NWS Operations Proving Ground

AOP Milestone Report

Mesoanalysis Think Tank

January 30-February 1, 2018

NWS Operations Proving Ground
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Operations Proving Ground Mesoanalysis Think Tank

Summary of Motivations, Activities, Findings and Recommendations

Background and Motivation

The National Weather Service (NWS) Operations Proving Ground (OPG) hosted a 3-day Mesoanalysis Think Tank from January 30 through February 1, 2018. The meeting was prompted by results from OPG milestone projects conducted in 2016* and 2017**.

Feedback from 35 forecasters who participated in 12 week-long Operational Readiness Evaluations (OREs) suggested emphatically that the NWS needs to devote resources toward effective use of the myriad high-resolution data sets in near real-time for operational decisions during convective weather. It is self-evident that effective decision making can be positively influenced by the ability to interrogate the right data for the situation at hand and by displaying those data in a manner that can be quickly and accurately assimilated. The essential challenge, therefore, lies in determining which data are of primary importance and knowing how to mine those data to improve warning and forecast decisions.

Another finding in both OREs was that timely access to multiple high-resolution data sets significantly increases the importance of the mesoanalyst in convective warning operations. Not surprisingly, forecasters agreed that expert mesoanalysis skills are critical, especially in complex environments, scenarios characterized by rapidly evolving convective modes, etc. However, exploratory feedback from local forecast offices indicates the mesoanalyst role is often underutilized or even compromised by expecting an individual to fulfill it as one of several assigned tasks during a severe weather event.

However, the potential for skillful mesoanalysis to add value to the NWS mission is not restricted to the warning process. Arguably the largest area of opportunity to improve our value to core partners lies in communicating insight during the time before convection even forms – the so-called “nearcast” time frame that falls roughly within the 1-to-3 hour range before convective initiation, and within the few hours before locations are impacted ahead of established storms. Typically this time period represents a gap between convective outlooks/watches and warnings, a period ripe for capitalizing on our Weather-Ready Nation goal of conveying a continuum of free-flowing information aimed at assisting “deep relationship core partners” in preparing for, and potentially taking actions to mitigate, the impacts from high-impact events.

Armed with these compelling results, the OPG was left with several unanswered questions. For example,

- Why should we invest in developing specialists in mesoanalysis for high-impact convective events at WFOs, and what is the cost of failing to make that investment?
- What diagnostic, prognostic, and communication skills require development in order to operate as an effective mesoanalyst?

- How does the availability of cutting-edge data sets such as GOES-16 imagery, output from convection-allowing models, probabilistic guidance such as the NOAA/CIMSS ProbSevere model, etc. influence our understanding of conceptual models?
- What does optimal collaboration between a mesoanalyst and a warning forecaster or DSS forecaster look like and entail?
- What new products and services might be possible if the mesoanalyst were employed in a dedicated and effective way?

To begin the process of answering these questions, the OPG invited six NWS Subject Matter Experts (five Science and Operations Officers and one Lead Forecaster) – all of whom are renowned for their expertise in mesoscale convective meteorology and warning operations – to attend a Think Tank meeting at the OPG.

Summary of Activities

On the morning of Day 1, we identified overall goals, established expectations, and discussed some fundamental principles of decision-making psychology. We invited Dr. Kris Bedka (NASA Langley Research Center) to share applied research of convective satellite signatures that have been verified as reliable precursor signals to the occurrence of observed severe weather. Finally, Dr. Ariel Cohen (SOO, WFO TOP) presented ideas on how a skillful mesoanalysis can raise situational awareness, enhance IDSS in the watch-to-warning gap, and improve evidence-driven forecast and warning decisions.

During the afternoon of Day 1, the six participants were divided into three pairs. Each pair created a variety of display schema designed to facilitate efficient and effective situational awareness. For the remainder of the Day 1 afternoon, and on Day 2, they used those displays while working three historical cases. As those events developed, the pairs experimented in applying their analytical and communication skills while documenting specific practices, products, and IDSS communications that might be employed in three different phases of the convective life cycle: (1) convective initiation, (2) development and maturation into predictable convective mode(s), and (3) evolution of modes and hazards into more complex environments. Each case was accompanied by facilitated discussion of key takeaways (e.g., important observations, reinforcing concepts, lessons learned, and new ideas for synthesizing mesoscale knowledge into actionable intel for decision makers).

On the final day, the entire group debriefed collective conclusions and articulated the five findings and recommendations that are presented below.

Findings and Recommendations

Finding 1. The role of performing superior mesoanalysis is critical in evaluating the potential for convective storms to pose hazards that threaten life and property. When implemented effectively, thorough mesoanalysis allows the communication of focused location and timing of specific threats associated with high-impact convective events. In practice, the mesoanalyst has been underutilized in NWS Weather Forecast Offices and, in many cases, it is given a relatively low priority among the many roles assigned in a forecast office's Severe Weather Operating Plan (SWOP).

Recommendation 1. Dedicated resources (e.g., staffing, training, computer resources, etc.) should be routinely allocated to support effective mesoscale analysis necessary to evaluate the potential for convective storms that produce threats to life and property.

Finding 2. It is important to distinguish between proficiency in the mechanics of generating a forecast product and applying meteorological knowledge and experience to skillful analysis, forecasting, and effective communication to decision makers. With that premise in mind, the unanimous opinion of this group is that there is presently an inadequate level of mesoscale knowledge throughout the NWS.

Recommendation 2. A "needs analysis" should be conducted by OCLO to identify specific knowledge and skills which comprise performance gaps that hinder consistent application of convective mesoanalysis. The results from this analysis can be used to develop training, simulation environments, and follow-on exercises for building and maintaining forecaster proficiency in effective mesoanalysis and attendant IDSS.

Finding 3.
There exists a substantial IDSS void between watch/outlook phases of convective events and the warning/advisory phases (i.e., the "WWA gap"). Effective mesoanalysis can serve as the tool that bridges this IDSS communication gap by providing sound, science-based actionable information to deep core partners, especially emergency managers.

Recommendation 3.
The OPG should host additional meetings to further explore various ideas for bridging the WWA gap with participation by a diverse group of SMEs (i.e., SOOs, WCMs, select core partners) who can speak to overlapping science, communications, and user decision responsibilities. These meetings should focus on tools, services, and procedures to efficiently translate expert knowledge of the evolving environment into meaningful, actionable language that deep core partners can use to make timely, proactive risk management decisions. The pre-storm alerts that WFO Topeka, KS demonstrated on the February 6, 2018 NWS Fireside Chat could serve as a template for such innovations.

Finding 4.
The SPC Mesoanalysis page provides access to hourly diagnostic fields derived from a three-dimensional objective analysis routine. These data are only available to the field via the SPC web interface. While effective mesoanalysis entails far more than referencing hourly fields at 40 km grid spacing, availability of the same unified objective mesoscale analysis fields within AWIPS would facilitate more effective collaboration, both among team members within the office, as well as between SPC and WFOs.

Recommendation 4.
Prioritize plans to deliver hourly SPC Mesoanalysis fields to AWIPS, or at least make them available to download locally via Data Delivery subscription. It would also be beneficial to use the 13-km RAP output for some background fields, in lieu of the 40-km RAP.

Finding 5.
Adult Learning Theory posits that professional adults learn best when placed in hands-on, job-relevant, collaborative problem solving exercises which focus on applying learning in a way that connects to improving performance. Therefore, traditional training intervention is not necessarily the best method to improve critical mesoanalysis skills.

Recommendation 5.
Create immersive, job-relevant exercises that lay the foundation for developing specialists who demonstrate the ability to perform expert mesoanalysis and communicate their insights, both internally (e.g., to the warning or IDSS forecaster) and externally (to core partners) to improve decision making. This interactive and scientifically-driven approach will allow participants to practice and build proficiency with subject matter experts and end users in a controlled but realistic environment.

It is proposed that the OPG develop a prototype immersive simulation experience comprised of job-relevant exercises, and modeled after the success OPG had in creating the IDSS Boot Camp. This interactive experience would focus on evaluating the application of expert mesoanalysis for targeted IDSS. Participants would gain hands-on experience in the context of real weather events, augmented by intensive oversight and instruction from relevant subject matter experts. Like the IDSS Boot Camp, this experience would culminate in a full-day functional exercise involving both forecasters and emergency management partners. This “Mesoanalyst Boot Camp” concept would facilitate a translation of expertise to selected WFO forecasters who would further encourage science sharing among their forecast offices while serving in the capacity of mesoanalysis specialists. This would ultimately support the widespread infusion of a critical enhancement of the science background to improve IDSS and concurrently support the exploration of new products and services that bridge the WWA gap.

Conclusion

Many service assessments can be cited with examples where a lack of situational awareness and/or ineffective distribution of duties led to sub-optimal performance during severe weather events. For example, the "*Tornado in Rogers, Minnesota, September 16, 2006*" NWS Service Assessment Report provides compelling evidence that environmental analysis serves as a fundamental cornerstone for improving convective warning operations - a direct testament to the valuable role of mesoanalysis in the NWS's mission to protect life and property. This and other events serve to highlight the critical need to integrate a dedicated, skilled mesoanalyst into the warning phase of a high-impact event and are a direct testimony to the cost of not having one. **Skilled mesoanalysis could also form the foundation for improved services in the nearcast time frame** and open the door for NWS offices to capitalize on our expertise to **fill an important gap in our service delivery model**. Specifically, it is our objective to synthesize our knowledge of the evolving environment into actionable information for risk management professionals – **in many cases, before storms even form**.

Realizing this vision would advance many of the goals of Weather-Ready Nation: achieving a fully integrated field structure; utilizing a collaborative forecast process; devoting the majority of our time and focus on high-impact weather; and, ultimately, enabling our deep core partners to be proactive with their most crucial risk management decisions by providing targeted messaging concerning timing, location, intensity, and confidence about pending hazards and threats to public safety.

In order to position ourselves to perform that role effectively, the discrepancy in mesoanalysis skills must be addressed and the role must be given priority when high-impact convective events are unfolding. Therefore, the OPG proposes developing and executing a series of focused, week-long immersive simulation experiences in FY2019 that are designed to evaluate the efficacy of this vision. If successful, regular use of the mesoanalyst has the potential to create shared situational awareness, improve triage during the evolution of complex convective events, and facilitate effective communication both internally among members of the WFO team and externally to our primary users.

** - In 2016, the OPG conducted an Operational Readiness Evaluation (ORE) to assess advantages and challenges of incorporating 1-minute satellite imagery into the convective warning process. This ORE was comprised of eight week-long sessions, with 23 field forecasters participating.*

*** - In 2017, the OPG conducted an ORE to evaluate the operational readiness of Near Storm Environmental Awareness tools. These evaluations encompassed four week-long sessions, with 12 field forecasters participating.*

References

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Subject Matter Experts Involved in the OPG Mesoanalysis Think Tank

Front row from left to right: Brian Carcione (NWS Huntsville, AL), Kim Runk (NWS OPG), Katie Crandall Vigil (NWS OPG), Chauncy Schultz (NWS Bismarck, ND), and Corey Mead (NWS Omaha, NE)

Back row from left to right: Matthew Foster (NWS OPG), Ariel Cohen (NWS Topeka, KS), Seth Binau (NWS Wilmington, OH), Daniel Hawblitzel (NWS Nashville, TN), and Chad Gravelle (NWS OPG)