

Unanswered questions:

Session 1

Question answered by

Vijay Tallapragada, Ph.D.  
Chief, Modeling and Data Assimilation Branch  
Environmental Modeling Center, NOAA/NWS/NCEP

1) Can anything be learned from identifying the observations that are NOT used by the models (e.g. observations that are rejected during the data assimilation process because they are too far away from the model background state?)

Answer:

1. Yes - we can learn a lot from analyzing the data assimilation statistics to identify observations that are far from model background state (in operational GFS the model background comes from previous cycle's 6-hr forecast). This could mean two things - one, model is struggling to capture short-term evolution of state variables, either due to lack of observations in the prior cycle, or deficiencies in the model physics. Two - not enough weight given to the observations (especially cloud impacted data from satellites) or instrument errors are larger than the threshold. In either case, the analysis will certainly help improving the use of observations by refining the error characteristics or improving model physics/resolution. Density of observations, co-located observations, error covariances, and localization also play a big role in accepting or rejecting the observations.

2) Question for Vijay: you showed the positive impact of AR Recon data on the ensemble system; can you elaborate further on that result? are the improvements both on the reliability/calibration and skill of the system?

Answer:

2. The improvements in precipitation forecasts (reliability of QPF) shown for GEFSv12 (ensemble system) are directly on the ensemble system itself (not calibrated). Initial conditions for GEFSv12 ensemble members are derived from 80-member ensembles of the Global Data Assimilation System (GDAS) that have assimilated the AR recon observations.

*The reliability diagram measures the accuracy with which a discrete event is forecast by an ensemble or probabilistic forecasting system. According to the reliability diagram, an event should be observed to occur with the same relative frequency as its forecast probability of occurrence over a large number of such forecast-observation pairs. The Reliability diagram plots the average forecast probability within each bin on the x-axis. The y-axis shows the corresponding fraction of observations that fall in each bin. If the forecast is perfectly reliable, the observed fraction within each bin will equal the average of the associated forecast probabilities, forming a diagonal line on the reliability diagram. Deviation from the diagonal line represents bias in the forecast probabilities, notwithstanding sampling uncertainty. (taken from [http://www.cosmo-model.org/content/tasks/pastProjects/versus2/docs/epsDocument\\_task5.pdf](http://www.cosmo-model.org/content/tasks/pastProjects/versus2/docs/epsDocument_task5.pdf))*

3) Following up: Are the control/denial precipitation differences beyond the operational GEFS ensemble spread?

Answer:

3. In general, precipitation forecasts from GEFSv12 have shown significant improvements. We have not conducted data denial experiments with the ensemble system.

4) Would fixed buoys with vertical pointing radar make a significant observational difference?

Answer:

4. Data from fixed buoys with vertically pointing radar can certainly help - need more information on the characteristics of the radar and calibration of the instrument.

5) What else can you share re: timing and approach for the precipitation grand challenge?

Answer:

5. Forecasting both timing and magnitude of precipitation are important apart from location and spatial extent. Precipitation Prediction Grand Challenge program is trying to address all these aspects, including enhanced observing systems, improved modeling and process level understanding, post-processing and data analytics.

6) Is AR-Recon data currently used for operational GFS/GEFS runs, or separate experimental product?

Answer:

6. Yes - AR recon data (especially dropsondes) are currently assimilated in the GFS, which also provides initial conditions for the GEFS. We plan to include more data (high-density flight level data and surface buoy measurements) starting in February 2021 when we are implementing GFS v16 with higher vertical resolution, advanced physics and advanced DA).

## Session 3 and 4

Question answered by

Cary Talbot, PhD, PE  
Chief, Flood and Storm Protection Division  
Coastal & Hydraulics Laboratory  
US Army Engineer Research & Development Center

14) We have pre-NEPA WCMs. When we request \$ from O&M to update & advise they need Section 7 consultation @ \$1 million+, no \$ is forthcoming. Adding FIRO's potential ops variability could make Sec 7 even harder. Thoughts?

Answer:

In a sense, the person asking the question is correct – there is limited funding for WCM updates even in the best of times and if you've added FIRO requirements, you've made the process even more complicated and therefore costly. However, the good news is that Congress has recognized that in order to see FIRO achieve its full potential, WCM updates are needed and thus they have provided a separate funding line specifically for FIRO-based WCM updates, including for Section 7 dams. Joe Forbis is involved with the management of these funds and can speak to how they are being prioritized and used to accomplish the intent Congress has stated for the funds.

We don't know if Congress will continue to provide funding for this down the line but based on my experience with FIRO funds from Congress to date, funding follows progress so if they see that action is happening and progress is being made, they will likely continue to provide funding to keep the FIRO WCM update ball rolling.

Question also answered by

**Joe Forbis, P.E.**

Chief, Water Management Section  
Sacramento District, U.S. Army Corps of Engineers

Answer: Thanks Cary.

You are correct – the funding that USACE received in FY2020 was to update WCMs for Section 7 dams that are specifically involved in FIRO. Other wording in the appropriation effectively limited the funding to be used for the WCMs for Oroville Dam and New Bullards Bar Dam, located within the Sacramento District. USACE hasn't yet received any additional funding to directly update WCMs in this way (directly connected to FIRO) for other locations, but we hope with the spotlight that FIRO has helped shine on the need to update WCMs across USACE, funding will be provided more frequently for this purpose.

As for the difficulty to update WCMs due to funding and internal-to-USACE inertia to overcome, that highlights even more so the importance to make the WCM update “count” when you can. So even though incorporating FIRO concepts in a WCM update may complicate the analyses, by doing so you may be able to develop a WCM that does not need to be updated as frequently as it would have been otherwise. Using FIRO with an adaptive water control plan (which can accommodate changes to forecast information and methodologies improvements) could give a WCM a level of relevancy and staying power that our current WCMs lack. Long story short – it very well could be worth it to deal with more complications at the beginning due to the potential benefits realized in the future.

## Session 5

Questions answered by

Luca Delle Monache  
Deputy Director, Center for Western Weather and Water Extremes  
Scripps Institution of Oceanography  
University of California San Diego

1a) How does the statistic of machine learning look for events with  $IVT > 1000 \text{ kg/m}^2$ ?

Answer:

During my presentation I mentioned some preliminary work we have been doing for the prediction of 24-hour accumulated prediction over a 3-km grid covering most of California. We have developed and we are further testing and refining a convolutional neural network (CNN) leveraging CW3E's 34-year reforecast data set, which is based on the West-WRF numerical prediction system. For high precipitation events, the CNN is either improving or preserving West-WRF skill. We are currently exploring ways to further improve these results focusing on extreme events.

1b) And with the change in the global climate pattern, how is machine learning would perform?

Answer:

This is a great question. In an ideal scenario, the training data set should be based on a "static" version of the dynamical system, e.g., a condition that is violated with climate change for the atmosphere. However, climate change signal is mostly detectable over large spatial domains and a long period of time (e.g., several decades). What it matters for machine learning successful implementation in a postprocessing framework, is learning the dynamical model behavior and the model error characteristics, and this can still be accomplished over smaller scales (e.g., at the mesoscale or over watersheds) to improve short-term predictions as we are empirically showing with our research.

8) Luca - can you comment on the potential for using ML for S2S forecasting of ridging conditions?

Answer:

ML has a lot of potential for S2S, as shown by the research of our group and many others. That includes the prediction of ridging, which are predictable on S2S temporal/spatial scales as shown by Gibson et al. (2019). We are currently exploring statistical methods, which are a form of machine learning, to generate S2S predictions of ridging conditions, and preliminary results are promising.

## Session 6

Questions answered by

Sean L. Smith, P.E.  
Principal Hydrologic & Hydraulic Engineer  
Hydrology, Hydraulics & Coastal Community of Practice Leader  
U.S. Army Corps of Engineers  
Headquarters (CECW-EC)

8) In May 2020, USACE published a report on how the Corps has/plans to use Managed Aquifer Recharge. Can MAR be included in the water management alternatives analyzed for FIRO related changes to the WCP/WCM and what would it take?

Answer:

The report published by USACE-IWR noted the utility of MAR and the potential benefits of the strategy. The key aspect of the use of MAR would need to be founded in the original authorization for the project. If it can be determined/assessed that use of such a strategy does not impede the Congressional authority, the use of MAR may be explored with all the necessary assessments within the National Environmental Policy Act (NEPA). The most notable case of such efforts is where USACE may release water from a reservoir project in a manner that a downstream entity may lift the water out of the receiving stream and have that water injected into the MAR system. The water made available for this was within the Congressionally authorized pool (within the reservoir) and the operation associated with the release of the water would need to be codified within the approved WCM. Therefore, the FIRO may inform the operational release strategy from the reservoir to better define how the downstream MAR strategy may be employed. All affects of the operational strategy would need to be assessed under NEPA.

9) For Lake Mendocino, once the FVA is done, how long would it likely take to update the WCM?

Answer:

The FVA can provide for strategies that may be considered as part of a WCM update. The steps required for a WCM update can be examined in the attached flow-chart. The amount of time required is directly related to the nature of the changes that may be considered (through alteration of the actual operations). Therefore, the ability of the FVA to inform or provide direct information within the flowchart will have a direct influence on the time frame. The bulk of the work within the FVA would be more so tied to the technical analyses or formulation of the technical requirements to assess the alternatives under consideration. What many are not as familiar with is all the other requirements under NEPA that drive the time lines to a large degree. To attempt to convey the full procedure typically employed for a water control plan update, the attached flow chart should be referenced. The process is relatively the same for deviation requests with the exception of certain steps may be omitted based on specific details of the request. I did not provide specific time lines since many of the time aspects are directly tied to the scope of effort for an update. However, it is important to note Section 310 of WRDA 1990 had specific requirements for public involvement for changes to water control plans in addition to general Corps of Engineers guidance on public involvement. The requirements of Section 310 are also mentioned in ER 1110-2-240. The Corps of Engineers procedures for implementing NEPA can be found in ER 200-2-2. NEPA also provided a statutory basis for more in-depth public involvement in the Corps of Engineers' process. In the 1970s the Army Corps of Engineers revised its public involvement programs and implemented procedures and practices to

implement NEPA. See Appendix B on Public Involvement. Public Involvement, Collaboration and Coordination in ER 1105-2-100 "Planning Guidance Notebook." It stated, "The Administrative Procedures Act, (including Section 3, the Freedom of Information Act) and the National Environmental Policy Act (PL 91-190), are among the principal legislative acts requiring public involvement. Federal planning policies, Corps practice, and regulations have consistently required and encouraged open and effective public involvement."

11) "Old" WCMs are routinely and automatically castigated in the media as red flags. Are there any plans to try to educate the public/media about pros and cons (some old WCMs are still the best we can do, etc)?

Answer:

Age is not an indicator for the adequacy of an existing WCM. WCMs contain a provision authorizing the operating District to update/revise the manual when appropriate. Normally the Corps updates the WCM at a dam as a result of dam modifications; however reviews occur more frequently. Update/revision of a WCM is funded through the limited Operations and Maintenance (O&M) budget provided on an annual basis. Thus, each district must prioritize how the funding resource is allocated. In many cases, there are more urgent needs such as equipment repairs, sediment removal, levee and channel repairs, etc. Hence, update/revision of a manual may have lower priority. If the non-Federal sponsor requests a WCM update, the Corps may, if O&M funds are made available, update the manual as appropriate. Under certain provisions, the Corps may also receive contributed funds from non-Federal entities for review and/or revisions to a WCM. Detail of the update/revision process is outlined in ER 1110-2-240. The ER states that WCMs shall be prepared to meet initial requirements when storage in the reservoir or water control projects begins. They shall be revised as necessary to conform to changing requirements resulting from developments in the project area and downstream areas, improvements in technology, improved understanding of ecological response and sustainability, new legislation, and other relevant factors, provided such revisions comply with existing federal regulations and established Corps policy.

12) For WCM changes, are only flood space re-evaluated, or are downstream flow capacities examined also?

Answer:

In accordance with NEPA, a full assessment is required both upstream and downstream.

13) Mike showed a slide that says the software used has to be Corp approved. How does the EFO model fit into this requirement?

Answer:

The EFO tool is not on the USACE list of Approved Software. The enterprise software for water management operational purposes is the Corps Water Management System (CWMS). CWMS is the Corps data management, real-time modeling, decision-support, analysis, and information dissemination system supporting the USACE Water Management Mission. The 24/7 mission performed at Corps offices encompasses decision making related to congressionally authorized project purposes such as reservoir regulation, flood control, hydropower, navigation, water quality, water supply, recreation, fish and wildlife and others. The EFO tool is not integrated within this system but may be used by the Sonoma Water Agency to aid in their coordination with USACE for management of the Lake Mendocino system.

14) How can FIRO streamline the WCM updates?

Answer:

Similar to question #9 above – FIRO understanding/application can inform operational scenarios for consideration as part of a WCM update. The integration of that information must be codified in the WCM as per USACE policy/regulation. How the operators are expected to account for the information in terms of making release decisions is the critical aspect of FIRO and how those products are integrated within the forecasts provided by the NOAA River Forecast Center offices (as an input to USACE for decision making) is the linkage between concept/idea and real-time operation. It really boils down to improving forecast skill as an output to be utilized as an input to the USACE decision making process.

15) Can you talk about some of the differences between Goals vs. Objectives when developing a framework to update a Water Control Plan (to include FIRO)?

Answer:

The overarching objectives for water management include operating in accordance with authorized purposes and applicable law, maintaining the structural and operational integrity of the project and avoiding risk to public health and safety, life, and property. To keep water control plans up to date, personnel from the water control office responsible for regulation of each project shall periodically review the plan for each project. These personnel will be professionally qualified in the technical areas involved and familiar with comprehensive project objectives and other factors affecting water control management. Goals of the framework would be to assess/modify the operations for more efficient use of the resource (for whatever means in accordance with the authorization) but doing so with the projects objectives still held at the forefront.

16) Of the 181 reservoirs mentioned by Sean, how many have a major physical modification planned? Since they would already require a WCM update due to the construction, would it be efficient to carry out a full FIRO viability assessment too?

Answer:

The level of effort (or scope) is still under development by the various field offices involved; yet it is not envisioned that physical modifications are the basis for such an update. If physical alterations are the basis for the WCM update, the funding associated with that physical alteration would address the costs associated with efforts to update a WCM. To what degree FIRO fits into that strategy would be subjective to the changes being scoped (it may include FIRO or it may not if the project is not a viable project for FIRO).

## Session 8

Question answered by

Mike Anderson  
State Climatologist  
Senior Engineer, Water Resources  
Hydrology and Flood Operations Office  
Department of Water Resources, State of California

- 1) How involved in the S2S product development are the global operational NWP centers, if at all? Any plans to bring other models in or do you think what we have is sufficient?

Answer:

The S2S Collaborative Development effort includes projects with NOAA's Earth Systems Research Lab and the Climate Prediction Center which engage NOAA's Global Weather Prediction Models. The team at NASA and Scripps have ties to ECMWF, but no formal agreements to do technology transfer. I think the NASA/CW3E team look at the US/ECMWF/Canadian models. If we can tap into the expertise in other centers, I am open to exploring the opportunities.