Mesocyclone Detection Algorithm Neural Network (MDA NN)

Briefing for the TAC

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Objective

- **Measure the skill of the MDA NN vs MDA and TDA**

- **Use County Warning Scoring methodology instead of time-window scoring**

Original MDA NN

- **Found errors in the data used to train the original NN**

- **Developed a new NN instead of correcting the original NN**

New MDA NN

- **Uses fewer input parameters than the original NN**

- **Developed on a larger data set than the original NN**

- **Designed to minimize over-fitting of the training data**

New MDA NN

- **Like the original NN, has both radar-only and radar + near-storm environment (NSE) components**
- **Like the original NN, predicts the probability of tornado**
- **Unlike the original NN, wasn't developed to predict the probability of severe wind**

County Warning Scoring

- **An automated algorithm scoring system using simulated county warnings**

- **Methodology is similar to that used by the NWS to determine severe weather warning performance**

Scoring algorithm output

- **Output scored indirectly via simulated warnings**

- **Simulated warnings are issued based on categorical output or by thresholding a parameter**

- **Performance measures are calculated from simulated warnings and ground-truth verification**

Procedure for issuing a warning

- **Select a warning parameter**

- **Select a warning threshold**

- **Set duration time for warnings**

Procedure for issuing a warning

- **For each volume scan:**
  - **Check if parameter $\geq$ warning threshold**
  - **If yes, and storm not in county already being warned**
  - **Calculate areal coverage of warning**
  - **Use "default warning polygon" criteria from AWIPS WarnGen program**

Polygon criteria

- **2 miles upstream and 6 miles either side of location**

- **Widens out by a factor of 0.012 for each mile along the path**

- **Length determined from motion vector and duration of warning**

Example of warning polygon
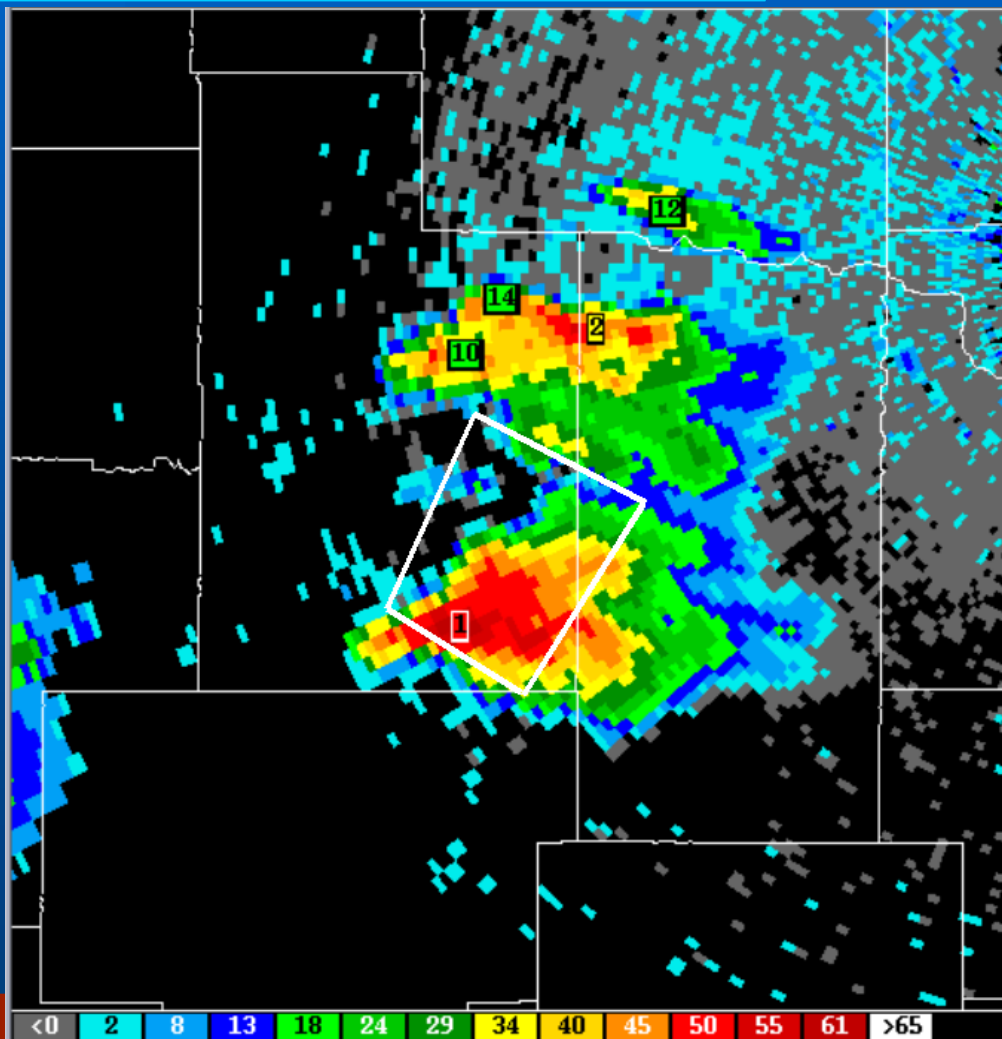
Performance measures

$$POD = \frac{\text{warned tornado reports}}{\text{total tornado reports}}$$

$$FAR = \frac{\text{unverified county warnings}}{\text{total county warnings}}$$

$$CSI = \frac{\text{warned tornado reports}}{\text{total tornado reports + unverified county warnings}}$$

Test data

- **36 severe weather events (storm cases)**
- **284 tornado reports**
  - **5 cases with 0 reports (null cases)**
  - **14 cases with 1 - 5 reports**
  - **8 cases with 6 - 10 reports**
  - **9 cases with >10 reports**

National coverage from 32 sites

Primary evaluation

- **Simulated tornado warnings**
- **Analysis domain: 230 km from each radar site**
- **Algorithm predictors:**
  - **MDA – strength rank ≥ 5 with time continuity**
  - **MDA+NN**
  - **MDA+NN+NSE**

Secondary evaluation

- **Simulated tornado warnings**
- **Analysis domain: 100 km from each radar site**
- **Algorithm predictors:**
  - **MDA – strength rank ≥ 5 with time continuity**
  - **MDA+NN**
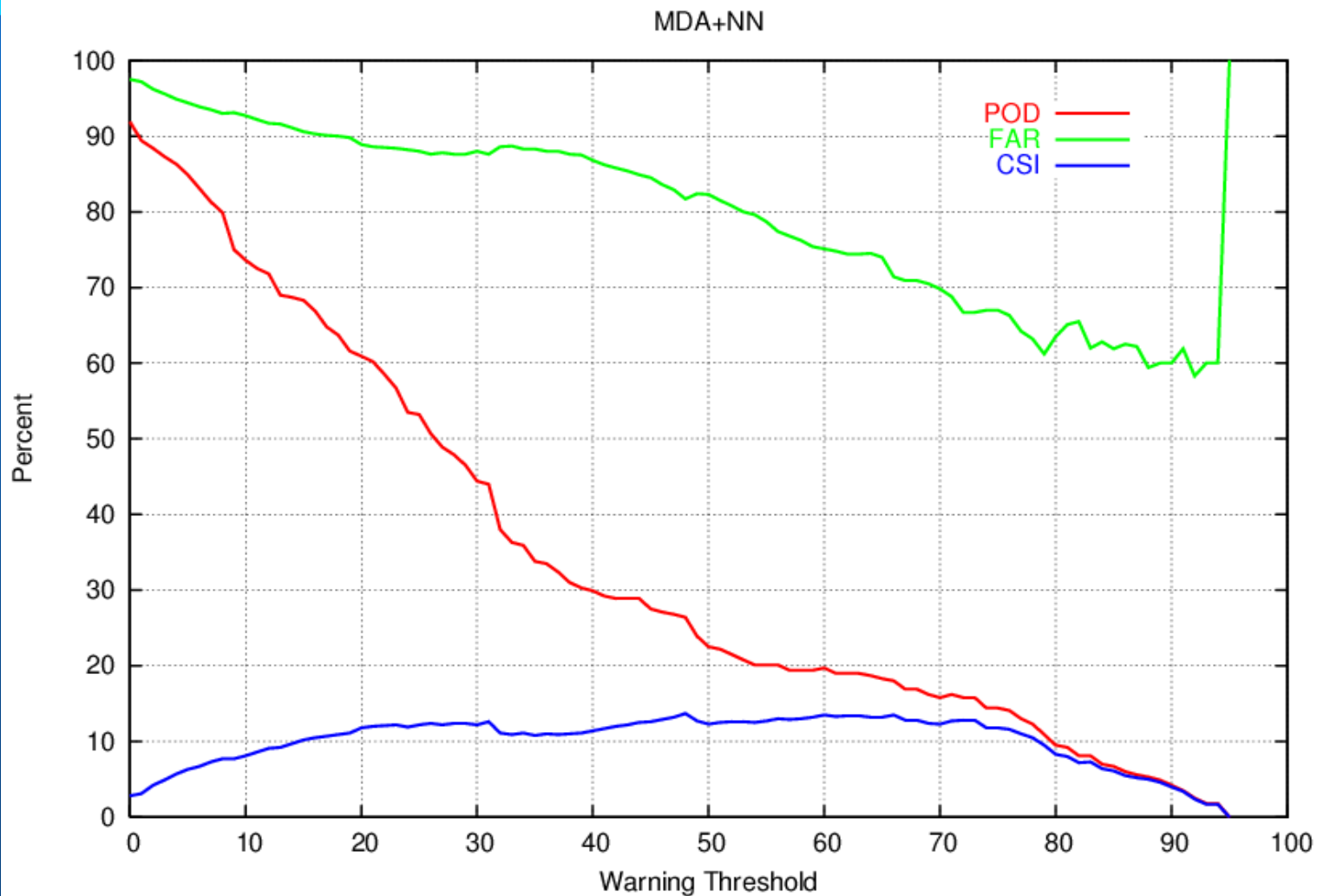 - **MDA+NN+NSE**
  - **TDA – default parameter settings**

Results - Primary evaluation
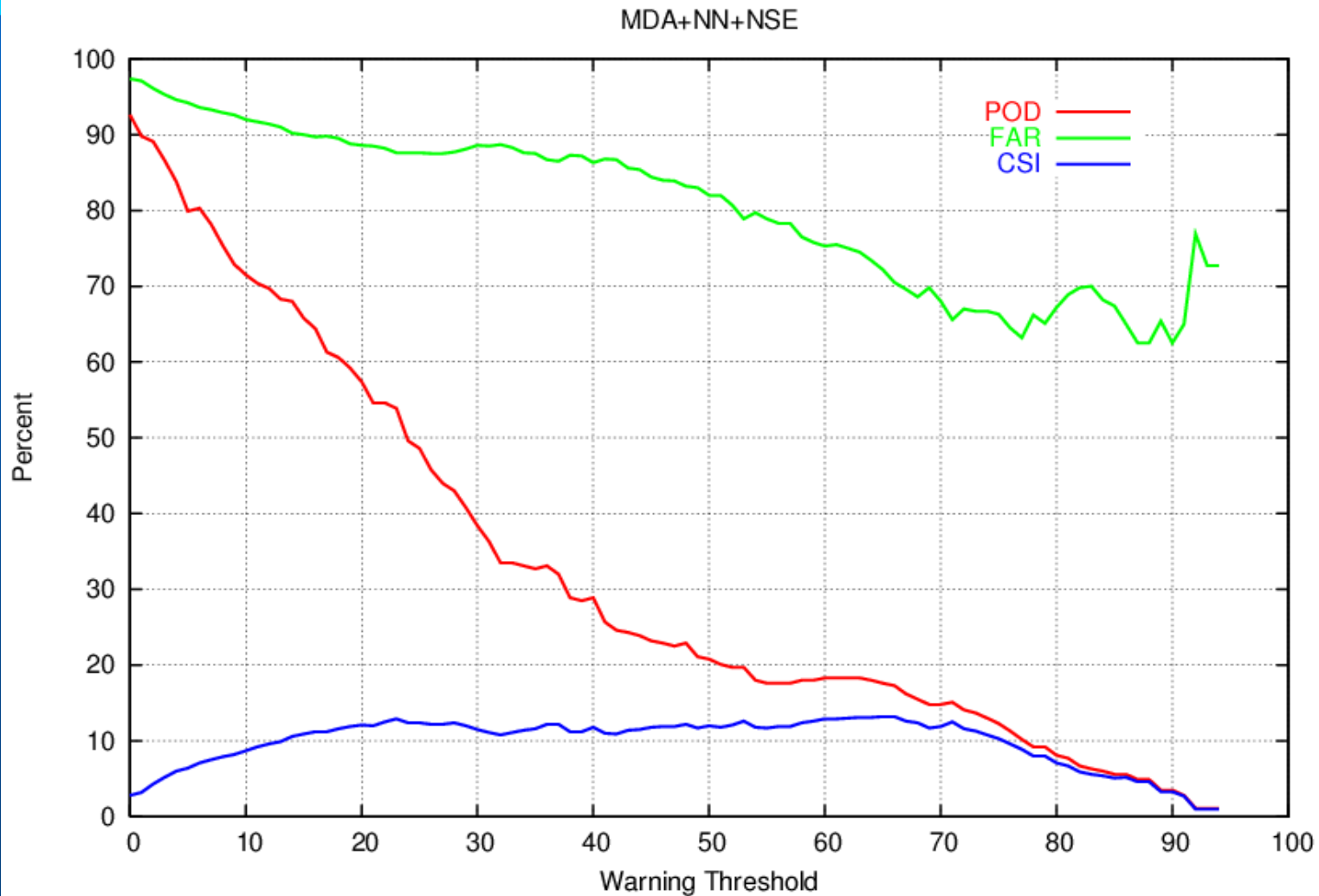
- **MDA – all cases combined:**
  - **POD = 69%**
  - **FAR = 91%**
  - **CSI = 10%**

Results - Primary evaluation

Results - Primary evaluation

MDA+NN+NSE
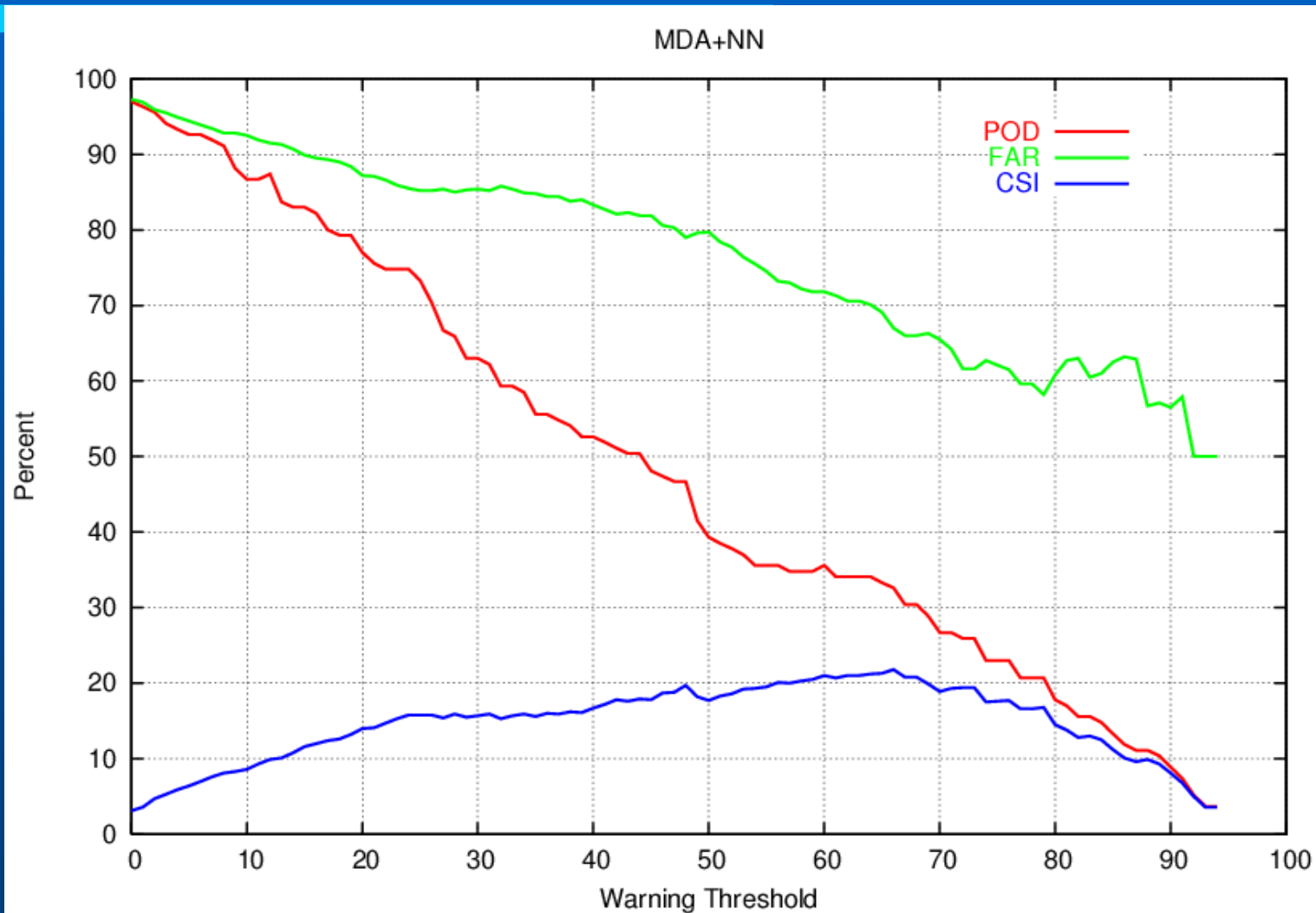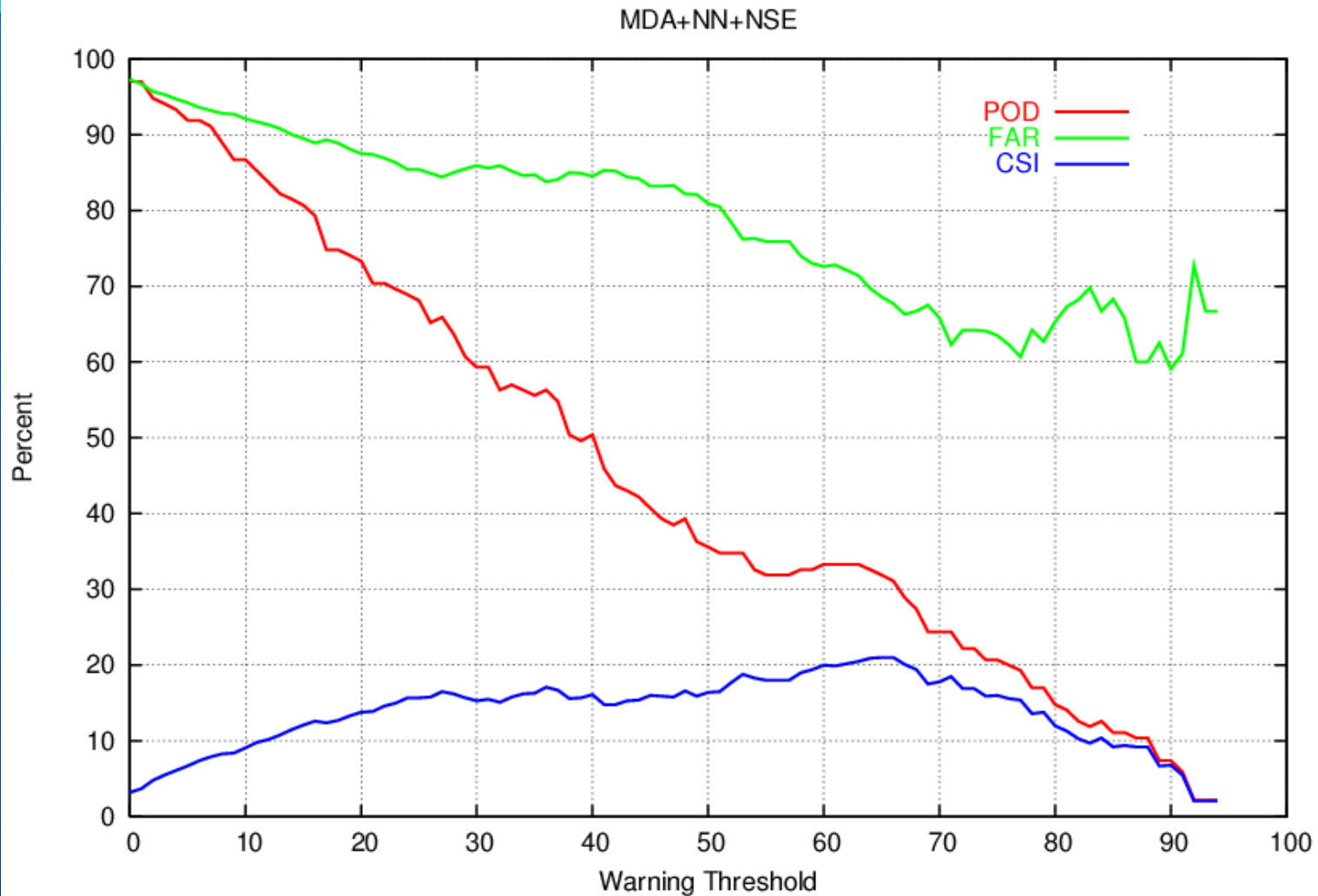
Results - Secondary evaluation

- **MDA:**
  - **POD = 79%**
  - **FAR = 89%**
  - **CSI = 13%**
- **TDA:**
  - **POD = 66%**
  - **FAR = 90%**
  - **CSI = 12%**

Results - Secondary evaluation

Results - Secondary evaluation

Conclusions

- **Primary results – only small improvement in skill**

- **Secondary results – somewhat greater improvement in skill, but only at higher warning thresholds**

- **No improvement in skill when NSE data is included**

Non-performance NN Issues

- **Consolidates many parameters into a single probability-based forecast of tornado**

- **Useful "screening tool" in active severe weather situations**

- **Probabilities provide a measure of confidence and are easier to use and understand than many algorithm parameters**

Non-performance NN Issues

- **Acts like a "black box" – many forecasters don't like this**

- **With increasing emphasis on analysing base data, NN output may be ignored**

- **If character of input data changes, it may be necessary to retrain the NN**

Recommendation

- **There is insufficient evidence to support this particular NN being added to the operational WSR-88D system at this time**