Scoring Changes in the ILAMB Methodology

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Oak Ridge National Laboratory
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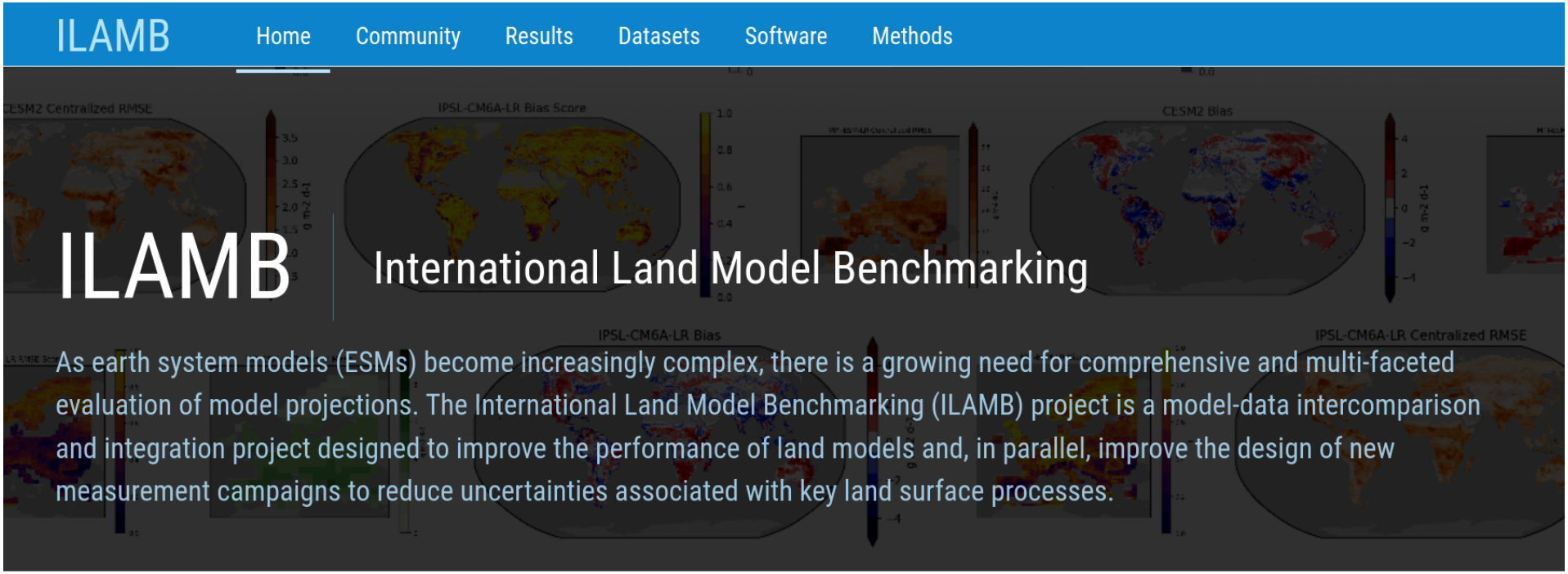
ILAMB = International Land Model Benchmarking

- **Community:** global group of scientists enthusiastic about benchmarking
- **Methods:** innovative assembly of techniques for benchmarking models
- **Software:** open-source python package
  - `https://github.com/rubisco-sfa/ILAMB`
  - `conda config --add channels conda-forge`
    `conda install ilamb`
- **Datasets:** curated collection of datasets formatted for easy comparison
  - `https://github.com/rubisco-sfa/ILAMB-Data`
- **Results:** catalog of comparisons which you can access and peruse
  - `https://www.ilamb.org/CMIP5v6/historical/`
  - `https://www.ilamb.org/CMIP5v6/IOMB/`
  - `https://www.ilamb.org/land-hist/`

Revamped ilamb.org



1 DECEMBER 2022

ILAMB intake Catalog

We are pleased to announce that the reference datasets that we have reprocessed and can be mass downloaded via ilamb-fetch are now also available as an intake catalog. Intake is a lightweight set of python tools for loading and sharing data in data science projects. It allows you to write python code referencing the ILAMB datasets by name, and then intake manages the download, using cached versions if available on your system.

Dataset Page

ILAMB Collection

Albedo	CERESed4.1, GEWEX.SRB
Biomass	Tropical, GlobalCarbon, NBCD2000, USForest, Thurner, ESACCI
Burned Area	GFED4.1S
Carbon Dioxide	NOAA.Emulated
Diurnal Max Temperature	CRU4.02
Diurnal Min Temperature	CRU4.02
Diurnal Temperature Range	CRU4.02
Ecosystem Respiration	FLUXNET2015, FLUXCOM
Evapotranspiration	GLEAMv3.3a, MODIS, MOD16A2
Global Net Ecosystem Carbon Balance	GCP, Hoffman
Gross Primary Productivity	FLUXNET2015, FLUXCOM, WECANN
Ground Heat Flux	CLASS
Latent Heat	FLUXNET2015, FLUXCOM, DOLCE, CLASS, WECANN
Leaf Area Index	AVHRR, AVH15C1, MODIS
Net Ecosystem Exchange	FLUXNET2015
Nitrogen Fixation	Davies-Barnard
Permafrost	NSIDC
Precipitation	CMAPv1904, FLUXNET2015, GPCCv2018, GPCPv2.3, CLASS
Runoff	Dai, LORA, CLASS
Sensible Heat	FLUXNET2015, FLUXCOM, CLASS, WECANN
Snow Water Equivalent	CanSISE

ILAMB Intake Catalog

```
In [1]: import intake
   ...: cat = intake.open_catalog("https://raw.githubusercontent.com/nocollier/intake-ilamb/main/ilamb.yaml")

In [2]: cat['
```

```
'albedo | CERESed4.1'                'lai | MODIS'                          'rlns | GEWEX.SRB'
'albedo | GEWEX.SRB'                 'mrro | CLASS'                         'rlns | WRMC.BSRN'
'biomass | ESACCI'                   'mrro | Dai'                           'rlus | CERESed4.1'
'biomass | NBCD2000'                'mrro | LORA'                          'rlus | FLUXNET2015'
'biomass | Thurner'                 'mrsos | WangMao'                      'rlus | GEWEX.SRB'
'biomass | Tropical'                'nbp | GCP'                            'rlus | WRMC.BSRN'
'biomass | US.FOREST'               'nbp | Hoffman'                       'rns | CERESed4.1'
'burntFractionAll | GFED4.1S'       'nee | FLUXCOM'                       'rns | CLASS'
'cSoil | HWSD'                      'nee | FLUXNET2015'                   'rns | FLUXNET2015'
'cSoil | NCSCDV22'                  'pfext | NSIDC'                       'rns | GEWEX.SRB'
'co2 | NOAA.GMD'                    'pr | CLASS'                         'rns | WRMC.BSRN'
'dtr | CRU4.02'                     'pr | CMAPv1904'                     'rsds | CERESed4.1'
'evspsbl | GLEAMv3.3a'              'pr | FLUXNET2015'                   'rsds | FLUXNET2015'
'evspsbl | MOD16A2'                 'pr | GPCCv2018'                     'rsds | GEWEX.SRB'
'evspsbl | MODIS'                   'pr | GPCPv2.3'                      'rsds | WRMC.BSRN'
'fBNF | DaviesBarnard'              'reco | FLUXCOM'                     'rsns | CERESed4.1'
'gpp | FLUXCOM'                     'reco | FLUXNET2015'                 'rsns | FLUXNET2015'
'gpp | FLUXNET2015'                 'regions_continental | ILAMB'       'rsns | GEWEX.SRB'
'gpp | WECANN'                      'regions_continental | IPCC'        'rsns | WRMC.BSRN'
'hfdsl | CLASS'                     'regions_global_land | ILAMB'        'rsus | CERESed4.1'
'hfls | CLASS'                      'regions_global_land_no_ant | ILAMB' 'rsus | FLUXNET2015'
'hfls | DOLCE'                      'regions_whittaker_biomes | ILAMB'   'rsus | GEWEX.SRB'
'hfls | FLUXCOM'                    'rhums | CRU4.02'                     'rsus | WRMC.BSRN'
'hfls | FLUXNET2015'                'rhums | ERA5'                        'swe | CanSISE'
'hfls | WECANN'                     'river_basins | Dai'                 'tas | CRU4.02'
'hfss | CLASS'                      'rlds | CERESed4.1'                  'tas | FLUXNET2015'
'hfss | FLUXCOM'                    'rlds | FLUXNET2015'                 'tasmax | CRU4.02'
'hfss | FLUXNET2015'                'rlds | GEWEX.SRB'                   'tasmin | CRU4.02'
'hfss | WECANN'                     'rlds | WRMC.BSRN'                   'twsa | GRACE'
'lai | AVH15C1'                     'rlns | CERESed4.1'
'lai | AVHRR'                       'rlns | FLUXNET2015'
```

ILAMB Intake Catalog

```
In [1]: import intake
   ...: cat = intake.open_catalog("https://raw.githubusercontent.com/nocollier/intake-ilamb/main/ilamb.yaml")

In [2]: gpp = cat['gpp | WECANN'].read()

In [3]: gpp
Out[3]:
<xarray.Dataset>
Dimensions:      (time: 108, nb: 2, lat: 180, lon: 360)
Coordinates:
  * time         (time) object 2007-01-16 12:00:00 ... 2015-12-16 12:00:00
  * lat          (lat) float64 89.5 88.5 87.5 86.5 ... -86.5 -87.5 -88.5 -89.5
  * lon          (lon) float64 -179.5 -178.5 -177.5 -176.5 ... 177.5 178.5 179.5
Dimensions without coordinates: nb
Data variables:
    time_bounds  (time, nb) object 2007-01-01 00:00:00 ... 2016-01-01 00:00:00
    gpp          (time, lat, lon) float64 9.969e+36 9.969e+36 ... 9.969e+36
Attributes:
    title:         Water, Energy, and Carbon with Artificial Neural Networks ...
    version:       1
    institutions:  Columbia University
    source:        Solar Induced Fluorescence (SIF), Air Temperature, Precipi...
    history:       \n2020-11-02: downloaded https://avdc.gsfc.nasa.gov/pub/da...
    references:    \n@ARTICLE{Alemohammad2017,\n  author = {Alemohammad, S. H...
    comments:      \ntime_period: 2007-01 through 2015-11; temporal_resolutio...
    convention:    CF-1.8
```

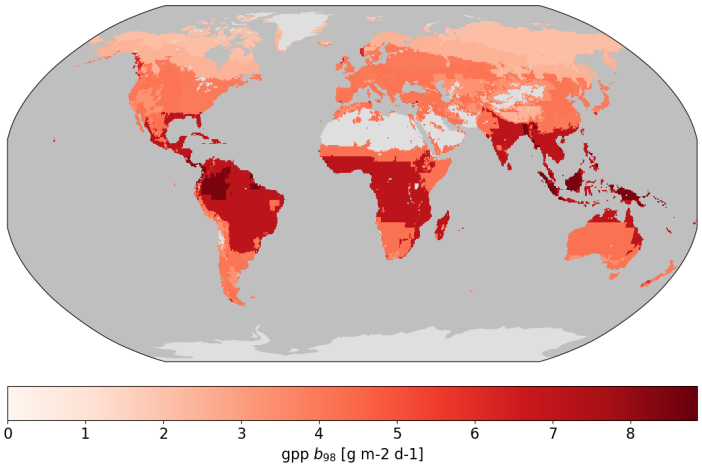
Synthesizing Performance Globally

Our normalization technique aims to make errors from different areas of the globe comparable. We could accomplish this by:

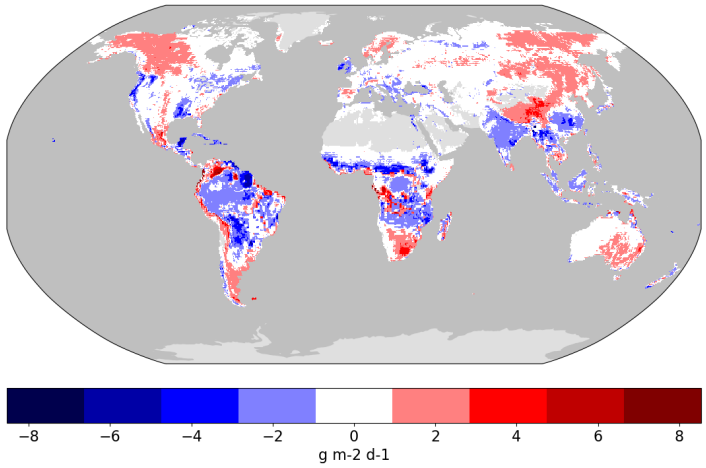
- Select a set of biome-like regions (e.g. Whittaker, Koppen) in which errors will be treated as commensurate in order of magnitude.
- For each region and across a selection of models (e.g. our CMIP5v6 subset), compute quantiles of the absolute value of the bias, $|b(\mathbf{x})|$
- Spatial errors are then normalized by some choice of quantile, for example the 98^{th} represented here as b_{98}.
- The bias score $s(\mathbf{x}) = 1 - \frac{|b(\mathbf{x})|}{b_{98}}$, restricted to $[0, 1]$
- The overall scalar score S is a global integral of $s(\mathbf{x})$ (no mass weighting)

CESM2 | gpp | FLUXCOM

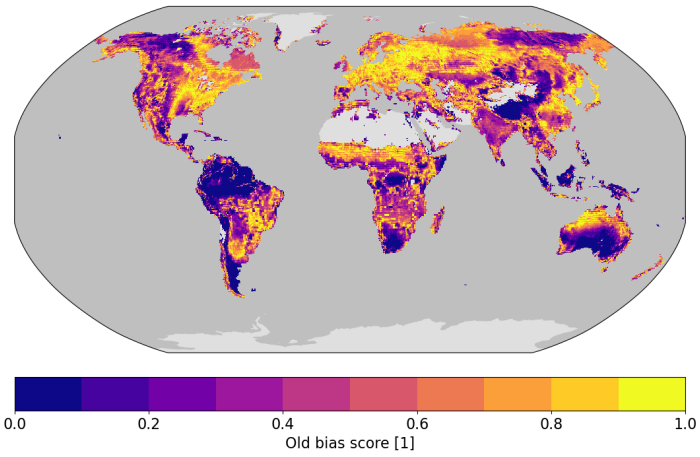
98^{th} Percentile



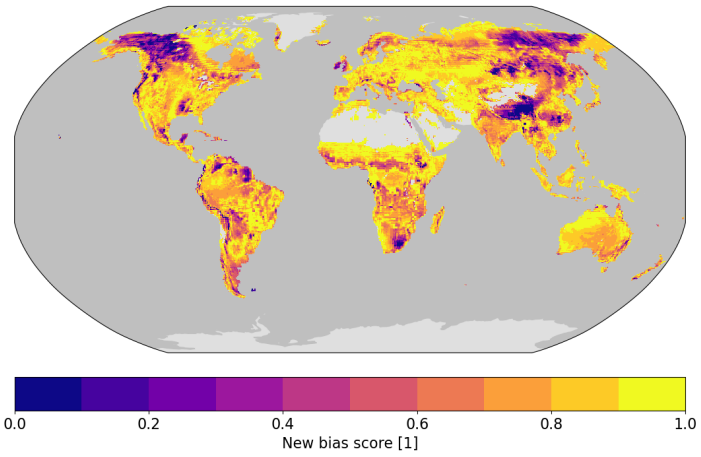
Bias



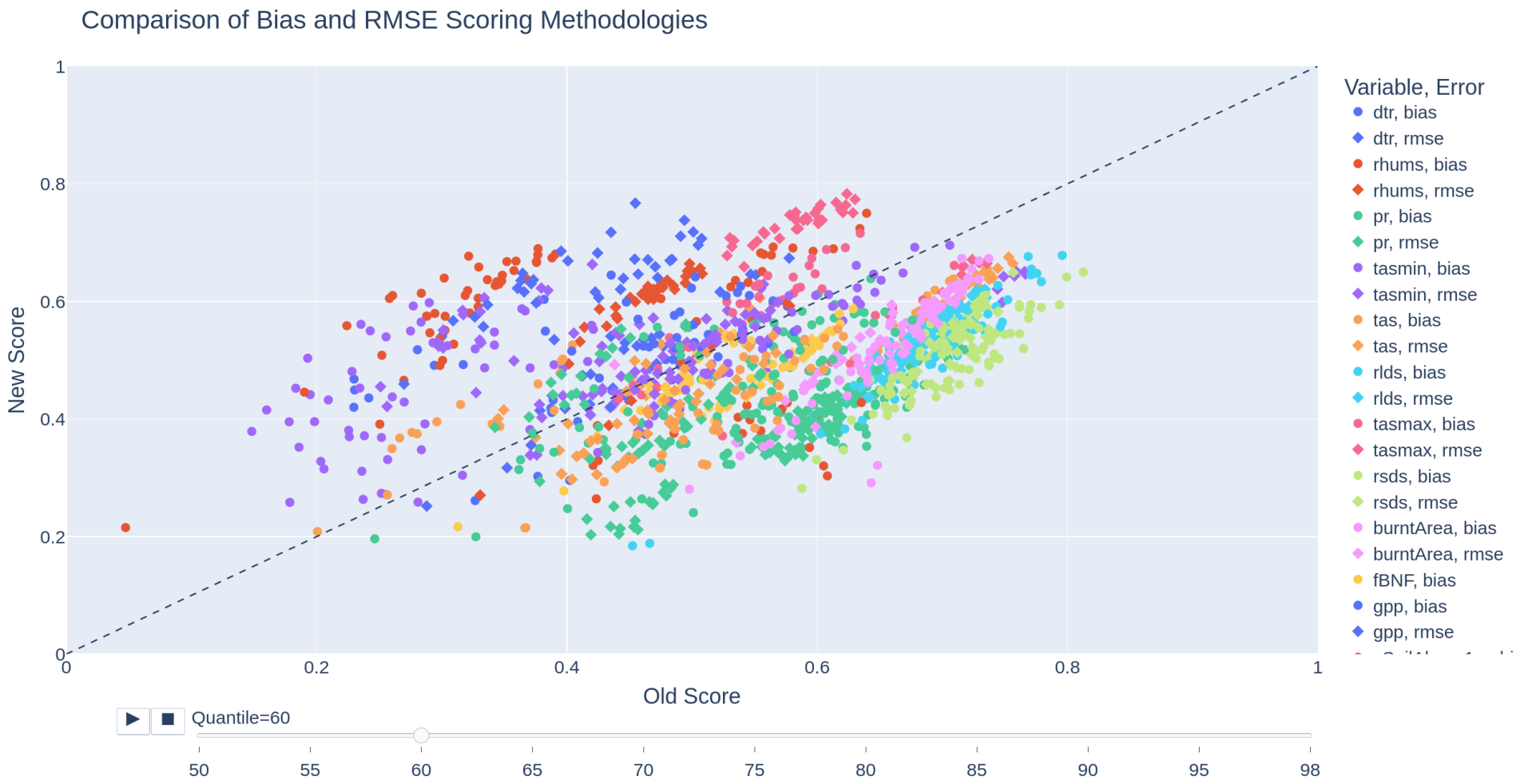
Old Bias Score



New Bias Score



New vs. Old: Which quantile?



https://www.climatemodeling.org/~nate/score_comparison.html

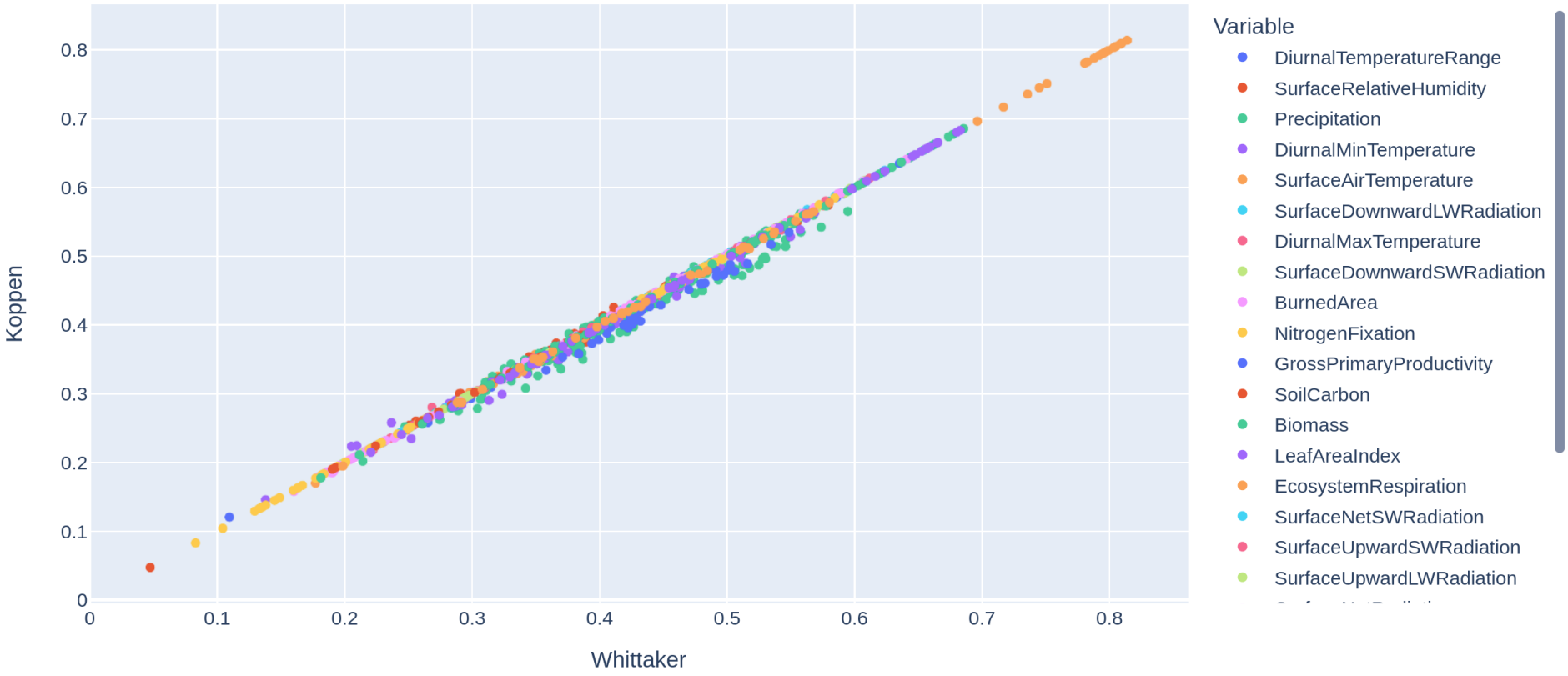
CMIP5v6: Which quantile?

https://www.climatemodeling.org/~nate/score_comparison_CMIP.html

CMIP5v6: Which quantile?

https://www.climatemodeling.org/~nate/score_comparison_CMIP.html

CMIP5v6: Which region?



https://www.climatemodeling.org/~nate/region_comparison.html