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Interaction between soil type and cropping system on albedo dynamics leads to contrasted impact on climate mitigation

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The biogeochemical effects of conservation agriculture (CA), such as soil organic carbon storage and greenhouse gas emissions, have been extensively studied. However, recent research has shown that management practices also have biogeophysical effects on both local and global climates by altering surface albedo and energy partitioning. We assessed the biogeophysical impacts of CA in maize fields during two successive seasons (2021/22-2022/23) at two long-term experimental sites in Zimbabwe with contrasting soil properties: Domboshawa Training Center (DTC) with a light abruptic Lixisol (sandy soil) and the University of Zimbabwe Farm (UZF) with a dark xanthic Ferralsol (clayey soil). We monitored surface albedo, longwave radiation, leaf area index (LAI), and soil moisture/temperature under three treatments: conventional tillage (CT), no-tillage (NT), and no-tillage with mulch (NTM). Our findings reveal that, across all treatments during the two monitored seasons, the average surface albedo of the xanthic Ferralsol at UZF was consistently lower than that of the abruptic Lixisol at DTC. It results a cooling effect in both NT and NTM treatments compared to CT in the clayey soil at UZF. During the 2021/22 season, the mean annual radiative forcing (RF) of NT and NTM were -0.83 W.m-² and -0.43 W.m^{-2} respectively, while during the second season (2022/23) the annual mean RF was -1.43 W.m^{-2} for NT and -1.03 W.m^{-2} for NTM.On the sandy soil at DTC, a warming effect was observed due to soil darkening induced by mulching. The mean annual RF of NT in this site was -3.34 W.m^{-2} during the first season and -2.78 W.m^{-2} during the second. In contrast, NTM showed a warming effect with an RF of 1.2 W.m^{-2} in 2021/22, and 2.77 W.m^{-2} during the 2022/23 season. The RF induced by albedo change were converted into CO_2-equivalents in order to compare it with biogeochemical effects of CA through changes in soil N_2O emissions and SOC storage. The results demonstrated an opposite effect on RF and of the same magnitude between albedo and soil organic carbon (SOC) in the NT and NTM treatments at DTC, suggesting that CA might not bring any mitigation benefit if mulch is applied on light coloured soils.