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An observation-based perspective of haze days in four major polluted regions of China

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An observation-based approach is used to make a quantitative evaluation of the effectiveness of emission control in reducing the number of annual haze days in four major polluted regions of China: Beijing-Tianjin-Hebei (BTH), Yangtze River Delta (YRD), Pearl River Delta (PRD) and Sichuan Basin (SCB). We examine the key characteristics of annual number of haze days of each region (1973-2016) and study their relationship with emissions of air pollutants, as well as with meteorological and climate parameters. Analysis of time series of the annual number of severe haze days in BTH reveals that there was a surprising lack of significant trend in the annual haze days over a long 40-year span (1973-2012). This feature is robust against different classifications of haze days, and it is widespread over the majority of provinces and special districts in eastern China, albeit over somewhat different time spans. The feature can be attributed to a depression of the annual haze days within the period 1999-2012, which remains visible with varying degrees in all regions of eastern China. The lack of trend is in a stark contradiction with the PM emission (including emissions of PM precursors) which has increased by as much as three folds from 1973 to 2012. We propose an explanation for the lack of trend: that the interannual variability of annual haze days in eastern China is controlled primarily by changes of meteorological and climate conditions, which overwhelmingly masks the effect of PM emission. A remarkable beneficial ramification of the lack of trend is that residents in the affected areas apparently didn't suffer the expected increasing detrimental effects due to increased PM emission, thanks to the particular combination of meteorological and climate conditions. Since the interannual variability is controlled by meteorological and climate conditions, which we lack the capability to predict at this point in time, the interannual variability poses as a masking effect (noise) that must be overcome by any change in PM emission before its impact (signal) can be detected. We find that the interannual variability of the four polluted regions ranges from 18% to 125% depending on the regions and time intervals, most of which are too large for any short term (< ten years) control strategies. In addition, meteorological and climate conditions need to be considered in formulating effective future air pollution control strategies.