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Climate Simulations And Projections Over Russia And The Adjacent Seas: a CMIP5 Update

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Voeikov Main Geophysical Observatory, St. Petersburg, Russia

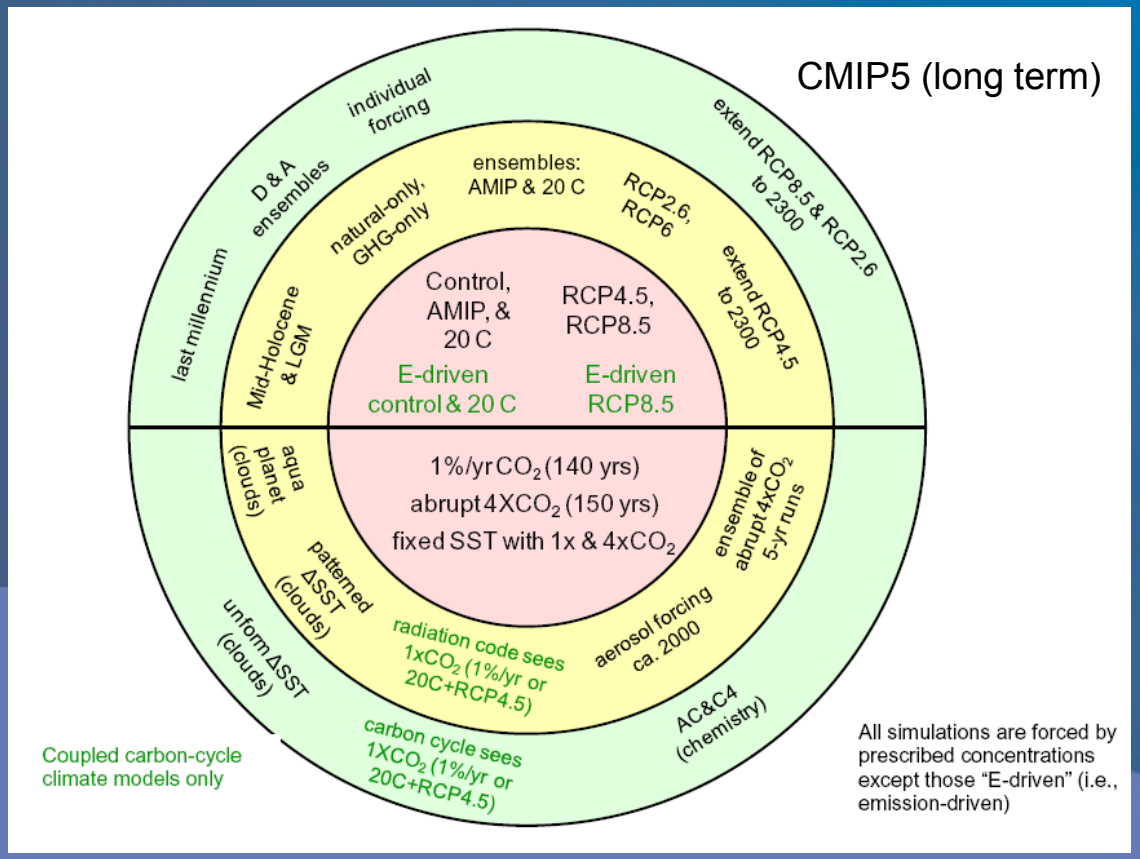
Workshop on Global Assessment of the Implications of Climate Change on the Spatial Distribution of Fish and Fisheries
(WKSICCME-Spatial), St. Petersburg, Russia, 22-24 May, 2013

Coupled Model Intercomparison Project (CMIP)

IPCC AR4 (2007) - CMIP3: > 20 AOGCMs

20CM3, A2, A1B, B1

IPCC AR5 (2013) – CMIP5: > 50 AOGCMs



Taylor et al., 2007

IPCC projections

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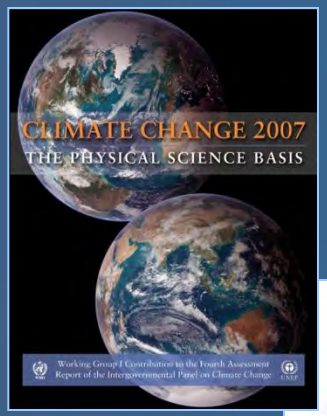

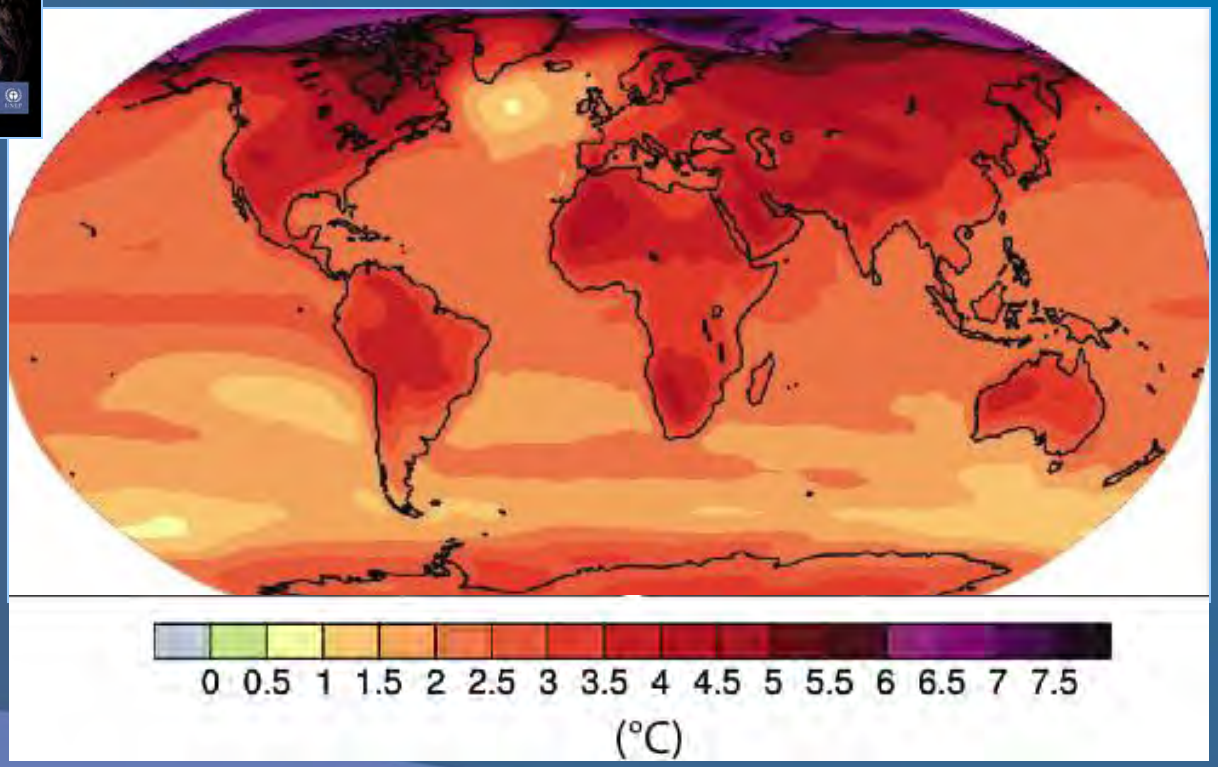

A1B is a typical “business as usual” (2090-2099) scenario: Global mean warming 2.8°C;
Much of land area warms by ~3.5°C
Arctic warms by ~7°C

Annual mean surface air temperature change (deg C) for 2080-2099 related to 1980-1999 (CMIP5 ensemble mean, RCP4.5)

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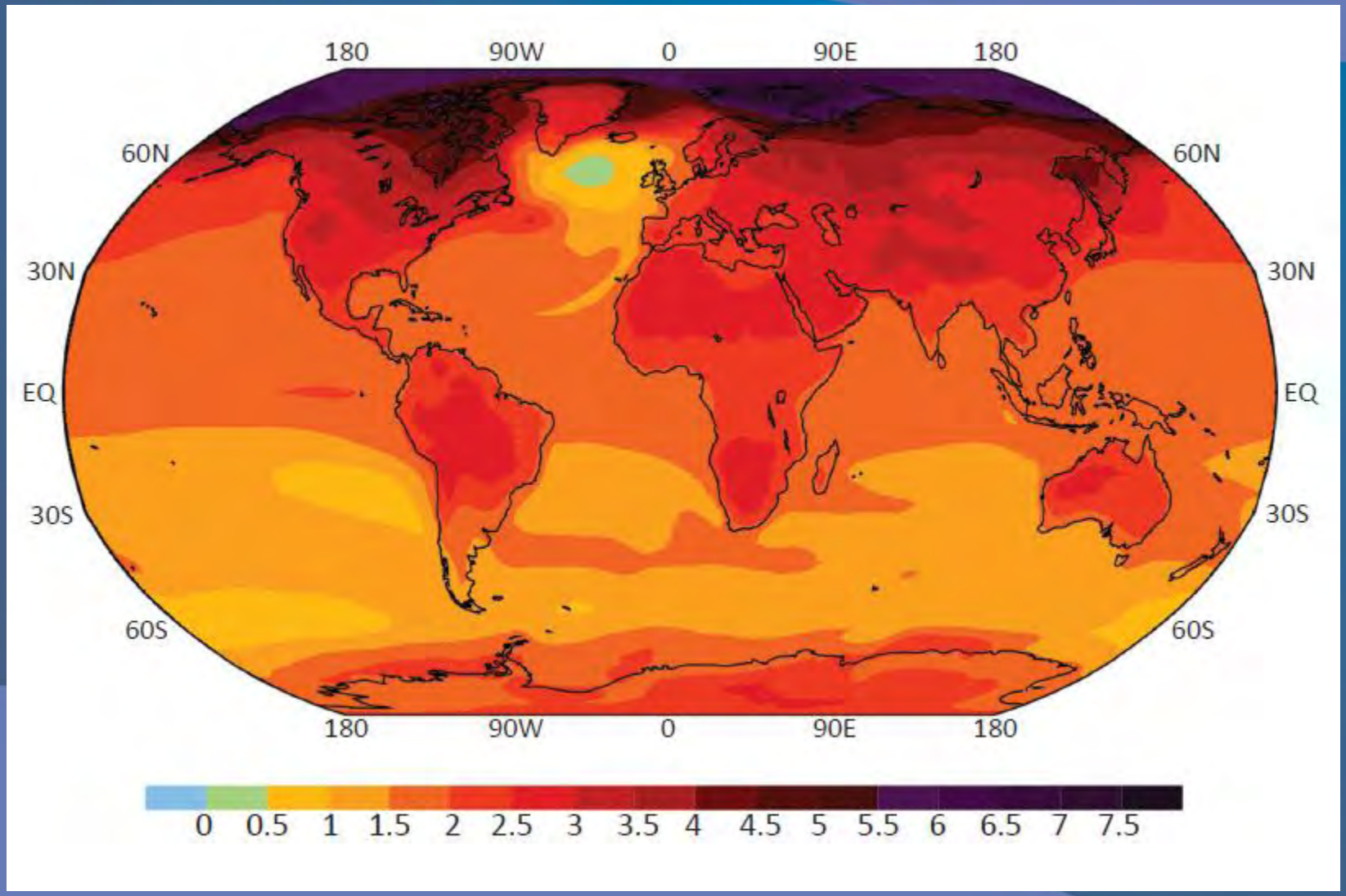

Simulated sea ice distribution in the N.Hemisphere For February and September (1986-2005)

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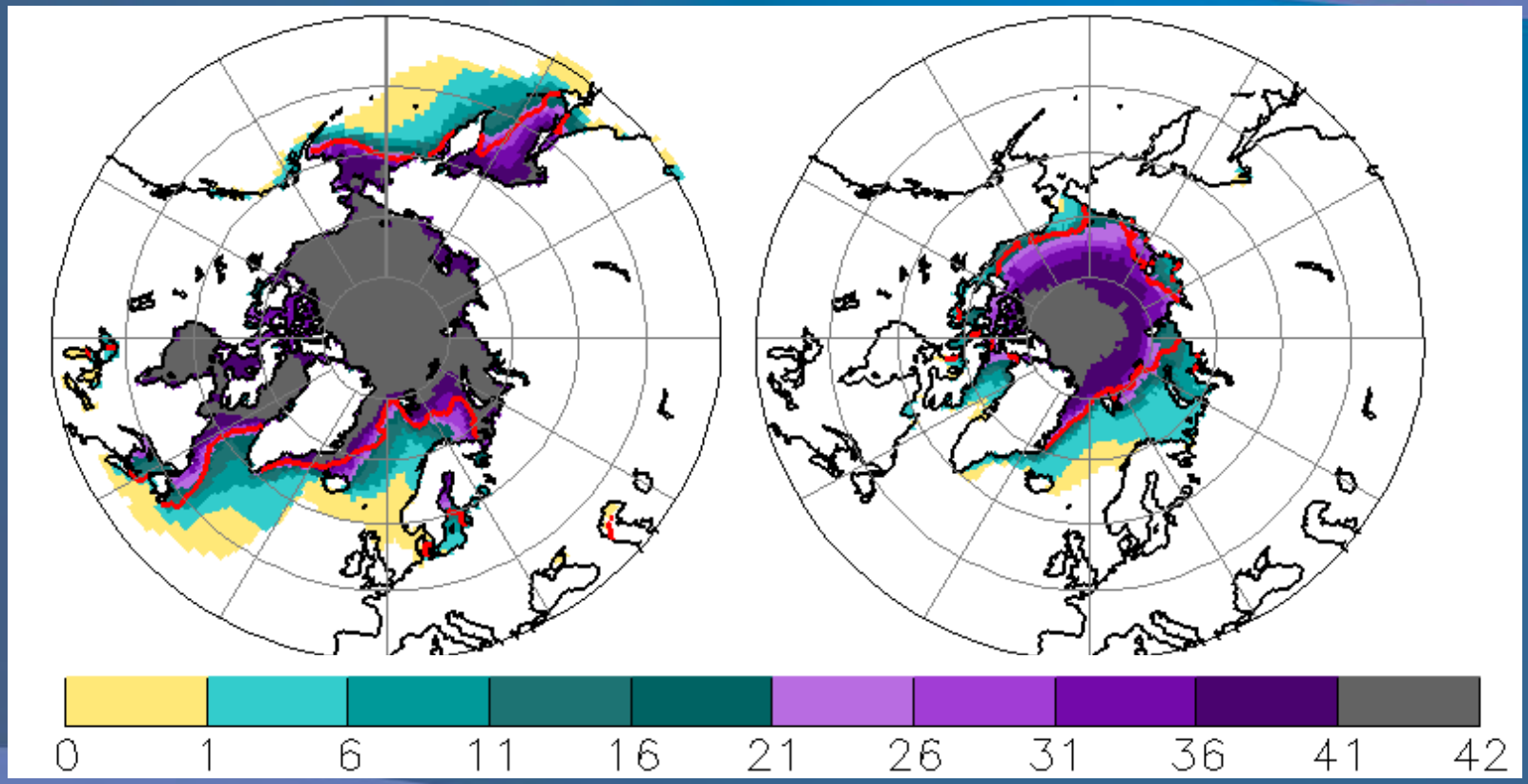
CMIP5 models

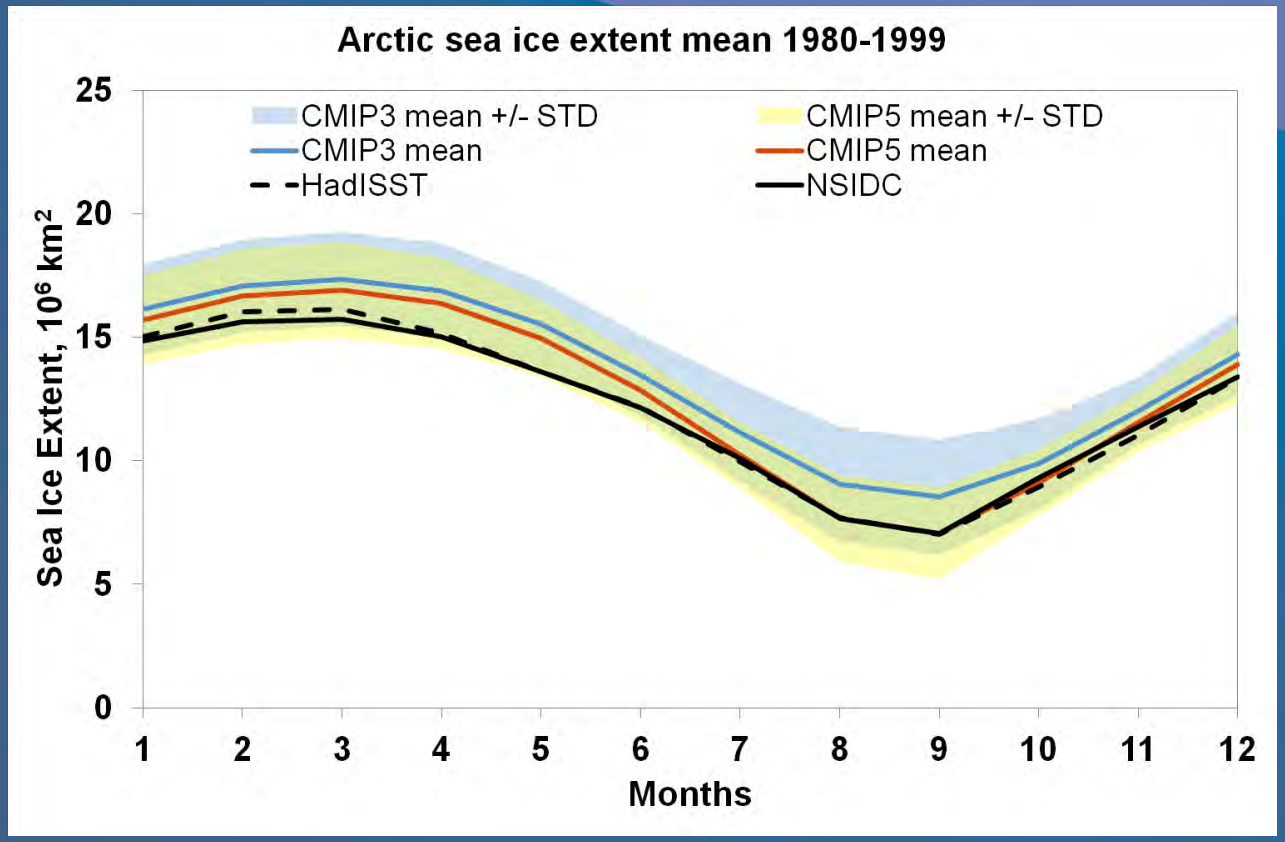
February September



For each 2.5x2.5º longitude-latitude grid cell, the figure indicates the number of models that simulate at least 15% of the area covered by sea ice. The observed 15% concentration boundaries (red line) are based on HadISST data set (Rayner et al., 2003).

IPCC, 2007; Pavlova and Kattsov, 2013

AR4 (1980–1999) baseline climate model mean sea ice extent seasonal cycles



Sea ice extent (the ocean area within 15% sea ice concentration) seasonal cycles in the Northern hemisphere as simulated by CMIP5 and CMIP3 ensembles.

The observed sea-ice extent cycles are based on the National Snow and Ice Data Center – NSIDC (Fetterer, Knowles et al. 2002) (satellite) and HadISST data sets (Rayner et al., 2003). The shaded areas show the inter-model standard deviation for each ensemble.

Pavlova and Kattsov, 2013

Models too conservative?

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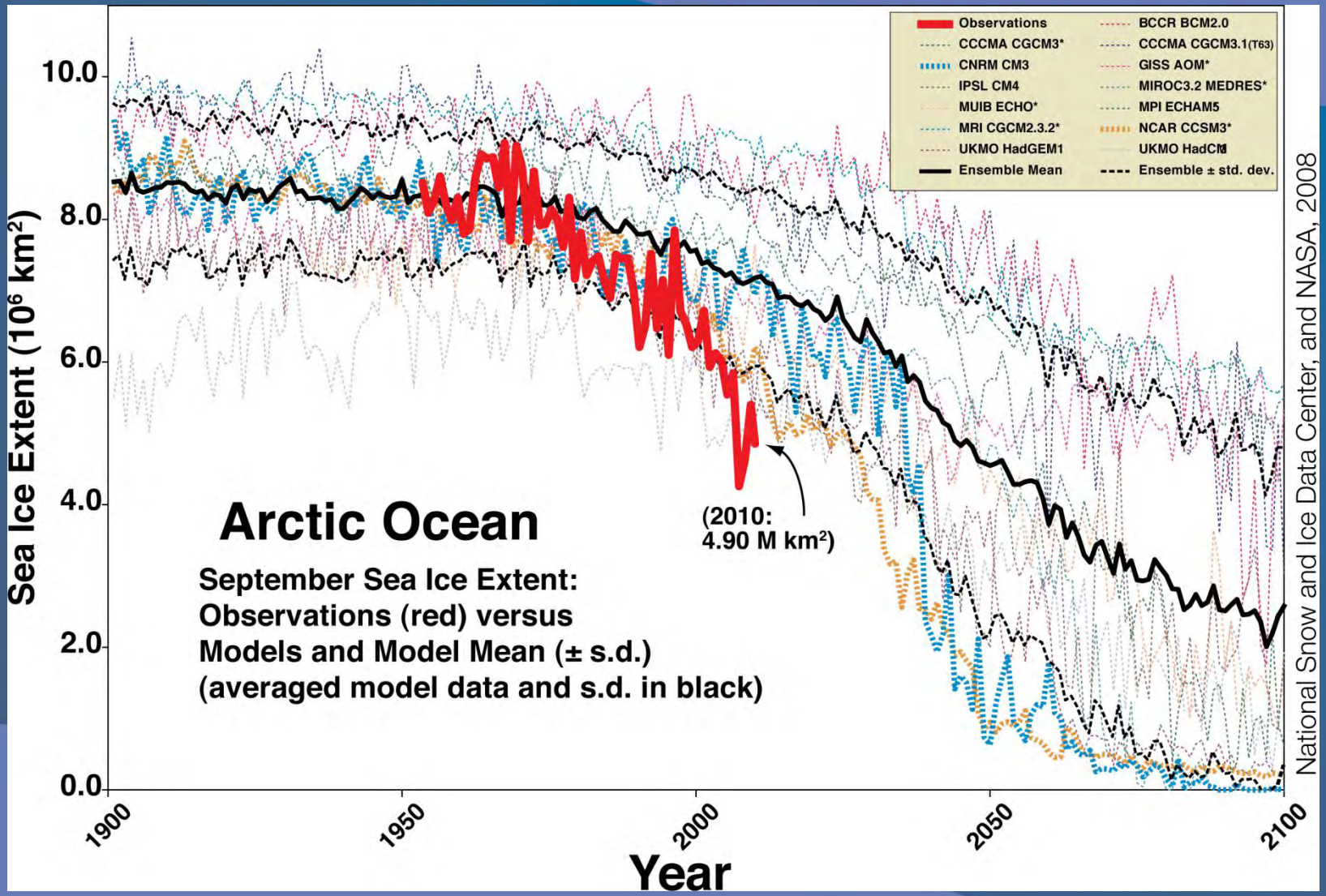
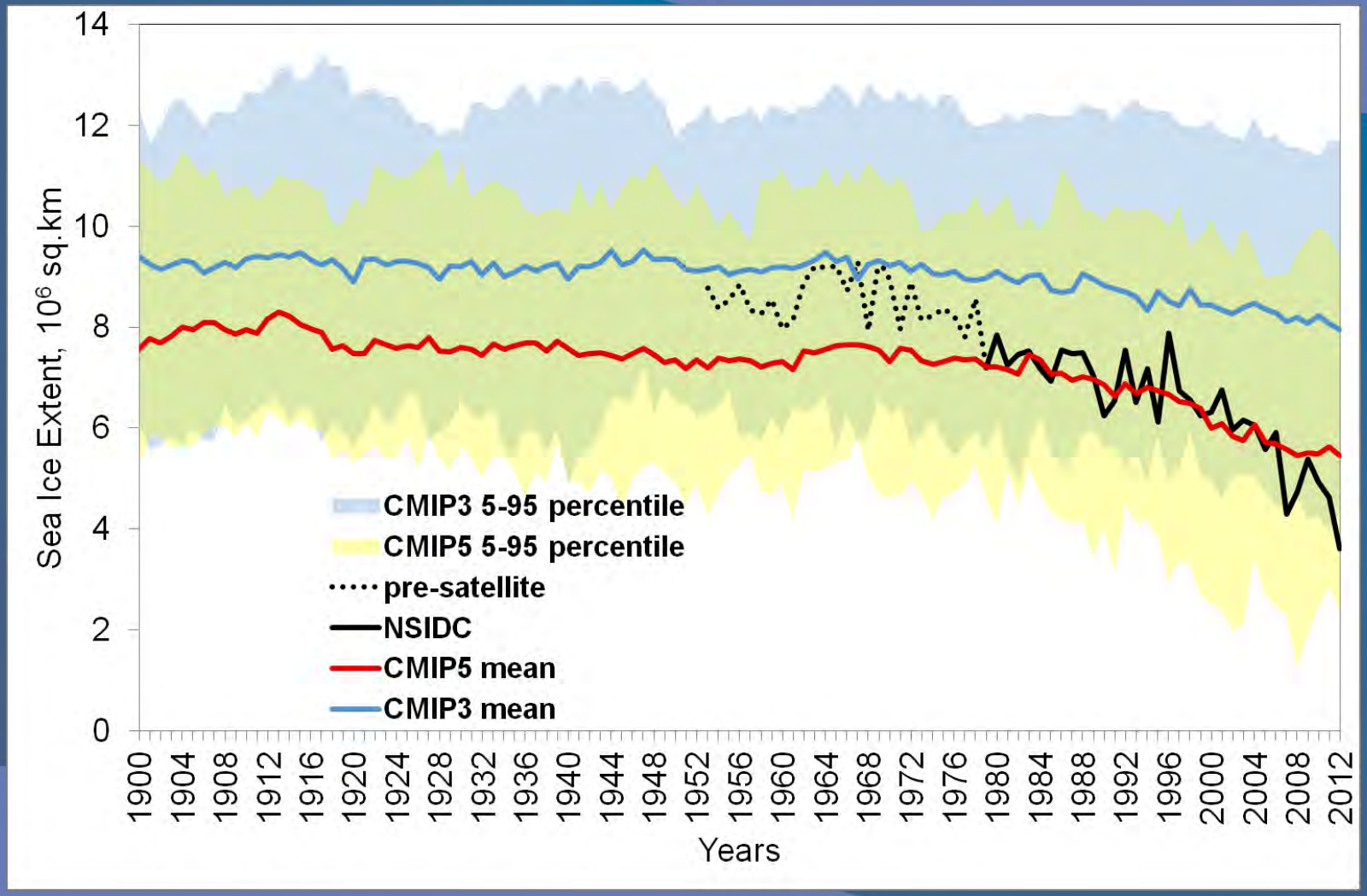


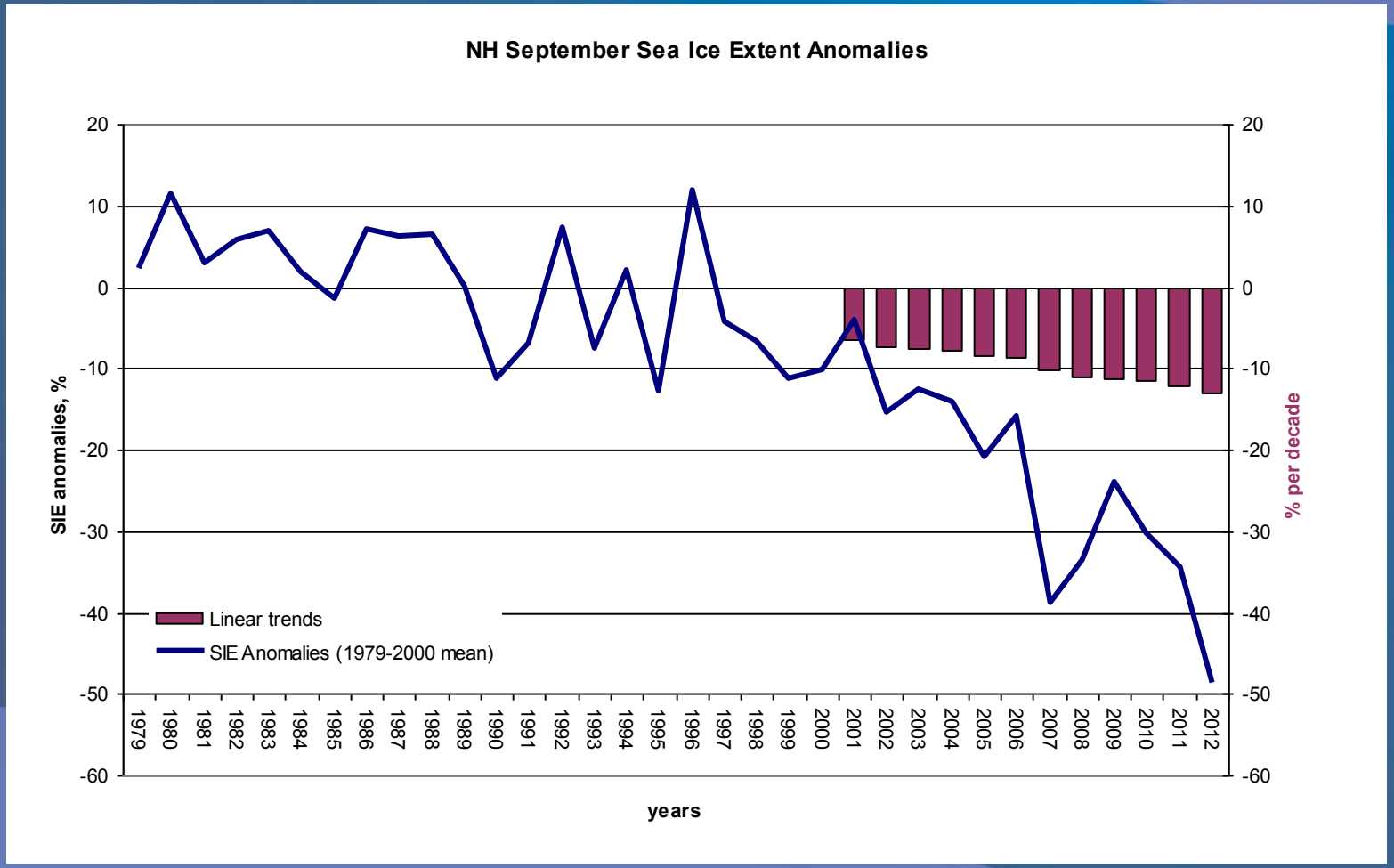
J.Stroeve, 2007 (updated)

September sea-ice extent



Pavlova and Kattsov, 2013

Observed Arctic sea ice extent (SIE) anomalies and linear trends (related to mean SIE 1979-2000)



Based on NSIDC data

NH September Sea Ice Extent
Linear Trends 1979-2012 related to mean SIE 1979-2000

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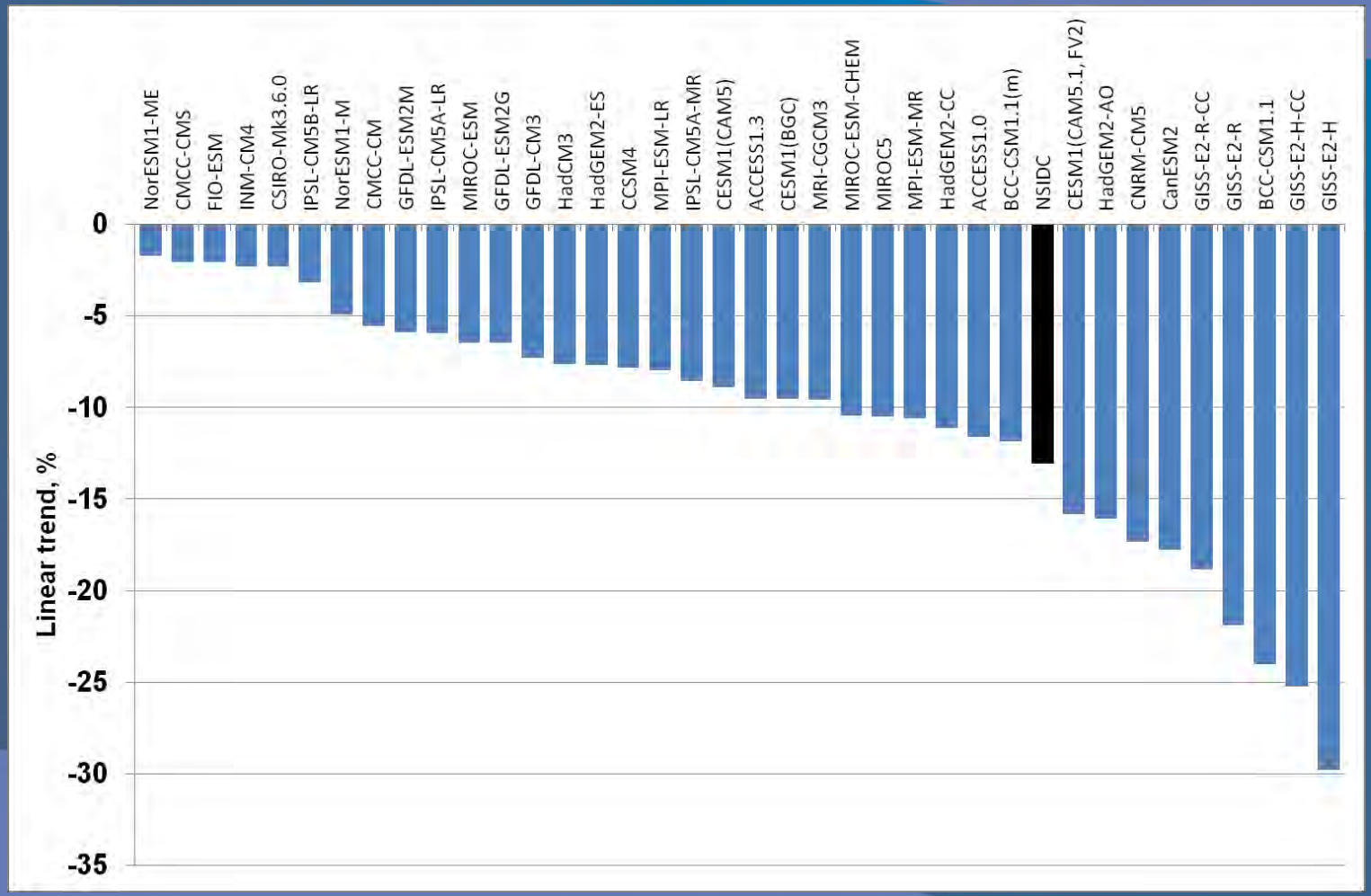

Pavlova and Kattsov, 2013

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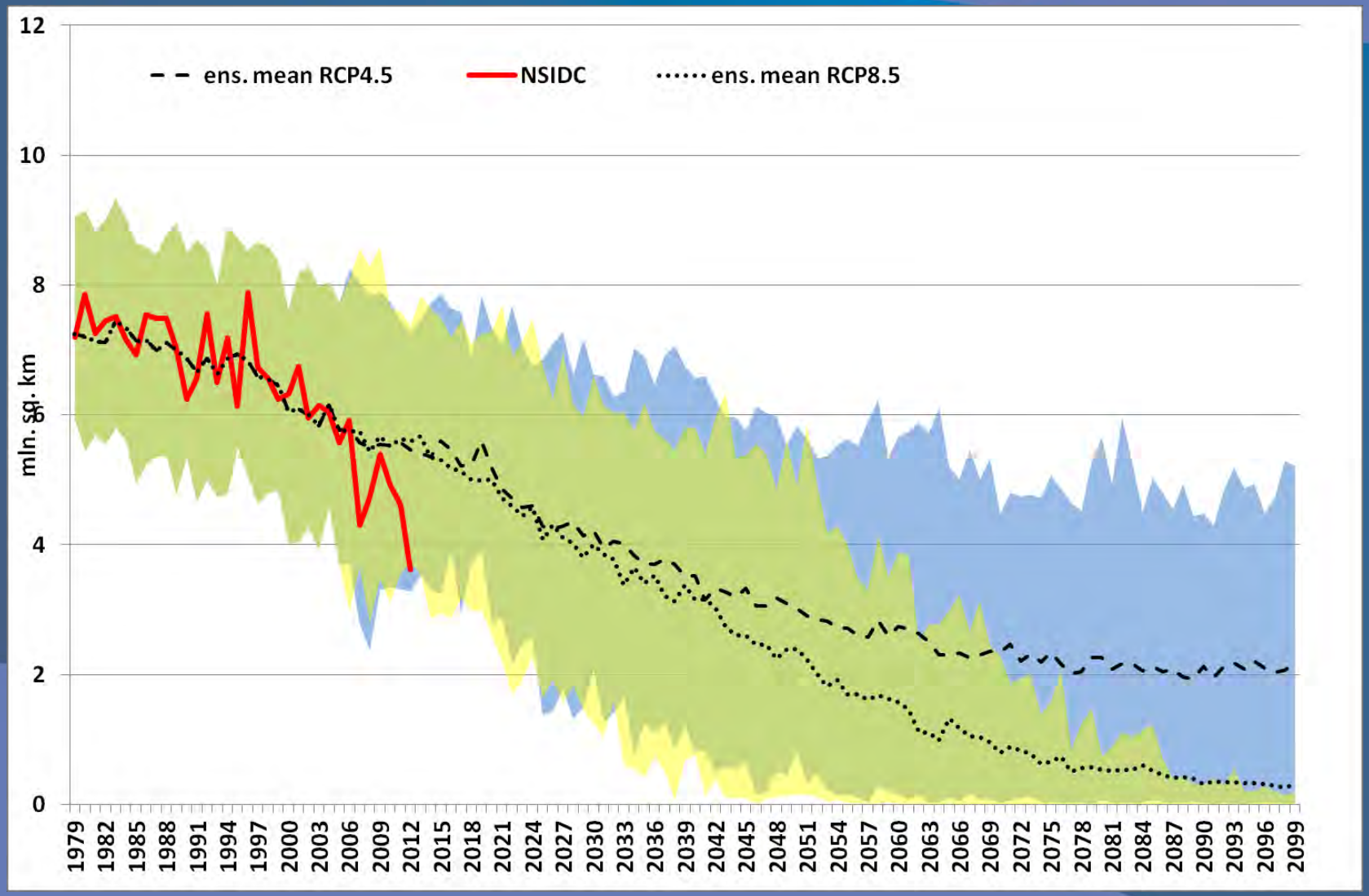
Compared to CMIP3, CMIP5 ensemble mean is in better agreement with observed mean climatological state of the sea ice cover and the rate of decline over the satellite observation period

CMIP5: NH September sea ice extent evolution

RCP4.5 vs RCP8.5



Pavlova and Kattsov, 2013

Part of models (%) simulated NH September SIE < 1 mln sq km

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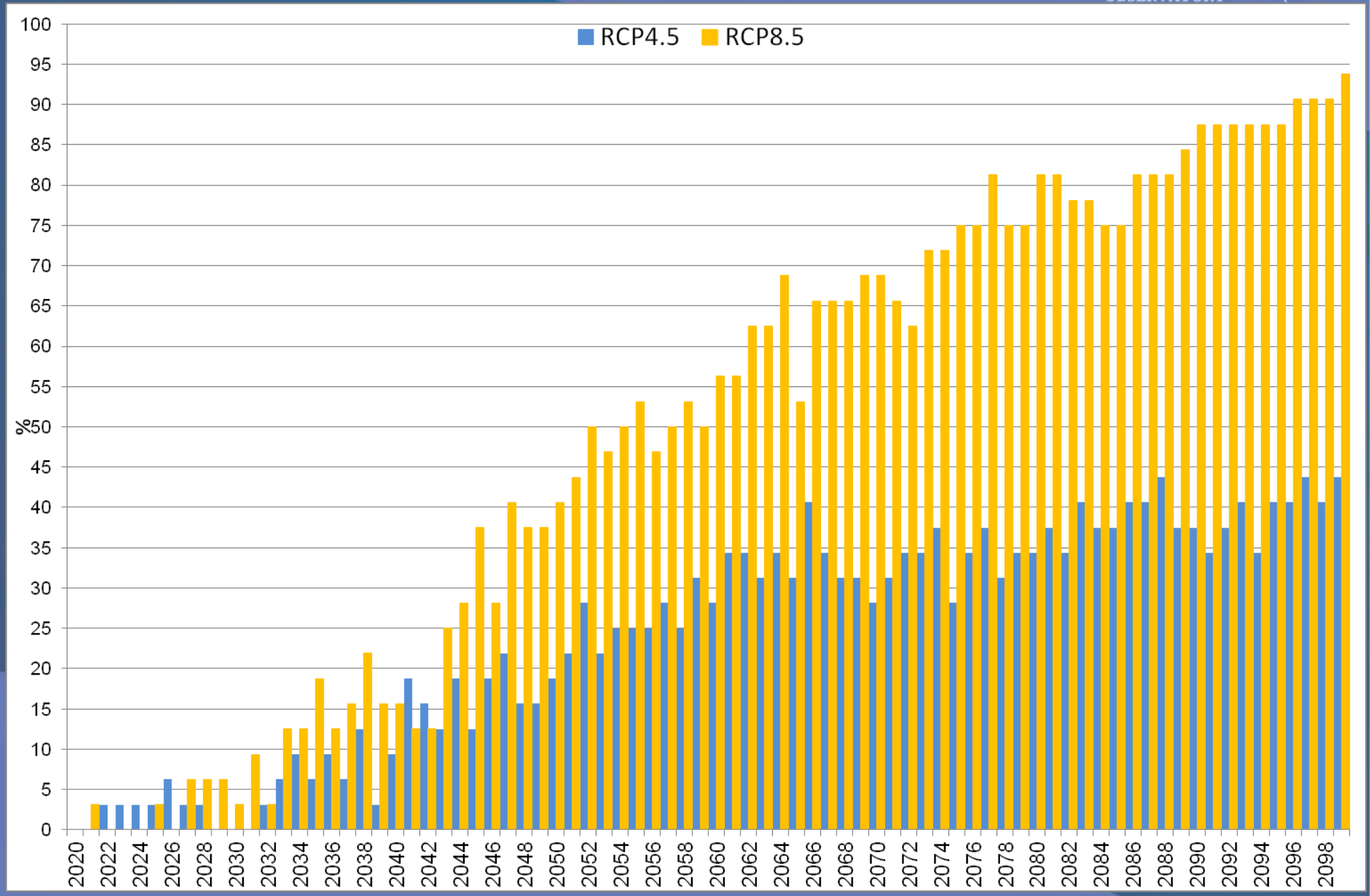

Pavlova and Kattsov, 2013

Simulated (1980-1999) and projected (2041-2060) sea ice distribution in March and September (RCP4.5 and RCP8.5)

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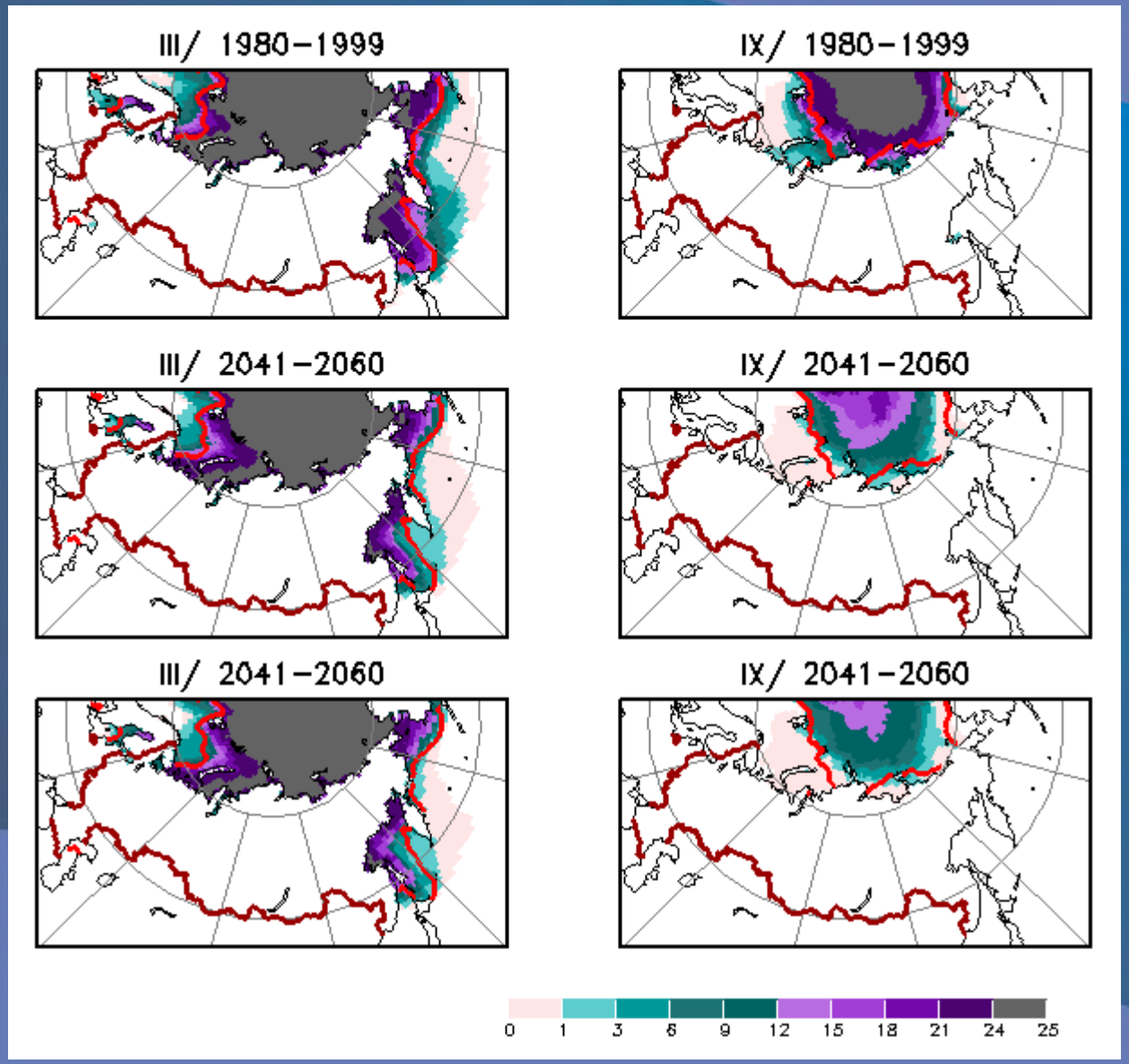

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RCP4.5

RCP8.5

Simulated (1980-1999) and projected (2080-2099) sea ice distribution in March and September (RCP4.5 and RCP8.5)

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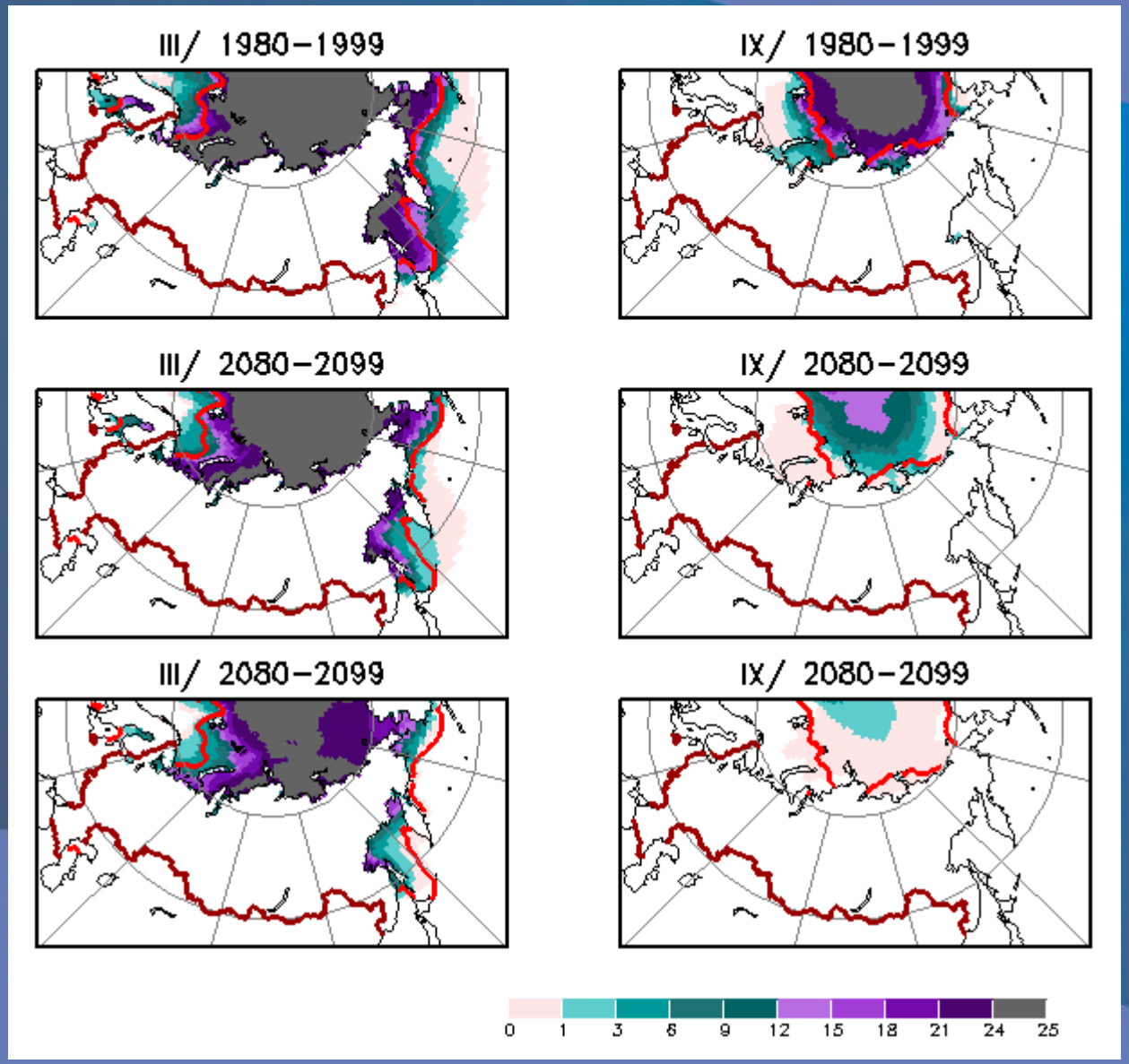

RCP4.5

RCP8.5

Changes in surface air temperature (deg C) over Russia and adjacent seas during the period 2041–2060 as compared to 1980-1999

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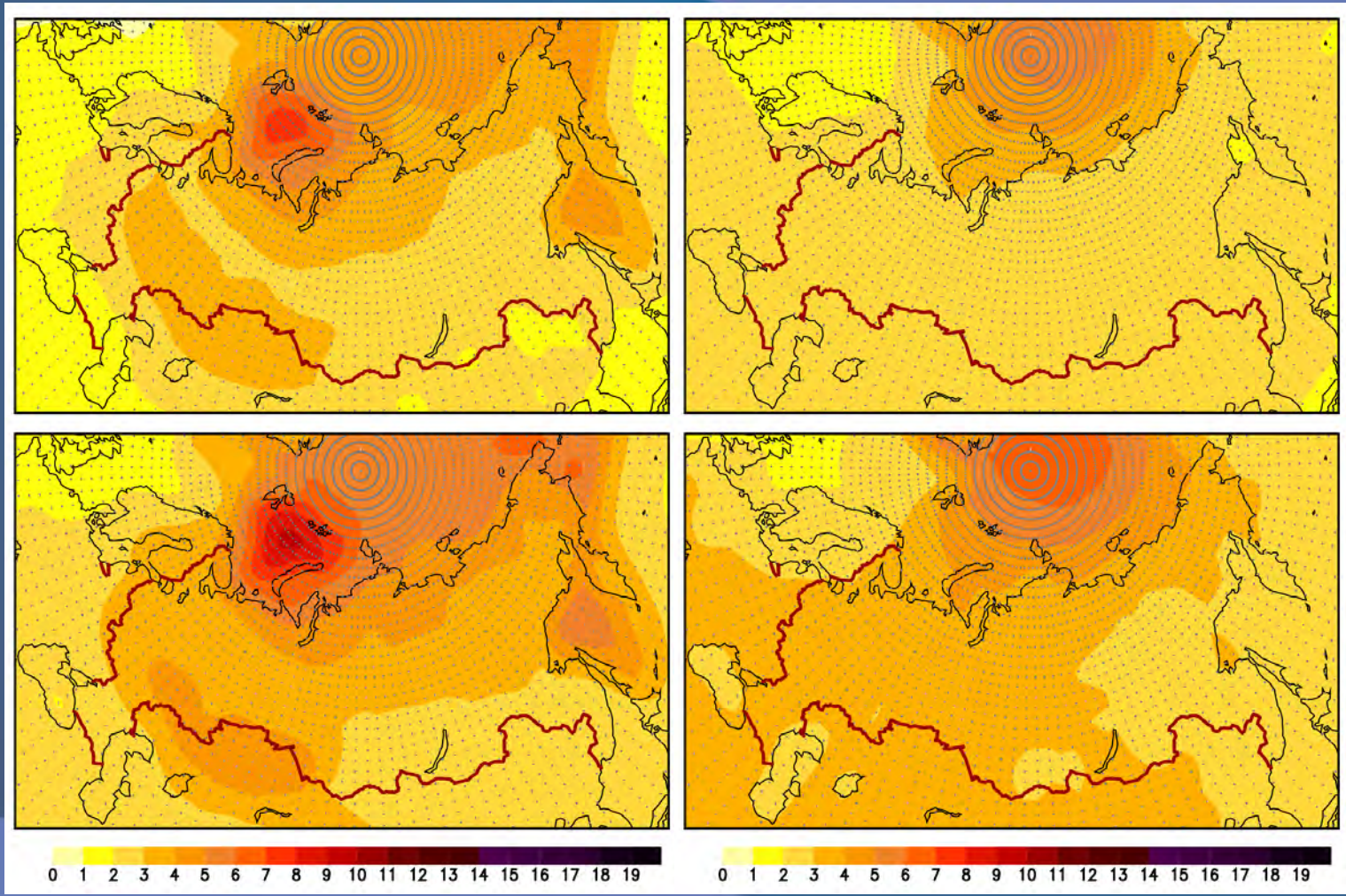

RCP4.5

RCP8.5

dots imply that mean temperature changes exceed the standard deviation of the intermodel scatter

Kattsov et al., 2013

Changes in total precipitation (%) over Russia and adjacent seas during the period 2041–2060 as compared to 1980-1999

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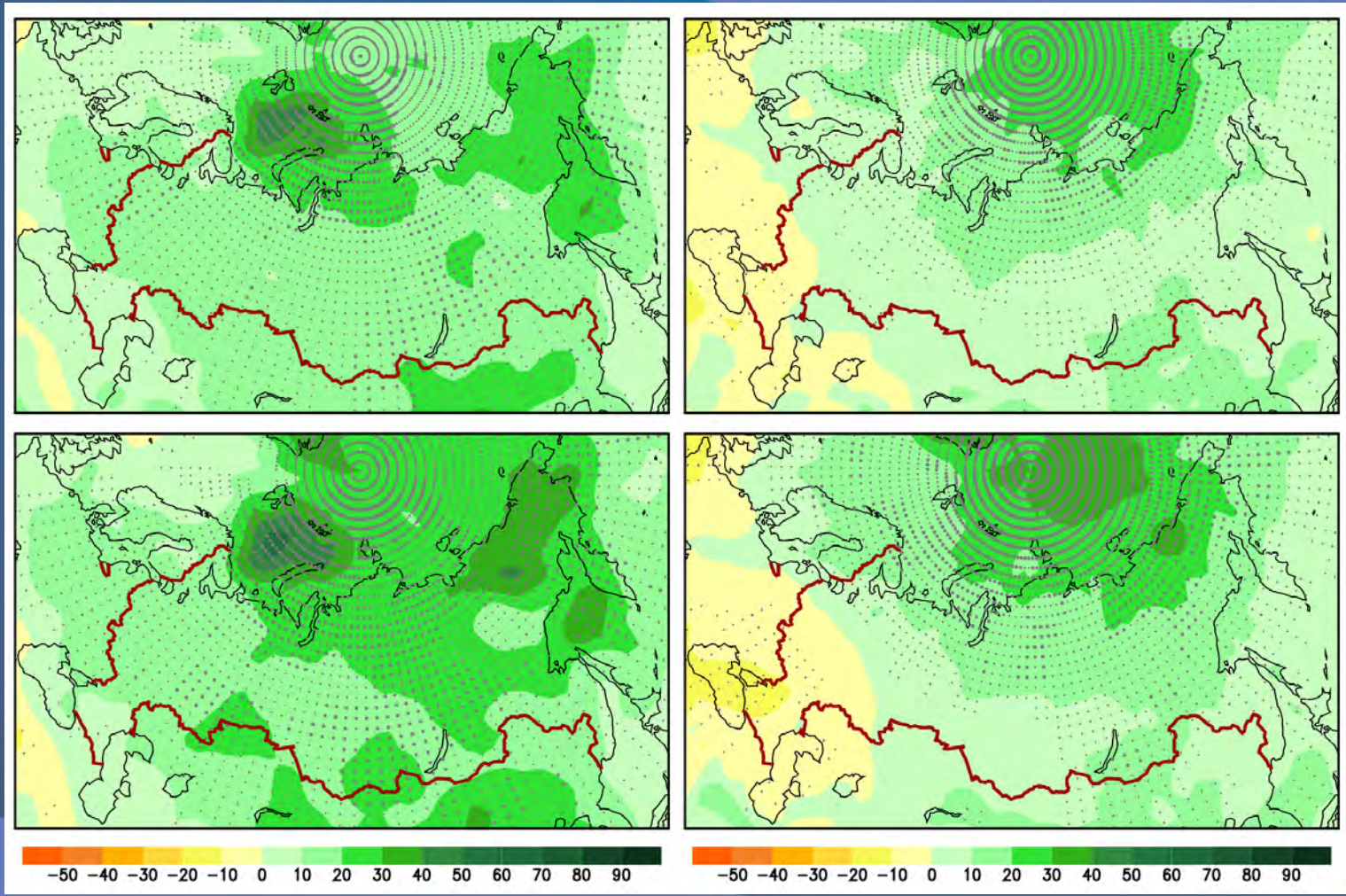

RCP4.5

RCP8.5

precipitation is given in percent relative to its value in the corresponding month for the period 1980–1999. Dots denote the areas where 66% (small dots) or 90% (large dots)of the models show changes of the same sign

Kattsov et al., 2013

RUSSIAN FEDERAL SERVICE FOR HYDROMETEOROLOGY AND ENVIRONMENTAL MONITORING (ROSHYDROMET)

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Assessment Report On Climate Change And Its Consequences In Russian Federation

2008 - First Assessment Report

2014 - Second Assessment Report

Section 5. The impact of climate change on marine ecosystems

- Chapter 5.1 Russian Arctic Seas
- Chapter 5.2 Baltic Sea
- Chapter 5.3 Southern Seas
- Chapter 5.4 Far Eastern Seas

Model uncertainties

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Increasing number and complexity of the models leave poor chances for decreasing projection uncertainties.

This calls for discrimination of the models, i.e. quantification of our confidence in the projections.

Evaluation (discrimination) of climate models is absolutely dependent on observational data availability.

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Adaptation Actions for a Changing Arctic
AACA-C Workshop

22.04-24.04.2013
St.Petersburg

AMAP
Arctic Monitoring and Assessment Programme

РОСГИДРОМЕТ
ROSHYDROMET

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Instead of conclusions:

The use of climate model outputs in practical applications is a significant scientific challenge. Model data can be useless or even misleading if used improperly. Improper use of model data is a result of both unsatisfactory communication between providers and users and existing major gaps in the scientific knowledge.

The challenge is practically pronounced in the Arctic region with its notorious inter-model projection scatters and the vigorous climate variability.

The scientific problems of model data use in impact studies and risk assessments include approaches to model discriminations, dealing with model ensembles and associated probabilities and uncertainties, added value and added uncertainties of downscaling techniques, different confidence in model projections of different climate variables, etc.

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Thanks to *Veronika Govorkova* for her help with some figures and CMIP's model outputs interpolation

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Thank you!