3: Simulation Suggestions

I. Introduction

There is only one displaced real-time (DRT) simulation for this event, which is localized for the Wilmington, OH (ILN) Weather Forecast Office (WFO). The simulation will run from 0415 UTC to 0630 UTC on 21 July 2010. During this simulation, you will analyze the following information:

- Mesoscale environment
- Observed and model-derived Skew-T diagrams
- Radar observations and trends
- FFMP data and trends

The job-sheet style approach will allow you to systematically analyze the event during the simulation. The performance objectives outlined here coincide with the learning objectives from the ***Flash Flood Warning Best Practices*** course. You will be responsible for issuing flash flood warnings for the impacted regions and later issue follow-up statements for their warnings, as described by the simulation schedule outlined on Page 3-4. Make sure that you use appropriate wording and call-to-action statements within your warning products, including the use of a "*Flash Flood Emergency*."

Additional information will be provided during the running of the simulation. An introductory Articulate presentation will appear during the opening minute of the simulation. This presentation will provide you with vital information needed to become familiar with case while gaining local knowledge of the hydrological characteristics of the area, including topography, soil characteristics, and any antecedent precipitation.

A WESSL script will be enabled to help pace the simulation and to provide extra data for you. Local storm reports (LSRs) and information regarding river stage heights will appear during the simulation, which will assist in your analysis and your determining of the magnitude of the event as it unfolds. Another Articulate presentation will appear at the end of the simulation, which will debrief you on the event, including the meteorological and hydrological impacts, and how the reasoning behind the issuance of a "*Flash Flood Emergency*" by the ILN WFO.

At the end of the presentation, you will have access to the following interactive maps, which are linked in the debrief presentation:

- Local Storm Report Map:
    - Extensive details of each LSR
    - Pictures from Lewis County and one video from the town of Olive Hill, KY
- Post-Brief Map:
    - CoCoRaHS rain gauge data
    - Stage hydrographs from USGS river gauge data
    - One-Hour and Three-Hour basin trace flash animations (includes rain rate, QPE, FFG thresholds, KILN 0.5° reflectivity, and difference from FFG)

****** Remember to review the performance objectives and evaluation criteria prior to running the simulation ******

II. Simulation - July 20-21, 2010 Event

Simulation Information:

WFO Localized -- Wilmington, Ohio (ILN)

Simulation Start Date/Time -- 0415 UTC 21 July 2010

Simulation End Date/Time -- 0630 UTC 21 July 2010

WES Macro -- ILN-0415-21July2010

Overview:

This simulation will focus on the flash flood event that occurred in the southern part of the Wilmington, Ohio (ILN) county warning area (CWA). Rainfall started falling in the southern part of the CWA around 2000 UTC 20 July and continued on-and-off into the overnight hours. Some flash flooding has been reported within the CWA where high water is being reported across several roads in the town of Augusta in Bracken County, KY.

The objectives of this simulation are as follows:

1. Complete an environmental analysis and determine the flash flood threat and magnitude.
2. Understand radar and FFMP observations and trends and apply this knowledge to flash flooding situations.
3. Issue appropriate flash flood warnings and follow-up statements, including the use of a "*Flash Flood Emergency*."

You are expected to generally follow the schedule shown on the next page. The simulation is provided in a job-sheet type format to maximize the learning experience from the event while providing an opportunity for you to issue flash flood warnings in a DRT environment.

Schedule for Trainee:

The following schedule is a basic timetable of the simulation. The time spent on each performance objective may vary.

- 0415-0430 UTC (15 mins): **Pre-Brief Presentation**
- 0430-0500 UTC (30 mins): **Performance Objective #1 -** Mesoscale Analysis
- 0500-0520 UTC (20 mins): **Performance Objective #2 -** Radar and FFMP Analysis - Part I
- 0520-0540 UTC (20 mins): **Performance Objective #3 -** Issuing Flash Flood Warnings
- 0540-0610 UTC (30 mins): **Performance Objective #4 -** Radar and FFMP Analysis - Part II
- 0610-0630 UTC (20 mins): **Performance Objective #5 -** Issuing Flash Flood Statements

*The **Post-Brief Presentation** will appear at the end of the simulation and will run for approximately 15 minutes.*

****** Before you begin this simulation...***

1. Make sure that you have a copy of the student guide with you. Review the simulation guide in order to completely understand the objectives prior to starting the simulation.
2. Ensure that you have a readily accessible map of the CWA (see Appendix C for a copy of the CWA map).

Performance Objectives:

Performance Objective #1 -- Mesoscale Analysis

Time Period -- 0430 UTC to 0500 UTC

The mesoscale analysis is important here to characterize the environment and forcing involved in this case since it is not synoptically evident. A short-term (3-4 hour) analysis can help identify the flash flood potential for localized areas.

Evaluation Criteria 1.1 - First perform a basic surface analysis for the region. Load the procedure ***Sfc_Analysis*** from the ***MesoAnalysis*** procedure bundle into a blank D-2D pane. This procedure contains METAR observations, surface winds (as streamlines), and satellite IR imagery. Make sure that you scroll back in time to the RUC40 0400 UTC model output.

**** If you are having problems loading this procedure, refer to **Surface Analysis** on Page C-4 in Appendix C for the procedure details. ****

1. Identify the location of the boundary based on surface streamlines and IR satellite at 0400 UTC. Scroll between the 0000 UTC and 0400 UTC time frame. Describe the movement of this boundary between 0000 UTC and 0400 UTC.

2. Bring the image back to the 0400 UTC analysis. Perform a basic surface analysis using the METAR observations provided in the procedure. You can increase the density of the number of METAR stations to help your analysis.

Evaluation Criteria 1.2 - The next step is to evaluate the moisture content of the atmosphere. In another D-2D pane, load the procedure ***PW_MoistTrans*** from the ***MesoAnalysis*** procedure bundle. This procedure displays the precipitable water, 925-850 mb moisture transport vectors, and 925-850 mb moisture convergence. Again, make sure that you scroll back in time to the RUC40 0400 UTC model output.

**** If you are having problems loading this procedure, refer to **Precipitable Water and Moisture Transport** on Page C-5 in Appendix C for the procedure details. ****

1. What are the general precipitable water values (in inches) across southern Ohio and northern Kentucky? Are these values considered to be above normal for this region (see Figure 3-1)?

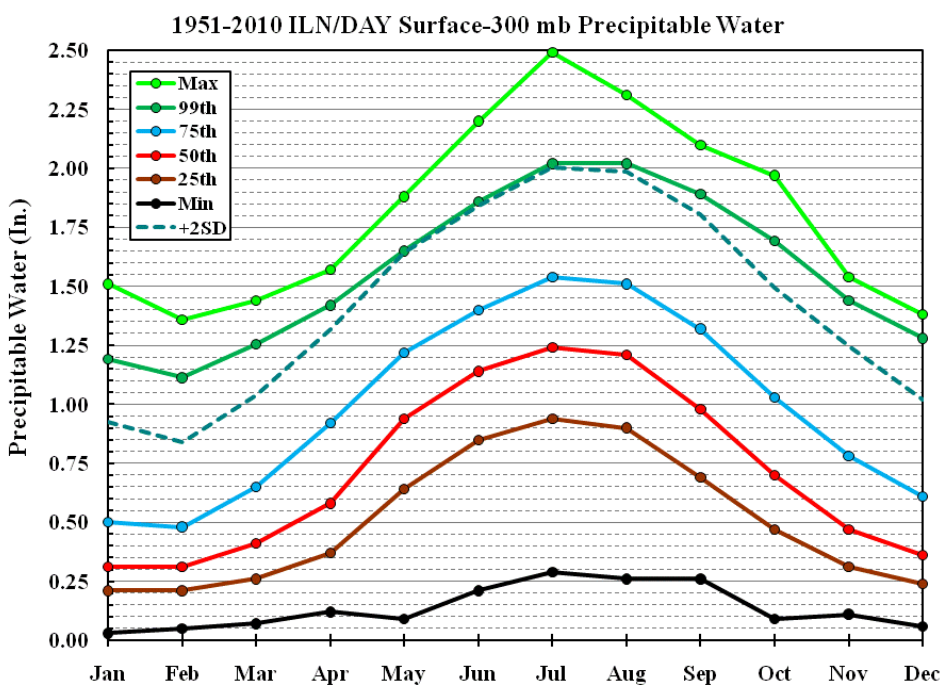

Figure 3-1: Precipitable water climatology from the surface to 300 mb for the ILN sounding from 1951-2010. All the solid lines represent a specific percentile, as seen in the legend, with the red line representing the mean precipitable water for each month. The green dashed line represents +2 standard deviations from normal.

2. Where are the maximum values of 925-850 mb moisture convergence located in this region?

3. Move forward in time to the three-hour RUC40 forecast at 0700 UTC. Are there any significant changes to the location and magnitude of the precipitable water and moisture convergence in this region?

Evaluation Criteria 1.3 - Now evaluate the Corfidi Vectors and the atmospheric flow/instability for this region using the RUC 40 output at 0400 UTC. In another D-2D pane, load the procedure ***Corfidi_Vectors*** from the ***MesoAnalysis*** procedure bundle and set to 0400 UTC.

**** If you are having problems loading this procedure, refer to **Corfidi Vectors and Atmospheric Flow/Instability** on Page C-6 in Appendix C for the procedure details. ****

1. The top left panel contains the 850-300 mb mean wind (which represents the storm-scale steering flow), 850 mb winds, and Corfidi Vectors overlaid onto the 0.5° mosaic reflectivity. What does the wind and Corfidi Vector analysis tell you about the convective movement and duration potential?

2. The top right panel contains 925-850 mb vorticity, winds, and moisture transport. Describe the location of the vorticity maximum and what impact it has on the low-level flow around the southern part of the ILN CWA.

3. The bottom left panel displays the 0-3 km most-unstable convective available potential energy (MUCAPE) for the region. What are the approximate values of MUCAPE in the ILN CWA?

4. The bottom right panel displays 925-850 mb divergence, frontogenesis, and moisture transport. At 0400 UTC, where are the maximum values of convergence and frontogenesis located? Based on the 925-850 mb moisture transport vectors (this panel) and magnitude image (top right panel), where are the convergence and frontogenesis maxima in relation to the maximum moisture transport? And what can you imply from this?

5. Advance the RUC40 analysis to the three-hour forecast at 0700 UTC. Describe the evolution of the environment between 0400 UTC and 0700 UTC based on the parameters shown in this section.

Evaluation Criteria 1.4 - Load into a blank D-2D pane the 0000 UTC 21 July 2010 sounding from Cincinnati, Ohio (ILN). Examine the different parameters shown in Table 3-1 and write your answers in the table.

Table 3-1

Skew-T Parameter	Answer
Moisture Depth: Determine how deep the moisture profile is for this sounding. In the answer column, write the approximate height (in mb and feet) of the top of the moist layer.	
Precipitable Water: Find the parameter *Precip Water* in the text shown below the sounding and write down the value (in inches).	
LCL: Write down the LCL height (in mb and feet) as it is described in the parameters below the sounding.	
Sub-Cloud Layer: Determine the depth of the sub-cloud layer by subtracting the elevation of the sounding location (1,063 feet) from the LCL height.	
Height of the Freezing Level: Write down the height of the freezing level (in feet) as described in the parameters provided with the Skew-T.	
Warm Cloud Layer: Determine the depth of the warm cloud layer (in feet). To do this, subtract the height of the LCL from the height of the freezing level.	
Mean Layer Flow: Write down the direction and magnitude (in kts) of the 0-6 km winds as shown in the parameters below the sounding.	
CAPE Profile: Describe the CAPE profile of this sounding. Write down the CAPE value (*Positive Energy Abv LFC)* in J/kg. Then describe the CAPE profile of this sounding (i.e., tall and skinny CAPE, short and fat CAPE, etc.)	

Evaluation Criteria 1.5 - In another D-2D pane, set the zoom to *WFO* scale and load *Points* from the *Tools* menu. Place one of the points over Lewis County, KY at approximately 38.6°N, 83.4°W. Open a *Volume Browser* and change the product type to *Sounding*. Load a RUC40 sounding for the point over Lewis County. Conduct an analysis on the RUC40 sounding at 0400 UTC 21 July 2010 using Table 3-2.

Table 3-2

Skew-T Parameter	Answer
Moisture Depth: Determine how deep the moisture profile is for this sounding. In the answer column, write the approximate height (in mb and feet) of the top of the moist layer.	
Precipitable Water: Find the parameter *Precip Water* in the text shown below the sounding and write down the value (in inches).	
LCL: Write down the LCL height (in mb and feet) as it is described in the parameters below the sounding.	
Sub-Cloud Layer: Determine the depth of the sub-cloud layer by subtracting the elevation of the sounding location (873 feet) from the LCL height.	
Height of the Freezing Level: Write down the height of the freezing level (in feet) as described in the parameters provided with the Skew-T.	
Warm Cloud Layer: Determine the depth of the warm cloud layer (in feet). To do this, subtract the height of the LCL from the height of the freezing level.	
Mean Layer Flow: Write down the direction and magnitude (in kts) of the 0-6 km winds as shown in the parameters below the sounding.	
CAPE Profile: Describe the CAPE profile of this sounding. Write down the CAPE value (*Positive Energy Abv LFC)* in J/kg. Then describe the CAPE profile of this sounding (i.e., tall and skinny CAPE, short and fat CAPE, etc.)	

Evaluation Criteria 1.6 - After examining the mesoscale environment and soundings, complete the checklist in Table 3-3 for the southern Ohio and northern Kentucky region. After answering all of the questions in the checklist, write a brief summary on the atmospheric conditions in place over the southern part of the ILN CWA and how conducive it is for flash flooding. The summary should include a short-term forecast for the next three to four hours for the southern part of your CWA.

Table 3-3

Checklist	Yes	No
Is there a quasi-stationary forcing mechanism (i.e., boundary)? A slow moving line segment or numerous storms moving along a boundary can lead to increased rain duration over areas.	☐	☐
Does an abnormally high amount of precipitable water exist over the region?	☐	☐
Is there a considerable amount of moisture transport and convergence over the area? High amounts can lead to strong moisture flux into storms and better rainfall efficiency and rates.	☐	☐
Are there low LCL heights over the area?	☐	☐
Does a deep warm cloud layer (i.e., > 10,000 ft) exist in this area based on the soundings? This can imply that warm rain processes will be dominant and better precipitation efficiency.	☐	☐
Is there weak mean cloud layer flow (i.e., layer winds generally less than 10 kts) over the region? Weak flow can lead to very slow moving or nearly stationary storms.	☐	☐
Are the Corfidi vectors weak (i.e., approximately 10 kts or less) over the region, which could signify slow system movement?	☐	☐
Are the CAPE values relatively small over the area? Note that moderate CAPE is not required for flash flooding events since they can potentially lead to significant DCAPE, which could lead to cold-pooling and forward propagation.	☐	☐
Was there a significant amount of antecedent precipitation that fell over the region prior to the start of the simulation? Recall this information from the pre-brief presentation.	☐	☐

Use this blank page to write your discussion for Evaluation Criteria 1.6.

Performance Objective #2 -- Radar and FFMP Analysis - Part I

Time Period -- 0500 UTC to 0520 UTC

Evaluation Criteria 2 - During this part of the simulation, you will take a look at real-time radar observations and FFMP data. Document any areas that have received a significant amount of rainfall within the ILN CWA. Use FFMP to determine what basins have exceeded the 1-HR and 3-HR flash flood guidance (FFG) and by how much. Observe any radar and basin trends to determine what areas will exceed FFG in the near future.

Do not issue any warnings during this time period! A WESSL pop-up window will appear at 0520 UTC to inform you when you can start issuing warnings. This message will also signify the end of Performance Objective #2 and the beginning of Performance Objective #3. The evaluation criteria for the flash flood warnings are defined in Evaluation Criteria 3 beginning on Page 3-16.

Recommendations and Notes for Your Analysis:

- This event is occurring along the southern part of your CWA border and it is about equidistant between the Wilmington, OH WSR-88D (KILN) and the Jackson, KY WSR-88D (KJKL). You can use both radars to help with your analysis on precipitation accumulation; however, this simulation focuses on the KILN WSR-88D data.
- Be aware that as you start your analysis, there are a lack of reports for your area. Therefore, you will have to rely on reports from other areas and create comparisons to determine the severity of the flash flooding.
- Remember to go to the Layers menu in FFMP and set it to "*All and Only Small Basins*" for the greatest basin detail.
- Make sure that FFMP has been set to "*Link to Frame*" and that the frame count is set to a low number. FFMP is a memory-intensive program and could become sluggish.
- When using FFMP, focus on the 1-HR and 3-HR difference product to assist in determining the magnitude of the flash flooding. Please note that 6-HR FFMP data is currently not available.
- Be cognizant of the downstream flow of runoff from the basins receiving the heavy precipitation. You can make FFMP editable in D-2D and then right click the basin in the display to see downstream traces.

We have provided two procedures to assist you during your analysis:

- ***KILN_Analysis***
- ***FFMP_ILN***

Both of these procedures are located in the ***Radar_FFMP*** procedure bundle. The ***KILN_Analysis*** procedure is a four-panel display containing 0.5° base reflectivity along with one-hour precipitation, storm-total precipitation, and an image combination of one-hour and three-hour FFG. The ***FFMP_ILN*** procedure is a pre-built display for FFMP with various maps overlaid onto FFMP (e.g., cities, CWA borders, etc.).

**** If you are having problems loading these procedure, refer to **KILN WSR-88D Radar Analysis** on Page C-7 and **ILN FFMP Analysis** on Page C-8 within Appendix C for the procedure details. ****

Performance Objective #3 -- Issuing Flash Flood Warnings

Time Period -- 0520 UTC to 0540 UTC

Evaluation Criteria 3 - Demonstrate the ability to issue effective *Flash Flood Warnings* for the impacted regions. Ensure that the flash flood warnings cover the threat area and also accounts for the immediate downstream basins. Also, make sure that the warnings clearly describe the magnitude of the threat and use appropriate call-to-action statements. Remember not to issue one large warning because of the differences in flash flood magnitude and anticipated and/or continued flash flooding based on radar and FFMP trends.

Once you have finished issuing your flash flood warnings, you can move on to Performance Objective #4 to continue your radar and FFMP analysis.

Performance Objective #4 -- Radar and FFMP Analysis - Part II

Time Period -- 0540 UTC to 0610 UTC

Evaluation Criteria 4 - This is a continuation of the radar and FFMP data analysis that you completed in Performance Objective #2. Again, identify any areas that have received a significant amount of rainfall within the ILN CWA. Use FFMP to determine what basins have exceeded FFG and by how much. Continue observing any radar and basin trends to determine what areas will continue to exceed FFG in the near future.

Do not issue any flash flood statements for your warnings during this time period! A WESSL pop-up window will appear at 0610 UTC to inform you when you can start issuing follow-up statements for your warnings. This message will also signify the end of Performance Objective #4 and the beginning of Performance Objective #5. The evaluation criteria for the flash flood statements are defined in Evaluation Criteria 5 beginning on Page 3-19.

Recommendations and Notes for Your Analysis:

- Focus on the ratio and difference from 1-HR and 3-HR FFG and their rate of increase over the analysis period. You can use basin trend graphs to assist in your analysis of the situation. Take note of areas that have significantly exceeded FFG (e.g., basins that have exceeded 3-HR FFG by over three inches and/or 300%). The FFMP products based on the 6-HR FFG will be available after 0600 UTC.
- Take note of any incoming storm reports, including those outside of your area of responsibility. Compare these reports with the rainfall totals and FFG in their respective areas. This can help provide an understanding of what might be happening in areas where you are lacking storm reports.
- Be cognizant of the downstream flow of runoff from the basins receiving the heavy precipitation. The combination of the antecedent precipitation and the rainfall totals already received to this point guarantees that the top layers of soil are completely saturated and rainfall is being converted directly into runoff.
- After 0600 UTC, you will receive some river gauge data from the USGS. Although the stage heights are unremarkable at this time, please note their rates of increase. Note that it takes time for rivers and creeks to respond to heavy rains based on flood-routing and time-of-travel.

We have provided two procedures to assist you during your analysis:

- ***KILN_Analysis***
- ***FFMP_ILN***

Both of these procedures are located in the ***Radar_FFMP*** procedure bundle. The ***KILN_Analysis*** procedure is a four-panel display containing 0.5° base reflectivity along with one-hour precipitation, storm-total precipitation, and an image combination of one-hour and three-hour FFG. The ***FFMP_ILN*** procedure is a pre-built display for FFMP with various maps overlaid onto FFMP (e.g., cities, CWA borders, etc.).

**** If you are having problems loading these procedure, refer to **KILN WSR-88D Radar Analysis** on Page C-7 and **ILN FFMP Analysis** on Page C-8 within Appendix C for the procedure details. ****

Performance Objective #5 -- Issuing Flash Flood Statements

Time Period -- 0610 UTC to 0630 UTC

Evaluation Criteria 5 - In the final part of the simulation, you will now issue *Flash Flood Statements* for the *Flash Flood Warnings* issued earlier in the simulation. Determine what region of your CWA is currently experiencing extreme flooding based on your FFMP analysis and the flooding reports you have received over the past hour and issue a "Flash Flood Emergency" for the appropriate area. Make sure that your follow-up statements clearly describe the magnitude of the threats for each warning polygon and use appropriate call-to-action statements. A copy of the template for a flash flood statement containing the "Flash Flood Emergency" wording is available on Page 3-20.

Try to compare the rainfall totals and flooding to previous events in order to evaluate the magnitude of the event. Due to a lack of river and stream gauges in the area, you do not have much to work with regarding the hydrologic response to the rainfall. However, an update on some of the river gauge data in the region was provided in the WESSL just after 0600 UTC. Also, here are a couple of significant events that have impacted the region near the Ohio River that are either within or near the ILN CWA:

- ***May 1-2, 2010*** -- Areas south of the Ohio River, notably Mason and Lewis Counties in Kentucky, received over five inches of rain. Numerous roads were closed due to flooding in both counties, and the Kinniconick Creek was flowing over its banks near Petersville. Outside of the ILN CWA, Tygarts Creek near Greenup, KY (RLX CWA) recorded a record crest of 24.40 ft. on May 3rd. The town of Olive Hill in Carter, Co. (RLX CWA) had five feet of water in the downtown area.
- ***May 18, 2001*** -- Counties along the Ohio River received five to eight inches of rainfall over a six day period (14-19 May 2001) with the majority of the rain falling on 18 May 2001. Some of the most notable flash flooding occurred in Scioto County, OH, where numerous roads were closed with a number of houses and a fire department evacuated.

Note that the simulation is ending at 0630 UTC. A post-brief presentation will open up during the final minute of the simulation. Make sure that you have all of your flash flood statements issued before the simulation concludes.

Flash Flood Statement Containing the "Flash Flood Emergency" Format from NWS Directive 10-922:

```
WGAAii cccc ddhhmm (BBB)
FFSxxx

FLASH FLOOD STATEMENT
NATIONAL WEATHER SERVICE <city, state>
hhmm am/pm time_zone day mon dd yyyy

stCNNN-NNN-NNN-ddhhmm-
/k.CON.cccc.FF.W.####.yymmddThhnnZB-yymmddThhnnZE
/0000.s.ic.000000T0000Z.000000T0000Z.000000T0000Z.OO/
<county #1>-<county #2>-<county #n>-
INCLUDING <THE CITIES OF> location...location
hhmm am/pm time_zone day mon dd yyyy

...THE FLASH FLOOD WARNING REMAINS IN EFFECT UNTIL <hhmm am/pm time_zone>
FOR <geographic area>...

...A FLASH FLOOD EMERGENCY FOR <geographic area>...

<current hydrometeorological situation and expected impacts>.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

<call-to-action statement> (optional)

&&

LAT...LON nnnn nnnn

$$

<Name/Initials/Forecaster ID> (optional)
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