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Climate of the Past Discussions

Interactive comment on "Mechanisms for European summer temperature response to solar forcing over the last millennium" *by* D. Swingedouw et al.

Anonymous Referee #1

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1 General comments

The manuscript presents an important contribution for the understanding of natural climate variability during the last millennium that falls well withing the scope of CP. However the robustness of the results could be improved by using a larger number of reconstructions and some of the proposed mechanism should be described more in detail. Therefore, I advise acceptance for publication in CP with minor to major revisions.

short summary: The paper analyzes the role of variations in the solar forcing during

the last millennium for summer temperatures in Europe and examines mechanisms that could explain regional differences in the response. The findings are based on model simulations and temperature reconstruction data. With higher solar activity, surface temperature in Europe increases, but the warming in Central Europe is reduced due to negative soil feedbacks: the increased soil moisture (due to higher winter precipitation), leads to an increase in evapotranspiration, leading to more clouds and reduced SW radiation reaching the surface. In Northern and Southern Europe the soil moisture feedback is not the dominant mechanism.

The model results are compared to a single spatial summer temperature reconstructions for Europe (Guiot et al. 2010). A comparision to other reconstructions would make the findings more robust. In the last year, several summer-time temperature reconstructions for Europe were published, e.g.

- Luterbacher et al. (2004, Science): Seasonal European temperature reconstruction 0.5°x0.5° (since 1500 AD).

Additionally, if the results are robust, they should also be found in regional temperature reconstructions. For example:

- McCarroll et al (2011, Millennium Project) North Fennoscandia summer temperatures. (1085-2007).
- Büntgen et al. (2011, Science) Central Europe, summer temperatures (past 2500 years).
- Büntgen et al. (2008, Climate Dynamics), Pyrenees, Warm season temperatures (1260-2005).

I suggest to use these (and other) reconstructions to test the robustness of the results, presented for example in Fig. 2 and 4.

2 specific comments

2.1 2 Experimental design

- Please add a brief (1-2 sentences) model description (model components, spatial resolution) to the experiment description.
- Please mention the amplitude of the solar forcing used, e.g. by comparing the value in the Maunder Minimum to present days value.
- related to the assumption, that regression captures mainly the solar signal: The authors could exclude the years that are affected by volcanic eruptions (e.g. the 10-20 years following an eruption) and calculate the regression again. If the results are comparable this would strengthen the assumption.

2.2 3 Result

- related to the model-reconstruction comparison: Between 1500 and 1700 the reconstructions and the model results differ strongly. Moreover, the reconstruction show more or less the opposite pattern than the solar forcing: the highest values in the reconstruction can be found in periods with the lowest solar activity, the Spörer and the Maunder Minimum. Could you please comment on this and maybe explain, why we find this pattern in the reconstruction but not in the model. Please also comment on how this period affects the solar-temperature regression. In which way does the regression change, when the period 1500-1700 is excluded from the regression?
- Why do you refer to the region with increased cloud cover etc as 'Central Europe'. For me it looks more like 'Central and Eastern Europe', at least the maximum cloud cover reductions are found over western Russia.

- related to Fig. 4: It would be easier to compare the degree of similarity between model and reconstruction if confidence intervals for the zonal mean regression coefficient were included in the figure. Moreover this would help to interpret the difference between the latitudes. Since less land grid cells are found in the north compared to the south, the regression slopes are not directly comparable without an estimate of the uncertainty.
- '... we diagnose that 65 % of this increase is related to convective precipitation'. Where does this number come from? Is it possible to distinguish convective precipitation from large scale precipitation in the model and is the estimate based on this information? Then please mention it.
  - if this is not possible, how robust is the robust is the existence of the Schär et al. (1999) then? Could it also be, that the increased precipitation is only a local process with a 'recycling of the additional evapotranspiration'?
- the explanation why the mechanism is not working in the North is to short. Please explain this more in detail.
  - The warming is explained by sea ice retreat. I would prefer a more detailed analysis of this sea ice reduction and the feedbacks involved. How much sea ice is lost? When (summer or winter)? Where? Does this change the pressure patterns and circulation systems or is this only a local process?
  - The local sea-ice feedback after major volcanic eruptions (that, according to their results, leads to the transition into the little ice age) is analyzed in Miller et al. (2012, GRL) and Zhang et al. (2011, Clim Dyn). Following their finding, your assumption, that the regression captures mainly solar signals, could become crucial for the Northern Europe response. Please comment on the possibility, that the Northern Europe signal could be influenced by volcanic eruptions, which then lead to the LIA transition.

- Why is Seneviratne et al. (2006) cited here? I do not find any reference to the claim in this paper. Northern Europe is not really discussed in this paper, as far as I can see. Why is the radiative flux availability the limiting factor here?

2.3 Conclusions

- Please discuss the amplitude of your solar reconstructions and compare it with other state of the art solar reconstructions. Is the reconstruction used in this study characterized by a comparable large amplitude? A good review on this is Gray et al, 2010 (Reviews of Geophysics).

3 technical corrections

- page 1303, line 13: "Evapotranspiration is a actually..." – please delete 'a'
- page 1304, line 20: reference to Fig 1a should be Fig. 1, I guess.
- page 1305, line 14: Please replace 'figure' by 'value'
- page 1306, line 5: '...twice larger than...' - check phrase
- page 1306, line 12: 'largest changes', instead of 'mains changes'
- page 1306, line 17: 'the changes in evap. is the' better '... are the...'
- page 1307, line 22f: do you mean Swingedouw et al 2011 (not 2010)? And most likely Fig 3a should be referred, not 2a.
- page 1308, line 2: Fig 4 should be referred here, not Fig. 4.

- page 1308, line 13: 'Such a long time scale as the...' - check phrase
- page 1309, line 8: 'The extension ... also improves the ...' – with trailing s
- Fig. 1.: '... with its own axis on the right'. There are no labels on the right axis.
- Fig. 2: last line: brackets around 2010 (Guiot citation)
- Fig. 3.: '...and negative...' (instead of 'negatibe'). The labels on the color bar are a bit to small.
- Fig. 4: the unit on the x-axis should be 'deg C / Wm-2'; please mention that the zonal mean temperature was regressed on the solar forcing.
- Fig. 6: 'each line corresponds to a computation each century...' I do not understand this sentence.
- better: 'solar forcing' instead of radiative forcing. X-Axis: better Jan-Dec, than 1.0-12.0
- Fig. 7: mention which part of the scheme is based on the mechanism proposed by Schär et al.
- Why is there a plus between 'surface SW' and 'surface temperature'?? Less surface SW results in higher temperatures?

Interactive comment on Clim. Past Discuss., 8, 1301, 2012.