

# Microsoft Weather

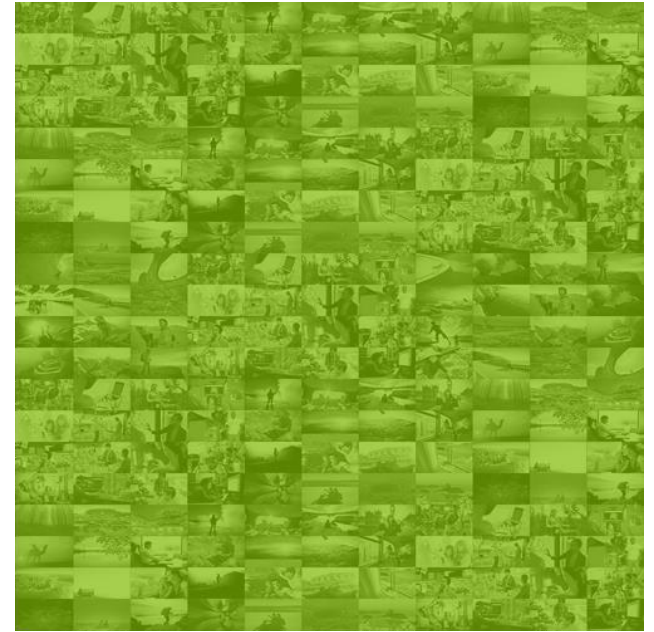
AI4NWP

November 28, 2023

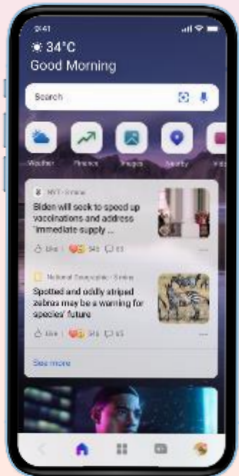
- What is Weather from Microsoft Start?
- WRN Ambassador success
- Microsoft AI weather modeling
- LLM AI copilot integration to Operations
- Quality Observations- critical to AI future with weather
- AI model advantages for weather operations

# Microsoft's mission

Empower every person and every organization on the planet to achieve more



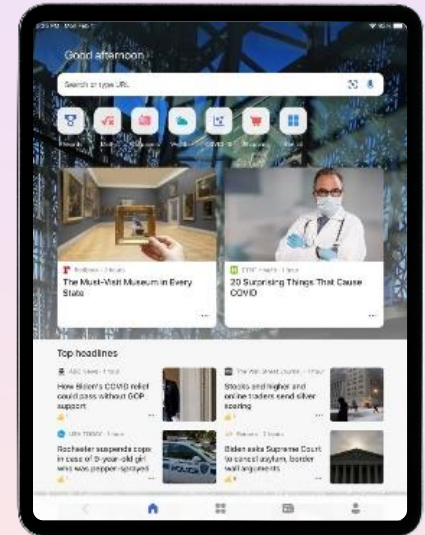
# A Multitude of Experiences



Mobile



Desktop



Tablet

## Weather serving users worldwide



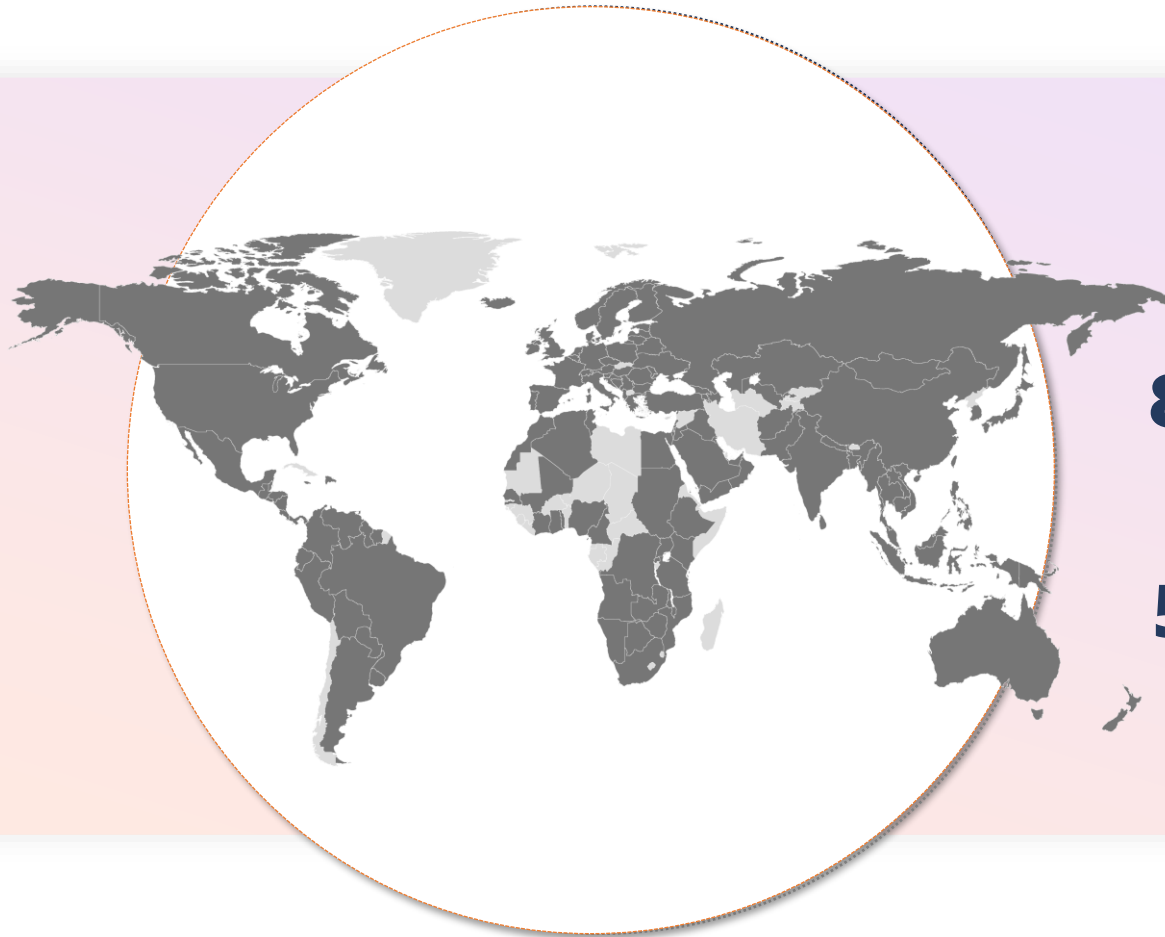
**180** Countries



**31** Languages



**1B+** Devices



**800M** Monthly user interactions

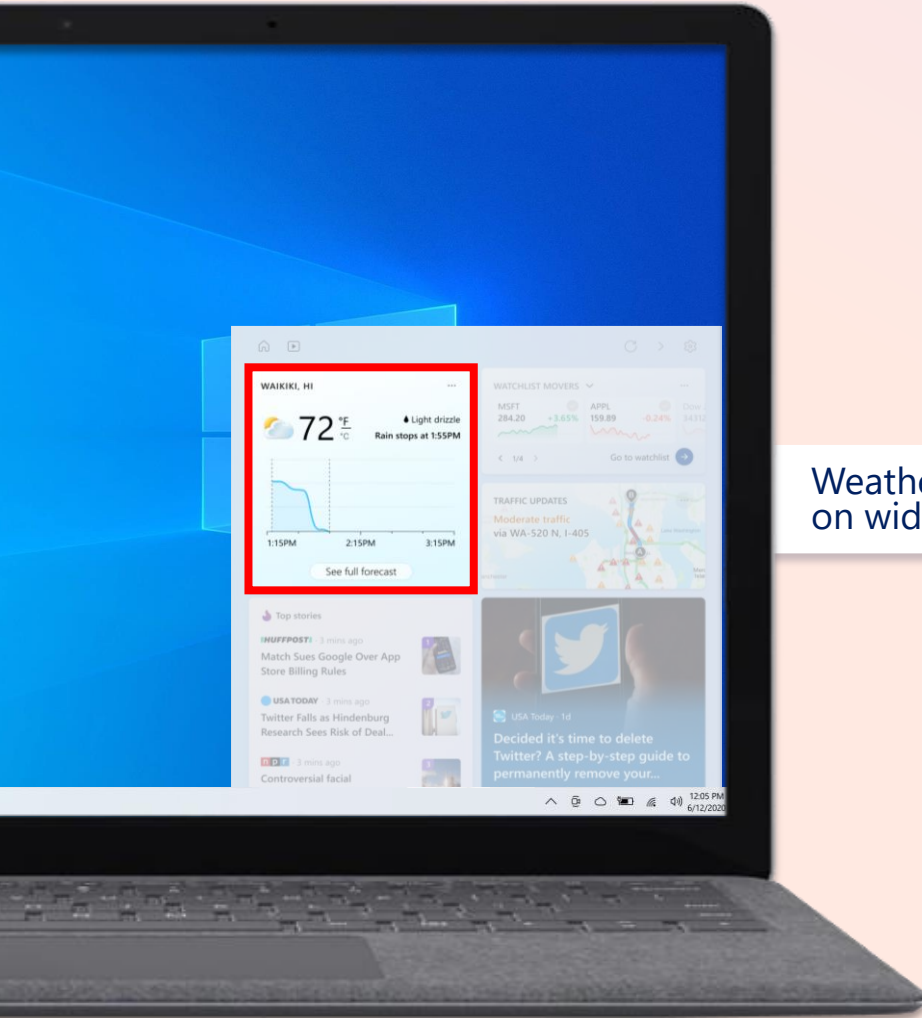


**500M** Daily weather impressions



# Smart notifications on Windows

## Weather-specific detail + alerts built right into Windows



Weather-specific detail on widgets panel

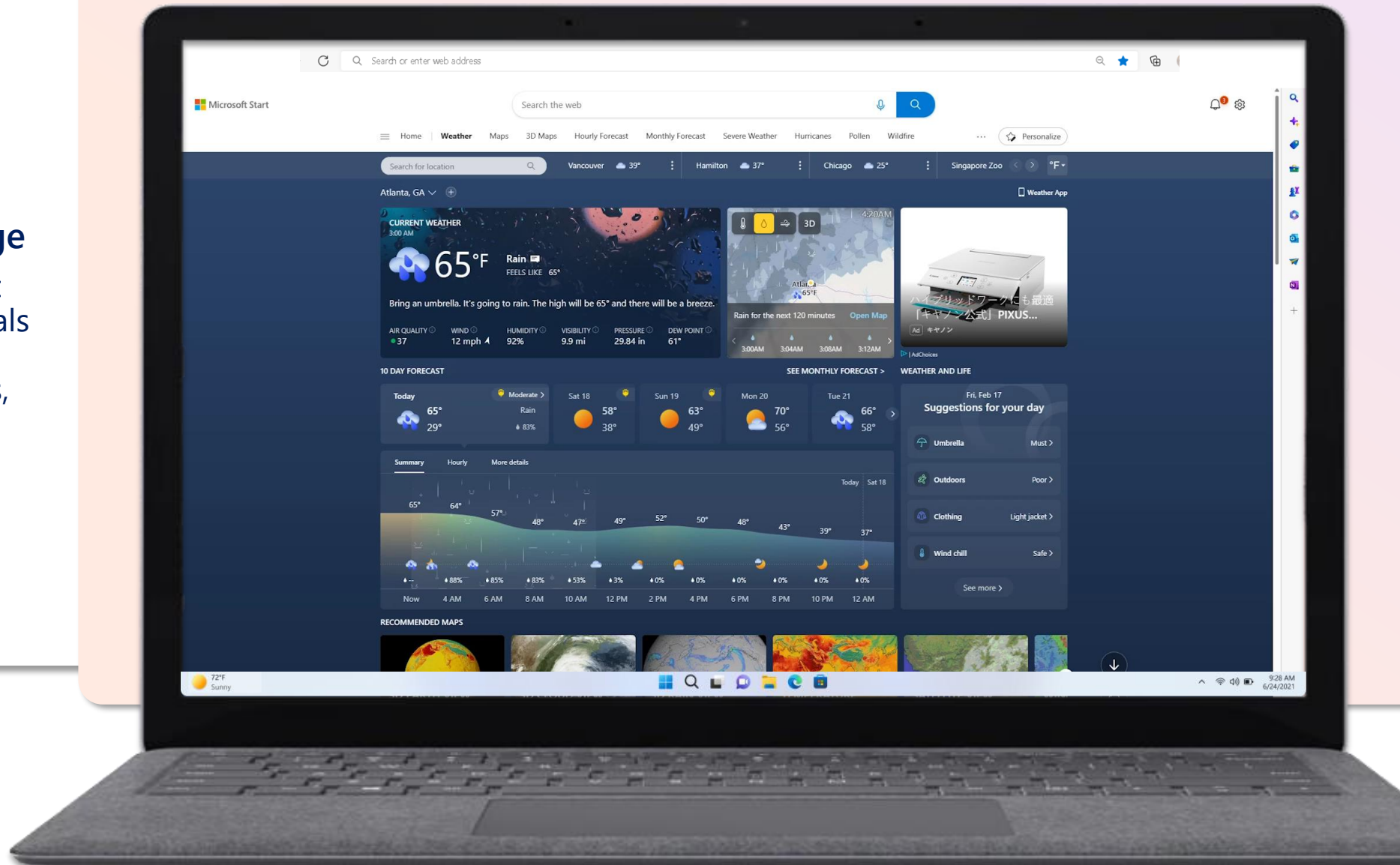


Weather alerts on Taskbar

# Rich & Engaging Weather Experience

## Dynamic Landing Page

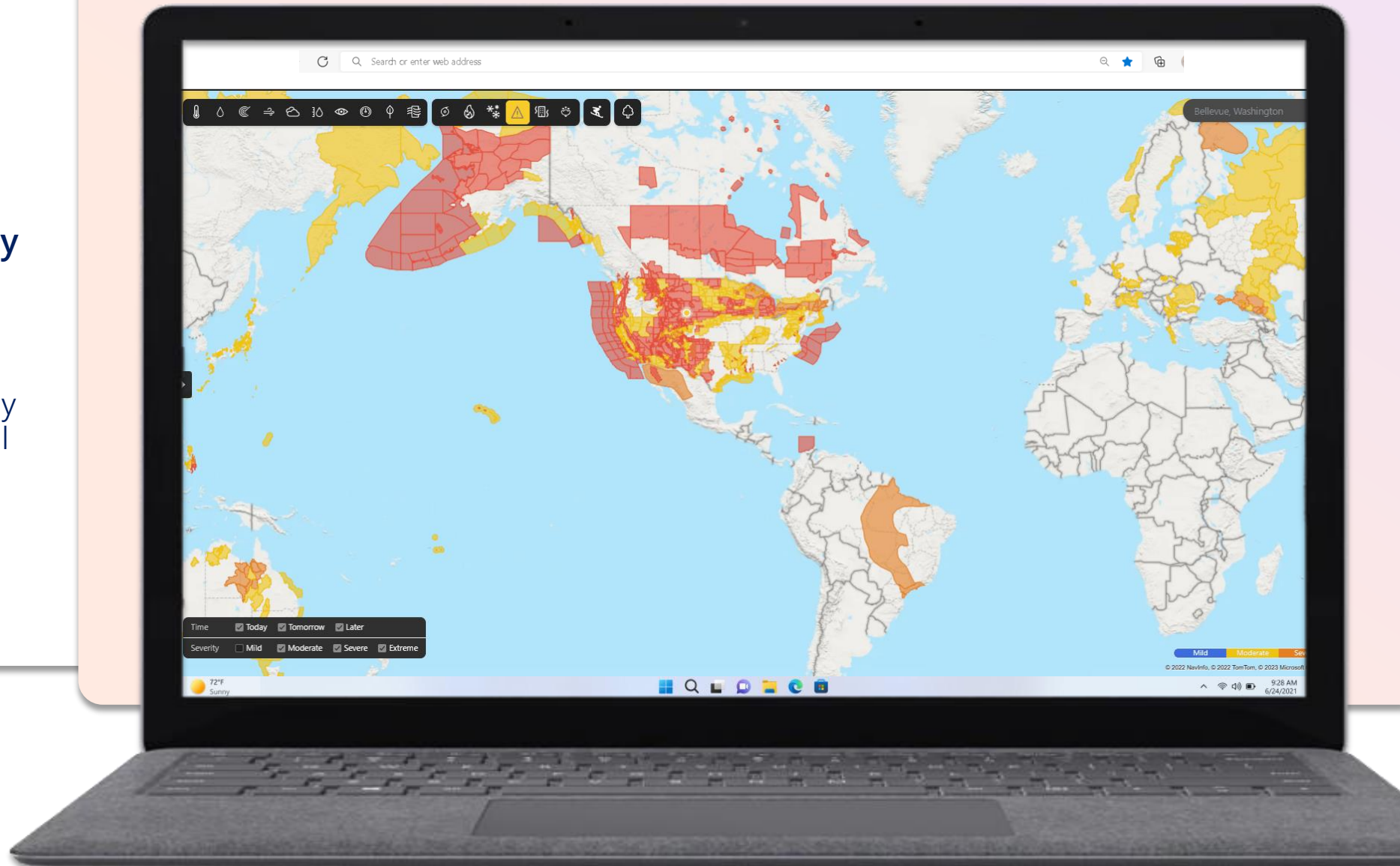
A dynamic starting point with rich interactive visuals gives users a view of key weather data + forecasts, updated constantly.



## Rich & Engaging Weather Experience

### Global Weather Safety

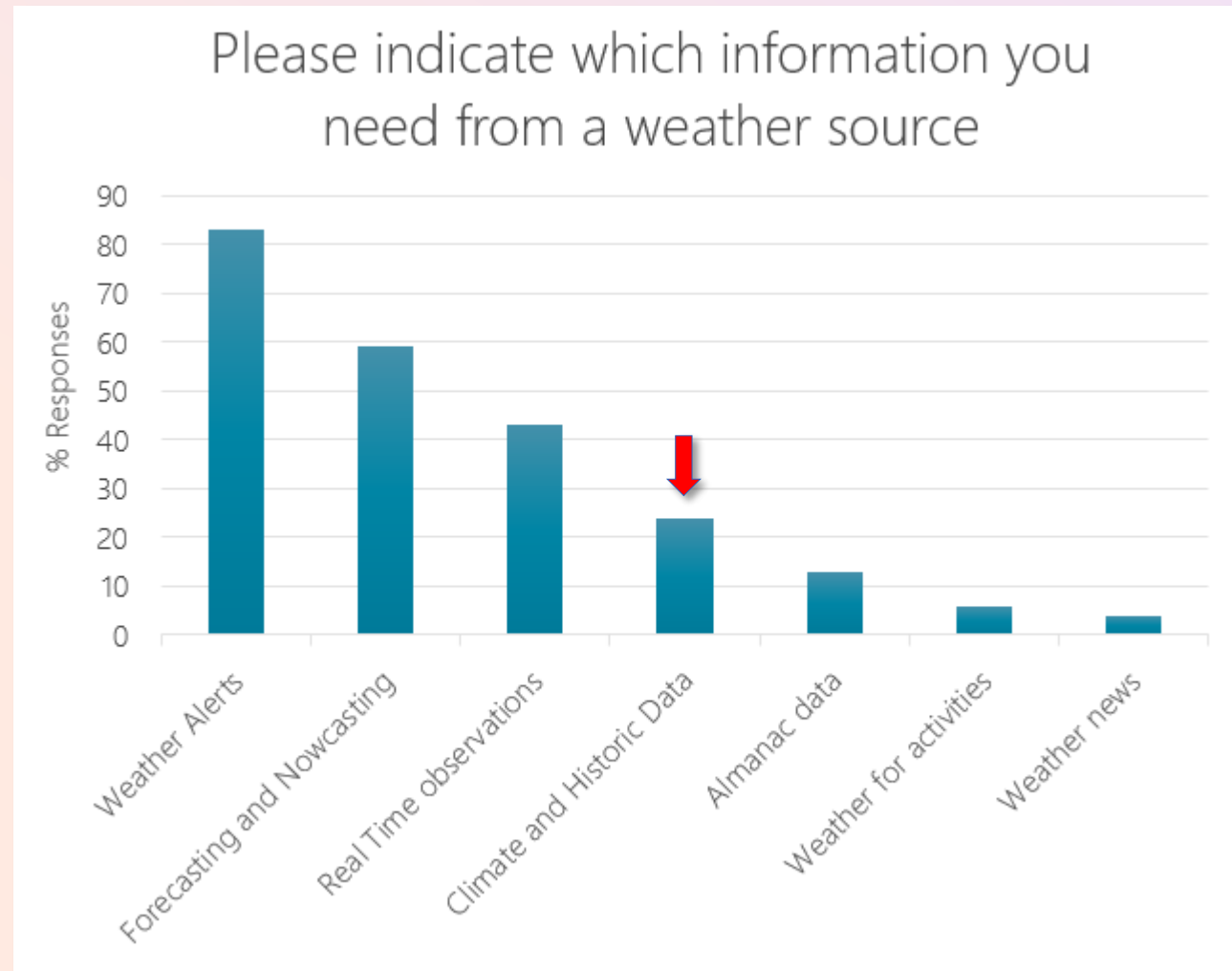
Leveraging trusted government watches and warnings, Microsoft empowers users to quickly and effectively find critical weather information to help make informed decisions.



## User Centric Approach

### 2020 User Study

Climate and Historical Data Scored #4 from users as "information needed"



\*Weather Survey Report July 2020- Microsoft



## New: Weather Trends & Climate Page

Historical averages going back 70 years:

- High and Low temperatures
- Precipitation & Snow Days
- Humidity
- Wind

Month by Month

Daily averages

Short and Long term Trends

Weather Planning Calendar



# Microsoft Weather

## What is Microsoft Start?

- Microsoft's mission aligns closely with NOAA's to **empower and protect citizens**
- Microsoft Weather has a **tremendous reach** across the US and the Globe
- We **leverage NWS watches and warnings** to help users make better decisions
- We use a strong **Customer Centric approach** and user signals to create products that users love

# WRN and Microsoft

# Weather Ready Nation- Summer of 2022



A proud member of NOAA's Weather Ready Nation

*"Microsoft performs a critical role in making sure the public receives National Weather Service weather warnings."*

Ken Graham, director of NOAA's National Weather Service

**LIGHTNING SAFETY**

- When you hear thunder, go indoors
- Don't touch electrical equipment
- Stay away from windows and doors

Tropical Storm Julia has formed in the Caribbean and is likely to hit Central America as a hurricane in the upcoming days. Track the storm with Microsoft Start: [msft.it/6015dKRqz](https://msft.it/6015dKRqz) #MyStartWeather #MyStartNow #Julia



# Climate Ready Nation & Beyond



## NOAA, Microsoft team up to advance Climate-Ready Nation

*"We are excited about the potential of partnering NOAA's environmental intelligence with Microsoft's cloud computing in hopes of amplifying NOAA's ability to predict climate, weather and ocean changes,"*

Rick Spinrad, Ph.D., NOAA Administrator



## EARLY WARNINGS FOR ALL

The UN Global Early Warning Initiative for the Implementation of Climate Adaptation

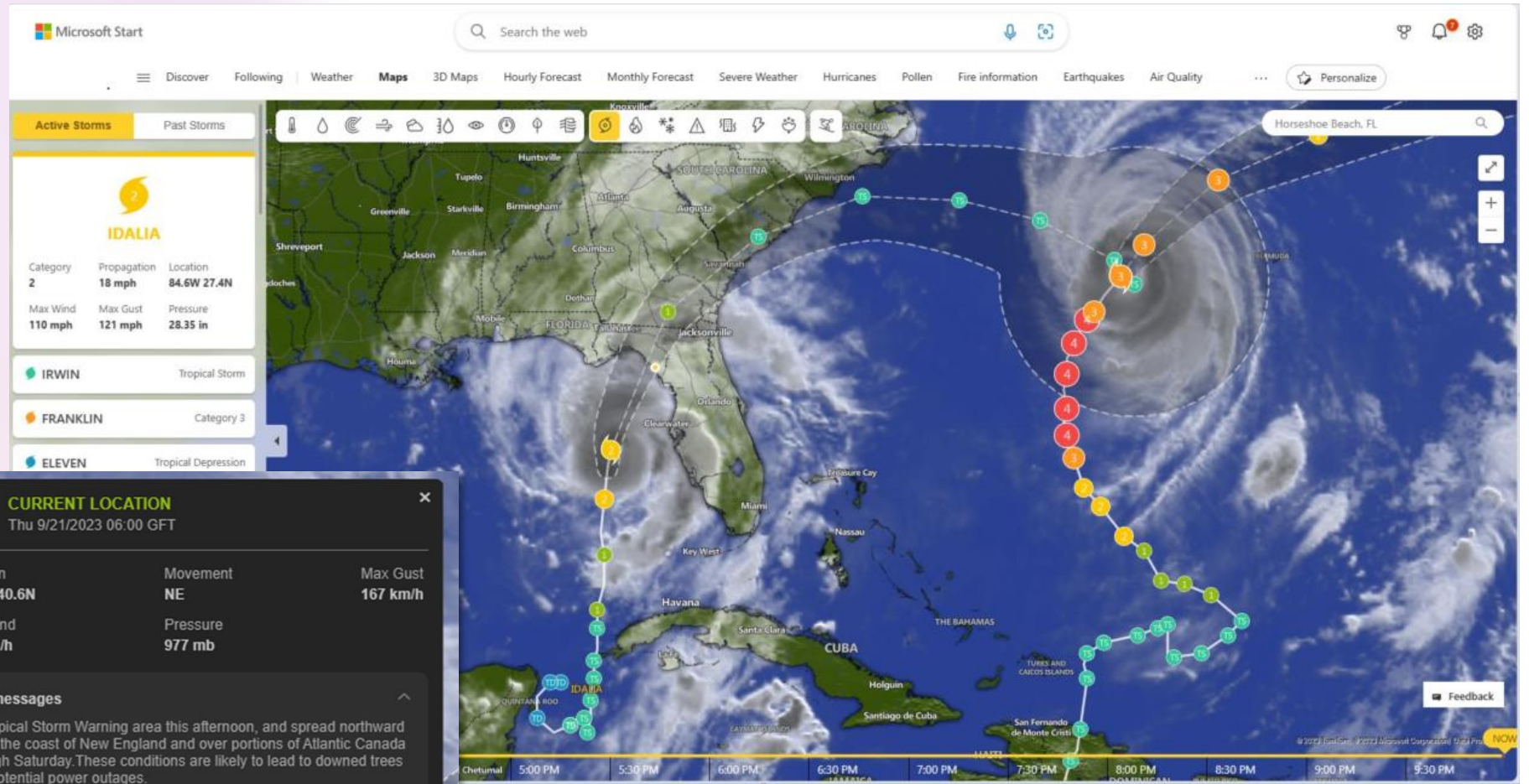
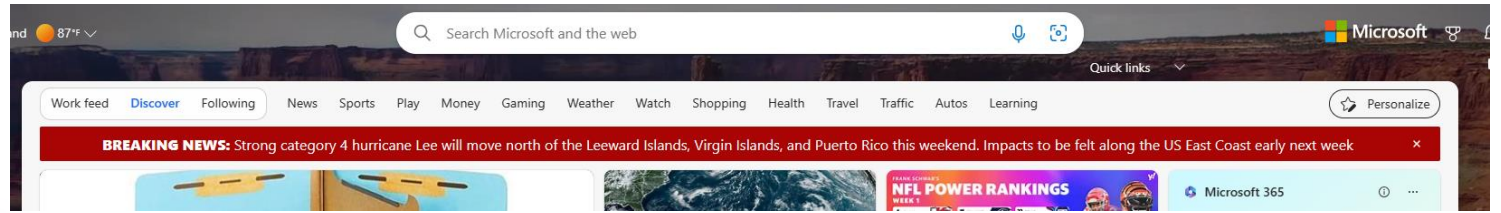


# Updated Hurricane Experience

- Updated icons
- Key messages
- Satellite defaults
- Actions and Tips
- Edge, mobile and Bing notifications

## Future items:

- Preformation
- Impact products



# New: Global Lightning and Thunderstorm Nowcasts

- Global solution
- Augments NWS warnings
- High value and engagement to users

The screenshot displays the Microsoft Start weather interface for Van Buren, MI. The current temperature is 82°F, and the forecast indicates heavy rain soon. A red circle highlights the **Thunderstorm Watch** warning, which includes the text "Rain starting in 36 minutes." Below this, there are recommendations for an umbrella (Must) and outdoor activities (Very poor). A news snippet mentions flooding in Detroit. An advertisement for Acronis is also visible. The map shows a large purple area representing the storm's path, with yellow lightning bolts indicating strikes. A callout box states "Storm arriving in 50 minutes." The map includes a legend for "Lightning strikes" and "Storm warnings" and a timeline at the bottom showing the storm's progression from 7:00 PM to 8:00 PM.

# Microsoft Weather

## WRN and Microsoft Weather?

- We are a **PROUD Ambassador of WRN** and embrace it's mission
- Microsoft's serves as an **amplifier** of the watches and warnings & more
- We augment watches and warnings with additional datasets on a global basis. We believe that the **NWS is the trusted source** for severe weather warnings
- We want to do more with NOAA to improve quality, timeliness, and accuracy in severe weather outputs. **We all win!**



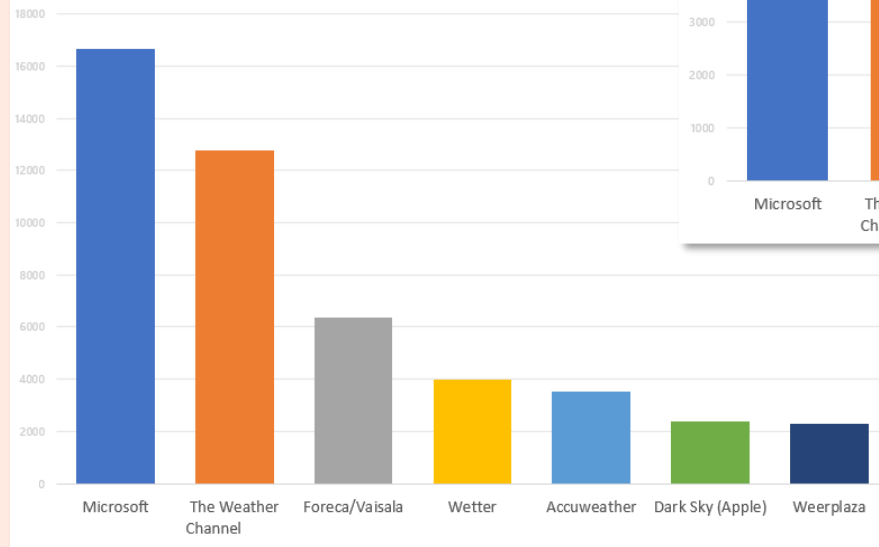
# Modeling and AI

# Global Weather Leader: Confirmed

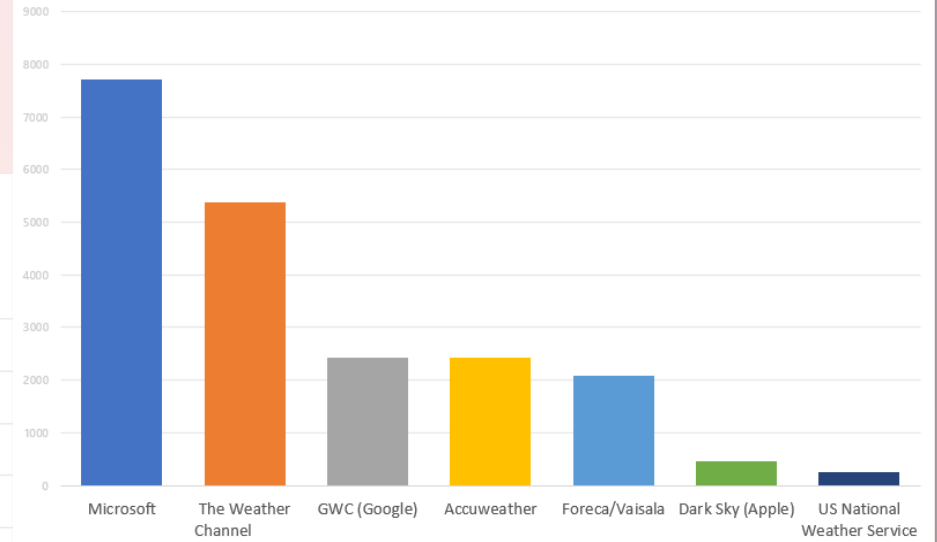
“*In this analysis, Microsoft was determined to be the overall most accurate provider globally, as well as in the metrics of high temperature, low temperature, and wind speed.*”

*\* Independent Forecast Study*

### Total Forecast Score for All Parameters



### Total Forecast Score for High/Low Temperatures



\*Analysis compared 24 global weather providers of one to five day out global temperature, wind speed, precipitation, and opacity for January- June 2022 | Intellovations, LLC, [www.forecastwatch.com](http://www.forecastwatch.com)

## ML+ Weather: Two strategies



### Augmenting NWP

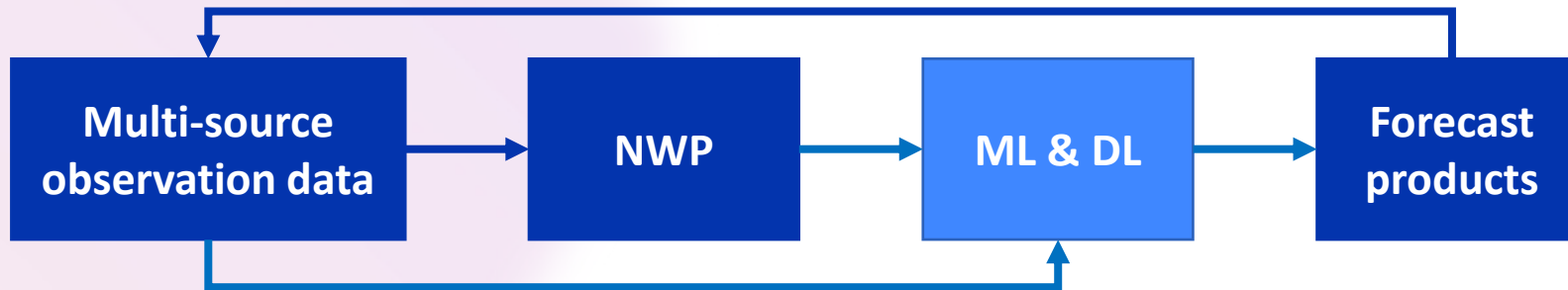
Post-processing and calibration  
Super-resolution



### New models or replacement

Precipitation nowcasting  
Physics-aware deep learning models

## Augmenting NWP by ML & DL



Augment and correct NWP model forecast using **machine learning** and **deep learning**

Cutting-edge ML & DL technique  
Diverse NWP & observation data  
Large-scale global operational system

# Large-scale global operational system

## Large scale:

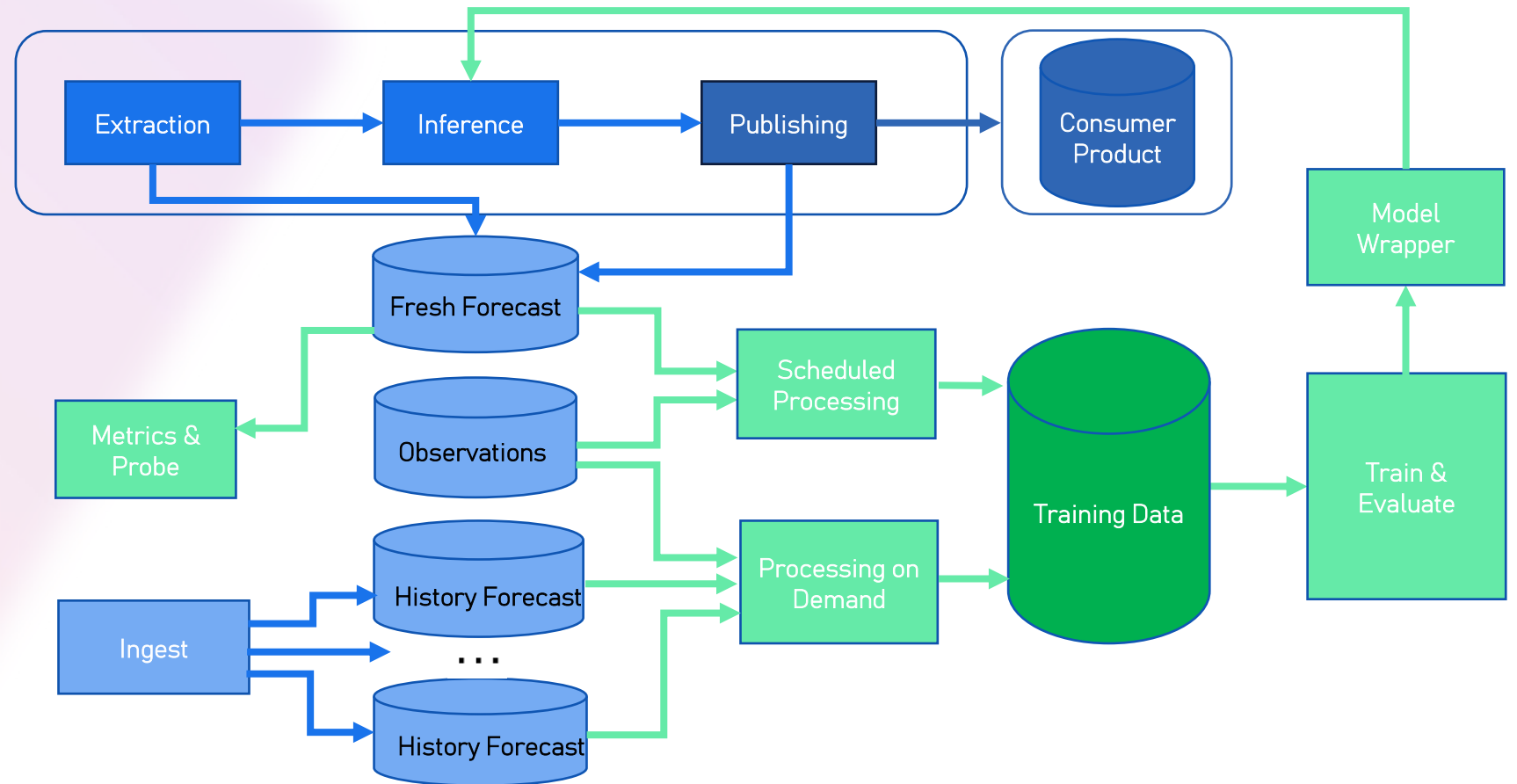
- Cover 130k+ locations over the globe
- **Update per 5min**

## All about automation:

- Inference
- Data extraction
- Training
- Evaluation

## Improvement in every step:

- Efficient pipeline
- **Data quality control**
- Model generalization
- Metrics-driven iteration



# Microsoft Nowcasting

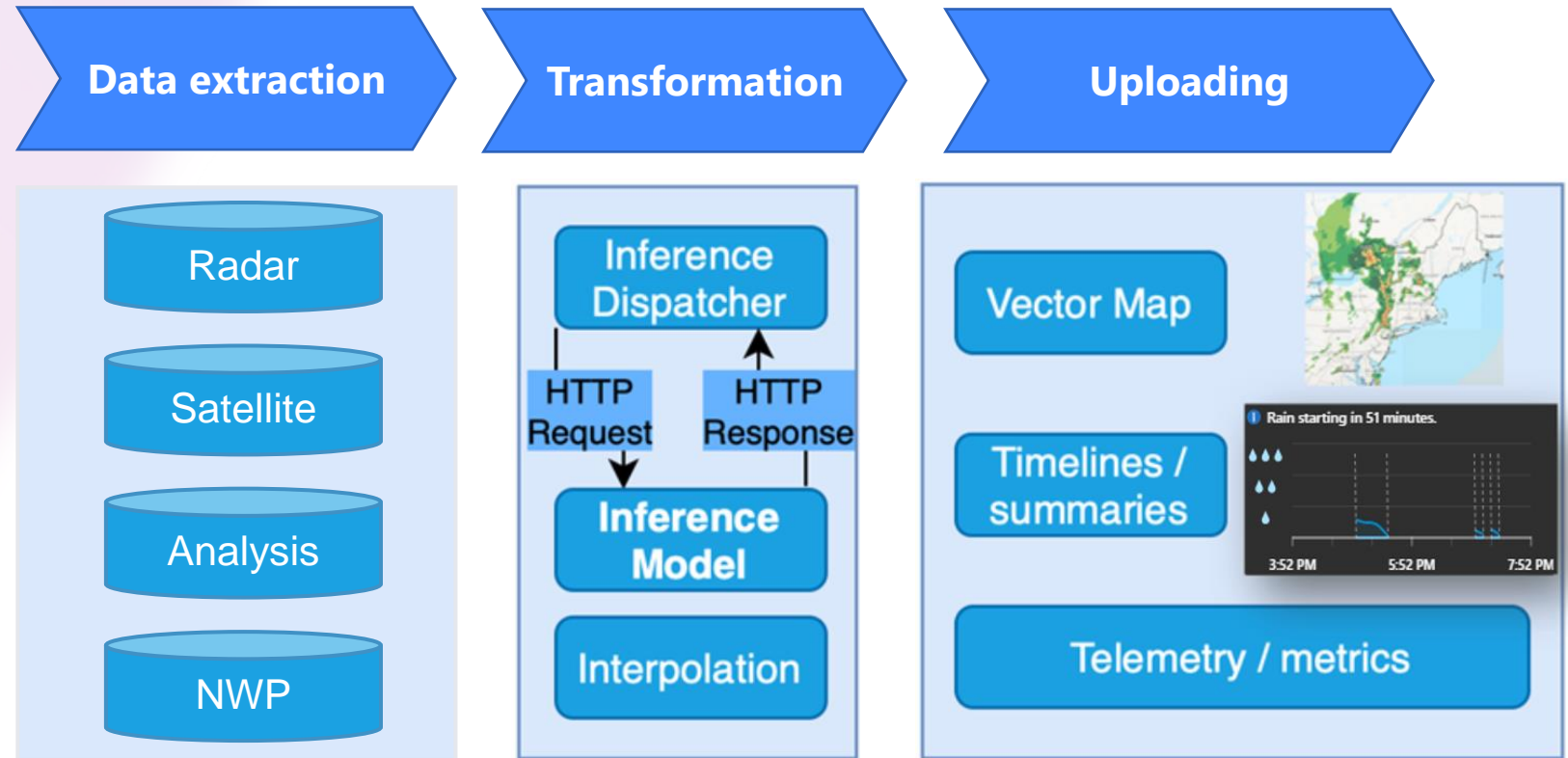
## 1. Timeliness

- Produce nowcasts over the entire US in **under 2 minutes**
- Nowcasts are available to consumers **within about 6 minutes** from radar observation

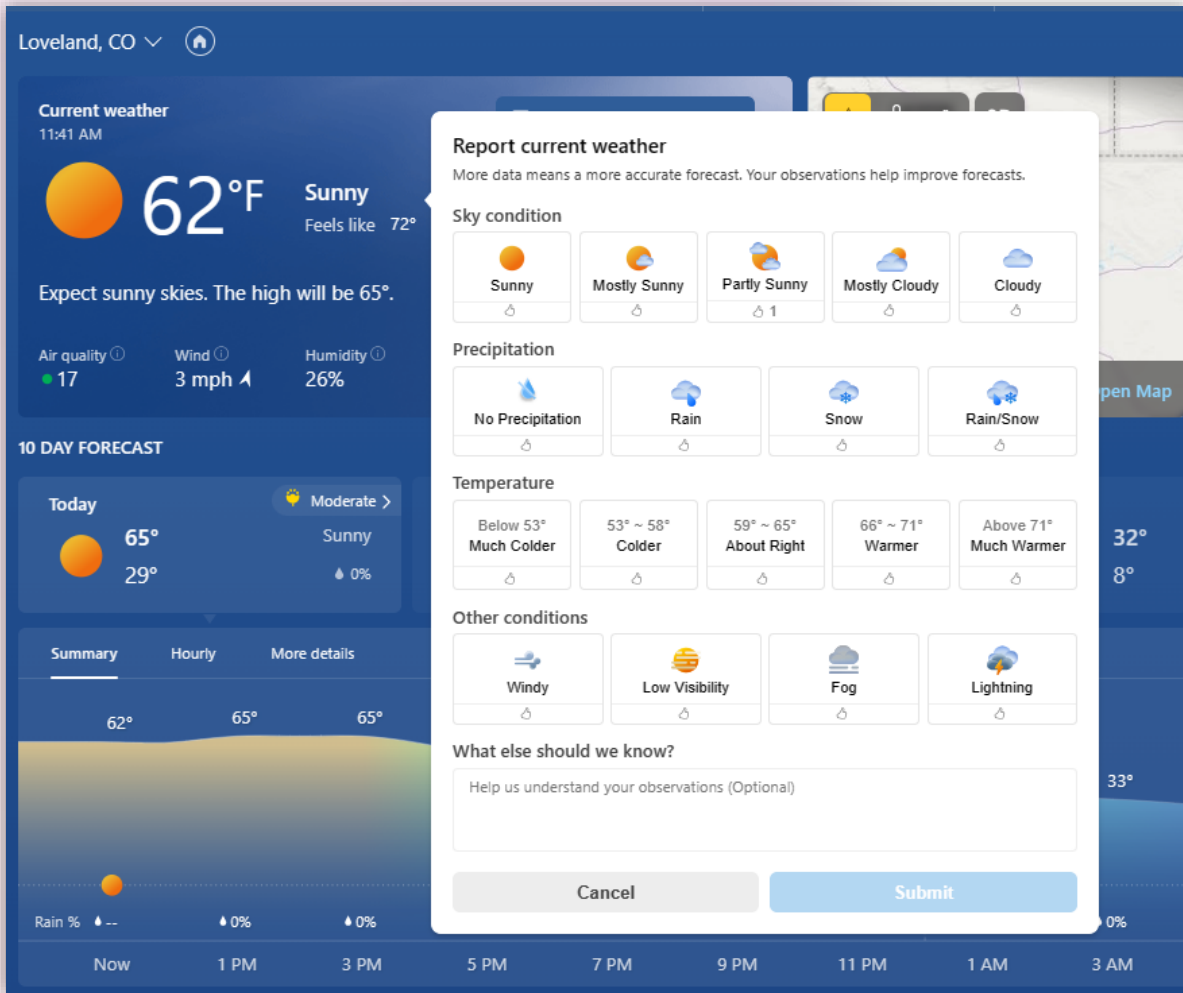
## 2. Multi-modal

- Final product consists of making **text summaries, timelines, and maps**

## 3. Global coverage



## Weather Watcher Initiative- Are we right?



“Everyone talks about the weather, but nobody does anything about it.”

Mark Twain

“More accurate than other daily weather predictions.”

“Your site seems to be better at giving the right weather for my local area.”

“All the weather information I need in one place. I have told several people about it.”

# Microsoft Weather

## Modeling and AI?

- Microsoft Weather is proud to be **named #1 in global accuracy** in a 3rd party a weather study. (Jan-June 2022) – we have gotten better since then!
- Our approach includes **Augmenting NWP by ML and DL** techniques & replacement models with nowcasting and **physics aware DL techniques**
- Our 10 day hourly forecasts are **run globally every 5 minutes**, Nowcasting globally with up to **2 minute frequency**
- We augment and verify using a growing set of **user reports and surface observations**



# Large Language Models (LLM): Serving the Underserved

## How can AI help enhance delivery to the underserved?

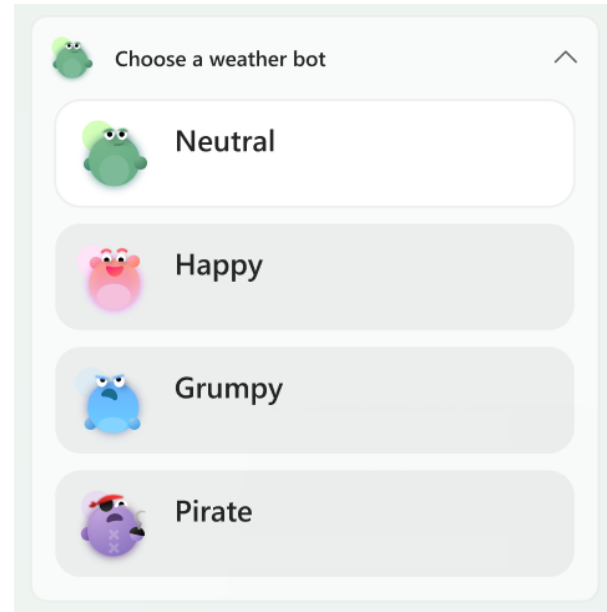
### Key Point Communicating to the underserved

#### AMS Annual Meeting- January 2023: NOAA Partners Meeting Notes

- Ken Graham's focus: **The Last Mile: Communicating to the Underserved**
- Seattle Office- **26 languages**: challenges in communication
- Boulder social scientist- concept of "**Meteorological Justice**"
- Small group exercise resulted in this goal: "**Trustworthy and Constant Feed of Information that resonates with all Global Citizens**".

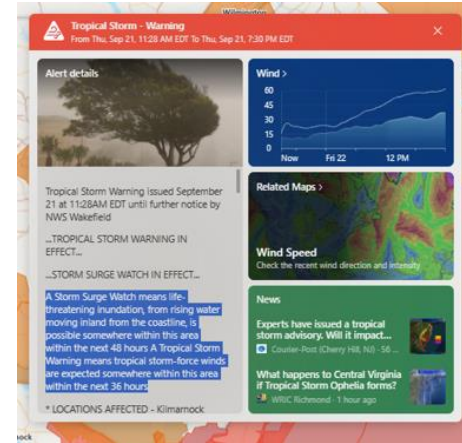
# How can AI help enhance delivery to the underserved?

**Key Point**  
**GPT AI technology is really good at mimicking a persona**



Persona	Example Summary
<b>Friendly Neighbor</b>	Good morning! Today's weather is sunny, with a high of 75°F. Enjoy the day!
<b>Professional Meteorologist</b>	Today, expect sunny skies, a high of 75°F, and a low of 55°F. 10% chance of precipitation.
<b>Energetic Sportscaster</b>	Rise and shine, sports fans! It's a sunny day with perfect weather for outdoor activities!
<b>Yoga Instructor</b>	Embrace the day's warmth and sunshine as you practice mindfulness and stretch your body.
<b>Nature Lover</b>	The sun is shining, and the birds are singing. A great day to connect with nature.
<b>Science Enthusiast</b>	Solar radiation is high today, leading to a warm, sunny day with a 75°F high.
<b>Pirate</b>	Ahoy, me hearties! 'Tis a fine sunny day to set sail on the high seas! Yarr!
<b>Medieval Knight</b>	Good morrow! The sun doth shine upon us today, with a high of 75°F.
<b>TV Show Host</b>	Welcome, viewers! Today's episode brings sunny weather and a high of 75°F. Stay tuned!

# How can AI help enhance delivery to the underserved?- Forecaster Text Co-Pilot



**NWS Text:**  
A Storm Surge Watch means life-threatening inundation, from rising water moving inland from the coastline, is possible somewhere within this area within the next 48 hours. A Tropical Storm Warning means tropical storm-force winds are expected somewhere within this area within the next 36 hours.

**Bing Chat:** Update this information pretending that the user has minimal education, is an immigrant, and is elderly.

**Bing Chat Results:**  
A **Storm Surge Watch** is like a heads-up that the sea might rise and flood the land near the coast within the next two days. This can be very dangerous, so it's important to stay alert and be ready to move to a safer place if needed.  
A **Tropical Storm Warning** is a signal that strong winds from a tropical storm are expected in your area within the next day and a half. These winds can be strong enough to cause damage, so it's important to secure your belongings and find a safe place to stay until the storm passes.

**Bing Chat:** Update this information pretending that the user has minimal education, is an immigrant, and is elderly, and **only speaks Spanish.**

**Bing Chat Results:**  
Una **advertencia de marejada ciclónica** es una señal de que el mar podría subir e inundar la tierra cerca de la costa en los próximos dos días. Esto puede ser muy peligroso, por lo que es crucial mantenerse vigilante y estar preparado para trasladarse a un lugar más seguro si es necesario.  
Una **Advertencia de Tormenta Tropical** es una señal de que se esperan vientos fuertes de una tormenta tropical en tu área dentro del próximo día y medio. Estos vientos pueden ser lo suficientemente fuertes como para causar daños, por lo que es importante asegurar tus pertenencias y encontrar un lugar seguro para permanecer hasta que pase la tormenta.

# How can AI help enhance delivery to the underserved?- Forecaster Text Co-Pilot

## NWS Text:

TXZ049-054-064>066-071>073-076>078-098-099-113-114-127-128-139-140-154-155-168>170-251930-Fisher-Nolan-Sterling-Coke-Runnels-Irion-Tom Green-Concho-Crockett-Schleicher-Sutton-Haskell-Throckmorton-Jones-Shackelford-Taylor-Callahan-Coleman-Brown-McCulloch-San Saba-Menard-Kimble-Mason-224 PM CDT Tue Oct 24 2023

This Hazardous Weather Outlook is for portions of west central Texas.

.DAY ONE...This Afternoon and Tonight

Numerous showers and thunderstorms are possible overnight, mainly after 3AM. A few strong to severe thunderstorms are possible Wednesday morning, mainly across the western Concho Valley and Big Country, along with Crockett County. The main hazards will be large hail, damaging winds and locally heavy rainfall, which may result in flooding.

.DAYS TWO THROUGH SEVEN...Wednesday through Monday

Showers and thunderstorms are expected across all of West Central Texas Wednesday into Wednesday evening. A few strong to severe thunderstorms are possible with large hail and damaging winds being the main concerns; although a brief/weak tornado cannot be ruled out across our eastern counties tomorrow evening. In addition, locally heavy rainfall may result in flooding, especially of low lying areas, low water crossings, and city streets.

A strong cold front this weekend will likely bring the coolest temperatures of the season to the area next week with widespread lows in the 30s Tuesday and Wednesday mornings. Some locations may get close to their first freeze of the season.

## Bing Chat Results:

**Today and Tonight:** There might be a lot of rain and thunderstorms, especially after bedtime around 3AM. Some of these storms could be really strong tomorrow morning, especially in the western Concho Valley, Big Country, and Crockett County. These storms could bring big hailstones, strong winds, and lots of rain that could cause flooding.

**Wednesday to Monday:** We're expecting more rain and thunderstorms all over West Central Texas from Wednesday to Wednesday evening. Some of these storms could be really strong with big hailstones and strong winds. There's also a small chance of a tornado in our eastern counties tomorrow evening. The heavy rain might cause flooding, especially in low areas, near small bridges over water, and on city streets.

This weekend, a big cold front (that's a boundary separating two different types of air) is coming and it's going to make things really cold next week. We're expecting the coldest temperatures of the season with lows in the 30s on Tuesday and Wednesday mornings. Some places might even have their first freeze of the season.

**Bing Chat:**  
Update this information for a user mimicking that they are a 5<sup>th</sup> grader.



# Microsoft Weather

## Large Language Models (LLM)

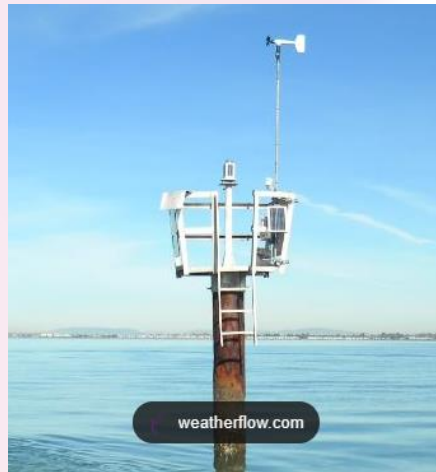
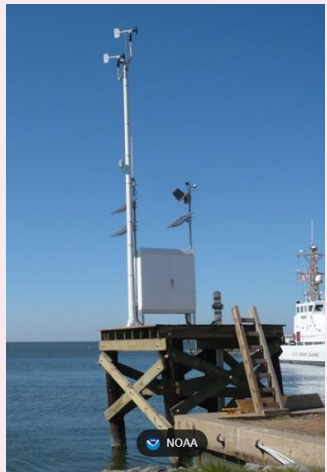
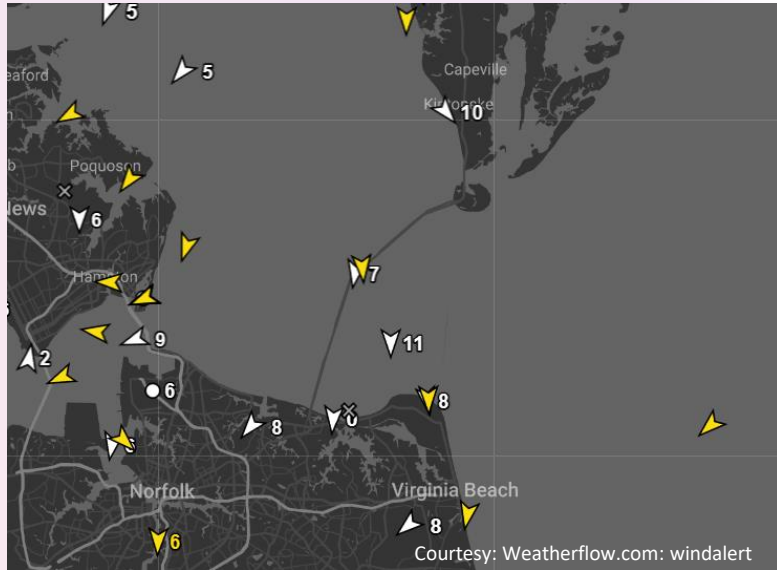
- In response to a request from NWS Director, **can a LLM be used to better communicate** with the underserved?
- As a leader in LLM AI technology: A good potential use could be as a **“copilot” to mimic a multitude of user personas** to better “speak their language” vs. NWS assumed user understandings.
- Using LLM could greatly **improve the efficiency** of forecast preparations and awareness from citizens.
- LLM can also serve as a **translation pilot** for NWS warnings and texts.

# Matt's Soapbox

Global High Density  
Reference Network



## Most Valuable Forecast Tool: Mesonets



“ *How do you know you are right?* ”

Matt Corey

- 20 years as a Chief Meteorologist at WeatherFlow
- Professionally sited and maintained weather stations placed where our customers are located
- Learning from our mistakes= unparalleled forecast accuracy
- Worked with increasingly higher profile partners who recognized our expertise in these regions



## What can we learn from Product Management?

**Customer Centric Design....** always starts with research to find out what the end-customers need and what the business and technology requirements are.”  
([sofokus.com](http://sofokus.com))

# Gemba

Gemba (現場) is the Japanese term for “actual place,” often used for the shop floor or any place where value-creating work actually occurs. Lean Thinkers use it to mean the place where value is created. Japanese companies often supplement gemba with the related term “genchi gembutsu” — essentially “go and see” — to stress the importance of empiricism.

A gemba walk is a management practice for grasping the current situation through **direct observation and inquiry before taking action.**

Industry	Example Gemba
Manufacturing	Factory floor
Hospital	Operating room
Hospitality	Kitchen, dining room
Construction	Job site
Software	Software code

Source: [www.lean.org](http://www.lean.org)

Add: Weather/Climate Research →

Reliably sample where people are

## Tragic example: Marshall Fire: Dec 30, 2021



## *The Most Destructive fire in Colorado History*

- Driven by winds gusting to 115 mph, this fire destroyed 1084 structures, killed 2 people, and cost \$2 Billion.
- AMS Summer presentation: there were weather stations 'up canyon' that recorded the winds
- These weren't official stations, nor trusted to use in model training
- Some forecast models hinted at the wind potential but none to the extremes that occurred
- **How are our models going to improve if we don't train them with actual conditions from where our citizens are?**

## Global High Density Reference Network



“ *How do you know you are right?* ”  
Matt Corey

- **ML/AI emerging technologies are strongly reliant on the quality of the training data.** Garbage in= Garbage out.
- ASOS and AWOS represents the “gold standard” but too costly
- IoT, PWS, Big Data to the rescue? How do we trust the data? QC challenges
- National Mesonet is a good start but we need more investment in data collection, standards, and QC
- **Today’s weather data is tomorrow’s climate record & used to verify and train ML/AI algorithms.**

# Forecasting and Severe Weather

Operations: Discussion topics

## How can AI help enhance delivery in day to day forecast operations?

- **Timeliness of model updates- Goal: No idle time**
  - Example: 5 minute model refresh + 2-4 minute nowcasting
- **Trust in model outputs- Goal: Fire and forget**
  - Continuous model for every day use (no special models)
  - Fast model iterations based on Meteorologist feedback
  - Integration of increasing vetted QC observations for continuous learning
  - Situational analysis to weight initialization algorithms on weather scenarios
- **LLM “forecast pilot”- Goal: maximize efficiency**
  - Remove the mundane tasks so forecaster can focus on the “critical few”
  - Seamless delivery to end user with minimal overhead
  - Automatic translations

### Key Points

**Trust  
&  
Timeliness**

## How can AI help enhance delivery in severe weather operations?

- **If daily weather is mostly on “autopilot”, this frees up resources to focus on severe weather**
- **Trust in model outputs**
  - Continuous model for every day use will instill confidence from forecasters
  - Situational analysis + algorithms tuned to weather type that is happening
  - Tropical Cyclone modeling largely ML already
  - Fast updates to keep stakeholders updated with refreshed analysis and timely forecasts
- **LLM Goal: maximize efficiency and communications to underserved**
  - Persona mimicking
  - Automatic translations

### Key Points

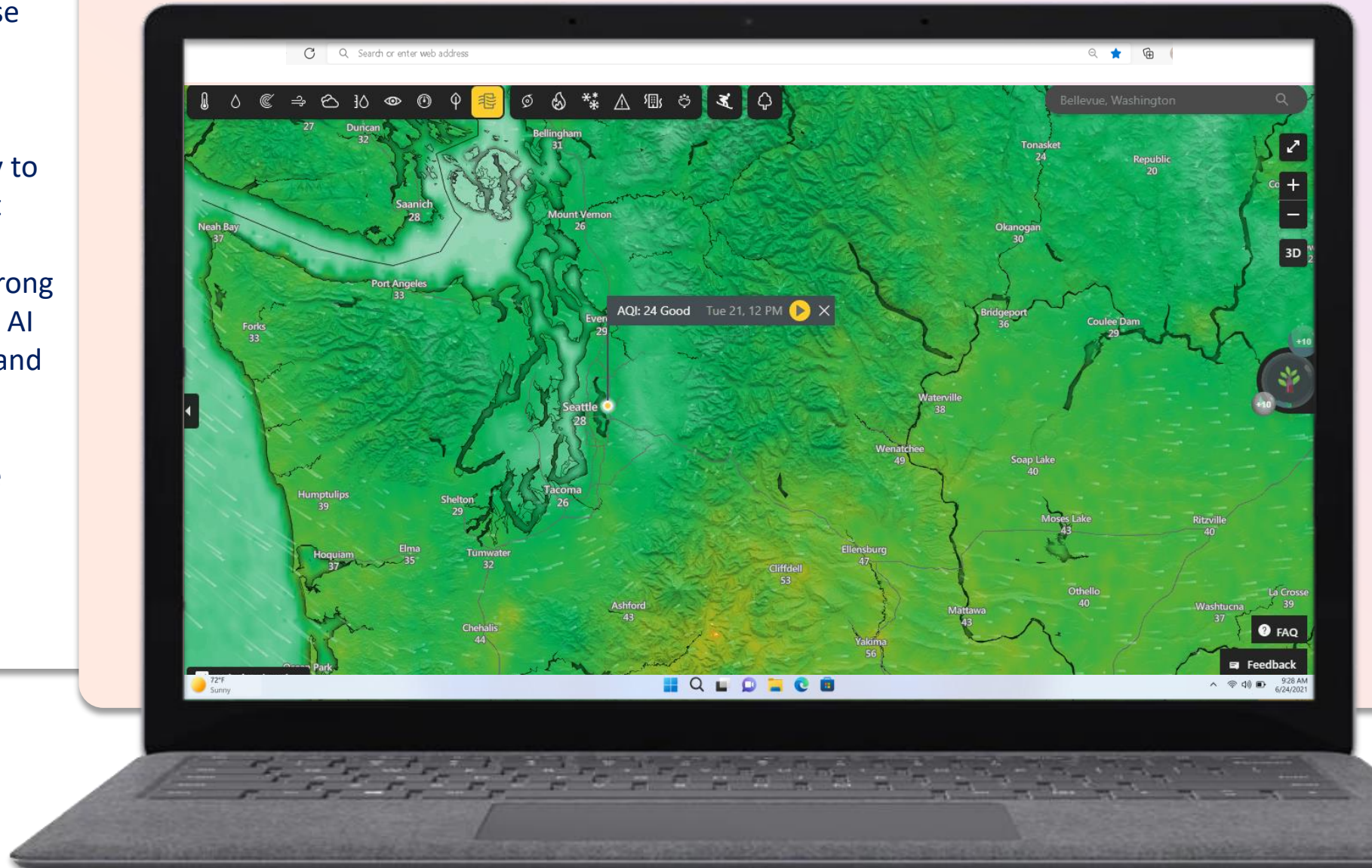
**Efficiency  
&  
Baseline**

### Matt’s Point

**Single source of  
truth**

# Summary

- ✓ Microsoft Weather's platform delivers to a large userbase aimed at keeping users informed
- ✓ AI LLM can be a great way to optimize weather content
- ✓ Microsoft Weather has strong operational capabilities in AI modeling via nowcasting and forecasting
- ✓ Quality and dense surface observations are key to AI modeling success
- ✓ Ideas for AI to Operations





# Thank you

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