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Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology MeteoSwiss

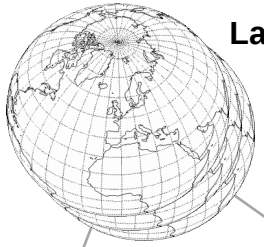
Status report about the operational COSMO-1E and COSMO-2E suites

André Walser

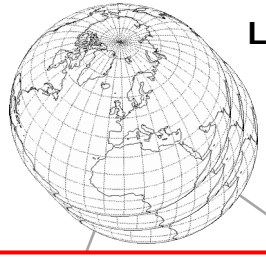
Outline

- operational setup and system
- COSMO issues
- objective model performance
- subjective model performance
- outlook

Operational suites



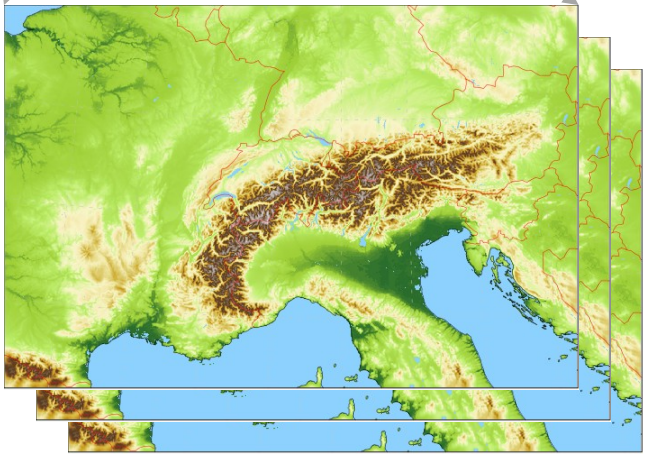
Lateral boundary conditions:
IFS ENS & HRES
18km / 0.2°
4x per day



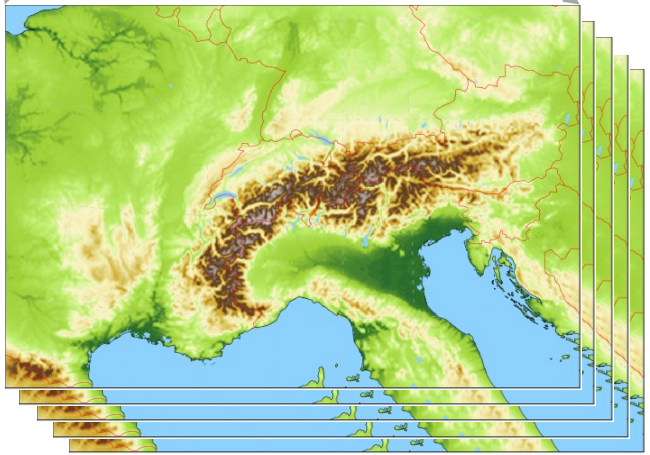
Lateral boundary conditions:
IFS ENS
18km / 0.2°
4x per day

ensemble data assimilation: KENDA at 1.1km

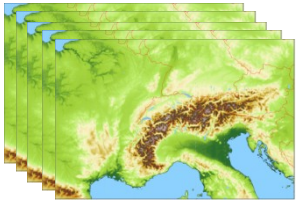
COSMO-1E: 33 hour forecasts, 8x per day
1.1km grid size (convection permitting)
11 ensemble members



COSMO-2E: 5 day forecasts, 4x per day
2.2km grid size (convection permitting)
21 ensemble members

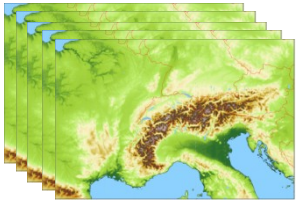


COSMO-1E setup



- 11 members (control and 10 perturbed runs)
- 1.1 km horizontal mesh-size, 80 vertical levels
- 8 forecasts per day up to +33h (03 UTC +45h)
- initial condition (perturbations): KENDA-1 analyses
  - KENDA-1 deterministic run for control
  - KENDA-1 members 1-10 (out of 40)
- lateral boundary condition (perturbations): ECMWF (6h older LBCs)
  - HRES control for control
  - ENS members selected by member selection based on clustering
- model uncertainty: SPPT (range_rn=0.6)
- COSMO 5.08 (single precision)

COSMO-2E setup



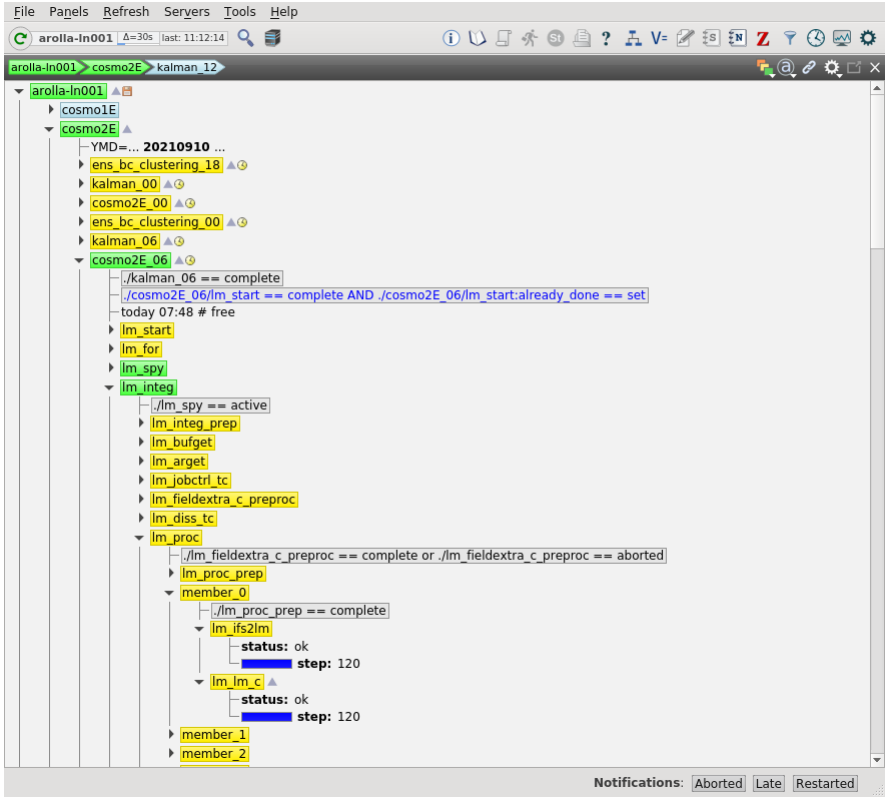
- 21 members (control and 20 perturbed runs)
- 2.2 km horizontal mesh-size, 60 vertical levels
- 4 forecasts per day up to +120h
- initial condition (perturbations): KENDA-1 analyses upscaled by fieldextra to 2.2 km
  - KENDA-1 deterministic run for control
  - KENDA-1 members 1-20 (out of 40)
- lateral boundary condition (perturbations): ECMWF (6h older LBCs)
  - ENS control for control
  - ENS members selected by member selection based on clustering
- model uncertainty: SPPT (range_rn=0.8)
- COSMO 5.08 (single precision)

HPC system Pigne d'Arolla

- Cray CS-Storm with 3 racks with two logical partitions (production and R&D/failover)
- 18 GPU nodes in total with
  - 8 NVIDIA V100 GPUs
  - 2 Intel Skylake (8-core, 3.2GHz) CPUs
- production requires 11 GPU nodes (for all members, alternative: cloning)
- nodes swappable between partitions
- time needed (without product generation):
  - COSMO-1E: ~50 min (for +33h)
  - COSMO-2E: ~40 min
  - 1h KENDA-1 cycle: 20 min

Steering

- ecFlow
- task manager and monitoring tool for operating
- use of python API to automatically generate suite definition files



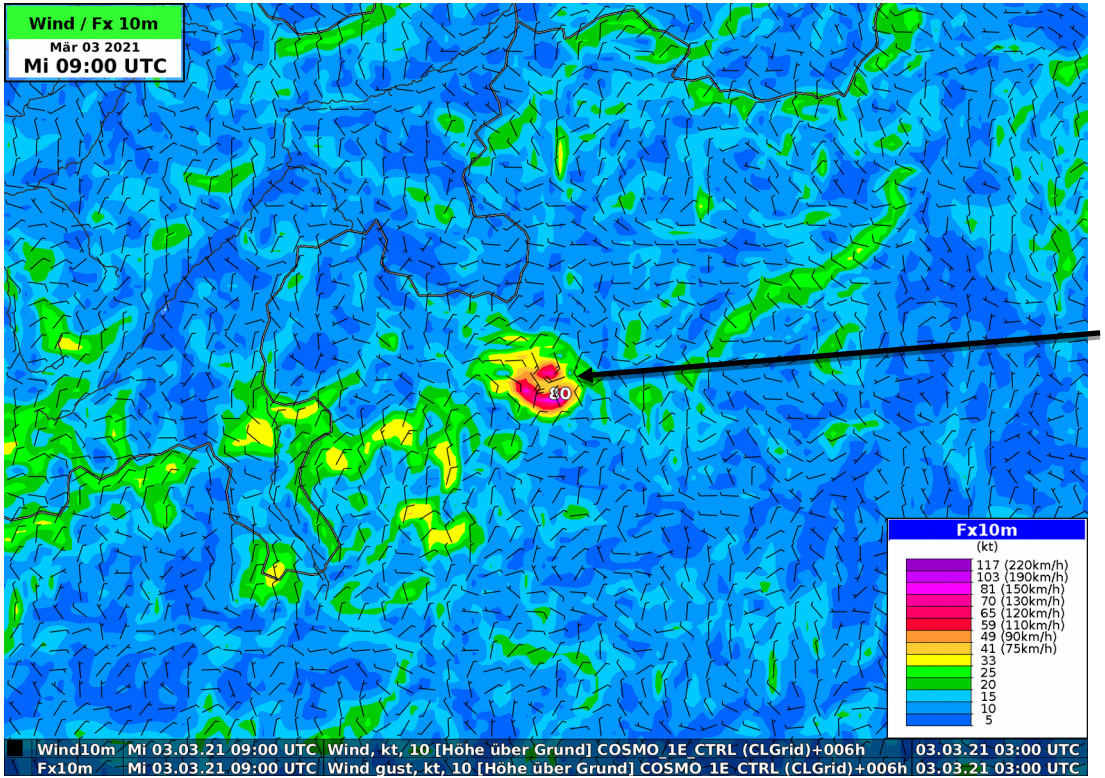
Issues in
in COSMO-1E

Unpysical anomalies

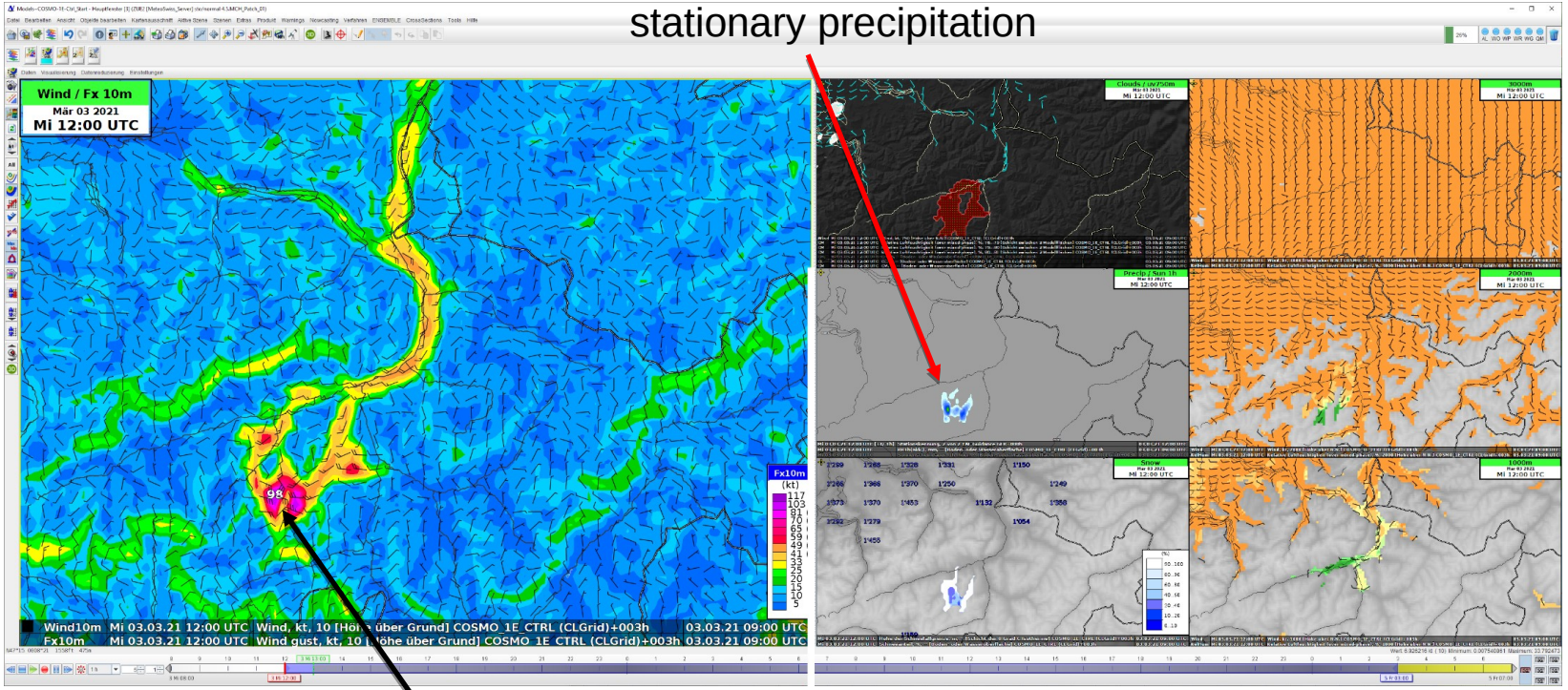
- usually locally, seen in
  - wind speed
  - temperature in the lowest levels
  - dew point temperature

- explosions of pollen concentration in complex topography
- … seen with long-lasting divergence in the wind field in the lowest levels

Wind speed anomalie in Ortler region

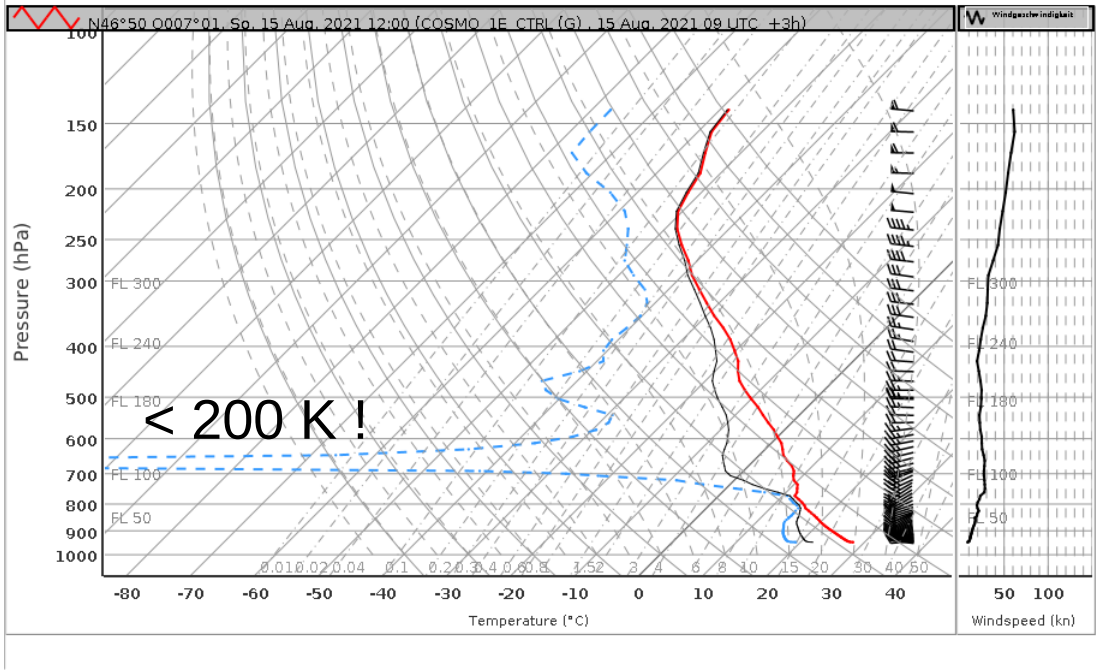


Anomaly with outreaching impact



Dew point temperature anomaly

Skew-T diagram from COSMO-1E control



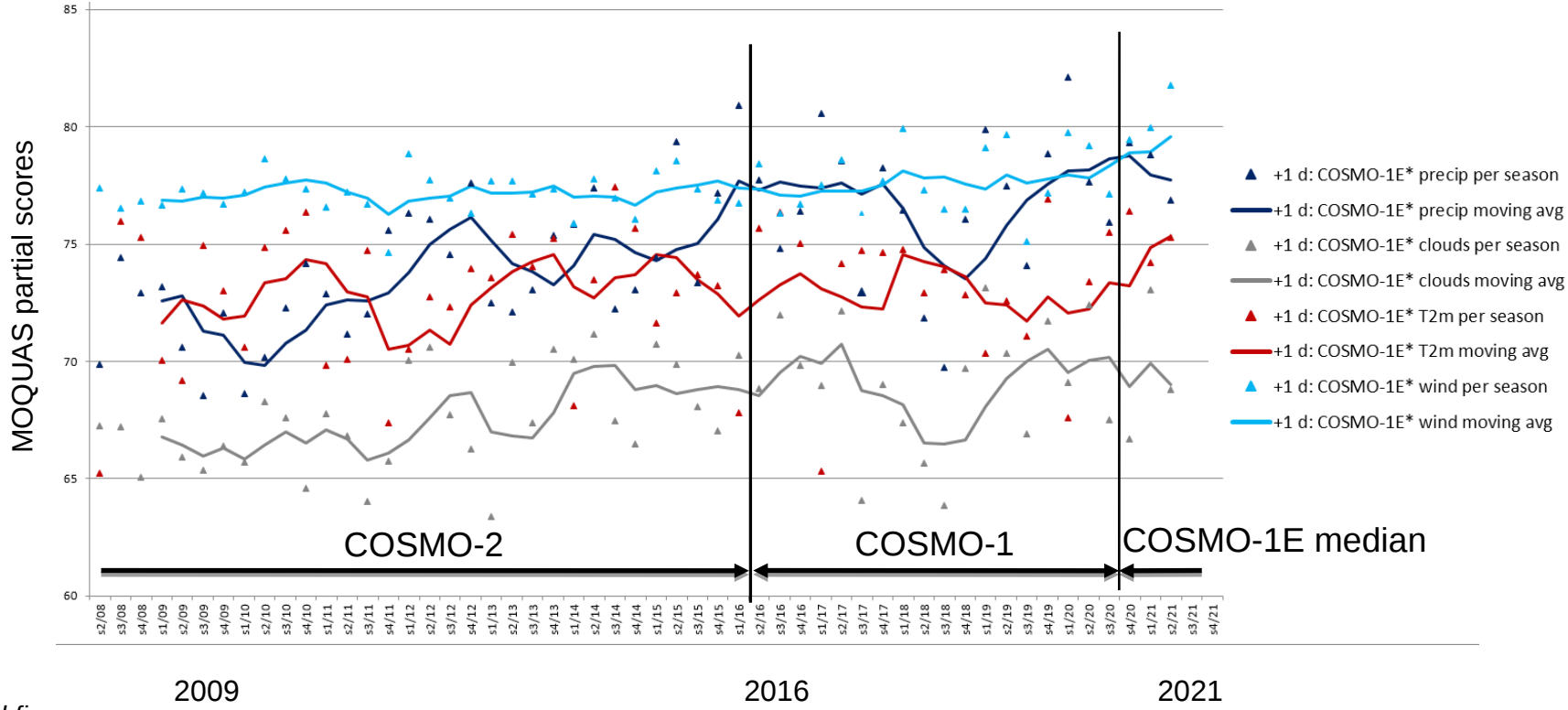
Model changes

- 2021-03-17:
  - COSMO 5.08 & original SKC field (canopy layer stable with this version)
  - switched on horr. diffusion of U/V (hd_corr_u_in=0.1)

- 2021-08-11: increased bare soil evaporation (c_soil = 1.0)

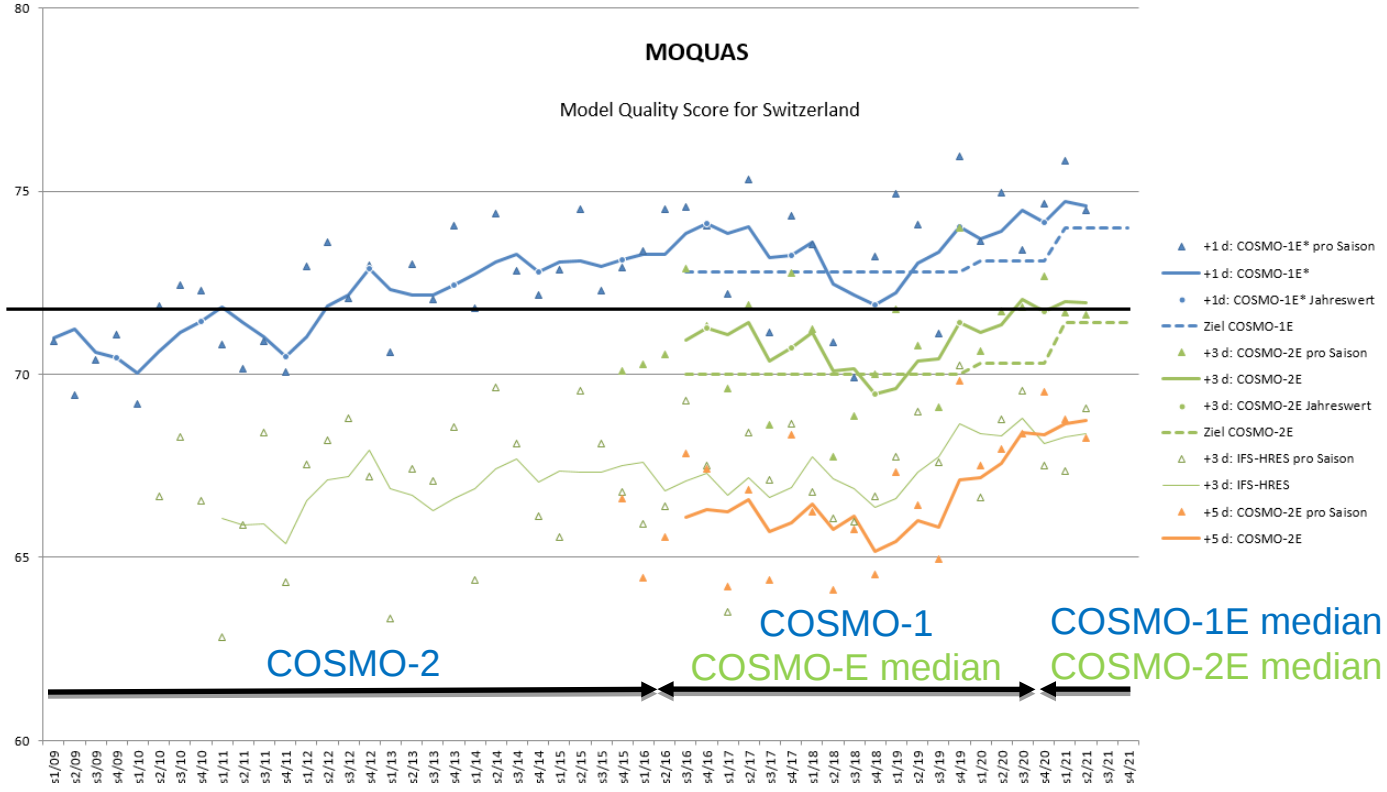
Objective model performance for Switzerland

MeteoSwiss model performance scores



original figure:
Pirmin Kaufmann

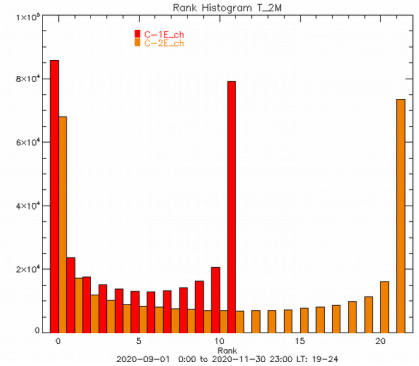
MeteoSwiss model performance scores



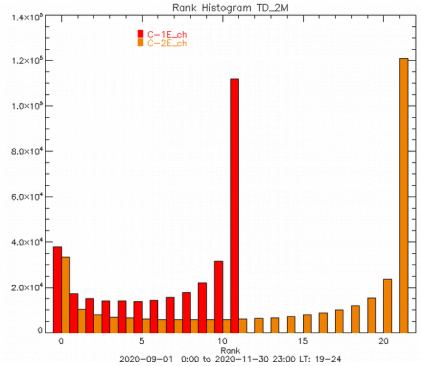
original figure:
Pirmin Kaufmann

Rank Histogram +24h autumn 2020

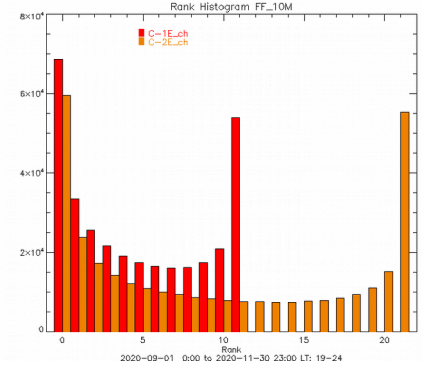
2m temp



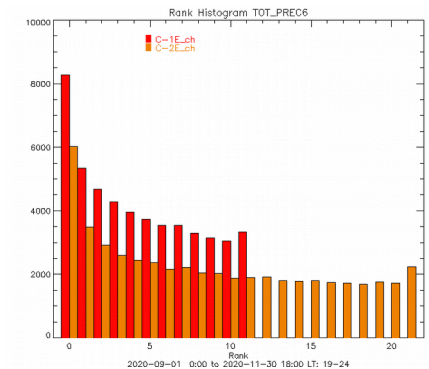
2m dew point



10m wind speed



6h precip



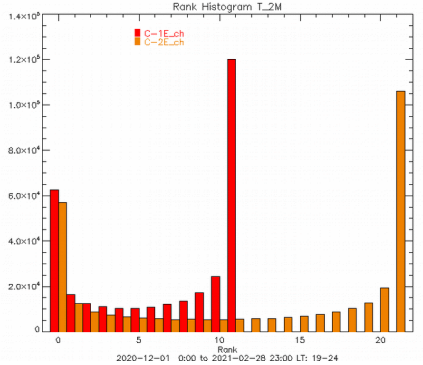
- underdispersive
- too much precipitation

11 members COSMO-1E

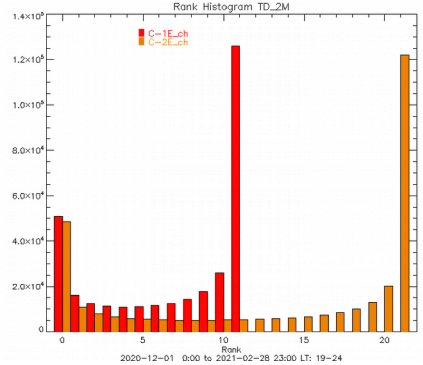
21 members COSMO-2E

Rank Histogram +24h winter 20/21

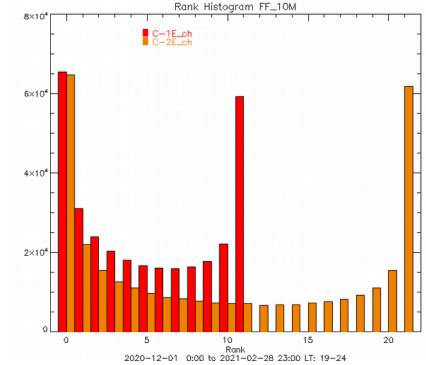
2m temp



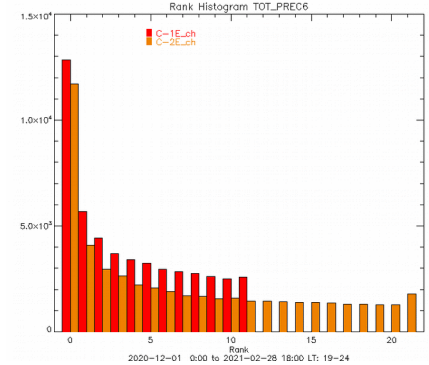
2m dew point



10m wind speed



6h precip



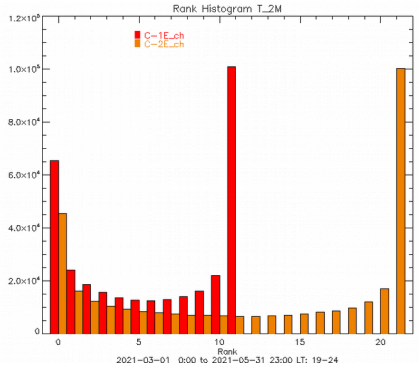
- underdispersive
- too much precipitation

11 members COSMO-1E

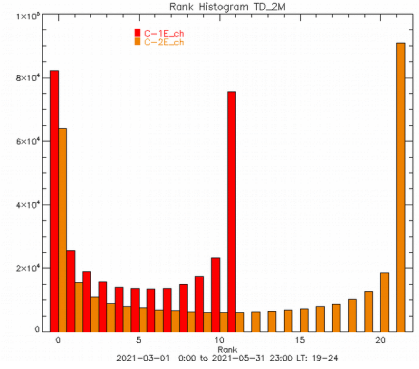
21 members COSMO-2E

Rank Histogram +24h spring 2021

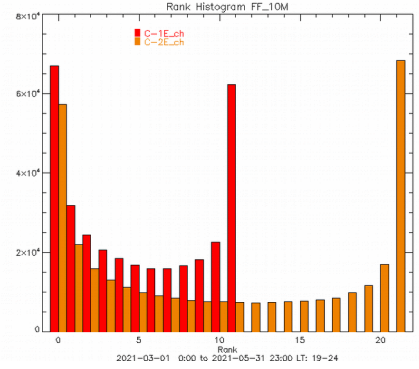
2m temp



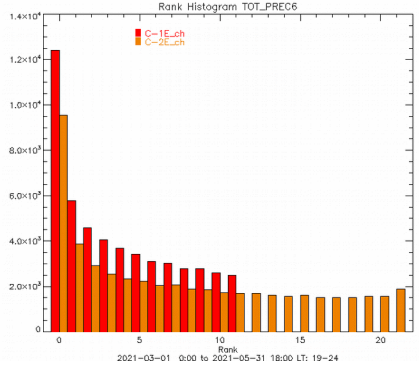
2m dew point



10m wind speed



6h precip



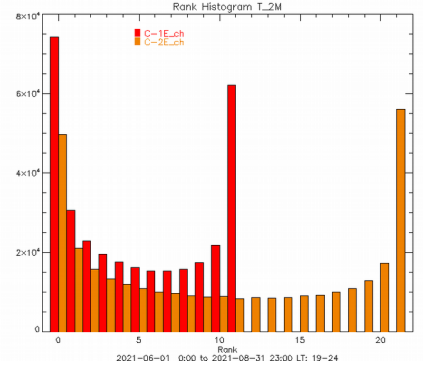
- underdispersive
- too much precipitation

11 members COSMO-1E

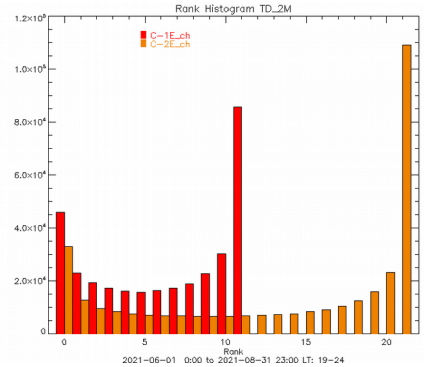
21 members COSMO-2E

Rank Histogram +24h summer 2021

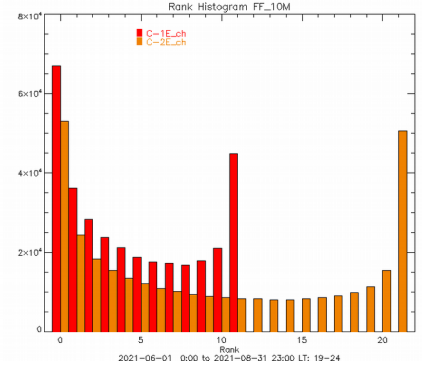
2m temp



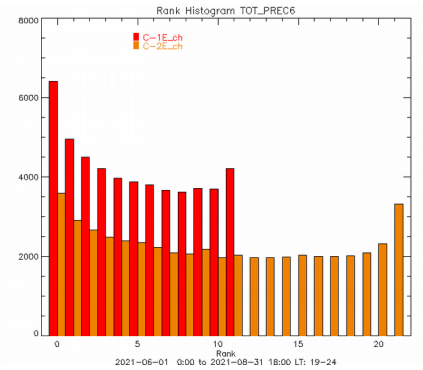
2m dew point



10m wind speed



6h precip



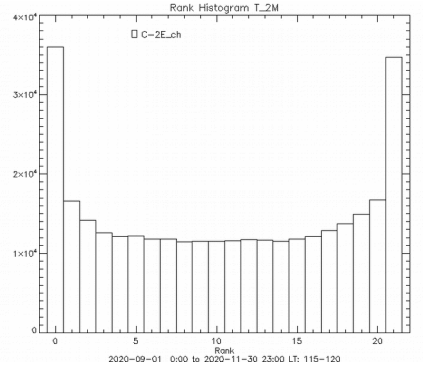
- underdispersive

11 members COSMO-1E

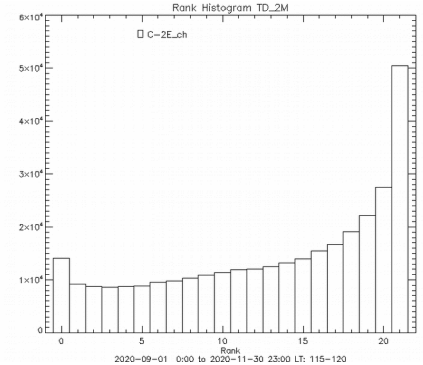
21 members COSMO-2E

Rank Histogram +120h autumn 2020

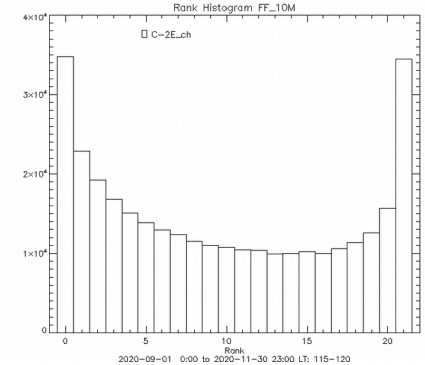
2m temp



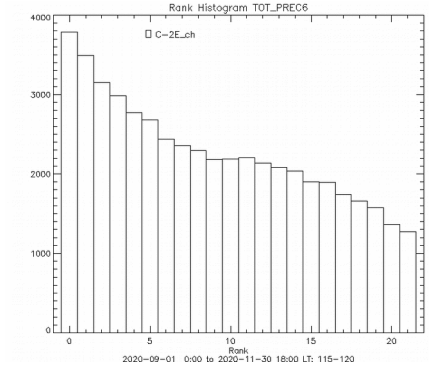
2m dew point



10m wind speed



6h precip

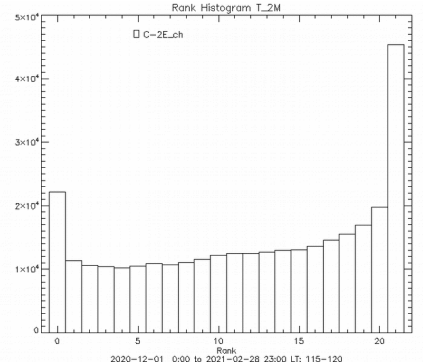


- underdispersive
- too much precipitation

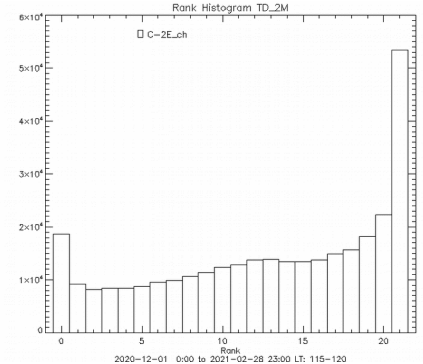
21 members COSMO-2E

Rank Histogram +120h winter 20/21

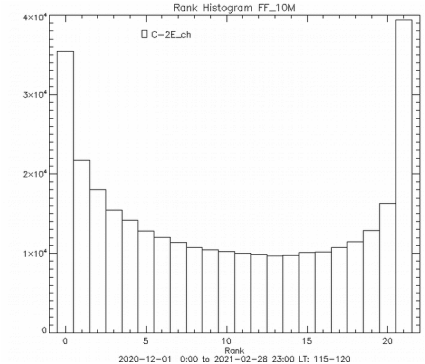
2m temp



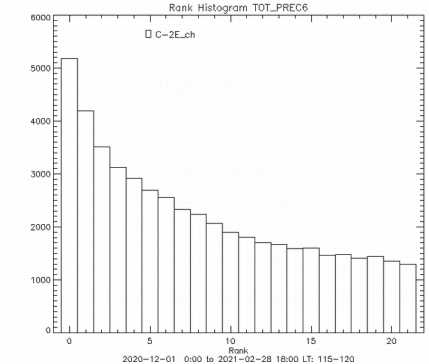
2m dew point



10m wind speed



6h precip

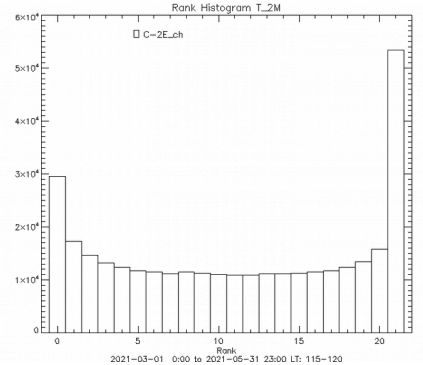


- underdispersive
- too much precipitation

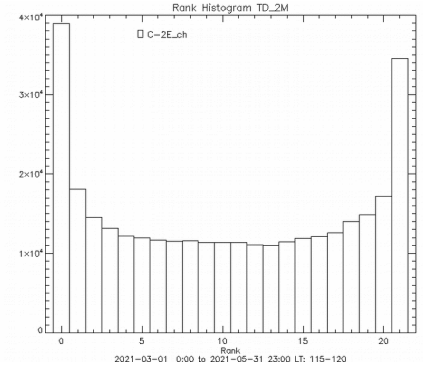
21 members COSMO-2E

Rank Histogram +120h spring 2021

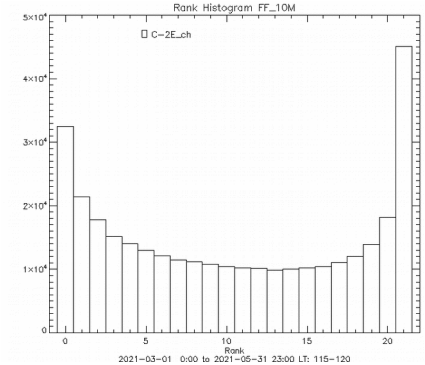
2m temp



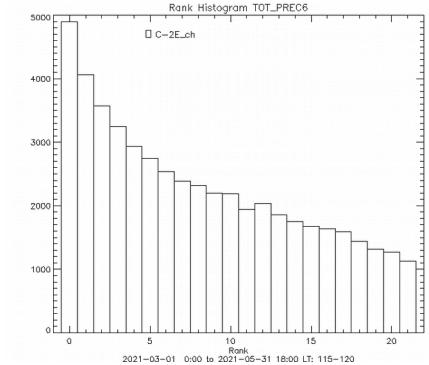
2m dew point



10m wind speed



6h precip

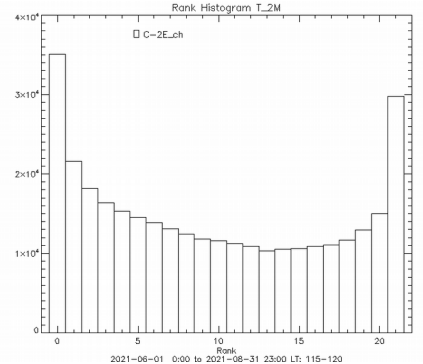


- underdispersive
- too much precipitation

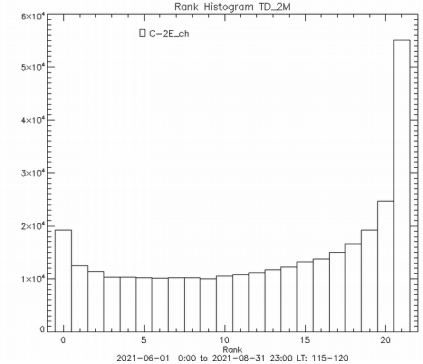
21 members COSMO-2E

Rank Histogram +120h summer 20/21

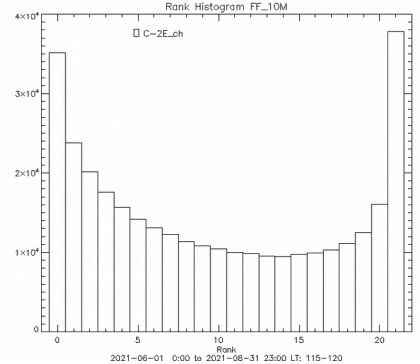
2m temp



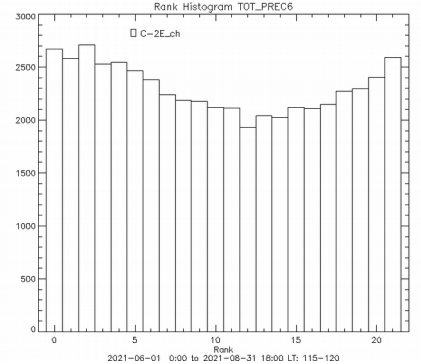
2m dew point



10m wind speed



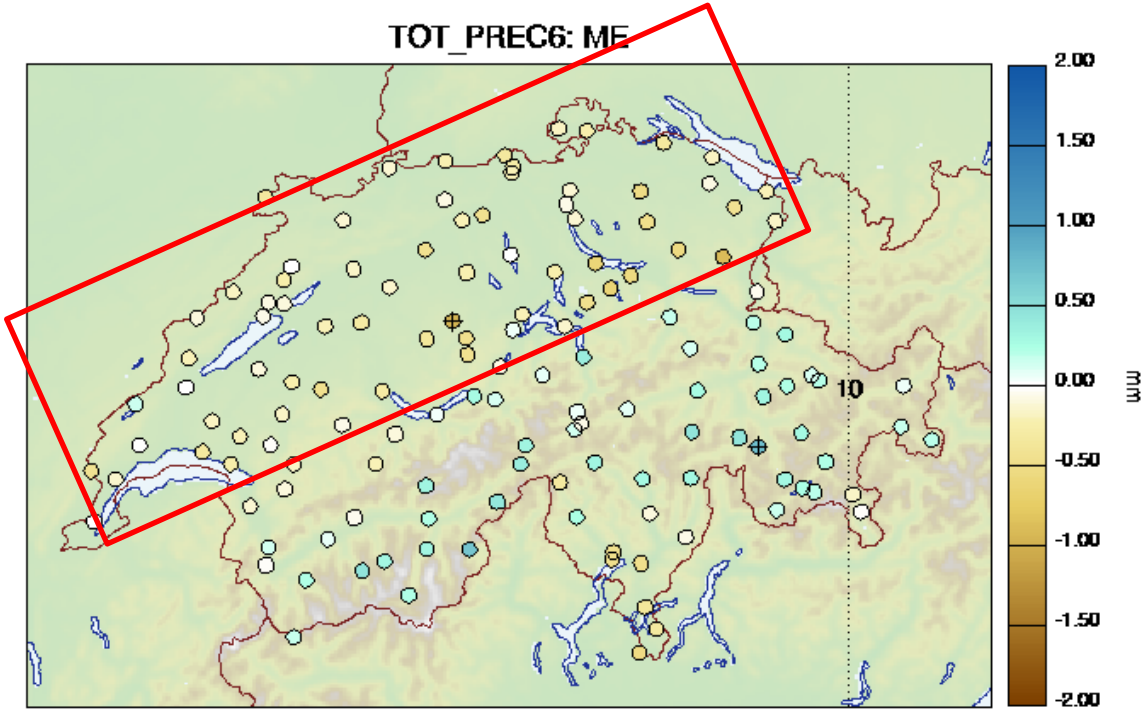
6h precip



- underdispersive

21 members COSMO-2E

6h precipitation bias +24h summer 2021



- dry bias on Swiss Plateau
- wet bias in Alps

Verification summary

- COSMO-1E and COSMO-2E ensemble forecasts underdispersive, in particular for 2m temperature and 10 m wind speed
- worst in the short-range, but even for +120h larger than expected
- might by partly due to systematic biases at some stations (representation errors), needs further investigations

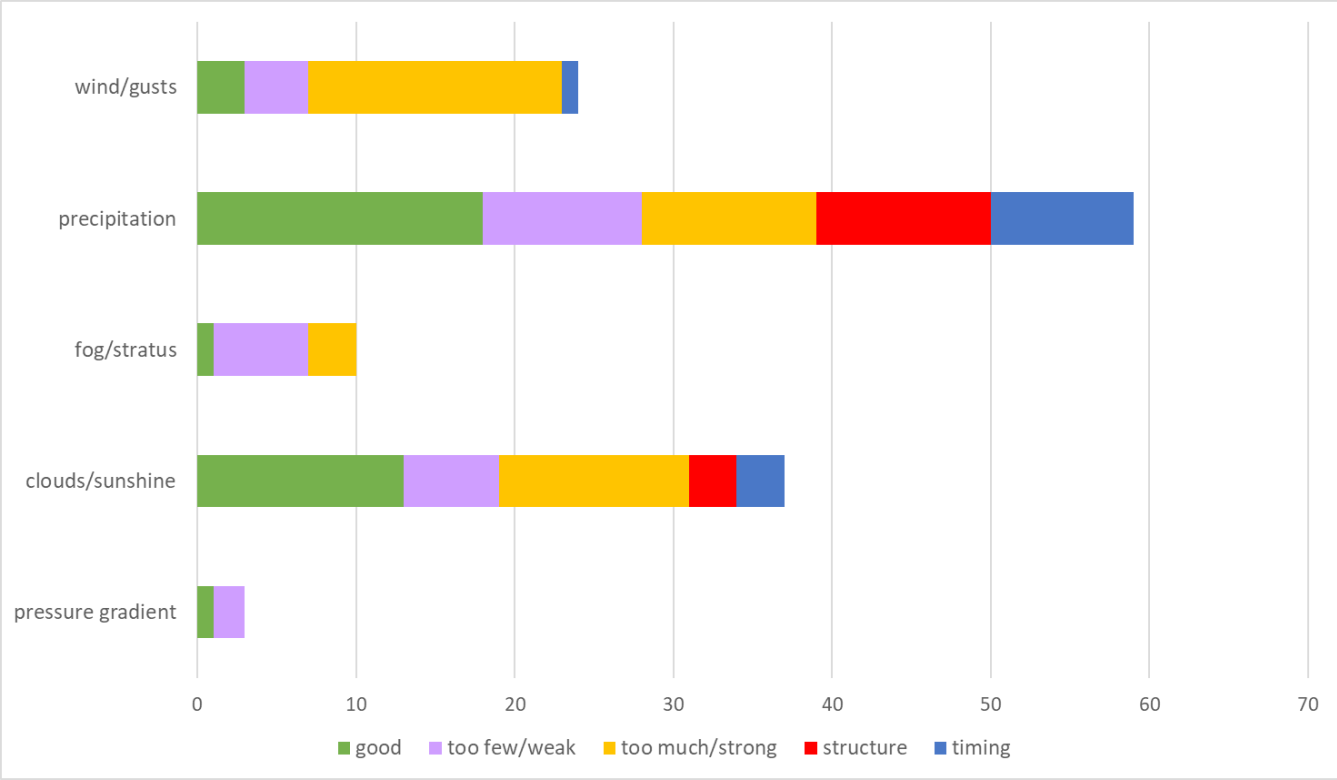
 nevertheless shows that more effective model perturbations are needed

Subjective model performance for Switzerland

Information exchange with forecasters

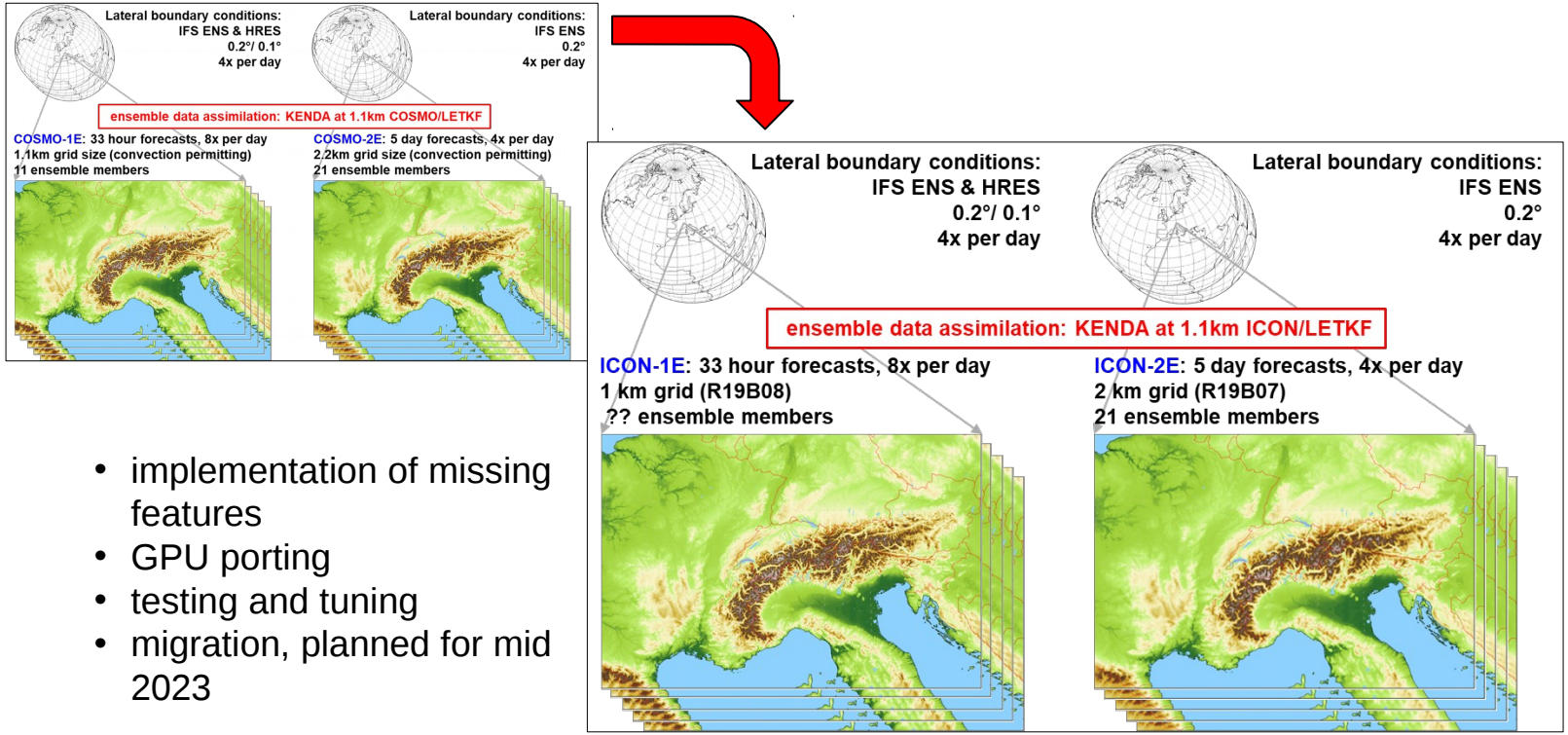
- model feedbacks from forecaster on duty every day (scheduled, up to 15 min)
- increased use of ensemble information also in the short range
- probabilities are translated to keywords in forecast bulletins (e.g. possible, likely,..)
- …but control run still get (too) much attention

Forecaster feedbacks 2021 (until 9.9.2021)



Outlook

Project ICON-22: ICON-1E & ICON-2E



- implementation of missing features
- GPU porting
- testing and tuning
- migration, planned for mid 2023

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Swiss Confederation

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