Z-coordinate

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Milano 2004

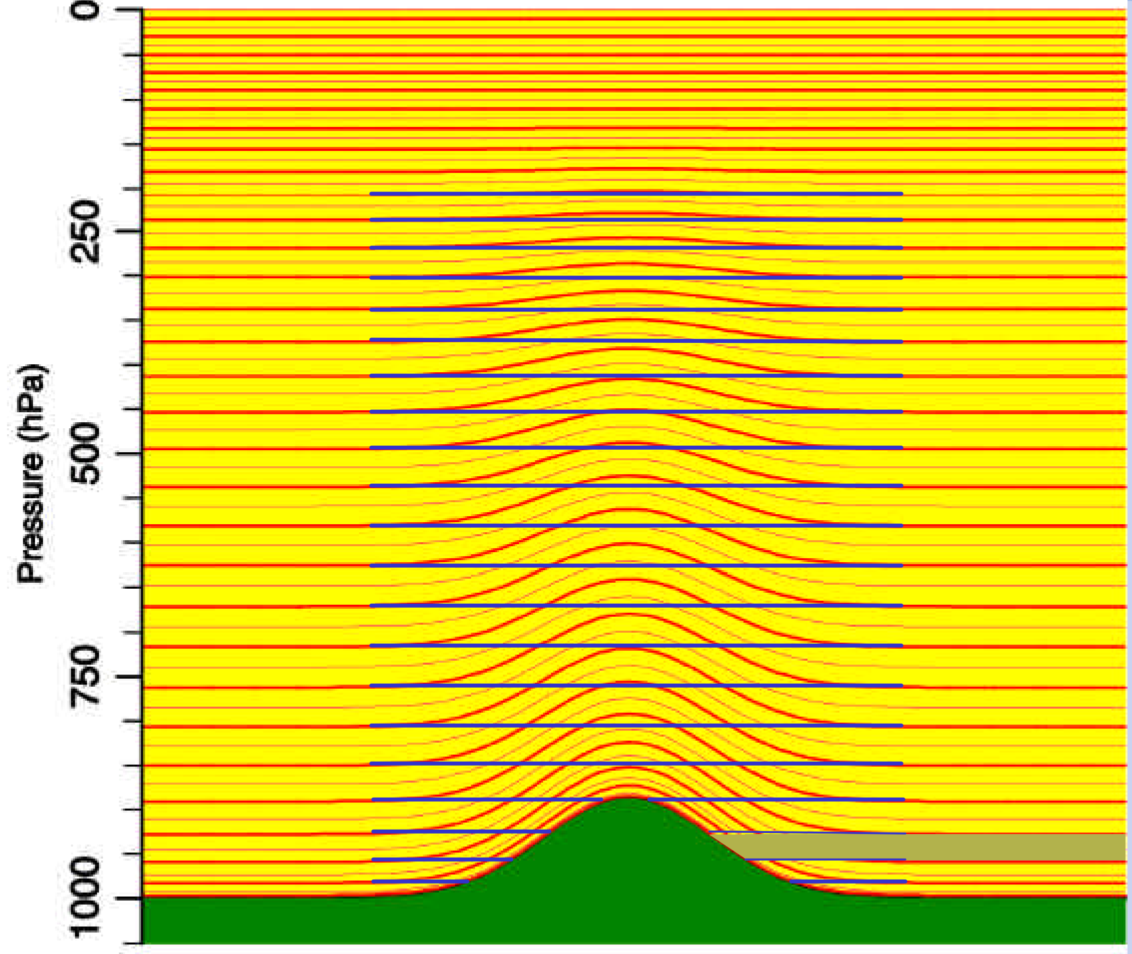
Semi Lagrange(SL) and Euler(EL) LM-Z

- Both methods use finite volumes for the fast waves and finite differences for the slow waves
- For time integration of the fast waves SL uses implicit integration and EL split explicit (limits the time-step)
- Advection terms (slow waves) are done Lagrangian (allows in principle CFL>1) with SL and using centred differences with EU (Limited to CFL<1)
- Results presented here concern the Eulerian version

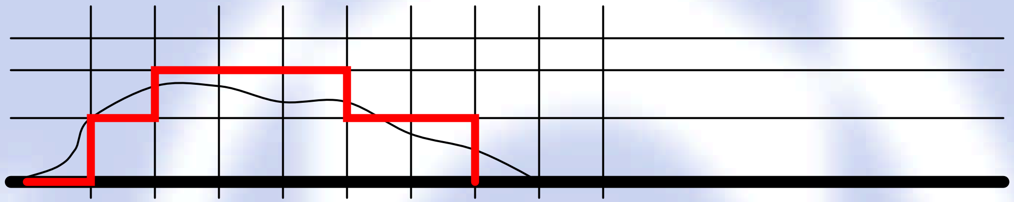
- Introduction: Why z?, Eta model, Euler/SL
- Adiabatic tests of LM-Z
- The two grid physical parameterisation concept
- Idealised tests with physics
- Tests with real initial fields
- Conclusions
- Aspects of further work

Expected advantages of the Z-coordinate

- The atmosphere at rest can be represented in Z-coordinates, but not in terrain following coordinates
- Stratiform clouds and low stratus are predicted better in LM-Z
- Mountain and valley winds are better with LM-z
- Precipitation amplitudes should be better with LM-Z, in particular maxima and minima near mountains


Pressure (hPa)
0
250
500
750
1000

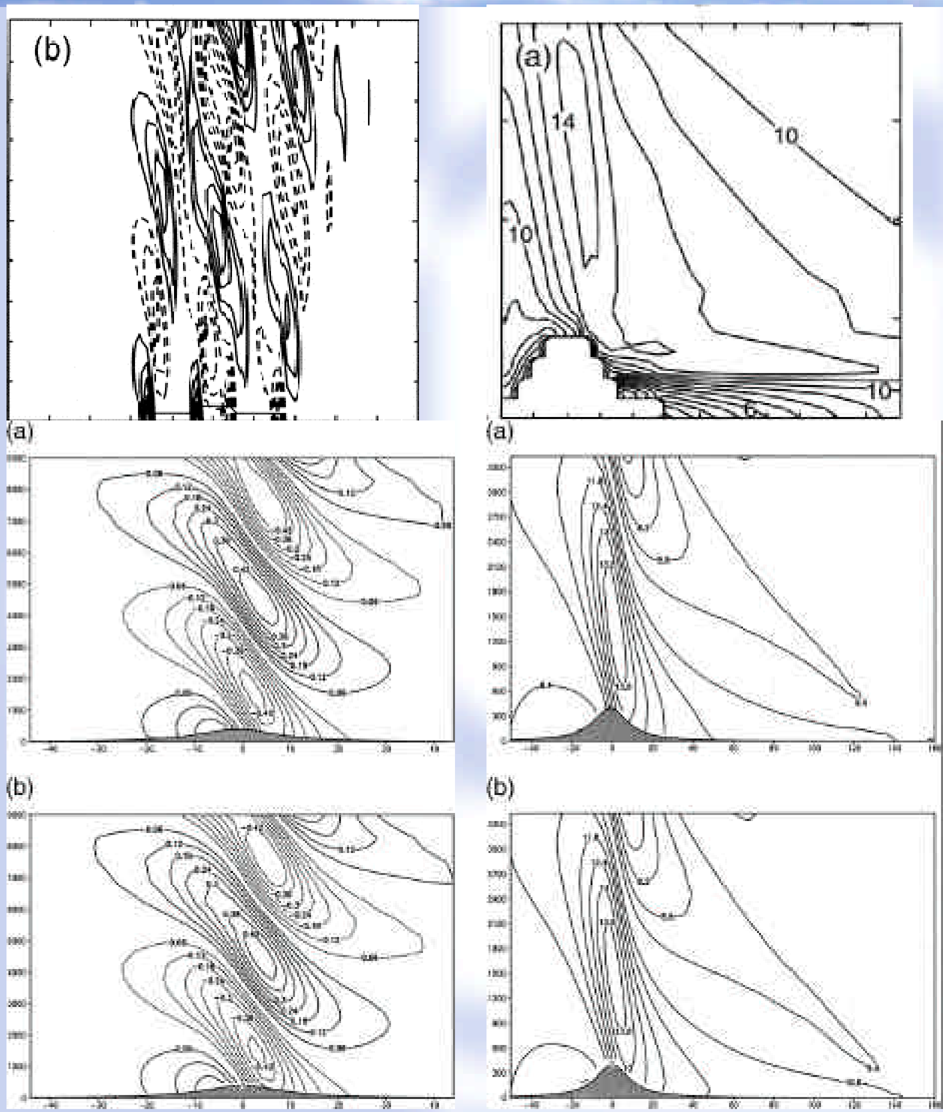
The step-orography



•Advantage: simle boundary conditions with z-coordiante

•Disadvantages: No proven convergence; In CFD not used ("legoland topography"; Problems with precipitation forecasts; Problems pointed out by Klemp

•**The disadvantages are avoided by representing the orography by a linear spline rather than steps**



Mountain generated waves:

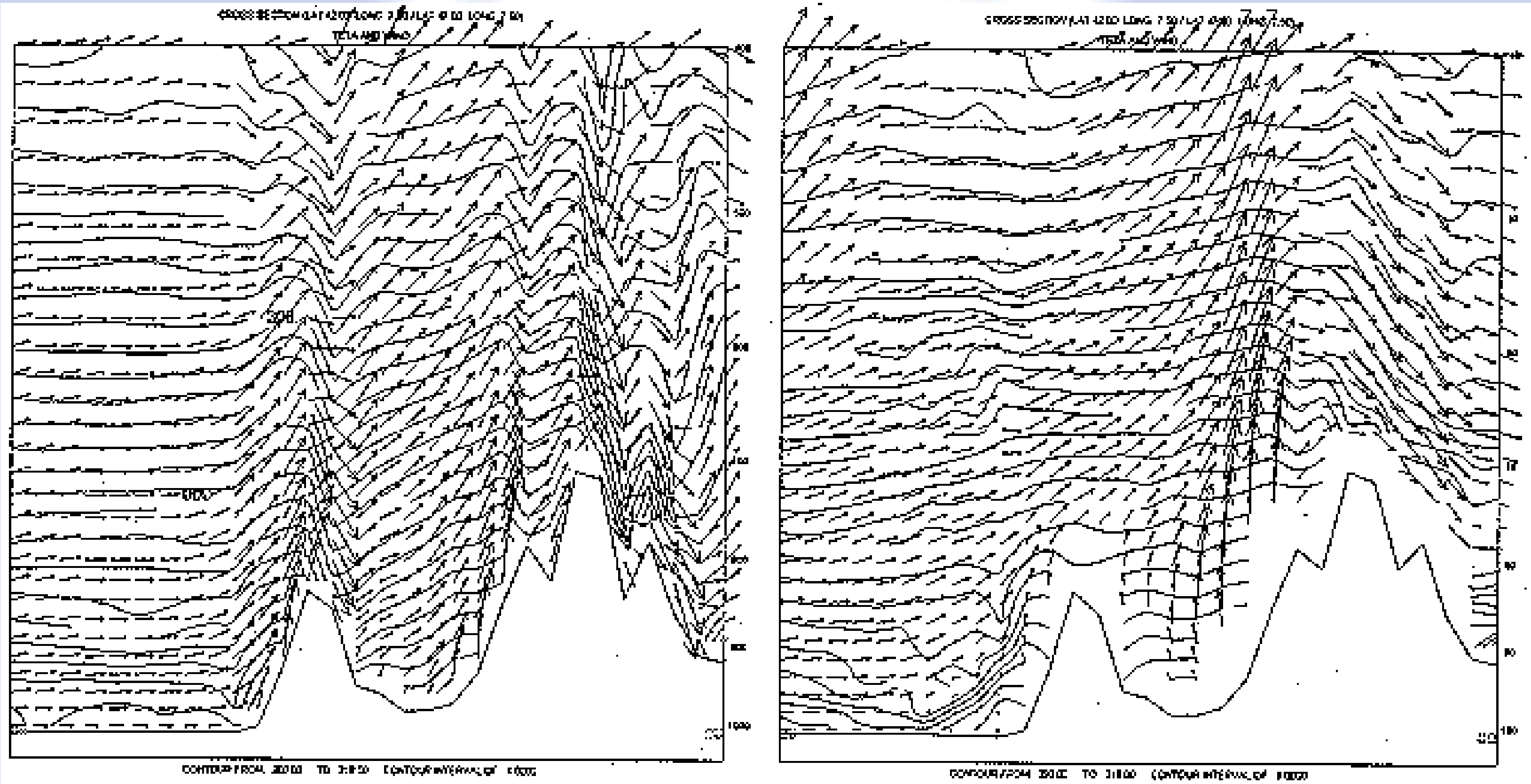
W (left), U (right)

Eta - Model

Analytic solution

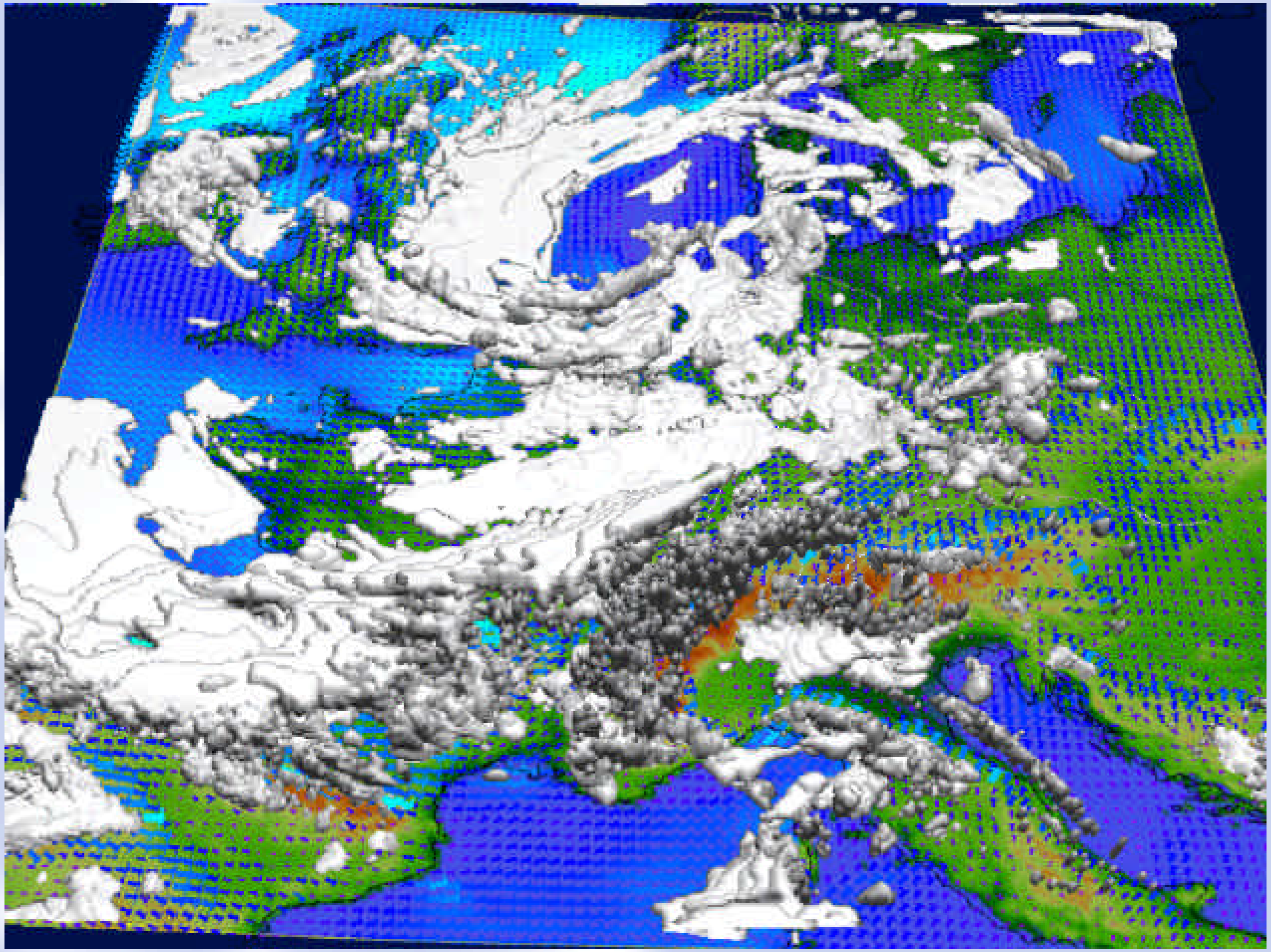
LM_Z

Cross Section for Flow Over the Alps, Forecasted by Eta Model with Step Orography (Right) and with Terrain Following Orography (Left)



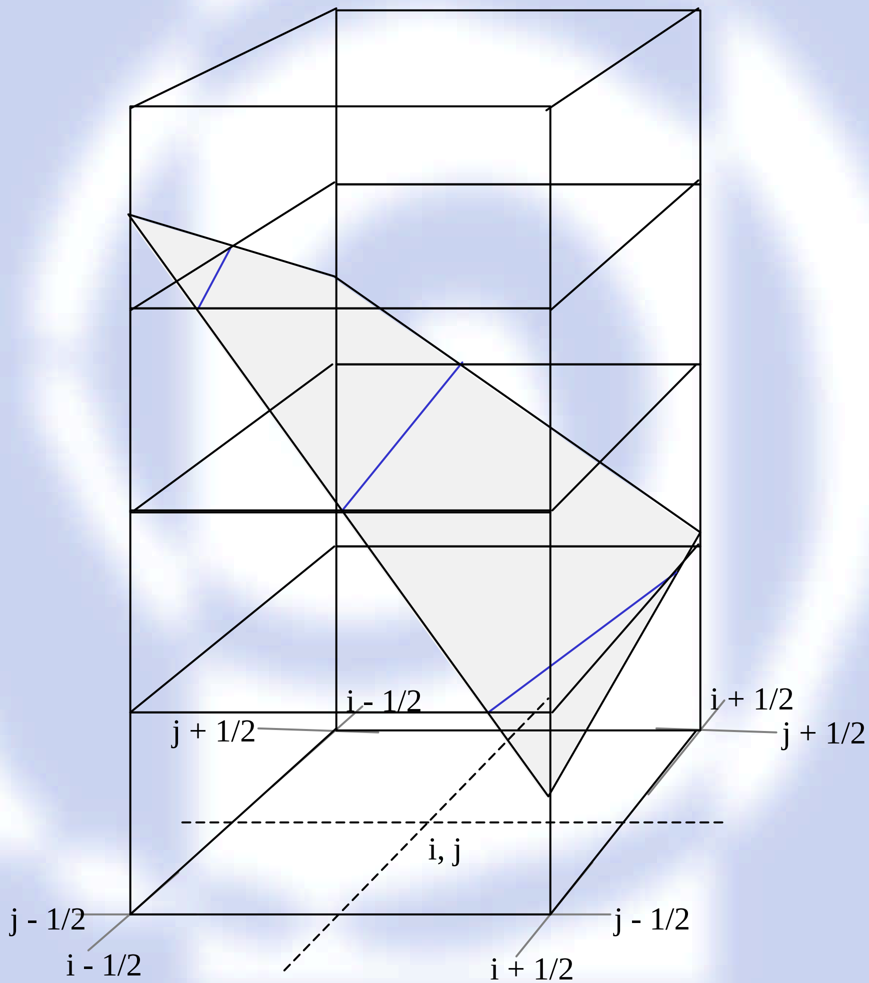
3-D Cloud-Picture

18 January1998

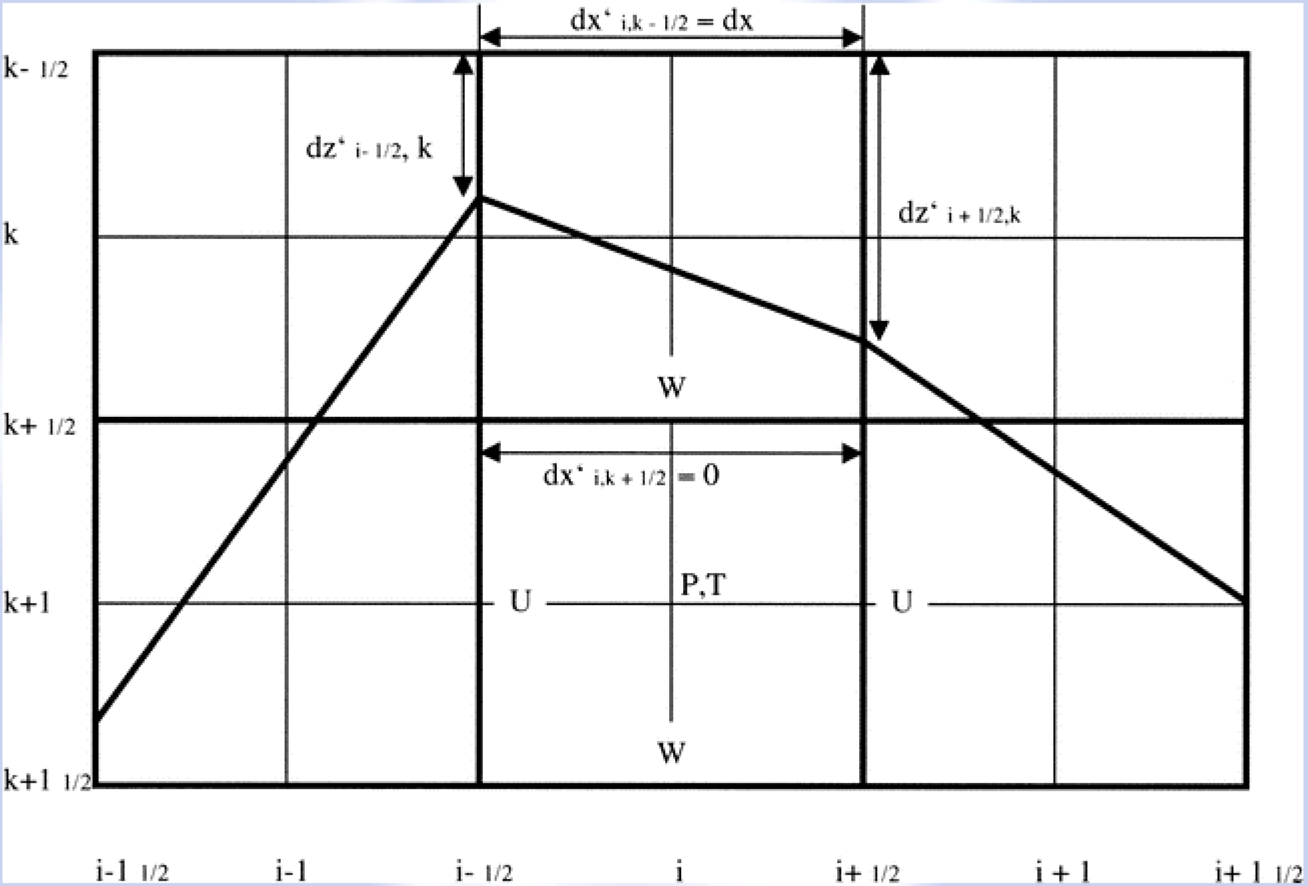


The mountain related bias of convectional clouds and precipitation is supposed to disappear with the Z-coordinate

Shaved Elements



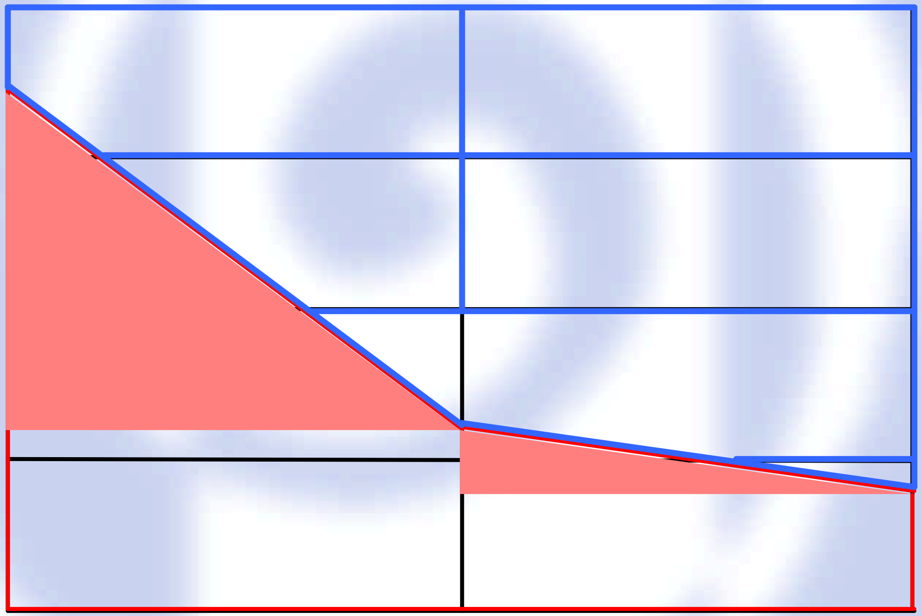
2-d Diagramm


dx' i,k - 1/2 = dx
k- 1/2
dz' i- 1/2, k
k
dz' i + 1/2,k
W
k+ 1/2
dx' i,k + 1/2 = 0
P,T
k+1
U
U
W
k+1 1/2
i-1 1/2
i-1
i- 1/2
i
i+ 1/2
i + 1
i+ 1 1/2

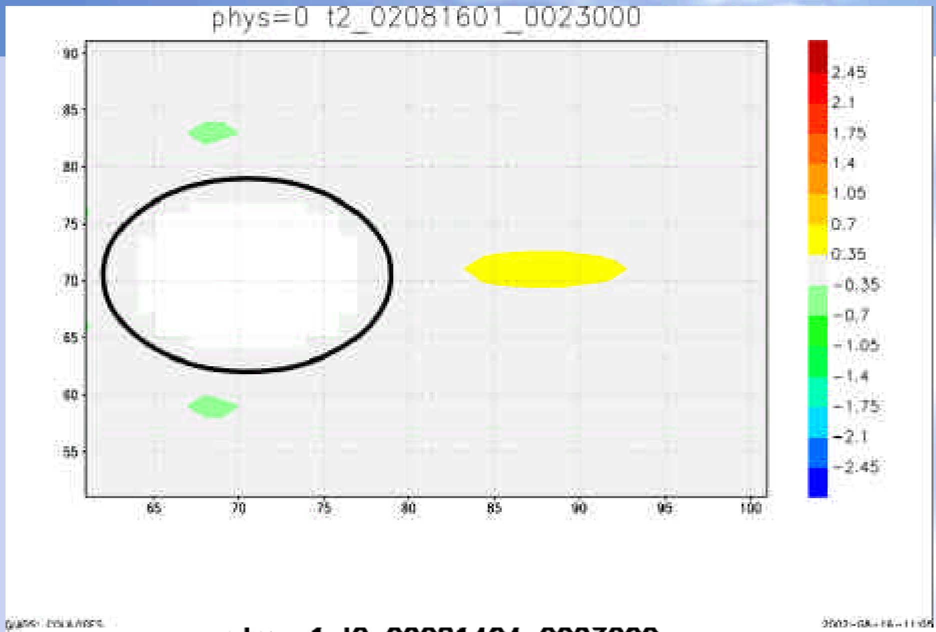
The finite volume method for the treatment of the fast waves in LM-Z

- The computation of the fast waves is based on the the evaluation of fluxes into a cell
- The evaluation of the fluxes requires weights associated with the cell surfaces, which depend on their open part
- Advection terms (slow waves) are computed by finite difference methods

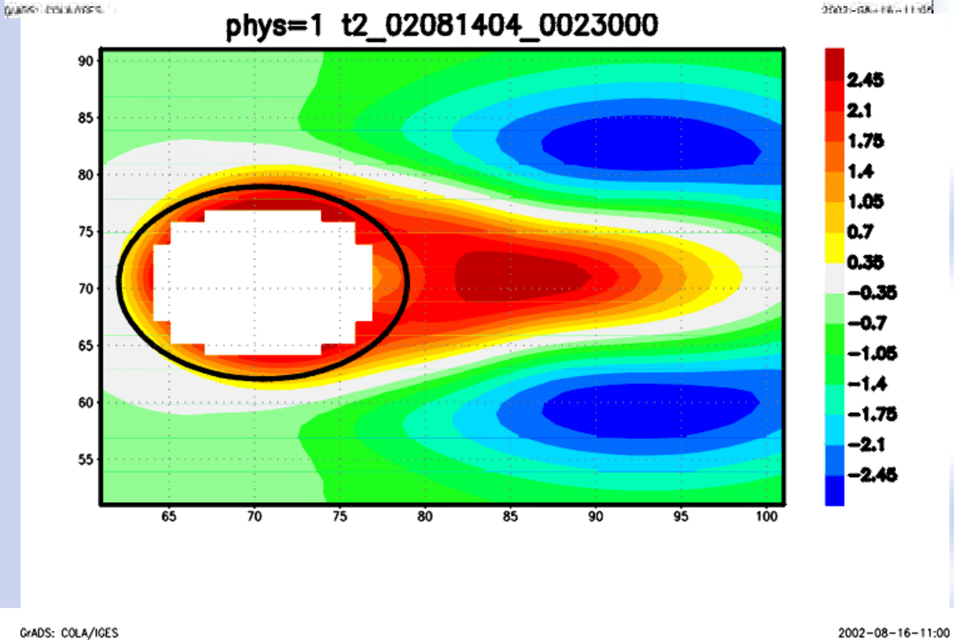
Kombination von Elementen



Deutscher Wetterdienst

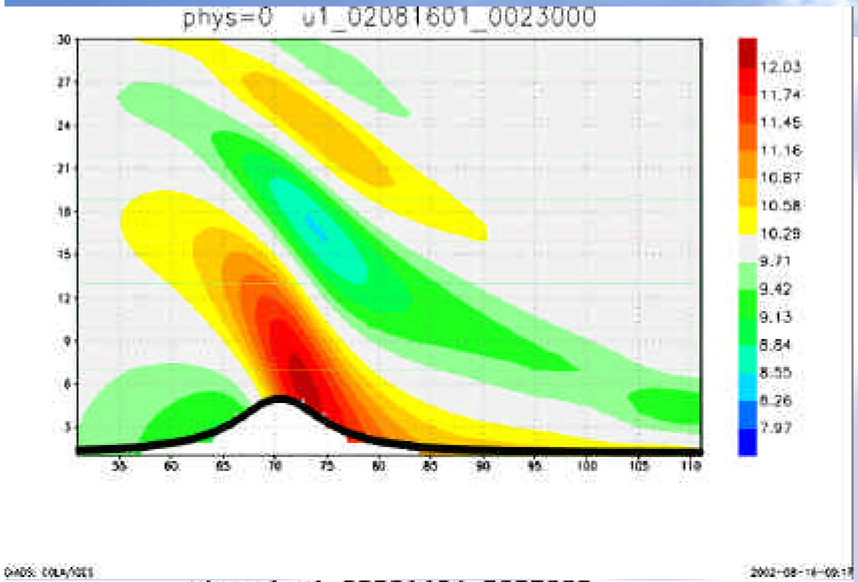


NO physics

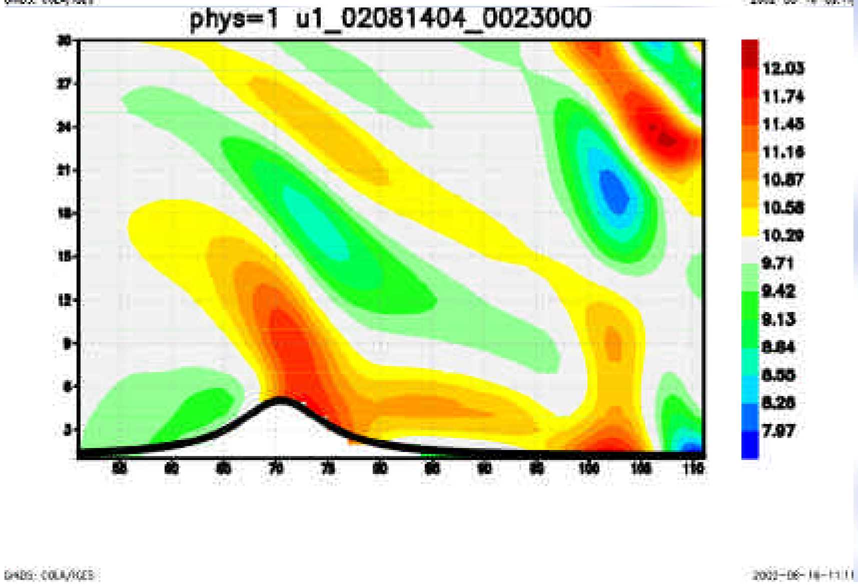


„dry“ Physik

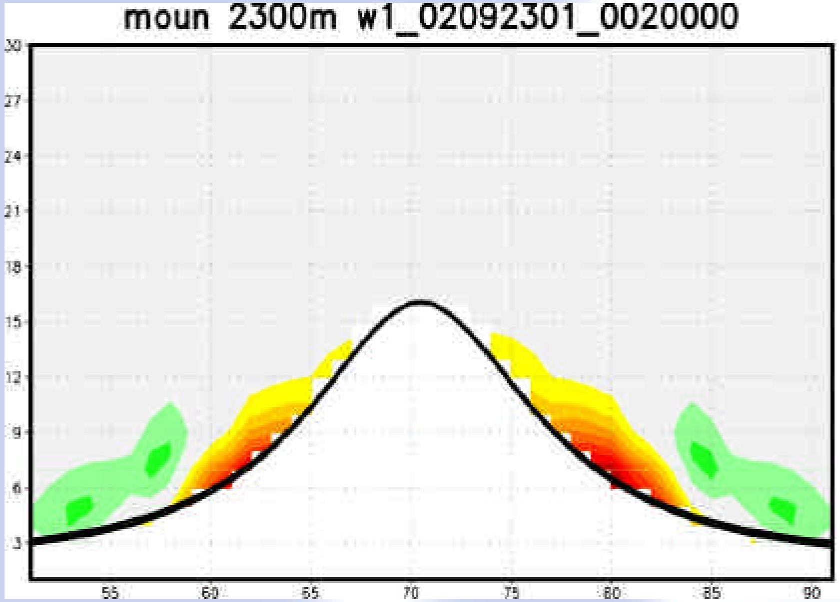
Deutscher Wetterdienst

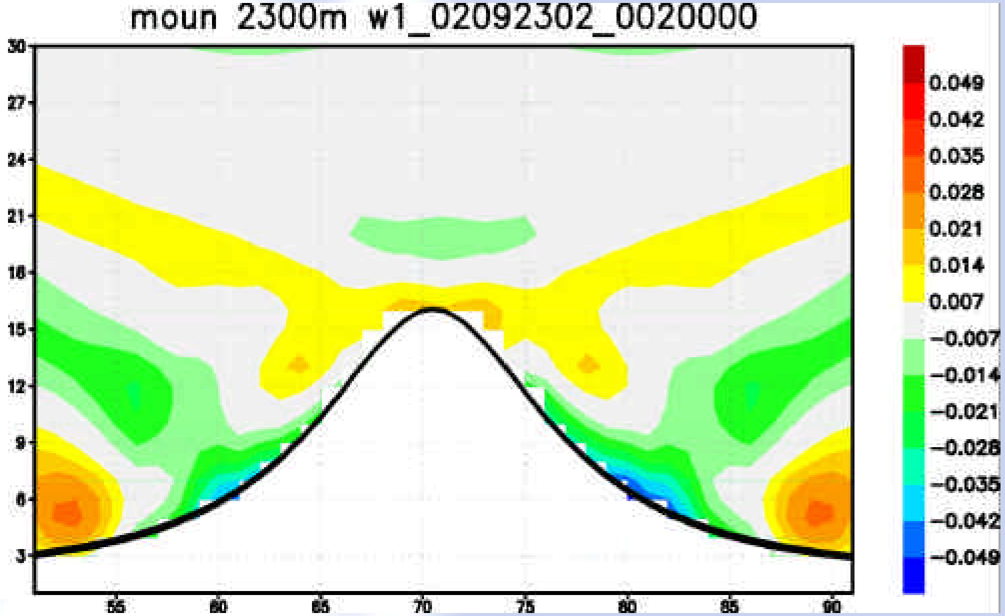


No physics



Dry physics
(Including radiation)

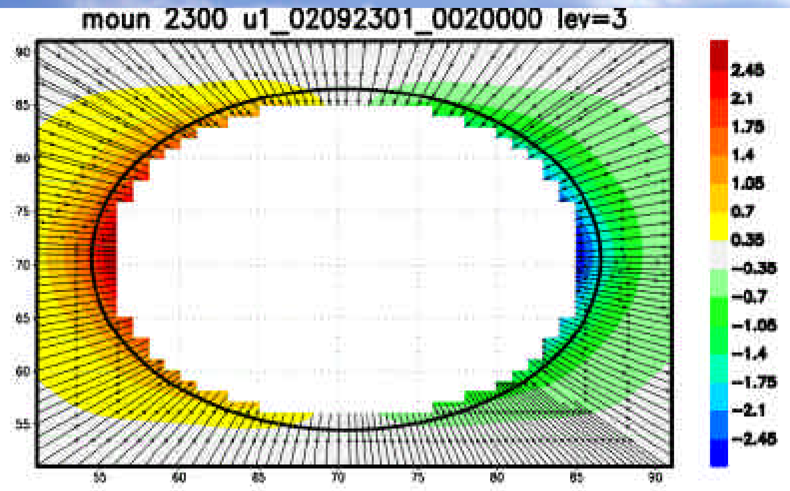




Day

Night

The Atmosphere at Rest Computed with the Z_LM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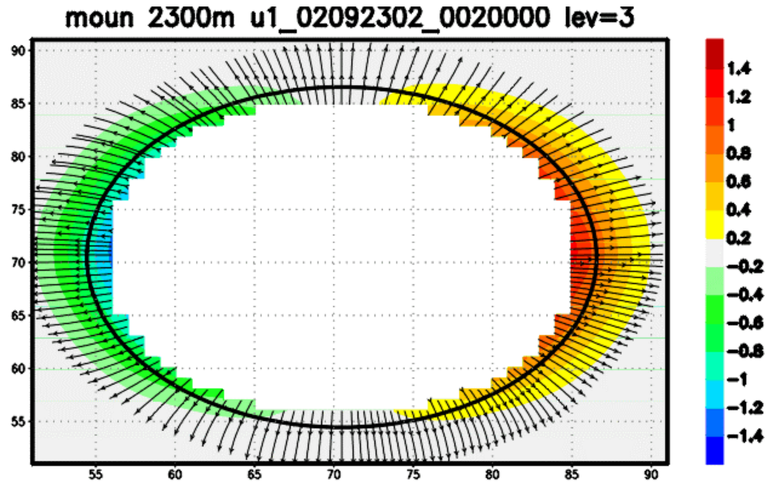
2.45
2.1
1.75
1.4
1.05
0.7
0.35
-0.35
-0.7
-1.05
-1.4
-1.75
-2.1
-2.45

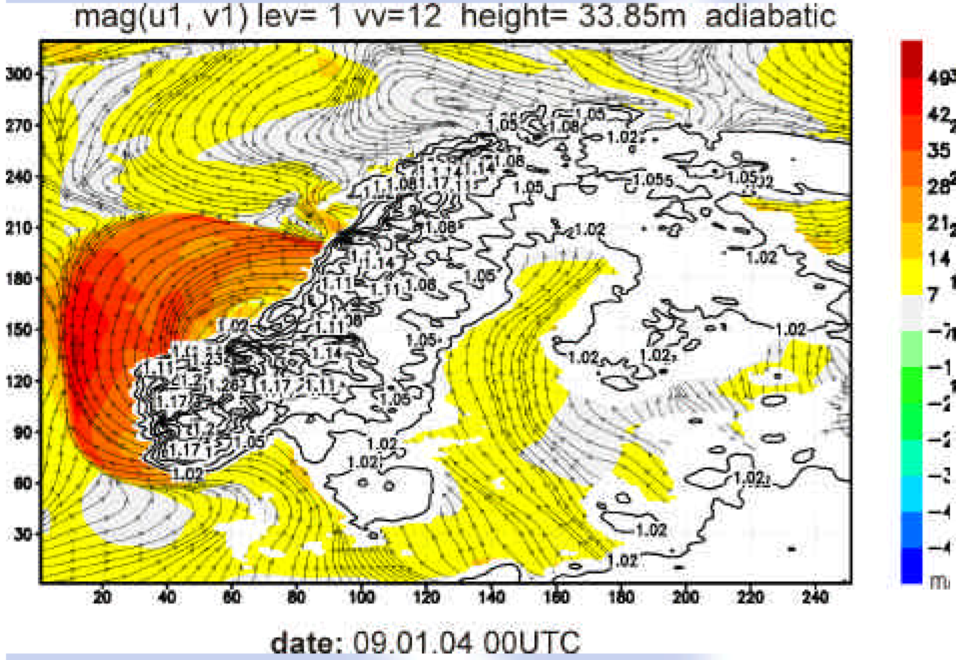
Day

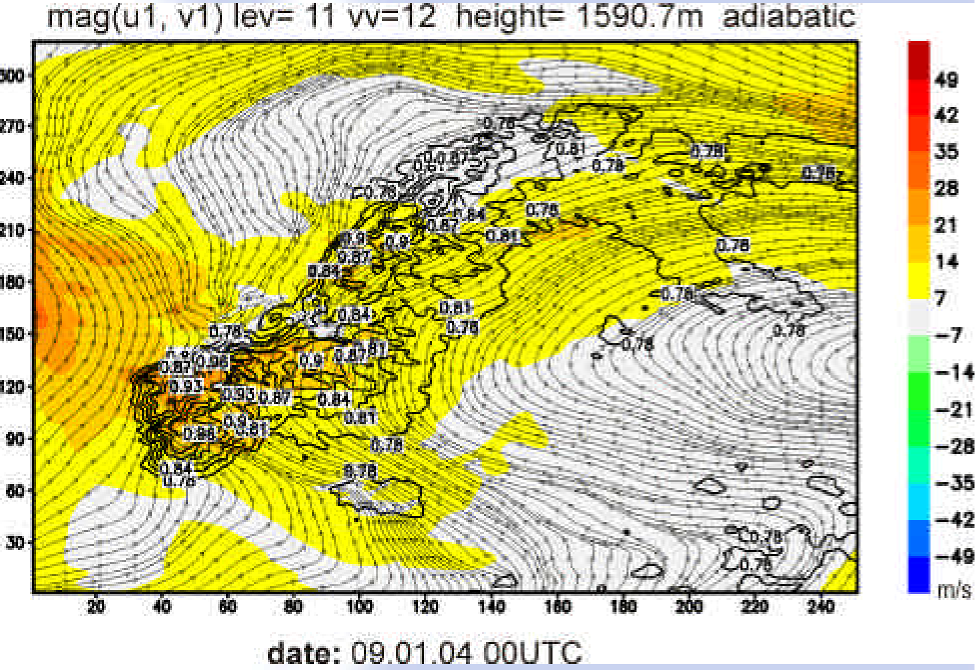

moun 2300m u1_02092302_0020000 lev=3
1.4
1.2
1
0.8
0.6
0.4
0.2
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
GrADS: COLA/IGES
2002-09-23-15:53

Night

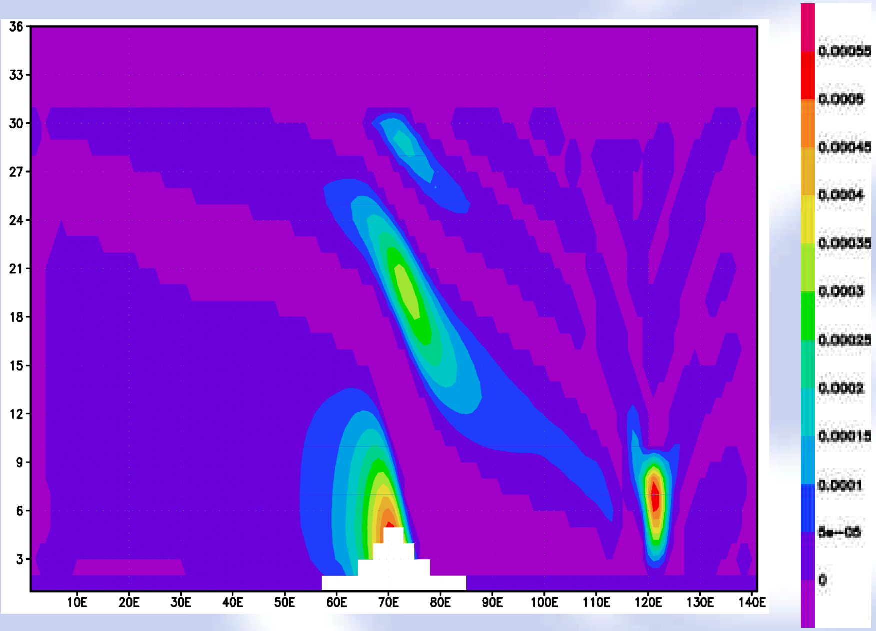
Deutscher Wetterdienst

No physics / Physics

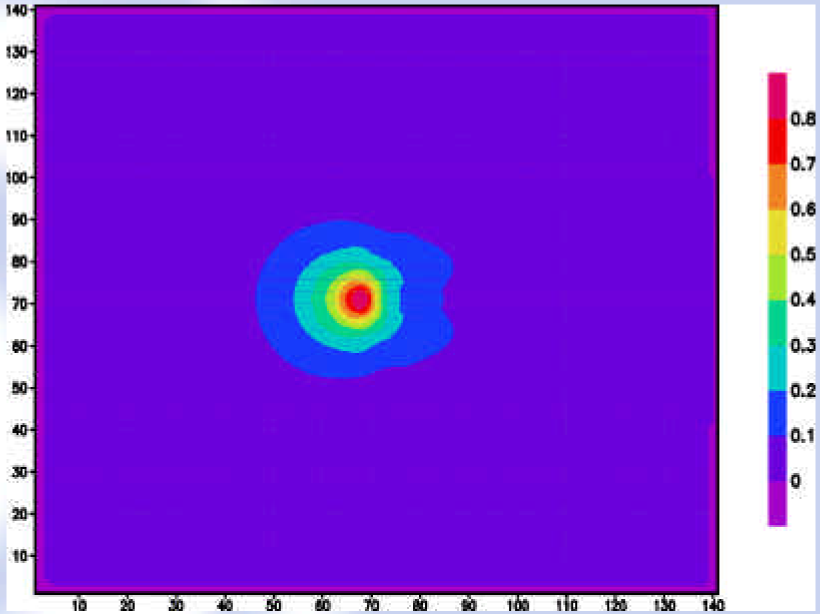




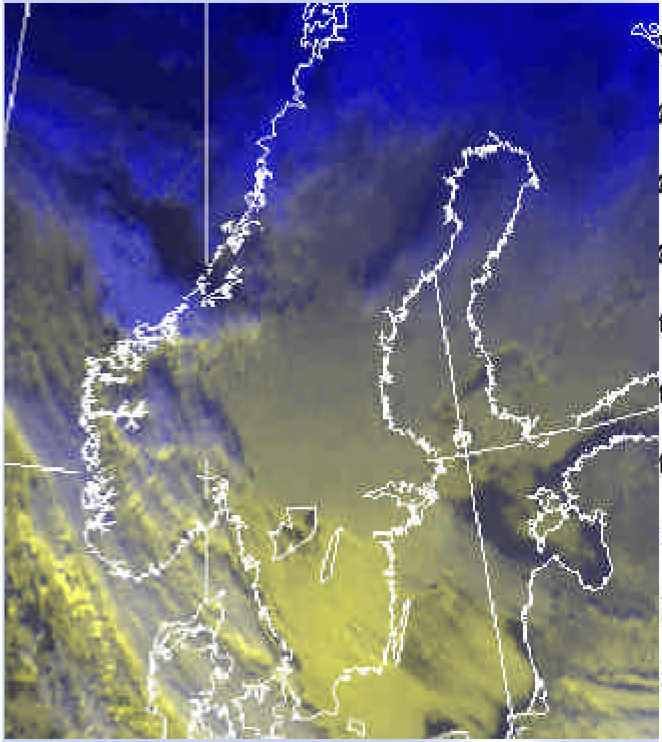
Cloud water

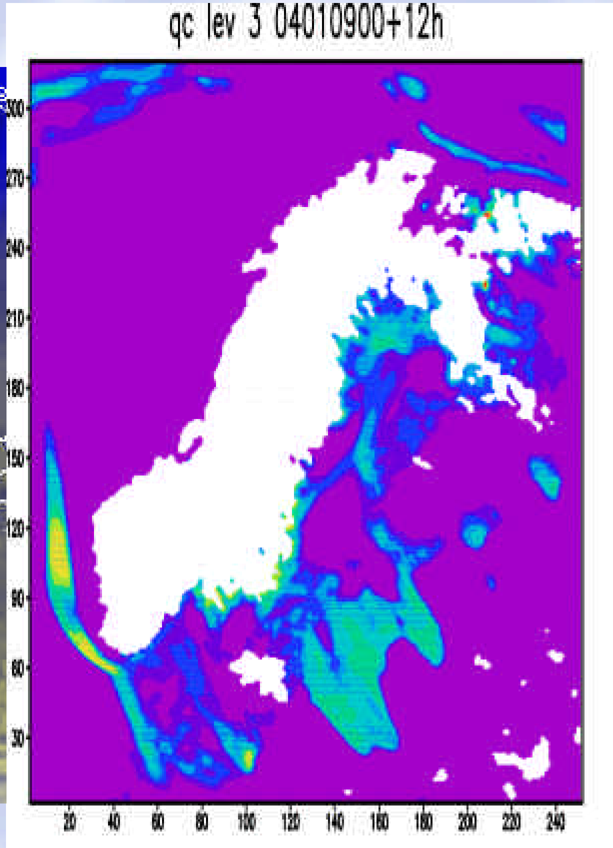


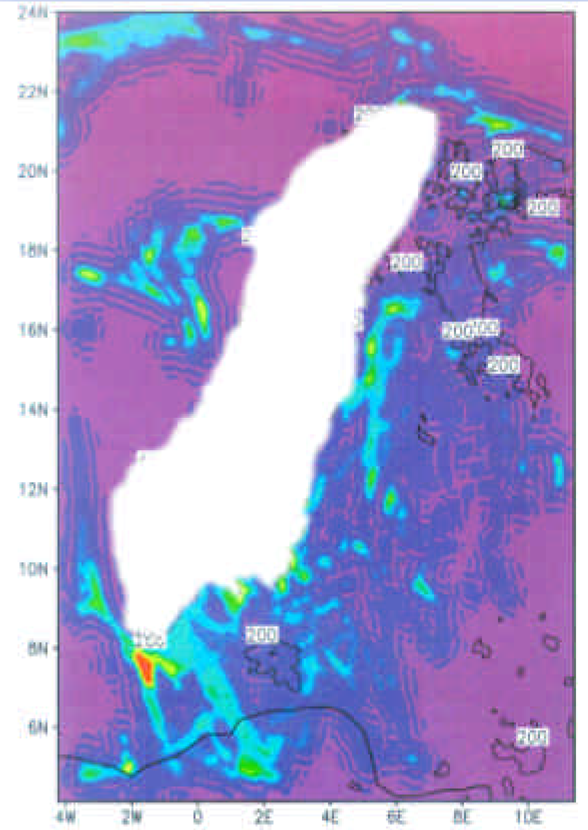
Precipitation



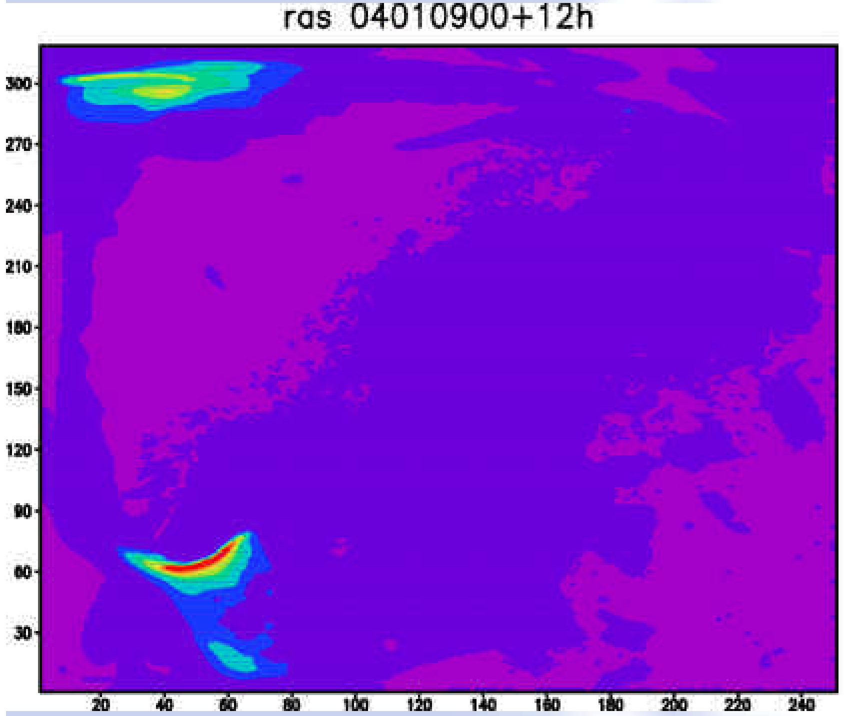
Low stratus

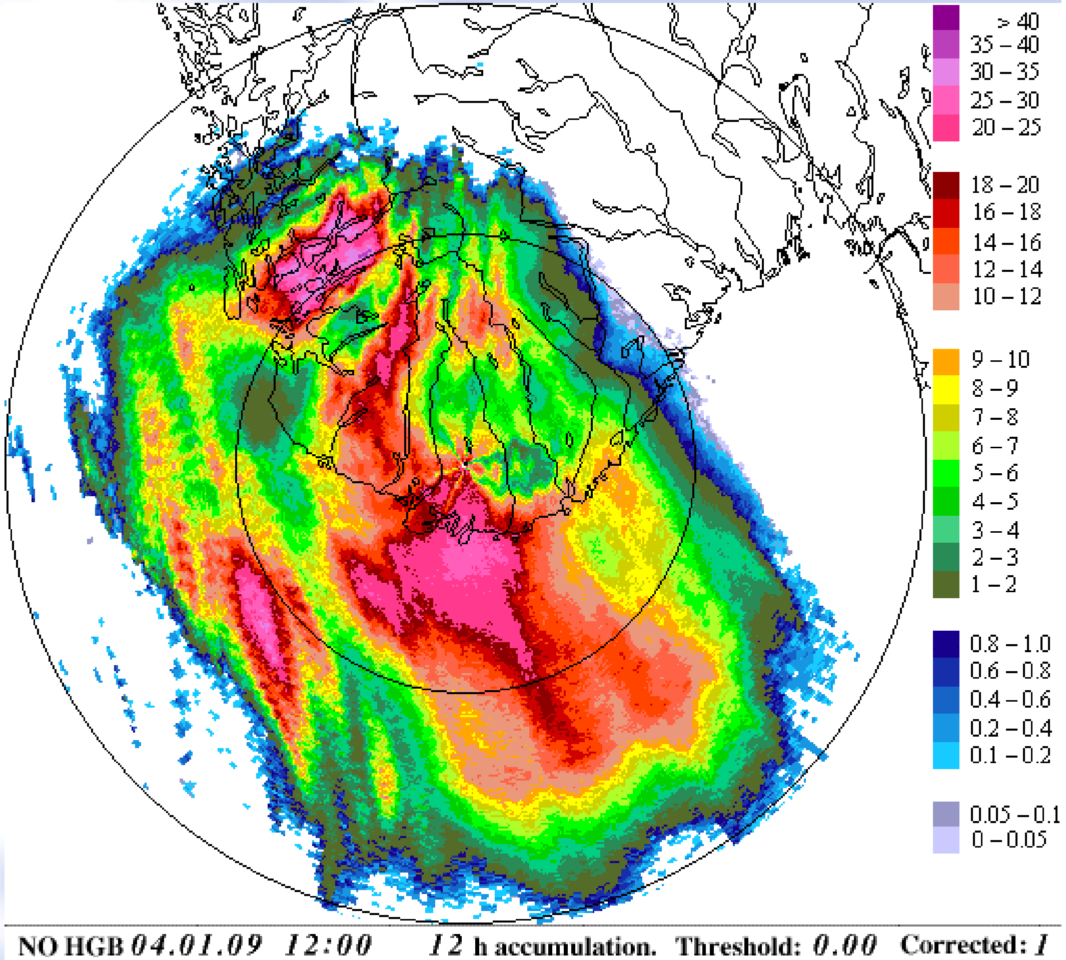






Z-coordinate





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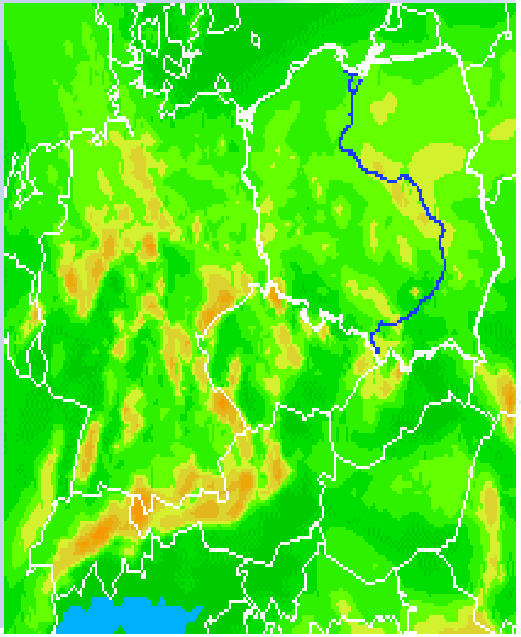
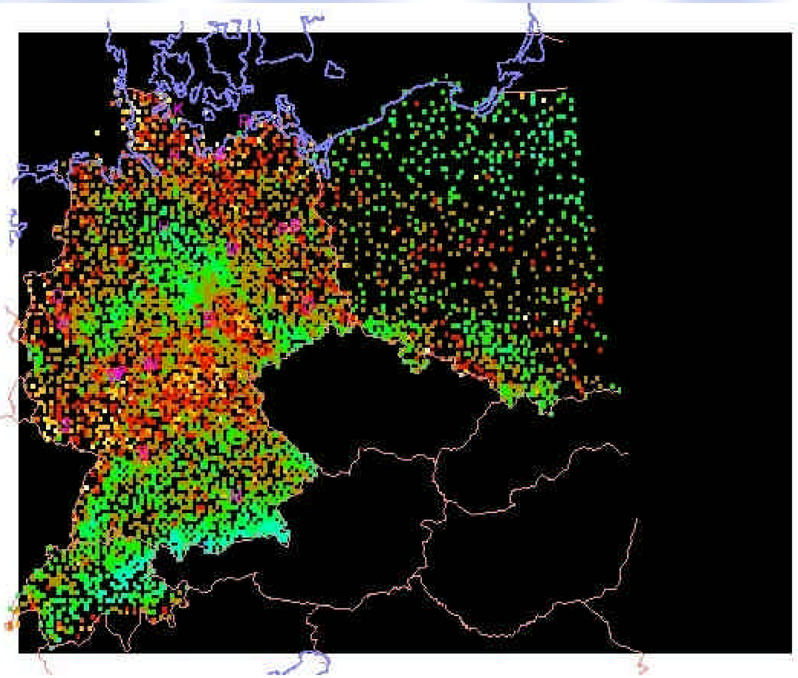
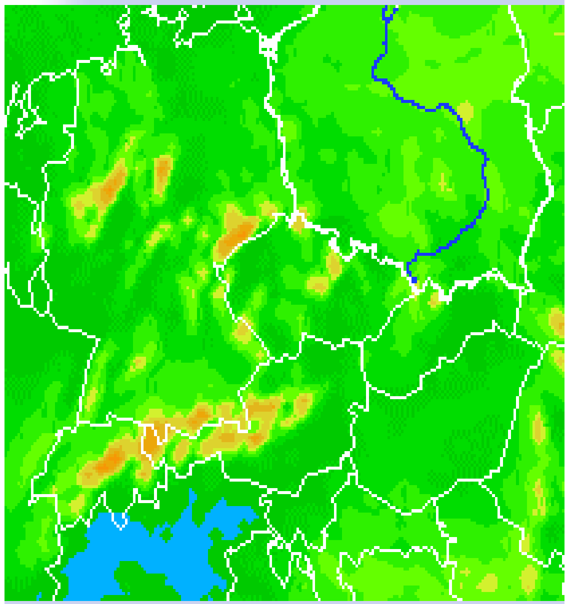
- LM-Z OBS LM-tf







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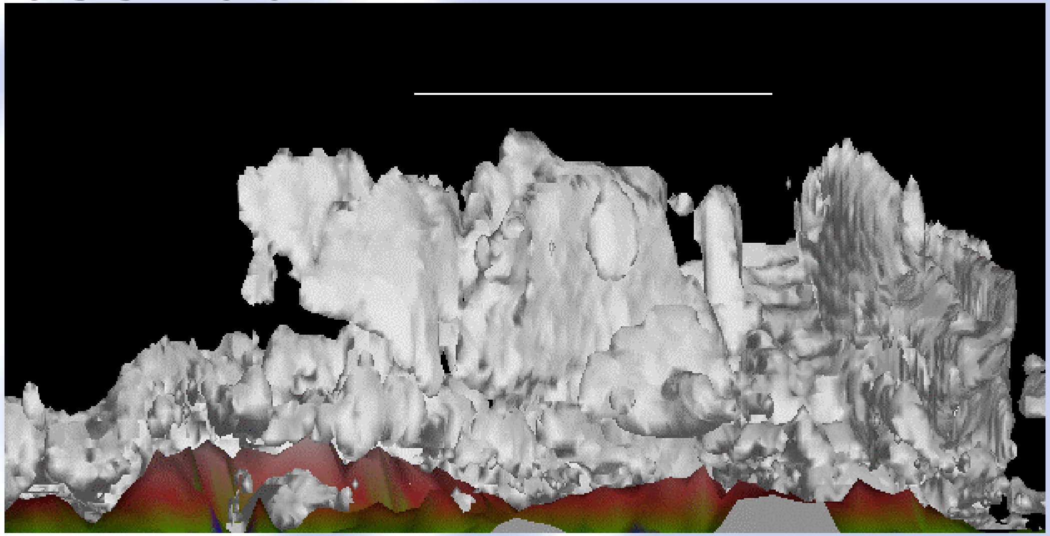
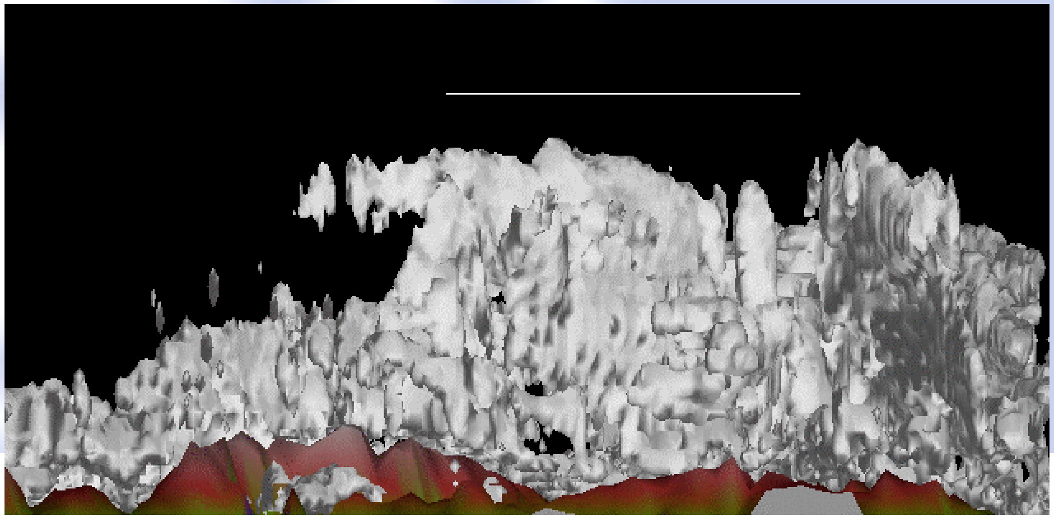
- LM_Z



- LM_tf



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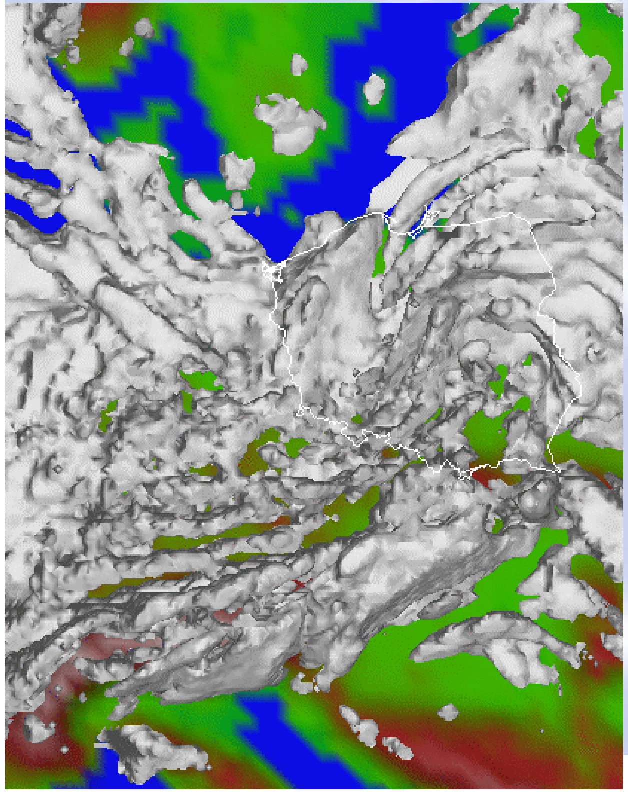
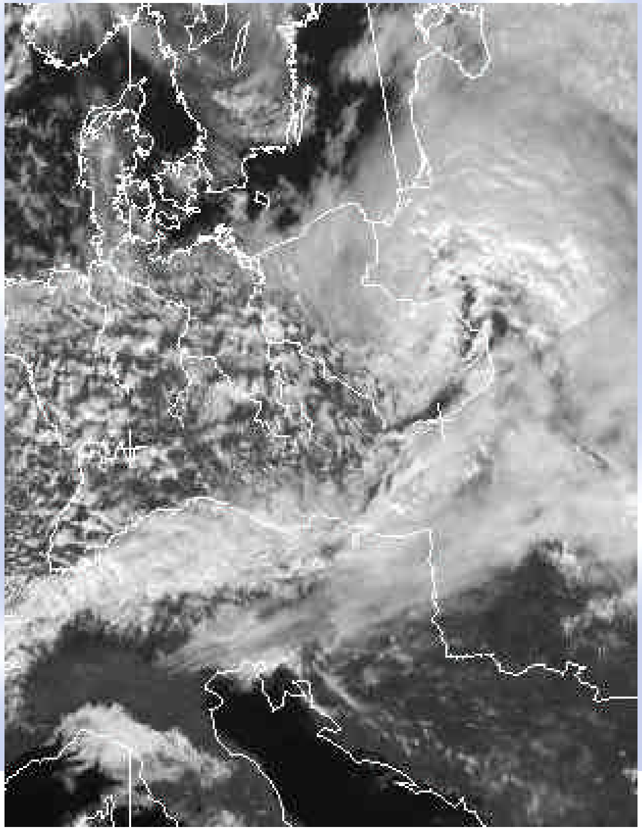
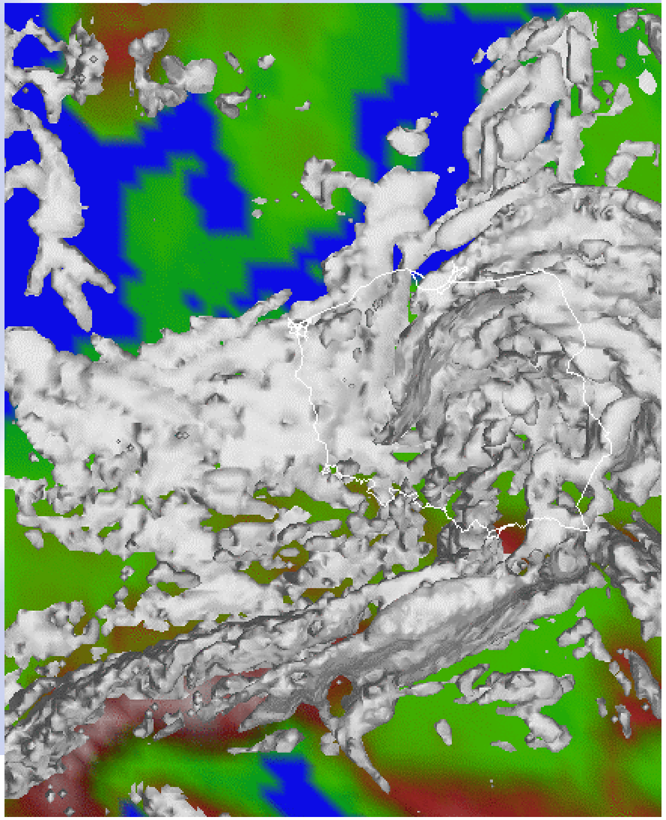
- LM_Z

LM_tf







Current State of LM-Z

- Idealised tests with bell shaped mountain available for Euler (3-d) and SL (2-d)
- SKANIA Test with Euler version
- Four Physics implementations available with Euler version
- First realistic runs show impact on mesoscale cloud structuree and precipitation
- LM-Z library available for Euler and SL versions

Further work for 2004/2005

- More Realistic runs (COSMO?)
- Testing of the LM-Z concept
- Realising the potential for increased efficiency of the SL-version of LM-Z or by other methods