Update on INM RAS and HMCR long range prediction system

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# SL-AV global atmosphere model

SL-AV: Semi-Lagrangian, based on Absolute Vorticity equation

- Finite-difference semi-implicit semi-Lagrangian dynamical core (Tolstykh et al, GMD 2017).

- Many parameterizations algorithms for subgrid-scale processes developed by ALADIN/ALARO consortium.

- Shortwave and longwave radiation: CLIRAD SW + RRTMG LW.

- INM RAS- SRCC MSU multilayer soil model (Volodin, Lykossov, Izv. RAN 1998).

- Hindcast initial data are prepared using SEKF for multilayer soil initialization and ERA5 for atmosphere data

- Current forecasts use SEKF for soil initialization

- Resolution 0.9x0.72° lon-lat, 96 levels (top at 0.04 hPa)

- 41 members for forecasts, 11 members for hindcasts
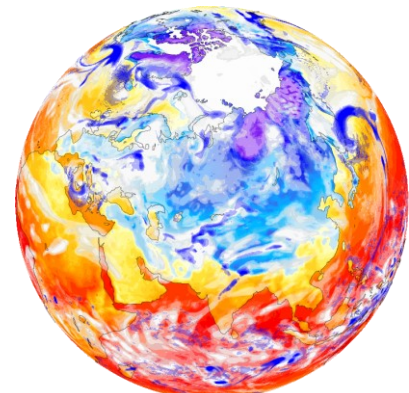
Changes of RMSE and ACC in SL-AV new version for current 1-month forecasts: forecast with zero (blue) and 2-weeks lead time (red). CIS region (20-180E, 40-70N), 18 cases
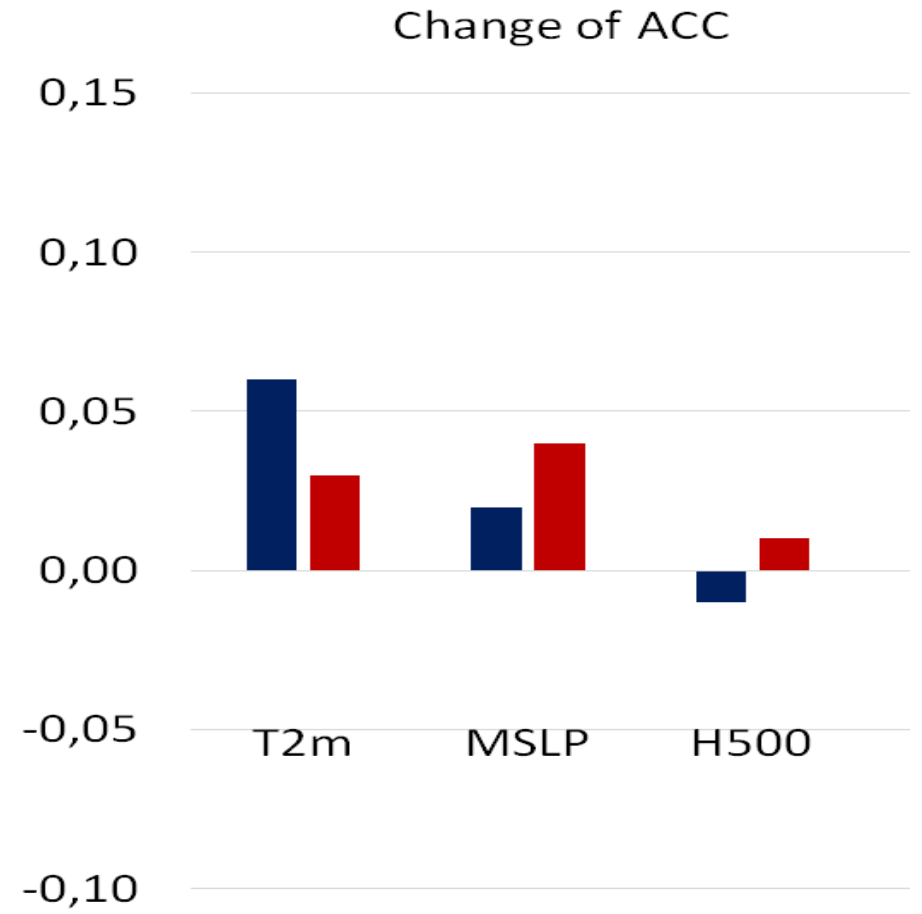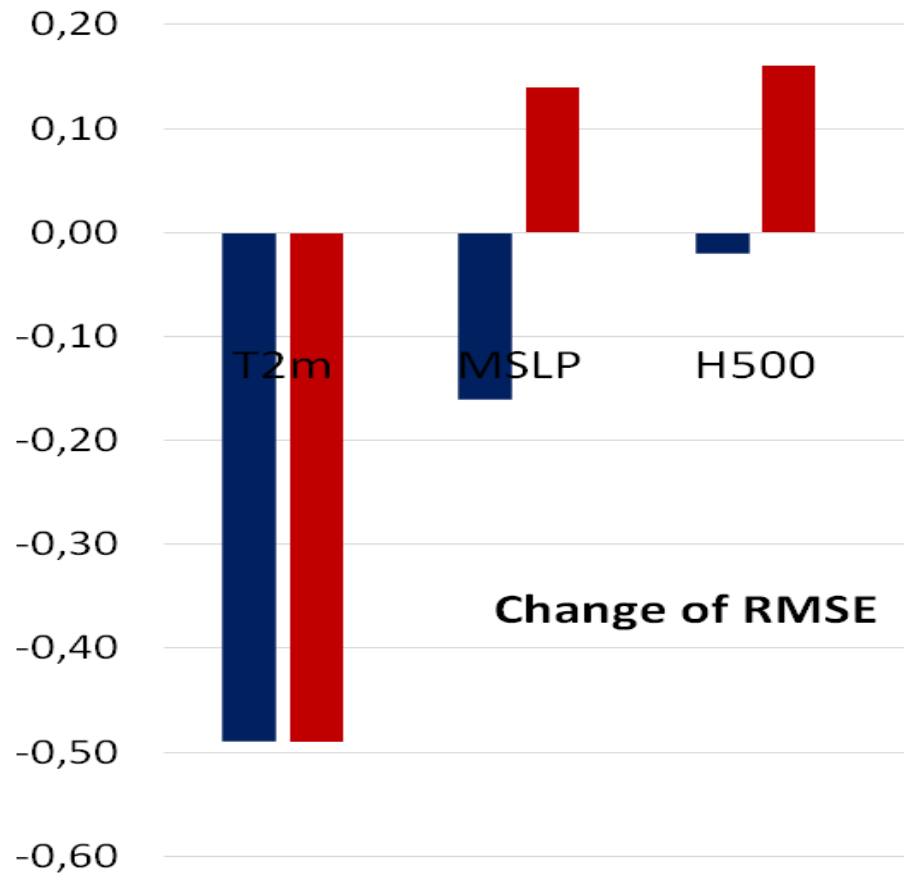
Recent works and studies

- Retuning (better stratosphere and QBO picture)
- MJO diagnostics: SL-AV is capable to predict MJO for ~3 weeks
- Coupling with NEMO ocean model successful, climate reasonable
- Study of forecasting Northern midlatitudes summer heatwaves

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- Seasonal operational forecasts with INM RAS coupled model – under evaluation
- Model uncertainties revision: only 3 parameters are perturbed now
 (SPP) instead of 15 in long-range forecasts version

Mechanism of soil impact on heatwave generation
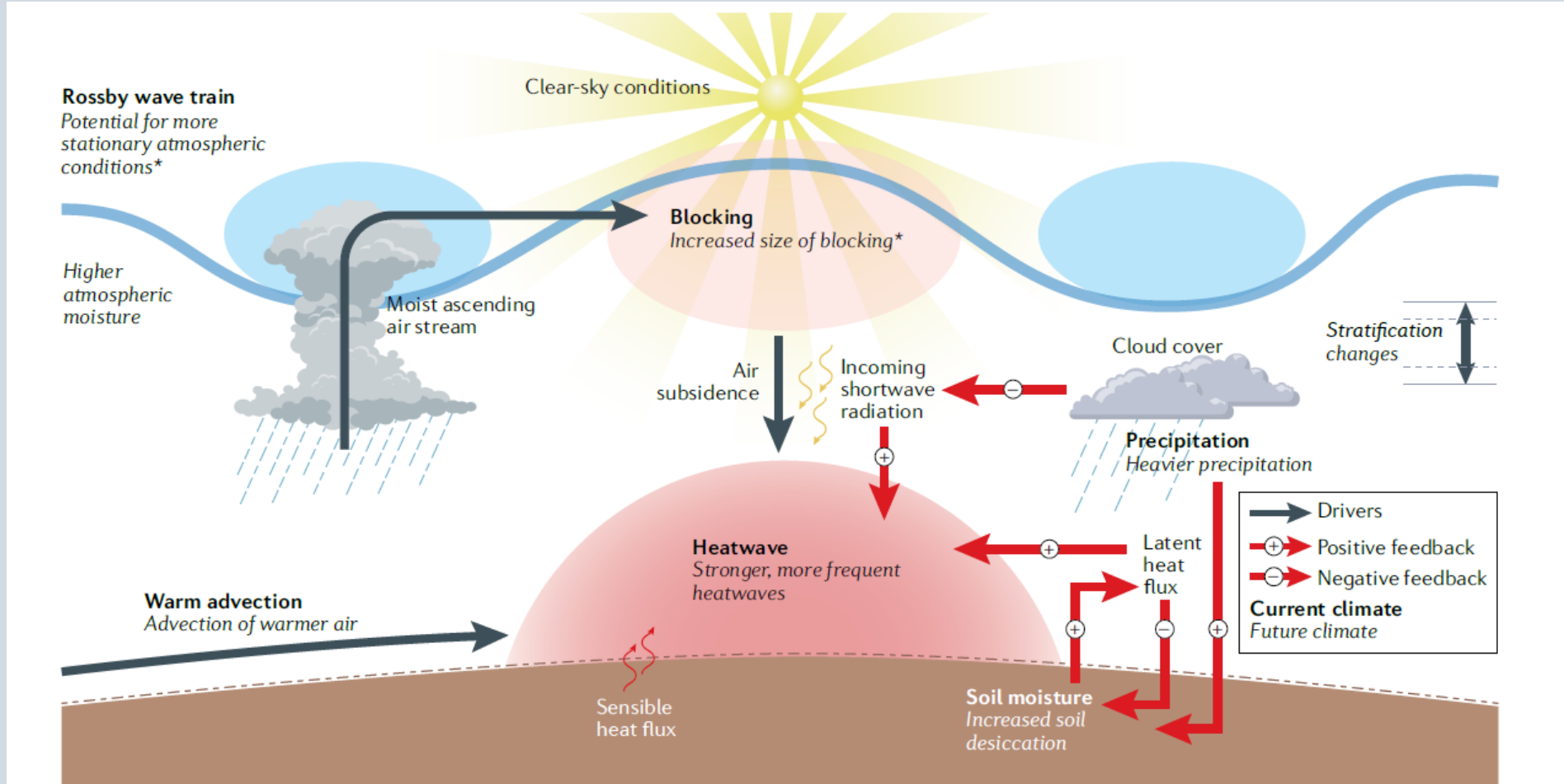## *(Domeisen et al., Nature 2023)*

Fig. 2 | Schematic representation of processes contributing to mid-latitude summer heatwaves. Black arrows represent driving mechanisms and red arrows feedbacks, wherein + indicates a positive feedback and − a negative feedback. Boldface text indicates processes in current climate and italic text projected changes under anthropogenic warming. Asterisks indicate projected changes with high uncertainty. Not all of the depicted processes have to be present for a heatwave to occur. Many of the depicted processes will change under climate change, leading to an amplification of heatwaves, although the dynamical atmospheric processes have the least certainty.

Experiments setup

- 10-member ensemble 4-month forecasts initialized 30 Apr 1991-2015 with SL-AV atmosphere model using persistent SST anomalies:

   - with ECOCLIMAP data for sand and clay percentage

   - with GSDE data for sand and clay

- Processing different ensemble size (from 4 to 12)

Impact of soil composition on long-range heatwave forecast

ECOCLIMAP

GSDE

ERA-5
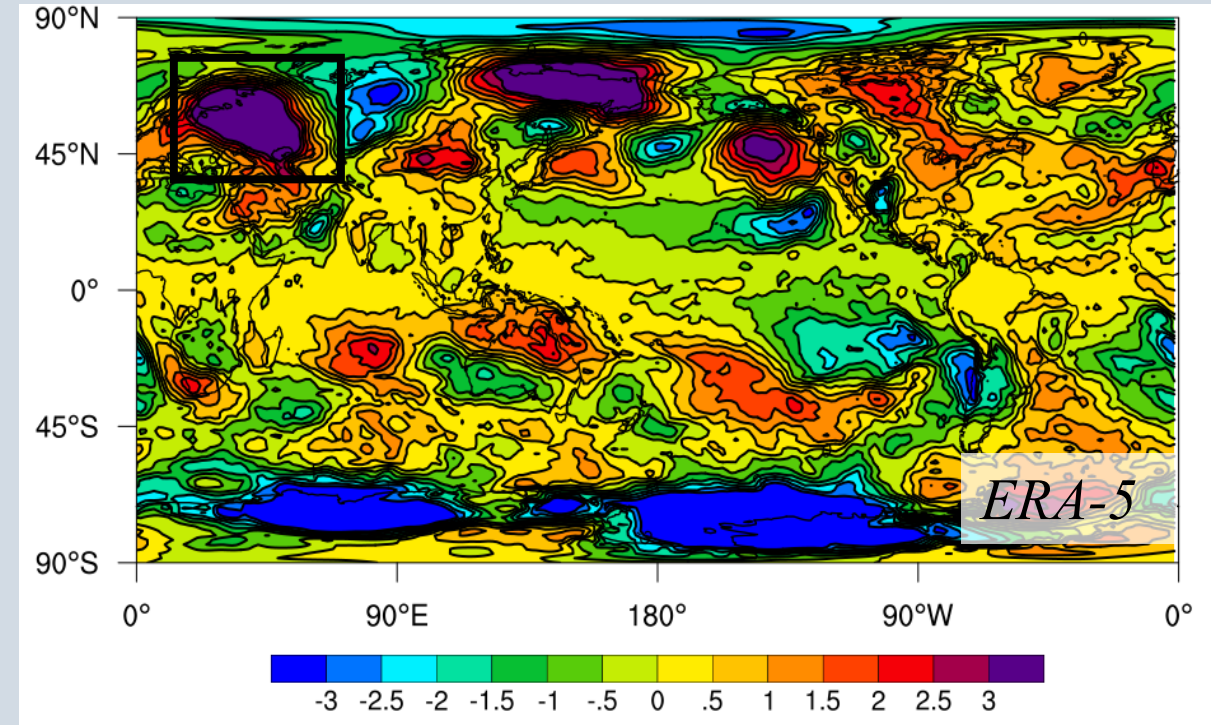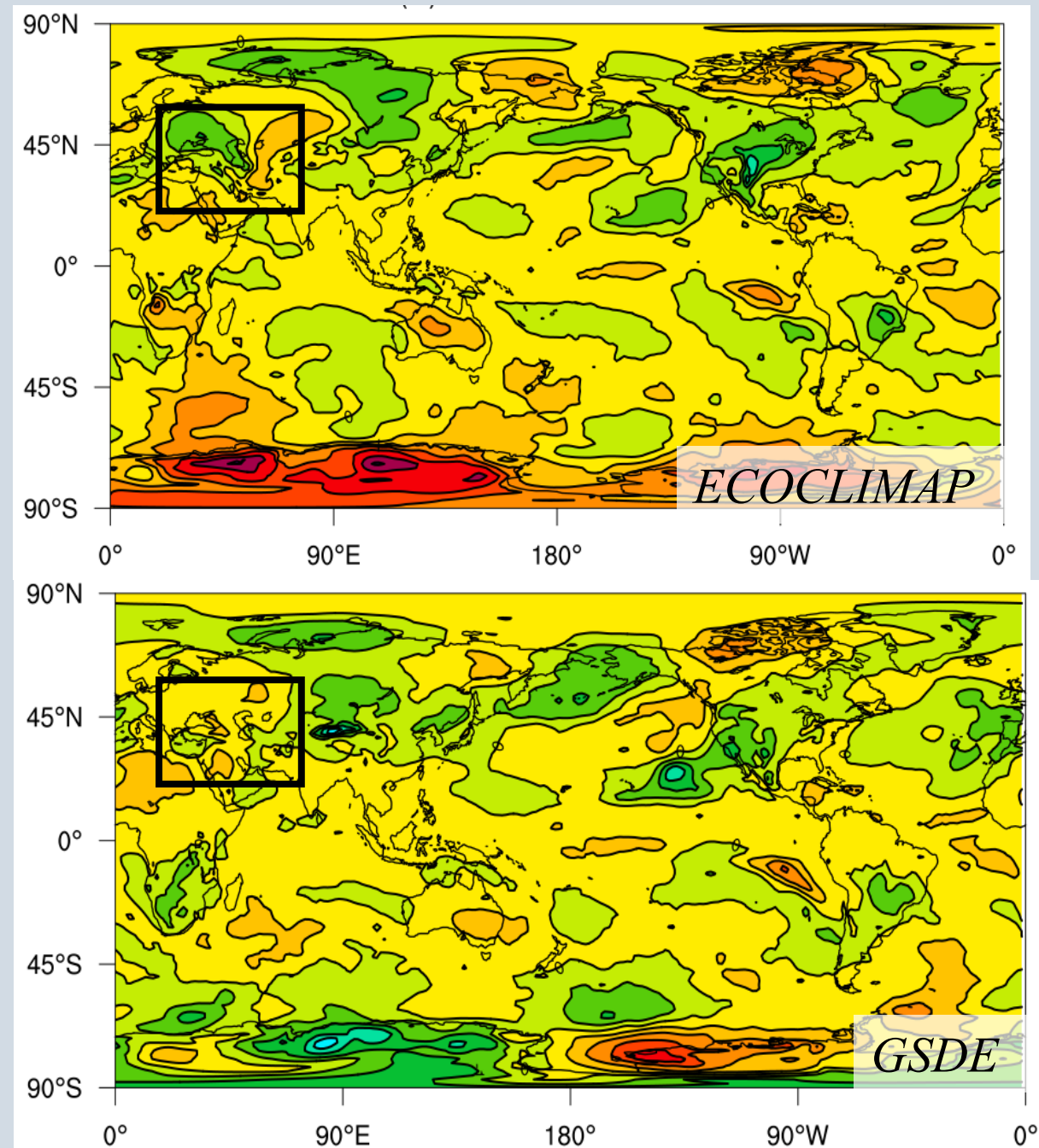
Monthly mean T850 anomalies of 10-member ensemble forecast for July 2010 initialized 30Apr2010 (all figures use the same scale)

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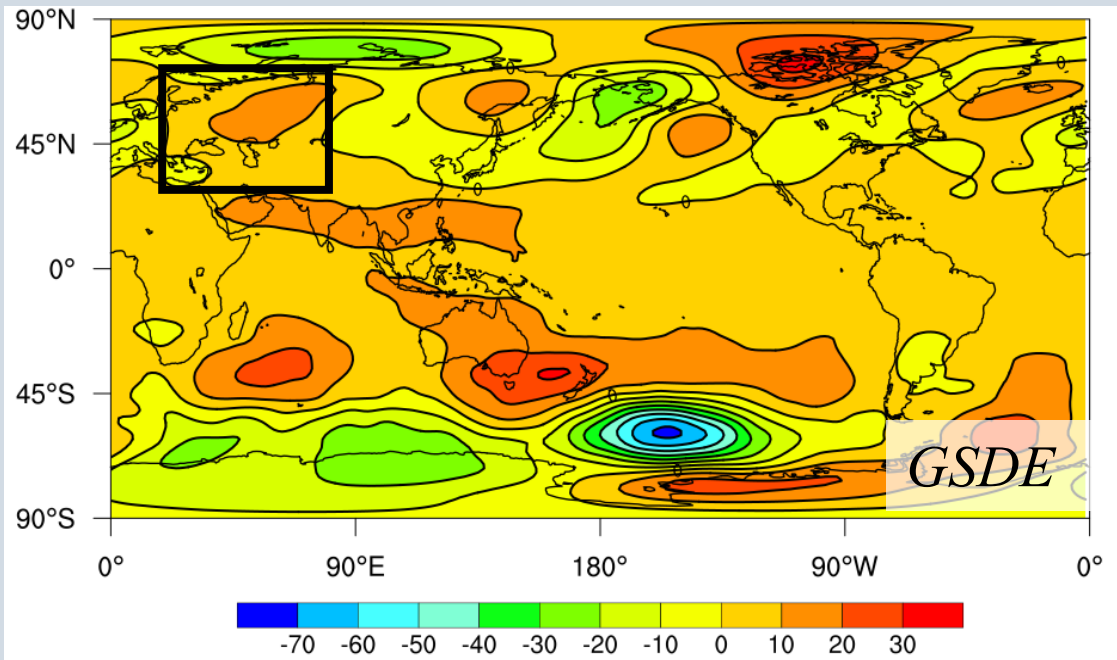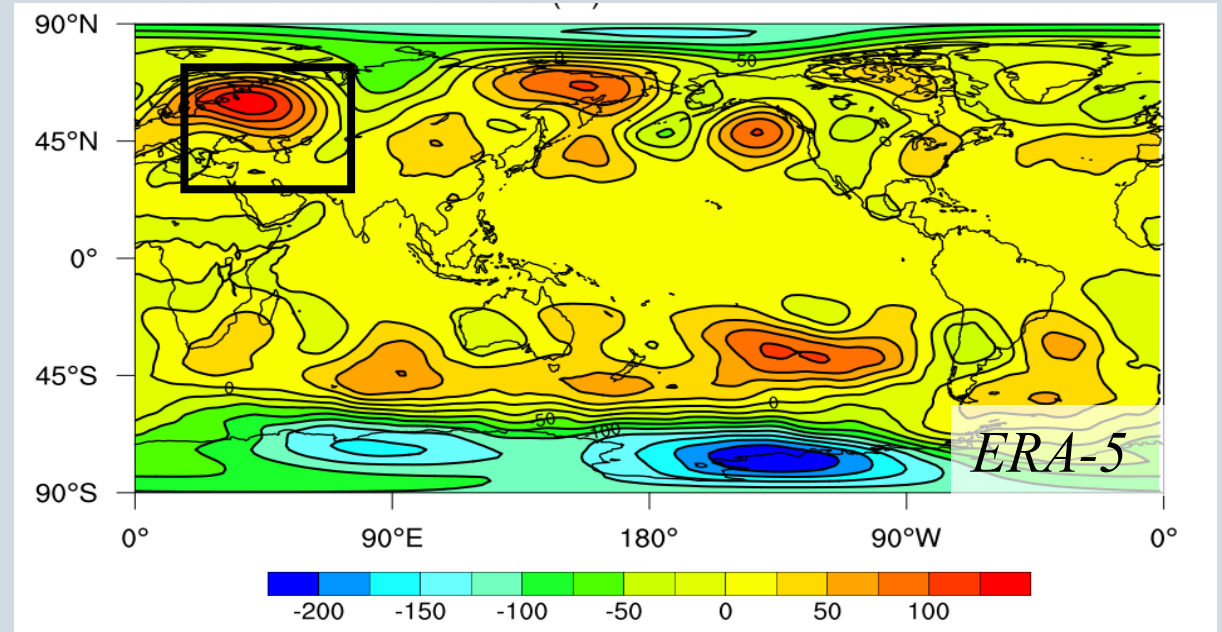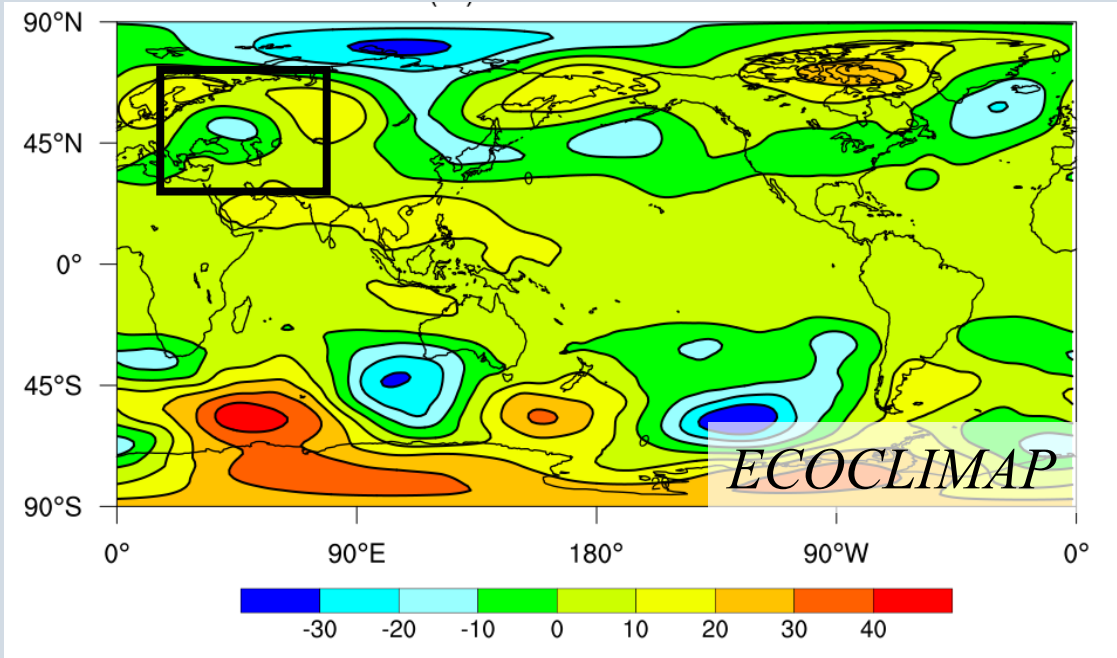
Monthly mean H500 anomalies of 10-member ensemble forecast for July 2010 initialized 30Apr2010

More results

- Results are robust: the amplitude depends on ensemble size, but the sign of response remains the same.

- Similar results for heatwaves in European part of Russia 1998 and in Europe 2003.

- Response in T2m, unlike T850, is noisy

Ongoing works

- Improvement of multilayer soil, implementation of lakes in SL-AV model

- Interactive aerosols in SL-AV

- Further examination of teleconnections in SL-AV

- Operational technology for initialization of SL-AV – NEMO coupled model

Plans

- Multimodel seasonal ensemble of SL-AV coupled with NEMO and INM RAS climate model

Thank you for attention!