Fluxes of Nitrous Oxide and Other Nitrogen Trace Gases from Intensively Managed Landscapes: A Global Perspective

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Concentrations of N$_2$O in the global atmosphere have been rising over the last 20 yr at about 0.8 parts per billion volumetric (ppbv) or 0.25% yr$^{-1}$ to the 310 ppbv present in today’s atmosphere (Fig. 6-1; Elkins and Rossen, 1989). Ice core data that indicate concentrations of around 280 ppbv in the preindustrial atmosphere (e.g., Pearman et al., 1986) suggest that this rise reflects a long-term trend (Fig. 6-2; IPCC, 1990). In fact, this 0.8 ppbv increase represents a 3.5 Tg addition of N$_2$O–N to the global atmosphere each year, and if one assumes that the present photodissociation rate of N$_2$O in the stratosphere (11 Tg yr$^{-1}$ N) is typical of preindustrial steady-state loading rates, then the preindustrial loading rate of N$_2$O–N was 11 Tg yr$^{-1}$—suggesting that we are today adding another 40% (3.5 Tg N) of N$_2$O to the atmosphere each year than was the case 100 yr ago (Cicerone, 1987; Robertson et al., 1989).

This loading rate is significant primarily for two reasons. First, N$_2$O is one of the major greenhouse gases, accounting for 6 to 8% of the present greenhouse forcing rate ascribed to anthropically derived gases (CO$_2$, CFC’s, CH$_4$, and N$_2$O; Hansen et al., 1990; IPCC, 1990). On a molar basis N$_2$O is about 250 times more potent than CO$_2$ as an absorber of infrared radiation—in part due to its molecular structure but largely due to the fact that it absorbs in a portion of the infrared transmission window that in our present atmosphere is relatively clean (Duxbury et al., 1993). Second, N$_2$O is the major natural regulator of stratospheric O$_3$, which effectively controls the earth’s ultraviolet-B (UV$_B$) radiation balance. Through a series of reactions elucidated over the last 20 yr, the oxidation of N$_2$O to NO via reaction with photolytically produced atomic oxygen O(1D) in the upper stratosphere (>25 km) produces NO that in turn reacts with O$_3$ to form...