**CAC-WP Meeting Summary**

**January 8, 2021**

Present:

Tom Graziano – NOAA – Director, OWP

Ed Clarke – NOAA – Director National Water Center; Deputy Director OWP

Jocelyn Burston – NOAA NWS – OWP Director, Service Innovation & Partnership Division

Trey Flowers – NOAA NWS – OWP Director, Analysis & Prediction Division

Fred Ogden – NOAA NWS – OWP Chief Scientist

Donna Page – NOAA NWS – OWP Chief of Programs

Troy Wilds – NOAA NWS – OWP Director, Project Management Office

CAC-WP

David Maidment, UTA – Co-Chair

Don Cline, USGS – Co-Chair

Matt Ables – KISTERS

Ana Barros – Duke Univ

Levi Brekke – Reclamation

Patrick Burke – NOAA NOS

Efi Foufoula – UC Irvine

Curt Jawdy – TVA

Steve Kopp – ESRI

Ehab Meselhe – Tulane Univ

David Tarboton – Utah State University

Dwane Young – EPA

Ex Officio

Roy Rasmussen – NCAR

Jerad Bales – CUAHSI

Unable to attend:

Michael Lowry – FEMA

UCAR

Tammy Kepple – CPAESS Meeting Planner

Bill Kuo – UCAR Community Programs (UCP) Director

Hanne Mauriello – UCP Scientific Partnership & Service Center Director; CPAESS Director

Eileen McIlvain – CPAESS Writer/Editor; CAC-WP Contact

Melanie Russ – CPAESS Senior Program Manager

**Introduction**

Maidment and Cline opened with welcome and introduction to the presentation by Graziano and Clark on the NOAA Office of Water Prediction (OWP) Strategic Plan FY2021 to FY 2026.

Graziano gave an initial intro to the Strategic Plan, covering the organization, purpose of OWP—vision, mission, and values—all centering on continuing realization of NWS water-ready nation goals to address national challenges regarding water extremes (too much/too little), water security, water quality, improved water prediction and related decision-support services.

Goals are to leverage the capabilities of the National Water Center (NWC) for both long-range and near-term objectives and expand and facilitate community engagement and development. Those NWC capabilities include:

* the Water Prediction Operations Division and NWS field support
* the National Water Model (NWM)—currently operating under version 2.0. (Version 2.1 is scheduled for release in FY2021; Version 3.0 is anticipated for release for FY2023)
* the Next Generation Water Model
* Community Hydrologic Prediction System (CHPS)
* and Hydrologic Ensemble Forecast System (HEFS)

Ed Clark, Director of the National Water Center and Associate Director of OWP, expressed appreciation for the contributions of the CAC-WP—the cross-pollination across a diversity of viewpoints from the federal, academic, and private sectors is very valuable and much appreciated. OWP incorporated elements of feedback from the CAC-WP 2018 and 2019 meetings into the five-year plan, as was feasible within the overall NWS/OWP operating goals.

**Background**

Senate Bill 914 was unanimously passed on July 31, 2020. Title III, Section 301(a) of that legislation formally authorized the establishment of the National Water Center and defined in detail the roles and functions of OWP activities (page 9 of the Draft Strategic Plan). The legislation is now signed into law. Functions of NWC are:

* Improving understanding of water resources, stakeholder needs regarding water resources, and identifying science and service gaps relating to water resources.
* Developing and implementing advanced water resources modeling capabilities.
* Facilitating the transition of hydrological research into operations.
* Delivering analyses, forecasts, and inundation information and guidance for all hydrologic events in the U.S. including flash flooding, riverine flooding, and water resources outlooks.
* In collaboration with warning coordination meteorologists, providing decision-support services to inform emergency management and water resources decisions.

There are nine national centers within NOAA (collectively, the National Centers for Environmental Prediction (NCEP)[[1]](#footnote-1)); thirteen river forecast centers; and 122 weather forecast offices, with whom OWP and NWC work closely. The draft was shared with senior managers within NWS and all field personnel having anything to do with water. There is now an established coordination within NOAA for water issues, the NOAA Water Team, which Graziano heads up.

**OWP long-range goals** include:

* Predicting critical water budget variables and streamflow.
* Predicting the full range of hydrologic extremes and providing impact-based decision support services during floods and droughts (summit to sea).
* Developing and implementing model validation capabilities, rolling those out through the RFCs.
* Predict total water in the coastal zone (compound flooding)
* Predicting interaction of surface water and shallow aquifers. This effort was jointly developed between NWC and NCAR, and also supports multiple CUAHSI Summer Institute activities.
* Predicting changes in water quality: evolve modeling to incorporate water quality; involves a collaboration with NOAA Fisheries—we are not yet there but it is on our docket.
* Evolving the NWM architecture to support broad community development: looking forward to evolving that further; making the NWM more modular in nature to enable the broad community to engage and leverage joint modeling capability.
* Adopting an Earth System Modeling Framework under the Modeling Board and the NWS Unified Forecast System (UFS). NWC is looking to incorporate the NWM as a program of the national Earth System Prediction Capability (ESPC).

**Discussion**

The development of a common federal framework for water prediction is ongoing, and this strategic plan contributes to that. A related project is with the University of Alabama on snow/soil moisture data assimilation, producing valuable results (with contributions from UCAR/NCAR).

*Tarboton:* what is the schedule for moving the document from draft to addressing recommendations, to final released version?

*Clark:* We hope to have this completed by the end of February. We want to be responsive to broad community development and to the national forecast capability – NWM version 3.0 – incorporates inundation activity with NOS; coupling of coastal and inland water models; creates a framework compelling to multiple agencies.

*Jawdy:* What is the background to this federal framework? Clark: the Advanced Weather Interactive Processing System (AWIPS); Advanced Hydrologic Prediction Service (AHPS) and the Community Hydrologic Prediction System (CHPS).

Aspects of this effort include:

* Potential to engage, re-engage, and renew for water prediction improvements
* Operational Infrastructure—how we deploy, how do we develop a common operating picture for water resources
* Data integration, analysis, dissemination, and forecast services
* Continuity of operations—supporting NWS in RFC capabilities – this has been especially key during the COVID 19 pandemic
* The operational center of NWC is congressionally mandated for operations

**Near term objectives**

* Modularized architecture
* Nationwide flood inundation activities
* Coupling of coastal and inland water models
* Machine-learning based simulation of reservoir practices
* Shallow aquifer modeling
* Expanded terrain and bathymetric analysis
* Improved data assimilation
* Big data and geospatial assimilation
* Enhanced techniques for evaluation NWS hydrologic modeling performance
* Enhanced HEFS forecasts
* Development, integration, and enhancement of operational information dissemination
* Improved precipitation frequency estimates
* Exploratory efforts for water quality prediction

Beginning this FY21: NOAA is funding competitions for three new Cooperative Institutes, one of which will be for NOAA Marine Research and Ecosystem Management: <https://www.ci.noaa.gov/News/Announcements/competition-for-3-new-cooperative-institutes>

**Questions - Round-robin**

*Tarboton****:*** this is really a nationwide question—what is the status of the Texas proof of concepts project?

Clark: This is another agency priority goal set for achievability. Serving flood inundation maps across lower 48—this depends on appropriations. We are moving that data to the cloud vs. having it on an OWP server. There is extensive coordination with FEMA on this—they are much involved to that. Demonstrating broader geospatial reach is important. Right now, inundation flooding covers about 1/3 of the population; we are looking to deliver a fuller picture as we move forward.

*Foufoula:* This is an impressive and ambitious plan. Weather production is one thing but getting on-the-ground feedback is critical. I recommend involving the academic community to identify scientific gaps. A good example is S2S (Subseasonal to Seasonal). I don’t think we have yet done the science to translate this to on-the-ground impact. We should not dismiss opportunities to engage the community in this.

*Jawdy:* How does what you are doing with inundation mapping tie in with USACE?

*Clark:* The National Water Center serves as the coordinating agency across federal efforts. We are, in effect, layering what is available. We can talk further off-line about our rapid innovation efforts. For inundation maps – availability is one issue. Federal entities are better aligned to coordinate on this. We are looking to enable common metadata, better forcing.

*Brekke*: At big river scale—catching up with rivers where there never was a forecast before—the investment seems focused on tech capability. Is there any emphasis on fine-scale capability? e.g., third party apps?

*Clark:* there are a lot of third-party groups who do that much better than we do. We are having conversations on that level. Some of our private industry partners may have some input on that.

* *Kopp* – at ESRI we’ve been serving forecasters with web maps for about three years; and these see a good bit of use. We are often asked when we will have national innundation maps, apps for phones. Some services are already aggregating that kind of information. We look forward to further integration.
* *Ables* – at KISTERS, we are looking at integrating additional data sources into the model, especially for higher resolution. How to do that using cloud-based systems is progressing; there are opportunities. Thank you for the draft strategic plan – it certainly helps us to plan on how we go forward in concert with OWP.

*Graziano* – in response to Efi’s comment: Congress mandated that we focus on S2S. That is within the precipitation prediction Grand Challenge – we are working with USGCRP to tackle the problem in earnest. There has not been much shown in appreciable skill over the last several decades. We need a community-coordinated ESP (Ensemble Prediction System) capability to do so, and are working on mobilizing the community to that end.

*Foufoula:* We are not only passive receivers of S2S prediction. I don’t want to wait until the atmospheric scientific community is completely on board. There is a lot of opportunity; that box has some specific filters and dampers: scientific and water-prediction specific aspects of S2S that would benefit from acceleration.

*Barros:* I am impressed by the statements in the plan moving from years to months. When talking about very high fine resolution skills: a serious consideration is computational infrastructure. In order to make good predictions for flash flooding, e.g., we need to have much more computational infrastructure to do that. I am not sure that the cloud will serve those purposes. This will be essential for widespread community engagement and participation.

*Brekke:* I look forward to water temperature forecast products being developed. I would like to see some sharpening of vision for coordinating for success – a coordinated federal approach. There is an NRCS water center (National Resources Conservation Service of USDA) whose activities might be of interest. As for the Bureau of Reclamation, embedding river regulation impairment effects in your modeling would be beneficial. Can you dovetail planned regulations with the model?

*Burke*: For NOS, I look forward to working together on metrics, so we are looking at the same thing from coast to river. Excited by temperature, but salinity—the chemistry—we need to see how we can progress on this before 2026.

*Young:* A marker on water-quality, especially nutrients, would be helpful. Additional collaboration on the underlying hydrofabric—connecting the wetlands—that would add to the water modeling effort. A question to think about: what would elevation-derived hydrology mean for you? I would like to put that on the radar screen to think about.

*Meselhe:* embedding the successful experiment on inundation mapping for Texas – what are the next steps for all of us to expand on that experiment, that mapping product? How is that experiment going to be repeated next year?

*Tarboton:* I recommend thinking of ways to engage the academic community more broadly – open up the model as it is. There is a lot of data in the model; the hydrofabric; some of the forcings are valuable in their own right. It is also important to not be limited to the minutes-to-months time scale the plan mentions; when thinking about droughts, water supply forecasts need to be over years.

*Rasmussen:* I’m representing NCAR, and want to say we look forward to continuing to work with OWP on coupling the atmosphere with hydrology and engaging the community more.

*Cline:* The Next Generation activity is very important; we need engagement with the social science community—that is critical to flood activity. Cloud optimization is another priority.

*Maidment:* it’s clear that for water model evolution to the Next Generation, the CAC-WP would like to engage more directly with that subject. Section 3.1 speaks to the establishment of *communities of practice*. If we could work toward that for NWM functionality, that would bring in other valuable community energy and contribution.

*Cline:* – The committee is the community – the desire to collaborate has been a theme since the beginning. Specificity in each of the bullets of the plan would be helpful – what’s included and not included—fundamentally, be more clear about what is in and what is out, and how you went about it.

*Meeting adjourned at 2:05pm ET.*

**Post-meeting commentary by CAC-WP members, Jan 8 – Jan 19, 2021**

**Ana Barros** – Duke University - 01/08/21

Thank you for a very informative meeting and for sharing the Draft plan with us. It is a tribute to the National Water Center and Office of Water Prediction efforts to accomplish so much progress.  I was impressed with Tom's and Ed's accounts of the number of beneficiaries of the flood inundation mapping capability. It is a transformative change in operational capabilities.

I second everyone's comments that a plan for collaborative efforts be available to engage the community. I must emphasize my concerns with HPC needs and computational infrastructure overall at the Water Center and RFCs. My understanding is that this is a big challenge already on the house's atmospheric side, and it will only grow when we start thinking about users on the scale of 100's of millions and time-scales of minutes. Beyond operations, if such infrastructure does not exist, this might handicap collaborative efforts to accelerate innovations. This concern deepens with the desire to add water quality, which is very important. I understand (heard from others) that the bottleneck is happening already to some degree with existing Cooperative Institutes in the hand-off of new developments to operations. I did a quick search of the words HPC/computing etc., in the strategic plan and could not find it. In any case, I should like to urge you to consider adding/highlighting these needs, so they are on the radar screen of decision-makers at NOAA, DoC, etc., as the price tag is very high and these sorts of resources require careful planning.

**Efi Foufoula** – UC-Irvine - 01/08/21

Great meeting today. This is an exciting and ambitious activity, and we should all do our best to make sure it delivers. A few things I would like to propose to expand the visibility of the effort.

1.  As you know NSF has commissioned a report on “Advancing a Systems approach to modeling the Earth” (see some slides of GEO Director Bill Easterling).  George Hornberger is chairing this NRC study.  Hydrology and land-atmosphere feedbacks are key to the Earth system.  It will be good at some time to present to that NRC committee.  Pls also see the last slide where NSF wants to develop ways to engage more with other federal agencies.

2.  I wonder whether an NRC study should be commissioned from NOAA/OWP to bring some community experts together for a report on “Water-ready nation” or “US Water Prediction in a changing world”.  I am not fond of more reports myself but, if done well, it can give visibility to the effort and also a more formal path to engage other agencies (the question today as to how exactly will this be done?).

3.  In terms of the “science gaps” I keep bringing up (note that this is also one of the 3 defined functions of the NWC as presented in the Plan, page 9), we need to more specifically work on them and I think as NRC study as mentioned above could also address those as part of their statement of task.  Issues of S2S predictability cannot be decoupled from hydrology.  We know that over land, a big part of this predictability comes from the memory for hydrologic processes, yet not as much work is done on this as a research frontier.

*Attachment:* [NSF\_ESS\_william Easterling-sts roundtable February 2020.pdf](https://drive.google.com/file/d/15oNPJgFO6tgvLBH-hiCRTlI85quHNcIy/view?usp=sharing)

**Steve Kopp** – ESRI – 01/08/2021

Thank you again for today’s presentation and sharing of the strategic plan document. It is great to see continued progress in this. A couple additional comments...

I’ve been asked a few times since our last CAC meeting “how good is the model for this area.” At the last CAC meeting I saw a map of basins where some degree of calibration work and model skill assessment had been done. Has that work continued or expanded, and is such a map publicly available? This would be useful for end users when the model reaches a point that there are enough basins that you feel have high enough skill.

At the last CAC meeting one topic discussed was incorporating a larger amount of observational/gauge data to improve calibration and model skill. Is that part of the roadmap?

**Ehab Meselhe –** Tulane University – 01/08/2021

I would like to echo the sentiment expressed by many of the committee members about the impressive OWP strategic plan.  Following are some additional comments:

- The terms *collaboration* and *partnership* are mentioned throughout the plan, which is excellent.  It would be helpful to add more specificity on the mechanisms through which the partnerships and collaborations can be implemented and accomplished. The mechanism should not be limited to the funding opportunities. It should describe a holistic engagement program. I believe the NEXTGEN is an excellent platform that can be used as the starting point to launch such a comprehensive collaboration mechanism.

- The flood inundation mapping effort in the state of Texas is very exciting. The mandate to expand that program by Sept 30, 2021 is good; but this program deserves an even greater push for expansion.  Mapping products are an excellent approach to effectively engage the general public and enhance their appreciation of these federal products. Further, it would be helpful to outline a plan of how this effort could be duplicated in other states and regions.

Couple more specific comments:

- Page 25. (2. Strengthen Operational Infrastructure).  The bullets under this item are good; but did not help to understand specifically what are the plans to improve the existing infrastructure? And how?

Page 25/26 (3. Enable Collaboration and Organizational Excellence)

- It would be very helpful to add more specificity on how to infuse social science in water prediction.  I do believe that the mapping tools could be a communication vehicle that can be used to perform research in the “sociohydrologic modeling” arena which combines four fields: physical science, engineering, social science and policy. The key point here is specificity on how to effectively achieve this fusion among the social and physical sciences.

I hope some of these comments are helpful.  Thank you all for the excellent meeting earlier today.

**David Tarboton** – Utah Water Research Laboratory – 01/17/2021

The draft strategic plan and associated presentation provided to the committee represent a strong vision for growing the federal water prediction capability provided by the NOAA/NWS office of water prediction. I appreciate the opportunity to comment on and offer suggestions on a few elements of this plan.

Community engagement aspects of the plan (pages 13-14 and 18) are important. I appreciate the work done towards engagement with academia, notably with UCAR/NCAR and CUAHSI. I would like to comment on the work towards sharing and opening the model code. The plan describes improving code modularity, first incrementally (page 18 notes modularity improvements in Version 2.0, 2.1 and 3.0) and the transformative improvement anticipated with the next generation NWM. The presentation indicated that the architecture was evolving to support broad community development, as a long-range goal. I feel that it would be better for community involvement in the code to be a short-term goal. I do not think it should wait for the new next generation modular architecture. One of the lessons learned in open code community development projects, about which much has been written, is to involve the community from the beginning, and have the community help with what needs to be done. The issue of openness, availability, and transparency should be separated from issues that relate to code organization. The current model, even if not at the desired level of modularity should still be available. I do realize that the current model is built on WRF-Hydro which is open and has code and versions in the WRF-Hydro Github site. I think that there is a need to document the precise instance of WRF Hydro that underpins each NWM version with the configuration detailed clearly on a web page somewhere for researchers to use and refer to, so that, in principle, capable modelers could reproduce the results being generated from the NWM. There is much information available on WRF Hydro that underpins NWM on the web and in Github, but it is unclear to me, and I did not see or hear it stated, that the specific configurations underlying current versions are pinpointed.

The NWM research and operational program is producing a lot of data that is of value beyond just the NWM, and part of opening the model should be making this data available. Specific datasets of interest include

* The hydrofrabric. I understand that this is derived from NHDPlus but has had some “work” done on it to clean it up to use with the NWM. I think that the NWM version of the hydrofrabric is a valuable community data product that could be used in hydrologic modeling research and that it should be disseminated in a way that it is freely available. There should also be some degree of description as to how it is derived from NHDPlus.
* Input forcing. This appears to be the result of an integration process within NOAA/NWM drawing upon the best available data sources, described as a “best-in-breed hydrometeorological forcing engine.” This makes it a valuable assimilation dataset in its own right, alongside other assimilation datasets such as NLDAS and Daymet. Examination of similarities and differences between these may identify errors and shed light on challenges with generating these datasets that result in their improvement. I can imagine the availability of this data fueling independent academic research that the NWS does not have to pay for, but could benefit from.
* Retrospective model runs. I understand that some of these are available, but that the complete associated forcing data may not be available. The ability for researchers to reproduce retrospective model runs for a watershed they are familiar with, can be a good starting point for research to investigate ways to improve the model.

To support community engagement aspects, both in terms of the model and data (paragraphs above), I think that dedicated community support and outreach staff are needed at the NWC. These staff could have specific responsibilities for documenting, interpreting, and providing access to NWM products, and could serve other government (i.e. River Forecast Centers, other agencies) as well as non-government product consumers (water professionals and academic researchers).

In reading the plan, it seems unclear how the National Water Model and Next Generation NWM, which are given more than 3 pages in the plan, relate to the community hydrologic prediction system (CHPS), which is given less than half a page. I think that some sort of alignment between CHPS updates and NWM is needed. It is unclear in the plan how they relate and how priorities for CHPS enhancements are related to NWM planning.

There is also information in the plan about the hydrologic ensemble forecast service (HEFS), which is described as being part of CHPS. Ensemble prediction is important as it provides a way to quantify uncertainty. But, as with CHPS, it was unclear how this part of the plan related to NWM parts of the plan.

1. Aviation Weather Center (AWC); Climate Prediction Center (CPC); Environmental Modeling Center (EMC); NCEP Central Operations (NCO); National Hurricane Center (NHC); Ocean Prediction Center (OPC); Storm Prediction Center (SPC); Space Weather Prediction Center (SWPC); and Weather Prediction Center (WPC). [↑](#footnote-ref-1)