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Biosphere-Atmosphere exchange of C and N trace gases in annual and perennial land use systems of the irrigated areas in the Aral Sea Basin, Uzbekistan

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Nitrous oxide (N_2O) and methane (CH_4) emissions were monitored in various annual and perennial land use system of Khorezm, Uzbekistan, a region located in the arid deserts of the Aral Sea Basin. The annual land use systems comprised irrigated cropping sites of cotton, winter wheat and rice, the perennial systems a plantation of poplar trees and a natural Tugai (floodplain) forest. In the annual systems, average N_2O emissions ranged from 10 to 150 μg N_2O-N m^{-2} h^{-1} with highest N_2O emissions in the cotton fields. The cropping sites were managed using different fertilizer management strategies and irrigation water regimes. Seasonal variations in N_2O emissions were principally controlled by fertilization and irrigation management. Very high N_2O emissions of up to 3000 μg N_2O-N m^{-2} h^{-1} were measured in periods following N-fertilizer application in combination with irrigation events. These "emission pulses" accounted for 80-95% of the total N_2O emissions. Emission factors (uncorrected for background emission) of the different cropping sites, used to determine the fertilizer-induced N_2O emission as a percentage of N fertilizer applied, ranged from 0.2 to 2.6%. The unfertilized poplar plantation showed high N_2O emissions over the entire study period (30 μg N_2O-N m^{-2} h^{-1}), whereas only negligible fluxes of N_2O ($<$ 2 μg N_2O-N m^{-2} h^{-1}) occurred in the Tugai forest. Significant CH_4 fluxes only were determined from the flooded rice field, but with comparably low mean seasonal

value of 35.2 kg CH_4 ha^{-1}. The global warming potential (GWP) of the N_2O and CH_4 fluxes was highest under rice and cotton, with seasonal changes between 500 to 4000 kg-CO_2eq.ha^{-1}. The biennial cotton-wheat-rice crop rotation commonly practiced in the region would average a GWP of 2500 kg CO_2 eq.$ha^{-1}$$year^{-1}$. The study points out opportunities for reducing the GWP of these irrigated agricultural systems. There is scope for reducing N_2O emission and at the same time increasing the fertilizer use efficiency from the irrigated cropping systems by the use of advanced application and irrigation techniques such as sub-surface fertilizer application, drip irrigation and fertigation. Further mitigation opportunities exist by changing land use from an annual cropping system to perennial forest plantations or taking land out of irrigated agricultural production, in particular on marginal lands where annual crops are no longer profitable.