Calculation of the surface outgoing long-wave radiation flux with due regard for the low frequency of the radiation routine calls

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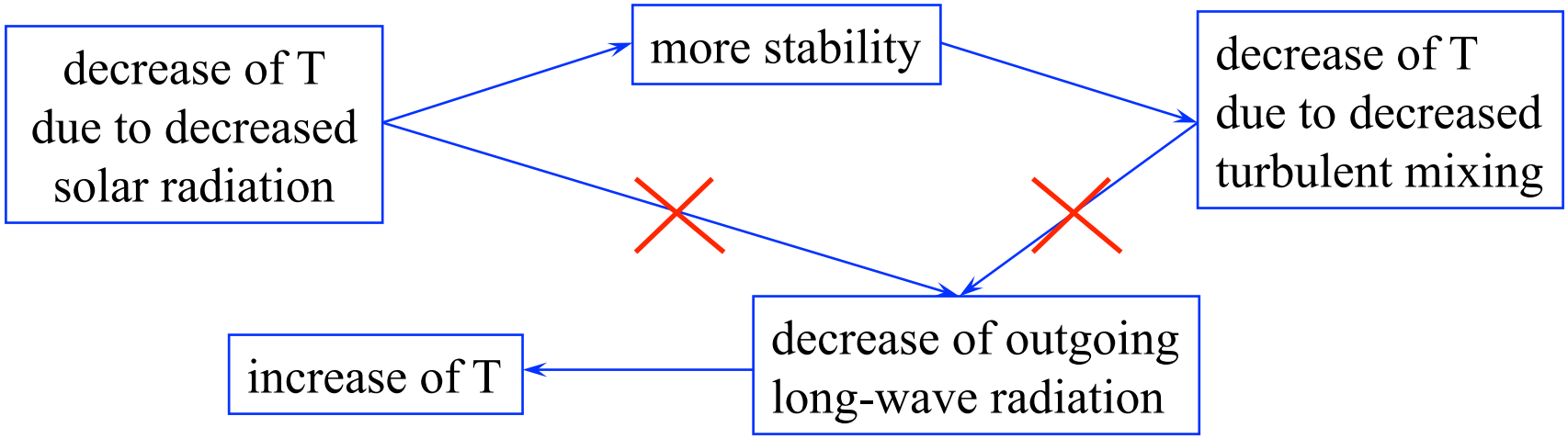
Problem: too low temperatures in the "multi-layer" model at nights

One of the causes:

radiation routine is called not at each time step →
outgoing long-wave radiation "frozen" by the temperature of the last call of the radiation routine

= switch off the negative feedback:



Problem: too low temperatures in the "multi-layer" model at nights

Solution:

Tracing the actual outgoing longwave radiation:

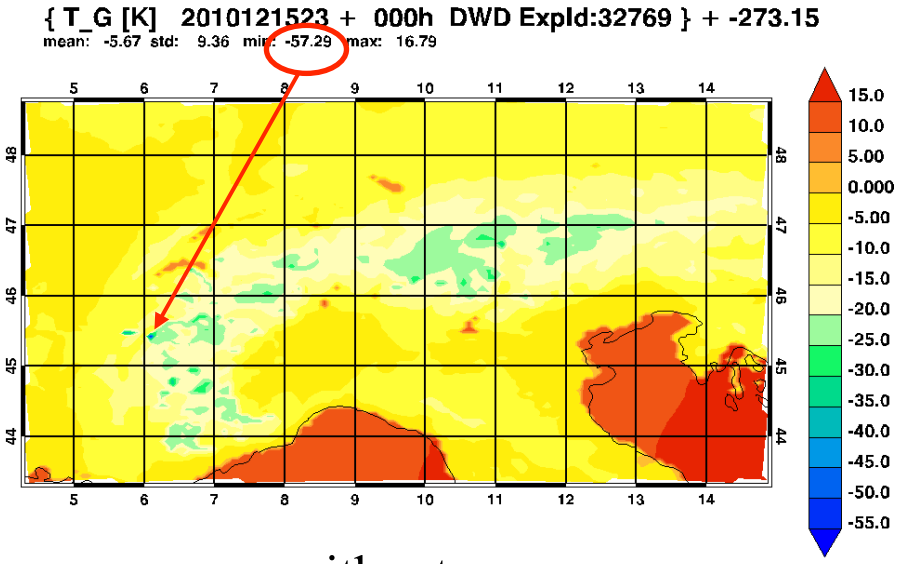
1) save $T_g(old)$ from the time step of the last call of the radiation

2) at each time step in TERRA:

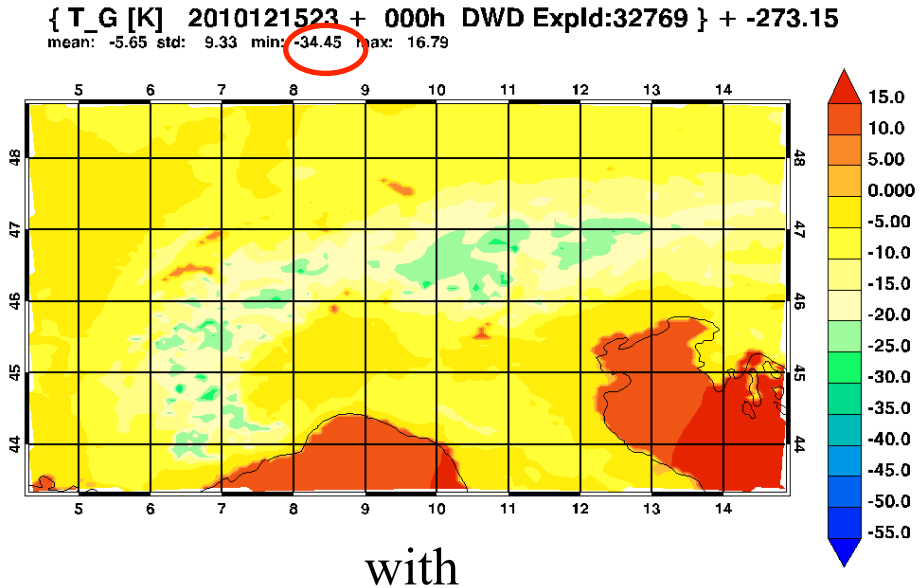
R_{lw} (balance of the longwave radiation at the surface) =

R_{lw} *(from the radiation routine)*$- \sigma T_g(old)^4 + \sigma T_g(current)^4$

Example: surface temperature with and without tracing

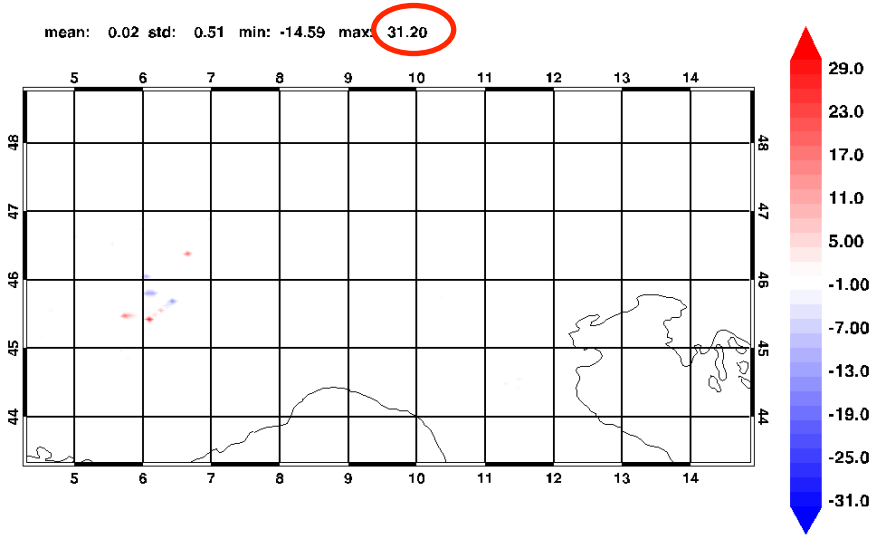


without

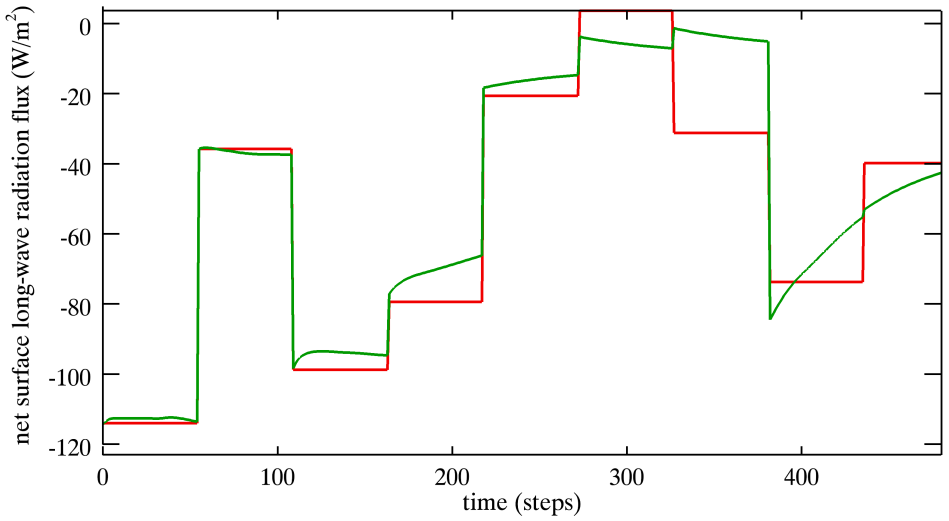


with

difference:



Example: one-layer snow model with and without tracing

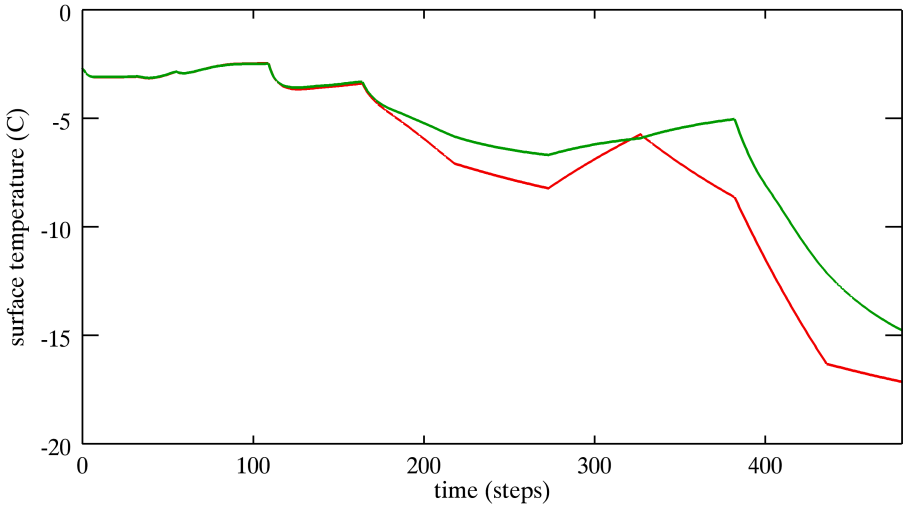


COSMO-EU forecast

started 20.01.2011
at 12 UTC

grid point (248,251)
(Alps)

Red – without correction
Green – with correction

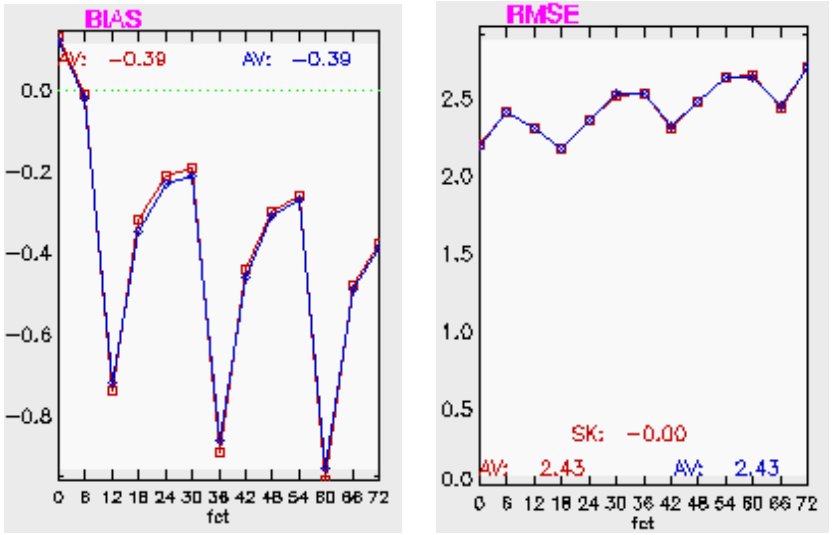


The difference is up to tens of W/m² and several degrees

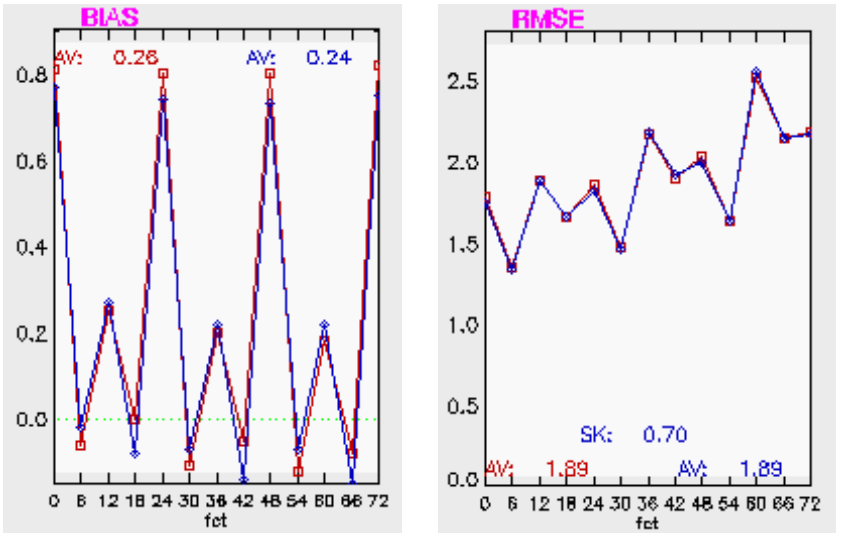
Surface temperature with tracing: verification

COSMO-EU domain, 2m temperature

January 2011



July 2011



Nights become warmer, days become colder →
even more underestimated diurnal cycle

However, a positive impact on 2m temperature during winter nights (cold bias reduced) and summer days (warm bias reduced)

2m specific humidity and wind, cloud cover, precipitation are not affected

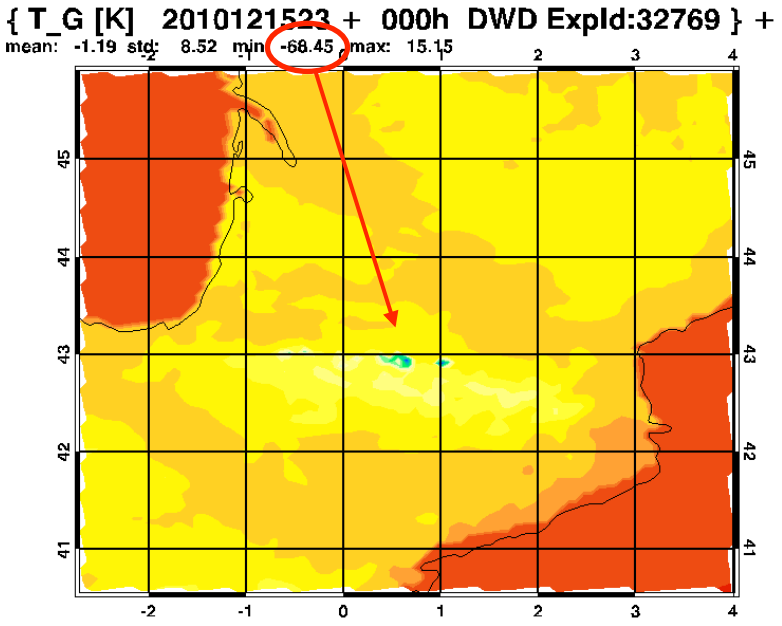
Conclusions

- The correction of the surface outgoing long-wave radiation flux with due regard for the low frequency of the radiation routine calls is proposed
- Although the correction is physically justified and meaningful, the forecast skills of the COSMO model do not necessarily increase (e.g. the amplitude of diurnal temperature cycle); representation of the surface temperature of winter nights and summer days is slightly improved
- Make it operational?

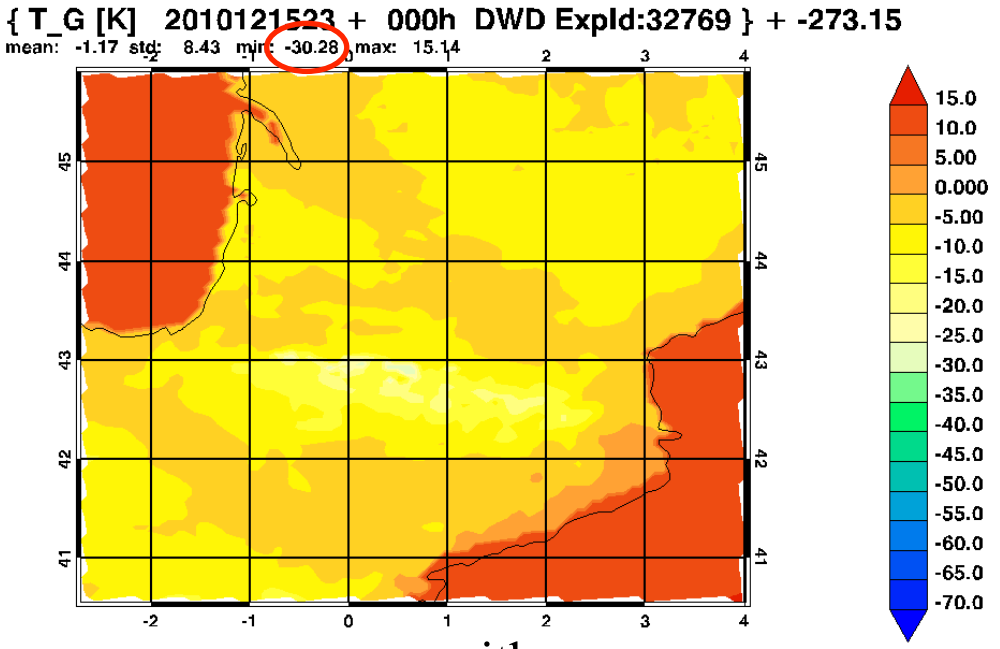
Thank you for your attention!

Thanks to Jochen Förstner, Thomas Hanisch, and Dmitrii Mironov!

Example: surface temperature with and without tracing



without



with

difference: