ModE-Sim – a medium-sized atmospheric general circulation model (AGCM) ensemble to study climate variability during the modern era (1420 to 2009)

1.1 Hypothesis :

The primary motivation of ModE-Sim lies in its role as a medium-sized ensemble of AGCM simulations spanning an impressive 600-year period (1420 to 2009). The objective is to provide a versatile tool for studying climate variability, with a focus on understanding extreme events. The hypothesis is that this ensemble, with its diverse setups, can effectively capture internal variability and shed light on the mechanisms driving climate extremes.

1.2 Contribution:

ModE-Sim makes a significant contribution by not only addressing mean state biases but also excelling in sampling internal variability, especially concerning near-surface temperature. Its unique design, encompassing different setups reflective of uncertainties in forcing and boundary conditions, adds a valuable dataset to the climate research community.

1.3 Methodology:

The methodology involves computing heat wave frequencies as a case study for extreme events. The ensemble is assessed based on 2 m temperature data, comparing results with established reanalysis datasets (20CRv3 and ERA5). The analysis covers distinct periods (1780–1850 and 1950–2005) and adopts two heat wave definitions, incorporating fixed climatology and a 31-year running window to account for anthropogenic warming.

1.4 Conclusion:

In conclusion, ModE-Sim emerges as a potent tool for studying climate variability. It successfully captures internal variability, demonstrated through various timescales in temperature and precipitation. Notably, its ability to depict extreme events, such as heat waves, positions it as a valuable resource for understanding the intricate processes driving climate extremes.

2.1 First Limitation:

An inherent limitation is the need to analyze epochs separately due to differences in forcing and boundary conditions. Although this approach is recommended for accuracy, it introduces complexities in data interpretation and analysis. Researchers must navigate these nuances to extract meaningful insights from ModE-Sim.

2.2 Second Limitation:

While ModE-Sim performs well overall, there are discrepancies, particularly in the early 20th century in the Southern Hemisphere, attributed to missing data and uncertainties in 20CR. Acknowledging and addressing these uncertainties is crucial for refining the model's performance during specific historical periods.

3. Synthesis:
ModE-Sim's findings on heat waves hold practical implications for climate studies. The ability to link observed heat waves to external forcing, especially in the Southern Hemisphere, opens avenues for understanding climate dynamics. This synthesis suggests that the insights gained from ModE-Sim can inform future climate models and contribute to refining strategies for climate adaptation and mitigation. The dataset's availability facilitates further exploration and comparison by the broader scientific community, fostering collaboration and advancing climate science.