# Minor Winter Flooding Event in northwestern Pennsylvania 12-13 January 2017

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## 1. Overview

A combination of snow melt, frozen ground, and areas of 1 to 2 inches of rainfall (Fig.1) produced a minor flooding event in northwestern Pennsylvania and southwestern New York on 12-13 January 2017. The higher rainfall amounts fell along and on the warm side of quasi-stationary frontal boundary. There was some deeper convection in the warm air which led to thunderstorms. These thunderstorms produced locally higher rainfall amounts and at least 17 known reports of severe weather (Fig. 2).

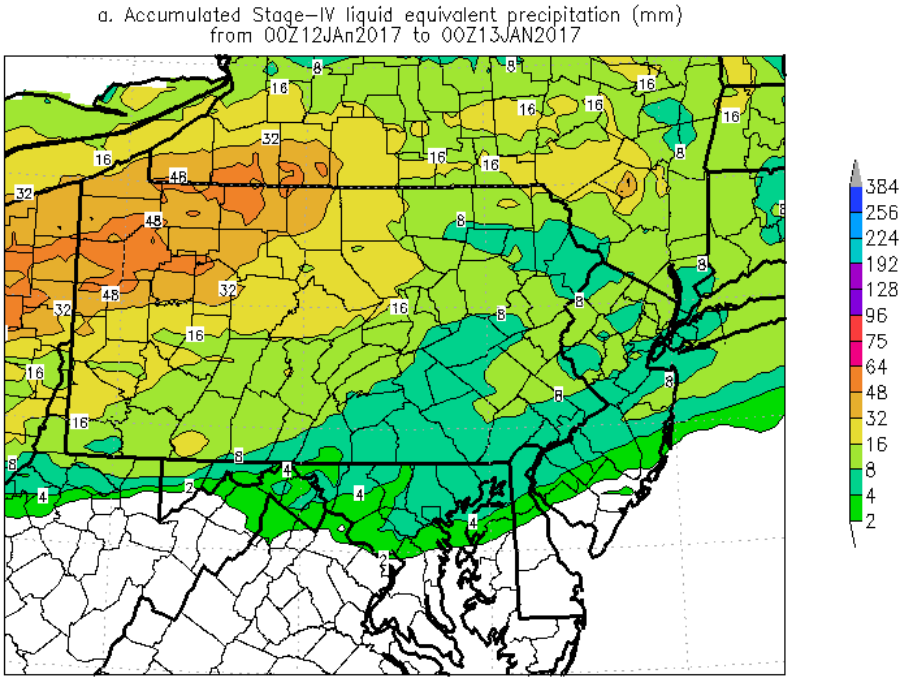


Figure 1. Stage-IV total observed precipitation (mm) from 0000 UTC 12 to 0000 UTC 13 January 2017. Contours and shading as in the color bar to the right of the image.

Nearly all the rainfall was observed between 0000 UTC 12 and 0000 UTC 13 January 2016 (Fig. 3). The heaviest rainfall in northwestern Pennsylvania and southwestern New York was observed between 0600 and 1800 UTC on 12 January 2017 (Figs. 3b-c). Around 1800 UTC the frontal boundary pushed eastward as a cold front and the higher rainfall rates and 6-hour totals shifted to the east (Fig. 3d).

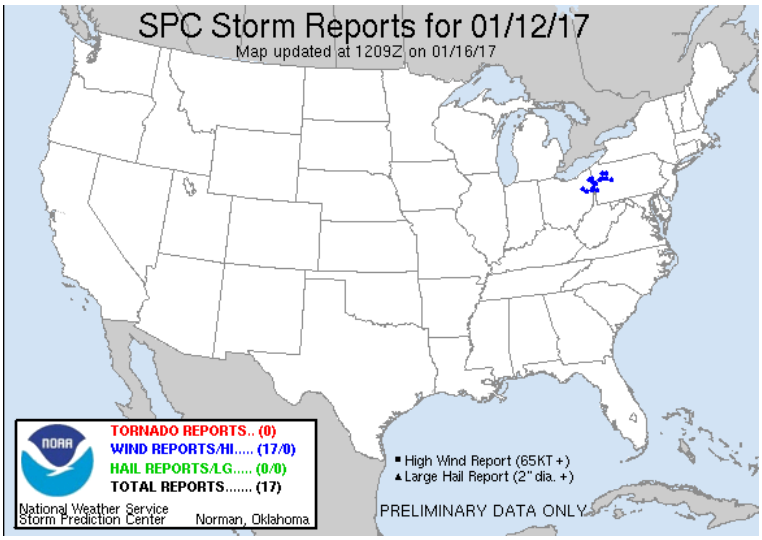


Figure 2. Storm reports for 12 January by type from the Storm Prediction Center website.

The combination of warm

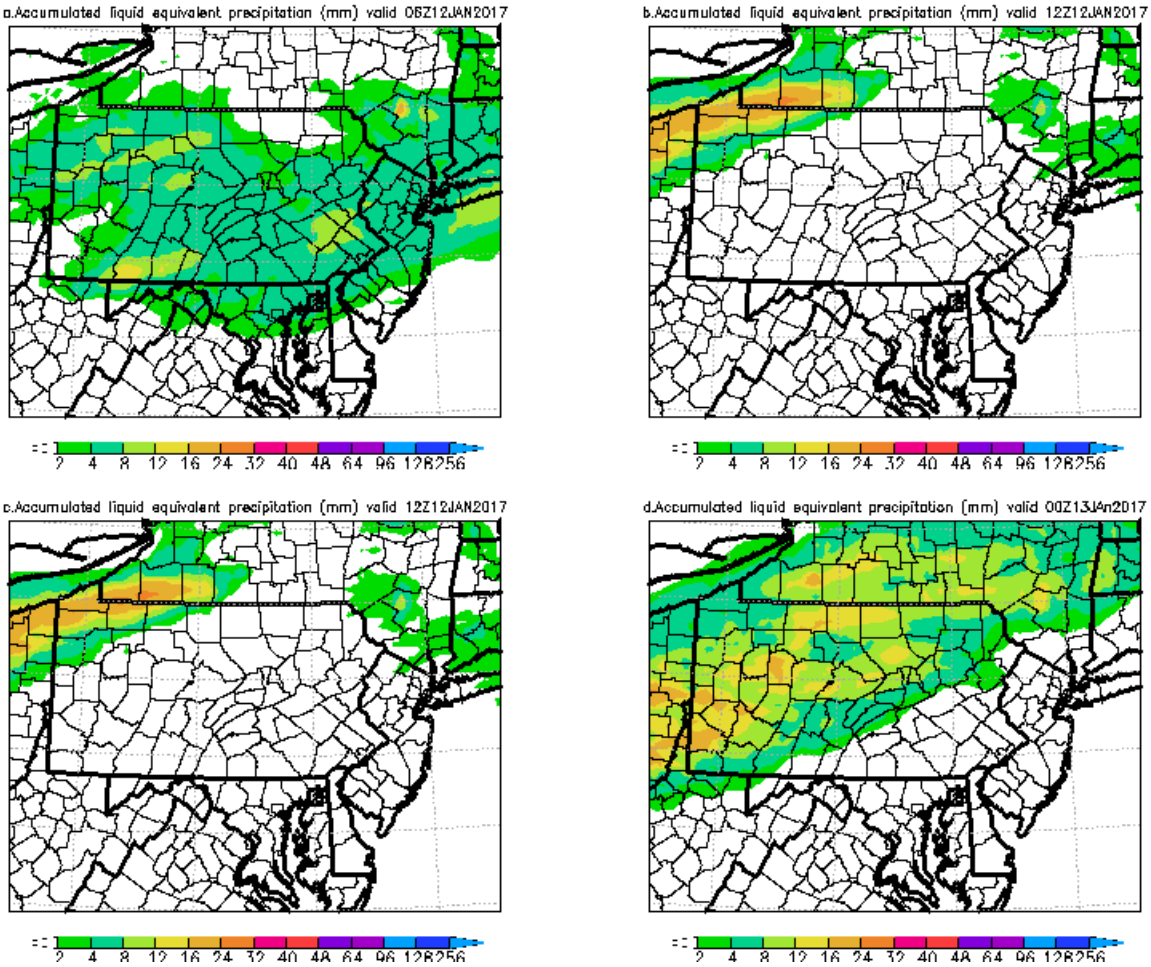


**Figure 3. As in Figure 1 except for the 6-hour total QPE for the 6 hour periods ending at a) 0600, b) 1200, and c) 1800 UTC 12 January and d) 0000 UTC 13 January 2017.**

temperatures, melting snow, and the rain produced minor flooding issues across the region. Road closures and minor issues with water impacting private homes were observed northwestern Pennsylvania and southwestern New York (WIVB). In the southwestern New York portions of routes 60 and 62 were closed due to flooding and many small creeks in the region reached flood stage (WIVB).

The frontal boundary and the high precipitable water (PW: Fig 4) shows the surge of high PW into western Pennsylvania around 0000 UTC 12 January 2017. PW values of 30 mm which are about 3 to 4s above normal for this time in January moved into the region. After 1800 UTC 12 January a cold front with drier moved into western Pennsylvania and New York. The 850 hPa temperatures were above normal at this time (not shown) and during the period of peak rainfall a strong low-level 850 hPa southerly jet moved across the region (Fig. 5). The v-wind anomalies peaked at +3s above normal between 0000 and 0600 UTC 12 January 2017 (Fig. 5b-c).

The HRRR 00-hour forecast never indicated significant CAPE in Ohio or Pennsylvania (not shown). However the HRRR PW fields showed the surge of high PW air into Pennsylvania and

the entry of the drier air behind the cold front. The warm air ahead of this front produced an extremely warm day over the Mid-Atlantic region with many locations recording high temperatures 20 to 30C above normal.

The NCEP GEFS showed a relatively low probability of over 25 mm of QPF in the 24 hour window of this event (Fig. 7). The probability rose significantly with the shorter-range forecasts (Fig. 7f). The mean QPF and each member's 37.5 mm contour showed (Fig. 8) that the GEFS had the region of heavy rainfall quite well but underestimated the higher end amounts near and over 50 mm (2 inches). The 37.5 mm contour was shown in Figure 8 due to the lack of a 50 mm contour in any GEFS members.

Figure 9 shows 6 shorter term HRRR forecasts of the QPF during the key period of 0600 to 1800 UTC. This does not encompass the entire 24 hours of QPE but straddles the period of heavier rainfall. These data show that the short-range HRRR forecast the area of 25 mm or more QPF quite well. These 12 hour window accumulations also showed streaks of 37.5 mm (1.5 inches) of QPF and the 0500 UTC HRRR had a small close 50

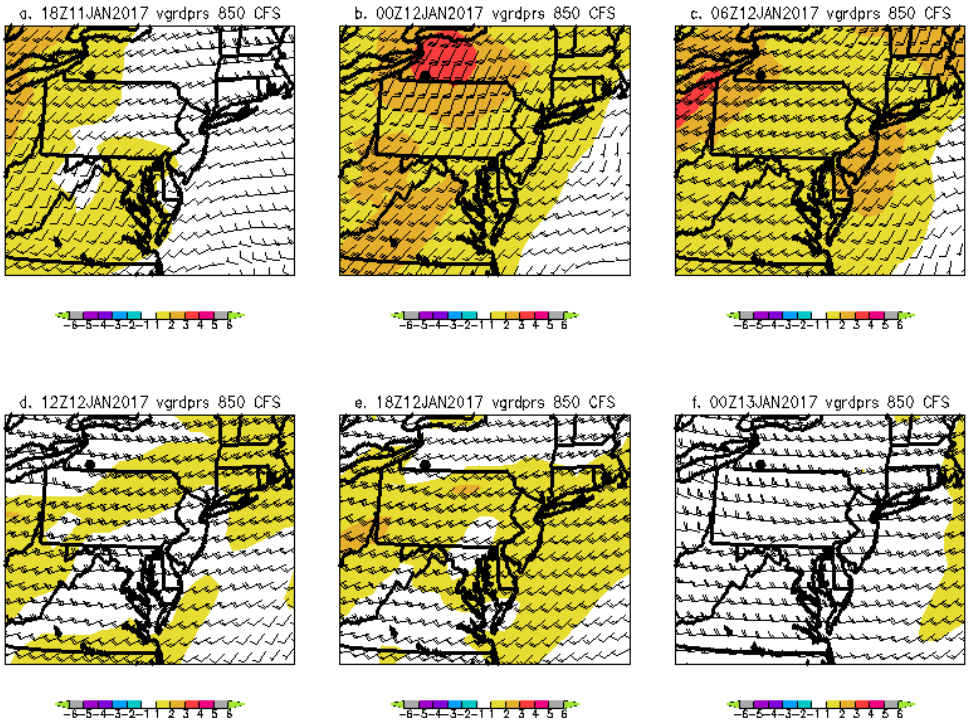


Figure 4. As in Figure 4 except for 850 hPa winds and v-wind anomalies.

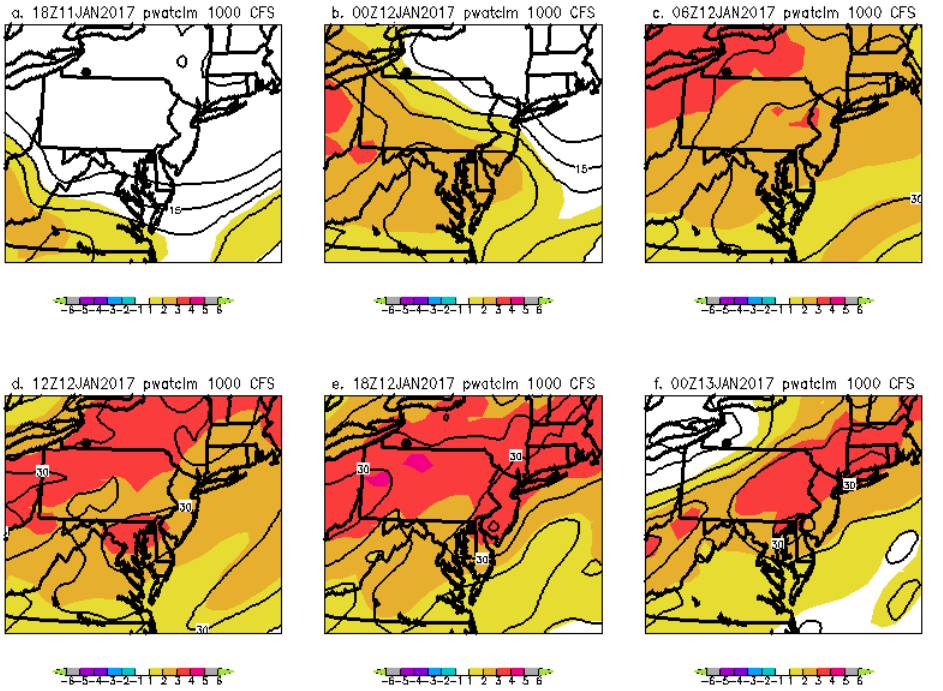


Figure 5. CFSRV2 precipitable water (mm) and anomalies in 6 hour increments from a) 1800 UTC 11 through f) 0000 UTC 13 January 2017. Contours every 5 mm. Black dot is Salamanca, NY.

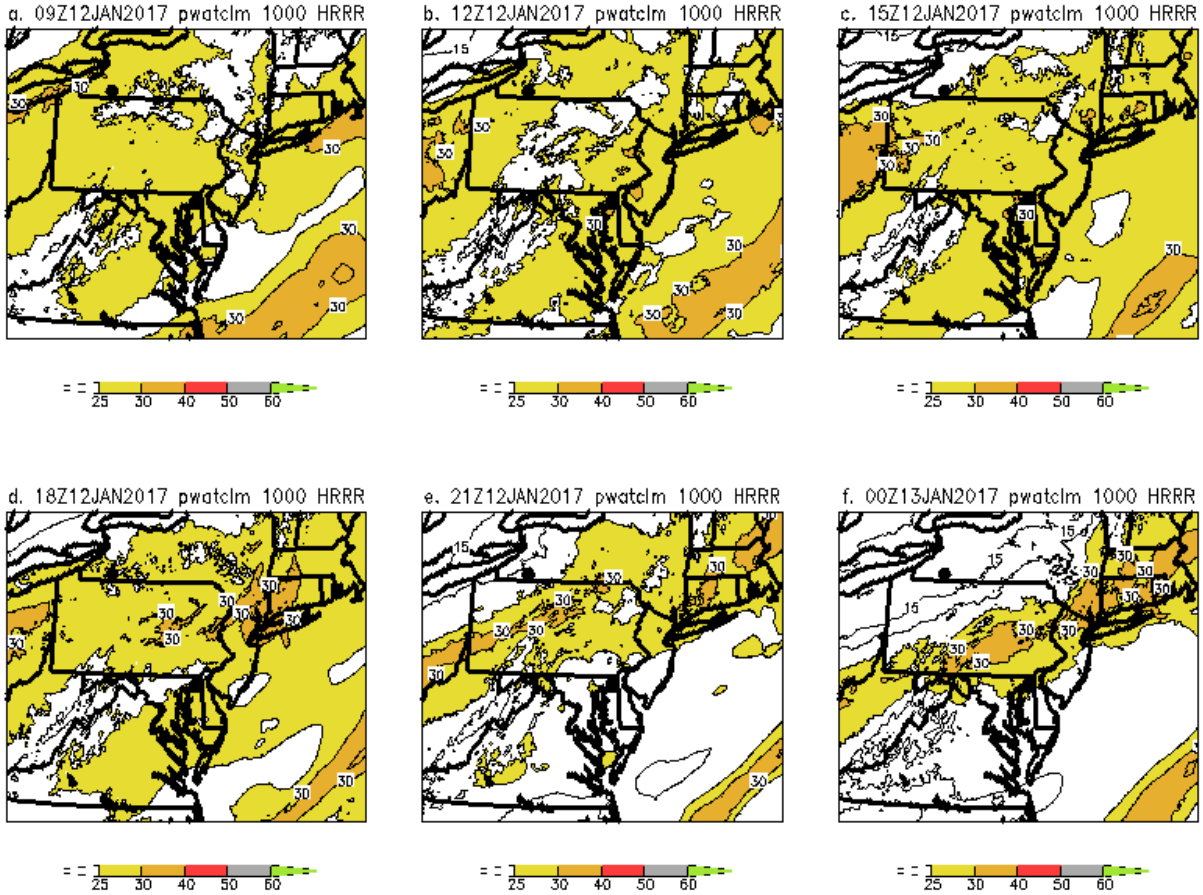


**Figure 6. As in Figure 4 except for HRRR 00-hour forecasts of PW. Shading here shows PW values of 25mm or greater as indicated by the color bars.**

mm contour in western Pennsylvania (Fig. 9e).

The combination of unseasonably warm air and an intrusion of humid air likely helped produce snow melt in northwestern Pennsylvania and southwestern New York. This likely reduced significant water from the snow pack. This combined with a widespread rainfall event of 1-2 inches (Fig 1) led to localized flooding over the region. Additionally, much of the region affected by the higher rainfall amounts received most of the rainfall in a 6-hour window. Many locations received 1 to 1.5 inches of QPE in a relatively short 6-hour window.

The pattern in which the rainfall developed was relatively well forecast (not shown). The NCEP GEFS was able to predict the potential for 1 inch or more QPF but was limited in its ability to produce much more than 1.5 inches of QPF. Due to the frozen ground, snowmelt, and the 2 inches of rainfall, this relatively low end QPF/QPE event did produce minor flooding. The threshold for flooding is typically a bit higher, in the 3 inches and greater range in the warm season. However, in this case the antecedent and current conditions favored a better hydrologic response with relatively low rainfall amounts.

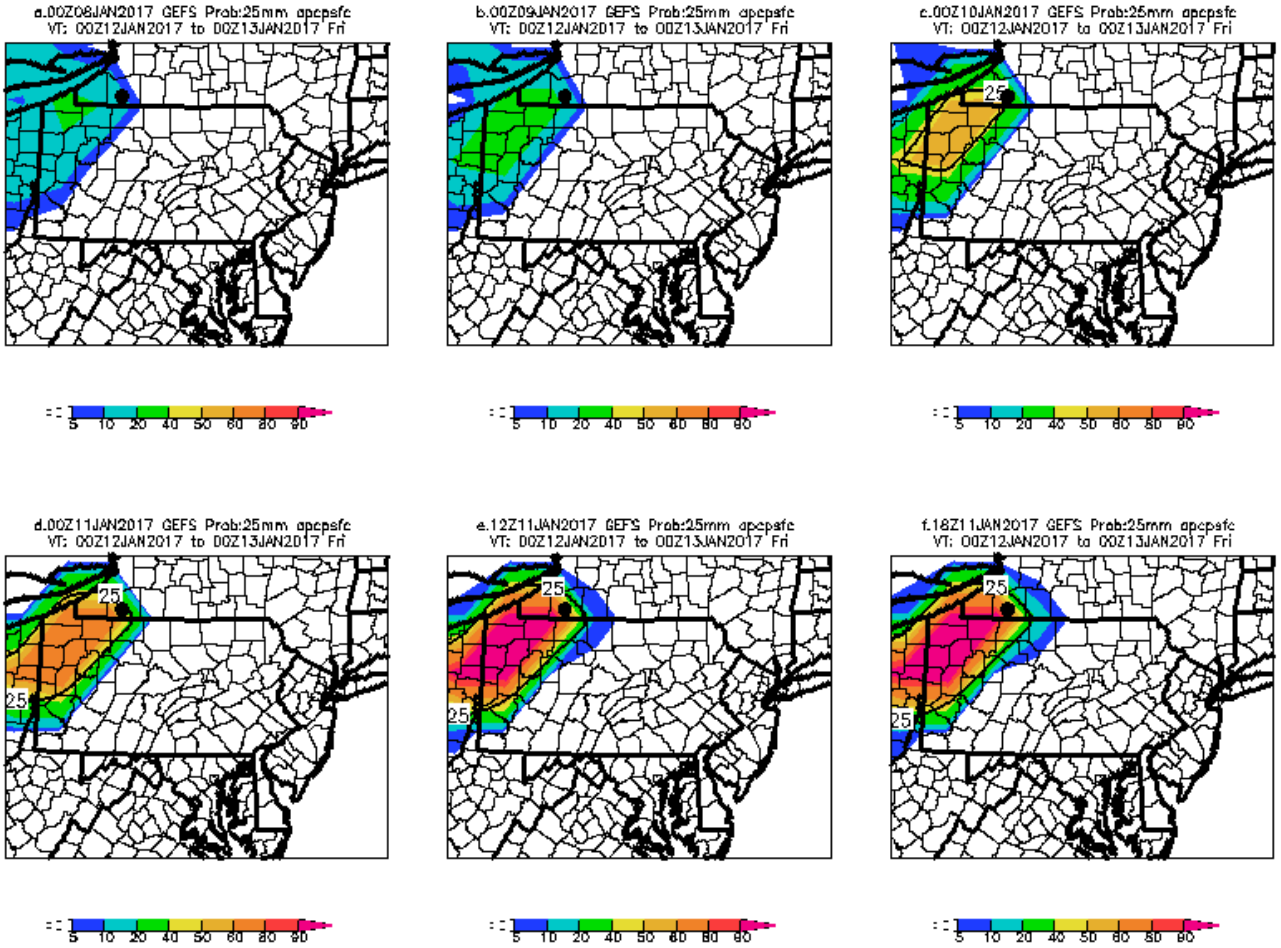


**Figure 7. NCEP GEFS forecasts of 24 hour QPF greater than or equal to 25 mm for the period ending at 0000 UTC 13 January 2017. Forecasting initialized at a) 0000 UTC 6 January, b) 0000 UTC 9 January, c) 0000 UTC 10 January, d) 0000 UTC 11 January, e) 1200 UTC 11 January and f) 1800 UTC 11 January 2017. Selected cycles show a long range forecast, several medium range forecasts and 3 relatively short-range forecasts.**

The NCEP HRRR did relatively well providing relatively accurate forecasts of 25 to 50 mm of QPF during the period of heaviest rainfall (Fig. 9). Though not shown, 6-hour accumulation windows imply the HRRR did relatively well with timing of the period of higher QPF amounts.

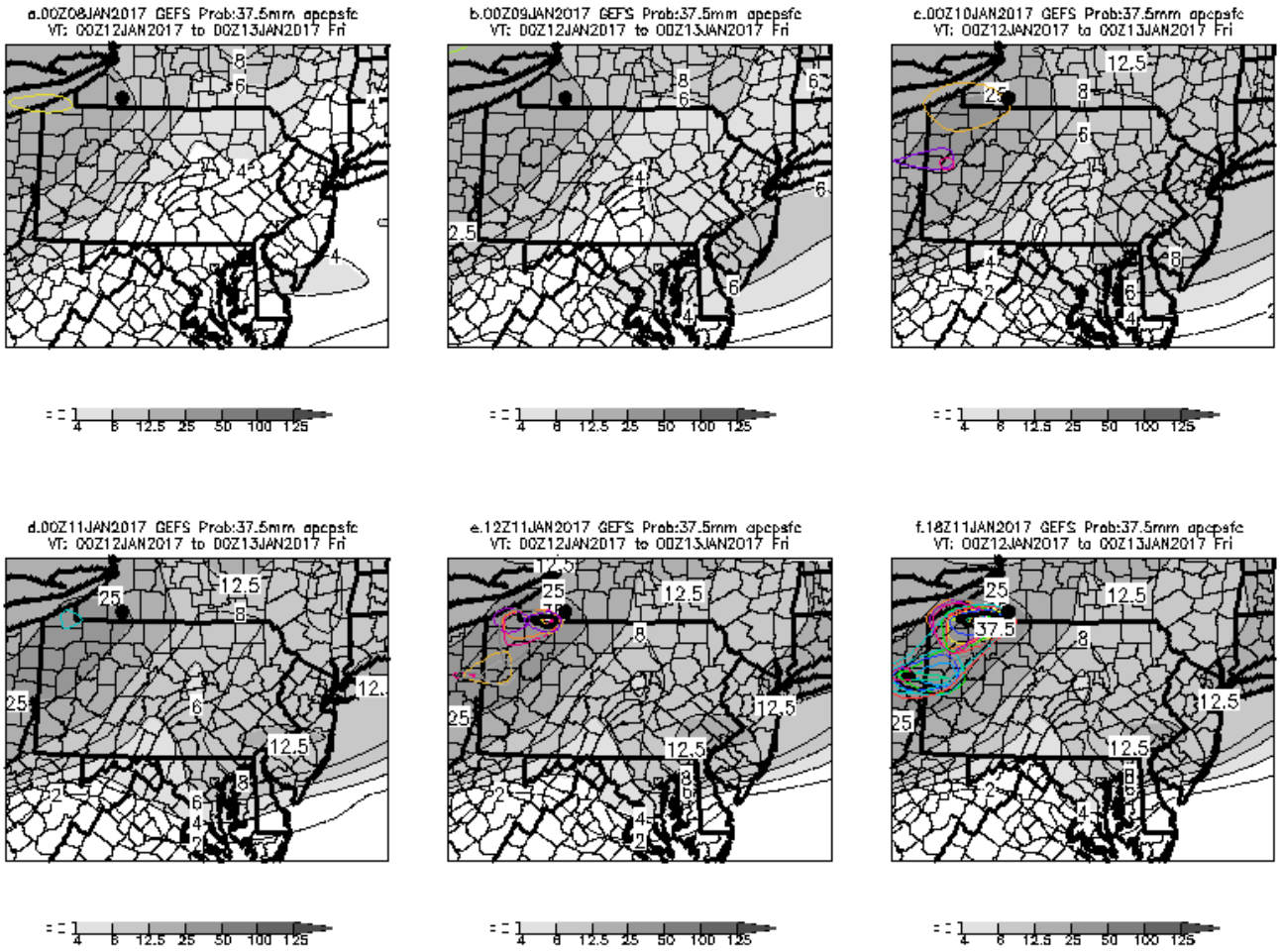


**Figure 8. As in Figure 7 except for the ensemble mean QPF (shaded) and each member's 37.5 mm contour if present. The 50 mm contour had no points so 37.5 mm was selected to show where the GEFS did forecast at least 1.5 inches of QPF.**

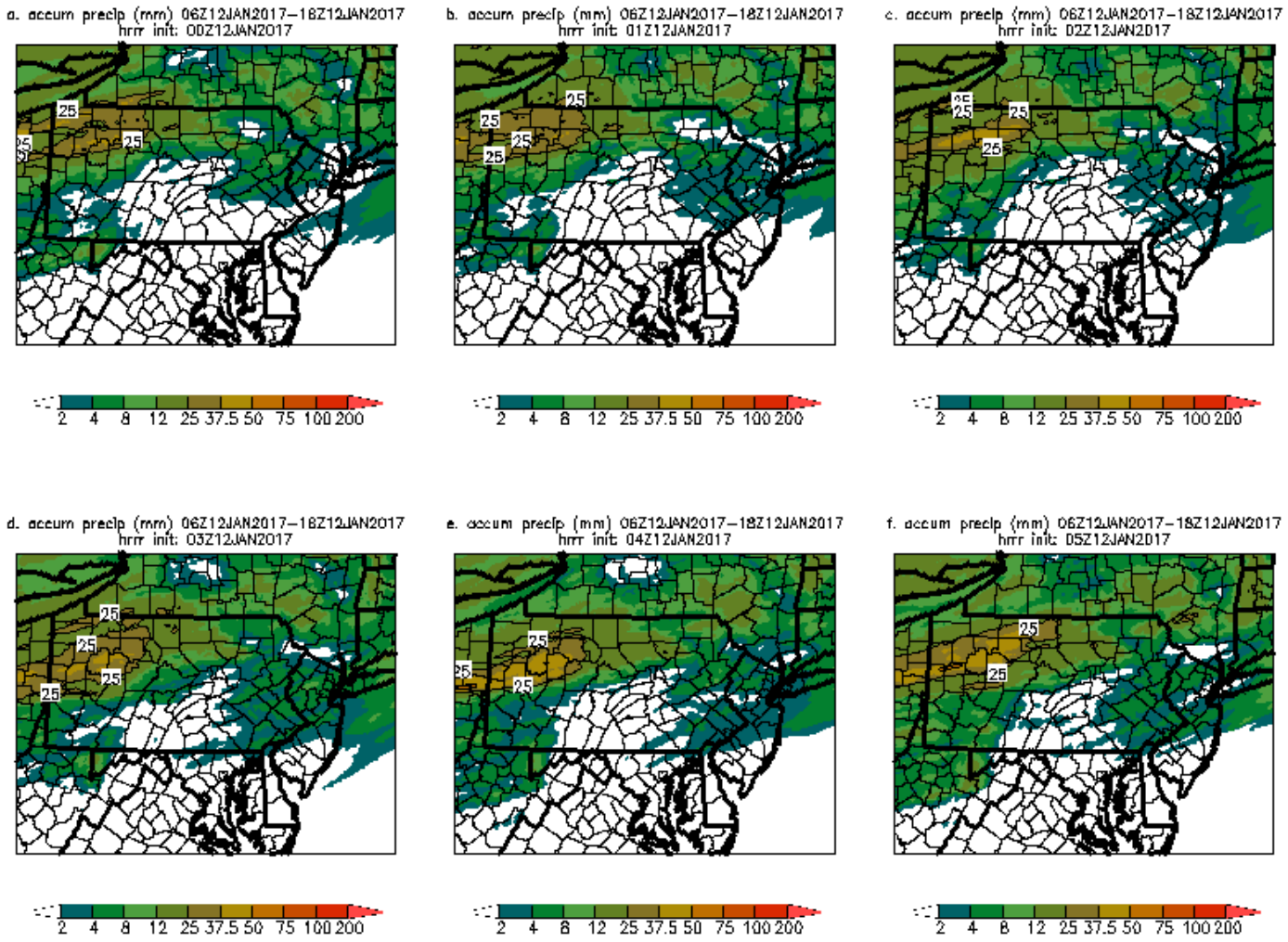


**Figure 9. NCEP 3km HRRR forecasts of total QPF for the 12 hour window from 0600 to 1800 UTC 12 January 2017. Forecasts initialized every hour from a) 0000 UTC 12 January through f) 0500 UTC 12 January 2017. Shading shows the QPF based on the color key and the contours show the 25 and 50 mm contours if present.**