Contrail warming

Nature Clim. Change **1,** 56–60 (2011)

ISTOCKPHOTO.COM / MAURICE VAN DER VELDEN

The short-lived, linear clouds generated by cruising aircraft can evolve into irregularly shaped ice clouds under favourable meteorological conditions. Model simulations suggest that together, the two cloud types — collectively known as contrail cirrus — exert a radiative forcing that is nine times greater than that associated with linear clouds alone.

Ulrike Burkhardt and Bernd Kärcher of Deutsches Zentrum für Luft- und Raumfahrt, Germany, incorporated the entire life cycle of aircraft-induced clouds into a global climate model, forced by aviation data, to examine the prevalence and radiative impact of these man-made clouds. According to their simulations, the contrail cirrus cause warming, as they exert a global average radiative forcing of 37.5 mW m^{-2}. These aircraft-induced clouds were most common in Europe and eastern North America, where their local radiative forcing can exceed 300 mW m^{-2}.

The researchers note that contrail cirrus also reduce natural cirrus coverage, offsetting some of the forcing. However, the net radiative impact remains positive, at around 31 mW m^{-2}.

Late-Cambrian oxygen

Proc. Natl Acad. Sci. USA doi:10.1073/pnas.1011836108 (2011)

The evolutionary boom known as the Great Ordovician Biodiversification Event actually began in the Late Cambrian period, about 500 million years ago. Geochemical data suggest that this period was marked by a rise in oxygen levels to near present-day levels, which could have spurred the biological diversification.

Matthew Saltzman of Ohio State University and colleagues assessed the oxygenation of the Earth's atmosphere during the Cambrian period using two independent techniques: carbon and sulphur isotope systematics and paired $\delta^{13}C$ analyses of co-existing carbonates and organic matter. Both techniques suggest a rise in atmospheric oxygen levels associated with a period of increased burial of organic carbon and pyrite. Burial prevents the oxidation of the carbon and pyrite, allowing free oxygen to accumulate in the atmosphere and oceans.

Higher oxygen levels in the oceans would have made available to phytoplankton the trace micronutrients that are generally lacking in anoxic waters, such as molybdenum. This could have fuelled the rapid rise in plankton diversity at the onset of the event.

Metals from magma

Geology **39,** 351–354 (2011)

© 2011 GSA

The presence of molten sulphur has long been reported at crater lakes on active volcanoes. Sampling carried out at an undersea volcano also identified molten sulphur carrying abundant metals.

Jonguk Kim and colleagues at the Korea Ocean Research and Development Institute dredged the surface of an active caldera associated with the Northeast Lau spreading centre in the southwest Pacific Ocean. While collecting rocks, the chain and frame of the equipment were enveloped by solidified and partially molten sulphur, implying that it must have encountered molten sulphur. Back in the lab, the team found that the sulphur grains were enriched in copper, arsenic and gold, as well as other metals commonly associated with volcanic activity. The isotopic composition of the sulphur suggests that it formed from gases released from the magma.

This vapour, which was also enriched in metals, would have then condensed and flowed into pools along the flanks of the caldera. The researchers speculate that these easily leached deposits could supply sulphur and metals to the surrounding hydrothermal systems.

Cold accreted cores

Icarus doi:10.1016/j.icarus.2011.02.021 (2011)

Planetary embryos that form through cold accretion often develop precursors to a core known as protocores. Model simulations identify the pathways by which these protocores — that consist of a cold central region, a layer of iron and an outer shell — yield to true iron cores.

Ja-Ren Lin at National Taiwan University and colleagues used two-dimensional thermomechanical models to identify the mechanisms by which protocores destabilize and true cores form in small planetary bodies. In some of the scenarios, the protocore could be pushed to the surface of one hemisphere of the planetesimal, allowing liquid iron to fill the core. In another, the protocore was fragmented, partially through the movement of iron blocks and diapirs. The third regime was marked by the deformation of the protocore, possibly associated with planetary-scale rupture zones.

Based on the amount of time it takes for these destabilization scenarios to occur, the team estimates that the total time for core formation in the planetary embryos does not exceed two million years.

Antarctic groundwater

Geophys. Res. Lett. doi:10.1029/2010GL046394 (2011).

Measurements in the Southern Ocean along the coast of East Antarctica show high rates of submarine groundwater discharge. The groundwater seems to be supplied by subglacial meltwater produced beneath the coastal region of the ice sheet.

Takeshi Uemura, of the Graduate University of Advanced Studies, Japan, and colleagues measured the rate at which groundwater is discharged from the sea floor in Lutzow-Holm Bay, East Antarctica, with automated seepage meters lowered through holes drilled in the sea ice. Rates of groundwater discharge were two orders of magnitude higher than those observed at similar depths in the mid-latitude oceans. There was no decline in the rates of discharge at increasing depths, also unlike the mid-latitude oceans.

The team suggests that the high rates of submarine discharge along the Antarctic coast can be explained by a combination of large volumes of glacial meltwater accumulating in subglacial ponds and the wealth of potential groundwater flow paths in the rugged subglacial topography that channel the meltwater to the coast.