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STRATOSPHERIC FEEDBACK FROM CONTINUED INCREASES IN TROPOSPHERIC METHANE

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Tropospheric concentrations of methane have increased steadily over the past ten years at an average rate of 16.5 ppbv per year, to a value in January 1988 of 1.69 ppmv. Measurements of CH_4 concentrations in air bubbles trapped in ice cores have shown concentrations of about 0.7 ppmv 200 years ago, with little further change for thousands of years before that. Interpolation earlier into this century suggests a concentration of about 1.1-1.2 ppmv in the 1940s.

The only important pathway believed to be important for transfer of air from the troposphere to the stratosphere is through the tropical tropopause which is cold enough to reduce the mixing ratio of H_2O in that air to about 3 ppmv. The only other major pathway for the delivery of H to the stratosphere is through the simultaneous injection of gaseous CH_4 in the same rising air. Satellite observations of the concentrations of both H_2O and CH_4 have shown that the summed H concentration is approximately constant at 12 ppmv H, the equivalent of 6 ppmv H_2O, corresponding roughly to 3 ppmv H_2O and 1.5 ppmv CH_4. As the trace concentrations of CH_4 in the troposphere have increased from 0.7 to 1.0 to 1.7 ppmv, the total H in the stratosphere has probably risen from about 4.4 to 5.0 to 6.0 to 6.4 ppmv H_2O equivalent. In well-oxidized air with most of its CH_4 converted to H_2O, these H_2O changes can account for as much as 45% more than was present 200 years ago, and 28% more than was there about 40-50 years ago. (These estimates assume that no change has occurred in the average temperature of the tropical tropopause which controls the H_2O concentration in the air entering the stratosphere.)

The formation of clouds in the stratosphere is dependent upon very low temperatures, and generally upon the amount of water vapor available. The possibility of a positive feedback exists, especially in "well-oxidized methane" air that clouds are easier to form than earlier. This could mean enhancement of PSCs in both Antarctic and Arctic locations. Additional H_2O in the stratosphere can also add to some of the greenhouse calculations.