NDFD Weather Element ("ugly string") Verification

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September 7, 2011

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What is an ugly string?

- Weather element has 5 parts:
  - Coverage/Probability
  - Weather Type
  - Intensity
  - Visibility
  - Attributes
- Combine those 5 parts to form the ugly string

Sample Weather String	Meaning
<NoCov>:<NoWx>:<NoInten>:<NoVis>:	No Weather
Def:R:+:4SM:	Definite heavy rain, visibility at 4 statute miles
Lkly:S:m:<NoVis>:^Chc:ZR:-:<NoVis>: ^Chc:IP:-:<NoVis>: ^Areas:BS:<NoInten>:<NoVis>:	Likely moderate snow, chance light freezing rain, chance light ice pellets, areas of blowing snow

NDFD Forecasts

- Forecasts produced on a 5 km grid
  - Extract data (using degrib) at points where there are METAR stations.
  - Very specific list of points which have been approved by WFOs
  - At this time, only points are being verified
- NDFD forecasts can be updated every hour.
- Forecasts are valid from the top of the hour until 59 minutes past the hour.

Forecast Encoding

Probability	Code	Meaning	NewCode	
0-14.9%	<NoCov>	No Coverage	100	0
No QPF	Patchy	Patchy	101	1
	Areas	Areas Of	102	
15-24.9%	SChc	Slight chance	103	2
	Iso	Isolated	104	
25-54.9%	Chc	Chance Of	105	3
	Sct	Scattered	106	
55-74.9%	Lkly	Likely	107	4
	Num	Numerous	108	
75-100%	Def	Definite	109	5
	Wide	Widespread	110	
	Pds	Periods Of	111	
	Frq	Frequent	112	
	Ocnl	Occasional	113	
	Inter	Intermittent	114	
	Brf	Brief	115	
	UNK	Unknown	199	

Code	Meaning	New Code	
<NoWx>	No Weather	200	0
IC	Ice Crystals	201	
WP	Water Spouts	202	
FR	Frost	203	
ZY	Freezing Spray	204	
A	Hail	205	
R	Rain	206	1
RW	Rain Showers	207	
L	Drizzle	208	
S	Snow	209	2
SW	Snow Showers	210	
IP	Ice Pellets	211	
ZL	Freezing Drizzle	212	3
ZR	Freezing Rain	213	
T	Thunderstorms	214	4
F	Fog	215	5
ZF	Freezing Fog	216	
IF	Ice Fog	217	
H	Haze	218	
BD	Blowing Dust	219	6
BN	Blowing Sand	220	
K	Smoke	221	
VA	Volcanic Ash	222	
BS	Blowing Snow	223	
Unknown	Unknown	299	

Observations

- The forecasts are verified with METAR observations that occur at the top of the hour.
  - There are up to 3 independent weather types reported
  - Verify weather types 206-213 and 215-223
- Thunderstorms are verified with METAR observations and the 20km convective predictand dataset (Charba and Samplatsky) which is a combination of radar data and NLDN.
  - Observations are reported over a one hour range

Verification

- Critical Success Index (Threat Score)
- $$CSI = \frac{a}{a+b+c}$$

where a = hits, b = false alarms, and c = misses

Event forecast	Event observed	
	Yes	No
Yes	a	b
No	c	d

Ignored

Assumptions

- Forecasts
  - 1. Forecasts that fall within a chosen probability range and their corresponding observations are used in the computation of the threat score.
  - 2. Observations that have a corresponding valid forecast and were missed will count as both a false alarm and a miss. For example, if snow was forecasted and rain was observed, the event would be counted as a false alarm for the snow forecast and a miss for the rain.
  - 3. Frost, freezing spray, water spouts, and snow grain forecasts were considered no weather forecasts.

Assumptions

- Constrained by what is reported in the METARs and how those data are processed
- Observations
  - 1. Multiple weather types can verify various forecast precipitation types. Rain verifies rain, rain shower, and drizzle forecasts and so on.
  - 2. Unknown precipitation verifies rain, rain shower, drizzle, snow, snow shower, ice pellet, freezing rain, and freezing drizzle forecasts.
  - 3. All fog forecasts (normal, freezing, and ice) are verified by any fog observation.
  - 4. Blowing dust or sand forecasts are verified by any observation of blowing dust or sand.

Assumptions

- Observations
  - 5. Observations reported to be within sight of the observation location do not verify a forecast as a hit. (e.g. 40 = VCFG Fog between 5-10 miles from the station.)
  - 6. Dust, mist, spray, tornado, and blowing spray are considered no weather observations.
  - 7. If a forecast is considered a false alarm, the observation is not always considered a miss. No weather and unknown precipitation observations are not counted as misses.
  - 8. When the coded observation is ambiguous, only the most likely precipitation type is considered the missed observation. In most cases, this applies to coded observations 68 (light rain/snow/drizzle mix) and 69 (moderate or heavy mix).

The Script

- Default setting: Analyze entire month of data for both the 00Z and 12Z cycle, for all locations, for all forecast projections, using all weather strings (except NoWx forecasts) outputting the results for each cycle and forecast projection.
- In manual mode, a user can control these forecast parameters:
  - weather (ugly) string
  - cycle
  - date range
  - coverage/probability groups
  - forecast projection hours
  - locations (Region, WFO, or multiple stations)

Output

- Location CSI Cases
  - CSI for CONUS and Regions heads the output
  - Followed by individual station and WFO data.
- At the bottom of text file, individual weather element statistics are printed.
  - WxElement Hits False Alarms Misses
    - Total 500 200 50
    - Rain 200 150 25
    - Snow 200 25 20
    - Fog 100 25 5

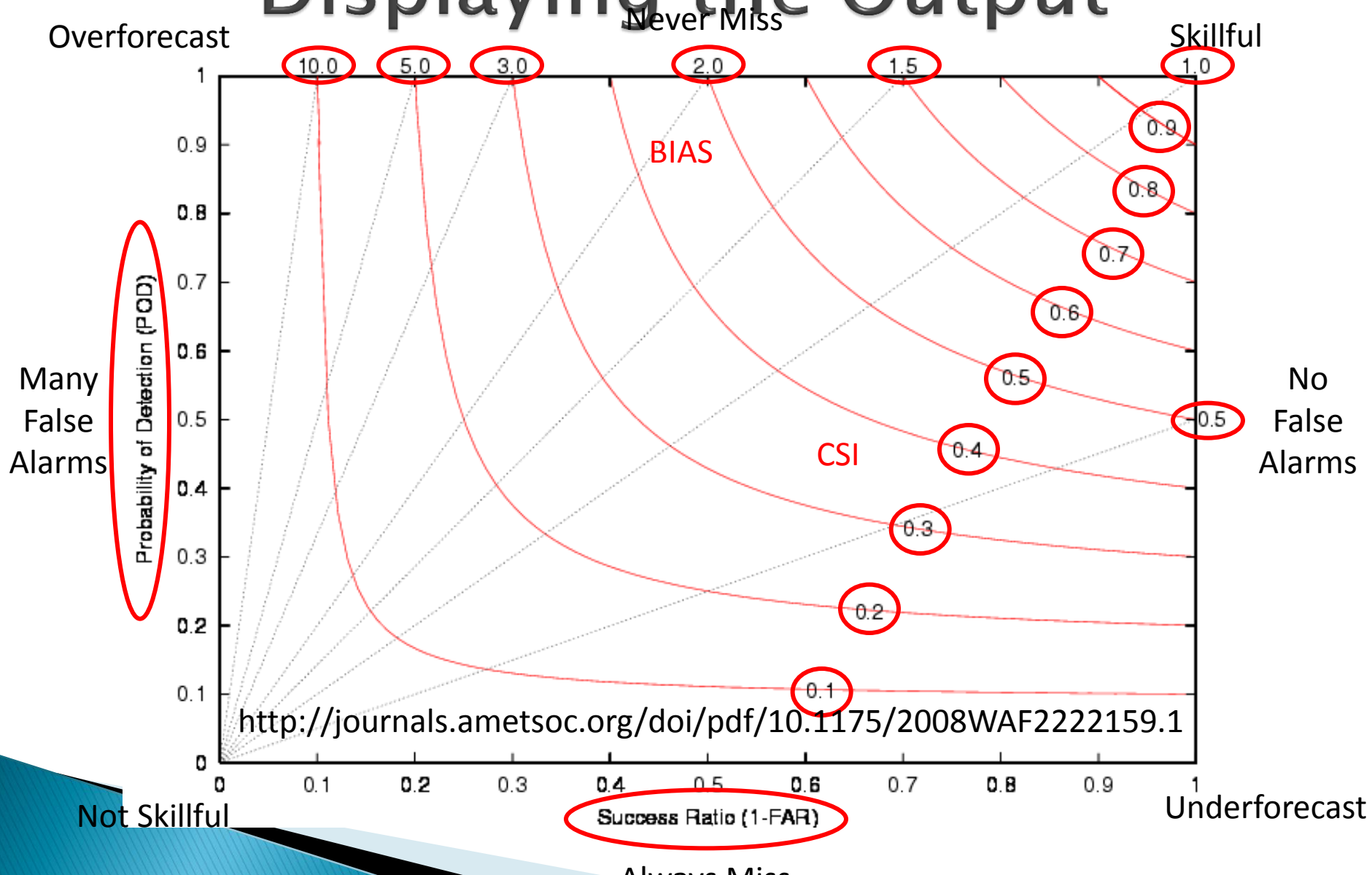
Displaying the Output

- Knowing the Hits, False Alarms, and Misses, four quality measures can be calculated:
  - Probability of Detection (POD) = A/(A+C)
  - False Alarm Ratio (FAR) = B/(A+B)
  - Bias = (A+B)/(A+C)
  - CSI = A/(A+B+C)

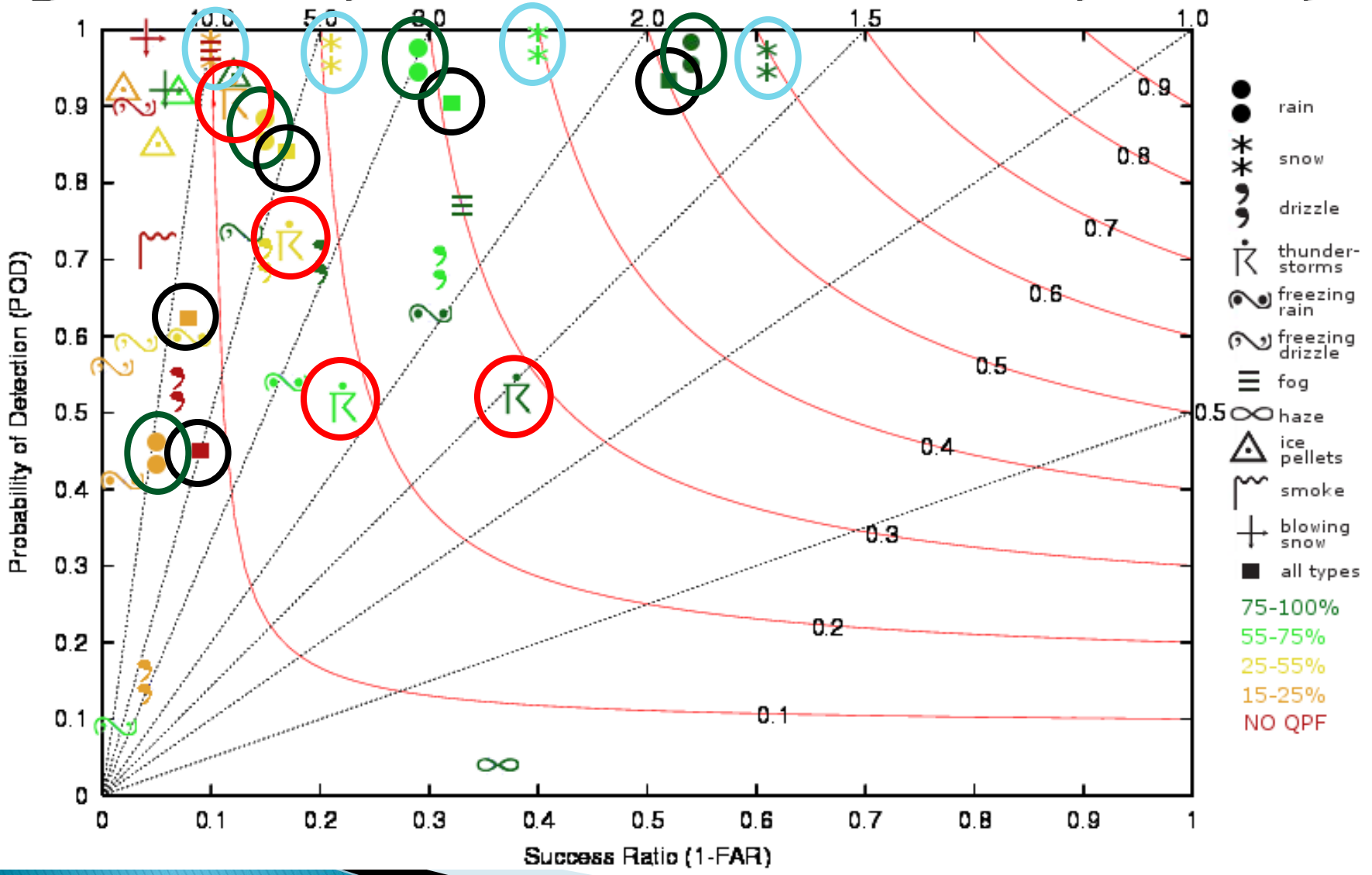
These commonly used measures are mathematically related and can be geometrically represented on the same diagram.

Event forecast	Event observed	
	Yes	No
Yes	a	b
No	c	d

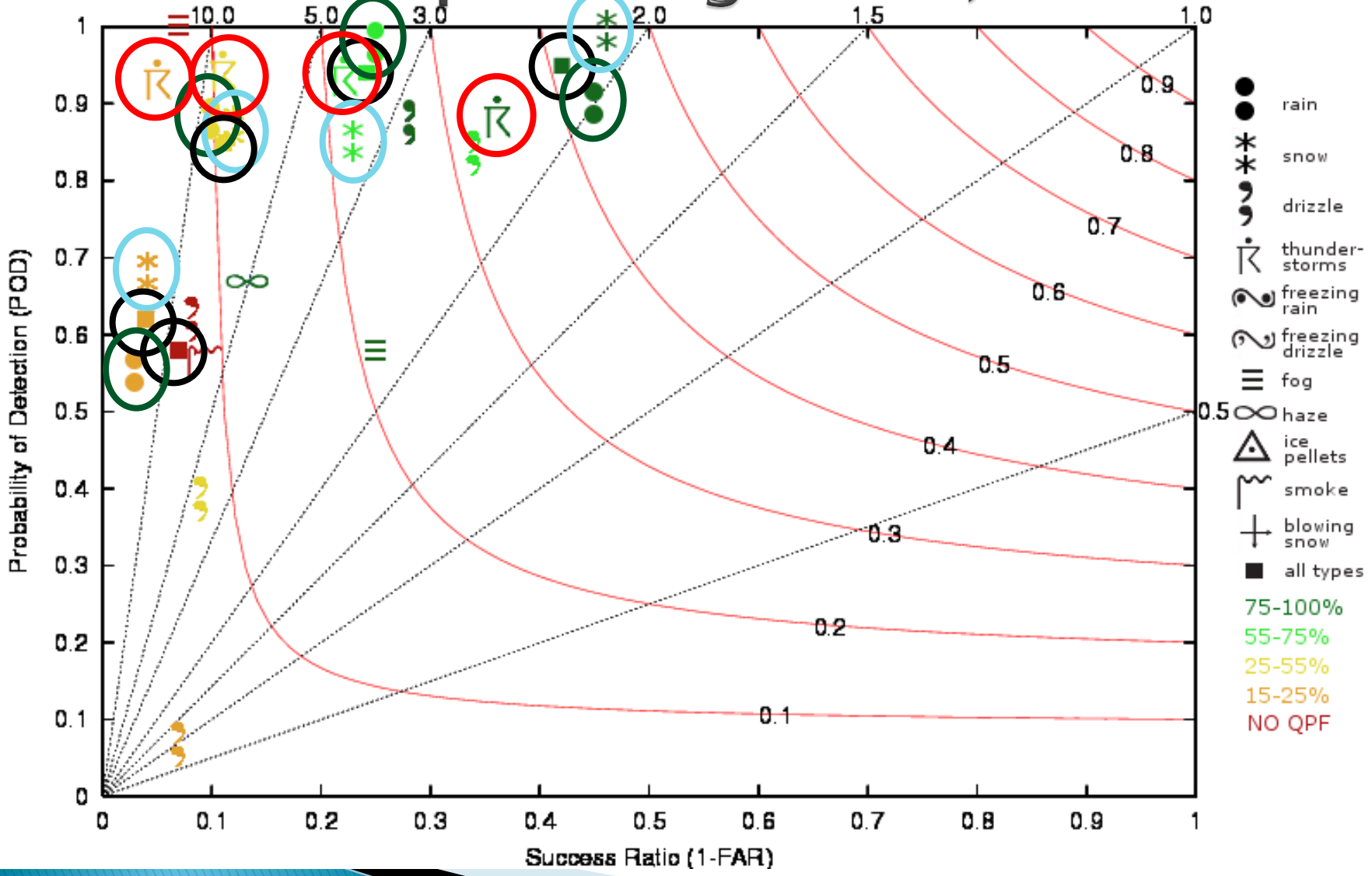
Displaying the Output



Results (Cool Season Jan-Mar/2010 and Oct-Dec/2010)



Results (Warm Season Apr – Aug 2010)



Results

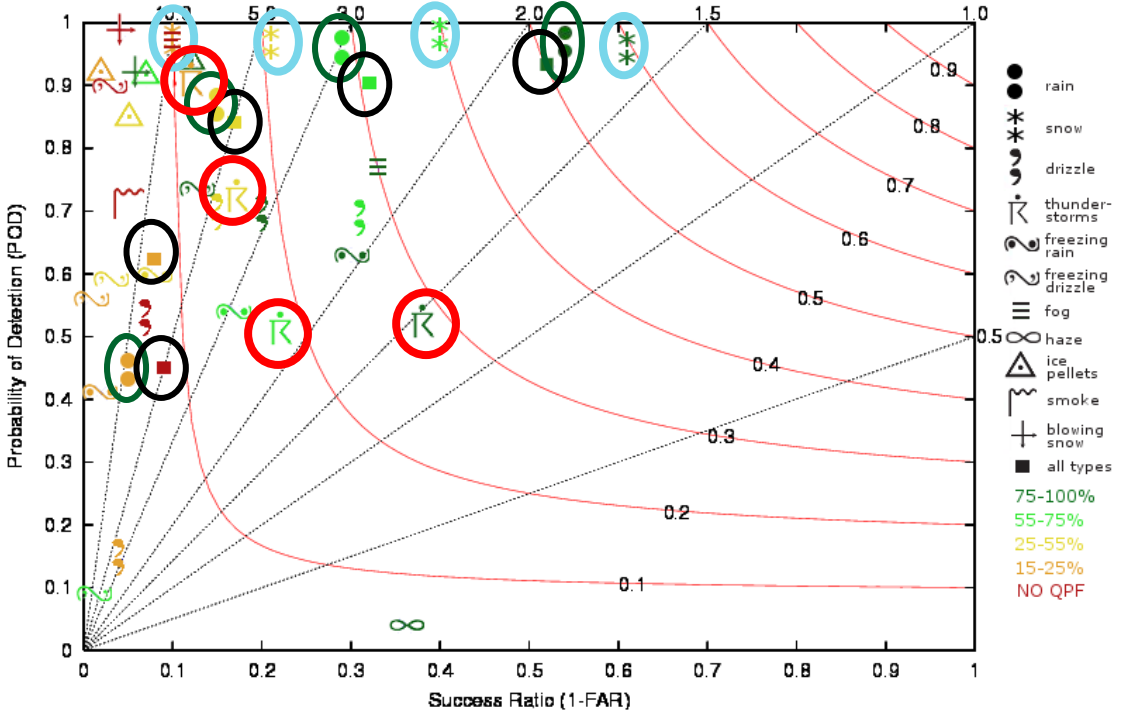
- Thunderstorm forecast scores improved considerably with convective observations
- Cool season had higher CSI for all probability groups.
- Warm season had more cases in every prob group, except 75-100% and non-QPF probabilities.
- Rarer events (freezing rain, freezing drizzle, ice pellets) don't verify very well at any probability group.

Future Work

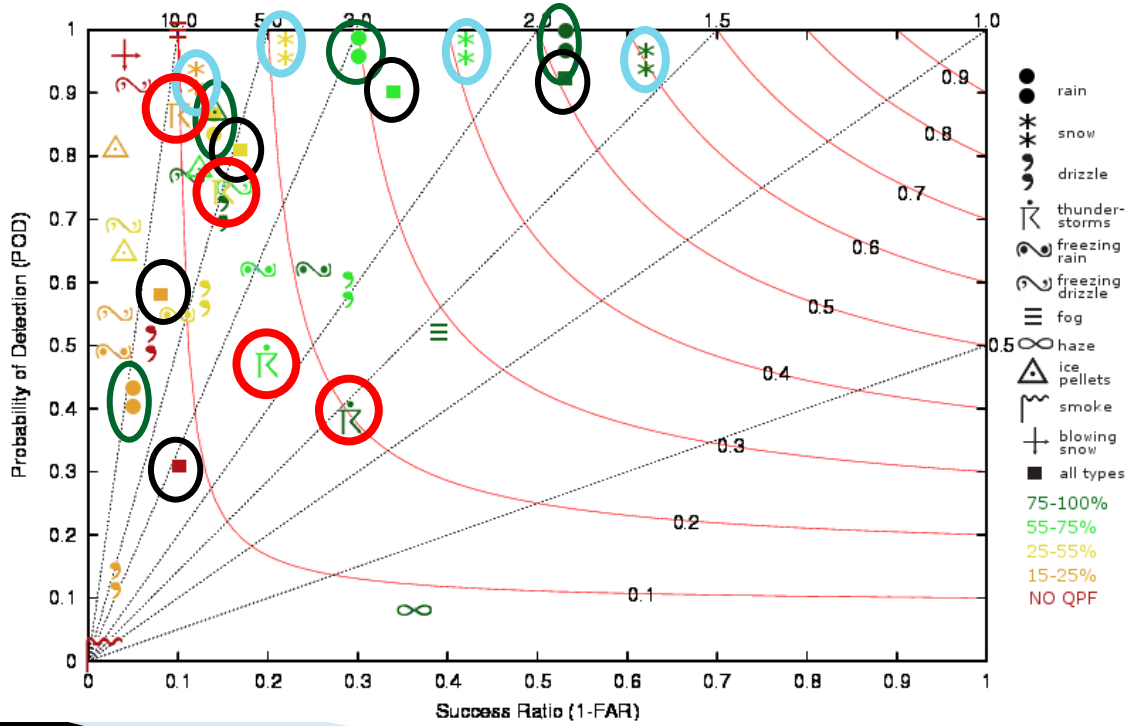
- Verify GMOS at points
- Compare GMOS vs. NDFD
- Add ability to handle a matched sample of cases for any number of forecast sources
- Add POD and FAR to text output.
- Automate the entire process from data ingest to production of plots.
- Verify more seasons

QUESTIONS?

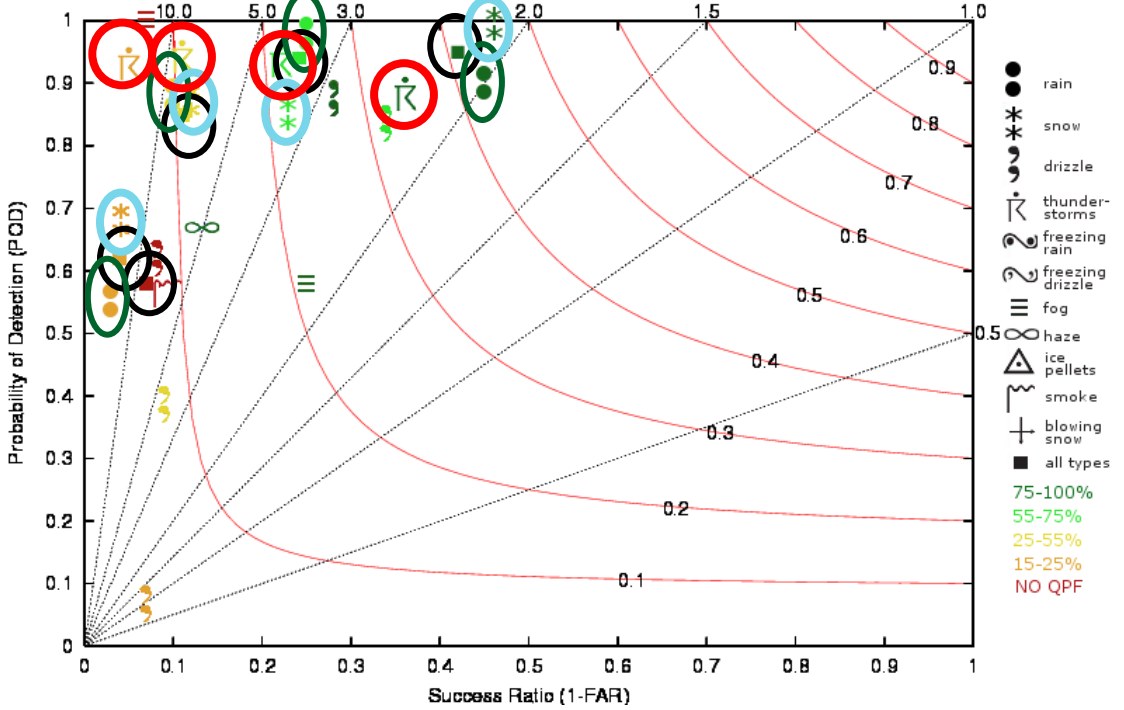
Cool Season 00Z



Cool Season 12Z



Warm Season 00Z



Warm Season 12Z