Hyperspectral airborne imagery for carbon flux modelling in a wood-pasture ecosystem

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EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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SUMMARY

1. Introduction
2. Methods
3. Estimation of Sun Induced Fluorescence
4. Results
5. Preliminar discussion

Biospec

FLUXPEC

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EUROPEAN COOPERATION
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1. Introduction

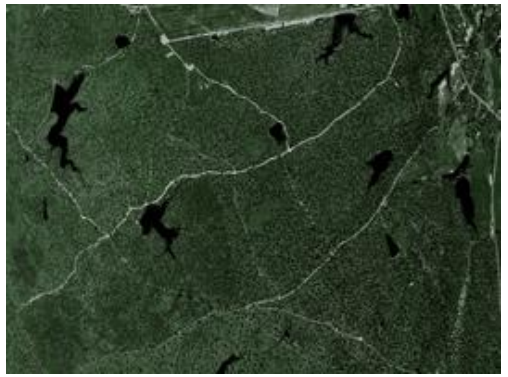
- Carbon fluxes modeled from remote sensors (Gamon et al. 2006 and 2011)
  - WHAT is measured?
    - Mix of different covers
  - From WHERE does the fluxes come from?
    - Spatial aggregration of spectral variables and flux data
  - WHEN spectral and flux variables are related?
    - Temporal aggregration of flux data and spectral variables
    - What do spectral variables mean?

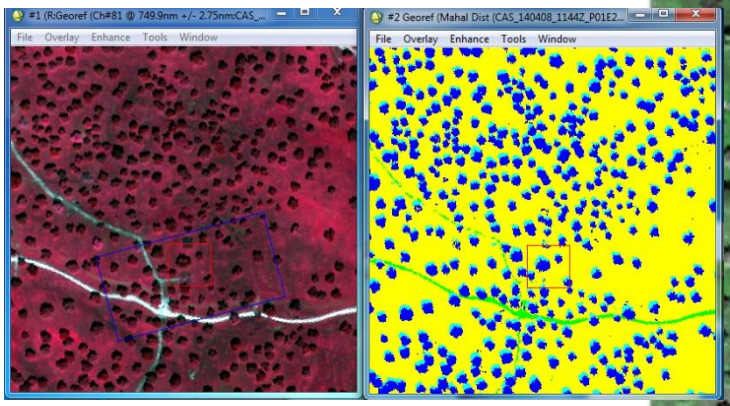
1. Introduction

- To adress these questions
  - High spatial resolution
  - Different strategies to select the area from where spectal data are related with the flux data
  - Different time windows from where flux data are related with spectral variables
  - Use different models to relate the variables

2. Methods

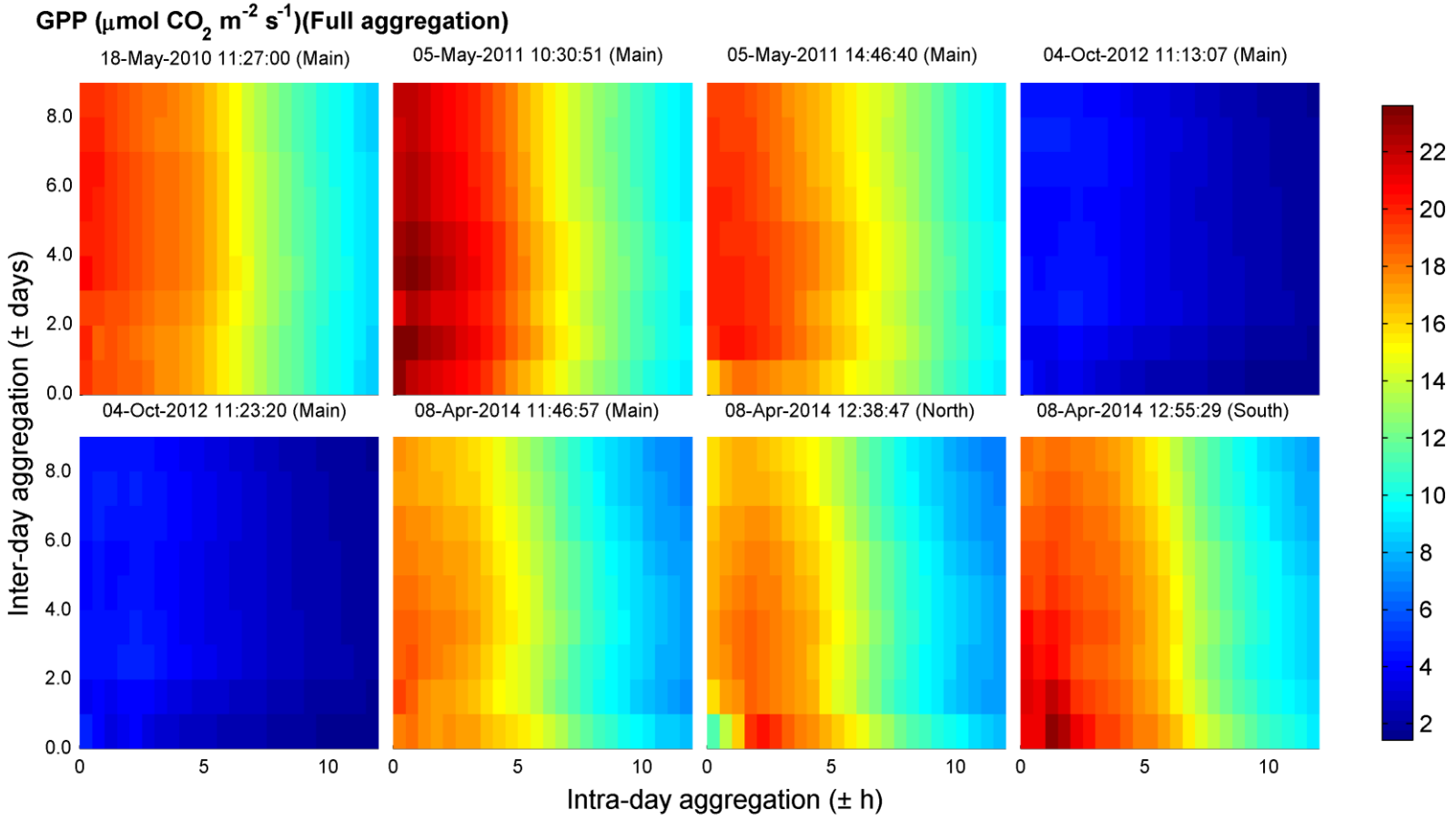
- 8 Airborne hyperspectral images
  - CASI (VNIR sensor, INTA)
  - Majadas del Tiétar site
    - Grass – pasture ecosystem
    - 1-3 EC towers
  - 4 different dates
  - Supervised classification
    - Grass / Trees
    - Soil-roads / Shadow-water





2. Methods

- Eddy Covariance Data



2. Methods

- Selection of different areas for pixel extraction
  - Modis pixels (centered)
    - 250 m
    - 500 m

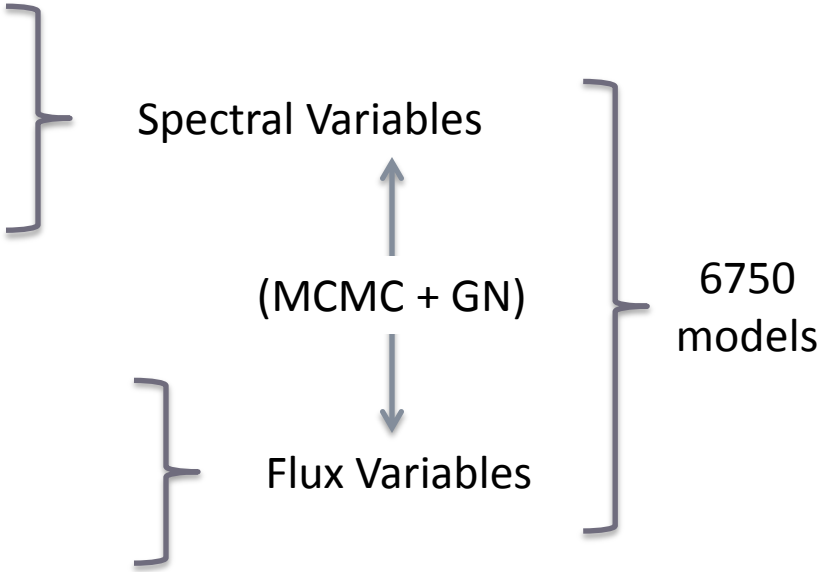
  - Footprint analysis PDFs
    - Corresponding to the periods of EC data aggregation
    - Work in progress…

2. Methods

- GPP Models
  - $GPP = \varepsilon \times fPAR \times PAR$ (Monteith 1972,1977)
    - Model 1: $GPP = a + b \times SVI$
    - Model 2: $GPP = (a + b \times SVI) \times PAR$
    - Model 3: $GPP = (a + b \times SVI) \times (c + d \times \varepsilon) \times PAR$

2. Methods

- Data integration
  - Each model
    - Each sampling area type
      - Grass
      - Grass & Trees
      - All
      - Intra-day (± 12 h)
      - Inter-day (± 9.5 d)



2. Methods

- Spectral Vegetation Indices

$$NDVI = \frac{\rho_{800} - \rho_{680}}{\rho_{800} + \rho_{680}} \qquad RDVI = \frac{\rho_{800} - \rho_{670}}{\sqrt{\rho_{800} + \rho_{670}}} \qquad Vogelmann\ 1 = \frac{\rho_{740}}{\rho_{720}}$$

$$EVI = 2.5 \times \frac{\rho_{858} - \rho_{645}}{\rho_{858} + 6 \times \rho_{645} - 7.5 \times \rho_{469} + 1}$$

$$TCARI/OSAVI = \frac{3 \times \left[(\rho_{700} - \rho_{670}) - 0.2 \times (\rho_{700} - \rho_{550}) \times \frac{\rho_{700}}{\rho_{670}}\right]}{(1 + 0.16) \times (\rho_{800} - \rho_{670}) \Big/ (\rho_{800} + \rho_{670} + 0.16)}$$

- Light Use Efficiency

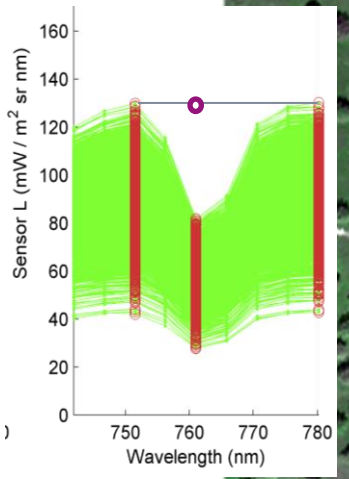
$$PRI = \frac{\rho_{531} - \rho_{570}}{\rho_{531} + \rho_{570}}$$

- PAR: global radiation

3. Estimation of Sun Induced Fluorescence

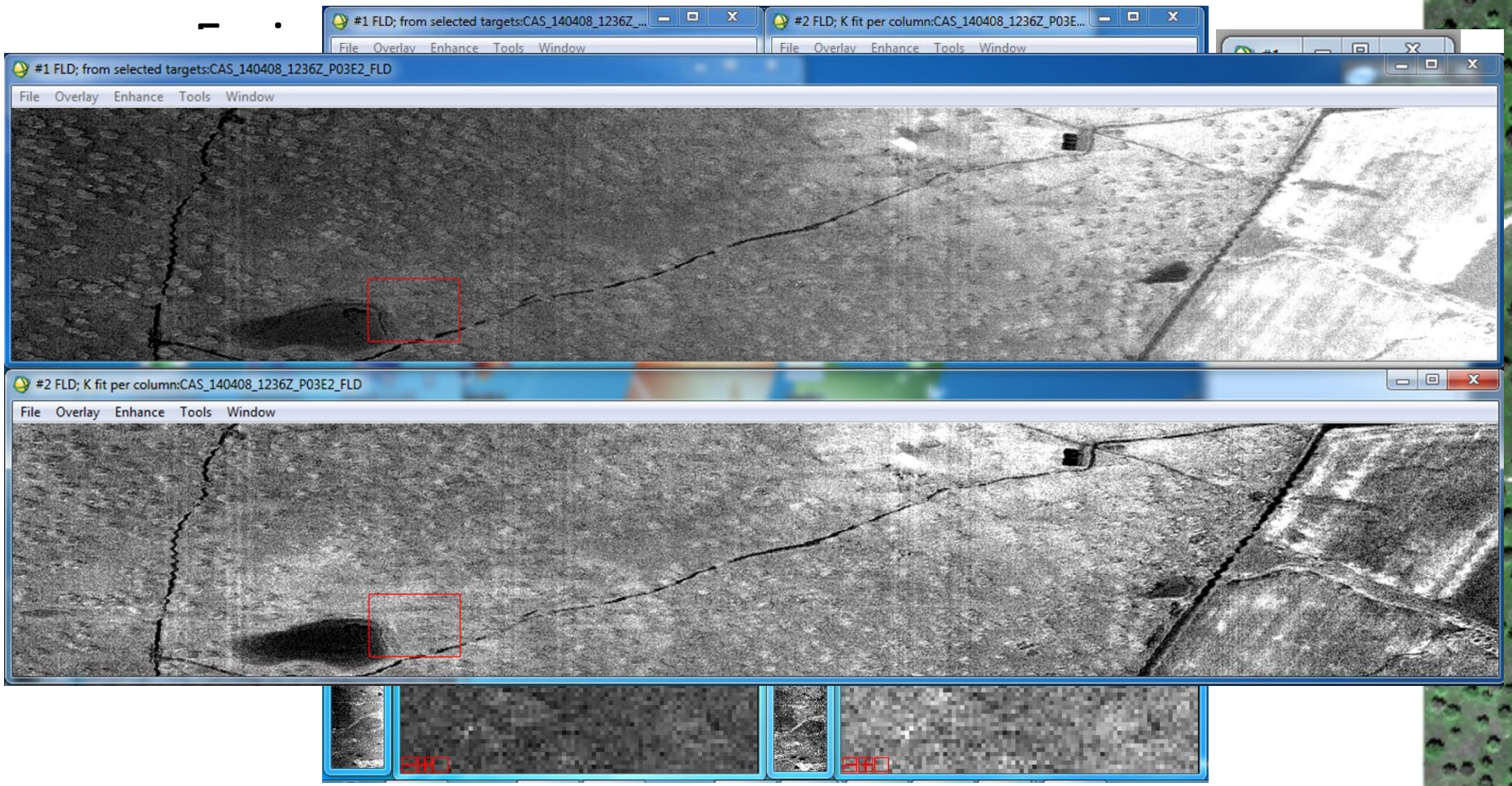
- University of Milano-Bicocca
  - Micol Rossini (& Pablo Zarco-Tejada)
  - Fluxpec Stay + STMS (Cost Action Optimise)

- Attempt to retrieve SIF (~LUE)
  - FLD & 3FLD
  - Non-fluorescent targets: $L_i = k_1 L_o + k_2$
  - F_{760} retrieval: $k_3 L_f = L_i - (k_1 L_o + k_2)$



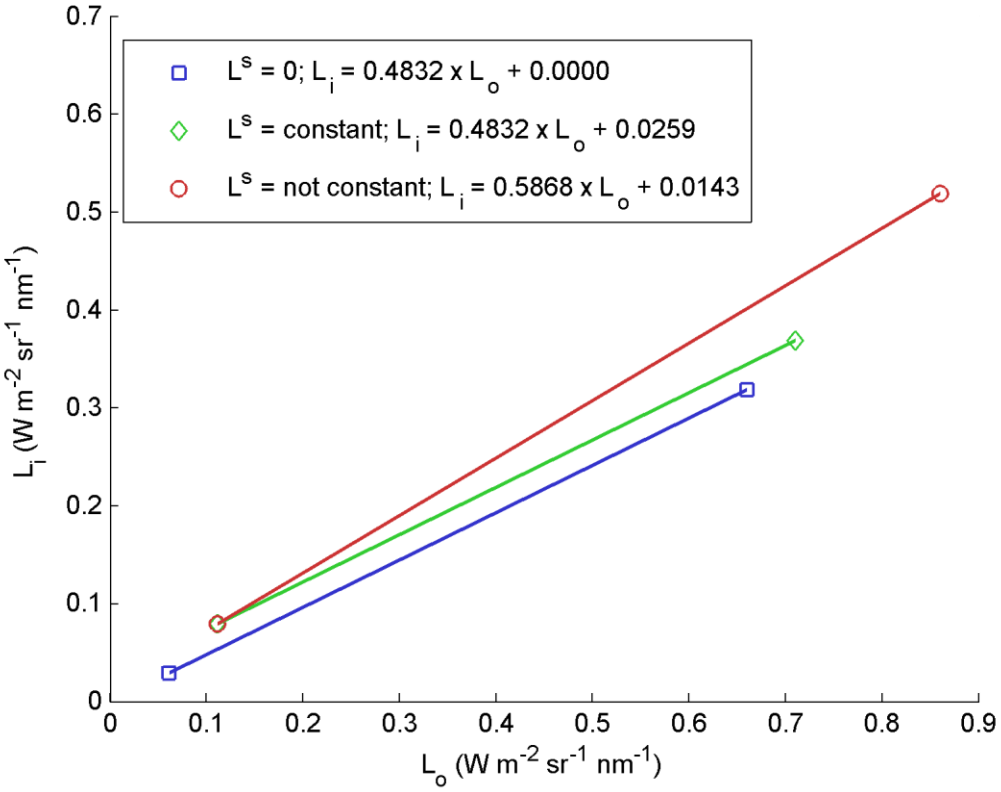
3. Estimation of Sun Induced Fluorescence

- Problems F_{760} retrieval



3. Estimation of Sun Induced Fluorescence

- Bias formulation (from Maier et al. (2002))



Further details in the STMS report.

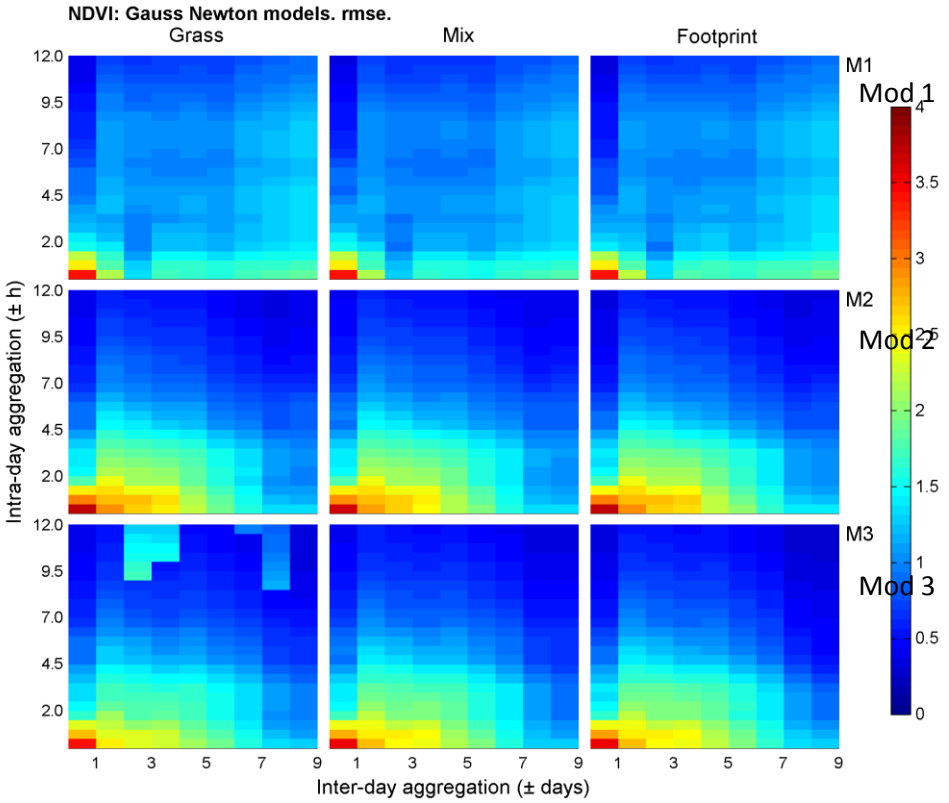
Should be published soon in:

http://optimise.dcs.aber.ac.uk/stsms/

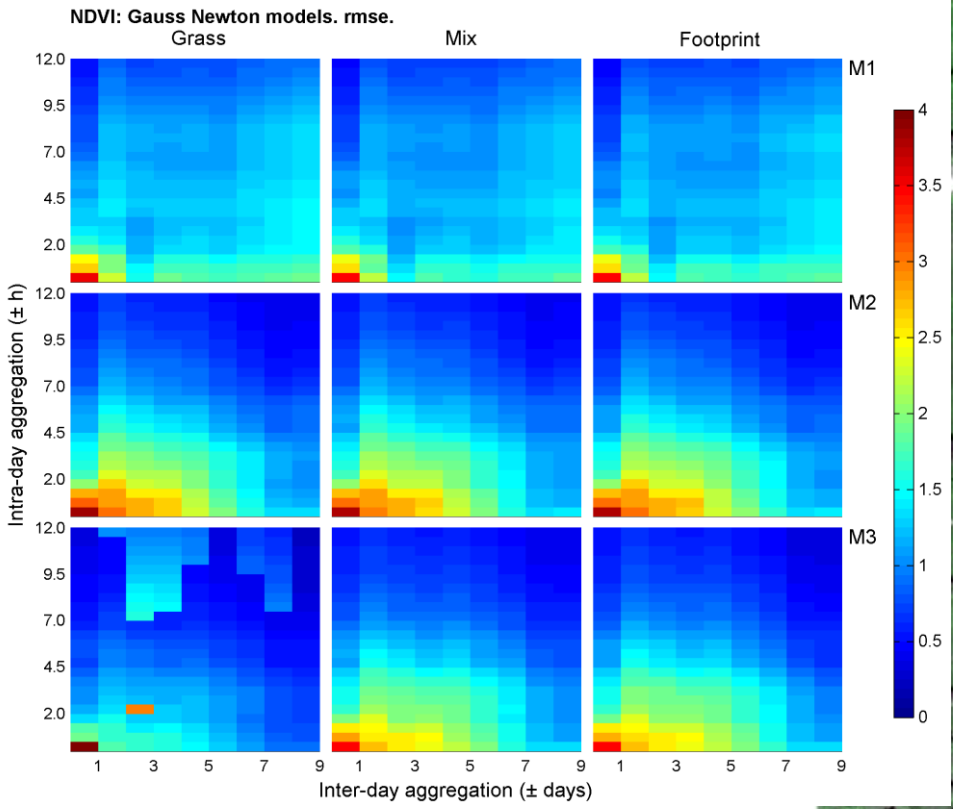
→ Biased coefficients actually adjusted

4. Results

250 m x 250 m

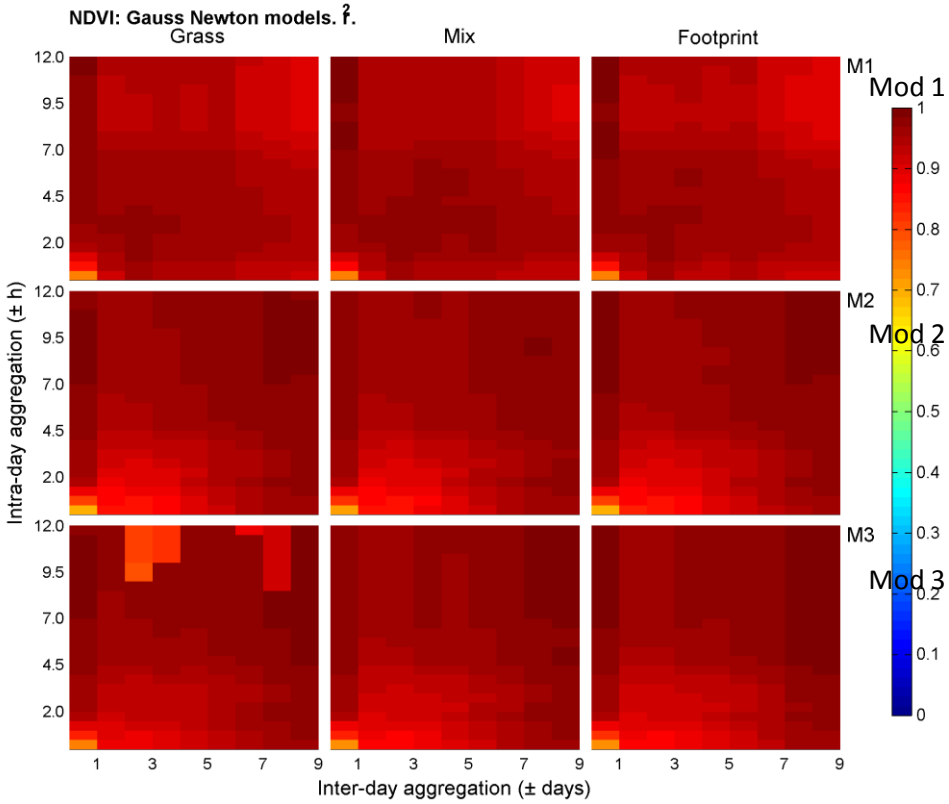


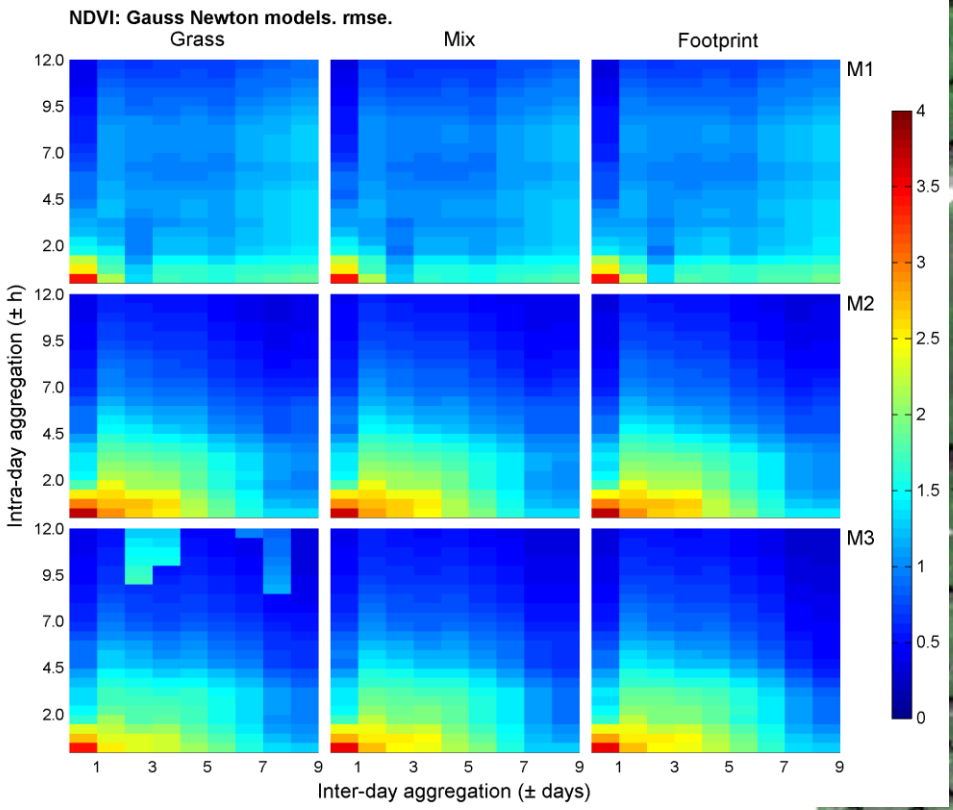
500 m x 500 m



4. Results

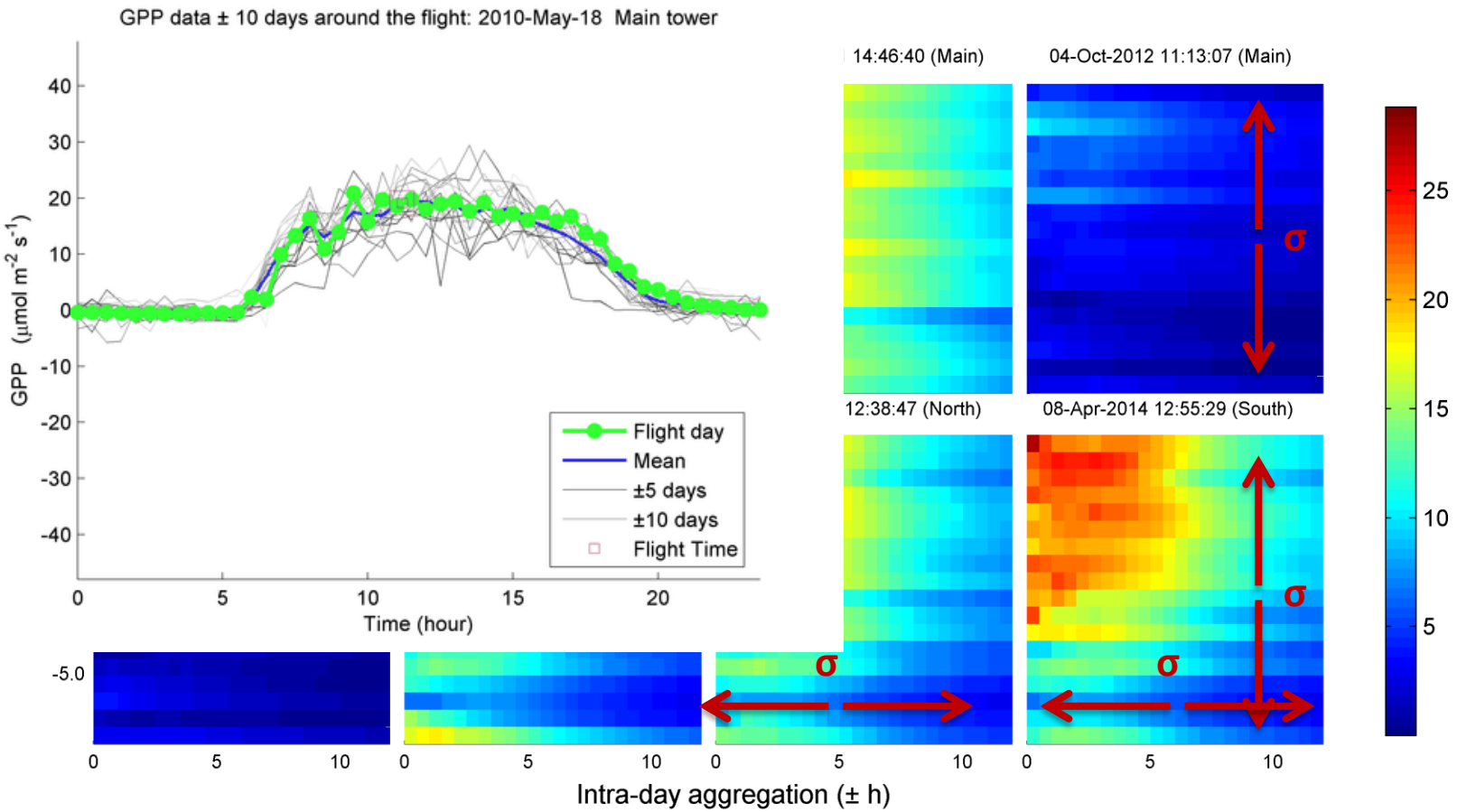
- Relationships in the time domain





4. Results

- Understanding errors



5. Preliminar discussion

- No large differences with simulated MODIS pixels
  - Footprint analysis: to be done…
- Spectral mixture
  - Mix of vegetation spectra do not improves estimates (different relationships)
  - Non-vegetated cover slightly increase errors

5. Preliminar discussion

- Temporal aggregation of flux data
  - In general, daily averages and averages of more several days are better predicted than instantaneous GPP
- Model used
  - Including radiation improves estimation further from the flight
  - PRI does not always lead to better results

Questions & suggestions?

THANKS!!!