AMERICAN PUBLIC POWER ASSOCIATION

Powering Strong Communities

Improved Weather Modeling for Public Power

This material is based upon work supported by the Department of Energy under Award Number DE-CR0000012.

Overview

This document outlines an improved mechanism for weather forecasting for critical/disaster situations that might be harmful to public power maintenance, grid viability, and consumer energy needs.

There is a clear need for greater preparation for extreme weather events. Decision trees and stepladder functions are involved, as is linkage with sources for data that would enter usage (e.g., numerical models, satellite data, access to climatological information). The projection deals with predictions first in the near term (0 to 5 days out), then expands into the medium range (6-10 days), and finally the long-term to seasonal perspective (11-15 day, monthly, and seasonal).

The growth of this coverage would be spread out over perhaps three years. One aspect that should be mentioned is that the preparation and dissemination of the outlooks will be performed without any consultation with local National Weather Service Forecast Offices, National Oceanic and Atmospheric Administration branches such as the National Hurricane Center and Storm Prediction Center, or the United States Geological Survey Hydrological or Fire Hazard Offices.

The objective of this work is to increase the speed of warning with greater accuracy of information.

Forecast Templates

The first step in the process is creating adaptable templates for various events:

Severe Weather
including large hail, damaging winds, and tornadoes

Tropical Cyclones
waves, depressions, tropical storms, hurricanes, and major cyclones

High Wind Events
straight line, orographic/ Chinook, and gravity waves

Winter Storms
high-impact snow or ice, blizzards, and glazing/ black ice risks

Heat Waves
maximum temperature surpasses 95˚ F four or more days in a row

Cold Spells
minimum temperature falls below 10˚ F three or more nights

Flood Threats
excessive rainfall with local/street/stream overflow, coastal surges

Drought & Fire Hazards
extreme aridity accompanied by dust storms/ haboobs, brushfire warnings, red flag warnings

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Using the Templates

INGEST: Users would obtain data to fill the templates through a basic numerical model derived from interpolation, arithmetic, and geometric means with standard deviations indicating the potential range of threats in the geographic area and likelihood in percentiles. The data would include coverage and track scenarios.

PROCESS: Users would then pass the information through three computers. If and when the potential audience of users grows, upgraded hardware may become necessary and a scalable server solution will be proposed. For the initial system construction, PCs or Macs with internet or satellite data are anticipated to suffice.

STORE/SEND: The best results would be obtained through known computer languages used in meteorology, MATLAB and Python. GRIB data obtained from NOAA, UKMET, ECMWF, Environment Canada, and other sources would be stored in the software, using decoding modeled after the BUFKIT system.

Formula:

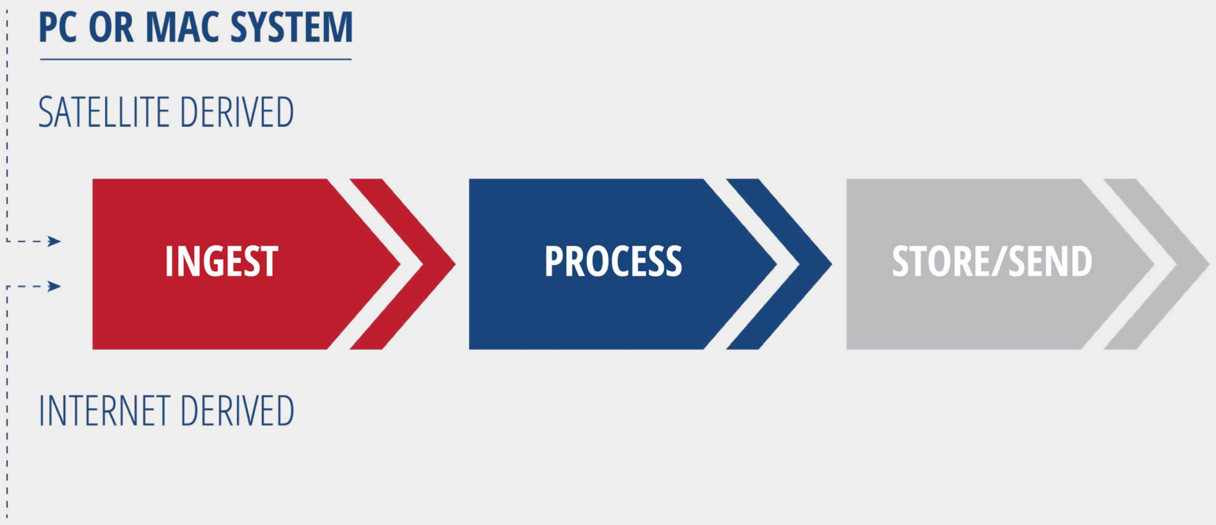
Ungrouped Data: $\bar{x} = \dfrac{x_{12} + x_{12} + \cdots x_{n}}{n}$

Grouped Data: $\bar{x} = \dfrac{\Sigma f x}{n}$

Where: f = frequency in each class

x = midpoint in each class

n = total number of scores



TABULAR

MAPS

GRAPHICS

BUFKIT

BUFKIT is a forecast profile visualization and analysis tool kit developed by staff at the National Weather Service office in Buffalo, NY. It is in use by the NWS, Department of Defense, universities, and other entities across the world.

See: https://training.weather.gov/wdtd/tools/BUFKIT/

Anyone accessing the system can create graphics, tabular data, and tables with relative ease. This includes the various forecast models that are the backbone of the proposed APPA system:

- **Near Term:** 12KM NAM, WRF, RGEM, FV3, UKMET, ICON
- **Medium Range:** ECMWF, GFS, GGEM, JMA
- **Longer Term:** EPS, GEFS, GEPS
- **Weekly, Monthly, Seasonal:** CFS, ECMWF, PSL Derived Analogs

Example of first usage

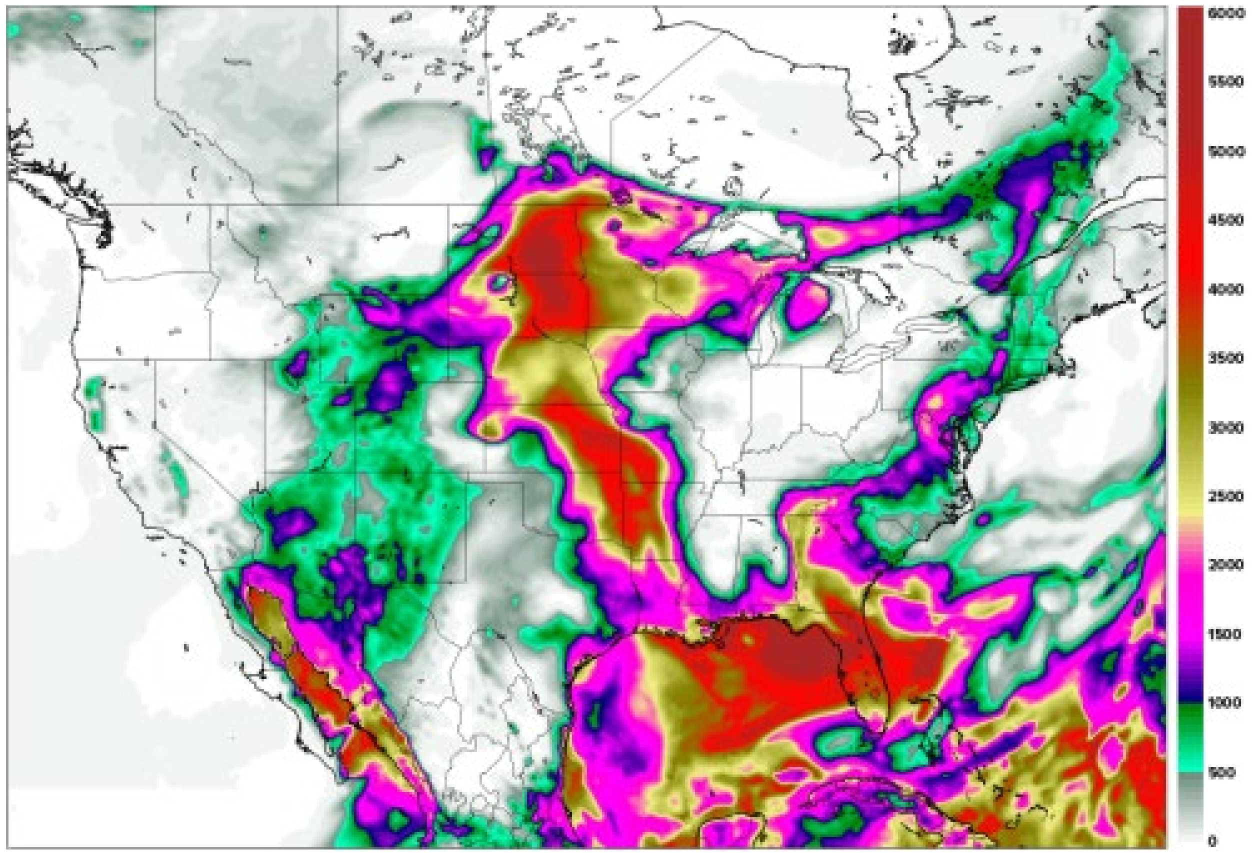
Severe Weather Threat Potential

These parameters (which can be added to, subtracted, or altered) are sifted by the equation from the data pile:

- 500 millibar (MB) vorticity intensity, distribution, and shape
- 700MB vertical velocity
- Energy Helicity Index (EHI)
- Surface dewpoints above 50˚ F
- 850MB temperatures (below 20˚ C)
- Convective Inhibition Factor (j/kg) projected at greatest threat time
- Lifted Index below +2, incremental rise in potential with declining value
- Convective Available Potential Energy (CAPE)

NAM-12km | CAPE Surface [J/kg]

Initialized: 18z Fri, Jun 24, 2022 | Forecast Hour: [01] | Valid at: 19z Sat, Jun 24, 2022



United States ICONUSI

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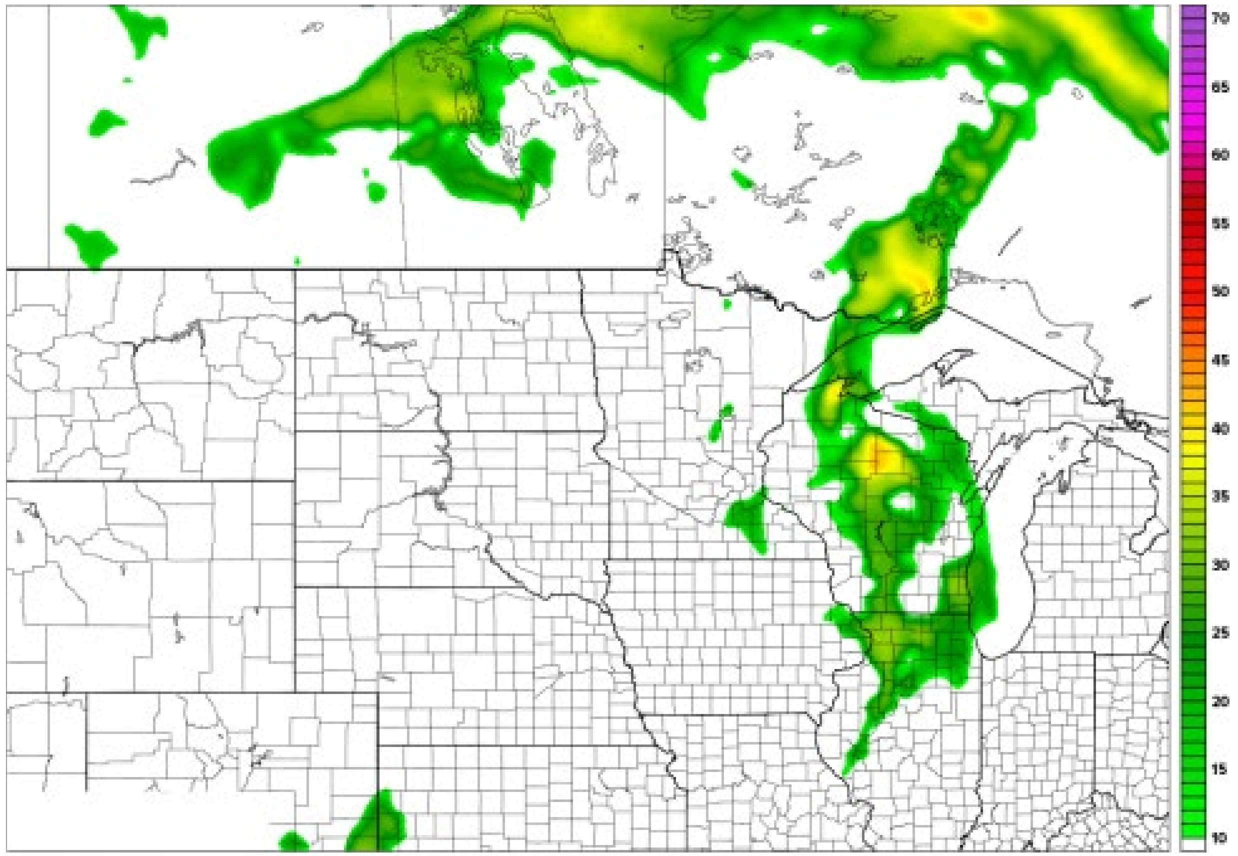
NAM-12km | 1000m AGL Reflectivity (dbZ)
Initialized: 18z Fri, Jun 24, 2022 | Forecast Hour: [24] | Valid at: 18z Sat, Jun 25, 2022



United States North Central CONUSI

Surface pressure at or below 995MB

Surface convergence with low-level jet stream present (southerly fetch more than 20 knots)

The data and images can be sent and accessed either via a smartphone app or via a PC/Mac. The final collected means should be ready by either 4 am or 4 pm on any given day, when critical model runs are completely finished.

A threat rating is generated by how large the aggregate score is, with 1 being relatively minor and 5 being high-impact extreme conditions:

1 2 3 4 5

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Project Costs / Requirements

Initial project costs are expected to be low in the first three months of execution and gradually increase as more resources (personnel, equipment, licensing costs, etc.) are added to the project. An agile approach will be used to build a minimal viable product and progress in stages to expand on functionality.

Hardware / Software Considerations:

- **Server(s) (specifications TBD) located in a data center meeting any/all compliance criteria**
- **Server and solution to be scalable to allow for expansion of resources as needs increase**
- **Costs for redundant data storage**
- **Costs for bandwidth as access to the solution expands**
- **Costs for server software/licenses (e.g., virtual machines)**
- **Costs for other software/licenses (e.g., graphics/data visualization; programming software)**
- **Costs for maintenance and security (e.g., firewalls, monitoring, audits)**

Also to be determined are costs for personnel including software engineers with experience with MATLAB and Python, data scientist(s), and potentially an advisor/overseer meteorologist as more modules come into usage. Once a firm scope and objectives are established and an analysis of all systems is conducted to help determine capabilities, an initial estimate of required effort and cost can be presented.

There will also be charges with the major weather organizations around the world. While some (JMA, ECMWF) might offer a reduced price due to APPA being a non-profit with a service goal, other groups, such as UKMET and ICON, might not be as forgiving. Keep in mind that wider scale data participation and timely dissemination will prove critical to the accuracy of the forecasts.

Summary

The objective of the weather forecast model development is simple: avoid delayed interaction with the National Weather Service and other NOAA branches in favor of an APPA Meteorological Center that can alert management, maintenance, and eventually users of extreme weather situations as far ahead as possible, utilizing aggregate data and artificial intelligence.

Starting out in the near term (five days or less), then expanding into the medium range, with the ultimate goal being observation of risks through the monthly and seasonal time frames. New forecast modules would emerge at a rate of one every two or three months.