CLIMATE SCIENCE

El Niño and nitrous oxide

Glob. Biogeochem. Cycles <http://doi.org/nsf> (2013)

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Soils are a significant source of atmospheric nitrous oxide, a potent greenhouse gas that also contributes to the depletion of stratospheric ozone. Numerical simulations suggest that the El Niño/Southern Oscillation modifies soil nitrous oxide emissions on a global scale.

Eri Saikawa, of Emory University, Atlanta, and colleagues examined seasonal and interannual variability in soil nitrous oxide emissions around the globe between 1975 and 2008, using a model that broadly captures emissions at a coarse scale. According to their simulations, emissions were lower than average during El Niño years, and higher than average during La Niña years. This pattern was apparent in North America, South America, southern Asia and central and equatorial Africa,

regions particularly affected by the El Niño/Southern Oscillation.

Emissions of nitrous oxide from soils were strongly correlated with soil water content in equatorial regions and with temperature in the Northern Hemisphere, suggesting that perturbations to both parameters contributed to the simulated emission anomalies.

AA

GEOCHEMISTRY

Primordial mix

Earth Planet. Sci. Lett. **377–378**, 324–335 (2013)

Primordial material left over from Earth's formation about 4.5 billion years ago has mostly been stirred into the mantle by convection, but the rate of mantle mixing is unclear. Geochemical analyses of ancient rocks from Greenland indicate that Earth's mantle became largely homogenized between 3.4 and 3.3 billion years ago.

Hanika Rizo at Clermont Université, Université Blaise Pascal, France, and colleagues analysed the geochemistry of rocks sampled from the Isua Supracrustal Belt in southwest Greenland. The rocks formed from a source in Earth's mantle between about 3.8 and 3.3 billion years ago. The researchers found that the oldest rocks contained an excess amount of the isotope ^{142}Nd that is not observed in mantle-derived rocks today, and is therefore thought to be the fingerprint of primordial material. This fingerprint was detected previously in rocks formed 3.7 and 3.4 billion years ago. However, it was absent from the Greenland rocks aged 3.3 billion years. Together, these findings suggest that the

window between 3.4 and 3.3 billion years ago marked a period of mantle homogenization.

The results imply that any distinct reservoirs of primordial material were probably largely erased from the mantle within about a billion years of Earth's formation.

AW

PLANETARY SCIENCE

Wonky to the core

J. Geophys. Res. <http://doi.org/nsh> (2013)

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The geologically active surface of Enceladus indicates that this icy moon of Saturn is differentiated into a rocky core, an icy mantle and possibly an internal ocean; however, the moon's shape is inconsistent with differentiation. Mathematical analyses suggest that a modestly flattened and distorted core can explain the global shape of Enceladus.

William McKinnon at Washington University in St Louis, USA, used a mathematical model to quantitatively assess the hypothesis that the core of Enceladus is topographically lumpy. Core irregularity would alter Enceladus's global geoid and therefore the dimensions of its axes, assuming Enceladus is in hydrostatic equilibrium. He finds that the amount of excess topography that is required to explain the moon's shape is only about 10 km for a core with a radius of 160 km. The model predictions can be tested by measuring the gravity field of Enceladus.

A suitably irregular core would affect the tidal heating of the icy mantle and allow an internal ocean to remain unfrozen near the south pole of Enceladus, potentially explaining the concentration of geological activity at high southern latitudes.

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PALAEOCLIMATE

Interglacial monsoon

J. Clim. <http://doi.org/nsg> (2013)

The interglacial period that occurred 500,000 years ago — known as Marine Isotope Stage 13 — is thought to have been cooler than the present interglacial, with persistent continental ice in the Northern Hemisphere. A numerical simulation suggests that the East Asian summer monsoon was stronger during this interval.

Helene Muri of Université catholique de Louvain, Belgium, and colleagues used a coupled ocean-atmosphere general circulation model to assess the climate conditions that resulted from the combination of relatively high incoming solar radiation and low levels of atmospheric greenhouse gases during Marine Isotope Stage 13. In the simulations, global mean temperatures during the Northern Hemisphere summer were similar to those in pre-industrial times, whereas winter temperatures were one to two degrees cooler. Over east Asia, however, summer temperatures were several degrees warmer than in the pre-industrial period, with a weak temperature gradient between the eastern and western Pacific Ocean and a different pattern of zonal atmospheric circulation. In addition, an intense high pressure system persisted over the North Pacific. The presence of ice sheets in North America and western Eurasia further altered atmospheric circulation and precipitation patterns.

In sum, the simulated climate conditions increased summer monsoon precipitation over East Asia, and pushed precipitation farther north than present, in agreement with palaeoclimate records.

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