Norwegian Meteorological Institute

Changes in precipitation with near-real-time aerosols

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Using CAMS setup by Daniel Martín (AEMET)

Background (HIRLAM ASM 2020)

Known coast-to-mountain bias in precipitation in MetCoOp domain (too dry coast, too wet inland)

Previous non-physical instant change of CCNs as airmass reaches land

Sensitivity experiments with same CCNs as well as near-real-time aerosol setup

Background (ACCORD ASM 2021)

1 month (Jan 2020) cy40h11

Promising results with near-real-time aerosols

	All stations		Mountain stations (>700 m)		Coastal stations		
Variable	**Abs mean error**	**SD of error**	**Abs mean error**	**SD of error**	**Abs mean error**	**SD of error**	**Corr.**
Precipitation [mm/day]	-0.21 (-53%)	-0.15 (-2.2%)	+0.00050 (+0.023%)	-0.27 (-4.0%)	-1.1 (-51%)	-0.082 (-1.0%)	+0.017
T2m [K]	+0.29 (+93%)	+0.048 (+3.0%)	+0.35 (+54%)	+0.047 (+3.2%)	-0.037 (-46%)	+0.051 (+5.7%)	-0.002
RH2m [0-1]	+0.0033 (+8.0%)	+0.00048 (+0.61%)	-0.0016 (-2.5%)	0.000085 (+0.11%)	+0.0042 (+1.2%)	-0.00033 (-0.51%)	-0.009
Wind 10m [m/s]	-0.13 (-17%)	-0.037 (-1.8%)	-0.27 (-25%)	+0.06 (+2.0%)	+0.0087 (+11%)	-0.024 (-1.1%)	+0.006
SLP [m]	-5.4 (-38%)	+2.6 (+3.2%)	+1.2 (+4.7%)	+2.6 (+2.4%)	-3.3 (-24%)	+5.5 (+7.1%)	±0

+ CAMS NRT setup ported to cy43 by Daniel

What's new since last year?

MetCoOp updates:

- Same CCN concentrations over sea and land (100 cm^{-3}) previously 100 & 300
  - → No sudden change when advected from sea to land
- Lowest model level reduced droplet numbers with 50%

How does the near-real-time aerosol setup compare now?

Experimental setup

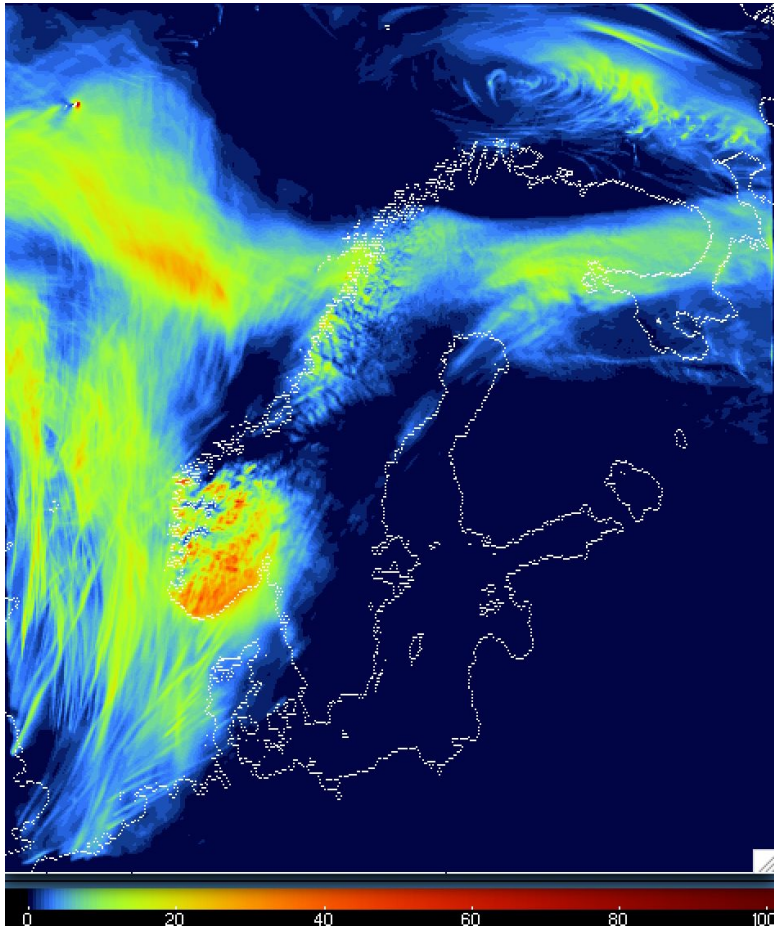
Near-real-time aerosol setup from Daniel Martín (AEMET)

- impacts both microphysics and radiation
- (CTR sim using default setup:
  microphysics: fixed CCN concentration
  radiation: Tegen aerosol climatology)

Domain: METCOOP25D

Cold start 2021-09-22, 3-hour cycling,
for all of October: 30-hour forecasts at 00h

METCOOP25D domain

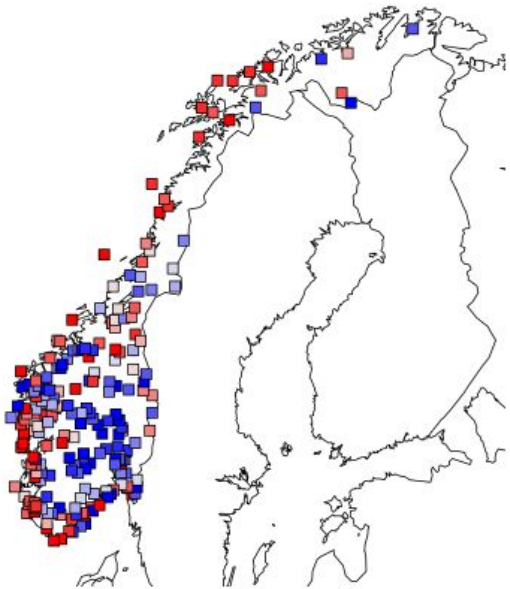


2021-10-30 06h-30h acc. precip. [mm]

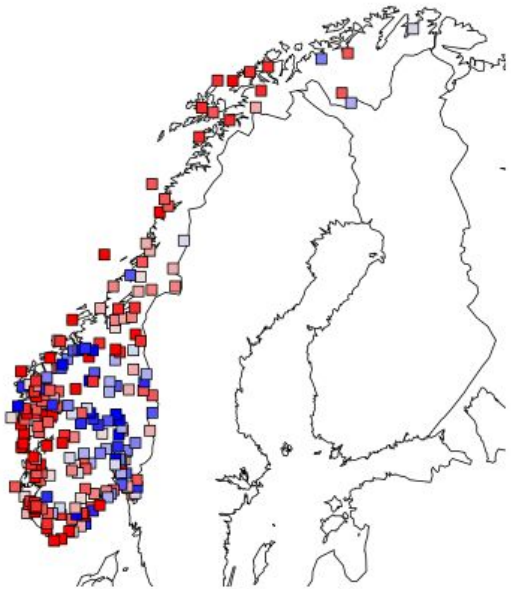
Mean precipitation bias relative to stations

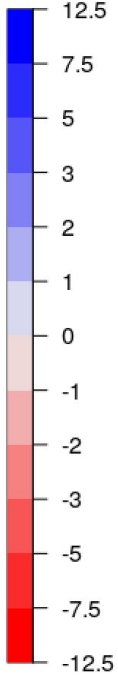
Oct 2021

MEPS deterministic (cy43)



cy43 + CAMS NRT aerosols





Bias [mm/day]

Drier in general

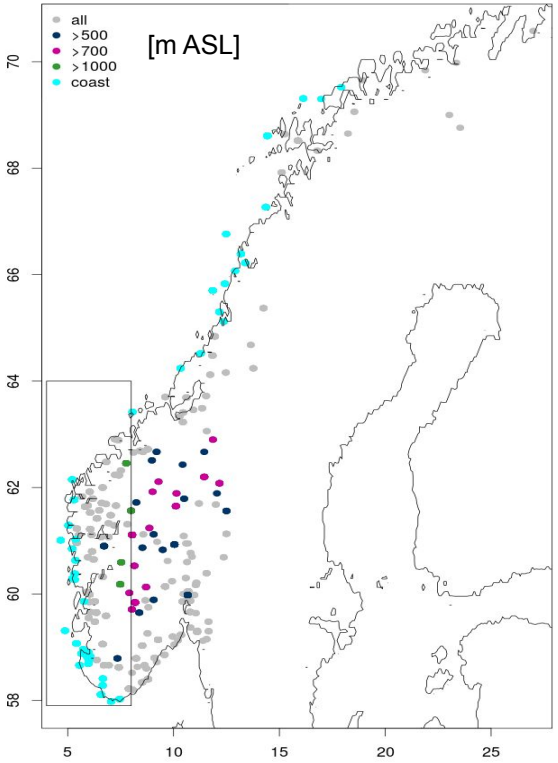
Precipitation evaluation

232 precipitation stations from Norway

Categories: "coast" (n=68) and "mountain" (n=26)

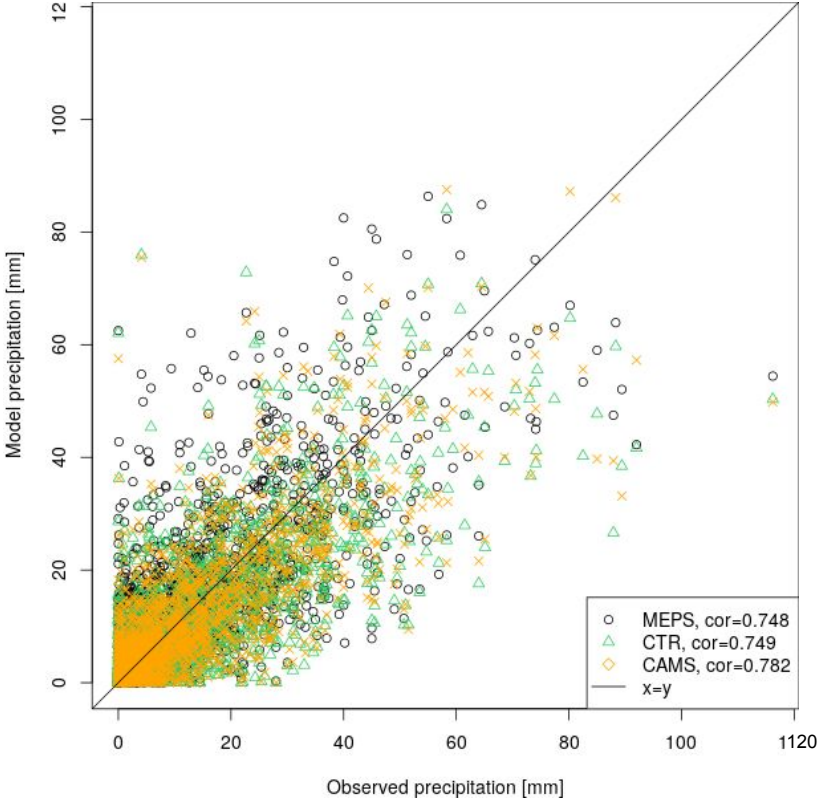
Separate focus area: south-western Norway

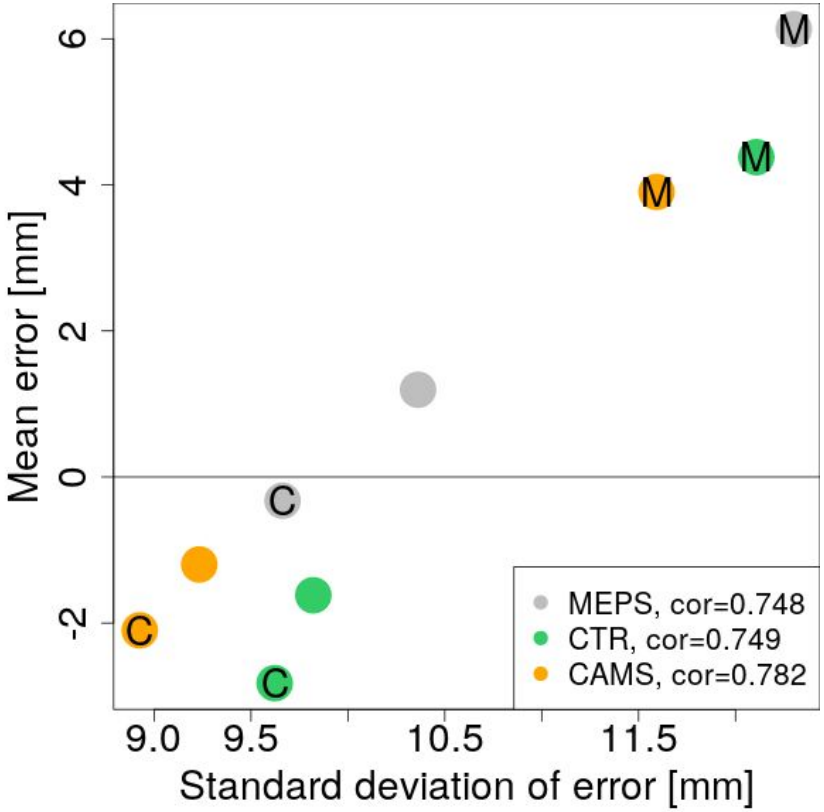
Evaluating 24h accumulated precipitation 06h-30h



Precipitation evaluation

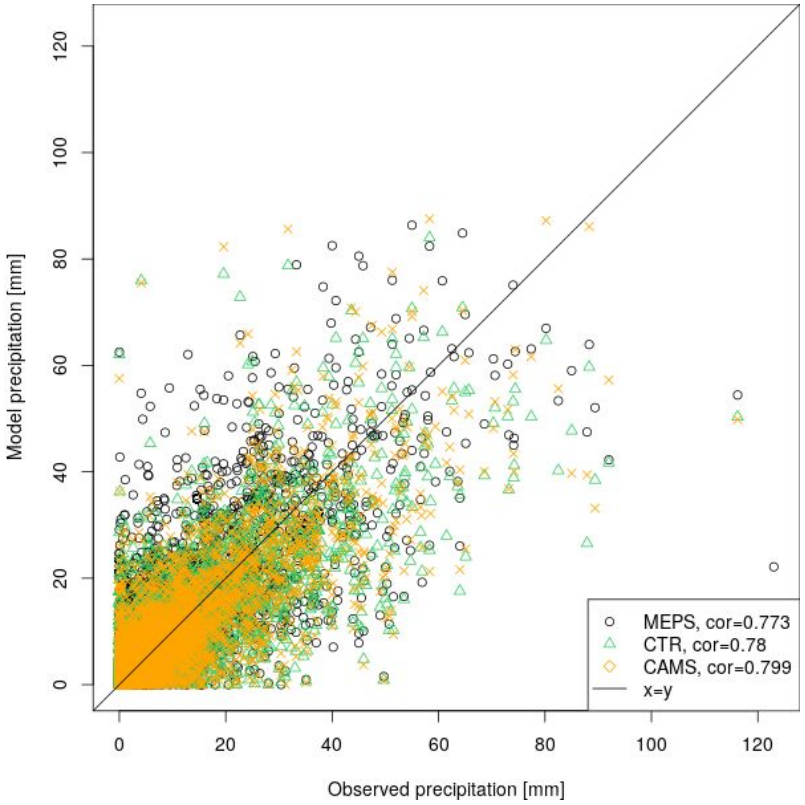
Time period: Oct 2021
Area: Southwestern Norway, 67 stations

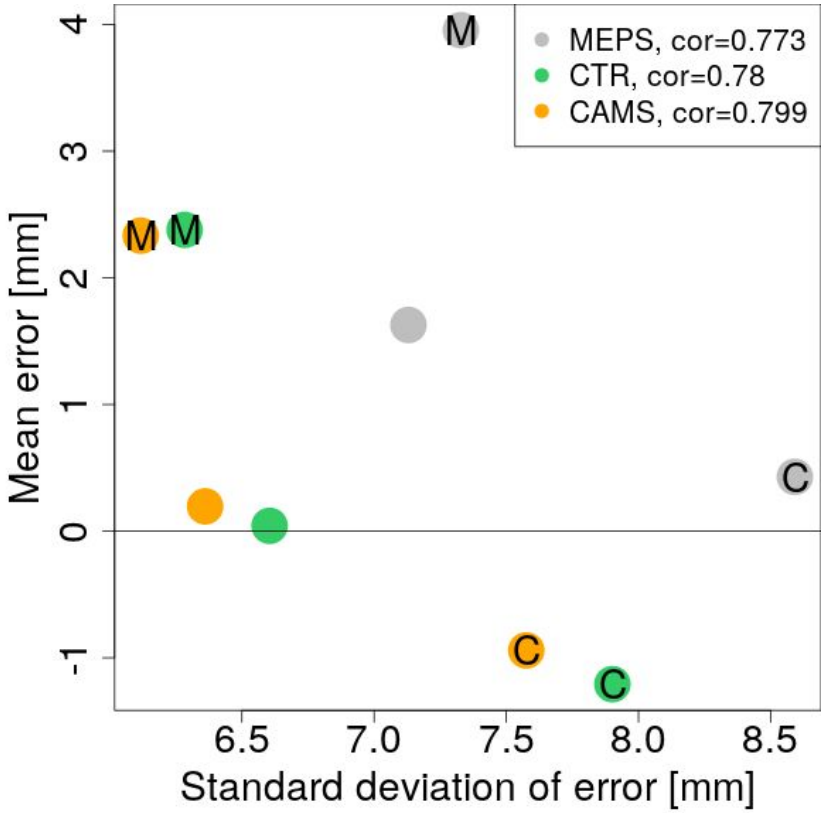




Precipitation evaluation

Time period: Oct 2021
Area: Norway, 232 stations





Surprisingly small difference between CTR and CAMS

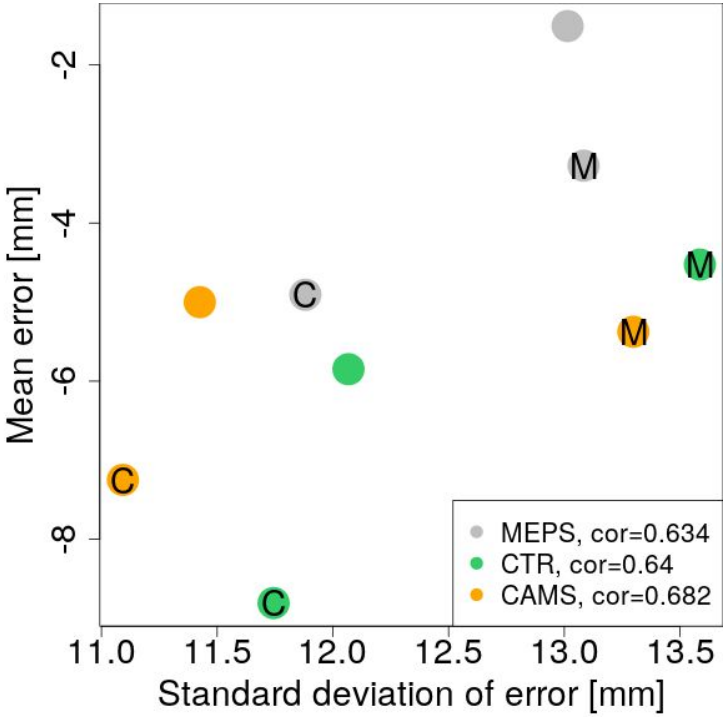
Precipitation evaluation

Time period: Oct 2021
Area: Norway, 232 stations

Selecting only cases with observed precipitation >10 mm/day

Improvement with CAMS aerosols vs CTR (correlation, mean error and error std.)

MEPS deterministic has lower mean error

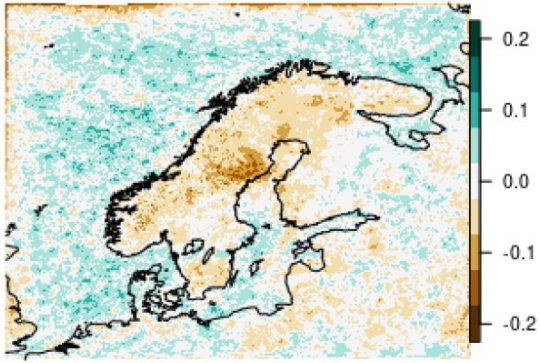


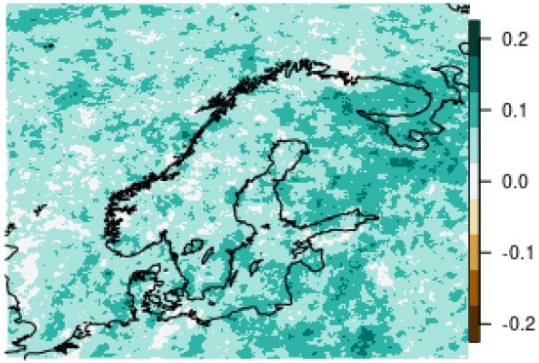
Impact on cloud cover

Time period: Oct 2021

Low cloud area fraction | **Medium cloud area fraction** | **High cloud area fraction**

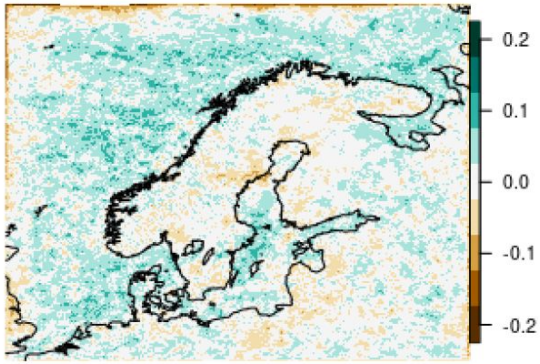
CAMS-MEPS

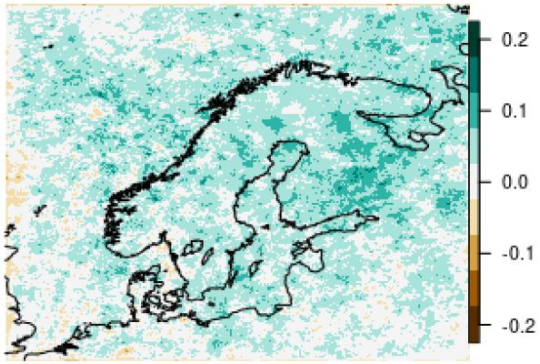


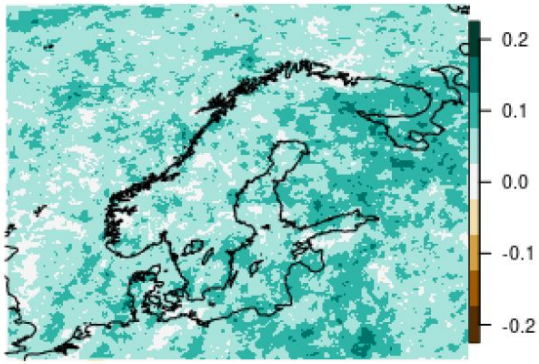


Reduced low cloud cover

CTR-MEPS







Note on computational requirement

MakeCycleInput: +10-16%

but most processes are serial, so little actual cost

Forecast: **+12-24%**

Discussion and preliminary conclusions

Near-real-time aerosols introduces more physical spatio-temporal distribution and reduces errors in precipitation on average vs CTR

Overall decrease in precipitation: south-western Norway now too dry

Decrease in low cloud cover

MEPS deterministic better precipitation on average

Why so small differences in precipitation between CAMS and CTR?

- Smaller bias and more impact with cy40 for Jan 2020 experiments
- More experiments needed

Future work

Check possible other differences in setup vs MetCoOp operational, e.g.

vertical gradient of CCNs (new RFRMIN options)

(XRIMAX 0.2 here vs 0.4 operational)

Updated after the questions: It turns out ECUME6 was not used. That should make an impact.

Verification as function of lead time

Bjørg Jenny Engdahl and I will perform sensitivity experiments over the Arctic (PolarRES project)