



## Black carbon and ozone pollutants may be driving tropical expansion

**Man-made pollutants** may be responsible for the expansion of the tropics in the northern hemisphere, according to recent research. Black carbon aerosols and tropospheric ozone, formed from human activities, are heating the atmosphere and shifting major atmospheric circulation patterns further north, which could create drier conditions in the subtropics.

**Recent observations** have found that the tropical belt running around the equator has grown wider, and has expanded by around 2° to 5° latitude into the adjacent subtropical regions since 1979. Previous studies have found that depletion of ozone in the stratosphere (upper atmosphere) is contributing to the expansion of the tropics in the southern hemisphere, but less is known about the causes of the northward expansion of the tropics in the northern hemisphere.

The relevant pollutants; black carbon (soot) and tropospheric (lower atmosphere) ozone are formed from the incomplete combustion of fossil fuels, biofuels and biomass. Both air pollutants absorb sunlight and have a warming effect in the lower atmosphere. Although these pollutants have decreased over Europe during the last few decades, black carbon and tropospheric ozone have increased significantly overall in the northern hemisphere, especially over south-east Asia, during this time.

In this study, the researchers compared observational data with the results from climate models containing detailed aerosol physics to estimate the extent of expansion of the tropics. Climate models that did not include the influence of black carbon and tropospheric ozone in the atmosphere, underestimated the rate of expansion of the tropics when compared with the observed data. When the effects of black carbon and tropospheric ozone were included, modelling results suggest that the presence of these pollutants is likely to play a major role in the expansion of the tropics in the northern hemisphere.

Although global greenhouse gases emissions contribute to expansion of the tropics (about 0.05° per decade) the effects, in the northern hemisphere tropics, from black carbon and tropospheric ozone emissions are about twice the size of those due to greenhouse gases alone (about 0.07° to 0.12° per decade). Black carbon and tropospheric ozone does not appear to be affecting the southern expansion of the tropics in the same way. In addition, the study found that expansion rates vary according to the season, with the impacts of black carbon and tropospheric ozone pollutants peaking during the hottest months of June to August in the northern hemisphere.

Even with the effects of black carbon and tropospheric ozone included, models still underestimate the magnitude of the poleward shift in the northern hemisphere. The same is true in the southern hemisphere, for models that include stratospheric ozone depletion. This implies tropical expansion may be occurring faster than model projections. Why models underestimate the magnitude of the shift is not known.

It is the warming of the atmosphere in the mid-latitudes (30° to 50° N) that drives the expansion of the tropical belt. As a consequence, major atmospheric circulation patterns are also displaced towards the poles. In the northern hemisphere, mid-latitude rains moving north could have a dramatic impact on agricultural production in those regions.

Black carbon and tropospheric ozone are short lived pollutants, remaining in the atmosphere for only a couple of weeks. The researchers point out that strict policies aimed at curbing black carbon and ozone precursor emissions would not only improve human health and help mitigate global warming, but could also reduce the adverse effects of changes to large-scale atmospheric circulation patterns.

**Source:** Allen, R.J., Sherwood, S.C., Norris, J.R., & Zender, C.S. (2012) Recent Northern Hemisphere tropical expansion primarily driven by black carbon and tropospheric ozone. *Nature*. 485: 350-354. DOI:10.1038/nature11097

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