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Effects of the 11-year solar cycle on tropospheric circulation in the Southern Hemisphere in winter

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We analyze effects of the variations of solar activity related to the 11-year cycle on tropospheric circulation of the Southern Hemisphere in winter in terms of (i) modes of low-frequency variability and (ii) the frequency of types of tropospheric circulation over southern South America. The modes are detected by principal component analysis (orthogonally rotated) in an S-mode. The analyzed domain is the Southern Hemisphere Extratropics south of 20°S (inclusive); the circulation is characterized by 500 hPa heights; the analyzed period is 1950-2011. Solar activity is described by Wolf sunspot numbers. Monthly mean values of both circulation and solar variables enter the analysis. The modes are detected separately for the months with a low and high solar activity, and differences between the spatial patterns of the modes (principal component loadings) are tested for statistical significance. All the modes detected exhibit variations in their spatial extent, position of action centers, and intensity in response to the solar activity. Our findings include that during solar minima in winter, the Southern Annular Mode strengthens and that the two circumpolar wavenumber-3 wavetrains break down into two parts. The strongest effects appear near to and west of South America and concern mainly the modes consisting of two meridional dipoles shifted by half a wavelength. The one-point correlation maps for the action centers of the modes indicate that the changes in the appearance of the modes are real and not artifacts of the analysis method. The circulation types are detected in sea level pressure according to the Jenkinson-Collison algorithm over two domains, one covering subtropical latitudes between 20°S and 40°S, the other mid-latitudes between 40°S amd 60°S. The solar effects detected in frequencies of circulation types are in accord with the changes detected in the variability modes around South America.