



# An Algorithm for Downscaling Wind Speed in Areas of Pronounced Terrain

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# Objectives

- To generate downscaled gridded model wind speed guidance in areas with pronounced terrain by leveraging 10-m model wind speed **and** wind gust forecasts.
- To capture the same spatial detail as NDFD forecasts without introducing regional and artificial boundary discontinuities.

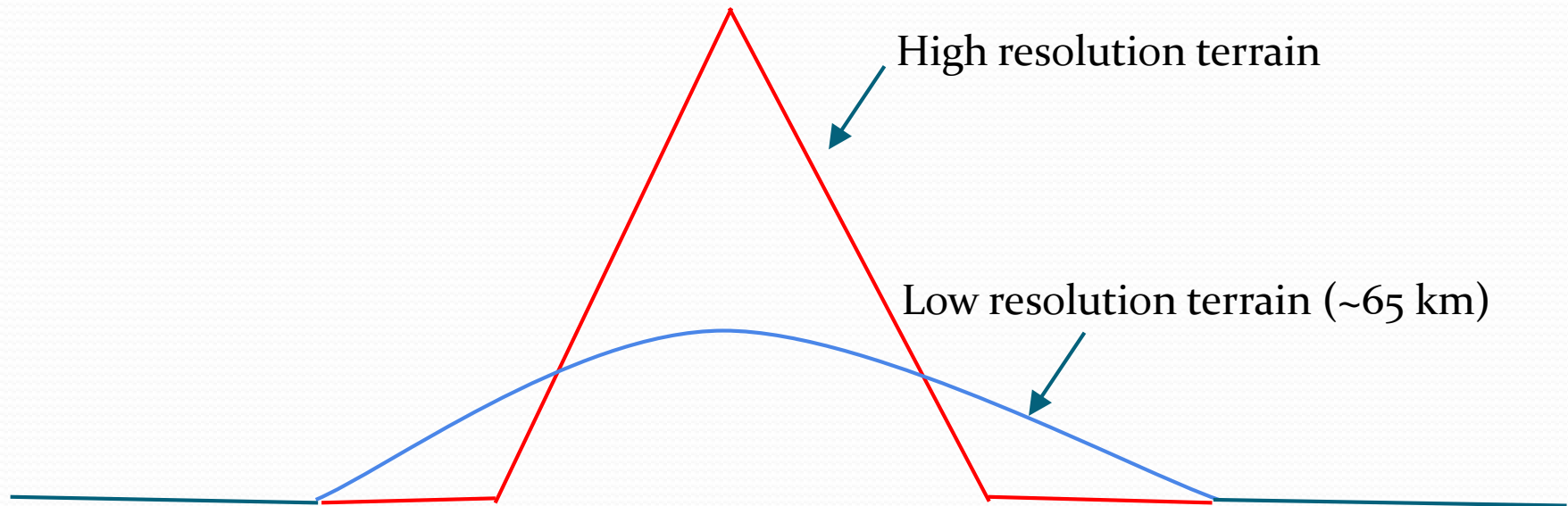


# Identifying Areas of Pronounced Terrain

- To identify pronounced local terrain features such as ridge-tops, we compare the elevation of each gridpoint to the average elevation in its vicinity.
- We subtract a high-resolution elevation dataset from a smoothed elevation dataset (~65 km) to find the elevation difference.
- The elevation difference is used to identify localized terrain features at the NDFD grid resolution.

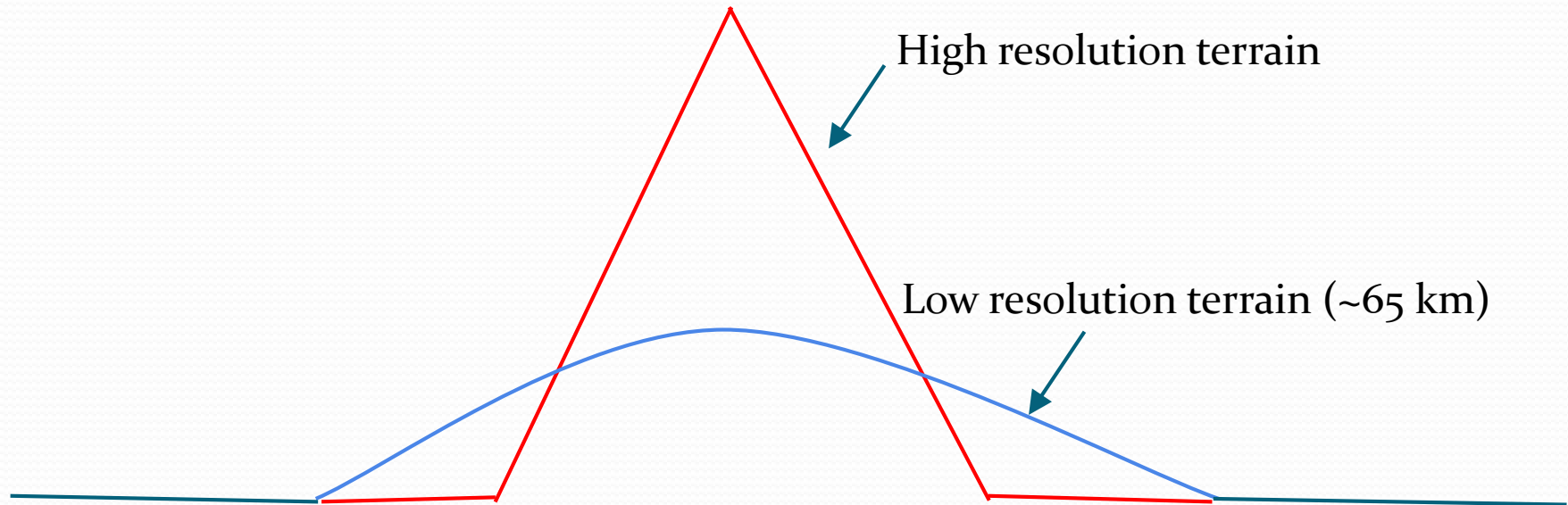


# Identifying Areas of Pronounced Terrain (Cont.)



# Identifying Areas of Pronounced Terrain (Cont.)

- Compute difference between high and smoothed resolution elevations: Terrain Difference (TDIFF)





# Algorithm for Downscaling Wind Speed

$$\text{Downscaled Wind Speed} = \beta_{\text{gust}} * \text{WG} + (1 - \beta_{\text{gust}}) * \text{WS}$$

Where,  $\beta_{\text{gust}}$  = Weight assigned to the wind gust (see below)

**WG** = Wind gust forecast after interpolation to high resolution grid

**WS** = Wind speed forecast after interpolation to high resolution grid

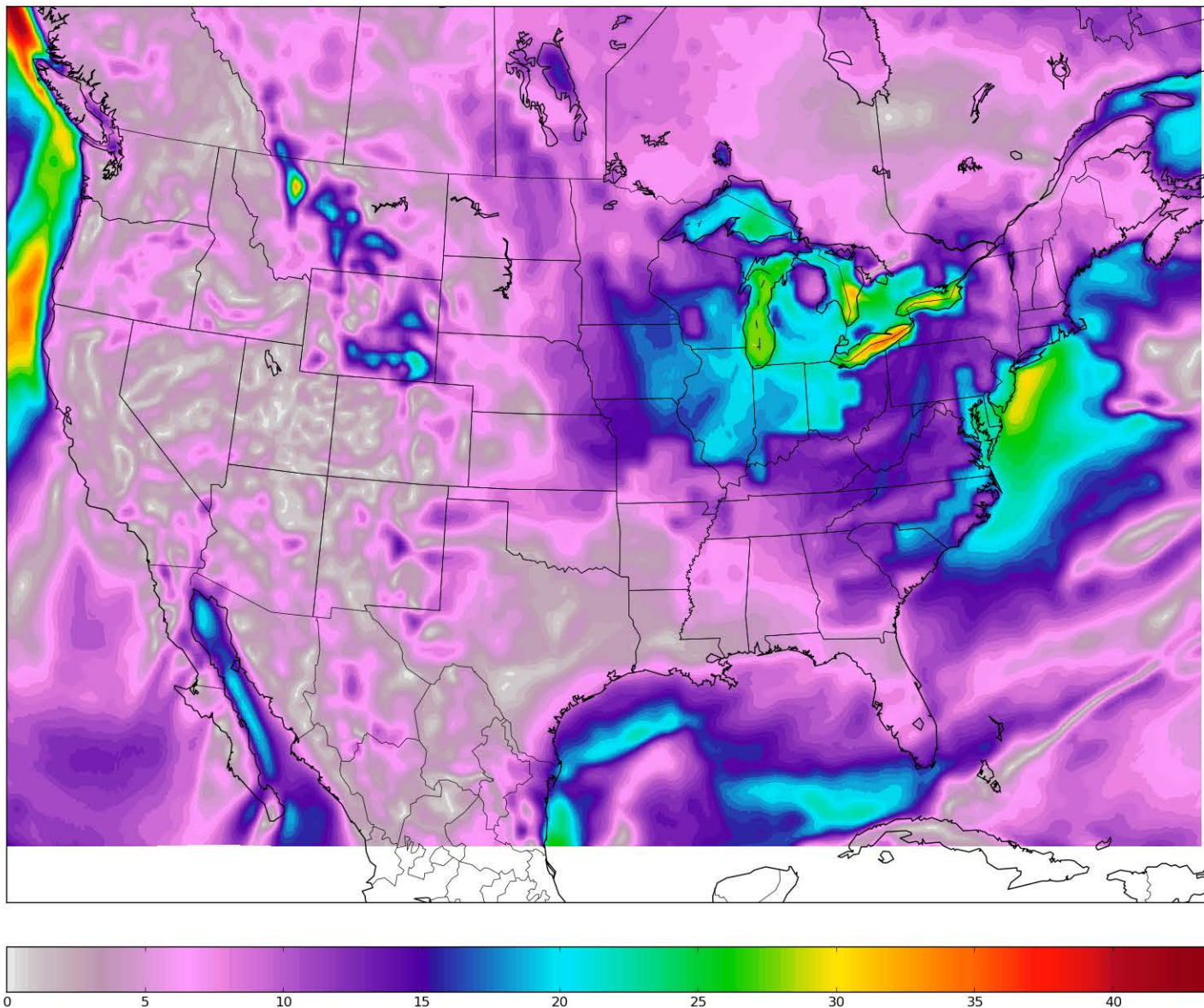
and, **TDIFF** = High Resolution Terrain – Low Resolution Terrain

$\beta_{\text{gust}} (\text{TDIFF} > 55 \text{ meters}) = \text{Minimum}(1, \text{TDIFF}/200)$

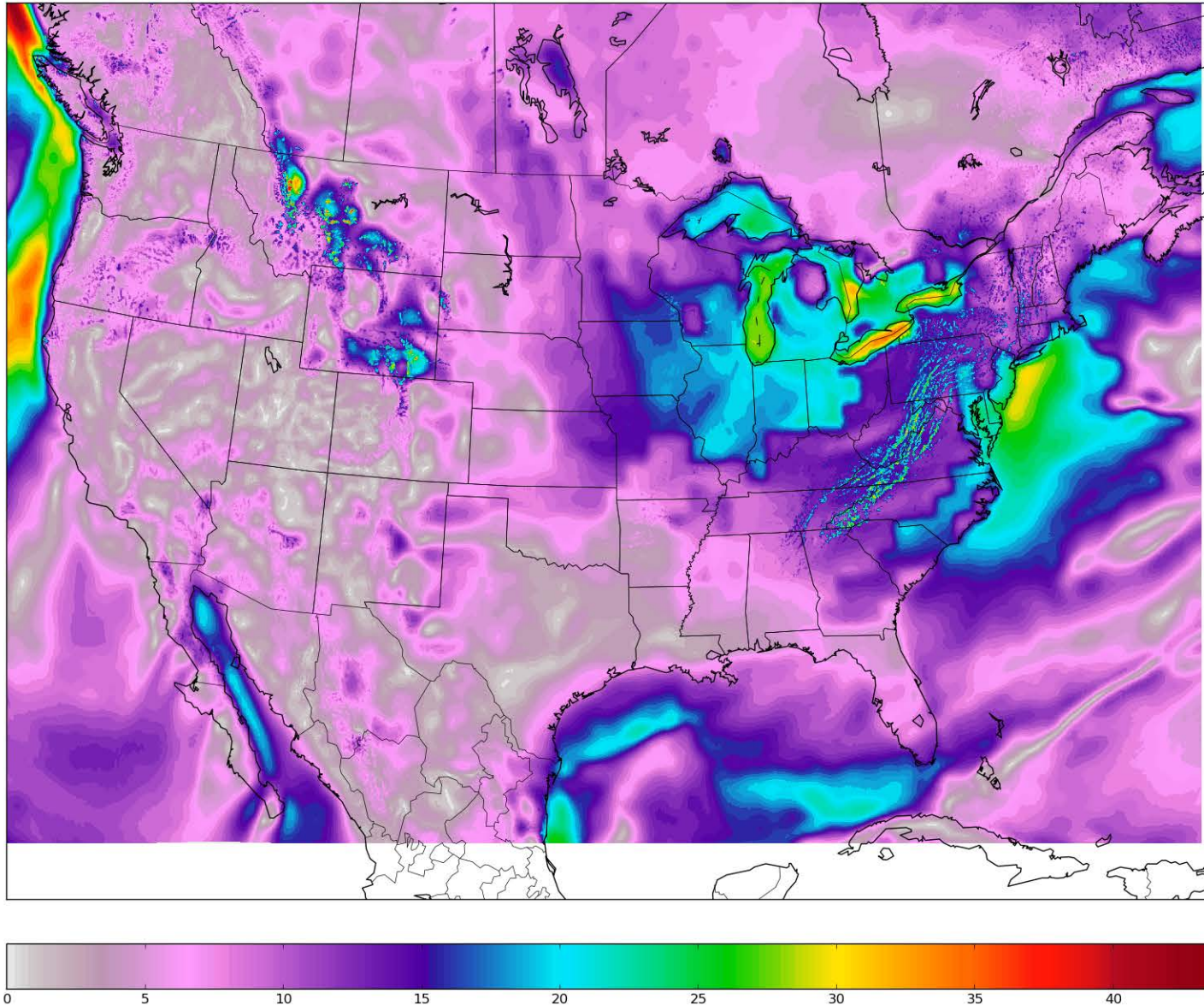
$\beta_{\text{gust}} (\text{TDIFF} \leq 55 \text{ meters}) = 0$



# Raw GFS Wind Speed Issued: 10 January 2016 00Z, 66-hr Forecast



# *Downscaled* GFS Wind Speed Issued: 10 January 2016 00Z, 66-hr Forecast





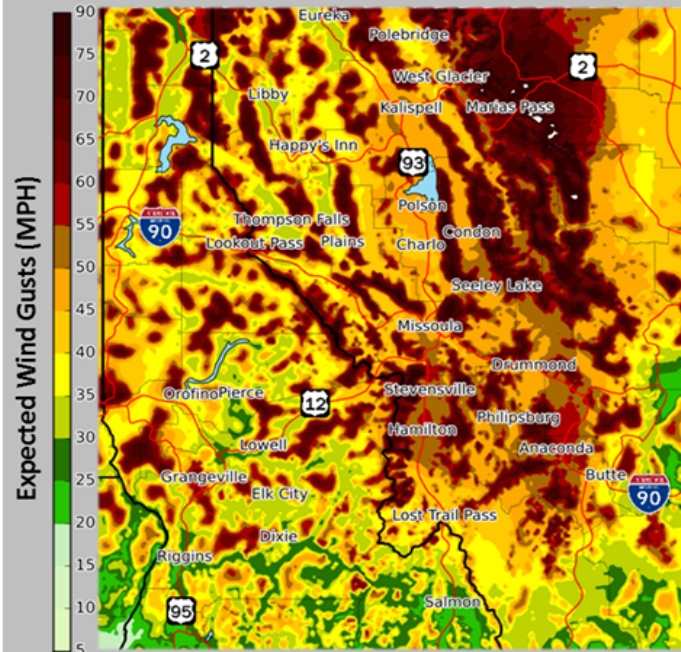


# Benefits of this Algorithm

- Local adjustments to wind speeds in pronounced terrain are not tied to predefined terrain height thresholds. The adjustment is made relative to the local terrain features.
- Incorporating the wind gust forecast into the calculation provides a reasonable upper limit to the wind speed forecast.
- The simplicity of this algorithm allows for easy implementation.
- For extreme wind events, this algorithm realistically captures the wind speeds along ridgetops.

# WFO Missoula – Ridge Winds

## Damaging Winds Expected



**Tue Evening –  
Wed Morning**

### Impacts:

- Downed trees
- Power outages
- Dangerous backcountry conditions
- Hazardous travel for high profile vehicles
- Blowing snow over high mountain passes
- Damage to outdoor personal items

Example of WFO Missoula Forecasters using NBM to increase forecast wind speeds over higher terrain. The forecast was then used in a social media post.

*“The forecaster I worked with merely ran a tool to pull in the NBM wherever it was greater than our going forecast.”*

– Darren Van Cleave (Missoula, MT)



#### US National Weather Service Missoula Montana

Confidence is now high for a damaging wind event Tuesday evening through Wednesday morning across the Northern Rockies. Wind gusts in excess of 50 mph could result in power outages, tree damage, and hazardous cross winds for higher profile vehicles. The Bitterroot Valley and the I-90 corridor from Deer Lodge to Butte are of particular concern, where gusts could be into the 60 mph range. Snow and blowing snow in the terrain above 5500 feet will be added dangers for those traveling over area passes or in the backcountry, and in these higher elevations, wind gusts to 70+ mph are likely.

Here is a video talking through the event: <https://youtu.be/zGmvnfJbxzY>

November 16

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Thank You.