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Title:
Detection of land surface induced atmospheric water vapor patterns

General Comments

This paper aims to study "whether spatial water vapor distributions can be connected to land surface properties". It uses instruments from the ground-based remote sensing infra structure JOYCE and builds on a number of more technical papers, mostly produced as part of the TransRegio32 project, that for this particular site and instrument-set developed methodologies/algorithms for the radiometer retrievals, boundary layer height, etc., as well as inter-comparison studies, algorithms for landuse maps, virtual MWR scans from MODIS IWV measurements and the LES-LEM set-up.

As I understand it this paper wants to take advantage of all these tools that have been developed before to now focus on a process study into the influence of the surface to the amount of water vapour found in the atmosphere directly above these surfaces.

This in itself is an interesting objective and well worth publishing. However in my view the authors fail in the execution. There is too much attention on repeating all the technical work done before. It is not clear to me how some of the presented results contribute to answering the research questions (e.g. the inclusion of the MODIS data and the drastic landuse change in the LES). Furthermore, there is not much attention to the processes that make up the water vapour field in the atmosphere and once that would have been outlined continue with how to zoom in to contributions from the local land surface into the water vapour field as measured by the radiometer (a slant path over 4.3km in the horizontal reaching to 2.5km height).

This paper borders rejection in my view because it fails to orderly describe the processes at hand, come up with a good research strategy and presenting results that all lead to answering the research question. It would require a very major revision to fix this. In the following I will substantiate my statement with some specific points.

Specific Issues

1. Outline the main concepts:

   I miss a conceptual framework that described the water vapour concentration in the atmosphere, some notion of the scale of mixing in the horizontal and vertical and then connect these to the slant, integrated measurements of the MWR and land-use map. The LES could serve as a means to distinguish processes by switching them on/off.

A simplified budget equation would be a good anchor for the analysis:

$$\frac{\Delta<q>}{\Delta t} = \frac{1}{\rho L_v}\frac{\Delta LE}{h} + u\frac{\Delta<q>}{\Delta x}$$

It shows the boundary layer humidity tendency as a function of a local source (evapotranspiration) and a non-local source (transport term) of humidity. h represents the boundary layer height.

Next step would be to connect some sense of scale to this equation on what sort of surface area the local part of the budget is sensitive to as the MWR beam transverses the atmosphere horizontally and vertically at the same time. The blending height concept might be useful here. What is the meaning of the part of the MWR path that is above the boundary layer in terms of its relation with the underlying surface?

The difficulty the MWR measurements is that transport will always play some role and at some height the connection with the surface directly below will be at least partly lost. This must be discussed and a clear approach must be sketched on how to zoom, as much as possible, into the local influence on the measurements. Large, synoptic scale transport if important will likely affect the whole scanning region equally, but can local transport (within the scanning beam) lead to a shift between scanning beam and underlying surface?

With the LES the two terms of the budget can be determined and evaluated separately. Also a run could be set-up with no local flux or no transport.

2. Section 3.1:

- To exclude advection you set an arbitrary limit to the humidity tendency (p7 lines18-25). Looking at the equation above it seems to make more sense to set a limit to the wind speed or look for synoptic weather patterns that go with low dq/dx (large scale high pressure situations). What is confusing is that 2 pages further on (p9 lines 11-12) you mention that you do an additional filtering on wind to rule out the transport? But supposedly you already filtered for this effect?
- What is the reason to lump all the cases with no clouds and little advection into one figure which combines situations from beginning to end of the growing season (crop-fields changing from bare soil to green to yellow) over a period of years (dry, wet conditions all mixed). Wouldn’t it make more sense to present here the case you will study with the LES as well and off-set it against the multi-year picture and/or a situation in which advection does play an important role?
- Figure 2 is very busy. I suggest to separate the line plots from the surface plots. Also it Fig 2a is maybe easier to interpret if you plot it radially so it matches the scanning circle of Fig 1. In Fig1 you could indicate the 36 bins?

- Most of the text on pages 8-10 is on technical interpretation of the figures (e.g. you find out that the data filtering leads you to focus on anticyclonic weather types and that the WD compares well between methods); but there is very little on the relation between the MWR reading and the influence of the surface.

3. MODIS

The MODIS section reads as an intercomparison exercise of MWR measurements against constructed, virtual MWR scans from the MODIS data. They agree well, which is nice but the MODIS data doesn't provide additional insides on the research question. Fig3b without the MODIS line would have provided the same information relevant to the connection between MWR and the surface. I suggest to leave this section out and move Fig3b to section 3.1.

4. LES

- See final comment under point 1. The LES gives you the tool to investigate the relative importance of local influence vs transport under various conditions.
- I am not sure what the "inverted" landuse map teaches us. The MWR profile looks roughly the same (Fig 5) and moisture and cloud fields show similar patterns albeit with different intensity. Is it fair to conclude that the advection and topography are more important than landuse?

Minor issues:

1. Lines 11-12; Change "which was used in addition to investigate changes in surface fluxes and the water vapor and cloud field for an altered land use input." to "which was used to investigate changes in surface fluxes and the water vapor- and cloud fields for an altered land use input."

2. Line 10 (and corresponding reference in the literature list): "Guerau de Arellano (2008)" should be "Vilà-Guerau de Arellano (2008)"