What use is eddy covariance data to farmers?

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Mark Crump, Ross Woods, Lara Wilcocks

OzFlux Meeting July 2010, Methven, New Zealand

Acknowledgements:

Craige MacKenzie / Eric Watson

Permanent Eddy Covariance tower

Weather Station

Lysimeter

WaterScape and associated programmes (ECAN/NIWA/MSI)

NIWA Instrument Systems & Environmental Data

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What use is an eddy covariance network to anyone?

1. **Ecosystem science:**
   - Climate/Climate change effects on ecosystem functioning
   - Ecosystem disturbance effects (fire, insects, extreme weather)
   - CABLE, CLM etc. Chronosequence studies

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   - Ground truthing of products, GPP, NEE, Evap, Albedo, LAI
     fPAR, new flourescence-based products
   - Data assimilation models
   - New empirical algorithms

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4. **Plantation Forestry - Production**
   Controls on tree growth, light use efficiency, water use efficiency, Reco/GPP ratios, nutrient use efficiency.

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5. **Boundary layer meteorology, micrometeorology, local climate**

Energy exchange, albedo, net radiation, surface roughness and vegetation-climate feedbacks. Opportunistic studies of turbulence?

Risk assessment

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5. **Boundary layer meteorology, micrometeorology, local climate**
   - Energy exchange, albedo, net radiation, surface roughness and vegetation-climate feedbacks. Opportunistic studies of turbulence?
   - Risk assessment

6. **Greenhouse gas science – Inventory/Mitigation**
   - Carbon storage from annual sums
   - CO_2/CH_4/N_2O fluxes – net warming potential
   - Net radiative effects – GHGs and albedo
   - Carbon equivalent estimates
   - Trade-offs between GHG & water conservation
   - Validation of mitigation
   - Assessment of CCS
   - Ingestion (first guess of fluxes into atmospheric inverstions)

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7. **Agricultural productivity**
   Pasture/crop productivity and production parameters
   LUE, Fertiliser response
   Calibration of agricultural models, eg, APSIM, Overseer

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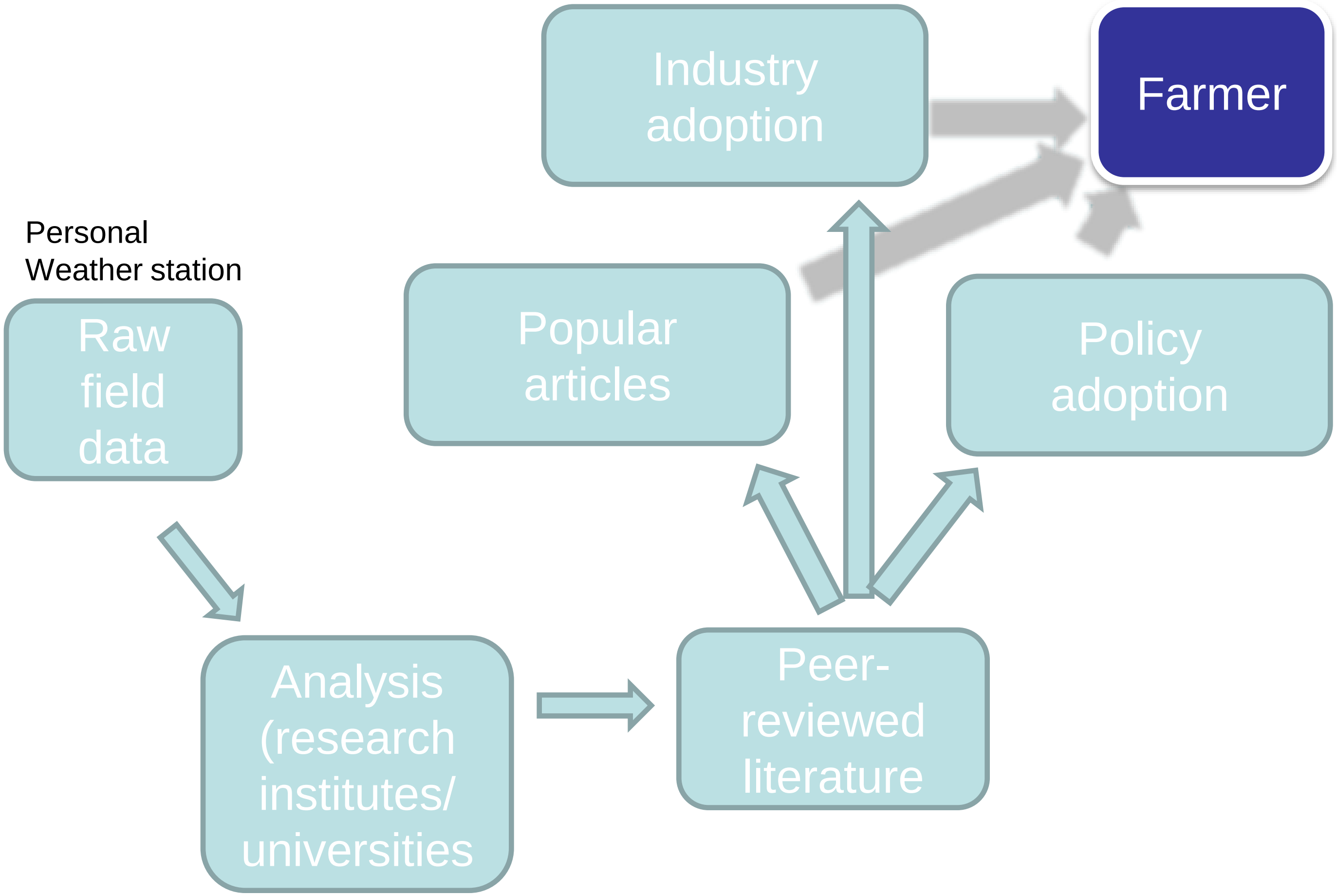
How can farmers use eddy covariance data?

- **Environmental impacts of farming**
  - Water conservation - water balance, ET etc
  - Nitrogen leaching / water quality
  - Greenhouse gas emissions
    - Soil N_2O emissions from N deposition
    - CH_4 emissons –enteric / waste pond
    - Possibility of carbon storage
- **Farmers' concerns**
  - Sustainability
  - Public image (domestic/international)
  - Cost-effectiveness

“default mode”



How do farmers use environmental data?

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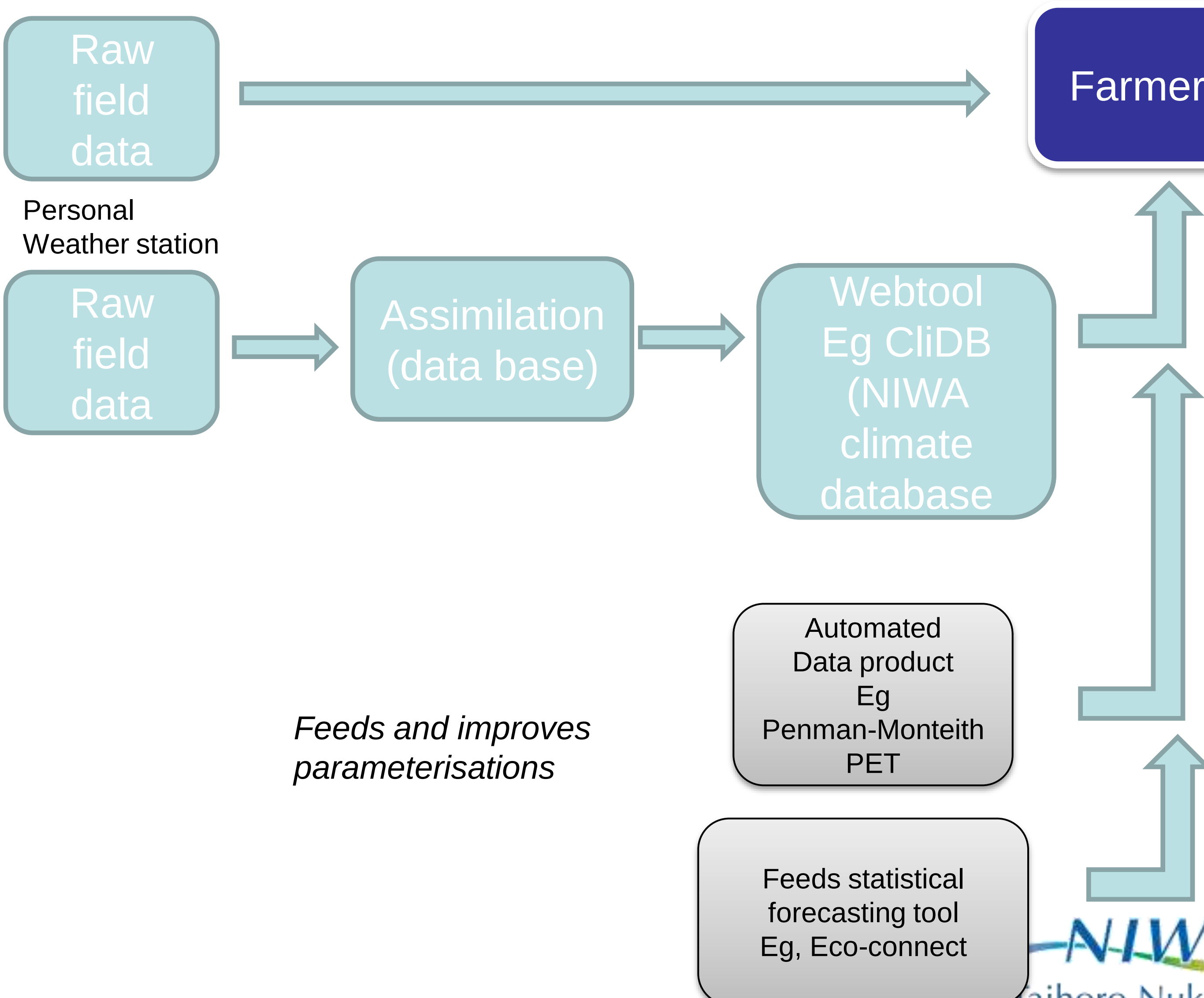

Raw field data
Personal Weather station
Raw field data
Assimilation (data base)
Webtool Eg CliDB (NIWA climate database
Farmer
Automated Data product Eg Penman-Monteith PET
Feeds statistical forecasting tool Eg, Eco-connect
Feeds and improves parameterisations

Sites

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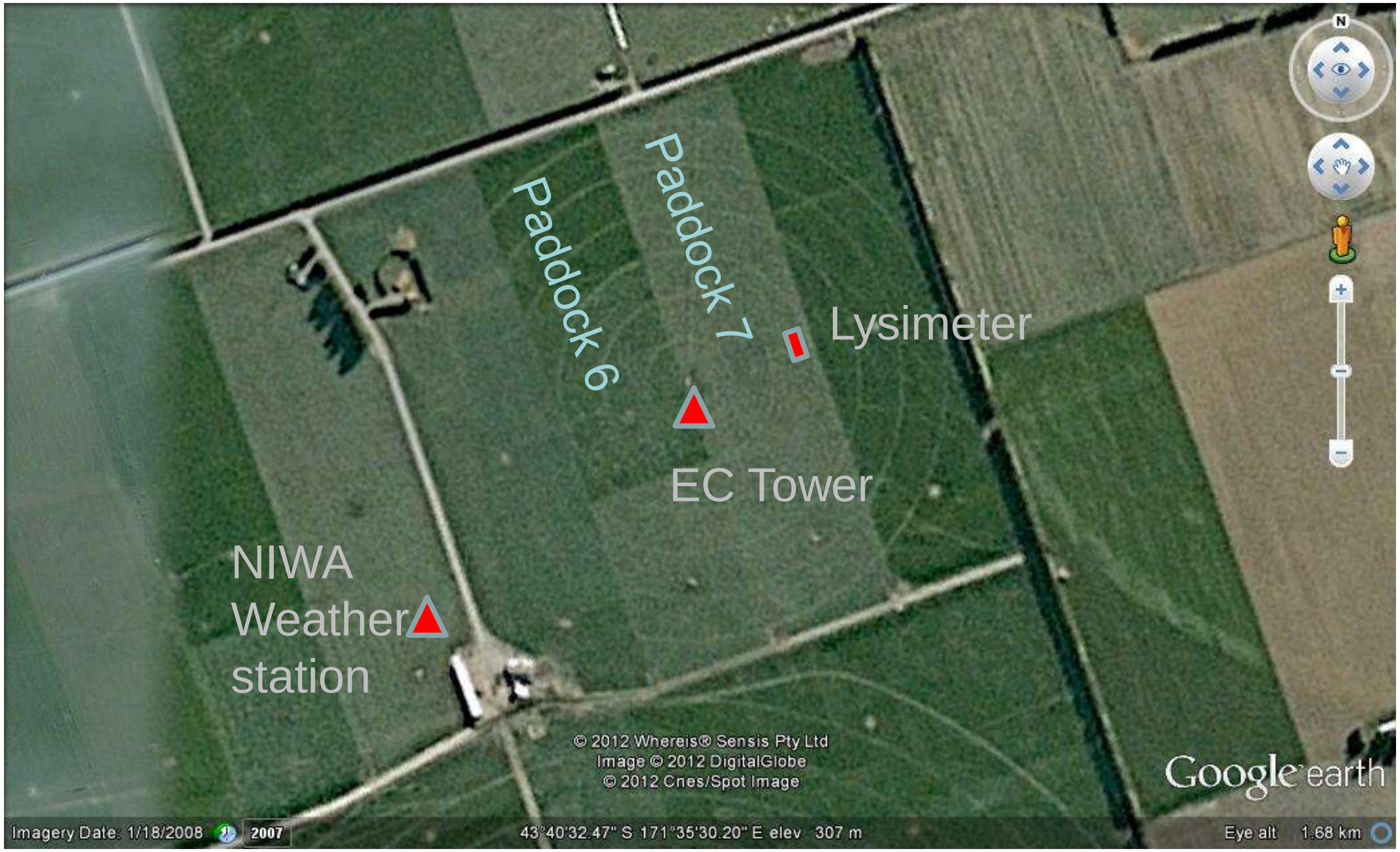
Methven Tower at Three Springs Dairy



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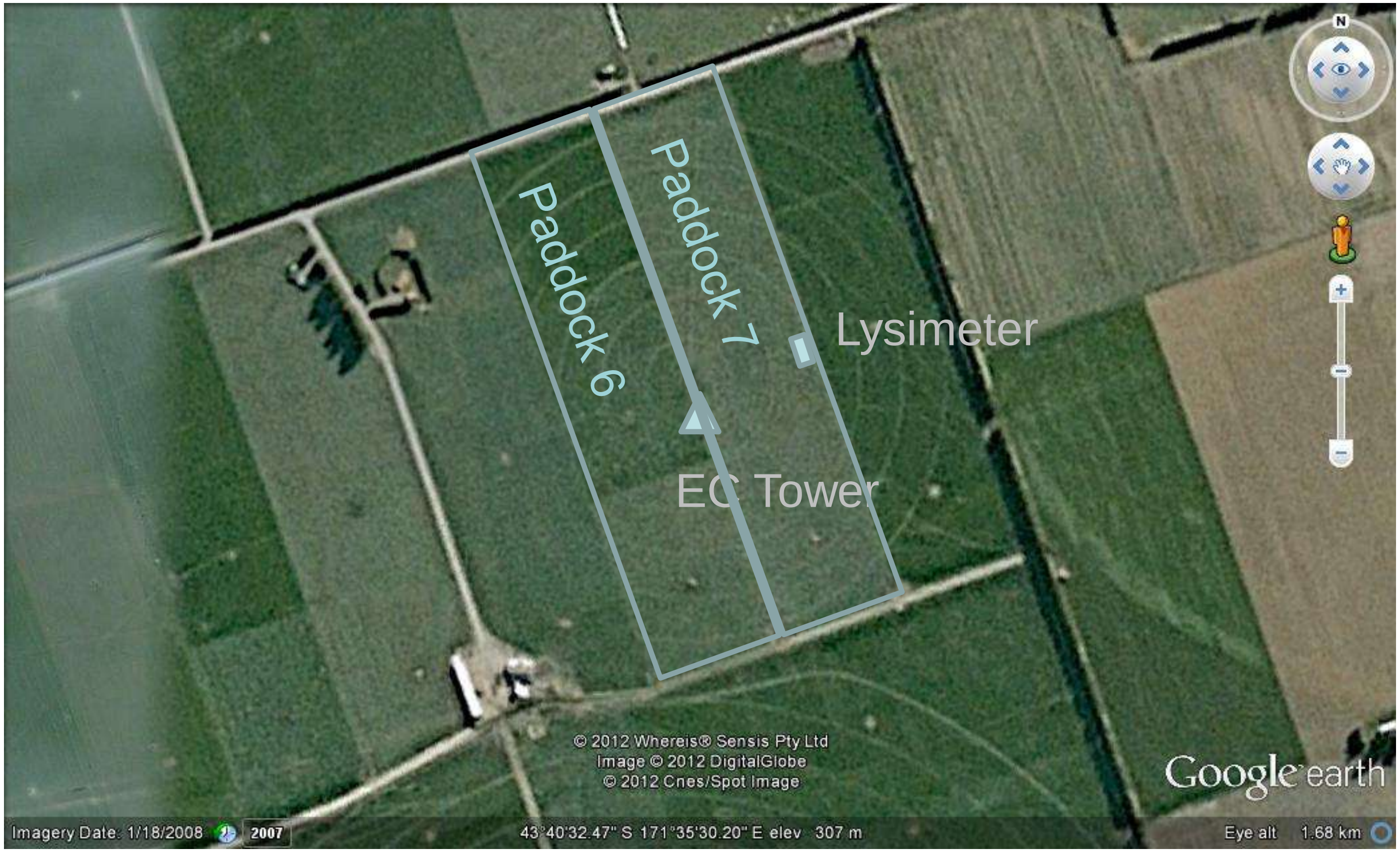

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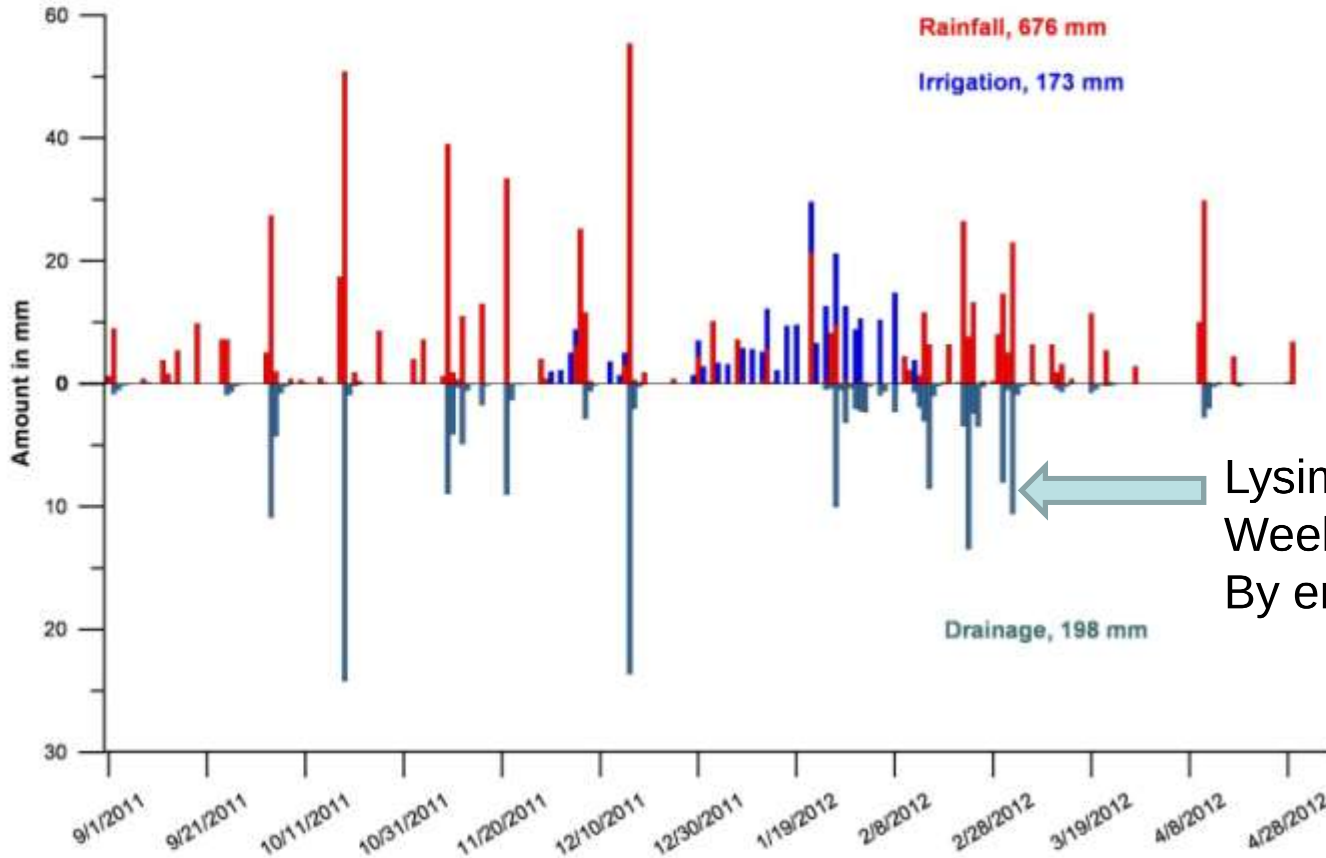
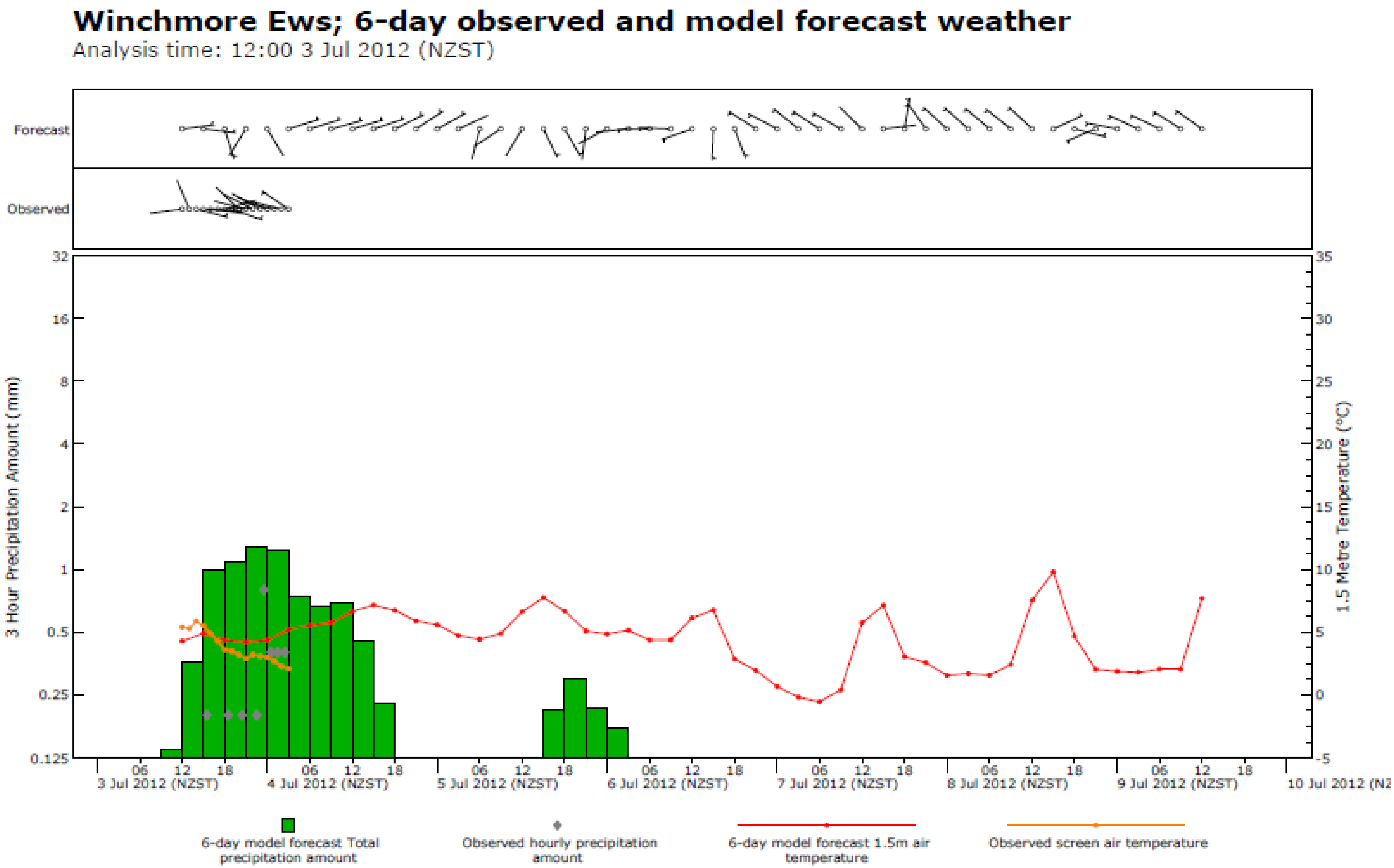
Example – Irrigation scheduling

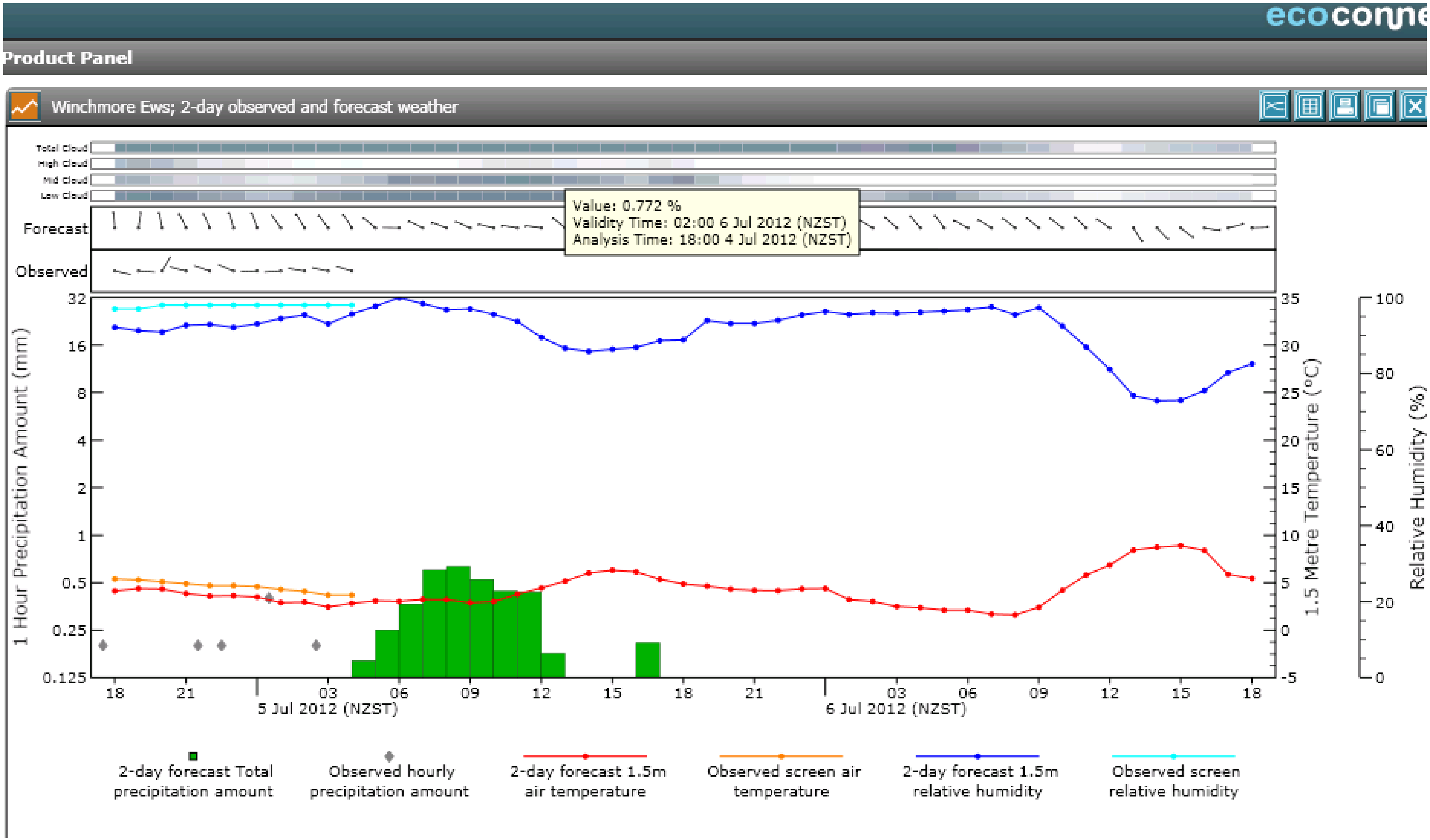


Lysimeter data
Weekly feed
By email

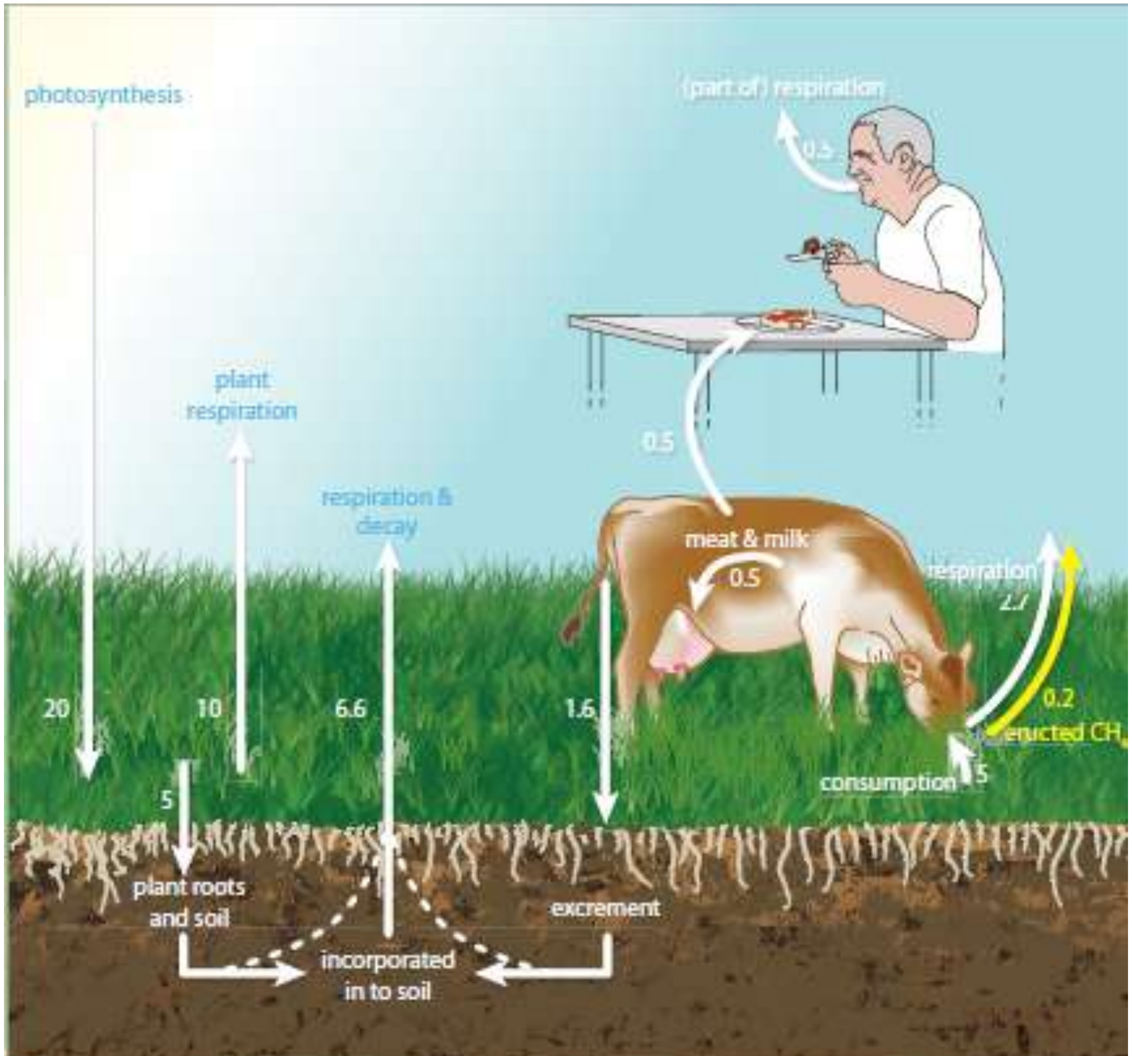
EcoConnect – NIWA Forecasting Tool



EcoConnect – Two day forecast for irrigation scheduling



Carbon Balance



Credit: Keith Lassey, Parsons & Chapman

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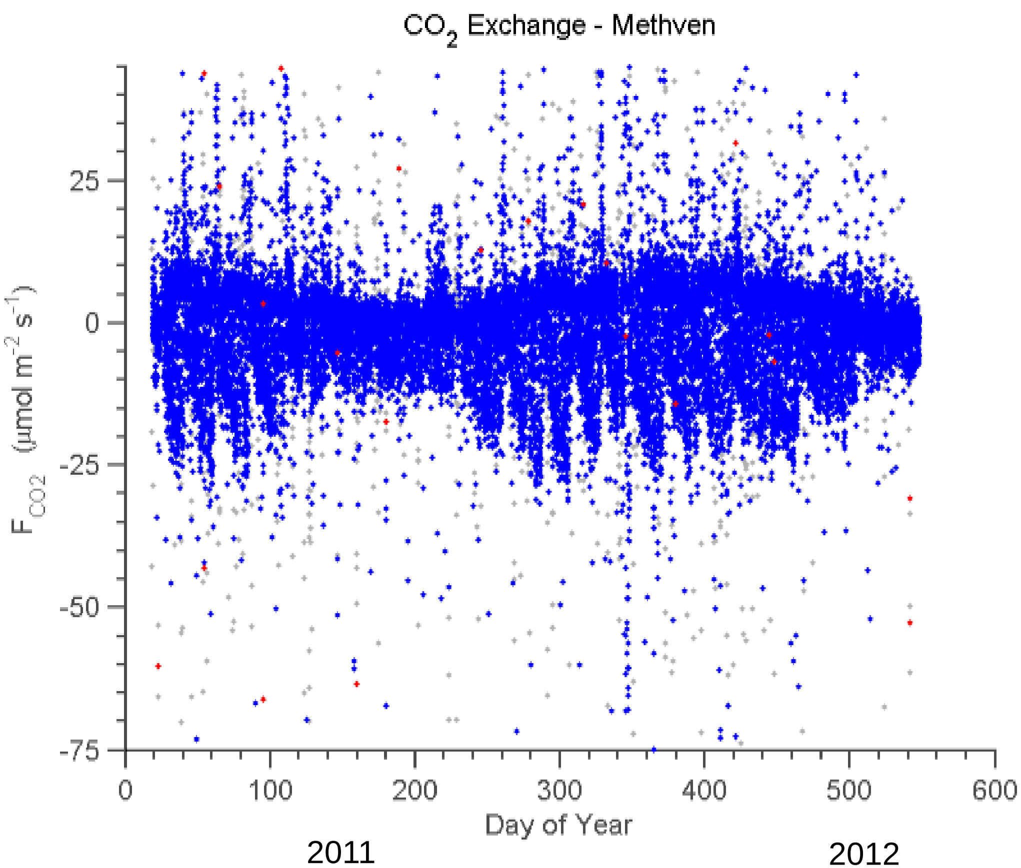
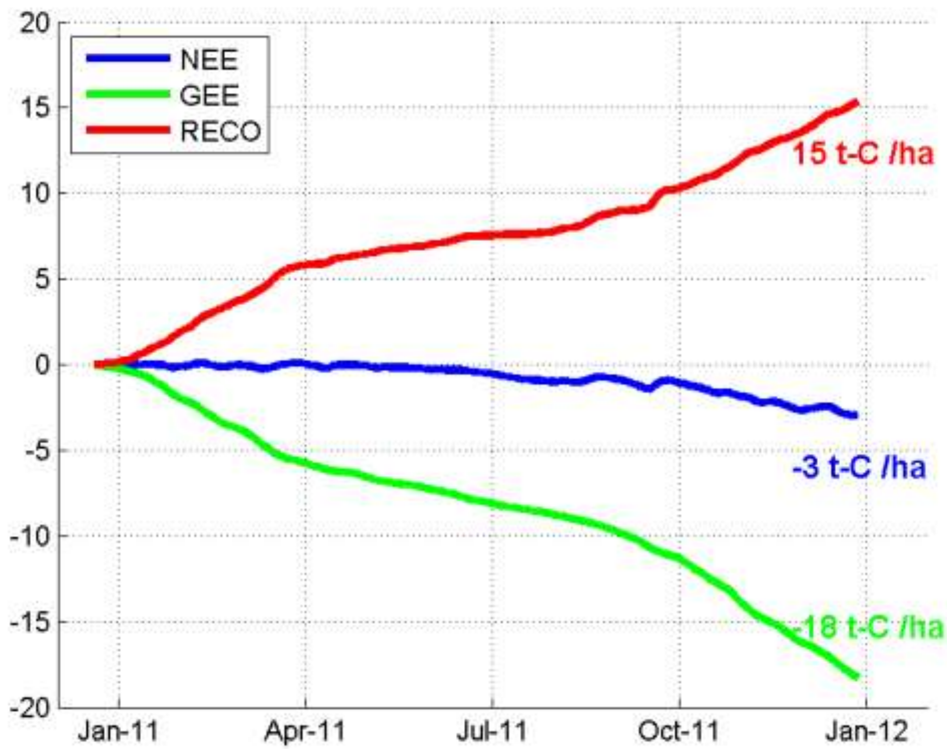
Methven CO2 Flux








Preliminary Carbon Balance



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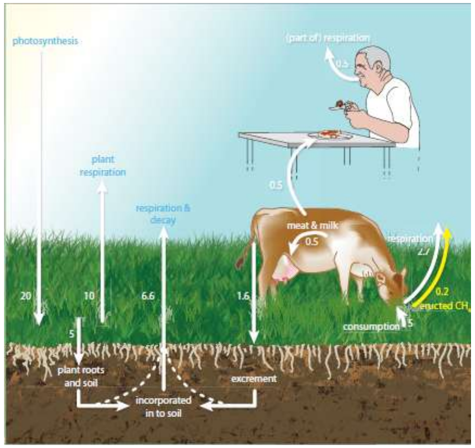
Carbon Balance



	Parsons & Chapman	Mudge et al (2010) Scott Farm	This study
GPP	20	19.8	18
Reco	15	18.2	15
NEP	9.5	1.6	3

Sites

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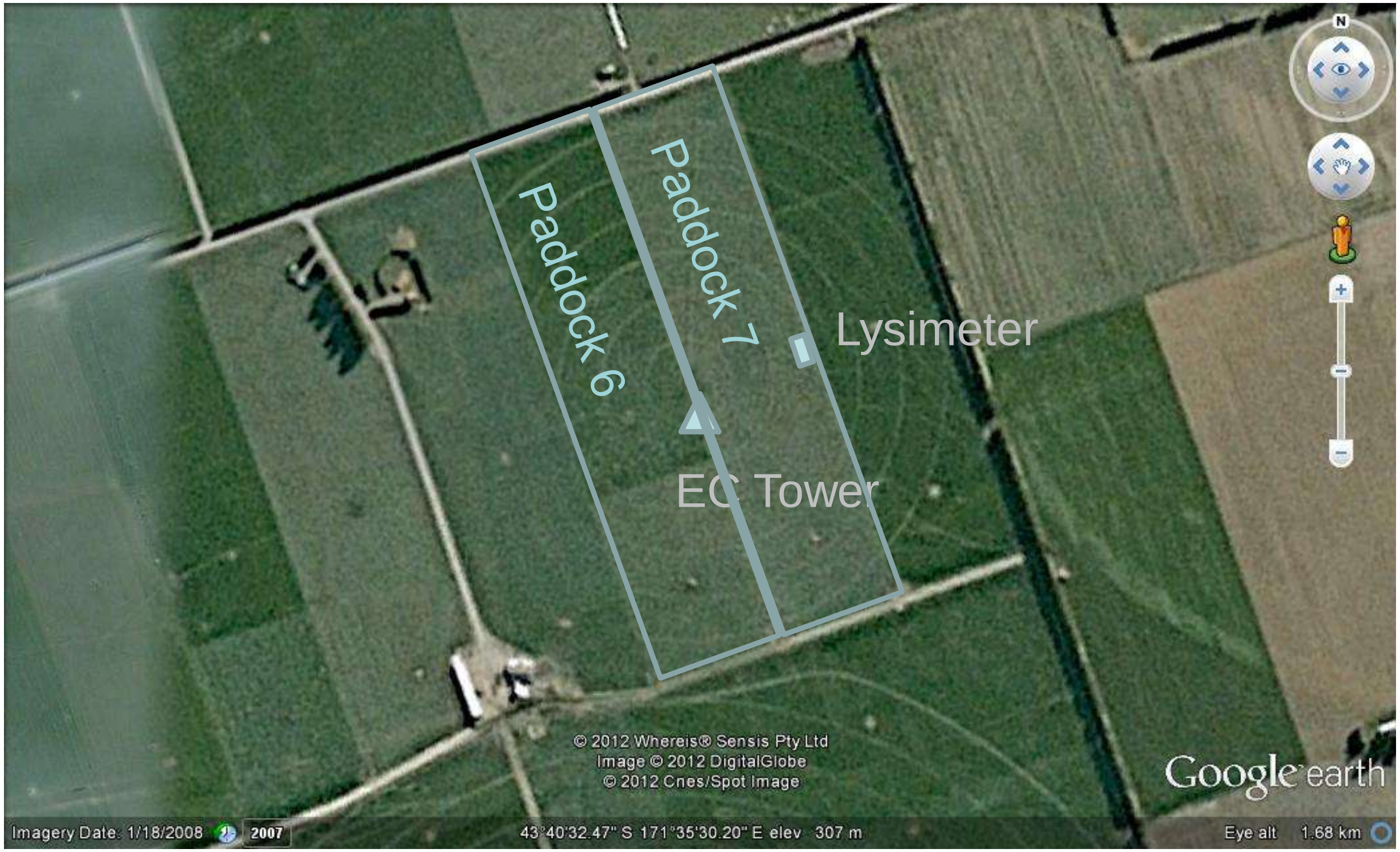

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Lysimeters

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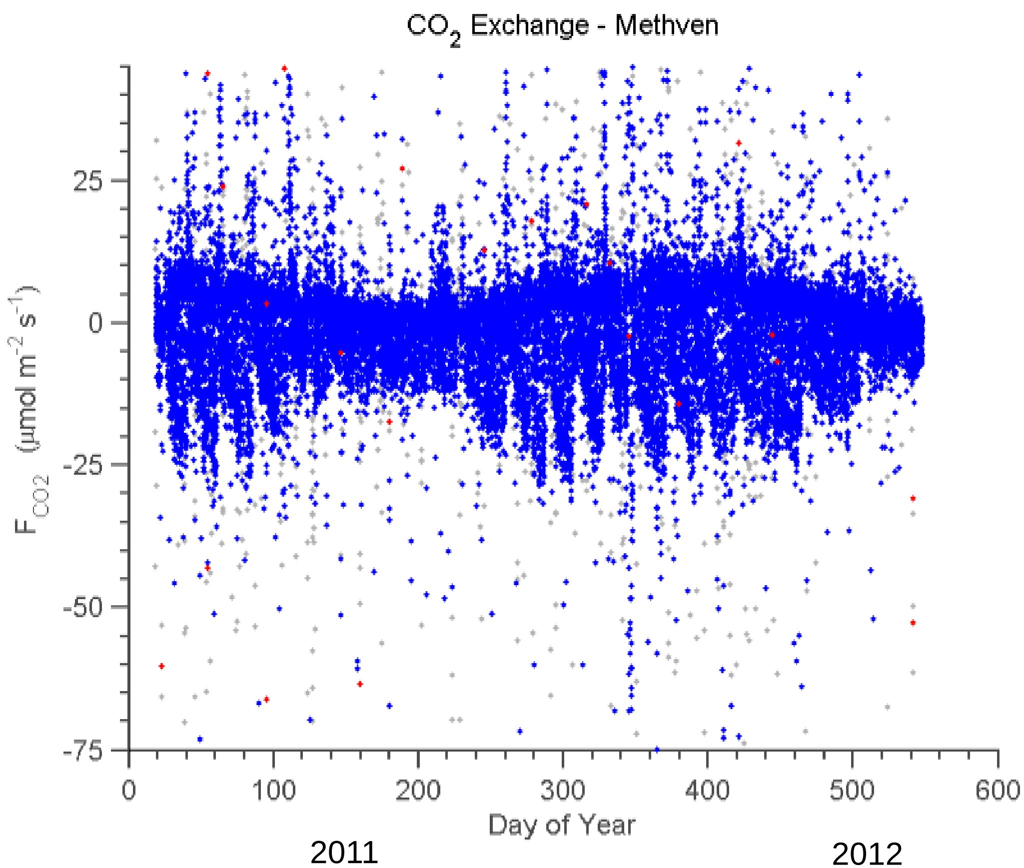

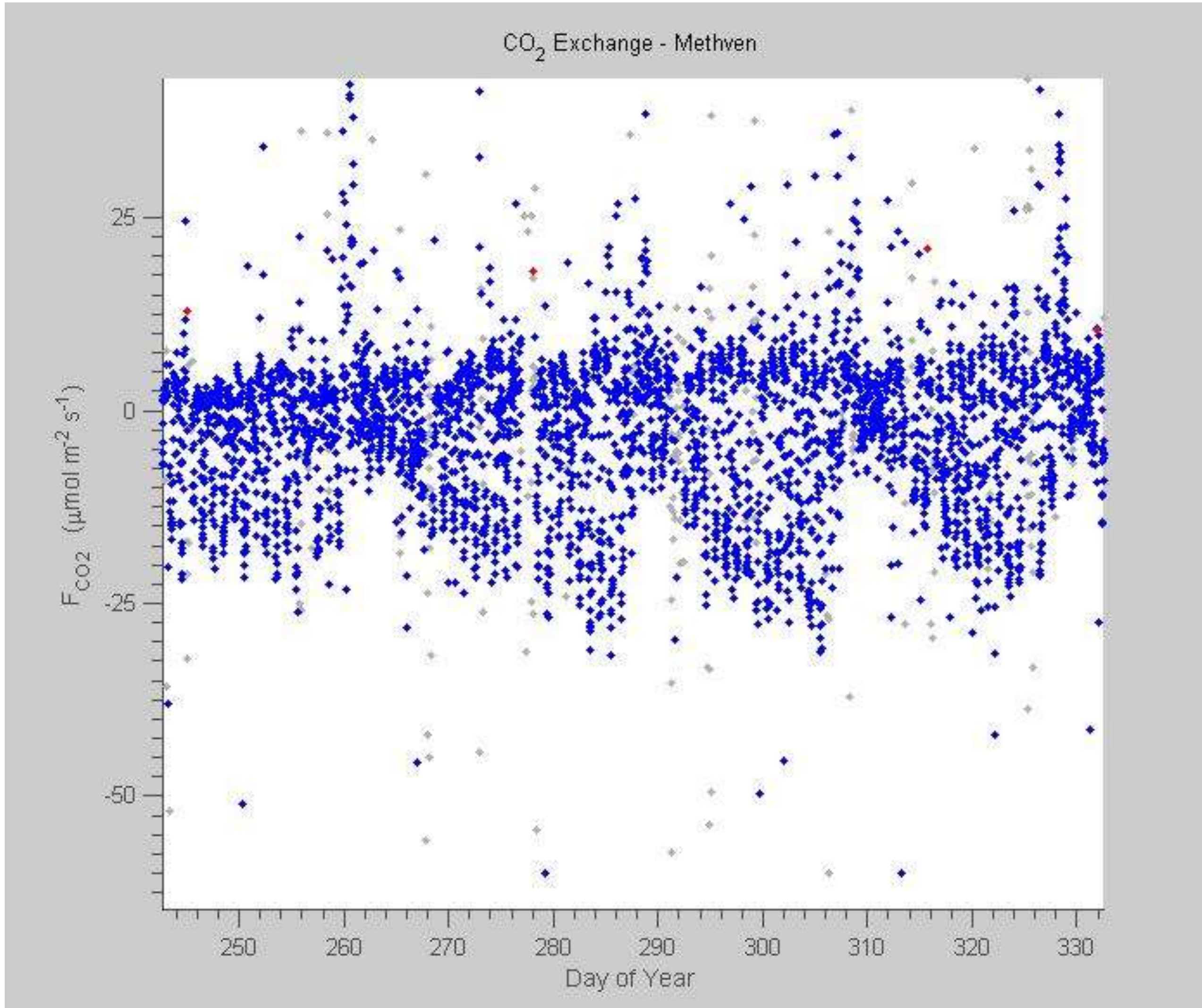

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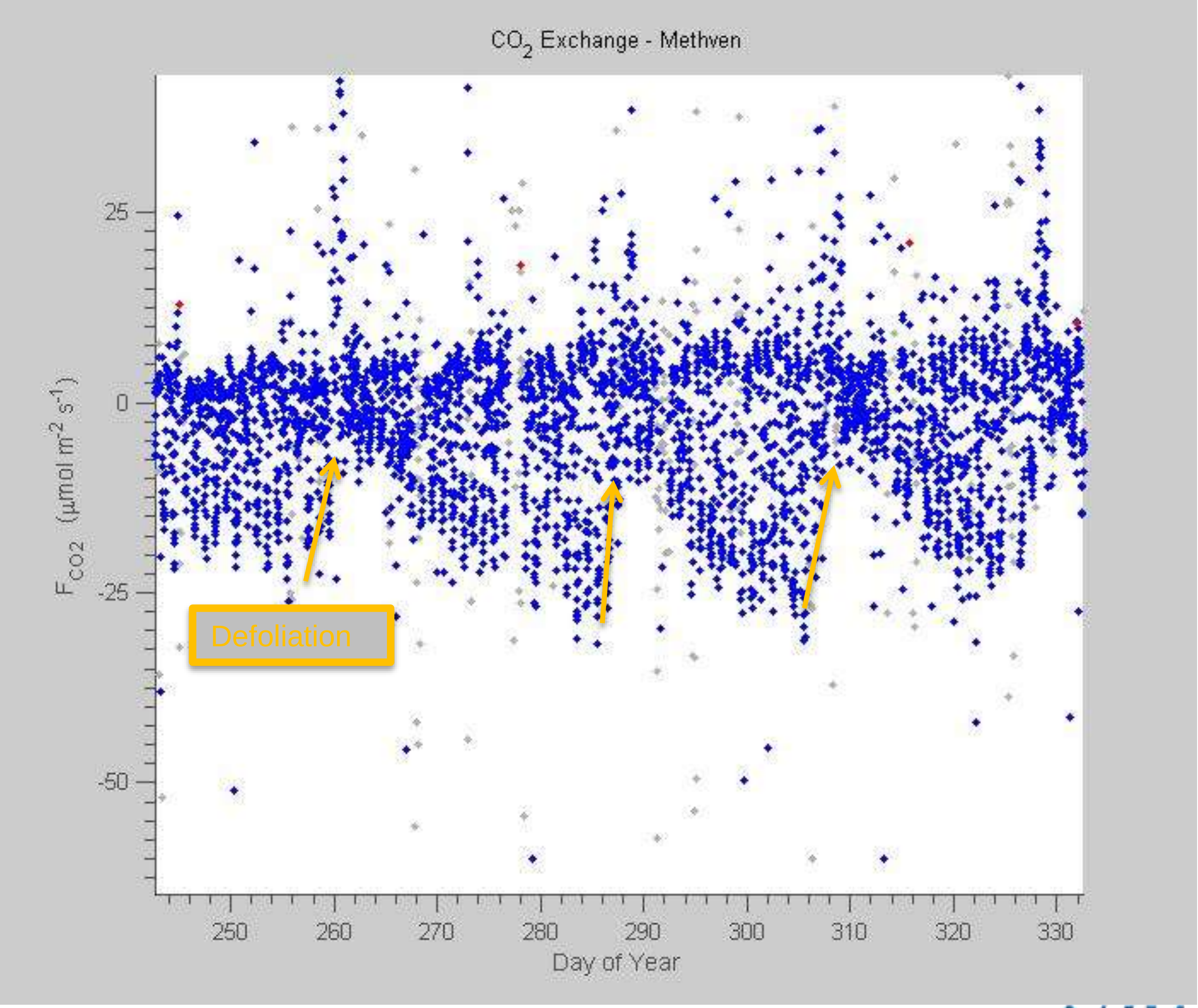
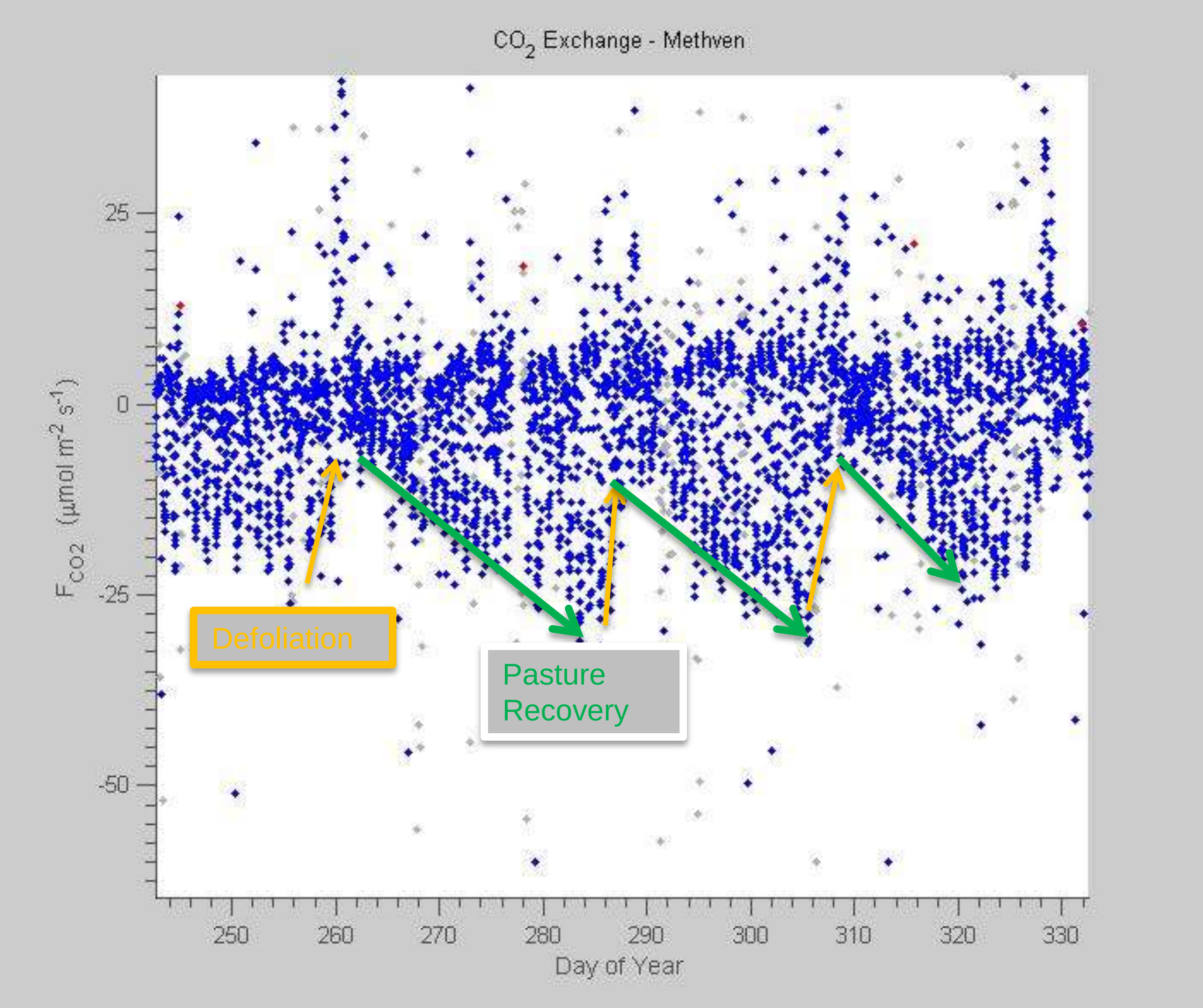


CO2 Exchange - Methven
Fco2 (µmol m-2 s-1)
25
0
-25
-50
250
260
270
280
290
300
310
320
330
Day of Year
Defoliation



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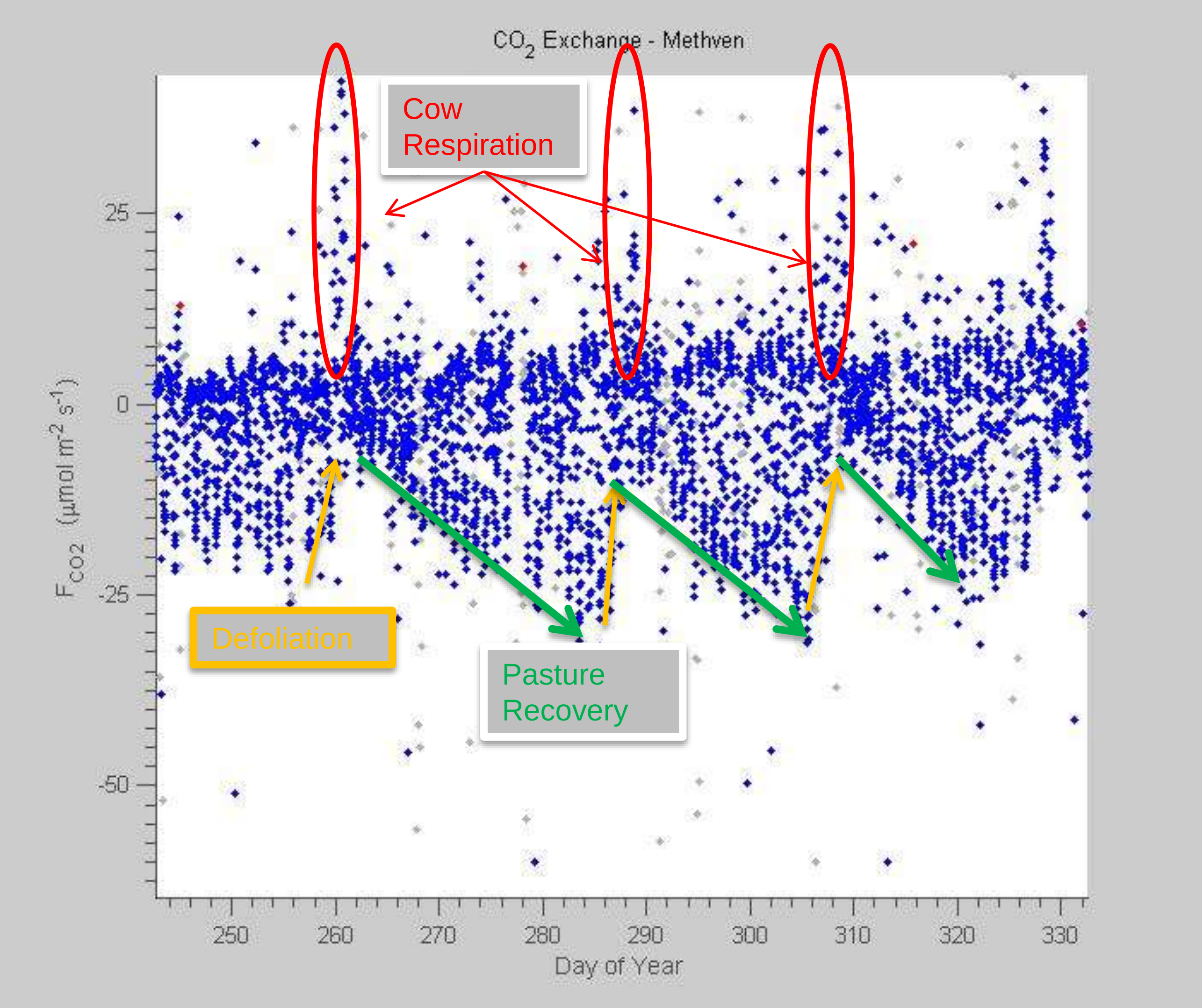

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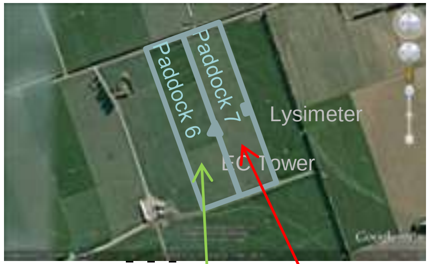
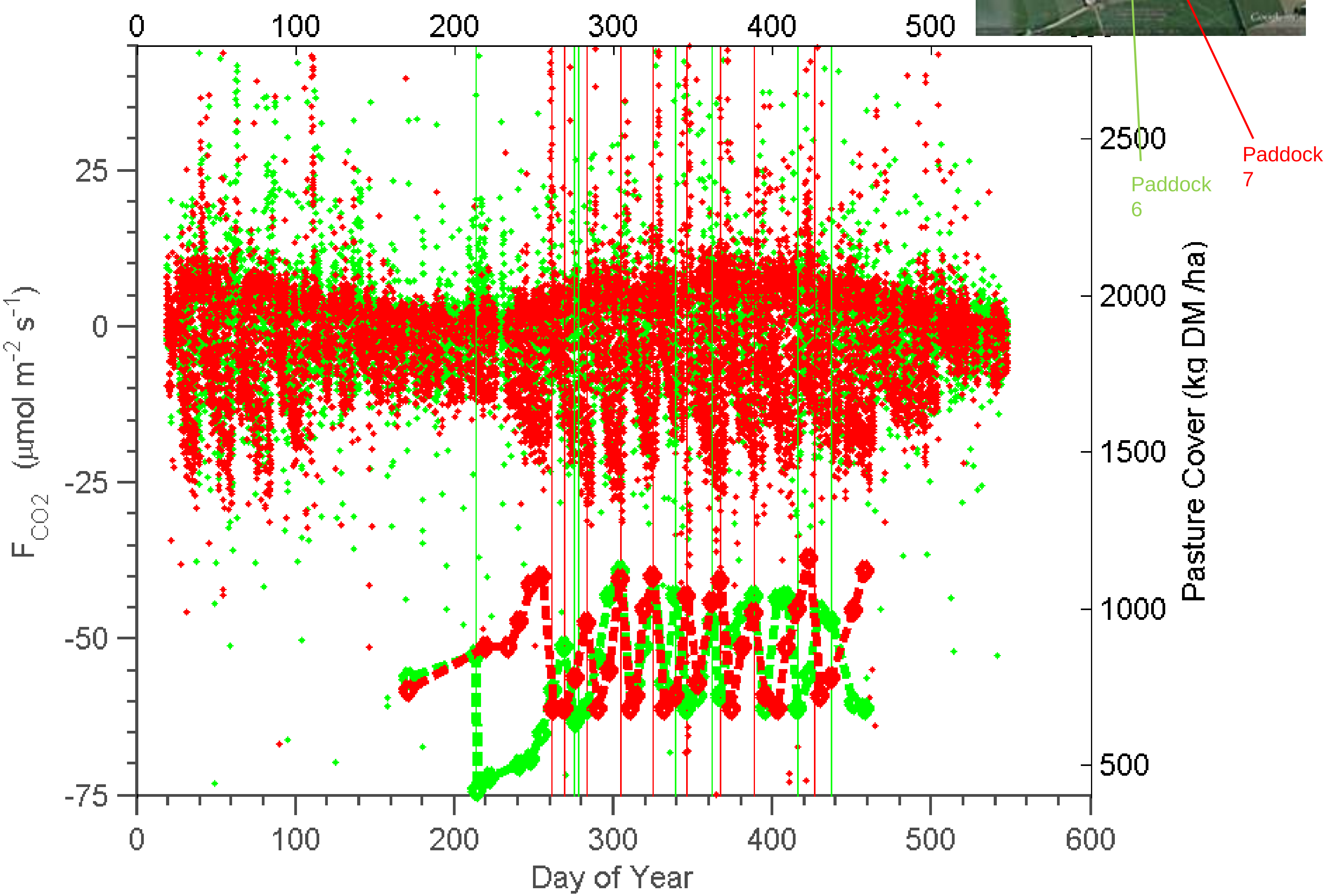
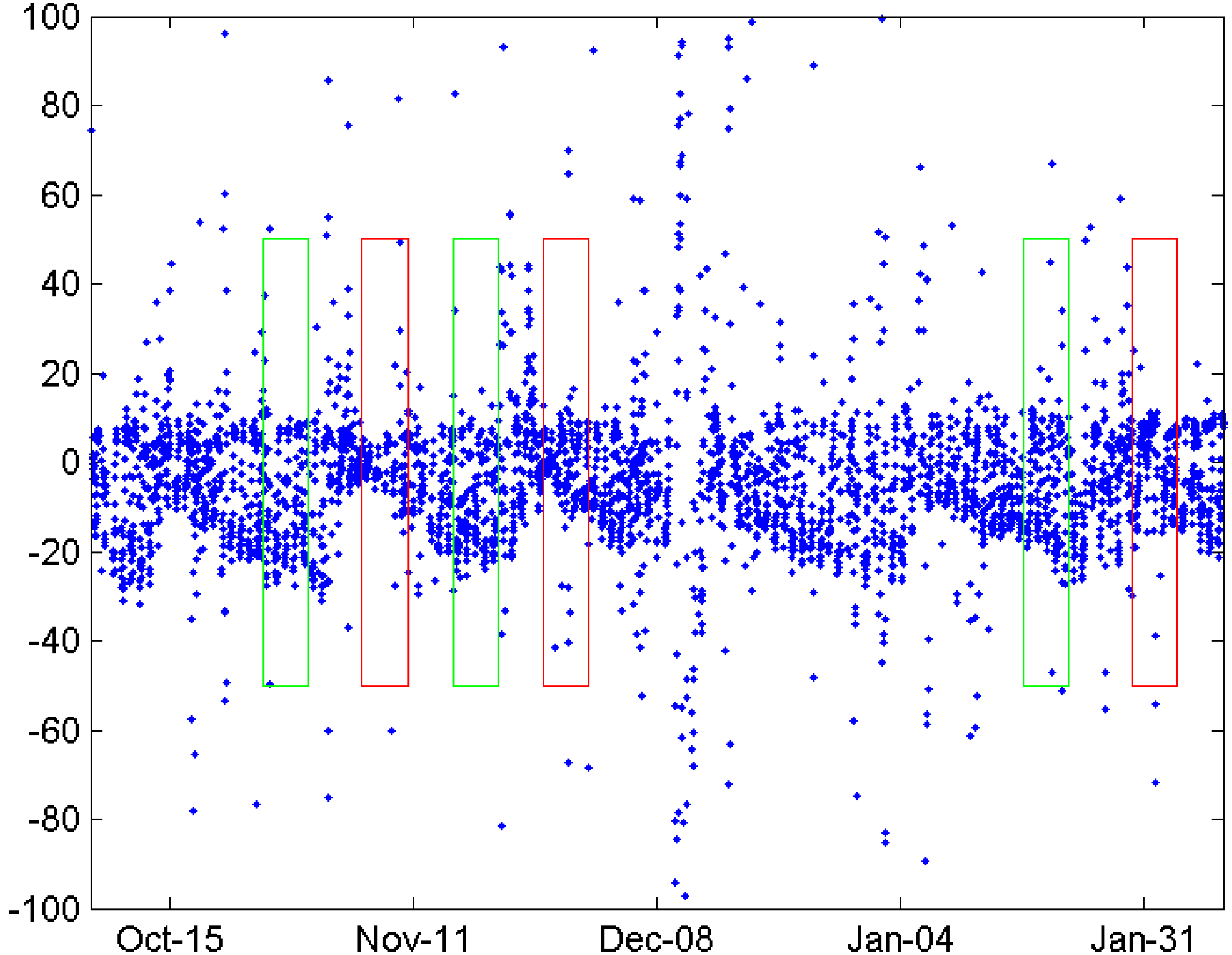
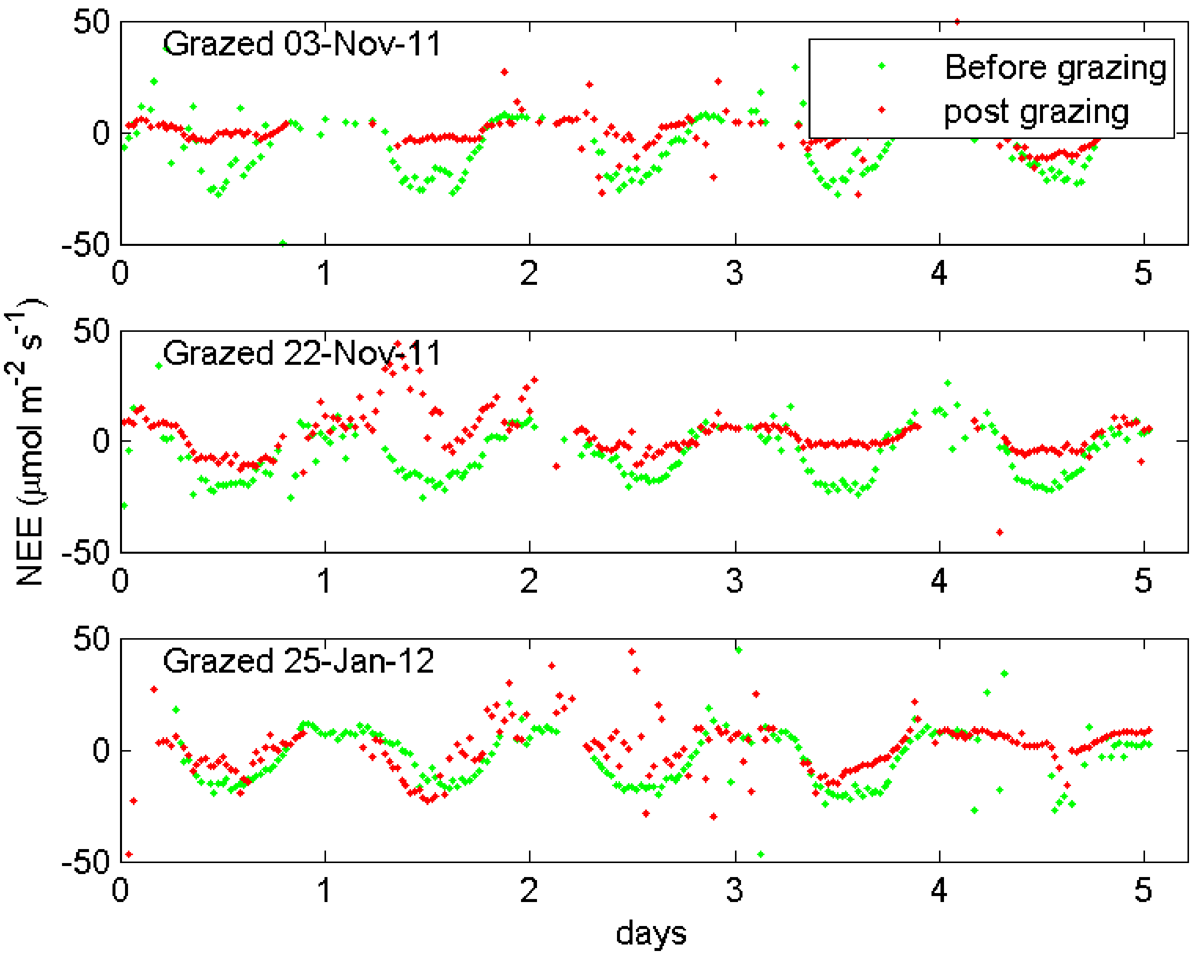
Comparing EC CO_2 flux with Pasture Probe measurements






100
80
60
40
20
0
-20
-40
-60
-80
-100
Oct-15
Nov-11
Dec-08
Jan-04
Jan-31

Net ecosystem exchange



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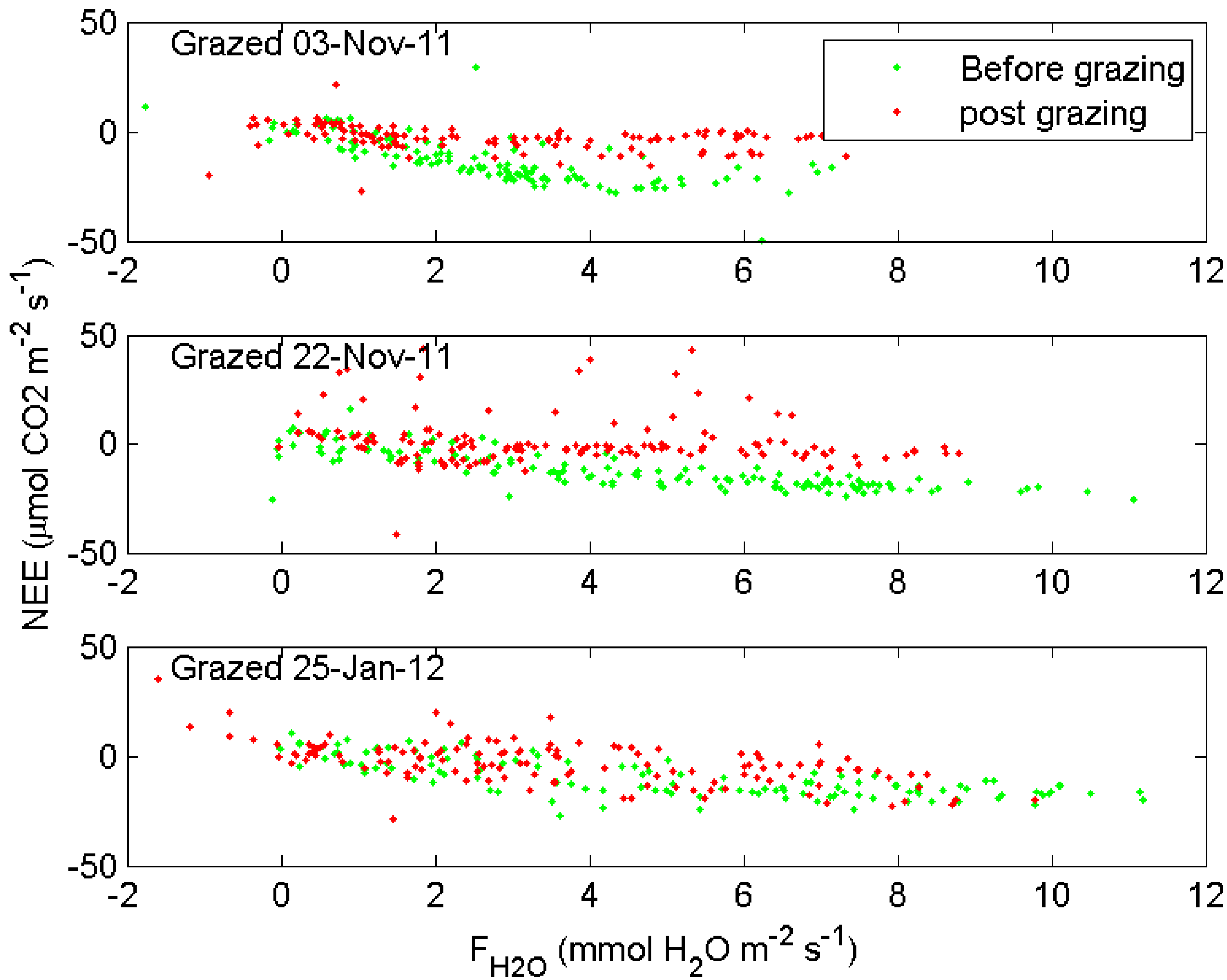
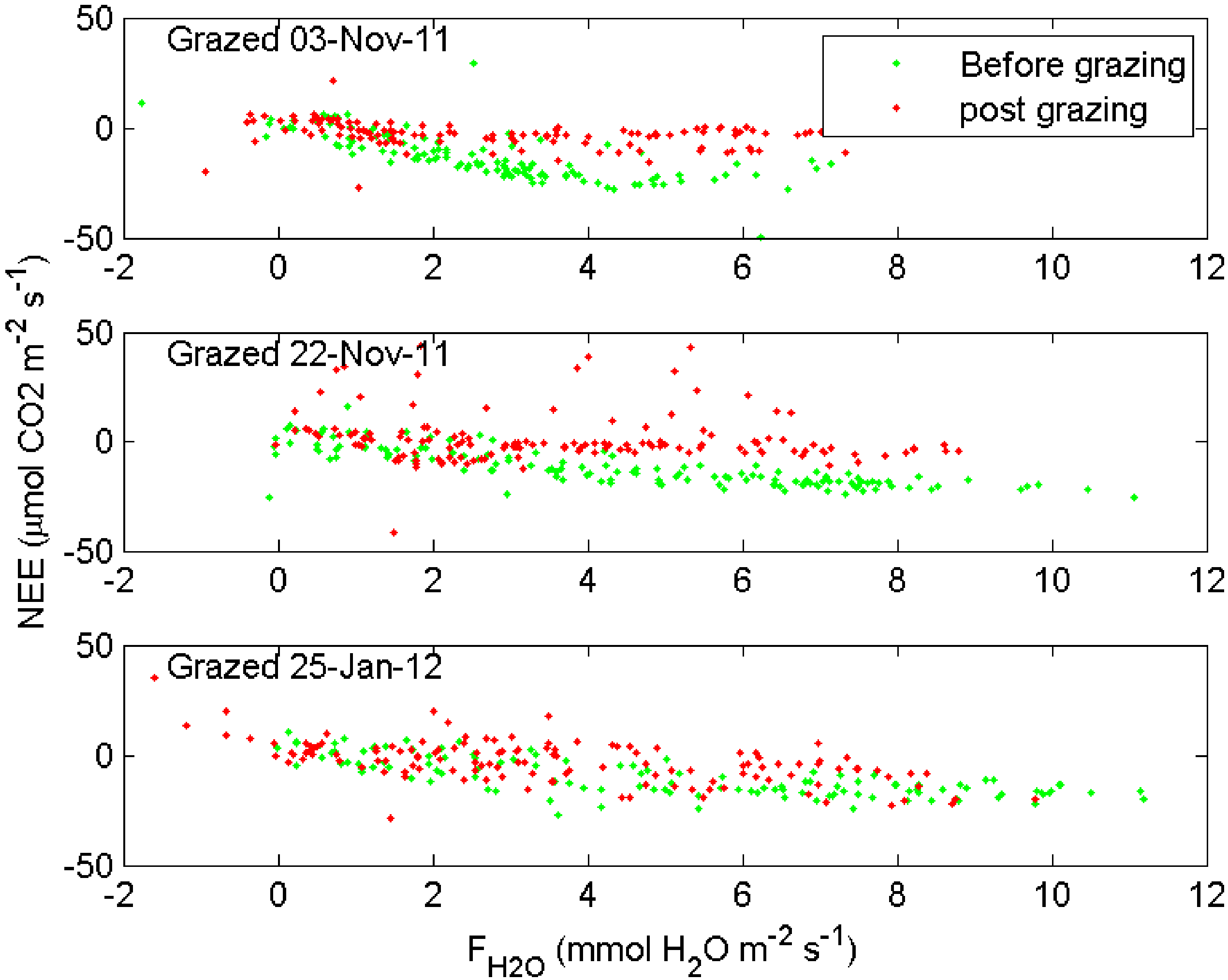
Light use efficiency



Water use efficiency



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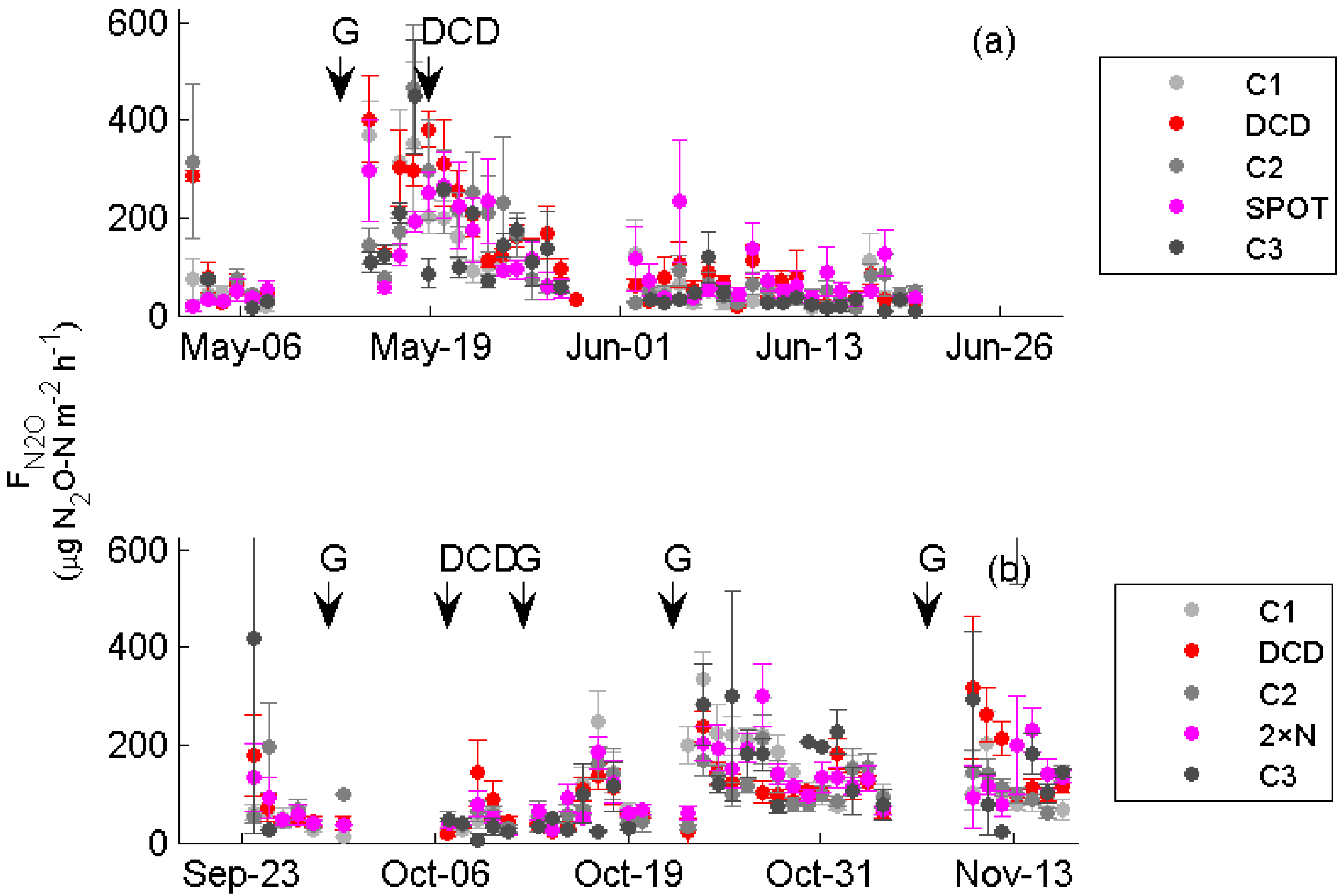
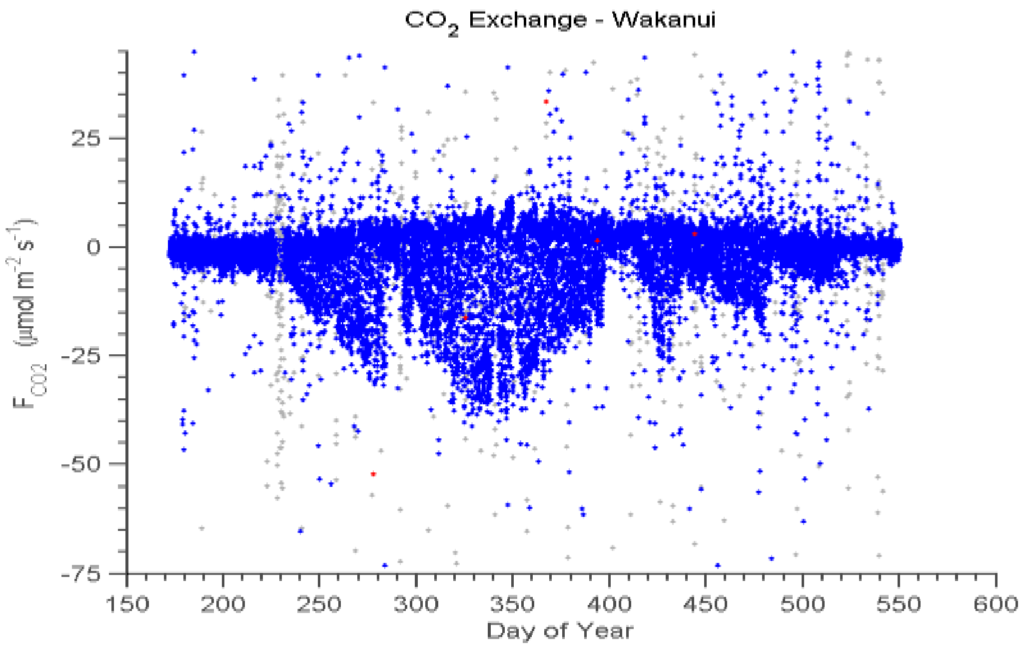
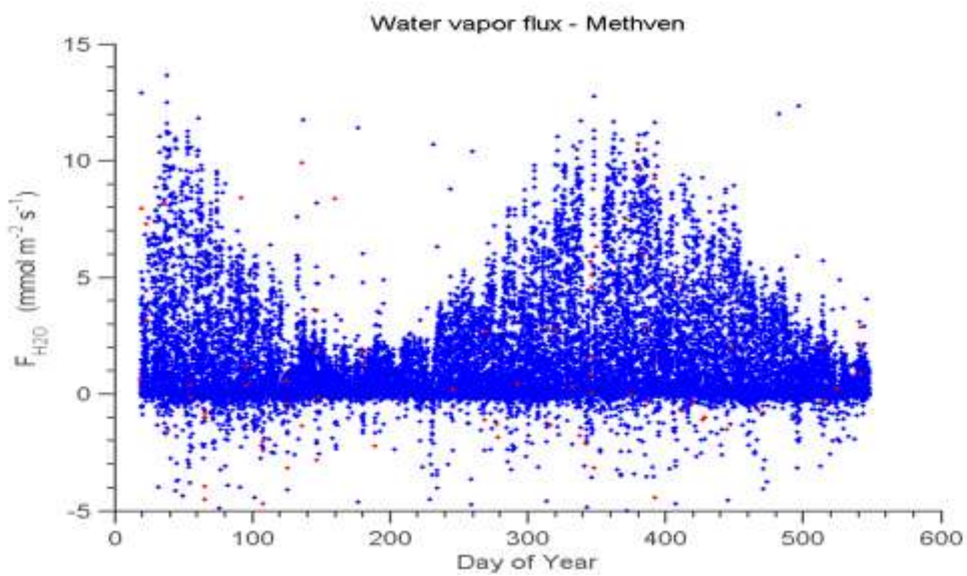


F_N2O (μg N2O-N m-2 h-1)
(a)
G
DCD
600
400
200
0
May-06
May-19
Jun-01
Jun-13
Jun-26
C1
DCD
C2
SPOT
C3
(b)
G
DCD
G
G
G
Sep-23
Oct-06
Oct-19
Oct-31
Nov-13
C1
DCD
C2
2×N
C3

Outline





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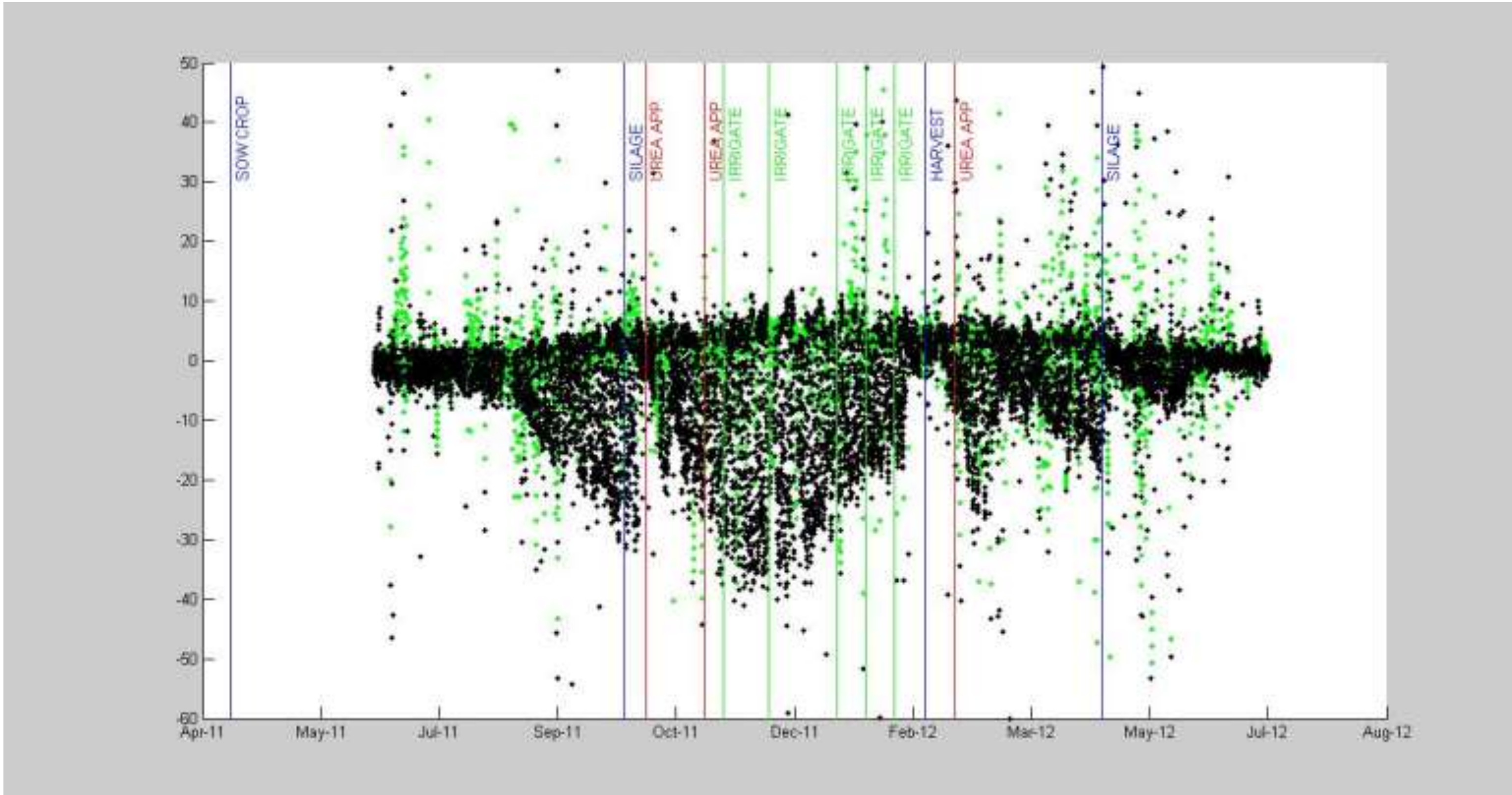

SOW CROP
SILAGE
UREA APP
UREA APP
IRRIGATE
IRRIGATE
IRRIGATE
IRRIGATE
IRRIGATE
HARVEST
UREA APP
SILAGE
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
Apr-11
May-11
Jul-11
Sep-11
Oct-11
Dec-11
Feb-12
Mar-12
May-12
Jul-12
Aug-12

Outline

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Outline

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Precision Agriculture – mostly spatial – but many temporal possibilities as well

Ability to finely resolve temporal dynamics

Conclusions

- **<u>Water Balance</u>**:
  - Operational farm management -great and partially realised potential for improving PET estimates
  - Groundwater recharge – measurements important for understanding irrigation on regional basis – implications for water use generally (water restrictions/cost affect farm economics)
- **<u>Greenhouse Gases & C storage:</u>**
  - Annual sums - high potential for quantifying C-cycle components (production statistics, well behaved, homogeneous ecosystem)
  - Micromet. Techniques have validation role for emissions inventory – spatially explicit, integrating, high temporal resolution -- but strong communication needed for increased uptake
- **<u>Agricultural production:</u>**
  - Exploit fine detail of EC data – temporal precision leads to cost reductions/better environmental outcomes

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