Forecast problem in the atmosphere as an optimization problem.

December 15, 2005

1 Introduction

Currently two main type of atmospheric forecast models can be distinguished. These are the global model, that consider the all globe to make the forecast and the regional model, that deals with a limited region. The basic difference between the models is the resolution of the grid on which the calculations are carried through. The global model uses a low resolution space grid and the regional model works with a more dence grid. The reason of the existence of these two types of model is, basically, computational. Even nowadays it is not possible to compute, in a acceptable time period, the global model with the detailed phisics and with the space resolution of the regional model. Thus, global and regional models work with different physical processes. The global model describes evolution of the large scale slow processes, with the character time period more than 3 hours and the tipical space dimension above 60 km. The regional model can describe evolution of the mesometheorological fast processes (small cyclones, tornados, storms), with the time period less than 3 hours and the space dimension between 500 meters and 60 km.

These models are described by a system of nonlienar partial differential equations. To solve the system that represents the global model we need only initial conditions and boundary conditions on the ground and at the top of the atmosphere. On the other hand, to get the solution of the regional model we also need lateral boundery conditions, because the domain is a closed region. In practice, the lateral boundery conditions for the regional model are obtained from the global model. For this the global model solution near the border of the regional model is interpolated into its lateral boundary grid points.

The lateral boundary conditions obtained from the global model solution do not respresent the atmospheric structures of smaller scale than the size of mesh of the global model. On the other hand, space and

time spectrum of the biggest meteorological structures are worse represented by the regional model than by the global model. This follows from the fact that the regional model have not the information about the phenomenae that occur outside of its domain and therefore cannot describe with good precision the results of these phenomenae development inside of its domain.

In this work we propose a way to resolve regional forecast problem using the global model data not only for initial and boundary conditions but also those which are available inside of the regional domain for forecast time period. To verify the approach, we will use the nonlinear barotropic vorticity equation of Rossby-Obukhov for both models, the global and the regional. For the global model we solve the equation directly, on a thick mesh, using a finite differences scheme of second order. Then on the base of global model solution we formulate the minimization problem for regional model, on a finer mesh.