

New version of the long-range forecast system at the Hydrometcentre of Russia

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1. Description of the system

We are developing a new system for operational long-range forecasts. While the old system was based on the atmosphere-only model, the new system consists of the SL-AV atmospheric model [1], INMIO ocean model [2] and CICE sea-ice model [3]. Some details on this coupled model, including a brief description of the coupler and implementation, are given in [4].

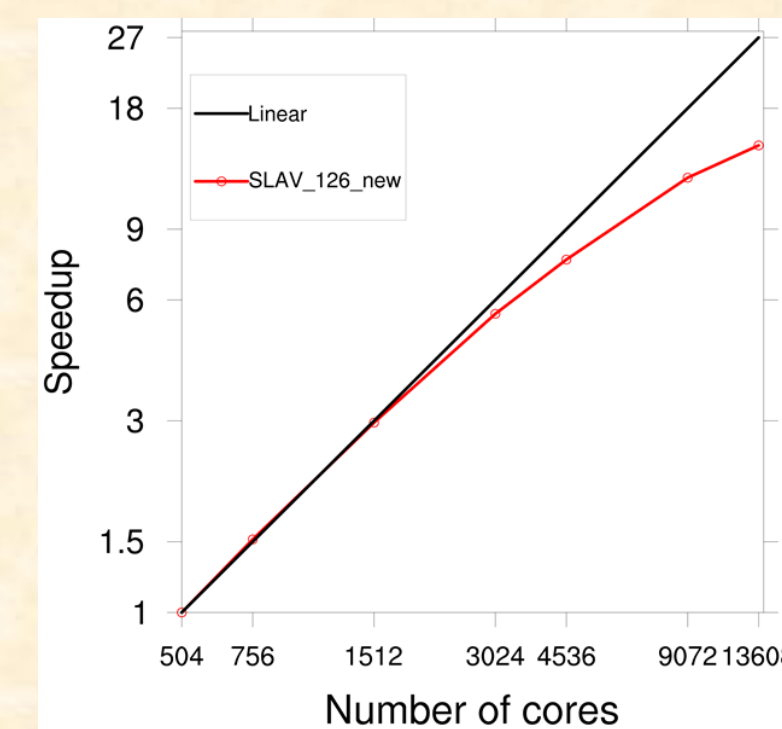
The resolution of the atmosphere model has increased from 1.4x1.1 degrees lon-lat and 28 levels to 0.9x0.72 degrees, 100 levels with the uppermost level at 0.3 hPa. The parameterizations of subgrid-scale processes in the atmosphere model (shortwave- and longwave radiation, planetary boundary layer, cloudiness, shallow convection) have been substantially upgraded [1]. The ocean model has the resolution of 0.25 degrees and 49 horizons.

Each component of the surface heat balance in the coupled model is tuned according to IPCC recommended values. Both mean annual integral values and geographical distribution are in a good agreement with reanalysis data.

2. Global atmospheric semi-Lagrangian model SL-AV

- SL-AV: Semi-Lagrangian, based on Absolute Vorticity equation
- Finite-difference semi-implicit semi-Lagrangian original dynamical core. Vorticity-divergence formulation, unstaggered grid (Z grid), 4th order finite differences. Possibility to use variable resolution in latitude. Possibility to use reduced lat-lon grid in dynamical core [5].
- Many parameterizations algorithms for subgrid-scale processes developed by ALADIN/ALARO consortium [6].
- Parameterizations for shortwave and longwave radiation: CLIRAD SW + RRTMG LW.
- (Hines 1997) parameterization [7] for non-orographic gravity waves.
- INM RAS- SRCC MSU multilayer soil model [8].
- Marine stratocumulus parameterization
- Parallel performance:

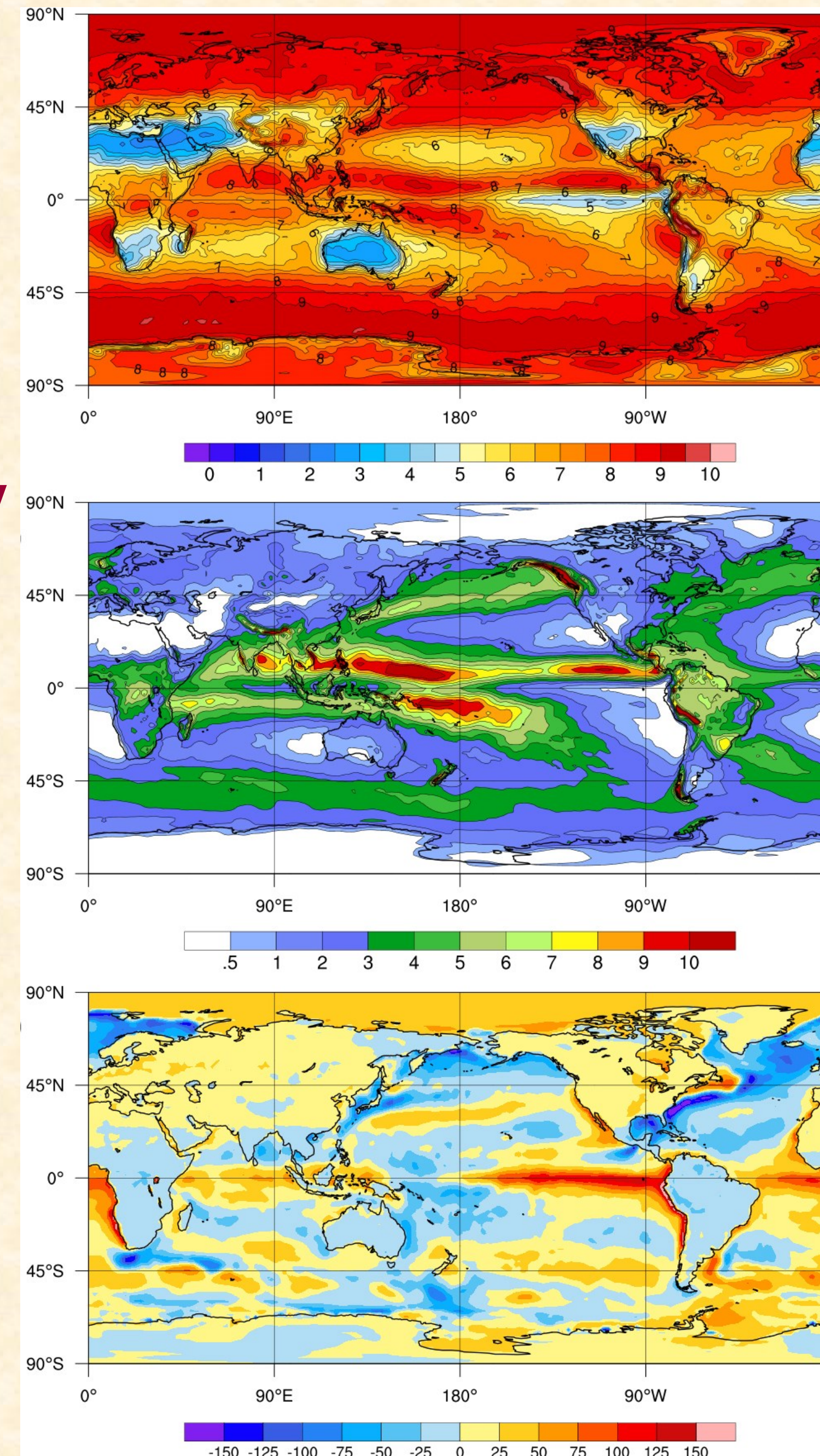
8 simulated years per day for 0.72°x0.9° lat-lon horizontal resolution, 100 levels with 480 cores at Cray XC40



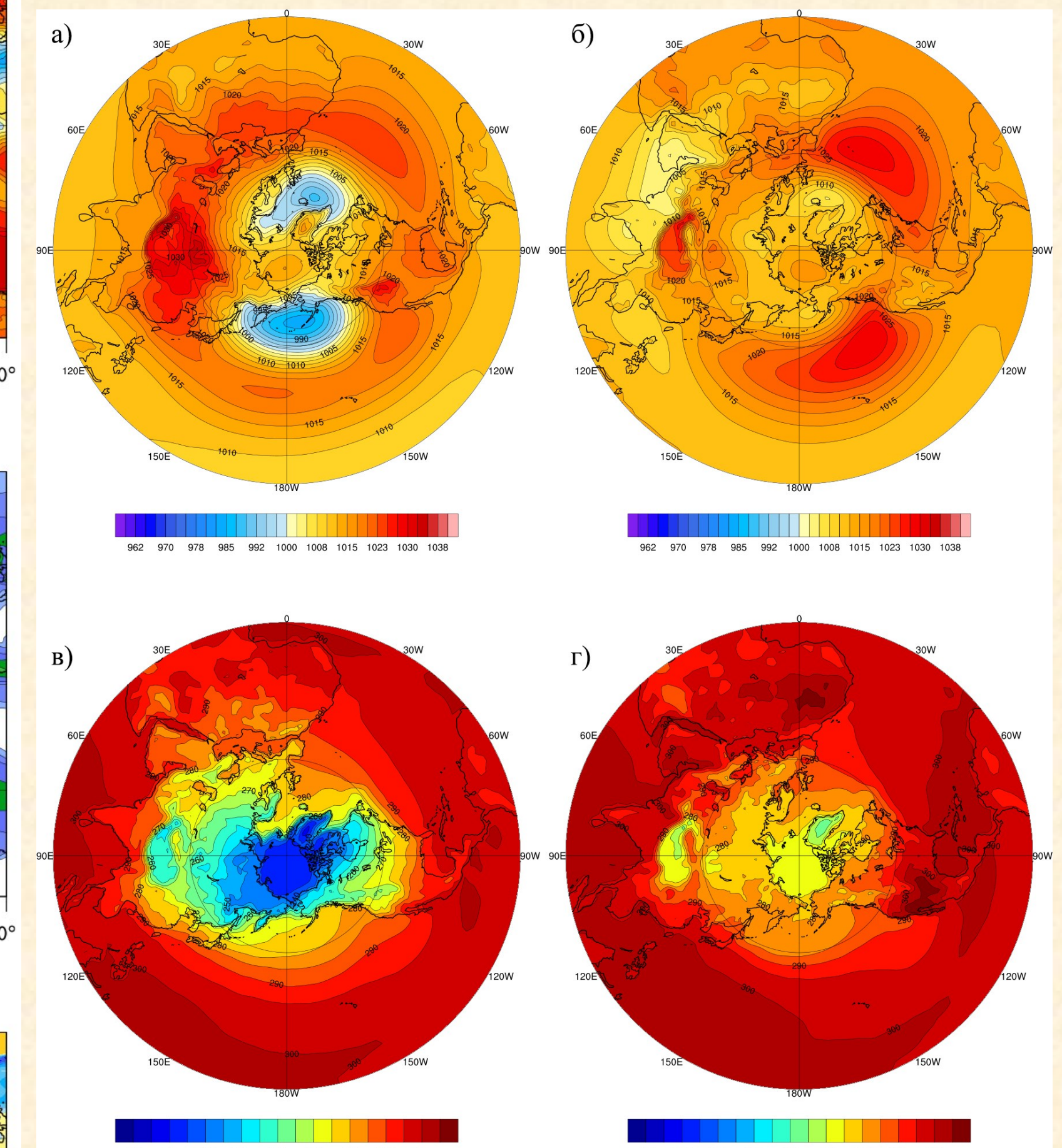
Strong scalability of the SL-AV code with ~ 13km horizontal resolution, 126 vertical levels (red curve); linear speedup (black curve).

3. Model climate

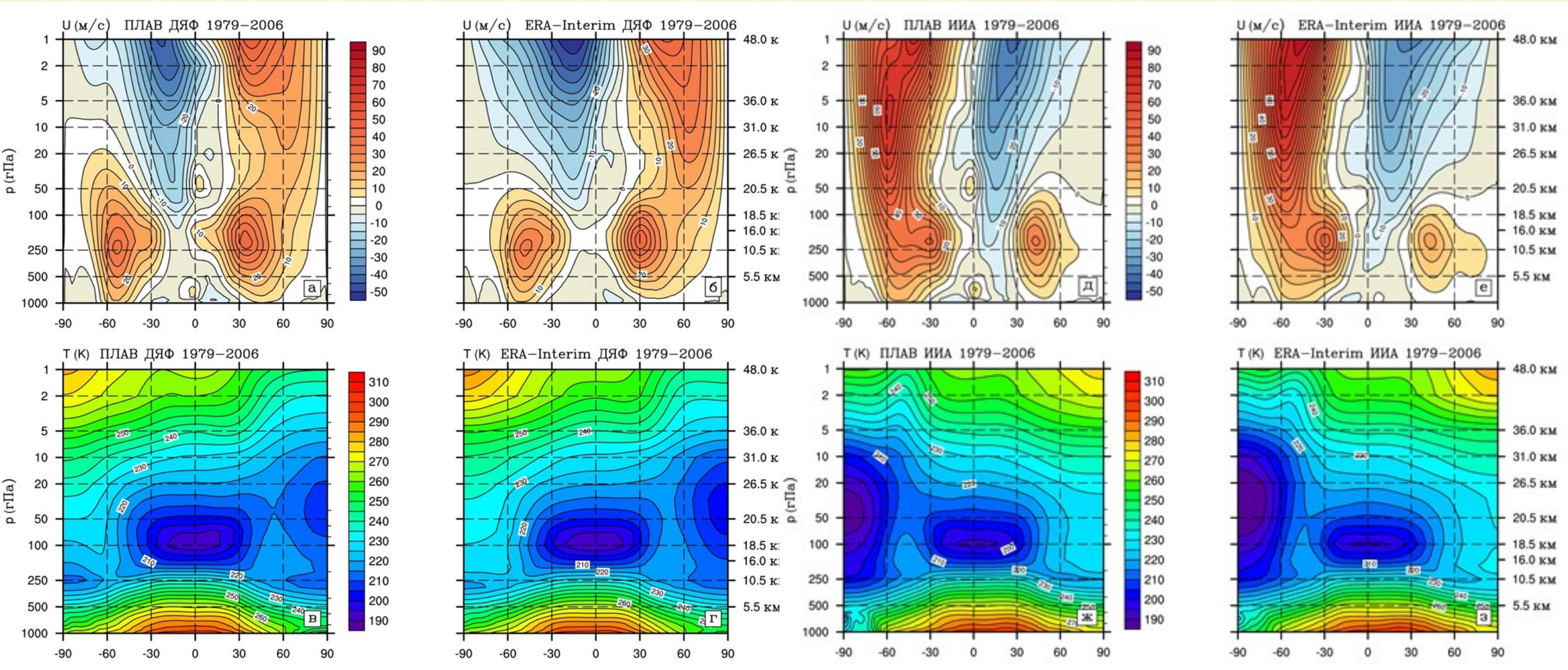
AMIP2 protocol, 1979-2006



Annual mean: total cloud cover (top), precipitation (middle), net surface heat flux (bottom)



Mean sea level pressure in the Northern hemisphere: DJF (top left), JJA (top right). 2m temperature in the Northern hemisphere: DJF (bottom left), JJA (bottom right)



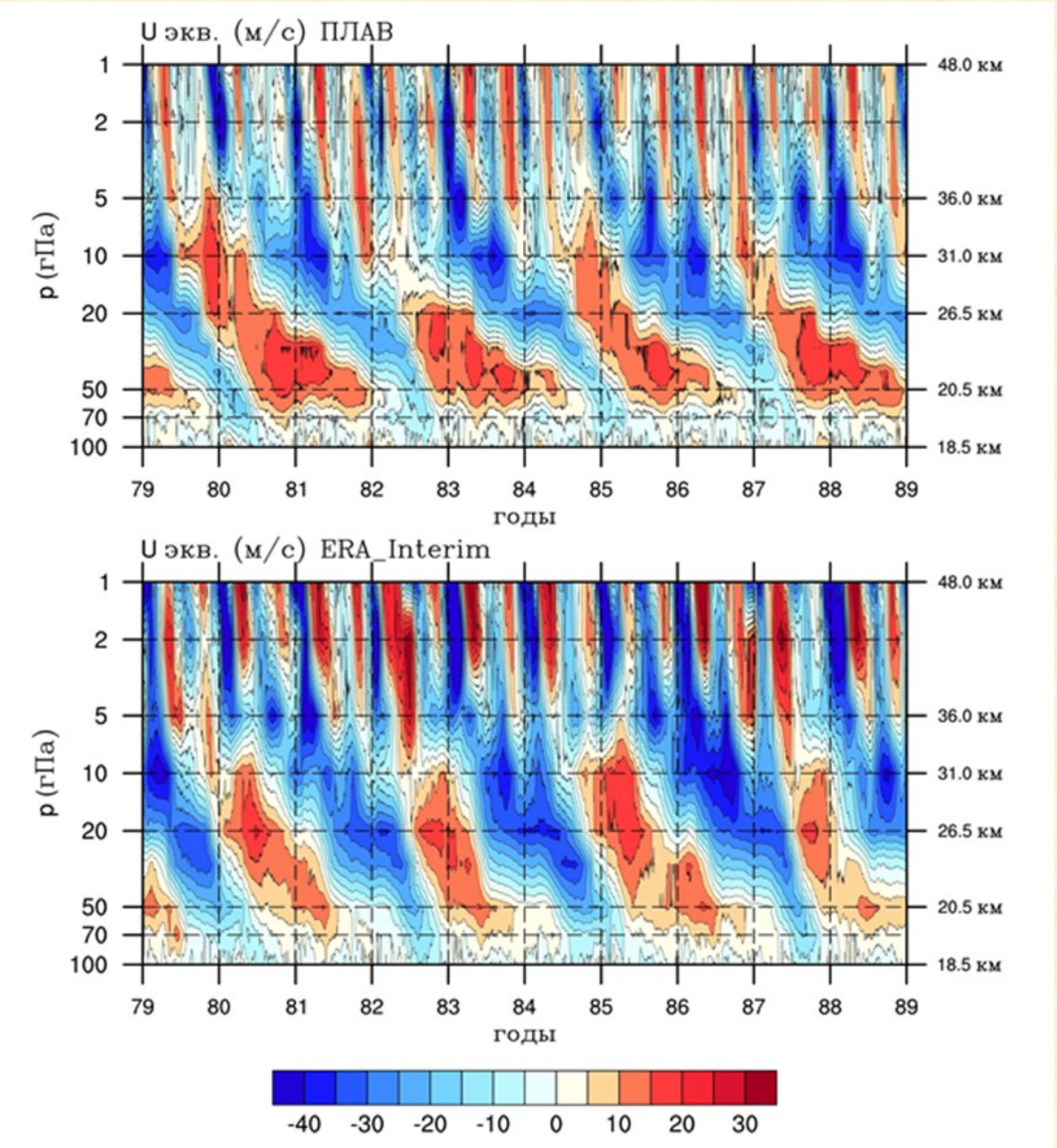
Zonal mean U and T (DJF, 1979-2006), SL-AV (left), ERA-Interim (right)

Zonal mean U and T (JJA, 1979-2006), SL-AV (left), ERA-Interim (right)

4. Annual mean integrals of heat flux components

	Component	SL-AV, Wm ⁻²	IPCC recommended data, Wm ⁻²	
			Value	Range
At the top	Incoming solar radiation	341.6	341.3	340:341
	Outgoing solar radiation	97.6	100	96:100
	Outgoing longwave radiation	-243.1	-239	-(236:242)
At the surface	Downwards solar radiation	161.2	161	154:166
	Net thermal radiation	-54.6	-56	-(54:58)
	Sensible heat flux	-14.7	-20	-(15:25)
	Latent heat flux	-91.1	-84	-(70:85)
	Net heat flux	0.8	1	-

5. Reproduction of stratospheric oscillations



7. Conclusion

The new model for long-range forecasts reproduces main characteristics of modern climate, including stratosphere oscillations.

Further work: Fine tuning at seasonal time scale. Running large ensembles (up to 80 members). Running coupled model.

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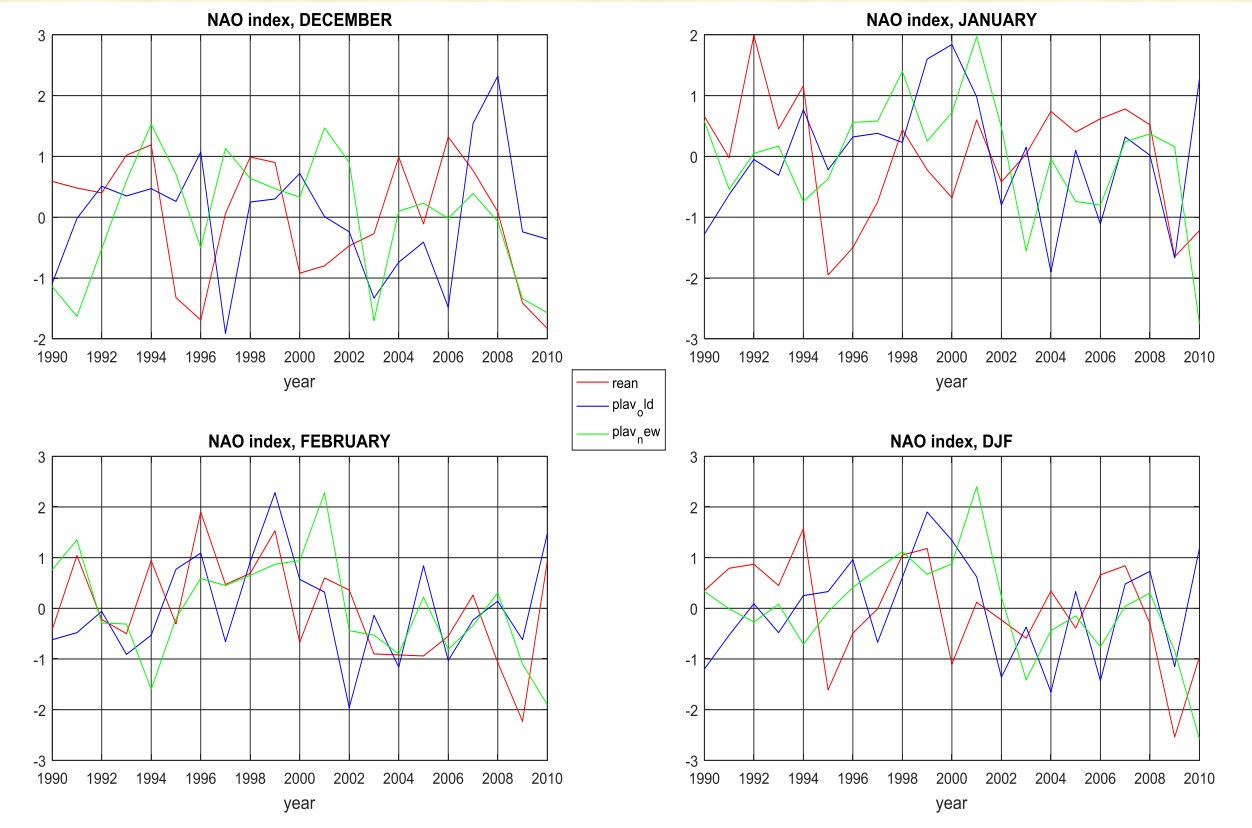
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6. Very first results for winter NAO forecast



Start from 1st of November, 1990-2010. ERA-Interim (red), old model (blue), new model (green). Just 10-member ensemble so far!