Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

Overview of DA activities in RC LACE

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DHMZ SHMÚ ARSO METEO Slovenia OMSZ ZAMG ROMANIA ANM

Contents

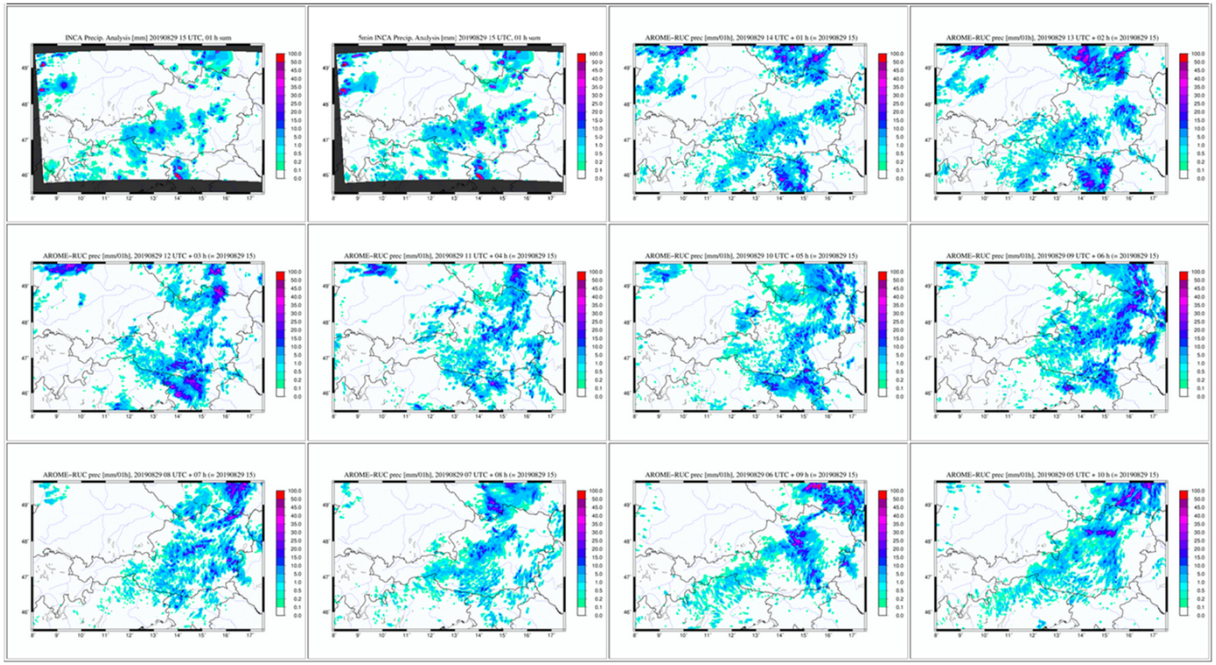
- Evolution of operational systems (RC LACE)
- Algorithmic developments
- Pre-operational hourly RUC installations
- Background errors
- Variational bias correction in LAM
- Advances in observation use
- Assimilation of radar observations
- Synop data
- GNSS data
- Mode-S observations
- Land surface observations
- New observations

Evolution of operational DA suites

- LACE countries run ~10 assimilation systems with ALADIN model, using either AROME or ALARO physical package, at 1.2 – 8 km resolution
- Methodology:
- Typical 3D-Var for atmospheric and OI for soil fields
- Blending techniques (BlendVar, DF blending, CZ, SK)
- Forecast enhanced by nudging (AT)
- 3-6 hour assimilation cycle (1h pre-operational)
- Large variety of observations provided by OPLACE
- Conventional (surface, aircraft) and satellite data (radiances, AMVs scatterometers)
- Local sources: additional surface data in LACE area, Mode-S, GNSS

Hourly-updated DA systems

- AROME-RUC at 1.2 km (AT) to be operational soon
- Final setup includes two 1h cycles:
- IAU (Brousseau) cycle (applied over 45 min)
- Nudging cycle: 30-min LHN (Stephan, 2008), 20-min FDDA (Liu et al. 2006)

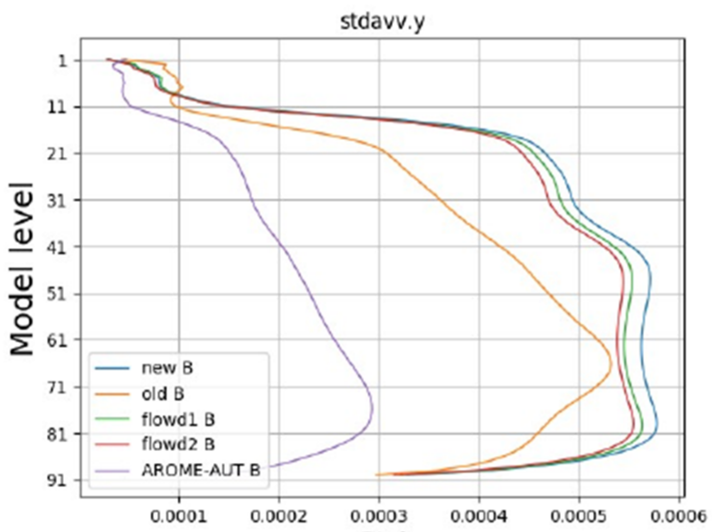


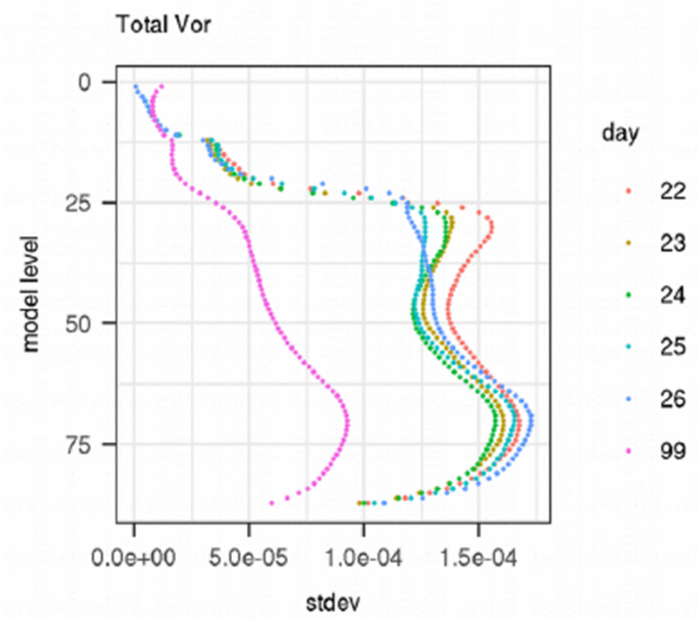
Precipitation analyses (first two frames

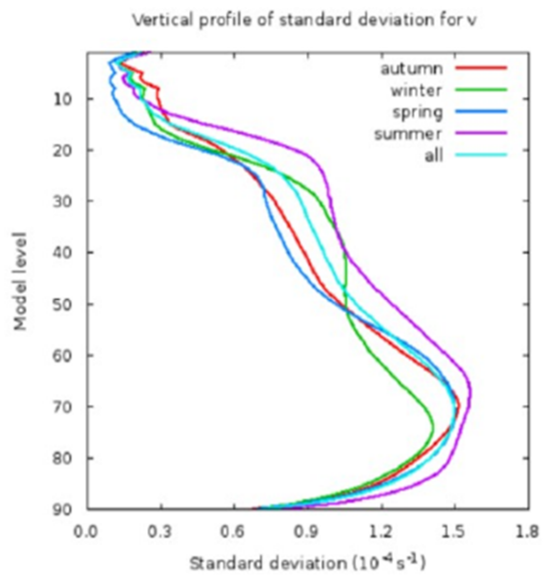
Properties of background errors in 3D-Var

- Several re-computations based on EDA technique (favorable for LAM, Stanešić et al., 2019) for models setups with improved resolution
- Comparative studies of seasonal and daily variability of

Vorticity σ_b vertical profile



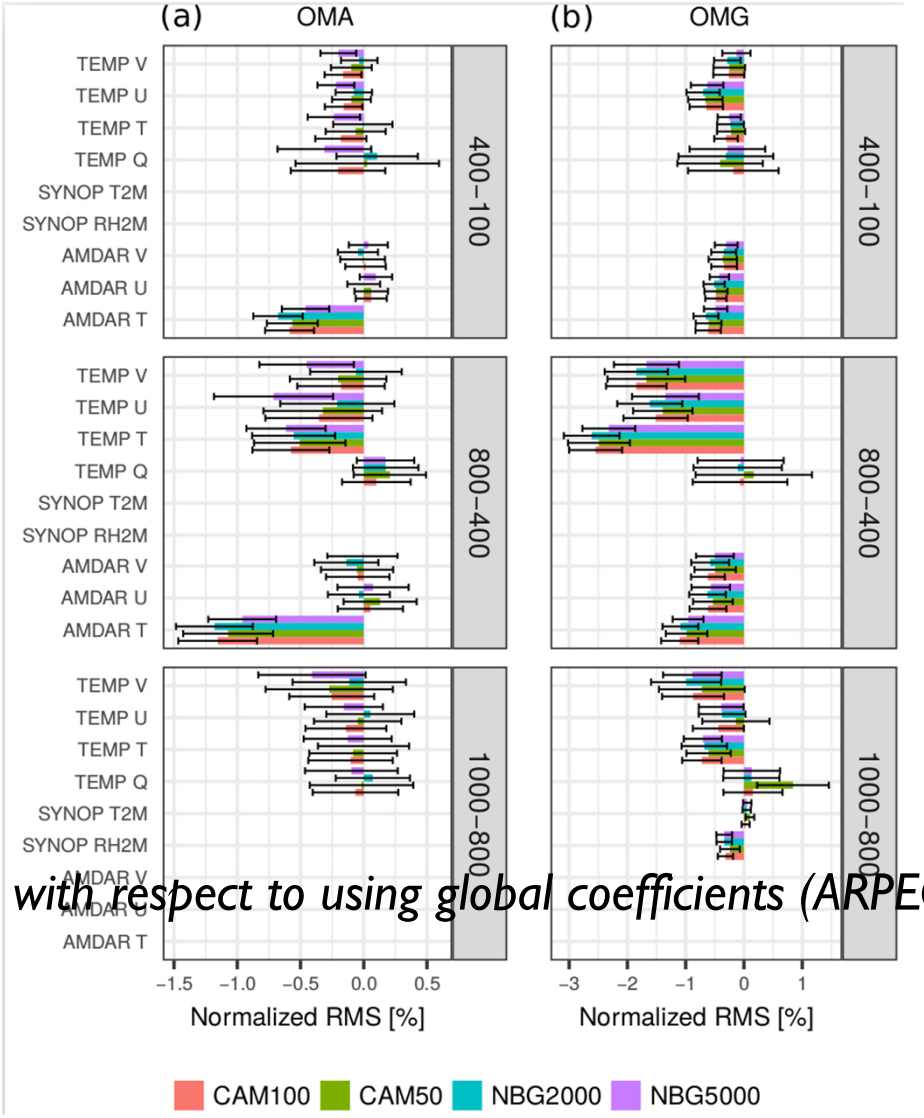




a: EDA vs. DSC B for 1.2 km AROME-RUC | Slovenia: EDA vs. DSC, daily variability, 4 km ALARO | Hungary: seasonal variability, 2.5 km Al

Diagnosis of VarBC in LAM

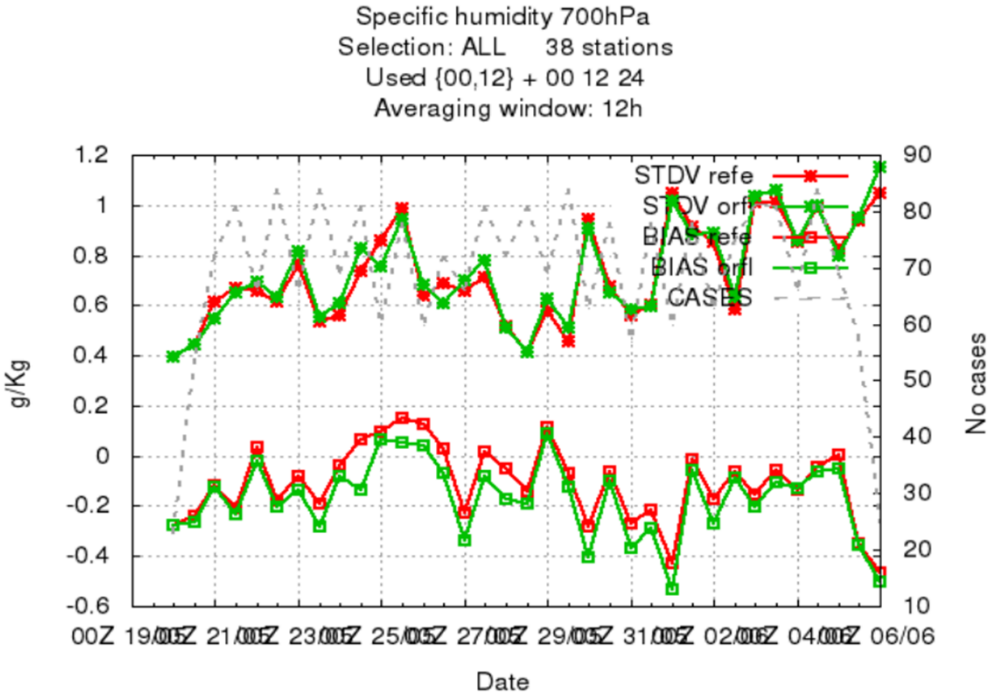
- Several experiments with adaptivity of predictors for radiances (PhD study P. Benaček)
- Static tuning of the adaptivity
- Dynamic adaptivity
- Tuning improves OMG in the assimilation cycle, both methods outperform the reference using global coefficients



Reduction of RMS of tuned VarBC experiments with respect to using global coefficients (ARPEGE).

Advances in assimilation of OPERA reflectivity

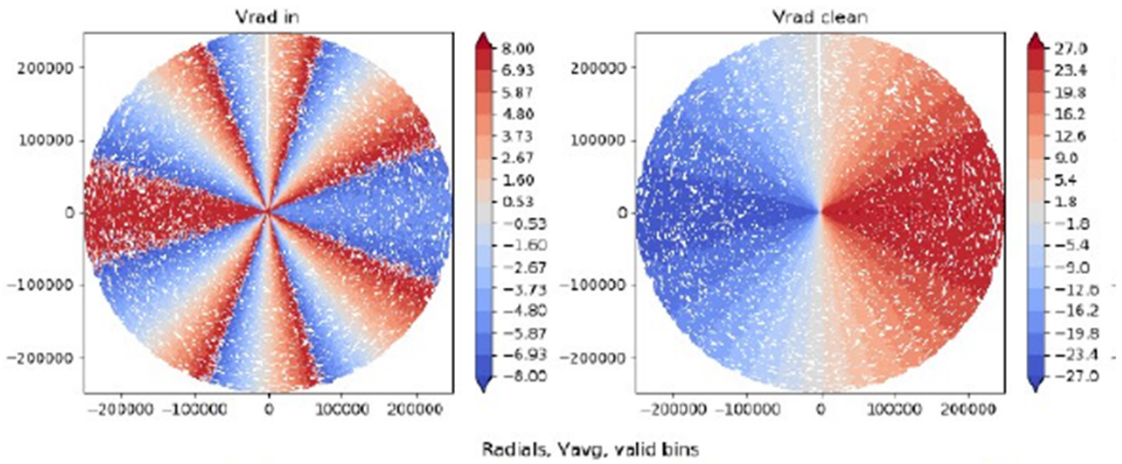
- Software for homogenization of radar data set (HOOF)
- Consistency check (data structure, quantities, quality indices, metadata)
- Data reduction
- Driven via namelist
- Enables joint processing of ~150 radars
- First impact studies (SI)
- Assimilation of reflectivity (1D+3D-Var) improved surface scores



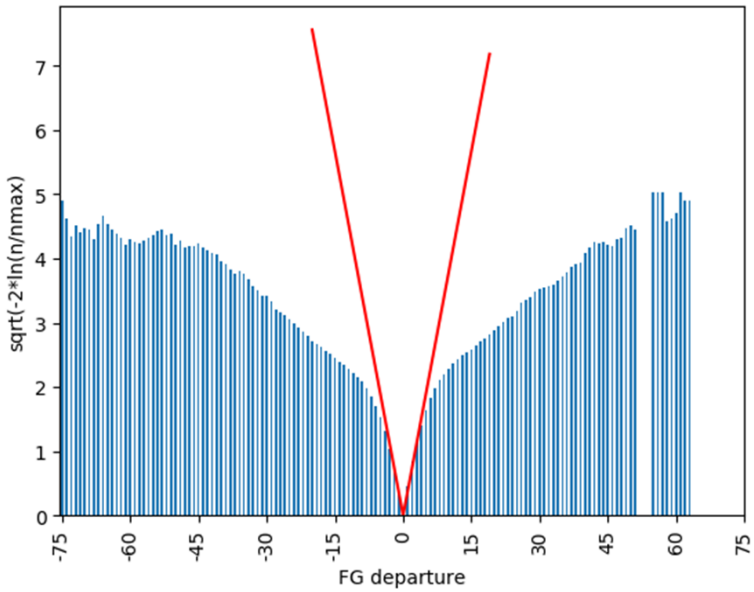
Impact of assimilated OPERA radar reflectivity (green) on 700 hPa hu

Radar data assimilation – Doppler winds

- Austria: Var-QC applied to the Doppler winds (and also pseudo humidity profiles). GE limit we use seems to be too large.
- Slovenia: dealiasing tested on synthetic and real cases (CINDA - He et al., torus mappin



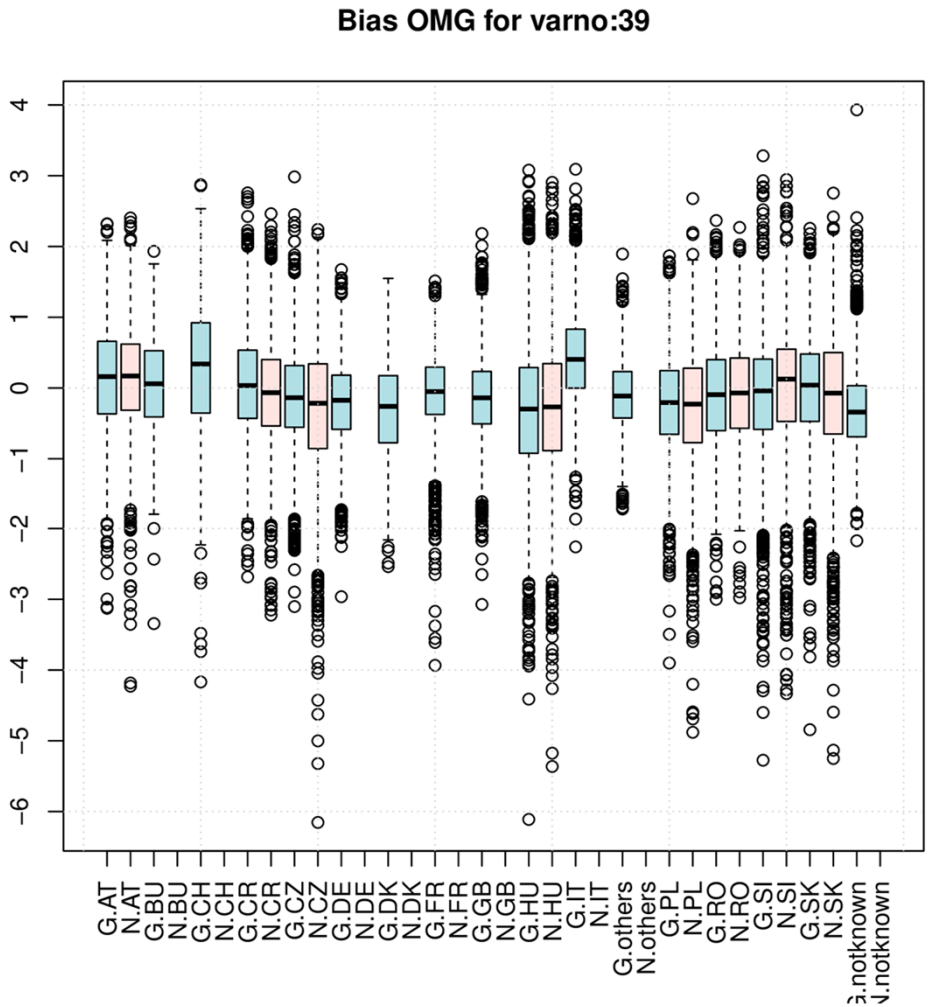
Dealiasing of synthetic Doppler wind data with noise.



Finding the optimal gross-error limit for Var-QC.

Assimilation of Synop and national surface observations

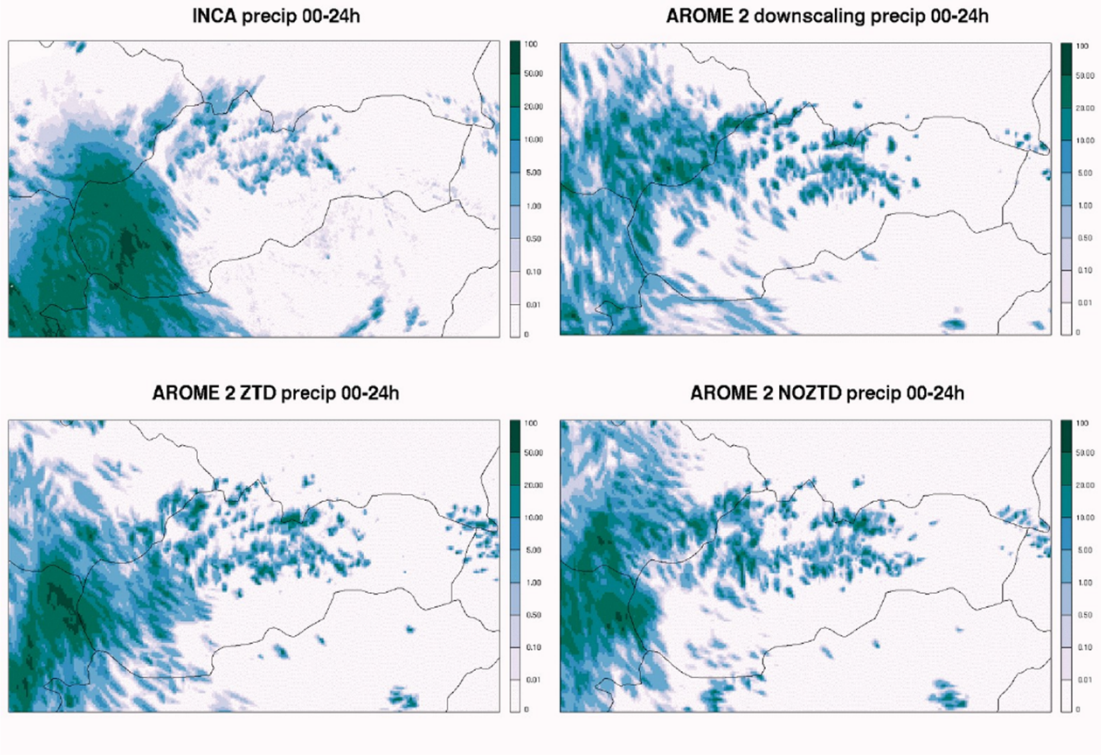
- CZ: Quality assessment of 3 months of Synop/national data to construct a local blacklist
- Revealed several problems with metadata and format
- Bias is slightly larger for Swiss and Italian stations, otherwise national and Synop data are comparable.



Distribution of hourly bias per country and data type aft

Assimilation of GNSS observations - ZTD

- LACE plans to use ZTD (E-GVAP) data, will be distributed to OPLACE
- First experiments with Slant Delays
- Slovakia: lc … with focus on heavy preci…
- Slovenia: Ir … ta differ and give the opp… ve different errors.



INCA

AROME-SK downsc…

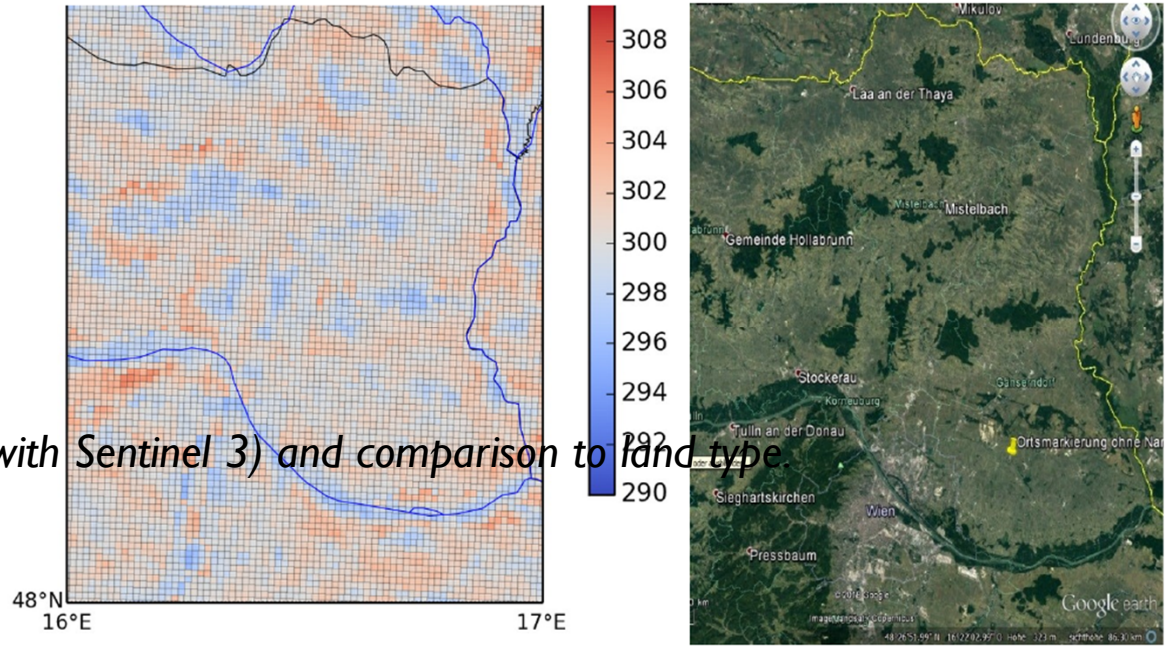
AROME-SK ZTD

AROME-SK No ZTD

Positive impact of ZTD assimilation on a precipitation case in Slovakia.

Surface assimilation – extended Kalman filter

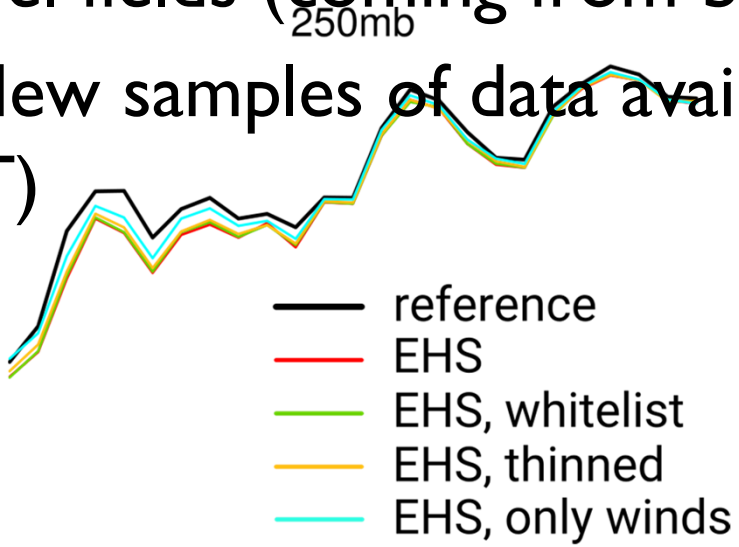
- Austria: Assimilation of LST (down-scaled MSG product using Sentinel-3 data)
- Slovakia: Prototype of EKF using gridded conventional observations (analysis).

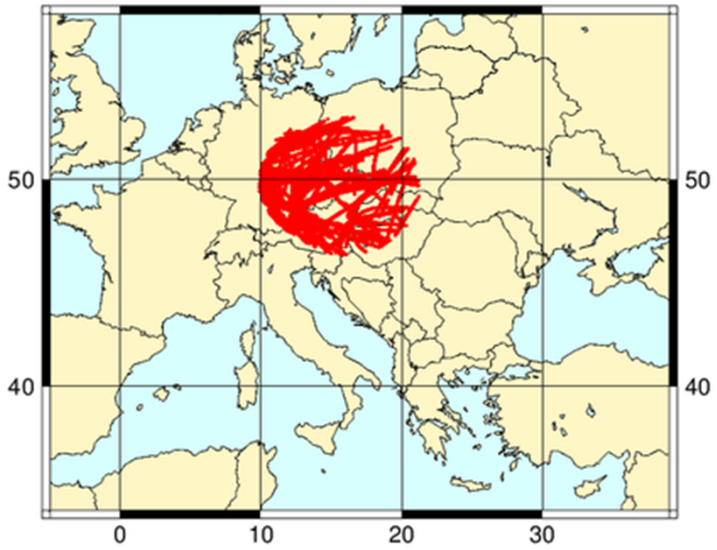


Example of downscaled MSG data (with Sentinel 3) and comparison to land type.

Mode-S observations

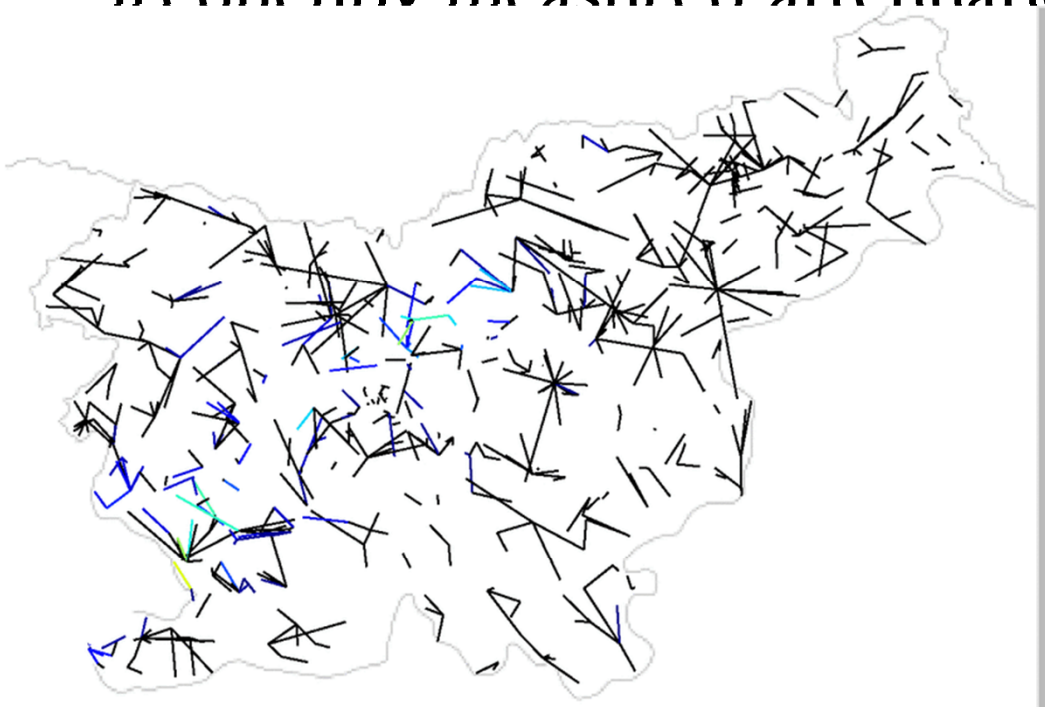
- Mode-S data set can be seen as crowd-sourced data
- In LACE, both EHS (KNMI) and MRAR (CZ, SI) types are disseminated and used
- Whitelisting approach was implemented for MRAR
- All studies showed small, but consistent impact on high level fields (coming from both wi
- New samples of data available o , AT)

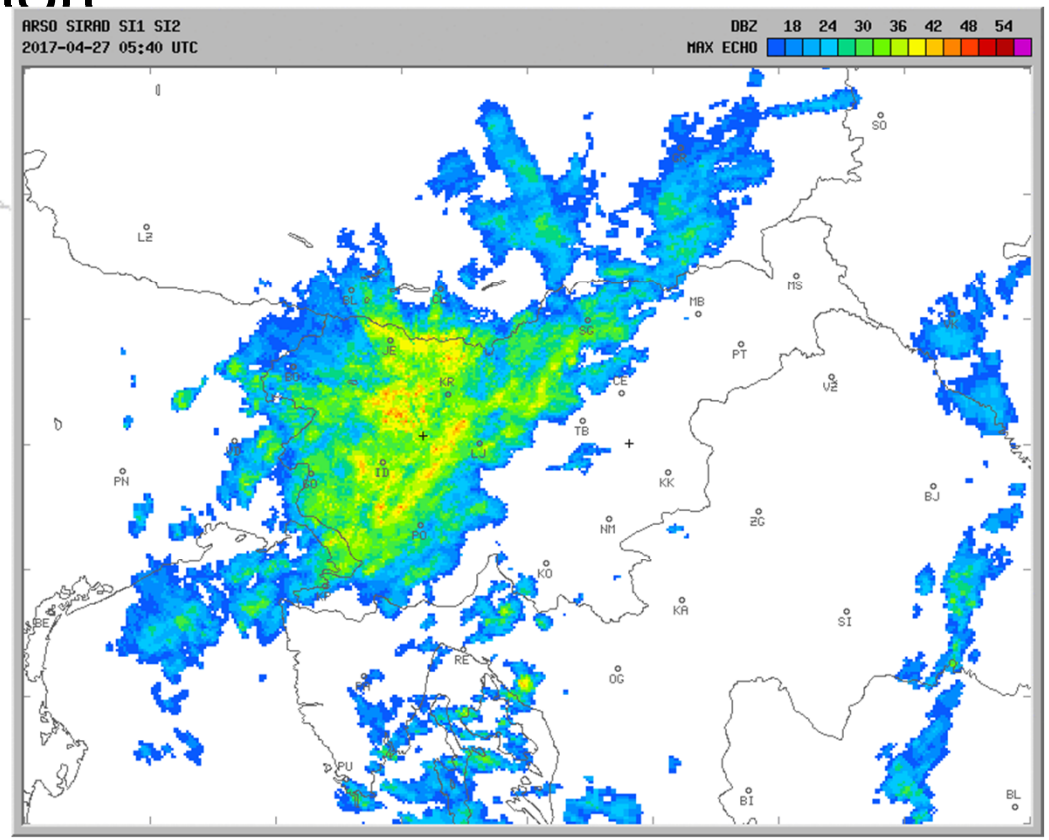




Crowd-sourced data: attenuation in telecommunication microwave links

- Link is a connection between transmitting and receiving antenna in mobile network (usually both-sided) with frequently measured attenuation



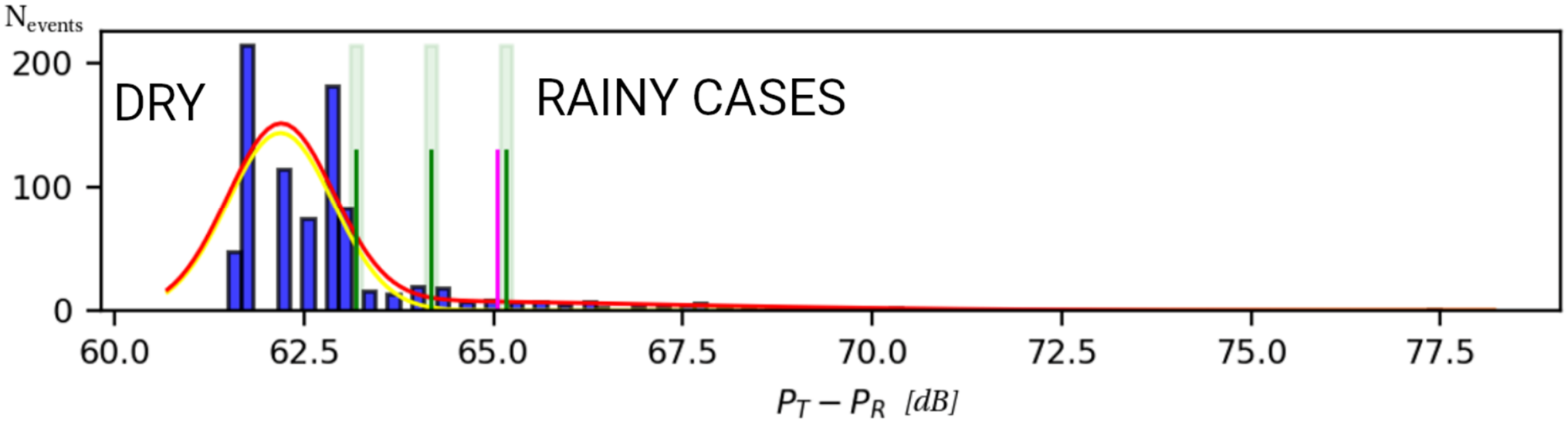


Attenuations for links in a mobile network compared to max. radar reflectivity.

Crowd-sourced data: attenuation in telecommunication microwave links

- Measurement is difference between transmitted and received

$$P_T - P_R = \Delta P = La\langle R\rangle^b + f_W(R) + B$$



Histogram of attenuation [dBZ] in one example inter-antenna link.

Outlook

- Upper-air DA: numerous 1h RUC setups in 2020
- Further progress on radar assimilation (impact studies with reflectivity, towards solution for wind)
- Further tests with additional observations (OSCAT, high res. AMVs, ATMS radiances, GNSS-derived observations: ZTD, STD, GPS-RO), extension of Mode-S derived data, microwave attenuation in telecommunication links.
- Surface DA: towards operational EKF

- Questions? (benedikt.strajnar@gov.si)