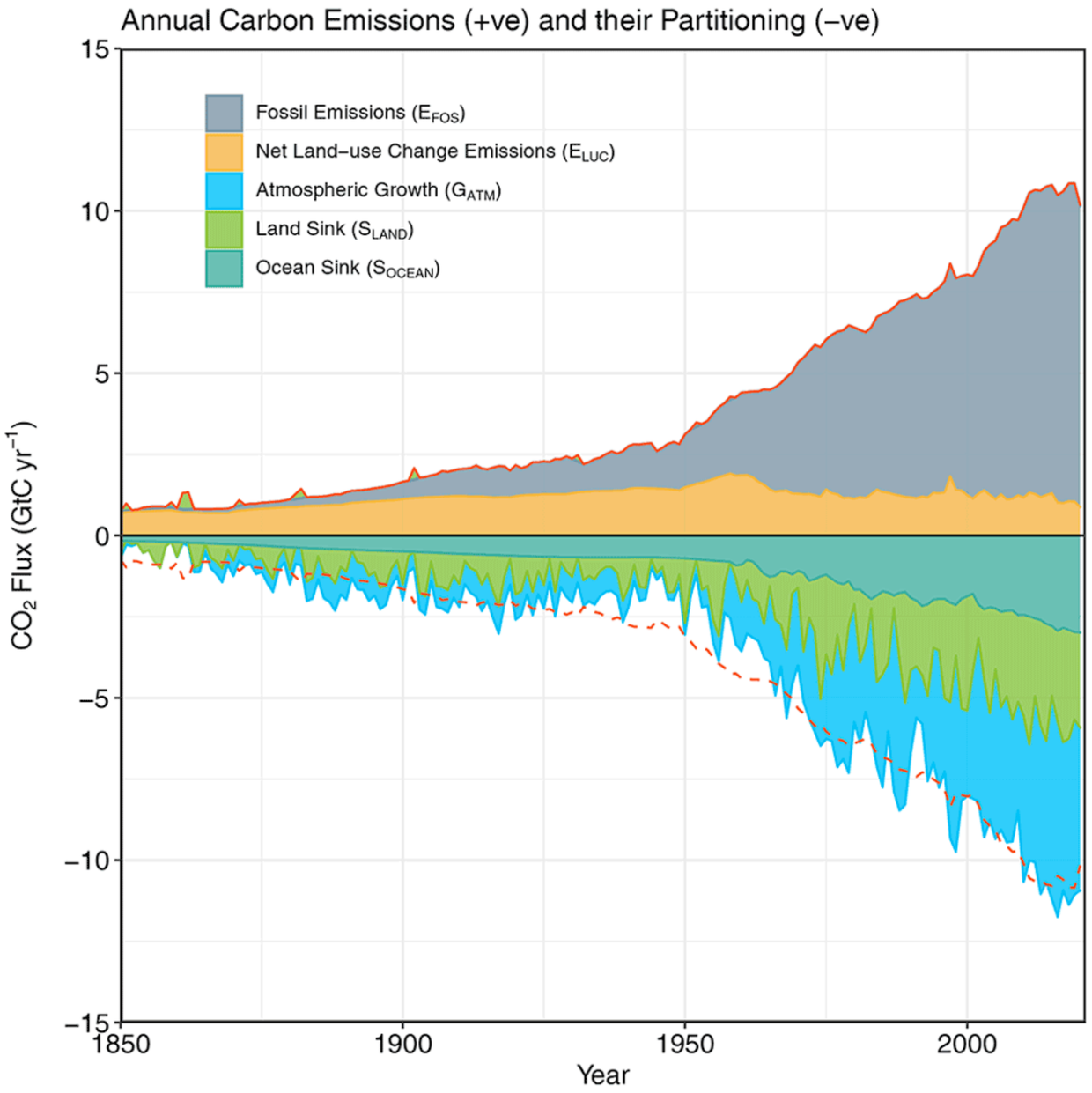
Modeling global vegetation processes and hyperspectral canopy radiative transfer using CliMA Land

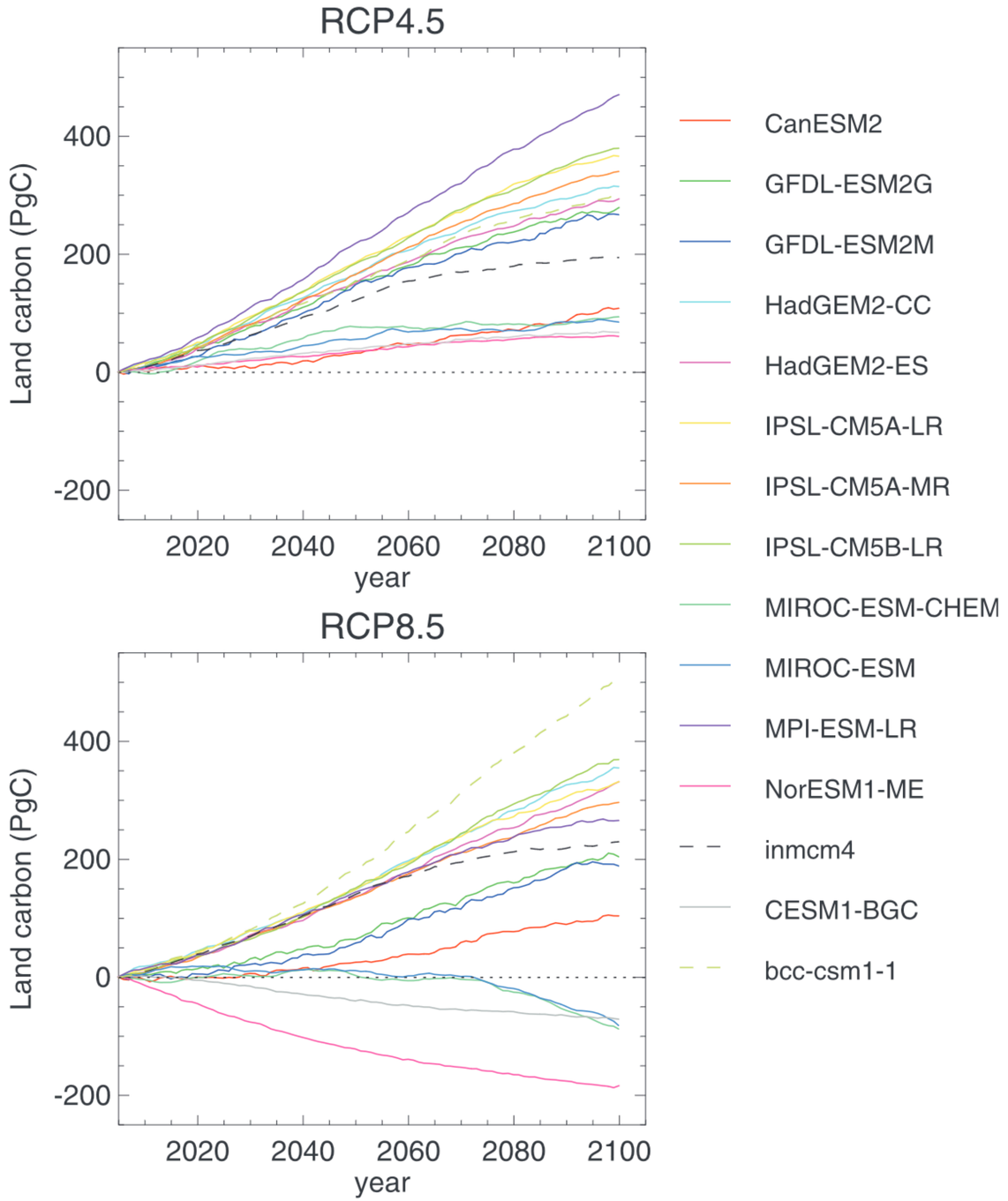
Yujie Wang, Renato Braghiere, …, Anthony Bloom, and Christian Frankenberg

Land takes up 25% of emitted CO_2, but we do not know how much nature can help in the future



Friedlingstein et al. (2022) Earth System Science Data

Climate models differ in their projections of land carbon sink strength, even in the directions

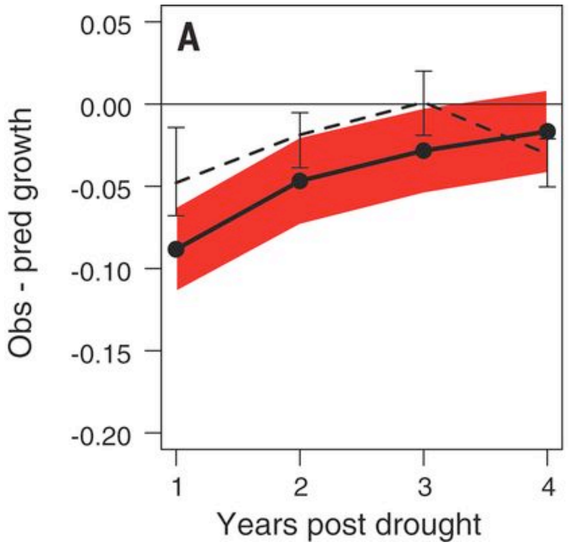


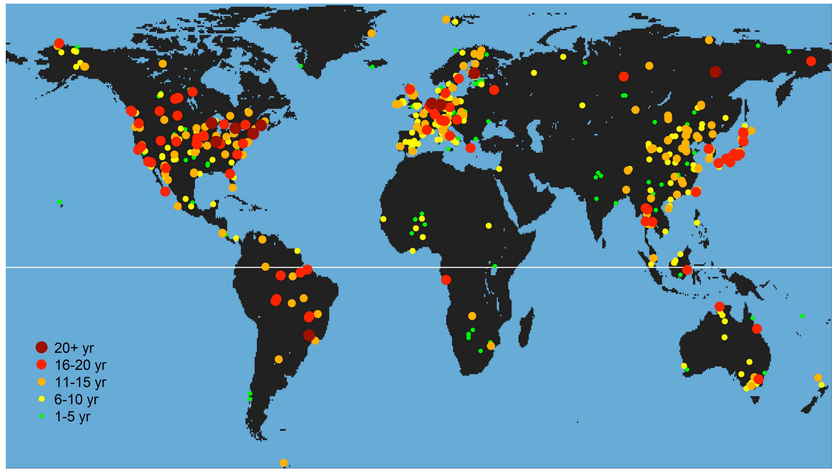
Jones et al. (2013) Journal of Climate

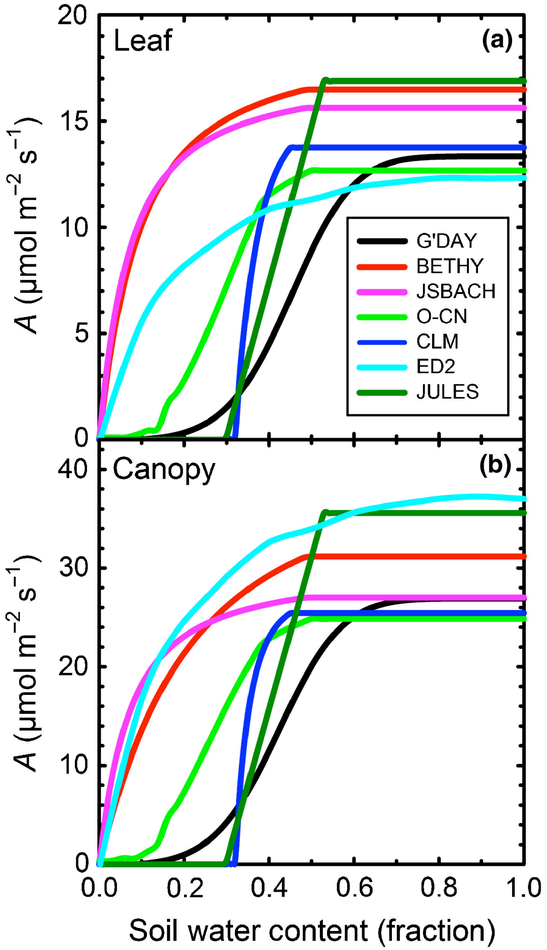
1. **Lack physiological representations**

2. **Contrasting model parameterization**

3. **Limited data to calibrate the model**







Anderegg et al. (2015) Science; Rogers et al. (2017) New Phytologist; FluxNet 2015

Challenges

1. Schemes

Improve model representation of soil-plant-air continuum

2. Setups

Advance model parameters configuration

3. Calibration

Use more data to calibrate the models

A next generation model—CliMA Land
Bridging vegetation processes with remote sensing

1. Schemes

Improve model representation of soil-plant-air continuum

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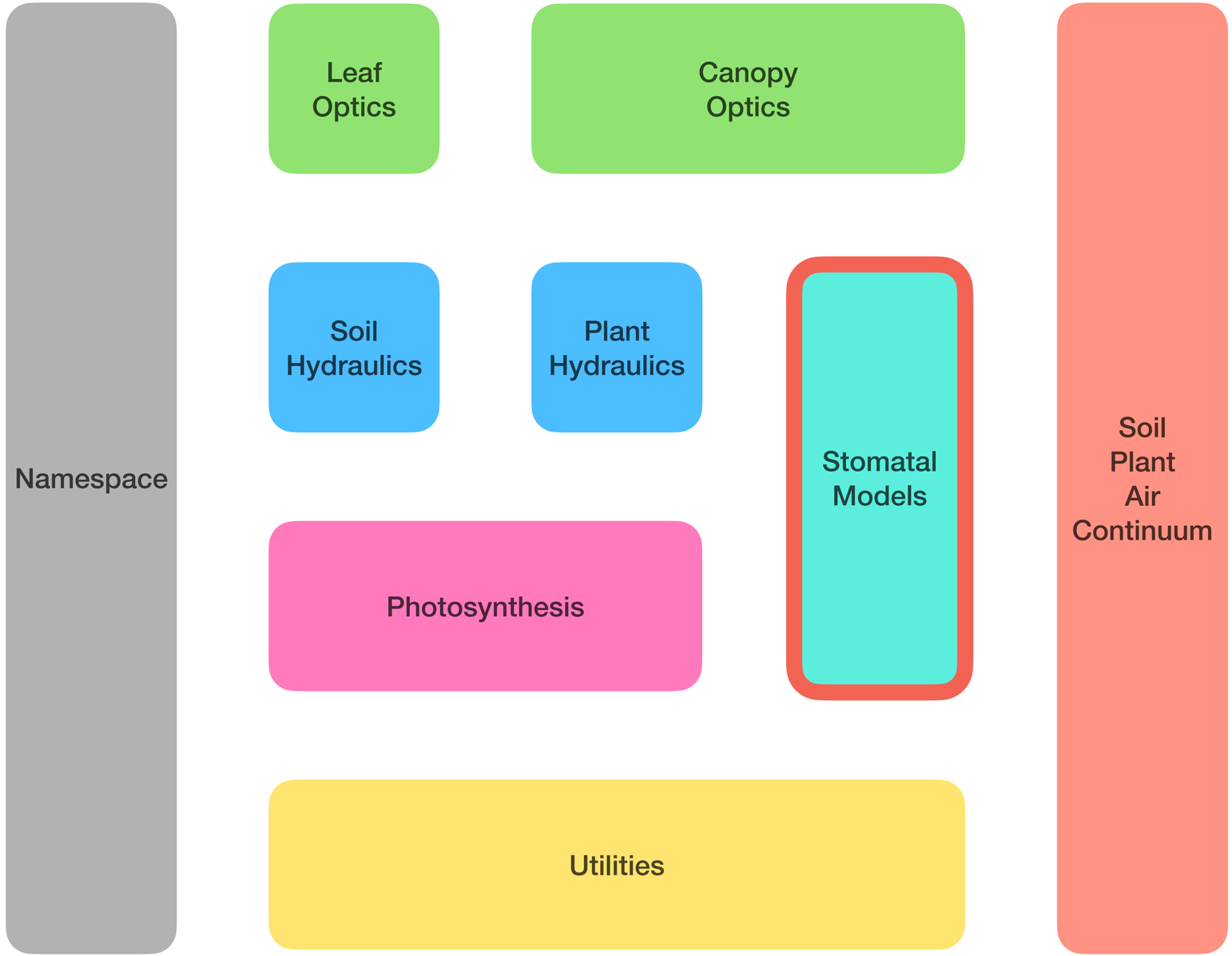
1. Modularity

Each module can be used as a standalone package



https://github.com/CliMA/Land

2. User friendly

Convenient functions to begin with

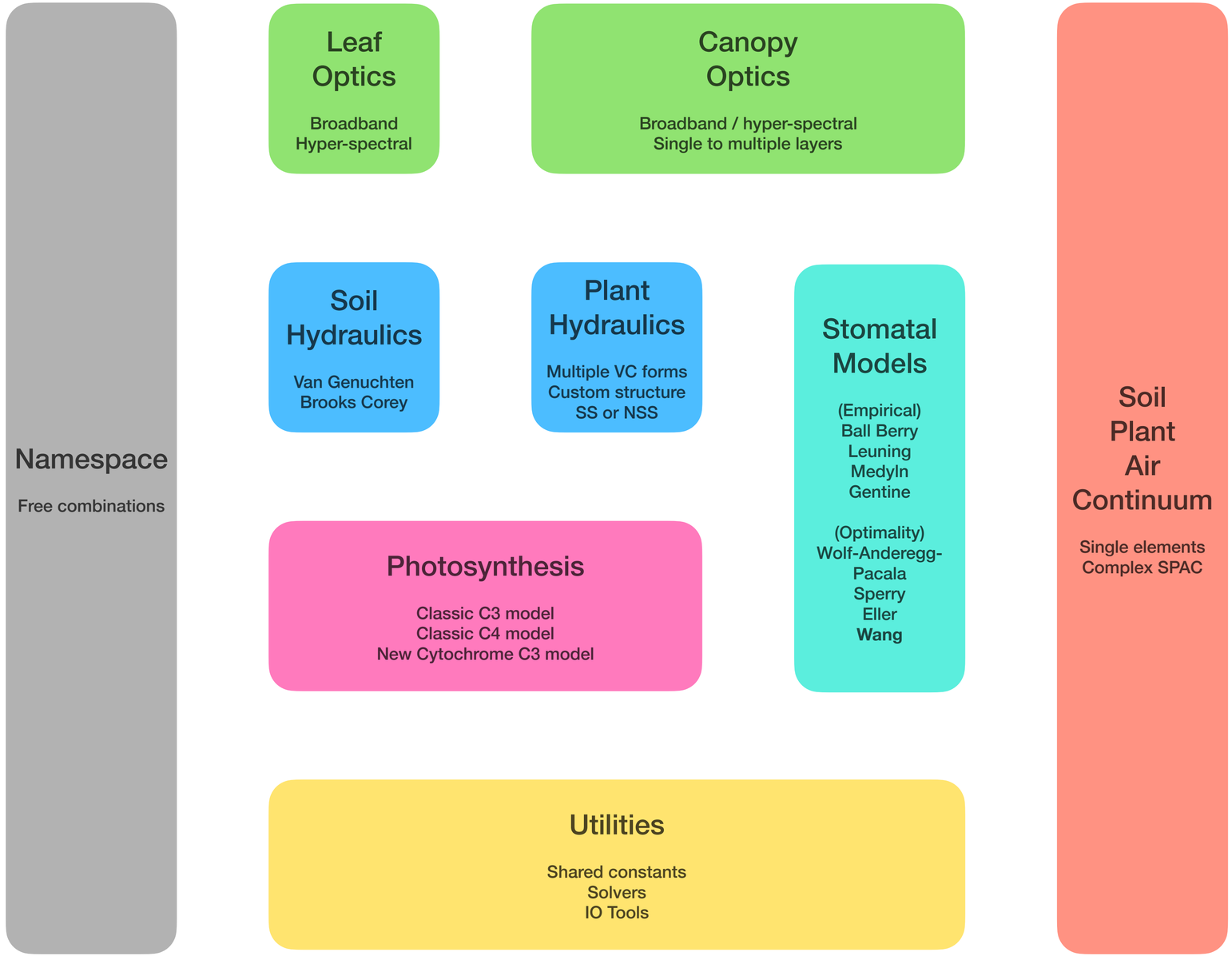
GUI on the way for teaching purpose

```
spac = MonoMLTreeSPAC{Float64}();
initialize!(spac);
update!(spac; cab = 40, car = 6);
soil_plant_air_continuum!(spac, 120.0);

@show TROPOMI_SIF740(spac.CANOPY);
@show MODIS_NIRv(spac.CANOPY);
@show OCO2_SIF759(spac.CANOPY);
```

3. Freedom

Various model schemes to choose from



4. Database

TAG is the only thing you need to know

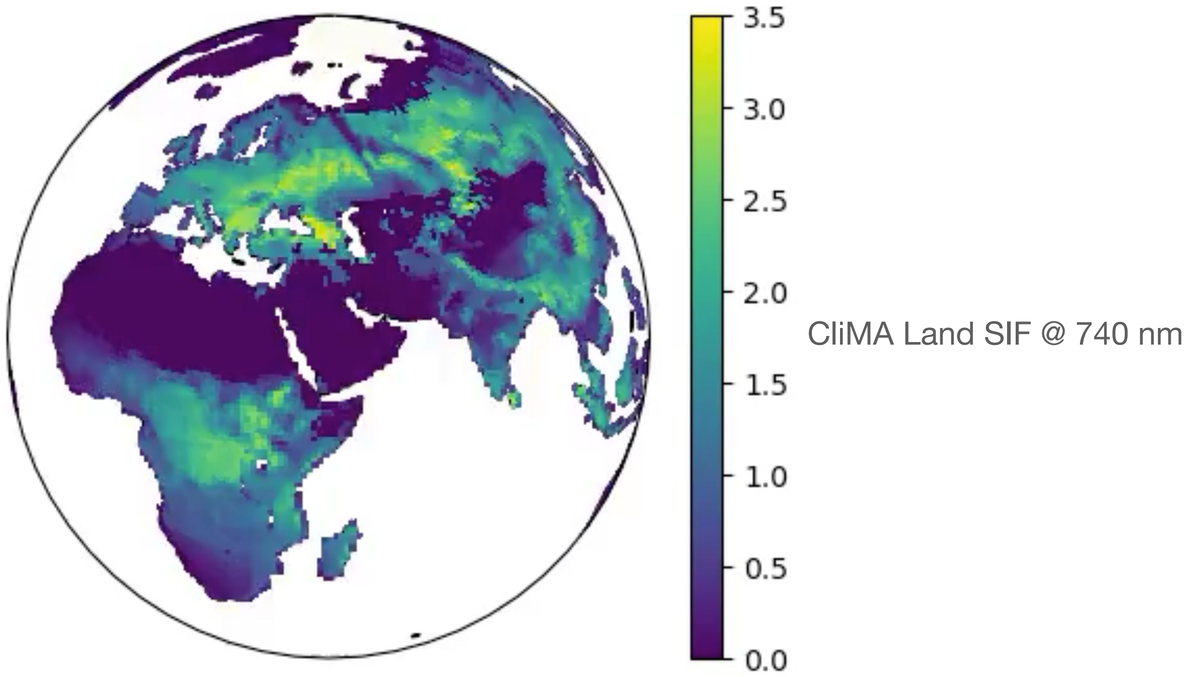
```
using GriddingMachine.Collector: query_collection;
file_path = query_collection("VCMAX_2X_1Y_V1");

using GriddingMachine.Requestor: request_LUT;
dat,std = request_LUT("LAI_MODIS_20X_1M_2020_V1", 28.6, -81.2);
```

Dataset type	LABEL	EXTRALABEL	IX	JT	YEAR	VK	Reference	Change logs
Gross primary productivity	GPP	MPI_RS	2X	1M, 8D	2001-2019	V1	Tramontana et al. (2016)	4,9
	GPP	VPM	5X, 12X	8D	2000-2019	V2	Zhang et al. (2017)	1,4
Leaf area index	LAI	MODIS	2X, 10X, 20X	1M, 8D	2000-2020	V1	Yuan et al. (2011)	1,4,9
Latent heat flux	LE	MPI_RS	2X	1M, 8D	2001-2015	V1	Jung et al. (2019)	4,9
Solar induced chlorophyll	SIF	TROPOMI_683, TROPOMI_683DC	1X, 2X, 4X,	1M, 8D	2018-2020	V2	Köhler et al. (2020)	1,8

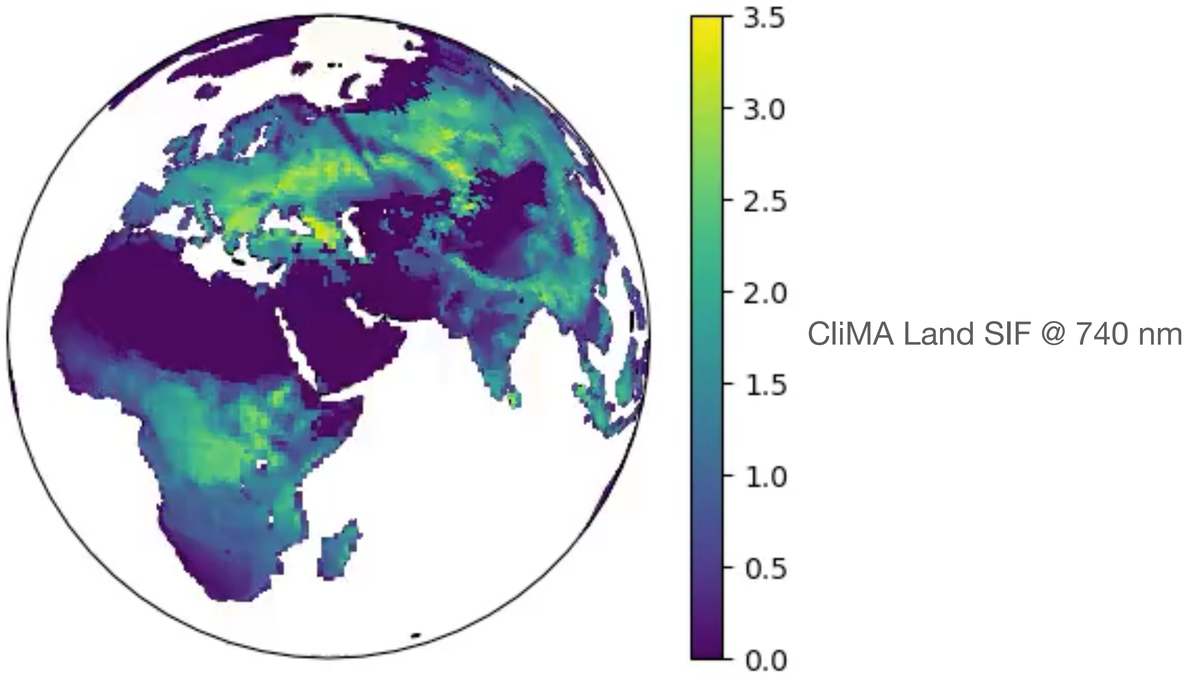
https://github.com/CliMA/GriddingMachine.jl

Global simulations of canopy optical properties that can be seen from space

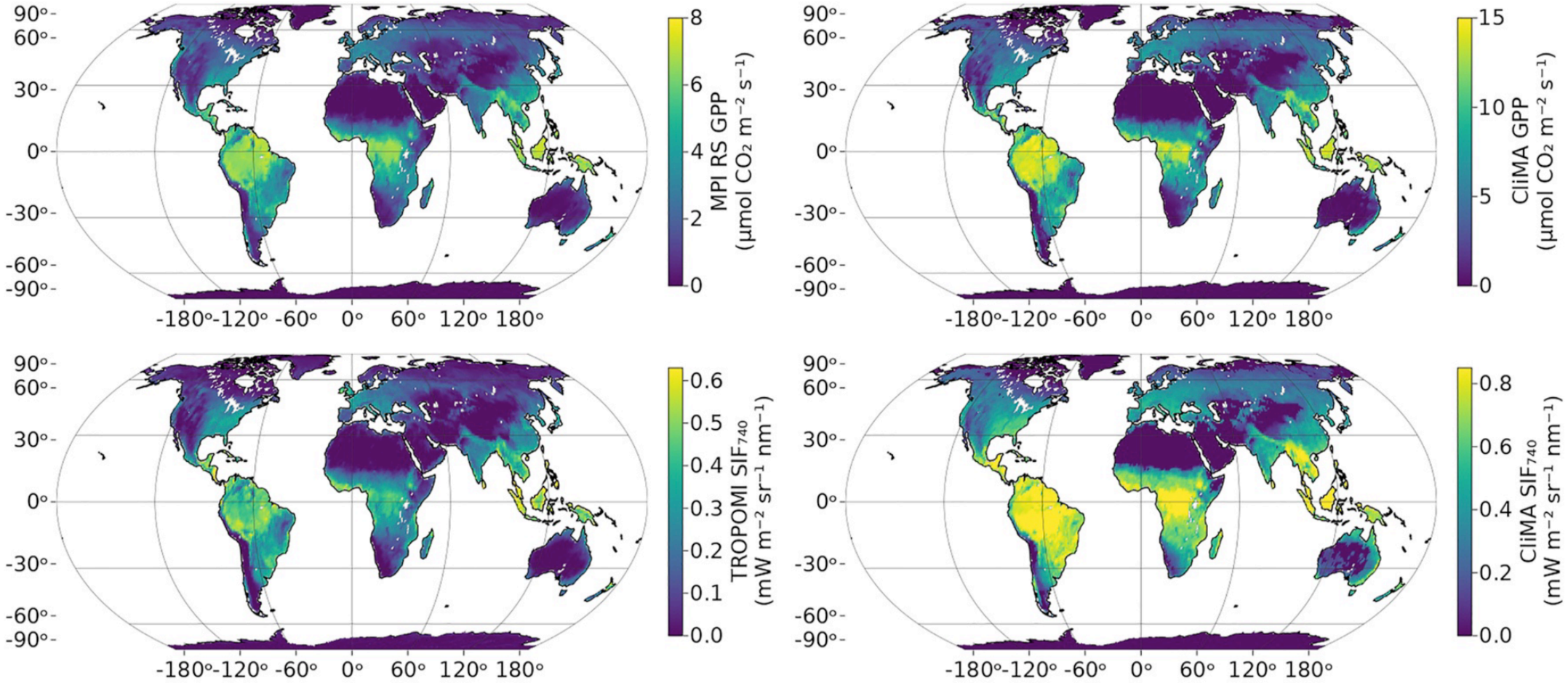


CliMA Land SIF @ 740 nm

Global simulations of canopy optical properties that can be seen from space

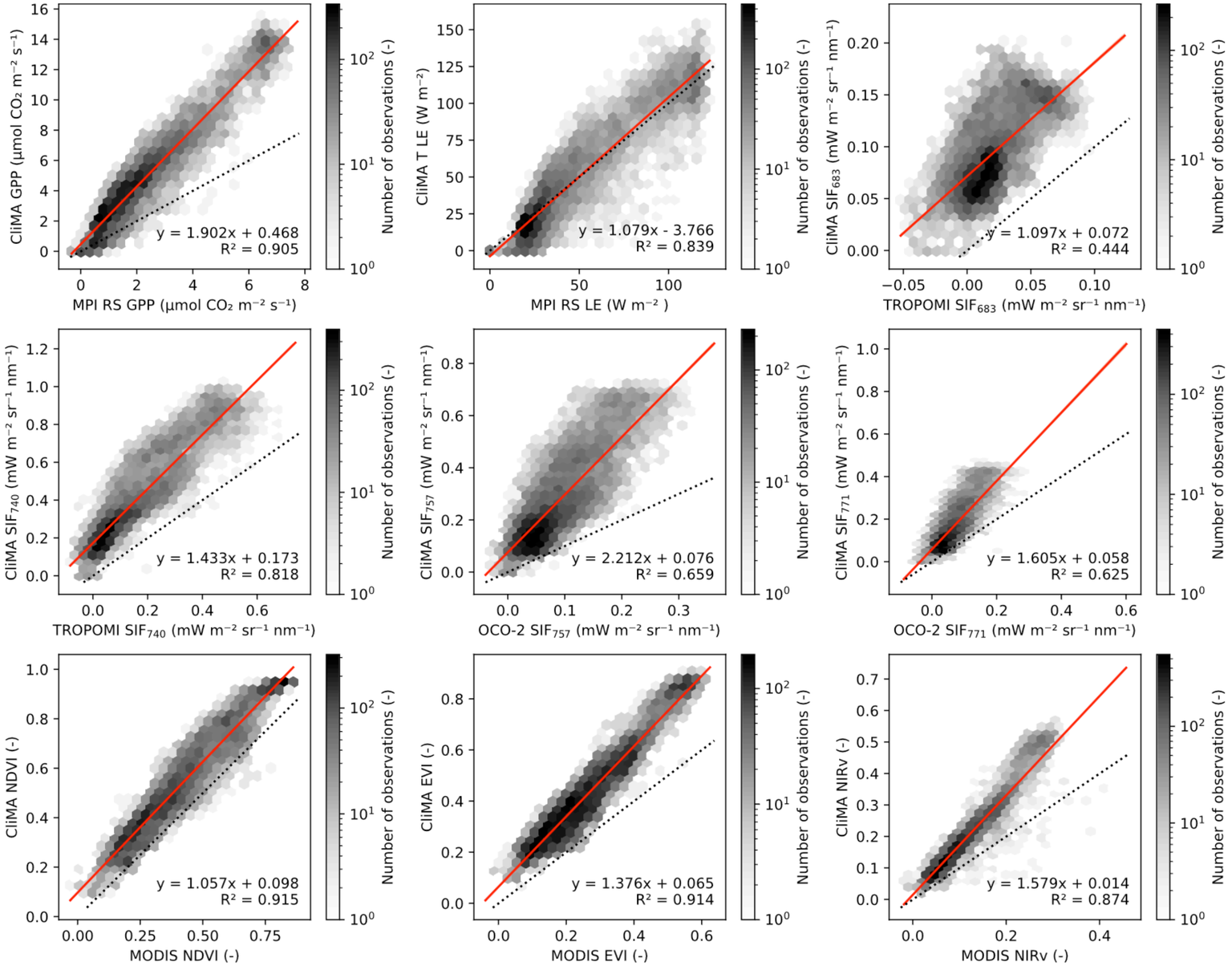


CliMA Land SIF @ 740 nm



Wang et al. (2023) Journal of Advances in Modeling Earth Systems

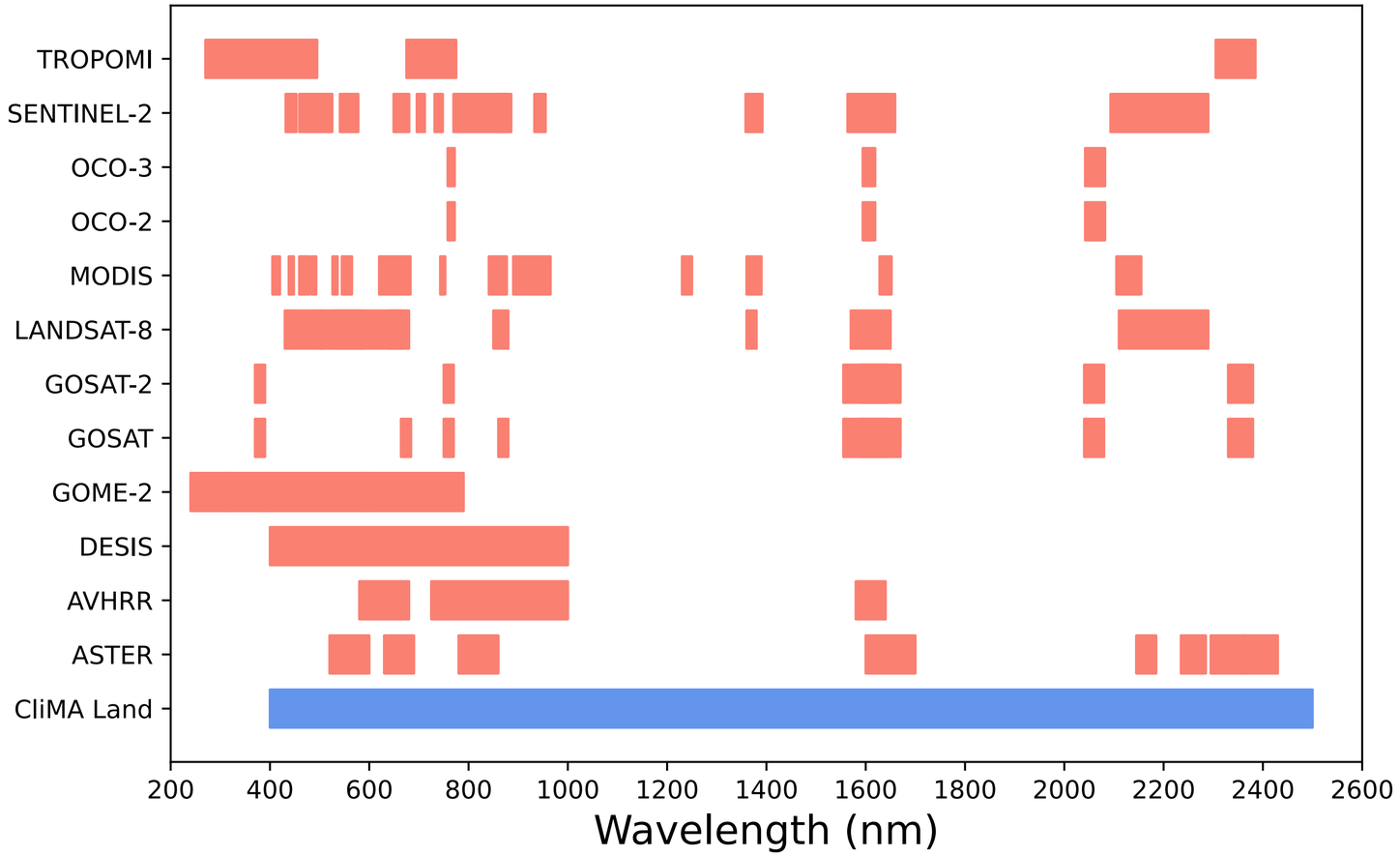
CliMA Land performs well for simulated quantities without any calibrations



Wang et al. (2023) Journal of Advances in Modeling Earth Systems

Remote Sensing

CliMA Land is capable of running hyper-spectral radiative transfer, allowing for using remote sensing data directly



Acknowledgments

Caltech:
Christian Frankenberg, Philipp Köhler, Yi Yin, Russell Doughty, Rupesh Jeyaram, Vincent Humphrey, Liyin He, Rui Cheng, Newton Nguyen, Ke Liu, Yitong Yao, Alexandre Renchon, Yinon Bar-On, Nora Oshima

CliMA:
Tapio Schneider, Charles Kawczynski, Zhaoyi Shen, Eviatar Bach, Leilani Rivera-Dotson

JPL:
Anthony Bloom, Renato Braghiere, Marcos Longo, Alexander Norton, Shuang Ma

University of Missouri:
Jeffrey Wood

University of Utah:
John Sperry, William Anderegg, David Bowling, Jame Ehleringer, Fred Adler, Tom Kursar, David Love, Martin Venturas, Kailiang Yu, Anna Trugman, Xiaonan Tai

Special Thanks:
Melvin Tyree