Final Report 'Enhancing Undergraduate Python and Modeling Skills: A Jupyter Notebook Multi-Core Server at Central Michigan University'

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Opportunities for students to develop programming skills throughout their undergraduate meteorology experiences are important to training the next generation of atmospheric scientists. The meteorology program at Central Michigan University (CMU), with support from a Unidata Equipment Award, has now purchased and deployed *Sprite.eas.cmich.edu*, a server dedicated to teaching undergraduates skills in Python, modeling, and increasing the use of Jupyter Notebooks. Implementation of the server occurred during Fall 2017. Students became active on the server during Spring 2018, making use of it in the Atmospheric Modeling (MET 480) and Computer Applications in Meteorology (MET 315) courses. In the senior level Atmospheric Modeling course, students worked through a series of Jupyter notebooks and worksheets developed locally and adapted from MetPy workshops as part of their instruction in Python on the server, evolving from learning basic syntax through reading in netCDF4 data, to retrieving and plotting of GFS forecasts and other model data from the National Centers for Environmental Information (NCEI). This forecast data and reanalysis data from the North American Regional Reanalysis was used to evaluate the forecast performance and reasons behind model failure. In addition, students developed their skills by running increasingly challenging modeling tasks. Initially, students ran simple difference models in Python, followed by simple cloud modeling, and finally idealized WRF simulations of supercells and squall lines. Students plotted the results of these simulations using Python and explored how modifications to model parameterizations changed the resulting simulated storms. In Computer Applications, students learnt the basics of interacting with the Unix shell, and experienced their initial exposure to Python. One lesson learned by faculty through these initial attempts at teaching Python is the need for more structured walkthroughs of elementary skills in order to improve student uptake. To remedy this, faculty created screencasts demonstrating commonly used tasks, which will soon be shared with the Unidata community.

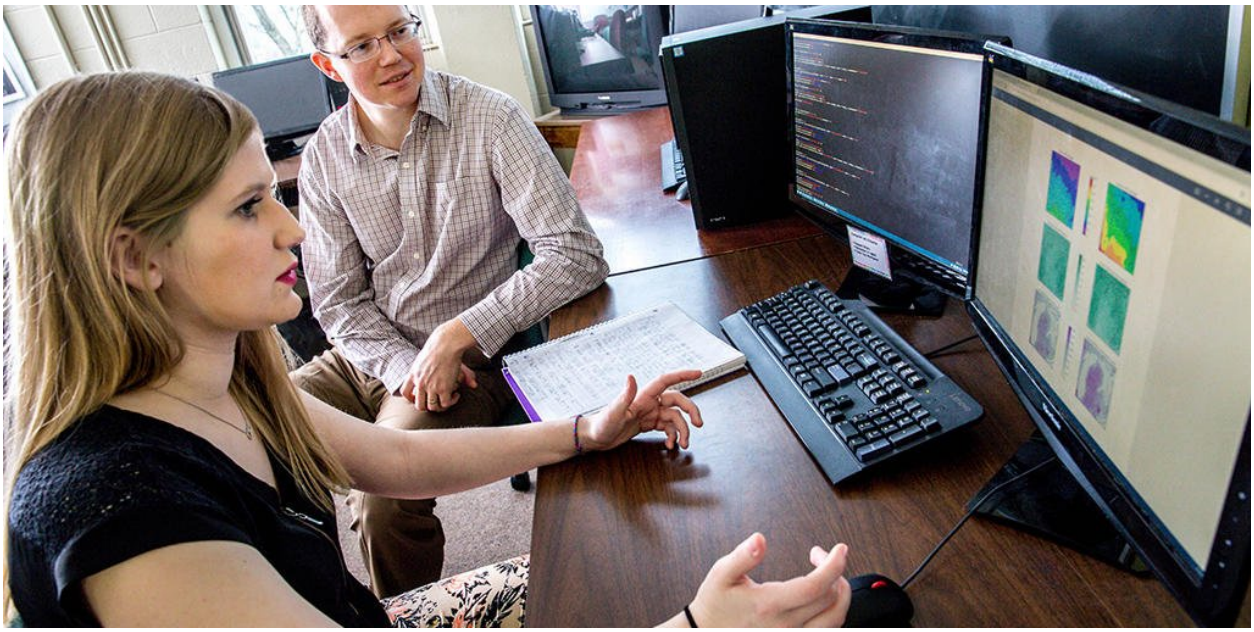

Figure 1: Undergraduate researcher Emily Tinney (advised by Prof. Allen) working in Python on Sprite to explore dynamically downscaled climate model output. Photo Credit: CMU Photography.

In addition to the deployment of *Sprite*, university funds have been provided to the Meteorology program to purchase additional disk storage for Sprite, along with six new computers dedicated to undergraduate research. Unidata software has been installed on these workstations, and students are able to easily use them to work with the Jupyter notebooks hosted on *Sprite*. These new workstations are in a separate space from our teaching computer lab, allowing students to better concentrate on their research. Future plans to leverage *Sprite* during Fall 2018 include the use of JupyterHub in additional courses such as Mesoscale Meteorology (MET450), Climate Dynamics (MET460) and Atmospheric Thermodynamics (MET310). A local JupyterHub has been established on *Sprite* during Summer 2018, allowing students access to notebooks without the complications of understanding how to use the Linux operating system, and allowing remote, web-based access to the server from any browser. Development of notebooks for these courses is underway and will be shared with the community via GitHub following preliminary testing. It is expected that within the next couple of years, exposure to programming via *Sprite* will be at least part of each course in the CMU Meteorology program.