Doppler Wind Lidar Improves 1999 Christmas Storm Forecasts

Ad.Stoffelen@KNMI.NL
Gert-Jan Marseille
Jan Barkmeijer
Overview

- SOSE cycling concept

- Christmas storm (Martin)

- Conclusions
Definition of an improved initial state for one cycle

Model State
\( t = 0 \)

Forecast Run
\( t = 0 \rightarrow 48 \text{ h} \)

Forecast
\( t = 48 \text{ h} \)

Key Errors
\( t = 0 \)

Sensitivity (\( B \) norm)
Computation
\( t = 48 \text{ h} \rightarrow 0 \text{ h} \)

Forecast Error
\( t = 48 \text{ h} \)

Analysis
\( t = 48 \text{ h} \)

Updated State
\( t = 0 \)

Analysis
Forecast Run
\( t = 0 \rightarrow 48 \text{ h} \)

Better Forecast
\( t = 48 \text{ h} \)
Single Cycle SOSE

Analysis is used as pseudo-truth to simulate DWL
SOSE cycling

- SOSE improvements propagate in the forecast
- ~12 hour forecast gain over the full forecast range

➢ Subsequent cycles may reinforce the forecast gain and be constructive
SOSE single cycle vs. cycling mode

- The synthetic sensitivity structures are added to the FG of each cycle in the Pseudo-truth run.
- The synthetic control run minus Pseudo-truth run differences evolve to typical analysis error amplitude (and spatial structure), i.e., the evolving sensitivity structures grow fast, but are constrained by observations in the subsequent cycles.
- Despite the synthetic nature of the sensitivity structures, O-B statistics and rejections are very similar for the control run and Pseudo-truth run, i.e., the added and evolved synthetic variance appears to be in equal parts correlated and uncorrelated with the observations as for SOSE single cycle structures.

- The SOSE cycling pseudo-truth represents realistic unobserved atmospheric structures.
SOSE cycling mode forecast improvement

- Z500 (m) forecast error, VT: 28 December 1999 12 UTC
- Forecast initiated with (1) OPER analysis, (2) pseudo-truth from SOSE single cycle and (3) pseudo-truth from SOSE cycling mode

The pseudo-truth generated in SOSE–cycling mode gives significant larger forecast improvement over Europe (41%) than in single-time mode (24%) (the DA system is capable to propagate sensitivity structures) CYCLING WORKS !!
DWL scenarios: Tandem Aeolus

- Same dawn-dusk orbit and instrument, but phase difference 180 degrees (45 minutes)
- Minimum of observation coverage redundancy; great heritage (low cost)
- Twice as many HLOS profiles as Aeolus

6-hour orbit started at the equator
**DWL simulation**

- Orbit simulation
- Interpolation of pseudo-truth fields to DWL locations
- LIPAS
  - Input: atmospheric scene at laser shot location
  - Aerosol backscatter variability according to Vaughan database statistics
  - Cloud scheme to simulate laser penetration
  - Instrument error; no bias
  - Assumptions:
    - Advanced processing to discriminate between cloudy and cloud-free returns
    - Two wind solutions from Mie and Rayleigh channel, the best is used.
  - Output: Simulated profiles of HLOS winds, including error statistics in BUFR format
**DWL impact on analyses**

- Analysis improvement at forecast initial time of ’99 Christmas storm Martin (26 Dec. 1999 12UTC) for the Tandem-Aeolus scenario

**Single-time SOSE; 6 hours DWL obs.**

**SOSE – cycling; 84 hours DWL obs.**
Verifying analysis

SOSE forecast

GOS forecast

GOS + DWL forecast
**EPS storm probability forecast**

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<td>Pseudo-truth</td>
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- Three times more storm members in DWL (30%) than in noDWL (10%) over France and Gulf of Biscay
- DWL storm locations are better situated than noDWL
SOSE-cycling conclusions

• The SOSE method in cycling mode works !!
• Further analysis and experimentation is needed with cycling SOSE
• A tandem Aeolus is able to improve the forecast of fast cyclogenesis, such as the extreme Christmas ’99 storm Martin
• More DWL experimentation would reveal the importance of wind profile coverage, perspective and quality in cycling mode

➢ SOSE in cycling mode is a useful tool to assess the added value of prospective observing systems w.r.t. the current GOS (in real extreme events)