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Eidgenössisches Departement des Innern EDI
Bundesamt für Meteorologie und Klimatologie MeteoSchweiz

KENDA activities at MeteoSwiss – Part II

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Microwave Radiometer Data Assimilation

Towards MWR data assimilation

EMER-Met:
Emergency Response
Meteorology

- 3 **microwave radiometers** (MWR)
- temperature and humidity profile information in the boundary layer
- **assimilation of radiances with KENDA** using the forward operator RTTOVgb (version of RTTOV to simulate upward-looking microwave radiometer radiances, CETEMPS)

Towards MWR data assimilation

- radiometer: passive instrument that measures atmospheric radiation at several frequency bands
- HATPRO, 14 frequency channels
- high temporal resolution (5 minutes)

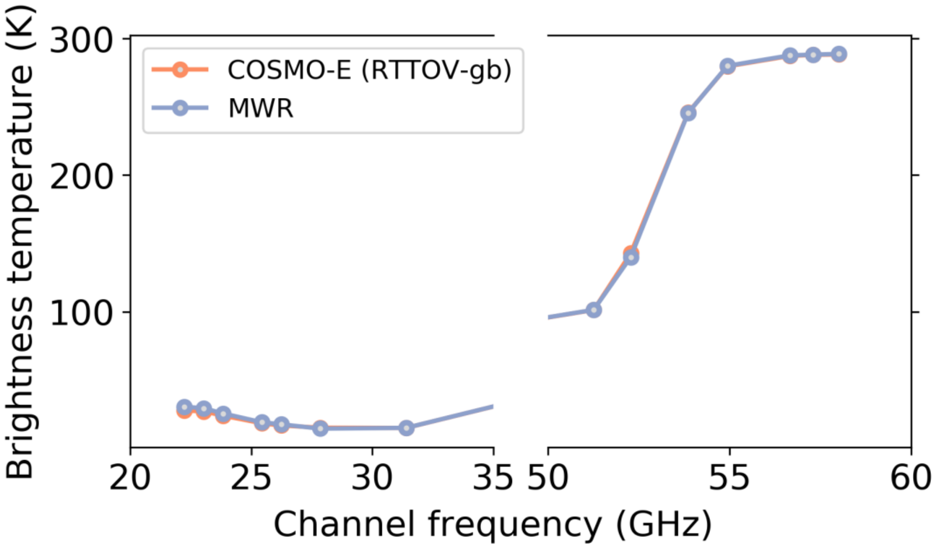
Towards MWR data assimilation

Required steps

- ✓ **RTTOV-gb** at MeteoSwiss
- ✓ Accessible **radiometer data** (netCDF format)
- ✓ Standalone **feedback file generator** for O-B statistics
  - “MEC-light” in DACE/datools
- O-B statistics
- Integration into MEC and LETKF

Towards MWR data assimilation

Validation of the RTTOV-gb setup: comparison between model and observations



Comparison of brightness temperature for 14 channels (Payerne, 19.04.2019 12UTC):

Radiometer observation

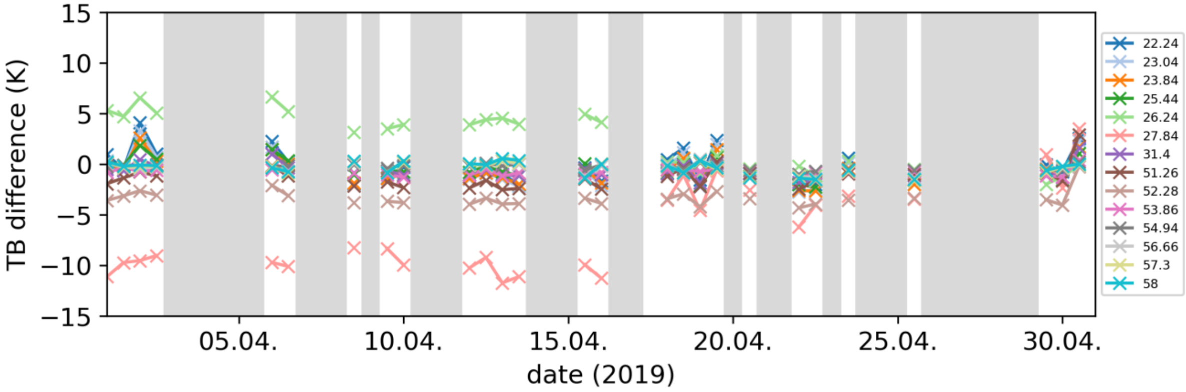
COSMO-E model equivalents

Towards MWR data assimilation

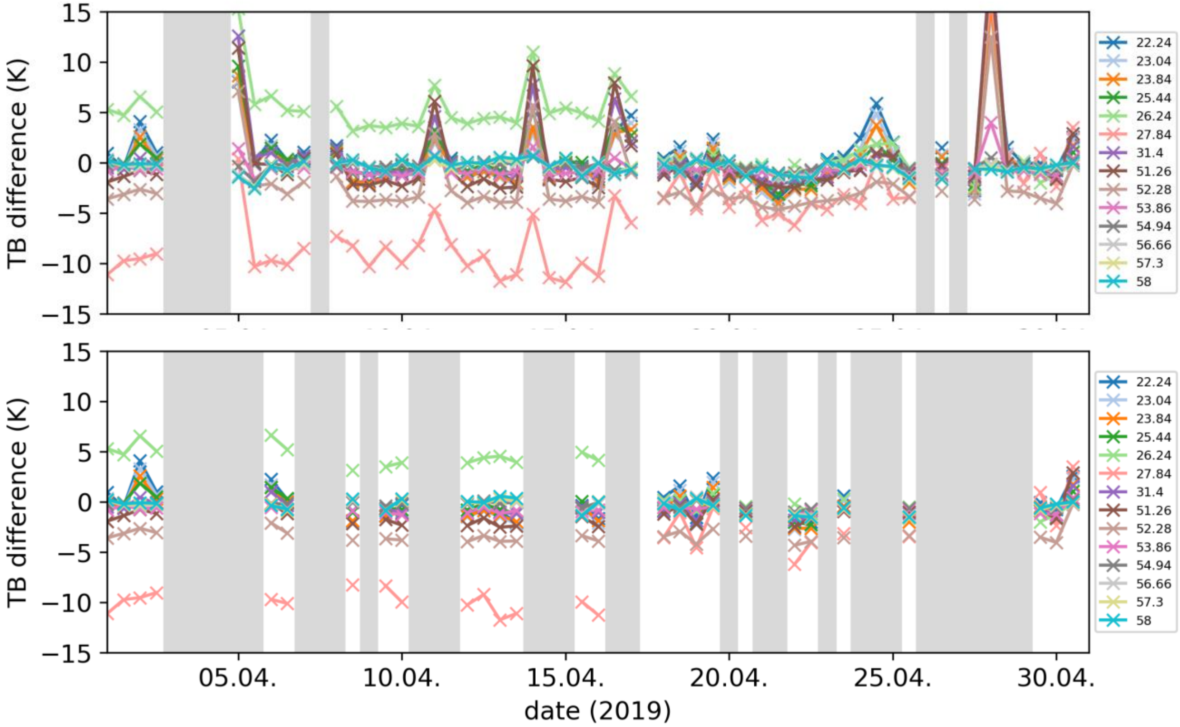
First O-B statistics:

- April 2019 (00UTC and 12UTC), Payerne station
- COSMO-E deterministic run (first guess)

➢ Radiometer recalibration in some channels visible



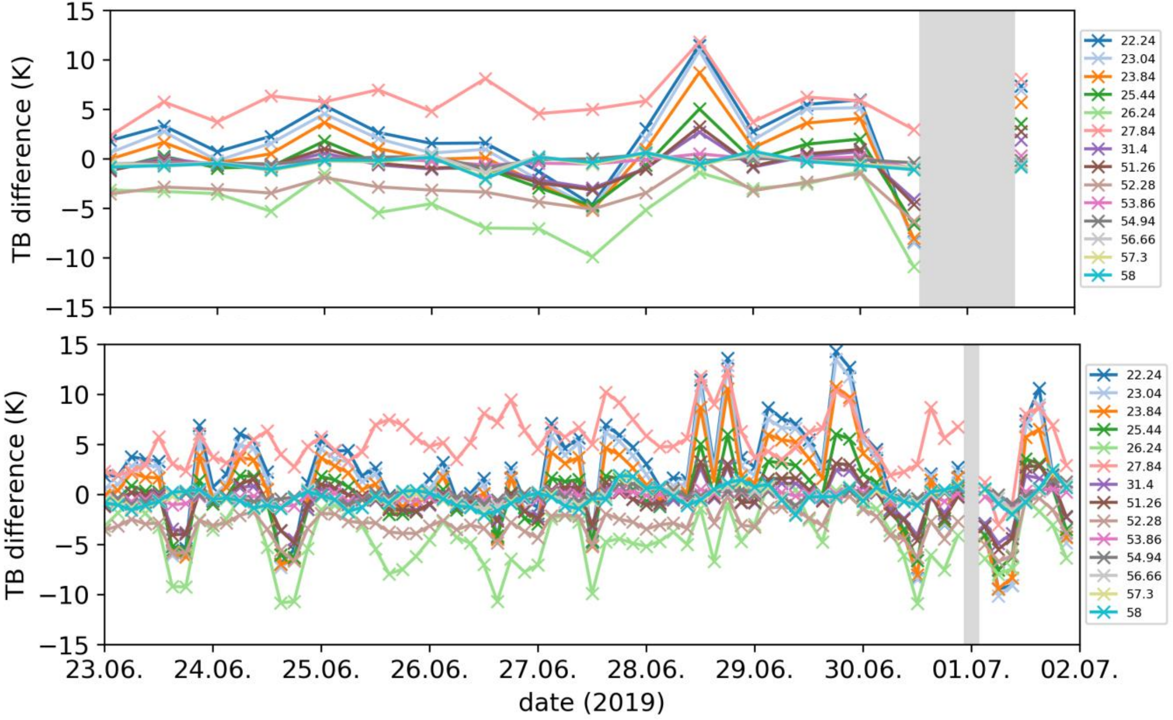
Towards MWR data assimilation



Rain flag only

Rain and cloud flag

Towards MWR data assimilation



Resolution: 12h

Resolution: 3h

Next steps

- **extend O-B statistic** (more stations, other/longer period…)
- O-B distributions for each frequency channel
- consolidate workflow (netCDF data generation, from “MEC-light” to integration into MEC…)
- **first assimilation experiments**

Additive Covariance Inflation for COSMO-E domain

ACI matrix from limited area domain

Additive covariance inflation (ACI)

- **random perturbations with climatological covariance** added to the analysis ensemble

- climatological covariance obtained from forecast differences used as proxy for model errors ("NMC" method: differences between forecasts with different lead times valid at the same time)

ACI matrix from limited area domain

Climatological error covariance matrix

- ✓ from global ICON model
- from limited area COSMO model
- requires solving Poisson's equation on limited region to express the error covariance in terms of stream function ψ and velocity potential χ

$$\nabla^2\psi = \zeta, \nabla^2\chi = \delta$$

δ: divergence
ζ: vorticity

ACI matrix from limited area domain

Problem: $\nabla^2\chi = \delta$ (1), $\nabla^2\psi = \zeta$ (2)

Known: u, v, δ, ζ

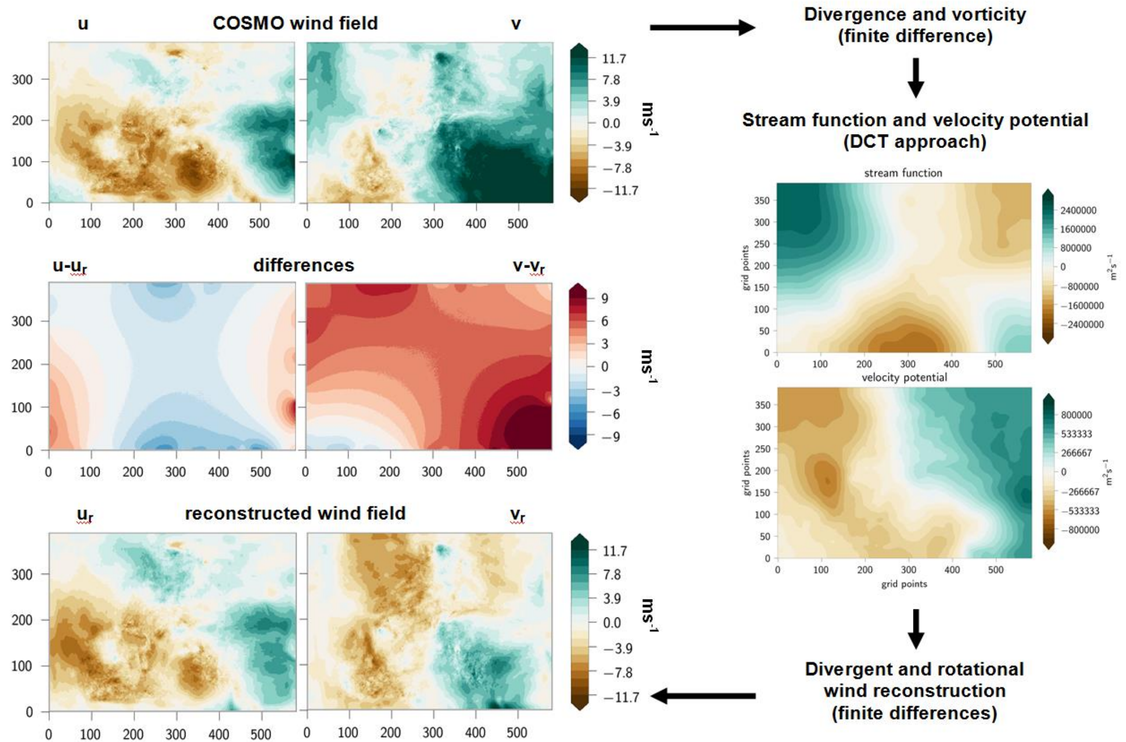
Other relations: $u = \frac{\partial\chi}{\partial x} - \frac{\partial\psi}{\partial y}$ (3), $v = \frac{\partial\chi}{\partial y} + \frac{\partial\psi}{\partial x}$ (4)

u, v: wind field

δ: divergence
ζ: vorticity

χ: velocity potential
ψ: stream function

ACI matrix from limited area domain



Simple approach solving both equations independently does not work

Investigate new method according to Sangster (1960) ?

Sangster's method - overview

wind field decomposition on a limited area domain

- Solve (1) for χ assuming zero boundary conditions ($\chi_B = 0$)
  [implementation: Discrete Sine Transform approach]

- Integrate (3) around boundaries, with specific (known) values for u to obtain boundary values ψ_B

- Solve (2) for ψ assuming specific boundary conditions ψ_B
  [implementation: Discrete Sine or Cosine Transform approach, with inhomogeneous boundary conditions handling]

Next steps

- Is this a good approach?
- Iterative approach?
- Implement and try out…

Thank you for your attention :)