Rain Check:
A Hard Look at Weather's Impact on the Construction Process & the Granular Data Now Promising to Clarify the Risks

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Agenda

1. Introductions
2. Natural disasters on the rise: Parallel impact on construction industry
3. Construction point of view: Managing weather risk in today's world
4. Big data advantage: New models & analysis to change planning, scheduling, & risk management
5. Conclusion

Athenium Analytics background

- Web-based **decision-support** software for construction organizations, insurance, government & financial trading
- Industry-leading products for **risk management**, quality assurance, underwriting & claims
- **115 employees** across three offices in Washington D.C., Waltham, MA, and Dover, NH
- Mostly made up of **scientists & technologists**
  - Meteorologists, structural engineers, data scientists, product developers and software engineers

Natural disasters on the rise:

Parallel impact on construction industry

Weather risk in construction

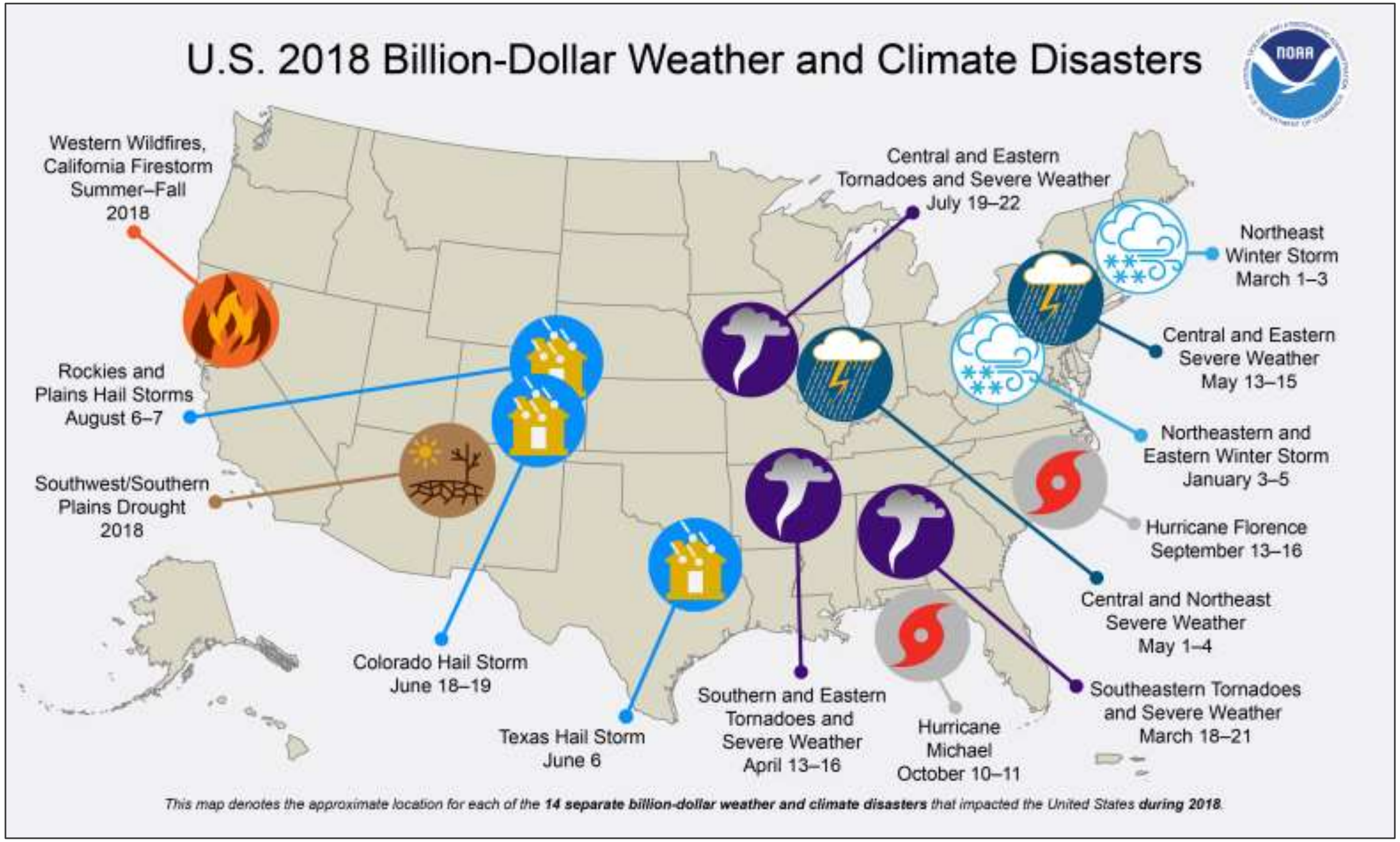
“The construction industry loses billions of dollars on delays and failures caused by bad weather. Buildings are damaged during storms; sites turn into seas of mud; freezing temperatures make it impossible to pour concrete.”

“Every state in the country has been impacted by at least one billion-dollar disaster since 1980.”

More extreme weather disasters

14

Weather disasters with losses exceeding $1 billion in 2018



https://www.ncdc.noaa.gov/billions/

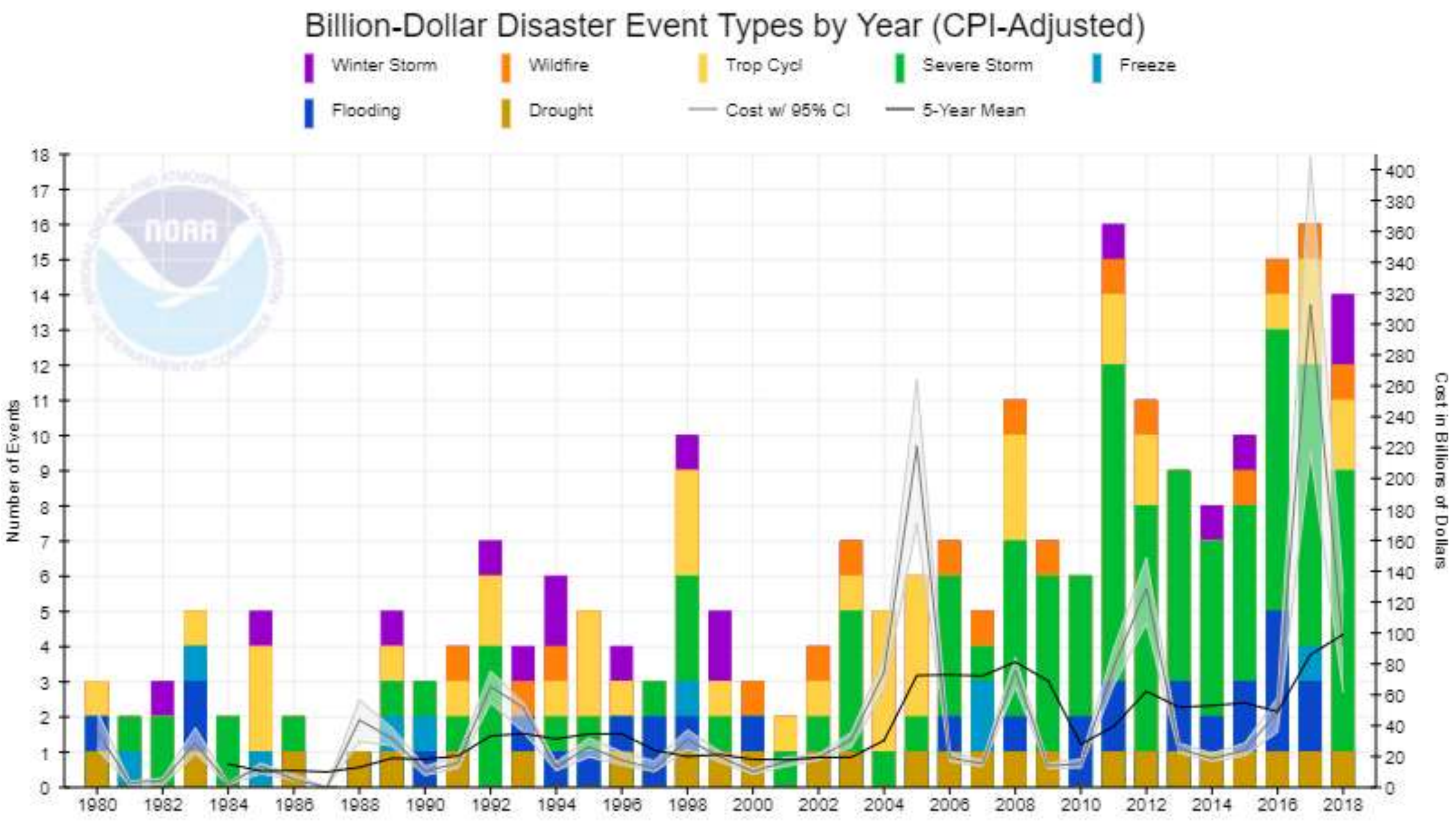
Annual disasters have doubled

6.2

Average annual $1B+ disasters:
1980 - 2018

12.6

Average annual $1B+ disasters:
2014 - 2018



https://www.ncdc.noaa.gov/billions/

Changing climate

- Heavy-precipitation events have increased by 30% in the last century
- Temperatures have risen more than 2 degrees since 1950
- Days above 90 degrees expected to increase on average 20-30 days by 2050

A costly risk

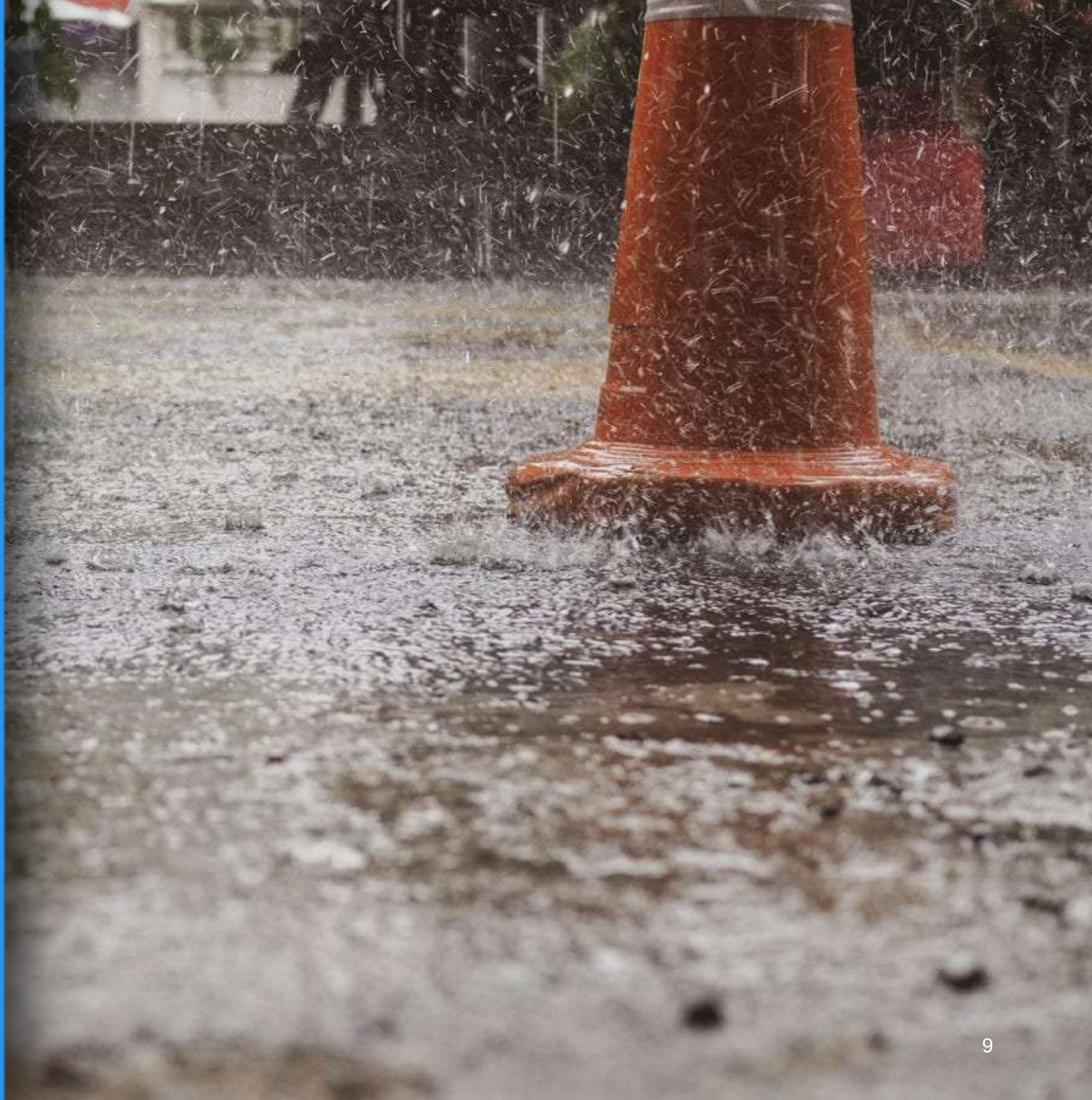
"UK weather extends project durations by an average of 21%. However, using climatological data derived from weather observations when planning could lead to average reductions in project durations of 16%, with proportional reductions in indirect and overhead costs."

- Ballesteros-Pérez et al (2018) Incorporating the effect of weather in construction scheduling and management with sine wave curves

Source: https://www.tandfonline.com/doi/full/10.1080/01446193.2018.1478109

Construction point of view:

Managing weather risk in today’s world



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Corpus Christi LNG project


CAT MODELLING REPORT

Corpus Christi LNG Project

Report – DRAFT Issue 03
August 2014

Weather impacts are not uniform

How will your supply chain be affected by weather?

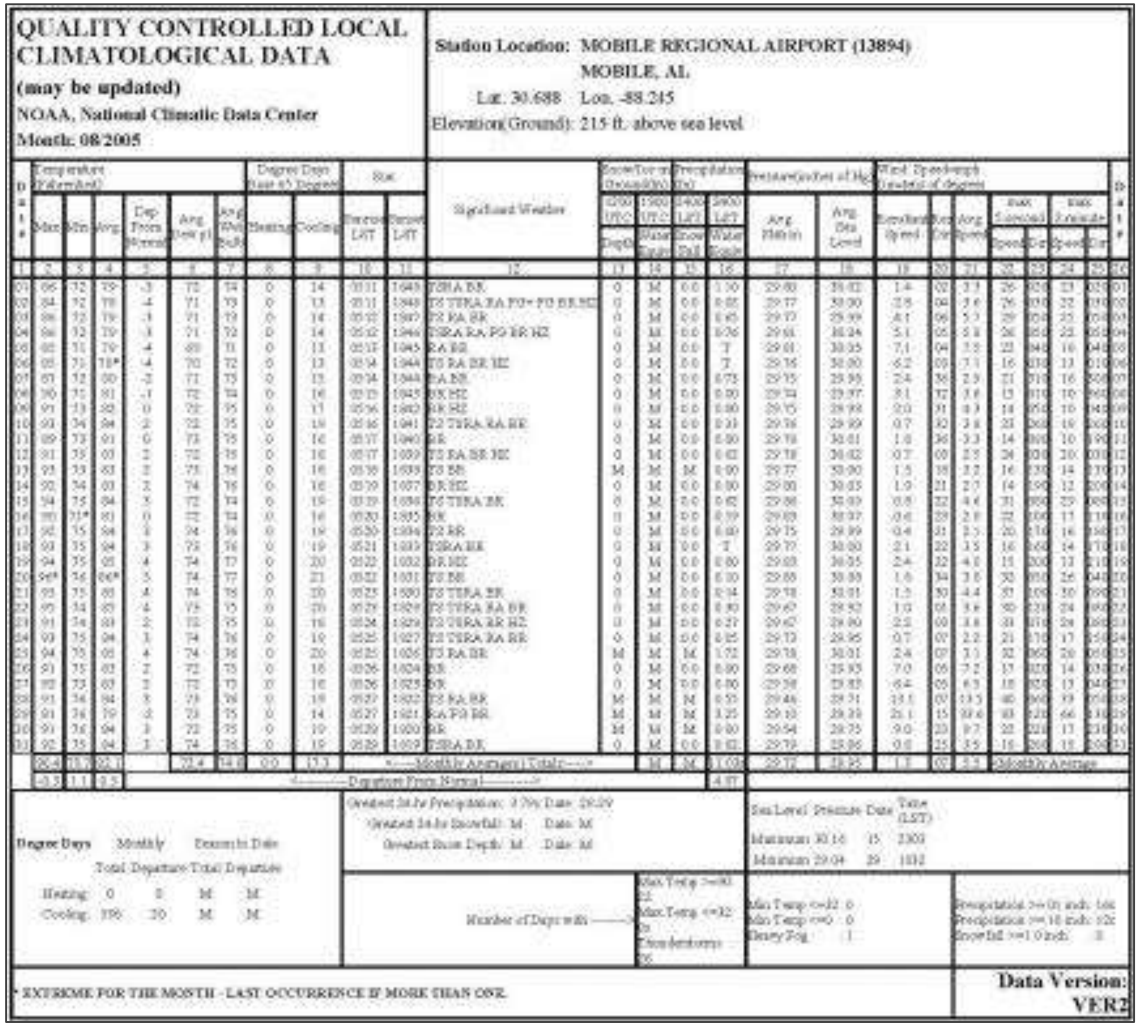
Winter impacts on craft workers

Can you contract away weather risk?

How does the contract deal with weather?

- Force Majeure
- Normal vs “Unusual Weather”
- Change Relief

Publicly available data


QUALITY CONTROLLED LOCAL CLIMATOLOGICAL DATA
(may be updated)
NOAA, National Climatic Data Center
Month: 08/2005

Station Location: MOBILE REGIONAL AIRPORT (13894)
MOBILE, AL
Lat. 30.688 Lon. -88.245
Elevation(Ground): 215 ft. above sea level

* EXTREME FOR THE MONTH - LAST OCCURRENCE IF MORE THAN ONE.

Data Version: VER2

Weather risk considerations in estimating

- Project location
- Underground vs above ground work
- Forecast of non-working days
- Worker Productivity impact
- Consideration of “normal” weather impact
- Consideration of abnormal weather impacts through duration of work

Big data advantage:

New models & analysis to change planning, scheduling, & risk management

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Computing power & weather forecasting

- More and more data each day!
  - 500 million tweets
  - 300 billion emails
  - 28 petabytes of data from
  - Entire digital universe is 2020!!!

G
C

2MHz
4K

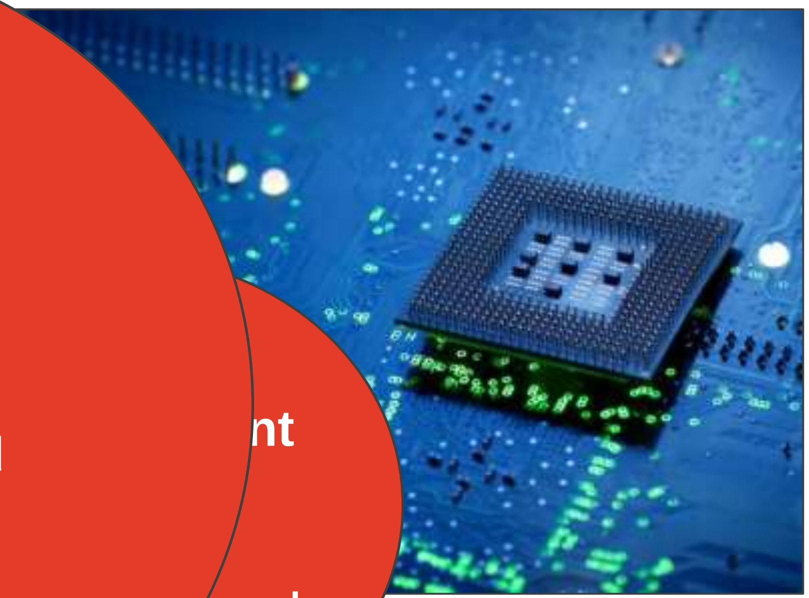
IPhone 11

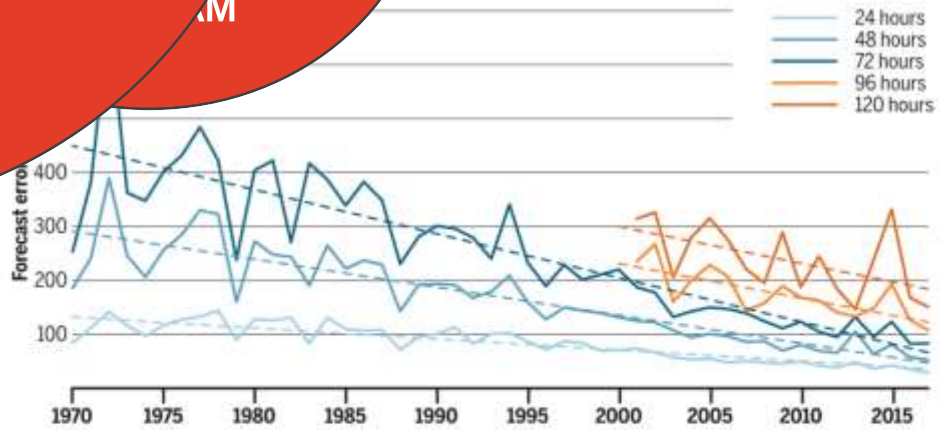
2.65MHz CPU Speed
4GB RAM

nt

peed
M

- Weather forecasting
  - Better computing power
  - Improved understanding of the a
  - Developments in numerical modeling & data
  - Modern 5 day forecast is better than a 1-day forecast from 1980





Gridded weather data – a better solution

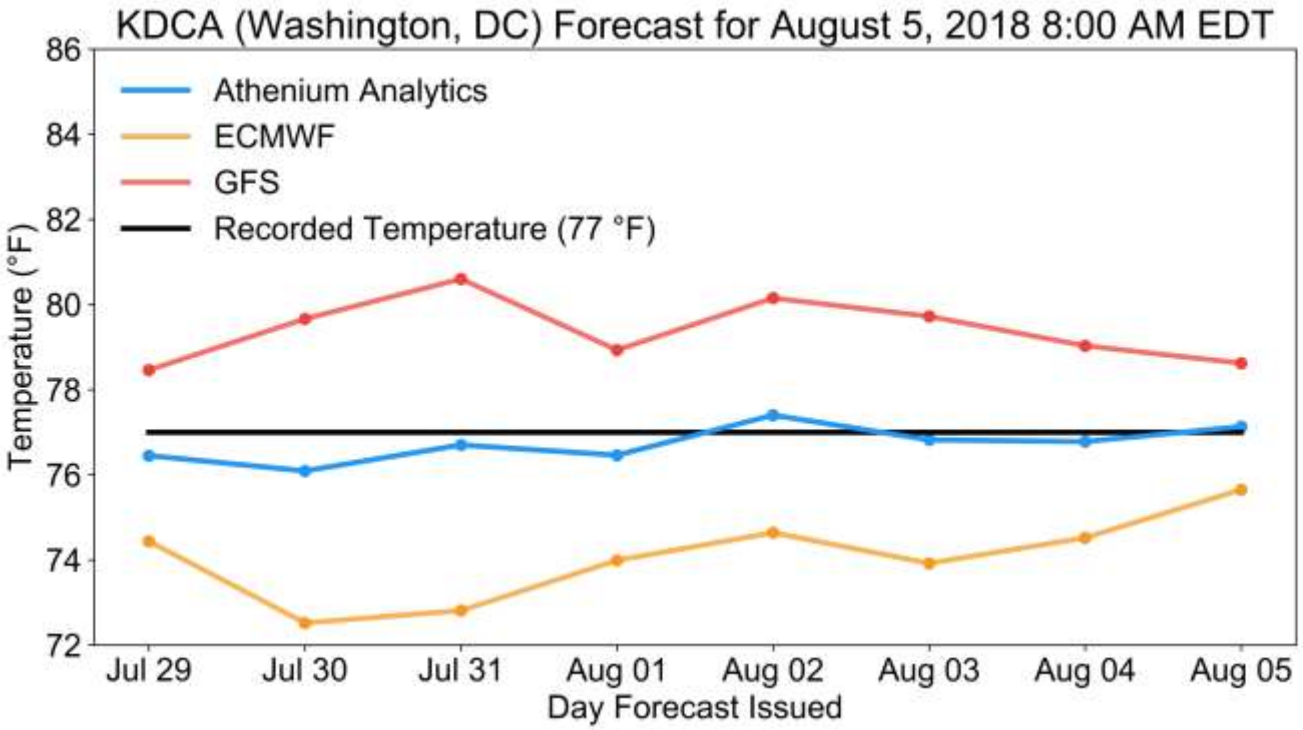
Intersecting project with gridded data provides opportunities for local weather risk analyses

- Not dependent on observation facilities
- Not dependent on weather station hardware on-site
- Real-time analysis for forecast & post-event

Why is blending better?

Weather models can have biases

- Specific times of day, geographic locations, types of events, etc.
- E.g. GFS (American model) does poorly in cold-air damning situations
- E.g. ECMWF (European model) tends to move storms too slowly from west to east coast

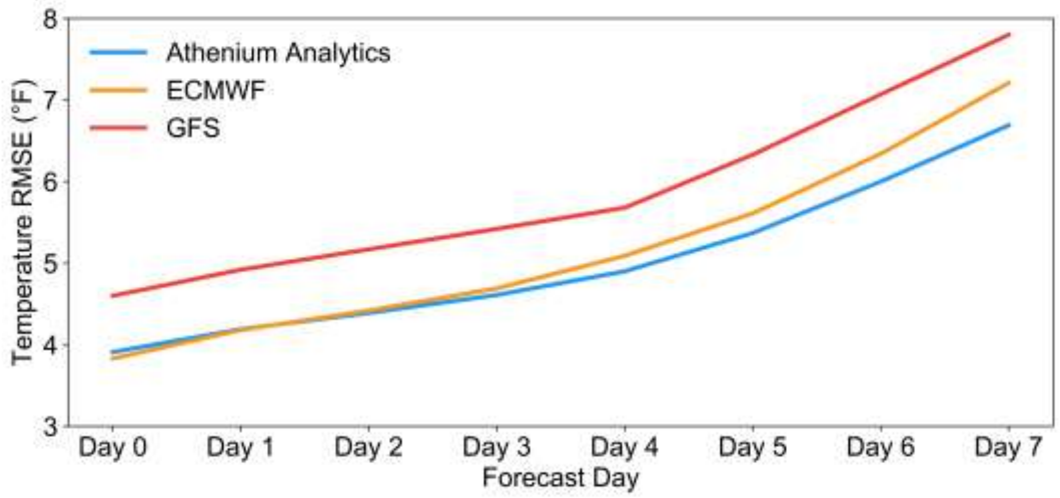


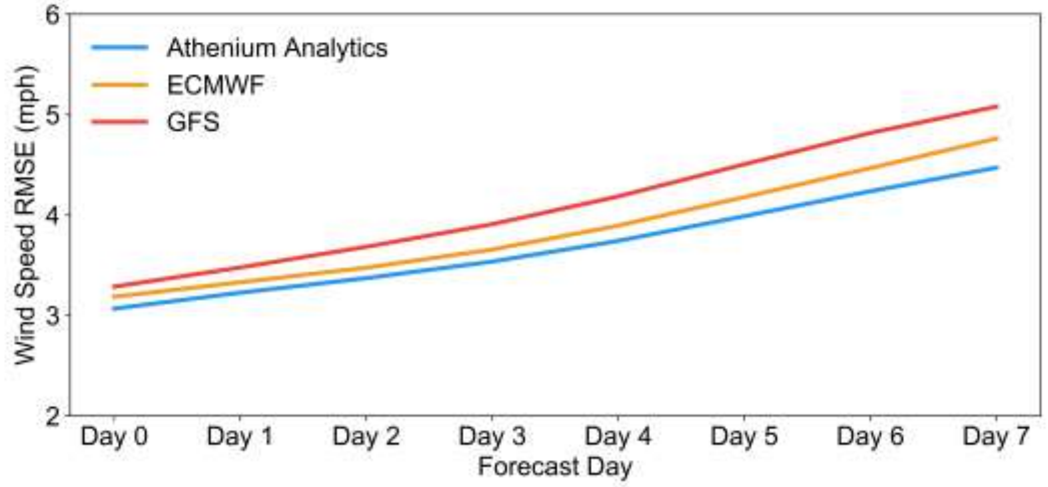
Why not use a free weather app?

Algorithmic blending – a way to improve forecasts

Increase in temperature accuracy			
	Day-5	**Day-6**	**Day-7**
vs. GFS	15%	15%	14%
vs. ECMWF	4%	5%	7%

Increase in wind speed accuracy			
	Day-5	**Day-6**	**Day-7**
vs. GFS	18%	20%	20%
vs. ECMWF	5%	8%	10%

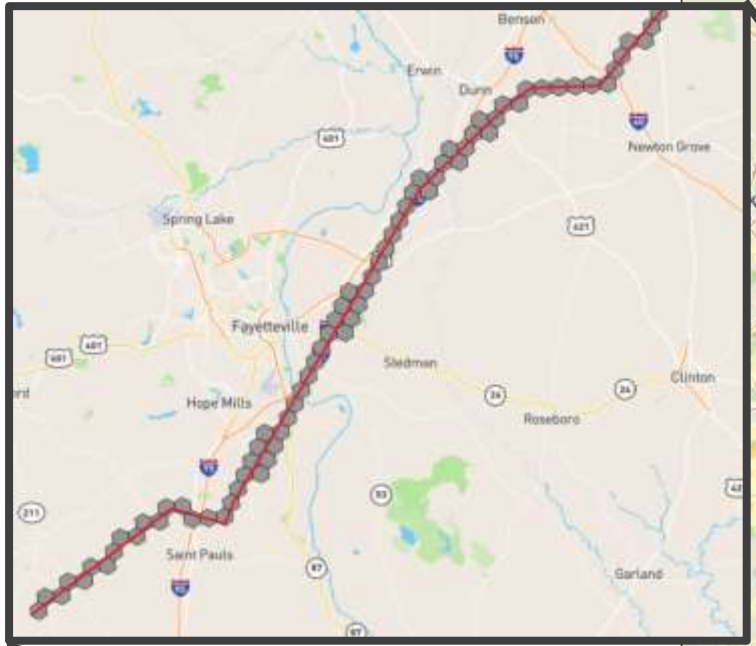


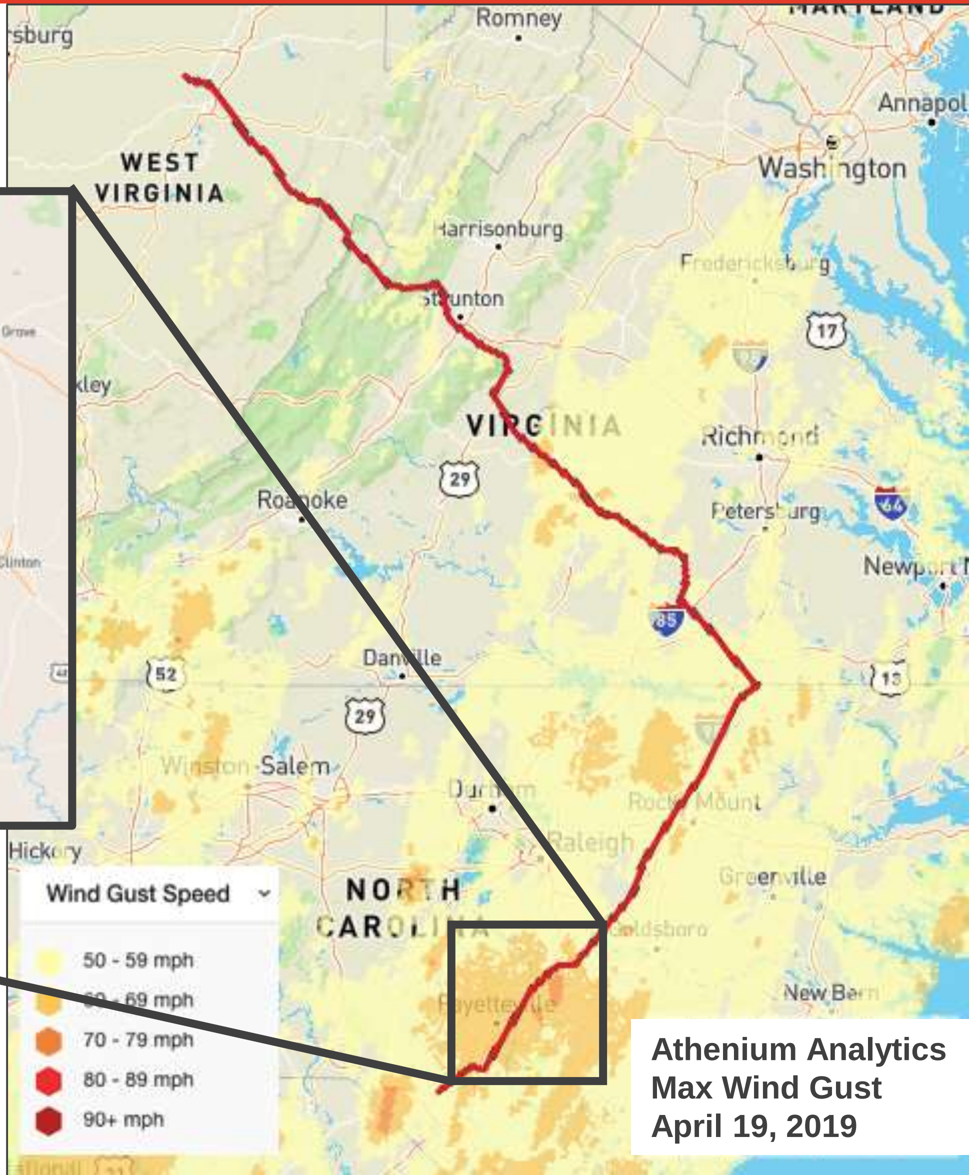


Post-event analysis – a “virtual” weather station

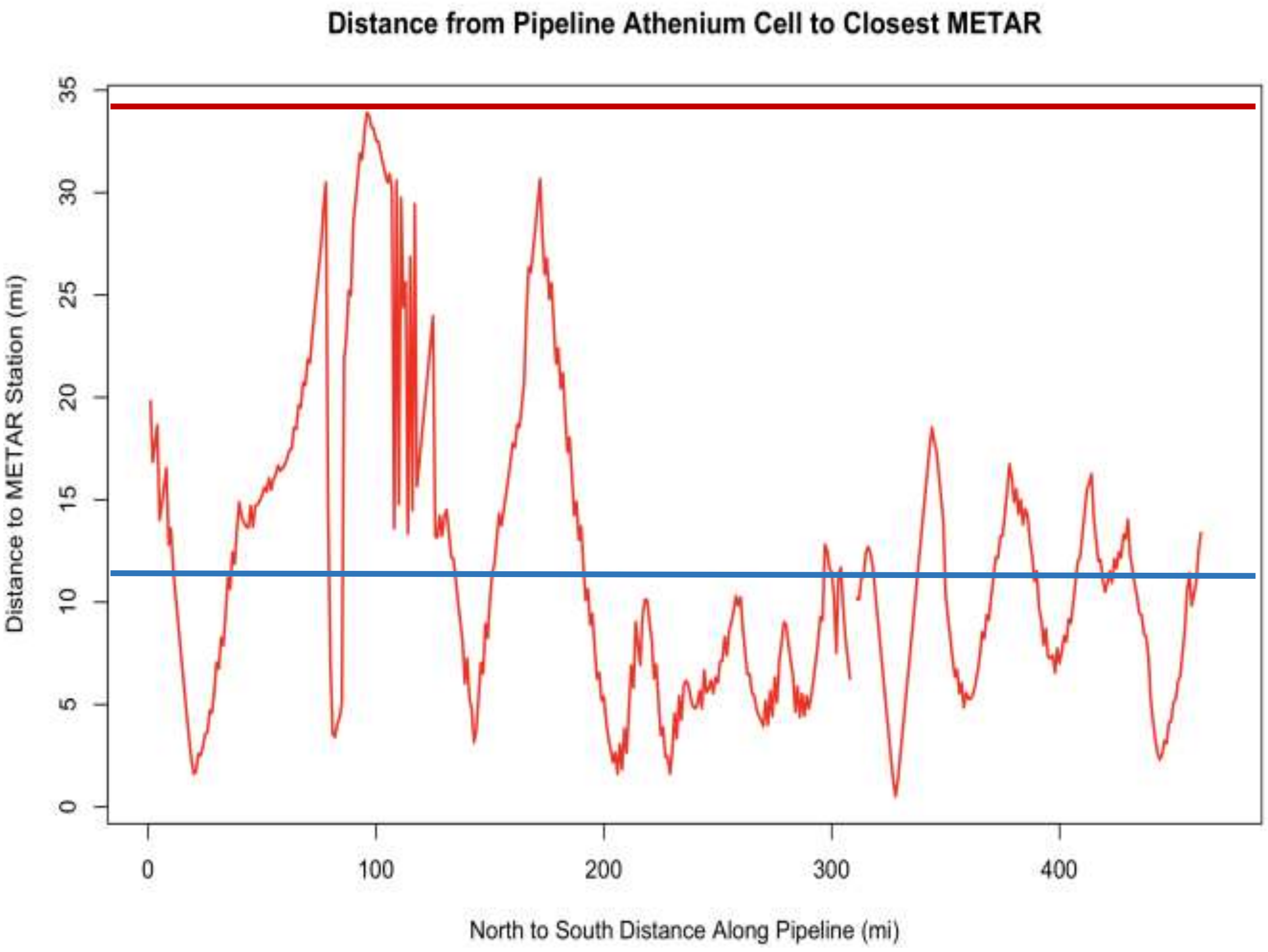
Blended radar, satellite & modeled post-event data allows for high-resolution, 0.3 to 1.5-square-mile verification of project-specific weather events

- Straight-line wind (surface & elevation)
- Hail
- Rainfall
- Snowfall
- Freezing rain
- Temperature



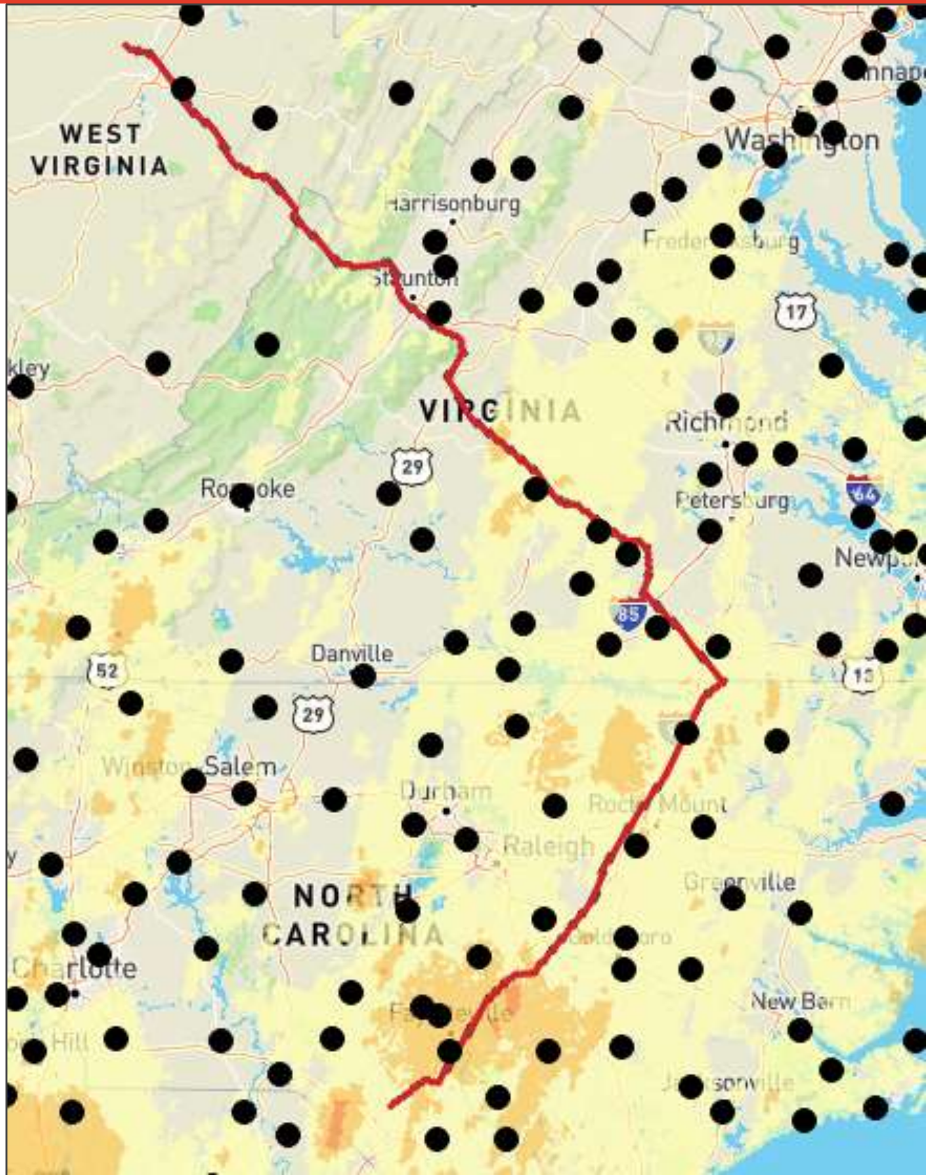


Hyper-local analysis better than station data



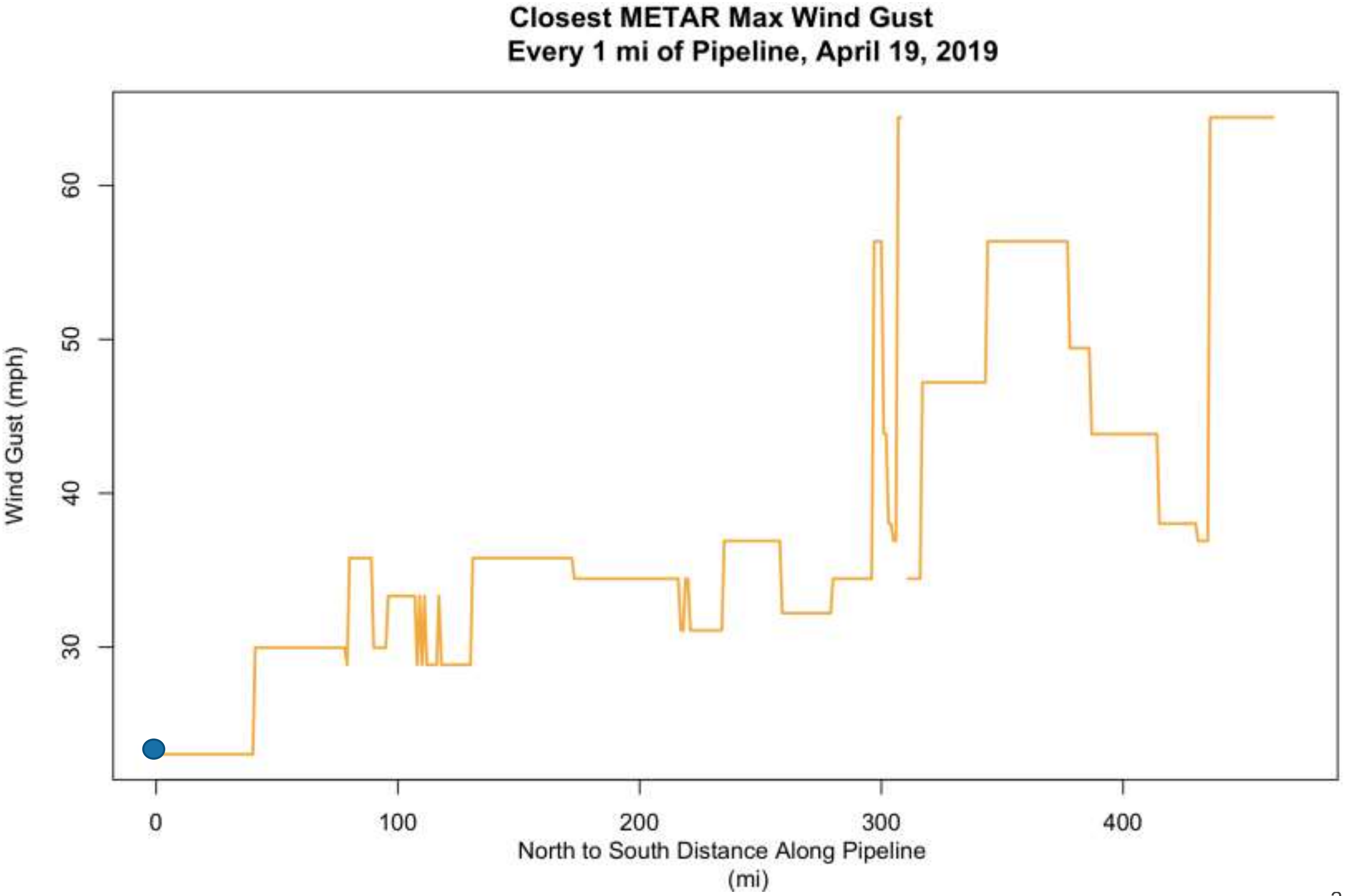
Max Dist.
34 miles

Avg. Dist.
12 miles



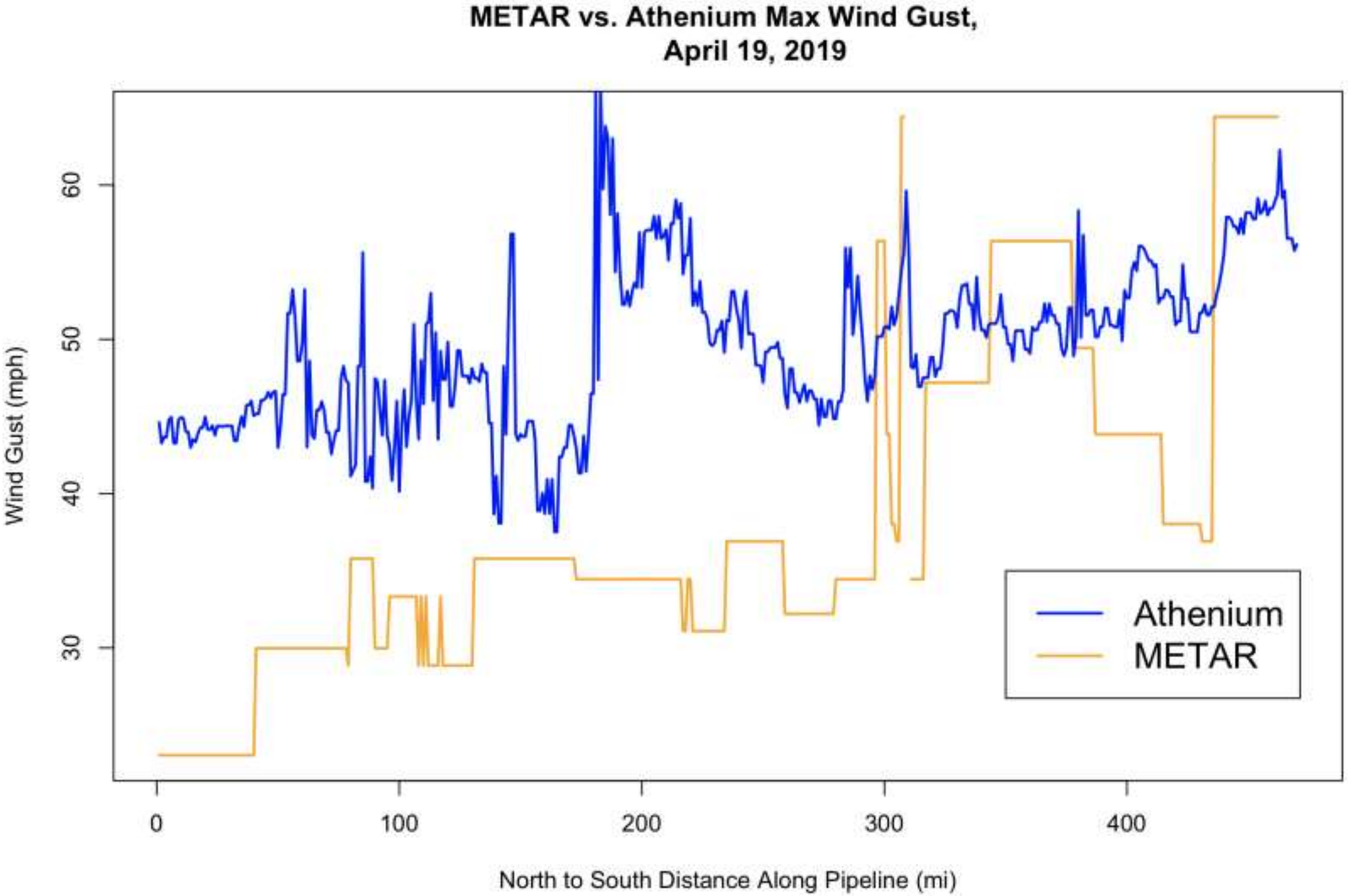
Verifying project wind gust speeds – station data

Why the flat peaks?



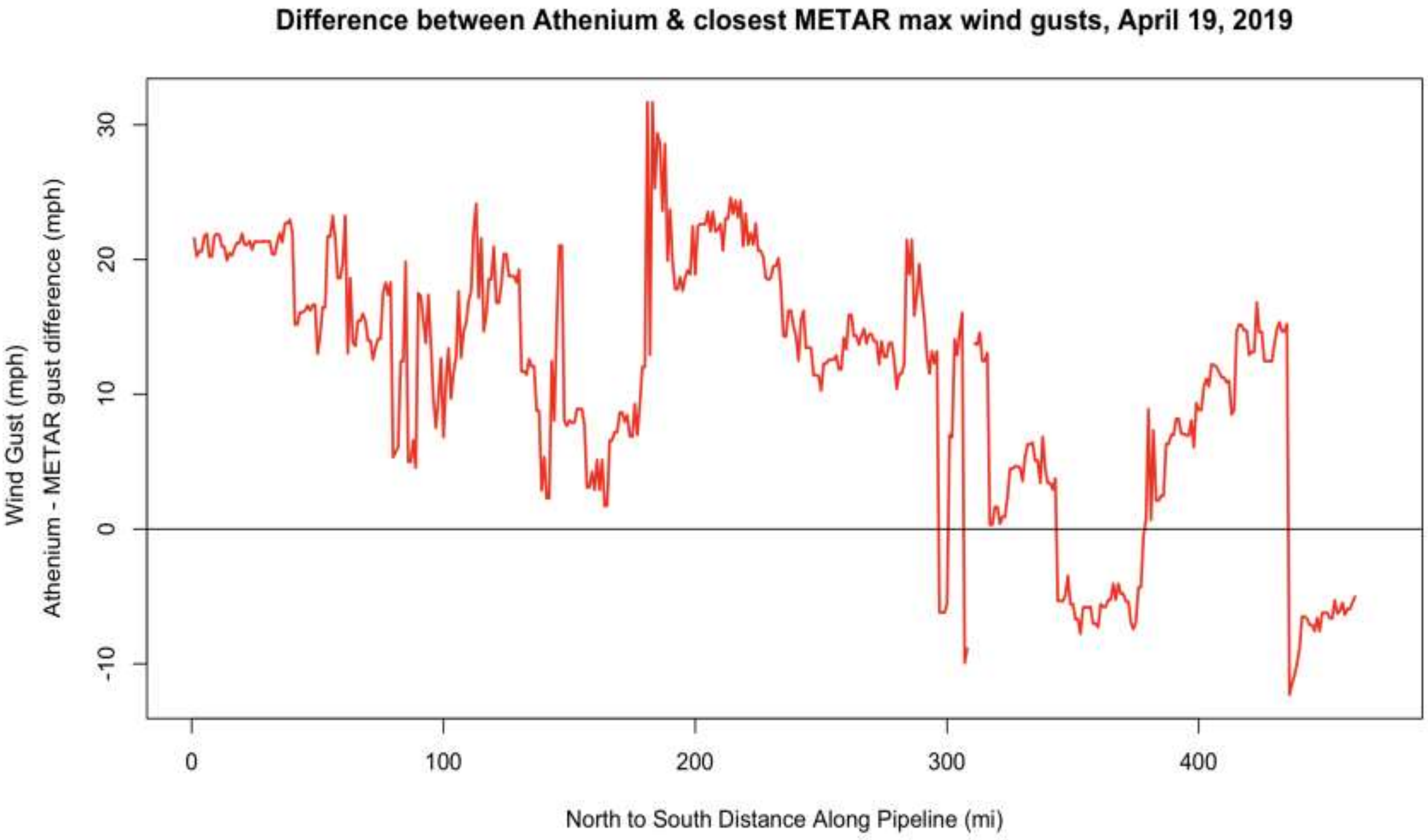
Verifying project wind gust speeds – hyper-local data

Modeled maximum wind gusts offers greater resolution & site-relevance

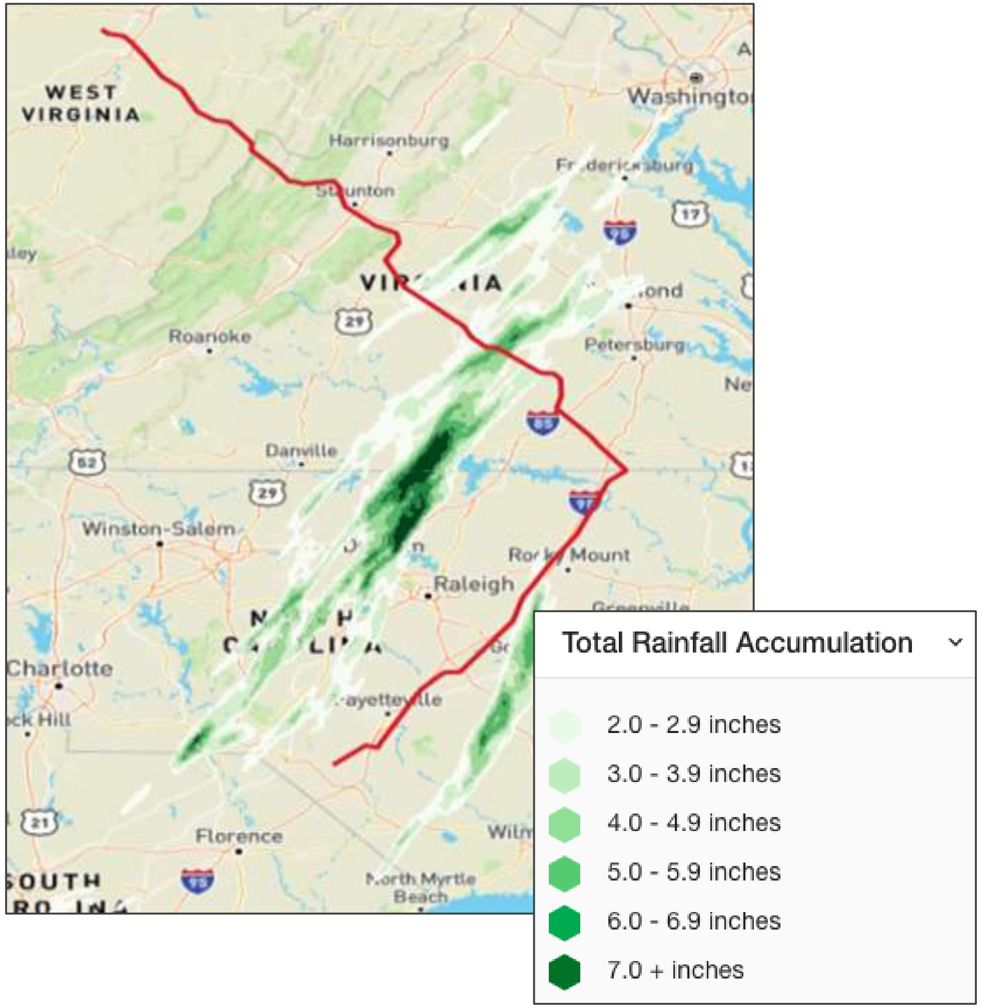


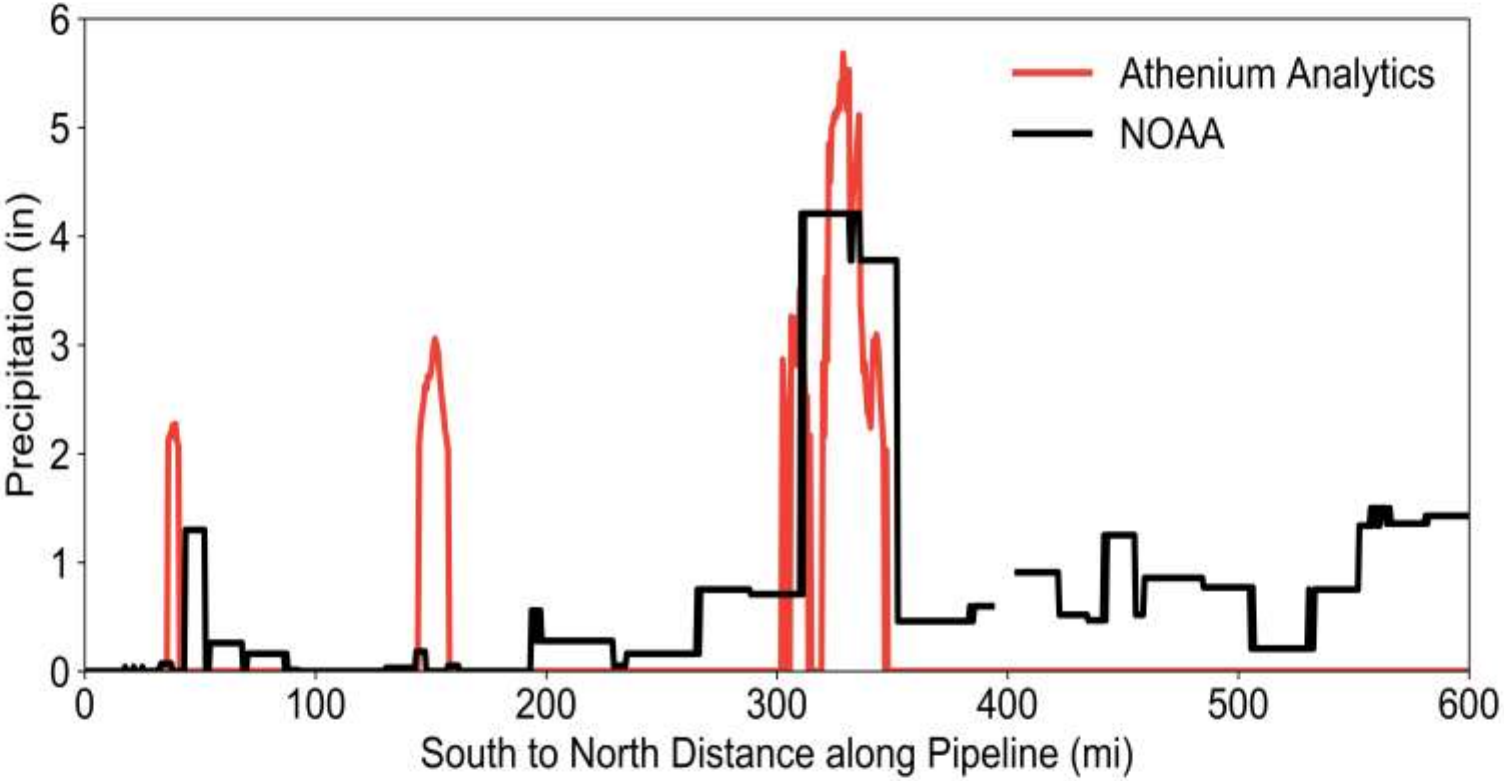
Verifying project wind gust speeds – hyper-local data

Difference in wind gusts between hyper-local data & nearest station data was upwards of 20-30 mph in some areas

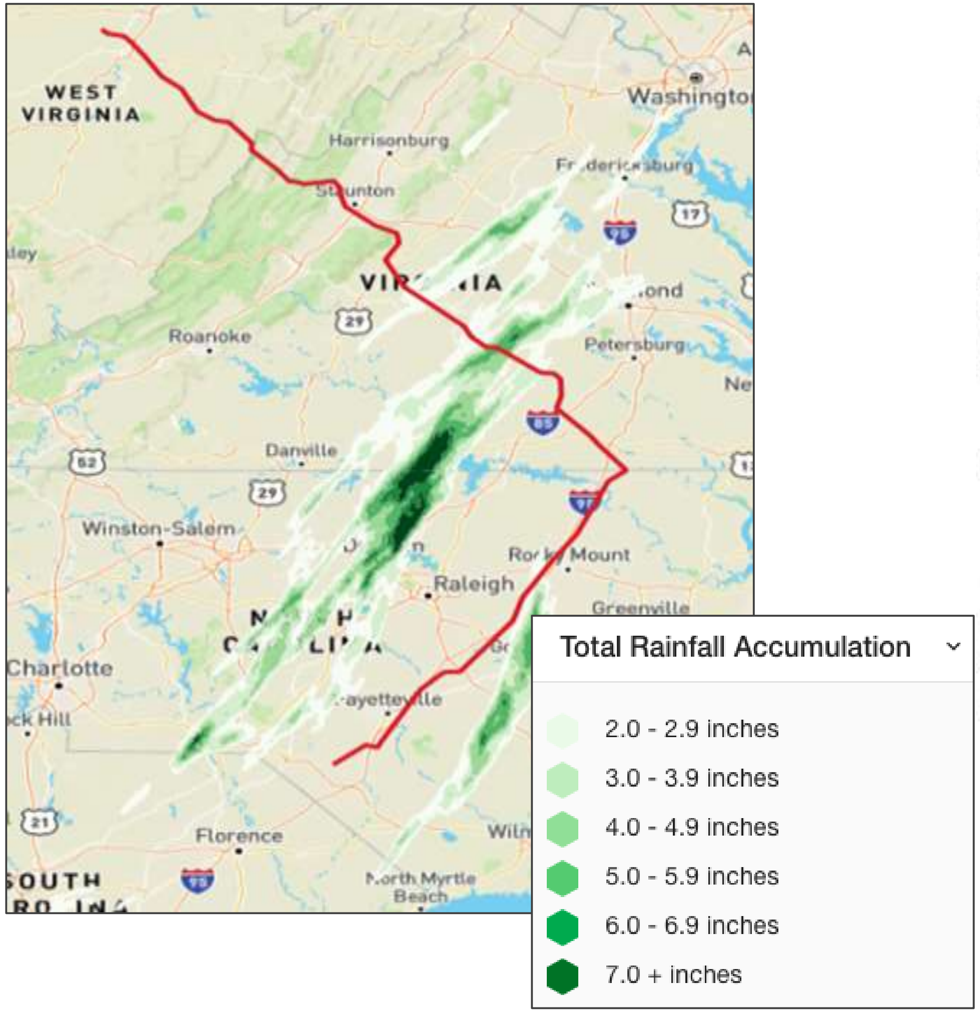


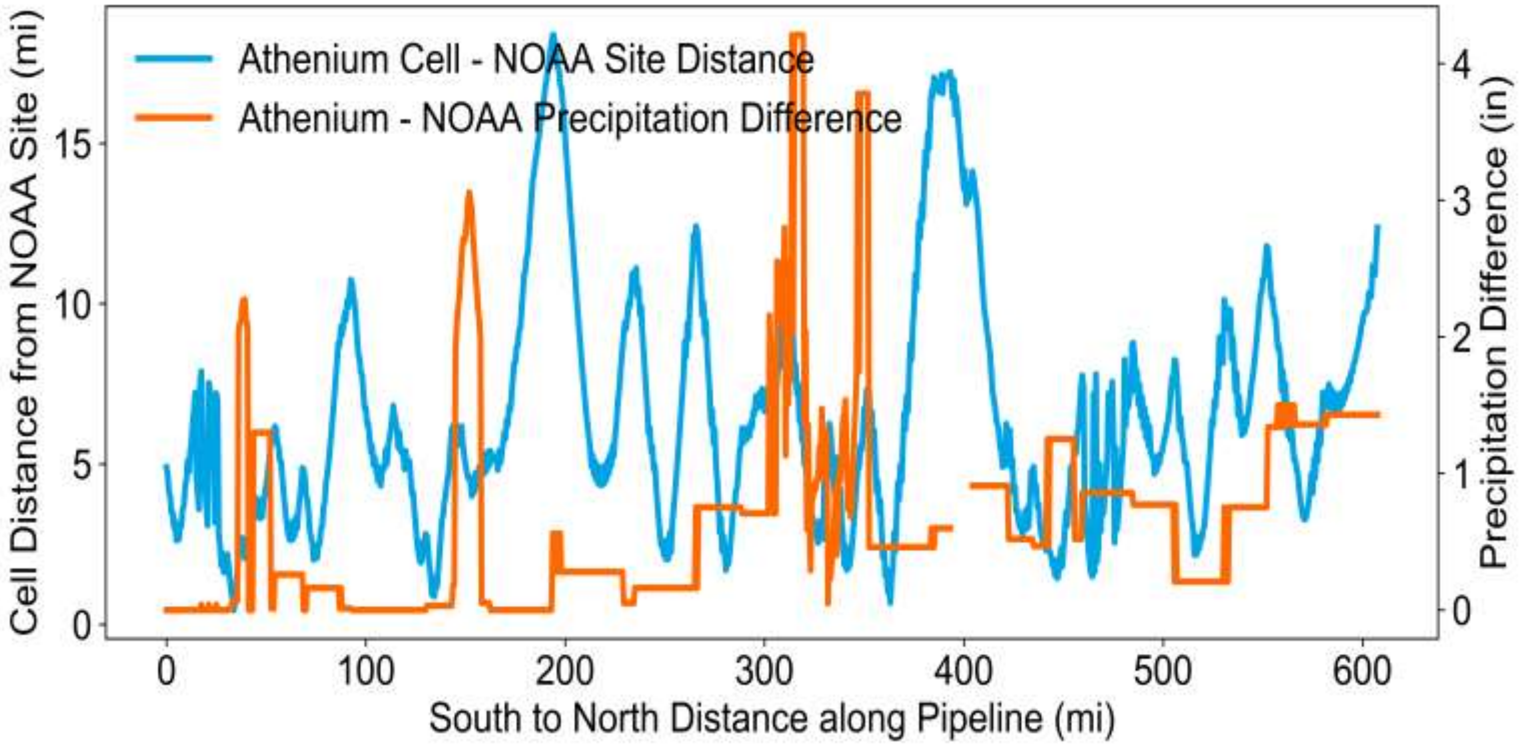
Verifying project rainfall – NOAA data



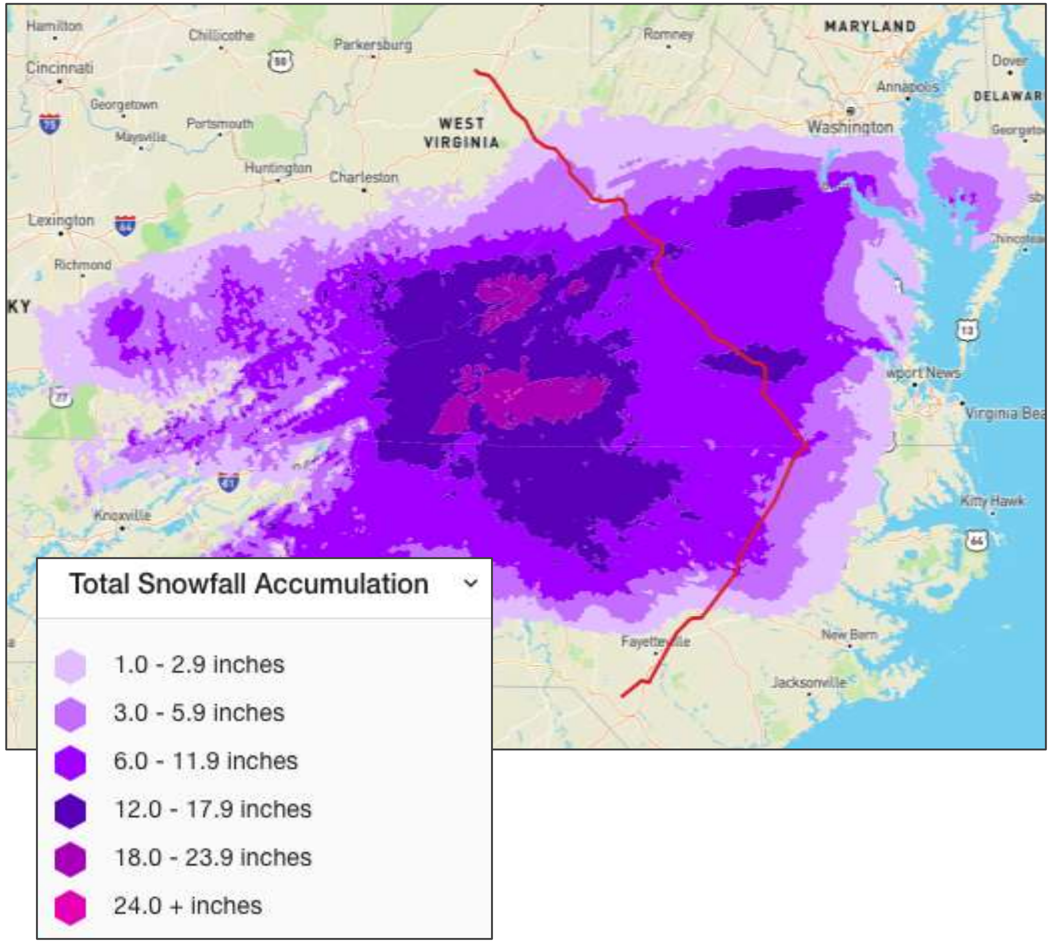


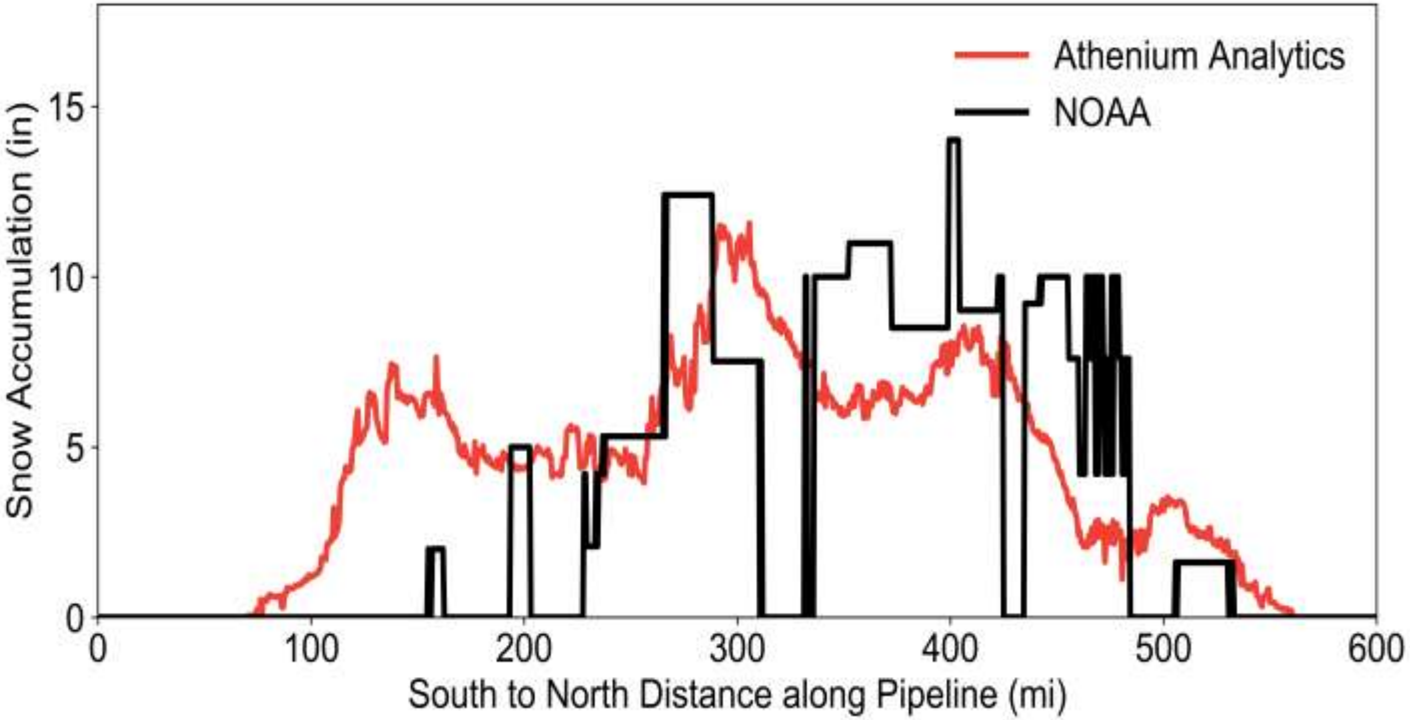
Verifying project rainfall – NOAA data



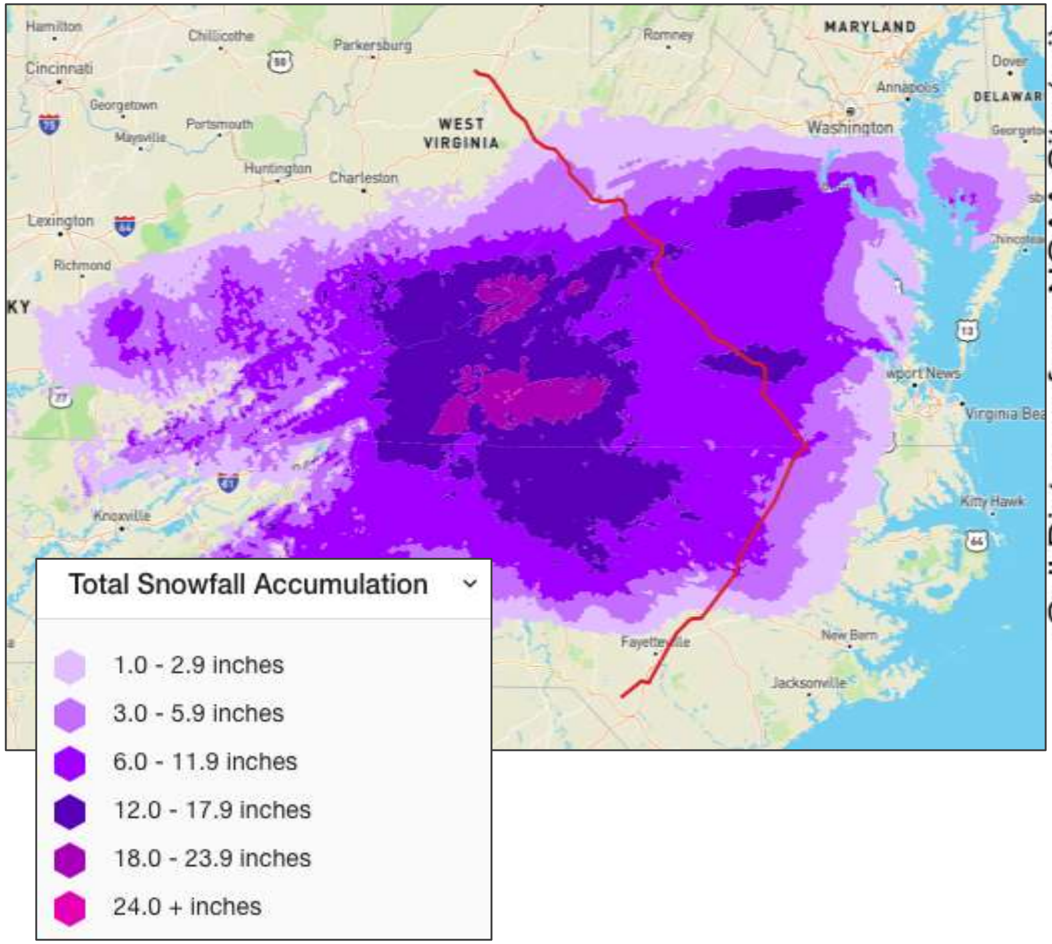


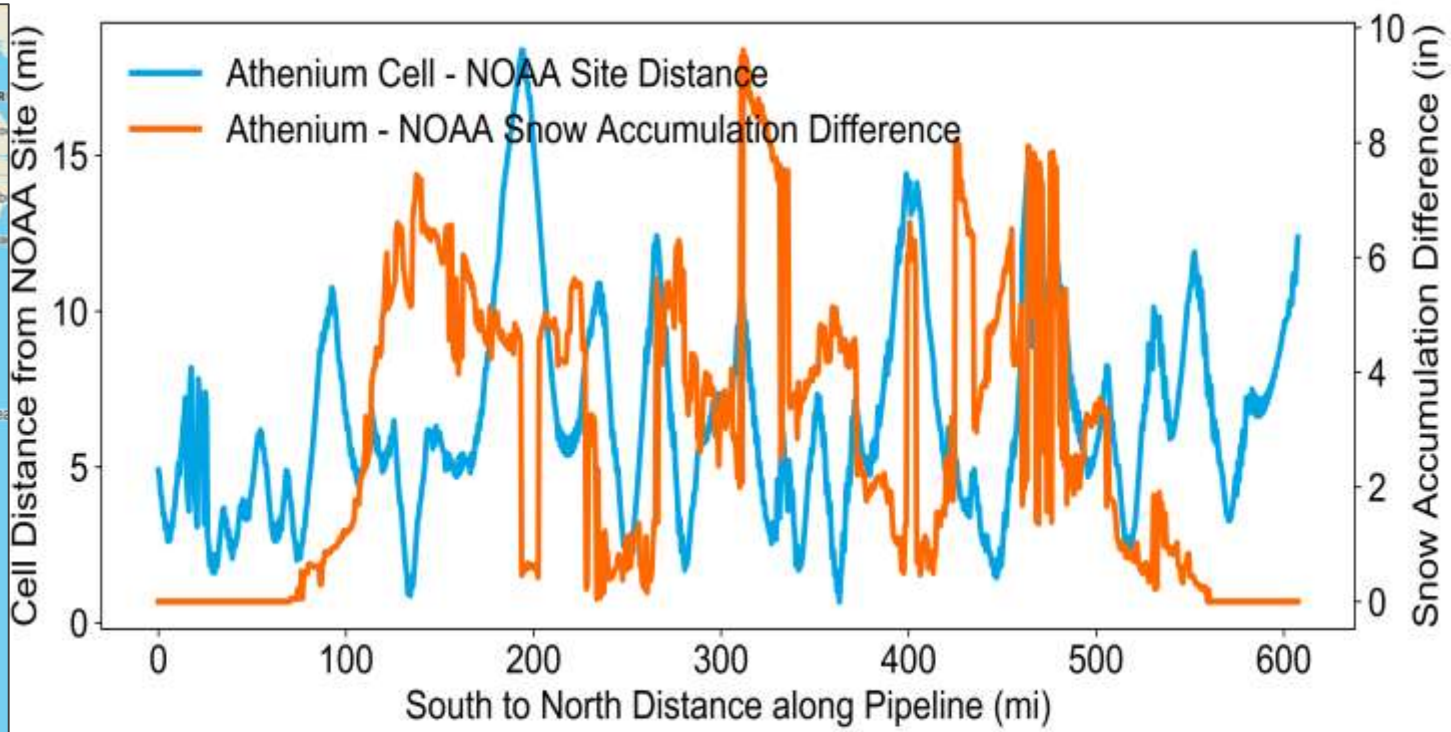
Verifying project snowfall – NOAA data





Verifying project snowfall – NOAA data





Minimizing weather delays

Weather delays can be expensive for a construction project

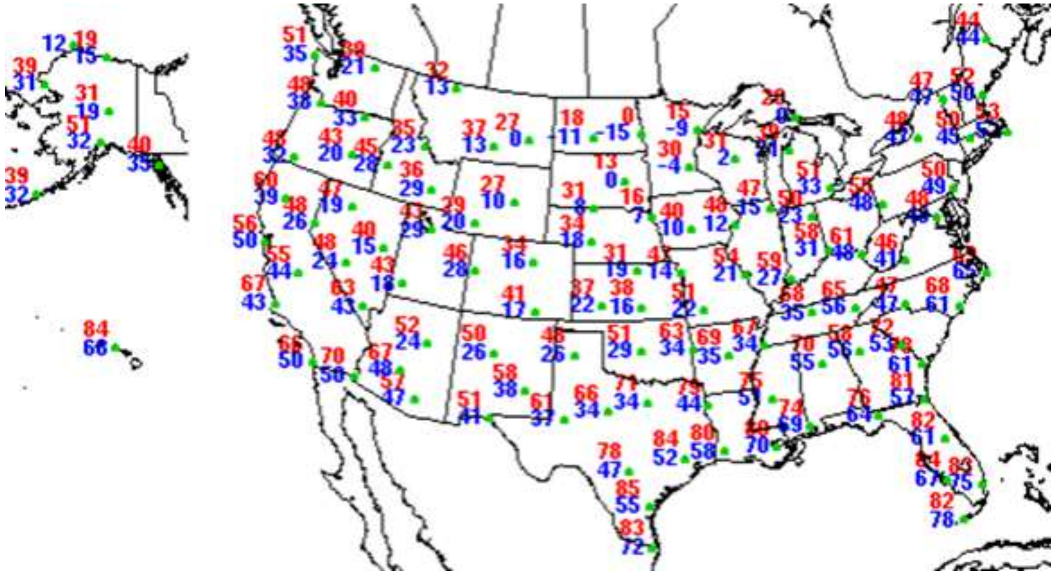
- Labor costs
- Equipment costs
- Material costs
- Subcontractor costs
- Storm damage costs
- Contractual costs

Accounting for weather delays while bidding, scheduling, & planning your project can help reduce costs & mitigate delays

Lost weather days

Predicting non-working weather days can be tricky

- Weather stations may be miles away
- Data may be limited and inconsistent
- Analysis may be complicated and time consuming



```
                                        STATION:   ELKINS WV
                                        MONTH:     AUGUST
                                        YEAR:      2019
                                        LATITUDE:   38 52 N
                                        LONGITUDE:  79 51 W

 TEMPERATURE IN F:       :PCPN:    SNOW:  WIND        :SUNSHINE: SKY      :PK WND
================================================================================
1   2   3   4   5  6A  6B    7    8   9  10  11  12  13   14  15   16   17  18
                                     12Z  AVG MX 2MIN
DY MAX MIN AVG DEP HDD CDD  WTR  SNW DPTH SPD SPD DIR MIN PSBL S-S WX    SPD DR
================================================================================

 1  86  61  74   4   0   9 0.00  0.0    0  2.4 12 120   M    M   5 123   16 120
 2  86  61  74   4   0   9 1.74  0.0    0  2.1 22 350   M    M   5 123   30 340
 3  85  60  73   3   0   8 0.00  0.0    0  2.3 10 290   M    M   5 12    14 310
 4  82  59  71   1   0   6 0.00  0.0    0  2.1 12 320   M    M   4 12    17 300
 5  86  58  72   2   0   7 0.12  0.0    0  2.5 10 160   M    M   3 1238  13 130
 6  85  61  73   3   0   8 0.00  0.0    0  2.8 12 290   M    M   5 12    16 270
 7  81  63  72   2   0   7 0.19  0.0    0  3.2 13 230   M    M   5 13    16 220
 8  83  60  72   2   0   7 0.07  0.0    0  5.3 17 250   M    M   4 13    24 300
 9  81  57  69  -1   0   4 0.14  0.0    0  5.8 17 280   M    M   6 13    24 280
10  79  54  67  -3   0   2 0.00  0.0    0  2.4 13 310   M    M   3 12    18 290
11  82  53  68  -2   0   3 0.00  0.0    0  1.7  8 290   M    M   3 12    12 360
12  88  53  71   1   0   6    T  0.0    0  1.2 10 290   M    M   2 12    14 260
13  86  68  77   7   0  12 0.32  0.0    0  3.1 15 250   M    M   6 1     23 230
14  83  66  75   5   0  10 0.34  0.0    0  1.7 12  10   M    M   6 18    17 260
15  87  65  76   7   0  11 0.00  0.0    0  2.6 13 280   M    M   5 12    16 260
16  84  61  73   4   0   8 0.00  0.0    0  2.2 12 290   M    M   4 12    16 280
17  86  59  73   4   0   8 0.00  0.0    0  2.0 10 300   M    M   2 12    13 260
18  90  62  76   7   0  11 0.00  0.0    0  1.8 18 170   M    M   1 1238  27 180
19  87  64  76   7   0  11 0.00  0.0    0  1.8 12 290   M    M   1 1     16 250
20  89  64  77   8   0  12 0.27  0.0    0  2.5 15 210   M    M   3 1238  20 240
21  85  67  76   7   0  11 0.08  0.0    0  3.6 15 250   M    M   6 1     20 250
22  86  65  76   7   0  11 0.25  0.0    0  2.1 22 270   M    M   6 13    29 280
23  70  56  63  -6   2   0 1.98  0.0    0  3.5  9 350   M    M   8 12    14  10
24  77  55  66  -2   0   1 0.00  0.0    0  2.1 10  10   M    M   7 12    13 140
25  74  49  62  -6   3   0 0.00  0.0    0  2.6 13 140   M    M   3 12    22 140
26  78  49  64  -4   1   0 0.01    M    0  4.3 15 140   M    M   1       21 140
27  79  62  71   3   0   6 0.04  0.0    0  4.7 10 210   M    M   9 1     16 160
28  80  56  68   0   0   3 0.54  0.0    0  3.5 15 290   M    M   6 1     22 280
29  76  51  64  -4   1   0 0.00  0.0    0  3.3 14 300   M    M   2 1     20 320
30  83  50  67   0   0   2 0.00  0.0    0  2.4 13 300   M    M   3 1     18 270
31  86  60  73   6   0   8 0.00  0.0    0  2.0 10 110   M    M   2 13    17 120
================================================================================
SM 2570 1829         7 201  6.09     0.0  85.6          M       131
================================================================================
AV 82.9 59.0                              2.8 FASTST   M    M   4    MAX(MPH)
                               MISC ---->  # 22 350                # 30  340
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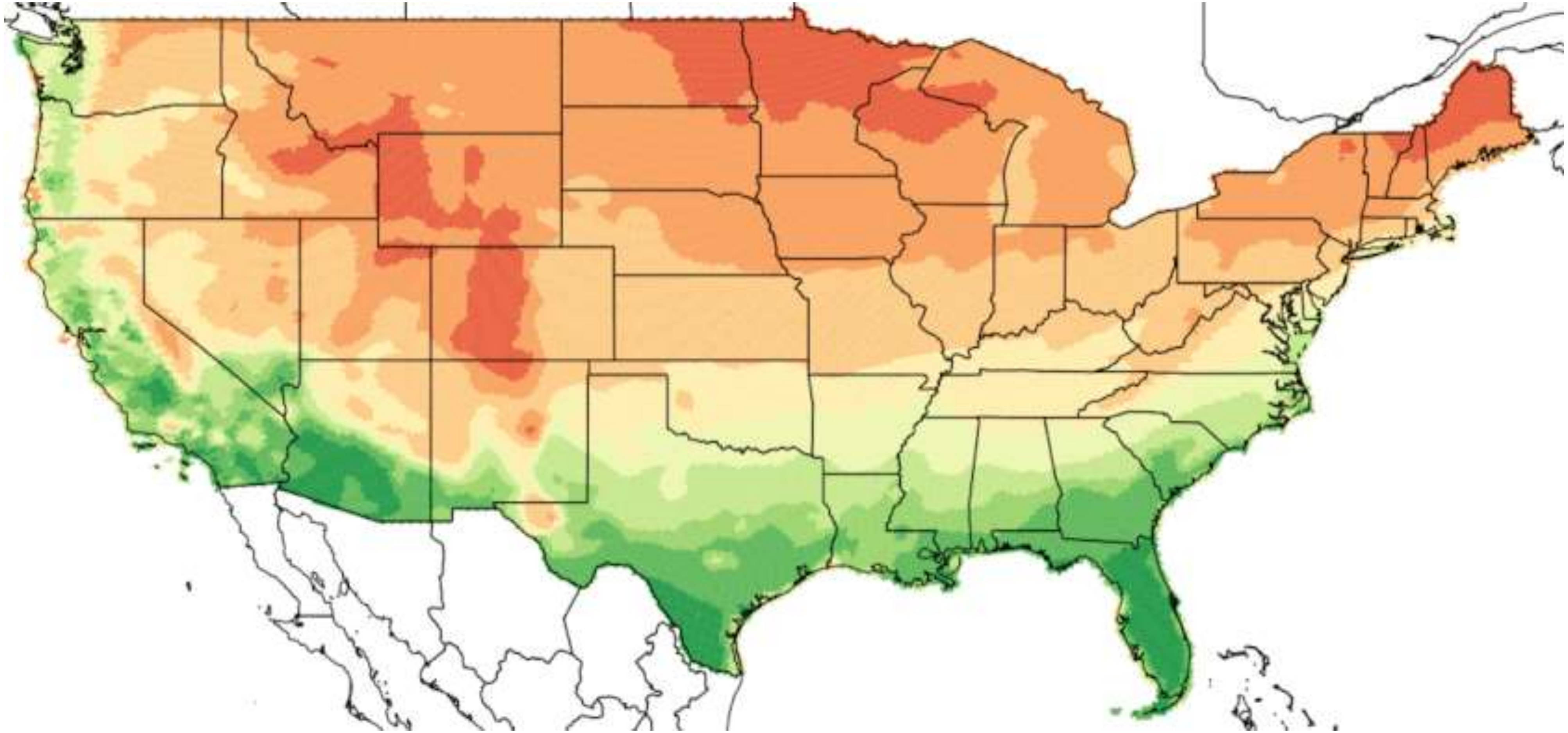
Using historical weather data to plan ahead

Weekly Weather Risks for Framing | January - December

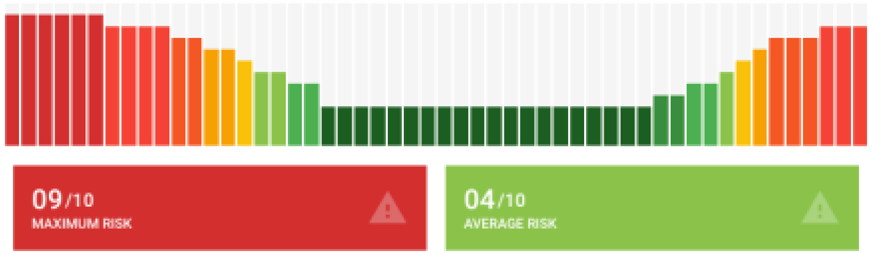


Weather risk variation

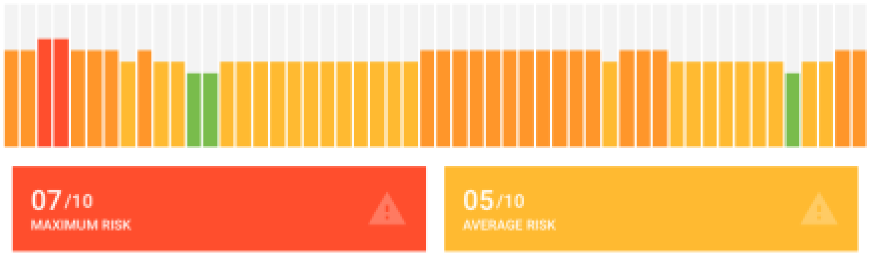
Right: Maximum weekly risk scores for a combination of weather perils & thresholds relevant to **foundation** work, over 1 year

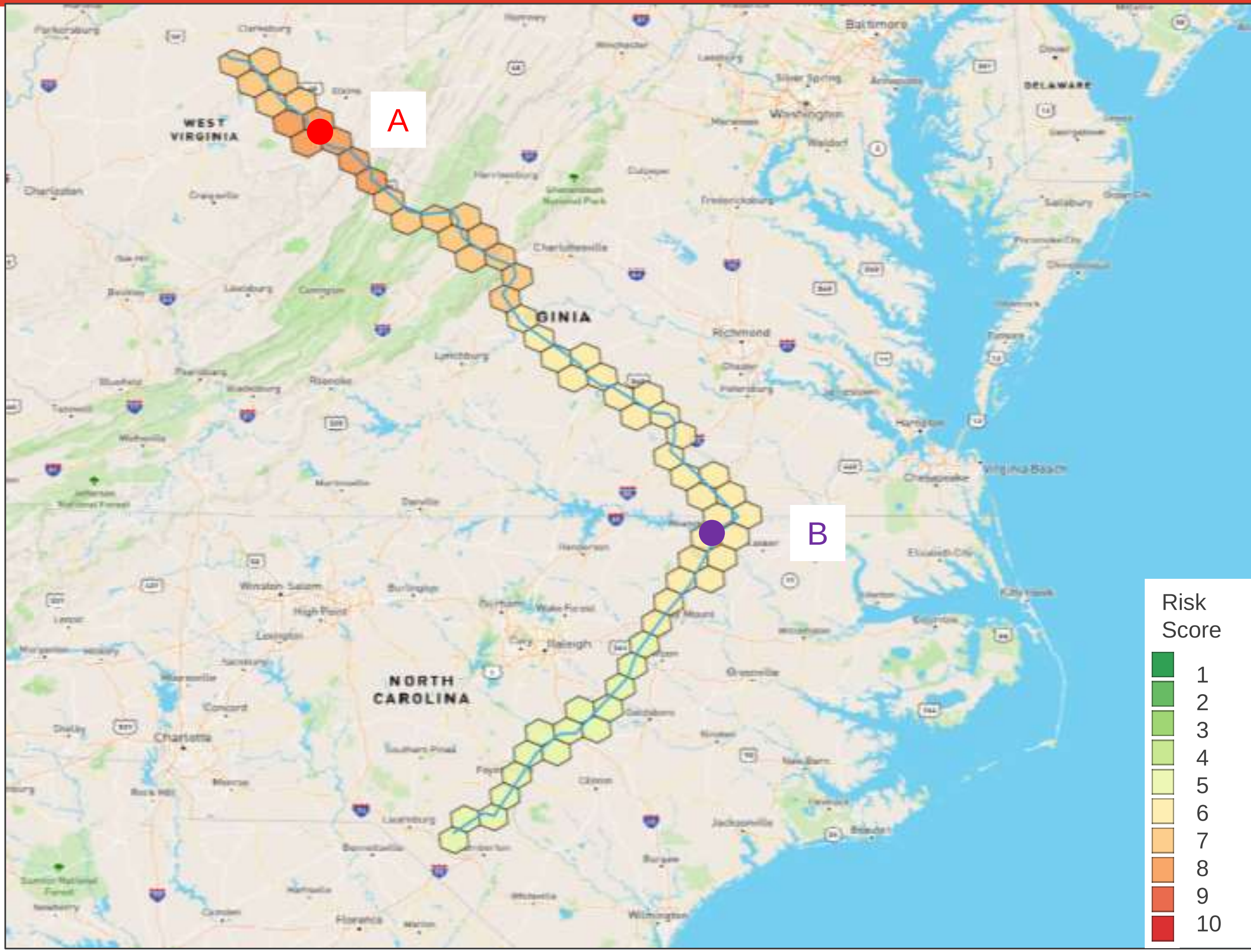
Below: Weekly **foundation** risk for points A and B

A:



B:



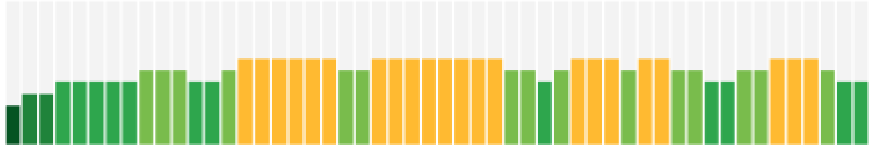


Weather risk variation

Right: Maximum weekly risk scores for a combination of weather perils & thresholds relevant to **excavation** work, over 1 year

Below: Weekly **excavation** risk for points A and B

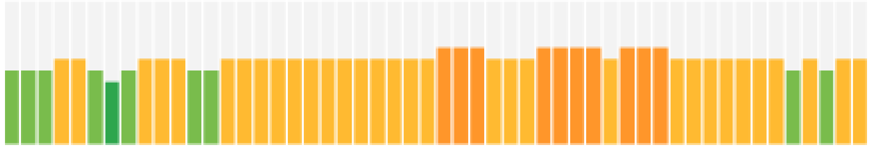
A:



05/10 MAXIMUM RISK

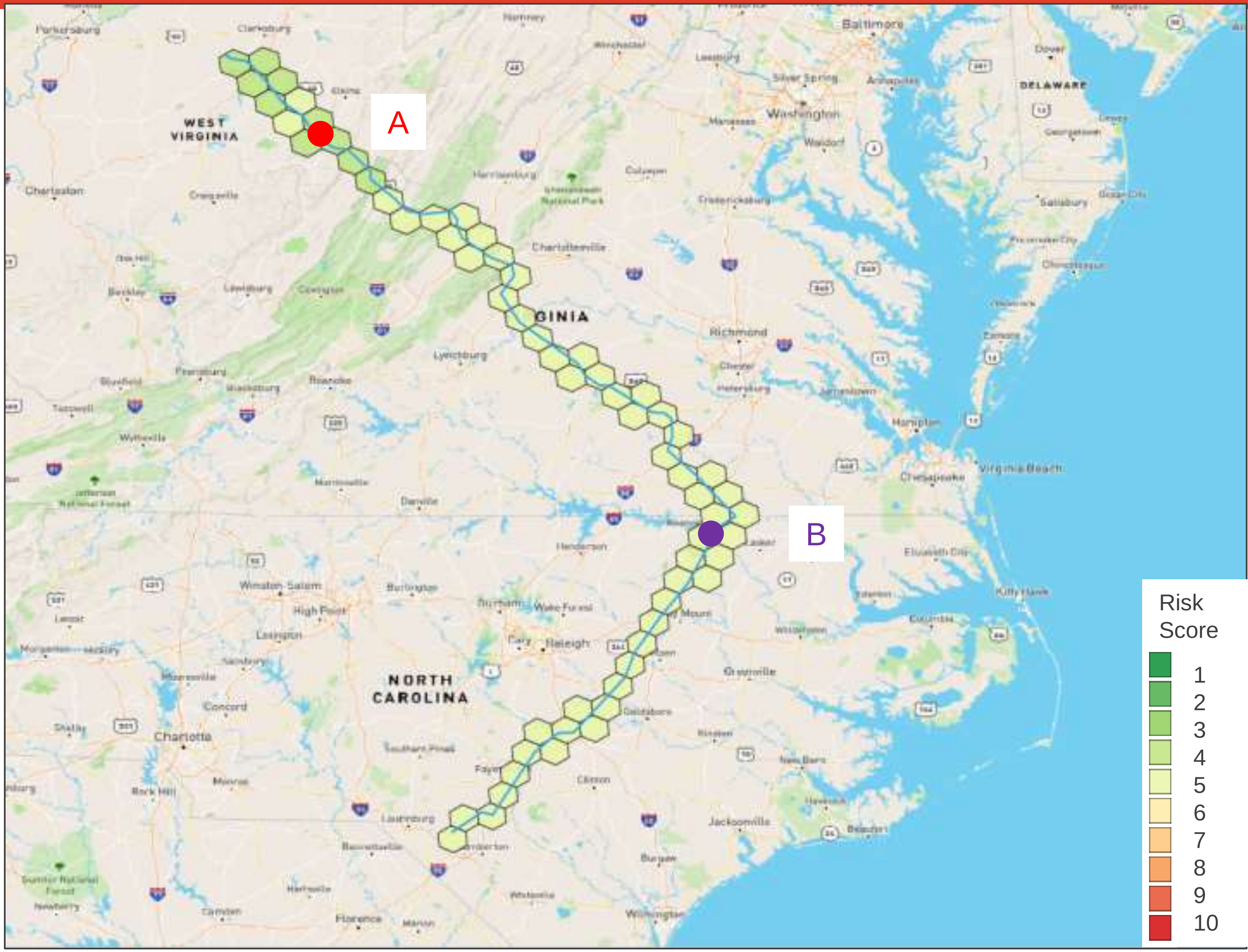
04/10 AVERAGE RISK

B:



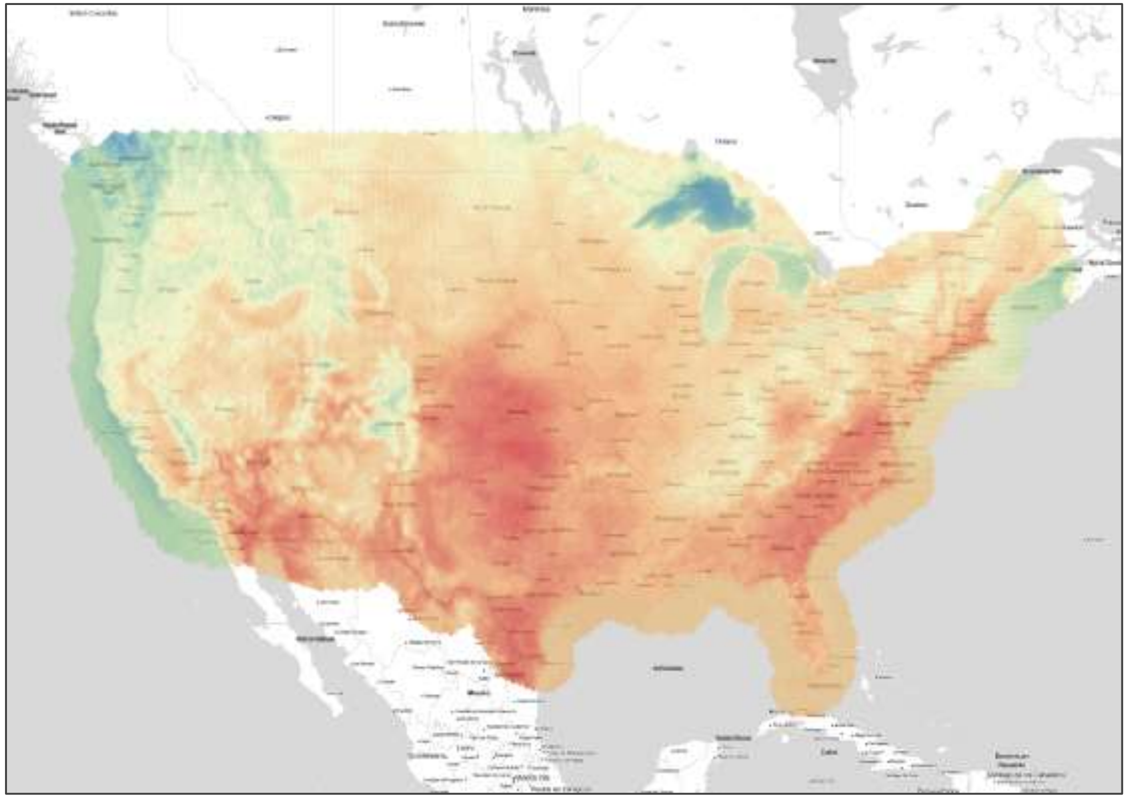
06/10 MAXIMUM RISK

04/10 AVERAGE RISK



Conclusion

- With a changing climate, there is an even greater need for granular, project-specific weather information
- While forecasts & computing power have improved, station data & free weather app data have their limitations
- Installing high-quality weather stations in linear projects (or others) can be cost-prohibitive
- How are you currently trying to de-risk the weather?
  - Contractually
  - Risk management
  - Project management



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