ISDA-Online

June 11, 2026: 15-17 UTC

“Assimilation of High Frequency/Resolution Observations”

Organizers and Conveners: ***Hristo Chipilski*** *(Florida State University, US),* ***Minghua Zheng*** *(University of California San Diego, US),* ***Guannan Hu*** *(University of Reading, UK),* ***Tobias Necker*** *(ECMWF, Germany)*

The rapid growth of high-frequency, high-resolution observations is transforming how we estimate key components of the Earth system. Platforms such as satellites, ground-based profilers, radars, lidars, unmanned aerial systems (UAS), and targeted observations now deliver unprecedented detail across scales. This session invites contributions on the integration of these observations into Earth system models, emphasizing their impacts as well as the unique opportunities and challenges they present for modern data assimilation.

Program: (UTC)

15:00 – 15:05	**Welcome**
15:05 – 15:25	**Modelling and accounting for spatially correlated errors at ECMWF and the UK Met Office**
(17’ + 3’)	Bhatt et al.
15:25 – 15:45	**Potential of ground-based DIAL and MWR profiling networks and their synergy with MTG-IRS**
(17’ + 3’)	Raabe et al.
15:45 – 16:05	**Insights from assimilating a network of 12 Doppler wind lidars in the ICON-D2 model**
(17’ + 3’)	Thomas et al.
16:05 – 16:25	**Lightning data assimilation experiments over Argentina**
(17’ + 3’)	Cutraro et al.
16:25 – 16:45	**Rapid update mesoscale data assimilation for a mid-latitude high-impact weather event**
(17’ + 3’)	Alfie et al.
16:45 – 16:50	**Closing: Information on upcoming sessions**

Please note:

- When you login to the session before 15:00 UTC, and everything is quiet, this is most likely because we muted the microphones.
- The times in UTC are approximate. In case of technical problems, we might have to change the order of the presentations.
- **Time Zones**: 15 – 17 UTC
  Europe: 04 – 06 pm BST (London) | 05 – 07 pm CEST (Berlin)
  Asia/Australia: 11 – 01 am CST (Shanghai) | 00 – 02 am JST (Tokyo) | 01 – 03 am AEDT (Sydney)
  Americas: 08 – 10 am PDT (San Fran.) | 09 – 11 am MDT (Denver) | 11 – 01 pm EDT (New York)

Modelling and accounting for spatially correlated errors at ECMWF and the UK Met Office

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In operational data assimilation (DA), only a small proportion of available satellite observations are used, partly due to unaccounted-for spatial observation error correlations. Operational centres typically apply strategies such as spatial thinning and inflated observation error variances, limiting the exploitation of high-resolution data and the representation of small-scale features. This study presents estimates of spatial error correlations for AMSU-A all-sky radiances using background and analysis departure diagnostics from ECMWF and the UK Met Office systems. Strong spatial observation error correlations are found for tropospheric channels over land, with length scales of 75-125 km, while stratospheric channels and observations over ocean show negligible correlations. These correlations are likely associated with inadequacies in modelling surface emissivity, surface skin temperature, clouds, and precipitation. We also investigate a parallel implementation of a correlated observation error covariance matrix with increased AMSU-A observation density using idealised experiments. Performance is evaluated in terms of computational cost, minimisation convergence, and retention of small-scale features in the analysis. These results provide a framework for assessing the feasibility of implementing correlated observation errors in operational systems such as OOPS.

Potential of ground-based DIAL and MWR profiling networks and their synergy with MTG-IRS

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The demand for accurate weather forecasts is increasing with more frequent high-impact weather events and rising importance of renewable energies. However, convection-scale numerical weather prediction still lacks precise initial conditions, particularly in atmospheric boundary layer (ABL). To fill this observational gap, ground-based remote sensing sensors measuring temperature and humidity, such as microwave radiometers (MWR) and water vapor lidars (DIAL), have been developed and are suitable for network operation. In addition, the Infrared Sounder aboard Meteosat Third Generation (MTG-IRS) will provide temperature and humidity fields over Europe every 30 minutes.

This contribution presents progress in investigating the potential of ground-based profiling networks, focusing on DIAL and MWR and their synergy with MTG-IRS.

First, we present a computationally cheap Ensemble Sensitivity Analysis (ESA) set-up to evaluate the impact of different DIAL networks on ICON-D2 forecasts. An ESA quantifies changes in variance of a forecast metric ensemble due to assimilating more observations. First results for two summer afternoon cases show that additional DIAL observations reduce the model ensemble variance on average by 5.5 to 7 %.

Second, we present the VITAL II campaign (Vertical profiling of the troposphere: Innovation, opTimization and AppLication), planned for summer 2026 in the Cologne area. Seven sites will host ground-based systems, including DIAL, Doppler lidar, and MWR. We aim to improve the accuracy and resolution of MTG-IRS temperature and humidity profiling in the ABL and under cloudy conditions by combining it with the ground-based in-situ, MWR, and DIAL observations. Assimilation experiments using improved profiles are planned.

Finally, we outline upcoming assimilation experiments combining zenith-pointing DIAL and scanning MWR observations to exploit synergies between high-resolution vertical profiles and horizontal water vapor gradient information.

Insights from assimilating a network of 12 Doppler wind lidars in the ICON-D2 model

Julia Thomas[1], H. Reich[2], T. Steinert[2], G. Geppert[2], K. Stephan[2], M. Borne[1], P. Gasch[1], N. A. Carrassi[3], J. Keller[2], P. Knippertz[1], and A. Oertel[1]

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The mesoscale variability of wind is poorly captured by conventional observation systems, particularly in complex terrain. To improve the understanding of summertime flow conditions over and around the Black Forest and Swabian Jura mountain ranges in southwest Germany, the ‘Swabian MOSES’ 2023 field campaign was conducted in June, July and August 2023. The ultimate goal was to better understand the initiation of thunderstorms in that region, which is particularly prone to hailstorms.

A key component of the campaign was a network of 12 Doppler wind lidars (DWLs) placed in and around the Black Forest mountains. We assimilated DWL retrieved profiles of horizontal wind at 100m vertical resolution up to around 4km in addition to operational and other campaign observations into the regional forecasting system of Deutscher Wetterdienst. We performed an hourly cycling using the ICON model at 2 km resolution coupled to the Kilometer Scale Ensemble Data Assimilation system (KENDA) that is based on the Local Ensemble Transform Kalman Filter (LETKF). With this setup, we built a campaign (CMPG) and a control (CTRL) reanalysis. In CMPG, the DWLs make up 25% of all observations assimilated in the area of interest.

Comparing CMPG and CTRL reveals that the DWL observations lead to systematic differences in wind speed (up to 0.5 m/s) and direction (up to 2°). This wind bias is further supported by comparing reforecasts initialized from CMPG and CTRL. Moreover, using the Partial Analysis Increment method (Diefenbach et al., 2022), we reconstruct the influence of the DWL observations on flow and temperature. Overall, we highlight the added value of assimilating DWL wind profiles in addition to radiosonde and radar wind profilers and discuss possible sources of the identified bias by stratifying the analysis increments by time of day and flow direction. Finally, we address open questions about the appropriate choice of the localization radius and the degree of thinning.

Lightning data assimilation experiments over Argentina

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Radars provide good quality mesoscale observations but have different shortcomings, such as short-range coverage and attenuation; additionally, the network development and maintenance are expensive. In Argentina in particular, there has been an expansion of the radar network in recent years; however, this is insufficient to provide coverage of the entire territory. Lightning observations are a good candidate to address these gaps, as many studies have shown that their assimilation in models has an impact almost equivalent to that of radar. For that reason, we run different assimilation experiments with a coupled 4 km resolution WRF-LETKF system using a novel deep-learning-based observation operator and synthetic lightning observations with a 10 minute frequency generated from a higher resolution WRF forecast under independent initial and boundary conditions.

In the presentation, the results obtained from a variety of experiments will be shown. From the assimilation of null observations for suppressing spurious convection to the use of humidity pseudo-observations to initiate convection that wasn't forecasted, all analyses represent a clear improvement with respect to a forecast without data assimilation. These results motivate further investigations, like the joint assimilation of lightning and radar observations and the development of a real case experiment with the aim of implementation in the Argentinian National Meteorological Service data assimilation system.

Rapid update mesoscale data assimilation for a mid-latitude high-impact weather event

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In this work we use the WRF-LETKF system to investigate the impact of radar data assimilation at convective-allowing resolution upon the representation of the convection organization for a case study on March 19, 2024, which involved a heavy rain event and urban flooding in the city of Buenos Aires, Argentina.

We perform numerical experiments over a large domain in the central region of Argentina. From the analyses generated by assimilating radar data, short-term ensemble forecasts are initialized using the same spatial resolution as the analysis. All experiments assimilate radar observations from the Argentinean radar network as well as data from automatic weather stations. We performed experiments changing the assimilation frequency from 1 hour to 5 minutes and the horizontal resolution from 4 km to 2 km.

The results show that the highest-resolution forecasts perform better in the representation of isolated convection. However, it has more spurious convection associated with it than the lower resolution, particularly in areas outside the radar coverage. Higher-resolution experiments provide a more realistic representation of the features associated with the organized convection, both in the analysis and subsequent forecasts. Moreover, those experiments assimilating radar data hourly fail to appropriately capture the dominant convective organization and to provide a spatio-temporally coherent representation of the dominant convective organization modes.