Science Goal: relate hydrometeor types, kinematic fields to electrification

Where we are right now

LMA / KTYX data available

DOW data now QC’ed and available

EFM data in QC

Imager data in need of final processing step

Ground precipitation observations

IOPs with known flashes

	DOW data	Imager data	EFM data (UTC)
IOP2a	-	-	-
IOP2	1 flash intersected scan volumes	-	2258; 0139; 0252
IOP3	RHIs perpendicular through flash producing band, 20-40 km away (1048-1130 UTC)	Ground level	-
IOP11 (GTRI only)	<10 km from flashes	-	0211

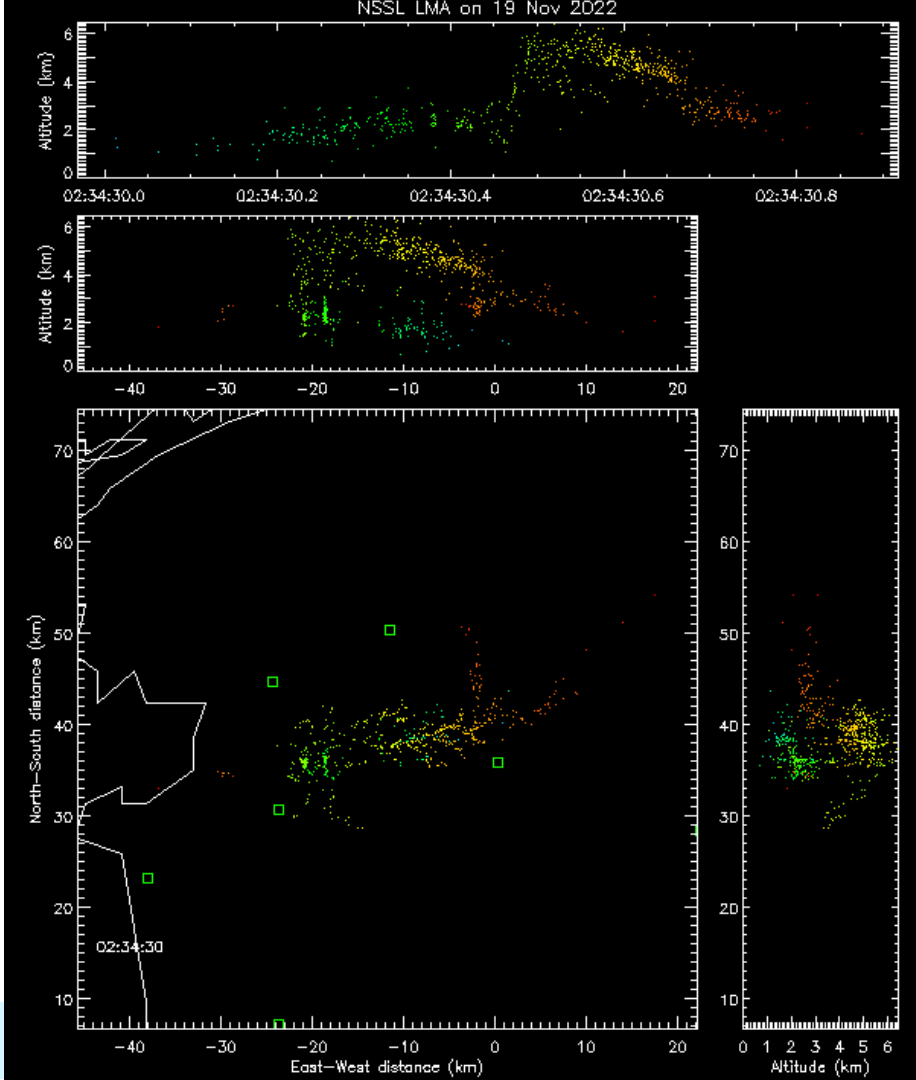
One flash that's especially intriguing from IOP2

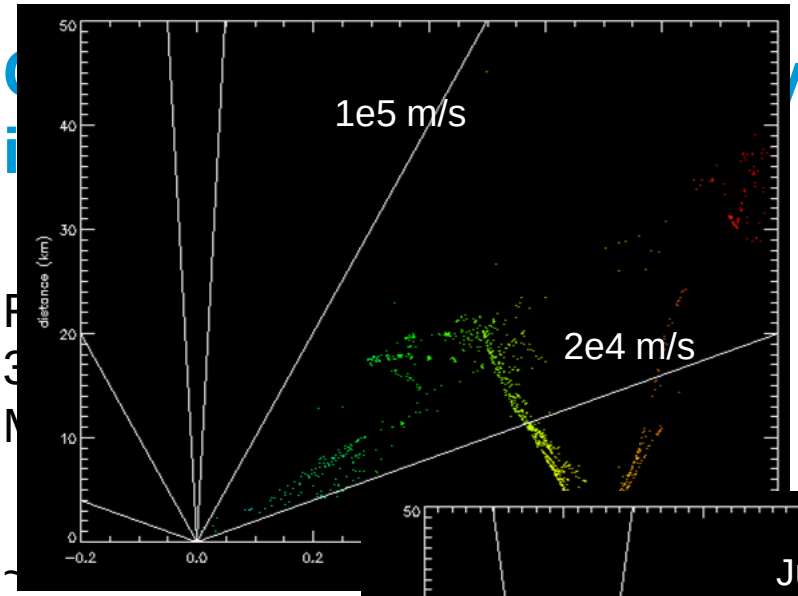
Flashes about hourly, most below 3 km, but one approaching 6 km MSL

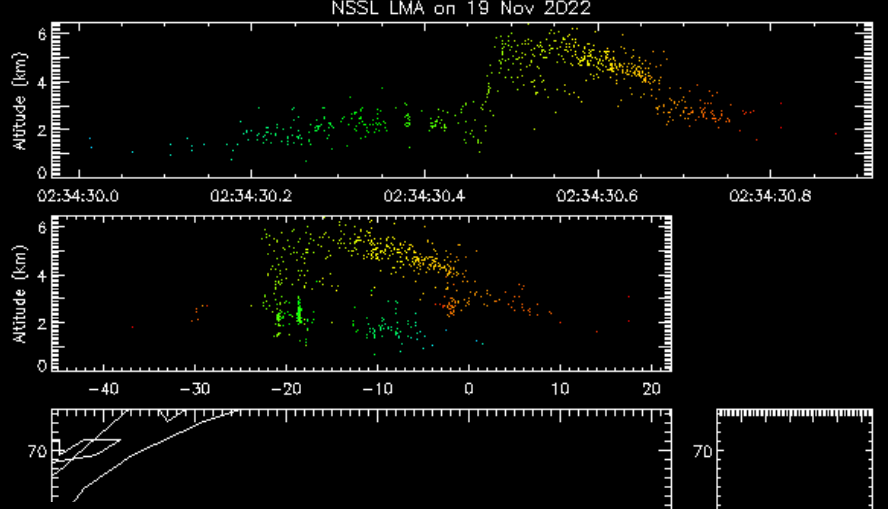
~1 hr after EFM launch #2

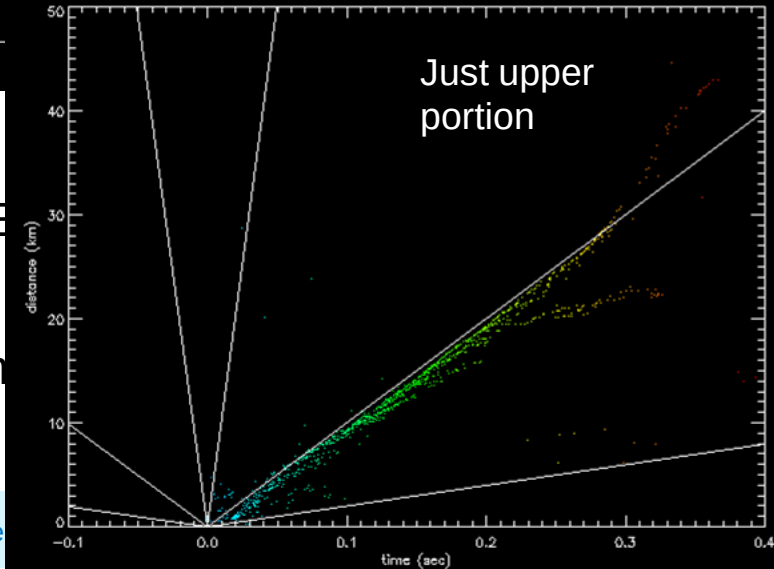
~20 min before EFM launch #3

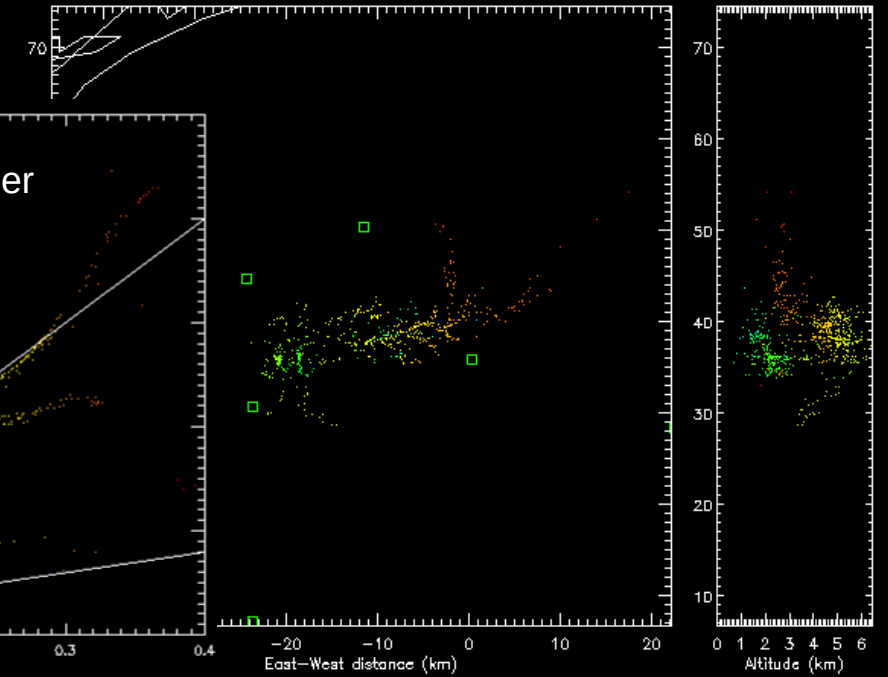
Similar flashes in IOP3!







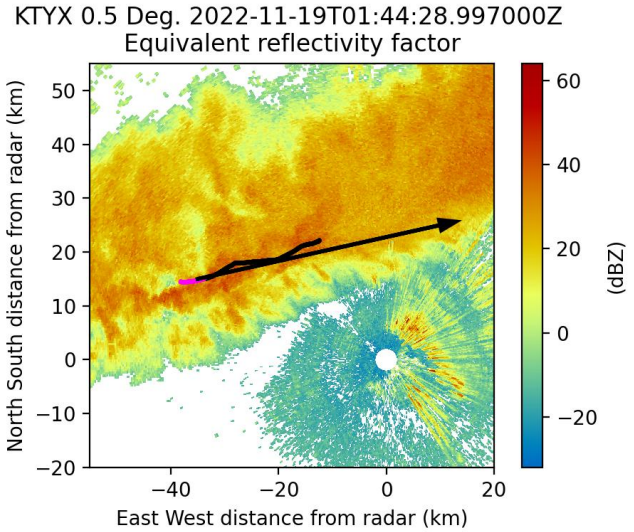


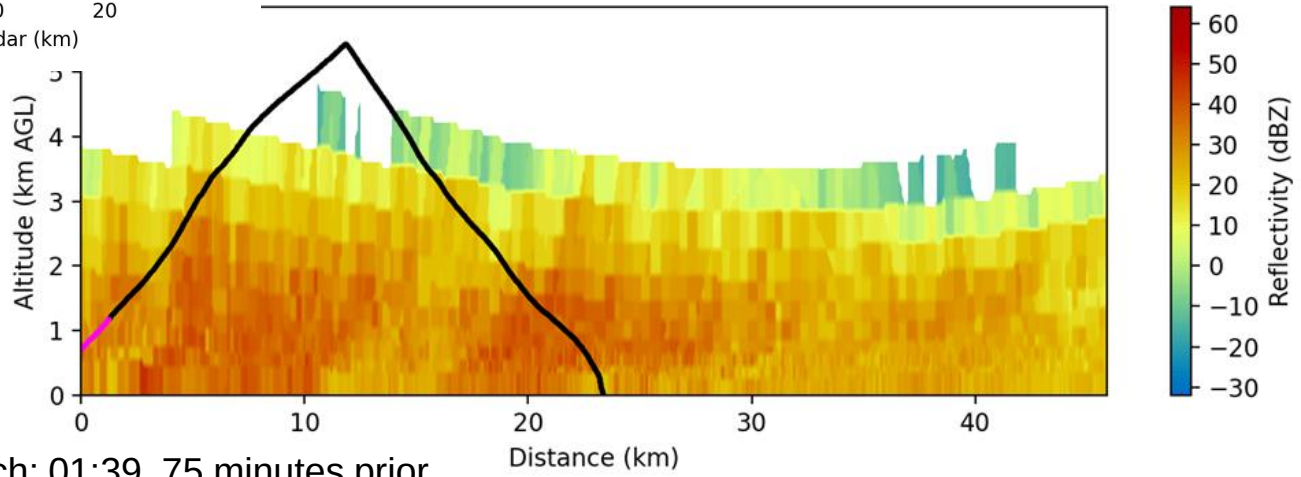


~20 min before E

Similar flashes in

KTYX perspective - 50 min prior



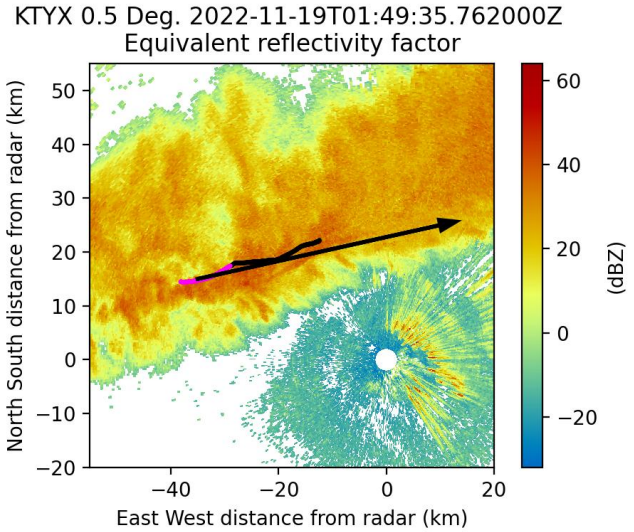


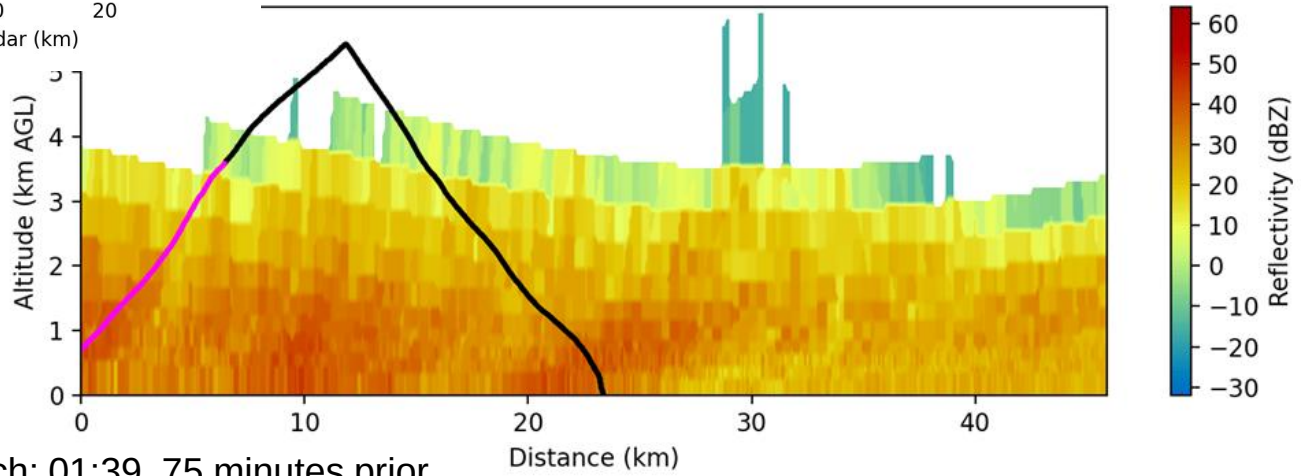
Nearest neighbor interpolation to cross section grid

Launch: 01:39, 75 minutes prior

Landing: 02:08, 26 minutes prior

KTYX perspective - 45 min prior





Nearest neighbor interpolation to cross section grid

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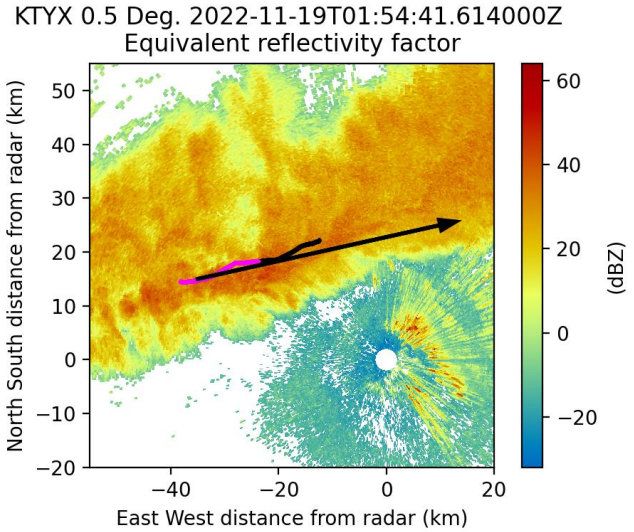
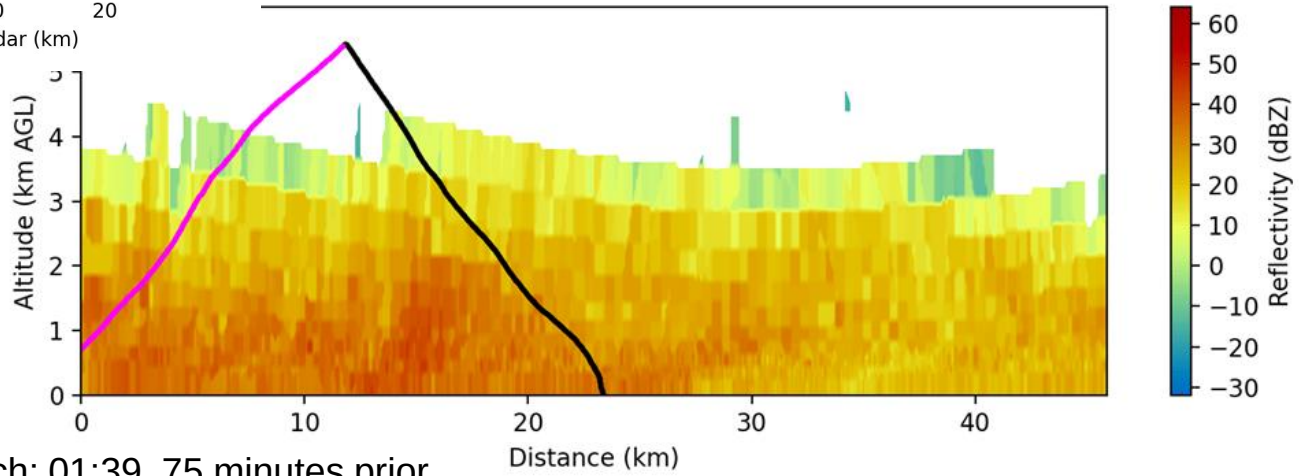
Landing: 02:08, 26 minutes prior

KTYX perspective - 40 min prior





Nearest neighbor interpolation to cross section grid

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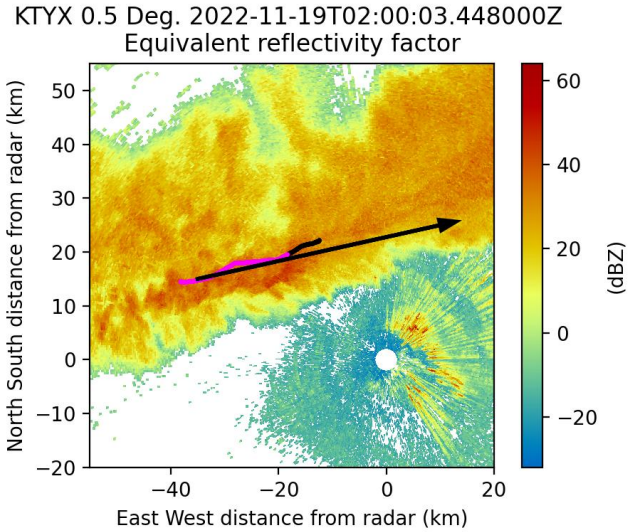
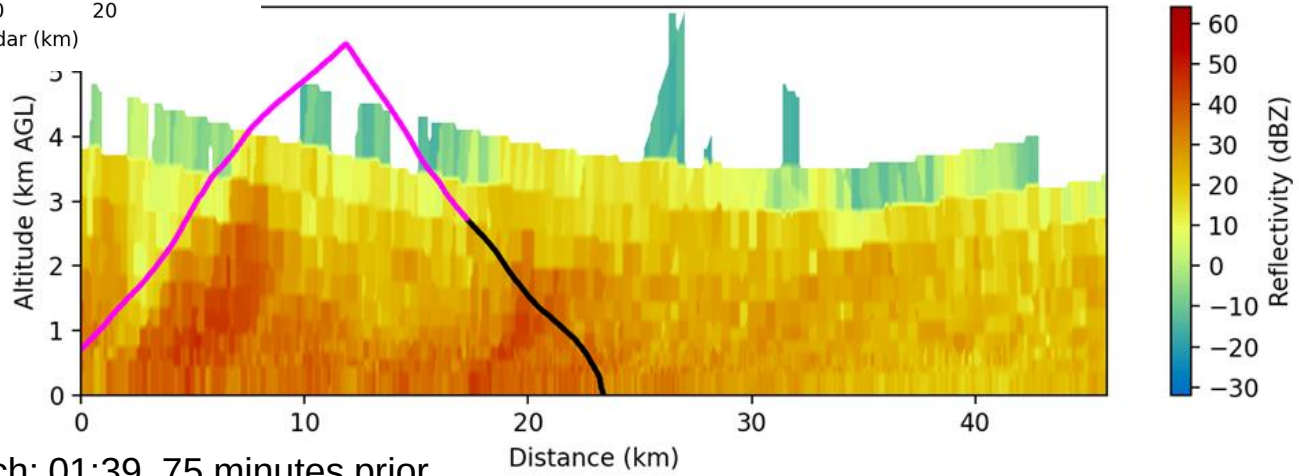
Landing: 02:08, 26 minutes prior

KTYX perspective - 34 min prior



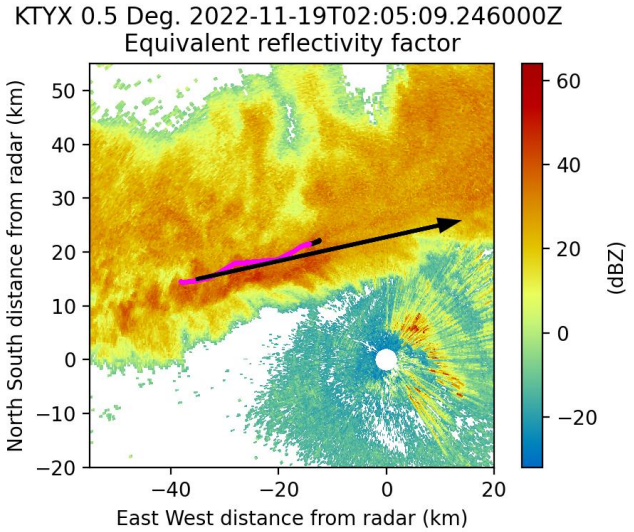


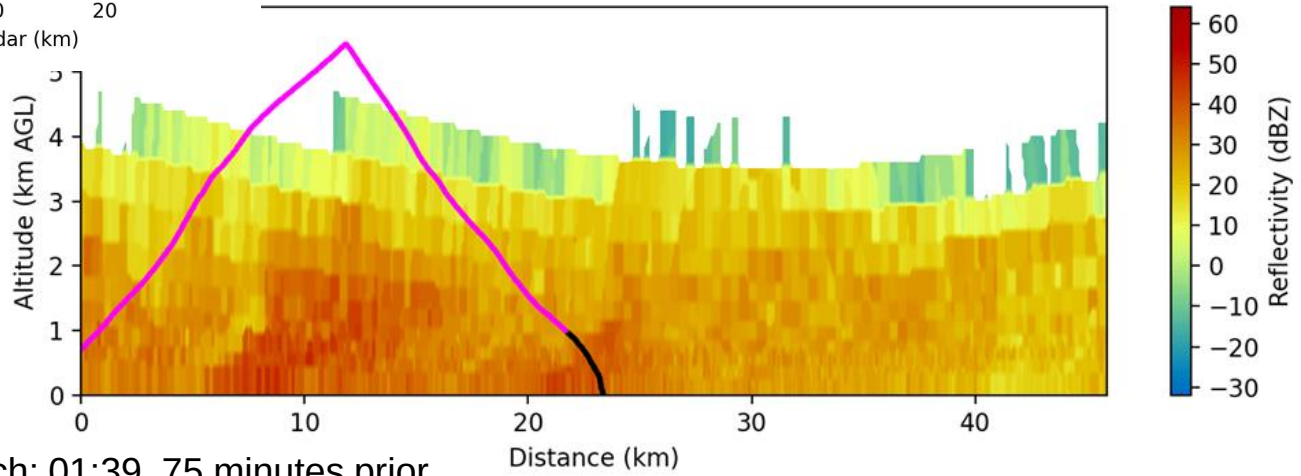
Nearest neighbor interpolation to cross section grid

Launch: 01:39, 75 minutes prior

Landing: 02:08, 26 minutes prior

KTYX perspective - 29 min prior



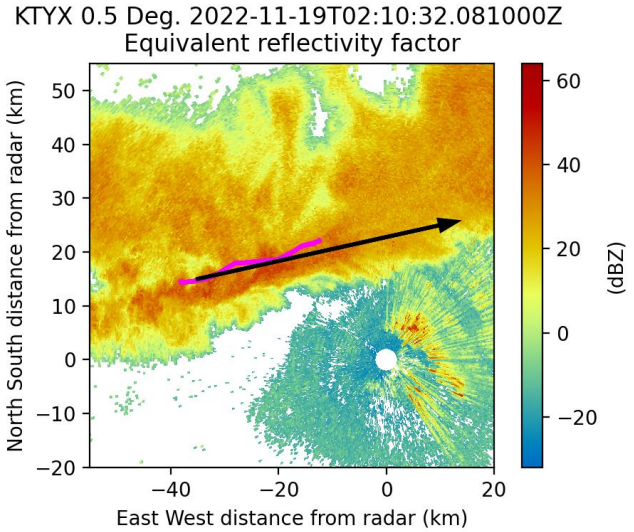


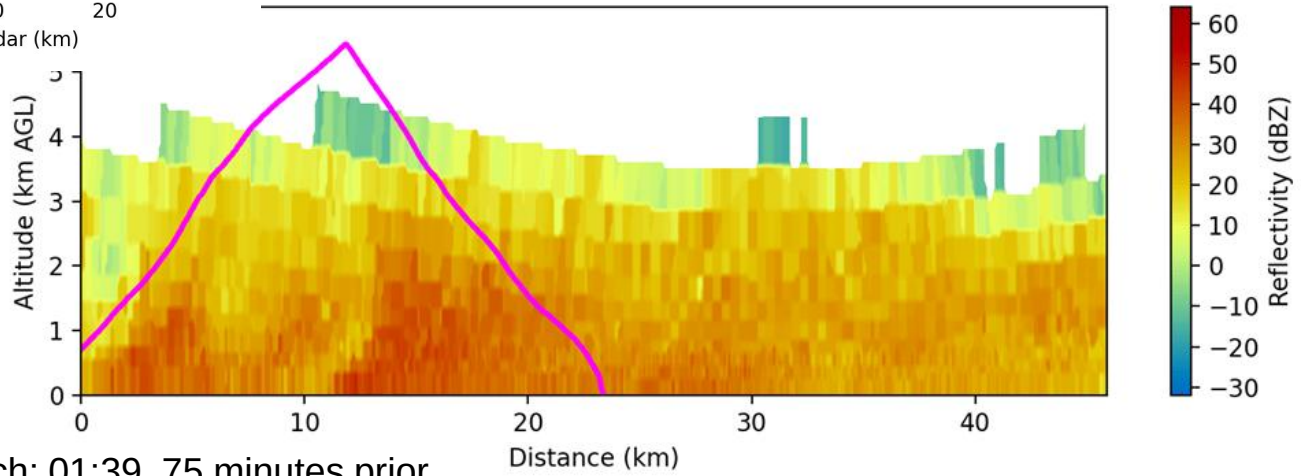
Nearest neighbor interpolation to cross section grid

Launch: 01:39, 75 minutes prior

Landing: 02:08, 26 minutes prior

KTYX perspective - 24 min prior



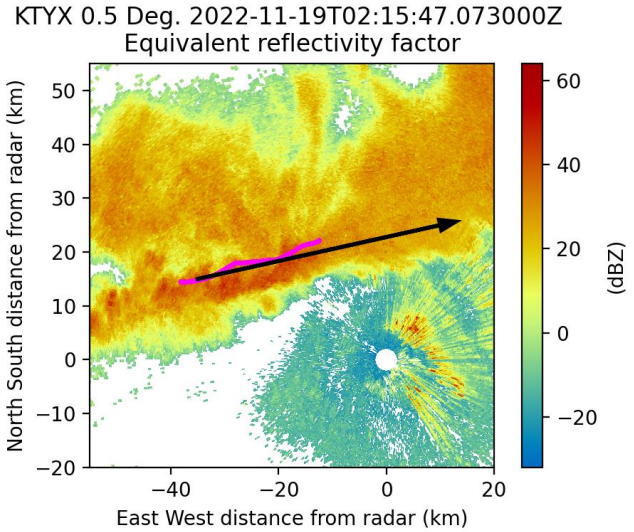


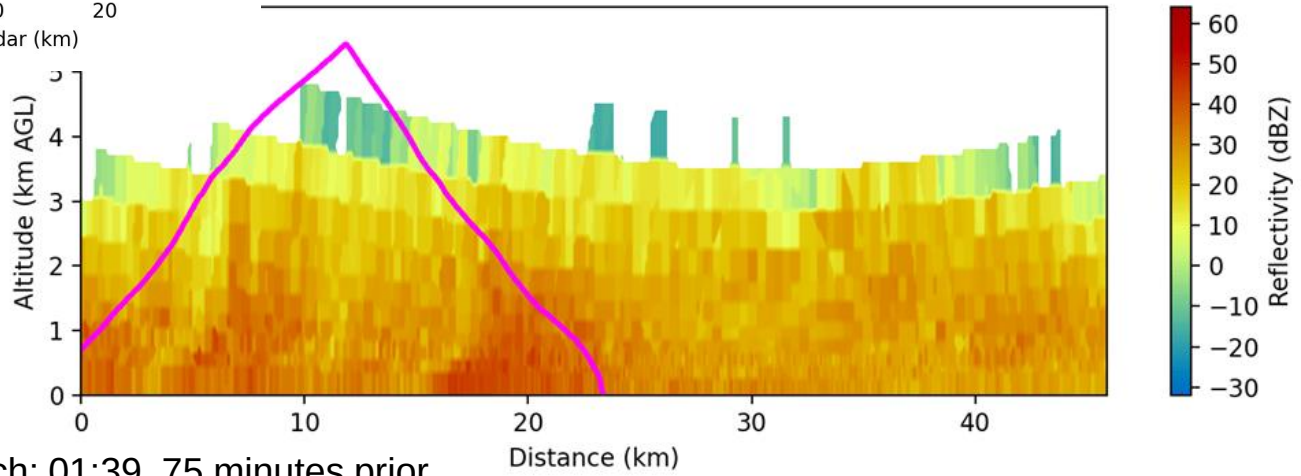
Nearest neighbor interpolation to cross section grid

Launch: 01:39, 75 minutes prior

Landing: 02:08, 26 minutes prior

KTYX perspective - 19 min prior



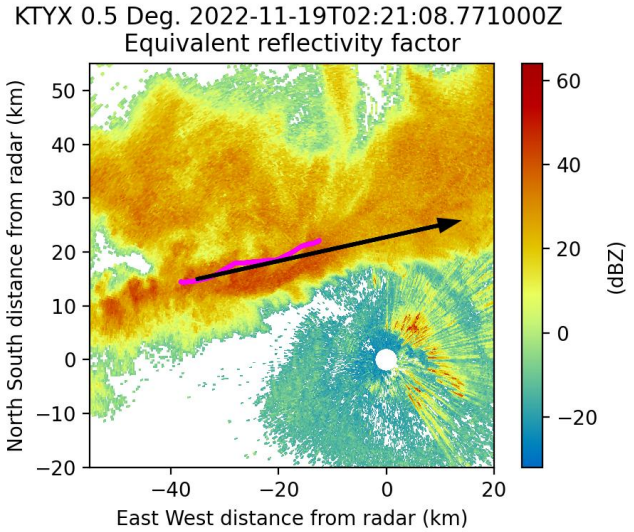


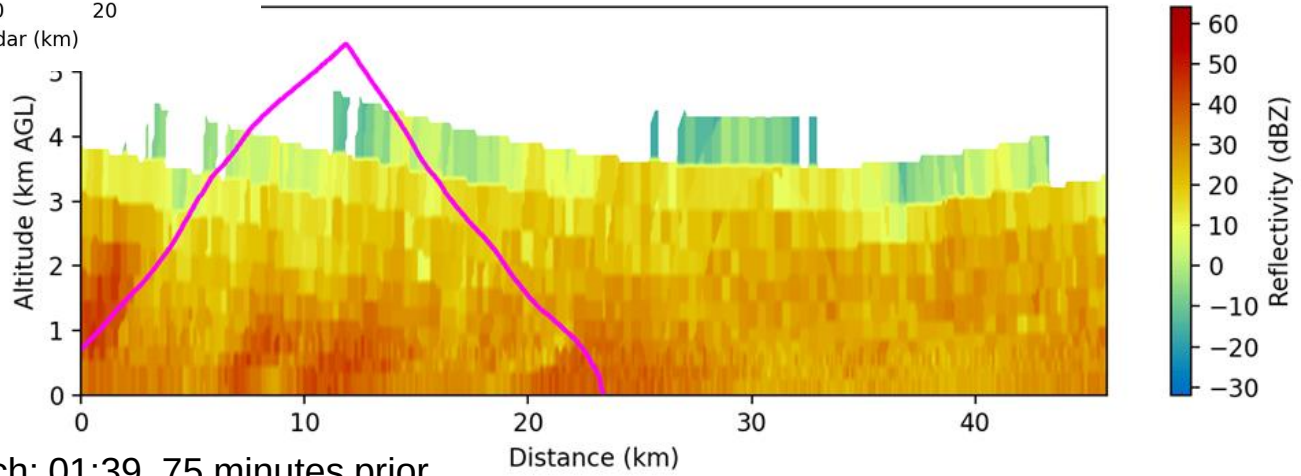
Nearest neighbor interpolation to cross section grid

Launch: 01:39, 75 minutes prior

Landing: 02:08, 26 minutes prior

KTYX perspective - 13 min prior



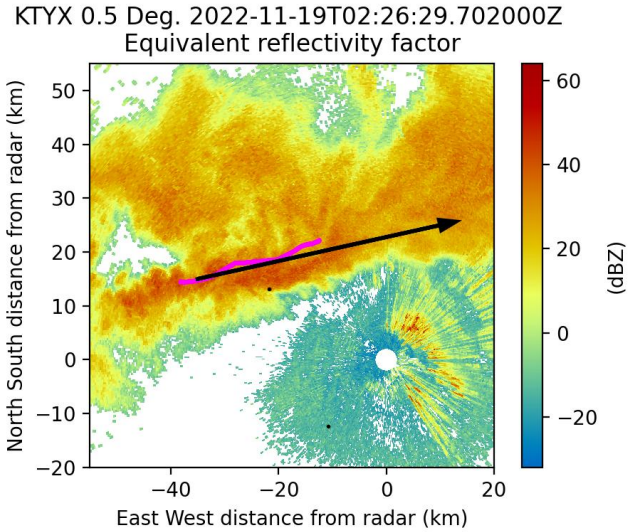


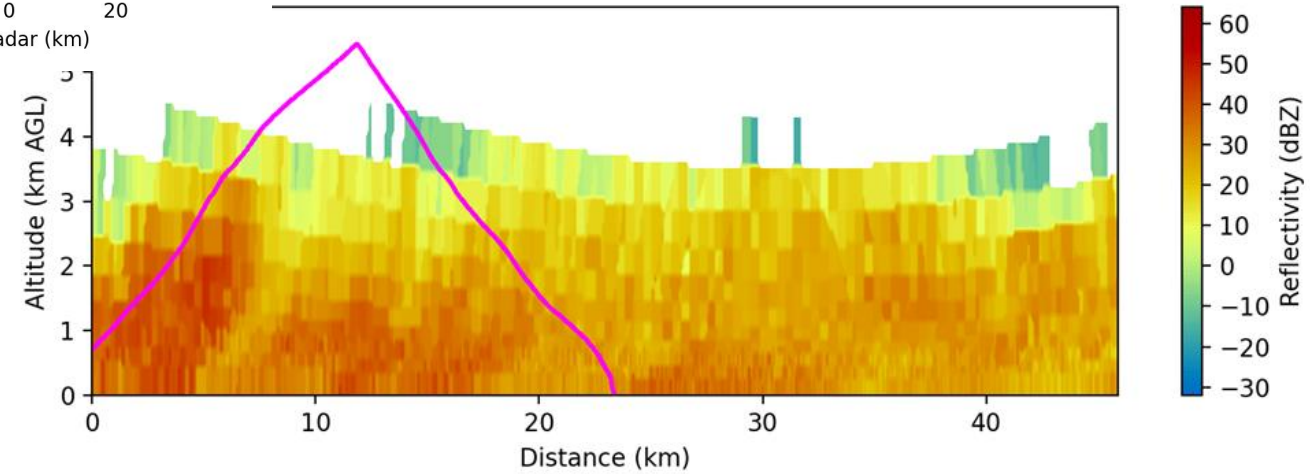
Nearest neighbor interpolation to cross section grid

Launch: 01:39, 75 minutes prior

Landing: 02:08, 26 minutes prior

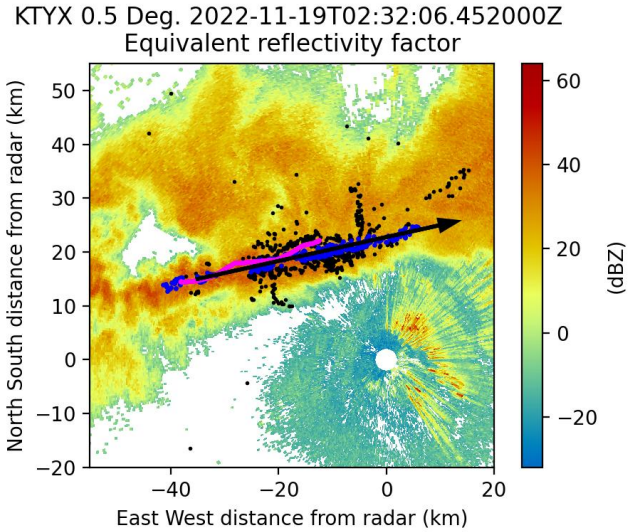
KTYX perspective - 8 min prior

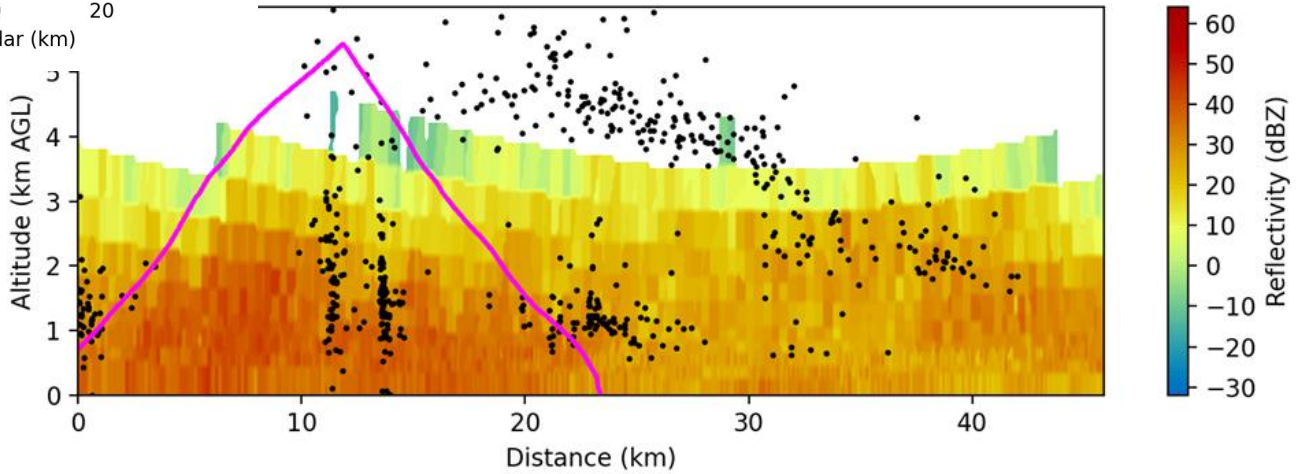




Nearest neighbor interpolation to cross section grid

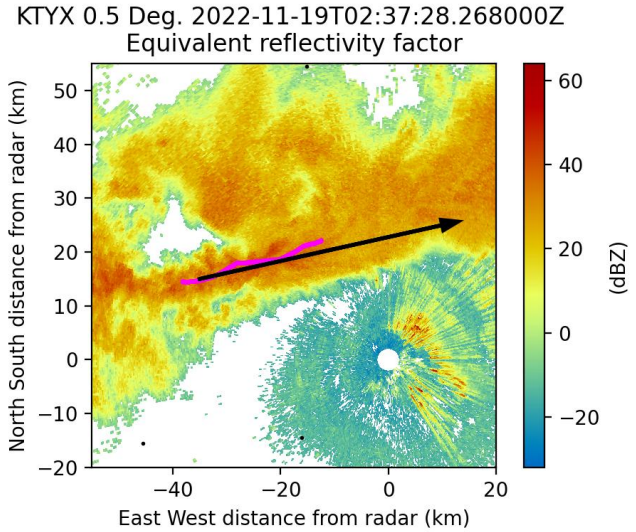
KTYX perspective - 2 min prior

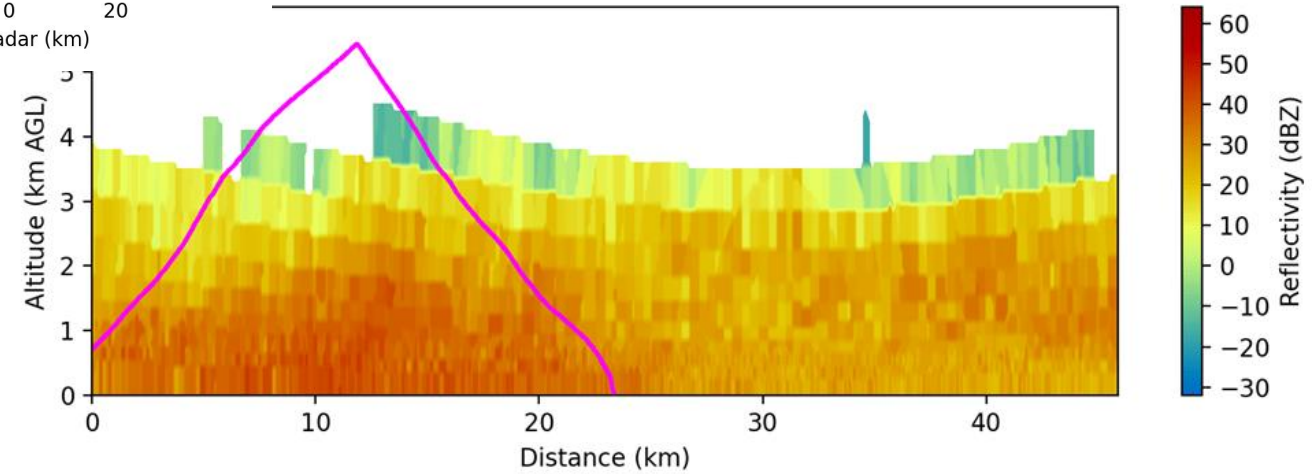




Nearest neighbor interpolation to cross section grid

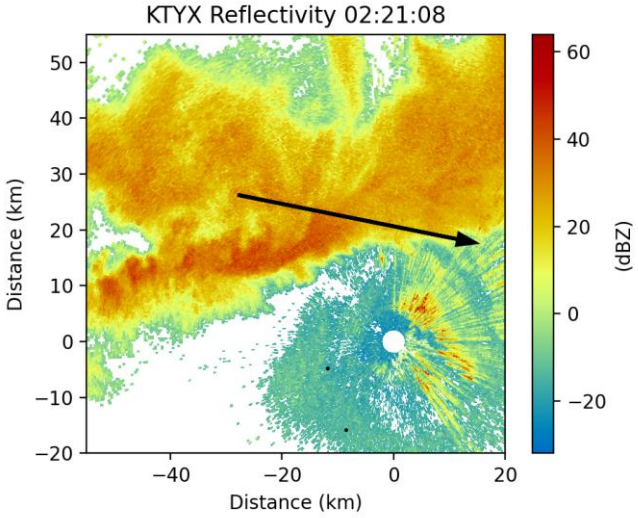
KTYX perspective - 3 min after



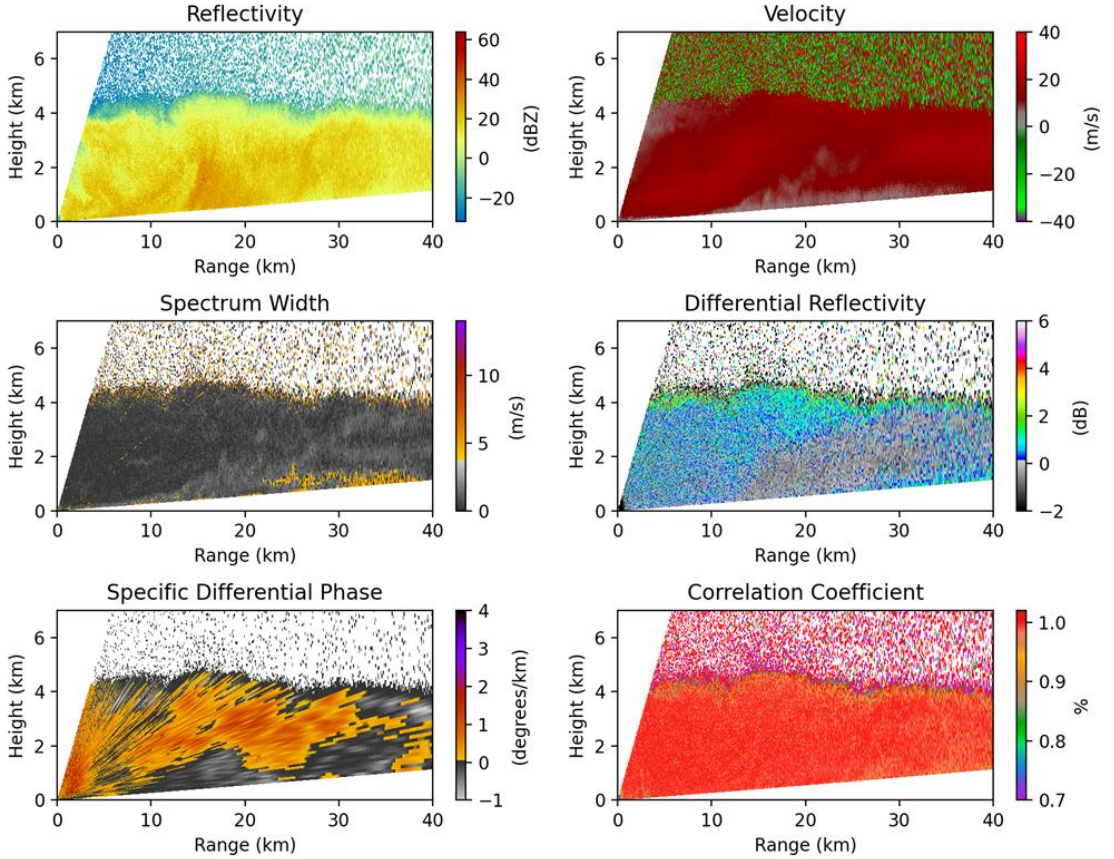


Nearest neighbor interpolation to cross section grid

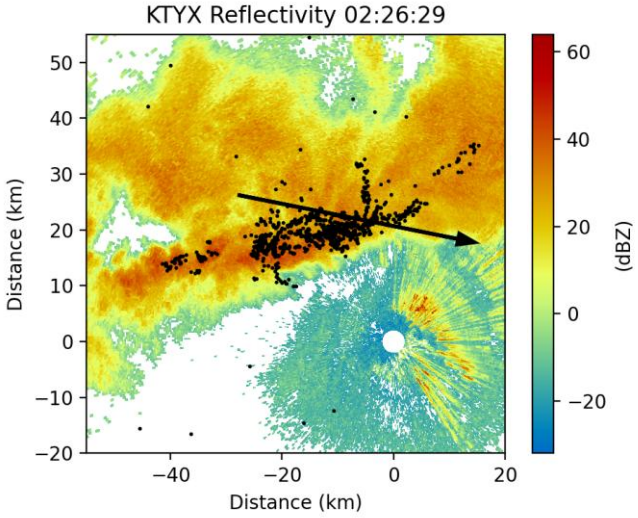
DOW perspective
02:22:02.1 - RHI
02:35:30 - Flash



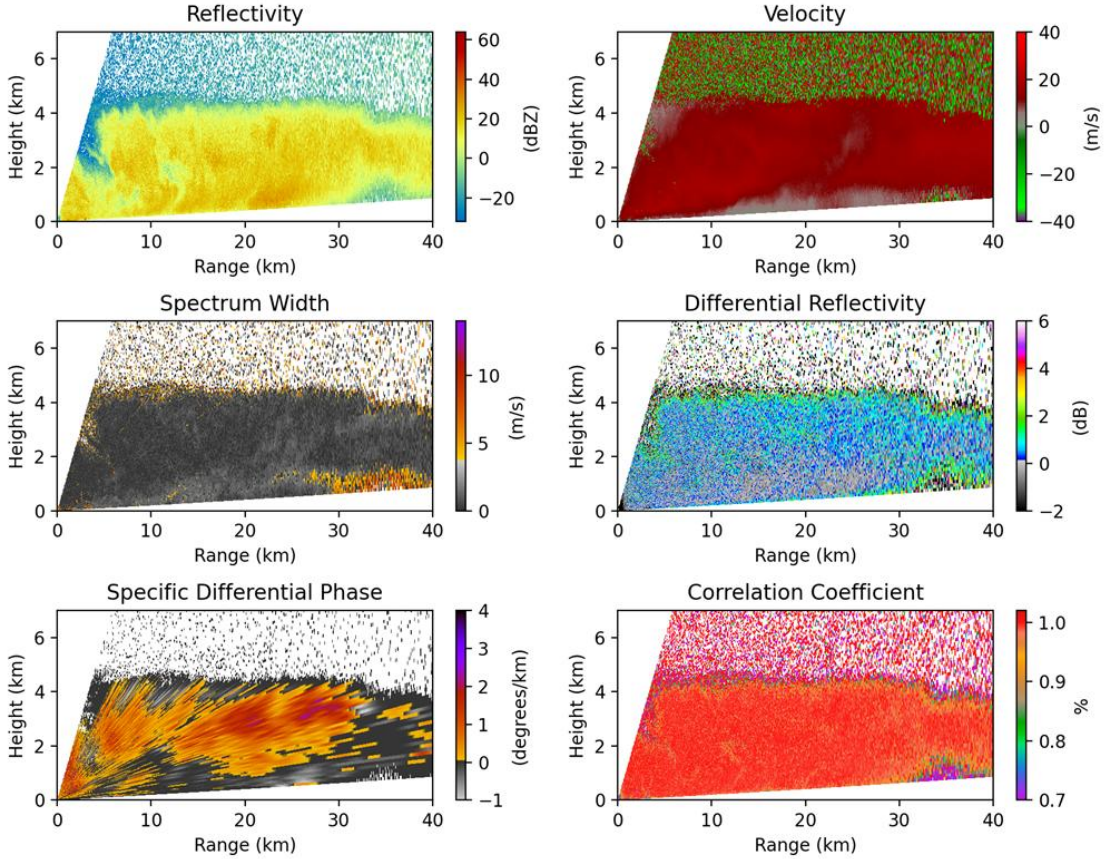
KTLX PPI reference
DOW7 RHI at 101.3°



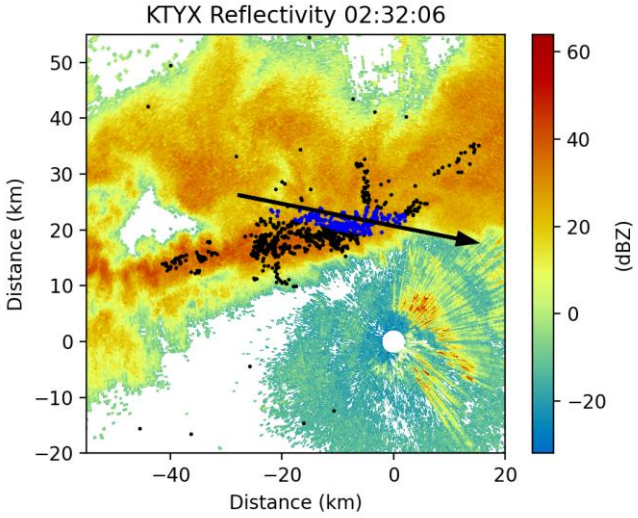
DOW perspective
02:31:30.8 - RHI
02:35:30 - Flash



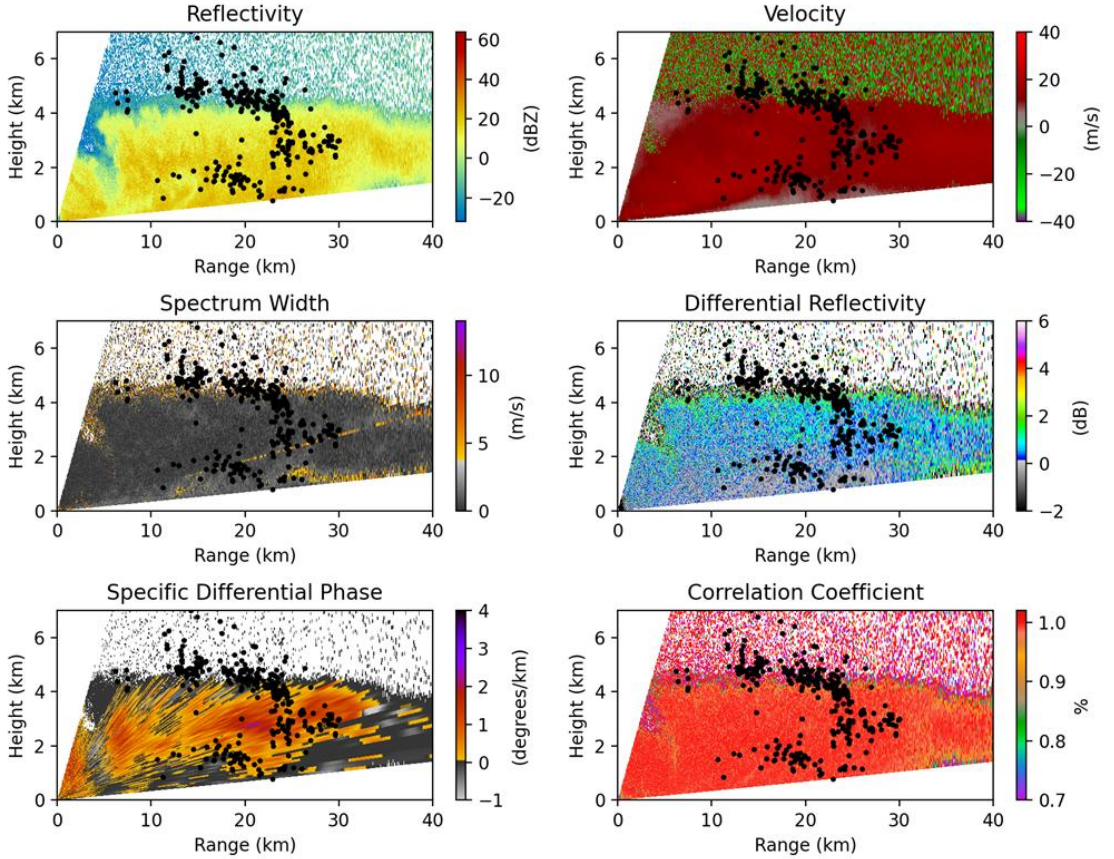
KTLX PPI reference
DOW7 RHI at 101.3°



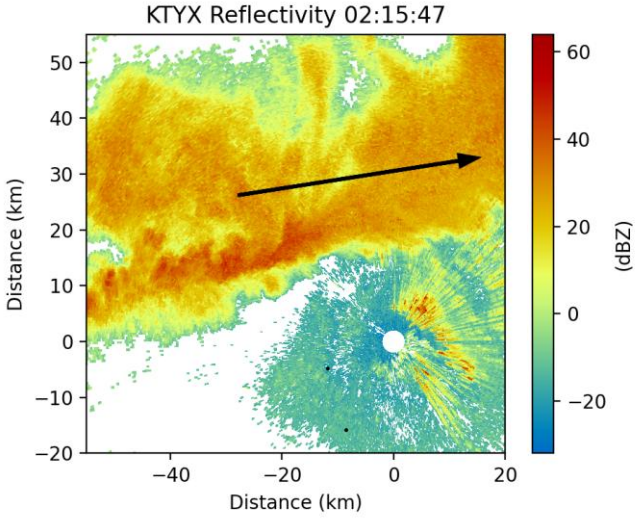
DOW perspective
02:32:46.3 - RHI
02:35:30 - Flash



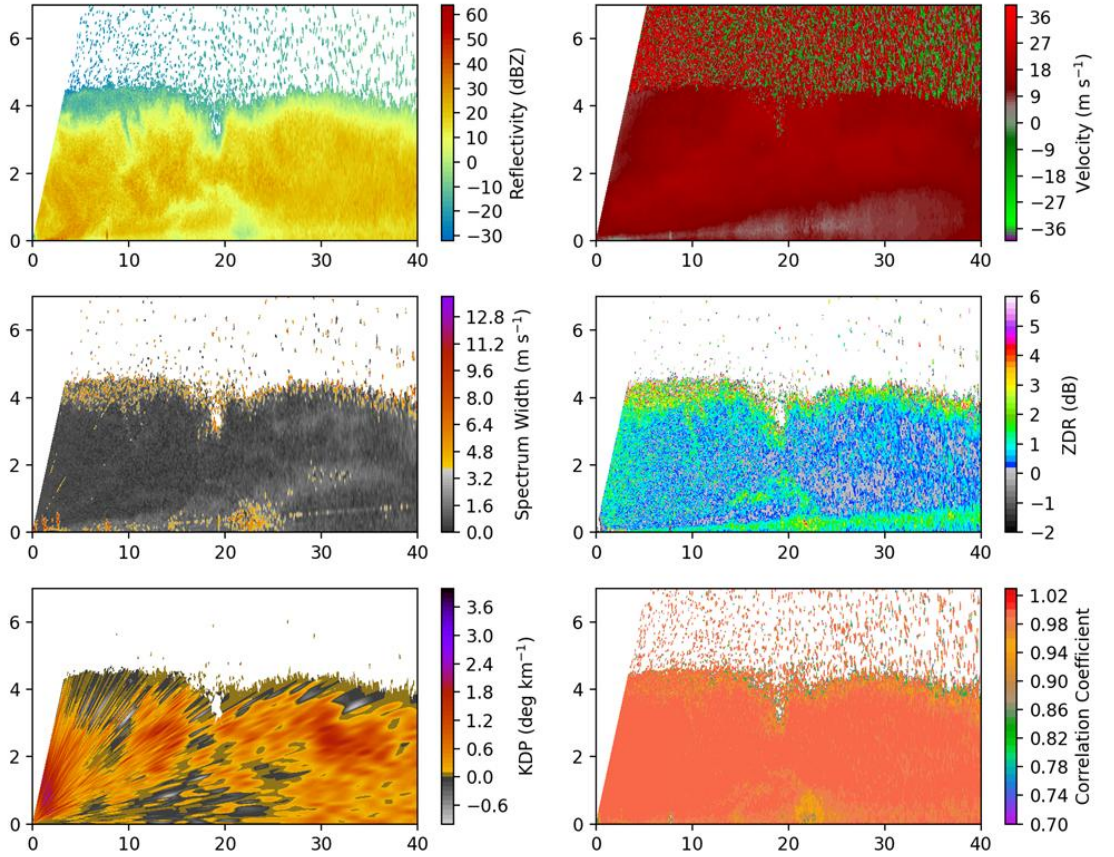
KTLX PPI reference
DOW7 RHI at 101.3°



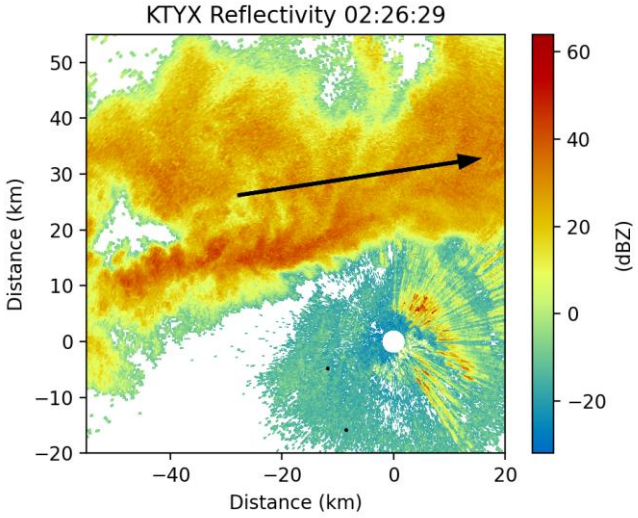
DOW perspective
02:20:29.4 - RHI
02:35:30 - Flash



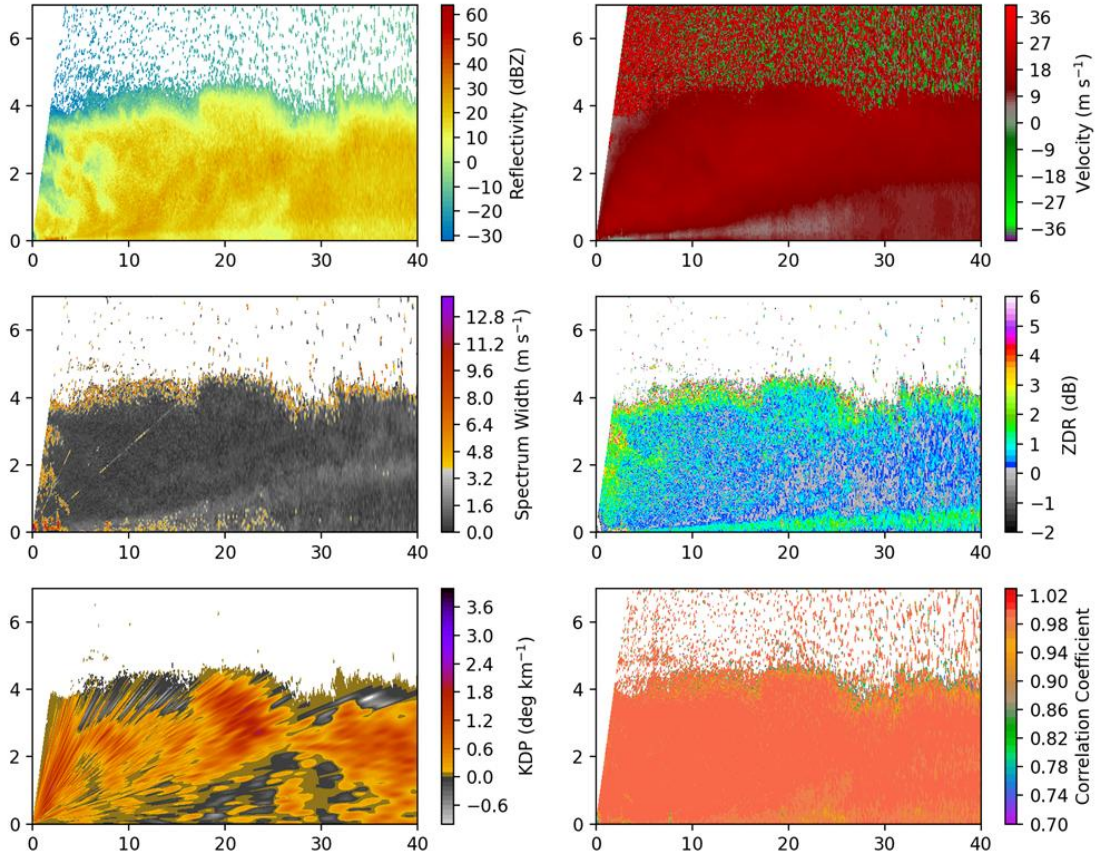
KTLX PPI reference
DOW7 RHI at 81.3°



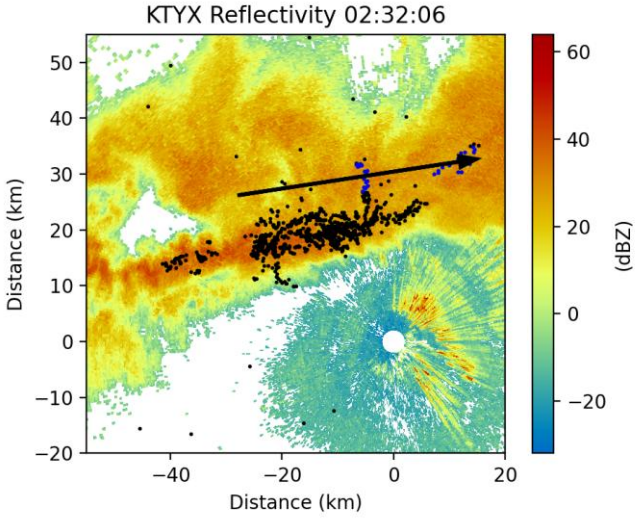
DOW perspective
02:27:43.1 - RHI
02:35:30 - Flash



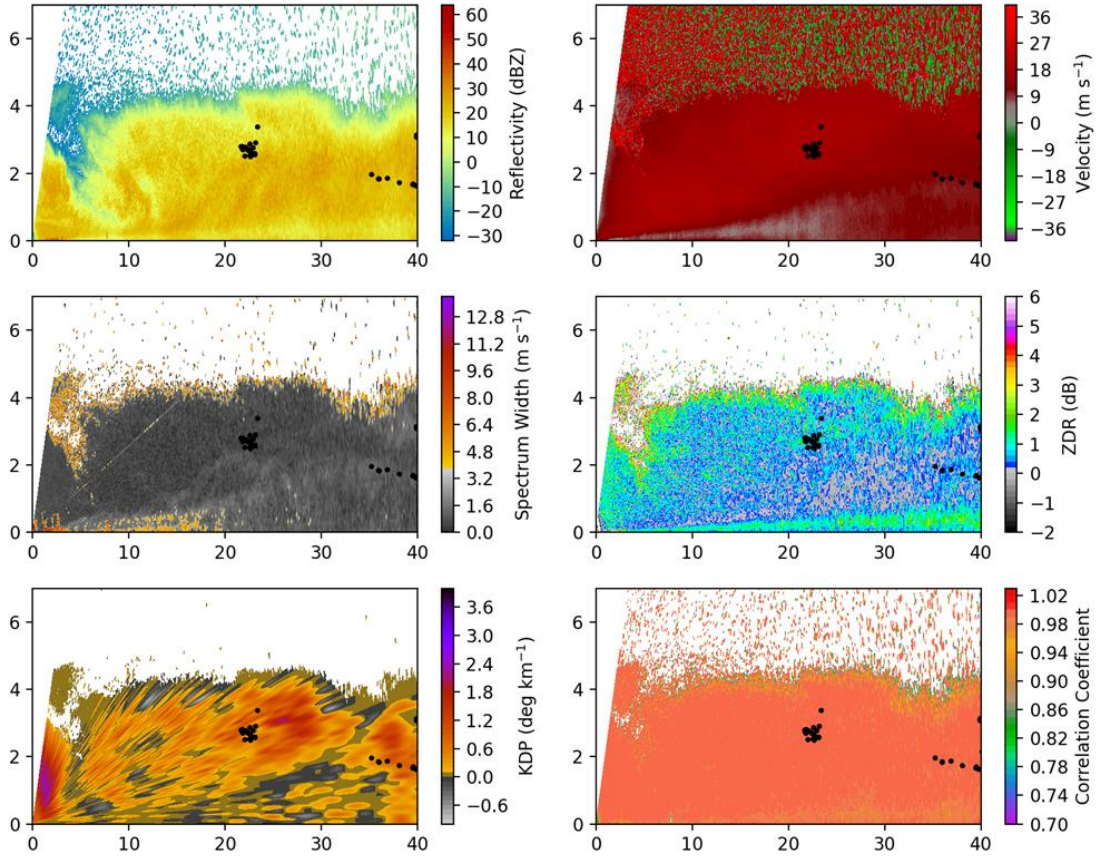
KTLX PPI reference
DOW7 RHI at 101.3°



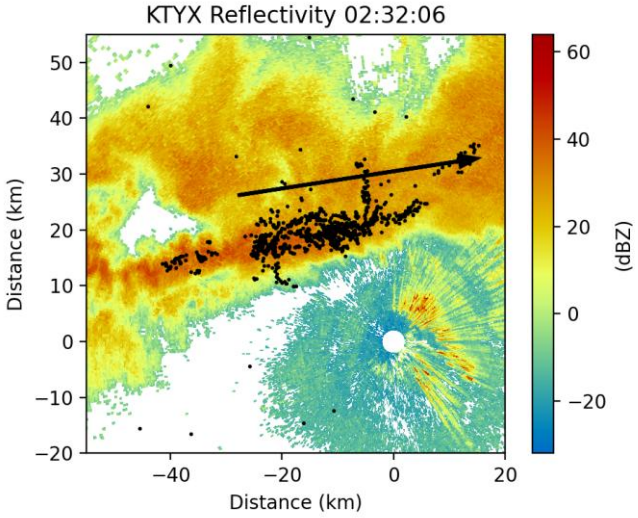
DOW perspective
02:32:27.5 - RHI
02:35:30 - Flash



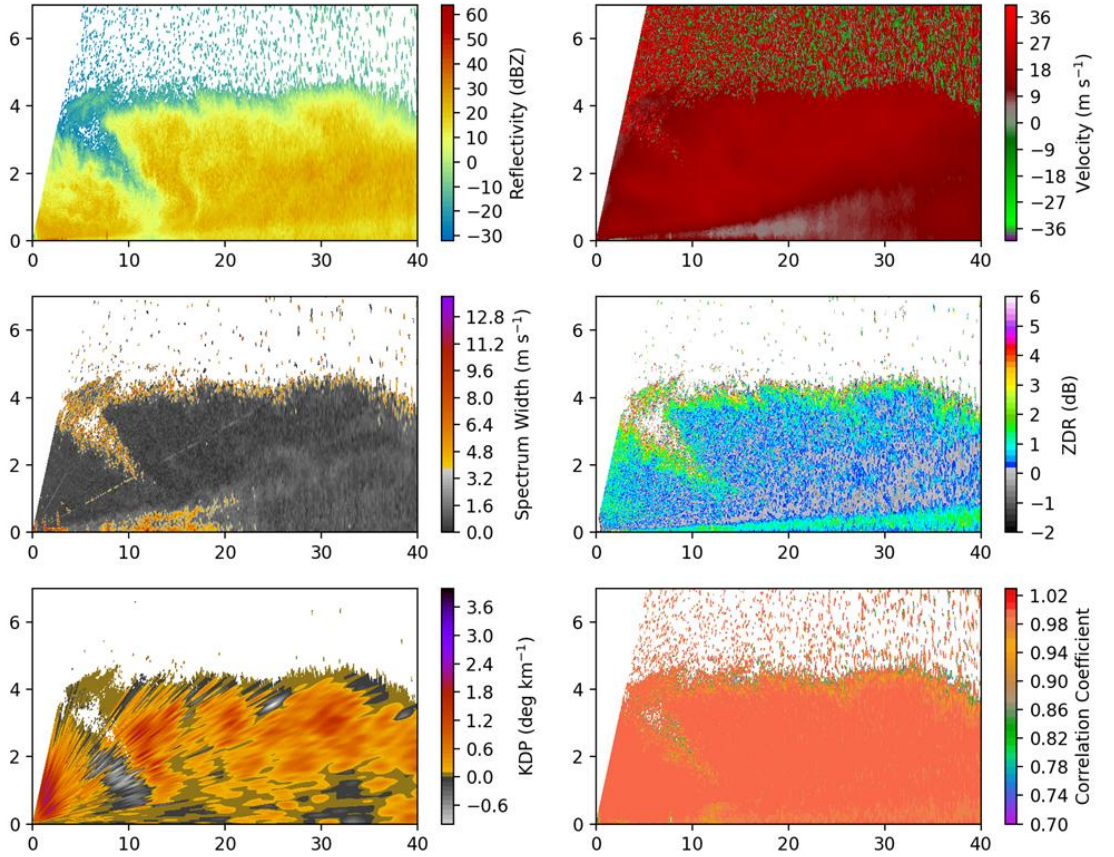
KTLX PPI reference
DOW7 RHI at 101.3°



DOW perspective
02:37:05.7 - RHI
02:35:30 - Flash



KTLX PPI reference
DOW7 RHI at 101.3°



Where can we go?

Incorporate in-situ profiles from soundings

Incorporate other radars

Kinematic structures

Hydrometeor classifications

Correspondence to imager where available

Correspondence to surface precip observations

Other IOPS of interest

	DOW data	Imager data (UTC)	EFM data (UTC)
IOP1	x		1141
IOP4	x	1256	0356; 1253
IOP5	x		1655
IOP6	x		2053
IOP8	x		1631 coast; 1653 inland
IOP10	x	1854	1805; 2302

Flashes between these IOPs

Flashes before this IOPs

Did not let down

Outside of cloud

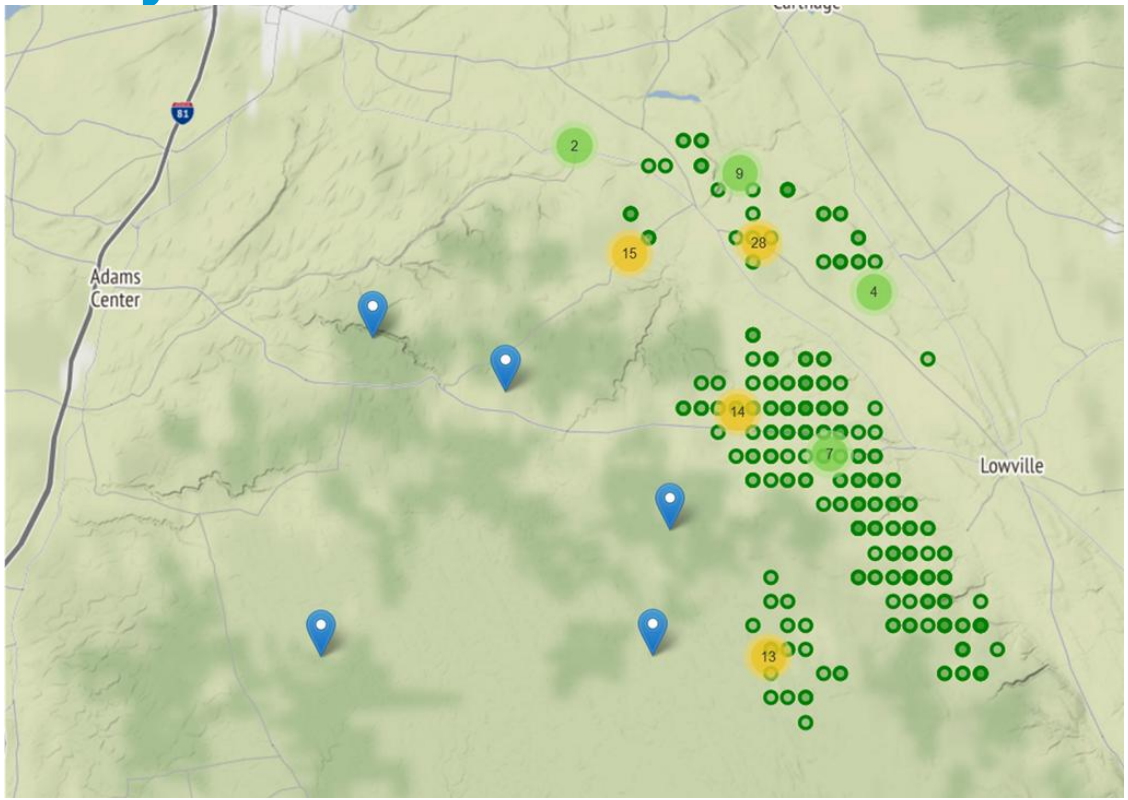
Other days with flashes which we can use for LMA+KTYX analyses

- September 28, 2022 - lake effect rain event (GTRI LMA data, soundings)
- November 6-7
- November 17-18 before IOP2 (11/18 0800-1100 UTC; 1500 UTC)
- November 20 between IOPs 2 and 3 (0700-1000 UTC)
- December 1 over turbines (0200-0900 UTC)
- December 7
- December 18-19 flashes between IOPs (2000, 2200; 0500-0800 UTC)
- December 23 over Tug (1600-1800 UTC)
- January 25 ET cyclone
- January 28

And maybe others

Predictability of lightning from radar data
Project led by Joseph Berry

LMA flashes and wind farm on 11th November 2022: Most LMA flashes were on the hill concentrated near the windfarms.



Periods examined

11/20 hour (UTC)	LMA flashes	NLDN-CG		12/19 hour (UTC)	LMA flashes	NLDN-CG
700	5	0		400	3	1
800	10	1		500	5	0
900	26	7		600	2	0
1000	27	4		700	9	0
1100	26	2		800	0	0
1200	0	0		900	0	0
1300	3	0				
1400	0	0				
1500	0	0				

Storm #1: 20 Nov

Storm tracks from TINT (numbers)

- Reflectivity > 35 dBZ
- Area > 8 (grids)
- Reflectivity “boxed” around the Tug.

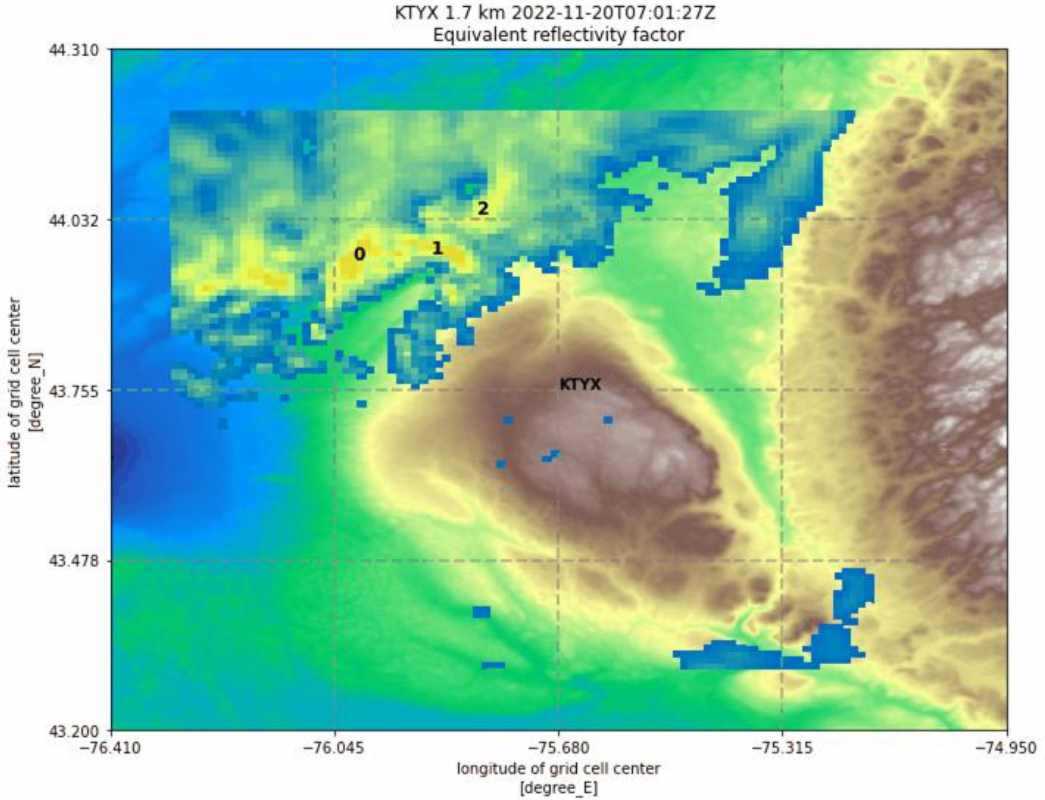
Black Triangles: LMA Flashes (> 10 sources per flash)

Black Crosses(‘X’) : NLDN CG Flashes

Takeaways:

1.Storm objects dissipating over the Tug contain the flashes.

2. Storm objects dissipating on the northern, and southwestern flanks contain no flashes.



Storm #2: 19 Dec

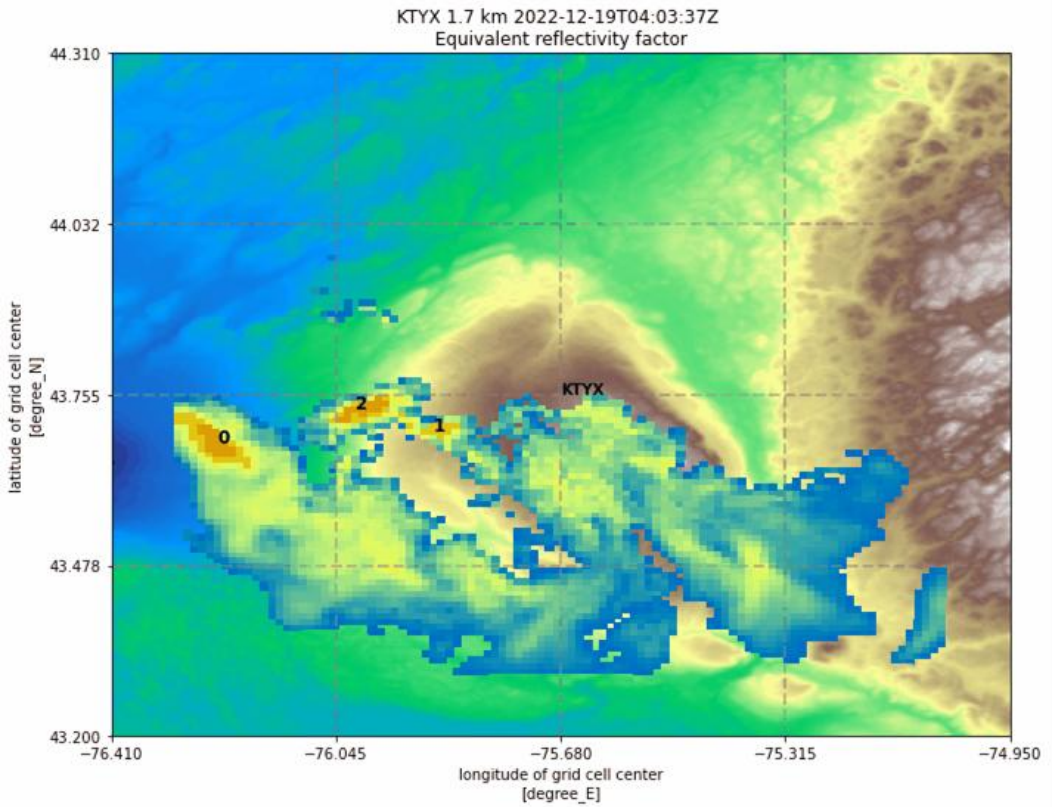
Same Tracking Parameters

With the minimum 8 pixels, smaller cellular convection towards the end isn't captured.

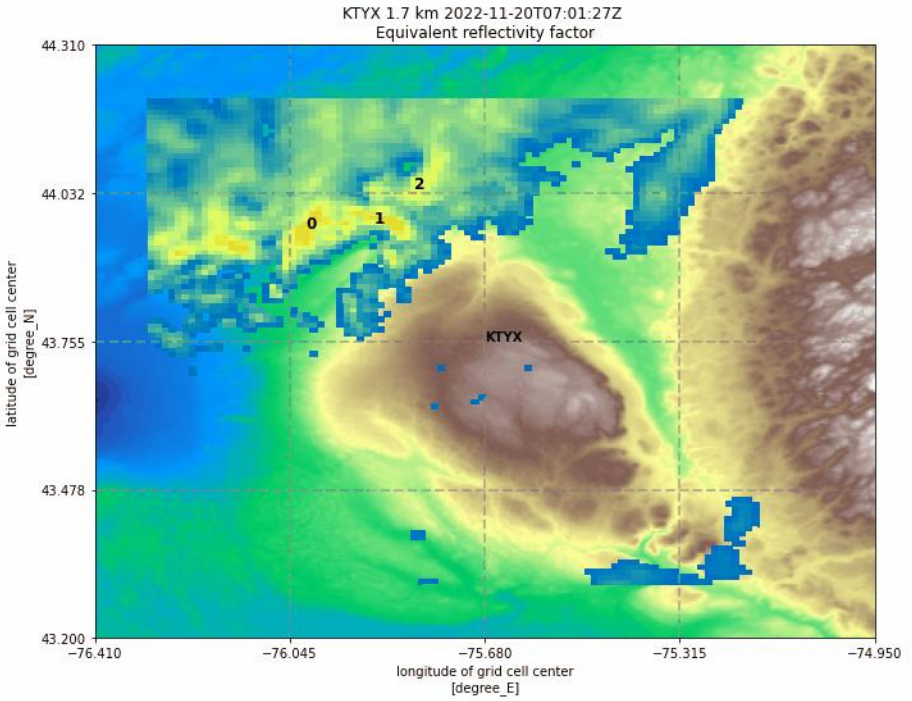
With a minimum of 6 pixels, storm objects are assigned in stratiform regions.

Takeaway

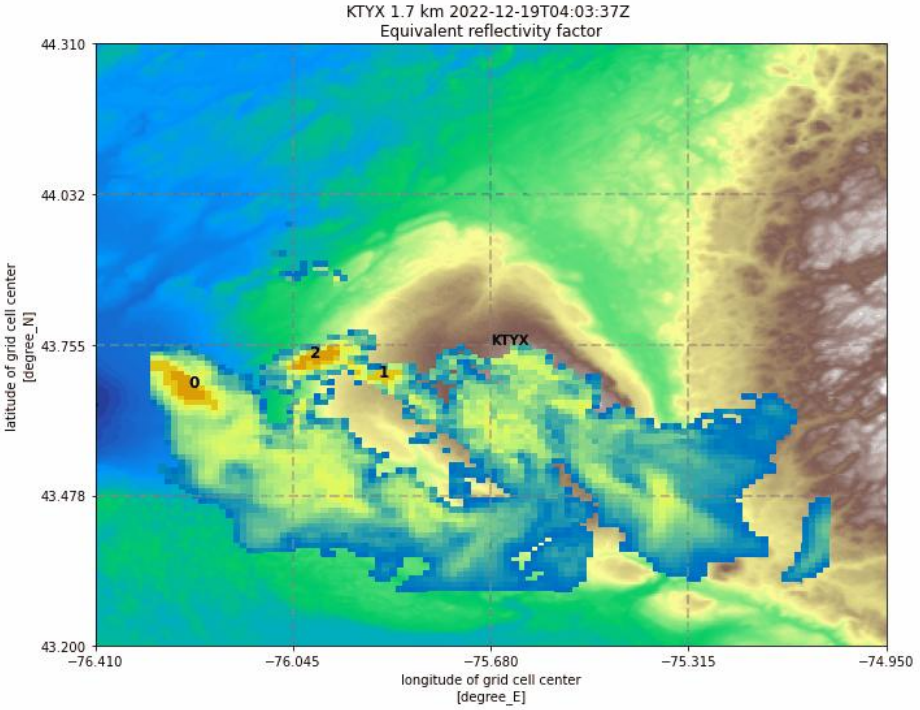
Storm objects dissipating over the higher elevations tend to be the lightning producers, and storm objects flanking the hill tend to not. In this case, even smaller convective cells might produce flashes, yet in a smaller quantity.

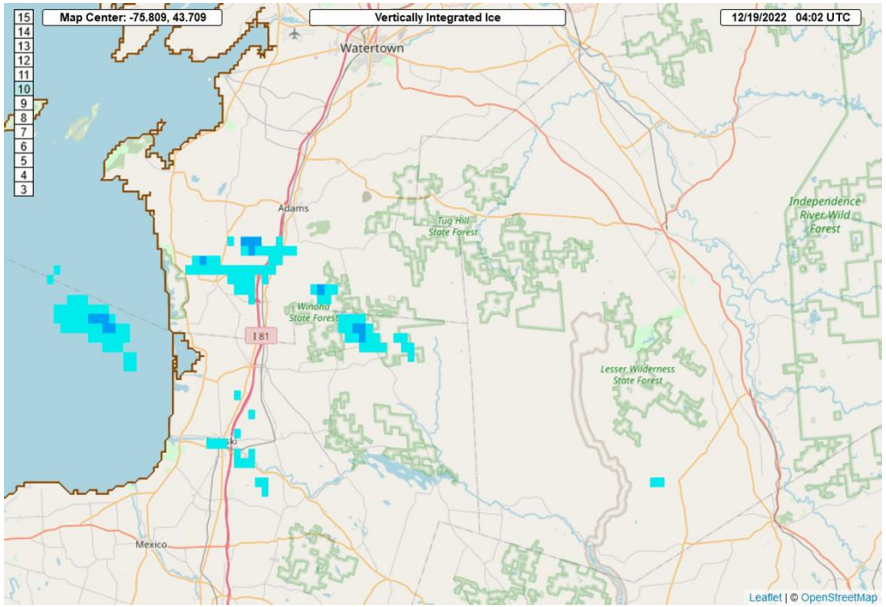


Vertically Integrated Ice – MRMS: Storm#1: 20 Nov



Vertically Integrated Ice – MRMS: Storm#1: 19 Dec





Storm Object Summary

20-Nov	Number of Storms(Tracked)	Avg Change in Area	Avg Change in Volume	Avg Change in Max Reflectivity	Avg Change in Alt. of Max Reflect.
Storms with No Flashes	11	-6.59	-20.92	-2.42	-0.76
Storms with Flashes	15	-16.39	-28.67	-3.82	-1.5
19-Dec	Number of Storms(Tracked)	Avg Change in Area	Avg Change in Volume	Avg Change in Max Reflectivity	Avg Change in Alt. of Max Reflect.
Storms with No Flashes	5	-3.47	-8.97	-2.34	-0.71
Storms with Flashes	3	-10.31	-28.27	-6.42	-0.39

Difference between time of max reflectivity and last scan with storm object identified, as most flashes occur just after the storm object track was lost. Largest changes in area and volume in storms which produced flashes

Storms in which traversed over the higher elevations of the hill(eastern side) have a greater chance of producing flashes. Storms that flanked the hill, had a lesser chance of producing a flash.

Utilizing storm attributes from the TINT tracker we can see the flash producers did have a larger average change in reflectivity/area/volume, compared to the non-flash producers.

Utilizing MRMS-VIL 2Hr. we can observe swaths > (1 kg m^-2) located on top of the hill can be a good indicator of flash producing storms versus VIL swaths flanking the hill

Utilizing MRMS-VII, When VII is observed to be > 0.1 (kg m^-2) and descending over the eastern flanks of the hill, this is usually a good indicator of a flash producing storm versus non-flash producing.

Most flashes were located on the eastern sides of the hill, near a windfarm when the storms were in a dissipating stage. VII, Max Reflectivity, VIL, Alt of Max Reflectivity usually decreased before a flash event.