

# Numerical Weather Prediction MAPH P313

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## *Syllabus*

**Text:** *Atmospheric Modeling, Data Assimilation and Predictability*, by **Eugenia Kalnay**, Cambridge University Press (2002).

## 1 Numerical Weather Prediction

### 1.1 *Basic NWP System.*

Data Acquisition and Quality Control. Objective Analysis. Prediction Model. Post-processing. Verification. Graphical Interface. Forecast Products.

### 1.2 *Data Assimilation.*

Review of Methods. Optimal Interpolation. Variational Analysis. 4-Dimensional Assimilation. Kalman Filtering. Quantitative Use of Satellite Data.

### 1.3 *Initialization.*

Historical Review of Filtering Methods. Filtering of Sound and Gravity Waves. Nonlinear Normal Mode Initialization. The Digital Filtering Technique.

### 1.4 *Numerical Methods.*

Finite Difference Method. Spectral Method. Time Integration Schemes. Numerical Stability. CFL Criterion. Eulerian and Lagrangian Advection. Semi-implicit Method. Helmholtz Equations on a Sphere. Treatment of Lateral and Upper Boundary Conditions. Non-linear Numerical Instability.

### 1.5 *Numerical Prediction Models.*

Quasi-geostrophic Filtering. The Equivalent Barotropic Model. QG and Balanced Baroclinic Models. Primitive Equation Models. Vertical Discretisation and Grid Staggering.

### 1.6 *Physical Parameterisation.*

Radiation Processes. Cloud Parameterisation. Turbulence Schemes. Surface Energy Balance.

### **1.7** *Analysis of Specific Modelling Systems.*

Global Gridpoint Models. Global Spectral Model: ECMWF. Limited Area Model: HIRLAM. Introduction to Nowcasting Systems.

### **1.8** *Predictability.*

Limitations on Deterministic Prediction. The Lorenz Convection Model. Implications of Chaos Theory. Probability and Ensemble Forecasting.

### **1.9** *Climate Modelling.*

Climate Variability and Climate Change. Coupled Atmosphere-Ocean Models. Climate Change Detection. Climate Change Simulation. Climate Change Impacts. Politico-Economic Implications. Global Climate Simulation: Hadley Centre Model. Regional Climate Simulation: Rossby Centre Model.