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The sensitivity of a long-range numerical weather forecasting model

to small changes of the earth radius

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Abstract

The atmospheric processes are described by a system of complex nonlinear partial differential equations. Because of their non-linearity, it is not possible to solve these equations analytically. Thus, approximate numerical methods are used to solve them on powerful computers. The systems for approximate solving of atmospheric equations are called numerical models of the atmosphere. To run a numerical model of the atmosphere, one also needs to specify initial, as well as boundary conditions if regional models are used. Herewith, we are using a global model.

The non-linearity in the equations is producing chaotic behavior, e.g., a small perturbation of initial conditions in numerical model runs can produce divergent solutions. The connection between the initial disturbances and final consequences remains unpredictable in these solutions. These features are well known from E. Lorenz's papers.

In this work, the sensitivity to small perturbations in numerical integrations of a complex numerical model of the atmosphere has been investigated. Negligible changes of the Earth radius in the interval from 0.0001% to 1% of the reference value have been introduced. The results of the experiments have been compared on hemispheric

charts at the 500 hPa surface. The sensitivity to the computer round off-error has been analyzed, too. The obtained results can be used to assess the challenges of long-range weather and climate forecasting.