Maryland
Department of the Environment

CLIMATE AND WEATHER CONDITIONS LEADING TO WILDFIRE SMOKE AIR QUALITY EVENTS IN THE METROPOLITAN WASHINGTON REGION

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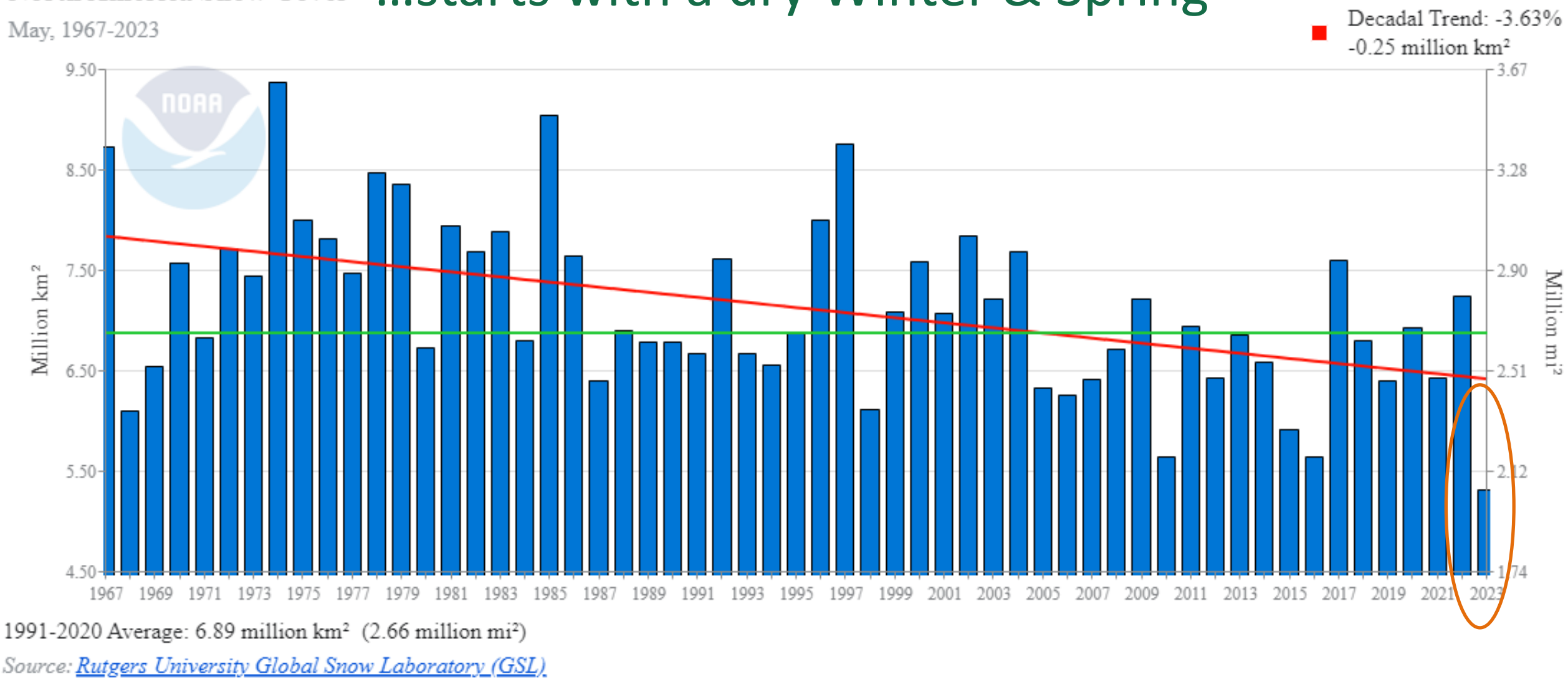
THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

The Summer 2023 AQ Season in VA/DC/MD…

…starts with a dry Winter & Spring

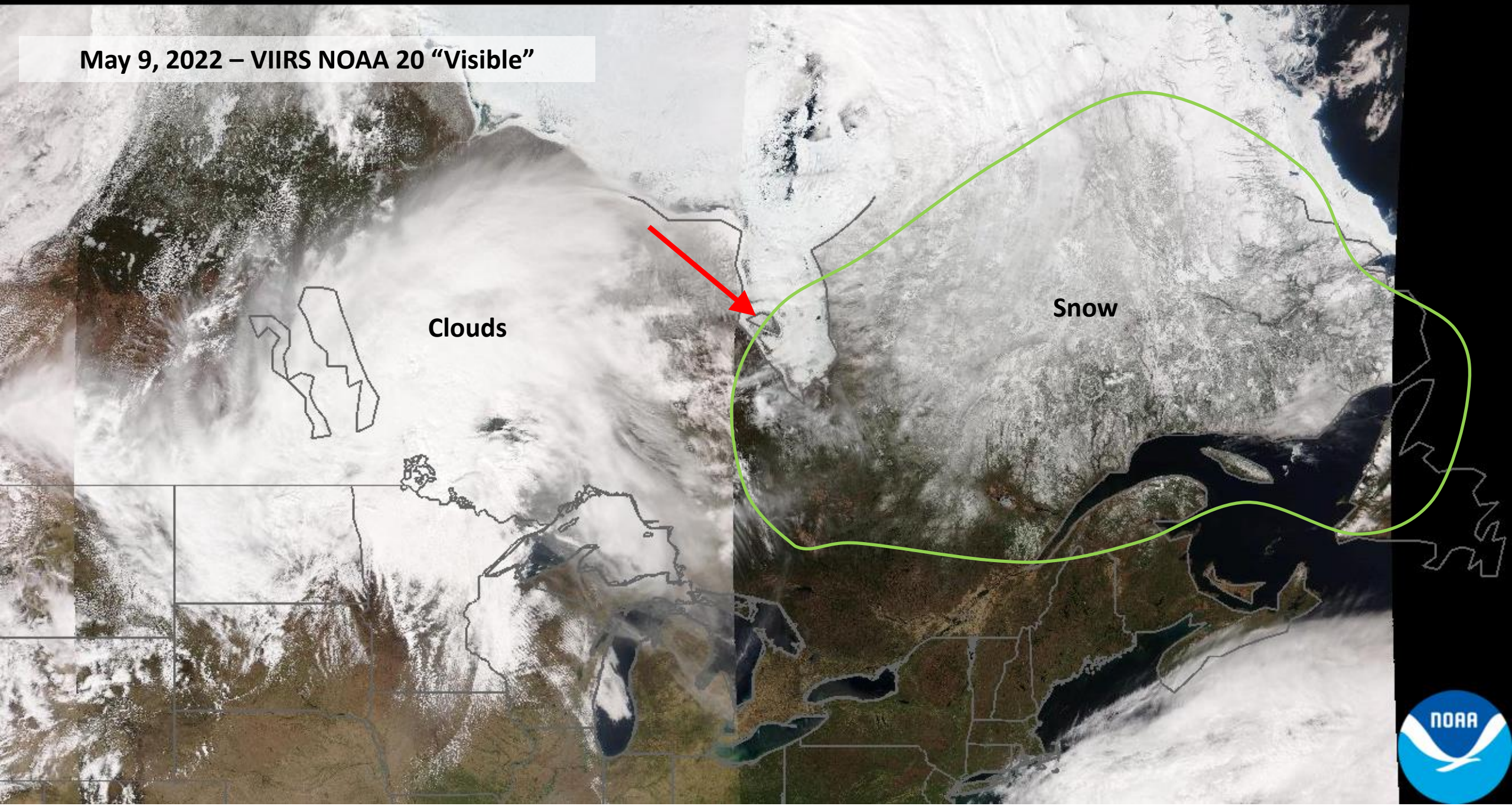


https://www.ncei.noaa.gov/access/monitoring/snow-and-ice-extent/snow-cover/nam/5

https://climate.rutgers.edu/snowcover/chart_vis.php?ui_year=2023&ui_month=4&ui_set=1

20220509

May 9, 2022 – VIIRS NOAA 20 “Visible”



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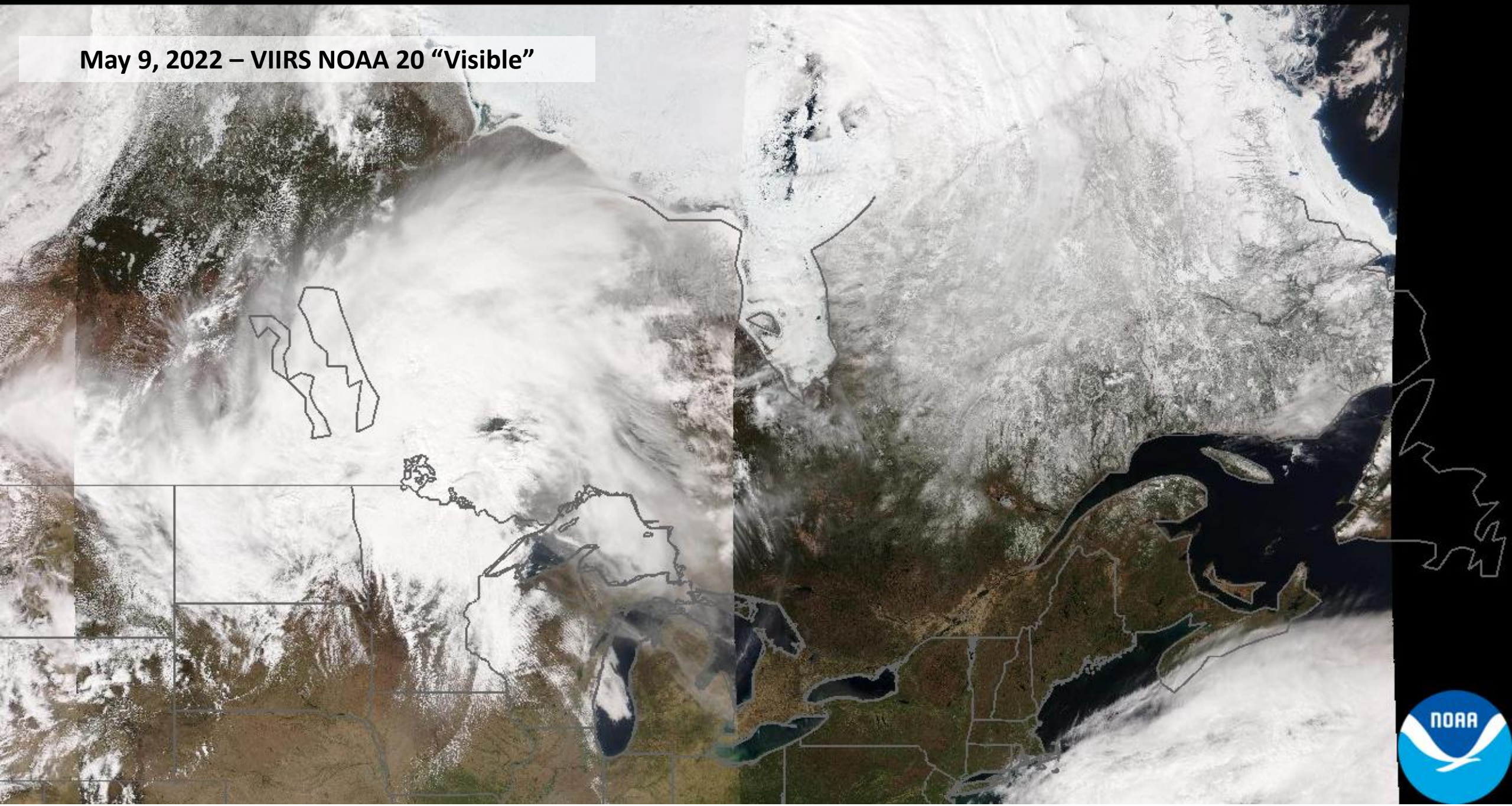

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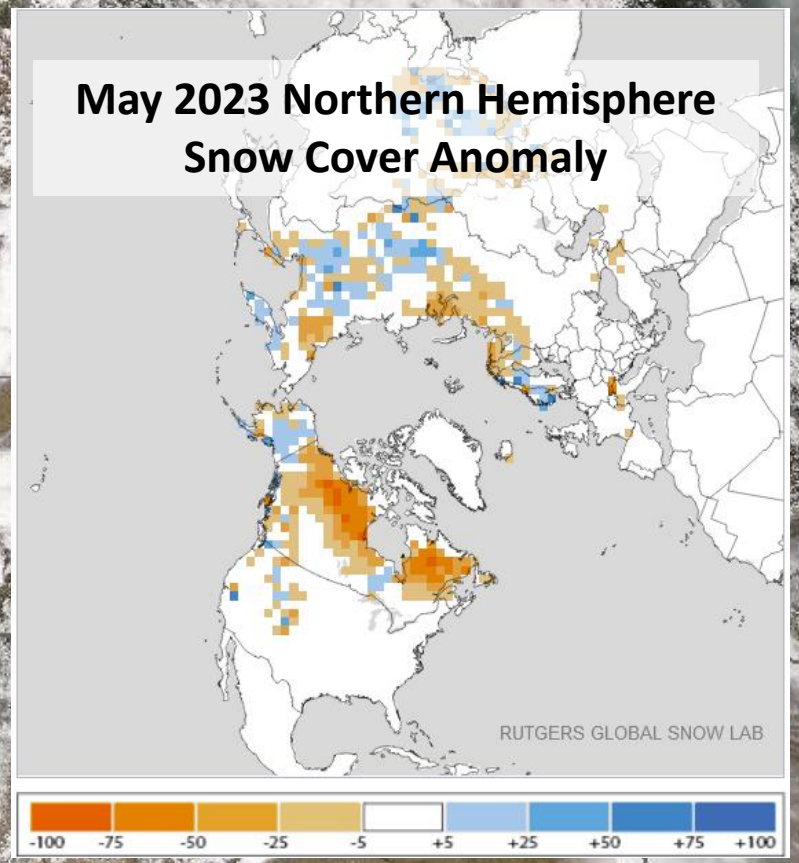
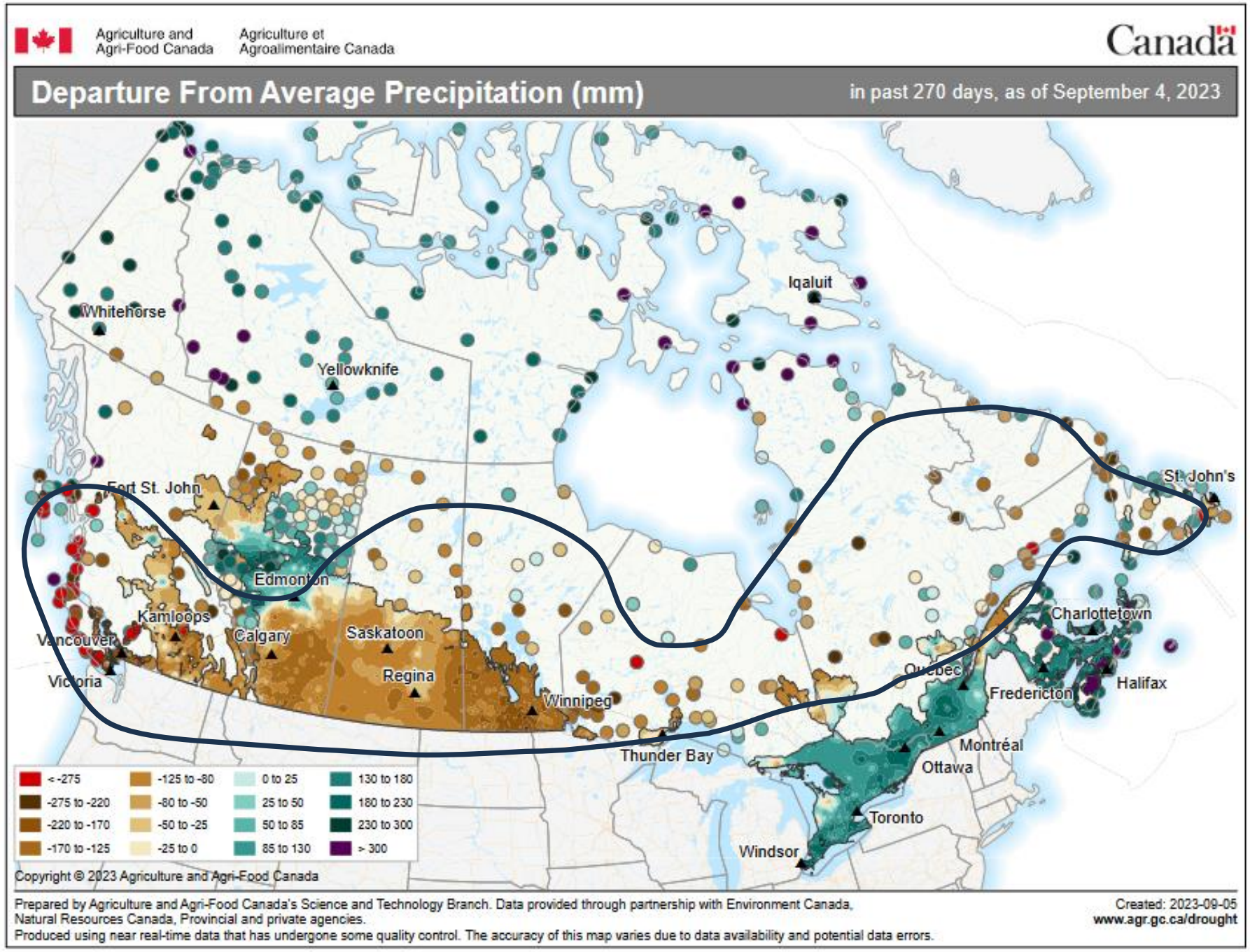
May 9, 2023 – VIIRS NOAA 20 “Visible”

Smoke

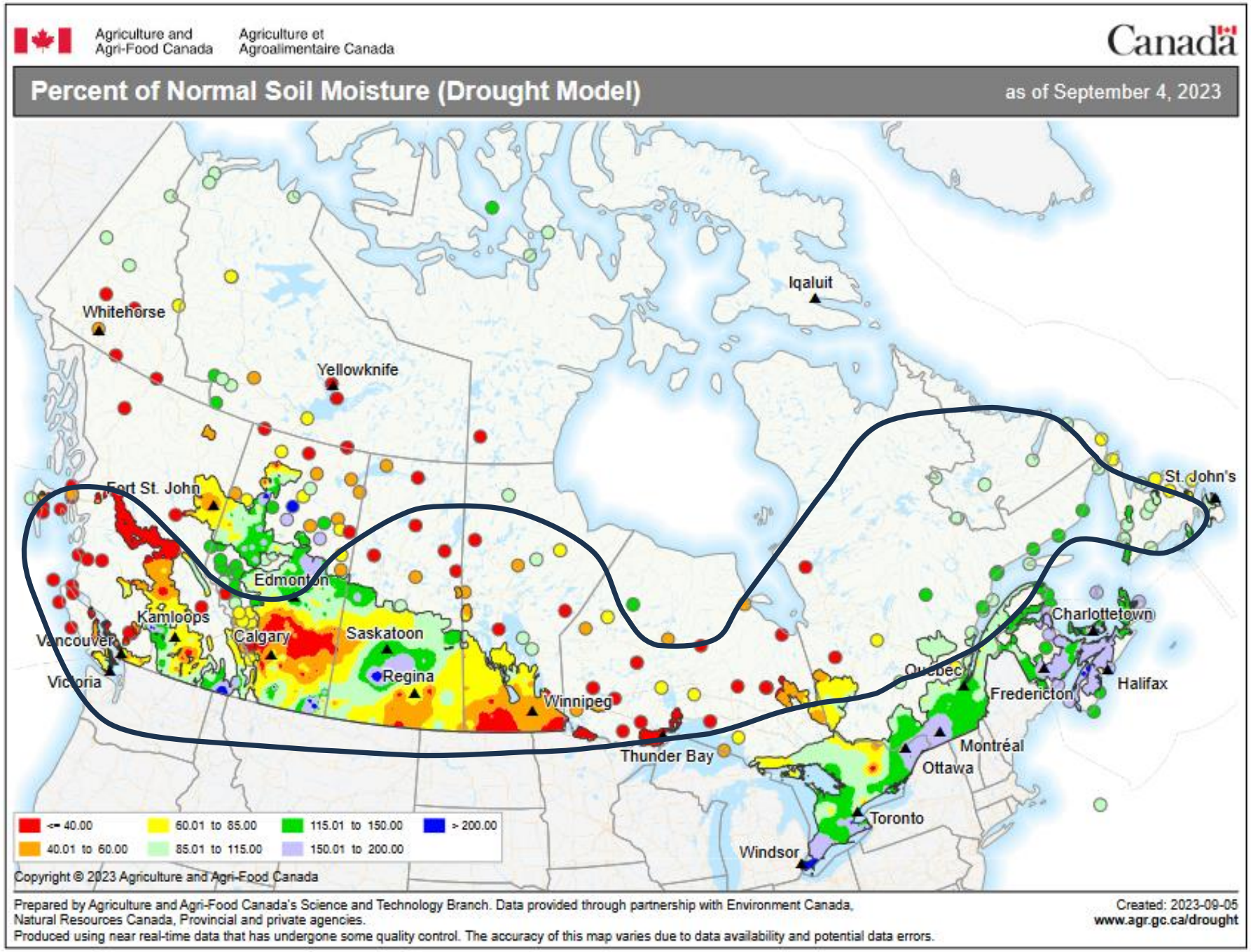
Smoke over Snowband

Clouds



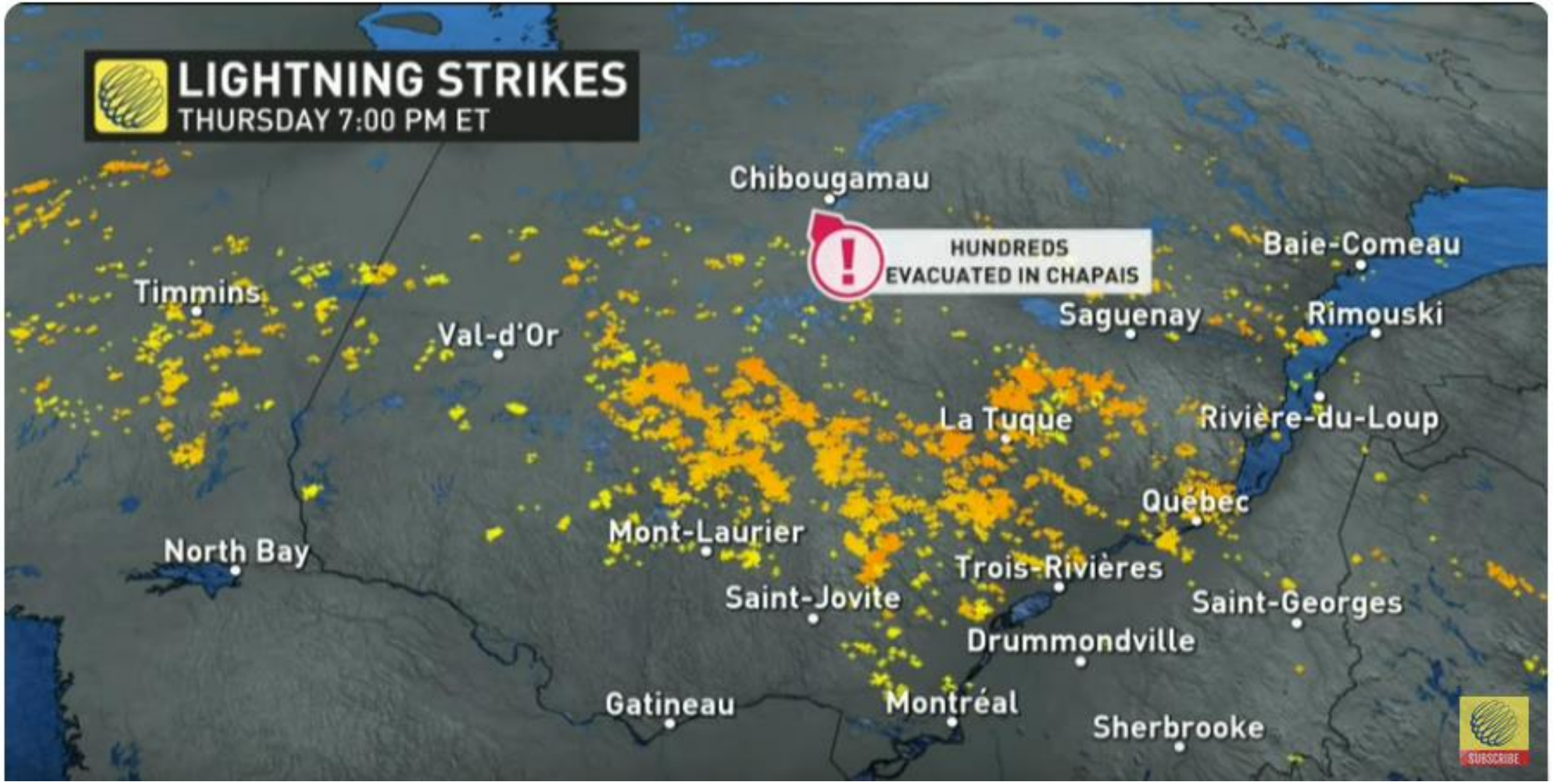


- Between December 2022 and July 2023, some central regions of Canada experienced precipitation 275 mm (~10.1”) lower than normal, or less than half what is typical.
- Most of that falls as snow in the winter, leading to little snow pack



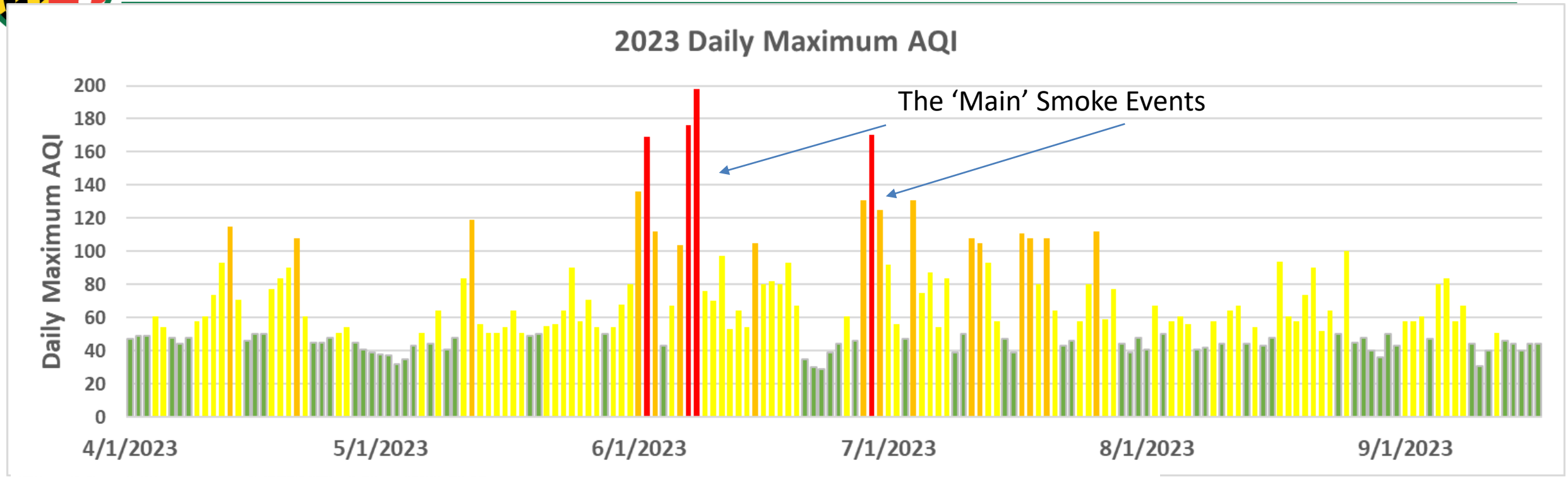
- Long term lack of moisture led to soil moisture less than 40% of normal in same areas
- Soil moisture gives an indication of the amount of moisture vegetation may retain (e.g., fuel for fires)

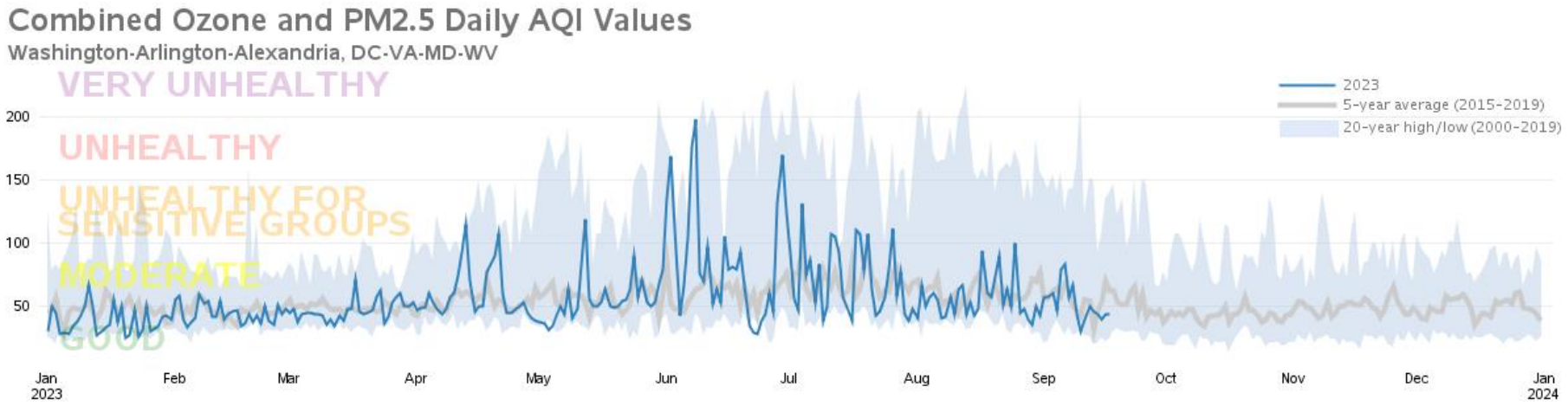
Lightning Strikes – Thursday, June 1, 2023



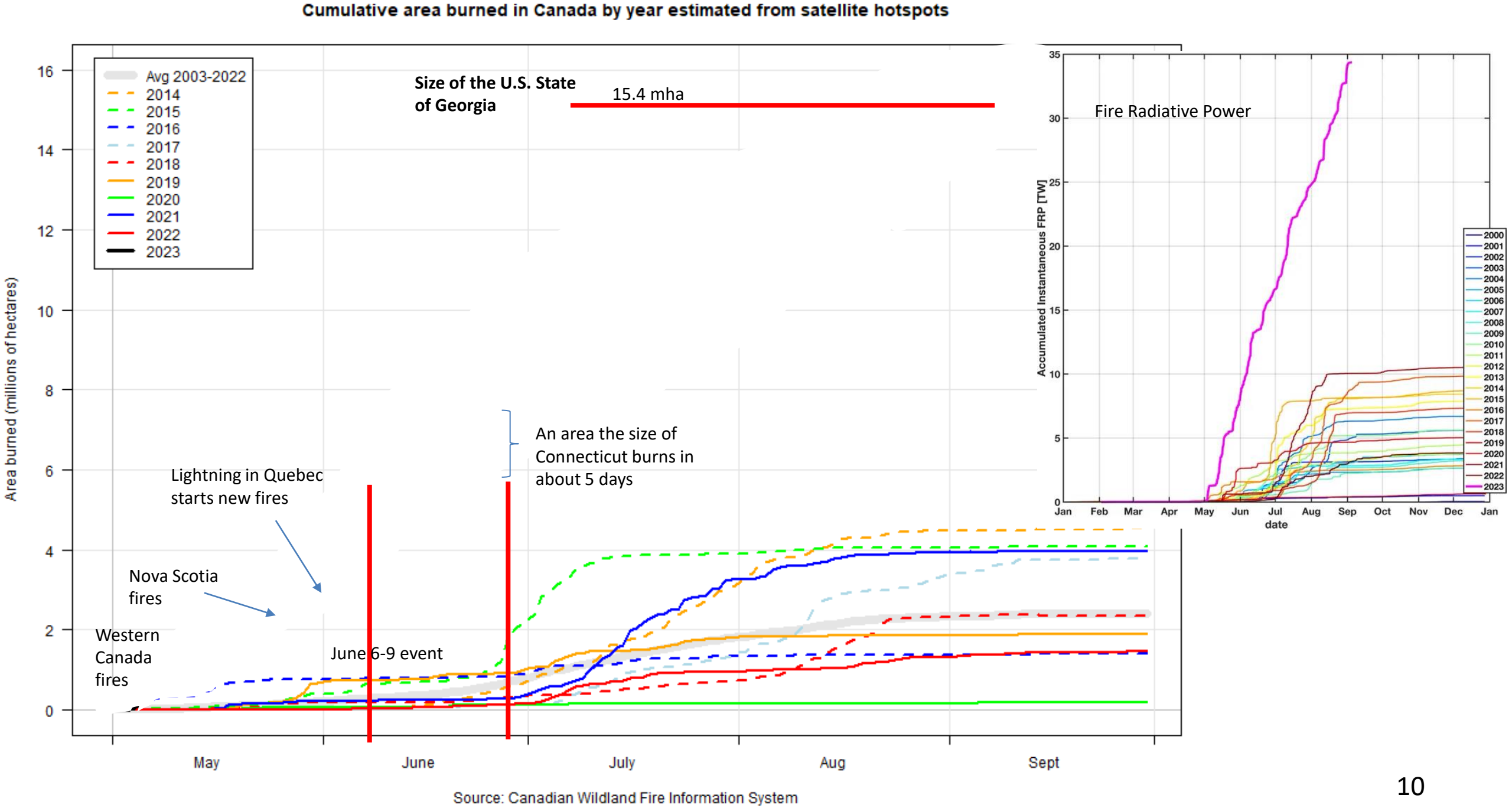
https://www.youtube.com/watch?v=CDYkr3QS3IY

2023 Air Quality Season At-a-Glance





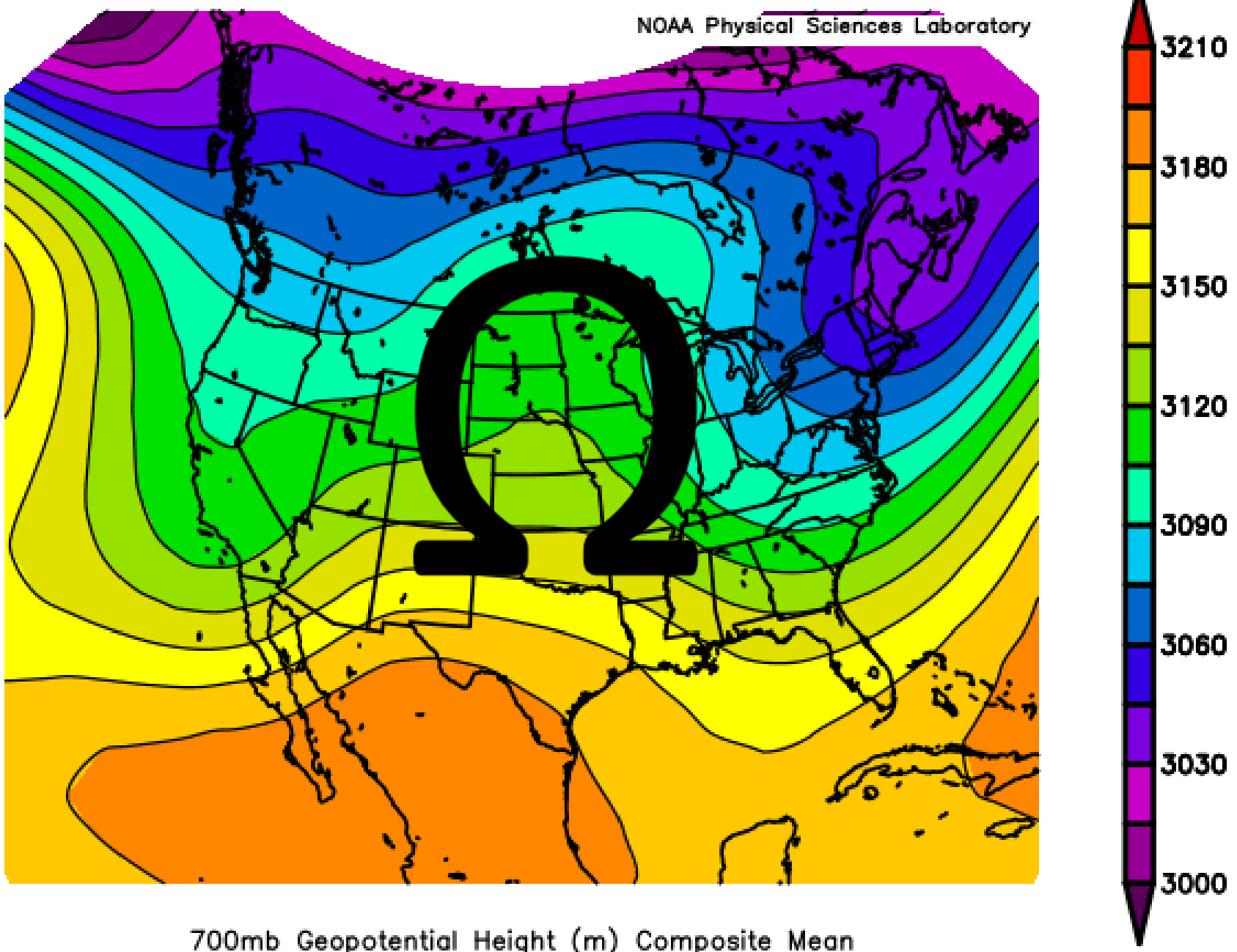
While June 7-9 and June 29-30 were significant events, there were a number of events punctuating the first two thirds of the 2023 summer air quality season


Cumulative area burned in Canada by year estimated from satellite hotspots
Avg 2003-2022
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
Size of the U.S. State of Georgia
15.4 mha
Area burned (millions of hectares)
0
2
4
6
8
10
12
14
16
May
June
July
Aug
Sept
An area the size of Connecticut burns in about 5 days
Lightning in Quebec starts new fires
Nova Scotia fires
Western Canada fires
June 6-9 event
Source: Canadian Wildland Fire Information System
Fire Radiative Power
Accumulated Instantaneous FRP [TW]
0
5
10
15
20
25
30
35
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
date
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

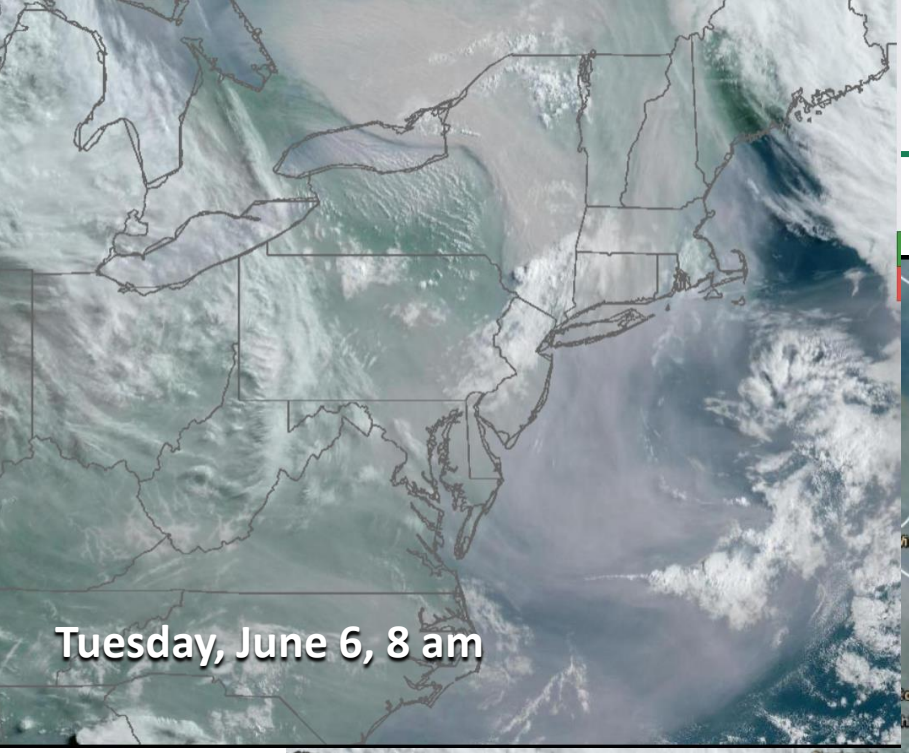
- “Omega Block” patterns cause persistent weather conditions over wide regions (Continents) for long periods of time

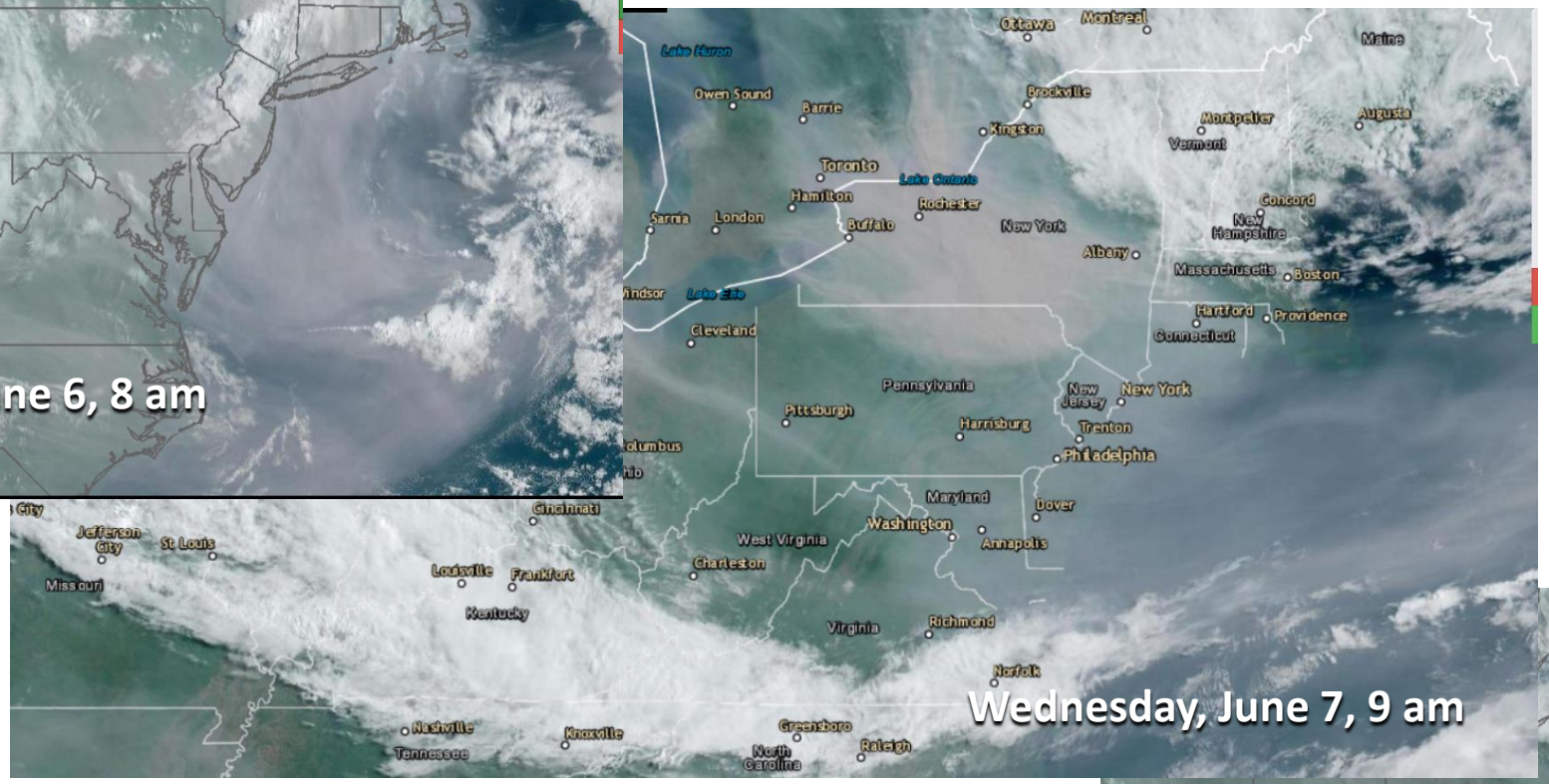
- Can be persistent rain in one area, or persistent drought in another

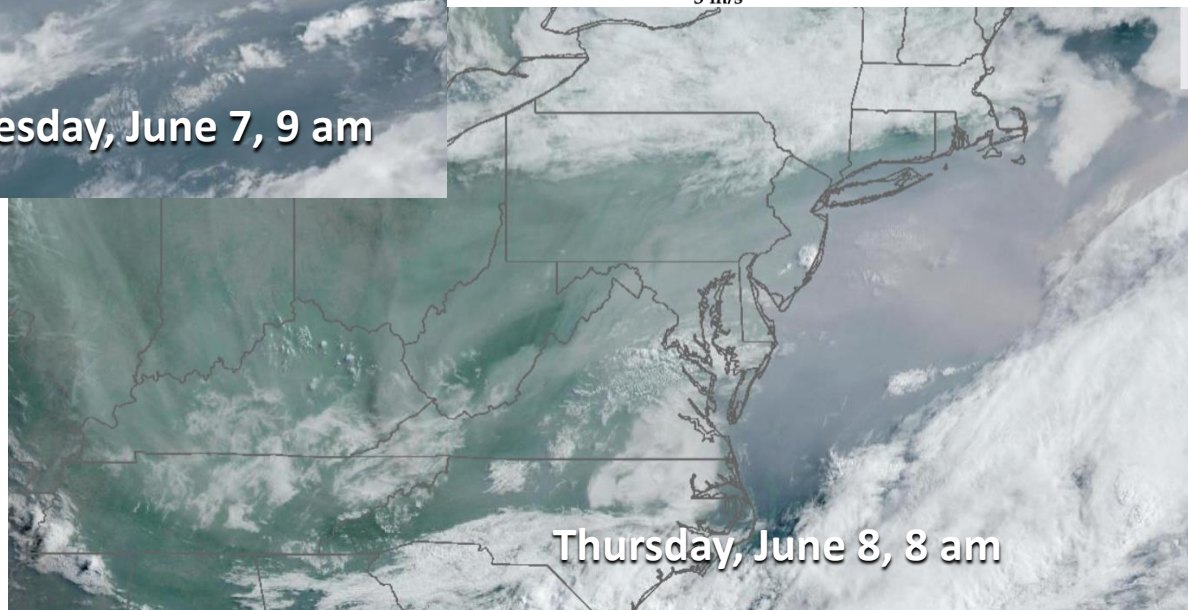
- This recurring pattern in 2023 – particularly ridging into Central Canada, allowed dry warmth to continue over much of Canada, with northerly flow over the northeast US



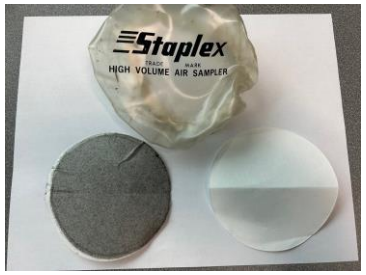
June 6-8, 2023 Quebec Smoke Event







"Waves" of smoke occurred along the atmospheric transport "highway" as the fires surged and calmed with diurnal conditions

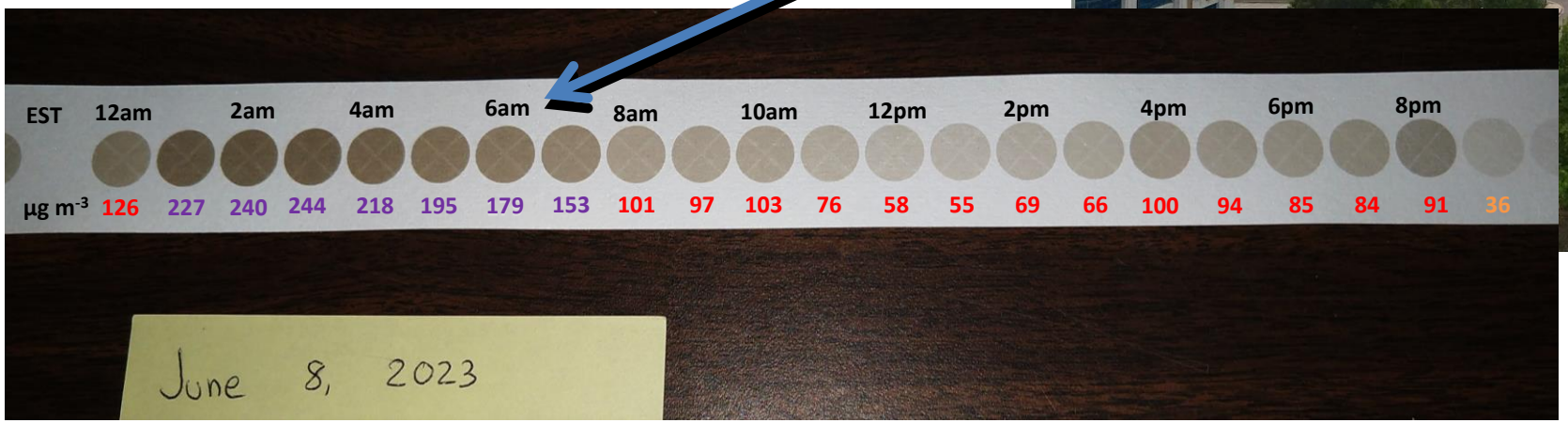


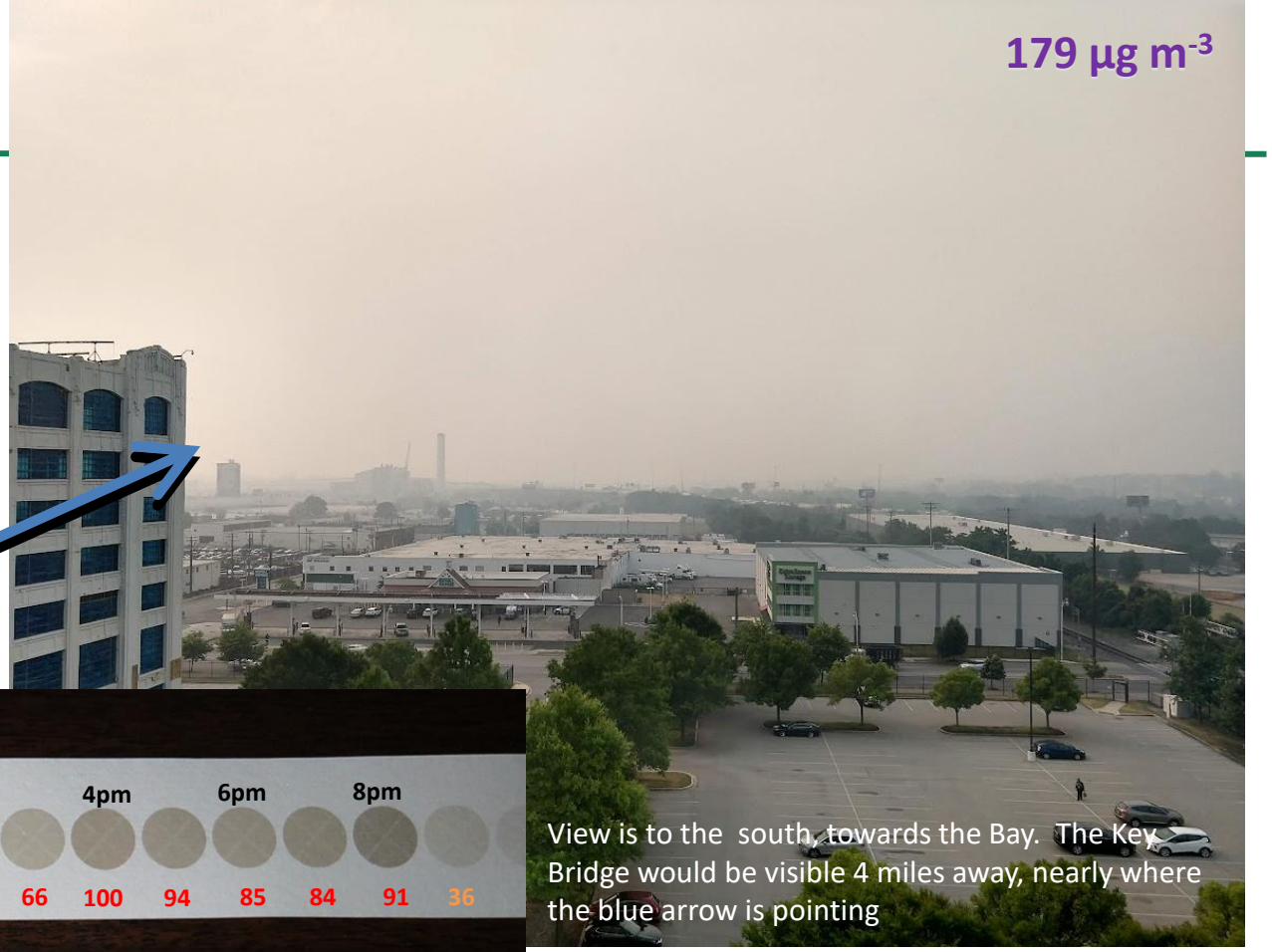
Courtesy: Dr. Russ Dickerson

June 8, 2023

Picture taken by MDE meteorologist Joel Dreessen on June 8, 2023 at 7:52 am EDT from the Montgomery Park Offices in southeastern Baltimore City. The picture corresponds to the circle highlighted by the blue arrow. The hourly concentration was 179 µg m^{-3}.

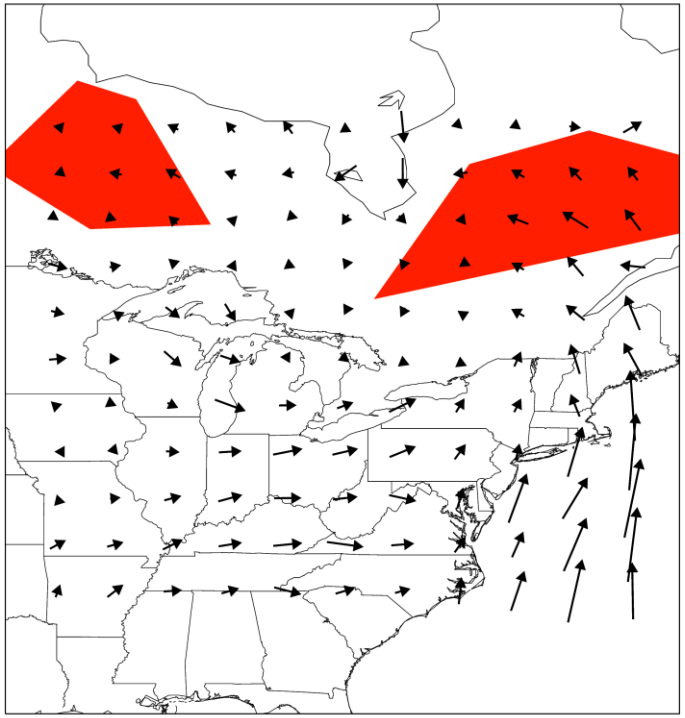
Note: EPA requires all observations in EST

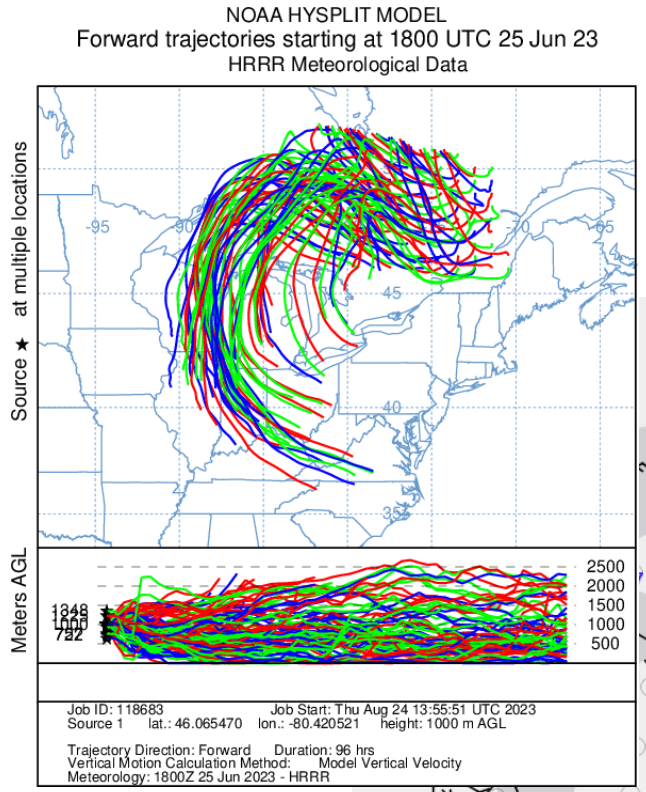


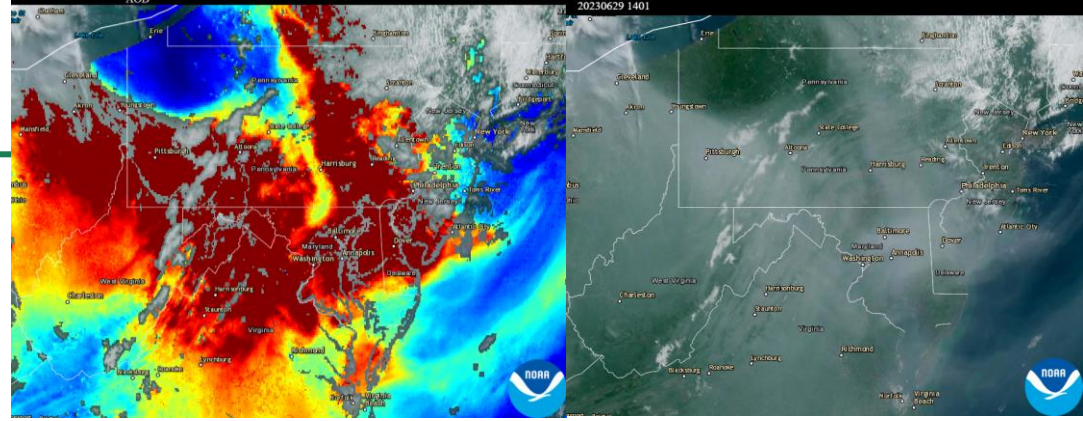


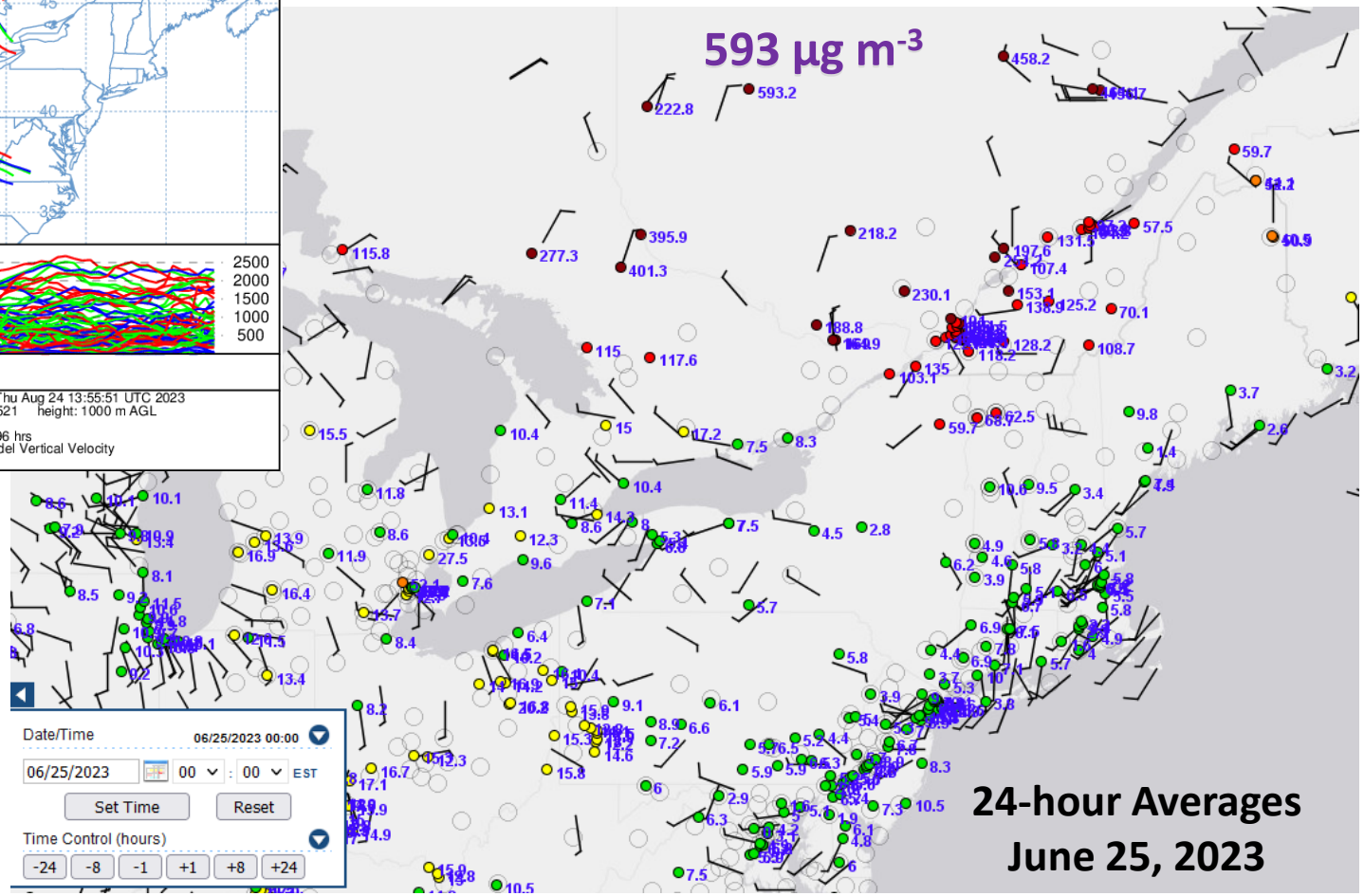
The above image is an MDE $PM_{2.5}$ "Beta Attenuation Monitor" (BAM) sample tape from June 8, 2023. Each circle corresponds to a 1-hour sample spanning midnight to midnight on June 8 from the Lake Montebello site in downtown Baltimore. The filter collects what is in the air onto a filter for measurement, essentially illustrating what would end up in your lungs if breathing outside for an hour. The $PM_{2.5}$ standard is 35.4 µg m^{-3} as a 24-hour average. The hour highlighted measured 179 µg m^{-3}.

June 29-30, 2023 Smoke Event



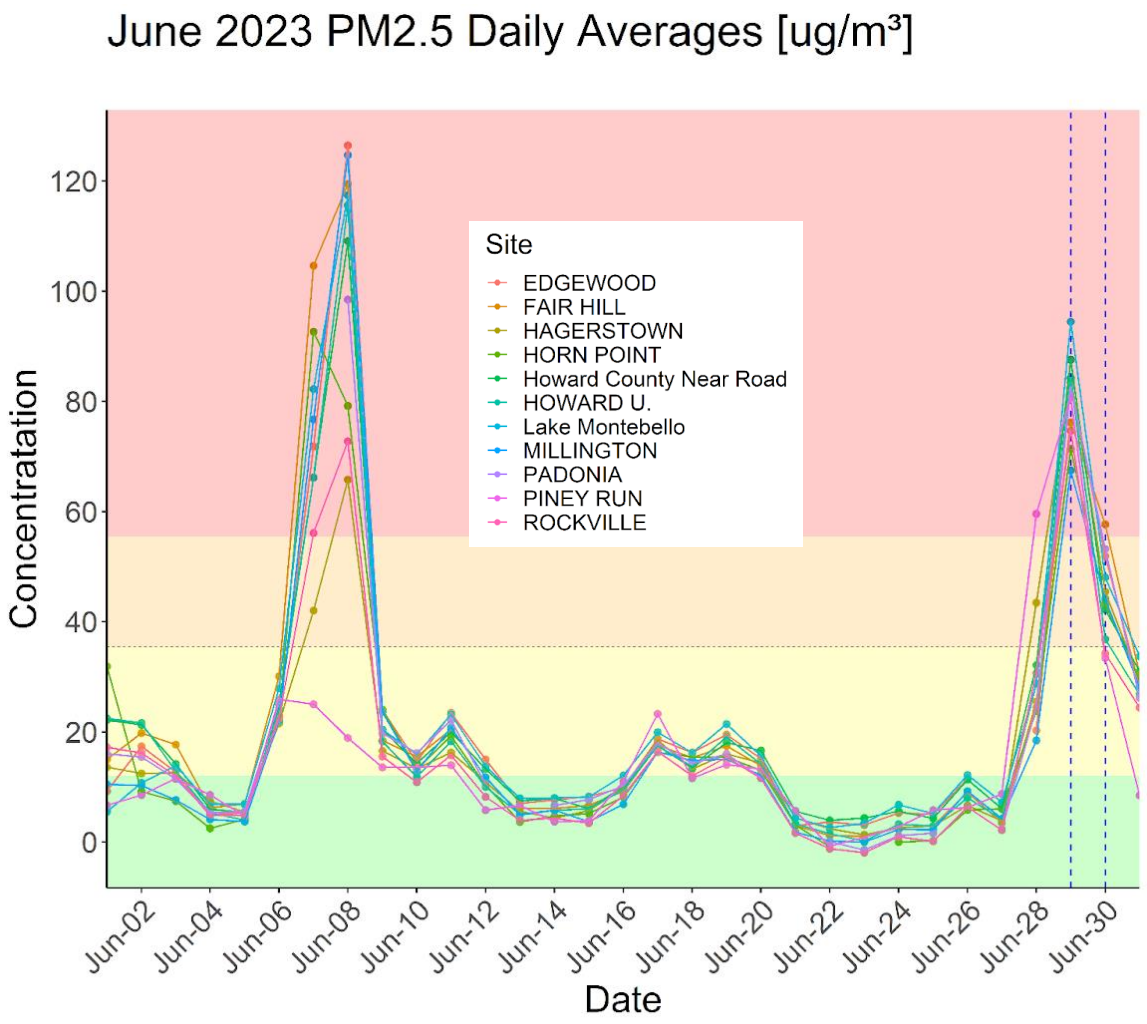


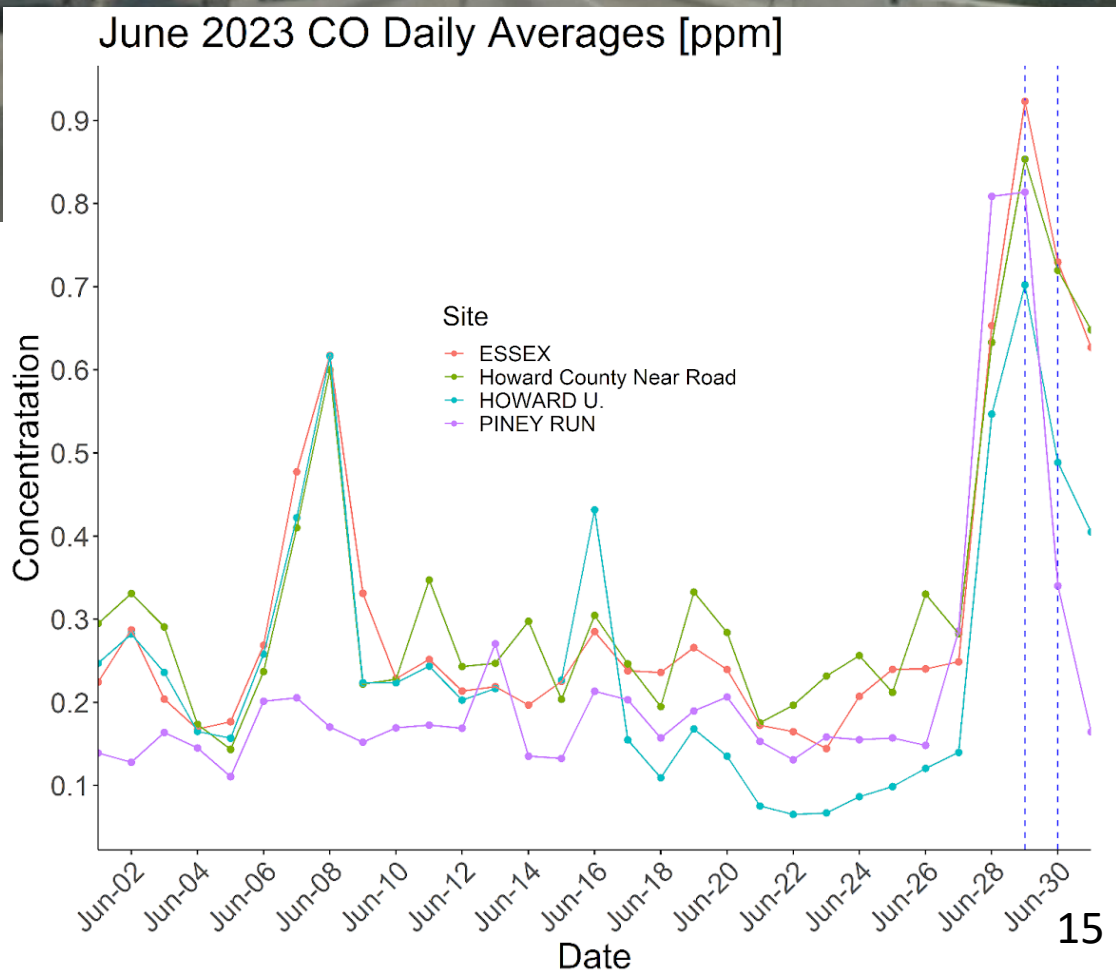




- Breakdown in Omega Pattern
- Storm system pulled gathering smoke over Quebec towards the Mid-Atlantic like a pinwheel

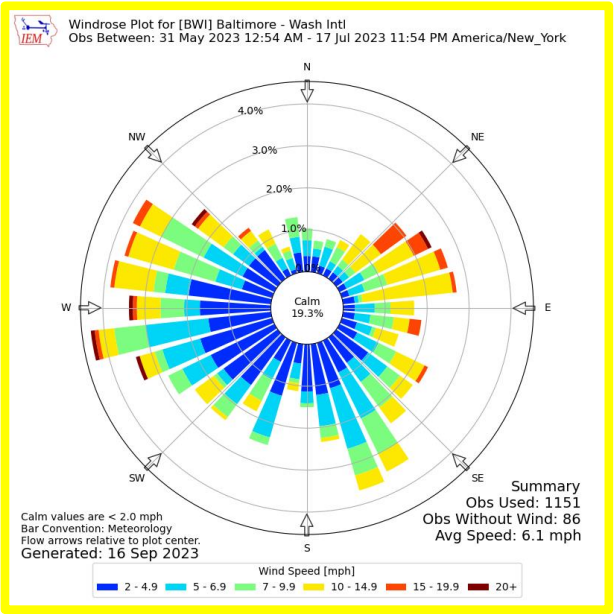
June 29, 2023

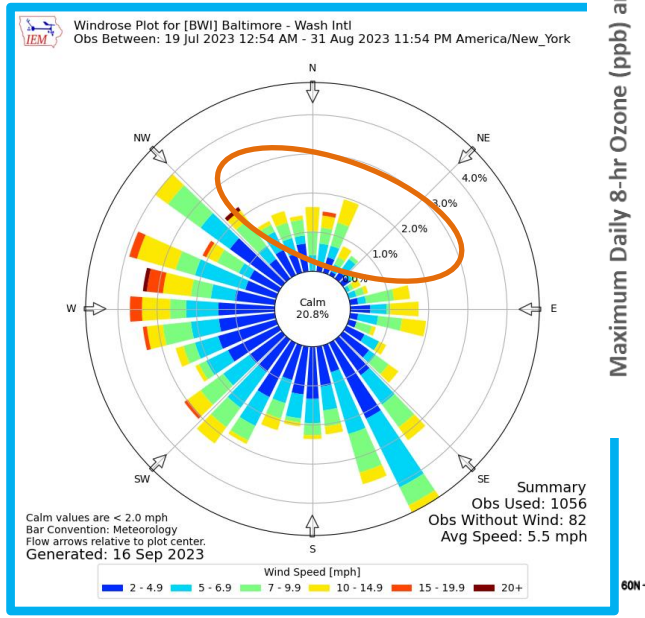

June 2023 PM2.5 Daily Averages [ug/m³]
Concentratation
Date
Site
EDGEWOOD
FAIR HILL
HAGERSTOWN
HORN POINT
Howard County Near Road
HOWARD U.
Lake Montebello
MILLINGTON
PADONIA
PINEY RUN
ROCKVILLE
0
20
40
60
80
100
120
Jun-02
Jun-04
Jun-06
Jun-08
Jun-10
Jun-12
Jun-14
Jun-16
Jun-18
Jun-20
Jun-22
Jun-24
Jun-26
Jun-28
Jun-30

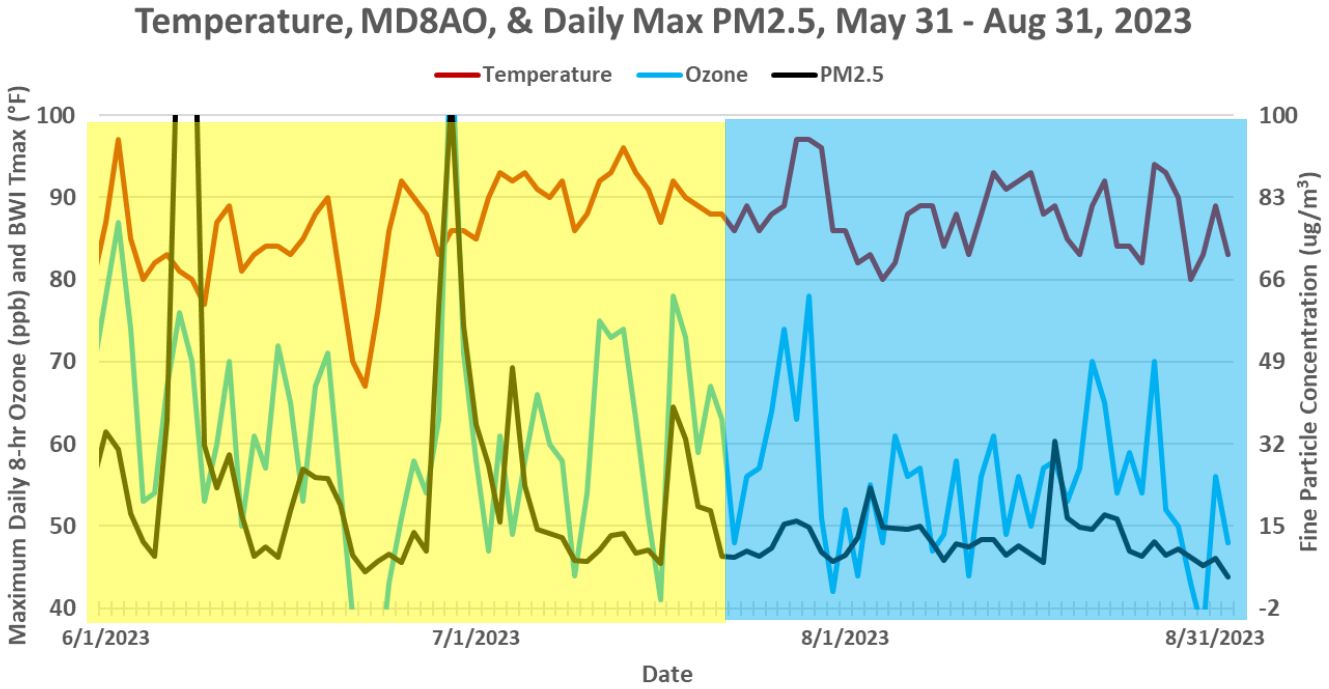

June 2023 CO Daily Averages [ppm]
Concentratation
Date
Site
ESSEX
Howard County Near Road
HOWARD U.
PINEY RUN
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Jun-02
Jun-04
Jun-06
Jun-08
Jun-10
Jun-12
Jun-14
Jun-16
Jun-18
Jun-20
Jun-22
Jun-24
Jun-26
Jun-28
Jun-30

Where's the smoke?

… Fires kept burning, so why didn't we have more smoke events in July and August?

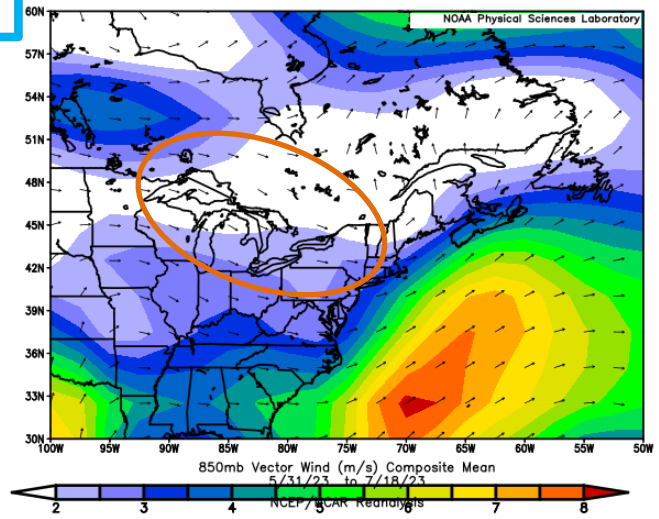


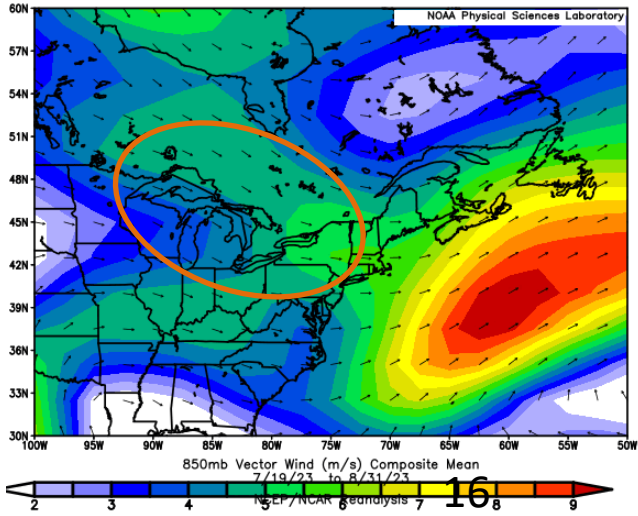




We DID see smoke impacts in July and August…but they weren't as noticeable

We saw MORE northerly winds in the later period, with less easterly winds…surface alone doesn't explain the decreasing smoke events in the Mid-Atlantic

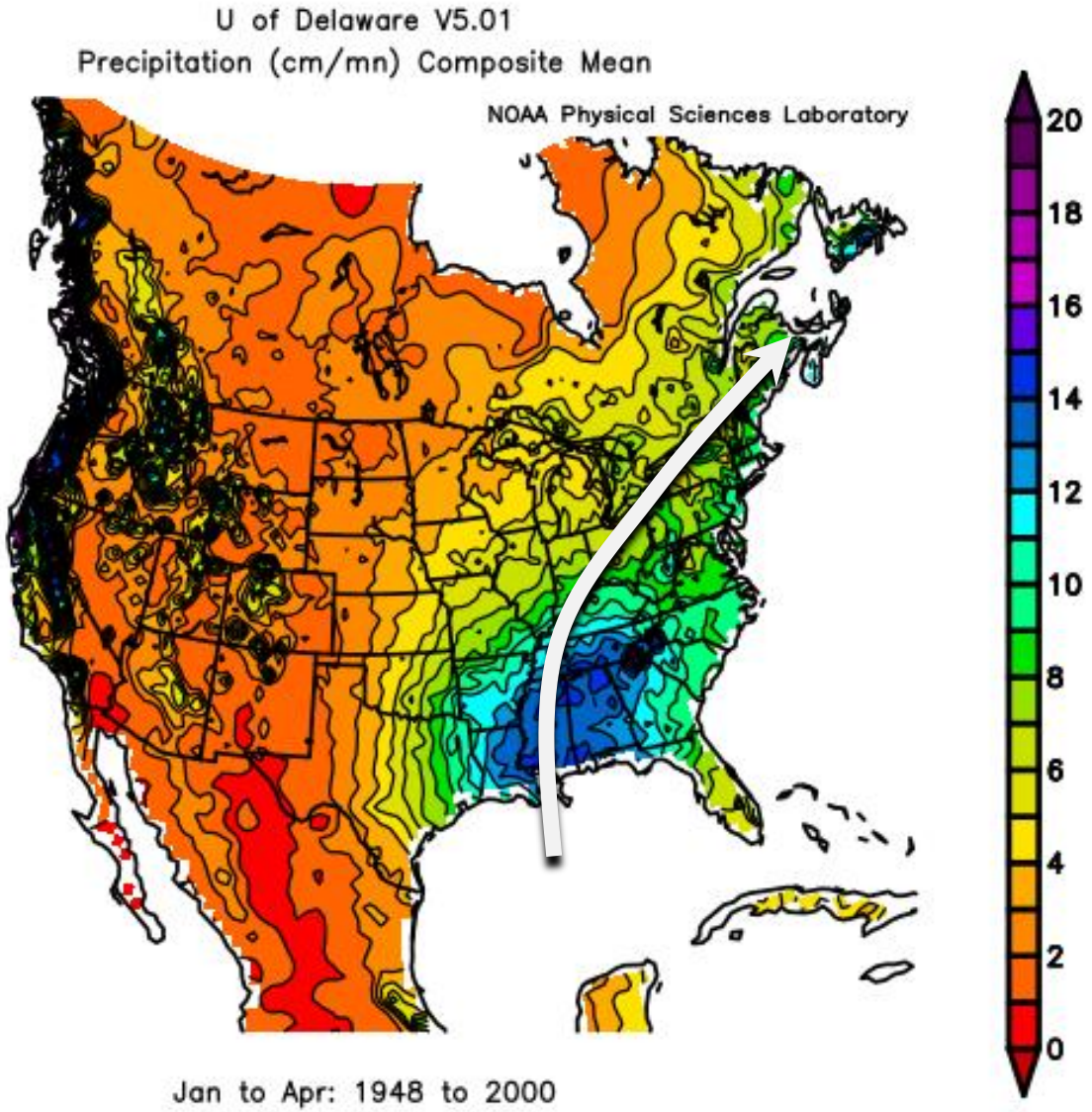


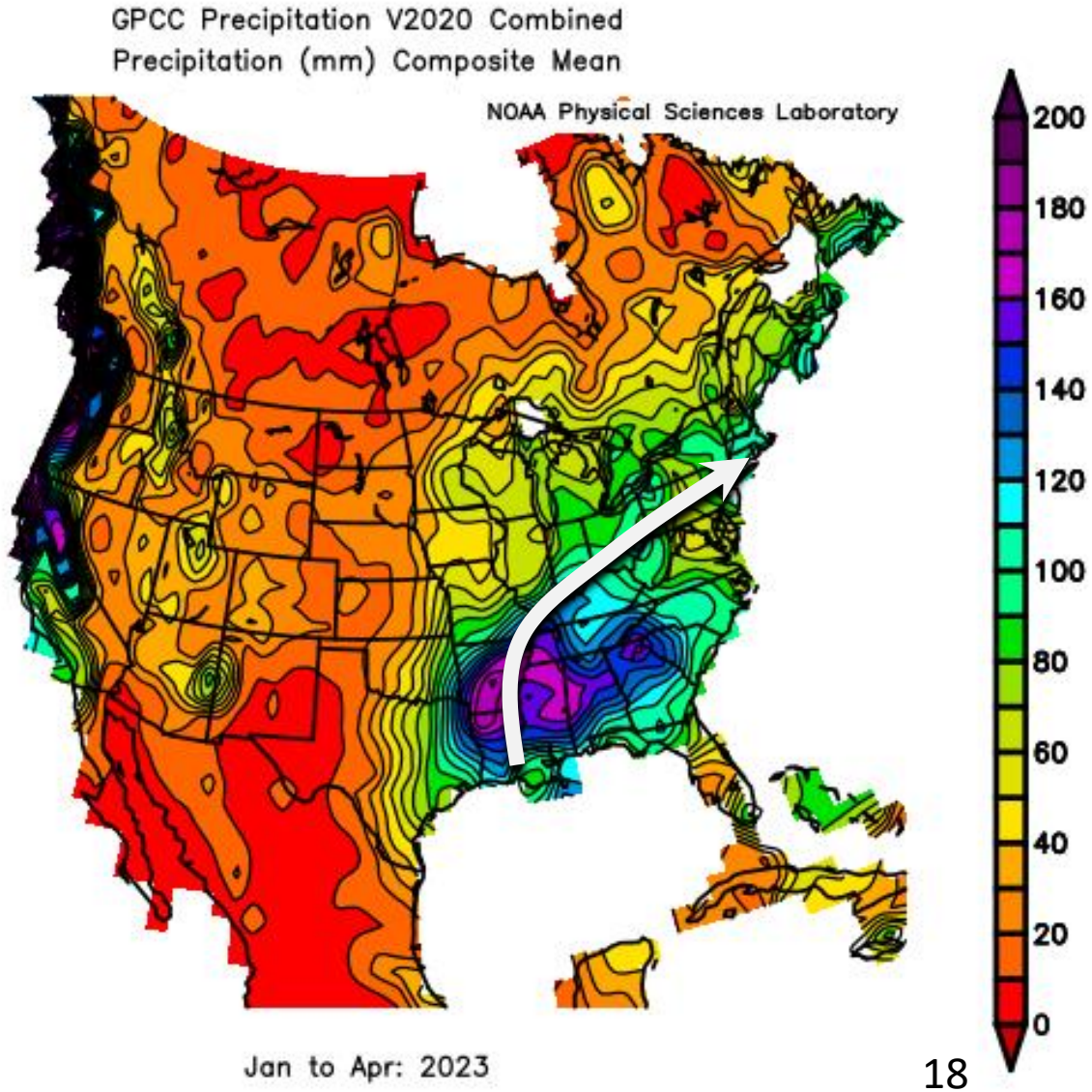


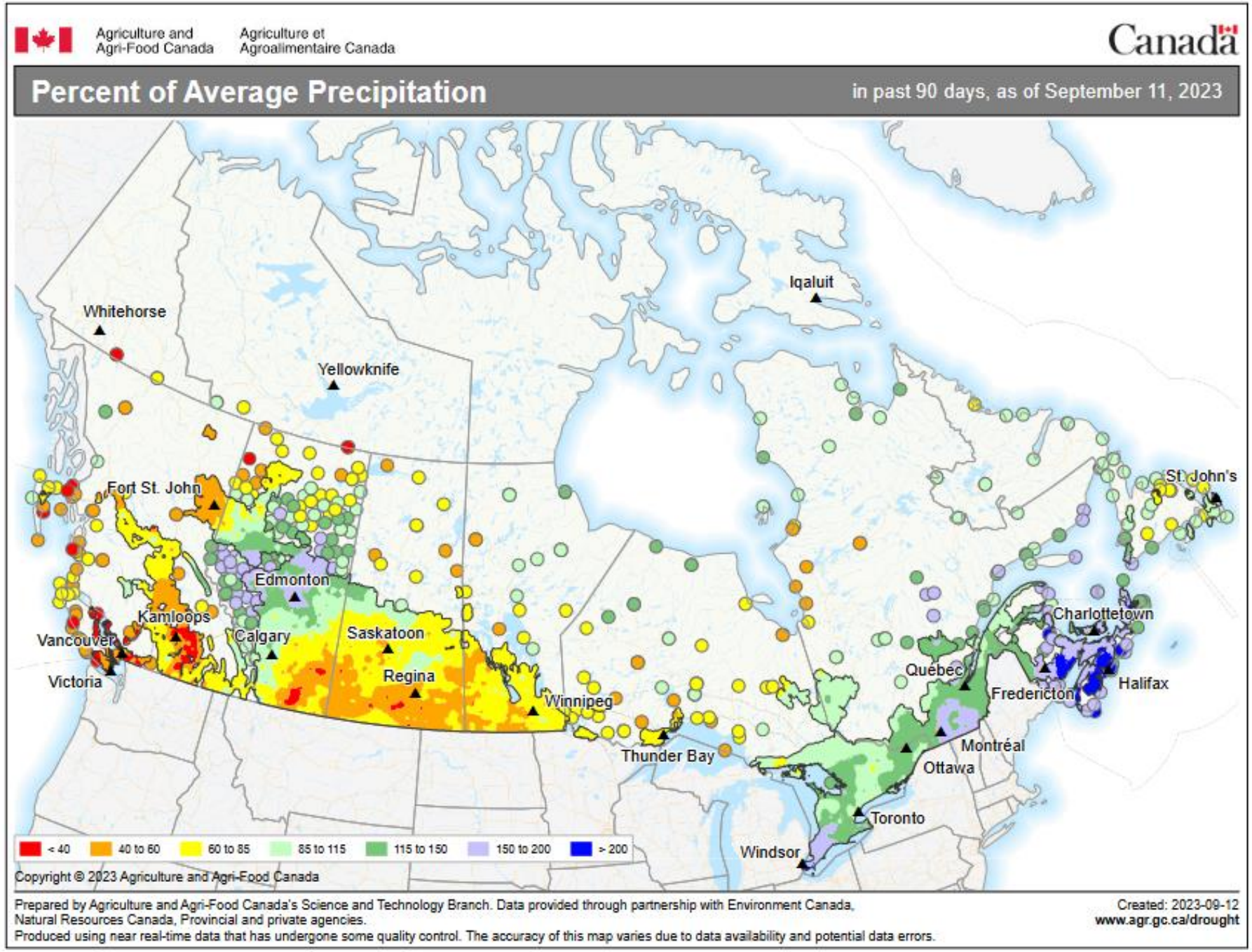
A pattern change brought <u>stronger mean winds aloft</u> and a change in the <u>source of fires</u> impacting Mid-Atlantic, reducing the "noticeable" impact from smoke

Questions

Annual Precipitation – Lack of Moisture Northward Extent






Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Canada
Percent of Average Precipitation
in past 90 days, as of September 11, 2023
Iqaluit
Whitehorse
Yellowknife
Fort St. John
St. John's
Edmonton
Kamloops
Charlottetown
Vancouver
Calgary
Saskatoon
Québec
Victoria
Regina
Fredericton
Halifax
Winnipeg
Thunder Bay
Montréal
Ottawa
Toronto
Windsor
< 40
40 to 60
60 to 85
85 to 115
115 to 150
150 to 200
> 200
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Produced using near real-time data that has undergone some quality control. The accuracy of this map varies due to data availability and potential data errors.
Created: 2023-09-12
www.agr.gc.ca/drought