IPCC AR5:
Projections of Arctic Sea Ice Change

K. Riemann-Campe[(1)], R. Gerdes[(1)], M. Karcher[(1,2)], F. Kauker[(1,2)]

[(1)]Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung
[(2)]O.A.Sys - Ocean Atmosphere Systems

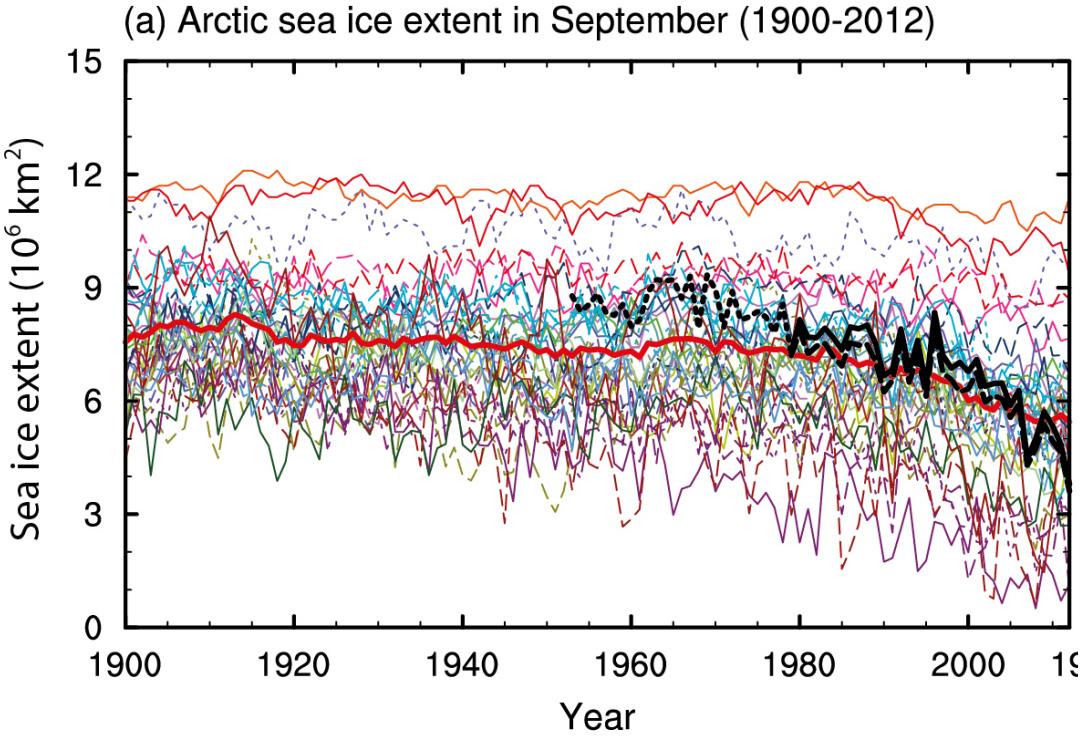
Overview

- IPCC AR5/CMIP5 climate model simulations
  - what kind of models
  - large uncertainty range
- How to narrow the uncertainty range?
- Why are there still large differences?
- Summary

CMIP5 climate models

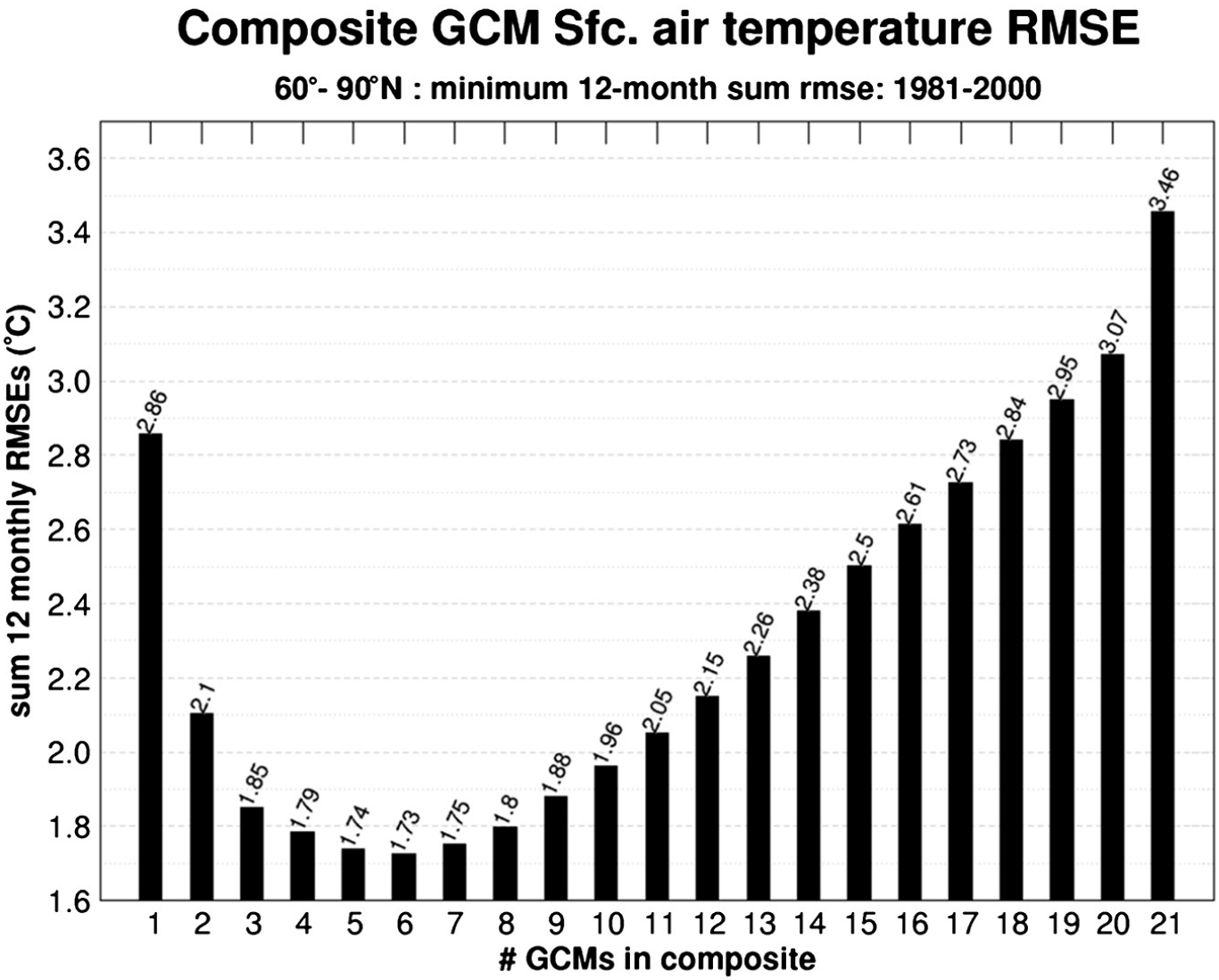
- **C**oupled **M**odel **I**ntercomparison **P**roject (CMIP)

  standard experimental protocol for studying the output of coupled atmos.-ocean general circulation models
- by World Climate Research Programme (WCRP)
- standard experiments:
  - historical simulation (1850-2005)
  - future emission scenarios (2006-2100)
- IPCC AR5: CMIP5



IPCC AR5 WG1 Fig. 9.24

How to narrow the uncertainty range?



Overland et al., 2011 DOI:10.1175/2010jcli3462.1

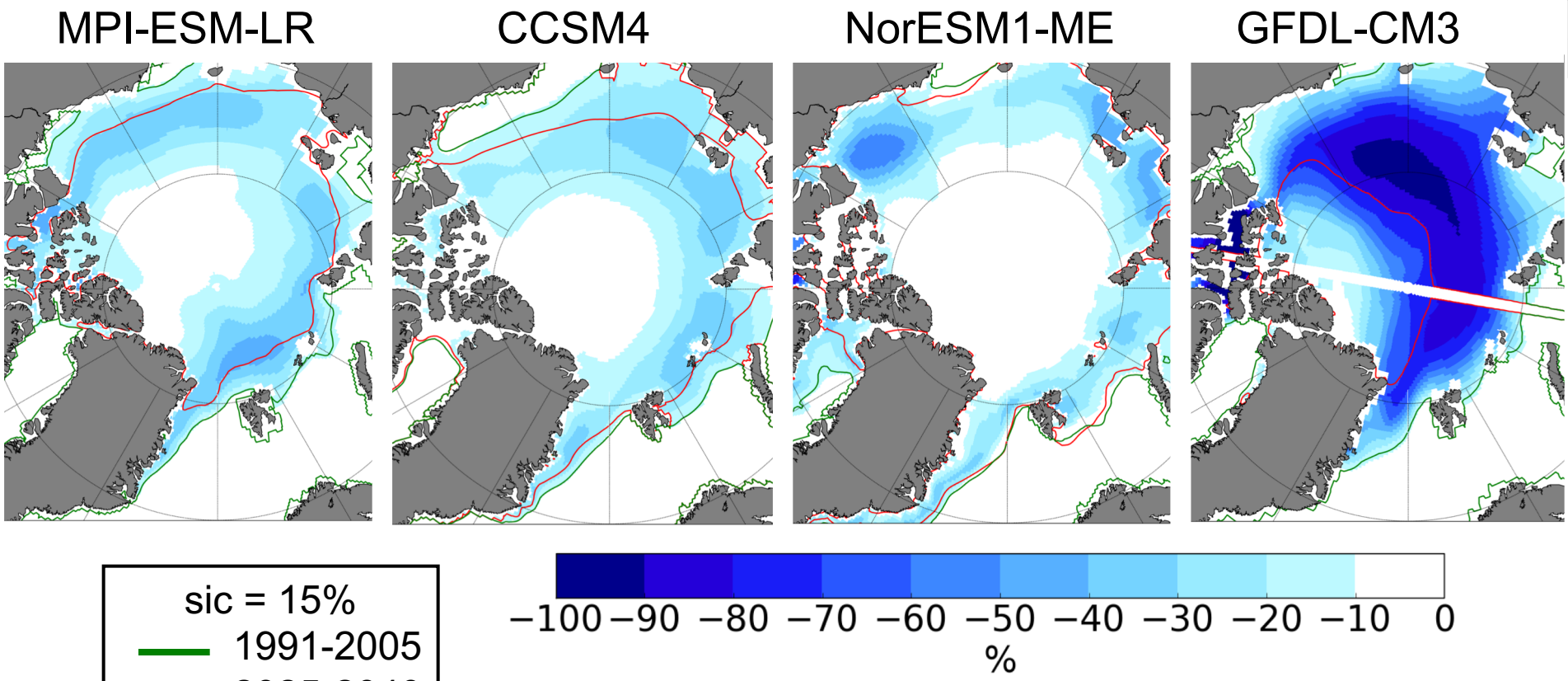
How to select the better models?
Sea ice area misfit: model - observations

rank	OSI SAF 1979-2005 WP4.1 regions	norm. misfit WP4.1 regions	OSI SAF 1979-2005 whole Arctic	norm. misfit whole Arctic	SSMI IFREMER 1992-2005 whole Arctic	norm. misfit whole Arctic
1	MPI-ESM-LR	1.000	MPI-ESM-LR	1.000	MPI-ESM-LR	1.000
2	MIROC4h	0.998	MPI-ESM-P	0.984	MPI-ESM-MR	0.959
3	MPI-ESM-MR	0.997	MPI-ESM-MR	0.980	CCSM4	0.952
4	GFDL-CM3	0.988	NorESM1-M	0.930	EC-EARTH	0.945
5	NorESM1-M	0.979	NorESM1-ME	0.890	MPI-ESM-P	0.945
6	MPI-ESM-P	0.966	CCSM4	0.888	CESM1-CAM-1FV2	0.944
7	ACCESS1-0	0.926	GFDL-CM3	0.853	NorESM1-ME	0.937
8	NorESM1-ME	0.882	IPSL-CM5A-MR	0.853	NorESM1-M	0.934
9	INMCM4	0.878	MIROC-ESM	0.847	GFDL-CM3	0.932
10	CCSM4	0.859	MIROC-ESM-CHEM	0.840	CNRM-CM5	0.913

ACCESS report D1.51 by AWI (http://access-eu.org/en/deliverables2/wp1.html)

Future development of sea ice concentration

Future change in September sic
mean(2025-2040) - mean(1991-2005); RCP 4.5



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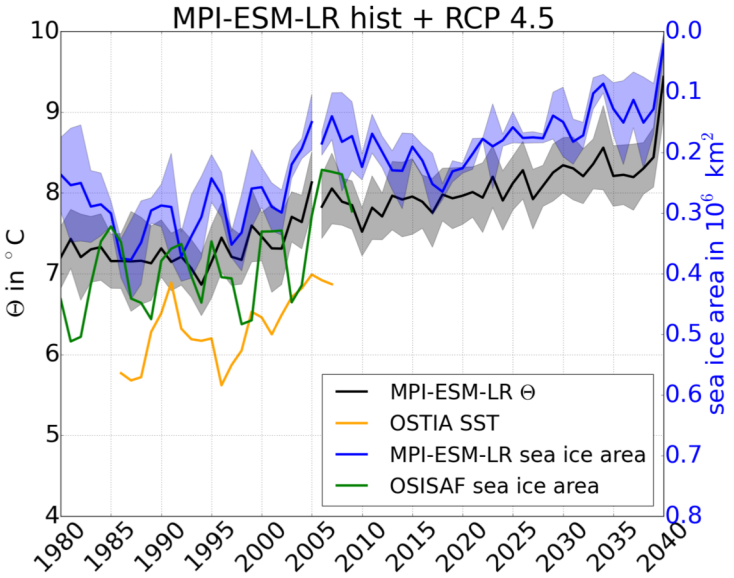
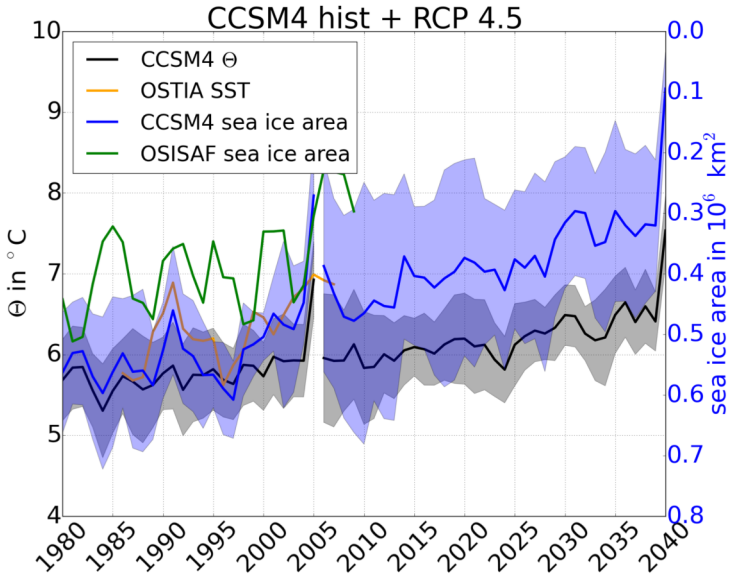
Why are there still large differences?

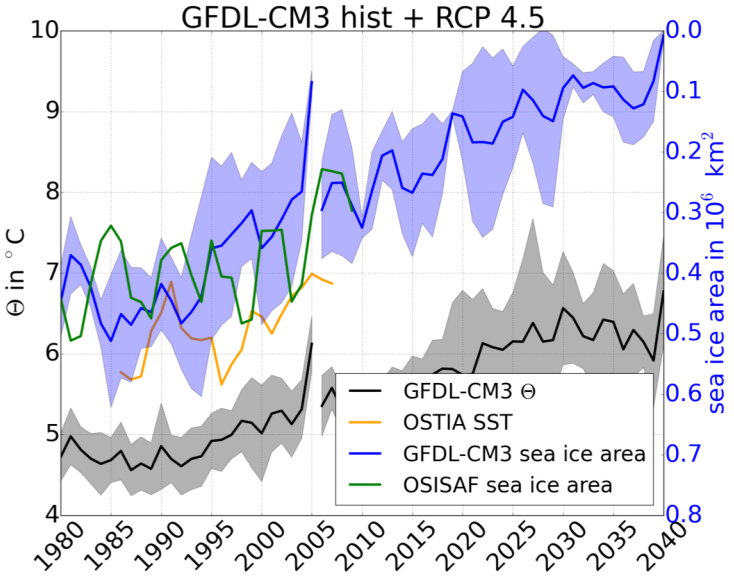
- global climate models
- different sea ice models
- other reasons?
  - yearly (Jul-Jun) sea ice area in the Barents Sea is strongly linked to warm Atlantic water inflow

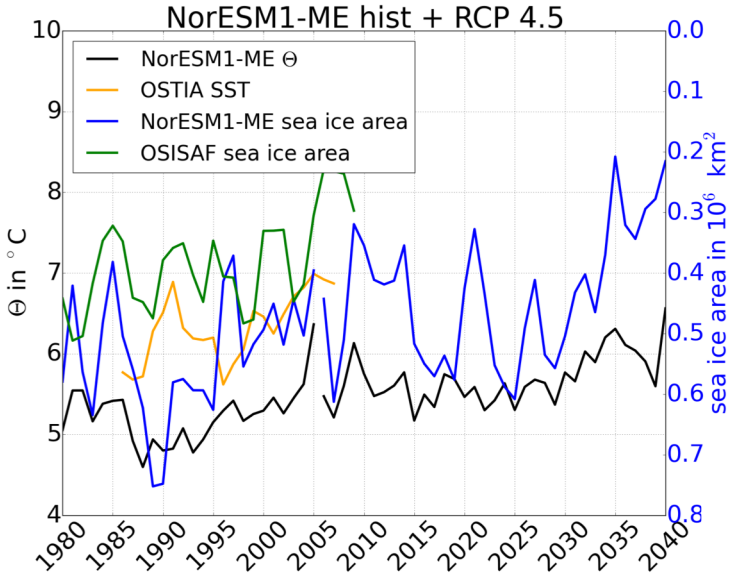
    (Arthun et al., 2012; DOI: 10.1175/jcli-d-11-00466.1)
  - Arctic wide summer sea ice area is strongly linked to 2 m air temperature
  - are these links similar in the models?

Yearly Barents Sea sea ice area and warm Atlantic water inflow

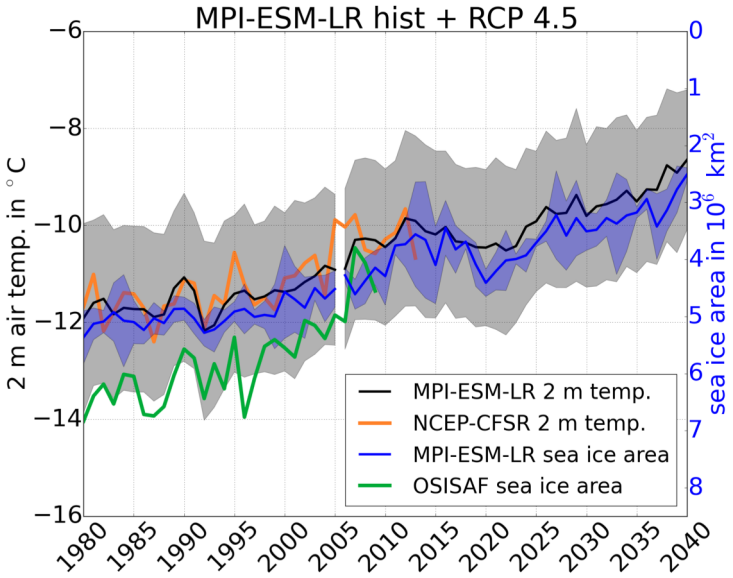


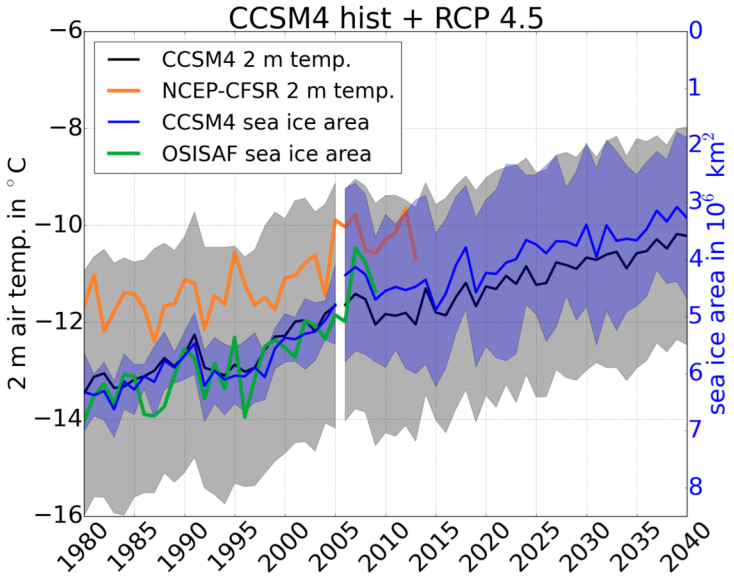


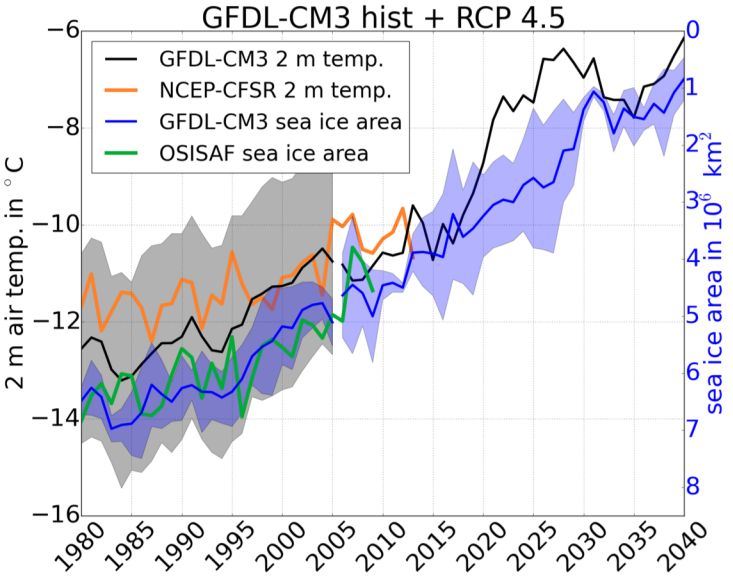


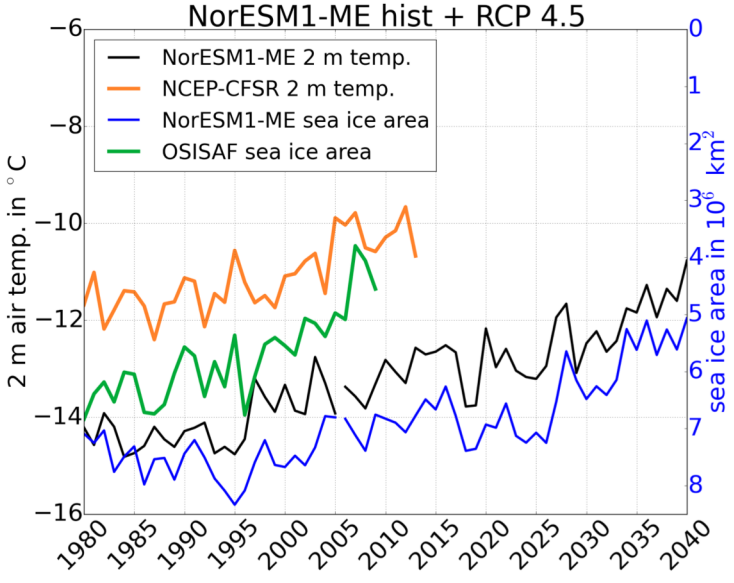


Arctic wide September sea ice area and yearly T2m : 66° N-90° N









Summary

- CMIP5 models have different strengths in different regions
- a subset of models reduces the uncertainty range considerably
- still large differences are due to
  - applying different sea ice models
  - **different distributions of ocean currents and air temperature**

  in past and future simulations
- CMIP5 models help a lot, but analyse with caution

Conference in Reykjavik, Iceland

October 2016

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