ITC

Multi-site Validation of Daily SCOPE-Model-Simulated Carbon and Energy Fluxes

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Questions: Using SCOPE not for solar-induceed chlorophyll fluorescence (SIF)

SCOPE - Soil Canopy Observation of Photosynthesis and Energy fluxes model (Van der Tol et al., 2009, Yang et al., 2021)

- **how well** does the SCOPE model **simulate** ecosystem fluxes?
  [spoiler: extremely well]
- which plant functional type **(PFT) specific values** lead to more **accurate** flux simulations?
  [spoiler: default]
- which group of **input parameters** is the most **important**: meteorological, structural or biochemical?
  [spoiler: meteorological]

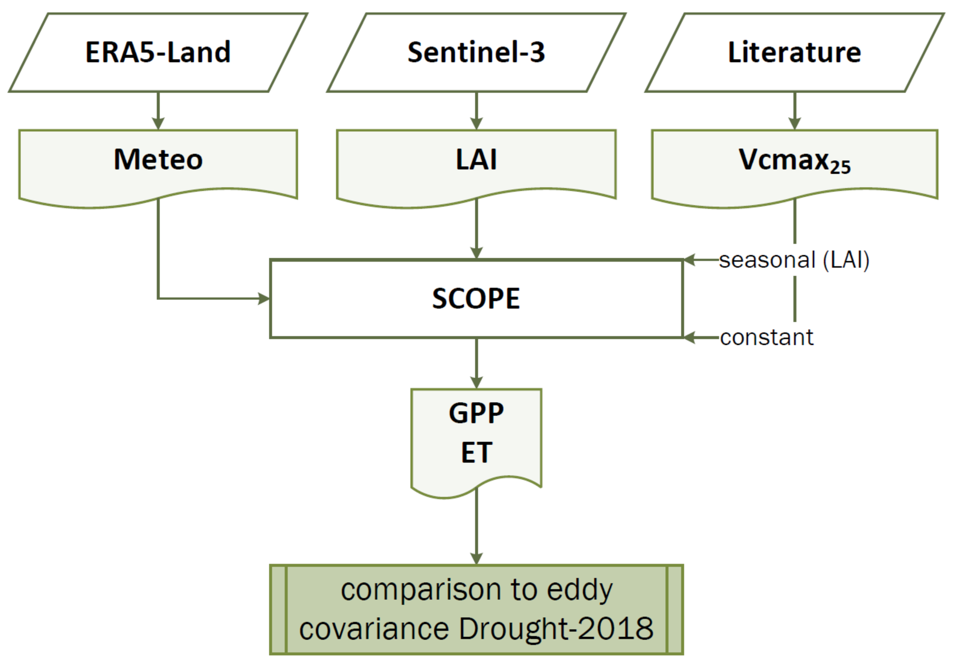

Figure 1: Workflow

Table 1: Default and literature (Groenendijk et al., 2011) values of ***$Vcmax_{25}$*** and ***BallBerrySlope***.

PFT	$Vcmax_{25}$ μmol CO_2 m^{-2} s^{-1} default	$Vcmax_{25}$ Groenendijk mean	BallBerrySlope default	BallBerrySlope Groenendijk mean
CRO	60	48.6	8	7.6
GRA	60	43.3	8	12.7
SAV	60	18.0	8	13.8
ENF	60	27.7	8	11.6
MF	60	36.4	8	8.3
DBF	60	30.9	8	7.6

Results: Seasonal cycle and Interannual variability captured well

Gross primary productivity (GPP):

- daily root-mean-square error (RMSEs) 2.5 μmol CO_2 m^{-2} s^{-1} (R^2 0.72) (Figure 2, top)
- annual RMSE 285 g C m^{-2} $year^{-1}$ (R^2 0.67) (Figure 3, top)

Latent heat flux (LE) and Evapotranspiration (ET):

- daily RMSE for LE 39 W m^{-2} (R^2 0.40) (Figure 2, bottom)
- annual RMSE 106 mm $year^{-1}$ (R^2 0.53) (Figure 3, bottom)

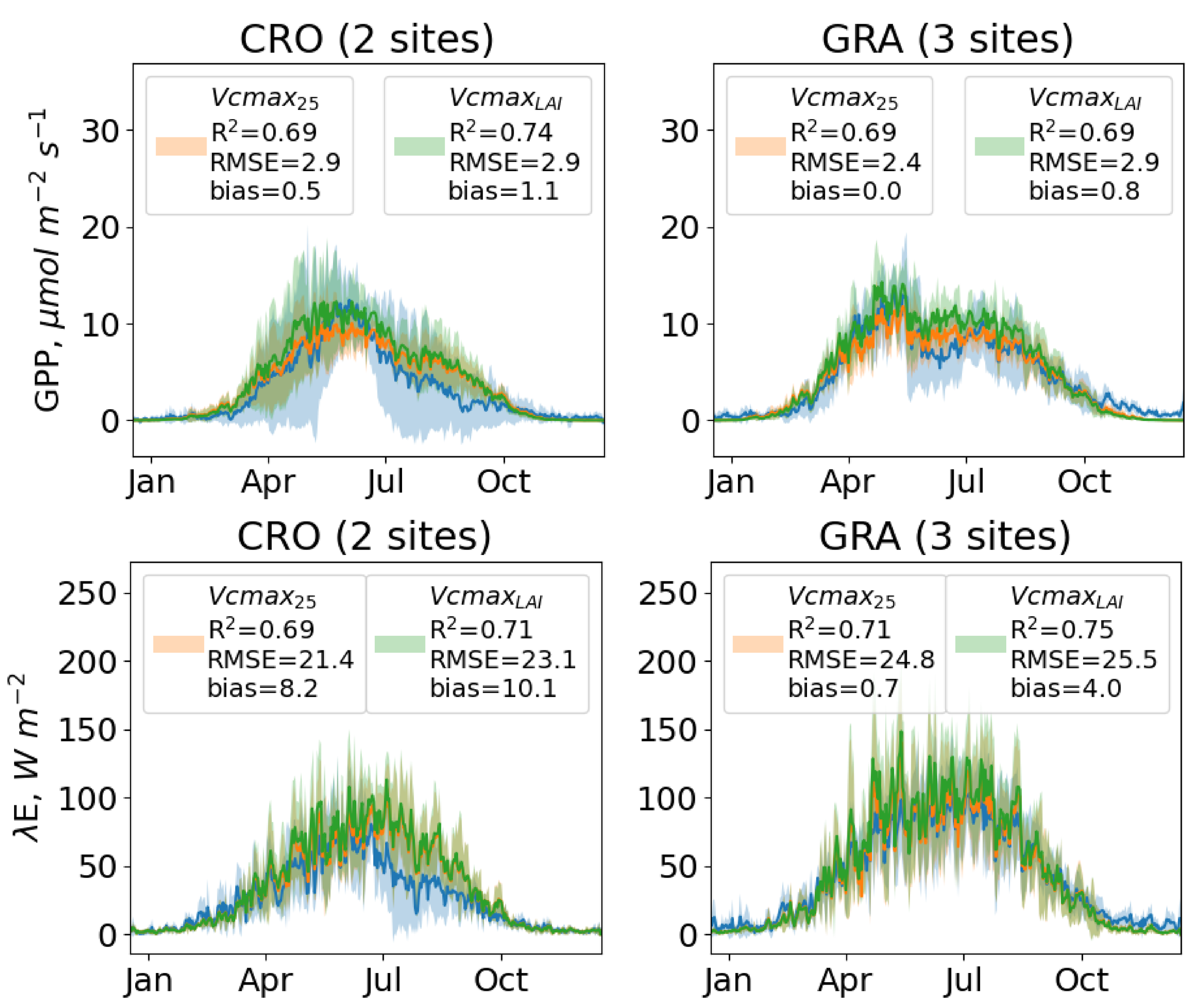

Figure 2: Daily time series performance. Blue - measured, eddy covariance data. Mean annual cycle with standard deviation shading.

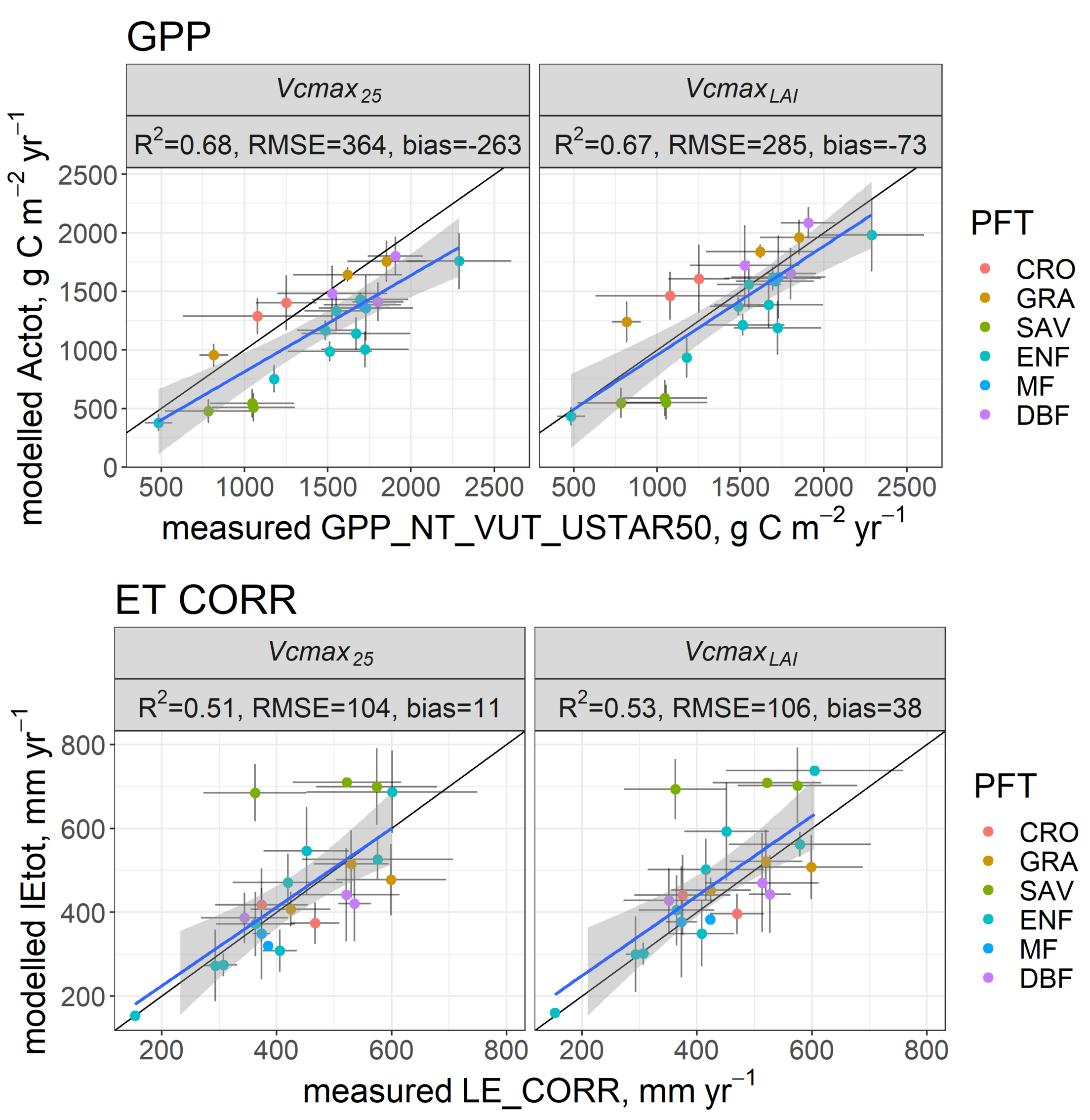

Figure 3: Interannual and across-site performance

Puzzle: PFT-specific data and seasonality worsen the simulations

Models allow playing with parameters (meteorology, LAI, biochemistry, seasonality) to identify their importance (Figure 4).

meteo	LAI	$Vcmax_{25}$	seasonality	RMSE	R^2
		default		**420**	0.5
+		default		290	0.5
	+	default		340	0.5
+	+	default		286	0.67
+	+	default	+	**420**	0.67
+	+	literature		**360**	0.65

RMSEs of GPP for naive [all average] and complete cases are equally bad.

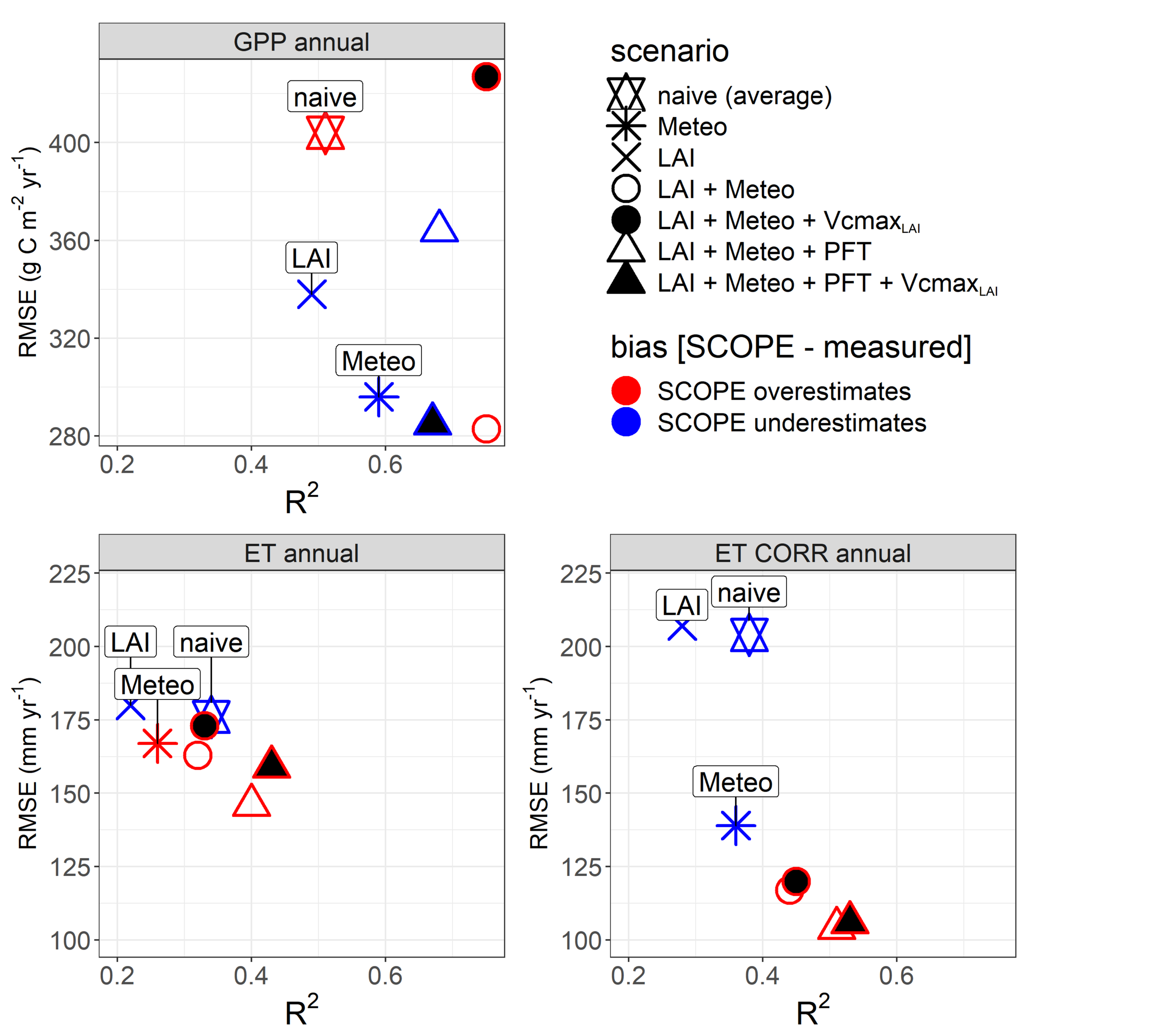

Figure 4: Scenarios performance

Take-home messages

- SCOPE model works extremely well for GPP simulations
- SCOPE model works well for ET simulations in temperate (energy-limited) climates
- PFT-specific $Vcmax_{25}$ with LAI-imposed seasonality reduced bias in annual GPP
- literature $Vcmax_{25}$ may perform dramatically worse than the default SCOPE values
- higher complexity does not automatically mean higher accuracy

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