Testing the new ACDRAG scheme in the ALPIA environment

Bart Catry
Ghent University
Belgium

F. Bouyssel (Fr)
R. Brozkova (Cz)
J. Cedilnik (Si)

M. Derkova (Sk)
D. Dvar (Hr)
J.-F. Geleyn (Fr)
R. Mladek (Cz)

Outline Presentation

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- The new ACDRAG scheme (short)
- The ALPIA domain
- Momentum Budgets
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- Need for a parameterization scheme ?
- Suppression of the envelope
- Conclusions

Introduction

Representation of the subgrid scale effects

of the unresolved orography:

- Increased surface roughness length
- Envelope orography (flow blocking & valley air isolation) Still needed while others don't
- Gravity wave & from drag Contradiction concerning F_c
- Lift (volume effect orthogonal to the background wind) Need for a geostrophic wind approximation

Problems

The new ACDRAG scheme

F	inverse Froude number
F_c	critical F value (=0.5)
τ	total surface stress
τ_{lin}	surface stress from the linear theory
C_d	drag coefficient

Old scheme

$F < F_c$: $\tau = \tau_{lin} F_c / F$

$F > F_c$: $\tau = \tau_{lin} \frac{F_c}{F}\left(1 + C_d \frac{F_c}{F}\left(1 - \frac{F_c}{F}\right)\right)$

New scheme

$F < F_c$: $\tau = \tau_{lin}$

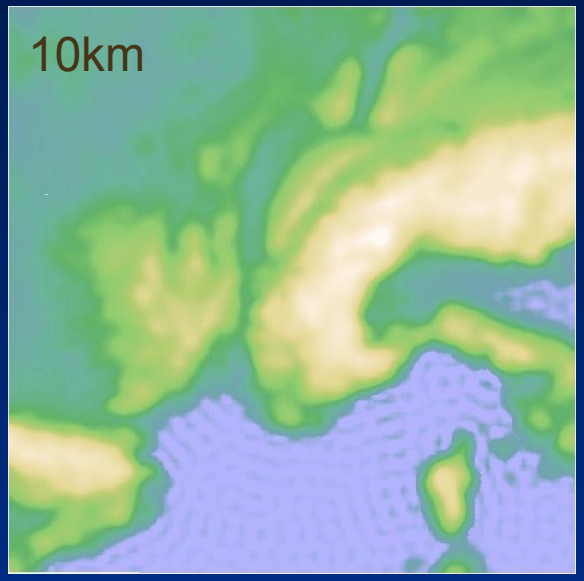
$F > F_c$: $\tau = \tau_{lin} \frac{F_c}{F}\left(1 + C_d\left(1 - \frac{F_c}{F}\right)\right)$

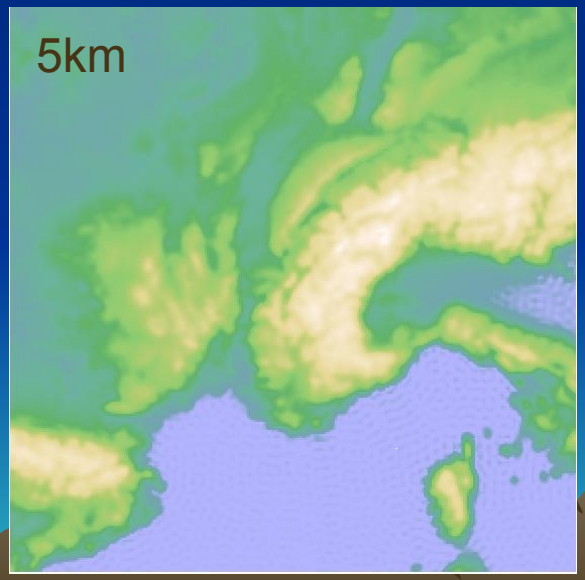
+ new lift

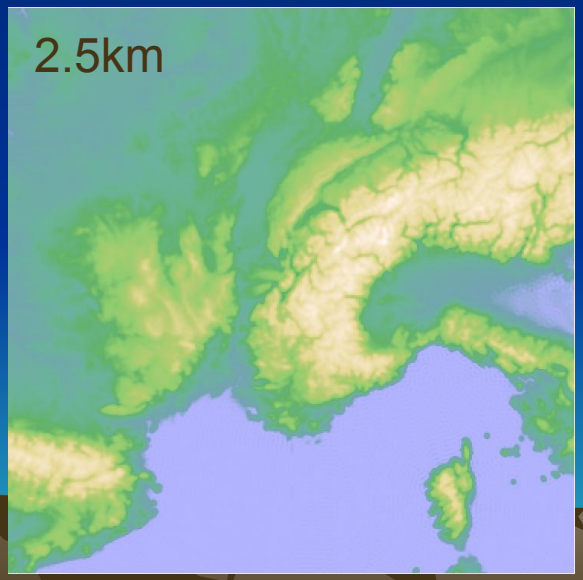
The ALPIA domain

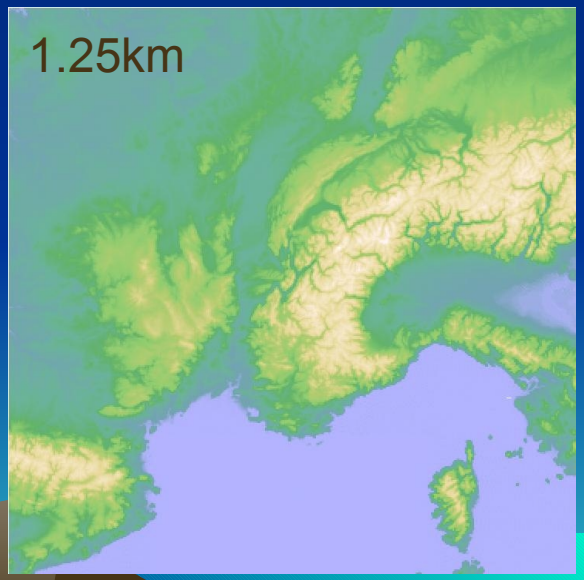
Domain centered over the French Alps in 4 different resolutions:

10 km	96 x 96 x 37
5 km	192 x 192 x 52
2.5 km	384 x 384 x 71
1.25 km	768 x 768 x 96









Momentum Budgets

Momentum budgets are studied in a box (of which the height varies from 0 to 20km)

Should agree the following balance equation (e.g. for the meridional case):

$$\overleftrightarrow{\frac{\partial(\rho v)}{\partial t}} + \overleftrightarrow{\frac{\partial(\rho uv)}{\partial x}} + \overleftrightarrow{\frac{\partial(\rho v^2)}{\partial y}} + \overleftrightarrow{(\rho uw)_z} + \overleftrightarrow{\frac{\partial(p - p_{ref})}{\partial y}} + \overleftrightarrow{\rho f u} + \overleftrightarrow{(p - p_{ref})_h \frac{\partial h}{\partial y}} + \text{param} = 0$$

With: $\overleftrightarrow{Q} = \int_h^z Q dz,$

h: surface
z: top of the box

Contribution of parameterizations

$$\overline{Q} = \frac{1}{A} \iint_A Q dx dy$$

Experiments (Semi-Academical)

- The atmosphere is dry, inviscid, in hydrostatic equilibrium and its static stability is given by a constant Brunt-Vaisälä frequency $N = 0.01$
- A constant reference flow of 7 m/s form the NW
- Geostrophic equilibrium with a constant Coriolis parameter $f = 0.0001$
- Reference values of temperature and density prescribed in the middle of the domain at sea level: $T_0 = 300K$ and $\rho_0 = 1\ kg/m^3$
- Forecast length set to 6 hours
- Two time level semi Lagrangian semi implicit approach with an Aladin 15 master

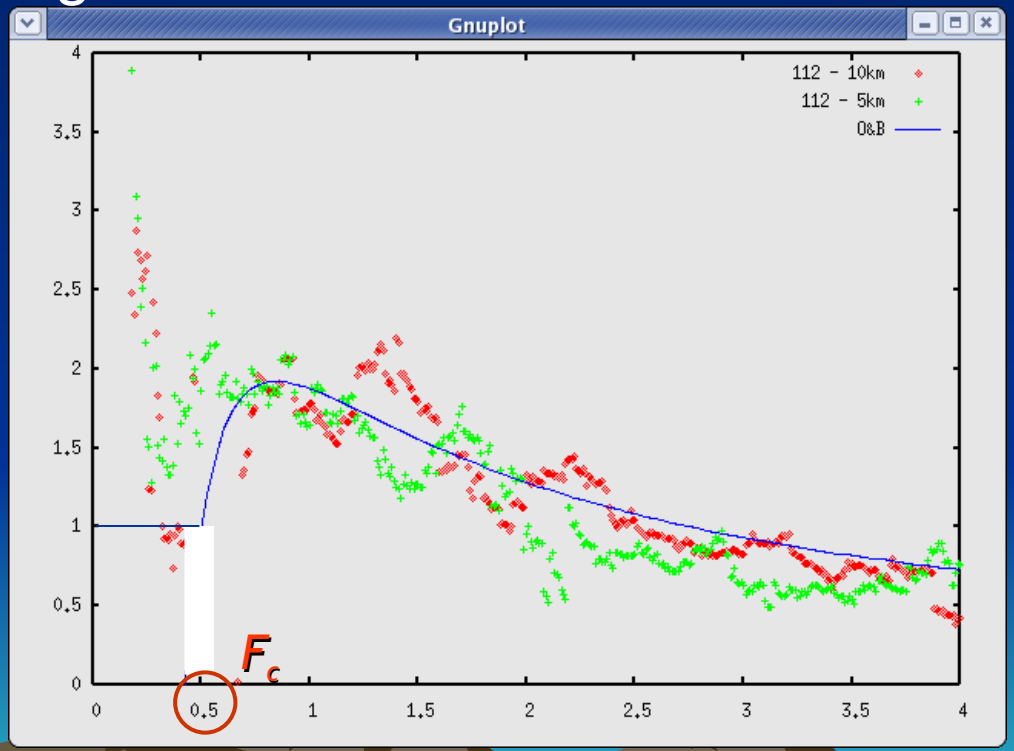
Experiments (Global)

- ARPEGE model in T358 resolution and in unstretched mode
- Equivalent to parallel suite in Toulouse
- New topography database
- No envelope

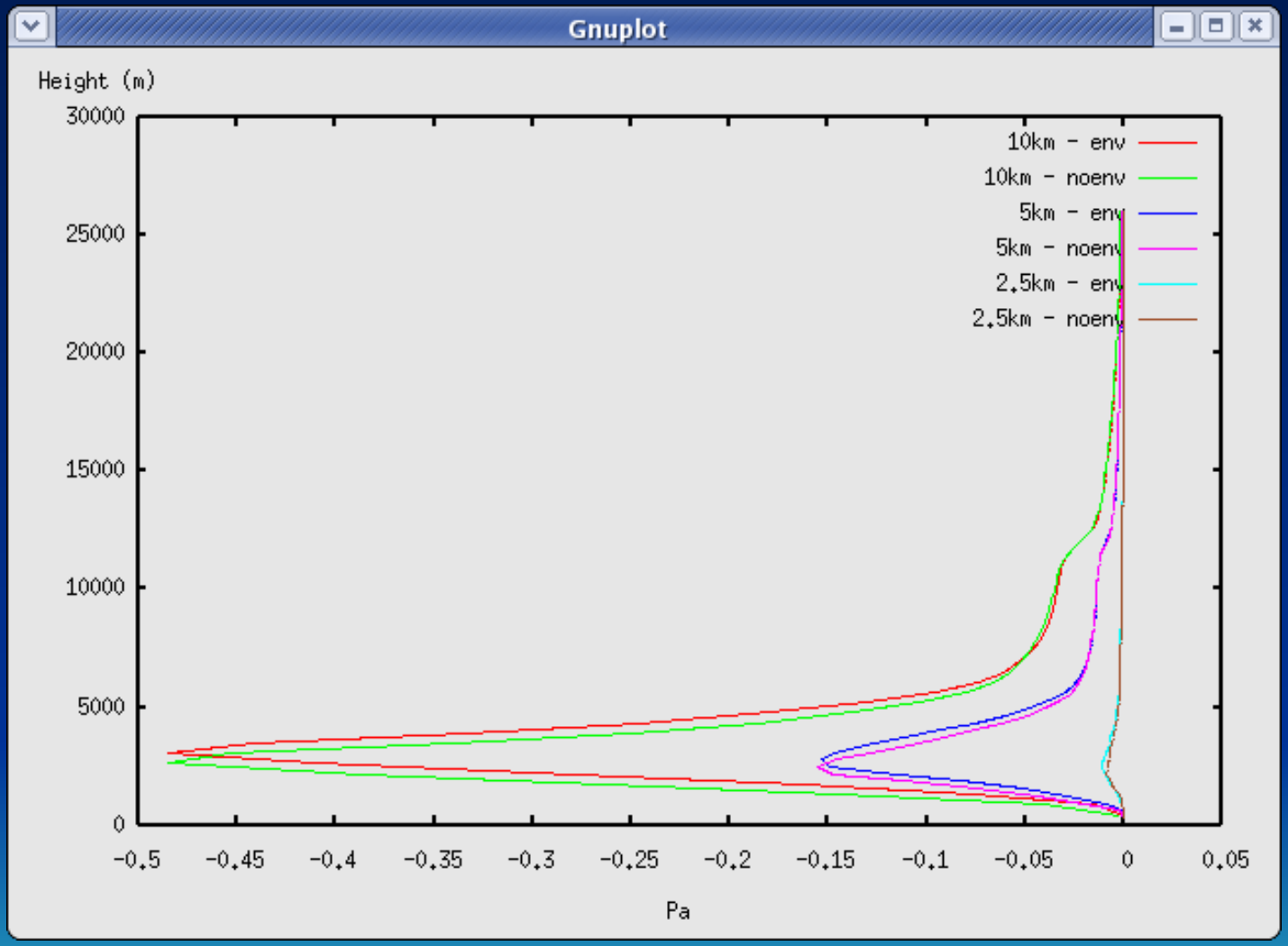
Tuning of the new scheme (resolution independent)

Performed on ALPIA domain and checked with ARPEGE and ALADIN-CE tests + additional constraint given by the Olafsson & Bougeault 1997:

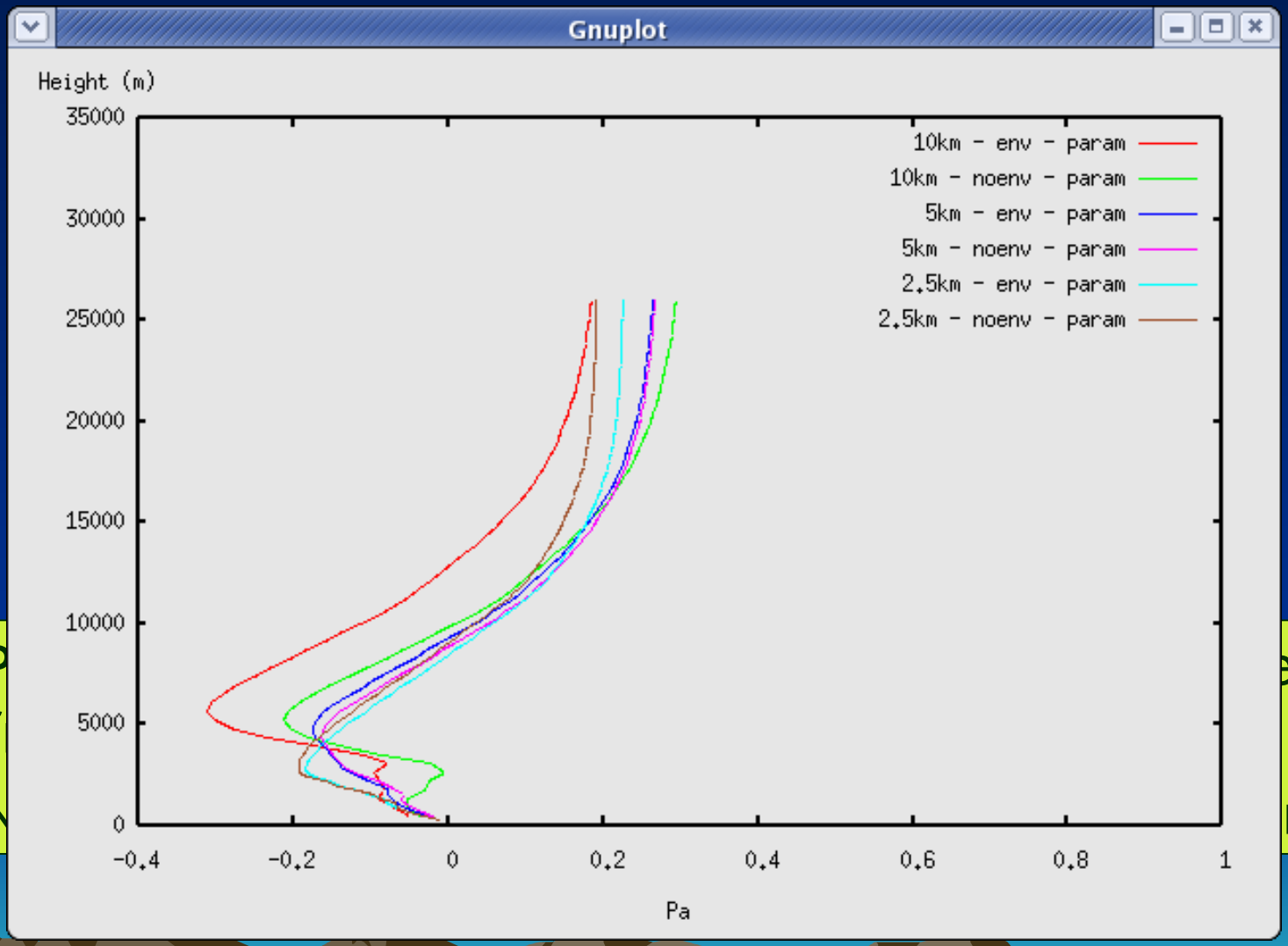
$$\frac{\tau}{\tau_{lin}}$$



Need for a parameterization (1)



Need for a parameterization (2)



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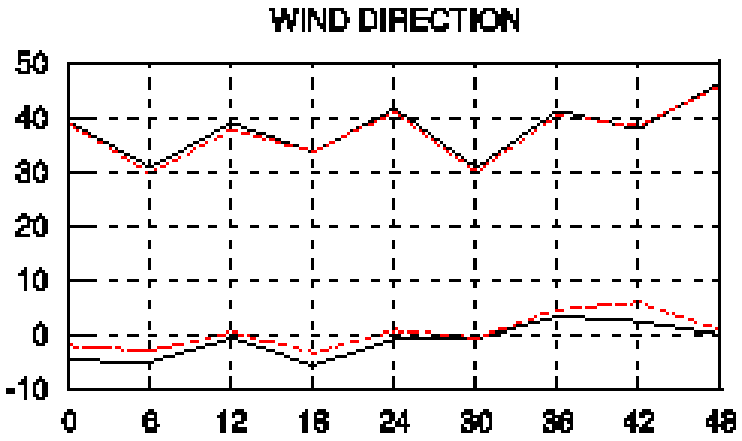
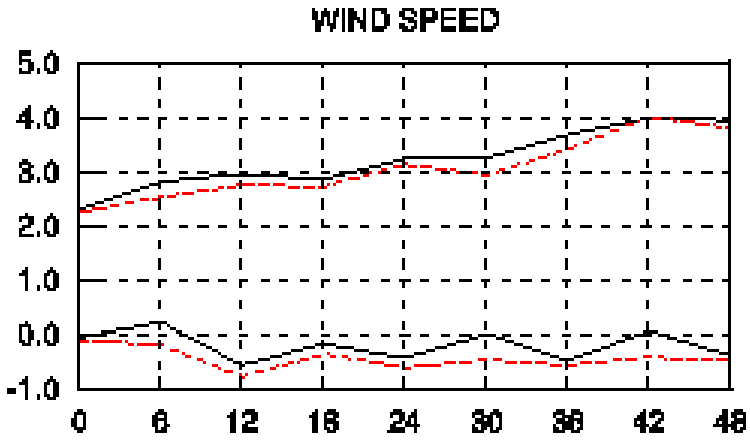
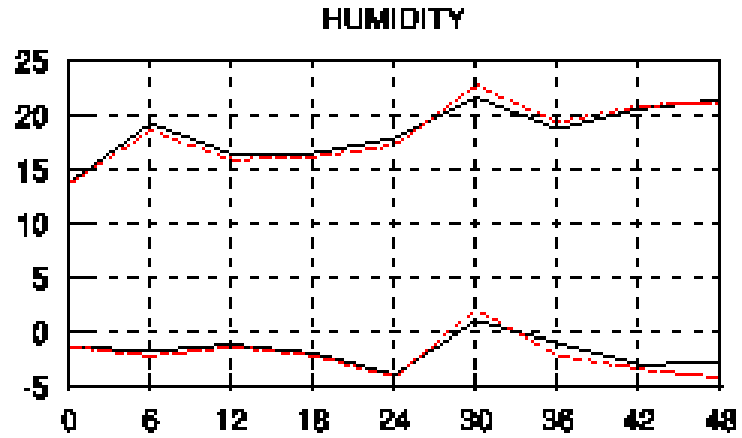
Need for a parameterization (3)







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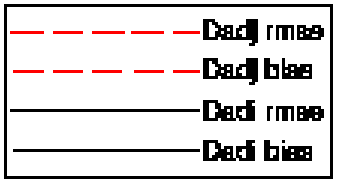

Suppression of the envelope (1)

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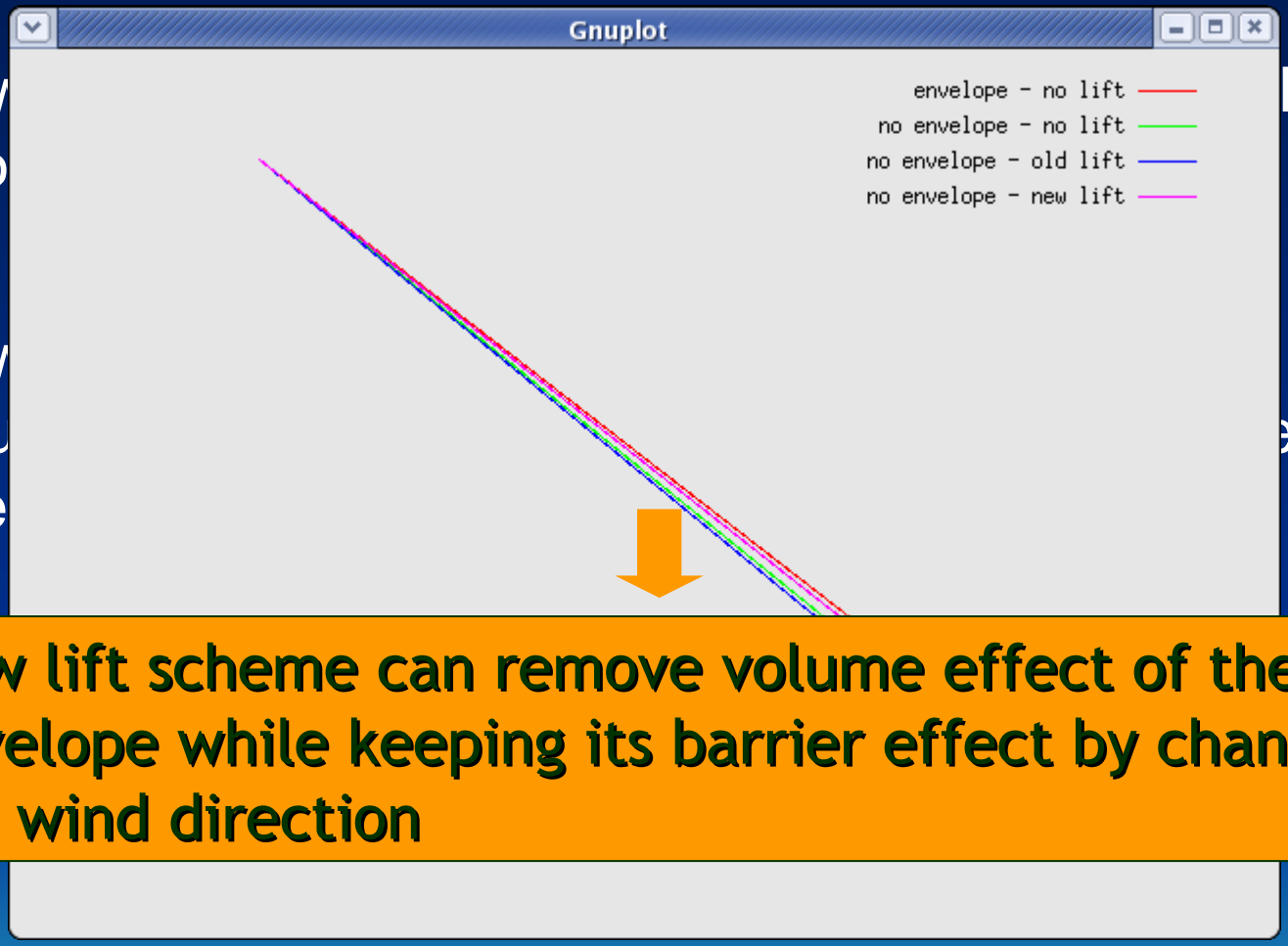
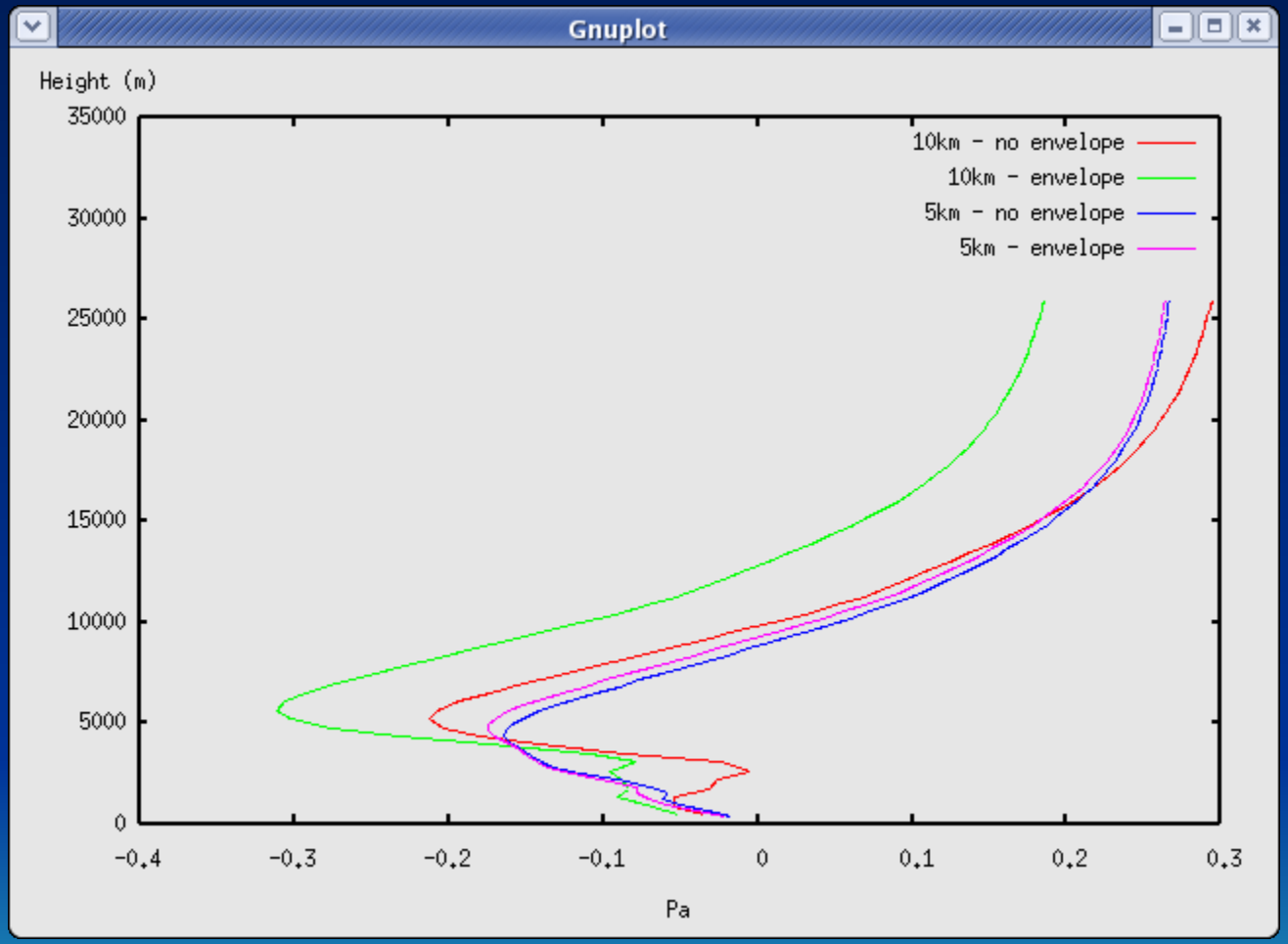
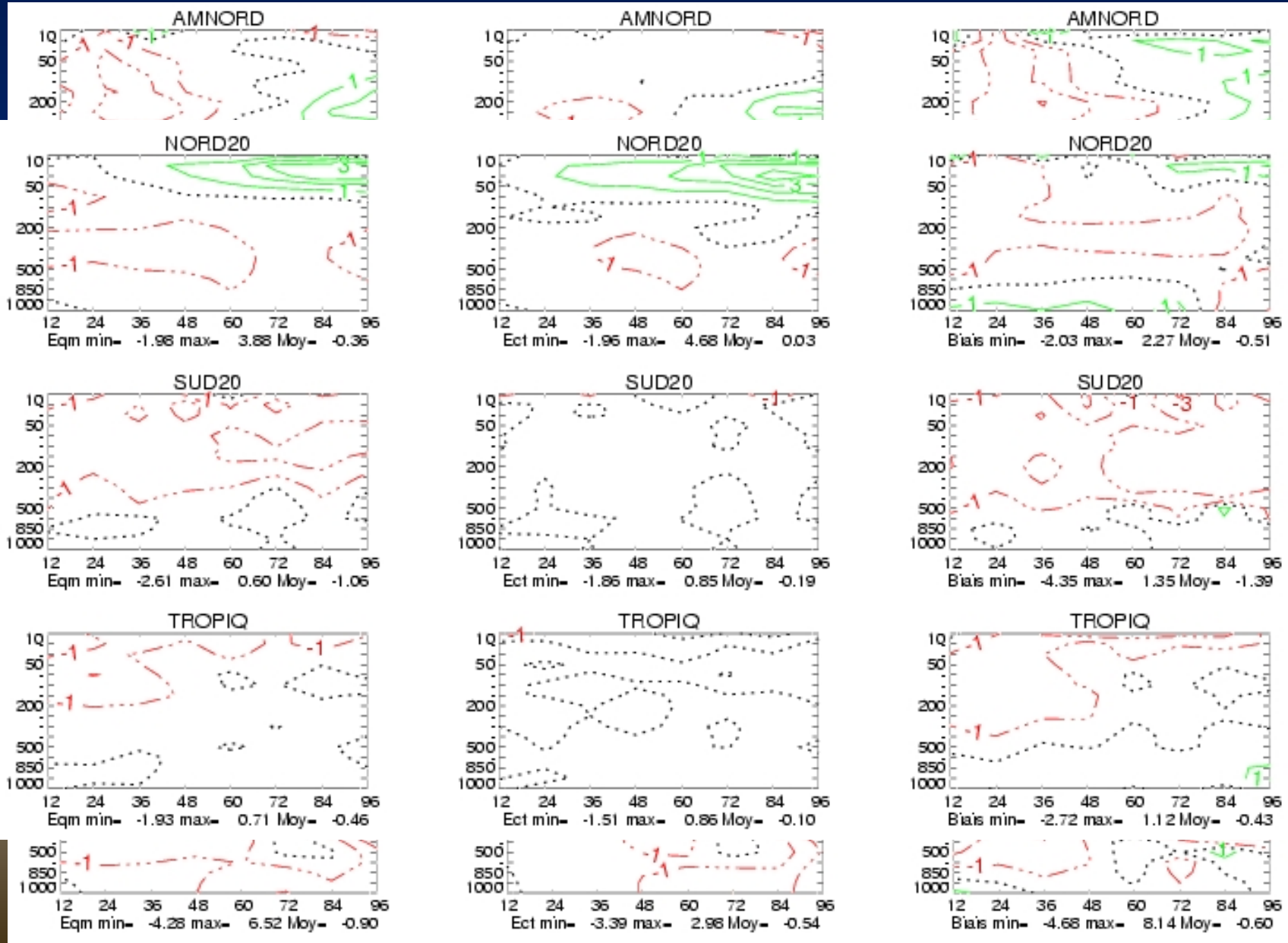


New lift scheme can remove volume effect of the envelope while keeping its barrier effect by changing the wind direction

Suppression of the envelope (2)



Suppression of the envelope (3)



Conclusions

- The new ACDRAG scheme is tuned to be resolution independent
- Parameterization is needed for horizontal mesh sizes from ~ 5 km
- The envelope can be suppressed by the new lift scheme
- The thin line between param / no param is not clear