Evaluation of the improved Joint Uk Land Environment Simulator (JULES) against flux data from 20 stations

OUTLINE

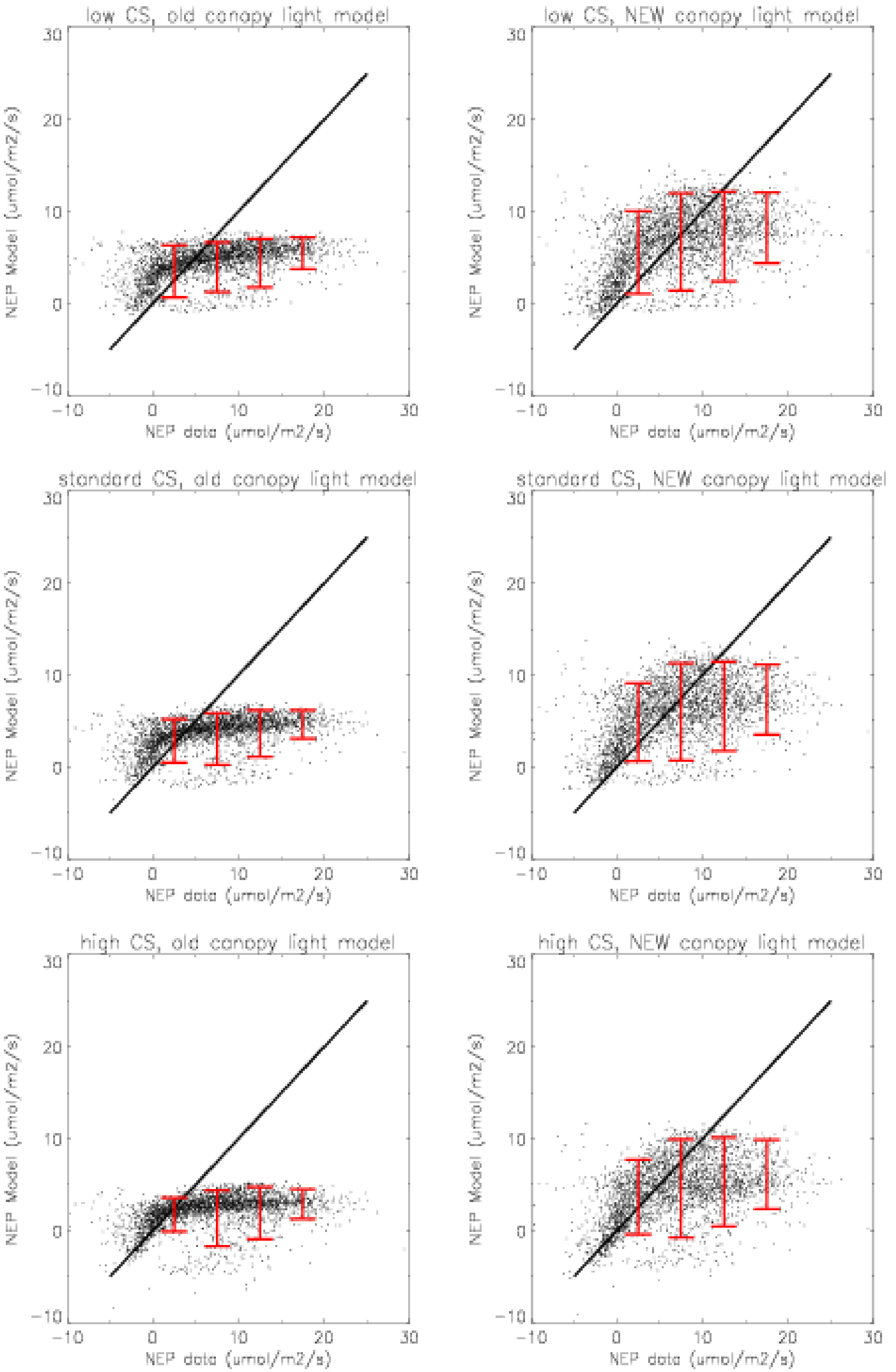
- Introduction
  - -Background (JULES)
- Model Improvements
  - - the “Light-Mod”
  - - Evaluation “Light-Mod” against diurnal Loobos Flux data
- Evaluation of Improved Model against flux data from 20 stations on the Seasonal timescale
  - -Experimental protocol
  - -Methods for model evaluation
- Results
- Conclusions

Background: JULES

Martin please add.

Optimisation of MOSES for Loobos

Systematic bias – original MOSES cannot reproduce High NEP values in middle of day.



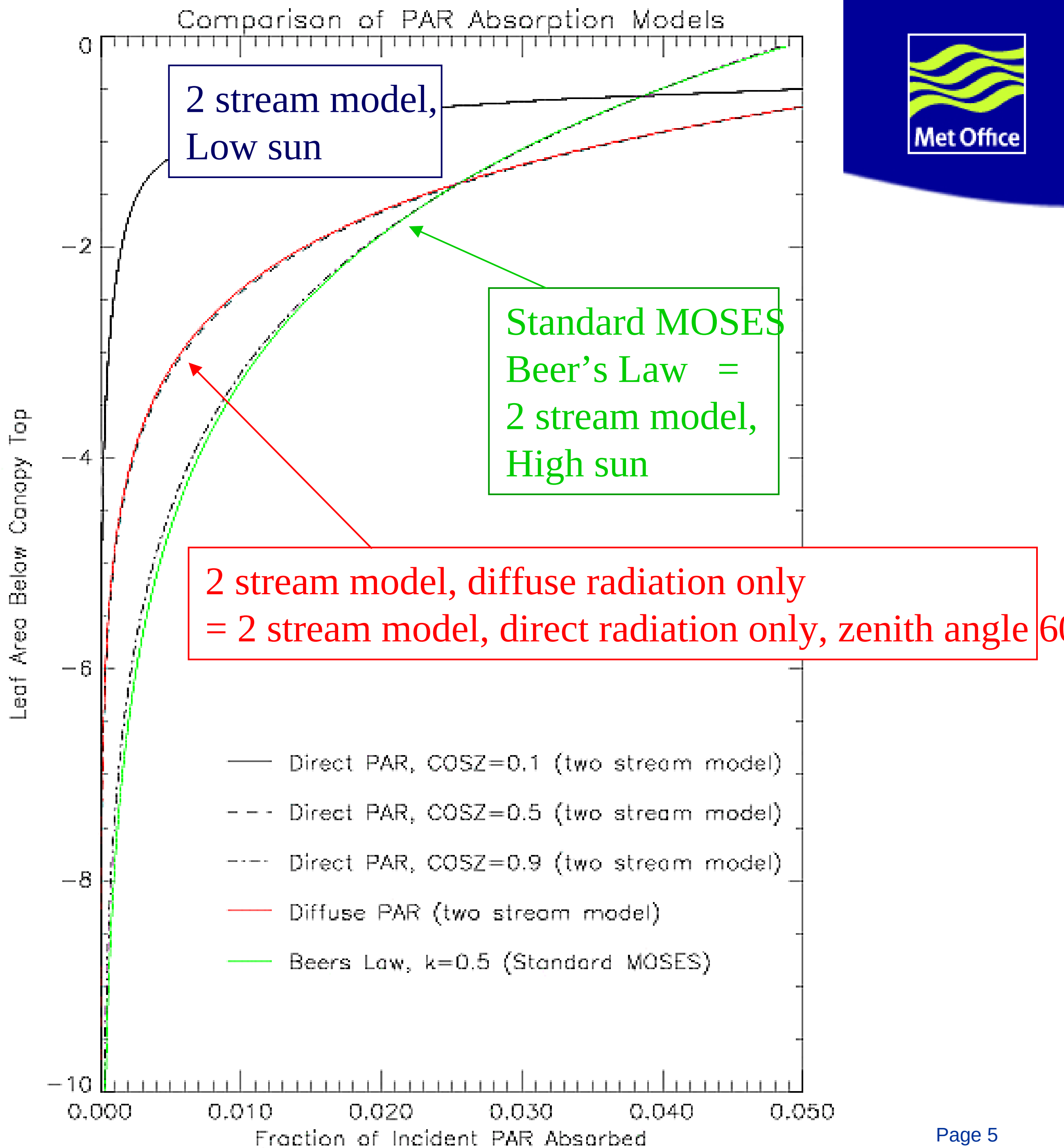
Centre for Ecology & Hydrology

NATURAL ENVIRONMENT RESEARCH COUNCIL

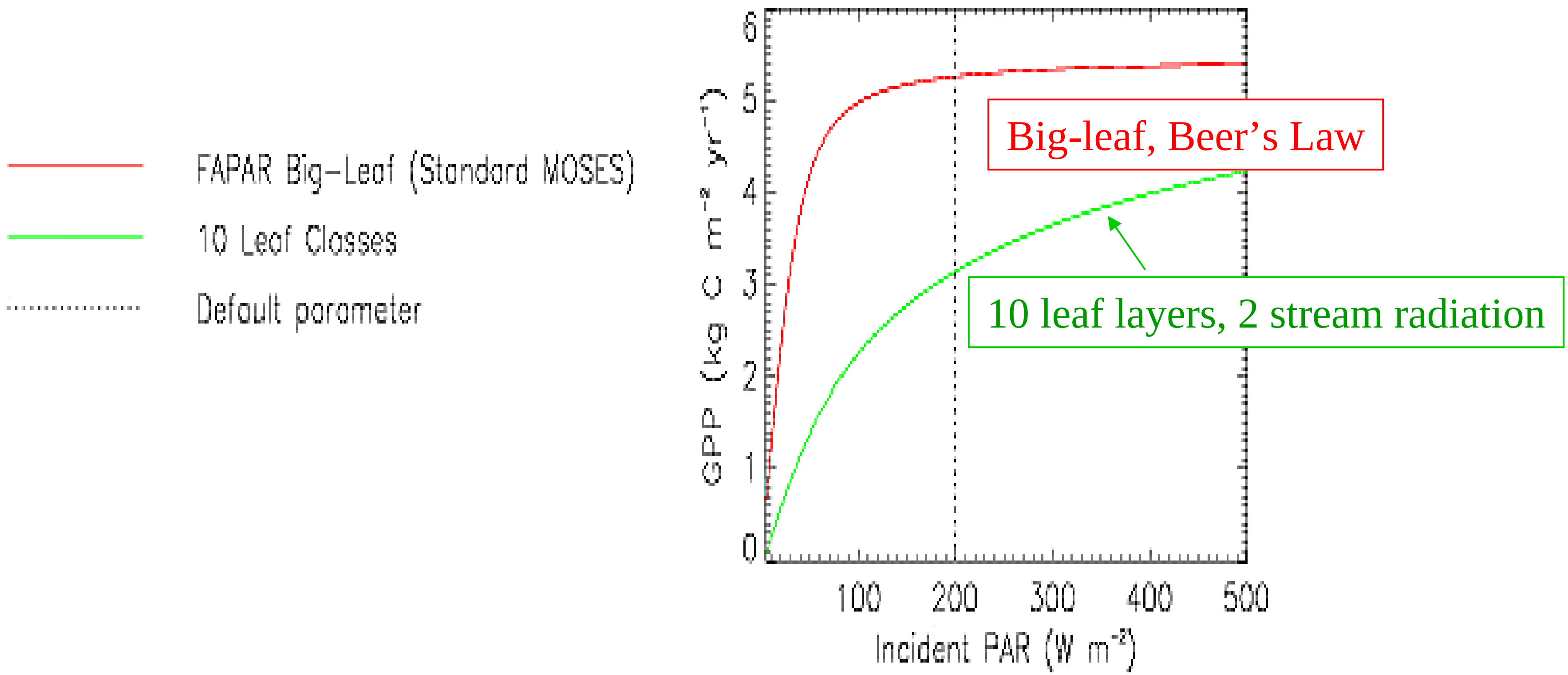
Models of Light Absorbed in the Plant Canopy

- Original MOSES canopy model only appropriate at high sun angles

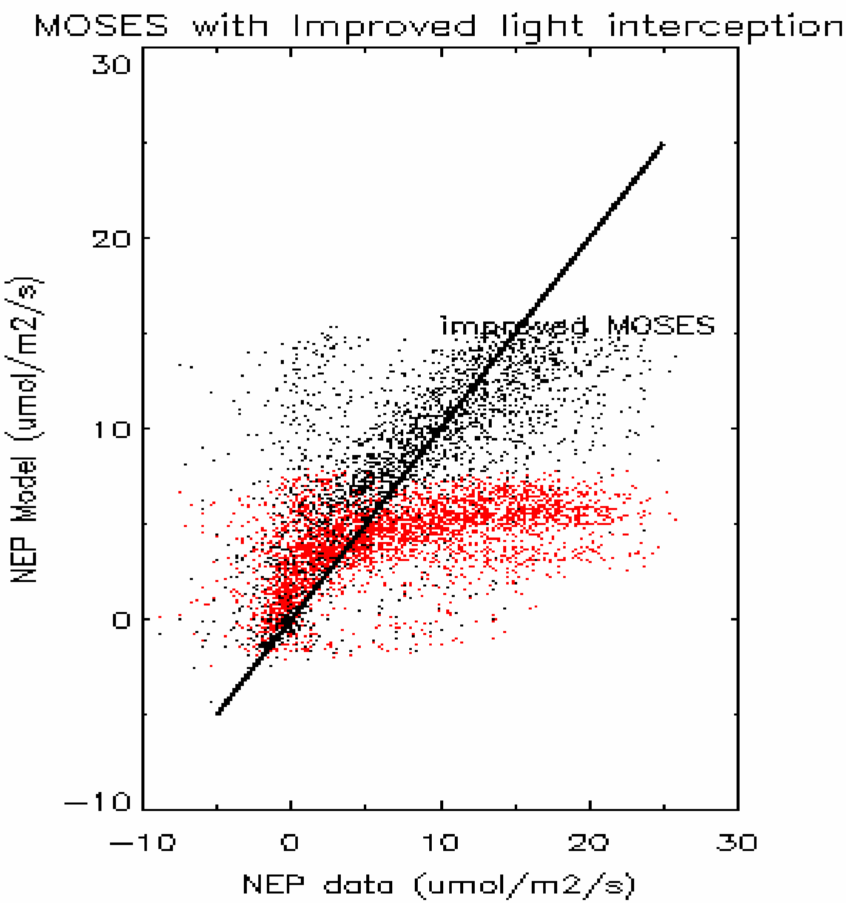
- More diffuse radiation only beneficial if COSZ < 0.5 (i.e. Zenith angle < 60°)

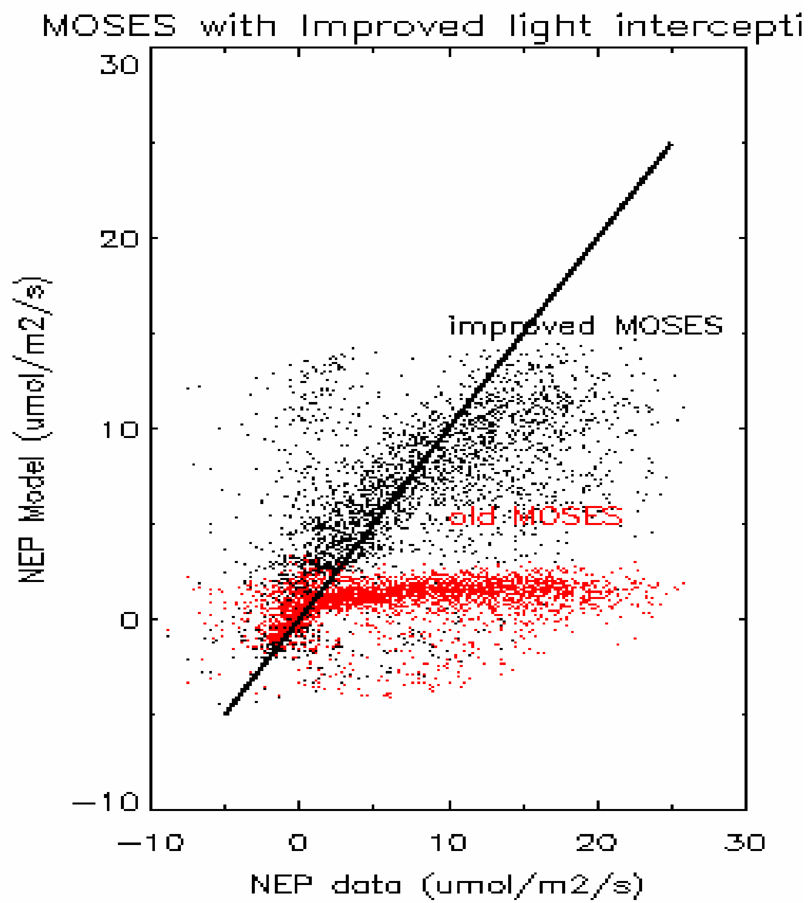


Explicit integration of leaf-level responses produces a more gradual light response



MOSES – Light interception process





OUTLINE

- Introduction
  - -Background (JULES)
- Model Improvements
  - - the "Light-Mod"
  - - Evaluation "Light-Mod" against diurnal Loobos Flux data
- Evaluation of Improved Model against flux data from 20 stations on the Seasonal timescale
  - -Experimental protocol
  - -Methods for model evaluation
- Results
- Conclusions

Model Protocol

- JULES is forced using site meteorology for the duration of the measurement record, with dynamic vegetation switched off.

- Site information is adopted in JULES where possible, e.g. fractional coverages of dominant and sub-dominant plant species, LAI, canopy height, and when available, soil organic matter content (Otherwise Ancillary File).

- Half-hourly output of the following five variables aggregated to monthly: sensible heat flux, FTL, latent heat flux, LH, Gross Primary Production, GPP, total ecosystem respiration, RESP and Net Ecosystem Exchange, NEP [NEP=RESP-GPP]

Methods: Model Evaluation

- The correlation coefficient (r) measures the degree observed (O) and simulated values (S) are linearly related and how well the shapes of simulated and measured data match (Morales et al., 2005).

$$r = \frac{\sum_{i=1}^{n} (O_i - \overline{O})(S_i - \overline{S})}{\left(\sum (O_i - \overline{O})^{1/2}\right)\left(\sum (S_i - \overline{S})^{1/2}\right)}$$

- To estimate the average error of the simulations the root mean square error (RMSE) is calculated,

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} (S_i - O_i)^2}{n}}$$

- To enable comparison of model performance among sites the RMSE values are normalised for each site, i.e.

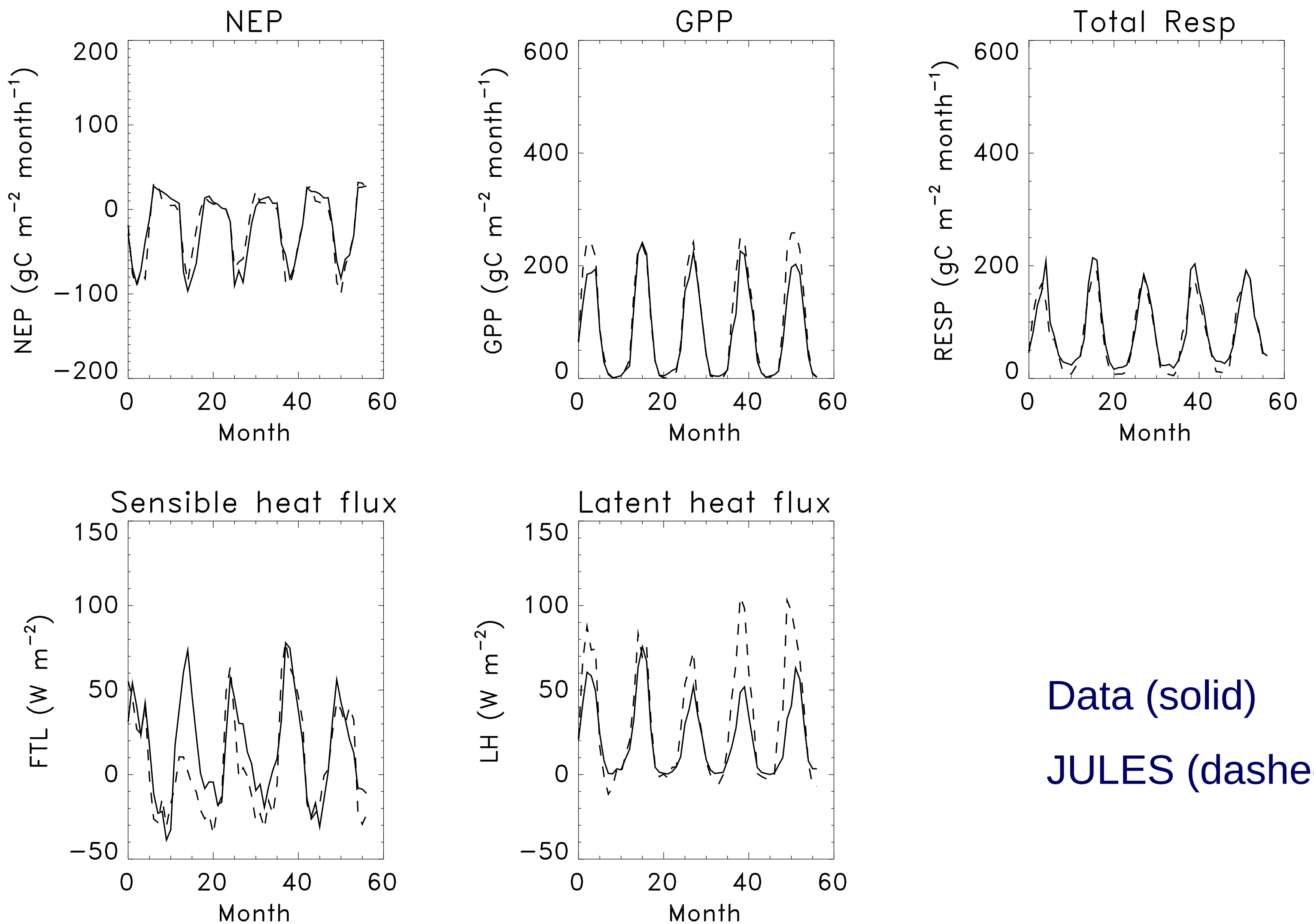
-

$$normRMSE = \frac{100}{\overline{(\mathrm{mod}\, O)}} \sqrt{\frac{\sum_{i=1}^{n} (S_i - O_i)^2}{n}}$$

Results: Northern Forest Ecosystems

Biome	Site name	Country	Latitude	Dominant Species	Age	Years Measurement	Correlation Coefficient (r)	RMSE (gC m^{-2} $month^{-1}$)	Normalised RMSE
Arctic Tundra									
	Upad	USA	**70.3**	Eriophorum angustifolium,		1	**0.93**	39.9	**532.3**
Boreal evergreen forests									
	Flakaliden	SWE	**64.1**	Pinus sylvestris Picea abies	34	3	**0.79**	31.1	**84.0**
	Hyytiala	FIN	**61.9**	Pinus sylvestris	41	5	**0.93**	14.3	**40.7**
Boreal deciduous forest									
	Gunnarsholt	ICE	**63.8**	Populus trichocarpa	9	3	**0.24**	87.1	**235.8**
Temp Conifer forest									
	Aberfeldy	UK	**56.6**	Picea sitchensis	23	2	**0.95**	38.4	**65.6**
	Brasschaat	BEL	**51.3**	Pinus sylvestris Quercus robur	74	3	**0.74**	31.8	**84.2**
	Tharandt	GER	**51**	Picea abies	116	5	**0.84**	61.1	**100.7**
	Loobos	NEL	**52.2**	Pinus sylvestris	96	5	**0.82**	47.0	**117.6**
	Weidenbrunnen		**50.2**	Picea abies	46	4	**0.87**	38.3	**126.4**
	Metolius	USA	**44.5**	Ponderosa pine		2	**0.01**	28.8	**85.2**

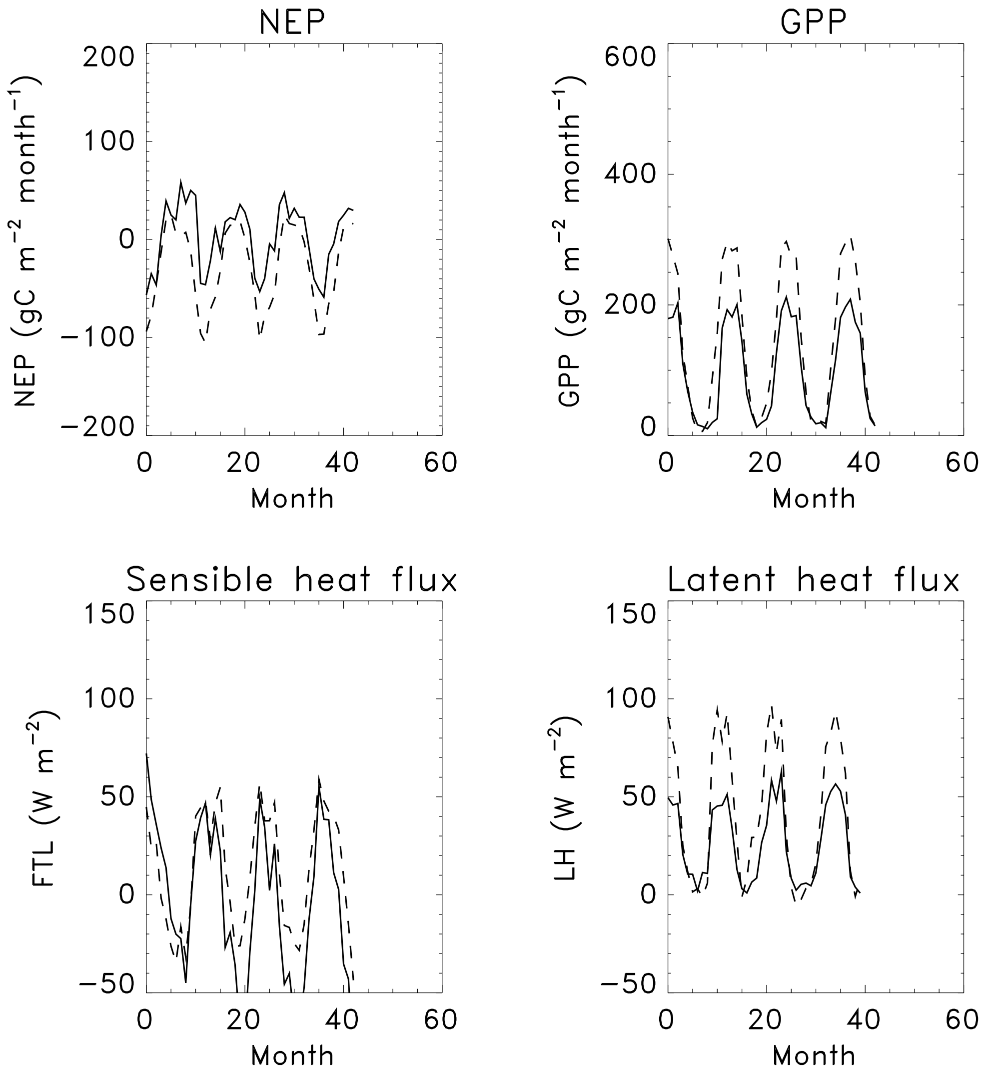
Results: Boreal Evergreen Forest (Hyytiala, FIN)



Data (solid)

JULES (dashed)

Results: Temperate Conifer Forest (Weidenbrunnen, GER)



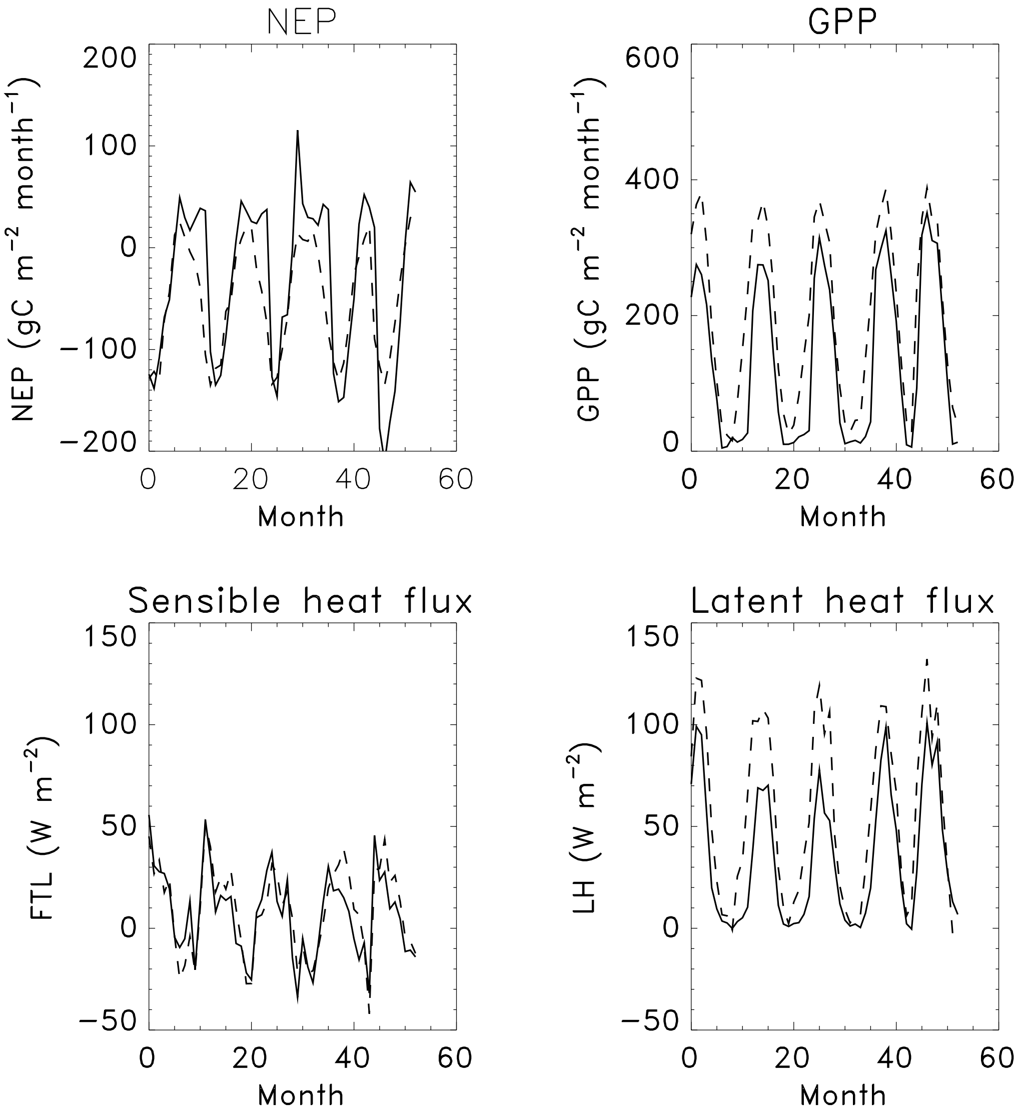
Data (solid)

JULES (dashed)

Results: Temp/Med/Grass Ecosystems

Biome	Site name	Country	Latitude	Dominant Species	Age	Years Measurement	Correlation Coefficient (r)	RMSE	Normalised RMSE
Temp deciduous forests									
	Soroe	DEN	**55.5**	Fagus sylvatica	78	3	**0.84**	35.0	**66.6**
	Vielsalm	BEL	**50.3**	Fagus sylvatica Pseudotsuga	90	3	**0.77**	58.8	**109.7**
	Hesse	FRA	**48.7**	Fagus sylvatica	37	5	**0.83**	49.6	**70.6**
	Harvard	USA	**42.5**	Quercus rubra, Acer rubrum,	90	8	**0.37**	75.9	**115.3**
	Walker Branch	USA	**36**	Quercus alba, Quercus prinus,	58	4	**0.04**	110.3	**139.1**
Maritime/Med Evergreen forests, Chaparral									
	Bordeaux	FRA	**44.1**	Pinus pinaster	33	2	**0.84**	46.3	**73.5**
	Castelporziano	ITA	**41.8**	Quercus ilex	33	2	**0.5**	68.0	**129.0**
	Sky Oak Old	USA	**33.4**	Adenostoma fasciculatum,	78	4	**0.32**	29.6	**137.0**
Grassland/Prairie Cropland									
	Bondville	USA	**40**	Corn (C4) 2001 Soybeans (C3) 2000	1	3	**-0.06**	133.1	**184.8**
	Little Washita	USA	**35**	Schizachyrium scoparium (C3)		2	**0.46**	87.3	**237.0**

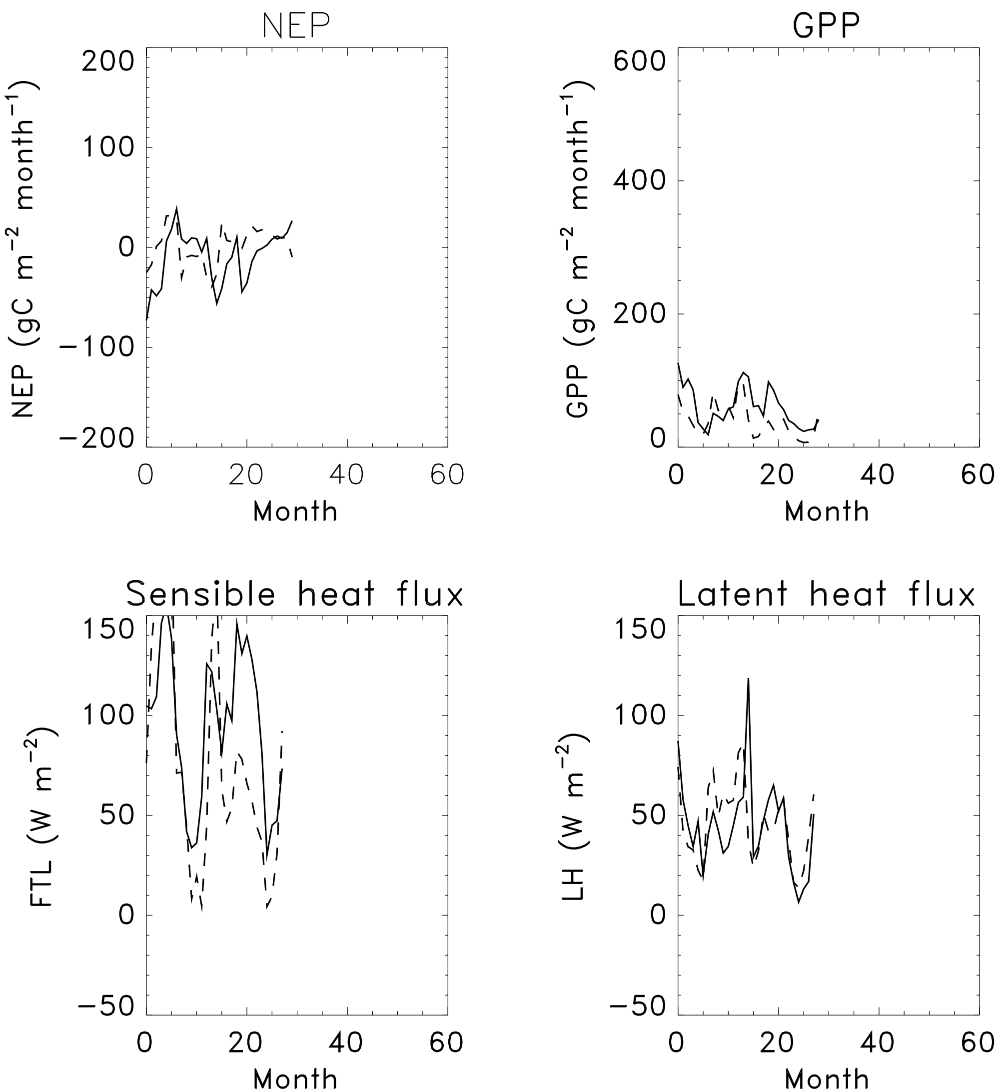
Results: Temperate Deciduous Forest (Hesse, FRA)



Data (solid)

JULES (dashed)

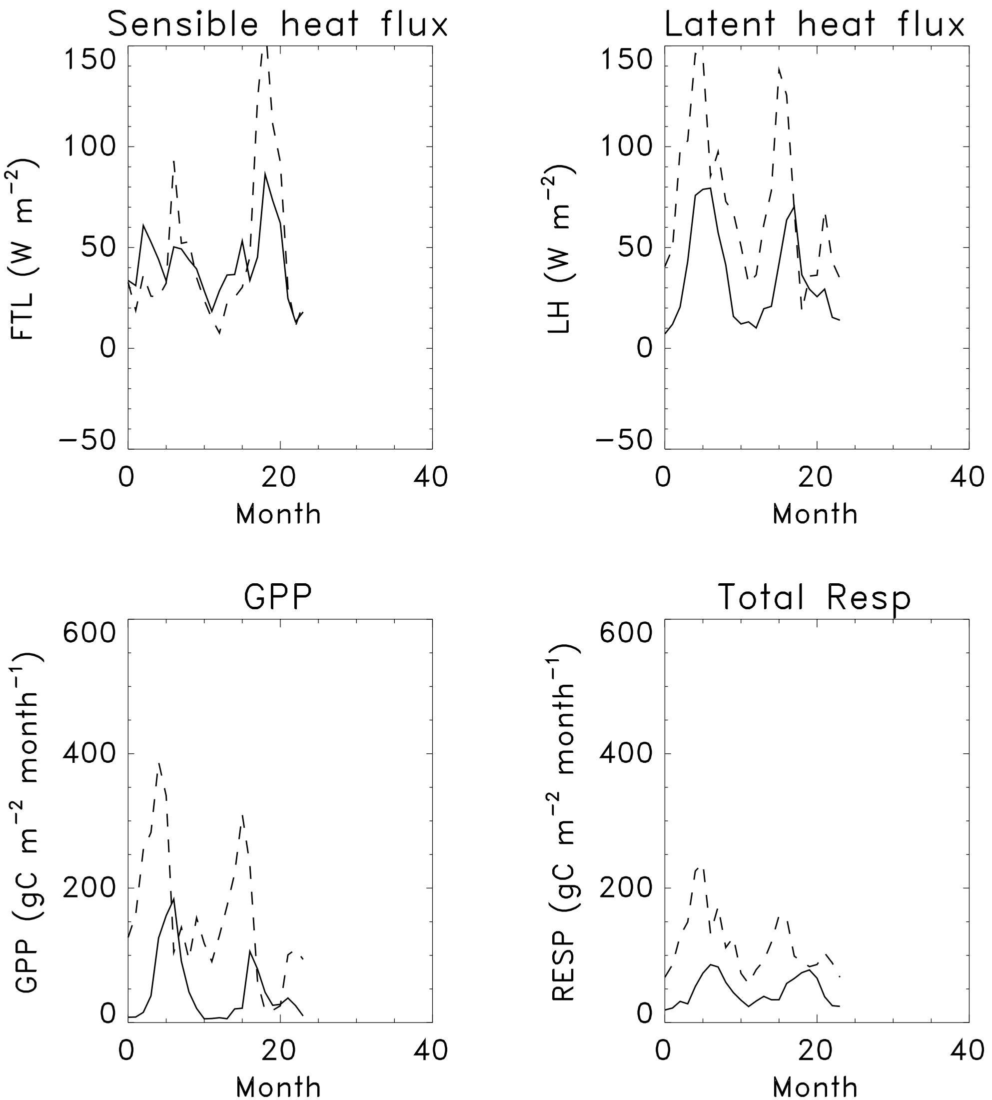
Results: Chaparral/Mediterranean Type Ecosystem (Sky Oak Old, USA)



Data (solid)

JULES (dashed)

Results: Grassland (Little Washita, USA)



Data (solid)

JULES (dashed)

Conclusions

- Inclusion of “Light-Mod” improves diurnal C exchange
- JULES is able to capture the seasonality in both sensible and latent heat exchange
- JULES is able to capture seasonality in NEP in forested ecosystems
- Model-data NEP fit improves with increasing latitud
- Results are worse at sites representing water limited ecosystems