CELO* Priority Project
Continuation of the CDC project

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*Celo – in Esperanto: goal, aim, purpose

CELO motivation

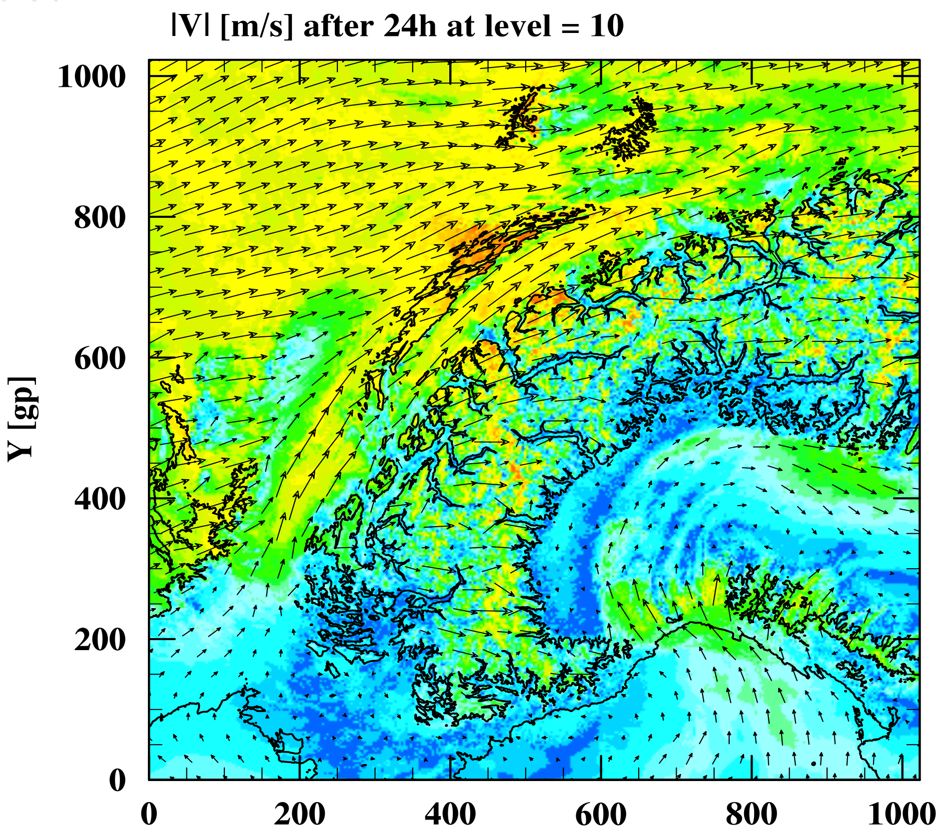
Tatra mountains, IMGW mountain observatory

The future very-high resolution COSMO model will require a **robust and efficient** dynamical core allowing for:

- explicit representation of vigorous convective processes involving close coupling of dynamics and physics
- successful handling of steep mountain slopes.

Kłodzko (Glatz) in *Mittelsudeten* after 1997 "Millenium Flood"

CELO motivation



In CDC Priority Project, Eulag DC proven robustness in treating steep mountain slopes, as well as reasonable efficiency, following the excellent scientific record of Eulag.

No major obstacles towards full integration with COSMO has been observed so far.

Propotype Cosmo-Eulag running at 0.55 km resolution

CELO actions

- Integration of EULAG DC with COSMO framework (Task 1)
- Consolidation of the EULAG DC formulation (Task 2)
- Code engineering towards clarity, performance and adaptation to emerging architectures (Task 3)
- Optimization, tuning and testing of the model (Task 4)

CELO Task 1

- coupling to a complete necessary set of physical parameterizations (adaptation to A-grid may be needed)

- coupling with surface model

- implementation of appropriate organization of computational domain
  - ➔ standarization of halo treatment and relaxation profiles

CELO Task 2

- Optimization of boundary conditions treatment
  - Optimal boundary conditions to MPDATA, sourcing the data from the halo for correct inflow information
  - Optimal way of adjusting the flow at the boundaries to satisfy the integrability condition (multiplicative, additive, no adjustment and variable upper boundary/mass of the domain)
- Implementing a flexible vertical coordinate transformation

$$(t;x;y;z) \equiv (t;E(x;y;t);D(x;y;t);C(x;y;t))$$

$$\Downarrow$$

$$(t;x;y;z) \equiv (t;E(x;y;t);D(x;y;t);C(x;y;z;t))$$

- Allowing variable mass in the computational domain
  - relaxing the need to adjust mass flux on boundaries to ensure integrability
- Optimal implementation of full pressure recovery
  - reconstruction from anelastic pressure perturbation, integration over domain (MesoNH approach)
- Efficiency of the preconditioner
  - what is the optimal degree of accuracy demanded from pressure solver

CELO Task 3

- Code optimization and restructuring
  - EULAG DC core will be restructured for clearer exposition of its algorithmical foundation
  - Optimizations minimizing the need for communication, especially global operations of pressure solver will be introduced
  - Overlapping of computation and communications will be added

- Integration of restart subroutines
  - Needed for climate mode

- Introduction of flexible parallelization subdomains
  - Loop ranges and boundary conditions will be modified to allow for flexible subdomain size

- Assessment of the applicability of the stencil library (link to POMPA)

CELO Task 4 (After accompilishing tasks 1-3)

- Tuning of physical parameterizations and models
  - Important parametrizations' parameters tuned for RK core need to be identified
  - Sensitivity of EULAG DC to these parameters need to be determined and tested for optimal settings

- NWP suite testing
  - EULAG DC needs to be run routinely in NWP suite mode to acquire its general tendencies, biases and forecasting score parameters for various meteorological realizations

- Climate mode testing
  - Long term regional climate runs are needed

CELO Task 4 cont.

- Case studies
- Conservation properties testing
- Preparation of the “Dynamics and Numerics” documentation
- Preparation of the “Implementation” documentation

CELO co-sponsors and links

- Task 1 is supported by the NCAR DOE grant "Multiscale simulation of moist global atmospheric flows" by NCAR staff with up to date IMGW team member Marcin Kurowski in part regarding the role of anelastic pressure perturbation in moist processes

- Task 2 is cofunded by the project "Towards peta-scale numerical weather prediction for Europe" of the Foundation for Polish Science within Homing Plus program, 2012-2014 funded by the UE Innovative Economy programme

- Task 1 and 4 are naturally connected to the Cosmo NExT aiming at 1 km forecast for alpine regions

- Resources of Task 3 regarding the stencil library will be supported by the National Science Centre (NSC) grant "Methods and algorithms for organization of computations in the class of anelastic numerical models for geophysical flows on modern computer architectures with realization in the EULAG model ", 2012-2015.