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Assimilating Canopy Reflectance data into an Ecosystem Model with an Ensemble Kalman Filter

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Acknowledging inputs from CTCD/NCEO colleagues

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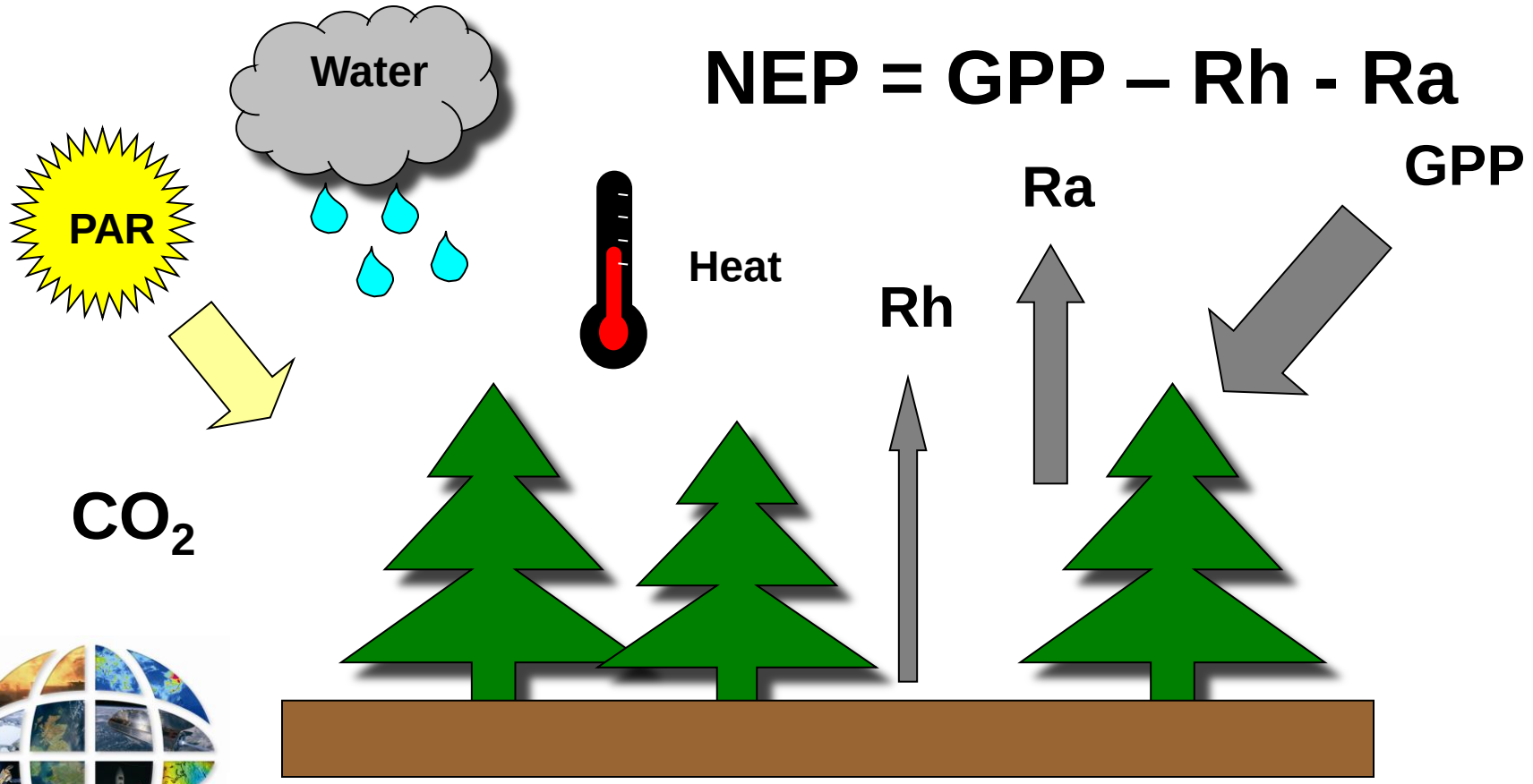
Want to map net carbon flux: Spatially, globally



Carbon Balance – Net Ecosystem Production

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Estimate C fluxes from vegetation

- Use ecosystem models
  - Need to test models / process understanding
  - Parameters not (well) known *a priori*
    - Use flux tower data (++)
    - Detailed characterisation at site

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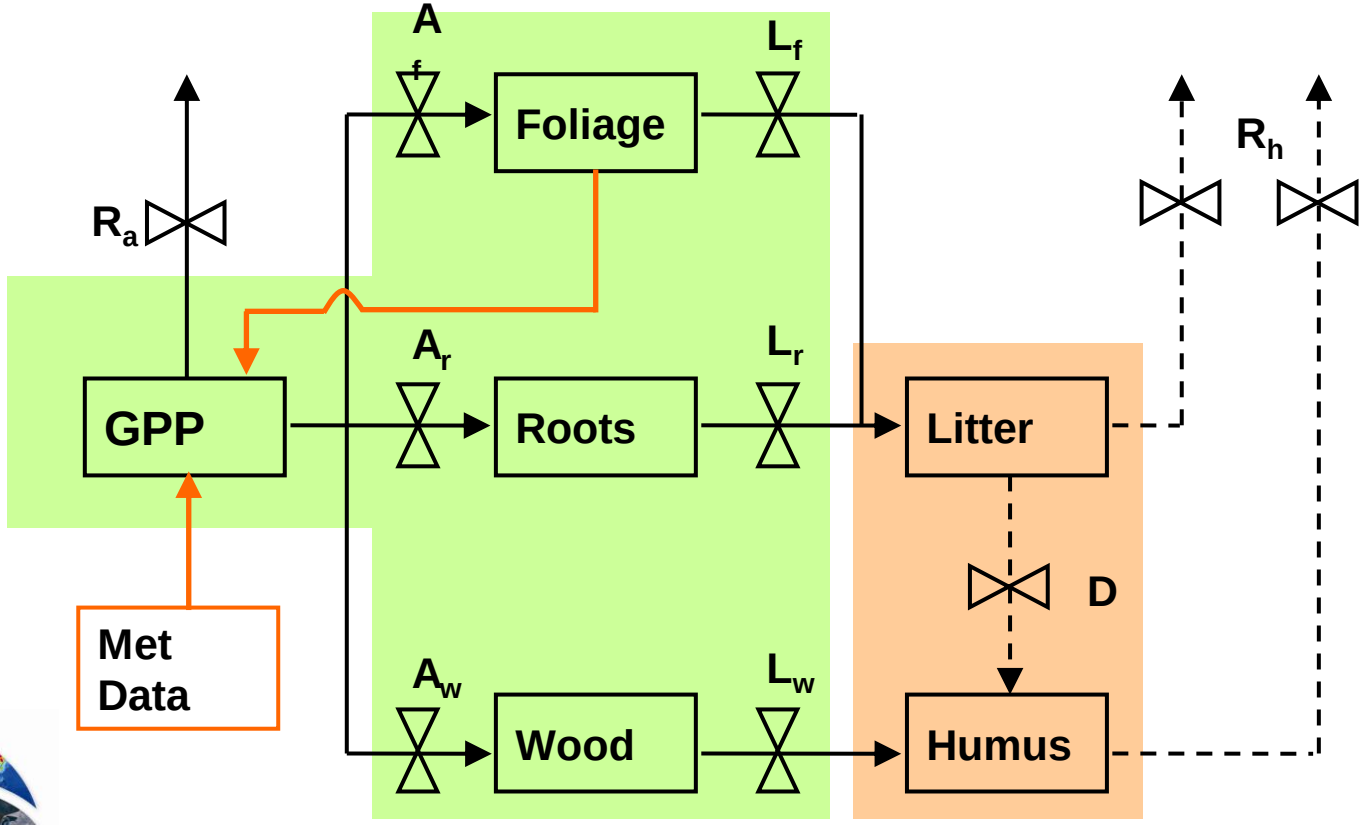
DALEC – ecosystem model



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How to spatialise?

- EO data
  - e.g. via land cover / PFT
    - but model parameters vary spatially …
  - so could use EO ‘biophysical’ products
    - e.g. use LAI to **drive** foliage pool dynamics
    - or **assimilate** products into model

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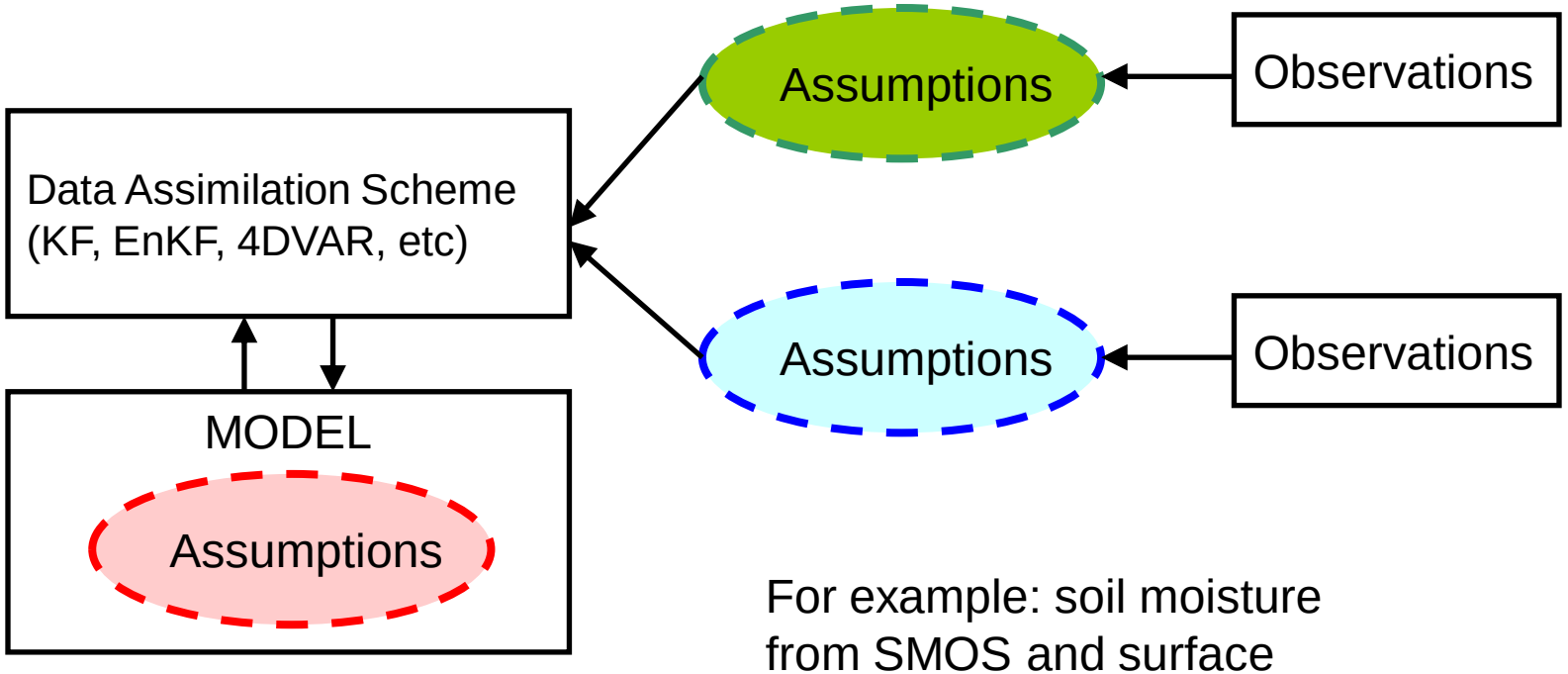
Assimilating products



For example: soil moisture from SMOS and surface temperature from MODIS

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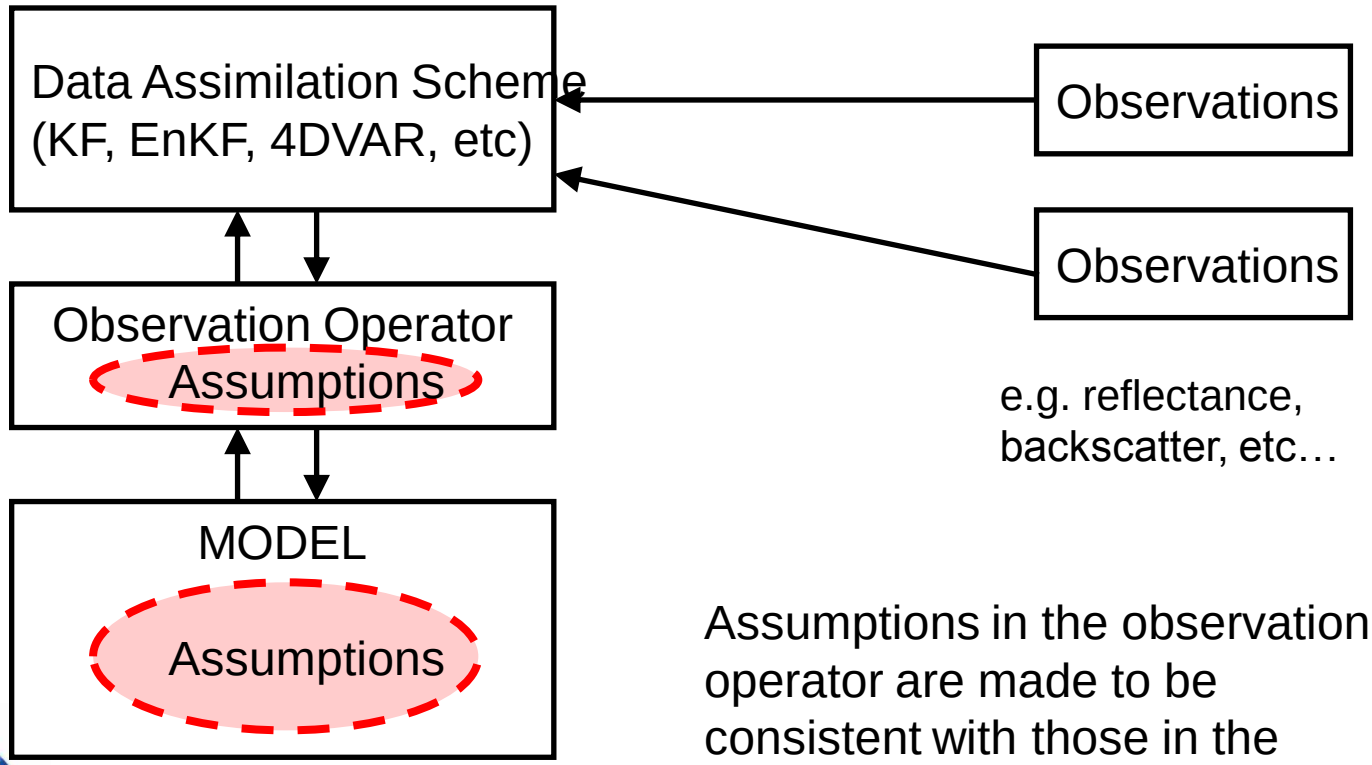
Assimilating lower level products



Assumptions in the observation operator are made to be consistent with those in the model

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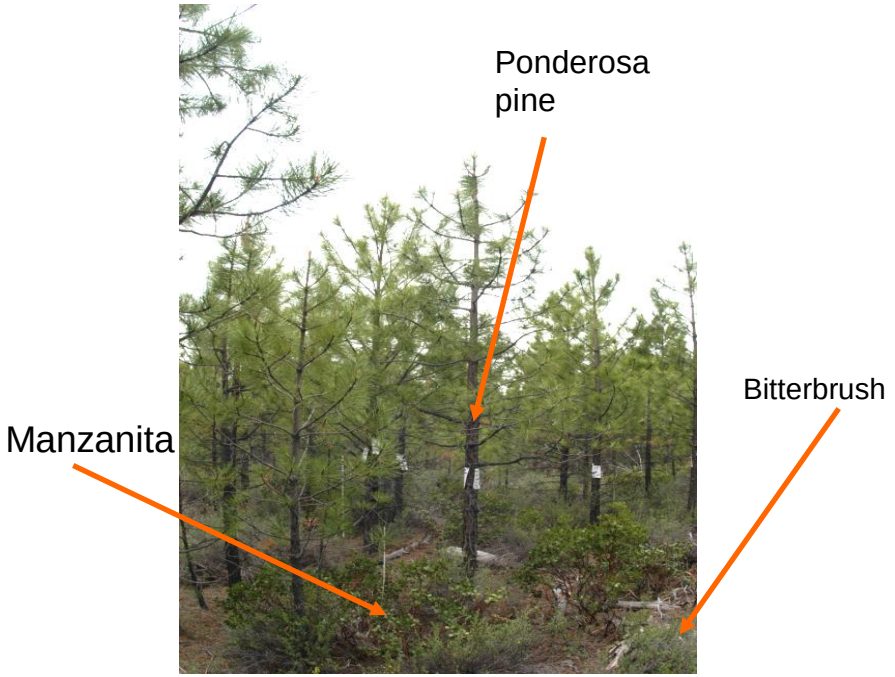
Oregon Metolius: flux towers

- **Site1 ("Young" site):**
  - 3 years met data
  - 3 years eddy covariance data (NEP)
  - Many field observations
    (sap flow, litter fall, soil respiration etc.)
- **Site2 ("Intermediate" site)**:
  - 1 years met data
  - 1 years eddy covariance data (NEP)
- **MODIS data at both.**



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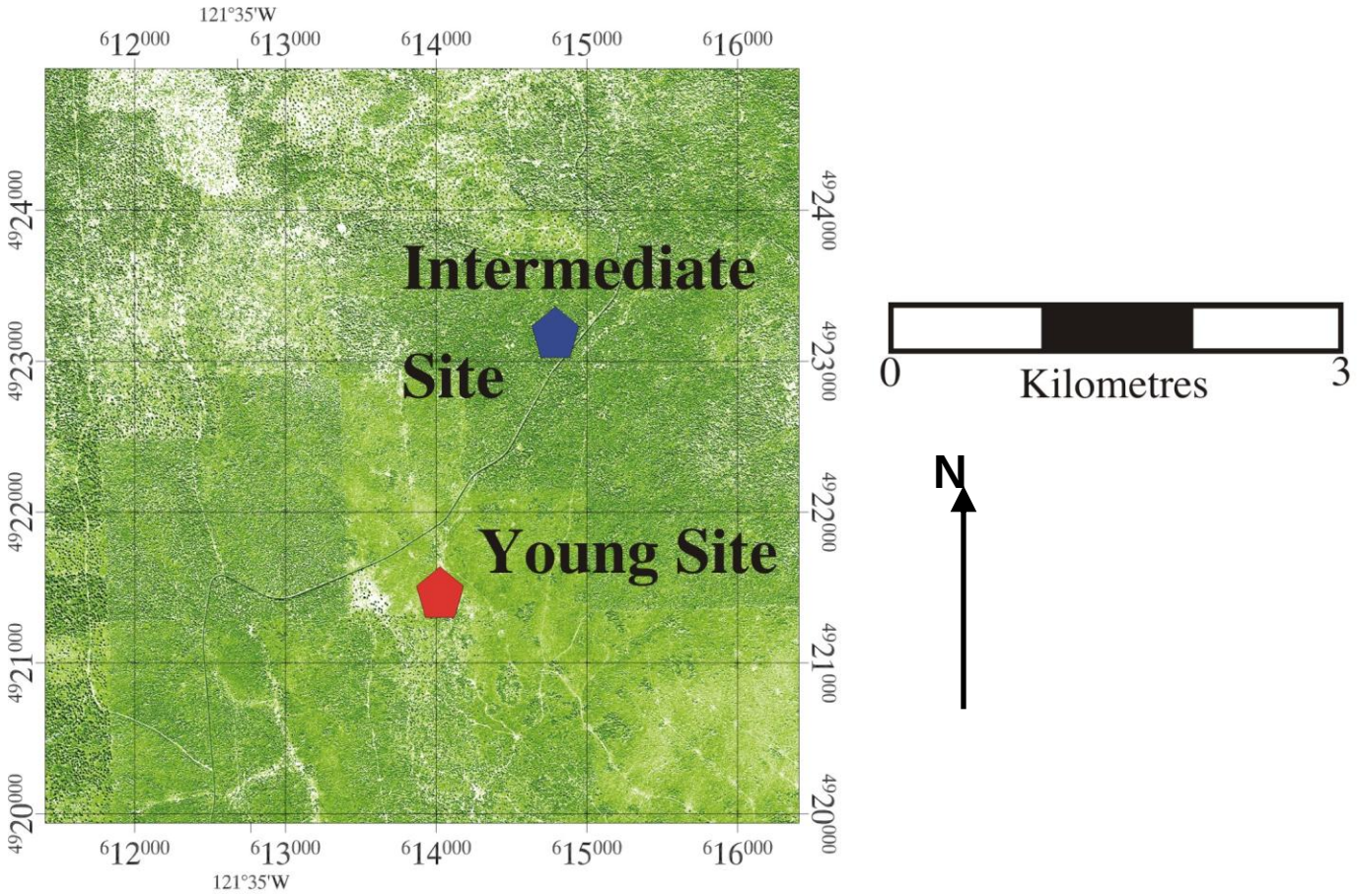
Data



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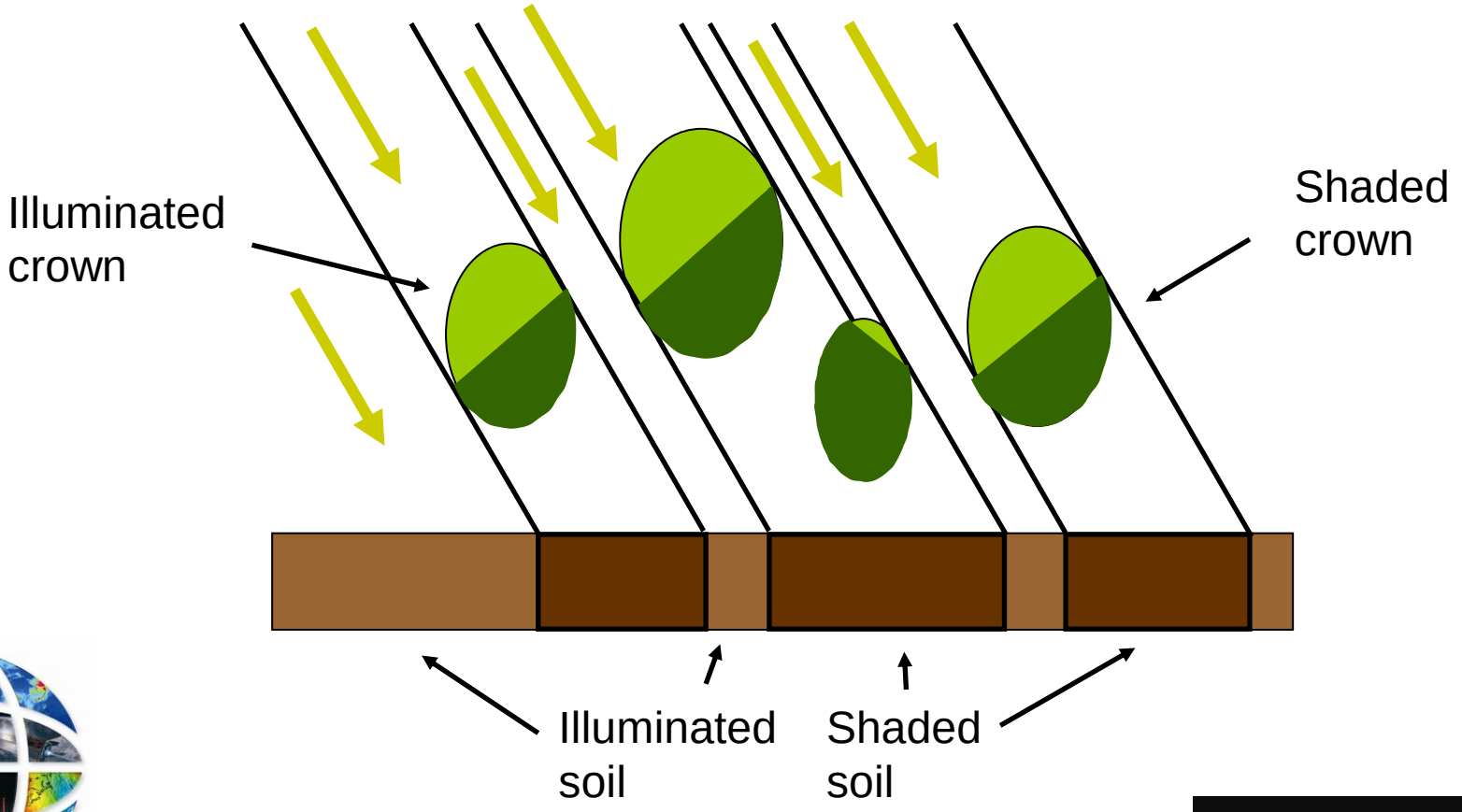
Observation operator - GORT



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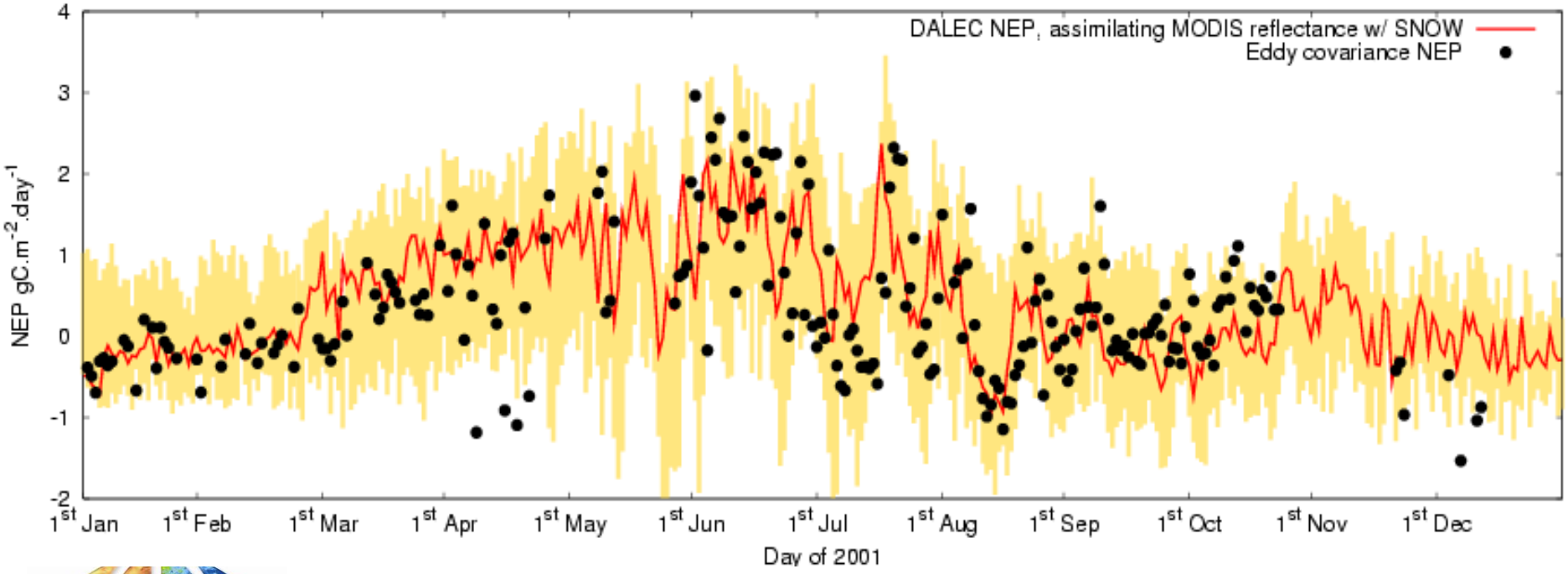
Flux tower site 1: Oregon ('Young')



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Integrated flux predictions

Flux ($gC.m^{-2}$)	Assimilated data	Total	Standard Deviation
NEP	Assimilation exc. snow	373.0	151.3
	Assimilation inc. snow	404.8	129.6
	Williams et al. (2005)	406.0	27.8
GPP	Assimilation exc. snow	2620.3	96.8
	Assimilation inc. snow	2525.6	42.7
	Williams et al. (2005)	2170.3	18.1

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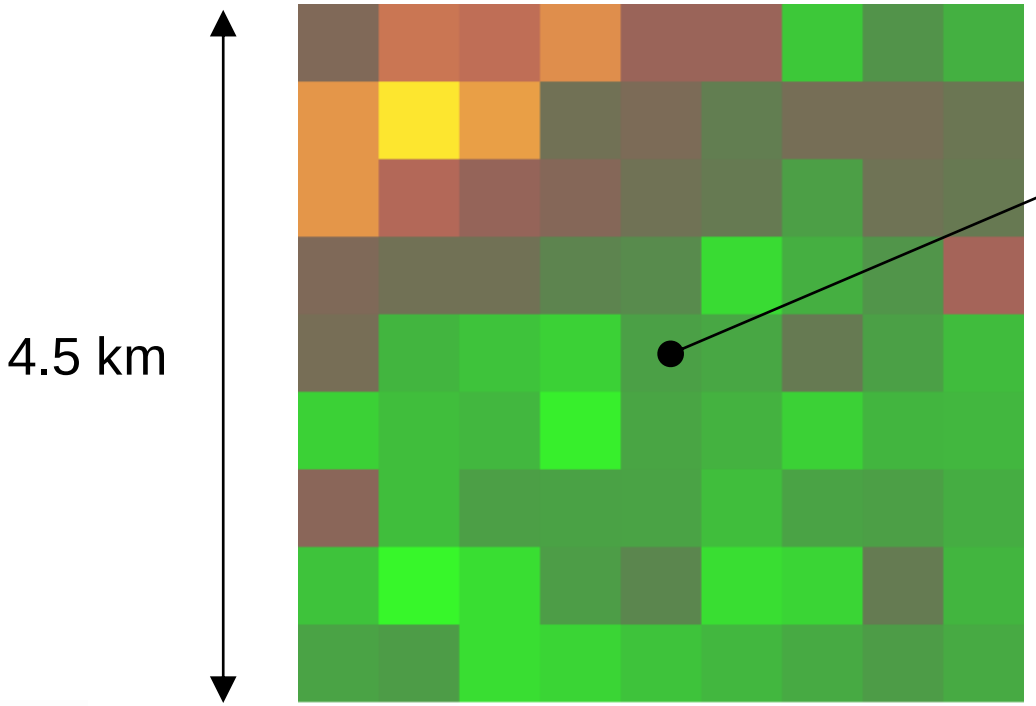
Mean NEP for 2000-2002



Spatial average = 50.9

Std. dev. = 9.7

(gC/m^2/year)

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But how well does this really translate?

- Model parameterisation at site 1
- Then re-calibrate (2 parameteres)
  - from EO only

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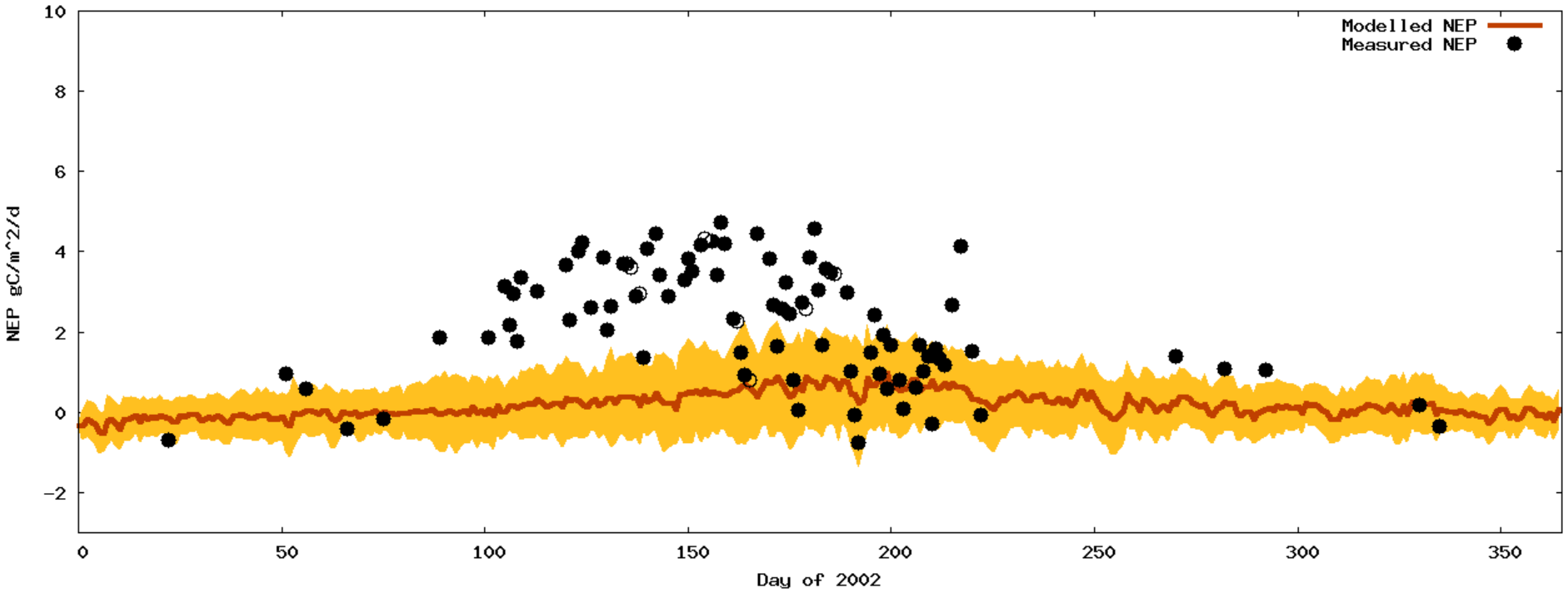
NEP – Site1 (young) parameters, no DA



Model running at Site 2,
Site 1 parameters,
NEP observations from Site 2

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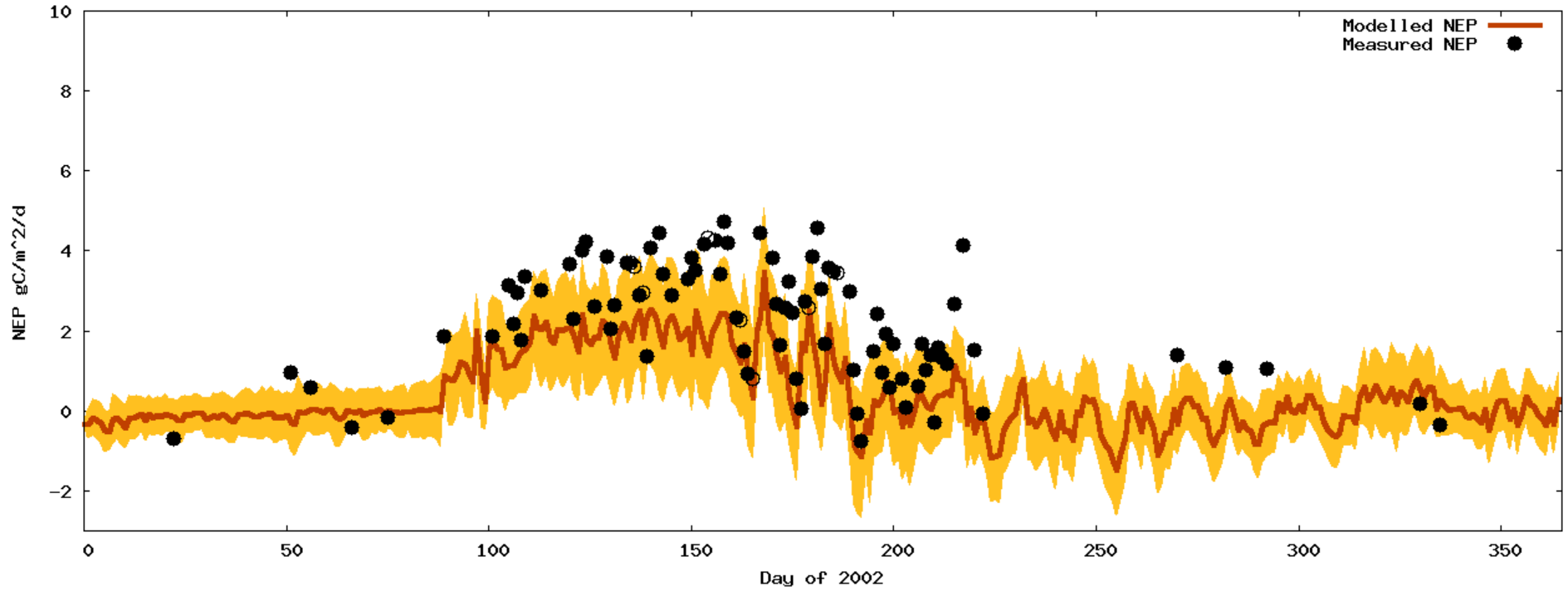
NEP – Site1 (young) parameters, with DA



Model running at Site 2,
Site 1 parameters,
NEP observations from Site 2

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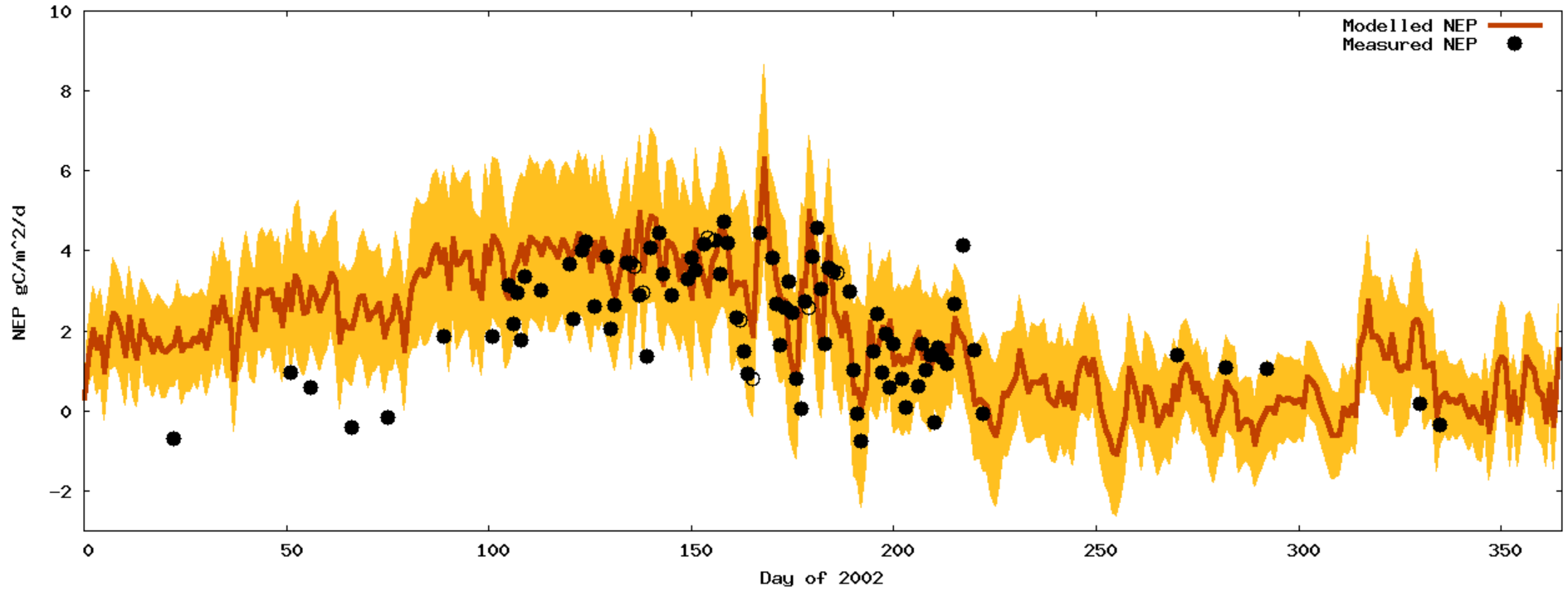
NEP – Site2 (intermediate) parameters, no DA



Model running at Site 2,
Site 2 parameters,
NEP observations from Site 2

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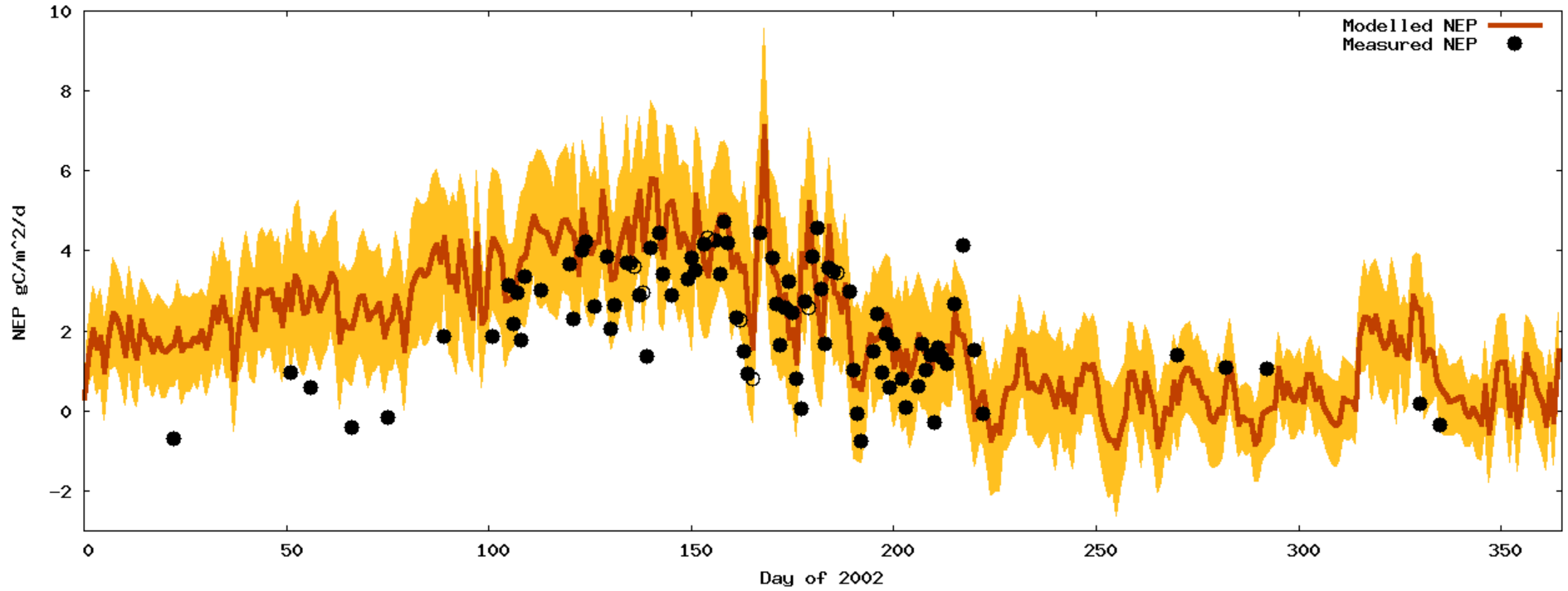
NEP – Site2 (intermediate) parameters, with DA



Model running at Site 2,
Site 2 parameters,
NEP observations from Site 2

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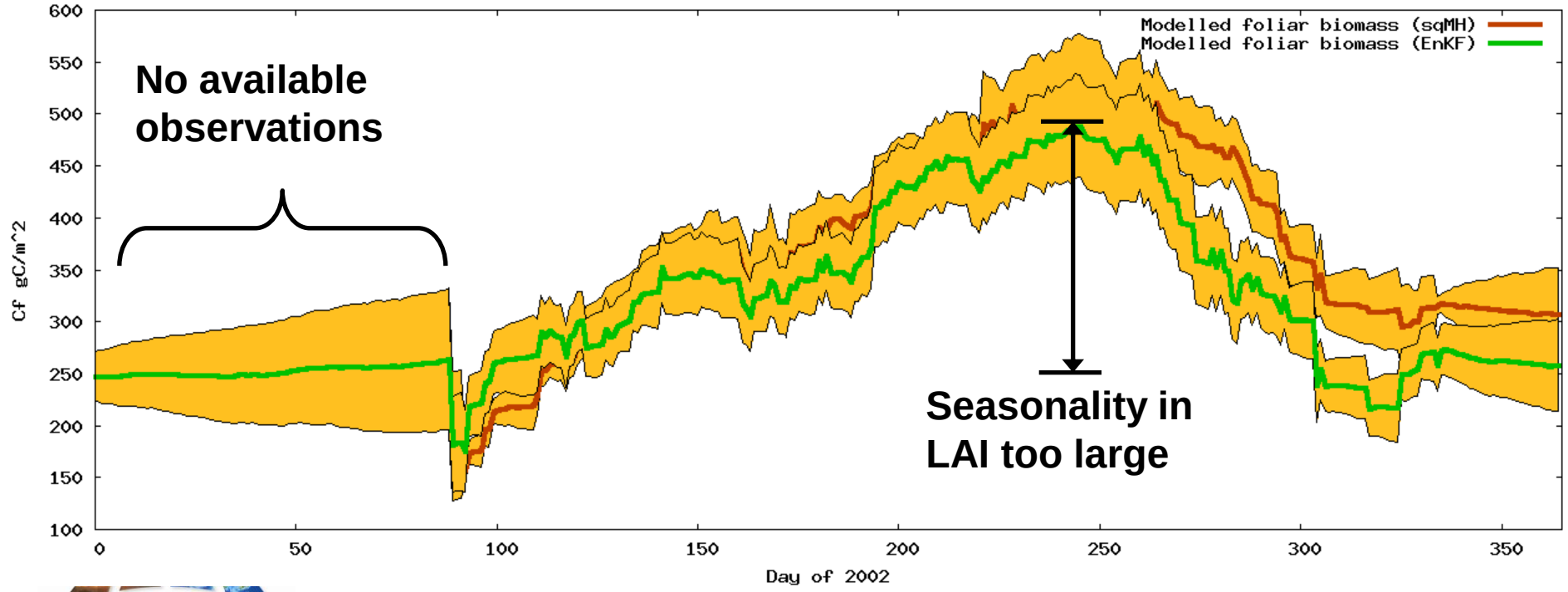
LAI – comparison of EnKF & seqMH



Makes little difference in practice!

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Conclusions & Issues #1

- Demonstrated reflectance DA into C model
  - Red/NIR BRF
  - Improved flux estimates
    - Partly through GPP/R compensation
    - Red/NIR BRF only impacts part of model
      - Not much constrain e.g. on soil respiration
  - Need to solve for ‘ancillary’ parameters
    - Chlorophyll, soil/snow reflectance etc.
    - Would be better to have model expectation of these

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Conclusions & Issues #2

- Model recalibration against MODIS reflectance data seems to account for a large component of NEP variation.
- Viable approach for extrapolating outwards from a flux tower.
- Shouldn't rely on (sequential) data assimilation techniques to compensate for inadequate model parameterisation.

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