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Inter-annual variability in atmospheric nitrous oxide over the past two decades

R.L. Thompson (1,2), P. Bousquet (2), F. Chevallier (2), S. Zaehle (3), L. Bopp (2), and E. Dlugokencky (4)

(1) Norwegian Institute for Air Research, Kjeller, Norway, (2) Laboratoire des Sciences du Climat et l'Environnment, INVSAT, Gif sur Yvette, France, (3) Max Planck Institute for Biogeochemistry, Jena, Germany, (4) NOAA, Global Monitoring Division, Boulder, Colorado, USA

Nitrous oxide (N2O) concentrations have been steadily increasing in the atmosphere over the past few decades at a rate of approximately 0.3% per year. This trend is of major concern as N2O is both a long-lived greenhouse gas and an Ozone Depleting Substance (ODS). This trend is largely due to the increased input of reactive nitrogen (Nr) to the environment, primarily in N-fertilizers. Before the widespread usage of N-fertilizers, the naturally occurring N2O source was approximately balanced by the atmospheric sink, that is, photochemical destruction in the stratosphere. Super-imposed on the atmospheric trend, is significant inter-annual variability (IAV), which is thought to be mainly determined by inter-annual variations in stratosphere-troposphere exchange.

Using global N2O records since the late 1990's (when more than 50 stations are available worldwide), we found significant IAV in the N2O atmospheric growth-rate with a positive anomaly from 1998 to 1999 in the northern hemisphere and a negative anomaly in 2003 in Europe, North America and Asia. To test the influence of the inter-annual variations in emissions versus stratosphere-troposphere exchange on the observed growth-rate, we carried out simulations using the global circulation model, LMDZ4, which was driven using ECMWF reanalysis data and was coupled to emissions estimates from the global eco-system model, Orchidee O-CN and the ocean biogeochemistry model, PISCES, which were also driven by climate data.