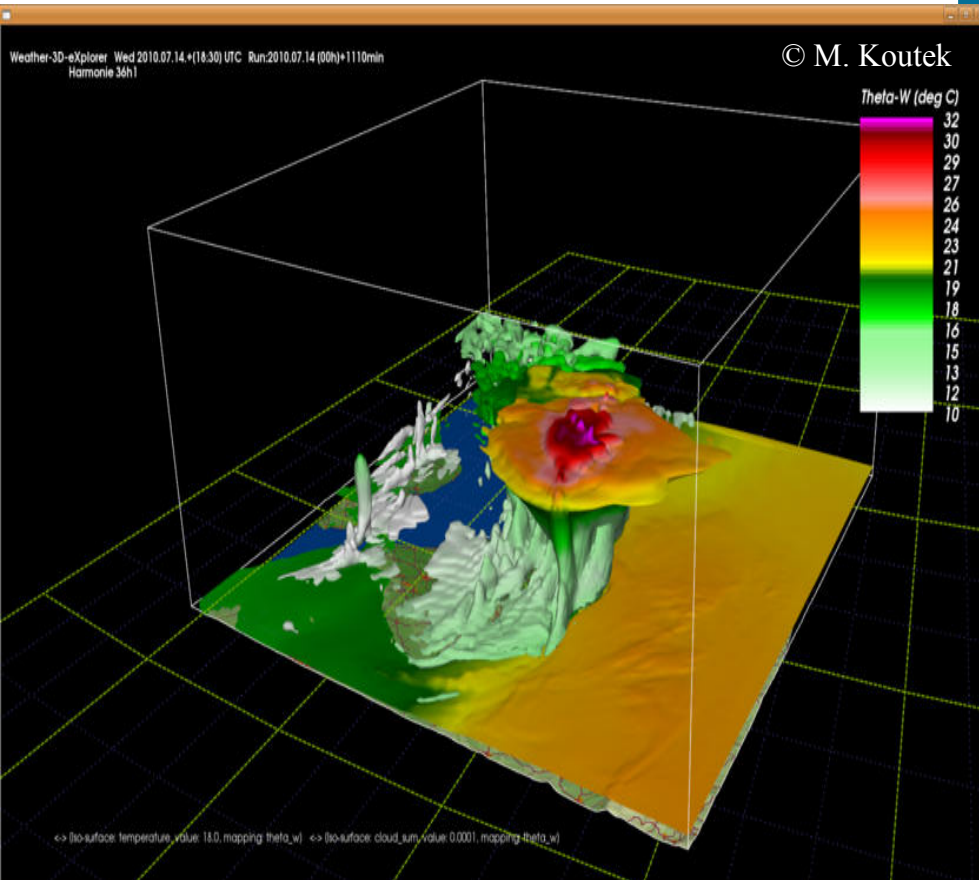




Royal Netherlands
Meteorological Institute (KNMI)
*Ministry of Infrastructure and the
Environment*



Systematic HARMONIE problems as seen from a user perspective

Sander Tijm
KNMI



Overview

- Models used in the KNMI operational forecasts
- Use of HARMONIE
- HARMONIE problems



Models used at KNMI

- HIRLAM*
- ECMWF (Deterministic & EPS)*
- HARMONIE
 - NORLAMEPS (to be replaced by GLAMEPS)
 - PEPS
 - UKMO, WRF, GFS

*Used in statistical applications



Models used at KNMI: Aim

- HARMONIE*
- ECMWF (Deterministic & EPS)*
- GLAMEPS*
- HarmonEPS*

*Used in statistical applications

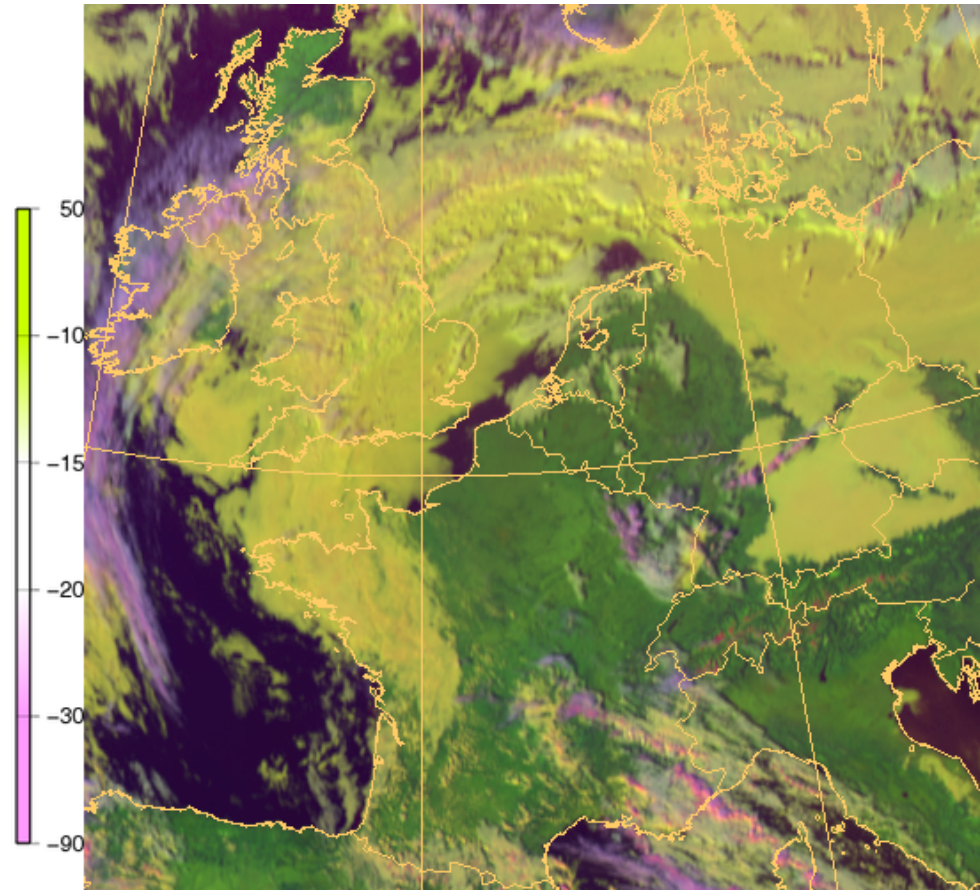
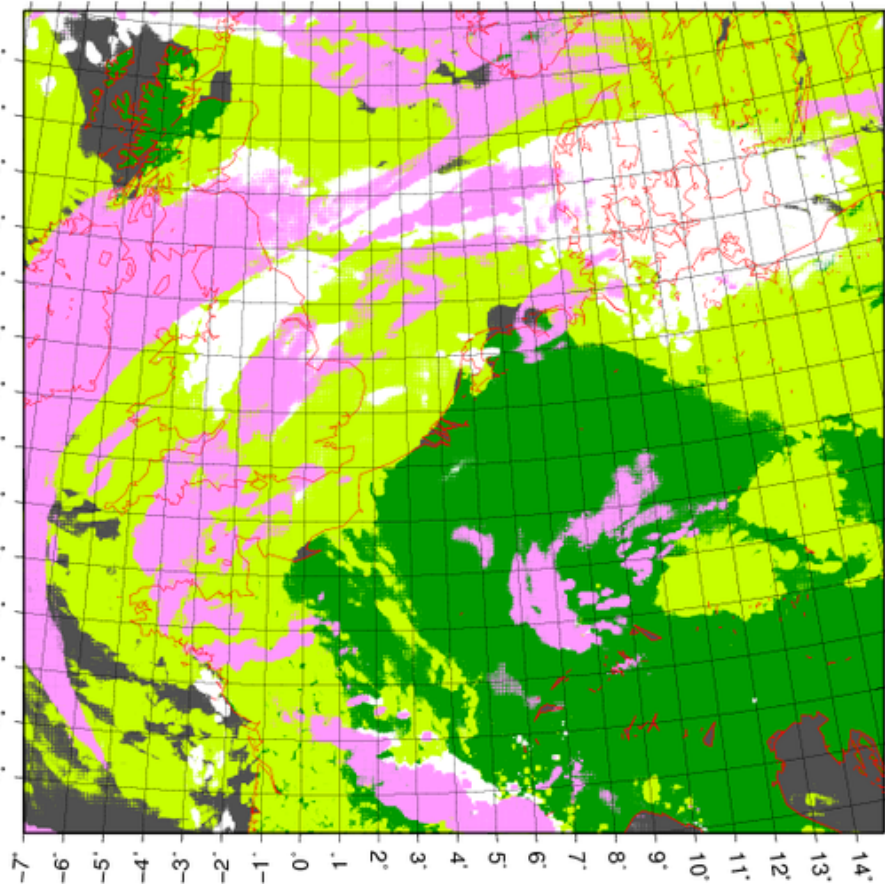


Use of HARMONIE at KNMI

- HARMONIE has operational status at KNMI
- Output only visible via pre-processed images on the internal webpages
- Used as 'second opinion' for normal weather
- Leading in strong convective situations, strong role in dynamical conditions (deep low pressure areas, active frontal systems, thunderstorms)
- Not yet present in statistical applications, on the meteorological work station
- HARMONIE performs well, sometimes remarkably good.....



HARM36 l,m,h wolken an 2012102200 val 22 - 10, 14 UTC





HARMONIE problems

- Overestimation of fog over cold sea
- Underestimation of Sc/St $-15^{\circ}\text{C} < T < 0^{\circ}\text{C}$
- Too warm longer forecasts in Summer -> leading to convection not materializing in reality
- Underestimation of strong winds (winds in neutral and unstable conditions)
- Overestimation of wind gusts in stable conditions
- Surface snow melting too slowly (problem in all models)
- Too much graupel being formed, too quick melting of snow, too quick refreezing of rain, too strong evaporation of rain/snow



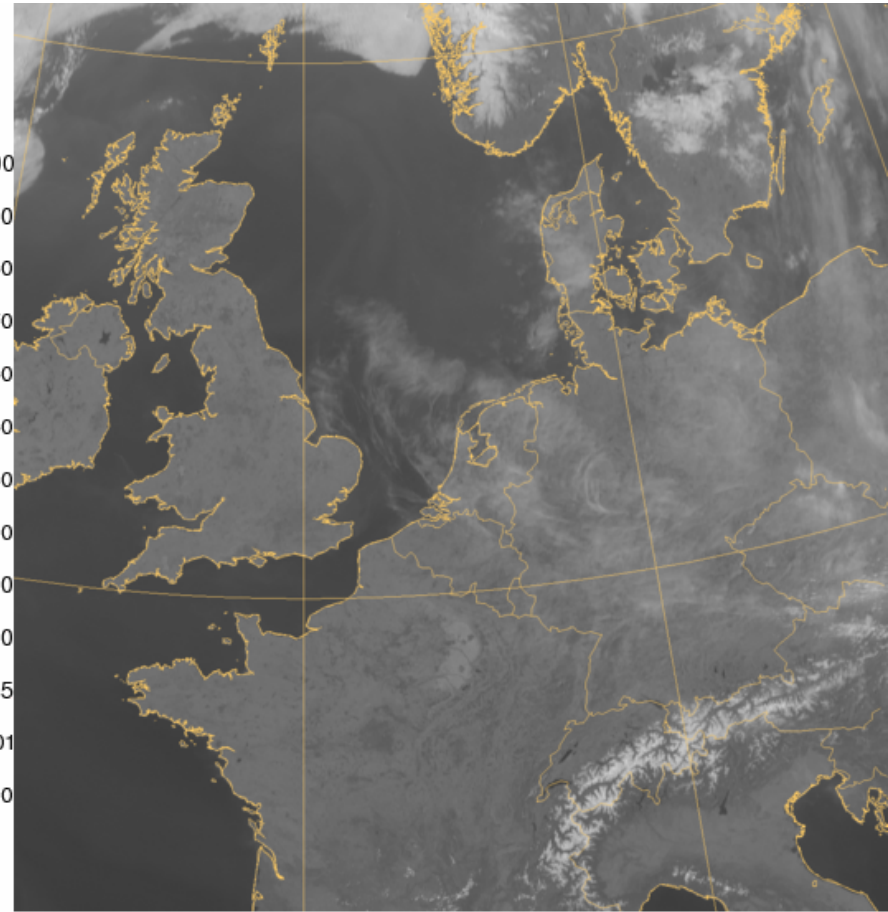
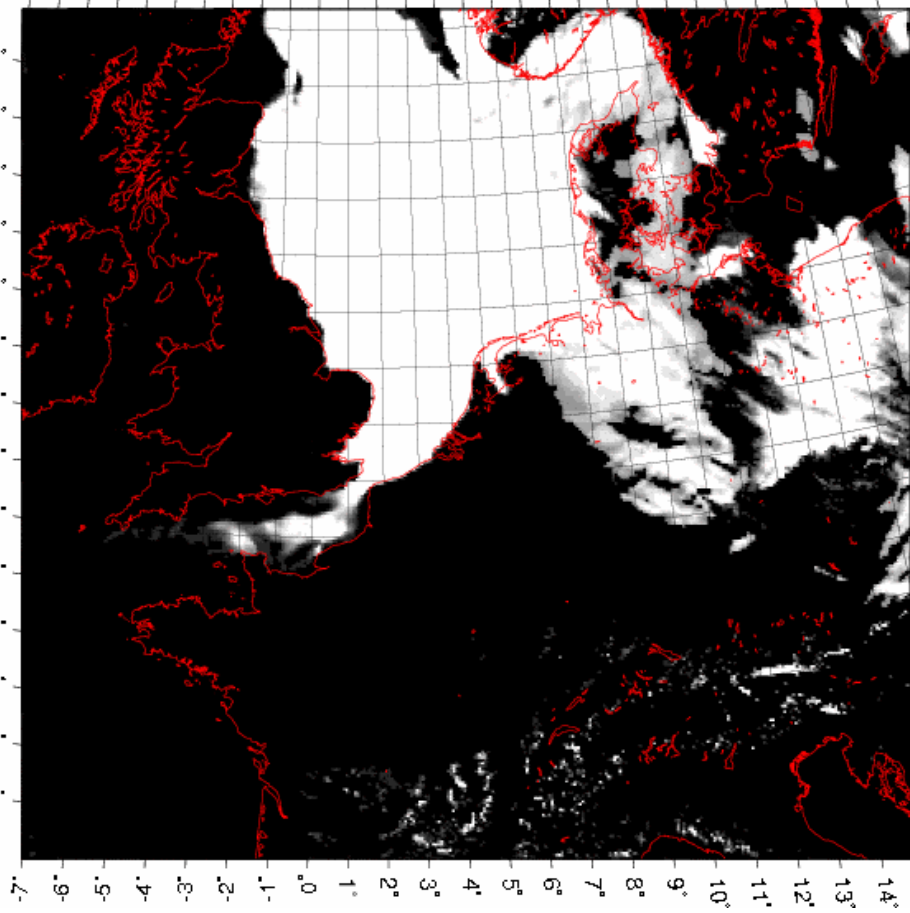
HARMONIE problems

- Overestimation of incoming short wave radiation caused by water clouds being too transparent
 - Overestimation of high clouds
 - Too low cloud base caused by too high Td
 - Not enough isolation from thin (<10 cm) snow layers, -> too high minimum temperatures
 - Problems with uninitialized snow density
 - Daily cycle in Td that is not present in observations
- > Important to solve problems, forecasters tend to stick to what they are familiar with (worse, but with known errors)



Model output

HARM36 Cloud cover 2012032700 + 013

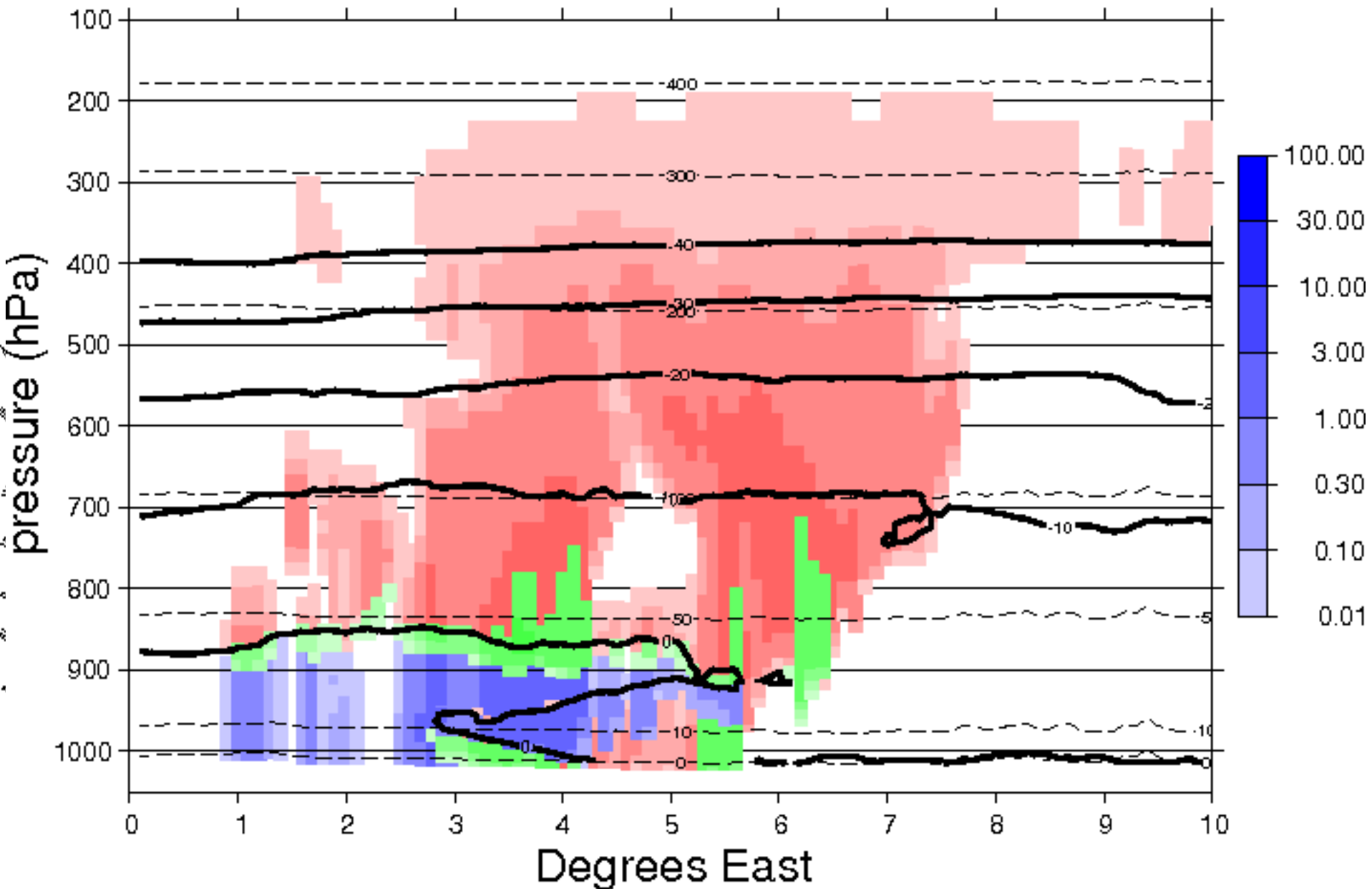




Microphysics issues

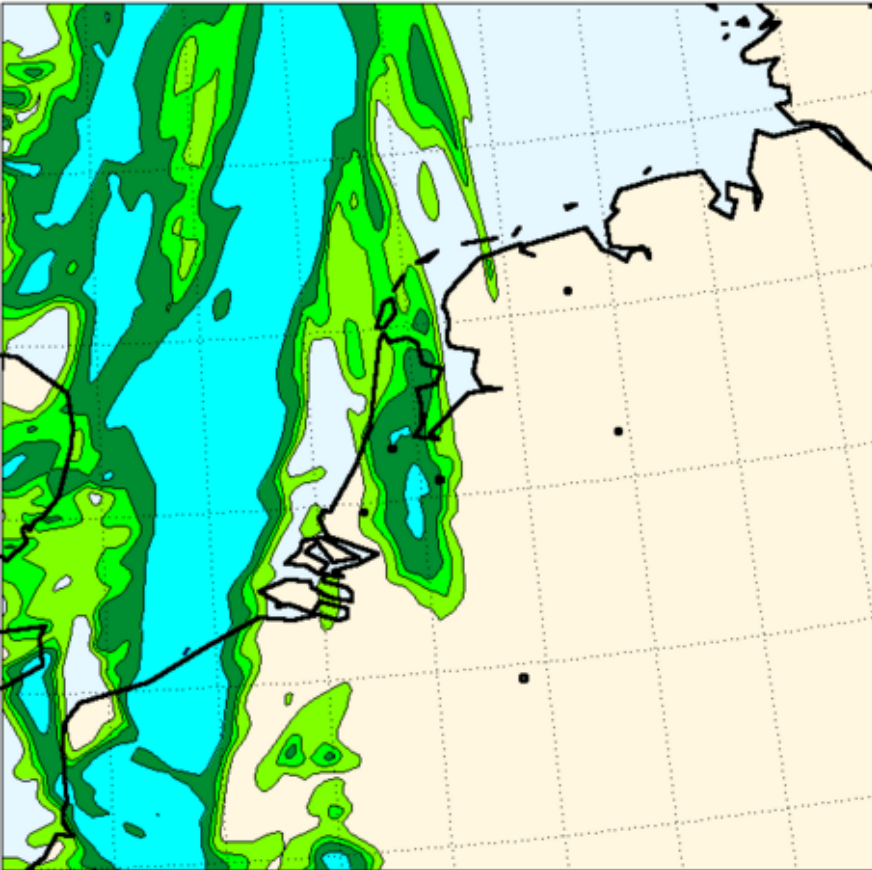
- Precipitation evaporating too quickly, not enough precip reaching the ground at the leading edge of frontal systems
- Snow melting too quickly, refreezing too quickly when rain falls through cold layer -> underestimation of freezing rain
- Too much graupel being formed

Prec wwee +03 fcst 2013021409 in mm/uur

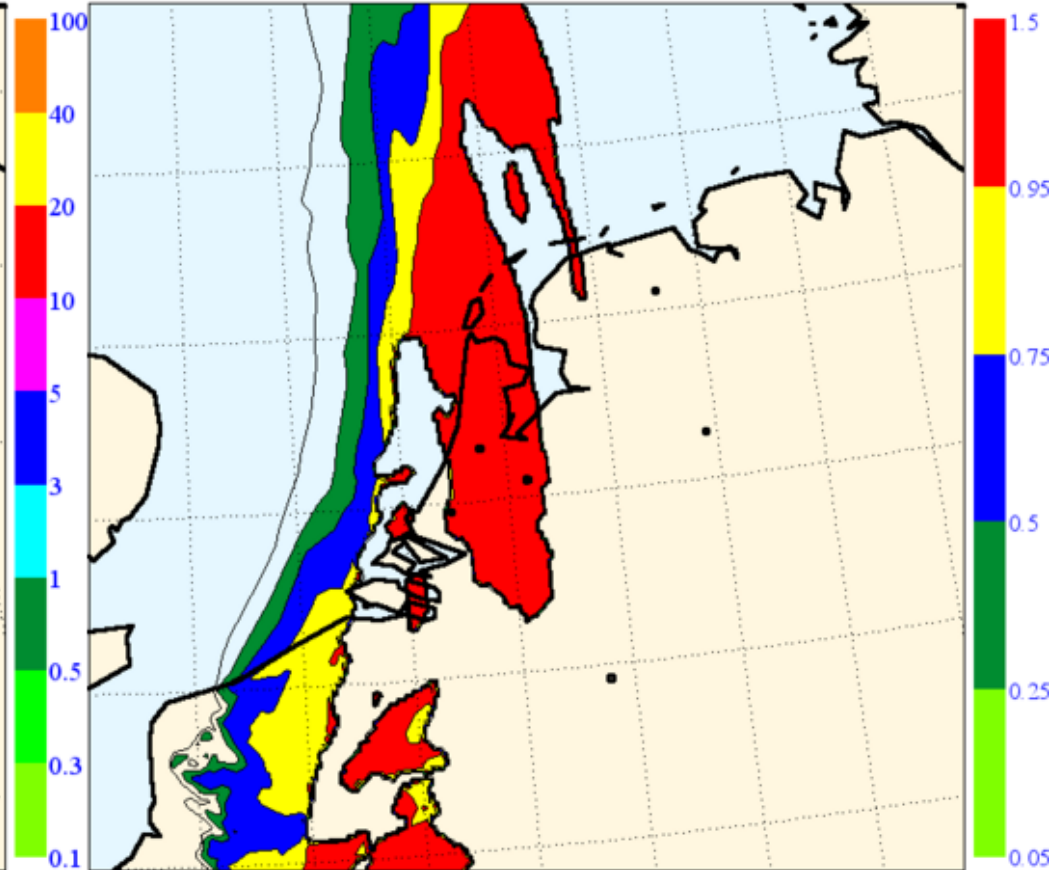




**HARMONIE 36H1 t+12 1-h precipitation
forecast VT:12 UTC on 14 February 2013**

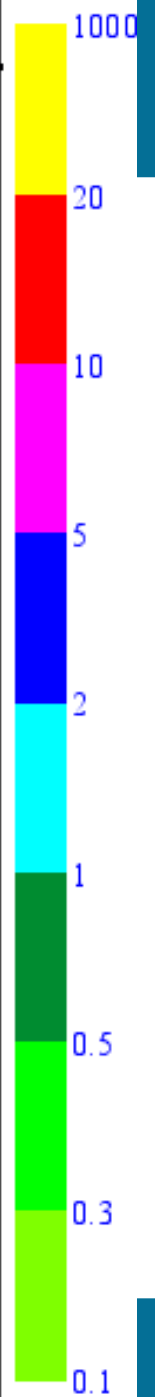


**HARMONIE 36H1 t+12 1-h solid fraction
forecast VT:12 UTC on 14 February 2013**



14:00

T



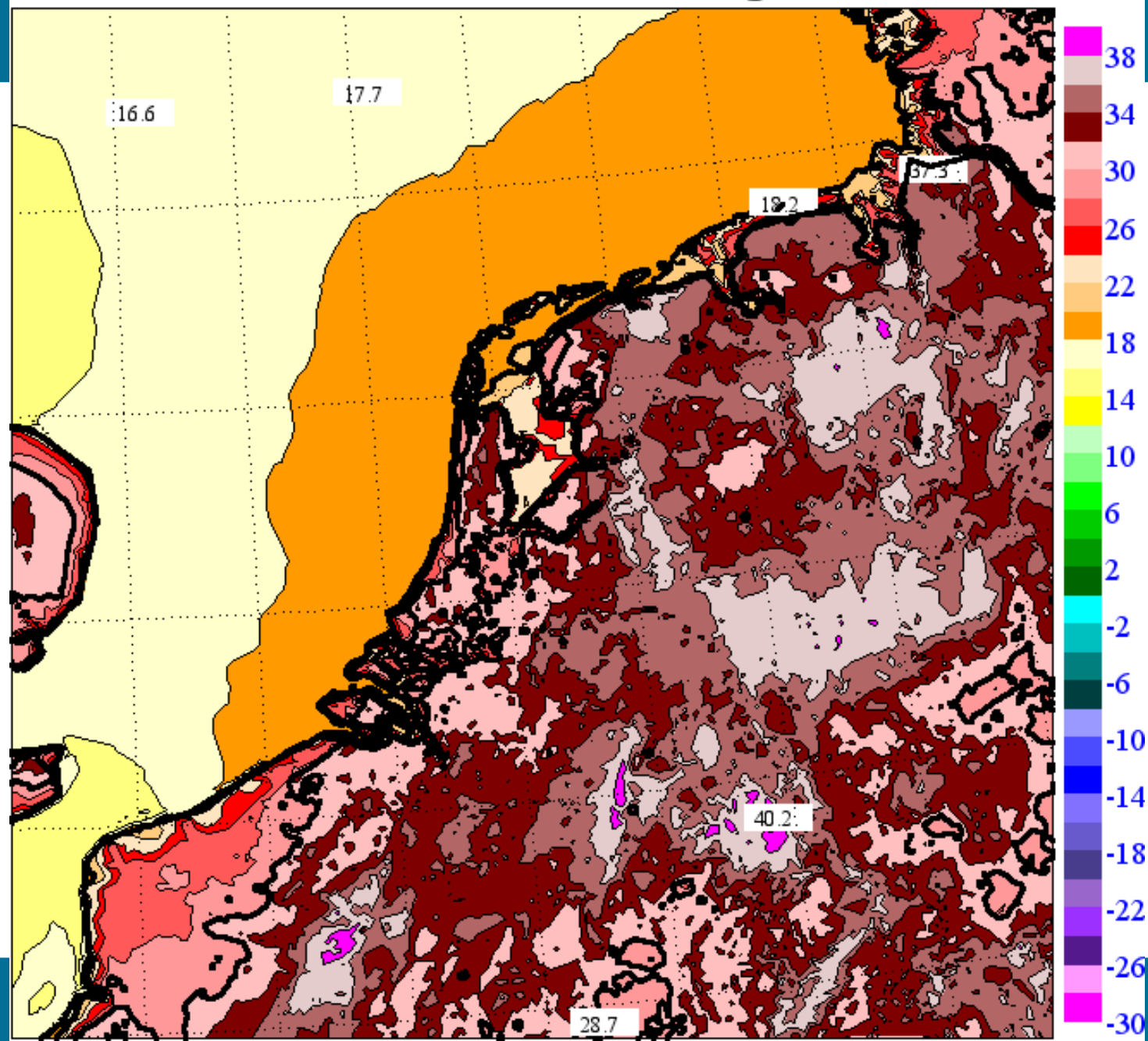
BuienRadar.NL - 1x1km - 17 december 2010 14:00



Overestimation of T2m, impact on convection

- Overestimation of T2m on 19 August (extremely hot day in the Netherlands, T_{max} 37°C)
- Especially in older runs (before 2012081906) strong convective signal in evening
- Convection on top of very deep dry boundary layer
- Extreme gusts (up to 90 kts) forecasted in association with deep convection
- Eventually some mid-level disorganized convection developed, no severe weather.
- Forecaster mentions “apocalyptic runs” in guidance

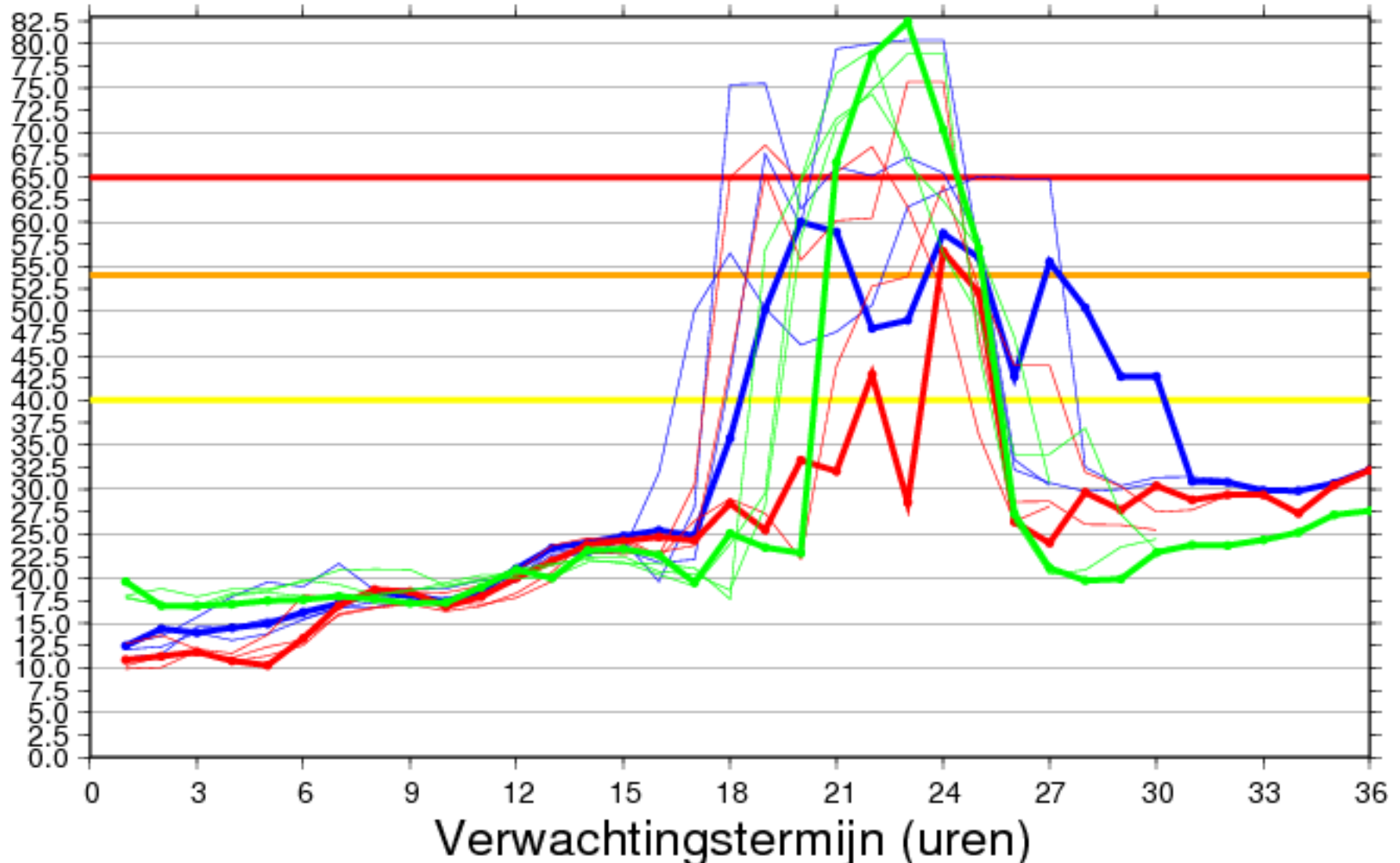
HARMONIE 36H1 t+1 2m Temperature forecast VT:13 UTC on 19 August 2012



HARMONIE 36H1 t+22 10m Wind gust (kt)

forecast VT:22 UTC on 19 August 2012

HARMONIE FFx (kt) NL, zee (b), kust (r), land (g), 2012081900

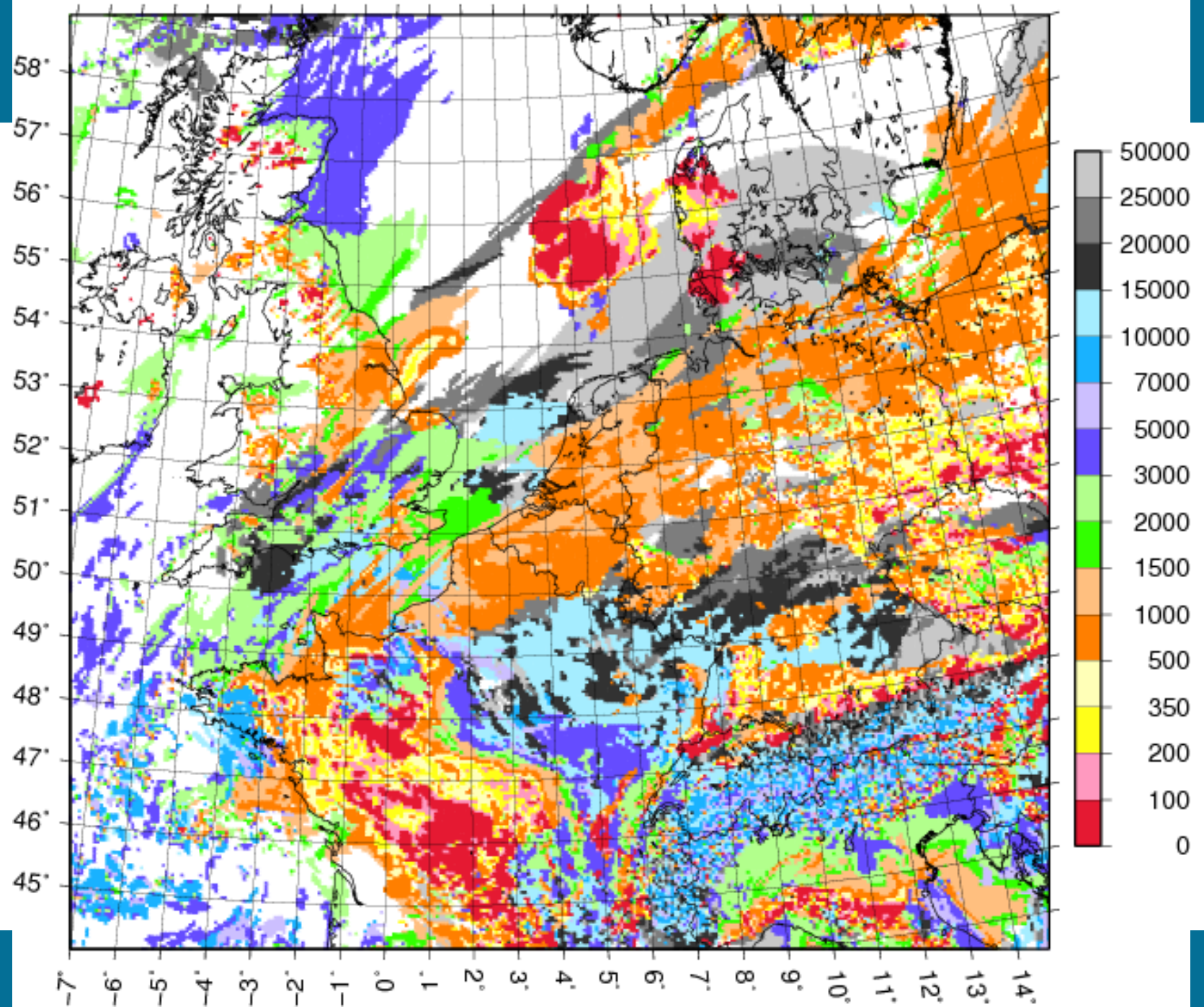




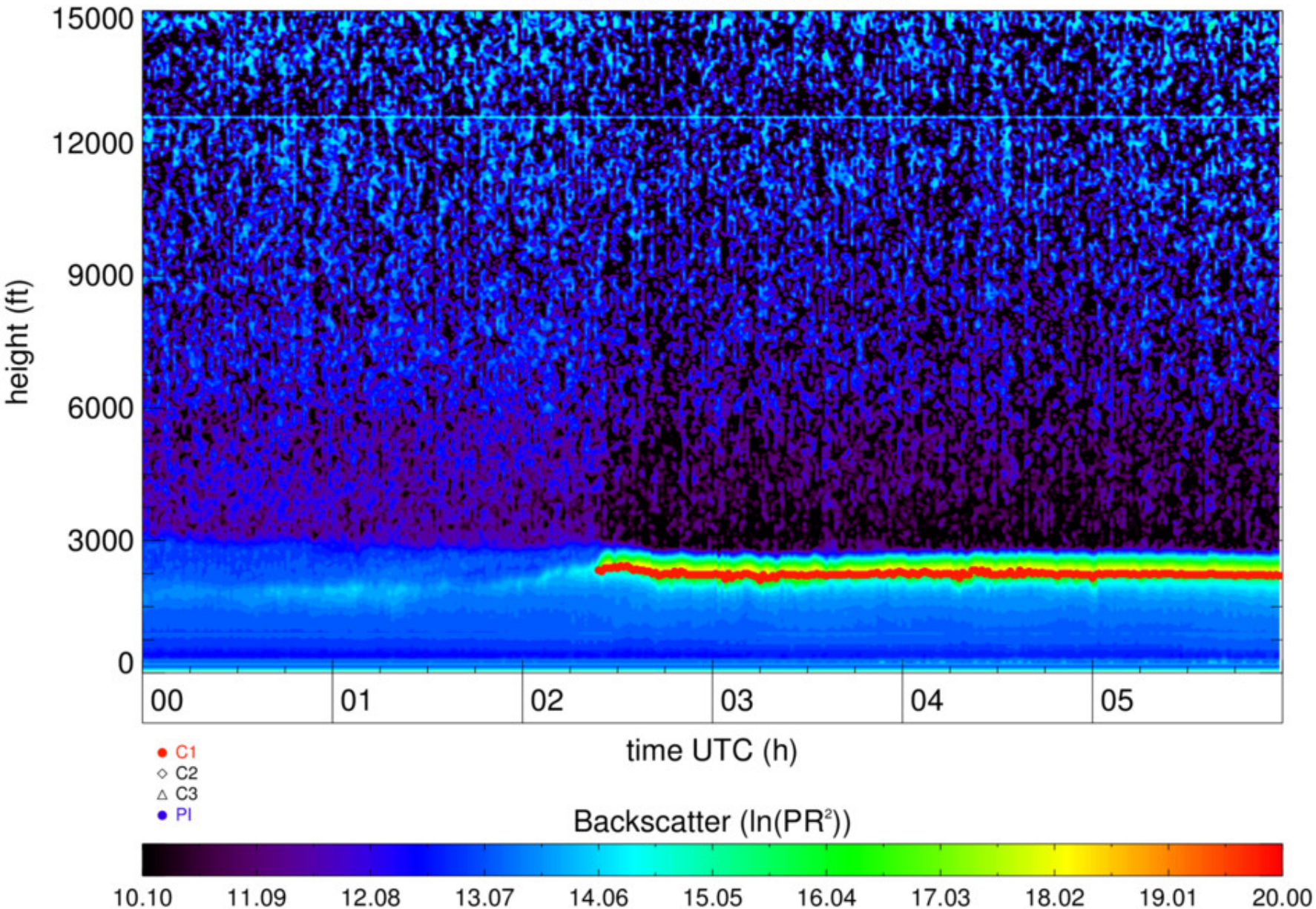
Too low cloud base

- March and first 10 days of April 2013 very cold
- Northeasterly flow with a lot of low clouds (below 2500 metres)
- Some nights with Sc, observed cloud base 2000-3500 ft, forecasted 500-1000 ft (problematic for aviation)
- Air too cold and moist
- Origin of too cold and moist air?

HARM36 cloud base an 2013040400 val 05 - 04, 06 UTC

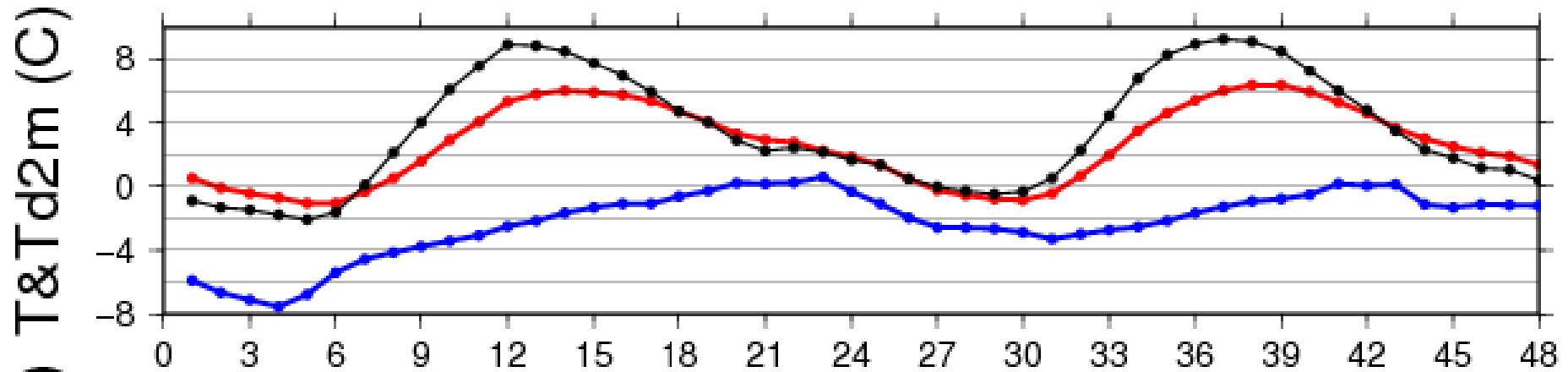


LD-40 backscatter Beek

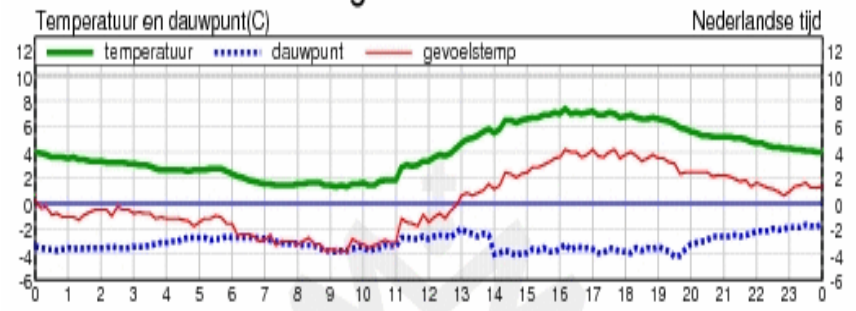




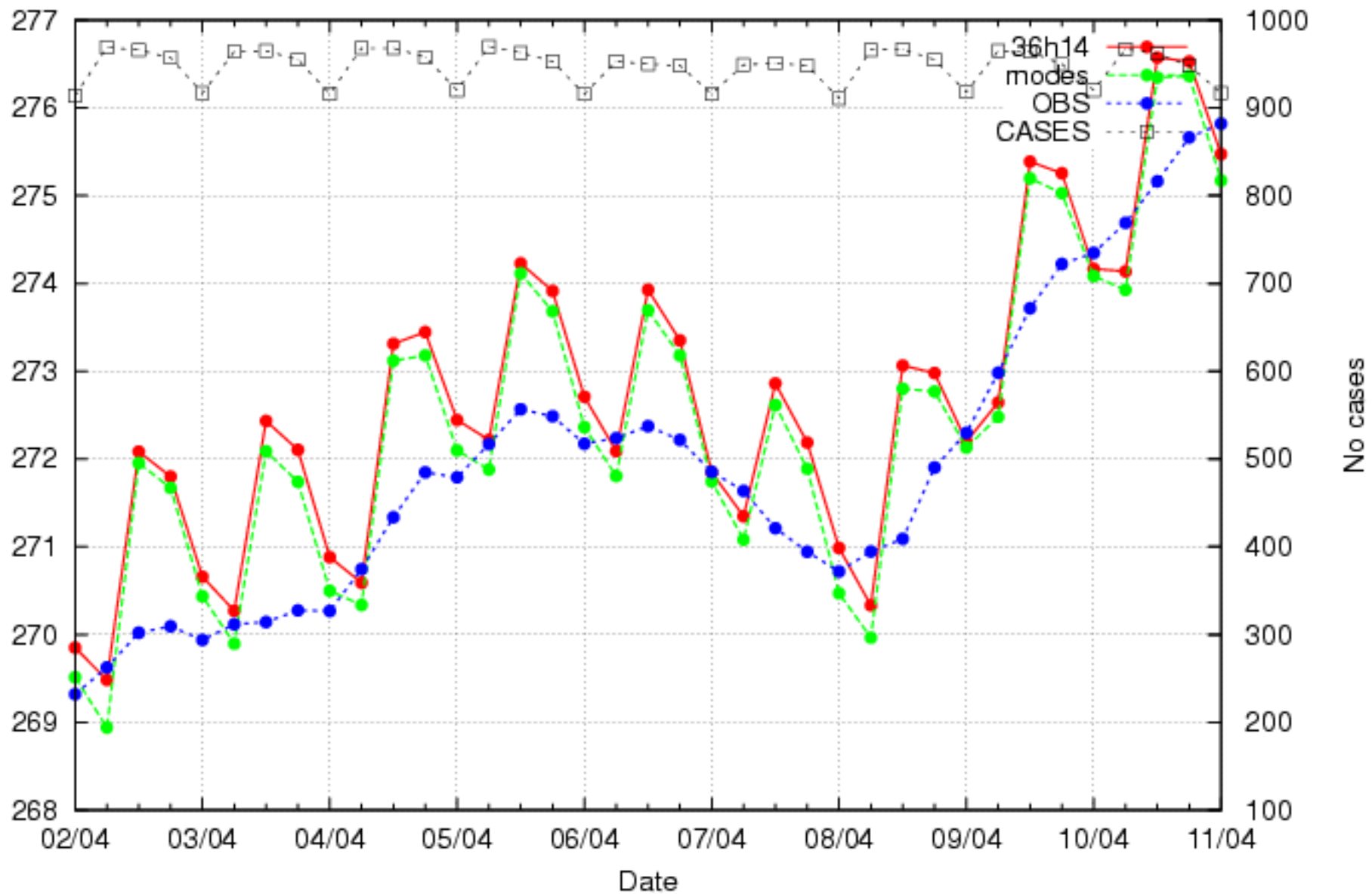
T&Td2m (r,b) 2m & Ts (z) time series EHDB 2013040400



10-minuut waarnemingen De Bilt 00:00 uur



Selection: ALL 977 stations
Td2m
Used 00,06,12,18 + 24 Window: 6h





Summary

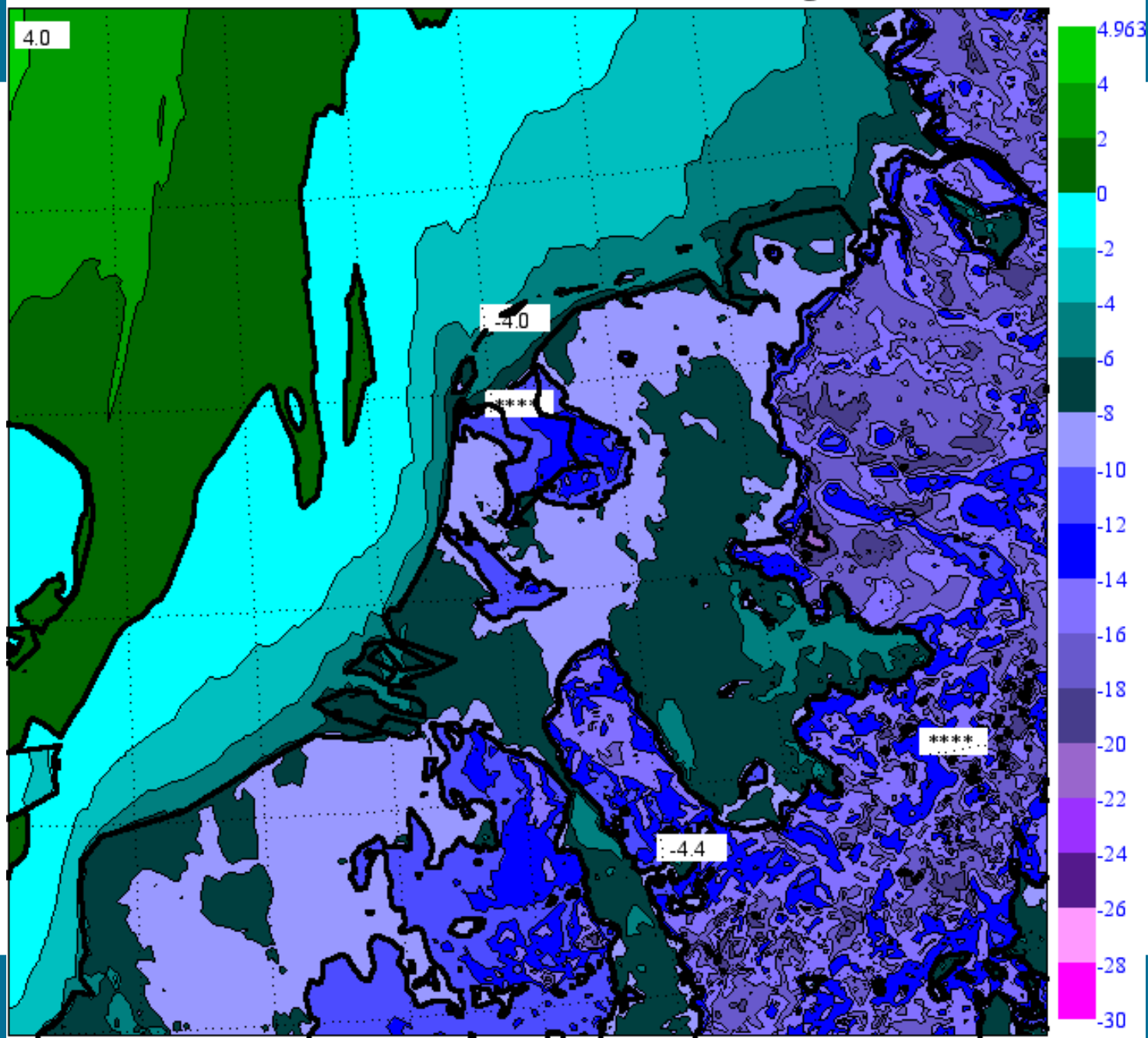
- HARMONIE/AROME performs well, forecasters like the HARMONIE products
- HARMONIE/AROME has some systematic problems, can be bad for acceptance of model in operations
- Some are/can be solved quickly, some need more study to diagnose the origin of the problems
- Microphysics more important, is it being developed further?
- Needs to be good balance between (short term) problem solving and (longer term) research and development



Problems with T_s and snow

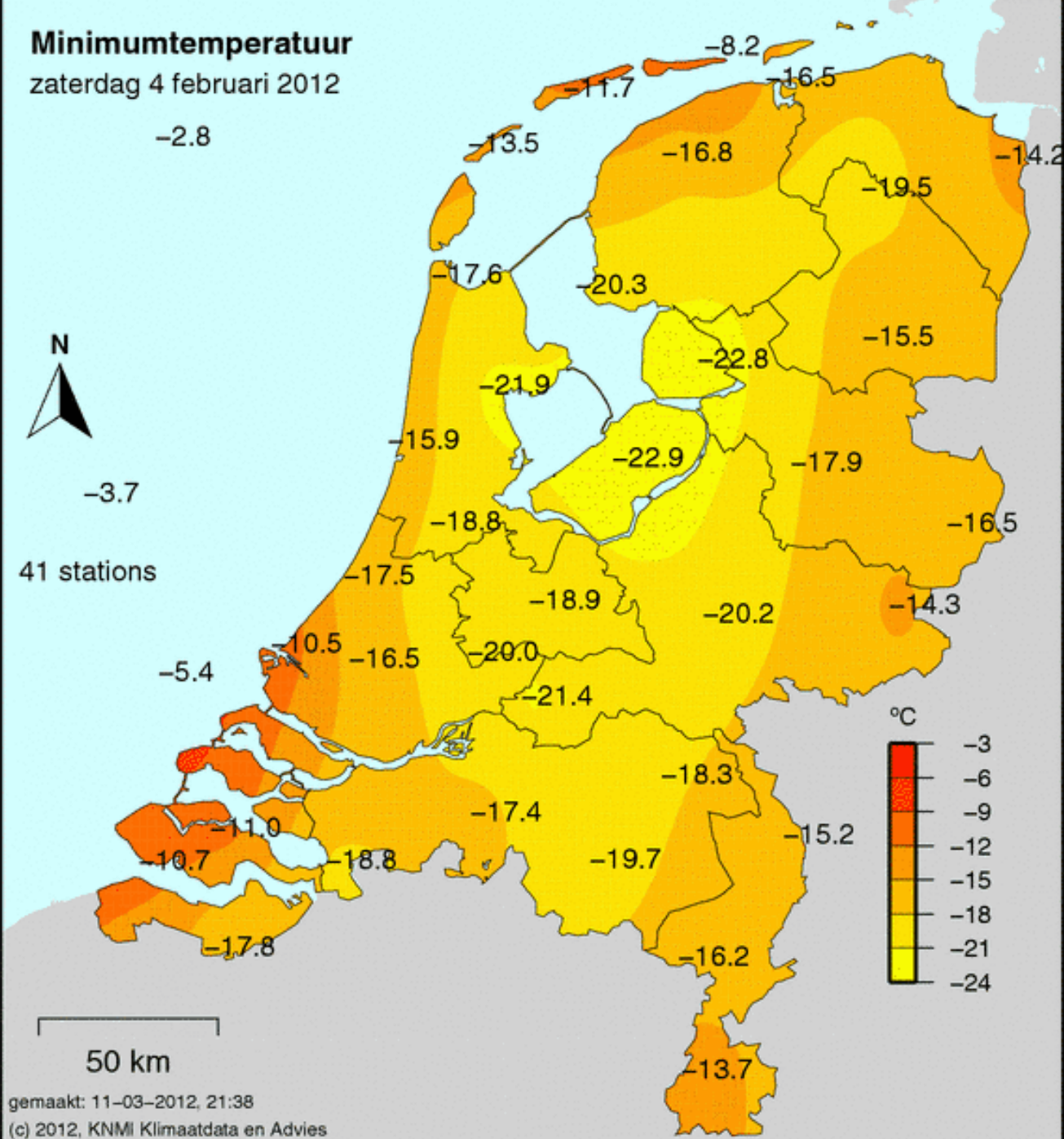
- In cold conditions sometimes strange patches with (much) too high T_s
- Patches change position from run to run
- Overestimation of T_{2m} of 10-15°C in cold conditions
- Problem also the other way around, too cold when $T > 0^\circ\text{C}$
- Problem caused by uninitialized snow density when snow was added through DA

HARMONIE 36H1 t+18 2m Temperature forecast VT:6 UTC on 5 February 2012



Minimumtemperatuur

zaterdag 4 februari 2012



-2.8

-8.2

-11.7

-16.5

-13.5

-16.8

-14.2

-19.5

-17.6

-20.3

-15.5

N

-22.8

-21.9

-3.7

-17.9

-15.9

-22.9

-18.8

-16.5

41 stations

-17.5

-18.9

-20.2

-14.3

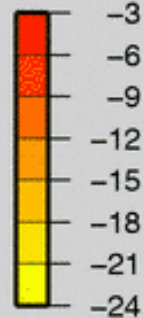
-5.4

-10.5

-16.5

-20.0

°C



-21.4

-18.3

-15.2

-11.0

-17.4

-19.7

-10.7

-18.8

-17.8

-16.2

-13.7