

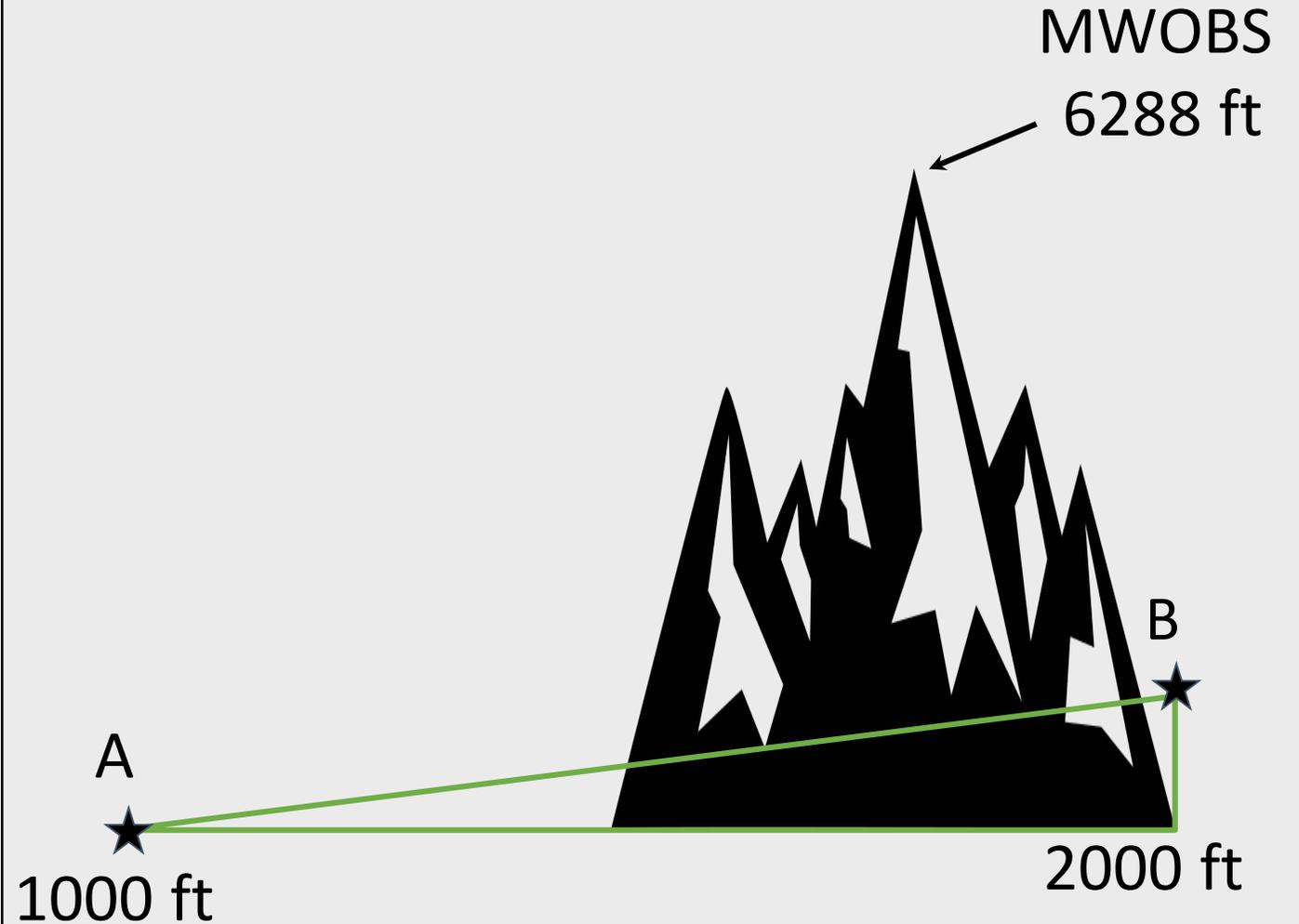


Mountain Weather Forecasting

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Motivation

- MWOBS produces twice-daily 48 Higher Summits Forecast
- Models can't see small features (like mountains)
- Forecasting relies on:
 - Physical weather models
 - Forecaster experience
 - Model Output Statistics (MOS)

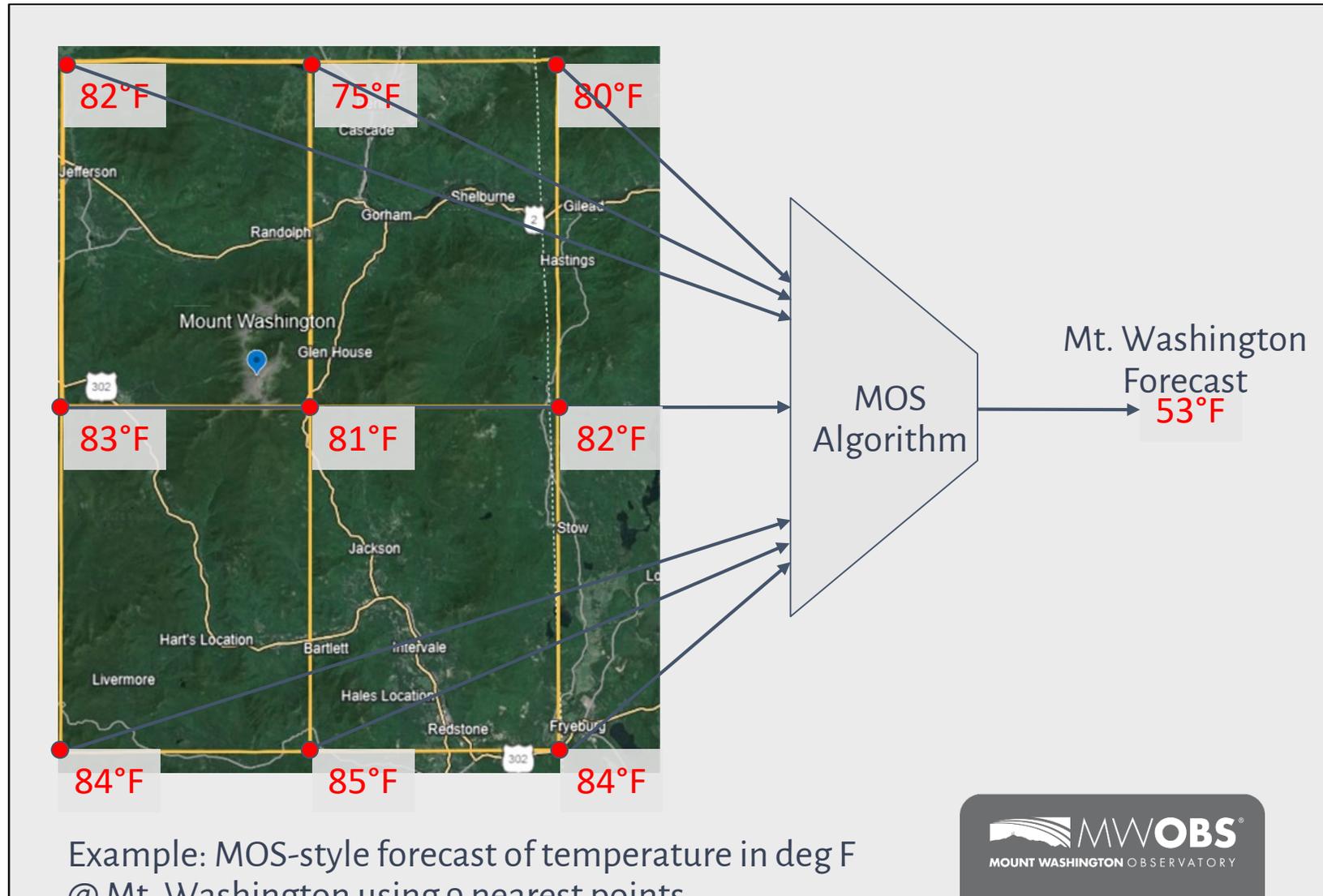


Actual terrain (black)

Quarter degree resolution model terrain (green)

Model Output Statistics (MOS)

- Steps
 - Get gridded model data
 - Get observational data
 - Find statistical relationship
 - Make forecasts
- Pros
 - Easy to compute
 - Makes good use of observations
- Cons
 - Non-physical (uses Machine Learning instead)



Data

- MOS Products: GFS MOS, NAM MOS, NBM
- Period of study: 11/01/2020 - 05/16/2024
- Lead times: 6-72 hrs at intervals of 3 hrs

Variable	Short name	Units
Temperature	T	°F
Dewpoint Temperature	T_d	°F
Dewpoint Depression	$T - T_d$	°F
Wind Speed	V	kts
Wind Direction	θ	degrees

Metrics

- NWS verification standards:
 - MAE - how far off is the average forecast?
 - Bias - does the model systematically forecast high or low?

$$\frac{\sum_{i=1}^N |x_i - y_i|}{N}$$

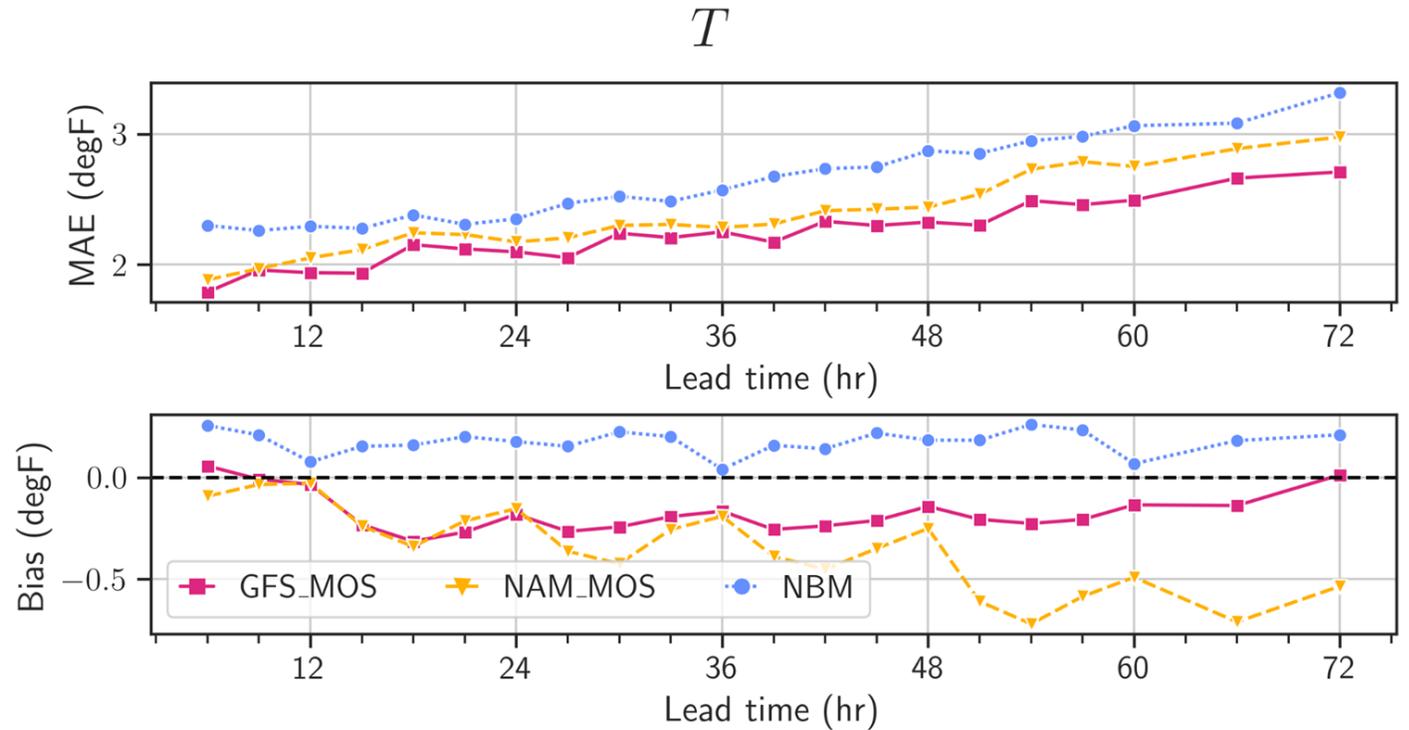
Mean Absolute Error (MAE)

$$\frac{\sum_{i=1}^N (x_i - y_i)}{N}$$

Bias

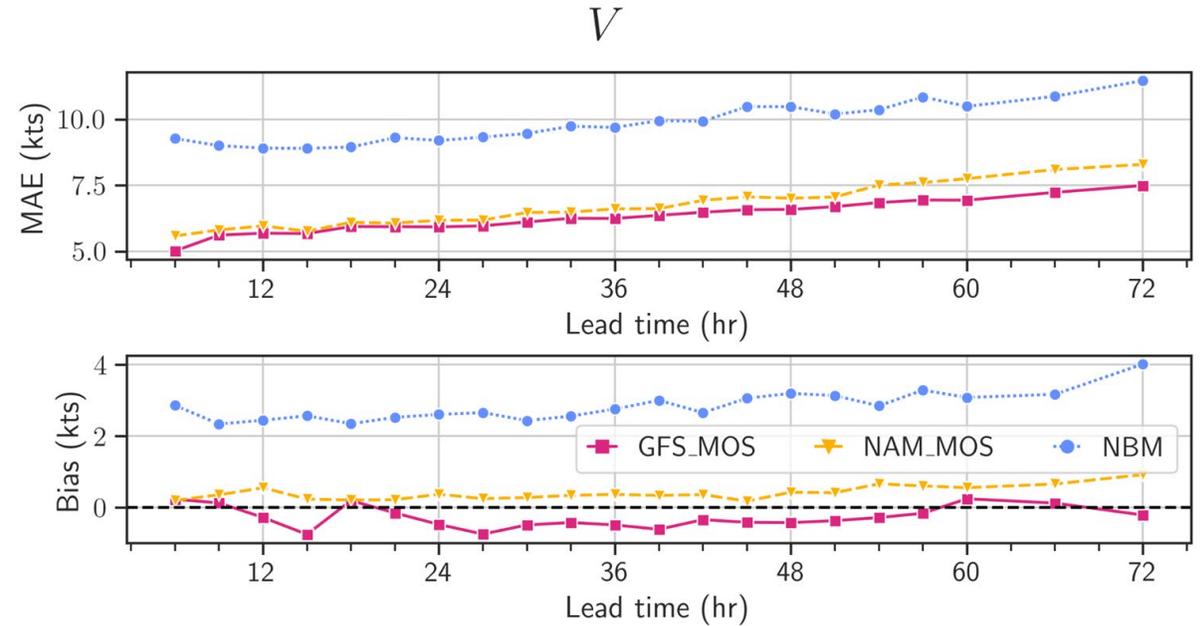
Temperature Verification

- All products perform well
- Errors rise from ~ 2 °F to ~ 3 °F
- MAE Differences small (< 1 °F)
- Low bias



Wind Speed Verification

- GFS / NAM outperform NBM
- Error rises steadily: 5 to 7.5 knots for GFS/NAM
- Only notable bias is NBM

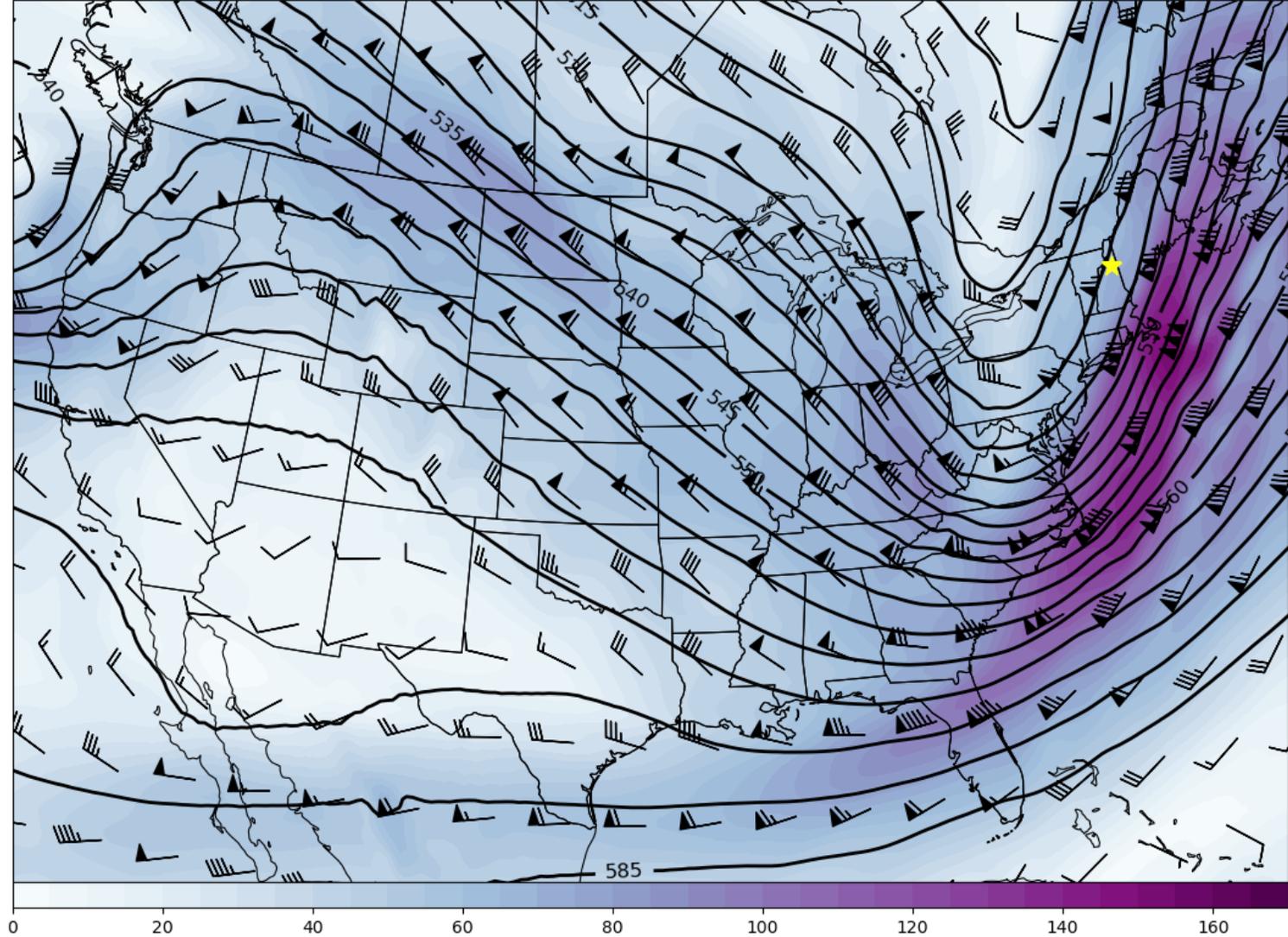


Case Studies

- Picked representative plots
- Temperature
- Dewpoint
- Dewpoint Depression
- Wind Speed
- Wind Direction

500 hPa
Wind in knots (shaded)
Height in dam (contoured)

ERA5 analysis for 00z 13 Mar 2022

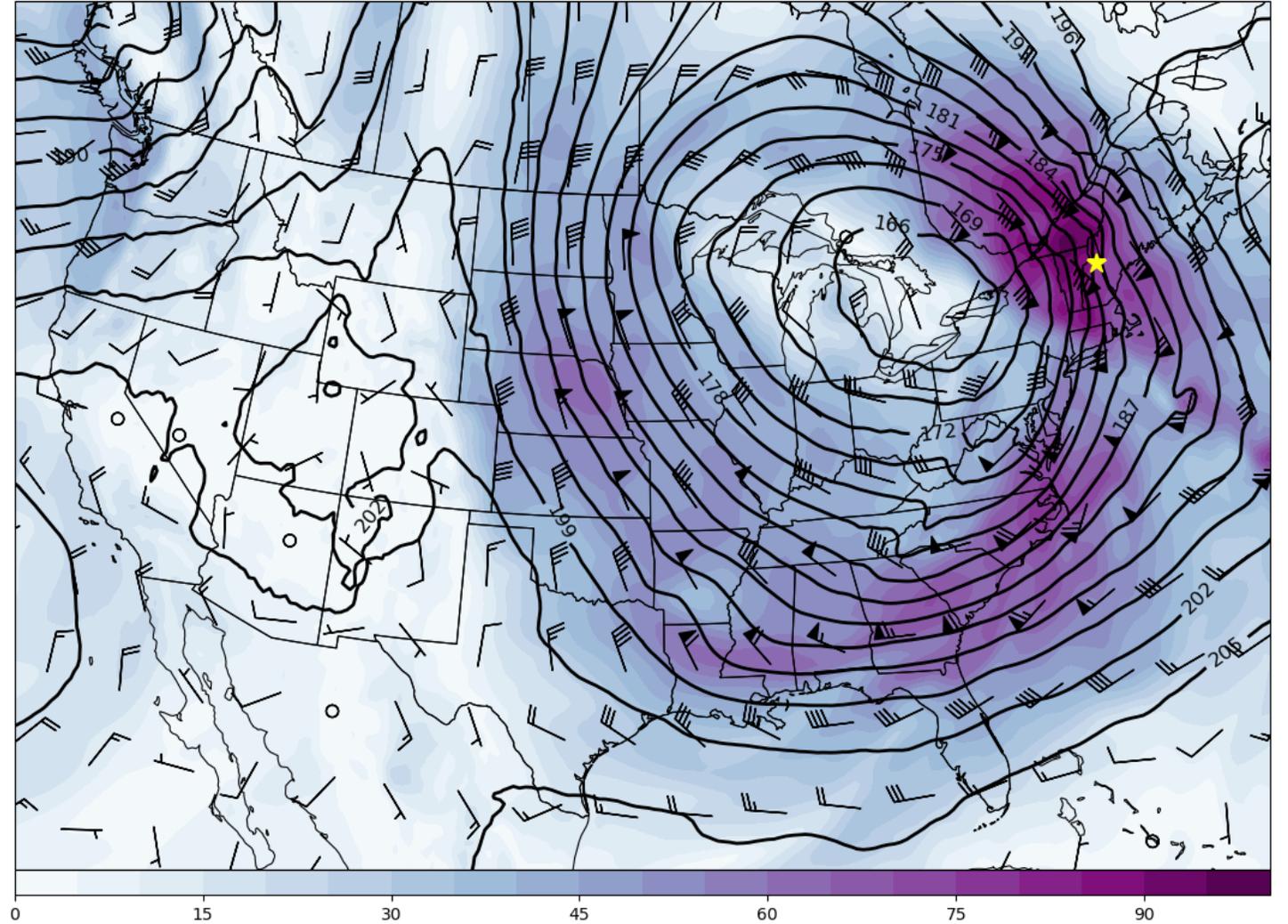


Wind Speed

- Low pressure
- Southerly winds
- GFS MOS error of 44 knots
- NAM MOS error of 35 knots

800 hPa
Wind in knots (shaded)
Height in dam (contoured)

ERA5 analysis for 12z 23 Dec 2022

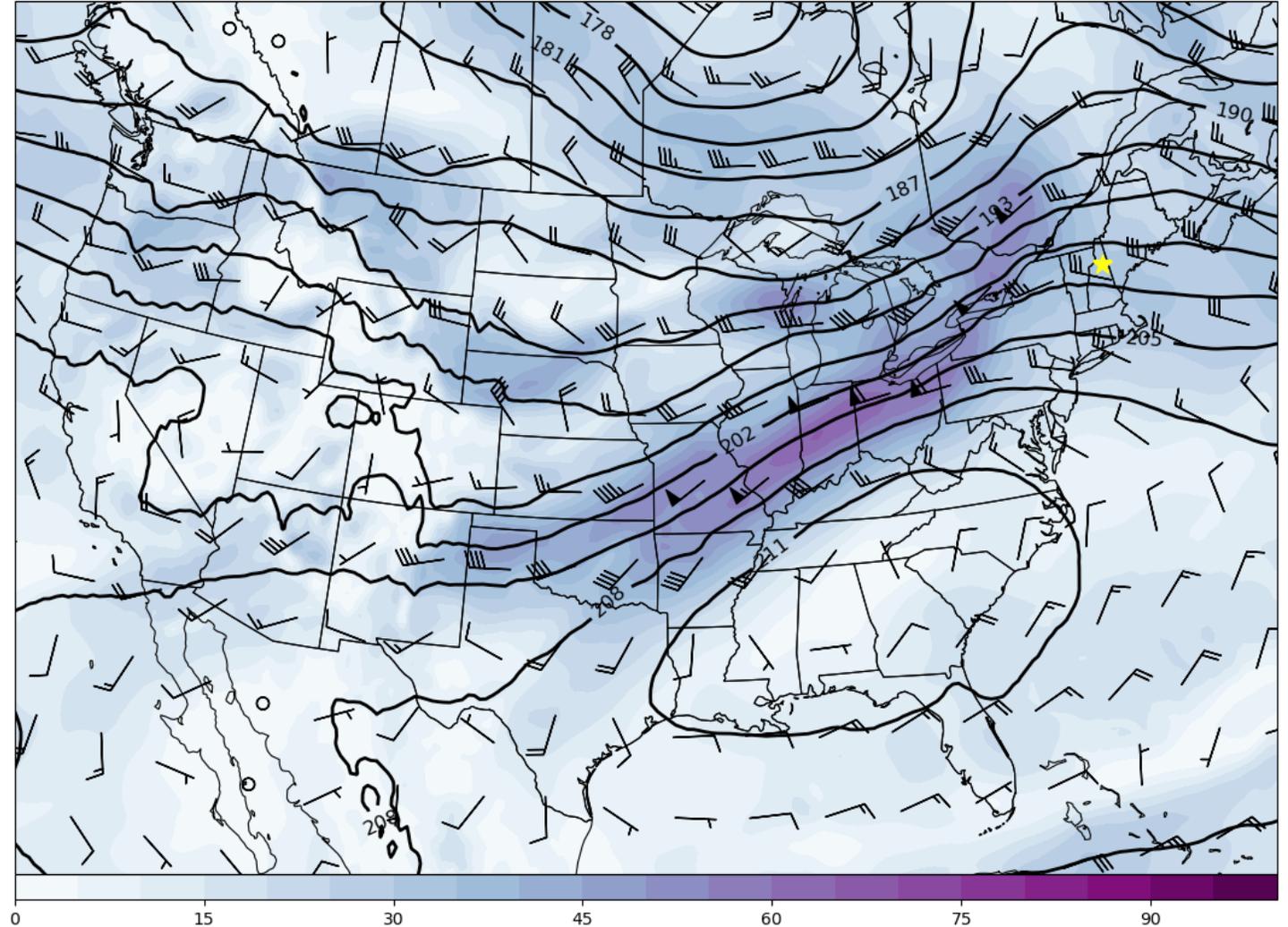


Dewpoint

- High pressure
- Brief dry periods
 - Fog “mixes” out
- NAM MOS error of 42°F

800 hPa
Wind in knots (shaded)
Height in dam (contoured)

ERA5 analysis for 12z 19 Nov 2020



Conclusions

- Rankings
 - Temperature, Dewpoint, Dewpoint Depression
 - : GFS > NAM > NBM
 - Wind Speed and Direction
 - : GFS > NAM >>> NBM
- Highest wind errors found under southerly winds
- Highest dewpoint errors caused by brief clearing

Future Work

- Study new version of NBM
- More variables (probabilistic, visibility, temperature extrema)
- Break down analysis by season



Thank you!