UW-CIMSS and ASPB 2010 OCONUS Aviation Weather Products Demonstration Status

GOES-R Proving Ground Face-to-Face
July 28-30, 2010
Honolulu, HI

STAR Center for Satellite Applications and Research
formerly ORA — Office of Research and Applications

Advanced Satellite Products Branch

UW-Madison

GOES-R PG Plan Decision Support Candidates

- Baseline Products (Testbed):
  - **Volcanic Ash: detection & Height (Pacific, High Latitude, Aviation)**
  - **Cloud Height and Typing (Pacific and High Latitude)**
  - Cloud and Moisture Imagery (HWT)
  - Hurricane Intensity (Hurricane)
  - Lightning Detection: Events, Groups & Flashes (HWT, Aviation, Hurricane)
  - Rainfall Rate / QPE (Hydrology)
  - Total Precipitable Water (HWT)
  - Fire/Hot Spot Characterization (Fire)
- Option 2 Products:
  - ***Convective Initiation***
  - **Low Cloud and Fog**
  - **SO_2 Detection**
  - Aircraft Icing Threat
  - Enhanced "V" / Overshooting Top Detection

GOES-R Proving Ground Testbed Participation

GOES-R Proving Ground Testbeds - National Centers	Provider's Focal Point	Convective Initiation AWIPS/N-AWIPS (Option 2 proxy, Funding Source - GIMPAP, transition to GOES-R algorithm	GOES-R Overshooting-top/Enhanced-V algorithm Proxy - AWIPS/N-AWIPS (Aviation AWG Option 2 proxy)	GOES-R Volcanic Ash algorithm proxy - AWIPS/N-AWIPS (NEW Baseline AWG proxy algorithm)	GOES-R SO2 algorithm proxy - AWIPS/N-AWIPS (NEW Baseline AWG proxy algorithm)	GOES-R Low cloud/Fog proxy - AWIPS/N-AWIPS (NEW Option 2 AWG proxy algorithm)
NOAA Hazardous Weather/Fires/Hydrology Testbe (SPC, NSSL, OU-CIMMS)	Wayne Feltz/Jordan Gerth	FY2009, 2010 HWT Formal Evaluation FY2011 Formal Evaluation Continuation,	FY2010 HWT Formal Evaluation			FY2011 Formal Evaluation Planned
Alaska High Latitude Testbed (Alaska WFO, U of Alaska Fairbanks)	Michael Pavolonis/Jordan Gerth			FY2011 Formal Evaluation planned, 2010 - Volcanic ash algorithm transitioned to Alaska	FY2011 Formal Evaluation planned??	FY2011 Evaluation planned
Aviation Weather Testbed	Wayne Feltz/Michael Pavolonis/Jordan Gerth	FY2011 AWC 2011 Formal Evaluation planned		FY2011 AWC Formal Evaluation planned	FY2011 AWC Formal Evaluation planned??	FY2011 AWC Formal Evaluation planned
Hurricane Testbed	Chris Velden/Wayne Feltz		FY2011 Formal Evaluation Candidate			
Pacific Testbed	Mike Pavolonis/Andy Heidinger/Wayne Feltz	FY2011 Formal Evaluation Candidate		FY2011 Formal Evaluation Candidate	FY2011 Formal Evaluation Candidate	FY2011 Formal Evaluation Candidate

University of Wisconsin Convective Initiation (UWCI)
Proxy GOES-R CI Product

Developed by

Justin Sieglaff, Lee Cronce, Wayne Feltz

CIMSS UW-MADISON, MADISON, WI

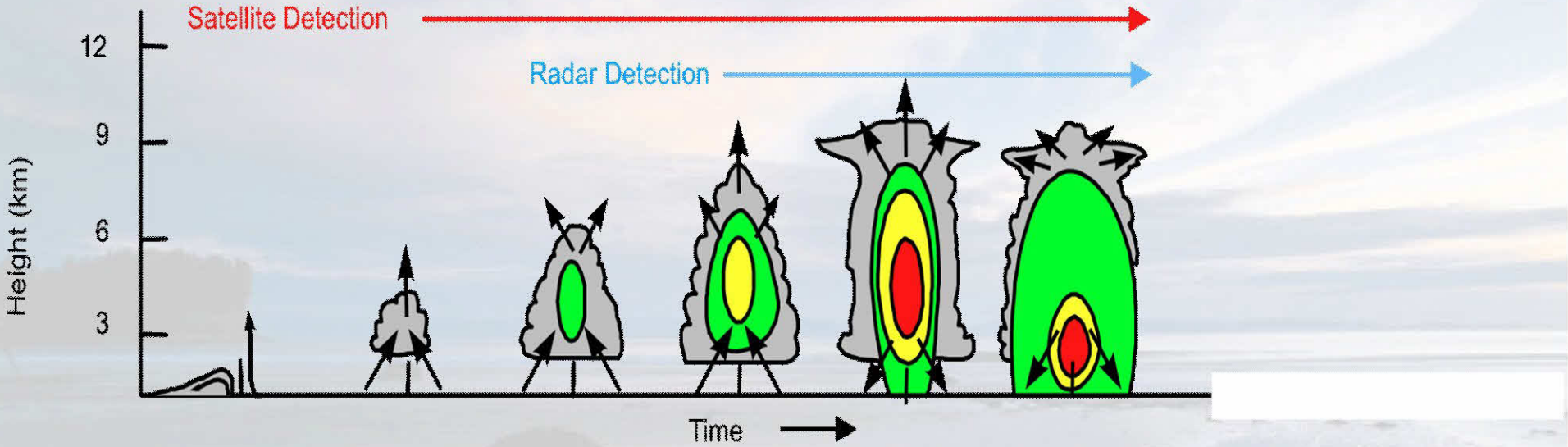
Kristopher Bedka

SSAI, HAMPTON VA

Mike Pavolonis and Andy Heidinger

NOAA/STAR/ASPT MADISON, WI

What does satellite data add to convective detection?



UWCI Objectives

- Provide a CI nowcast signal during day and night
- Minimize false alarm at the expense of some probability of detection
- Use alternative method for time trend computation (non-AMV) to minimize pixelation
- Provide coherent radar-like satellite-based CI signal as direct AWIPS/N-AWIPS satellite convective initiation decision support aid in field

What is output from UWCI?

- Value of 0: No CI nowcast
- Value of 1: “Pre-CI Cloud Growth”: growing liquid water cloud
- Value of 2: “CI Likely”: associated with growing supercooled water or mixed phase cloud
- Value of 3: “CI Occurring”: Associated with a cloud that has recently transitioned to thick ice – that is, it has glaciated
- Cloud top cooling -> 15 minute BT rate

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GROWING MEANS THE CLO
IS COOLING, BECOMING TA

Once the cloud has glaciated, UWCI not needed

Characteristics of UWCI

- Nowcasts cloud development in regions not dominated by cirrus
- Uses only IR channels from GOES satellite
- Results available ~2 minutes after satellite scan
  (distribution to AWIPS takes an additional 5-10 minutes)
- Operates in regular and RSO mode
- Large spatial coverage: CONUS east of Rockies
- Up to 30-45 minutes of lead time before significant radar echoes/lightning strikes
- Low FAR, good POD, error sources understood

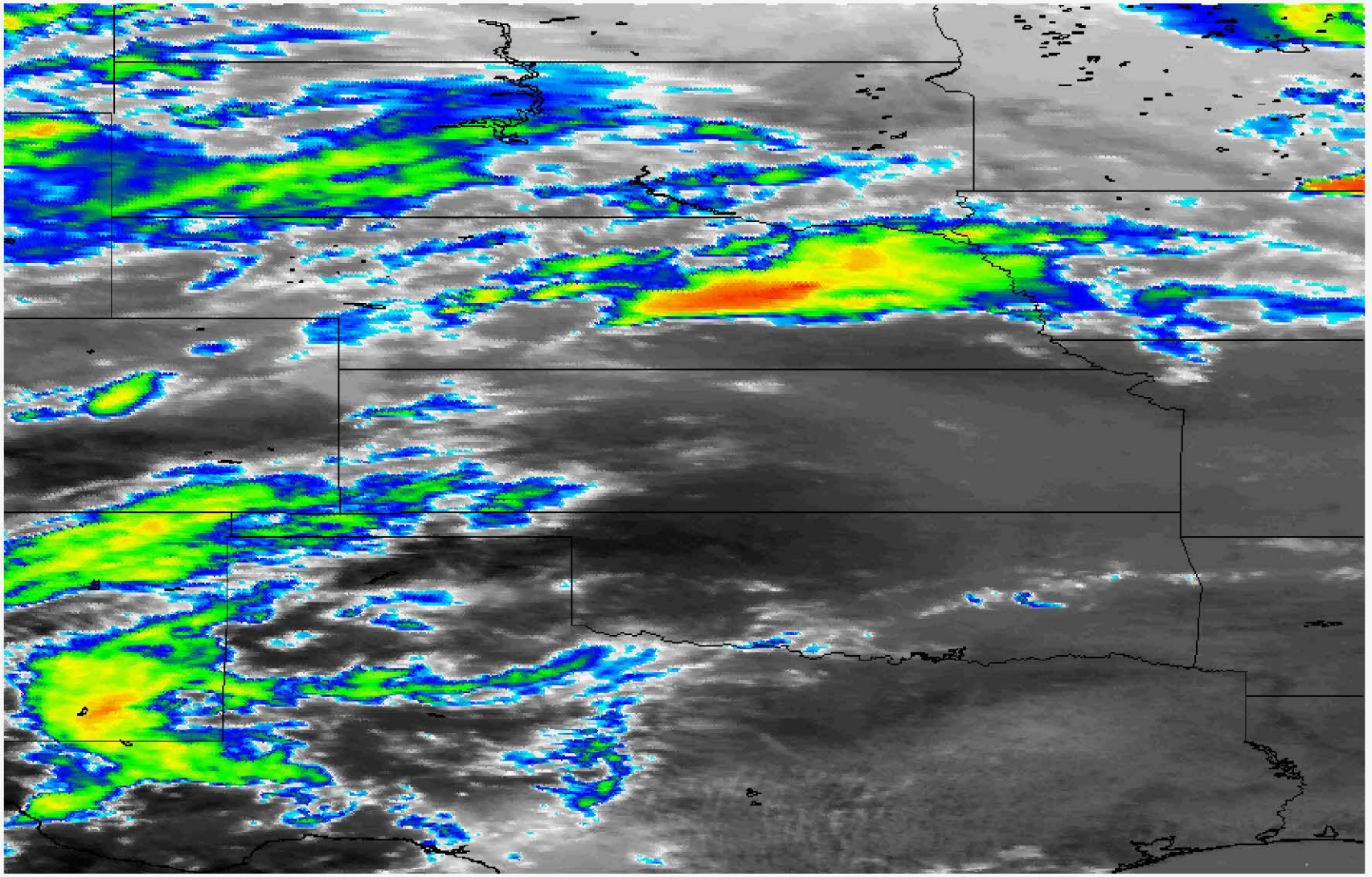
When should you use UWCI with caution?

- Algorithm does not work well where cirrus cloud cover exists
- Fast-moving clouds can cause false alarms
- Thirty minutes between images? False alarm rate increases
- CI is more a *diagnostic* tool – that is, you lose the good lead times – in true maritime Tropical airmasses

UWCI: Algorithm logic – an overview in words

1. Box average 11 micron brightness temperature (**BT**) is calculated for current time and previous time, using specific classes from GOES Cloud Typing product
2. Unfiltered Cloud Top Cooling (**CTC**) Rate is calculated by differencing box average 11 micron BT for current time from previous time
3. Large/small box approach eliminates most of false CTC due to cloud motion (and additional checks reduce false cooling further)
4. CI Nowcast is assigned to remaining CTC pixels with cooling rates less than or equal to -4.0K/15 minutes by leveraging GOES Cloud Typing product

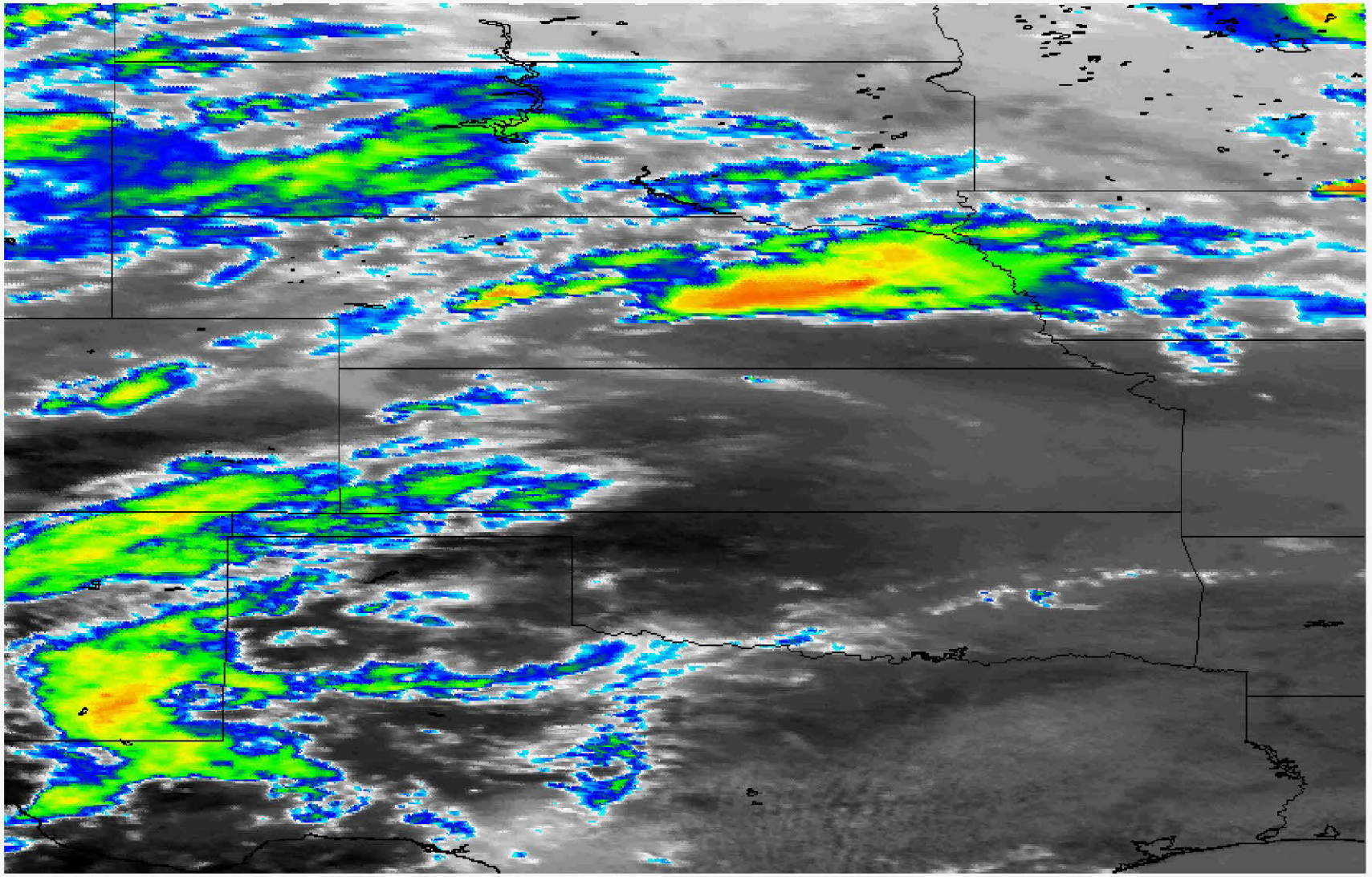
GOES-12 4km IRW: 2009168_1545



Brightness Temperature (K)

180 190 200 210 220 230 240 250 260 270 280 290 300 310

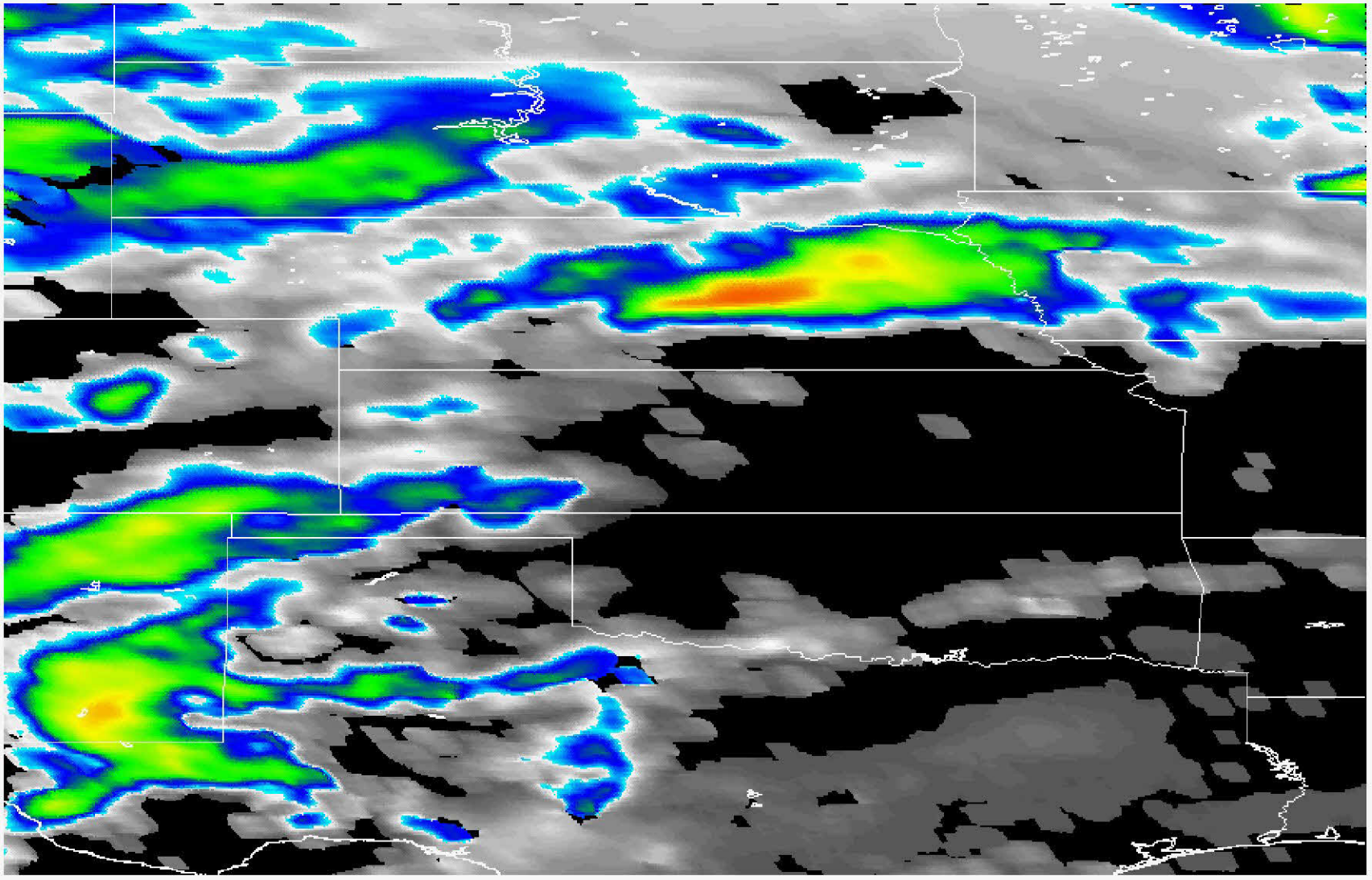
GOES-12 4km IRW: 2009168_1602



Brightness Temperature (K)

180 190 200 210 220 230 240 250 260 270 280 290 300 310

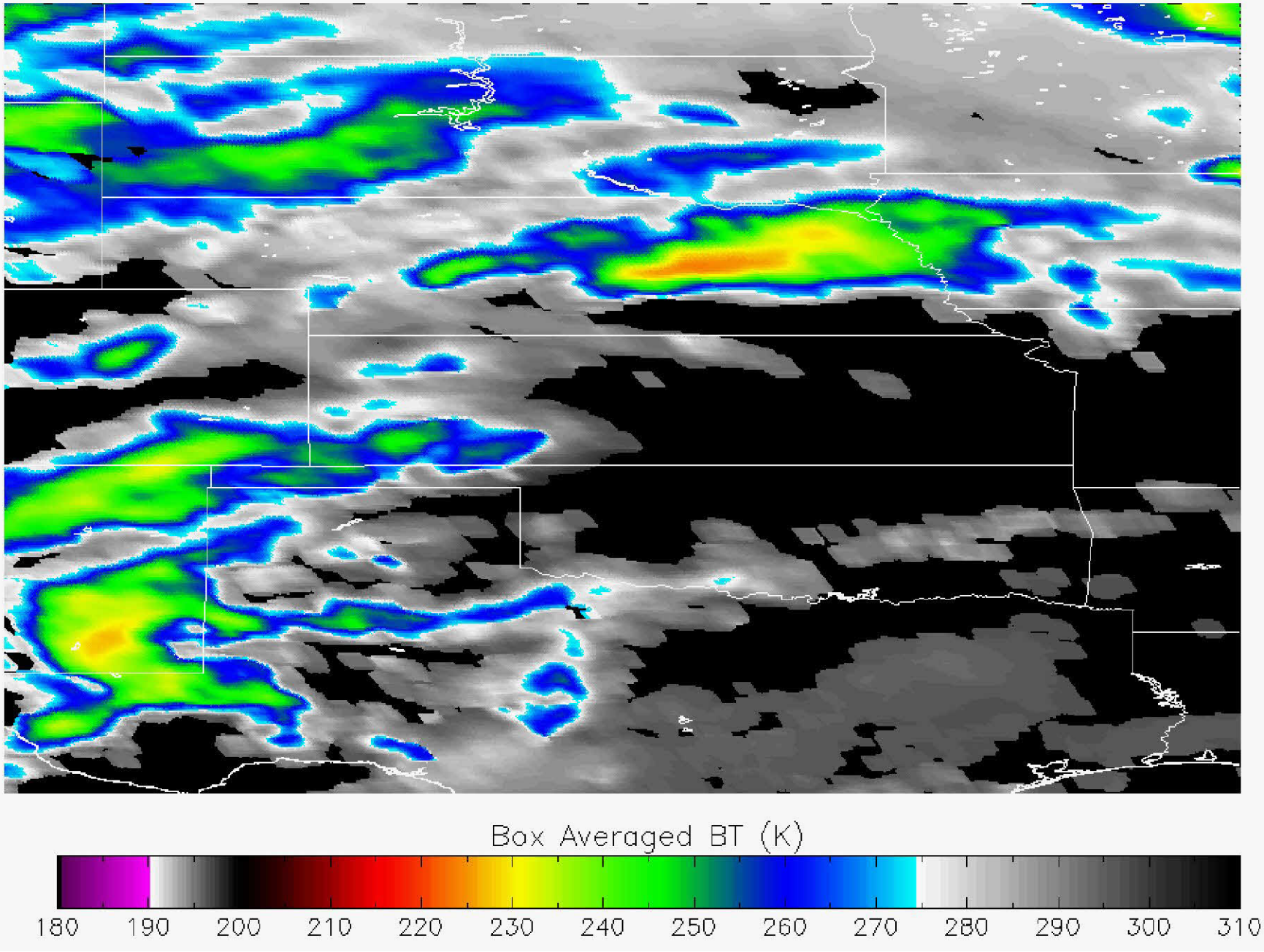
Box Averaged IRW: 2009168_1545

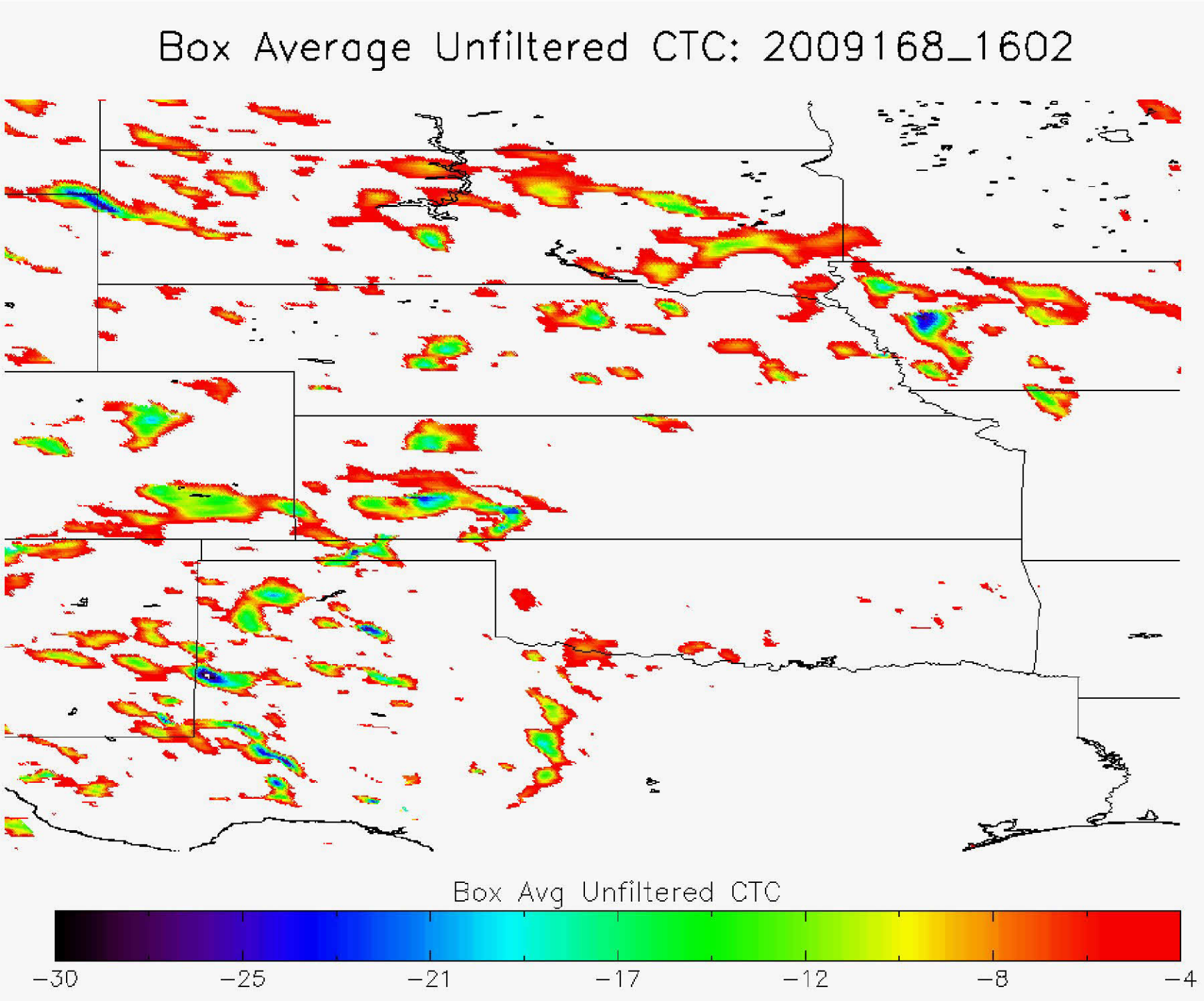


Box Averaged BT (K)

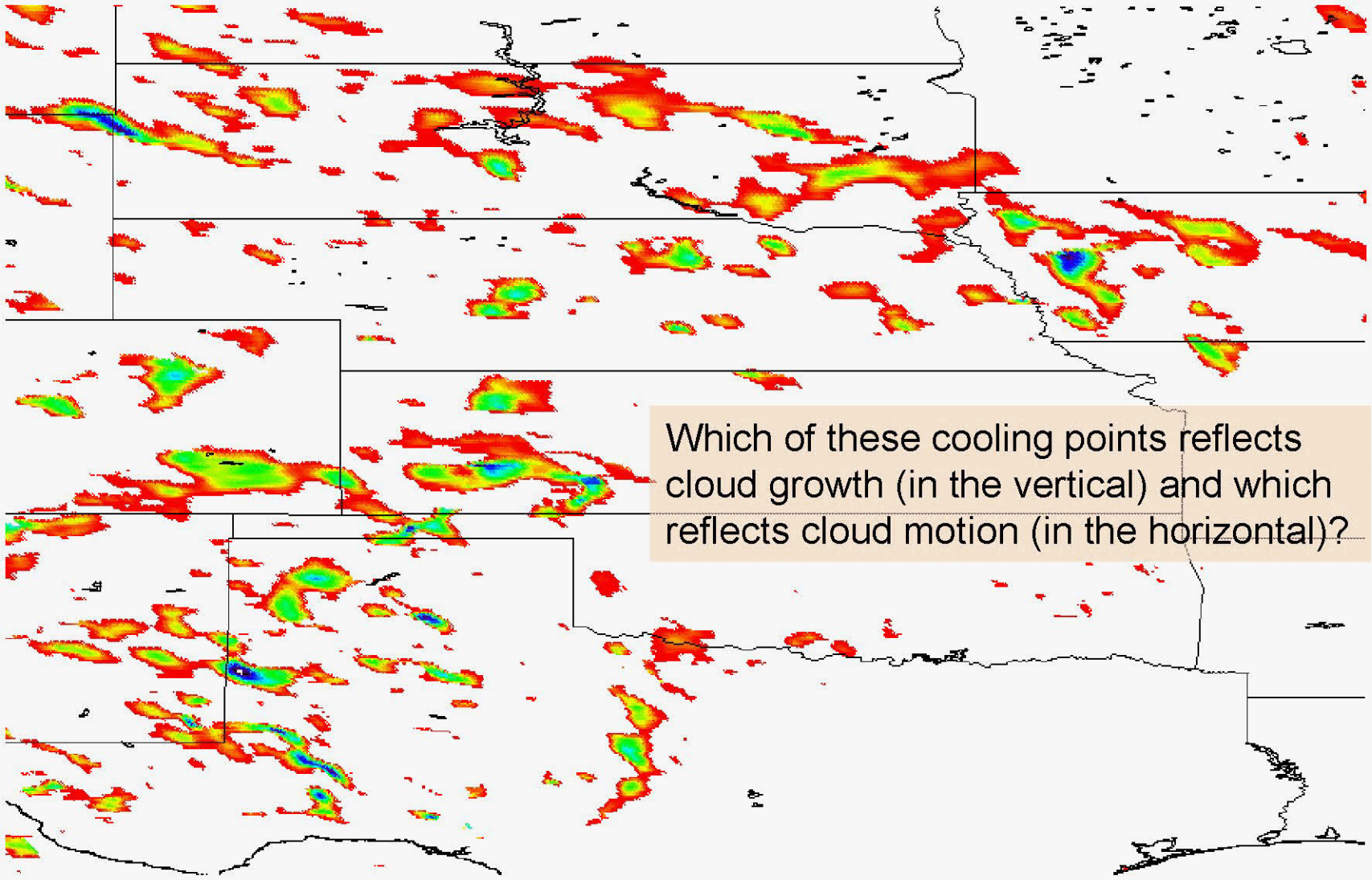
180 190 200 210 220 230 240 250 260 270 280 290 300 310

Box Averaged IRW: 2009168_1602




Box Average Unfiltered CTC: 2009168_1602
Box Avg Unfiltered CTC
−30
−25
−21
−17
−12
−8
−4

Box Average Unfiltered CTC: 2009168_1602

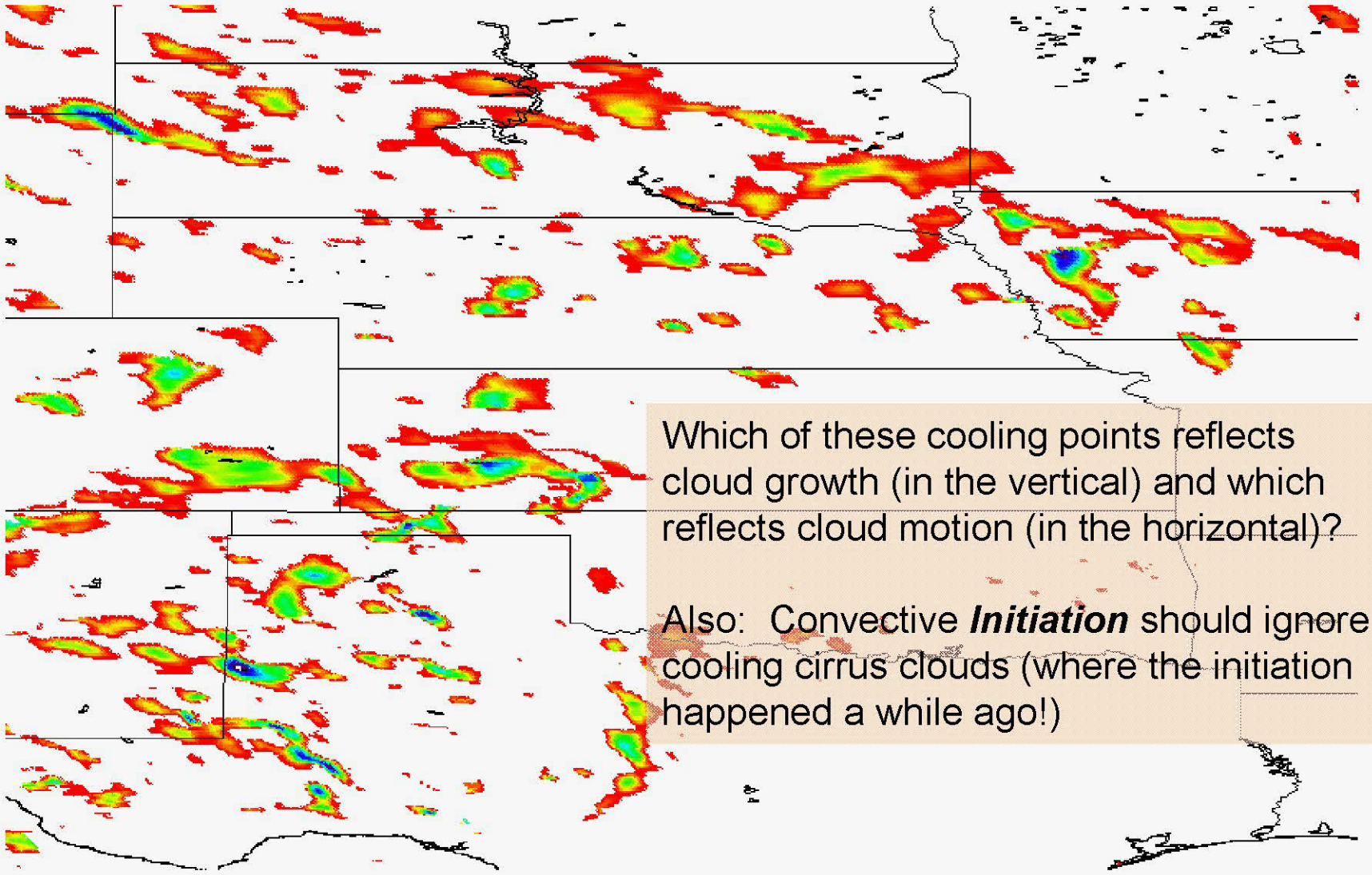


Which of these cooling points reflects cloud growth (in the vertical) and which reflects cloud motion (in the horizontal)?

Box Avg Unfiltered CTC

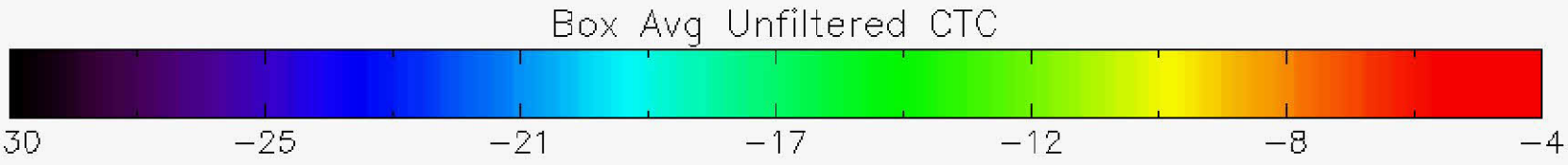
−30 −25 −21 −17 −12 −8 −4

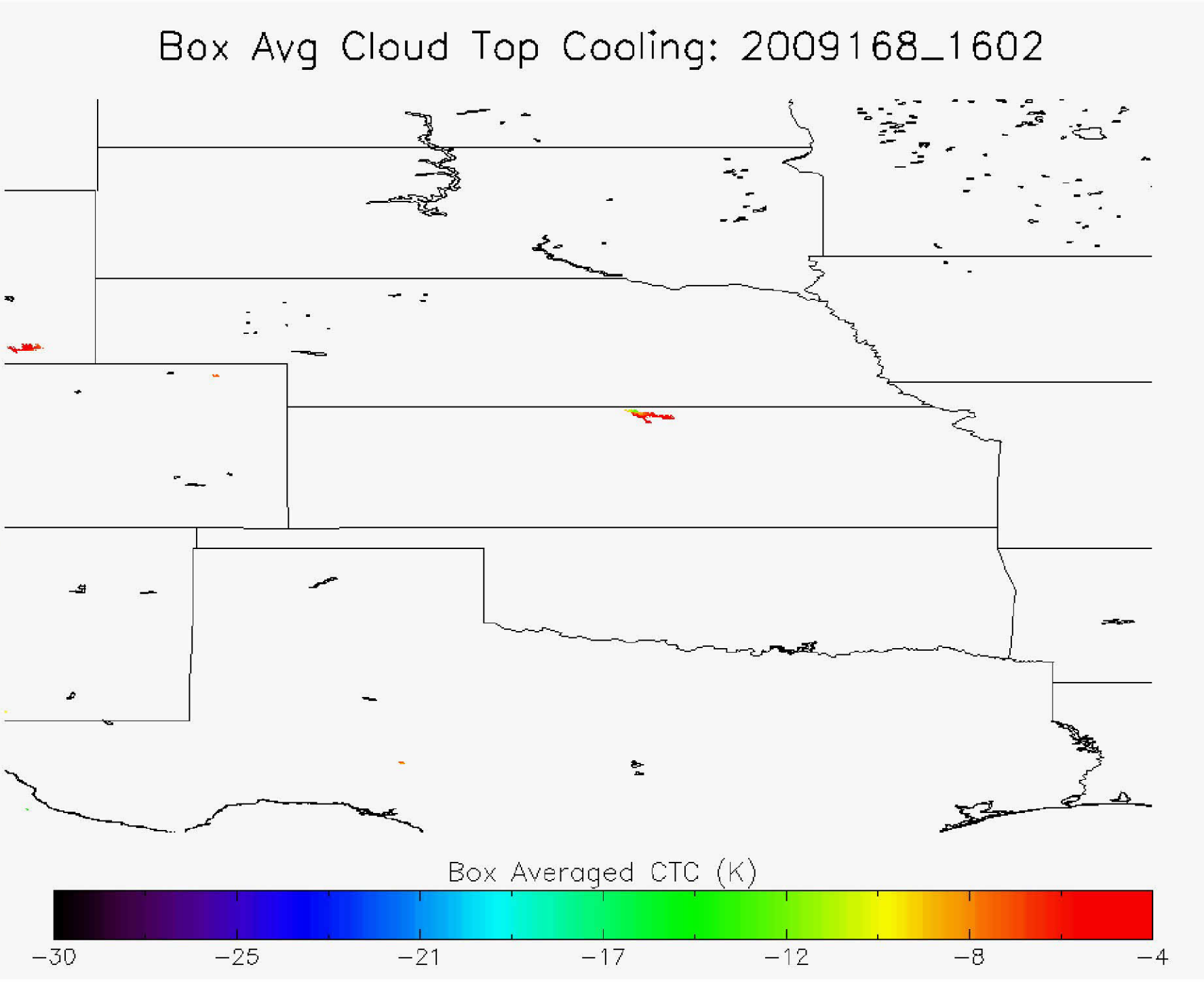
Box Average Unfiltered CTC: 2009168_1602



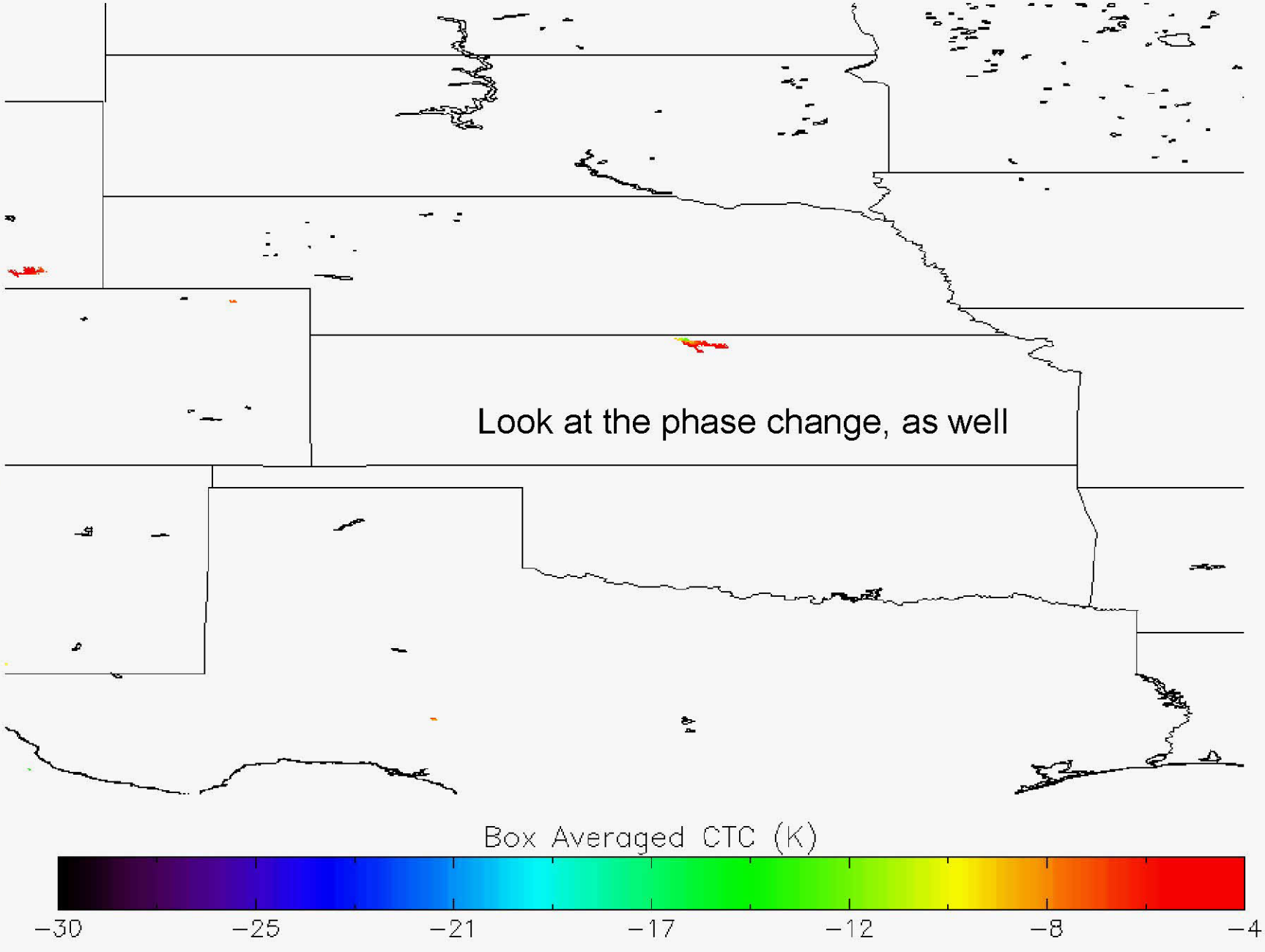
Which of these cooling points reflects cloud growth (in the vertical) and which reflects cloud motion (in the horizontal)?

Also: Convective ***Initiation*** should ignore cooling cirrus clouds (where the initiation happened a while ago!)

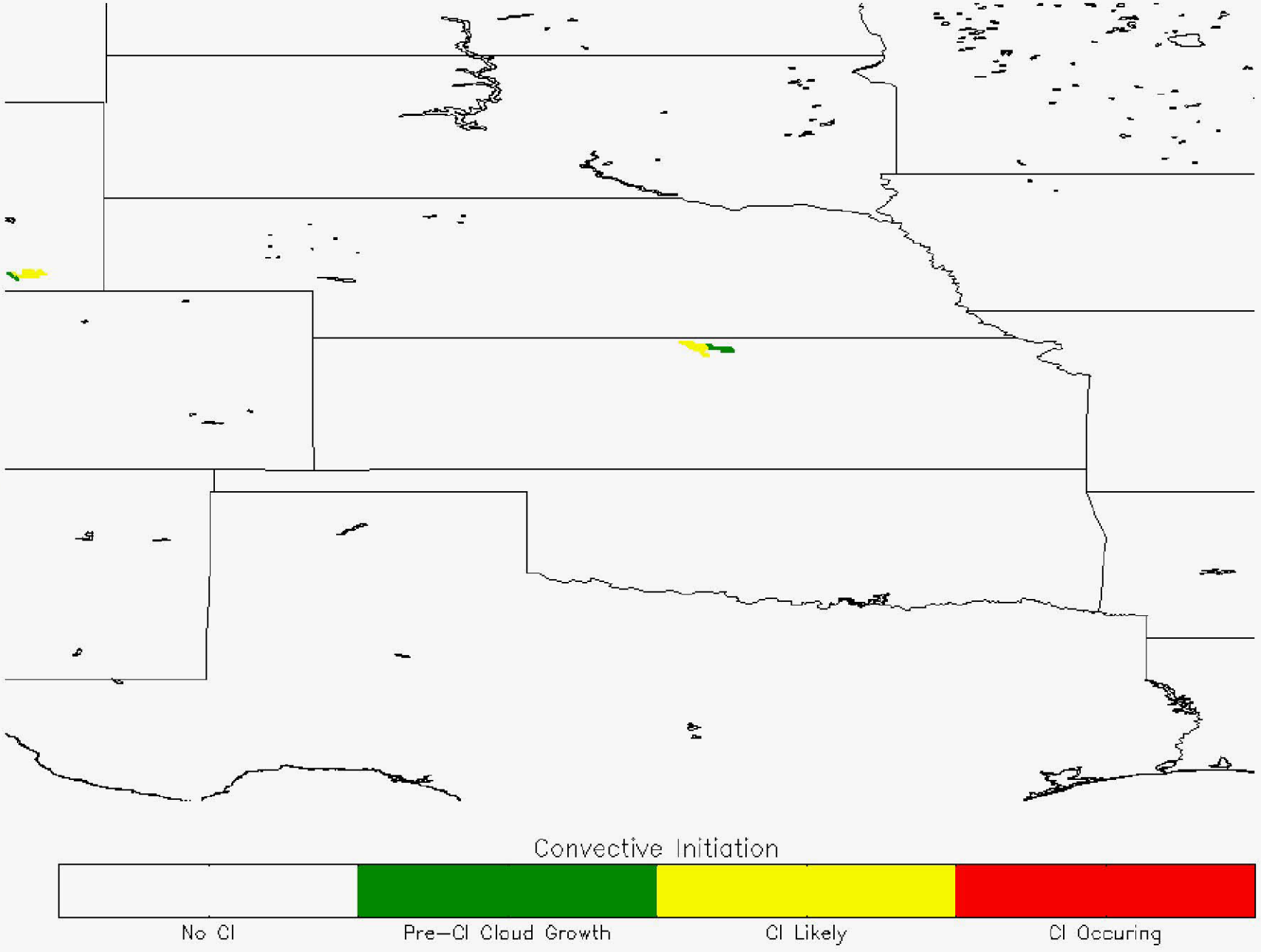


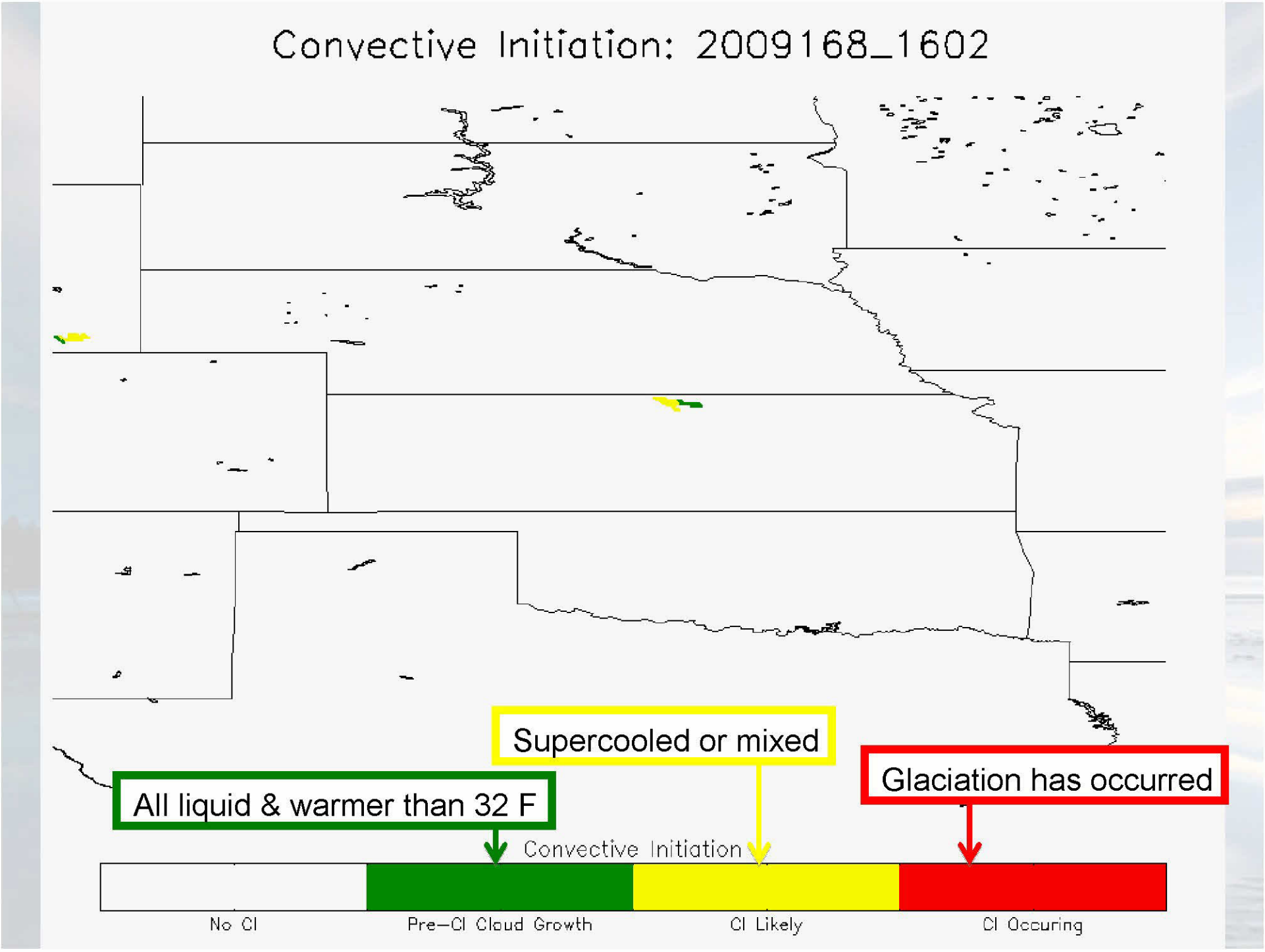

Box Avg Cloud Top Cooling: 2009168_1602
Box Averaged CTC (K)
−30
−25
−21
−17
−12
−8
−4

Box Avg Cloud Top Cooling: 2009168_1602

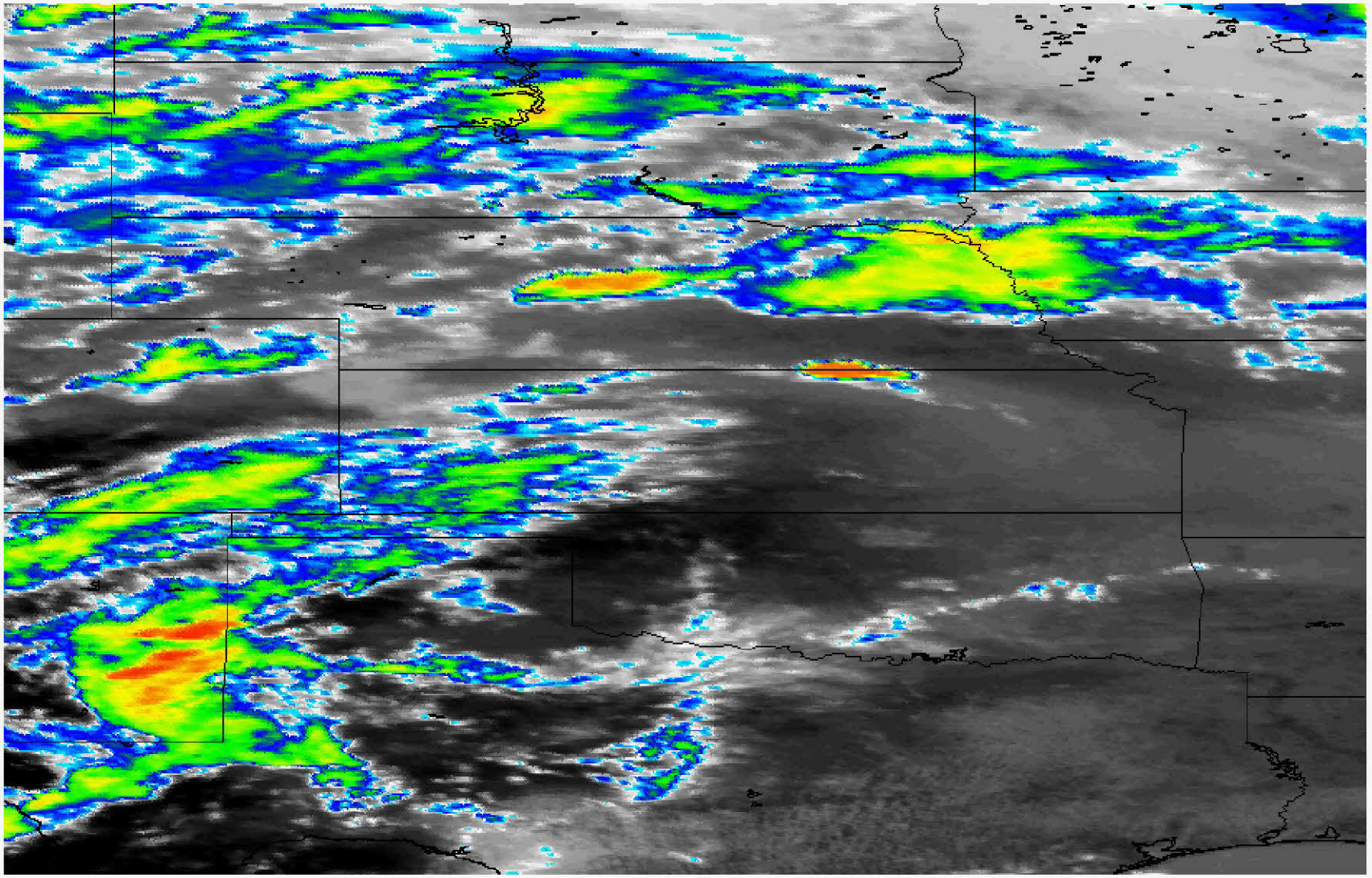


Convective Initiation: 2009168_1602




Convective Initiation: 2009168_1602
Supercooled or mixed
All liquid & warmer than 32 F
Glaciation has occurred
Convective Initiation
No CI
Pre-CI Cloud Growth
CI Likely
CI Occuring

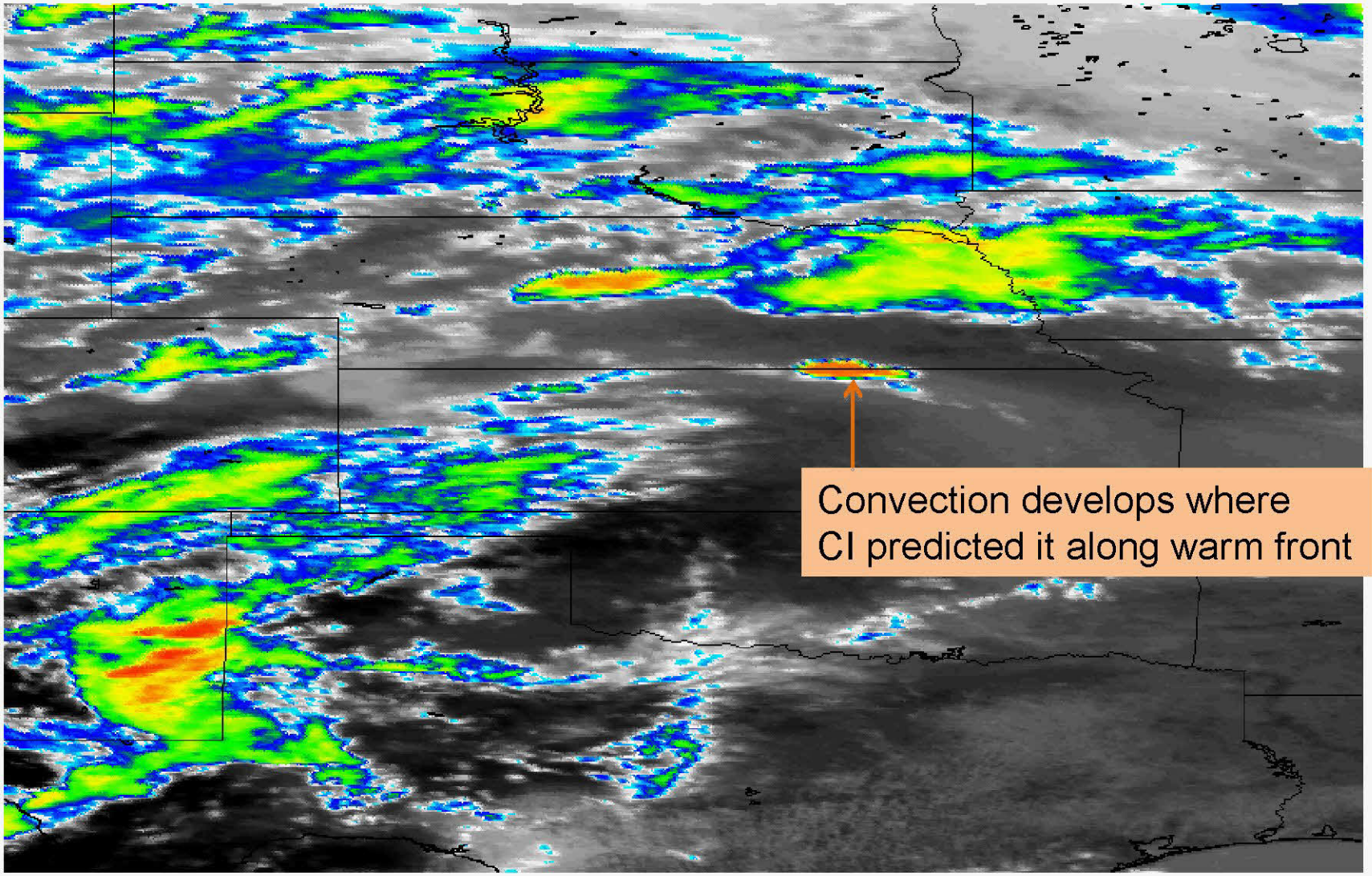
GOES-12 4km IRW: 2009168_1702



Brightness Temperature (K)

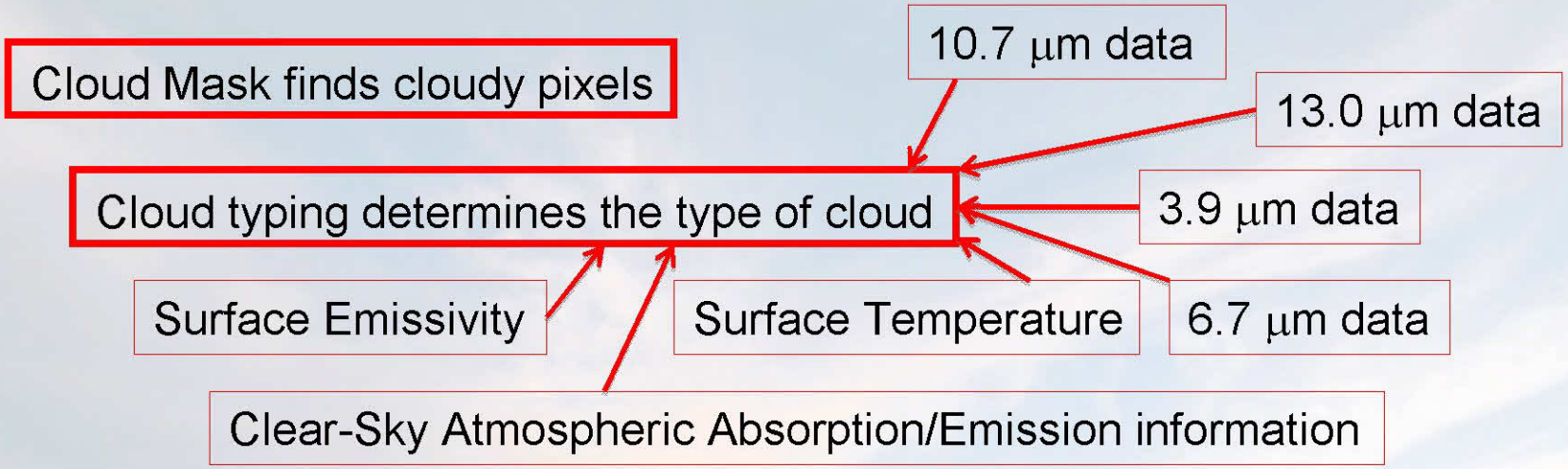
180 190 200 210 220 230 240 250 260 270 280 290 300 310

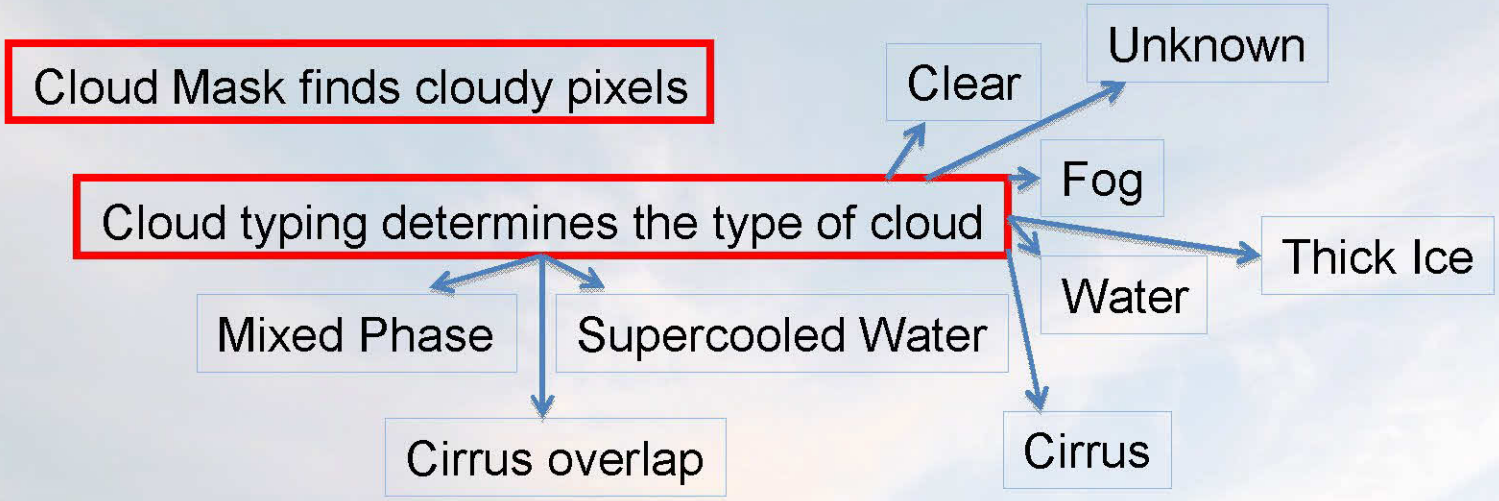
GOES-12 4km IRW: 2009168_1702

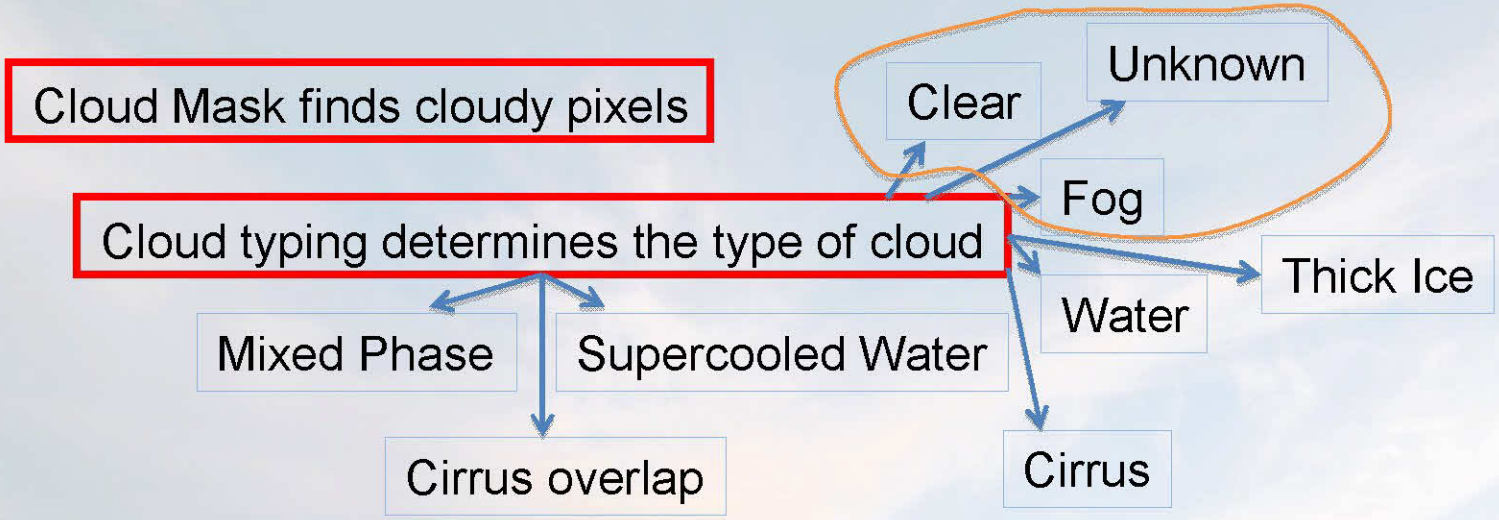


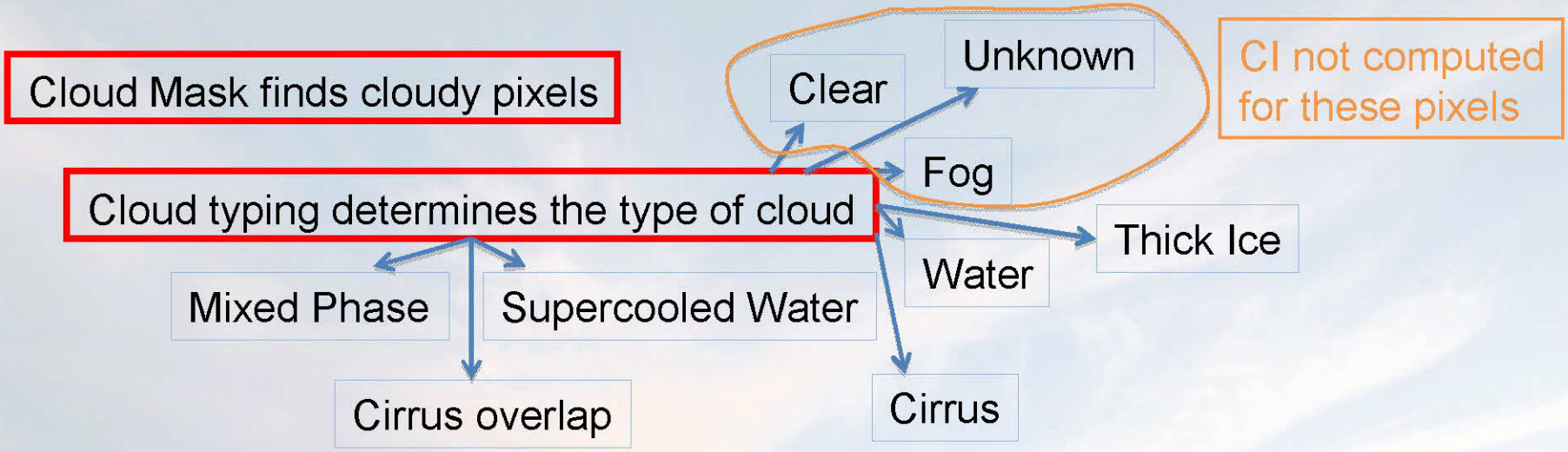
Brightness Temperature (K)

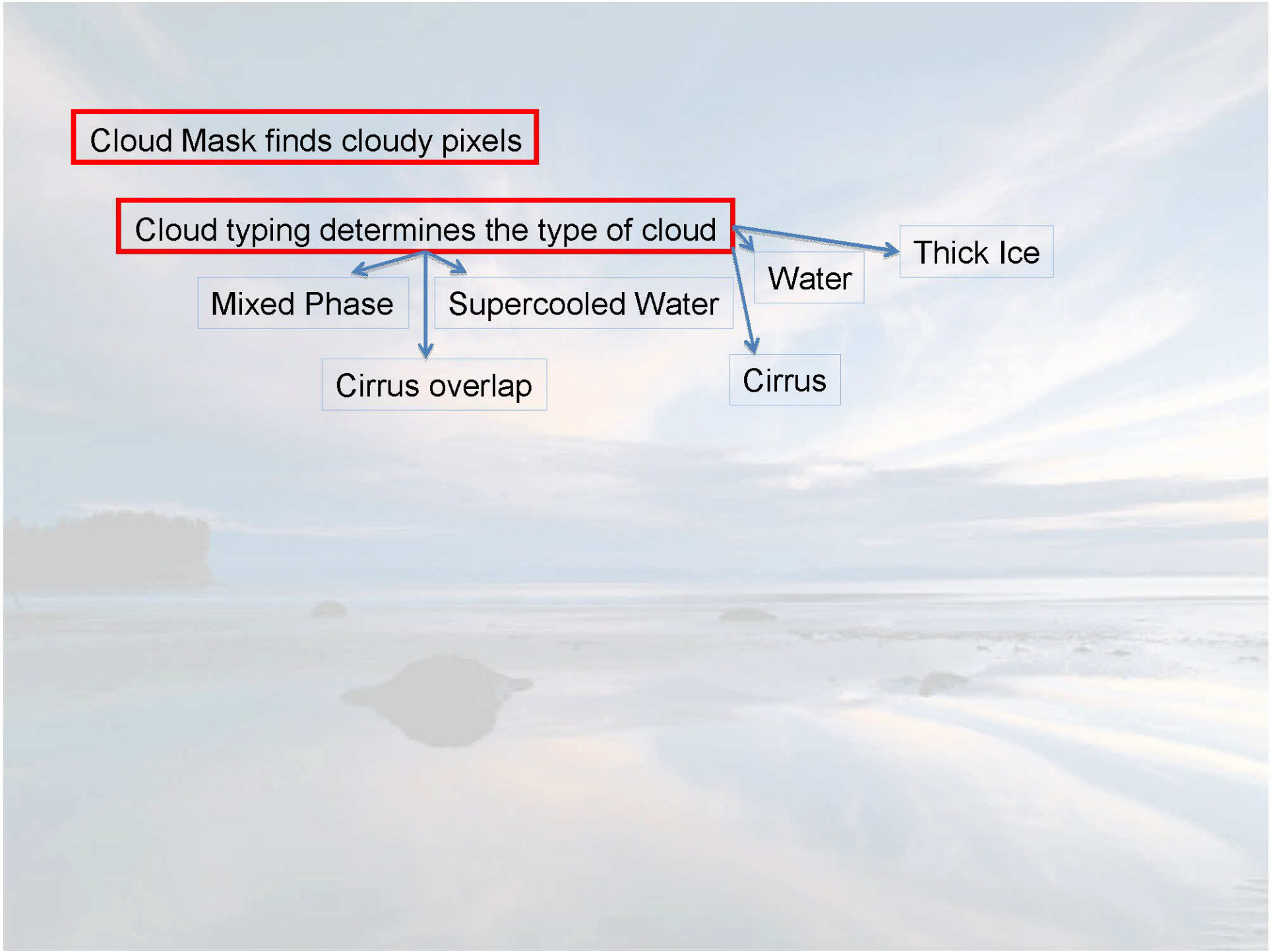
180 190 200 210 220 230 240 250 260 270 280 290 300 310


Cloud Mask finds cloudy pixels
10.7 μm data
13.0 μm data
Cloud typing determines the type of cloud
3.9 μm data
Surface Emissivity
Surface Temperature
6.7 μm data
Clear-Sky Atmospheric Absorption/Emission information


Cloud Mask finds cloudy pixels
Cloud typing determines the type of cloud
Clear
Unknown
Fog
Thick Ice
Water
Mixed Phase
Supercooled Water
Cirrus overlap
Cirrus


Cloud Mask finds cloudy pixels
Clear
Unknown
Fog
Cloud typing determines the type of cloud
Thick Ice
Water
Mixed Phase
Supercooled Water
Cirrus overlap
Cirrus


Cloud Mask finds cloudy pixels
Clear
Unknown
CI not computed for these pixels
Fog
Cloud typing determines the type of cloud
Thick Ice
Water
Mixed Phase
Supercooled Water
Cirrus overlap
Cirrus


Cloud Mask finds cloudy pixels
Cloud typing determines the type of cloud
Mixed Phase
Supercooled Water
Cirrus overlap
Water
Thick Ice
Cirrus

Cloud Mask finds cloudy pixels

Cloud typing determines the type of cloud

- Water
- Thick Ice
- Mixed Phase
- Supercooled Water
- Cirrus overlap
- Cirrus

Determine percentages of each cloud type in 7x7 and 13x13 box

Determine cooling rate of cloudy pixels (normalized to a 15-minute δt)

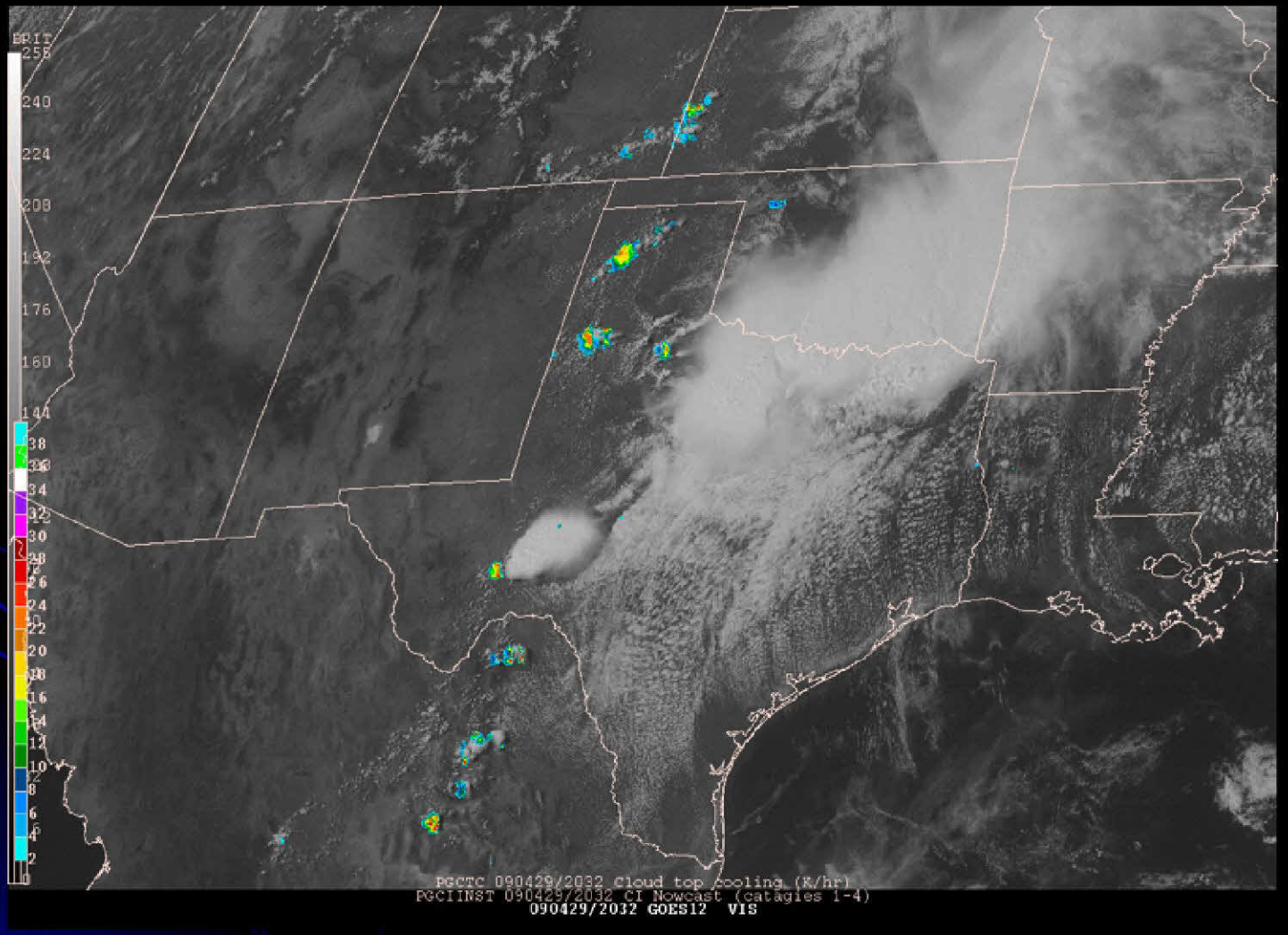
Throw out pixels that show warming relative to the values around the perimeter of the larger box

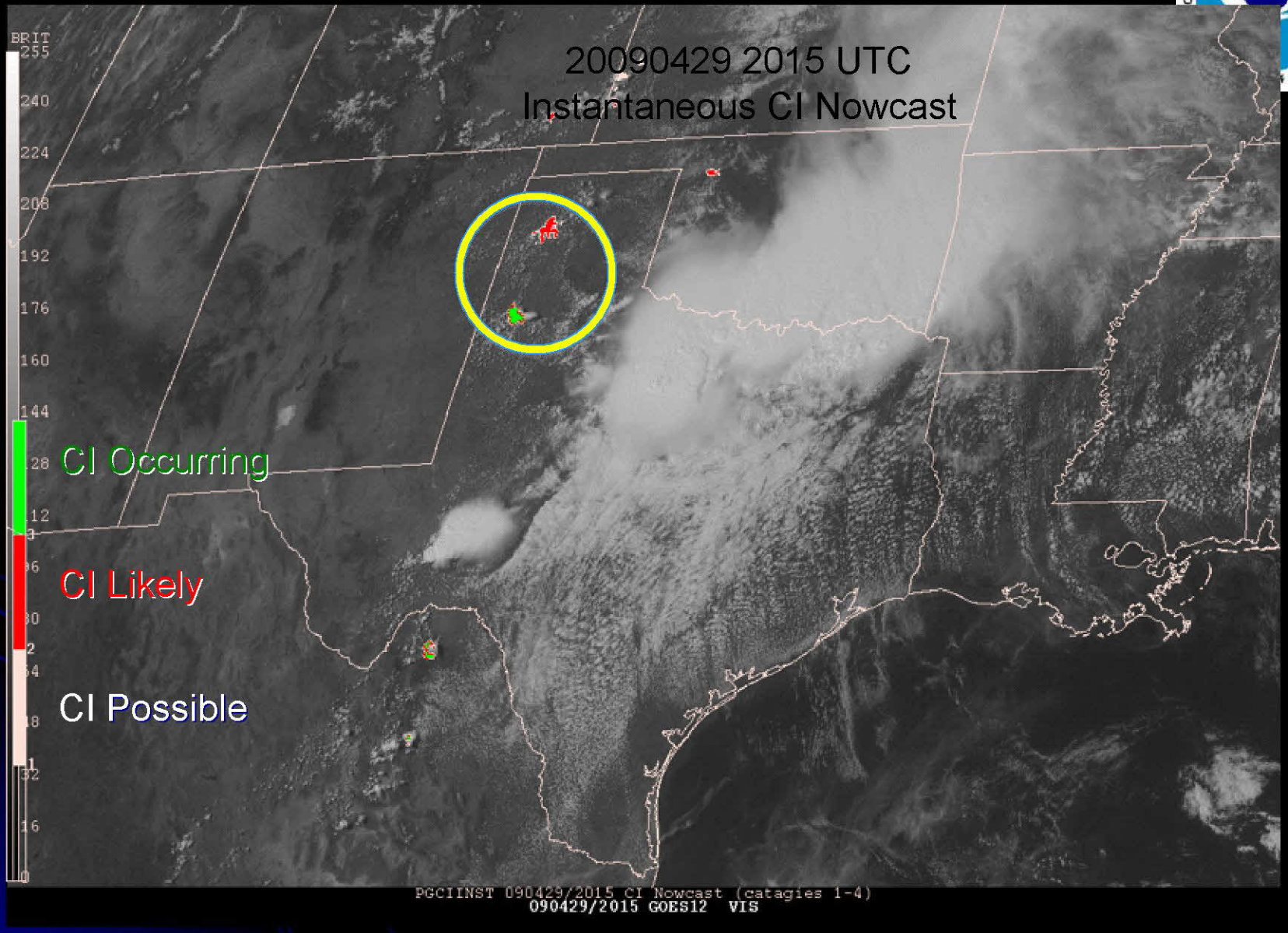
Throw out pixels if >50% of pixels in large box are ice clouds

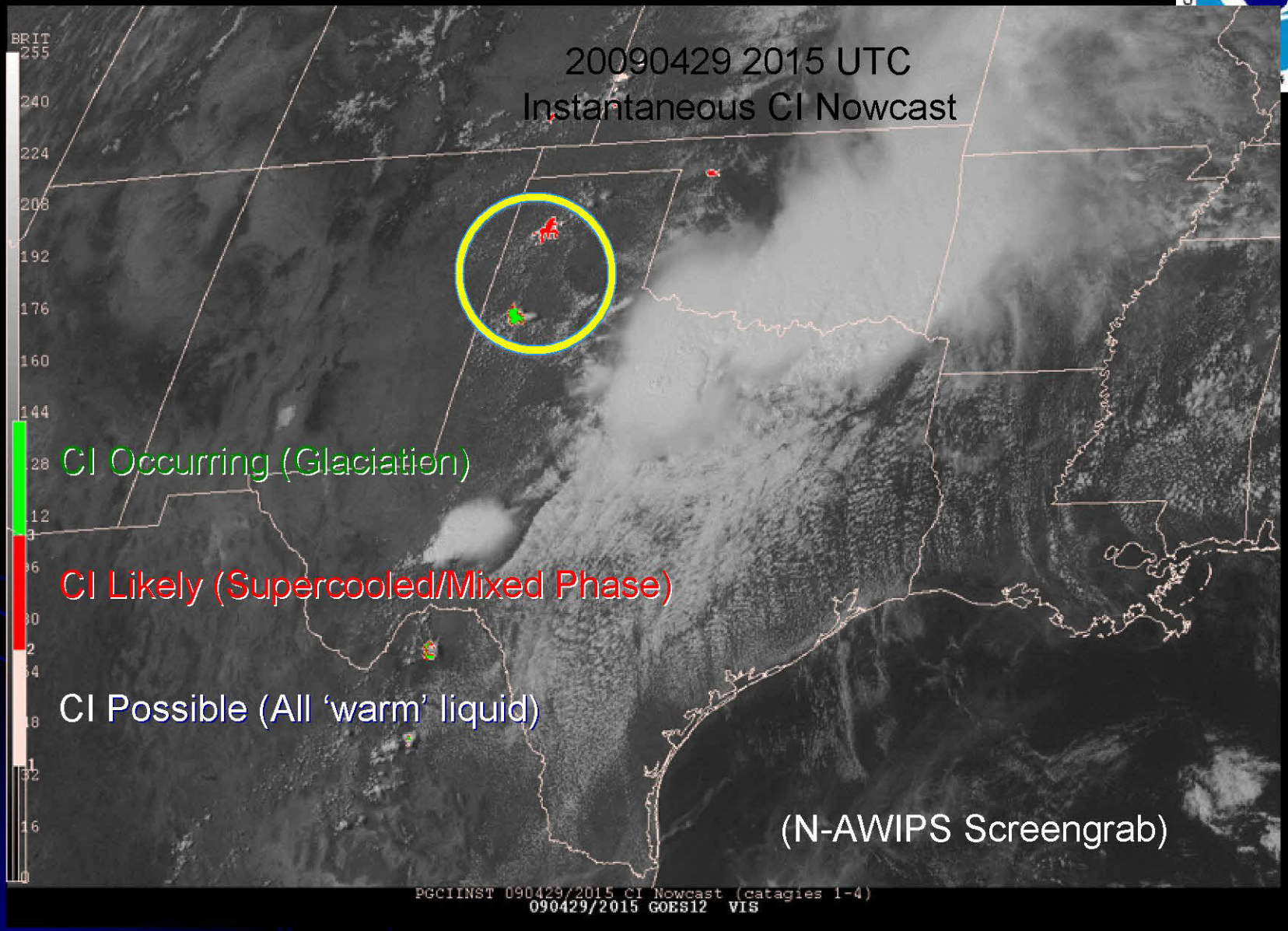
Sieglaff et al, 2010: **Nowcasting Convective Storm Initiation Using Satellite Based Box-Averaged Cloud-Top Cooling and Microphysical Phase Trends, Accepted for publication Journal of Applied Meteorology**

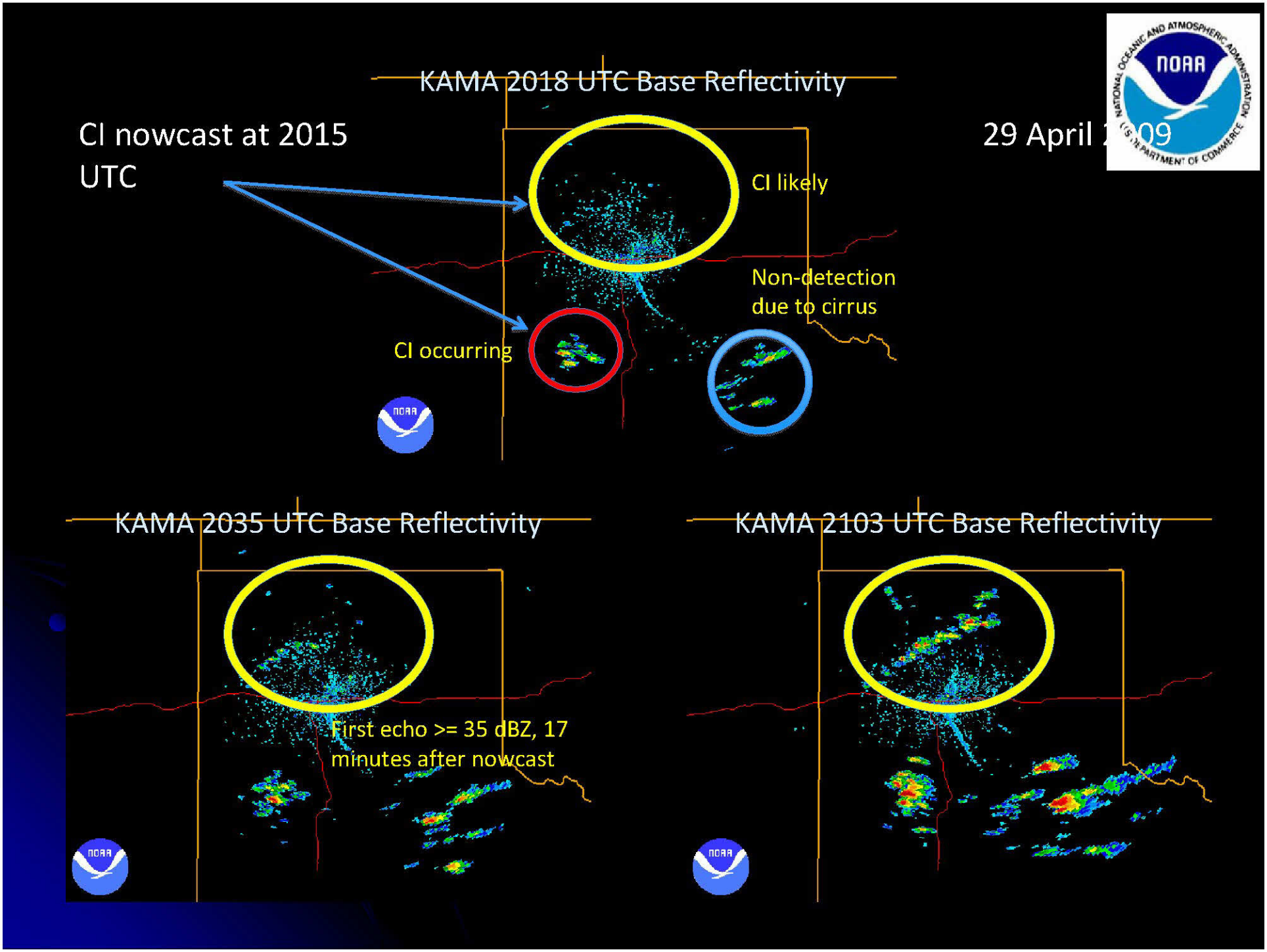

Case Studies

20090429 Dryline CI Case

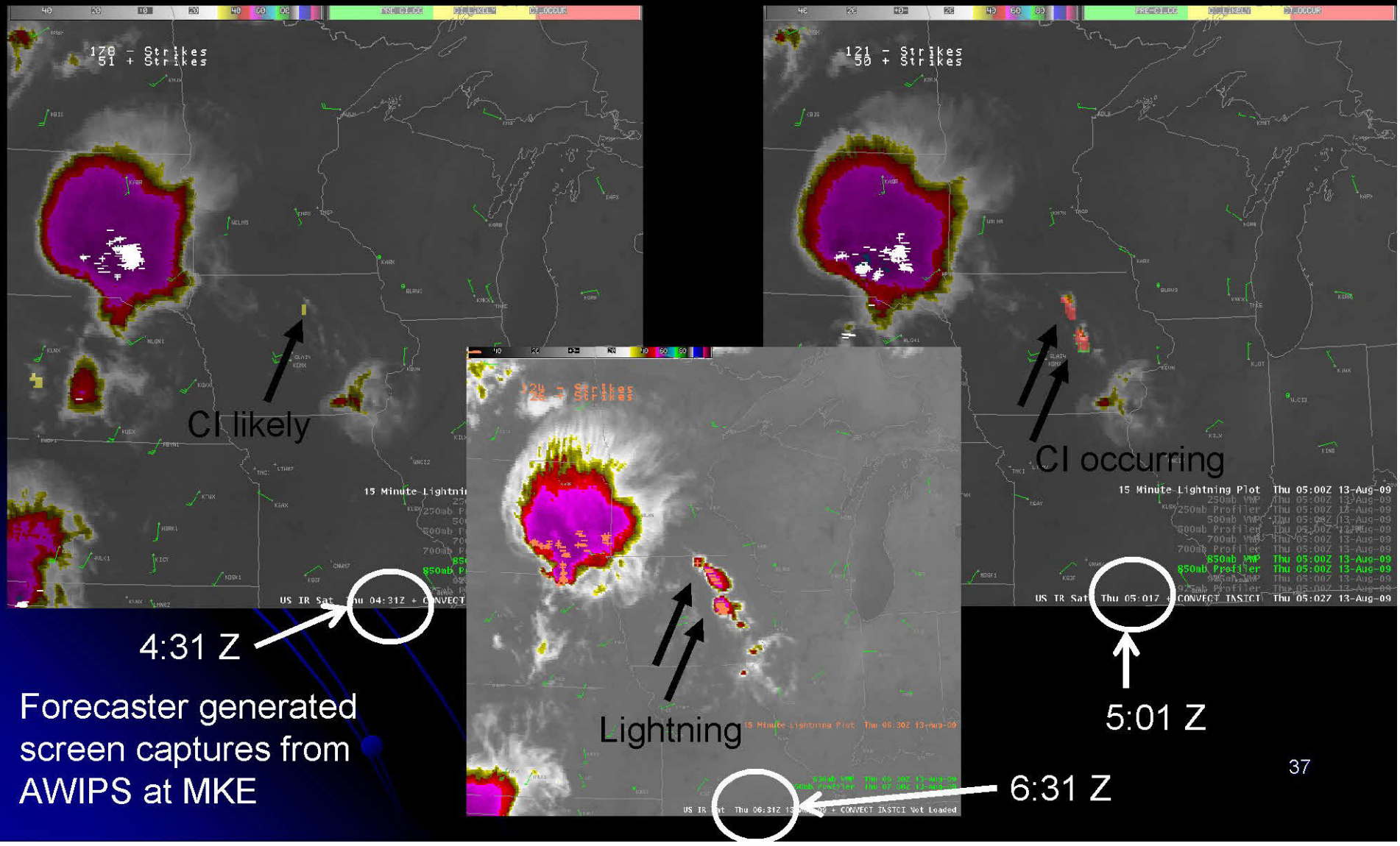



20090429 2015 UTC
Instantaneous CI Nowcast
BRIT
255
240
224
208
192
176
160
144
128
112
96
80
64
48
32
16
0
CI Occurring
CI Likely
CI Possible
PGCIINST 090429/2015 CI Nowcast (catagies 1-4)
090429/2015 GOES12 VIS

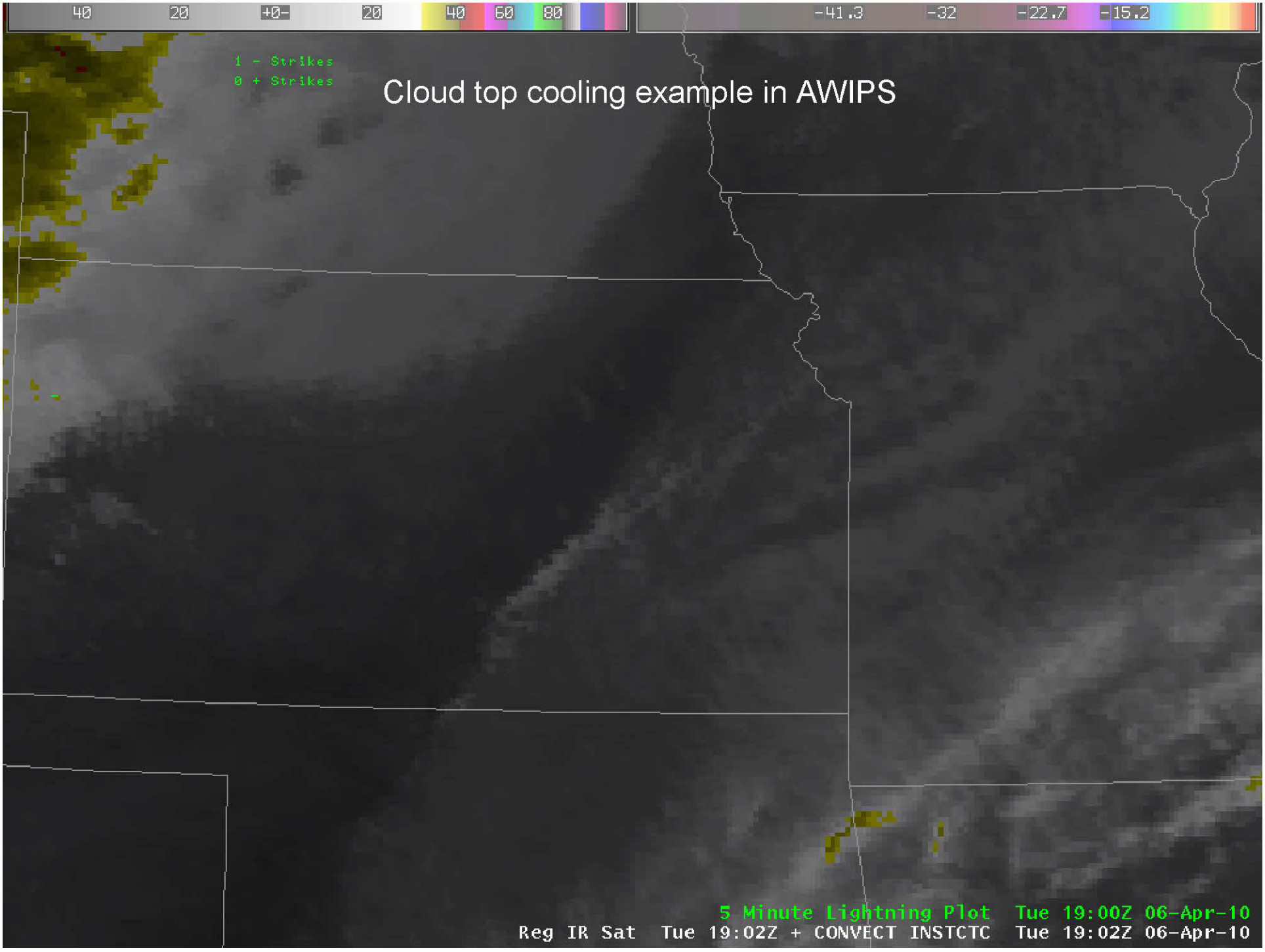

20090429 2015 UTC
Instantaneous CI Nowcast
CI Occurring (Glaciation)
CI Likely (Supercooled/Mixed Phase)
CI Possible (All 'warm' liquid)
(N-AWIPS Screengrab)
BRIT
255
240
224
208
192
176
160
144
128
112
96
80
64
48
32
16
0
PGCIINST 090429/2015 CI Nowcast (catagies 1-4)
090429/2015 GOES12 VIS

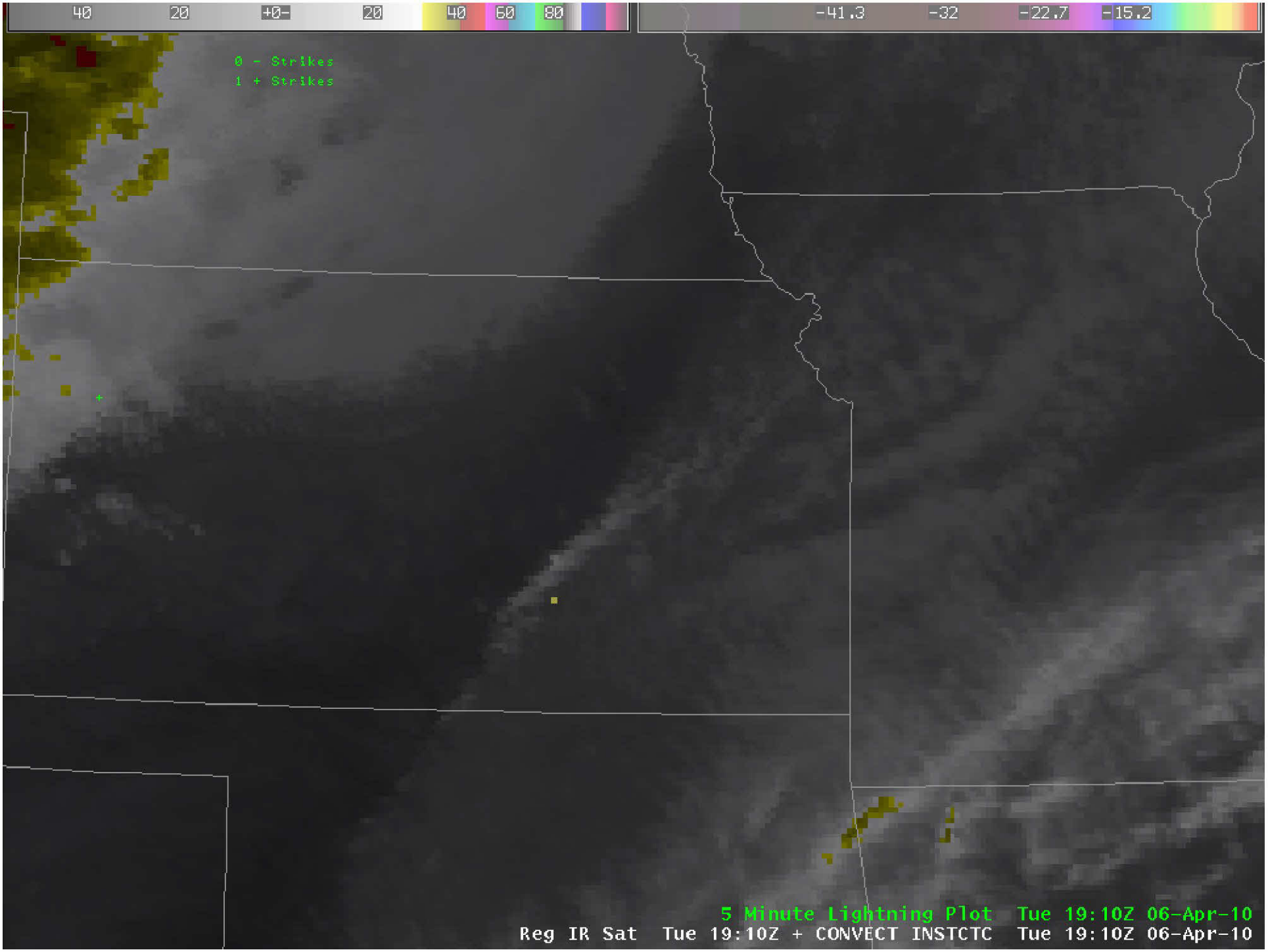

KAMA 2018 UTC Base Reflectivity
CI nowcast at 2015 UTC
29 April 2009
CI likely
Non-detection due to cirrus
CI occurring
KAMA 2035 UTC Base Reflectivity
First echo >= 35 dBZ, 17 minutes after nowcast
KAMA 2103 UTC Base Reflectivity

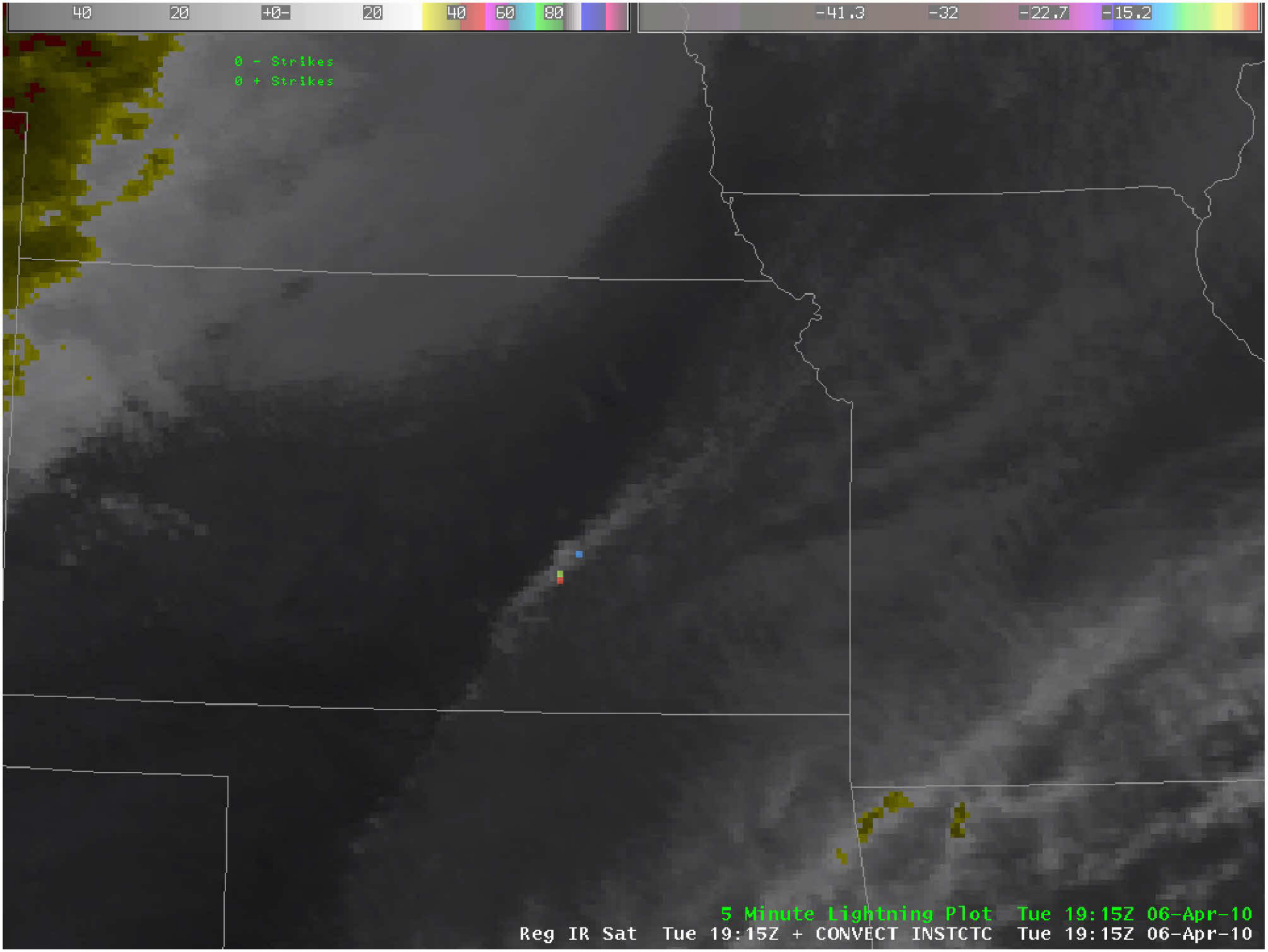
AWIPS CI/CTC Interaction with Sullivan (MKE) NWS Office

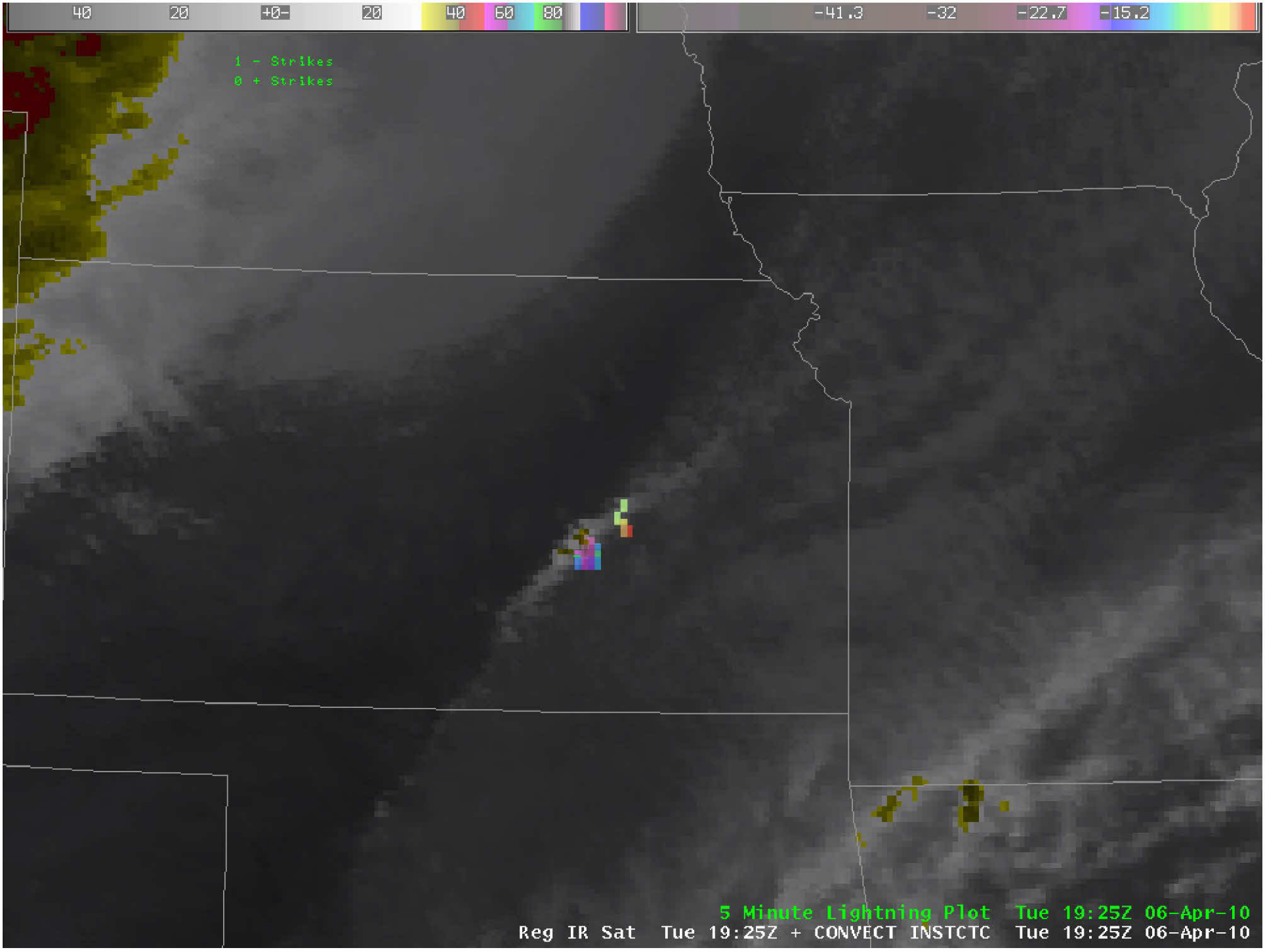


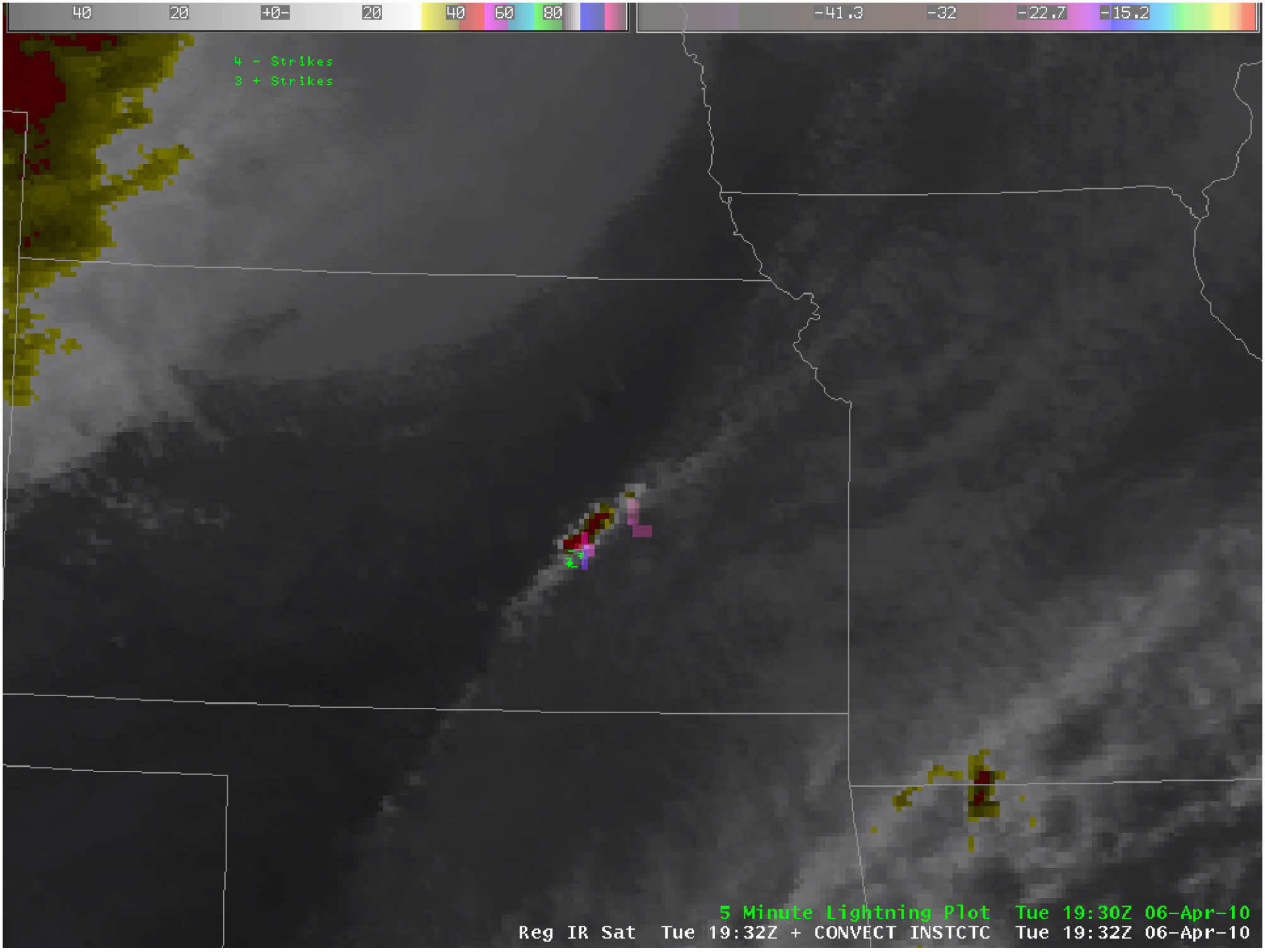
Forecaster generated screen captures from AWIPS at MKE

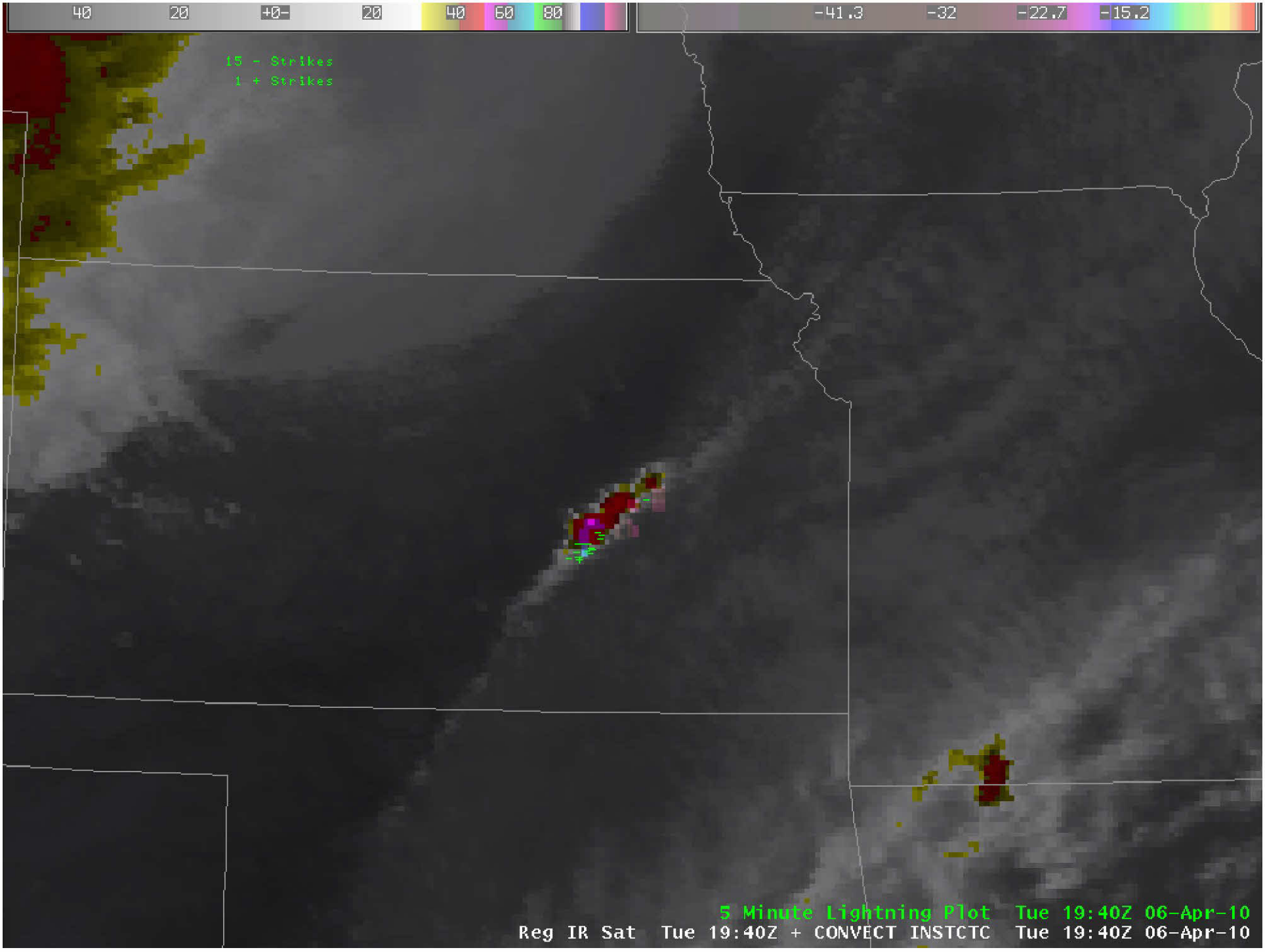

40 20 +0- 20 40 60 80
-41.3 -32 -22.7 -15.2
1 - Strikes
0 + Strikes
Cloud top cooling example in AWIPS
5 Minute Lightning Plot Tue 19:00Z 06-Apr-10
Reg IR Sat Tue 19:02Z + CONVECT INSTCTC Tue 19:02Z 06-Apr-10

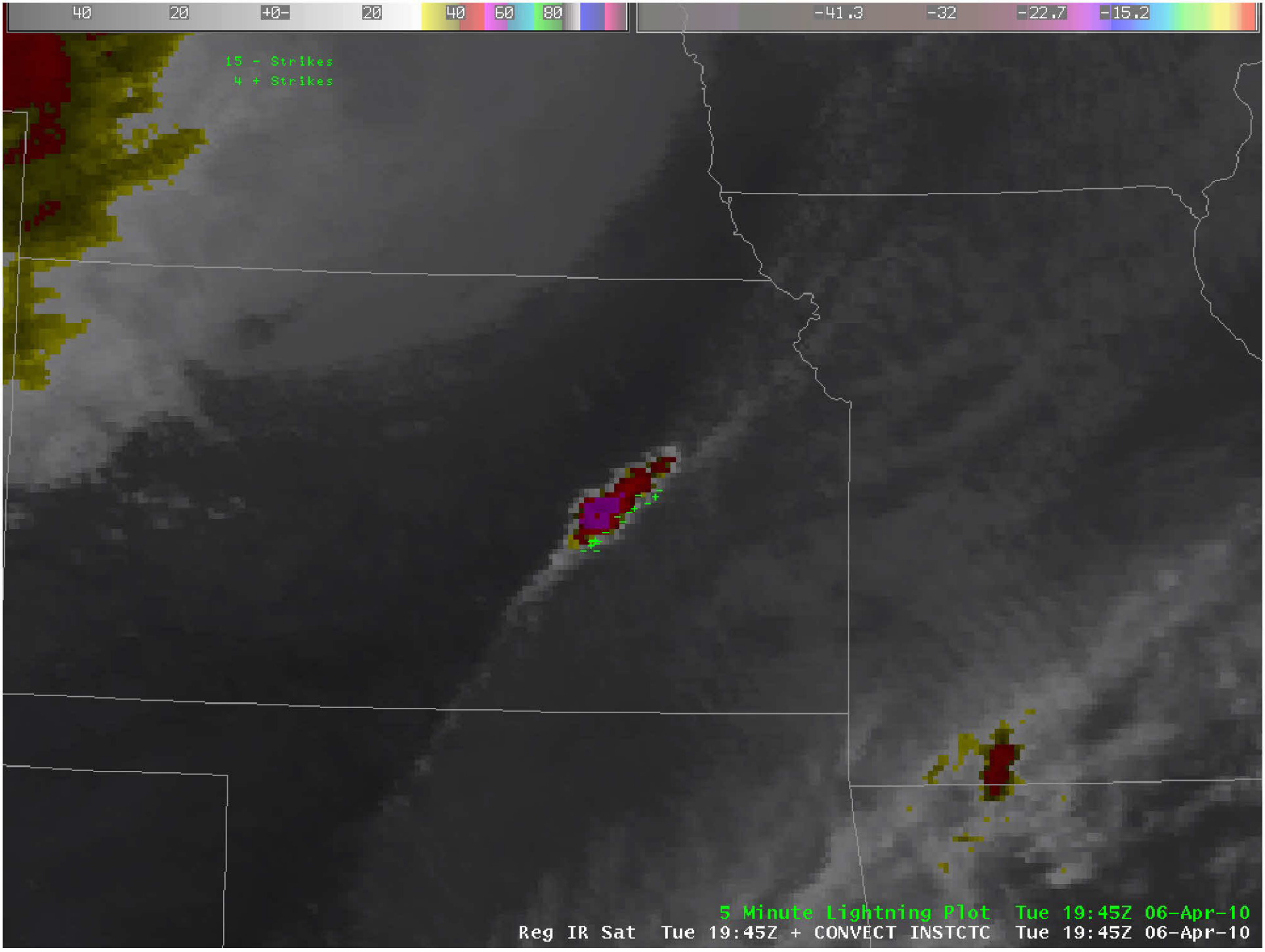

40 20 +0- 20 40 60 80
-41.3 -32 -22.7 -15.2
0 - Strikes
1 + Strikes
5 Minute Lightning Plot Tue 19:10Z 06-Apr-10
Reg IR Sat Tue 19:10Z + CONVECT INSTCTC Tue 19:10Z 06-Apr-10

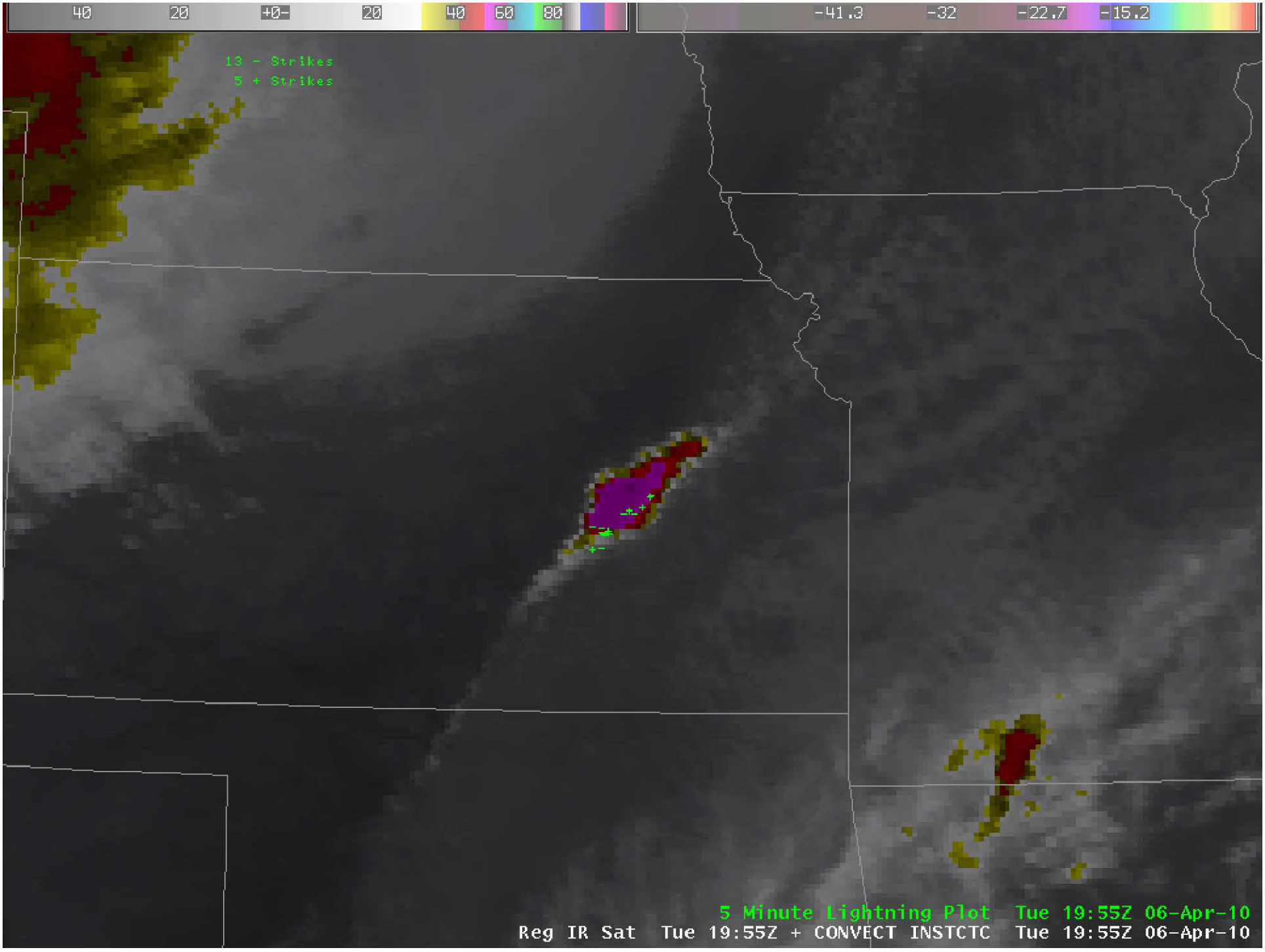

40 20 +0- 20 40 60 80
-41.3 -32 -22.7 -15.2
0 - Strikes
0 + Strikes
5 Minute Lightning Plot Tue 19:15Z 06-Apr-10
Reg IR Sat Tue 19:15Z + CONVECT INSTCTC Tue 19:15Z 06-Apr-10

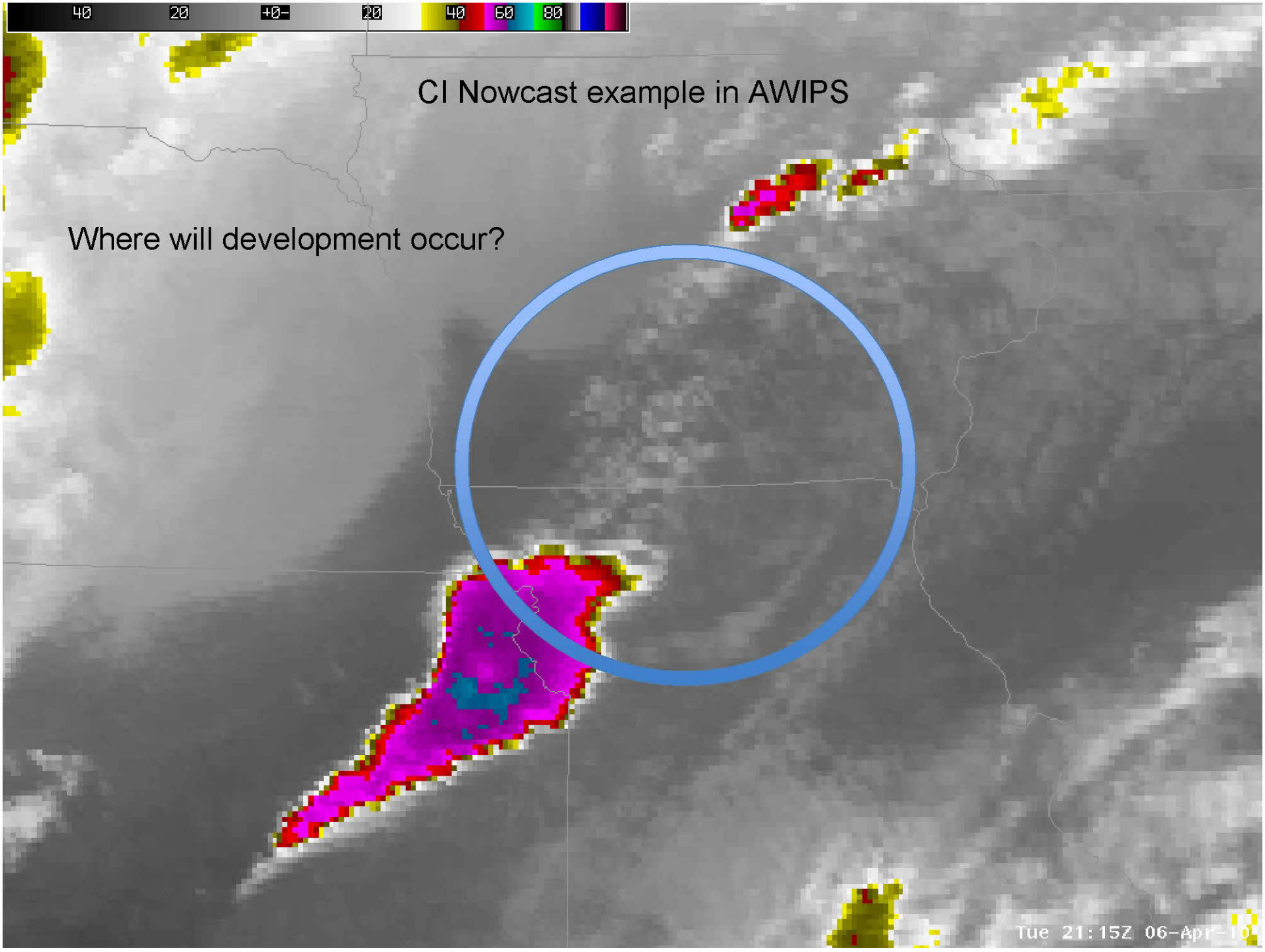

40 20 +0- 20 40 60 80
-41.3 -32 -22.7 -15.2
1 - Strikes
0 + Strikes
5 Minute Lightning Plot Tue 19:25Z 06-Apr-10
Reg IR Sat Tue 19:25Z + CONVECT INSTCTC Tue 19:25Z 06-Apr-10

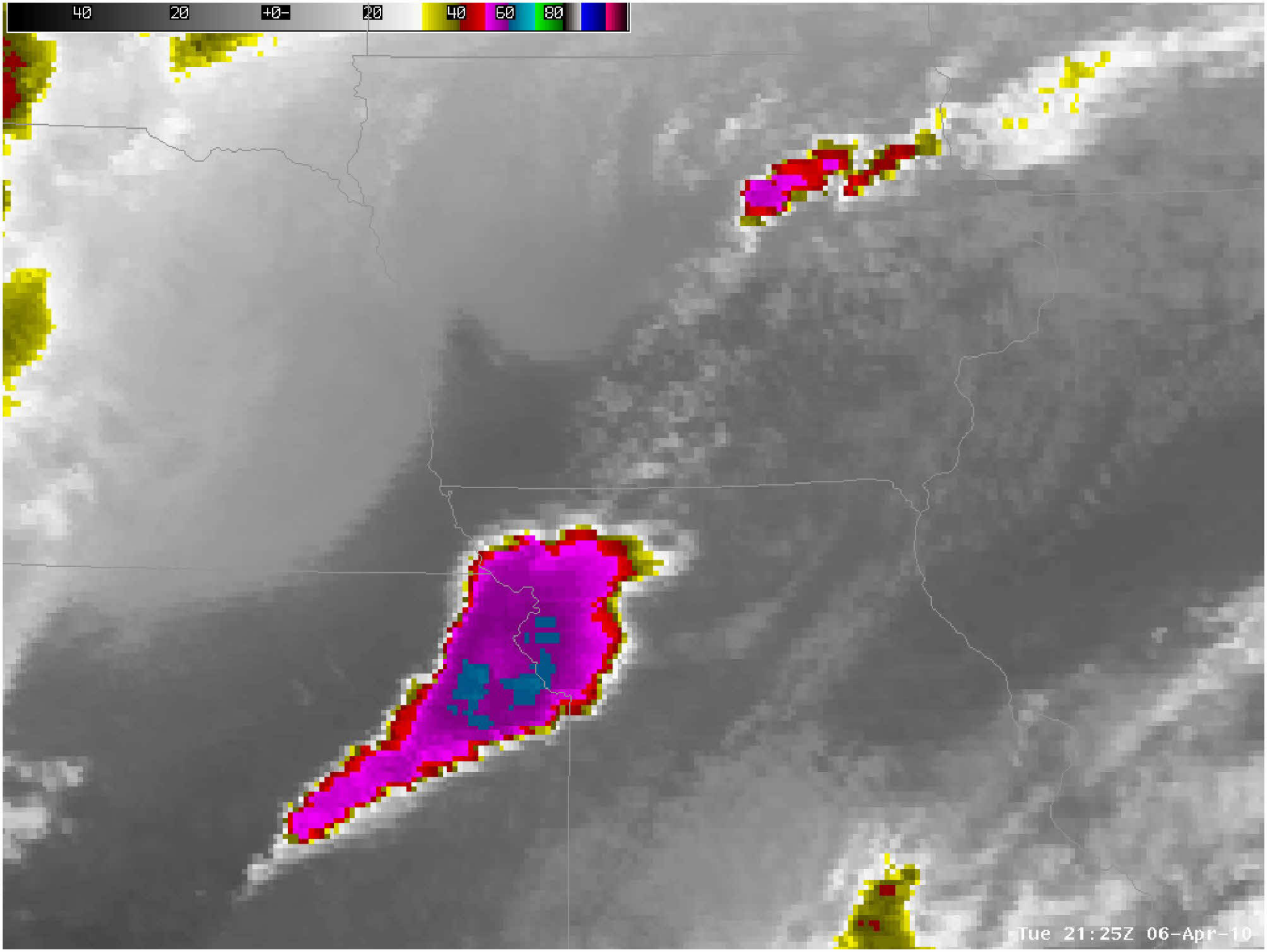

40 20 +0- 20 40 60 80
-41.3 -32 -22.7 -15.2
4 - Strikes
3 + Strikes
5 Minute Lightning Plot Tue 19:30Z 06-Apr-10
Reg IR Sat Tue 19:32Z + CONVECT INSTCTC Tue 19:32Z 06-Apr-10


40 20 +0- 20 40 60 80
-41.3 -32 -22.7 -15.2
15 - Strikes
1 + Strikes
5 Minute Lightning Plot Tue 19:40Z 06-Apr-10
Reg IR Sat Tue 19:40Z + CONVECT INSTCTC Tue 19:40Z 06-Apr-10


40 20 +0- 20 40 60 80
-41.3 -32 -22.7 -15.2
15 - Strikes
4 + Strikes
5 Minute Lightning Plot Tue 19:45Z 06-Apr-10
Reg IR Sat Tue 19:45Z + CONVECT INSTCTC Tue 19:45Z 06-Apr-10


40 20 +0- 20 40 60 80
-41.3 -32 -22.7 -15.2
13 - Strikes
5 + Strikes
5 Minute Lightning Plot Tue 19:55Z 06-Apr-10
Reg IR Sat Tue 19:55Z + CONVECT INSTCTC Tue 19:55Z 06-Apr-10


40 20 +0- 20 40 60 80
CI Nowcast example in AWIPS
Where will development occur?
Tue 21:15Z 06-Apr-10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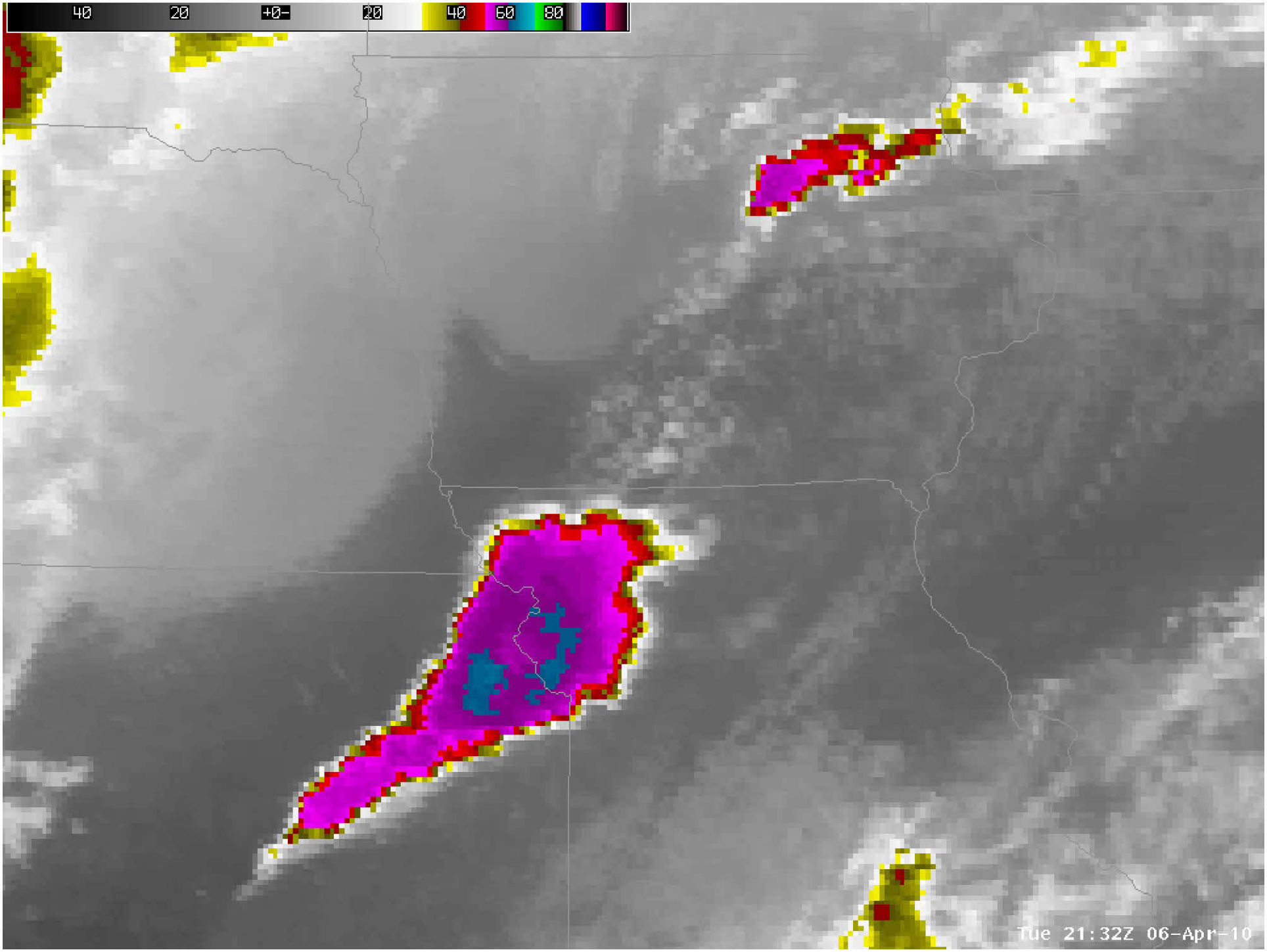
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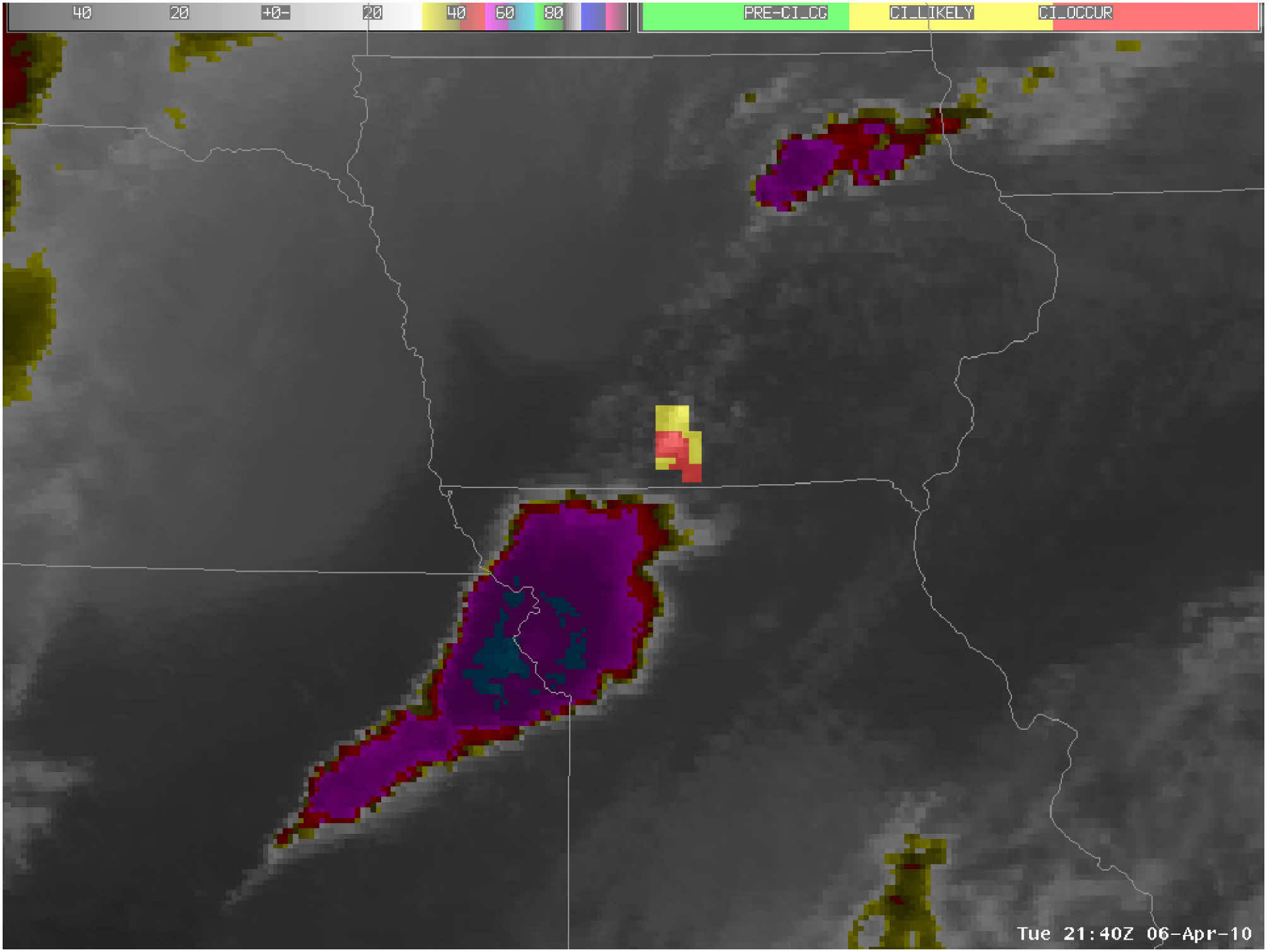
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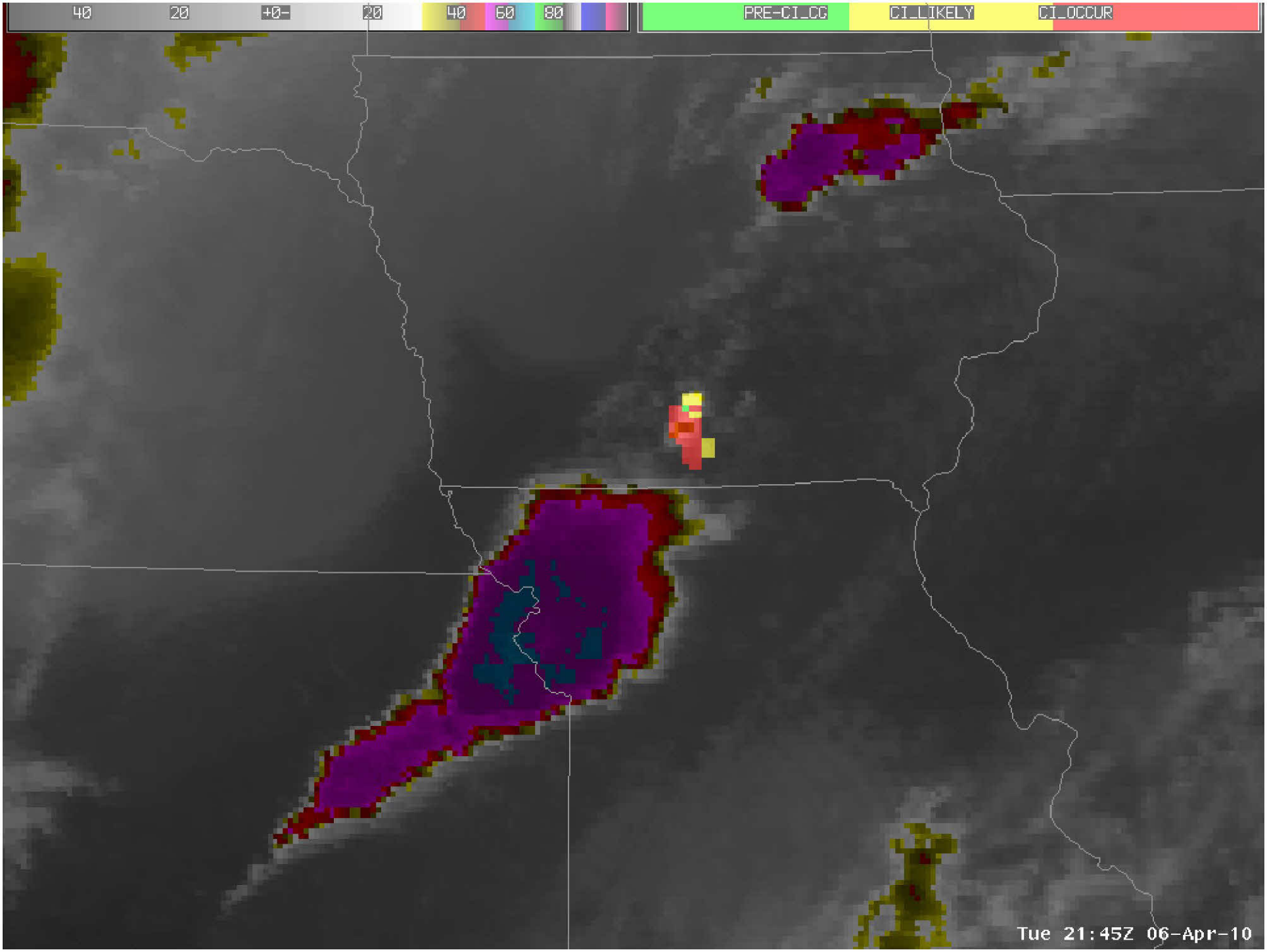
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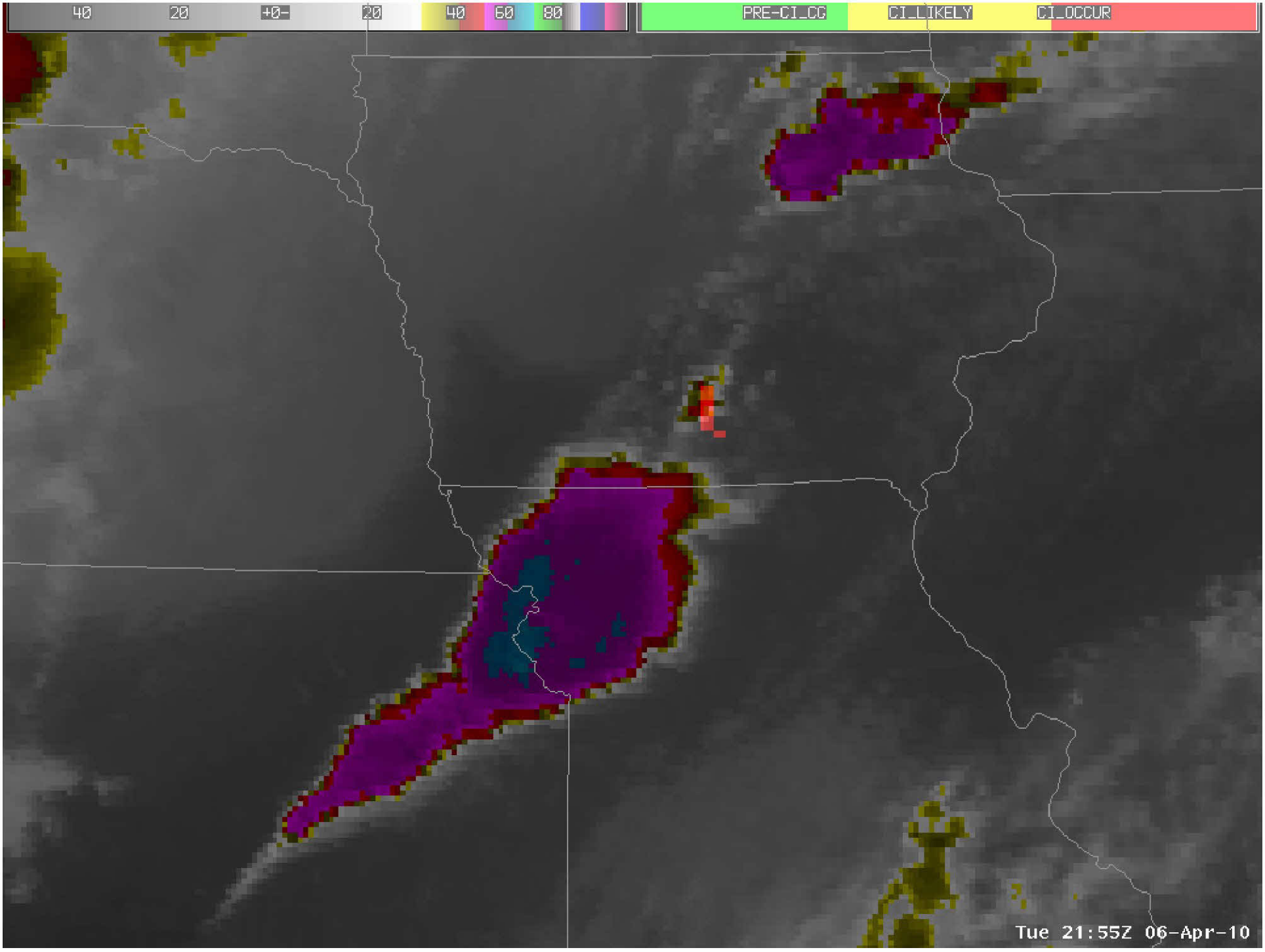
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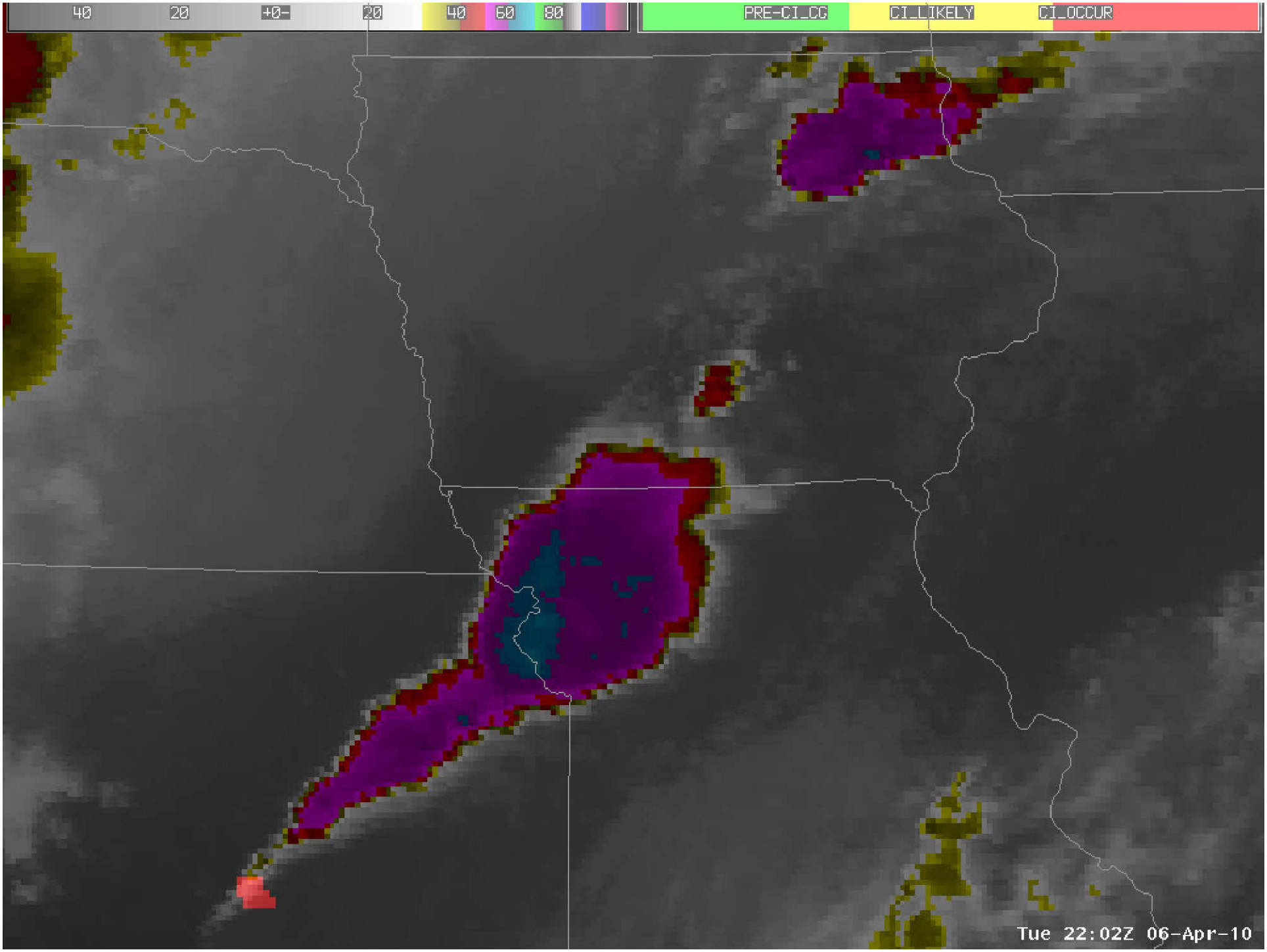
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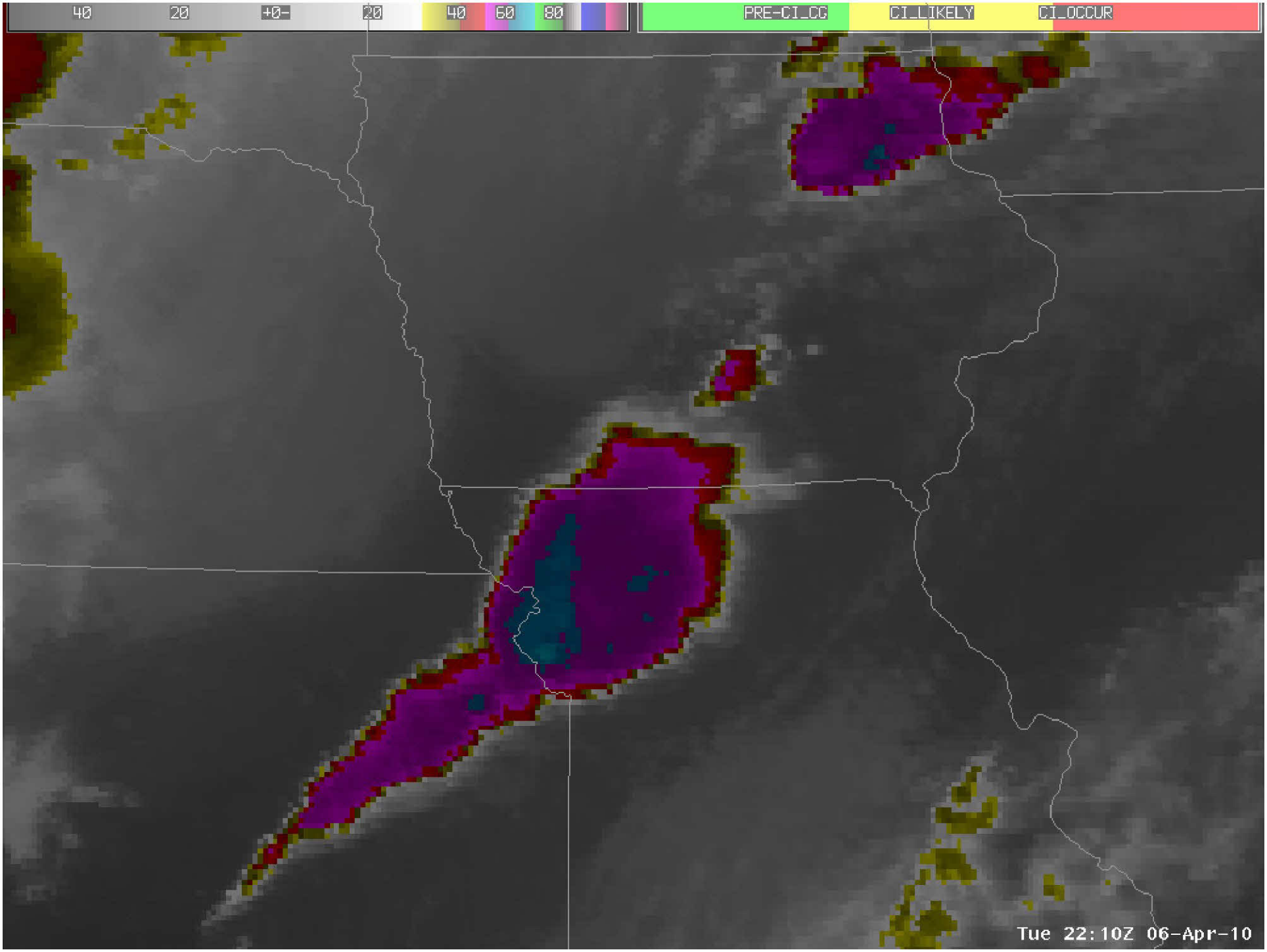
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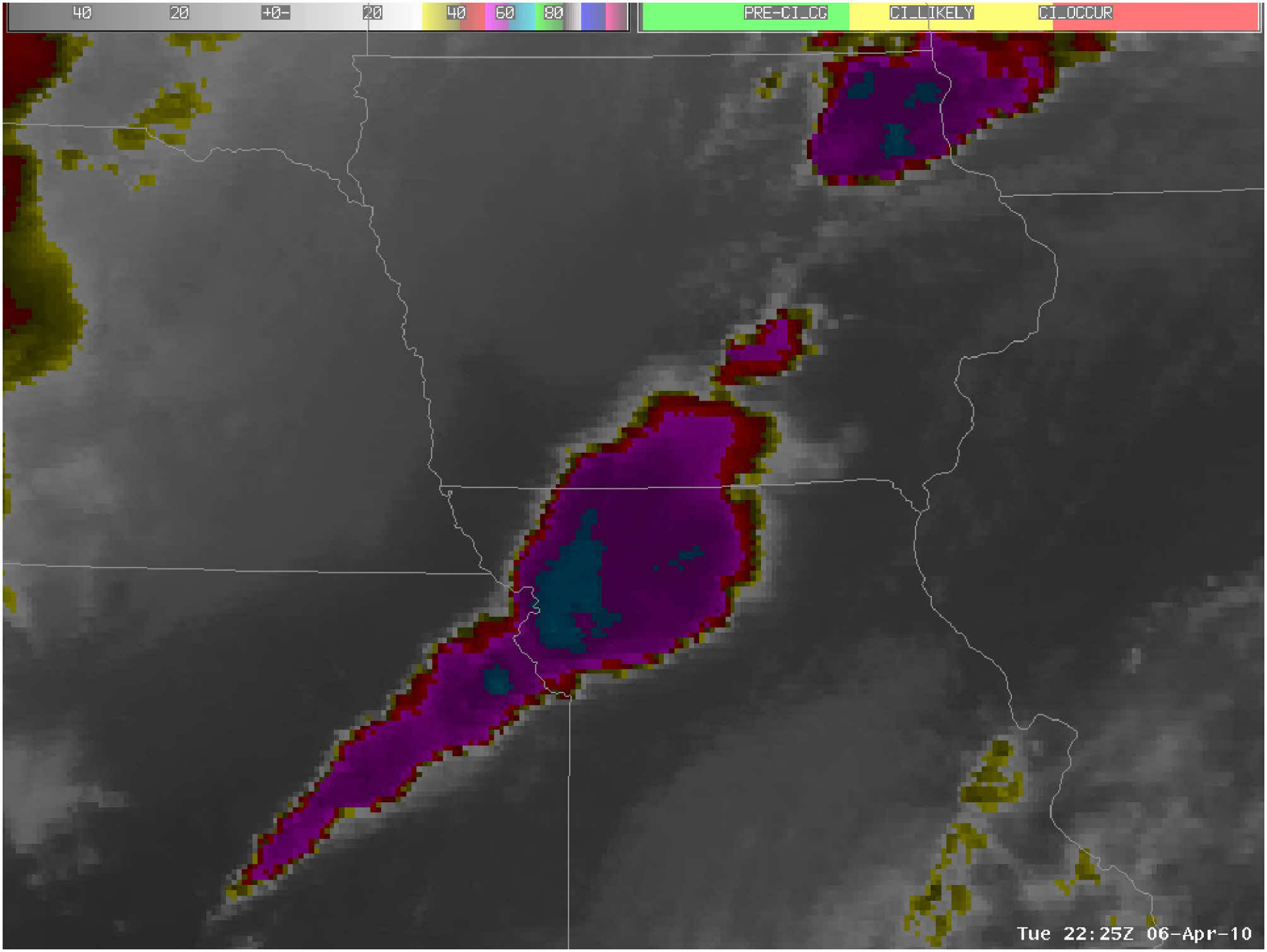
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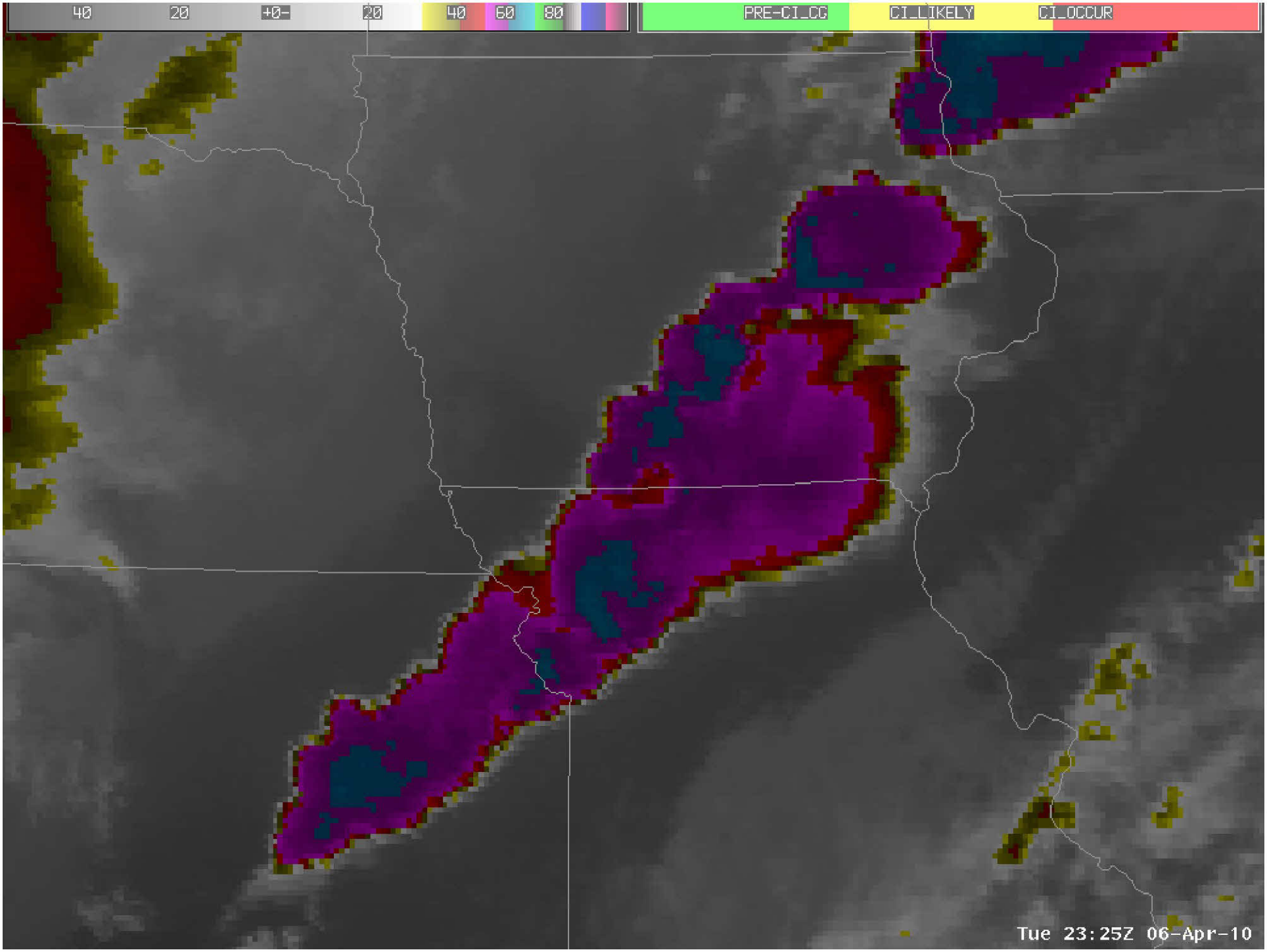
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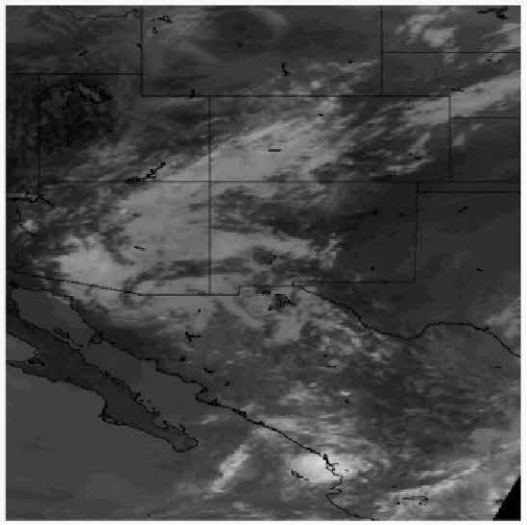
Tue 23:25Z 06-Apr-10

GOES-11 Capable

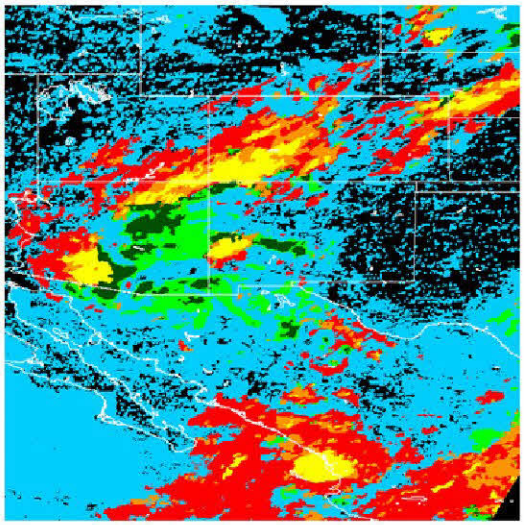
GOES-11 4km IRW: July 22, 2010 1715 UTC



Brightness Temperature (K)

190 200 210 220 230 240 250 260 270 280 290 300 310 320

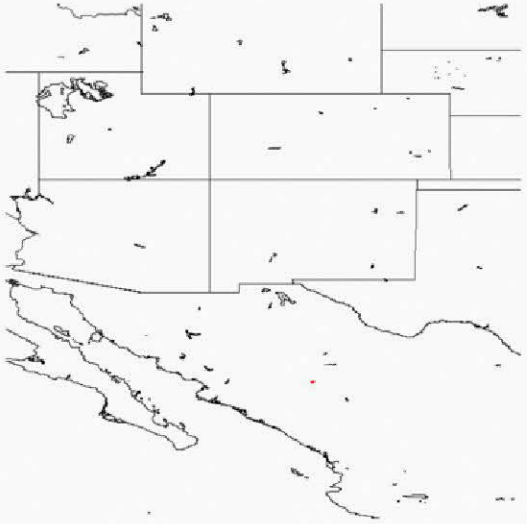
Cloud Type: July 22, 2010 1715 UTC



Cloud Type

Clear Fog Water Supercooled Mixed Thick Ice Thin Ice Overlap Spare Unknown

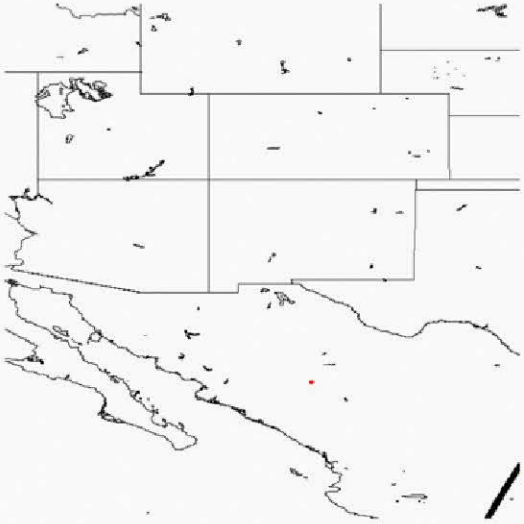
Box Avg Cloud Top Cooling: July 22, 2010 1715 UTC



Box Averaged CTC (K)

−30 −25 −21 −17 −12 −8 −4

Convective Initiation: July 22, 2010 1715 UTC

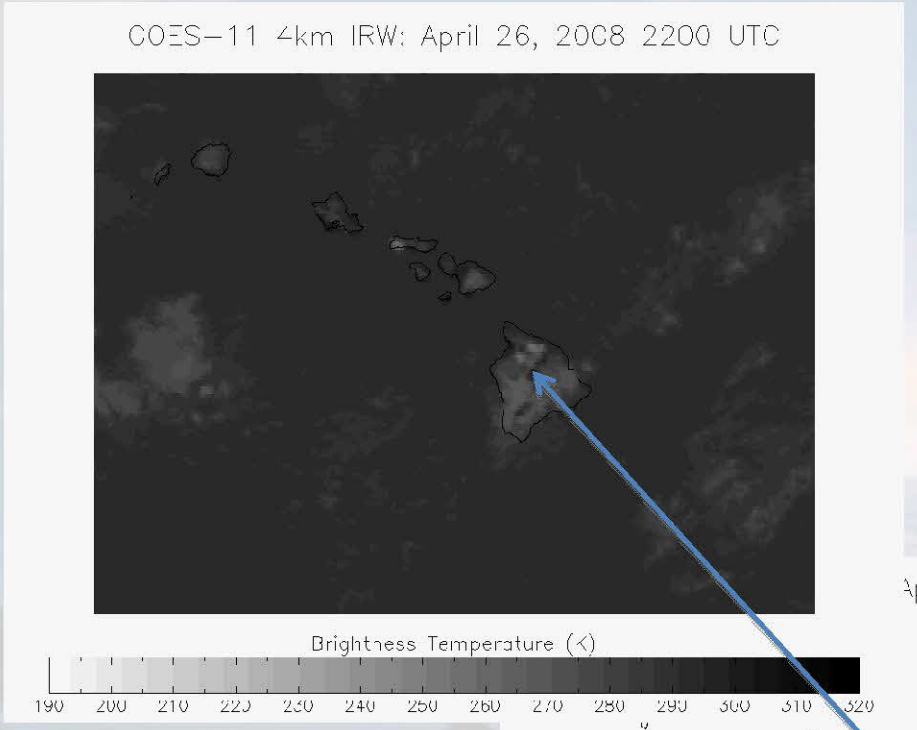


Convective Initiation

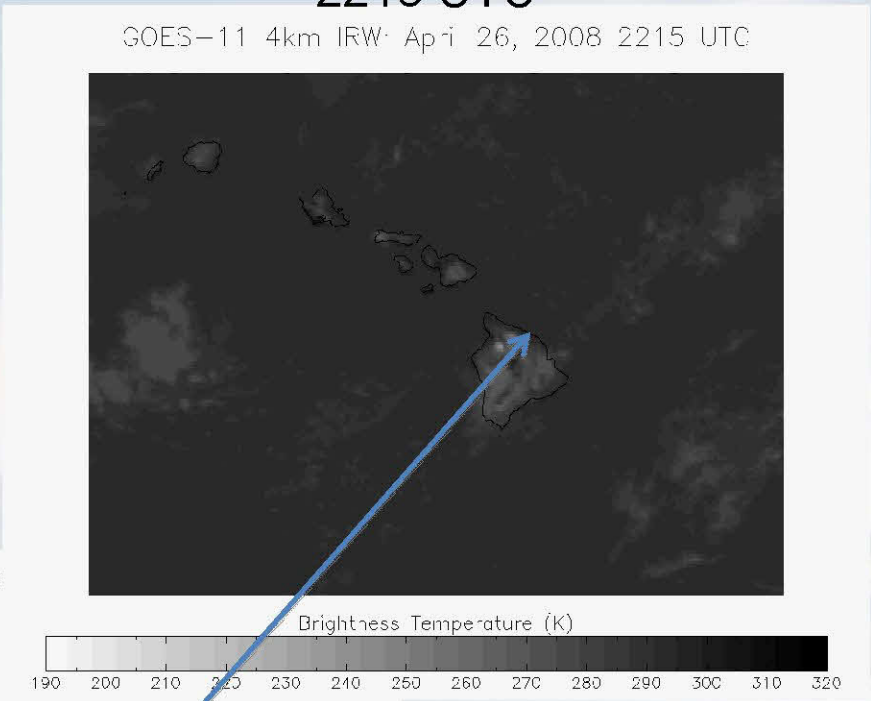
No CI Pre-CI Cloud Growth CI Likely CI Occuring

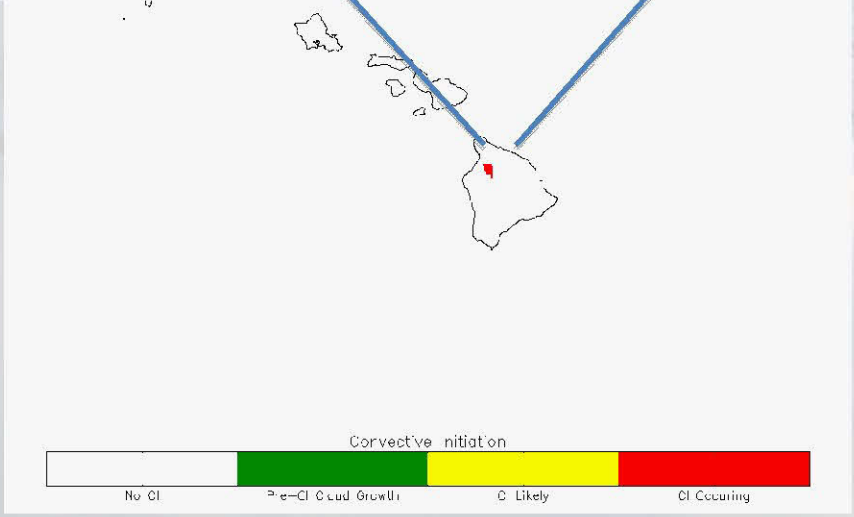
GOES-11 Imager UWCI Support for Hawaii

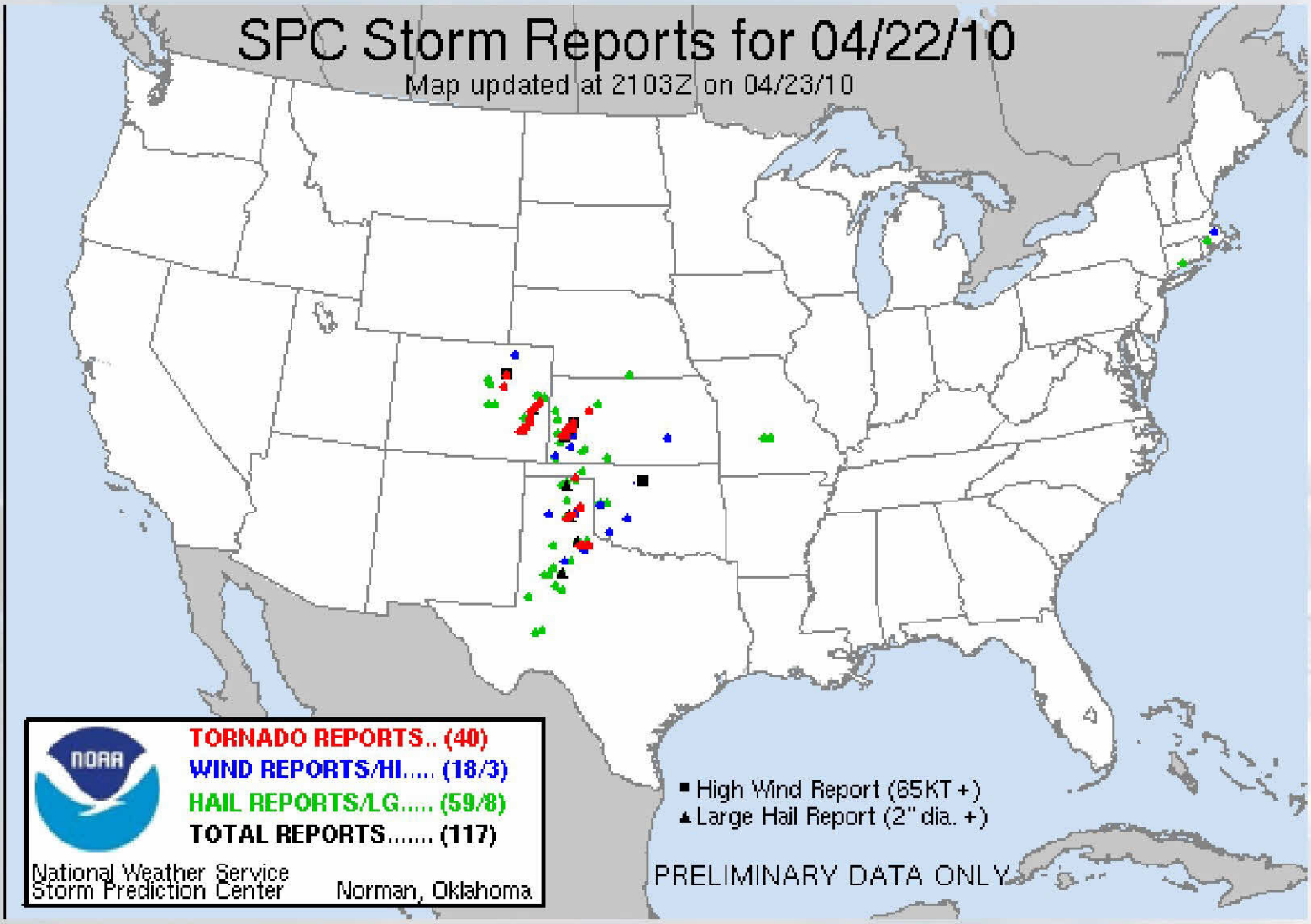
2200 UTC



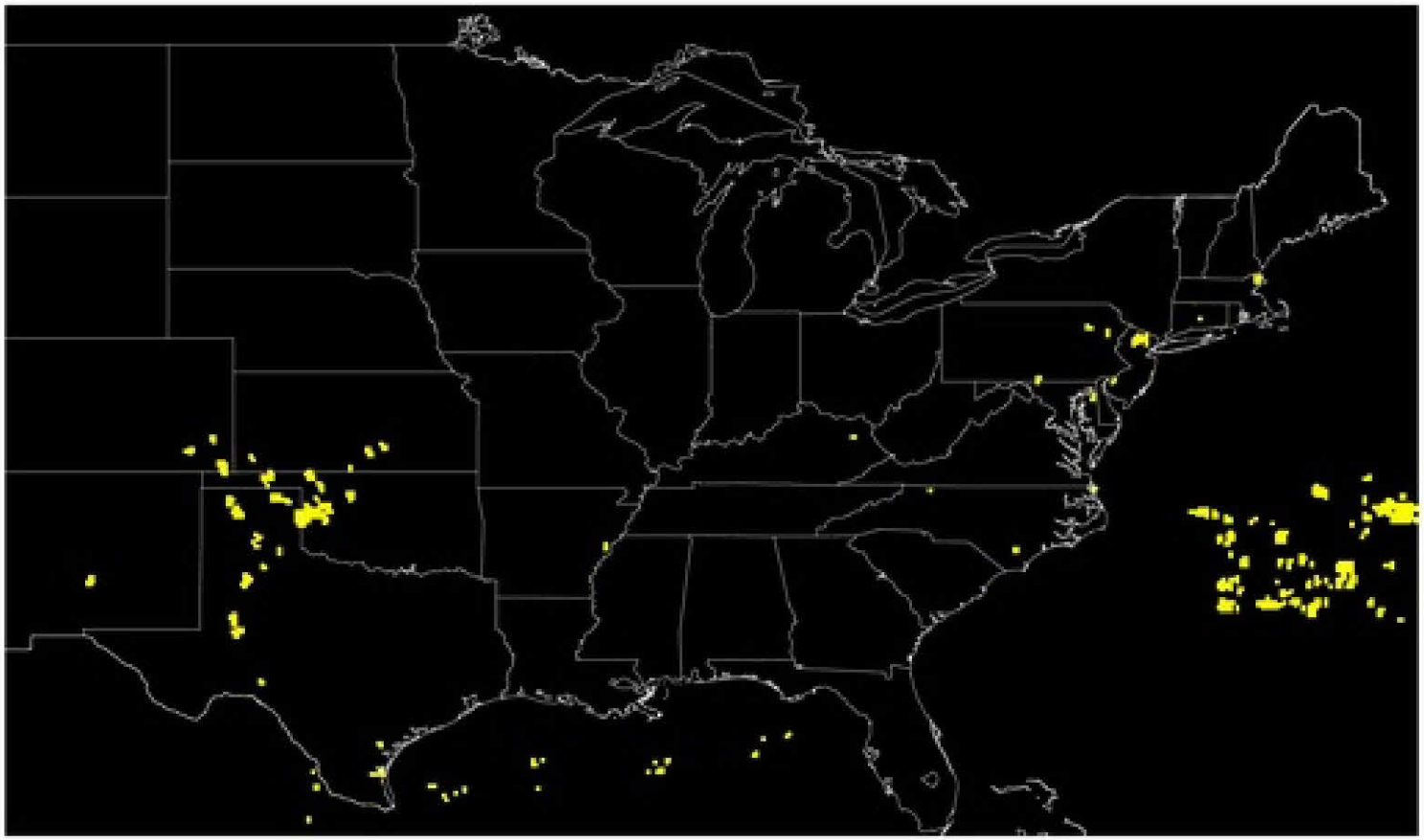
2215 UTC






SPC Storm Reports for 04/22/10
Map updated at 2103Z on 04/23/10
TORNADO REPORTS.. (40)
WIND REPORTS/HI..... (18/3)
HAIL REPORTS/LG..... (59/8)
TOTAL REPORTS..... (117)
National Weather Service
Storm Prediction Center
Norman, Oklahoma
High Wind Report (65KT +)
Large Hail Report (2" dia. +)
PRELIMINARY DATA ONLY

24-hour CI valid from
20100422 1200 UTC to 20100423 1200 UTC



Current Status UWCI

- UWCI are available in GRIB2 format -> AWIPS, N-AWIPS, AWIPS-II, McIDAS-V, GEMPAK, and other visualization software.
- Training is provided via Visitview module and web based sessions
- Transition to GOES West processing in ongoing
- Evaluations at: SPC, AWC, MKX WFO, CRH
- Algorithm peer reviewed paper has been accepted for publication and further information is available at:

http://cimss.ssec.wisc.edu/goes_r/proving-ground/SPC/SPC.html

UWCI Conclusions

- Algorithm considers both cloud-top temperature changes and cloud type changes
- Works day and night
- Lead time of up 45 minutes before 35 dbZ echoes is common
- Several checks to minimize false alarms: When CI says convection is initiating, it usually is (POD: 55.6%; FAR: 26.0%)

CI Conclusions

Nowcast forecasts more than half the storms that develop

- Lead tim… …oes is comm…
- Several checks to minimize false alarms. When CI says convection is initiating, it usually is (POD: 55.6%; FAR: 26.0%)

Forecaster can trust that 3 out of 4 forecasts verifies

CI Conclusions

Nowcast forecasts more than half the storms that develop

Forecaster can trust that 3 out of 4 forecasts verifies

- Lead tim… …pes is comm…
- Several checks to minimize false alarms. When CI says convection is initiating, it usually is (POD: 55.6%; FAR: 26.0%)

Stats are from UWCI nowcasts and newly-developing CG-producing storms occurring within SLGT (or greater) RSK boxes for 23 convective afternoons (1800 – 0000 UTC) in Spring/Summer 2008 and 2009. CI nowcasts: 288; LI events: 260. Includes clear sky days when POD is very high and cirrus-filled days when POD is low.

More information on UWCI

- Satellite blog: http://cimss.ssec.wisc.edu/goes/blog (check on the 'Convective initiation' category)
- Strengths and weaknesses are discussed at http://cimss.ssec.wisc.edu/goes_r/proving-ground/GOES_CINowcast.htm
  - Ice clouds and rapidly moving clouds cause problems
  - 30-minute step between imagery? Detection drops

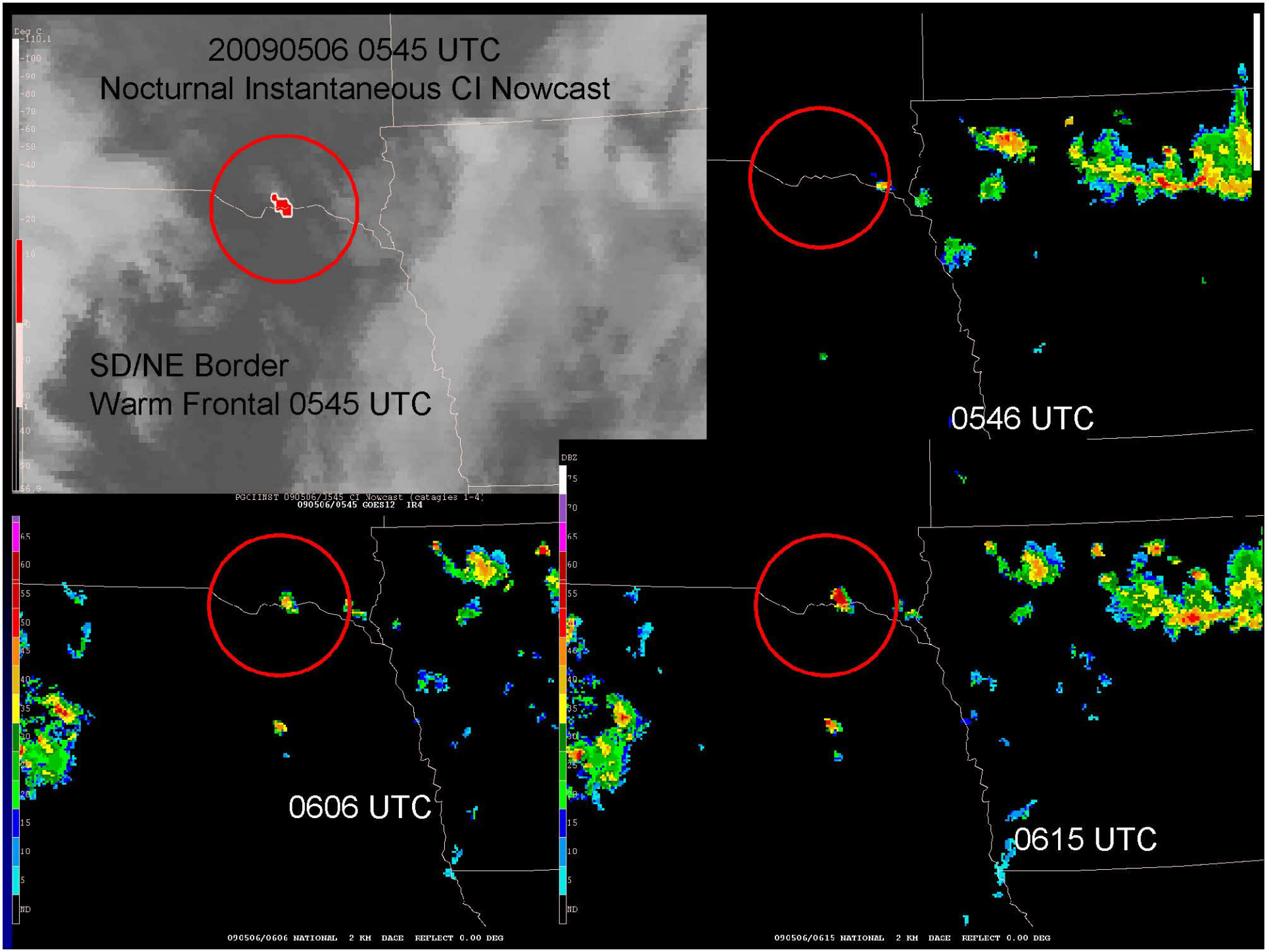
Source of Confusion: More than one CI algorithm exists!

- CI from UAH (SatCast)
  - Daytime Only
  - Uses pixel-based mesoscale Atmospheric Motion Vectors
  - Uses multispectral GOES IR data
  - Computationally intense (esp. to compute vectors)
  - Being extended via object tracking

Source of Confusion: More than one CI algorithm exists!

- CI from CIMSS
  - 24-hour coverage
  - Uses cloud-typing algorithm to detect phase changes
  - Uses multispectral GOES IR data
  - Not computational intensive

- CI from UAH (SatCast)
  - Daytime Only
  - Uses pixel-based mesoscale Atmospheric Motion Vectors
  - Uses multispectral GOES IR data
  - Computationally intense (esp. to compute vectors)
  - Being extended via object tracking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Nocturnal Instantaneous CI Nowcast
SD/NE Border
Warm Frontal 0545 UTC
0546 UTC
0606 UTC
0615 UTC
090506/0606 NATIONAL 2 KM DAGE REFLECT 0.00 DEG
090506/0615 NATIONAL 2 KM DAGE REFLECT 0.00 DEG

Nebraska 090724: Nocturnal Case