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Climate of the Past Discussions

Interactive comment on "Influence of solar variability, CO_2 and orbital forcing during the last millennium in the IPSLCM4 model" *by* J. Servonnat et al.

Anonymous Referee #1

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The analysis presents a statistical approach to decompose the temperature response of a forced climate simulation into parts related to the applied forcings of the last millennium. The climate model IPSLCM4, which consists of an AOGCM coupled with a sea-ice model and a vegetation model, is forced by greenhouse gas (GHG) concentrations and tropospheric aerosols in the control run (CTRL) and with variable Total Solar Irradiance (TSI), GHG concentrations and orbital parameters in the forced run (SGI). Although the results disclose no fundamental new findings, the work presents a careful interpretation of the simulation results including an evaluation of the simulated temperatures against proxy data reconstructions. The presentation of the results is well structured and the text well written. A new aspect is, that the analysis is done

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for continuously decreasing horizontal scales, i.e., from global to grid-cell scale. The finding of a significance threshold for the signal-to-noise ratio (SNR) to lie between 3-7 x 10ˆ6 kmˆ2 is an interesting conclusion.

Some specific comments and technical corrections are given for further improving the presentation.

1. The experimental design and Figure 1 describe two simulations (CTRL and SGI) from 1000 to 2000 AD. The statistical decomposition analysis seems to use only the simulated temperatures from the preindustrial period 1000 - 1850 AD. If that is the case then the title should be changed accordingly.

2. The last sentence of the abstract (page 422 line 23-25) is difficult to understand. What is meant by individual temperature reconstructions? Do these temperatures show only a weak linear response to the external forcing because a) they show a non-linear response to the forcing, or b) they are affected by internal variability, or c) they are affected differently by the external forcings?

3. After a 110-year spin up of the model, a steady state is reached (page 427 line 5-6), but then the first 100 years of CTRL are said to present a weak drift (page 427 line 9-10). This sounds contradictory and why is the drift in the first 100 years in CTRL not seen in Fig 3a?

4. The sentence on page 427/428 line 29/1 should say that the radiative forcing is null when averaged over the year and over the globe and not when averaged at hemispheric scale. The annual and global insolation received at the top of the atmosphere does not change with changes in precession or obliquity, but changes only with eccentricity which is negligible over the millennium period.

5. The simulation SGI does not account for volcanic activity and land-use changes which are considered in many previous climate simulations for the past millennium. Is there a reason to omit these forcings? On page 430 line 13-17, the volcanic forcing

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is shown to produce an even better agreement with reconstructions in the industrial period after 1850.

6. The significance of the linear decomposition of the temperature response in relation to TSI, GHG and orbital forcings is shown to depend on the spatial resolution and on the region. In some regions localized processes come into play, e.g., the ice-albedo feedback in high northern latitudes or the ENSO dynamic. In addition, the dissimilar latitude-month patterns of TSI and GHG forcings alter the relative influences from TSI and GHGs on the temperature response which is not discussed. I can imagine, that different forcing patterns can contribute to the differences seen in Fig 6 between C_1ˆBV and C_2ˆBV in the high northern latitudes. While C_1ˆBV is relatively large in the northern latitudes in northern summer, C_2ˆBV is relatively large both in summer and winter. The different forcing patterns could also play a role for explaining the percentages of the temperature variance shown in Fig. 7. See for instance Fig 1 in Govindasamy et al (2003) and the discussion therein.

7. Why is in the definition of SNR (Equ. 4) the weighting of the elements depending on a length scale (sqrt(a_i)) instead depending on the area (a_i)?

Technical corrections:

p 425 l 17: change "until" to back until or since

p 429 l 2: The order of the authors Wahl and Ammann are interchanged, see also reference list.

p 431 l 14: Is it more adequate here to say: We calculate the signatures associated to TSI (S_ˆTSI = ...?

p 432 l 14; p 436 l 22 and p 437 l 4: unit of sensitivity C_1* in °C / Wmˆ-2

p 432 l 15: change F_3 to S_3?

p 432 l 26: change reproduced to repeated

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p 436 l 6: Does the term "frequency of the variability" here refer to the time-window of smoothing?

p 432-433 : The different variances of the signatures described in the text for the two time sections (1000-1425 AD and 1425-1850 AD) should be given in an extra table.

Fig 1a: Orange line is hard to see

Fig 1a caption, p 451: TSI values are shown on the right not left of figure

Fig 4: What is the meaning of the colors on the globe?

Fig 5: An alternative to "spatial extend" is maybe geographic dimension.

Fig 6 and 7: Change summer to maybe JJA and winter to maybe DJF

B. Govindasamy, K. Caldeira, P.B. Duffy, Geoengineering Earth's radiation balance to mitigate climate change from a quadrupling of CO2, Global Planet. Change 37, 157 (2003)

Interactive comment on Clim. Past Discuss., 6, 421, 2010.