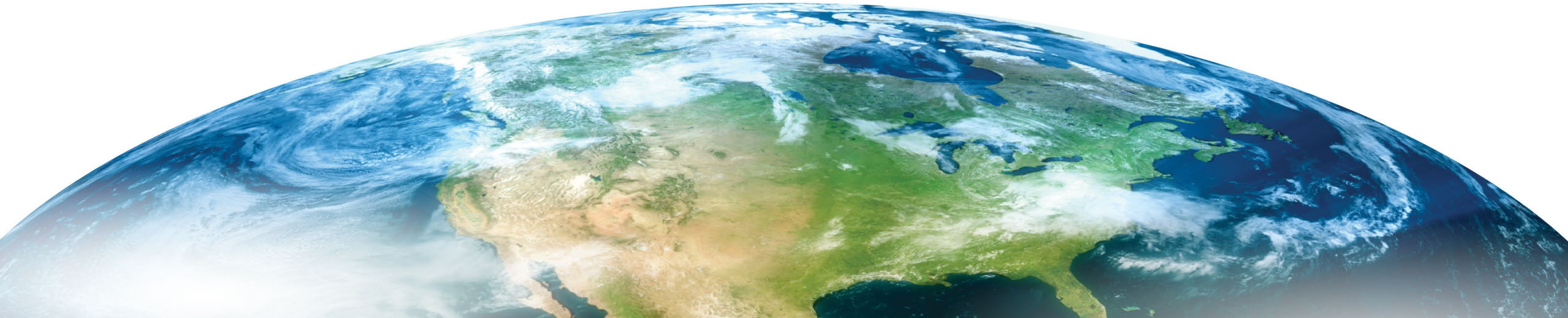
AWDE Precipitation on the Glass (PoG) Table Top Demonstration Summary

Date: November 2020



Outline

- Introduction and Background
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- Table Top Demonstration Approach
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- Summary of Participant Feedback
- Conclusions

Introduction and Background

Introduction

- The Standard Terminal Automation Replacement System (STARS) display is used by air traffic controllers across the United States as part of the FAA's modernization plan for the National Airspace System (NAS). STARS allows controllers to verify sequencing, spacing, and weather advisories.
- The Weather Forecast Improvement (WFI) program has funded Concept Requirements like work to determine a more suitable and usable precipitation radar product to implement into the STARS display.
- The Precipitation on the Glass project (ANG-C63) tasked the Aviation Weather Demonstration and Evaluation (AWDE) Services Program (ANG-C63) to conduct a low-fidelity assessment of proposed alternative products being considered to display precipitation on STARS.

Background

- The Precipitation on the Glass Shortfalls analysis determined false, missing, obsolete, or rapidly changing areas of weather, specifically precipitation, on an air traffic controllers' primary display may lead air traffic control to unnecessarily or inaccurately re-route traffic.
- The current precipitation on STARS from the Airport Surveillance Radars (ASRs) is often cluttered and does not present current precipitation accurately.
- An operationally suitable weather radar input with an acceptable update rate needs to be identified in order to close these shortfalls.
- AWDE Services conducted a low fidelity Table Top Demonstration consisting of virtual interviews with participants to provide an initial review of alternate precipitation products.

Objectives

Table Top Assessment Objectives

- Provide an initial demonstration and review of examples of single site, regional and national alternative precipitation products/sources.
- Explore alternative precipitation product/source coverage and update rate as compared to the baseline ASR product.

Participants

- AWDE coordinated with the Precipitation on the Glass Project Lead, National Air Traffic Controllers Association (NATCA) representatives and Air Traffic Services (AJT) to identify specific participants for the Table Top Demonstration.
- Participants of the virtual Table Top Assessment included:
  - 6 NATCA Representatives
  - 2 AJT Representatives

Table Top Demonstration Approach

Approach for the Virtual Table Top Demonstration

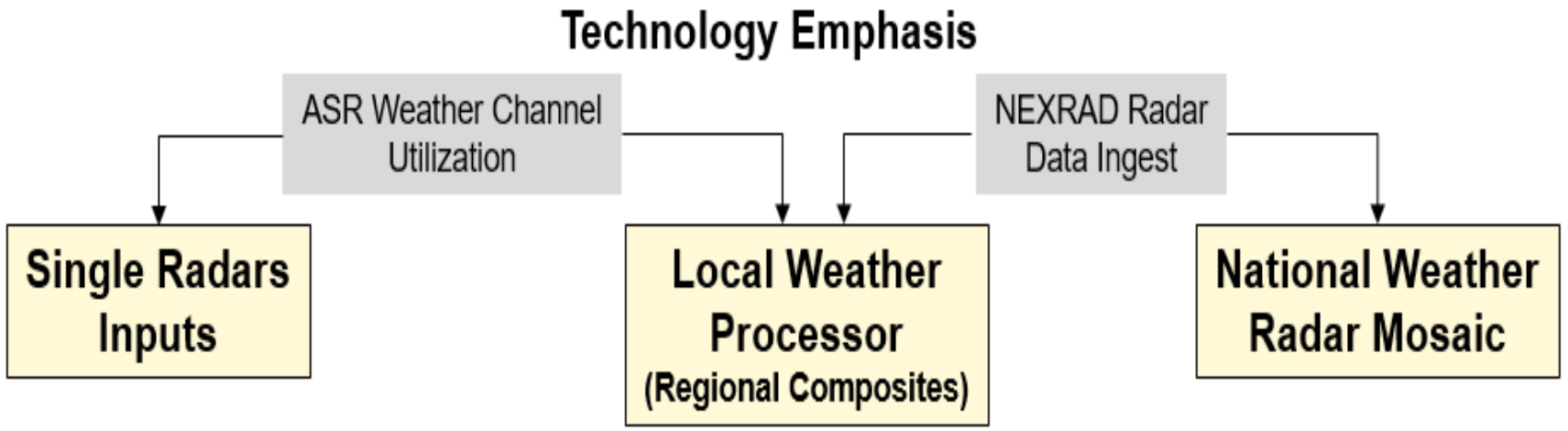
- The table top demonstration consisted of:
  - Overview of objectives
  - A brief description of each alternate precipitation product
  - Rules of engagement
  - 4 scenarios
- For 3 scenarios, participants were shown side-by-side videos of the baseline product (ASR-9/ASR-8) and an alternate product.
  - As participants viewed each scenario and compared the baseline to each alternate precipitation product, evaluators asked interview questions to gain feedback focused on the update rates and coverage.
  - Videos were replayed or stopped at the request of participants.
- For 1 anomalous propagation (AP) scenario, Greer, SC, only images were presented.
- After completing all scenarios, participants were asked to complete a questionnaire.

Data Collection Tools and Handouts

- The briefing, interview questions, and end of assessment questionnaire were sent to all participants prior to the assessment date of October 27th to ensure materials could be reviewed in advance if desired.
- Interview questions were asked while participants viewed each scenario. The questions are below:
  1. When compared to the current STARS precipitation product (ASR), does the alternate precipitation product:
     - Provide usable precipitation information?
     - Show less clutter or false precipitation returns?
     - Provide information to adequately detect building or decaying areas or changes in precipitation intensity (indicated when product updates)?
     - Provide increased resolution of precipitation areas?
     - Provide a comparable or better update rate?
     - Provide coverage for the terminal area as well as areas just outside the terminal airspace?
  2. Does the alternate precipitation product create new issues not found with the current STARS precipitation product (ASR)?
- During each scenario videos were stopped, rewound, fast forwarded, and replayed based on participant needs.

Precipitation Product Descriptions

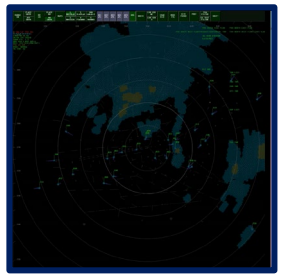
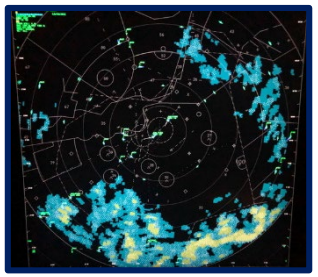
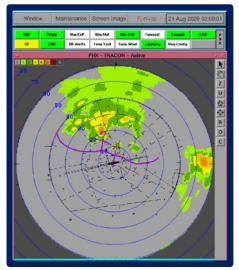
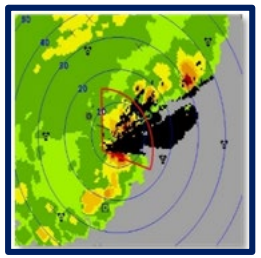
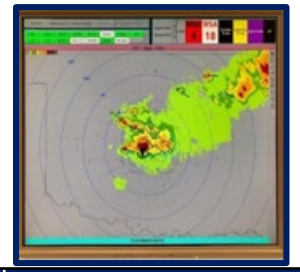
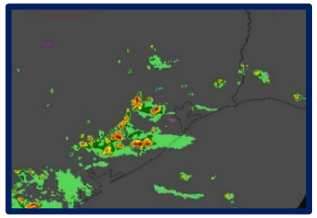
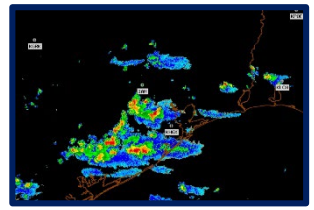
POG Range of Alternatives



- ASR-8
- ASR-9
- ASR-11

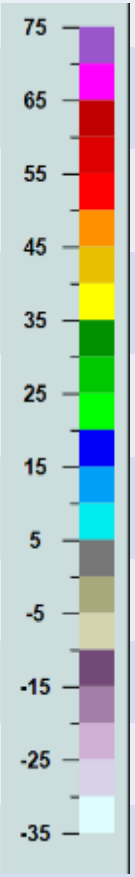
- ITWS AP Edit
- ASR TRACON Mosaic
- NEXRAD & TDWR Long Range Mosaic

- NWP
- MRMS

	ASR-9	ASR-8	ITWS TRACON	ITWS AP Edit	ITWS Long Range	NWP	MRMS
Update Rate	~30 sec	~30 sec	~30 sec	~30 sec	~150 sec	~25 sec	~2 min
Range Resolution	1 km	1 km	1 km	1 km	1 km	1 km x 1 km grid	1 km x 1 km grid
Radar	ASR-9	ASR-8	ASR-9, ASR-11	ASR-9, ASR-11, NEXRAD, TDWR	NEXRAD, TDWR	NEXRAD, TDWR, CANRAD	NEXRAD, TDWR, CANRAD
Source Coverage	Per-radar	Per-radar	TRACON	TRACON	Expanded TRACON	CONUS Plus	Expanded CONUS
Precipitation Data	Six levels of reflectivity (dBZ) intensity thresholds	Six levels of reflectivity (dBZ) intensity thresholds	Six levels of ASR reflectivity (dbZ), CompRef	Single radar with AP edits, CompRef	Six level dBZ product converted from VIL	VIL, CompRef, BaseRef, Echo Top	VIL, CompRef, BaseRef, Echo Top

ASR-9 ~ 28 sec			ASR-8 ~ 28 sec		ITWS TRACON ~ 30 sec Long Range ~ 2.5 min		NWP ~25 sec		MRMS ~2 min
Level	dBZ	Color	Level	dBZ	Level	dBZ	Level	dBZ	dBZ
1	<30	Solid blue	1	0-29	1	18-29	0	33-<18	75-64
2	30	Solid blue, light stipple	2	30-40	2	30-38	1	18-<30	65-54
3	41	Solid blue, densely stipple	3	41-45	3	39-44	2	30-<41	54-44
4	46	Solid mustard, no stipple	4	46-49	4	45-49	3	41-<46	45-34
5	50	Solid mustard, lightly stipple	5	50-56	5	50-57	4	46-<50	35-24
6	57	Solid mustard, densely stipple	6	57+	6	57+	5	50-<57	24-14
							6	>57	15-4
									5- (-14)
									(-15)-(-24)
									(-25)-(-34)
									-35



Summaries of Participant Feedback

Structured Interview Feedback

When compared to the current STARS precipitation product (ASR), does the alternate precipitation product:
Provide usable precipitation information?

Scenario	ASR-8	ITWS TRACON (ITWS AP Edit was used for Phoenix)	ITWS Long Range	NWP	MRMS
ASR CTD AP	The ASR-8 filtered out the AP very well.	N/A	N/A	Not all the AP is filtered out. Would prefer to assess at a closer range.	MRSM filtered out the AP very well.
Greer, SC AP	N/A	N/A	N/A	Provides usable information.	Provides usable information.
Houston, TX Airmass	N/A	Similar to STARS. STARS ASR might be showing weaker returns than the ITWS. ITWS showing stronger intensity returns in southwest than STARS ASR. Because it seems to be similar to STARS, yes, it is providing usable information.	The Long Range is picking up the east side cell well. The area on the southwest side picks up very well too. Picking up good precipitation. STARS ASR is not picking up the light as quick as Long Range.	Yes, presents better information	Yes, good intensities, maybe more usable information if accurate
Phoenix, AZ	N/A	Yes	Yes	Yes	More usable information and better intensities similar to NWP

When compared to the current STARS precipitation product (ASR), does the alternate precipitation product: *Show less clutter or false precipitation returns?*

Scenario	ASR-8	ITWS TRACON (ITWS AP Edit was used for Phoenix)	ITWS Long Range	NWP	MRMS
ASR CTD AP	Less clutter, seems to be removing all the AP.	N/A	N/A	Has some clutter and is not filtering out all the AP.	Less clutter, seems to be removing all the AP.
Greer, SC AP	N/A	N/A	N/A	N/A	N/A
Houston, TX Airmass	N/A	ITWS TRACON might be showing more precipitation than the other two. Seems to be an intensity difference between ITWS TRACON and STARS ASR. Difficult to answer this question without seeing a longer or higher resolution loop. Seems to not line-up with reflectivity intensities.	Difficult to answer due to the different ranges. May need a longer loop to assess.	*Has more lower level weather presented. Similar to MRMS but not as bad.	*Too hard to answer with the low intensity returns. Shows too much low level precipitation or the color scale is distorting.
Phoenix, AZ	N/A	Lines up very well with ASR.	Seems to show similar returns when compared to STARS ASR. The Long Range is picking up on some additional cells due to the limited ASR range.	*If level 1 precipitation can be removed, then the NWP product is well aligned with the ASR levels.	*Too much low level precipitation

*Technical Operations has a mandate to filter out all precipitation 18 dBz and lower (TIB, 6310.24 Section 10). STARS ASR is not displaying precipitation below 18 dBz, therefore, for the Table Top Demonstration, the STARS ASR did not show the lower level precipitation. This may have resulted in NWP and MRMS has appearing to show too much low level returns.

When compared to the current STARS precipitation product (ASR), does the alternate precipitation product:
Provide information to adequately detect building or decaying areas or changes in precipitation intensity (indicated when product updates)?

Scenario	ASR-8	ITWS TRACON (ITWS AP Edit was used for Phoenix)	ITWS Long Range	NWP	MRMS
ASR CTD AP	N/A	N/A	N/A	N/A	N/A
Greer, SC AP	N/A	N/A	N/A	N/A	N/A
Houston, TX Airmass	N/A	Seems to identify precipitation areas before STARS ASR. Not clear as to why ITWS TRACON and STARS ASR information is different since both are based on ASR data.	Difficult to see the areas that are building and decaying because some of the areas are smaller and further out in range.	Picked up on more intense storms faster.	Picked up more intense weather before the ASR did even though the update rate is slower.
Phoenix, AZ	N/A	Yes	Providing better airspace coverage and accuracy. Specifically over the NE and SE mountainous regions the Long Range is providing good precipitation intensity information. ASR data is very limited the further out from the site and the ASR is not picking up higher intensities.	Stronger returns shown sooner in NWP as compared to ASR	More intensity shown for storms even with the slower update rate, MRMS is picking up growth earlier.

When compared to the current STARS precipitation product (ASR), does the alternate precipitation product:
Provide increased resolution of precipitation areas?

Scenario	ASR-8	ITWS TRACON (ITWS AP Edit was used for Phoenix)	ITWS Long Range	NWP	MRMS
ASR CTD AP	N/A	N/A	N/A	N/A	N/A
Greer, SC AP	N/A	N/A	N/A	N/A	N/A
Houston, TX Airmass	N/A	TRACON has the same range as STARS, but seems to pick up on more intensities.	Long Range has increased resolution and showing stronger intensities.	Yes, alternatives in general seem to be identifying stronger areas sooner	Yes, differentiates between higher returns and picks up the growth for those higher returns sooner.
Phoenix, AZ	N/A	Aligning with the STARS ASR	Long Range has increased resolution and showing stronger intensities.	Increased resolution for NWP. Seems like better data.	Yes, increased resolution

When compared to the current STARS precipitation product (ASR), does the alternate precipitation product:

Provide a comparable or better update rate?

Scenario	ASR-8	ITWS TRACON (ITWS AP Edit was used for Phoenix)	ITWS Long Range	NWP	MRMS
ASR CTD AP	Comparable	N/A	N/A	N/A	N/A
Greer, SC AP	N/A	N/A	N/A	N/A	N/A
Houston, TX Airmass	N/A	Comparable, the two have the same update rate, STARS ASR and ITWS TRACON seem to be aligned.	There may not be an issue with the slower update rate because the Long Range is picking up on more intensities quicker and at longer ranges. In order to assess the slower update rate, the capability needs to be assessed with a fast moving storm and traffic to determine if the slower update rate is adequate.	Comparable.	Slower update rate but if it provides better weather, it may be usable. Further investigation with faster moving weather and traffic would need to be completed.
Phoenix, AZ	N/A	Comparable, the two have the same update rate, STARS ASR and IITWS TRACON seem to be aligned.	There may not be an issue with the slower update rate because the Long Range is picking up on more intensities quicker and at longer ranges. In order to assess the slower update rate, the capability needs to be assessed with a fast moving storm and traffic to determine if the slower update rate is adequate.	Comparable	Slower. Would need to see comparison of this update rate with traffic for faster moving weather.

When compared to the current STARS precipitation product (ASR), does the alternate precipitation product:
Provide coverage for the terminal area as well as areas just outside the terminal airspace?

Scenario	ASR-8	ITWS TRACON (ITWS AP Edit was used for Phoenix)	ITWS Long Range	NWP	MRMS
ASR CTD AP	N/A	N/A	N/A	Seems to provide greater coverage than the ASR.	Seems to provide greater coverage, but there is no precipitation to compare too.
Greer, SC AP	N/A	N/A	N/A	N/A	N/A
Houston, TX Airmass	N/A	The coverage is the same between the STARS ASR and ITWS TRACON.	The Long Range provides an extended range, more coverage, and more detail than STARS.	Better coverage particularly in the SW corner.	Better coverage particularly in the SW
Phoenix, AZ	N/A	The coverage is the same between the STARS ASR and ITWS TRACON.	The Long Range provides an extended range, more coverage, and more detail than STARS.	Improved coverage for Northern AZ airspace. Lack of coverage in this area is a significant issue.	Better coverage beyond the terminal area particularly for Northern AZ.

Does the alternate precipitation product create new issues not found with the current STARS precipitation product (ASR)?

Scenario	ASR-8	ITWS TRACON (ITWS AP Edit was used for Phoenix)	ITWS Long Range	NWP	MRMS
ASR CTD AP	None	N/A	N/A	NWP left some clutter. ASR AP mitigation was better than NWP as the remaining clutter on NWP could cause confusion with controllers as to whether or not it is real weather.	None If it is confirmed that there was no precipitation in this scenario and everything showing up was just AP, then there are no issues.
Greer, SC AP	N/A	N/A	N/A	None	None
Houston, TX Airmass	N/A	There is a difference in intensities between STARS ASR and ITWS TRACON. Participants did not understand why or what is causing the difference.	Based on the scenarios, it is not clear if the slower update rate is an issue or not. Would need to assess the update rate using a fast moving storm with traffic. The Long Range might be holding on to cells longer which may have dissipated or are growing, but due to the slow update rate users may not be aware.	*Depends on filtering but NWP seems to have more low level weather than ASR. Less than MRMS but more than ASR.	*MRMS has increased amounts of lower level weather. Need to figure out why. Right now it presents too much information.
Phoenix, AZ	N/A	There is a difference in intensities between STARS ASR and ITWS TRACON. Participants did not understand why or what is causing the difference.	Based on the scenarios, it is not clear if the slower update rate is an issue or not. Would need to assess the update rate using a fast moving storm with traffic. Because the Long Range is a NEXRAD product the Long Range may hold on to weather longer.	*Too much light precipitation shown	*Too much light precipitation shown

*Technical Operations has a mandate to filter out all precipitation 18 dBz and lower (TIB, 6310.24 Section 10). STARS ASR is not displaying precipitation below 18 dBz, therefore, for the Table Top Demonstration, the STARS ASR did not show the lower level precipitation. This may have resulted in NWP and MRMS has appearing to show too much low level returns.

Scenario	Additional Comments
ASR CTD AP	As a controller, when working traffic, AP is easily identified with ASR-8. With the NWP image it is difficult to distinguish between AP and precipitation. Seems to be easier to distinguish AP using ASR rather than NWP.
Greer, SC AP	Having a mix of AP and real weather for a case would be good for another assessment. Participants were concerned with knowing how to determine or know if the AP mitigation is correct. Participants stated the need to see satellite imagery to verify.
Houston, TX Airmass	During this scenario, participants noted the 3 panel display made it difficult to assess the weather on ITWS. New videos were generated and sent for participant review. Participants also asked how to determine the truth between the ASR and ITWS. Both are operational observing radars. Truth data was not available for this demonstration. Participants also noted that having longer scenarios would be helpful. Each scenario contained 30 minutes of data.
Phoenix, AZ	NWP and MRMS seem well aligned. Expanded coverage would solve a long-standing issue with lack of coverage in Northern AZ. Seems like there are intensity issues at furthest range of the ASR as compared to MRMS and NWP.

Questionnaire Data

Median Ratings (N=5)

5=Strongly Agree, 4=Agree, 3=Neutral, 2= Disagree, 1-Strongly Disagree	ASR-8	ITWS TRACON	ITWS Long Range	NWP	MRMS
1. When compared to current STARS precipitation, the product provided better coverage.	3	3	5	5	5
2. When compared to current STARS precipitation, the product provided data that adequately represented the actual precipitation intensity.	3	4	4	5	4
3. When compared to current STARS precipitation, the product update rate was acceptable.	3	4	3	5	3
4. The product is an improvement over the current STARS precipitation product.	3	2	5	5	4
5. When compared to the current STARS precipitation, the precipitation product provides the capability to easily see the growth and decay or changes in precipitation intensity (as indicated when product updates).	3	4	4	4	4
6. When compared to current STARS precipitation, the product provided an increased resolution for the display of the precipitation area.	3	3	4	4	4
7. When compared to current STARS precipitation, the product sufficiently removed false echoes or clutter.	3	3	3	2	5
8. The product provides sufficient precipitation information.	3	2	4	4	5

Medians in red indicate ratings disagreeing with the statement.
5=Strongly Agree, 4=Agree, 3=Neutral, 2= Disagree, 1-Strongly Disagree

Additional Comments

ASR-8	ASR coverage is same as legacy ASR.	CTD removal of AP provided better data.	AP reduction meets only one of the shortfalls	
ITWS TRACON	TRACON view is using ASR data and seemed to provide similar coverage.	ITWS seemed to show a similar picture.	The TRACON view didn't appear to add a lot of value and seemed to paint a similar picture to STARS ASR.	
ITWS Long Range	The coverage was much better for long range.	It's a long range radar, obviously it provides better coverage.	ITWS Long Range radar appeared to correlate closer to all other sources	Given we don't have a "truth" to compare it to, it seemed to accurately depict the weather.
	How can this be confidently determined when we do not know what the "actual precipitation intensity" is? When comparing with other WX sources, it did appear to be more accurate	It appears adequate but need to assess with a fast moving system.	It appeared adequate; however, we would like to see a scenario with a faster moving front.	Given that none of the scenarios had fast moving storms it is hard to judge the update rate.
	Based on what was presented, I'm neutral. In order to confidently answer this question, I would prefer to see a fast moving front so a comparison can be made	ITWS Long Range appeared to pick up heavier intensities.	We only viewed limited scenarios with limited time for each scenario. Would like to see additional scenarios	

Additional Comments

NWP	NWP seemed to do a much better job at picking up storm intensities.	Appears there could be attenuation issues with STARS when comparing to NWP.	Seems to do a much better job at picking up on the precipitation.	Example for LCH still appeared to show some clutter.
	The Lake Charles example still showed some clutter around the radar. It did however filter out the really bad AP. On the GSP example it did do a good job.			
MRMS	MRMS also picks up lesser intensities that STARS filters out.	Looking at the number of colors and DBZ levels made it hard to compare as we later learned that STARS filtered out any return below 18.	Need to see a fast moving system to assess update rate.	Need to see additional scenarios to make proper assessments.
	Given that none of the scenarios had fast moving storms it is hard to judge the update rate.	Would like to see this in real time instead of the faster video loop we observed.	Hard to tell fully with the fast rate of speed that we watched the video at.	

Conclusions

Conclusions

Provide an initial demonstration and review of examples of single site, regional, and national alternative precipitation products/sources.

- Participants were provided the capability to view alternative precipitation sources from single radar inputs, local weather processors, and national weather radar mosaics.
- Each precipitation product was displayed side-by-side with the baseline STARS ASR-9 product.

Conclusions

Explore alternative precipitation product/source coverage and update rate as compared to the baseline ASR-9 product.

- ASR-8 AP Mitigation Algorithm:
  - The ASR-8 AP Mitigation algorithm was provided as an example of single site post-processing.
  - The ASR-8 AP Mitigation did remove AP and had less clutter.
  - When compared to ASR-8 with no AP Mitigation, the coverage and update rate were similar.
  - Given the reduction in AP, the ASR-8 AP Mitigation algorithm provided improvement but only for the AP reduction shortfall.
- ITWS TRACON:
  - As compared to the ASR-9, the ITWS TRACON product provided similar precipitation information, update rate and coverage, but provided better resolution of precipitation areas and adequately detected building and decaying of precipitation.
  - ITWS TRACON showed more precipitation, however, there may be an intensity difference between the ITWS TRACON and ASR-9 as the reflectivity intensities did not line up well.
  - ITWS TRACON identified precipitation before ASR-9 but it was not clear why since both products are based on ASR data.
  - Overall, the ITWS TRACON product provided similar precipitation information as the baseline ASR-9 with improved resolution of the precipitation areas, due to the increase in resolution, the ITWS TRACON is a slight improvement over ASR-9 but should be further assessed due to the identified intensity differences.

Conclusions

Explore alternative precipitation product/source coverage and update rate as compared to the baseline ASR-9 product.

- ITWS AP Edit:
  - As compared to the ASR-9, the ITWS AP product provided usable precipitation information, adequately detected building and decaying of precipitation, had an increase in resolution, and had a similar update rate and coverage.
  - ITWS AP Edit product seemed to align well with the ITWS Long Range product and had better resolution than ASR-9.
  - Overall, the ITWS AP Edit product provided similar precipitation information as the ASR-9 with improved resolution, therefore, due to the increase in resolution the ITWS AP Edit product is a slight improvement over ASR-9. However the ITWS AP Edit product should be further assessed to determine if the increase in resolution is consistent and adequate.
- The ITWS Long Range Product (200 NM):
  - ITWS Long Range identified precipitation areas before ASR-9 and had an increase in coverage and resolution.
  - As compared to the ASR-9, ITWS Long Range provided better coverage, accuracy, resolution, and showed stronger intensities.
  - The update rate was difficult to assess due to the limited data and duration of videos.
  - The ITWS Long Range is an Improvement over ASR-9, however, the update rate requires further assessment using longer scenarios with faster moving weather and traffic overlays.

Conclusions

Explore alternative precipitation product/source coverage and update rate as compared to the baseline ASR-9 product.

- NWP:
  - NWP did not filter out AP as well and displayed more clutter when compared to ASR-9.
  - As compared to ASR-9, NWP provided more usable precipitation information, displayed stronger returns faster, provided better coverage, and had a similar update rate.
  - *As compared to ASR-9, NWP displayed too much light precipitation.
  - Overall, NWP is an improvement over ASR-9, however, NWP displayed too much light precipitation displayed and AP mitigation needs to be addressed further. If NWP precipitation was filtered to only show 18 dBZ or higher, the low level precipitation issue may be resolved.
- MRMS:
  - As compared to ASR-9, MRMS provided more usable precipitation information, better intensities, identified precipitation growth faster, provided better coverage and filtered out AP very well.
  - *As compared to ASR-9, MRMS displayed too much lower level precipitation.
  - The MRMS update rate was difficult to assess due to the limited data and duration of videos.
  - Overall, MRMS is an improvement over ASR-9, however, the update rate needs to be assessed using faster moving precipitation and traffic overlays and the product shows too much low level precipitation. If MRMS precipitation was filtered to show only 18 dBZ or higher, the low level precipitation issue may be resolved.

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Additional Note

Technical Operations has a mandate to filter out all precipitation 18 dBz and lower (TIB, 6310.24 Section 10). STARS ASR is not displaying precipitation below 18 dBz, therefore, for the Table Top Demonstration, the STARS ASR did not show the lower level precipitation. This may have resulted in NWP and MRMS has appearing to show too much low level returns.