KENDA-O:

Km-scale ENsemble-based Data Assimilation for high-resolution Observations

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KENDA-O:
Background, motivation, goals

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- Strategic decision (SP):
  further develop EnDA based on **4-D LETKF**, for operations
  (truly 4-D, low costs)

- Main aim for next years:

  increase quality of KENDA-LETKF analyses + forecasts (deterministic + EPS)
  particularly of cloud + precipitation in very SR (towards nowcasting)

  → increase use of high-resolution obs for convective scale
  (cloud, precip, humidity, PBL, surface → remote sensing)

  → mostly ongoing activities started in PP KENDA, different timelines

→ PP, 5 years:

  – foster coordination, collaboration, exchange of information
  – attract additional resources
  – reflect the high relevance for COSMO and its strategic goals (SP)

KENDA-O, Task 1: Further development of LETKF scheme

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Aims: further refine LETKF for optimal results in all weather situations
for deterministic forecast & EPS (possibly combine perturbations)

(1 – 2 FTE / y → Reich et al, Leuenberger, Marsigli et al., Marcucci et al., Gayfullin (PG))

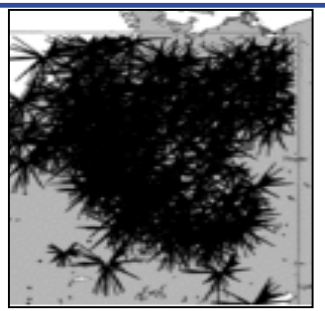
- **optimization** (ensemble size, obs errors, adaptive methods)
- **additive covariance inflation** (pattern generator, self-evolving perturbations …), physics perturbations (SPPT, intrinsic stochastic physics, perturbed parameters)
- (multi-step) **multi-scale** (with variable localisation); analysis **update frequency**

more optional / conditional:

- approaches to reduce **position errors** (e.g. pseudo obs from warped fields; use of ensemble members with lagged valid time to reduce phase errors ?)
- Kalman smoother to use obs valid after analysis time
- etc.

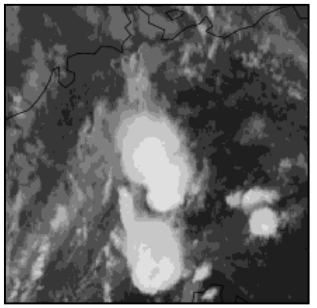
KENDA-O, Task 2 : Extended Use of Observations (1)

- pre-convective environment: no clouds
  → GNSS Slant Path Delay : humidity integrated over path from GNSS (GPS) station to satellite

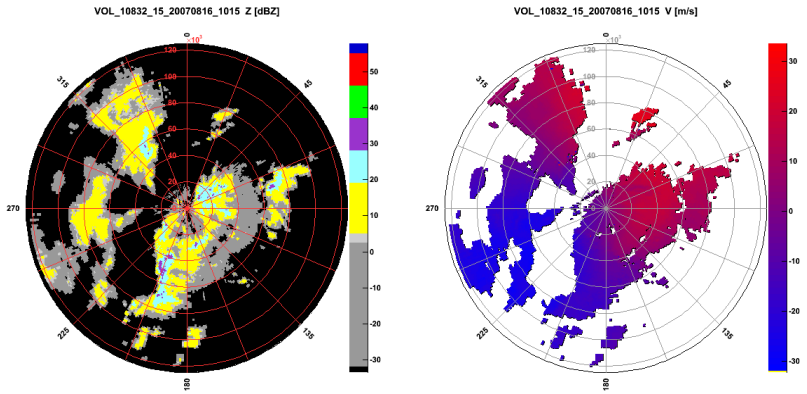


- (also: clear-sky SEVIRI WV channels, screen-level obs, ,..)

- developing convection: clouds
  → cloud top height from satellite data (Meteosat / SEVIRI)



- mature convection: precipitation
  → radar: 3-dim. reflectivity
  3-dim. radial velocity



KENDA-O, Task 2 : Extended Use of Observations (2)

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Aims: (implementation,) forecast improvements from using these observations

- 3D radar radial velocity + 3D radar reflectivity
  (Resources rather unclear at DWD: Bick (end of 2016), fixed pos 2017?, etc.; Poli)
- GPS Slant Path Delay
  M. Bender (IAFE) until 2018
- direct use of clear-sky SEVIRI WV channels (for T, qv)
  (1 PostDoc HErZ for 1y : 2016/17)
- direct use of cloudy SEVIRI IR window + WV channels (for cloud info)
  IAFE until Q4 2019 (first usable version end of 2018)
- Cloud Top Height (CTH) derived from SEVIRI
  Required 1 – 2 FTE; probably mostly missing

KENDA-O, Task 2 : Extended Use of Observations (3)

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Aims: (implementation,) forecast improvements from using these observations

- Screen-level observations (T2m, q2m, uv10m)
  (Necker, MCH, Schraff; Sept. 2017)

- Mode-S (high-resolution) wind and temperature data (from aircraft).
  (Lange, Reich, Schraff: Sept. 2016)

- Ground-based remote-sensing data, such as microwave radiometer & Raman lidar T, qv profiles, Doppler lidar wind profiles; ceilometer cloud base height)
  (A. Haefele (MCH) 0.2 FTE/y)

- use of AMSU, ATMS, IASI radiances from polar orbiting satellites,
  (also to pave way towards using MTG-IRS high-res hyperspectral radiances, 2019)
  (Marcucci; ARPA-SIM to be discussed: 1st version Sept. 2018)

KENDA-O, Task 3 : Analysis + Perturb. of Lower Boundary Fields

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- Soil moisture analysis (+ perturbations) using satellite soil moisture data

  (and possibly screen-level obs)

  – analysis level in LETKF for the soil, and
    apply strong localization for calculating the transform matrix for this level

  – use the ensemble in current stand-alone variational SMA (perturbations?)

  → Eumetsat fellowship Valerio Cardinali at CNMCA (3 years)

- other analyses (soil temperature; snow cover + depth, …):
  yet to be discussed in the future

KENDA-O, Task 4 : ICON-regional, non-Gaussianity

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- KENDA for ICON-regional: porting from COSMO to ICON
  - MEC-based LETKF (for conventional / operational obs)
    (little work: MEC (to do: grid pt. assignment for ICON) produces feedback files that can be used by LETKF)
  - efficient implementation for all data types (start Q1 2017), 2 options:
    - implement obs operators in ICON: for full 4-D LETKF
    - implement obs operators in LETKF (CASDA) code
      → less development / maintenance work, much more I/O
- (to be decided: adaptation to COSMO-EULAG)
- to address non-Gaussianity: Particle Filters (PF) and hybrid LETKF-PF
  (PF in ensemble space: already implemented for COSMO)
  (Robert et al., ETH; Potthast, DWD)