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Interactive Comment

Interactive comment on "Role of radiatively forced temperature changes in enhanced semi-arid warming over East Asia" *by* X. Guan et al.

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We appreciated the insightful suggestions and comments provided by reviewers. The responses to the reviewer's comments and suggestions have been stated as below.

Review of ' Role of radiatively forced temperature changes in enhanced semi-arid warming over East Asia'

Reviewer #1: 1. Scientific comments: Title: since the manuscript focuses exclusively on the cold season, the authors should consider adding "cold season" to the title, perhaps before "temperature changes".

Response: We appreciated reviewer's comments and agreed to do the change. The new topic of revised manuscript is ‘Radiative forced enhanced semi-arid warming in cold season over East Asia.”

2. P22976-L26: it is unclear what the authors mean by "The non uniform of population and economic distributed in this area led to an obvious change discrepancy to the environment." Needs clarification.

Response: " The non uniform of population and economic distributed in this area led to an obvious change discrepancy to the environment." has been changed to “The regional environment change has a close relationship with local population density and economic development level”. This sentence aims to state that the environment change induced by the human activities has a spatial discrepancy, which will be illustrated in the results of revised manuscript. As the regional discrepancy, the radiatively forced temperature change extracted by the dynamical adjustment method needs investigating in further.

3. P22978-L1: probably best to refer to the method as "dynamical adjustment".

Response: we agree with reviewer’s suggestion and the "dynamic adjusted" has been changed into "dynamical adjustment" in the revised manuscript.

4. P22979-L10: (MAJOR) since there are large trends in the data, I suggest that the authors high pass filter or detrend the predictand time series prior to calculating the cross-correlation maps used in Step (1). This follows Smoliak et al. (2015) and ensures that you are not fitting trends in the PLS regression process. Bear in mind that this detrending or high pass filtering need only be applied to the predictand. If the authors analysis is fitting trends, this methodological change will influence the results. If not, the authors can be confident that their dynamically influenced temperature (DIT) reflects the influence of month to month and year to year changes in the atmospheric circulation.

Response: We thanks reviewer’s insightful question. Per the reviewer’s question, in our study, we have done the high pass filter to the predictand time series prior to calculating the cross correlation maps used in Step (1). The dynamical adjustment method we used is totally follows the steps in Smoliak et al., (2015). In order to avoid the misunderstanding of the method and appearing the similar puzzle from readers, we rewrite the method introduction in section 3 to state the procedure of dynamical adjustment method.

5. P22980-L4: the authors should probably state that non-radiative factors resulting from thermodynamic processes will also be lumped into the RFT. They may be able to argue that thermodynamic effects are small over the semi-arid regions.

Response: We agreed with the reviewer's suggestions and revised the statement of RFT. The non-radiative factors resulting from thermodynamic process, which lumped into the RFT has been stated and more description has been added in the revised manuscript.

6. P22980-L9: define the cold season length (calendar months) here or in section 2 or 3.

Response: We have added the definition of cold season in section 3, which is as follow that in the previous results (Huang et al., 2012). Semi-arid region as a sensitive area to climate change appeared enhanced warming in boreal cold season (Nov.-Mar.), it is also satisfied with the suitable period of dynamical adjustment.

7. P22980-L10: why did the authors choose the period 1902-2011. This should be justified.

Response: The data was selected in the manuscript is from CRU, with a period of 1901 to 2012. As our study has been focused in the cold season, the cold season contains the Nov., Dec. in this year and Jan., Feb., Mar. in next year, which induced the period of data has been changed from 1901-2012 to 1902-2012. In addition, the sea level pressure data we used in the dynamical adjustment method have a time period of

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1901-2011, so the period 1902-2011 was chosen.

8. P22981-L24: is it appropriate to use annual-mean precipitation as a basis for classifying climate regions for a cold season analysis? Why?

Response: The annual-mean precipitation of 1961-1990 is as climatology index has been widely used (Fu et al., 2002; Huang et al., 2012; Feng and Fu, 2013). The climate regions are determined by the climatological annual mean water budget, not by the cold season or warm season mean. So the annual-mean precipitation is appropriate as a basis for classifying climate regions for a cold season or a warm season analysis. However, annual-mean precipitation is not working well in the high latitude areas in classifying climate regions, which we have recognized that, and our study area is located in the middle latitude of East Asia. In order to illustrate the confirmation of our results, the function of raw, radiatively forced and dynamically induced temperature with aridity index (AI) (Feng and Fu, 2013; Huang et al., 2015a; Huang et al., 2015b) has been also plotted as follow (Fig. 1). It takes a similar curve with annual-mean precipitation. Besides, results in this manuscript is a part of series work on the regional enhanced warming, in order to consistent with previous results (Huang et al., 2012) and supply a better understanding to readers, we prefer the annual-mean precipitation of 30 years as the climatology index for classifying the climate regions.

9. P22982-L7: how does this result improve on previous studies? "Confirm" may be a strong word here. I believe the results are more of a "suggestive" nature.

Response: Huang et al., (2012) found that warming trend was particularly enhanced, in the boreal cold season (Nov. to Mar.) over semi-arid regions (with precipitation of 200-600 mm yr-1). In mid-latitude semi-arid areas of Europe, Asia, and North America, temperatures in the cold season increased by 1.41, 2.42, and 1.5 oC in the period of 1901-2009. The results revealed the semi-arid region of Asia is the most sensitive region to enhanced warming and needs further investigation. Our work aims to explore the reason that induced the enhanced warming in the semi-arid region of Asia.

Therefore, it claims as an improved work on the Huang et al., (2012). In order to avoid misunderstanding, we have detected this sentence. And we accepted the suggestion and changed the “confirms” to “suggests”.

10. P22983-L13: what does this sentence mean? "A relative homogenization of temperature" is confusing and could be reworded.

Response: The sentence of “The DIT as the basic background provided a relative homogenization of temperature change on a large scale” wants to illustrate that temperature difference between low and high latitudes area for large scale are majorly decided by the dynamically induced temperature (DIT). It was proposed to relative to the RFT, which is greatly induced the local discrepancy warming. P22983-L13-14 has been reorganized as “The DIT was mainly dominated by major dynamic factors, such as the NAO (Li et al., 2013), PDO (Trenberth and Hurrell, 1994; Kosaka and Xie, 2013) and AMO (Wyatt et al., 2012; Wyatt and Curry, 2014).

11. P22983-L15: where are the teleconnection indices obtained? This should be stated explicitly in the text.

Response: The sources of these teleconnection indices have been provided in the text.

12. P22983-L17: why did the authors correlate an 11-year running mean with the teleconnection indices? Were the SAT data and teleconnection indices filtered like this? Why did the authors select 11-years as the averaging period? Are the results not significant otherwise? This should be clarified. I understand and accept that these patterns play a role in the DIT, but more could be done to establish their relationship.

Response: The 11-yr running is a filter for removing interannual signal. The filter applied to teleconnection indices can remove the inter-annual signal, and reflect the relationship between dynamically induced temperature and teleconnection indices over the decadal scale. Only NAO has been filtered by 11-yr running, because the NAO is a teleconnection index with interannual signal. As the 11-yr running is a simple and easy

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understanding method in extracting the decadal variability for long-term, it maybe a little stronger, but the signal left is favor in reflecting the variability for long-term. Meanwhile, we totally agree and thanks your suggestion, more could be done to establish the temperature change with dynamic factors. We have another paper which is under reviewing by JGR now, and discussing the influence of different dynamic factors on the variability of dynamic temperature change. Therefore, three major teleconnection indices (NAO, PDO and AMO) have been listed in the paper to illustrate the effective of the dynamical adjustment method in dividing the raw temperature into dynamically induced temperature and radiatively forced temperature.

13. P22984-L19: how were these correlations computed? The ensemble mean time series with the DIT and Arafat time series? Was any filtering employed? Were the time series detrended? The ensemble mean will tend to downplay randomly phased dynamical variability in each of the model runs, whereas the external forcing is highly similar between the models, so the ensemble mean will primarily reflect the RFT. I find this comparison somewhat disingenuous.

Response: Fig. 13 of manuscript is a spatial distribution of correlation coefficient between ensemble-mean CMIP5 simulations and dynamically induced temperature (a), and between ensemble-mean CMIP5 simulations and radiatively forced temperature (b) in the cold season from 1902 to 2011 over East Asia. Ensemble-mean is the mean of 20 models data, which has been listed in table1. DIT and RFT are the dynamically induced temperature and radiatively forced temperature datasets. We did not do filtering to DIT, RIT and ensemble-mean of CMIP5 datasets, but we detrended the time series before calculating the correlations. We agreed with that the CMIP5 model runs have a similar external forcing. Figure 13 is used to prove the effectiveness of dynamical adjustment method in the selected region. As stated in Fig. 13b, it indicated the radiatively forced temperature has a close relationship with simulated temperature of CMIP5. It is mainly forced by external forcing. In order to avoid the disingenuous, we reorganized the description and discussion of Fig. 13.

14. P23000: how many degrees of freedom were used in this two-tailed students t test? Were the running mean time series used in the t-test? If so, the effects of autocorrelation should be considered. This could be done by computing the so called "effective degrees of freedom". This reduces the degrees of freedom based on the lag-1 auto-correlation of the time series being considered.

Response: The degree of freedom is 108 in this two-tailed student's t test, and we did not do the running mean time series to PDO and AMO. For Fig. 11b and Fig. 11c of manuscript, the PDO, AMO and the dynamically induced temperature time series are all without 11-year-running mean. In Fig. 11a, we applied the 11-year running mean to NAO (remove the high frequency signal), not the dynamically induced temperature time series. We agree with reviewer's comment that the filter process will reduce the degrees of freedom. Fig. 2 as follow is similar with Fig. 11 of the manuscript, but without 11-yr running mean to NAO. We can find that the area with 95% confidence in Fig. 2 (a) is larger than it in Fig. 11a. In order to avoid the problem of freedom change after filter, we use the Fig. 2 to replace the Fig. 11 in the revised manuscript.

References:

Huang, J., Guan, X., and Ji, F.: Enhanced cold-season warming in semi-arid regions, Atmos. Chem. Phys., 12, 5391–5398, doi:10.5194/acp-12-5391-2012, 2012.

Huang, J., Ji, M., Xie, Y., Wang, S., and He, Y.: Global semi arid climate change over last 60 years, Clim. Dyn., doi:10.1007/s00382-015-2636-8, 2015a.

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Feng, S., and Fu, Q.: Expansion of global drylands under a warming climate. Atmos. Chem. Phys. 13, 10081-10094, doi: 10.5194/acp-13-10081-2013, 2013.

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Editorial comments: In general the manuscript needs copy-editing to improve the English prior to publication. I will highlight a few particular areas for improvement here:

Thanks for editors' comments; we will revise them case-by-case in the manuscript. P22976-L4: I suggest the authors insert "regional" between "investigate" and "surface temperature change"

Response: "regional" has been inserted between "investigate" and "surface temperature change"

P22976-L21: to say that Asia is the most sensitive area to climate change is an extremely strong statement. I would accept "Asia is arguably the most...", but additional references are necessary to back up this strong introductory claim.

Response: The sentence of "to say that Asia is the most sensitive area to climate change is an extremely strong statement" has been changed to "Asia is arguably the most sensitive area to climate change".

P22978-L7: this sentence is awkward and should be rephrased. For example, "This study uses monthly precipitation, maximum daily temperature, and minimum daily temperature data from the land-only TS3.21 dataset obtained from the Climatic Research Unit at the University of East Anglia...".

Response: The sentence has been changed.

P22978-L17: I suggest rephrasing "which almost covers the most area of East Asia" to "which comprises much of East Asia."

Response: The revision has been done.

P22979-L11: I suggest rephrasing following past references, "...based on partial least squares (PLS) regression using sea level pressure (SLP) to predict SAT."

Response: this part has been rephrased.

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P22981-L4: remove "ly" from "radiatively"

Response: It has been done.

P22982-L6: do the authors mean "previous knowledge"? "previous acknowledge" does not make much sense in this sentence.

Response: In order to avoid to misunderstanding, we have deleted this sentence.

P22982-L17: typo, "cover" should be "over"

Response: It has been revised.

P22984-L11: remove "obvious". Too casual of a word.

Response: removed the word

P22984-L19: typo, "modes" should be "models"

Response: It has been revised.

P22985-L8: I suggest that the authors rephrase "...the NAO, PDO, and AMO took a decadal variability" as "...the NAO, PDO, and AMO on decadal time scales."

Response: We took the suggestions and rephrased the sentence.

P22993: the figures all look nice in general; Figure 4 could be improved by scaling the color bar to the data better. There are no values below about 30%, so this could be the bottom of the color scale.

Response: Figure 4 has been updated.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 22975, 2015.

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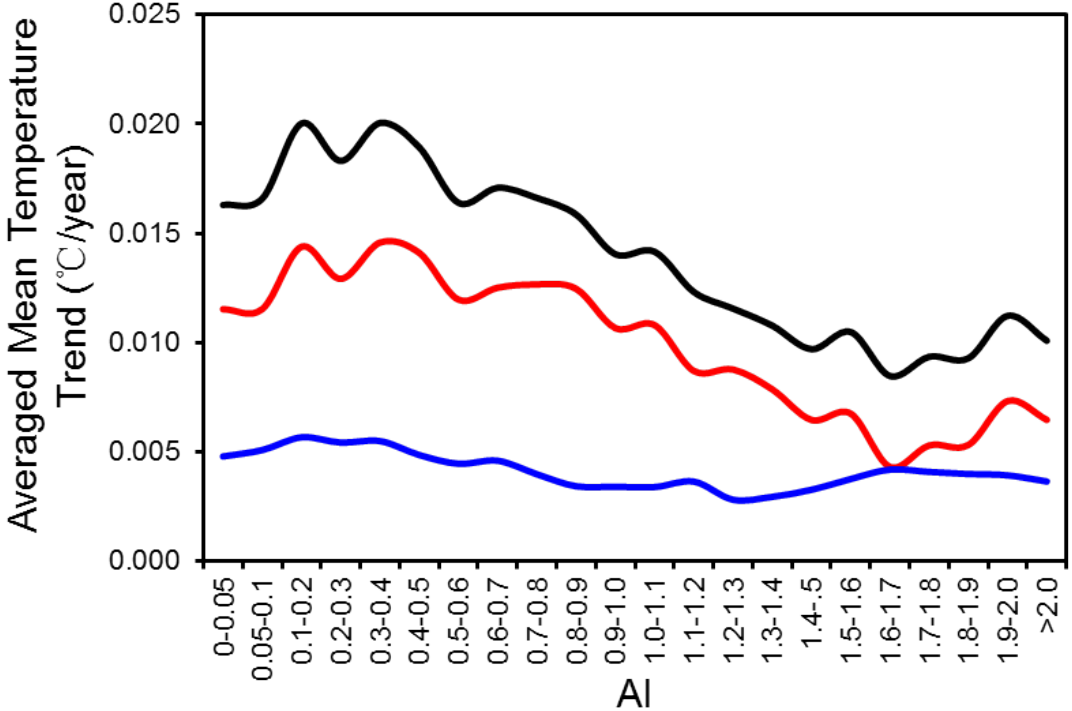

Fig. 1. Regionally averaged temperature trend as a function of AI for raw (black), dynamically induced (blue) and radiatively forced (red) temperatures in the cold season from 1902 to 2011 over East Asia

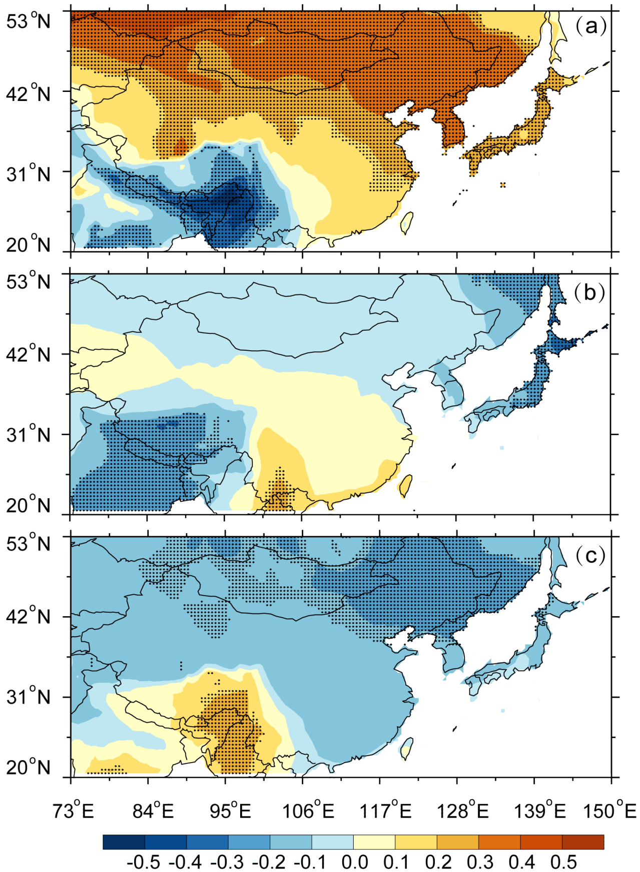

Fig. 2. Spatial distribution of the correlation coefficient between detrended dynamically induced temperature and detrended NAO (a), PDO (b), and AMO (c)

Model name	Modelling centre
BCC-CSM1.1	Beijing Climate Center, China
CanESM2	Canadian Centre for Climate, Canada
CanESM2	Canadian Centre for Climate, Canada
CCSM4	National Center for Atmospheric Research, USA
CNRM-CM5	Centre National de Recherches Meteorologiques, France
CSIRO-Mk3.6.0	Commonwealth Scientific and Industrial Research, Australia
GFDL-CM3	Geophysical Fluid Dynamics Laboratory, USA
GFDL-ESM2G	Geophysical Fluid Dynamics Laboratory, USA
GFDL-ESM2M	Geophysical Fluid Dynamics Laboratory, USA
GISS-E2-R	NASA Goddard Institute for Space Studies, USA
HadGEM2-CC	Met Office Hadley Centre, UK
HadGEM2-ES	Met Office Hadley Centre, UK
INM-CM4	Institute for Numerical Mathematics, Russia
IPSL-CM5A-LR	Institute Pierre-Simon Laplace, France
IPSL-CM5A-MR	Institute Pierre-Simon Laplace, France
MIROC-ESM	Japan Agency for Marine-Earth Science and Technology, Japan
MIROC-ESM-CHEM	Japan Agency for Marine-Earth Science and Technology, Japan
MIROC5	Atmosphere and Ocean Research Institute, Japan
MPI-ESM-LR	Max Planck Institute for Meteorology, Germany
MRI-CGCM3	Meteorological Research Institute, Japan
NorESM1-M	Norwegian Climate Centre, Norway

Fig. 3. table 1. CMIP5 models examined in this study

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