



# Evaluation of the sea ice simulation in a new coupled atmosphere-ocean climate model: HadGEM1

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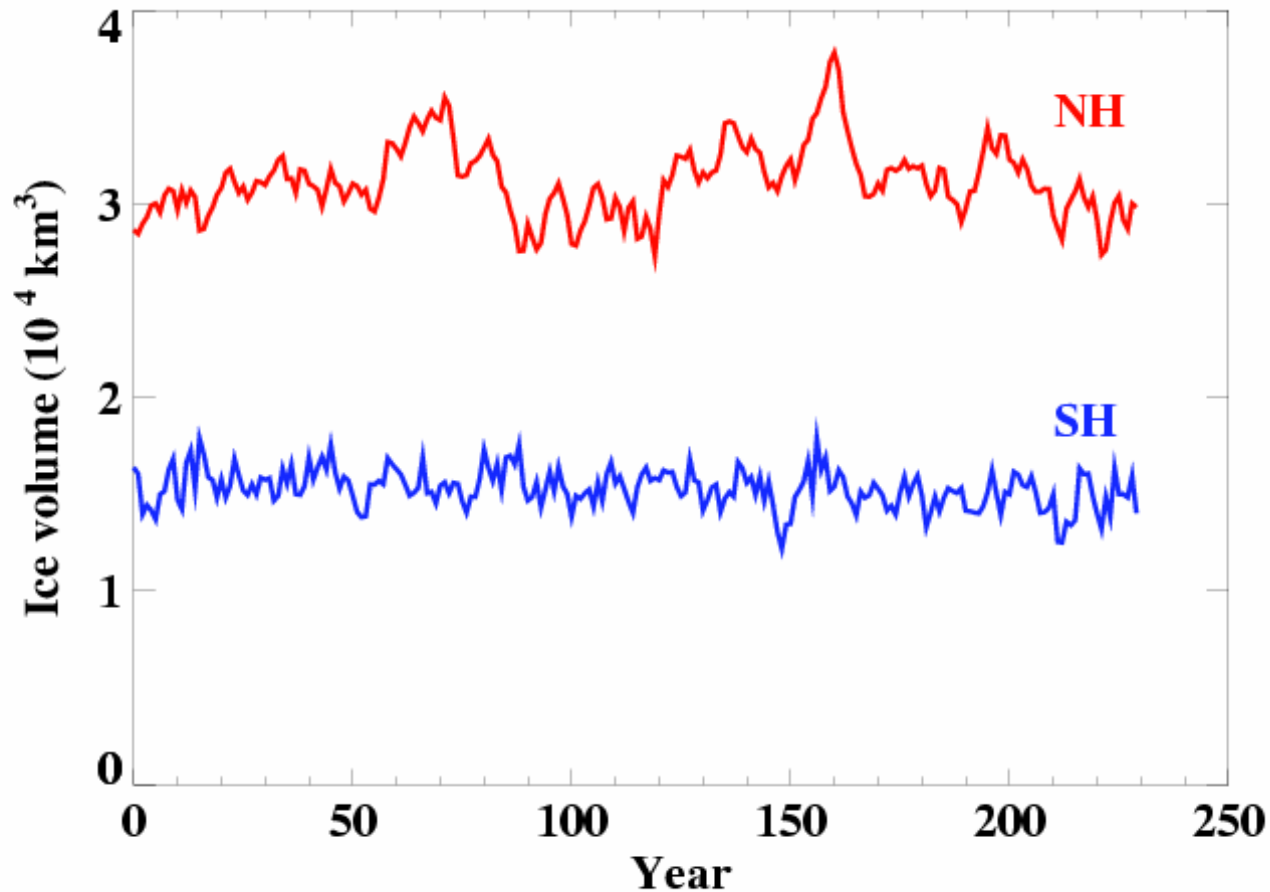
Seymour Laxon (UCL)

UK sea-ice meeting: 8-9<sup>th</sup> September 2005

- Fully coupled atmosphere-ocean model
- Atmosphere:
  - $1.25^\circ \times 1.825^\circ$ , 38 vertical levels
  - New dynamical core c.f. HadCM3
  - Coastal tiling (allows non-congruent grids)
- Ocean:
  - $1^\circ \times 1^\circ$  at poles, gradually increasing over 30N-30S to  $1^\circ \times 1/3^\circ$  at equator, 40 vertical levels
  - Implicit linear free surface

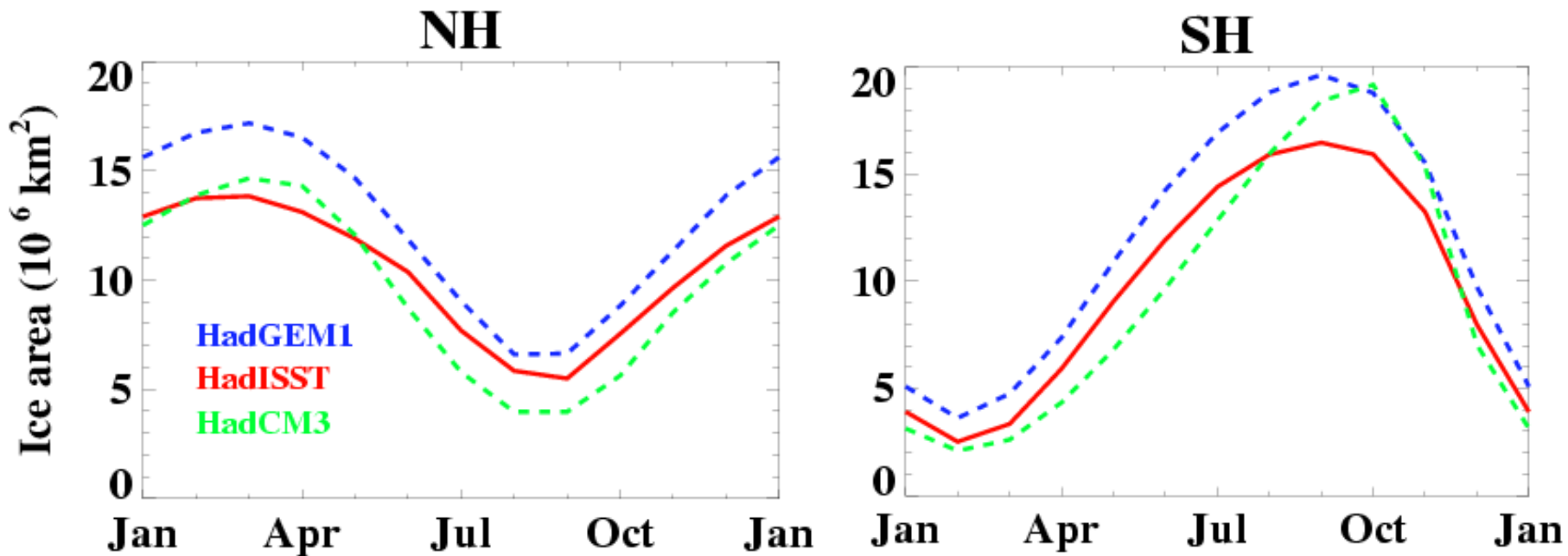
	HadCM3	HadGEM1
Dynamics	Advection by ocean currents with max. thickness limit of 4m	Advection by wind and ocean currents with EVP rheology Flow over NP
Thermodynamics	Zero-layer Semtner	Zero-layer Semtner with sub-grid scale ice thickness distribution scheme
Ridging	Specified max ice concentrations	Full ridging scheme
Albedo	Dependent on T	Dependent on T and snow depth

# Ice volume timeseries



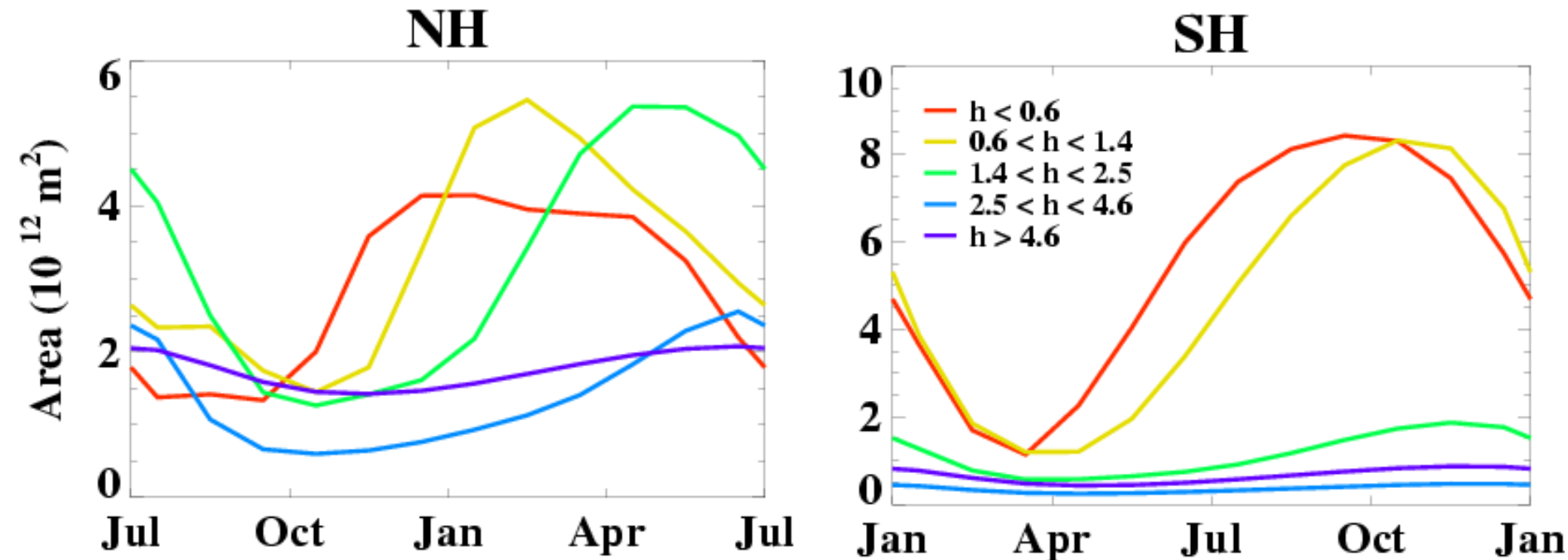
- HadGEM1 control run (after 85 yrs spin-up)

# Ice area seasonal cycle



- Phase good in HadGEM1
- HadGEM1 amplitude larger than HadISST
- HadGEM1 area larger than HadISST

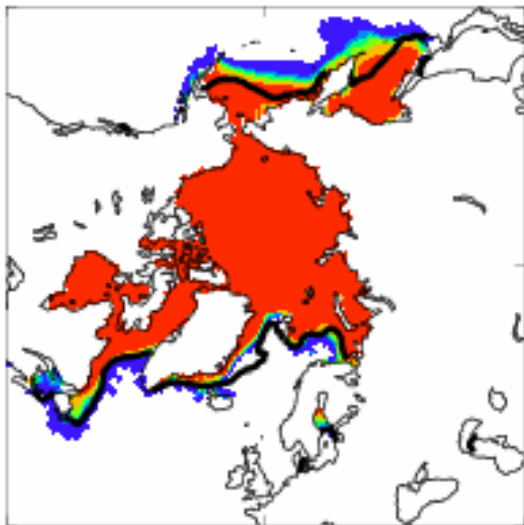
# Ice area categories seasonal cycle



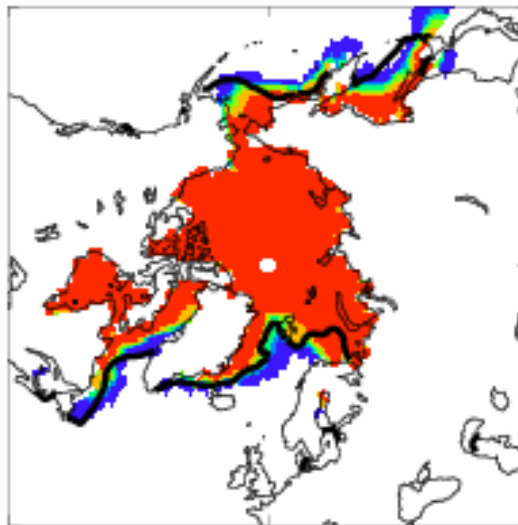
- Thinnest category grows first in autumn
- Volume transferred as ice grows
- Small seasonal cycle for thickest categories

# NH March ice concentration (>15%)

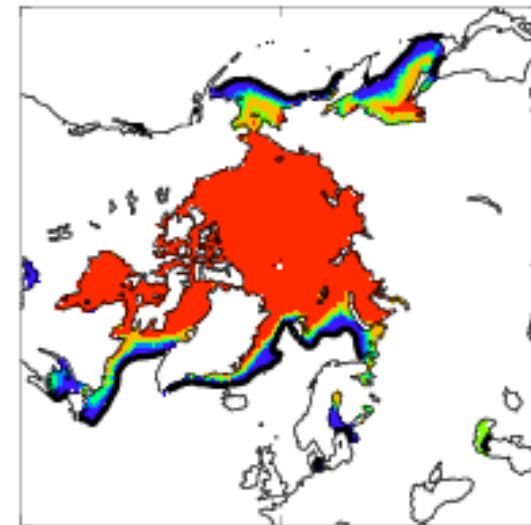
HadGEM1



HadCM3



HadISST obs



0.15 0.5 0.6 0.7 0.8 0.9 1

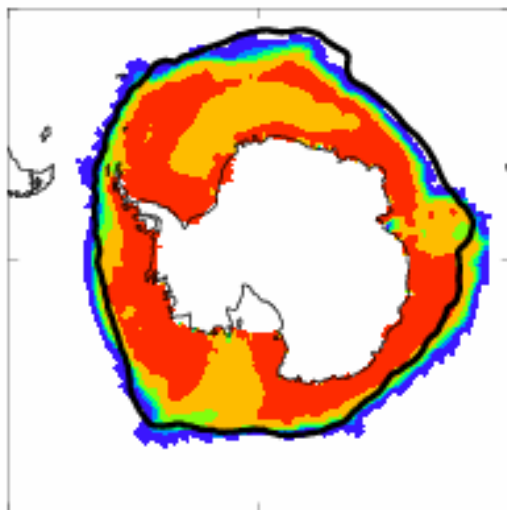
0.15 0.5 0.6 0.7 0.8 0.9 1

0.15 0.5 0.6 0.7 0.8 0.9 1

- Atlantic extent good in HadGEM1
- Pacific extent too great in HadGEM1

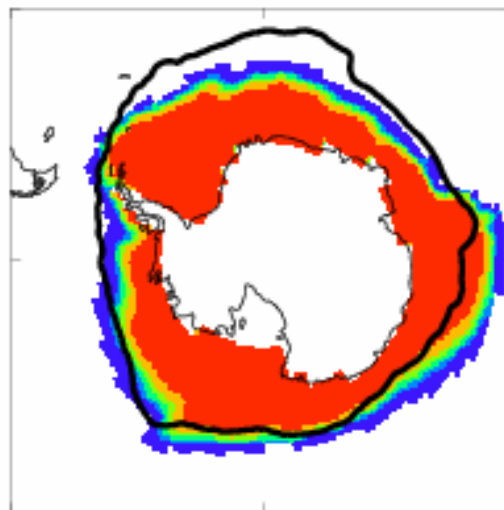
# SH September ice concentration (>15%)

HadGEM1



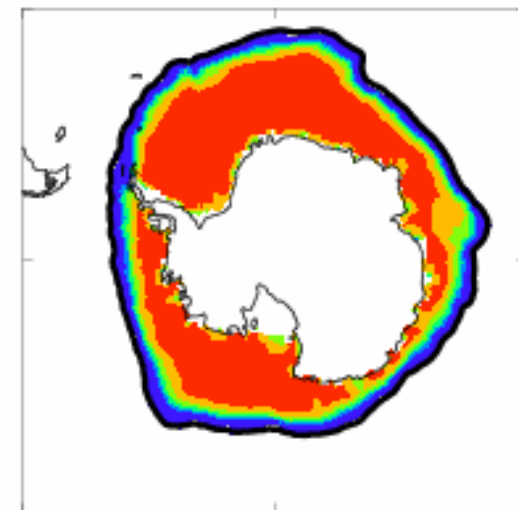
0.15 0.5 0.6 0.7 0.8 0.9 1

HadCM3



0.15 0.5 0.6 0.7 0.8 0.9 1

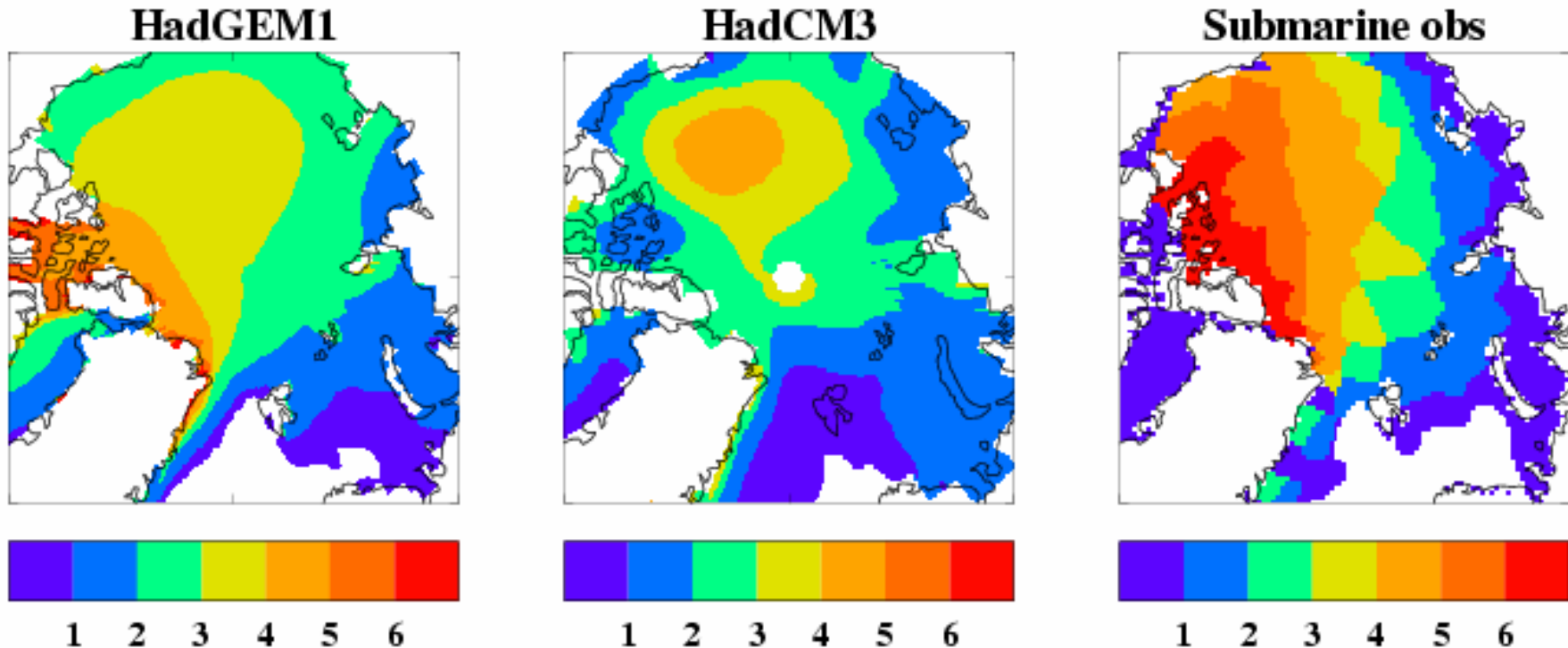
HadISST obs



0.15 0.5 0.6 0.7 0.8 0.9 1

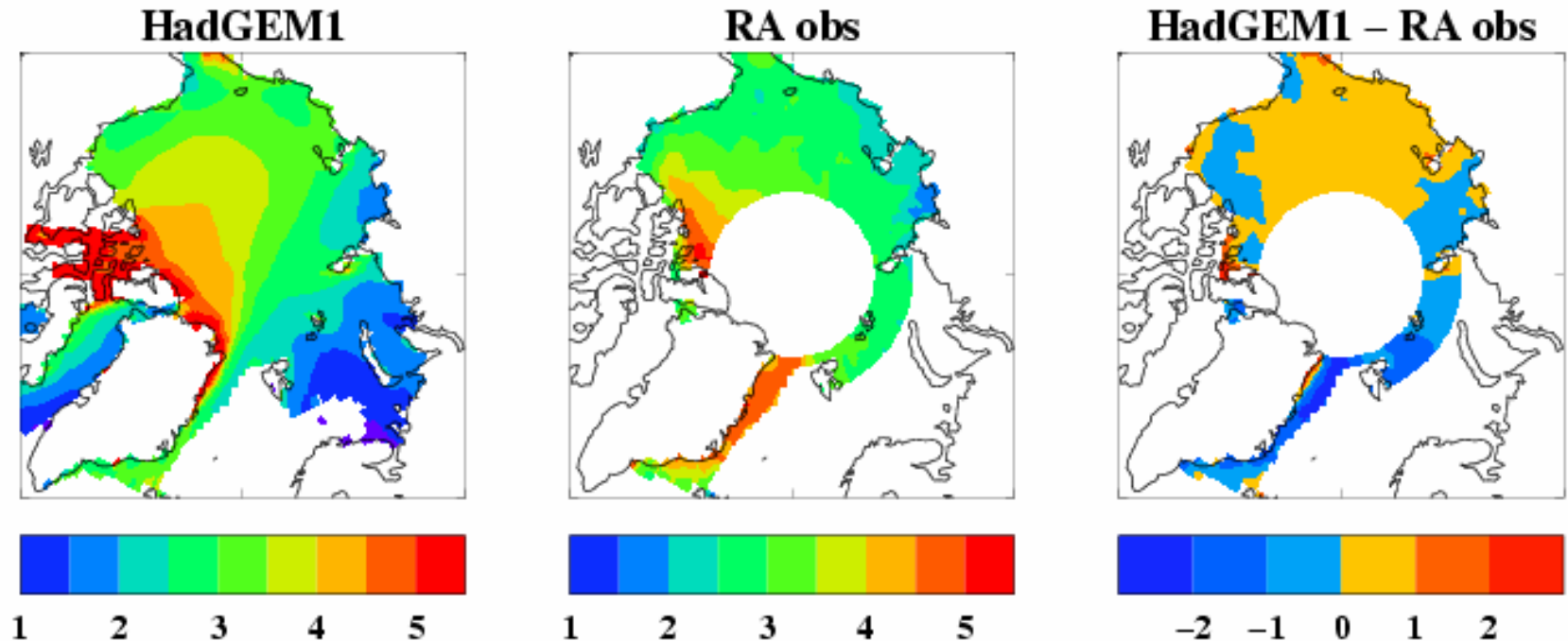
- Extent good in HadGEM1
- Concentration too low in some places

# Winter ice thickness (m)

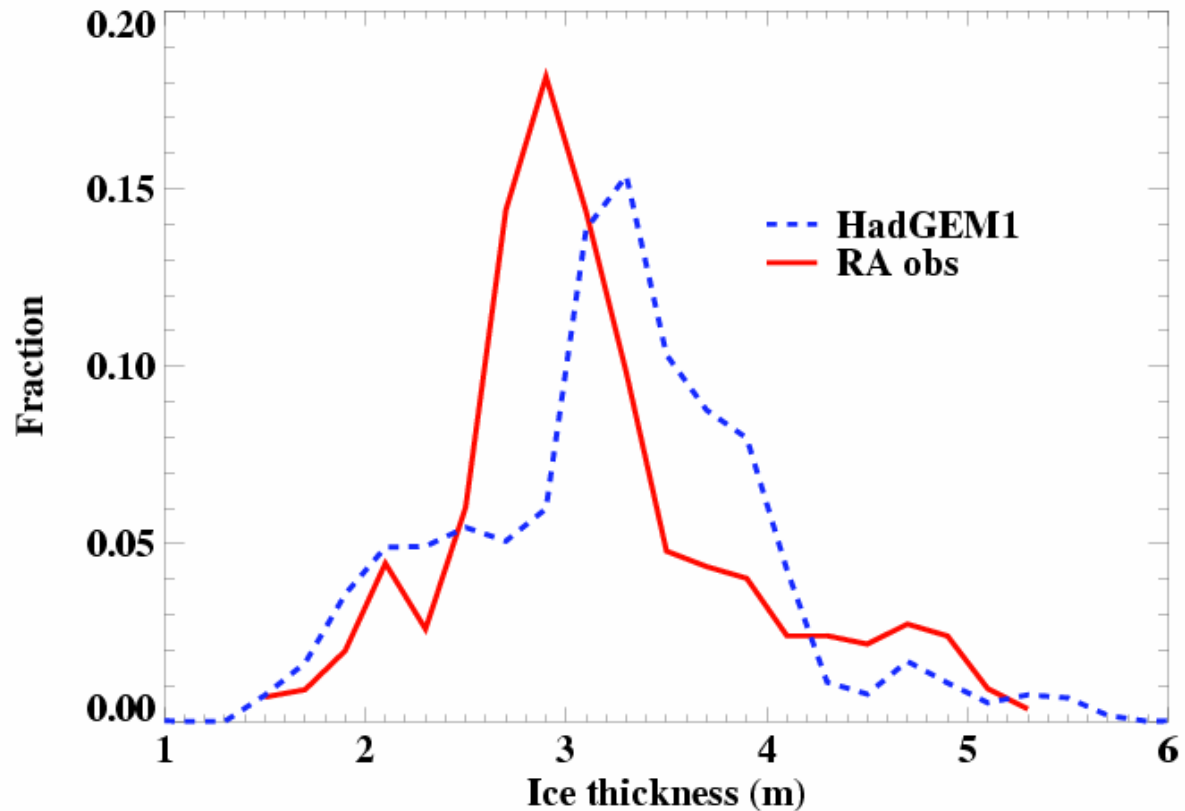


- 17 sub cruises (1960-1982), compiled by Bourke and Garrett (1987) and digitized at NCAR
- HadGEM1 mean = 2.6m, sub mean = 2.9m (north of 65°N)

# Winter ice thickness (m)

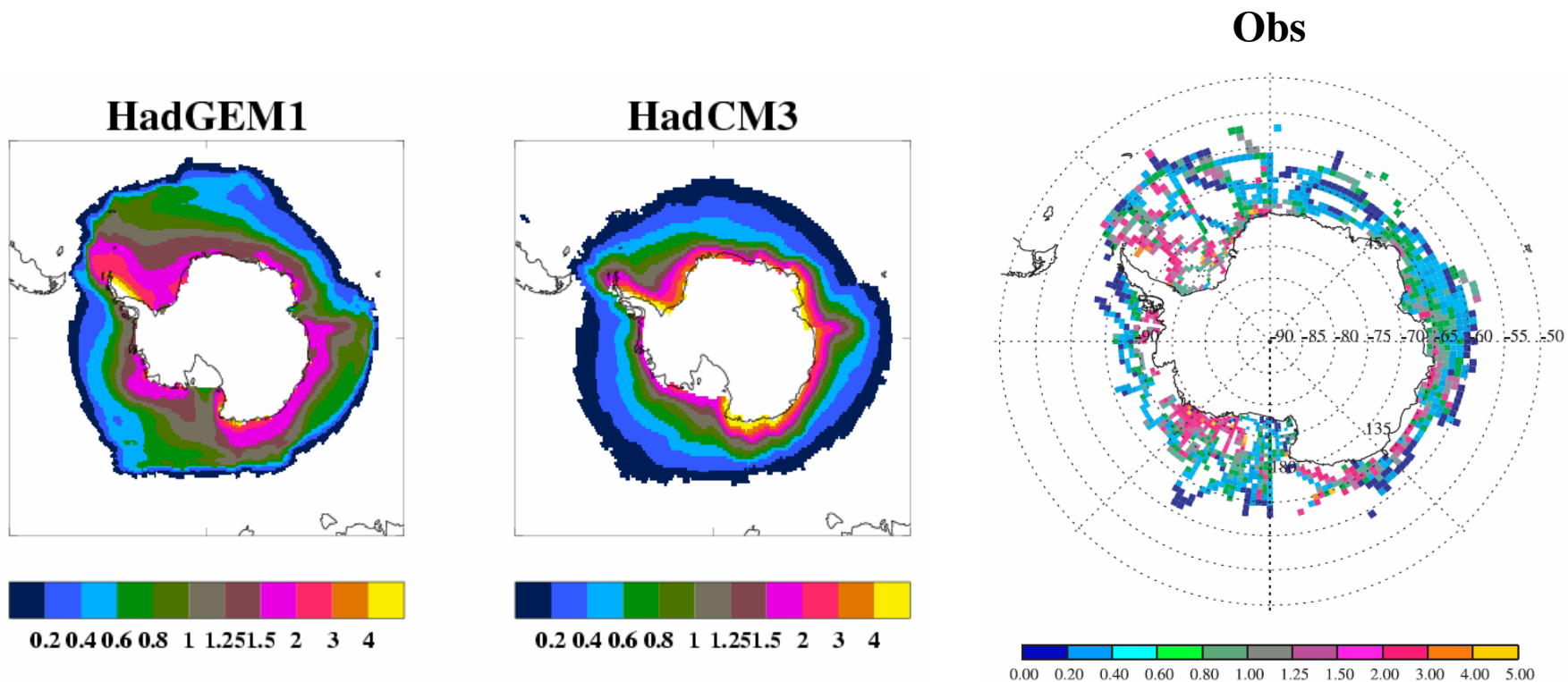


- RA thicknesses derived by Laxon et al, UCL.
- Excludes ice < 0.5m and open water
- RA observations 1993-2001 = thin ice
- HadGEM1 mean = RA mean = 3.1m



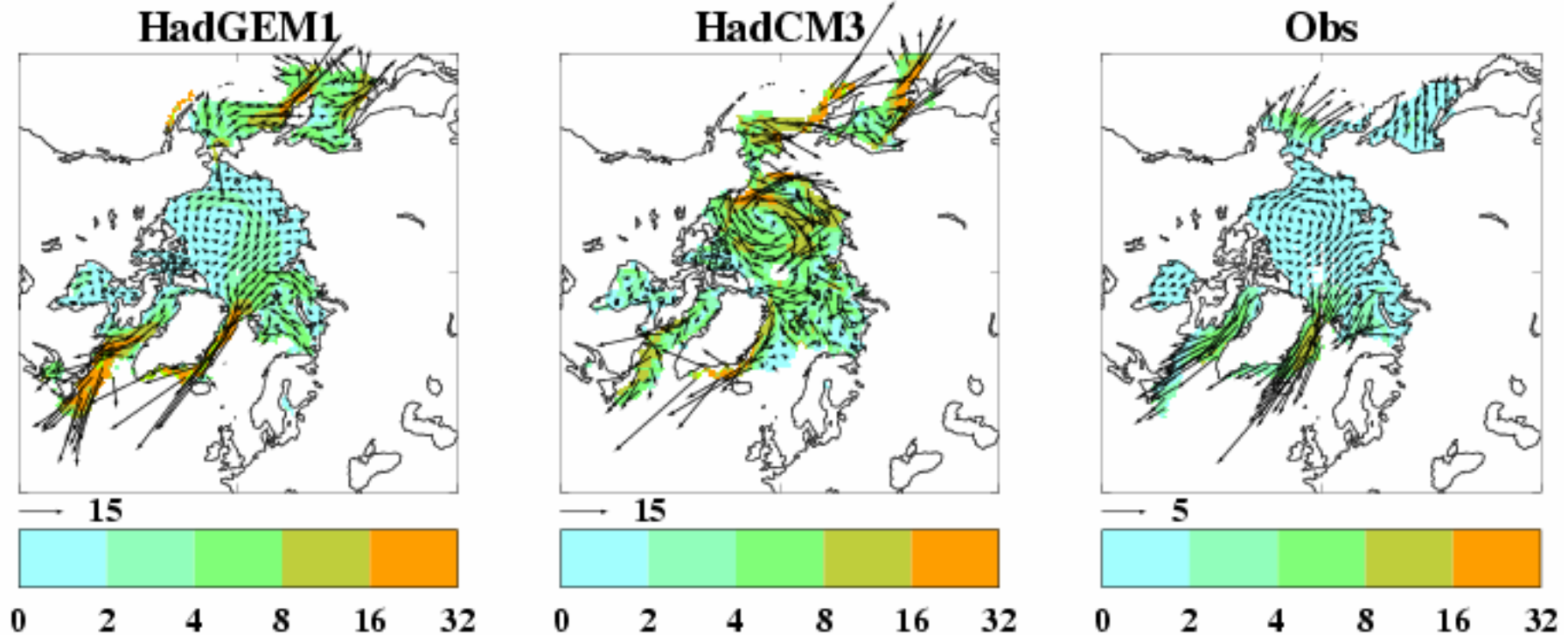
- Excludes ice < 0.5m and open water
- Difference at 3.5-4m due to thicker ice in Beaufort Gyre in HadGEM1
- Difference at 2-2.5m due to thinner ice in Laptev, Kara & Barents Seas

# Annual mean ice thickness (m)



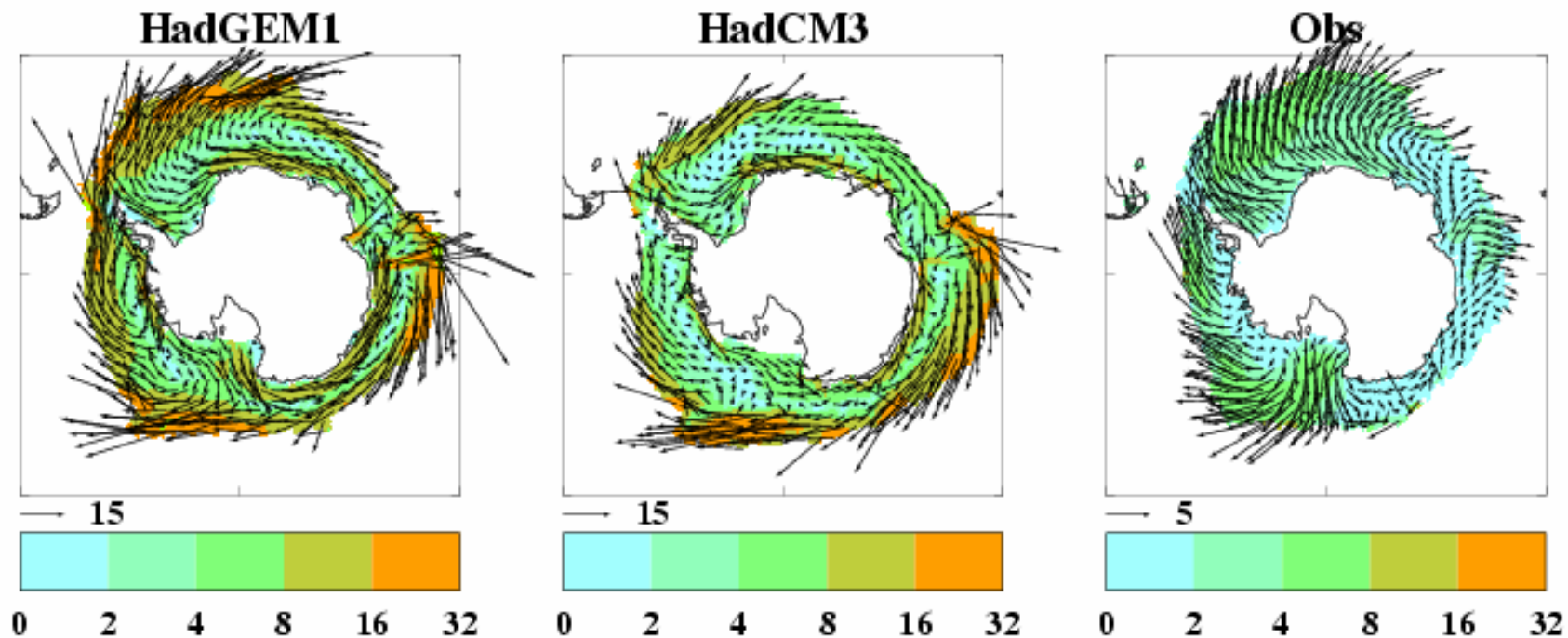
- Obs: ASPeCt mean ice thicknesses corrected by model estimate of sampling bias. Timmerman et al. (2004)

# NH winter ice velocities (cm/s)



- Fowler observational dataset
- Fram Strait volume flux in good agreement with observations

# SH winter ice velocities (cm/s)



- Mostly in free drift
- Wind stress too great off ice shelves
- Ocean-ice drag too weak at ice edge?

- Sensitivity experiments: Is improvement in HadGEM1 due to forcing, ITD or EVP (*talk by Alison McLaren*)
- Arctic ice volume variability
- Use of CICE sea ice model within a flexible modelling environment (*talk by Helene Banks*)

- Still a challenge to evaluate model against observations: short duration of observations, pre-industrial model
- HadGEM1 sea ice in good agreement with observations except ice speeds
- Ice thickness, seasonal cycle phase, N. Atlantic and SH winter extent improved in HadGEM1 relative to HadCM3