1. Introduction

The Ensemble Clustering and Sensitivity Analysis (ECSA) Experiment, part of the Hydrometeorology Testbed (HMT) at the Weather Prediction Center (WPC) will be held completely virtually this year. It will run for one intensive session week, with two separate sessions for different sets of participants across timezones:

March 30, 2026 - April 3, 2026
Morning Session: 09:00am ET - 01:00pm ET // 08:00am CT - 12:00pm CT // 07:00am MT - 11:00am MT
Afternoon Session: 02:00pm ET - 06:00pm ET // 01:00pm CT - 05:00pm CT // 12:00pm MT - 04:00pm MT
Facilitators: *Austin Coleman* (CIRES / WPC), *Jim Nelson* (WPC), *Mark Klein* (WPC SOO), and *Brian Colle* (Stony Brook University)

The primary goal of this experiment is to understand how ensemble clusters and sensitivity analysis tools are operationally used in the medium range time frame, both as forecast and communication tools. We seek to establish best practices for product use and for training purposes within the National Weather Service (NWS). Additionally, recommendations for collaborating across Weather Forecast Offices (WFOs) while messaging scenarios and contextualizing uncertainty through ensemble sensitivity analysis will be explored. Finally, we scheduled three 30-minute invited seminars addressing ensemble system use in operational contexts. These seminars will take place during the Morning Session, but are open to all testbed attendees, all NWS Science and Operations Officers (SOOs), and any interested parties in academia outside of the NWS.

I. **Ryan Torn - "Application of Ensemble Sensitivity for AR Recon Forecasting and Observation Targeting"**
   Wednesday, April 1 · 12:30 - 01:00pm ET
   Add to Google Calendar
   Google Meet joining info
   Video call link: https://meet.google.com/wbh-fkmj-byg
   Or dial: (US) +1 650-530-3205 PIN: 960 960 530#
   More phone numbers: https://tel.meet/wbh-fkmj-byg?pin=6932043041536

   Wednesday's speaker will be Dr. Ryan Torn, atmospheric science professor at SUNY Albany, who will be speaking about ensemble sensitivity analysis in the context of Atmospheric River Reconnaissance and other observation targeting applications.

II. **Steve Willington - "The forecast process used by Operational Meteorologists in the Met Office Expert Weather Hub, and new ensemble interaction tools as we transition to an all-ensemble NWP system"**
   Thursday, April 2 · 11:00 - 11:30am ET
   Add to Google Calendar

Google Meet joining info
Video call link: https://meet.google.com/nfo-nmvg-boj
Or dial: (US) +1 530-428-6228 PIN: 880 943 306#
More phone numbers: https://tel.meet/nfo-nmvg-boj?pin=3480975238113

Thursday's speaker will be Steve Willington, Chief Operational Meteorologist and Head of Ensemble Exploitation at the UK Met Office, who provided the following abstract ahead of his talk:
With the Met Office's transition to an all-ensemble NWP suite, it has become essential to identify capability gaps and develop new tools and visualisation systems that enable Operational Meteorologists to extract maximum value from this expanded dataset. This talk will outline the forecast process, the barriers that currently limit deeper ensemble integration, and the reasons why innovative tools are needed to overcome these challenges. It will also summarise the progress made so far toward meeting this goal.

III. **Brian Ancell - "Convective-Scale Ensemble Sensitivity and Sensitivity-Based Subsetting for Real-Time Adjustment of High-Impact Probabilities"**
Friday, April 3 · 10:30 - 11:00am ET
Add to Google Calendar
Google Meet joining info
Video call link: https://meet.google.com/may-juju-zec
Or dial: (US) +1 561-614-0704 PIN: 582 287 395#
More phone numbers: https://tel.meet/may-juju-zec?pin=6560209498676

Friday's speaker will be Dr. Brian Ancell, atmospheric science professor at Texas Tech University. He will present on ensemble sensitivity applied to convective-scale operational forecast problems in a talk entitled "Convective-Scale Ensemble Sensitivity and Sensitivity-Based Subsetting for Real-Time Adjustment of High-Impact Probabilities."

2. Science and Operations Objectives

An overarching goal of this experiment is to understand how clusters and ensemble sensitivity analysis are being used currently across the NWS, and whether the use cases and strategies deployed by current users match the best practices we aim to come up with during the week. Toward this goal, participants will receive a pre-experiment survey regarding how they use this suite of tools. While brief post-event overviews will be provided after each case, the focus of the experiment will be on identifying optimal use cases and best practices with these tools, rather than evaluating forecast accuracy.

The objectives of the 1st Ensemble Clustering and Sensitivity Analysis Experiment will be as follows:

- Understand how utility from the ensemble clustering and sensitivity analysis approaches changes by region, atmospheric phenomenon, and lead time for a set of medium-range retrospective weather events.
- Evaluate how ensemble clustering and sensitivity analysis are currently being used in NWS operations as a whole.
- Establish best practices for how and when ensemble clustering should be used in quantifying and communicating forecast uncertainty.
- Identify how forecasters collaborate on ensemble cluster and sensitivity analysis messaging across WFOs and how to optimize this collaboration.
- Investigate the medium-range situations in which ensemble sensitivity analysis is most useful as a forecast tool and establish approaches to encourage its use by NWS forecasters.
- Identify any product gaps that can be addressed through the use of cluster and sensitivity tools during the experiment.

3. Description of the Guidance and Tools

3.1 - Long-Range Ensemble Forecast System

The long-range ensemble forecast (LREF) system used for all forecasting activities herein relies on three operational ensemble subsystems. This superensemble consists of 100 members in total, with 50 members from the European Centre for Medium-Range Weather Forecasts (ECMWF) ensemble system, 30 members from the National Center for Environmental Prediction (NCEP) Global Ensemble Forecast System (GEFS), and 20 members from the Canadian Meteorological Centre Ensemble (CMCE) system.

In the Dynamic Ensemble-based Scenarios for IDSS (DESI) platform, half of the ECMWF ensemble members are time-lagged to the initialization 12 hours prior to its current initialization cycle. The LREF system is otherwise the same as that used by WPC, but one can attribute slight differences in ensemble clustering output between the WPC and DESI applications to this difference in ECMWF membership.

The WPC Quantitative Precipitation Forecast (QPF) Clustering application relies on a post-processed version of the LREF, referred to as National Blend of Models (NBM) Precipitation Quantile Mapping and Dressing (QMD) members. A subset of the NBM QMD ensemble system based on the 100-member global LREF dataset is still used to compute QPF clusters, only the precipitation fields from NBM QMD membership are calibrated to produce more accurate forecasts.

3.2 - Ensemble Clustering

The ensemble clustering approach applied in WPC products and DESI is based upon Empirical Orthogonal Function (EOF) Analysis and k-means clustering methodologies. EOF Analysis is a helpful way to diagnose the leading modes of variability within large datasets. It is commonly used in climatological studies to reveal primary spatial modes of variability in time series data. However, in our use case, we seek to understand the primary modes of variability (uncertainty) among the ensemble members themselves for a 24-hour averaged forecast period (e.g., Zheng et al. 2017). For a complete overview of ensemble clustering methodology used by WPC, readers are referred to Lamberson et al. (2023). EOFs are calculated over a limited area in order to understand dominant uncertainty modes for a single atmospheric feature. Regional domains used in this experiment to calculate EOFs and resulting clusters are shown below (Table 1). The QPF Clusters are the exception to this preset set of regional domains, as regions are object-based and center on 0.25-inch and 0.5-inch precipitation objects within the NBM QMD forecasts for a given day.

Domain Name	***Domain Area***
East	25°-55°N, 60°-100°W
Central	25°-55°N, 75°-115°W
West	25°-55°N, 95°-135°W
Alaska	40°-75°N, 120°-180°W
Pacific	28°-68°N, 108°-205°W
Hawaii	5°-45°N, 135°-185°W
Guam	3°-30°N, 185°-229°W

Once the two leading EOFs (primary and secondary modes of forecast uncertainty) are identified for a particular forecast variable, lead time, and region, individual ensemble members are projected into the context of these forecast uncertainty modes by plotting them in Principal Component (PC) Phase Space. Each ensemble member's PC value defines the degree to which that ensemble solution is similar or dissimilar to a given EOF, relative to the ensemble mean, which is represented at the origin of the PC phase space. Projecting ensemble members into PC phase space allows us to view forecast scenarios from individual ensemble solutions in two-dimensional space. In turn, k-means clustering is applied to the 100-member dataset to group similar members in this space. If you would like to learn more, Bryan Gurante of UCAR's COMET Program developed an interactive demonstration of how k-means clustering works based on 100 ensemble solutions. All WPC clustering applications except for the QPF Clusters apply k-means clustering to group solutions into four distinct cluster scenarios. The QPF Clusters based on 100 NBM QMD members use a metric known as the silhouette score to determine the optimal number of clusters for a given forecast variable and region. Further details on ensemble clustering variables and configurations can be found below (Table 2).

After performing k-means clustering on the dataset, the resultant cluster scenarios are visualized spatially to summarize the prevalent forecast outcomes in the ensemble dataset.

Visualizations of cluster means (percentiles for the QPF Clusters) and differences of cluster means (x-th percentiles) from their full ensemble counterparts are plotted to contextualize the forecast uncertainty. Further specifics can be found in Table 2.

Cluster Variable	***Regions***	***Lead Times***	***Number of Clusters***	***Product Visualizations***
24-h averaged 500-hPa Heights	East Central West Alaska Pacific Hawaii Guam	Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9	n = 4	1. 500-hPa Height EOF Patterns 2. 500-hPa Height PC Phase Space 3. 500-hPa Height Cluster Means (Anomalies relative to NCAR Climate Forecast System Reanalysis, CSFR) 4. 500-hPa Height Cluster Means (Differences from Full Ensemble Mean) 5. Maximum 24-h Temperature Means (Differences from Full Ensemble Mean) 6. Minimum 24-h Temperature Means (Differences from Full Ensemble Mean) 7. Accumulated 24-h QPF Means (Differences from Full Ensemble Mean)
24-h averaged Mean Sea Level Pressure (MSLP)	East Central West Alaska Pacific Hawaii	Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9	n = 4	1. MSLP EOF Patterns 2. MSLP PC Phase Space 3. MSLP Cluster Means (Differences from Full Ensemble Mean) 4. Maximum 24-h Temperature Means (Differences from Full Ensemble Mean) 5. Minimum 24-h Temperature Means (Differences from Full Ensemble Mean) 6. Accumulated 24-h QPF Means (Differences from Full Ensemble Mean)
QPF	0.25” QPF Objects - Object 1 - Object 2 - Object 3 - Object 4 - Object 5 - Object 6 0.50” QPF Objects - Object 1 - Object 2 - Object 3 - Object 4 - Object 5 - Object 6	24-h averaged QPF - Day 1 - Day 2 - Day 3 - Day 4 - Day 5 - Day 6 48-h averaged QPF - Day 1-2 - Day 2-3 - Day 3-4 - Day 5-6	Varies based on silhouette score	1. QPF EOF Patterns 2. QPF PC Phase Space 3. QPF Cluster Percentiles Percentile Thresholds: 10th, 25th, 50th, 75th, 90th, 95th 4. QPF Cluster Percentiles (Differences from Full Ensemble x-th Percentile) Percentile Thresholds: 10th, 25th, 50th, 75th, 90th, 95th

3.3 - Ensemble Sensitivity Analysis

While forecasters often report the benefits of ensemble clustering in quantifying the prevalent forecast outcomes in large ensemble datasets, in many cases they still wish to know more about the sources of forecast uncertainty. A powerful diagnostic tool, known as Ensemble Sensitivity Analysis (ESA), quantifies the sources of forecast uncertainty by linearly regressing a chosen high-impact forecast metric onto the early forecast state (Hakim and Torn 2008; Ancell and Hakim 2007; Torn and Hakim 2008). The traditional formulation of ensemble sensitivity analysis can be described by the slope of a linear regression line (raw sensitivity):

$$\frac{\partial J}{\partial X_0} = \frac{cov(J, X_0)}{var(X_0)}$$

where J represents the response function or forecast metric of interest, X_0 represents the sensitivity variable, cov stands for covariance, and var stands for variance. This representation of ESA is based on arbitrary changes to early forecast variables, rather than expected changes in early atmospheric conditions due to uncertain features reflected in early ensemble spread. Thus, it can be advantageous to apply the version of ESA that takes early forecast spread into account (standardized sensitivity):

$$[\frac{\partial J}{\partial X_0}]_s = \frac{cov(J, X_0)}{var(X_0)} * \sigma_{X_0}$$

where σ_{X_0} represents the standard deviation of the sensitivity variable at each grid point. Because the PC value for each ensemble member summarizes the projected difference between each ensemble solution and the ensemble mean in the direction of a given EOF, this metric can be used as the response function J in representing high-impact forecast uncertainty. When PCs are applied as response functions, the units they carry turn the standardized sensitivity equation into a correlation coefficient (Zheng et al. 2013), shown below:

$$[\frac{\partial J}{\partial X_0}]_s = correlation = \frac{cov(J, X_0)}{\sqrt{var(X_0)}\sqrt{var(J)}}$$

Therefore, ESA in the context of EOFs and PCs reveals which early forecast features correlate most strongly with uncertainty modes later in the forecast time frame. ESA configurations are shown below by Table 3.

Response Function	***Sensitivity Variable***	***Regions***	***Lead Times***
24-h averaged 500-hPa Heights PC1 Values	500-hPa Heights 0-h to X-h (where X = end of response function lead time)	East Central West Alaska	Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9
24-h averaged 500-hPa Heights PC2 Values	500-hPa Heights 0-h to X-h (where X = end of response function lead time)	East Central West Alaska	Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9

24-h averaged MSLP PC1 Values	500-hPa Heights 0-h to X-h (where X = end of response function lead time)	East Central West Alaska	Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9
24-h averaged MSLP PC2 Values	500-hPa Heights 0-h to X-h (where X = end of response function lead time)	East Central West Alaska	Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9
QPF PC1 Values (directly from LREF membership, not calibrated from NBM QMD members)	500-hPa Heights 0-h to X-h (where X = end of response function lead time)	East Central West Alaska	Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9
QPF PC2 Values (directly from LREF membership, not calibrated from NBM QMD members)	500-hPa Heights 0-h to X-h (where X = end of response function lead time)	East Central West Alaska	Day 3 Day 4 Day 5 Day 6 Day 7 Day 8 Day 9

3.4 Testbed Experiment Web Tools

The ECSA Testbed Website will serve as a one-stop shop for non-DESI clustering and sensitivity products for the two weather events of interest. More powerful, in-depth ensemble interrogation may be found on the DESI platforms.

DESI (CAC authentication enforced)
DESI-GSL (public-facing)

Major thanks are owed to Travis Wilson of the NOAA Global Systems Laboratory for publishing the DESI clusters to the public-facing GSL version of the DESI platform ahead of this testbed experiment, so that participants external to the NWS may access the DESI clusters!

4. Forecasting Activities

Participants are expected to understand the basics of ensemble clustering prior to the beginning of the testbed experiment. Ensemble Sensitivity Analysis (ESA) tools will be taught on the first day of the experiment. The Operations Plan, as well as a Pre-Experiment Survey will be sent out to participants the week before the experiment, along with links to training resources should they need a refresher on ensemble clustering approaches. Each day of the experiment, participants will focus on a particular event, with activities evolving slightly throughout the week to answer different key science questions.

4.1 Primary Forecast Activity Priorities

1. **Understanding how ensemble cluster messaging varies regionally and across CWAs for the same event.**
   - Do any common themes or best practices emerge?
   - How often and in what ways should adjacent WFOs be collaborating between County Warning Areas (CWAs)?
2. **Assessing the impact of cluster variable(s) used on forecast messaging.**
   - Do different cluster variables lead to different forecast messaging?
   - Do different ESA variables tell different stories about most important early forecast features? Do these differences impact forecast messaging?
3. **How do model trends influence ensemble cluster use?**
   - Does ESA help increase forecaster confidence by revealing consistent contributors to forecast uncertainty, or do sensitive features exhibit as much run-to-run variability as the ensemble systems themselves?

4.2 Testbed Schedule

Monday | 3.30.26	Tuesday | 3.31.26	Wednesday | 4.1.26	Thursday | 4.2.26	Friday | 4.3.26
09:00am ET — Morning Icebreaker Activity	09:00am ET — Event 1 Day 3 WPC Briefing	09:00am ET — Event 2 Day 6 WPC Briefing	09:00am ET — Event 2 Model Trends and ESA Demonstration - Austin Coleman	09:00am ET — Individually Review Slide Deck of all Forecast Messages from Morning Group
09:30am ET — Orientation Begins	09:15am ET — Individual Forecaster Assessments	09:15am ET — Individual Forecast Assessments	09:45am ET — Short Model Trends / ESA Exercise	09:15am ET — Discuss Overall Themes from Forecast Messaging
10:30am ET — Break	10:00am ET — Break	09:45am ET — Breakout into Three Different CWA / Cluster Variable Groups. Develop D6 Messaging	10:30am ET — Event 2 Post-Event WPC Overview	09:45am ET — Focus Group Discussion 10:15am ET — Break
10:45am ET — Event 1 Day 5 WPC Briefing	10:15am ET — Breakout into Three Groups for Different CWAs. Adjust Day 5 Messaging for Day 3	10:35am ET — Break	10:45am ET — Break	**10:30am ET — Brian Ancell Presentation**
11:00am ET — Individual Forecast Assessments	11:15am ET — Discuss D3 Forecast Messaging / Collab	10:45am ET — Event 2 Day 3 WPC Briefing	**11:00am ET — Steve Willington Presentation**	11:00am ET — Open up the "Jam Board" Group Document of Best Practices. Participants can reflect and contribute notes
11:40am ET — Breakout into Three Groups for Different CWAs. Generate Day 5 Forecast Messaging	11:30am ET — Event 1 Post-Event WPC Overview	11:00am ET — Individual Forecast Assessments	11:30am ET — Post-ESA Activity Discussion	11:45am ET - Break
12:30pm ET — Break	11:45am ET — Break	11:30am ET — Adjust D6 to D3 within CWA/Variable Groups	12:00pm ET — Break	12:00pm ET — Consolidate Jam Board Themes into a Group

Monday | 3.30.26	Tuesday | 3.31.26	Wednesday | 4.1.26	Thursday | 4.2.26	Friday | 4.3.26
		12:20pm ET — Break	12:15pm ET — Discuss D3 Messaging. Evaluate Effectiveness of Morning Group Messaging	Document of Best Practices
12:40pm ET — Discuss D5 Forecast Messaging	12:00pm ET — Evaluate Effectiveness of Morning Group CWA Forecast Graphics. Compare with Afternoon Group	**12:30pm ET — Ryan Torn Presentation**	12:45pm ET — Compare and Critique Afternoon Group Event 2 D6 / D3 Messaging	12:50pm ET — Closing Remarks
01:00pm ET — Morning Group Adjourns	01:00pm ET — Morning Group Adjourns	01:00pm ET — Morning Group Adjourns	01:00pm ET — Morning Group Adjourns	01:00pm ET — Morning Group Adjourns
02:00pm ET — Afternoon Icebreaker Activity	02:00pm ET — Event 1 Day 3 WPC Briefing	02:00pm ET — Event 2 Day 6 WPC Briefing	02:00pm ET — Adjust Event 2 D6 to D3 within CWA/Variable Groups	02:00pm ET — Compare and Critique Morning Group Event 2 D6 / D3 Messaging. Closing out Event 2 Discussion
02:30pm ET — Orientation Begins	02:15pm ET — Individual Forecaster Assessments	02:15pm ET — Individual Forecast Assessments	03:00pm ET — Break	02:30pm ET — Individually Review Slide Deck of all Forecast Messages from Afternoon Group
03:30pm ET — Break	03:00pm ET — Break	03:00pm ET — Break	03:15pm ET — Event 2 Model Trends and ESA Demonstration - Austin Coleman and Brian Colle	02:45pm ET — Discuss Overall Themes from Forecast Messaging
03:45pm ET — Event 1 Day 5 WPC Briefing	03:15pm ET — Breakout into Three Groups for Different CWAs. Adjust Day 5 Messaging for Day 3	03:15pm ET — Breakout into Three Different CWA / Cluster Variable Groups. Develop D6 Messaging	04:00pm ET — Short Model Trends / ESA Exercise	03:15pm ET —Break
				3:30pm ET — Focus Group Discussion
04:00pm ET — Individual Forecast Assessments	04:15pm ET — Discuss D3 Forecast Messaging / Collab	04:15pm ET — Discuss D6 Forecast Messaging	04:45pm ET — Break	04:00pm ET — Open up the "Jam Board" Group Document of Best Practices. Participants can reflect and contribute notes
04:40pm ET — Breakout into Three Groups for Different CWAs. Generate Day 5 Forecast Messaging	04:30pm ET — Event 1 Post-Event WPC Overview	04:45pm ET — Event 2 Day 3 WPC Briefing	05:00pm ET — Event 2 Post-Event WPC Overview	04:45pm ET —Break
05:30pm ET — Break	04:45pm ET — Break	05:00pm ET — Break	05:15pm ET — Post-ESA Activity Discussion	05:00pm ET — Consolidate Jam Board Themes into a Group Document of Best Practices. Merge with Morning Document
05:40pm ET — Discuss D5 Forecast Messaging	05:00pm ET — Evaluate Effectiveness of Afternoon Group CWA Forecast Graphics. Compare with Morning Group	05:15pm ET — Individual Forecast Assessments	05:35pm ET — Evaluate Effectiveness of Afternoon Group Messaging	05:50pm ET — Closing Remarks
06:00pm ET — Afternoon Group Adjourns	06:00pm ET — Afternoon Group Adjourns	06:00pm ET — Afternoon Group Adjourns	06:00pm ET — Afternoon Group Adjourns	06:00pm ET — Afternoon Group Adjourns

4.3 Forecast Messaging

Forecast activities for two high-impact winter events will be conducted, centering on Day 6 and Day 3 (Day 5 and Day 3 for Event 1) lead times to consolidate the needed forecast data. For each event, a WPC Forecaster (Cody Snell in the Morning Group and Mussie Kebede in the Afternoon Group) will help spin up participants' situational awareness by presenting a broad forecast overview using deterministic and ensemble forecast data for the given event.

Starting with ensemble clustering and sensitivity analysis data from a week in advance of the event, participants will then get a chance to individually peruse and assess the atmospheric situation. They will develop a mini Area Forecast Discussion (affectionately known as an AFD-Lite) to give experiment facilitators a sense of their initial thoughts on the case. Participants will paste these mini AFDs as feedback in the Individual Forecaster Assessment Survey, in which they will also answer questions about which tools they relied on most for their given lead time, forecast situation, and region.

Mini AFDs may be submitted in bullet-point form or short paragraph form to summarize one's initial thoughts on the forecast situation. Here are two excellent examples from our ECSA Testbed Demo Day back in February:

> "The potential for heavy rain has increased dramatically from D7, with only modest spread among the QPF footprint for the WFO RNK CWA. There continue to be significant upstream challenges with respect to northern and southern stream troughs and how they will interact keeping confidence modest. However, if the impulses phase into a more amplified longwave trough this will suggest more southerly flow and potentially more westward focus of the QPF footprint, whereas a less phased solution would allow QPF to spread farther east, with less intensity, but maybe longer duration. The confidence has increased in heavy rainfall though, with a >40% chance of at least 1" of rain with locally 2-3" possible (5-10%), especially in the terrain of SW VA into terrain areas."

> "500mb pattern: 09/00z-11/00z pattern uncertainties relate primarily to timing variances in the progression of longwave trough/ridge pattern, and secondarily related to the amplitude of the pattern itself. These differences relate to the existence of a closed-off low in the SW in earlier days and its phasing with a second shortwave trough that moves in behind it which grows deeper with time."

After individual assessments, participants are assigned to breakout rooms associated with different CWAs to develop key message graphics at the given lead time. During the second case, participants will be assigned to breakout rooms associated with different CWAs and different cluster variables to use in their forecast process. For both forecast events, the full set of participants will later regroup and evaluate/discuss their key messages to determine how each group utilized the ensemble cluster tools in their messaging.

Finally, facilitators Austin Coleman and Brian Colle will go over the key model trends and ensemble sensitivity aspects regarding the second forecast event. After the ESA and model trends demonstration, participants will be asked to rejoin their groups with different CWAs and cluster variables to identify the key sensitive features for their forecast variable of focus. They will create a couple Google slides highlighting the feature(s) that they consider most important to the forecast case, whether the key sensitive feature changes with each initialization cycle or remains constant, and whether the ESA-identified source of forecast uncertainty aligns with forecasters' dynamic understanding of the atmospheric event.

Once both cases are finished, participants will evaluate which aspects of the experiment did or did not go well and how these conclusions can guide best practices for ensemble cluster and sensitivity product use moving forward. We will host a Focus Group session at the end of the week followed by a Jamboard-style brainstorming session during which a document of best practices and any training gaps, unaddressed product needs, and future collaboration strategies will be identified. After the experiment week concludes, participants will receive one last post-experiment survey to determine if their product usage and messaging strategies changed in light of experiment results.

5. References

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