NATIONAL WEATHER SERVICE

An Alaska Case Study in Extreme Snowfall Verification

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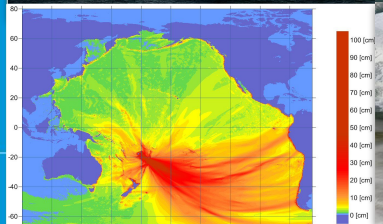
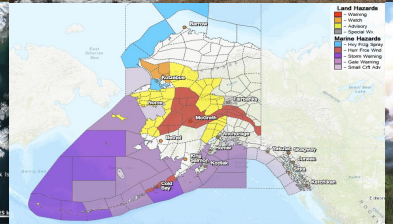




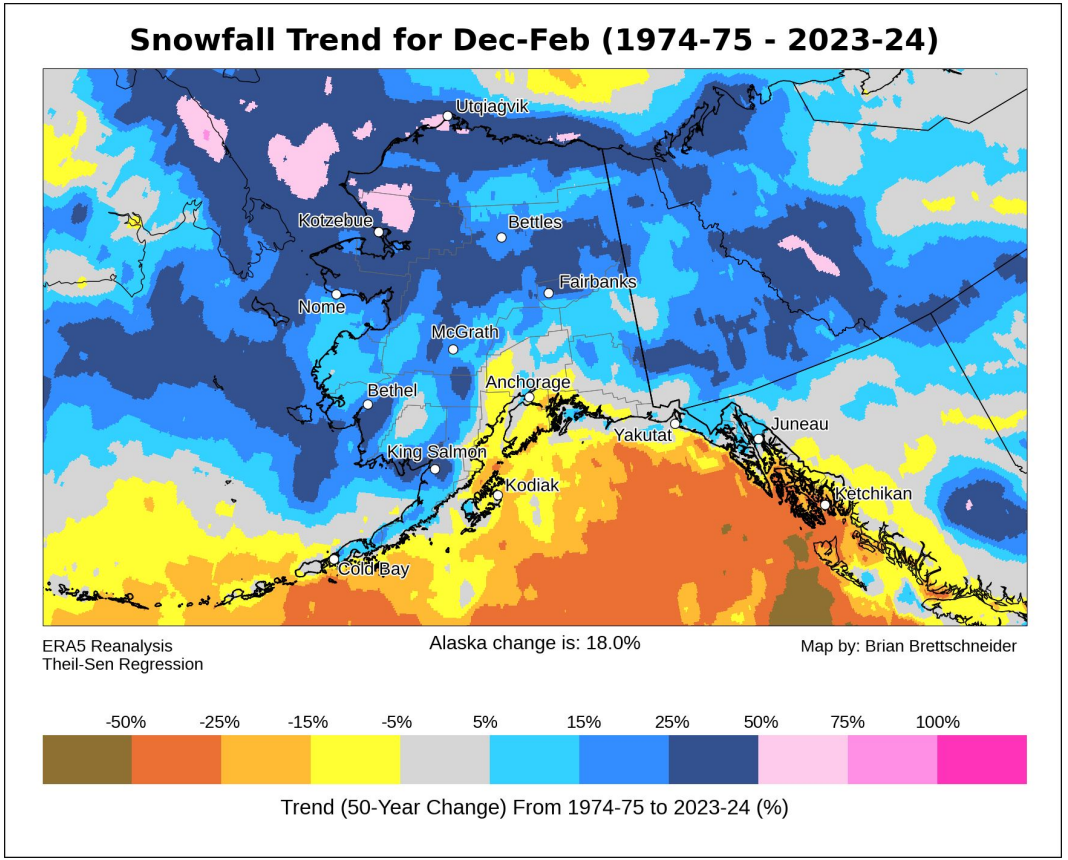
Why Worry About Extreme Snowfalls?

Large snowfalls are a significant hazard in much of Alaska.

Travel disruptions, supply-chain delays, avalanche dangers, snow loads, overflow, etc.

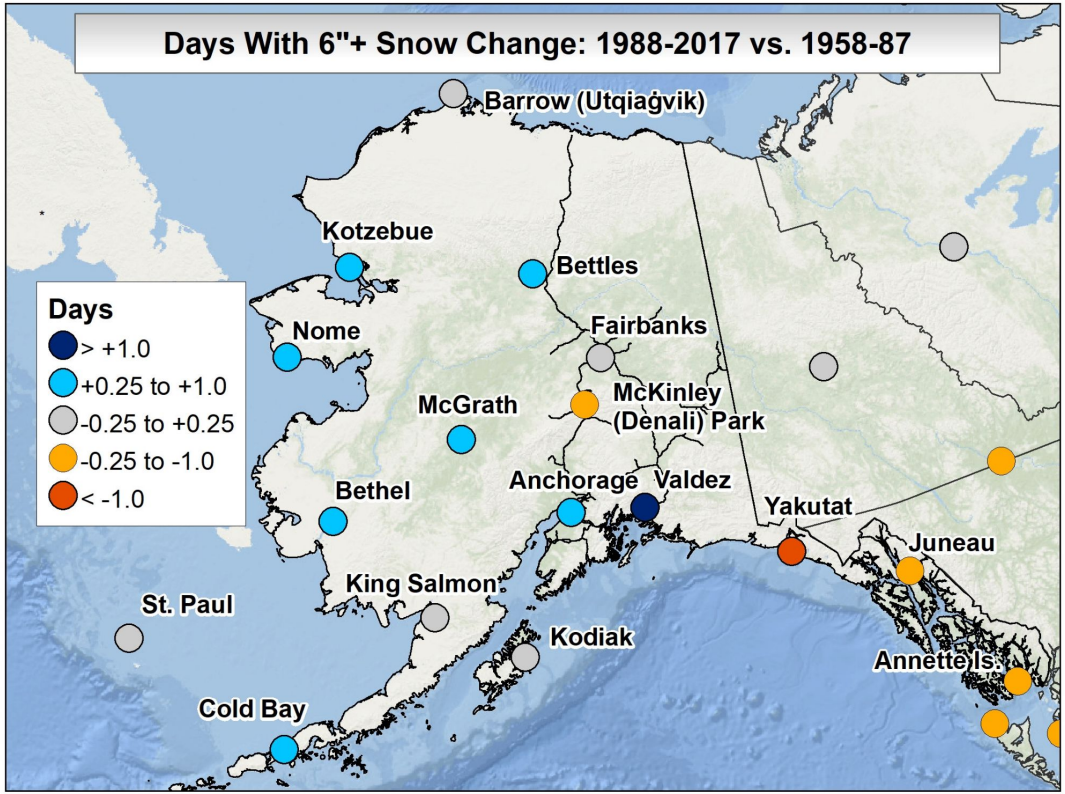
Little research exists regarding the interaction between ARs, complex terrain, and boundary layer conditions for coastal Alaska winter storms.

Seasonal Snowfall Trends



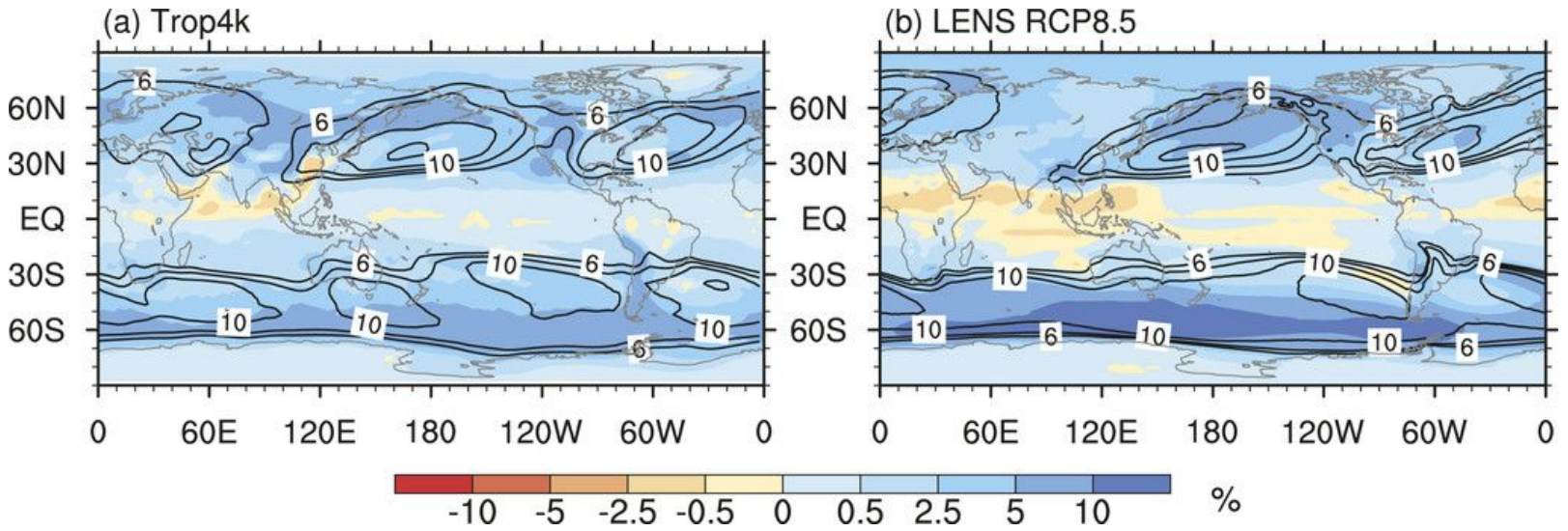
Mainland Alaska, has seen little change in full-season snowfall over the last 50 years, but core winter (DJF) snow has increased by a significant amount.

More Heavy Snow?



Correspondingly, the frequency of heavy events show an increase in nearly all mainland locations.

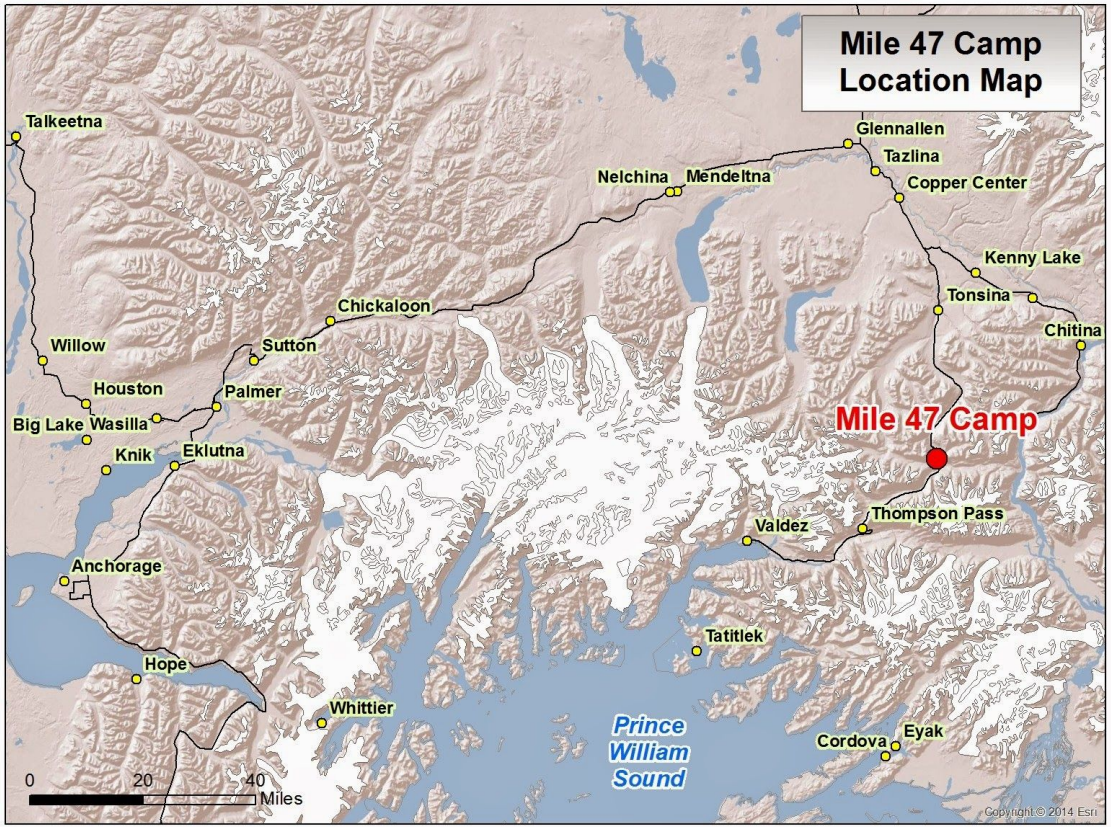
Increase in Atmospheric Rivers



Zhang, P., G. Chen, W. Ma, Y. Ming, and Z. Wu, 2021: Robust Atmospheric River Response to Global Warming in Idealized and Comprehensive Climate Models. *J. Climate*, **34**, 7717–7734, https://doi.org/10.1175/JCLI-D-20-1005.1.

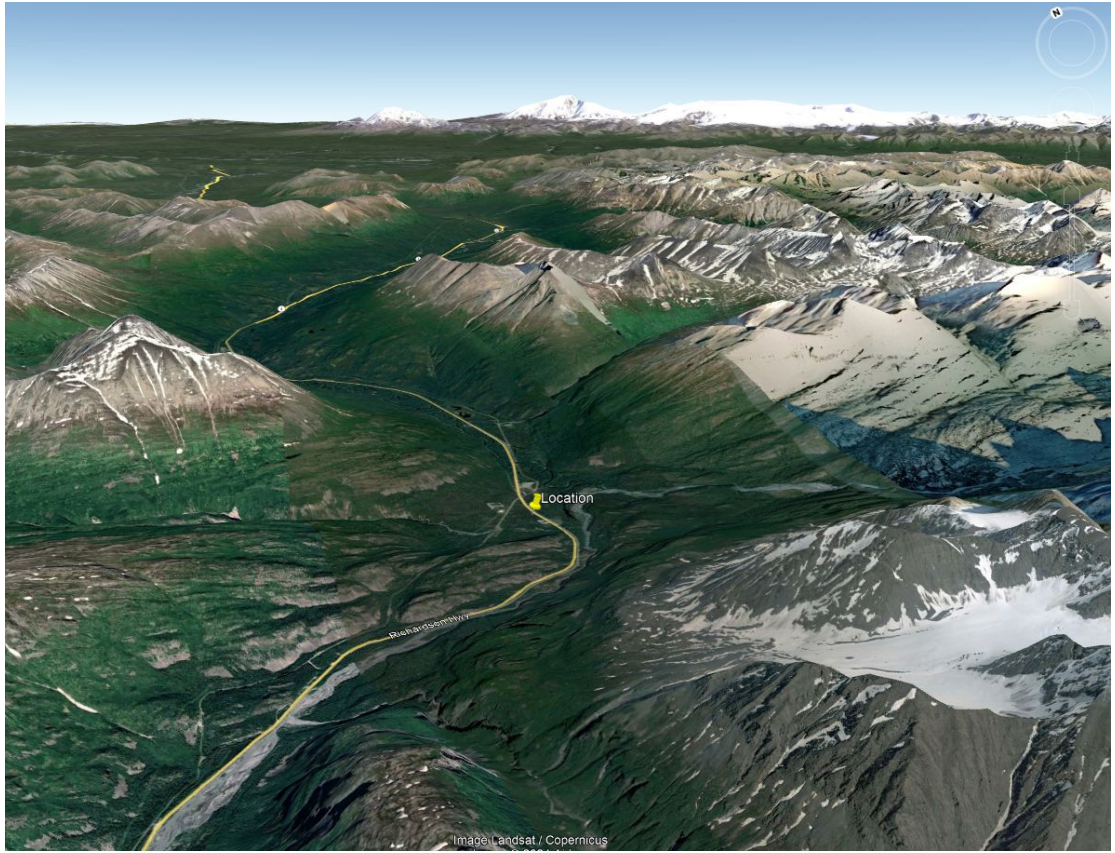
Coastal Alaska should experience a 2% to 4% increase in atmospheric rivers in a warming world according to recent studies.

Mile 46/47 of Richardson Highway



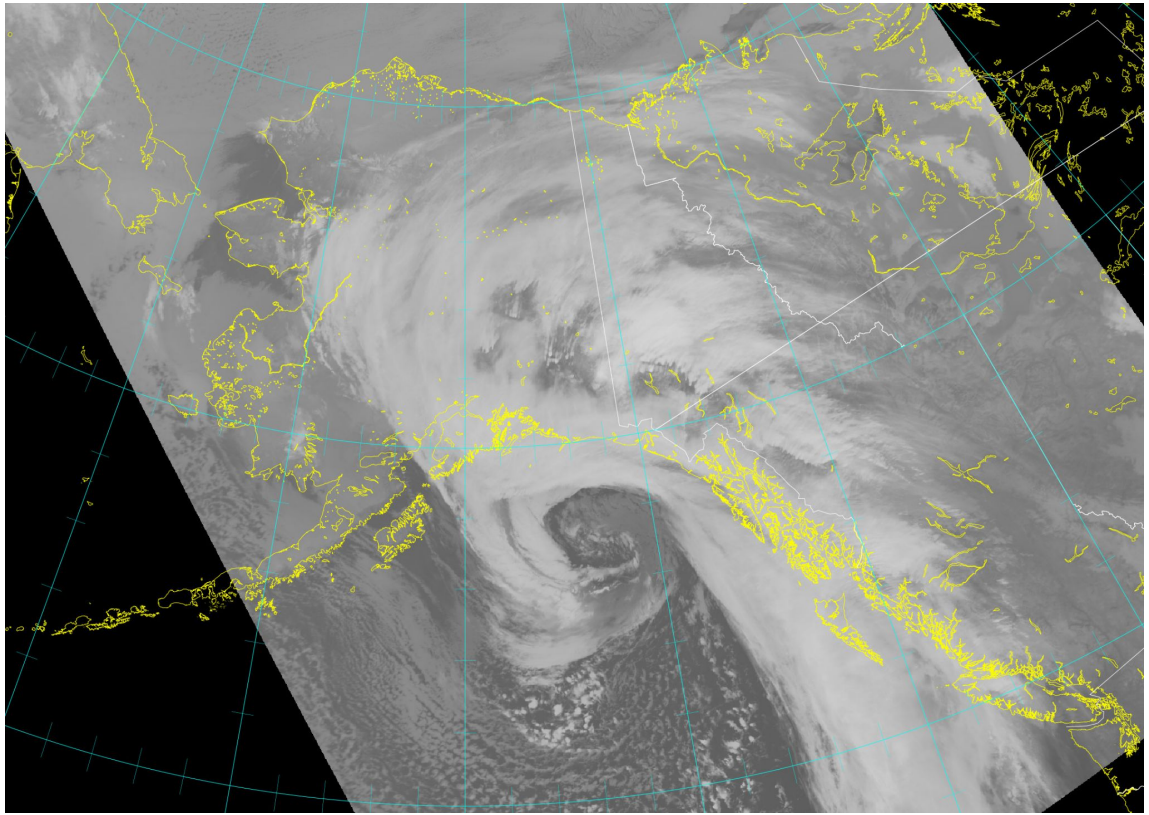
The Richardson Highway is a key corridor between the interior and the Port of Valdez. It descends from the Copper River Basin (~ 2000') down to sea level. Mile 46/47 is 1,250' above sea level.

Location Setting



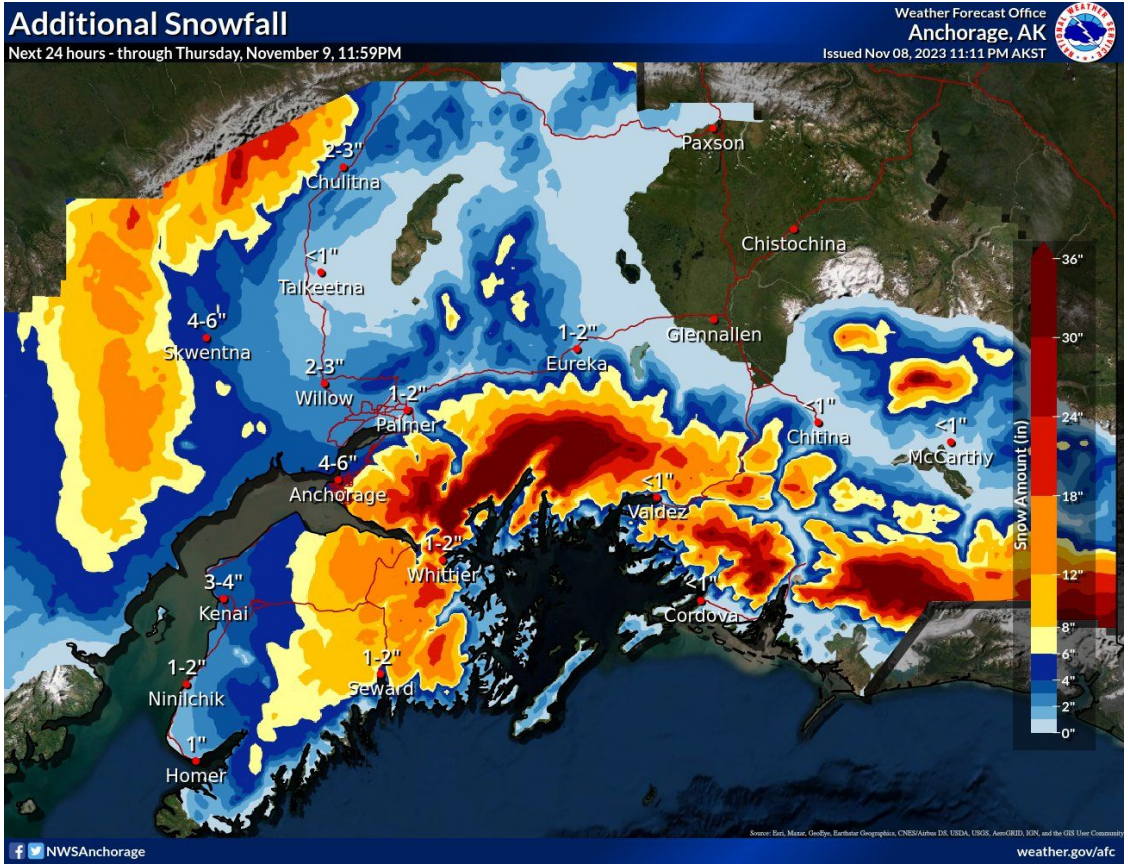
The Mile 46/47 location along the Richardson Highway is 1,250’ above sea level and is surrounded by 5,000’ to 6,500’ mountains. The Tiekel River valley intersects the highway at a right angle.

November 8-9, 2023, Event



A low pressure and an atmospheric river (AR) was directed at Prince William Sound on Nov 8-9, 2023. This was a highly impactful event for a 200-mile section of the southern Alaska coast.

November 8-9, 2023, Forecast



The forecast was for 12”-18” for the Mile 46/47 location. NWS Anchorage FB Live: https://www.facebook.com/watch/live/?ref=watch_permalink&v=804162938062823

What Happened? Historic Snowfall

0730 PM	Snow	18 NE Thompson Pass		61.26N 145.28W
11/08/2023	M72.0 inch	Copper River	AK	Dept of Highways

Update to previous report. Information from AK DOT. By Milepost 46 on the Richardson Highway. Snow began just after midnight on the 8th. Measured 24 inches at approximately 7am. Measured 65 inches at 445pm. Measured 72 inches at 730pm. At that time, snow transition to a rain/snow or rain mix. Measurement performed by both DOT and local citizen. Additional accumulation of 14-16 inches by 7am Thursday.

A remarkable 86” (218 cm) snow in 31 hours, 72” (183 cm) in 19.5 hours, and 24” (61 cm) in 2 hours were observed by the Alaska DOT. No snow clearing was performed through the first 19.5 hours.

What Happened? Historic Snowfall

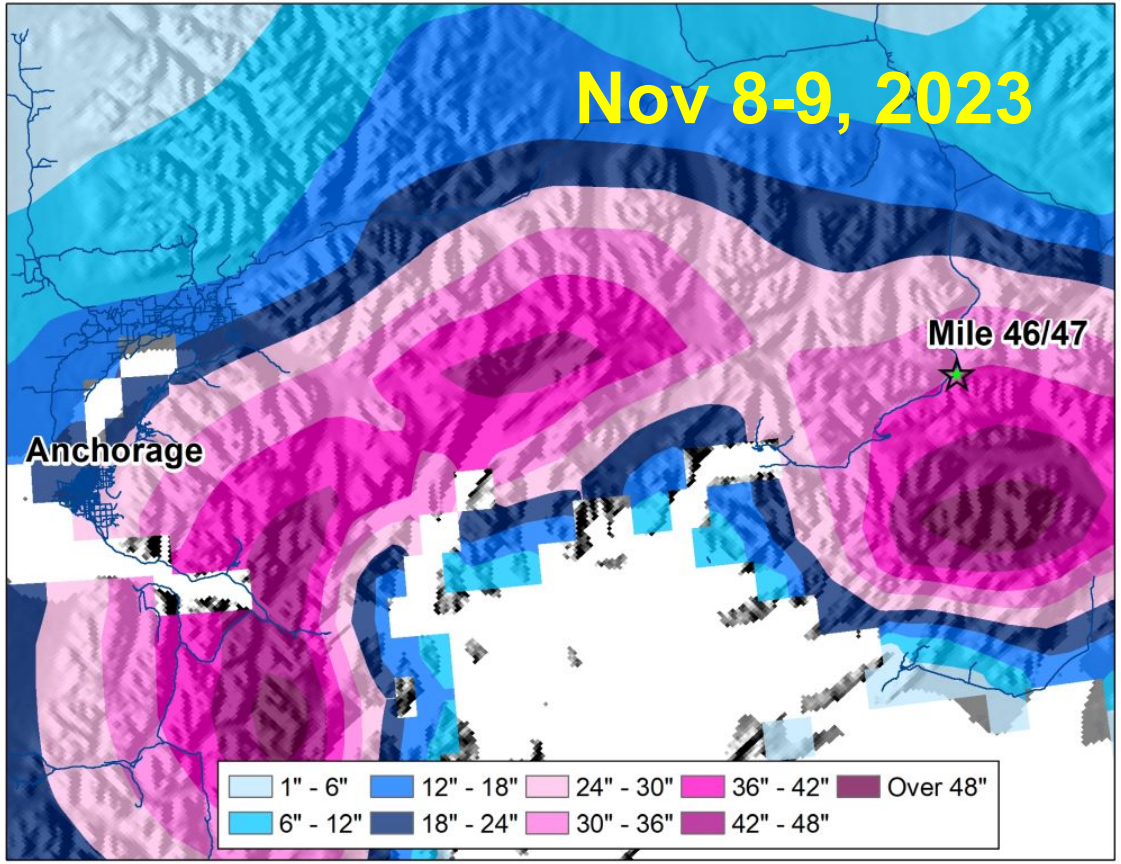
From bare ground to snow depth over 6 feet. Locals call these events, “Copper Whoppers”.

Photo credits: Derek Galbraith

Local Knowledge. Can We Do More?

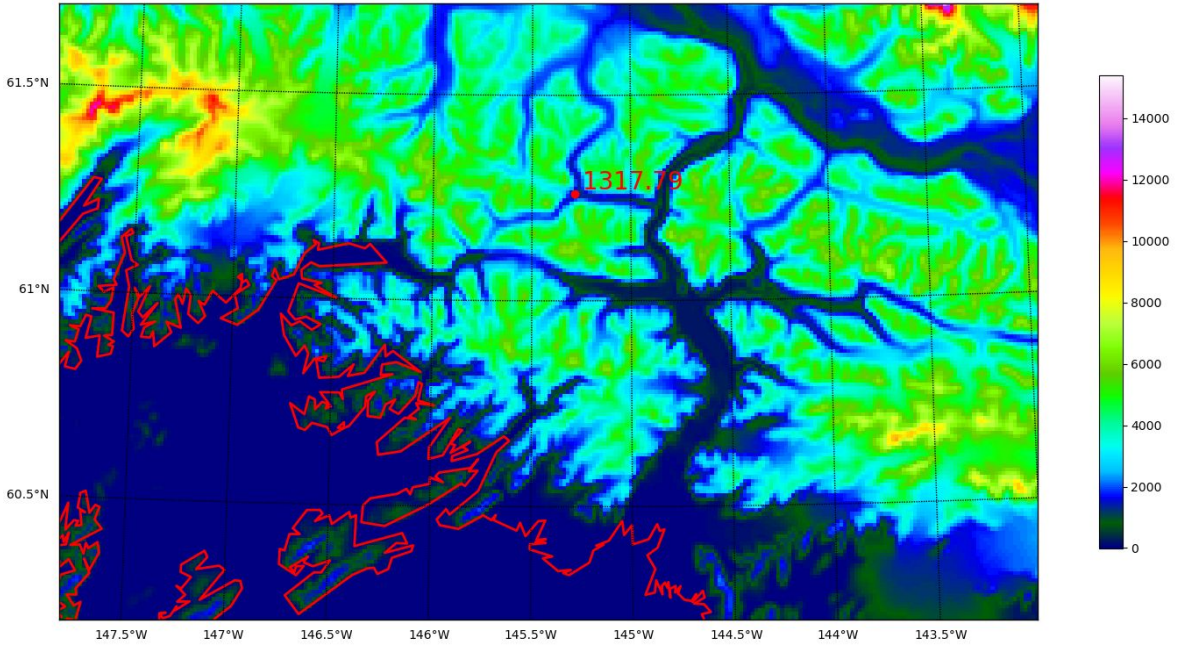
Global models vastly under-forecasted this event. Anchorage NWS forecasters called the DOT and told them a massive snow dump was coming based on local knowledge.

How Did ERA5-Land (0.1°) Do in 2023?



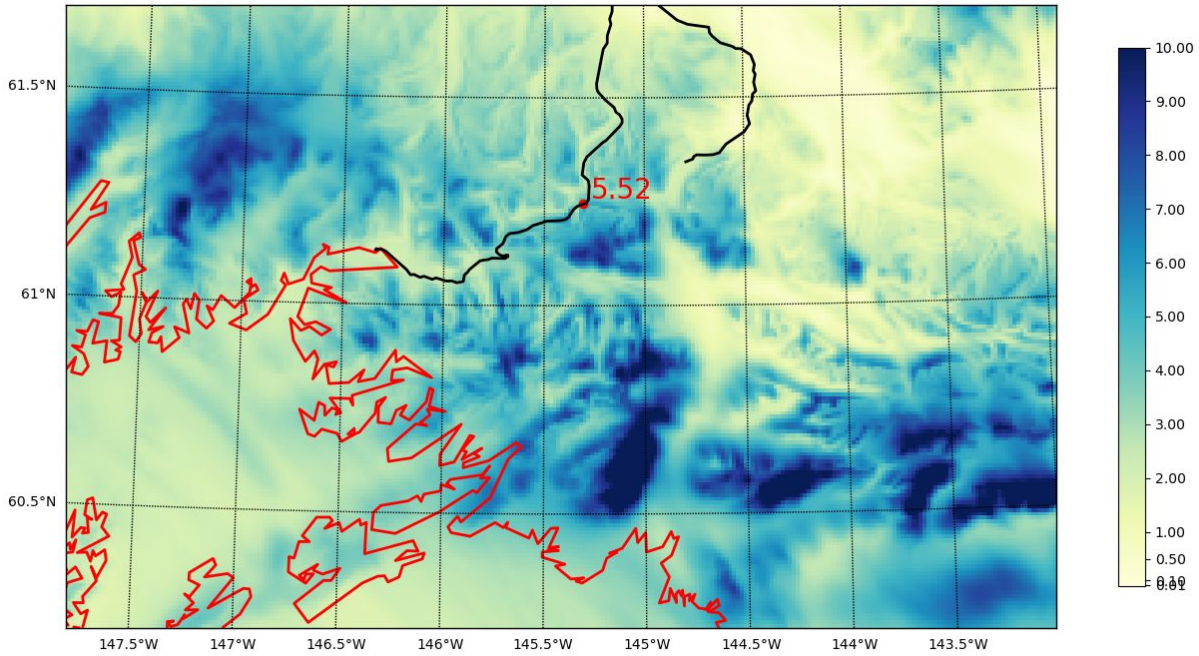
Map shows the accumulated hourly snowfall from ERA5-Land for the event. The reanalysis shows approximately 36” at the measurement site. Note the smoothed nature of the snowfall.

WRF (HRRR) Reconstruction



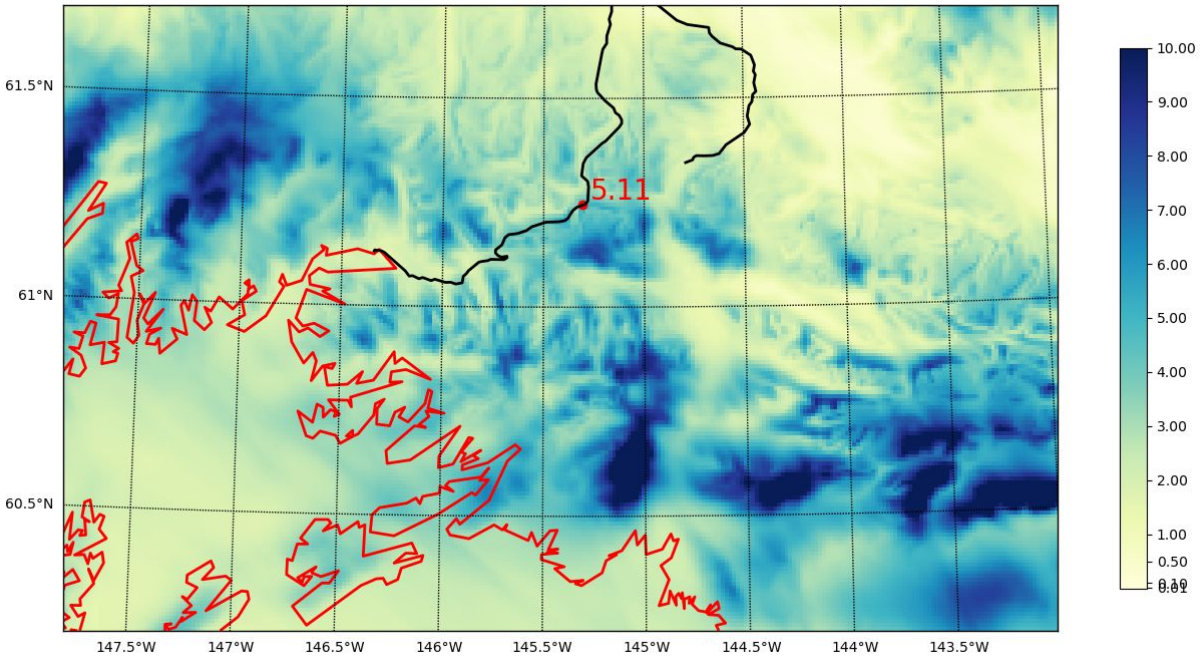
We ran WRF model reconstructions using GFS 0.25 degree initialization and ERA5-Land initialization. Were these models able to capture the local effects?

2023 WRF: GFS Initialization



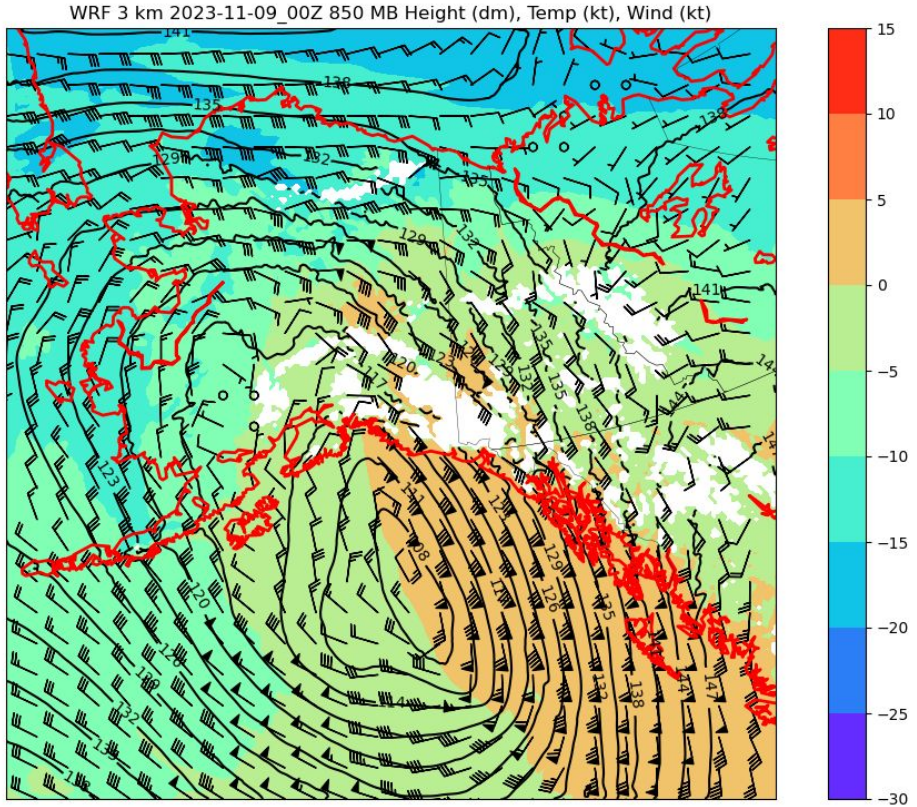
High resolution model precipitation was 5.52” using GFS initialization. The model captured the local effects.

2023 WRF: ERA5 Initialization



High resolution model precipitation was 5.11” using ERA5 initialization. This tells us that “old” events can be reconstructed using this reanalysis dataset.

2023 WRF Reconstruction Evaluation

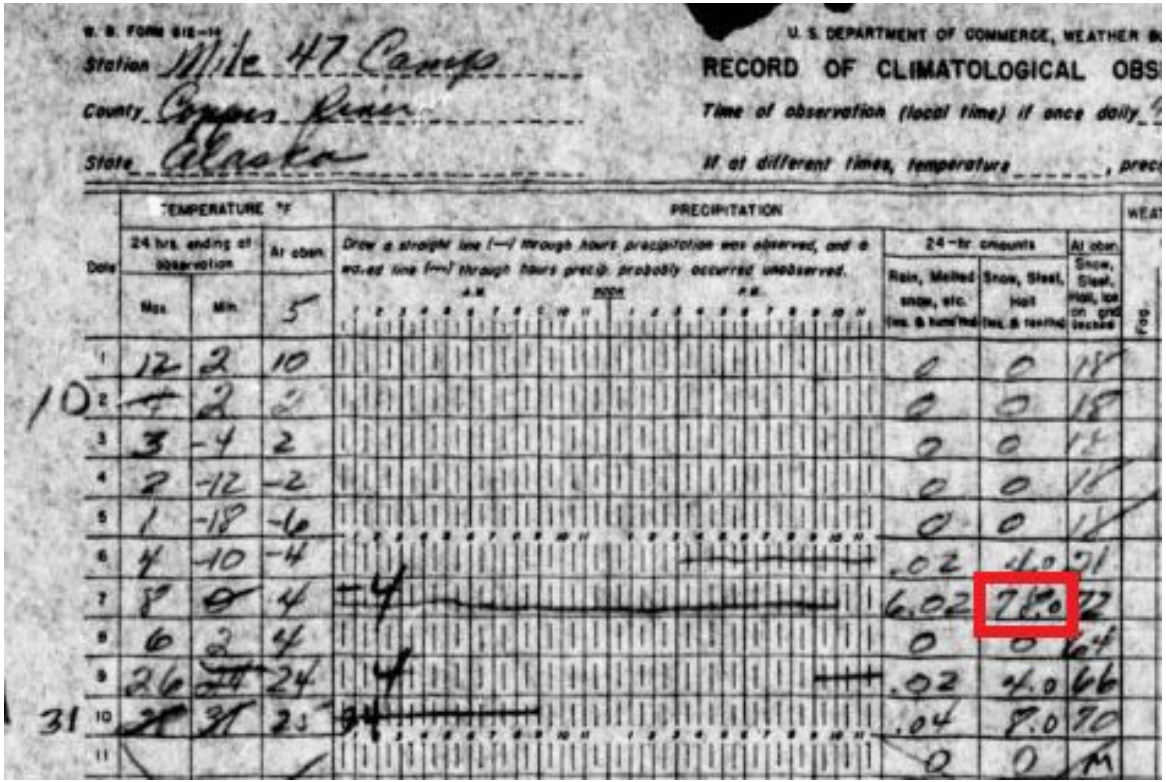


The WRF model did a very good job estimating the precipitation totals in the target region. Since it is essentially the same as the HRRR, this gives us confidence that the real-time HRRR forecasts do a good job in this region.

2023 WRF Reconstruction Evaluation

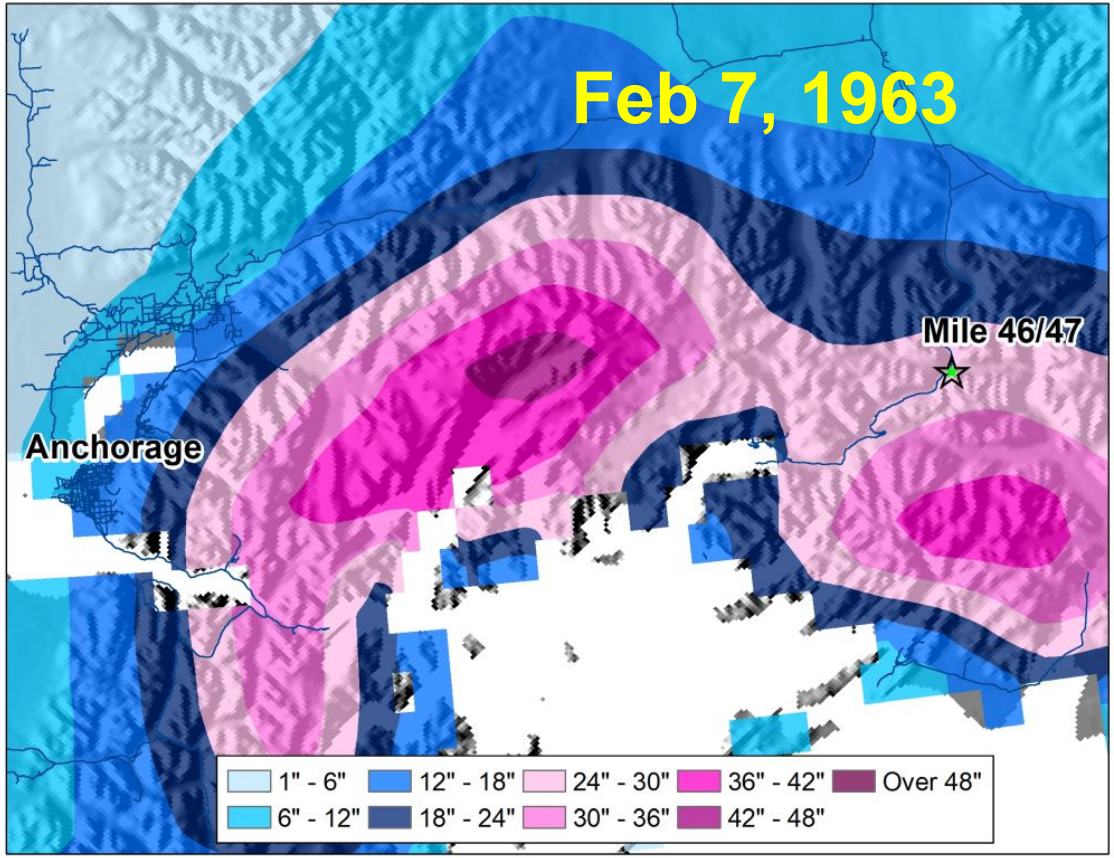
The model did not do a great job with low-level temperatures. This is problematic with p-type delineations. Since the ERA5-Land initialization produced very similar results, we now feel comfortable using it to initialize historical events.

Can Older Events Be Modelled?



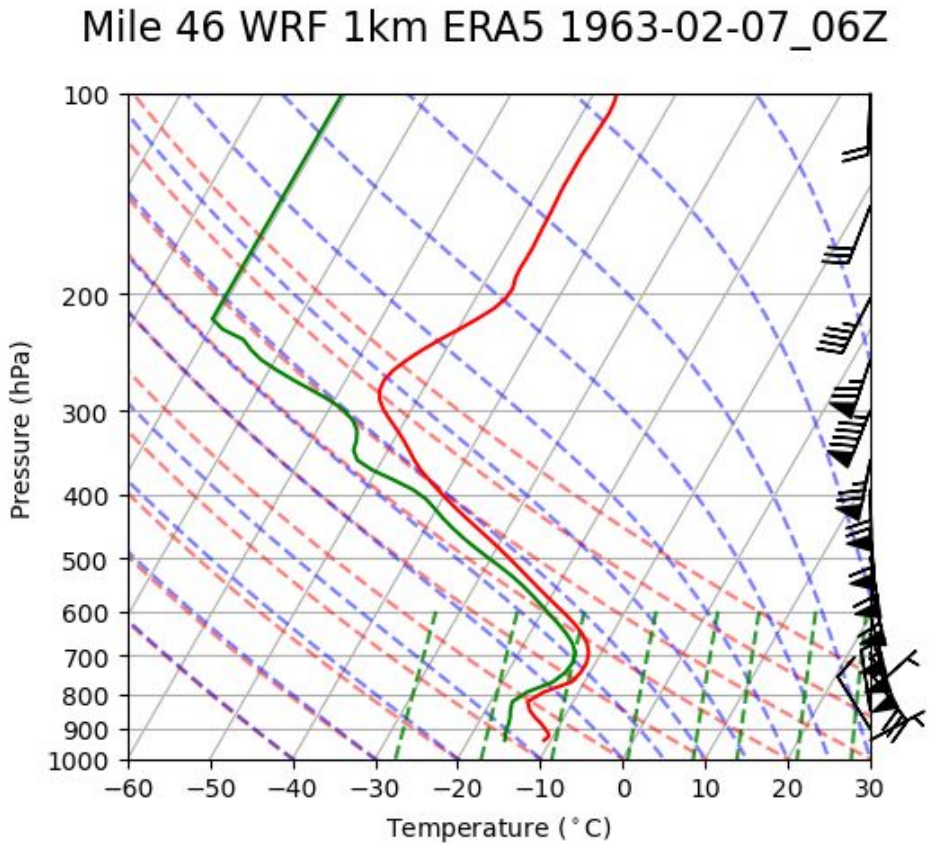
Now that we know WRF can be initialized using ERA5-Land, let's see how it handled a similar event at the same location. An incredible 78" of snow was recorded on Feb 7, 1963, and 82" in two days.

How Did ERA5-Land (0.1°) Do in 1963?



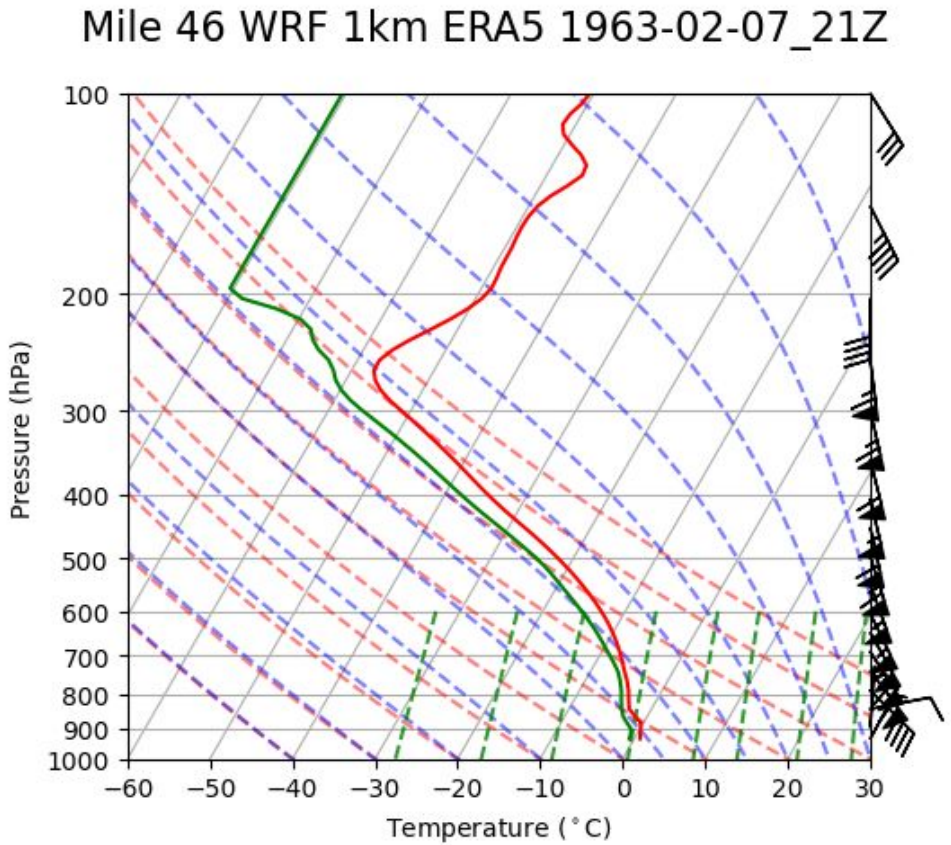
Map shows the accumulated hourly snowfall from ERA5-Land for the event. The reanalysis shows approximately 27” at the measurement site. Note the very similar pattern and amounts as the Nov 2023 event

1963 WRF Reconstruction



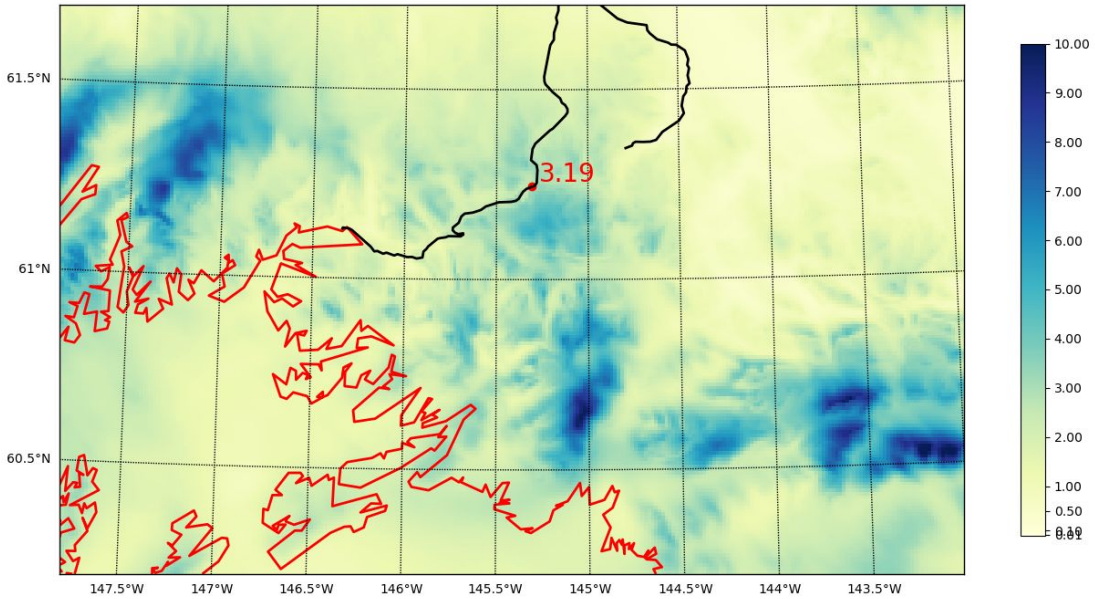
As noted a few slides ago, the 2023 event was accurately reconstructed using ERA5-Land initialization. Early in the 1963 event, the reconstruction very nicely reflects the observed conditions.

1963 WRF Reconstruction



However, the WRF model completely scoured out the low level cold - whereas the actual event maintained very cold air in the lowest 100 m (approx) in a cold air drainage scenario.

1963 WRF Reconstruction: Precipitation

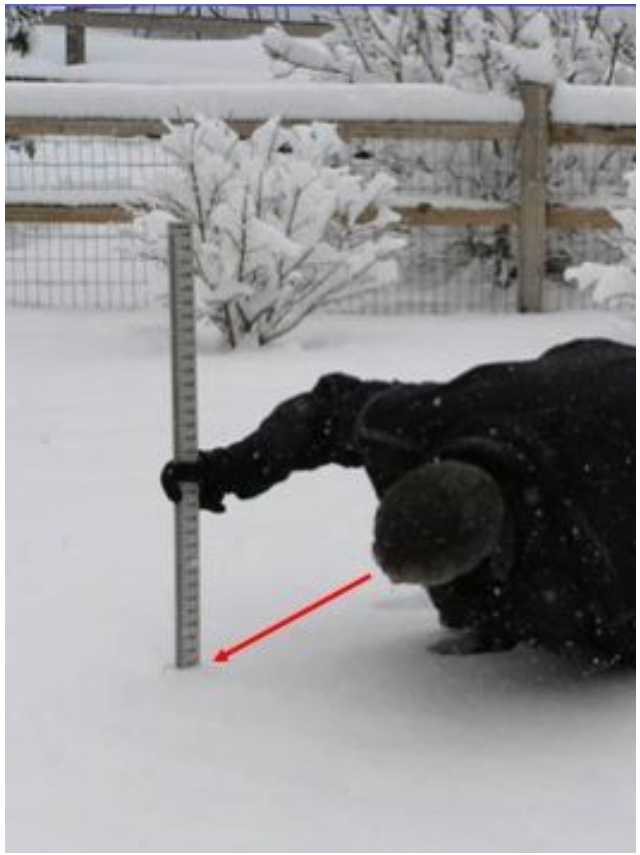


The Cooperative observer precipitation total of 6.02” is 88% more than the WRF model was able to generate; however, the snow total is consistent with the WRF model if a SLR of ~24:1 occurred (which seems too high).

1963 WRF Reconstruction Evaluation

The WRF model for the February 1963 event was initialized with ERA5 data. As with the 2023 event, it produced a very heavy precipitation bulls-eye at the same location. Also similar to 2023, it shows that local topography did not funnel moisture to this location. This lends credibility to the 1963 observer's totals; however …

1963 WRF Reconstruction Evaluation



The WRF produced storm total precipitation for the 1963 event that was lower than the 2023 event using ERA5 initialization. The ERA5 run for both 1963 and 2023 had a dry bias compared with observation of about 75-80%.

Conclusions

Heavy snow is still a significant hazard in Alaska. High resolution modeling has promise in identifying locations that are susceptible to local snowfall maximum; thereby providing officials with extra information for making important decisions.

Thank You!