# Optimizing yield and reducing greenhouse gas emissions for resilient cropping systems in rain fed semiarid environments


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Transitioning Cereal Systems to Adapt to Climate Change

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QUT

$N_2O$ Network

# Key Principles

- Adaptation and mitigation strategies must be synergistic

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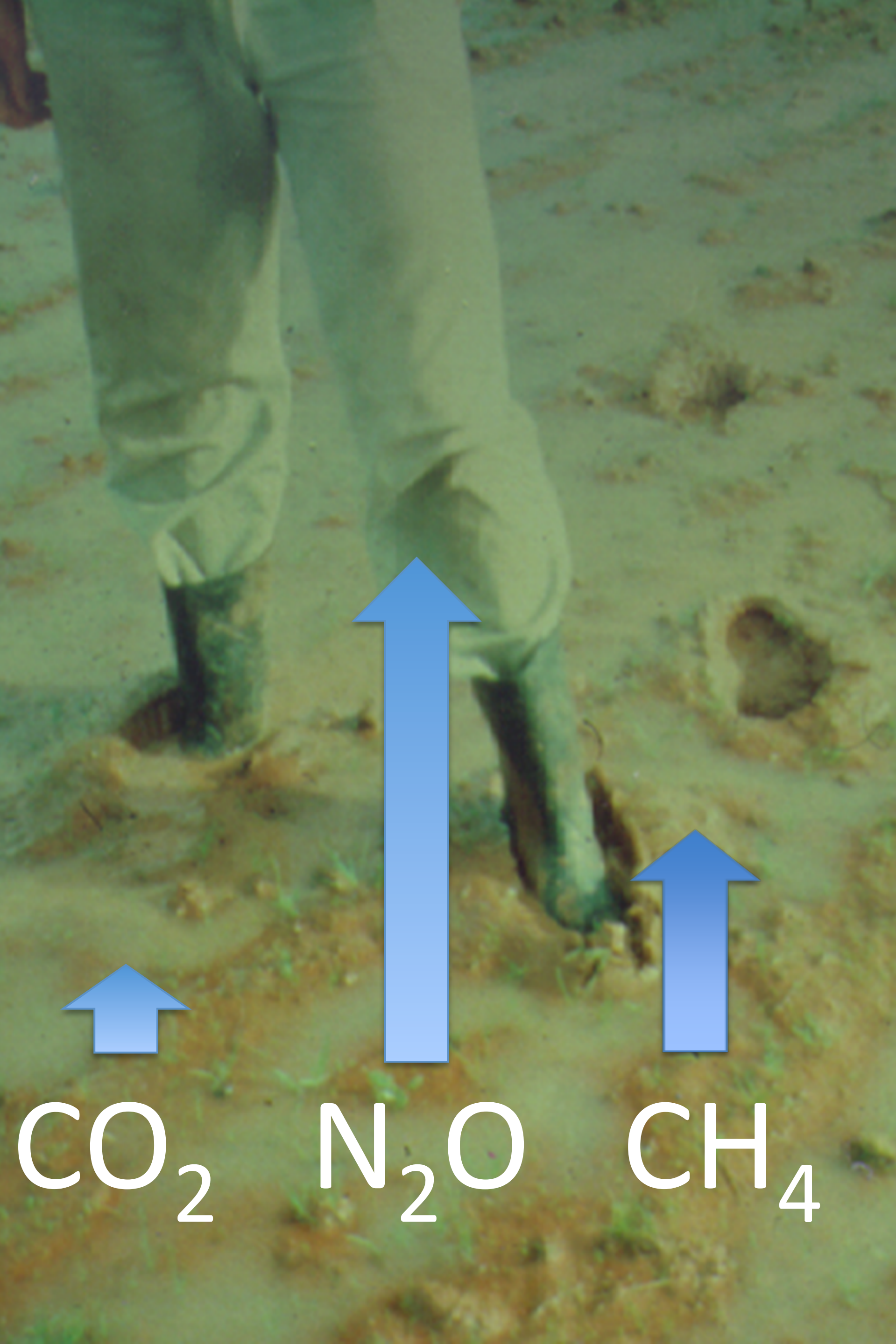
- **Greenhouse gas emissions are excellent indicators of sustainability**

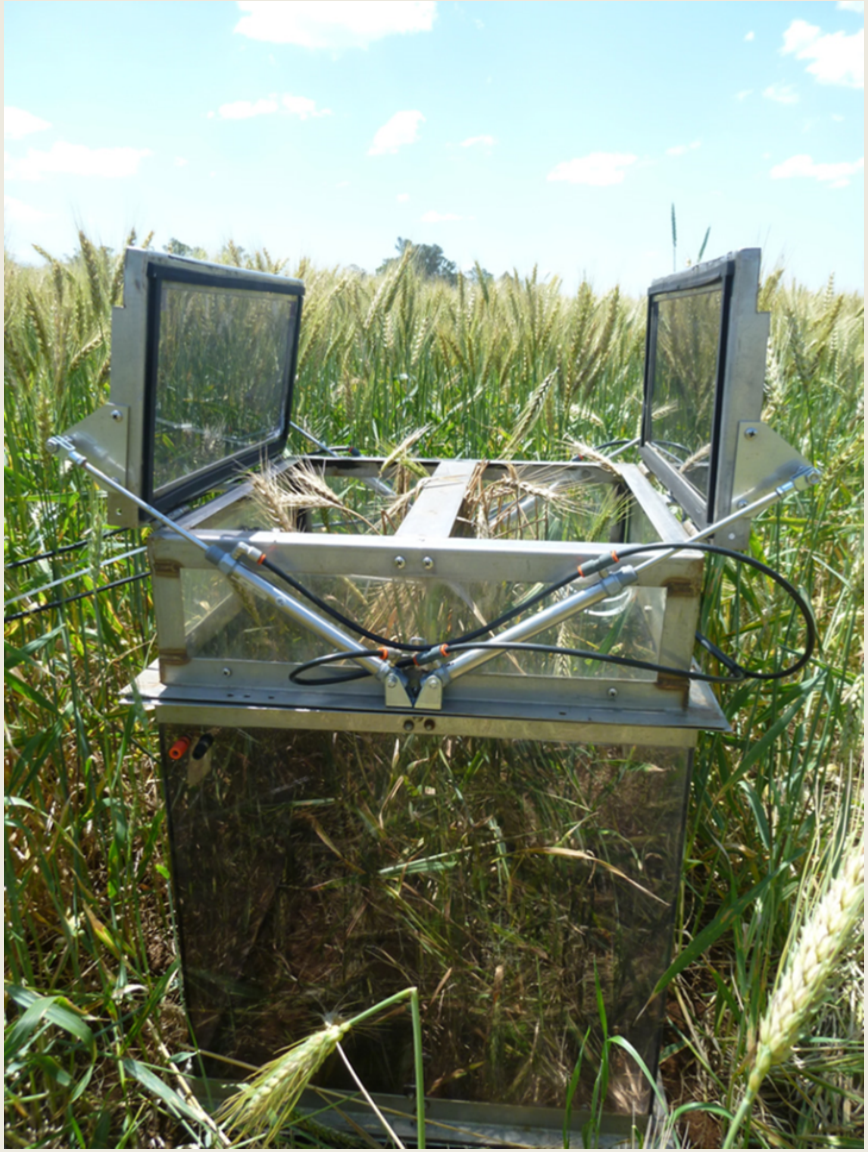

$CO_2$
$N_2O$
$CH_4$


$CO_2$
$N_2O$
$CH_4$

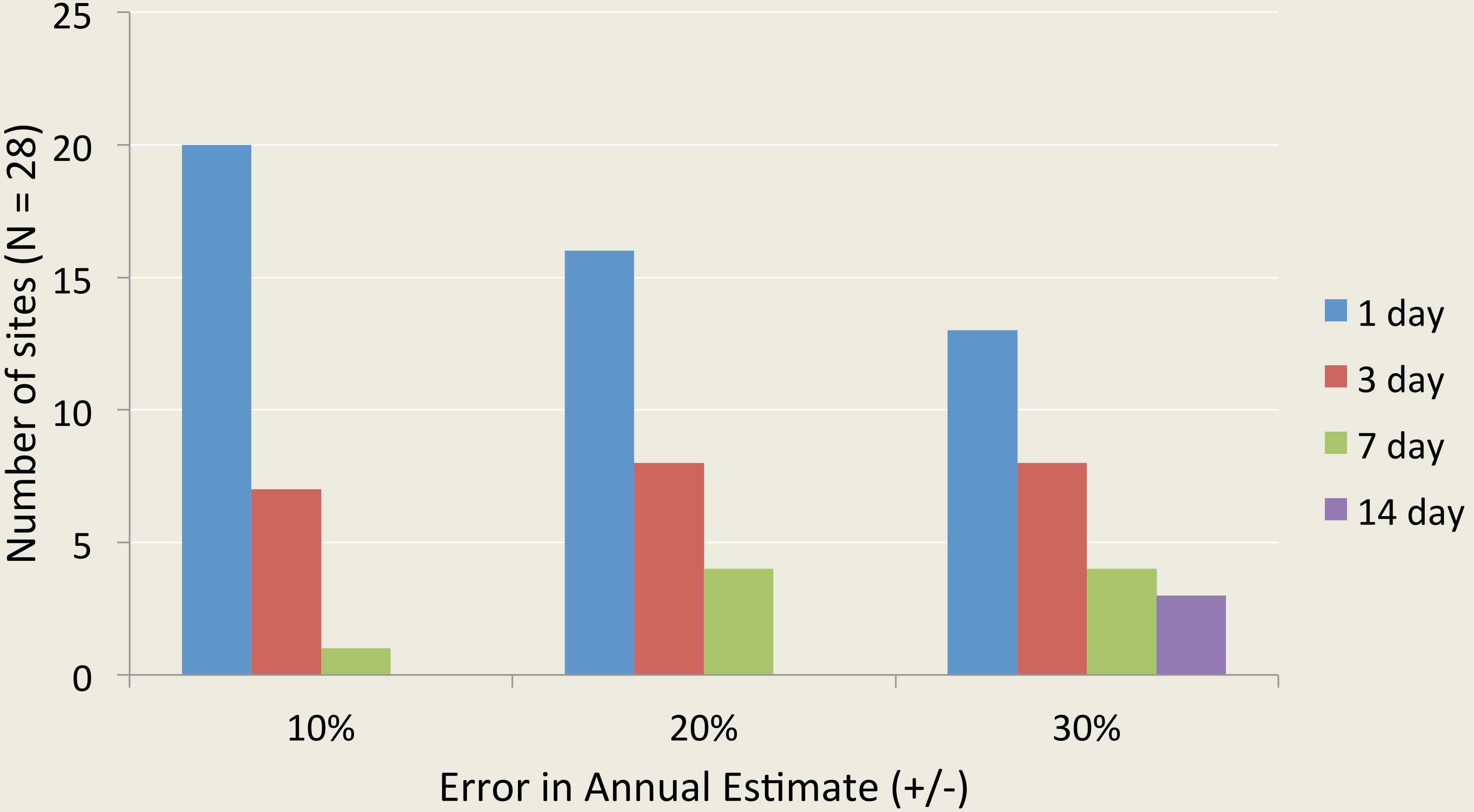
# Key Principles

- Adaptation and mitigation strategies must be synergistic
- Greenhouse gas emissions are excellent indicators of sustainability
- **Process level understanding of GHG emissions across diverse agroecosystems is essential for developing robust simulation models**

# GHG Monitoring Systems

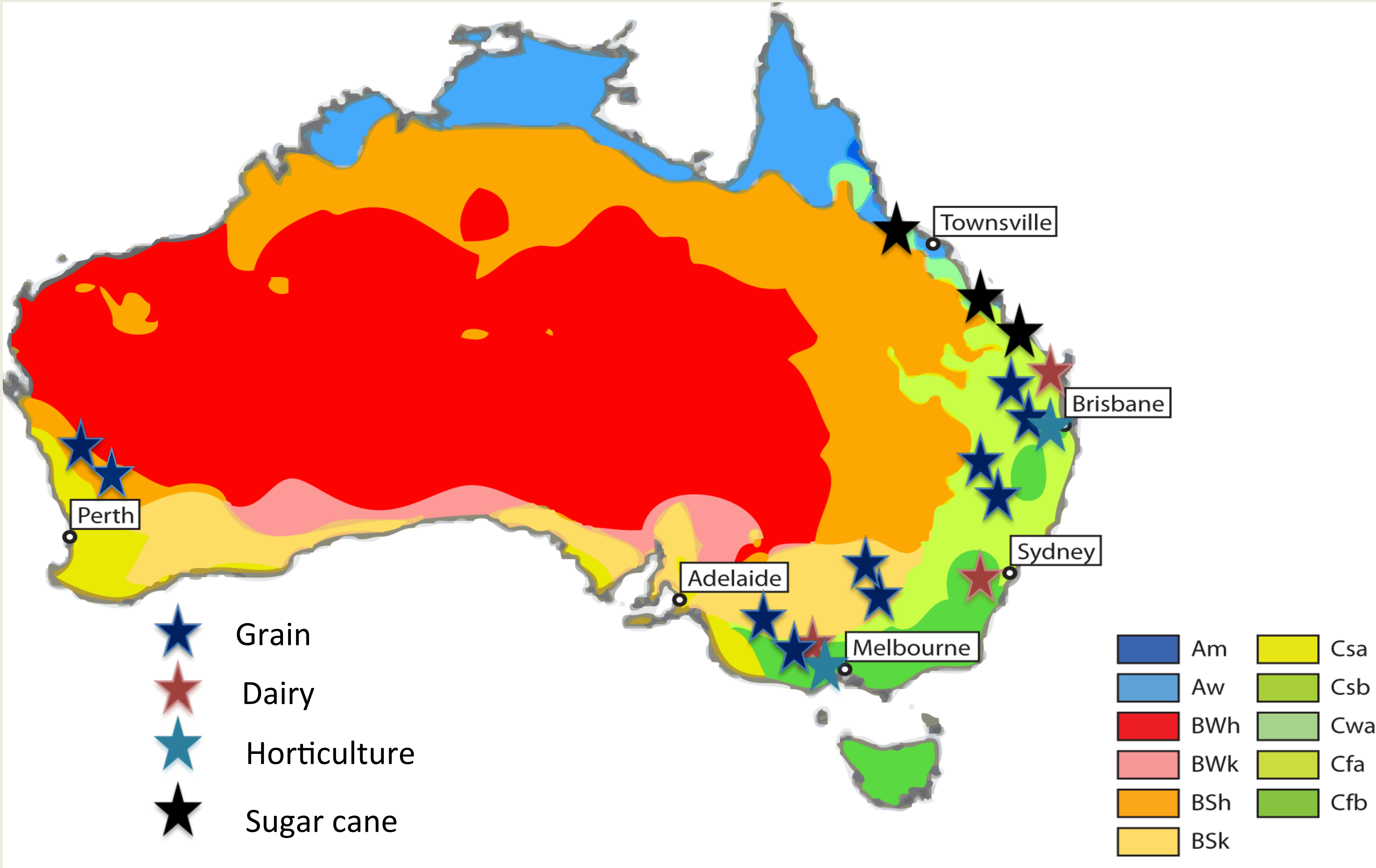


# Annual $N_2O$ Estimates vs Sampling Frequency*




*Barton et al. (2015)

# GHG Network Core Datasets (2005+)
# Automated chambers



# National Agricultural Nitrous Oxide Research Program (NANORP)

National inventory and GHG reduction methodologies

**Coordination**
Simulation modelling
Data protocols
Database
GIS

**Automated 'core' sites**
High temporal resolution
Multiple treatments
Key locations

*Model calibration and validation*

**Laboratory studies**
Basic processes
Temp * $H_2O$ * soil type
Fertiliser products

*Model calibration*

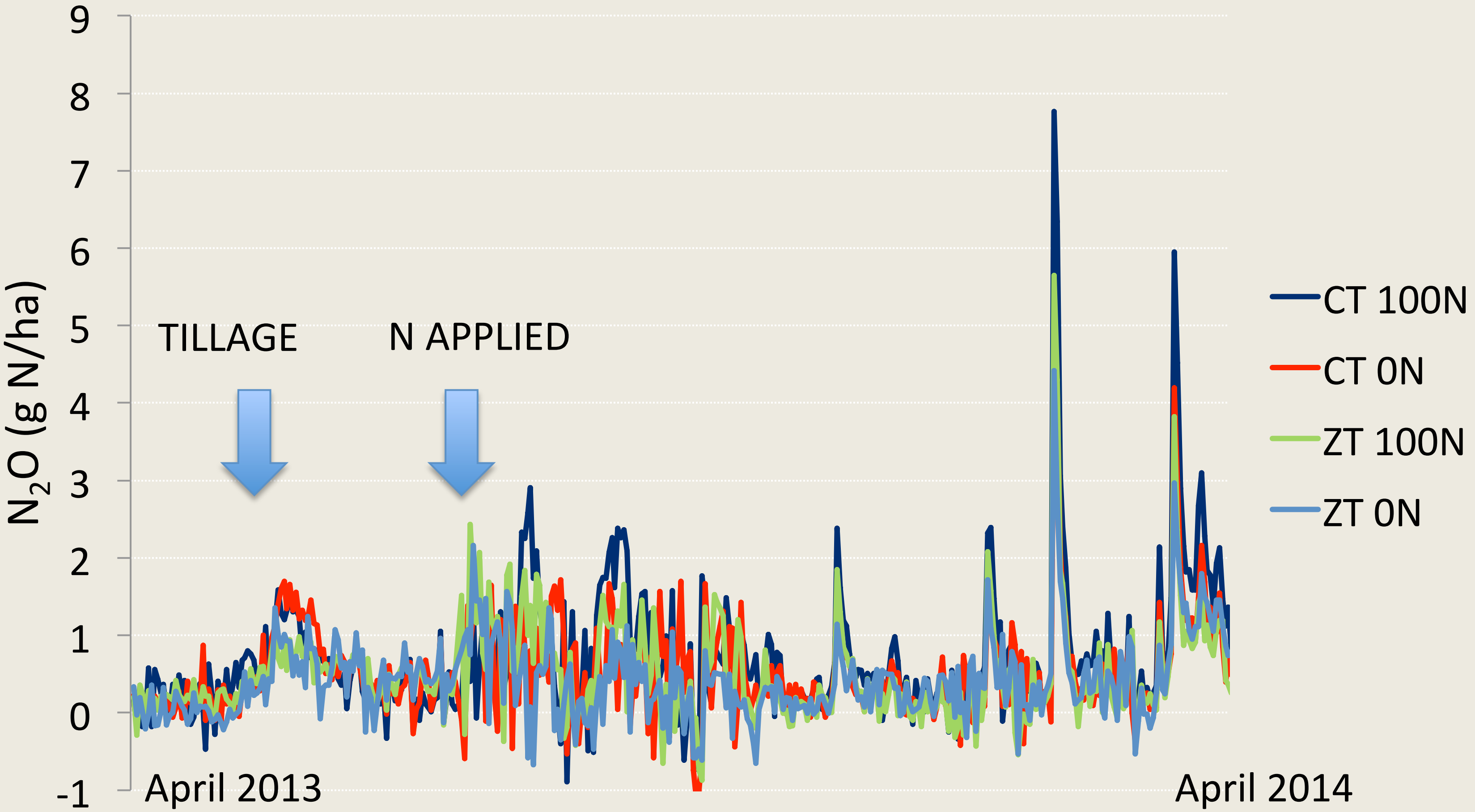
*Model validation*

**Manual 'satellite' sites (3-4/core)**
High temporal resolution
Limited treatments
Regional locations

# $N_2O$ vs Tillage vs N

## Canola (2013/14)

## Wagga (Australia) - Alfisol




*Guangdi Li et al. (unpublished)

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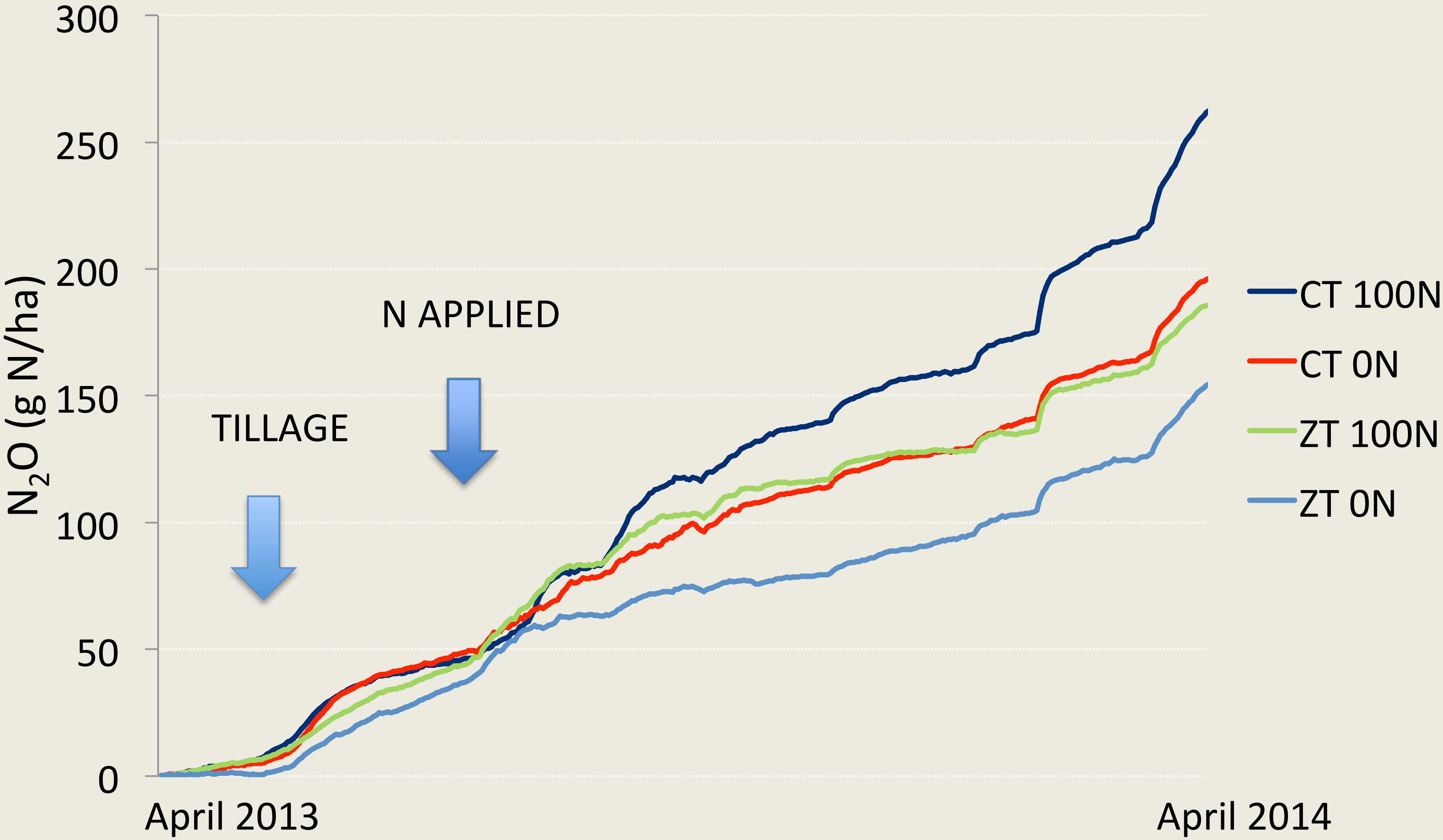
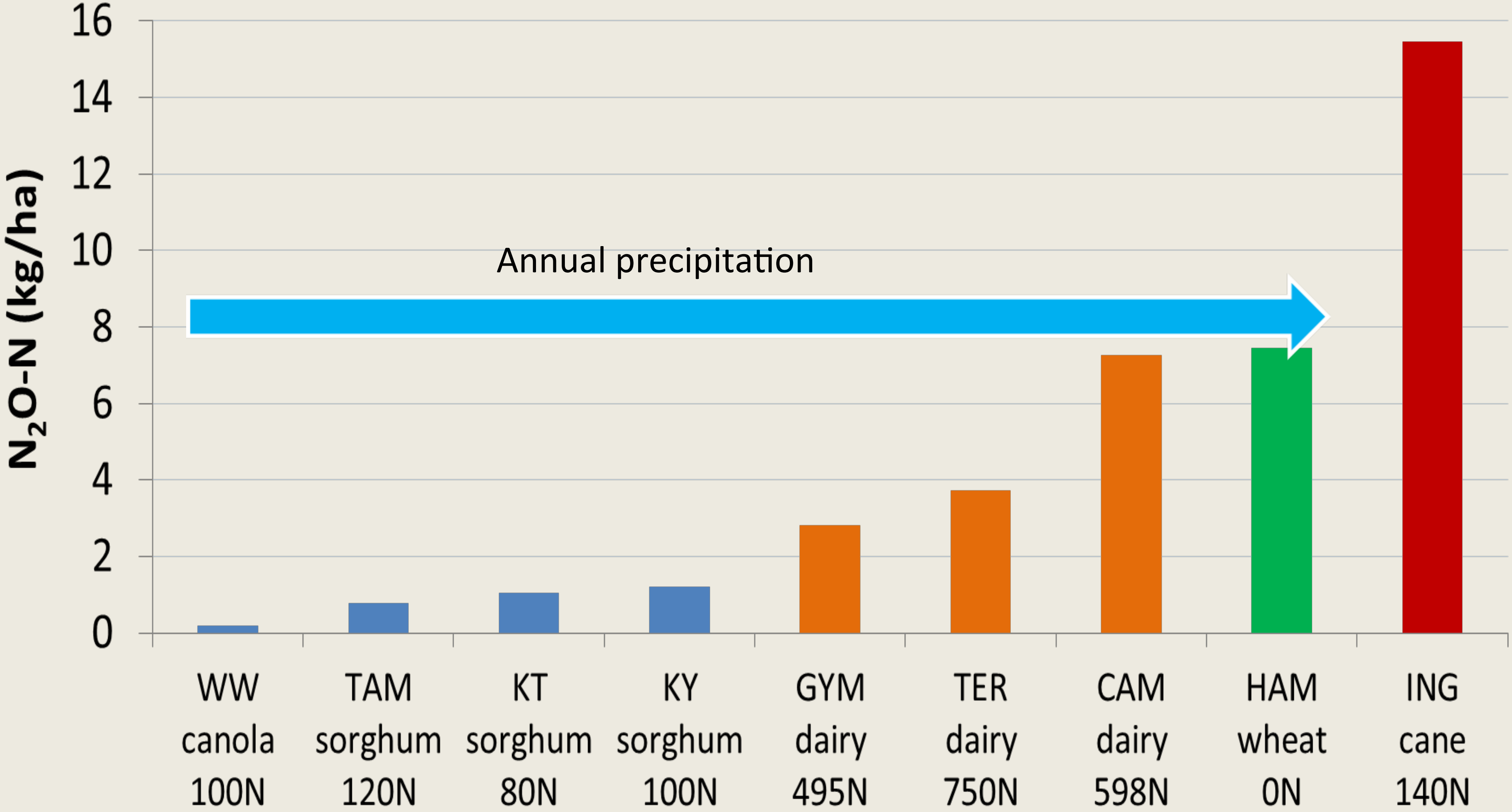



*Guangdi Li et al. (unpublished)

# $N_2O$ Emissions per Annum

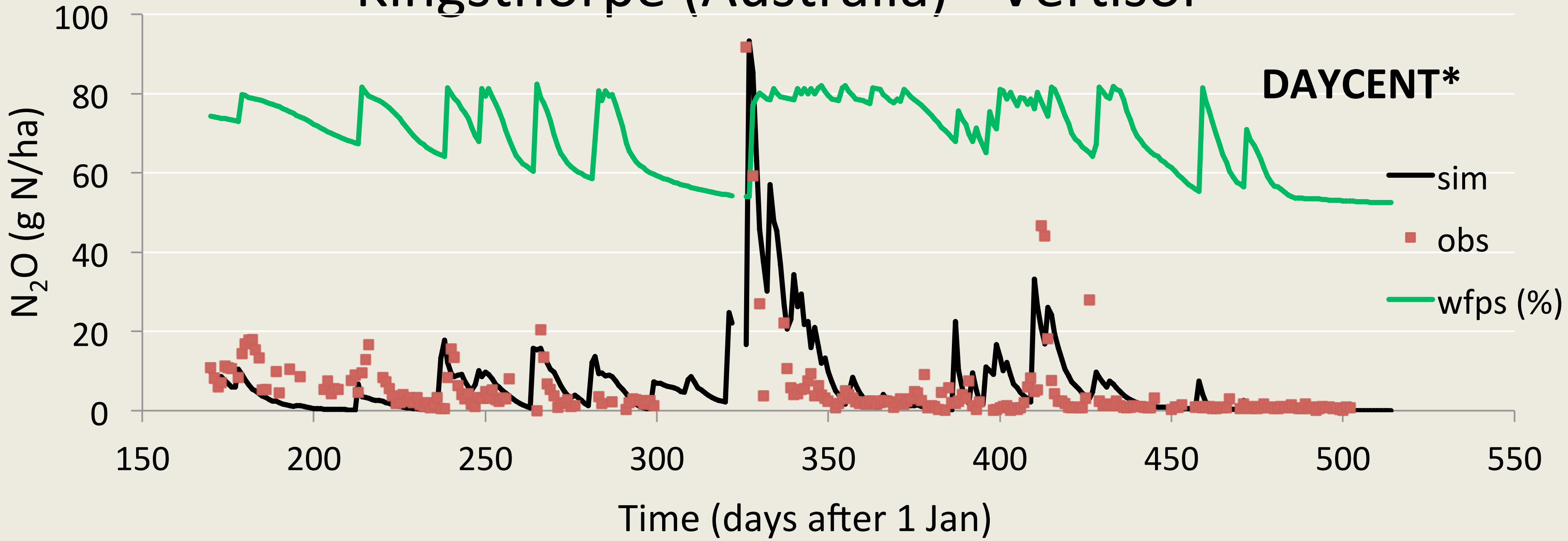
## Australia



# $N_2O$ Emissions (Sim vs Obs)

## Wheat-Cotton (2009/10)

## Kingsthorpe (Australia) - Vertisol




*Scheer et al. (2014)

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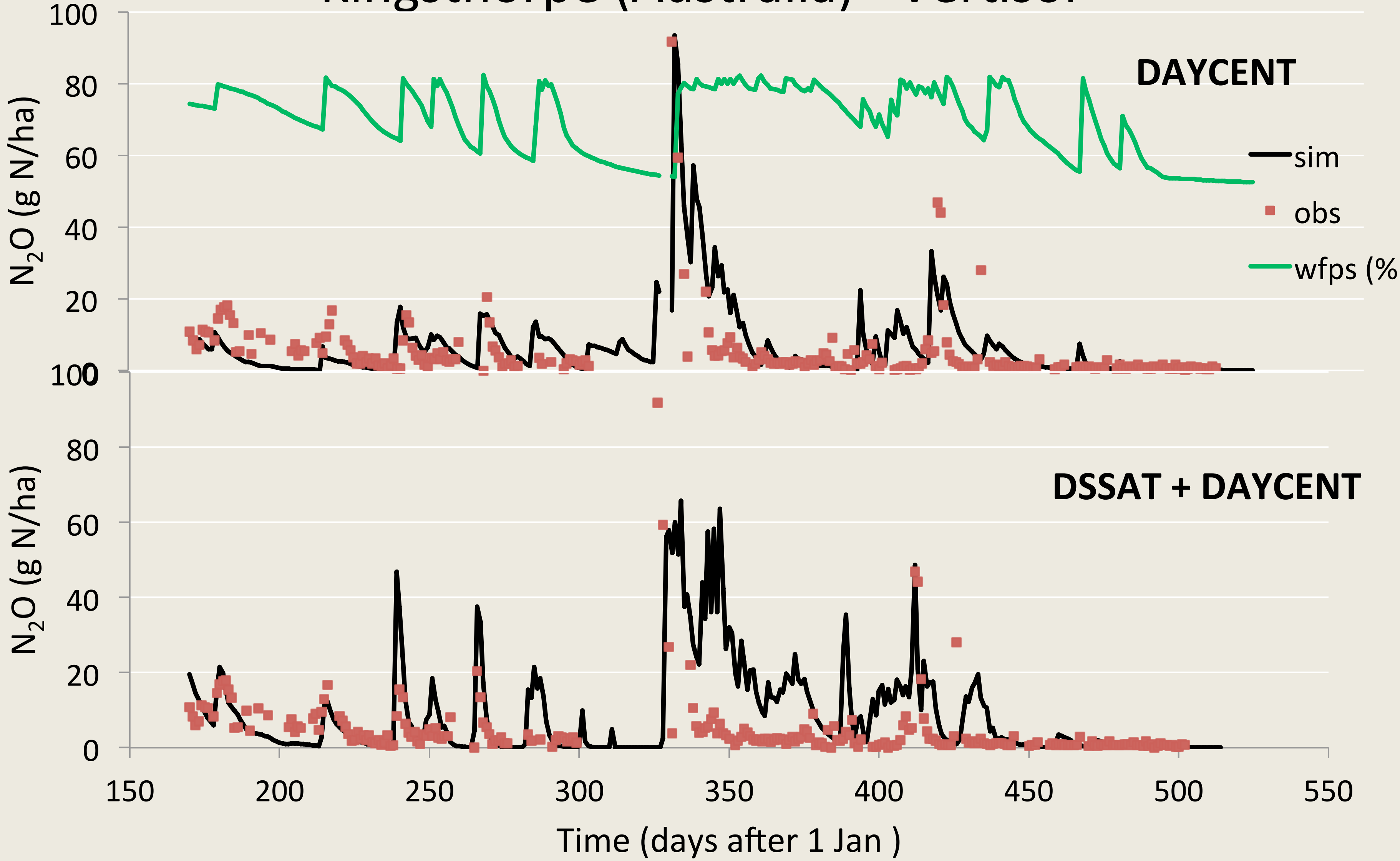
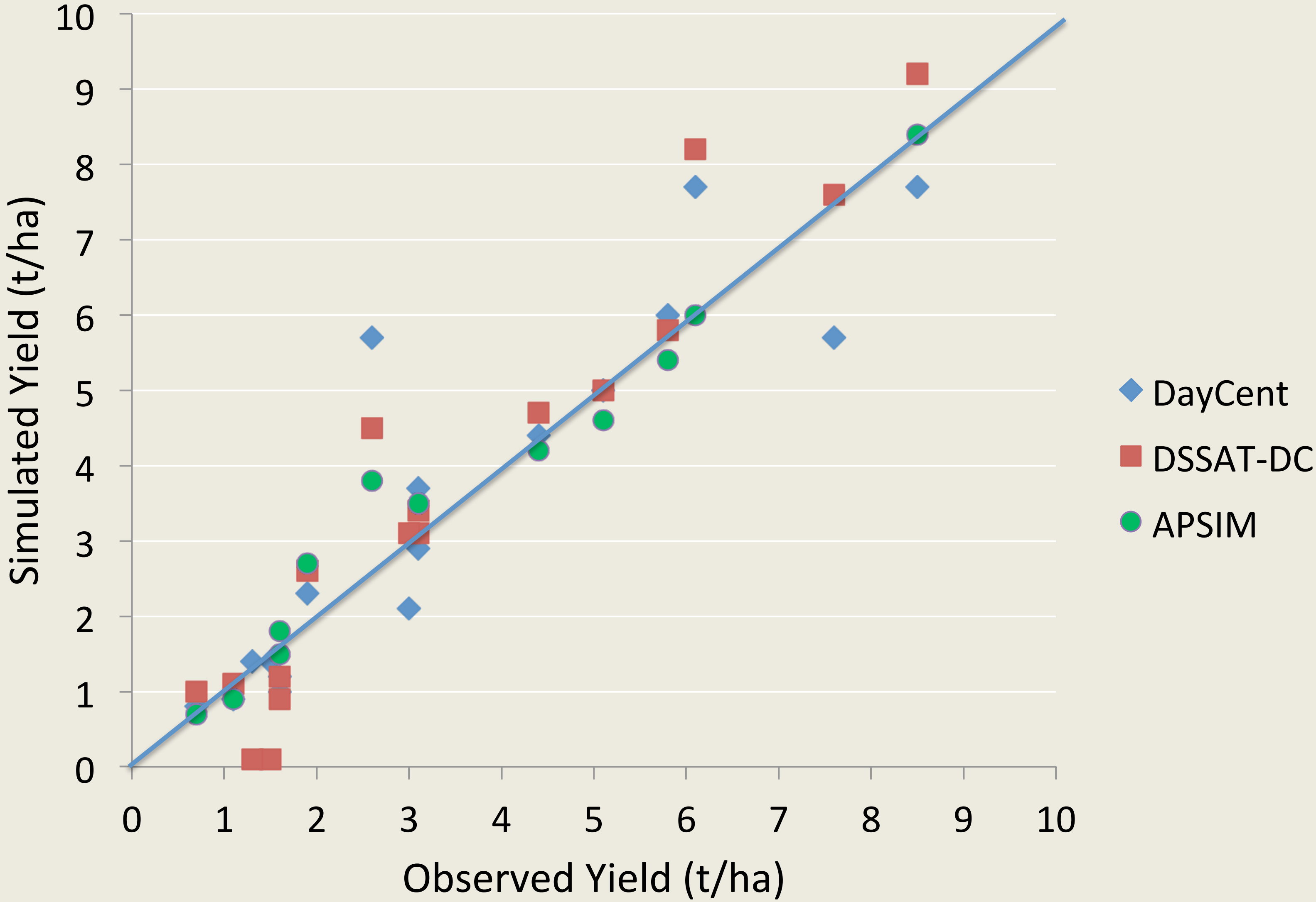
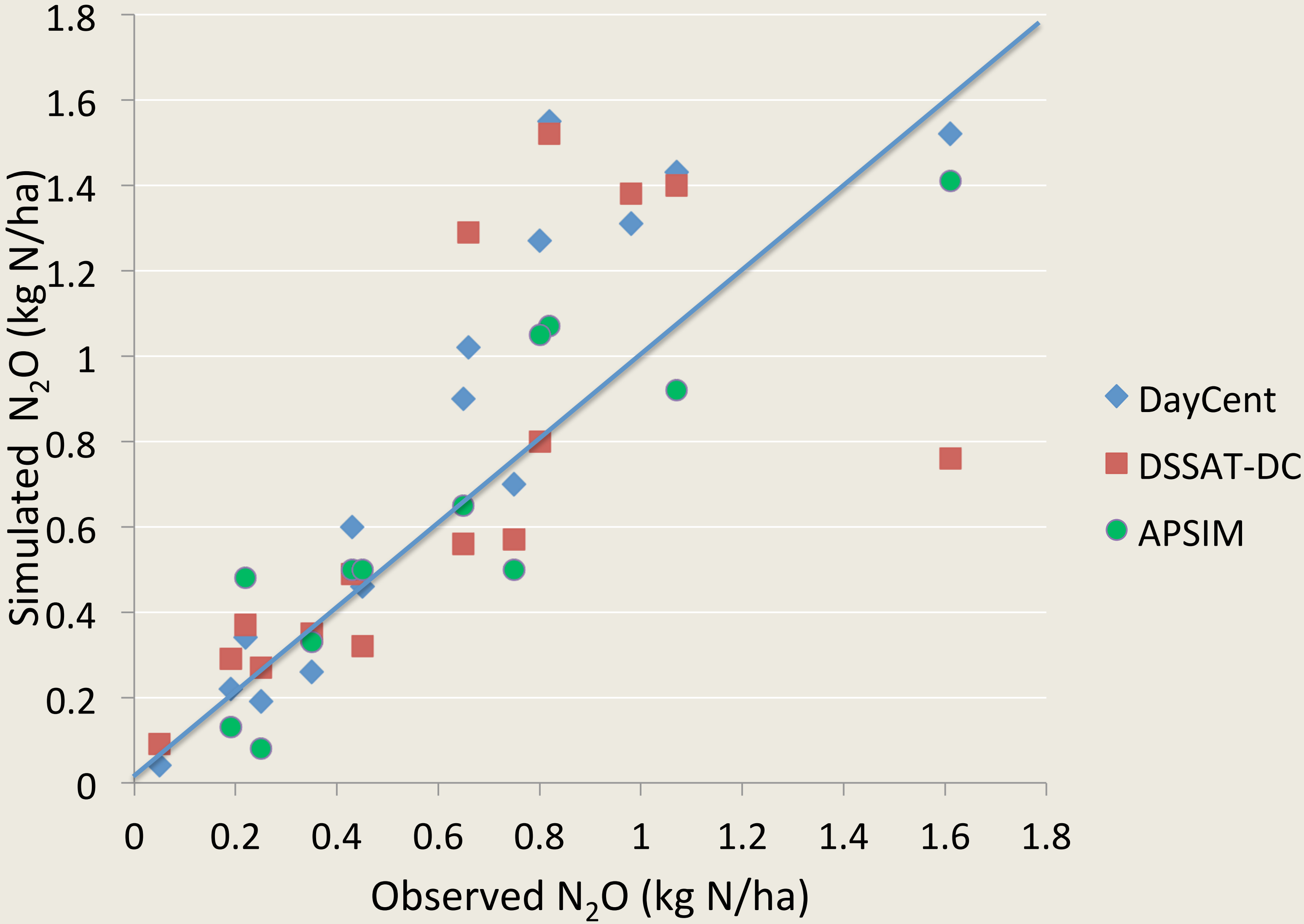


# Model Performance (Grain Yield)



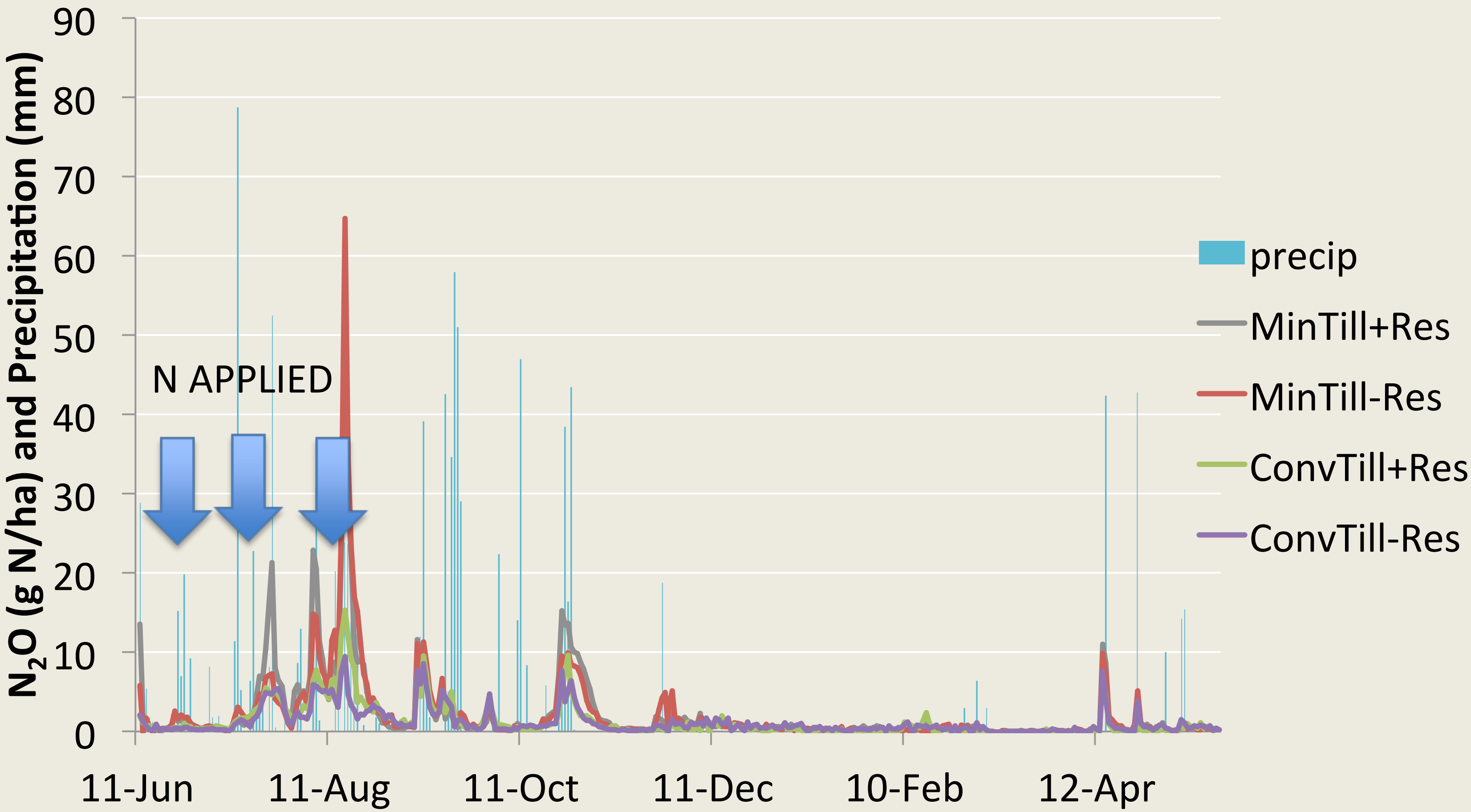
# Model Performance (Annual $N_2O$)



# $N_2O$ vs Tillage vs Residue Management*

## Maize-Chickpea (2013/14)

## Hyderabad (India) - Vertisol




*Rowlings et al. (unpublished)

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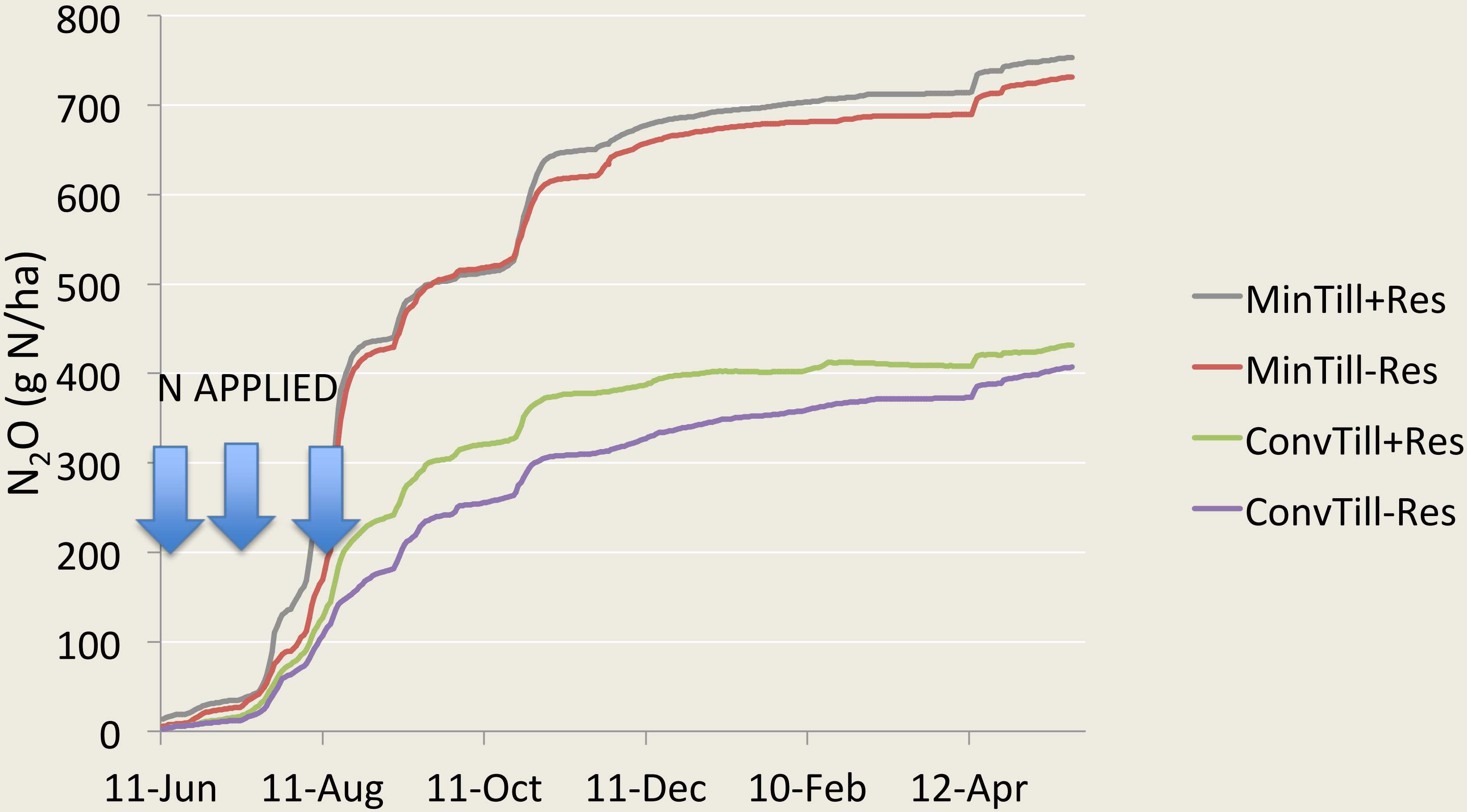
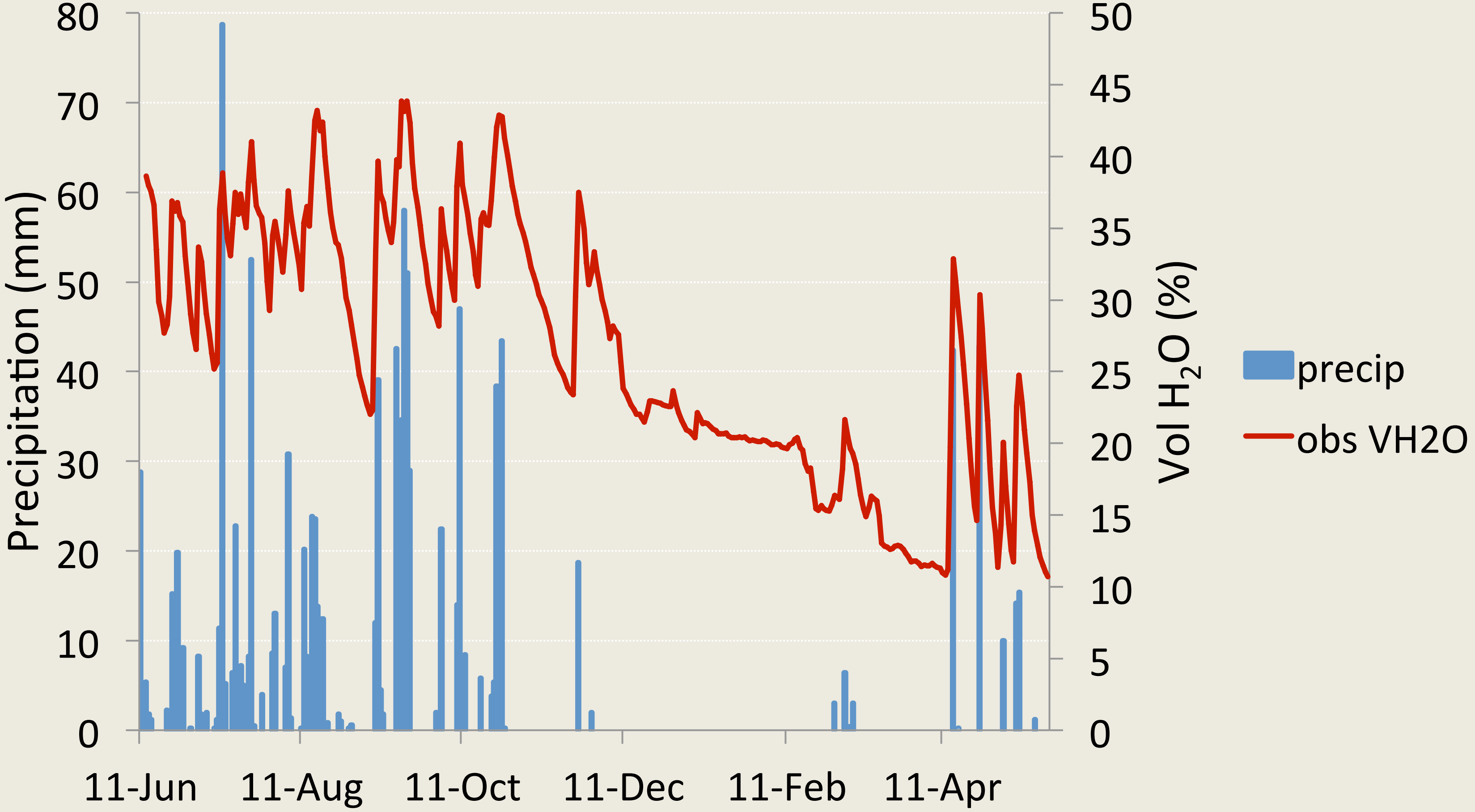



*Rowlings et al. (unpublished)

# Soil $H_2O$ (0-10 cm) vs Precipitation

## Maize-Chickpea (2013/14)

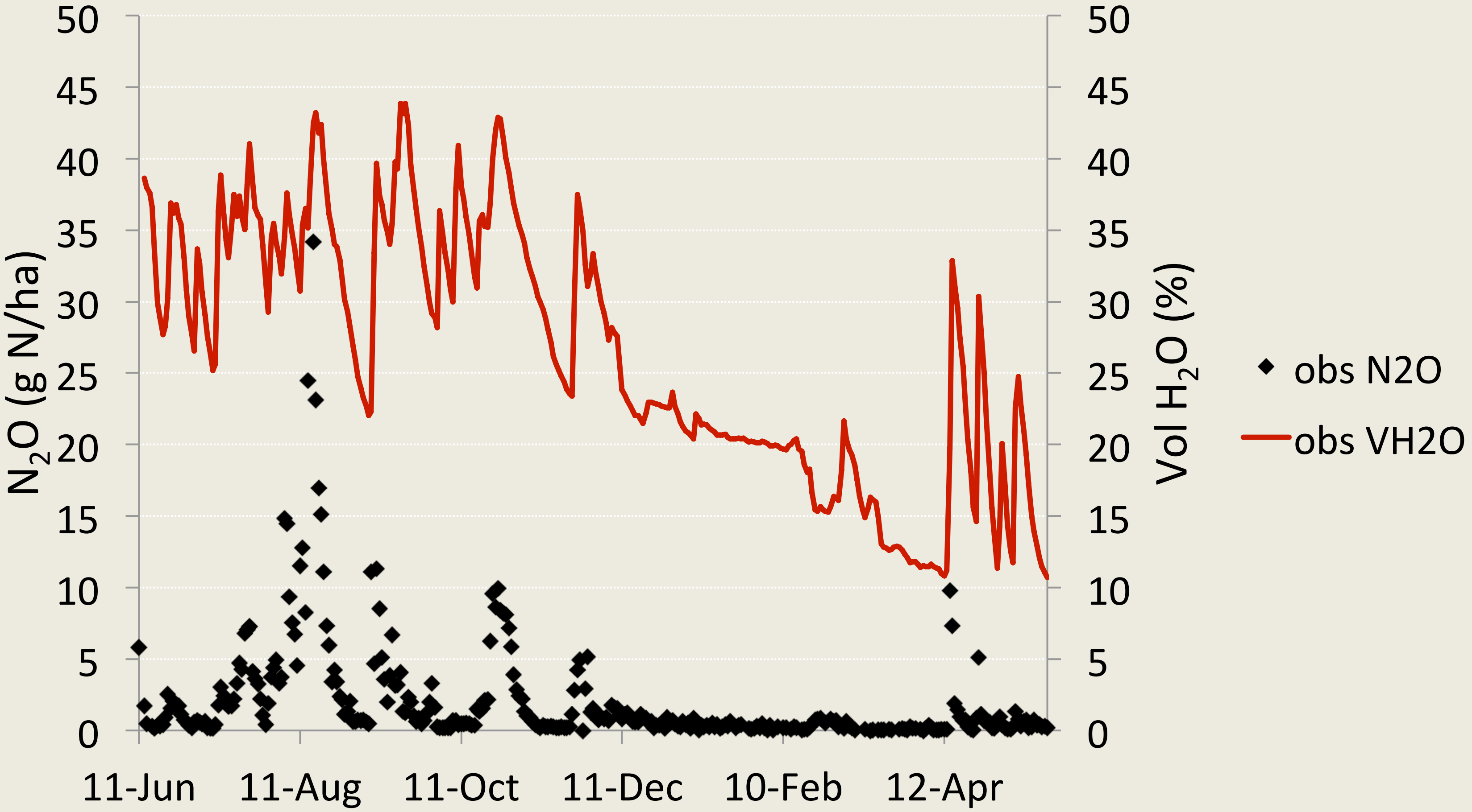
### Hyderabad (India) - Vertisol



# $N_2O$ vs Soil $H_2O$ (0-10 cm)

## Maize-Chickpea (2013/14) – MinTill/Zero Residue

### Hyderabad (India) - Vertisol



# $N_2O$ (DSSAT Sim vs Obs)

## Maize-Chickpea (2013/14) – MinTill/Zero Residue

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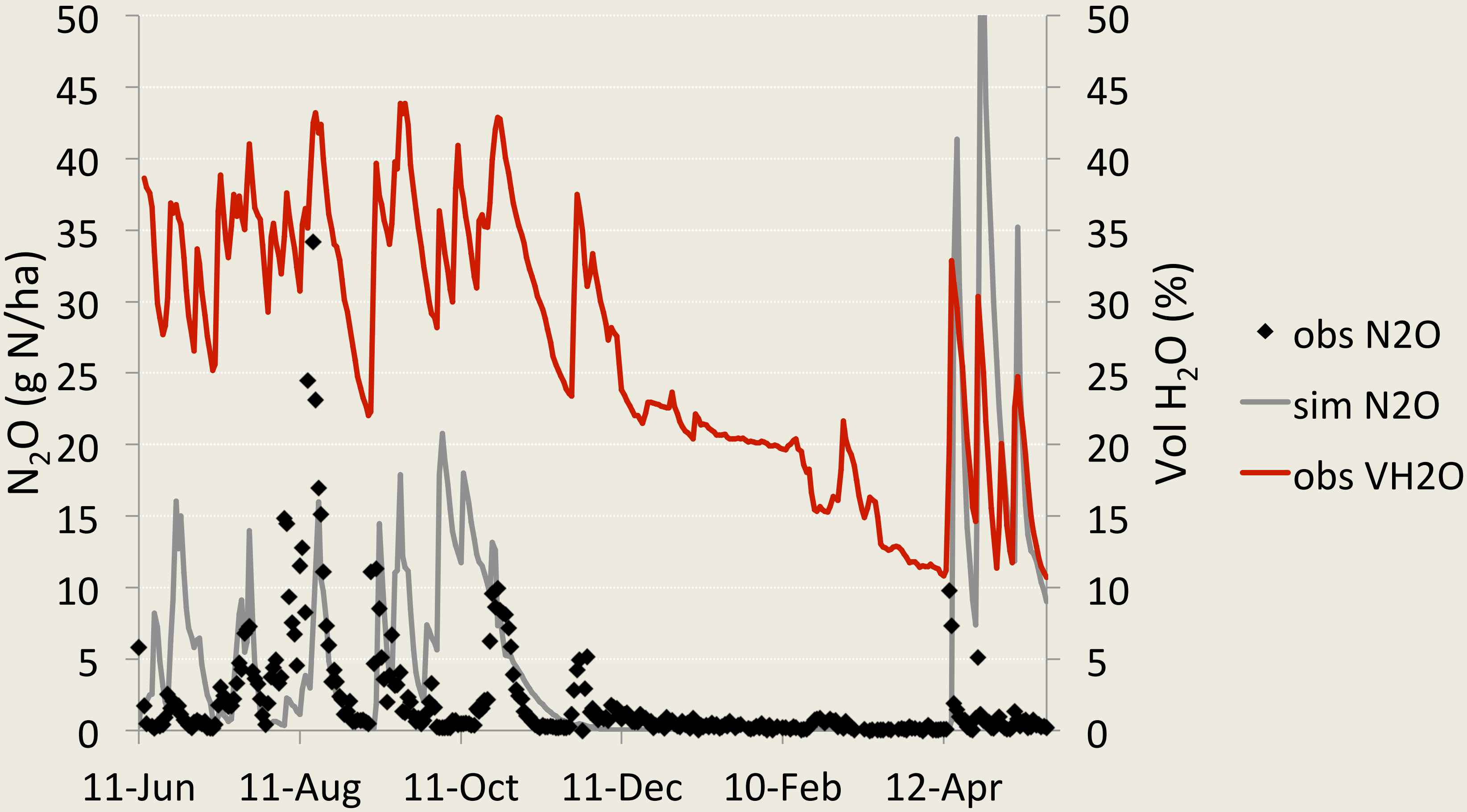

# $N_2O$ (DSSAT Sim vs Obs)

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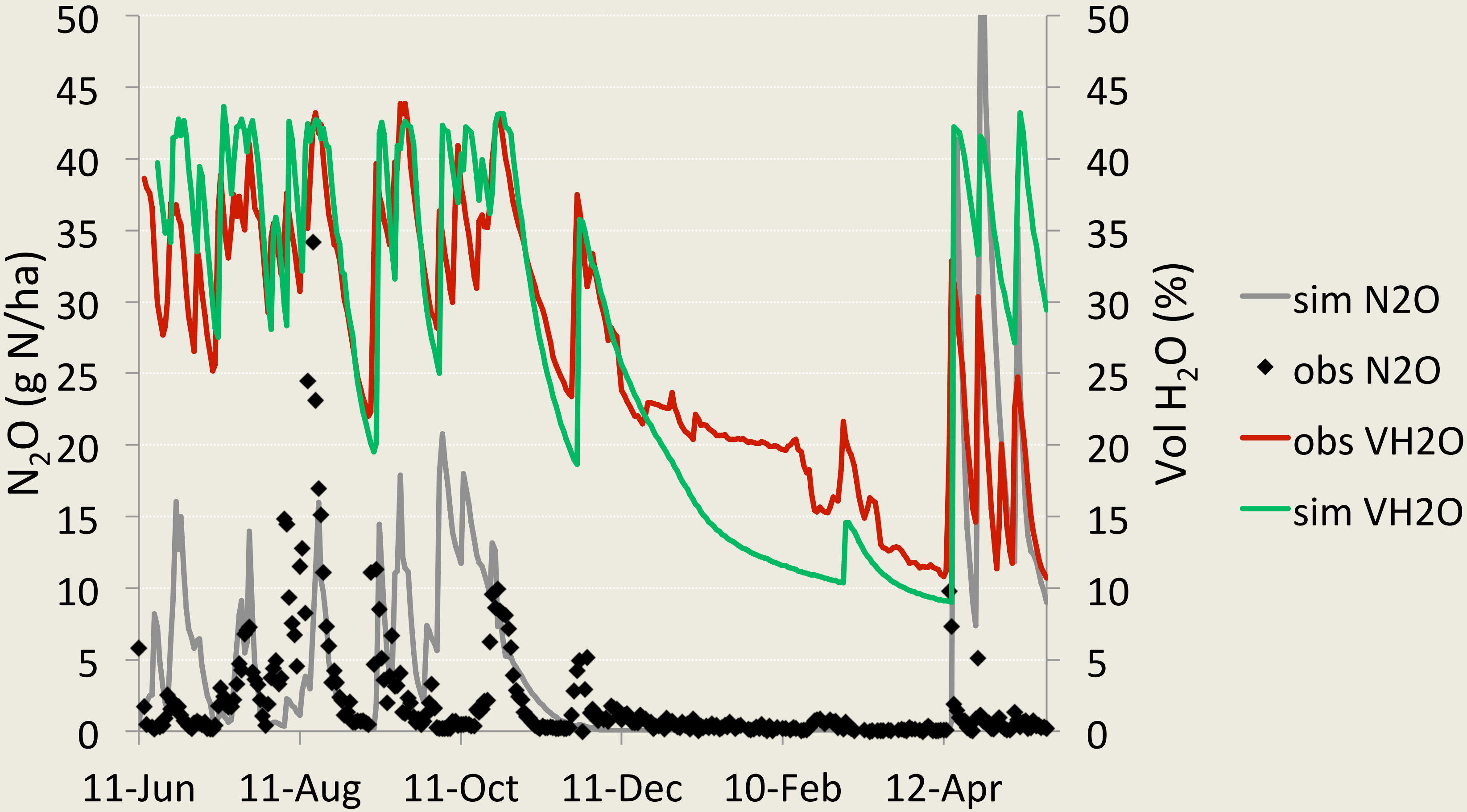

# Soil $H_2O$ (0-10 cm) – DSSAT+DayCent

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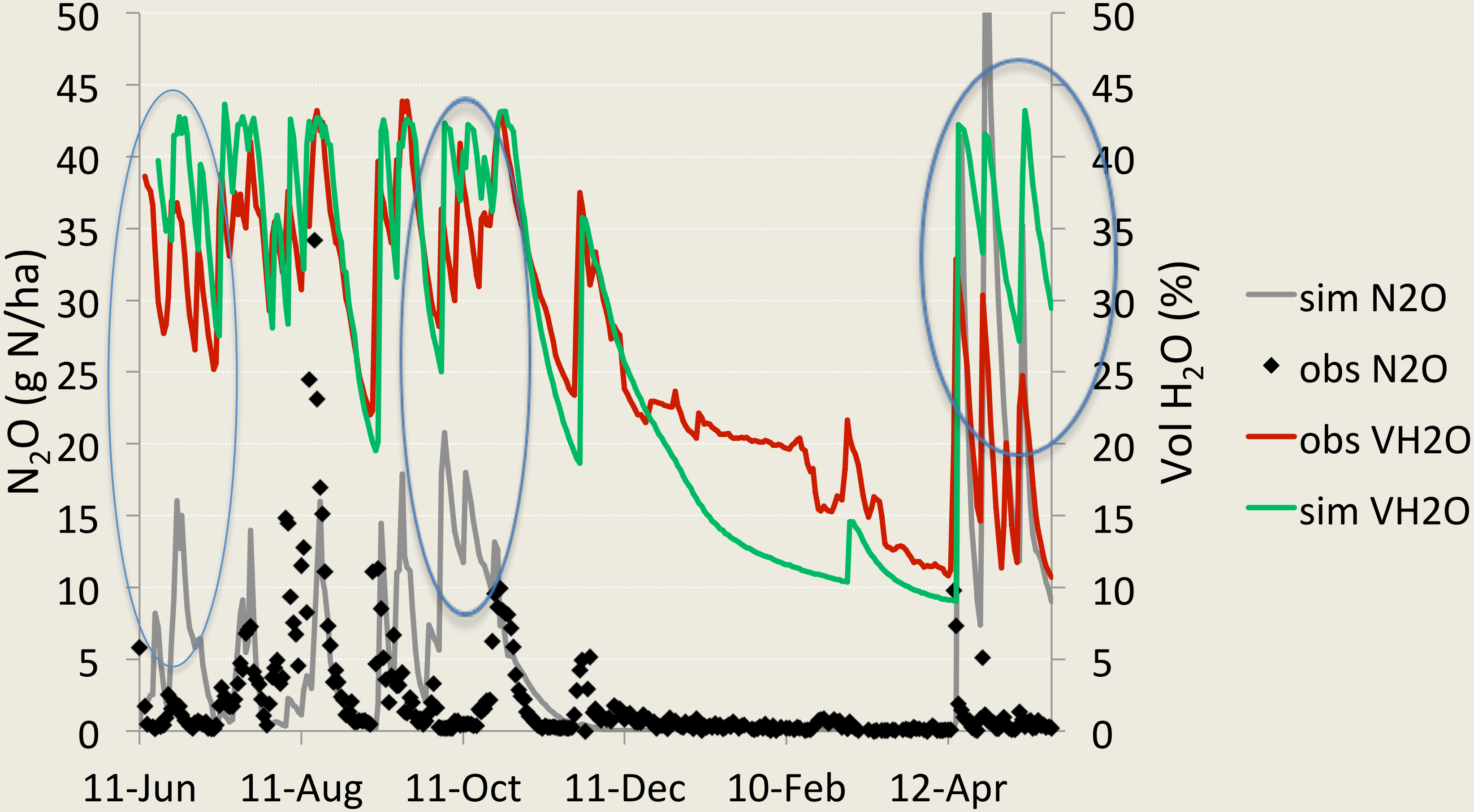
### Hyderabad (India) - Vertisol



# Summary

- Synergistic adaptation and mitigation strategies are now possible using mainstream crop-soil models (e.g. DSSAT and APSIM)
- Accurate initialisation of soil carbon pools is critical
- Source and magnitude of $N_2O$ varies with soil texture in semi-arid environments
- Scope for changes in tillage, residue and N management for reducing $N_2O$ in fine textured soils in semi-arid environments
- Nitrification inhibitors have consistently proven to reduce $N_2O$ but do not shown consistent yield benefits – model algorithms being developed

Transitioning Cereal Systems to Adapt to Climate Change

REACCH
Regional Approaches to Climate Change –
PACIFIC NORTHWEST AGRICULTURE

# Thank you!

University of Idaho

Washington State University

USDA NIFA

United States Department of Agriculture
National Institute of Food and Agriculture

Oregon State University OSU

CHS

Pacific Northwest Farmers Cooperative

Monsanto