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Next generation models at MeteoSwiss: communication challenges

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Material from André Walser and Marco Arpagaus

Outline

- New model systems at MeteoSwiss: Project COSMO-NExT
- New possibilities: How should we use the Ensemble COSMO-E?
- Communication challenges: How to bring probabilities to the customer?

NWP at MeteoSwiss: Status Quo

ECMWF IFS-HRES (global)

- 16 km, 137 levels

COSMO-7 (regional)

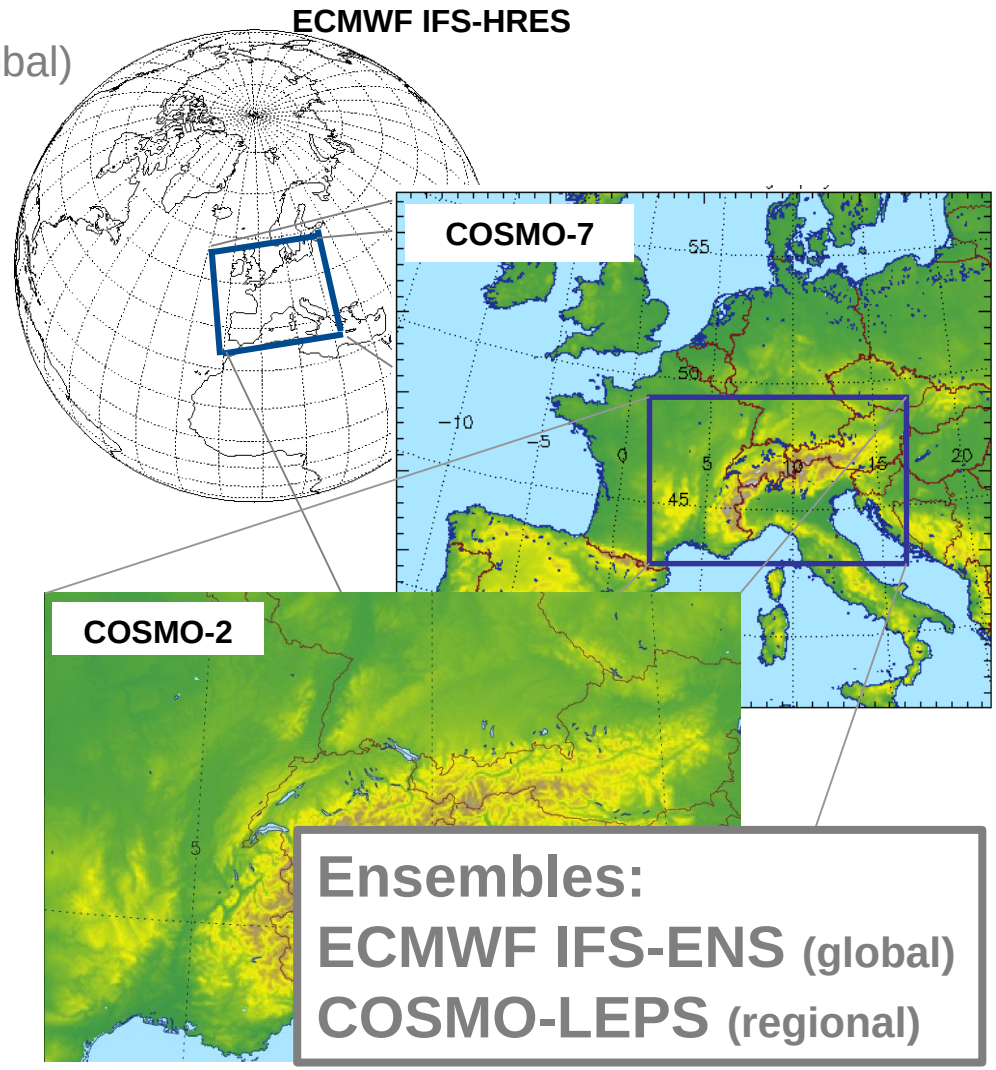
- 6.6 km, 60 levels
- +72h, 3x per day

COSMO-2 (local)

- 2.2 km, 60 levels
- +33h, 8x per day

on-demand mode

- *+6h, hourly*



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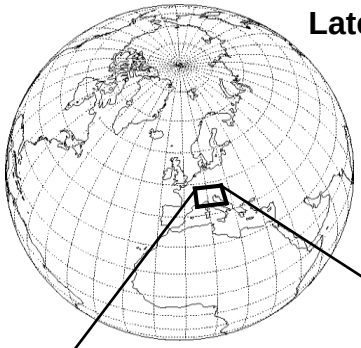
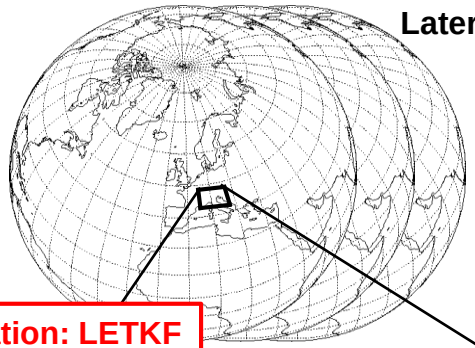
New model systems at MeteoSwiss: Project COSMO-NExT



Lateral boundary conditions:
IFS-HRES
10km
4x per day

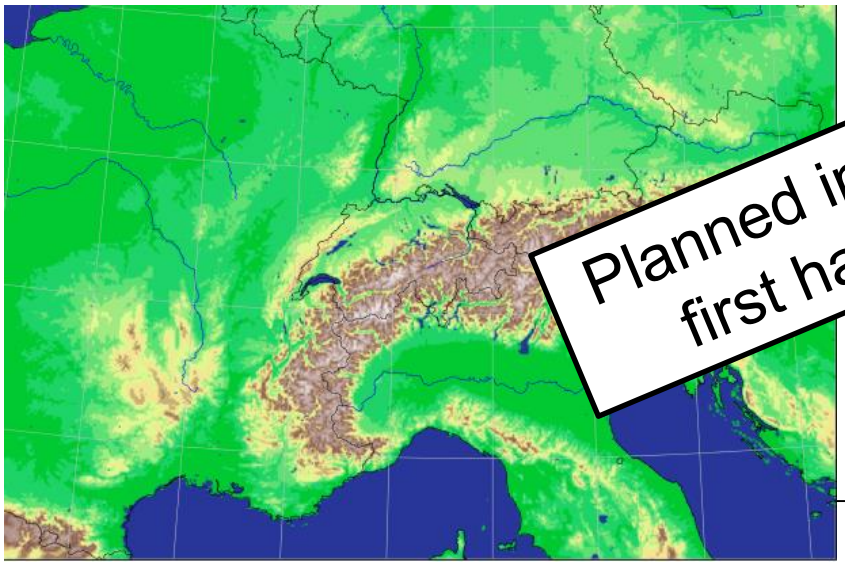


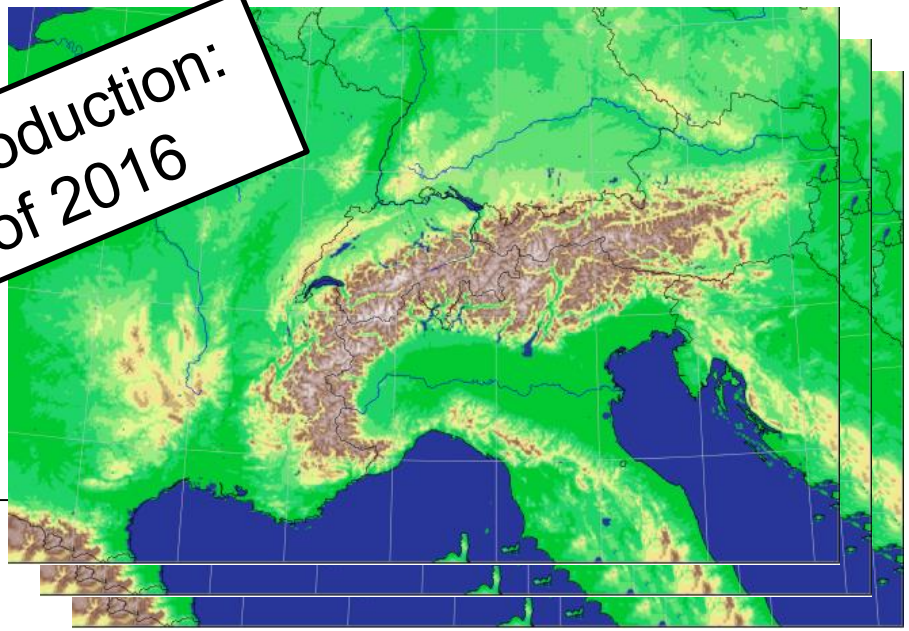
Lateral boundary conditions:
IFS-ENS
20km
2x per day

ensemble data assimilation: LETKF

COSMO-1: O(24 hour) forecasts, 8x per day
1.1km grid size (convection permitting)

COSMO-E: 5 day forecasts, 2x per day
2.2km grid size (convection permitting)
O(21) ensemble members

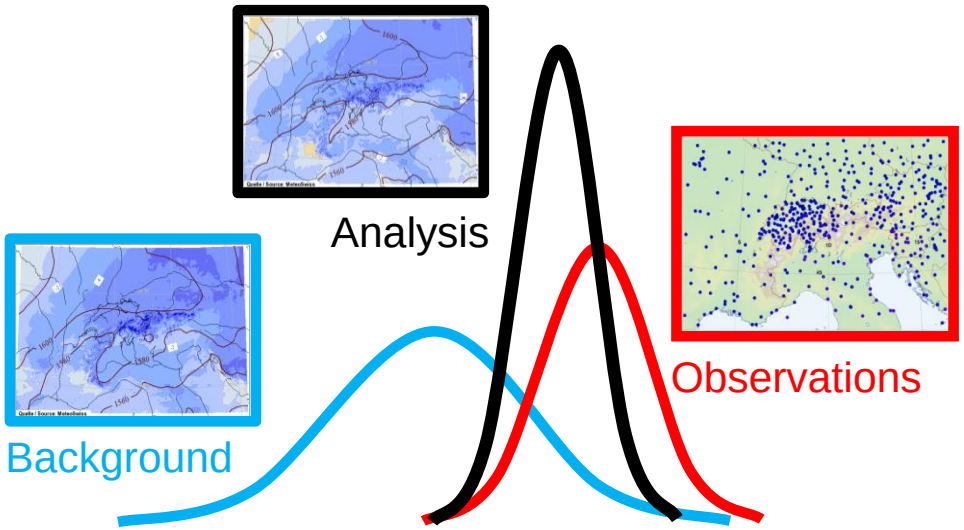




Planned introduction:
first half of 2016

KENDA:
km-scale ensemble data assimilation

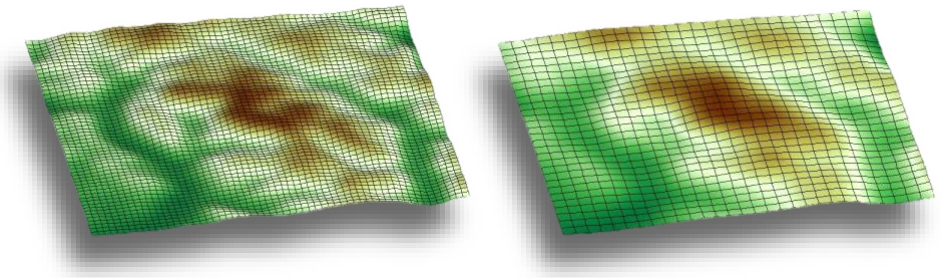
Replace current COSMO nudging assimilation system with a new, state-of-the-art Ensemble Kalman Filter
(**LETKF**: **L**ocal **E**nsemble **T**ransform **K**alman **F**ilter)



Better analysis through

- optimal combination of model and observations based on error statistics;
- flow-dependent background error statistics based on ensemble;
- much more flexibility in using new observations!

COSMO-1: Keywords

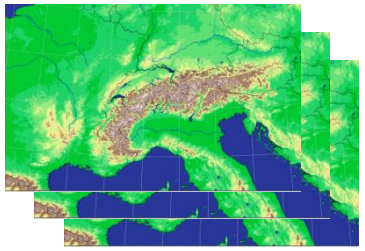


- Deterministic forecasts with convection-permitting resolution (1.1 km mesh-size)

- Targeted for the very short-range (+24h)
- Rapid update cycle with new forecast every 3 hours
- On demand mode for key clients
- ICs from LETKF, LBCs from IFS-HRES

- COSMO-1 has the best representation of the
  - complex Alpine topography
  - physical processes of extreme weather events

COSMO-E: Keywords



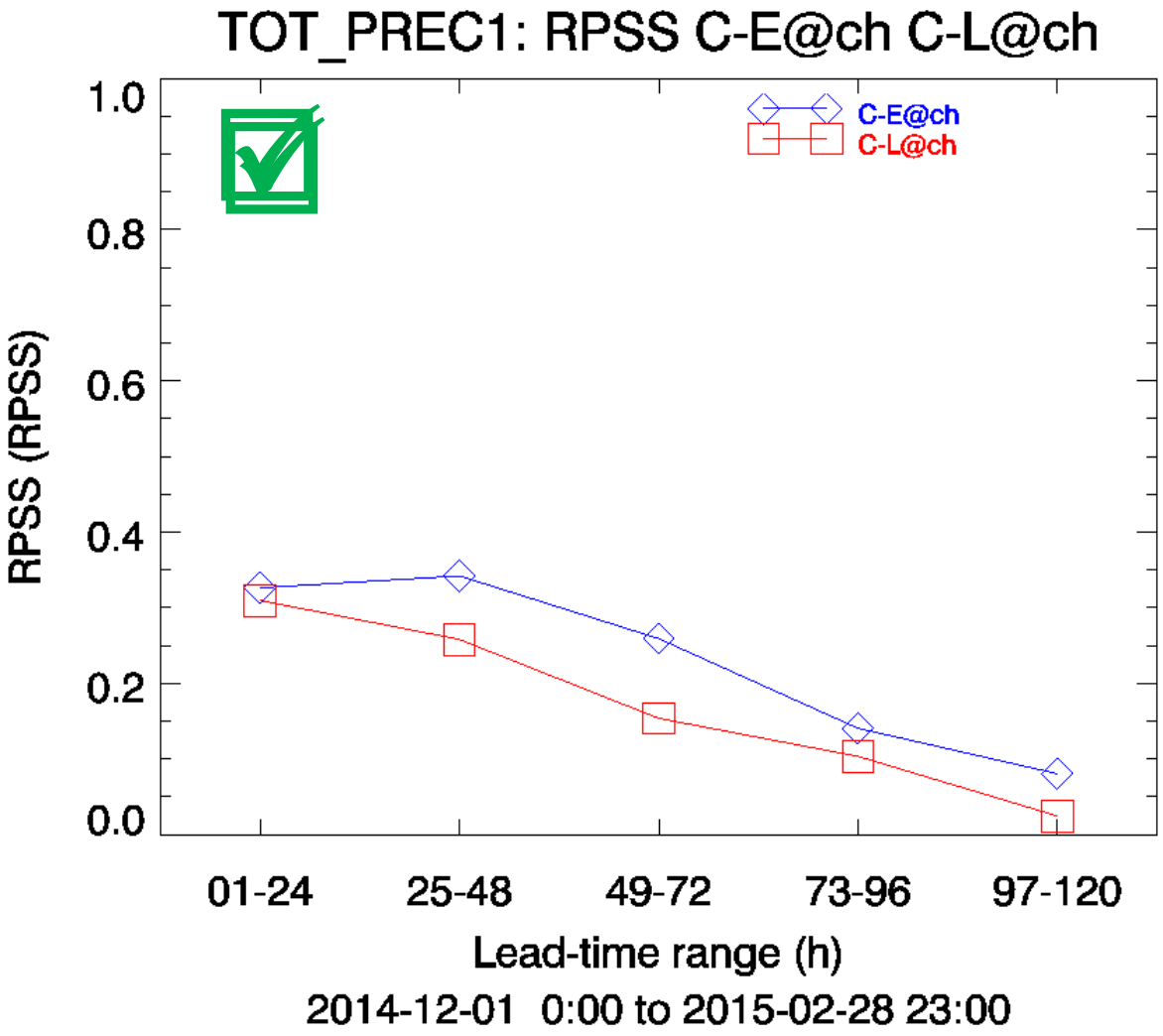
- Ensemble forecasts with convection-permitting resolution (2.2 km mesh-size) and 21 members
- Runs twice a day up to +120h for Alpine area
- Perturbations:
  - initial conditions (ICs): from KENDA (currently IFS-ENS and re-cycled soil)
  - lateral boundary conditions (LBCs): IFS-ENS
  - model errors: Stochastic Perturbation of Physical Tendencies (SPPT)
- Provides probabilistic forecast as well as “best estimate” and forecast uncertainty

Verification

Summary surface Winter 2014/2015; COSMO-E vs. COSMO-LEPS; Total scores all lead times

Parameter	RPS(S)	Outliers	Spread/ Error	Resolution Thrs1	Resolution Thrs2
Surf. Pres.	na	na	na	na	na
T 2m	☑	☑ / ☒	☑	☑	☑
Td 2m	☑	☑ / ☒	☑	☑	☑
dd 10m	na	na	na	na	na
ff 10m	☑	☑	☑	☑	☑
CLCT	na	na	na	na	na
Prec 12h	☑	☑	☑	☑	☑
Prec 1h	☑	☑	☑	☑	☑
Gusts	☑	☑	☑	☑	☑

Precipitation 1 h Sum



Thresholds
0.1,0.5,1.,2.,5.,10

How should we use COSMO-E? Best practice (1)

- use full probabilistic output in a probabilistic approach

- use of COSMO-E in deterministic forecasting
  - mean (strong smoothing effect for high-impact weather)
  - median
  - representative member of most probable cluster in case of large spread of ensemble
  - … and additionally provide uncertainty!

- consider post-processing techniques to account for not (yet) sampled model errors

How should we use COSMO-E? Best practice (2)

- use of COSMO-E for warnings
  - use full probabilistic output and do not ignore low probability events (“early indications … will be … in the tail …”)

References:
[1] http://www.wmo.int/pages/prog/www/Documents/1091_en.pdf
[2] http://www.wmo.int/pages/prog/www/DPFS/Documentation/Guidelines_ET-EPS2006.pdf
[3] http://www.wmo.int/pages/prog/amp/pwsp/documents/TD-1422.pdf

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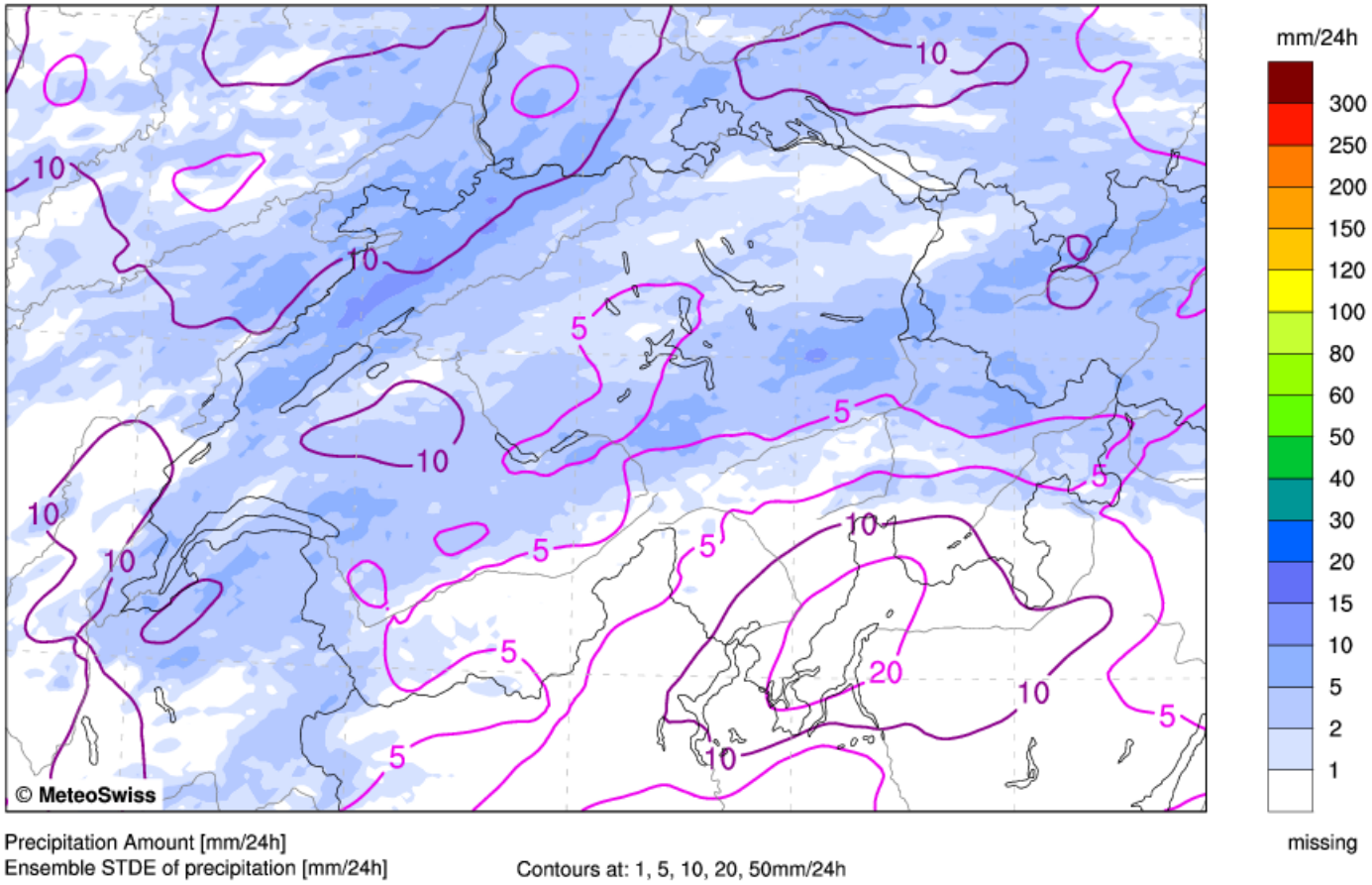
Example products: median + spread



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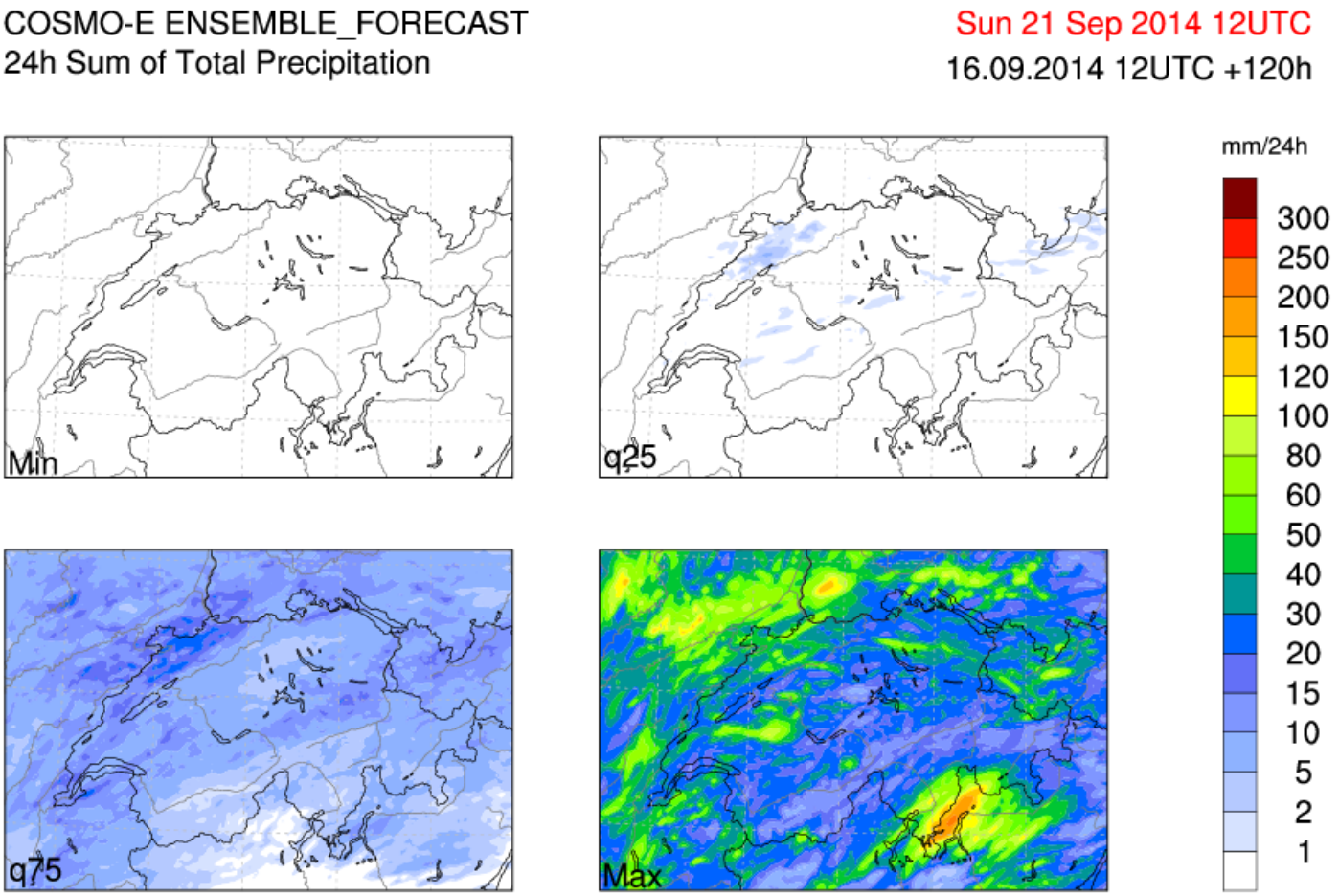
Example products: quantiles



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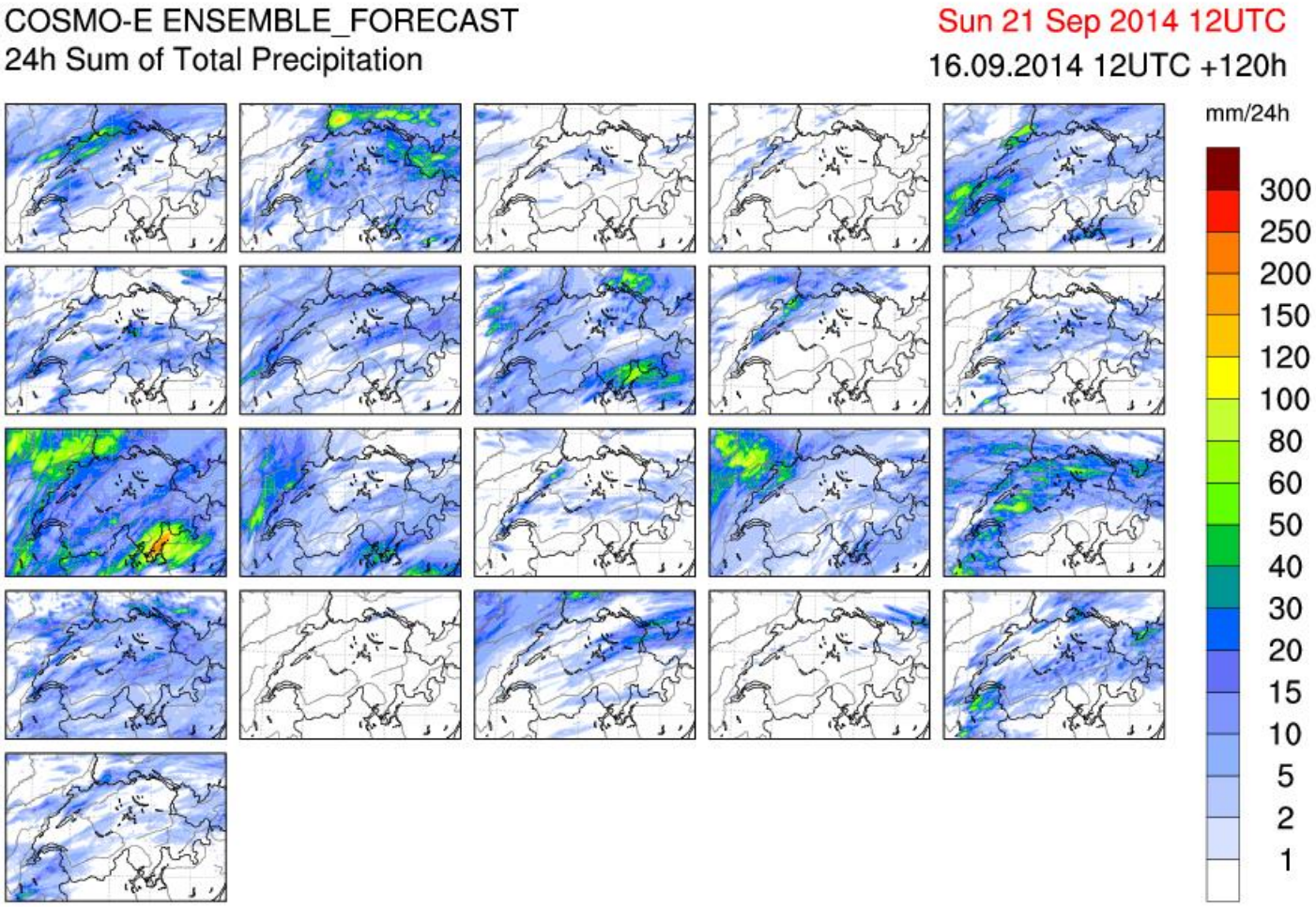
Example products: stamp map



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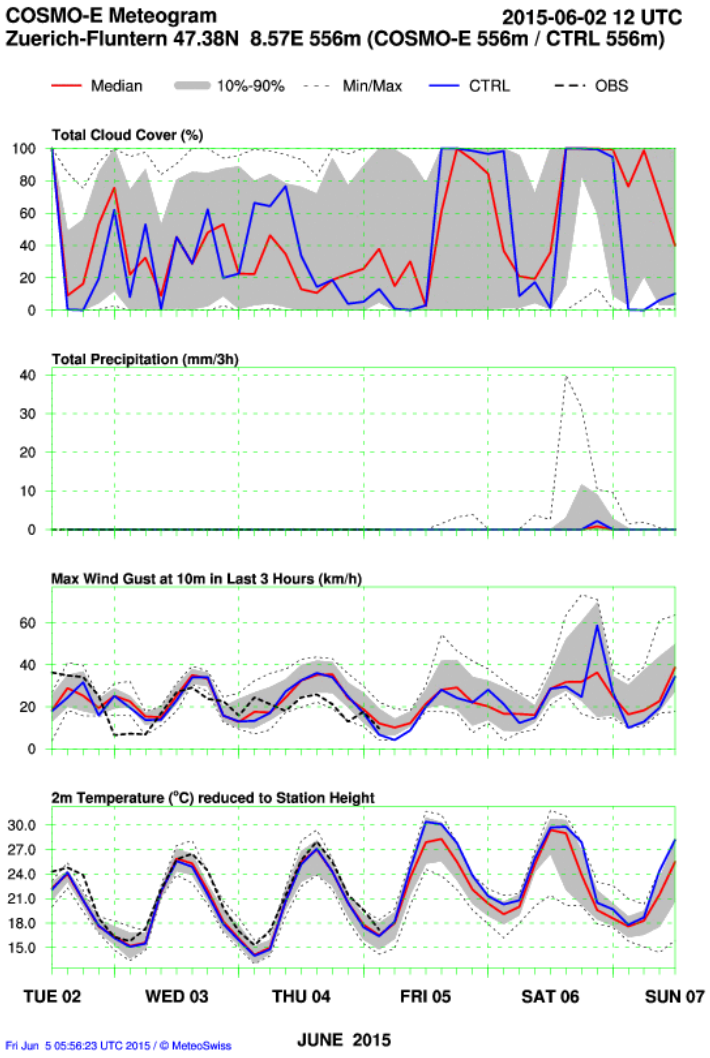
Example products: Meteogram



Summary: Potential for new products

- **COSMO-E**
  - probabilistic products at convection-permitting resolution
  - especially suited for rare / extreme events → warnings
  - forecast always accompanied with an "error bar"
- **COSMO-1**
  - best possible deterministic forecast with high update frequency; benefit over COSMO-E especially for process and regions, where horizontal resolution is most important
- **KENDA**
  - best state of the atmosphere, with an estimation of the uncertainty

Communication challenges: «How to bring probabilities to customer?»

- many existing customers will get COSMO-E products instead of deterministic COSMO-7 / COSMO-2, i.e. added value

- But: probably not all of these customers can / want to handle uncertainties

- Speak to customers to decide whether and how uncertainties are useful
  - what is the added value → uncertainty may be an improvement for customer applications
  - choose appropriate deterministic product if necessary (median or ctrl)

Communication challenges: «How to bring probabilities to customer?»

- Use of COSMO-E (all members):
  - potentially lots of data
  - availability of all members offers flexibility, but requires processing on customer side
  - processing on our side (probabilities, quantiles,…) reduces data amount

→ Challenges concerning field customers

  - data amount
  - deterministic forecast (constistent; ctrl, median or others?)

→ Challenges for «individual point» customers

  - add quantiles or probabilities to current forecast

Discussion

… from your experience, how should we proceed …

- Give as much probability information as possible to the customer, no matter if they want it?

- If deterministic forecast required, which is the best choice: median (which verifies best) or control (which is an actual forecast and not an artificial product)?