Clim. Past Discuss., 7, C2417–C2425, 2012
www.clim-past-discuss.net/7/C2417/2012/

Climate of the Past Discussions

CPD

7, C2417–C2425, 2012

Interactive Comment

Interactive comment on "Extreme climate, not extreme weather: the summer of 1816 in Geneva, Switzerland" *by* R. Auchmann et al.

R. Auchmann et al.

renate.auchmann@giub.unibe.ch

Received and published: 18 January 2012

We thank the second reviewers for valuable comments and suggestions on the manuscript and graphics. We respond to the particular points in the following. Reviewer comments are shown in quotation marks:

Anonymous Referee 2. Received and published: 2 January 2012

"This manuscript provides an interesting contribution to characterise in detail an outstanding climatic event (YWS). Using daily and sub-daily data for Geneva the authors have done a good job explaining a) the role of clouds on asymmetrical changes of morning and 2.p.m temperature distributions, b) how the rainier summer of 1816 resulted from an increase of wet days frequency rather their intensity, c) how changes in WTs frequency were partially responsible for the observed changes in temperature, precipitation and cloudiness. Overall the paper is clearly written with an appropriate length and abstract and supported by an appropriate number of figures and tables. In summary I consider that this manuscript is good and worth to be published after some minor clarifications listed below. Minor suggestions/comments: 1 (Section 3.4) I would like to suggest the authors to provide one or two references that help supporting the Weather Type (WT) classification methodology presented (even if applied to other regions). The set of rules used to define the different WT classes looks plausible and the obtained results confirm their usefulness (in respect to temperature and precipitation impact). However, this WT type classification is rather unusual as it depends only on local information from one station. No large scale information is used as is standard procedure in most WT classifications developed over the years. Could you please elaborate a little bit more to what extent are your results dependent on this particular WT methodology."

We have, at the moment, only subdaily data from one station for performing a classification, while homogenized subdaily data series from other stations are under construction. Hence, standard classification tools such as clustering or approaches using spatial gradients could not be used. There are studies presenting daily weather type classifications for single stations, especially studies dealing with influence of weather on pollution (e.g. Grass and Cane, 2008). However, to our knowledge no study is based on exactly the same set of parameters we use. We confined our classification to the available parameters pressure and wind direction as those variables may possibly best separate differing weather situations in combination with flow characteristics. A very rough orientation for our weather type definition was Schüepp's Alpine weather classification (Schüepp 1968, 1989). However, due to the orographic situation of Geneva (e.g. channeling effects between Jura and Alps) and the fact that we use data from only one station, the correspondence to Schüepp's weather types (which are defined on 500 hPa geopotential height gradients) is necessarily very weak. Using only data from one station is not sufficient to reproduce large scale weather types providing regional patterns. Rather, as discussed in section 3.4. some local- to mesoscale situation is captured, with differing influence of local wind effects. A comparison with the weather types of Schüepp's alpine weather statistics in the period 1987-2010 shows agreement only for pronounced low and high weather situations. To show the applicability of our classification in the study we applied our methodology to a more recent period – as also suggested in the second comment – 1981-2010. As we find very similar weather type frequencies (see updated Figure 6, showing now also weather frequencies for the period 1981-2010) in the reference period and the period 1981-2010 we conclude that for describing local- to mesoscale circulation patterns our methodology is suitable, even though spatial patterns can only be roughly interpreted from local surface wind directions and data from one station. However, even though our method is very different to standard procedures, we think that especially pronounced situations such as frequencies of low and high pressure situations as well as fronts can be well distinguished for Geneva with the method and parameters applied.

"2 (Section 3.4) Following the issue raised above I wonder if the average SLP signature of your WT classes is similar to others obtained with more standard WT classification approaches developed for Switzerland. While I can imagine that daily SLP is not readily available on a gridded format for the considered reference period (1799-1821), you could always apply the same methodology to a more period (e.g. 1970-2000) and check the characteristics of the obtained patterns. For a comprehensive analysis of WT classifications over Europe using a large range of approaches please have a look on the papers summarizing the output of COSTaction_733 dedicated to WT classifications, validation and impacts), including the following summarizing papers: âA ÌĘc ÌĄ Philipp A., J. Bartholy, C. Beck, M. Erpicum, P. Esteban, X. Fettweis, R. Huth, P. James, S. Jourdain, F. Kreienkamp, T. Krennert, S. Lykoudis, S. Michalides, K. Pianko, P. Post, D. Rasilla Álvarez, R. Schiemann, A. Spekat, F. S. Tymvios (2010): COST733CAT - a database of weather and circulation type classifications. Physics and Chemistry of the Earth, 35, 360-373. DOI: 10.1016/j.pce.2009.12.010. âA ÌĘ c ÌĄ Beck C. and A. Philipp (2010): Evaluation and comparison of circulation type classifications

CPD
7, C2417–C2425, 2012

for the European domain. Physics and Chemistry of the Earth, 35, 374-387. DOI: 10.1016/j.pce.2010.01.001"

As mentioned above (author comment to point 1) we applied our methodology to the period 1981-2010 in order to check for consistency of the weather types. Furthermore, an updated Figure 6 showing histograms of the weather type frequencies for the reference period, 1816, and for the period 1981-2010 is provided. The characteristics of the obtained patterns are additionally discussed in section 3.4. in a revised version. In general, markedly similar patterns are obtained in the periods 1799-1821 and 1981-2010. We therefore claim that our classification methodology and the weather types derived therefrom can be readily used for studying differences in weather type frequencies in 1816 and the reference period.

"3 (Sections 3.4, 3.5 and 3.6) There isn't much contextual information on previous works that have used large-scale circulation patterns (even at the monthly/seasonal scale) and the climate anomalies observed. A number of works have dealt with the impact oflarge-scale atmospheric circulation patterns (NAO, EA, etc), obtained from EOF analysis or based in station defined indices. Besides the works of Trigo et al (2009) I would suggest the authors to add some more contextual information on the anomalous values of these large-scale circulation indices for the summer 1816, and also the unusual summer 1818. Just a few examples: Casty C, Handorf D, Sempf M (2005) Combined climate winter regimes over the North Atlantic/European sector 1766–2000. Geophys Res Lett 32. doi:10.1029/2005GL022431 Casty C, Wanner H, Luterbacher J, Esper J, BoÂ ÌĄļhm R (2005) Temperature and pre- cipitation variability in the European Alps since 1500. Int J Climatol 25:1855–1880. doi:10.1002/joc.1216"

To address the large scale circulation, we added the following paragraph at the end of section 3.4: Casty et al. (2005a) investigated large scale climate regimes over the North Atlantic/European sector since 1766. They show that the period 1805-1825, which overlaps to a great extent the reference period, is characterized by an anomalously westerly flow regime. However, the reconstructed parameters are confined to winter (Dec-to-Feb). According to Casty et al (2005b), analyzing Alpine temperatures, the cold summer 1816 was the coldest of a series of below-average summers, which followed a period with generally warm summers between 1780 and 1810 (the warmest being 1807). While winter climate anomaly patterns can be analyzed in the framework of large scale circulation variability, this is more difficult for the summer seasons both because of weaker relations between climate and circulation indices and the lower reconstruction skill of circulation indices. In fact, the anomaly pattern of SLP (Fig. 7) does not project strongly onto the NAO pattern but rather resembles the East Atlantic pattern. Whether this pattern is affected by global volcanic forcing remains to be explored. As the winter 1815/1816 was likely an El Niño winter, remote effects from the tropical Pacific could be considered. There is a tendency for an excitement of such a pattern accompanied by increased precipitation over central Europe in springs following El Niño winters, which was also found in climate reconstructions (Brönnimann et al. 2007). However, the relation between El Niño and European climate is weak.

“4 (Table 2) I would suggest the authors to add another column to this table with the annual absolute frequency of each WT for the entire reference period and for the year 1816. Figure 6 provides only the relative frequency and is also restricted to the summer months.”

We added absolute frequencies of the corresponding weather types for the reference period and 1816 (separately for JJA and all year) to Table 2 and adjusted the Table caption as follows:

Table 2. Weather type classification. Note that days classified as “fronts” could theoretically also fit in other categories, but were attributed to “front” (in practice this occurred only rarely). The fifth column indicates whether significant ($p<0.05$) differences were found within this weather type between 1816 and the reference period according to a Wilcoxon test (y = yes, n = no, - = not enough cases). The sixth column indicates mean absolute frequencies of a weather type in the reference period for an average summer, JJA (annual averages). The last column indicates absolute frequencies of a weather

type for summer 1816, JJA (frequencies for the entire year 1816).

“5 (Figure 2 caption) There is confusion with the use of green and blue colour in this Figure caption (and a contradiction with the inset legend). Where it states: "The green lines denote ±1 standard deviation from the mean, the blue lines give the minima and maxima for the reference period" it should read: "The blue lines denote ±1 standard deviation from the mean, the green lines give the minima and maxima for the reference period". Please re-write.”

Yes this is a mistake, we corrected Figure caption 2.

“6 (Figure 2, upper panel) There is no information regarding the use of different tick lines in the inside part of the x-axis (2 green, 1 red and 2 black). Is this necessary? if so please add additional information. It is also not clear if the vertical line corresponds to the 16 April (last negative temperature that is mentioned in the manuscript), if that is the case it should be mentioned in the Figure caption. Why is the red line apparently highlighting the following day?”

To make the different ticks at the x-axis in Figure 2 clearer we added some more information to the caption as follows: Figure 2. Time series of daily values of temperature at sunrise (top) and 2 pm (bottom) in the year 1816 (thin black solid line) as well as for the average of the reference period (red dashed line). The blue (solid bold) lines denote ±1 standard deviation from the mean, the green (dashed bold) lines give the minima and maxima for the reference period. Note that all annual cycles from the reference period were obtained from the statistics for each calendar day. They were then smoothed by fitting the first two harmonics of the annual cycle. The black dotted vertical line in the upper panel indicates the last day of morning temperatures in spring below 0°C in 1816. Ticks on the x-axis indicate the mean last day-of-year with morning temperatures below 0°C in the reference period (red dashed tick), ±1 standard deviation (blue solid bold ticks), and the earliest and latest date with negative spring temperatures in the morning (green dashed bold ticks). The black dotted vertical line in the lower panel

CPD
7, C2417–C2425, 2012

indicates the date of the annual maximum temperature in 1816.

Concerning the date of the last negative values in 1816: The black dotted line (last date of morning frost in spring 1816) and the red line (mean last day of morning frost in spring in the reference period, which is not an exact date as for 1816) do not represent exactly the same date or day of year. That's why they should not exactly match which is correct. This is indicated in the text as "This corresponds almost exactly to the mean date of the last negative spring temperature in the reference period." (p. 3751, line 16-17).

"7 (Figure 2, lower panel) Why not providing the exact location of the 14 of August using a vertical line (in order to be consistent with the upper panel). The explicit location of the zero line in this graphic might be as relevant for 2.p.m temperature as it is for the morning values. Please be more consistent on the use of the information. In particular there's an outstanding cold event earlier in the year (late January), with both temperatures dropping below the minima observed for the reference period that deserves to be mentioned (with 2.p.m. temperatures close to -8âŮęC). In this case, it would be an unusual weather event and not unusual climate!"

The exact location of the date of the annual maximum temperature in 1816 (14th August) is now also clearly indicated in Figure 2 (lower panel).

The reason for adding the zero line just to upper panel in Figure 2 which shows the morning temperature anomalies is to show the last day of morning temperature in spring lying below zero (morning frost). We also added the zero line to the lower panel of Figure 2.

Regarding the late January cooling event (30th January 1816: morning temp.: -10.6°C, 2 pm temp.: -8.1°C): We did not mention it explicitly in our paper because 15 even colder events (both, morning and noon temperatures below 30th Jan. 1816) happened in the reference period: e.g. 29.1.1802: morning -13.1°C; 2 pm -9.35°C 13.1.1820: morning -10.6°C; 2 pm -9.6°C

“8 (Figure 4) There’s a remarkable drop in 1818 of both the total amount of precipitation (less than 100 mm) and the number of rainy days (about 10 days). This intense decline (that can be regarded has being symmetric to the wet summer of 1816) deserves some additional clarification, namely on the possible context of a regional drought during that year, where it was also dry at least in Iberia (Trigo et al., 2009). Please consider comment #3 when addressing this issue.”

We included some comments on the year 1818 in our paper (p. 3754, line 5): On the contrary to the wet summer 1816, a notably dry summer appears in 1818 (see Fig. 4). Both, the total annual precipitation sum as also the number of precipitation days were the lowest within the whole period 1799-1821. Van der Schrier et al. (2007) use the self-calibrated Palmer Drought Severity Index (Wells et al., 2004) to identify wet and dry seasons over the Alps. Negative index values (dry conditions) within a prolonged period of positive values (1816-1825; wet conditions) for the NW-sector of the Greater Alpine region (including Geneva) for summer 1818 confirm our results. Furthermore, reconstructed SLP anomalies from Luterbacher et al. (2002) for summer 1818 show, in large contrast to the summer 1816, positive SLP anomalies (with the center west of the northern British Isles) covering almost all Europe (Trigo et al., 2009).

“9 (References) I saw no reference in the manuscript to the work of Aguilar et al. (2003). If this citation is not necessary please remove it.”

Yes, that’s true. we removed this reference.

Furthermore, we added the following references, which arose from the review process:

Casty, C., Handorf, D., and Sempf, M.: Combined climate winter regimes over the North Atlantic/European sector 1766–2000, Geophys. Res. Lett., 32., doi:10.1029/2005GL022431, 2005a.

Casty, C., Wanner, H., Luterbacher, J., Esper, J., and Böhm, R.: Temperature and precipitation variability in the European Alps since 1500, Int. J. Climatol., 25, 1855–

1880, doi:10.1002/joc.1216, 2005b.

Brönnimann, S., Xoplaki, E., Casty, C., Pauling, A., and Luterbacher, J.: ENSO influence on Europe during the last centuries, Clim. Dyn., 28, 181-197, doi:10.1007/s00382-006-0175-z, 2007.

Luterbacher, J., Xoplaki, E., Dietrich, D., Rickli, R., Jacobeit, J., Beck, C., Gyalistras, D., Schmutz, C., and Wanner, H.: Reconstruction of sea-level pressure fields over the eastern North Atlantic and Europe back to 1500, Clim. Dyn., 18, 545–561, doi:10.1007/s00382-001-0196-6, 2002.

van der Schrier, G., Efthymiadis, D., Briffa, K.R., and Jones, P.D.: European Alpine moisture variability for 1800-2003, Int. J. Climatol, 27, 415-427, doi:10.1002/joc.1411, 2007.

Wells, N., Goddard, S., and Hayes, M.J.: A self-calibrating Palmer Drought Severity Index, J. Climate, 17, 2335-2351, doi:10.1175/1520-0442(2004)017<2335:ASPDSI>2.0.CO;2, 2004.

Interactive comment on Clim. Past Discuss., 7, 3745, 2011.