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Interactive comment on "MODIS NDVI and vegetation phenology dynamics in the Inner Mongolia grassland" *by* Z. Gong et al.

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To Reviewer: We appreciate your valuable comments on our manuscript. Most of them helped greatly in revising this manuscript. Our responses are listed below.

Comment 1: The phenology changes were calculated by the NDVI series. However, there is no field investigation data to validate the result for the 18 meteorological stations. For example, the actual phenology changes of the individual meteorological station can be collected and compared to the NDVI time series at the same location.

Response 1: Agreed. Comparison between in situ and satellite-derived phenology is considered as the best way to validate the results for the selected stations. However, the collection of the field investigation data is a challenging task because the MODIS

data are produced with a spatial resolution of 250 m. Each pixel includes a mosaic of land cover and vegetation types. The phenology of different vegetation types, such as typical and desert steppes, are various because of the different response to the climate. Furthermore, even areas that are homogeneous in regards to land cover can show significant spatial variability in phenology. Thus the existed filed investigation methods (point measurements) that can be used to compare with the satellite-derived phenology are still controversial. Besides, unfortunately, the in situ phenology data of the meteorological stations in Inner Mongolia are restricted to specific agencies, so the in situ data are unavailable to us. This is the main reason that among almost all of publications conducted in Inner Mongolia, the satellite-derived phenology were not validated using filed investigation data. According to the recent research, our phenology results have corresponded well with the general knowledge of the Inner Mongolia. We are now cooperating with the local meteorology institution and trying to develop a suitable observation method in the future work.

Comment 2: I would like to see a statement in the methods section how the cumulative annual NDVI trend was calculated and when the significant test was performed.

Response 2: We have added the statement about the calculation of the cumulative annual NDVI trend. The significant test was performed just after the change trend finished. Change in the manuscript (P9 L177–L181): Using the smoothed NDVI time series data (299 values/pixel from 2002 through 2014), linear models were developed. The trends in the NDVI changes were quantified by the slope of the regression line derived from the linear models of the cumulated NDVI time series against time. The slopes were tested for significance with a significance level of 0.05.

Comment 3: A decimal significant figures would be enough for the SOS, POS, EOS and LOS. The origin significant figures in the manuscript would be meaningless and cause a statistical bias.

Response 3: We have changed the statistic method as the population regression function and had obtained better results. And according to the new results, we have found that the increasing precipitation was the main driving factor of the extension in growing season rather than the promotion in temperature. The climate situation has changed in recent decade. The revised results and discussion part has been modified as below. Results part (P11 L262–L281): The selected regression models at different phenological stages (SOS, POS, EOS, and LOS) between precipitation (monthly and accumulated value during different periods) and temperature (monthly and mean value during different periods) are presented in Table 4. The delayed effect from climate in SOS was obviously detected. Generally, the SOS negatively correlated with the cumulative precipitation, especially during the growing season in the last year (March–September, R2 = 0.95, P < 0.001). Furthermore, the temperature in the last May also negatively correlated with SOS well (R2 = 0.73, P < 0.05). Therefore, the increasing precipitation and the temperature in May in the last year could advance the SOS. The POS negatively correlated with the cumulative precipitation from May to June (R2 = 0.62, P < 0.001) and positively correlated with the mean monthly temperature from June to July (R2 = 0.52, P < 0.001). The increasing precipitation and colder weather were considered can advance the peak vegetation activity date. The EOS positively correlated with the precipitation in the last August (R2 = 0.68, P < 0.05) but the temperature in March with lower significance (R2 =64, P = 0.06). Thus the delay in the senescence of vegetation was considered because of the wetter autumn in the last year and the warmer spring in the current year. Overall, the LOS positively correlated with the cumulative precipitation from April to May (R2 = 0.49, P < 0.05) and mean temperature from January to March (R2 = 0.72 P < 0.001), indicating that the wetter and warmer weather during the early vegetation growing period could extend the LOS. Discussion part (P14 L312–L324): Some researchers have indicated that the phenology could be influenced by the climate several months before (Estrella and Menzel, 2006; Miller-Rushing and Primack, 2008). In our results, this delayed effect has been found. Our results were in agreement: the global warming could promote the vegetation growth and extend the growing season (Linderholm, 2006). The temperature has increased

significantly, particularly since the 1980s (Ding and Chen, 2008; Gao et al., 2009). However, from 2002 to 2014, the IMAR grassland tended to be slightly colder in the spring (from January to May). We speculated that the increasing precipitation might be the main driving factor of the advance in SOS and the delay in EOS. Nevertheless, previous work revealed that precipitation decreased slightly over the last 50 years compared with the obvious inter-annual change. Thus, the precipitation appeared to increase over the recent decade. Rather than the change in temperature, the wetter weather condition were considered the main reason for the phenology change in the IMAR. (P25): Table 4. The climate variables most strongly correlated with phenology, and the corresponding parameters of its linear model. Phenology Variable Slope Intercept R2 P SOS Prec March–September (last year) –0.77 310.15 0.95 <0.001 Temp May(last year) –49.68 861.99 0.73 0.03 EOS Prec August (last year) 0.13 151.96 0.68 0.04 Temp March 20.70 326.81 0.64 0.06 POS Prec May–June –0.35 243.54 0.62 <0.001 Temp June–July 7.69 49.75 0.52 <0.001 LOS Prec April–May 2.59 54.13 0.49 0.02 Temp January–March 12.25 281.26 0.72 <0.001

SOS is the start of growing season; POS is the maximum NDVI date during the growing season; EOS is the date of the end of season; LOS is the length of growing season. Prec and Temp represent the precipitation and temperature, respectively.

Comment 4: Figure 4 is not clear to show the result.

Response 4: As in order to improve the quality of the Figures, the Figure 4 has been made in color. Please also see the attached file.

Please also note the supplement to this comment:
http://www.solid-earth-discuss.net/7/C1213/2015/sed-7-C1213-2015-supplement.zip

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Interactive comment on Solid Earth Discuss., 7, 2381, 2015.