Geophysical Research Abstracts
Vol. 12, EGU2010-3122-3, 2010
EGU General Assembly 2010

Simulation of Gaseous Fire Pollutants Transport Using the Remote Sensing Data

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Wildfires emissions spreading mechanism is one of the important problems when methods for forecasting of catastrophic fires smoke propagation are developing. The methodology of trace gases concentration reconstruction in the grid for the given region using fire remote sensing and meteorological data is presented. To estimate the area covered with smoke aerosol the methodology is developed by using backward trajectories calculation. Meteorological data on wind and temperature at the different specified isobaric surfaces were used for calculations. To reconstruct greenhouse gases concentrations the model for emissions estimation was applied using data on biomass burned. The adjustment of concentration values was performed by using of exponential interpolation. Because the wind characteristics were given with uncertainties, the backward trajectories were reconstructed considering errors in wind speed and direction measurements. The meteorological data on wind, temperature and height were provided by “Reanalisys” international archive and Russian Hydrometeorology Center (Moscow).
The gaseous pollutants spreading was simulated by using the ensemble of backward trajectories. The ensemble of wind fields was simulated by addition of random disturbances to the wind components. The concentration values at the grid nodes for the given region were reconstructed utilizing observation data and the emission transport model using the data assimilation procedure based on dynamic-stochastic approach. The average gas emission value and corresponding root-mean-square error of wind field forecasting were calculated using the sample of reconstructed concentration values on the basis of ensemble approach when calculating the backward trajectories.
Numerical experiments were conducted for forest fires which detected in Yakutia in 2002 and in Krasnoyarsk and Irkutsk regions in 2006. NOAA/AVHRR/TOVS and Terra/MODIS imagery of low and moderate spatial resolution for the Eastern Siberia, Republics of Sakha (Yakutia) and Tyva were used as the source of remote sensing data.
The calculations results were compared to the data of satellite monitoring of catastrophic forest fires. The satisfactory spatial coincidence between gaseous components maximum concentration areas and the areas of large fires was obtained.
The complex analysis of satellite imagery, meteorological data and the results of numerical analysis showed that the suggested methodology allows to obtain the trace gases distribution over the given region and outside it. The calculation results show that the large fires have not only local impact, but also can influence the atmosphere state over the large regions.

KEYWORDS: modeling, numerical experiments, data assimilation, meteorological data, remote sensing data, wildfires, smoke aerosol , backward trajectory, gas emission, Siberian boreal forests.