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Meeting/Workshop Reports

1st LIAISE Conference and Determining Evapotranspiration (dET) CrossCut Workshop

Lleida, Spain,
27–29, March 2023

Aaron Boone¹, Joaquim Bellvert⁶, Martin Best³, Jennifer Brooke³, Guylaine Canut-Rocafort¹, Joan Cuxart², Oscar Hartogensis⁷, Josep Ramon Miró⁸, Jan Polcher⁴, Jeremy Price³, and Pere Quintana-Seguí⁵

¹CNRM-Université de Toulouse, Météo-France/CNRS, France; ²Université des Iles Baléares, Palma, Spain; ³UK Met Office, Exeter, United Kingdom; ⁴Laboratoire de Météorologie Dynamique, CNRS/IPSL, Ecole Polytechnique, Palaiseau, France; ⁵Observatori de l'Ebre (Universitat Ramon Llull-CSIC), Barcelona, Spain; ⁶Institute of Agrifood Research and Technology/Efficient Use of Water in Agriculture Program, IRTA, Lleida, Spain; ⁷Wageningen University and Research, Wageningen, The Netherlands; ⁸Servei Meteorològic de Catalunya, Barcelona, Spain

Workshop Objectives

The overall objective of the Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment (LIAISE) project is to improve our understanding of the impact of anthropization on the water cycle in terms of land-atmosphere-hydrology interactions, and the limitations of models to represent all aspects of the terrestrial water cycle in a semi-arid environment characterized by strong surface heterogeneity owing to contrasts between the natural landscape and intensive agriculture (<https://www.hymex.fr/liaise/index.html>). The LIAISE study area is located over the Catalan counties of Urgell and Pla d'Urgell within the Ebro basin in northeastern Spain, which contains a sharp delineation between a vast, nearly continuous intensively-irrigated region and the dryer natural zone to the east. The main water source consists of artificial reservoirs located to the north in the Pyrenees mountains, and this water is brought into the irrigated area using a highly anthropized river and canal network. The ability to make robust estimates of water use efficiency (WUE) is critical for managing the limited water resources in this region. Evapotranspiration (ET) is the process linking the water, energy, and carbon cycles, and modulating the WUE. ET is a challenge to observe and model across a range of spatial scales using a myriad of methods (Cuxart and Boone, 2020): it was studied extensively during the LIAISE field campaign in 2021 from very different perspectives, ranging from a focus on process understanding and prediction by Earth system modelers, to quantification at a range of spatio-temporal scales for hydrological or agricultural applications, such as reservoir dam regulation or crop irrigation.

The LIAISE field campaign was the first of the GEWEX determining Evapotranspiration (dET) cross-cut initiative, which

focuses on measuring ET, especially in terms of the surface energy balance, ET-atmospheric boundary layer (ABL) interactions, modeling and parameterizations of ET (notably within numerical models), partitioning of ET into its various components (bare soil, transpiration, etc.), and the quantification and study of potentially-significant spatial heterogeneity of ET. The goal of the joint LIAISE-dET meeting was to bring together researchers specializing in estimating ET experimentally using in-situ observations, via remote sensing data and/or models, from the leaf to the regional scale.

Conference Summary

The workshop was held near the end of March at the Parc Científic i Tecnològic Agroalimentari de Lleida, in Lleida, Spain (<https://www.gewexevents.org/meetings/liaise-and-det/>). There were 41 oral and 15 poster presentations, and over 60 participants attended the 2.5 day event. It brought together experts from diverse disciplines who study ET, consisting mainly of agronomers, hydrologists, meteorologists, soil scientists, remote sensing specialists, and plant physiologists, with a majority presenting results from LIAISE field campaign data analysis and numerical modeling experiments (see Boone et al., 2021 for a review of the field campaign). It was the first opportunity for many of the researchers present to finally meet face-to-face in the same location, since contact between groups was limited during the campaign due to the COVID-19 sanitary crisis.

Sessions were organized around three topics: (i) land surface ABL conditions during the LIAISE campaign, with a focus on the contrasting conditions over the irrigated and rain-fed areas; (ii) ET derived from observations using both in situ measurements and remote sensing techniques over a range of spatial scales (from plot to region); and (iii) integrated land-atmosphere-hydrology interaction studies. Note that the ET studies were not limited to the LIAISE study area. All of the presentations and posters are available on the LIAISE project page (https://www.hymex.fr/liaise/LIAISE_conf/Workshop_March_2023/presentations/).

After the end of the conference at mid-day on the 29th, the afternoon was devoted to LIAISE working group (WG) meetings. These groups form the core of the LIAISE project, and tie in with the dET initiative. There are three WGs, and their name and focus are defined as follows: *Surface processes* (WG1) focuses on water, energy, and carbon balances and related processes in the interaction between the surface and the atmosphere (with ET as a key process that integrates all three balances) from the leaf to the field scale. *Meteorology* (WG2) deals with ABL processes and mesoscale circulations related to wet-dry surface contrasts, topography, and sea breeze interactions. Fire, as a fundamental feature of semi-arid landscapes with strong surface-ABL interactions, is also included. *Regional scale hydrology* (WG3) explores the linkages between irrigation, streamflow and reservoirs (and their regulation), and regional-scale estimates of surface properties related to soil moisture.

Each WG meeting took place in a parallel session, with the final plenary session devoted to short presentations by each of



Attendees of the GEWEX Integrated Product Workshop

the group leads and discussions. The main outcomes are as follows: WG1 discussed the first results of the ET-methods (eddy-covariance, gradient, lysimeter, scintillometer, remote sensing algorithms) intercomparison effort, how to best organize the various LIAISE data products for general use, the new LIAISE Unified Eddy Covariance flux product, the ecophysiological measurements (leaf area index, vegetation cover fraction, photosynthesis traits), soil moisture, and the development of consistent locally-informed land use and irrigation maps (such maps are generally superior in quality to the default global data sets often used by land surface modelers). WG2 reviewed the progress of the LIAISE mesoscale model intercomparison project (the current pilot study and a future follow-up, which will focus on an Intensive Observation Period from the LIAISE campaign); the atmospheric observational data, which has been processed and is available (e.g., ultra high frequency wind profiler, radio soundings), and the current status of data processing (e.g., turbulence from aircraft and tethered balloon); mesoscale circulations within the LIAISE region (wet-dry surface induced, the sea breeze, nocturnal jets and mountain-induced circulations); plans for large eddy simulations (LES) over the LIAISE domain by several groups; a specific study on two rain events during the special observation period (the focus thus far has been on clear days); and synergies with other projects exploring the impact of land surface heterogeneities on the ABL and subsequent mesoscale circulations [e.g., Model and Observation for Surface-Atmosphere Interactions, MOSAI, <https://en.aeris-data.fr/projects/mosai-2/>, or the GEWEX-sponsored Coupling Land and Atmosphere Sub-grid Parameterizations (CLASP) project (Chaney et al., 2023)]. WG3 focused on whether current land surface and hydrological models can simulate a realistic water cycle at km-scale resolutions in mountainous areas. This is especially important in a semi-arid region like the Ebro basin, which has limited water resources and where mountain reservoirs provide drinking water to the local population, generate a substantial amount of electricity, and feed the canals that provide irrigation water for intensive agricultural activities. The main scientific objectives for a regional-scale model intercomparison project (MIP) were discussed. First, adequate (high) spatial resolution input atmospheric forcings are key. Bias correction methods were presented that combine observations gathered in the Système d'analyse fournissant des renseignements atmosphériques

à la neige (SAFRAN) reanalysis system (Quintana-Seguí et al., 2016) and simulated values from a km-scale model run executed within the European Climate Prediction (EUCP) system project (<https://cordis.europa.eu/project/id/776613>). The aim is to combine the available observations in low-lying areas with the simulation of near surface conditions over high elevation areas. An analysis of this new data set showed that precipitation is enhanced over high elevation areas as expected, while the evaporative demand, on the other hand, is reduced over these areas. These presentations led to a discussion of the potential coordinated land surface and hydrological MIP that could be proposed to the community. All three groups then met together and summary conclusions were made, mostly related to future WG activities in the upcoming few years (notably for the aforementioned intercomparison projects).

Public Outreach

Drought is predicted to be one of the main effects resulting from climate change in the Mediterranean. The frequency and severity of meteorological and hydrological droughts have increased in the recent past, and it is expected that this trend will continue in the 21st century in the Mediterranean, resulting in a major competition for water resources between different domestic, agricultural, industrial and tourism uses. Taking advantage of the LIAISE conference and the beginning of an uncertain irrigation campaign (owing to historically low reservoirs this year in the LIAISE region), a public outreach day entitled *Climate change, drought, meteorology and its impact on water resources in Mediterranean agriculture: the LIAISE project* was organized with the aim to present highlights from the LIAISE conference to the main irrigation actors (water managers, farmers, and local politicians) at the Espai Cultural dels Canals d'Urgell (Urgell Canal Cultural Space) in Mollerussa, Spain, located within the heart of the LIAISE field campaign domain. In addition, this meeting provided a forum for debates with experts on how weather prediction models can be improved, how the drought can affect such irrigated areas of the Mediterranean, and potential strategies for how water resources can be managed best. The meeting was organized by the Institute of Agrifood Research and Technology (IRTA), The Catalan Meteorological Service, and the Irrigation Authority in collaboration with the LIAISE project steering committee.

Next Steps

The LIAISE database is being updated continuously with processed field campaign data along with products derived using models and data from local sources, such as regional land cover and soil property maps. The data catalog can be viewed at <https://liaise.aeris-data.fr/>. Note that there is an embargo in place that restricts the data to those who have requested and been granted access; in less than two years, the data will be available via open access. This data is central to the WG activities, and these groups will continue to function through at least the next two years. Several data product and model intercomparison projects are either already underway (e.g., ET products, the mesoscale MIP) or will begin (regional hydrological MIP) within the next year or so, and they are being run through the WGs. Those interested in following or joining a WG are invited to visit the LIAISE WG webpage for more information. Some of the instrumented sites have remained or will be renewed within the LIAISE region: the Mollerussa potential evaporation site has been taking measurements since the campaign was conducted in 2021 along with the weighing lysimeters; the Els Plans rain-fed super-site 50m tower and several remote sensing instruments remained operational for approximately a year after the campaign; a surface energy balance (SEB) station and lysimeter are currently present and will be operational until at least autumn 2025; and an eddy covariance site will be installed along the shore of Lake Ivars by the end of this year, owing to the interest the campaign data generated for the lake managers. The public outreach was deemed a success, and allowed a lively debate between the scientists involved in LIAISE and local stakeholder and decision makers. As the extreme drought conditions experienced this spring in the region have already resulted in significant crop losses for many of the regional farmers, it was a timely event. LIAISE will continue to remain active in exchanges with the local water management and agricultural sectors. Finally, a future workshop will be planned, likely either in conjunction with or adjacent to the 10th International Conference on Meteorology and Climatology of the Mediterranean (MetMed) meeting, tentatively planned to be held in Toulouse, France, in spring 2025.

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