"건강한 환경 행복한 미래"

October 7, 2020 BIPM Ozone Workshop

Impact on national O_3 monitoring network by the new ozone absorption cross-section value in Korea

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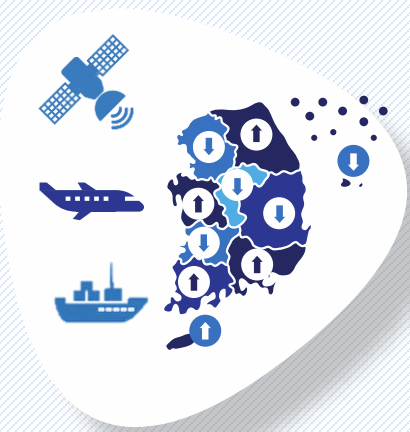
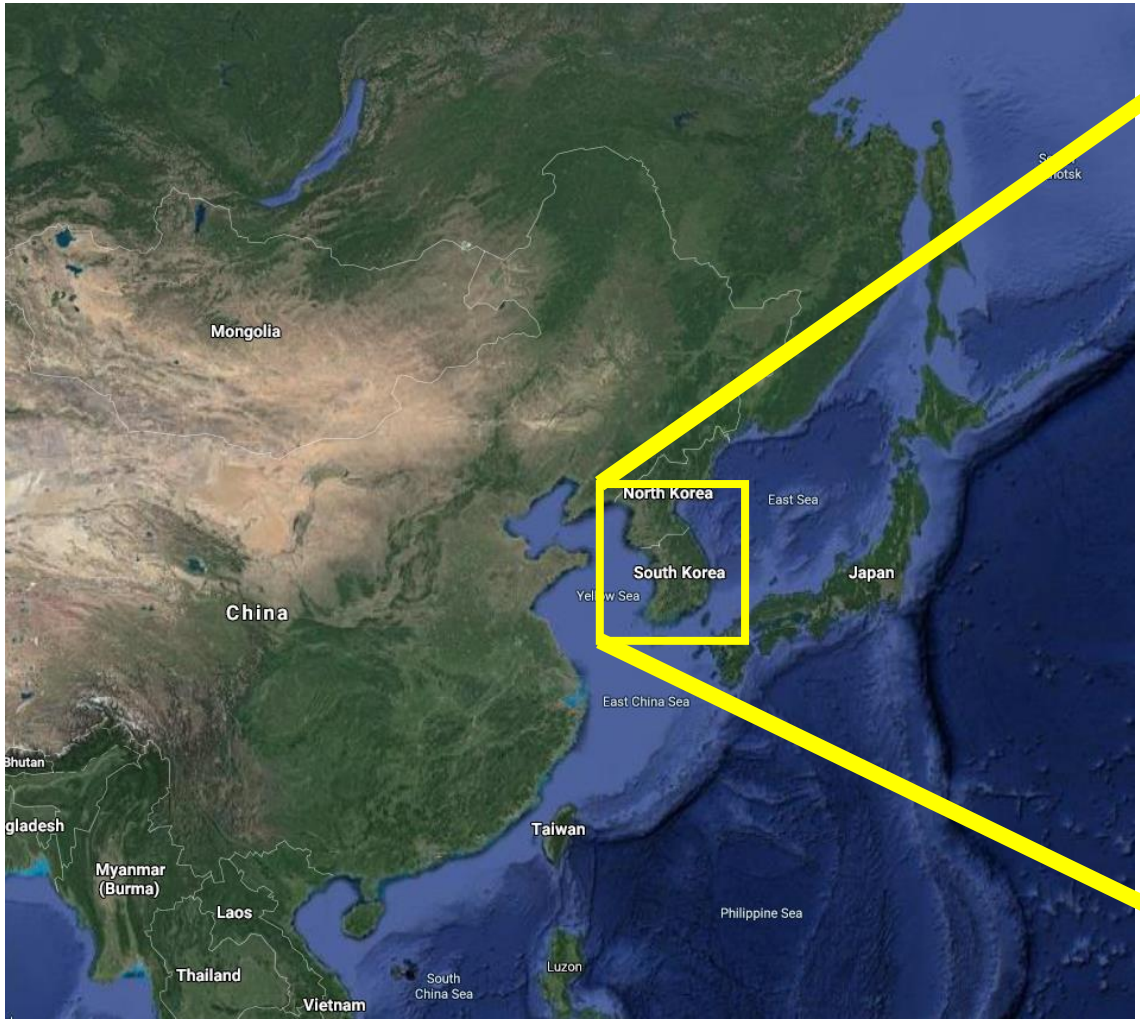


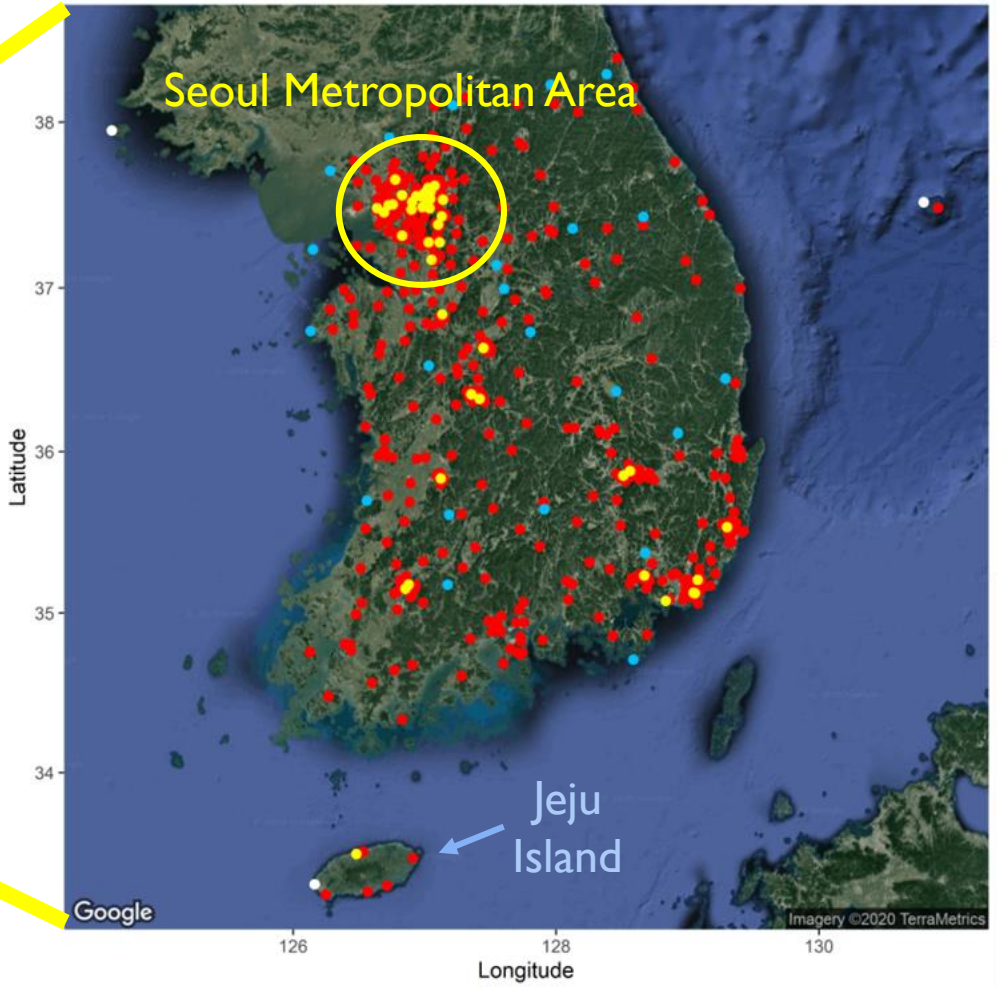
국립환경과학원 +Pride
National Institute of Environmental Research

01 Current Air Quality Observations in Korea

Republic of Korea
- located in northeast Asia.
- a neighbor of China and Japan.
- about 50 million people live in (~ a half people in SMA)



Air quality monitoring stations

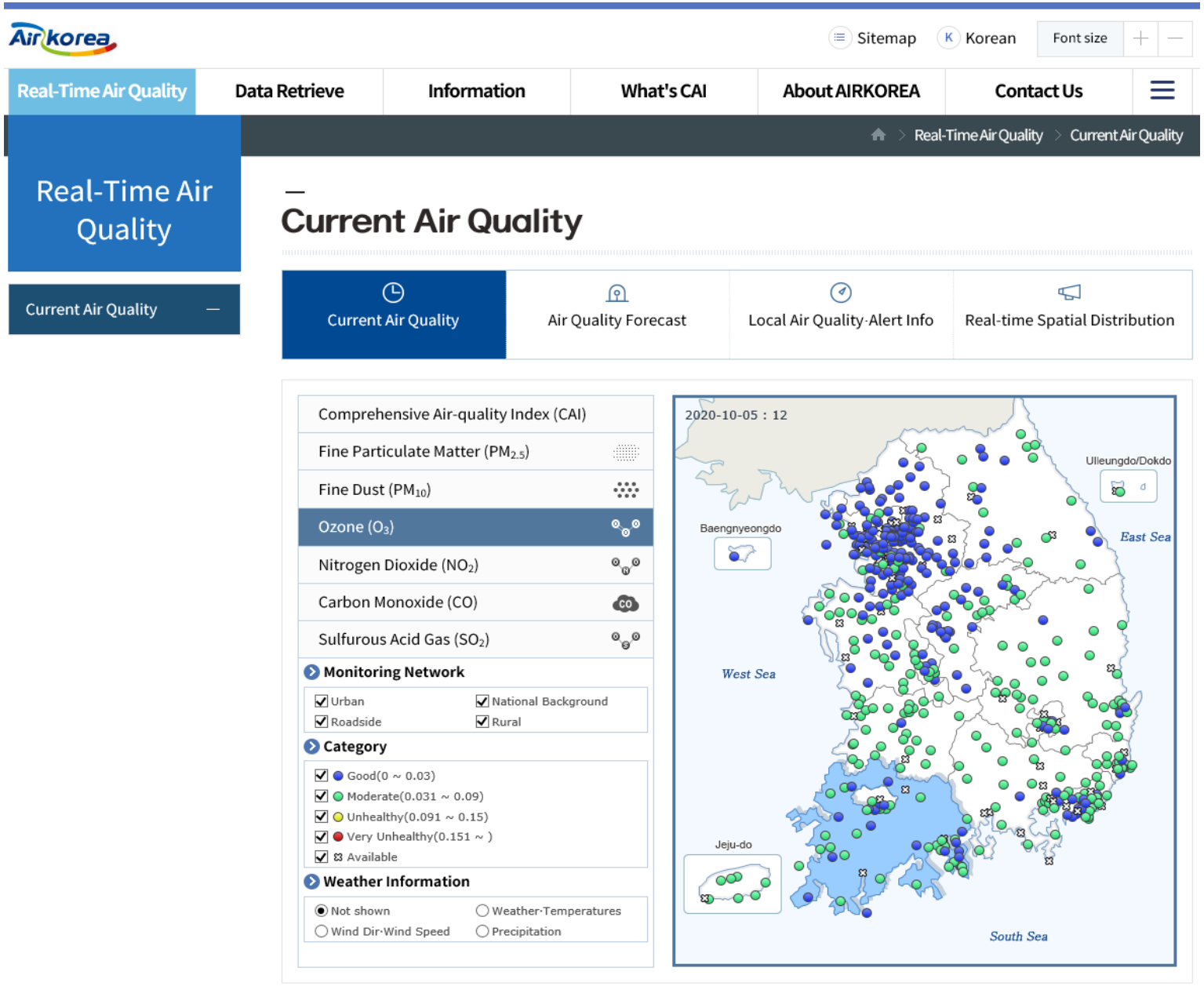


02 National Air Quality Monitoring Network

Total 532 stations (as of Sep. 2020)

Categories	# of Sites
Urban	459
Roadside	48
Rural	22
National Background	3

www.airkorea.or.kr provides a real time AQ information **every hour** for O_3, $PM_{2.5}$, PM_{10}, NO_2, CO, and SO_2.

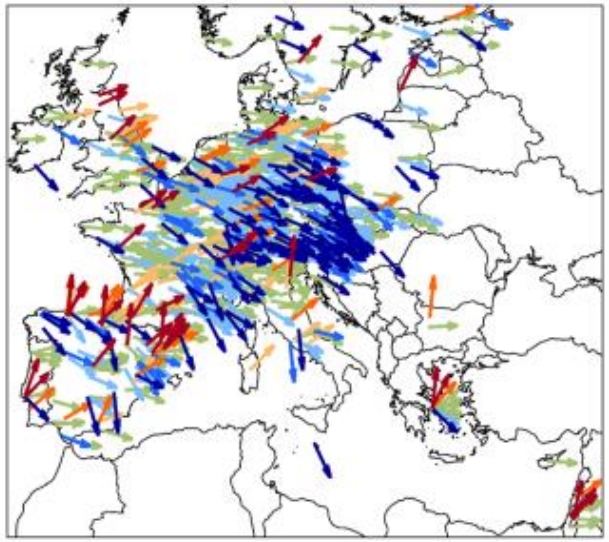


Korean NAAQS

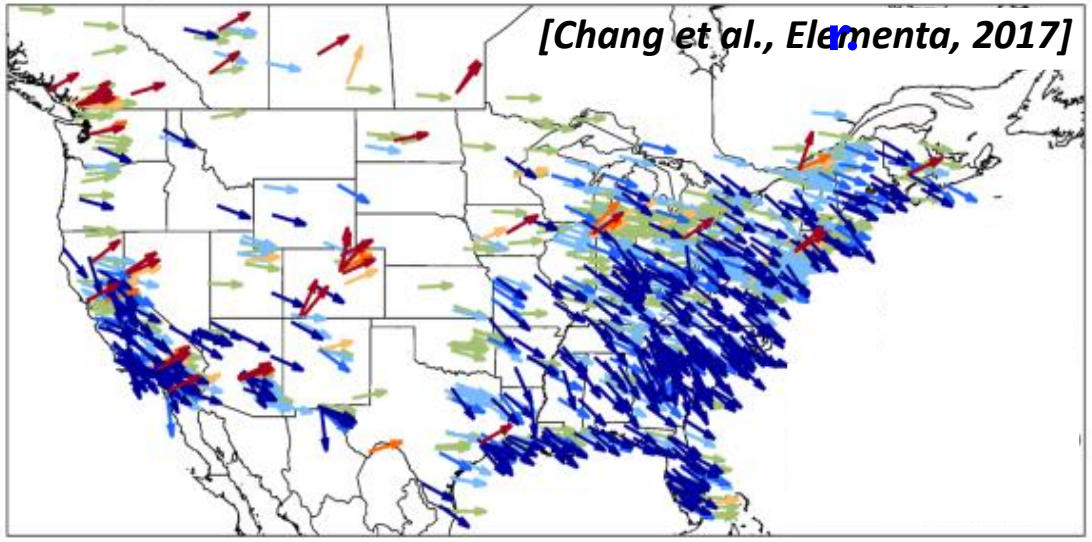
Air pollutants	National ambient air quality standard	
$PM_{2.5}$	Yearly	15㎍/㎥ or less
	24-hour	35㎍/㎥ or less
PM_{10}	Yearly	50㎍/㎥ or less
	24-hour	100㎍/㎥ or less
O_3	8-hour	0.06ppm or less
	1-hour	0.1ppm or less
NO_2	Yearly	0.03ppm or less
	24-hour	0.06ppm or less
	1-hour	0.10ppm or less
CO	8-hour	9ppm or less
	1-hour	25ppm or less
SO_2	Yearly	0.02ppm or less
	24-hour	0.05ppm or less
	1-hour	0.15ppm or less
Pb	Yearly	0.5㎍/㎥ or less
Benzene	Yearly	5㎍/㎥ or less

04 World's Ozone rate of change (2000 – 2014)

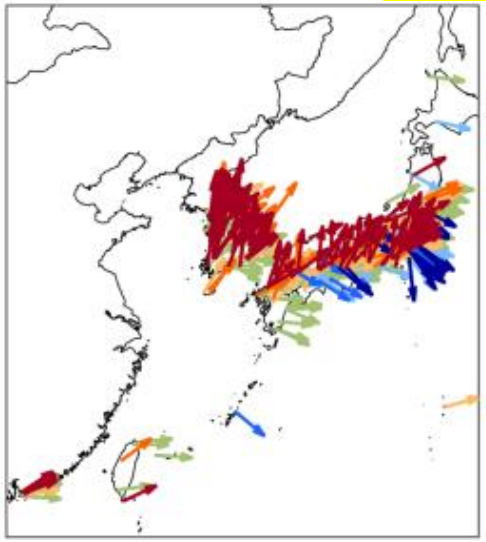
Europe ↘ Decr.

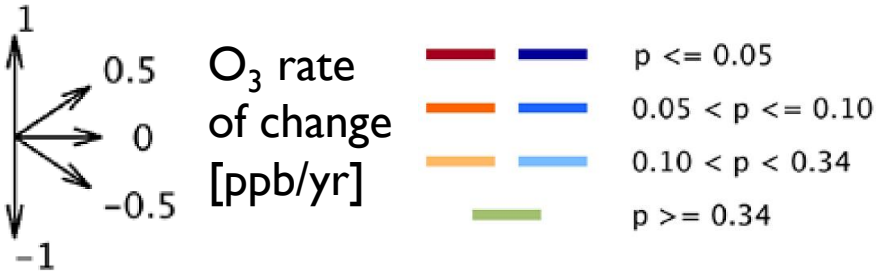


North America ↘ Dec



East Asia ↗ Incr.

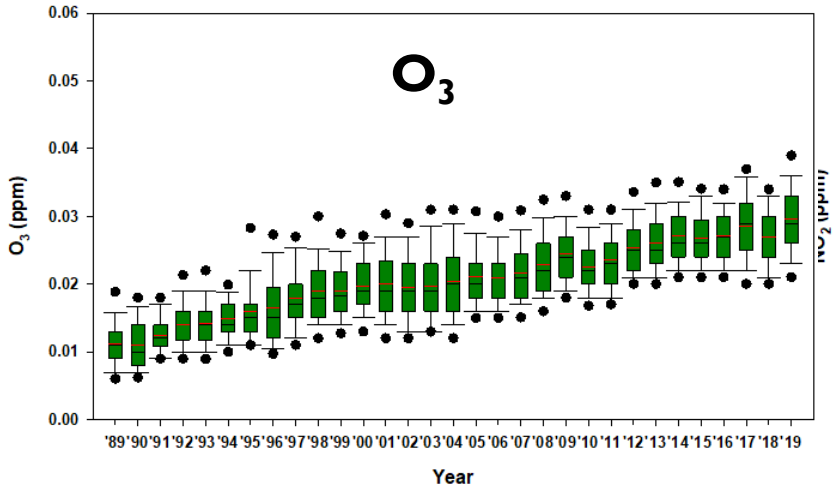


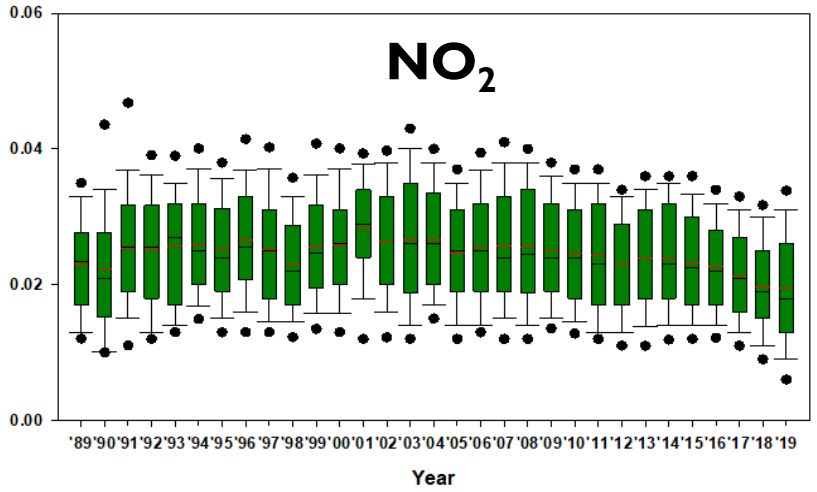


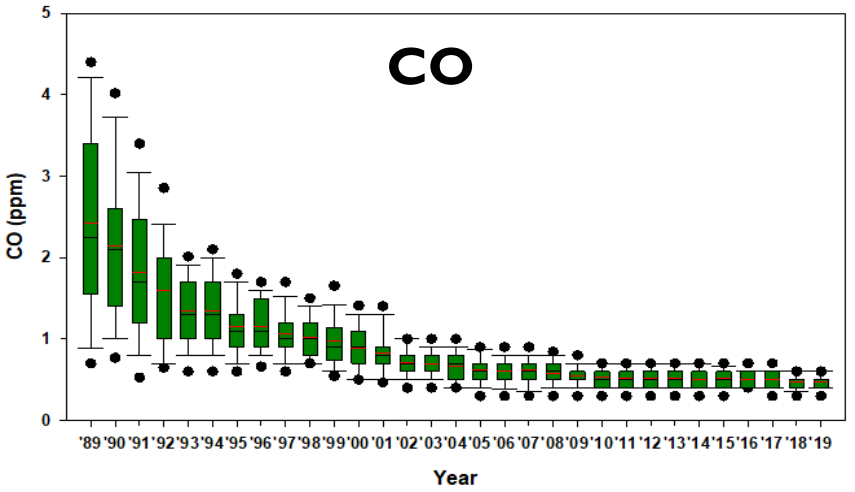
* Europe & N.America: mostly decreasing (except some urban area)

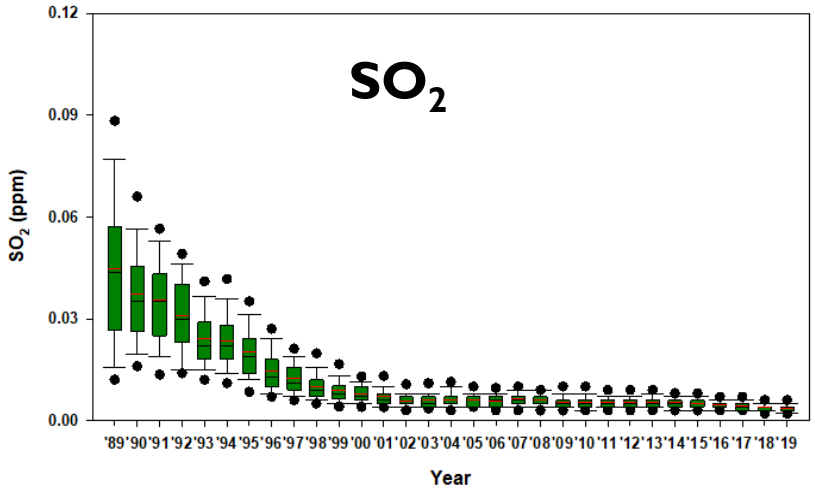
* East Asia: increasing drastically

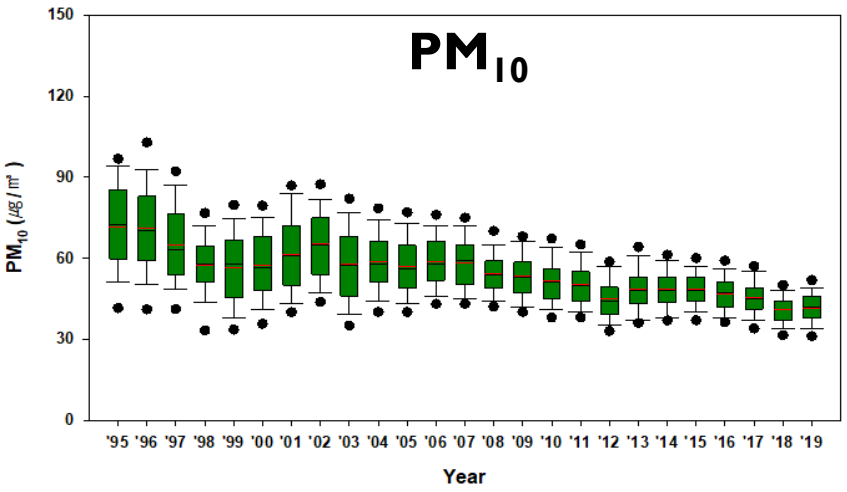
05 Long-term Trends of Air Pollutants in Korea

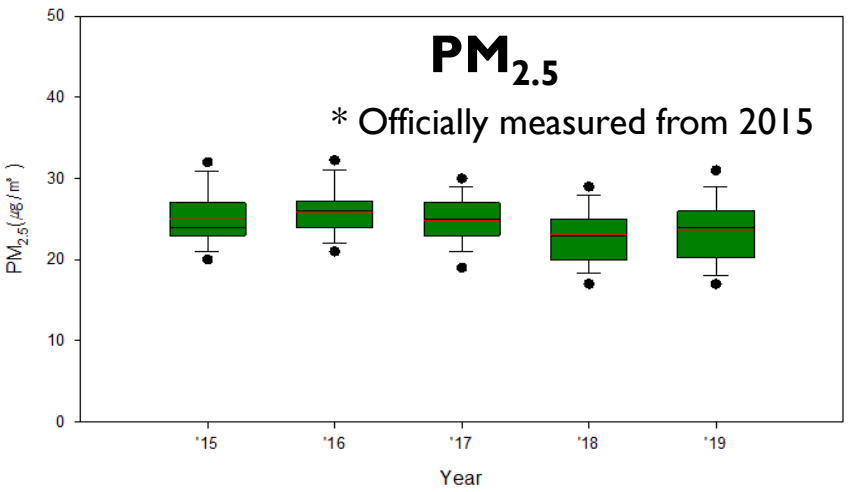






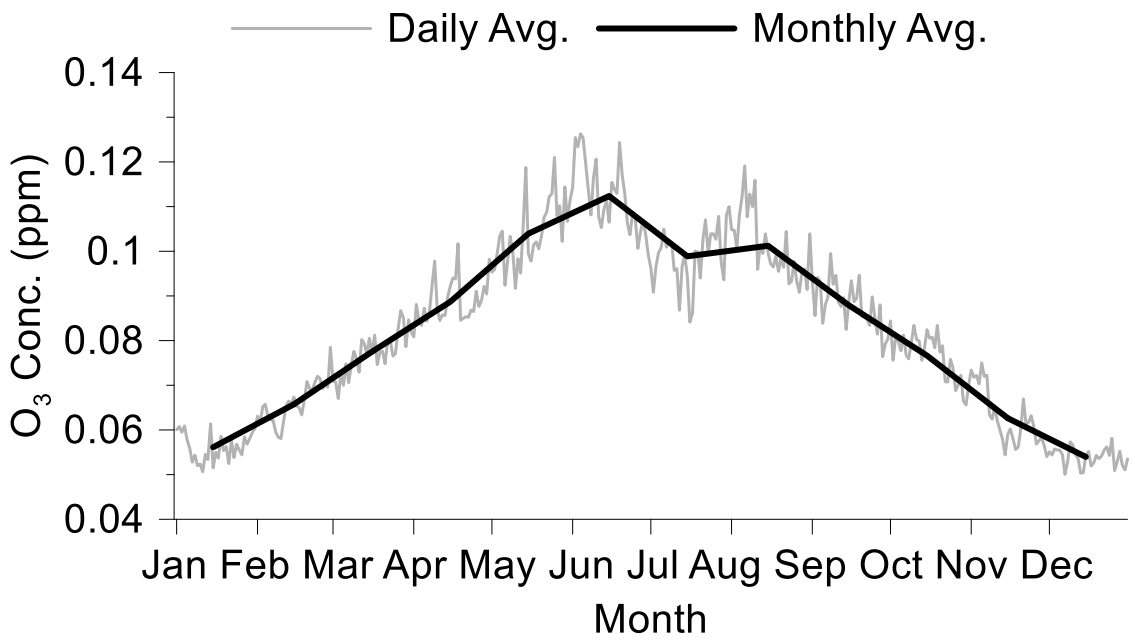




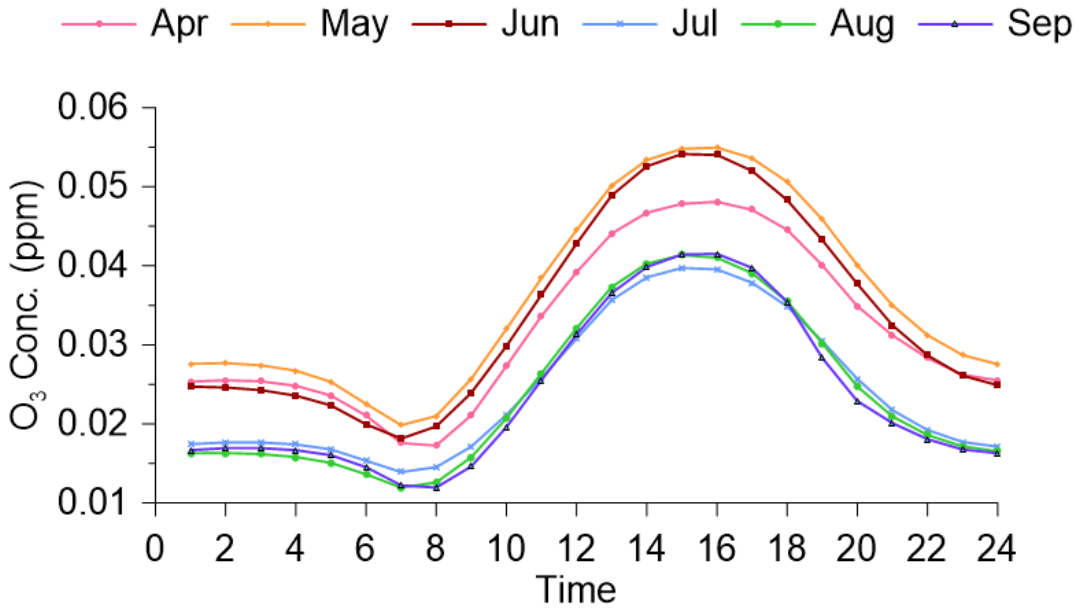


06 Monthly and Daily Ozone Trends

Monthly Ozone Variation



Daily Variation in Spring & Summer

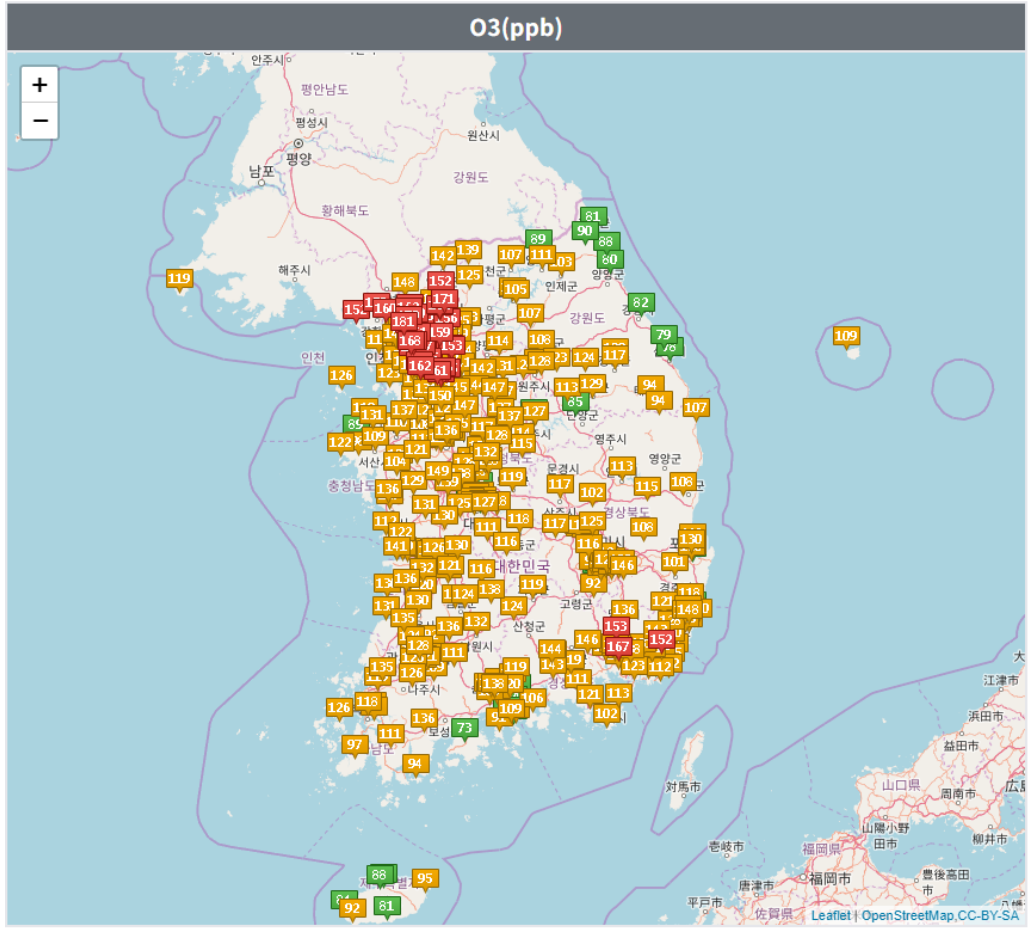


Min. and Max. values are typically around 7-8h and 15-16h, respectively.

07 High Ozone Episode

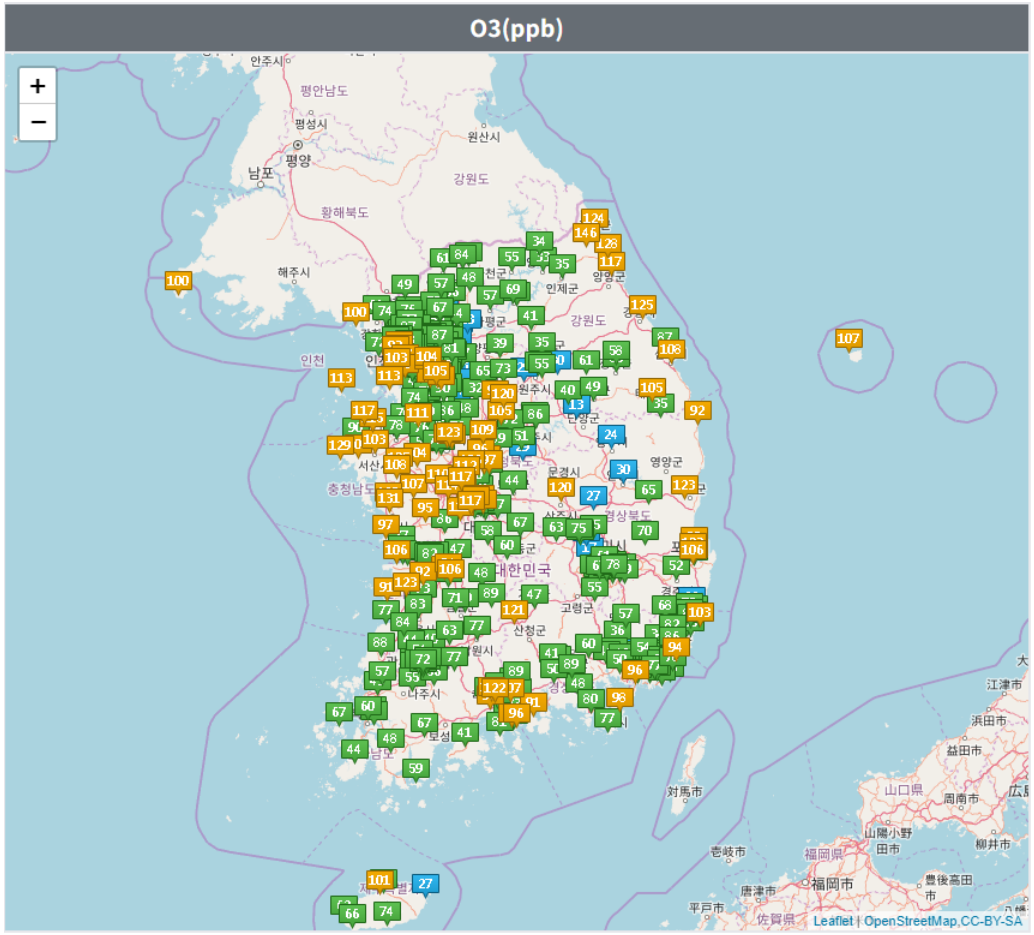
Daytime

(3 PM on May 24, 2019)



Nighttime

(3 AM on May 25, 2019)

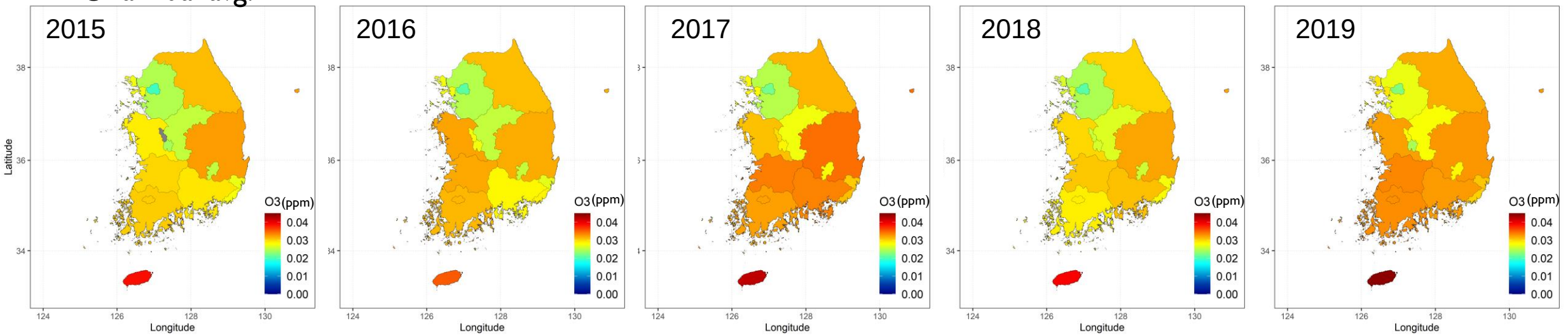


[ppbv]	
Good	≤30
Moderate	31-90
Unhealthy	91-150
Very Unhealthy	≥151

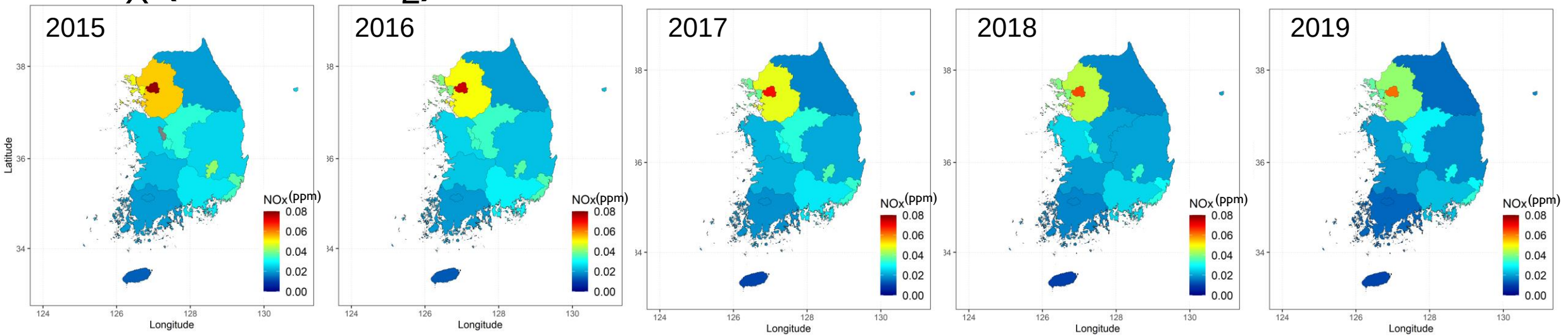
Max ozone records since 2000: **234 ppbv** O_3 was observed in June 4th, 2004,
232 ppbv O_3 was the second highest in June 2nd, 2018.

08 Ozone and NO_x during recent 5 years

O_3 annual avg.

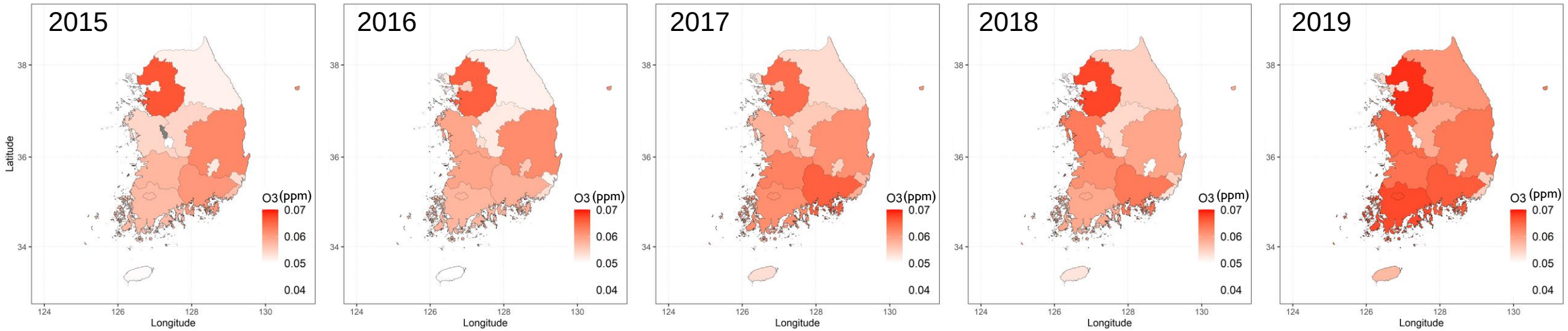


NO_X ($NO + NO_2$)



Max. Ozone during Recent 5 years

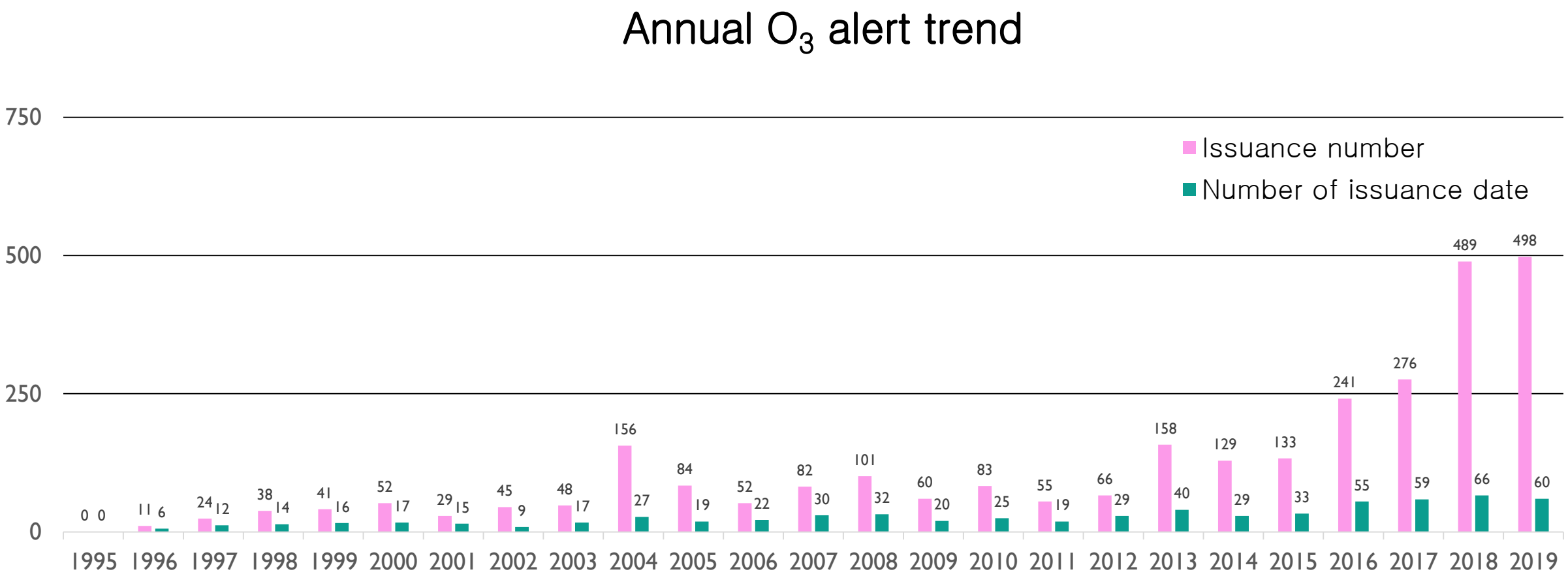
O_3 (14~18h, Max.)



Ozone Alert and Protective Actions

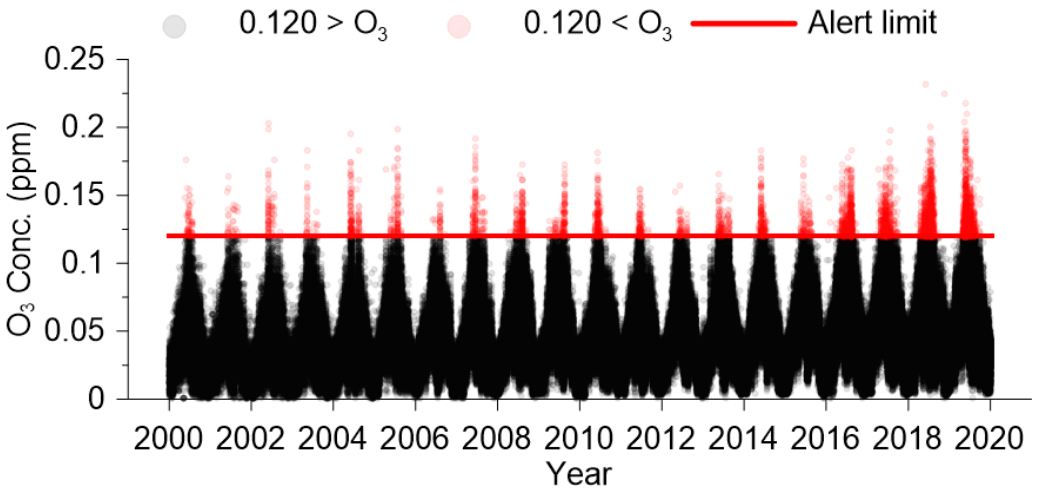
Categories	General Public	Vehicle Drivers	Relevant Agencies	Businesses
Alert (0.12ppm or more)	• Requests: No open burning • Refraining from outdoor activities and require less heavy exertion. • Recommendations: Use mass transit (especially, children, patients with respiratory ailments and heart diseases) / Limit outdoor activities.	• Recommendations: Drive less in the alert zone (Car-pooling) • Use mass transit • Restrain inessential use of vehicles.	• Issue an air pollution alert • Requests: National broadcasting and publicity • Analysis of changes in air pollution and review of weather monitoring data.	
Warning (0.3ppm or more)	• Requests: Restrict the use of incineration facilities • Avoid prolonged outdoor activities and heavy exertion. • Recommendation: Restrict outdoor classes.	• Request: Limit driving in the warning zone.	• Issue an air pollution warning. • Requests: Closer monitoring of air pollution and weather observation • Enhance the publicity of the issuance.	• Recommendation: Reduce fuel consumption
Emergency (0.5ppm or more)	• Requests: Suspend and restrict incineration facilities / No outdoor class. • Recommendations: Temporary closure of schools • No outdoor activities, especially the elderly, children, and patients with respiratory ailments and heart diseases.	• Forbid driving vehicles in the emergency zone	• Issue an air pollution emergency. • Requests: Closer monitoring of air pollution and weather observation • Enhance the publicity of the issuance.	• Operation Reduction

Long-term Trend of Ozone Alert

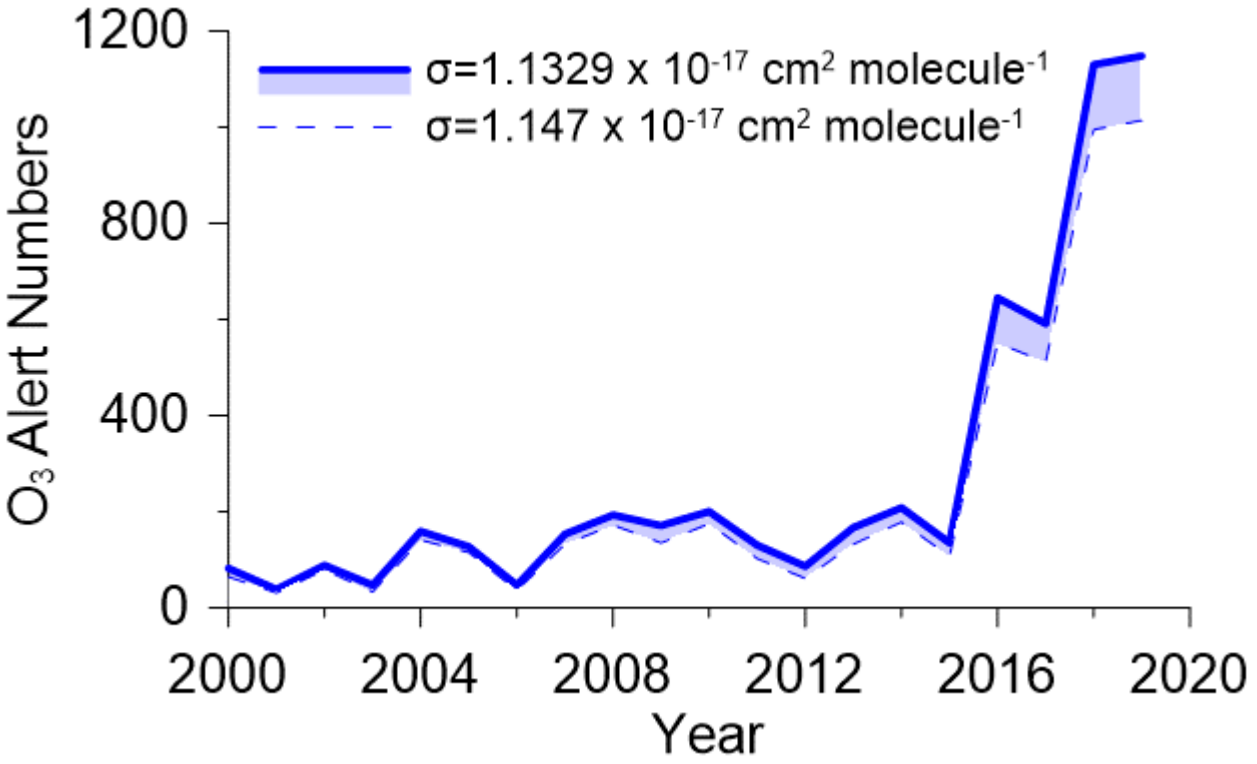


Impact of Ozone Cross-Section Value change

Daily max O_3 of all SMA stations



Exceedance number of SMA stations



Total exceedance numbers for 20 years

Using cross-section value;

σ=1.147 by Hearn et al.(1961) *vs.* σ=1.1329 by Hodges et al.(2019)

4764 → **5545**

~ 16.4 % increase

Korean official test method for ozone in ambient air

대기오염공정시험기준 ES 01607.1

환경대기 중 오존 측정방법 - 자외선광도법 2016

(Method for the Determination of Ozone in Ambient Air - Ultraviolet Photometric Method)

3.2.1 측정 원리 (Principle)

이 방법은 파장 253.7 nm 자외선 흡수량의 변화를 측정하여 환경대기중의 오존을 연속적으로 측정하는 방법이다. 안정된 저압 수은 (Hg) 방전 램프로부터 방출된 253.7 nm의 자외선은 시료 공기가 흐르는 광학 흡수셀을 통과 하면서 오존에 의해 흡수되고, 광전다이오드 또는 광전관으로 측정되어 전기 신호로 바뀐다. 흡수셀은 측정기의 형태에 따라서 하나 또는 두 개가 사용된다. 채취된 시료 공기의 일부를 오존 촉매 변환기를 사용하여 오존만을 선택적으로 제거하고, 시료 흡수셀 (단일셀 배치)에 시료와 번갈아 흘리거나 이중 흡수셀 (2중셀 배치)에 흘리면서 오존 흡수가 없는 상태의 자외선 세기를 측정한다. 이와 함께, 시료가 있는 상태에서 흡수셀을 통과한 자외선의 세기를 측정한 다음 자외선 흡수 세기의 차이 비율로부터 오존 농도를 계산한다. 측정된 자외선 흡수 비율, 흡수셀의 길이, 253.7 nm에서의 오존 흡수단면적 그리고 오존 농도는 Beer-Lambert 법칙을 따르며 다음과 같은 관계를 나타낸다.

$$x = \frac{-1}{\alpha L} ln\left(\frac{I}{I_o}\right) \quad \text{(식 1)}$$

여기서 $\frac{I}{I_0}$: 오존 시료의 투과율, 즉 셀이 오존 세정 공기를 포함할 때의 자외선

Misprint !!!

의 세기에 대한 셀이 시료 공기를 포함할 때 자외선의 세기의 비

α 257.7nm에서의 오존 흡수단면적

(α =1.1476×10^{-17} cm^2/molecule)

x : 흡수셀 안의 단위 부피당 오존 분자수 (molecule/cm^3)

L : 광로 길이 (cm)

absorption cross- section should be corrected to 1.1329x10^{-17} cm^2/molecule ???

This method basically follows:

- ISO 13964 Air Quality – Determination of Ozone in Ambient air – Ultraviolet Photometric Method First Edition 1998
- ASTM D5119 Standard Practice for Calibration of Ozone Monitors and Certification of Ozone Transfer Standards Using Ultraviolet Photometry 1998

Ozone Measurement Instruments

Thermo Science (USA)

49i (27EA)

49iQ (80EA)

Teledyne API (USA)

400E (23EA)

T400 (82EA)

Ecotech (Australia)

EC-9810 (25EA)

HORIBA (Japan)

APOA-360 (1EA)

APOA-370 (143EA)

KIMOTO (Japan)

OA683 (3EA)

OA781 (64EA)

KENTECH (Korea)

KN-410 (2EA)

Thank you !!!