ALARO in the global semi-Lagrangian model SL-AV model at Hydrometcentre of Russia

M.A. Tolstykh

Institute of Numerical Matematics
Russian Academy of Sciences;
Hydrometcentre of Russia

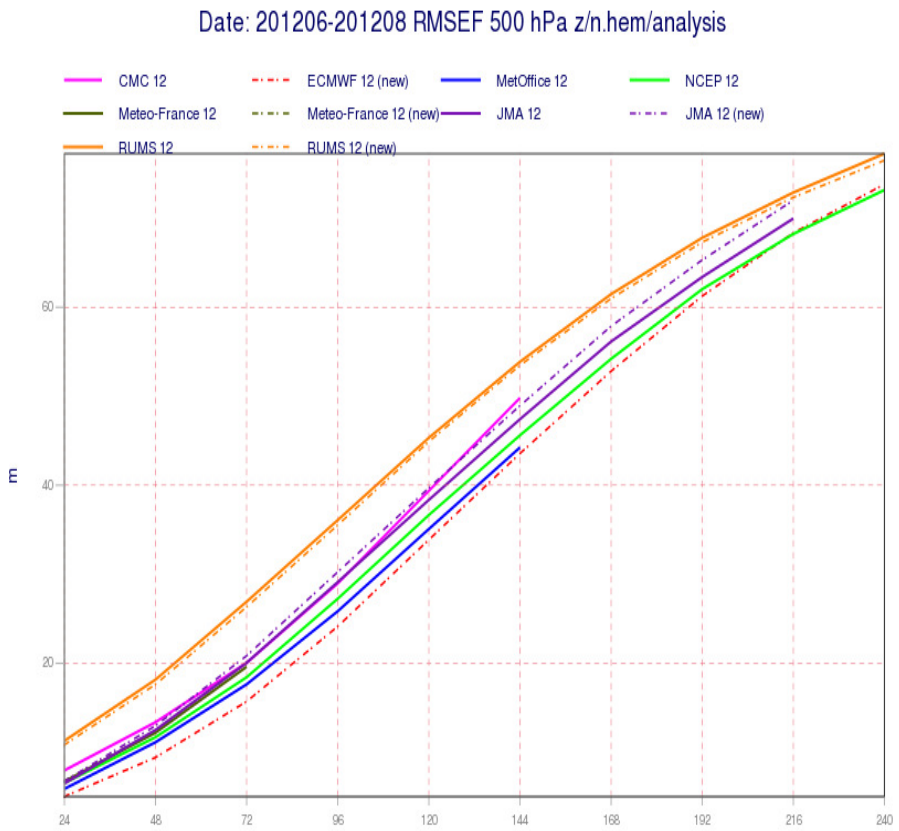
SL-AV model

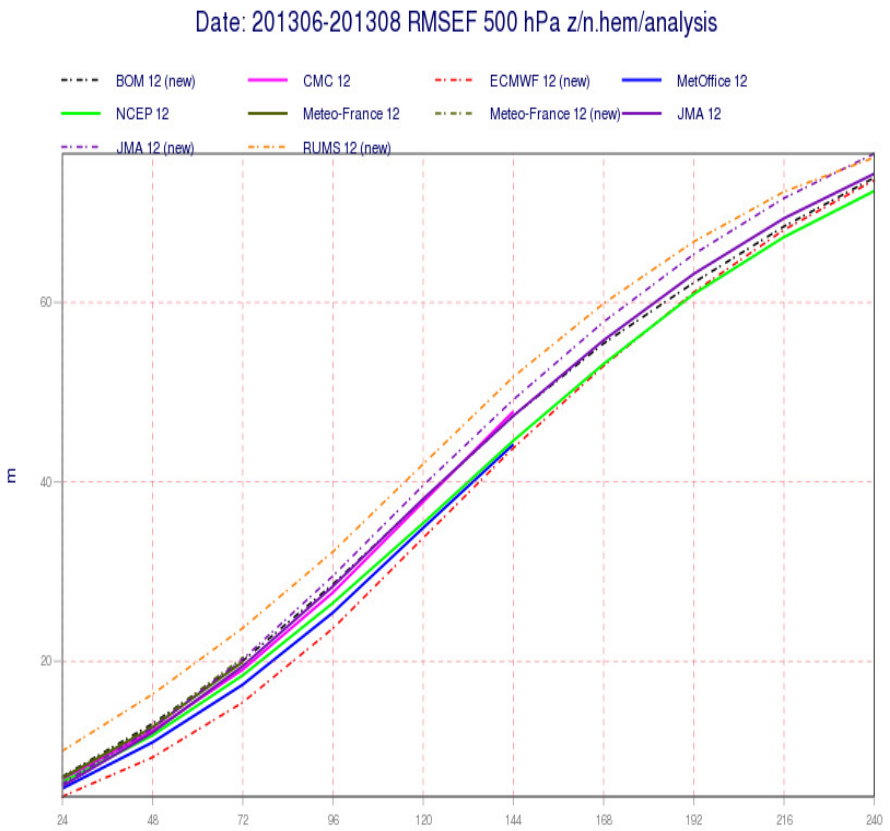
- Semi-Lagrangian vorticity-divergence dynamical core of own development (Tolstykh JCP 2002), (Tolstykh Shashkin JCP 2012) (Shashkin Tolstykh GMD 2014)
- ALARO parameterizations (some exception in the new version).
- Operational (old): 0.9x0.72 degrees lon/lat, 28 levels, runs on Altix 4700 computer (mixture of preALARO0 and ALARO0)
  http://www.meteoinfo.ru/plav-forc-rus
- Version with the resolution 0.225x(0.18-0.23) degrees, 51 levels under operational trials (ALARO0minus3MT).
- Seasonal forecast version (1.4x1.1, 28 levels)
  http://wmc.meteoinfo.ru/season

H500. 20N-90N. RMSE vs forecast lead time

SL-AV is orange (RUMS12)

(from http://apps.ecmwf.int/wmolcdnv/ **)**



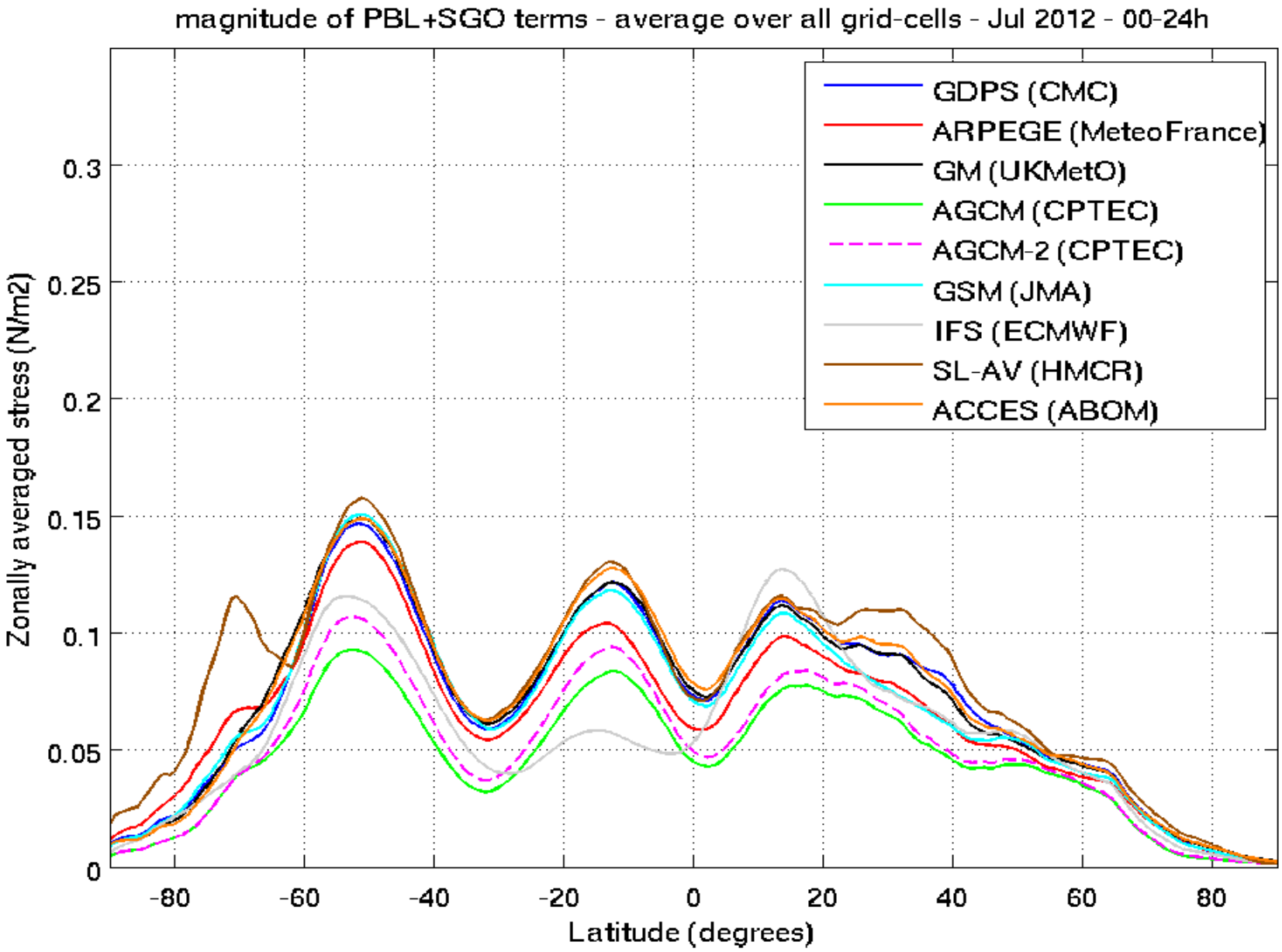


Jun-Aug 2012

Jun-Aug 2013

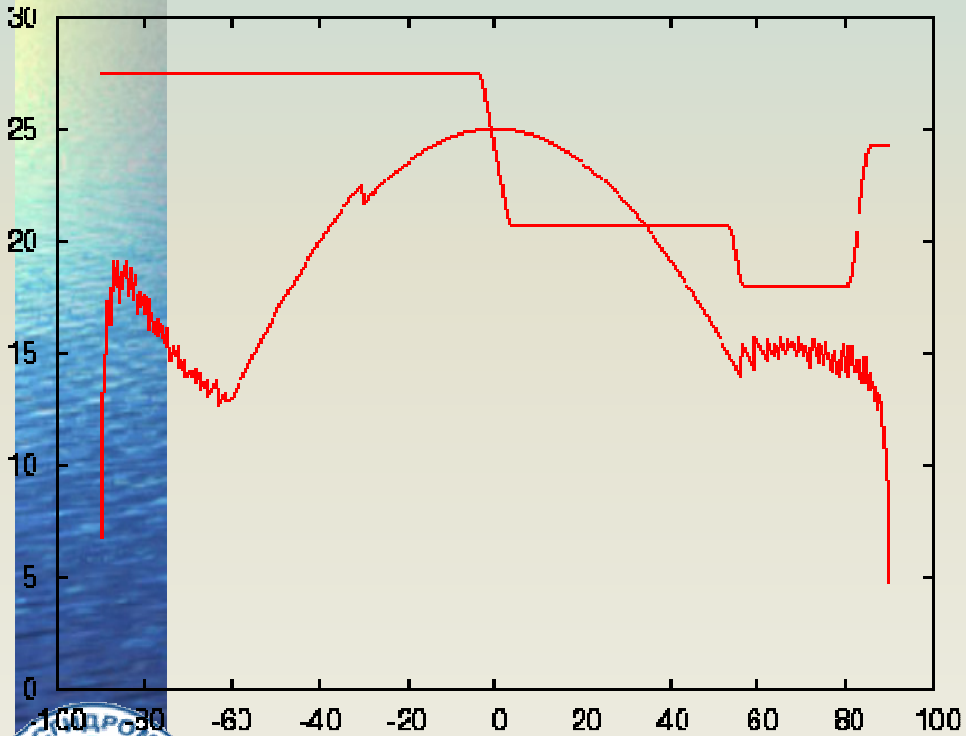
Operational implementation of 3D Var improved the scores.
The prognostic model is almost the same as a year before

WGNE surface drag project

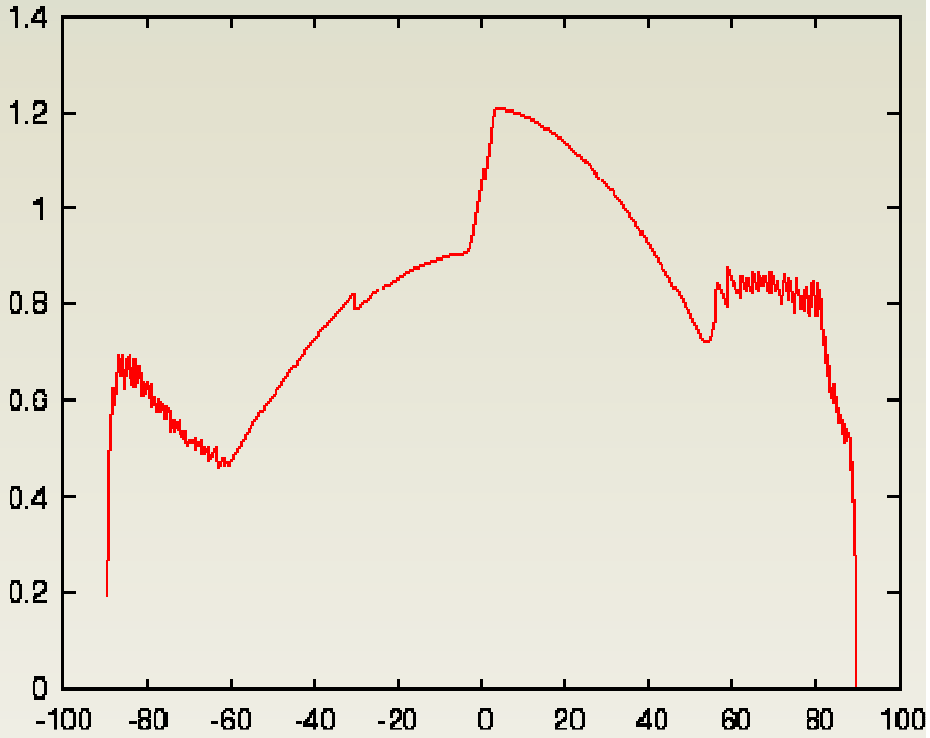


Grid characteristics for the version with the resolution 0.225x(0.18-0.23) degrees, 51 levels

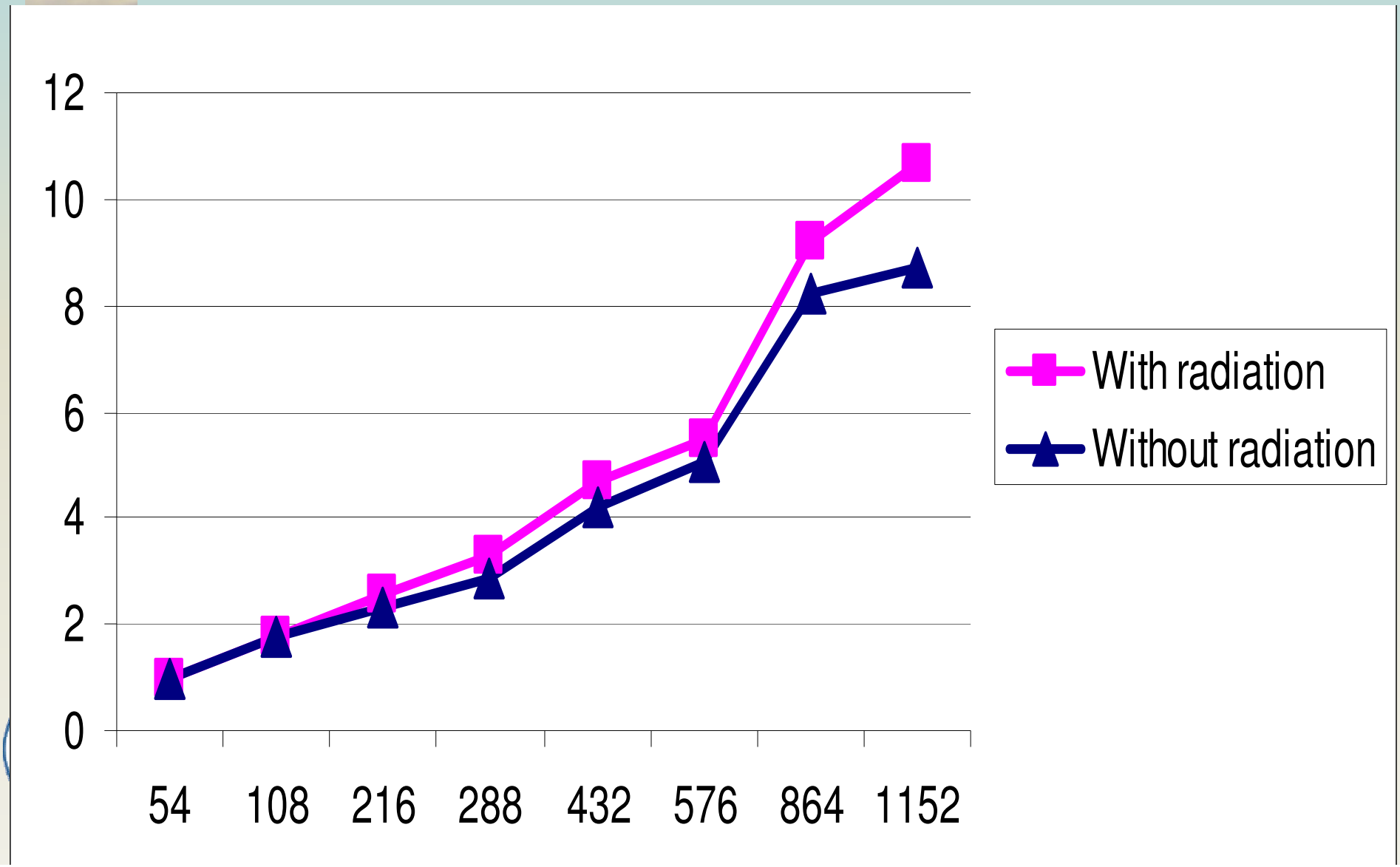
Grid step in latitude (upper curve) and longitude (lower curve), in km



Proportion of 'physical' grid steps Max(dx/dy, dy/dx)

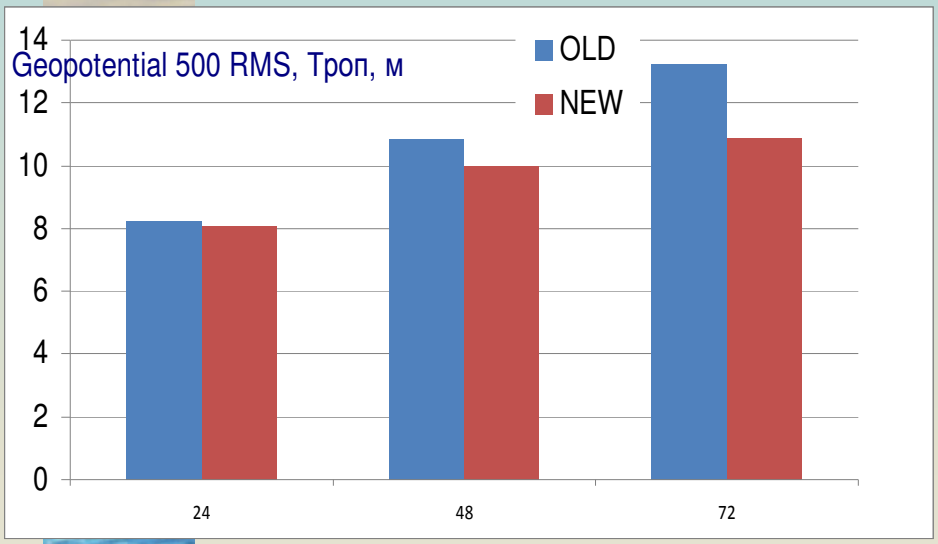


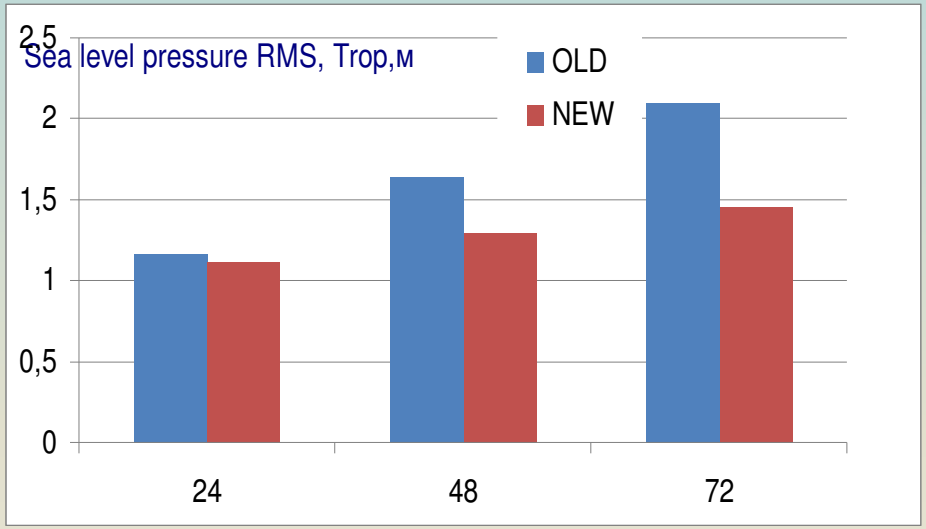
SL-AV parallel speedup (0.18°x0.225°, 51 levs) with respect to 54 cores

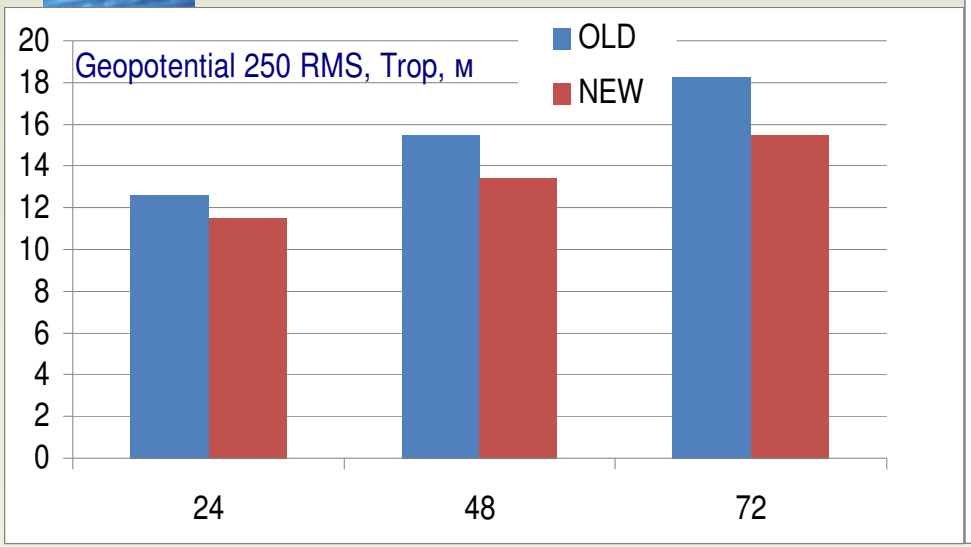


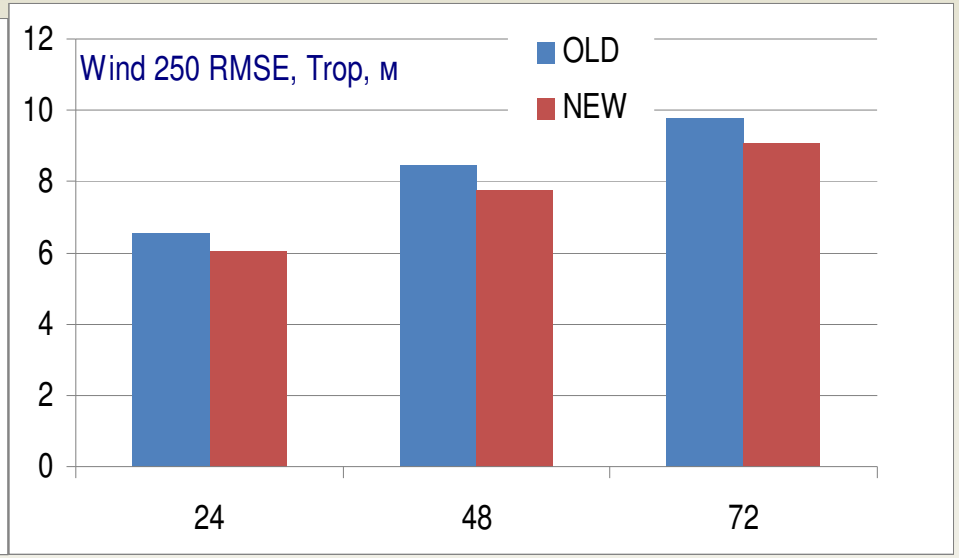
Scores of old (0.9°x0.72°, 28 levs, OPER) and new (0,225°x0,18°, 51levs, SLM20) SLAV

Tropics. May-Oct 2013



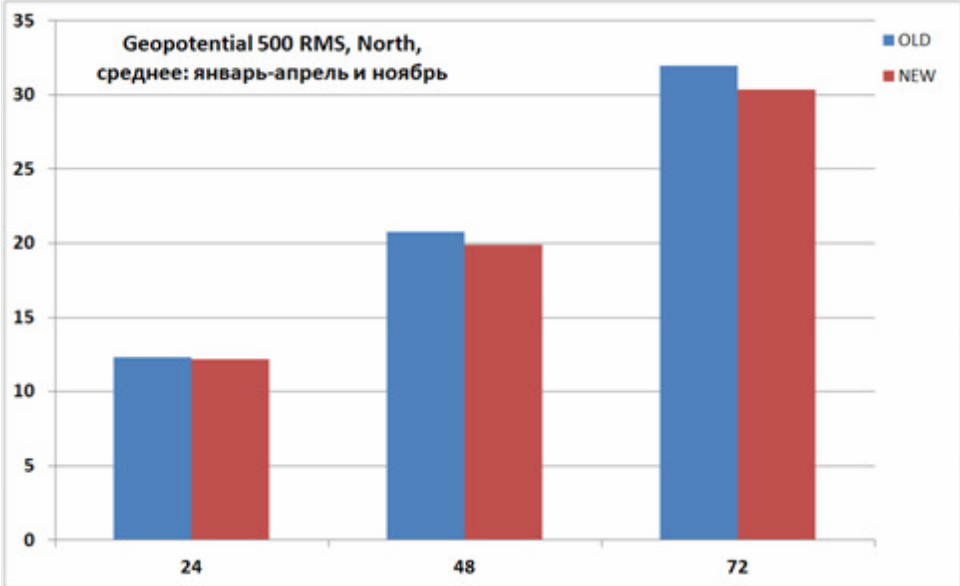


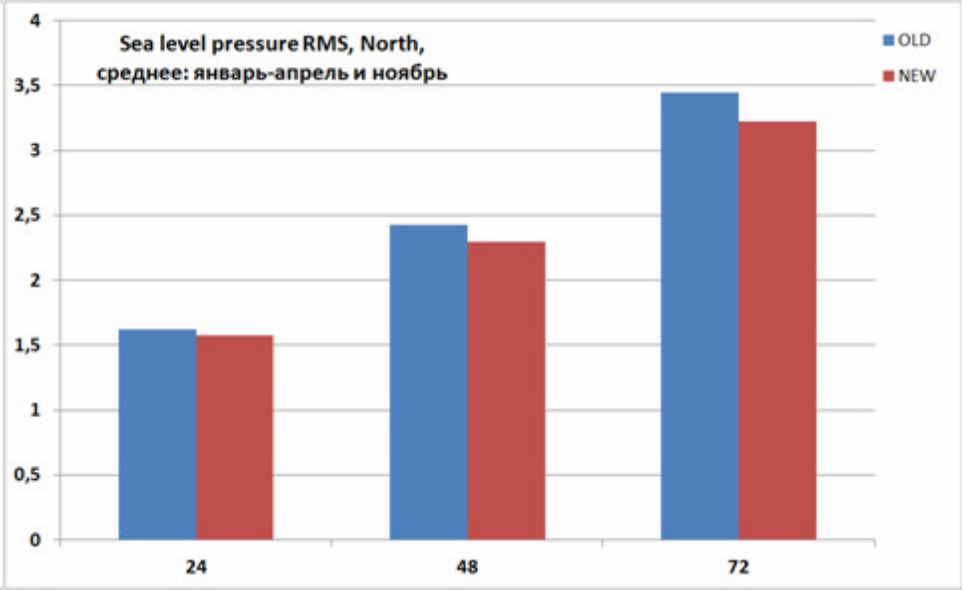


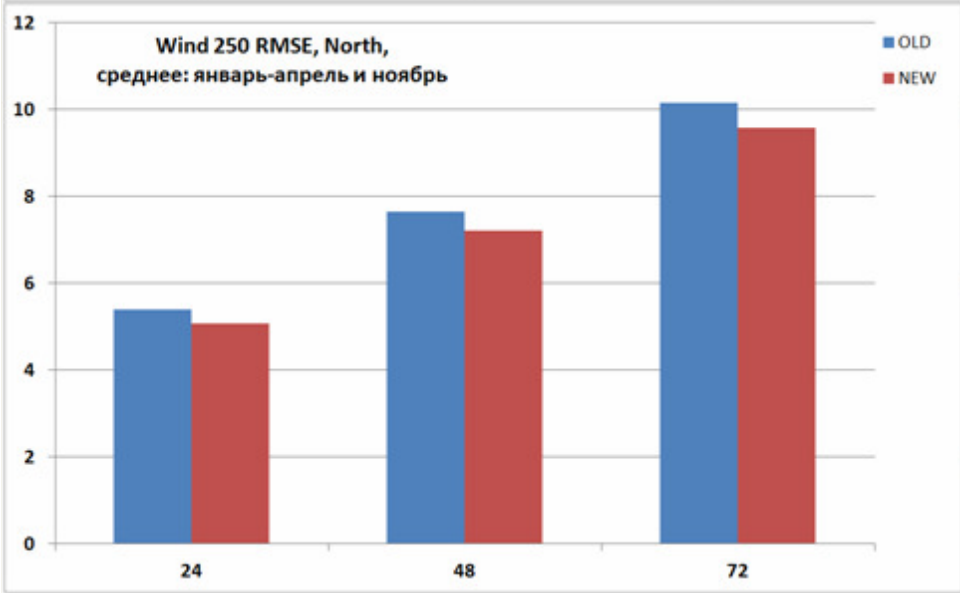


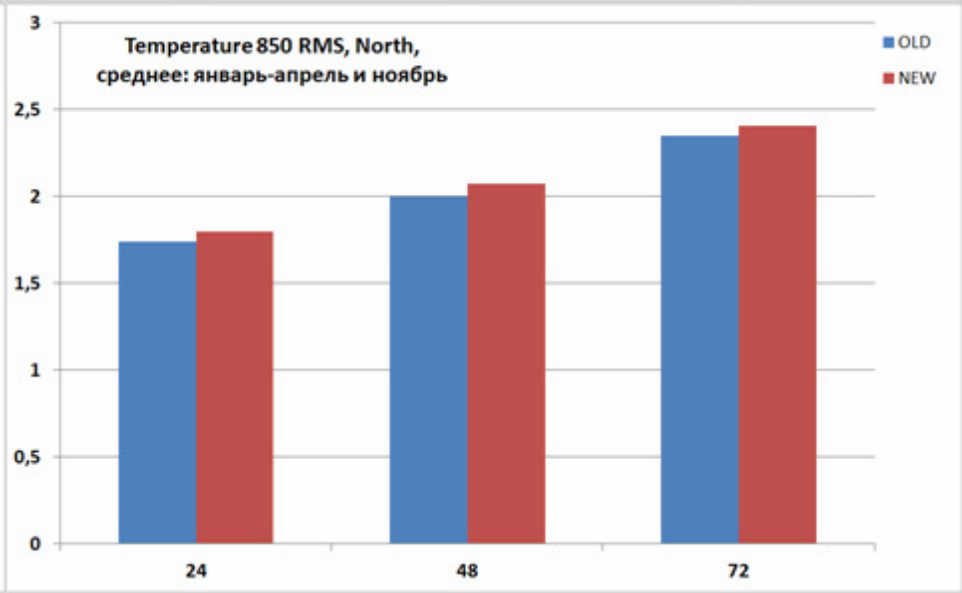
Scores of old (0.9°x0.72°, 28 levs, OPER) and new (0,225°x0,18°, 51levs, SLM20) SLAV model

20-90N. Jan-Apr, Nov 2013









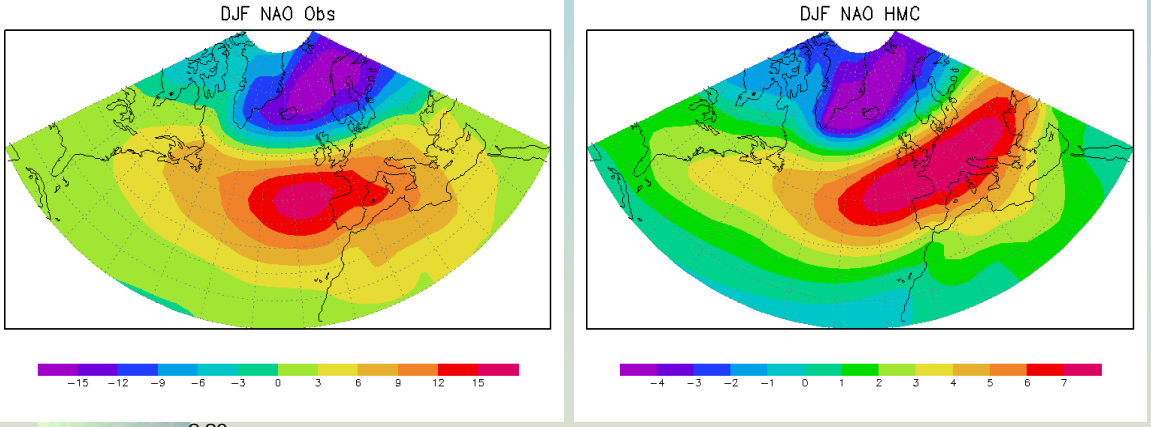
Seasonal version of SL-AV model

- 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).*
- Allows to have more realistic precipitation with relatively low resolution.
- RHMC is one of ~12 WMO Global producing centers for LRF, also one of WMO Regional Climate Centers (NEACC – North Eurasia Climate center http://neacc.meteoinfo.ru)

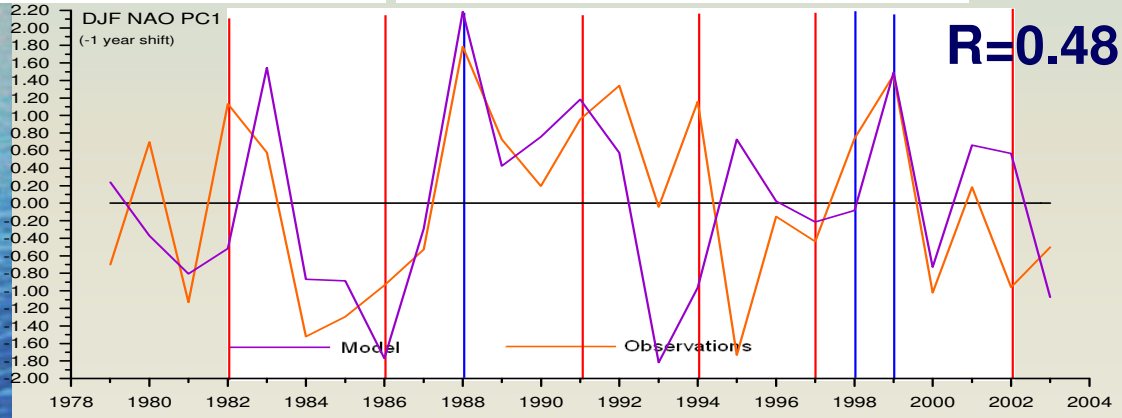
Running forecasts

- 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)

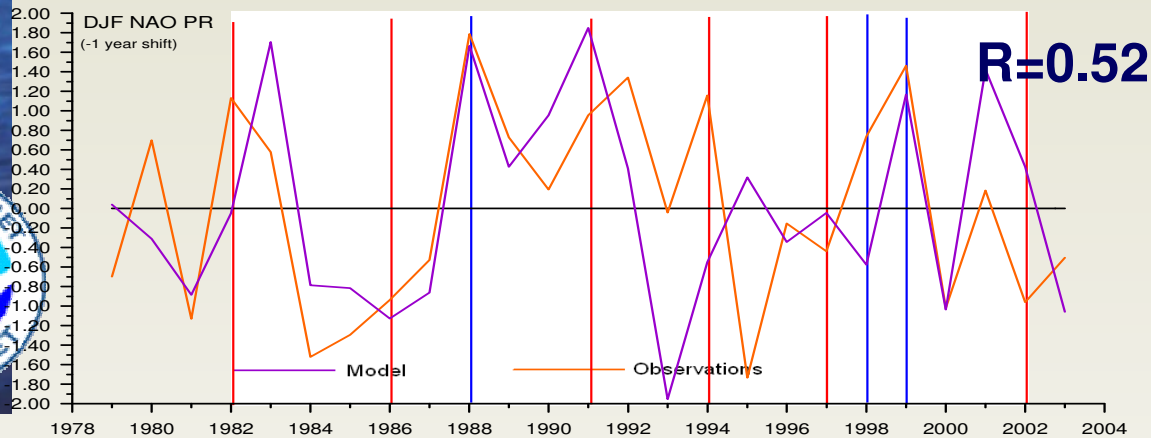


EOF1 of wintertime (DJF) SLP over the North Atlantic in observations (left) and model predictions (right)



R=0.48

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

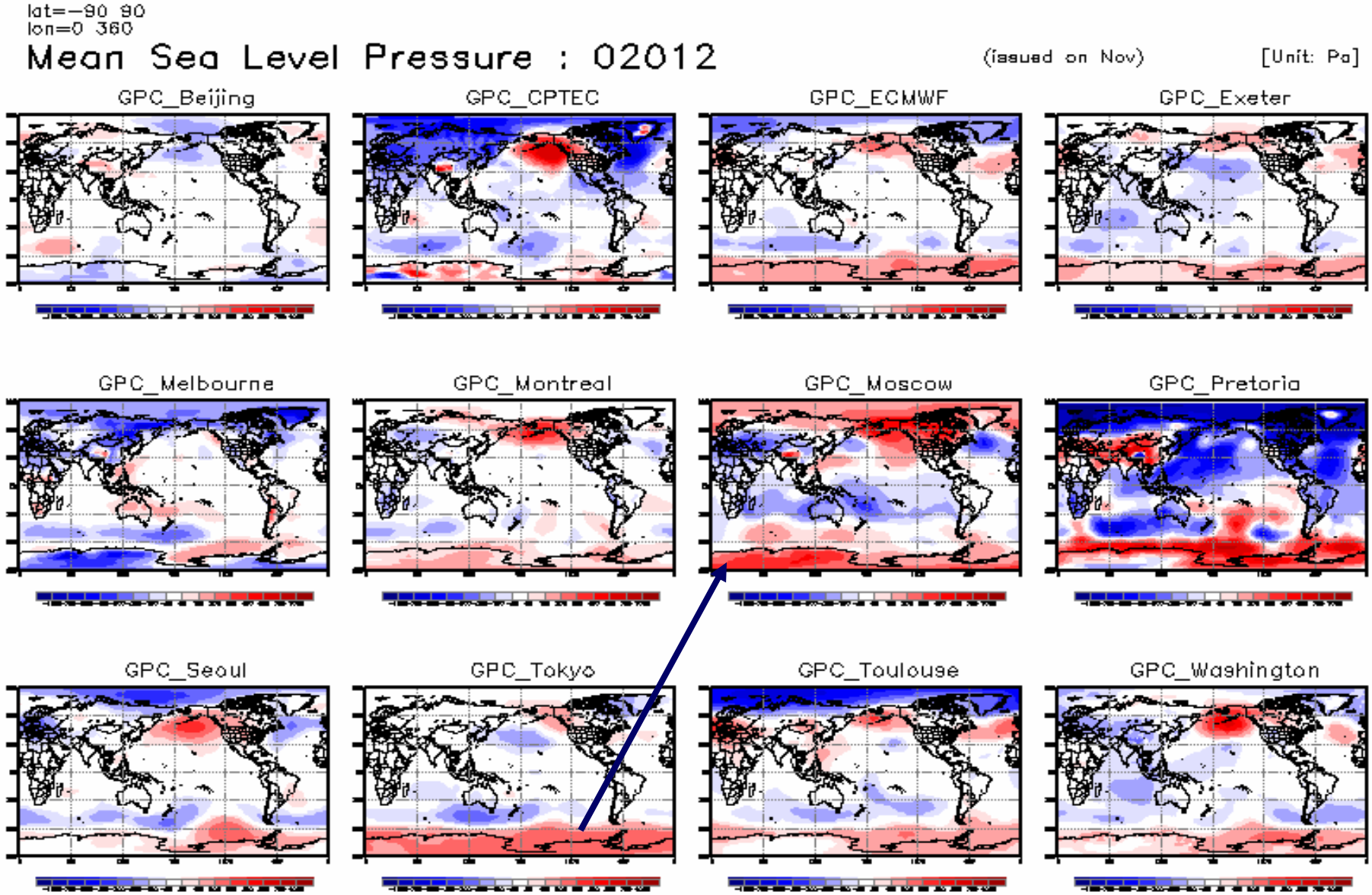


R=0.52

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

GPC predictions of DJF'12-13 mean SLP

(from WMO LC LRF-MME)

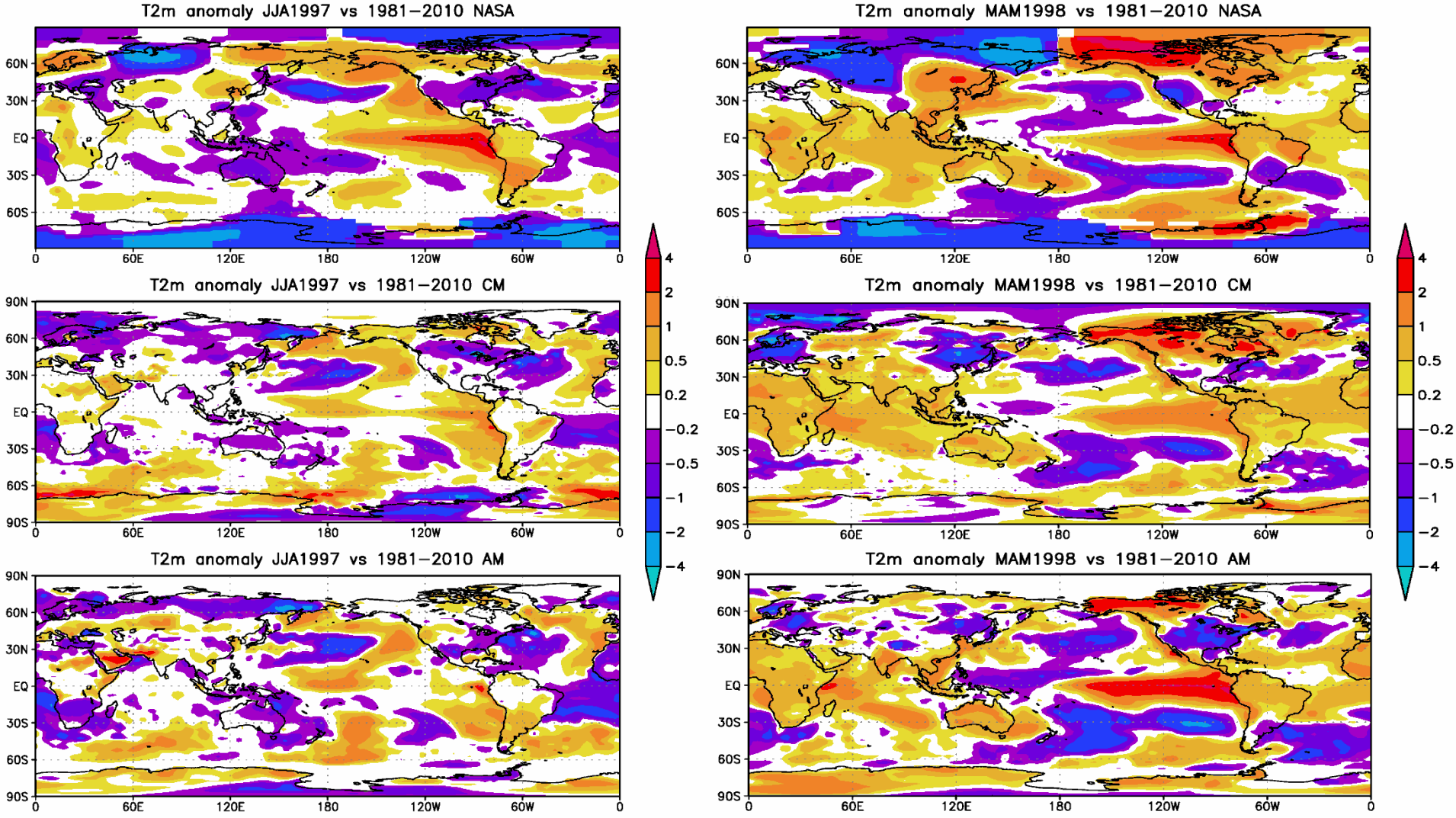


Distinct negative phase of the AO predicted!

Experimental atmosphere-ocean-ice model

- Joint work with N.A.Diansky, A.V.Gusev (Institute of Numerical Mathematics RAS) – published in Tolstykh et al Izvestia PhAO 2014
- 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.
- Sigma-coordinate model with isopicnic horizontal diffusion
- 1˚x0.5˚ , 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

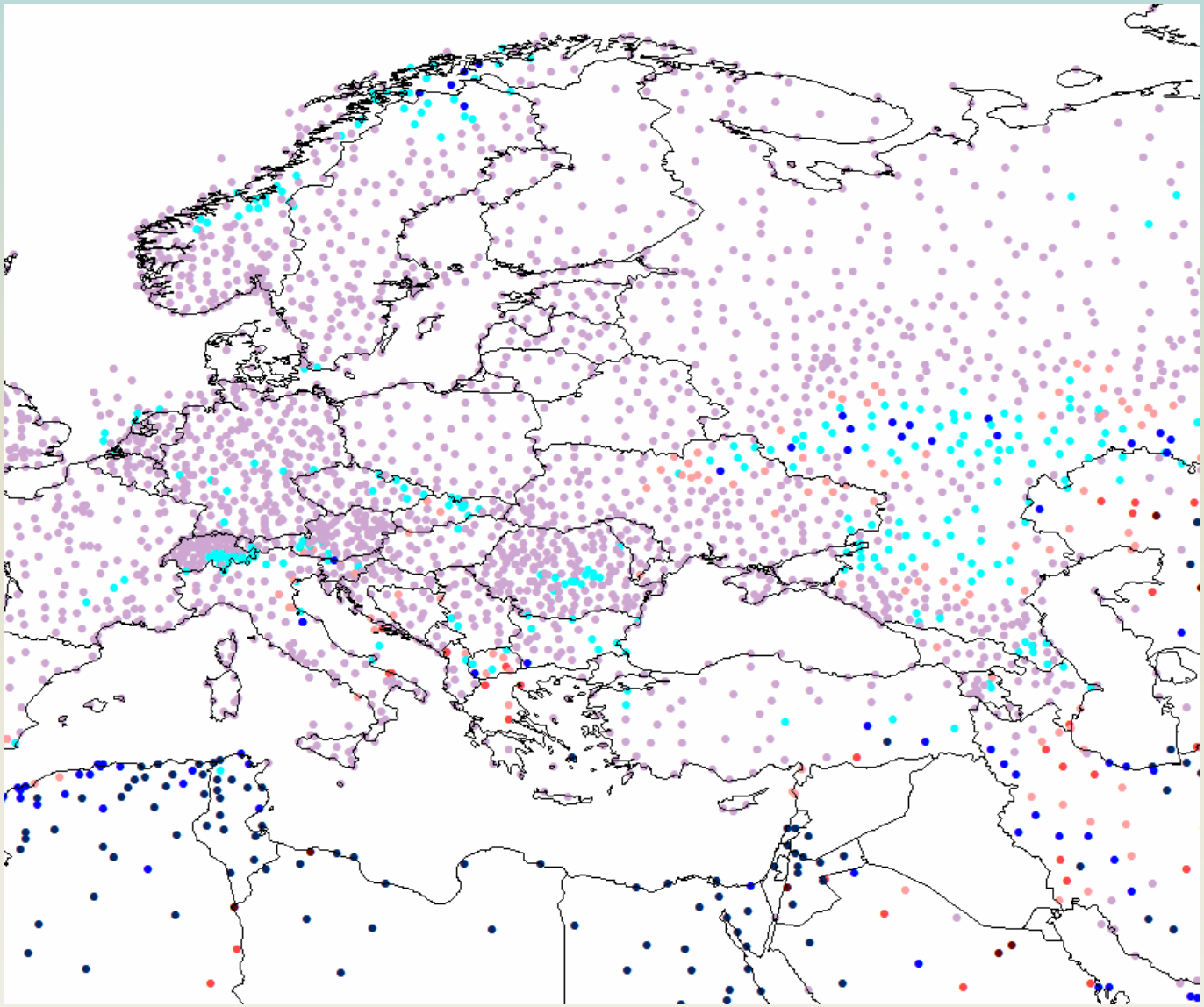
Averaged over season observed T2m anomaly, as a deviation from seasonally averaged 1989-2010 field according to NASA (http://data.giss.nasa.gov). The same anomaly with respect to model climate in SL-AV with simple extrapolation of SST anomaly (bottom). The same anomaly in coupled model (middle). Left: JJA1997, Right: MAM1998



Ongoing developments

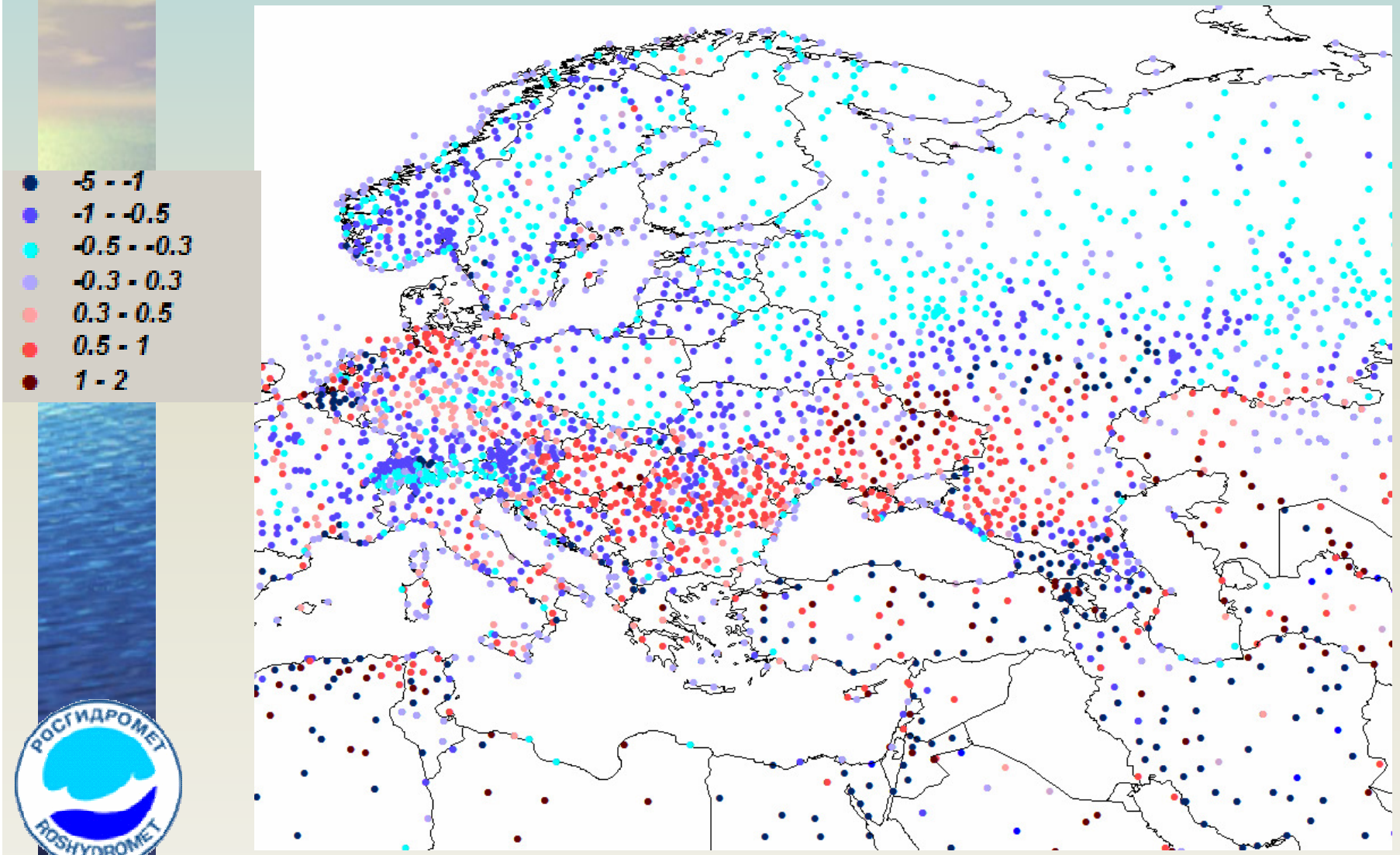
- Finalization of the mass-conservative version (Shashkin, Tolstykh GMD 2014) (parallel implementation). This will enable further developments (ozone cycle, chemistry…)
- INM RAS multilayer soil model (awaits soil moisture initialization scheme)
- Snow albedo
- Moving to hybrid coordinate
- Contributing seasonal forecasts data to WMO CHFP and S2S databases
- Increase of scalability up to 3000 cores (same resolution of ~20 km)

Difference in abs error of T2м_max ((INM soil model) – (ISBA)).
SLAV (version 0.56°x(28-60km)x51 levs). Average over Apr. 2013.
Second day



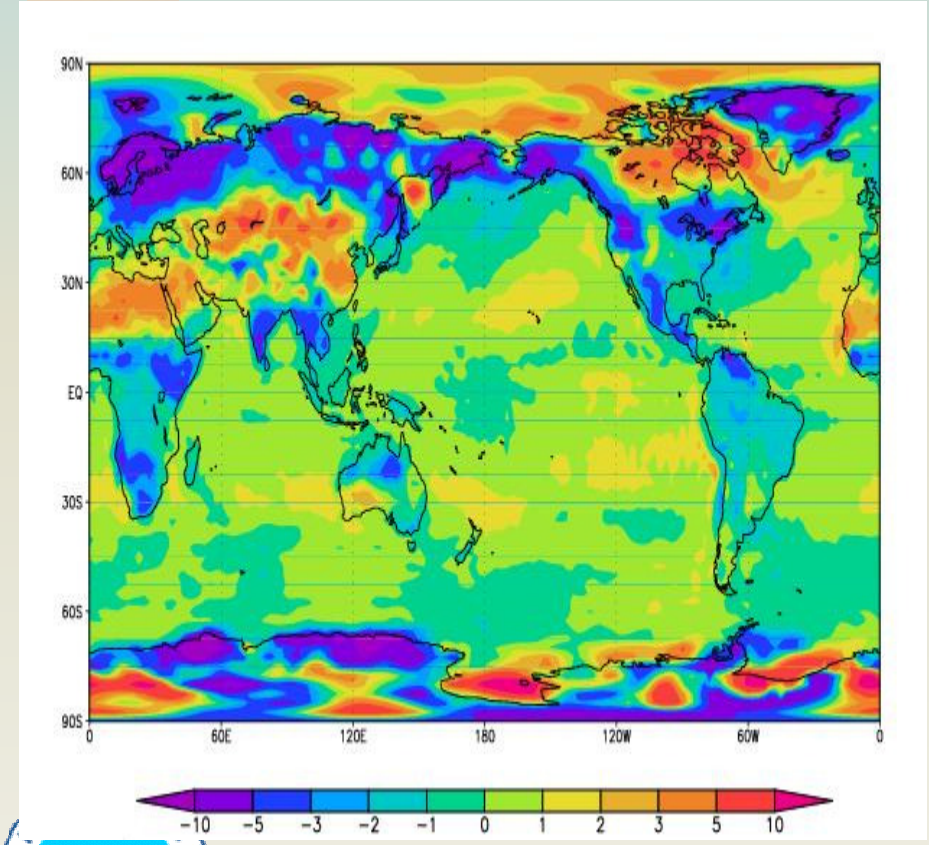
Голубой и синий цвета соответствуют областям уменьшения ошибки прогноза

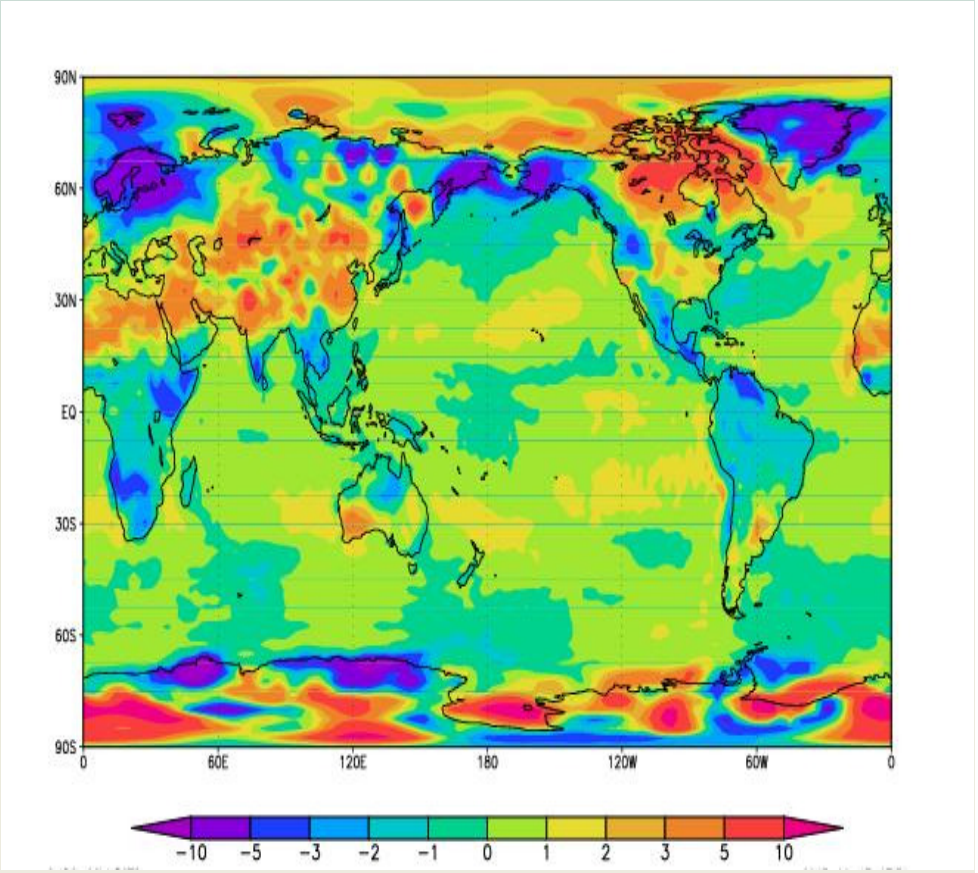
Difference in abs error of T2м_min ((INM soil model) – (ISBA)).
SLAV (version 0.56°x(28-60km)x51 levs). Average over Apr. 2013. Second day



Голубой и синий цвета соответствуют областям уменьшения ошибки прогноза

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





Further plans

- Trying ACRANEB2
- Activating 3 MT in high-res version
- Study MJO behaviour
- After some modifications, try AMIP and CMIP experiments

Thank you for attention!

More description of activities and publications

(sorry, Russian only) –

http://nwplab.inm.ras.ru