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Spatio-Temporal distribution and long-term trend of ozone sensitivity over South Korea inferred from OMI data

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- Tropospheric ozone is formed in the atmosphere through chemical reactions of its precursors such as nitrogen oxides (NO_x), volatile organic compounds (VOCs), etc., in the presence of sunlight.
- Its formation can be determined by the ratio of the columns of formaldehydes to nitrogen oxides (called FNR), which has been used as an indicator to identify NO_x-limited or VOC-limited O₃ formation regimes.
- In this study, we investigated spatio-temporal distributions and long-term trends of O₃ and its precursor's concentrations, and FNR in South Korea during the O₃ season (May-September) and non-O₃ season (October-April), respectively, using OMI data for the past decade (2005-2014).

● Tropospheric O₃ data from AURA OMI/MLS [*Ziemke et al., 2006*]

Tropospheric O₃ data products from OMI in combination with Aura Microwave Limb Sounder (MLS)

- OMI : total column (tropospheric + stratospheric) ozone
- MLS : stratospheric ozone

Trop. O ₃	Trop. NO ₂	Trop. HCHO
OMI/MLS	OMI	OMI
Level 3 (Monthly)	Level 3 (Monthly)	Level 3 (Monthly)
1.0°x1.25°	0.25°x0.25°	0.25°x0.25°



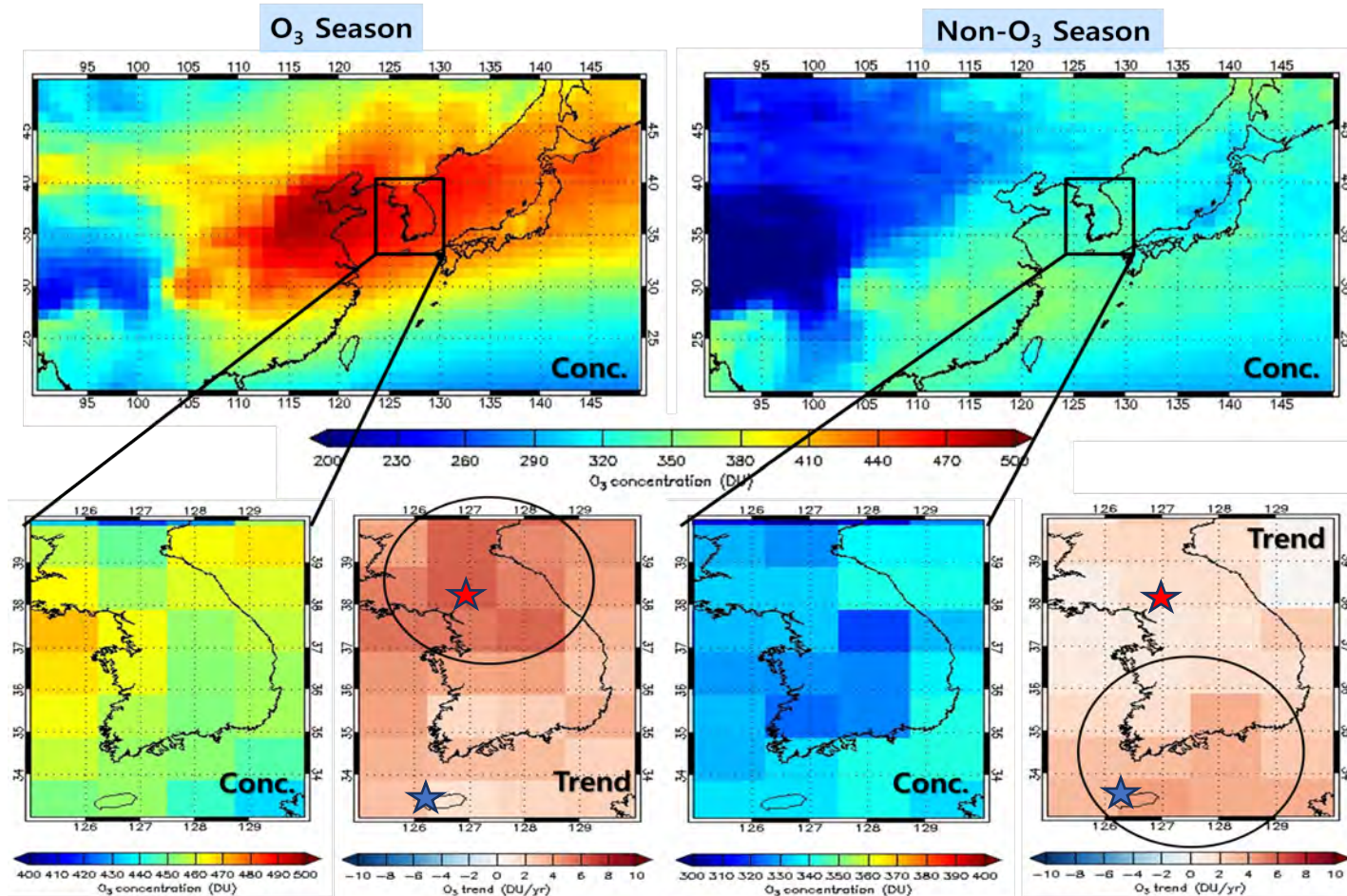
[Morris et al., 2006]

- HCHO to NO₂ ratio (FNR) [*Duncan et al., 2010*]

- Space-based indicator to understand efficient way to reduce ozone concentration

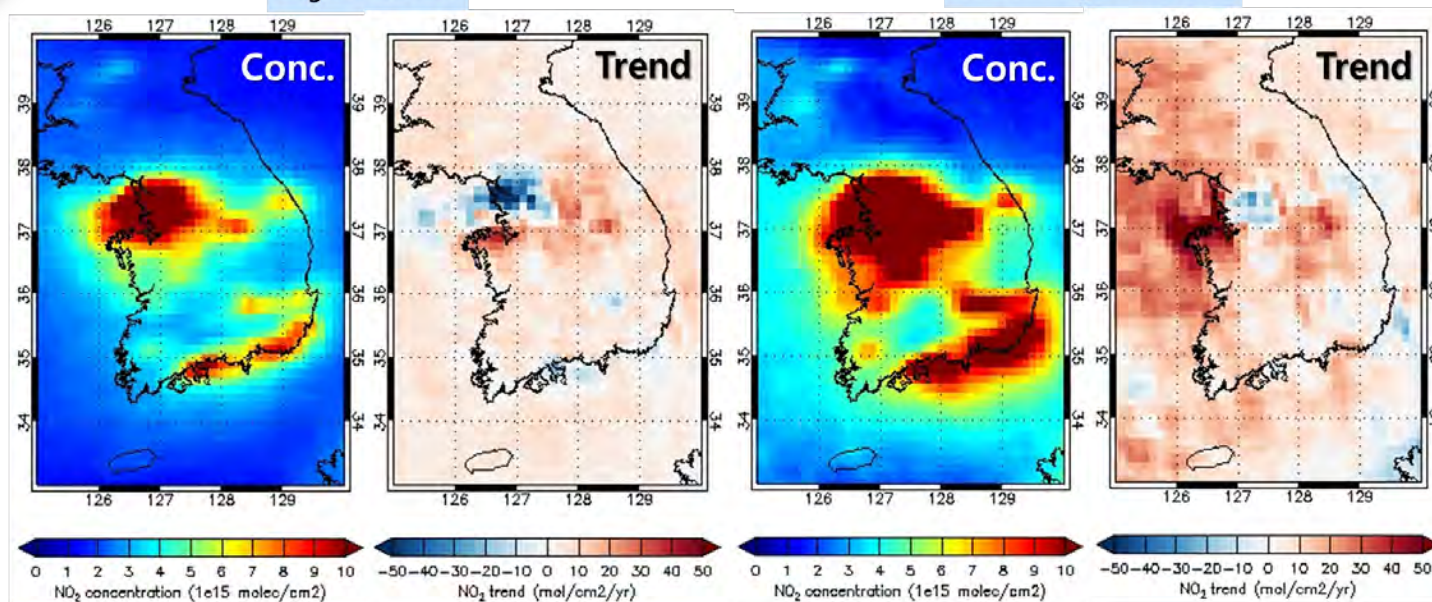
VOC-regime	HCHO/NO ₂ < 1	VOC control is more effective for ozone reduction (The effect of Local area)
NOx-regime	HCHO/NO ₂ > 2	NOx control is more effective for ozone reduction (The effect of long-range transport)
Transition or Mixed regime	1 < HCHO/NO ₂ < 2	Both NO ₂ and VOCs are effective for surface ozone reduction

- Investigating **spatio-temporal distribution and long-term trend of trop. O₃ for the decade**
- Figure: 1) high concentrations show in Korea, East China, and Japan during the O₃ season
 2) the trends are increasing at all the regions of S. Korea as well as NE Asia. Especially, strong increasing trends represent at **Seoul (City)** in O₃ season, whereas at **Gosan** in non-O₃ season

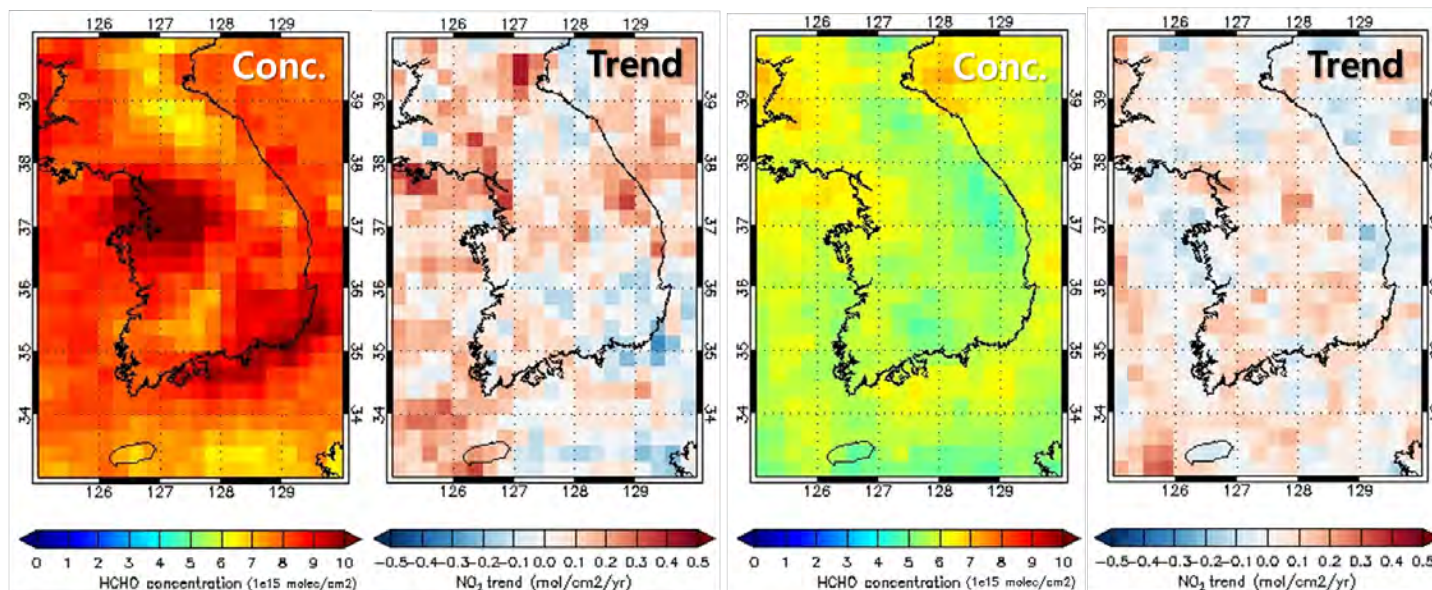


O₃ season: May-September
 Non-O₃ season: October-April

Trend (DU/year)	NE Asia	KOR	Seoul	Gosan
O ₃ Season	2.8	3.0	5.3	3.0
Non-O ₃ Season	2.5	1.8	1.1	3.2
ALL	2.2	2.3	2.8	3.1

O₃ SeasonNon-O₃ SeasonNO₂

HCHO



- NO₂ is more abundant in cities and industry area during the non-O₃ season than O₃ season.
- It has negative trend in Seoul Metropolitan Area in all seasons.
- N.Korea and Yellow Sea have positive trend by power plants, etc., especially in non-O₃ season.
- High concentrated HCHO is also distributed largely in cities, especially in O₃ season.
- It has no significant trend over South Korea.

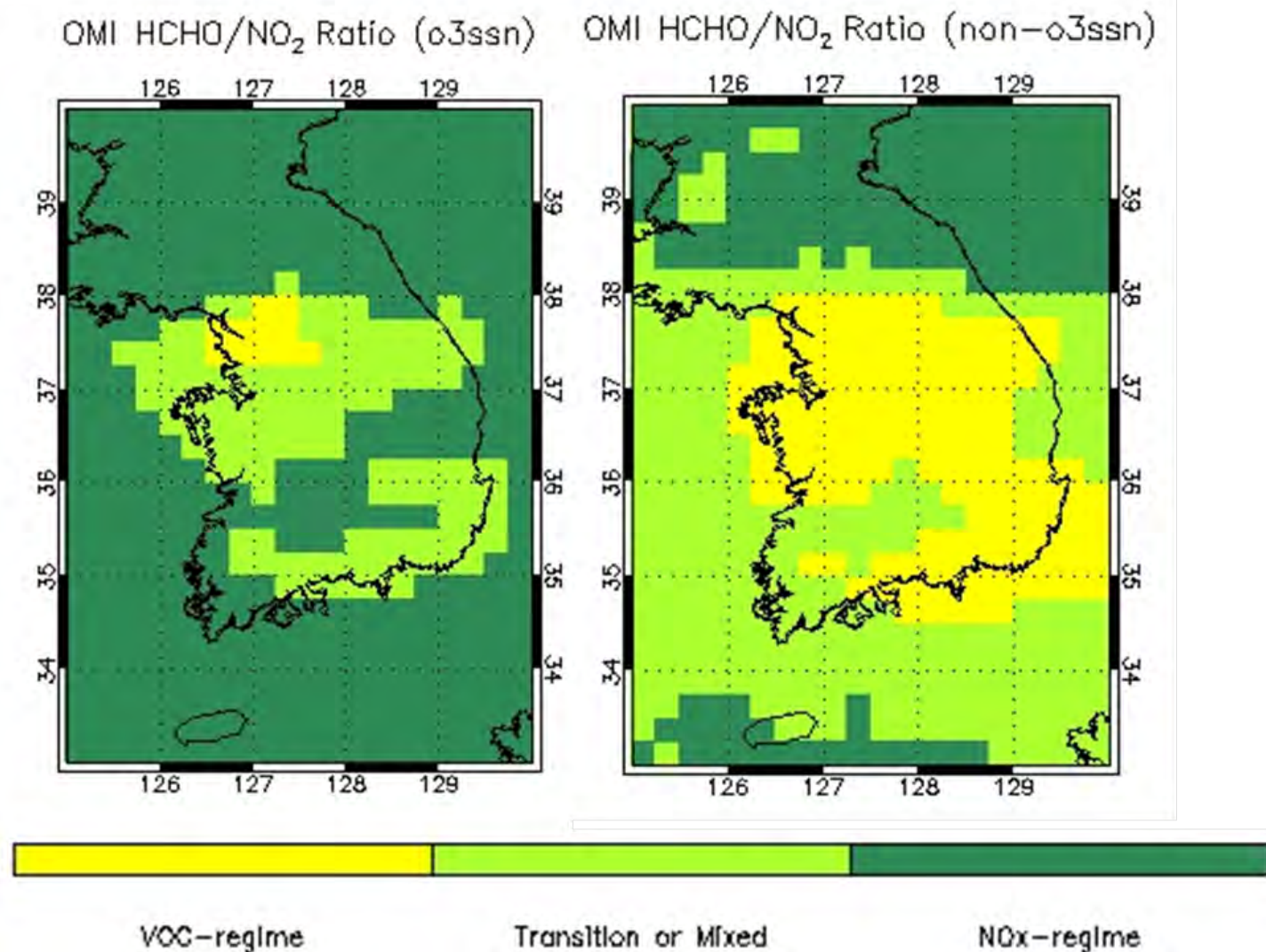
▪ The **averaged FNR** for the past decade (2005-2014)

1) O₃ season (left)

- NO_x-regime prevails.
- VOC- and mixed regimes represent only in big cities and surrounding areas.

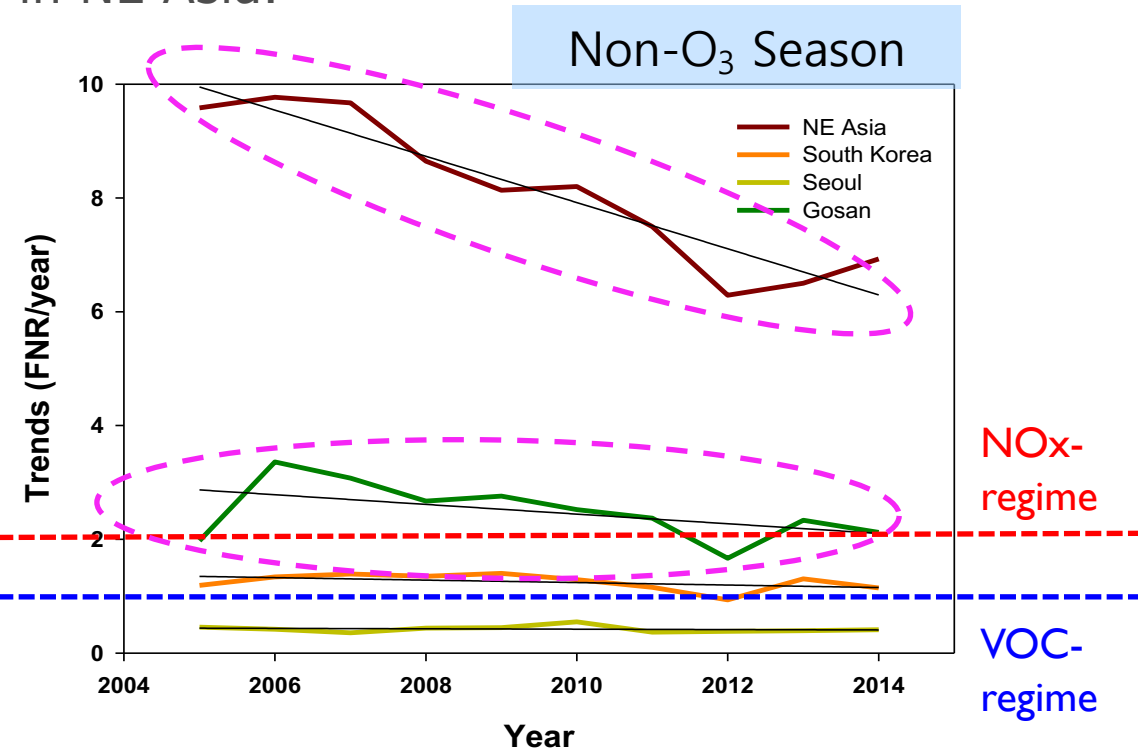
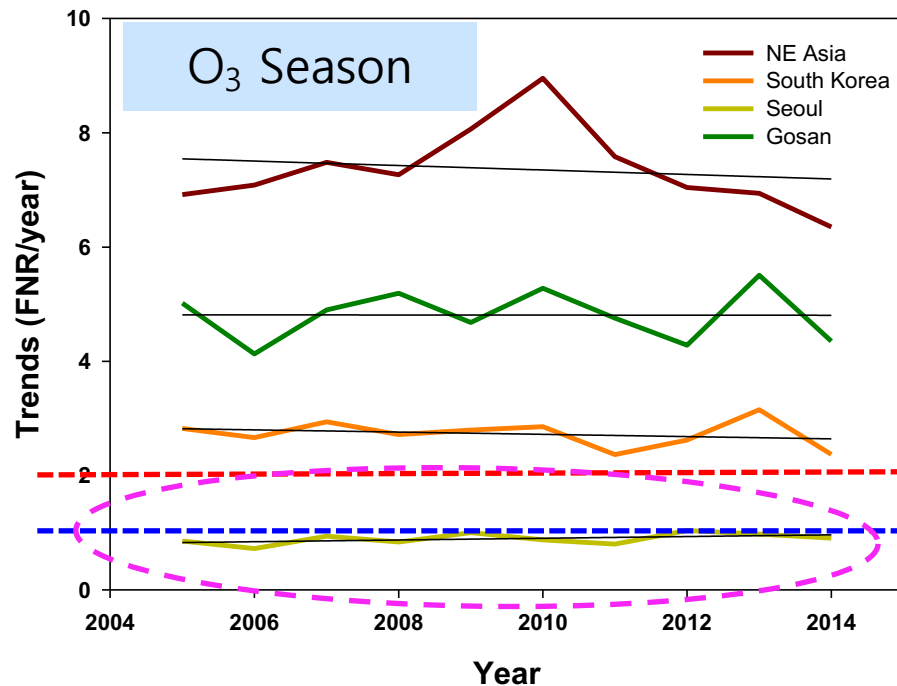
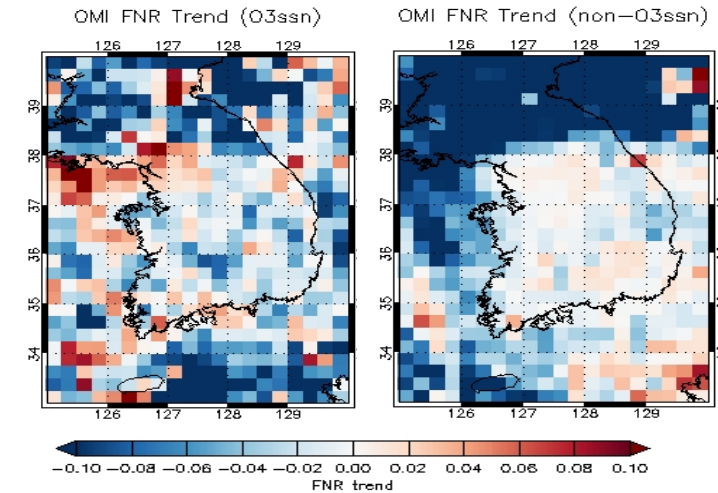
2) Non-O₃ season (right)

- VOC- and mixed regimes are expanded to the whole region of South Korea.



■ Trend of FNR for the past decade

- 1) **O₃ season**: VOC-regime changed to mixed regime (Seoul)
 - Due to implementation of emission controls, etc.
- 2) **Non-O₃ season**: NO_x regime is transferring slightly to mixed regime (Gosan)
 - Due to increasing NO₂ in North Korea and Yellow sea, and decreasing HCHO in Jeju.
 - Also, we found that FNR decreased rapidly in NE Asia.





GEMS

- GEMS is loaded aboard **GEO-KOMPSAT2B** which is **undergoing several tests until the launch period('20.3)**.
- Air pollutants and causes of climate change including **SO₂, NO₂, O₃, HCHO and aerosols** will be observed with UV-Visible hyper-spectral sensor in East Asia.



Future plan about ozone sensitivity study

- Changing application platforms **from OMI to GEMS data** (LEO → GEO)
- Extending study area **from South Korea to Asia** (GEMS coverage)
- Supporting **environmental policy maker** by providing science data from satellites

Thank you for your effort!
