Geophysical Research Abstracts
Vol. 20, EGU2018-6792, 2018
EGU General Assembly 2018

Evidence of the aerosol semi-direct effect over South China from 2006 to 2015 based on satellite observations

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Aerosol and cloud changes over South China during the 10-year period 2006-2015 are estimated and analysed, based on observations from passive and active satellite sensors, and emission data. The results show a decrease in aerosol optical depth over the study area by about 20% on average, accompanied by an increase in liquid cloud cover and cloud liquid water path (LWP) by 5% and 13%, respectively. Analysis of aerosol types and emissions suggests that the main driver for their reduction is a decrease in biomass burning aerosols, led mainly by biofuel consumption. These changes occurred mainly in late autumn and early winter months and coincided with changes in cloud properties. Variations in aerosol vertical profiles demonstrate that aerosol and cloud changes are in good agreement with different manifestations of the aerosol semi-direct effect, which depend on their relative heights. Overall, these findings suggest a human-induced reversed aerosol semi-direct effect, whereby less aerosols lead to an overall decrease in evaporation of cloud droplets, thus increasing cloud LWP and cover.
Being one of a few cases where the aerosol semi-direct effect is clearly evident in independent data records, and the first time that this effect is shown to be manifested under decreasing aerosol loads, this study highlights the potential of the synergistic use of aerosol and cloud observations from multiple sources.