Karlsruhe Institute of Technology

Modeling N_2O emissions from Enhanced Efficiency Fertilizers (EEFs) in LandscapeDNDC

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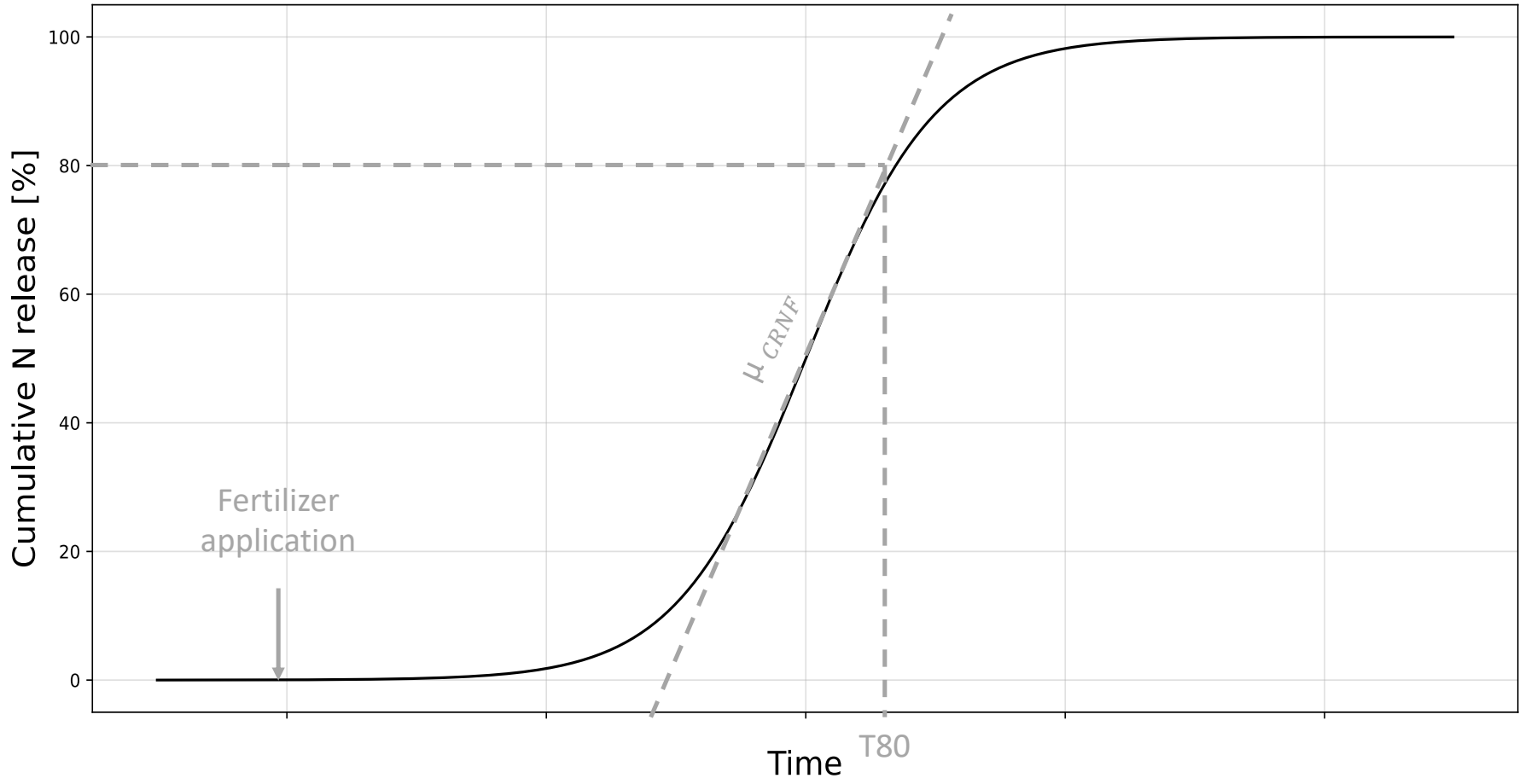
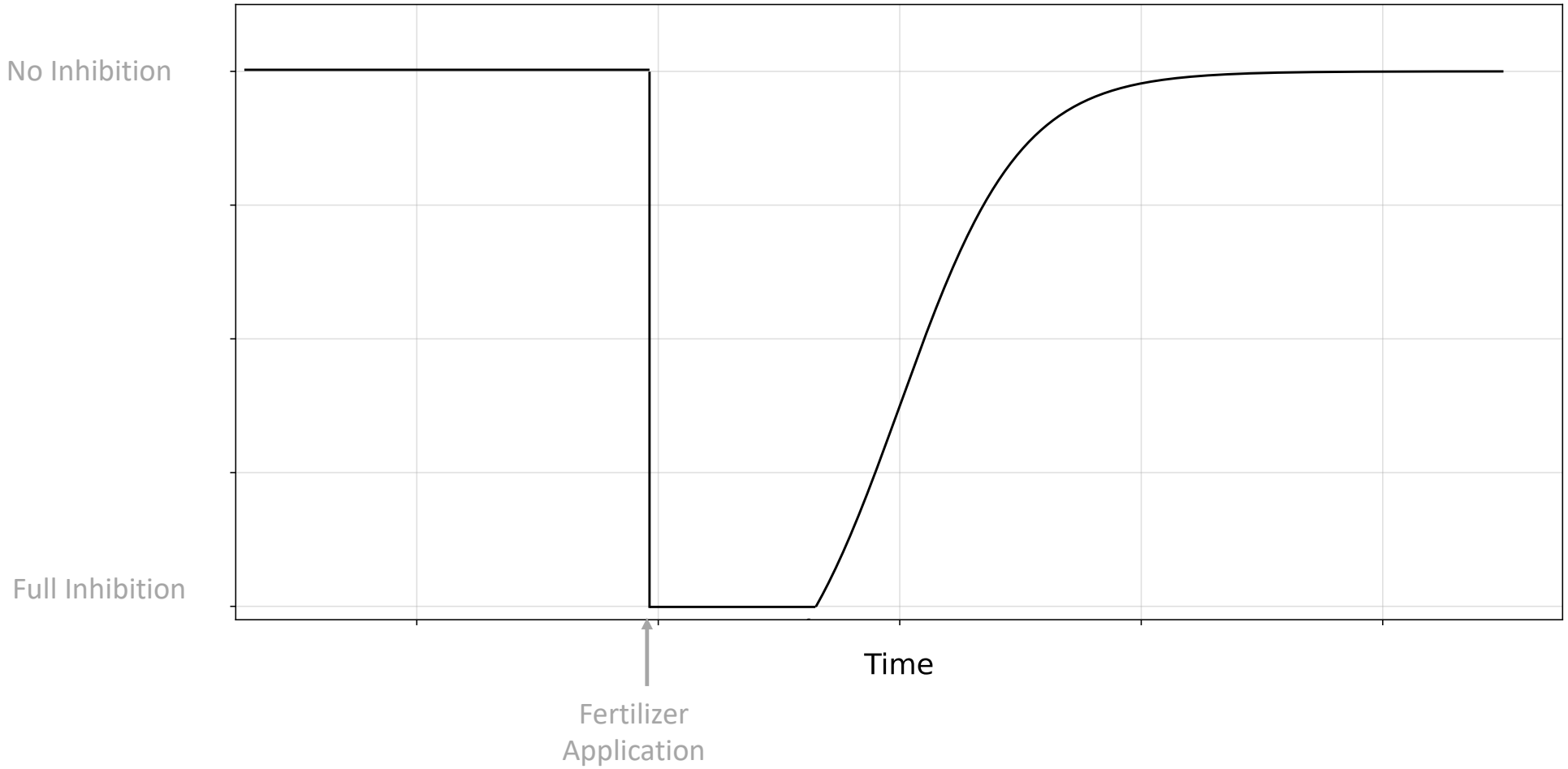
Enhanced Efficiency Fertilizers

- Problem: Excessive N input in agriculture leads to high N_2O emissions
- EEFs promise to increase plant N use efficiency
- Nitrification Inhibitors (NIs) inhibit nitrification ($NH_3 \rightarrow NO_3^-$), increasing plant N availability
- Controlled Release N Fertilizers (CRNFs) release N gradually to synchronize with the plant's nutrient requirements
- Emission reduction potential demonstrated in global meta-analyses e.g. Akiyama et al. (2009): -38%(-44% to -31%) for NIs and -35%(-58% to -14%) for CRNFs
- LandscapeDNDC can help to extrapolate measurements while accounting for variance between land-use/soil type/climate

CRNFs in LandscapeDNDC

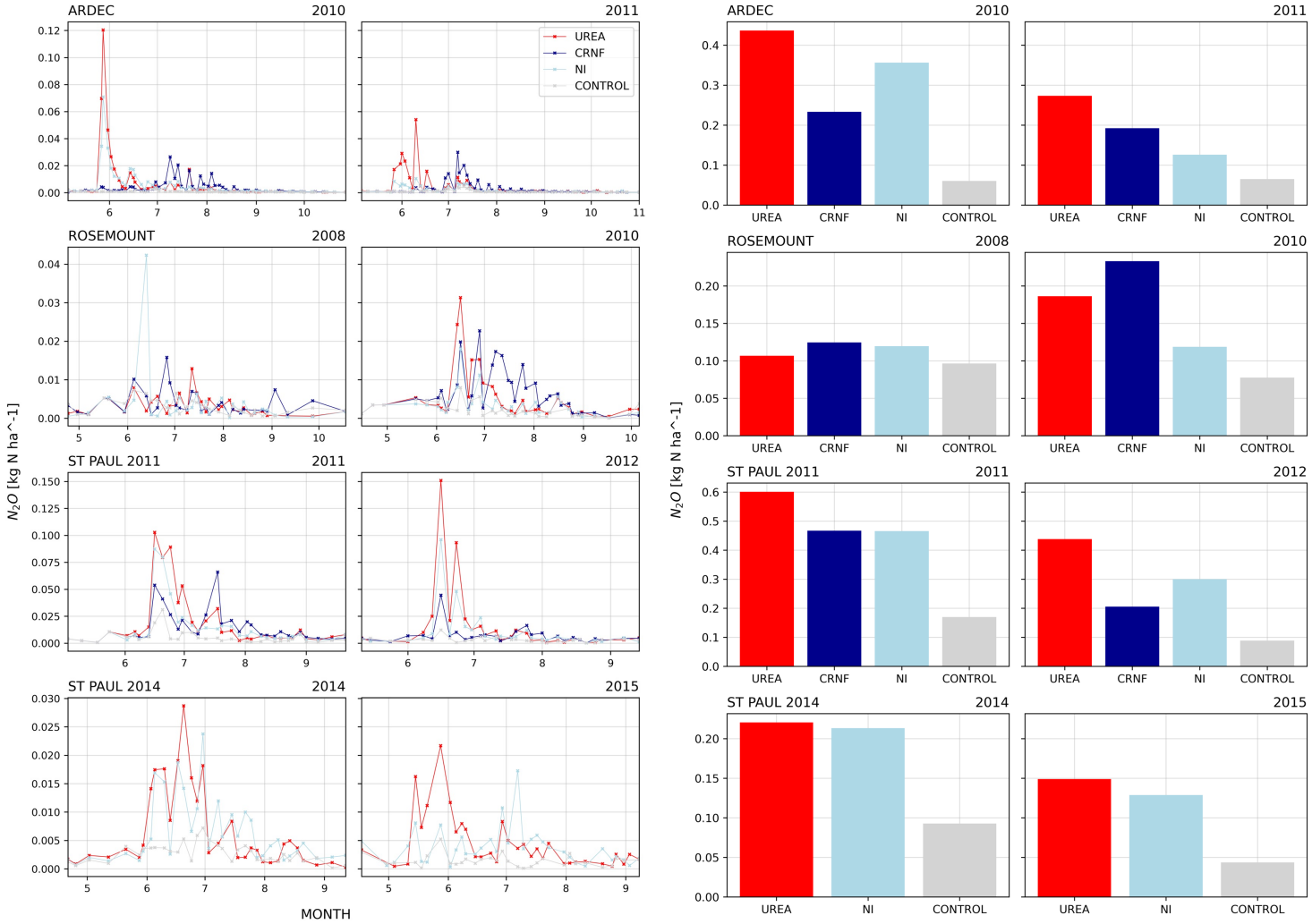


NIs in LandscapeDNDC

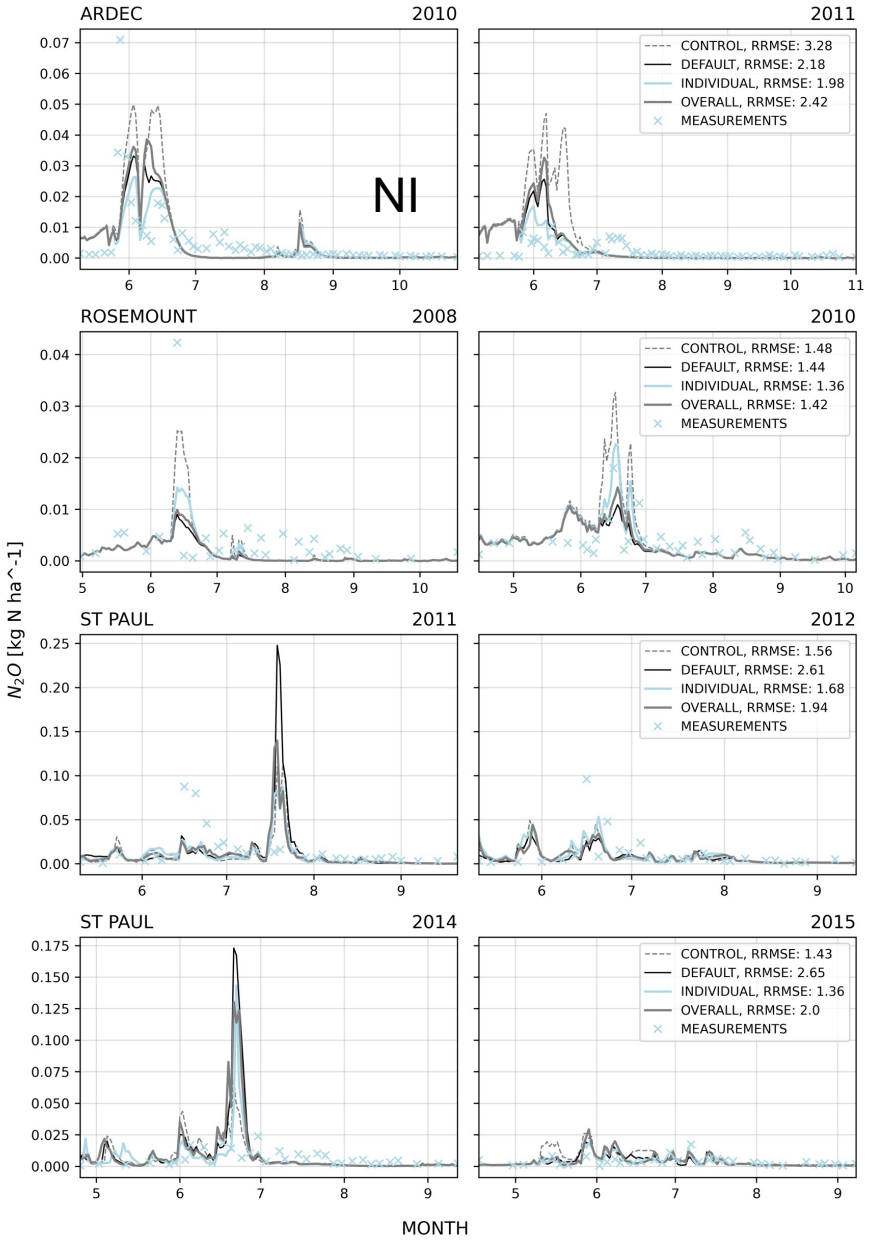


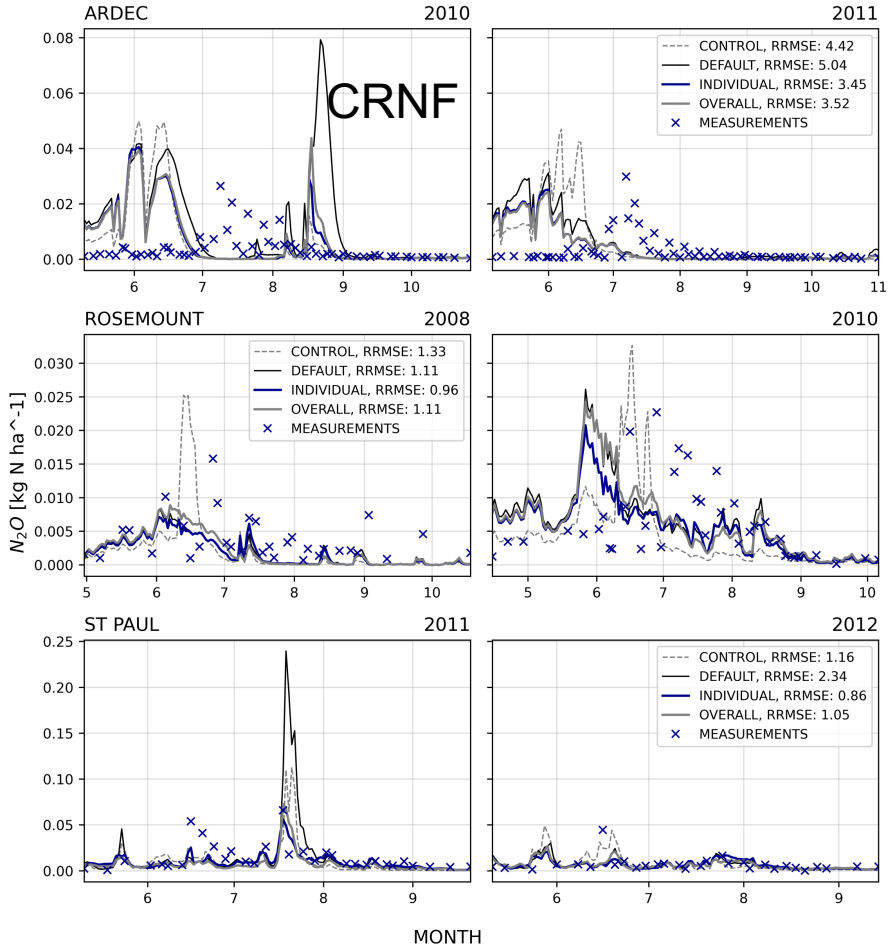
Data for model calibration

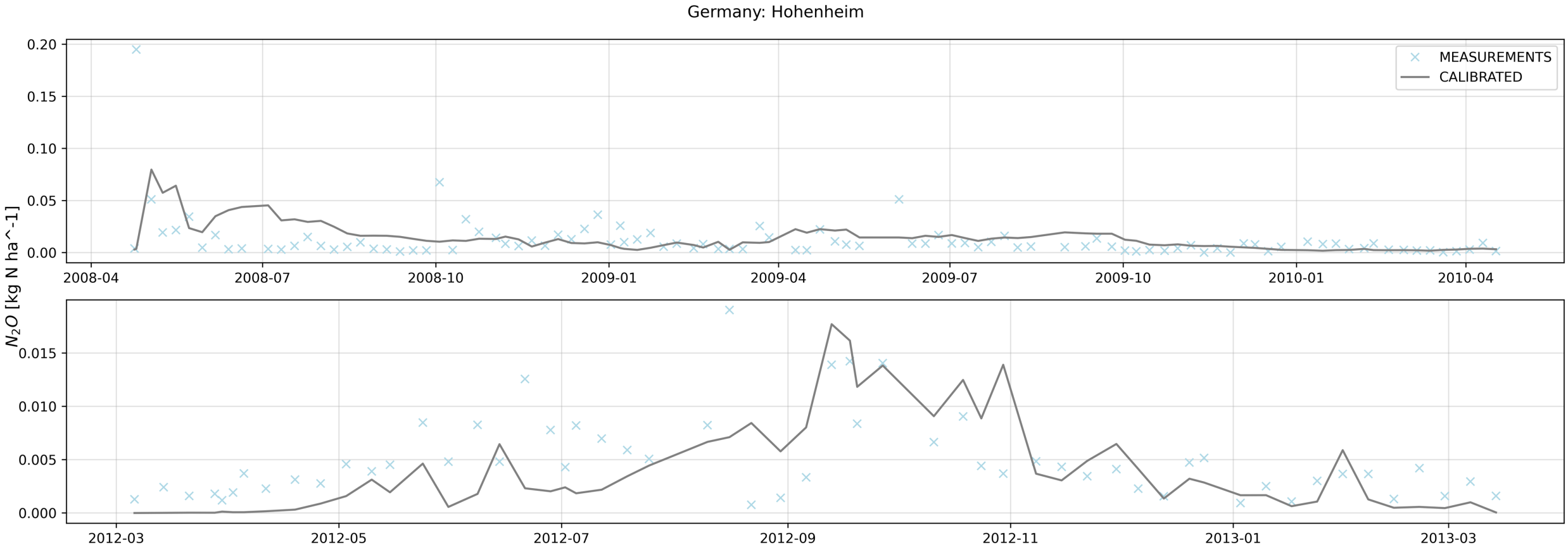
- 4 US corn cropping systems
- ~weekly measurements during growing season
- Control, conventional urea, NI and CRNF



Results


ARDEC
2010
2011
NI
CONTROL, RRMSE: 3.28
DEFAULT, RRMSE: 2.18
INDIVIDUAL, RRMSE: 1.98
OVERALL, RRMSE: 2.42
MEASUREMENTS
ROSEMOUNT
2008
2010
CONTROL, RRMSE: 1.48
DEFAULT, RRMSE: 1.44
INDIVIDUAL, RRMSE: 1.36
OVERALL, RRMSE: 1.42
MEASUREMENTS
ST PAUL
2011
2012
CONTROL, RRMSE: 1.56
DEFAULT, RRMSE: 2.61
INDIVIDUAL, RRMSE: 1.68
OVERALL, RRMSE: 1.94
MEASUREMENTS
ST PAUL
2014
2015
CONTROL, RRMSE: 1.43
DEFAULT, RRMSE: 2.65
INDIVIDUAL, RRMSE: 1.36
OVERALL, RRMSE: 2.0
MEASUREMENTS
N_2O [kg N ha^-1]
MONTH


ARDEC
2010
2011
CRNF
CONTROL, RRMSE: 4.42
DEFAULT, RRMSE: 5.04
INDIVIDUAL, RRMSE: 3.45
OVERALL, RRMSE: 3.52
MEASUREMENTS
ROSEMOUNT
2008
2010
CONTROL, RRMSE: 1.33
DEFAULT, RRMSE: 1.11
INDIVIDUAL, RRMSE: 0.96
OVERALL, RRMSE: 1.11
MEASUREMENTS
ST PAUL
2011
2012
CONTROL, RRMSE: 1.16
DEFAULT, RRMSE: 2.34
INDIVIDUAL, RRMSE: 0.86
OVERALL, RRMSE: 1.05
MEASUREMENTS
N_2O [kg N ha^-1]
MONTH


Germany: Hohenheim
MEASUREMENTS
CALIBRATED
N_2O [kg N ha^-1]
0.20
0.15
0.10
0.05
0.00
2008-04
2008-07
2008-10
2009-01
2009-04
2009-07
2009-10
2010-01
2010-04
0.015
0.010
0.005
0.000
2012-03
2012-05
2012-07
2012-09
2012-11
2013-01
2013-03

Conclusion

- More data is needed, especially for CRNFs in Germany/Europe and during winter
- In a consistent data set LandscapeDNDC predicts N_2O emissions from EEFs with reasonable accuracy
- A step further towards representing EEFs in Tier 3 emission budgets