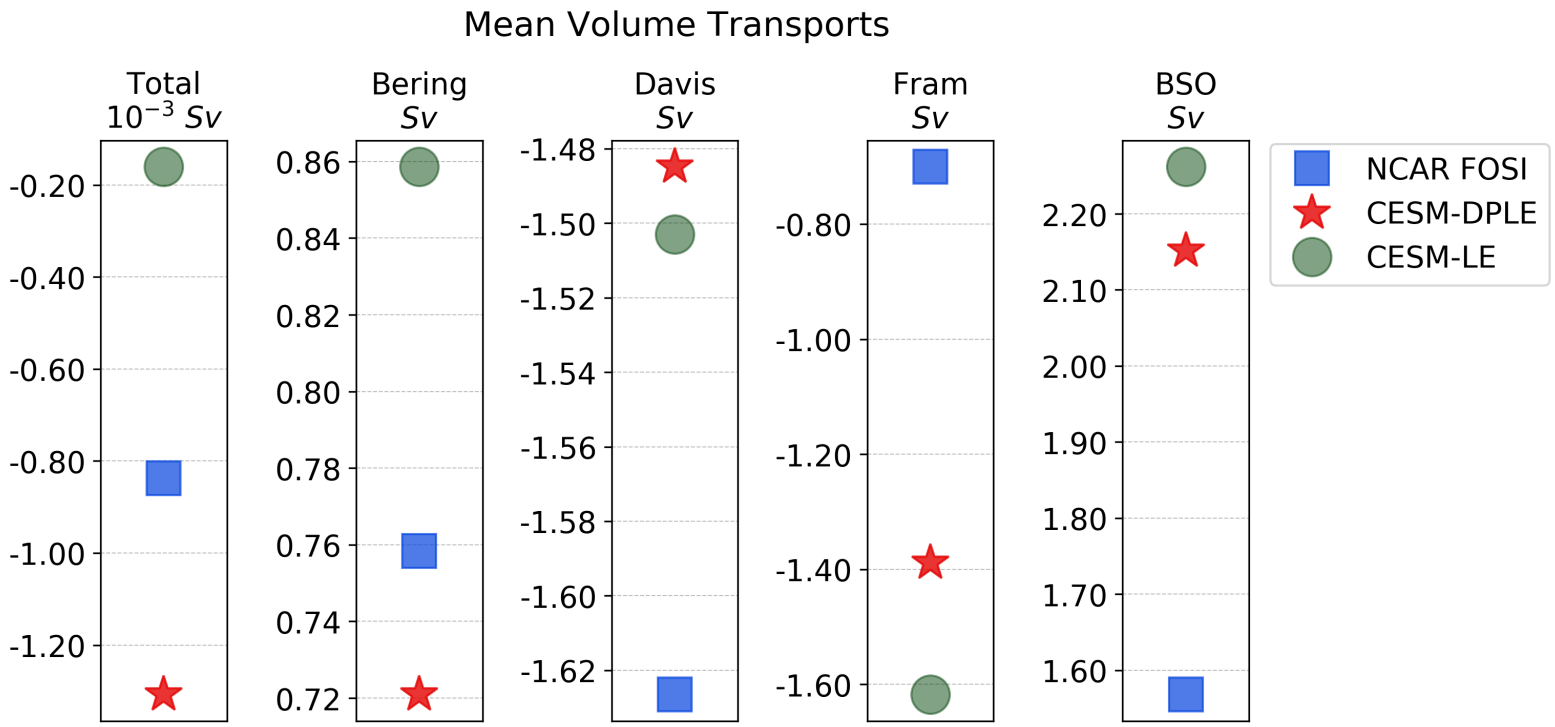
Rapid Reduction in Surface Freshwater Flux





- Rapid Adjustment of surface FW fluxes.
- Most of the reduction in surface FW flux can be accounted by reduction in MELT flux.

Volume Transports through Arctic Ocean Gates



- Negligible change in total volume transport; as expected
- Partitioning among different gates is modified; the transports across Fram strait and BSO shows the largest increases

Conclusions

- Large model drifts are seen in CESM-DPLE over the Arctic; systematic reduction in Arctic liquid freshwater amount over the 10-year period.
- Arctic ocean in the Core II* forced ocean sea ice simulation is fresher than the corresponding fully-coupled simulation.
- A rapid adjustment (~few months) is seen in surface fluxes in response to the drift; Sea ice melt flux seems to be the dominant term.
- Partitioning of the total volume transport across different straits is modified in response to the drift.