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Research on nitrous oxide formation in engineered wastewater systems has experienced an exponential development in the recent years due to the important environmental impact of this greenhouse gas. These efforts have crystalized in a large number of publications that aim to identify the importance of the main microbial processes responsible for its production and consumption. The conceptualization of these pathways in mathematical models has the potential to become a key tool to increase our understanding on the complex interrelationships within these ecosystems and develop strategies to minimize the carbon footprint of wastewater treatment plants. Unfortunately, existing model structures are limited to describe the emissions of individual microbial pathways in an attempt to decrease their complexity and facilitate their calibration. The present contribution summarizes the recent developments in this field and makes use of sensitivity analyses, and an in-depth study of model uncertainties to establish experimental protocols that facilitate the calibration and predictive ability of a new generation of more realistic models describing N_2O production during wastewater treatment.