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Climate of the Past Discussions

CPD
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Interactive Comment

Interactive comment on "Northern Hemisphere temperature patterns in the last 12 centuries" *by* F. C. Ljungqvist et al.

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We are encouraged by the positive, and constructive, comments given by Anonymous Referee #1 and use this opportunity to respond to his/her specific comments in detail below.

Specific comments:

Page 3350, lines 16–17: The data set used in Christiansen and Ljungqvist (2011) is not an exact subset of the proxy collection in the present paper, although there is overlap. The reference to Ljungqvist (2008) is an error and it should be Ljungqvist (2010).

Page 3351, lines 8–10: We agree with Anonymous Referee #1 that the term "global forcings" is unclear and will thus change it to "external forcings". Concerning the com-

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ment on volcanic forcing, we would like emphasize that volcanic forcing can have a considerable impact on hemispheric temperature, even on centennial time-scales, since clustering of large volcanic eruptions can result in decadal to multi-decadal cooling. The discussion of whether solar or volcanic forcing has had the largest impact on the long-term evolution of temperature over the last millennium is ongoing.

Page 3352, line 1: We will include a Table showing the number of Northern Hemisphere proxies extending beyond AD 1000 used in previous hemispheric or global scale multi-proxy temperature reconstructions.

Page 3352, line 12: In a comparison of the frequency response between a 100-yr moving average (i.e. 100-yr rectangular filter) with the performance of four different splines (parameter = 100, 167, 200, 315) we found that the 100-yr moving average has a 50% response/cutoff near 167 years. None of the spline parameters tested look exactly like a 100-yr moving average. However, the 167-yr spline and the 200-yr spline are the closest (see the Figure).

Frequency response of a spline parameter of 167:

Wavelength variance

52.92 99.0% 126.86 75.0% 236.19 20.0%

66.90 97.5% 140.40 66.7% 289.23 10.0%

80.05 95.0% 167.00 50.0% 348.69 5.0%

96.36 90.0% 198.61 33.3% 417.33 2.5%

118.05 80.0% 219.76 25.0% 526.77 1.0%

Page 3360, line 11: Yes, many tree-ring width records are used in our study besides MXD records.

Page 3361, line 5: It is true that for many trees the environmental conditions during fall, winter, and spring can impart an influence on annual growth. This is particularly true of conifer species with long needle retention rates. It seems only logical that, in extreme tree-line situations, such eco-physiological mechanisms may have an even greater impact on annual growth and may in fact be responsible for the longer temperature response found in some ring width data from high latitudes (e.g., Jacoby and D'Arrigo, 1989). The physiological argument for this theory is both intuitive and convincing (Tranquillini, 1979; Jacoby and D'Arrigo, 1989; Havranek and Tranquillini, 1995; Jacoby and D'Arrigo, 1995). However, the effect of these unique conditions on ring width cannot be the foundation for any general rule regarding all high latitude ring width chronologies on all time scales. One must always keep in mind that ultimately cambial activity is regulated by temperature and takes place mainly in the growing season. Numerous studies since 1989, including that of Tuovinen et al. (2009) and D'Arrigo et al. (2006) have concluded that ring width, even from these northern tree-line sites, is still strongly correlated with growing season temperature. Whether this departure from earlier conclusions is the result of the particular trees studied, the quality, type, and location of climate data used, or the chronology development techniques is debatable.

Despite the relatively few, albeit well designed, experiments that have compared tree-ring width (TRW) and density (MXD) data from high latitude trees, (e.g., Jacoby and D'Arrigo, 1995; D'Arrigo et al., 2009) few have looked at the low-frequency signal of TRW and MXD reconstructions from the same trees. There is one figure in Jacoby and D'Arrigo (1995) (their Figure 2a and 2b) that approaches this comparison but the variables and scales are not the same. Nevertheless, if you scrutinize this figure seriously you can see that the year to year variability of the seasonal (MXD) reconstruction is very similar to what a high-frequency filter of the annual (TRW) reconstruction would produce. The point being, they are both tracking the same low-frequency trends.

For a comprehensive discussion on this topic we would refer the reader to the following articles: Wilson et al. (2007a) (their Table.1), Wilson et al. (2007b), D'Arrigo et al. (2009) and most recently Andreu-Hayles et al. (2011). The latter article being most appropriate as it nearly revisits one of the same sites described in Jacoby and D'Arrigo (1989).

Page 3367, lines 20–22: We will try to find an appropriate place in the main text to insert the statement "Because the spatial coherence is expected to increase with increasing time-scales this comparison reveals that the proxy series exhibit a substantial amount of noise which motivates the use of spatial averaging of proxy anomalies".

Technical corrections:

Page 3350, line 10: Accepted, this will be corrected.

Page 3351, line 18: Accepted, the study by Mann et al. (1999) will be added but not Mann et al. (1998) since it only covers the last 600 years.

Page 3354, line 15: Accepted.

Page 3359, line 22: Accepted.

Page 3361, lines 7–10: Accepted, we will try to rewrite this sentence to make it clearer.

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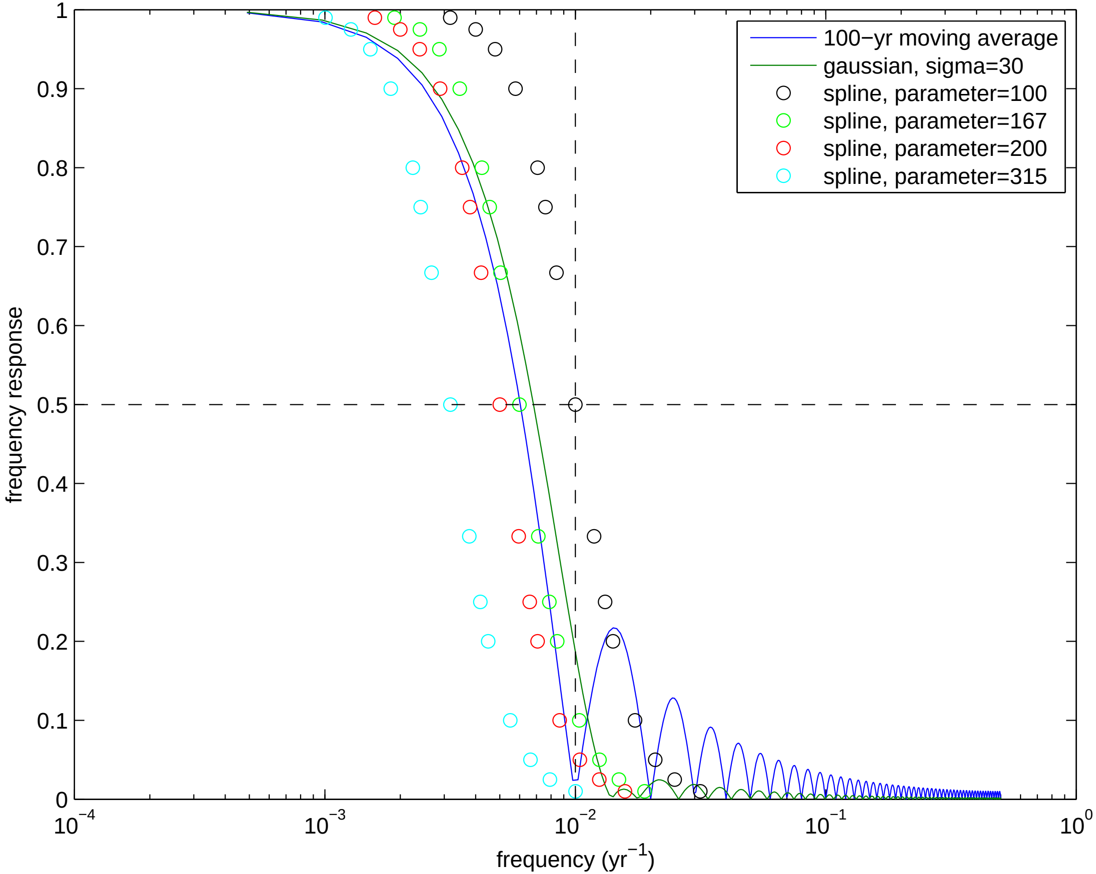

100−yr moving average
gaussian, sigma=30
spline, parameter=100
spline, parameter=167
spline, parameter=200
spline, parameter=315
frequency response
frequency (yr^{-1})
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}

Fig. 1.