

## CHANGES IN CONCENTRATIONS OF CO<sub>2</sub>, CH<sub>4</sub> AND N<sub>2</sub>O OVER THE PAST 2000 YEARS AND THEIR CAUSES

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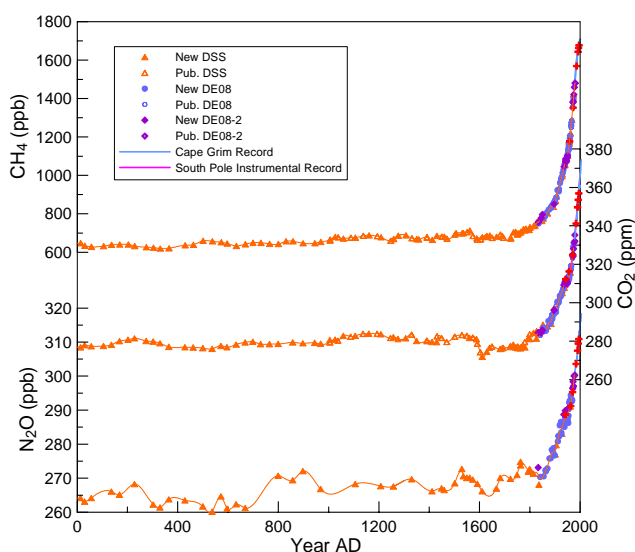
### Abstract

The concentrations of the major greenhouse gases carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) have increased significantly over the industrial period. We present new evidence of these increases and other changes and their causes over the past 2000 years from measurements of the air preserved in ice cores.

The measurements are on air from Law Dome (Antarctica), which is enclosed rapidly into bubbles, reliably recording past atmospheric composition. Advanced techniques of air extraction and analysis are used to precisely measure a large number of trace gas concentrations and isotopic ratios.

The results show major increases in CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O (29%, 150%, and 21% respectively) over the past 200 years and relative stability beforehand. Variations of up to 10 ppm CO<sub>2</sub>, 40 ppb CH<sub>4</sub> and 10 ppb N<sub>2</sub>O occur on decade to century timescales throughout the pre-industrial period.

Measurements of the isotopic composition ( $\delta^{13}\text{C}$ ) of CO<sub>2</sub> and CH<sub>4</sub>, combined with modelling of their sources and sinks, help to identify the causes of these changes. Anthropogenic emissions are the main cause of the increases over the past 200 years, or even longer for methane, whereas the effects of climate on natural sources are the main likely cause of the decade-century variability.



**Figure 1.** Concentrations of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O over the past 2000 years.

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