

# **NWS Operations Proving Ground**

## **Final Report**

### **Hazard Services for Severe Convection**

*An OPG in-residence evaluation of Hazard  
Services-Convection*

**NWS Operations Proving Ground  
7220 NW 101<sup>st</sup> Terrace  
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## 1. Background (Spirit and Intent)

The OPG began coordinating with the National Weather Service Headquarters (NWSHQ) and scientists from the Global Systems Laboratory (GSL) in 2021 on a proposed test of Hazard Services using the baselined AWIPS workstations at the OPG. GSL was most interested in understanding how Hazard Services-Convective (HS-C) performed on a realistic near-operational AWIPS workstation as opposed to Cloud AWIPS. In early 2022, we felt we could safely conduct a test in-residence at the OPG with a small group of participants from nearby local forecast offices (such as Pleasant Hill, Topeka, Omaha, Springfield, or Des Moines). We also had access to several forecasters with past warning experience at Central Region HQ, the Training Center, and the Aviation Weather Center who could participate if local field forecasters were unavailable.

Our primary goal was to ensure that HS-C is ready to support convective operations. This involved both assessing technical readiness and user experience readiness via:

1. ensuring HS functions effectively on a near-operational AWIPS workstation during real-time and displaced real-time convective events, and
2. evaluating the user experience of HS during real-time and displaced real-time severe convection using near-operational AWIPS workstations

Table 1 below discusses the objectives set forth by GSL and the proposed evaluation methods.

*Table 1. Evaluation objectives and their corresponding methods to address them.*

<b>Objective (Questions to Answer)</b>	<b>Evaluation Method</b>
Does the Storm Track Tool allow for hazard events to be created and issued in an intuitive manner for a variety of convective modes and do hazard events created by the Storm Track Tool behave like “other” hazard events created through other means	Using a variety of displaced real-time and possible real-time scenarios allow forecasters to use the storm track tool single storm, and line of storms feature to create an issue many different short-fuse hazard events of different types (e.g., SV.W, TO.W, SP.S, EW.W, etc.)
Does the Version 4 Hazard Services architecture support the creation and federation of several hazard events on multiple LX workstations that are successfully federated to the central registry (TNCF)?	Follow the hazard event lifecycle process and ensure that hazard events of a variety of statuses (e.g., ISSUED, ENDED, ELAPSED) can be transmitted to the TNCF, shipped back to OPGA, and there are no errors thrown
Is the Version 4 Hazard Services architecture stable enough to bolster confidence in the deployment of an AWIPS Test Authorization	Use Hazard Services heavily for several days, keep the sessions open for several hours and ensure no memory leaks appear,

Note (ATAN) in the Winter of 2022/2023?

issue some Hydrology hazard events and verify they can go through the standard hazard lifecycle with no errors

### 3. Experimental Design

The evaluation took place over four days (16–19 August 2022), with the first three days being dedicated to meteorological analysis using HS-C and the last day being dedicated to a short 2-hr debrief. We had a total of four forecasters from WFOs Omaha and Springfield, and one from the Training Center who joined us for the in-residence evaluation (Fig. 1). Each participant was assigned to a WFO under the threat of convection and had a total of four monitors (two AWIPS monitors, one text workstation, one windows monitor) on a baseline AWIPS infrastructure, with the local EDEX<sup>1</sup> pointed to the test NCF (TNCF).

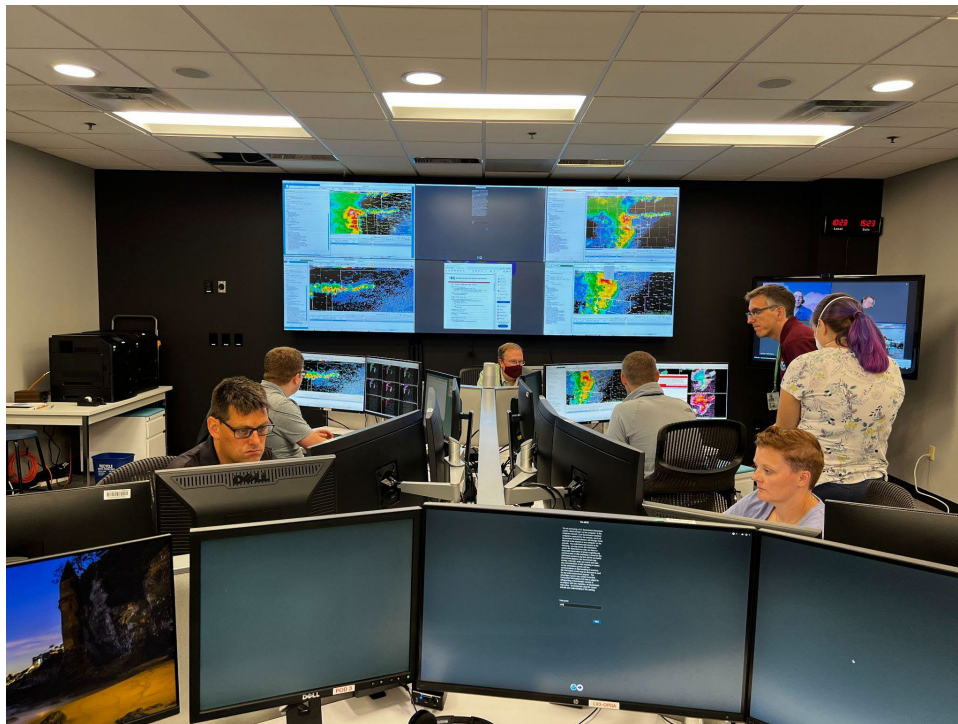


Fig. 1. Photograph of participants and some GSL and OPG staff during the evaluation

Participants issued a wide array of hazards using HS-C including:

- Severe Thunderstorm Warning (SV.W) - Storm Track Tool Only
- Tornado Warning (TO.W) - Storm Track Tool Only
- Extreme Wind Warning (EW.W) - Storm Track Tool Only
- Dust Storm Warning (DS.W) - Storm Track Tool Only
- Dust Advisory (DS.Y) - Storm Track Tool Only

<sup>1</sup> Note that OPG has all forecasters pointed to the same EDEX, similar to standard operations, and not to individualized EDEX.

- Snow Squall Warning (SQ.W) - Storm Track Tool Only
- Special Marine Warning (MA.W) - Storm Track Tool Only
- Marine Weather Statement (MA.S) - Storm Track Tool or Free Draw
- Special Weather Statement (SP.S) - Storm Track Tool or Free Draw
- Airport Weather Warning (AW.W) - Airport Weather Warning Tool

In total, the participants used HS-C approximately 6 hr daily, with a 15 min recap of errors/comments at the end of each day. OPG had pre-selected three archive cases to run for 2–3 hr in the morning in a displaced real-time format, with the goal of using live data in the afternoons. OPG also selected three alternate archive cases to run in the afternoons if live convection was sparse (Table 2). Ultimately, live data was only used in the afternoon of 18 August 2022. Cases were chosen to highlight a variety of severe conditions including: isolated severe, linear convection, tropical (i.e., landfalling hurricane) convection, and mixed-mode convection (Table 2).

Participants were divided into neighboring WFOs; however in order to test warning sectorization, forecasters were often paired together, representing a single WFO. We also tested the hand-off of warnings issued near WFO borders. One alternate case (17 August 2022) was established to test the ability for warnings to be issued in service back-up mode for other WFOs. Participants documented any and all errors they encountered in a Google document and linked survey (i.e., an error log).

*Table 2. Information on cases (archive and live) chosen for each date of the evaluation*

<b>Date</b>	<b>Session</b>	<b>Case date</b>	<b>Case time</b>	<b>Case description</b>	<b>WFOs</b>
16 August	AM	10 August 2020	16–18 UTC	IA Derecho	DMX, DVN
16 August	PM	06 November 2018	5–8 UTC	TN tornado event	OHX, HUN
17 August	AM	06 October 2017	20–23 UTC	CO/NE linear convection and CI	BOU, DDC, GLD
17 August	PM	28 February 2017	23–02 UTC	Chicago tornado case	IWX (backing up LOT), LSX (backing up ILX)
18 August	AM	11 October 2018	21–00 UTC	Hurricane Michael	AKQ, LWX
18 August	PM	Live	1730–2045 UTC	Gulf coast convection	TAE, MOB

Subject matter expert, Michael Magsig, provided training on the use of HS-C via interactive webinar in the morning of 16 August 2022. The participants were also instructed to complete a detailed Job Sheet that details the tools and usage in a step-by-step manner. This Job Sheet can be found here: [Convective \(SV.W/TO.W\) - August 2022 OPG](#)

### 3+. Results and Findings

Overall, participants were excited and enthusiastic about HS-C and its performance over the three day period and offered much praise for the software. Aside from a few issues (discussed below), they thought the software performed well, was easy to use, and was intuitive. The participants also greatly appreciated the Multi-hazard management capabilities in HS-C. In particular, they felt HS-C promoted increased efficiency because they could:

- generate multiple *pending* hazard events
- end multiple events at the same time
- prepare multiple warnings simultaneously

This multi-hazard management approach allows for a new shift in warning operations, where forecasters can queue something up with a proposed polygon and wait for new radar volume scans to confirm without needing to cancel it if they have to work on a different warning. Forecasters can also use the '*Propose*' option to line-up warnings and collaborate on warning areas both within their WFO for sectorization as well as between WFO CWAs. Participants, generally, thought it was fairly easy to issue different hazard types quickly from HS, as they could open it in *Convective* mode then change the hazard type and go to *Hydro* or *No Precip*. One participant claimed that after using HS-C, it "*makes it hard to go back to WarnGen*" and that "*HS has many more usable features*".

At the end of the evaluation, the OPG asked participants to rank the software in terms of 'readiness' on a scale of 1–10, with 10 representing: "*Fully ready to be integrated into operations*", and 1 representing "*Not ready at all*". Participants rated HS-C as a 7–8 out of 10 on readiness (minus a major time-lag issue encountered during the evaluation, discussed below in point 1).

One of the major benefits of conducting this experiment in-person and on a baseline AWIPS system was the ability for GSL staff to conduct minor changes in real-time. For example, GSL made adjustments to the functionality of polygons created with the line tool. The participants provided exceptionally positive feedback and were impressed with the changes made. Participants felt that they could see the potential in the software, but there were a combination of minor and major issues that needed to be addressed before integrating HS-C into operations. These minor and major issues are summarized below, organized by topic:

#### **Issue 1: Console Freeze, Time Lag, and CAVE Issues (Major)**

Participants noted that different actions conducted during the evaluation lead to variable time lags and situations where the CAVE would freeze or lock up for a considerable amount of time. **This**

**was, by far, the most significant issue that participants felt must be resolved prior to transitioning HS-C to operations.** Below is a list of various actions and the resulting lag scenarios:

- When participants would hit “Issue All” for warnings, there would be a time lag for where the CAVE session would freeze for 30 s to 2 min.
  - When issuing multiple (> 2) warnings at the same time, it took approximately 90 s for the warnings to be sent out to the test NCF (TNCF) server.
  - Participants noted that it seemed that the more counties that are within a warning and the more complex the landmass (i.e., coastlines near the ocean or bays), the longer it would take to get the warning out and for the CAVE session to unfreeze.
- There was also a major issue when drawing polygons along complex coastal geometries. When issuing a product along a high-resolution, complex coastline with many inlets, the CAVE would lock-up for an extended period of time. It appears that this issue is linked to the complexity of the shapefile used. This behavior also occurred when updating the hatched area and for a multitude of warnings and special statements.
  - Example 1: WFO Wakefield (AKQ) locked up HS-C for over 15 min when issuing a product.
  - Example 2: Bay of Mobile, AL locked up for over 3 min
- Editing settings for the setup in the console caused the CAVE to freeze for a few seconds.
- Interestingly, there were NO lag issues when participants proposed warnings or when they issued statements such as Special Marine Statements or Special Weather Statements.
- **Based on these findings, it is inconclusive whether it is a TNCF messaging handling system issue, HS-C issue, OPGA issue, or another culprit altogether.**

## **Issue 2: Storm Track Tool Configuration (Moderate)**

Participants also noted some inconsistencies and changes they would like to see with regard to the storm track tool in HS-C. These findings are noted below, with the caveat that some of these were addressed and changed in the middle of the evaluation:

- It would be best to have a default of three vertices on a line, rather than two, so cities in the middle of the polygon are included in the path cast.
- The back edge of the "initial guess" polygon should start further back, perhaps even further back than the updated 15-km method.
- Forecasters prefer the white arrows compared to the gray tracking dots, as they are more visible but don't cover as much data.
- The participants also indicated that they would like to see the whole line propagated out into the future and not just the center dot.
- One participant encountered an error of "No projected tracking points in polygon" which inhibited them from issuing a warning. They indicated that this was problematic because often there is a threat behind the leading edge of the storm and moving the storm track point to cover this threat leads to confusion on timing for people within the same county.

- Example: One warning says the storm will be near "x town" at 11 AM and another warning says storm will be near "x town" at 11:15 AM. Thus, this concept should not apply to expiring or cancel statements since one cannot move the tracking point.
- The initial storm track was usually not the best and would require some manipulation. Further, it would automatically reset storm motion to be perpendicular to the line every time it was adjusted, which doesn't work in complex or perpendicular propagation-motion oriented storms.
  - Forecasters would, ideally, like to have a more simple flow of operations for the storm motion:
    - Start with background storm motion → adjust line → keep original storm motion without resetting it to be perpendicular to line
  - An alternative, more customizable, option would be to have a drop down menu to allow the warning operator to select the method (i.e., last storm motion, radar derived motion, perpendicular, etc.) to develop the track.
- The line tool made some redundant explanations of locations within the storm path.
  - Example: There would be two in a row, or 3–4 locations repeated
- There were some issues with regard to the storm track tool for SP.S products:
  - Some participants could not get the storm track tool to be editable for convective SP.S. The text product would put a storm track into the product, but there was no way to edit it like a SV.W or TO.W. Ideally the storm track would work with the convective SP.S just like it does with other convective products.
  - Modifying SP.S tracking dots doesn't update the storm track/polygon. Steps to reproduce the error:
    - Click the convective hazard button and drag to location
    - Switch to convective SP.S (dots the disappear)
    - Click track geometry to make dots reappear
    - Adjusted dots now no longer update the storm track

### **Issue 3: Polygon Drawing Quirks (Minor)**

Participants also noted some issues with the drawing of polygons and snapping of vertices (i.e., clipping vertex issue). They noted that while the snapping is a nice feature, it would be ideal if the box-drawing vertices would snap to the AWIPS "not-as-precise locations" when dragging the vertices during editing. Forecasters further suggested that some rounding should occur when placing points

- Participants noted that there was trouble in drawing polygons where they were unable to move original vertices. Any time they tried, it just added more vertices. However, selecting a newly added vertex would move as expected. This behavior did not happen with TO.W or SP.S.
- Occasionally, participants noted that their polygons would reset or revert back to the default shape or information. This occurred with changes to polygon shape as well as the metadata (such as warning end time, hail size, wind speed, etc.)



#### **Issue 4: Copying of Events and Handoff (Minor)**

Copying of events was attempted more frequently than expected and forecasters encountered a few issues in doing so.

- Forecasters expressed that they would like to copy an event from a neighboring CWA, grabbing only the necessary subsets of features contained within the existing warning such as spotter report text, hail size, wind, etc. that would be needed for consistent messaging.
  - At present, it will copy all of the information over and crash.
- Forecasters would also like to be able to see, select, and grab hazards that are near the CWA border and take them over if needed.

#### **Issue 5: Expiration of Products (Minor)**

All of the participants indicated that they would like an additional option under the 'warning cancellation' menu that indicates that a warning has been replaced. Under the current HS-C structure, forecasters are limited to a few options that primarily are for situations where the hazard threat has diminished.

- Forecasters also indicated that they would like to reduce the time it takes for an overdue or elapsed product to disappear from the console.
  - With regard to Special weather statements (SP.S), they should simply drop off once they expire, but have not been deleted, rather than being flagged as an overdue project.
- It could be beneficial to have an option in the Hazard Information GUI where one can cancel/expire the warning or delete it (if someone wants to restart), so they don't have to always go back to another menu to find the warning and right-click.
- Participants noted that they were not able to expire a warning exiting their WFO CWA, because the storm itself was out of their area and polygon. They received an error message indicating that there were no points in the polygon
- Similar to the above point, there were several warnings that could not be expired/canceled as there were no points within the polygon.

#### **Issue 6: Column Entries and Other Menu Options (Minor)**

Participants noticed that the 'user name' column entry in the console changed to whomever most recently clicked on the product as opposed to who issued the product (or most recently issued an update). This is a problem that needs to be addressed. While the participants thought, overall, that the HS-C GUI was intuitive and in many ways superior than WarnGen, there were some modifications they suggested:

- Have the ETN and Site ID as default columns, as they would be regular tracking items for a warning forecaster

- Have the ability for columns to be sorted by WFO, with their WFO always at the top under the site ID section
- Move the "ADDITIONAL REPORTS" section directly under the "SELECT FROM BELOW IF EITHER WIND AND/OR HAIL OBSERVED" section

### **Issue 7: Warning Styles and Options (Minor)**

Participants noted some inconsistencies and changes they would like to see in warnings displayed that were issued via HS-C. These findings are noted below:

- Issued FF.Ws have different display characteristics on the D2D view. FF.Ws issued with the "draw polygon" option were bolded, while those issued using the "motionless hazard" from the storm track tool were not bolded
- Emergency warnings should be more eye catching and easily differentiable from other warnings
  - Example: There should be a stronger differentiation between TOR and TOR emergency colors (preferably bolded *and* purple in color for the TOR emergency, perhaps flashing)
- Locations of flooding that are taken from the GUI are not formatted correctly within the text generation.
  - Example: When a location starting with a number is used in the GUI (3 WNW of Guntersville), it displays as "XXX AM, flooding was reported at 3 WNW of Guntersville". Should remove the "at" if the location starts with a number.
- Some hazards were only available as one category, when they can be put in multiple hazards in the various dropdown menus. This was especially egregious with the marine products.
  - Example: Special Marine Statement is under *Marine* but not under *Convective* or under *All Hazards*; the Special Marine Warning is under *Convective*, but not under *Marine*

### **Issue 8: Basic Keyboard and Mouse Operations (Minor)**

Participants noted some minor items related to 'buttonology' that could be addressed:

- Mouse wheel scrolling through the products in the timeline section of HS is inverted, which may take getting used to or could be flipped
- Right-clicking anywhere on the D2D map when HS is running creates a pop-up. This is not ideal, because right-clicking is the primary method to change between the time and product legends in the bottom right of the CAVE maps
- There are some hidden WarnGen key shortcuts (i.e., Alt-key movements) to make the workflow quicker that should be highlighted, such as 'Alt + click' to drag features around
- Some forecasters liked to click on warnings in D2D to get the warning Hazard Information GUI to appear. They indicated that it would be beneficial to be able to click on the product

in D2D and do all the options for it, including issue follow up statements, cancel, delete, etc.

### 3.1 Other configuration, set-up, or operating errors/comments

Outside of the above eight topic areas, participants noted other errors that they encountered throughout the evaluation process using a Google Form. Those documented errors (sans those already discussed above) and other comments are summarized and highlighted below. For the *full* list of all errors and comments, please refer to: [Participant Errors/Comments](#).

- There were occasions when participants would receive an error message related to the Failure to put VTech records, which were not reproducible. Two examples of this error were documented: [VTech Record Error](#). As this error prevented the issuance of warnings and was unreproducible, it is highly recommended to investigate these errors further.
  - These errors would only be circumvented via CAVE restart
- One forecaster noted that if they had their console on 'All Hazards' setup, once they clicked to issue a convective warning, their console immediately showed *Convective*.
  - They noted that this can be changed in the settings, but would be best if the console did not make this change unless they loaded different settings.
- The transition from HS-C to HS-Hydro needs to be smoother when using the track storm mode. When using the 'track storm' mode, all hazard types are not available but can be accessed by jumping around to various setup options.
- Forecasters noted some odd behaviors when changing, replacing, updating, or upgrading warnings.
  - **Flooding:** If you issue a FF.W from the motionless track, then go replace it with a Flood Warning, a new polygon (default square) is created for the Flood Warning. It correctly ends the Flash Flood Warning, but does not replace the polygon. If you draw a polygon for the FF.W instead, then go to replace it with a Flood Warning, it does keep the same polygon for the Flood warning. This is only an issue when the Flash Flood Warning is created by a motionless track.
  - **Severe:** Errors occur when switching from SV.W warning to TO.W on a proposed warning, but not from TO.W to SV.W. Participants noted the following message: *"HazardDetailViewPart.MegawidgetManager error occurred while attempting to apply megawidget interdependencies"*.
  - The colored bar in the range under the timeline in the HS-C window sometimes disappears after issuing/updating some product
- There were a couple of instances where the radar data inhibited optimal usage of polygons or the storm track tool.
  - Scans within the same minute, which have the same timestamp, make the white dot on the storm track tool go away.
  - New scans of radar mess with the user's edits if the data comes in while they are adjusting vertices

- If the user is holding left click on the vertex in a different location than it was previously (as if to adjust the polygon) the vertex snaps out of the user's control to the previous location
  - This is related to the storm track issue (discussed in point 2 above) where the track defaults to always be perpendicular to the line. Thus, the polygon automatically adjusts with each scan
- There were instances during the evaluation where the CAVE screen would appear 'black' and the view would be zoomed in somewhere off-screen outside of the map extent. This would require a switch in the map view to get a usable view of the data.
  - This occurred when dragging the line tool outside of the WFO CWA (had State(s) view in D2D)
  - It did not seem to be an issue if the storm was outside the WFO CWA, but the track box was in the CWA.
- Recommender errors: We documented two separate instances of recommender errors. These errors can be found here: [Recommender Error](#)
  - The first occurred when in service backup mode and there was no radar data for the closest radar. Thus, when searching for the regex, it produced a 'noneType' during the execution of the `getStormMotionFromSTI` function.
  - The second occurred when a participant attempted to adjust a warning end time.

## 4. Summary

Thus, to summarize, the OPG has identified seven issues that need to be addressed regarding the operational use of HS-C:

1. TNCF registry time lag when issuing warnings
2. Interoperability between versions
3. Inconsistency of "Failure to put Vtech" records error
4. Complex coastline vertices cause insurmountable time lag for issuance
5. Clipping vertices and snapping of polygons
6. Cancellation of warnings and replacement with new warnings verbiage/function
7. Storm track tool needs to be optimized
  - a. Track needs to not simply be perpendicular to the line
  - b. Overlapping of polygons is an issue
  - c. Need to go backwards further than 15-km on the initial guess

There are some additional minor changes discussed that would be best to be addressed, but are not as pressing as the seven points above. Once these items are addressed by GSL and/or other supporting entities, the OPG **recommends further testing of HS-C on a baseline AWIPS either at a test bed/proving ground or at select pilot WFO locations.**