Level: Bachelor

Course title: Numerical methods of weather forecasting

Status: obligatory

ECTS: 6

Requirements: Dynamic Meteorology I and defended seminar

Learning objectives

Students acquire the basic knowledge of basic numerical methods in meteorology. Students are introduced to the basics of numerical schemes, as well as to the general approaches to horizontal and vertical numerical differentiation.

Learning outcomes

Upon completion of the course, students should have developed a general ability to follow the professional literature, to analyse different solutions and select the most appropriate ones. Students should be able to understand the processes that characterize the dynamics of the atmosphere, and to understand and use mathematical governments and numerical methods. This should qualify them to work in scientific research institutions of the importance in Meteorology.

Syllabus

Theoretical instruction

Numerical methods in meteorology. Discrete presentation functions. Control examples of differential equations. Basic numerical methods. Basics of finite difference methods. Fundamentals. Convergence and stability. Stability testing. Conclusion. Numerical differentiation in time. Introduction. Examples of numerical schemes. Features scheme in the application of the oscillatory equation. Features scheme in the application of the equation of friction. Equation of depreciated oscillations. Noise in time and filtering.

Advective equations. Scheme with central differences in space. Calculated dispersion. Scheme with non-central difference. Approximation of fourth-order accuracy in space for an excerpt. Advective dimensional equations. Error recognition and nonlinear instability. Prevention of nonlinear instability. Horizontal numerical differentiation – Euler approach. Basic principles of horizontal and square mesh. Geostrophic adjust to different square grid. Comparison of geostrophic network settings B / E and C. Nonlinear advection and basic properties of Arakawa Jacobian. Additional features of Arakawa Jakobian. Arakawa Jacobian advective scheme as the C and E networks. Energy conservation and the C network and the implications to the nonlinear cascade. Conservation of energy and the E network and the implications of the nonlinear cascade. The semi-generalization scheme for network divergent flow. Conclusions about the schemes that conserve energy and entropy for divergent flow. Horizontal numerical differentiation – Semi-Lagrangian approach. Semi- Lagrange schemes, linear advection with constant speed, stability and accuracy. Semi- Lagrangian scheme, linear, non-constant advection speed, stability, accuracy and convergence condition. Semi-Lagrangian scheme, linear, non-constant advection speed on pushing. Horizontal numerical differentiation - spectral approach. The method of spectral transformation. Computational efficiency. General problems, Flashover and Eliason schemes. Economical explicit scheme, the scheme forward-backward on the E / B network. Vertical numerical differentiation. The main problems, the general form of the pressure gradient force in the system. Discretization and calculation of the gradient force. Analysis of error in gradient force and the possibility of its reduction.

Practical instruction

Weekly teaching load				Other:
Lectures: 3	Exercises: 2	Other forms of teaching: 0	Student research:	