

# Initial Look at Ammonia Incidents and Satellite Data

Question: can you see evidence of ammonia incidents in satellite data?

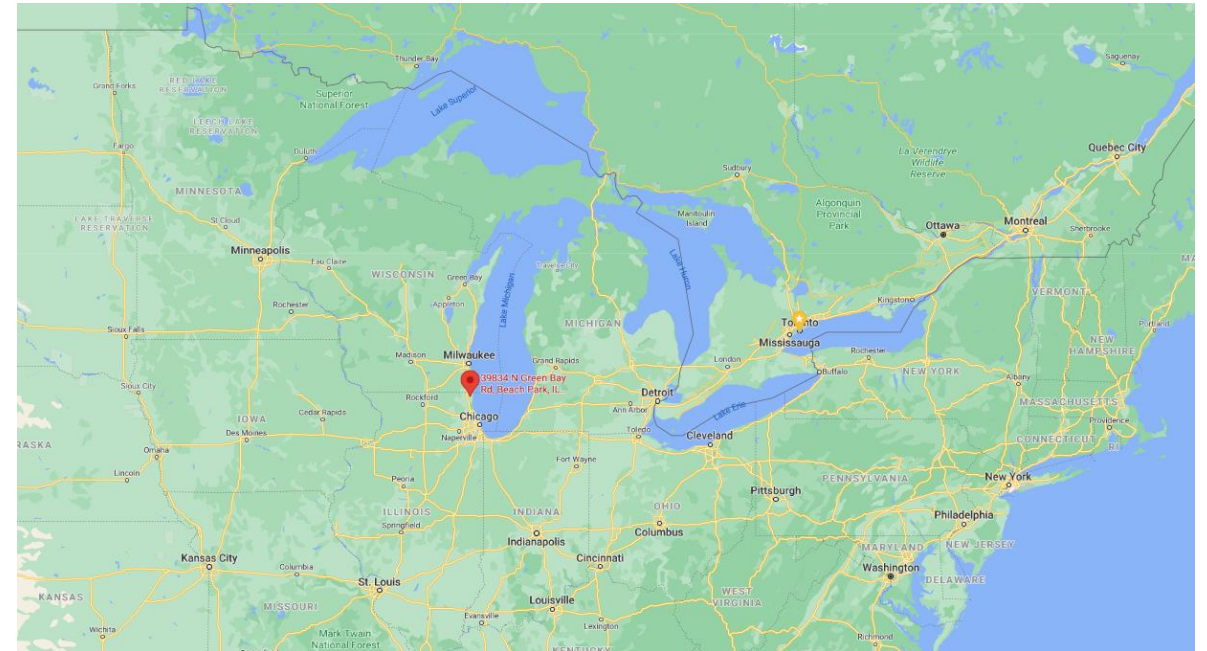
Simon Gant (HSE), 6 August 2021

# Beach Park, Illinois, USA (25 April 2019)



About 750 gallons of anhydrous ammonia liquefied compressed gas were accidentally released from these two 1,000-gallon nurse tanks mounted on a farm trailer, according to the U.S. National Transportation Safety Board investigation. (NTSB)

The leak occurred at approximately 4:30 a.m. April 25, when about 750 gallons of anhydrous ammonia liquefied compressed gas were accidentally released from two 1,000-gallon nurse tanks mounted on a farm trailer that was being pulled by a John Deere tractor, according to a U.S. National Transportation Safety Board preliminary report on the investigation released on June 11.



<https://www.chicagotribune.com/suburbs/lake-county-news-sun/ct-lns-ammonia-spill-no-charges-st-0626-20190625-ikztowrhfhwhgym3lryjk4v2m-story.html>

<https://www.lakecountyil.gov/4178/Beach-Park-Ammonia-Spill>

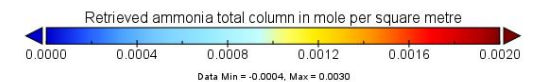
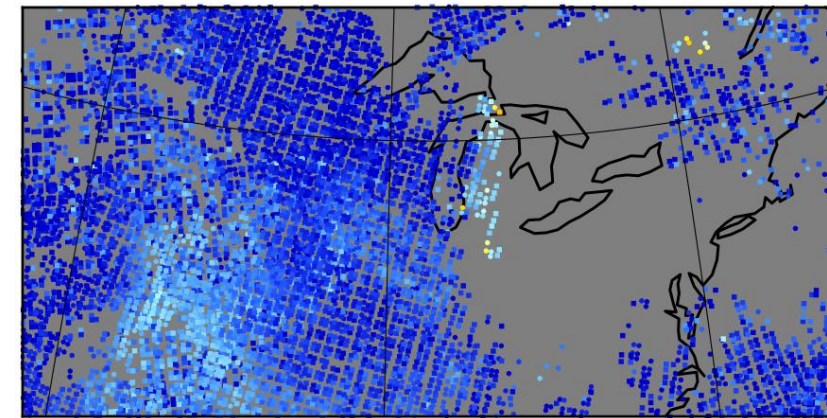
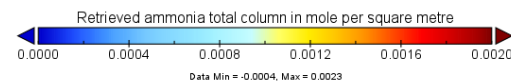
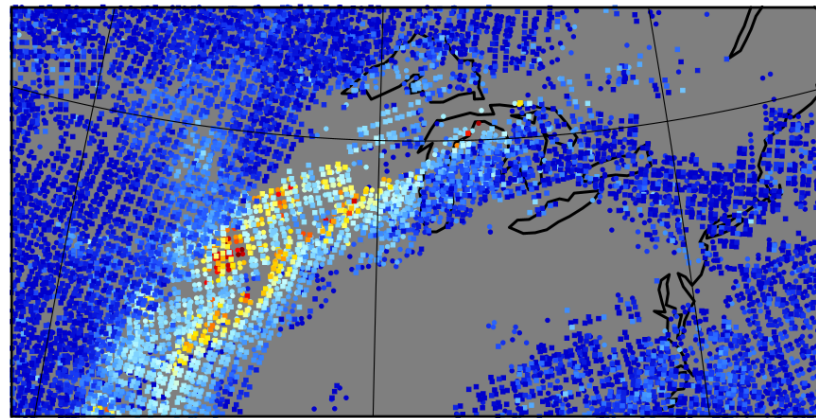
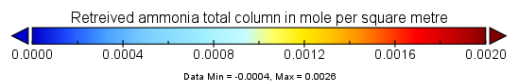
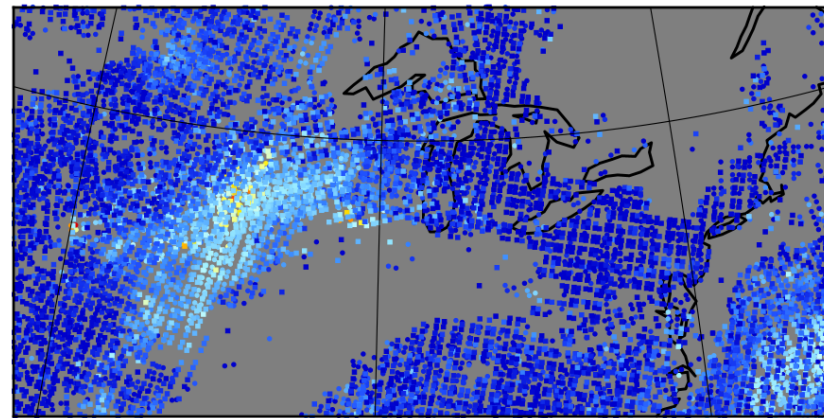
# Beach Park, Illinois, USA (25 April 2019)

Ammonia total column data (mol/m<sup>2</sup>) from IASI satellite

24 April 2019

25 April 2019

26 April 2019

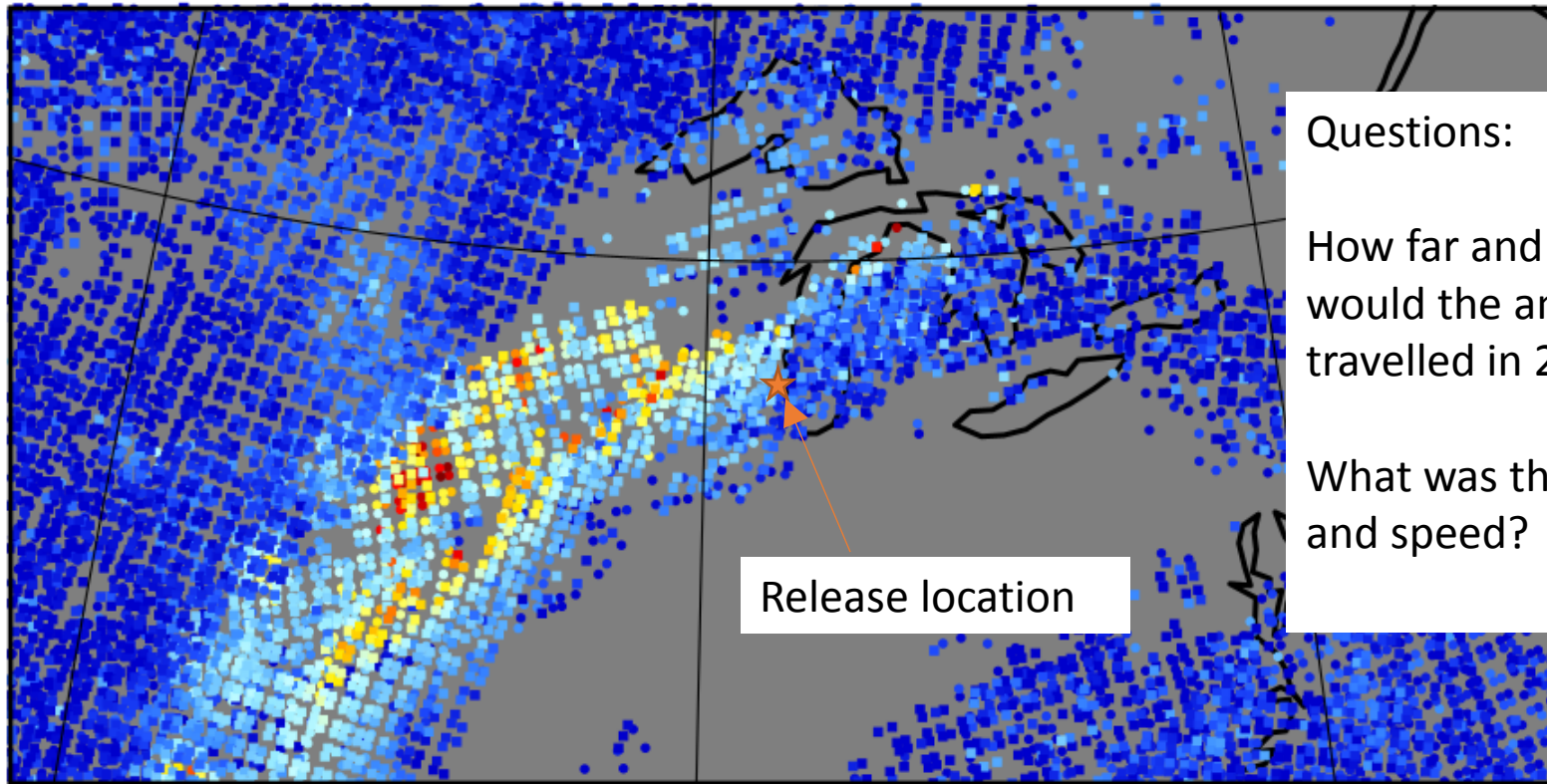


Question: Could this high concentration have anything to do with the ammonia incident?

Data from <https://iasi.aeris-data.fr/nh3/> . Circles symbols = METOP-A, Square symbols = METOP-B



# Beach Park, Illinois, USA (25 April 2019)

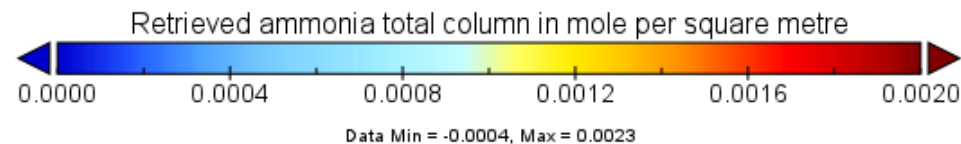


Questions:

How far and in what direction would the ammonia cloud have travelled in 24 hours?

What was the wind direction and speed?

Release location

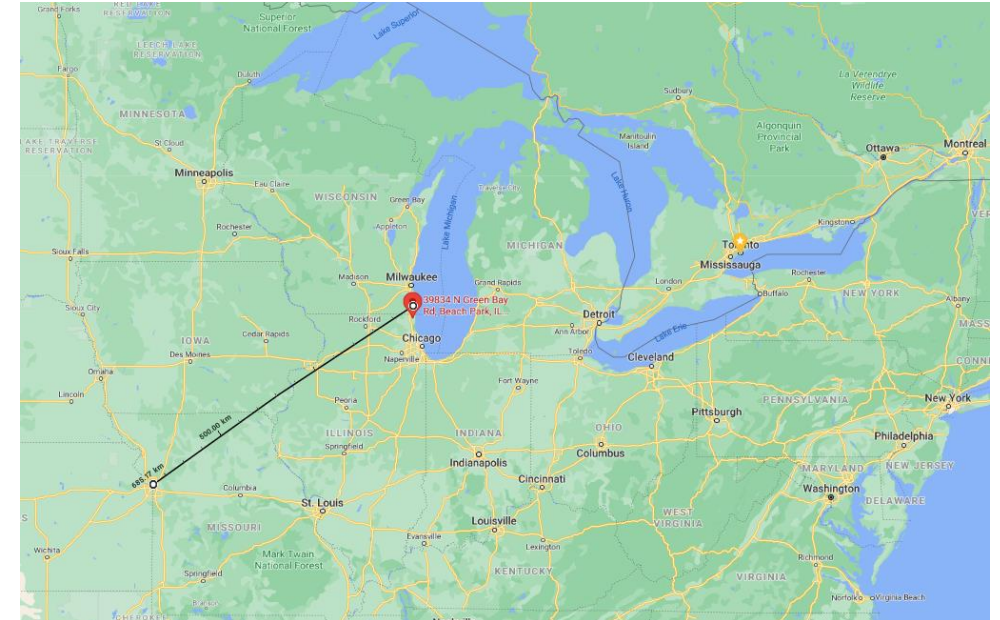
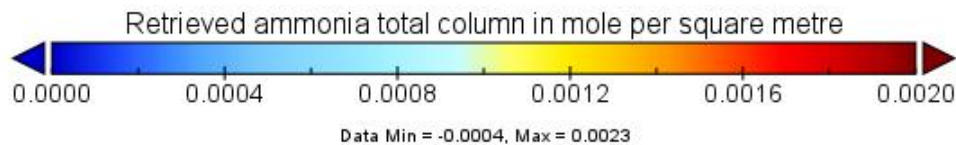
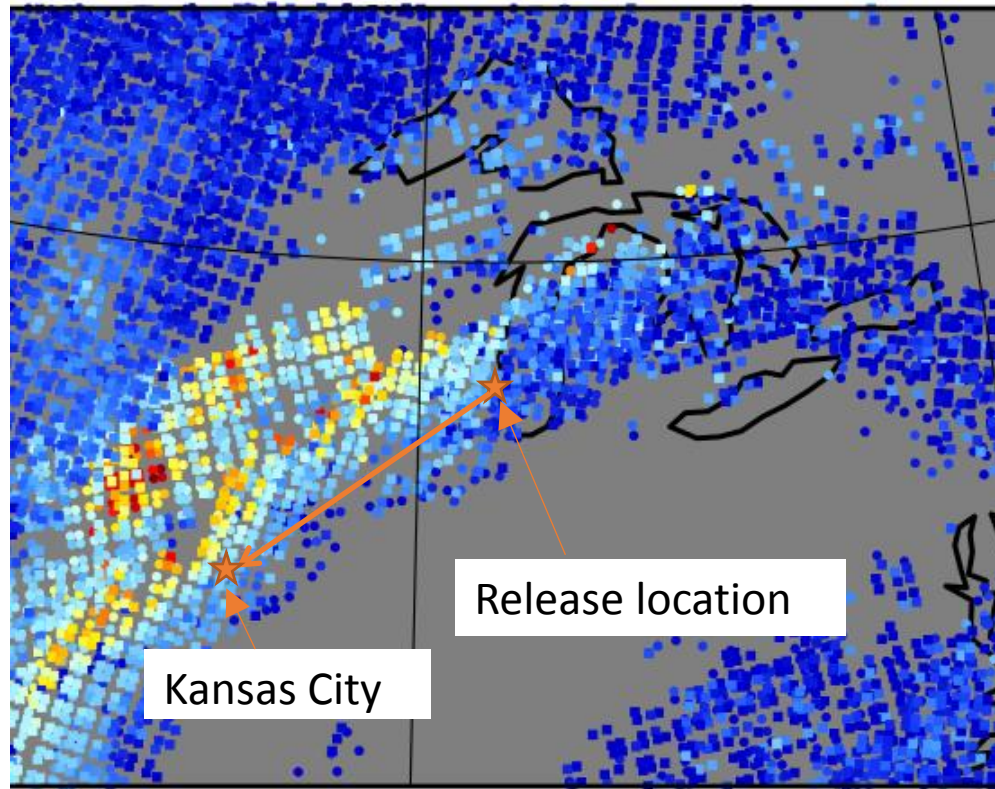


Data from <https://iasi.aeris-data.fr/nh3/>

Circles symbols = METOP-A

Square symbols = METOP-B

# Beach Park, Illinois, USA (25 April 2019)



Distance from Beach Park to Kansas City = 680 km  
To travel that distance in 24 hours requires a wind speed of  
 $680,000 / (24 \times 3,600) = 7.9 \text{ m/s}$   
which seems like a fairly realistic wind speed

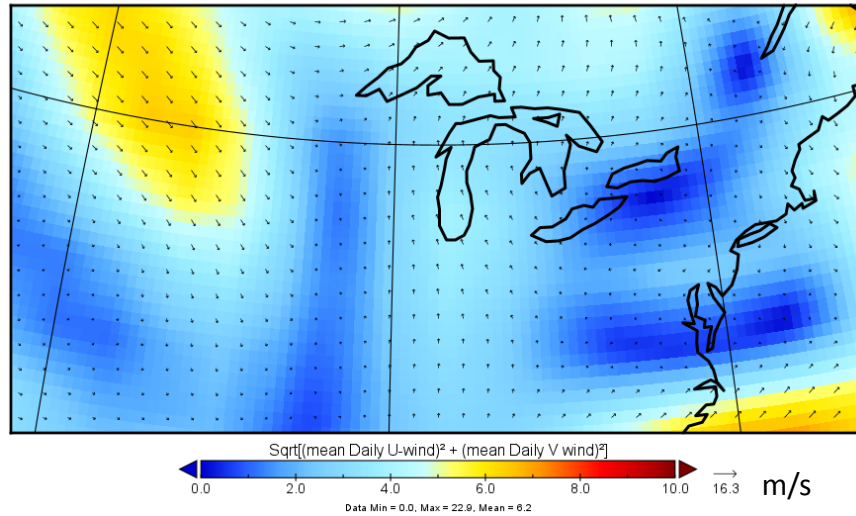


# Daily average wind vectors at 00:00 on 25 April 2019

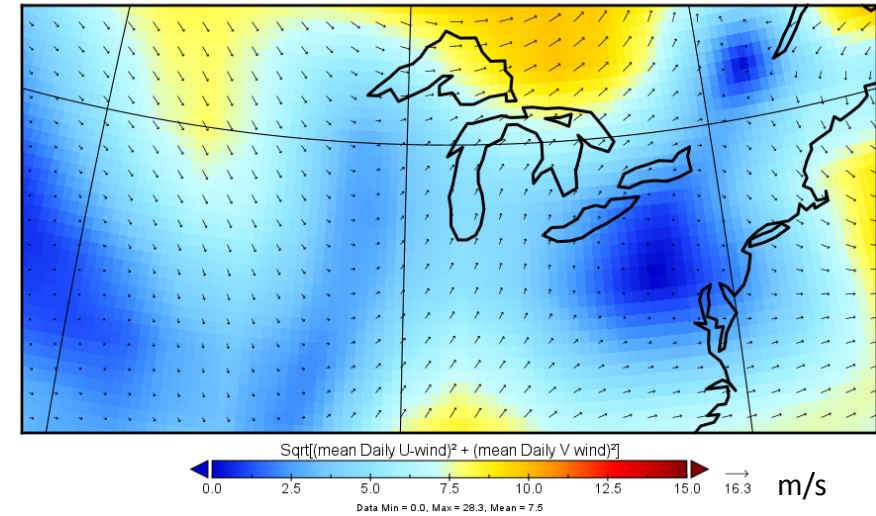
NCEP Reanalysis data provided by the NOAA/OAR/ESRL PSL, Boulder, Colorado, USA, from their website:

<https://psl.noaa.gov/data/gridded/data.ncep.reanalysis.pressure.html>

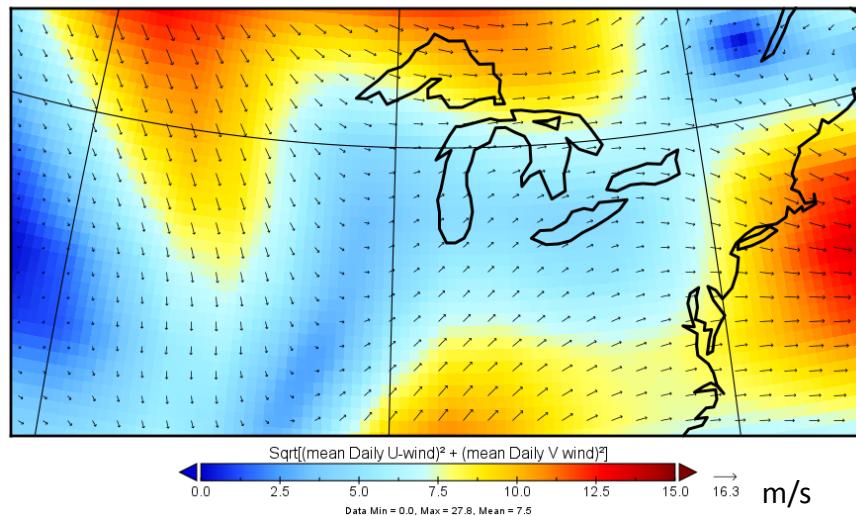
1000 mbar



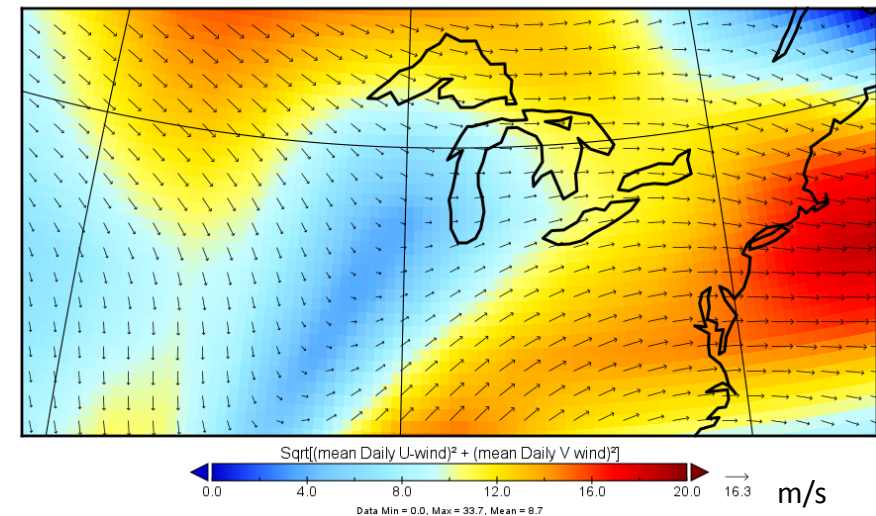
925 mbar



850 mbar



700 mbar

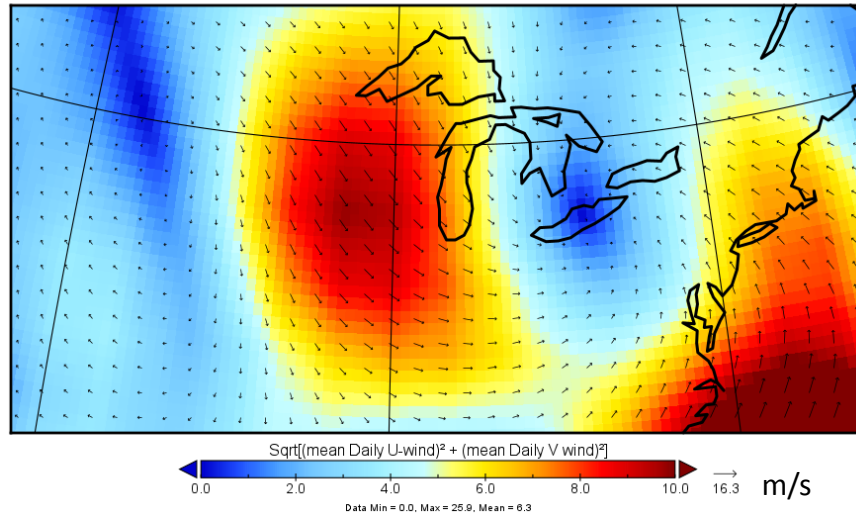


# Daily average wind vectors at 00:00 on 26 April 2019

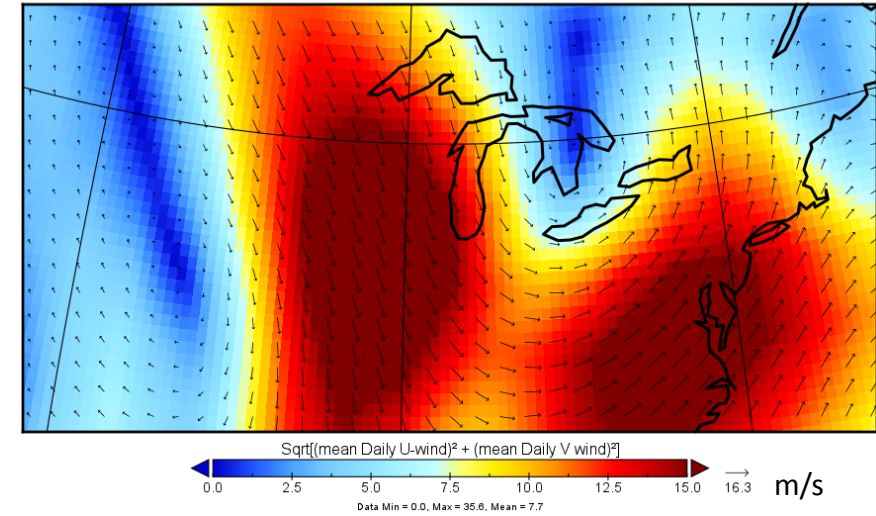
NCEP Reanalysis data provided by the NOAA/OAR/ESRL PSL, Boulder, Colorado, USA, from their website:

<https://psl.noaa.gov/data/gridded/data.ncep.reanalysis.pressure.html>

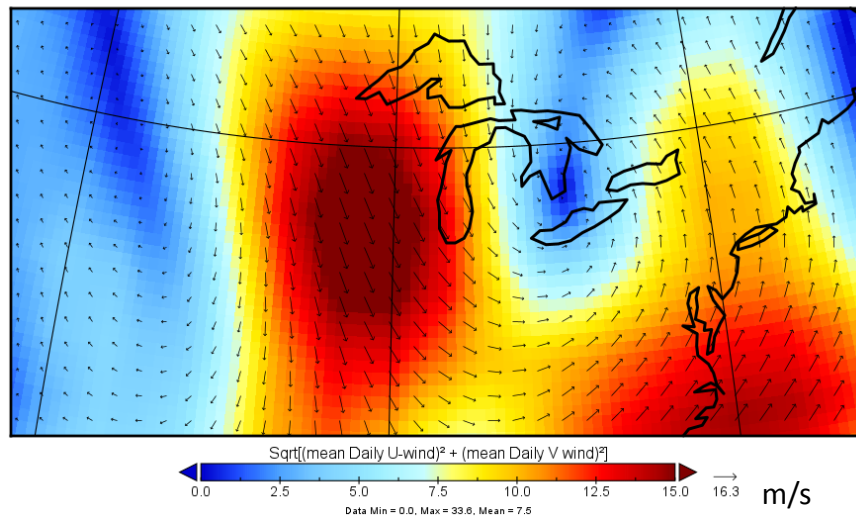
1000 mbar



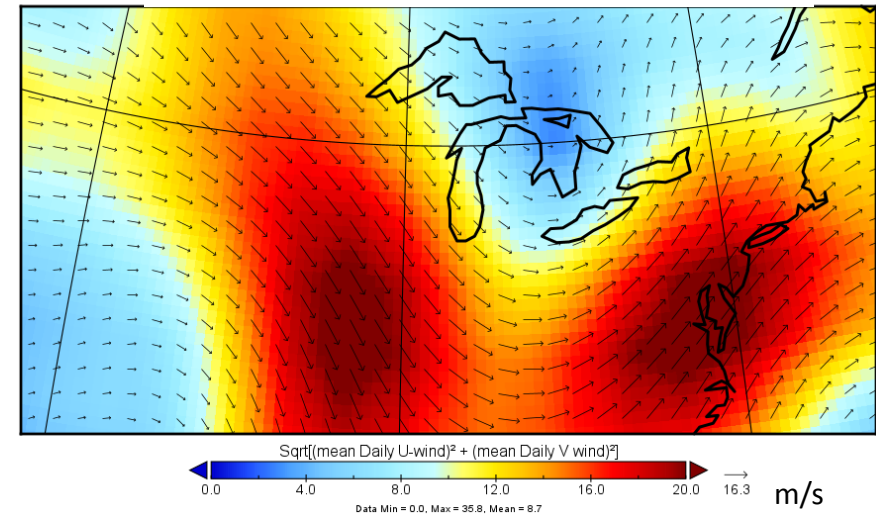
925 mbar



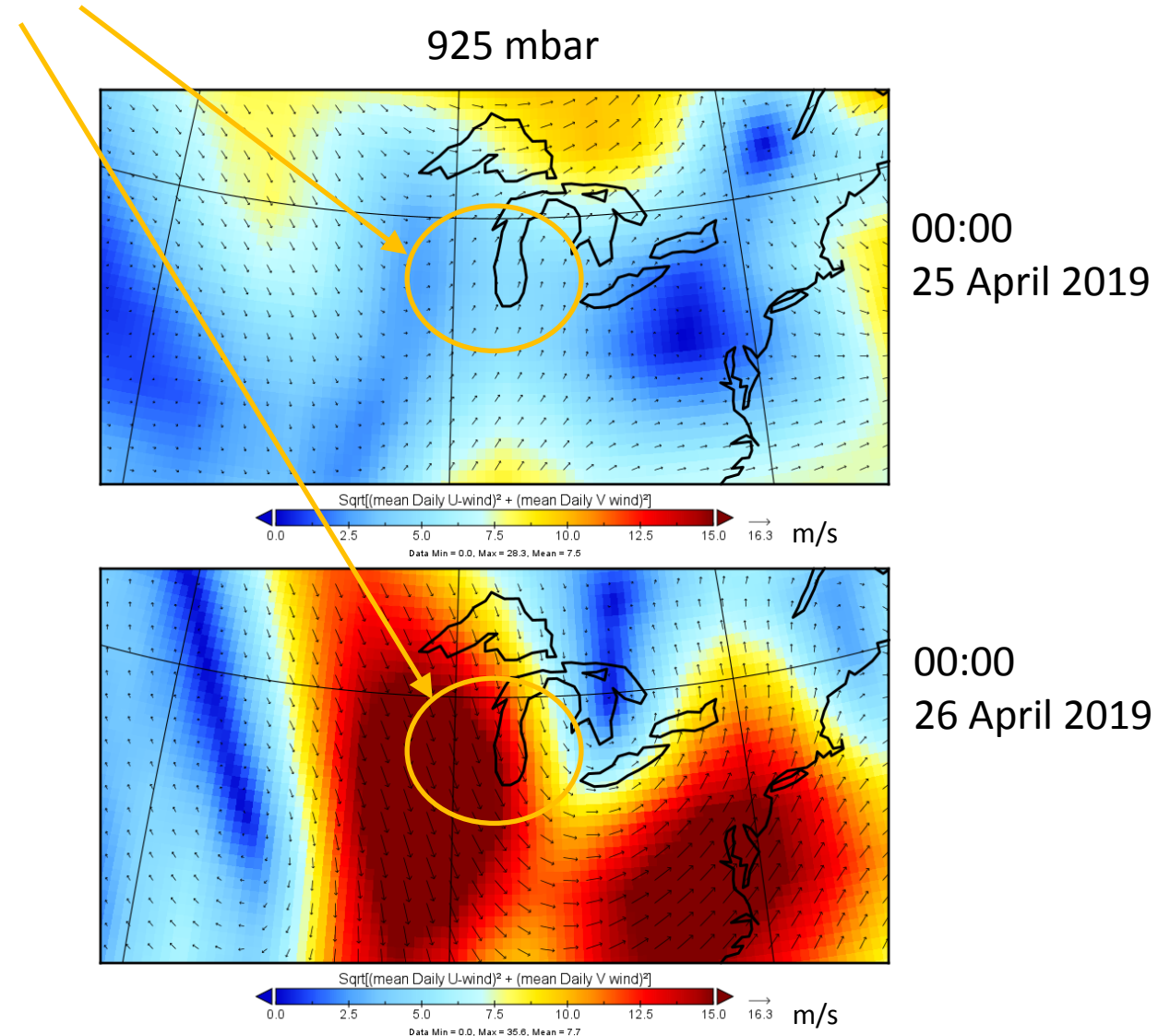
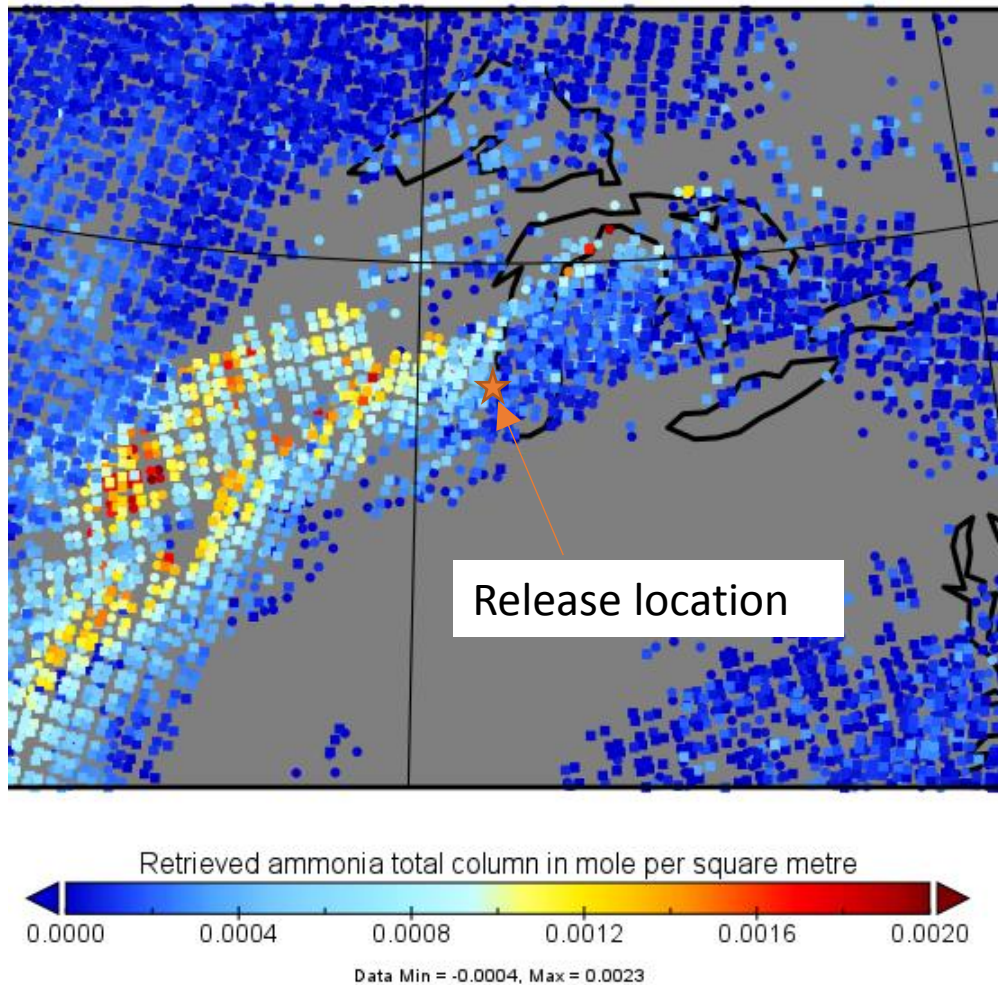
850 mbar



700 mbar



Wind direction was not consistent with ammonia from Beach Park incident producing high concentrations in METOP-A/B satellite data

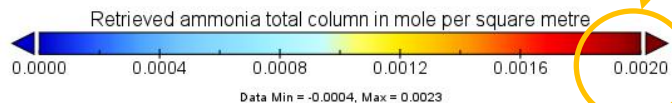
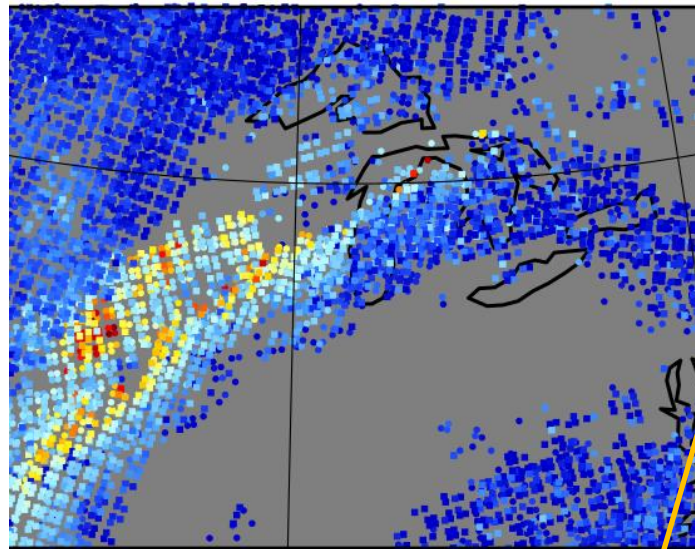




## Sanity check on some numbers



About 750 gallons of anhydrous ammonia liquefied compressed gas were accidentally released from these two 1,000-gallon nurse tanks mounted on a farm trailer, according to the U.S. National Transportation Safety Board investigation. (NTSB)



Liquid ammonia volume released: 750 US gallons =  $2.8 \text{ m}^3$

Liquid ammonia density at  $0^\circ\text{C}$  =  $640 \text{ kg/m}^3$

Liquid ammonia mass released =  $2.8 \times 640 = 1,800 \text{ kg}$

Ammonia vapour density at  $0^\circ\text{C}$  =  $0.76 \text{ kg/m}^3$

Let's assume the ammonia liquid mass all turns to vapour (no chemical reactions), then the volume of pure ammonia vapour is:  $1,800 / 0.76 = 2,400 \text{ m}^3$

Molar volume of gas at  $0^\circ\text{C}$  =  $0.022 \text{ m}^3/\text{mol}$

Number of moles of gas =  $2,400 / 0.022 = 110,000 \text{ mol}$

The max limit in this IASI satellite plot is a total column of ammonia:  $0.002 \text{ mol/m}^2$

Let's assume the background concentration was zero

The area covered by ammonia to give the satellite max value is  $A = 110,000 / 0.002$   
 $= 5 \times 10^7 \text{ m}^2$

This area equates to a circle with diameter  $D = \sqrt{(4.A/\pi)} = 8,000 \text{ m} = 8 \text{ km}$

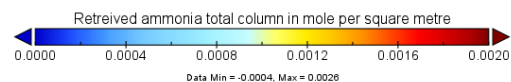
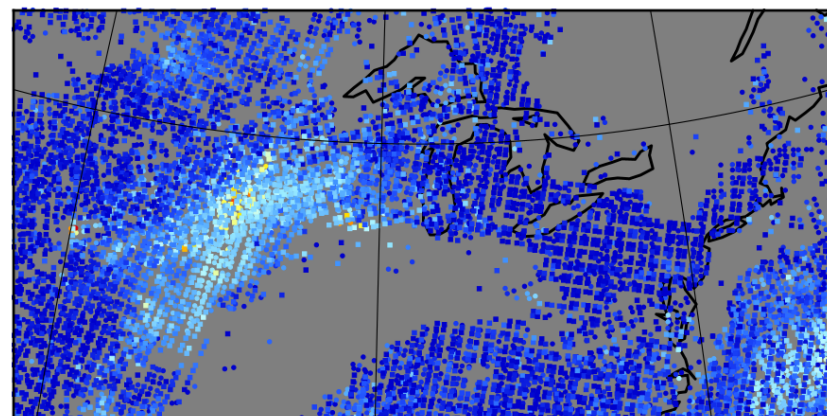
In comparison, the satellite pixel size is 12 – 39 km (depending on scan angle)\*

In other words, the release was too small to be seen in the satellite data

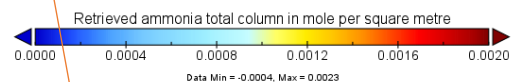
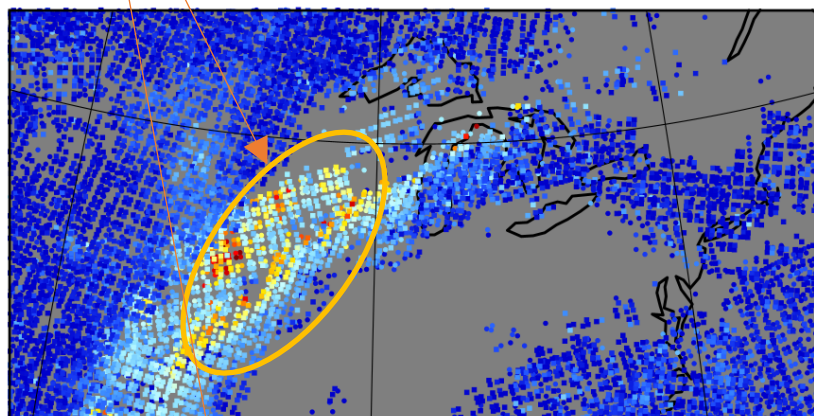
\* Source: Cathy Clerbaux (Cathy.Clerbaux@latmos.ipsl.fr)

An aside: are high ammonia concentrations correlated with light wind speeds in areas with agricultural emissions?

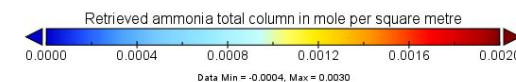
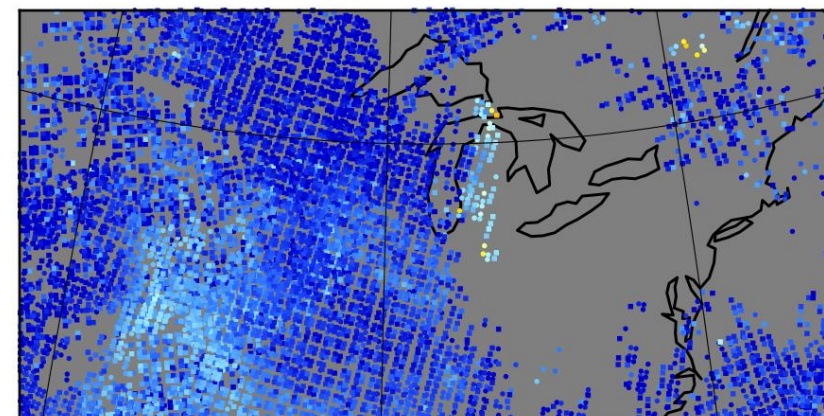
24 April 2019



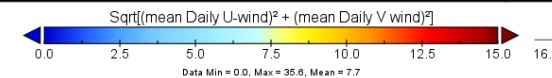
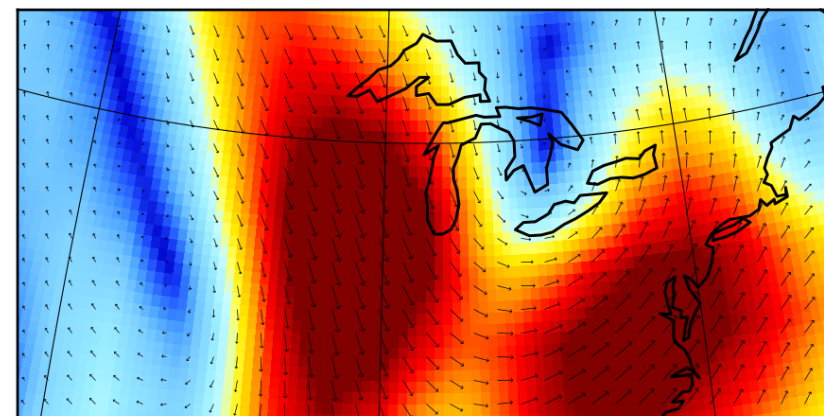
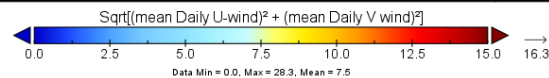
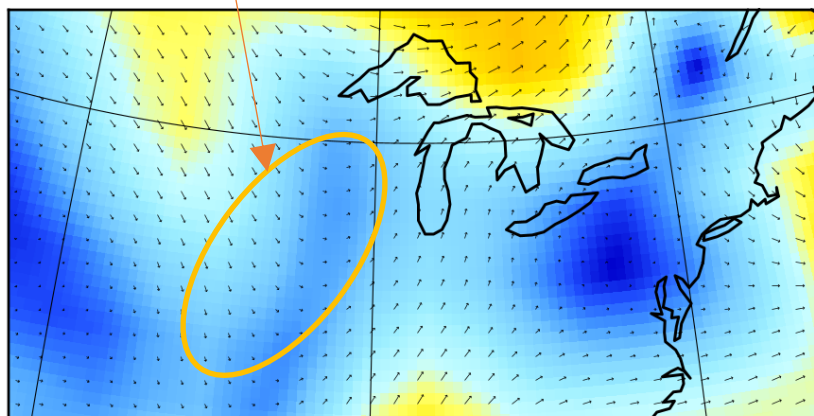
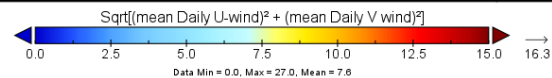
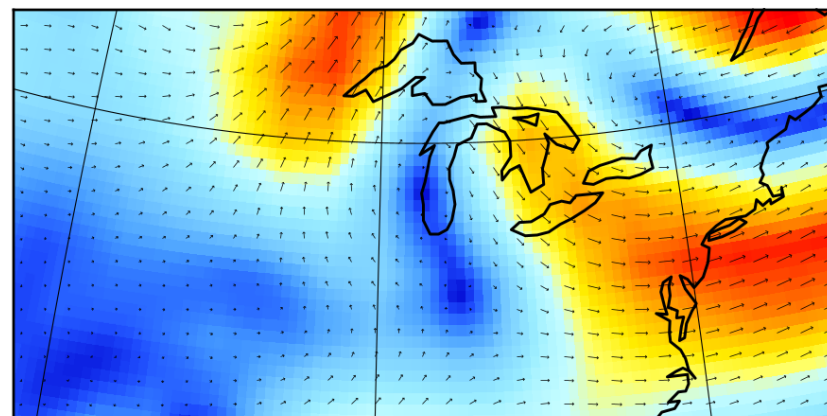
25 April 2019



26 April 2019



All wind vectors shown at 925 mbar





# What about other recent ammonia incidents that might show up in satellite data?

Source: Maureen Wood, JRC ([Maureen.WOOD@ec.europa.eu](mailto:Maureen.WOOD@ec.europa.eu))

See later slide →

Country / Region	Location	Date	Month	Year	Brief description of the incident	Severity Level	Comments
Ukraine	Sumy	7	Oct	2020	Near Sumy there was a powerful release of toxic ammonia from the tank. Video	Limited or no community impact	
France	Gonfreville-l'Orcher	27	May	2020	The facts took place during the night of Wednesday 27 to Thursday 28 May in a factory of the Yara chemical	Limited or no community impact	
Brazil	Sete Lagoas	16	May	2020	Five people were injured on Saturday night (16) after ammonia leakage at a company on Avenida Zoello Sola,	Limited or no community impact	5 injuries
India	Assam	6	Jan	2020	Assam: BVFCL shut down after explosion The blast occurred in the pipeline connecting the high-	Limited or no community impact	
Mexico	Cuauhtémoc	20	May	2020	The confirmation of a chemical leak, generated the mobilization of emergency elements on Avenida	Limited or no community impact	
Mexico	Ixtacuixtla	26	March	2020	About 500 workers from the Condumex factory , located on the Texmelucan-Tlaxcala federal highway ,	Limited or no community impact	
Brazil	Iranduba	4	Sept	2020	Refrigerator explosion causes ammonia leak in Iranduba, AM	Local disaster (Severity 3 or 4)	48 people injured
India	Purpur, Uttar Pradesh	22	Dec	2020	At least two people died in an ammonia leak from a fertilizer plant in northern India	Local disaster (Severity 3 or 4)	2 deaths, 15 injuries
Zambia	Witbank	1	May	2020	Residents from Tasbet Park in Witbank (Emalahleni) were forced to evacuate their homes at around	Local disaster (Severity 3 or 4)	4 hospitalised, 150 evacuated for 4 hours, road closed
China	Ma'anshan	17	June	2020	June 17, according to the Anhui Provincial Emergency Management Department website, at 9 a.m. on June	Limited or no community impact	2 deaths, 1 injury
Norway	Tomrefjord	1	Oct	2020	Gas leak on Vard Thursday at 11:12 Leakage has stopped The ammonia	Limited or no community impact	3 injured
Bulgaria	Blagoevgrad	5	Oct	2020	A leak of ammonia shocked workers at the Blagoevgrad brewery from BNT16:50, 05.10.2020Read in: 00:15	Limited or no community impact	

No METOP-A/B/C data available for 22/12/20

No METOP-A/B/C data available for 22/12/20

Country / Region	Location	Date	Month	Year	Brief description of the incident	Severity Level	Comments
Czech Republic	Trebon	16	Oct	2020	Ammonia leaked in the Třeboň brewery. Firefighters evacuated eighteen people	Limited or no community impact	
Finland	Imatra	24	March	2020	An ammonia leak occurred this morning in Imatra Ice Hall number one.	Limited or no community impact	
Germany	Herne	24	Aug	2020	Ammonia leaked into an ice rink in Herne, which led to a large-scale deployment of the fire brigade for	Limited or no community impact	2 injured
Germany	Kulmbach	22	July	2020	Ammonia alarm in the slaughterhouse Because a line was damaged, there was a major	Limited or no community impact	1 injury
Brazil	Passos	3	Nov	2020	JBS keeps workers exposed to the risk of ammonia poisoning; remember cases	Limited or no community impact	2 injuries
Chile	Talcahuano	1	Oct	2020	Camanchaca rules out the release of gases after a call from the Seremi de Salud to close windows	Limited or no community impact	
China	Tainan	2	June	2020	In the vicinity of Xinren Road, Anping Industrial Zone, South District, Tainan City, ammonia gas	Limited or no community impact	In the vicinity of Xinren Road, Anping Industrial Zone, South
Mexico	Querétaro	11	Jan	2020	On the afternoon of Saturday an ammonia leak occurred in an ice factory in the city of Querétaro.	Limited or no community impact	
New Zealand	Hamilton	25	June	2020	Fonterra factory in Hamilton evacuated after ammonia leak	Limited or no community impact	
USA	Rochester, MN	20	June	2020	An ammonia leak Friday night caused an evacuation and traffic shutdown in downtown	Limited or no community impact	
Israel	Migdal Hamek	30	Aug	2020	100 workers evacuated after suspected ammonia leak at northern factory	Limited or no community impact	1 injury
Serbia	Belgrade	14	March	2020	(Photo by A. Vasiljevic) The leakage of ammonia at the BIP plant, located on	Local disaster (Severity 3 or 4)	5 injured
India	Bandapalli	21	Aug	2020	14 hospitalised after ammonia gas leak at milk dairy unit in Andhra's Chittoor	Local disaster (Severity 3 or 4)	14 hospitalised
Austria	Dornbirn	7	Nov	2020	Ammonia leaked into company building On Saturday morning there was a leak of ammonia	Limited or no community impact	
Honduras	Cuts	4	Feb	2020	A leak of large amounts of toxic material was reported this day at a factory located in the López	Limited or no community impact	

Refrigerant at brewery

Refrigerant at dairy



# Ammonia railcar release at Sumy, Ukraine, 7 October 2020

## Near Sumy, there was a powerful release of toxic ammonia from the tank. Video

20:34, October 7, 2020



📷 Most likely, there is no longer any threat to people. Screenshot from video

Ammonia was released near the Toropilovka railway station near the town of Stepanovka, Sumy region, which is considered moderately toxic, but can kill in high concentrations.

The video of the emission appeared on the social network, and soon the information about it was confirmed by the director of the department of civil protection of the population of the Sumy regional state administration Alexander Milash.

It is reported by "Suspilne".

A video clip with the moment of the gas release, filmed on the phone, was posted in the Sumy Instagram community at about 13:00 on October 7. The caption to the video says that Toropilovka is located only 8-10 km from Sumy.

And the head of the department of state supervision over the observance of sanitary legislation of the Main Directorate of the State Food and Consumer Service in the Sumy region, Valentina Tishchenko, said that there was a depressurization of the railway tank car. Specialists of the State Emergencies Service informed the service that no dangerous concentrations of ammonia were detected at the site of the depressurization, Tishchenko added. Now employees of the civil service department and the regional laboratory center are working at the scene of the accident and taking measurements to determine if there is a danger to people. They promised to submit the details of the check on October 8.

"Given the property of this gas, most likely its concentration has already been diluted with air masses and does not pose a threat to people," Tishchenko reassured.

A similar case already happened in this region three years ago: in Sumy itself, almost 5 tons of ammonia spilled out of the tank.

# Conclusion

- The incident at Beach Park, Illinois (1.8 tonnes of liquid ammonia) was too small to be seen in satellite data
- Most recent incidents seem to involve relatively “small” amounts, often at refrigeration plants (a few tonnes), which will not be visible on IASI satellite data
- Data for a larger release, e.g. Ukraine railcar (80 tonnes?) is not yet available on IASI
- Useful to look out for significant ammonia incidents and review ammonia satellite capabilities periodically



# Acknowledgements

- For inspiration and helpful advice on data sources, information and plotting:
  - Cathy Clerbaux ([Cathy.Clerbaux@latmos.ipsl.fr](mailto:Cathy.Clerbaux@latmos.ipsl.fr))
  - Claire Witham ([Claire.Witham@metoffice.gov.uk](mailto:Claire.Witham@metoffice.gov.uk))
  - Dan Potts ([dap33@leicester.ac.uk](mailto:dap33@leicester.ac.uk))
  - Maureen Wood ([Maureen.Wood@ec.europa.eu](mailto:Maureen.Wood@ec.europa.eu))
- Images created using Panoply (<https://www.giss.nasa.gov/tools/panoply/>)
- Ammonia data from IASI satellite (<https://iasi.aeris-data.fr/nh3>)
- NCEP Reanalysis data provided by the NOAA/OAR/ESRL PSL, Boulder, Colorado, USA, from their website:  
<https://psl.noaa.gov/data/gridded/data.ncep.reanalysis.pressure.html>