USING ISIMIP MODEL OUTPUT WITH ILAMB AND ESMValTool.

FIRST INSIGHTS IN APPLICATION / MODIFICATION AND CHALLENGES TOWARDS ITS USABILITY AS A QUALITY ASSESSMENT TOOL FOR IMPACT MODELS

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OBJECTIVES

Apply ISIMIP model output data from the global water sector (as a pilot sector) to the pre-selected quality assessment tools (ILAMB and ESMValTool).

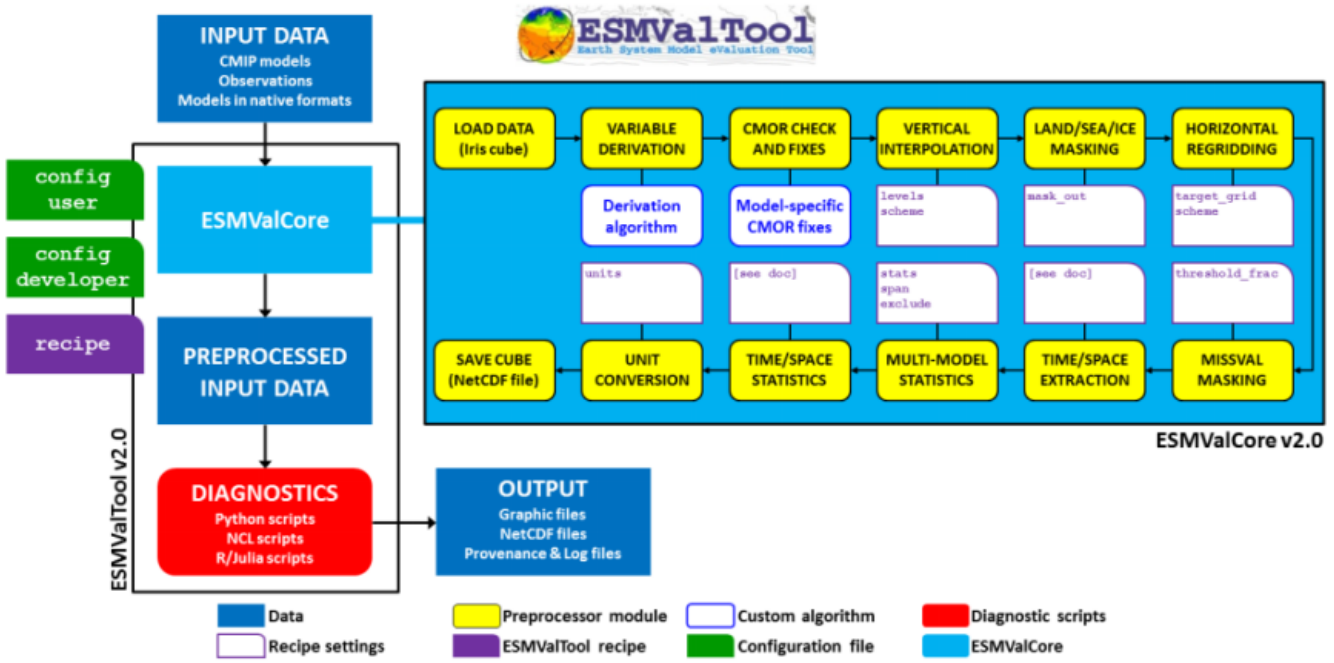
~Testing usability of these tools for impact model evaluation

~Generating a pathway towards adapting those tools for usability within the global water sector and furthermore across the ISIMIP sectors.

ESMValTool: OVERVIEW AND FRAMEWORK

Community diagnostics and performance metrics tool.

~ mainly developed to improve comprehensive and routine evaluation of Earth system models participating in the Coupled Model Intercomparison Project



Technically impossible to make ISIMIP model output complaint with ESMValTool for the given time frame.
~ (Compliant Tool Needed)

Image source: https://docs.esmvaltool.org/en/latest/introduction.html#id3

ILAMB: OVERVIEW AND FRAMEWORK

Open-source software for benchmarking Analysis

~variables in categories of biogeochemistry, hydrology, radiation and energy and climate forcing

Model performance metrics:

Period Mean, Bias, RMSE, Spatial distribution , Interannual Coefficient Of Variation, Phase shift

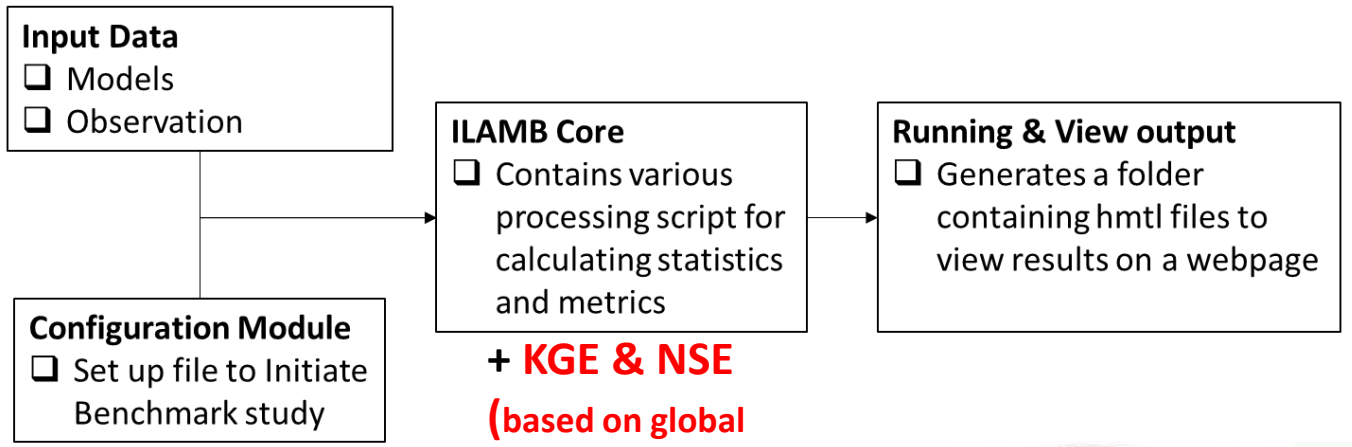


Image source: https://vistapointe.net/focus.html

DATA

Variable	Period	Data Source	Temporal Resolution	Spatial Resolution
Total water storage Anomaly	2002-2014 (Ref. 2004-2009)	GRACE **	Monthly	0.5° x 0.5°
		WaterGAP2 (WFDEI)*	Resampled Monthly	0.5° x 0.5°
River discharge	2001-2010	GRDC**	Monthly	-
		WaterGAP2 (WFDEI & GSWP3)*	Resampled Monthly	0.5° x 0.5°
		PCR-GLOBWB (WFDEI)*	Resampled Monthly	0.5° x 0.5°

Note:
**=Benchmark
*=Model
()=Climate forcing

Conversion tool available for making GRDC data ILAMB compliant

Image source:
https://depositphotos.com/stock-photos/available-now.html

ILAMB CONFIGURATION SETUP (e.g. Total Water Storage anomaly)

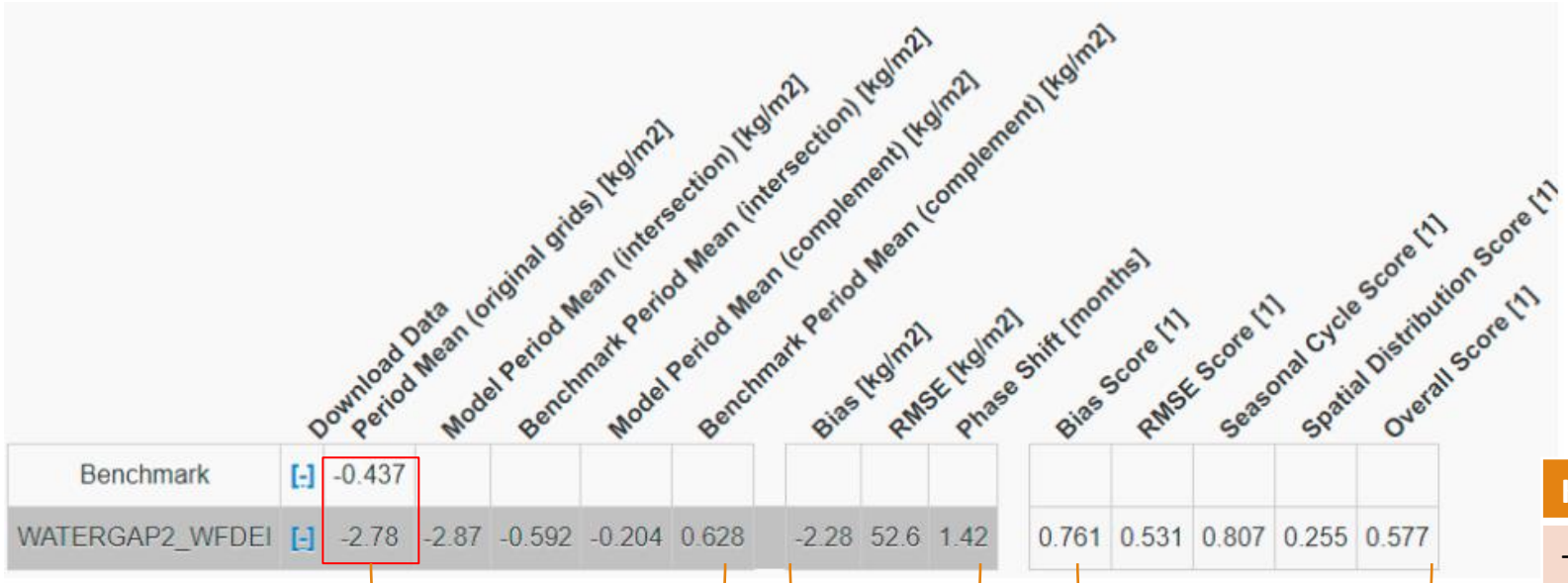
sample.cfg

```
# This configure file specifies the variables
[h1: Model Evaluation]
bgcolor  = "#FFECE6"

[h2: Total Water Storage Anomaly]
variable = "twsa"

[GRACE]
source   = "DATA/twsa/GRACE/twsa_0.5x0.5_grace.nc"
```

BENCHMARKING USING GRACE TWSA



Download Data	Period Mean (original grids) [kg/m2]	Model Period Mean (intersection) [kg/m2]	Benchmark Period Mean (intersection) [kg/m2]	Model Period Mean (complement) [kg/m2]	Benchmark Period Mean (complement) [kg/m2]	Bias [kg/m2]	RMSE [kg/m2]	Phase Shift [months]	Bias Score [1]	RMSE Score [1]	Seasonal Cycle Score [1]	Spatial Distribution Score [1]	Overall Score [1]
Benchmark	[-]	-0.437											
WATERGAP2_WFDEI	[-]	-2.78	-2.87	-0.592	-0.204	0.628	-2.28	52.6	1.42	0.761	0.531	0.807	0.255	0.577

KGE	NSE
-2.85	0.83

Mean Values

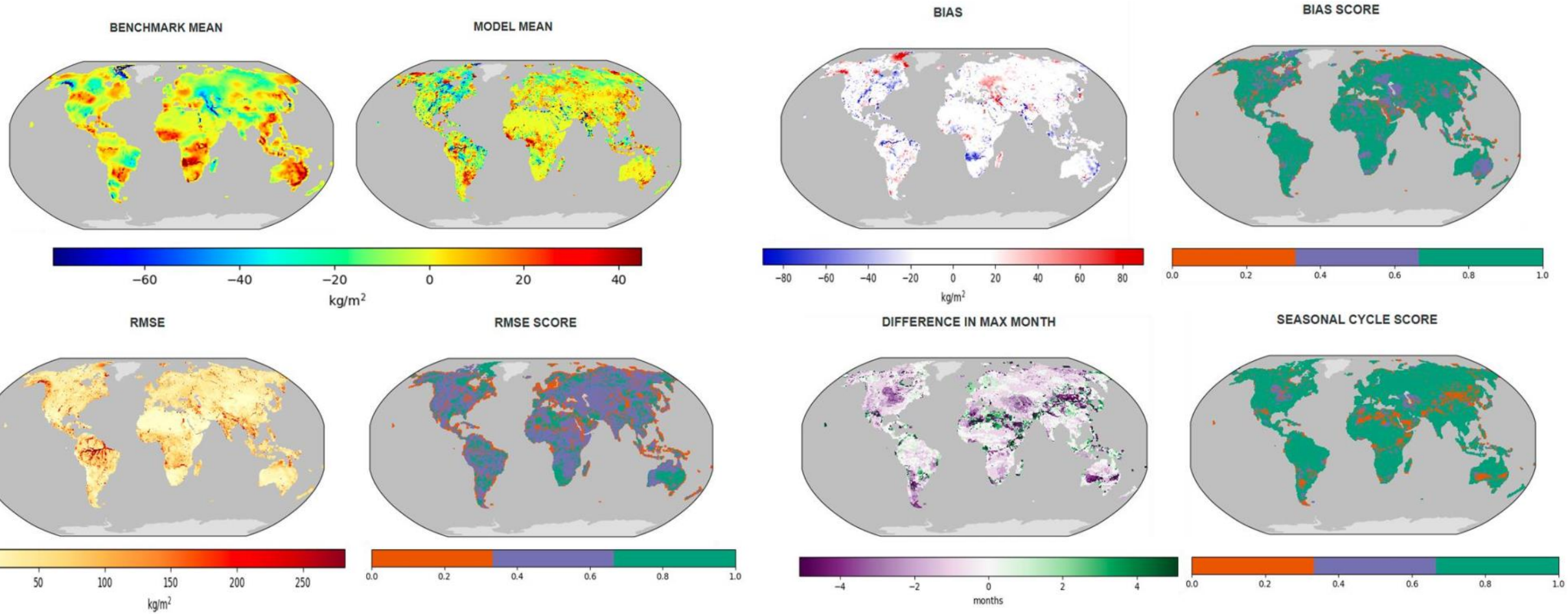
Metrics

Bias score & RMSE score → Normalization of bias and RMSE

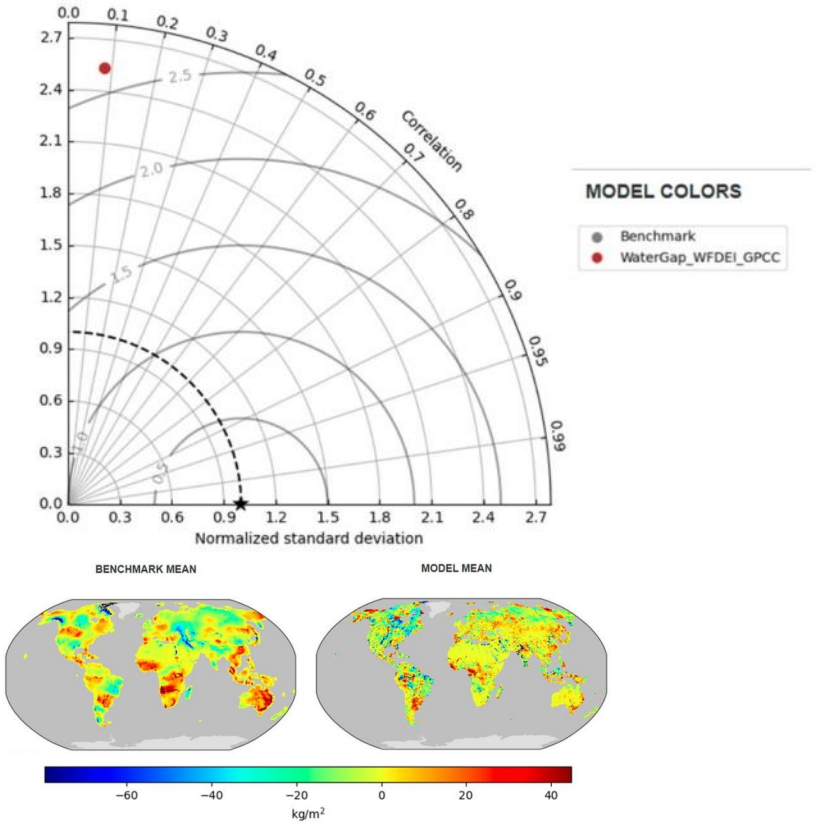
Seasonal cycle score → *R*emapping *Phase shift* to a unit interval

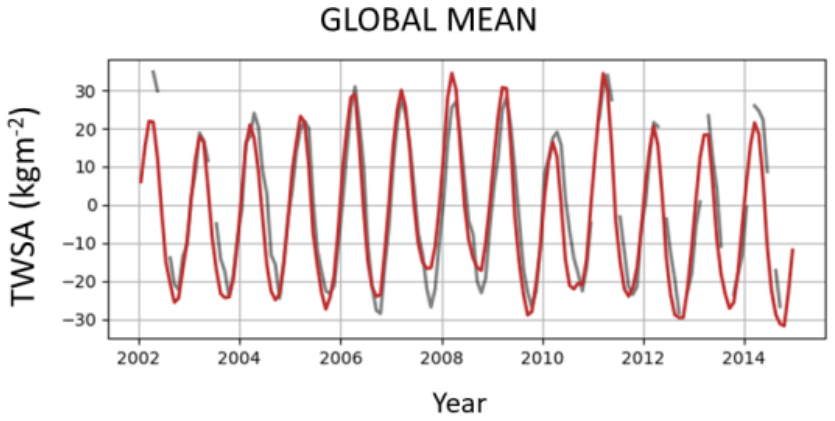
Spatial distribution score ~ Pearson correlation coefficient & normalized standard deviation (displayed in a Taylor diagram)

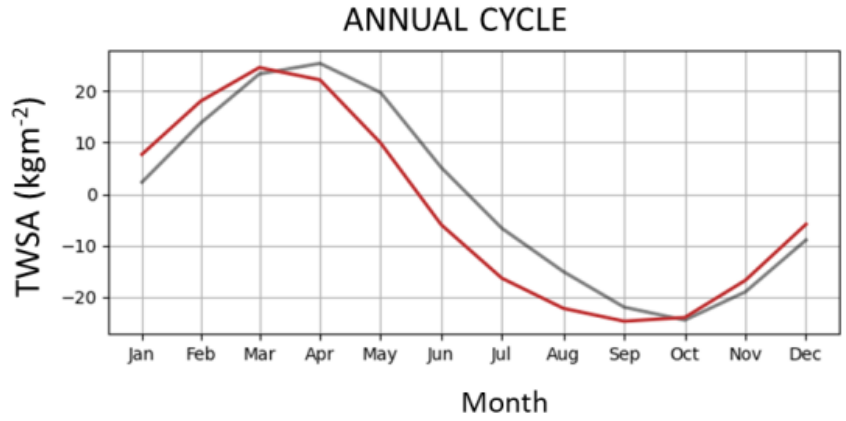
SPATIAL DISTRIBUTION

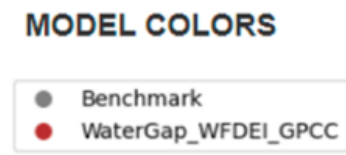


Taylor diagram & Temporal Distribution







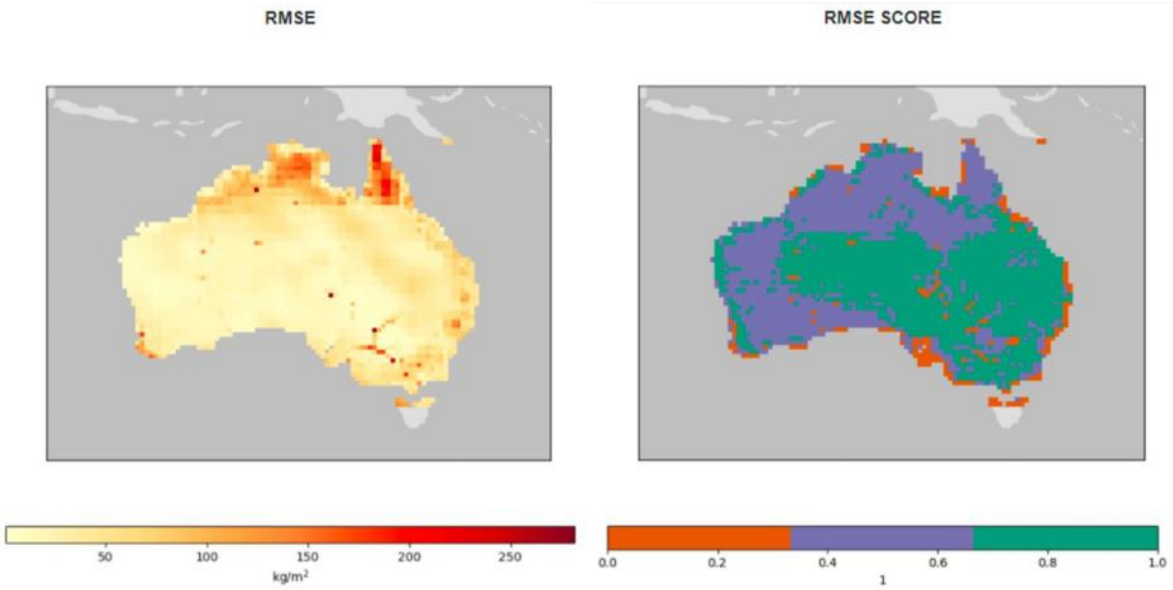


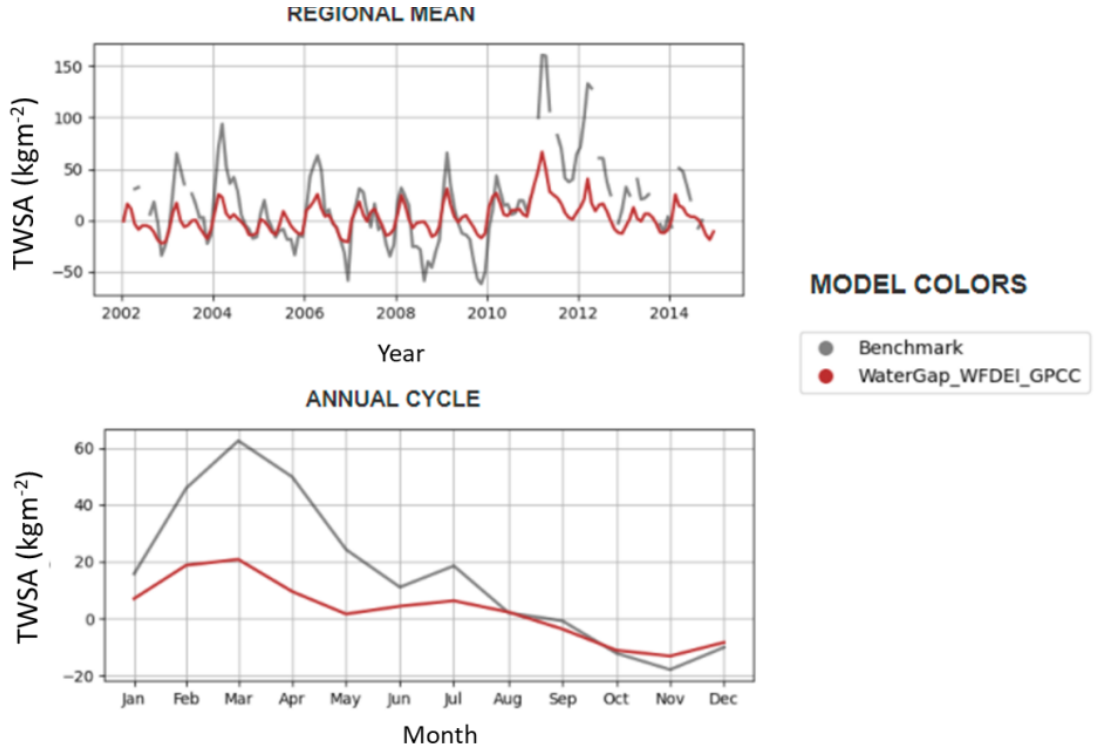
Taylor diagram (~spatial distribution score):

~Compare spatial mean between model and observed

Regional Benchmarking (Australia)

Shape file selection ~ predefined regions
Rectangular selection ~ regions not defined in ILAMB
Coding required for basin specific benchmarking





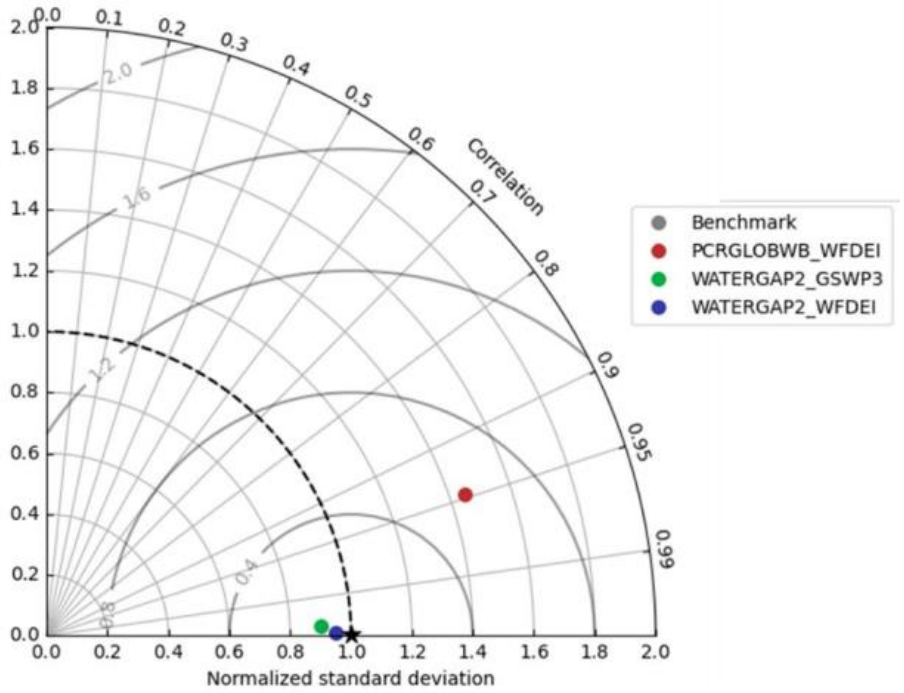
BENCHMARKING USING GRDC (12 STATIONS)

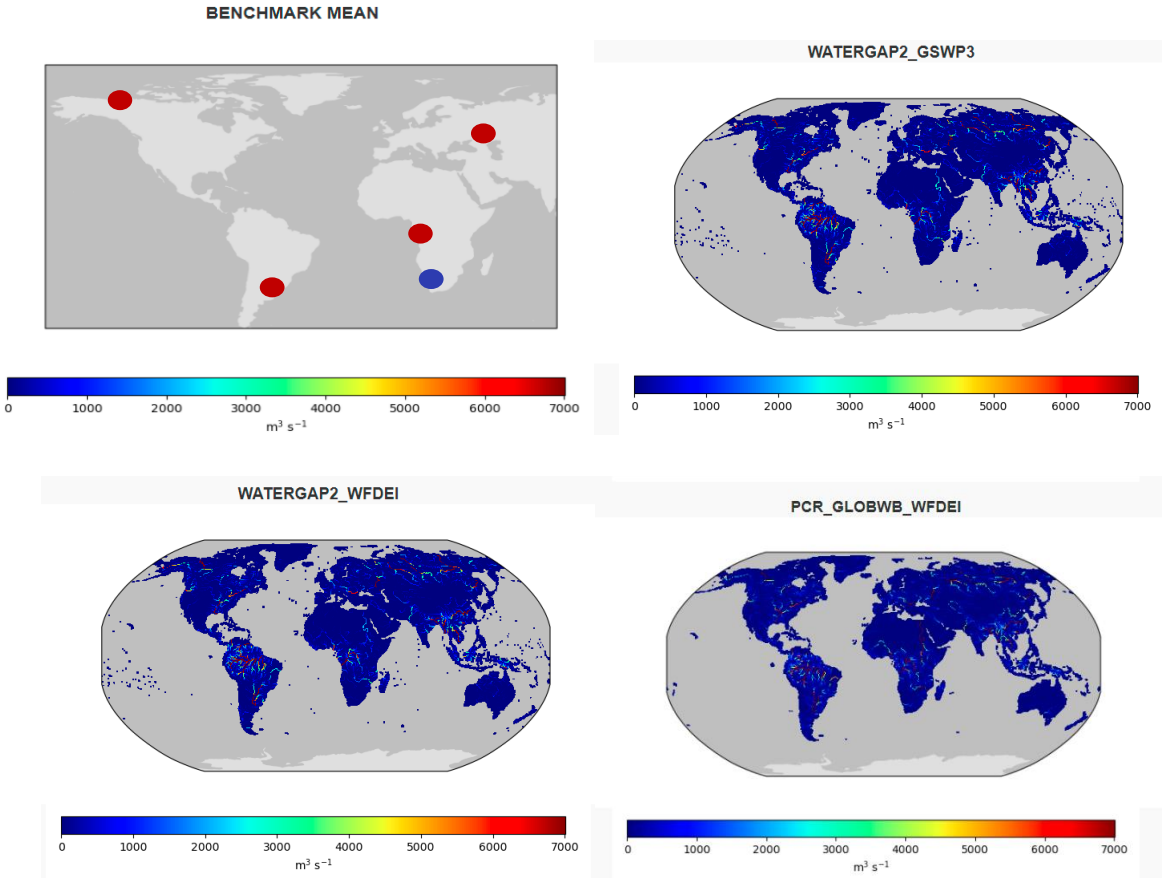
		Download Data	Period Mean (original grids) [m3 s-1]	Model Period Mean (intersection) [m3 s-1]	Benchmark Period Mean (intersection) [m3 s-1]	Model Period Mean (complement) [m3 s-1]	Benchmark Period Mean (complement) [m3 s-1]	Bias [m3 s-1]	RMSE [m3 s-1]	Phase Shift [months]	Bias Score [1]	RMSE Score [1]	Seasonal Cycle Score [1]	Spatial Distribution Score [1]	Overall Score [1]
Benchmark	[-]	1.70e+04													
PCR_GLOBWB_WFDEI	[-]	411.	2.29e+04	1.70e+04	410.			5.85e+03	1.11e+04	1.87	0.287	0.308	0.762	0.851	0.503
WATERGAP2_GSWP3	[-]	476.	1.60e+04	1.70e+04	475.			-1.04e+03	3.11e+03	0.675	0.865	0.574	0.917	0.989	0.784
WATERGAP2_WFDEI	[-]	470.	1.62e+04	1.70e+04	469.			-814.	2.91e+03	0.675	0.848	0.608	0.917	0.997	0.796

Not Needed

KGE	NSE
-1.1	-10.3
0.68	0.19
0.70	0.28

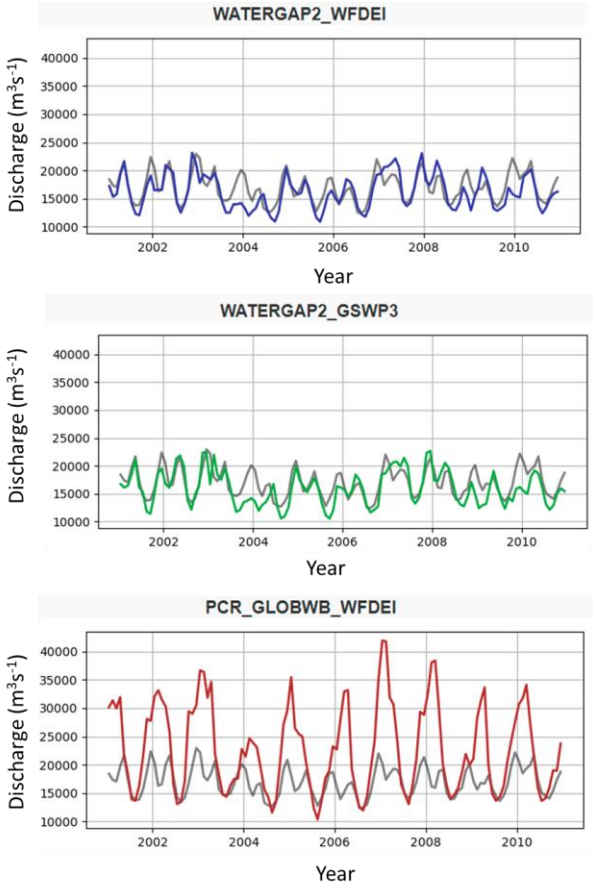
Taylor diagram

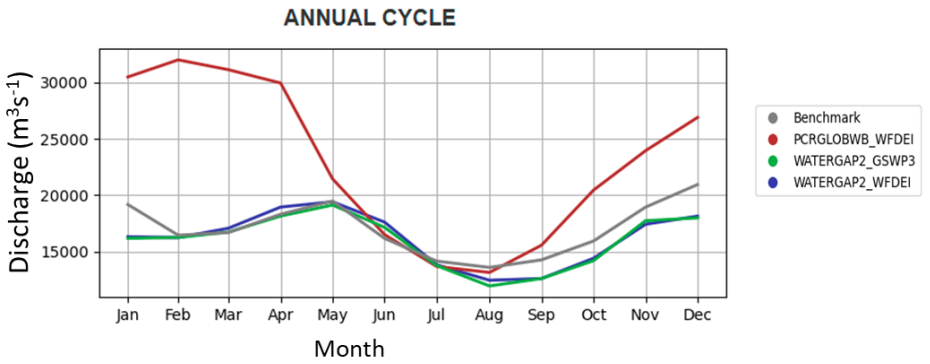




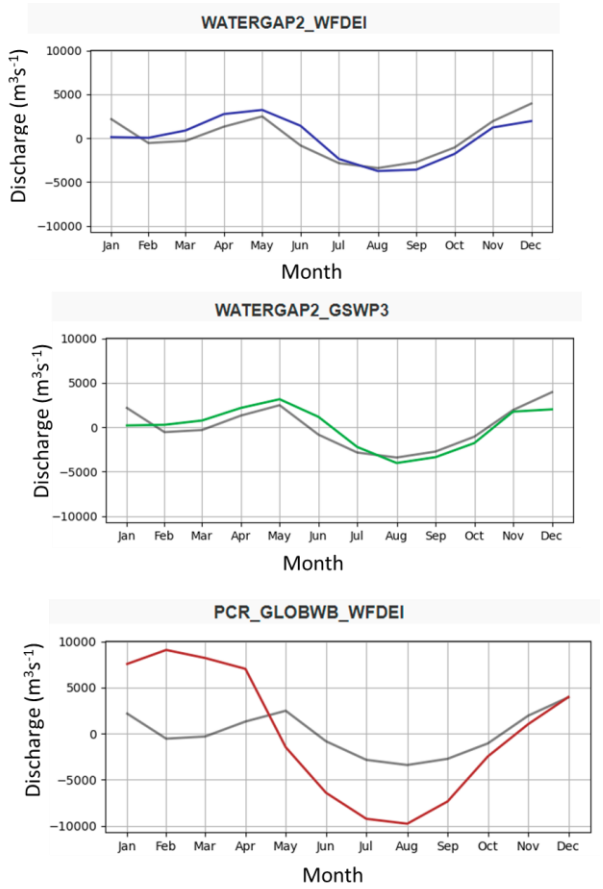
Temporal Distribution

Global mean





Monthly Anomaly



Pros and cons QA

QA Tool	Coding Flexibility (Addition Of Metrics)	Reference Data Extendable	ISIMIP Output Compliant	Basin Specific Benchmarking	Individual & Inter-model Comparison
ESMValTool	Yes	Yes	CMORization tool required	?	Yes
ILAMB	Yes	Yes	Yes	Coding required	Yes

Conclusion and Outlook

- Application of ISIMIP model output (mainly TWSA and river discharge) was successful using ILAMB but unsuccessful using ESMValTool.

~ Compliant tool needed to enable use of ISIMIP output in ESMValTool

- Sector specific metric (KGE and NSE) now available in ILAMB

~ prints in console instead of output webpage: To be improved in future studies

- Coding is required for basin specific benchmarking

A technical documentation to reproduce this result is available.

Reference

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2. Eyring, V., Bock, L., Lauer, A., Righi, M., Schlund, M., Andela, B., Arnone, E., Bellprat, O., Brötz, B., Caron,
L.-P., Carvalhais, N., Cionni, I., Cortesi, N., Crezee, B., Davin, E. L., Davini, P., Debeire, K., de Mora, L., Deser, C., … Zimmermann, K. (2020). Earth System Model Evaluation Tool (ESMValTool) v2.0 – an extended set of large-scale diagnostics for quasi-operational and comprehensive evaluation of Earth system models in CMIP. *Geoscientific Model Development*, *13*(7), 3383–3438. https://doi.org/10.5194/gmd-13-3383-2020

3. Müller Schmied, H., Cáceres, D., Eisner, S., Flörke, M., Herbert, C., Niemann, C., Peiris, T. A., Popat, E., Portmann, F. T., Reinecke, R., Schumacher, M., Shadkam, S., Telteu, C.-E., Trautmann, T., & Döll, P. 19 (2021). The global water resources and use model WaterGAP v2.2d: model description and evaluation. *Geoscientific Model Development*, *14*(2), 1037–1079. https://doi.org/10.5194/gmd-14-1037-2021