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Possible interaction of meteor explosion with stratospheric aerosols on cloud nucleation based on 2011 observations.

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The lack of knowledge on the nature and the variability through time of stratospheric aerosols strongly constrains the understanding of precipitation events at local to regional scales. Along other causes, meteoroid ablation is assumed to creating significant disturbances on the upper stratosphere layers, particularly by debris production and flash heating. Due to the lack of observations, the impact on cloud and precipitation processes of cosmic debris that are annually delivered to Earth is not taken into account in climate modeling. Here we report on the data collected from 2011 cosmic events that occurred on the Angles village in Pyrenees Orientales (France). The trajectory of a meteor was traced by the CNES from Toulouse (France) to the Pyrenees boarder with Spain where it exploded at high altitude on August 2. 30 hours later, a detonation with debris pulverization at the ground was recorded at the same location across a restricted area. In the following days, unusual heavy rainstorms and violent fall of hailstones were locally recorded from the Pyrenees to the coastal plain. Meticulous sampling of the 2011 August 3rd debris fall and of the soils affected by the subsequent precipitation events has been performed. A similar assemblage of organic and mineral components of stratospheric origin was revealed. It is formed of aliphatic carbonaceous polymorphs of terrestrial origin, volcanic dust, charred and fresh organic grains, fine grained sandstones with native metals and micrometeorite spherules. Microscopic assemblage, isotopes and geochemical data show composite materials formed of imbricated terrestrial and extra-terrestrial components. Based on their C14 and C13 values the terrestrial carbonaceous polymorphs appear to derive from fossil combustible. The fine imbrication of all the other terrestrial components with the carbonaceous polymorphs indicates a common origin from the upper stratosphere. The mixing of the extraterrestrial debris with the stratosphere aerosols is suggested to resulting from the energy released by the meteor explosion. A direct link between the meteor explosion and the subsequent hailstones and heavy precipitation is clearly established by their similar range of composite debris. The meteor explosion is suggested to have initiated phase transformation of the stratospheric aerosols and their agglutination by complex mechanisms that remain to be further elucidated. The agglutinated particles with carbonaceous components have probably initiated condensation processes thus resulting into cloud formation. This was accomplished within a few days as shown by the time lag between the initial meteor explosion and the following precipitation events. The occurrence of the later across approximately the same region as the one of the debris pulverization from the meteor explosion suggests that the trajectory of the meteor would strongly constrain the agglutination processes. This data reveals the occurrence of solid aerosols with carbonaceous components in the stratosphere, most probably loaded by former volcanic events. In the case of serial meteor explosion the agglutination processes could significantly increase the agglutination process of stratospheric aerosols with resulting cloud formation and thus change of radiative forcing. Further research should reveal the role of meteor explosion on climate through cloud-aerosol precipitation interactions.