

SOFT-IO-Li:

A new tool merging space and ground based lightning observations and aircraft NOx measurements

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SOFT-IO-Li



Pre-treatment of satellite lightning (GLM) and cloud (ABI) observations



LMAs (NLDN)



Foresee future inputs MTG LI



EUMETSAT

IAGOS NO_x flight data:

- Filter to remove anthropogenic and stratospheric influences and plane exhausts,
- Identify zones of excess NO_x in troposphere



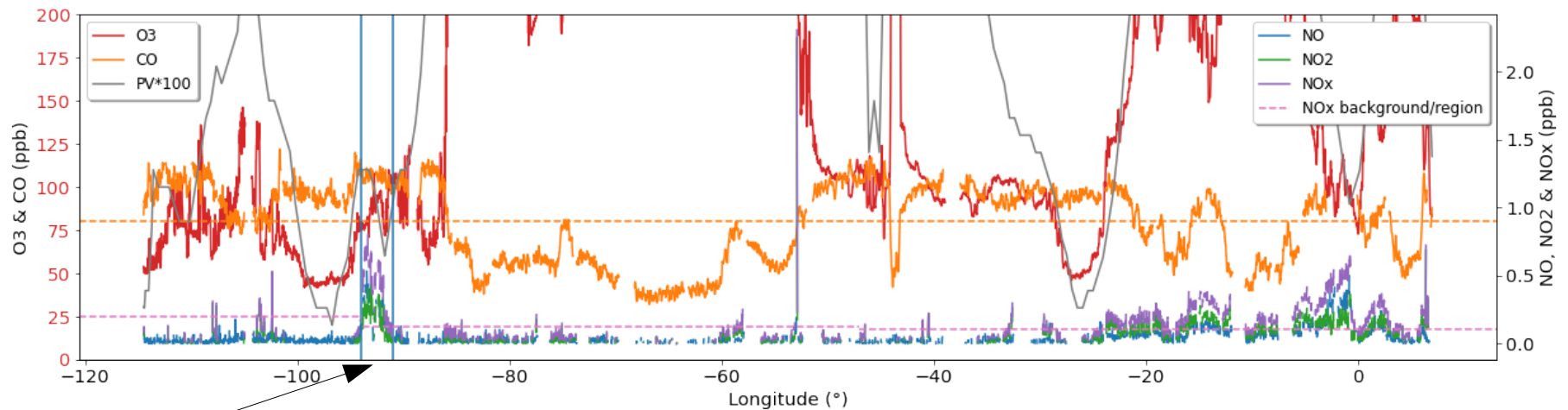
10 day backward trajectory providing residence time of plume dispersion

Lightning metrics corresponding to plume dispersion :
Flash numbers, energy, type, NO_x, CO, O₃, airmass lifetime...

- * Provide a database of Lightning-NO_x characteristics
- * Provide a tool to trace sources of NO_x measurements

Plume chemistry data

['FRA, Frankfurt, Germany', '-->', 'SAN, San Diego, United States', 'IAGOS-CORE']



Plume 1

Plume extent (time) : 2018-06-05T16:13:21.000000000 --> 2018-06-05T16:43:49.000000000
 Plume extent (longitude): -90.6571 ° --> -95.1277 °
 Plume extent (latitude) : 48.1915 ° --> 45.8978 °

NOx Plume 1

Mean NOx : 0.351
 Stdev NOx : 0.232
 Median NOx : 0.394
 Q3 NOx : 0.566
 Q1 NOx : 0.117
 5th NOx : 0.050
 95th NOx : 0.679

CO Plume 1

Mean CO : 105.054
 Stdev CO : 5.053
 Median CO : 105.0
 Q3 CO : 108.0
 Q1 CO : 101.0
 5th CO : 97.000
 95th CO : 114.000

O3 Plume 1

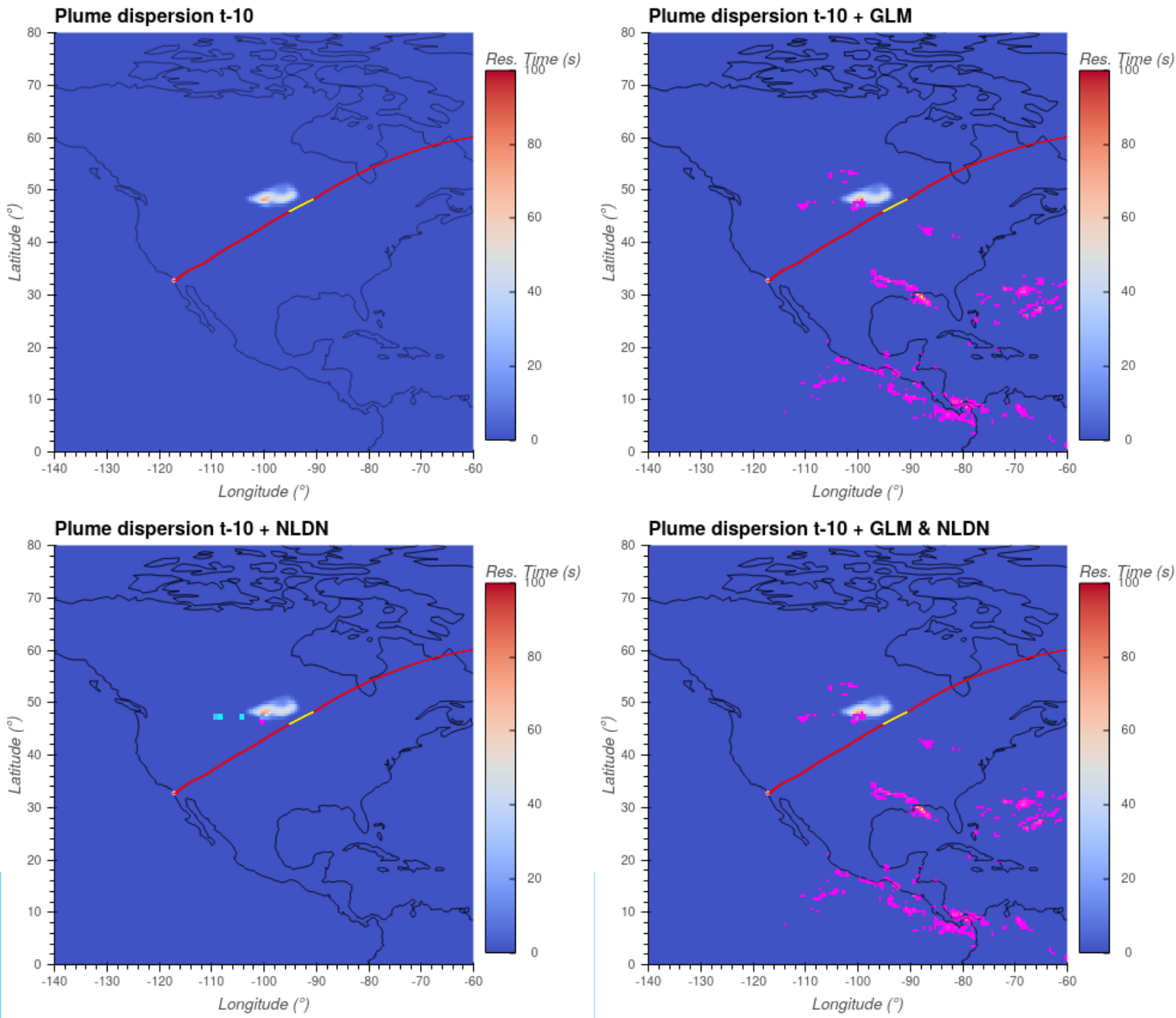
Mean O3 : 83.378
 Stdev O3 : 14.214
 Median O3 : 82.5
 Q3 O3 : 94.0
 Q1 O3 : 76.0
 5th O3 : 57.000
 95th O3 : 105.000

RHL Plume 1

Mean RHL : NA
 Stdev RHL : NA
 Median RHL : NA
 Q3 RHL : NA
 Q1 RHL : NA
 5th RHL : NA
 95th RHL : NA

Cloud presence: 0

Plume dispersion t-10h



Max.
residence
time :



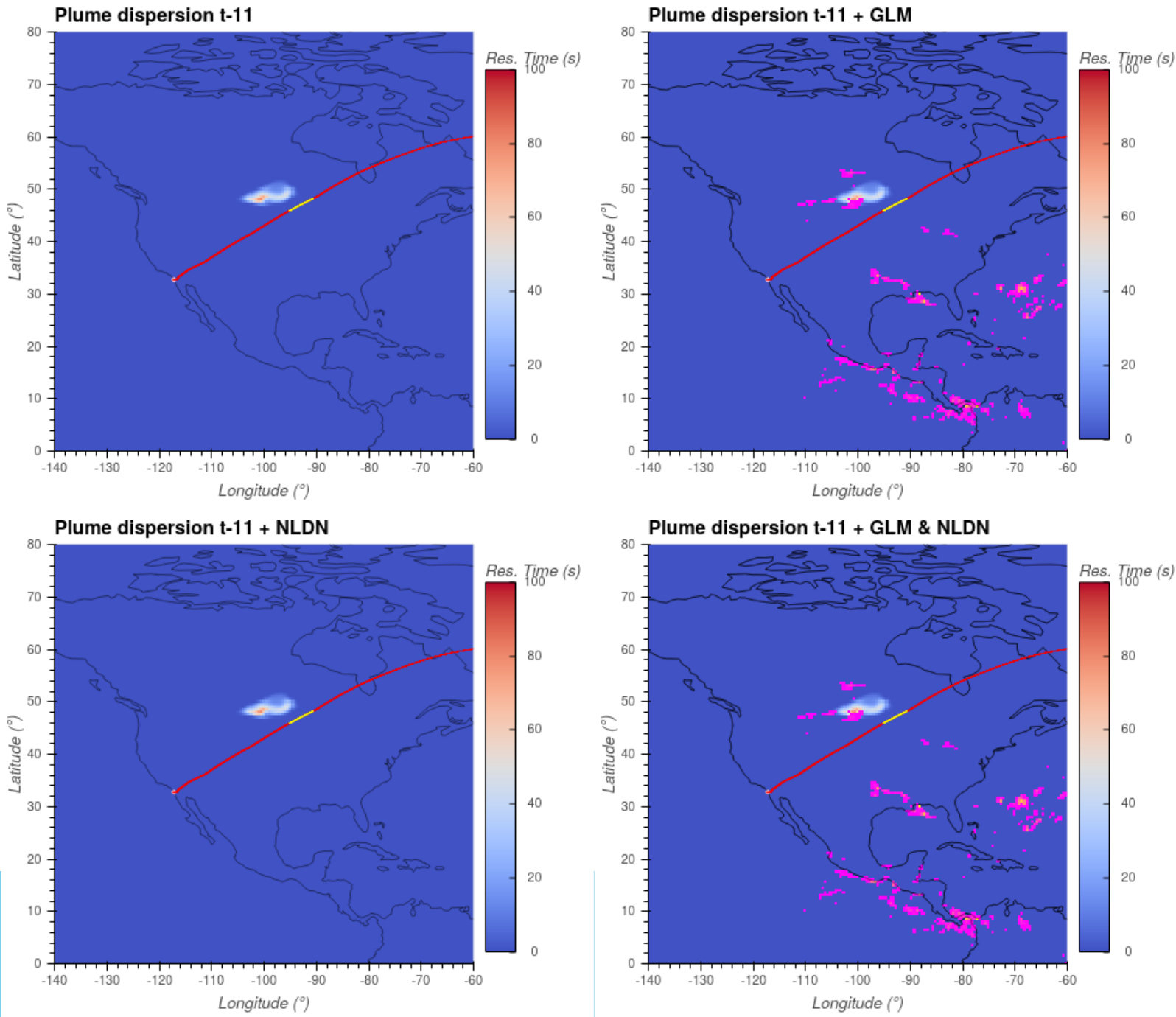
GLM :



NLDN :



Plume dispersion t-11h



Max.
residence
time :



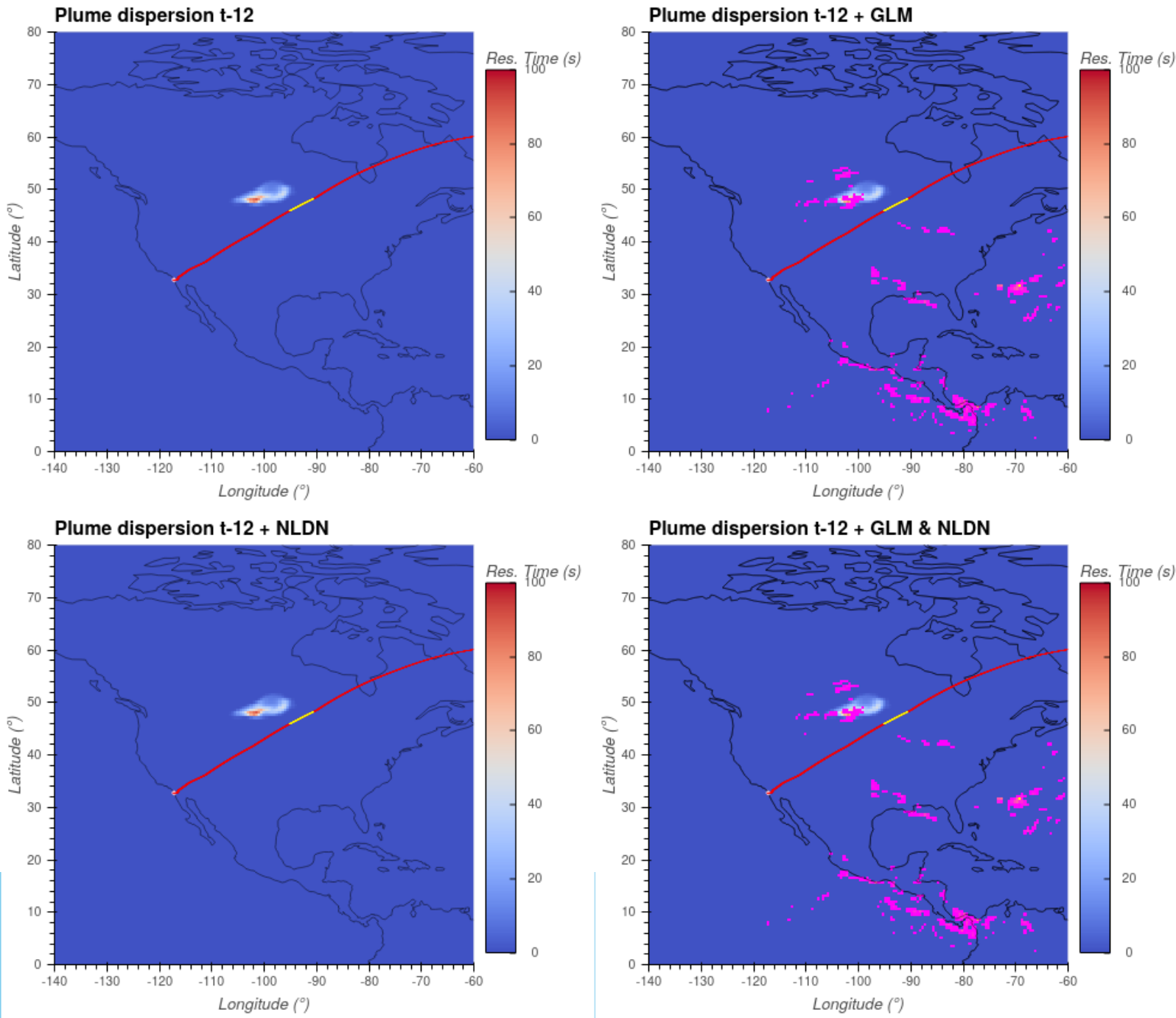
GLM :



NLDN :



Plume dispersion t-12h



Max.
residence
time :



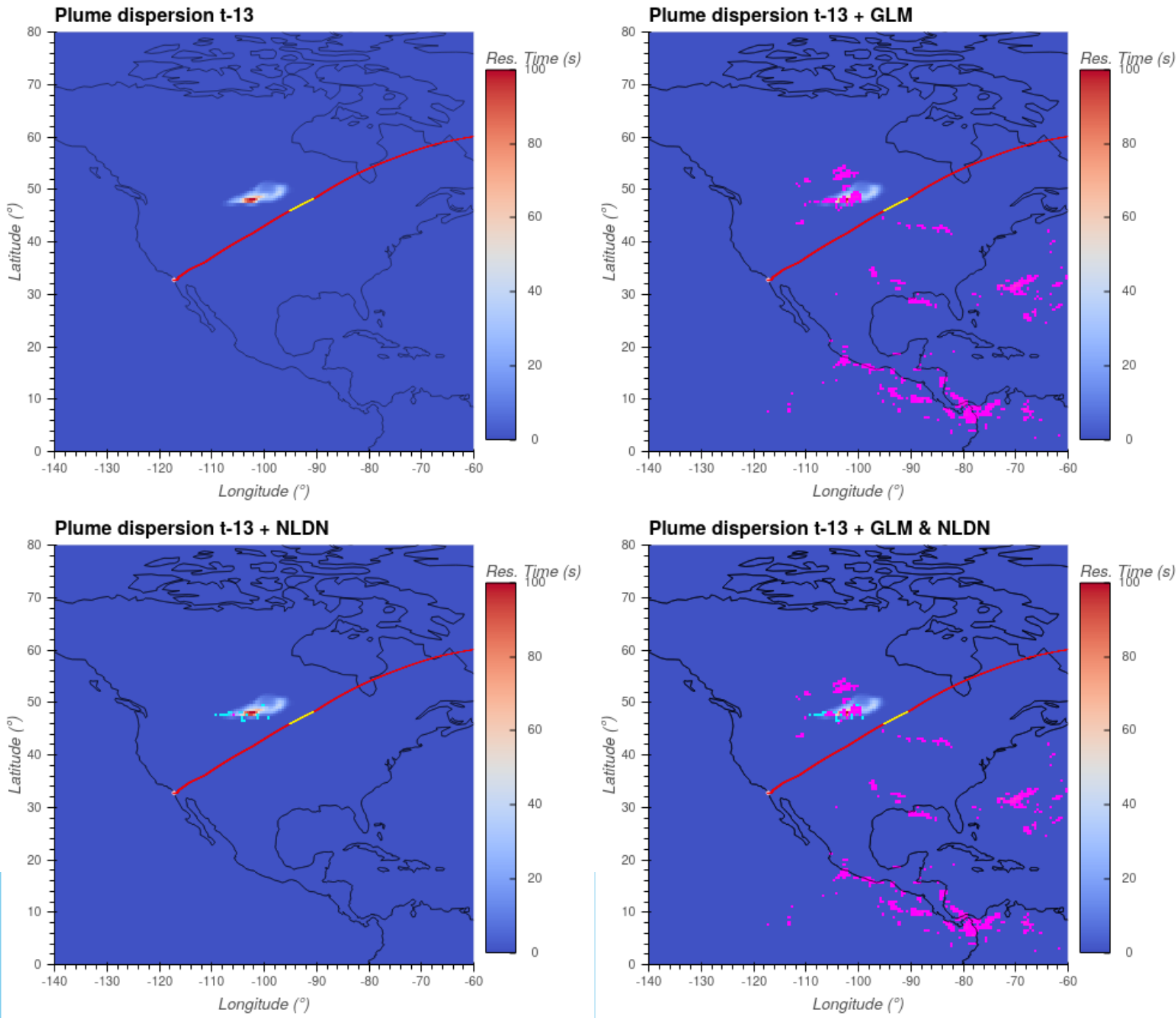
GLM :



NLDN :



Plume dispersion t-13h



Max.
residence
time :



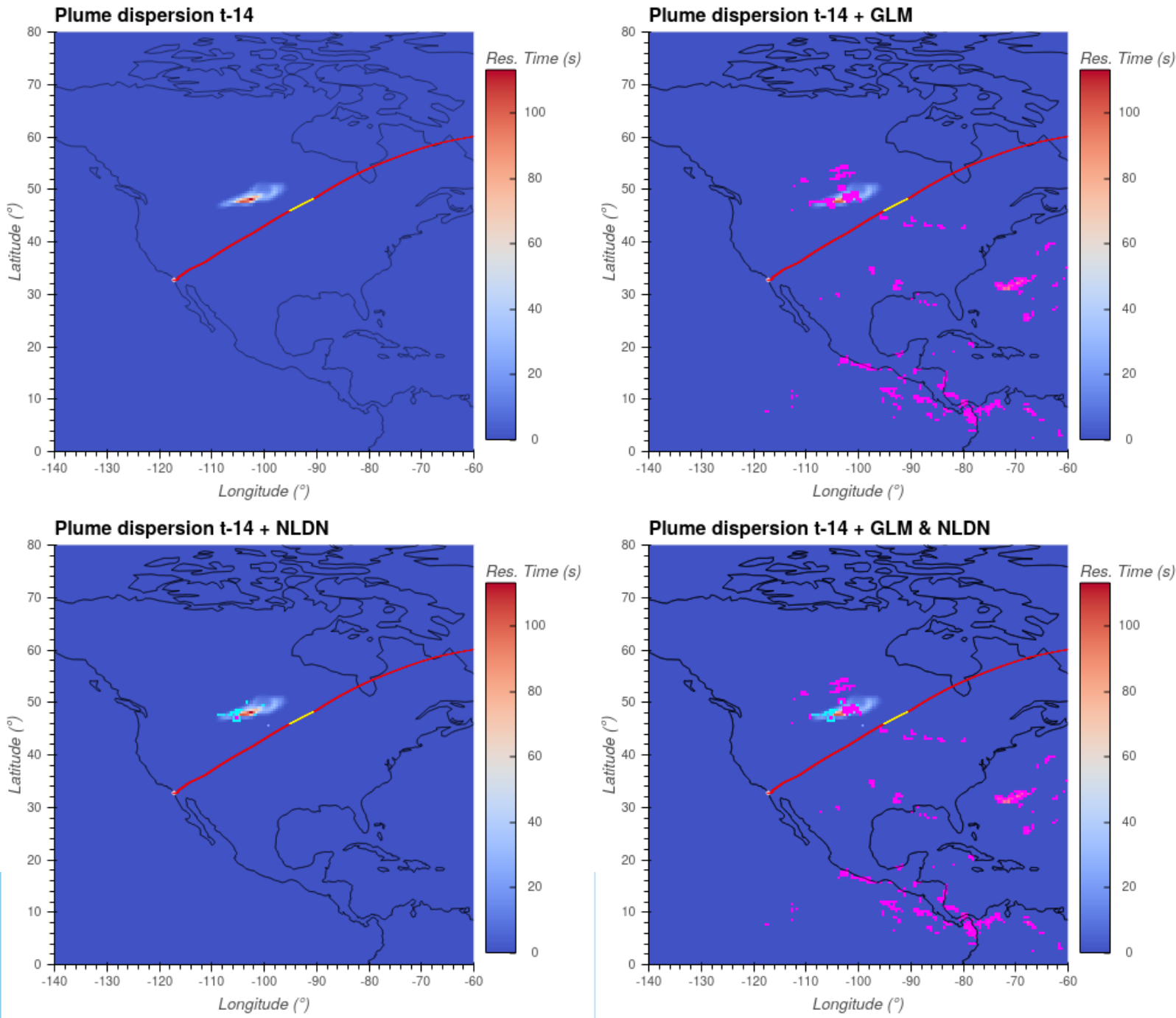
GLM :



NLDN :



Plume dispersion t-14h



Max.
residence
time :



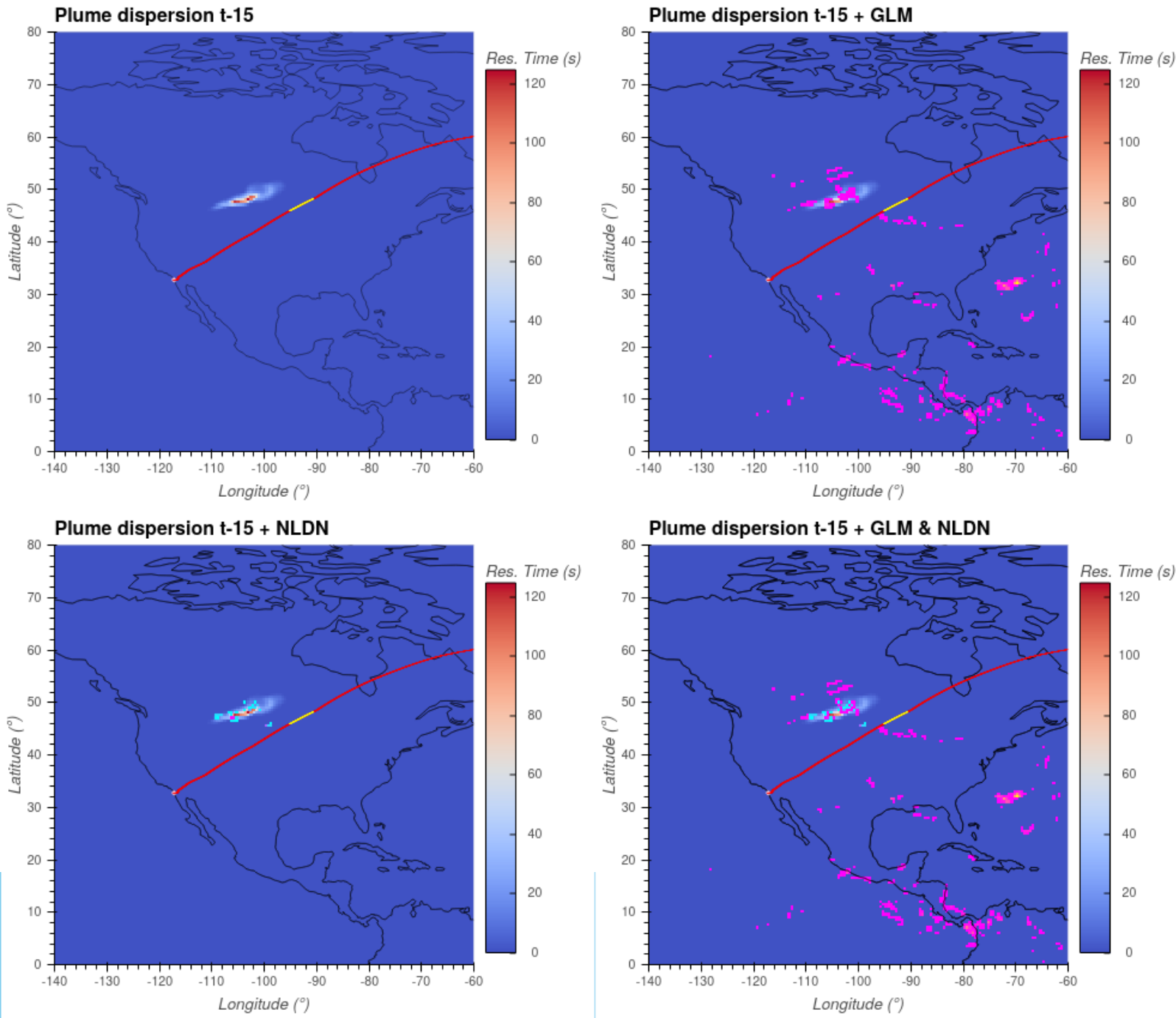
GLM :



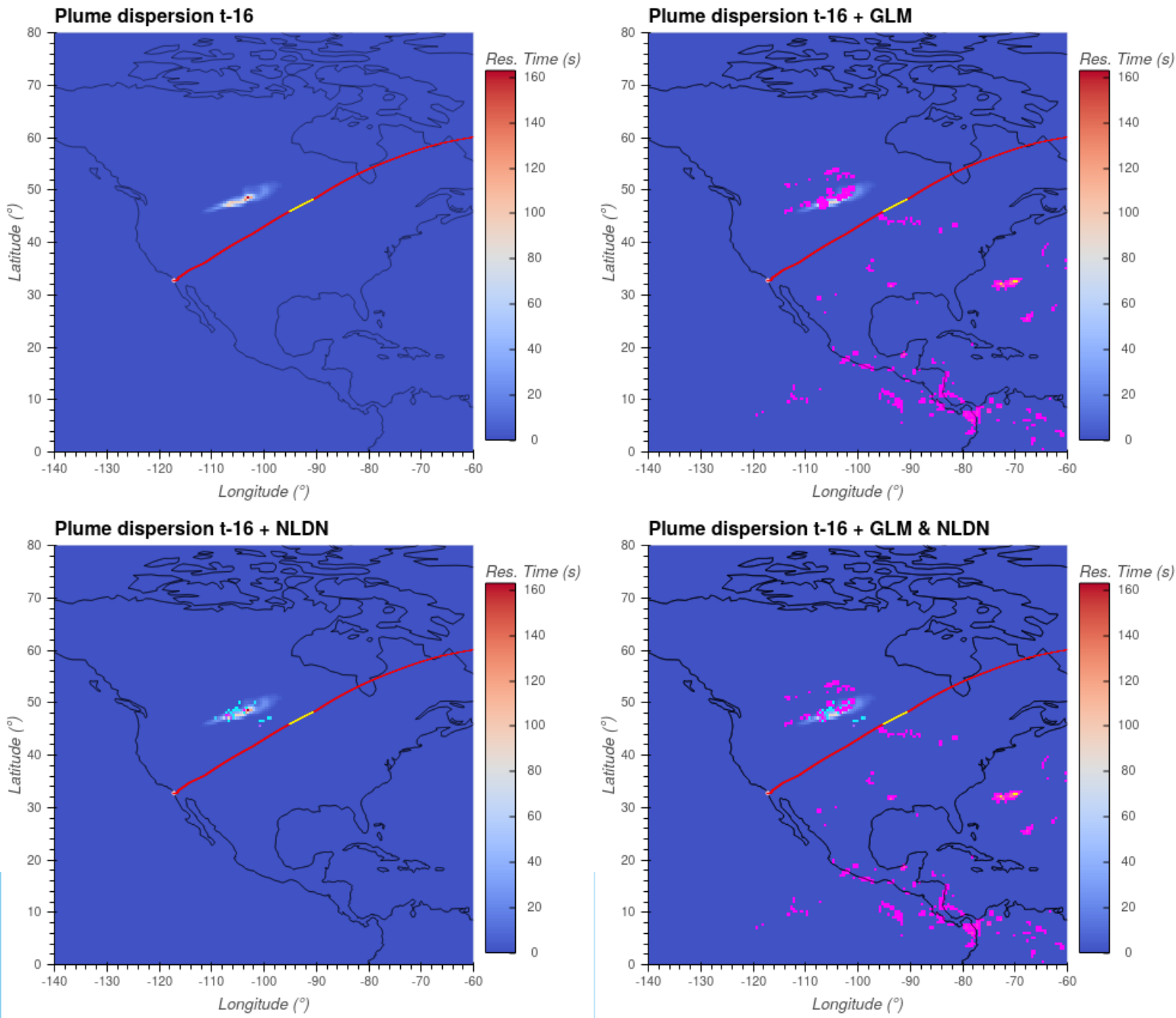
NLDN :



Plume dispersion t-15h



Plume dispersion t-16h



Max.
residence
time :



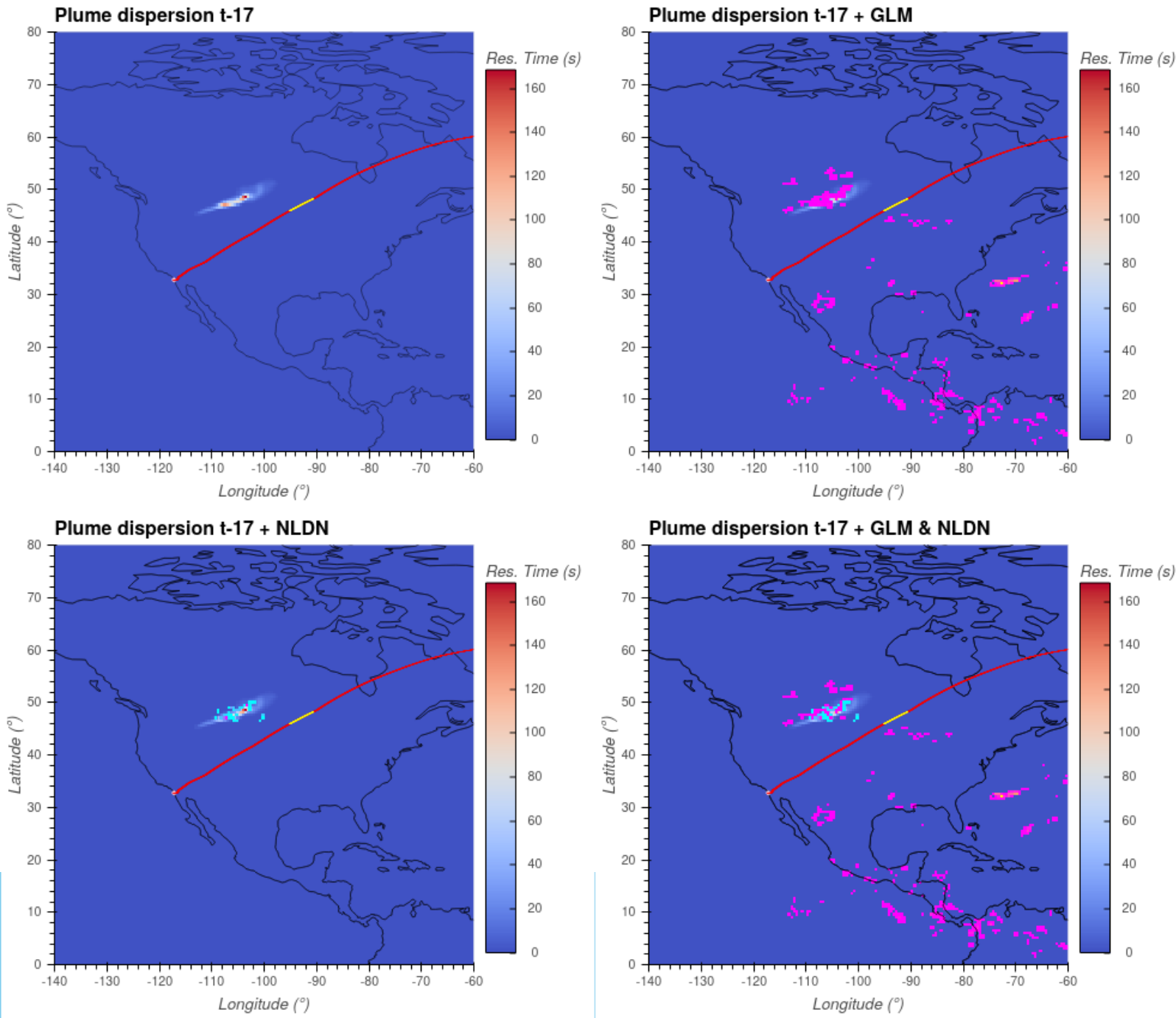
GLM :



NLDN :



Plume dispersion t-17h



Max.
residence
time :



GLM :

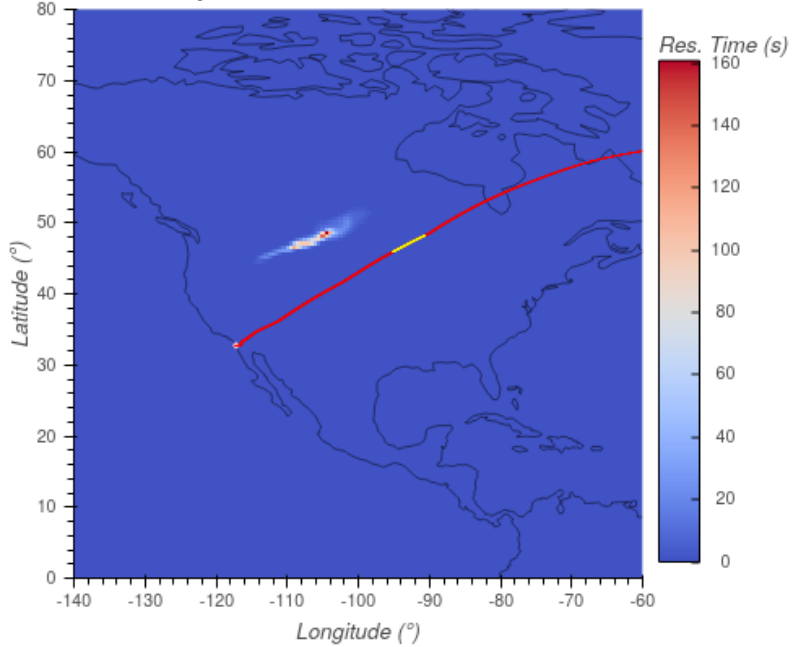


NLDN :

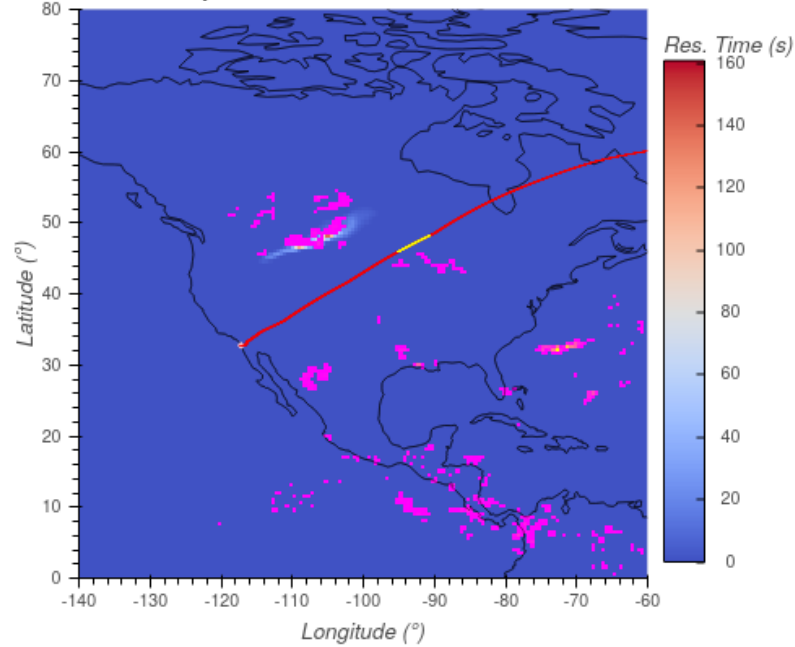


Plume dispersion t-18h

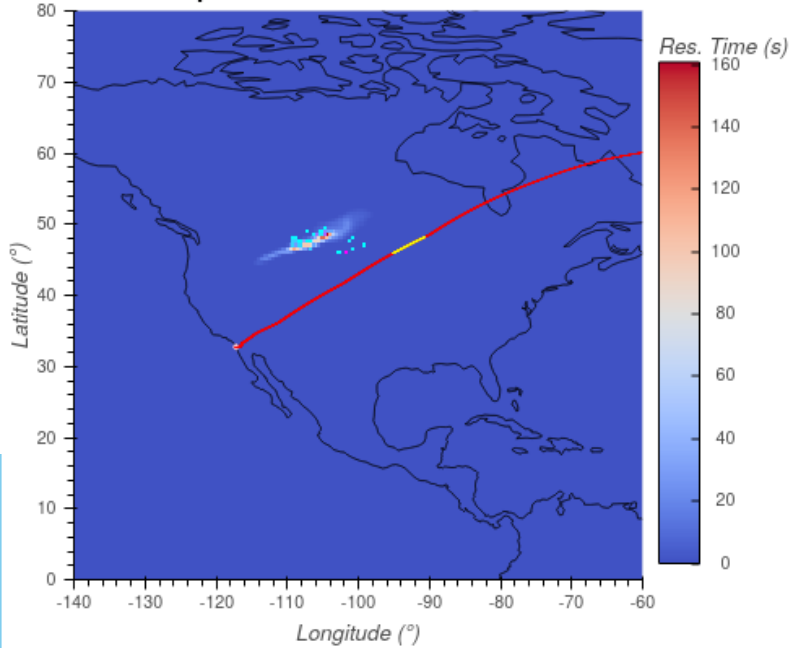
Plume dispersion t-18



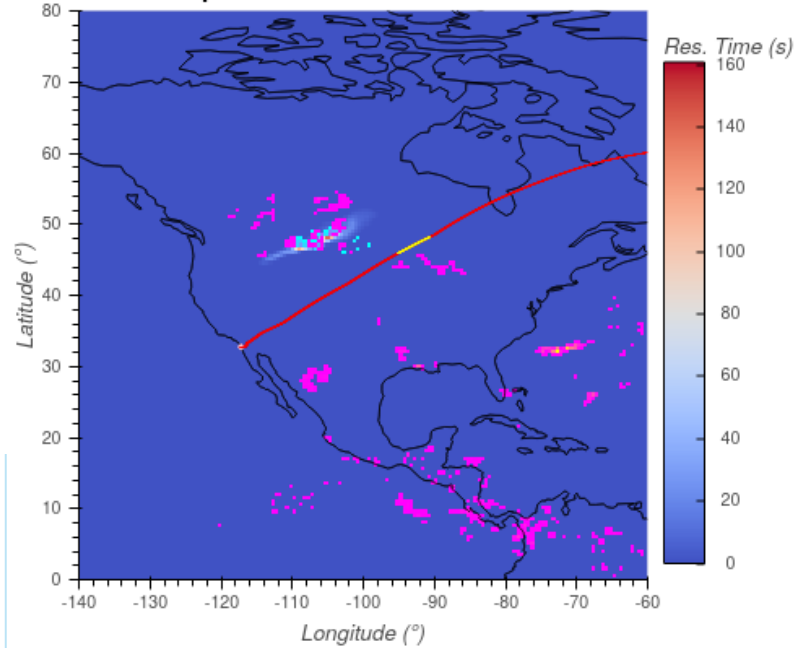
Plume dispersion t-18 + GLM



Plume dispersion t-18 + NLDN



Plume dispersion t-18 + GLM & NLDN



Max.
residence
time :



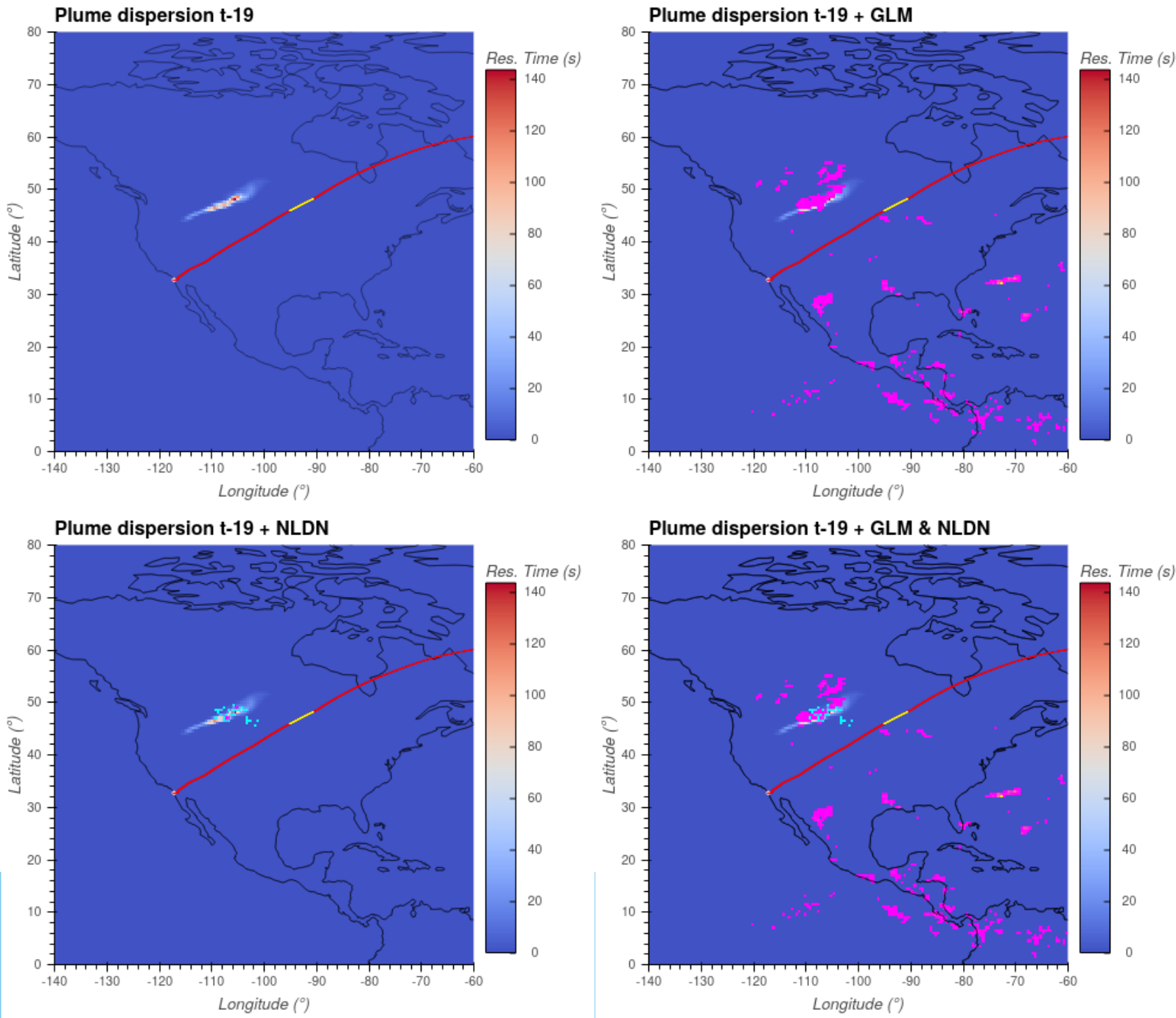
GLM :



NLDN :



Plume dispersion t-19h



Max.
residence
time :



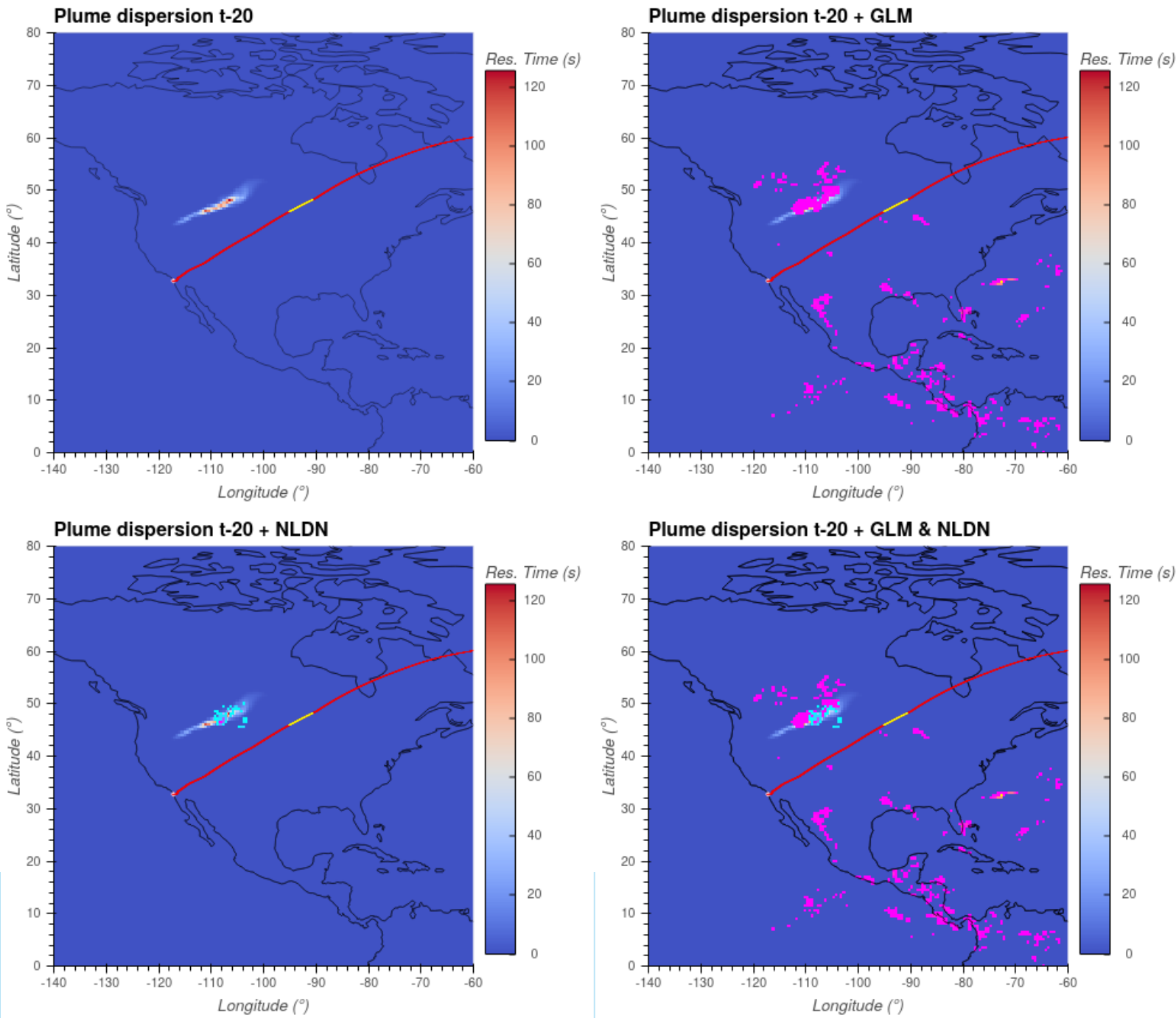
GLM :



NLDN :



Plume dispersion t-20h



Max.
residence
time :



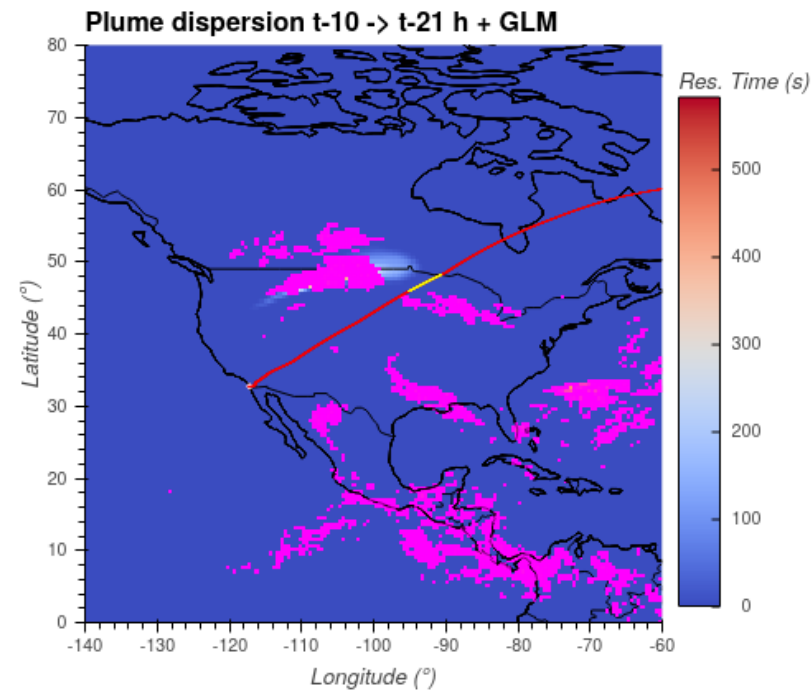
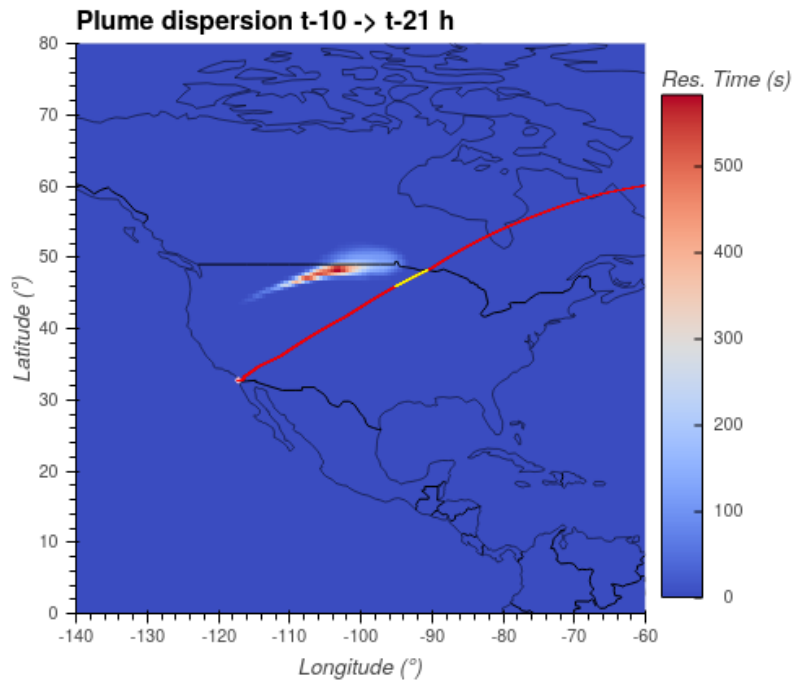
GLM :



NLDN :



Comparison FLEXPART, GLM & NLDN



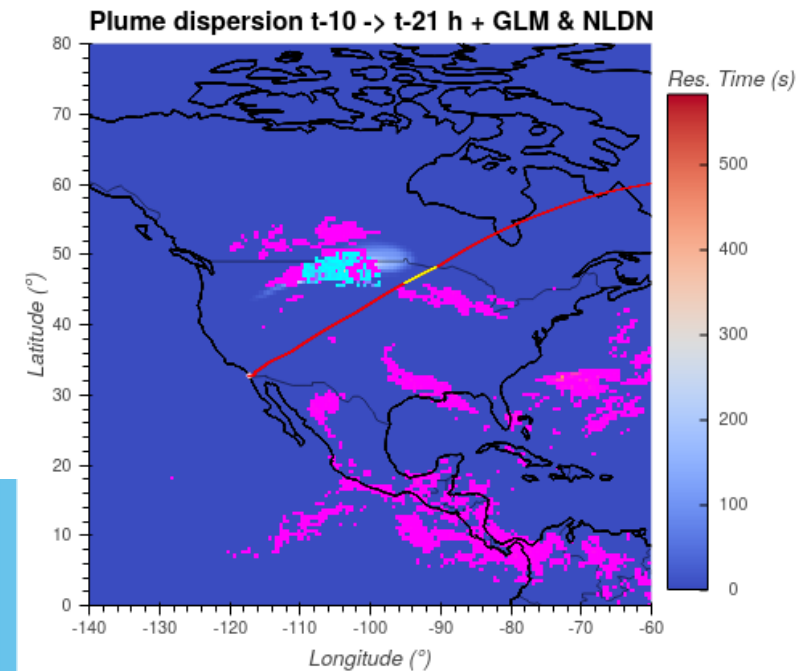
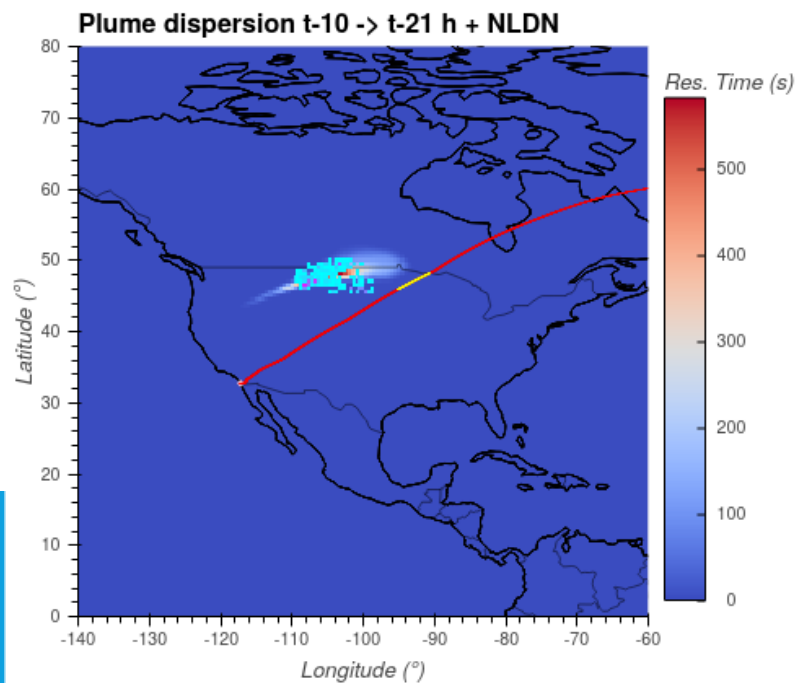
Max.
residence
time :



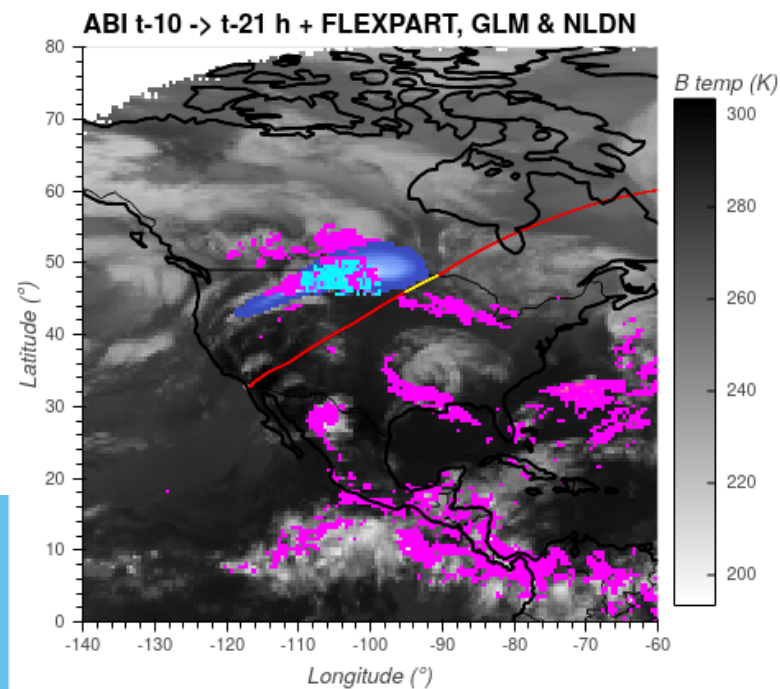
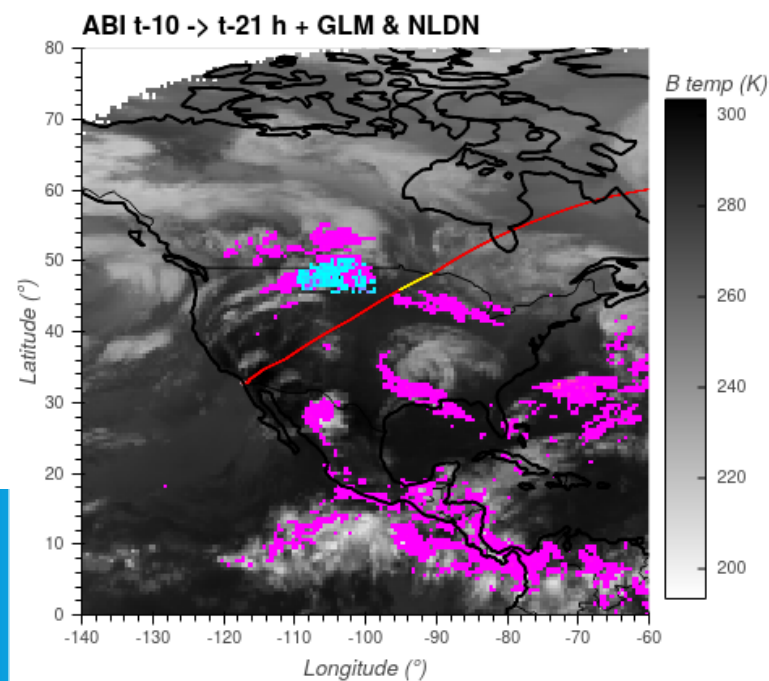
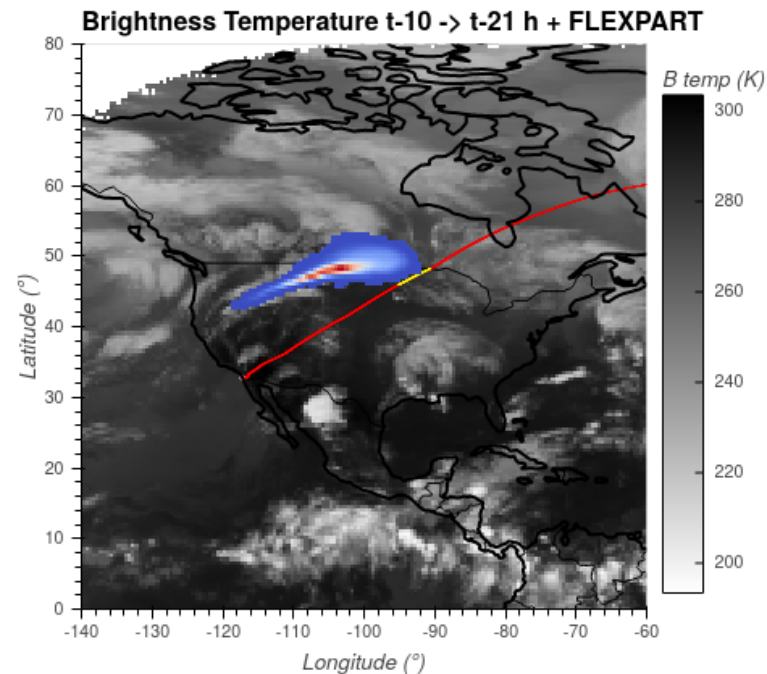
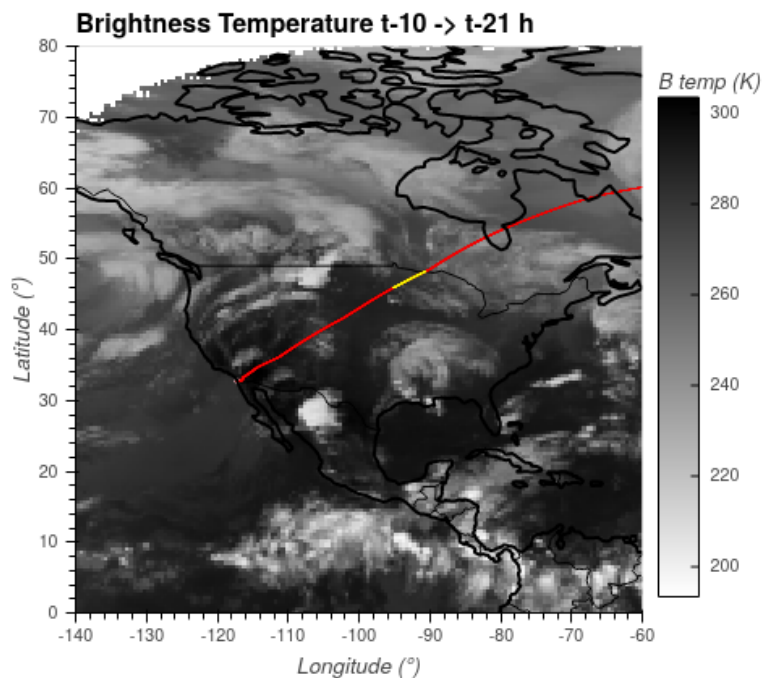
GLM :



NLDN :



Comparison ABI, GLM & NLDN



Max.
residence
time :



GLM :



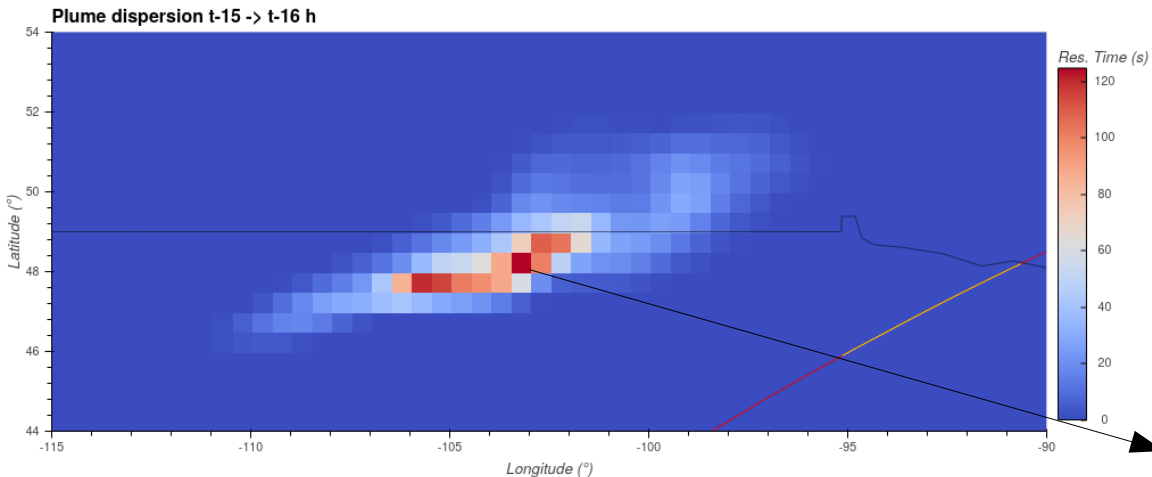
NLDN :



ABI :



Plume Lightning Data



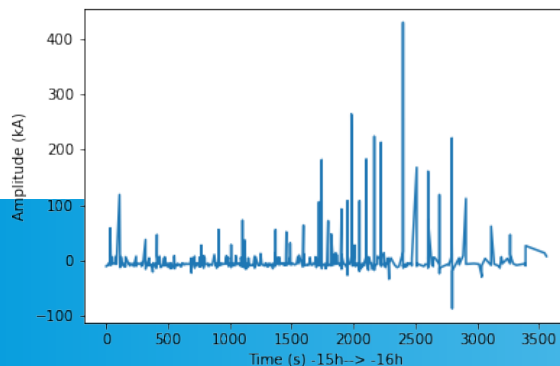
Flag associated lightning : 1
No of associated storms : 1
No of plumes : 1
Plume age(s) : 10-21 hrs

For each pixel of 0.5° per hour where there is a correspondance with NLDN, GLM, or ABI data ($\pm 0.5^\circ$ lat/long):

Maximum residence time : 124.791 s
Latitude : 48.25°
Longitude : -103.25°
Time : -15 $\rightarrow$ -16 h

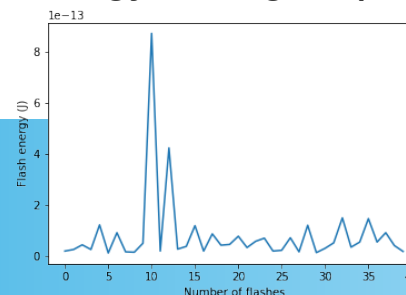
NLDN :

Stroke rate : 634/h
Distribution of stroke amplitude.



GLM :

Flash rate : 40/h
Group rate : 183/h
Distributions of :
flash energy, flash area,
group energy and group
area.



ABI Cloud Top (CT) Info:

Min. brightness temp : 232.1K
Max. CT height : 16193m
Mean CT height : 7377m
Stdv CT height : 4473m

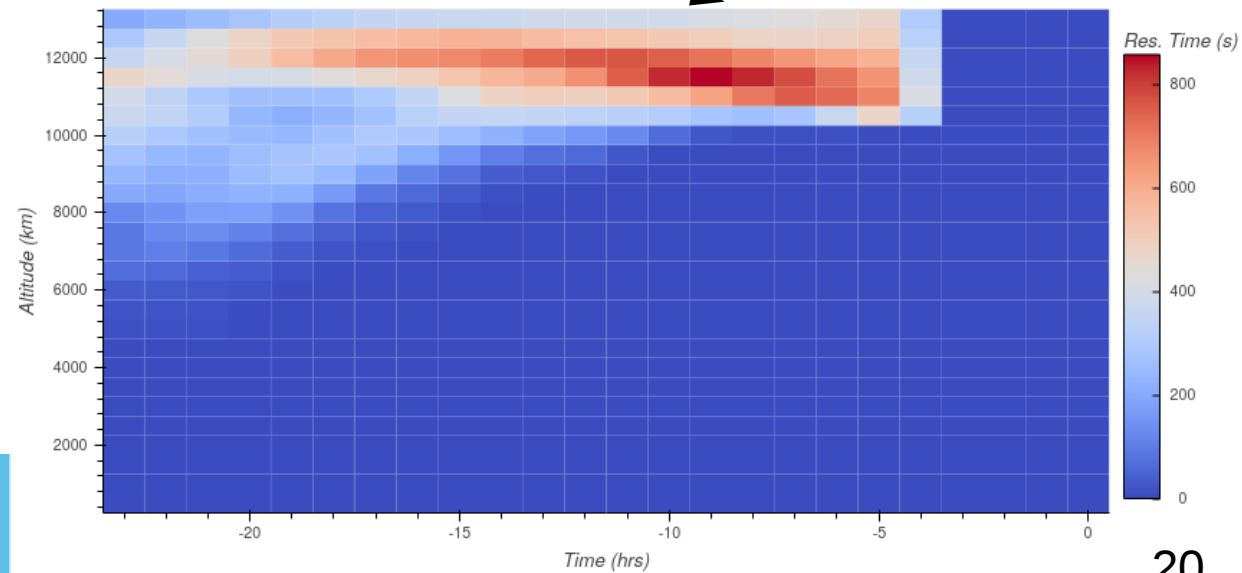
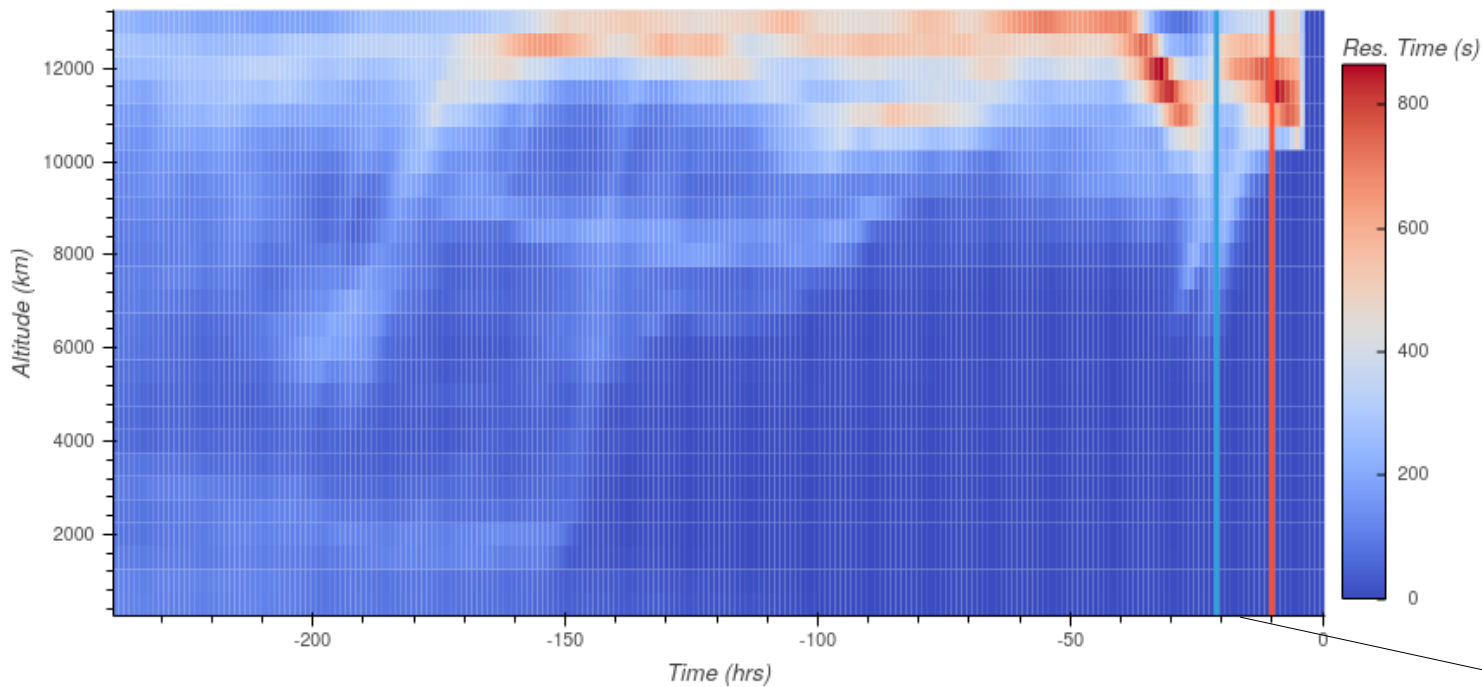
Conclusion

- *SOFT-IO-Li provides a tool to trace sources of NO_x measurements*
- *SOFT-IO-Li provides a database of Lightning-NO_x characteristics including:*
 - **Chemistry:** NO_x, CO, O₃, relative humidity
 - **Air mass characteristics:** estimated lifetimes, locations
 - **Electrical characteristics:** total number of flashes, flash type, histograms of electrical currents and /or light intensities and parent cloud characteristics such as brightness temperature, horizontal extension and geographical coordinates
 - Provisional data available late 2022 in the **IAGOS database**
 - We welcome requests for any additional information you might require: Catherine.Mackay@aero.obs-mip.fr

ADDITIONAL MATERIAL

Variation with Altitude

Max residence time for all altitudes



Hourly variations from t-10h to t-21h

IAGOS observed
NO_x excess

FLEXPART predicted
maximum residence
time (s)

ABI brightness
temperature (K)

GLM flash
energy (J)

NLDN peak
Current (kA)

