# A global $N_2O$ emission inventory for tropical rainforest soils

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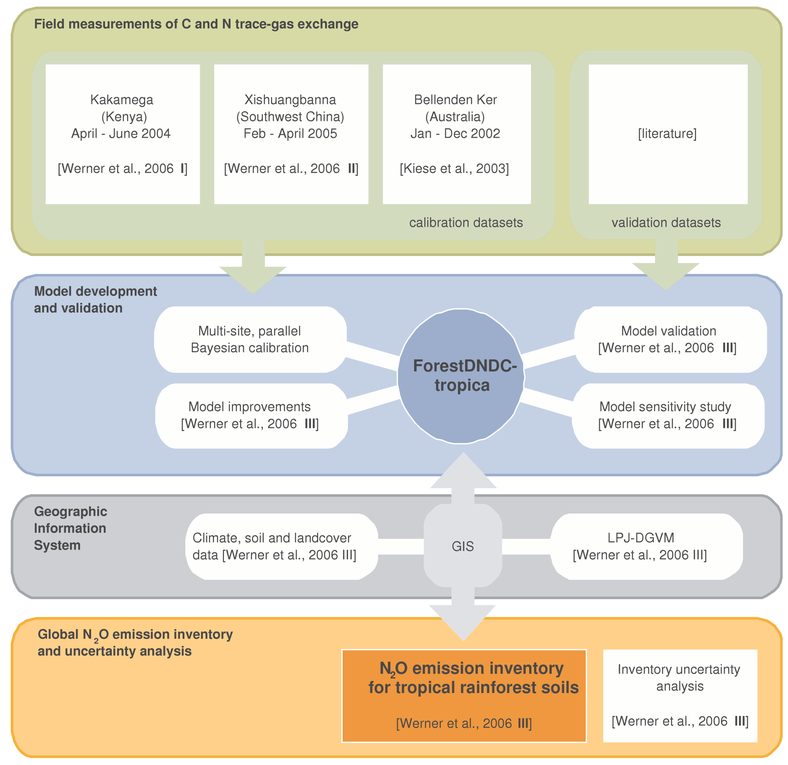
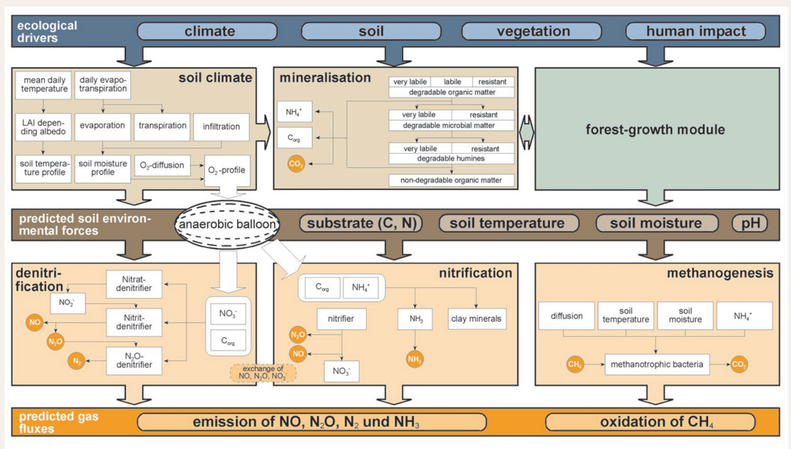
## Abstract

An improved version of the ForestDNDC-tropica model coupled to a newly created GIS database was used to simulate global $N_2O$ emission inventories. We used a spatial resolution of 0.25 × 0.25 degrees and simulated on a daily time-step for the years 1991-2000. Extensive validation and sensitivity studies underlined the good agreement of the improved biogeochemical model with observed $N_2O$ fluxes. Our results show striking spatial and temporal differences of $N_2O$ source strength. Based on the calculations in this study the source estimate of global $N_2O$ emissions from tropical rainforest soils was revised from previously 1.2 - 3.6 Tg N $yr^{-1}$ (collection of literature data) to 1.3 Tg N $yr^{-1}$. As the accuracy of the model output is dependant on the data quality driving the models, an uncertainty assessment was performed to quantify the data-induced uncertainty on the presented $N_2O$ emission inventory. Using a Latin hypercube sampling approach, the uncertainty range was calculated to be 0.9 - 2.4 Tg N $yr^{-1}$. Another key finding of this study was the strong seasonal and interannual variability of $N_2O$ emissions originating from tropical rainforest soils at the global scale. So far, this was not captured by statistical upscaling approaches. Furthermore, these temporal variations were accompanied by significant spatial variations in the $N_2O$ emission strength on a continental scale (e.g., 90% variation between 1993 and 1994 for the African continent). It could be shown, that the ForestDNDC-tropica model offers the possibility to account for the spatial and temporal heterogeneity of the $N_2O$ soil-atmosphere exchange as observed during field measurements in tropical rainforest worldwide.
The presented approach might help to overcome the static concept of previous inventory assessments towards a more dynamic understanding of $N_2O$ biosphere-atmosphere exchange processes on a global scale, thereby also allowing considering feedbacks to changes in climate and land use.

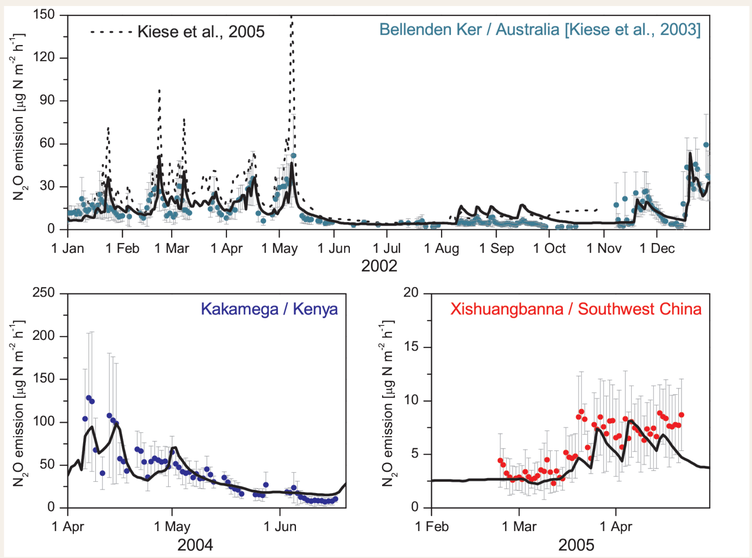



**Structure** of this study and corresponding publications.

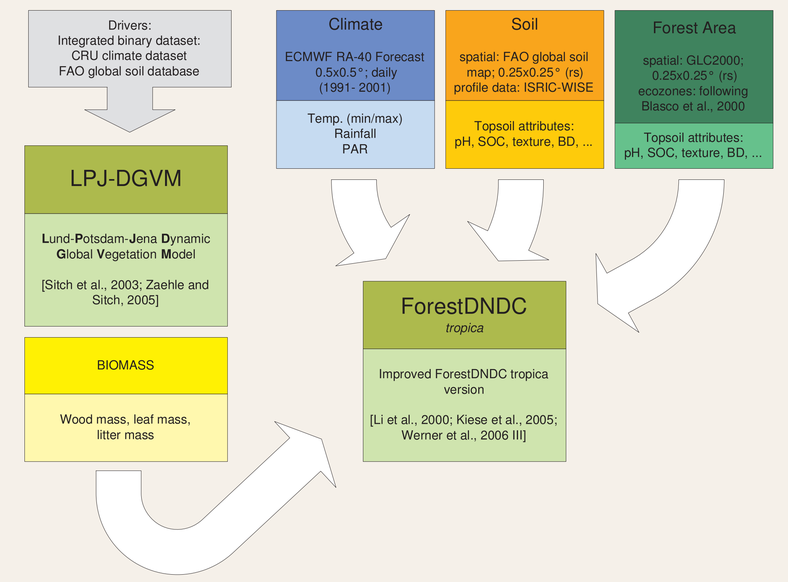
## Model development, validation and data




**Structure of the mechanistic, biogeochemical model ForestDNDC.** The detailed simulation of all relevant controls enables for the realistic simulation of the dynamic nature of the formation and emission of $N_2O$ from the soil.

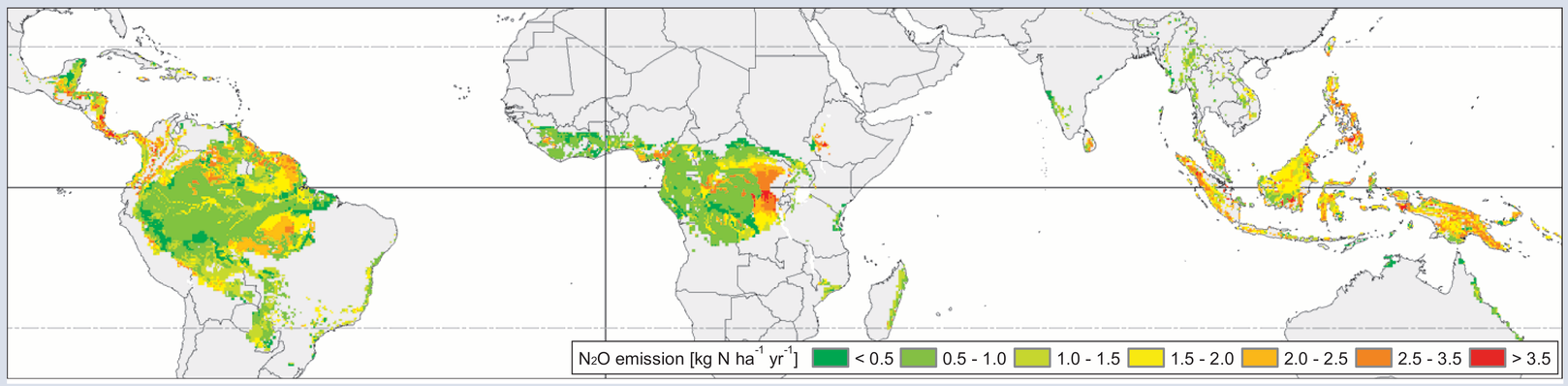



**Model improvements and recalibration enhanced the agreement of simulated $N_2O$ emission levels and temporal dynamic** with high-resolution $N_2O$ flux data from chamber measurements (independant validation and sensitivity tests were also performed; see Werner et al., 2007 III).




**Geographic datasets selected for driving the mechanistic models** used for upscaling $N_2O$ emissions from tropical rainforest soils to the global scale.

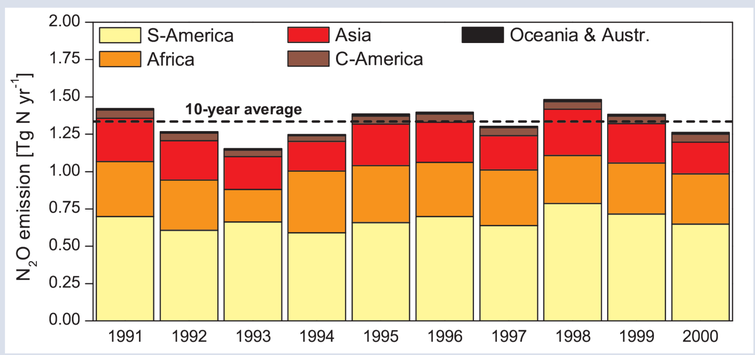
## Results



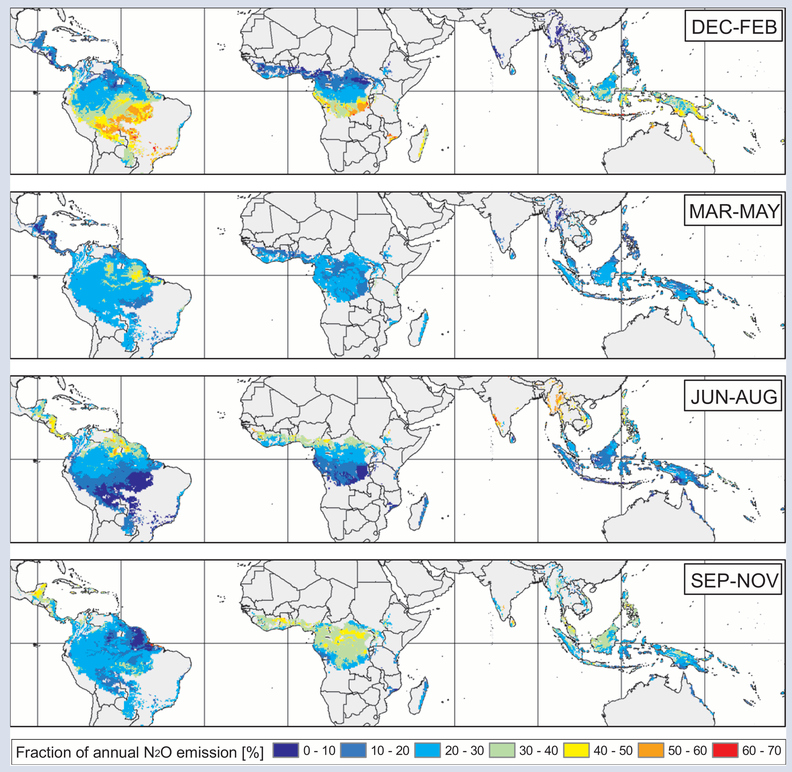

**Spatial distribution of annual $N_2O$ emissions from tropical rainforest soils.** Given is the 10-year average for the years 1991-2000.

- Tropical rainforest soils emit 1.3 Tg $N_2O$-N $yr^{-1}$ (uncertainty: 0.9 - 2.4 Tg).
- Spatial variability of $N_2O$ emissions induced by local site conditions can be observed.
- A strong inter- and intra-annual dynamic of $N_2O$ emissions exists.

$N_2O$ emissions from tropical rainforest soils are not static and must be evaluated spatially explicit, over years and in daily resolution.




**Inter-annual variations of simulated $N_2O$ emissions from tropical rainforest soils** at continental and global scales.




**Seasonality of simulated $N_2O$ emissions from tropical rainforest soils.** Given is the seasonal contribution to the annual total of $N_2O$ emissions (based on the 10-year mean annual $N_2O$ emission of the years 1991-2000).

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