

On long-term evolution of seasonal precipitation in southwestern Europe

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Abstract. Annual cycles in long time series of precipitation from sixteen southwest European observatories have been analysed using complex demodulation. The stations have been clustered into two distinct regions and a hybrid one. They are referred to as the southwestern Europe precipitation Atlantic regime (SEPAR) and the southwestern Europe precipitation Mediterranean regime (SEPMER), with the hybrid regime referred to in terms of the mean amplitude ratios between semiannual and annual rainfall components. Some evidence of linking between seasonal cycle harmonic amplitudes and the zonal circulation has been found for SEPAR stations and a more obscured relationship for the SEPMER region. Within the SEPAR region the strength of the relationship is diminished towards the north. A trend analysis of the amplitudes against time since 1920 has also been carried out and the results reveal a divergent pattern in trends between annual and semiannual component amplitudes for the SEPAR region. In fact, both an increasing annual-amplitude trend and a decreasing semiannual-amplitude trend are observed, in each case statistically significant. The fact that the seasonal cycle variability of rainfall in southwestern Europe becomes more sensitive southwards to changes in atmospheric zonal circulation over the North Atlantic might, in our opinion, be related to the swing of the circumpolar vortex.

1 Introduction

Thomson (1995) has recently pointed out the evidence of a worldwide link between winter-summer temperature contrast and the climate change induced by greenhouse gases. Taking into account the physical relationship between the difference in the amount of solar energy that the

Earth receives in winter and summer and the amplitude of the annual cycle in temperature, he finds that the likely role of solar energy on the climatic change is not as important as might be thought. Furthermore, tracking the annual cycle, he shows that there exists a general drift in the timing of the seasons (the date of the beginning of a “meteorological” year), which began around the 1940s, just when human-induced greenhouse warming appears to become stronger. This idea is based on the natural drift of one day per century, derived from the precession of the Earth, in the timing of the annual cycle. He also found variations in the timing of the annual cycle by studying northern-hemisphere records from about 1940. Moreover, by analysing both the temperature records in selected locations and the temperature averaged over the northern and southern hemispheres, he was able to identify an anomalous phase difference which accumulates over time and may even lead to reverse the sign of the natural phase drift of the annual cycle. This result is important because, according to Tabony (1984), the temperature contrast between seasons is related to the amplitude and phase of the annual cycle through the first and second harmonics. Generally, since the annual cycle accounts for a very important fraction of total variance of most meteorological variables, its time variations may have a non-negligible impact on atmospheric variability and therefore act upon the intra-annual (seasonal) variability and the timing of the seasons.

Climate may change in a wide range of potentially serious ways other than global warming. Precipitation can be considered one of the principal climatic elements to detect some likely climate change. Its high variability in time and space yields a low signal-to-noise ratio. Thus, evidence for any climatic change in precipitation becomes more difficult to detect than, for instance, that for the temperature itself. In fact, distribution of precipitation within a zonal belt is highly non-uniform and forces one to study this climatic element in a more restricted spatial setting.

Much of the variability in the extratropical atmosphere is directly associated with internal instability and

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