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CSC405

Climate Change Science and the Computational Challenge

On September 28, 2016, a seminar was presented by Ben Kirtman from the University of Miami’s Department of Atmospheric Sciences. He is a part of the Cooperative Institute for Marine and Atmospheric Studies, a research institute of Rosentiel School of Marine and Atmospheric Science. Kirtman addressed the importance of computational models and how they can be used to reflect the human influence on the climate. He stresses the importance of the urgency in understanding this, warning that the warming of the climate system is definitive, and it is 95 to 100% likely that human influence has been the dominant factor of global warming. The climate has been warming since the 1950s due to human activity and conclusively, it is necessary for us to mitigate this situation.

He began by introducing the challenges of forecasting the climate through time, space and complexity variables. Observing the real world is a big factor in defining the variables in models. The climate change models have ups and downs that do not correlate with the observed model, but the statistics taken on these models is the important factor, rather than the precision of how closely the models match up with reality. The argument in global warming are the natural variabilities that can cause the warming, like volcanoes, CO2, methane, El Nino, and other factors. The models help us understand the comparison of these natural causes vs human influence, and the combination of the two. Variation in these models are necessary, some based on first principle, some semi-empirical; how one researcher chooses to make what the objective is, is subjective.

By looking at the different models, we can see the temperature fluctuations. For example, it can be seen that the temperature is affecting the arctic keyhole. When ice melts, the deflector of light diminishes and allows more solar energy into the ocean, which further warms the ocean. Glaciers can also be seen to be declining, 98% of them are retreating whilst the natural cycle of glaciers are 50% growth, and 50% retreat. For more understanding, we can look at the Gulf Stream, which is being affected by the rapidly melting ice caps, which chokes the circulation of the stream. Judging from the graphs, we can predict that sea levels will lower in the east coast where the flow of water is fast, and see higher sea levels where it is slow.

The big problem here is the battle of balancing the plane of computing resources between resolution and complexity, for variability and detail is largely lost in low resolution simulations. Higher resolution reduces the need for a large ensemble size, and has more timescale variability. However, high resolution computations require great costs and great computing resources, which America is limited to. We can see this in the difference between the US climate model and the Euro climate model, which are both intelligent models, but the Euro model has a higher resolution, which allows them to define things much better, like prediction of location of rainfall, its droplet sizes, and cloud formations. Also, the climate models are extremely “naïve” in techniques. Improvements can be made when we create faster, more efficient codes written by computer programmers rather than by climate scientists who are borderline coders. The challenge in this is if computer scientists continued building from existing code, it is too complex, because the code has had been written on an inferior level, and rebuilding codes from the ground up takes up too much investment. The future of this research is in finding a good balance of resources, and the collaboration of highly skilled coders and climate scientists.