

UCACN Model Advisory Committee Report

Based on August 3-4 Meeting

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**UMAC is a sub-committee of the
UCAR Community Advisory Committee for NCEP (UCACN)
Administered by the
University Corporation for Atmospheric Research**

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Preamble

On August 3-4, 2017, the UMAC (UCACN Modeling Advisory Committee) held an in-person meeting at the National Center for Weather and Climate Prediction near College Park, Maryland. The Agenda is provided in Appendix A. The meeting was partially held in parallel with meetings of the NGGPS Principal Investigators and of the Strategic Implementation Plan (SIP) Working Group leaders. Additional invitees included NMC and NOAA modeling leaders, and other NWS/NOAA staff. This document provides a Summary Statement that represents common themes articulated by UMAC members as well as individual narratives from most of the UMAC members. Thoughts on the future of UMAC are also provided.

Summary Statement

Overarching Comments

The Next Generation Global Prediction System (NGGPS) Strategic Implementation Plan (SIP) process has successfully incorporated a large community of government and academic experts to contribute to the development of community-model based unified modeling systems. This engagement is a notable accomplishment and needs to be nurtured and made substantive. It is only the beginning and much work will be required.

The SIP Working Groups have made great progress identifying the near-term (1-3 year) priorities for many aspects of an end-to-end unified forecast system. Likewise, there is an improved estimate of resource needs. This is a unique opportunity to improve model development and implementation processes within NOAA. To take advantage of this opportunity effective governance and management practices need to be implemented as soon as possible. A year from this meeting is far too long in the future.

The progress in Convection Allowing Model (CAM) is encouraging. There is demand from the field forecast offices for CAM ensemble guidance. The operational HREF-2 is a good start but research on a single-model CAM ensemble should be a high priority, initially with the HRRRE, and subsequently with a CAM version of FV3.

Initiatives to develop unified metrics and standard testing are encouraged. This needs to be part of a verification and validation plan that spans the applications of the unified forecast system. Community participation will be required.

Strategic Planning

The efforts on strategic planning need to continue and need to identify high-level, quantifiable goals. Five-year and ten-year goals should be identified. Two-year and three-year activities need to be aligned with these longer-term plans. The culture of short-term urgency undermining strategic, organizational goals must be changed. The UMAC restates the need for evidence-based decision-making that balances scientific excellence, cost, and end user requirements.

Strategic plans for forecast systems need to be aligned with high-performance computing. That is, High-Performance Computing (HPC) requirements and procurements need to reflect strategic goals such as Warn-on-Forecast and seasonal and sub-seasonal forecasts. It should be beneficial to identify and execute test cases to explore the cost and benefit of enhanced modeling capabilities.

The Strategic Implementation Plan (SIP) has been a new and very useful process for NCEP and the community. The process has been generally open, transparent, and the community has been engaged, which are all positives. However, in many respects the SIP lacks sufficient coordination and prioritization among the various projects, and generally have not been linked to resource allocations (human and computational).

Strategic goals (e.g., a 5-year strategic plan) need to be announced publically, creating a positive and visionary image, and citing the benefits for society.

UMAC recommends rebranding GFS when a superior global model is deployed.

Next Generation Global Prediction System (NGGPS) and the Environmental Modeling Center (EMC)

The NGGPS project, through its SIP working groups and in concert with NOAA and non-NOAA partners, has built community and capacity external to EMC. The community and capacity represent enormous strategic investments and provide the foundation for meeting the goals of world-class environmental forecasts. How these strategic investments will migrate into EMC is far from clear. It is not obvious that EMC as a unit views these investments as strategic organizational assets. New governance and management practices are needed to assure that the benefits of these strategic investments are realized. Questions that need to be addressed are:

- What is the role and function of the NGGPS/SIP Working Groups going forward?
- What are the mechanisms to encourage and support longer-range support?
- How can collaboration with NCEP be made more attractive?
- Are resources adequate for the community to implement the SIP Working Group recommendations to realize the goal of an end-to-end FV3-based unified forecast system?

Community

Though a significant community has been engaged in the NGGPS and SIP processes, continued engagement and future success is not assured. Despite the good will contributions by many, resources to support community participation in model development and evaluation are needed (see questions in previous section). A governance structure that incorporates community involvement in an effective manner needs to be stood up. That is, NCEP should aspire to develop of a large community of active modelling users of the NGGPS model beyond the SIP community.

To further clarify what UMAC means by community, we offer the following definition:

A successful community is "a vibrant, active and very large set of users of the model that have downloaded, installed and frequently run the model, and are willing to share their technical experiences and scientific knowledge of the model with others."

This requires the modeling system to be well-documented, with a well-resourced support system, and a governance structure that also involves the community. It also requires a mechanism for feedback from model stakeholders (e.g., operational forecasters) who often have insight into model problems.

In order to catalyze such a community, UMAC proposes the "Grad Student Test": Can a typical graduate student easily figure out how to download , install and run the model successfully and have resources available for help if needed.

The NCAR-NOAA letter of intent to collaborate has the potential to be game changing. However, there are many issues conflated in potential partnerships which need to be identified and planned. The expectations associated with the intent to collaborate are high and not consistently communicated. UMAC encourages the development of an MOU (Memorandum of Understanding) to articulate in more detail how the goals of the LOI will be implemented.

Global Model Test Bed (GMTB) and Developmental Testbed Center (DTC)

UMAC was confused by the role(s) of GMTB. There is a clear near-term mission associated with the Common Community Physic Package (CCPP) and the Interoperable Physics Driver (IPD). There are less clearly-defined roles for the testing, verification, and validation of part or all of the coupled-model applications. Finally, there is a perception by some that GMTB is a primary resource and organization for community support. Related comments and questions include:

- The mission and roles of Developmental Test Center (DTC) & Global Model Test Bed (GMTB) do not seem well defined or communicated. For example:
 - How will physics integration and testing be coordinated?

- Expectations of testing, community support, and scope of modeling applications are projected onto a notional GMTB. How will this be addressed?
- The GMTB needs community participation to help define its governance and role in NGGPS implementation and research goals.
- Resources (e.g., for documentation, tutorials, workshops, computing, etc.) and planning do not appear to be aligned with expectations for an active community modeling effort.
- We note here that while the GMTB/CCPP/IPD at least constitutes a mechanism for research and implementation of improved physics in NCEP modeling system, no such mechanism or plan is available for the vital data assimilation component of the modeling system. The JEDI effort is commended but an overall vision/ plan for all aspects of data acquisition and data assimilation is not apparent.

Research

NOAA needs to improve mechanisms to support long-range research in direct support of its forecast mission. Long range is defined as a 3- to 5-year, and 5- to 7-year, the distinction being that on the 3-5-year time frame the strategic plan should be targeting development and implementation for next-generation releases. Some in UMAC feel that many current NGGPS funded projects (which are 1-2 years in length) do not meet the standard of being relevant to near-term implementation needs. UMAC notes that planning, both strategic and implementation, is necessary to increase the relevance of research to ultimate operational implementation; - that is, there has to be a balance between the need for short-term projects immediately relevant to next-generation implementation goals, and longer-term research needs. As noted earlier, this must be a community effort and NOAA needs to improve the benefits of collaborating with NCEP.

Communications

As with all organizations, communications require constant attention and practice. This is especially true for development of complex systems across many individuals and multiple organizations. If a community effort is to succeed, a communication plan needs to be developed, implemented, and adhered to. The development of the NGGPS SIP Communication Plan is a positive development, but how it will be put into action is not clear.

High Performance Computing and WCOSS

UMAC continues to advocate for a stable, multi-year procurement plan for High-Performance Computing, hopefully one that does not require natural disasters such as Sandy to motivate or justify budget lines. This multi-year plan should include a computing requirements analysis to align computing investments with the resource

needs. We note that obtaining top HPC performance among national NWP centers is a moving target. In a recent list of the top 500 fastest supercomputers in the world, the new NOAA/WCOSS Intel Broadwell clusters Mars and Venus are at numbers 131 and 132, behind the Met agencies of Japan (4), UK (15, 46, 47), ECMWF (27,28), Korea (58,59), and France (61, 62). We also realize that it is difficult for NCEP to achieve this without support from leaders in NOAA and DOC, and advocacy from the external community.

There are two additional vital components to NOAA HPC acquisitions: First, research computing capacity has to remain commensurate with operational capabilities; otherwise new ideas and implementations cannot be properly developed and tested. [Note that “commensurate” here does not mean equal; research needs should also be scoped out via a requirements process, which may result in R&D requiring more HPC than operations.] Second, not all HPC resources should go just for increased CPU (super-computer) acquisition; it is vital to have “HPC investment balancing”, in which disk storage, archival storage, memory and interconnect bandwidth as well as software to support data management and workflow are obtained to optimize both operational and R&D effectiveness.

As noted throughout the individual UMAC narratives, NCEP is being strongly encouraged to use its available computing capacity to move boldly toward a convection-allowing model ensemble, and improved physics and data assimilation for all models. UMAC notes that there are several ways to increase computing capacity for these HPC resource-intensive goals. One is to decrease the amount of “white space” and make more effective use of the existing capacity. Second, we encourage use of very fast compute clusters to handle runs for which the costly 99.99% reliability standard for WCOSS is not required, freeing up time for convection-allowing model ensembles. Finally, owing to the large difference between peak and actual performance, it may be worth teaming with other large HPC centers and vendors to test methods for more efficient use of HPC capacity.

UMAC Future

There were some discussions that the August, 2017 meeting might be the final meeting of the UMAC. There was the presumption that a community governance would be set up and external community participation might be realized through a different process. In absence of that community governance and until informed otherwise, the UMAC considers itself still active.

The UMAC believes that NCEP and the NGGPS program would benefit from an advisory panel and is willing to help out as needed. If a different role is envisioned by NCEP/NWS (e.g., serving as advisory at the OSTI level), NWS/NCEP leadership needs to write the terms of reference, and then we can work together with respect to a new charter, scope, and membership.

The UMAC encourages NCEP to continue to engage with other branches of NWS and NOAA to ensure that there is a coherent and collaborative effort linking all aspects of water-related products (deep ocean, coastal ocean, estuaries, storm surge, waves, tides, hydrology, water quality, etc.). This could be assisted by, for example, creation of a UWAC (UCAR Water Advisory Committee).

UMAC Individual Contributions

Chris Bretherton

My comments largely echo those of Jim Kinter.

1. **Progress:** Overall, it is great to see EMC taking concrete steps to focus model development as recommended by previous UMAC reports. Bill Lapenta and Mike Farrar have also taken strides toward developing a framework for giving the external US model development community a more effective way to contribute to the development of future EMC models such as FV3GFS.
2. **Strategic goals:** I would like to see NCEP adopt a small set of strategic modeling goals including timelines that embody its strategic thinking re future models and also partnership with the external community, and consistently remind everyone inside and outside the organization what they are. A set that I came up with is as follows – some are easy, some are not. I'm not wedded to the details, but I would like to see something like this in the strategic plan and future NCEP/EMC presentations.
 - i. By early 2019: **Operationalize FV3GFS with evolved physics** (improved microphysical, radiation and boundary-layer parameterizations).
 - ii. By 2020: EMC, in close partnership with the interested external model development community, should have developed a single **ensemble-based convection-allowing modeling system over CONUS** whose forecast skill exceeds that achievable with its current product suite, and which is an appropriate modeling foundation for developing a warn-on-forecast capability.
 - iii. By the end of 2020: EMC, in close partnership with the interested external model development community, should be ready to operationalize a single **unified ocean-coupled ensemble-based weather-climate global modeling system for short-range**

to seasonal timescales, evaluated using a small set of broadly-based metrics agreed on by the EMC and the broader interested developer community, and tested and refined in part through the GMTB process.

iv. By 2025: **The forecast skill of the above system should match or exceed that of any other forecast system in the world**, when assessed holistically across its target range of timescales.

v. To **translate these advances into better end-user forecasts**, NCEP, in partnership with the private sector, should maintain effective systems for rapid dissemination of the large model datasets generated by these new models.

vi. The **'graduate student test'**. By 2019 (better: 2018), an interested and intelligent graduate student should be able to access a computing environment, that including sufficient HPC resources, data storage resources, code access and sample data sets, in which she can easily run, analyze and modify the GFS and have access to adequate documentation to understand its parameterizations and outputs.

3. **SIPs**: The SIP framework needs streamlining. There are too many SIPs with overlapping portfolios. There are probably more SIP members than there are model developers at EMC. The future role of the SIPs needs to be clarified – it is up to NCEP to manage EMC. If the SIPs are to contribute in an advisory manner, a better procedure is needed for distilling and prioritizing their recommendations – even the short list of priorities seemed a bit diffuse, and the complete list of recommendations would drive me to depression. The steering committee recommended by the governance SIP should help with this but isn't an automatic solution. Do the SIPs have any independent resources to carry out their recommendations – what is their relation to NGGPS and CPO/MAPP? There also needs to be stronger feedback from EMC about their leading modeling issues, priorities, and strategic directions so that everyone is on the same page
4. **GMTB**: Something like the Global Modeling Test Bed (GMTB) is clearly needed to interface EMC models with the outside community, and it should be run outside NCEP. Its scope needs to include seasonal coupled modeling to support the development of unified modeling within NCEP. While GMTB is making good progress and has already helped evaluate a new parameterization (Grell-Freitas Cu parameterization) within the GFS system, it is struggling a bit to move into this complex and multifaceted role, which includes not only supporting interfaces that enable easy testing of new physics suites and parameterization, but also being a center for developing model documentation, uniform standardized metrics, user help, etc. Thus the community it is serving right now is very limited and Boulder-centric. This may be due to lack of clearly communicated priorities between DTC, NGGPS and NCEP, as well as limited computer resources and at most cautious buy-in from NCEP. Strong high-level guidance, management and sustained community and EMC feedback is needed for GMTB to realize its potential.

5. **Metrics workshop:** The proposed community metrics workshop has a lot of potential, as long as its goals are clear. In my experience, it is necessary to differentiate metrics, quantitative measures which are used to assess model skill and decide whether a potential model change is an improvement, from diagnostics, which are quantitative or visual measures that help model developers assess whether they are capturing particular physical processes well. It is easy and natural for a metrics workshop to turn into a semi-organized list-making exercise in which everyone adds their favorite diagnostics useful for assessing their favorite process in a model. That may have utility, especially if it can lead to a repository for code and documentation of these metrics. However, a much more important (and perhaps more contentious) focus of the workshop should be agreeing on a small suite of standardized metrics unified across the weather – seasonal forecast range that aid decisions about trade-offs between short-range and seasonal forecast performance and have buy-in from both the outside and EMC/CPC communities. Testing protocols and software to generate these metrics need to be openly available to aid in transparent, evidence-based decision-making.
6. **Operational computing:** It is important for EMC to adopt an evidence-based approach to dividing up its available resources for operational computing, especially since it may be difficult to fund a large increase in those resources. Will we actually be in position to run a 30+ member ensemble of FV3GFS at 13 km resolution in five years, with the computing we are likely to have? How important is higher GFS resolution vs. a larger CAM ensemble vs. more resources for seasonal forecasting, judged in terms of incremental benefit to forecasters, end users, and other stakeholders?
7. **EMC:** A challenge for NCEP and NGGPS leadership is how to best help and motivate EMC scientists and personnel to make best use of the partnership and community model development opportunities we are trying to create. How can EMC foster a culture of excellence that 'pulls' in the best from the community as well as one that supports the broader community in 'pushing' better modeling approaches? The SIP process was good in this regard in encouraging dialogue between EMC experts and outside modelers, but dialogue is only a start here.

Fred Carr

1. Much confusion exists as to who is primarily responsible for the **community modeling** component of the NGGPS effort. No extensive documentation, tutorials, workshops, or “help desk” support services have been developed, and the DTC seems conflicted about whether it or some other entity is responsible for them.

2. It is not clear what the future of the **SIP teams** is. Are they going to sunset (as originally suggested), continue as is, morph into another set of advisory teams, or ????????. However constituted, they should, at minimum, help drive the science behind all aspects of the NGGPS project as well as serve as a mechanism for organizing collaborations among the wider community for each team's area of responsibility. Each team should have liaisons to all other teams. There also needs to be a priority-setting aspect that leads to an ordering of what needs to be done first.
3. As an example of needed collaborations, the NGGPS effort to evaluate and develop **FV3 into a world-best CAM system** (DA, Model, Ensembles) should be a coordinated effort among EMC, GFDL, GSD, NSSL, CAPS and perhaps NCAR. There should not be any independent efforts occurring in one entity that are duplicating similar efforts elsewhere.
4. There are still **skill "dropouts"** in GFS forecasts, and it is not clear what the relative importance of data QC, DA or model physics is to their cause. Since the ECMWF model and the Panasonic version of GFS do not have dropouts of the same magnitude as NCEP, this should be a solvable problem, and some attention should be put into this to make sure the FV3 GFS model system does not have large skill dropout episodes.
5. A funded, long-term plan for steady **HPC acquisition/upgrades** is an annual UMAC recommendation but NCEP can not do this by itself. An outside effort (private sector and academia) needs to be organized to advocate for this. NCEP can do its part by quantifying the needs and providing success stories of how FV3 or CAM or WoF research results are better than what we can do now.
6. There should be a version of the **Strategic Plan/Roadmap** that is a widely-publicized visionary document of the type the ECMWF puts out every 5-years. It should have a high-profile public rollout with a glossy brochure and corresponding web presence. Needs to be collaborative effort with NCEP/NWS/OAR.
7. UMAC does not attempt to delve into the details of what tasks are assigned to what people in EMC, or how EMC personnel are reacting to the recent re-organization or their new responsibilities. However, it may be reasonable to assume that the comfort level of employees has been disturbed and that some staff are unhappy with the changes. I think it is very important for EMC and NCEP leadership to be proactive in developing a positive **esprit-de-corps among EMC employees**. That is, they are all well-trained and intelligent scientists who ought to be excited about having the opportunity to take on new tasks dedicated to the purpose of developing the world's best numerical forecast guidance. This should be an opportunity, especially for all the recently-hired managers and leaders to foster enthusiasm and dedication

in all employees to their new mission and responsibilities, and also to involve them in decision-making. There is a corresponding obligation for EMC/NCEP employees to support and accept the challenges of the new mission and to work as a team to achieve short and long-range goals.

8. **Tropical storm and hurricane modeling** plans were not made clear. A new regional model (HCON) appeared this year even though HWRF performance has been improving. Since global models forecast tracks better than either of these models, their purpose must be for intensification forecasting only. However, could a high-resolution HRRR or FV3 do just as well? A plan for hurricane model evolution is needed, keeping in mind that the multi-model approach is ultimately costly and not in concert with unified modeling goals.
9. While there is some organizational planning to address improved physics for NCEP models (e.g., the Common Community Physic Package and the Interoperable Physics Driver within GMTB), there is no concomitant plan for **data assimilation**. The SIP documents indicate that there are a lot of “to do” tasks in this area, especially if combined with the related tasks of quality control, implementation of new observing systems/instruments, creating well-sampling ensembles, etc. There are not enough personnel at EMC to address all of these tasks, even if combined with their OAR colleagues. It would be wise to take advantage of the data assimilation expertise at several U.S. universities (plus NCAR) and develop a cooperative agreement with them to enable faster progress - in a manner similar to how the U.K. Met Office works with the University of Reading through their Data Assimilation Research Centre.

Eric Chassignet

- 1) Many positive developments since the last UMAC meeting, especially the increase in communications among the SIP working groups and the emergence of concrete implementation steps. Congratulations to Mike and Bill.
- 2) There is a commitment to provide community based models and a lot of good will, but this requires more than basic outreach. Resources are needed to develop an interface for model documentation, test beds, metrics, users help, and a forum which truly allow for timely responses and interactions by NOAA scientists. The latter need to be engaged for the community model framework to be successful and this means creating an environment where exchanges take place easily.
- 3) The SIP planning exercise is generating a lot of documents - it is not clear to me on how their goals will be prioritized and who will do so. The governance model

is good, but the steering committee should be put in place sooner than later and ensure that the implementation is prioritized and line with the strategic plan.

- 4) Following up on the previous comment, there is an apparent disconnect between the strategic plan and the SIP framework - this needs to be reconciled to ensure coordination and awareness by all.
- 5) Obvious, but HPC needs to be commensurate with prioritized plans and the resources divided accordingly. Will a mechanism be in place to ensure that the resources are effectively used?
- 6) NCEP should continue to engage with other branches of NWS and NOAA to ensure that there is a coherent and collaborative effort linking all aspects of water-related products (deep ocean, estuaries, storm surge, waves, tides , hydrology, water quality, etc.). I support the creation of a UCAR Water Advisory Committee (UWAC) to help facilitate these interactions and the development of a coherent vision.

Brian Colle

Please see other committee comments about strategic plan, governance, etc... I share many of those same views. Rather than repeating them here, below are some other things to chew on....

Post-Processing Issues

Metrics for model testing, development, and stakeholders need to be defined as soon as possible. A metrics meeting this fall 2017 will help, but what are current metrics used (or have been used in the past) for model development? Sharing that list before that meeting would be helpful for those who plan to attend. Getting feedback via a survey, etc... could be useful for those who can not attend that meeting. Can NGGPS learn from NOAA MAPP, which has a process-orientated focus for various metrics.

There is a lot of emphasis on the modeling suite, but post-processing (for stakeholders, etc..) and verification still seem to be afterthought in the strategic plan, with little details given. Every Operational Center has its own set of post-processing approaches, data formats, and verification (and metrics), so the approaches at various Ops Centers all over the place. Just like we had to trim the focus the number of models in the productive suite during the past year, there needs to be more organization with the post-processing and verification. This should include input from the private sector.

There is a big data issue looming for the community. For more evidence-based work, more model data (vertical levels, higher temporal resolution,...) is needed, but it may not be possible. NCAR (Unidata?) recently had a big data meeting. Can some of the knowledge from that meeting help with this issue?

Modeling Priorities

Subseasonal forecasting is a lofty goal and there is motivation for warn-on-forecast, but field forecasters want a CAM ensemble now (e.g., to at least 48-60h – forecasters for winter storm issues want guidance beyond 24-h). This should be a very high priority as well, since the technology and computing resources likely exist to do this. Most of the current CAM effort is for 0-36 h, which is useful for the severe storm community, but there are many other needs for lead times to 72h, such as winter storms.

Model Documentation and Users

Forecasters are still one of the most important users of any new model guidance, but how will they be trained with any new modeling systems (CAM ensembles and FV3-GFS)? We also can not lose sight that forecasters still have no easy way to view and easily digest ensemble data (AWIPS ensemble tool is primitive).

In the last UMAC report there was mention of “super-users” for the FV3 to initially help build the community modeling effort (test model components, go through online documentation, etc..). Who are the superusers? Is there still a plan to do this, or will it just be released to all at once?

Working Groups for NGGPS

It is not clear how all these 60+ topics in the SIP will be distilled as the most important issues to be addressed. What topics need to be done by 2019, versus next 3-5 years?

The WGs need more focus. One way to do that is to determine important issues shared between the WGs that need to be resolved (e.g., metrics), and have calls with members from the relevant committees. It is doubtful just making the WGs open to all will draw people in to discuss. Experts with the topic of interest need to be invited and supported.

The question came up of whether resources can be given to the WGs. This may be difficult, but perhaps other programs within NCEP can help. For example, one could have a targeted Visiting Scientist Program to solicit research in the areas needed (or a student fellowship program). Perhaps the NCAR Visiting Scientist (or even NCAR ASP) can be used to help if there is a collaboration between NCEP and NCAR.

Research

There needs to be a more well defined and focused research plan to make improvements to the models with the community effort. Future call for proposals needs to be more theme based to address specific issues. For example, if a better PBL parameterization is needed, then focus the call on that issue.

More big picture research is needed, perhaps in collaboration with others (e.g., NSF). For example, a collaborative effort to do high resolution seasonal ensemble forecasts would be exciting and if it shows promise, could help provide the evidence for the next generation computer.

James Doyle

1. I was pleased that NOAA and NCEP have made substantial progress since the last UMAC meeting, and overall in the last several years. Highlights include the streamlining of the NCEP Production Suite, adopting of a new dynamical core, and moving towards the development of a community-based NOAA unified modeling system. The external community has been engaged in the planning process, which is a very positive development. The planning strategic process led by Mike Farrar has been very positive and I believe a very good exercise for NCEP and the community.
2. Metrics: Defining metrics that are standardized and unified across scales from weather through seasonal applications will become very important in the near future for the unified system. The upcoming Metrics Workshop discussed at the UMAC meeting will be important and should include a variety of stakeholders including key end users. One could envision scorecards comprised of key metrics that are weighted according to their impact and importance (e.g., to end users).
3. Computing: High performance computing remains a limiting factor for operations and a challenge. It may be helpful if NCEP and NOAA can create compelling use cases that highlight future capabilities and where possible establish quantitative return on investment (ROI) for future significant upgrades in the model suite including increases in resolution and sophistication (coupling, improved physics etc.). These use cases should include downstream models that highlight impacts with ROI estimates for specific scenarios or events (e.g., hurricane models, surge models, precipitation from the CAM, etc.). Entraining the community as appropriate into such a process may be beneficial as well.

Secondly, more of an evidence-based approach is needed related to the allocation of computational resources for the operational suite. The trade space between number of global ensemble members, global model resolution, CAM resolution, CAM ensembles etc. should be justified better for individual modeling systems and holistically. NCEP may want to utilize user specific metrics to better address the allocation of computational resources.

Thirdly, adequate computational resources for the research community are needed to take advantage of the expertise of the community and use these resources to motivate and inform operationally relevant research of highest priority to NCEP and NOAA.

4. Strategic Planning: The Strategic Implementation Plan (SIP) has been a very useful process for NCEP and the community. The process has been open, transparent, and the community has been engaged, which are all very positive. The challenge will be to quickly evolve from the many projects, details, and issues identified in the planning process to action (e.g., model development, evaluation, software development etc.) without losing momentum. The SIP comes across as a long list of milestones or even a “wish list”, as it has not been linked to resource allocations (human and computational). A realistic set of prioritized goals for the near- and medium-term need to be established.

Another issue that appears to have arisen is that coordination between the SIP and NNGPS processes hasn't been as strong as it could have been. Some NNGPS investigators apparently haven't been involved with the SIP process and need to be re-engaged. Better coordination between NNGPS and the SIP process is needed.

5. Rebranding opportunity: At the meeting, it was mentioned that there were no plans to rename the GFS when the FV3 core and associated upgrades are implemented operationally. NCEP may want to consider rebranding the GFS when this upgrade occurs. The new modeling system represents a major step forward for NCEP/EMC and rebranding the forecast system could be part of a messaging strategy to NOAA leadership and the community reflecting the new modeling capability and fresh change in strategy.
6. GMTB: The Global Modeling Test Bed (GMTB) will play a critical role in focusing and entraining the community's expertise in physical parameterization in the future. The GMTB has already made some good progress with the development of physics tools and software for EMC's and the community's use, as well as the testing and evaluation of new physics (e.g., Grell-Freitas convective parameterization). However, the GMTB lacks adequate computational

resources, and guidance on the hierarchical test suite procedure and governance is needed related to the transition pathway to operations at NCEP.

7. **Coupling:** Coupling of the unified model to the MOM6 ocean model is needed for the sub-seasonal to seasonal prediction capabilities. There was relatively little discussion at the meeting and within the SIPs regarding ocean coupling, as well as sea ice coupling. Coupled processes and models should be emphasized more given the importance for seasonal prediction.

Jim Kinter

1. There are many positive developments since the last UMAC meeting. These include:
 - **Unified modeling:** NCEP, NWS and NOAA are clearly adopting previous UMAC recommendations to simplify and transform the NCEP Production Suite (NPS) by adopting a unified modeling framework. This is a major change of strategy and culture within NCEP that will return much higher dividends over time.
 - **Community modeling:** There is ample evidence that NCEP and NWS have embraced a community-based set of values and a community-based business model for unified modeling. They are involving subject-matter experts, modelers and information technology experts from both inside and outside NOAA in important roles for planning and implementing future generations of models within the NPS. This will likewise provide tremendous return on investment over time.
 - **Communications:** NCEP and NWS have indicated a high degree of commitment to engaging in and supporting communication at all levels. This is a fairly new development, so it needs to be strongly encouraged and given time and resources to flourish and become a central part of EMC/NCEP/NWS culture.
 - **Planning:** Mike Farrar should be congratulated for the progress on the enormous organizational planning exercise he initiated. The process has been inclusive and proactive, if a bit overly detailed.
2. **Governance.** The governance plan that includes a Steering Committee and several Working Groups is very good, especially the intent to balance the membership on both with people from inside and outside NOAA. It will be important to also have an external advisory group that can provide objective, disinterested review and recommendations.
3. **Working groups.** For NGGPS and SIP, there are a great many working groups. These were stood up as requirements emerged. While the number of groups and the number of people involved are quite heartening, showing that there is a lot of

interest in the success of the enterprise, the level of organizational complexity is excessive and unwieldy, and it should be streamlined and prioritized. Also, while the SIP WGs were, by and large, volunteer activities, at least for those members not in EMC, that is not necessarily a sustainable business model. If the WGs do real work, then resources must be marshaled to compensate that work.

4. **Strategic plan.** The Unified Modeling Strategic Plan is quite good for what it covers; however, it lacks some critically important items that must be part of such a plan, including qualitative and quantitative, realizable objectives as well as stretch goals.
5. **Collaboration costs.** As everyone is learning, there are costs associated with a collaborative business model. These include the costs of shared governance (e.g., ceded control), the costs of coordination (e.g., time of participants; infrastructure to support collaboration), the costs of shared credit (e.g., potential loss of brand recognition), and the cost of potential delay due to increased number of parties involved in decisions. NCEP should be clear, both internally and externally, about these costs and endeavor to minimize the costs and maximize the benefits of collaboration.
6. **Timelines.** In general, the timelines are driven by operational imperatives and anticipated in-house resources at NCEP. A great deal of deliberateness and conservatism is apparent in the timelines, making the schedule of deliverables seem plodding. The most extreme example is the timeline for implementation of the coupled seasonal prediction system, which does not replace the current 2011-vintage system until at least 2022. That is a sunspot-cycle time frame, not a model implementation timeline, during which ECMWF, for example, is likely to roll out at least 3 new versions of their comparable seasonal prediction system. The way in which the timelines have been developed should be examined and ways to accelerate progress should be considered. For example, the evidence-based decision-making approach could be extended to project management with an eye to streamlining and accelerating progress. Also, related to the communications bullet above, expectations from both the operational and research communities must be better managed.
7. **Research.** The pathway from research to operations is becoming better defined; however, it is really a loop with requirements flowing from operations (on behalf of stakeholders) to the research community and research results transitioning to operations. A better definition of the operations-to-research segment of that loop is needed. In particular, what is the prioritized research agenda for model development? How can researchers determine what they should work on that would be of most benefit to operations and the community? Can NCEP or NWS articulate a research agenda that is structured in terms of readiness level and anticipated impact? The spectrum of research projects that are under consideration should include both high readiness level projects and others that are higher risk with potentially higher payoff. A better articulated set of research

needs would be of great value to the research community, would help prioritize questions that need to be addressed, and could potentially accelerate progress to address the issue mentioned in the Timelines bullet.

8. **Computing.** The update we received on HPC resources for operations and research was useful; however, it is not clear that the allocation approach is working optimally. It is particularly important in an environment of tightly constrained and slowly growing resources, to manage the resources carefully. Consistent with the community values and community-based business model, a more open, documented and community-managed allocation approach for research computing resources is needed. On the operations side, a similar evidence-based approach is needed to manage the “white space”.

Gary Lackmann

Although I was not able to attend the meeting, my sense from the materials shared and discussion is that progress has been promising.

My concerns remain similar to those I’ve expressed previously, including at the August 2016 meeting:

- (i) That a great modeling system doesn’t automatically guarantee great forecasts for end stakeholders. Forecasters need to be involved in the “community” discussion as well. There may be a tendency to overemphasize the academic research community, as important as they are.
- (ii) Some aspects of postprocessing can be centralized in a way that would greatly facilitate innovation and extraction of forecast information.
- (iii) The “metrics” discussion is of great importance. In measuring model skill, there has been a historical emphasis on 500-mb height anomaly correlation. Societal weather impacts often involve surface weather conditions. Re-thinking metrics to include quantities such as rainfall rate, and involving object-oriented approaches, are essential to progress.
- (iv) Stakeholder input, especially forecasters, could be quite valuable to the metrics discussion. Will the NWS field offices be included in this?
- (v) To what extent will a funding program accompany the community development aspect going forward? I understand that there must be considerable budget uncertainty, but this would be a great way catalyze research as needed to improve the modeling system.

Cliff Mass

- 1. A community model must be available to the community.** This includes tutorials, workshops, and user support by individuals experienced with the modeling system. Unfortunately, the National Weather Service has dedicated few resources and personnel to making FV-3 a community modeling system. NCAR, through DTC, stands ready to take on this role. The NWS should immediately invest in spinning up a community support system for its new global model.
- 2. Wise investment in extramural research.** Substantial investment in relevant extramural research is essential for the success of NGGPS and NWS prediction in general. The NWS has supported several dozen NGGPS projects, but few of them are clearly relevant to NWS and NGGPS goals. The NWS must identify high priority research areas and direct extramural funding to dealing with key questions and needs in a more strategic manner.
- 3. A strategic plan for U.S. NWP must be a plan.** The draft strategic plan has few plans, but rather is a list of principles, many of which have been outlined in previous UMAC documents. The NWS strategic plan for NWP must outline specific goals with associated timelines for the next 5-10 years.
- 4. The NWS needs to optimize and streamline its development of the NGGPS community modeling system and to gain a better understanding of the nature of a community modeling system.** The current SIP approach is unwieldy, with large number of people involved in over a dozen groups. This approach is a poor use of the key resource of the U.S. weather community: the time of its members. The key attribute of a community modeling system is that it is open to the community for both use and contributions. This is not yet true of FV-3. Gaining input from the community is important, but decision making and prioritization can only be done by a relatively small group, with input from the larger community.
- 5. The NWS and NOAA must support research that will explore potentially high impact and beneficial developments.** Examples include subseasonal prediction, convection-allowing ensembles, and warn-on-forecast prediction. Positive results can be used as powerful tools for garnering additional HPC and other support.
- 6. The NWS must be careful to test the viability of new approaches, before committing to them in strategic plans.** Seasonal forecasts and warn-on-forecasts are good examples of such issues.
- 7. NCAR/UCAR needs to be heavily entrained into the development and testing of NGGPS if success is to be expected.** The current letter of intent is

a good start, but far more concrete efforts are required. For example, NCAR could play a central role in developing the underlying infrastructure for FV-3 or given an explicit role in developing model physics options for the new modeling system.

8. **The Global Model Test Bed (GMTB) will only succeed if DTC gains mastery of the new modeling system and has successfully served as the conduit and support entity of the modeling system to the community.** Success will also depend on a clear definition of DTC's role and the provision of the resources required to develop the necessary software/data infrastructure.
9. **Although research and operational entities are working together far better than in the past, the underlying structure of R to O is flawed, with authority, personnel, and resources diffused in a non-optimal way.** There should be **one** NOAA/NWS model development center (located in Boulder, and encompassing ESRL/NCAR/and others), and DC EMC focused entirely on operations and verification. Postprocessing development (now in MDL/ESRL) should be in Boulder as well.
10. **NOAA/NWS should retain an external review panel, such as UMAC, to ensure it receives unbiased, outside evaluations.**

Peter Neilley

1. I remain concerned that NOAA/NCEP/NWS have not fully adopted the goal of NGGPS becoming the world's best. While everyone involved seems to aspire to reach this level, aspiration and being personally and institutionally accountable for achieving this goal are very different things. Only if such goals and accountability to them are ingrained in every individual associated with the project, will such goals be met. If NGGPS results in the US only being second best or worst, whose job is on the line?
2. Data volumes from NGGPS and eventual convective allowing ensembles are enormous, especially when high temporal resolution output (order of 10s of minutes) are made available. The volumes are such that transport of the data to all potential end users is not likely practical, therefore limiting access to and value of the NGGPS data. There is no strategic vision or plan in place to address this issue. The ECMWF appears to be moving to a model of providing direct HPC access allowing end-users to access and provide value-added services to its high-volume data at the source. The NWS needs to develop an equivalent model. While the current Big Data CRADAs have some successes, they are very far from developing solutions that address this model data issue.

3. The GFS name is now 3 (4?) decades old and continued use of it understates the significance of the NGGPS program and accomplishments. Not taking the opportunity to rebrand the global and regional modelling under NGGPS will perpetuate some of the misguided political vernacular about the role and value of the NWS. While renaming creates some technical challenges, that seems to be a silly excuse that has technical solutions, and not sufficient to not take advantage of the opportunity.
4. The current working groups are not working groups, but rather advisory groups. To transition these groups into actual working groups that provide development and testing input to the NGGPS process, funding is needed. As there appear to be limited opportunity for such funding, the scope, charge and name of the working groups should be clarified.
5. The “breaking news” regarding a possible NCAR-NCEP partnership for advancement of the NGGPS, and the alluded to references to this potentially translating into a major role of the DTC in the NGGPS process is welcome. This needs to quickly become real and tangible.
6. Some form of UMAC should endure. One of the primary values of UMAC has been to provide access to and input from a much broader set of the community than the typical set of modelling “insiders”. The UMAC has also taken more of a “forest” view of the modelling activities, as opposed to a “trees” perspective that many of the proposed advisory and oversight structures for NGGPS might allow for.

Christa Peters-Lidard

Overall, NCEP and EMC in particular have made excellent steps towards a new approach for modeling, community input, and user engagement. This is to be commended. The SIP process has been encouraging, but also somewhat disjointed due to lack of clear overarching strategic goals.

EMC needs a polished strategic plan with “SMART” goals (Specific, Measurable, Achievable, Relevant and Time-bound)

1. The ECMWF strategic plan is a good example. It should document where the production suite is now in terms of skill and capabilities, where it should go, and what steps are needed to get there. Right now the focus is so much on documenting the complexity without quantifying skill goals and focusing on improvements there.

2. **Once clear, measurable strategic goals are established, the SIP should be traceable to those goals.** For example, simplifying the production suite is a means to support enhanced focus towards improved forecasting skill.
3. **Water modeling within NOAA is beyond the scope of NCEP, and there is a clear need for coordination and strategic advice.** OWP, NOS, NCEP and others should jointly develop a set of goals and a SIP based on community input.
4. **The new community global model (FV3GFS) must be available to the community with a support infrastructure in place.** Beyond infrastructure, there must be resources and procedures for testing, uptake, responsible POCs, and ownership for each component within EMC. The transition from NGGPS to FV3GFS is not clear.
5. **Metrics and diagnostic benchmarks.** In order to maximize the return from the community, we need agreed-upon skill metrics in addition to process-oriented diagnostic benchmarks for each component as well as for the coupled system.

Richard Rood

- 1) There is a lot of confusion around the Global Modeling Test Bed (GMTB). I construe three "missions" associated with GMTB.
 - 1.1) GMTB work with the ~ Community Common Physics Package (CCPP) and the Interoperable Physics Driver (IPD).
 - 1.2) GMTB role in verification and validation
 - 1.3) GMTB role as/in "community."

These roles need to be deconstructed, planned, and consistently communicated.

The "physics" work should be well posed, but does require some strong and inclusive attention to management. If a community-based approach is a goal, then what "community" means and how to actually accomplish a community development is needed. This has potential for short-term benefit.

The verification and validation role is poorly posed in many ways. The existing in-house experience, methods, and resources do not scale to a unified system and coupled models. A differentiated and hierarchical validation strategy needs to be developed. There are many existing tools and great community expertise. The development of a community, systems wide approach to validation is among the most important strategic items that the community governance needs to address.

The role of GMTB "as community," which seems to be how about half of the UMAC understands GMTB, just seems wrong to me. Some see GMTB = NCAR = MMM = CESM. This is an issue that needs a big scrum of people to start to align reality with expectations and misconceptions.

2) The NCAR - NOAA agreement. This has enormous potential, but like the confused mission and expectations of the GMTB, there are many issues conflated in what the agreement really means. It needs a team a people pulling it apart and identifying what is real and substantive and then putting it back together. Then identifying gaps. To make it more complex the GMTB "as community" is also conflated into the NCAR-NOAA agreement.

3) There are many confusions about the SIP Communications Working Group/Subcommittee (Comm Group). The purpose of the Comm Group is to develop a communications plan. What is needed for the community to function?

There is no concept that this group writes documentation, does training, etc. There is no concept that a Communications Office is set up by the Comm Group. Plus, I don't expect the Comm Group to assign functions to organizations. I do expect the group to build off of already started efforts, perhaps identify some of those successful neo-efforts, and make some recommendations on tools and standards.

4) Rusty Benson's presentation was an excellent clarification of the GFDL as a community issue and revealed that some on the UMAC conflated GFDL as community with the GMTB issues. Some of the GFDL repository issues are conflated with verification and validation issues. It is critical that GFDL provide a stable, verified FV-3 core for community use, to isolate internal tuning and development of the FV-3 core, and to adhere to the same process of updating the repository that they expect for the community.

5) There are several issues that the SIP meeting and UMAC meeting have exposed that need to be addressed. This is positive in the sense that recognition of issues is an important first step. However, for people in the performing organizations, the organizational anxiety has increased. This leads me back to the need to set up some version of a community/unifying governance in the short term. Otherwise, people take their anxiety back into their organizations, look inward, and try to define things they can control, which will mean "do what we have always done."

Appendix A

UMAC Meeting Agenda

August 3-4, 2017 @ NCWCP
College Park, MD

Thursday, August 3:

8:00 am: Arrive at NCWCP security desk to go through security, register laptops, etc.

8:30 am: UMAC Discussion Session (with Bill Lapenta) - Room 2554-2555

Topics to include:

1. Discussion of SIP Governance Committee report (*need copy before meeting*)
 - (i) Leadership continuity; role of governance in EMC
 - (ii) Should UMAC examine un-reviewed WCOSS elements such as space weather, air quality, marine and water-related products, etc.
 - (iii) Future role of UMAC, if any

10:15 am: Break

10:30 am: UMAC Discussion Session (Cont.)

2. Discussion of latest Strategic Plan for NOAA Modeling (with Hendrik Tolman)
3. Discussion of IBM, Panasonic, Spire efforts; any actions needed?
4. Other topics?

11:00 – Noon: PI Poster Session - NCWCP Conference Center Lobby (attendance possible if discussion ends prior to noon.)

Noon – 1:00 pm: Box Lunch: NCWCP Conference Center Lobby

(Place lunch orders by **Tuesday, August 1** from the [Kloud Cafe](#))

1:00 pm – 5:00 pm: NCWCP Conference Center Room ABC

1:00 pm: Joint meeting with NCEP/OAR NGGPS and SIP leaders. The SIP teams will combine their efforts on Wednesday and Thursday morning to produce a draft coordinated FV3 implementation plan as the GFS replacement and as a community model. They will present this plan at this time, followed by a Q&A and discussion session. Note that the possible topics for discussion include: Dynamics/Nesting, Physics, CAM, Data Assimilation, Ensembles, Verification and Validation, Post-

Processing, Marine, Land Surface/Hydrology, Aerosols, System Architecture, Infrastructure, the GMTB, and the Community Model plan.

3:00 pm: Break

3:15 pm: Q&A and discussion of the SIP document (cont.)

5:00 pm: Adjourn

Thursday, August 3 cont.:

6:00 pm: UMAC Working Dinner - Room 1312 at College Park Marriott Hotel

Will discuss our reactions to the draft NGGPS/SIP implementation plan. Also, should consider whether the NGGPS organizational structure and process has been effective.

Friday, August 4:

8:30 am – 11:00am: UMAC Discussion Session - Conference Center Room AB

This is to be a discussion session on the SIP integrated plan and related topics that are of interest to UMAC. Note that we will be asking SIP/NGGPS attendees to join us. Possible topics are flexible, but will include:

8:30 am: Roadmap to a convection-resolving ensemble

9:00 am: FV3 as a community model (with Rusty Benson, Tim Schneider, others?)

9:30 am: Other specific topics UMAC wishes to discuss

10:00 am: Discussion of future HPC available to NCEP (*Ben Kyger and Brian Gross*)

10:30 am: Other specific topics UMAC wishes to discuss

11:00 am - Noon: UMAC in plenary session to develop Outbrief remarks

Noon - 2:00 pm: UMAC Outbrief (with box lunch) - Conference Center Room AB

The Outbrief is primarily for NGGPS/SIP leaders as well as for NCEP, NWS and OAR leadership. Depending on the room size, others could attend. UCAC will provide its initial reactions to the NGGPS/SIP plan and discuss where we go from here. UMAC will provide a written report a few weeks later.