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Model and Observation for Surface Atmosphere Interactions (MOSAI) project

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The Global Energy and Water cycle Exchanges and World Climate Research Program have pointed out the importance of the land-atmosphere (L-A) coupling for weather and climate models. The Working Group on Numerical Experimentation survey on systematic errors established that the outstanding errors in the modelling of surface fluxes of momentum and sensible and latent heat is the second most important issue. Earth System Models (ESM) and Numerical Weather Prediction (NWP) systems often have large biases in their representation of surface-atmosphere fluxes when compared to observations. The detailed quantification and reduction of these biases are still on-going efforts in many modelling centres. The Models and Observations for Surface-Atmosphere Interactions (MOSAI) project aims at contributing to this effort.

The first step to achieve this objective is to conduct a fair and correct evaluation of the L-A interactions simulated by ESM and NWP models. This is based on (1) reliable references against which the simulated L-A exchanges can be evaluated, and (2) relevant comparison methods able to point out the ESM and NWP system weaknesses. These points define the two first scientific objectives of MOSAI project. The first scientific objective is to investigate and determine the uncertainty and representativeness of L-A exchanges measured over heterogeneous landscapes. Three one-year campaigns are planned to document this heterogeneity on three of the ACTRIS instrumented sites in France. The objective is to make these permanent fluxes measurements well documented in terms of uncertainty, surface energy imbalance and surface heterogeneity representativeness at the scale of the model grid-mesh. The second scientific objective is to propose and test two methods to evaluate the L-A exchanges in ESM using long-term

measurements. The first approach is based on sensitivity studies performed with 3D models or with their corresponding single-column version, either forced by data from the MOSAI one-year campaigns or coupled with their LSM, and for which an atmospheric forcing will be derived from operational analyses. The second approach relies on Artificial Intelligence methods (Neural Network or Random Forest) to test the dependency of the surface fluxes to several meteorological variables, at the same time for observation and models. These two methods will allow identifying specific weaknesses of each model at different spatial and time scales.

The second step of the project concerns the improvement of the L-A exchanges simulated by ESM and NWP systems. The coupling between land surface models (LSM) and atmospheric models is based on several simplifications which are different when considering Large-Eddy Simulation (LES), weather or climate models. The third scientific objective of MOSAI project addresses some of these underlying simplifications in the coupling between LSM and atmospheric models, and their impacts on the simulated L-A exchanges. After determining the importance of a realistic heterogeneous landscape versus percentages of unified landscape to correctly simulate the surface flux in ESM and NWP, differential treatment of the boundary-layer parameterizations will be developed, so that the atmosphere model can describe as many sub-columns as the number of land-surface patches to explicitly represent the L-A coupling.

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