Improving initial conditions in a convection-permitting LAM

ENDI KERESTURI, YONG WANG, FLORIAN MEIER, FLORIAN WEIDLE, CHRISTOPH WITTMANN
ZAMG - ZENTRALANSTALT FÜR METEOROLOGIE UND GEODYNAMIK
Motivation

- LAMs are less effective at representing large-scale (e.g., synoptic) flow
  - Include large scale information from global model
    - Superior data assimilation
    - No lateral boundaries
State of the art

- **Digital filter blending method**
  - Brožková et al (2001)
  - Low-pass digital filter -> blend a large-scale analysis with small scales of LAM
  - Czech Republic, ALADIN-LAEF

- **Include global model information directly into limited area variational assimilation**
  - Guidard and Ficher (2008)
  - **Jk blending method**
  - Adopted to HIRLAM by Dahlgren and Gustafsson (2012)
  - Ensemble Jk method (Keresturi et al., submitted to QJRMS)
Theoretical background – Jk 3D-Var

**Cost function:**

\[ J(x) = \frac{1}{2} (x - x_b)^T B^{-1} (x - x_b) + \frac{1}{2} (y - Hx)^T R^{-1} (y - Hx) \]

- \( J_b \)
- \( J_o \)

**Cost function in Jk blending method:**

\[ J(x) = J_b + J_o + \frac{1}{2} (x - x_{ls})^T V^{-1} (x - x_{ls}) = J_b + J_o + J_k \]

- \( J_k \)
Model setup

- **LAM: AROME**
  - Equation system: nonhydrostatic fully compressible Euler
  - Grid size: 2.5 km
  - Vertical levels: 90
  - No deep convection parameterization
  - Jk blending

- **Driving model: ECMWF**
  - Grid size: 16 km
  - Vertical levels: 91
  - Jk truncation: 135 km
Verification

- July and August 2016
  - 12 UTC runs
  - Bootstrapping
- Surface – stations and INCA analyses
- Upper air – ECMWF and GFS analyses
Results – Upper air verification (500 hPa)

(a) RMSE - Temperature [K] - 0500
(b) RMSE - Relative Humidity [%] - 0500
(c) RMSE - Wind Speed [m/s] - 0500

(d) RMSE - Temperature [K] - 0850
(e) RMSE - Relative Humidity [%] - 0850
(f) RMSE - Wind Speed [m/s] - 0850
RMSE - MSLP [hPa] - 0001

RMSE - Temperature [K] - 0001

RMSE - Relative Humidity [%] - 0001

RMSE - Wind Speed [m/s] - 0001
RMSE +006 h - July, 2016

MSLP

RMSE +006 h - August, 2016

MSLP

Temperature

°C

Forecast Day

hPa

Forecast Day
Case study: 11. 7. 2016.
Conclusion

- Global model information included into convection permitting 3D-Var
- Positive impact on upper air variables
- Positive impact on surface pressure and precipitations
- Improved model performance in some cases
Future plans at DHMZ

- Test Jk blending in ALADIN/HR
- Test AROME (2 km)
- Regarding ensembles...
  - Test AROME EPS (ensemble Jk method)
    - As soon as enough computer power is available...
  - ALADIN-LAEF (5 km) will be available soon