Climate predictions for the Arctic with EC-EARTH

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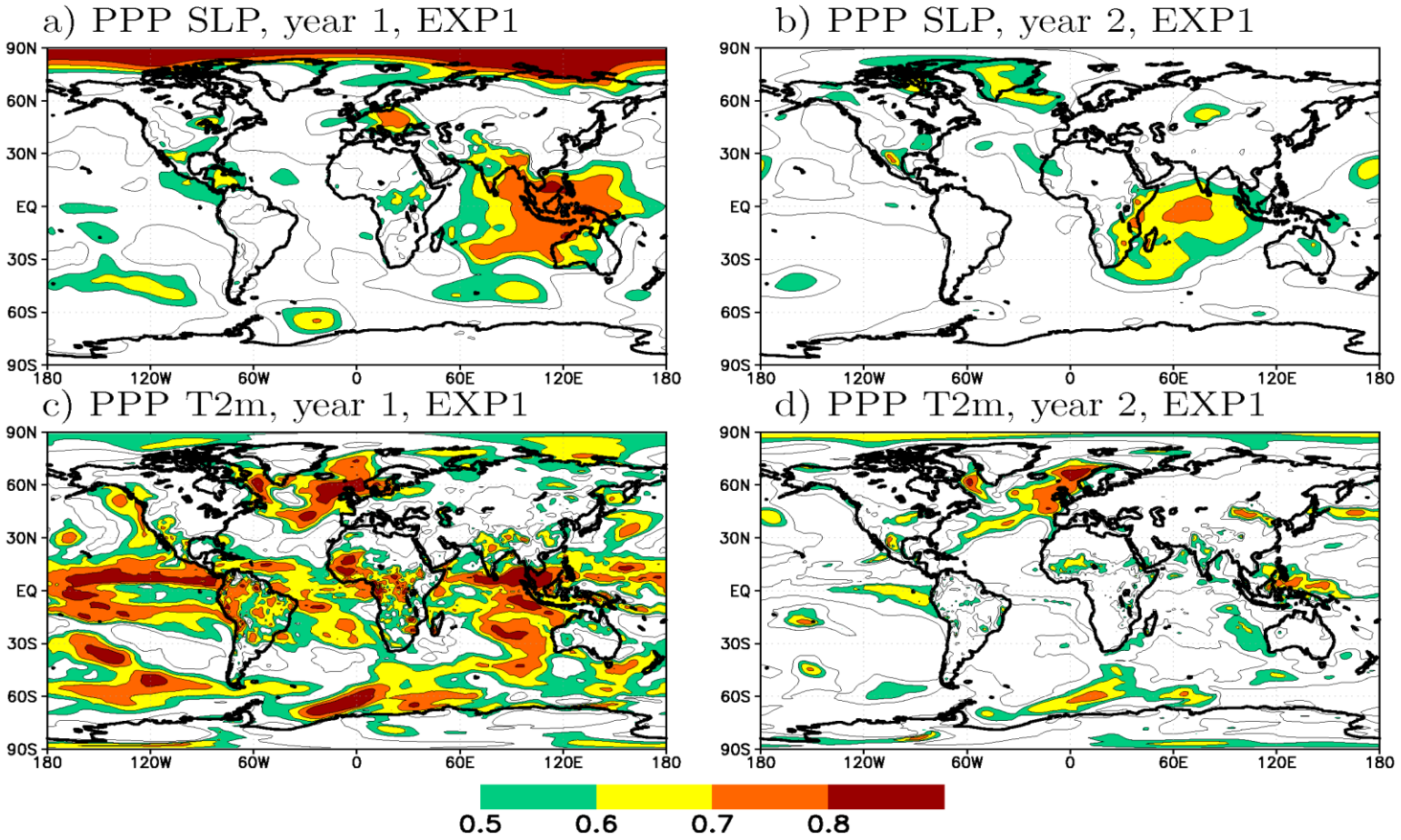
Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

Interannual predictability

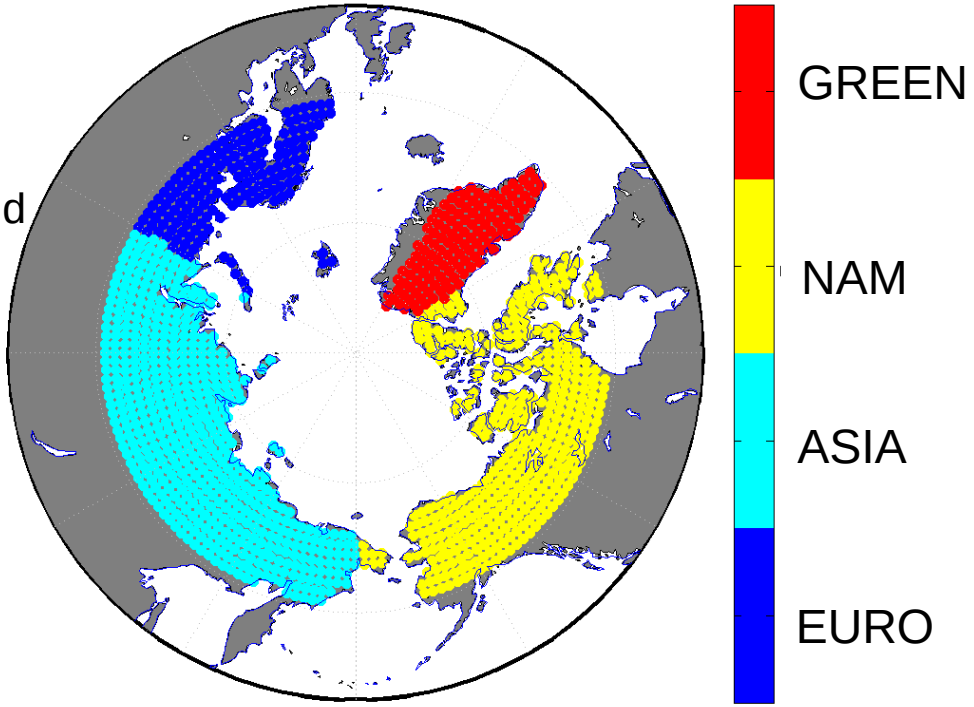


Prognostic potential predictability of SLP (a, b) and T2m (c, d) in the first year (left) and the second year (right) after initialization in EXP1.

Is there any useful information in decadal predictions for the Arctic?

Are decadal predictions better than climatology or persistence?

- Sea-ice volume and extent
- Temperature and precipitation over land
- Multi-year seasonal means
- Area integrated quantities



Experimental setup

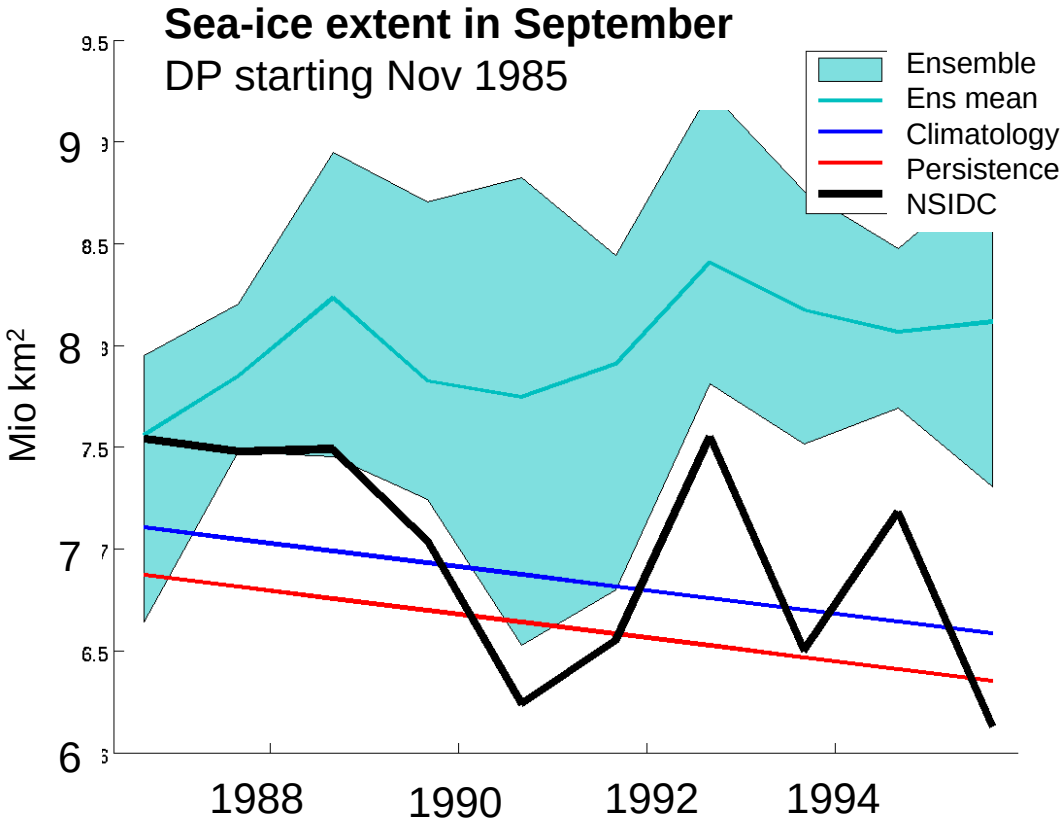
- EC-EARTH v2.3 (IFS-NEMO-LIM2)

- Decadal prediction experiment starting Nov 1 every year in 1980-2005
- 7-member ensemble

- Intial conditions
  - Atmosphere from ERA-40/interim
  - Ocean: anomalies from ORCA-S4 added to model climatology
  - Sea-ice: anomalies from a forced NEMO stand-alone run

Observations

- Sea-ice extent: NSIDC sea-ice index
- Sea-ice volume: PIOMAS
- Temperature and precipitation: CRU TS-3.1



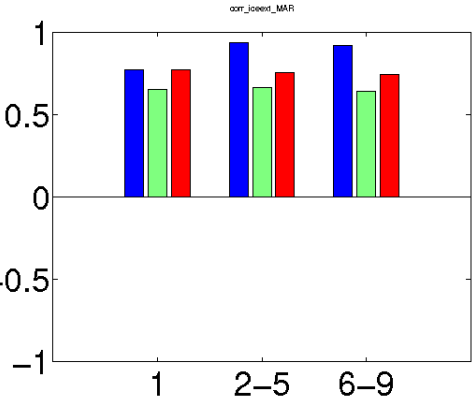
Climatologies are computed from the observation datasets. The liner trend from 1980-2009 is superimposed on the climatology.

Persistence is the 10-fold repetition of the observed annual cycle of the startyear with a superimposed linear trend

Anomaly correlation

Sea-ice extent

March



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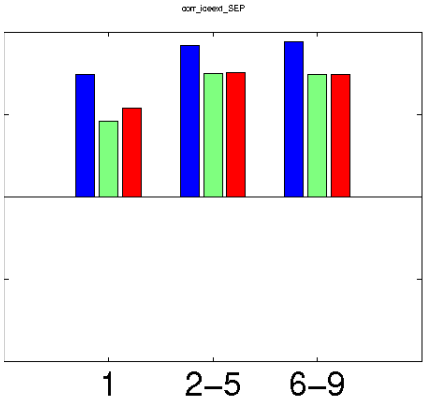
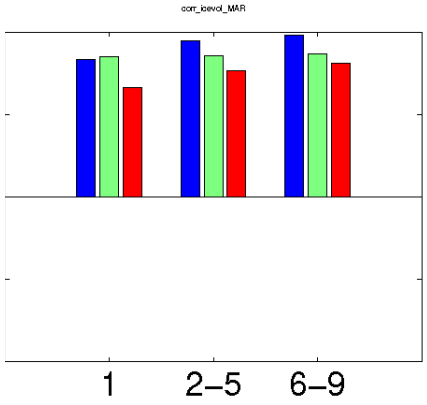


Sea-ice volume

March



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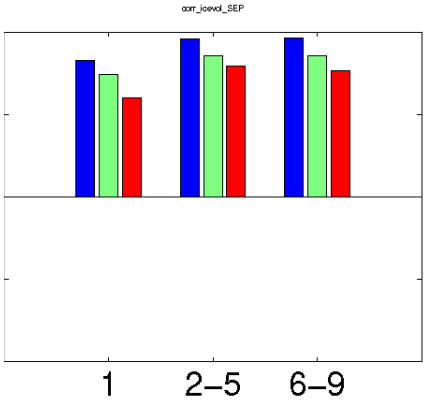

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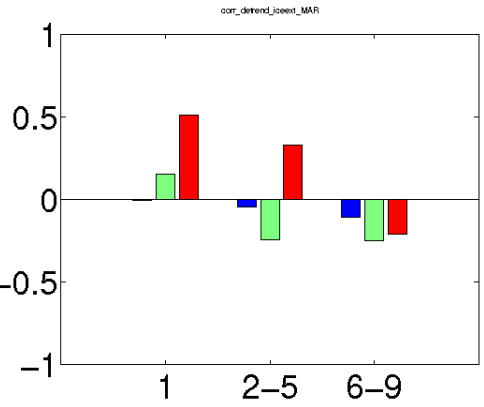
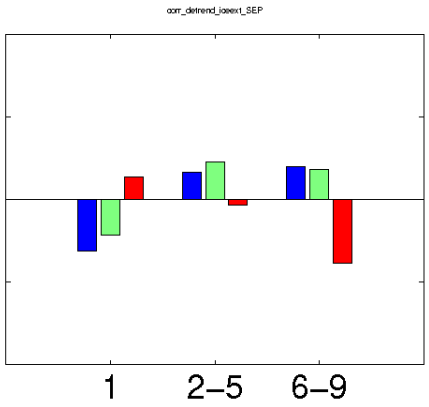
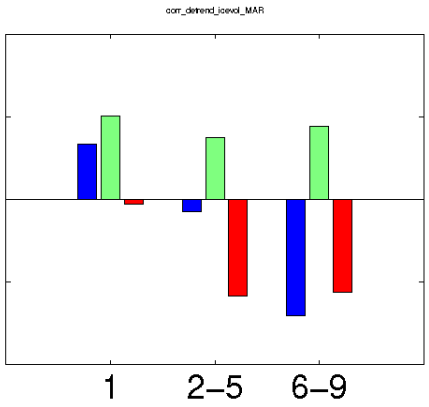
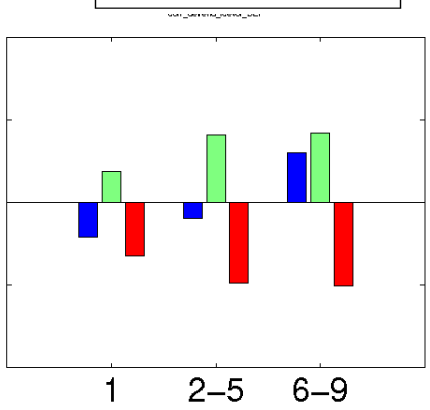
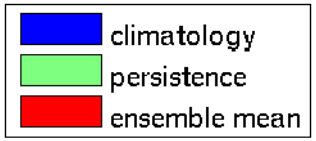




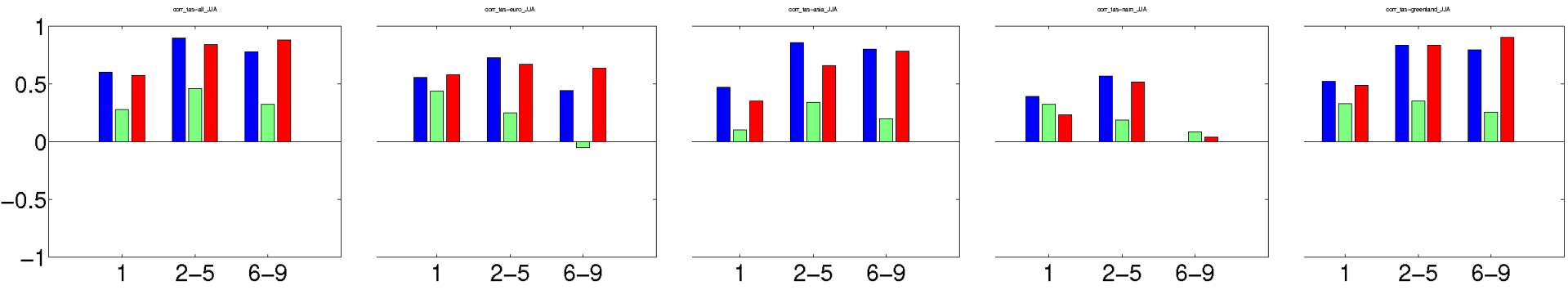






Anomaly correlation
Temperature JJA

ALL EURO ASIA NAM GREEN



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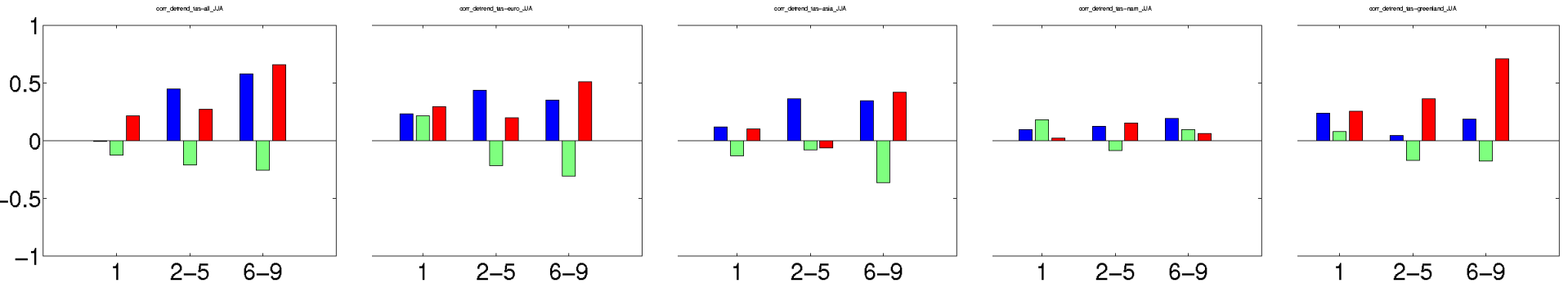

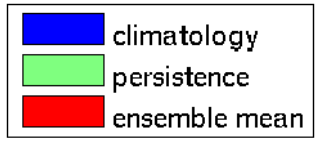

Anomaly correlation
Precipitation JJA

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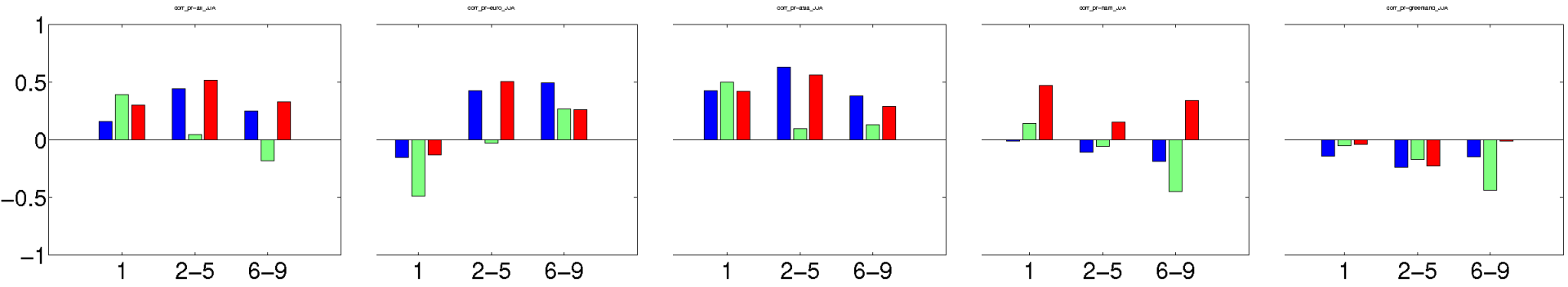

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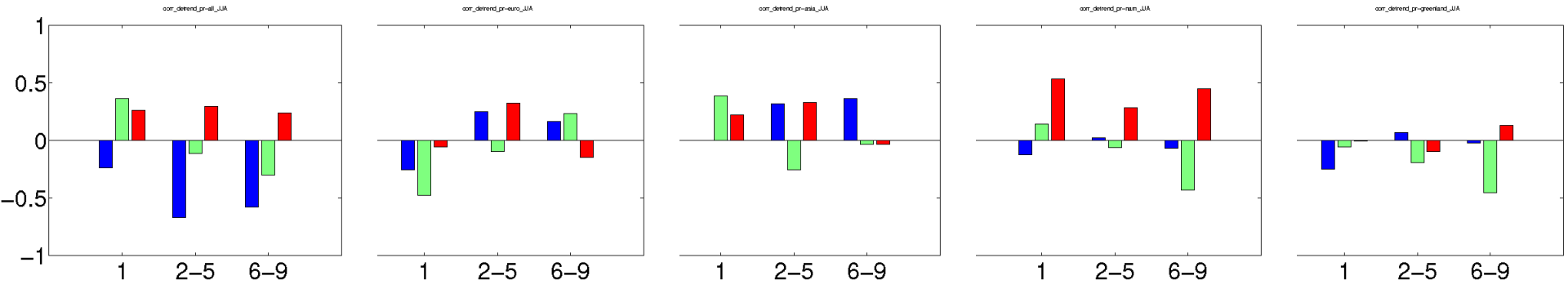
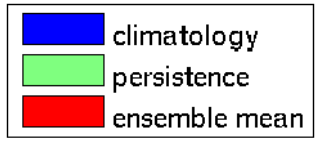




Brier skill score

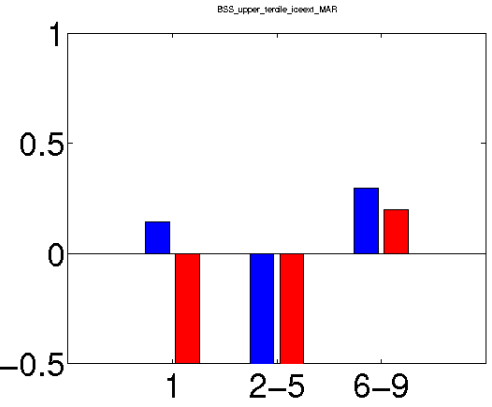
- Brier score: $BS = \frac{1}{n}\sum(p - o)^2$
  - p: predicted probability of an event
  - o: observed frequency of an event

- Brier skill score: $BSS = 1 - \frac{BS}{BS_{ref}}$
  - BS_{ref}: reference Brier score (here: climatology)

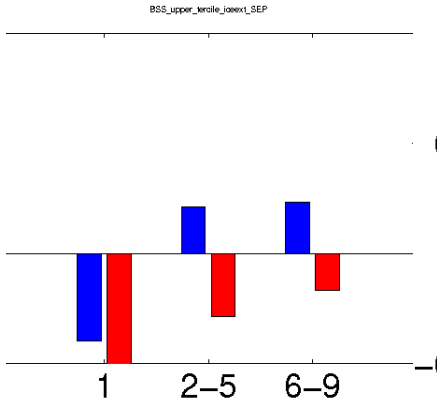
Brier skill score

Sea-ice extent

March

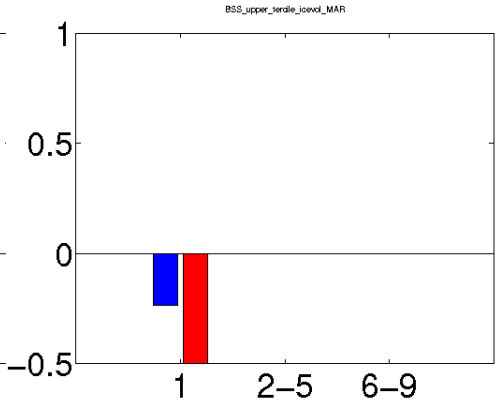


September



Sea-ice volume

March



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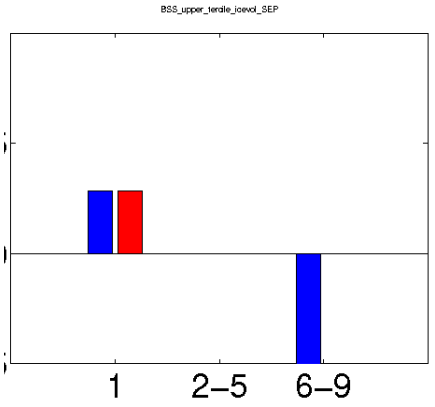
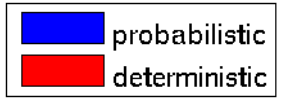
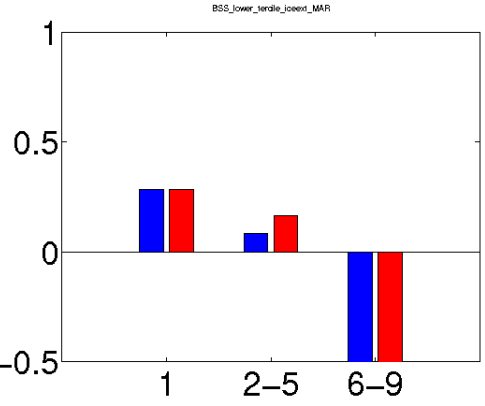
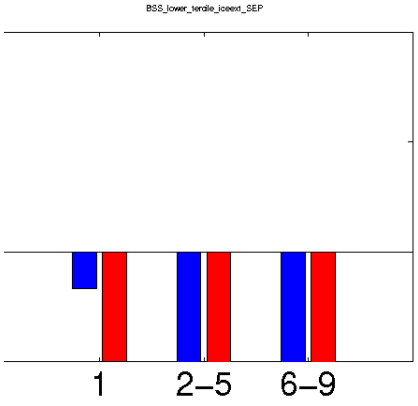


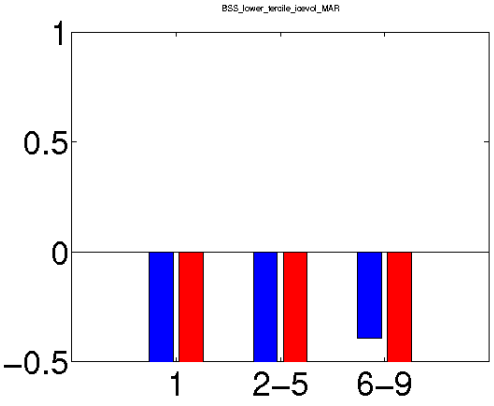
Upper tercile

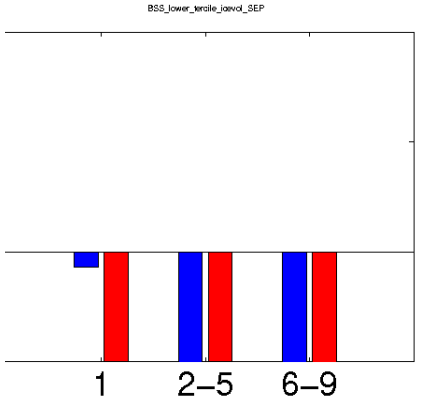


Lower tercile









Brier skill score
Temperature JJA

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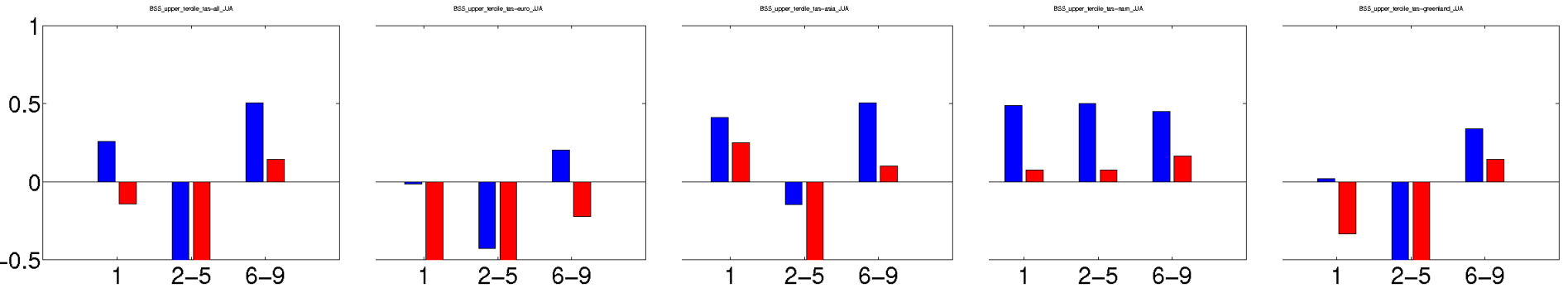
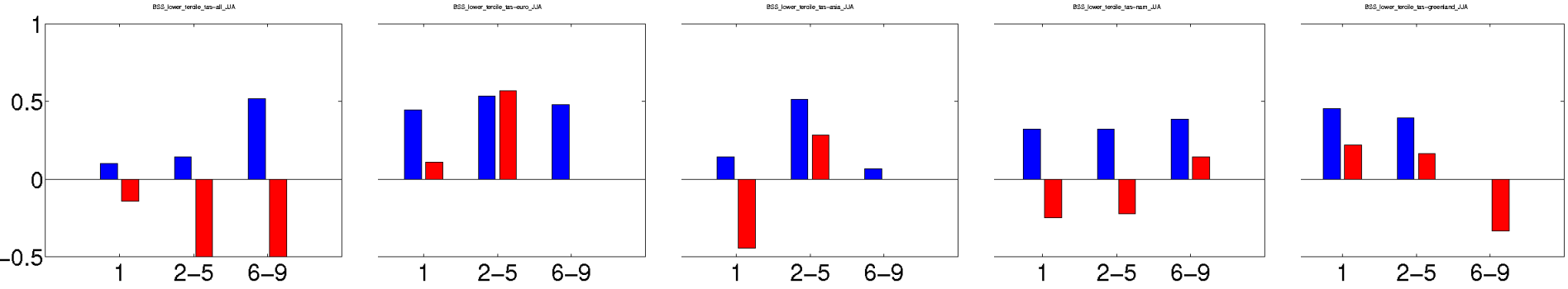


Upper tercile

probabilistic
deterministic

Lower tercile



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Precipitation JJA

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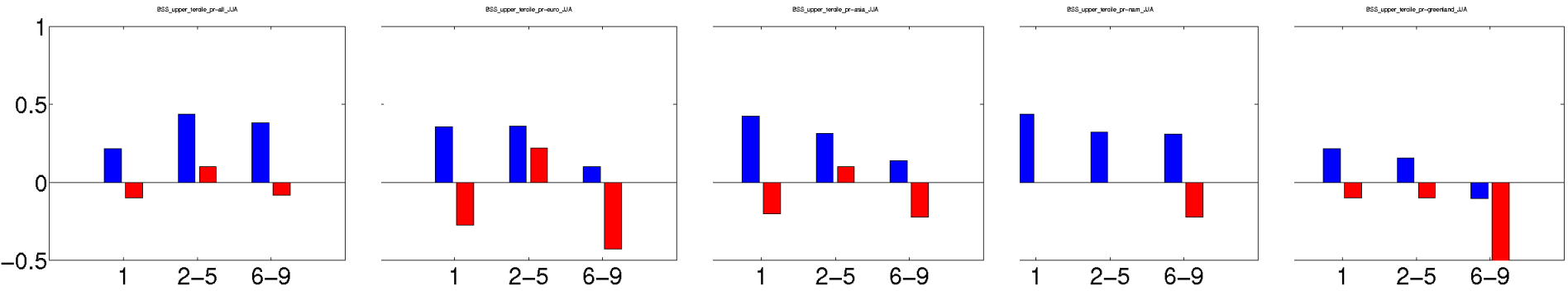
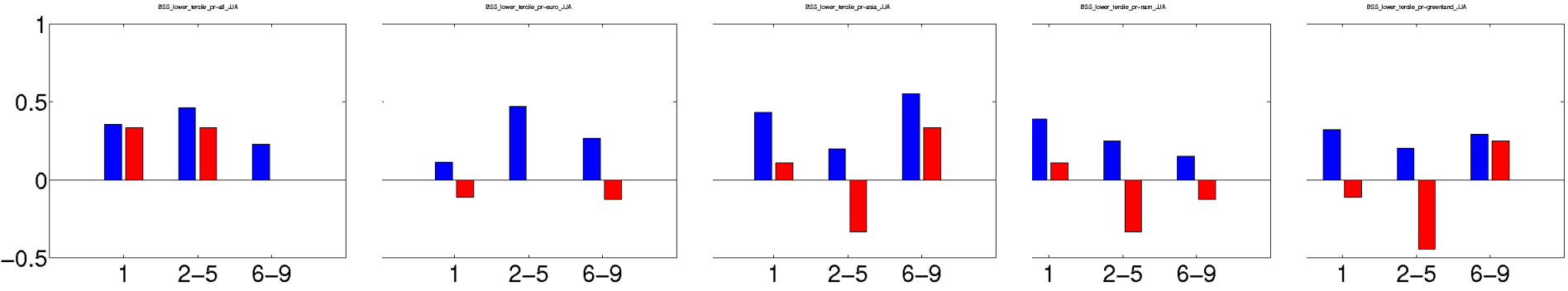


Upper tercile

probabilistic
deterministic

Lower tercile



SMHI

Findings

- Sea-ice volume and extent anomalies are predicted well but skill originates mainly from trend, not much skill left after detrending

- AC for climatology, persistence and the ensemble mean is higher in summer than in winter for T and Precip
- Climatology and ensemble mean show similar AC and higher than persistence

- Detrending reduces AC in general but not always (e.g. JJA Precip over NAM)

- Probabilistic forecasts for Precip and T with the full ensemble are often more skillfull than the ensemble mean
- Probabilistic forecasts for high and low Precip are better than climatology
  Probabilistic forecasts for low T are better than climatology, for high T results vary with region

Is there any useful information in decadal predictions for the Arctic?

Are decadal predictions better than climatology or persistence?

Decadal predictions of multi-year seasonal means are feasible, although much of the skill (especially for sea-ice) comes from the trend.

Deterministic forecasts with the ensemble mean don't beat climatology, but probablistic forecasts that take into account the full ensemble will do.

Caveat: all results are based on 1 model and a small ensemble, robustness needs to be established