2018 CESM Workshop

Update on Forced Ocean-Sea-Ice Simulations with JRA55-do

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H. Tsujino (MRI), A. Hogg, & K. Stewart (ANU)

Outline

- ✓ Quick comparison between JRA55-do (v1.3) and CORE-IAF
- ✓ Interannual Forcing (IAF)
- ✓ Repeat Annual Forcing (RYF)

A Quick JRA55-do and CORE-IAF Comparison

- ✓ JRA55-based dataset for driving ocean–sea-ice models
- ✓ Higher resolution (temporally and spatially); self-consistent; near real-time

	JRA55-do (~55 km)	CORE-IAF (~200 km)
Atm. State (*T, q, U, & SLP*)	JRA55 (**3-hr**)	NCEP (**6-hr**)
Radiation (Q_{SW} & Q_{LW})	JRA55 (**3-hr**)	GISS ISCCP-FD (**daily**)
Precipitation	JRA55 (**3-hr**)	GPCP/CMAP/Serreze (**monthly**)
Runoff	*Suzuki et al. (2017)* (JRA55-derieved; **daily**)*	*Dai et al. (2009)* (**monthly climatology**)
Available Period	1958 - present	1948 – 2009#
Adjustment strategy	Time-dependent (Phase I-III)	Time-invariant

* In addition, observed solid and liquid runoffs from Greenland and Antarctica are included

Interannually varying only after 1979 and 1983 for precipitation and radiation, respectively

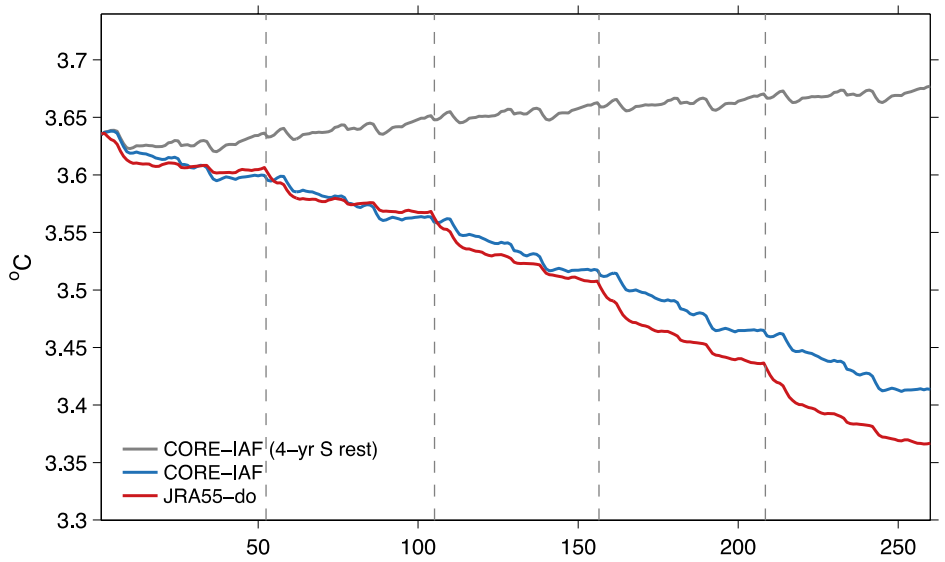
JRA55-do v1.3

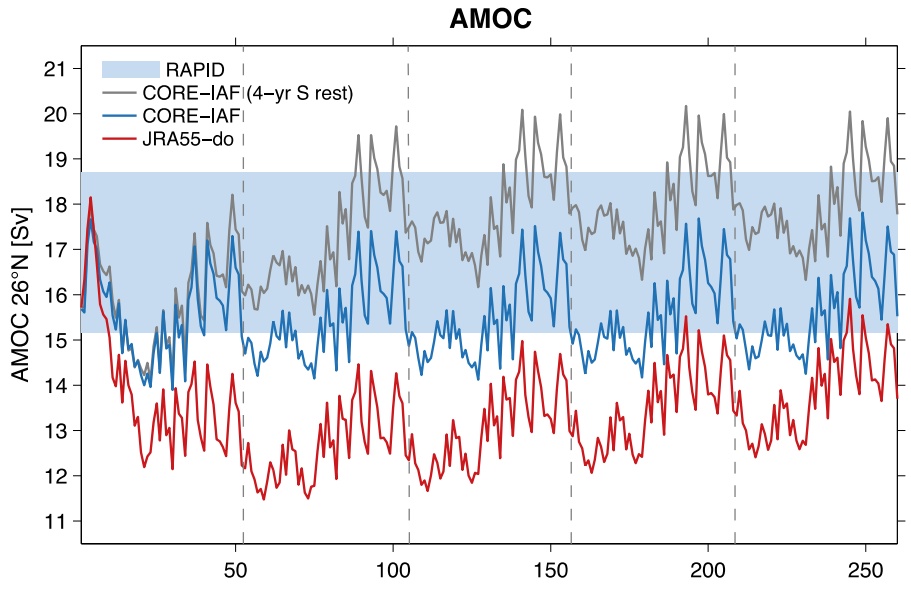
- ✓ Manuscript submitted to Ocean Modelling (*in revision*)
  - Tsujino et al., 2018: JRA-55 based surface dataset for driving ocean–sea-ice models (JRA55-do), *Ocean Model.*, submitted
- ✓ Available (v.1.3.1, - Jan. 2018) at http://esgf-node.llnl.gov/search/input4mips/?mip_era=CMIP6&activity_id=input4MIPs&institution_id=MRI&target_mip=OMIP&source_id=MRI-JRA55-do-1-3
- ✓ Reformatted version (v1.3, - Dec. 2016) for CESM use is available at /glade/p/cesmdata/cseg/inputdata/ocn/jra55/v1.3_noleap

IAF

- ✓ Too weak AMOC with 4-yr salinity restoring
  - Due to weaker wind variance in the Lab. Sea → weaker wind stress & curl
  - **1-yr salinity restoring** – 11 of 17 models in Danabasoglu et al. (2014) used 1-yr or shorter restoring timescales

- ✓ Parallel JRA55-do and CORE-IAF runs
  - Same POP2 configuration (CESM2_a10a)
  - Spin-up: 5 cycles (1958-2009); extended the last cycle to 2016





IAF

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  - Due to weaker wind variance in the Lab. Sea → weaker wind stress
  - **1-yr salinity restoring**
- ✓ Parallel JRA55-do and CORE-IAF runs
  - Same configuration (CESM2_a10a)
  - Spin-up: 5 cycles (1958-2009); extended the last cycle to 2016
- ✓ **Mean-states**: generally comparable
  - **Improvement**: Arctic sea-ice extent and thickness
  - More diagnostics are available at

    JRA55-do: http://webext.cgd.ucar.edu/GIAF/g20a10.GIAF_JRA.gx1v7.C03/ocn/diag_work.241-260/

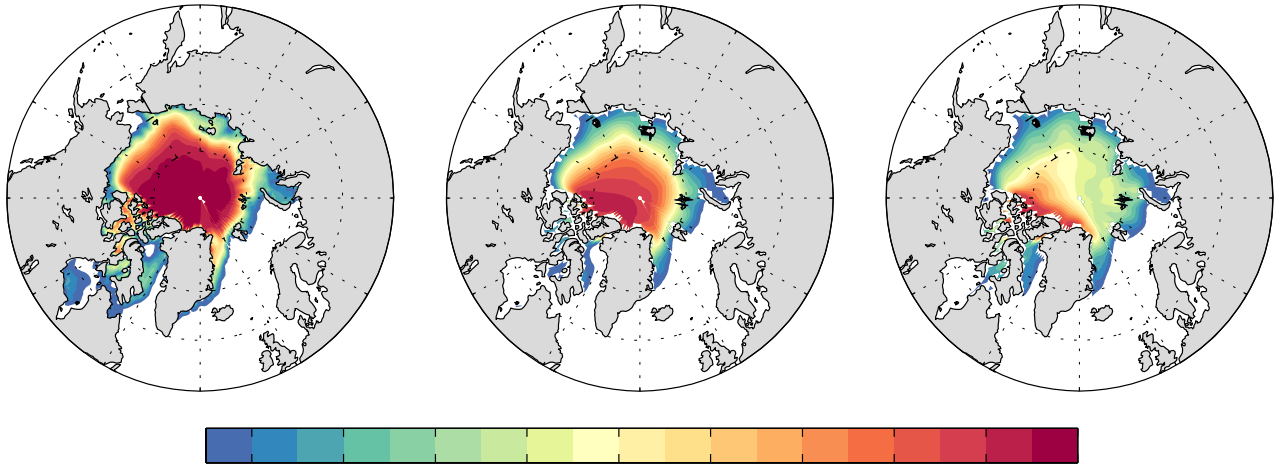
    CORE-IAF: http://webext.cgd.ucar.edu/GIAF/g20a10.GIAF.gx1v7.C01/ocn/diag_work.241-260/

Mean States

JAS Sea-Ice Concentration

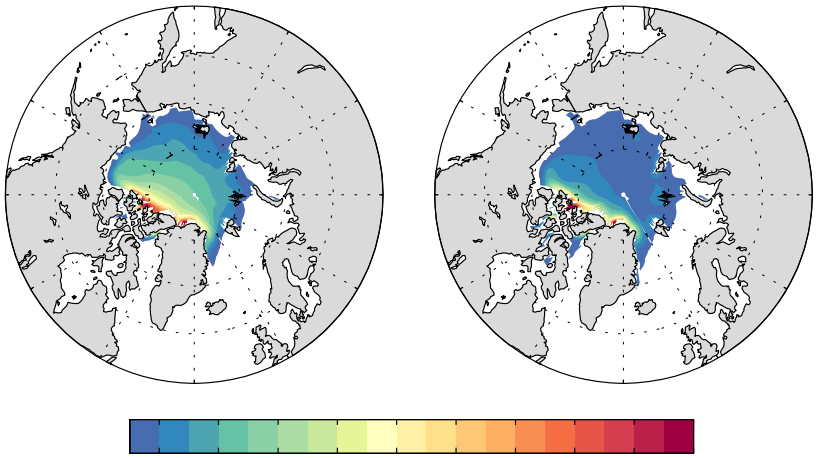
JAS

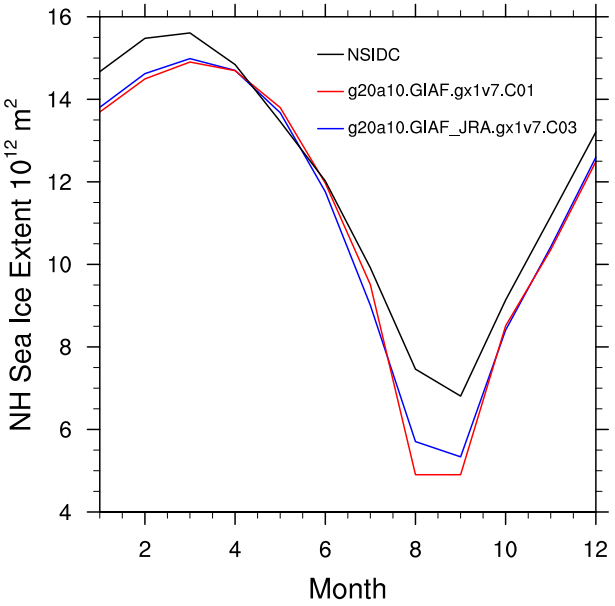
SSMI | JRA55–do | CORE–IAF



JAS Sea-Ice Thickness

JRA55–do | CORE–IAF

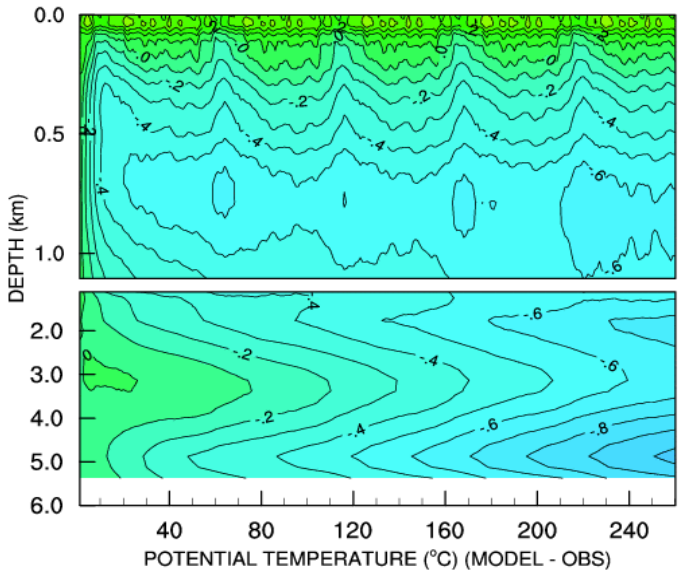




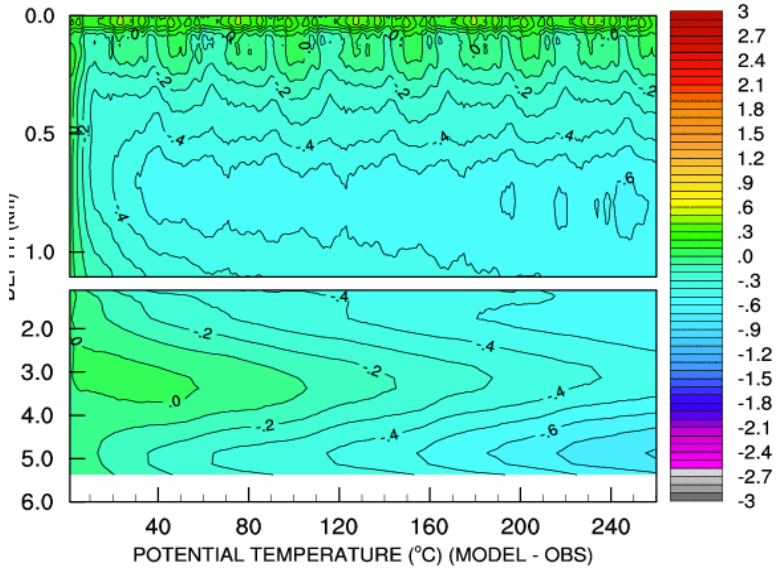
Mean States

Southern Ocean Temperature

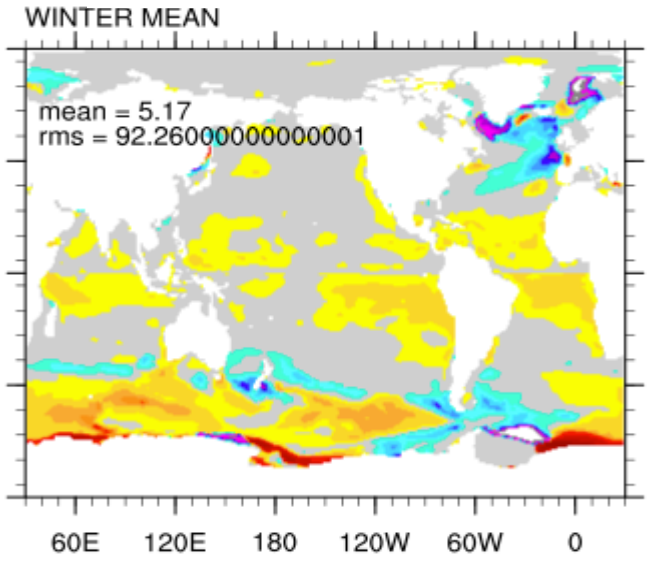
JRA55-do



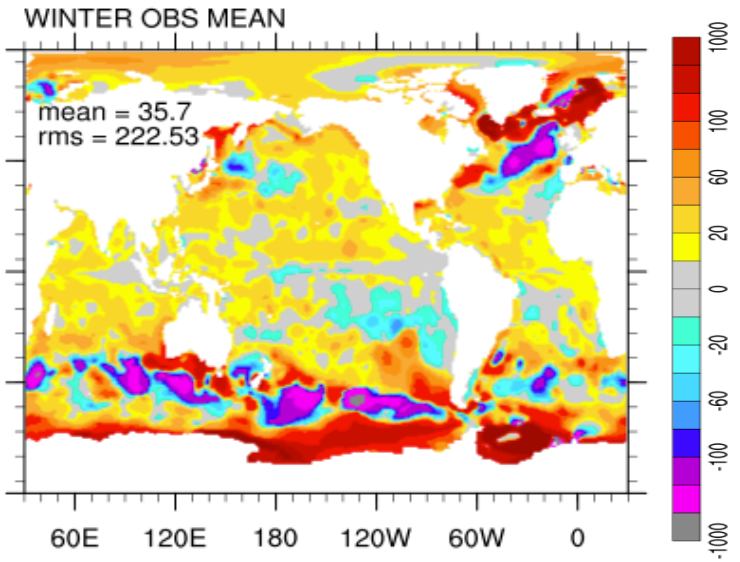
CORE-IAF



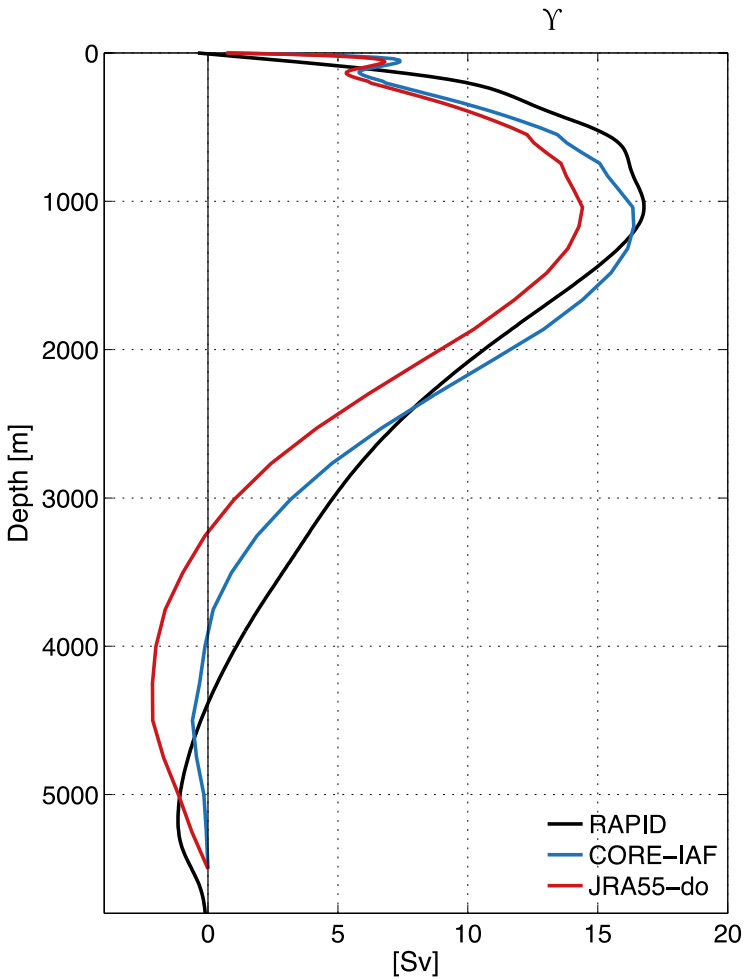
JRA55-do – CORE-IAF

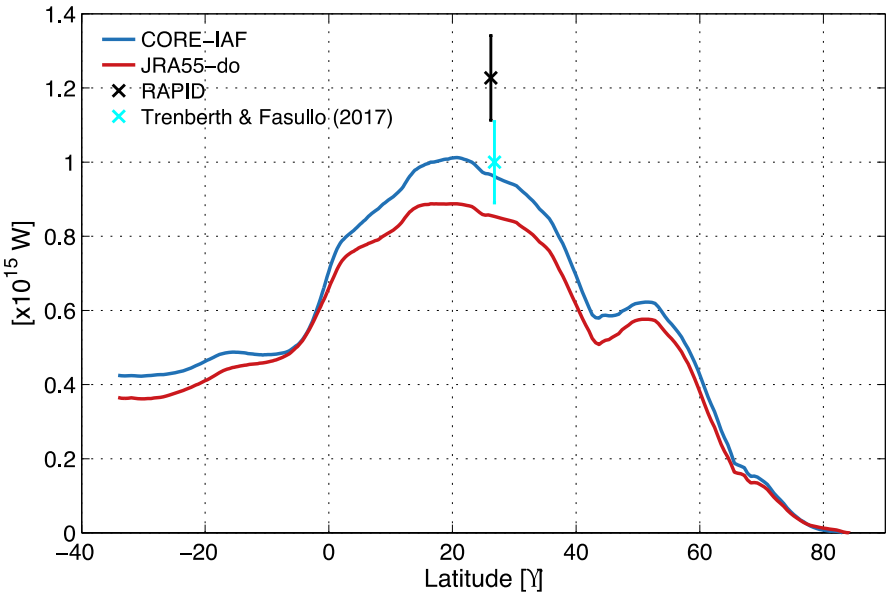


CORE-IAF – Obs



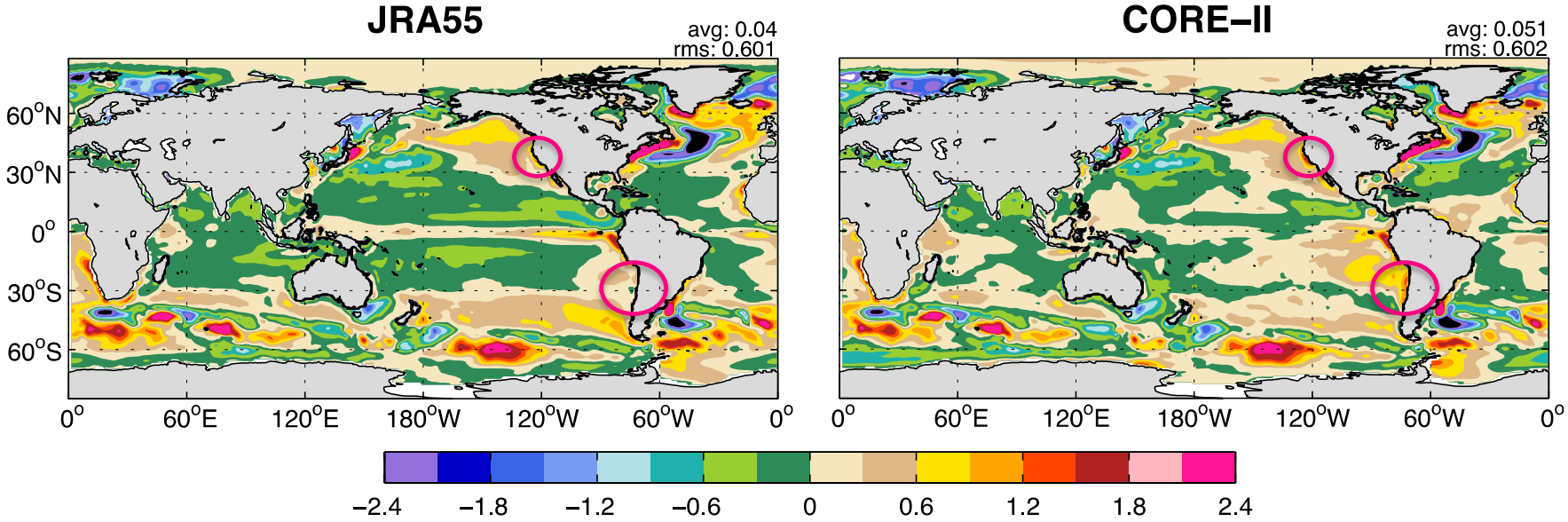
Mean States


Υ
0
1000
2000
3000
4000
5000
Depth [m]
0
5
10
15
20
[Sv]
RAPID
CORE–IAF
JRA55–do

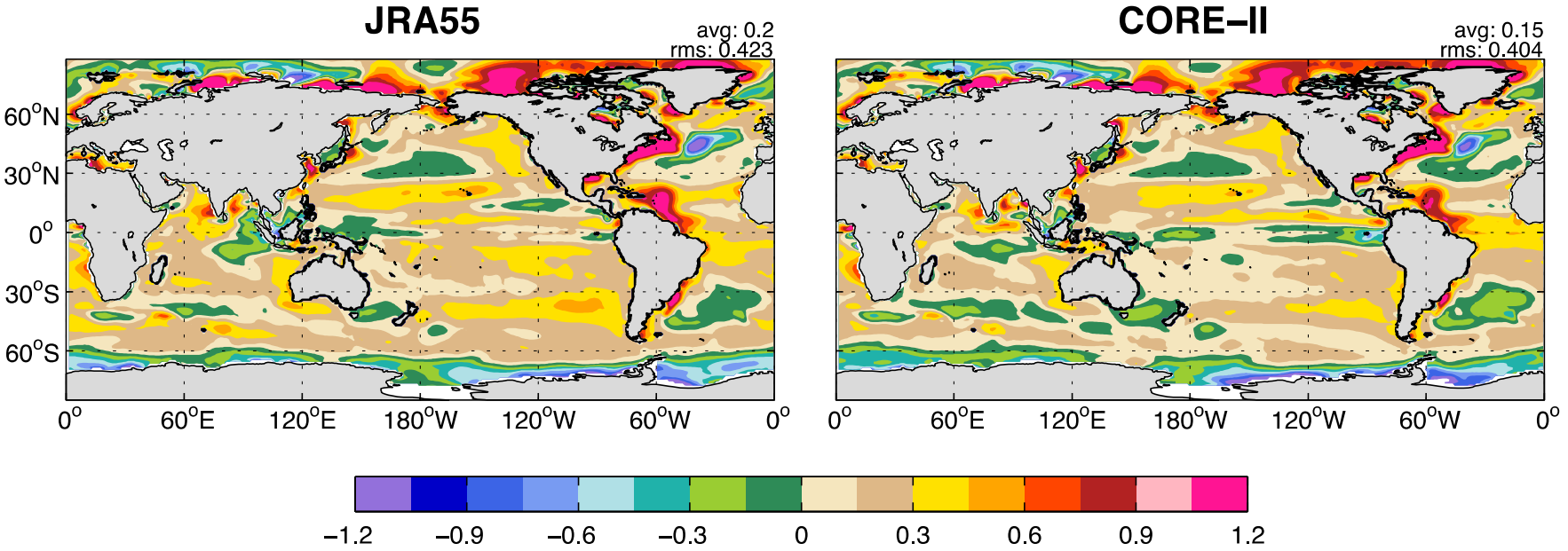

1.4
1.2
1
0.8
0.6
0.4
0.2
0
[x10^15 W]
–40
–20
0
20
40
60
80
Latitude [Υ]
CORE–IAF
JRA55–do
RAPID
Trenberth & Fasullo (2017)

Mean States

SST



SSS



IAF

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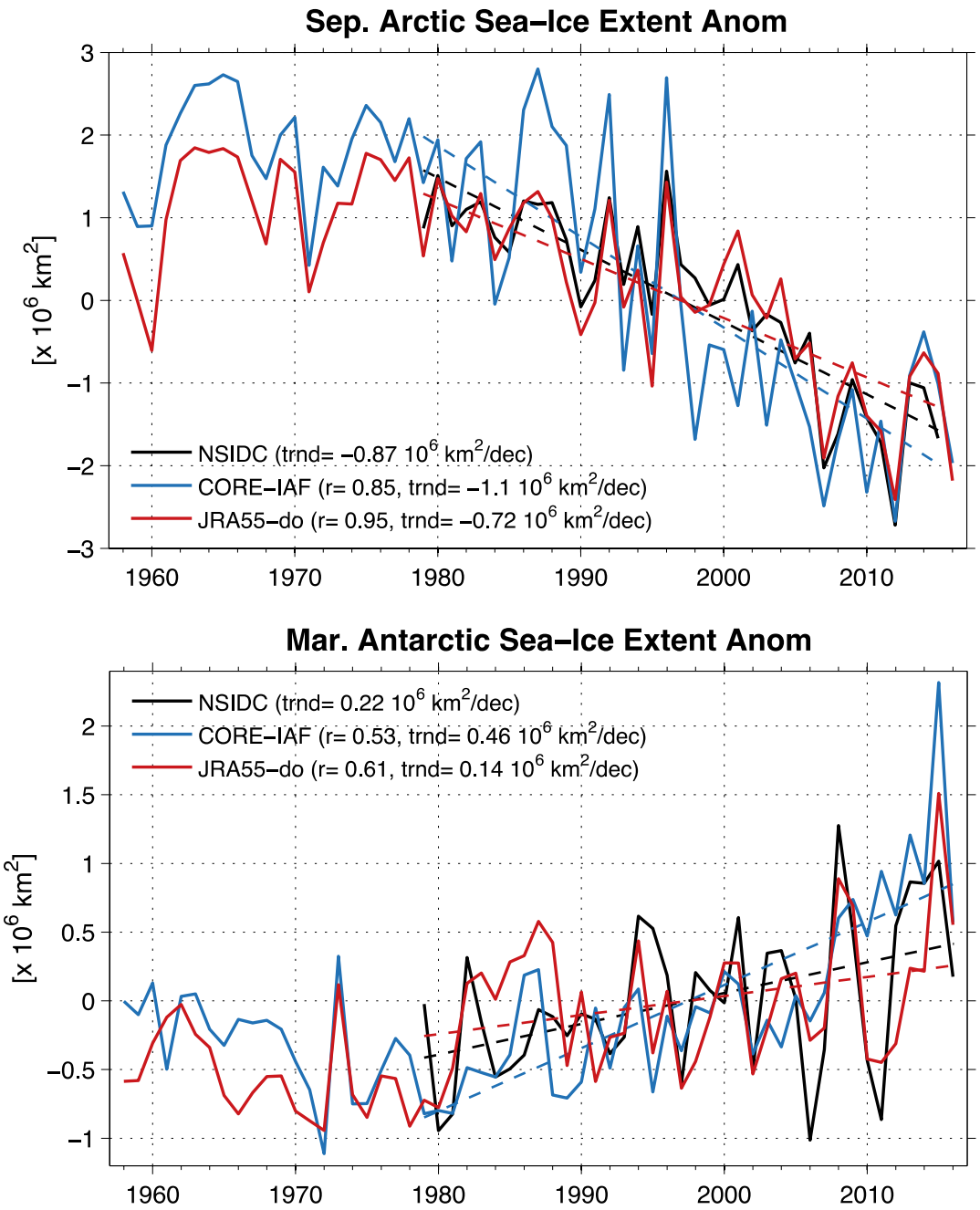
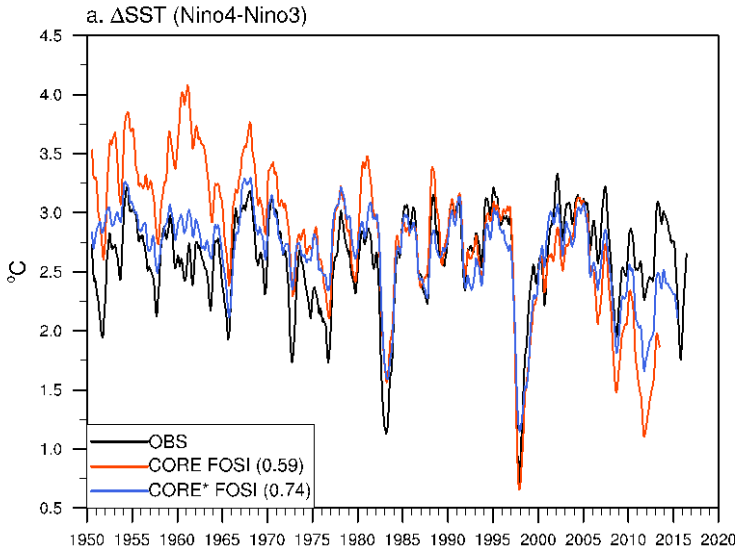
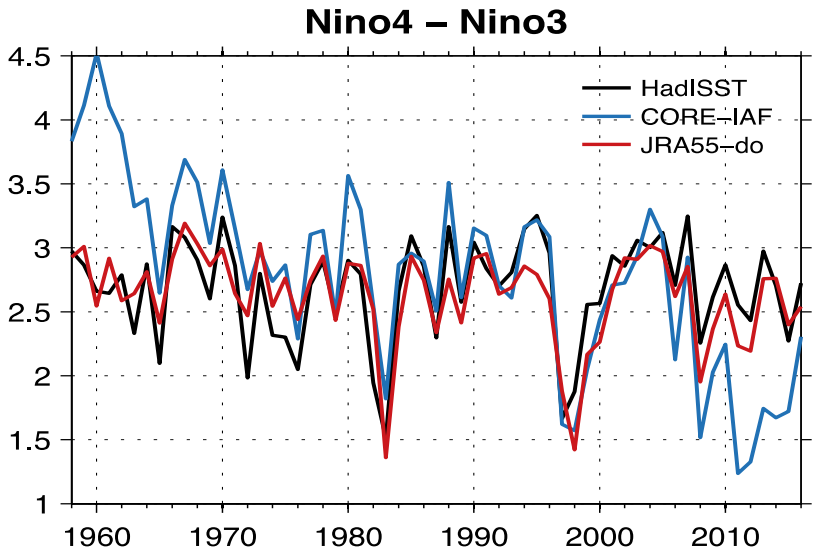
  - Due to weaker wind variance in the Lab. Sea → weaker wind stress
  - **1-yr salinity restoring**
- ✓ Parallel JRA55-do and CORE-IAF runs
  - Same configuration (CESM2_a10a)
  - Spin-up: 5 cycles (1958-2009); extended the last cycle to 2016
- ✓ **Mean-states**: generally comparable
  - **Improvement**: Arctic sea-ice extent and thickness
- ✓ **Variability:** generally comparable
  - **Improvement**: Arctic sea-ice and tropical Pacific SST

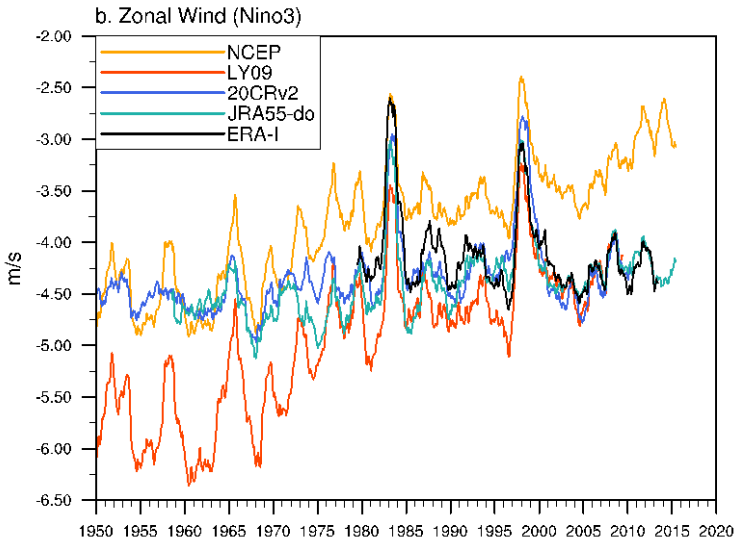
Variability



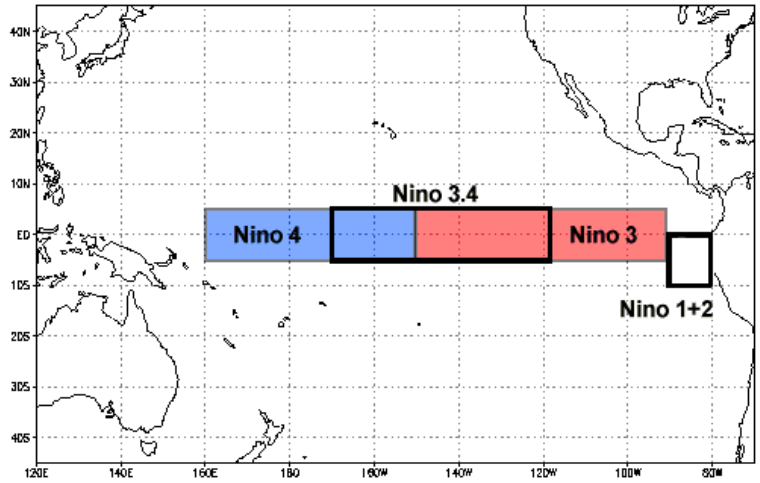
Variability







Yeager et al. 2018



https://www.ncdc.noaa.gov/teleconnections/enso/indicators/sst/

IAF Summary

- ✓ JRA55-do (v1.3) is ready for use
  - Tsujino et al. 2018, Ocean Modelling, in revision
- ✓ The results from the JRA55-do simulation are similar compared to the CORE-IAF simulation
  - **Improvement in sea-ice properties**
- ✓ Compset for JRA55-do is available (Thanks to Alper)

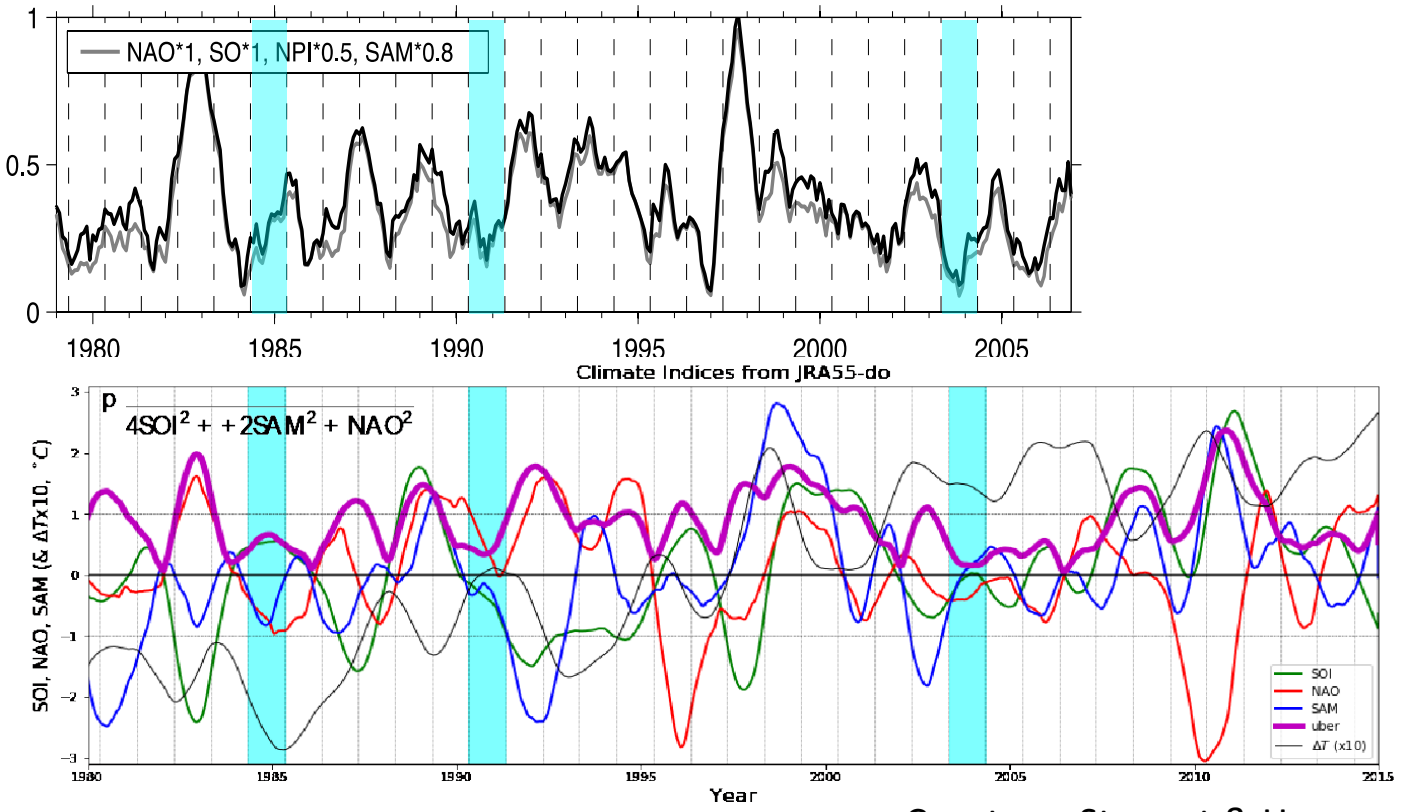
```
>> ./create_newcase --case $CASENAME --compset GIAF_JRA --res TL319_g17
--run-unsupported
```

RYF

- ✓ **Repeat Year Forcing (RAF)** – Single annual forcing representing a close-neutral conditions (Equivalent to CORE-NYF)
- ✓ Why RYF?
  - Synthetic synoptic fields (spectral averaging technique) in NYF does not necessarily yield physically consistent atmospheric state
  - Complicated and hard to generate
  - Not designed for over-ice → unrealistic sea-ice thickness distribution
  - Radiation and precipitation lack weather variance

RYF

- ✓ Identified 1984-85, 1990-91, & 2003-04 as three candidates based on climate indices during the satellite era
- ✓ To minimize transition shock, it starts from from May 1 (to avoid strong variance during winter in both hemispheres)

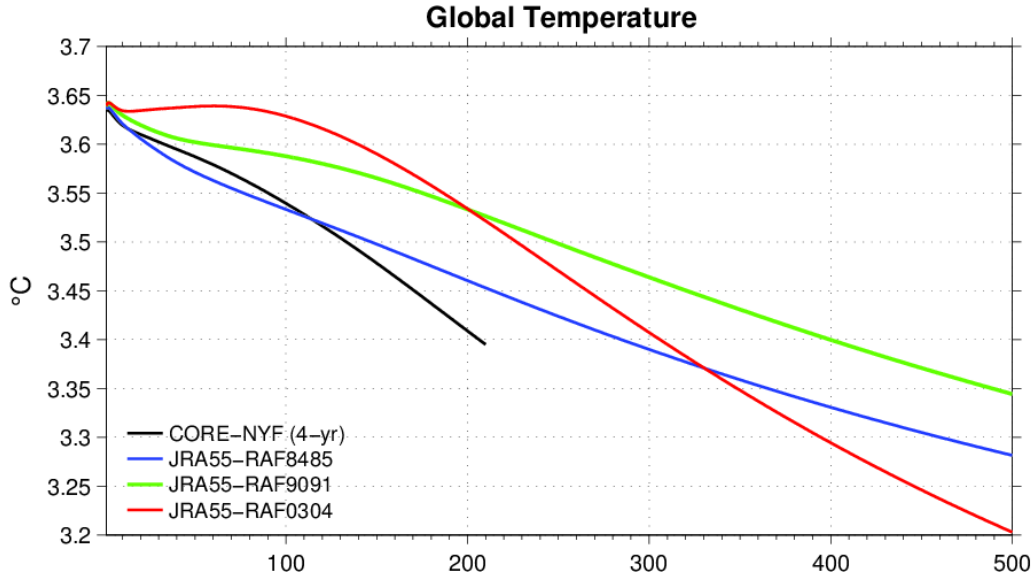


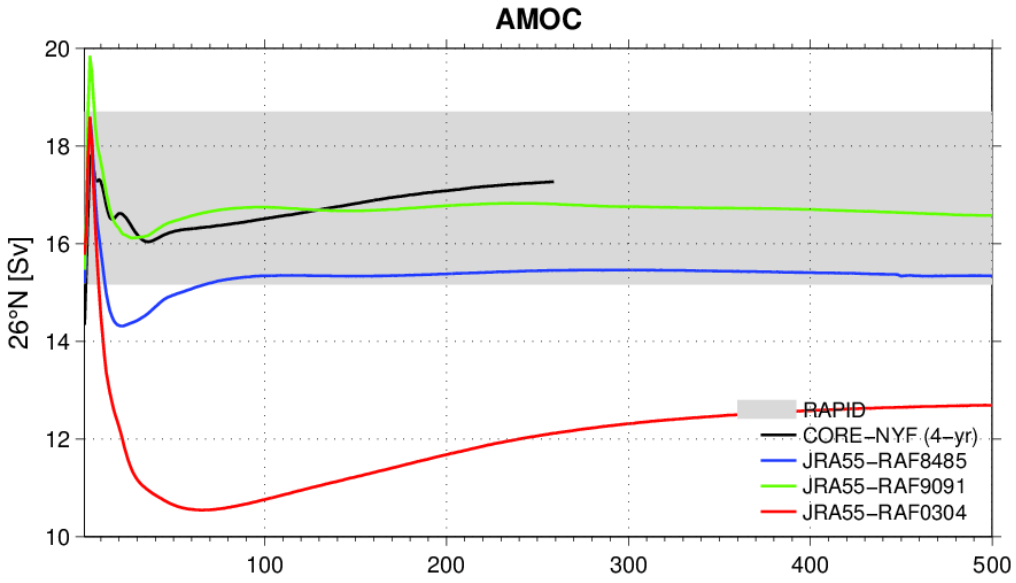
Courtesy: Stewart & Hogg

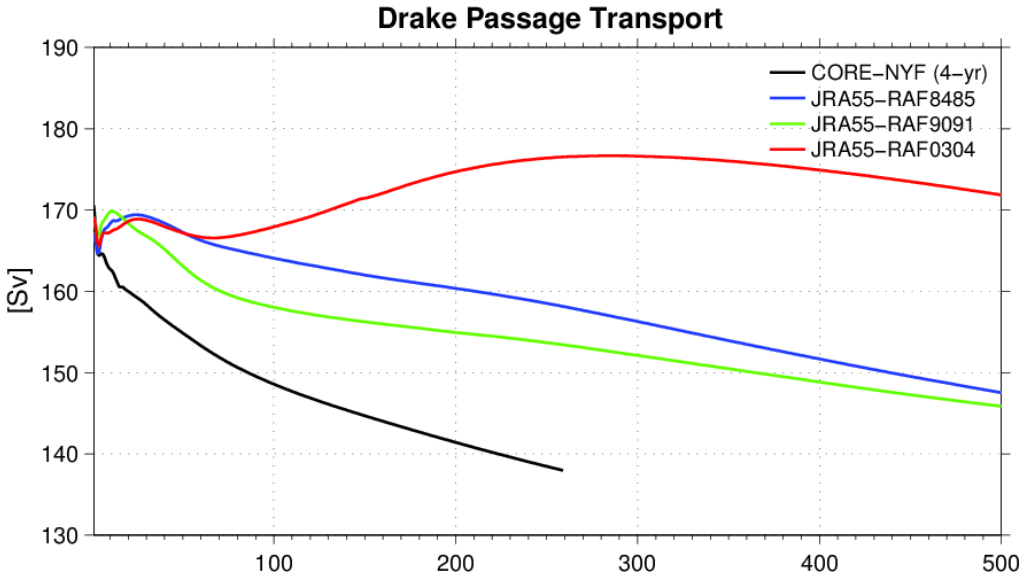
RYF

- ✓ Identified 1984-85, 1990-91, & 2003-04 as three candidates based on climate indices during the satellite era
- ✓ To minimize transition shock, it starts from from May 1 (to avoid strong variance during winter in both hemispheres)
- ✓ Three RYFs have been tested:
  - CESM2_a10a, 1-yr salt restoring
  - Integrated for 500 years

Simulation Results







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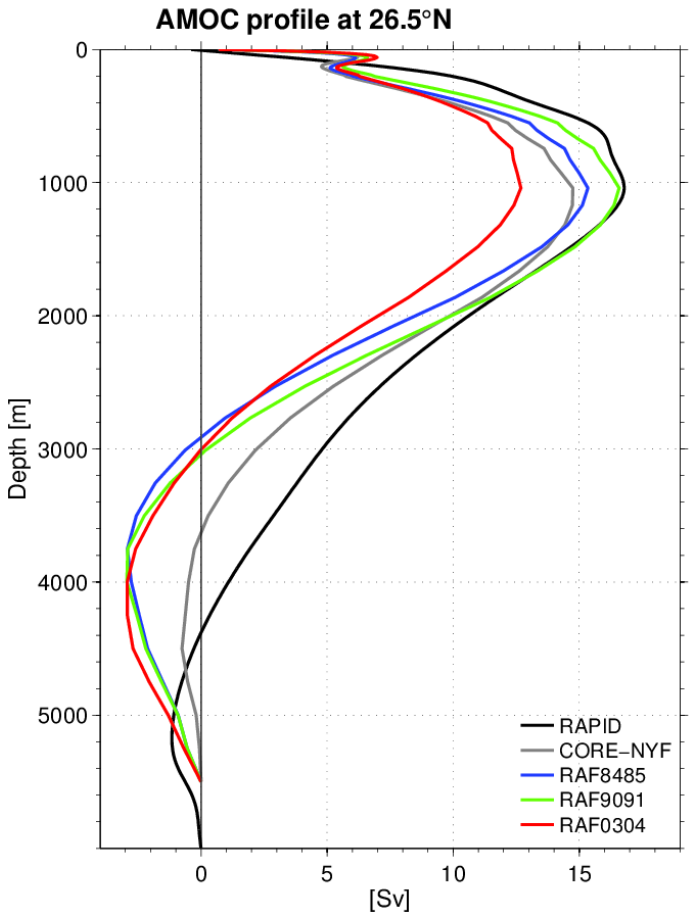
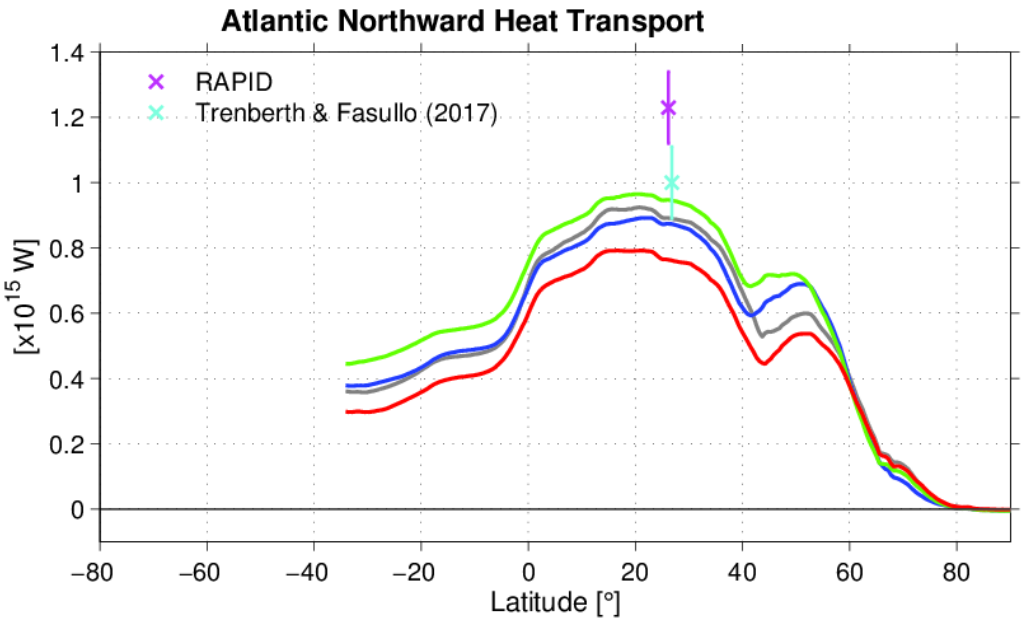
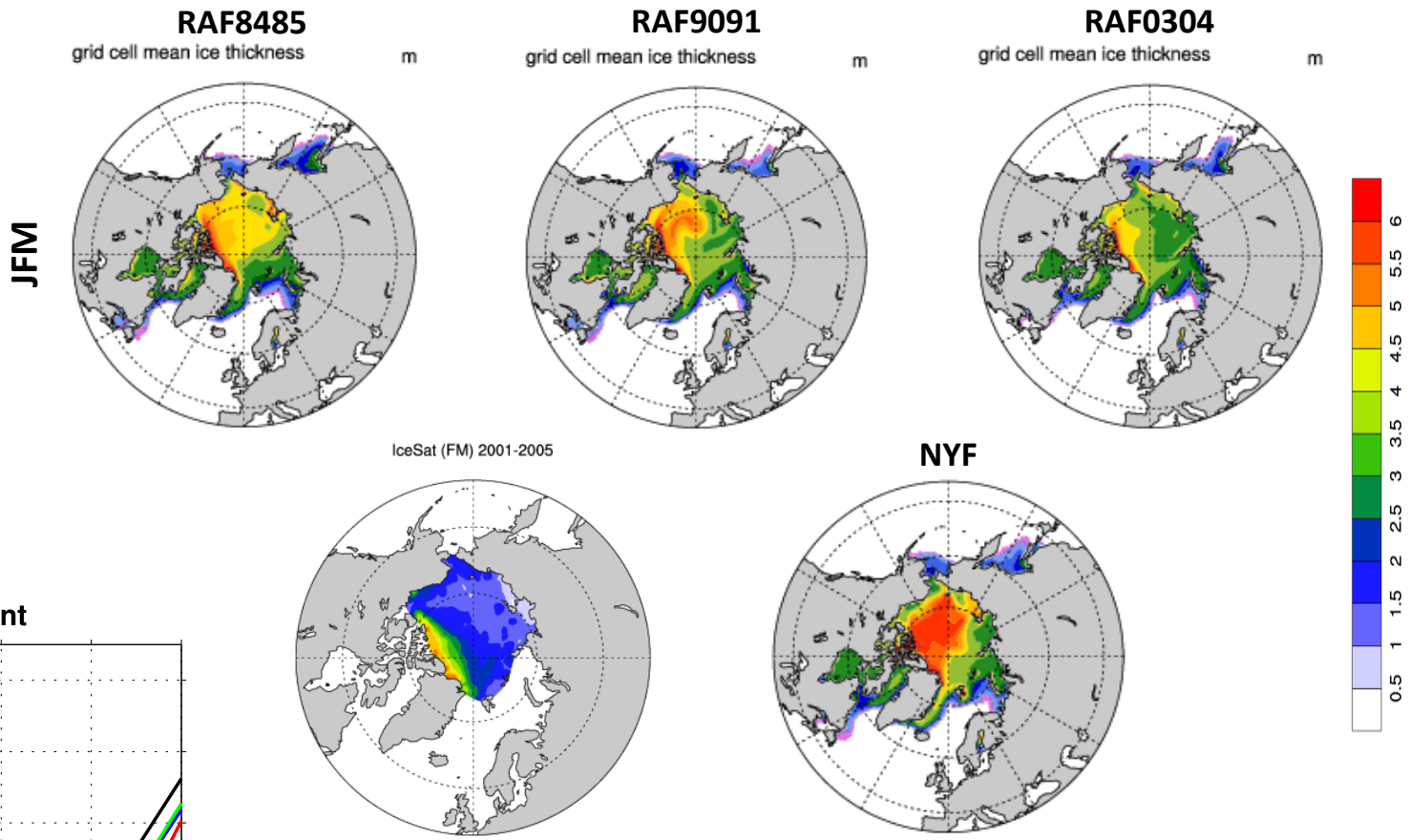
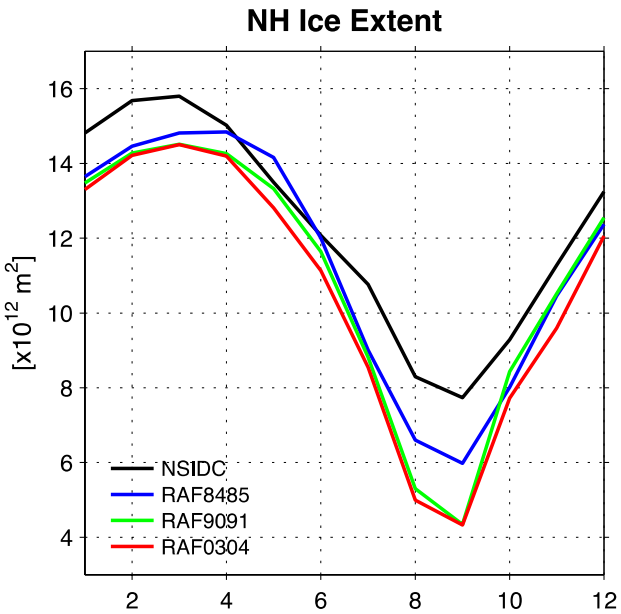




Simulation Results

JFM Sea-Ice Thickess





RAF Summary

- ✓ From ocean-perspective, 1990-91 RAF has a slight edge over 1984-85 RAF
  - Both perform similar in terms of upper ocean heat and salt contents
- ✓ From sea-ice-perspective, 1984-85 RAF appears to perform better
- ✓ Both 1984-85 and 1990-91 RAFs are acceptable
- ✓ The same experiments have performed at ANU and MRI and both prefer 1984-85 RAF based on their preliminary analysis
- ✓ A collaborative study that compares the three candidate RAF will be conducted and the final recommendation will be made