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Discussions

Interactive comment on "Have precipitation extremes and annual totals been increasing in the world's dry regions over the last 60 years?" *by* Sebastian Sippel et al.

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The authors scrutinize a recent study (Donat et al. 2016) that reported increasing trends in precipitation extremes and annual totals in the world's dry regions, as defined by precipitation amounts. The authors (1) suggest that the results of the scrutinised study were biased owing to choices of the reference period, and (2) discuss that the findings depend on how 'dry' regions are defined.

We thank the authors for pointing out the statistical issue related to the reference period which is now addressed in a Corrigendum (submitted to Nature Climate Change on 12th September 2016). Importantly, this statistical issue does not affect

the major conclusions of the scrutinised study, a point that should be made clearly in the current manuscript. However, the remainder of this manuscript, in particular the discussion related to the definition of dry regions, is biased, inconsistent, ambiguous (misleading), and incomplete as outlined below. Therefore the manuscript needs to be carefully revised before publication.

Biased: The current manuscript claims that the only valid definitions of wet and dry regions are those based on surface water availability, referring to what is 'commonly understood' or 'conventional'. However, in everyday language it is common to use 'wet' or 'dry' to refer to high or low precipitation for both regions and times of year. Furthermore, in the scientific literature there are numerous related studies that have defined wet and dry solely based on meteorological parameters such as precipitation (e.g. Allan et al.,2010; Sun et al., 2012; Liu and Allan, 2013), and these are ignored in the current discussion and should be included in a revised manuscript. The current manuscript, therefore, appears biased in that it is largely based on a claim that only a particular definition of dryness is valid, when several other definitions are in common use.

An important point that emerges from this discussion is that it is desirable to specify more clearly which type of definition of dry and wet is being used in studies of climate change. Indeed this is something the current manuscript could do better; see 'ambiguous' section below. We suggest to the authors that they make the conclusion of their paper and abstract a call for more specificity in the use of 'dry' and 'wet' in climate-change studies. For example, one could refer to 'meteorological' or 'hydrological' wet and dry regions, by analogy with the standard definitions of 'meteorological' or 'hydrological' drought. This would be of greater value than arguing that only one type of definition is valid.

Inconsistent: The analysis in Section 3 is likely affected by the same "regression to the mean" bias discussed in Section 2, because the dry-regions masks that include water demand were not defined over the entire study period 1951-2010.

Ambiguous: The current text uses 'dry' for different concepts, and this is likely to confuse readers. To avoid confusion, the authors should specify whether they are talking about 'low-precipitation' or 'arid'/'water-limited' regions. This is particularly problematic e.g. in the Abstract lines 3-5 where dry is defined in terms of water availability but then immediately used to refer to the scrutinised study in which dry means low precipitation. Similarly in the introduction it needs to be specified which concepts of 'dry' the authors refer to in each case.

Incomplete: The main reason why Sippel et al. don't find a (statistically significant) increase in Rx1day in arid regions seems to be related to scarcity of data. It is unfortunate reality that arid regions are insufficiently covered by observations. Aggregating only over a few grid cells results in relatively noisy time series, so that – despite a positive trend slope – the p-value of the applied trend test is too high to reject the null hypothesis of 'no change'. A relatively easy attempt to optimise spatial coverage by merging the two existing datasets HadEX2 (Donat et al., 2013a) and GHCNDEX (Donat et al., 2013b) gives a few additional grid cells with data in arid regions. Aggregating over this just slightly improved coverage results in a more robust trend estimate in observations and in the CMIP5 ensemble mean (Figure 1). This suggests that a major uncertainty when analysing precipitation changes in arid regions comes from the limited availability of observations. Also, if using the complete coverage as provided e.g. by the ensemble of CMIP5 models as used in Donat et al. (2016), the authors would find statistically significant increases in ensemble mean over the arid regions (not shown). Therefore we assume that the main reason why Sippel et al. conclude there is 'no significant increase in heavy precipitation' in arid regions is related to the scarcity of observations.

Specific comments:

Page 2, line 3: 'if there is enough moisture available' – do you mean annual average moisture availability? Or seasonal? Or on the day the rainfall extreme occurs?

Page 3, line 24: It would avoid possible confusion to include a clarification at the end of Section 3 that despite having effects on the quantification of trends, these biases do not affect the conclusions in the study under scrutiny. When avoiding the discussed biases, there are still statistically significant increases in Rx1day and PRCPTOT in the dry (i.e. low-precipitation) regions.

Page 3, lines 26-30: To avoid the impression of bias, it is important to mention other definitions of 'dry' here that are also commonly used in the scientific literature.

Page 3, lines 31-33: Donat et al. provided a number of sensitivity tests, and also analysed Rx1day changes in the dry regions defined based on PRCPTOT (see their Supplementary Information SI4) – in this mask Scandinavia and the Netherlands are not part of the 'dry' class, but they still find increasing trends (and this is also the case after correcting for the biases discussed in Section 2). Please reword to avoid the impression of cherry-picking.

Page 3, lines 5 and 12: The statements about changes in spread of the spatial distribution do not seem to be relevant since only means are included in the analysis (not e.g. variance). These statements should be removed, or it should be explicitly stated that they are not relevant to the current analysis.

Page 4, lines 6-9: Over which time period where these alternative masks (2,3,4) defined? If not 1951-2010, you need to clarify that they may introduce the "regression to the mean" bias.

Page 4, Line 9: What is the rationale behind including transitional regions when studying precipitation in dry regions?

Page 4, lines 15/16: large parts of these 'subsidence regions' with no or little precipitation changes are located over the ocean. Water availability can clearly not be a limiting factor here, so this is unrelated to the discussion of different definitions of 'dry'.

Page 4: Lines 17-21 give a hint of a balanced discussion, but unfortunately lead to a highly biased conclusion (lines 22-24), again appealing to what is supposedly 'commonly understood' and suggesting arid would be a conventional definition for dry.

References

Allan, R. P., Soden, B. J., John, V. O., Ingram, W. J., Good, P.: Current changes intropical precipitation. Environ. Res. Lett. 5, 025205, 2010.

Donat, M. G. , Alexander, L.V., Yang, H., Durre, I., Vose, R., Dunn, R., Willett, K., Aguilar, E., Brunet, M., Caesar, J., et al.: Updated analyses of temperature and precipitation extreme indices since the beginning of the twentieth century: the HadEX2 dataset, Journal of Geophysical Research: Atmospheres, 118, 2098–2118, 2013a.

Donat, M. G., Alexander, L. V., Yang, H., Durre, I., Vose, R., Caesar, J.: Global land-based datasets for monitoring climatic extremes, Bulletin of the American Meteorological Society, 94, 997-1006, 2013b.

Donat, M. G., Lowry, A. L., Alexander, L. V., O'Gorman, P. A., and Maher, N.: More extreme precipitation in the world's dry and wet regions, Nature Climate Change, 2016.

Greve, P., Orlowsky, B., Mueller, B., Sheffield, J., Reichstein, M., and Seneviratne, S. I.: Global assessment of trends in wetting and drying over land, Nature Geoscience, 7, 716–721, 2014.

Liu, C. and Allan, R. P.: Observed and simulated precipitation responses in wet and dry regions 18502100. Environ. Res. Lett. 8, 034002, 2013.

Sun, F., Roderick, M. L., Farquhar, G. D: Changes in the variability of global land precipitation. Geophys. Res. Lett. 39, L19402, 2012.

Figure Caption (complete caption as the online system seems to cut the caption after the second sentence):

Figure 1: Extreme precipitation changes in arid and humid regions. Time series of Rx1day (the annual-maximum daily precipitation) for dry/arid (a) and wet/humid (b) regions as identified by Greve et al., 2014. Area-weighted average time series are shown for HadEX2 and the ensemble mean and spread of CMIP5 simulations. Precipitation indices were first normalized by calculating annual values as a fraction of the 1951–2010 local mean before calculating the dry- and wet-region averages. Black lines, annual values from observations and ensemble mean; red lines, linear trend; blue dashed lines, 30-yr averages for 1951–1980 and 1981–2010; grey shading, $\pm$ one ensemble standard deviation. dRx1day indicates the difference between the averages during 1981–2010 and 1951–1980; slope is the linear trend Sen-slope estimate (unit, decade-1); and the p-value is the trend significance using a Mann–Kendall test. (c)

The mask indicates the locations of the grid cells contributing to the average of the dry (red) and wet (blue) regions, and the number n of grid cells contributing to the area averages of dry and wet regions is given. Land grid cells that are less complete than 90

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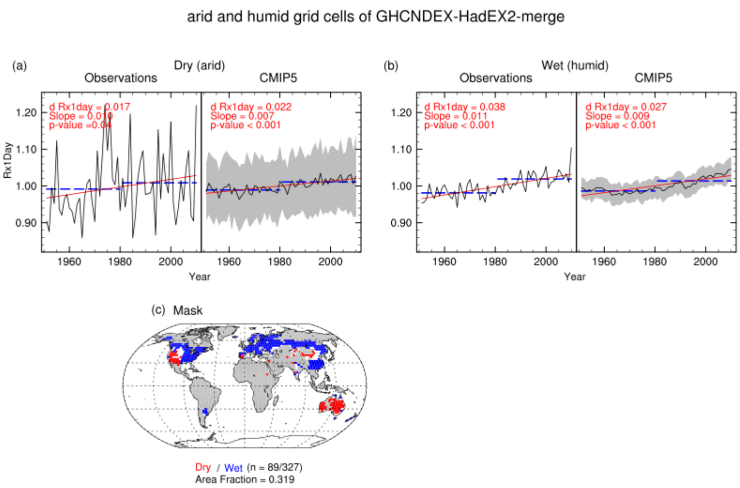

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