BP-91 A Gridded Snowfall Verification Method Using ArcGIS: Zone-Based Verification and Seasonal Bias Maps

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Motivation

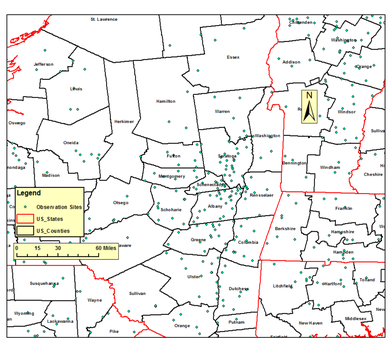
- Utilize Geographic Information Systems (GIS) technology for a gridded and more representative snowfall verification method
- Legacy zone-based verification method (adding reports and dividing by # of reports) has become antiquated:
- Does not factor in spatial variability between data points
- Spatial verification is important since NWS snowfall forecasts are prepared graphically.

Methodology

- Use ArcGIS 10.2 software ArcCatalog and ArcMap
- Create contoured snowfall maps and zonal statistics based on observations
- Careful QC of snowfall observations is necessary (from trained spotters, public, social media, etc.)
- Summary of reports issued as Public Information Statement (PNS)
- A Local Hydrometeorological Data Message (RRM) file is generated automatically from PNS
- Contains location name, snowfall amount, LAT/LON
- Important to have snowfall reports outside forecast area
- Allows for more representative interpolation
- Gather RRM files from surrounding offices
- Python script collects snowfall reports from RRM files and compiles them to a CSV file (script can be modified for LSR summary too)
- Import CSV file into a spreadsheet

Gridded Snowfall Map Creation

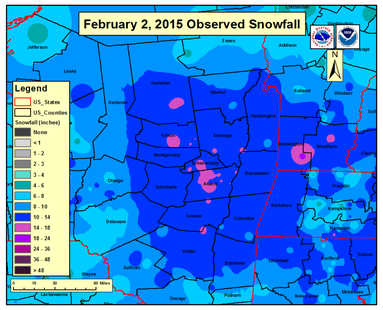
- Generate GIS shape file of snowfall reports from spreadsheet using ArcCatalog
- Import into ArcMap

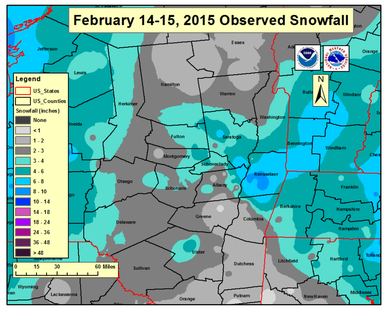


Example of snowfall reports as a shape file in ArcMap

- Run an Inverse Distance Weighting (IDW) function in ArcMap
- Can try other interpolation schemes such as Natural Neighbor or Spline
- Creates a gridded (raster) dataset and contoured snowfall map
- Color scheme can be matched to ER standardized forecast snowfall ranges

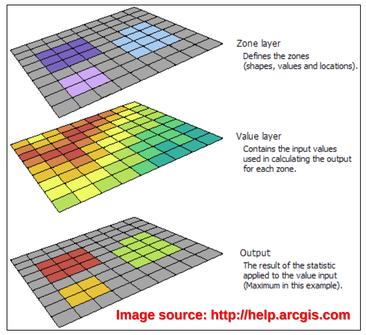
Gridded Snowfall Analysis Maps using IDW



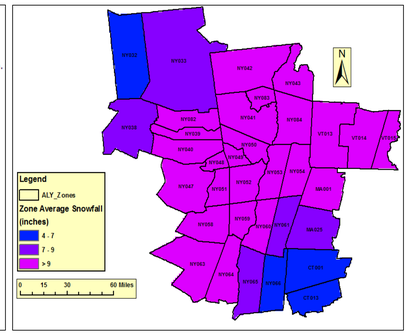


Verification by Forecast Zone

- In ArcMap, run Zonal Statistics (including mean) on the gridded map
- Create a verification map using ranges corresponding to local NWS office advisory & warning criteria



Graphic shows how zonal statistics are calculated in ArcMap



Example of zone-average verification map using local warning and advisory criteria (ALY)

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RRMALY
HYDROLOGIC OBSERVATIONS
NATIONAL WEATHER SERVICE ALBANY NY

.A X4270731 0320 Z DH0924/DVH11/SFV 1.0"LAT=42.733410 LON=-73.072480  CLARKSBURG  WEATHERNET6 "/
.A X4330728 0320 Z DH1017/DVH11/SFV 6.5"LAT=43.291580 LON=-72.838540  LANDGROVE  WEATHERNET6 "/
.A X4260730 0320 Z DH0245/DVH11/SFV 0.5"LAT=42.597840 LON=-73.043570  SAVOY  WEATHERNET6 "/
.A X4310745 0320 Z DH0921/DVH11/SFV 1.0"LAT=43.145310 LON=-74.489020  CAROGA LAKE  WEATHERNET6 "/
.A X4370737 0320 Z DH0203/DVH11/SFV 0.5"LAT=43.692910 LON=-73.718710  BRANT LAKE  WEATHERNET6 "/
.A X4280741 0320 Z DH0957/DVH11/SFV 0.8"LAT=42.793778 LON=-74.088728  PRINCETOWN  WEATHERNET6 "/
.A X4280739 0320 Z DH0100/DVH11/SFV 0.1"LAT=42.840400 LON=-73.894500  1 SSW ADUEDUCT  NWS EMPLOYEE "/
.A X4330736 0320 Z DH0932/DVH11/SFV 1.5"LAT=43.306680 LON=-73.576650  HUDSON FALLS  WEATHERNET6 "/
.A X4330738 0320 Z DH0933/DVH11/SFV 1.0"LAT=43.256280 LON=-73.832810  LAKE LUZERNE  WEATHERNET6 "/
.A X4300738 0320 Z DH0208/DVH11/SFV 1.0"LAT=42.975240 LON=-73.793540  MALTA  WEATHERNET6 "/
.A X4290730 0320 Z DH1006/DVH11/SFV 2.2"LAT=42.888640 LON=-73.012480  WOODFORD  WEATHERNET6 "/
.A X4350738 0320 Z DH0940/DVH11/SFV 3.0"LAT=43.490050 LON=-73.780560  WARRENSBURG  WEATHERNET6 "/
.A X4310739 0320 Z DH0307/DVH11/SFV 0.4"LAT=43.137275 LON=-73.881064  PORTER CORNERS  WEATHERNET6 "/
.A X4330737 0320 Z DH0309/DVH11/SFV 1.2"LAT=43.326210 LON=-73.689785  QUEENSBURY  WEATHERNET6 "/
.A X4310740 0320 Z DH0836/DVH11/SFV 0.3"LAT=43.137411 LON=-73.976125  MIDDLE GROVE  WEATHERNET6 "/
.A X4280738 0320 Z DH0330/DVH11/SFV 0.5"LAT=42.829340 LON=-73.820800  2 S CLIFTON PARK CENTER  NWS EMPLOYEE
.A X4310739 0320 Z DH0050/DVH11/SFV 0.2"LAT=43.060680 LON=-73.856897  MILTON  WEATHERNET6 "/

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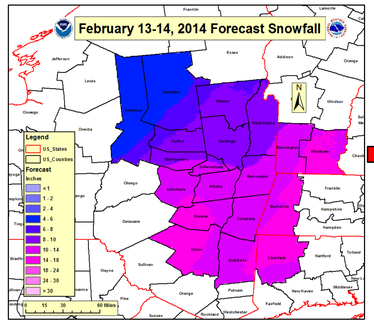
Example of RRM file output

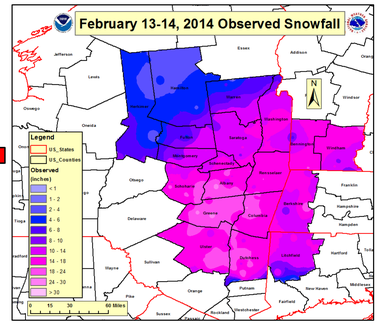
STATE_ZONE	MIN	MAX	RANGE	MEAN
NY041	9.358097	14.6787	5.320601	11.57697
NY083	9.026205	13.94906	4.922851	11.28288
VT014	8.901305	14.70455	5.803243	11.00508
NY082	8.084703	13.67106	5.586354	10.78737
NY039	7.598409	11.95377	4.35536	9.246692
VT015	7.28447	11.28742	4.002949	9.840925
NY048	7.08256	8.985294	1.902735	7.783468
NY050	6.71551	12.36138	5.645868	9.838463
NY042	6.537158	11.94206	5.404904	10.1689
NY049	6.358728	9.367656	3.008927	7.644748
NY051	5.857524	9.223201	3.365676	6.957891
NY040	5.712502	11.87092	6.158416	8.294919
NY063	5.462291	9.931149	4.468859	6.455654
NY084	5.300804	10.29936	4.998556	8.742426
NY032	5.188494	9.167603	3.979108	7.392359
NY047	5.073186	8.97722	3.904034	6.86191
VT013	4.824048	16.92382	12.09977	9.024548
NY038	4.507548	8.986527	4.478979	6.767919
NY058	4.02656	9.222359	5.195799	6.355621
MA001	4.012165	9.006271	4.994106	6.689355
NY053	3.992022	9.214822	5.2228	7.215665
NY064	3.551955	6.392246	2.840291	5.236844
NY054	3.53464	9.416963	5.882323	7.117262
NY065	3.424084	6.024916	2.600831	4.807932
CT001	3.349467	6.390776	3.041309	5.176173
MA025	3.323119	6.987253	3.664134	5.078218
NY033	3.29104	11.515	8.223958	9.229068
NY043	3.099223	10.61417	7.514901	7.602445
NY066	3.084693	4.8894	1.804708	4.302722
NY052	3.035466	8.644937	5.609471	6.212193
CT013	3.031178	5.74754	2.716362	4.017697
NY059	3.002487	7.65548	4.652993	4.438066
NY060	2.217992	4.982667	2.764676	3.338459
NY061	2.140911	4.617844	2.476932	3.411808

- Run Zonal Statistics as a table for statistical values
- Output for mean snowfall and other stats within each forecast zone
- Table is based on statistics computed from the gridded snowfall map
- Mean snowfall used for verification by forecast zone

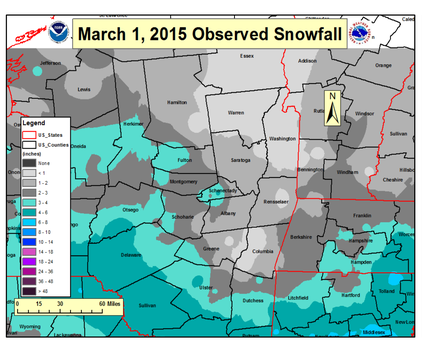
Creation of Forecast Error Maps

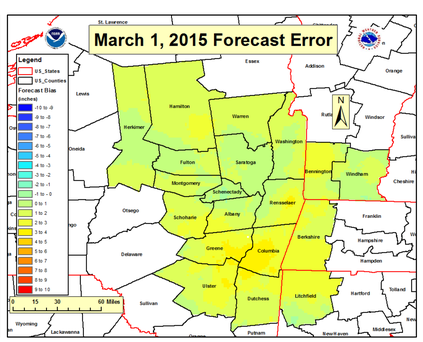
- Preceding an event, export Forecast Storm Total Snowfall from GFE to a netCDF file
- Script converts netCDF file to a shape file
- Import into ArcMap and convert shape file to raster
- Create Gridded snowfall map from observations after event
- Subtract **Forecast – Observed** snowfall grids to compute forecast error map





Warm colors indicate over-forecast, **Cold** colors indicate under-forecast

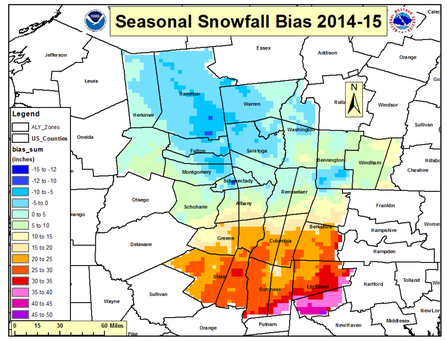




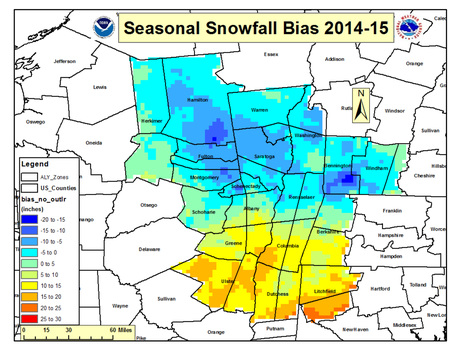
Observed snowfall analysis and forecast error map for March 1, 2015

Seasonal Snowfall Bias Maps

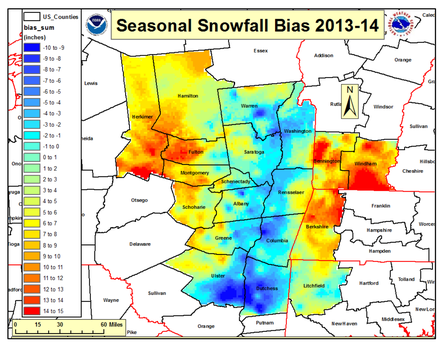
- Forecast error maps events can be compiled over entire winter seasons to compute positive or negative biases
- Sum rasters for each snowfall event into one map using raster calculator in ArcMap
- Must be careful single large outlier events may skew bias



2014-15 Seasonal bias map includes a large outlier event



2014-15 Seasonal bias map without outlier event more representative of the overall season (7 events)



2013-14 Seasonal bias map (limited to 3 events)

Future plans to expand database to include all warning and advisory snowfall events for the upcoming 2015-16 winter season

National Weather Service Eastern Region Technical Attachment link: http://www.erh.noaa.gov/er/hq/ssd/erps/ta/ta2015-04.pdf

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