

# Estimation of data assimilation influence on model WRF-ARW forecasts in some regions

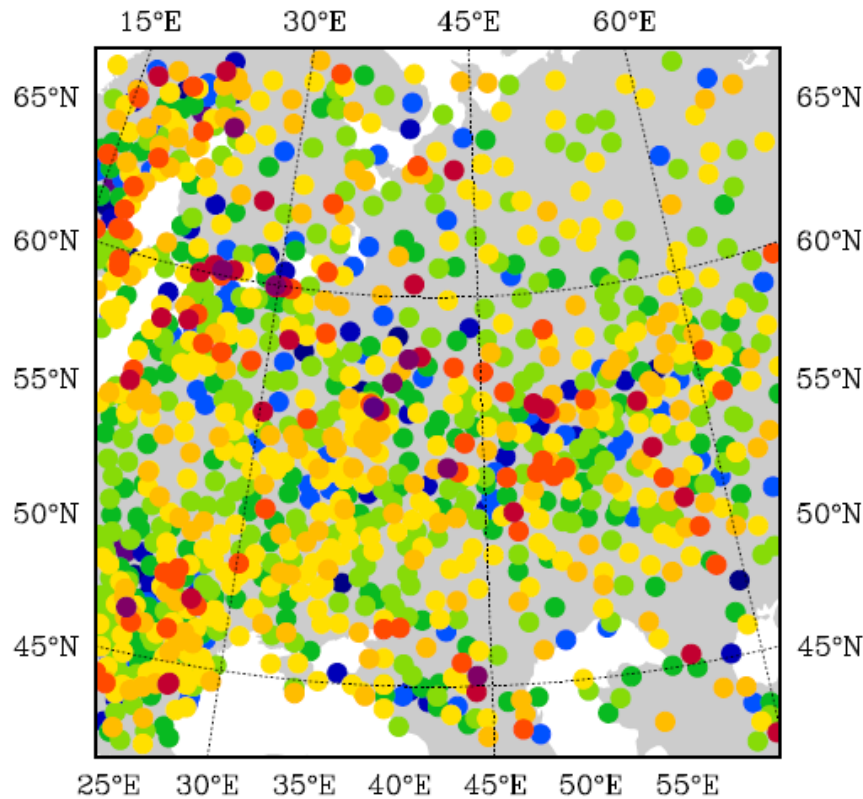
Smirnova M.M., Rubinstein K.G.

Hydrometcentre of Russia

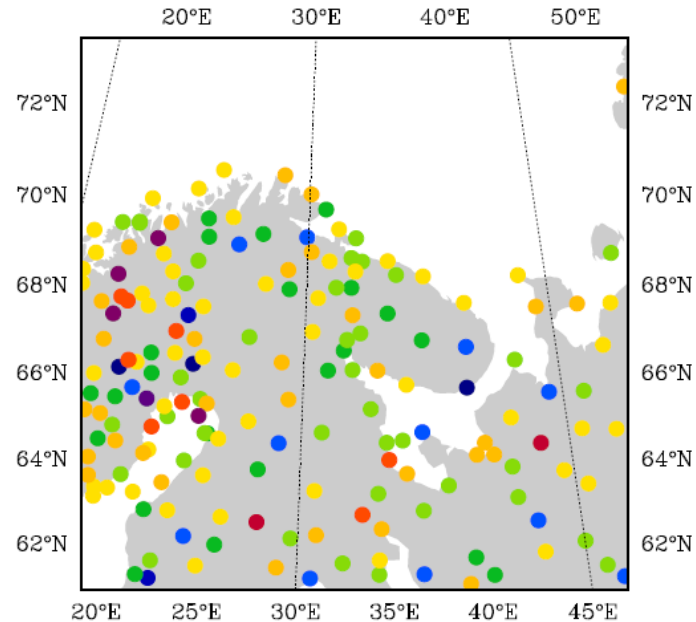
# Differences between initial temperature field and station data

1 July 2009

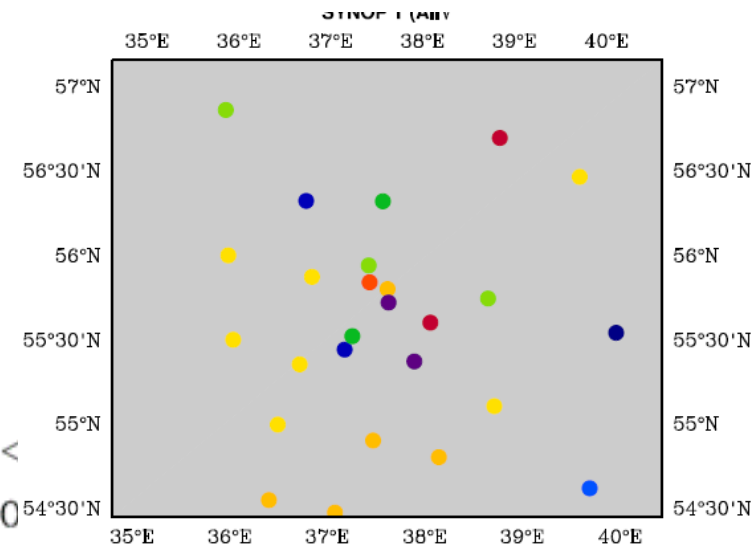
European Part of Russia



Moscow region



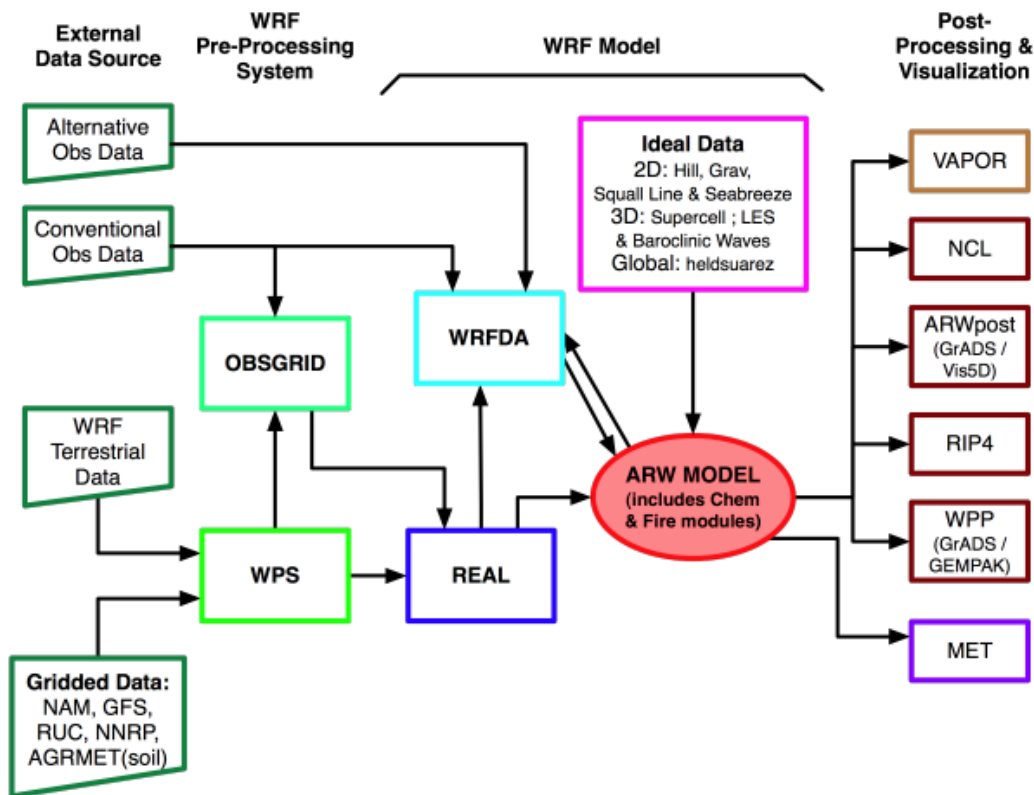
Murmansk region



# 3DVAR

$$J(\mathbf{x}) = \frac{1}{2}(\mathbf{x} - \mathbf{x}^b)^T \mathbf{B}^{-1}(\mathbf{x} - \mathbf{x}^b) + \frac{1}{2}(\mathbf{y} - H(\mathbf{x}))^T \mathbf{R}^{-1}(\mathbf{y} - H(\mathbf{x}))$$

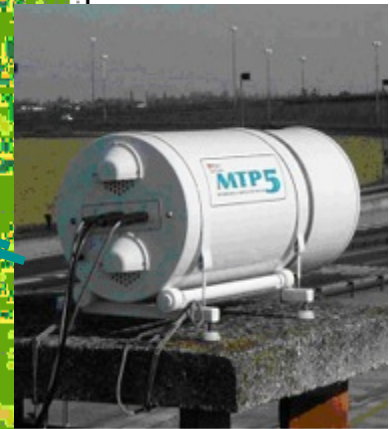
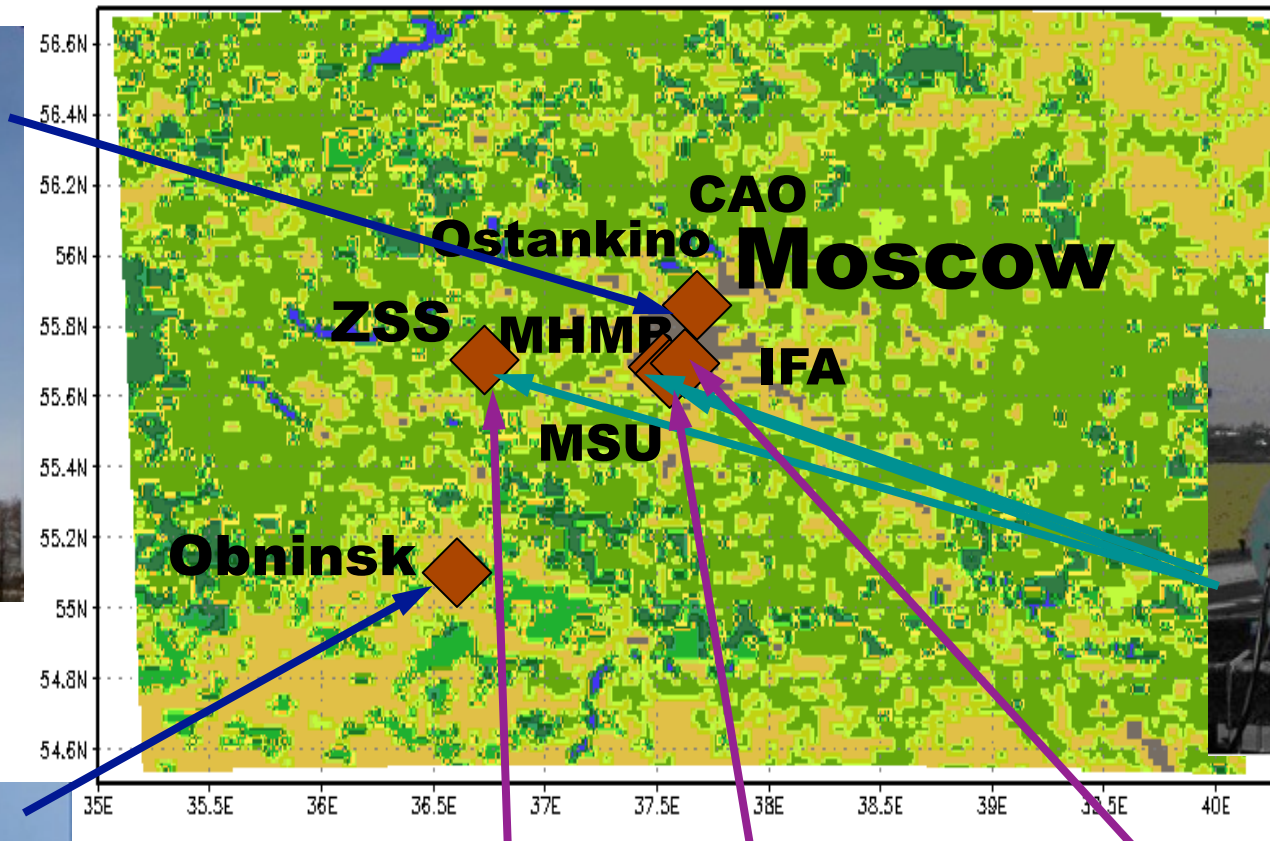
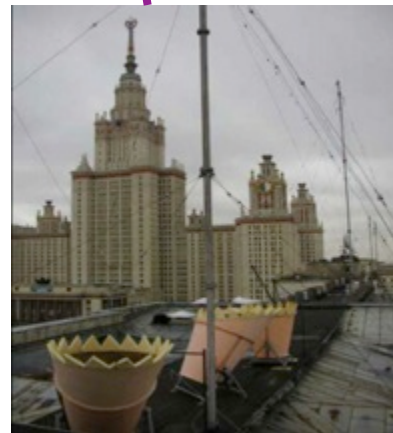
**WRF Modeling System Flow Chart**



## Data to use

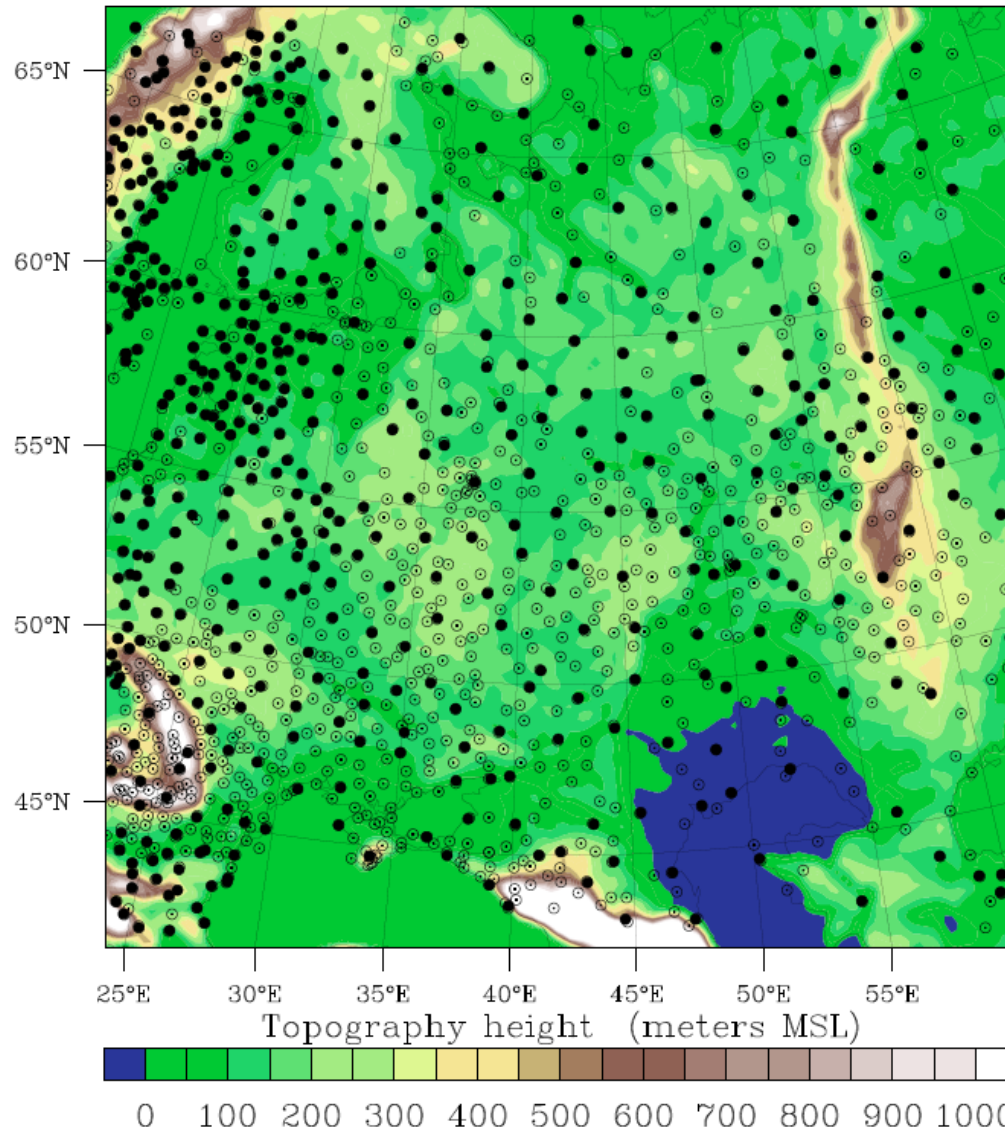
18 types: SYNOP, SHIPS, METAR, TEMP, AIREP, PILOT, AMDAR, PROFL, SATOB, SATEM, SSMT1, SSMT2, SSMI, GPSPW/GPSZD, GPSRF, QSCAT, BOGUS

# Observations in ABL in Moscow region



# Synoptic stations in NCEP data and in Hydrometcentre of Russia

## example in European part of Russia



# Initial data

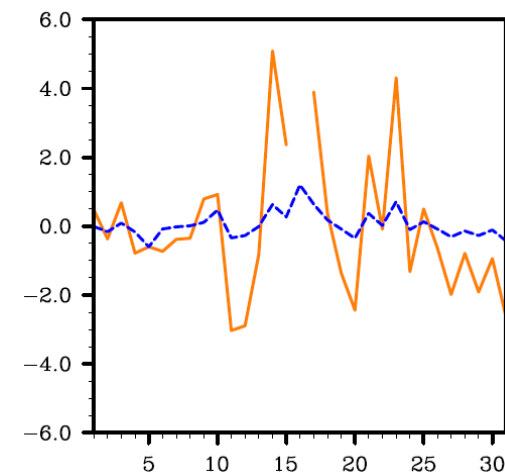
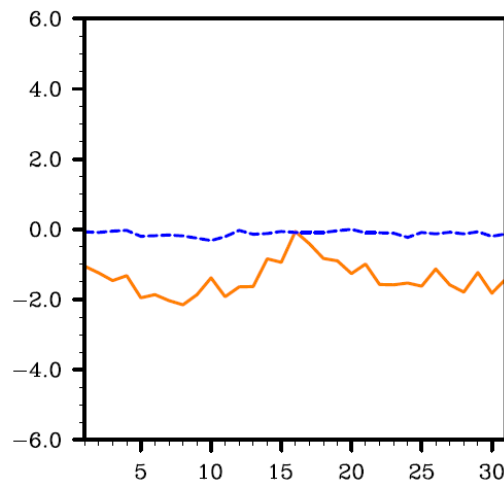
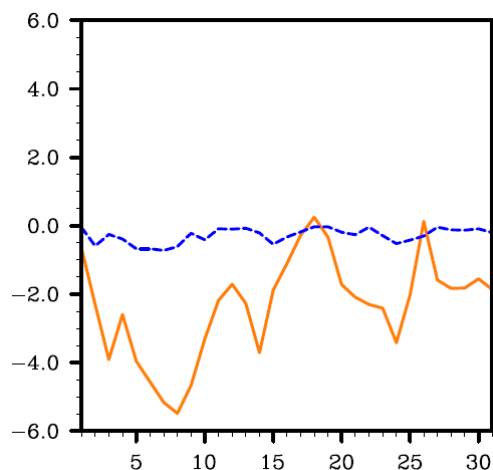
## Temperature (at 2 m) mean bias, °C

Murmansk region

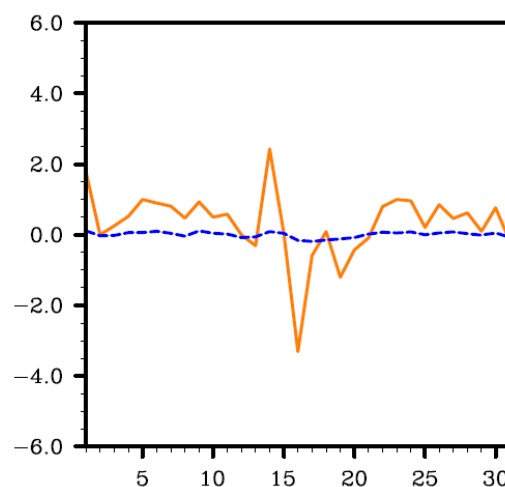
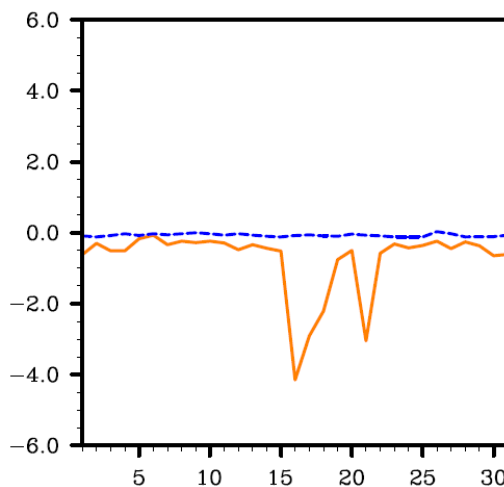
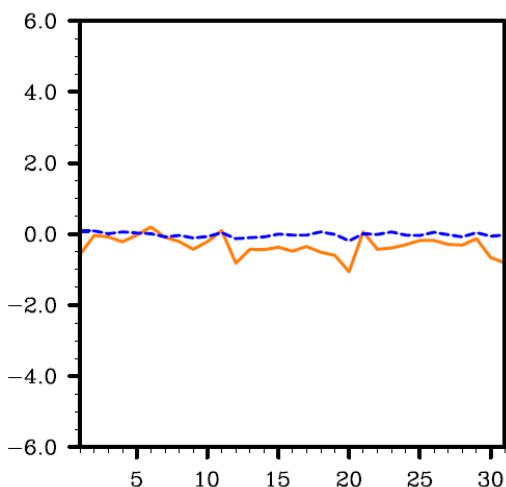
ETR

Moscow region

January  
2010



July  
2009



----- 3DVAR -----

————— base —————

# Initial data

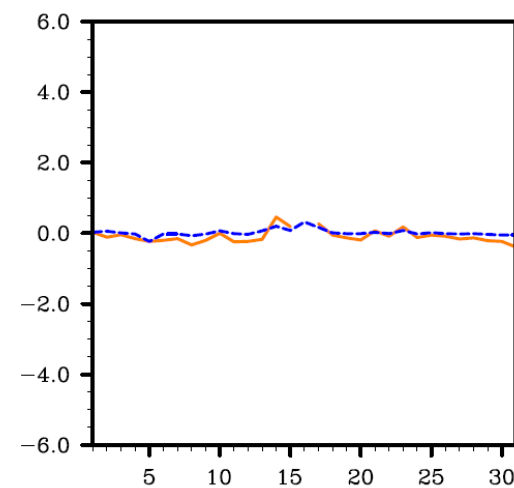
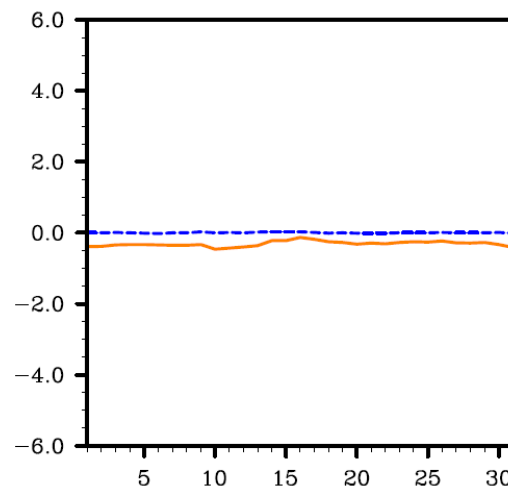
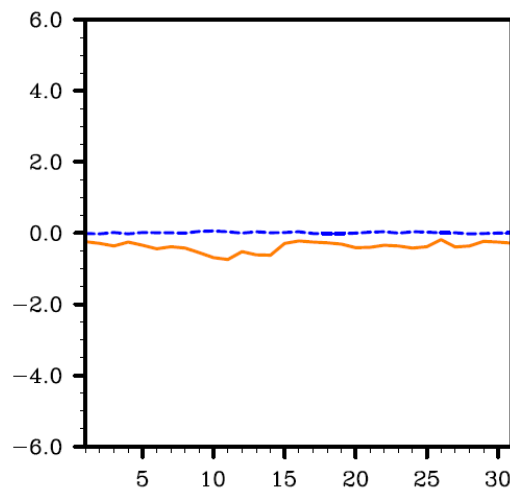
Humidity (mixing ratio)  
mean bias, g/kg

Murmansk region

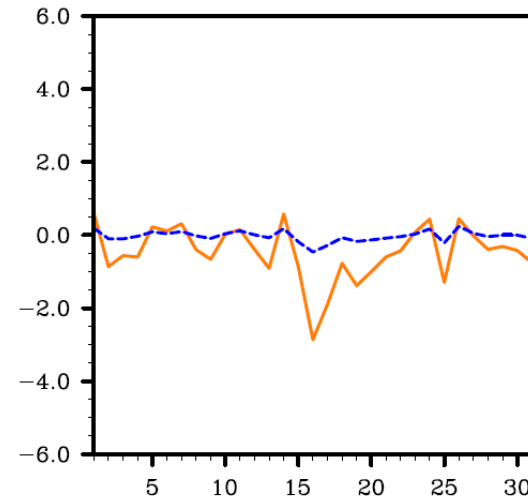
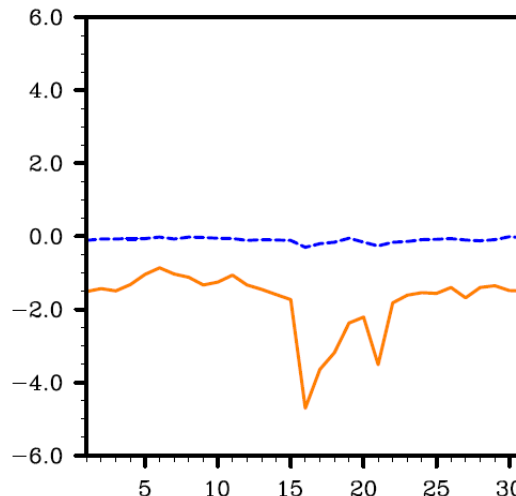
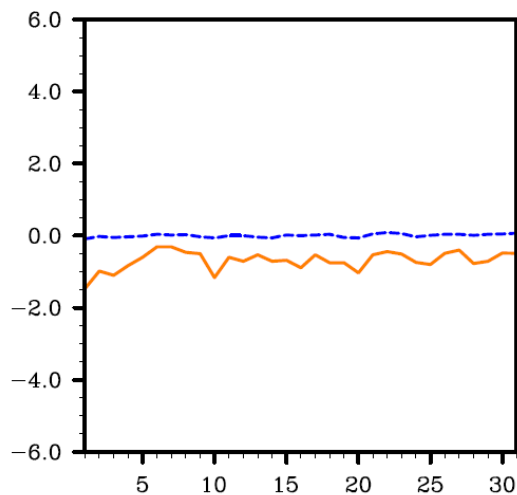
ETR

Moscow region

January  
2010



July  
2009



----- 3DVAR -----

————— base —————

# Initial data

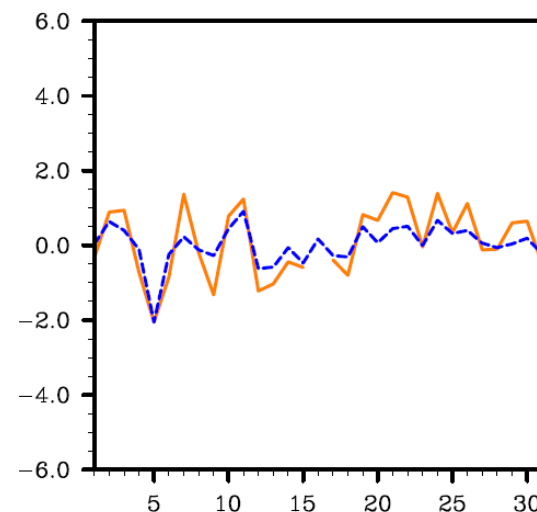
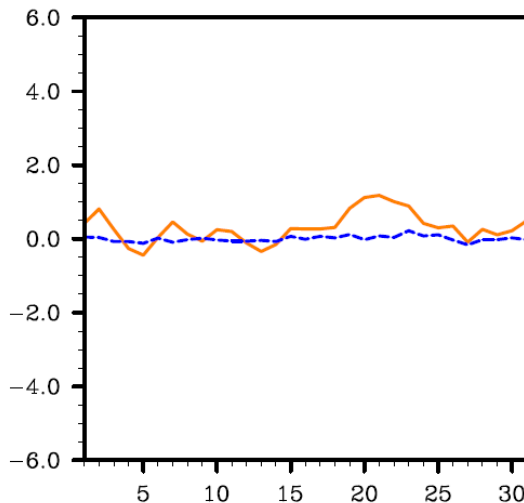
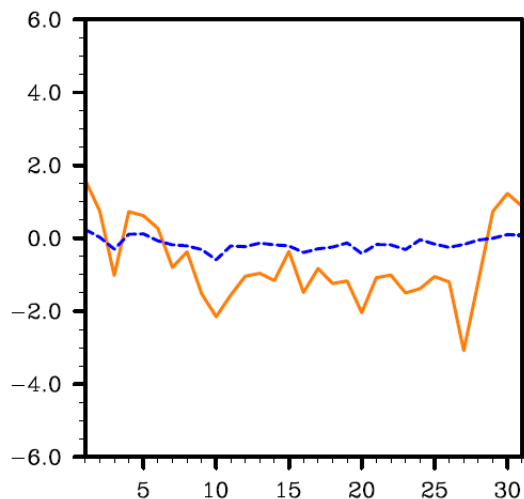
Wind speed (at 10 m)  
mean bias, m/s

Murmansk region

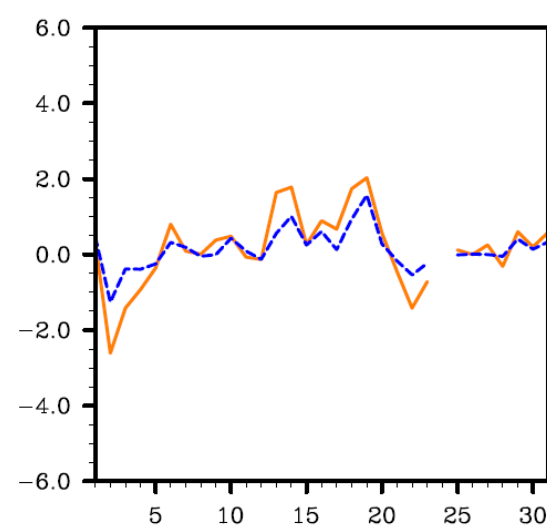
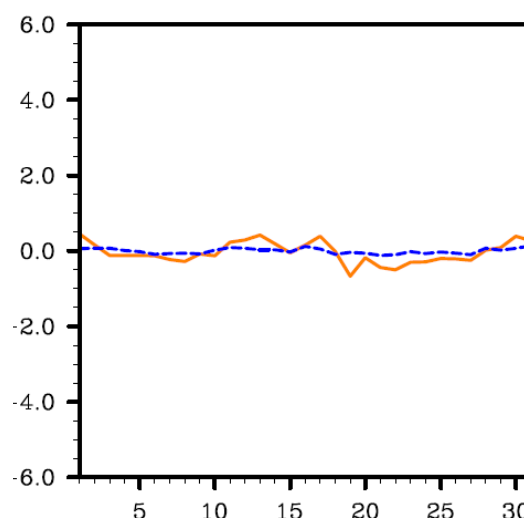
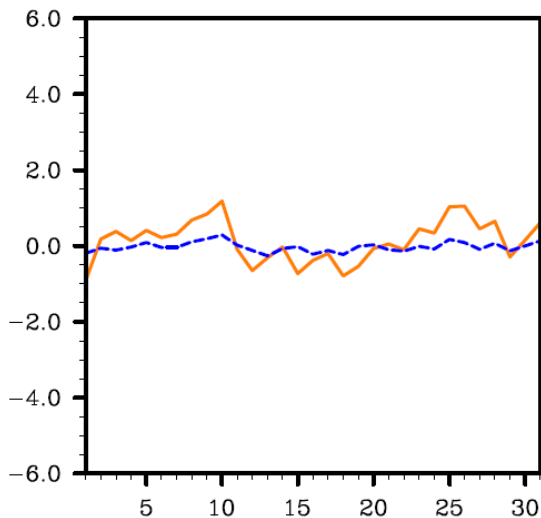
ETR

Moscow region

January  
2010



July  
2009



----- 3DVAR

————— base

# Initial data

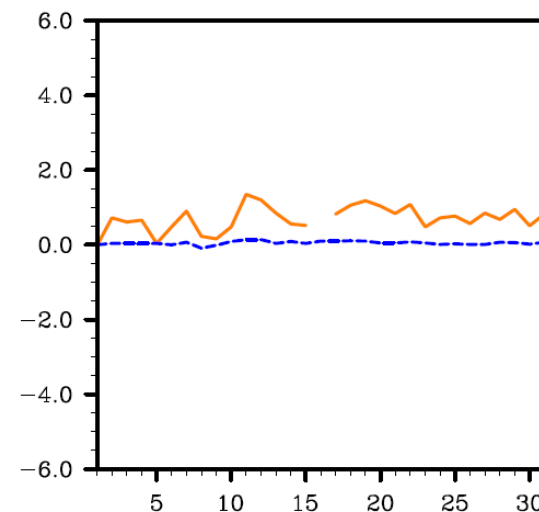
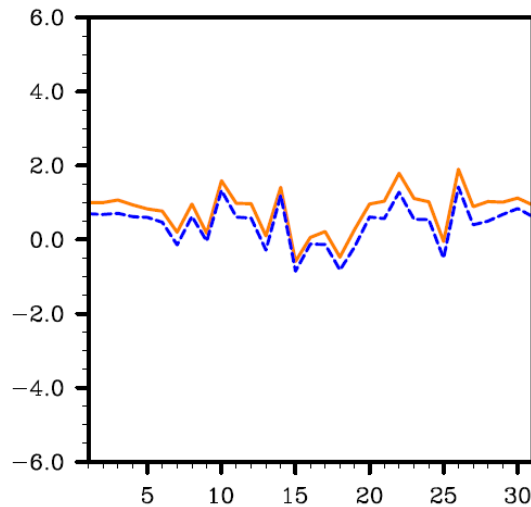
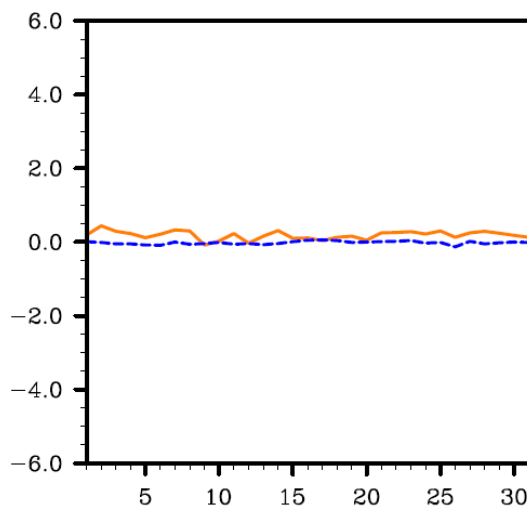
Pressure (sea level)  
mean bias, hPa

Murmansk region

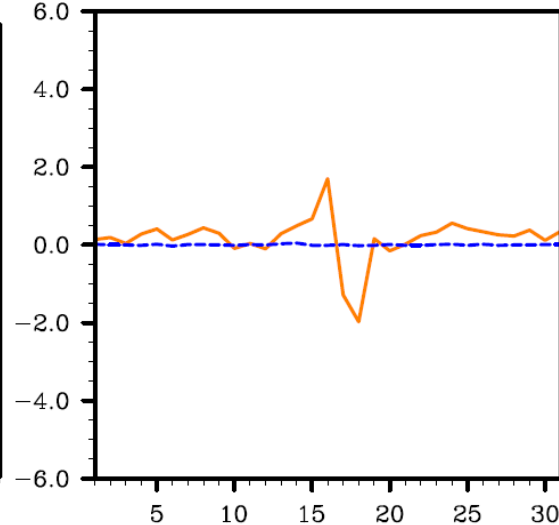
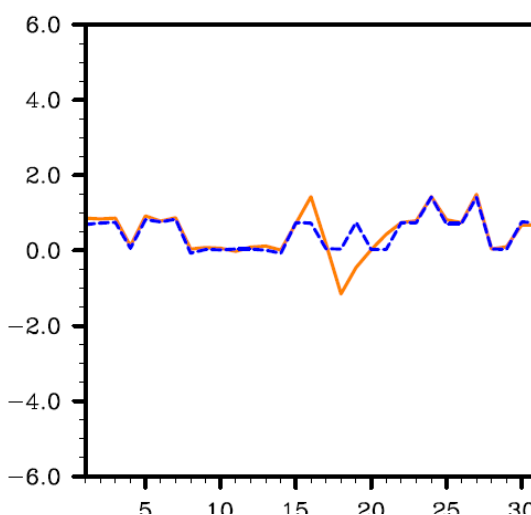
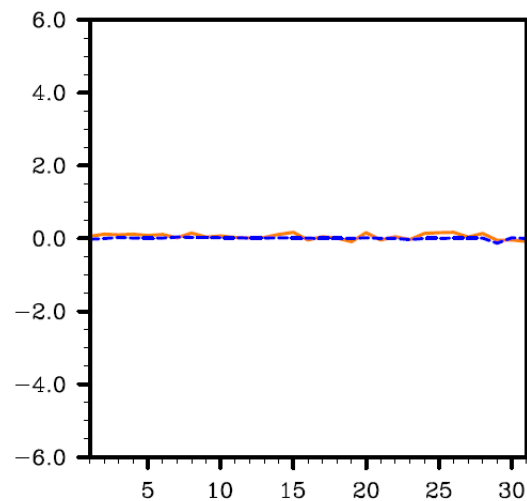
ETR

Moscow region

January  
2010



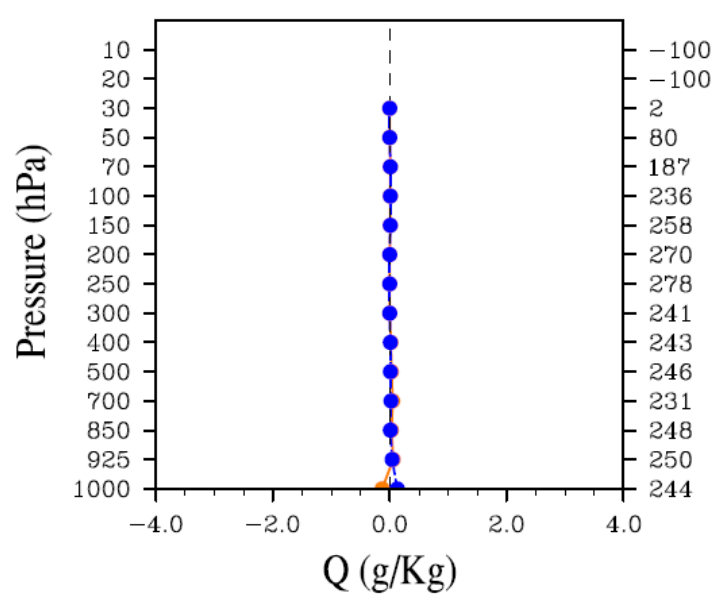
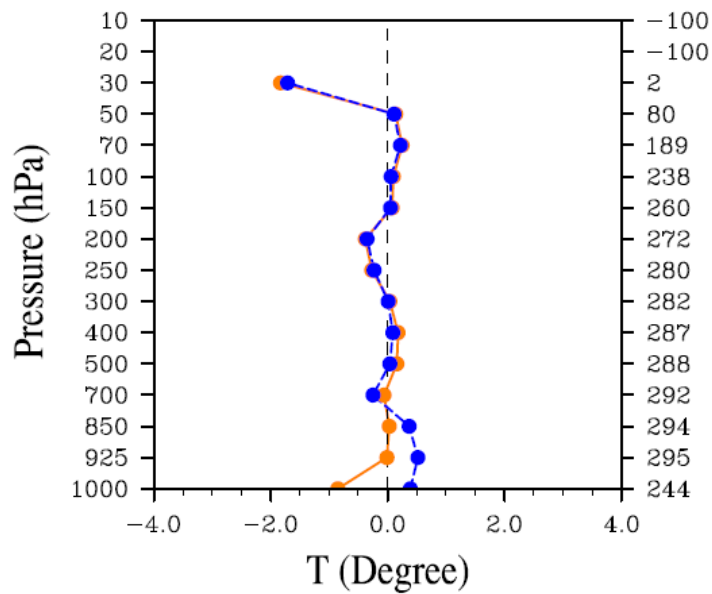
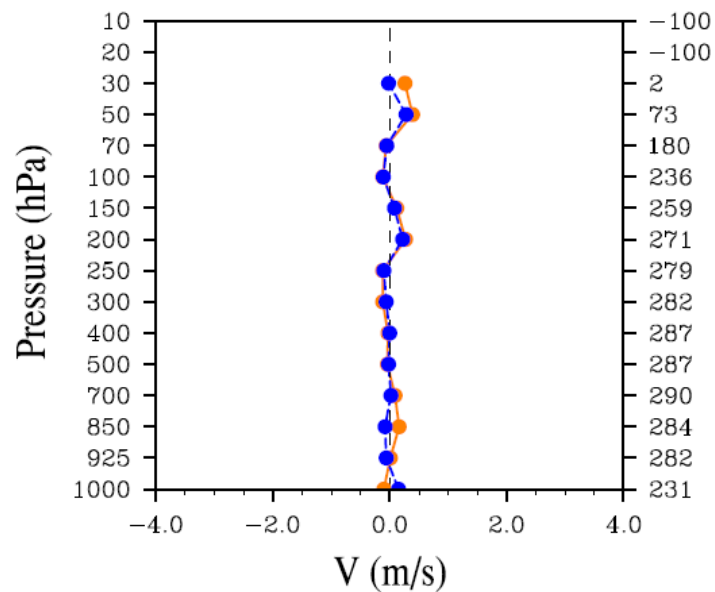
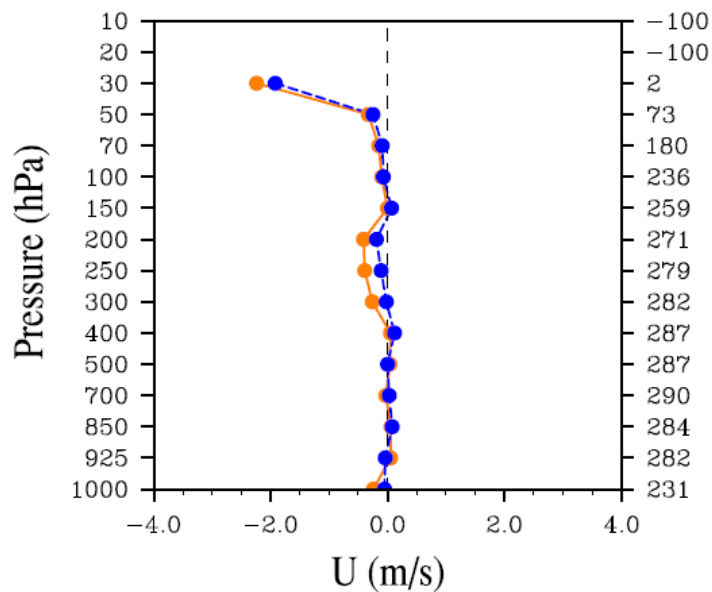
July  
2009



----- 3DVAR -----  
----- base -----

# Initial data

## Mean bias profiles Murmansk region, January 2010



# Forecast

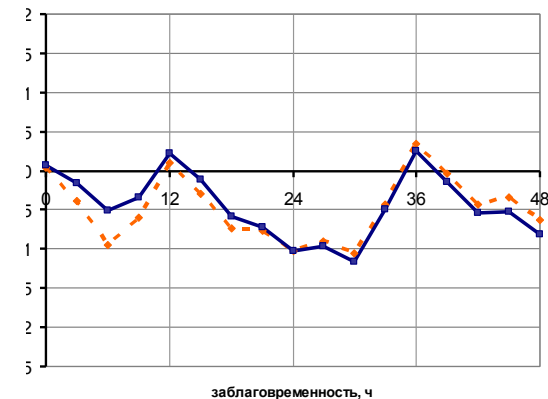
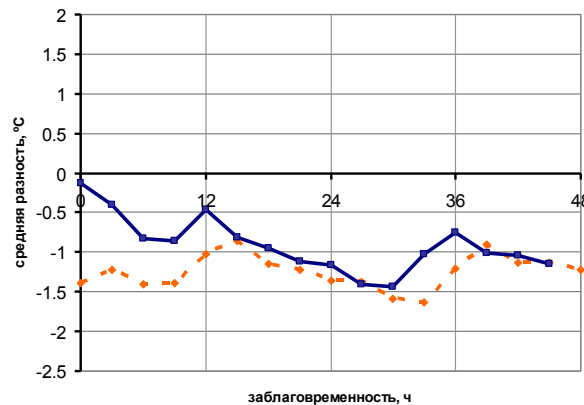
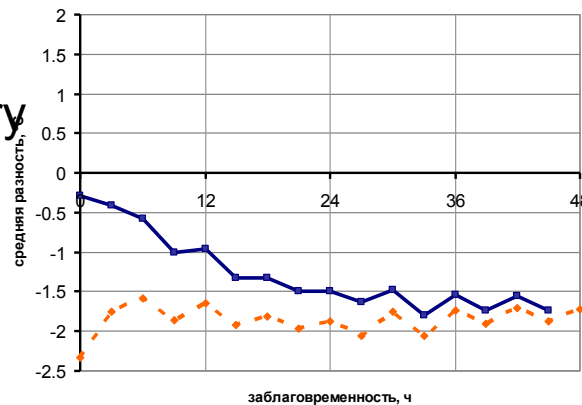
## Temperature (at 2 m) mean bias on forecast hour

Murmansk region

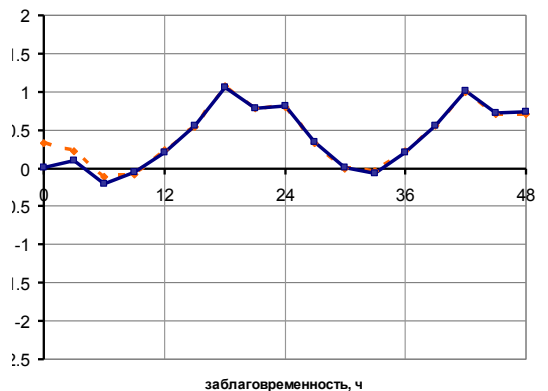
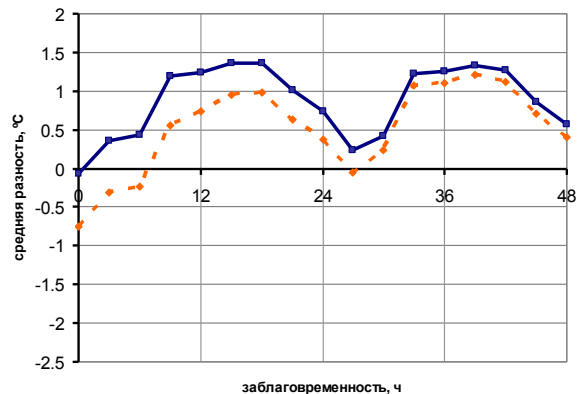
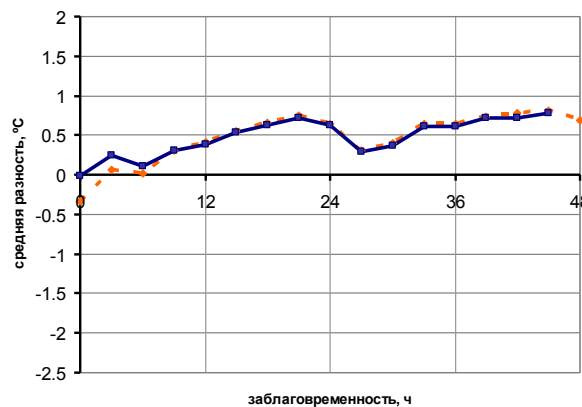
ETR

Moscow region

January  
2010



July  
2009



- - - base  
— 3DVAR

# Forecast

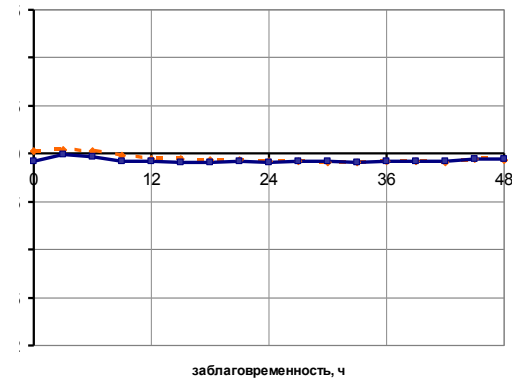
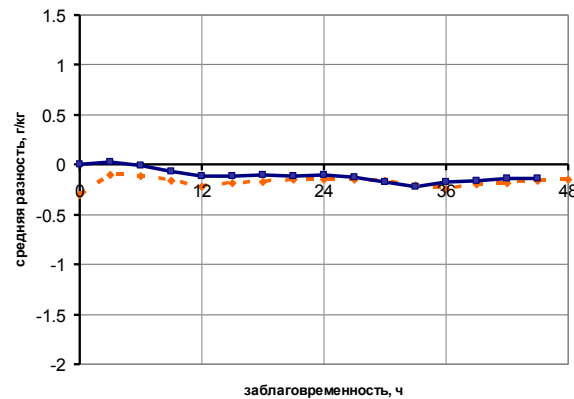
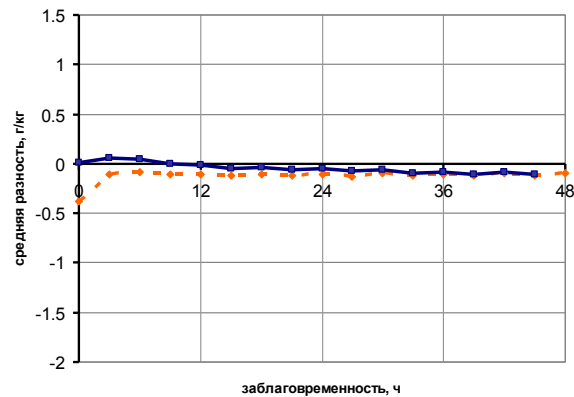
## Humidity (mixing ratio) mean bias on forecast hour

Murmansk region

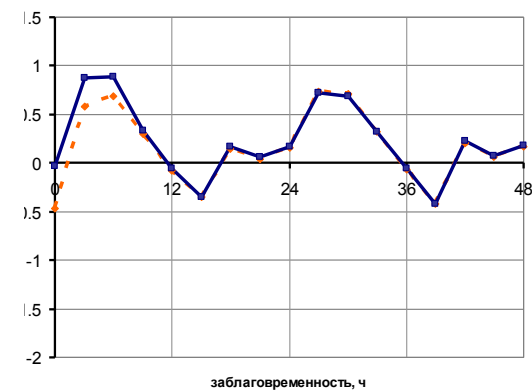
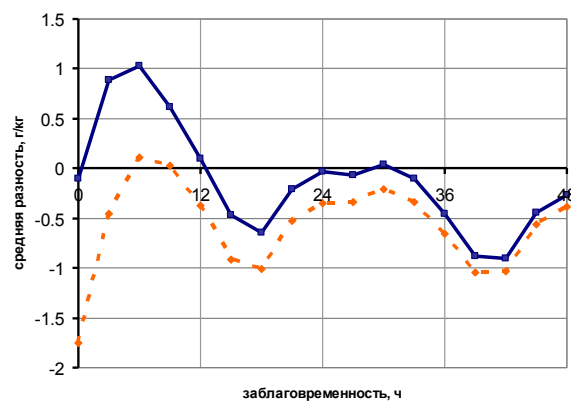
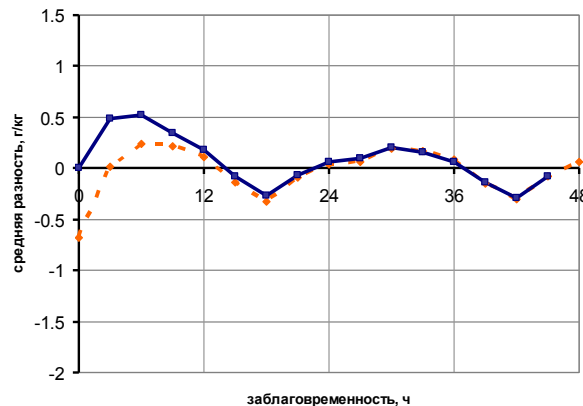
ETR

Moscow region

January  
2010



July  
2009



- - - base  
— 3DVAR

# Forecast

## Wind speed (at 10 m)

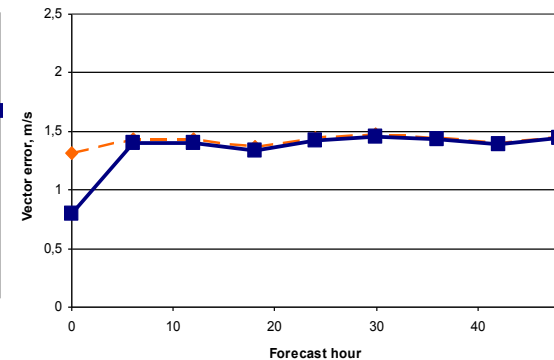
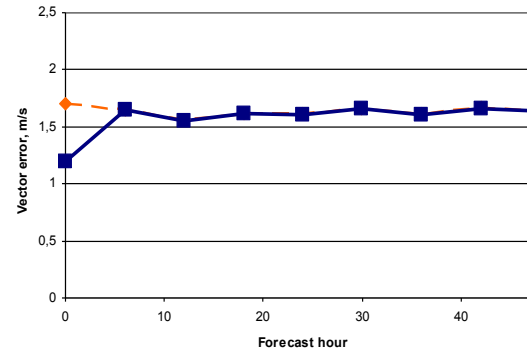
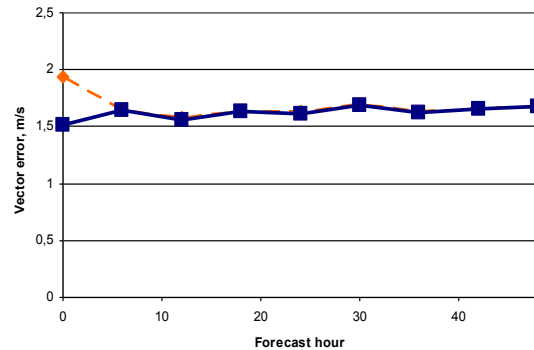
vector error on forecast hour

Murmansk region

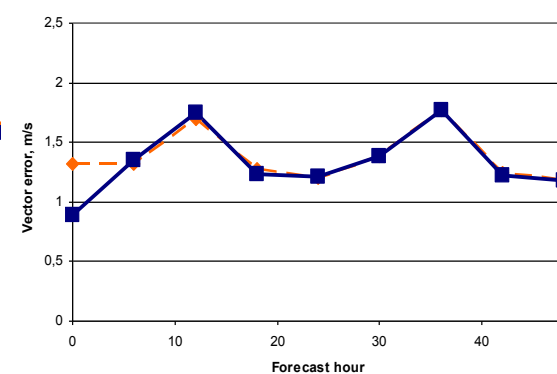
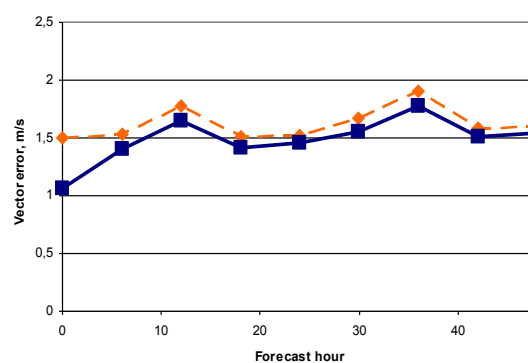
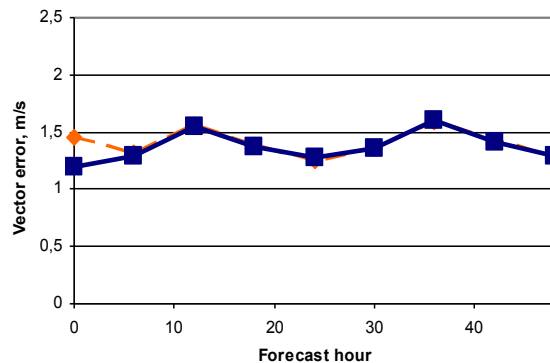
ETR

Moscow region

January  
2010



July  
2009



- - - base  
— 3DVAR

# Forecast

# Pressure (sea level)

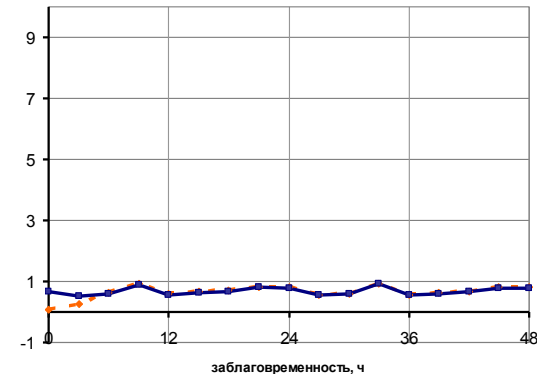
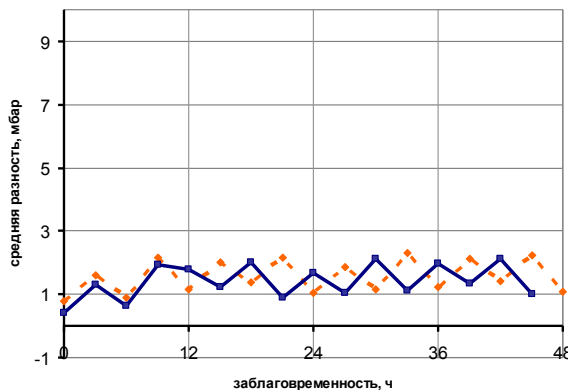
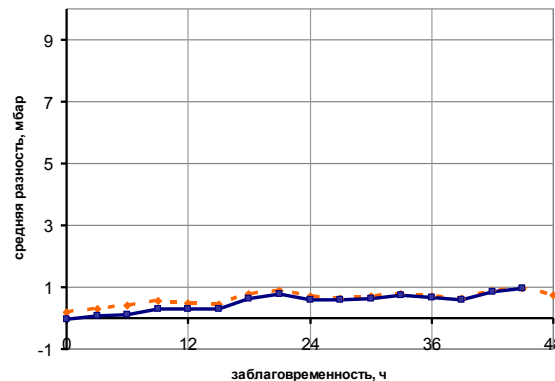
mean bias on forecast hour

Мурманская область

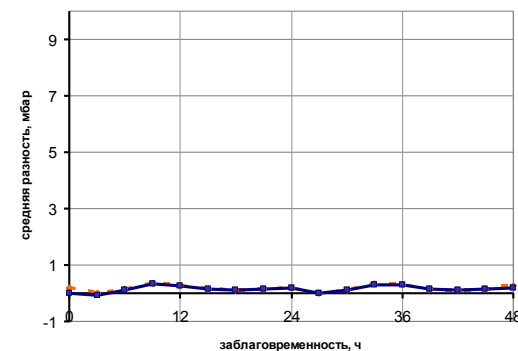
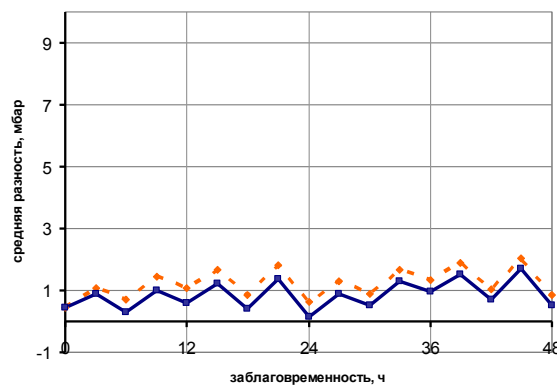
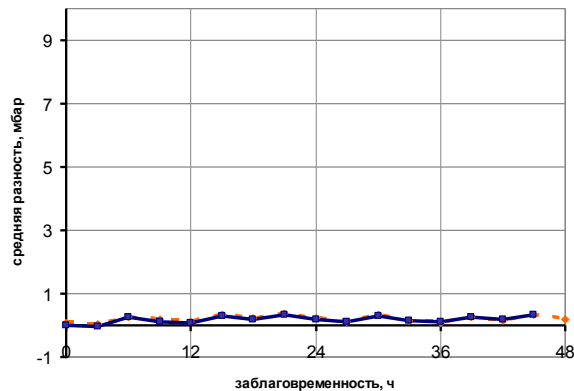
ETP

Московская область

январь  
2010



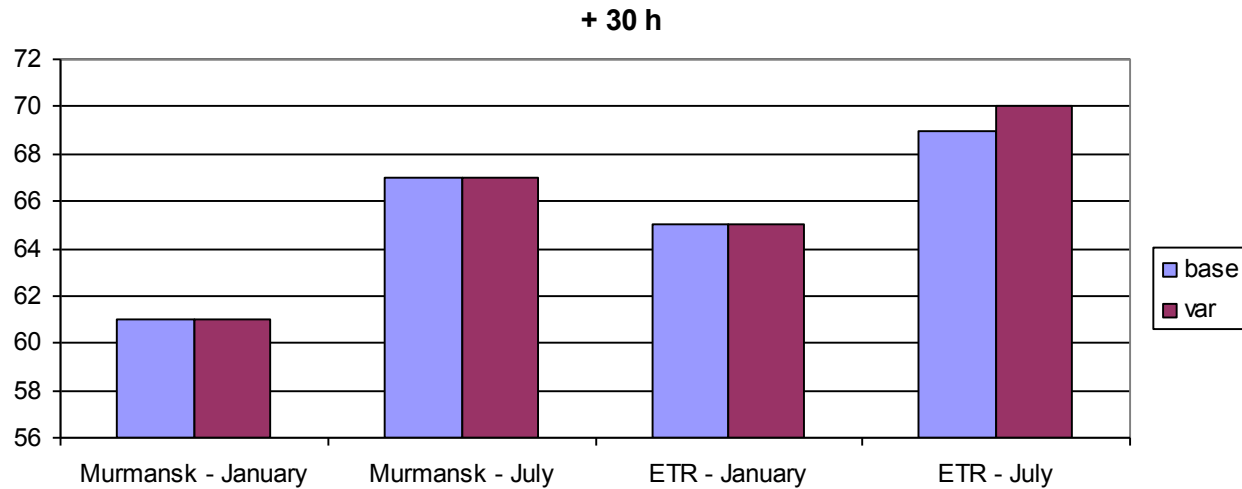
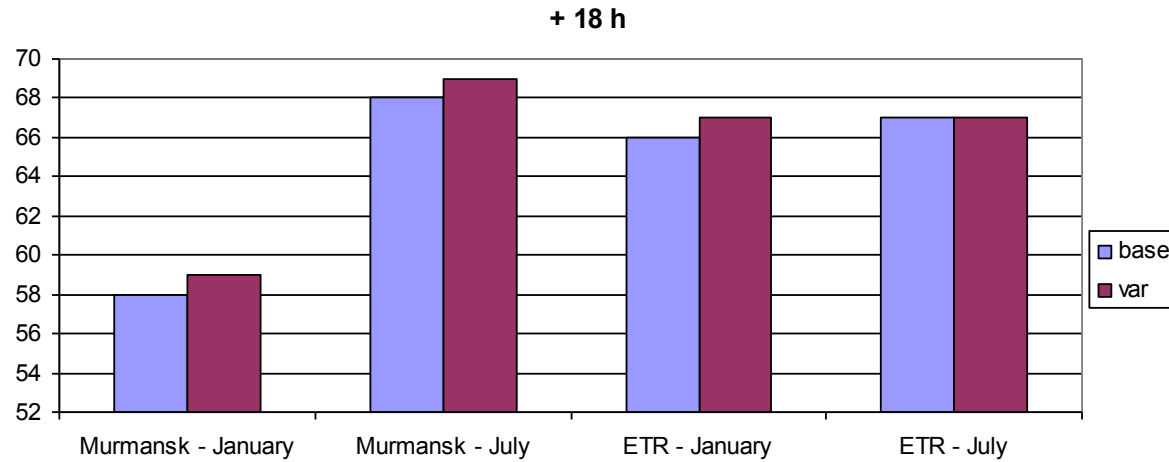
июль  
2009



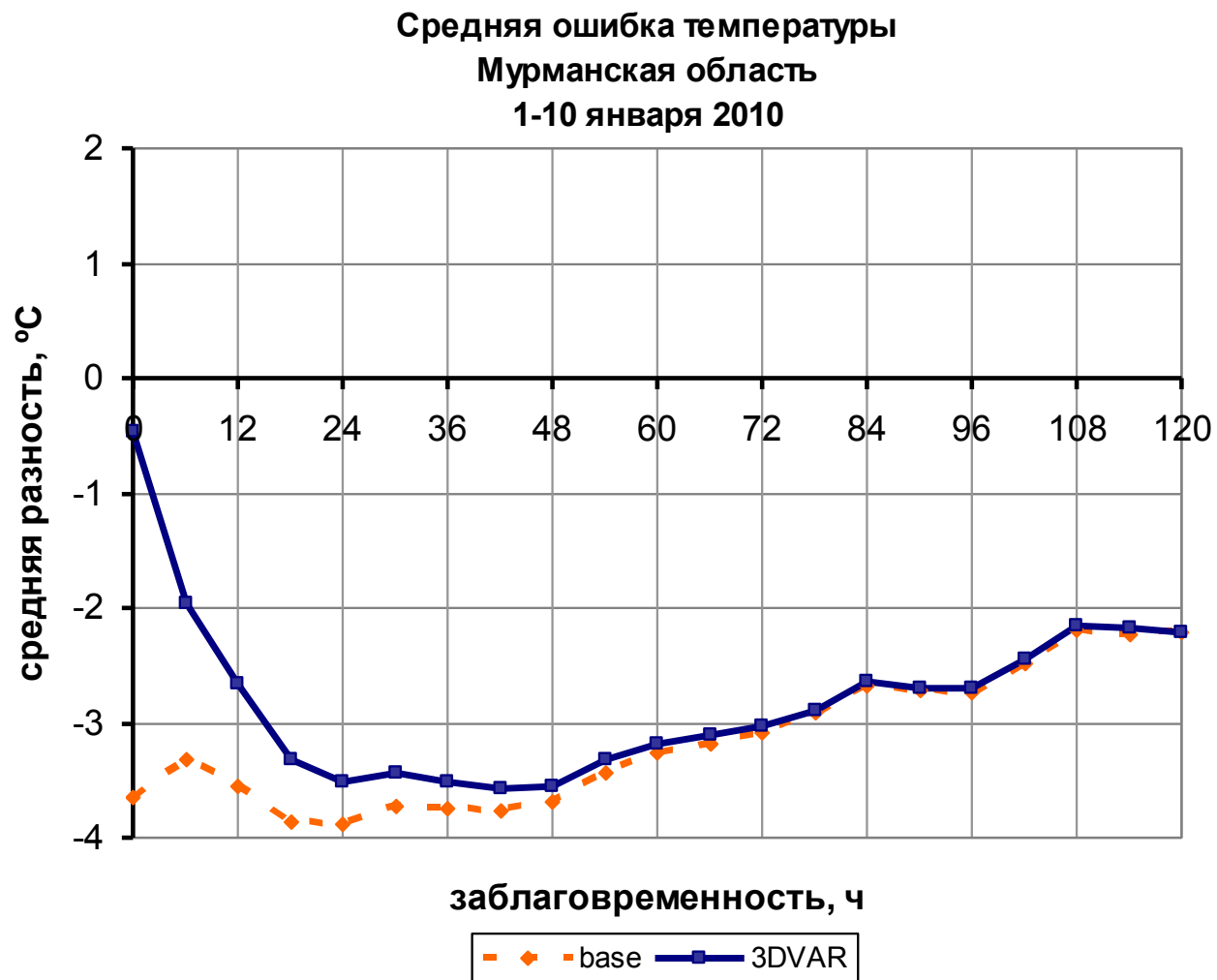
- - - base  
— 3DVAR

# Precipitations

## general accuracy

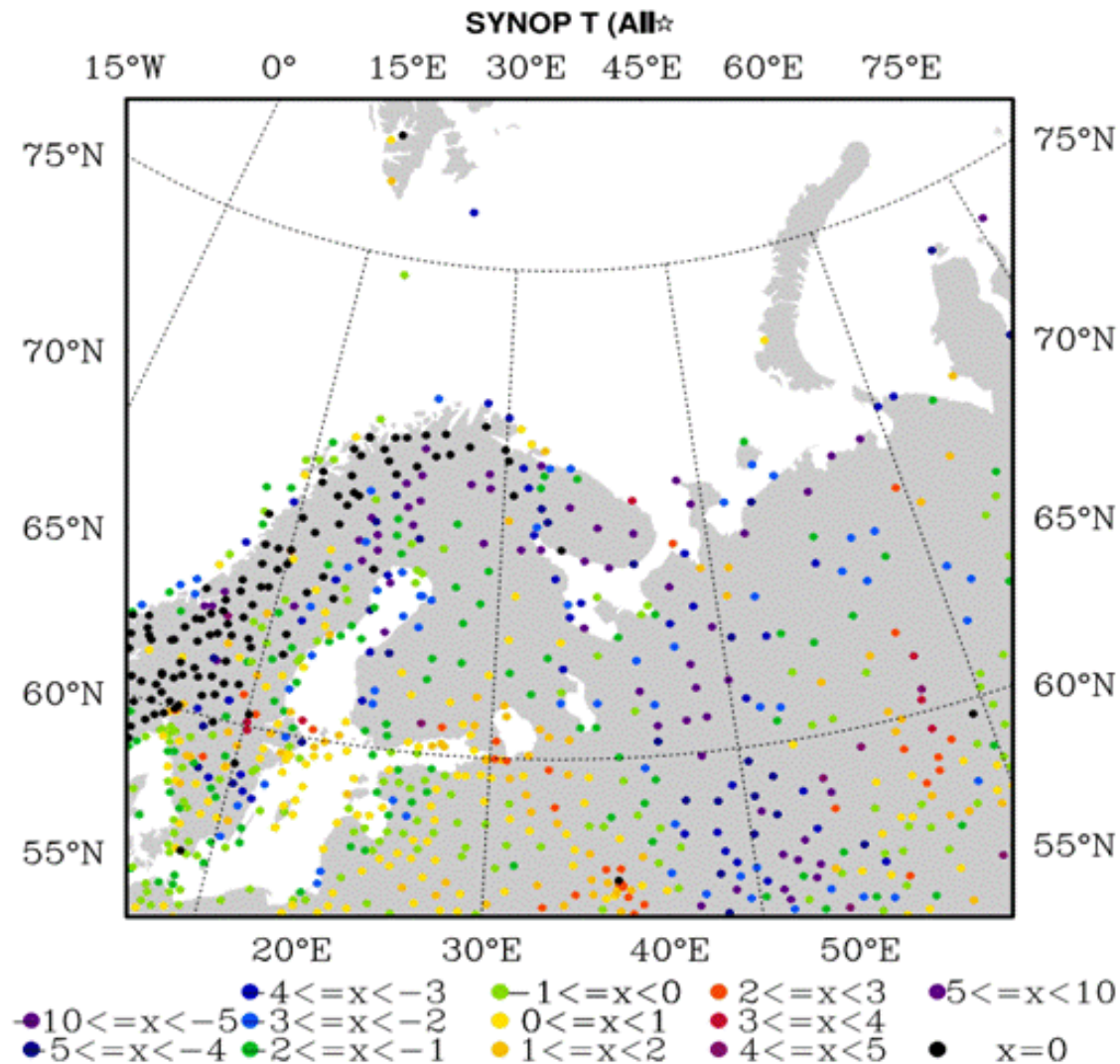


# Mean bias of temperature (longer forecast)



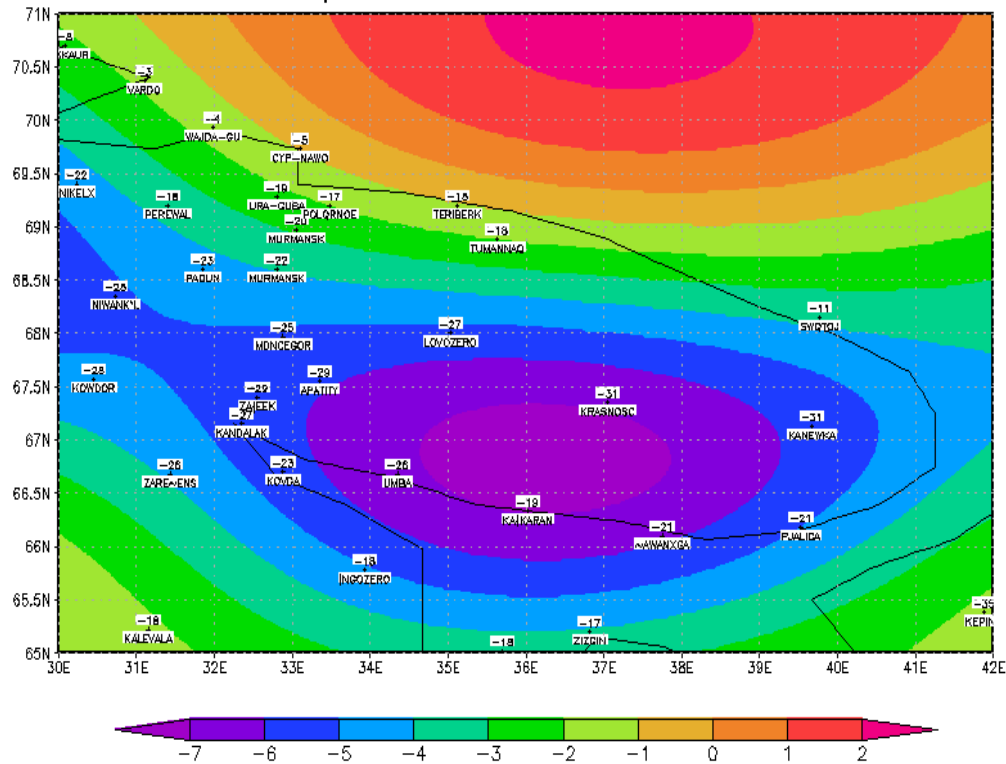
# Case of huge frost in Murmansk region

Differences between initial temperature field and station data  
05 January 2010

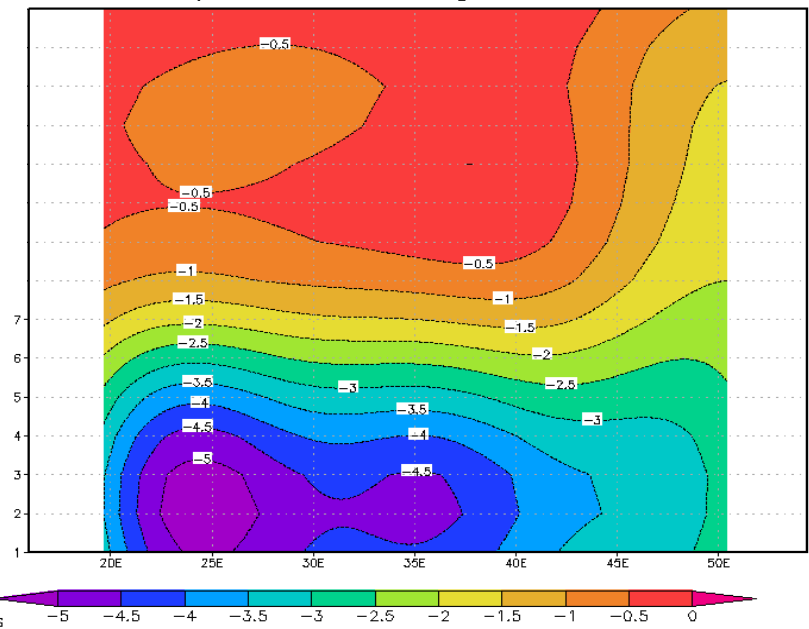


# Change of initial temperature field in Murmansk region

Init temperature field difference 3Dvar-fnl



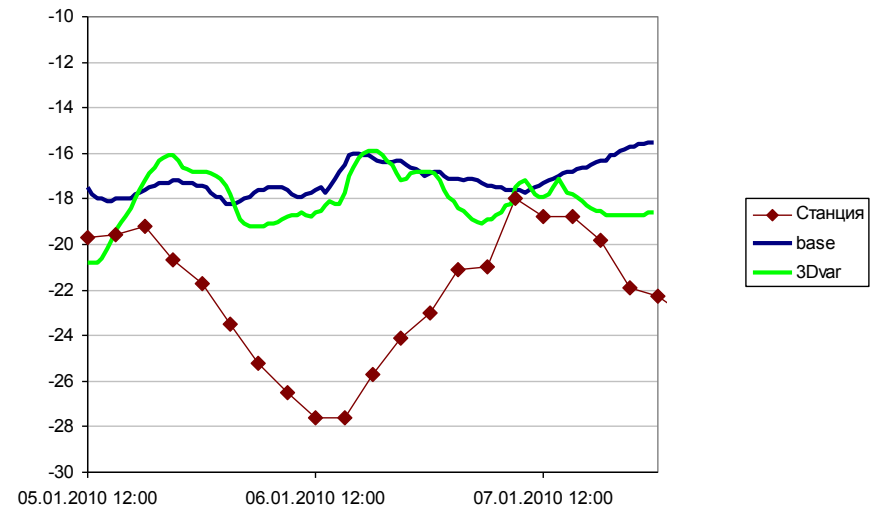
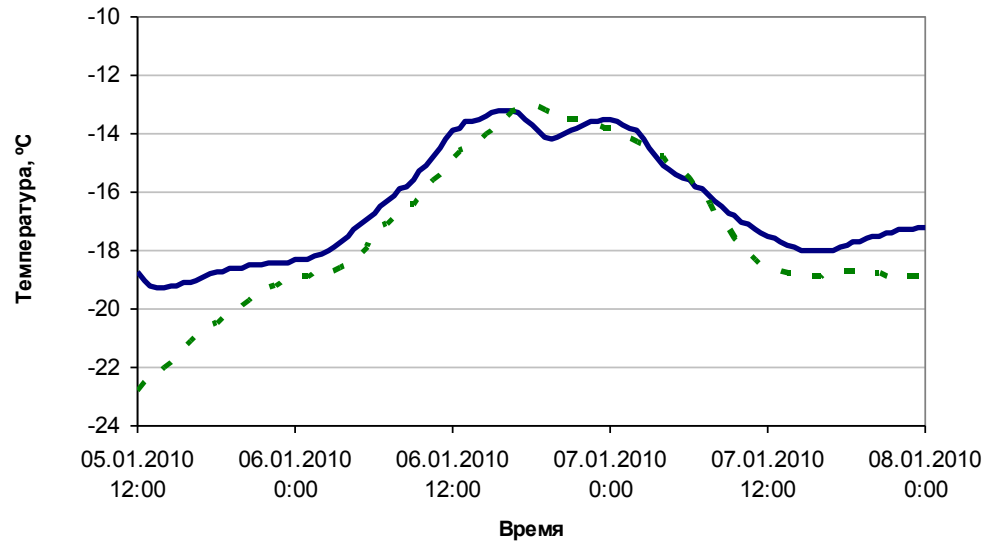
Init temperature field along lat=68 3DVAR-FNL



GrADS: COLA/IDES

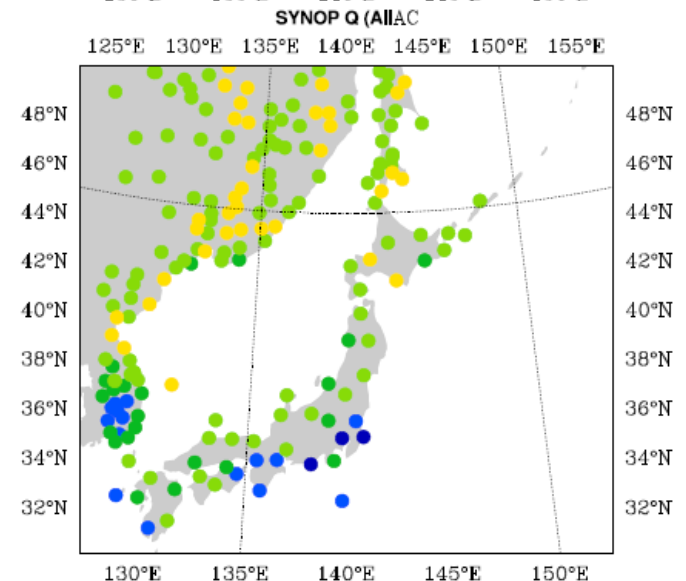
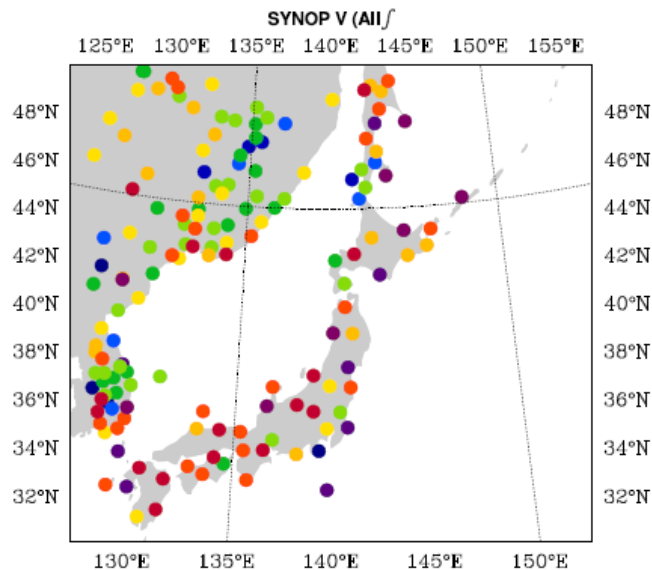
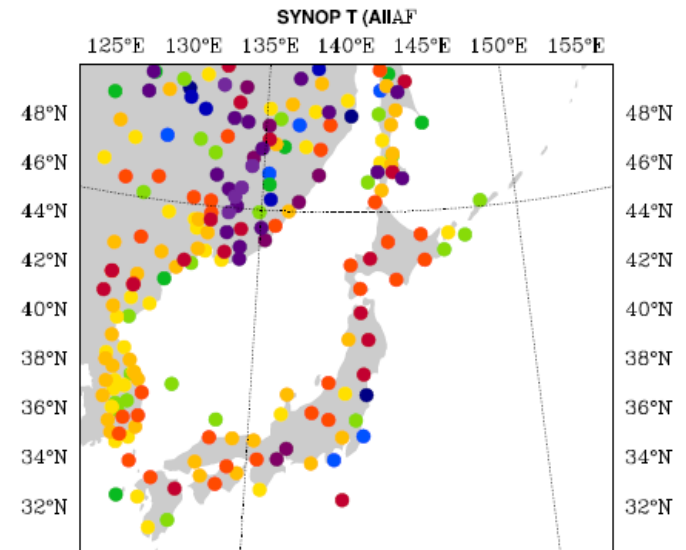
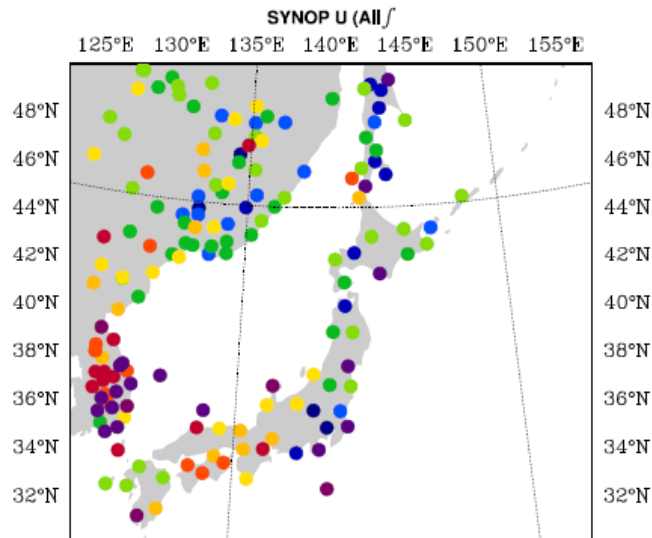
# Temperature forecast in Murmansk region

Изменение средней по области (67-69 с.ш.,35-40 в.д.) температуры



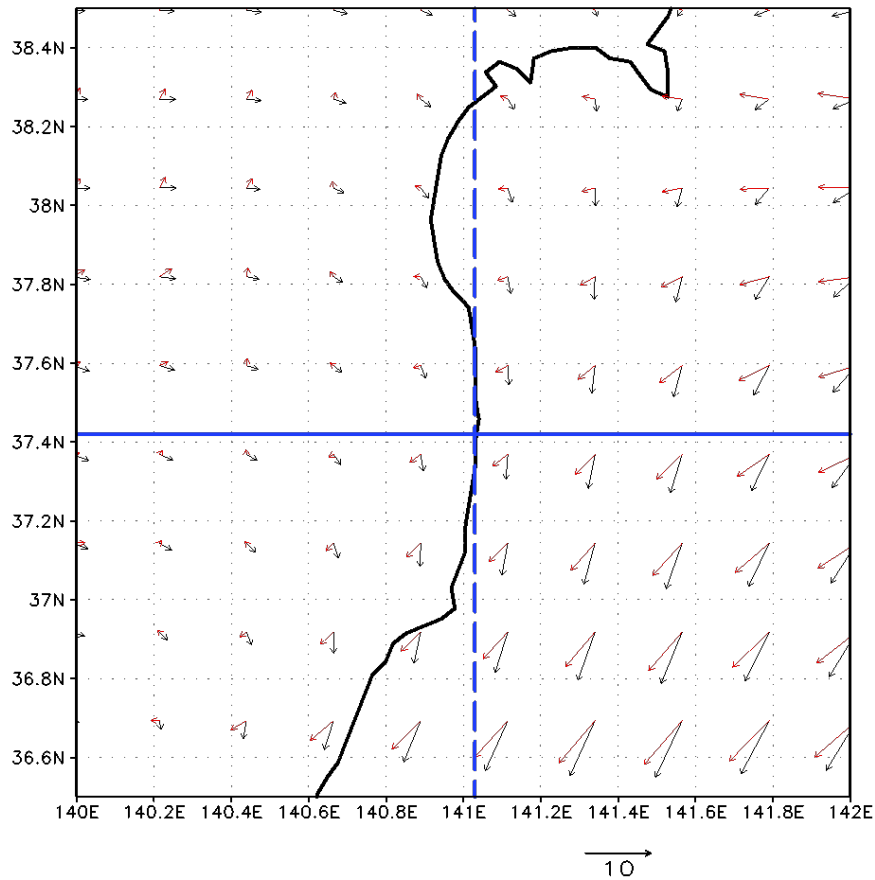
# Forecast around Fukushima

Differences between initial temperature field and station data

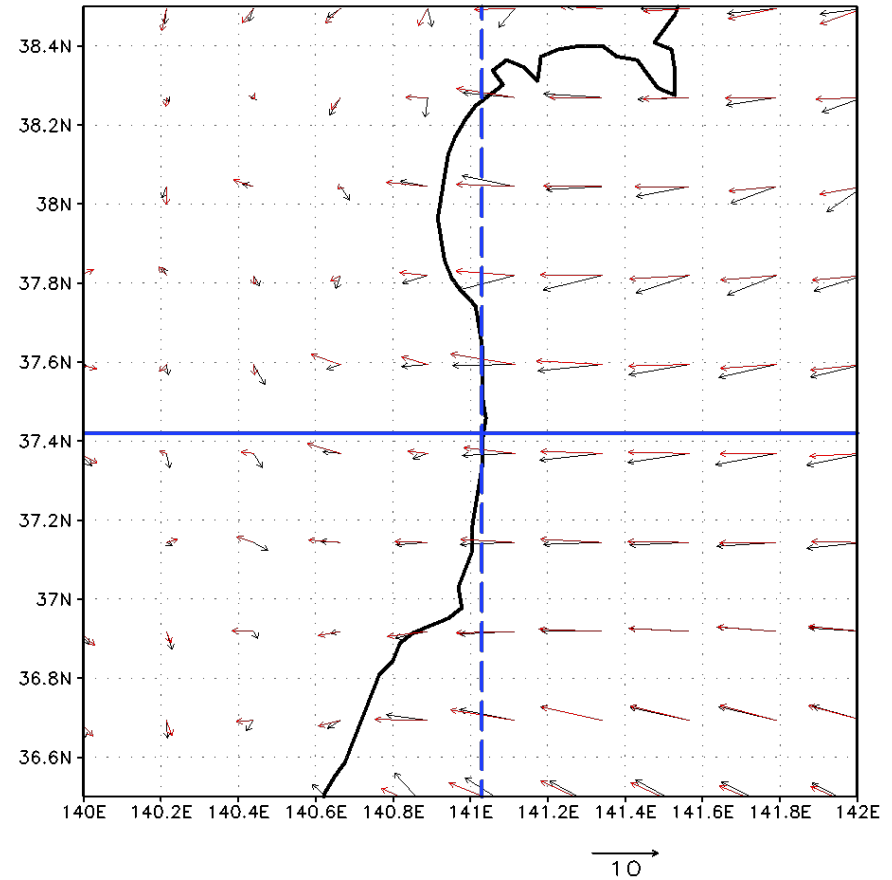


# Change of surface wind speed field

00h15mar +0h

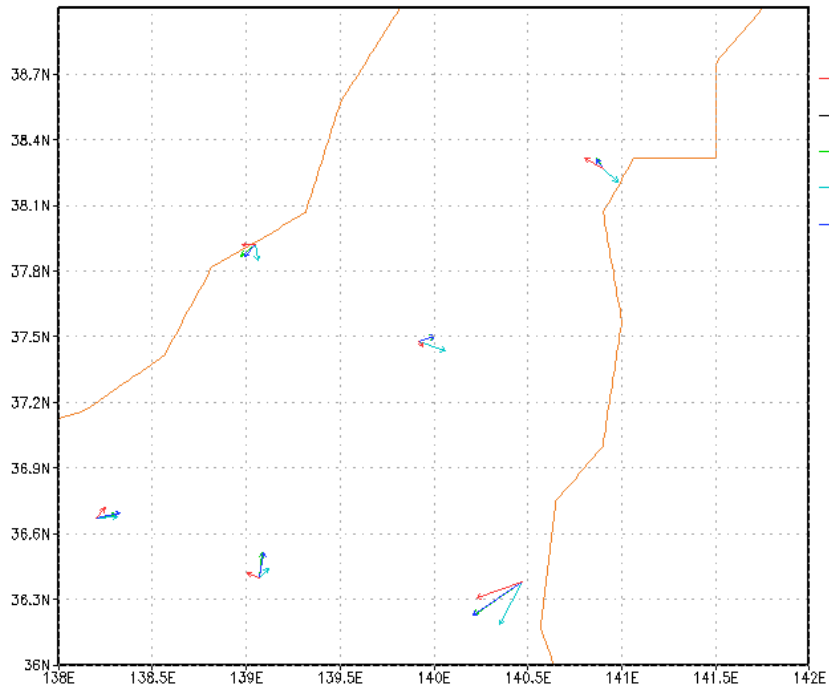


00h15mar +12h

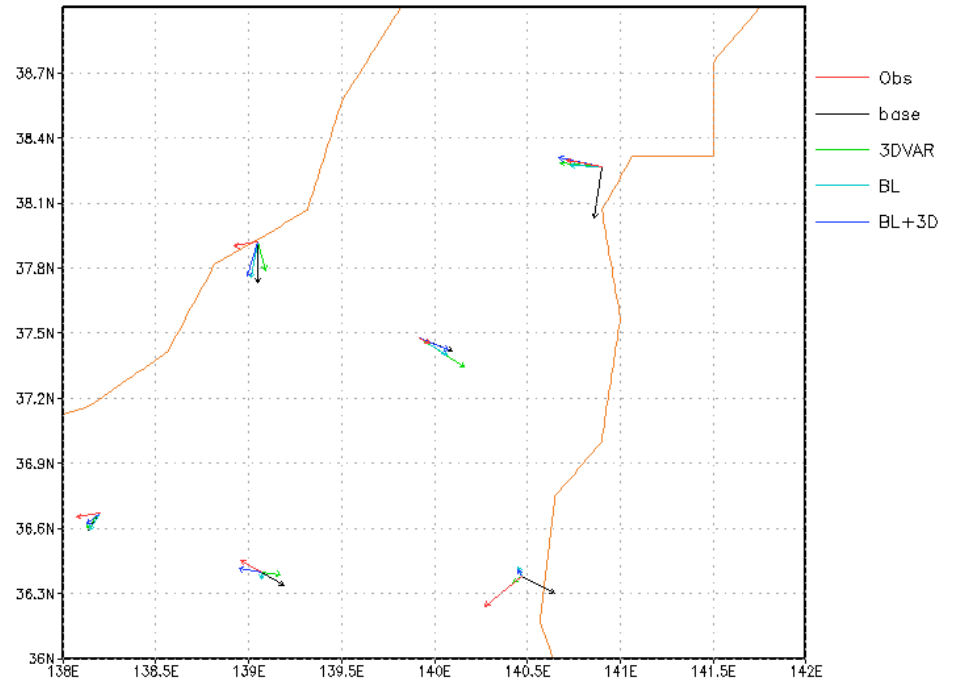


# Wind speed at stations

00z15mar2011

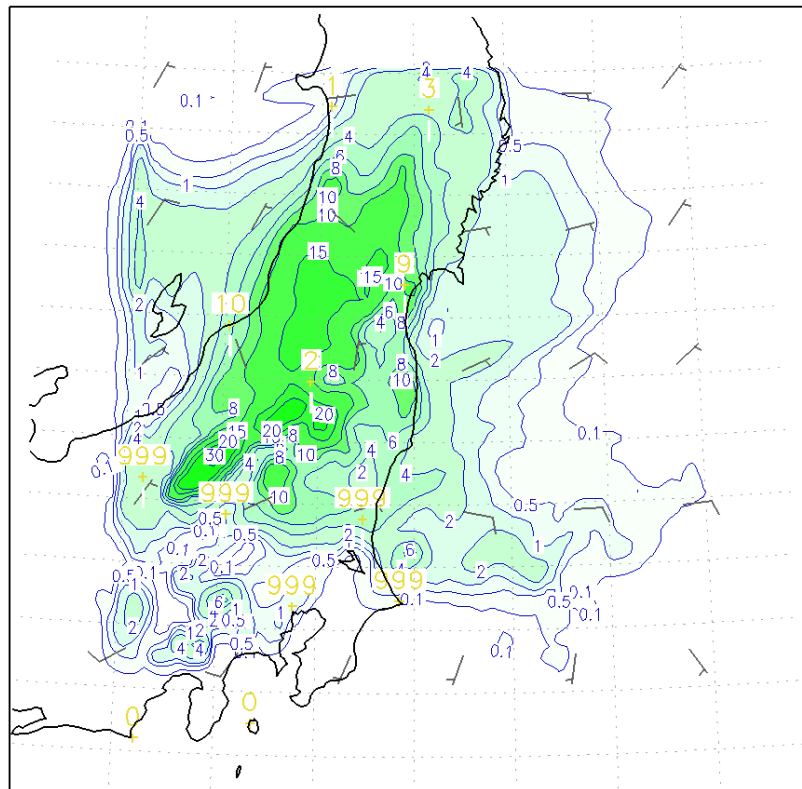


12z15mar2011

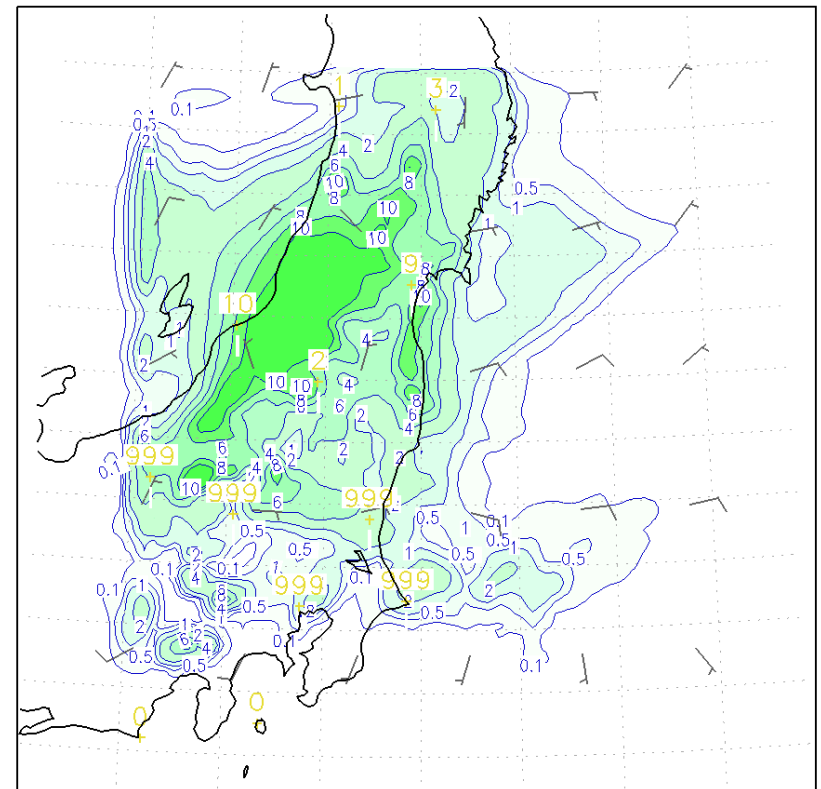


# Precipitations

forecast for 12 h



base

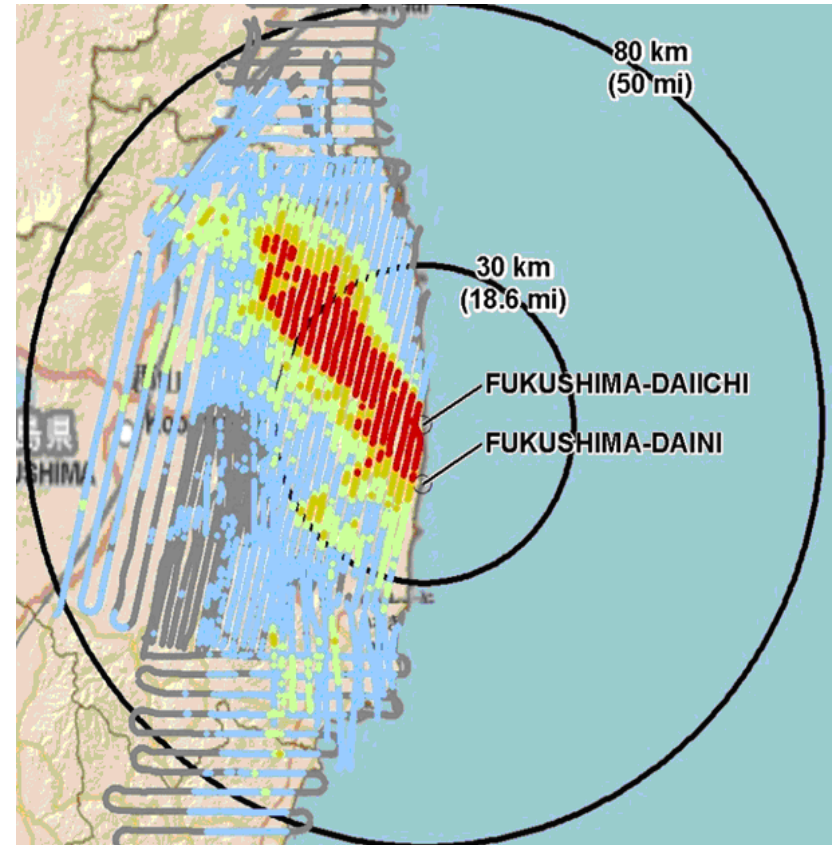
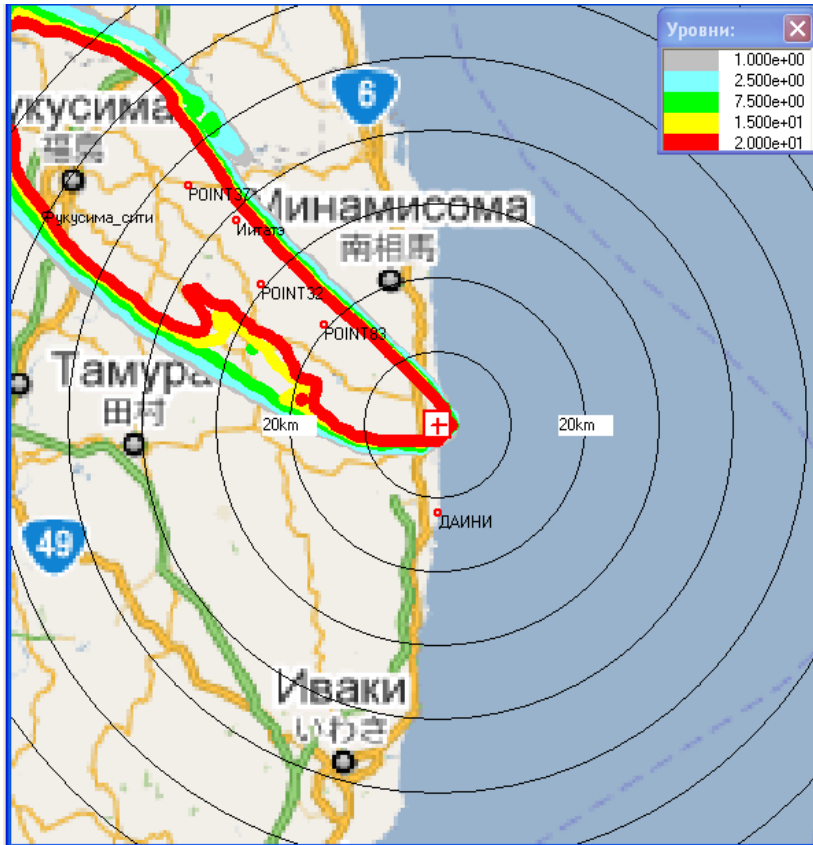


3DVAR

201

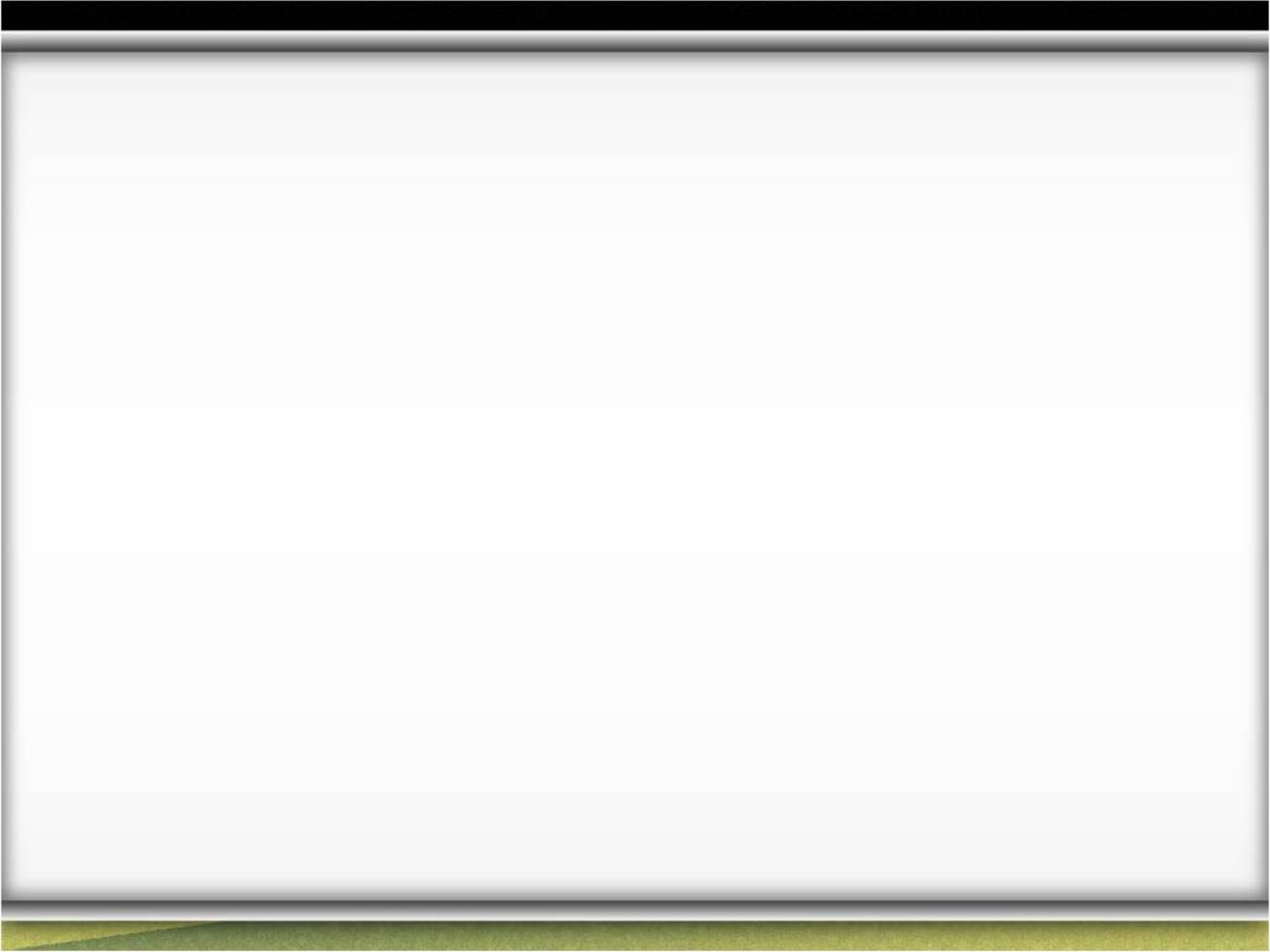
mm/12h

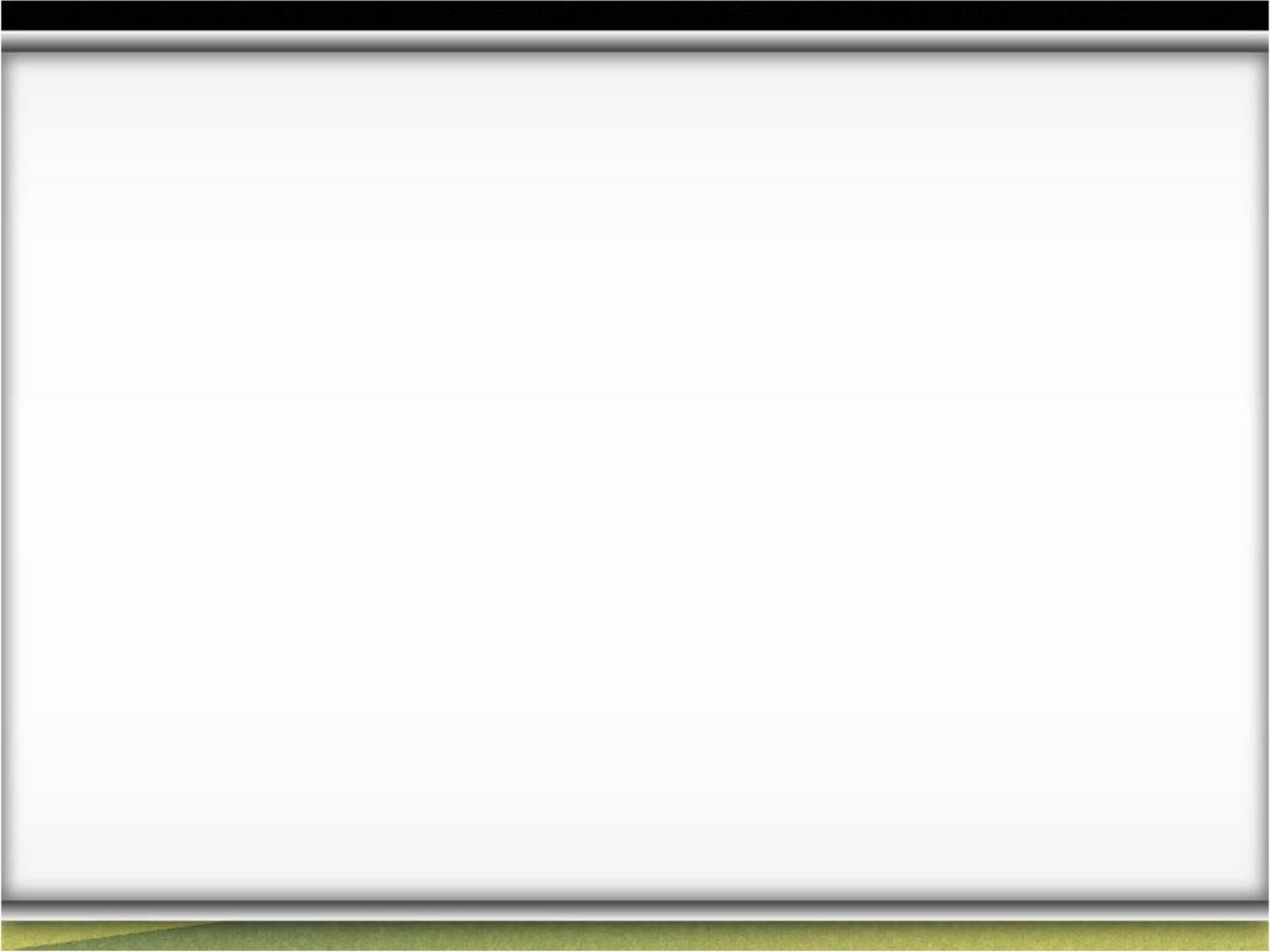
# Calculation of Surface Tracer Concentration



# Conclusions

- Presence of cases with huge differences between observation data and analyses was shown
- In such cases data assimilation generally decrease forecast errors
- 3DVAR influence is most significant in cases of big initial differences
- Initial data influence rapidly decrease with forecast time beginning about 36 hours
- Data assimilation mostly affect temperature forecast in winter, humidity in winter, and might wind in cases of very weak winds



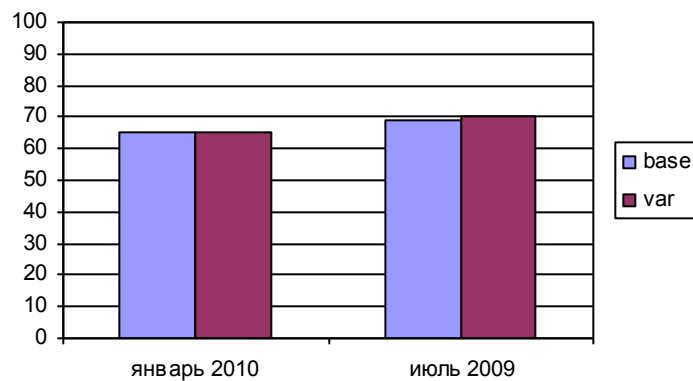


# Выводы

- Показано, что существуют случаи значительной разности между наблюдениями на станциях и анализом
- В таких случаях усвоение данных, как правило, позволяет улучшить начальных данные и соответствующий прогноз
- Влияние 3DVAR наиболее существенно при сильных отличиях данных наблюдений и анализа
- Влияние начальных данных ослабевает со сроком прогноза, начиная примерно с 36 часов.
- Эффект усвоения данных наиболее заметен в прогнозе температуры зимой, влажности летом и, вероятнее всего, ветра в случаях штиля.

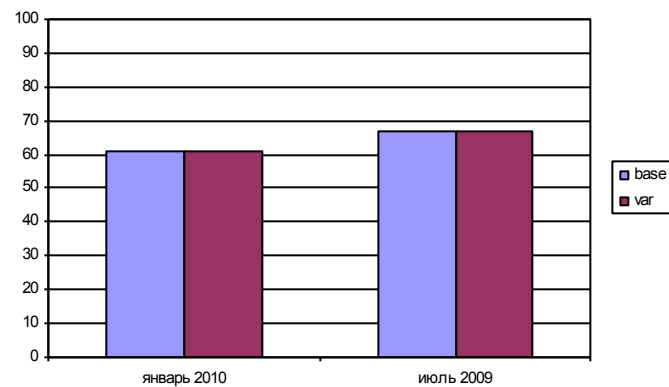
# ЕТР

Общая оправдываемость



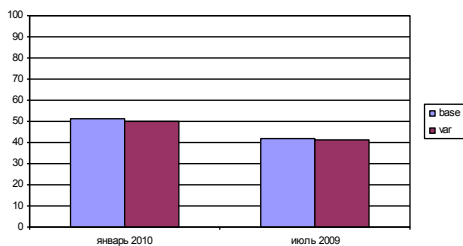
# Мурманск

Общая оправдываемость

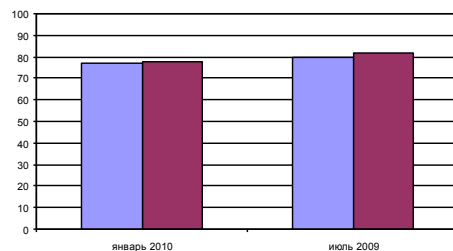


# ЕТР

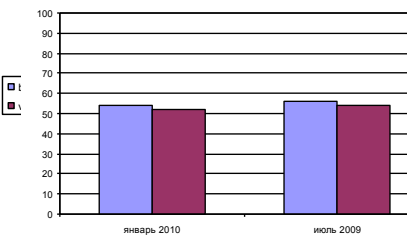
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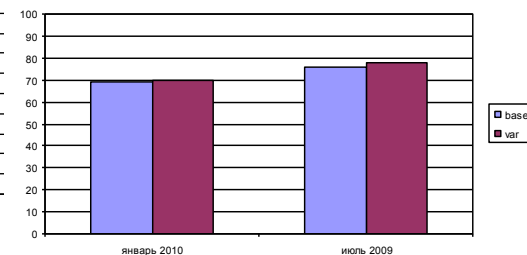
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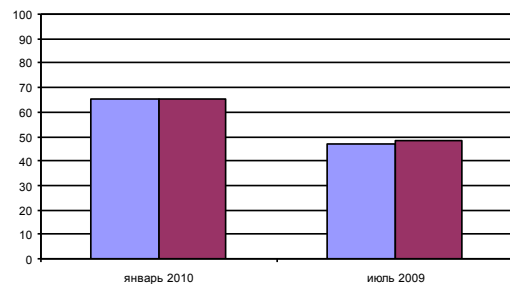
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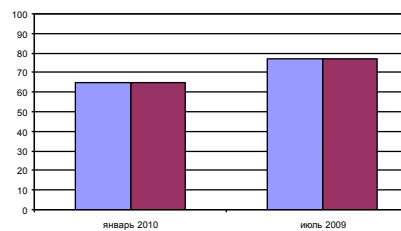
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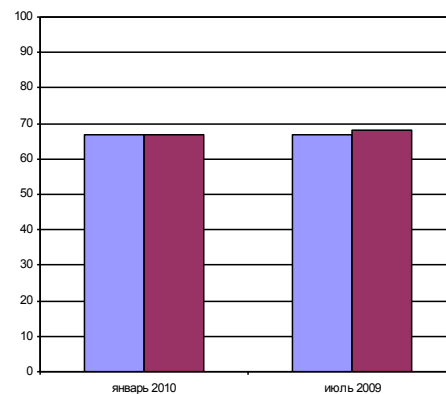
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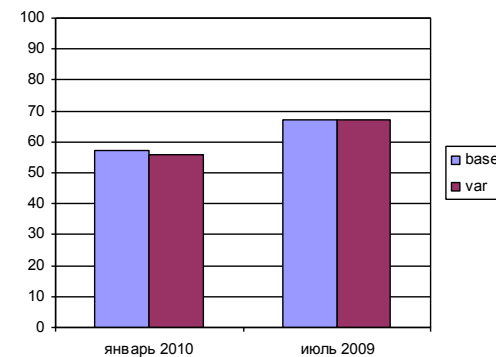
Предупрежденность факта БЕЗ осадков



Предупрежденность факта осадков



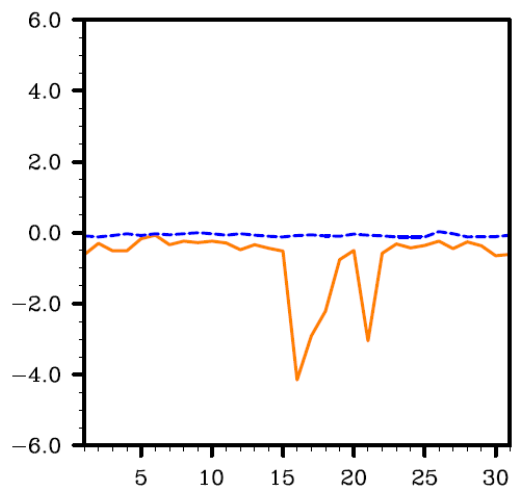
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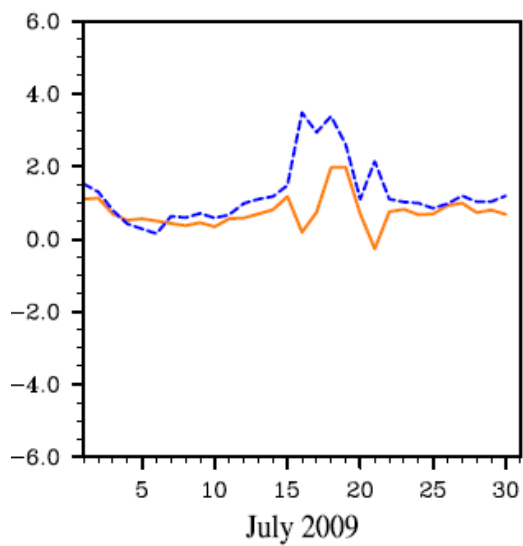
# Мурманск

# ЕТР июль

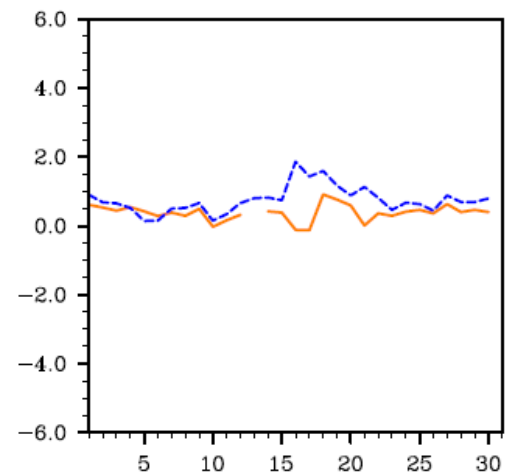
0 ч



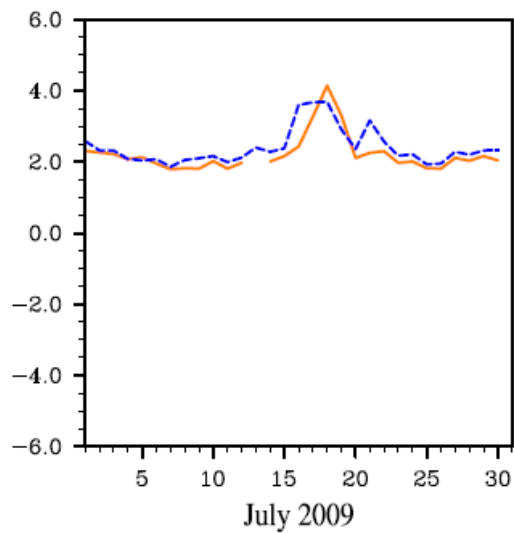
12 ч



24 ч

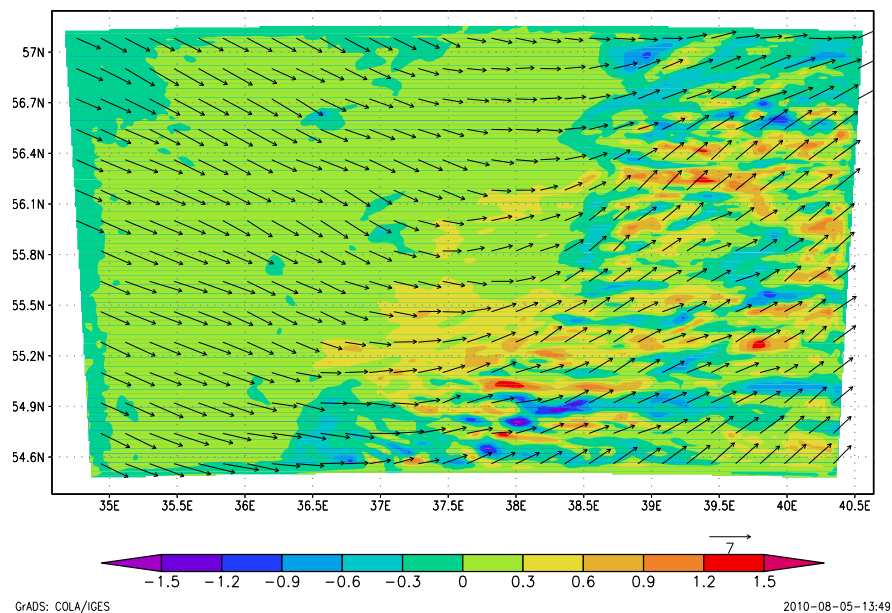


RMSE

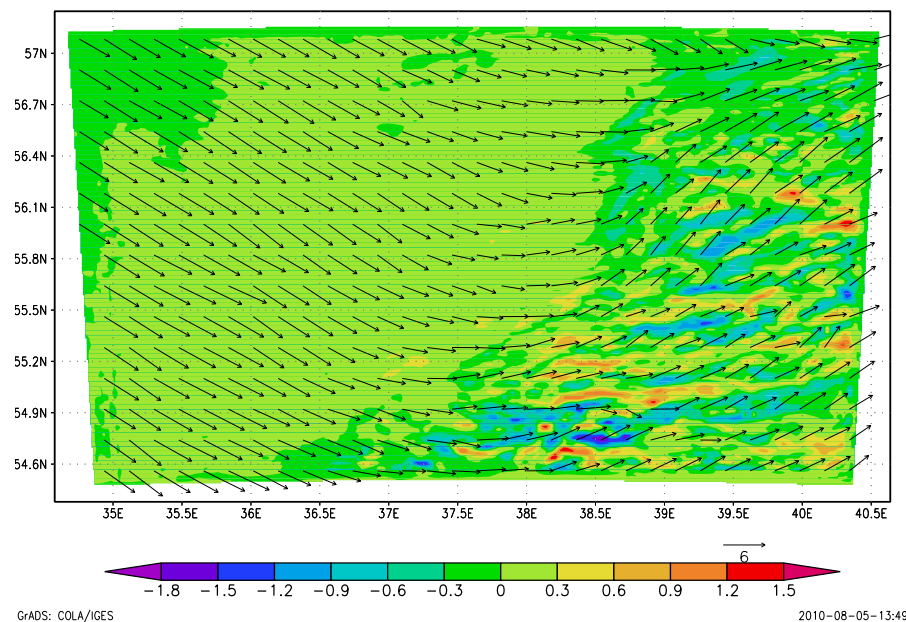


# Разность температуры между прогнозами и скорость ветра

nt=14

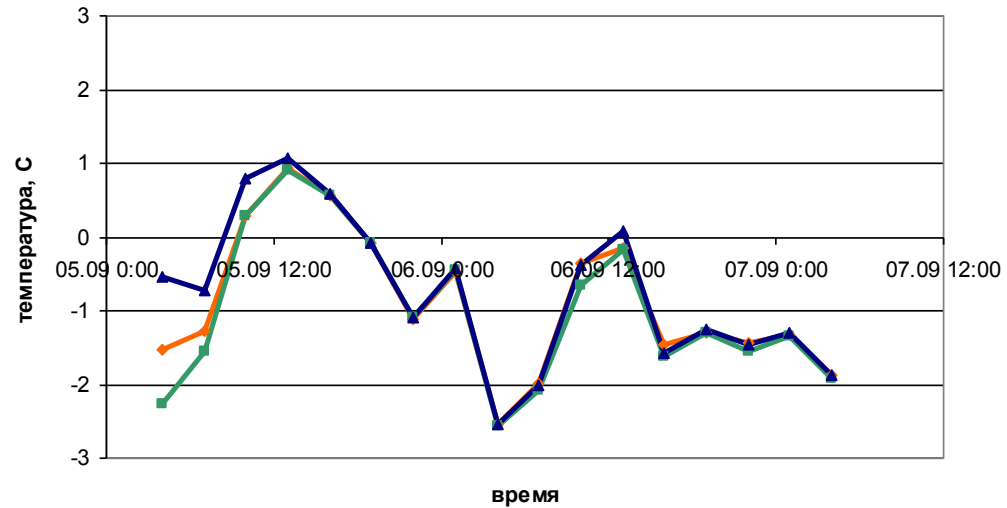


nt=17



# Усвоение профилей температуры

Ошибка прогноза температуры  
на уровне 2 м



Ошибка прогноза температуры  
на уровне 200 м

