Seasonal forecast system based on SL-AV model at Hydrometcentre of Russia

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Seasonal version of SL-AV model

- Semi-implicit semi-Lagrangian vorticity-divergence dynamical core of own development (Tolstykh 2010), mostly ALADIN/LACE parameterizations.
- Resolution 1.4x1.125 degrees lon/lat, 28 levels. Described in (*Tolstykh et al, Izvestia RAN, Ser. PhA&O, 2010)*
- Stochastic parameterization of large-scale precipitation *(Kostrykin, Ezau, Russ. Meteorol. and Hydrology, 2001).*
- Hybrid deep convection closure *(Tolstykh, WGNE Res. Act. 2003)*
- Allows to have more realistic precipitation with relatively low resolution.

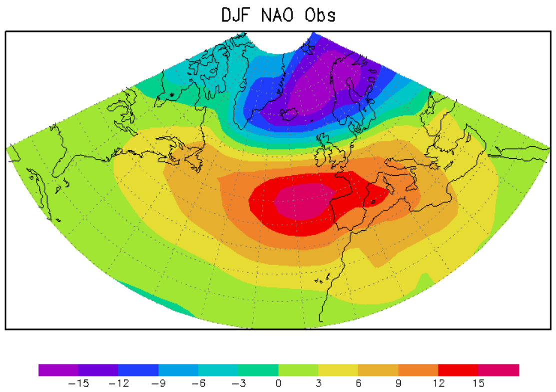
Running forecasts

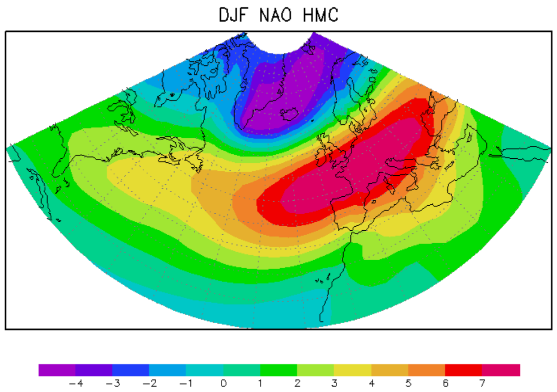
- d0-63: 1.1x1.4 L28 once a week, 20 member ensemble initialized on 00Z every Wednesday forced py persisted SST anomalies (mean for 2 weeks) from NCEP (Reynolds SST OI v2). Perturbation from a breeding cycle. Re-forecast suite with 10 members spanning 30 years (1981-2010) run in real-time.

- m0-4: Forecast suite is the same as d0-63, but forecast lead time is 4 months. Runs on the last Wednesday of a month. Re-forecast suite with 10 members spanning 30 years (1981-2010) 00Z and 12Z 26-30 of each month (24-28 for February).

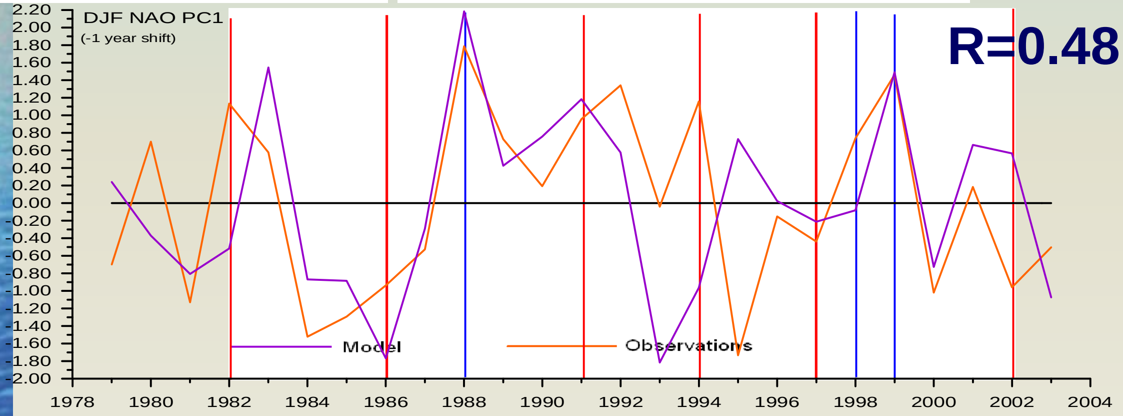
- Input to APCC, WMO LC LRF multi-model ensemble

Predictions of the DJF mean NAO index with the seasonal version of SLAV model (by V.N.Kryjov)

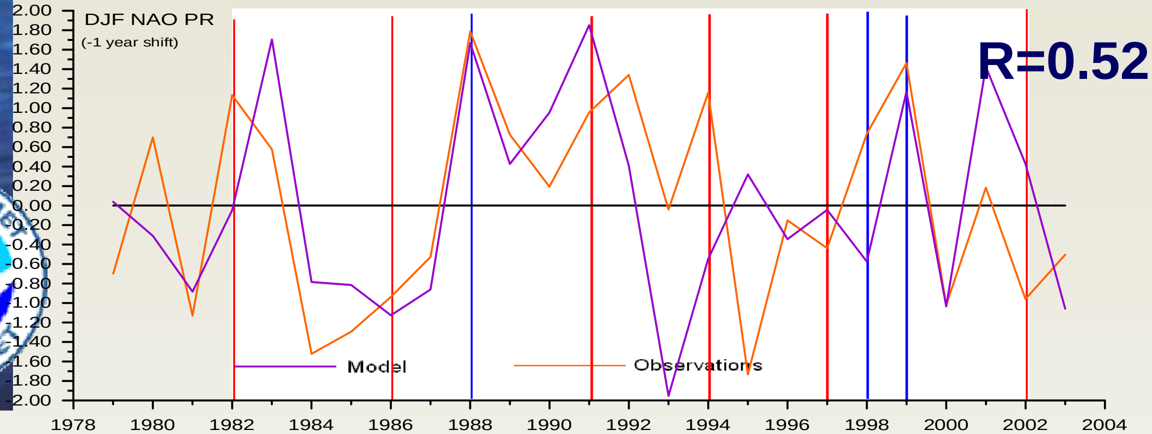




EOF1 of wintertime (DJF) SLP over the North Atlantic in observations (left) and model predictions (right)



Time series of the DJF mean NAO index in observations (PC1o, orange) and in model predictions (violet) as PC1m (middle) and as PR (bottom).



Blue/red vertical lines denote the winters of La-Nina/El-Nino, to which predictions appear not sensitive

Experimental atmosphere-ocean-ice model

- Joint work with N.A.Diansky, A.V.Gusev (Institute of Numerical Mathematics RAS)
- Atmospheric part is SL-AV (1.4x1.1, 28 levels)
- Ocean and ice models, as well as the coupler, are taken from the INM climate model. Calibrated in CMIP4, participating in CMIP5.

INMOM Ocean model

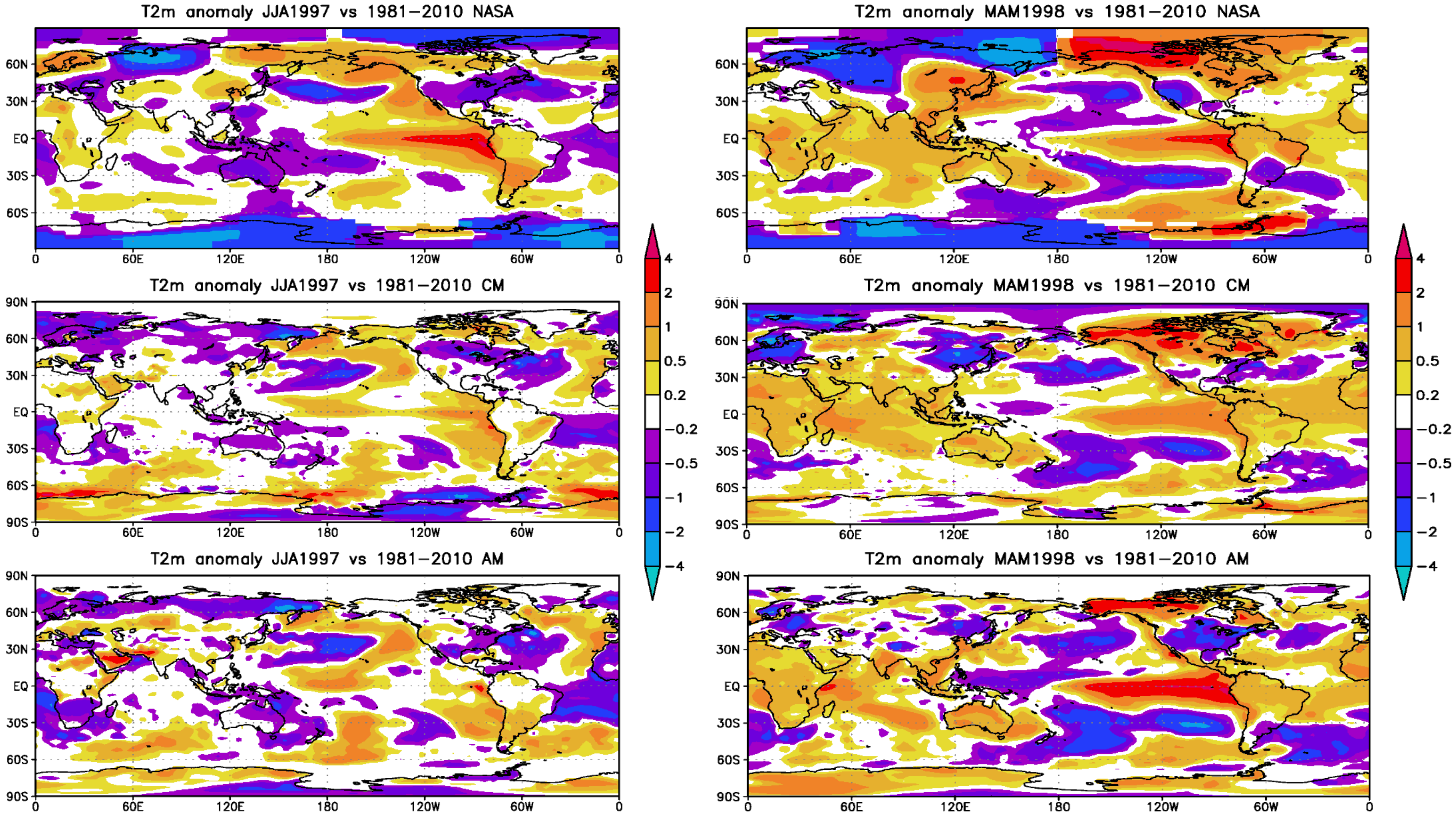
- Sigma-coordinate model with isopicnic horizontal diffusion
- 1ęx0.5ę, 40 levels
- The EVP (elastic- viscous- plastic) rheology, dynamics, Semtner thermodynamics sea ice model (Hunke, Ducowicz 1997; Iakovlev, 2005) is embedded.
- Coupling to the atmospheric model without flux correction

Coupled atmosphere-ocean model for seasonal prediction (2)

- Globally averaged over 4 seasons heat flux to the ocean with one-way interaction is 4.5 W/m^2. Model tuning allowed to reduce this value to 2.8 W/m^2.
- Atmosphere and ocean models are coupled without flux correction.
- 10-member ensemble. Only atmospheric initial data is perturbed.
- Seasonally averaged atmospheric circulation of the coupled model for months 2-4 is compared to the results of atmospheric model with simple SST evolution.

Averaged over season observed T2m anomaly, as a deviation from seasonally averaged 1989-2010 field according to NASA (http://data.giss.nasa.gov). The same anomaly with respect to model climate in SL-AV with simple extrapolation of SST anomaly (bottom). The same anomaly in coupled model (middle).

Left: JJA1997, Right: MAM1998



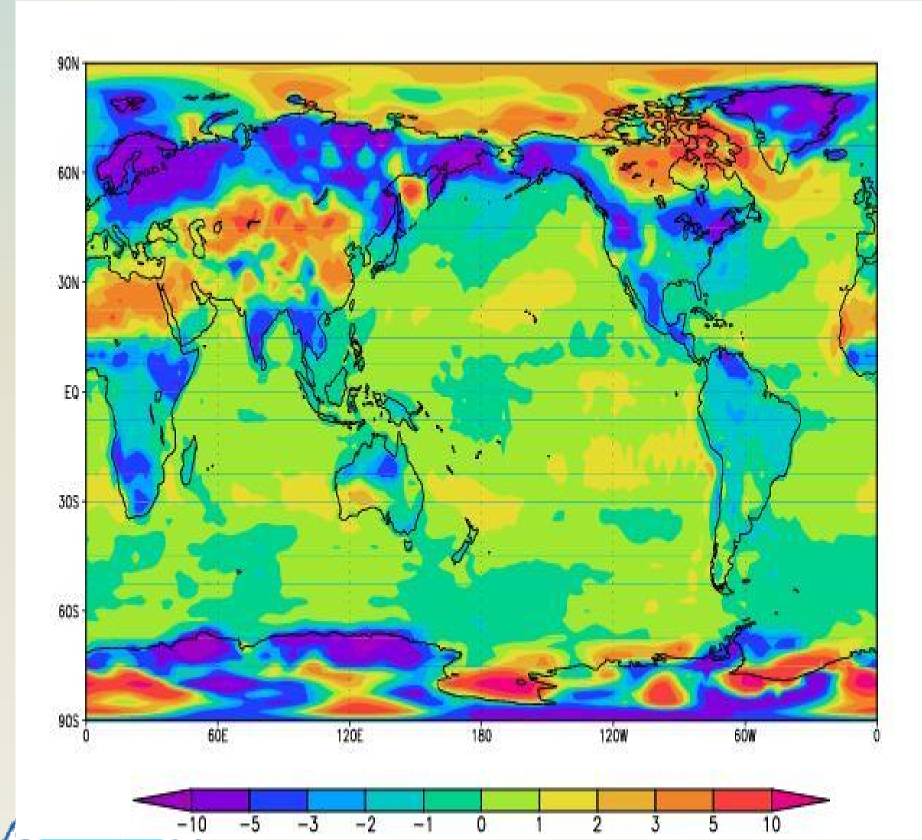
Ongoing work

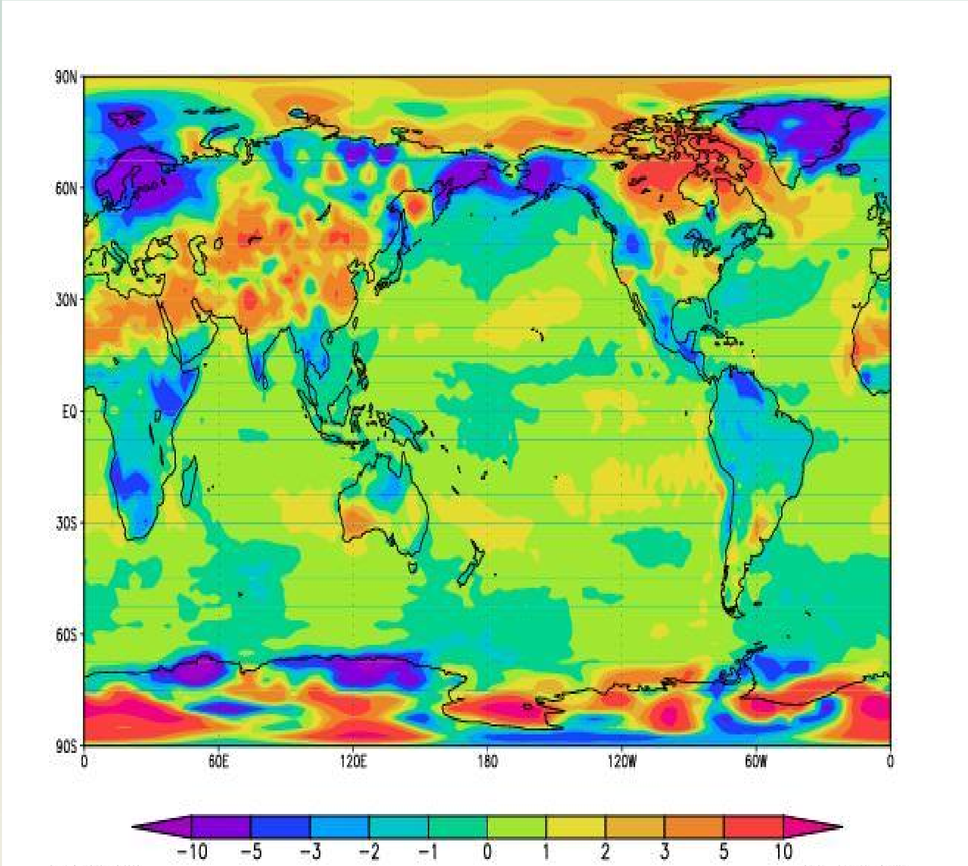
- Introduction of the INM RAS multi-layer soil parameterization – first positive results
- New SW and LW radiation parameterization(CLIRAD SW + RRTM LW). Likely switch to RRTM G SW+ LW
- Modification of snow albedo
- Higher horizontal and vertical resolution (0.9x0.72 lon-lat, ~40-50 vertical levels
- Switching to ERA-Interim reanalyses for hindcasts.

Futrher work:

- Using higher resolution ocean model, more sophisticated ice model.
- Numerical experiments using ocean data assimilation system developed in Hydrometcentre of Russia.

Role of snow albedo. Hindcast for March 1982. T2m bias: standard scheme (left), modified albedo (right) (A.Yurova)





Thank you for attention!

Calculating seasonal hindcasts with the coupled model: Initial data

- Running INMOM ocean model for 1989-2010 using ERA-Interim atmospheric forcing. Archiving ocean model state for the moments when historical seasonal forecasts start
- Using NCEP/NCAR reanalysis-2 data in upper atmosphere + SLP as initial data for atmospheric model.
- For soil variables, using own soil assimilation scheme correcting soil variables from T2m and RH2m 6-hour forecast error. T2m and RH2m analyses still come from reanalysis-2

Errors for 500 hPa height (H500) [м], sea-level pressure (MSLP) [mb], 2m temperature (T2m)[˚C], averaged over 1989-2010 years for all seasons for atmospheric model with SST extrapolation (SLAV) and coupled model (CM). Full fields and model anomalies (ANOM)

	SLAV RMSE	CM RMSE	SLAV ANOM CORR	ʉ∫ ANOM CORR	ANOM SLAV RMSE	ANOM CM RMSE
ɿ 500						
20-90 N	41.2	40.5	0.056	0.042	27.6	27.4
Tropics	14.6	12.1	0.040	0.030	6.3	5.7
90-20 S	39.1	40.3	0.126	0.123	27.6	27.4
MSLP						
20-90 N	3.23	3.06	0.060	0.069	2.11	2.05
Tropics	1.48	1.50	0.319	0.430	0.68	0.57
90-20 S	5.34	5.39	0.131	0.128	2.62	2.61
T2m						
20-90 N	2.23	2.59	0.102	0.085	1.37	1.40
Tropics	1.26	1.47	0.301	0.328	0.60	0.53
90-20 S	2.41	2.79	0.140	0.095	1.26	1.28