Comment on "Was the 2003 European summer heat wave unusual in a global context?" by Thomas N. Chase et al.

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Received 3 July 2007; revised 19 November 2007; accepted 6 December 2007; published 17 January 2008.

Citation: Connolley, W. M. (2008), Comment on ''Was the 2003 European summer heat wave unusual in a global context?'' by Thomas N. Chase et al., *Geophys. Res. Lett.*, *35*, L02703, doi:10.1029/2007GL031171.

[1] *Stott et al.* [2004] describe the European heat wave of 2003 as probably the hottest in Europe since at least 1500 AD; *Schär et al.* [2004] find the event to be statistically extremely unlikely, even taking into account the recent warming trend. But *Chase et al.* [2006] (hereinafter referred to as C06) find that extreme warm anomalies equally, or more, unusual than the 2003 heat wave occur regularly. To resolve this apparent incongruity I examine the definition used by C06 and find that the crucial disparity lies in C06's use of 1000–500 hPa thickness as the measure of anomaly. Using C06's methods on near-surface temperature I find that summer 2003 was indeed unique in the record. The source of data for this study is the NCEP NCAR reanalysis [*Kalnay et al.*, 1996], the same source as for the Th500 data of C06. Since much of the 22–80 N area is sea, the time-constant of temperature response will be different than over land, and may represent a mismatch with Th500.

[2] C06 use, as their measure of uniqueness, a criterion of a years anomalies exceeding the average by a given factor of the standard deviation (SD). They then calculate the fraction of the area of the globe (restricted to the domain 22–80 N to avoid the tropics and the less well observed pole) that is covered by an anomaly during the summer months of June, July and August. Using this measure applied to 1000–500 hPa thickness (Th500) they conclude that 2003, whilst warm in Europe, was far from unique in terms of the area covered by the "heat wave". For example, 1998 has 1.13% of the area exceeding 3 SD whereas 2003 has only 0.50%. Figure 1 largely replicates Figure 2 of C06 (but omits negative anomalies as less interesting), and shows the fraction of 22–80 N covered by positive anomalies exceeding 2, 2.5, 3 and 3.5 SD. Figure 1 also includes anomalies of near-surface temperature (T1.5). This shows that for lower values of SD-exceedance, representing unusual but not exceptional conditions, Th500 and T1.5 fractions correlate well. But for exceptional circumstances, of 3* or 3.5*SD, the two variables decouple. Th500 anomalies cover the largest area in 1998 at 3*SD and in 1991 at 3.5*SD; whereas T1.5 anomalies are largest in 2003 for both values. By this measure, then, the summer of 2003 was indeed unprecedented.

[3] The disparity between these two measures suggests that the 2003 heatwave was a relatively shallow event, at least in terms of its "exceptionalness". Figure 1 shows that 1991, 1998 and 2003 have the largest anomalies for 3 SD events. Table 1 shows the fraction of 22–80 N covered by anomalies in pressure-level temperature for levels ranging from 1000 to 500 hPa; only in the near-surface layer is 2003 exceptional. A similar result is found using thickness data from 1000 hPa to these levels. This may well indicate a strong role for surface drying in causing the 2003 event [*Ferranti and Viterbo*, 2006]; though *Black et al.* [2004] have suggested a role for large-scale anomalies leading to the surface drying.

[4] Thus it becomes clear that how "exceptional" the 2003 event was depends on how it is assessed; which is the more meaningful definition is not clear. With regard to impacts, the surface temperature is most important and in that sense the event was unprecedented. However in attempting to place the event within the context of anthropogenic climate change the large-scale situation and forcing might well be more important.

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0094-8276/08/2007GL031171$05.00

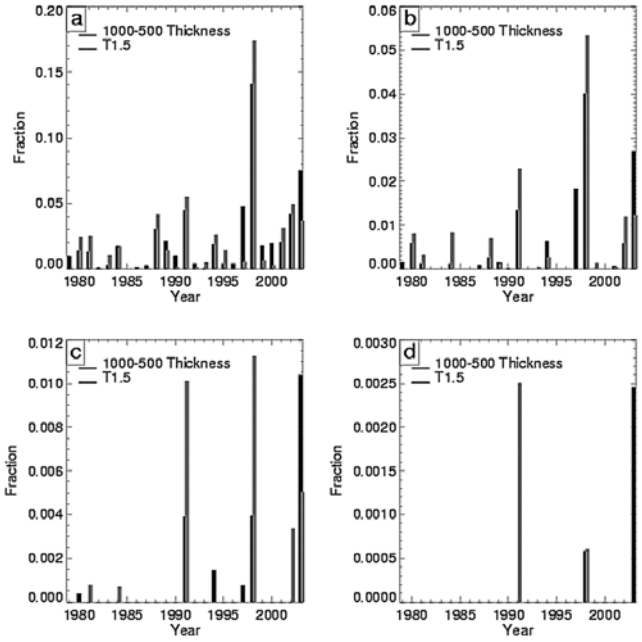

Figure 1. Fraction of 22–80 N covered by (a) 2, (b) 2.5, (c) 3, and (d) 3.5 SD anomalies of 1000–500 hPa thickness (grey) and near-surface temperature (black) for 1979–2003.

Table 1. Fraction of 22–80 N Covered by 3 SD Anomalies of Temperature on Given Pressure Levels for the Years 1991, 1998, and 2003[a]

Pressure Level	1991	1998	2003
1000	0.0038	0.0040	0.0095
925	0.0124	0.0054	0.0084
850	0.0133	0.0172	0.0068
700	0.0076	0.0100	0.0022
500	0.0074	0.0027	0.0003

[a]Pressure levels measured in hPa.