Analysis of Persistent Bias and Suggested Improvements in Forecasting Temperatures Patterns over Canaan Valley, WV with the National Blend of Models (NBM)

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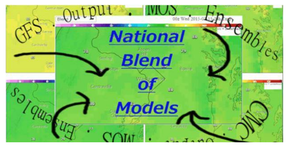
A. NBM and RTMA/URMA

- The **National Blend of Models (NBM)** is a post-processed forecast guidance suite at 2.5 km resolution that avoids discontinuities between forecast office warning areas
- **Real Time Mesoscale Analysis (RTMA)** blends a HRRR/NAM first-guess background with hourly observations to represent surface conditions
- **UnRestricted Mesoscale Analysis (URMA)** adds delayed observations and **is the NBM ground truth**



B. Canaan Valley, WV

- **Canaan Valley, WV (3,150 ft., Fig. 1)** is a textbook **frost hollow**, allowing for cold pooling on clear, calm nights
- Valley hosts important recreational activities, such as golfing, skiing, and hunting
- Valley includes a weather station **(DY007)** professionally maintained by Virginia Tech and **recognized by the NWS**

Fig. 1: Canaan Valley, WV[1]

C. Previous Canaan Valley Research

- Research conducted for AMS 2023 revealed NBM and URMA **struggling to represent Valley cold pools**
- Primary case was **1/22/2022**, with a **record low of -31°F** and an NBM value **above 0°F** (30°F+ warm bias, **Fig. 2**)
- This event **appeared in national headlines**[2]

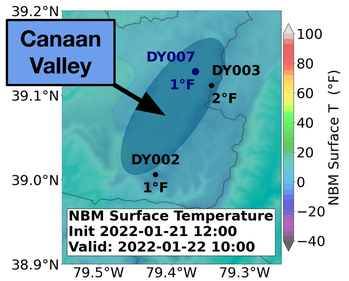


Fig. 2: NBM 1/22/2022 Temperatures

D. Initial Findings and New Case Selection

- Most DY007 observations (circles) **were assimilated** (green) **in URMA** but **not shown in analysis** (blue, **Fig. 3**)
- Initial cases suggested **Non-Linear Quality Control (NLQC)** was the primary cause of bias
  - URMA analysis adheres to **DY003 values** (diamonds)
- New cases include **varied Valley temperature patterns**

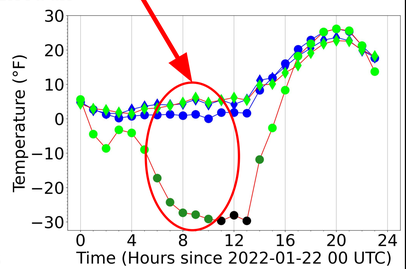


Fig. 3: 1/22/2022 URMA Analysis

E. Early June 2023 Cases

- Unusually cold start to meteorological summer, with **several nights below freezing** at the Valley floor **(Fig. 4)**

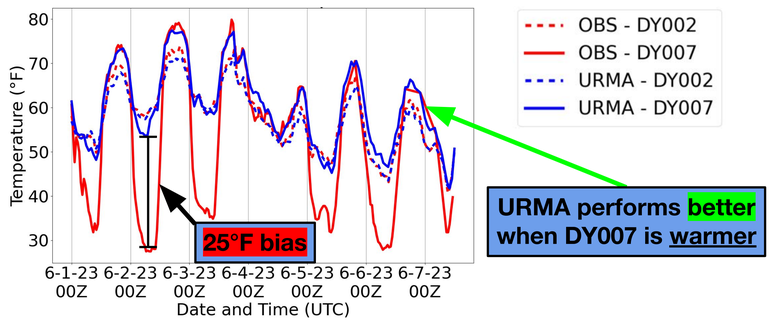


Fig. 4: URMA and Obs. DY002/DY007 Temperatures from 6/1/2023 to 6/7/2023

- **URMA failed to capture the cold pooling events,** leading to **poor NBM forecasts** for Valley temperatures
  - URMA adheres to DY002 temperatures, **indicating NLQC assigning a low analysis weight[3] to DY007**
- Interesting trend emerges involving **asymmetry** of URMA bias: **warmer temperatures at DY007 are captured <u>much more closely by URMA analysis</u>**
  - NLQC appears to **maintain higher DY007 weights during the daytime**

F. February 4, 2023 Detailed Case

- Case of the **lowest Valley temperatures of the season**
- **Asymmetric biases shown in overnight temperatures**
  - URMA follows DY007 **until it becomes colder than DY002**
- Biases also present in **<u>NBM</u>** and **<u>HRRR</u> background (Fig. 5)**
- **NLQC weights** change with ***z*:**

$$z = \frac{OB - URMA}{OB}$$ **(Fig. 6)**

- Higher *z* magnitudes **give lower NLQC weight**
- DY007 *z* values **decrease** as **URMA bias increases**

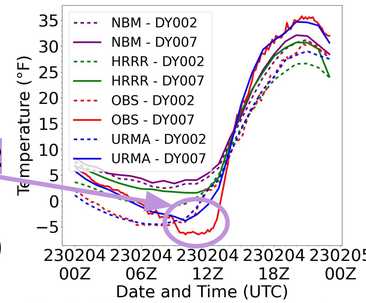


Fig. 5: 2/4/2023 Valley Temperatures

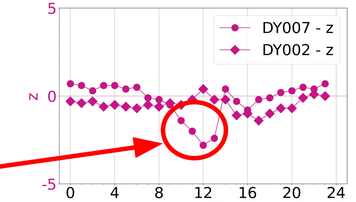


Fig. 6: 2/4/2023 Valley *z* Values

G. New Findings and Future Work

- ★ URMA warm bias **continues to occur during Canaan Valley cold pools,** resulting in **<u>lower NBM forecast skill</u>**
  - New cases show **low NLQC weights** as a likely cause
  - Asymmetry possibly linked to **NLQC weighting function**
- ★ **Adding Valley COOP observations** could improve bias
  - Possible improvement limited by **daily observations**
- ★ **Further research will include <u>examining cases on a broader scale</u> and <u>analyzing temperatures at more stations around the Valley</u>**

H. References and Acknowledgements

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References:
1. Canaan Valley photograph courtesy of Josh Brenneman; taken May 3, 2023.
2. Samenow, J., 2022: West Virginia's Canaan Valley Plummets to minus-31, setting record low for region. *The Washington Post*. https://www.washingtonpost.com/weather/2022/01/22/canaan-valley-low-temperature-record/ (Accessed November 28, 2022).
3. Purser, R. J., 2018: Convenient Parameterizations of Super-Logistic Probability Models of Effective Observation Error.