Singletrack Project Progress Report
April 2018

Introduction: What is Singletrack?

Within NCAR, the vision for a unified atmospheric model is being developed by a group of scientists and software engineers from all the NCAR laboratories that develop and employ atmospheric simulation technology. The Singletrack steering committee, composed of approximately 20 individuals, has spent the last 3 months analyzing applications-based requirements for a unified community atmosphere from weather to climate.

The NCAR-wide face of the project is a wiki page: https://wiki.ucar.edu/display/singletrack/ . This contains information about the project, especially contact information and a calendar. The core group, that we refer to as the *steering group*, has a standing meeting weekly. Our goal is outlined in two charges from Jim Hurrell.

The Singletrack project dovetails with several other NCAR wide development efforts. One is the development of a *Community Physics Driver* (CPD) begun in early 2018 to enable the unification (within a single repository) and sharing of physics across the NCAR atmospheric models. Another one is the *Model Independent Chemistry Module* (MICM) that unifies approaches to chemistry in global and regional models. A number of efforts to develop *scale-insensitive* (or *scale-aware*) atmospheric physics have been ongoing for some time both inside and outside NCAR, with the expectation that advances will lead to a smaller number of physics components and suites covering the application space. Efforts are ongoing to examine dynamical cores and extensions of these cores for geospace applications. There are also projects underway to port atmospheric model components to emerging computer architectures employing accelerators (e.g. GPUs), that will feed directly into Singletrack. These efforts on atmospheric modeling technology are complemented by other ongoing efforts to unify and advance other ESM components, for example the land models (Community Terrestrial System Model, CTSM), and chemistry (Multi Scale Interactive Chemistry Model for Atmosphere, MUSICA).

Resources for this visioning effort, and for some of the initial implementation work, are coming from NCAR's NSF base budget. Where possible, outside funding is being leveraged to accomplish some of the work that enables Singletrack requirements. While it is expected that the support and ongoing development costs will decrease once the unified atmospheric model is in place and functioning across the applications, ongoing support and development costs for our existing models means that the unification efforts are not strongly funded at present.

Singletrack Progress

Singletrack developed a list of science goals for a unified atmosphere model that will help in the development of model requirements and possible prioritization of the development roadmap items. These were developed into specific applications

Four working groups were established to allow for detailed discussion of specific aspects of the atmospheric modeling system. These working groups are: (1) Unified Physics, (2) Data Assimilation, (3) Dynamical Cores/Computation and (4) Infrastructure. These groups formulated *science goals*, *requirements*, and developed *implementation roadmaps*. These working groups have been meeting about once a week, and their meetings are listed on the singletrack calendar available on the wiki. It is within these working groups that we have been entraining significant participation by NCAR staff outside of the Singletrack steering group (~60 people). Each working group contained members from across NCAR as needed for topical expertise.

The singletrack project leads also met with the NCAR external advisory panel in January, and the steering group had a productive discussion with Julia Slingo about unified modeling.

During March and April 2018, the project distilled the progress into goals, requirements and roadmaps for each working group, and across working groups dealt with issues of infrastructure and physics dynamics coupling. These detailed discussions have been summarized, and the results are to be archived on the singletrack wiki page for future reference. Finally, the steering group worked on defining particular target applications as a goal to focus around, and used that to develop vision documents and summaries for the NCAR Executive Committee.

The steering committee is also working now to develop a roadmap and its associated implementation plan. The roadmap involves outlining capabilities and the frontier science they enable within selected applications. This was started at the working group level, and then is being summarized. In particular, we aim to identify potential forks, roadblocks and missing resources. These reports are available on the Singletrack wiki whose address is given at the end of this document. The roadmaps are being used to help define tasks in an implementation plan.

Singletrack Next Steps

Our plans for the Singletrack effort are to continue to wrap up the initial definition phase, and then start to seek input to refine the work. We are presenting our work to the NCAR director and the NCAR executive committee in mid-April. We will continue to develop and detail the implementation plan, with details of tasks and resource needs.

Our next step is to begin our community outreach, and start discussing two ‘cross-cutting’ issues for community modeling: diagnostics and governance. These plans take us through the early summer (June) at which point we expect to re-assess with the NCAR director and Executive Committee on further presentation and discussion of plans and implementation.

Community Outreach

Community outreach is expected to take at least two forms. One is to approach selected ‘external champions’ who are interested community leaders in climate modeling, weather forecasting with mesoscale models, chemistry and geospace modeling to gauge their interest and incorporate ideas or comments. Singletrack has also planned sessions at the WRF and CESM workshops in June 2018 to present ideas and plans, and get feedback.

Diagnostics

Current NCAR community models have an extensive series of diagnostic tools for comparisons to observations. Many of these are community tools. These serve as model development and analysis tools. Singletrack will assess the current state of diagnostics and comparisons against observations across weather, climate, geospace and chemistry to determine how observations and diagnostics can facilitate the development of a unified modeling framework, and what the overall suite of diagnostics for a unified weather can climate model should look like. This will include an analysis of observations in critical areas, and will incorporate broader expertise at NCAR (and beyond).

Governance

The success of a community model depends on its relationship to the user community for both model analysis and development. NCAR has two successful models of community governance of atmospheric models (WRF and CESM), with slightly different approaches. Singletrack also intends to analyze and discuss these governance structures, and try to provide recommendations for a governance structure of a unified atmospheric model designed to satisfy the weather and climate communities.