NWP Panel Recommendations for COMET Training Development in FY 2013

Section Contents:

Section 1 NWP Panel Objective

The purpose of the NWP Training development panel was to a review the development and utility of materials related to NWP training delivered by COMET and recommend an approach that improves the efficacy of FY13 training resources and ensures the continuation of future funding.

Section 2 NWP Panel Members

Each panel member listed below was nominated by his or her region for participation. Members' responsibilities included participating in conference calls, reviewing documents, and presenting suggestions and recommendations for discussion. COMET's representation on the panel served to provide information to the regional members.

Eugene Petrescu	Alaska Region
Bill Ward	Pacific Region
Brian Carcione	Southern Region
Joshua Scheck	Central Region
Justin Arnott	Central Region
Stanley Czyzyk	Western Region
Paul Sisson	Eastern Region
Bill Bua	COMET
Robert Rozumalski (Leader)	Training Division/FDTB

Greg Byrd (*Participant)* COMET

Section 3 Some Background and Guidance

As part of the annual NSTEP process, requests for the development of training are submitted from throughout the NWS. These identified training needs are ranked from 1 (must have) to 9 (not necessary) by members of the Field Requirements Group (FRG) representing each of the NWS Regions. The rankings from each region are averaged and sorted from highest to lowest along with the associated training cost. National training funds are then allocated toward each request according to the rankings until the resources are exhausted. Any training request that falls below the cut-off does not get the necessary resources.

Previously, support for development of NWP training by COMET has been positioned above the resource cut-off line, thus ensuring the continuation of training development. However, for FY 2013 NSTEP process, the request fell below the level of available funds and thus was subject to being eliminated. This situation was due in part to a reduction in available funds, as well as a decrease in the perceived value of NWP training by the regions.

However, a problem exists in that COMET NWP training, unlike many residence courses and distance learning modules, delivery may not be temporarily postponed. The elimination of funding for the COMET NWP team (SME + graphics people + instructional designer + others) means the loss of experienced personnel in which the NWS has large investment, which is an asset that could not easily be replaced. Consequently, an agreement was reached to partially fund the COMET NWP training team at approximately 60%. Unfortunately, this level represents a fraction of the resources necessary to accomplish the needed NWP training. Thus the NWP panel was organized to improve the efficacy of existing NWP training and to determine the most efficient use of the limited training resources for FY13.

Section 4 A Summary of WFO Field Surveys

One of the first panel actions was to conduct informal surveys of the WFOs regarding their NWP training needs. One survey was directed at the operational forecasters (Appendix A) while a second queried the NWS Science Operations Officers (Appendix B). The panel reviewed the feedback from the field to determine whether there was a consistent message.

The response from the forecaster community as to what NWP training they desired was dominated by requests for information regarding “model bias”, “model of the day”,

"model strengths and weaknesses" and "seasonal variability", which can all be similarly categorized. The panel determined that while the development of training in this area could potentially be of value to NWS field operations, it would be impractical to dedicate the limited resources toward this effort. It was suggested that the development of NWP bias training might be possible for some of the more easily demonstrated examples that have previously been identified and studied.

Some of the more common suggestions and requests from the forecaster community included:

- Training on high-resolution models and associated output
- Just-in-time information on model updates
- Improved organization of existing training material
- More focus on NWS operational forecasting
- New training delivery methods including visit sessions, teletraining, articulate presentations and "YouTube like" videos as part of a special training channel.
- Shorter modules - suggested ranges were between 5 and 30 minutes.

The responses from the SOO community indicated a more pragmatic approach to the NWP training issue. While they realize that an all-encompassing training program would be ideal, it was recognized that the operational demands limit the amount of time dedicated to training. Consequently, the available resources must well organized and prioritized, operationally relevant, easily digestible, and presented in a way to compliment forecasters' learning styles. More interactivity was also recommended.

Below is the response from a SOO that captured this sentiment:

> *"Out of all the training I've done, the NWP modules were the most difficult to get through. I think there was too much information presented about the background of the models. While it is important to know a basic background of how models work, differences in grid spacing and resolution, etc., I think it would be better if the modules focused on information more relevant to everyday forecasting. For example, instead of such an in-depth look at how NWP works, having a brief module on that, combined with something that compares the biases of commonly used models would be better. Maybe there's already something like that out there, but I personally felt so bombarded by the inner workings of NWP, that I couldn't remember everything. Additionally, if I remember right, the NWP modules were presented by having trainees read page after page of information. Brief videos of broken-down topics would be much more helpful in remembering the material."*

Section 5 Final Recommendations of the Panel

The panel acknowledges that the available resources severely limit what can be accomplished by the COMET NWP training team between the start of FY13 and the FY14 NSTEP review process next spring. However, it also recognizes that the continuation of current development and delivery strategies will likely result in all remaining NWP training resources being eliminated. Consequently, an objective of the panel was the infusion of ideas for FY13 that can be accomplished quickly and efficiently, and which also demonstrate the value of NWP training to NWS operations.

I. Create a series of LMS learning paths from existing COMET NWP modules

The panel recommends that COMET organize existing NWP modules to create a series of LMS learning paths tailored towards specific subject matter and NWS personnel. Paths should be limited in scope and require a relatively short amount of time to complete, no more than 12 hours. Paths should be initially created for NWS interns and operational forecasters, followed by paths directed at newly hired SOOs. The SOO paths should be organized so that they can be later integrated into a virtual COMAP course. There should be separate paths for operational NWP, NWP background material, and theory. Additional paths may be added to address other subject matter needs.

II. The development of any new NWP training should directly address the NWS operational forecast process

Given the limited resources, the panel recommends that any new NWP training focus on issues that directly influence the NWS forecast decision-making process. It is suggested that the developers adapt a "Black Box" approach to new training, focusing primarily on the NWP information available in NWS operations. To achieve this objective, it is suggested that any detailed discussion of NWP theory and the technical aspects of operational modeling systems be greatly reduced. While the panel acknowledges that this approach may not be long-term solution to NWP training, the current budget limitations dictate this short-term direction.

III. The Panel recommends that COMET NWP training resources be directed towards the following areas:

a. "Just-in-time" training on model updates & changes

Continue the development of model update videos similar to those created for the NMM-B and RAP releases; however, some of the "goofiness" in the previous videos should be reduced in favor of additional information and substance.

b. Training on the effective use of deterministic model fields in NWS operations.

A series of short training modules should be developed, each dedicated to a model-derived field available to NWS operational forecasters. Suggestions for training content include but not limited to:

- How fields such as radar reflectivity, wind gust, helicity and aviation products are calculated
- How these fields can be used operationally.
- The assumptions used in calculating the fields
- The limitations that exist in the use of the fields
- Examples demonstrating the application of these fields in NWP operations are critical

c. Training on the effective use of ensemble model fields in NWS operations.

Similar to the deterministic model guidance in (b), a series of short training modules should be developed, each dedicated to an ensemble product available to forecasters.

IV. Individual training modules should not exceed 30 minutes in length

The Panel recommends that the target length for new modules should be ~15 to 20 minutes; however shorter modules of 5 to 10 minutes may be incorporated in where appropriate. Modules longer than 30 minutes should be broken into multiple (shorter) segments. The recommendations for the reduction in module length should serve to keep the trainee's interest and to help in the scheduling of training within the WFOs.

V. Employ a variety of training delivery methods

The forecaster and SOO responses to the surveys suggest that modules consisting of mostly text and graphics are the least effective at keeping their attention. Consequently, the panel recommends that an effort be made to keep the trainees engaged by limiting this method of delivery. Additionally, it is important to integrate some interactivity into all training, especially for the longer sessions. It is also recommended that the developers vary delivery methods and styles by incorporating short videos; articulate presentations; recorded presentations and "pop" quizzes into the subject matter training.

Appendix A: Forecaster Survey Responses

The following are responses from the field to an inquiry sent by the panel leader regarding NWP training needs. The inquiry read as follows:

> **Good afternoon SOOs,**
> **The diminishing resources have necessitated a review of the development and utility of materials related to NWP training delivered nationally. While this type of inquiry would not typically be viewed as ultimately having a positive impact, I'm actually hopeful it can serve as a catalyst to redefine and refocus the future of NWP training within the NWS. So, I would like your assistance in this effort to improve the efficacy of new training materials, especially in regards to their use in operations.**
> **The initial step in this process will be relatively simple. I am asking you, the SOOs, to conduct an informal survey within your office to determine what type of NWP training would be of value to operations. Where should it be focused? Better use and/or information on new model fields? What about information regarding model updates? How should the material be delivered? I encourage you to foreword all suggestions and advice from your forecasters. Do not limit your input based upon the limited and naive questions above. I would like input on what type of NWP training would be most effective in operations. The only caveat is that requests for large projects may not be practical. Think YouTube rather that Blockbuster.**

Below are the responses as submitted by the SOOs from the field. . Each numbered item represents the response from an individual WFO in no specific order. Most references to a specific WFO have been scrubbed.

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1. Here is some input I have thus far. I'd have to say that another Intern at our office seconds the first paragraph, and also I agree with their assessment -- so that's three votes for the first paragraph.

   - "Out of all the training I've done, the NWP modules were the most difficult to get through. I think there was too much information presented about the background of the models. While it is important to know a basic background of how models work, differences in grid spacing and resolution, etc., I think it would be better if the modules focused on information more relevant to everyday forecasting. For example, instead of such an in-depth look at how NWP works, having a brief module on that, combined with something that compares the biases of commonly used models would be better. Maybe there's already something like that out there, but I personally felt so bombarded by the inner workings of NWP, that I couldn't remember everything. Additionally, if I remember right, the NWP modules were presented by having trainees read page after page of information. Brief videos of broken-down topics would be much more helpful in remembering the material."

   - "I think any training on known model limitations, especially in certain regimes would be very helpful. Also, training on significant model changes (code, equations, modules) would be helpful. I think knowing these types of things could help forecasters understand model output much better."

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2. This is a very interesting question! We had a discussion about this yesterday and today in the office and I believe the consensus is that currently, models are becoming more and more of a 'black box'. With so many guidance choices and with many of these changing very frequently (i.e. many on an annual basis), forecasters are losing the ability to stay up with the latest changes. This results in inadequate (or erroneous) knowledge of model biases. When this occurs, we get forecasters not making educated decisions on what guidance/guidance blend is superior in a particular case.

   My suggestion would be a set of in-depth modules, one per major set of guidance. Much of this information is included in the COMET model matrix, but I think a presentation format would be more effective and easier to incorporate into my local office training plan.

   For example, modules on the following would be a terrific start, but even just the NAM/GFS would be terrific.

   1. NAM
   2. GFS
   3. SREF
   4. GEFS
   5. GEM
   6. ECMWF
   7. RR/RUC
   8. WRF-ARW

   I think these should be pretty scientifically robust (i.e. don't skimp on the theory if we need it to understand a concept), but also have operational application sections. Then, each would be updated when there are model updates.

   I should stress that I think this type of training is imperative if forecasters are going to remain important in the forecast process. In this day of ever-improving model guidance, it requires a better understanding of the guidance to remain able to improve upon it.

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3. I think one of the challenges we face, and one of the reasons for what I included in my last email is that undergraduate students coming into the NWS don't have much more than very basic knowledge of NWP. As new forecasters in the NWS, we spin them up to get ready to work shift, WDTB gives them radar training through DLOC/AWOC, but they never really have focused training on the most important tool in their job. So, where do they learn to use NWP intelligently? Certainly experience is helpful (i.e. now many undergraduates have been looking at the models for years on the internet), but things like your training are essential.

   So, while I wish it could be somewhat more comprehensive, I think your idea of focusing on how different model aspects impact their use operationally is a terrific one.

   There are some basic concepts that I think would be good candidates for this, including:

   - We discuss MOS “trending towards climo” in the long term. How true is this? If we see temperatures 10F above normal on day 7 of the MEX guidance
   - MOS equations: These change seasonally, but how many forecasters know the dates, and what do the changes entail.
   - Major parameterization packages and their operational impacts

- I think a "bias-sharing forum" would be a great thing (and I think this has been done in the past), but only if we get some buy-in.

- Situations for which the GFS/NAM/RUC/ETC perform best. These are just a few ideas, but I think most of them fit with what you mentioned.

Some of this information is already out there and I think the recent NWP Training Series that has been put together is really slick. This course may go back to my first point about new forecasters. Requiring this course would probably be a good first step!

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4. It would be nice to have a comprehensive list of hi-res models and where they can be accessed. Whether this is on the intranet page or somewhere else. Model biases would be where I focus any training as that has a direct impact on which model we may ultimately adjust the forecast towards. Having any known biases understood, can help us choose a better model to follow. It might be nice to have this training delivered at a station meeting or workshop. Email is sometimes informal and can get glossed over, so it would be nice to have it in the office.

   Also, It would be nice to perhaps look at boiverfiystats a bit closer and try to figure out in what situations or on what occasions certain guidance does better than other times. We have all that information being collected here.

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5. A couple of comments to pass on:

   - Maybe the most useful and/or effective training regarding NWP would be through visit teletraining sessions and focusing on only the operationally impacting elements. Training on new fields and how they can be used operationally might be useful. I am not sure that we need information on model updates every time there is something that is changed, maybe just big changes that will result in noticeable differences to the forecasters in operations.

   - I would like to see a discussion on model bias especially for temperature and moisture fields. Also, a discussion on model output QPF would be great. It seems that the models are over forecasting QPF amounts.

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6. In response to your recent request, we had an equal number of responders requesting more information on new model fields, and desiring an improved method for tracking model biases.

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7. Here are responses:

   - My experience is that most of our operational forecasters have little interest in details of the model's innards. Training should emphasize what's new/different and where (D2D Families or the Browser, GFE Populate menu or within smart tools only, internet) it can be found. Less detail is better with an emphasis on what legitimate improvement we should see. Real examples of the improvements would be good. The why should be very limited with references to more detailed information for those who want it. Quick Camtasia type presentations should be fine for delivery. I would like to see a quiz or some sort of remedial exercise to verify that each of us has actually considered the more important information. I have a feeling that a lot of NWP

information goes in one ear and out the next. Minor updates with little or hard to see improvements should not even be brought up. My thinking here is like the tornado warning issues we are facing. If we get bombarded with information that is mostly useless operationally we are more likely to tune out the really important stuff when we get it.

- Personally, I would have to agree. Going through the "how the model does this" often covers up what we really need to know. There are so many models with so many differences it is difficult to keep track of.

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8. Stress strengths, weaknesses and the nature of the weaknesses. Also go over *verification statistics* for the models. Techniques for deciding the model of the day.

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9. From the forecasters, we have a couple of items for your consideration. Parts of these may be covered in current COMET modules. However, I think we could reach the forecasters better if there was a live webinar, where the speaker could also take questions. Just a thought. I'll point these forecasters to the COMET METED sight. The 3rd item is mine. I believe forecasters could do much better on the first period, if they knew what went into the initialization. There are fields that we don't see. Last summer, the model surface dew point temps were too high, clearly indicating too much transpiration. The average Td errors in the afternoons were 5-7 degrees, all biased too high. As a result, the max T errors were also too high, day after day. This is less of a training issue than an issue of sharing information. However, it might be helpful to have someone from MDL explain how, what and when initialization data goes into the model.
   - A concise explanation of the benefits and weaknesses of the various parameterization schemes that are available (included those used and not used in the operational models).
   - Explanation of model spinup issues that relate to precip generation in the first 12 hours of a run
   - Model initialization fields and their importance to models and ultimately MOS.

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10. Here is some input I have received:
    - The use of Hi-Res model data: Seems to be a multitude of hi-res models being used without what is really going into the model with respect to the physics packages and how it influences the model output with convection and or cold season precip.
    - Would be nice to have a short course on model strengths and weaknesses - where the hi res convective allowing models would outperform the "courser" operational models and why. What are the advantages of using "explicit" convective parameterization versus KF or BMJ? Just what does explicit infer in models?
    - The WRF-ARW core versus the WRF-NMM, differences along with strengths and weakness with each. Does either model outperform the other with QPF forecasting? I have heard that the WRF-ARW is much better with respect to forecasting not only rainfall amounts but the locations of the max qpf, why is that?
    - I realize COMET-METED site has a multitude of NWP courses to take but the setting is not very conducive to learning, it's a rather boring presentation of the material. If their presentation was similar to what is being done with the Dul-Pol Operations course at the WDTB, I think that would

be more beneficial than reading thru all that material online. I know METED can do better than what they are currently giving us, with respect to NWP courses.

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11. Here is a comment from one of our forecasters:

    - Which models use which observational data, and how do they ingest it?
    - We now have about 40 "models" from which to choose in the Model Blend tool -- what are all those models? How are the various perturbations of each model (such as the BC's) created?
    - Would like more information on model biases

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12. The following pretty much summarizes the forecasters' thoughts:

    - What are the individual Model biases and differences in physics?
    - How has the models' performance been of late?
    - What are the new updates (i.e. RUC vs RAP) and why are they important?
    - What's up with the flip-flop between 06Z/18Z and 00Z/12Z runs?
    - Is there a mid-range fall-off in model performance, if so why and how do we adapt to it?
    - Differences between ECMWF and GFS that make one superior in different situations?
    - How is data assimilation done and which models use what observation types for input?
    - What do we NOT know about NWP that we NEED to know?
    - Intelligent use of ensembles.
    - How best delivered - Like WDTB does with articulate presentation along side a WES case, which allows interactive training and hands-on discovery.

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13. I find many forecasters do not have a fundamental knowledge of how models work. NWP classes are not really taught in undergraduate (or sometimes even graduate) school. My first operational model introduction was the COMET NWP course. I found it VERY valuable. Learning how models make clouds and precipitation and learning about the various parameterization schemes would be my prioritized list.

    I realize COMET just updated the NWP course - however it does not have audio and is not that interactive. That was a real bummer. I wonder if the 0.6 FTE could be used to simply add audio to the existing NWP course?

    Finally, models change rapidly. It'd be great to have short teletrainings on operational model implementations. For example, the RAP just replaced the RUC. The GFS Hybrid is going in real soon. The 4 km CONUS NAM Nest was added.

    Highlights of the operational impacts of new model implementations can be very valuable (in-context training).

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14. The following are unfiltered forecaster comments:

    - I think training modules covering the parameterizations, strengths and limitations of the high resolution models available in AWIPS would be most beneficial to me, since I am most unfamiliar with those. I am starting to take a look at those more regularly now, particularly with regards to convective initiation. I know we get periodic updates to improvements made to the operational

models we use routinely, NAM, GFS, etc. but refresher training on these updates would be helpful. I know the ECMWF is a good model, and perhaps training on the inner workings/input of the ECMWF, and its strengths and limitations versus the GFS, NAM, etc. might be helpful?

- There are probably quite a number of new fields available that I am probably unfamiliar with, so training on what new fields are available will certainly be helpful to operational forecasting.
- I think training and information regarding model updates would be great as included within a training resource.
- I've always found the Articulate training presentation method provided by WDTB to be a good medium for training. The COMET module format is good too.
- One more thought came to mind too. There has been an ongoing discussion between various forecasters regarding whether or not the 06z and 18z runs of operational models are worthwhile, considering that they are not "initialized" with upper air data. A training module on whether this has merit or is mostly myth may be a good topic for operational forecasters.
- As always the main focus should be on short term forecasting including the Marine. With the new Marine zones coming soon emphasis should be a better understanding of the high res data for developing a more accurate forecast for all the marine zones. This means the performance of the wrf and arw data show be discussed and analyze on a daily basis so a more consistent product goes out to the public. Also, people should go back and check the performance of the SWAN data and mention any problems or inaccuracies that may arise.
- My suggestions are that NWP training be focused on QPF and also on biases particular to each model - and most importantly how to use these biases to improve our forecasting skill. I really don't have anything to suggest for new model fields, just to say that being able to look at model reflectivity and similar is really helpful/cool. The information that I've been receiving on model updates has been sufficient. I think it's easiest to have online training which makes it easier to get things done with shift work
- I would certainly love to know more about model updates when they happen. I know we get bulletins on what changes are being made, but I think it would be helpful to us to learn just how those changes may affect model behavior, what the impact to operations will be, and potential warning signs to look out for (unintended side effects of the changes). I think teletraining sessions work best, mainly because questions can be asked. If they could ever give us training on just how AWIPS calculates instability parameters that would be great!

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15. Input from forecasters:
    - I would like to see a "best practices" type of training. What fields do you look at if you are expecting a, b, or c as a weather event. What is best to use?
    - When are the models generally used for (like, I tend to use the GFS/EC to get a broad synoptic picture of the weather trends while I use the NAM/RUC/HRRR to get a feel for convection and snow bands)
    - Some training on all the new model fields would be beneficial as well.
    - New model fields would also be great to have training on obviously, so keep that coming!
    - Anything to understand the general bias issues would be helpful.

- How the models behave seasonally, from both a national and local scale (ask the forecasters which models they prefer and why).
- As far as training delivery, I am a huge fan of case studies or activities where I can look at the data myself and see for myself what is being taught instead of just being told. Obviously WES cases work great for this, but a less expensive way would be a case studies set up similar to the Recognizing High Impact Hydro Events (HIHE) (LMS). This was all web-based, but yet I think it drove the point home pretty well since I was able to look at the data myself.
- Model ensembles are an excellent forecasting tool and still underused. This may be a good place to continue to focus training.
- Another item that I think would be great is some sort of training on model biases. Given certain patterns, what tendencies do specific models tend to have. Obviously some biases are well documented, but I think something could be put together and used, as training that could be of potential operational use, especially in long term forecasting and helping improve all blends.
- Do certain models behave better in certain situations (i.e. major shifts in the weather pattern)? Ask the forecasters what they've observed over the years--much like your convective wind study.
- Some documentation/limitations/strengths of the GFS would be nice. Rather than selling us the same old - this works great - look at the verification stuff. It appears that some forecasters have no idea of the biases of the medium range models, even after a WFO SOO developed some training.
- I hear there are plans to do some significant upgrades to the GFS over the next 5 years to make it competitive with the ECMWF again. Examples I've heard are better MJO physics, NAO type things to catch the major shifts of sudden strat warming events as well as higher and deeper resolution of the atmosphere. I think it would be helpful to have things out there to help understand what changes we are making. Now, I don't propose a long or complex type training, but something that would show utility and a little behind what the physics are doing.
- Have an online knowledge base about each model's performance. For example, situations where each model is strong and weak. Although this could be anecdotal information, specific examples would help reinforce the information. Over the years I have heard bits and pieces about model performance in given regimes, but it is not collected into a knowledge base format. Having a venue where people could add information would be helpful.
- Something like a model Wiki page that provides a simple and easily accessible reference page regarding model strengths, weaknesses and bias.
- What each model abbreviation stands for in AWIPS, who runs it, the resolution of the model, how far out it goes, and what kind of parameterizations it uses.
- Might be nice for a yearly overview of both planned changes to models, and perhaps any major changes to model physics. Not sure if a webinar is needed, but maybe a recorded presentation that can be accessed remotely by each forecaster/office.
- Training on how to recognize recent model run verification and performance, maybe at 6 and 12 hours for each run. Training on how to recognize and capitalize and which models are doing well and which are not.
- How do people go through the process of seeing which model initialized the best? What fields do they look at and what do they compare them to? (satellite, metars, soundings, etc)

- Have real-time model verification data. Of course we would have to define the parameters to be defined. Having the model verification data would go hand-in-hand with a knowledge base concept.
- My primary concern there is that I find myself falling into a rut as far as what fields I look at, how I step through them, which models I typically use, etc. I have self-identified a need for increased use of ensembles, and I don't recall having much training on that (aside from hydrology).
- It also might be beneficial to have some kind of training on which models we have available and how they are related to each other - one model being a derivative of another and so forth. On occasion I have looked at two models that I deemed independent only to discover that they were related to each other.
- Training on how QPF is generated in the models. Too many forecasters, including myself, get suckered into looking at QPF when it is typically one of the worst performing fields. QPF is one of the most hand-waving grids we produce.

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16. Here are comments from forecasters (Summarized by the SOO):
    - I think NWP training should be focused on strengths/weaknesses/biases of the models we use in forecast operations and be coupled with verification stats. Model update information needs to be concise and tell forecasters how to use the information and any potential affects on the strengths/weaknesses/biases. After going through the NWP training in the past...I don't need to reinvent the wheel...I'm not a modeler. I just need to know how to apply the information...you know?
    - Audio/visual presentations would be best in my opinion. Camtasia/video based training modules would easily meet this requirement.
    - Refreshers on convective schemes, model terrain, and warm/cool season transitions would be highly beneficial.
    - I don't feel like I know enough about modern NWP capabilities to answer these questions. Anything that prepares me to effectively identify which model to use and when/how to use it should be helpful.
    - When the NWS modules first came out, I had the staff complete all of them. I added some extra material to relate the models to our CWA and forecast problems. Since then, I have only had interns complete modules except for the short modules that are made to describe model changes or new models.
    - I recently went to the matrix looking for information and was blown away by the amount of material. I do think that shorter modules in a matrix are useful, and they can be removed when outdated.

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17. Here are a few thoughts/suggestions from WFO:
    - Latest on High Resolution Models - hard to keep track of what's changing. Just hit the main talking points for ops staff - developers SOOs can get more thorough version

- Model Derived or Post Processed Products - e.g. the NSSL WRF "surrogate severe and heavy rain" project
- Better depiction of model skill scores - per regime, regime changes, regional?
- Short case study approaches to successes - and failures!

Training Delivery - most staff suggested:

- Short recorded presentations
- Teletraining (bandwidth dependent) - short, concise sessions (~30-45 min)

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18. I have gotten one staff reply:

    "I would like to see podcasts, possibly on YouTube, that discuss changes in model configurations. You could even show situations where the models did a great job or not so great of a job. They wouldn't have to be long, no more than 5 minutes. Use the recent GFS wind change - it would be nice to see a short video on the issue and maybe a few sample products to show the differences - like a video version of the web page they sent out. It might be more effective for some people."

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19. I have been getting some responses from the forecasters on this issue and here they are:

    - With the myriad of models now it is difficult to always know how best to interpret them. The forecasters were suggesting training on how to look at models under different weather regimes and how best to interpret the models. In particular looking at how models might vary by region.
    - With an ever increasing number of models how to utilize these in an efficient manner especially under field office time constraints.

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20. Full comments from forecasters are included below

    - "The main feedback that I would like to provide would be for update information related to the model changes to be provided in plain language terms for forecasters on a web site or training link that could assist forecasters involving model biases a little better. This should already exist, but it should be updated adequately and be provided more prominently by OCWWS/Training branch so that the forecasters would have a better idea of the model improvements/changes. I know I am more of an old timer, but I used to remember that NMC or NWSH would provide these model updates along with bias information in plain language so that forecasters could better understand the models and what models work well for certain scenarios/trends. "
    - I like the idea of a YouTube type channel or delivery method. That makes the updating of the material probably easier and you could probably deliver smaller/more focused pieces of information to the forecasters. Granted you probably wouldn't have it in an LMS/E-learning type format then, but it seems to get stale as soon as it gets in there.

      My biggest complaint about NWP is that many of the modules tend to try and cover "everything" under the sun. Maybe have some more "beginner/from the ground up modules" that do start from the more rudimentary fundamentals. These wouldn't need to be updated as much/as often. Then have a subset of training modules that hit at the models themselves. These could be more fluid,

focus on the highlights, changes, biases, etc. Specifically, what is operationally significant? What does the forecaster need to know?

I would like to see a module/module set that focuses strictly on the operational biases of the most used models (like above). I think the more general intro to ensemble modeling/practical use of ensembles is sufficient."

- "For me, I would like to better know the biases of the models in different situations. From a few years ago when Mike went on a visit to HPC ~ then they used to note if the ECMWF and Canadian models agreed, that is what happened more times than not. Now, I would bet that a comparison like that may not be correct. Something like this may be a tough idea to implement, given that the models are always being updated/improved.

  Would also like to know if/when they (the modelers) change model physics to account for cold/warm season processes. Otherwise, it seems like a hit or miss regarding the models; sometimes one is not favored, the next time it is (per the PMDHMD). From the above discussions, seems they like the ECMWF more of the time than not. "

- "I believe that more interactive regularly scheduled webinars teaching NWP would be most beneficial rather than the module/e-mail route, especially for interns. Perhaps they can try quarterly at first and then go from there based on feedback and attendance (i.e. if they needed to increase frequency).

  Regarding the focus and content…I would say that the focus should be on the strengths and weaknesses of each model including the various convective, precip schemes, etc. Now sometimes this can be hard to do, especially with some of the model updates, and effects on the local forecast area. This is especially true of the reliance of some on putting precip in the forecast only when the convective/precip scheme triggers precip. In addition, it might be useful for them to focus how to forecast for certain quantities using NWP (i.e. temperature, dewpoint, QPF, etc.). These could be evoked with the new model updates as well if the particular updates affected those quantities. "

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21. The comments below try to wrap into a couple of paragraphs the thoughts I have collected here.

    The use of NWP guidance in a gridded forecast environment needs some attention. We would like to see training focused on how to use numerical models to populate forecast grids in the Graphical Forecast Editor (GFE). It is our understanding that only a small number of people at the regional and national level are involved with the development of operational, hands-on GFE grid population methodologies. Yet, we use this software more than any other forecast tool at the office, and it is the primary means of translating numerical guidance into useful forecast information. Improved NWP interpretation and manipulation practices that help forecasters create, populate, or blend grids quickly and efficiently will benefit the field. An emphasis on EMS and other non-hydrostatic model GFE methodologies would be great. Sky, dew point, and wind grids often don't translate well into GFE from these models. Training on how to import this numerical guidance and how to use the fields in our grids would be beneficial.

    The fairly recent emphasis on the use of ensembles and anomalies (thanks to WDTB, Rich Grumm, et al.) leads us to believe that we should be paying more attention to those forms of numerical guidance rather than hanging our hats on single deterministic NWP models. It's important to be able to relate the anomalies to the atmosphere(s) depicted by the model(s), which, in turn, should be viewed within the context of the real atmosphere at the initial hour. So, training on these topics would be good.

Appendix B: SOO Survey Responses

The following are responses from the SOOs to an inquiry sent by the panel leader 2012 regarding their opinion of NWP training needs for their forecasters. The inquiry read as follows:

> **Good morning SOOs,**
> **As many of you recall, I sent out a request for feedback from the forecasters regarding the development of NWP training materials (see below). I've received a few dozen responses to my request but I would like to get as much input as possible, so if you have not done so please conduct a quick survey of your forecasters and send me any responses. I greatly appreciate your assistance.**
> **But wait, there's more!**
> **In addition, I would like to know what YOU would like to have available as training for YOUR forecasters. Please understand that I am not asking what the forecasters want, but rather, I am asking what you, the SOO & training manager would provide to your operational staff as NWP training if you were making all the decisions. Remember that you have limited resources (0.6 FTE) so you want to get the most from this training. Sometimes people don't know what they want or need until you show it to them.**
> **So, what would you provide your staff for NWP training? (Again, you only have 0.6 FTE)!**

Below are the responses as submitted by the SOOs. . Each numbered item represents the response from an individual WFO in no specific order. Most references to a specific WFO have been scrubbed.

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1. **Where should (NWP training valuable to operations) be focused?**

   Assumption: Our future employment as forecasters already does and will continue to depend on how we add value to local models – especially during high impact weather events with regard to timing, spacing and magnitude.

   With that said, I still feel forecasters must understand how a model works. We can make the training 'operational' all we want, but one must understand how the tool in the toolbox works and what it is to be used for. My experience is that we need to keep the theory, but get more to the point. It should not take 40-60 hours of modules to get the main points across. Even though existing modules do not say they are 40-60 hours, if one really wants to study the NWP problem, which is what it will take (and perhaps even more).

   VISUALIZATION: There are now so many data sources; our ultimate success depends on how we visualize the models. No one person on one shift can ingest all model data. You have to know how to navigate smartly and efficiently. Rather than viewing a single model's solution on a given day, or even looking at an ensemble envelope from a single run, I have spent many an hour playing with ways to better visualize the range of possibilities. One success I have stumbled upon is to use a 'Poor Man's ensembles but let the SREF mean be one of the members in a four panel. So, for a given field (e.g., MSLP) and as I am coming down the forecast funnel while still at the synoptic level, I may have the ECWMF, the GFS and the NAM80 in the three windows and the SREF (Mean and standard deviation) in the fourth of a four-pane display. Something like this can give one VERY QUICK insight as to how the models are handling a particular situation. I find it especially useful with key ingredients such as PW, MLCAPE and other derived parameters such as 1000-850 hPa MIXR, moisture transport and moisture flux divergence and

differential divergence. Once you glean what you feel may be the best performing model in a particular evolving weather situation, the other thing that is useful is a [d(prog)/dt] of sensible weather elements, ingredients, or other. This allows a final shaping of timing details and slight spatial adjustments that may need to be made. Also when models begin to change their solutions, which will affect your forecast, it shows up nicely when using this method. In short, we need to spend time on methods for visualization.

MODEL SIGNALS vs. MODEL SOLUTIONS – I still believe much can and should be gleaned from model signals. Sometimes, the model solution does not agree with the meteorological processes that support such a solution. We need more training in this area because it is the forecaster's actual beginning point of where key decisions are made. I feel if there was more emphasis on how to more easily detect those times when a model may produce a solution that is not internally consistent with physical processes that support that solution, we may improve our forecast skill in high impact events. However, this goes back to the first point above, you have to understand how the model works to begin with.

GFE – Let's hypothetically assume a forecaster correctly picks the best performing model to populate their grids with. Well, NWP understanding does not end there. There needs to be some training that deals with how those data are altered upon loading (e.g., resolution changes) and what forecasters may do to the data (blending, capping values, smoothing, etc..) that may detract from its usefulness in the digital forecast. In other words, there should be national training on how to correctly add value without adding artificial biases that change the original solution (or at least minimize it). In this manner, this help with consistency between WFOs assuming they both chose a preferred model solution in the same geographic region.

Better use and/or information on new model fields?

As a hypothetical example, let's say we received 'latent heat release' from the GFS as a new model field via the AWIPS SBN. There should be a short 'official' mini-module (see below) in LMS on why it is being introduced and how it may be used on the job – before it gets there. The same thing stands for 'better use' of existing fields. **In this manner, when something is added, the NWS learns together. NWP should be continuous throughout one's career so as to keep up with technology** (e.g., would we train forecasters on the inner workings of the barotropic model 30 years ago the same way we would for the RAP now? – I think not). I guess this would be the section to mention that future training should be devoted to running local models. I believe they are here to stay. There may need to be a separate course developed for 'model focal points' which is a bit more in-depth.

What about information regarding model updates?

I like the existing matrices and the short *YouTube* Videos, as long as they are kept up to date and timely, respectively.

How should the material be delivered?

Official (as in LMS) very short 'mini-modules' (<12 min) and even if there are more of them.

Again, in this manner, when something is added, the NWS learns together. NWP should be continuous throughout one's career so as to keep up with technology This mini-module approach could truly manifest itself as a learning laboratory when a forecaster is on shift. These 'mini-modules' should encourage forecasters to seek out like examples of what is being taught.

2. Basic training to answer the simple question: Which model is likely to perform best in a given weather situation at a given forecast time range. Start with the highest impact weather situations as work down, for example 1) Flash flood producing rain, 2) Heavy banded snow, 3) High winds, 4) Severe storms, 5) Blizzards, 6) Situations where the low track or placement of the front are critical, 7) Highly amplified weather patterns, 8) Long wave patterns in transition.

   SOOs/forecasters are totally unable to keep track of what training is available, and what is useful. Forecasters are bombarded with webinars, recorded training, LMS modules and seasonal local training. New training should be focused, efficient, relevant and able to be quickly referenced in the future- similar to the Meted Models Matrix, but distilled down much more.

   The Meted Models Matrix is a good start. The page is somewhat kitchen sink, but might be able to address some of the requests above for wiki pages or quick reference guides. Could be improved by adding, "When is this model expected to excel, when it won't". http://www.meted.ucar.edu/nwp/pcu2/

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3. I just like the idea of concentrating on the meat and potatoes stuff that could be directly useful to operations. I guess I'm just grasping at straws here as possible examples. What about information on how models are verifying? How about the different kinds of convective parameterization schemes that are being used in all these new high resolution models and why? What are some of the advantages of some over others? I also had convective initiation in mind as the result of a visit I had in Norman during my Facilitator Workshop (excellent class by the way!). I happened to have a little free time to go over to the Hazardous Weather Test bed and listen to some of the ideas being kicked around there. It was fascinating. Convective initiation seems to be a big issue with all these high-resolution models coming out. What about some training that gives some background and explains some of the problems and limitations, etc. That would be good information when trying to understand and interpret some of the output from the HRRR, RAP, ARW, and NNM.

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4. As a SOO, I think we seem to be heading towards higher resolution models. So any training there would be most beneficial. However, I would like to see the focus of the training geared towards impacting operations, with clearly define purposes and goals. Also, I would like it better if the training presents something useful that can be applied directly to the forecast process, e.g. NWP training centered on convective initiation.

5.

   - As changes are made to operational models…webinars on nature of the changes and how those changes will impact the model fields/forecasts that forecasters use.
   - How to configure local models for different phenomena…e.g., mixing height…cold air damming… etc.
   - The future of modeling and how we will be using models in the future (next 3-10 years)

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6. With the increasing use of high-resolution modeling, some training on the use of hi-res model output might be helpful. As forecasters (I still consider myself a forecaster as well), training focused on proper interpretation could help us too more confidently use hi-res output. One comment I've heard fairly often is something along

the lines of "model X forecast the development/timing of thunderstorms, but its storm placement was 20 miles off so the output was pretty much garbage." That's a good forecast! Hi-res output often looks so realistic that forecasters expect it to be nearly exact. I hope this is making sense…

More training on the use of ensemble models and ensemble products would also be desired. Under-dispersiveness in ensemble systems can lead to observe weather falling outside the model envelope, which greatly reduces forecaster confidence in using what are usually valuable products. Some discussion about when probabilistic products can be expected to be reliable and when they may be less reliable would be well received.

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7. I'm guessing that it has been mentioned already, but the use of high res models and proxy fields in forecasting convection. A second, more tenuous, NWP tie-in might be use of models data with analogs (e.g. SPC MARS, CIPS analog data)

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8. My only request for training is on the use of ensemble forecasts in forecast and (long-fuse) warning decision. Last winter, I focused my training on the use of ensemble information for making winter storm warning decisions. I did a literature search and also a search of courses, and I found the pickings pretty slim. I did use the COMETs ensemble course, which was pretty good, but we really need more.

   While there is a lot of information on what ensembles are, how they work, how you can view probabilities, spread, etc. there is surprisingly little on how you take this information and help with the actual forecast decisions that need to be done. My observations with the SREF, for example, are the mean and spread fields can change in similar ways as the operational models. And, of course, there is the problem of underdispersion of solutions - especially in extreme events. I don't think either has been well addressed in the literature or in training.

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9. I see training in filed offices as a two-pronged system.

   First, forecasters need some basic fundamentals on new NWP ideas, techniques, concepts, etc. This is where the traditional lecture type training (via modules, workshops, etc.) fits into the process.

   Second, they need some real life "decision making" training based on the new data coming available. This is where the WES (or WES2, or WES Bridge, or WES by northWES) comes into the act.

   As a training enterprise in the NWS, we need to make sure both ends of the spectrum are covered. I think in general, we put out too many modules and too few simulations for the forecasters.

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10. I guess what I'd like to see is something that contains a comprehensive overview of all of the various parameterization schemes used by the various models, and different cores (NMM, WRF, RAP, etc) - maybe not so much all of the detailed guts of how say a deep moist convective scheme or microphysics scheme works - but something that shows strengths and weaknesses, and where specific models using a specific combination of schemes typically handles the solution well, and where said scheme(s) might break down and result in a spurious solution. Same thing for the various members of the popular EPSs - NAEFS, SREF.

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11. NWP training needs to be immune to the constant changes in each model's physics, initialization, resolution, etc. I would like to see training focused mainly on operational utilization of model/ensemble spread to communicate uncertainty to varying audiences. Along those lines, perhaps some integration of how forecasters can use tools like (fill in blank with something like standardized anomalies and analog approaches) to actually lean on outlier, or at least statistically less probable, solutions.

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12. I think what is currently offered is generally very valuable and under-utilized by my staff. One of the most useful items that spring to mind is the NWP Matrix. The problem is that the information provided is not in-depth enough. For example, what exactly is ETKF, differences in convective/radiation schemes, etc.? Some of those specifics are given, but not all of them. Continuing to flush out that table would be very beneficial and cement it as an excellent go-to source for NWP questions.

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13. Keep the Operational Models Matrix as complete and up-to-date as possible. I think a one-stop shop for this sort of info is really nice to have. Unless other agencies are kicking in funding for this, I'd also pare it down to those models currently of primary use in NWS ops. So, for example, at least in my office no interest in the old NAM (Eta), the AFWA wrf-arw or NOGAPS. None of these are available on our awips and verif scores for say NOGAPS have been sufficiently poorer than for other global models that not much interest in making the effort to pull up on the web. On the other hand, would be nice to have complete info on the new HiResW-arw and -nmm and even DGEX. If I click on the link for ECMWF Overview, get ERROR - Cannot find document and the "What's New Archive" link on http://www.meted.ucar.edu/nwp/pcu2/ doesn't seem to have had anything added since March 2008.

    Training that focuses on how to best make use of model output in GFE. Populating wind and sky cover forecast grids, for example, can be really challenging, especially in areas of complex terrain. With GFE, challenge can be far more how to efficiently get the forecast grids to represent forecast thinking, than to subjectively reason through and interpret model output. Even just an improved approach for 1 parameter could be quite helpful.

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14. I guess I don't have a lot of specific suggestions, but my two cents is that future NWP training really needs to focus on use of NWP in the forecast process, and I think most importantly in the very near term. So this would include things like when to use a single high res, convective-allowing model as a starting point for forecast grids, vs. the blend or ensemble approach. Having said that, I really think that while the signals in the high res models (convective modes, evolutions, to some degree timing, etc) are extremely useful, forecasters still struggle with how best to incorporate that into high res forecast grids in the near term (say 6-24 hrs out). In many case, even if a model happens to be capturing current precip systems quite well (am thinking primarily of convection), that does not mean it's going to do well even a few hours from now, but maybe better than another model that doesn't have a clue about what's happening now. Thus, forecasters still tend to look and draw, rather than utilize direct model output as a starting point for PoPs, QPF, or sky cover (for example). We still really need to be heavily utilizing ensemble output even in the very near term, and this is very new area and of course there are not a lot of high res ensemble forecast systems available to everyone. VSREF is out there but not in AWIPS. But more of this is coming, and so we really need some training on how best to interpret and incorporate into the forecast process, ensemble output from these high res forecast systems. Perhaps VSREF could be used as an example, or if there are any clusters of WRF runs being utilized in some regions (there was at one time in the Great Lakes area, and we tried with RENCI in Chapel Hill before Brian Etherton moved to ESRL), but not sure what else is out there. Also, GSD is doing good stuff with the HRRR,

and developing a time-lag ensemble I believe is on their list (they are already doing this for t-storm probs, but hopefully also will do this for PoP in general and maybe other fields too), so I'd think those developing the training may want to work closely with the HRRR group.

So, in summary: Use of high res models in the near term gridded forecast process, but with a focus on output from high-res ensemble systems. I guess related to this would be better understanding of data assimilation, initialization, and assessing how well a high res model is really capturing important small scale and even larger scale features.

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15. Help forecasters understand what models can and cant do. When they fail.

    Focus on best practices, methods, techniques, analysis, and methods to use in those situations where NWP usually is weakest or fails (Usually extreme events).

    Without getting into advanced mathematics, the different types and kinds of models, their strengths and weaknesses.

    How the "black boxes" of the models work. All the difference parameterization schemes, their strengths and weaknesses.

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16. First, to be honest, we have not focused on NWP training here at BTV. There are many competing priorities for training such as for short-term warnings vs NWP. We have more training material than we ever have had in the past, which is good, but need to prioritize what is absolutely necessary. I'm sure you hear this all the time, and in our office, there is very little extra time for training with 3-hr forecast updates.

    However, recently at BTV, we finally achieved a baseline staffing level similar to rest of the WFOs in the country. We only had 9 forecasters; we just recently hired another, which has already had a positive affect on training accomplishment. Since the hiring in the past month or so, I've seen a noticeable increase in training being accomplished (dual-pol).

    I'm not sure how it works in every office, but the MIC, Region, and nationally, if NWP is a high priority for training, it always helps to hear it from the senior leaders. If there is something we need to get done in our office (not optional nice to know type stuff, but need to know) I always get the MIC on board to help the process along and make it an office priority. Ok just a bit of what our office is like

    - It should be focused on operational use of NWP. It should be coordinated, developed, and aligned with NCEP model updates. When there is a new model or significant update, there should be training that is available in advance (but not too far) of the update. Training should be planned accordingly.
    - If there are new model fields, or output, or new post-processing algorithms, then there should be training on how it's done, strengths, limitations, how to make the best use, and an example.
    - So I guess I'd like to see a bit more focus on the post-processing, such as how wind gust outputs, ceiling, visibility, simulated radar work. Much can be gleaned from the meteorological principles behind the algorithms and how to use it operationally.
    - Model update training is important as stated above. I think something between the 3 minute YouTube and the 2-3 hrs would be appropriate, but it depends. I guess I like the 2-3 minute as a cute notification, but it really doesn't deliver or test the knowledge. I have had some favorable feedback on the latest RAP video, but personally, I think a little bit more in depth is needed.

- For a major update, perhaps it could be broken down into 2-4 parts of 15-20 minutes each. For a minor model field/post-processing thing, one 20-minute session would be sufficient.

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17. It looks to me like there is already a lot of NWP training available, e.g., from the METED web site and probably other places. It's not obvious to me what else is needed. Are we taking full advantage of what training already exists? I'm pretty sure I'm not.

    Of course, models are always changing so the descriptive information needs to be kept up to date. Perhaps some additional case studies would be useful, i.e., cases where one or more model performed poorly, with an analysis of why they went wrong.

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18. I would like to see a set of training modules that addresses a methodology for properly interpreting and using hi-res deterministic AND hi-res ensemble model output. Ideally, I would like to see an end-to-end example or set of examples that illustrate ways for the NWS forecaster to take full advantage of the growing number of hi-res (<= 3km) models and the available ensemble data. Some focus would necessarily need to be on time management - I can't look at 42 member solutions from the NAEFS to diagnose that snowstorm at Day 6, so what should I use and why? And of course the focus should be on high-impact events and NWP's ability to forecast those on time scales from 2 hours to 10 days.

    Some of this material is already scattered about in some of the newer NWP lessons, but it needs to be tied together. I discussed some of this with Dr. Spangler when he visited last week. I'm thinking of a modernized version of Snellman's forecast funnel for modern NWS operations.

    You could call this set of lessons "Forecast Funnel 2020". You can even use that title and claim it as your own. The challenge will be putting something together that is pertinent today, but not obsolete in one or two years.

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19. Okay, I'll take the bait. First, I'll start with the problem. We have too many NWP models. Furthermore, they change often. What this means is that it is hard to get a handle on biases of a particular model. We can't really develop training for that. Rather, we have to figure that out on the fly. As soon as we figure out something has a particular bias, that problem is fixed and a new one develops.

    What do we really need? We need one great model like the ECMWF instead of a plethora of medium-quality models that compete with each other for computer time and research/development time.

    So, here is my radical suggestion. Let's provide better training on the ECMWF and forget about the rest. More and more I am finding that forecasters are using the ECMWF as their go-to model. Let's learn as much as we can about the ECMWF biases, as well as the ECMWF ensemble forecasting system. This is what people are using, so it makes sense to know more about it.

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20. Sorry I haven't sent in a response, but I honestly don't have much in the way of suggestions. It seems like a number of different strategies have been tried; yet none have been particularly successful. Even though NWP is the backbone of what we do, it just doesn't seem to grab the attention of forecasters and they get easily bored with the information. The other issue always seems to be keeping the information up to date as NWP continues to evolve and change. My only suggestions would be to keep the material short, to the point, and relatively basic, and tie in real world examples as much as possible. I've done lots of local NWP-related

training, and it seems like very few of the forecasters retain much of the information, regardless of the approaches I use (very frustrating).

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21. One other thing I'd like to see would be a quick-and-dirty module on model deltas. There are just too many model deltas to keep up with, at least from the forecaster POV. Ideally these nuggets would be at 30 min or less and suitable for showing at a staff meeting or a brown bag.

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22. From a general standpoint the education - training needs to be from a general standpoint that needs to be operationally significant. In general forecasters don not want to know about the different convective schemes or boundary layer schemes (granted it would do them some good). As a SOO, a few forecasters and myself enjoy learning these schemes). I deal with forecasters having different levels of understanding about the models.

    I believe one of the major items are what **biases** does each model have. A good one is how models can produce false precipitation in return flow situations where the model is actually detecting is clouds. There is a number of cases (dates) in our region where this happened. I know we need to keep better documentation when this happens. A similar situation occurred during the last week in April 2012 in which the GFS painted a large swath of precipitation across mid Missouri and into parts of KS and southeast into western Tennessee. A number of WFOs wanted to forecast precipitation. However, upon closer examination by viewing the forecast soundings, the GFS was producing fog - a lot of fog that really happened.

    Problems like this that can be identified would be beneficial for people to know about how/why this occurred and how to discern what is going on.

    Education - training on ways of diagnose problems and errors in the model data would be very helpful. Some of us would like to know why this is happening.

    Hope this information is helpful. I remembered way back during COMAP 1 when we identified a case and discussed as to why the models were responding in the way they were.

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23. In general, I think there are two themes worth noting, and they're particularly useful given the restrictions you mentioned on the SOO list. Everyone was very interested in getting a better and clearer idea of model biases, especially in a "quick-reference" format. Everyone also strongly endorsed smaller, more cohesive training that could be updated more frequently (and more easily) to respond to model changes.

    As the SOO, I fully agree with both of these items. I'm sure every office is different, but I've found that shorter, more succinct training tends to stick with my forecasters more, makes it more likely that they'll go through it to begin with, and makes it easier for me to incorporate into training plans. Having quick reference guides--more like the model matrix that I saw recently--will make the information more accessible when they don't recall all the training.

    I also would like to see a shift towards audiovisual learning because it helps those who learn better audibly and those who learn better visually, instead of writing everything out which excludes one group. (It took me a long time to figure out that I learn better when I hear someone say things.) Quite honestly, there are some modules with very good, solid information that were optional for our staff, and they got very little traction because they were long and mostly text. Those that did take those courses expressed a lot of frustration to me and encouraged me to never include "courses like that" again.

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24. I think that basic NWP training is well established, particularly with the updates to the NWP models in production at COMET. So the need I hear in our office is delta training associated with NCEP model upgrades.

    We do receive e-mails, which are essentially the same information sent out in the public information notices, but these fall short of meeting needs. The approach used by WDTB for WES updates and such is a good example to follow. So are the presentations by Stan Benjamin at GSD on the RUC/RAP. If I remember correctly, Bill Bua put out something like what I am trying to describe for the last NAM upgrade.

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25. An opportunity we miss today is one where we can look back on the previous few days of weather. Decades ago, when we hung fax charts, forecasters would come on duty, get briefed from the previous shift, then almost immediately go to the flip back through the fax charts of observed weather at 500mb, 850mb and surface, to see how the current weather came to be. It was a real learning moment. We don't have that today. We can do a little with dprog/dt, but even that falls short of what forecasters used to do to teach themselves. Is there a way you, or someone, could capture the 00-hr forecast of the standard level charts and place them in a 16 day loop (64 frames/4 pds per day = 16 days); the most recent bumping the oldest. Off hand, it seems that saving several days of model forecasts for comparison purposes might be difficult, although I can think how I would like to see it. Anyway, with the shortage of training funds, I thought it might be nice to create some tools that the forecasters could use to help train themselves.

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26. I conducted a short survey, covering some of your points about 1 year ago. Did it in a workshop. I began it because I saw AFDs from MANY offices comparing the GFS40 and GFS80 and NAM12 and NAM40. Of course these were just AWIPS names for the same models.

    I was shocked at how AWIPS alone simply confuses people's knowledge of the models and what they are.

    I also found recently, people get confused as they "hear" about NCEP going to an EnKF for the GFS and GEFS and then see EnkMOS and think those are the same too.

    The big weakness still is the reliance on NWP from single models and doing simple model comparisons and general lack of a shift to more probabilistic use of NWP.