

# Update on HMCR long range prediction system

#### **Mikhail Tolstykh,** Hydrometcenter of Russia, Institute of Numerical Mathematics RAS





### SL-AV global atmosphere model

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



- Finite-difference semi-implicit semi-Lagrangian dynamical core (Tolstykh et al, GMD 2017). Vorticity-divergence formulation, unstaggered grid (Z grid), 4<sup>th</sup> order finite differences. Possibility to use variable resolution in latitude.
- Many parameterizations algorithms for subgrid-scale processes developed by ALADIN/ALARO consortium.
- Parameterizations for shortwave and longwave radiation: CLIRAD SW + RRTMG LW.
- INM RAS- SRCC MSU multilayer soil model

(Volodin, Lykossov, Izv. RAN 1998).



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

#### SL-AV 2008

- Resolution 1,4x1,125° lonlat, 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



- 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
- Marine stratocumulus, sea-ice T
- INM RAS multilayer soil scheme
- 4 months forecast in 88 min at 128 cores of Cray XC40 (1 member)

# Initial data

- Hindcast initial data are now prepared for 1991-2020 using SEKF for multilayer soil initialization and ERA5 for atmosphere data
- Current forecasts use SEKF for soil initialization

# Multilayer soil initialization – simplified extended Kalman filter (SEKF) using 2m observations



# Recent works and studies

- Model improvements
  - surface characteristics for partial snow cover
  - improvement in coupling between multilayer soil and atmosphere
  - -climate mode retuning
  - LETKF-based system for generating initial ensemble to replace breeding technology
- Multilayer soil model coupling and initialization
- Model uncertainties implementation of SPP and SPPT scheme (SPPT is not used for LRF)
- Use of ERA5, including new initial data for hindcasts (1991-2019)
- Experimental parallel seasonal forecasts have started
- Diagnactice of curface flux components after model

### Zonal mean winter U velocity



#### Mean DJF model error in 2020 and now









#### Mean JJA model error in 2020 (left) and now (right)





- ITCZ doubling is nearly removed!
- Near-surface wind in Pacific is now OK!

# Ongoing works

- Ozone with photochemistry
- New deep convection parameterization with memory (L.Gerard et al)
- Improvement of multilayer soil, implementation of lakes
- Diagnostics of teleconnections
- Experiments in coupled mode.

#### Plans

- SL-AV version with the resolution of 0,9x0,72° lon-lat, 96 levels so far without ocean – implementation after parallel runs
- INM RAS coupled model (CMIP) experimental seasonal forecasts

#### Thank you for attention!