Using analysis uncertainty estimates from the Real-Time Mesoscale Analysis (RTMA) in the verification of grid-based forecasts

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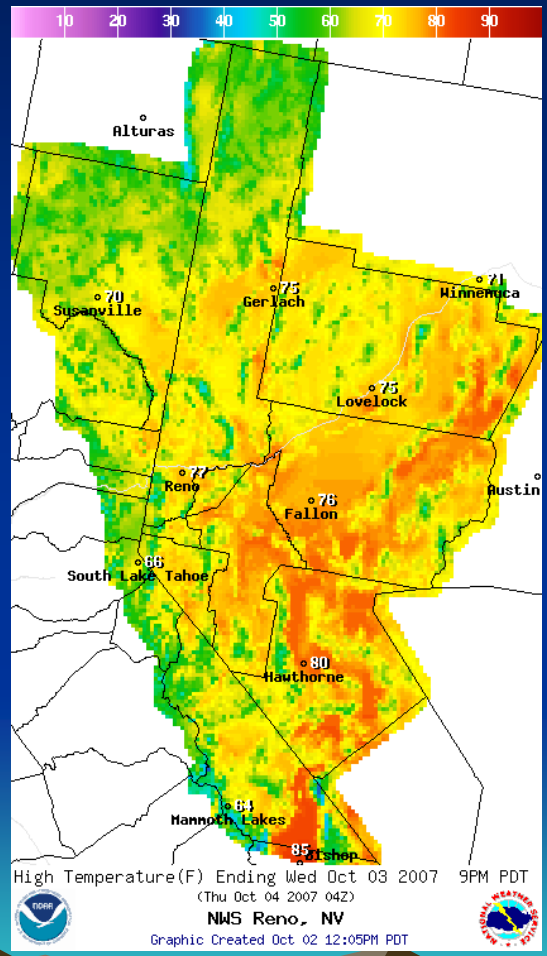
Points → Grids



Forecast Grid
Flagship Product

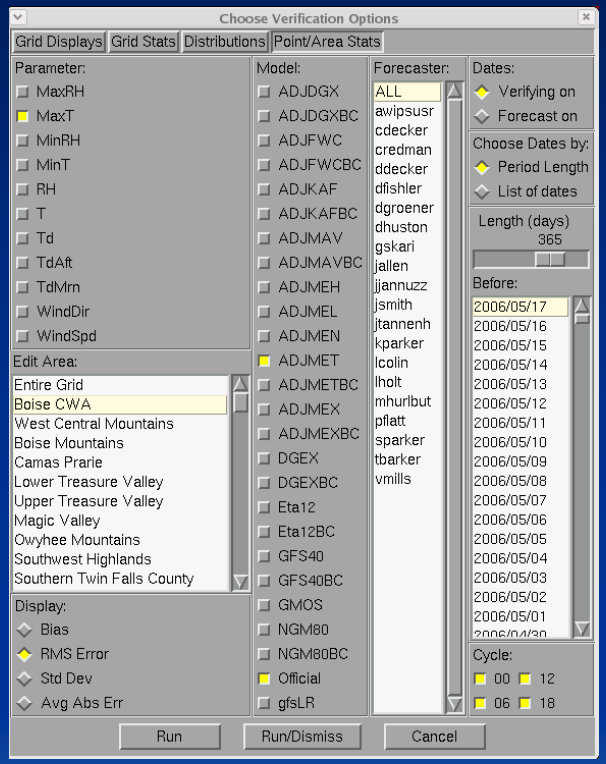
How did I do away from ASOS stations?

Need an analysis of observations to compare to

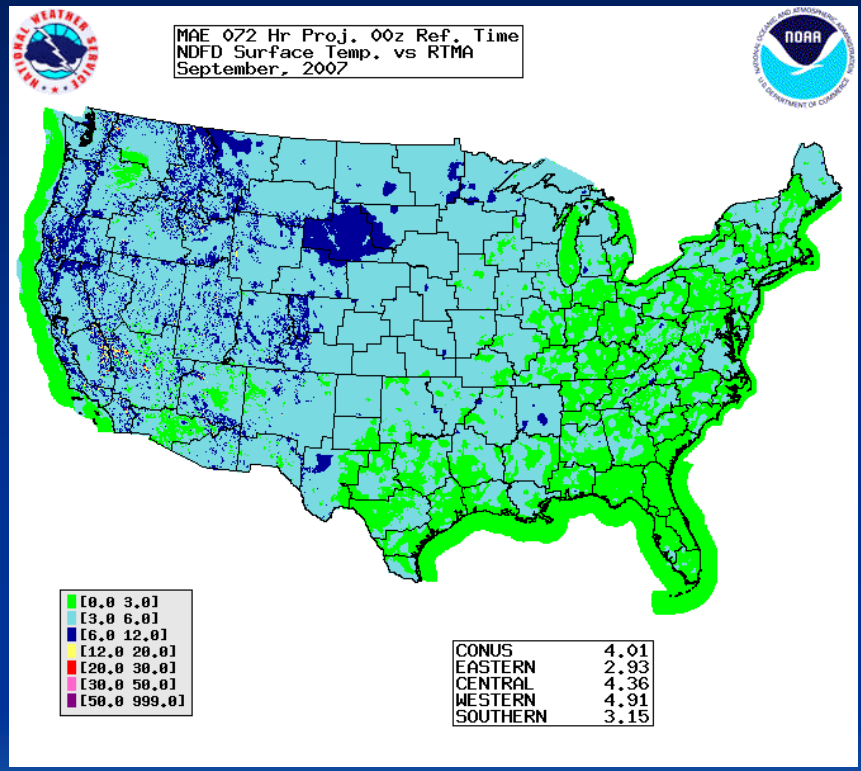
Motivation

- Forecaster concerns:
  - "The objective analysis never draws for the cold air that pools in the X valley!"
  - "I'll be penalized for adding detail to my grids!"
  - "The analysis never matches the observations in my northern mountain zones!"
- Forecasters need feedback on how they are doing across the entire forecast grid (CWA)

Current grid-based verification efforts



BOIVerify

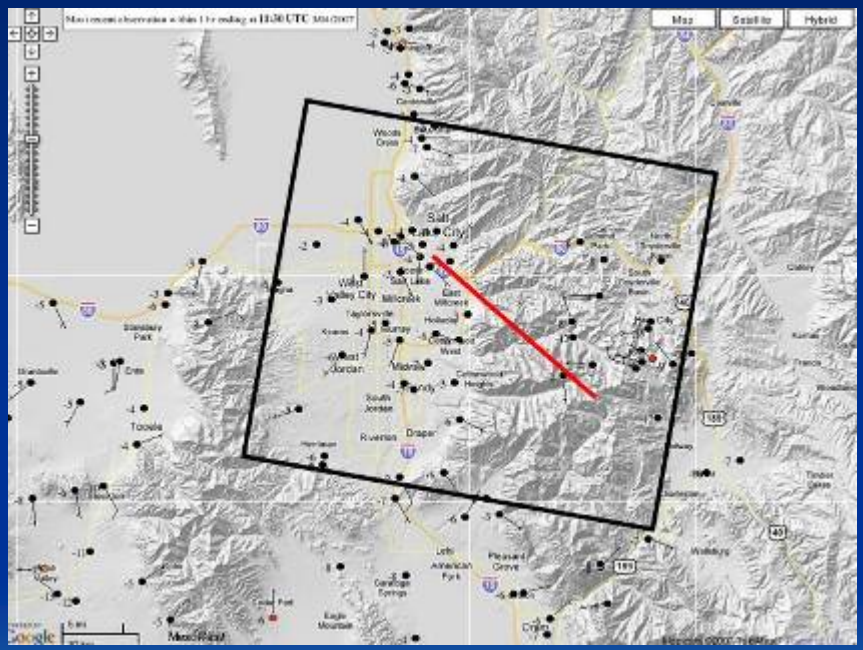


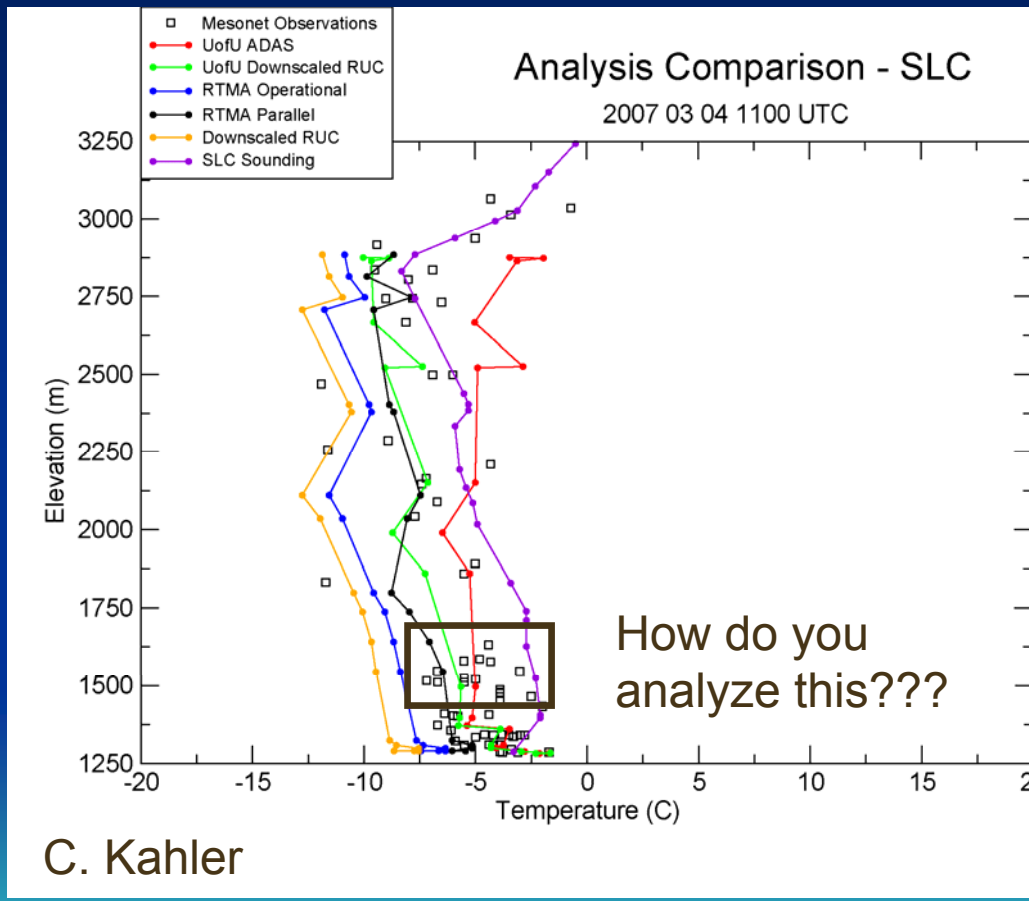
MDL – NDFD vs. RTMA

Objective Analyses are NOT perfect

- Errors are introduced by:
  - Background field
  - Assimilated observations
  - Observations that are not "representative" of the nearby area

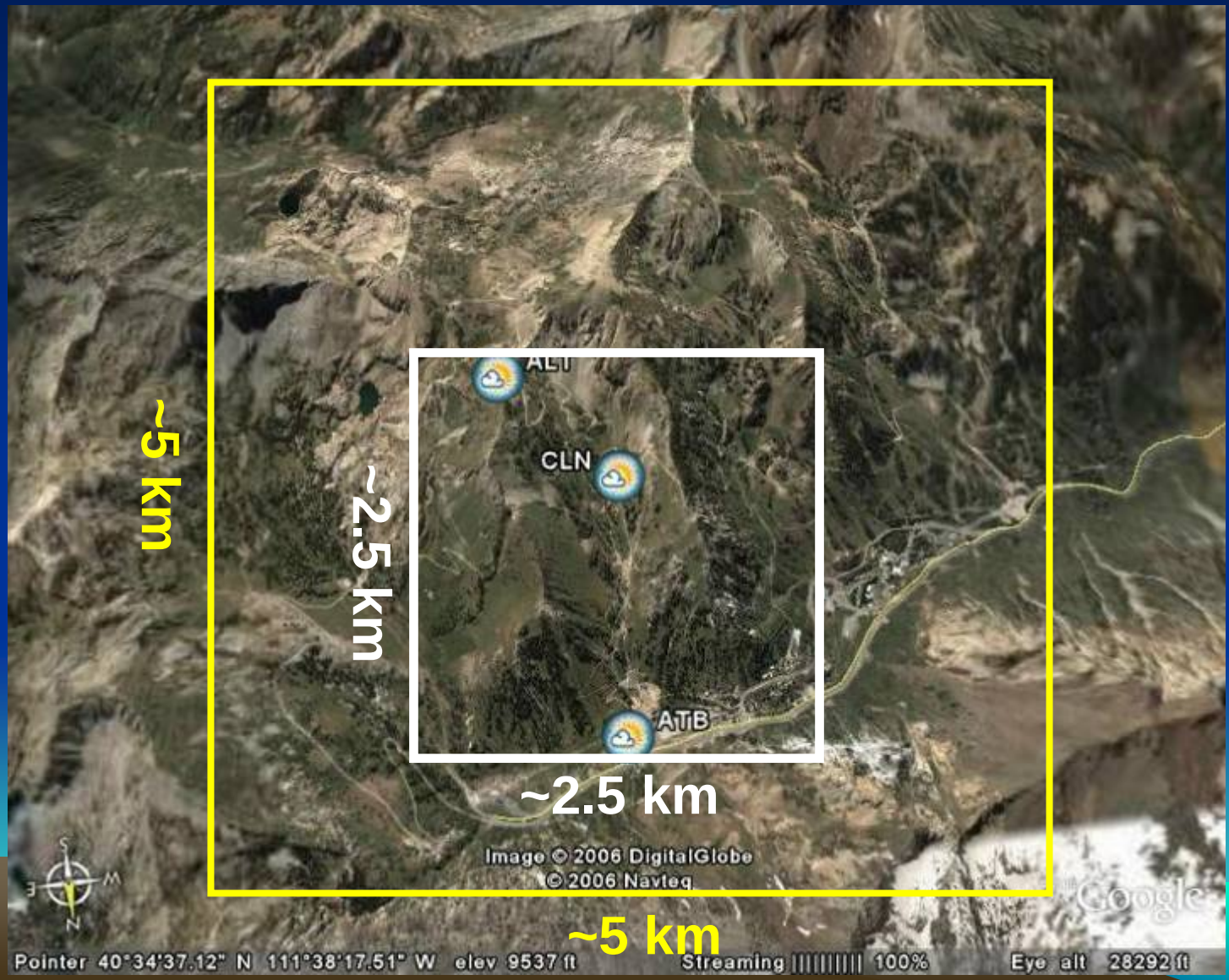
Representativeness Issue





C. Kahler

Alta Ski Area Example



Alta Ski Area Example

Looking up the mountain

Looking up Little Cottonwood Canyon

Alta Ski Area Example

Variation in a Grid Box

- Subtle differences also exist over flat(er) terrain
- Variation in temps walking around your neighborhood at night (Andy E's analogy)
- Proposed technique helps to account for the variation across a grid box

Objective Analyses are NOT perfect

- Analysis quality can vary by location:
  - Data density
  - Terrain structure
- Analysis errors can be estimated mathematically
  - Result can be used as an estimate of "uncertainty"

RTMA Uncertainty Estimates

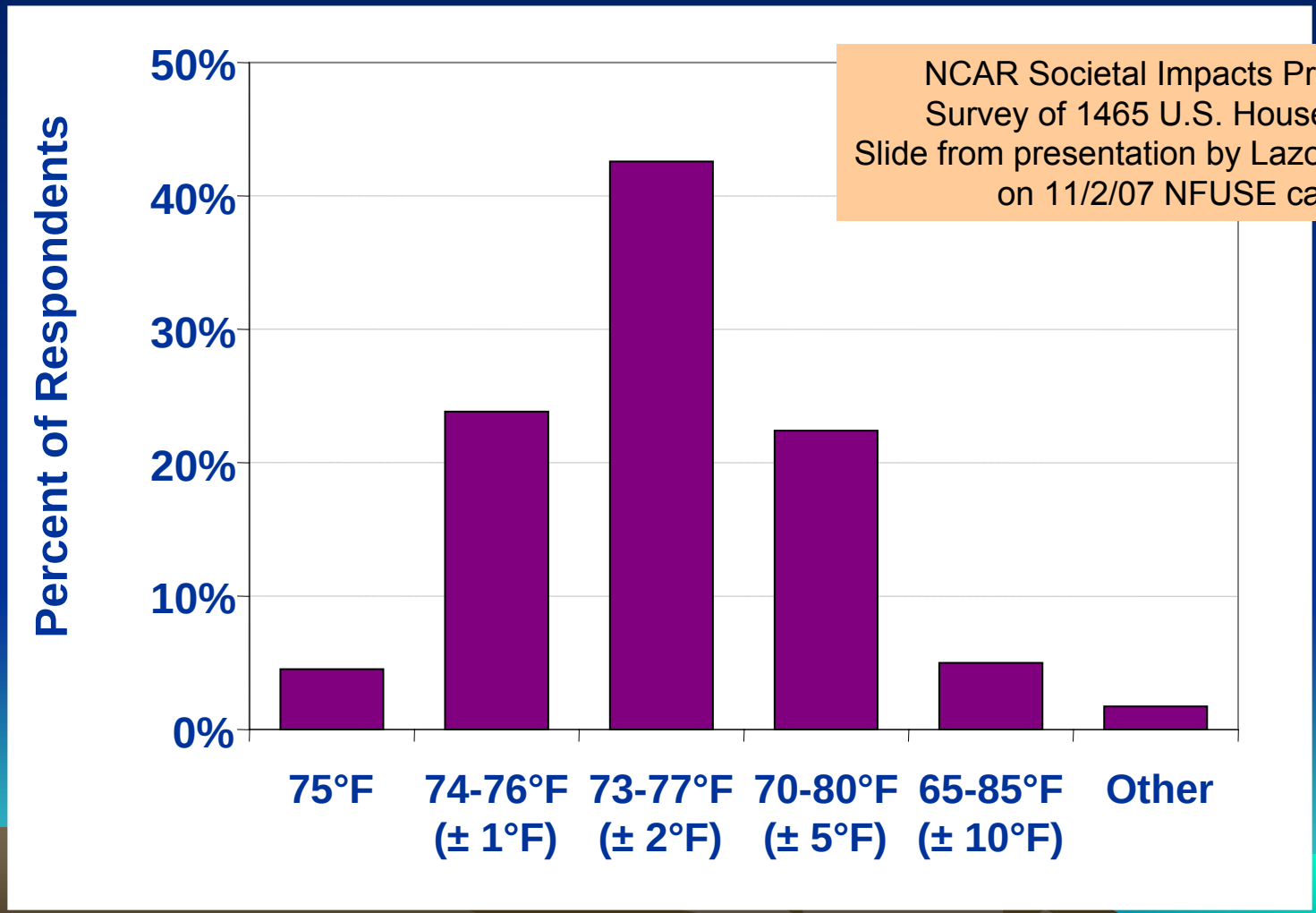
- Experimental product
  - RTMA: uncertainty is calculated at observation locations by taking the inverse of a simplified version of the Hessian matrix of the variational cost function (inexpensive)
  - Parallel RTMA: compute error using Lanczos method in conjunction with the conjugate gradient method of the GSI minimization procedure
- Goal:
  - Higher uncertainty in data sparse areas
  - Lower uncertainty in data dense areas
- Currently available for T, T_d, Wind

Idea

- Can we use the RTMA analysis uncertainty estimate as a proxy for a good forecast?
  - Lower margin of error in areas with obs
  - Forecasters would not be penalized as much in areas where the analysis struggles

Suppose the forecast high temperature for tomorrow for your area is 75°F.

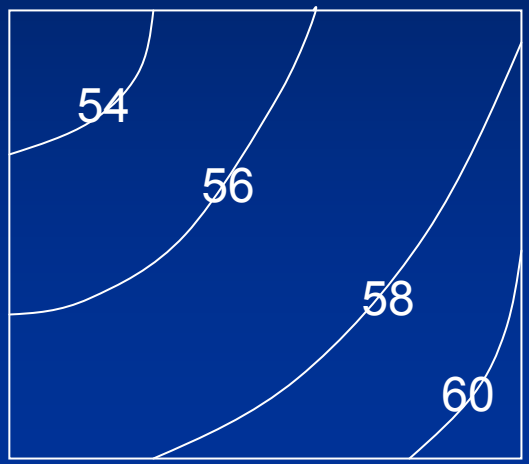
What do you think the actual high temperature will be?



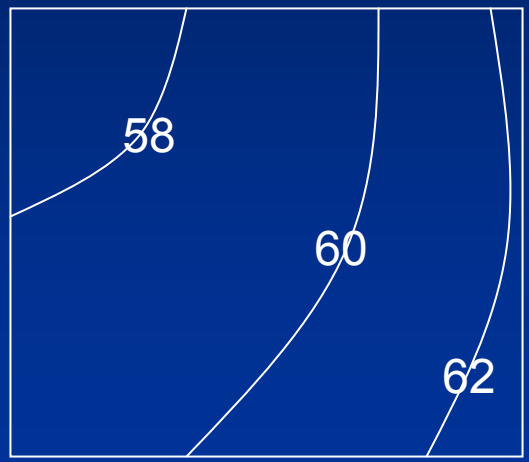
Example

- Forecast = 64ºF
- Analysis Value = 66ºF
- Analysis Uncertainty = +/- 3ºF
- Reward forecasts between 63-69ºF

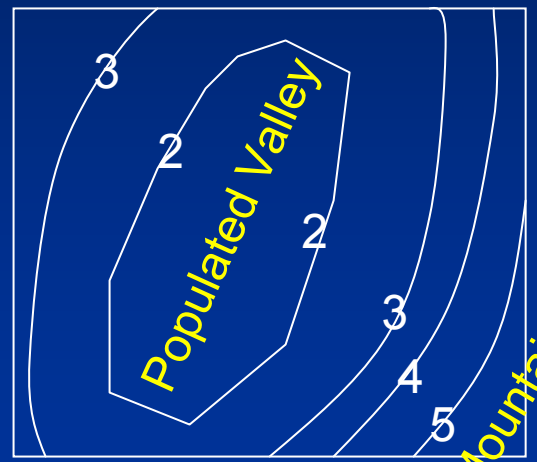
Temperature (°F) Forecast Example



Forecast

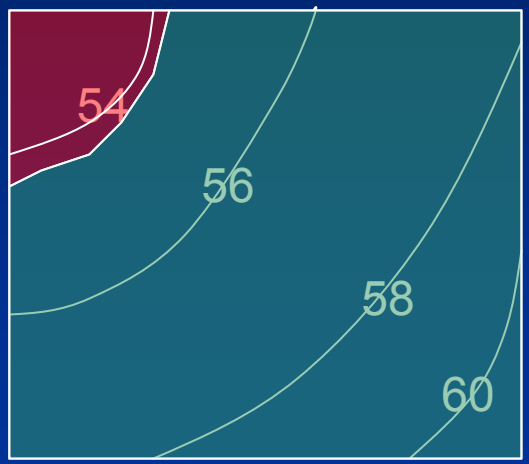


RTMA

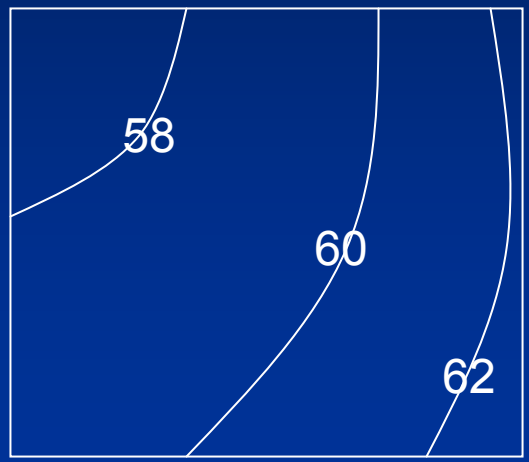


RTMA Uncertainty

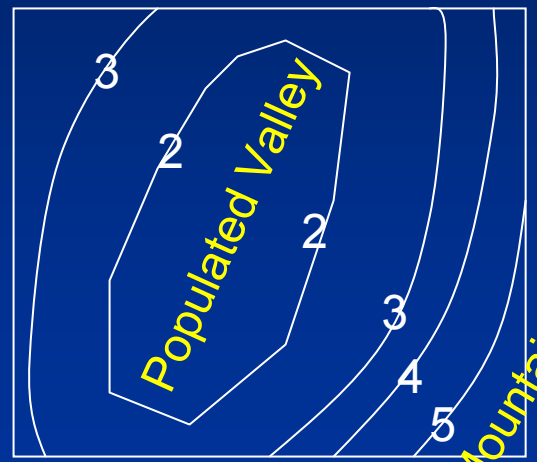
Temperature (°F) Forecast Example



Forecast



RTMA

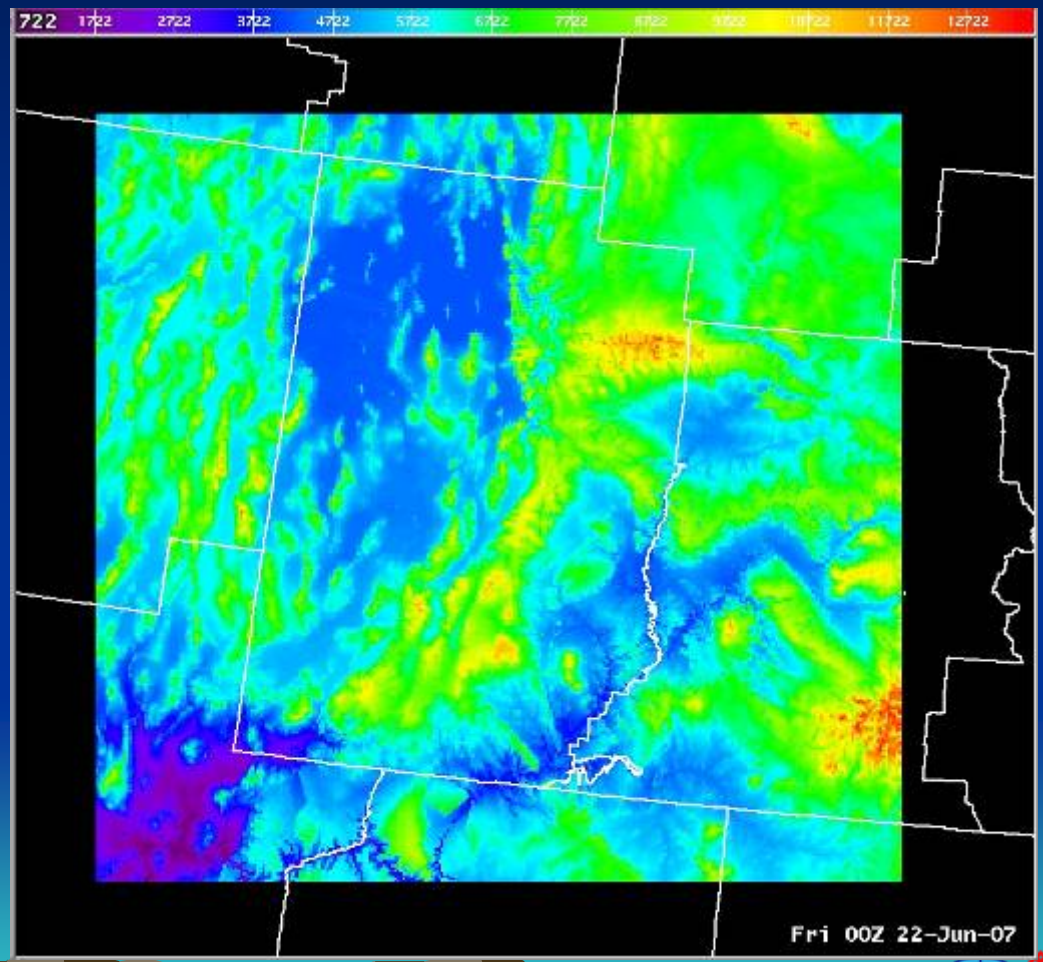


RTMA Uncertainty

Green = Forecasts are within the bounds of the analysis uncertainty
Red = abs(RTMA – Forecast) > Uncertainty

Utah Example

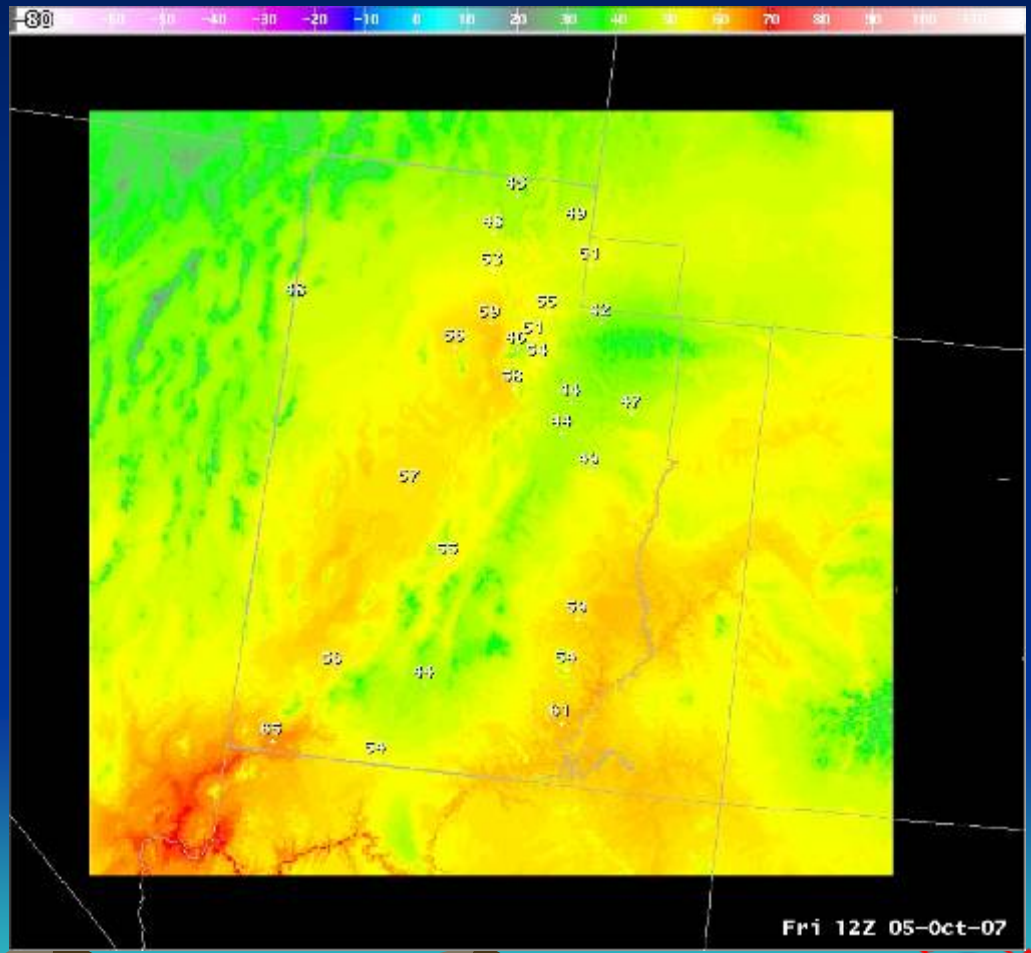
- NDFD terrain (used by the RTMA) captures the complex mountain/valley topography of the Great Basin



GFS40 T (ºF) Initialization

1200 UTC 5 October 2007

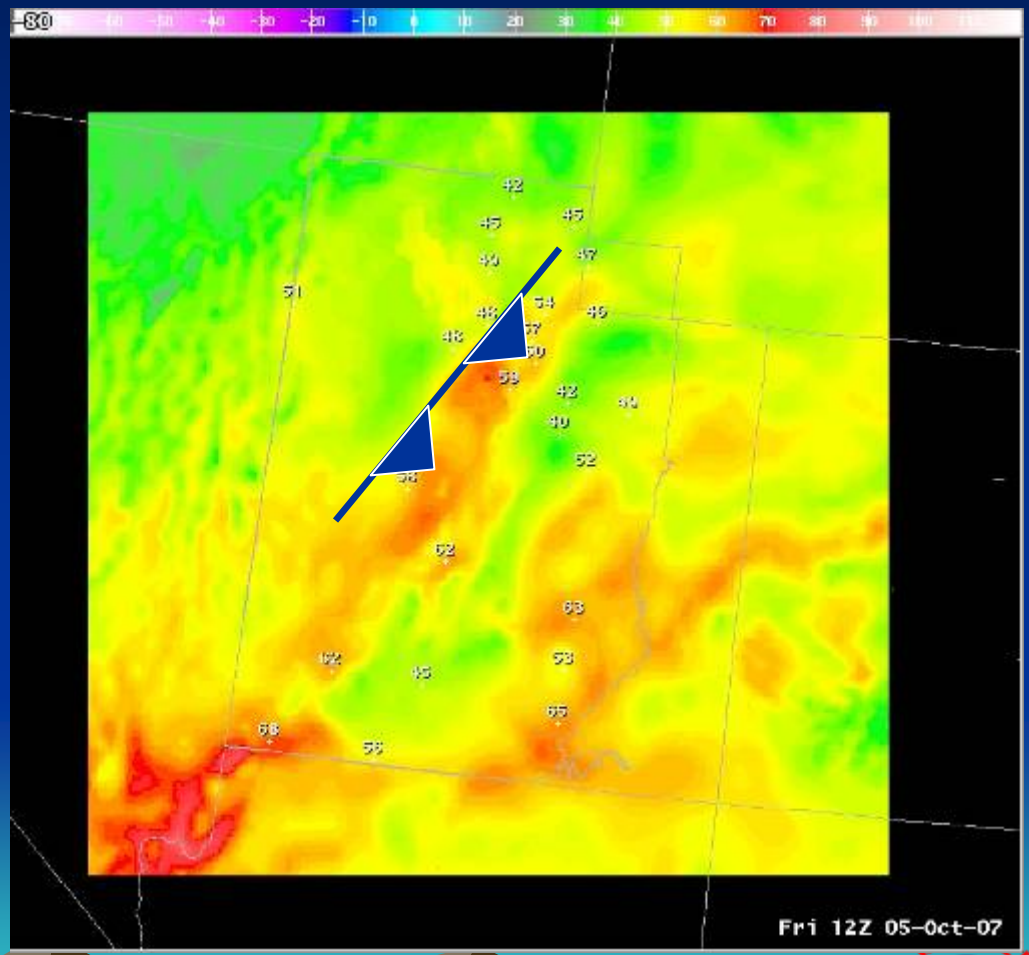
- Using model data to test technique
- GFS40 smartinit does a fairly good job downscaling to the terrain
- GFS40 – does not capture cold front along Wasatch Front



RTMA T (ºF)

1200 UTC 5 October 2007

- Cold front evident in the RTMA

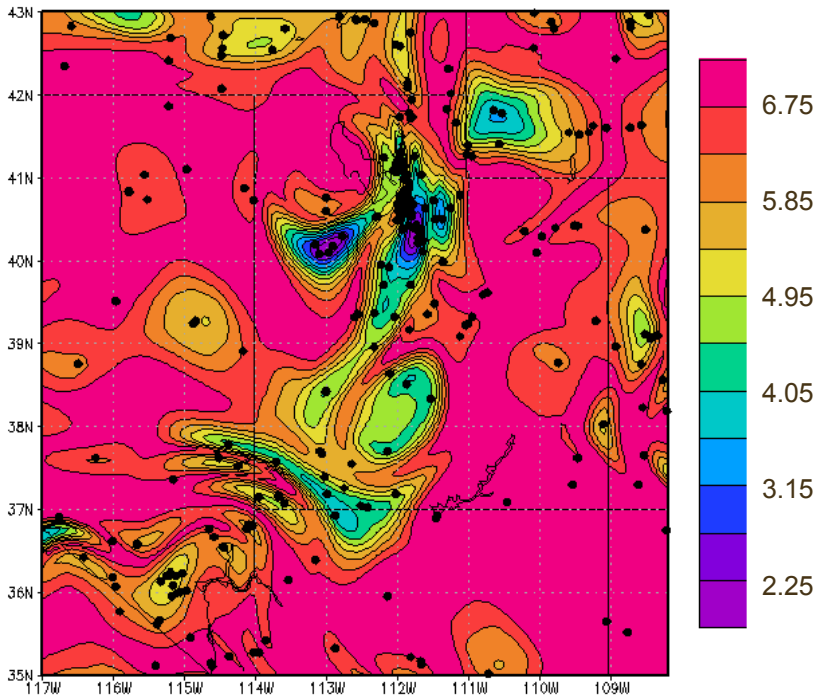


RTMA T (°F) Uncertainty

1200 UTC 5 October 2007

- NCEP/EMC working to incorporate vertical & terrain constraints into analysis of uncertainty

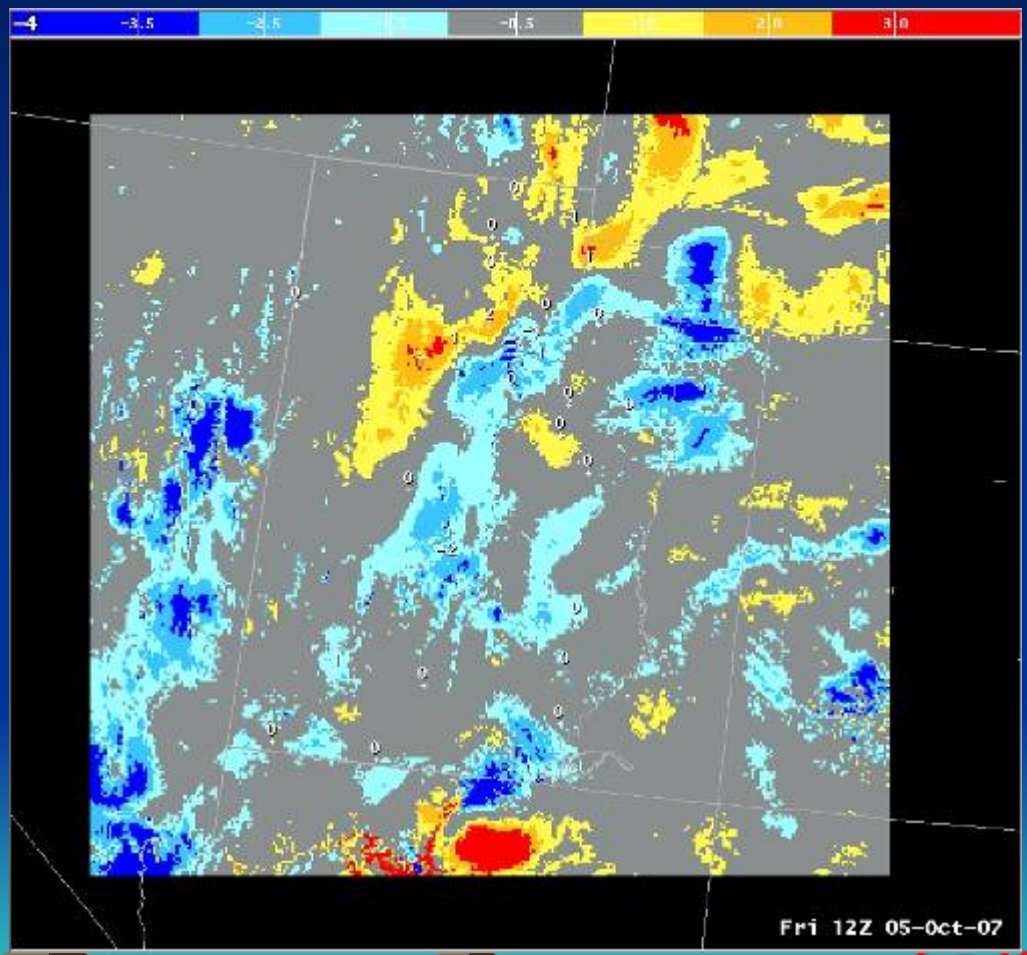
- Goal: lower values in data dense areas/valleys, higher values in data sparse areas/mountains



Uncertainty Verification T (°F)

1800 UTC 21 June 2007

- Gray areas = good forecasts (forecast is within bounds of analysis uncertainty)
- GFS40 too warm behind cold front
- GFS40 too cold ahead of cold front



Summary

- Challenge: How can we use an analysis in grid based verification without penalizing forecasters in areas with the analysis struggles?
- Proposal: Verify against RTMA ± Uncertainty
  - Give the forecaster credit for areas that are within the bounds of analysis uncertainty
- Goal: Provide feedback across the entire forecast grid
  - Where were temperatures too warm? Winds too weak? Dew points too dry?

More Information on the RTMA

RTMA COMET module (S. Jascourt) http://www.meted.ucar.edu/

Benjamin, S., J. M. Brown, G. Manikin, and G. Mann, 2007: The RTMA background – hourly downscaling of RUC data to 5-km detail. Preprints, *22nd Conf. on WAF/18th Conf. on NWP*, Park City, UT, Amer. Meteor. Soc., 4A.6.

De Pondeca, M., and Coauthors, 2007: The status of the Real Time Mesoscale Analysis at NCEP. Preprints, *22nd Conf. on WAF/18th Conf. on NWP*, Park City, UT, Amer. Meteor. Soc., 4A.5.

Horel, J., and B. Colman, 2005: Real-time and retrospective mesoscale objective analyses. Bull. Amer. Meteor. Soc., **86**, 1477-1480.