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A physical-empirical model of the East Asian winter monsoon using Eurasian snow cover and sea surface temperature

Lulu Yu (1), Zhiwei Wu (2), and Renhe Zhang (2)

(1) Institute of Atmospheric Science, Nanjing University of Information Science & Technology, Nanjing, China (lu_nuist@qq.com), (2) Institute of Atmospheric Sciences (IAS), Fudan University, Shanghai, China(zhiweiwu@fudan.edu.cn, rhzhang@fudan.edu.cn)

Seasonal prediction of the East Asian (EA) winter monsoon (EAWM) is of great significance yet a challenging issue. In this study, three physical-empirical (PE) seasonal prediction models for the EAWM are established using three leading modes of the Eurasian snow cover (ESC), the first leading mode of sea surface temperature (SST) and the first leading mode of the combination of the ESC and SST in preceding autumn, respectively. These leading modes are identified by the partial-least square (PLS) regression. The first PLS (PLS1) mode for the ESC features significantly anomalous snow cover in Siberia and Tibetan Plateau regions. The ESC second PLS (PLS2) mode corresponds to large areas of snow cover anomalies in the central Siberia, whereas the third PLS (PLS3) mode a meridional seesaw pattern of ESC. The SST PLS1 mode basically exhibits an El Niño-Southern Oscillation (ENSO) developing phase in equatorial eastern Pacific and significant SST anomalies in North Atlantic. A strong EAWM tends to emerge in a La Niña year concurrent with cold SST anomalies in the North Atlantic, and *vice versa*. After a 35-yr training period (1967t2001), three PE seasonal prediction models are constructed and the 13-yr hindcast is performed for the period of 2002t2014, respectively. The PE model based on combination of the autumn ESC and SST exhibits the best hindcast skill among the three models, its correlation coefficient between the observation and the hindcast reaching 0.88. This indicates that this PE model may provide another practical tool for the EAWM. In addition, the relative contribution of the ESC and SST is also examined by assessing the hindcast skills of the other two PE models constructed solely by the ESC or SST. Possible physical mechanisms are also discussed.