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Climate of the Past
Discussions

Interactive comment on "Effects on the Czech Lands of the 1815 eruption of Mount Tambora: responses, impacts and comparison with the Lakagígar eruption of 1783" *by* R. Brázdil et al.

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We would like to thank Anonymous Referee 3 for very valuable comments contributing to the improvement of the paper.

1. There might be some problem in this paper's structure and contents. The authors have centered their paper on the 1815 eruption and its consequences. But they also include information about the Lakagigar eruption mainly within the "results" section (only a short paragraph in the introduction). This is quite confusing. Even the title is too long and quite ambiguous. Moreover the two eruptions are rather different and so are their impacts. I think the authors could consider two solutions - A) Either concentrate on the 1815 eruption, as they possess more instrumental and documentary information

- B) Or write a paper on the comparison of the two eruptions and their consequences, change the title and modify the paper's structure accordingly, using and developing the texts where this comparison is already carried out. RE: The option A was selected. The paper orients only on the Tambora eruption and the title was changed as follows: Climatic effects and impacts of the 1815 eruption of Mount Tambora in the Czech Lands

2. Introduction - Explain how an eruption in tropical site may affect the climate in central Europe. If you include the L. eruption, compare the features of both eruptions. RE: Accepted. We believe that the recent improved version of the first paragraph is related also to central Europe, i.e. changes in the radiative balance are implying subsequent cooling and changes in circulation. See particular: "For example, Fischer et al. (2007) analysed winter and summer temperature signals in Europe following 15 major tropical volcanic eruptions and found significant summer cooling on a continental scale and somewhat drier conditions over central Europe. The effects of large tropical volcanic eruptions on radiative balance manifest themselves not only in widespread cooling, but also contribute to large-scale changes in atmospheric circulation, leading to one or two post-volcanic mild winters in the Northern Hemisphere (Robock, 2000). Fischer et al. (2007) associated volcanic activity with a positive phase in the North Atlantic Oscillation (NAO), causing stronger westerlies in Europe and wetter patterns in Northern Europe. Literature addressing volcanic effects on precipitation is more sparse (Gillett et al., 2004). For example, Wegmann et al. (2014) analysed 14 tropical eruptions and found an increase of summer precipitation in south-central Europe and a reduction of the Asian and African summer monsoons in first post-eruption years. Weaker monsoon circulations attenuate the northern element of the Hadley Cell and influence atmospheric circulation over the Atlantic-European sector, contributing to higher precipitation totals."

3. Data section – Documentary data and the notes that accompany some of the instrumental data should be described in more detail. In some cases, the authors refer to their own past publications, but a short sentence could clarify the content of each of

the sources (e.g. 1), p. 3, l.11). Indicate clearly the new information brought about by this paper. RE: Accepted, information about instrumental and documentary data were re-elaborated – see new Sections 2.1 and 2.2 below: "2.1 Instrumental data The climatological analysis herein is based on the following monthly, seasonal and annual temperature and precipitation series for the Czech Lands (Fig. 1): (i) Prague-Klementinum (central Bohemia): homogenised series of temperatures (1775–2010) and precipitation (1804–2010), starting in a block of buildings that were once the Jesuit college of St. Clement, and located on the same site until quite recently (for data see Brázdil et al., 2012a) (ii) Brno (south-eastern Moravia): homogenised series of temperatures (1800–2010) and precipitation (1803–2010) compiled from a number of places in the Brno area and homogenised to the recent Brno airport station (for data see Brázdil et al., 2012a) (iii) Czech Lands: series of mean areal temperatures (1800–2010) and mean areal precipitation (1804–2010) calculated from ten homogenised temperature series and 14 homogenised precipitation series over the Czech Lands (for data and details of calculation, see Brázdil et al., 2012a, 2012b) (iv) Žitenice (north-western Bohemia): homogenised series of temperatures (1801–1829) measured by parish priest František Jindřich Jakub Kreybich at Žitenice (measurements started in 1787 but incomplete before 1801), worked up by Brázdil et al. (2007) (v) Central Europe: reconstructed temperature series (AD 1500–2007), consisting of temperatures derived from documentary-based temperature indices for Germany, Switzerland and the Czech Lands up to 1759 and homogenised temperature series of 11 secular meteorological stations located in these three countries and Austria from 1760 onwards (DobrovolnÃ¡ et al., 2010).

2.2 Documentary data The pre-instrumental and early-instrumental period of meteorological observations in the Czech Lands is well covered by documentary evidence that contains information about weather and related phenomena. It occurs in a number of data sources (e.g. annals, chronicles, memoirs, diaries, newspapers, financial records, songs, letters, epigraphic records, and others), which provide the basis for research in historical climatology (Brázdil et al., 2005b, 2010b). As well as a wealth of chron-

icles and personal histories reporting various climatic and weather anomalies, their impacts and consequences (for those used in this study see Section 4.2), the following sources have proved particularly valuable: (i) Annual summaries of the weather and the general economic situation that accompany the daily weather observations kept by František Jindřich Jakub Kreybich in Žitenice for the years 1815, 1816 and 1817 (S1–S3) (ii) Qualitative daily weather observations and their monthly and annual summaries kept by Reverend Šimon Hausner of Buchlovice (south-eastern Moravia), spanning the 1803–1831 period (S4) (iii) The detailed weather records kept by Anton Lehmann, a teacher in Noviny pod Ralskem, over the 1756–1818 period, which were copied into the local "book of memory" by Joseph Meissner in 1842 (S6) (iv) Notes extracted from meteorological observations kept by Antonín Strnad and Alois David, the third and fourth directors of the Prague-Klementinum observatory (Poznámky, 1977). Moreover, the editions of newspapers published in Prague (Prager Zeitung), Brno (Brünner Zeitung) and Vienna (Wiener Zeitung) covering the post-Tambora years were also systematically scrutinised for 1815–1817. Although weather information appears relatively rarely in their pages with respect to descriptions of events in the Czech Lands or Austria, related stories from other parts of Europe or North America clearly prevail there."

4. The methods section (p. 3) should be more clear and developed, particularly when it comes to documentary data (different steps that were necessary to construct a dataset from the documentary data). This is included in other papers from the same authors but should be incorporated here referring to these specific cases. RE: Accepted, the new paragraph related to the use of documentary data was added as follows: "In this paper, descriptions of weather and related phenomena in the Czech Lands post-Tambora, i.e. May 1815–December 1817 are derived from documentary data. All such the data extracted were critically evaluated, including analysis of source credibility, place and time attribution of records, content analysis, interpretation of records with respect to recent meteorological terminology and cross-checking of records against various different places in the Czech Lands. The creation of a database was the next step, in which information about place, time and event, characterised by key-words, full re-

ports and data sources, has been recorded to provide a basis for further use (see Section 4.2). Kreybich's records from Žitenice (S1–S3) and Hausner's observations from Buchlovice (S4) were then further employed for calculation of monthly numbers of precipitation days in 1815–1817 (see Fig. 6)."

5. The results sections (p. 3- 7) should be reorganised according to your choice of A) or B) (see above, please). Should not the comparison of the two eruptions referring to climate and to their impacts be included in the results part? (if you follow B. If you select A, then these paragraphs should be deleted). RE: Accepted. Because of selection of option A, this paragraph was deleted.

6. Rewrite the discussion part adding some current explanations about the differences of the two eruptions and why are the impacts different (if you choose B), putting the events into European context. RE: Accepted. With respect to change only on the Tambora eruption, everything in the manuscript related to Lakagígar eruption was deleted and parts related to Tambora were changed accordingly.

p. 3, line 9 –Explain what are visual weather records RE: Under "visual weather records" we understand more-or-less systematic daily weather observations done without any instruments on the qualitative way. But due to restriction of the article only to the Tambora eruption, corresponding sentence was deleted.

p.4, 2nd paragraph. As the authors notice there had been already a cool period in 1812-1814. Perhaps the authors should point out more clearly the differences between these two cold periods and the drop of temperature anomaly after 1815. RE: Accepted, we add following sentences into Section Discussion where it seems more appropriate than in the results as proposed: "In the light of papers by Cole-Dai et al. (2009) and Guevara-Murua et al. (2014), the cold summers early in the second decade of the 19th century may also have been influenced by an unknown volcanic eruption in 1808/1809. In this context, Brönnimann (2015) demonstrated cool April–September 2010 patterns compared to mean surface air temperatures in 1801–1830 and argued that this erup-

tion could have set the stage for sustained ocean cooling (compare Stenchikov et al., 2009). However, 1811 was already warmer in the Czech Lands from spring to autumn, and lower temperatures started in 1812 (see Fig. 2)."

P. 4, line 16 (and Fig.4) – you refer that autumn 1817 shows strong negative anomalies, but autumn 1815 has also little rain. Please explain. RE: Analysis of precipitation data after post-Tambora years allows us to detect some climatic anomalies which are clearly reflection of some circulation patterns (e.g. more often high-pressure situations over Central Europe in the both mentioned autumns). But we are not able to go behind because we do not know papers explaining circulation changes after large tropical volcanic eruptions in Europe what is not intention of this article.

Figure 1 – indicate through different symbols the places from where you used meteorological and documentary data. If you have both data for the same site use a combined symbol. RE: Corrected as requested.

Figure 2 – why are the anomalies calculated relatively to the five years' period preeruption? RE: We used method of analysis applied in several papers dealing with effects of volcanic eruptions in temperature series: "The climatic effects of the volcanic eruption based on instrumental observations are expressed in the short-term and long-term contexts. In the short-term, the approach followed is that taken by several other papers addressing the effects of eruptions on temperature series (e.g. Sear et al., 1987; Robock and Mao, 1995; Kelly et al., 1996; Písek and Brázdil, 2006; Fischer et al., 2007)." As mentioned in Section 3: "Temperature patterns related to the eruption are described over a ten-year period to avoid the possible influence of a strong trend."

Figure 3- The Figure caption is not clear and the two "temperature _C" in the vertical axes are confusing. You could write in the right one "Temperature anomalies in C.E." and leave the left one as it is. RE: Corrected as requested.

Figures 6 and 10 – there is no need to include both figures. RE: Accepted, Figure 10 was deleted.

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