



## 50 Years Ago

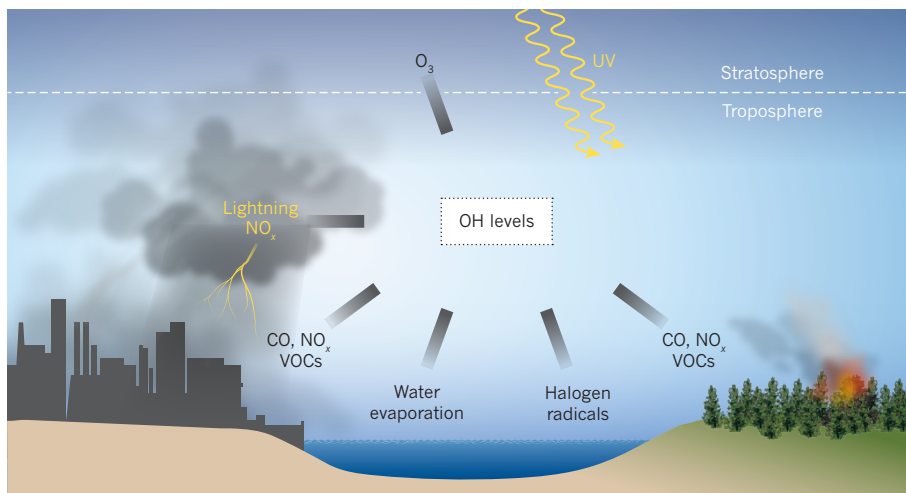
Some species of Diptera utilize freshly dropped cattle dung (cow pats) not only as an oviposition site and larval habitat but also as a male aggression site where mating occurs. The present investigation shows that males of some of these species protect their mates, thus preventing the mating activity of the preponderant and aggressive unpaired males from interfering in oviposition. Such co-operative behaviour is most striking in the cosmopolitan yellow dung fly, *Scatophaga stercoraria* ... unpaired males often attack couples, attempting to copulate with preoccupied females. The paired male responds to this aggression with one or both of two distinct actions: (a) one middle leg is thrust out in the direction of the aggressor, or (b) both forelegs are extended ... throwing the aggressor off ... It seems evident, then, that the male *Scatophaga* performs a vital role in assuring the deposition of eggs by the female.

From *Nature* 3 June 1967

## 100 Years Ago

While we are glad to know that it has been decided to establish a National War Museum, we are not a little alarmed at the many impracticable and sometimes fatuous suggestions as to the nature of the objects which should find a place there. We do not, for example, consider that ornaments made of chewed bread, even though they were made by prisoners of war in internment camps, are worthy of a permanent place in such a collection. As well might we add a lump of mud from the wheel of a limber in Flanders! ... By all means let us have this museum, but let a little judgment be exercised in its formation.

From *Nature* 31 May 1917



**Figure 1 | Factors influencing the self-cleansing ability of the troposphere.** The atmosphere has a ‘self-cleansing’ ability that depends on the abundance of oxidants in the troposphere, the lowest layer of the atmosphere — in particular, the abundance of the hydroxyl radical (OH). The primary production of OH depends on the availability of ozone ( $O_3$ , part of which is generated in the stratosphere and transported to the troposphere), water vapour and ultraviolet light. Secondary processes recycle OH in reactions that are driven by emissions of nitrogen oxides ( $NO_x$ ), carbon monoxide (CO) and volatile organic compounds (VOCs) from anthropogenic and biological sources.  $NO_x$  is also formed by lightning. Halogen radicals produced in sea spray tend to decrease OH levels. The relative contributions of the different processes to the overall OH budget are expected to alter as the climate changes. Geng *et al.*<sup>3</sup> report isotopic measurements that act as a proxy for tropospheric oxidant levels during the most recent glacial–interglacial transition, and argue that the main influencing factors were the chemistry of halogen radicals and the stratosphere-to-troposphere transport of ozone.

indirectly by measuring concentrations of trace gases<sup>4</sup> whose lifetimes are much longer and depend on OH abundances.

Inferring the abundance of tropospheric oxidants is even more challenging when trying to look into the past. Long-lived trace gases can be analysed readily from air trapped in ice cores, but this approach cannot be used for short-lived species, because they are too reactive to be preserved. This has led to a lack of information on past oxidant levels.

To address this problem, Geng *et al.* collected  $\Delta^{17}O(NO_3^-)$  data from a Greenland ice core that preserves a record of the most recent glacial–interglacial cycle.  $\Delta^{17}O(NO_3^-)$  had previously been suggested<sup>5</sup> as a valuable proxy for the tropospheric oxidation capacity — more specifically, for the ratio of the concentration of ozone ( $O_3$ ) to that of  $HO_x$  (the group of atmospheric compounds that includes OH and other oxidants called peroxy radicals). If the long-term evolution of  $O_3/HO_x$  is known, feedbacks between atmospheric chemistry and climate can be investigated.

The  $O_3/HO_x$  ratio was previously thought to be directly proportional to temperature, because emissions of ozone precursors from biological sources are expected to increase as the climate warms<sup>6,7</sup>. Geng and colleagues’ proxy data set surprisingly reveals an inverse relationship between  $O_3/HO_x$  and temperature, both at glacial-to-interglacial timescales and during most of two Dansgaard–Oeschger events (episodes characterized by rapid warming over a few decades, followed by gradual cooling over hundreds to thousands of years).

Puzzlingly, however, the authors observed that  $O_3/HO_x$  was, in fact, directly proportional to temperature during the cooling part of the warmer of the two Dansgaard–Oeschger events.

To interpret their results, the authors used a modelling framework that simulates the way in which climate and the biosphere affect tropospheric chemistry. On this basis, they infer that the primary factors responsible for the changes in oxidant levels were the chemistry of halogen-containing compounds in the atmosphere and transport of ozone from the stratosphere to the underlying troposphere. Those inferences are certainly plausible, but must be regarded as speculative, given the limitations of the authors’ modelling framework.

Climate models that simulate interactions between atmospheric chemistry and climate, and which include a realistic stratosphere, have indeed shown that stratosphere-to-troposphere transport of ozone increases under a warming climate<sup>8,9</sup>. But the impact of the simulated transport changes on tropospheric ozone depends strongly on the region involved, and can lead locally to either increases or decreases in ozone levels<sup>8</sup>. These models have not yet been used to study stratosphere-to-troposphere transport in past colder climates. They also generally do not incorporate the complex halogen chemistry invoked by Geng and co-workers; when this chemistry is added to the basic tropospheric chemistry typically used in models, simulations of modern conditions show reduced tropospheric ozone levels that are more in line with observations<sup>10</sup>.