

UV, the biosphere, the carbon cycle and the World Avoided by the Montreal Protocol

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The 1987 Montreal Protocol is often referred to as “the most successful environmental treaty”. Together with its amendments, the Protocol’s curtailment of the emissions of halogen-containing ozone depleting substances has been clearly shown to have arrested the destruction of the stratospheric ozone layer. This means that we have avoided large increases in surface UV-B (280-315 nm), which would have had disastrous consequences for human, animal and ecosystem health, as well as avoided additional climate change, from the fact that CFCs and their replacements are potent greenhouse gases. Several studies have quantified the benefits and impacts of the Montreal Protocol for human health and climate change, but an investigation of the avoided consequences on the biosphere has not yet been conducted. This study addresses that omission, investigating what the avoided surface UV-B enhancements means for the health of the biosphere as a carbon store.

We have developed a modelling system that includes the UV-B impact on biomass accumulation in terrestrial biosphere and have used it to calculate the carbon cycle impacts that could have occurred in a world without the Montreal Protocol: the “World Avoided”. Although there are several known effects of increased UV-B on terrestrial plants, meta-analyses of field and laboratory studies point to a clear inhibition of biomass accumulation at the enhanced UV-B levels that we would expect in the world avoided. Inhibiting biomass accumulation reduces the land carbon store, meaning increases in the atmospheric abundance of CO₂. Therefore, through these avoided additional increases in CO₂, we find it very likely that the Montreal Protocol has had a hitherto unquantified benefit for climate change.

Key words: ozone, UV, biosphere, Montreal Protocol