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Italian variability and trends of the frequency of days with visibility higher than 10km and 20km (1951-2017)

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Visibility is attracting every day more attention considering its importance in helping to assess the environmental effects of air pollution due to the longer period covered by these data. A better understanding of visibility variability and trends improves also the understanding of the role of aerosols on climate change and shares light on aerosol related phenomena which are not yet adequately represented in climate models. This work analyses and presents the variability and trends of the fraction of days with visibility higher than or equal to 10km (fVV10) and 20km (fVV20) at 12 UTC for the 1951-2017 period over the Italian territory. The obtained means over the whole considered period show a strong spatial variability with values ranging from 0.17 to 0.99 for fVV10 and from 0.07 to 0.78 for fVV20 with the lowest values observed in the Po plain, one of the most polluted areas of Europe. The series representative of the plain area show a positive trend over the whole period under analysis (+29% and +7% in the north and south, respectively at annual scale, p-value ≤ 0.05). This positive trend is mostly due to the strong increase starting in about 1980. Differently, in the previous period, visibility shows an opposite trend. The series for 20km show similar behaviour, even if climatology and intensity of the trends are different. Moving from low elevation areas to mid and high elevation ones the observed trends become much weaker highlighting how the signal generally decreases with elevation. Moreover, the analysis performed removing the days with high RH (RH $\geq$ 90%) shows how high RH values have a significant effect on climatological values, especially in winter and autumn, whereas they do not have any effect on the trends. Similar results are obtained performing the analysis considering only the clear-sky days. Therefore, the main driving factor of the observed visibility trends seems to be aerosol load. This hypothesis is supported by comparison with trends of aerosols and aerosol precursor emissions available over the 1970-2012 period from the Emission Database for Global Atmospheric Research (EDGAR v4.3.2 - http://edgar.jrc.ec.europa.eu/overview.php?v=432), aerosol optical depth reanalyses available over the 1980-2017 period from MERRA2 (https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/), and PM10 concentrations over the 2010-2017 period from Copernicus Ensemble Model (http://www.regional.atmosphere.copernicus.eu/). The obtained results are also in agreement with the Italian global radiation and sunshine duration trends (e.g., dimming and brightening periods, differences between north and south and between low and high elevation areas) reported in literature, strengthening the hypothesis that their variations are significantly due to aerosol concentration changes.