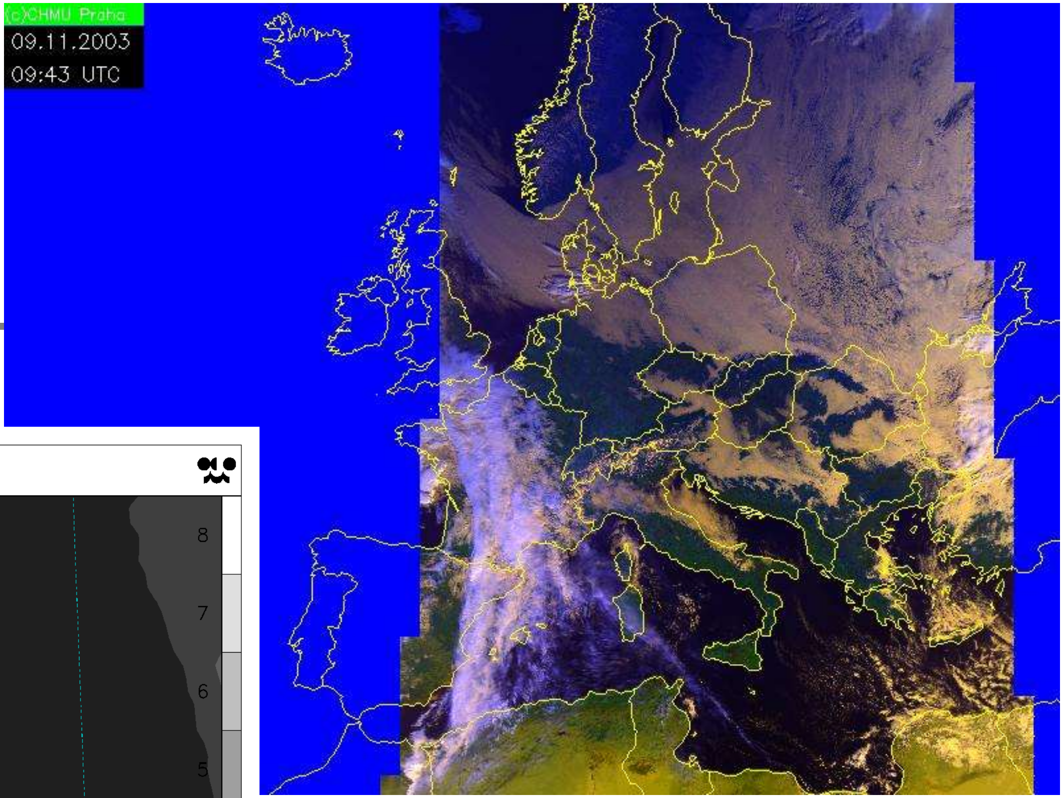
Recent changes in cloudiness scheme

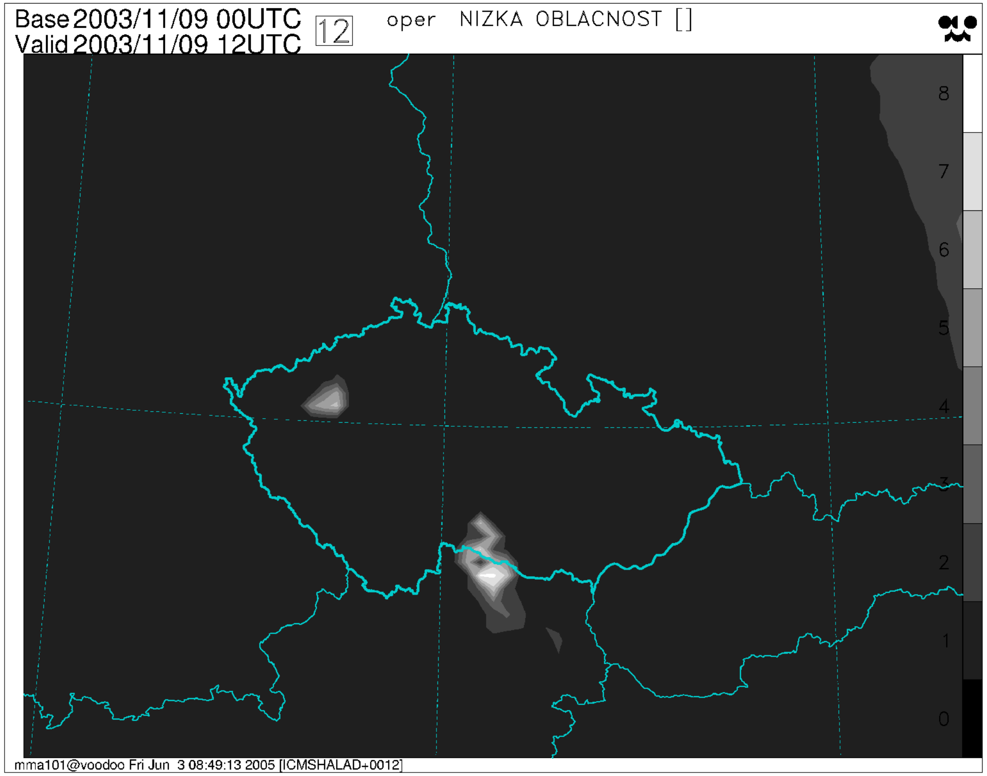
Aladin @ CHMI

Problem

- Low inversion clouds poorly forecasted
- These were too transparent and often missing:
  - Too strong 2m temperature diurnal cycle, especially in winter anticyclonic conditions;
  - Large errors in 2m temperature forecasts.

Illustration

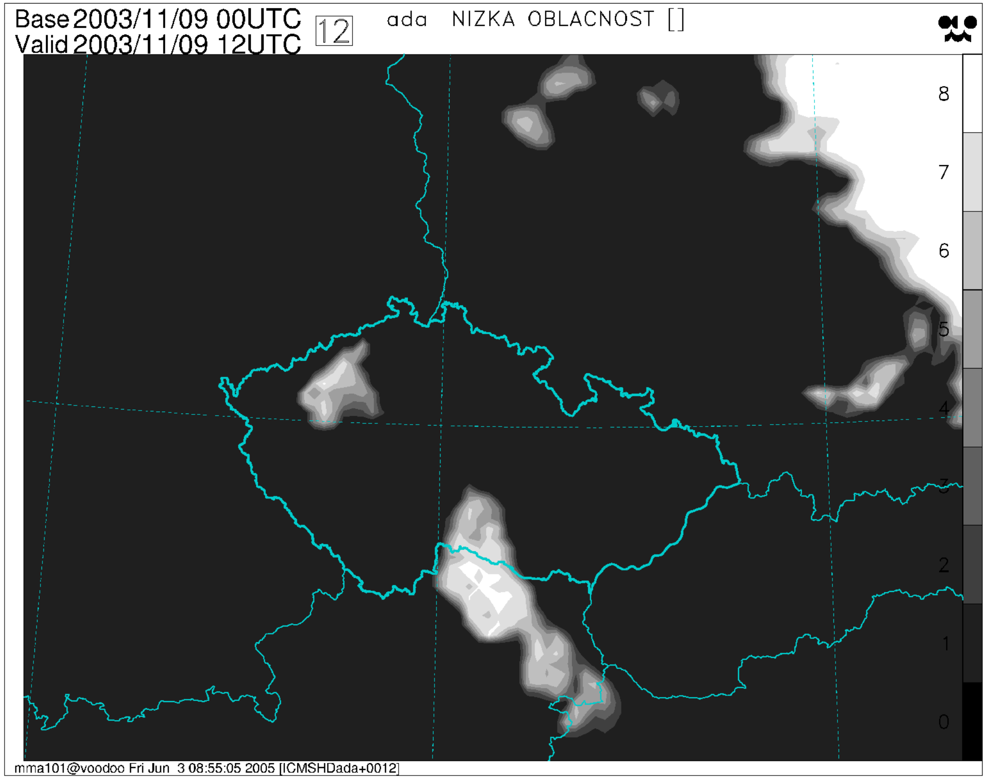




Should we switch the model off from November to February?

Developments: Xu-Randall (I)

- Switch to Xu-Randall formula: COCONUT package

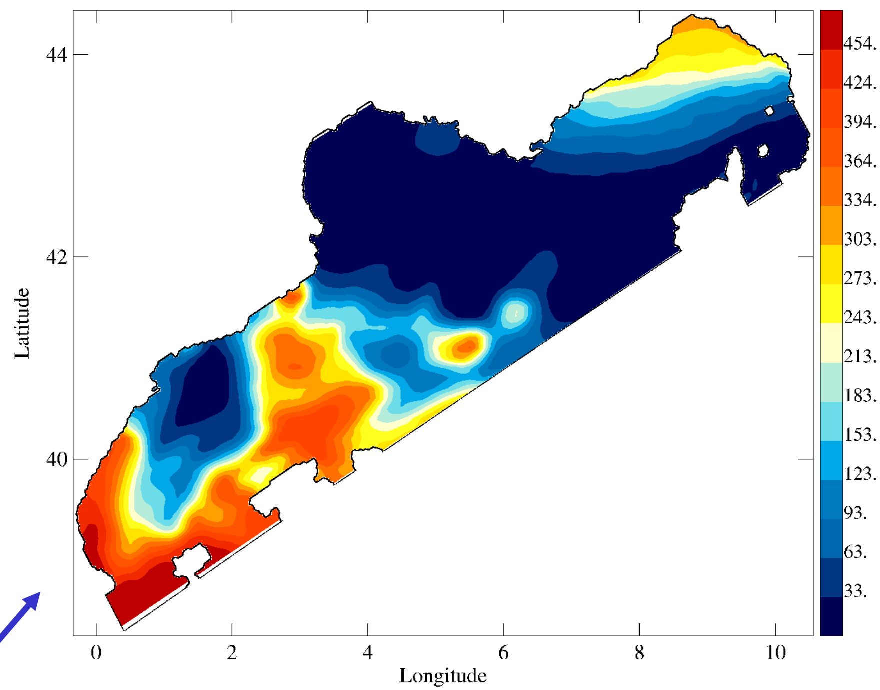


First application:
We added a small correction to obtain an earlier saturation (for the radiative clouds only).
Results: promising, we get more clouds.

But:
There are almost no intermediate clouds.
It is either 0 or 1 mostly.

Developments: Xu-Randall (I)

- Problem:



MFSTEP validation of solar radiation flux revealed that its values are not realistic. They are too low, below 30 Watts/m2 under the clouds. This is too small even in January.

It was then necessary to search rapidly for a better solution.

NOVELTIS validation of ALADIN at Med Sea:
Downward solar short radiation flux

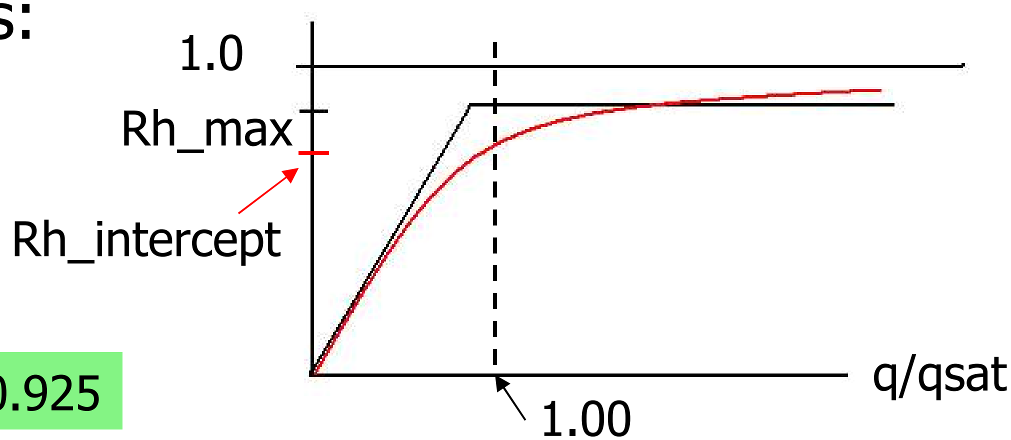
Developments: Xu-Randall (II)

- Independently of MFSTEP results:
  - New tuning to fit better to observations the critical humidity curve in the vertical (it is based on real data diagnostics made in ZAMG);

$$Huc = 1. - 1.4\eta\,(1-\eta)\,/\left(\left(1. - 0.6(\eta - 0.5)\right)\left(1. + 1.1(\eta - 0.5)\right)\right)$$

  - New function to compute the saturation for cloud diagnostics:

One compares Rh to Huc:
(Rh-Huc)*qsat -> XR



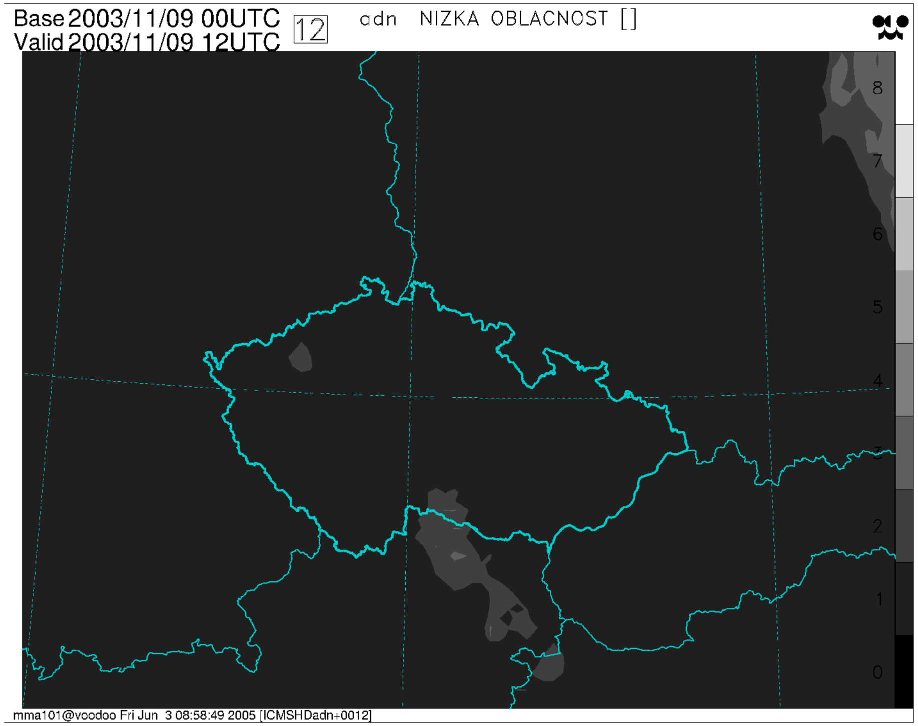
Rh_max=0.99; Rh_intercept=0.925

MFSTEP feedback

Based on the MFSTEP result we also changed the cloudiness geometry: from random to maximum-random overlap (key LRNUMX=.TRUE.)

☺

We now have intermediate clouds and better solar flux



!

We are back to square # 1 for the low-level clouds.

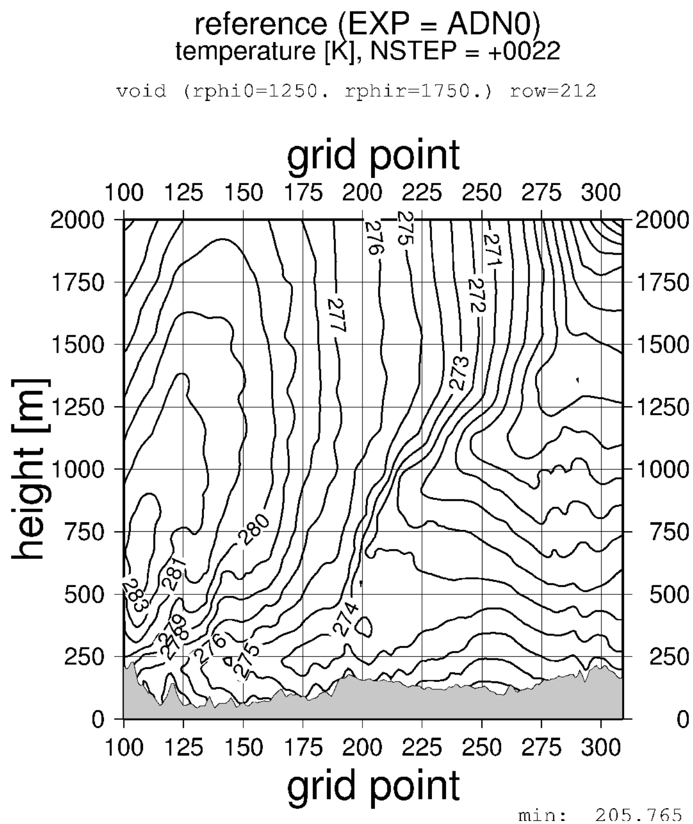
Low-level cloudiness (1/5)

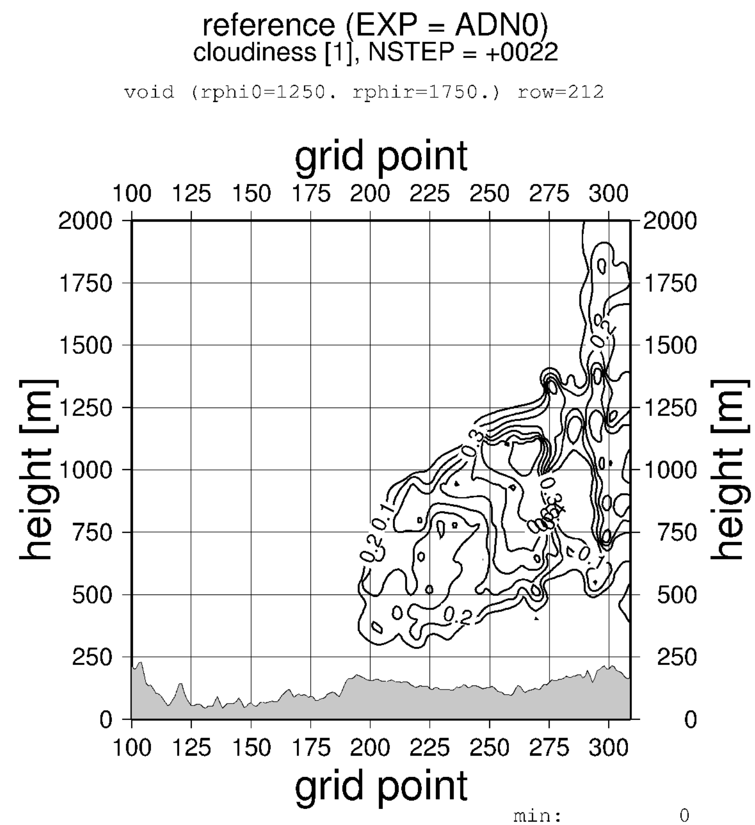
- Specific development
  - Idea: to diagnose temperature inversion layers (similar to Seidl-Kann approach) but also temperature vertical gradient
  - If the inversion layer is sufficiently thick (last tuning is 1750 J/kg) the saturation pressure qsat is computed with colder temperature within the layer
  - T-shifting is based on the detected gradient $\frac{\partial T}{\partial \phi}$

where the actual temperature difference is done by $d\phi$ distance (second tuning parameter; 1250 J/kg is used now)

Low-level cloudiness (2/5)

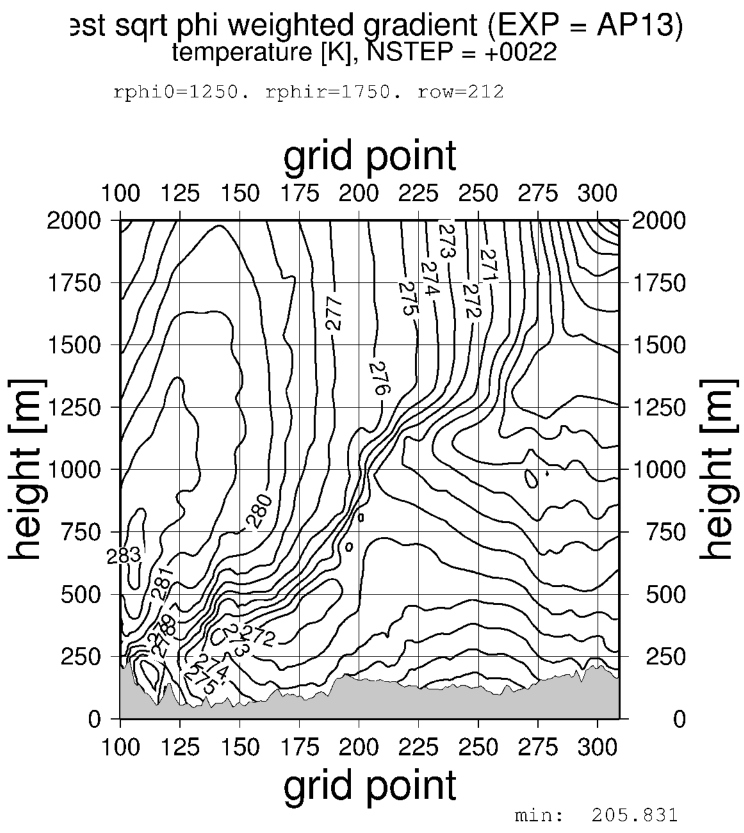
Impact of the modification: reference run

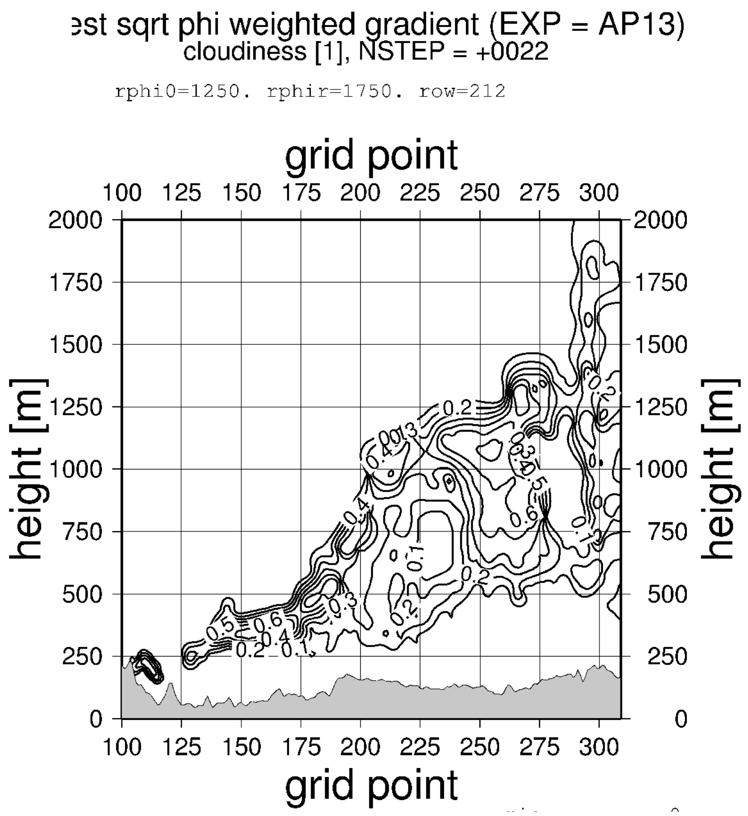




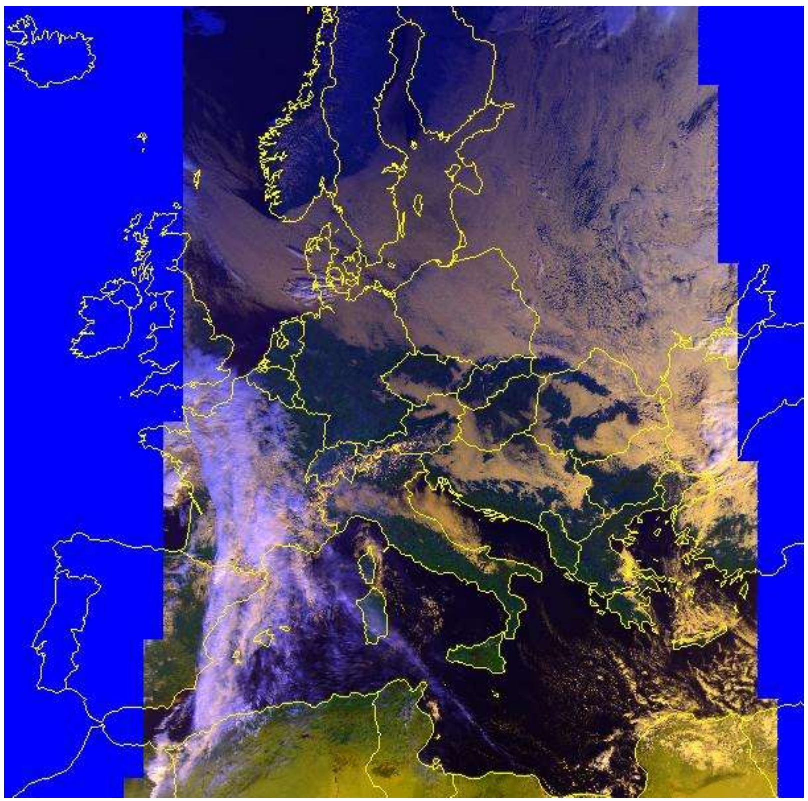
Low-level cloudiness (3/5)

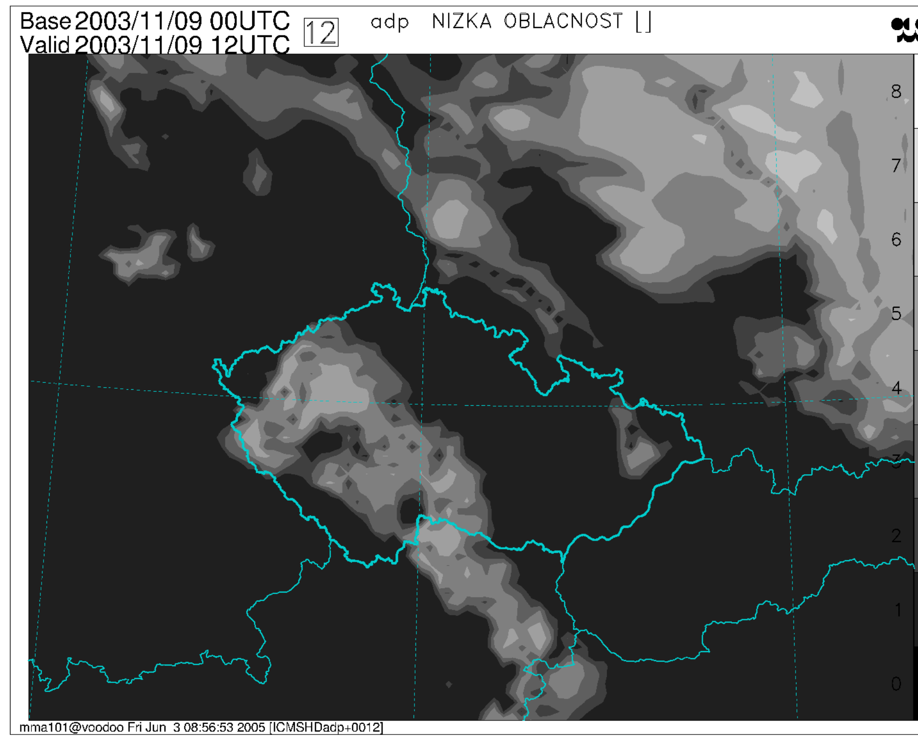
Impact of the modification: test run; there is a positive feedback





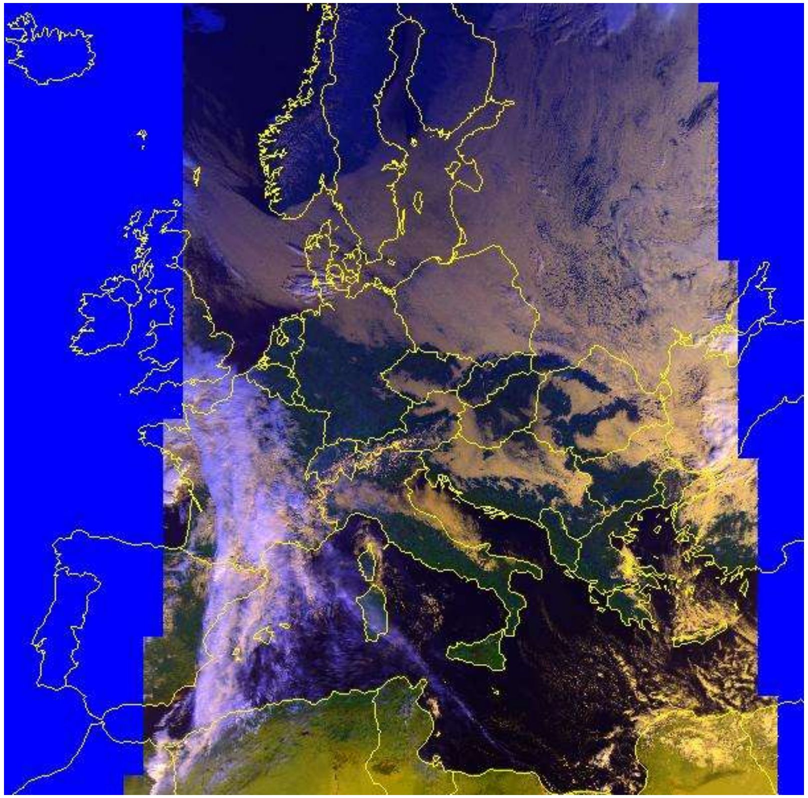
Low-level cloudiness (4/5)



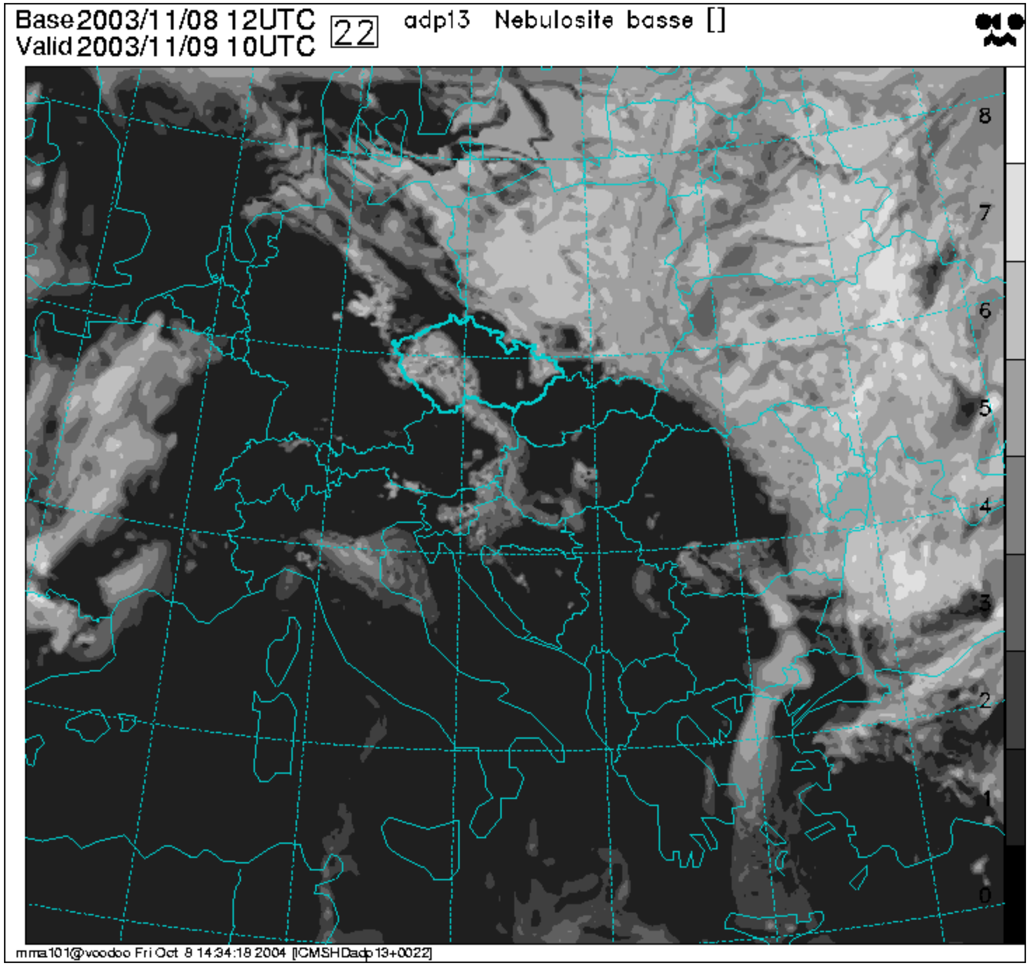


Last tuning; operational application

Low-level cloudiness (5/5)



How it works also elsewhere



Conclusions

- Current diagnostic Xu-Randall formula and tuning should be used with the maximum-random clouds overlap option;
- The low-level cloud modification is helpful, it goes to the right direction but is not perfect;
- When implementing prognostic cloud water, the problem will have to be re-assessed;
- See also CHMI poster and the nice Danube-valley fog.