# Hydrometcenter of Russia update

Tolstykh M.A.
Marchuk Institute of Numerical Mathematics RAS,
Hydrometcenter of Russia

# SL-AV global atmosphere model


SL-AV: **S**emi-**L**agrangian, based on **A**bsolute **V**orticity equation

- **Finite-difference semi-implicit semi-Lagrangian** dynamical core of own development. Vorticity-divergence formulation, unstaggered grid (Z grid), 4$^{th}$ order finite differences, variable resolution in latitude, possibility to use **reduced lat-lon grid** (Tolstykh et.al., Geosci.Mod.Dev., 2017).
- Many parameterisation algorithms from ALADIN/ALARO (except for radiation and land surface)
- The model can run at 9072 cores with 63 % efficiency (at 13608 cores with 52 % efficiency).

# Old and new long-range prediction system at Hydrometcentre of Russia

**SL-AV 2008**

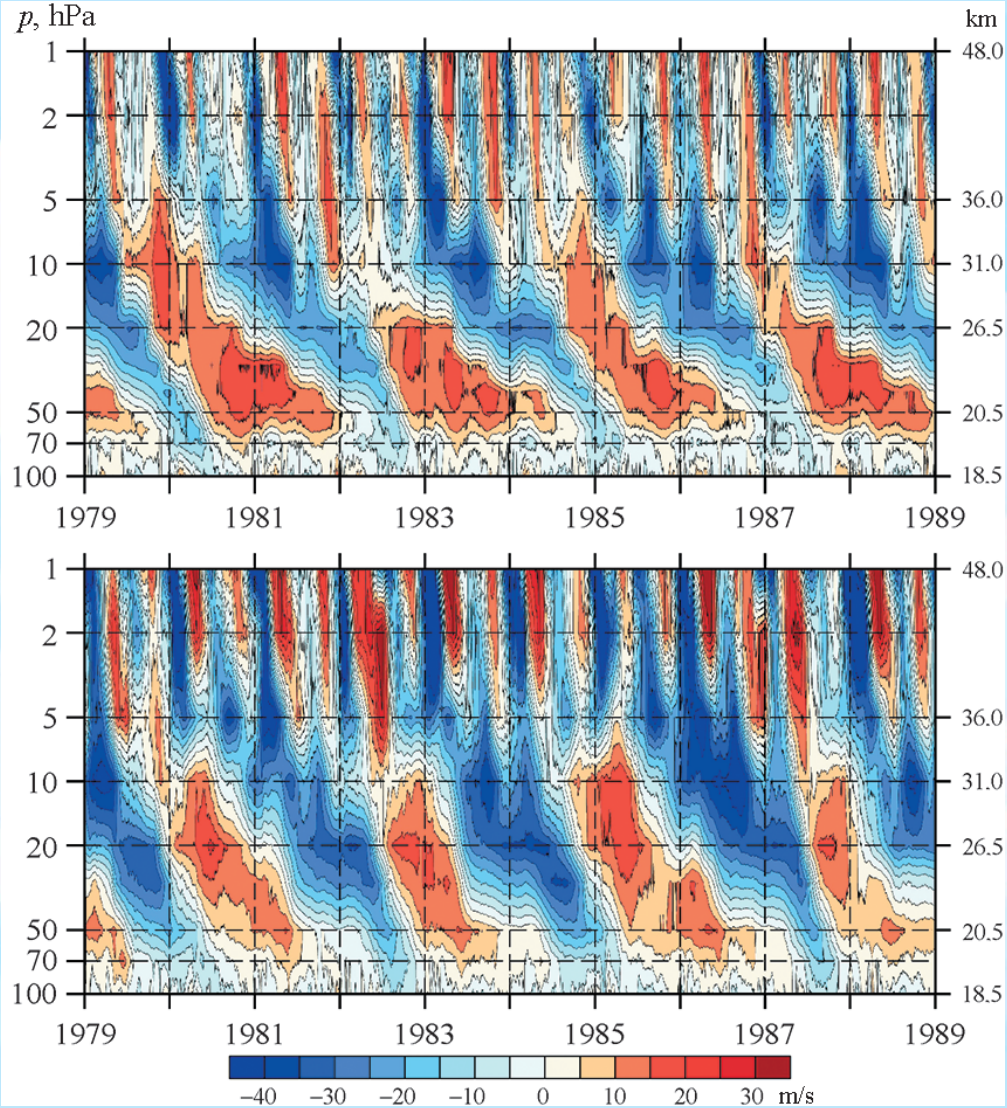
- Resolution 1,4x1,125° lon-lat, 28 levels
- Uppermost level at 5 hPa
- 1.5-3 km resolution in the stratosphere
- SW and LW radiation: Ritter, Geleyn 1992 (1+1 band)
- Boundary layer – improved version of Geleyn 1982
- ISBA surface scheme
- 4 months forecast in 40 min at 8 cores of Cray XC40

**SL-AV 2015**

- Resolution 0,9x0,72° lon-lat, 96 levels
- Uppermost level at 0,04 hPa
- 500-700 m resolution in the stratosphere
- SW radiation: CLIRAD SW, LW radiation: RRTMG LW (11 + 16 spectral bands)
- Boundary layer: Bastak-Duran et al JAS 2014
- Marime stratoculumus, sea-ice T
- INM RAS mulilayer soil scheme
- 4 months forecast in 40 min at 480 cores of Cray XC40

# Quasi-biennial oscillation in SLAV

## (V.Shashkin et al Russ Met. And Hydr. 2019)




**SL-AV – top,**
**ERA I - bottom**

# NAO index ACC comparison for old and new SL-AV model (1991-2010)

| | November | December | January | February | DJF |
|---|---|---|---|---|---|
| **Lead time** | 0 month | 1 month | 2 months | 3 months | 1 month |
| **SL-AV old** | 0.46 | -0.08 | 0.14 | 0.29 | 0.17 |
| **SL-AV new** | 0.78 | -0.09 | 0.29 | 0.34 | 0.29 |

# More results on model climate

- Fadeev R., Tolstykh M., Volodin E. **Climate Version of the SL-AV Global Atmospheric Model: Development and Preliminary Results.**

Russian Meteorology and Hydrology 2019 Vol.44 No 1 (available from SpringerLink)

# Some technology features

Old version:

- initial data uncertainty - breeding
- Model uncertainty – perturbation of parameterisation parameters (2 so far)

New version:

- Initial data uncertainty – LETKF centered to operational objective analysis
- Model uncertainty – as currently (but 4-6 parameters) + equivalent of SKEB

# Coupled model components

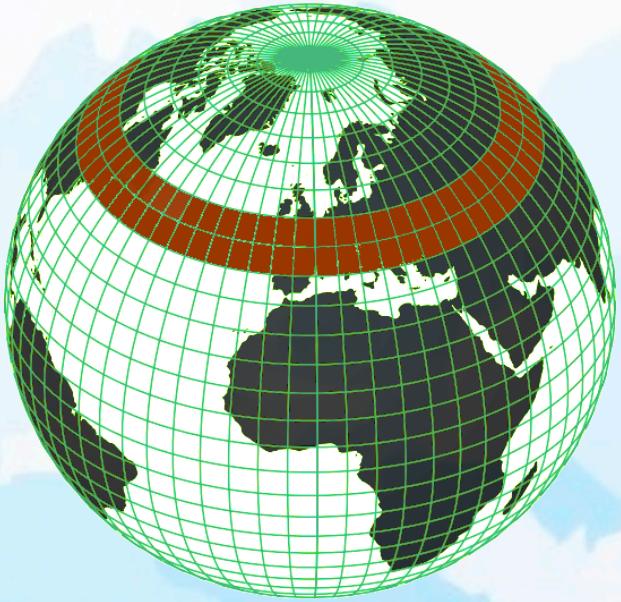
## **SLAV** atmosphere model

0.9°x0.72° (400x250), **85** levels.

Δt = 1440 s.

Lat-Lon, 1D MPI decomposition.

* includes multilayer soil model.

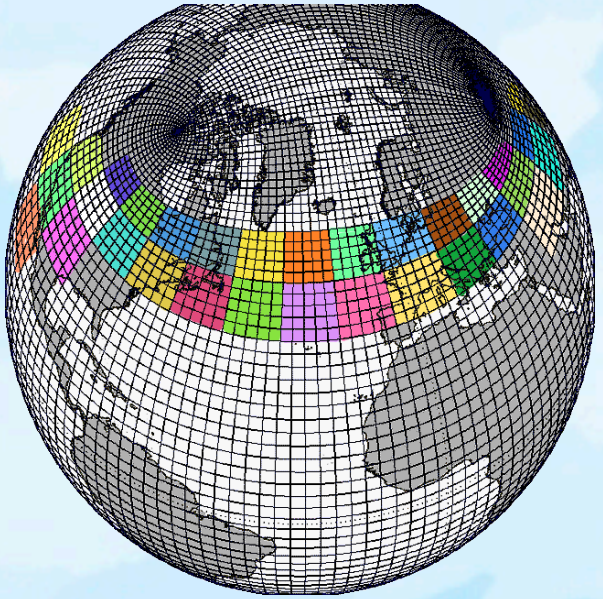


## **INMIO** World ocean model

0.5°x0.5° (720x360), 49 levels.

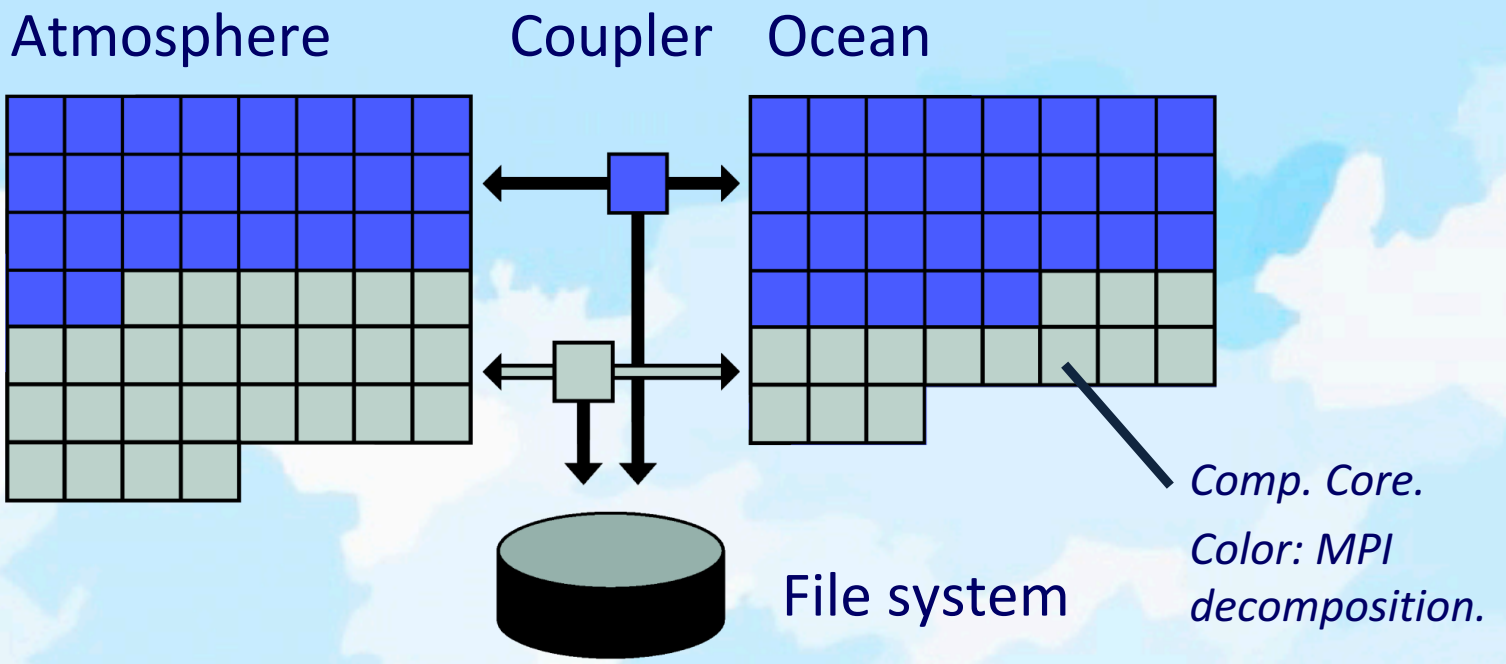
Δt = 600 s.

Tri-polar grid, 2D MPI decomposition.



*Tolstykh et al, GMD, 2017;*
*Ibrayev et al, Izv AOP, 2012;*
*Fadeev et al, RJNAMM, 2016.*

# Coupled model structure




**Coupler:** synchronize the components, transfer (with interpolation) data between them, works with file system.

**Data flow:** 9 fields from atm to ocean every 2 hour,

3 fields from ocean to atm every 4 hour.

**Efficiency:** 2 years/day on 258 cores (ATM 125, OCN 132, CPL 1).

# Conclusions

- New version of the SL-AV model reproduces main atmosphere characteristics
- A work is needed to improve stochastic mechanisms in the model to increase dispersion of model ensemble. So far, we use perturbations of model parameterizations parameters and plan to implement an equivalent of SKEB

- It is supposed to switch the operational subseasonal and seasonal forecasts to the new version once the technology is ready.

# Thank you for attention!