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Modelling the impacts of climate change and crop management on phenological trends of spring and winter wheat in China

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Crop phenology is co-determined by climate change and crop management. Over recent decades, climate change-related alterations in crop phenology have been observed and reported for various global crops. However, attributing changes in crop phenology to climate change is difficult, because there have been concurrent changes in crop management. In this paper, we isolated and quantified the impacts of climate change and crop management on the changes of wheat phenology in China, during the period 1981–2010, using a first-difference multiple regression model. Our results shows: (1) based on observed phenological data, in spring/winter wheat, the mean sowing and emergence date were delayed by 0.91/2.29 and 0.39/0.73 days decade^{-1}; mean anthesis and maturity date advanced by 1.05/2.28 and 0.01/1.42 days decade^{-1}; mean length of vegetative growth period (VGP) and whole growth period (WGP) were shortened by 1.09/2.86 and 0.89/3.69 days decade^{-1}; mean length of reproductive growth period (RGP) was prolonged by 0.55/0.61 days decade^{-1}. (2) At most stations, changing direction of wheat phenology affected by isolated impacts of climate change or crop management was consistent with that affected by combined impacts of climate change and crop management. (3) For observed trends of most phenological stages and growth periods, relative contribution from climate change was smaller than from crop management, and average temperature contributed the most among the three contributors (average temperature, cumulative precipitation, and cumulative sunshine hours) to isolated impacts of climate change on wheat phenology. (4) Crop management over the three decades was shown to have helped reduce the lengths of VGP and WGP, but increase the length of RGP for both spring and winter wheat, implying that shorter-duration varieties with a higher yield or better yield stability in changing climate might have been introduced by farmers.