New 2-Meter Relative Humidity Analysis for SL-AV model

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The global semi-lagrangian NWP model SL-AV [1] was developed in Hydrometeorological Research Center of Russia and Institute of Numerical Mathematics, Russian Academy of Sciences. The horizontal resolution of the model is 0.9° in longitude and 0.72° in latitude; currently there are 28 vertical levels. Subgrid scale parametrizations developed in Meteo-France for ARPEGE/IFS [2] model are used.

Recently, subgrid scale parametrization of the surface physical processes ISBA [3] has been implemented [4] in the model. The assimilation of soil variables was implemented according to [5]. This assimilation scheme uses 2 meter temperature (for brevity denoted as T2m) and relative humidity (RH2m) increments for yielding soil variables increments. It is straightforward that accurate and reasonable T2m and RH2m analysis is required.

Due to lack of accuracy in the existing analysis [6], new RH2m analysis was implemented for SL-AV model. The analysis uses SYNOP and SHIP observations. First guess of the analysis is SL-AV 6-hour forecast starting from the previous assimilation step.
The method used is the optimal interpolation, the algorithm is similar to those implemented in ECMWF [7] and HIRLAM [8]. The background covariance matrix depends not only on the distance between the points but also on the orography difference of the considering points.

Number of the observations that might be assimilated at each gridpoint is restricted to 50. Land / sea observations are used only for assimilation over land / sea.

It is known that analysis which does not take into account possible correlations between observations could increase analysis error in regions with high density of observations [9]. It is also known that optimal thinning could extract all necessary information from the observations. Averaging of the neighboring observations is a good alternative to thinning as it saves more information about observations. In the considered analysis in case of close observations (i.e. observations that are closer to each other than the prespecified distance set to 30 km) “superobservation” is generated which is simple average of these observations.

The implementation of analysis allows manipulation with the values of the e-folding distances that can be different for different latitude bands and as well for the land and the sea.

The experiments were carried out in order to determine the standard deviations of background and observation errors. As a result their values were set to 0.12 and 0.1 respectively.

Table 1 contains biases and root-mean square errors (RMS) of the implemented analysis (new) and previously used analysis (old) errors with respect to the observations averaged for November 2007. Obviously, new analysis significantly reduces biases and RMS errors of the RH2m analysis.

Table 1

	Bias (new)	Bias (old)	RMS (new)	RMS (old)
Central part of Russia	0,003	0,034	0,060	0,088
Europe	0,007	0,038	0,080	0,098
Asia	-0,001	-0,077	0,095	0,150
Russia	0,001	-0,047	0,082	0,128
Siberia	0,001	-0,054	0,079	0,123

RH2m analysis was also implemented for SL-AV model version with variable resolution grid [10]. The latitude spacing in this version is varying from 30 km over 48-90º N to 70 km in the southern hemisphere. Longitude spacing is 0.5625° ensuring horizontal resolution over Russia to be about 30 km. Table 2 contains biases and root-mean square errors of the first guess (FG) and implemented analyses for the variable resolution grid (var) and regular grid (reg) errors with respect to the observations. The statistics is averaged over November 2007. Previously used analysis is out of consideration because it was not adapted for the variable resolution grid.

Table 2

	Bias (FG)	Bias (var)	Bias (reg)	RMS (FG)	RMS (var)	RMS (reg)
Central part of Russia	-0,066	0,004	0,003	0,114	0,058	0,060
Europe	-0,048	0,005	0,007	0,130	0,077	0,080
Asia	0,019	0,002	-0,001	0,170	0,095	0,095
Russia	-0,007	0,002	0,001	0,146	0,081	0,082
Siberia	0,000	0,003	0,001	0,129	0,078	0,079

One can observe that the results of the analysis for the variable resolution grid are similar to those for the regular grid.

Introduction of the described RH2m analysis alone with recently developed T2m 2DVAR analysis and ISBA implementation [11] resulted in the improvement of the T2m and RH2m SL-AV model forecasts. The considered RH2m analysis for SL-AV model is used operationally since June 2007.

References

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