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Spatiotemporal vegetation variations and projections driven by atmosphere-ocean oscillations at multiple time scales: a case study in Gansu, China

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Vegetation is an integrated regional indicator of environmental changes related to soil, water and climate. For investigating climate change impacts on ecosystems, the transition zones of vegetations are natural hotspots of historical variations. As a transition zone between humid and arid climates in the northwest region of China, the terrestrial ecosystems of Gansu vary from dense vegetation landscapes in southeast to deserts in northwest. Exploring spatiotemporal vegetation responses to climate variations over Gansu has a great significance to project shifting northwest China vegetation patterns which affect regional water and food security. In this study, the spatiotemporal variations of vegetation were characterised by using the Normalized Difference Vegetation Index (NDVI). Between 2001 and 2019, there was a significant increase of the vegetation cover in almost the whole Gansu, and the increasing trend (around 0.015) was more predominant in the southeast part. Over the whole Gansu, especially at the southeast region, the Webster and Yang Monsoon (WYM) and the North Pacific El Nino oscillation (NP) had significant positive relationships with the extent of vegetation coverage at intra-annual and decadal scales respectively. Although the Central Pacific El Nino oscillation (CP) is only a statistically significant variable for some spotty locations of Gansu, it is negatively related to the vegetation variation over the northwest Gansu at an interannual scale. Based on the above relationships between vegetation and climate variables at different temporal scales, the future vegetation conditions of Gansu were projected based on the Beijing Normal University Earth System Model (BNU-ESM) outputs for the RCP4.5 and RCP8.5 scenarios. In a short term (the 2020s), vegetations in Gansu would increase because of the warmer temperatures along with possible increasing snowmelt water. However, for longer terms (the 2050s and the 2080s), the regional vegetation would significantly decline for both RCP4.5 and RCP8.5 scenarios, due to the depletion of snowmelt water sources resulted from the continuously increasing temperature and less snow accumulation in the region. The vegetation projections revealed the future desertification risk in Gansu. These results have important implications to water and food security in the vegetation transition zones of northwest China, which is a key region of the One Belt One Road initiative,

connecting semi-arid regions of central Asian nations.