

Factual Report – Attachment 1

Images presenting output from the Current Icing Potential (CIP) valid for 0908 for altitudes at and below FL210 for the accident region. Email correspondence with NCAR.

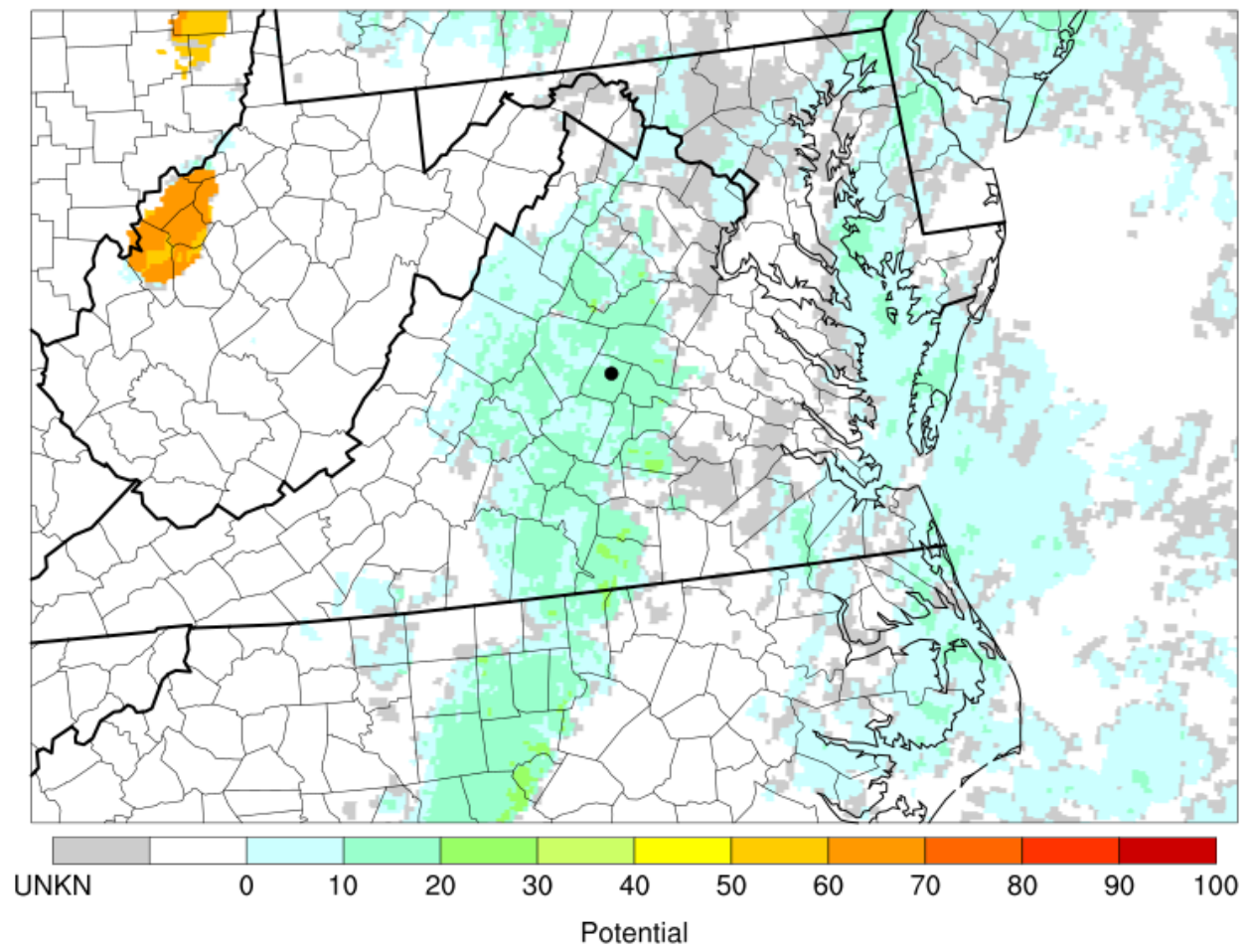
METEOROLOGY

ERA24FA209

*Submitted by: Mike Richards
NTSB, AS-30*

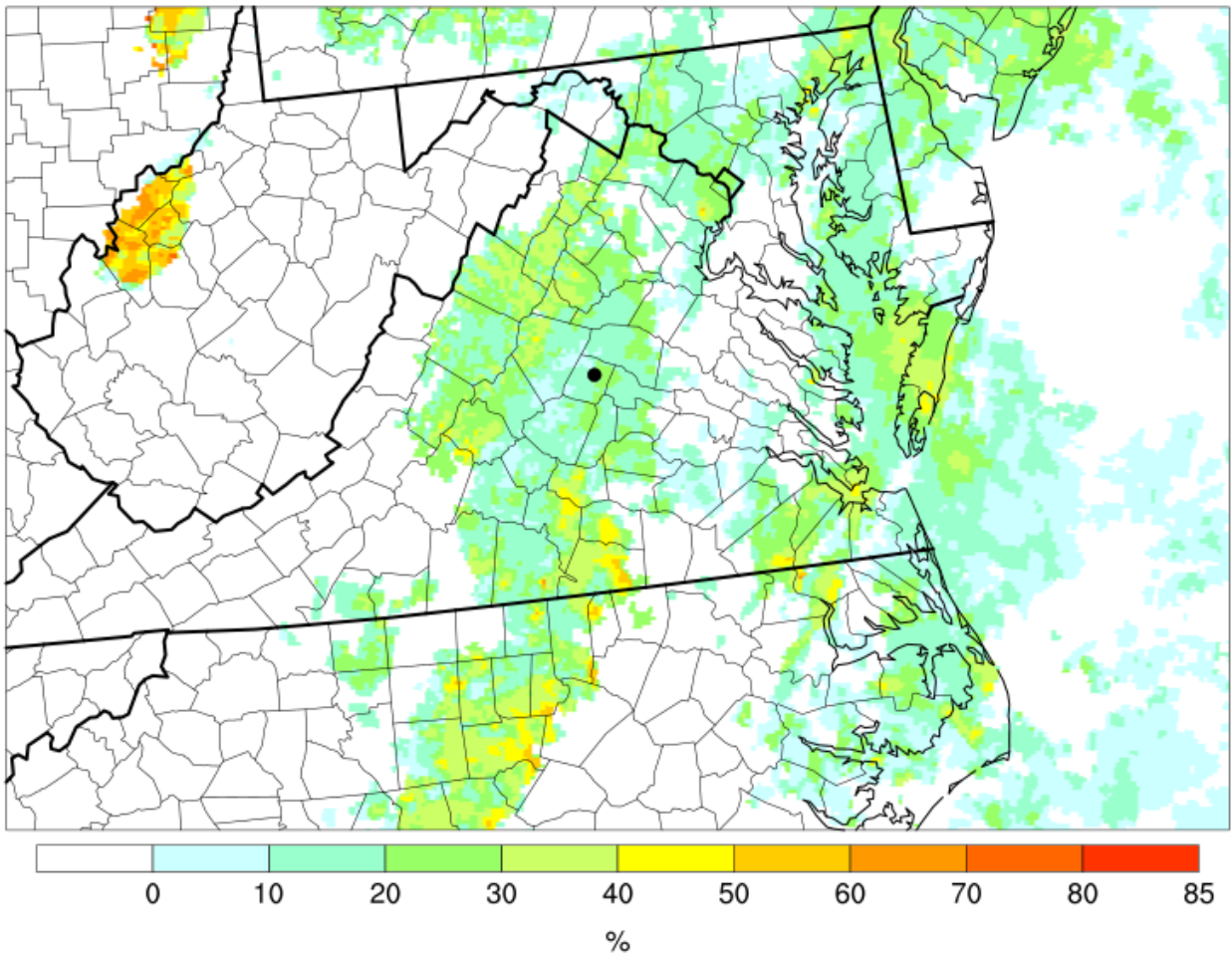
SLD POTENTIAL at FL 210

5/5/2024 1308 UTC



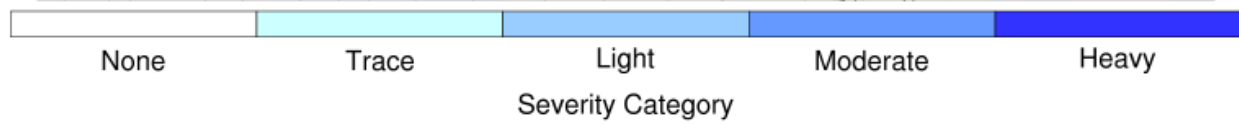
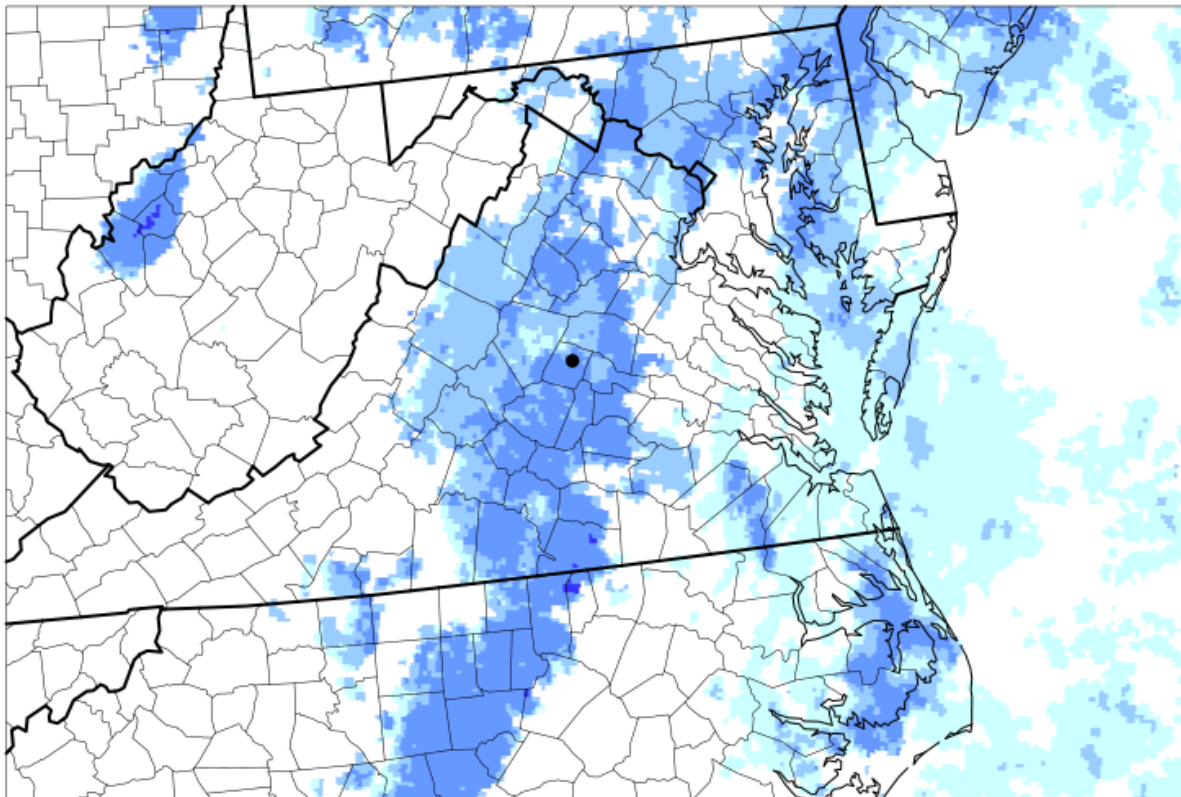
ICING PROBABILITY at FL 210

5/5/2024 1308 UTC



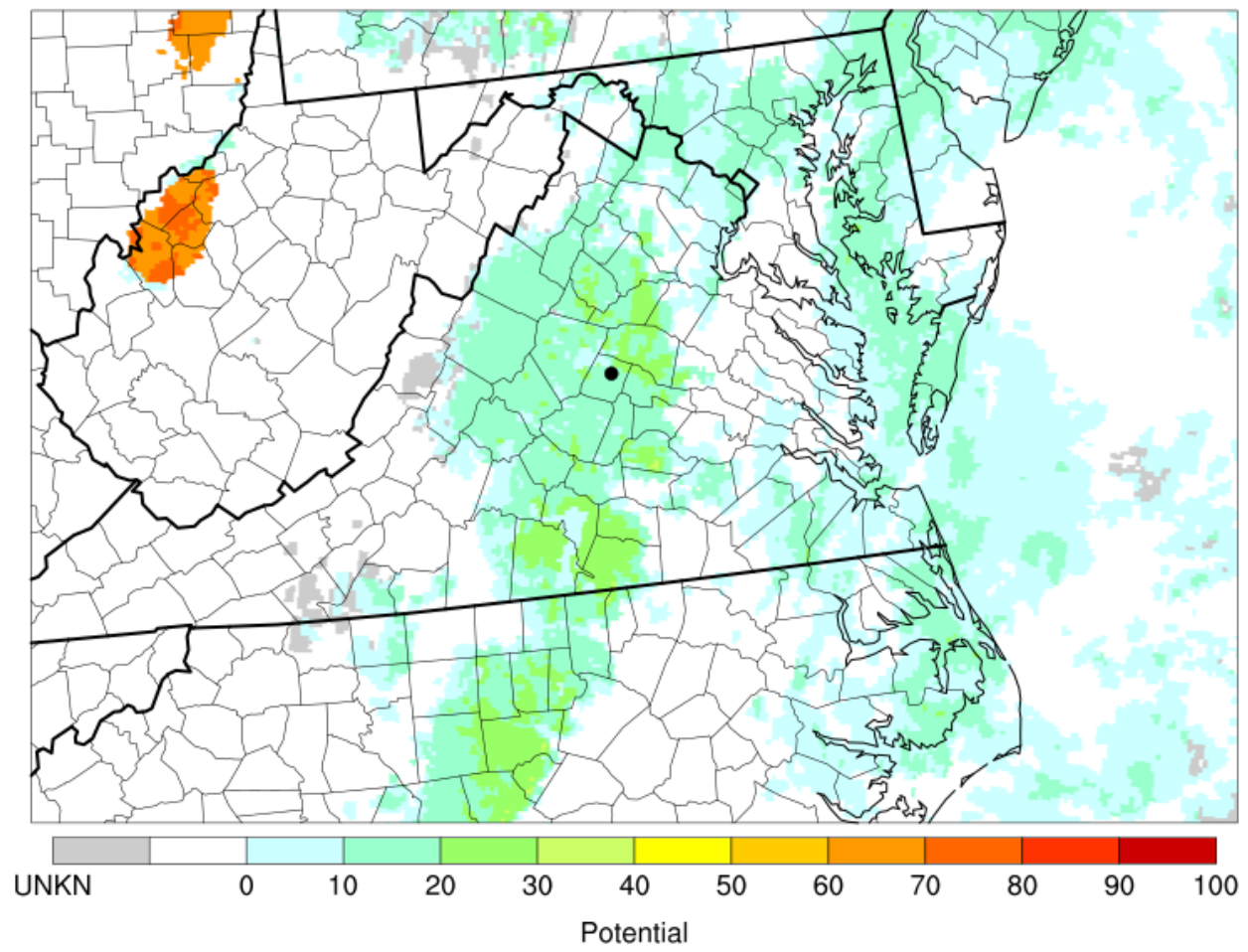
ICING SEVERITY at FL 210

5/5/2024 1308 UTC



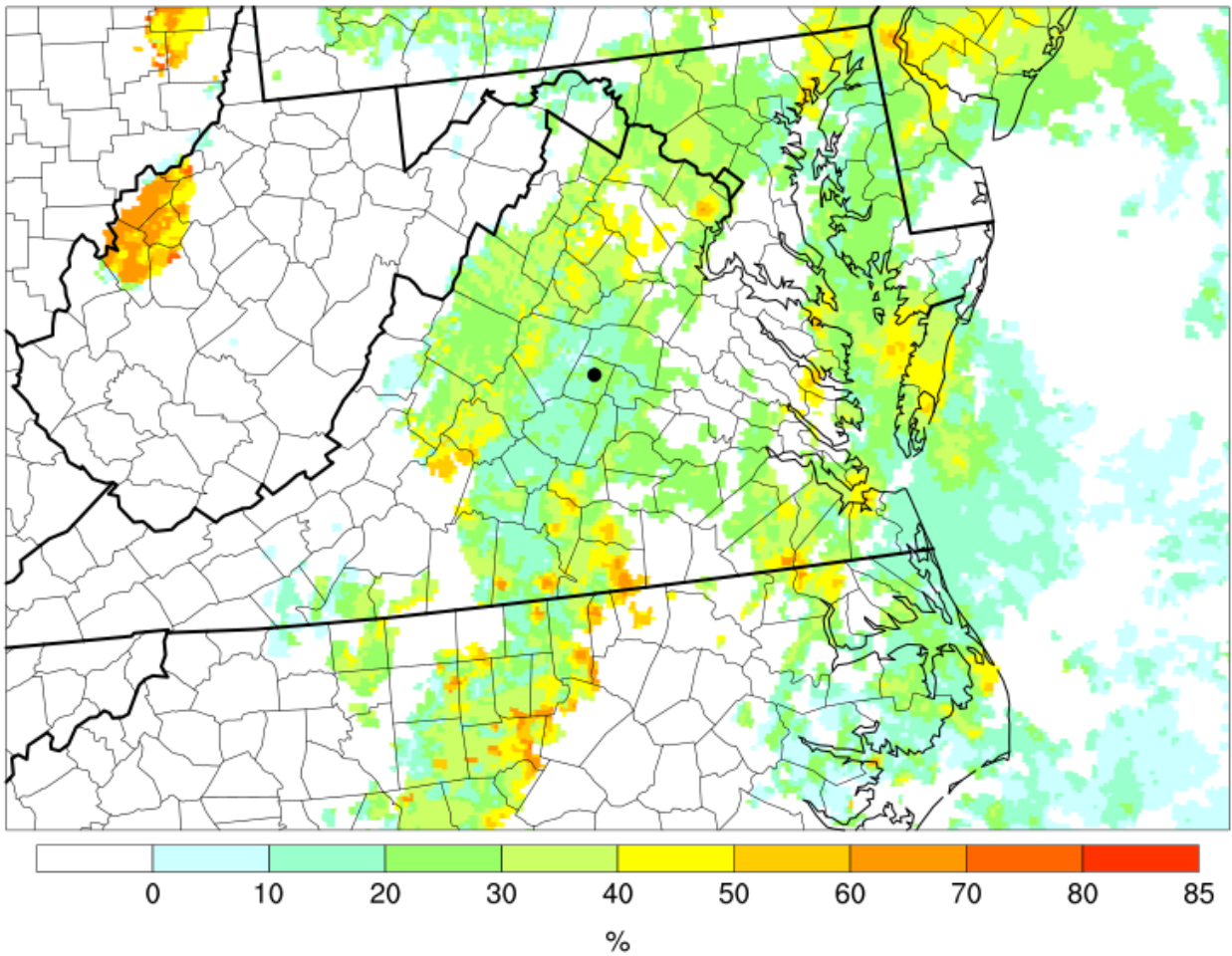
SLD POTENTIAL at FL 200

5/5/2024 1308 UTC



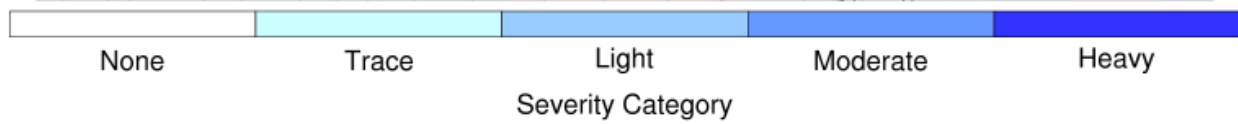
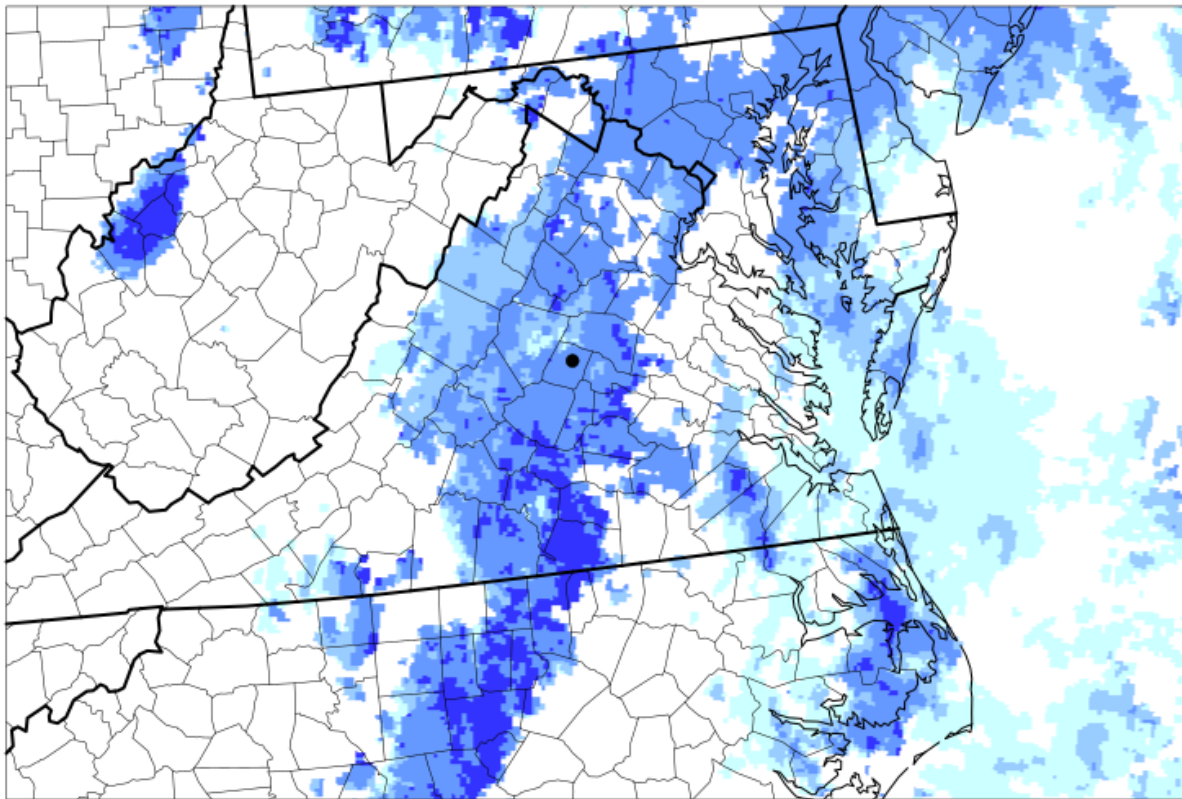
ICING PROBABILITY at FL 200

5/5/2024 1308 UTC



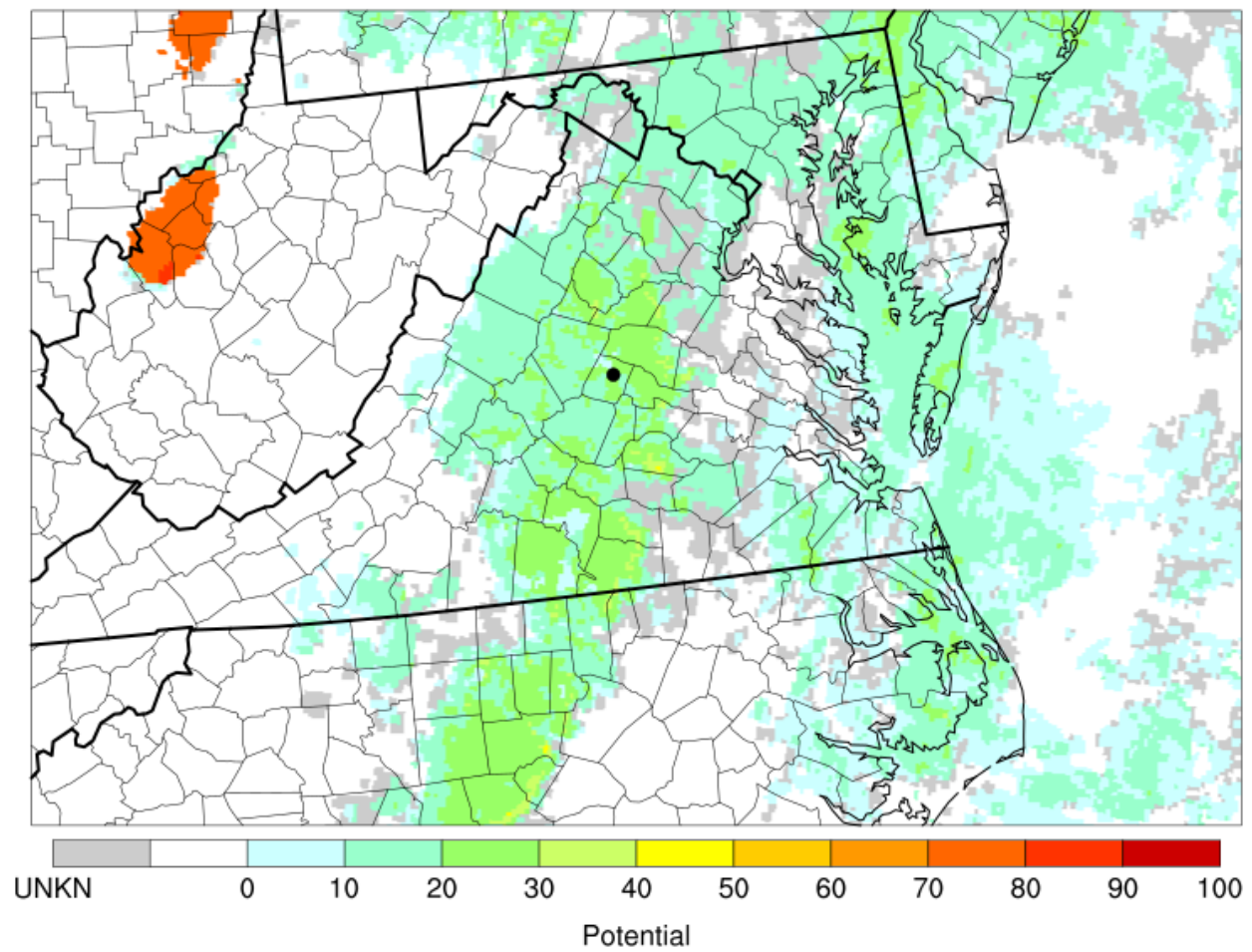
ICING SEVERITY at FL 200

5/5/2024 1308 UTC



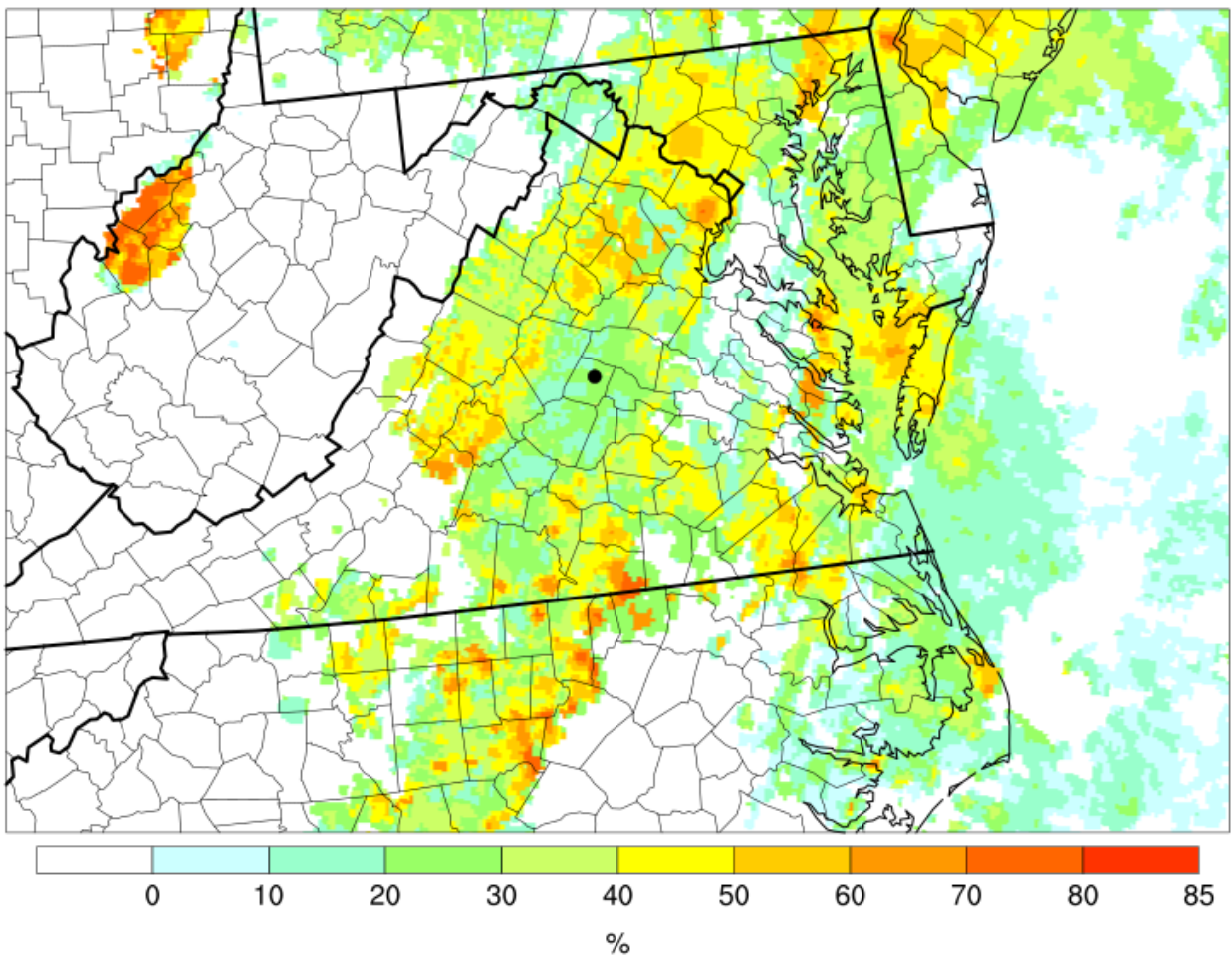
SLD POTENTIAL at FL 190

5/5/2024 1308 UTC



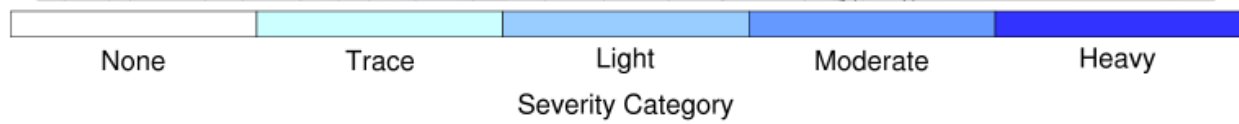
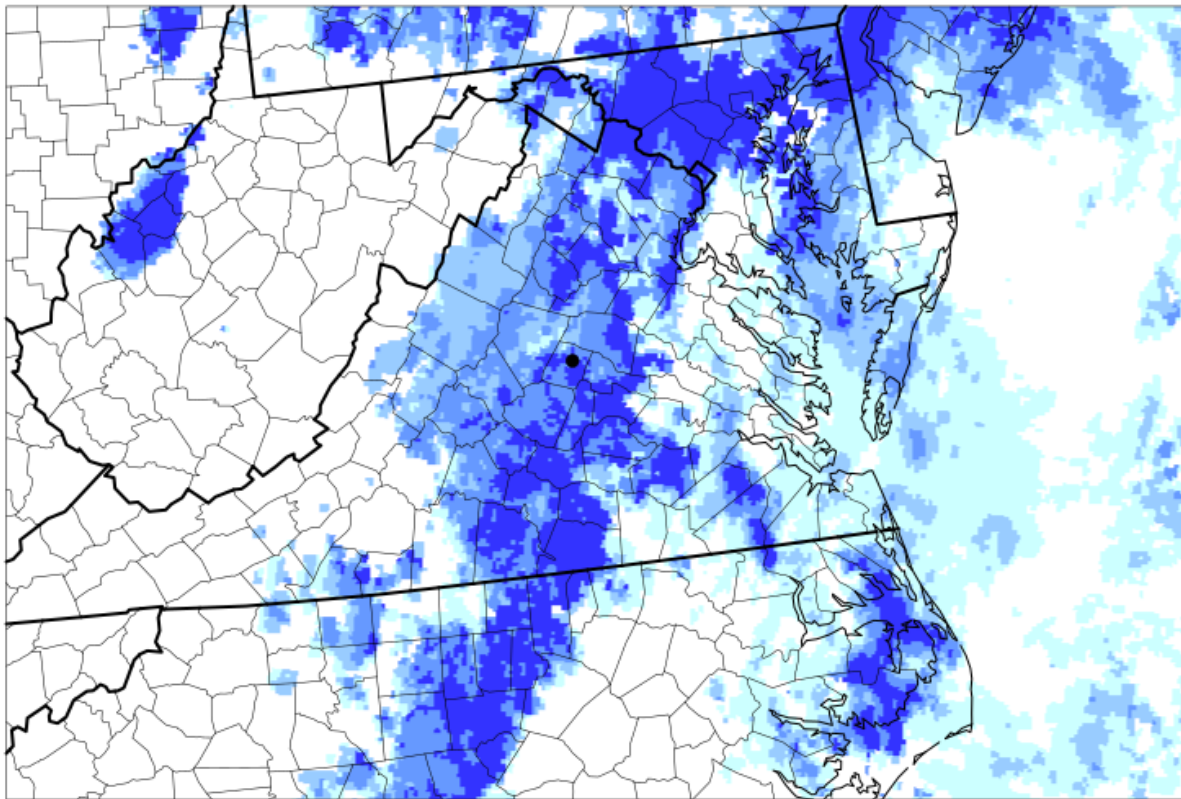
ICING PROBABILITY at FL 190

5/5/2024 1308 UTC



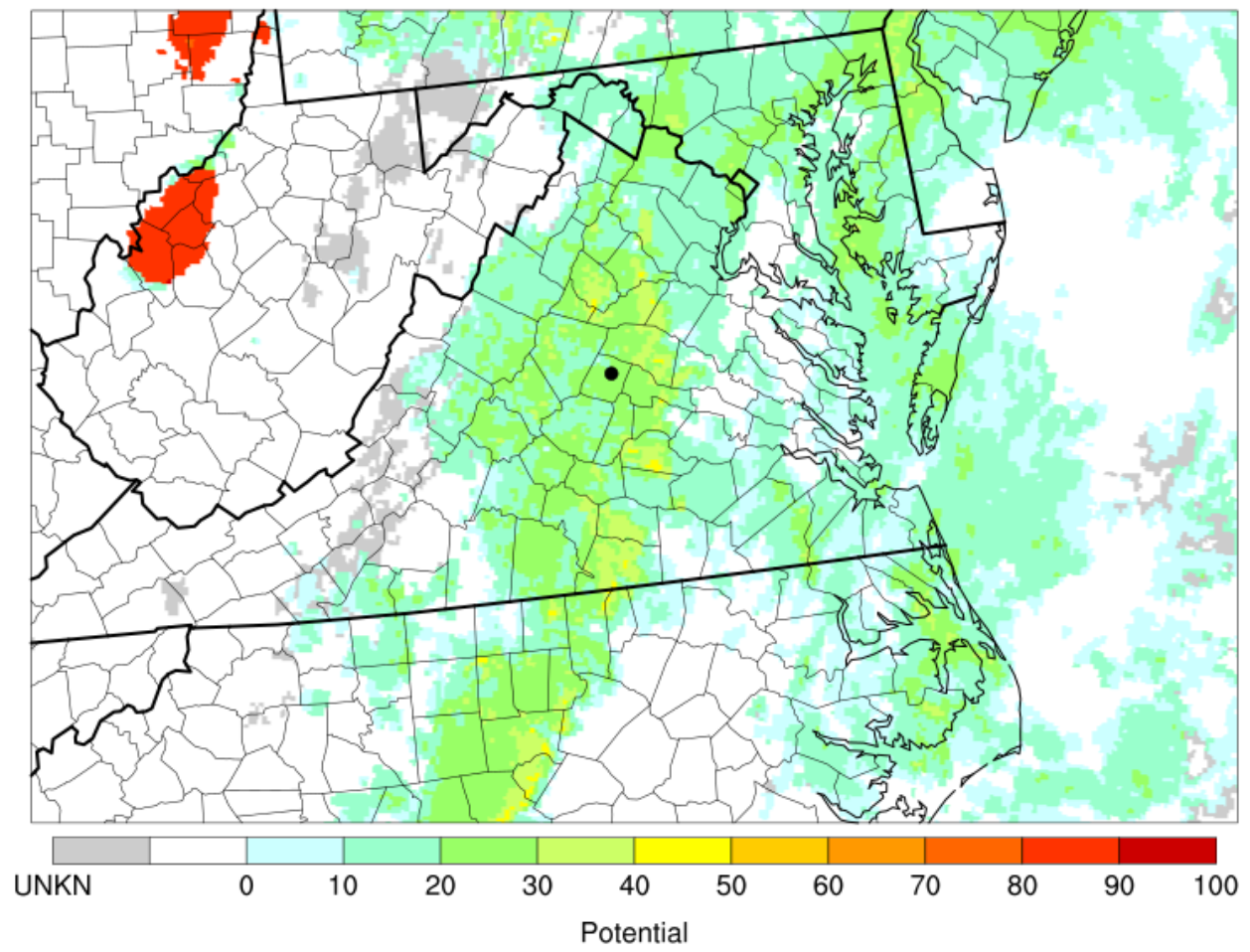
ICING SEVERITY at FL 190

5/5/2024 1308 UTC



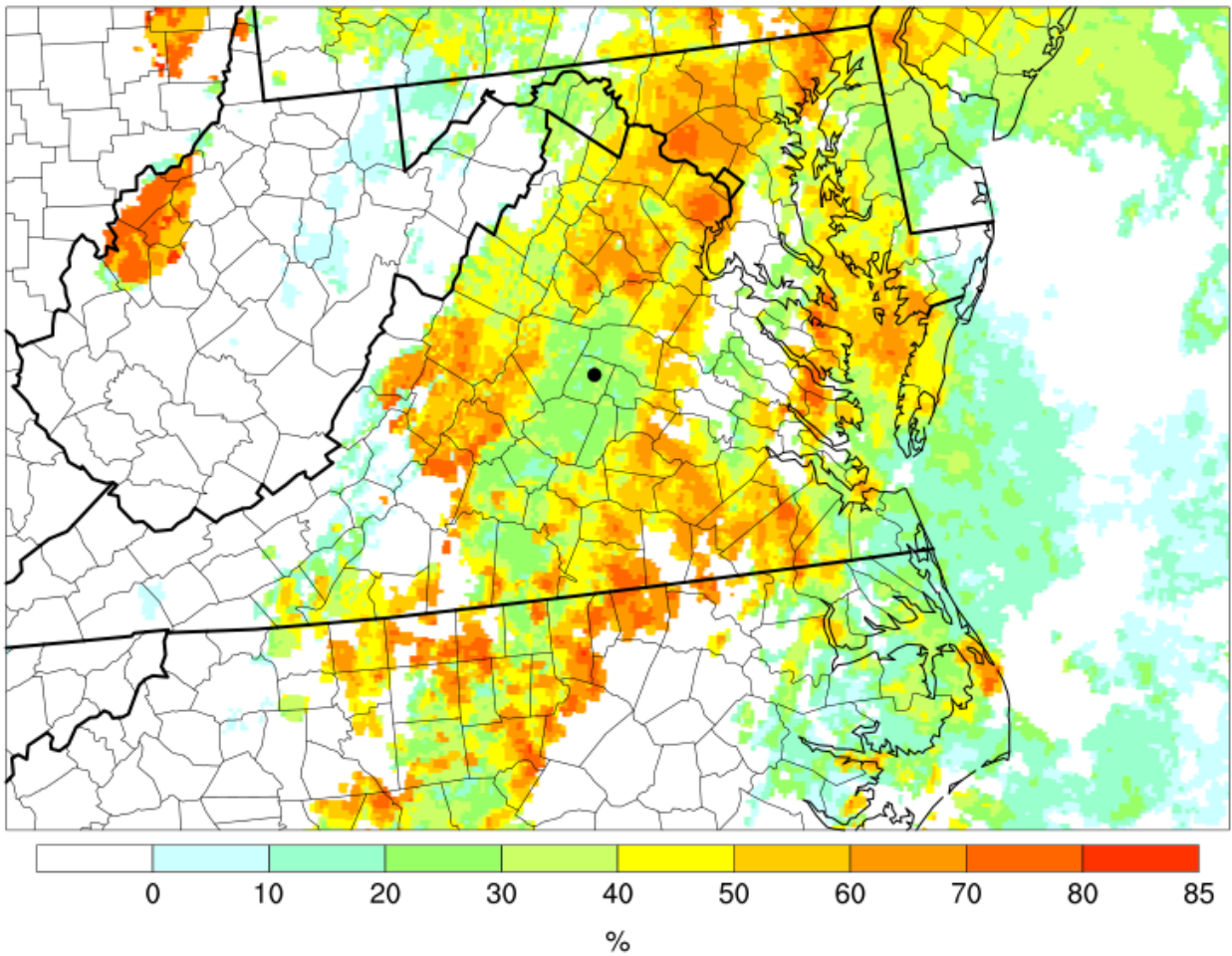
SLD POTENTIAL at FL 180

5/5/2024 1308 UTC



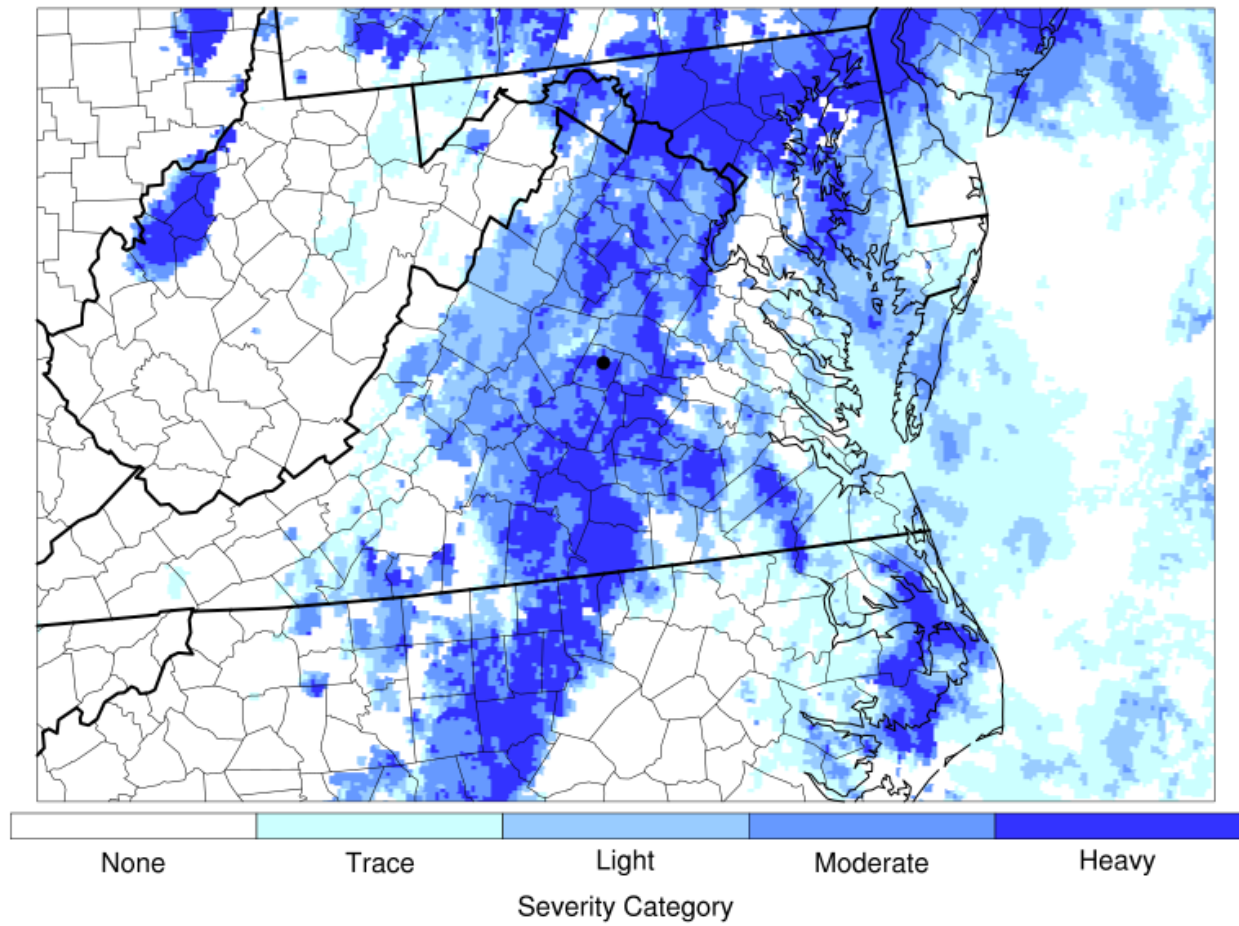
ICING PROBABILITY at FL 180

5/5/2024 1308 UTC



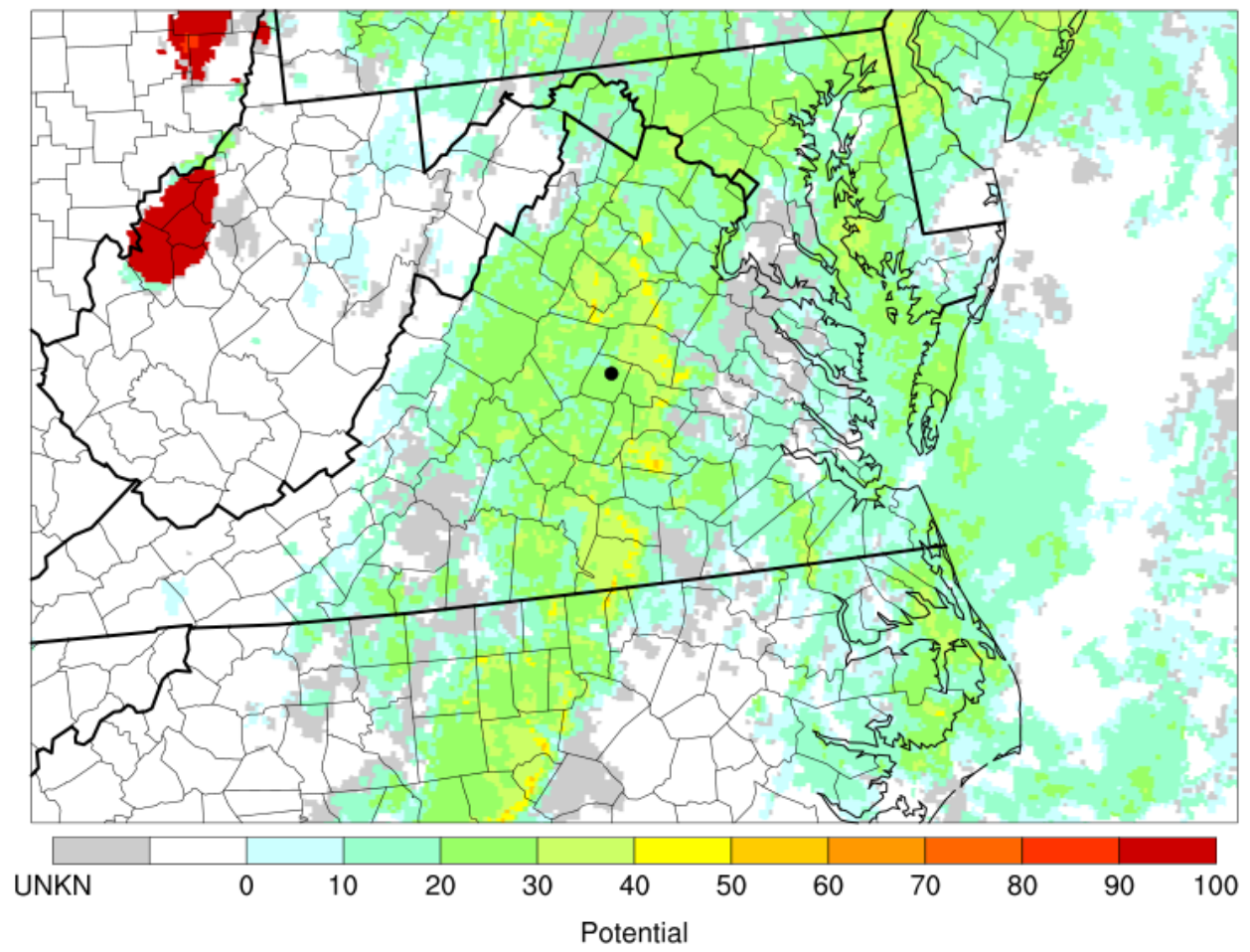
ICING SEVERITY at FL 180

5/5/2024 1308 UTC



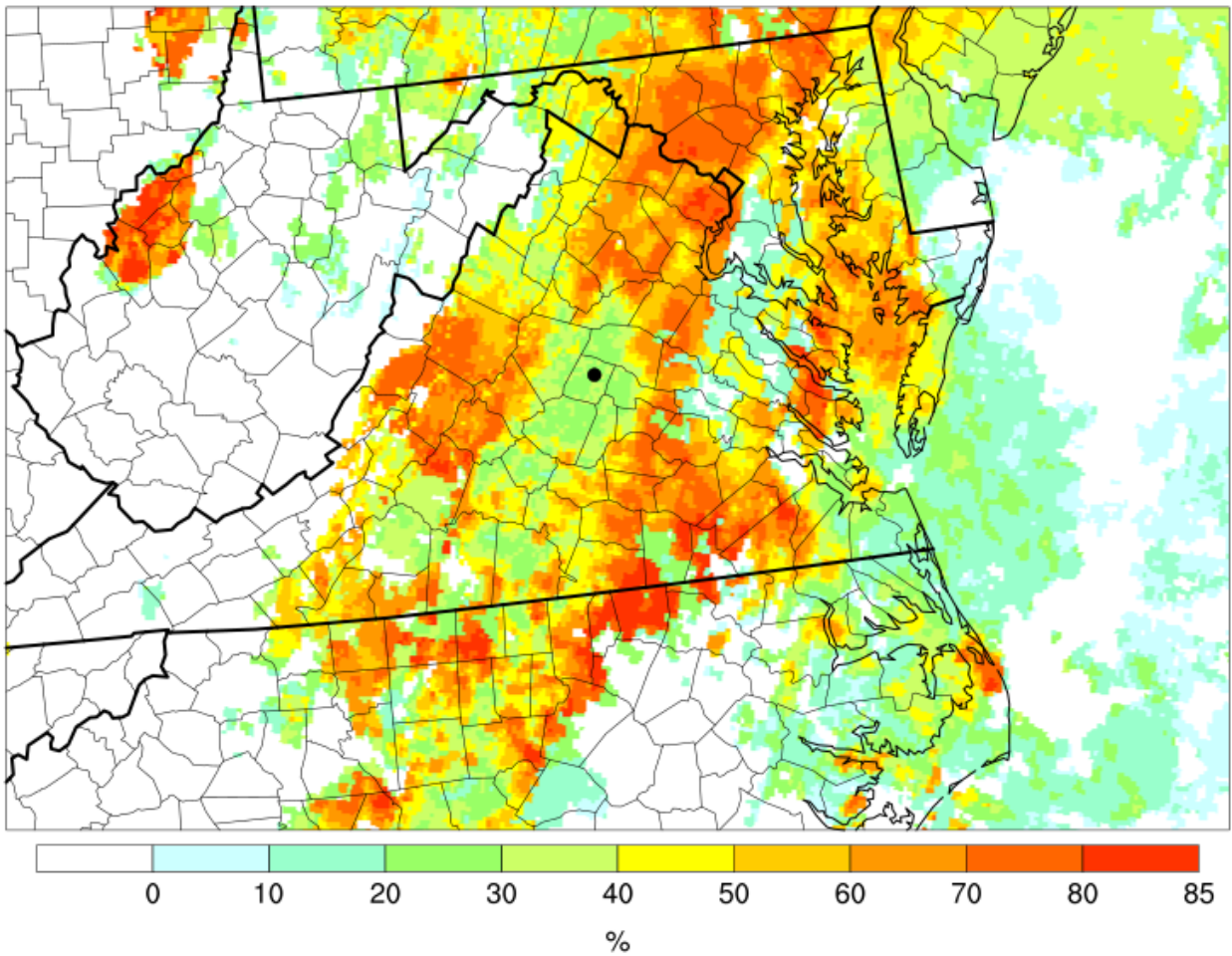
SLD POTENTIAL at FL 170

5/5/2024 1308 UTC



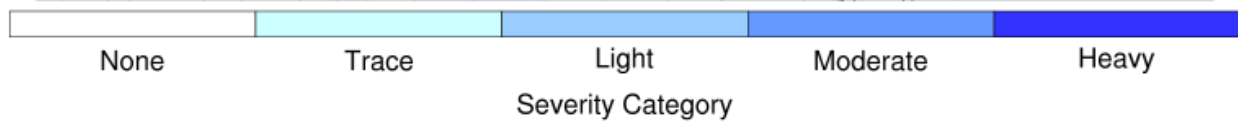
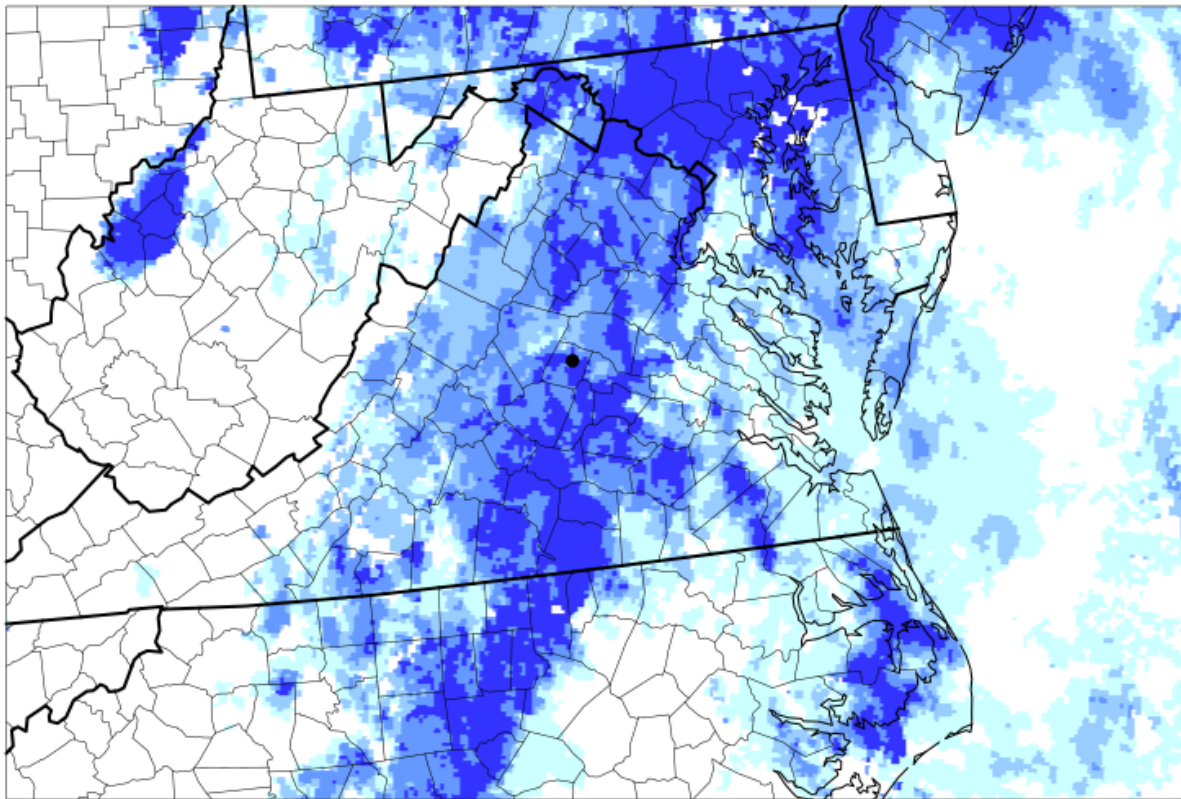
ICING PROBABILITY at FL 170

5/5/2024 1308 UTC



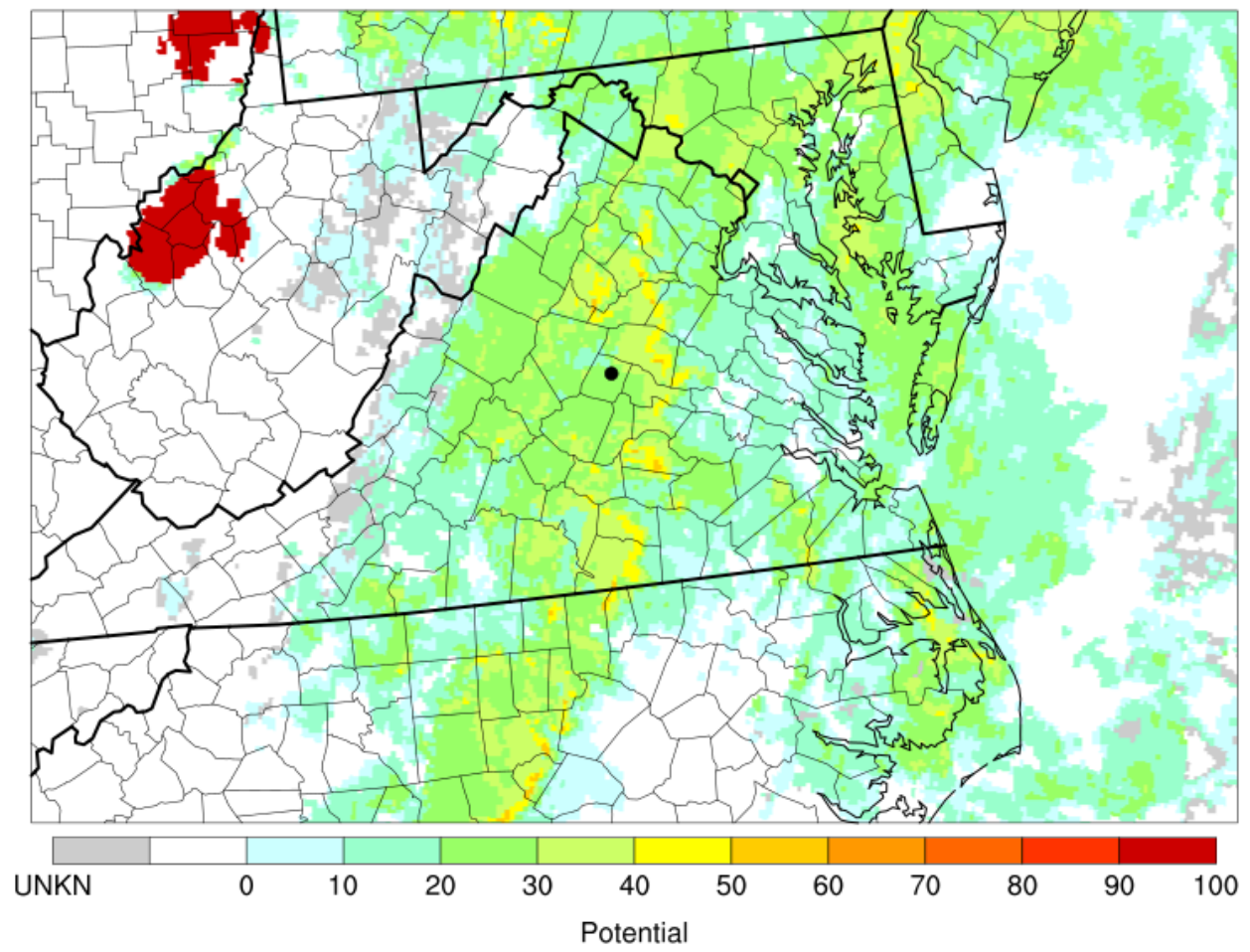
ICING SEVERITY at FL 170

5/5/2024 1308 UTC



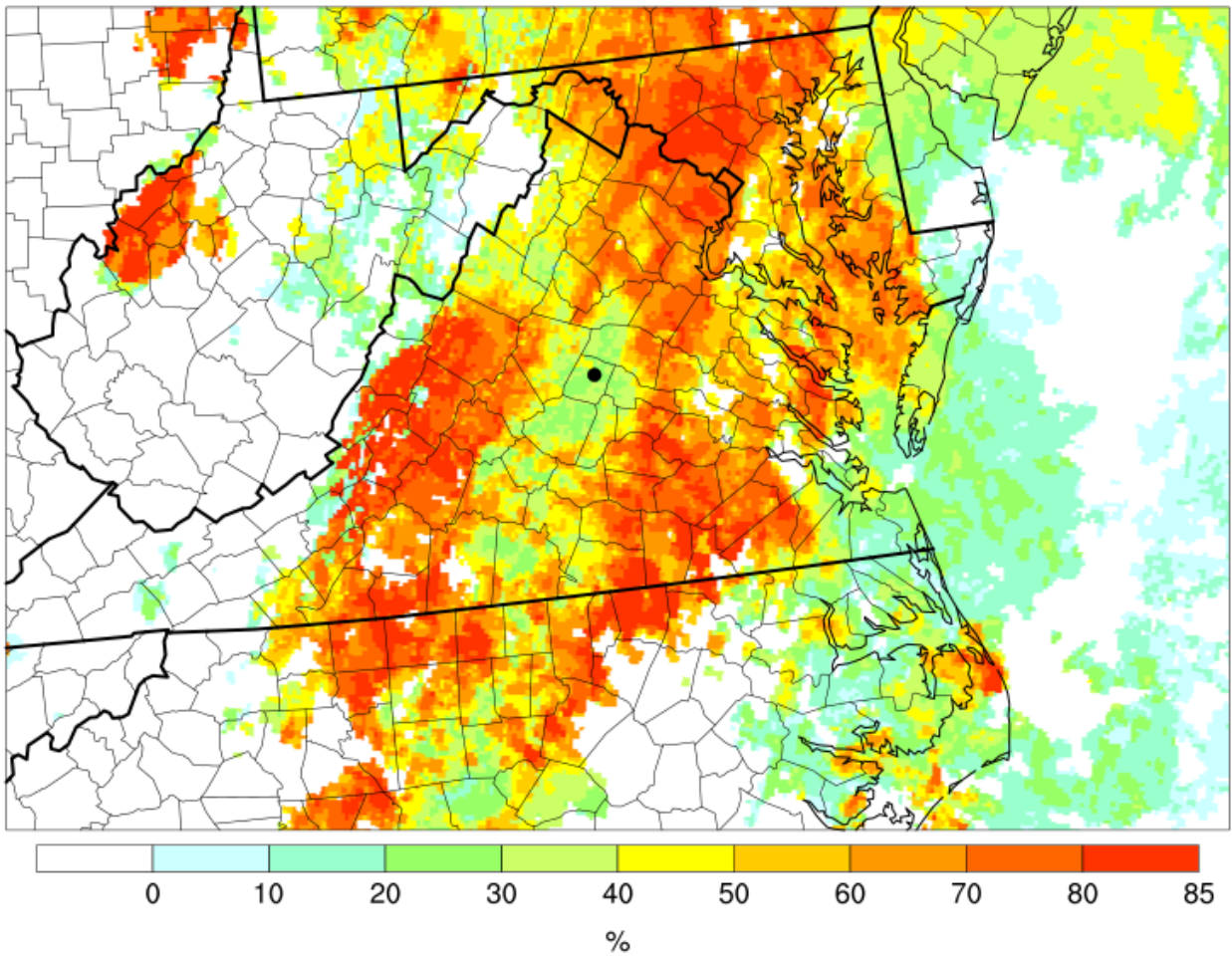
SLD POTENTIAL at FL 160

5/5/2024 1308 UTC



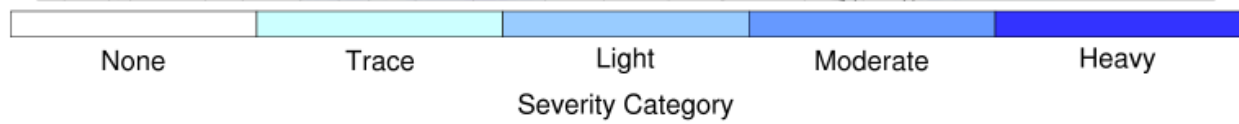
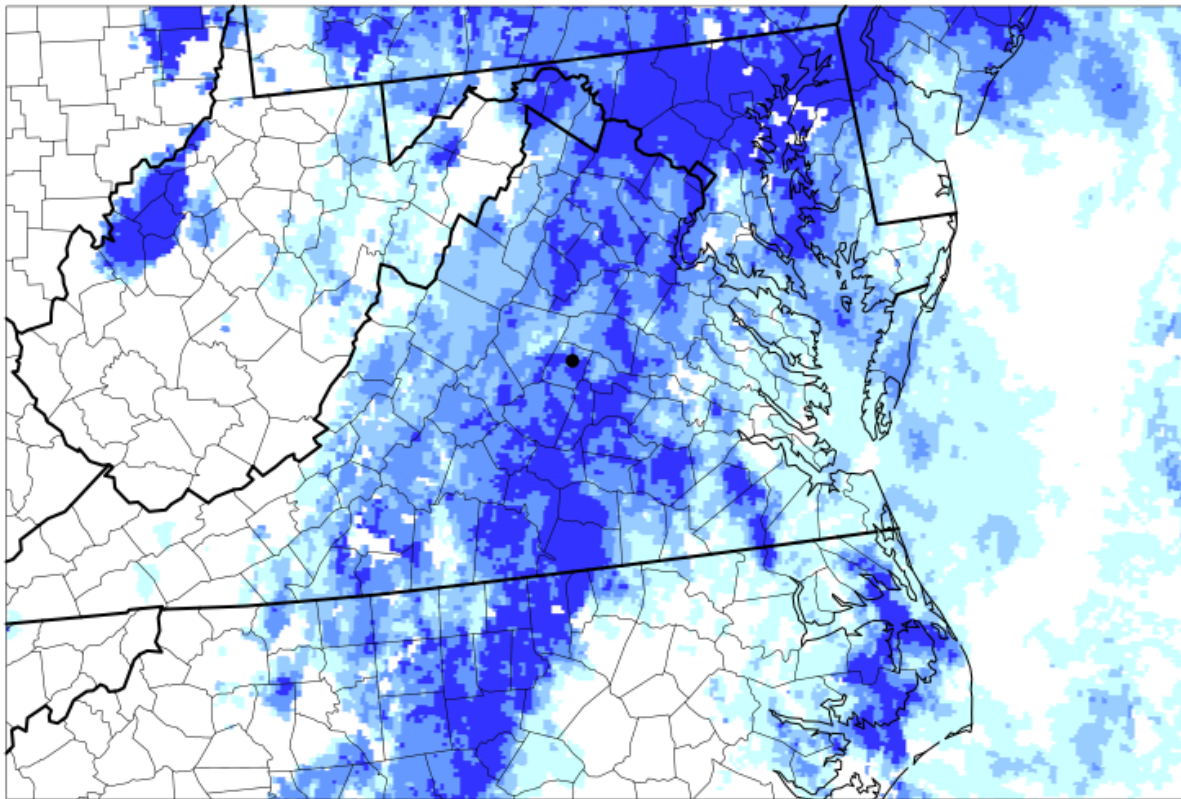
ICING PROBABILITY at FL 160

5/5/2024 1308 UTC



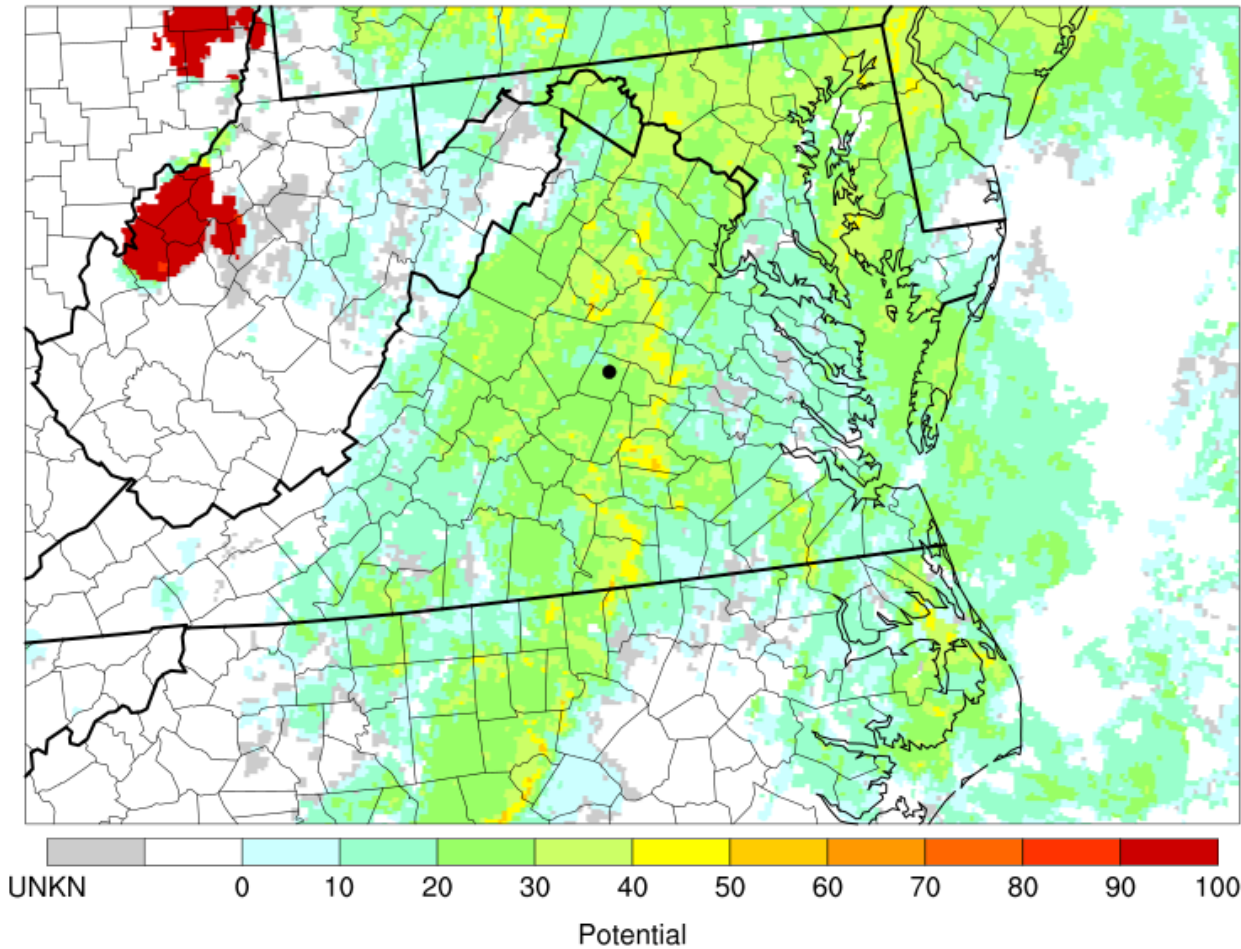
ICING SEVERITY at FL 160

5/5/2024 1308 UTC



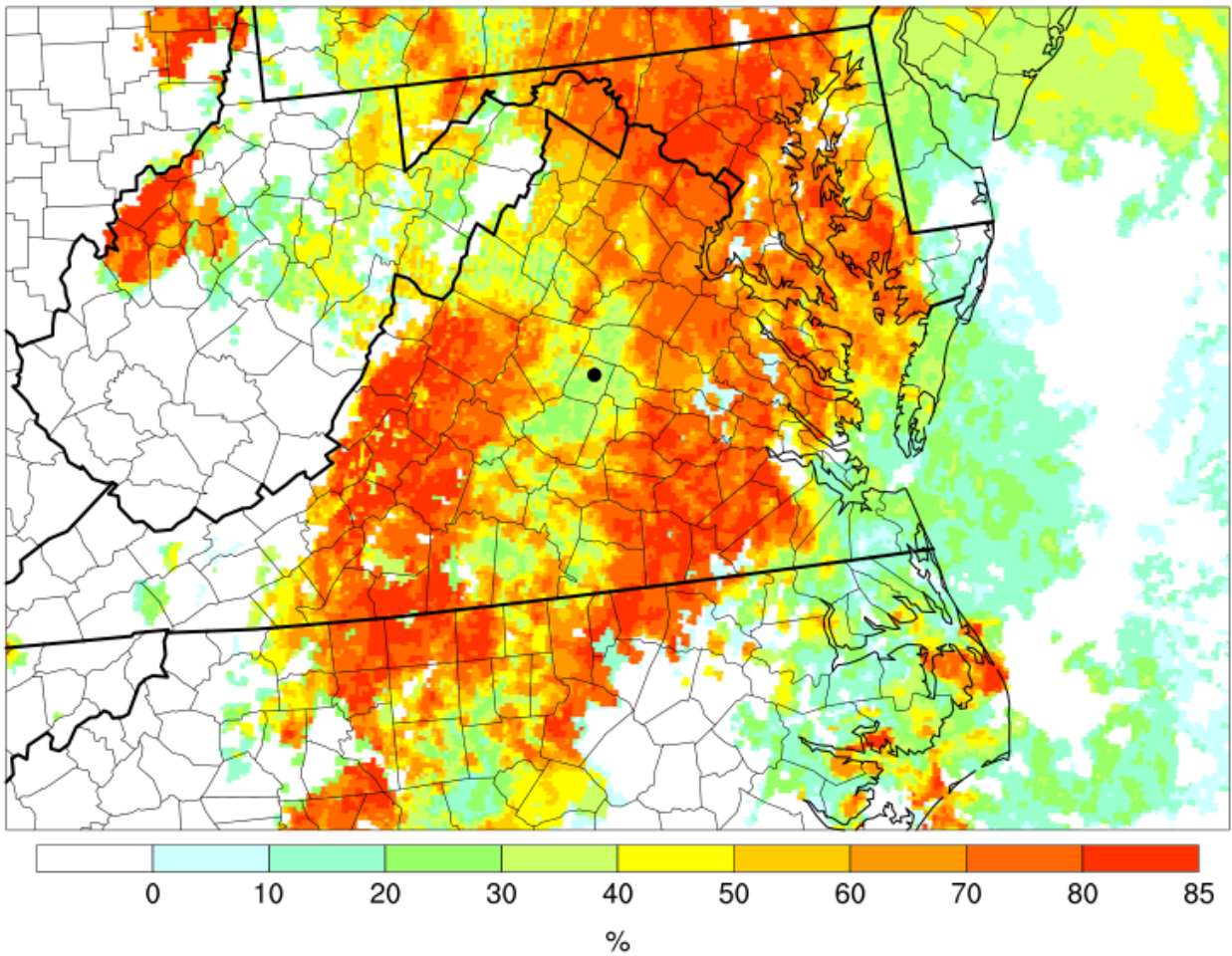
SLD POTENTIAL at FL 150

5/5/2024 1308 UTC



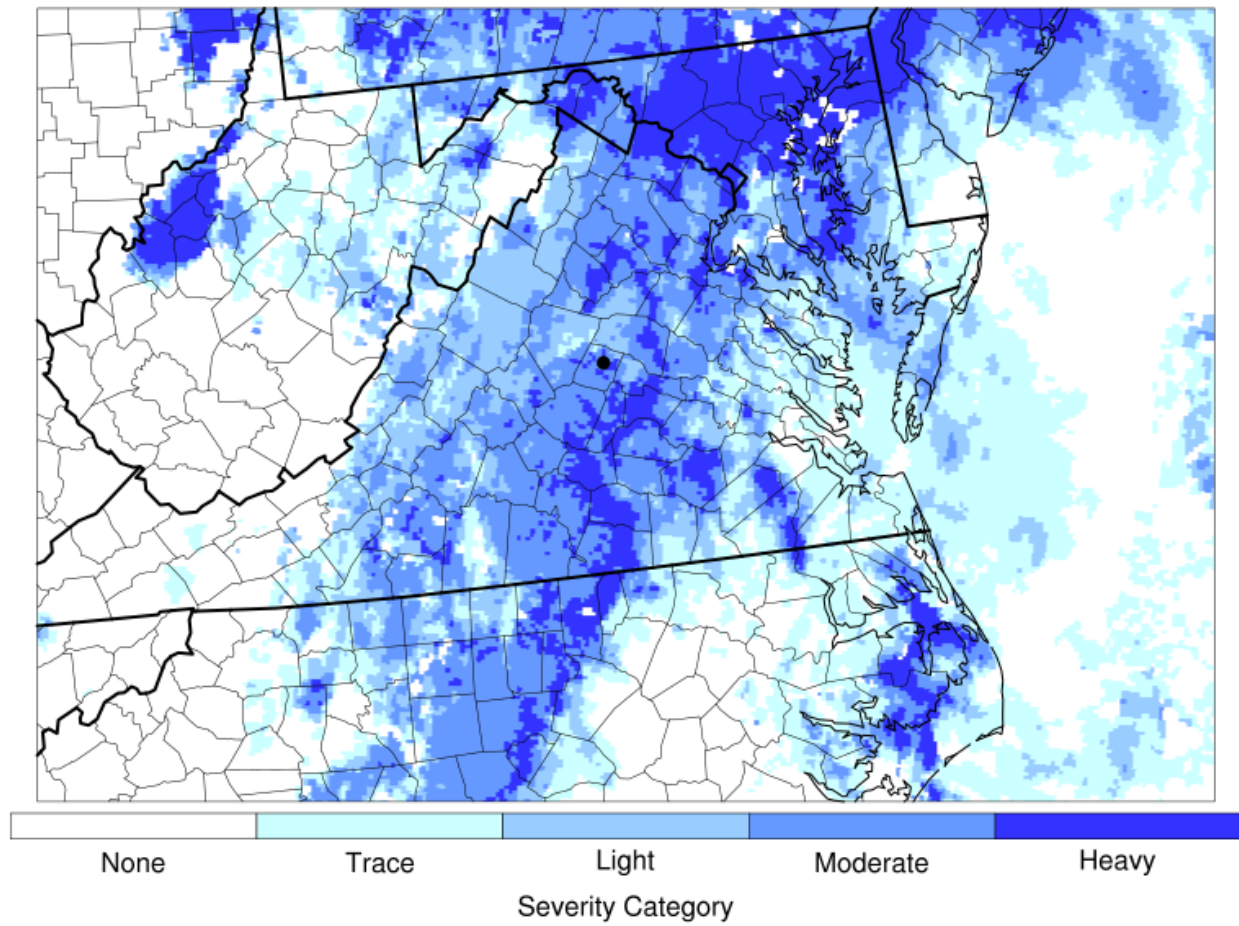
ICING PROBABILITY at FL 150

5/5/2024 1308 UTC



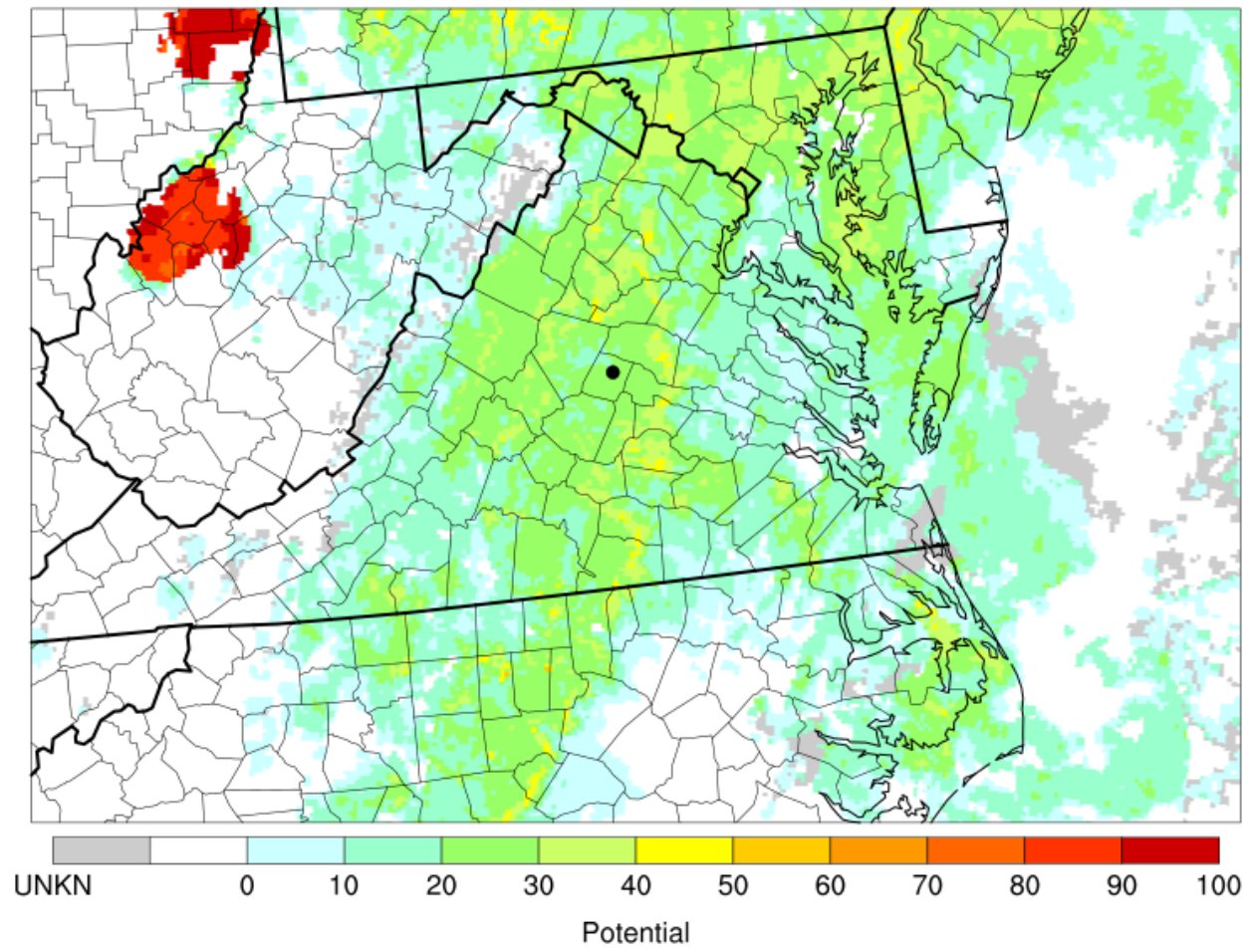
ICING SEVERITY at FL 150

5/5/2024 1308 UTC



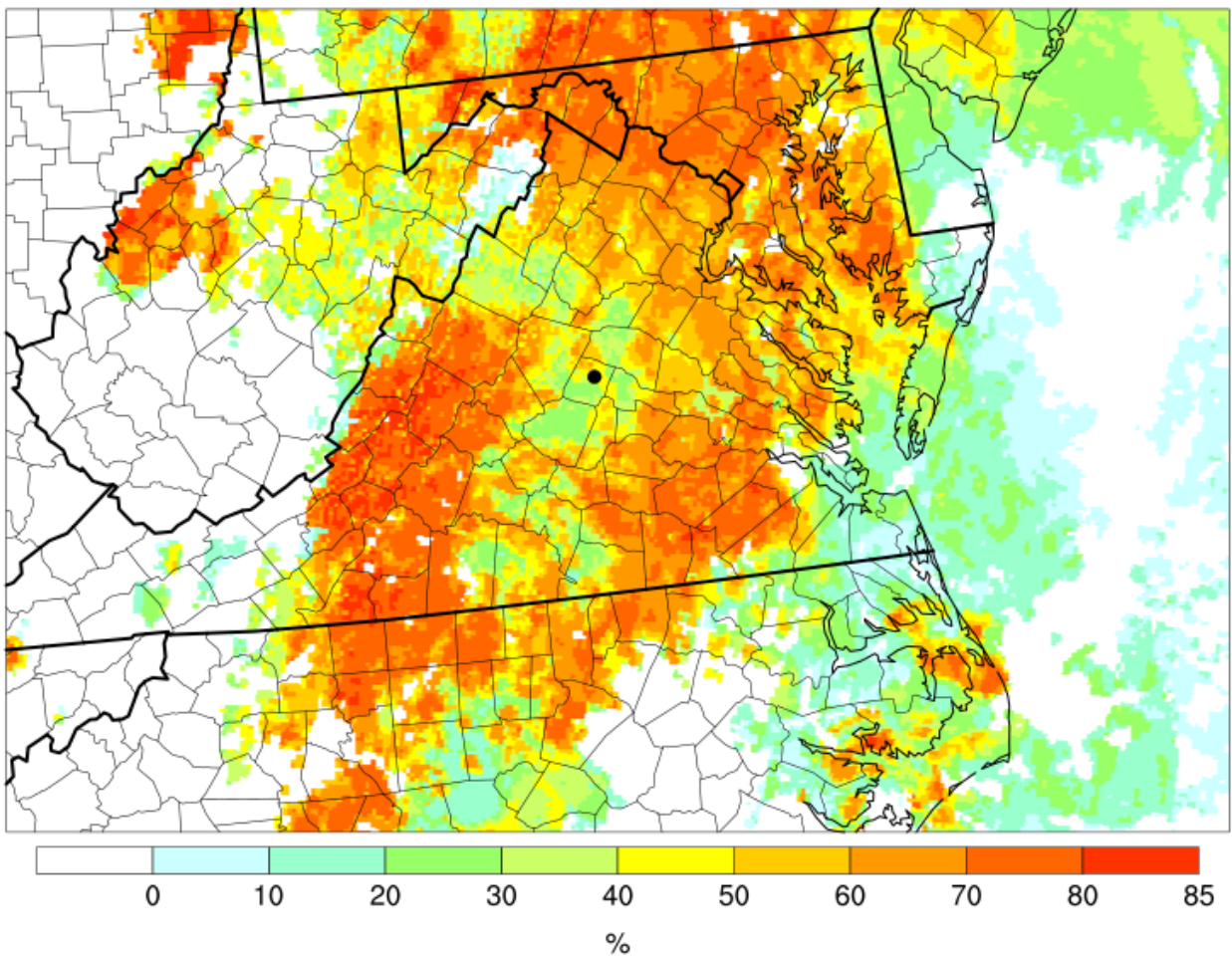
SLD POTENTIAL at FL 140

5/5/2024 1308 UTC



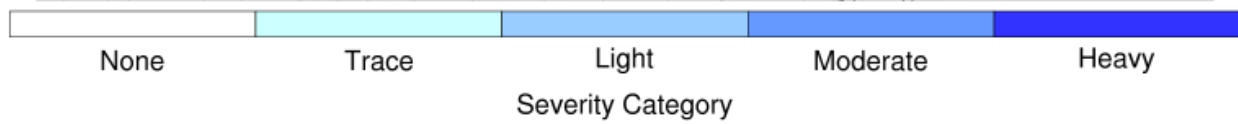
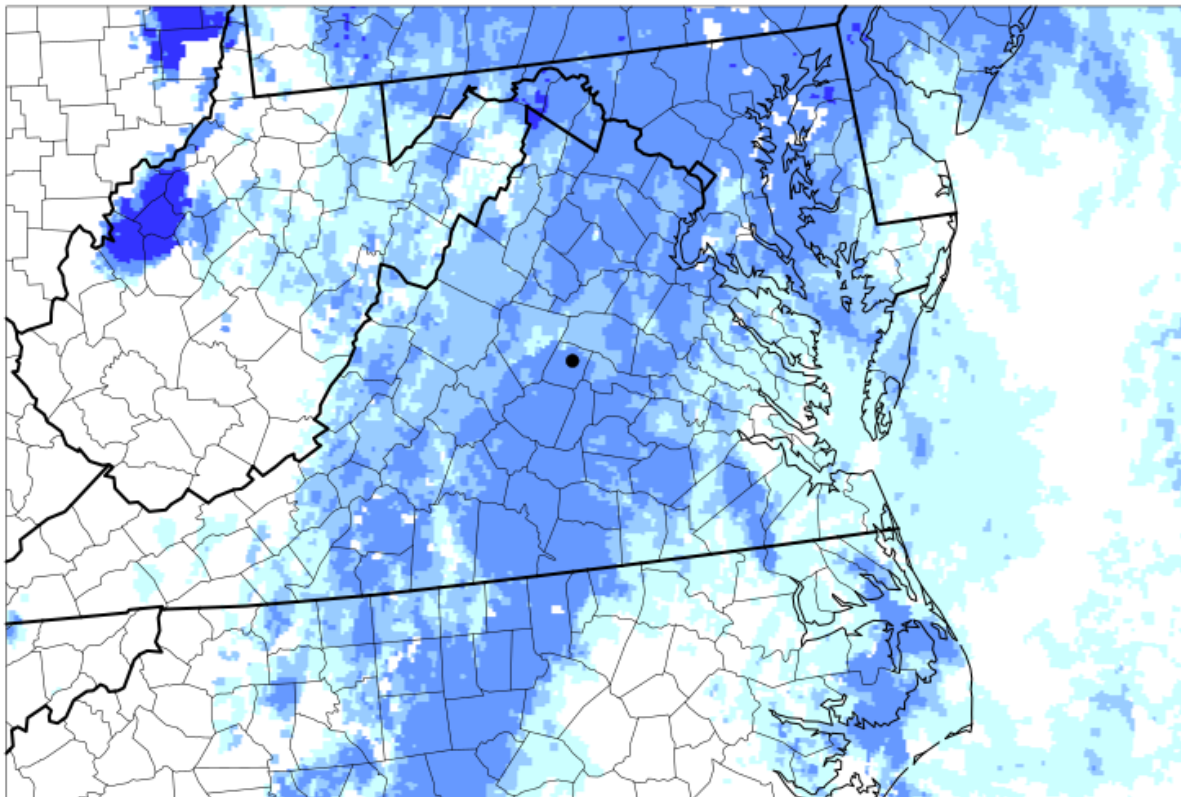
ICING PROBABILITY at FL 140

5/5/2024 1308 UTC



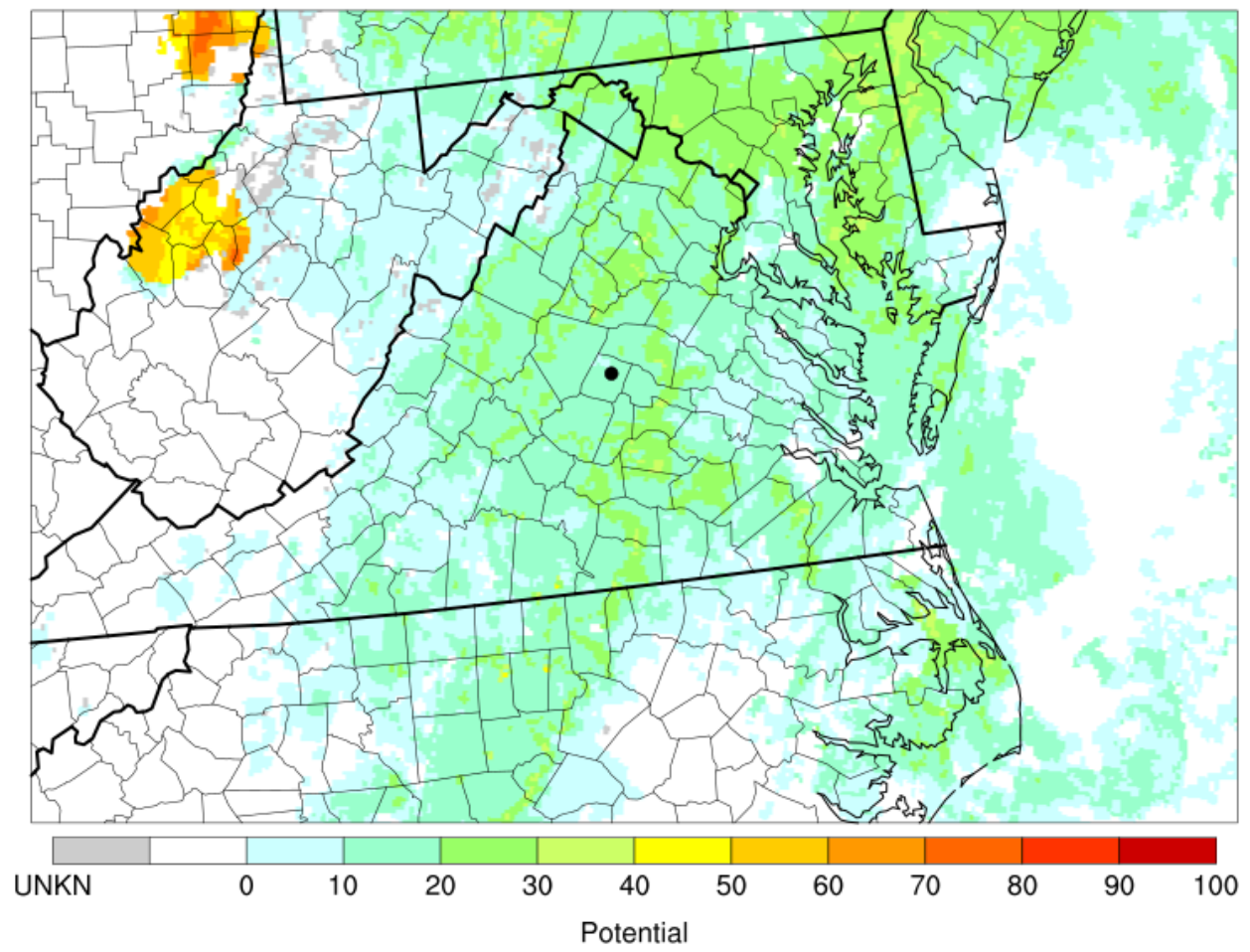
ICING SEVERITY at FL 140

5/5/2024 1308 UTC



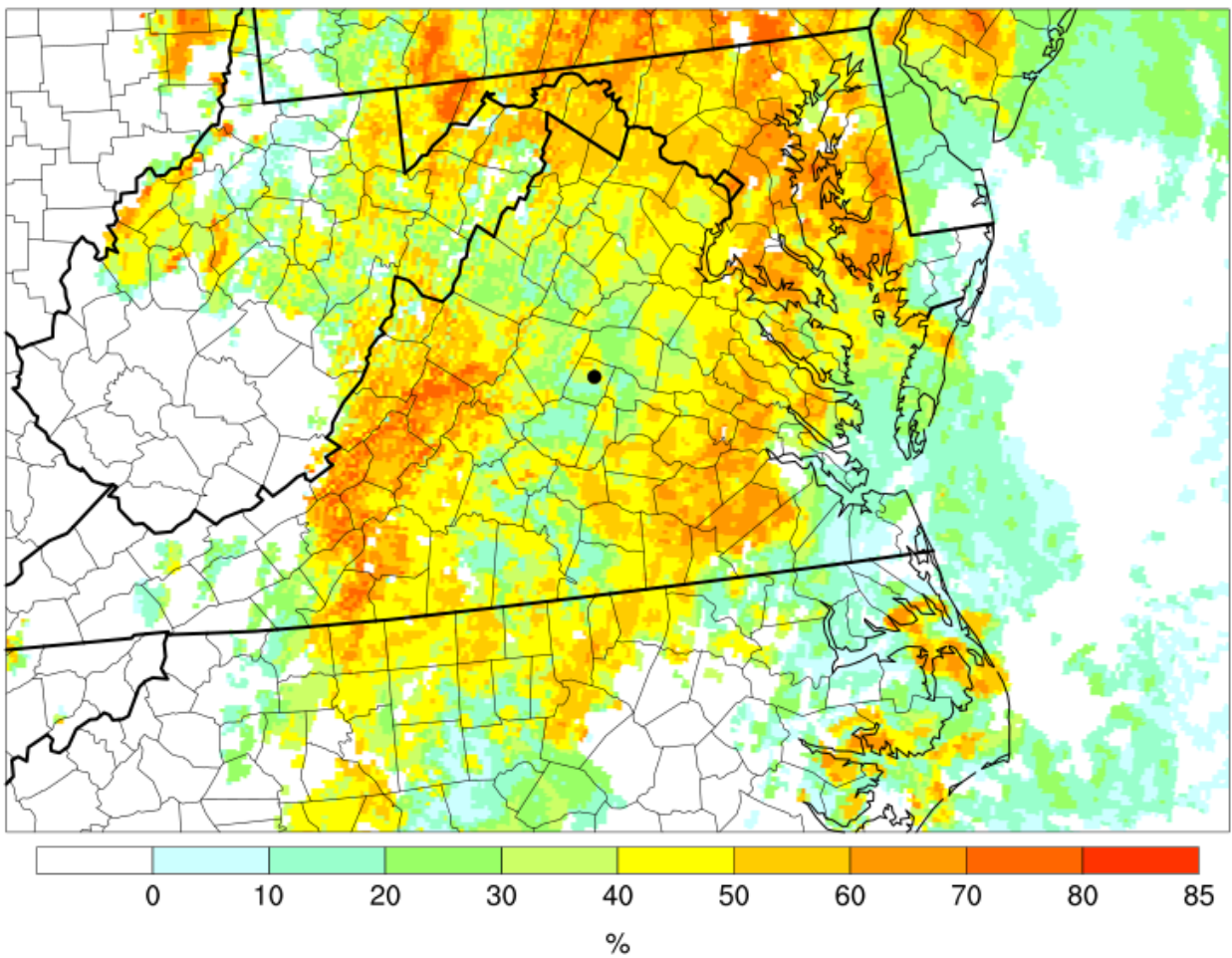
SLD POTENTIAL at FL 130

5/5/2024 1308 UTC



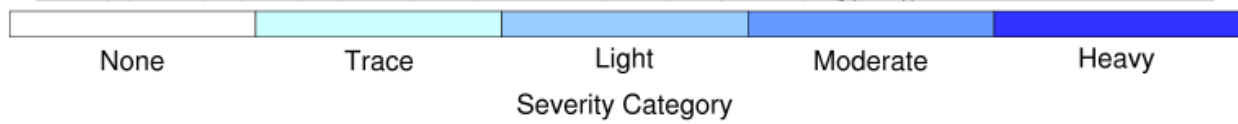
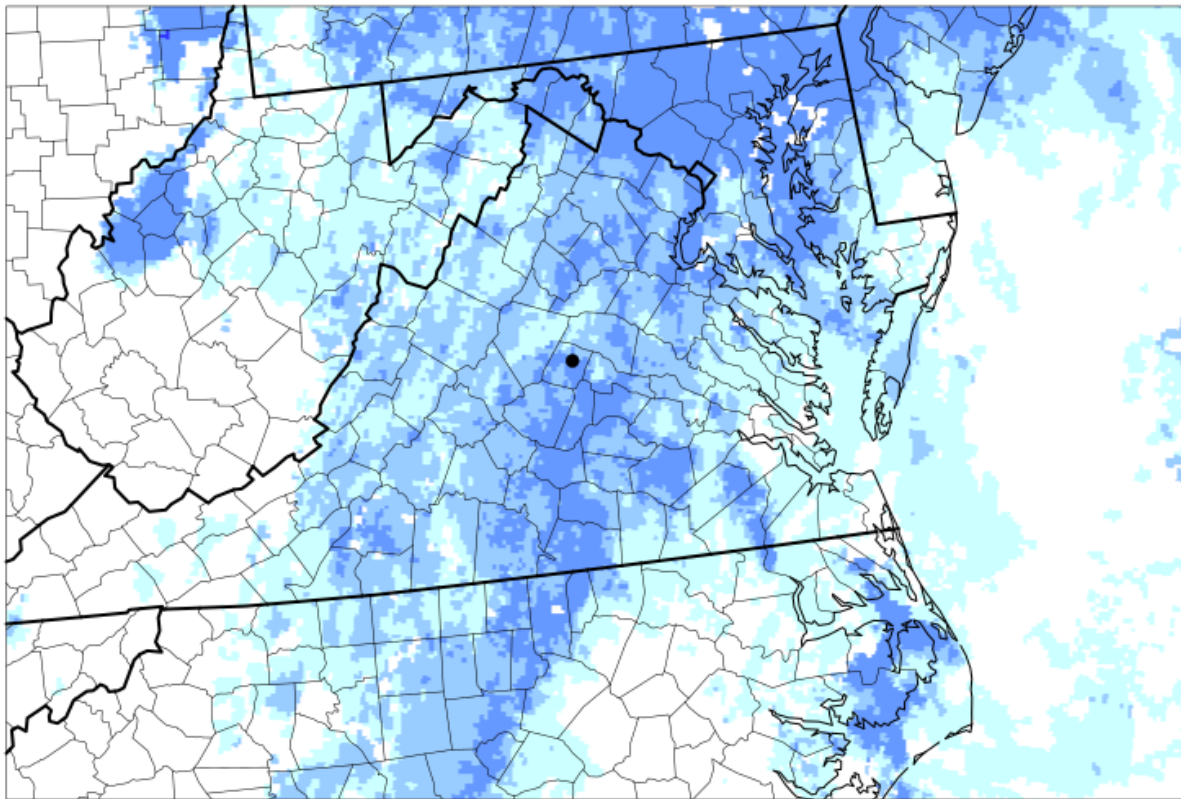
ICING PROBABILITY at FL 130

5/5/2024 1308 UTC



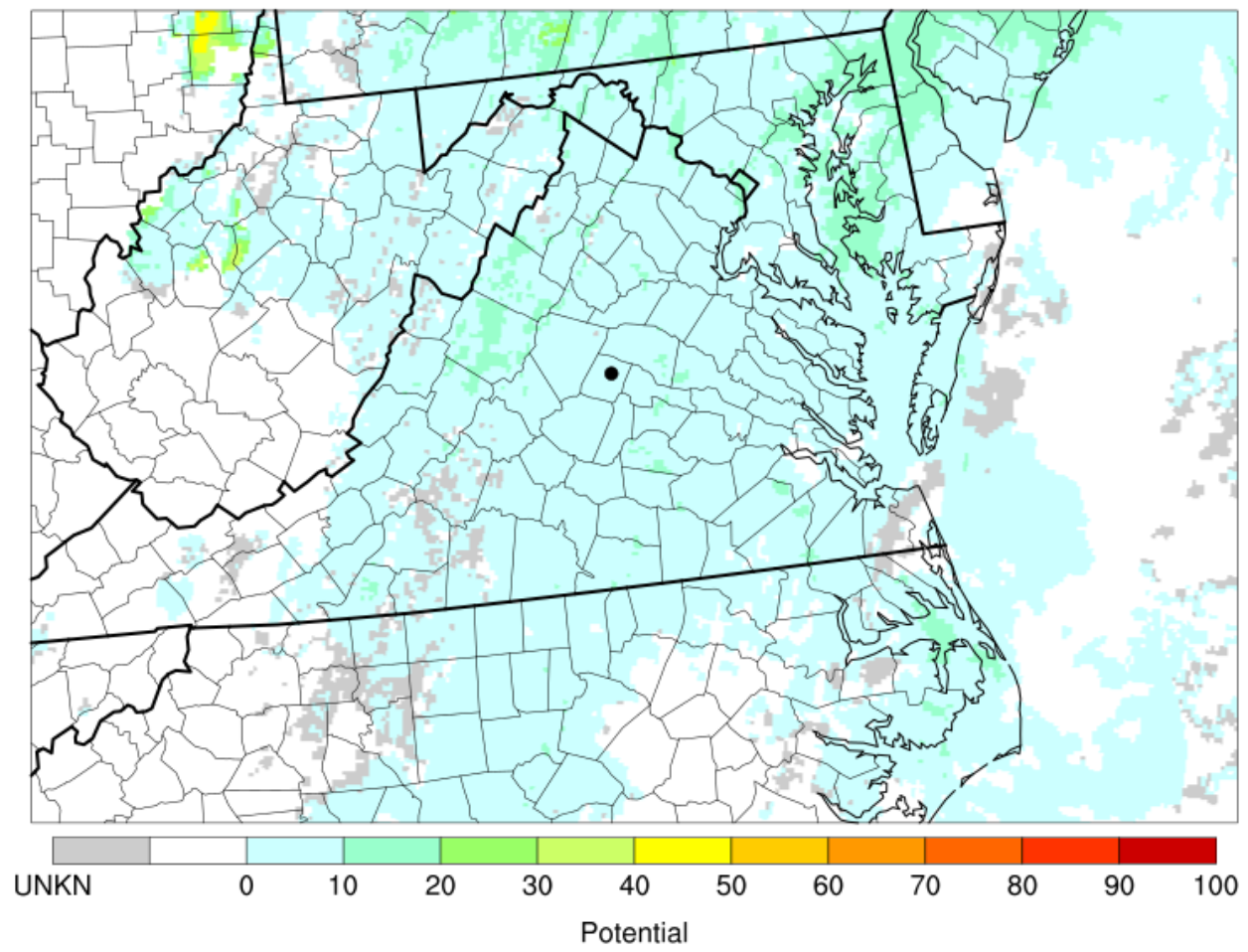
ICING SEVERITY at FL 130

5/5/2024 1308 UTC



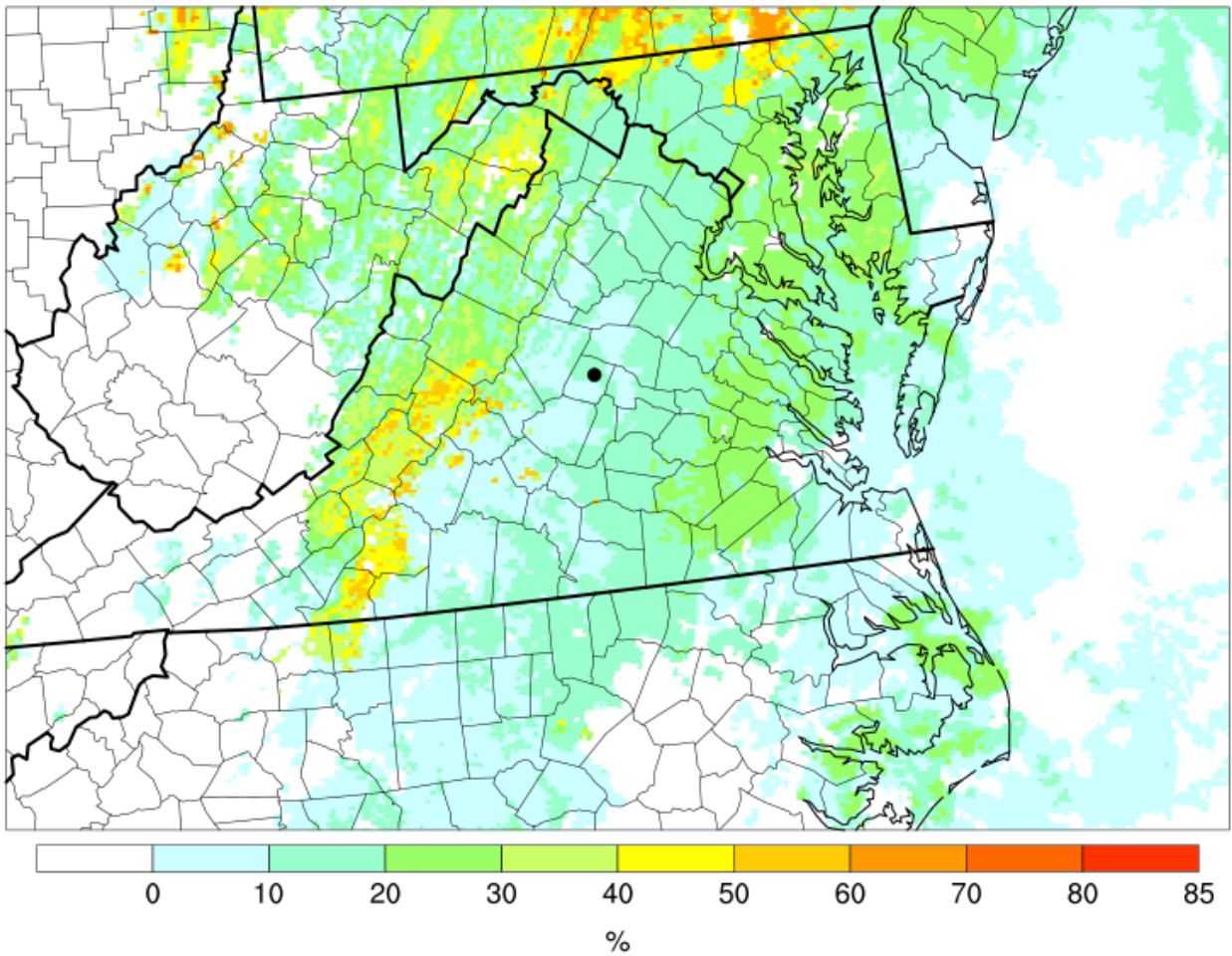
SLD POTENTIAL at FL 120

5/5/2024 1308 UTC



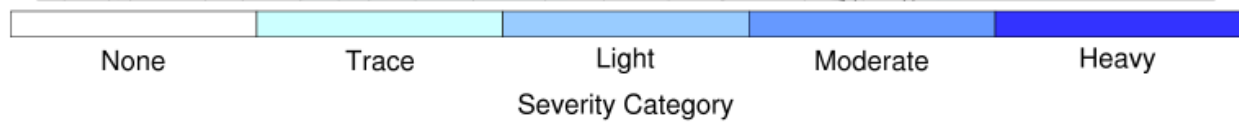
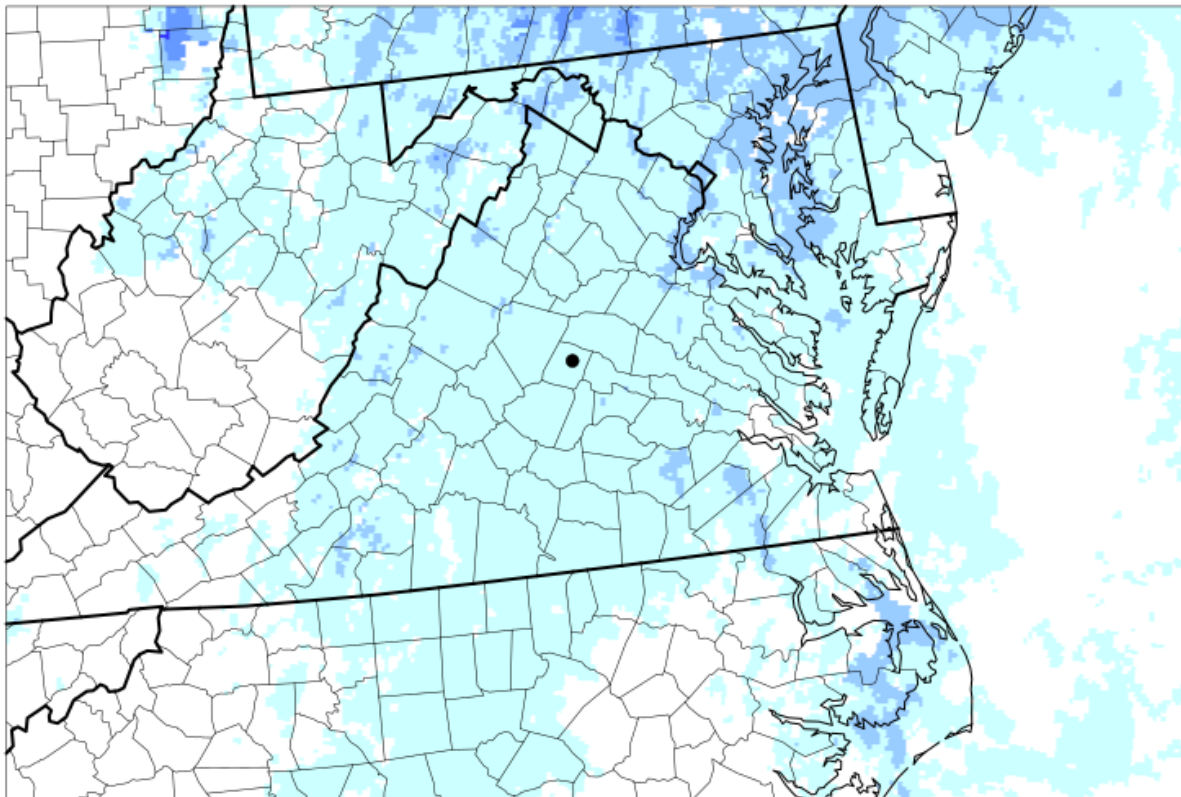
ICING PROBABILITY at FL 120

5/5/2024 1308 UTC



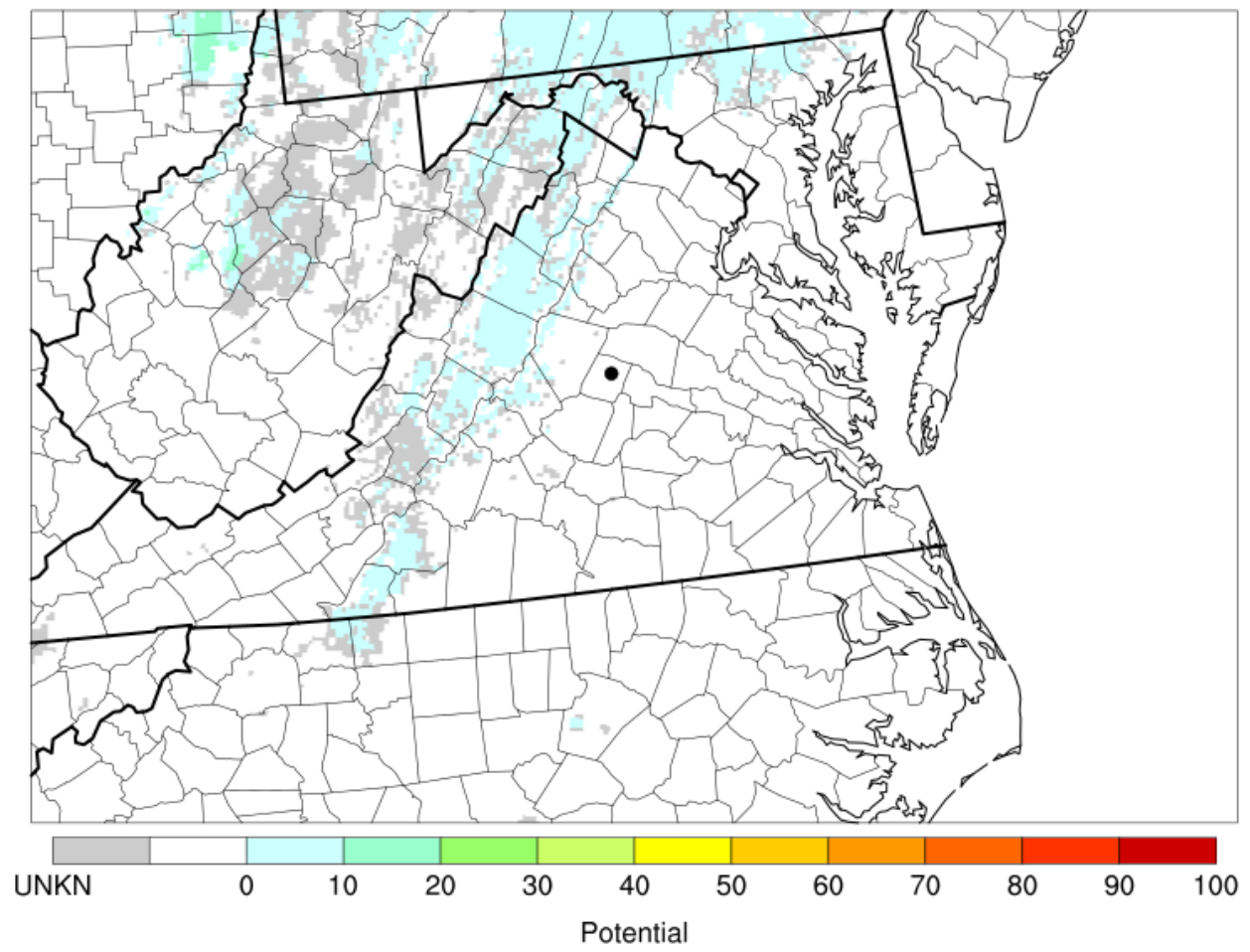
ICING SEVERITY at FL 120

5/5/2024 1308 UTC



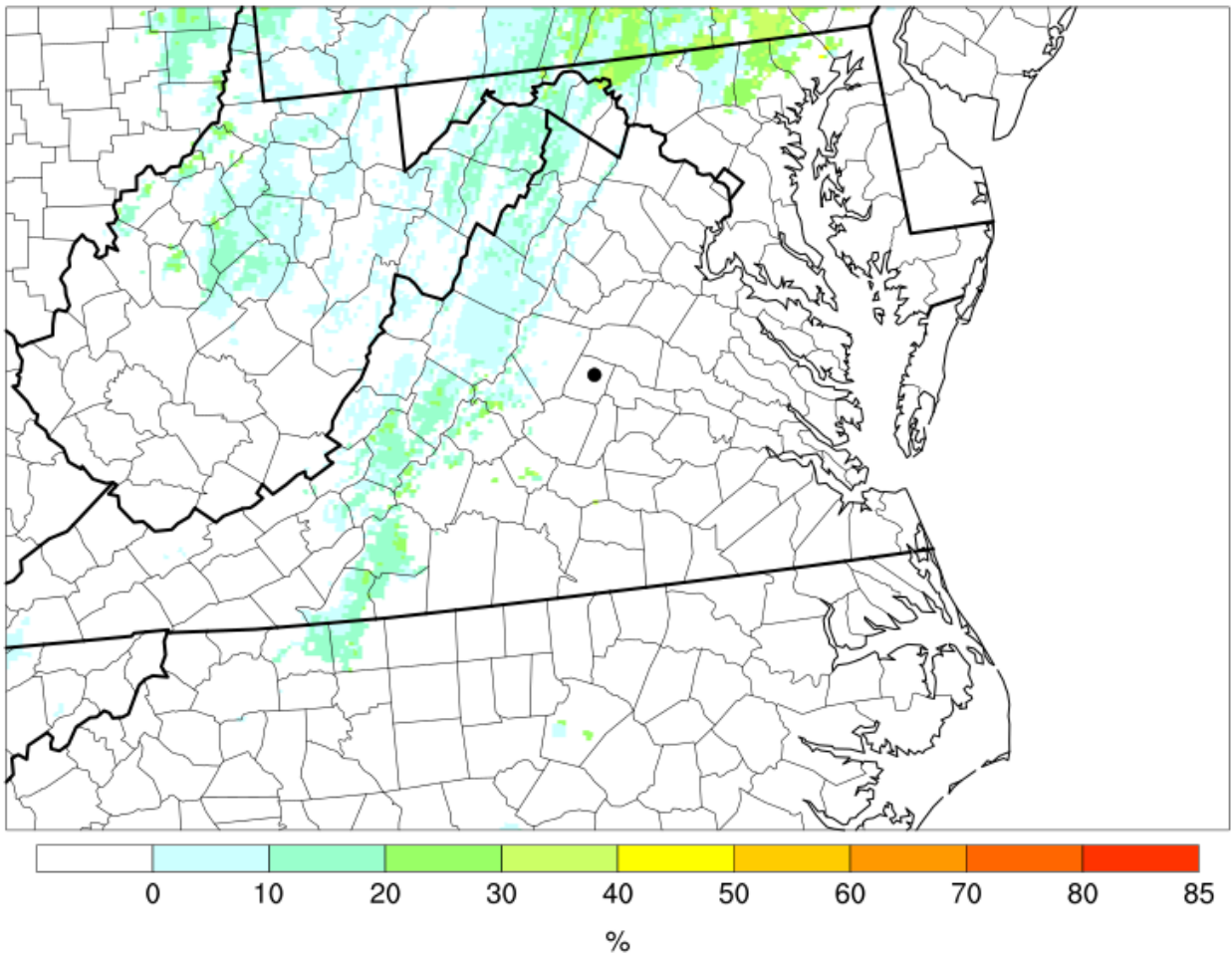
SLD POTENTIAL at FL 110

5/5/2024 1308 UTC



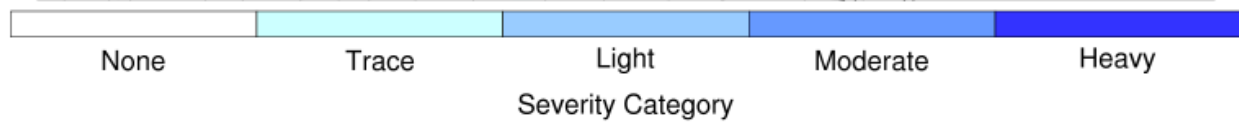
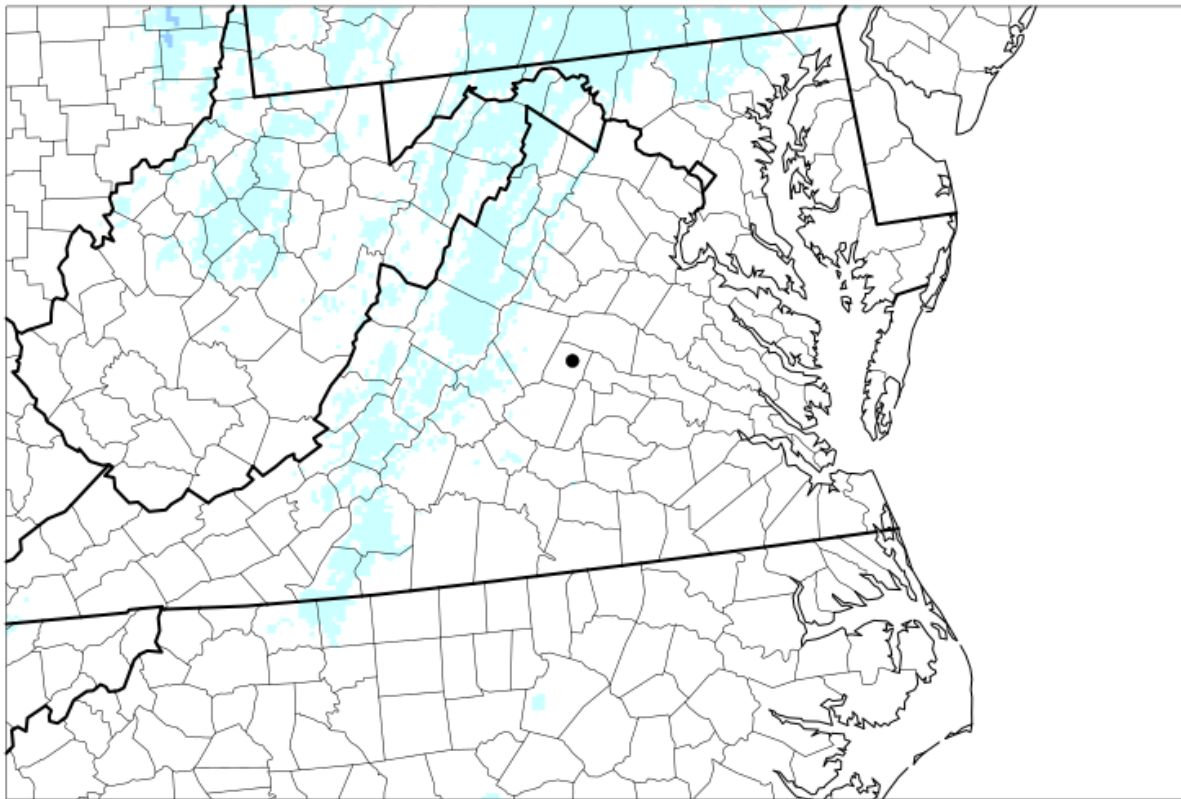
ICING PROBABILITY at FL 110

5/5/2024 1308 UTC



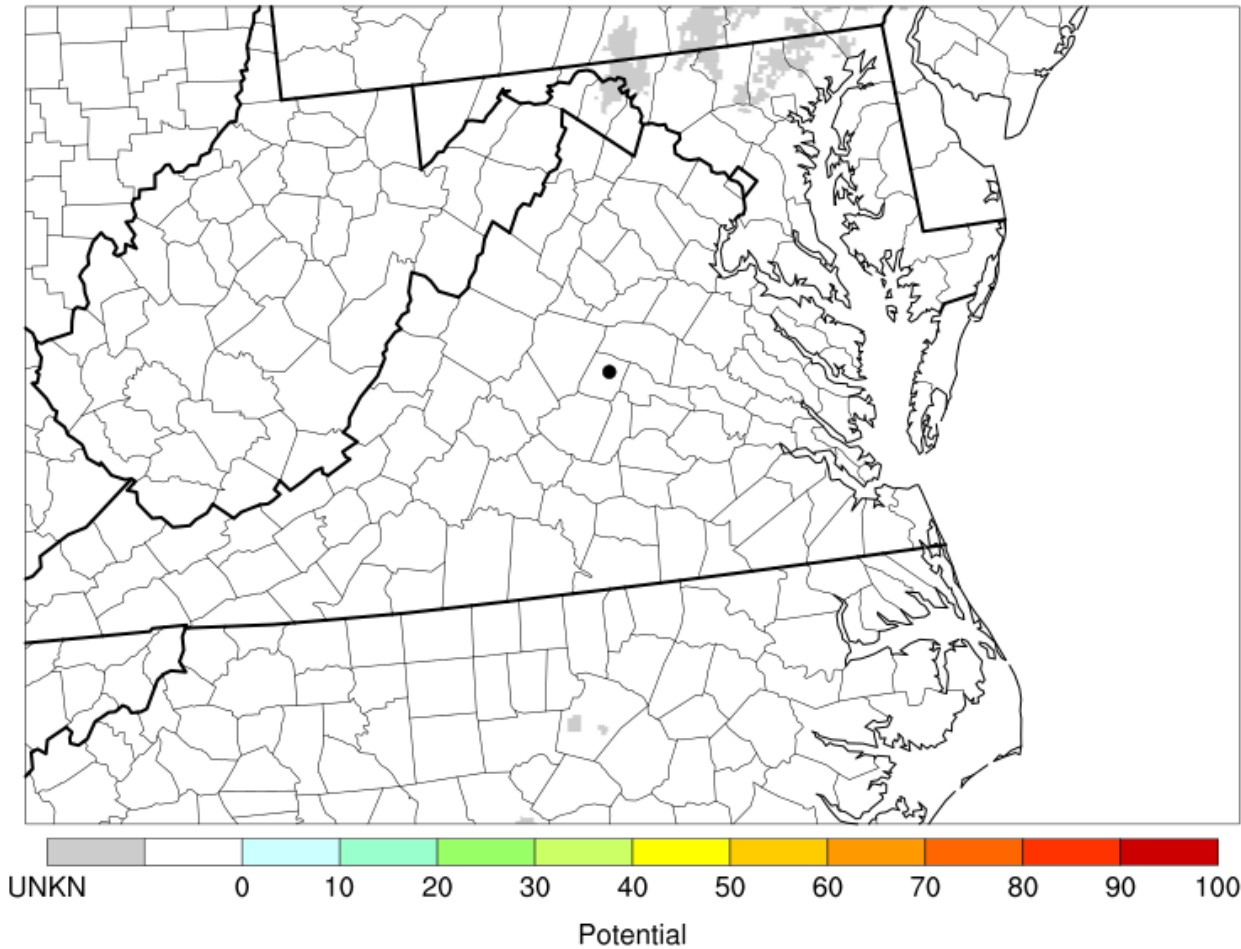
ICING SEVERITY at FL 110

5/5/2024 1308 UTC



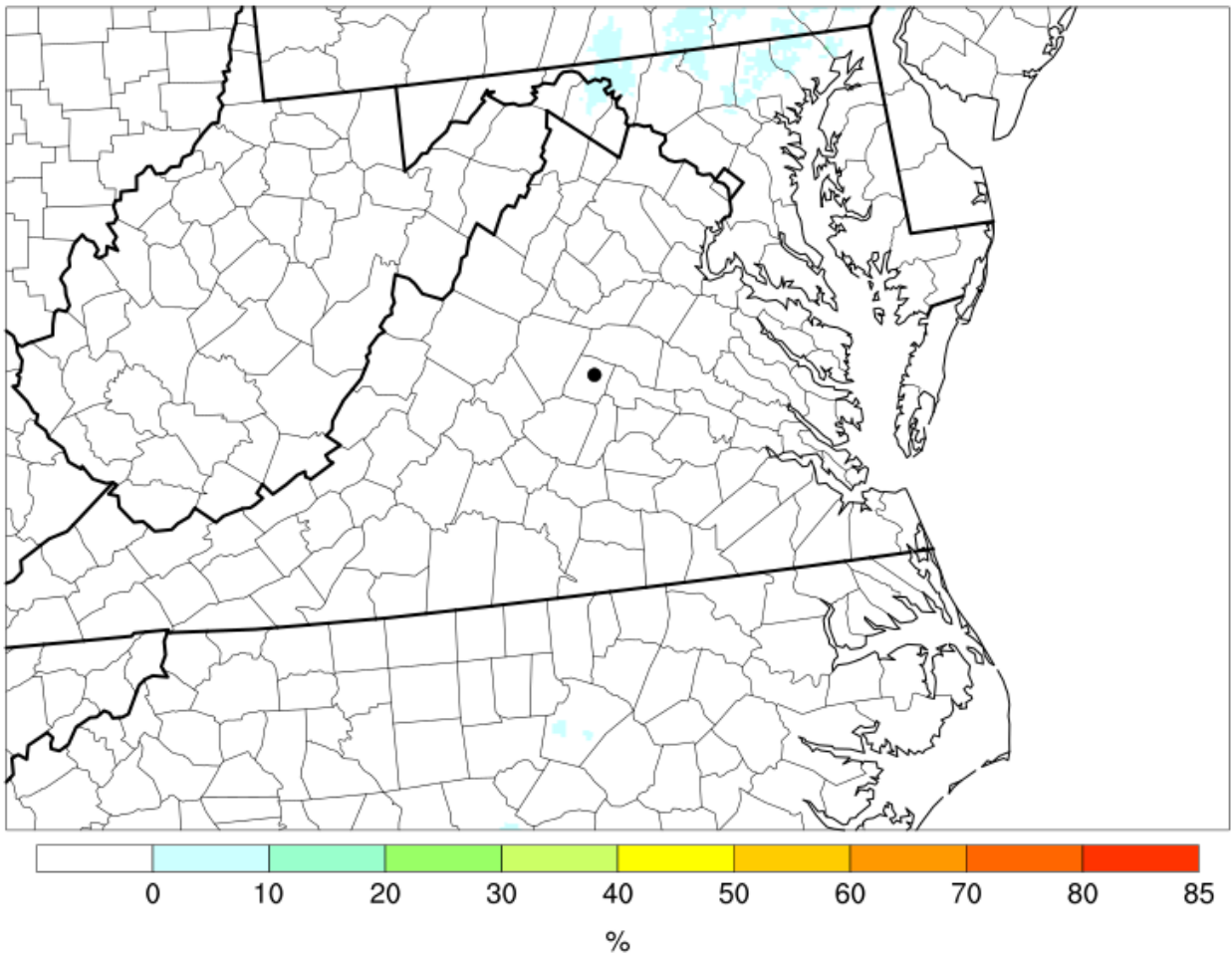
SLD POTENTIAL at FL 100

5/5/2024 1308 UTC



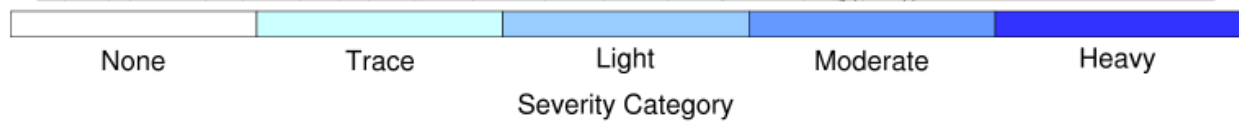
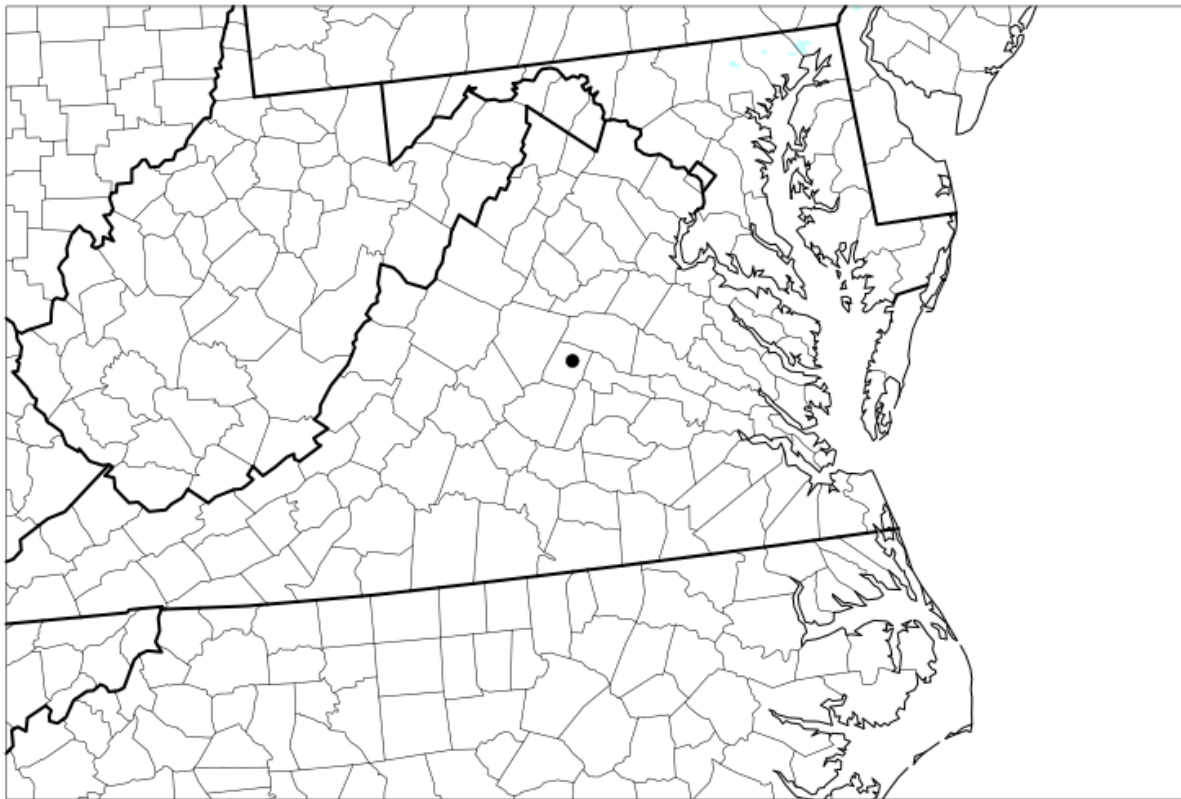
ICING PROBABILITY at FL 100

5/5/2024 1308 UTC



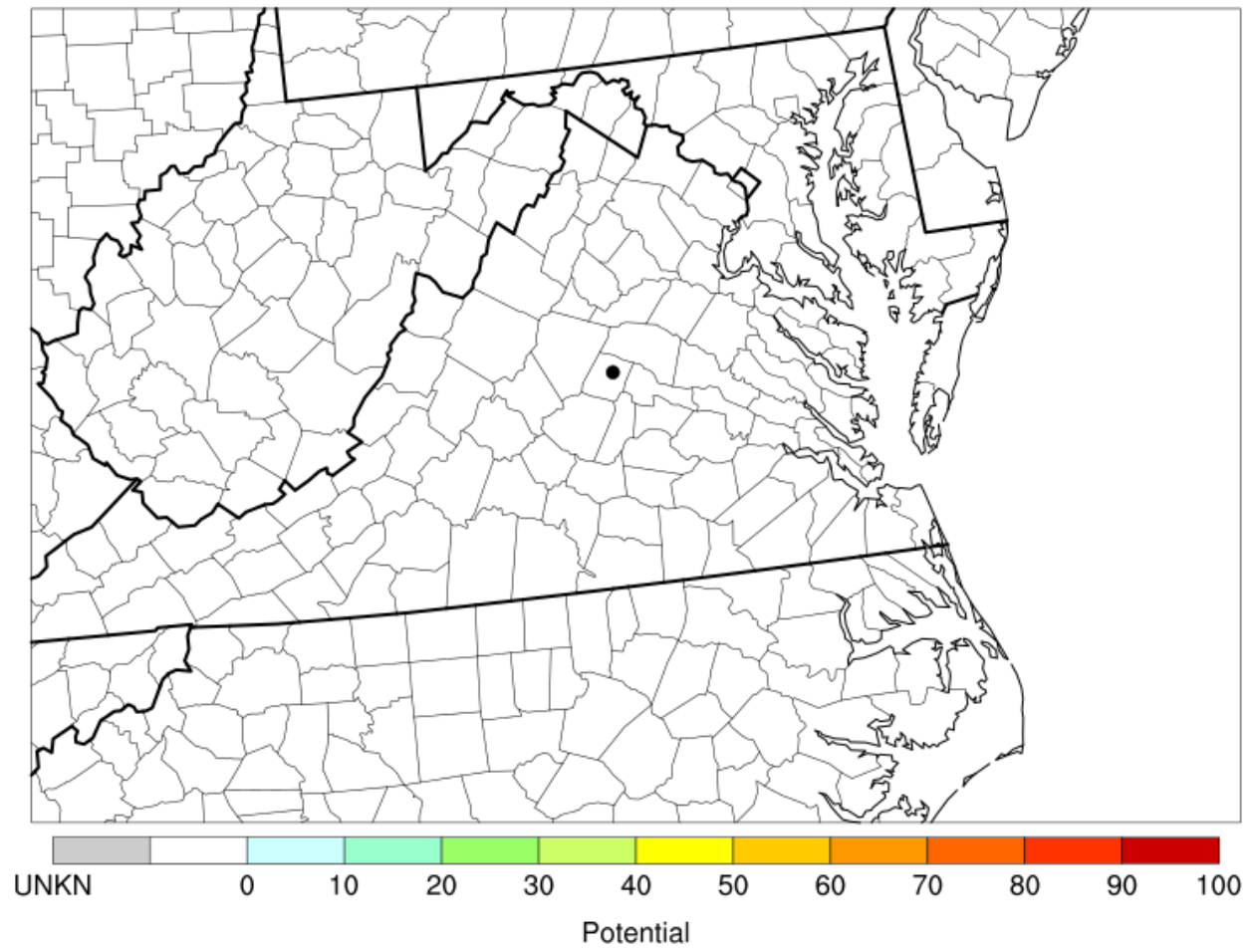
ICING SEVERITY at FL 100

5/5/2024 1308 UTC



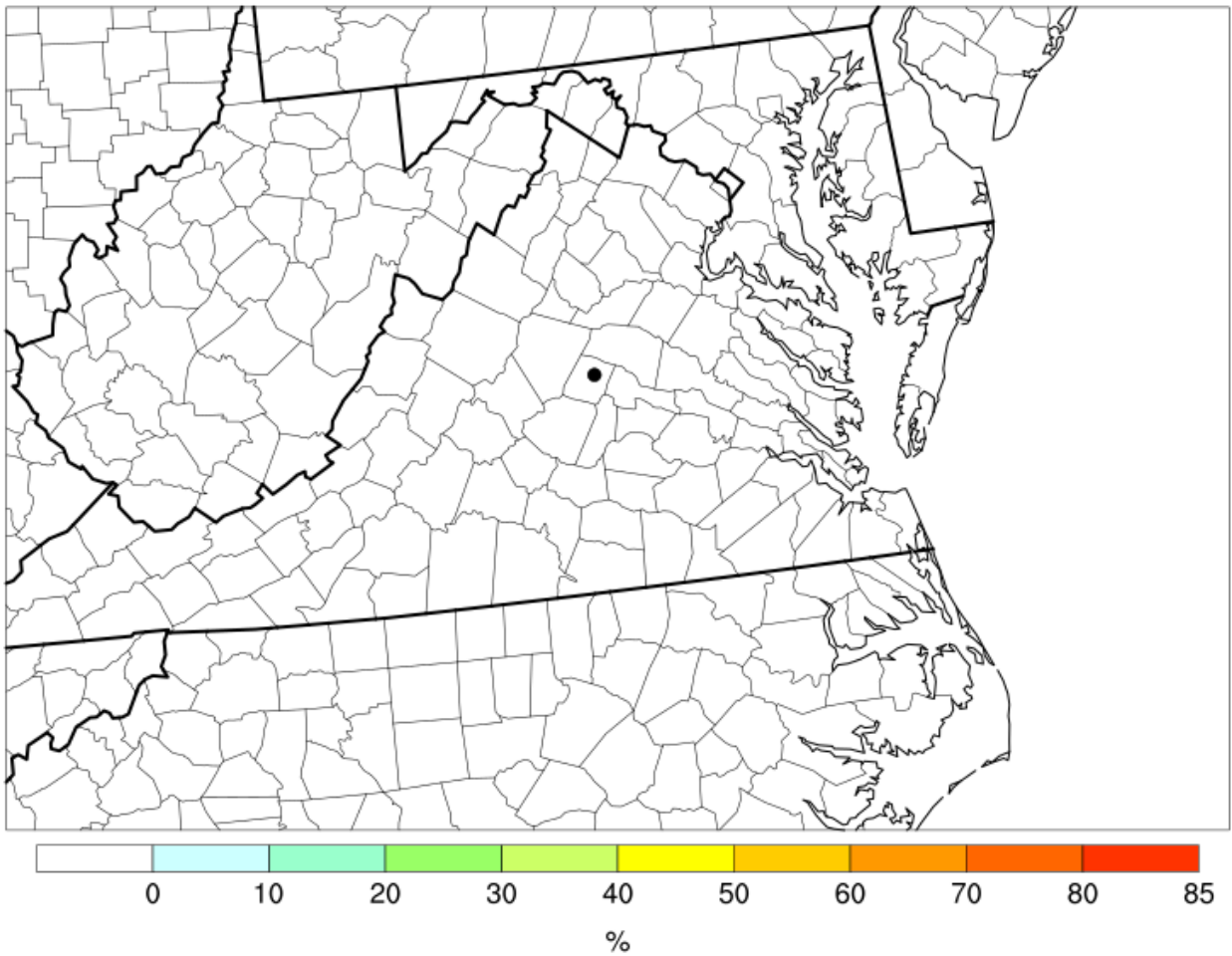
SLD POTENTIAL at FL 090

5/5/2024 1308 UTC



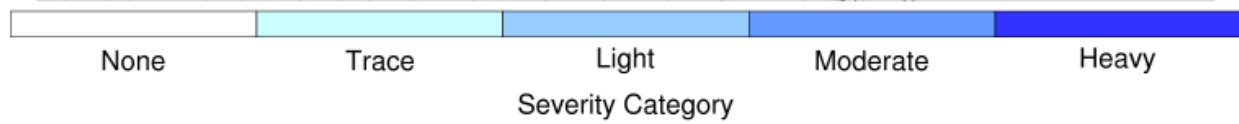
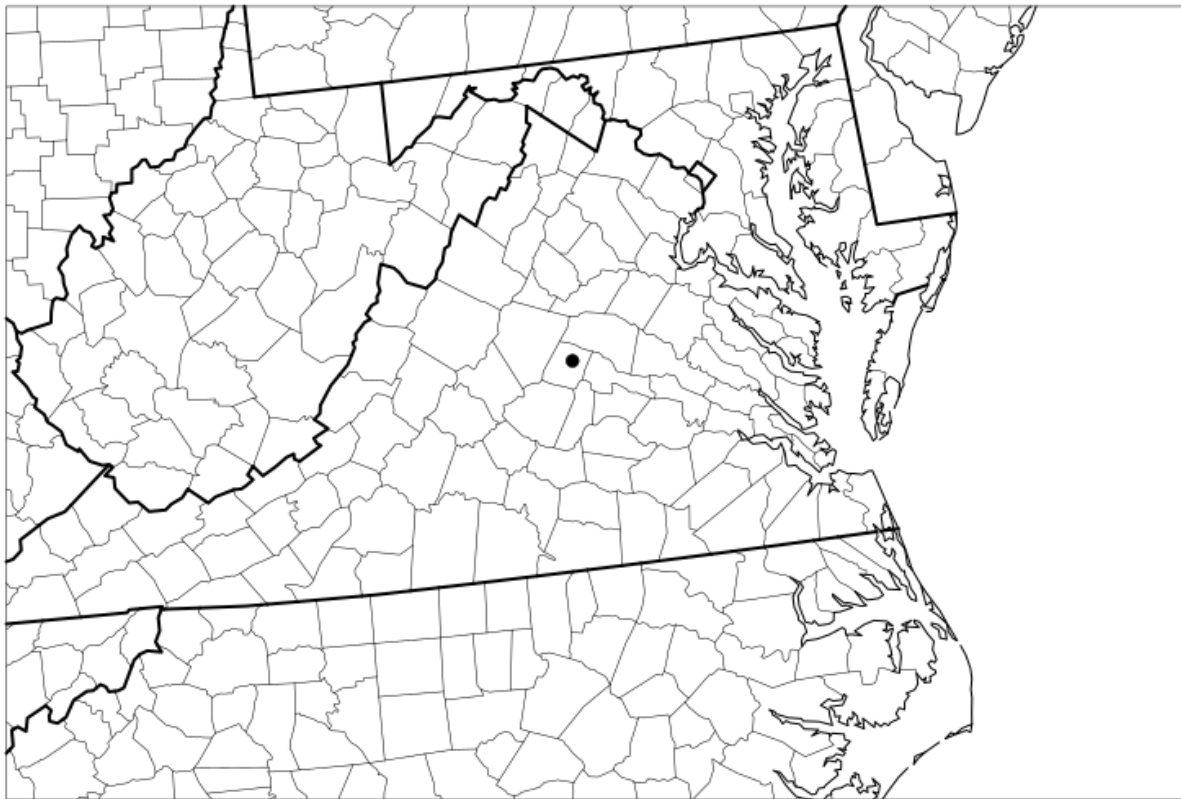
ICING PROBABILITY at FL 090

5/5/2024 1308 UTC



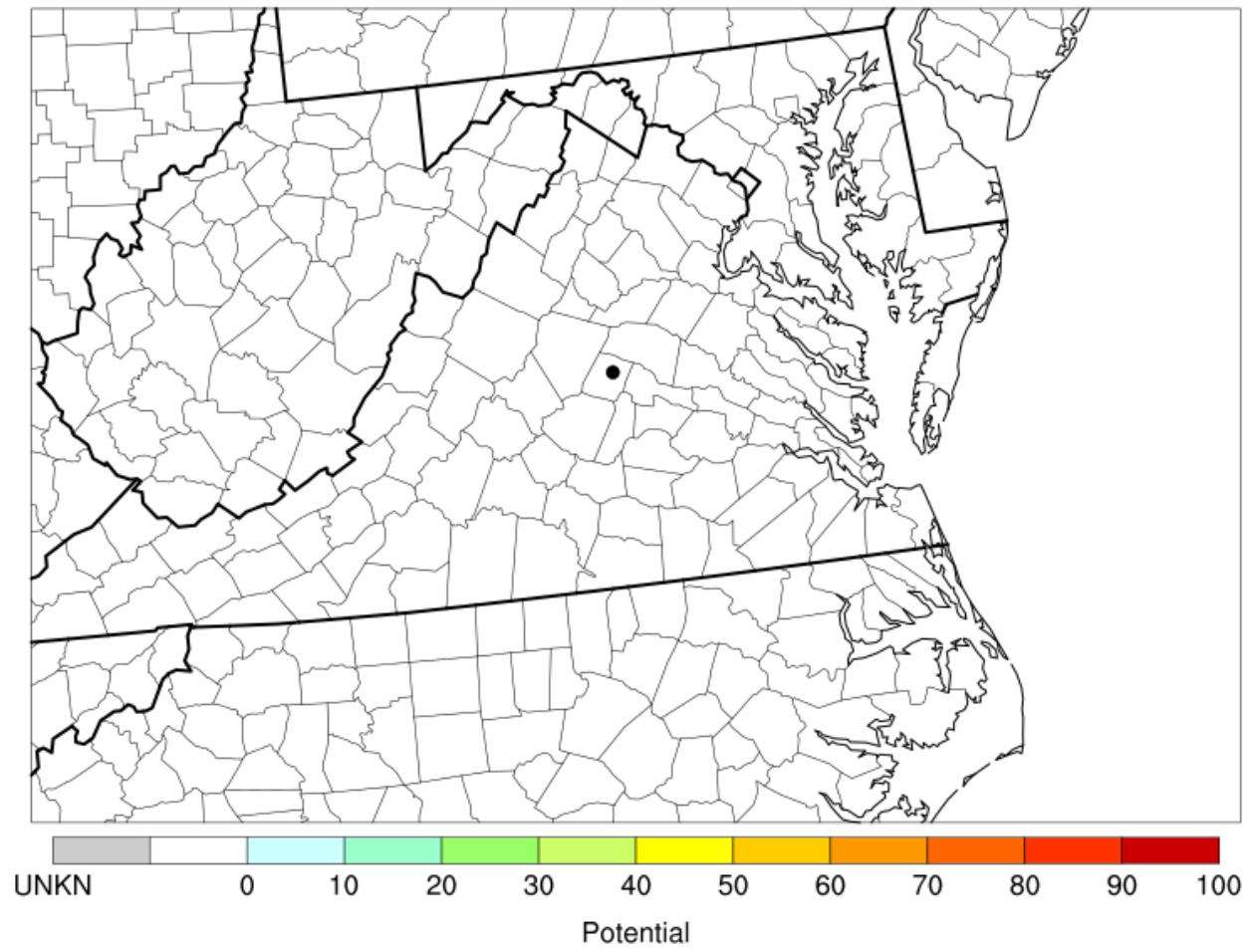
ICING SEVERITY at FL 090

5/5/2024 1308 UTC



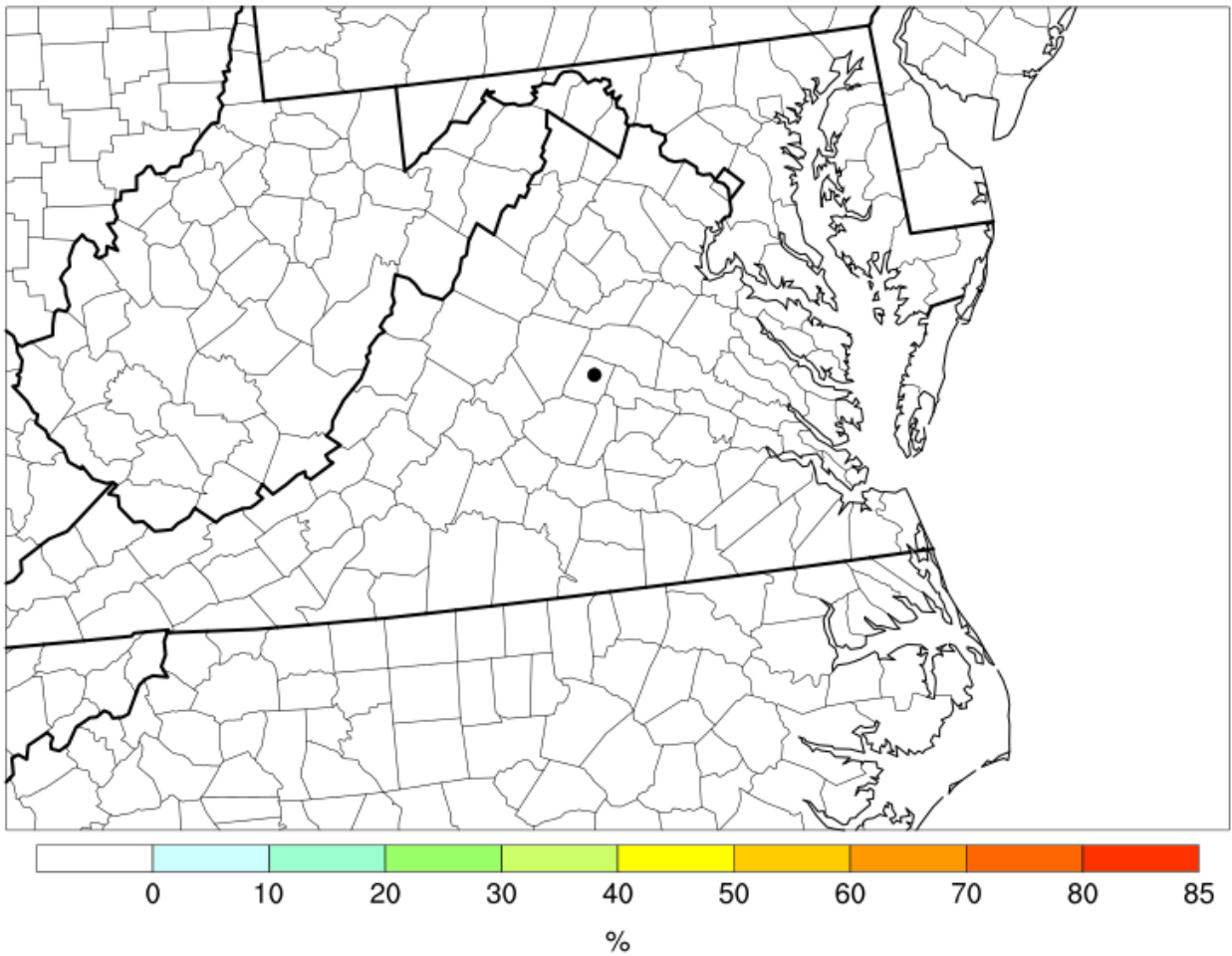
SLD POTENTIAL at FL 080

5/5/2024 1308 UTC



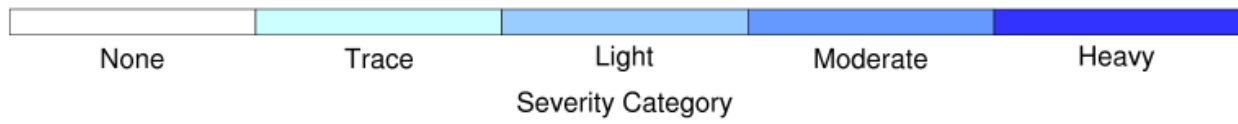
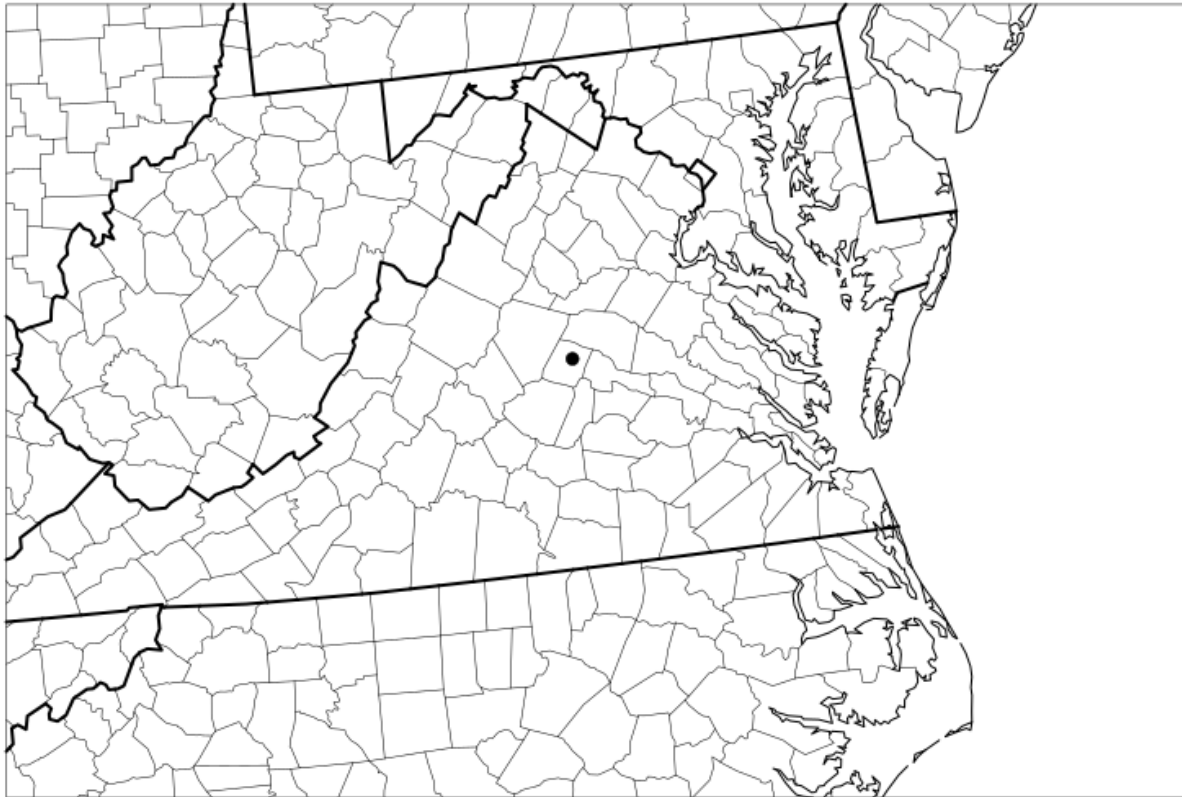
ICING PROBABILITY at FL 080

5/5/2024 1308 UTC



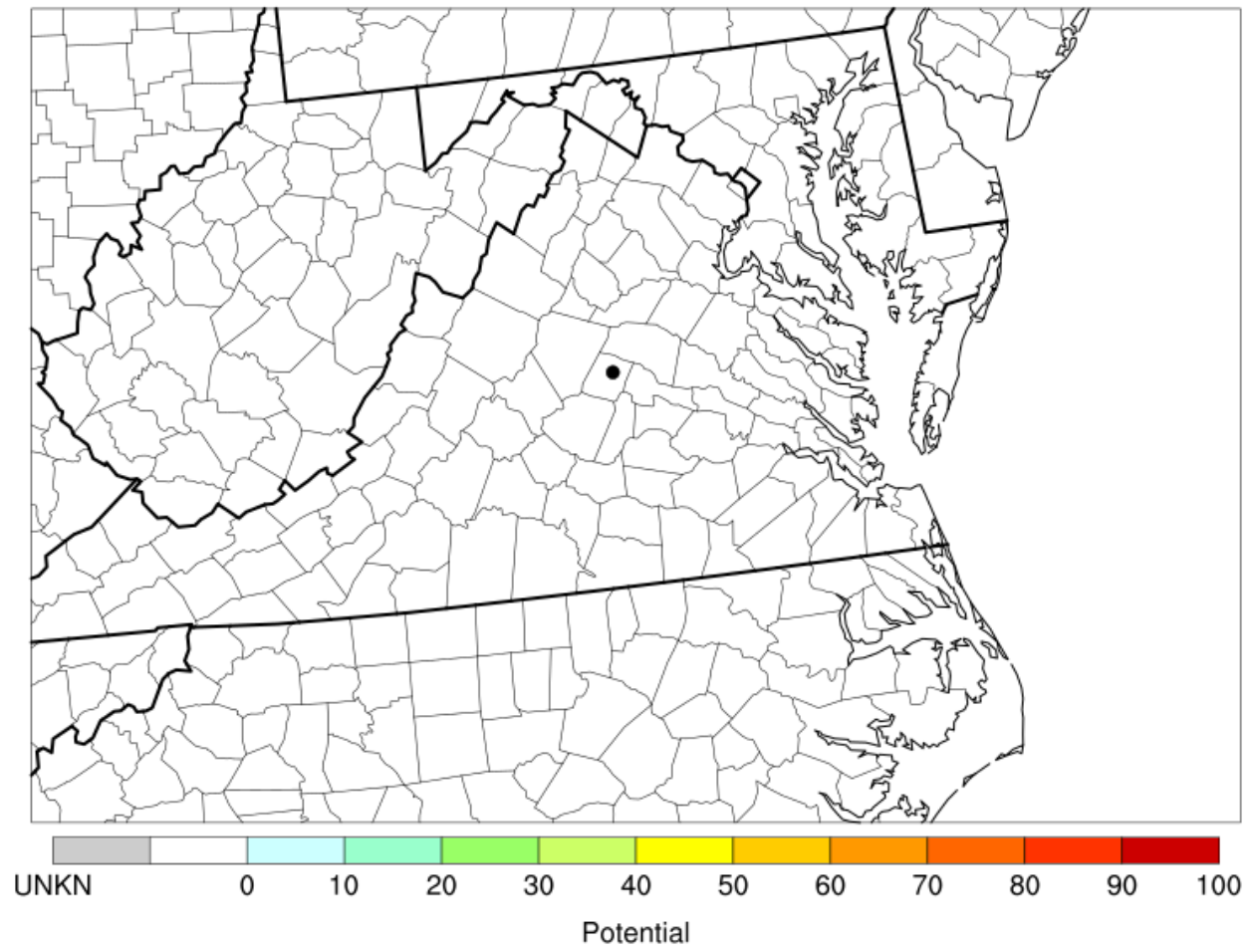
ICING SEVERITY at FL 080

5/5/2024 1308 UTC



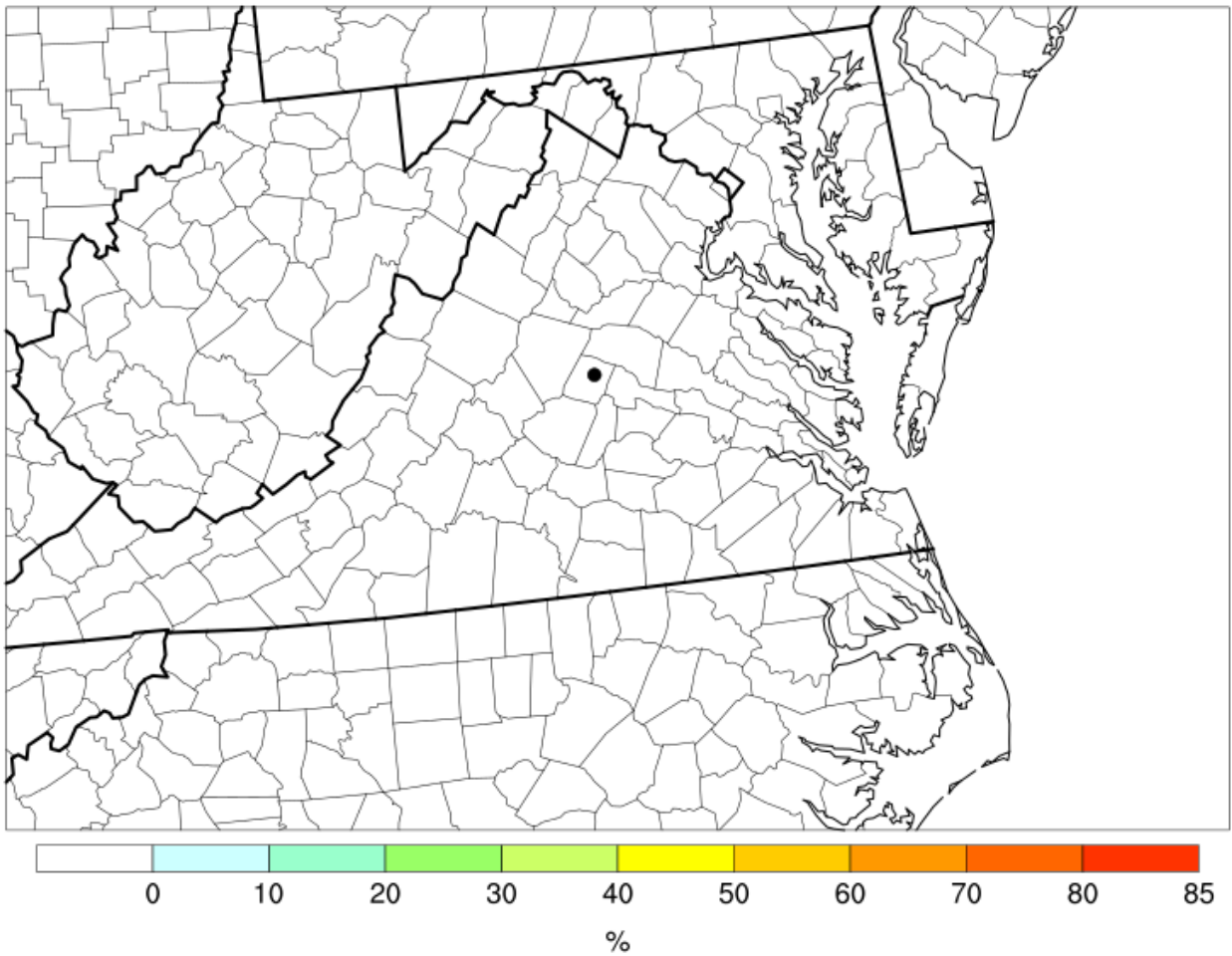
SLD POTENTIAL at FL 070

5/5/2024 1308 UTC



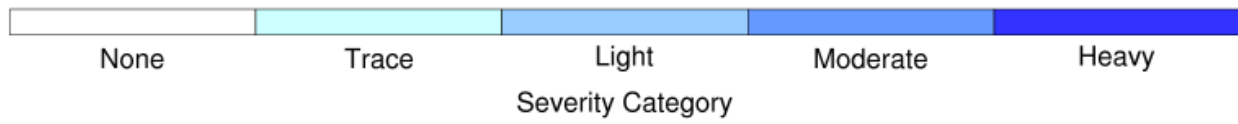
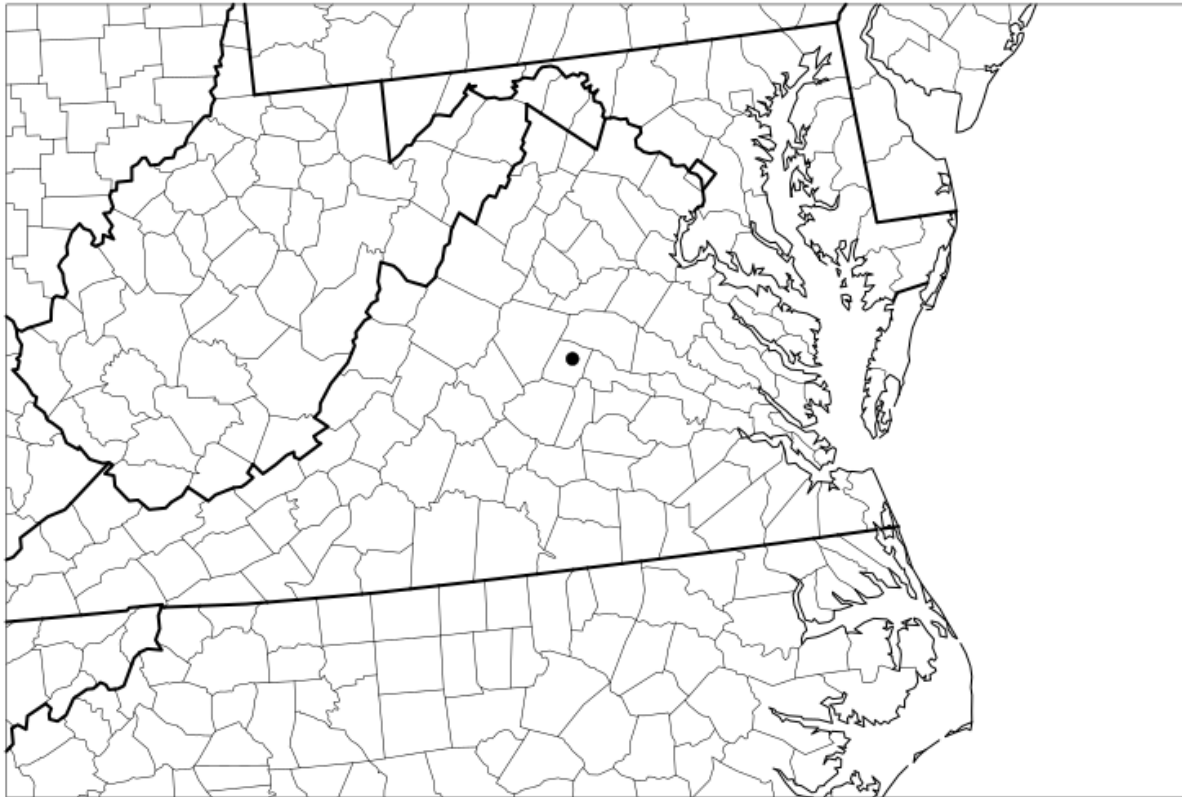
ICING PROBABILITY at FL 070

5/5/2024 1308 UTC



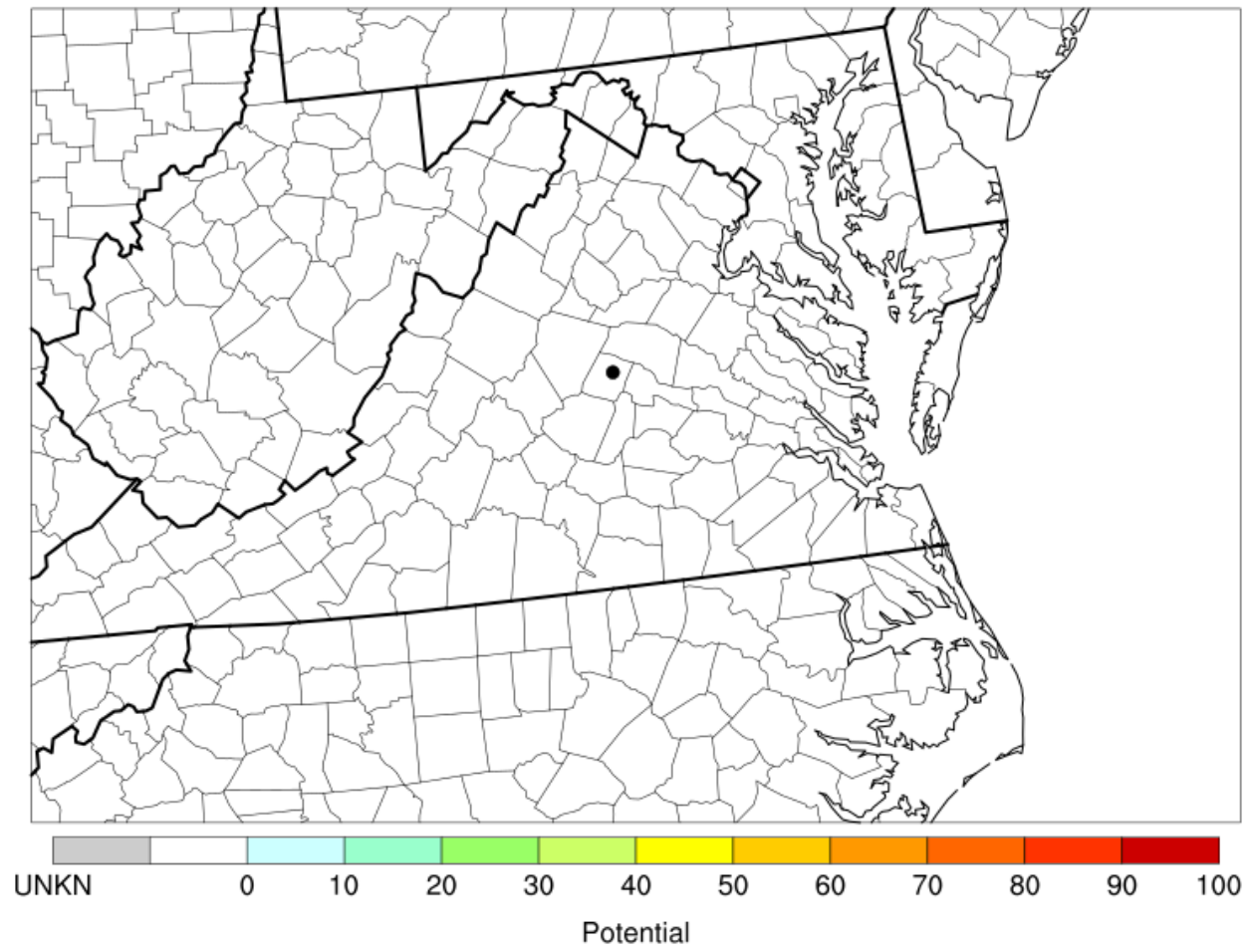
ICING SEVERITY at FL 070

5/5/2024 1308 UTC



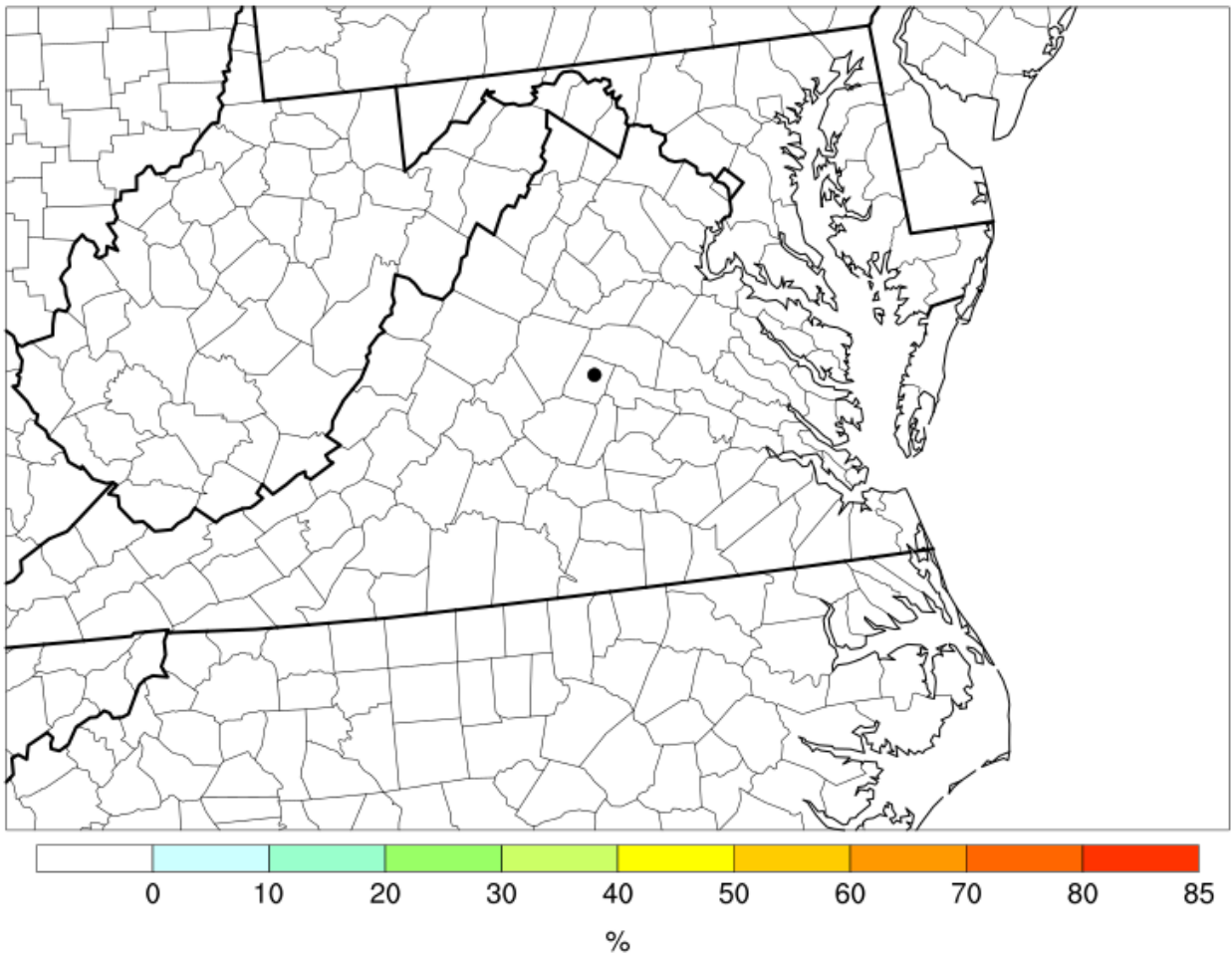
SLD POTENTIAL at FL 060

5/5/2024 1308 UTC



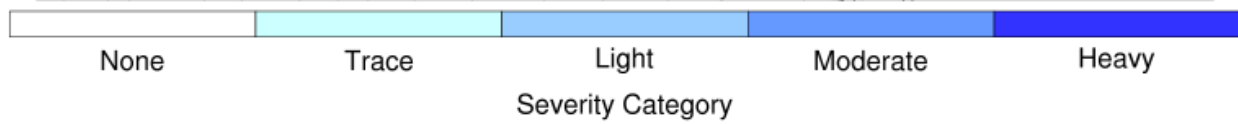
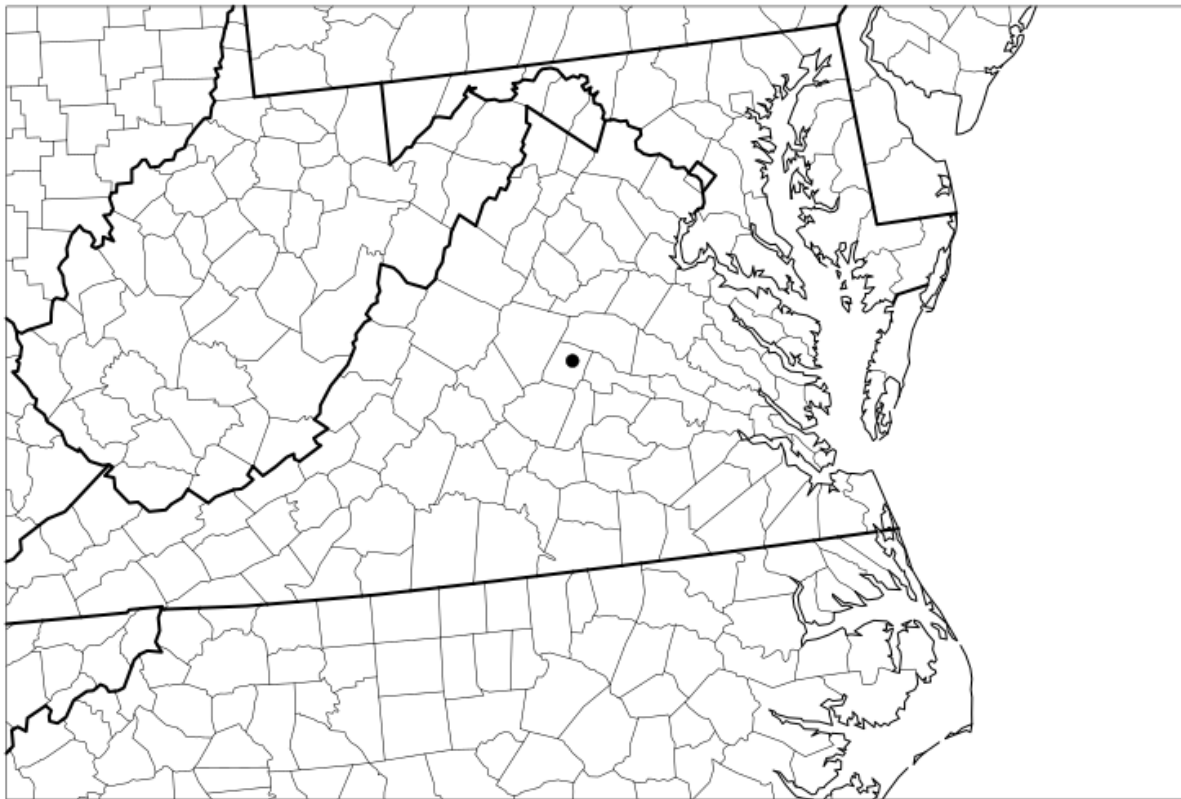
ICING PROBABILITY at FL 060

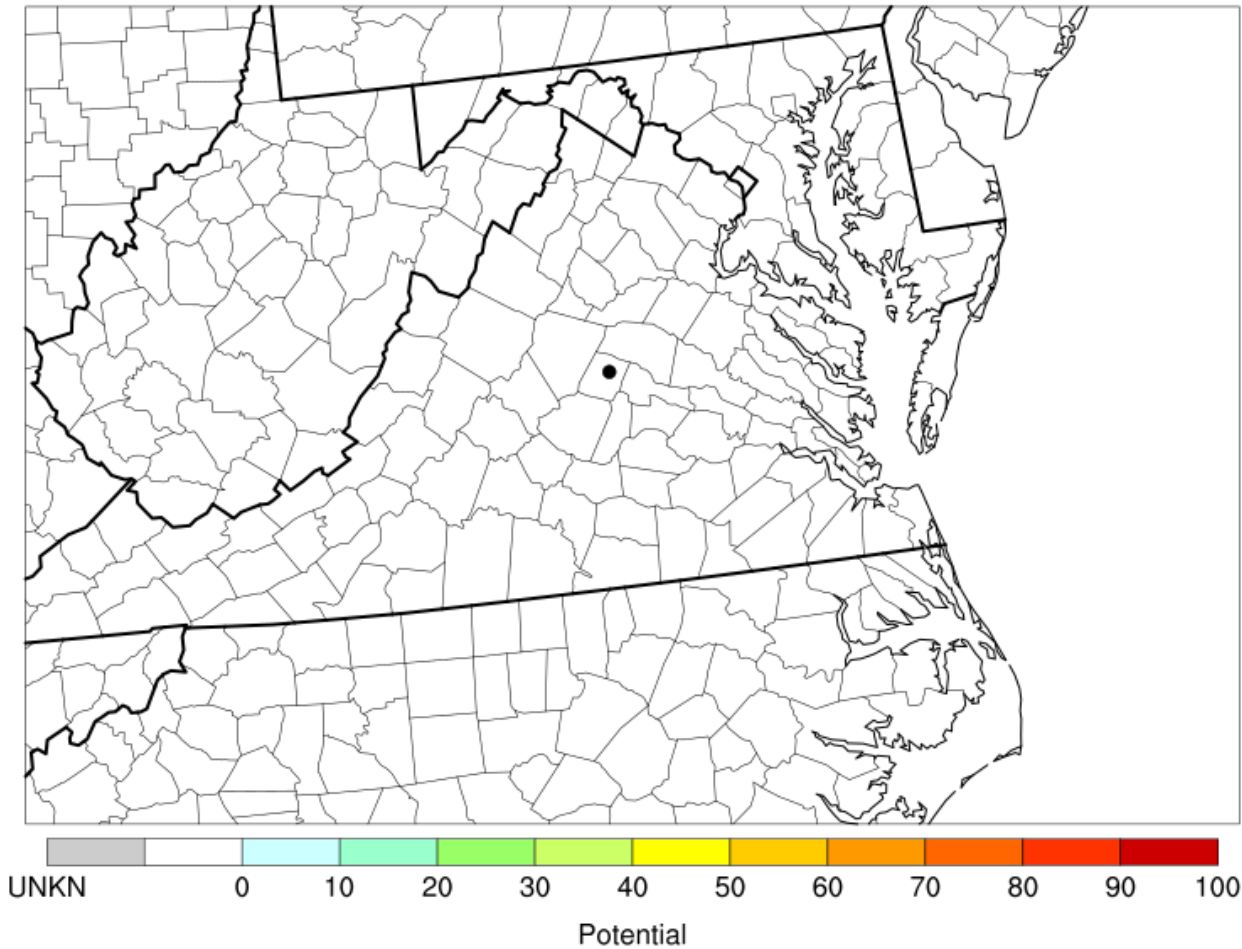
5/5/2024 1308 UTC



ICING SEVERITY at FL 060

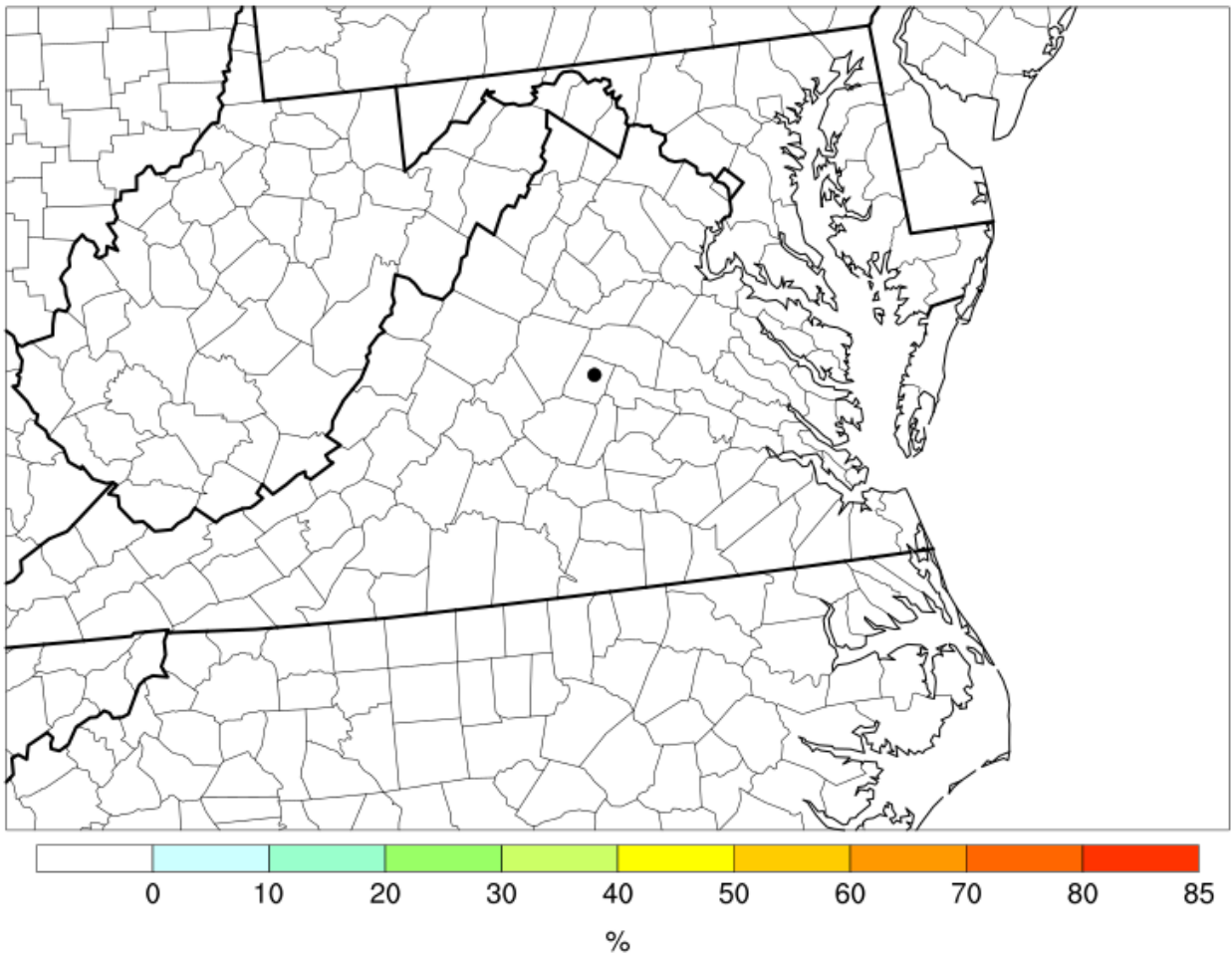
5/5/2024 1308 UTC





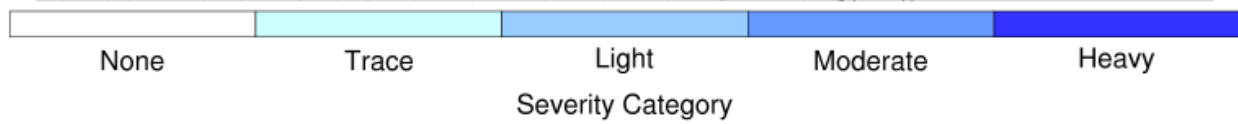
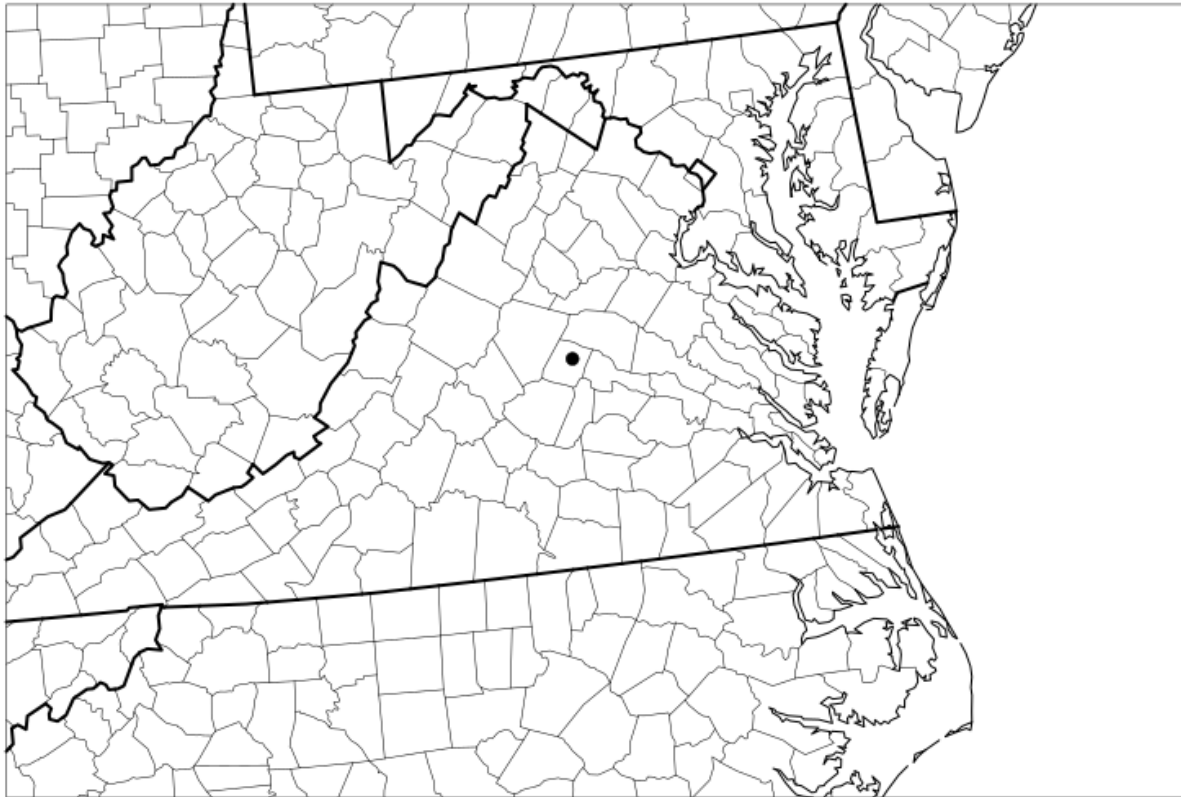
ICING PROBABILITY at FL 050

5/5/2024 1308 UTC



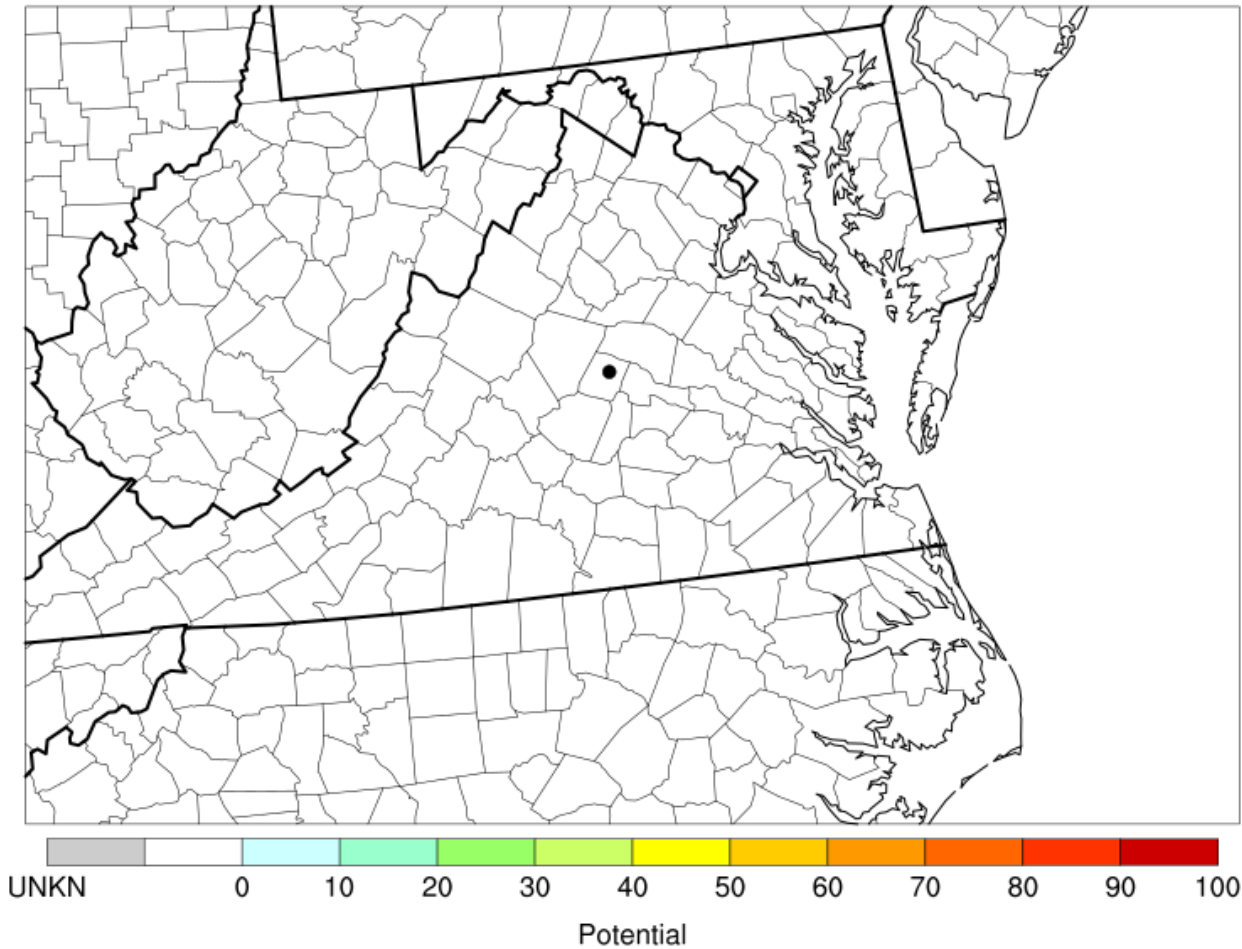
ICING SEVERITY at FL 050

5/5/2024 1308 UTC



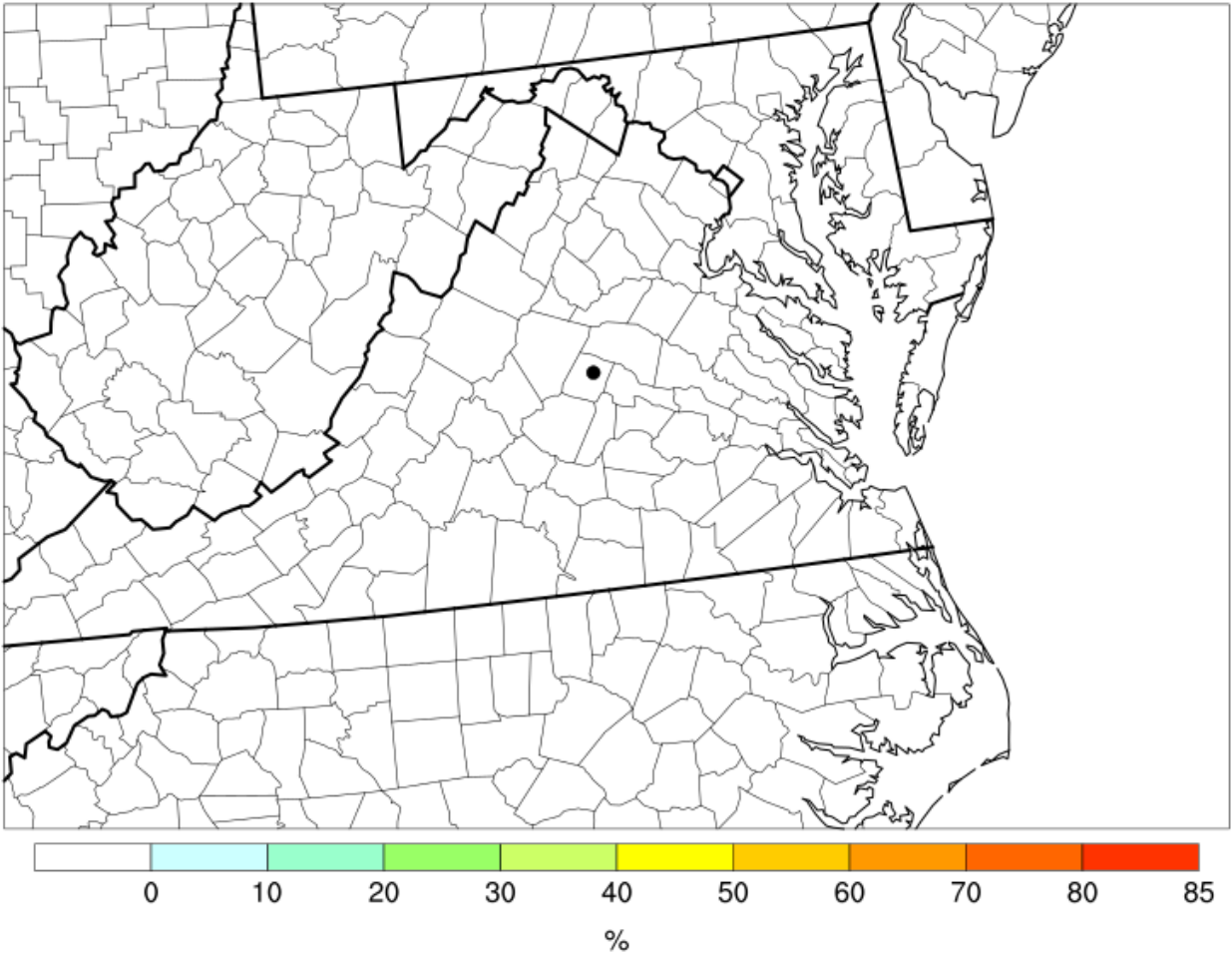
SLD POTENTIAL at FL 040

5/5/2024 1308 UTC



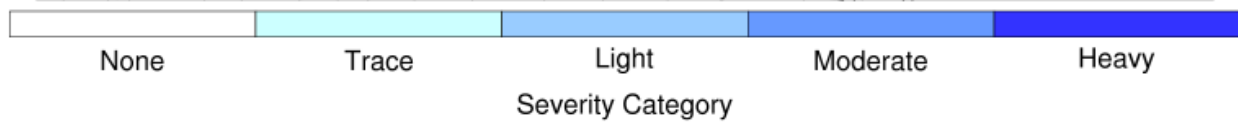
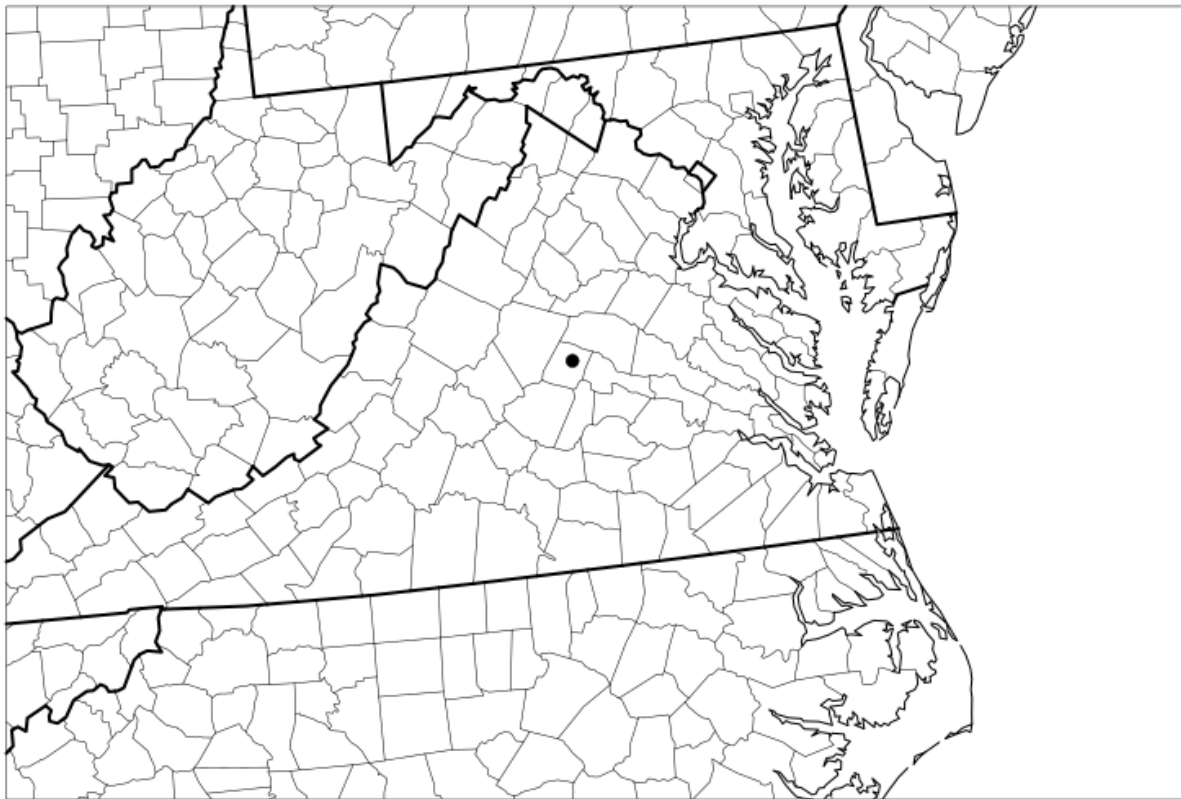
ICING PROBABILITY at FL 040

5/5/2024 1308 UTC



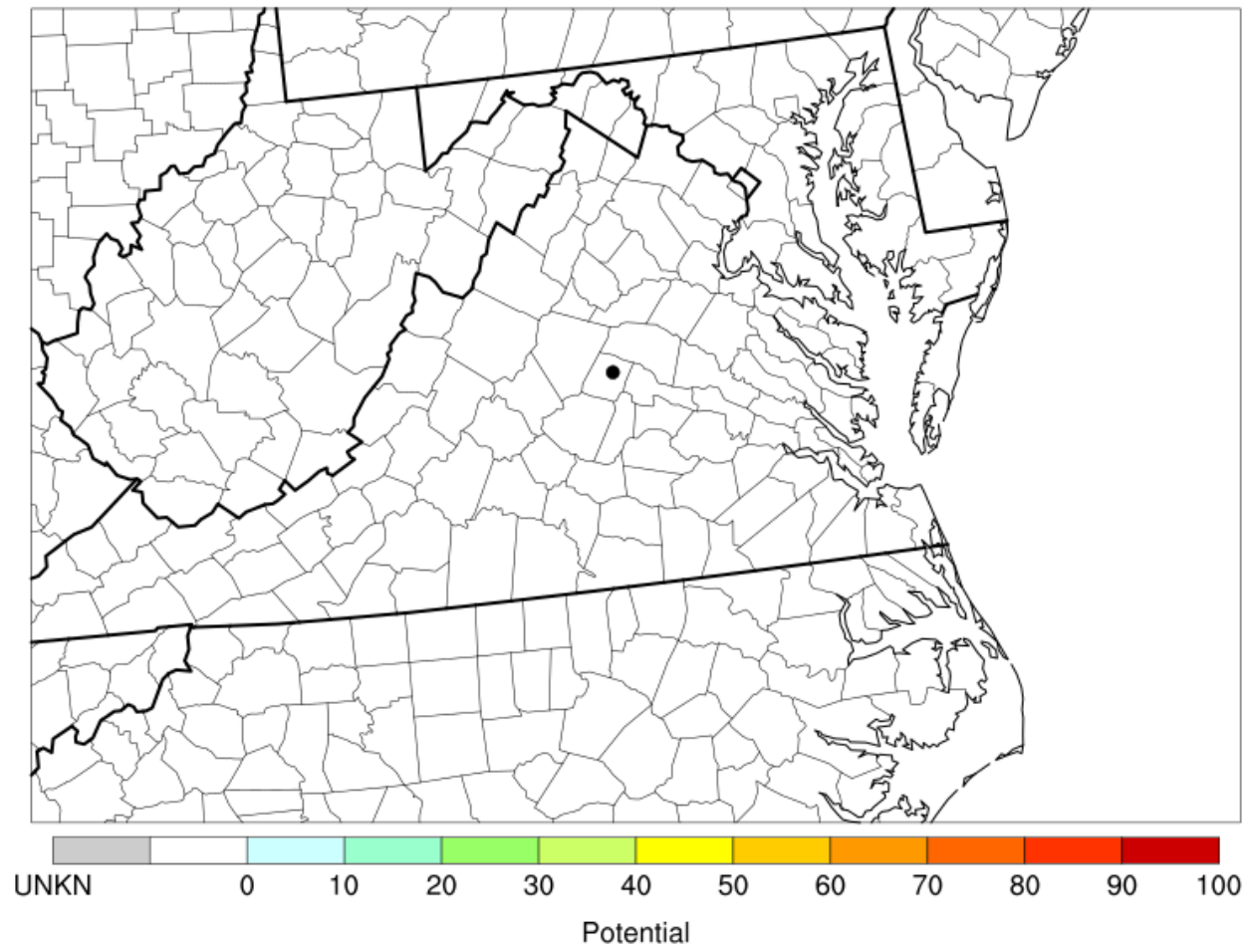
ICING SEVERITY at FL 040

5/5/2024 1308 UTC



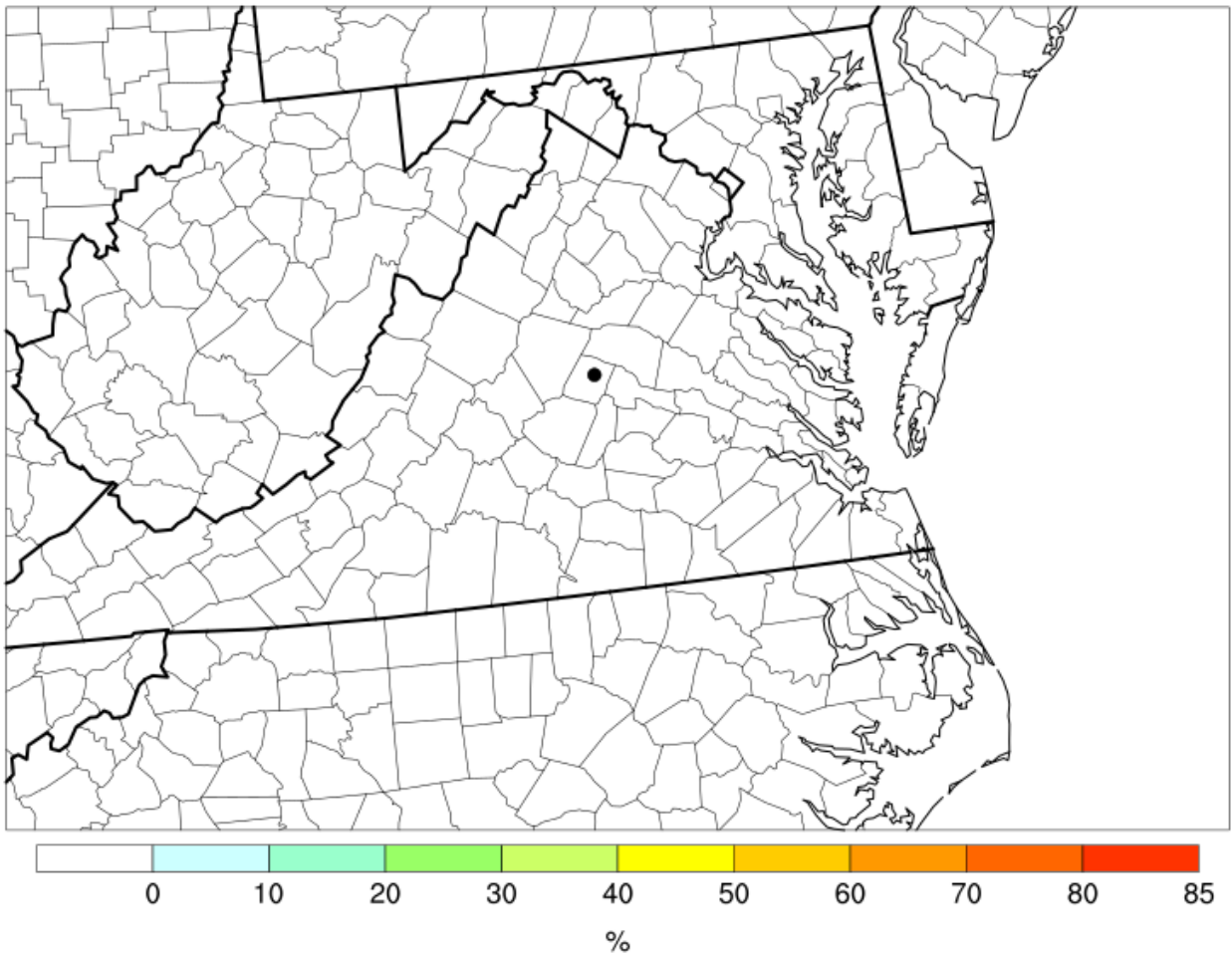
SLD POTENTIAL at FL 030

5/5/2024 1308 UTC



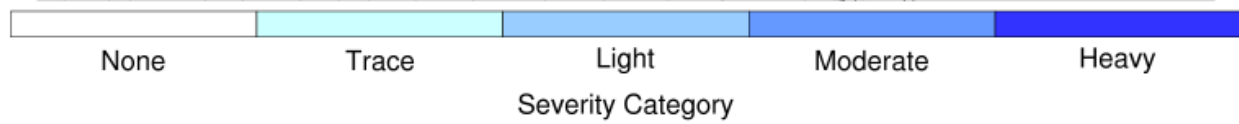
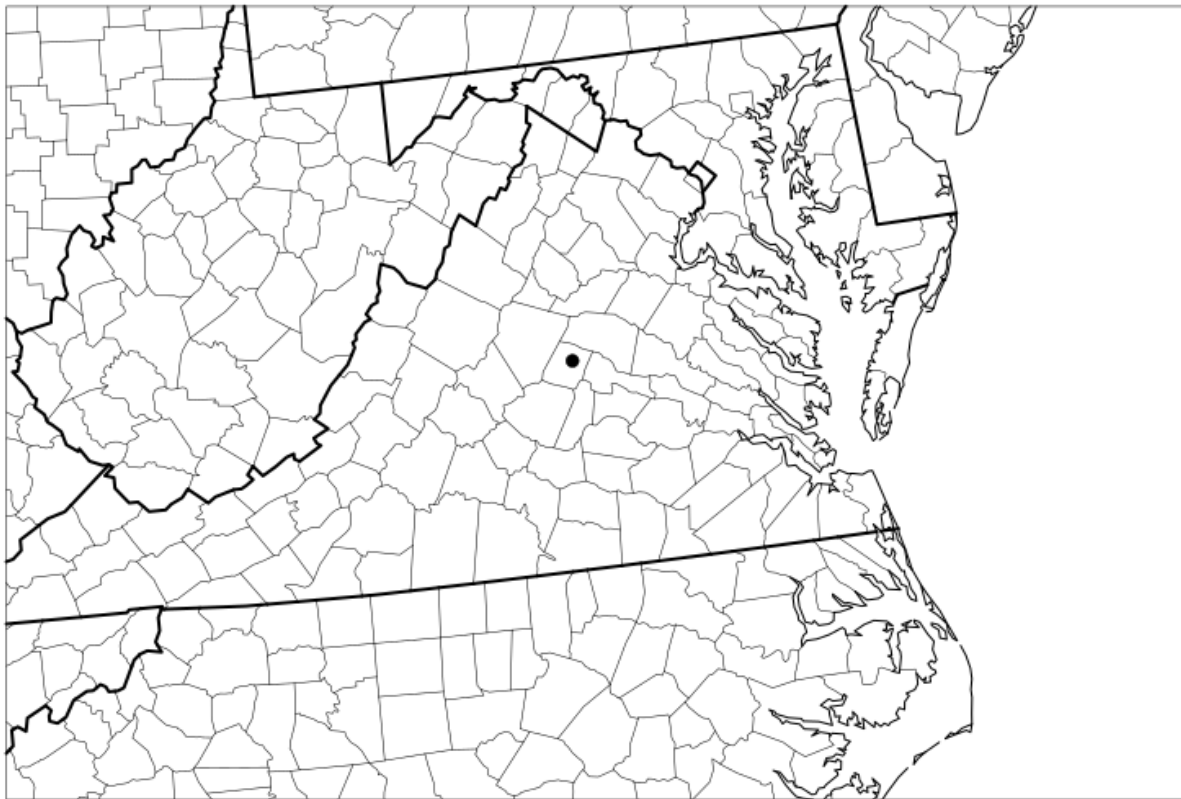
ICING PROBABILITY at FL 030

5/5/2024 1308 UTC



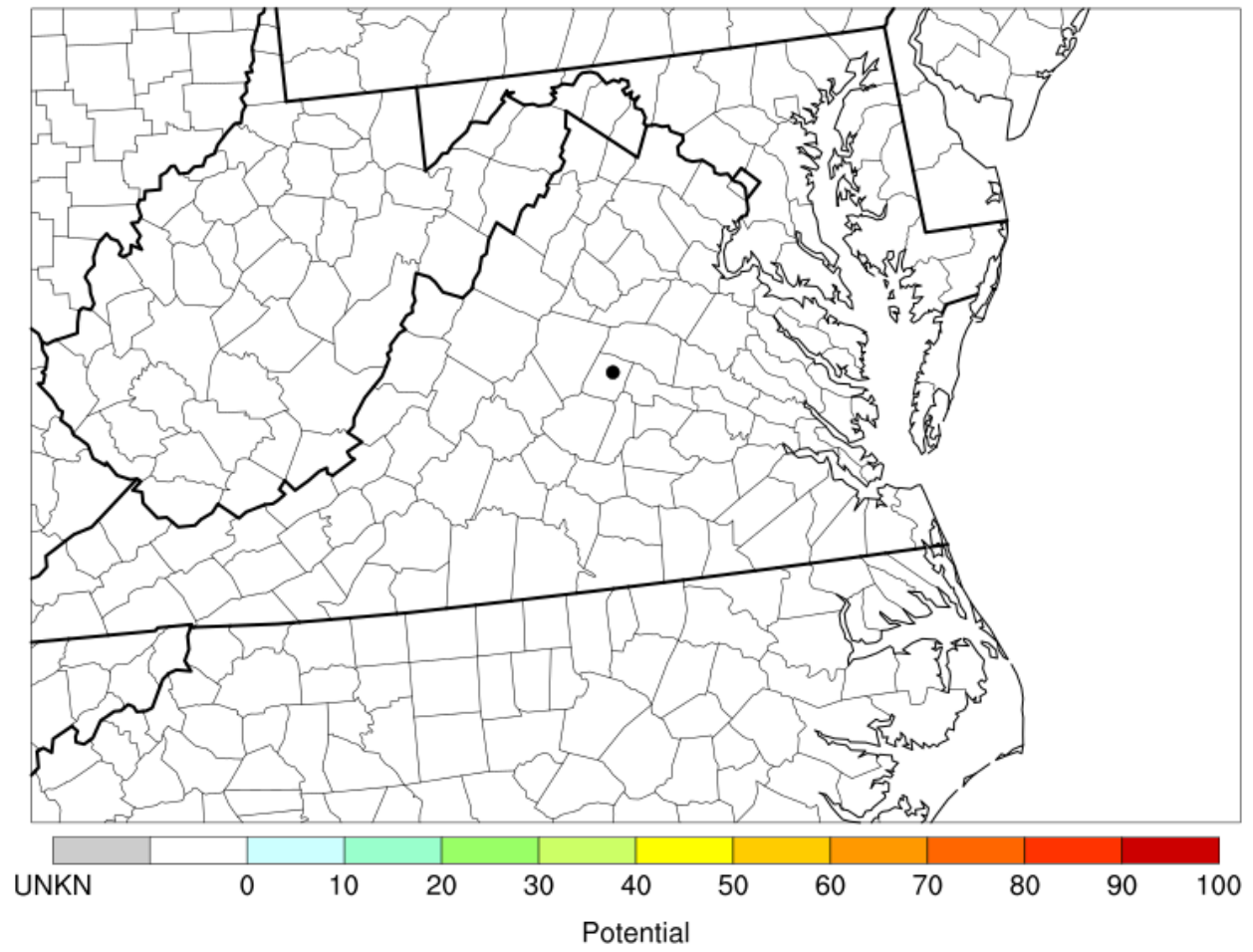
ICING SEVERITY at FL 030

5/5/2024 1308 UTC



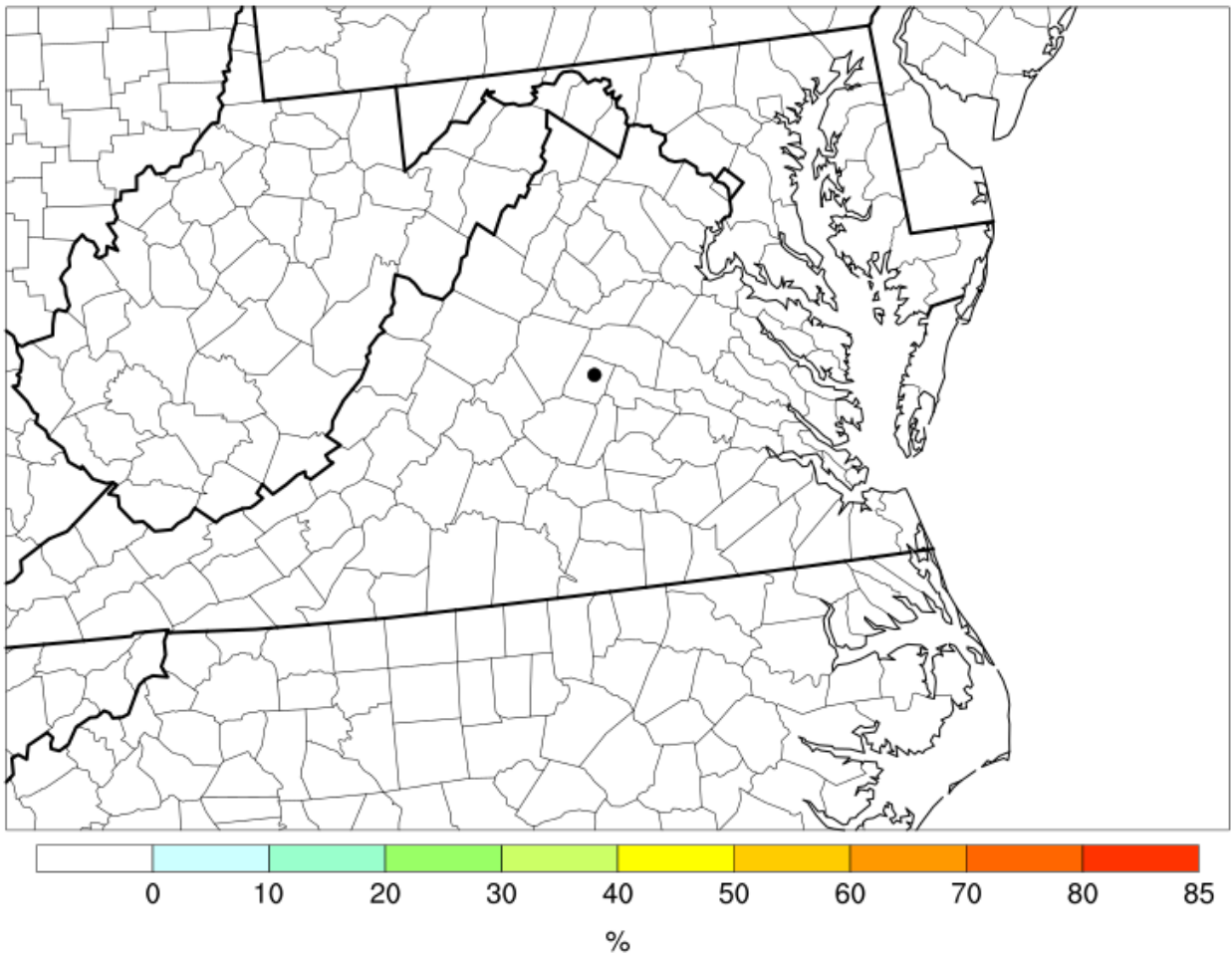
SLD POTENTIAL at FL 020

5/5/2024 1308 UTC



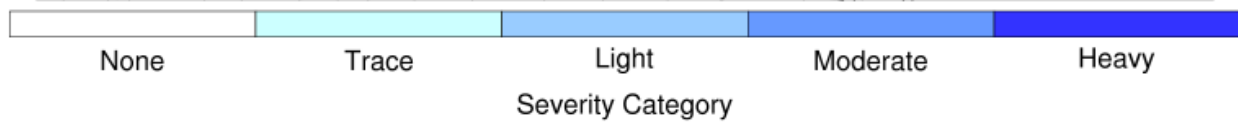
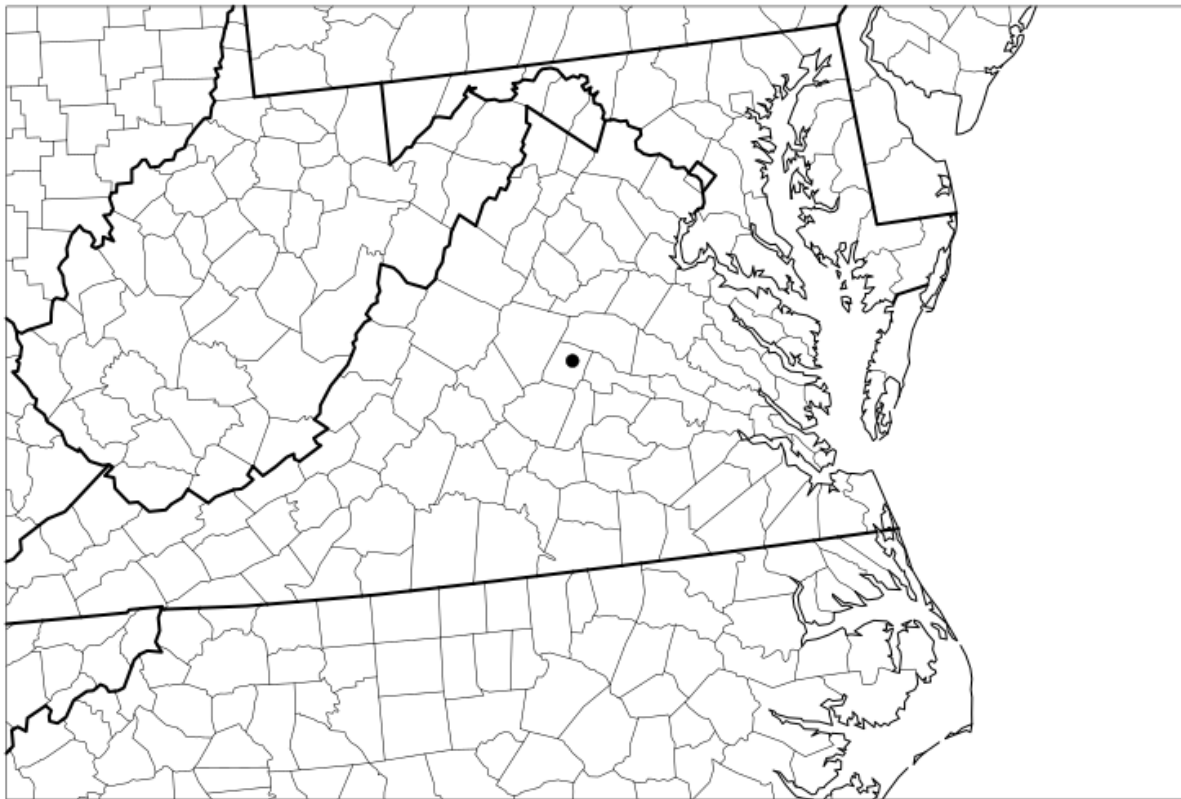
ICING PROBABILITY at FL 020

5/5/2024 1308 UTC



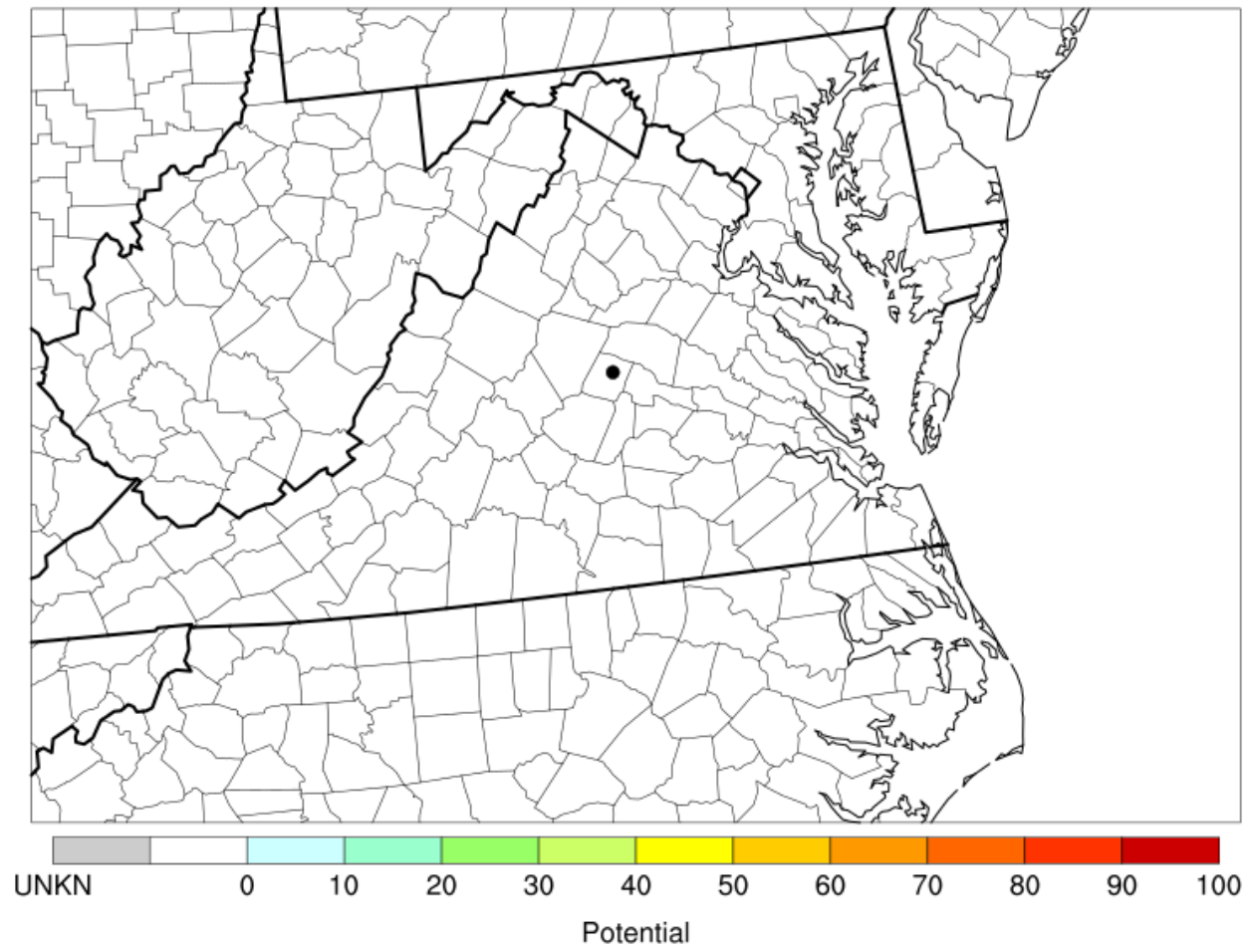
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5/5/2024 1308 UTC



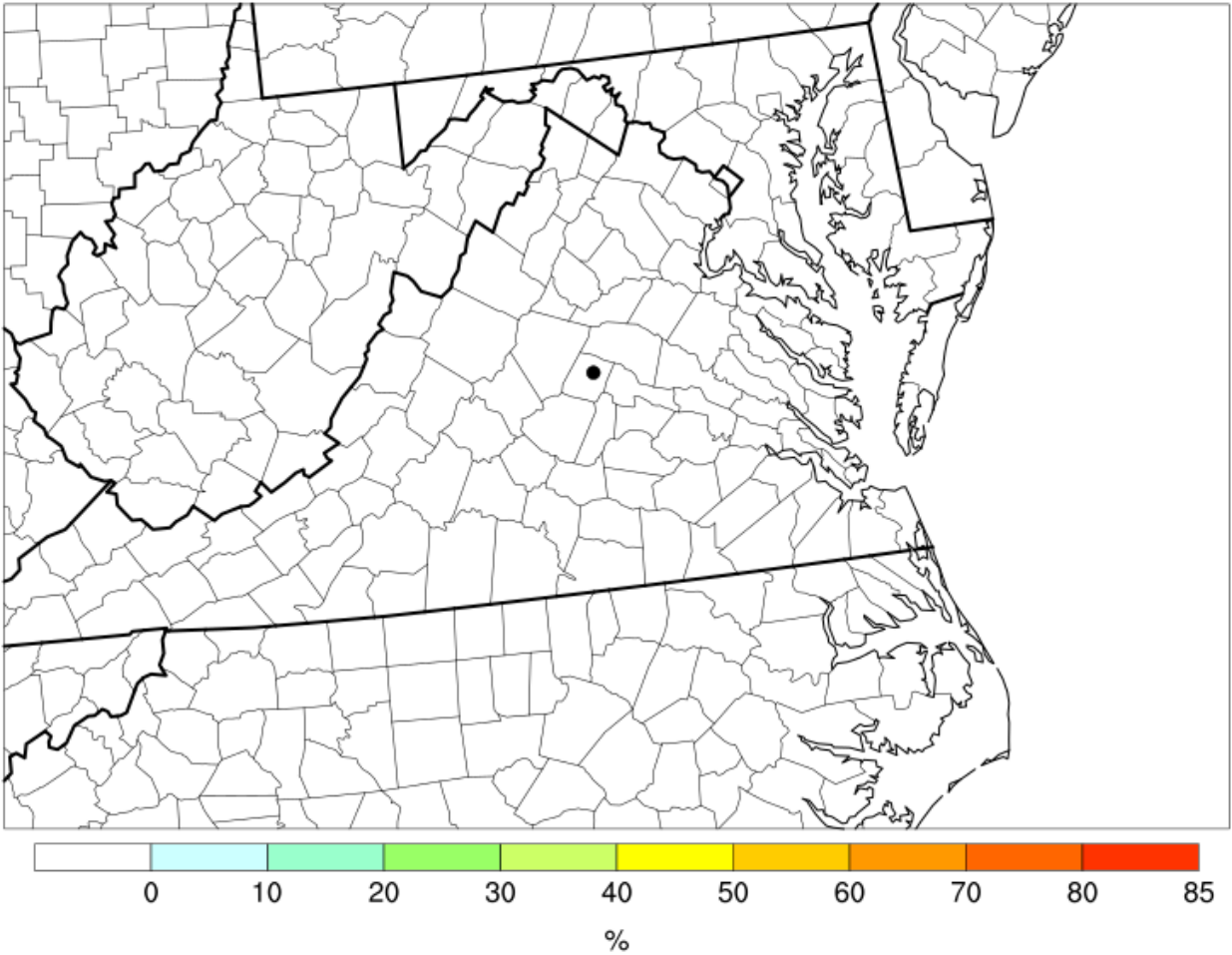
SLD POTENTIAL at FL 010

5/5/2024 1308 UTC



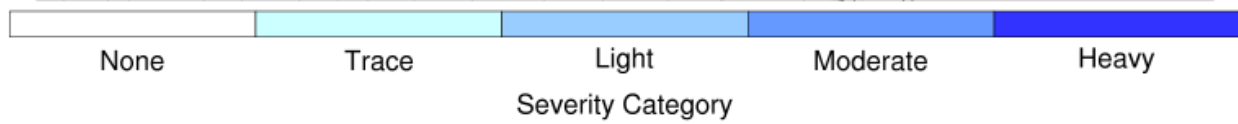
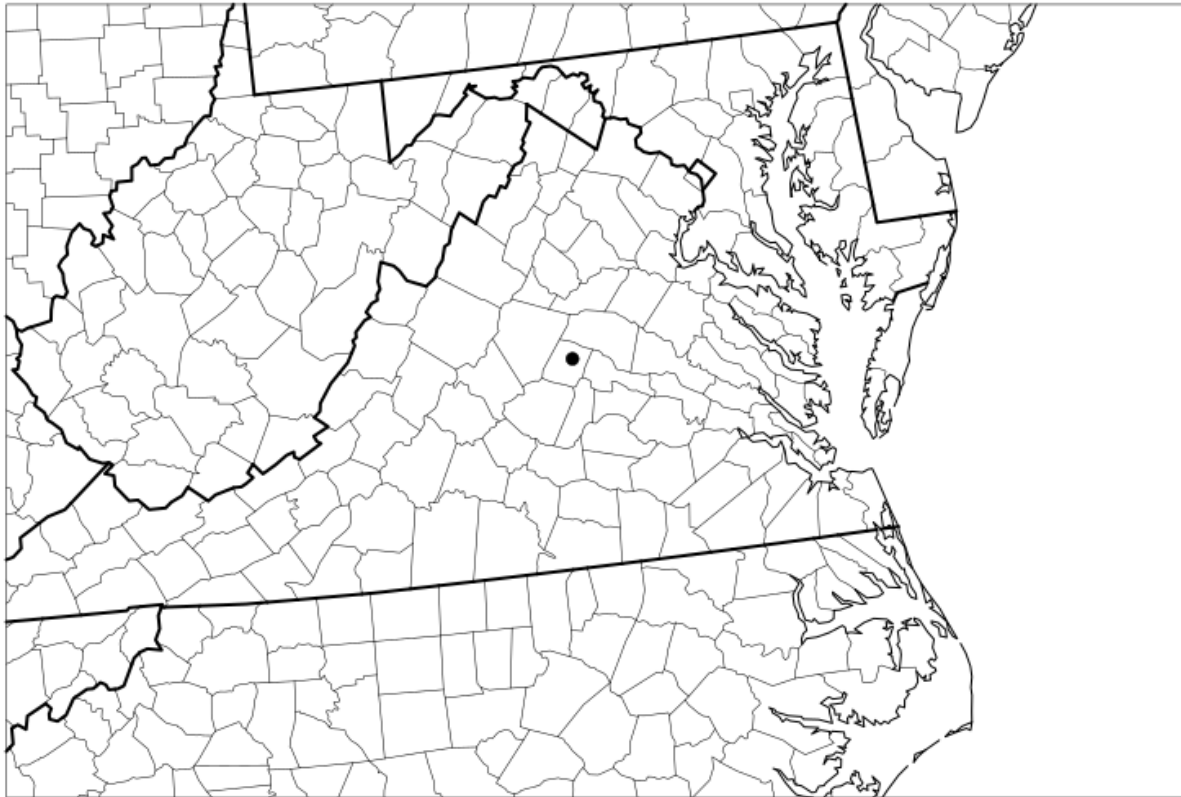
ICING PROBABILITY at FL 010

5/5/2024 1308 UTC



ICING SEVERITY at FL 010

5/5/2024 1308 UTC



Michael Richards

Subject: RE: request for support (Palmyra)

From: Alex Rugg Stebbins [REDACTED]@ucar.edu>
Sent: Tuesday, May 14, 2024 4:37 PM
To: Michael Richards [REDACTED]@ntsb.gov>
Subject: Re: request for support (Palmyra)

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Hi Mike,

Yes, SLD = supercooled large drops.

So, CIP uses model output as well as data from satellite, radar, ground stations, and pilot reports. Usually I give you ice accretion rates using just the model because it is the only piece that contains a precise prediction on the amount of supercooled liquid water (SLW), which is the main factor driving ice accretion rate. This SLW is not very accurate though, which is why I stress it's an estimate. There is often SLW in the atmosphere even when the model thinks there isn't any, which is why CIP Probability exists in the first place.

CIP Probability is the probability of there being any SLW in the atmosphere using the model and all those observations to try to correct the model, and in this case it thinks there's about a 50% chance there is some SLW that the model missed completely. CIP also thinks there might be SLD, but probably not. The ice accretion rates I gave you are based on CIP severity which is roughly correlated with SLW (CIP does not attempt to predict the precise amount of SLW because it is very difficult). If we assume there was SLW that the model missed, 0.1 to 0.2 mm is my best guess based on the CIP severity and my experience with it, but the error bars here are even larger than usual. And there is still a 50% chance the model is correct and there's no icing at all. The 0.35 mm is the upper bound I came up with by adjusting parameters within reasonable bounds given the data I have (very subjective of course), including the possibility of SLD. Keep in mind these values are always averages--the actual thickness of ice could be thinner in some places and thicker in others.

I'm sorry that's not as helpful as usual, even after looking at the satellite, radar, and surface data myself I'm not any more confident one way or another, it's quite ambiguous.

Allyson "Alex" Rugg, Ph.D.
Project Scientist I
NSF NCAR, Research Applications Lab

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On Tue, May 14, 2024 at 2:57 PM Michael Richards [REDACTED]@ntsb.gov> wrote:

Thanks Alex! Great stuff as usual.

Question – your acronym “SLD” below is for supercooled LARGE droplets, correct? So if I understand this correctly the CIP thinks there may have been some supercooled large droplets present (along flight path or just regionally), but doesn’t have any actual supercooled liquid water present in the path? But somehow this is rectified? Maybe I don’t understand this right.

Can you clarify exactly what we have and don’t have here? The reason I am asking is because I have one more question –

How sensitive are those accretion amount to the above? Is there a reasonable chance we could have a significant SLD environment here (with much more ice accreted) if we adjust one of these parameters slightly?

Appreciate you setting me straight on these particulars.

Mike

From: Alex Rugg Stebbins [REDACTED]@ucar.edu>
Sent: Tuesday, May 14, 2024 11:37 AM
To: Michael Richards [REDACTED]@ntsb.gov>
Subject: Re: request for support (Palmyra)

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Hi Mike,

Here are those figures. Roughly a 50/50 chance of icing at the higher altitudes with severity up to moderate. Possible SLD which would likely be in the form of freezing drizzle (freezing rain would be very unlikely). Accretion rate was trickier this time because there is no supercooled liquid water in the model along the flight track, despite some potential for icing according to CIP. We made some major improvements to CIP severity since I last gave you imagery though, and it better corresponds to liquid water content now. So using the relationship between CIP severity and liquid water content, my best estimate is 0.1 to 0.2 mm, with above 0.35 mm being very unlikely.

Since there isn't any icing in the model along the track, I have you a cross section of SLD Potential instead.

 PCIP_imagery_20240505VA.tar.gz

Allyson "Alex" Rugg, Ph.D.

Project Scientist I

NSF NCAR, Research Applications Lab

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From:



(Palmyra)

Date:

Thursday, May 23, 2024 3:28:32 PM

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Hi Mike,

How CIP uses the radar data depends on what the "scenario" is, which sort of describes the mesoscale conditions going on. In this particular case the radar reflectivity is not being used at all. So as far as CIP is concerned, "the mere existence of positive reflectivity at this altitude" is NOT enhancing Icing Probability. Does that answer your question? I'm not well versed in radar data myself, but I can bring in another colleague if your question is more about interpreting the images you sent.

Allyson "Alex" Rugg, Ph.D.
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