

Arctic sea-ice dynamics / state and ocean heat transport in HighResMIP

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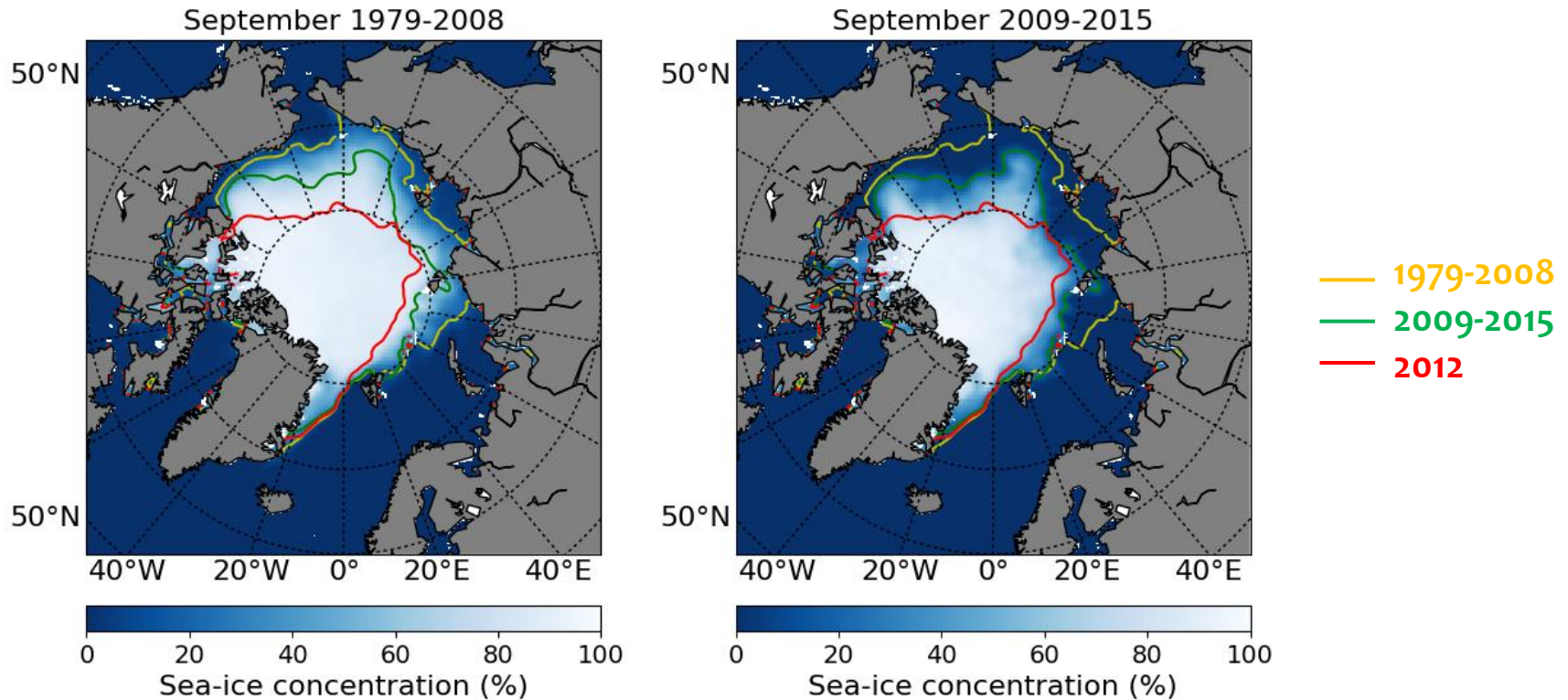
NASA / Kathryn Hansen



NSIDC / Andy Mahoney

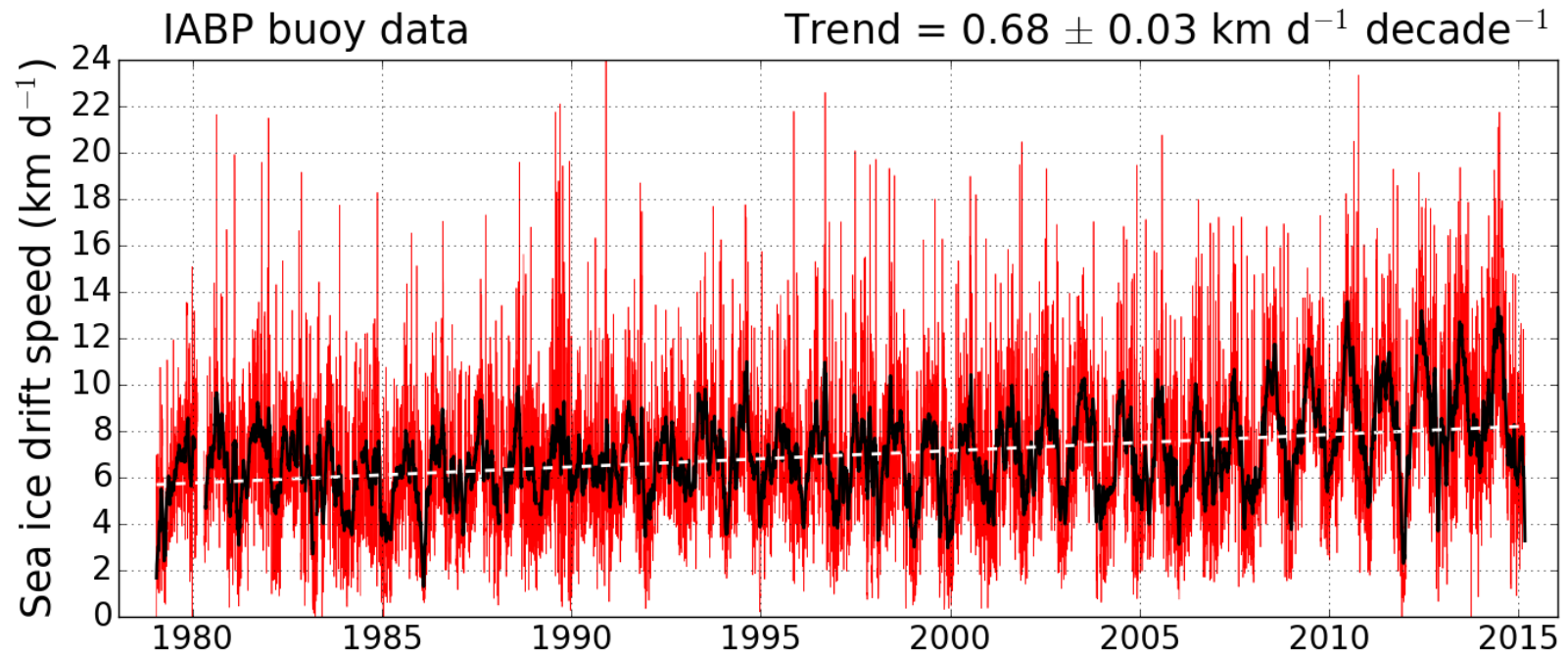


Arctic sea ice is retreating and thinning



OSI SAF satellite observations

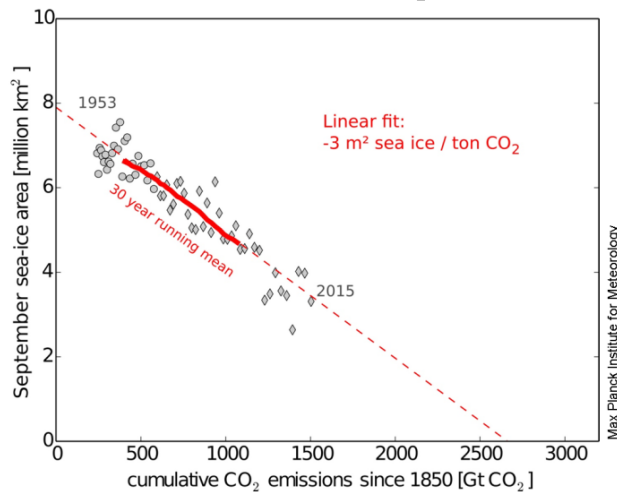
Arctic sea ice is becoming more mobile



Why is the Arctic changing?

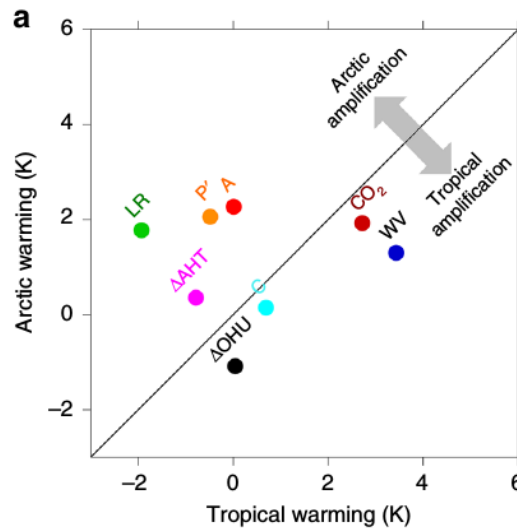
1. Anthropogenic Global Warming

Sea Ice and CO₂



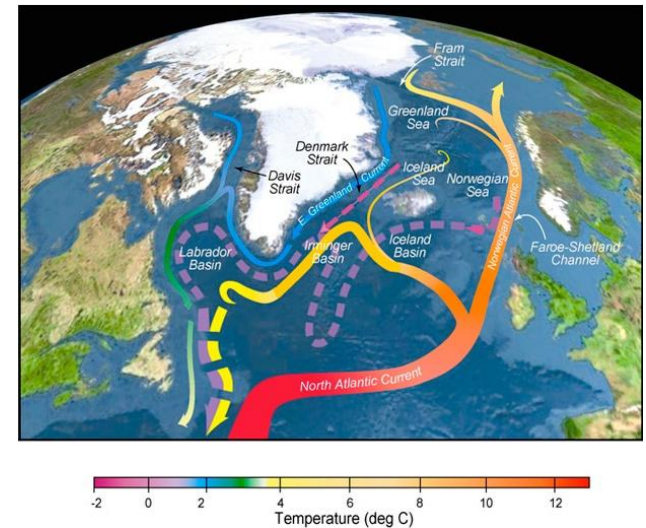
Notz & Stroeve (2016)

2. Climate Feedbacks



Goosse et al. (2018)
Pithan & Mauritsen (2014)

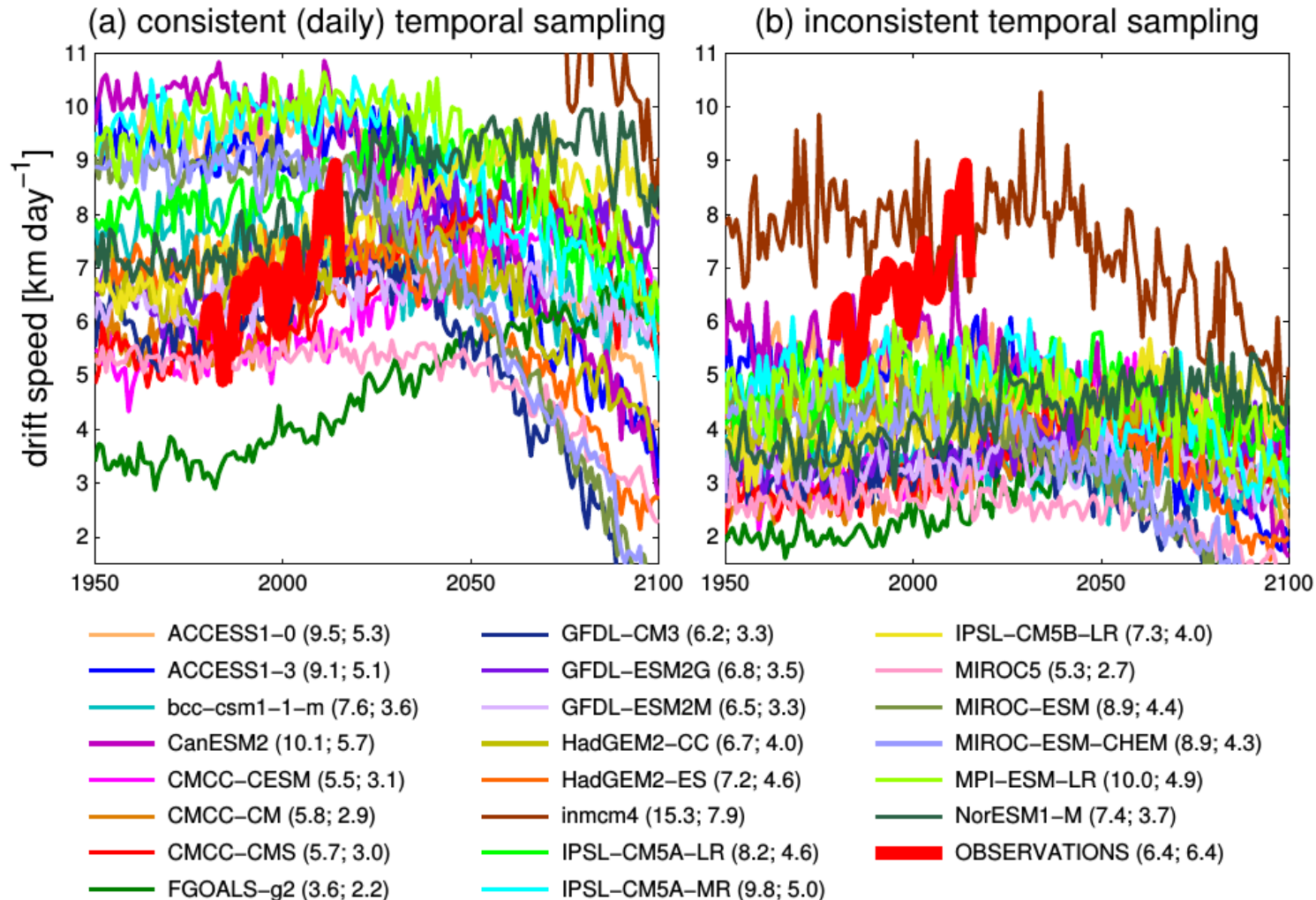
3. Ocean Heat Transport (OHT)



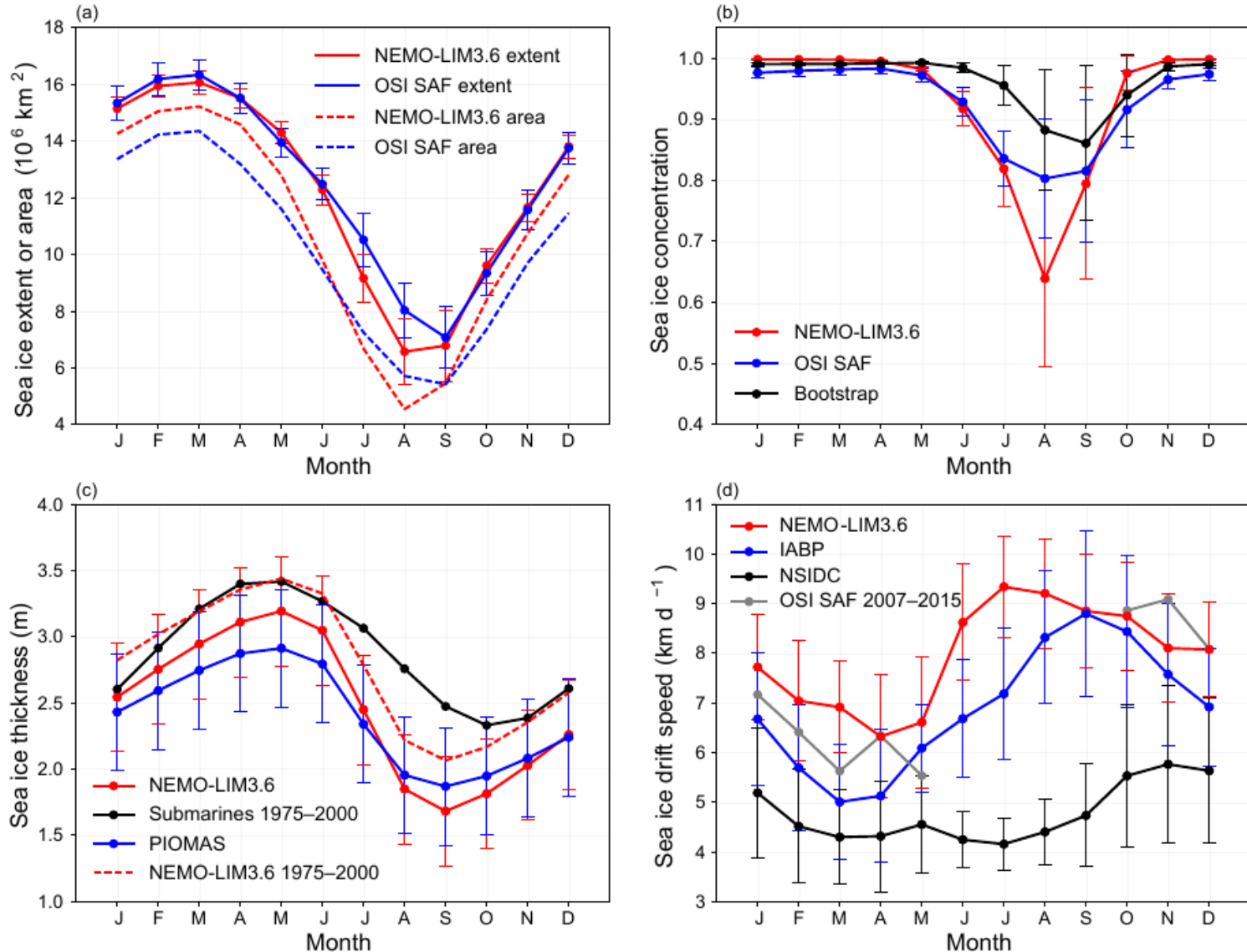
Curry & Mauritzen (2005)

4. Large-scale atmospheric circulation

CMIP5 sea-ice drift speed vs. Observations

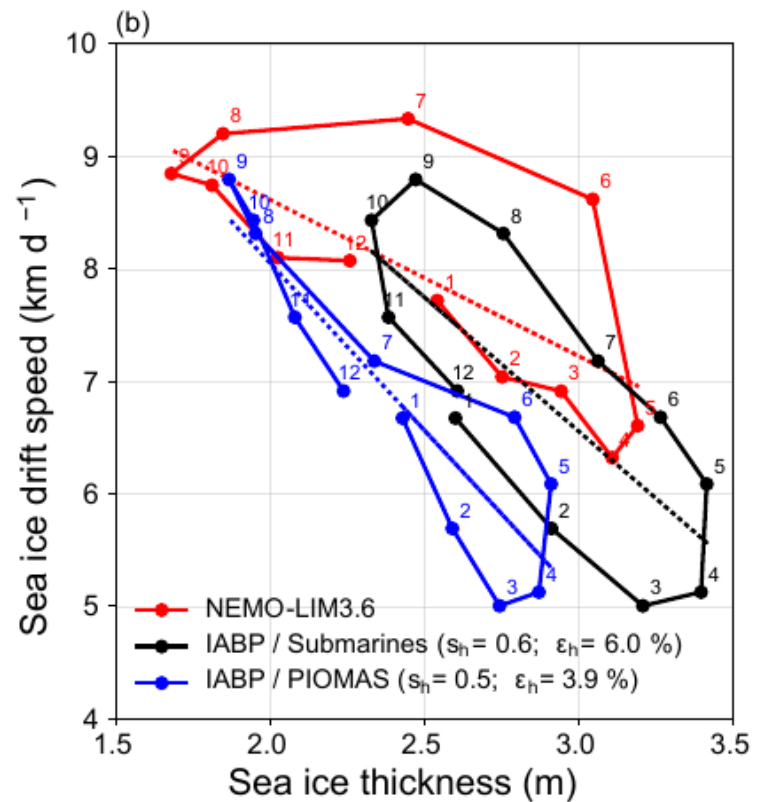
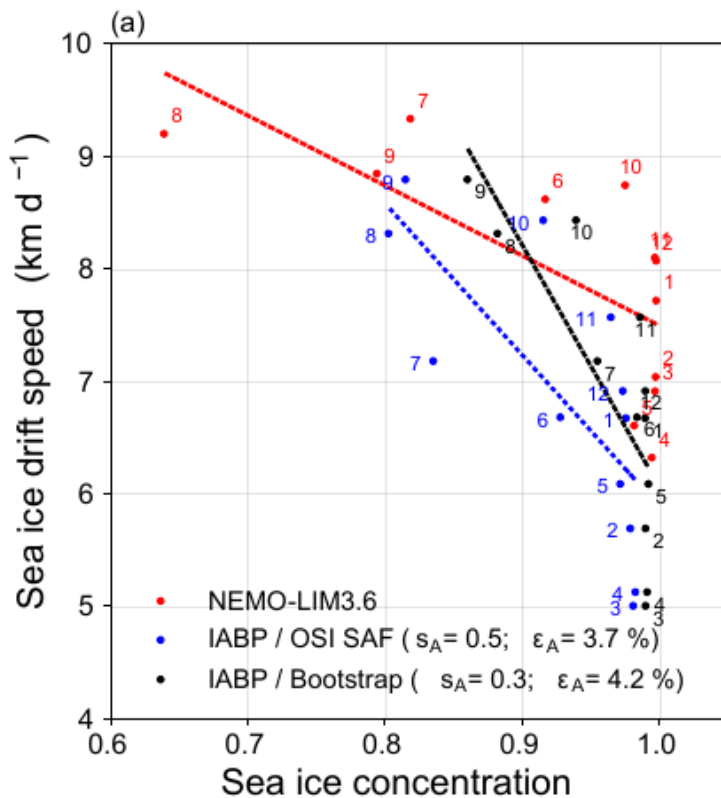


Evaluation of NEMO-LIM3.6



Drift-strength relationship

NEMO-LIM3.6 vs. Observations



1979-2013

Institution	MOHC, UREAD, NERC	EC-Earth KNMI,SHMI, BSC,CNR	CERFACS	MPI-M	AWI	CMCC	ECMWF
Model name	HadGEM3 GC3.1	EC-Earth3	CNRM-CM6	MPIESM-1-2	AWI-CM 1.0	CMCC-CM2	ECMWF-IFS
Model components	UM NEMO CICE	IFS NEMO LIM	ARPEGE NEMO GELATO	ECHAM6.3 MPIOM1.63 MPIOM1.63	ECHAM6.3 FESOM FESIM	CAM4 NEMO CICE	IFS cycle43r1 NEMO3.4 LIM2
Atmos dynamical scheme (grid)	Grid point (SISL, lat-long)	Spectral (linear, reduced Gaussian)	Spectral (linear, reduced Gaussian)	Spectral (triangular, Gaussian)	Spectral (triangular, Gaussian)	Grid point (finite volume, lat-long)	Spectral (cubic octohedral, reduced Gaussian)
Atmos grid name	N96, N216, N512	Tl255, Tl511	Tl127, Tl359	T127, T255	T63, T127	1x1, 0.25x0.25	Tco199, Tco399
Atmos mesh spacing 0N	208, 93, 39	78, 39	156, 55	104, 52	200, 100	100, 28	50, 25
Atmos mesh spacing 50N	135, 60, 25	71, 36	142, 50	67, 34	129, 64	64, 18	50, 25
Atmos nominal res (CMIP6)	250, 100, 50	100, 50	250, 50	100, 50	250, 100	100, 25	50, 25
Atmos model levels (top)	85 (85km)	91 (0.01 hPa)	91 (78.4 km)	95 (0.01 hPa)	95 (0.01 hPa)	26 (2 hPa)	91 (0.01 hPa)
Ocean grid name	ORCA	ORCA	ORCA	TP	FESOM (unstructured)	ORCA	ORCA
Ocean nominal res (km)	100, 25	100, 25	100, 25	40, 40	50, 25	25, 25	100, 25
Ocean levels	75	75	75	40	47	50	75

7 AOGCMs that follow the CMIP6 HighResMIP protocol

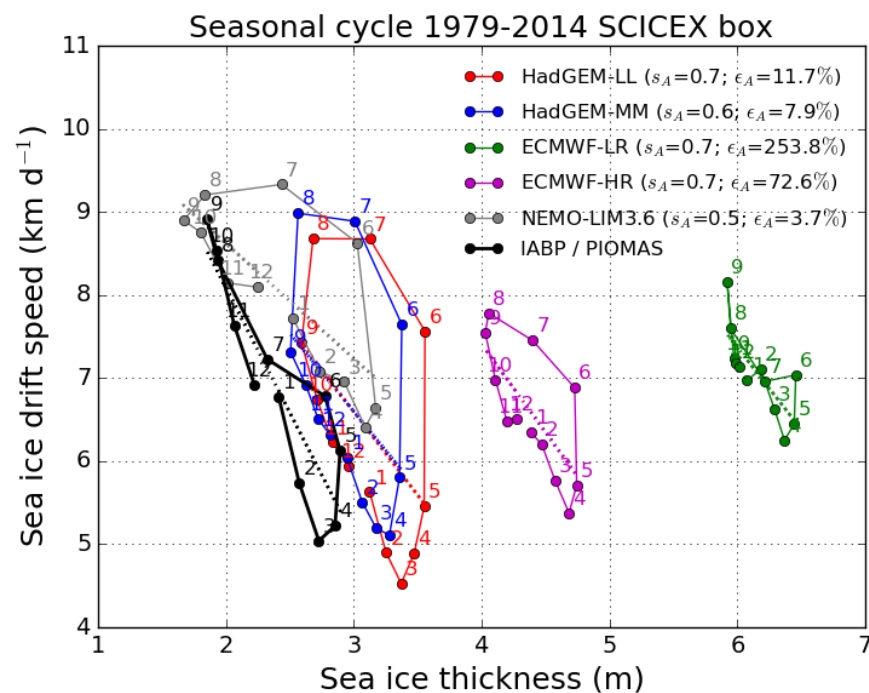
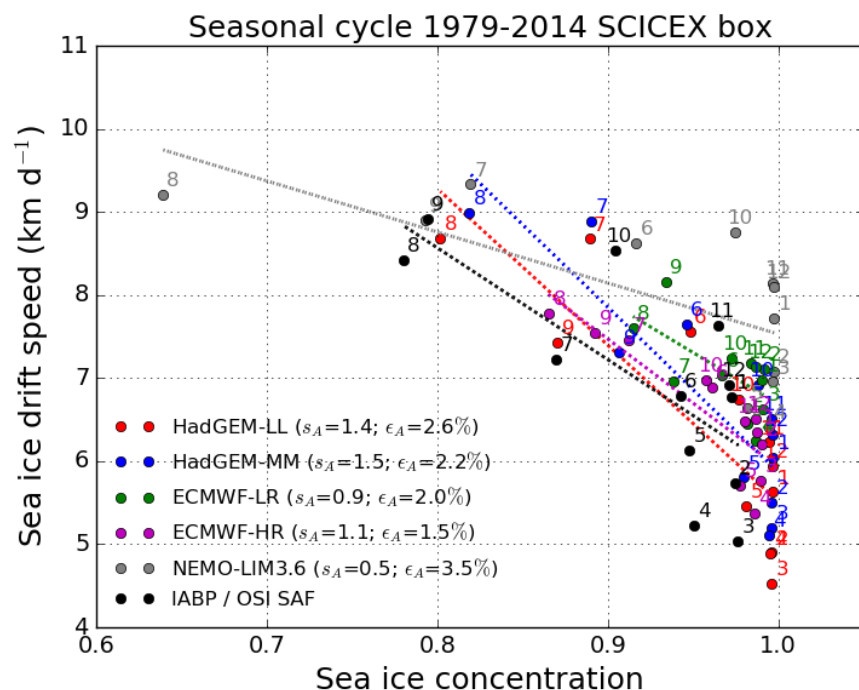
HadGEM-LL: 135km / 1°
HadGEM-MM: 60km / 0.25°

AWI-LR: 130km / 24-110km
AWI-HR: 65km / 10-60km

ECMWF-LR: 50km / 1°
ECMWF-HR: 25km / 0.25°

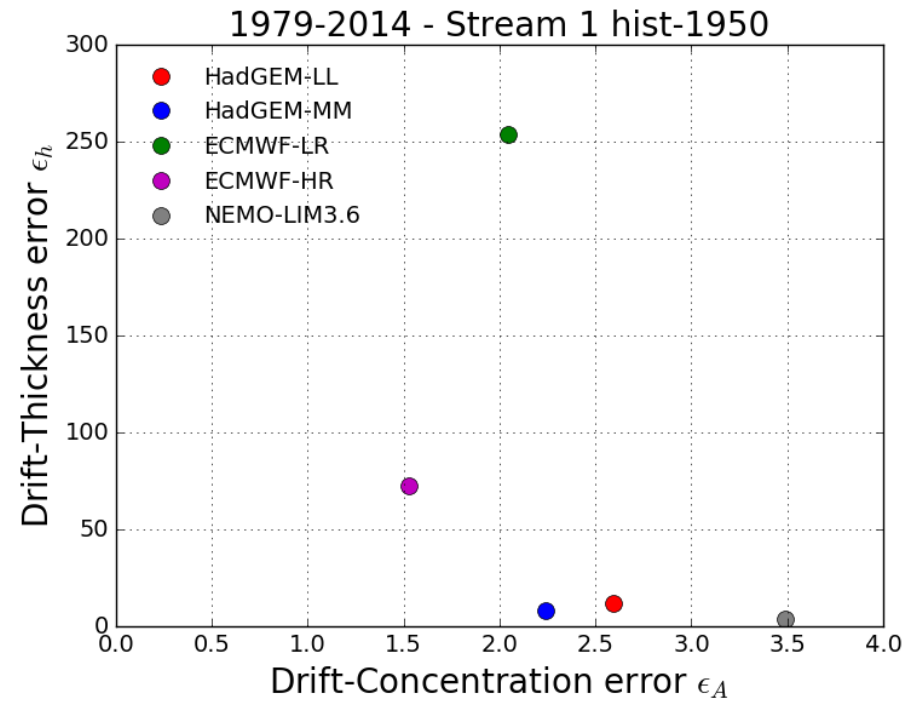
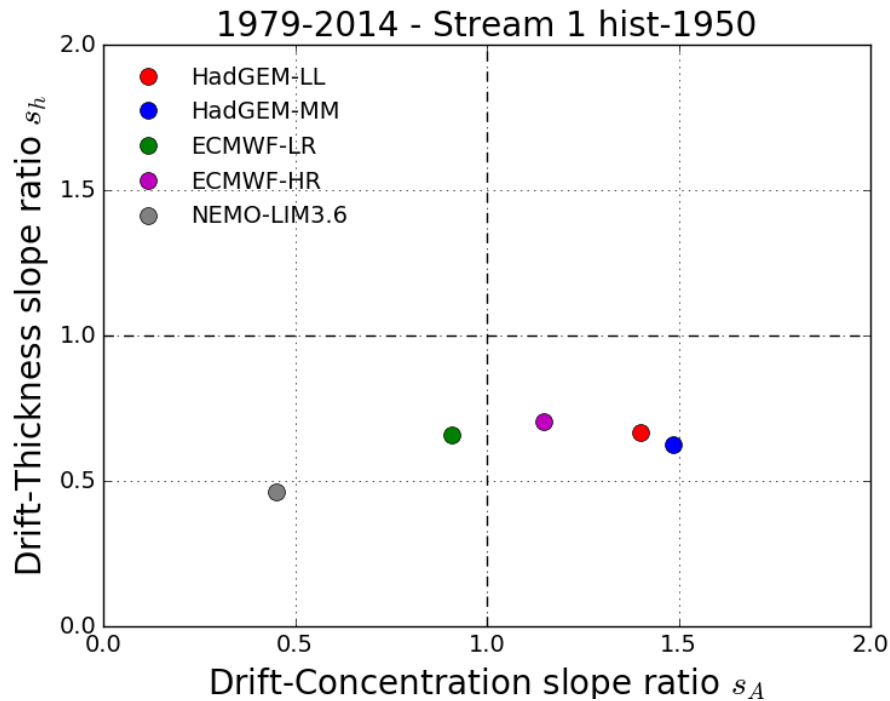
Drift-strength relationship

PRIMAVERA models vs. NEMO-LIM3.6 and Obs.



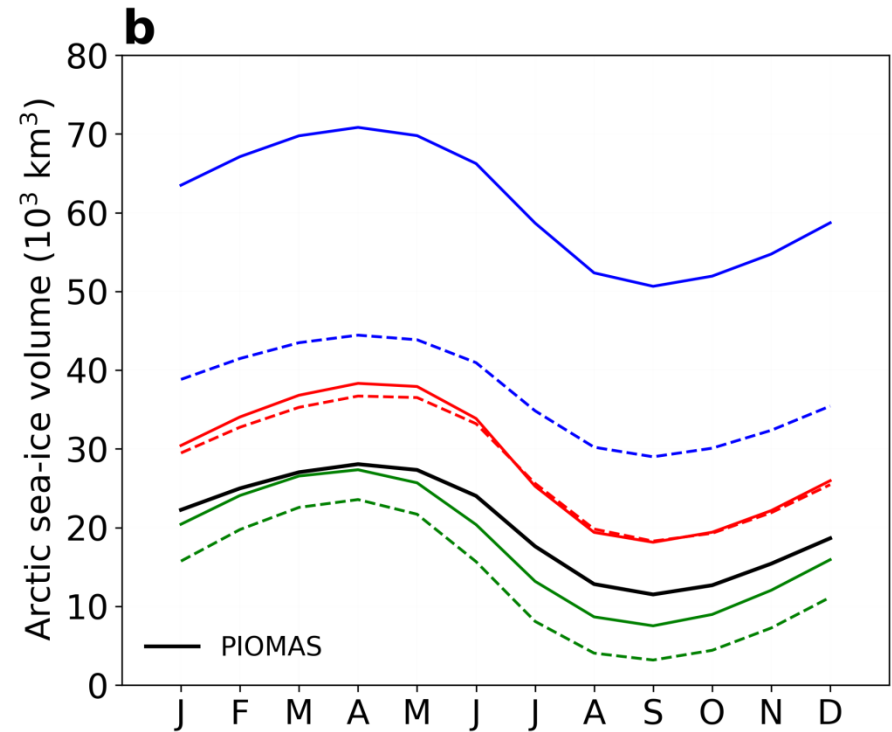
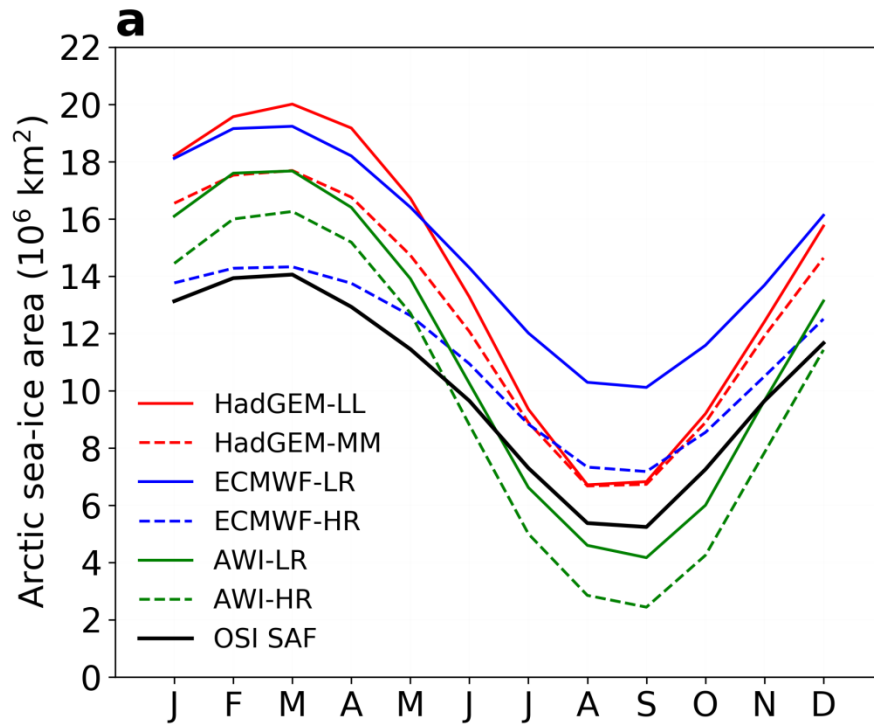
1979-2014

Building metrics



1979-2014

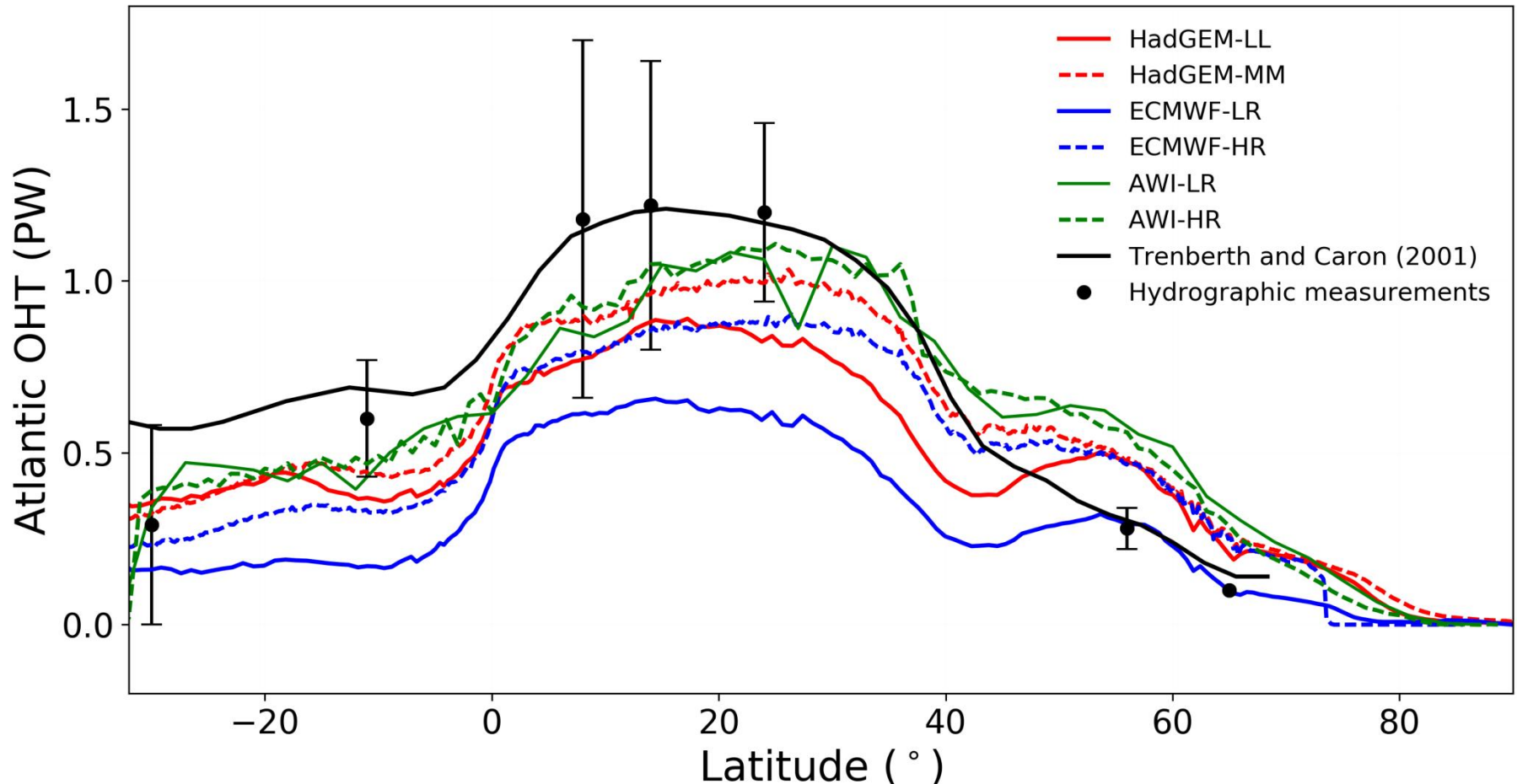
Arctic sea-ice area and volume decrease with finer resolution



1979-2014

Atlantic ocean heat transport (OHT) increases with finer resolution

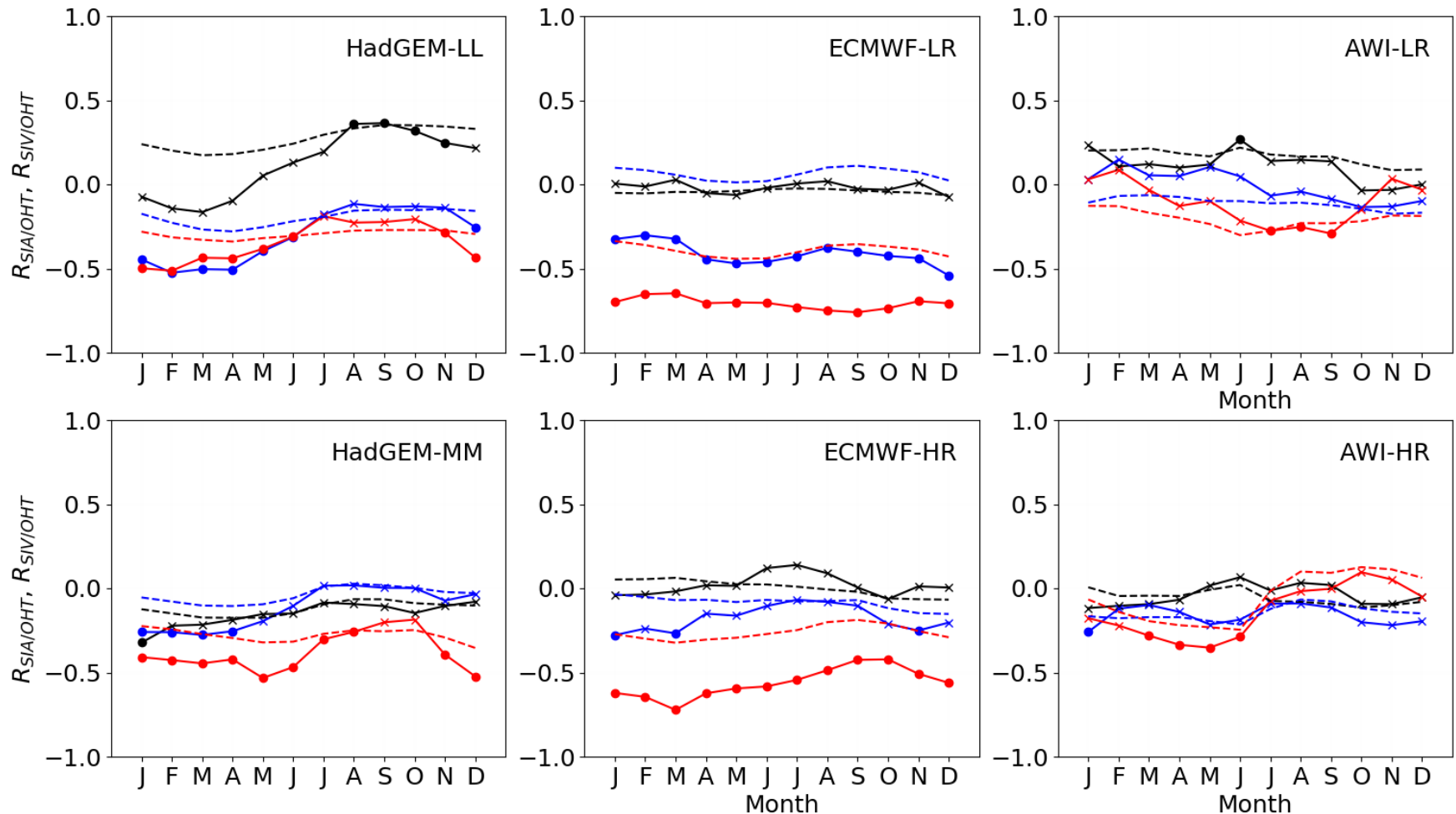
1950-2014



Correlation Arctic sea ice – Atlantic OHT

1950-2014

— OHT_{50N}
— OHT_{60N}
— OHT_{70N}
--- R_{SIV/OHT}



Summary

1. Context

- Arctic sea ice is retreating, thinning and more mobile

2. Sea ice drift-strength

- NEMO-LIM3.6: rather OK
- ECMWF and HadGEM: fair (except ECMWF-LR for drift-thickness)

3. Sea ice – ocean heat transport

- Arctic sea ice area/volume decrease with finer resolution
- Atlantic OHT increases with finer resolution
- Need for 0.25° ocean resolution

4. Outlook

- More models/resolutions are needed

More food

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- A background image showing three men walking on a paved path in a mountainous area. The man on the left is wearing a red shirt and a dark vest. The man in the middle is wearing a blue long-sleeved shirt. The man on the right is wearing a maroon t-shirt with a green and yellow geometric pattern. They are all smiling and looking towards the camera. In the background, there are green mountains and a small village with white houses and red roofs.
- Poster **196:** François Massonnet (presented by **Jan Lieser**)
SIPN South: Coordinating seasonal predictions of sea ice in the Southern Ocean
- Poster **202:** **Sylvain Marchi**
Seasonal prediction of the Antarctic sea ice using NEMO-LIM
- Poster **205:** François Massonnet (presented by **David Docquier**)
Re-interpreting thermodynamic Arctic sea-ice feedbacks
- Poster **249:** Olivier Lecomte (presented by **Hugues Goose**)
Vertical ocean heat redistribution sustaining sea-ice trends in the Ross Sea
- Poster **268:** **Jean Sterlin**
Importance of deformed ice in the polar regions for the climate models