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The impact of Sudden Stratospheric Warming and Stratospheric Cooling events on atmospheric circulation during high/low solar activity

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Sudden Stratospheric Warming (SSW) and Stratospheric Cooling (SC) episodes are among the impactful winter events on Northern Hemisphere atmospheric circulation. Several studies have shown that the polar vortex disturbances induced by abrupt changes in the upper stratosphere are often related to severe weather episodes at mid-latitude, such as severe cold spells (SSW), or significant increase of European windstorms (SC). Motivated by recent major stratospheric events, we investigated the possible role of solar activity in changing their impact on Northern Hemisphere circulation after a warming/cooling stratospheric episode, trying to provide a further prognostic element in seasonal forecasting. We identified 21 SSW and 37 SC episodes between 1948 and 2017 by using the methodology described by Baldwin and Dunkerton in 1999. The latter were stratified by the solar activity level through the Open Solar Flux (OSF) index. For each event, we analysed the behaviour of lower-troposphere circulation indices such as North Annular Mode (NAM) at 1000 hPa and North Atlantic Oscillation (NAO), in order to obtain both hemispherical and euro-atlantic evaluation in the 60 days following the warming/cooling stratosphere occurrence date. Furthermore, the surface circulation anomalies at local scale were also assessed through two circulation type classifications optimized for Italy between 1979 and 2015 on either mean sea level pressure or 500 hPa geopotential height. Solar activity resulted to have significant impacts on the two selected circulation index behaviour within the following sixty days, particularly for SC episodes. Remarkable climatological differences between SSW and SC circulation types during high/low solar activity were also noticed.