Reply to **Anonymous Referee #2**

We thank the reviewer 2 for the overall positive comments on our research. The specific comments on grammar, figures, tables, Introduction, Methods, Results and Discussion greatly improve the article quality. The reply is as follows.

Question 1 ： Figure 3 indicates there is a lot of variability in the response to sowing date across sites. The effect of climate differences across the gradient of sites examined is likely very important. The approach to analyzing the effect of Ta and P on the modeled Tc are not described in the methods as far as I can tell. I think the effects across climate should be important based on how this study was framed, so that analysis deserves more attention.

Answer 1 ： The method was added in section "**2.2.1 Meteorology**": "Climatological mean T_a and accumulated P during the wheat growth period were calculated in the 10 stations and were linearly regressed with the simulated differences between scenarios."

Question 2: The overall approach of the simulation experiment is a bit confusing to me. Since the study sites are so widely distributed in space (and climate), why apply a constraint to the sowing date that doesn't account directly for the variability in climate? As you describe, this leads to the northern sites and southern sites "shifting" sowing dates in opposing directions compared to the known phenology (becoming earlier at some sites and later at others). You suggest early in the paper that the trend in sowing dates overall is likely to be a delay due to the extension of warmer conditions later in the year. I'd like to see this choice more clearly justified and contextualized.

Answer 2: the reason was justified in secion "**2.3.2 Model simulation**": "The SiBcrop model was modified to be more cold tolerance (section 2.3.1), which causing

the sowing date was less controlled by temperature. The climate variability among stations has less constraint on sowing date. Our previous study showed that the delayed sowing date of winter wheat was mainly caused by the delayed harvest of maize in the NCP (Xiao et al. 2013). The sowing date in the two scenarios is within the climatological average of the region."

Question 3: I am left wondering about the impact of snow cover on the response of energy balance during the winter dormant period at these sites. The effect of snow at other sites in other studies is discussed, but the characteristic snow cover across this geographic region is never explicitly stated here. Is snow cover an important feature and is it included in the model? If so, why doesn't it affect radiative balance in the dormant season as elsewhere?

Answer 3: We thanks the comments. The snow is a very important factor influencing the surface albedo in winter. But in our simulation, the two scenarios had no difference in snow coverage. So we added some sentence for explanation: "Previous studies showed that the increase of vegetation cover caused warming feedback by destroying the high albedo of snow in the case of snow cover (Richardson et al. 2013; Bagley et al. 2015; Lombardozzi et al. 2018). In our simulation, except for the large difference in crop coverage in phase 1, the snow and crop had consistent coverages in other phases (Supplement Table 1), which means albedo difference between two scenarios was not caused by snow.

Question 4: Could you be more specific about the management implications of this study? For example, can you speculate about how the modeled changes in LAI impact yield, which was discussed as an important factor in changing management practices early on in the paper.

Answer 4: We detailed the management implication of the Conclusions. The

previous version were too broad. The last paragraph was modified into "Nevertheless, the study highlighted the divergent climate feedbacks on winter wheat dormancy as affected by sowing date. The simulation error of sowing date in land surface models is commonly higher than 10 days (Song et al. 2013; Chen et al. 2020), which may produce detectable climate effect especially in northern winter and then misestimate the variation of minimum temperature. The crop management changes as a potential way should be considered in mitigating climate warming. In the cold dry north, delayed sowing and reduced irritation would alleviate the temperature increase in winter, whereas in south with better hydrothermal conditions, enhanced vegetation coverage would be beneficial."

Question 5: Introduction: Since it is such an important piece of understanding to your study, I think a short overview of the annual lifecycle of winter wheat should be included in the introduction, perhaps even with a diagram indicating the critical period between sowing date and dormancy period that is the focus of your study. As you later describe in your results and discussion, there are significant differences one would expect as a result of different sowing times during the winter and growing season which would be helpful to explicitly state early on. Lines 59-62: Unclear which study these numbers come from. Please clarify references. Lines 66-67 By what management approaches were these various stages changed? Line 68 This statement needs support or a qualifier, eg if referencing changes due to climate, "These phenology changes are likely to benefit yield." or if referencing changes due to management, "These management strategies that shift phenology are intended to increase yield." Line 83: This way of stating the changes to latent and sensible heat is a bit confusing. Can these changes just each be explicitly listed for clarity? Do you mean ET here? Line 92: perhaps change to ": : :, a shift in radiative forcing with the

potential to warm the atmosphere by 1-1.4 C through declining evapotranspiration"? Line 103: Should this be "widely" instead of "wildly"? Line 110: Not sure how the effects last longer. Not supported in immediately following sentences

Answer 5: We generally accept the comments.

(1) Introduction: Since it is such an important piece of understanding to your study, I think a short overview of the annual lifecycle of winter wheat should be included in the introduction, perhaps even with a diagram indicating the critical period between sowing date and dormancy period that is the focus of your study. As you later describe in your results and discussion, there are significant differences one would expect as a result of different sowing times during the winter and growing season which would be helpful to explicitly state early on. The key phenology was marked in Fig.2 and interpreted in the text.

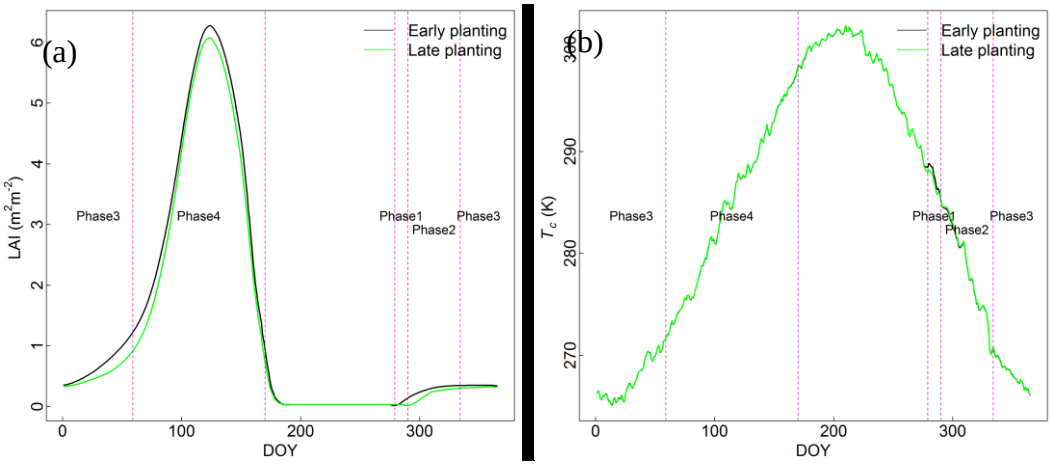

Fig.2 Dynamics of (a) LAI and (b) T_c under two sowing scenarios in winter wheat growing season

Phase 1: inter-sowing period, when wheat had been sown in the EP but hadn't in the LP; Phase 2: early growing period, from sowing date of LP to dormancy date; Phase 3: dormancy period, from dormancy date to re-greening date; Phased 4: from re-greening date to maturity date.

In the section "**3.2 Seasonal dynamics of LAI and T_c in scenarios**", we added "According to the T_c difference between scenarios, the following phenologies of winter wheat were relatively important: sowing date, dormancy date, re-greening date and maturity date. Based on the simulation results, the phenological dates used here as follows: EP sowing date, DOY279; LP sowing date, DOY290; dormancy date, DOY334; re-greening date, DOY59; maturity date, DOY170 (Fig.2a). The T_c difference between scenarios was separated into 4 phases: Phase 1, inter-sowing period, when wheat had been sown in the EP but hadn't in the LP; Phase 2: early growing period, from sowing date of LP to dormancy date; Phase 3: dormancy period, from dormancy date to re-greening date; Phased 4: from re-greening date to maturity date (Fig.2b)."

(2) Lines 59-62: Unclear which study these numbers come from. Please clarify references.

Added reference. "In the North China Plain (NCP), the dates of sowing, dormancy, re-greening, anthesis, and maturity in wheat system were changed by 1.5, 1.5, -1.1, -2.7, and -1.4 days/decade (a positive value indicates delay and a negative value indicates advance), respectively (Xiao et al. 2013)."

(3) Lines 66-67 By what management approaches were these various stages changed?

We added including sowing data adjustment and varietal change. "Crop management, including sowing date adjustment and varietal change, reduced the lengths of vegetative stage, but increased the length of reproductive stage (Liu et al. 2010; Liu et al. 2018)."

(4) Line 68 This statement needs support or a qualifier, eg if referencing changes due to climate, "These phenology changes are likely to benefit yield." or if referencing

changes due to management, “These management strategies that shift phenology are intended to increase yield.”

We accepted the comment. The statement changed to “The management induced phenology dynamics are intended to increase yield”.

(5) Line 83: This way of stating the changes to latent and sensible heat is a bit confusing. Can these changes just each be explicitly listed for clarity? Do you mean ET here?

Modified. New sentence: “Earlier planting date and longer grain-filling period increased the *LH* by 3 W m^{-2}, decreased *SH* by 2.5 W m^{-2}, in June and enhanced the net radiation (R_n) by 1.2 W m^{-2} in October by reducing the interval time from maturity to harvest in American Corn belt (Sacks and Kucharik 2011).”

(6) Line 92: perhaps change to “: : :, a shift in radiative forcing with the potential to warm the atmosphere by 1-1.4 C through declining evapotranspiration”?

Comment accepted, the sentence changed to “Harvest shifted the key influence factors of the radiative balance and evaporative fraction from leaf area and soil-atmosphere temperature difference to soil moisture in U.S. winter wheat (Bagley et al. 2017), and a shift in radiative forcing with the potential to warm the atmosphere by 1~1.4 ℃ through declining *LH* in the NCP (Cho et al. 2014).”

(7) Line 103: Should this be “widely” instead of “wildly”? Yes, Widely. Thanks!

(8) Line 110: Not sure how the effects last longer. Not supported in immediately following sentences

The sentence modified to “Compared with other phenology dynamics, such as earlier re-greening stage (Xiao et al. 2013; Zhang et al. 2013), longer reproductive period (Sacks and Kucharik 2011) and inter-cropping period (Cho et al. 2014; Bagley et al. 2017), the climate feedback of sowing date emerges gradually with crop

development. Particularly, winter wheat grows faster in early stage and slower as winter approaches, smaller change in sowing date could lead to larger and longer climate feedback in dormancy period."

Question 6: Methods: This is only a personal preference, but I find it difficult to interpret the climate data in a table and perhaps the range of variation in sites could be more clearly conveyed in a figure? Table 1. The label for "P" seems to be cut off. Table 2. Was canopy temperature measured or modeled at Yucheng, I am a bit confused by the caption description Lines 177-180 I suggest adding in the range of time periods as DOY, perhaps parenthetically to the months, to be consistent for reader to compare to sowing date. Also, I think there should be a reference to Table 3 here. Table 4. I suggest somehow highlighting (bold or shading) the significant trends in this table. Lines 214-220: Could you please provide a bit more detail as to why the original model is so different? Was it developed for warmer climates, hence the lower cold tolerance in the modifications? A very brief summary of how Chen et al 2020 came to these modifications would be useful. Line 251: Please define alpha here as well. I assume albedo.

Answer 6: We generally accept the comments.

(1) This is only a personal preference, but I find it difficult to interpret the climate data in a table and perhaps the range of variation in sites could be more clearly conveyed in a figure?. We've arranged our stations from high to low latitude to make it easier for readers to spot patterns.

(2) The label for "P" seems to be cut off. Corrected.

(3) Table 2. Was canopy temperature measured or modeled at Yucheng, I am a bit confused by the caption description. The data in the table are all measurements used to calibrate the model.

(4) Lines 177-180 I suggest adding in the range of time periods as DOY, perhaps parenthetically to the months, to be consistent for reader to compare to sowing date. Also, I think there should be a reference to Table 3 here. We accepted the comments. The DOY and reference added. "The phenology information was obtained from China agro-meteorological experiment stations and available in the period of 1981-2009, except for 2003 at Zhumadian and 1986 and 1988 at Miyun station (Table 3)."; "Winter wheat dormancy stage generally begins in DOY 330-360 (December) and ends in DOY 40-70 (late February and early March), and reaches maturity in DOY 150-160(mid-June). The standard deviation shows that the inter-annual fluctuations of dormant and re-greening period is larger, and harvest period is relatively stable.

(5) Table 4. I suggest somehow highlighting (bold or shading) the significant trends in this table. Bolded.

(6) Lines 214-220: Could you please provide a bit more detail as to why the original model is so different? Was it developed for warmer climates, hence the lower cold tolerance in the modifications? A very brief summary of how Chen et al 2020 came to these modifications would be useful.. We briefly explained the reason in secion "**2.3.2 Model simulation**": "The SiBcrop model was modified to be more cold tolerance (section 2.3.1), which causing the sowing date was less controlled by temperature. The climate variability among stations has less constraint on sowing date. Our previous study showed that the delayed sowing date of winter wheat was mainly caused by the delayed harvest of maize in the NCP (Xiao et al. 2013). The sowing date in the two scenarios is within the climatological average of the region.

(7) Line 251: Please define alpha here as well. I assume albedo. Defined in the section "**1. Introduction**"

Question 7: Discussion: It seems like the albedo results should be included in the

results rather than the discussion section. In general, it is a little confusing throughout this section to determine when the authors are discussing the results of this study versus other studies. Again, I am left wondering what exactly the snow regime is at these sites (and does it vary across the gradient), since it is so important in understanding dormant season energy partitioning in other studies. I also think it would be nice to have a brief discussion on how this choice of model could influence results compared to other models. Figure 5. Where do these photos come from? Line 444 - 445: This sentence is confusing, please rephrase Lines 476-477: Needs a reference and also more specificity on what kind of ecosystems this refers to.

Answer 7: We generally accept the comments.

(1) Again, I am left wondering what exactly the snow regime is at these sites (and does it vary across the gradient), since it is so important in understanding dormant season energy partitioning in other studies. We provide the snow and crop coverages in 4 phased at each station in Supplement. The data show little difference in coverage. "Previous studies showed that the increase of vegetation cover caused warming feedback by destroying the high albedo of snow in the case of snow cover (Richardson et al. 2013; Bagley et al. 2015; Lombardozzi et al. 2018). In our simulation, except for the large difference in crop coverage in phase 1, the snow and crop had consistent coverages in other phases (Supplement Table 1), which means albedo difference between two scenarios was not caused by snow."

(2) I also think it would be nice to have a brief discussion on how this choice of model could influence results compared to other models. We realized that "The single model simulation was highly dependent on the structure and parameterization scheme of the model.". And we compared the published results with our simulation in section "**4.2 Warming effect of EP-LP in the dormancy period**". "Although there were

literatures reporting that the albedo process in winter is relatively important (Richardson et al. 2013; Lombardozzi et al. 2018), fewer studies directly addressed the influence of different surface characteristics and climate effect through biophysical process in the dormancy period. In the Oklahoma's winter wheat belt, the rapid crop growth during November exhibited a distinct cool anomaly against adjacent regions of dormant grassland. Over the period of December through April, the cool bias was visibly diminished although the greenness difference between grassland and wheat was more distinct (McPherson et al. 2004). The biophysical impacts between maize and perennial grass were simulated using Agro-IBIS model in US corn belt (Bagley et al. 2015). The results showed that much higher LAI of perennial scenario was existed in winter December–February (3 vs 0 m^2 m^{-2}) and in summer June–August (10 vs 4 m^2 m^{-2}). Perennial grass had smaller surface albedo (coupling snow effect) than maize in winter, but showed quite small difference in summer. During winter and summer, the perennial scenario had slightly higher *LH* than the maize scenario, but the difference in R_n between two scenarios was more than 10W m^{-2} in winter (Bagley et al. 2015). The results of this current study indicate that higher LAI in winter has a warming effect, which is different from the conclusion above. The main reason was due to the relative contributions of surface albedo mechanism and surface flux distribution process.

(3) Figure 5. Where do these photos come from?. Figure 5 moved to Supplement Fig.2. and added location labels.

(4) Line 444 - 445: This sentence is confusing, please rephrase. Rephrased. “In the SiBcrop model, the reflectivity of different surface coverings varies greatly in the visible band (Table 6). The germination of winter wheat immediately changed the bare soil into soil with crop, which is favorable to the sharp reduction after crop covered.”

(5) 476-477: Needs a reference and also more specificity on what kind of

ecosystems this refers to. New sentence is: “Previous studies showed cooling effect in the photosynthetic active period through surface biophysical mechanism in the cropland (e.g. (Sacks and Kucharik 2011; Zhang et al. 2013; Bohm et al. 2020)).