Upscaling wetland methane emissions from FLUXNET-CH4 (UpCH4 v1.0)

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Science Question

How much methane is emitted globally from freshwater wetlands?
Can eddy covariance tower networks help improve emissions estimates?
Current process (bottom-up) and inversion system (top-down) diverge in global total and regional distribution of emissions.

Analysis

Random forest ensembles trained on 119 site-years (~6000 weeks) of FLUXNET-CH4 data
Leave-one-out cross validation on 26 spatially clusters of 43 wetland sites
A further ~150 globally-gridded variables were considered as candidate predictors
Monte-Carlo simulations of data uncertainties propagated to final product
Masked with WAD2M or GIEMS-2 dynamic wetland extents (Zhang et al. 2021; Prigent et al. 2020)

Results

UpCH4 reproduced extra-tropical flux patterns (R^2 0.59-0.64)
Global annual wetland methane emissions (146 $TgCH_4$ y^{-1}) overlapped with GCP estimates
Humid/monsoon tropics dominate upscaled emissions (68%) *and* uncertainties (78%)

Significance

Realistic baseline model emissions indicate utility of ML-based upscaling
Temperature plus greenness (EVI) model reproduces northern latitude wetland dynamics
More flux data for across humid-to-monsoon tropical gradients crucial to fill key gaps

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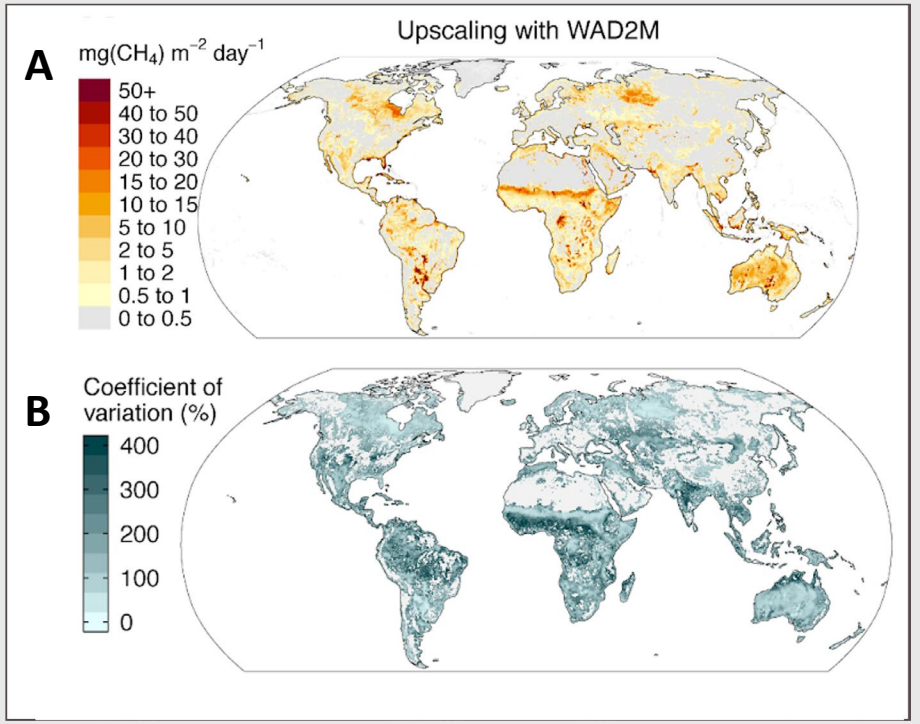

Figure 1. Global maps of: **(A)** Upscaled (UpCH4) mean 2001–2018 CH4 flux using WAD2M wetland area **(B)** CH4 flux uncertainty computed as coefficient of variation of random forest ensemble.