Effect of data assimilation in mesoscale model WRF

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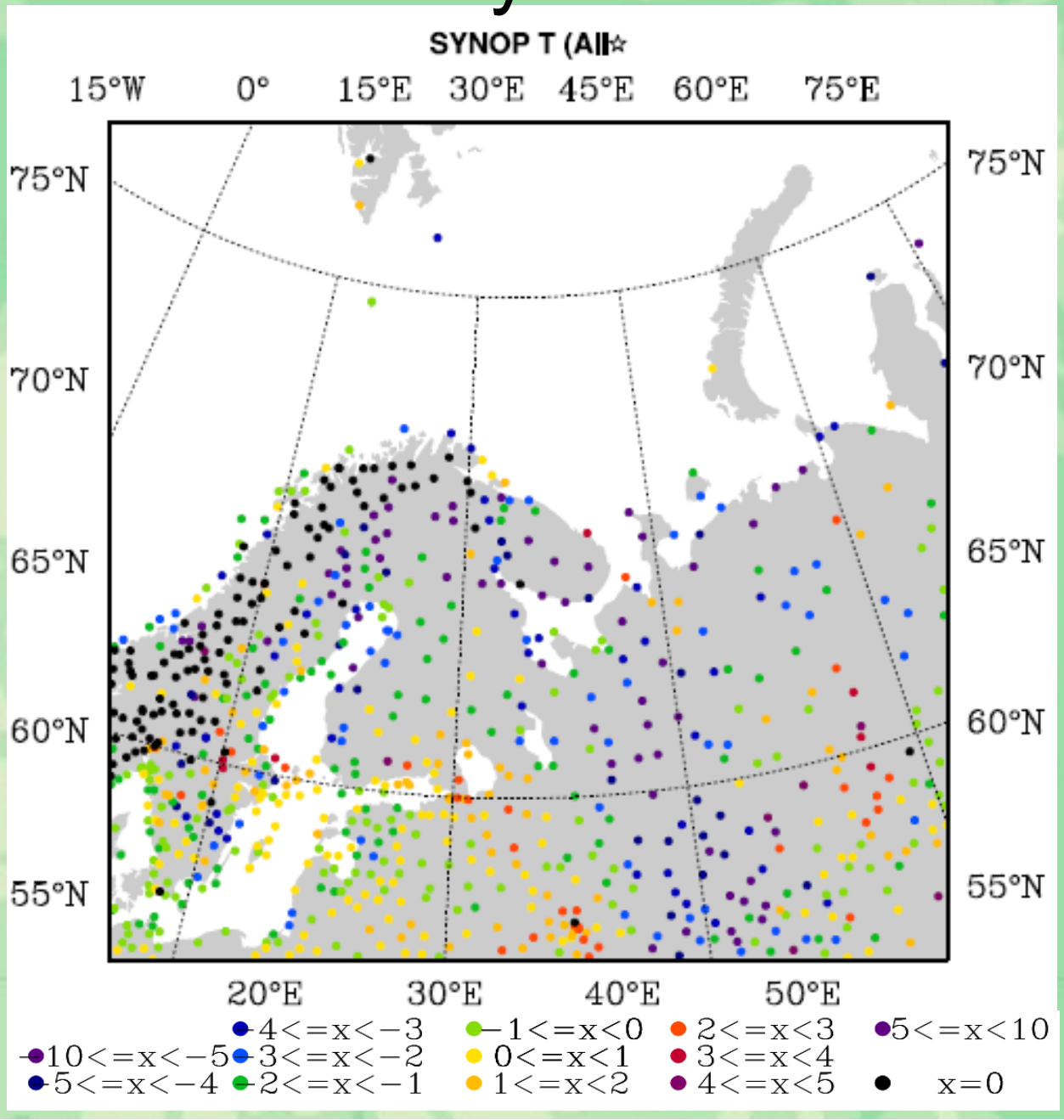
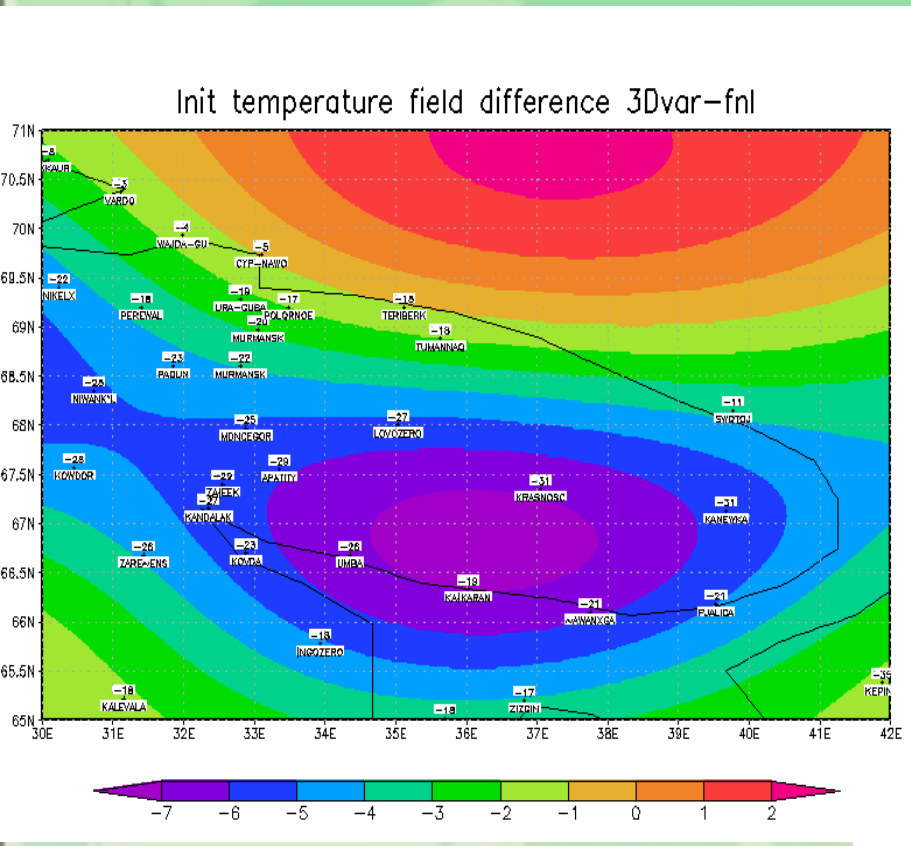
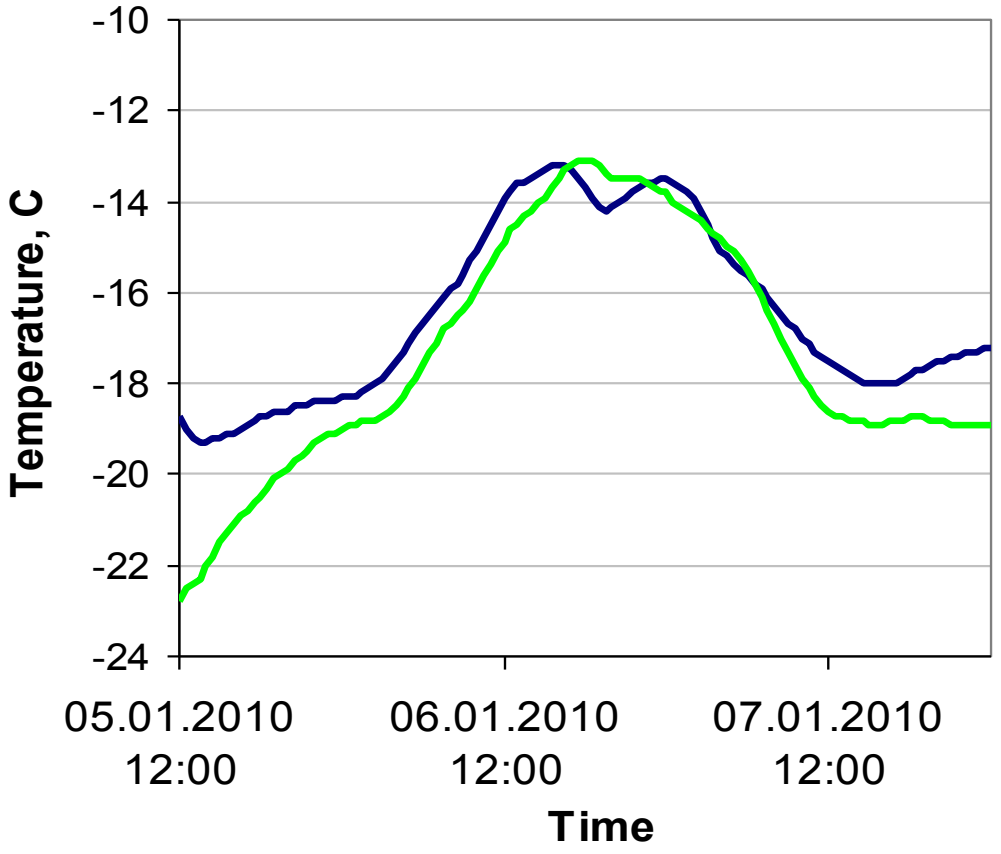
Difference between observations and analysis



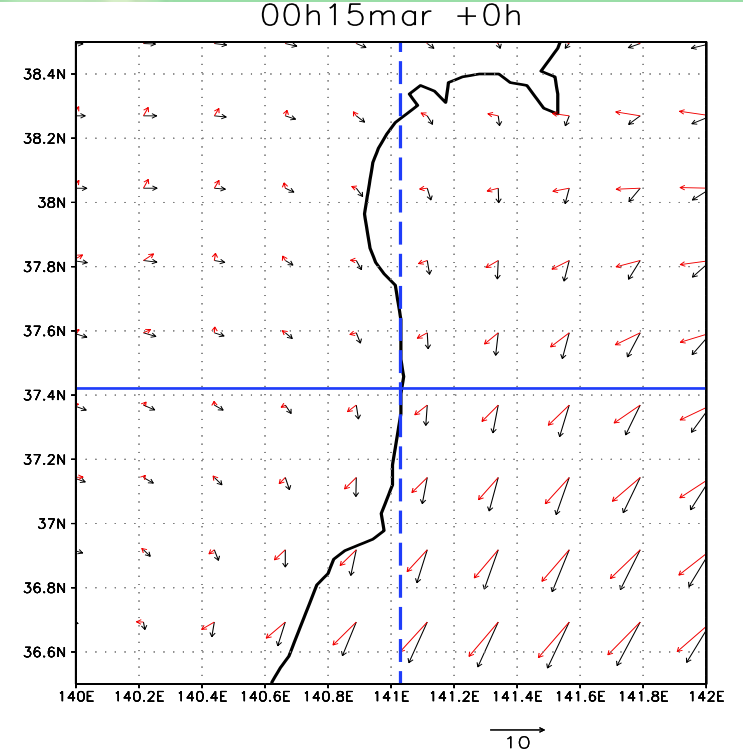
Huge frost in Murmansk region

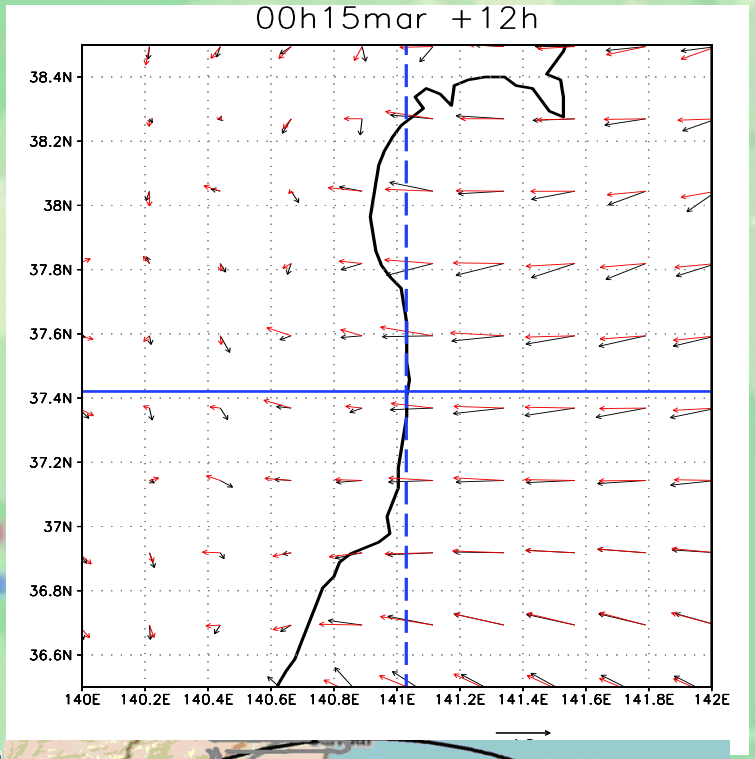


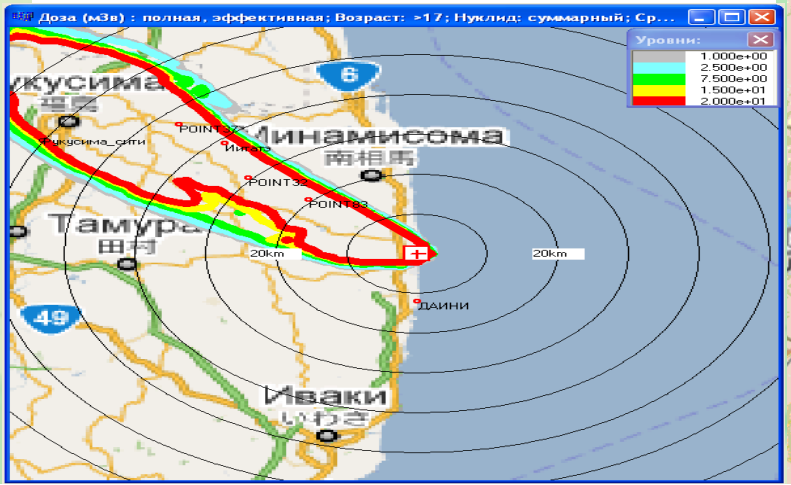
Area average (67-69 latitude, 35-40longitude) temperature using FNL and 3DVAR data as input

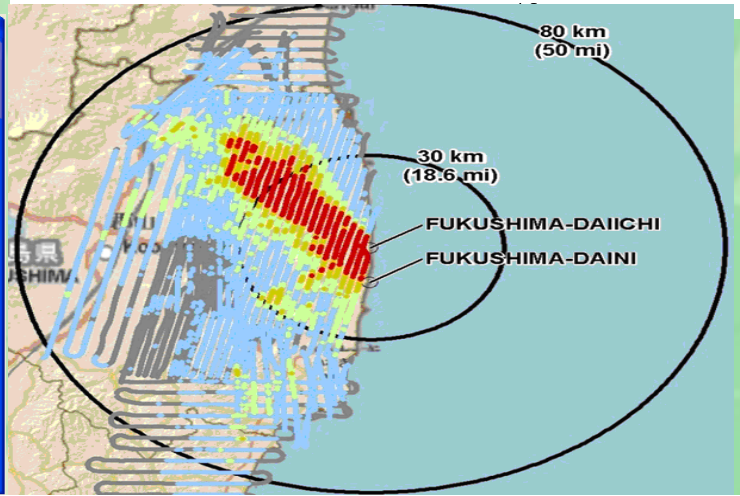


Wind direction for air dispersion model in Japan

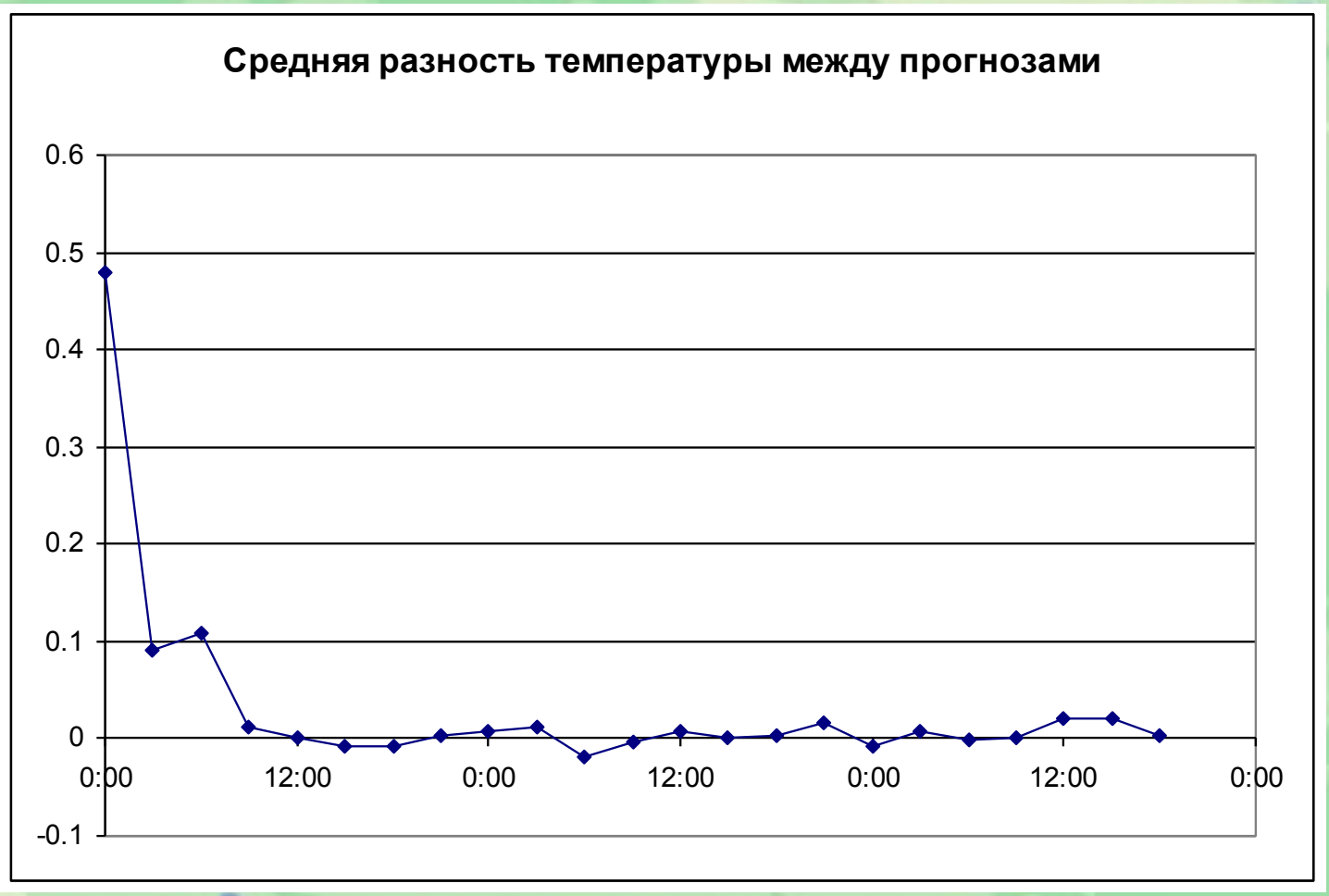




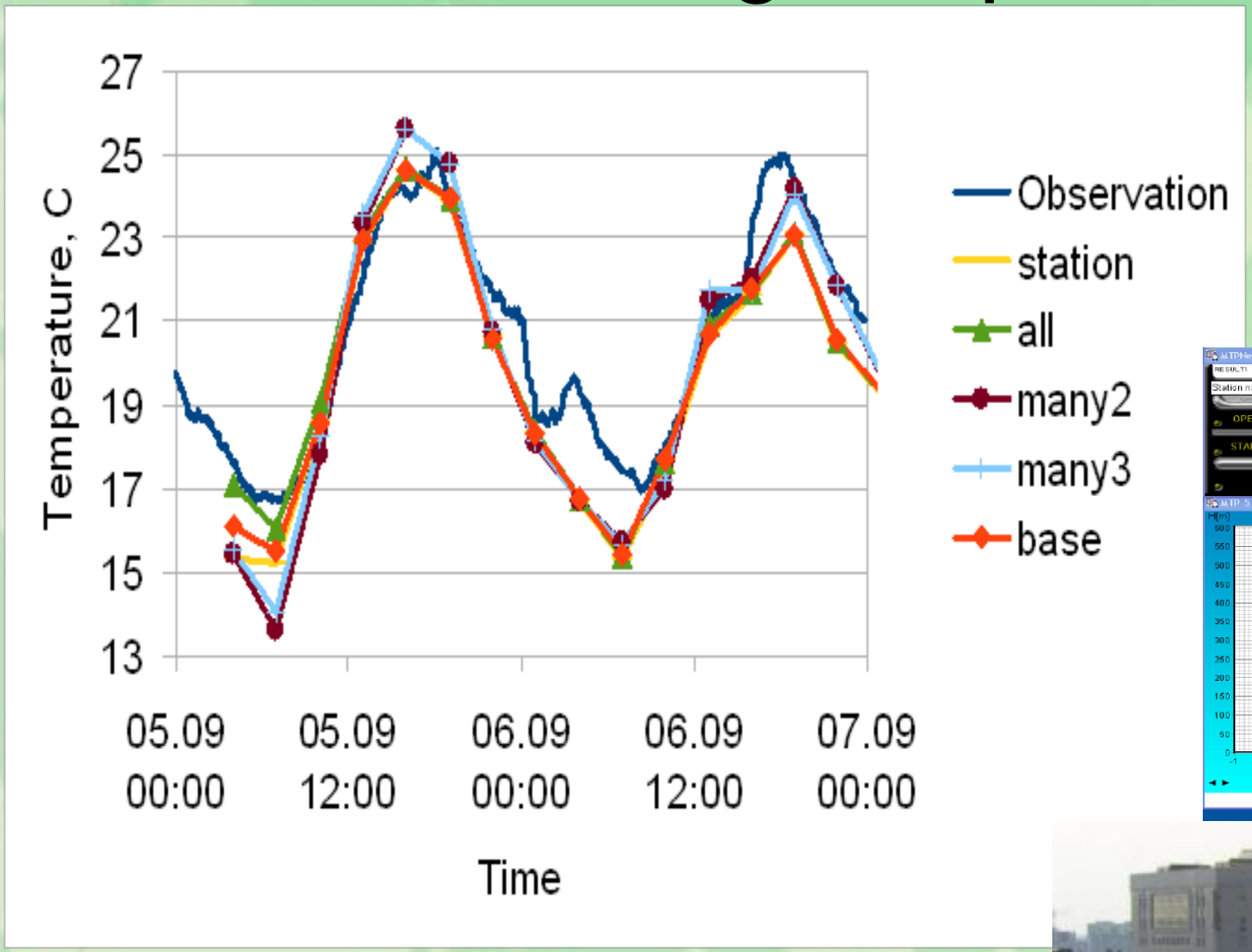


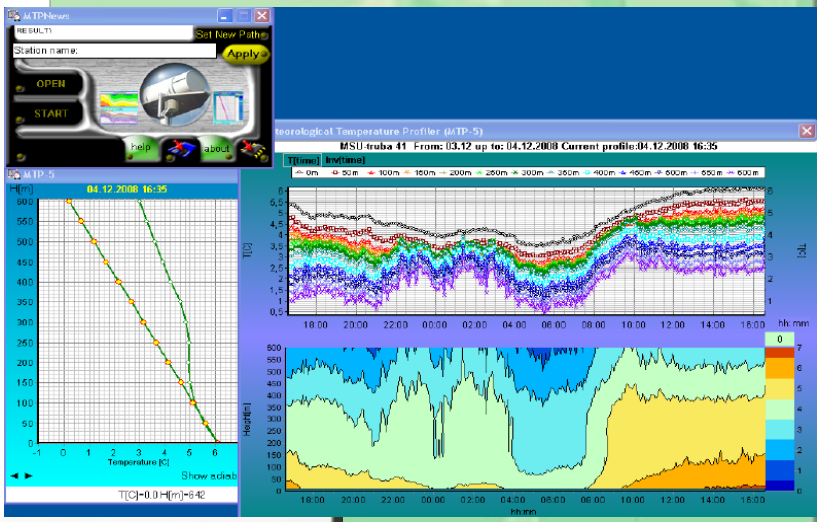


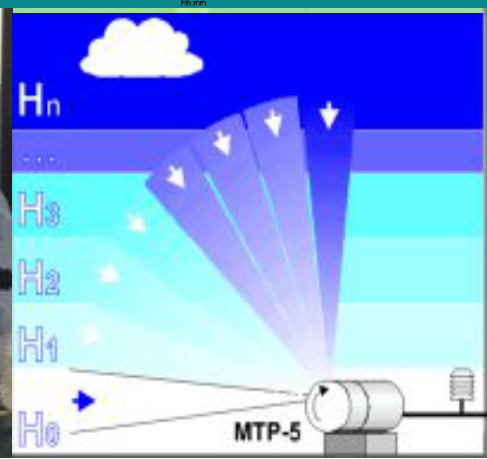
Mean difference between forecasts (temperature)



Assimilating temperature profiles







Conclusions

Forecast errors of temperature, humidity, pressure and wind speed for each series of experiments (using analysis data and after data assimilation) were calculated. Their analysis shows little error reducing using 3DVAR data. The role of data assimilation is the most significant in cases of large discrepancy of analysis and measurement data.

The most effective role of 3DVAR was demonstrated in cases with big difference between analysis and measurement data. One of this cases is the huge frost event, where data assimilation leaded to decreasing of temperature error at 2 ºC. The other one is case of Fukushima, where 3DVAR allowed forecasting correct wind direction.

It is also important to involve more various observation data for assimilation. It is shown that involving information about vertical structure of the hole domain at initial time influence significantly on forecast.

Thank you!

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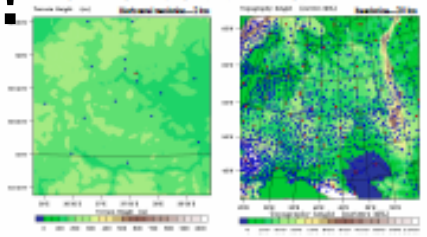
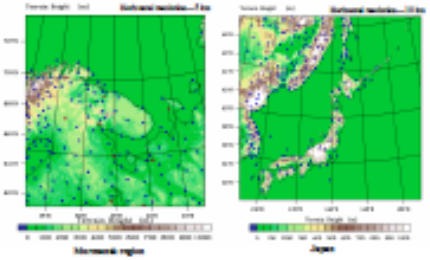
Model domains

indicating terrain height and synoptic (blue) and sounding (red) station location

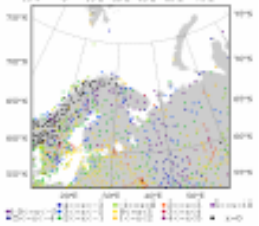




Moscow region — European part of Russia — Murmansk region — Japan

Case of huge frost 5-7 January 2010

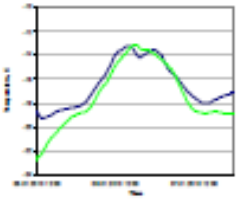
Init temperature BIAS



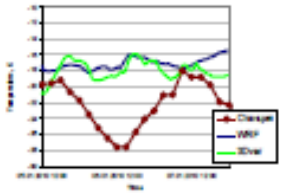
There was observed huge frosts in this dates in Murmansk region which was not indicated by the model. Analysis of initial data showed difference in temperature with station data up to 11 °C. Assimilation of this data allowed to low init temperature field at 6-8 °C, which is shown on the picture below.

So forecasts using different init fields were calculated. Pictures below show the resulting temperature. It can be seen its reducing, little approaching observed frosts. Though the model doesn't still catch temperature reducing 6 January. In some stations this can be explained their locations (for example, in a valley). But using 3DVAR leaded to decreasing of the error 7 January at 2 °C.

Area average (67-69 latitude, 35-40longitude) temperature using FNL and 3DVAR data as input



Temperature forecast using FNL and 3DVAR data as input and station (Murmansk) data



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This work is partly supported by RFBR 09-05-00650-a, 10-08-00690-a and FPT - IRSES - "Climate".

Input data can often cause errors in forecasts using meteorological mesoscale models. Errors in input data can occur due to various reasons such as absence of some station data in international exchange data, interpolation errors in model domain and others. Comparison of analysis data with measurements on meteorological stations shows occurrence of significant errors. One can improve input data for model using three-dimensional variational analysis. In WRF ARW model this can be done using WRFDA system (3dVar). In this work possibilities of this system were investigated in various domains and cases.

Initial data used in this study is NCEP final analysis with horizontal resolution of 0.5°. Meteorological synoptic and sound station data were used for assimilation to improve initial data.

Experiments

There were run two series of experiments which differ only in their initial data:

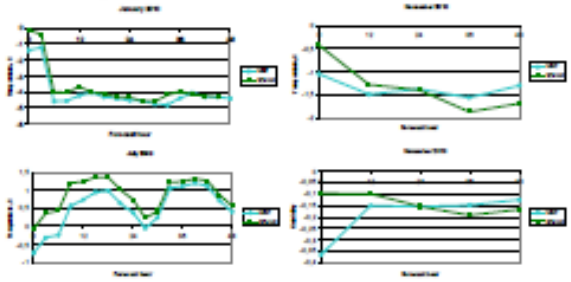
WRF	3DVAR
Standard model run Input files—Final analysis (0.5°x 0.5°), interpolated on model domain	Input files are changed using three-dimensional variational data assimilation WRFDA (3DVAR)

Resulting errors

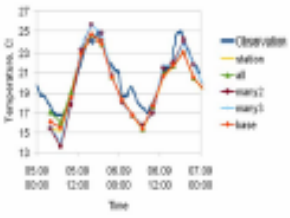
Despite on sometimes big difference in initial data of two experimental series this difference disappear rapidly in forecast time in most cases that is demonstrated on pictures below

Monthly averaged BIAS

European part of Russia — Murmansk region



Using remote sensing temperature profiles for assimilation



Picture show resulting temperature obtained using different data to assimilate.

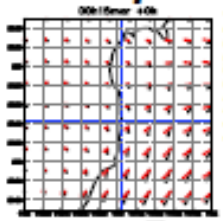
To improve model representation of vertical temperature profiles in atmospheric boundary layer data obtained by microwave temperature profiler MTP-5 was used. This measurements are provided in several points in Moscow region and give vertical profiles up to 600 m.

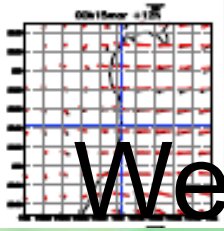
For real-time data measured on Faculty of Physics Moscow State University please visit

http://cpfem307-3.phys.msu.ru

Preliminary test of assimilating this data gave minor results. So this profiles were used in all domain. At each synoptic station was used measured temperature at 2m and temperature vertical gradient obtained by MTP-5 (though it was measured at different point results show propriety of this assumption).

Forecasting wind fields for air dispersion model





The situation around the Fukushima Daiichi station was modeled. It was characterized by rapid change of wind direction and accurate representation of wind field was extremely important for accurate modeling resulting radioactive trace. Picture show wind field using analysis data as initial (black arrows) and after assimilation (red arrows). Using 3DVAR in this case allowed forecasting correct traces. Traces obtained in collaboration with

Welcome to poster!