

International Earth Surfaces Working Group (IESWG) - 6th meeting report

Meeting held 11-13 June 2025, Deutscher Wetterdienst (DWD), Offenbach, Germany.

Local Organizers: Martin Lange and Helmert Jürgen, DWD.

Report prepared by Christoph Rudiger (ECMWF), Clara Draper (NOAA), and Benjamin Ruston (JCSDA).

Included: Appendix A, Meeting Agenda.



The 6th in-person meeting of the IESWG took place over three days and was hosted by the DWD in Offenbach. It brought together experts from various meteorological and research institutions to discuss recent developments in land surface modelling and data assimilation (DA). The meeting highlighted the ongoing investment into model development, integration of satellite data, and the development of flexible DA frameworks across global centres. Most importantly, it underlined the wish to maximise the value of existing Earth observation products (be it at L1 or L2), and to make more use of existing observations that have not been considered in the past.

A total of 40 people attended in person with a further 25 attending online. Attendees came from CGMS member agencies, such as NOAA, NASA, JMA, CMA, and EUMETSAT, as well as weather centres, including ECMWF, UK MetOffice, Météo France, DWD, and FMI. The

meeting was organised into talks, two breakout sessions, as well as a plenary on the third day (see Appendix A for the agenda).

Summary of presentation sessions

Representatives of eight operational centres provided an update on their activities with a strong focus on their current DA activities and recent achievements. All talks highlighted the improvements in their forecast skills when assimilating data into their models. The presentations were split evenly across atmospheric DA (OI of pseudo-observations, such as 2m temperature and humidity; IASI profiles), as well as direct land surface observations, in particular soil moisture (where most use EUMETSAT's ASCAT SSM product, with some also using SMOS/SMAP) and snow (NOAA, ECCO and ECMWF). With regard to the latter, NOAA showed that the assimilation of VIIRS snow cover provided better results than those with IMS. Similarly, ECMWF showed the improvement of assimilating observed soil temperature to reduce errors in the diurnal range and timing of the modelled skin temperatures.

All centres noted the concern about continuation of passive microwave missions for soil moisture observations, in particular the possible decommissioning of SMAP by NASA, as it performs better than ESA's SMOS due to better RFI filtering. ECMWF added that the assimilation of observed LAI helped reduce errors in the 2m temperature and relative humidity forecasts, due to an improvement in the latent and sensible heat fluxes coming with a better representation of the vegetation.

Most centres indicated a wish to expand on the number of observed variables, in particular additional types of snow (i.e. snow water equivalent, depth) and vegetation observations. This would not only be for the assimilation of the observations into the models, but also more fundamentally to improve model parameterisations or for the development of observation-driven forecasting systems.

It was also noted that there is a trend towards the direct use of L1 observation in particular for DA, which becomes more achievable due to ML/AI systems that can replace traditional physical algorithms. However, it was also emphasized that L2 products will remain important, in particular for the development and parameterisation of existing physical land surface models and the evaluation of model performances and to replace the climatologies currently in use, especially for vegetation and streamflows.

Further work presented the assimilation of land surface temperature data (ECMWF, Météo France, University of Reading). All indicated strong improvements in the forecasting skills, but also highlighted that further work is required, in particular around the development of appropriate Jacobians, scale-dependency, and optimisation of the size of the ensemble perturbation.

Work at the University of Reading also showed the value of assimilating ground-based observations, as long as they are representative across larger scales, such as the Cosmic

Ray network in the UK. The soil moisture information of those is more in line with the soil layers of operational land surface models due to its larger sensing depth. It was also noted, that while satellite observations are invaluable, land DA in operational NWP also relies heavily on ground-based observations, in particular of station temperature and humidity, and snow depth.

A range of new or revised satellite-based observational data products were also presented by different groups. In particular the new, higher resolution ASCAT soil wetness index showed that better communication is required (and can be achieved) when it comes to new products. The decision to change the resolution from 12.5 to 6.25km was commended, as it is in line with the increase in the land surface model resolutions. However, many centres were unaware of this development and product changes may have an unexpected impact on the existing DA systems. The eventual inclusion of the UK MetOffice helped to ensure a detailed review of the data product and sufficient time to test its impact.

Further data sets that were presented were EUMETSAT's new snow products (snow extent and snow water equivalent), as well as soil moisture products downscaled by ML systems or provided by opportunistic observations (i.e. GNSS-R).

Breakout session on use of AI



The main points identified during the breakout session and the plenary were:

- Currently, most land surface states remain underobserved at the spatial scales relevant to NWP, from either satellite or in situ sensors. In particular snow, land surface temperature and deeper soil moisture are underobserved affecting the amount of training data that can be used.
- Uncertainty is critical for modelling, but is often not included in AI/ML-derived products; this is an obvious area in which DA can contribute to AI/ML advances.
- AI/ML has the ability to close observational gaps in space and time.
- AI can be used to flag anomalies in datasets, which can be important as these anomalies could indicate either extreme events or unaccounted for anthropogenic influence.
- Data scarcity for extreme events presents a major challenge for AI and machine learning models, yet these are the very situations where accurate information is most critical.
- AI/ML can be used to make retrieval algorithms for satellite observations more efficient, but we will more, and more carefully located, in situ observations to see these benefits. These in situ observations are critical for both the current systems and to support future missions and require guaranteed reliability, consistent delivery, and quality control. A continuous and dedicated in situ land observation network is essential to provide the stable, foundational data needed to develop and validate models that link satellite observations to on-the-ground processes e.g. soil moisture, snow cover, and land temperature.
- AI/ML when combined with EO data, offer a powerful and consistent way to spatially map model and data assimilation parameters. This approach should be used more widely.

Plenary discussions

- It was identified that there is a need for better data sharing to avoid multiplication of data storage and increase collaboration (reduction of data processing overheads by sharing activities)
- Many participants reported issues with commercial data, in particular with regard to meta data, retrieval errors (apparently Spire did well at the end for the GNSS-RO products), longevity of data series, and continuity
- Concerns were raised over the continuity of existing, critical data sets (e.g. soil moisture, snow, IMS in general)
- A request from the CGMS community that this group needs to communicate their needs to the EO community was acknowledged and a survey about data needs (current and future) will be prepared
- IESWG will continue to serve as conduit from CGMS to its members, and report relevant member activity back to CGMS WGII.

Appendix A, Meeting Agenda.

Day 1 - Wednesday, June 11		
9:00	Registration	
Welcome & Introduction		
10:00	Roland Potthast, DWD Head of Research and Development	
10:15	Organisation, DWD Local host	
10:30	IESWG meeting framing, Working group lead	
10:50	Coffee Break	
Session I: Agency updates		
11:10	Martin Lange DWD	Recent advances in surface analysis at DWD
11:30	Marco L. Carrera ECCC	Modernization of land surface modelling and assimilation at ECCC
11:50	Kenta Ochi JMA	Recent and ongoing developments in global land data assimilation at JMA
12:10	Camille Birman Météo France	Assimilation of IASI retrieved land surface temperature in the surface analysis system of ARPEGE NWP global model and ongoing developments on surface data assimilation at Météo-France
12:30		Group photo 
Lunch		
Session II: Assimilation Systems		
13:40	David Fairbairn ECMWF	Exploring time-varying vegetation in the ECMWF land DA system
14:00	Christoph Herbert ECMWF	Exploiting the eXtended Control Vector (XCV) framework for improved coupled land-atmosphere data assimilation
14:20	Samantha Pullen Met Office, UK	Developing a new JEDI-based Land Surface DA system for Met Office Global NWP
14:40	Visweshwaran Ramesh University of Reading	Optimizing Soil Moisture Assimilation Strategies for Improved Hydrological Predictions in Land-Surface Modelling
15:00	Coffee Break	
Session I ctd., Agency updates		
15:30	Rolf Reichle NASA GSFC	The land surface in the MERRA-21C reanalysis
15:50	Clara Draper NOAA PSL	Land DA in NOAA'S NWP systems
Session III: IESWG related topics		
16:10	Chris Rüdiger	Results from the ECMWF workshop on land ancillaries

	ECMWF	
16:30	Clara Draper NOAA PSL	IESWG Survey on Status of Land DA Systems
16:50	Plenary	Plenary
Break		
18:00 – 20:00	Icebreaker event sponsored by ECMWF	

Day 2 - Thursday, June 12		
Session III ctd. IESWG related topics		
9:00	Jürgen Helmert DWD	Advancing Forecast Accuracy in NWP and Climate Models through Unified Geospatial Data Processing
Session IV: Land Atmosphere Interface		
9:20	Zdenko Heyvaert ECMWF	Potential of thermal infrared observations for coupled land-atmosphere assimilation in Earth system predictions systems – DANTEX/LSTM
9:40	Sophie Marimbordes Météo-France	Assimilation of Land Surface Temperature observations in a 2DEnVar surface data assimilation system within AROME-France
10:00	Luís Fróis University of Lisbon, Instituto Dom Luiz	Using Earth observations to assess the coupling between land surface temperature and soil moisture interannual variability in ERA5
10:20	Coffee break	
10:40	Riccardo Monfardini University of Reading	Land Surface Temperature Assimilation in LDAS at ECMWF
Session V: Modelling and Validation		
11:00	Vanya Romanova DWD	Impact of 2Dvar snow depth data assimilation on the seasonal forecast initialization performed with ICON XPP system
11:20	Pete Weston ECMWF	Enhanced ensemble-based land data assimilation at ECMWF
11:40	Sebastien Garrigues ECMWF	Assimilation of active microwave and solar induced chlorophyll fluorescence (SIF) satellite observations in the ECMWF Integrated Forecast System (IFS) at global scale using machine learning-based observation operators.
12:00	Lunch	
Session VI: Observations		
13:00	Ali Nadir Arslan FMI	Status update on EUMETSAT H SAF operational snow products
13:20	Cristina Charlton-Perez Met Office, UK	Same observation, new product: Looking at the new ASCAT soil wetness product from an operational point of view
13:40	Anke Tetzlaff Meteo Suisse	Global Surface Radiation and Landflux Climate Data Record
14:00	Hui Lu Tsinghua University	A remote sensing-based 'top-down' grid optimization method for global soil texture parameters

14:20	Coffee break	
14:40	Jifu Yin UMD/NOAA	Development of a NOAA One-kilometer Resolution SMOPS Climate Data Record
15:00	Sujay Kumar NASA	Development of a global, high-resolution, remote-sensing based reconstructed snow water equivalent product.
15:20	Dallas Masters Muon Space	GNSS-R L-band soil moisture product. Satellite program and product development at Muon Space.
Session V ctd. Modelling and Validation		
15:40	Min Huang UMD	Coupled modeling work relevant to TOAR and HTAP3
16:00	Coffee break	
Breakout group session		
16:20-17:20	all	Topical Breakout
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Break		
19:00	Meet at DWD for a walk to Conference Dinner (leisurely 20/30min walk)	
19:30	Conference Dinner (self funded)	

Day 3 - Friday, June 13		
Workshop wrap up		
10:00	Patricia de Rosnay ECMWF	Summary of the WMO snow requirement meeting
10:20	Paolo Ruti Eumetsat	Overview of the activities of CGMS
10:40	Rapporteurs	Reports from Topical Breakouts
11:20	Coffee break	
11:40	IESWG co-chairs	CGMS Final Report Recommendations and Actions
12:10	Final Remarks and Adjourn	
12:15	End of Workshop	