Knowledge Guided Machine Learning for Simulating Agricultural N_2O Emission
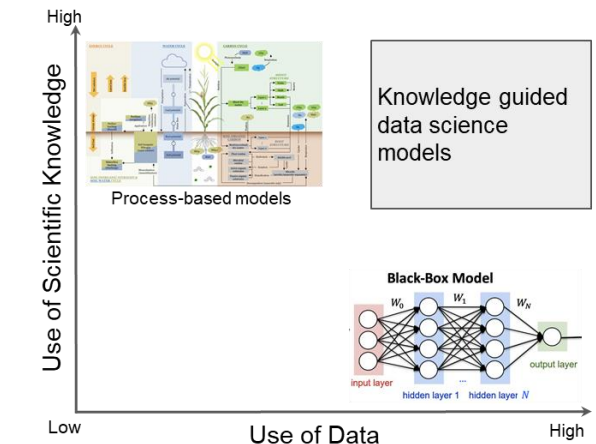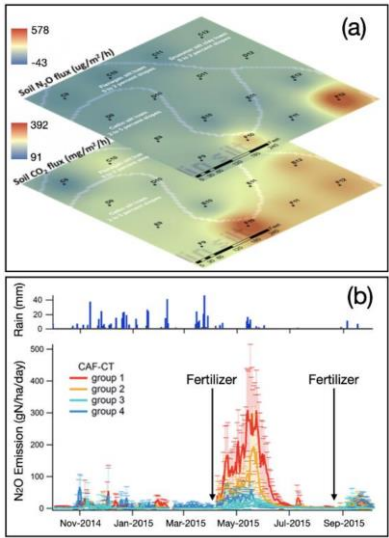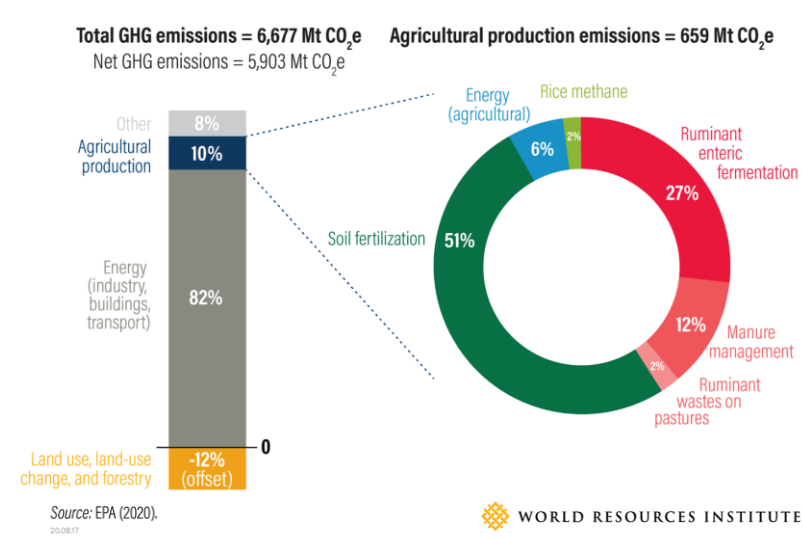
Presenter: Licheng Liu; lichengl@umn.edu;

Motivation:

Total GHG emissions = 6,677 Mt CO_2e
Net GHG emissions = 5,903 Mt CO_2e

Agricultural production emissions = 659 Mt CO_2e

Source: EPA (2020).

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Waldo et al. 2019

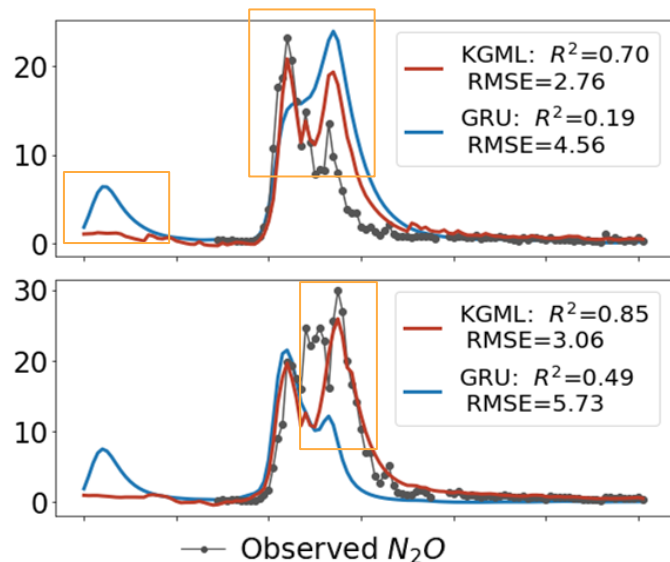Knowledge guided data science models

Process-based models

Black-Box Model

❑ Fertilizer use accounts for 51% of the ag emissions, largely in forms of **N$_2$O, 265x more powerful than CO$_2$** as a GHG

❑ Hard to estimate due to **hot spots, hot moment** of N$_2$O fluxes

❑ KGML model can take full advantage of data without ignoring the treasure of accumulated scientific knowledge
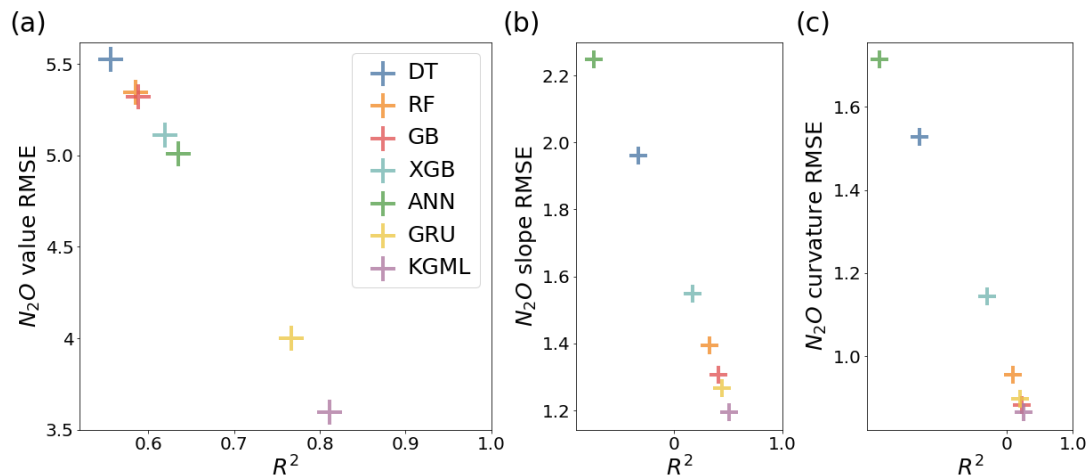
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Key results:

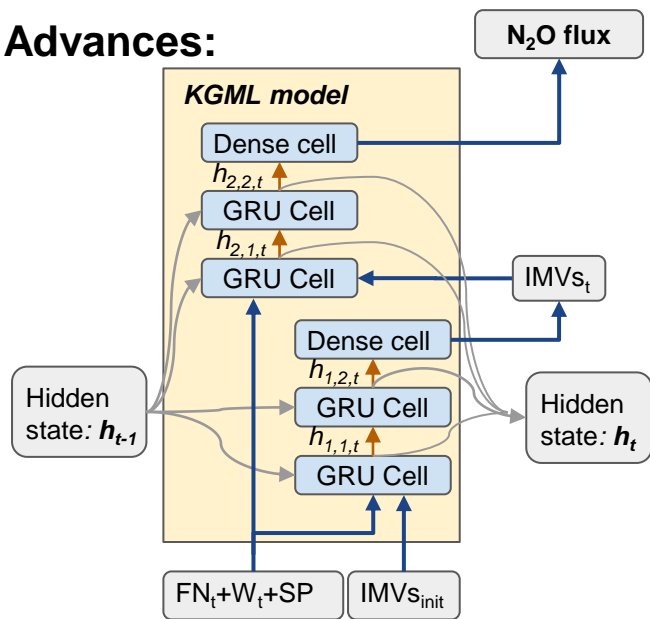One example of KGML model comparing to GRU model in mesocosm experiment data

❏ KGML (purple) outperform all other ML models

❏ This is mainly because (1) pre-training using synthetic data, (2) knowledge guided architecture, (3) knowledge guided initial values

Liu, L., Xu, S., Jin, Z., Tang, J., Guan, K., Griffis, T. J., ... & Kumar, V. (2021). KGML-ag: A Modeling Framework of Knowledge-Guided Machine Learning to Simulate Agroecosystems: A Case Study of Estimating N2O Emission using Data from Mesocosm Experiments. *Geoscientific Model Development Discussions*, 1-29.

AGU FALL MEETING

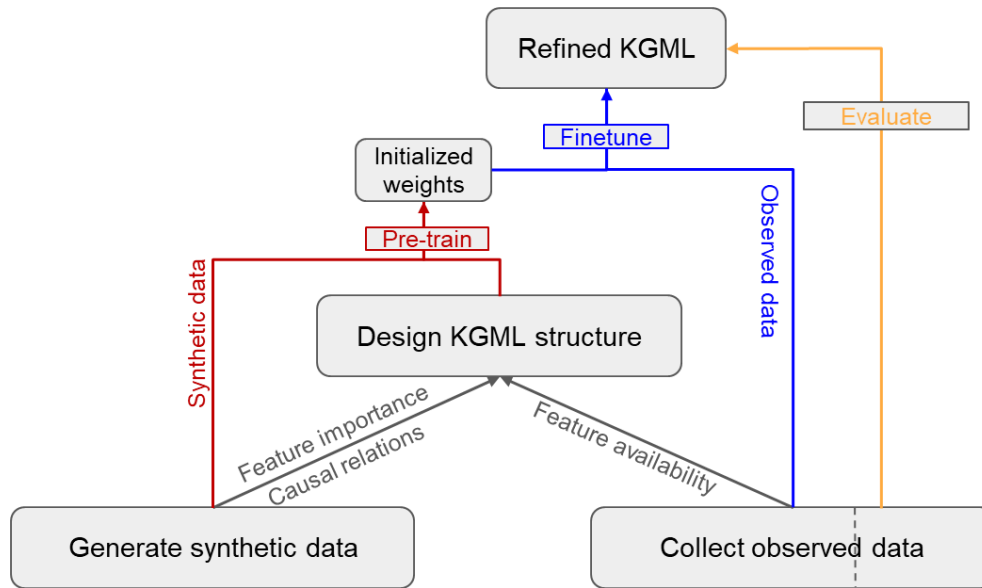UNIVERSITY OF MINNESOTA
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Knowledge Guided Machine Learning for Simulating Agricultural N_2O Emission

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Advances:

KGML model structure

KGML model development workflow

- ❑ High performance ❑ Low data demand ❑ Flexible structure
- ❑ Structure and workflow can be easily transfer to other similar geoscience tasks!

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