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Interactive comment on "CloudRoots: Integration of advanced instrumental techniques and process modelling of sub-hourly and sub-kilometre land-atmosphere interactions" *by* Jordi Vila-Guerau de Arellano et al.

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CloudRoots: Integration of advanced instrumental techniques and process modelling of sub-hourly and sub-kilometre land-atmosphere interactions Jordi Vilà-Guerau de Arellano1

Biogeosciences

Understanding sub grid variability of mass and energy fluxes, especially over heterogeneous landscapes or those subjected to full sun and shade under days with fair

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weather clouds remains a challenge to our field. This is an interesting effort to bring together observations and models to better understand these processes. I've always been curious about how sunlight can drive fluxes which in turn drive pbl growth and humidification of the boundary layer, which then affect humidity and the production of fair weather clouds. Hence a mix of positive and negative feedbacks acting in concert.

This paper describes the detailed CloudRoots experiment. It joins a class of papers, like many of the key papers in the past that described FIFE, HAPEX, BOREAS, the Boardman ARM Field Experiment and various Kansas studies that provide the background for large investigator integrated field experiments. This newer generation of studies has some advantages ove the past studies with the emergence of SIF as a proxy for photosynthesis. Plus there are better sensors for boundary layer height and more flux stations.

Overall it has the connections between leaf and soil, to canopy, to landscape, to region to boundary layer set of measurements and models to provide a rich database for discovery, model validation and model parameterization.

Methods The team is using state of art eddy covariance measurements methods that are well vetted, though ICOS. Spatial integration is with scintillometers and inference of fluxes with remote sensing like SIF. The CLASS model is one of the best and is based on LES origins and can be used to drive a simpler one dimensional model. The scale of this work is over 10 km, which is reasonable. The study was in Germany and conducted as 3 intensive field experiments over the summer growing season. Land is flat and the landscape is well documented and assessed. Interesting to see mini lysimeters, soil CO2 chambers and leaf physiological capacity measured, eg leaf gas exchange and sap flow, too. Well planned and executed.

My one complaint is use of MOST to interpret scintillometer measurements. They are often advocated to measure spatial averages, but the edges of the sampling will see advection, so there can be problems inverting fluxes with 2D measurements into a 1D

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framework. Eddy covariance works around this by establishing an internal boundary layer with large fetch.

One thing I do like about scintillometer, and something this team has done, is look at instant fluxes with sun and shade and calculate changes in surface conductance. That approach to me has proven powerful and interesting.

Van Kesteren, B., Hartogensis, O. K., Van Dinther, D., Moene, A. F., De Bruin, H. A. R., & Holtslag, A. A. M. (2013). Measuring H2O and CO2 fluxes at field scales with scintillometry: Part II–Validation and application of 1-min flux estimates. Agricultural and forest meteorology, 178, 88-105.

All this information is then integrated through measurements of boundary layer development. Not sure of other such comprehensive field studies, that compete, even FIF, BOREAS or HAPEX.

Results

Information on plant physiological performance is pertinent as it provides parameter information for subroutines in CLASS. I'd like to know more about Vcmax, Jmax and the Ball Berry or Medlyn/Leuning type stomatal conductance parameters used by the model.

The paper plays a new role to look at cloud induced fertilization of evaporation. Most studies focus on enhancement of co2 flux. So this is new and novel.

Interesting to see

At constant Q*, the median of LvE is always higher under clear skies than for cloudy skies. Diffuse fraction plays a minor role and the decrease on LvE under cloudy conditions is mainly due to the reduction in theincoming shortwave radiation.

There remains some debate and discussion on the term evaporation over evapotranspiration. I favor the former after hearing John Monteith advocate for it.

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The paper drives towards a connection with large scale integrated SIF to landscape average evaporation. Since water and carbon fluxes are tightly coupled, I am open minded to this spatial scaling assessment.

At boundary-layer integrated scale, they find that modelled sensible heat flux correlates better with the area weighted average flux than the local flux estimates. I find this interesting as we are dealing with a similar problem. How to best average fluxes from a network of flux towers as a lower boundary condition for a pbl model? Or do we get integration of fluxes at 30 m scale with ECOSTRESS?

This leads me to a suggestion. The PI should also look at ECOSTRESS data for their domain and compare the integrated evaporative fluxes with what they are producing. These data are publicly available and could be a nice alternative constraint.

Fisher, J. B., et al. (2020), ECOSTRESS: NASA's Next Generation Mission to Measure Evapotranspiration From the International Space Station, Water Resources Research, 56(4), e2019WR026058, doi:10.1029/2019wr026058.

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