

Interactive comment on “Recent changes of relative humidity: regional connection with land and ocean processes” by Sergio M. Vicente-Serrano et al.

Anonymous Referee #1

Received and published: 11 July 2017

The paper analyses changes in surface relative humidity (RH) in the last 35 years. It is mostly based on ERA-Interim reanalysis data, but observations (HadISDH) are also considered. The main technique used is a Lagrangian analysis of the moisture source regions.

I think the topic is very important, and in scope for Earth System Dynamics. The paper will be a valuable contribution to the field, but in my opinion it requires some revisions.

Major Issues

1. My main criticism is that the paper lacks clear conclusions. Section "Discussion and Conclusions" is dominated by a discussion of other relevant studies, with too little

C1

effort to distill out what is new. My suggestion is to separate out "Conclusions" to a separate section. There, clearly state what is new, what are the specific conclusions of this study.

2. I139-I151: Text and formulas for RH computation:

a. Why is the decision, whether the ice or liquid equilibrium pressure is used, based on the wet bulb temperature (and not, for example, the physical temperature)? Please justify or change.

b. There are two different equilibrium pressures to consider, one for liquid water and one for ice. Authors chose to use the ice one for temperatures below 0°C. There is no direct physical reason for this, since there will be large open water areas even at sub-zero air temperature and vice versa. But I guess it is a reasonable first choice if information on the surface itself is not available. However, the authors should be clear about that it is a choice they are making, and not dictated from physics.

c. Generally, I find text and formulas here confusing and outdated. From Eq. 1 it follows simply that

$$RH = 100 \cdot e / es(T) = 100 \cdot es(T_d) / es(T)$$

where RH = relative humidity in percent, e = water vapor partial pressure, T = physical temperature, T_d = dewpoint temperature, es() = equilibrium water vapor pressure.

So, to calculate RH from T_d, all that is needed is a valid parameterisation of es(T). An accepted modern one is given in Murphy, D. M. and T. Koop (2005), Review of the vapour pressures of ice and supercooled water for atmospheric applications, Q. J. R. Meteorol. Soc., 131(608), doi:10.1256/qj.04.94. (They give two different es(T) parameterisations, one for liquid, and one for ice.)

3. I would like to see an overview figure of the RH mean state and the E-P mean state, before the trends are discussed. Perhaps in the same style as Figure 1, for cold season, warm season, and annual mean. And also a short discussion, along with the

C2

figure. This is important to put the changes into perspective. Also, in my understanding the "null hypothesis", based on simple thermodynamic arguments and the simplistic assumption that the circulation does not change, is that the existing E-P pattern is enhanced under global warming. (The "dry gets drier, wet gets wetter paradigm (Held, Isaac M. and Brian J. Soden (2006), Robust Responses of the Hydrological Cycle to Global Warming, J. Climate, 19(21), 5686-5699, doi:10.1175/JCLI3990.1.)

Minor Issues

The paper contains some English errors and idiosyncrasies. Example: "On the contrary", used in several places, where I think the authors mean "on the other hand". I recommend a careful proof-reading, preferably by a native speaker.

l47 "water holding capacity": Please replace by "equilibrium amount of water vapor". (Holding capacity is physically wrong, since the air does not "hold" the water vapor in any way. The CC equation describes the equilibrium pressure of water vapor with liquid water.)

l49 "could increase": Please replace by "is expected to increase".

l83 "there are unavailable studies": Rearrange: "studies...are unavailable"

l103 "challengeable" → "challenging"

l239 "moisture support": Perhaps replace by "moisture supply"? (Meaning of support is not clear here.)

l277: "positive (E-P) field": I'm confused. Isn't Figure 1 showing just the RH trends? How does the E-P field enter the figure?

l364 "controlled by": I would say "correlated to". How do you know what controls what?

l378 [RH has increased] "as a consequence of changes in the continental humidity sources": Why have they increased?

C3

l407 "air temperature and SST ratio" → "and air temperature to SST ratio"

l492 "Thus, although some regions showed positive changes in the oceanic evaporation, the amount of increase was much lower than that found for SST, suggesting a general positive trend in most of the world's oceans (Supplementary Figure 48, Supplementary Table 1)."

Confusing. Did you mean:

"Thus, although some regions showed positive changes in the oceanic evaporation, the amount of increase was much lower than that found for SST, which suggests that SST changes do not drive evaporation changes (Supplementary Figure 48, Supplementary Table 1)."

l591 "This finding indicates that while different model experiments fully supported the hypothesis that the different warming rates between oceanic and continental areas can explain the projected decrease in RH under climate change conditions, our results for 14 different regions in the world are contradictory, given that most of these regions exhibited a negative RH trend for 1979- 2014."

What is the contradiction? The differential land sea warming mechanism predicts a decrease of RH over land, and you find a negative RH trend. I'm not sure if this is a language issue, or if there is a fundamental point that I'm missing.

l638 "Hadley Cell" → "Hadley Cell (HC)"

Figure 2: Please add a vertical zero line, so that one can judge whether trends are positive or negative.

Figures 6-8: Subplots are too small, titles almost impossible to read for me.

Figures 10-11: "Signification" → "Significance"

Interactive comment on Earth Syst. Dynam. Discuss., <https://doi.org/10.5194/esd-2017-43>,

C4

2017.

C5