Numerical Techniques 2025–2026

0. Welcome

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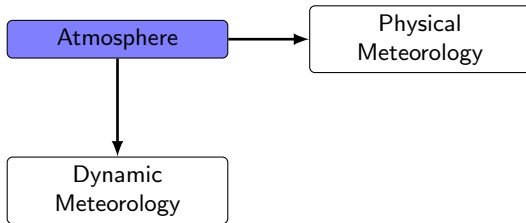
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Postgraduate Studies in Weather and Climate Modeling
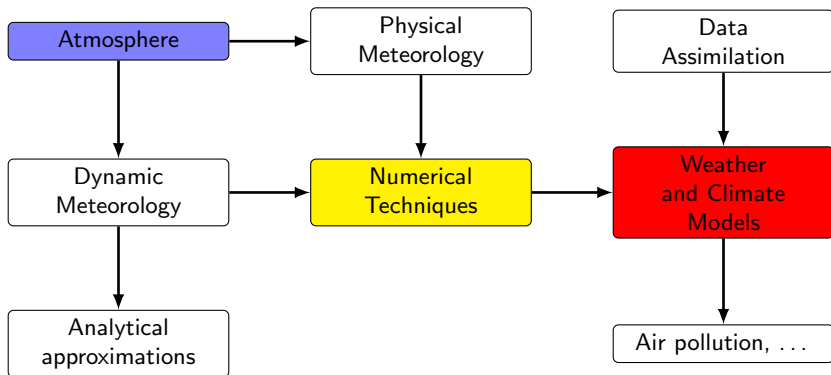
Ghent University

Content

- Welcome

- Context: why numerical techniques

- Objectives of this course

- Course material

- Practical information

Atmosphere

- Get hold of problems that occur due to solving equations numerically (with a computer)

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- Don't be frightened by code
  . . . but it's no course on programming either!

Relation to AI-driven models

- AI-driven weather models are performing better and better, sometimes beating physics-based models on specific scores, often at a fraction of the computational cost

- *[personal assessment!]* This will make physics-based models less and less relevant, especially for operational weather forecasting

- Nevertheless,
  - Physics-based models remain (for now) important for training AI models
  - There is value in scientific understanding
  - Many aspects treated in this course are also relevant for AI models, e.g. time-stepping, stability, scalability, etc.

date	16h00	17h30
22/09	Introduction, Stability	(optional) Practicum Python basics
29/09	Time discretization	
06/10	Time discretization (cont'd)	Space discretization
13/10	Space discretization (cont'd)	Spectral methods Advection equation
27/10	Nonlinearity	Practicum Linux & Fortran
10/11	Semi-Implicit and Semi-Lagrangian models	Project assignment + finish practica
17/11	Parallel computing (TBC)	Project support session
24/11	Guest lecture (TBC)	Project support session
01/12	Guest lecture (TBC)	Project support session
08/12	Student project presentations	

- Slides will appear on Ufora

- All material (slides sources, Jupyter notebooks) available on
  https://github.com/ddegrauwe/ugent_numtech

- References:

    ▶ *Numerical Methods for Wave Equations in Geophysical Fluid Dynamics*,
      Dale R. Durran, Springer, 1999, ISBN 0-387-98376-7.

    ▶ *Chebyshev and Fourier Spectral Methods*, John P. Boyd, Springer, 2001, ISBN
      978-3-540-51487-9.

- Some papers (depending on project)

- (Check Ufora for modifications to time schedule)

- Practical sessions

  ▶ We will use High-Performance Computing (HPC) infrastructure of UGent: create account on

    https://www.ugent.be/hpc/en/access/faq/access

  ▶ access through browser via https://login.hpc.ugent.be

  ▶ ...or you can just install Linux on your laptop

- Programs needed: python, Jupyter notebooks

- Evaluation: student project (2/3/4 persons) on simple model

  ▶ presentation for other students

  ▶ (small) report

Questions?