Novel tools for model evaluation from the Big Data and Climate FRONTIER project

With funding from The Research Council of Norway

Priscilla A. Mooney*[1], Andreas F. Prein[2], Carla Vivacqua[1,3], James Done[2], Alok Samantaray[1], Ming Ge[2], Erin Towler[2]

1. NORCE, Bjerknes Centre for Climate Research, Bergen, Norway
2. National Centre for Atmospheric Research, Boulder, Colorado, USA
3. Universidade Federal do Rio Grande do Norte, Brazil

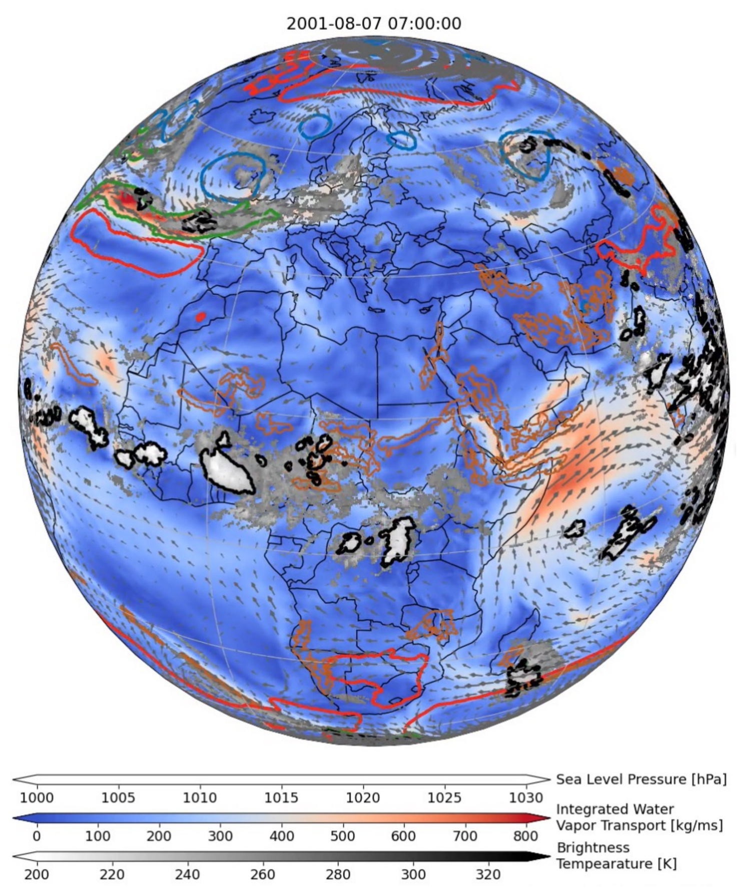
Contact: *prmo@norceresearch.no*

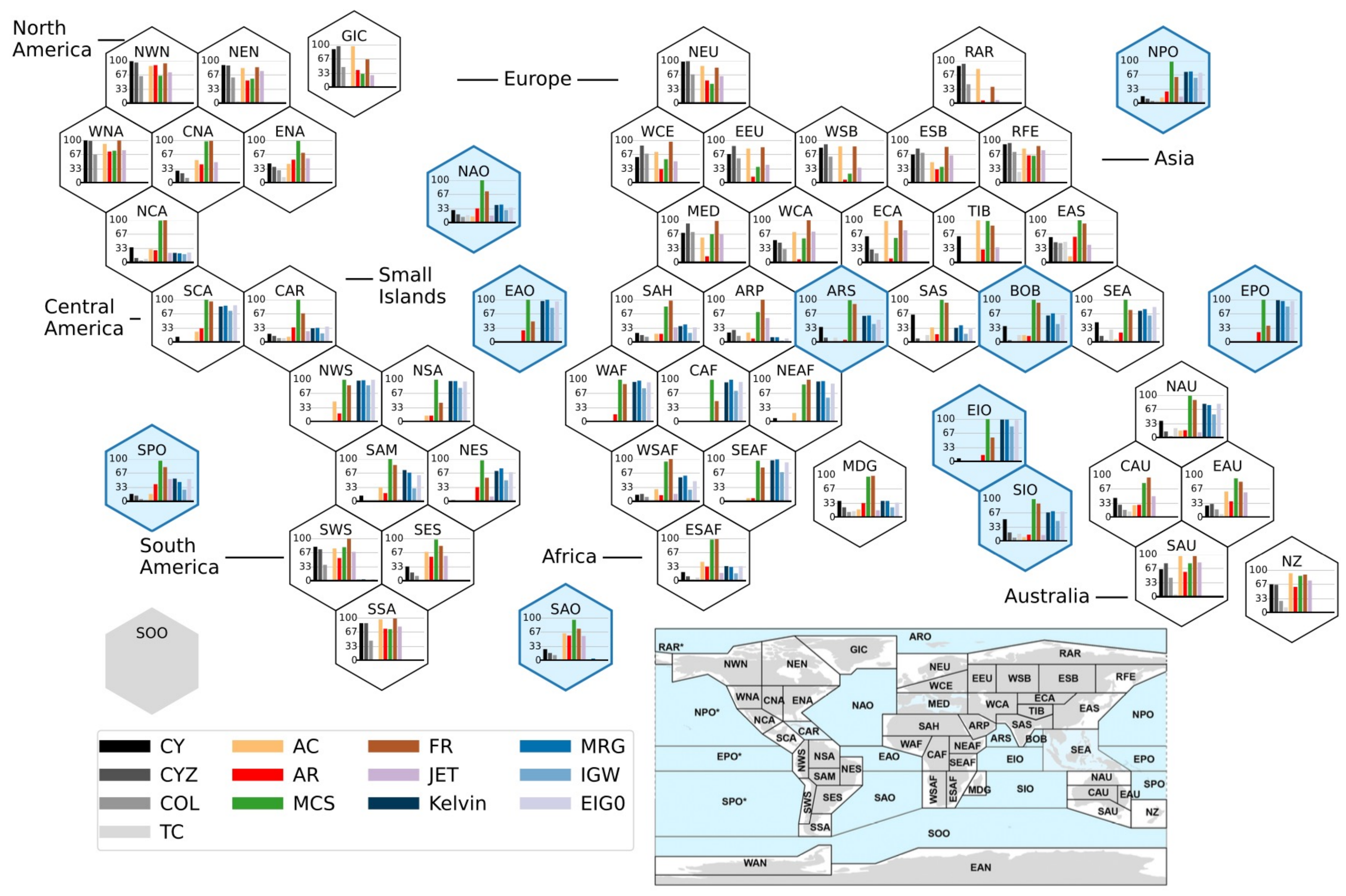
The **FRONTIER** project aims to address some of the challenges that are emerging from the rapidly increasing volume of climate data freely available. As part of this work, we have developed new tools and metrics that can benefit the wider community. In particular, we will present a novel feature tracking tool called the ***Multi-Objective Analysis of Atmospheric Phenomena (MOAPP)***. MOAAP tracks multiple atmospheric phenomena and has been used to understand their relationship to extreme precipitation. We will also present a new framework and composite metric called the ***Bergen Metric*** which summarises the overall performance of climate models and aims to ease interpretation of results from multiple error metrics.

Tracking Tool: Multi-Objective Analysis of Atmospheric Phenomena (MOAPP)

Phenomena Tracked

1. Surface cyclones (CYs)
2. Mid-level cyclones (CYZs)
3. Cut-off lows (COLs)
4. Tropical cyclones (TCs)
5. Anti-cyclones (ACs)
6. Atmospheric rivers (ARs)
7. Mesoscale convective systems (MCSs)
8. Fronts (FRs)
9. Jets (JETs)
10. Kelvin waves (Kelvin)
11. Mixed Rossby gravity waves (MRGs)
12. Inertia gravity waves (IGWs)
13. Eastward inertia gravity waves (EIG0).





Guiding Principles:
- use a minimum set of variables to identify and track a maximum number of atmospheric phenomena.
- only use standard output variables that are commonly available from reanalyses and climate models.

Extreme precipitation is typically associated with multiple atmospheric phenomena that interact across scales.

Input variables:
Temperature@850hPa, Eastward Wind Speed @850 hPa and @200 hPa, Northward Wind Speed @850 hPa and @200 hPa, Precipitation, Cloud Brightness Temperature, Sea Level Pressure, Geopotential Height @ 500 hPa, northward integrated vapor flux, eastward integrated vapor flux.

Frequency of features in the vicinity (1,000 km radius) of extreme precipitation events. Consider the 100 most extreme hourly precipitation events in each. Blue hexagons = ocean regions and grey hexagons = No GPM-IMERG precipitation data.

Pre-print: Prein et al. (in review), The Multi-Scale Interactions of Atmospheric Phenomenon in Extreme and Mean Precipitation, DOI: 10.22541/essoar.167591088.85086118/v1
Python Code: https://github.com/AndreasPrein/MOAAP/wiki

A new Framework and composite metric – The Bergen Metric

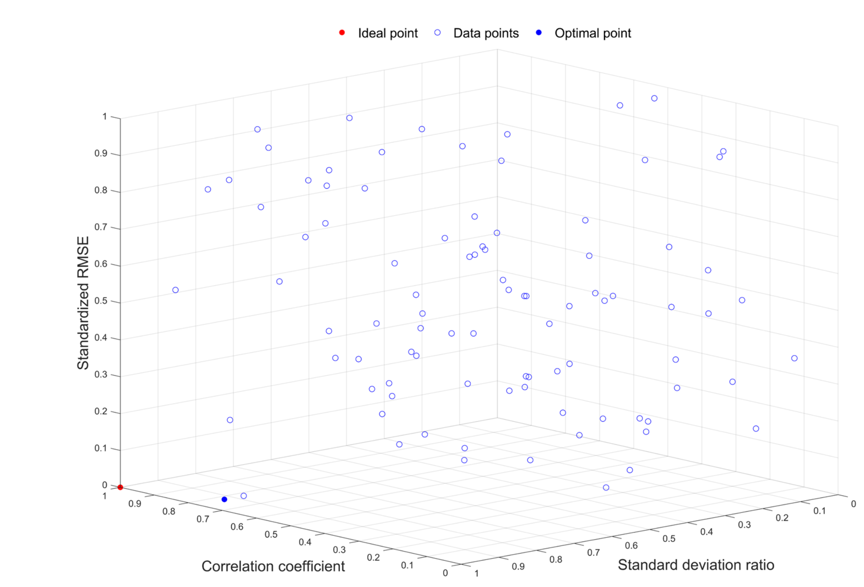
The Bergen Metric

Purpose: to summarise the overall performance of climate models and ease interpretation of results from multiple metrics.

Framework:
- Cluster error metrics into n clusters whose members generate similar rankings of climate models compared to those in the other clusters.
- Randomly choose one metric from each cluster
- Calculate the Bergen Metric using:

$$d_n(u,v) = \left(\sum_{i=1}^{n} |x_i(u_i, v_i)|^p\right)^{1/p}$$

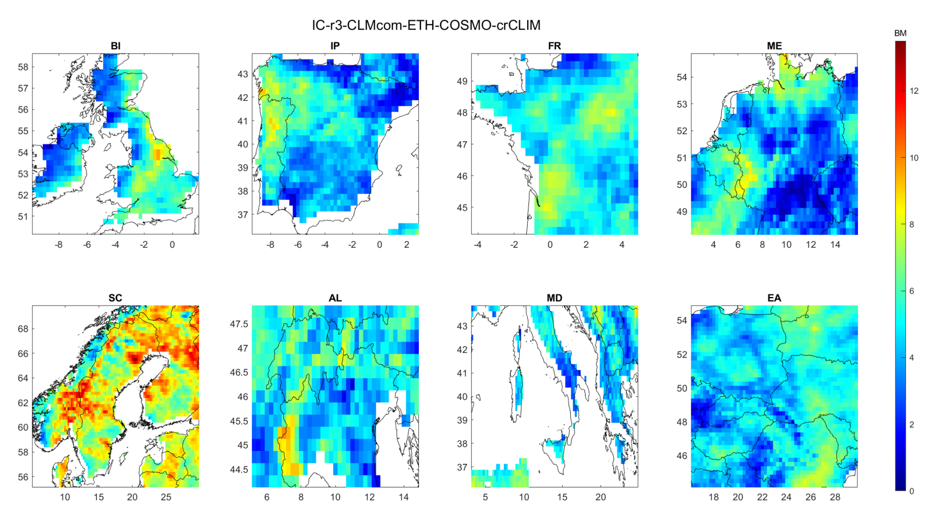
$x_i = u_i - v_i$
u_i = ideal value for v_i
v_i = error metric
P = p-norm
n = number of dimensions/metrics



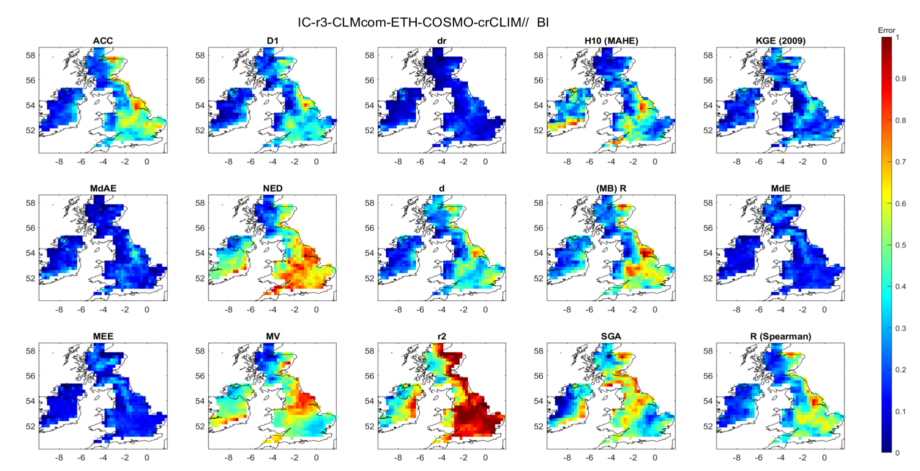
Example for three dimensional ideal point and the solution space of corelation coefficient (x-axis) , standard deviation ratio(y-axis) and standardized RMSE (z-axis). The new metric is the Euclidian distance between the ideal point (red) and optimal point (blue).

$$\text{Bergen Metric (BM)} = \sqrt[p]{(0-RMSE)^p + (0-Bias)^p + (1-SD)^p + (1-R)^p}$$

SD: Standard Deviation   R: Correlation Coefficient   p: p-norm



Spatial distribution of Bergen metric using precipitation data for all the eight Rockel Regions regions.



Spatial distribution of the error metrics used to compute the Bergen metric for precipitation and for British Isles (BI) region.

Pre-print: Samantaray et al. (in review), Bergen Metrics: composite error metrics for assessing performance of climate models using EURO-CORDEX simulations, DOI: 10.5194/gmd-2023-134
Python Code: https://github.com/badal01/Error-metrics-clustering

NCAR   UFRN UNIVERSIDADE FEDERAL DO RIO GRANDE DO NORTE   BJERKNES CENTRE for Climate Research   NORCE

NORCE Norwegian Research Centre AS
www.norceresearch.no