Methodology of detailed regional atmospheric modelling on the multi-year timescales

Vladimir Platonov[1], Alexander Kislov[1], Gdaly Rivin[2], Mikhail Varentsov[1], Inna Rozinkina[2] and Mikhail Nikitin[2]

contact: vplatonov86@gmail.com

[1]Moscow State University, Faculty of Geography, Department of Meteorology and Climatology, Moscow, Russian Federation, [2]Hydrometeorological Center of Russia, Moscow, Russian Federation

The regional non-hydrostatic atmospheric model **COSMO-CLM** used for the long-term (***30 years, 1985 – 2014***) simulation with **13.2**, **6.6** and **2.2** km horizontal resolutions. The **main objective** of creation this dataset was the investigation of *statistical characteristics* and *physical mechanisms* of *extreme weather events* (primarily, **wind speed extremes**) on the small spatial and temporal scales.

Model, experiments, methods and dataset description

COSMO-CLM (ver. 5.0) is the climate version of the well-known non-hydrostatic regional mesoscale atmospheric model **COSMO** developed by DWD and CLM-Community (http://www.clm-community.eu/)

Downscaling technique.

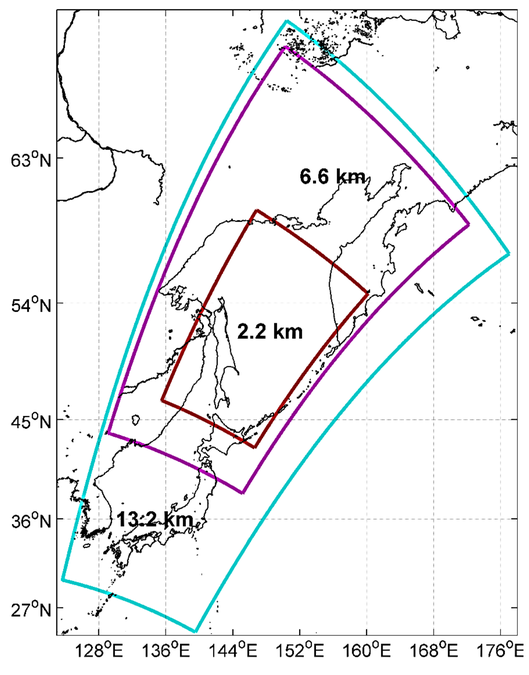
- Initial and boundary conditions for experiment over the **13,2 km domain** came from ERA-Interim reanalysis (every 6 hours) and from the global external parameters database (EXTPAR, provided by CLM-Community) for the **1985 – 2014 period**.
- Continuous runs has been executed for many months periods (up to 1 year)
- The **'spectral nudging'** technique was used in order to control the internal model behavior and allow to execute long-term experiments without significant deviation of the model fields from the actually observed.
- Output fields **from 13,2 km** domain are initial and boundary conditions for **6,6 km** domain during the whole 30-year period.
- The same technique was applied for **2,2 km domain**, but for the most extreme wind speed events only.
- **Resources and data volume**: SC "Tornado", Hydrometcenter of Russia, 35 Tflops, **288** CPU used, total computing time **~2400 hours**, total data volume **~6,5 Tb**.

Characteristics of experiments	13,2 km domain	6,6 km domain	2,2 km domain
Total points over domain	145*355 = **51475**	228*525 = **119700**	300*500 = **150000**
Horizontal resolution, degrees (~km)	0.12^0 (~13,2 km)	0.06^0 (~6,6 km)	0.02^0 (~2,2 km)
Time step (seconds)	120	40	20
Number of model levels in atmosphere	40	40	50
Number of model soil layers	9	9	9
Initial and boundary conditions	ERA-Interim (~0.75^0)	COSMO-CLM 13,2 km	COSMO-CLM 6,6 km

COSMO-CLM model configuration

- Runge-Kutta integration scheme with 5th advection order
- Height based hybrid Gal-Chen coordinate
- Prognostic TKE-based scheme for turbulence, 2.5 order closure
- **Spectral nudging** technique included
- Ritter-Geleyn radiation scheme
- Tiedtke schemes for deep and shallow convection
- Precipitation formation by a bulk microphysics parameterization
- Output every 1 hour for surface fields (see **List of main output variables)** ↙

Model domains for 13.2, 6.6, 2.2 km resolution

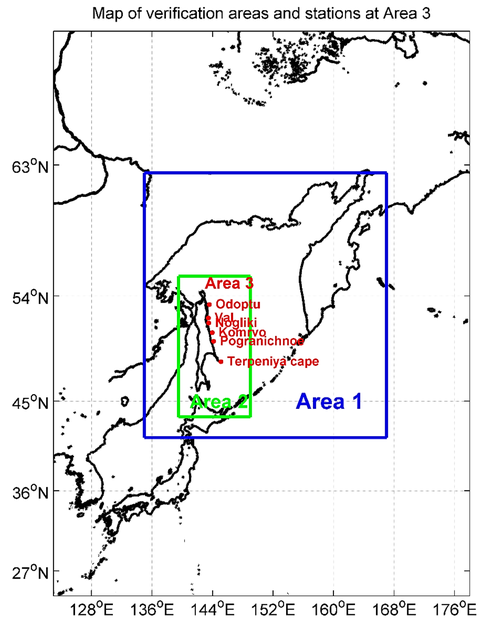


List of main output variables:

- ❑ Sea level pressure (hPa)
- ❑ Air temperature 2 and 10 m (^{0}C)
- ❑ Potential air temperature 2 and 10 m (^{0}C)
- ❑ Surface temperature (^{0}C)
- ❑ Specific humidity 2 and 10 m (g/kg)
- ❑ 10 m zonal and meridional wind (m/s)
- ❑ 10 m wind speed maxima during 1 hour (m/s)
- ❑ 10 m wind gust during 1 hour (m/s)
- ❑ Hourly snow and rain precipitation (kg/m^2, both)
- ❑ Radiation (direct and diffuse) shorter and longer than 700 nm (W/m^2, both)
- ❑ Downward shortwave radiation (W/m^2)
- ❑ Upward shortwave radiation (W/m^2)
- ❑ Downward and upward longwave radiation (W/m^2)
- ❑ Sensible and latent heat flux (W/m^2)

Verification: first results, for 2014

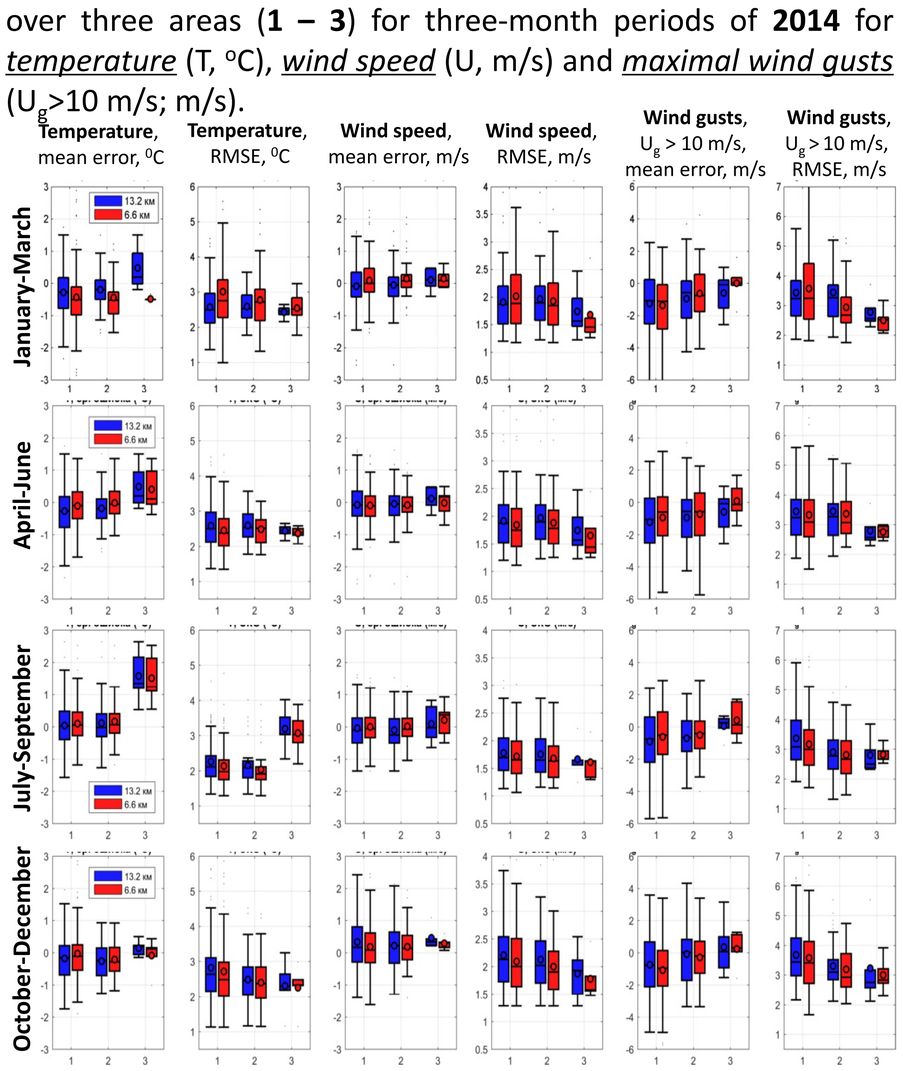
Map of verification areas and stations at Area 3



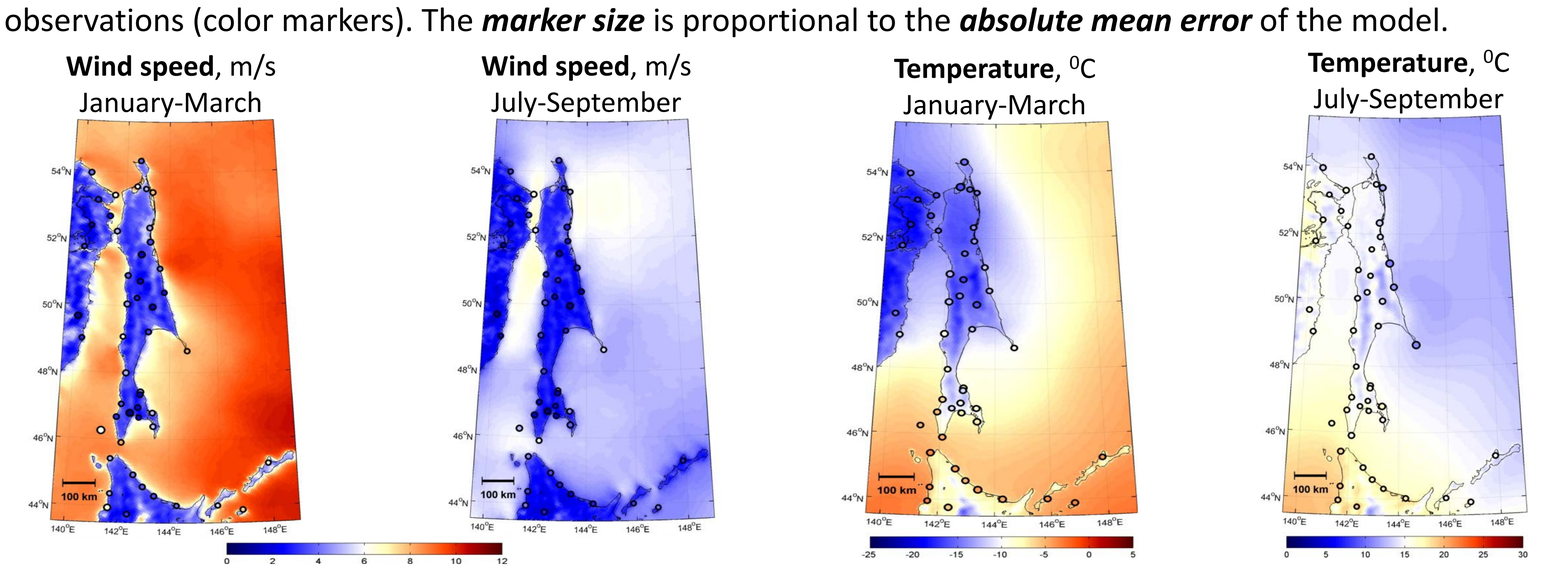
№ of area	Verification area	Number of meteorological stations inside domain
1	Okhotsk sea, adjacent water areas and coastal areas	124
2	Sakhalin island, strait of Tartary, southern part of Okhotsk sea	50
3	Northern part of the eastern Sakhalin coast	6

Verification of modelling results for three areas and two different model resolutions (~13.2 and ~6.6 km)

'Box-plots' for comparison of observations and modelling results over three areas (**1 – 3**) for three-month periods of **2014** for *temperature* (T, ^{o}C), *wind speed* (U, m/s) and *maximal wind gusts* (U_g>10 m/s; m/s).



Mean values of temperature (^{o}C) and wind speed (m/s) for three-month periods of **2014** by model (color) and observations (color markers). The ***marker size*** is proportional to the ***absolute mean error*** of the model.



Conclusion and perspectives

- **Verification** of created dataset indicated that the COSMO-CLM model has reproduced **many processes on different spatio-temporal scales adequately.**
- **Statistical assessments** for different horizontal resolutions revealed an certain **improvement** of model results on higher resolutions, especially on **~2,2 km.**
- Primary **synoptic analysis** has shown two main types of synoptic patterns leading to extreme winds over the region.
- **Next:** full and comprehensive analysis of the reproduction quality
- **Next:** statistical estimates of many fields, extreme values and climatological trends