



Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure
and Water Management*

Physics developments **HARMONIE-AROME**

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Physics work HARMONIE-AROME

Shallow and deep convection and interaction

Cloud aerosol radiation interaction

Microphysics

Near surface fluxes and translation to 2m

Fog study



Fog problems HARMONIE-AROME

Too large fog extent (spring and summer over the sea)

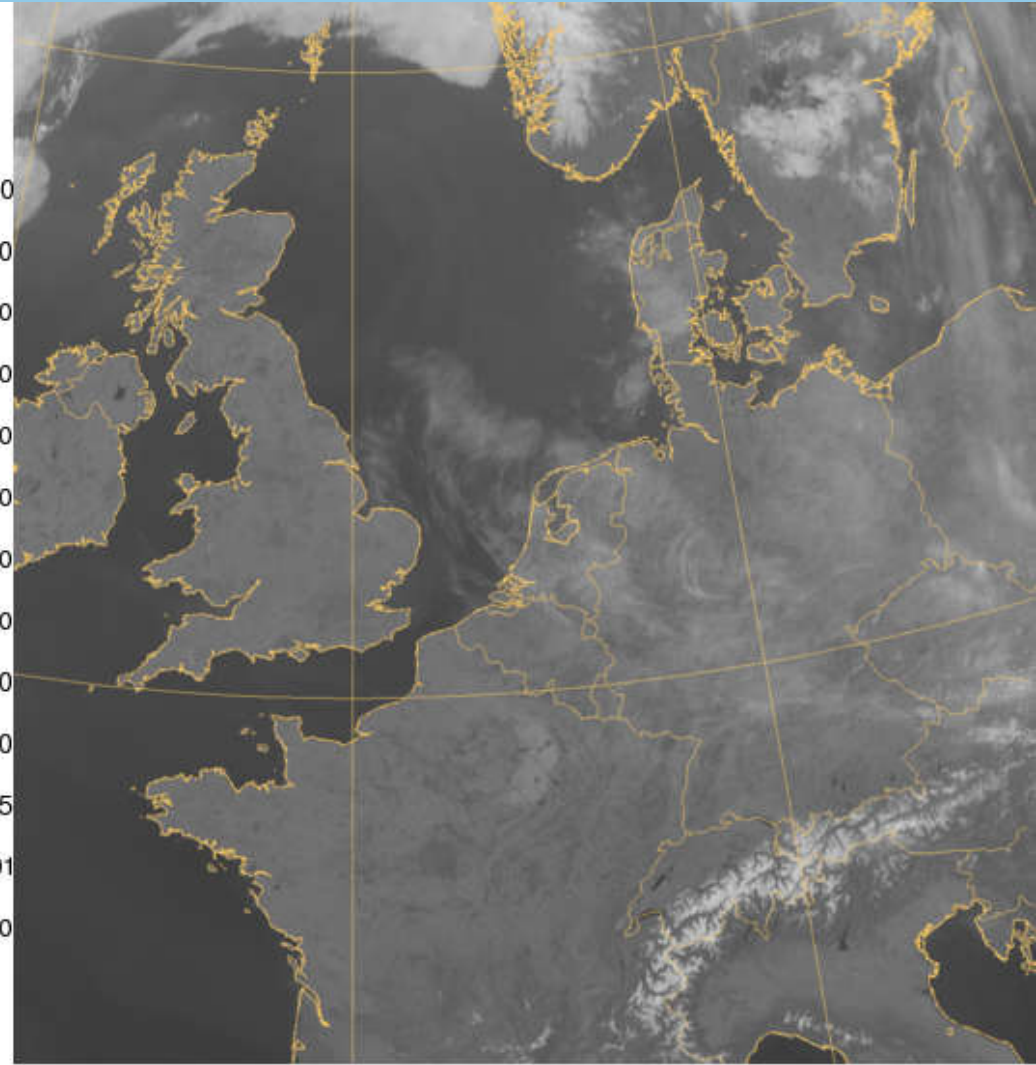
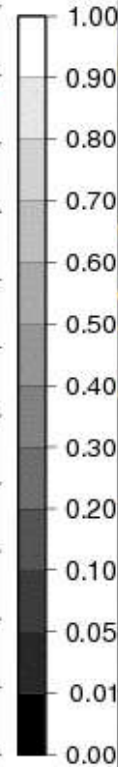
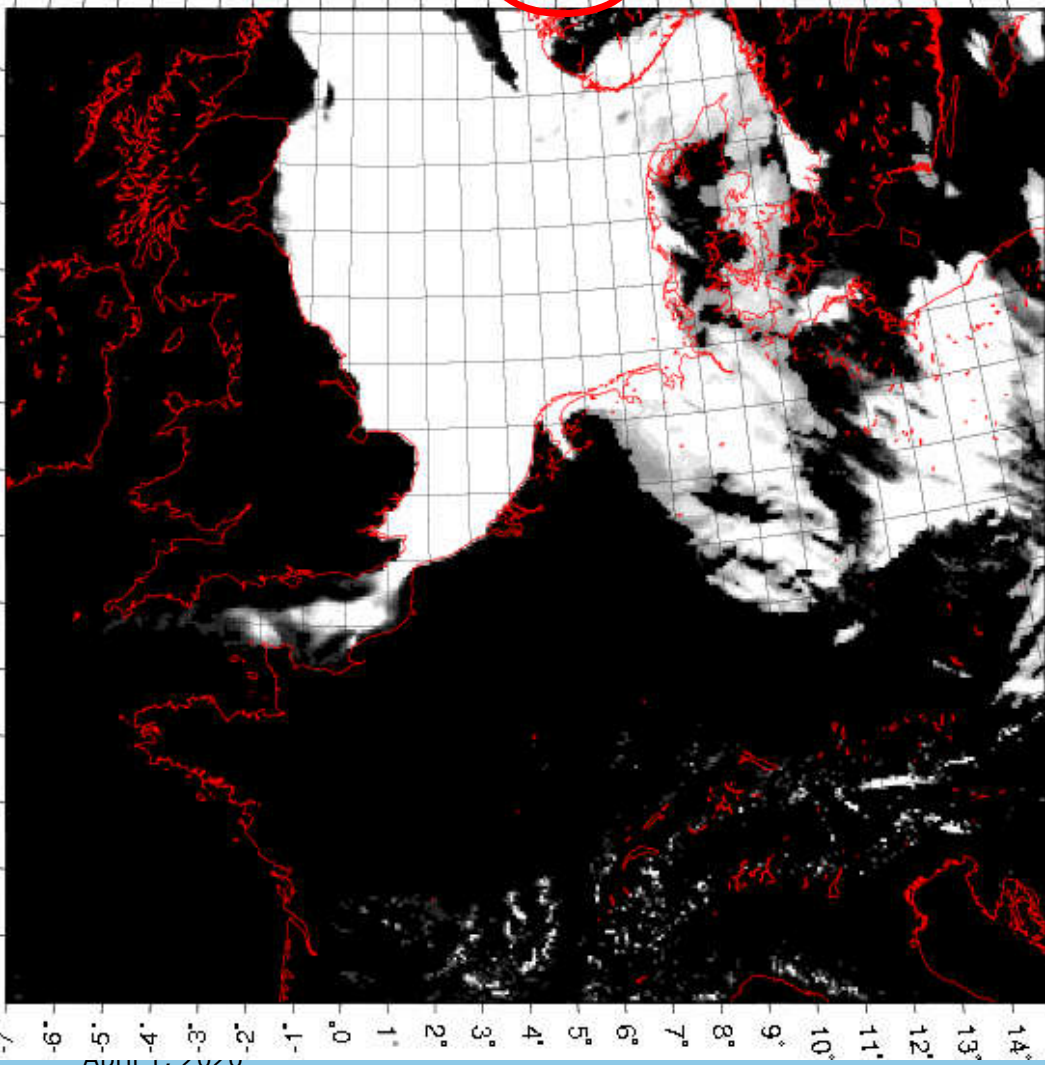
Fog cools too much over sea

Too much cloud water in fog -> too dense when translated to visibility

Study of 3D case 28/29-03-2019, setup of 1D case in MUSC

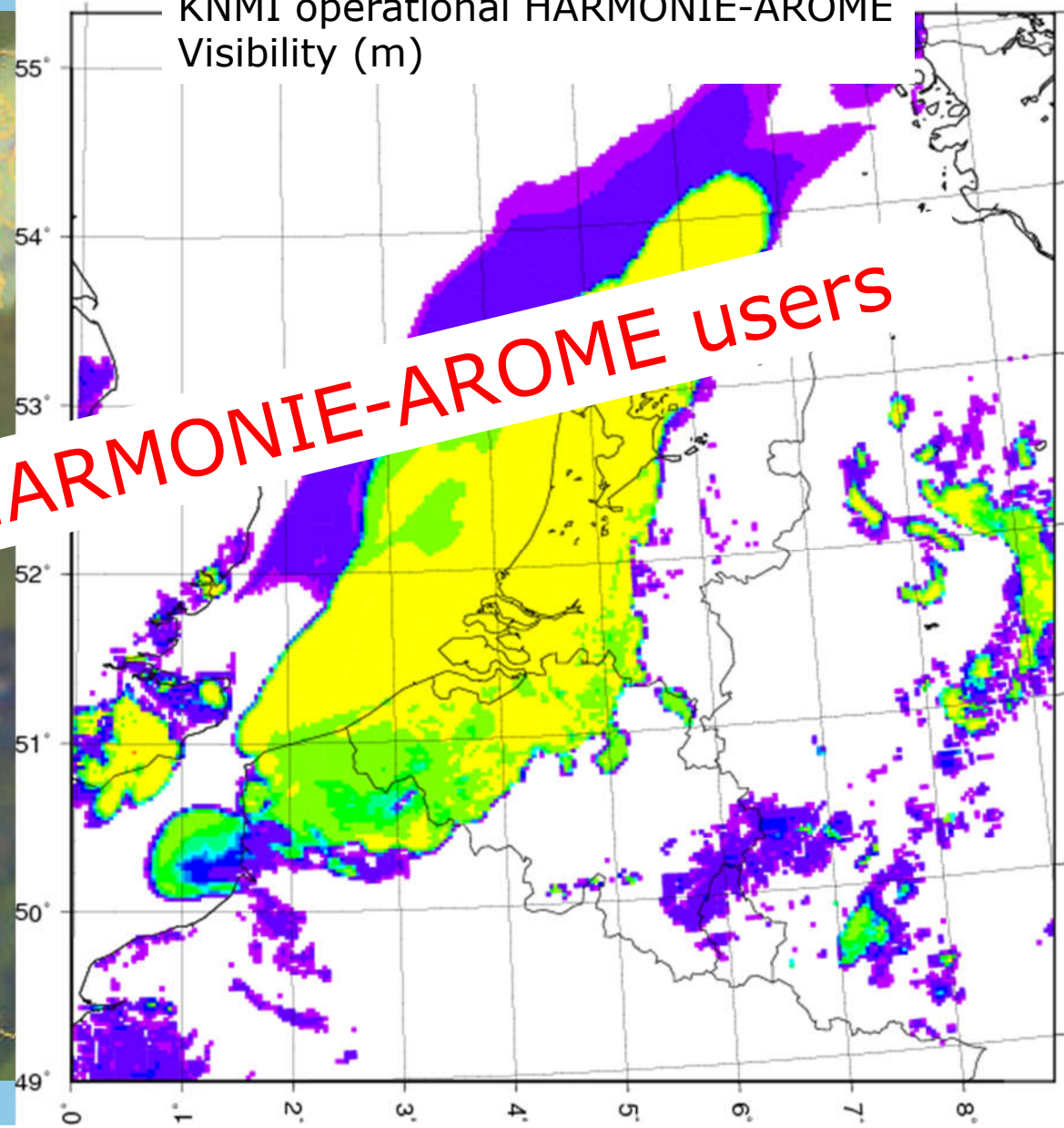


HARM36 Cloud cover 2012062700 + 013

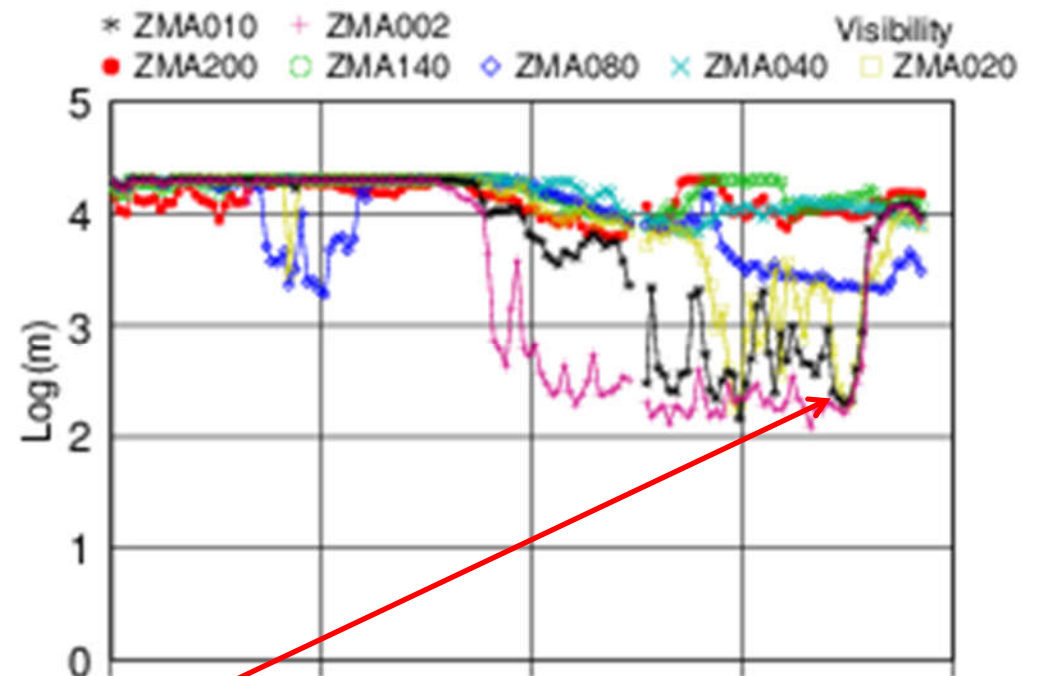
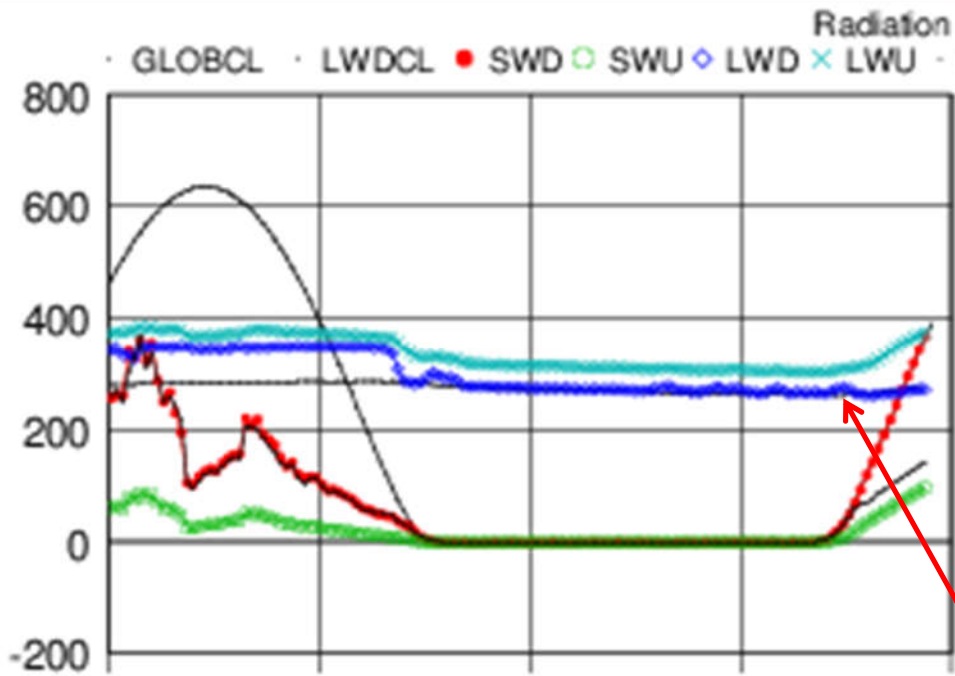




KNMI operational HARMONIE-AROME
Visibility (m)



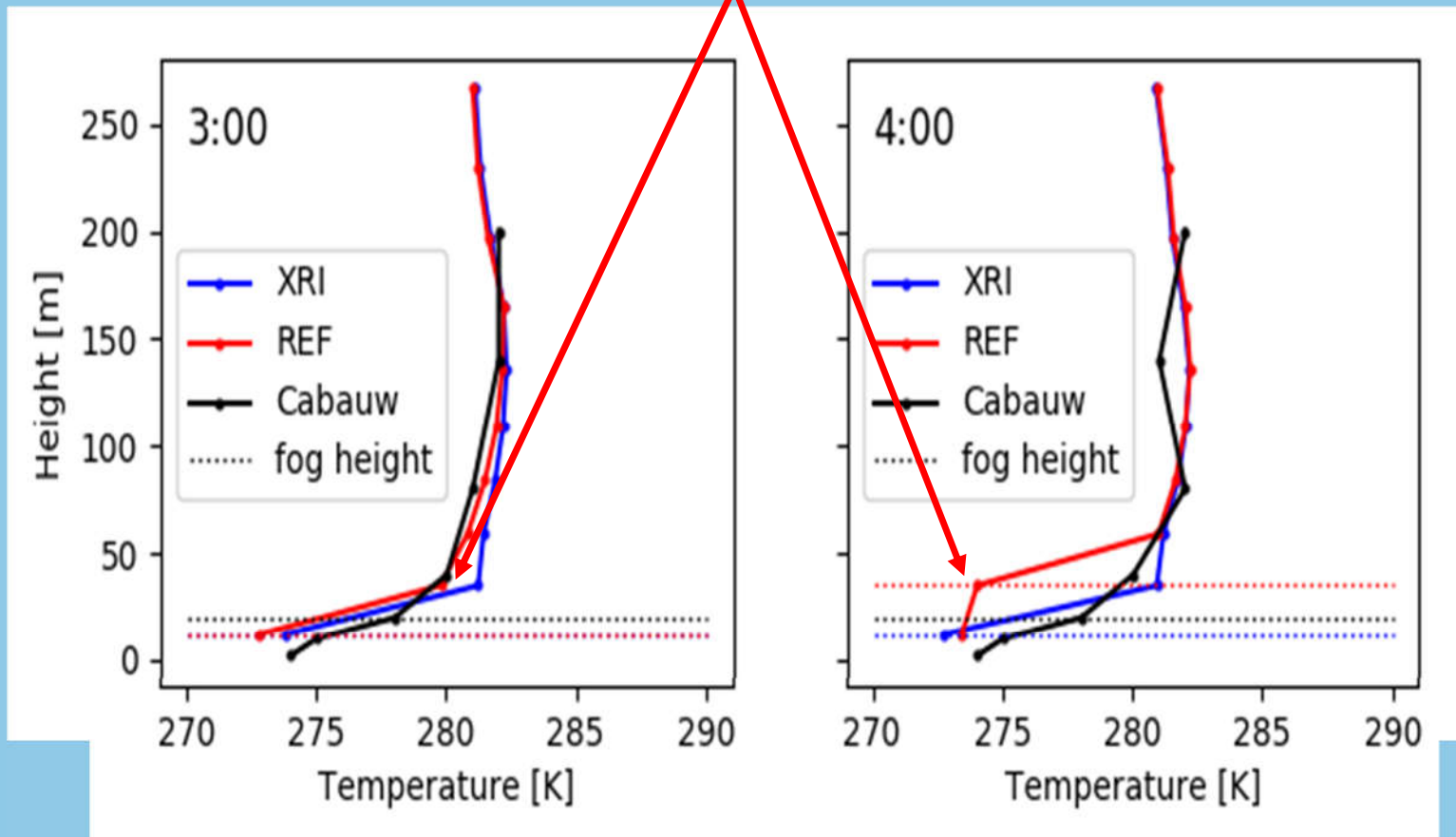
N°1 problem for HARMONIE-AROME users



Fog depth 10-20 m, small impact on downwelling longwave radiation



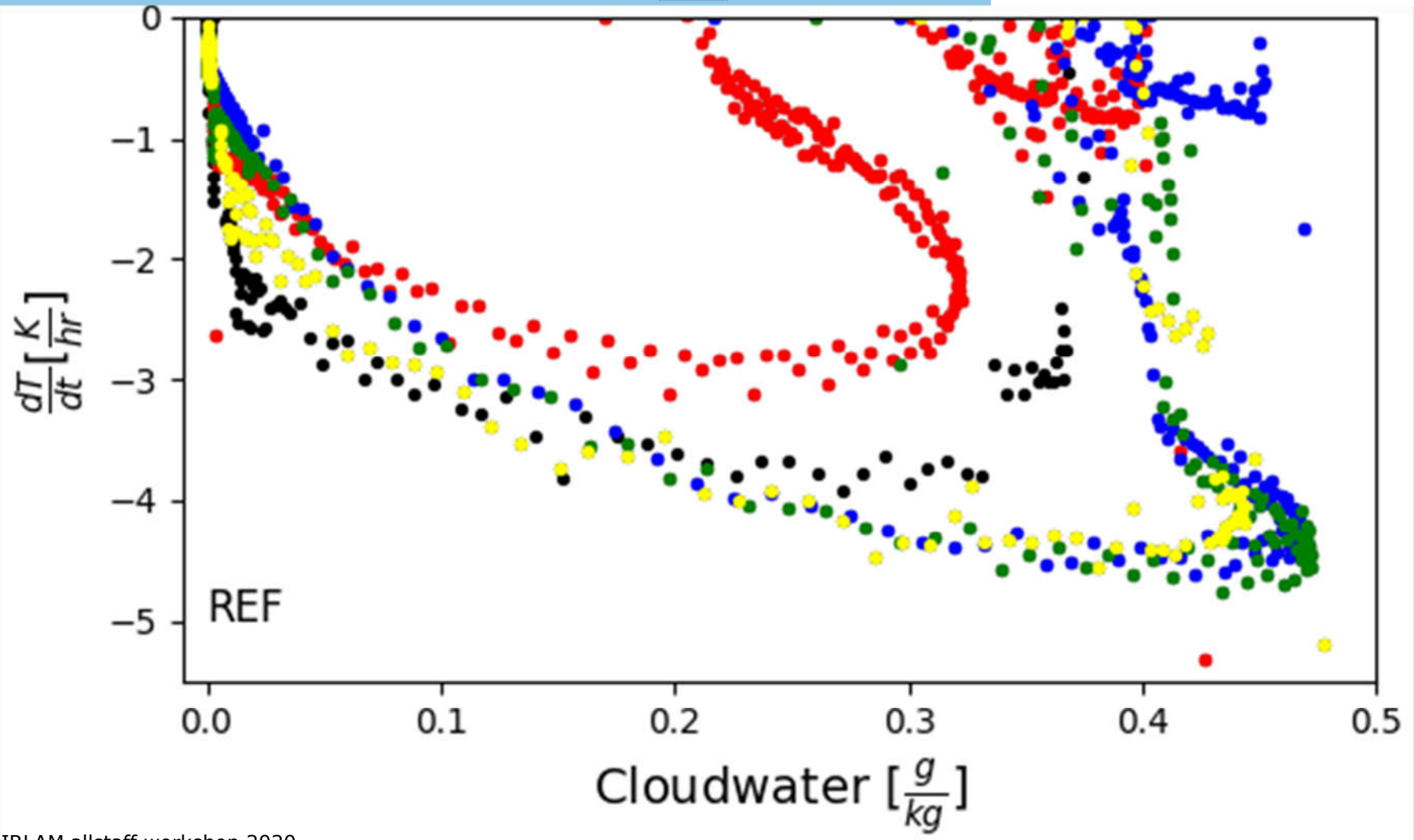
Fog layer of 25m cools 6K in one hour due to long wave radiative cooling



3D study
Tosca Kettler

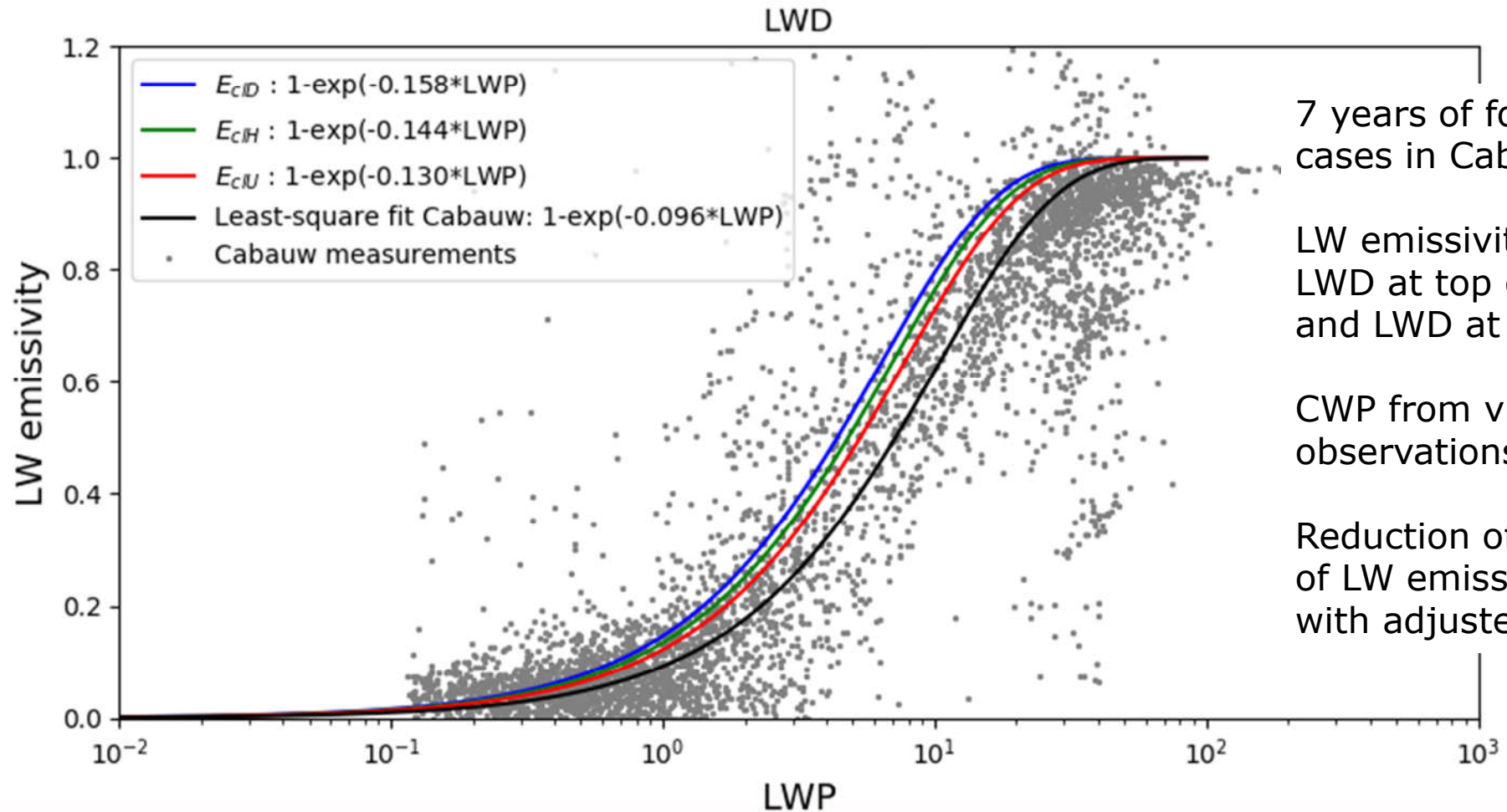


1D study, Tosca Kettler





Tosca Kettler



7 years of fog cases in Cabauw

LW emissivity from LWD at top of tower and LWD at surface

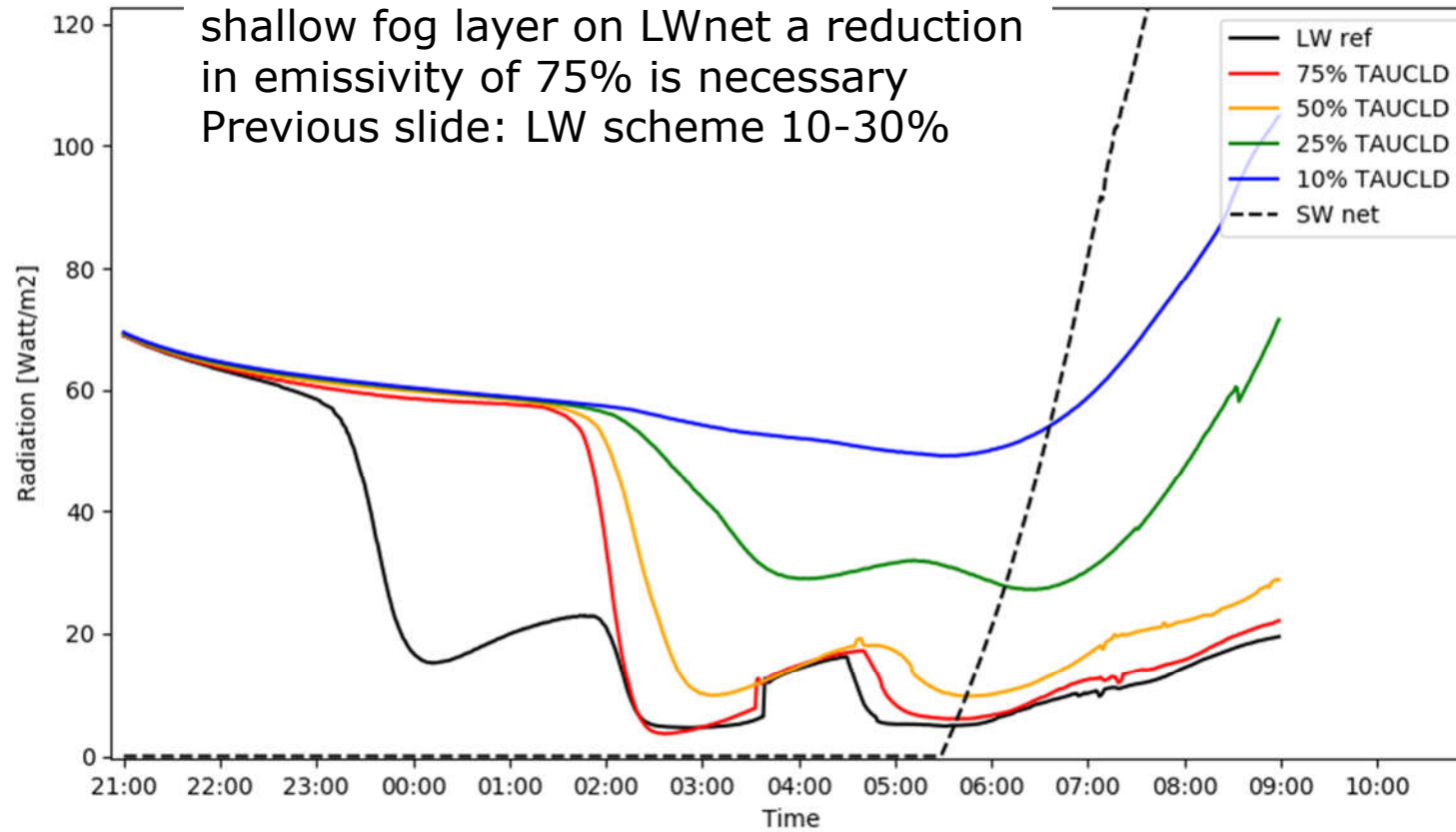
CWP from visibility observations in tower

Reduction of 5-30% of LW emissivity with adjusted relation



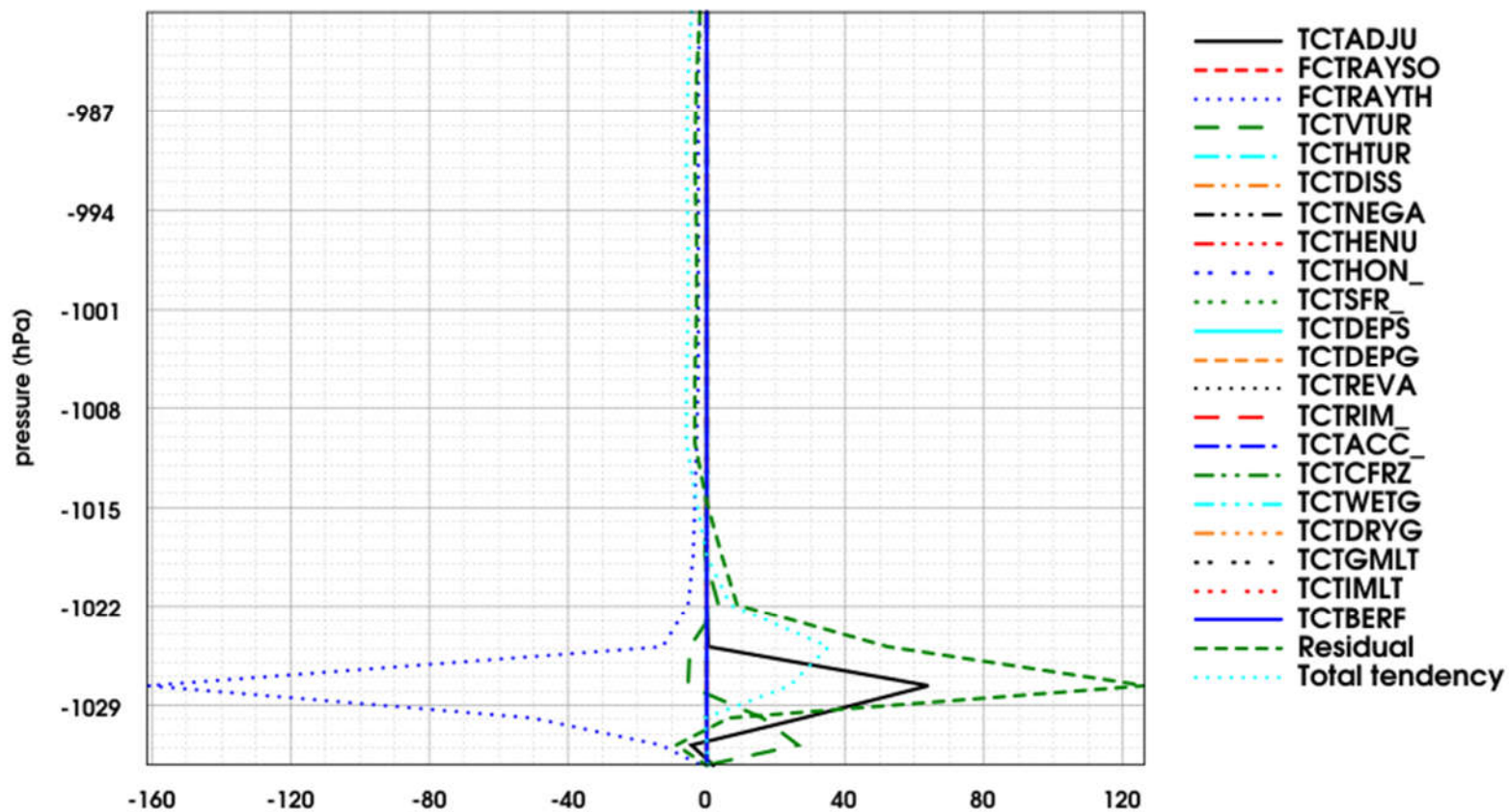
Tosca Kettler

To get a significant reduction of impact shallow fog layer on LWnet a reduction in emissivity of 75% is necessary
Previous slide: LW scheme 10-30%





CT (K/day) , FCST (ddh_02-01)
BASE 2019-03-29 01:00 ECH 1 H, 1 dom., 90 niv.

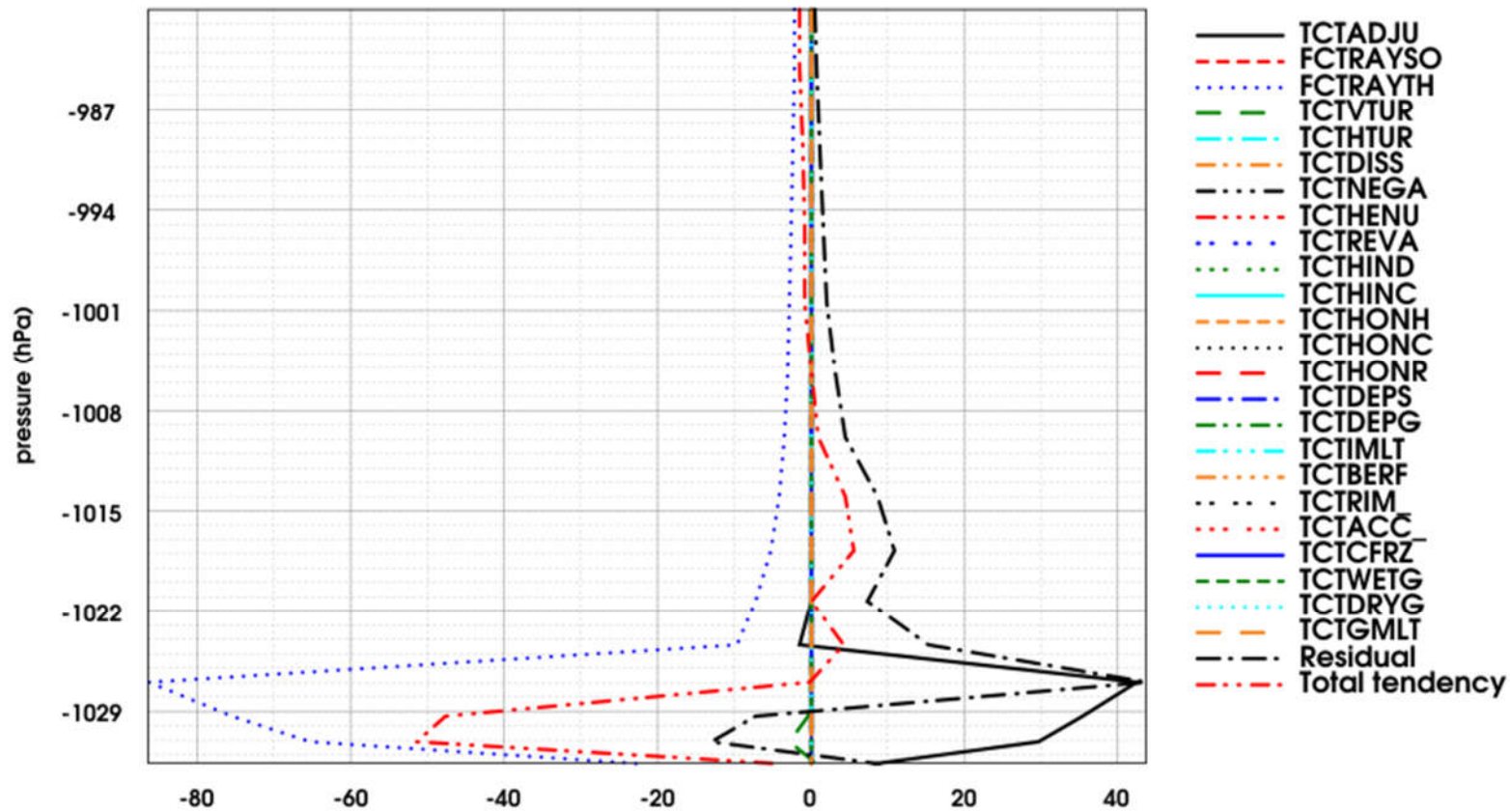


AROME ICE3:
Very strong radiative cooling in ICE3 at top of fog layer, present only in very shallow layer

Yann Seity



CT (K/day) , FCST (ddh_27-26)
BASE 2019-03-29 02:00 ECH 1 H, 1 dom., 90 niv.

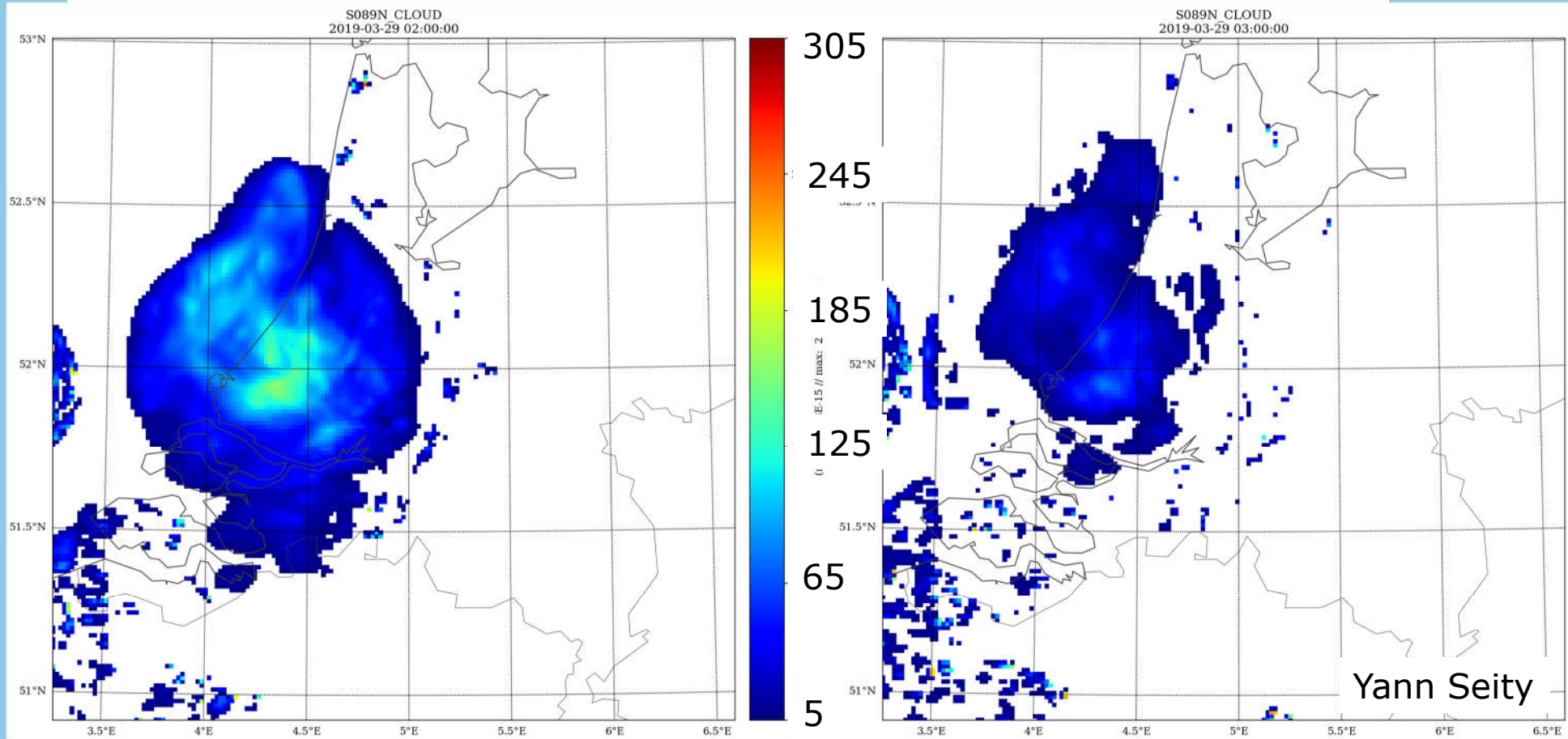


AROME LIMA:
Effect is halved when
using LIMA: dual
moment micro-
physical scheme

Yann Seity



Nc two (left) and three (right) hours after start of run (with $N_c(t=0)=300$).





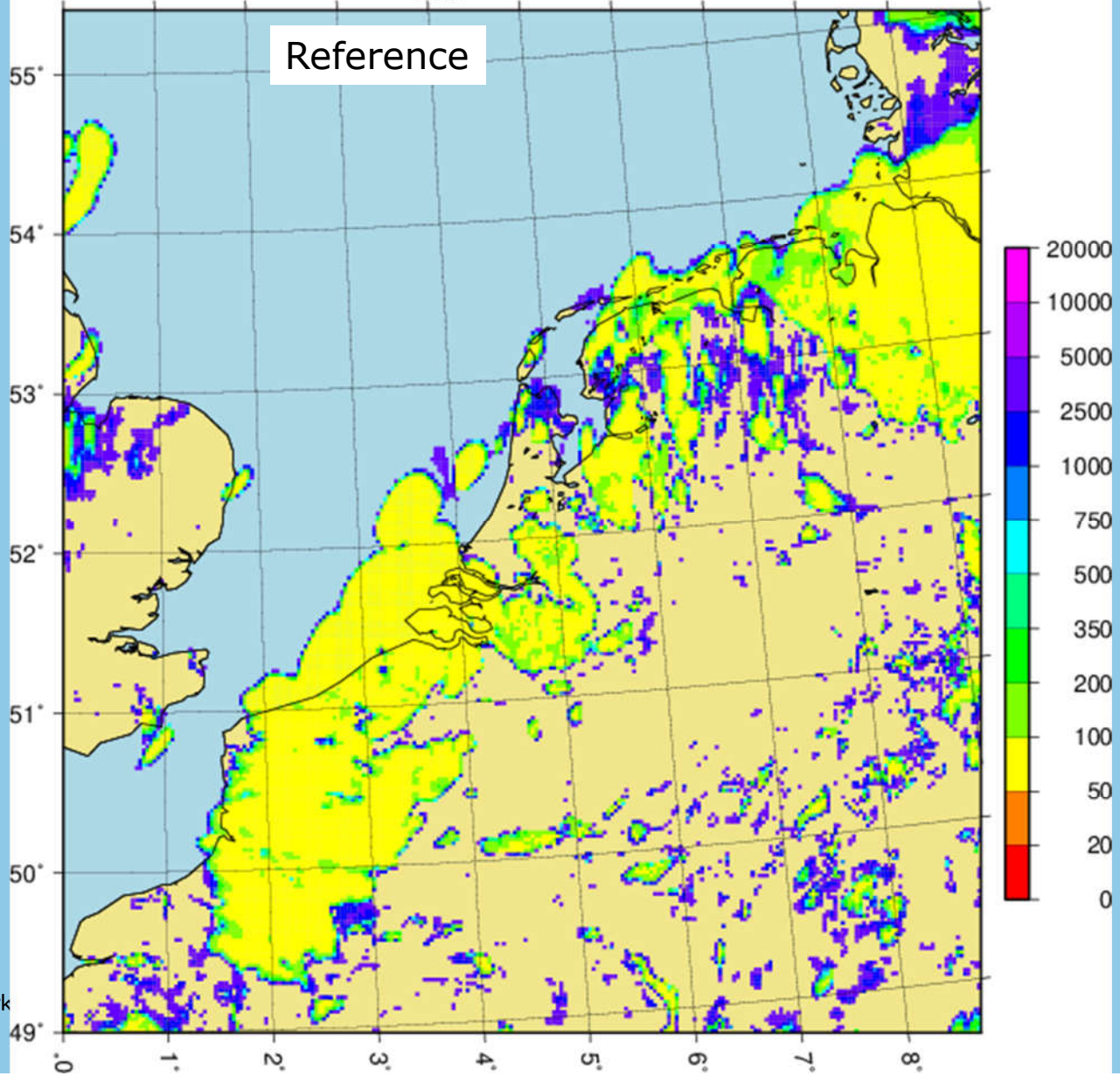
N_c is the difference between ICE3 and LIMA

Big part of explanation of difference in cooling rate of fog?

HARMONIE-AROME uses CCN ($=N_c$) = 300 over land (100 over sea).

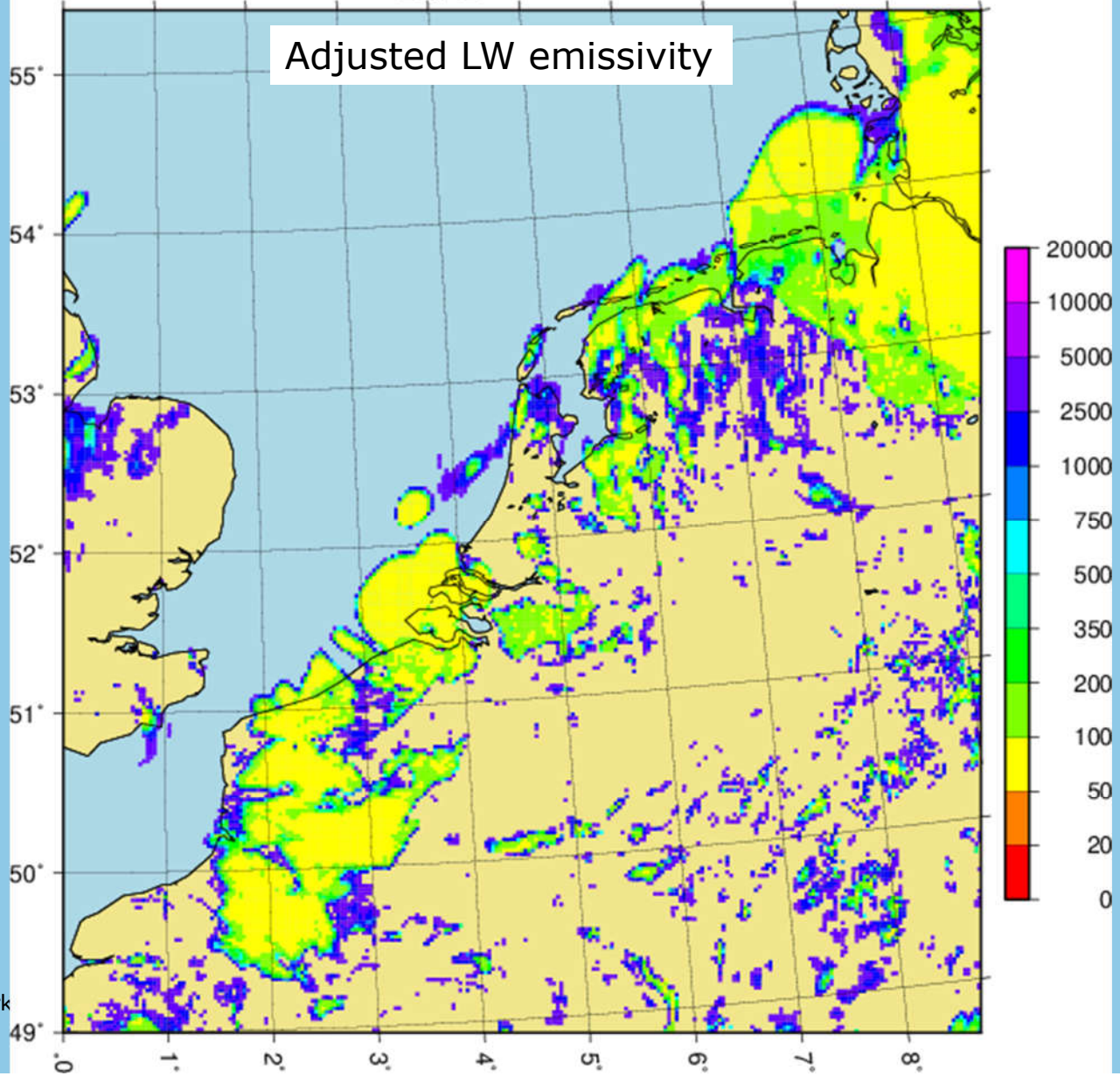
What is impact of using CCN=50 (N_c value in LIMA after 2-3 hours)?

Vis 43_tg1 2019032812+18

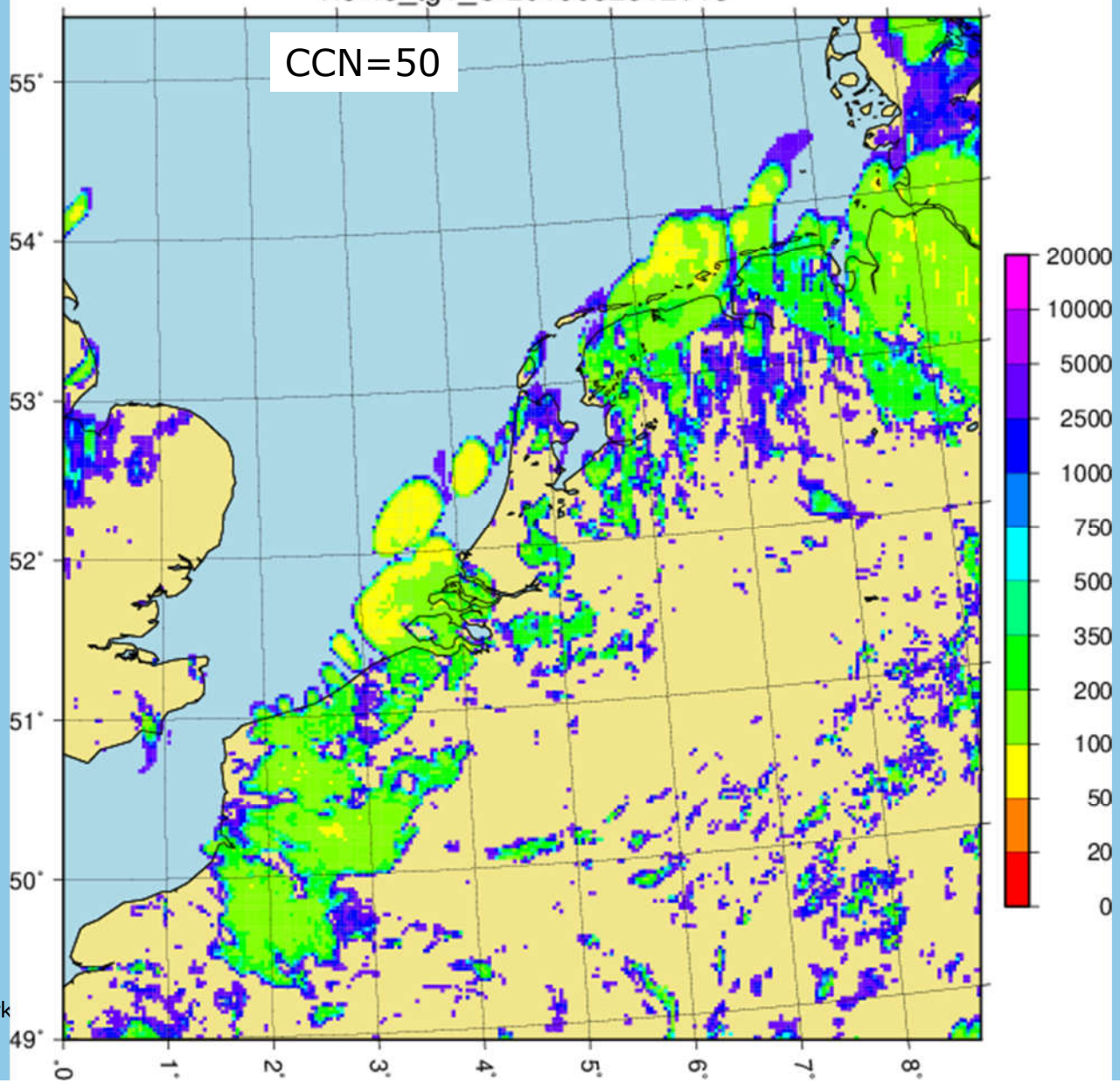


Vis 43_tg1_E 2019032812+18

Adjusted LW emissivity

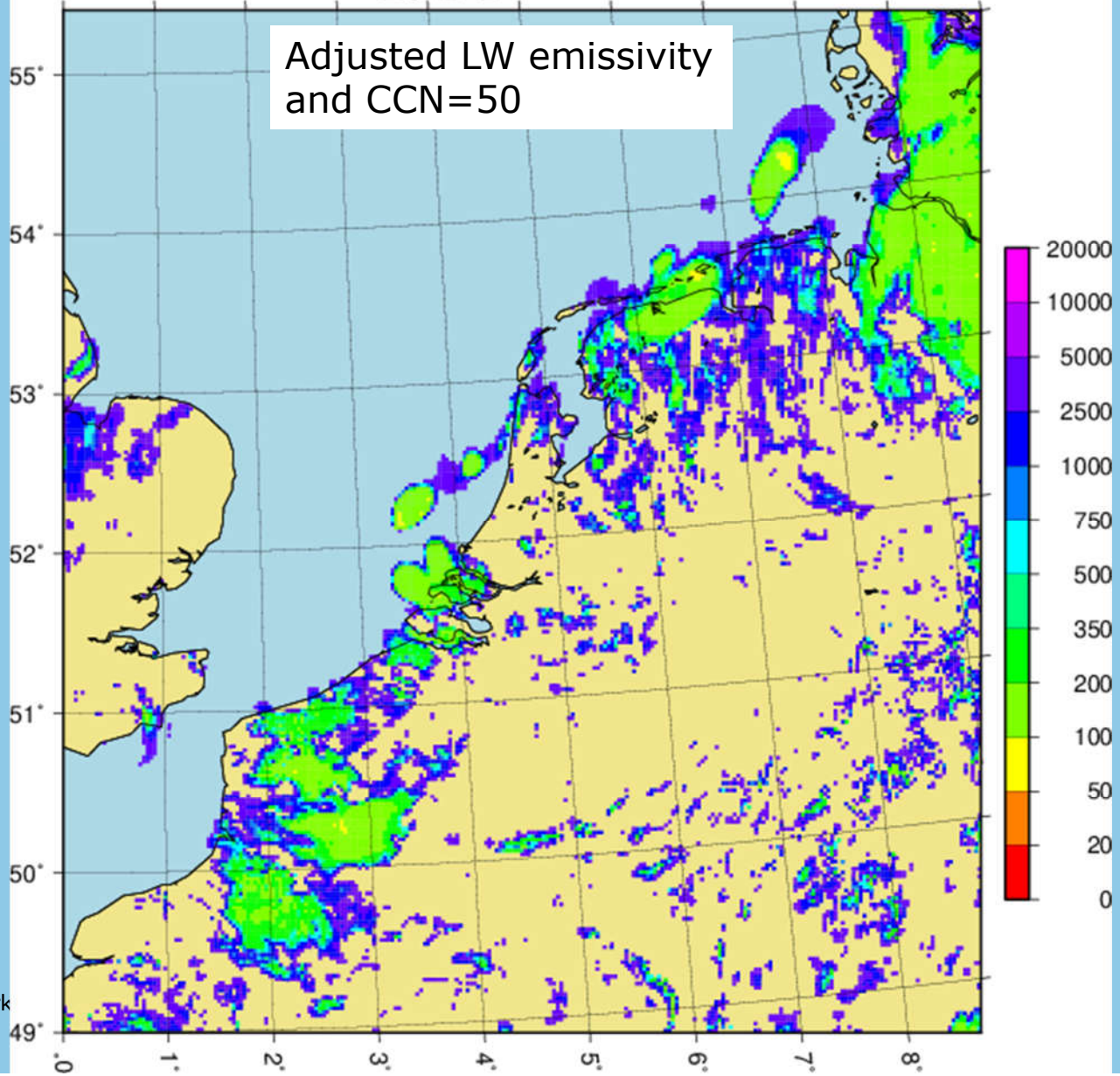


Vis 43_tg1_C 2019032812+18

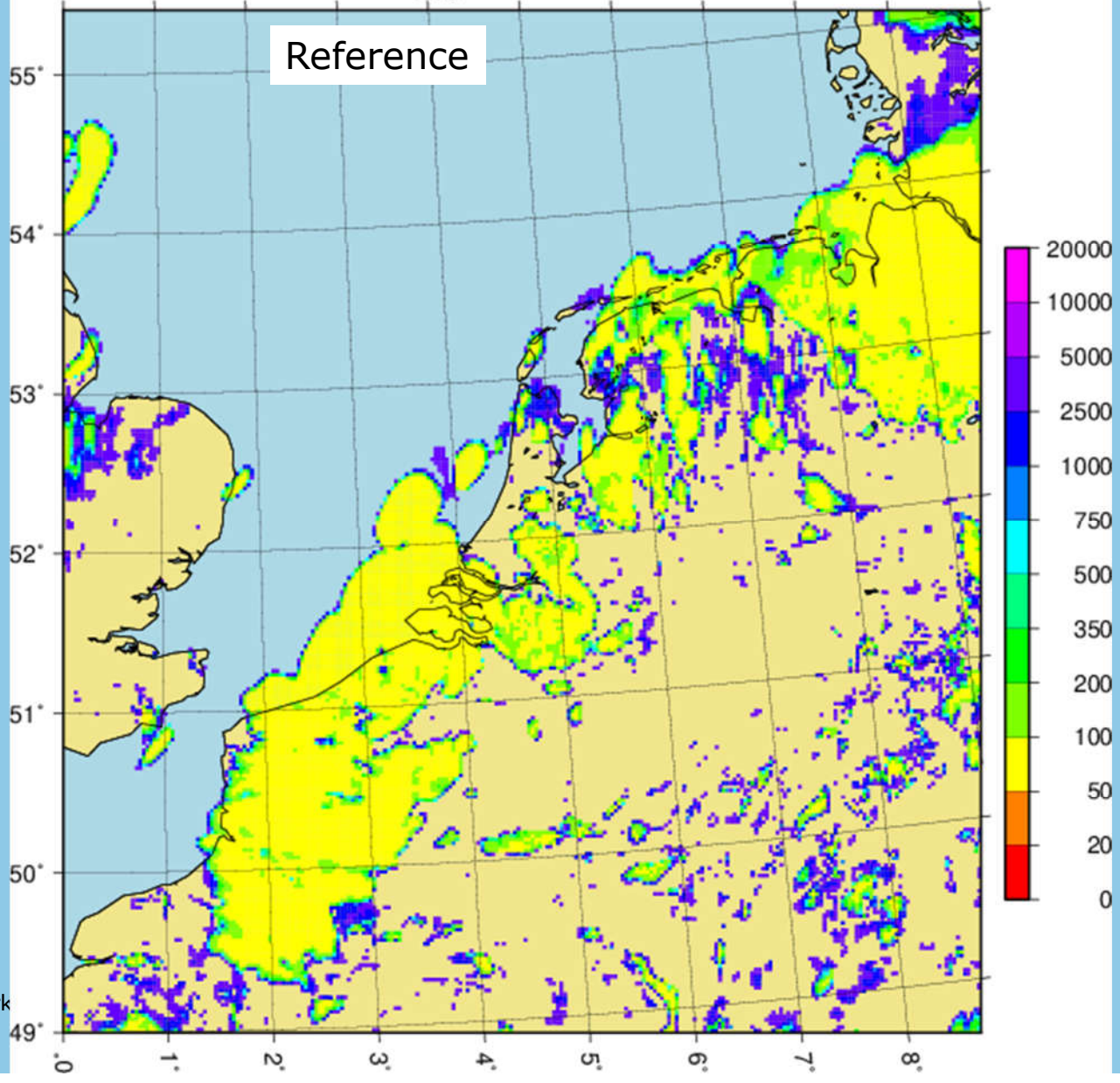


Vis 43_tg1_E_C 2019032812+18

Adjusted LW emissivity
and CCN=50



Vis 43_tg1 2019032812+18

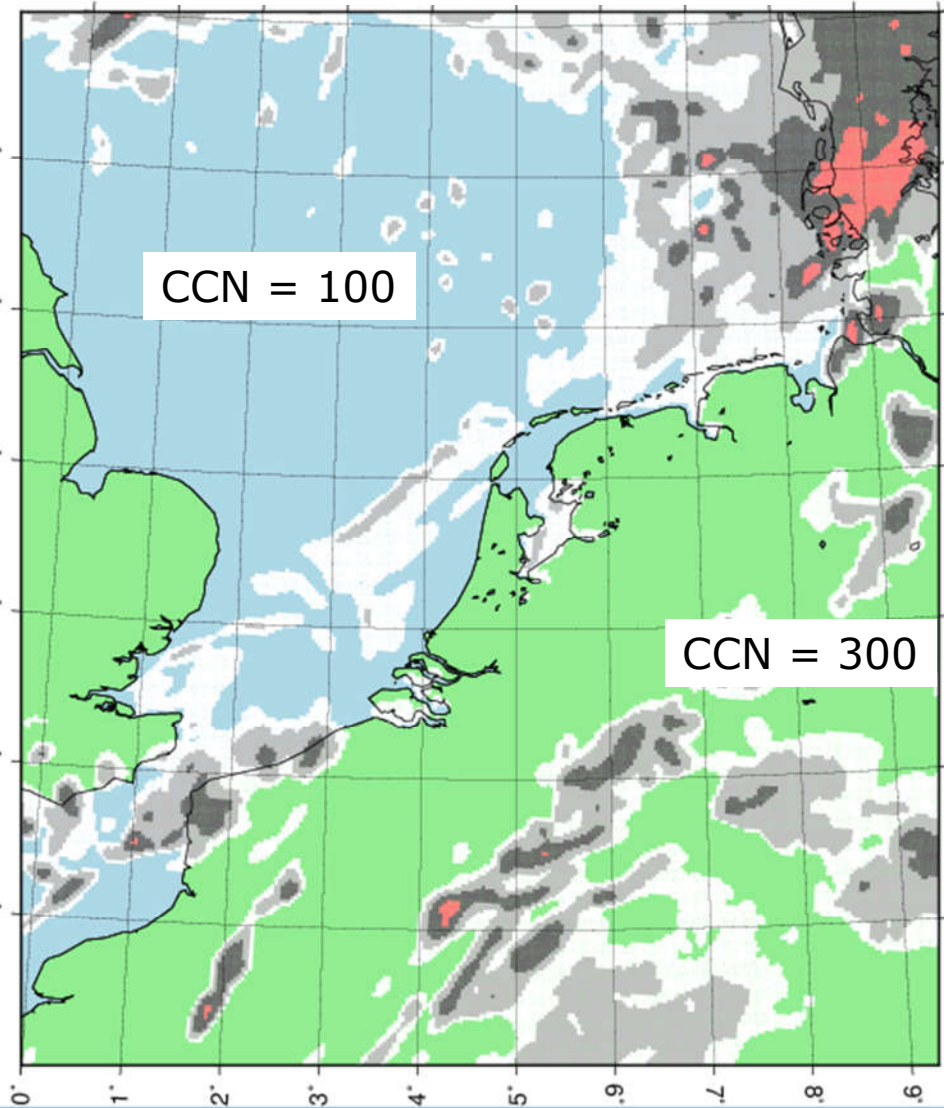




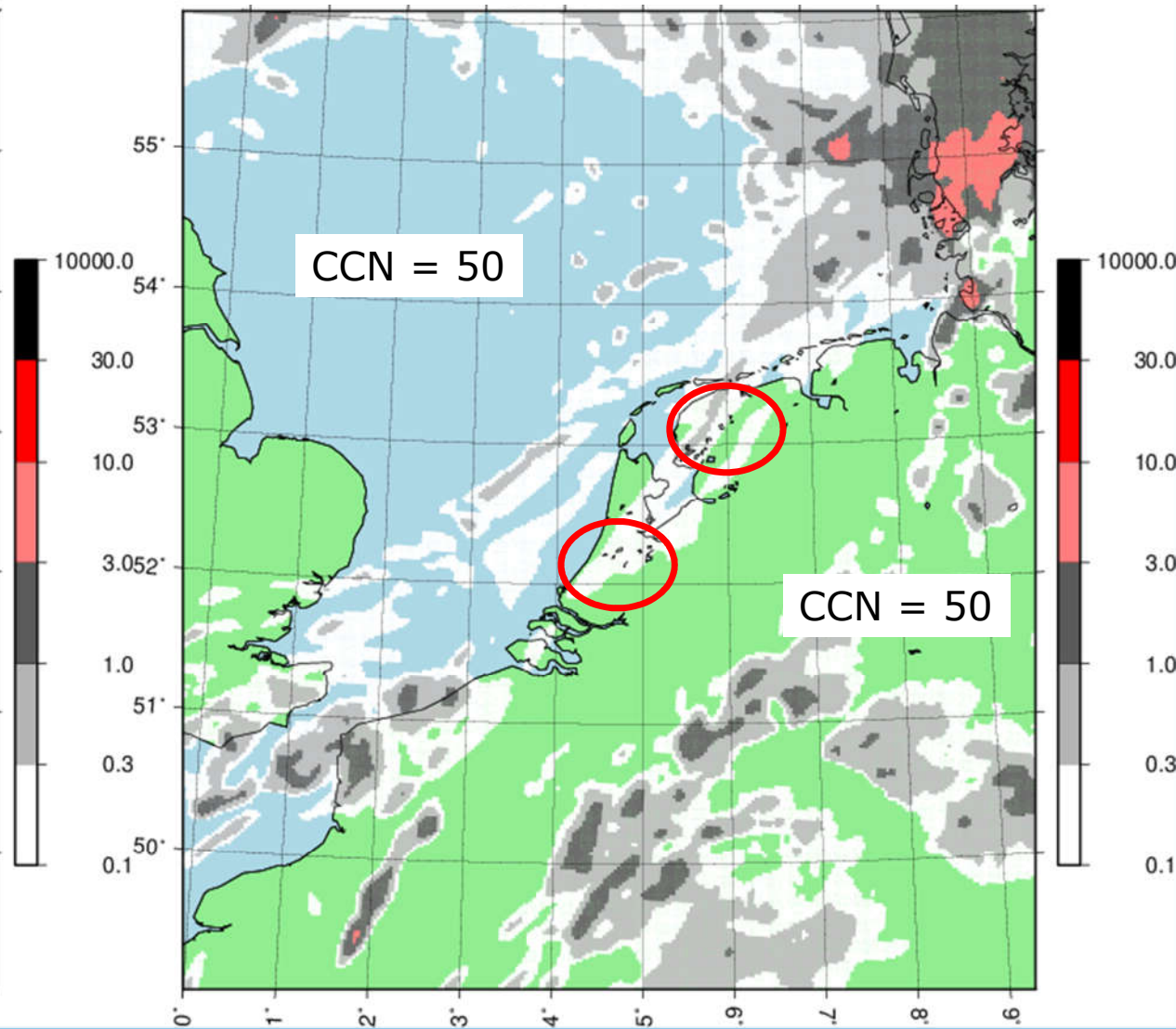
Fog problems alleviated through:

- Adjustment in LW radiation (more in accordance with observations Cabauw)
- Adjustment of CCN from 300 cm^{-3} over land and 100 cm^{-3} over sea to 50 cm^{-3} everywhere (more in accordance with Nc LIMA)

Experimental reference CY43



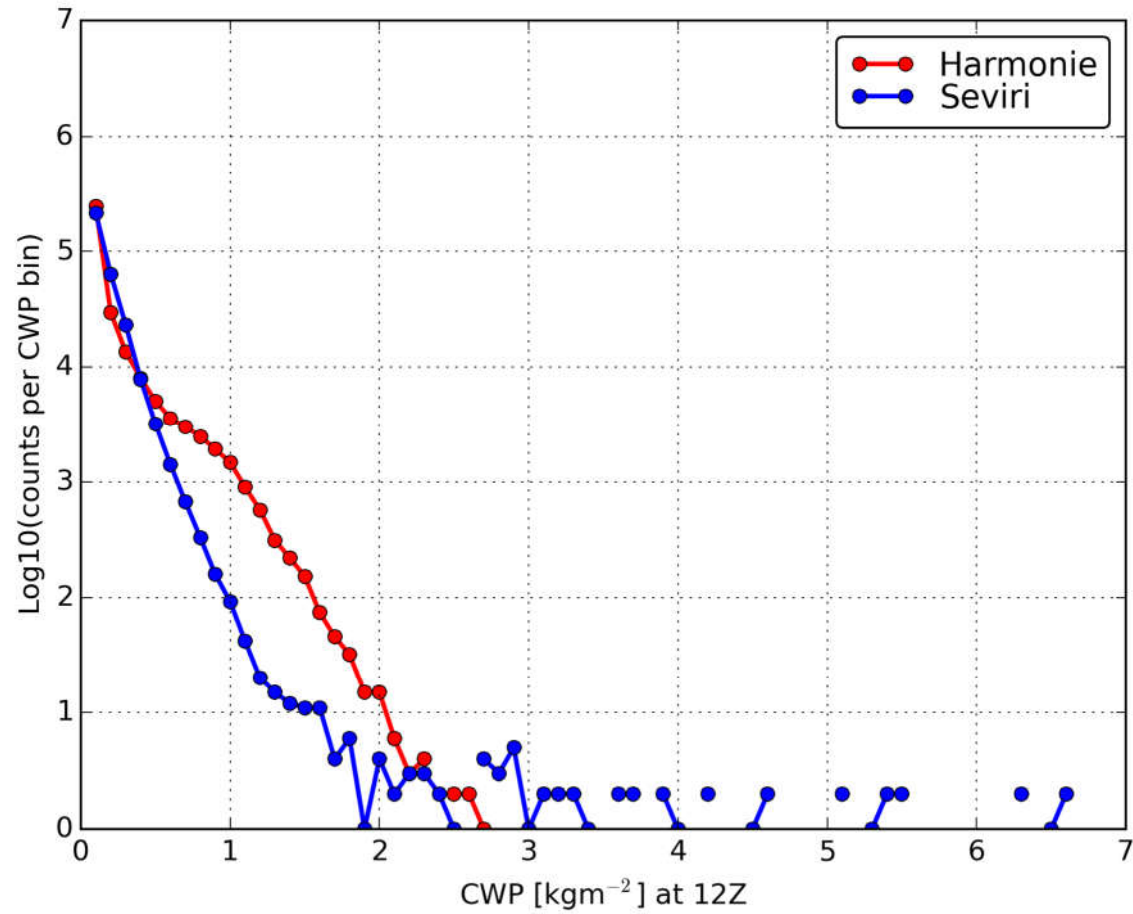
Experimental reference CY43 + fog changes



April 1, 2020



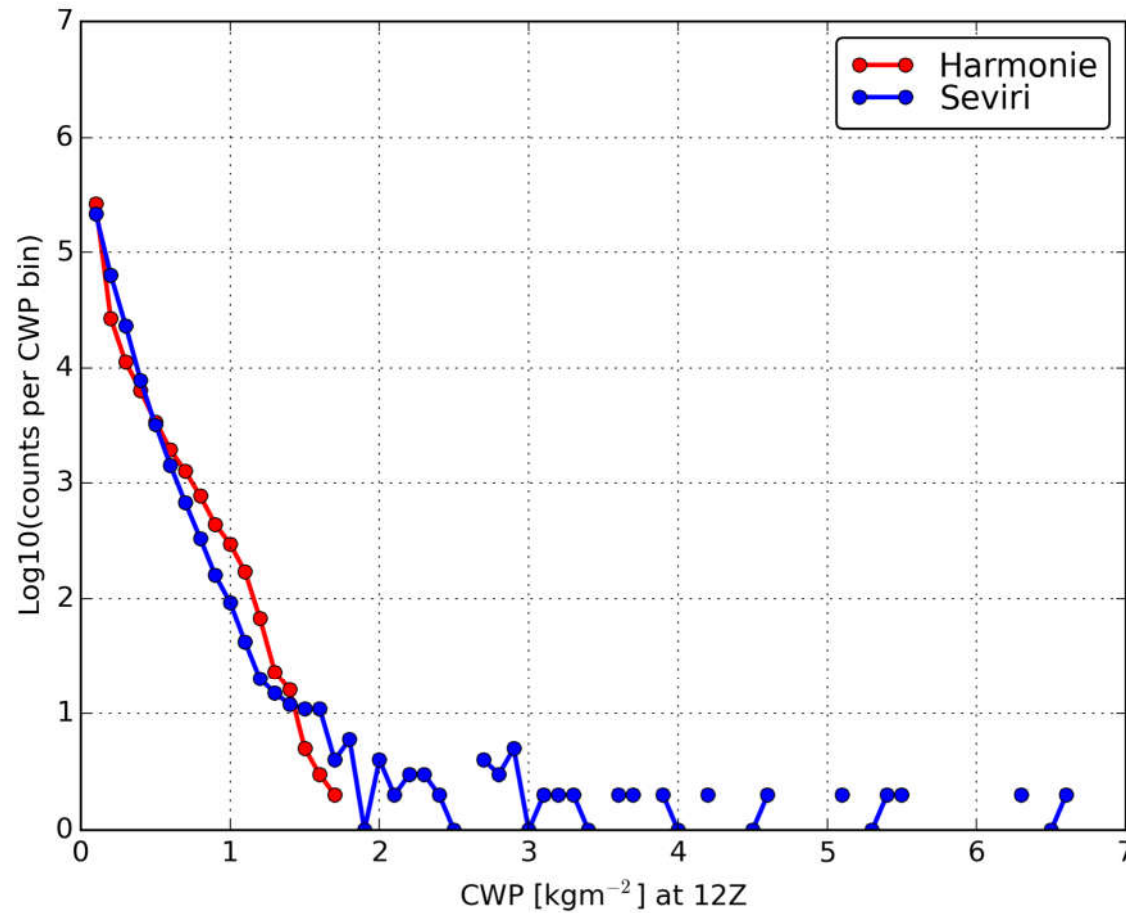
Reference HARMONIE CY43h2.1, Ireland



Emily Gleeson



HARMONIE CY43h2.1 with fog adjustments, Ireland



Emily Gleeson

Strong reduction
in overestimation
of cloud water
path



Fog problems alleviated through:

- Adjustment in LW radiation (more in accordance with observations Cabauw)
- Adjustment of CCN from 300 over land and 100 over sea to 50 everywhere (more in accordance with Nc LIMA)

These changes also improve:

- Drizzle problem at coast
- Underestimation of SW radiation in thick frontal clouds due to too large cloud water path



Future work:

- Start working with LIMA
- Use of CAMS aerosol as input for microphysics (and radiation)
- Fraction of aerosols active in condensation ($=N_c(0)$) important to model properly