

# Assessing the capacity of Earth System Models to simulate spatiotemporal variability in fire weather indicators

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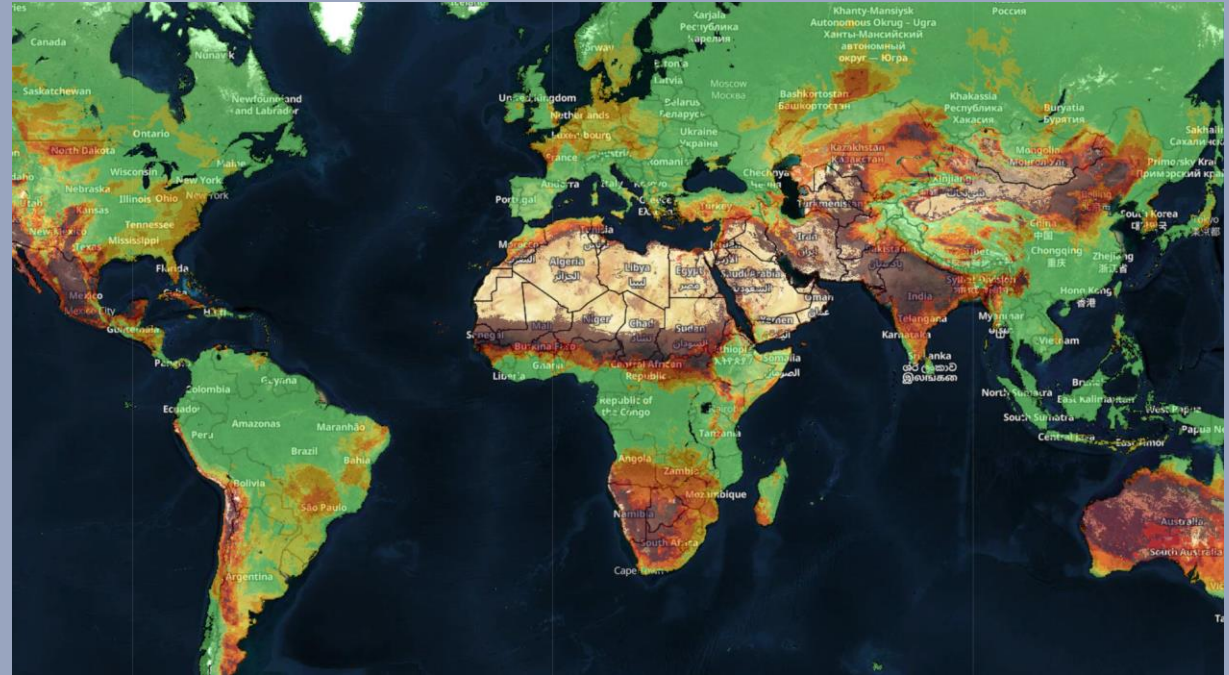
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# FUTURE CLIMATE-FIRE RELATIONSHIPS

- Global fire regimes and their geographical distribution are influenced by weather and climate
- Fire danger is likely to increase at the global scale in the future, due to warmer temperature and changes in precipitation patterns
- Need for more reliable projections of future climate-driven fire danger in order to enable appropriate decision-making



Fire danger forecast on 28 April 2021 (Global Wildfire Information System, European Commission)

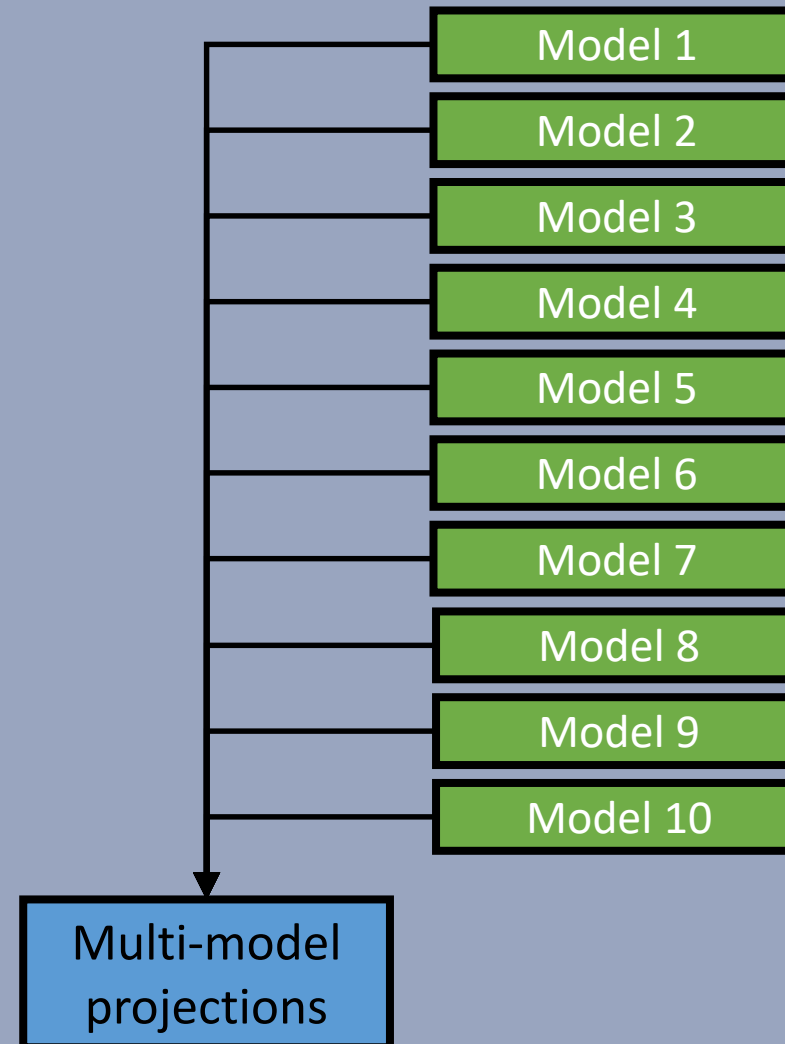
# USING MULTIPLE EARTH SYSTEM MODELS

Growing number of Earth System Models;  
**model evaluation** is a continuous challenge

- Assessment of model performance needs to be oriented for specific objectives and/or variables
- Accounting for uncertainties from internal climate variability and inter-model differences

Global projections of fire weather are currently limited to the use of a single model or **multi-model mean**

But are some models performing better than others?



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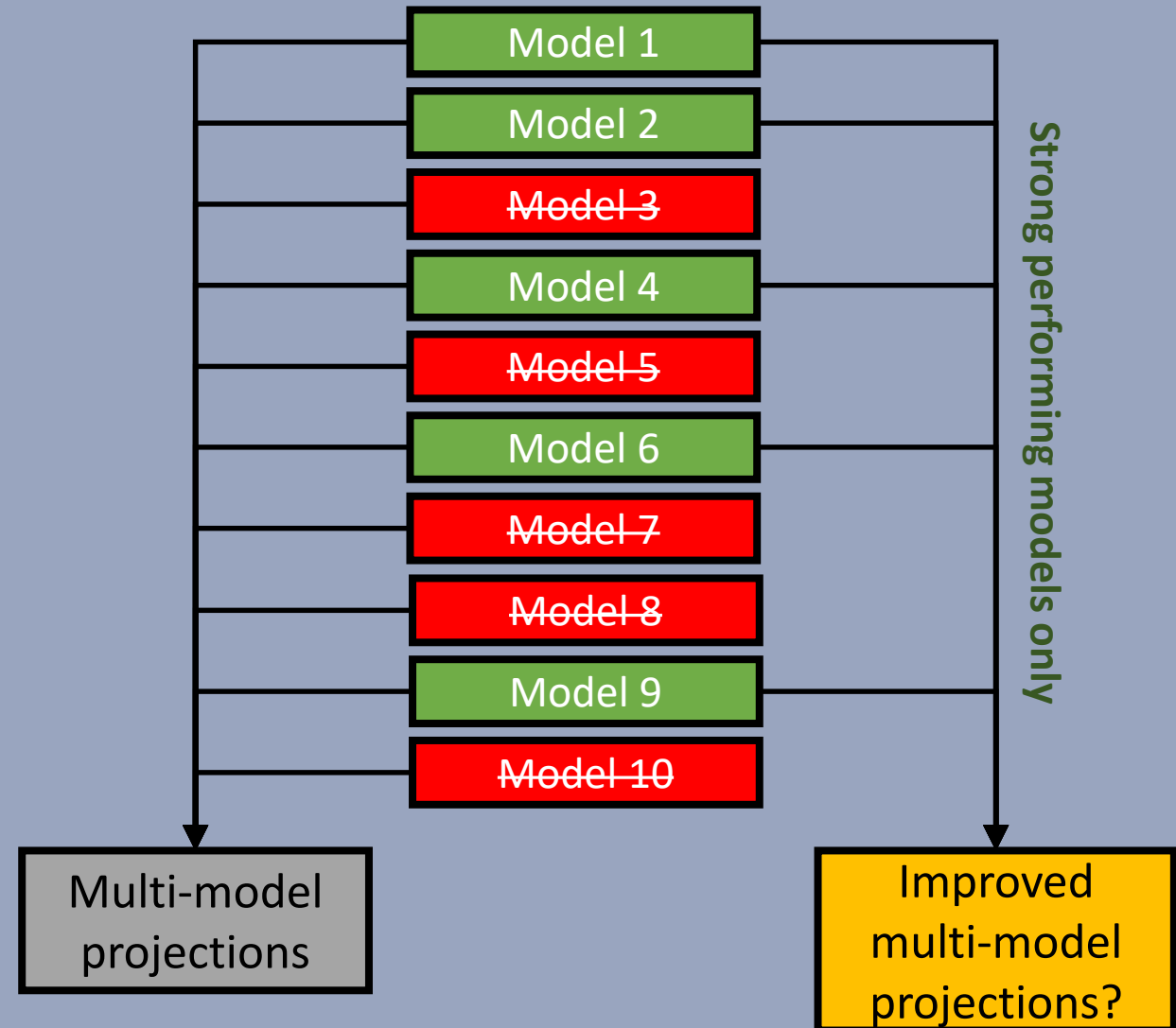
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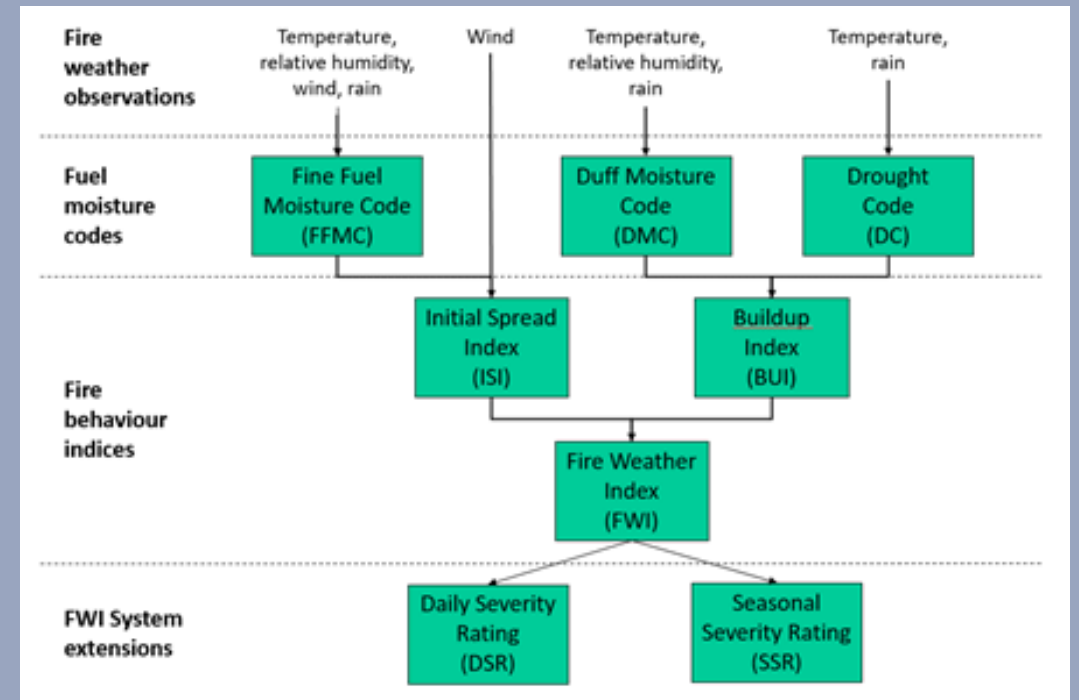
But are some models performing better than others?

Should the weaker models be excluded from the multi-model projections?



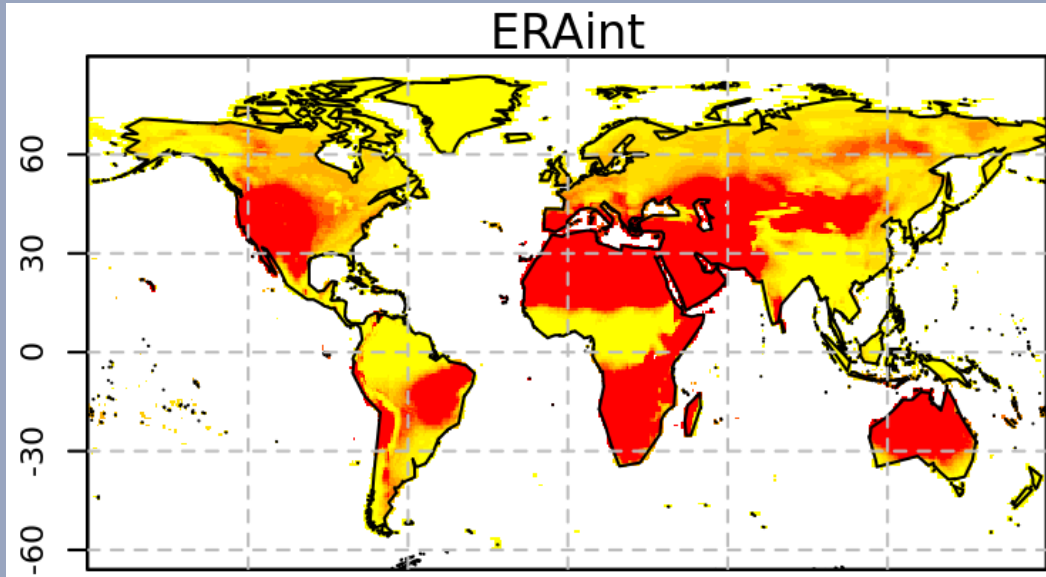
# EVALUATING FIRE WEATHER INDICATORS

- Daily fields from 18 CMIP6 Earth System Models.
- Here, we evaluate model-simulated FWI for the period 1980-2014.
- Model-simulated FWI compared with the Global Fire Reanalysis dataset (Vitolo et al., 2019).
- Comparison in mean, median and 90th percentile statistics is made using different metrics:
  - Ø Absolute and relative bias.
  - Ø Ratio of variance.
  - Ø Spatial correlation.



# RESULTS: model bias

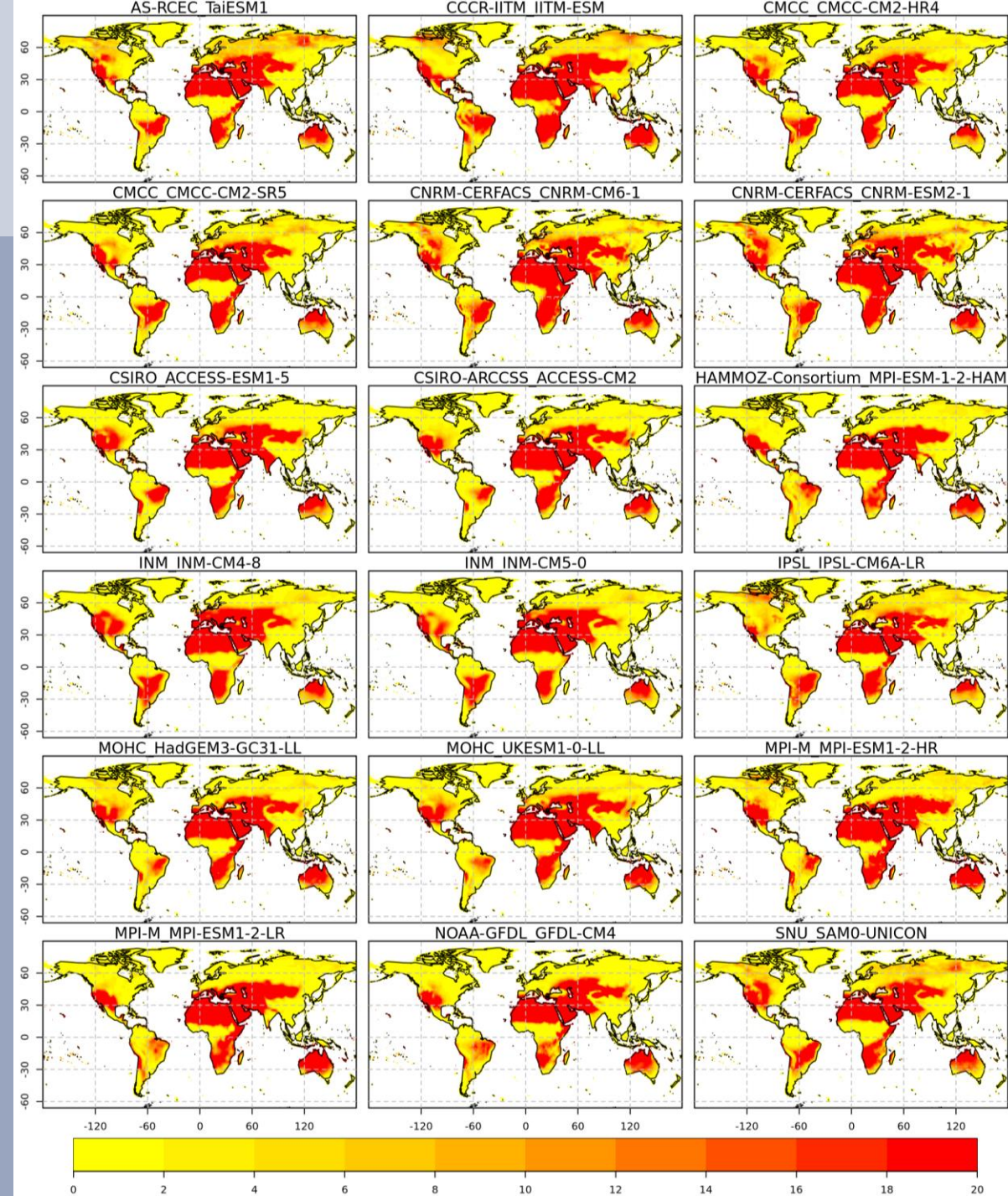
Observation



Figures show observed (reanalysis) and simulated **July mean FWI** for 18 different model ensembles

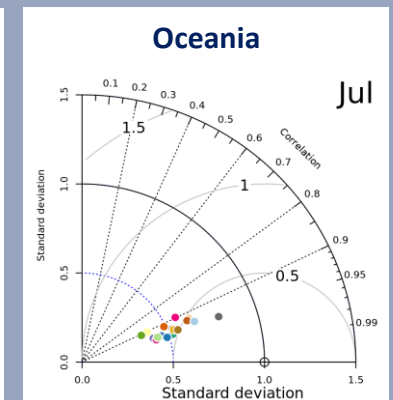
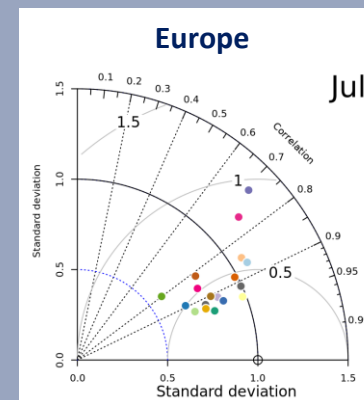
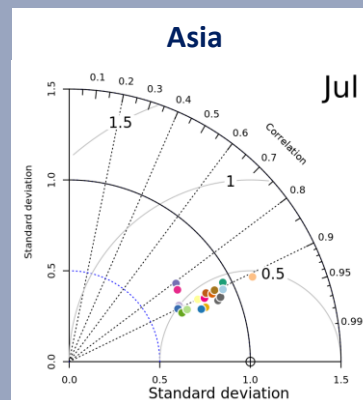
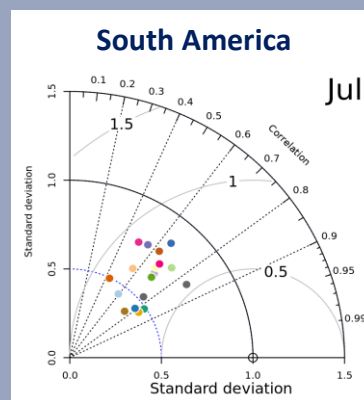
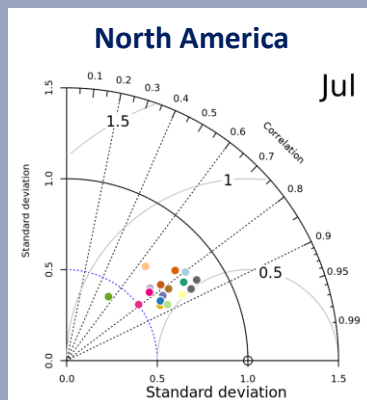
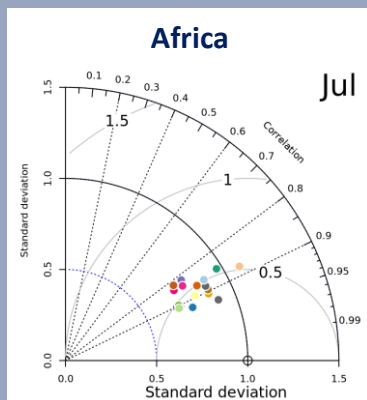
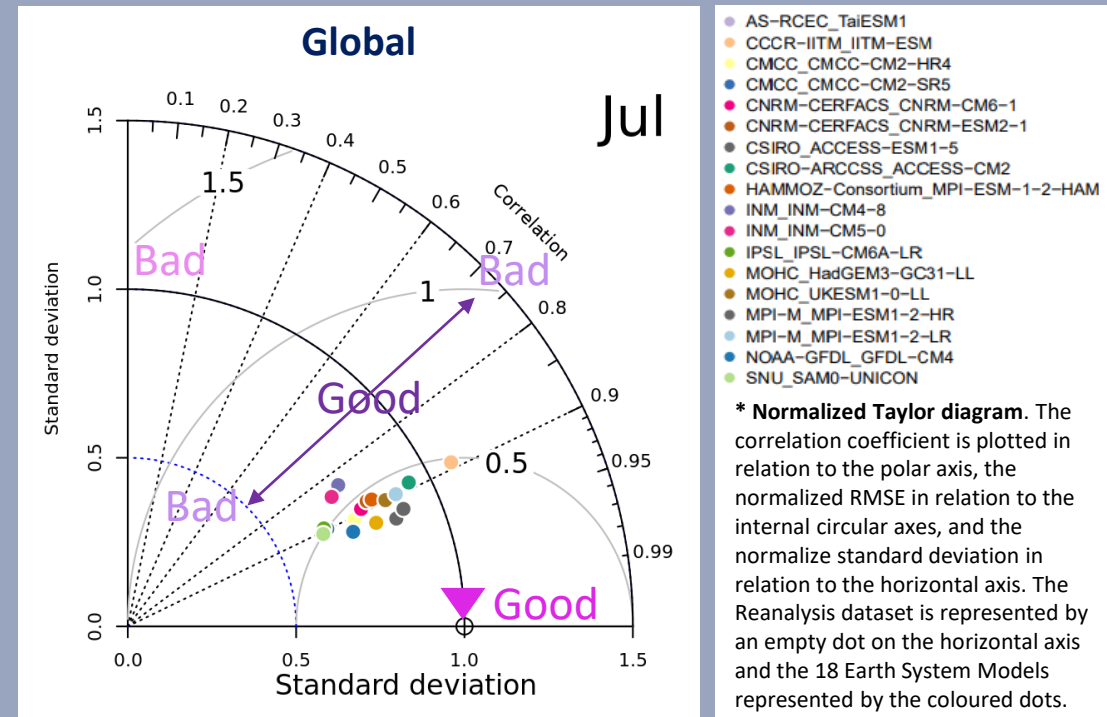
- Some models underestimate FWI values in parts of South America:
  - HadGEM3-GC31-LL
  - MPI-ESM1-2-LR
- Overestimation in India:
  - CNRM-CERFACS models

Simulated FWI

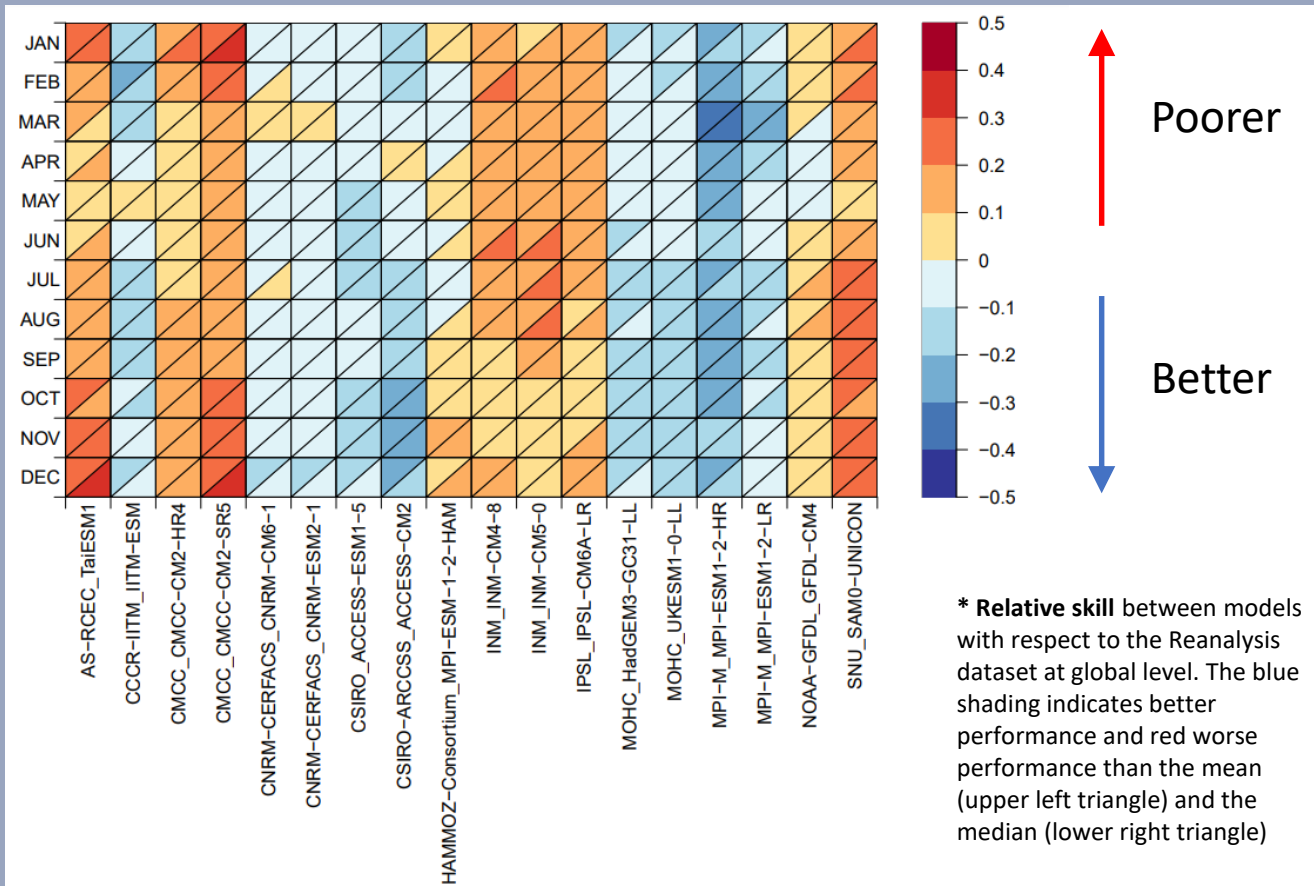


# RESULTS: model skill by continent

- Taylor diagrams provide a good statistical summary of how well a model represents the observed statistics: correlation, RMSE and standard deviation
- For instance, the model MPI-ESM-1-2-HAM performs quite well in Europe, but performs poorly in South America
- Another example is the IITM-ESM, that performs relatively well for Africa but not in the case of North America



# RESULTS: model skill by month



- The matrix displays the model **relative performance** by month at the **global scale**
- Some models consistently **performing better** in the mean and median throughout the year
- Other models show **poor performance**

# SUMMARY

- Representation of FWI in 18 CMIP6 Earth System Models evaluated.
- Preliminary results at **global scale** for the **month of July** show some models performing better than others (see right).
- Using multi-model means could be limiting given that model performance can vary substantially depending on the season and region of focus.
- Our approach will be used to identify a performance threshold that models must meet to justify being part of multi-model projections.

|                                  |
|----------------------------------|
| <del>AS_RCEC_TaiESM1</del>       |
| CCCR-IITM IITM-ESM               |
| <del>CMCC_CMCC_CM2_HR4</del>     |
| <del>CMCC_CMCC_CM2_SR5</del>     |
| CNRM-CERFACS CNRM-CM6-1          |
| CNRM-CERFACS CNRM-ESM2-1         |
| CSIRO ACCESS-ESM1-5              |
| CSIRO-ARCCSS ACCESS-CM2          |
| HAMMOZ-Consortium MPI-ESM1-2-HAM |
| <del>INM_INM_CM4_0</del>         |
| <del>INM_INM_CM5_0</del>         |
| <del>IPSL_IPSL_CM6A_LR</del>     |
| MOHC HadGEM3-GC31-LL             |
| MOHC UKESM1-0-LL                 |
| MPI-M MPI-ESM1-2-HR              |
| MPI-M MPI-ESM1-2-LR              |
| NOAA-GFDL GFDL-CM4               |
| <del>SNU_SAM0_UNICON</del>       |

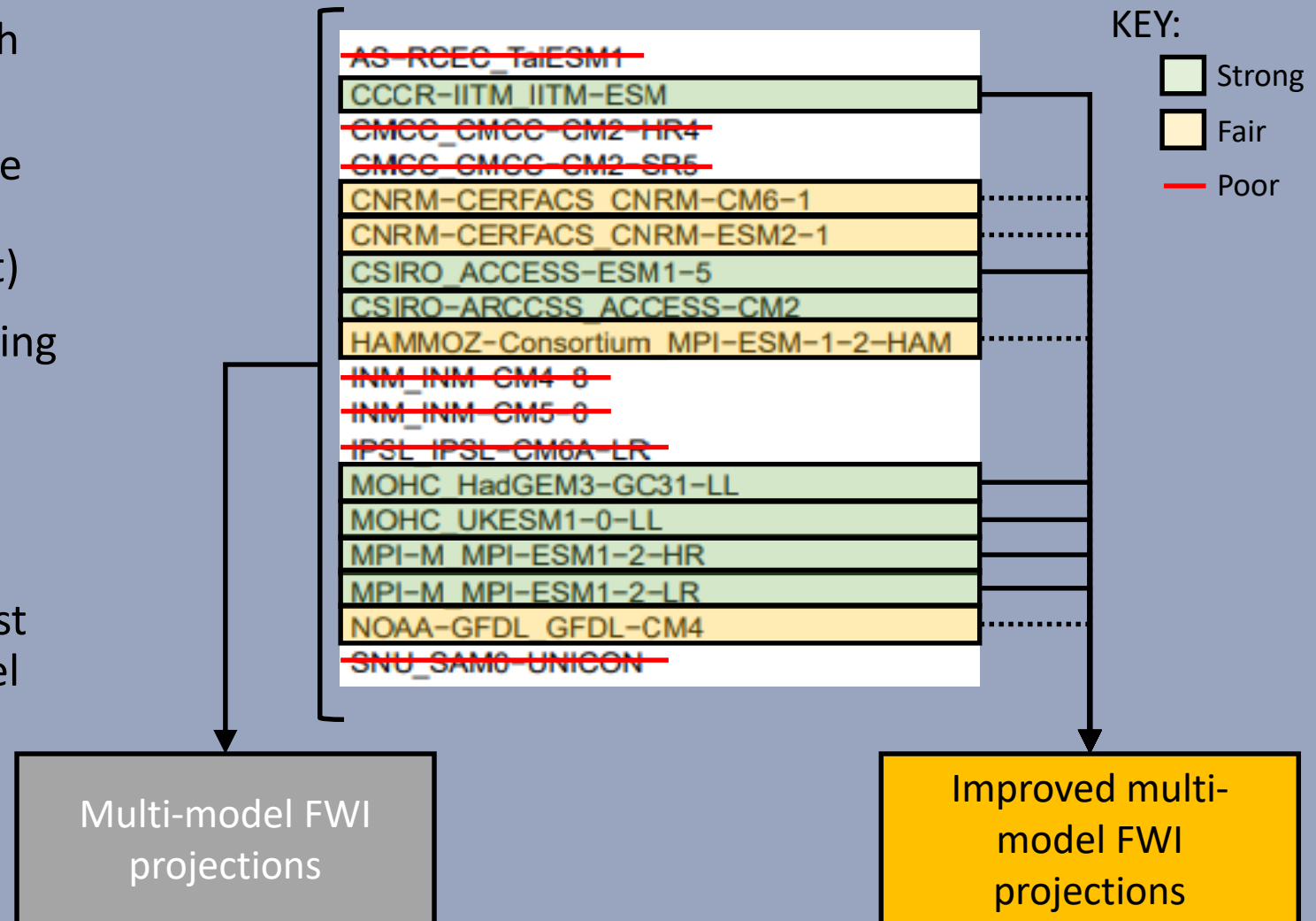
KEY:

- Strong
- Fair
- Poor

Multi-model FWI  
projections

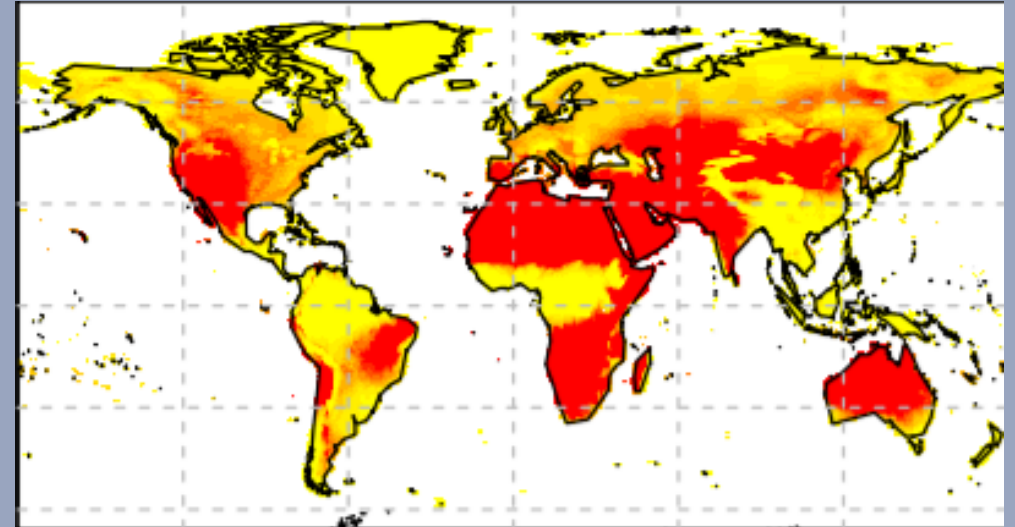
# SUMMARY

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- Preliminary results at **global scale** for the **month of July** show some models performing better than others (see right)
- Using multi-model means could be limiting given that model performance can vary substantially depending on the season and region of focus
- Our approach will be used to identify a performance threshold that models must meet to justify being part of multi-model projections.
- This is very important for future fire weather scenarios



# NEXT STEPS

- Add additional ESMs to our analysis.
- Analyse model performance for the other components of the Canadian Forest Fire Weather Index System.
- Calculate projections using highest-performing models, **excluding** models performing poorly or **weighting** them based on their performance.



Fire Weather Index simulated by one single model

# Thank you

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