Dynamical seasonal forecasts in Roshydromet – current state

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Hydrometcentre of Russia

Outline

- MGO T42L14 model perfomance in multi-year hindcast experiments;
- SL model of the Hydrometcentre of Russia and its performance in hindcast experiments;
- Sensitivity studies (MGO)

Dynamical LRF products issued:

- Global hydrodynamic-statistic 1-month forecasts have been issued since 2000 on monthly basis (Hydrometcentre of Russia, Main Geophysical Observatory (MGO));

- Dynamical seasonal forecasts of MGO have been issued since 2002;

- Hydrometcentre of Russia began issue of dynamical seasonal forecasts in 2004

Recent hindcast experiments of MGO.
AGCM: T42L14.

Potential predictability

- Experimental set-up - SMIP-2;
- Forecast period – 7 months;
- Ensemble size – 6 members, peturbed initial conditions from NCEP/NCAR Reanalysis;
- Experimental period – 1979-2002. 4 ensemble forecasts per year;
- Observed SSTs;
- Verified vs NCEP/NCAR Reanalysis

Practical predictability

- Experimental set-up - SMIP-2/HFP;
- Forecast period – 4 months;
- Ensemble size – 6 members, peturbed initial conditions from NCEP/NCAR Reanalysis;
- Experimental period – 1979-2000;
- 4 seasons with 1 month lead time;
- Persisted SST anomalies;
- Verified vs NCEP/NCAR Reanalysis

T850. Anomaly correlations for northern winter season. MGO T42L14

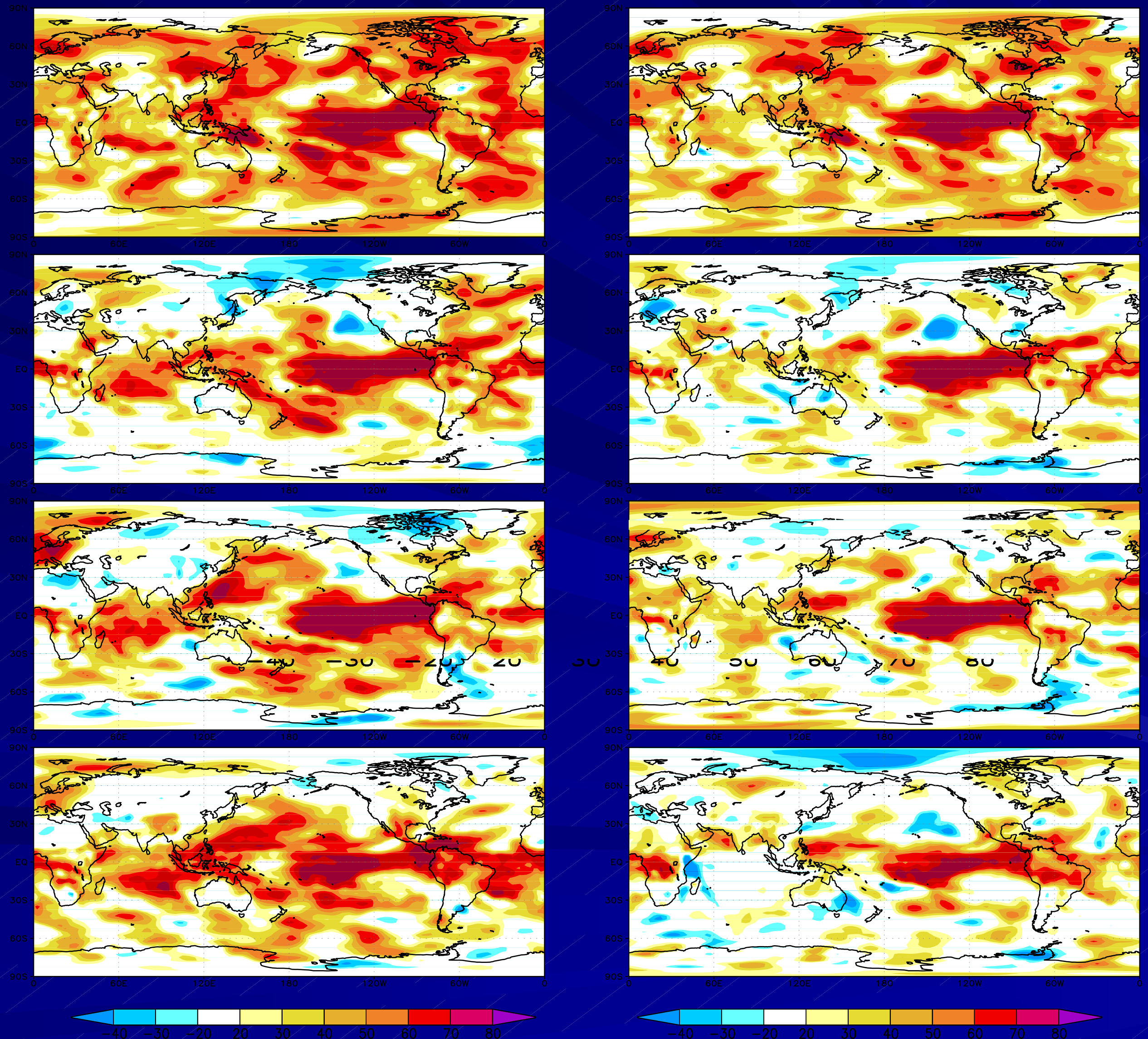
SMIP-2 | SMIP-2/HFP

1st month NOVEMBER

2nd month DECEMBER

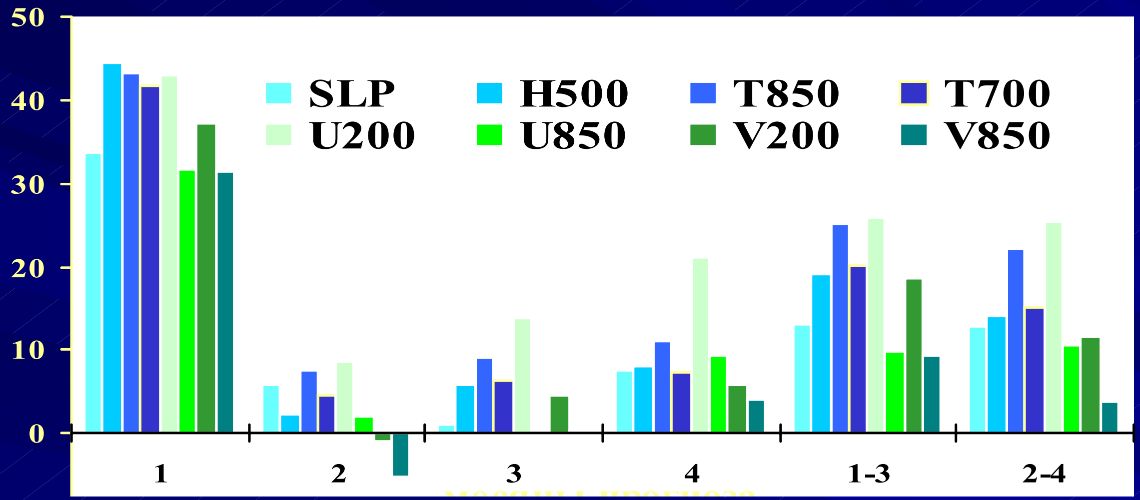
3rd month JANUARY

4th month FEBRUARY

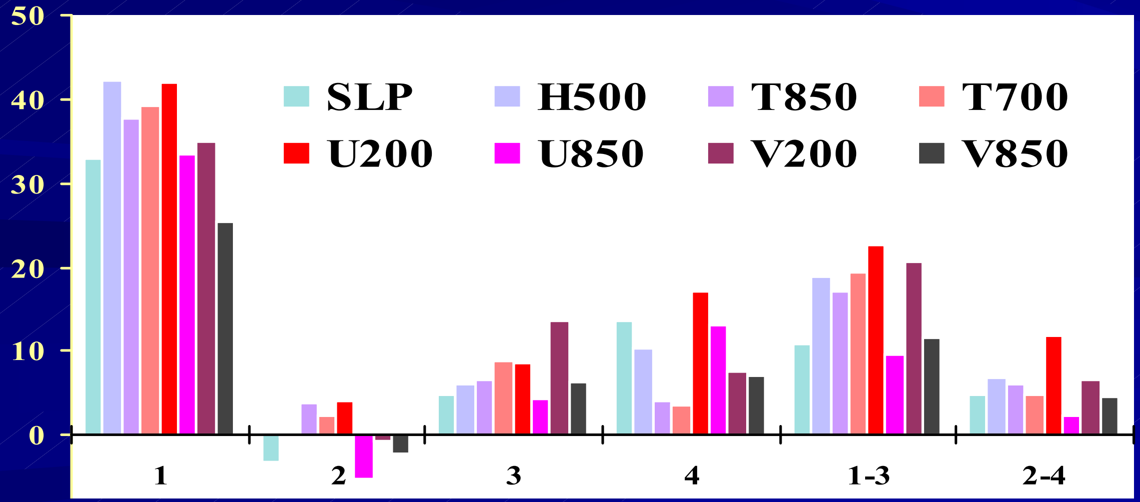


Monthly and seasonal anomaly correlation for seasonal hindcasts (MGO T42L14)

Winter; Northern Extratropics (20–87N); 1979-2001



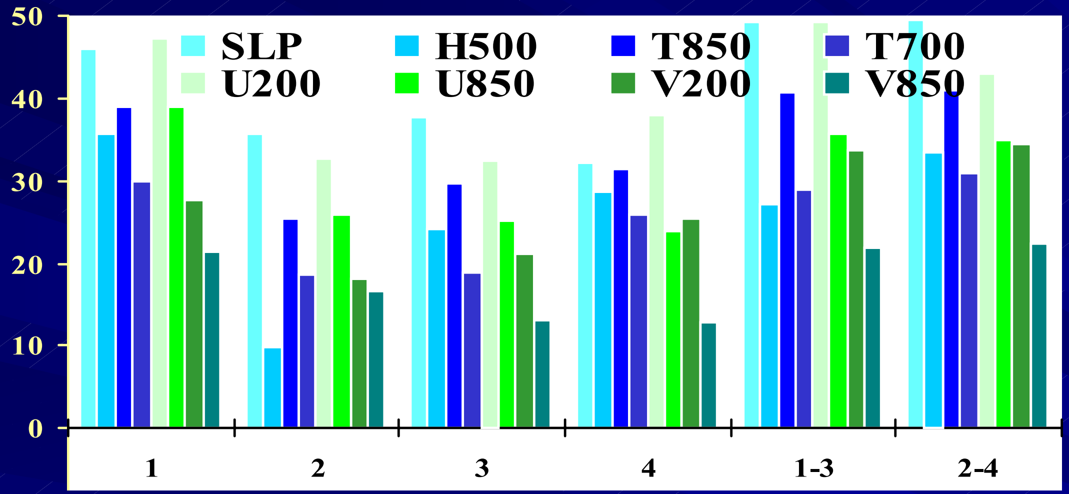
SMIP2



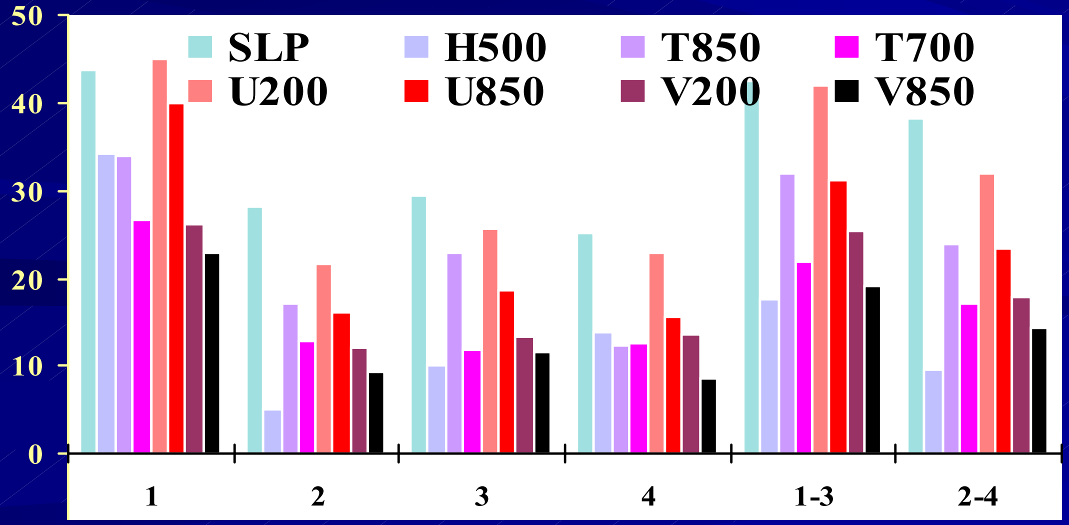
SMIP2 / HFP

Monthly and seasonal anomaly correlation for seasonal hindcasts (MGO T42L14)

Winter; Tropics (20S–20N); 1979-2001



SMIP2



SMIP2 / HFP

Global semi-Lagrangian vorticity-divergence model (SL model) of the Hydrometcentre of Russia

- Resolution 1.125°/ 1.40625° lat/lon, 28 sigma levels;
- 2 time-level scheme dt=36 min, ‘advected’ Coriolis term;
- 4th order compact differences for discretization of derivatives in non-advective terms, including semi-implicit scheme and U-V reconstruction;
- Direct FFT solvers for semi-implicit scheme, U-V reconstruction, and 4th order horizontal diffusion;
- Parameterizations from operational Meteo-France ARPEGE/IFS model with some minor modifications

Physical parameterizations of SL model (1)

RADIATION

- The radiation fluxes calculation method is based on delta – Eddington two-stream approximation to transfer equation solution. Gaseous absorption (H2O, CO2, O3) is computed for terrestrial and solar radiation. Cloud optical properties are are linked to diagnostic cloud liquid water content. Cloud geometry is with two possible options: random and maximum overlap.

CLOUDINESS AND CLOUD WATER CONTENT

- Cloudiness has three origins: large scale over-saturation, subgrid shallow convection over-saturation and subgrid deep convection over-saturation.
- Large scale and shallow convection cloud water content diagnostic is based on calculation of specific water vapor excess over its saturation value. This procedure takes into account the minimum critical relative humidity value that is the threshold for cloud formation beginning.
- The large-scale and shallow convection cloud amount is calculated using the diagnostic water content value and a tunable coefficients.
- The deep cumulus convection is presented following scheme of Bougeault (1985). The effects of sub-gridscale convection on the gridscale heat and water budgets are represented by the bulk mass flux scheme. The impact of downdraft is parameterized following Ducrocq and Bougeault (1995) .

TURBULENT FLUXES AND PBL PROCESSES

- The vertical turbulent transport of moment, heat and moisture in the surface layer is described using Monin – Obukhov theory for different stratification type. Above, in PBL the K – theory is used.

Physical parameterizations of SL model (2)

PRECIPITATION

- The precipitation is produced by the large-scale and deep convective condensation processes under supersaturation conditions.
- Large-scale precipitation calculation is based on the diagnostically defined water content under the Marshal – Palmer drop size distribution function and prescribed drops concentration. The drop falling velocity is calculated in dependence of it's diameter.
- Subsequent evaporation of large-scale precipitation in nonsaturated lower layer follows modified parameterization of Kessler (1969).
- The convective precipitation rate is given by the difference between the total moisture convergence and the environmental moistening due to detrainment, under the assumption of no evaporation of precipitation below the cloud base. Cloud condensate converts into precipitation when the saturated layer reaches a critical thickness.
- The precipitation has two phase: liquid and ice. Part of ice in cloud water content depends on temperature

SURFACE PROCESSES

- The surface processes include the four types of surface: sea, ice cap, low vegetation or desert and high vegetation – Being introduced.

OROGRAPHY

- The effect of drag flux is included to parameterize subgrid orography interaction with the large-scale flow.

Recent hindcast experiments with the SL model of the Hydrometcentre of Russia

Potential predictability

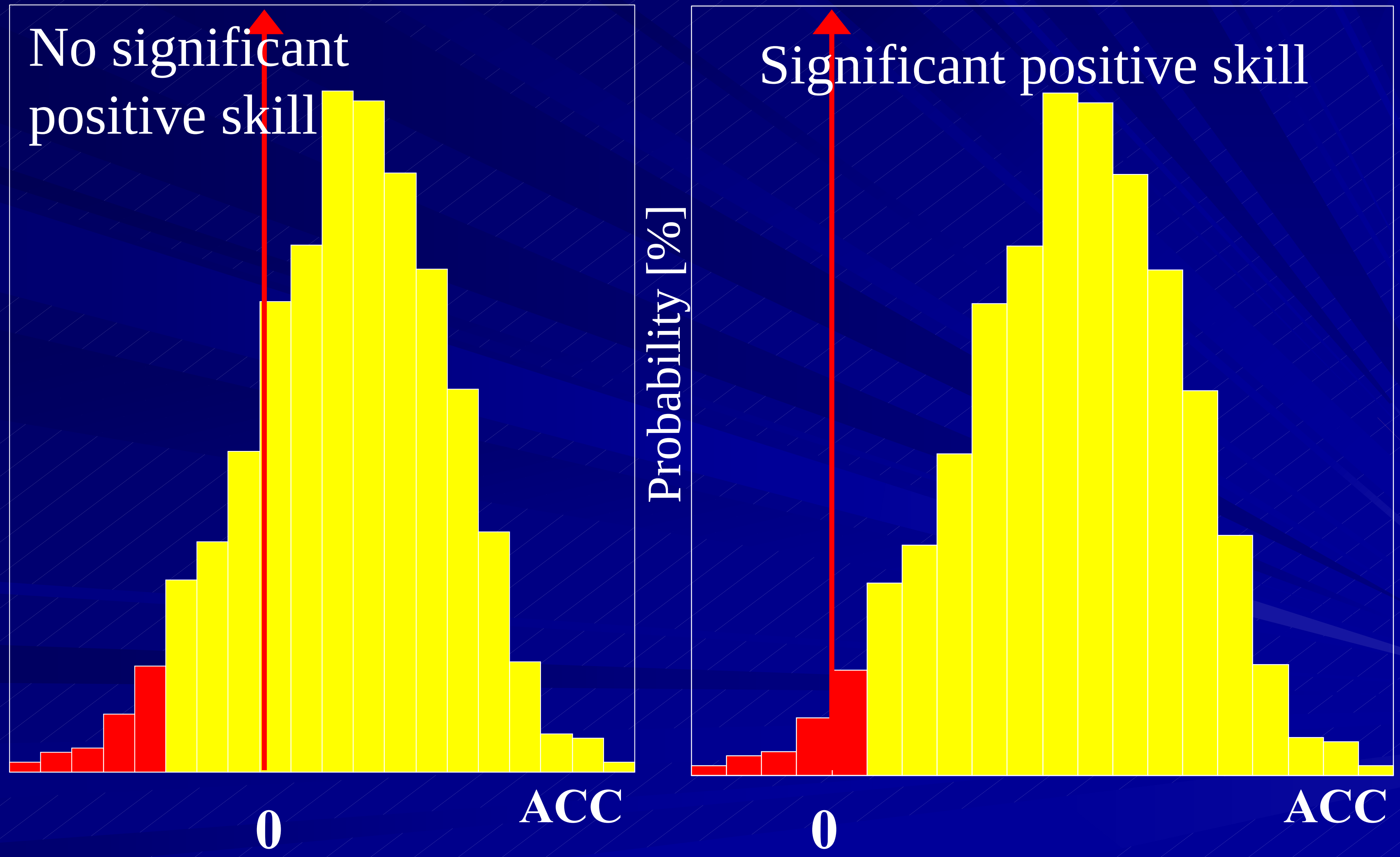
- Experimental set-up - SMIP-2
- Forecast period – 4 months;
- Ensemble size – 6 members with 12-hour time lag from NCEP/NCAR Reanalysis;
- Experimental period – 1979-2002;
- 4 seasons with 1 month lead time;
- Verified vs NCEP/NCAR Reanalysis

Practical predictability (not shown)

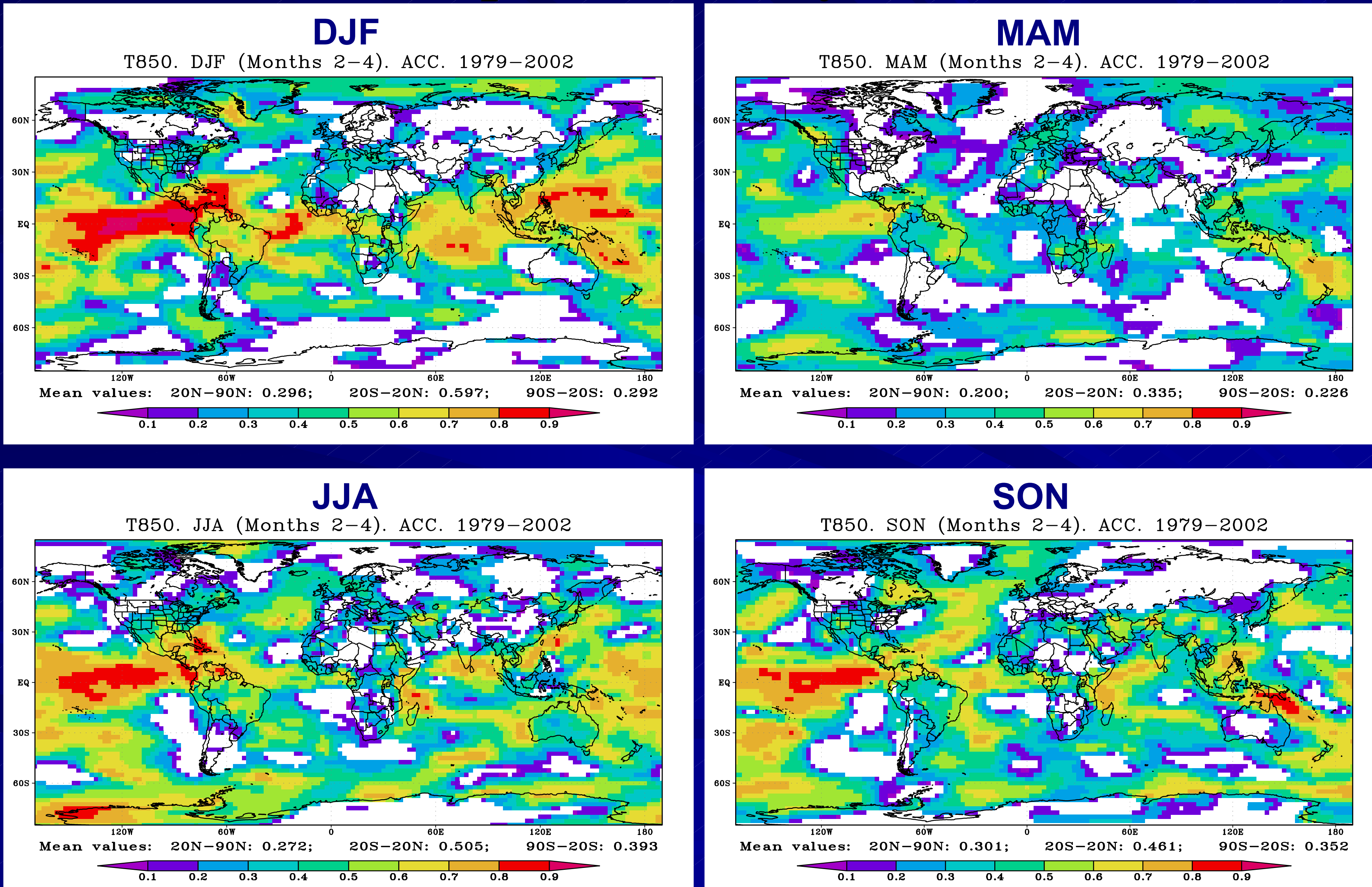
- Experimental set-up - SMIP-2/HFP;
- Forecast period – 4 months;
- Ensemble size – 6 members with 12-hour time lag from NCEP/NCAR Reanalysis;
- Experimental period – 1979-2002;
- 4 seasons with 1 month lead time;
- Relaxed SST anomalies;
- Verified vs NCEP/NCAR Reanalysis

Statistical significance test for ACC

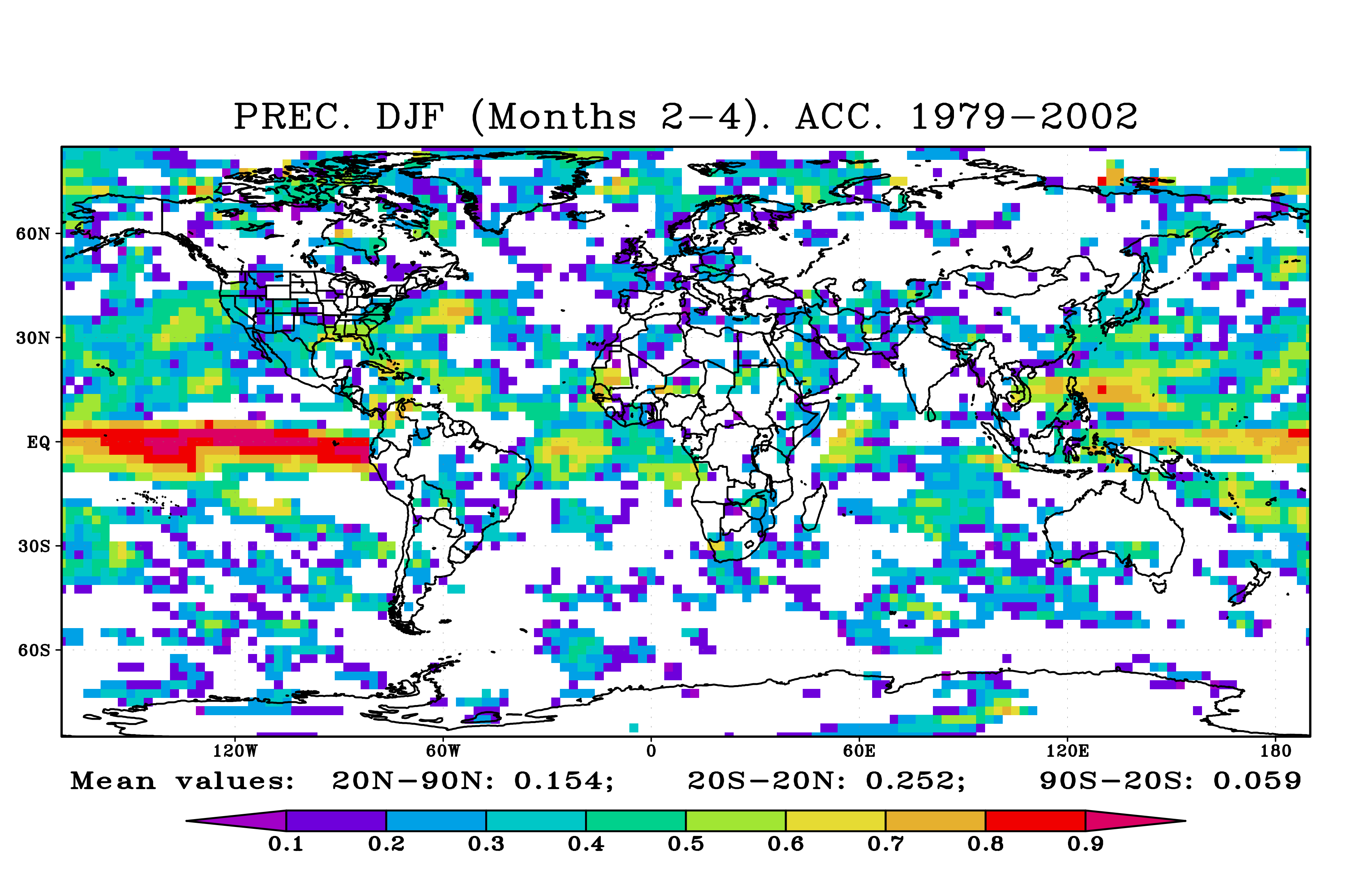
(Number of bootstrap realizations – 500. Significance level – 5%)



T850. ACC. SL model. Months 2-4. Potential predictability. 1979-2002.



Anomaly correlations for PRECIPITATION.
Season: DJF. Months 2-4. SL Model (Hydrometcentre of Russia)



How are the categories defined?

In order to account for model bias simulated / observed anomalies are calculated from the model / reanalysis climate (1979-2002):

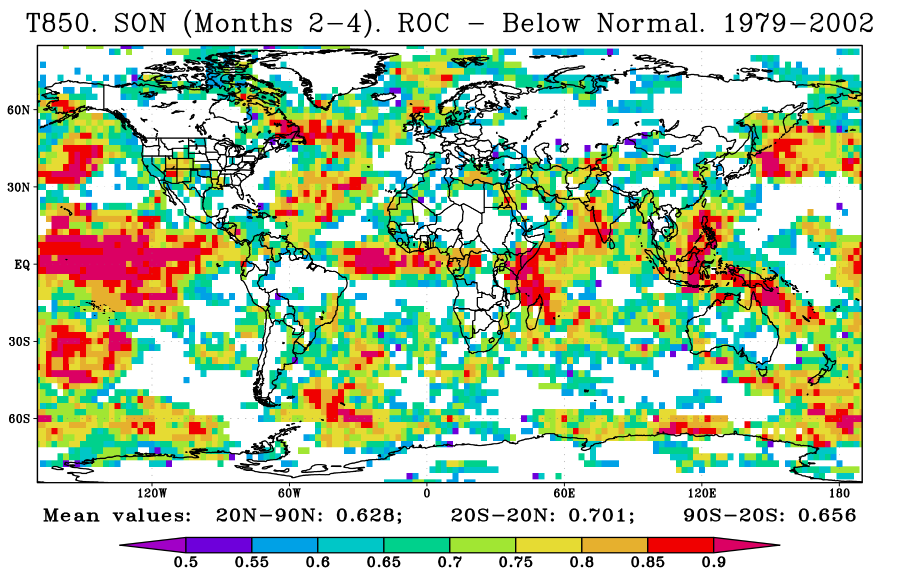
- BELOW NORMAL – anomaly is less than -0.43 STDEV;
- ABOVE NORMAL – anomaly is greater than +0.43 STDEV;
- NORMAL – anomaly is within -0.43/+0.43 STDEV

T850. ROC scores for the 3 categories

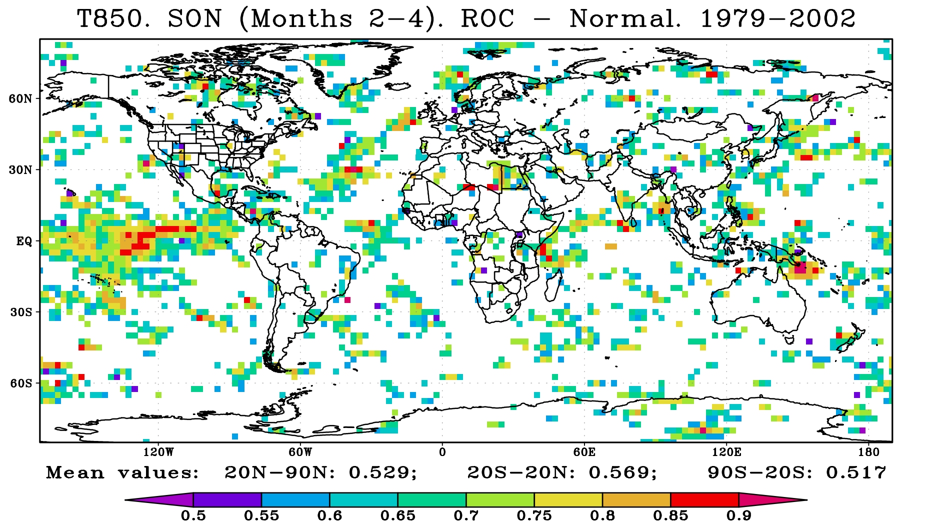
Period: DJF (Months 2-4) 1979-2002

Potential predictability

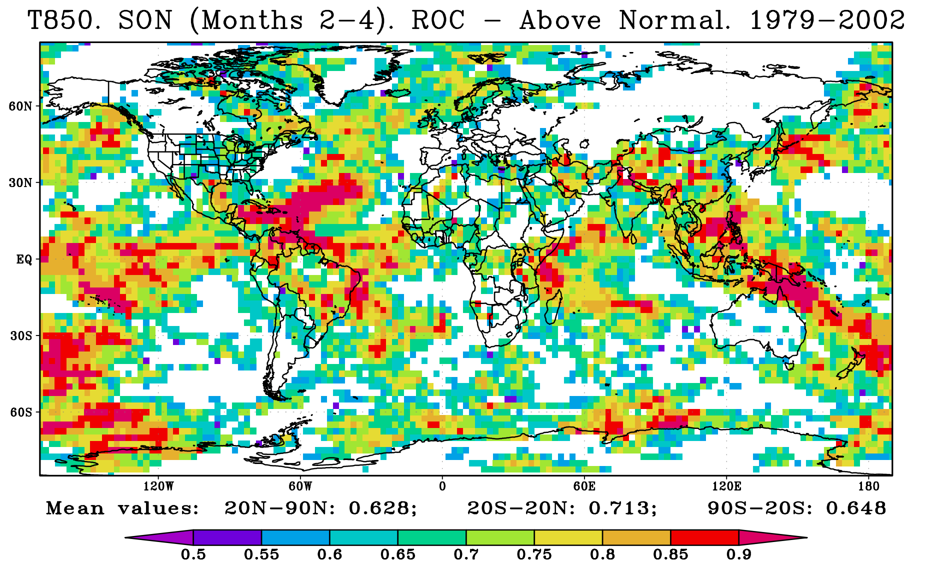
Below Normal



Normal



Above Normal



SL Model (Hydrometcentre of Russia)

T850. Aggregated ROC scores for SL Model. Region: 20N-90N. Months: 2-4. 1979-2002.

Season	Below Normal	Normal	Above Normal	All Categories
DJF	0.624	0.517	0.619	0.588
MAM	0.604	0.507	0.618	0.560
JJA	0.611	0.517	0.613	0.583
SON	0.628	0.529	0.628	0.597

T850. Aggregated ROC scores for SL model. Months: 2-4. Tropics (20S-20N). 1979-2002.

	Below Normal	Normal	Above Normal	All Categories
DJF	0.762	0.625	0.769	0.724
MAM	0.606	0.569	0.686	0.608
JJA	0.712	0.584	0.740	0.683
SON	0.701	0.569	0.713	0.665

Sensitivity experiments with T42L14 model of MGO

Parameters of interest:

- **Soil moisture;**
- **Sea ice.**

Idealized atmospheric model approach was accepted:
climate of soil moisture and sea ice vs their actual anomalies.

Ensemble size: 6 members. Period: 1979-2001

The assessments of the general effect depend on particular characteristics of predictability used for comparison of model runs.

Reproducibility:

$$R = 1 - \frac{\sigma_I}{\sigma_T}$$

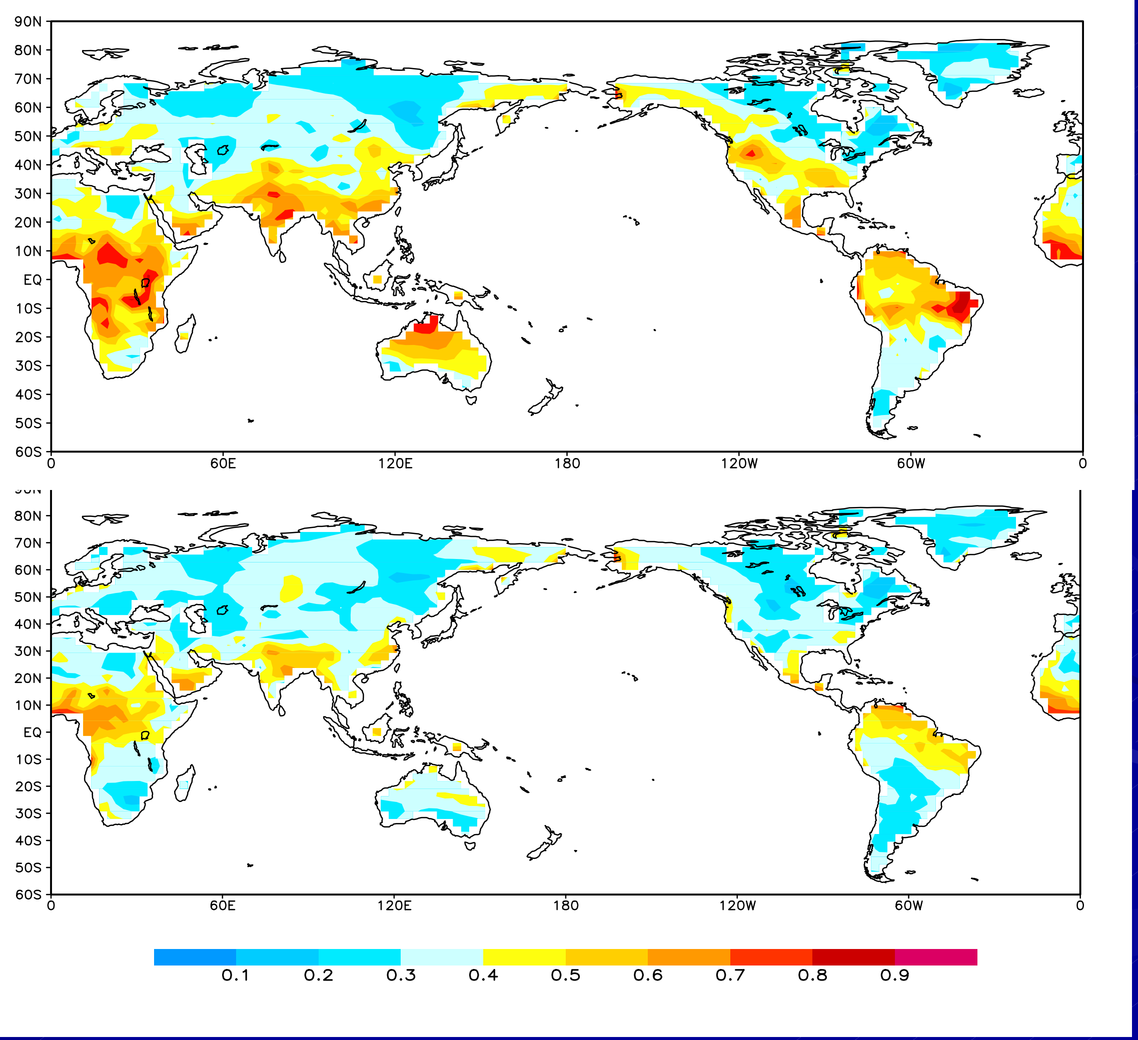
$(\sigma_I)^2$ - internal variability (between forecast ensemble members);
$(\sigma_T)^2$ - total variability

Impact of soil moisture anomalies on the reproducibility of mean monthly surface temperature. Model: MGO T42L14

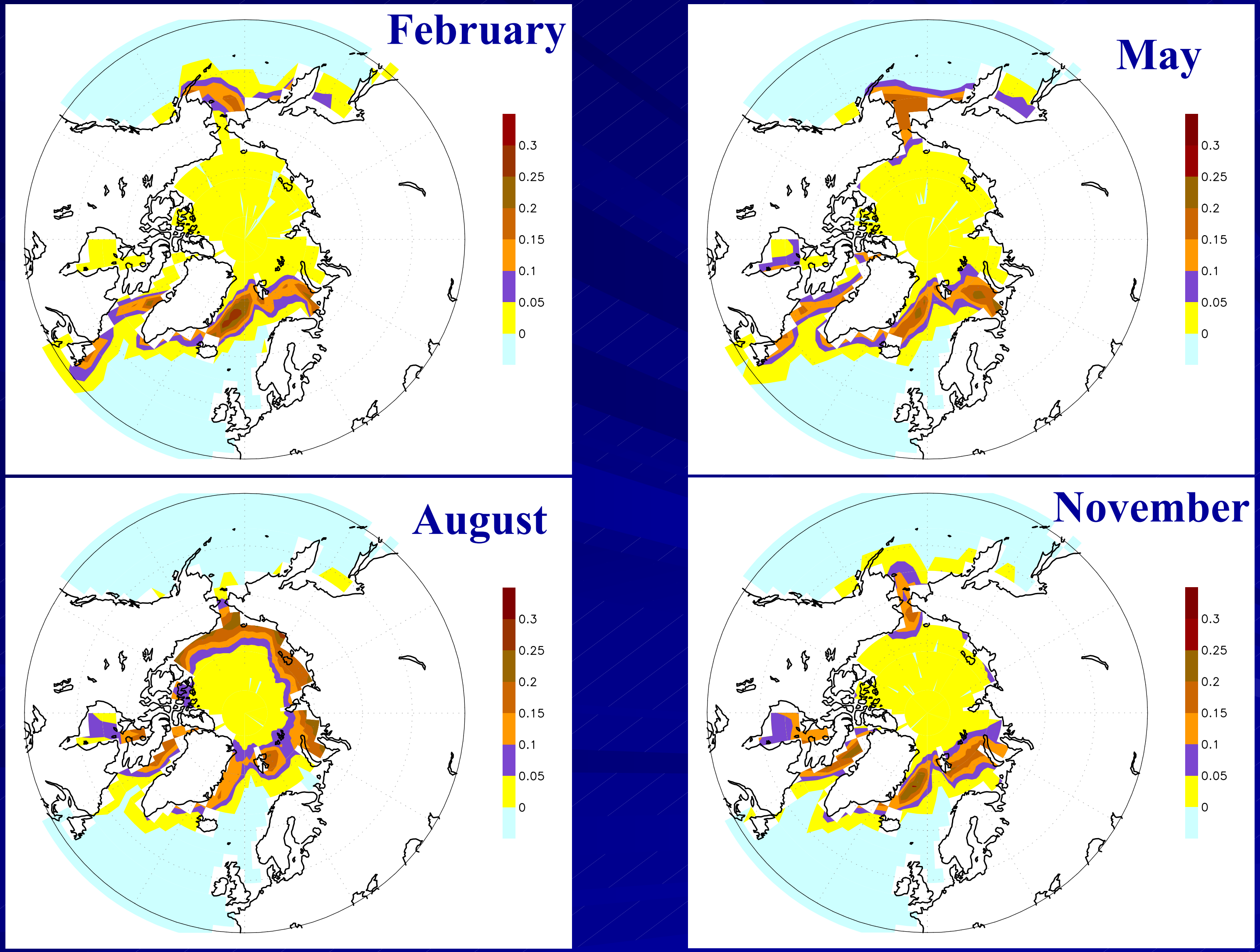
July (1st month). 1979-2000.

Initialized soil moisture in initial conditions

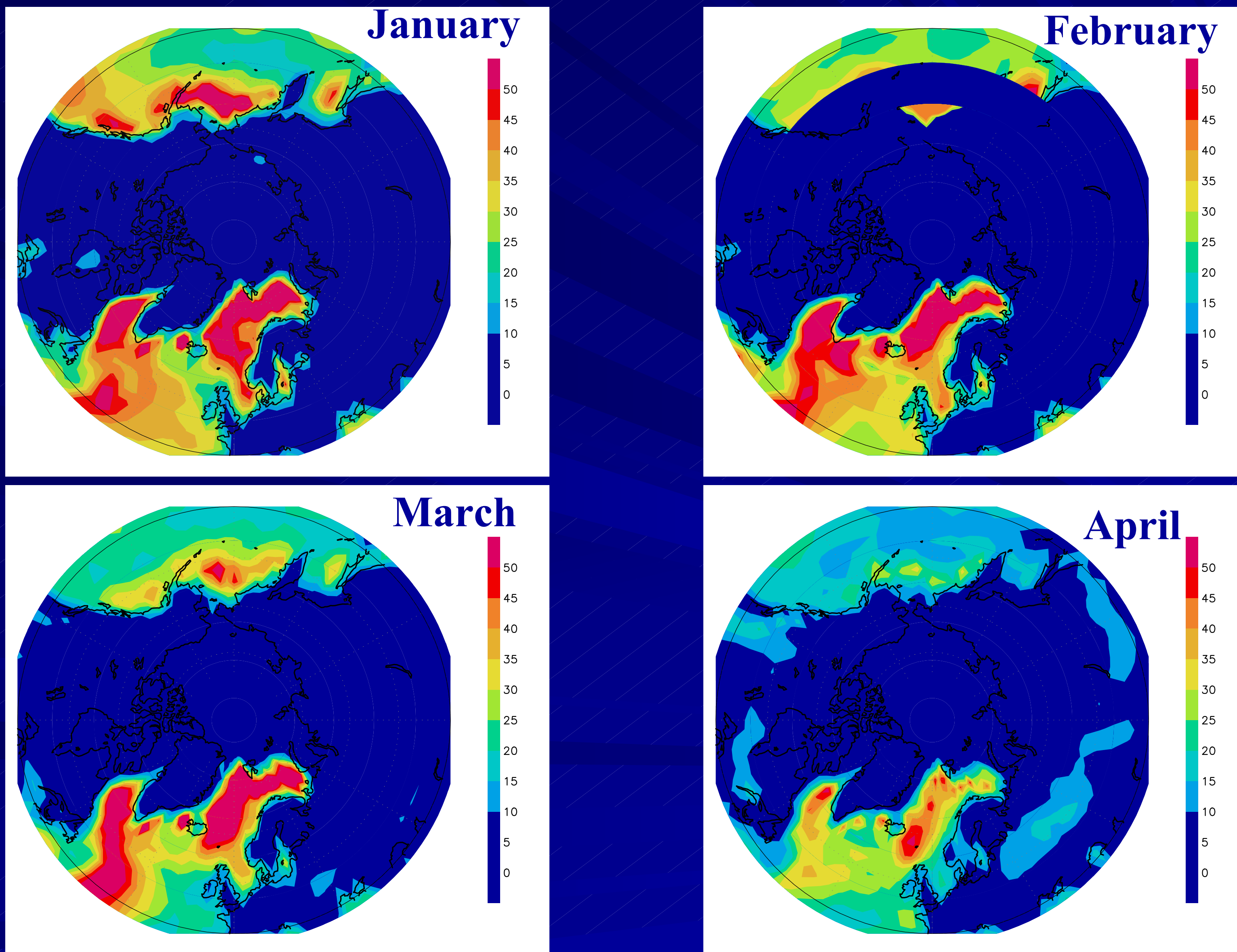
Climate soil moisture in initial conditions



Observed RMS-variations of the sea ice extent in the Northern hemisphere (1979-1999)

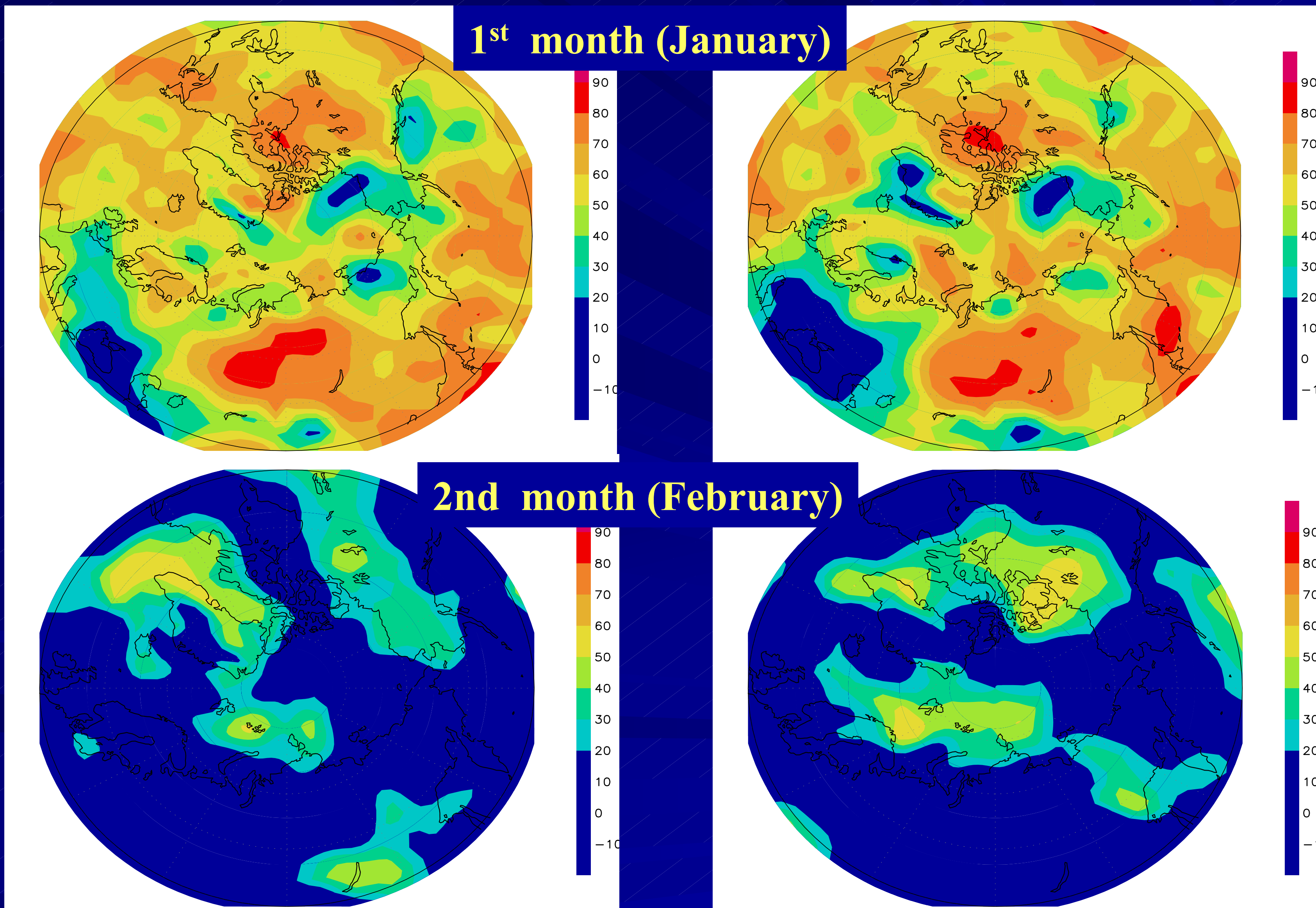


RMS-variations of monthly heat flux in the Northern hemisphere (Vt/m^2) at the surface level



Anomaly correlations for forecasts of T850.

Left – for actual anomalies of sea ice. Right – for climate sea ice.



Reproducibility for forecasts of T850 anomalies.
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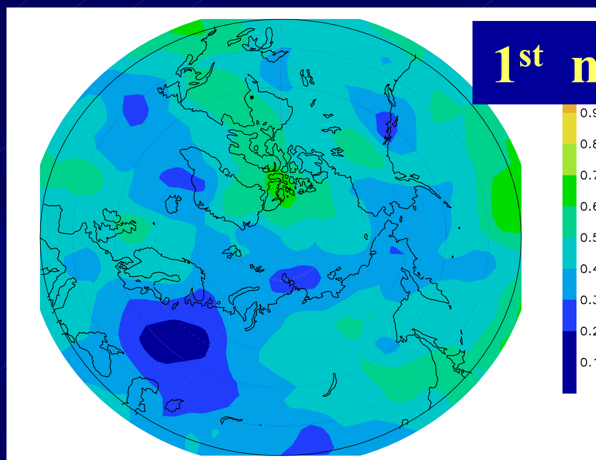
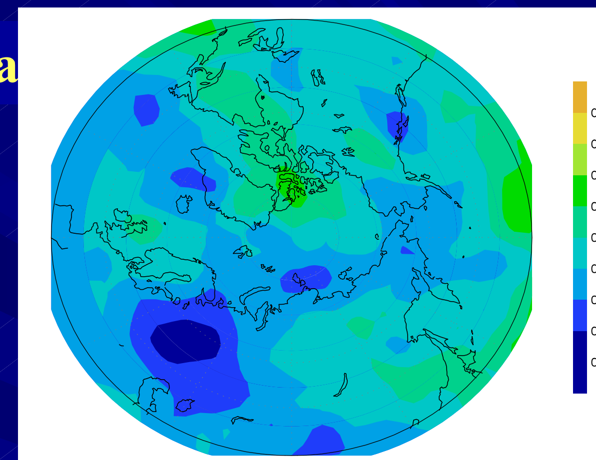
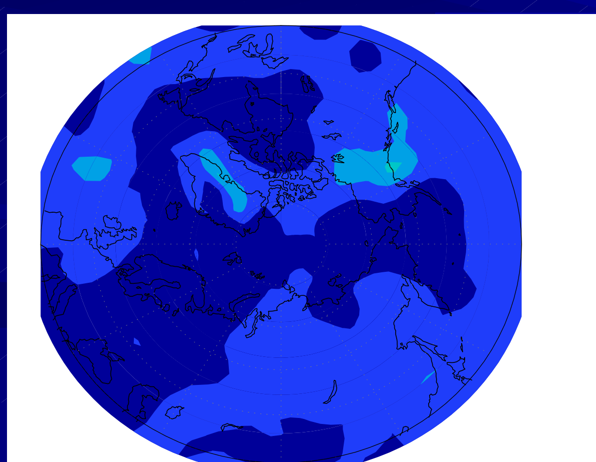
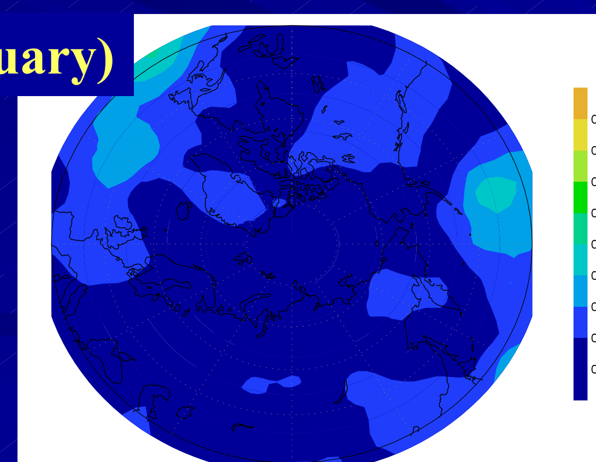


1st month (Janua



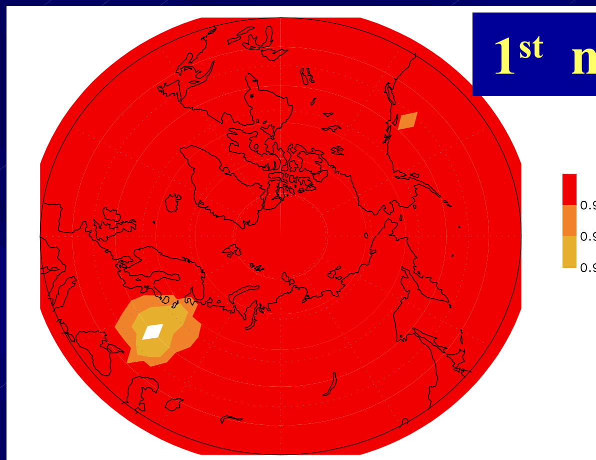


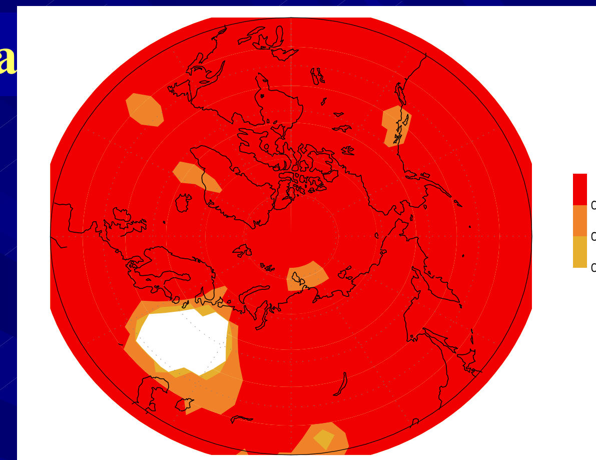
onth (February)



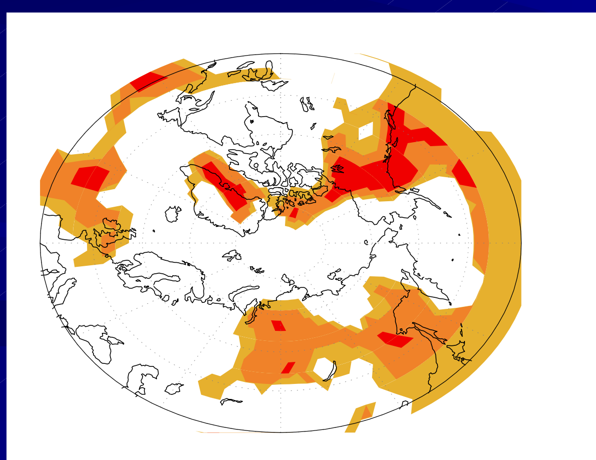
Statistical significance for reproducibility of T850 anomalies. Left – for actual anomalies of sea ice. Right – for climate sea ice.

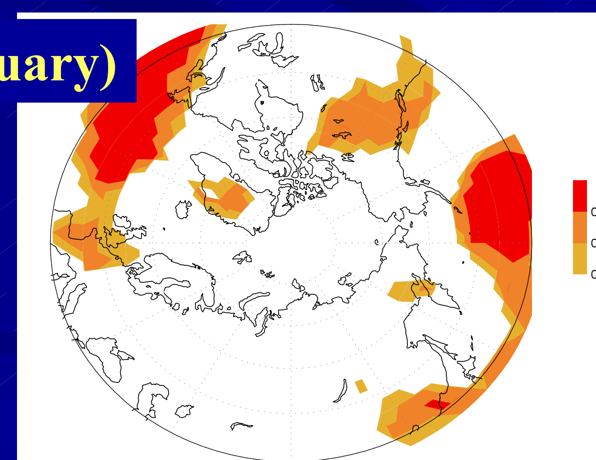
1st month (Janua





month (February)





Thank you