Numerical Techniques 2025–2026

0. Welcome

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Postgraduate Studies in Weather and Climate Modeling

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Content

- Welcome
- Context: why numerical techniques
- Objectives of this course
- Course material
- Practical information

Why numerical techniques?

Atmosphere

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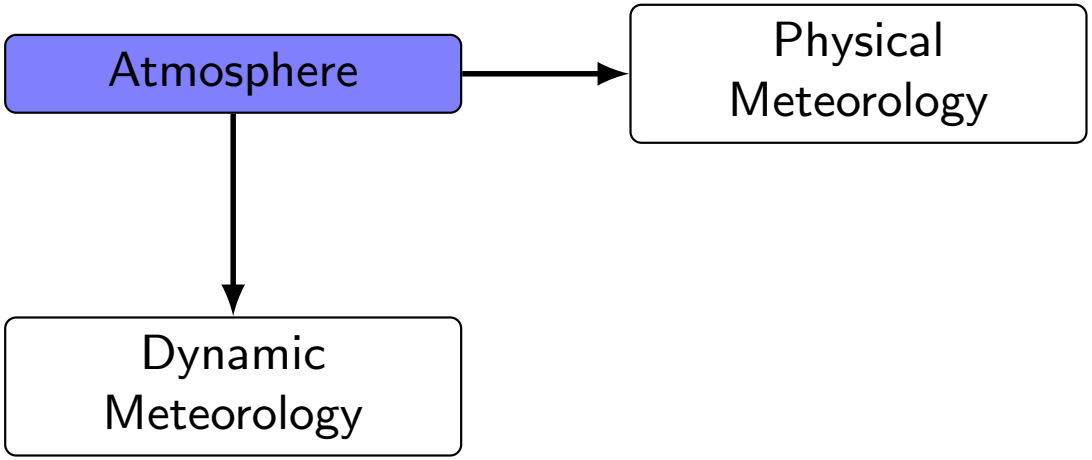

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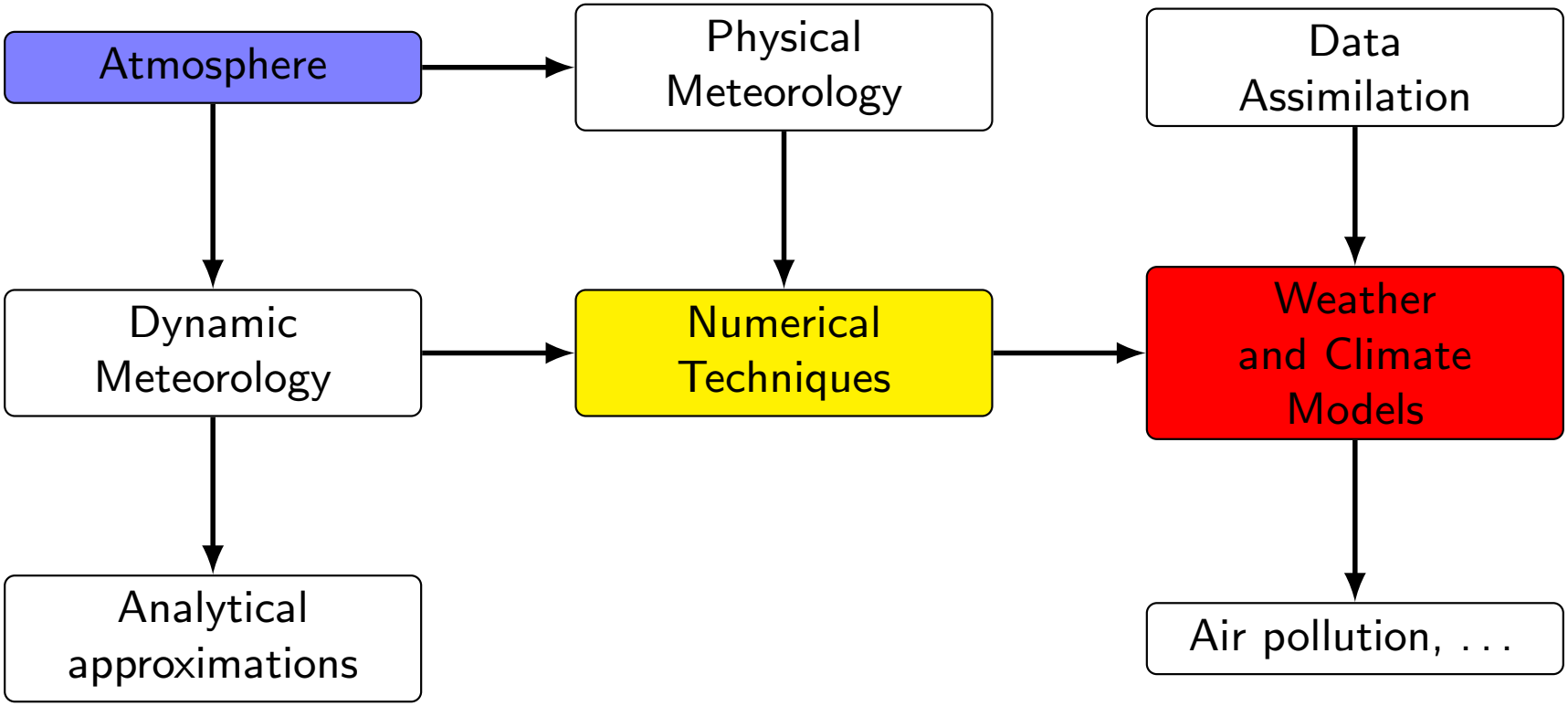

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- Don't be frightened by code
  . . . but it's no course on programming either!

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.

Course agenda

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
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	

Course material

- 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)

Practical information

- (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?