WFO Tucson Forecast Operations
Using Dual-Pol to Enhance Forecaster Decision Making

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Technical Advisory Council Meeting
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Tuscon Downpour Sept. 15\textsuperscript{th}, 2011

Overview

- **Phoenix (KIWA) dual-pol**
  - \(~80\) Miles from Tucson Airport
  - \(~1,380\) feet elevation

- **Tuscon (KEMX) single-pol**
  - \(~24\) Miles from Tucson Airport
  - \(~2,600\) feet elevation
Heavy Rain Application

- September 15th, 2012
- Forecasters identified a heavy rain threat based on the atmospheric conditions
  - Moist unstable air
  - Approaching short wave low pressure system
  - Weakly sheared environment
PWAT = 1.1”
Brief Atmospheric Review for Sept. 15th

12Z Sounding
PWAT ~ 1.2”

18Z Sounding
PWAT ~ 1.1”

PWAT Climatology ~ 80th Percentile
Radar Data from September 15th

Approx. 1.5 hours of data from the KEMX (Tucson) Radar

Black Star Represents the Tucson Airport
Dual-Pol Data from KIWA (Phoenix Radar)
Radar Products from Sept. 15th
Images are near the 20:38 Z time frame

Top Left = KIWA 0.5 Reflectivity
Top Right = KIWA 0.5 ZDR
Bottom Left = KIWA HHC with ML
Bottom Right = KIWA CC
Comparing HCA and KDP

HCA from 20:38 Z  
KDP from 20:38 Z
Storms trained over same area for +1 Hour. The Hybrid Hydrometeor Classification algorithm (HHC) exhibited a similar look and feel as the images below during that 1 hour period.

KIWA HHC at 20:38 Z  
KIWA HHC at 21:04 Z
KIWA Instant Precip at 20:38 Z
Highlighting the Purple areas ~ 4 inches per hour

KIWA Instant Precip at 20:38 Z
Highlighting the Orange areas ~ 7 inches per hour
Top Left = KEMX Storm Total Precip at 21:36 UTC
Top Right = KIWA Storm Total Precip at 21:37 UTC

Bottom Left = KEMX Composite Z at 21:36 UTC
Bottom Right = KIWA Composite Z at 21:37 UTC
Tuscon Downpour & QPE Performance

KEMX Radar Estimated ~ 5 - 6”

KIWA Radar Estimated ~ 3 - 4”

KEMX Legacy Rainfall Estimates
2+ inches too high

1.5” Hail Report near Airport

KIWA Dual-Pol Rainfall Estimates

Tucson Airport Measured 2.84” rain
Dual-Pol Radar

- Better precipitation amount detection
  - Improved flash flood guidance
- Better resolution
  - Improved detection of the coverage area of heavy rain
- Better hail detection
  - Improved severe thunderstorm warnings???
Monsoon 2012

- Historic wildfires burned across southern Arizona in 2011
- The burn scares pose a difficult challenge to forecasters
- Improved Dual-Pol precipitation estimates will be a much welcomed tool for flash flood detection
The Fires

Wallow

- Wallow Fire
- Largest Wildfire in Arizona State History
- Smoke Plume extended into Canada
- 32 Homes Destroyed, 5 Damaged
- 62 Total structures lost
- Burned from May 29th through July 8th
Horseshoe 2

- Horseshoe 2 Fire
- Destroyed 9 Homes
- Burned from May 8th through June 25th

<table>
<thead>
<tr>
<th>Soil Burn Severity</th>
<th>Acres</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>27,730</td>
<td>12%</td>
</tr>
<tr>
<td>Moderate</td>
<td>66,226</td>
<td>30%</td>
</tr>
<tr>
<td>Low</td>
<td>84,852</td>
<td>38%</td>
</tr>
<tr>
<td>Unburned</td>
<td>44,093</td>
<td>20%</td>
</tr>
</tbody>
</table>

Total Acres = 222,954
• Monument Fire
• Threatened a major population center – Sierra Vista
• Burned from June 12th through July 6th
• Damaged or destroyed 57 homes
• Over 100 structures impacted

Images Courtesy of US Forest Service
Severe Burn Areas

Hydrophobic Soil Conditions

Increased Flash Flood/Debris Flow Threat

Soil Modification

- Dramatically altered soil conditions and intense rainfall rates greatly increased flash flood threat. Post-burn 5-year peak flows were estimated to be 3 to 45 times greater than pre-burn peak flows.
- (Based on July 15, 2011 NOAA/NWS report by Reed, Schaffner and Kahler).
NWS Tucson staff participated in numerous community meetings in communities near the burn areas.
Fliers

- Two types of fliers were developed to highlight the flash flooding risk and suggested actions.
- The fliers were a huge success and appeared on various government agency web pages in digital form.
Two weather stations were installed in the Horseshoe 2 fire burn area on the Chiricahua Mountains. Service Hydrologist, Erin Boyle, produced burn area background maps and amended the Flash Flood Guidance to increase situational awareness within WFO Tucson.

Observing stations will help verify rain amounts from the Dual-Pol data.
Snow Level Application

- Dual-Pol improves winter weather forecasting and analysis
Snow Level Drop with Approaching Cold Front

- **November 5th**
- **Cold frontal passage across Arizona**
  - WFO Tucson/Phoenix
- **CC shows snow level drop**
  - Using KIWA (WFO Phoenix Radar)
- **Tucson forecasters amended package based on Dual-Pol Data**
• 7:34z – Front just east of Radar
• Melting level drops behind front by 2 to 3 kft
• 7:48z - Inner edge of melting layer is oblong shaped

• Front continues pushing east
• 8:00z – Entire melting layer becomes visible
• 8:18z – Melting layer shape “tightens up”
• 8:38z – Melting layer become a fairly well defined circle
• Melting level now sitting at about 5,500 to 6,000 feet
• Forecasters amend AFD and grids
AFD and Forecast Package
Amended

“SNOW LEVELS HAVE DROPPED DRAMATICALLY BEHIND THE FRONT...DOWN TO AROUND 5000 FEET PER PHOENIX DUAL POL RADAR. SNOW AMOUNTS ABOVE 6000 FEET WILL BE IN THE 2 TO 6 INCH RANGE...WITH HIGHEST AMOUNTS UP IN THE WHITES.”
July 5th, 2011 Dust Storm

http://www.youtube.com/watch?v=om-ib1XlfIg&feature=player_embedded

(Or go to YouTube and Search for “Driving into dust storm Haboob Phoenix, AZ – July 5, 2011”)
Pictures Taken from Motorist Driving from Phoenix to Tucson on July 5th, 2011
Within the “non-precip” area, highly variable CCs

Phoenix Dust Storm & Dual-Pol

- CC is your precip vs. non-precip discriminator
- Non-precip CC noisy & varies: usually < ~.80-.85
  - Look at CC in context!
Reflectivity – July 5, 2011
ZDR – July 5, 2011
Intrigues of the July 5 Storm

- Negative ZDR ("black hole")
- Occurred adjacent to & away from areas of precip
Intrigues of the July 5 Storm

Northern Boundary
- CC .73 - .99
- Vel ~20 kts
- Garden variety boundary stuff lofted

Southern Boundary
- CC .40 - .70!
- Vel 40-50 kts
- Variety of particles lofted
Thank You

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