The use of ASCAT ocean surface wind satellite observations in the data assimilation system based on the Local Ensemble Kalman Filter.

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1. Data assimilation system based on the Local Ensemble Kalman Filter.

The key idea of ensemble filters is to use ensemble of first guess instead of single vector and to find the ensemble of analysis instead of single vector with spread approximating the analysis error covariance matrix. This allow us to find first guess ensemble at the next assimilation step.

There are many forms for equations in ensemble filters. In Local Ensemble Transform Kalman Filter (LETKF) we perform computations in the ensemble space. In this space first guess error covariance matrix has a simple form . Final LETKF equations can be written as

$$\bar{x}^a = \bar{x}^b + X^b \widetilde{P}^a (HX^b)^T R^{-1} (y - H\bar{x}^b)$$

$$X^a = X^b [(k-1)\widetilde{P}^a]^{1/2}$$

$$\widetilde{P}^a = [(k-1)I + (HX^b)^T R^{-1} (HX^b)]^{-1}$$

Here is the analysis error covariance matrix in the first guess space.
The data assimilation system based on the LETKF is under development in Hydrometcentre of Russia.
Current version of this data assimilation system [8] assimilates following data:
1) SYNOP, SYNSHIP (surface weather stations and ship observations (approximately 10000 obs. at 00, 06, 12 and 18 UTS)).
2) TEMP (radiosonde observations at 16 p-levels, approximately 600-700 observations at 00 and 12 UTS., 70-90 at 06 and 18 UTS).
3) AIREP aircrafts observations (approximately 4000-11000).
4) SATOB satellite observations (more than 20000).

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2. ASCAT (Advanced SCATterometr).

Scatterometer is an active satellite instruments. It send signals with different polarizations and incidence angles and measure the amplitude of reflected signals from the water surface. This amplitude depends on the water surface form, which depends on the surface wind. So, scatterometers provide information about ocean surface wind components.

There are several problems with scatterometer observations. Rains (rain spots in the atmosphere and additional perturbation of the ocean surface) can cause significant changes of backscatter signal amplitude and increase observation errors. Coast and ice on the water surface also can course additional errors in observations. But in other cases this observations has enough accuracy and provide useful additional information about atmosphere state, which is especially important in data rare regions.

ASCAT is the latest generation of scatterometers and the only scatterometers available now. Today 2 ASCAT instruments are available. They are installed on the polar orbital satellites METOP-a and METOP-b of European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) and have global data coverage. Each ASCAT instrument provides observations in two 500km wide tracks separated by 700 km. Wind surface data are available at 12.5 and 25 km scale. The example of ASCAT data coverage in 6hr assimilation window is presented in fig.1.

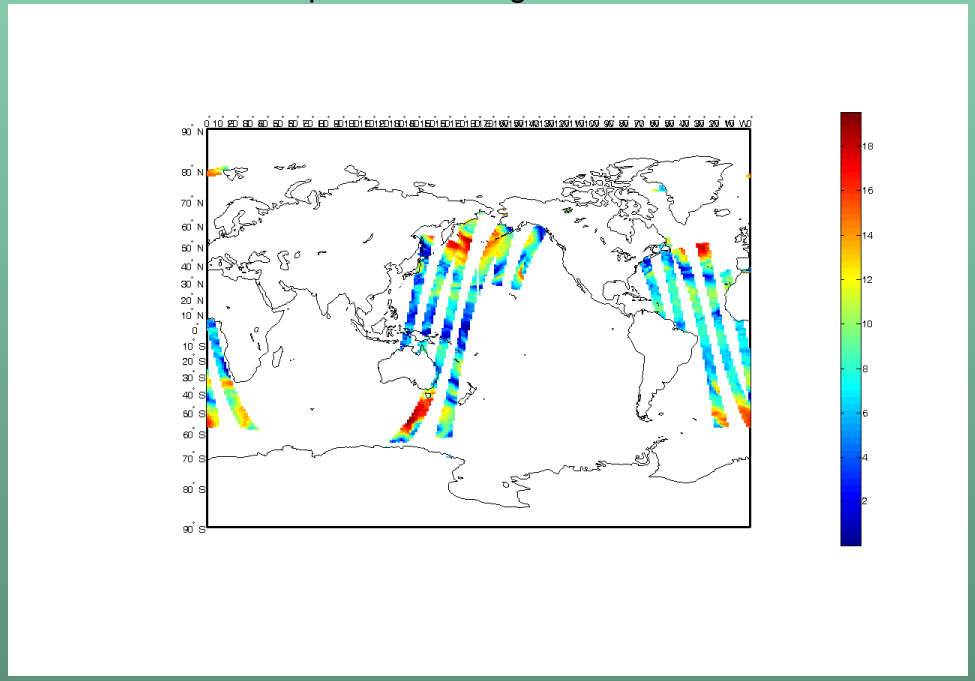

Fig.1. Surface wind speed in 6hr. assimilation window from 22hr. 9.11.2014 to 03hr. 10.11.2014.

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- We used this data in cycle assimilation together with global semilagrangian model SL-AV with 0.9*0,72 degrees horizontal resolution and 28 vertical sigma levels.
- Horizontal scale of this atmosphere model makes worthless the use of such detailed observations. ASCAT data with high resolution has significant observational errors. And errors of neighboring observations can be correlated and accurate accounting of this correlations can be difficult problem. To avoid this problems, all ASCAT observations were grouped into superobservations with resolution comparable to the model horizontal resolution.
- Numerical experiments with passive ASCAT data assimilation have shown significant dependence of observation error from the surface pressure. This dependence was used in observation error tuning. Also we didn't used observations from inland lakes, observations with extremely low surface pressure in first guess and observations with significant difference of model orography from the real height. This error dependence is shown below.

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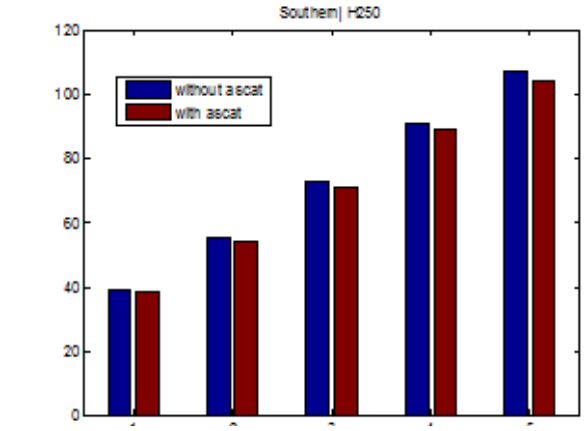

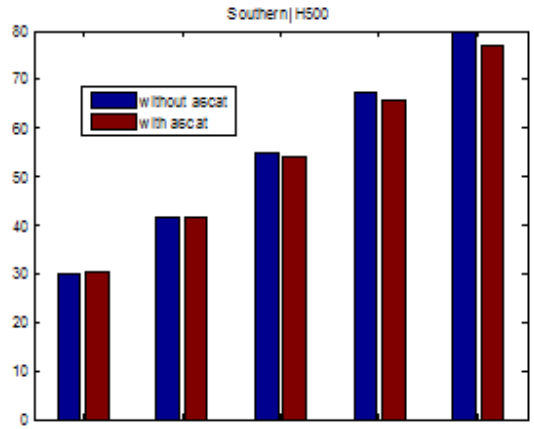

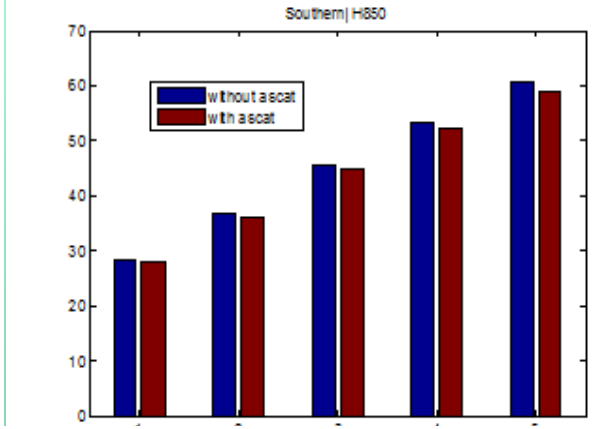

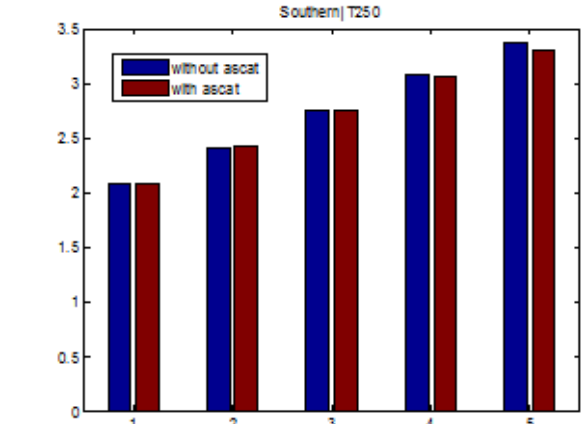

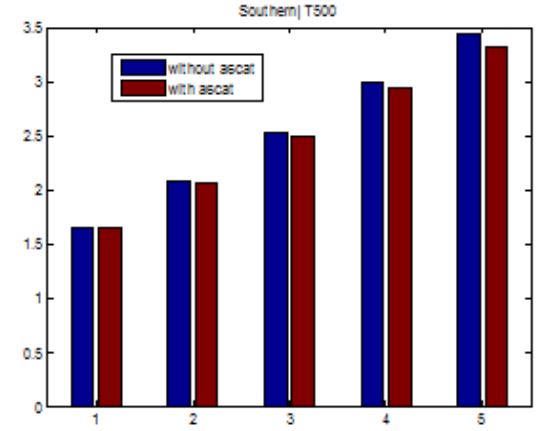

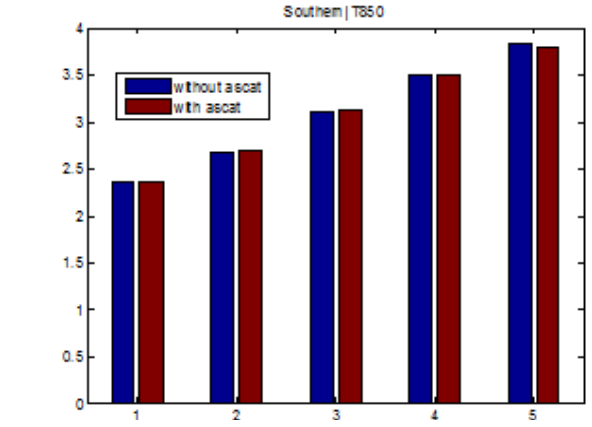

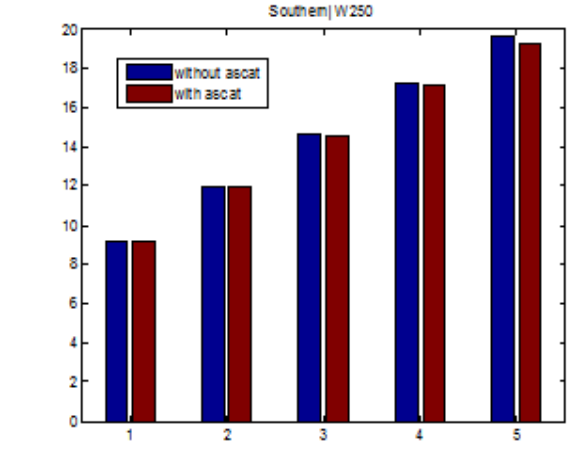

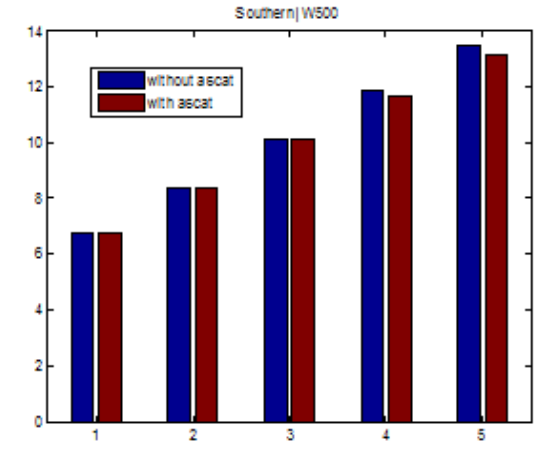

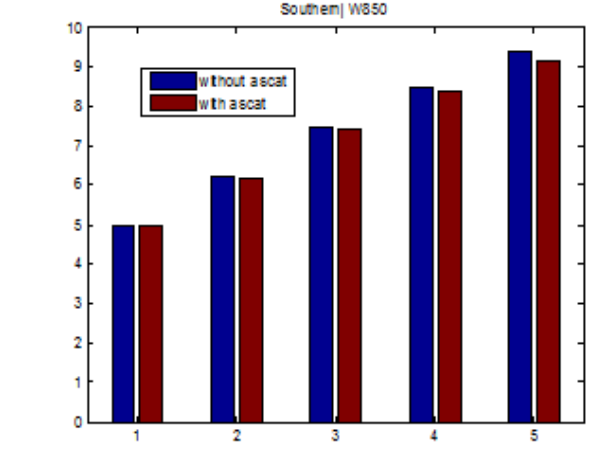

Спасибо за внимание.