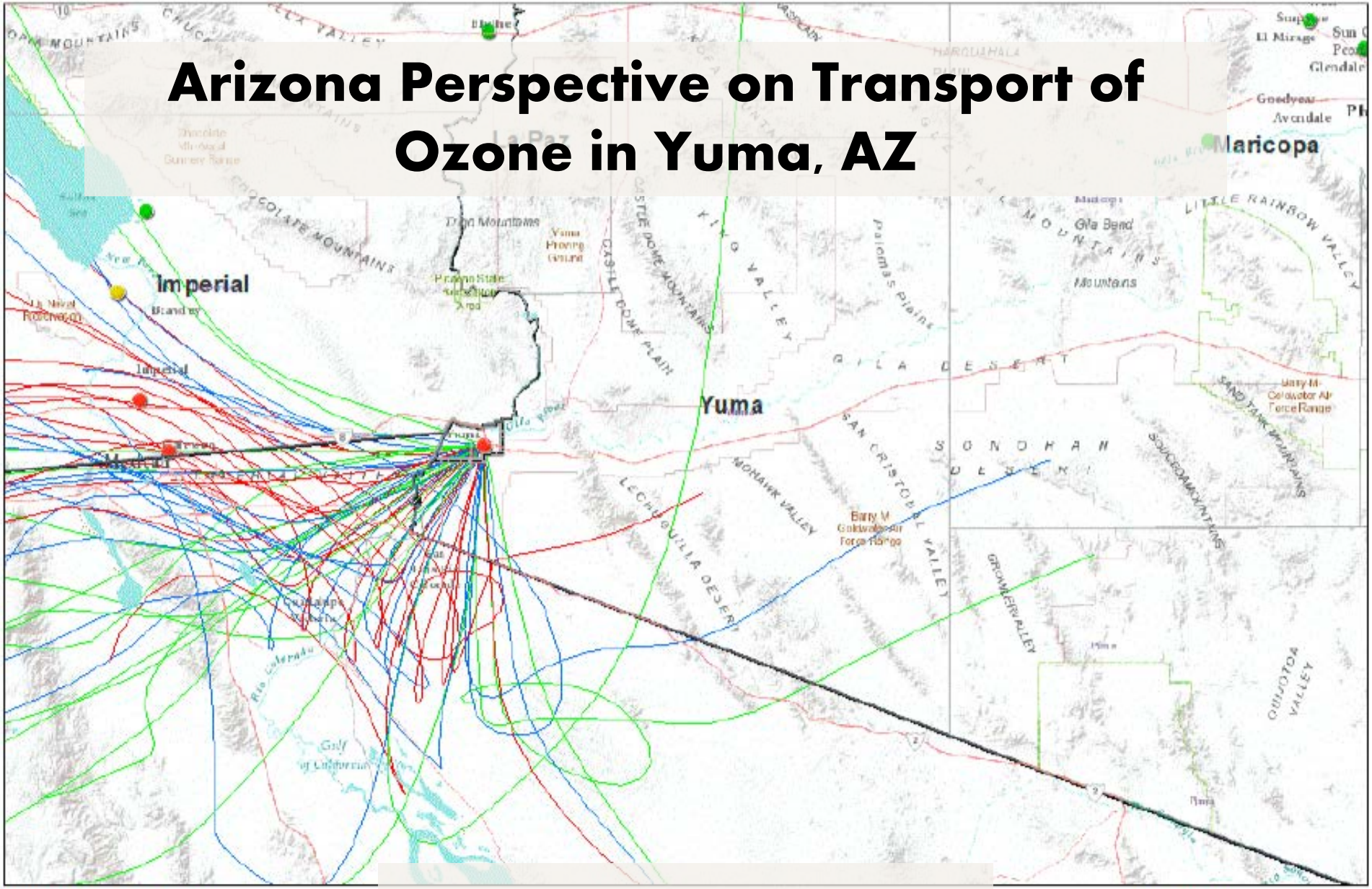
Arizona Perspective on Transport of Ozone in Yuma, AZ



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University of Utah

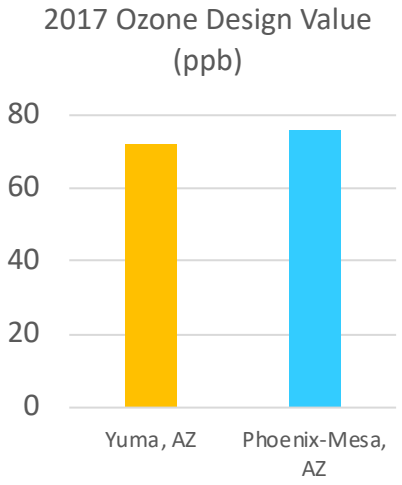
Topics

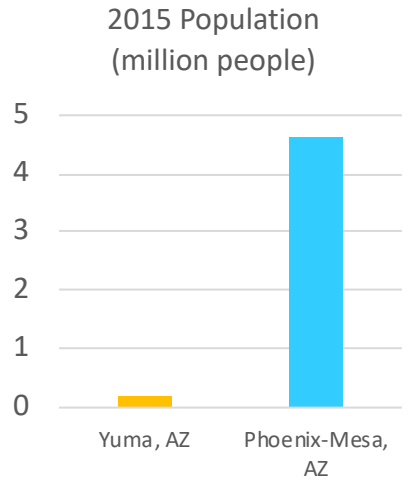
- Background and Motivation
- Ground based monitors
- Regional Emission Inventory
- STILT Modeling

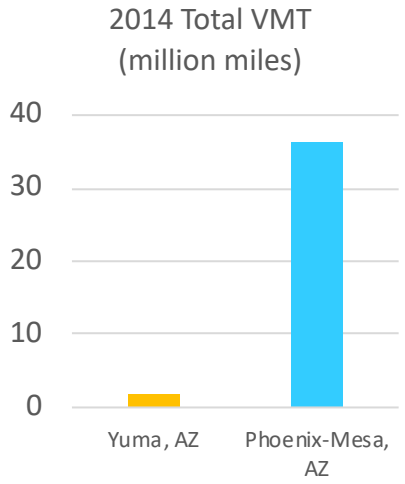
Study of International and Interstate Transport of Ozone in Yuma, AZ

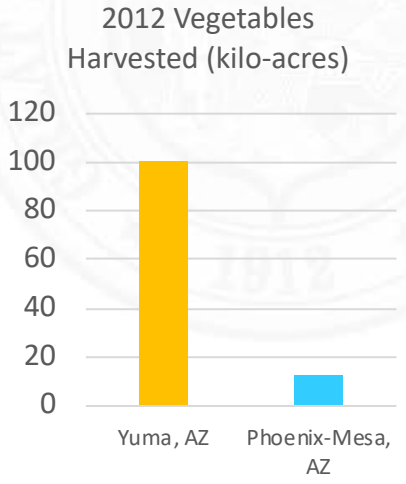
BACKGROUND AND MOTIVATION

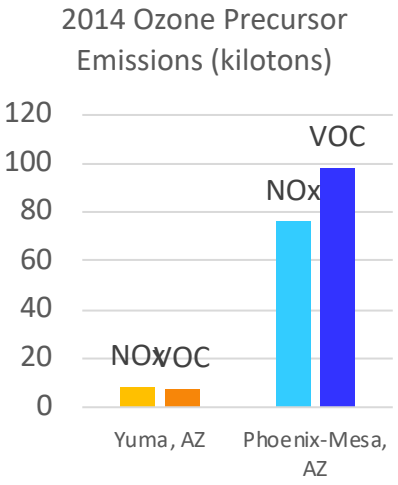
Motivation


2017 Ozone Design Value (ppb)
80
60
40
20
0
Yuma, AZ
Phoenix-Mesa, AZ


2015 Population (million people)
5
4
3
2
1
0
Yuma, AZ
Phoenix-Mesa, AZ


2014 Total VMT (million miles)
40
30
20
10
0
Yuma, AZ
Phoenix-Mesa, AZ


2012 Vegetables Harvested (kilo-acres)
120
100
80
60
40
20
0
Yuma, AZ
Phoenix-Mesa, AZ


2014 Ozone Precursor Emissions (kilotons)
120
100
80
60
40
20
0
VOC
NOx
NOx
VOC
Yuma, AZ
Phoenix-Mesa, AZ

Motivation

Arizona must ask California to control emissions

Arizona must control emissions

Arizona is not required to take further action

Clean Air Act Requirements (US emissions)

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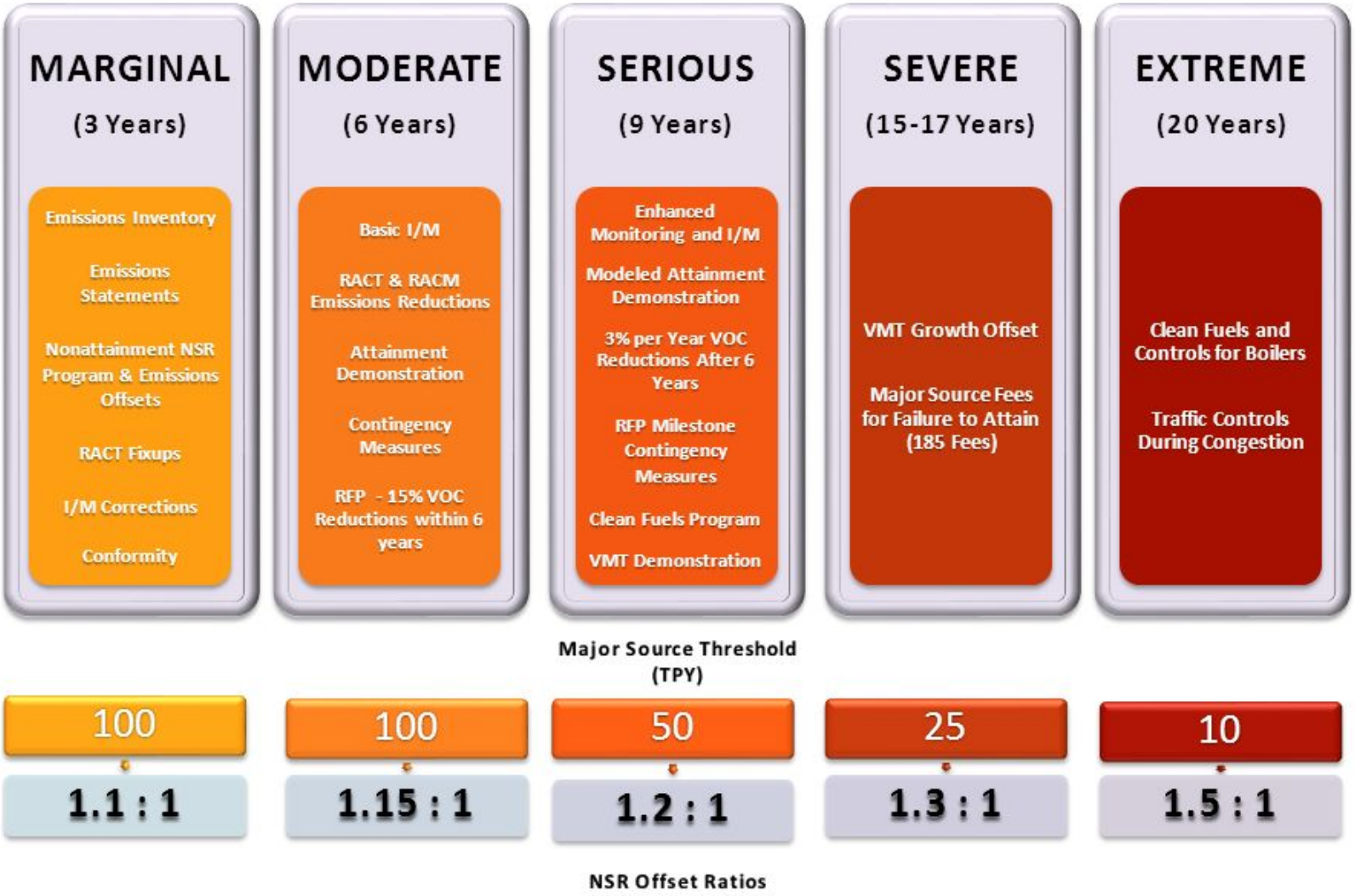
SIP Requirements for Ozone Nonattainment Areas



Nonattainment requirements compound as classification increases.

Clean Air Act Requirements (Int'l emissions)

SIP Requirements for Ozone Nonattainment Areas

Major Source Threshold (TPY)

Nonattainment requirements compound as classification increases.

Study of International and Interstate Transport of Ozone in Yuma, AZ

GROUND BASED MONITORS

International Monitoring Sites

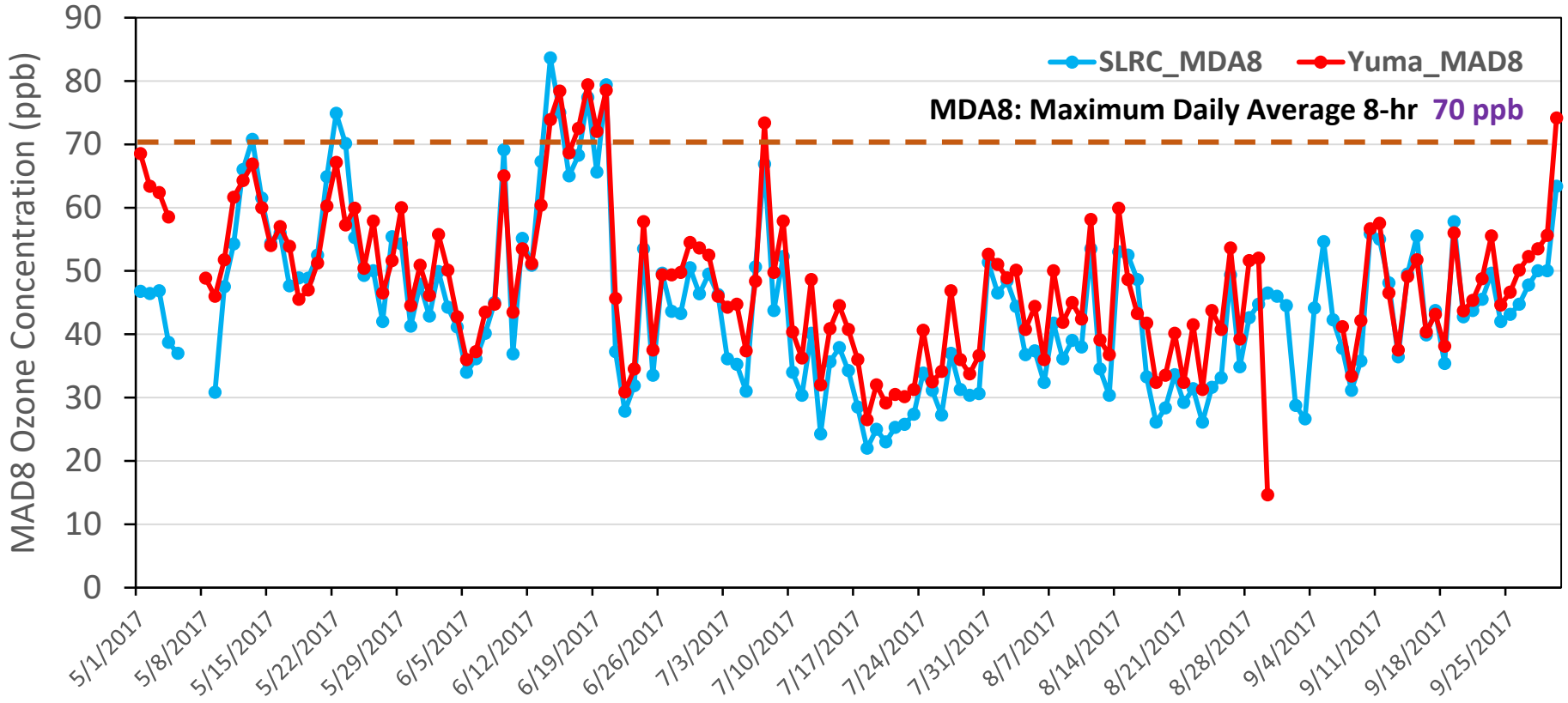
International Monitoring Sites

Yuma Supersite, AZ

San Luis Rio Colorado, Mexico

Site	Yuma Supersite	San Luis Rio Colorado
Parameters Monitored	Ozone & Met	Ozone & Met
Established Date	02/01/2006	05/09/2017

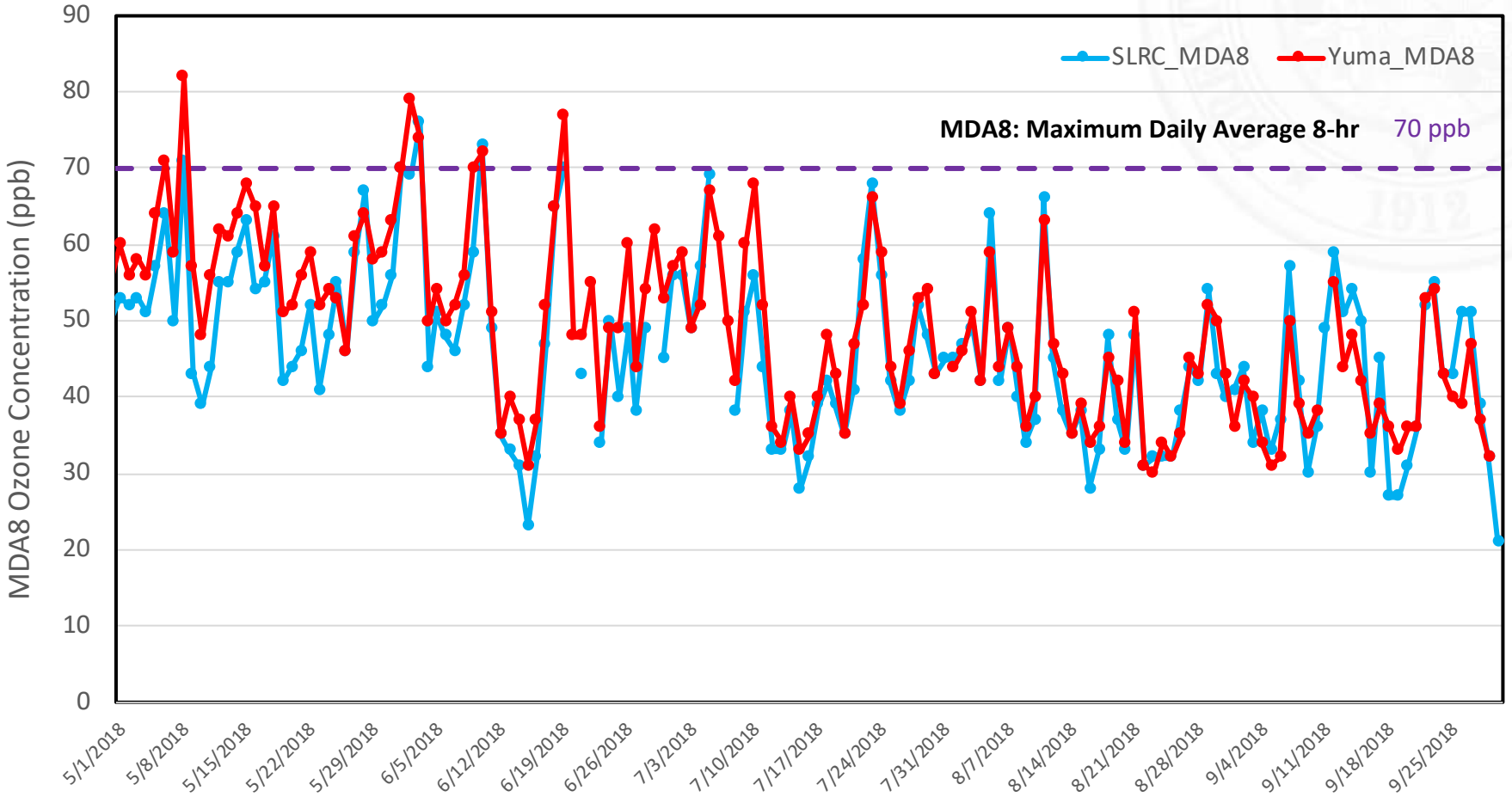
Ozone MDA8 at Yuma and SLRC in Summer 2017



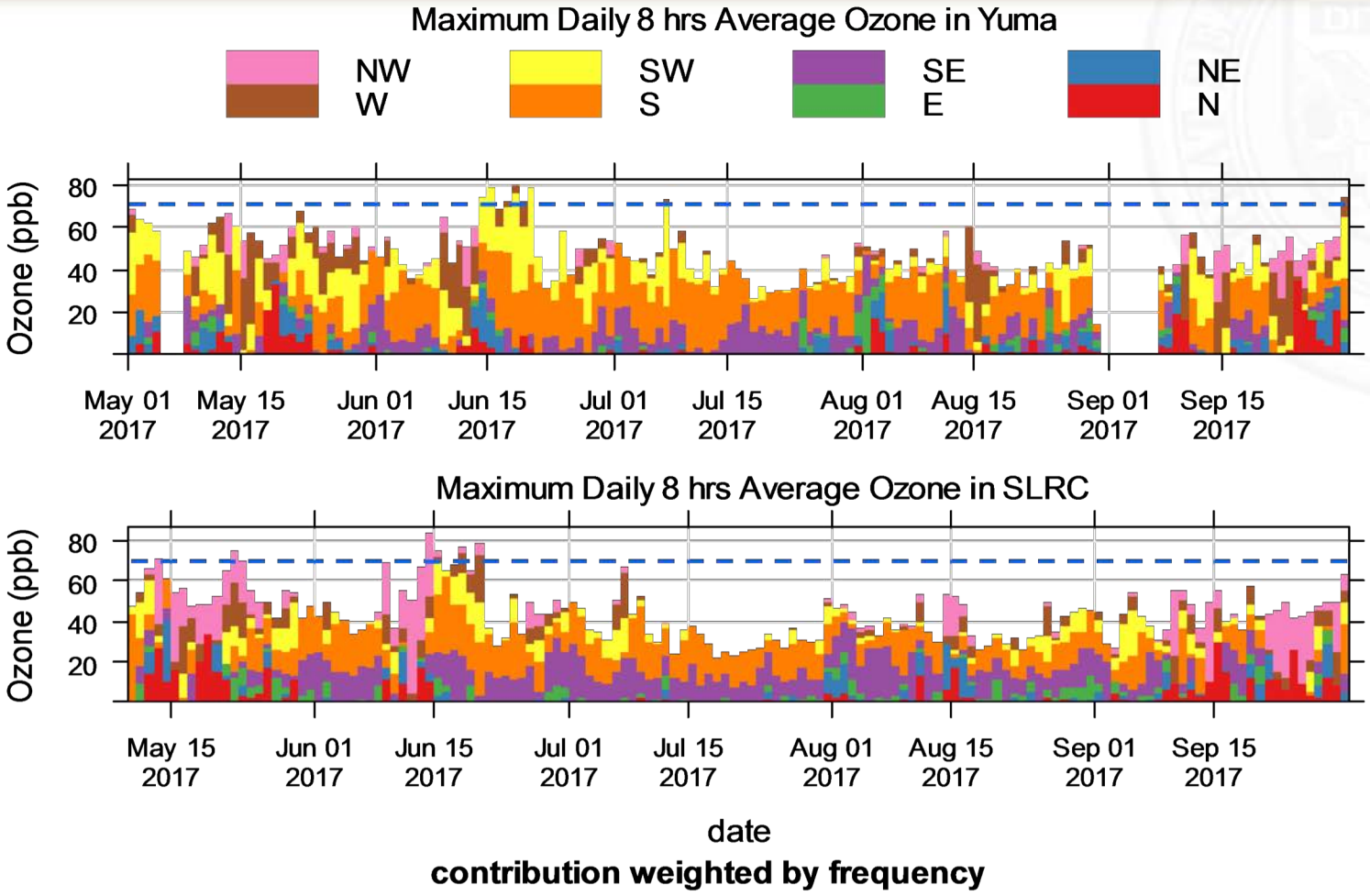
- The average hourly ozone concentrations were 31.5 ppb at SLRC and 36.3 ppb at Yuma. The r-squared (r^2) value was 0.72 between those two sites. The distance between Yuma and SLRC is 29 km.

- In 2017, there were 8 exceedances of the standard in Yuma and 7 exceedances in SLRC. However, only 4 exceedances occurred at both monitoring sites on the same day.

Ozone MDA8 at Yuma and SLRC in Summer 2018



Ozone at Yuma and SLRC in Summer 2017



- During exceedance days, the predominant wind direction was south in Yuma (43% SW, 31% S, 6% SE), while winds were from the south and west in SLRC.

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Study of International and Interstate Transport of Ozone in Yuma, AZ

REGIONAL EMISSION INVENTORY

Area Emission Inventory

Area	NO_X		VOC	
	Tons/Year	% of Total	Tons/Year	% of Total
Nonattainment Area	4,857	9%	3,451	7%
Area South of City of Yuma to Mexican Border	1,287	2%	861	2%
Imperial County, CA	6,192	11%	7,063	15%
Mexico (incl. Mexicali and San Luis)	43,021	78%	36,349	76%
Total of Area	55,358	100%	47,724	100%

Source: Environmental Protection Agency, Technical Support Document for Phoenix-Mesa and Yuma Nonattainment Areas, Table 4.6

Area Emission Inventory

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Study of International and Interstate Transport of Ozone in Yuma, AZ

STILT MODELING

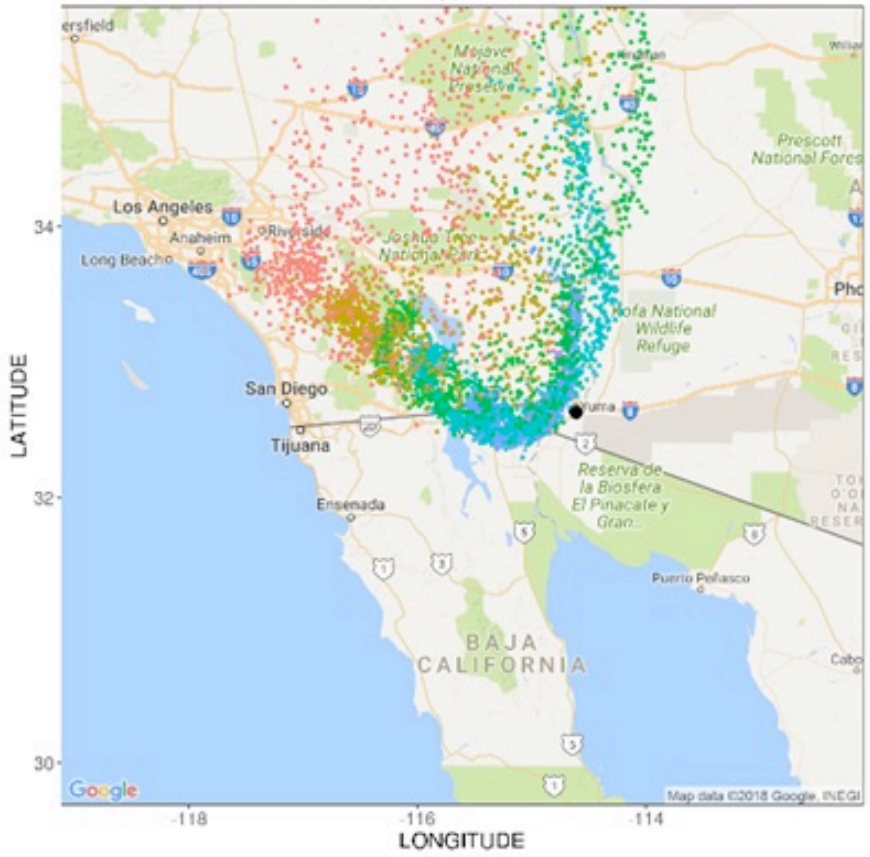
Back Trajectory (BT) from STILT model

STILT, the **S**tochastic **T**ime-**I**nverted **L**agrangian **T**ransport model (*Lin et al*., 2003; *Fasoli et al*., 2018)

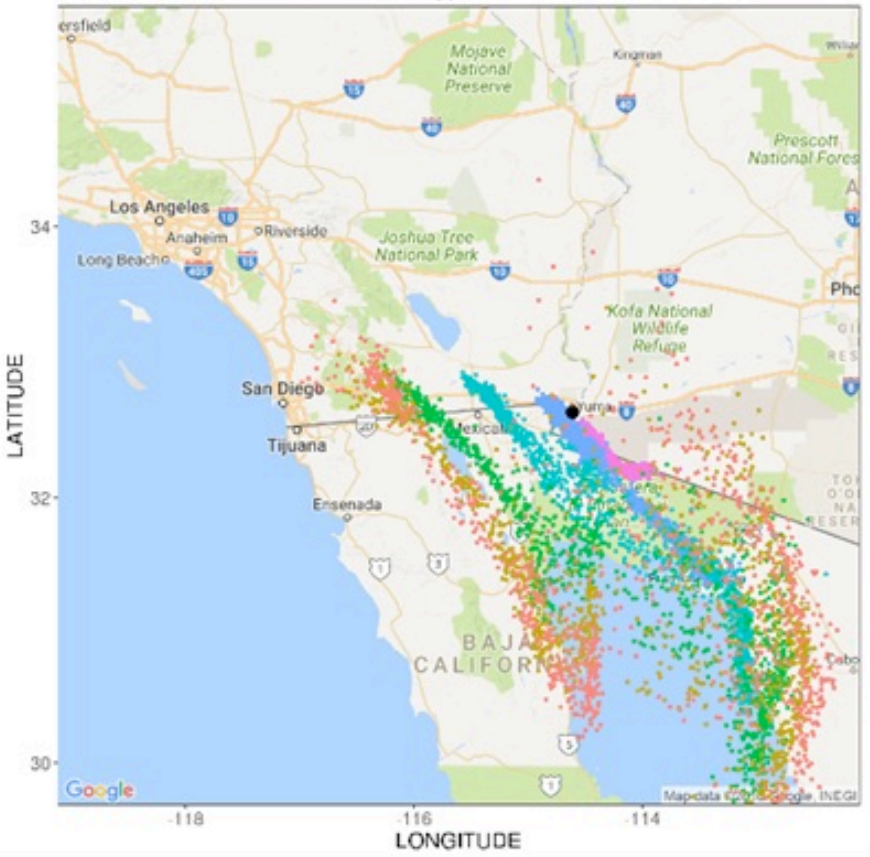
- A Lagrangian particle dispersion model (LPDM)
- Mean advection scheme from HYSPLIT **+ different turbulence scheme implemented**
- Tracks air parcels upwind to represent air flow and reveal surface influences (i.e., 'footprint') onto **downwind location (i.e., 'receptor')**
- Couple with Eulerian meteorological fields
  - e.g., the High Resolution Rapid Refresh (HRRR) (Sun et al., 2014)
- **While in this study:**
  - Focus on exceeding days from 2015-2017
  - 1000 air parcels release from Yuma supersite for each event
  - 24 hours back
  - Receptor Height= 4.3 meter above ground level

2015 Exceeding Day

1) 24 hrs EDAS40km-driven STILTv2 backward trajectories on 2015041821 from Yuma, AZ with observed O3 of 79 ppb



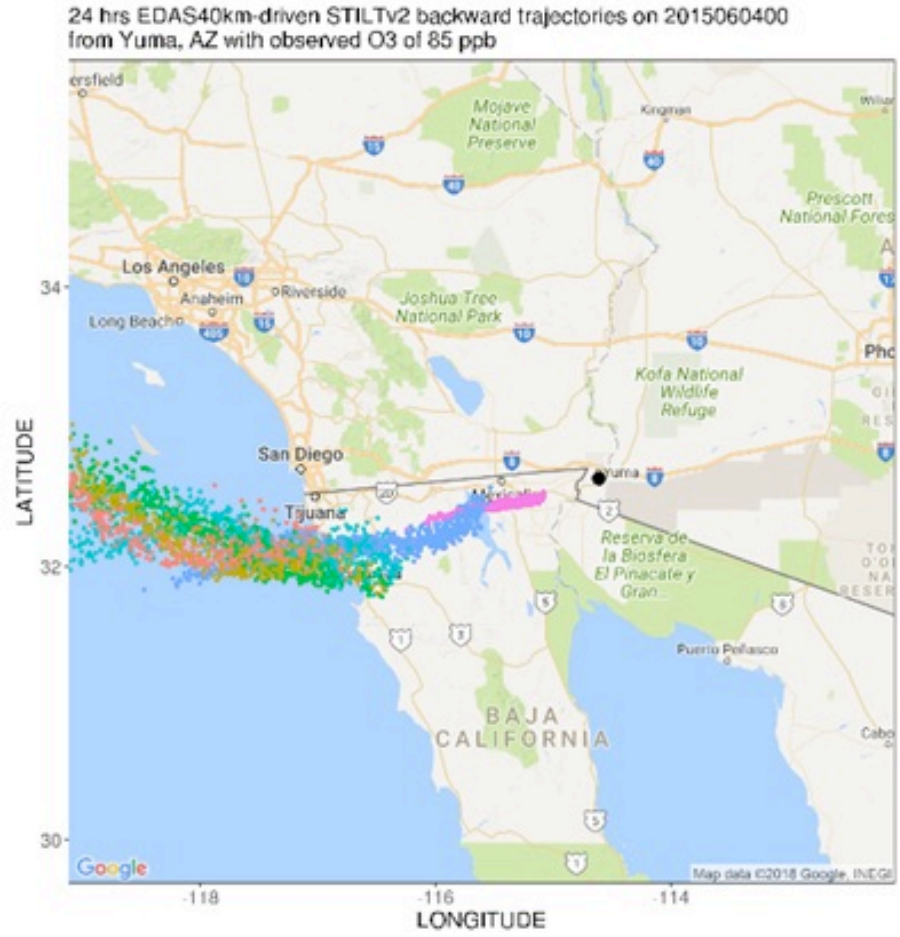
2) 24 hrs EDAS40km-driven STILTv2 backward trajectories on 2015041919 from Yuma, AZ with observed O3 of 86 ppb



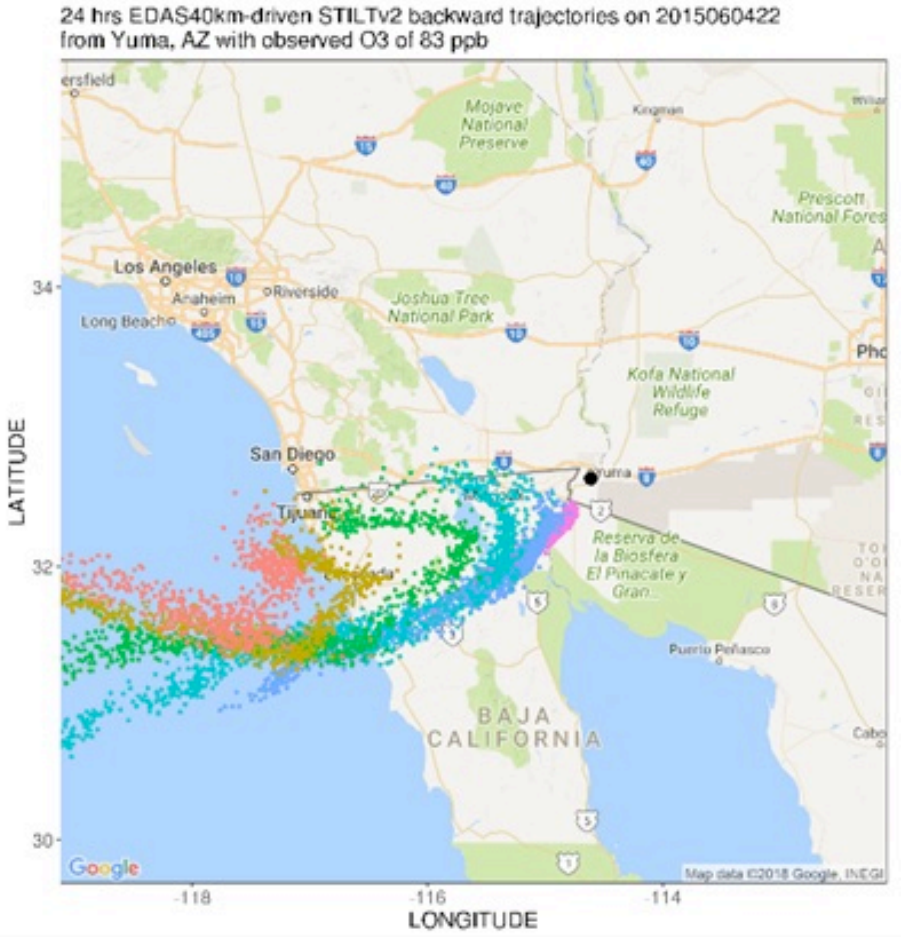
Hours back

-4	-8	-12	-16	-20	-24

2015 Exceeding Day



4)

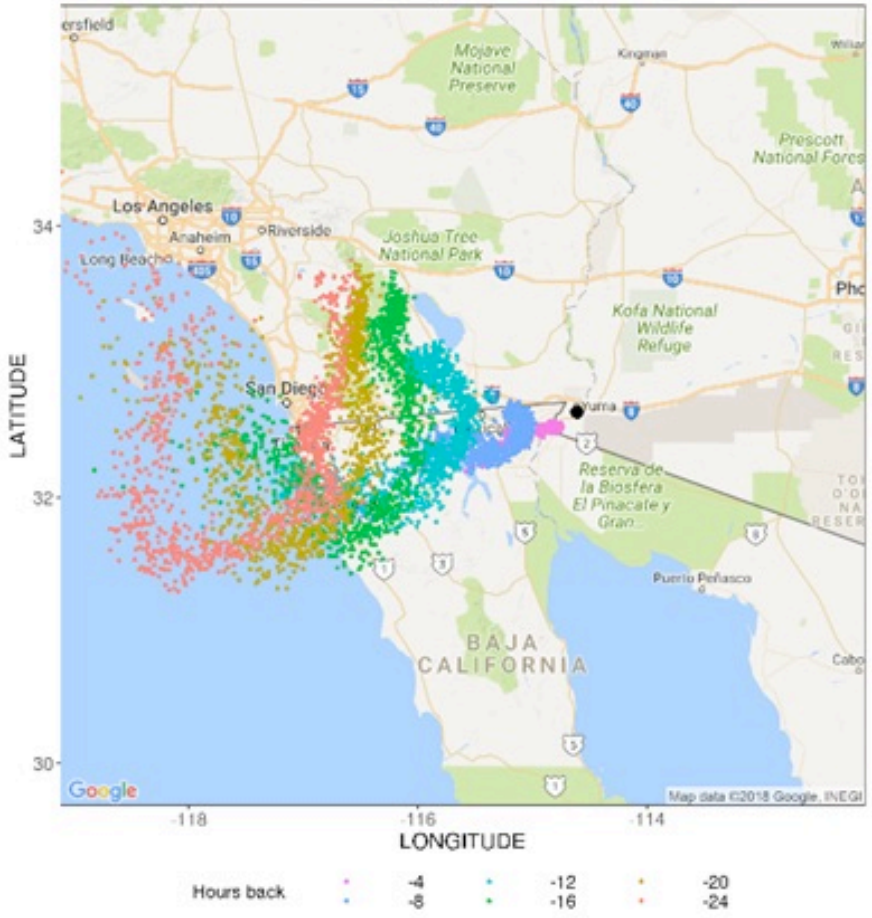


Hours back

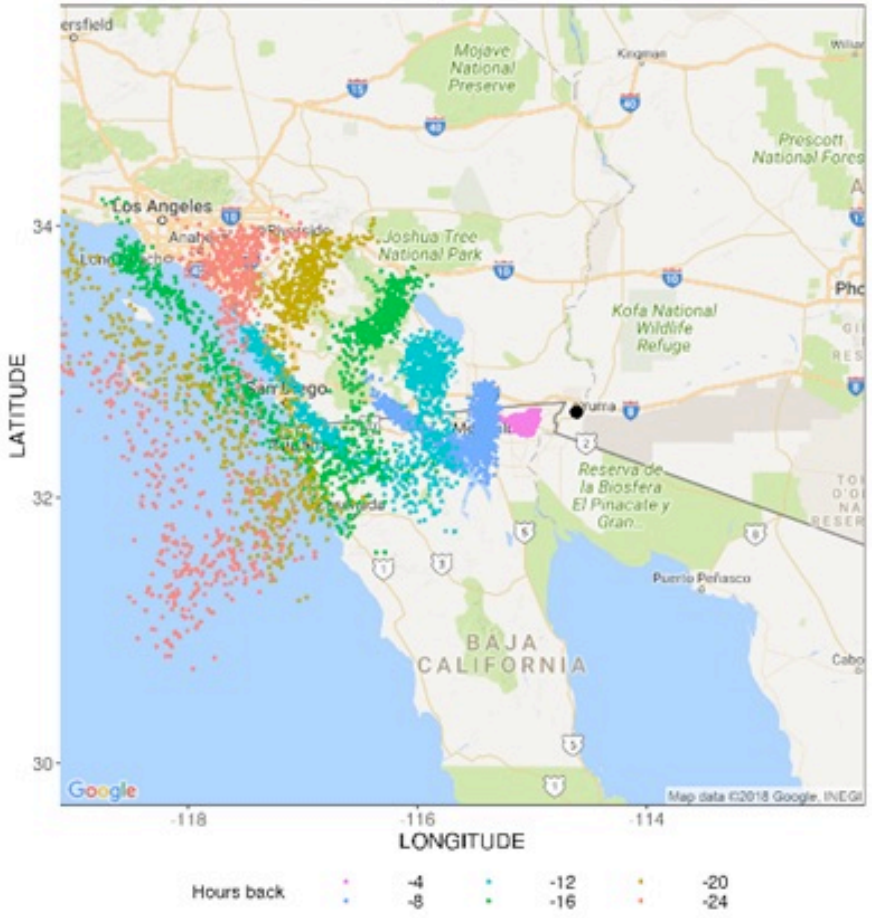
-4	-8	-12	-16	-20	-24

2015 Exceeding Day

5) 24 hrs EDAS40km-driven STILTv2 backward trajectories on 2015060622 from Yuma, AZ with observed O3 of 80 ppb



6) 24 hrs EDAS40km-driven STILTv2 backward trajectories on 2015061200 from Yuma, AZ with observed O3 of 92 ppb



Hours back

-4 -8 -12 -16 -20 -24

2015 Exceeding Day

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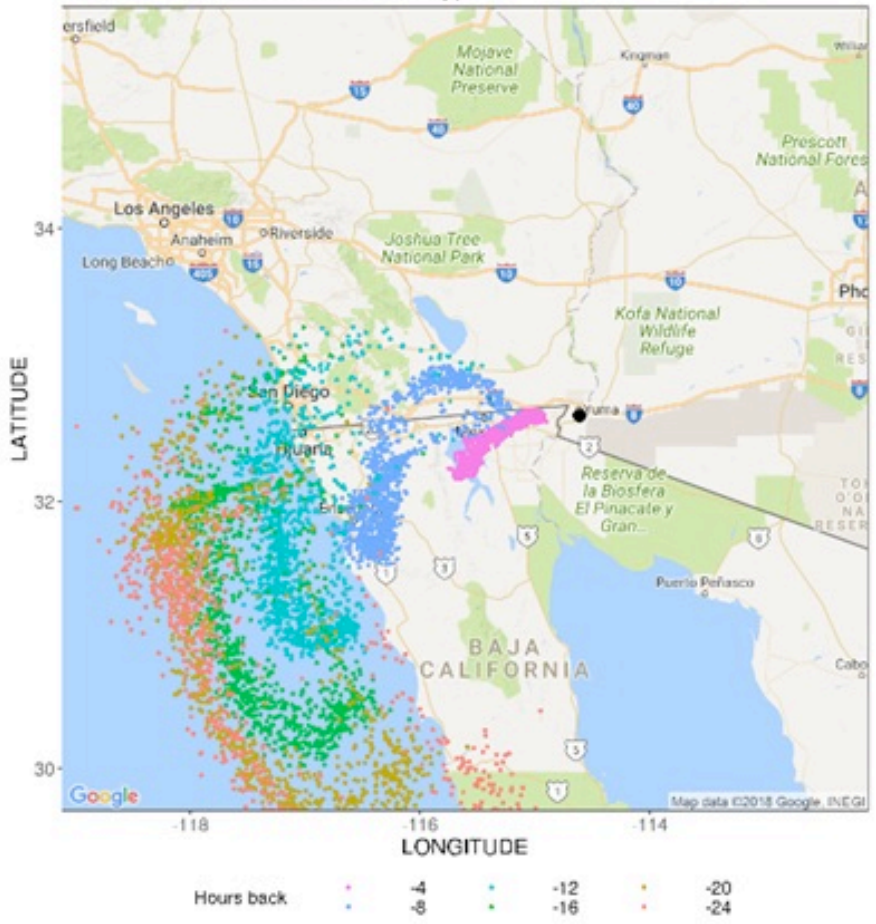
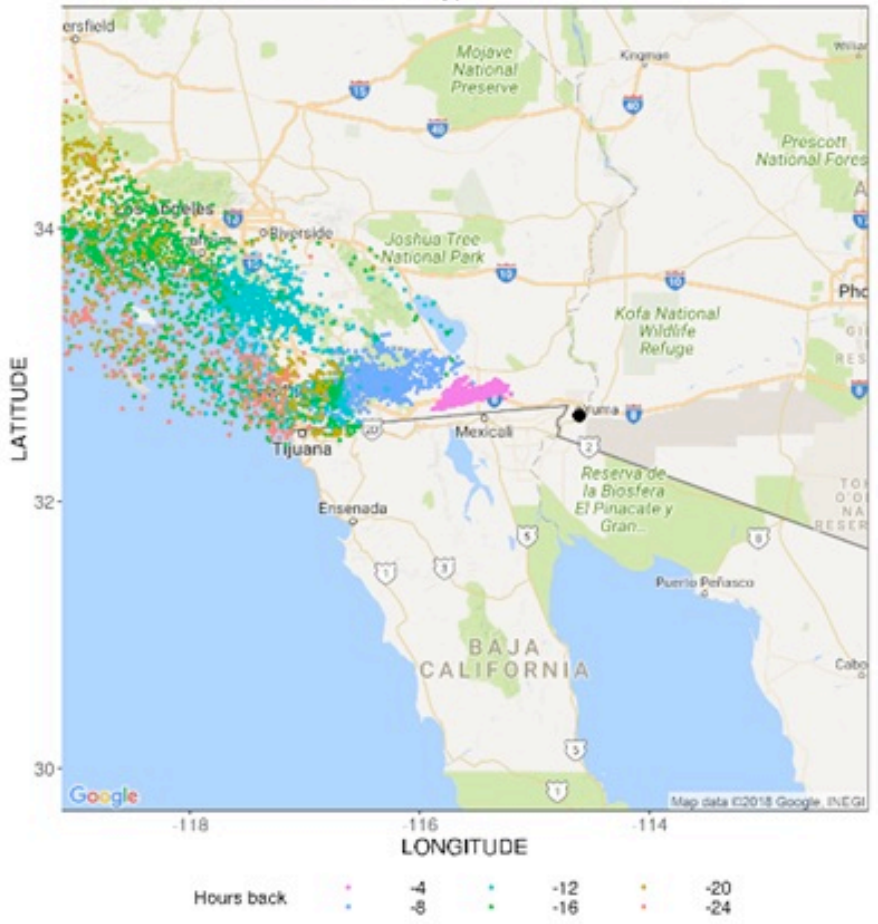
7) 24 hrs HRRR-driven STILTv2 backward trajectories on 2015061822 from Yuma, AZ with observed O3 of 81 ppb



8) 24 hrs HRRR-driven STILTv2 backward trajectories on 2015062000 from Yuma, AZ with observed O3 of 96 ppb



Hours back

-4 -8 -12 -16 -20 -24

2016 Exceeding Day

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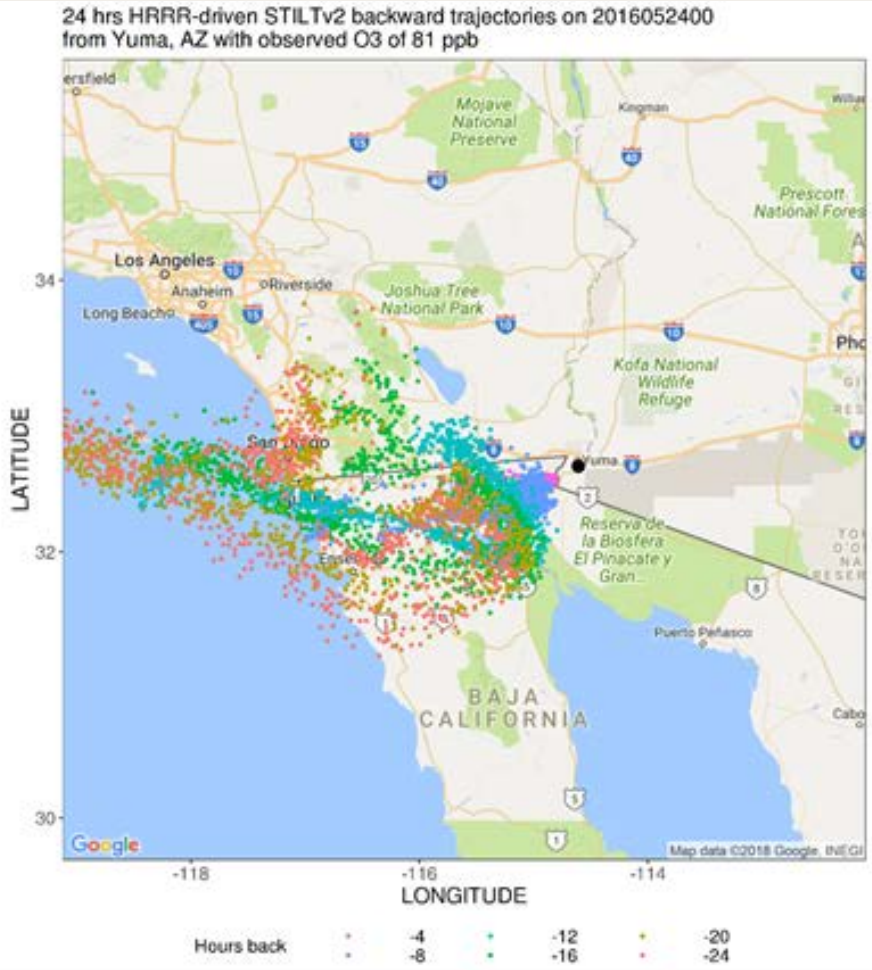
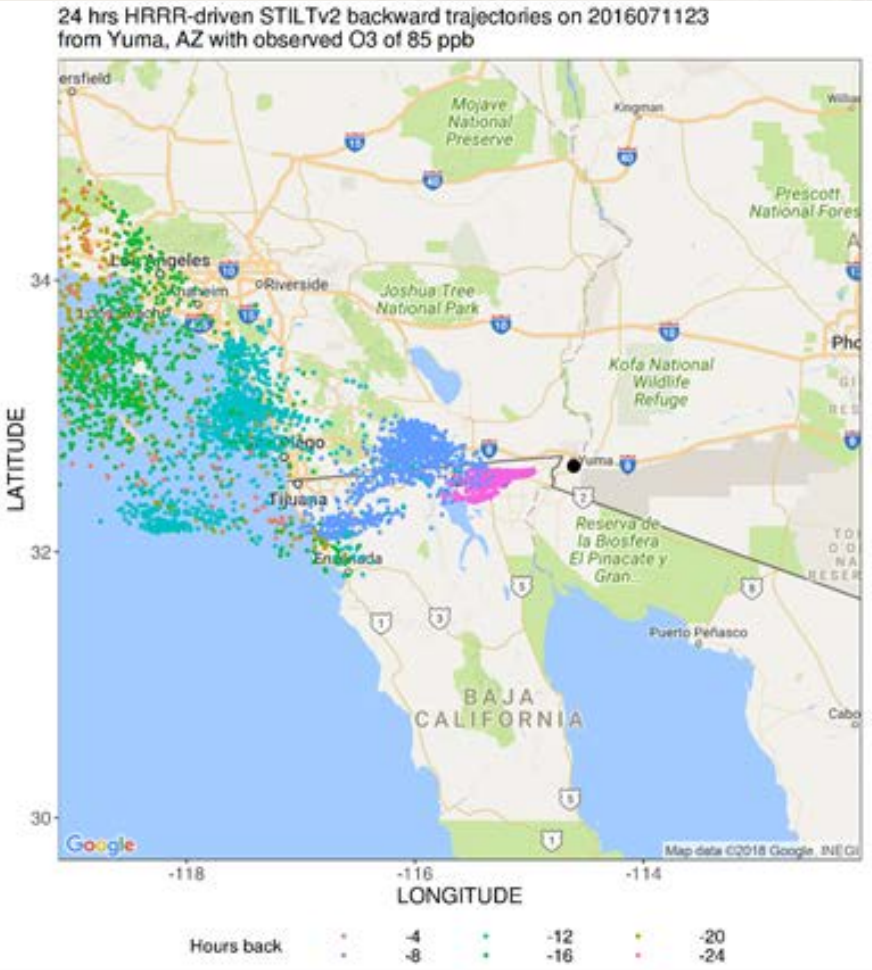
1)



2)

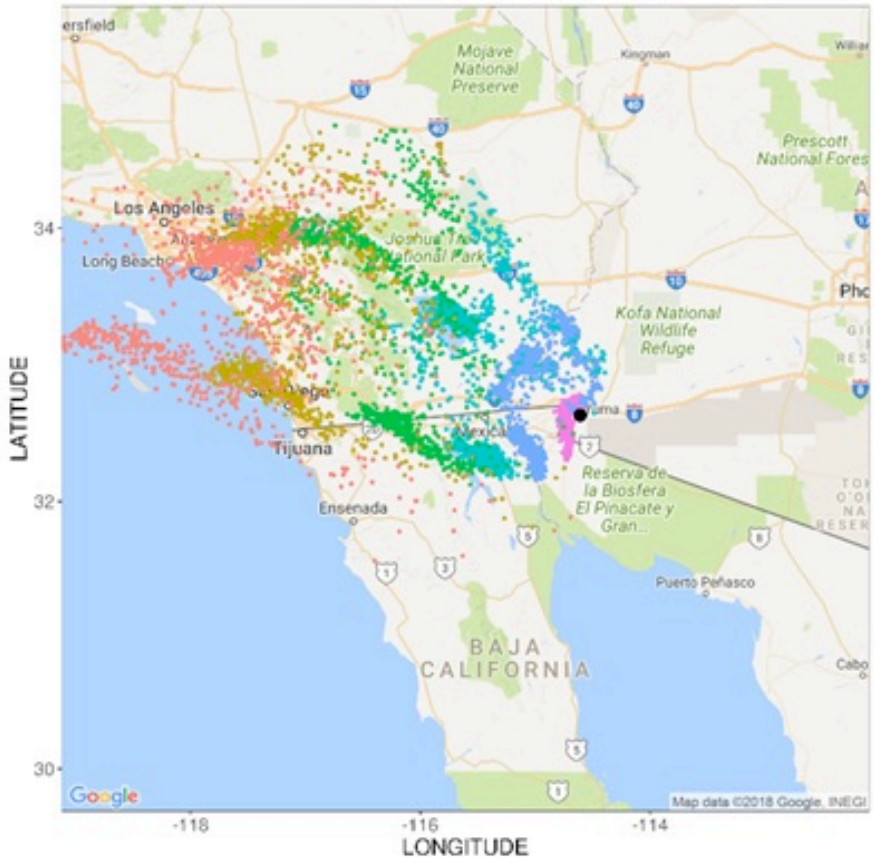


Hours back

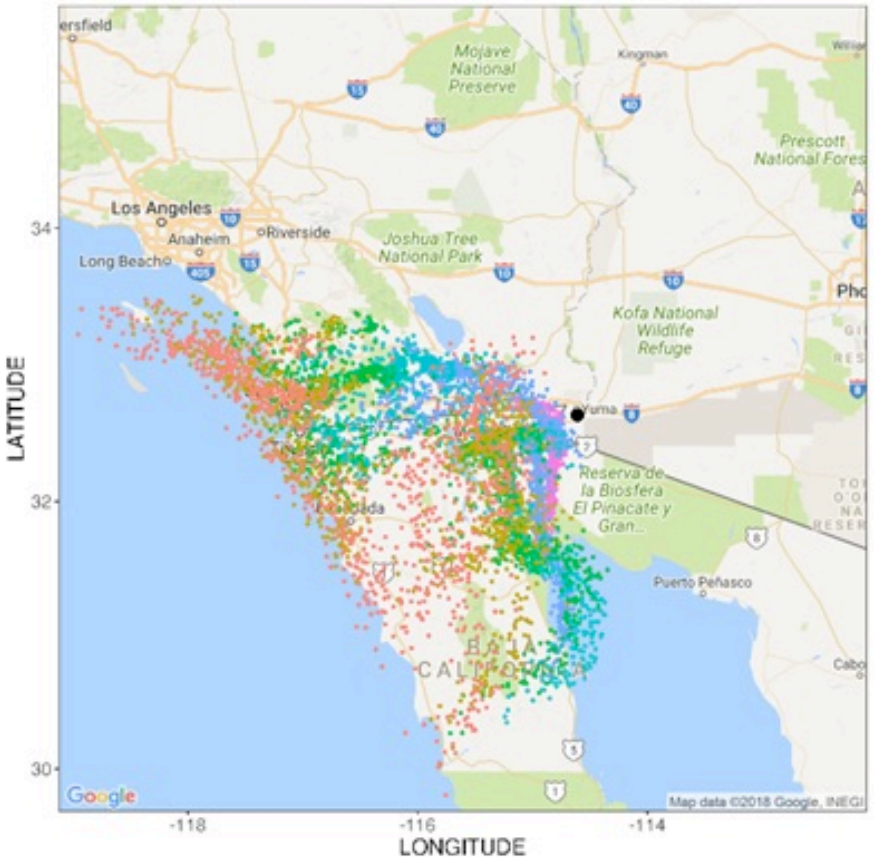
-4 -8 -12 -16 -20 -24

2017 Exceeding Day

1) 24 hrs HRRR-driven STILTv2 backward trajectories on 2017041220 from Yuma, AZ with observed O3 of 80 ppb



2) 24 hrs HRRR-driven STILTv2 backward trajectories on 2017042319 from Yuma, AZ with observed O3 of 76 ppb

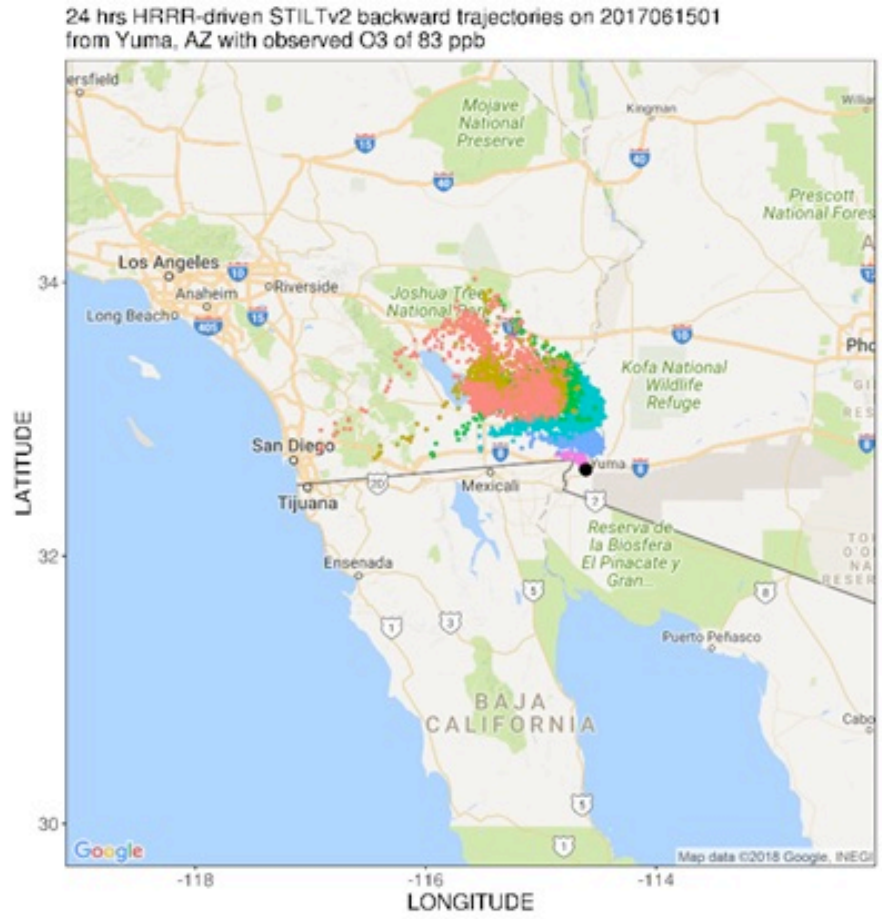


Hours back

-4	-8	-12	-16	-20	-24

2017 Exceeding Day

3)



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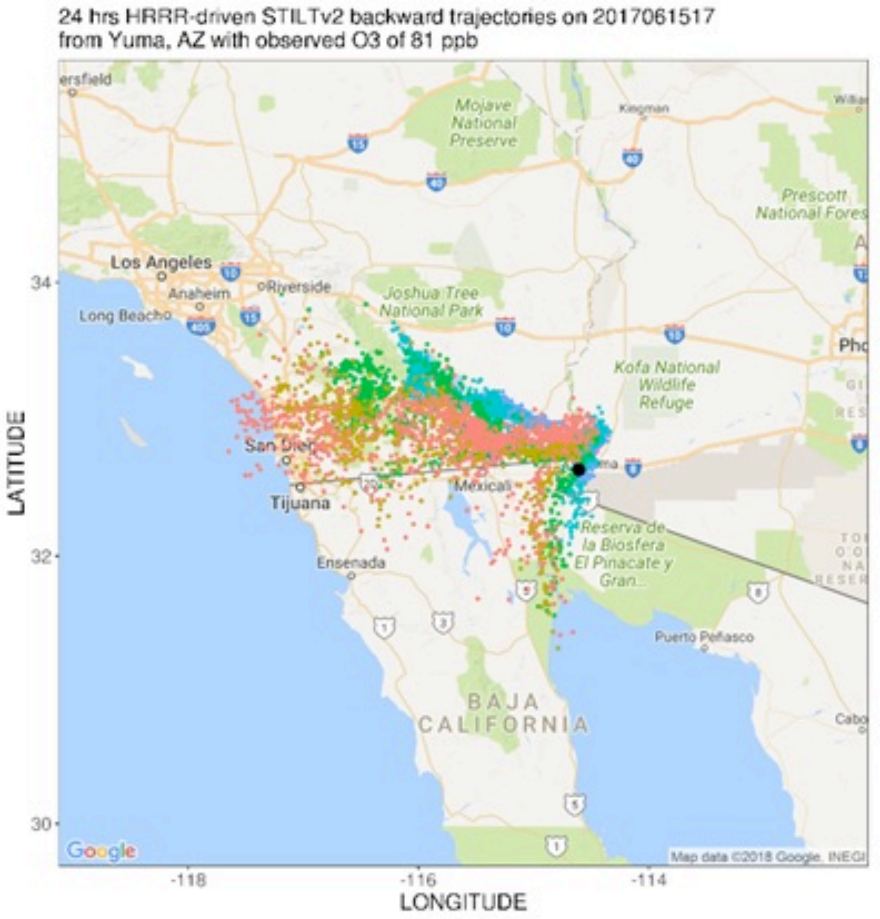
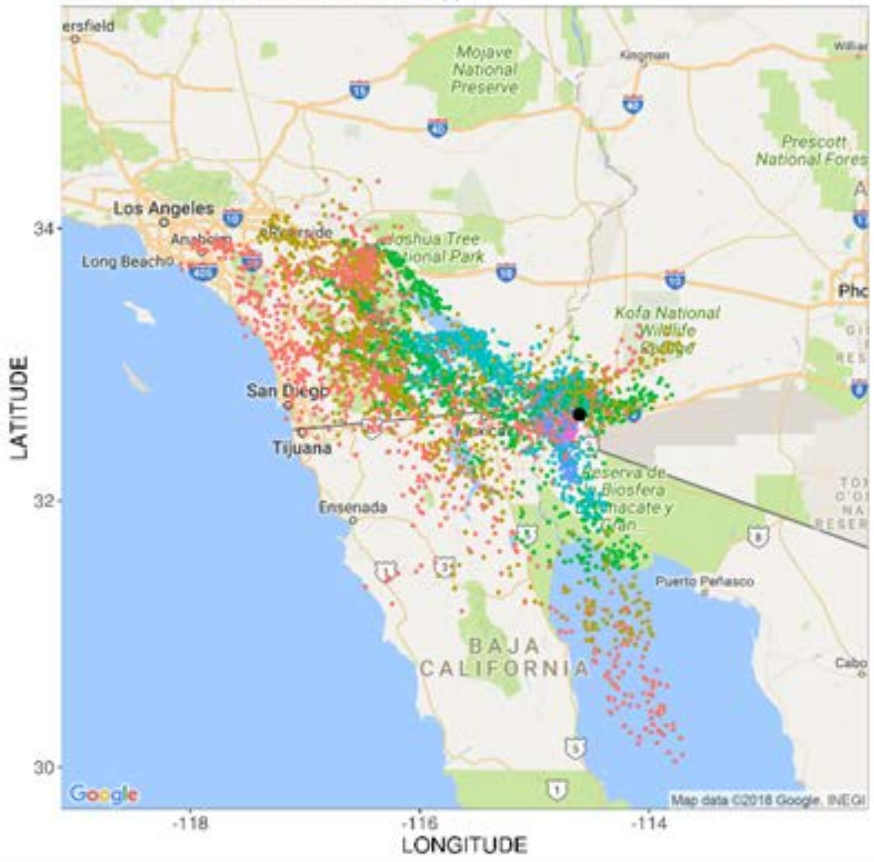


Hours back

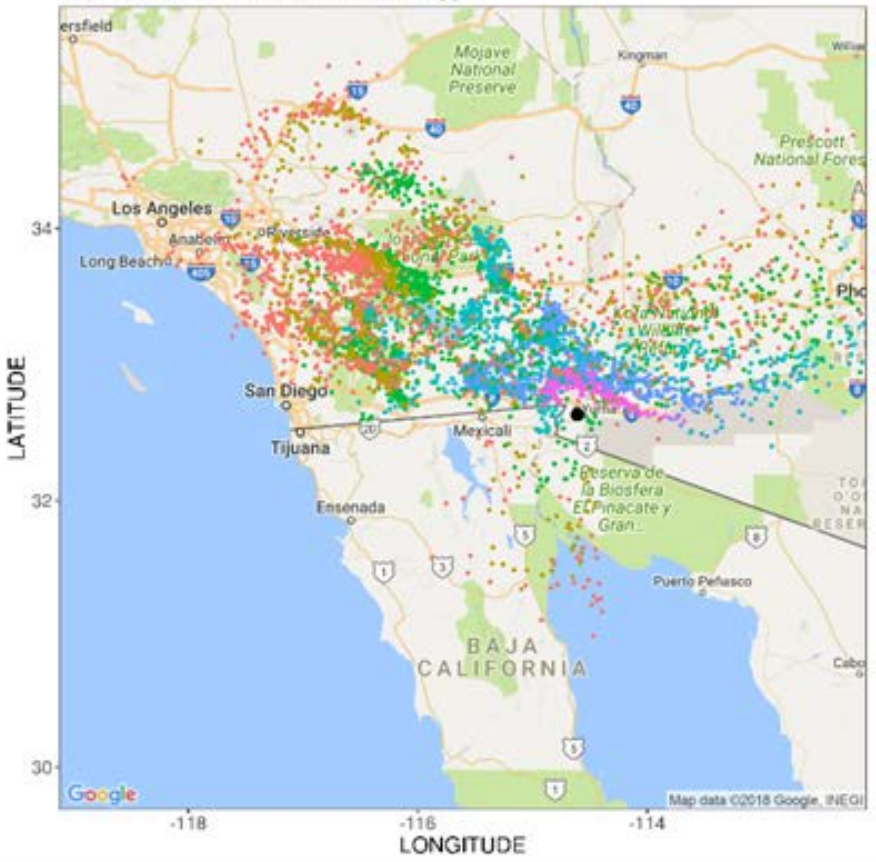
-4	-8	-12	-16	-20	-24

2017 Exceeding Day

5) 24 hrs HRRR-driven STILTv2 backward trajectories on 2017061722 from Yuma, AZ with observed O3 of 82 ppb



6) 24 hrs HRRR-driven STILTv2 backward trajectories on 2017061822 from Yuma, AZ with observed O3 of 87 ppb

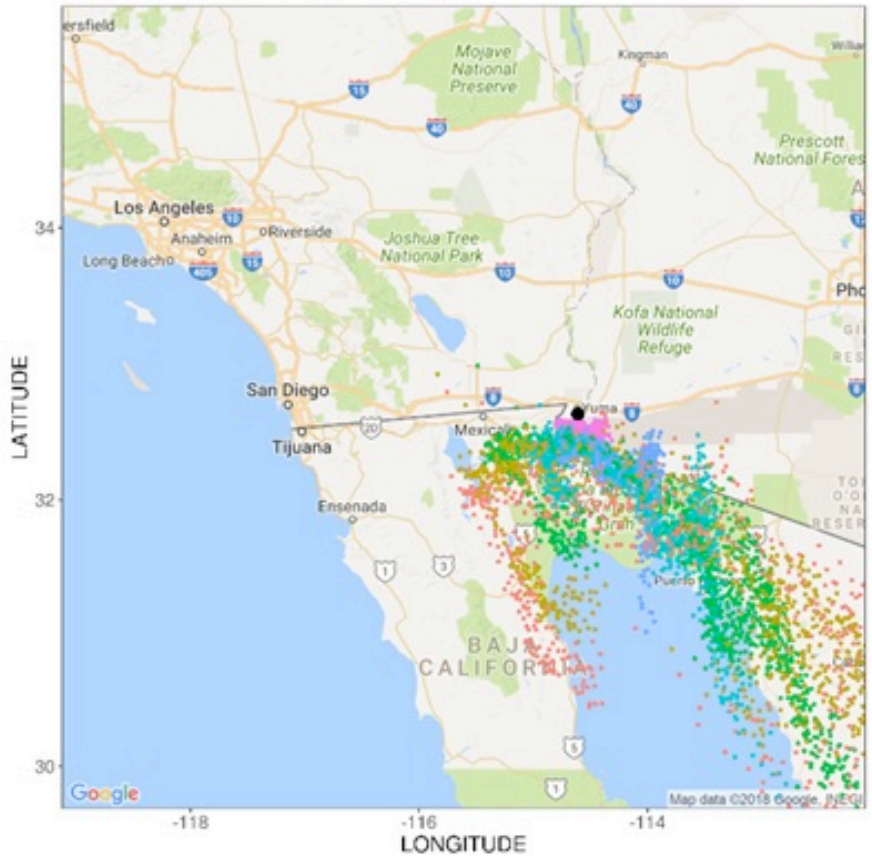


Hours back

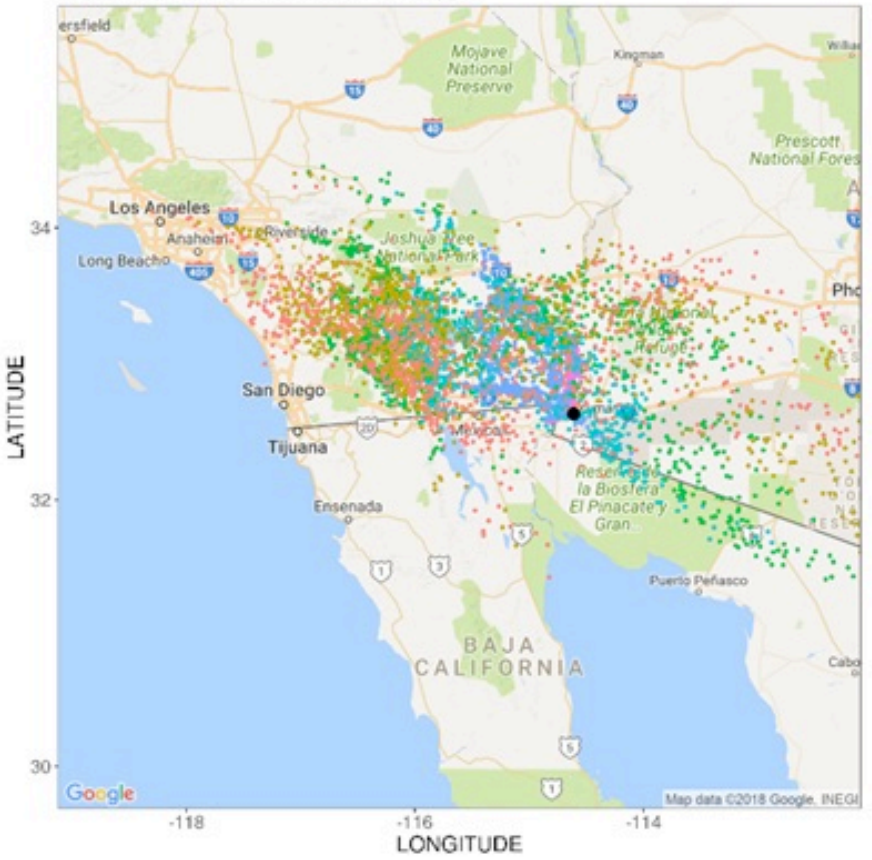
-4	-8	-12	-16	-20	-24

2017 Exceeding Day

7) 24 hrs HRRR-driven STILTv2 backward trajectories on 2017062000 from Yuma, AZ with observed O3 of 85 ppb



8) 24 hrs HRRR-driven STILTv2 backward trajectories on 2017070719 from Yuma, AZ with observed O3 of 84 ppb



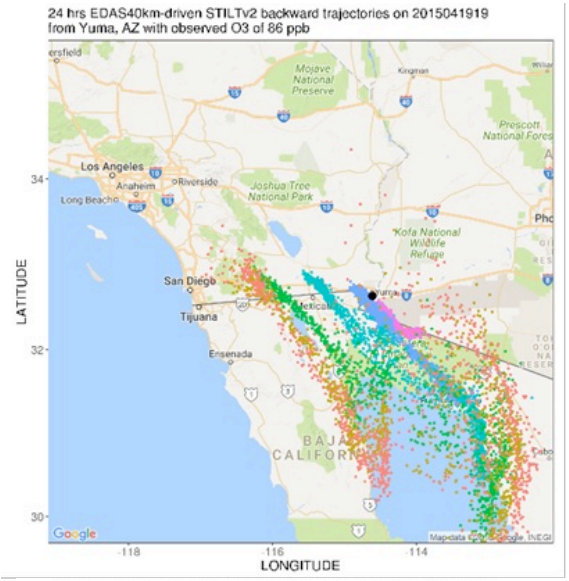
Hours back

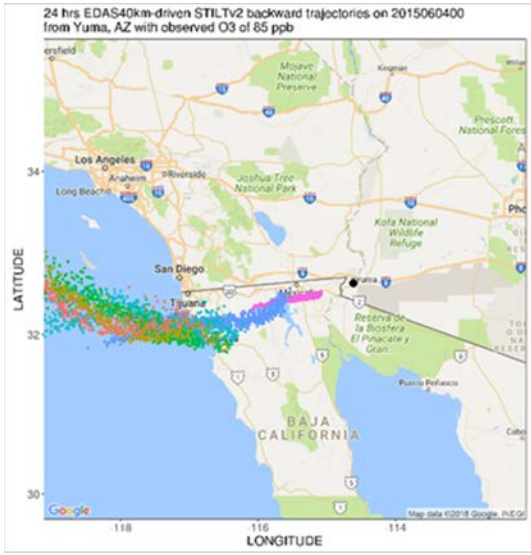
-4	-8	-12	-16	-20	-24

STILT Modeling

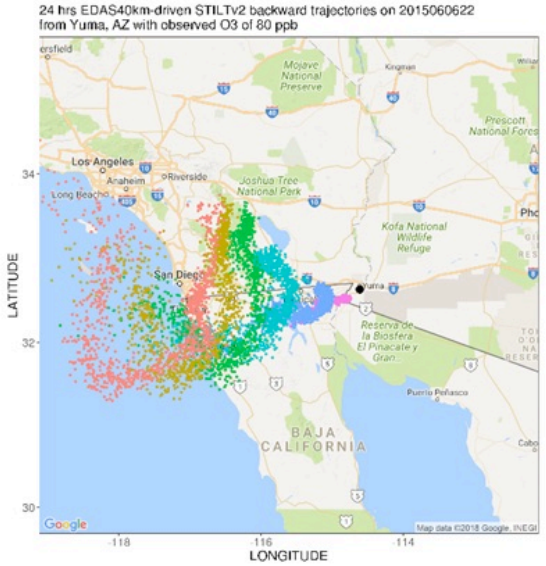
POTENTIAL EXCLUSIONS

Mexican Influenced Days

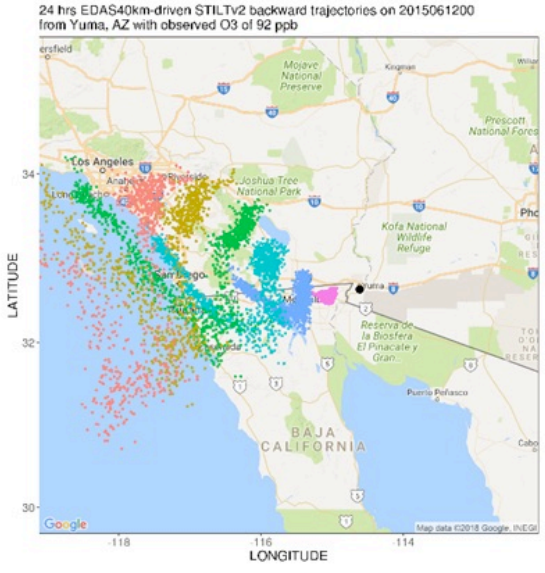


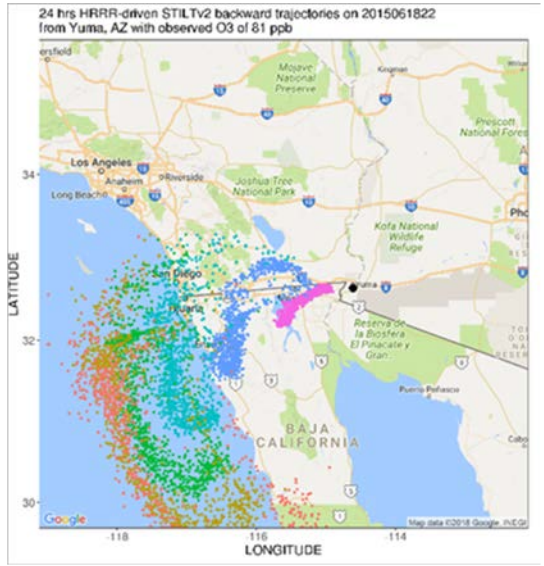


4)

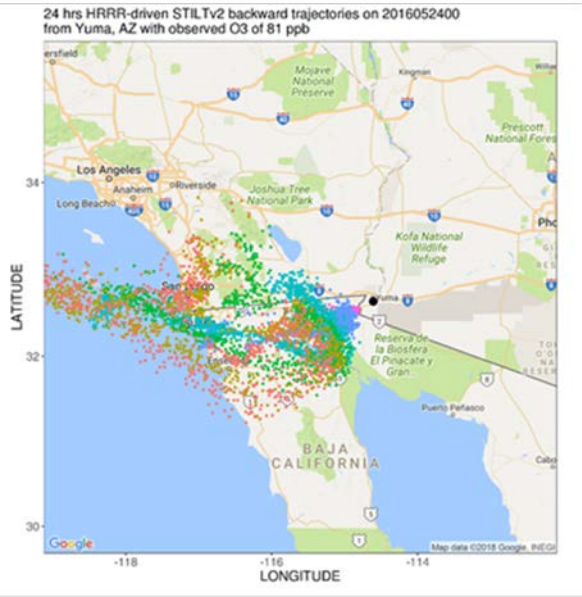


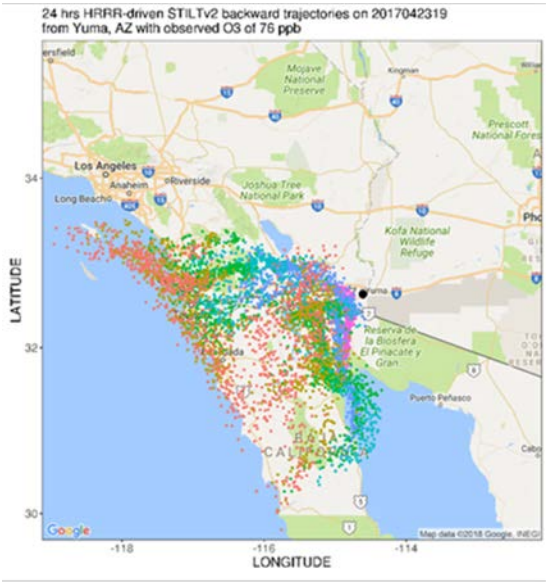
6)

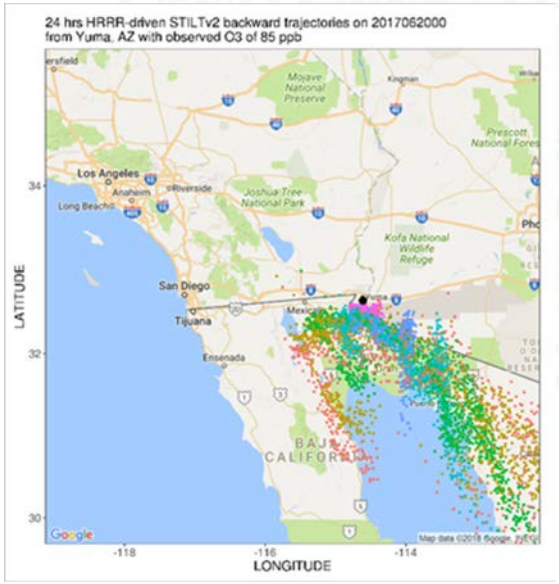




Mexican Influenced Days







- Excluding these 9 days lowers the design value
  - Actual Design Value = 72 (untruncated 72.666)
  - Hypothetical Design Value = 70 (untruncated 70.666)

Conclusions

- Reducing ozone concentrations in Yuma is a challenging task and needs intergovernmental cooperation.
- Emissions causing Yuma to exceed the ozone standard do not come from within Arizona

Acknowledgements and Thanks

- All the co-authors, especially thanks to
  - ❑ Dr. Zhen Qu (Advisor: Prof. Daven Henze), University of Colorado, Boulder
  - ❑ Dr. Dien Wu (Advisor: Prof. John C. Lin), University of Utah
- Dr. David Carslaw in King's College London, UK
- Dr. Yi Li, Arizona DEQ (Currently Sunset Cooper Environmental, Inc.)
- Openair Package Community

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