

Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra Federal Department of Home Affairs FDHA Federal Office of Meteorology and Climatology MeteoSwiss

Swiss Confederation

### **KENDA Activities at MeteoSwiss**

Daniel Leuenberger, Claire Merker, Alexander Haefele, Maxime Hervo, Giovanni Martucci and Marco Arpagaus MeteoSwiss Zurich and Payerne, Switzerland COSMO General Meeting, 9. 12. September, Rome, Italy

#### Overview

- Summary of activities during the last year
- Comparison of Nudging and KENDA driven forecasts with independent Lidar observations
- Assimilation of Meteodrone observations
- First results of KENDA-1 with a 1.1km grid



### Summary of Activities

- Changes to the operational KENDA
  - Introduction of Additive Covariance Inflation on 16.10.2018
  - Introduction of new FG check for radiosonde data in case of strong inversions on 20.12.2018
- Assimilation of MODE-S observations
  - Current obs cover only ca ¼ of our domain
  - Very small positive impact in T and wind in upper atmosphere



Discussions with Skyguide to provide Swiss Data



### Summary of Activities

- Comparison of Nudging and KENDA driven forecasts with independent Raman Lidar observations independent Raman Lidar observations
- Assimilation of Meteodrone observations in this talk
- Implemented KENDA-1 system using <u>COSMO@1.1km</u>
   later in this talk
- Assimilation of Brightness Temperatures from Microwave Radiometers Claire's talk this afternoon

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# Comparison of Nudging and KENDA

- From radiosonde verification we know that usually, KENDA driven forecast skill of T and RH are equal to Nudging driven forecast skill at and after +12h (wind: already at analysis)
- T and RH profiles from Raman Lidar are independent and available hourly and thus allow to assess the difference between the two DA systems at short lead times
- Uncertainty of Lidar obs: 10% in  $q_v$ , 0.5K in T
- Forecasts are initialized at 00 and 12UTC from KENDA det, NUDGING and NO-OBS analysis cycles
- Verification Period: JJA 2018 and SO 2018

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#### **C** Temperature

- KENDA and Nudging similar in STD at and after Analysis. Differences in BIAS longer lasting.
- Impact of assimilation on STD vanishes after ca +8h in summer, (after ca +24h in autumn)
- Impact of assimilation on BIAS longer lasting (still visible after +24h)

**MeteoSwiss** 



#### **v** Relative Humidity

- KENDA and Nudging similar in STD after +1h.
   Differences in BIAS longer lasting.
- Impact of assimilation on STD vanishes after ca +10h in summer, (after ca +18h in autumn)
- Impact of assimilation on BIAS longer lasting (still visible after +24h)

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## Summary of Comparison

- Hourly temperature and humidity profiles from Raman Lidar suitable as independent obs to validate NWP analyses and forecasts
- KENDA and Nudging driven analyses and forecasts are more similar as previously thought.
- Differences are larger and longer lasting in BIAS than in STD
- Differences are larger in humidity than in temperature
- Impact of assimilation lasts ca 8-10h in summer and 18-20h in autumn

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#### Meteodrones

- Operated by Meteomatics AG, St. Gallen, Switzerland
- Observations of T, RH, Wind and Pressure
- Profiles up to 1800m amsl
- Up to several profiles per hour



# Field Campaign

- 7 nights during Winter 2017/2018
- Observation Locations



# Assimilation Experiments

- Use of the operational MeteoSwiss COSMO-KENDA system
  - 2.2km grid size
  - LETKF (Local Ensemble Transform Kalman Filter)
  - 40 ensemble members
- Reference Experiment without Meteodrone Obs
- Experiment with Meteodrone Obs

	<ul> <li>Meteodrone observations are fed into COSMO as</li> </ul>															
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# Summary of Results

 Up to now, only cloudiness has been investigated and subjectively compared with a cloud product from MSG Satellites

Date	Weather Situation	Impact on COSMO cloud analysis	Duration of cloud forecast impact
2017-12-05	High pressure system, low Large-Scale Forcing	Positive	< 3h
2017-12-06	High pressure system, low LSF	Strongly Positive	12h
2018-02-13	Border of high pressure system, medium LSF	Neutral	-
2018-02-14	Border of high pressure system, medium LSF	Neutral	-
2018-02-15	Frontal passage, strong LSF	Neutral	-
2018-02-26	Border of high pressure system, medium LSF	Neutral	-
2018-02-27	Border of high pressure system, low LSF	Strongly Positive	< 3h
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### Impact on Analysis Mean Cloudiness





### Impact on Analysis Mean Cloudiness



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#### Impact of Meteodrones on T and QV

2017-12-06 23UTC, after 1 hourly assimilation update



#### Impact of Meteodrones on T and QV

2017-12-07 03UTC, after 5 hourly assimilation updates



# The COSMO Fog Dissipation Problem

- Usually, COSMO dissolves the fog too quickly during the forecast
- This model problem can obviously not been solved with additional observations, but is currently been investigated in the course of the PhD of Stephanie Westerhuis



## Forecasts of Cloudiness

#### Without Meteodrones



With Meteodrones



Satellite Observation

#### 2017-12-07 00UTC +00h





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# Forecasts of Cloudiness

#### Without Meteodrones



With Meteodrones



Satellite Observation

#### 2017-12-07 00UTC +06h





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# Forecasts of Cloudiness

#### Without Meteodrones



With Meteodrones



Satellite Observation

#### 2017-12-07 00UTC +09h





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#### Future MeteoSwiss NWP System



#### C KENDA-1

- 40 Ensemble member
- 1.1km grid size
- Difference in settings to operational KENDA
  - grib2
  - SST and T\_SO perturbations
  - flake
  - SPPT with reduced amplitude (stability reasons)
- Running continuously since 1.7.2019

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#### First Validation with Radiosondes Period of 10. – 21.8.2019



# Summary I

- KENDA and Nudging driven forecasts behave similarly when compared to independent Lidar obs (T and RH) in terms of STD
- KENDA driven forecasts have larger RH BIAS than Nudging driven forecasts. Difference lasts up to 10h
- Impact of assimilation lasts ca 8-10h in summer and 18-20h in autumn
- Meteodrone observations can have a very positive impact on COSMO analyses and forecasts
- In one investigated case the cloud forecast impact lasts up to +12h

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# Summary II

- KENDA-1 works as expected/hoped
- Will need to find ways to speed up the KENDA-1 cycle, currently takes ca 30min per cycle...
  - optimizations of nudging and LHN running on GPU have already been identified
  - revisit single precision version of COSMO (nudging, terra, flake)
  - Optimize number of CPU cores / compiler flags, etc. for LETKF



### **Outlook**

- KENDA-1 speed up and other improvements
- Assimilation of new obs types:
  - MW Radiometer BT (work of Claire)
  - wind profiles from wind lidar (1y position starting Oct 2019)
  - T and q profiles from Raman Lidar and meteodrones (work towards opr use)
  - Radar volume data or Satellite MTG T/q profiles (TBD) (2y position starting Jan 2020)
  - T2m and RH2m

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