Tropospheric Ozone Assessment Report (TOAR): A community-wide effort to quantify tropospheric ozone in a rapidly changing world

Global metrics for climate change, human health and crop/ecosystem research

Mission:
To provide the research community with an up-to-date scientific assessment of tropospheric ozone's global distribution and trends from the surface to the tropopause.

Deliverables:

1) The first tropospheric ozone assessment report based on the peer-reviewed literature and new analyses.
2) A database containing documented data on ozone exposure and dose metrics at hundreds of measurement sites around the world (urban and non-urban), freely accessible for research on the global-scale impact of ozone on climate, human health and crop/ecosystem productivity.

Stakeholders:

GMAC May 24, 2017

Global ozone trends: First results from the Tropospheric Ozone Assessment Report (TOAR), TOAR-Climate

TOAR-Ozone Budget
TOAR-Observations
TOAR-Metrics
TOAR-Health
TOAR-Vegetation
TOAR-Climate
TOAL-Model Performance
TOAR-Surface Ozone Database

GMAC May 24, 2017

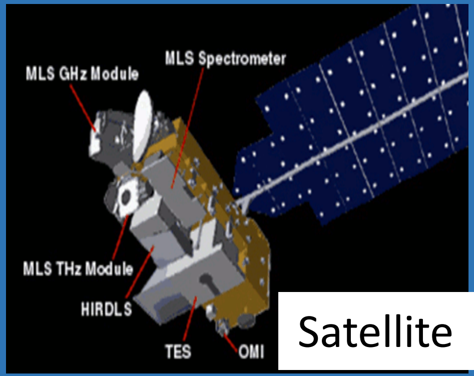
Global ozone trends: First results from the Tropospheric Ozone Assessment Report (TOAR)

A. Gaudel, O. R. Cooper, G. Ancellet, B. Barret, C. Clerbaux, P.-F. Coheur, J. Cuesta, E. Cuevas, S. Doniki, G. Dufour, F. Ebojie, G. Foret, M. J. Granados Muñoz, B. Hassler, G. Huang, D. Hurtmans, D. Jaffe, P. Kalabokas, B. Kerridge, S. Kulawik, B. Latter, T. Leblanc, E. Le Flochmoën, W. Lin, J. Liu, X. Liu, A. McClure-Begley, J. Neu, M. Osman, H. Petetin, I. Petropavlovskikh, R. Querel, N. Rahpoe, A. Rozanov, M. Schultz, J. Schwab, M. Steinbacher, R. Siddans, H. Tanimoto, D. Tarasick, V. Thouret, A. Thompson, T. Trickl, C. Wespes, H. Worden, C. Vigouroux, X. Xu, G. Zeng, J. Ziemke

GMAC May 24, 2017

Global ozone trends: First results from the Tropospheric Ozone Assessment Report (TOAR)

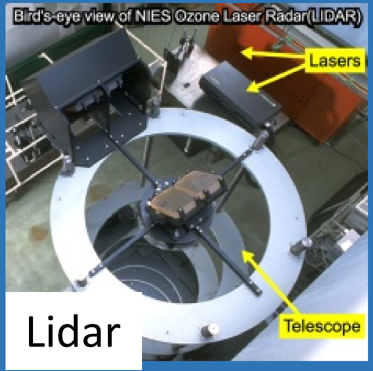
Commercial Aircraft IAGOS



Satellite


Dobson


Sondes



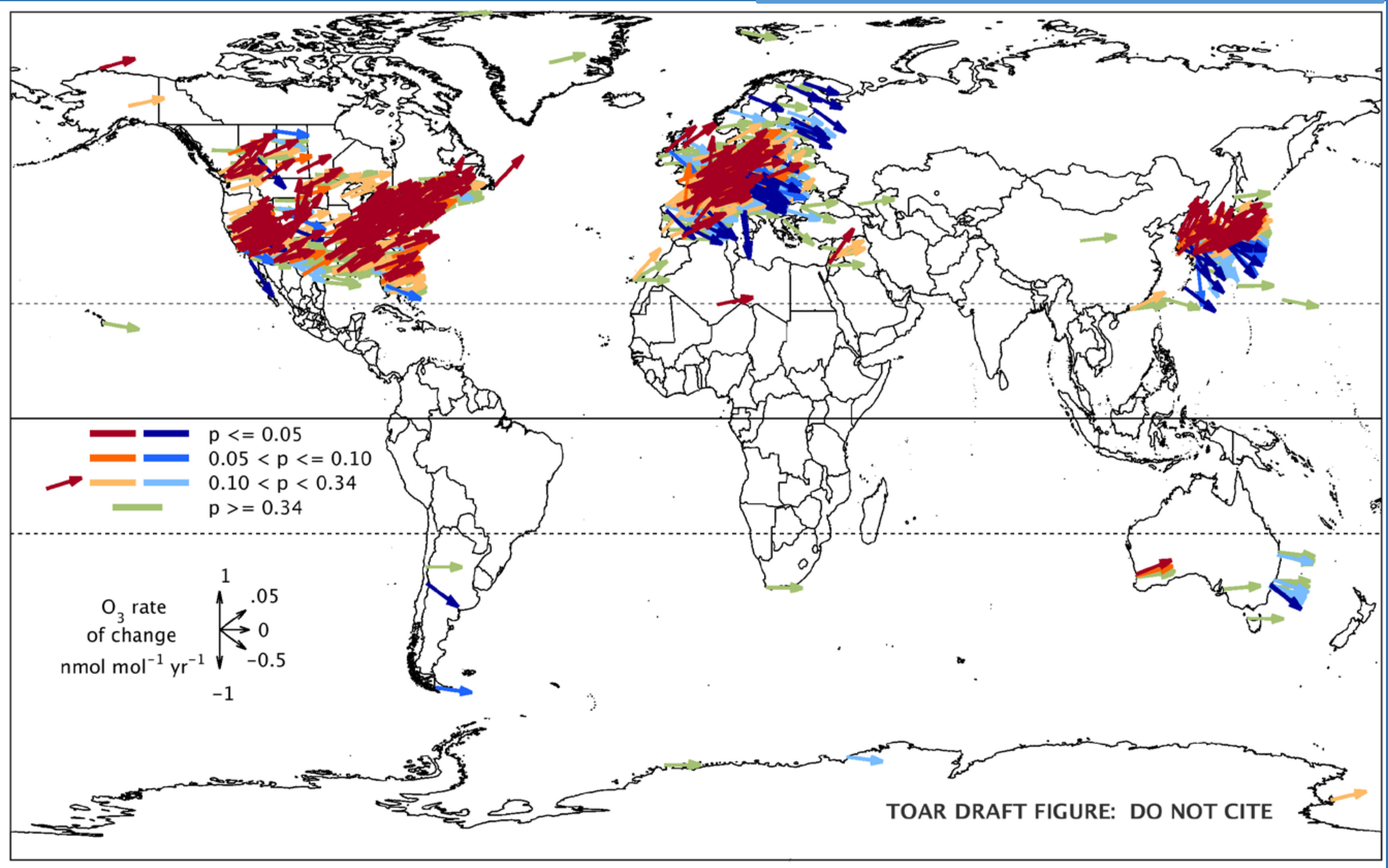
Lidar


FTIR

GMAC May 24, 2017

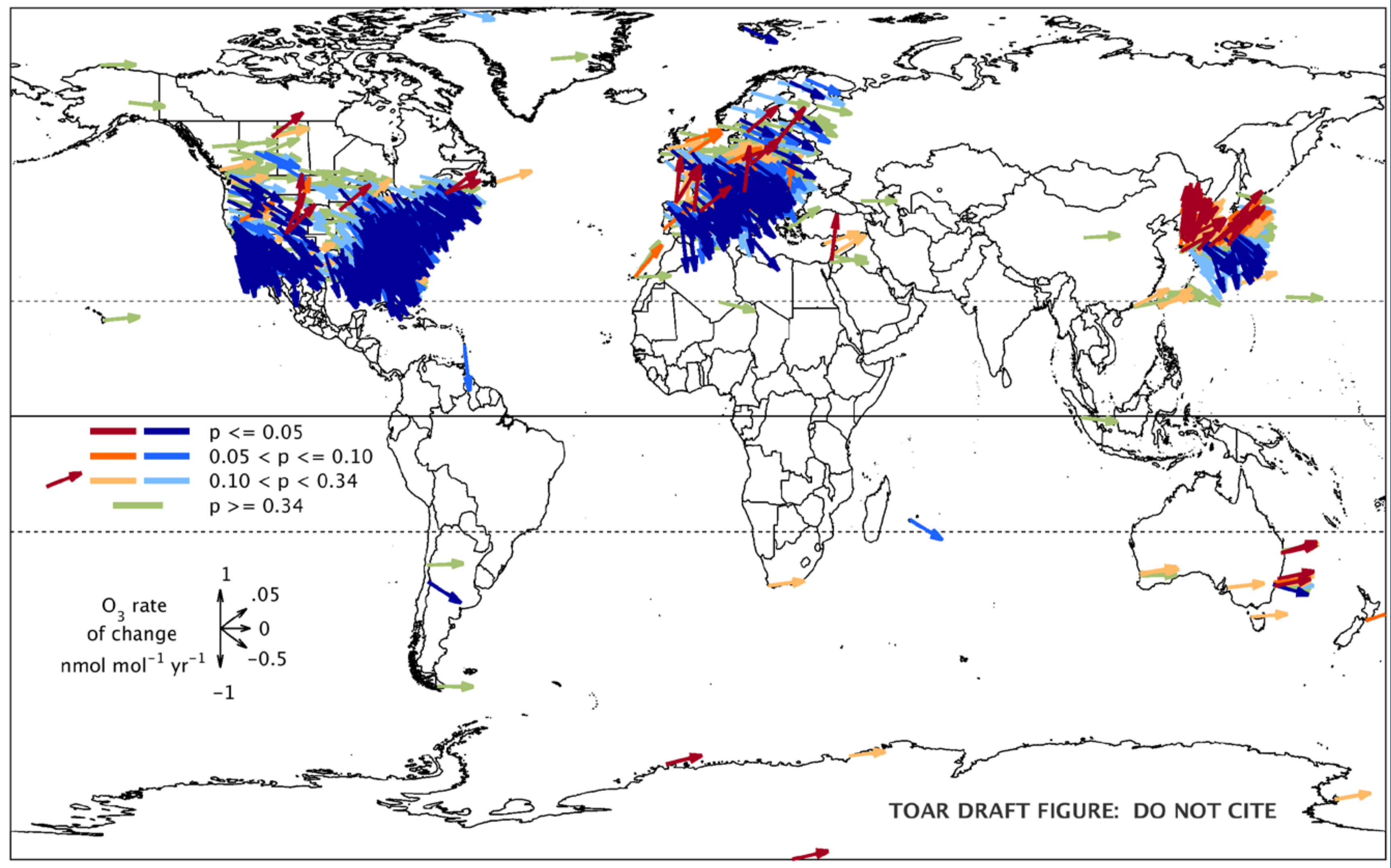
Increase of daytime average ozone (nmol mol^{-1} yr^{-1}) between 2000-2014 in winter of the Northern Hemisphere

1374 non-urban sites in DJF

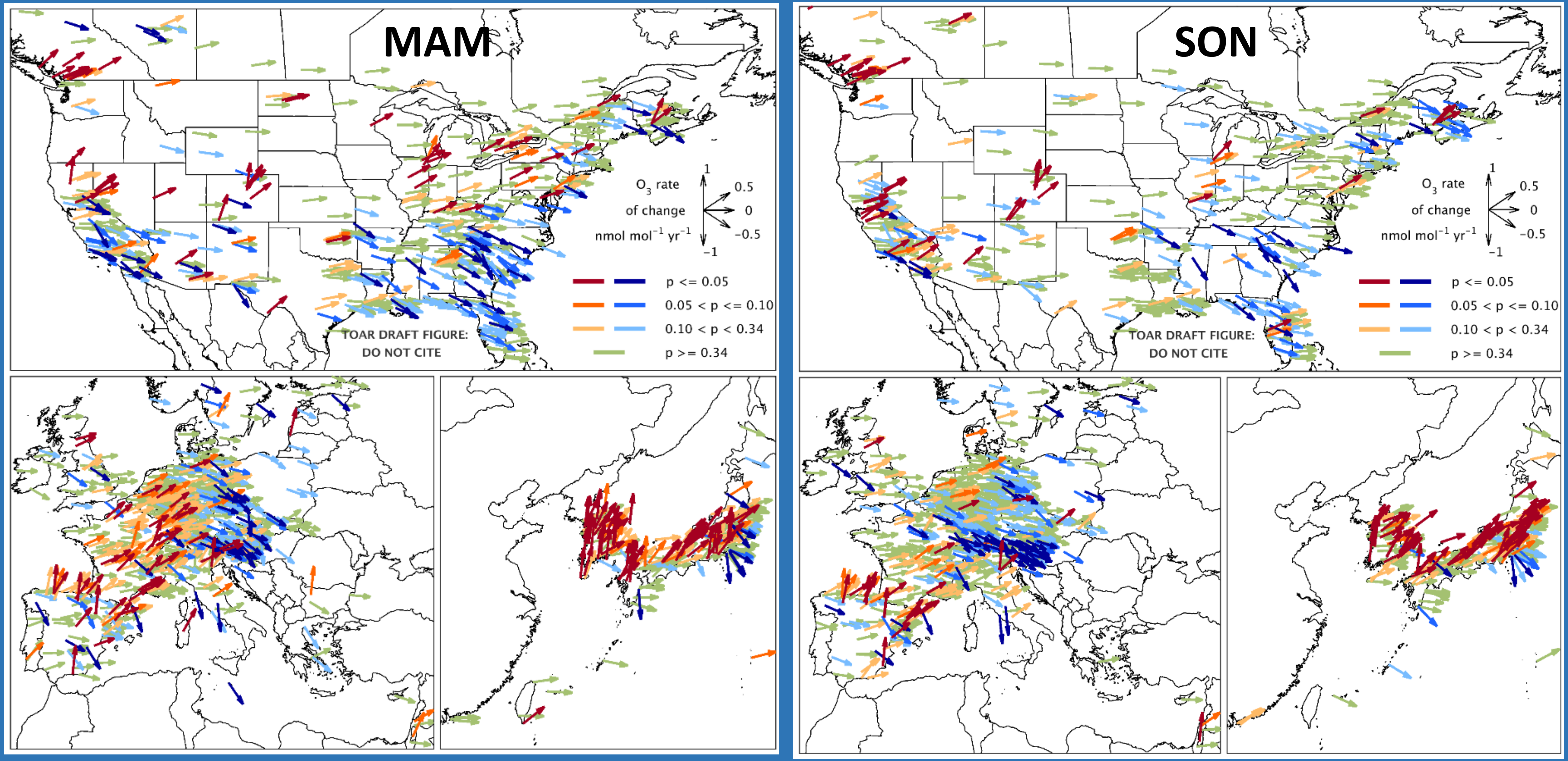


Decrease of daytime average ozone (nmol mol^{-1} yr^{-1}) between 2000-2014 in summer of the Northern Hemisphere

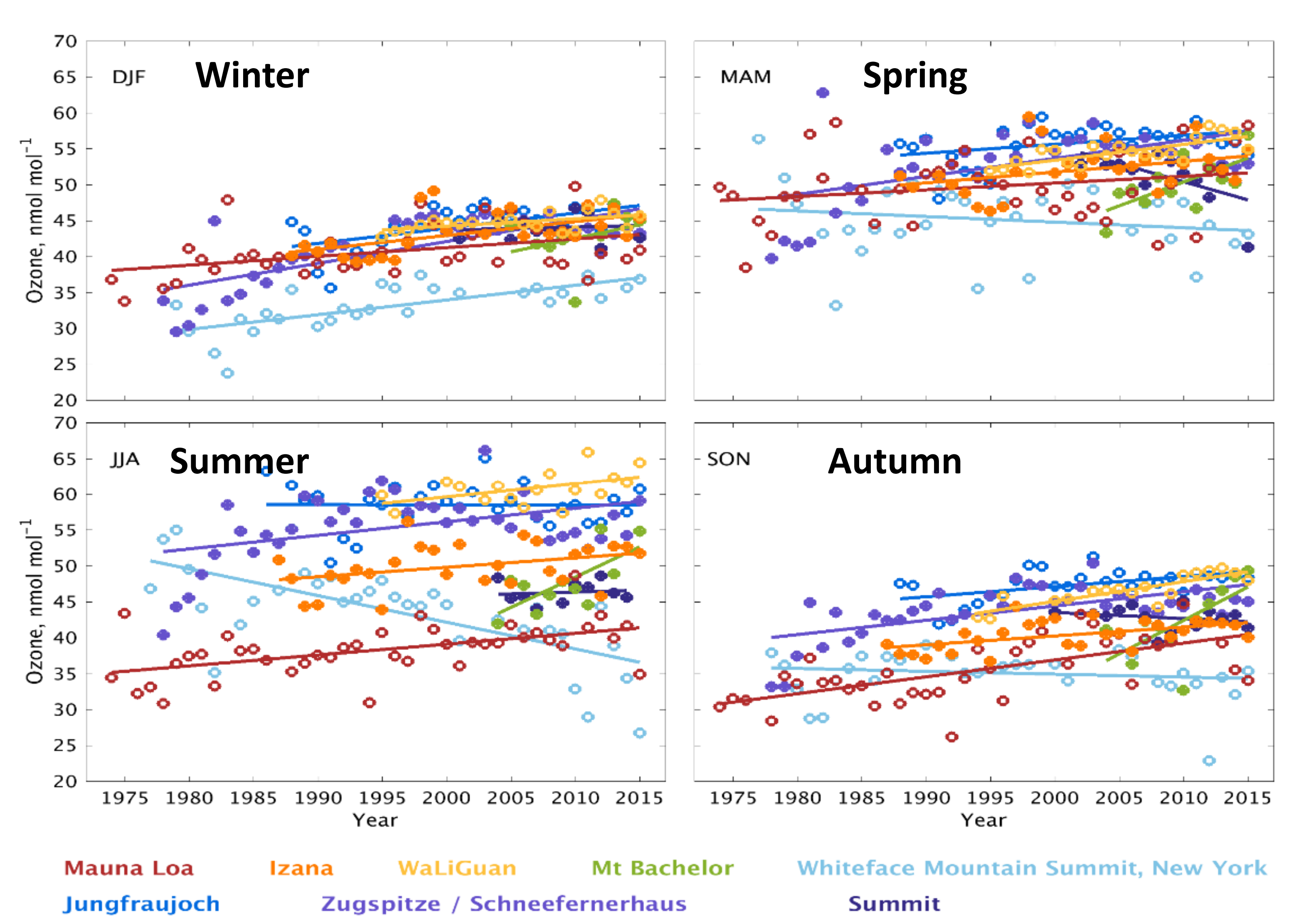
1784 non-urban sites in JJA



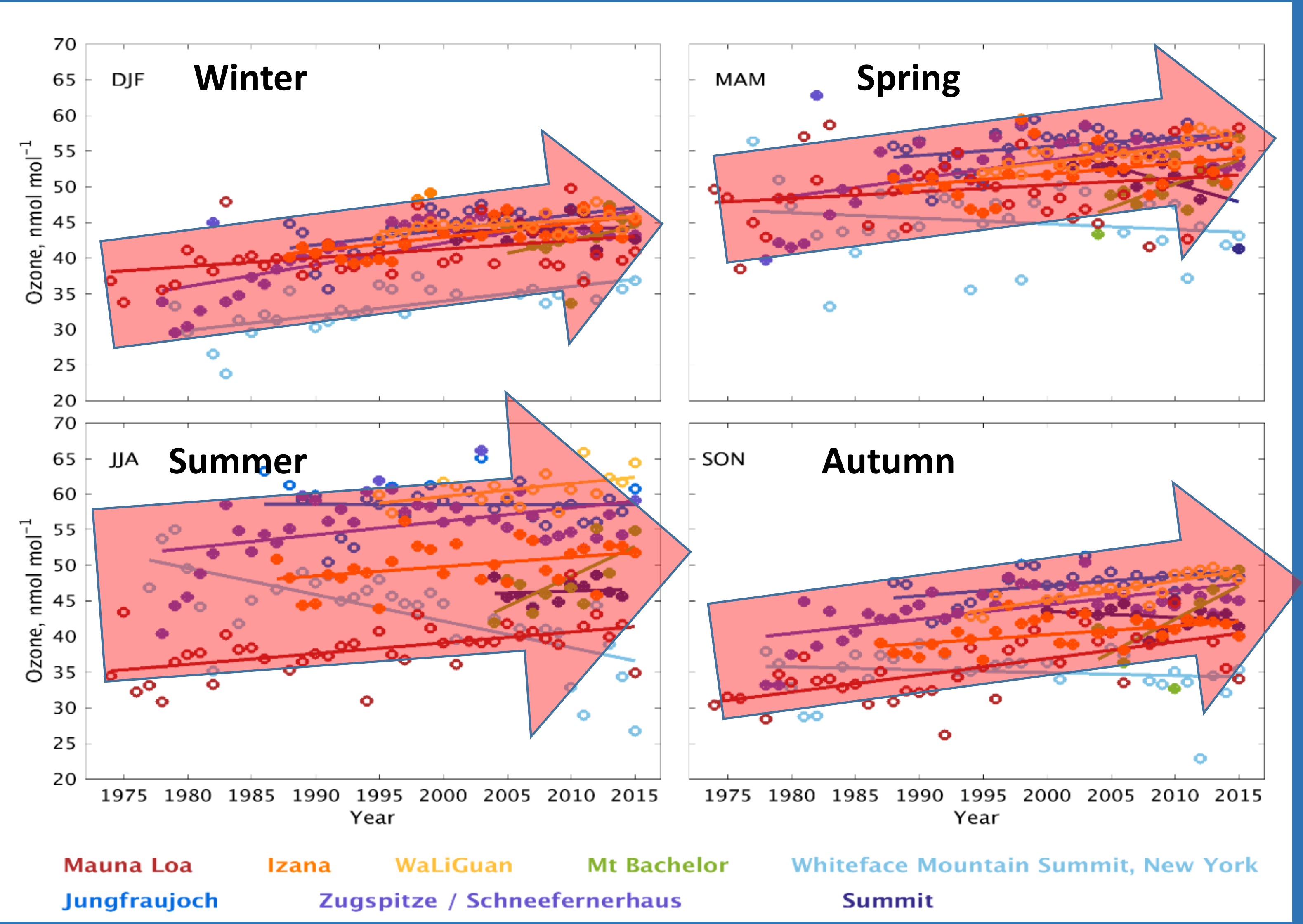
Increase of daytime average ozone (nmol mol^{-1} yr^{-1}) between 2000-2014 all seasons over East Asia



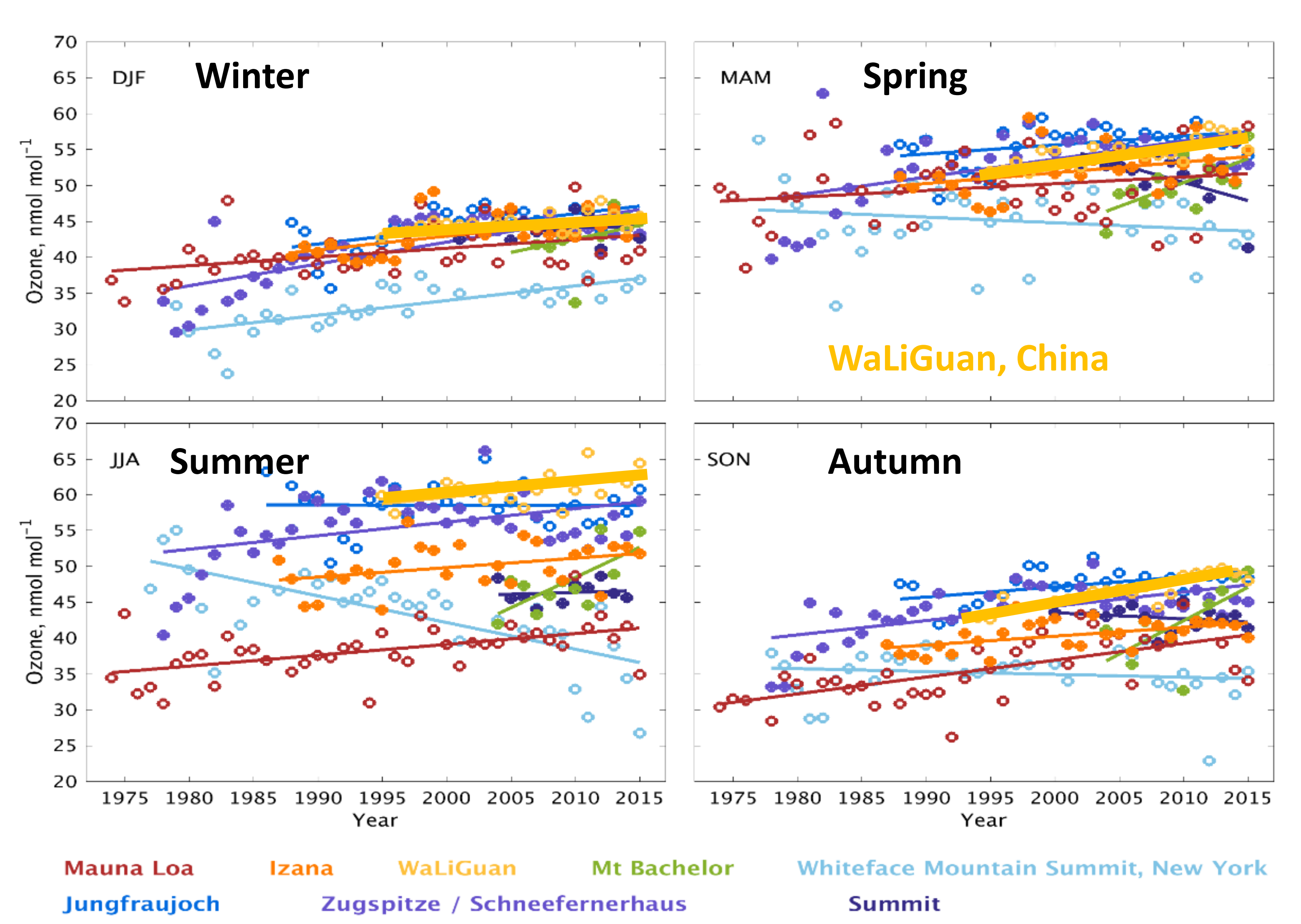
Increase of nighttime ozone at 8 Northern Hemisphere mountaintop sites at all seasons



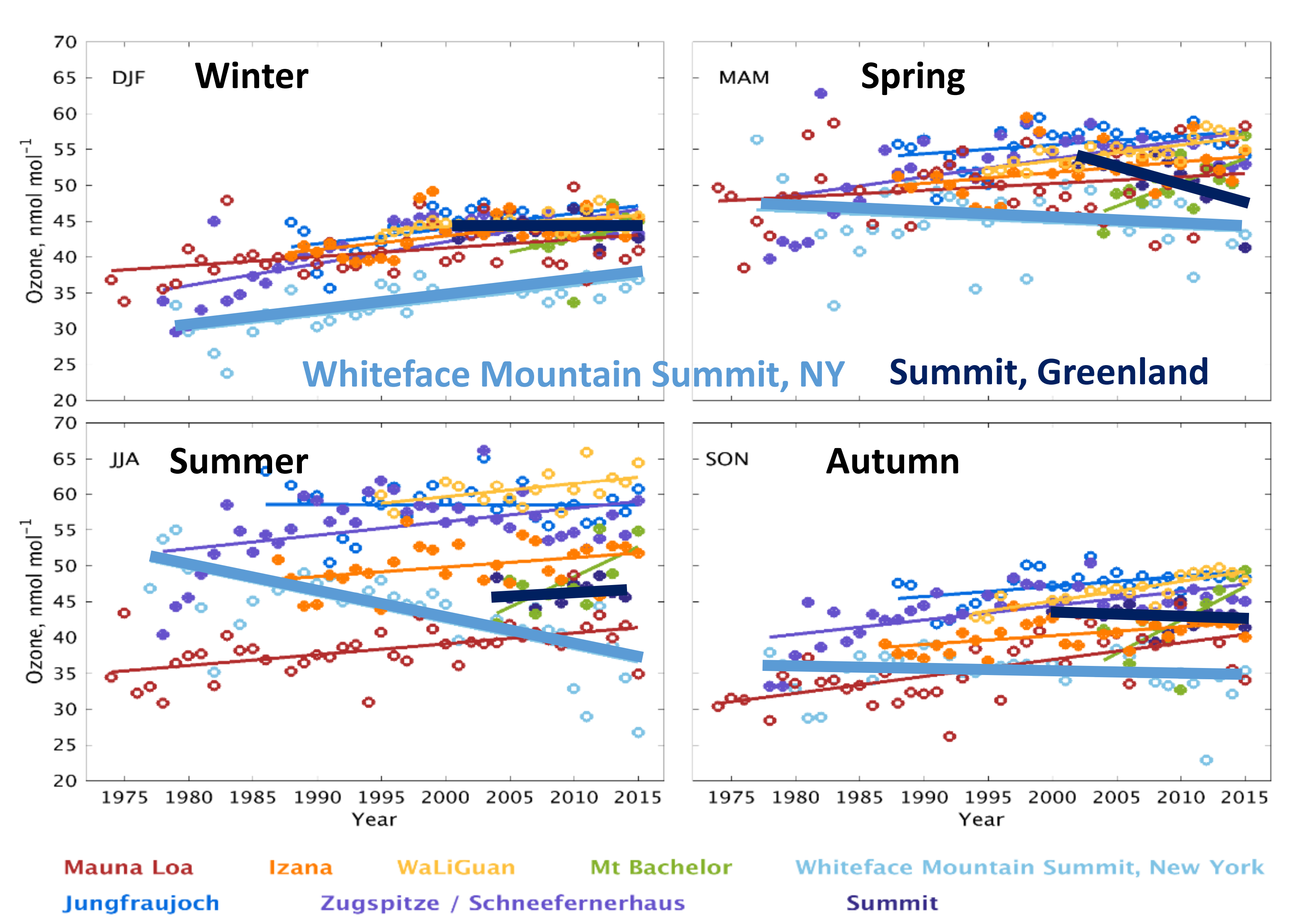
Increase of nighttime ozone at 8 Northern Hemisphere mountaintop sites at all seasons



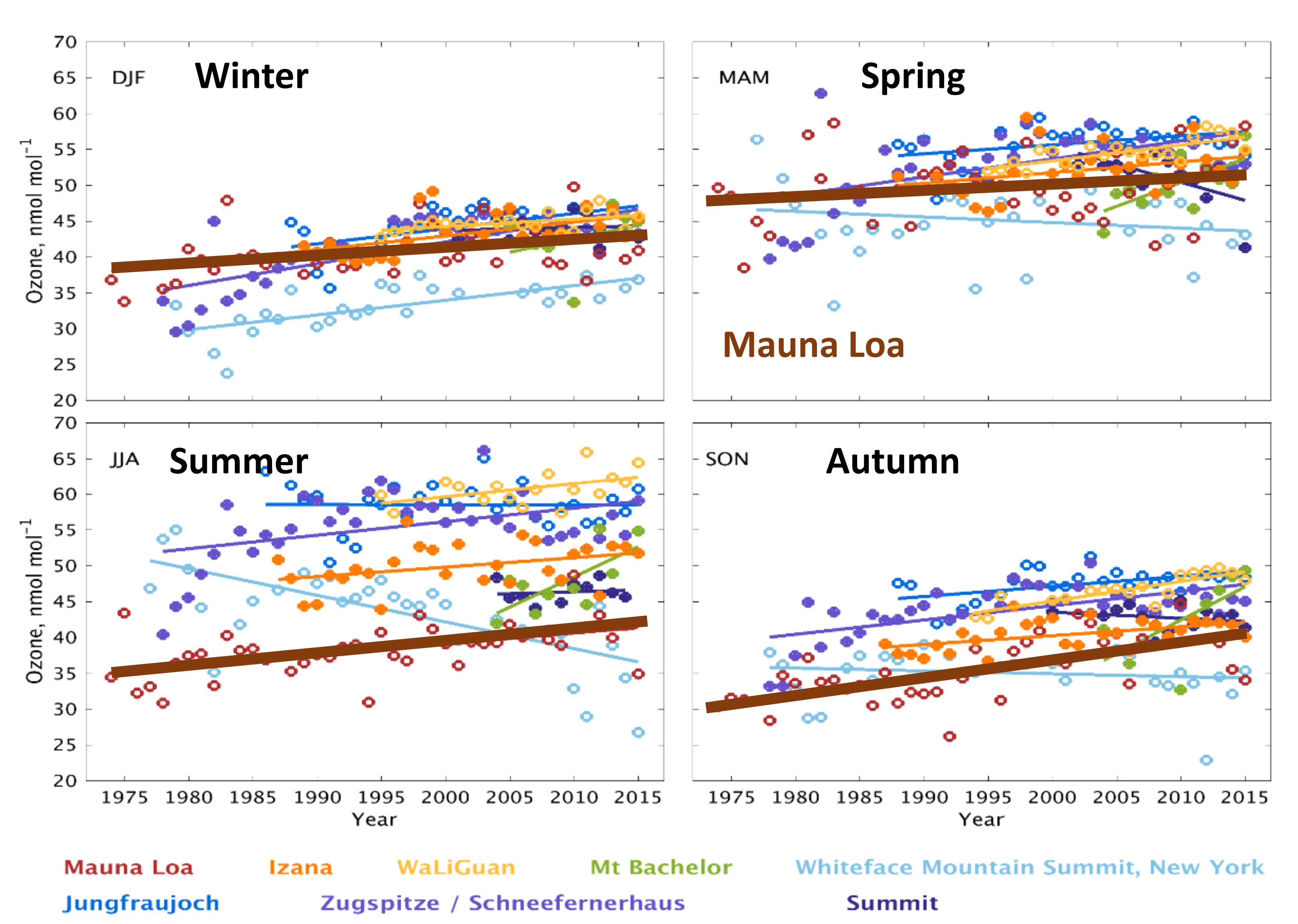
Increase of nighttime ozone at WaLiGuan (China) at all seasons, especially in spring and autumn



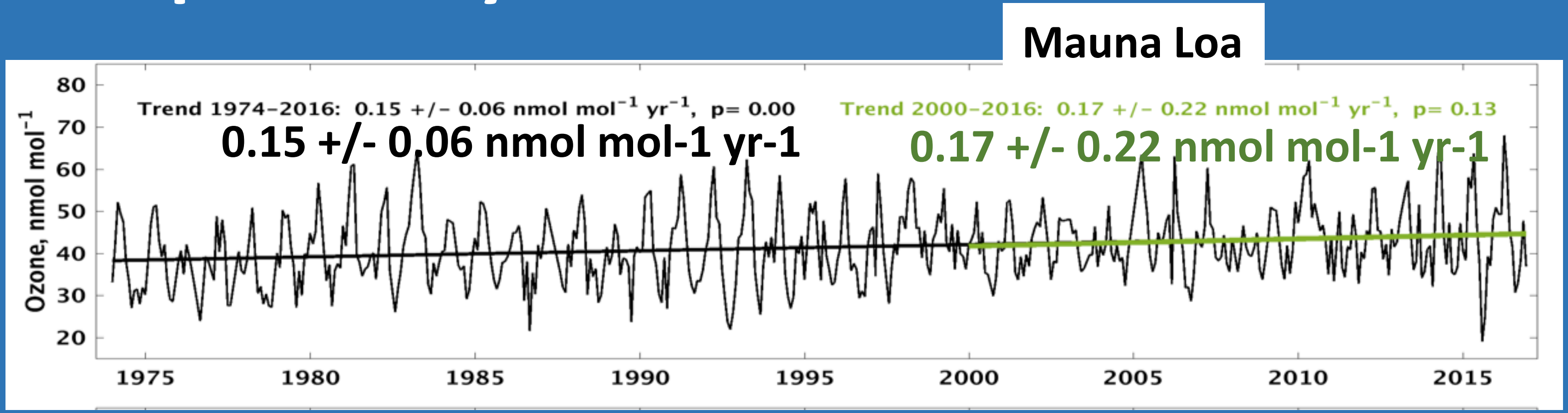
Decrease of nighttime ozone at 2 Northern Hemisphere mountaintop sites in spring, summer and autumn



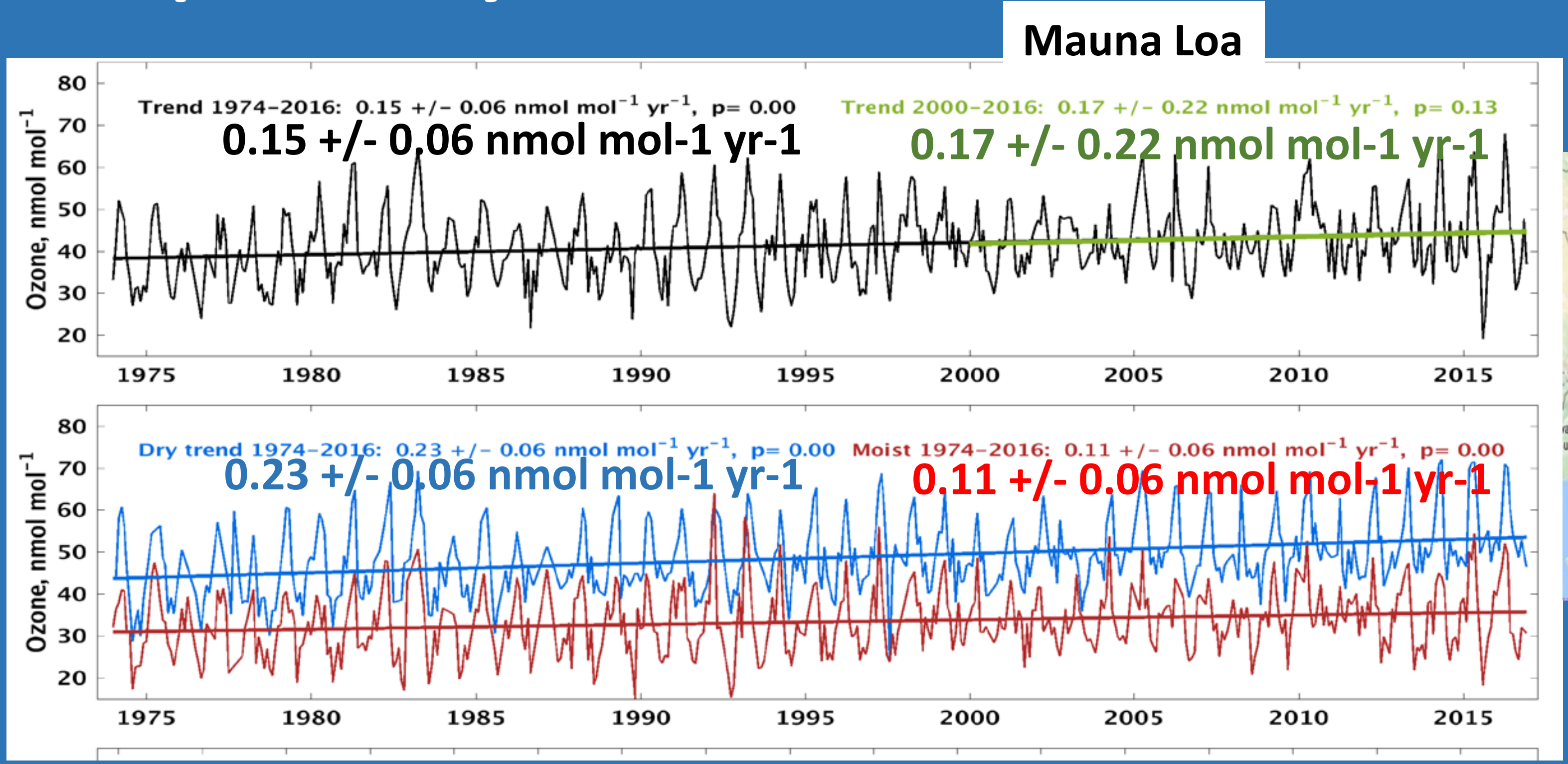
Increase of nighttime ozone for the 4 seasons at Mauna Loa where there is the longest record of ozone starting in 1973

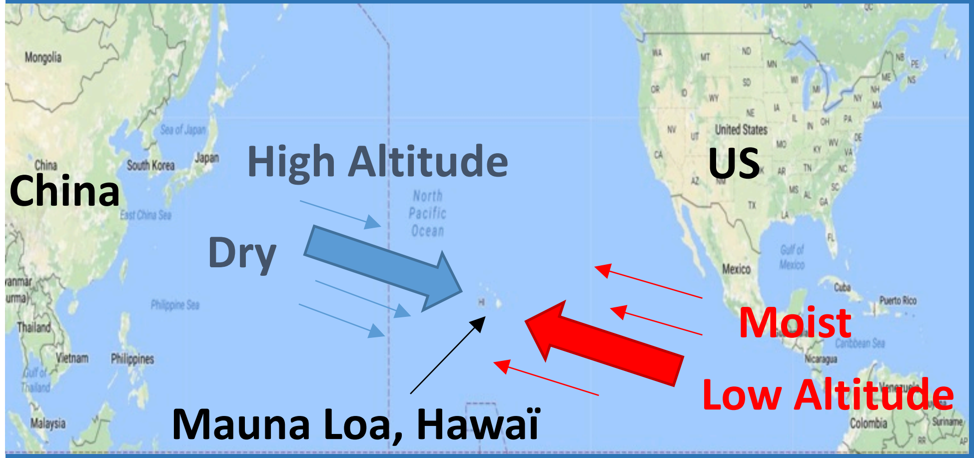


Increase of nighttime ozone at Mauna Loa driven by dry air masses Impacted by emissions from Asia



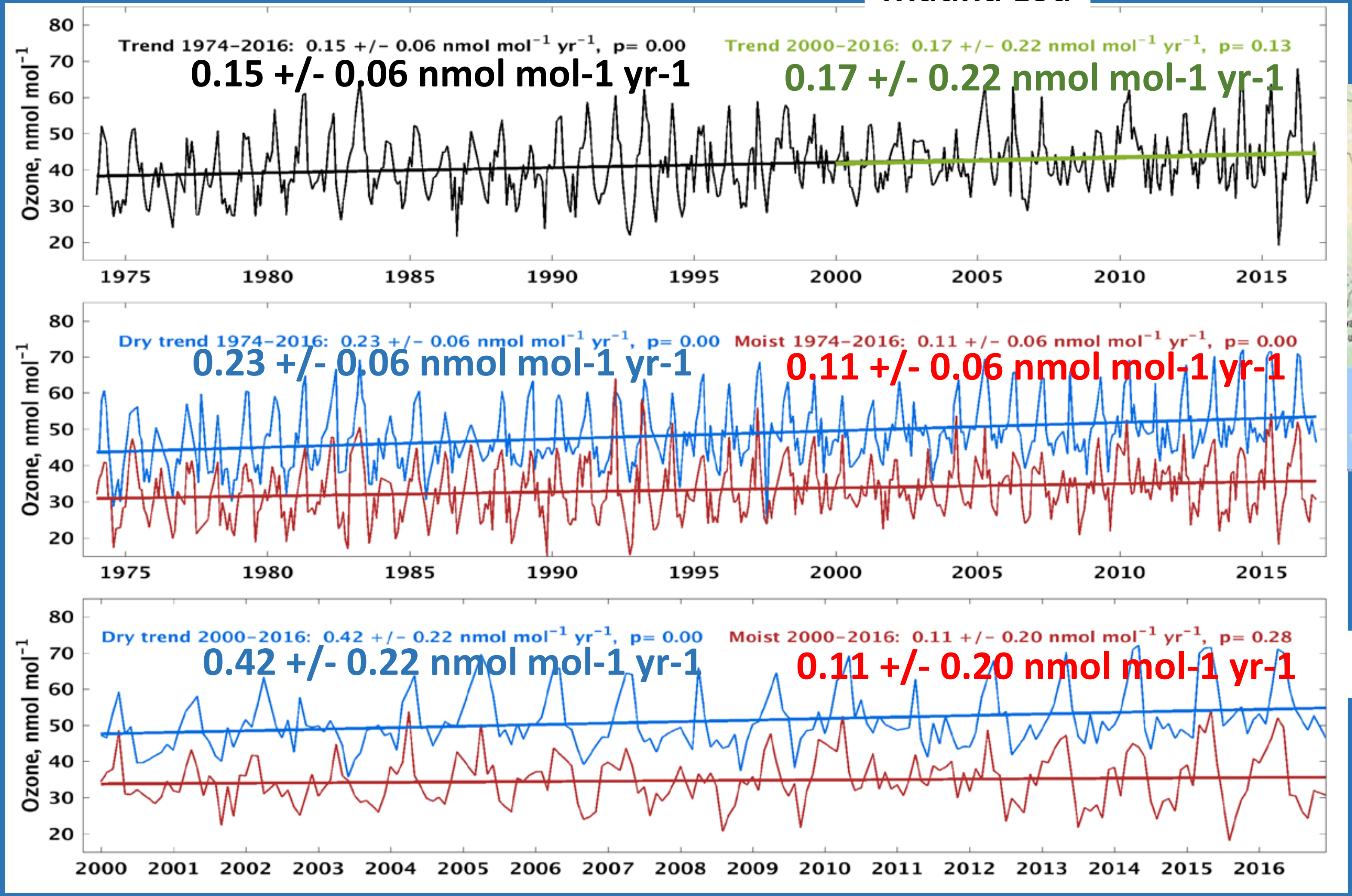
Increase of nighttime ozone at Mauna Loa driven by dry air masses Impacted by emissions from Asia

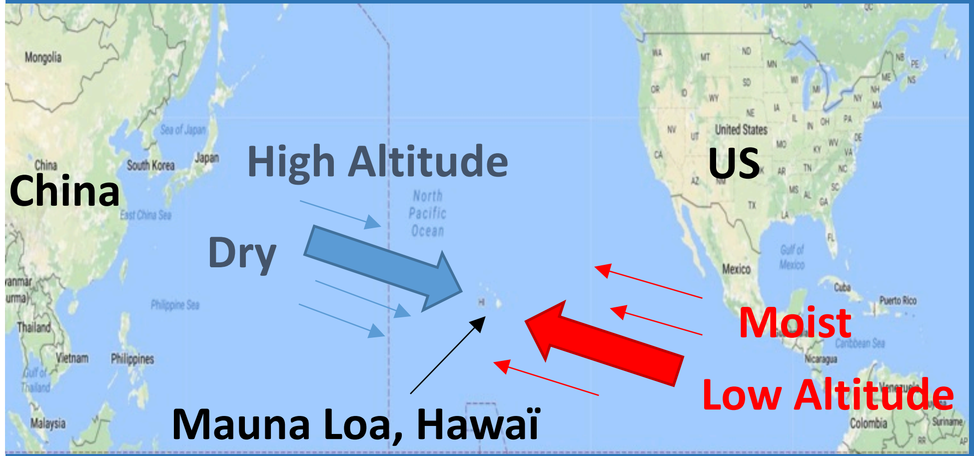




Increase of nighttime ozone at Mauna Loa driven by dry air masses Impacted by emissions from Asia

Mauna Loa

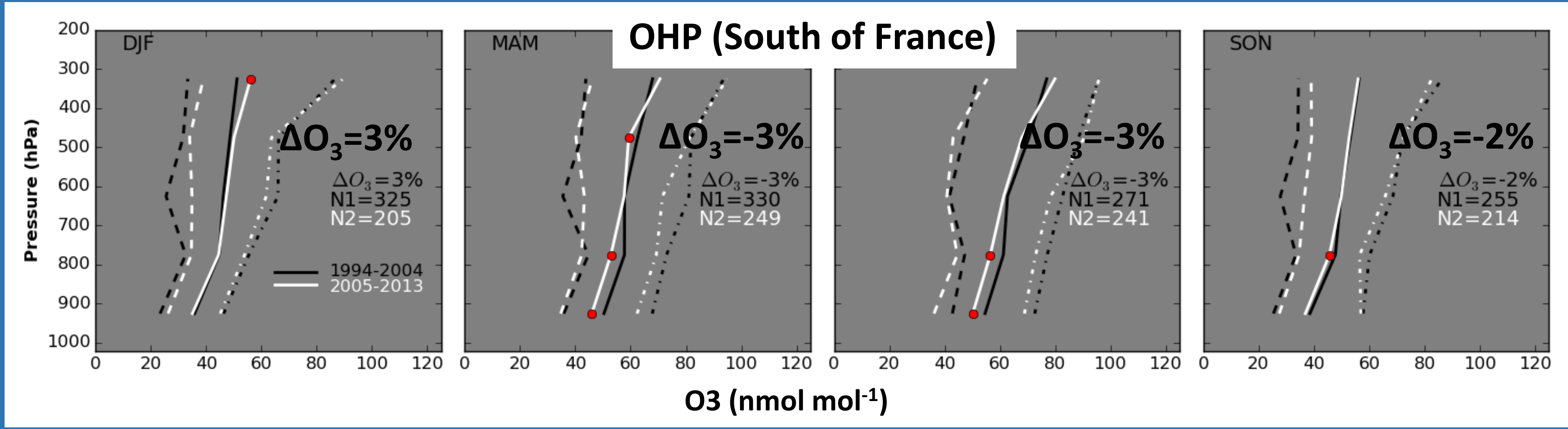


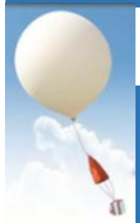


From 2000s

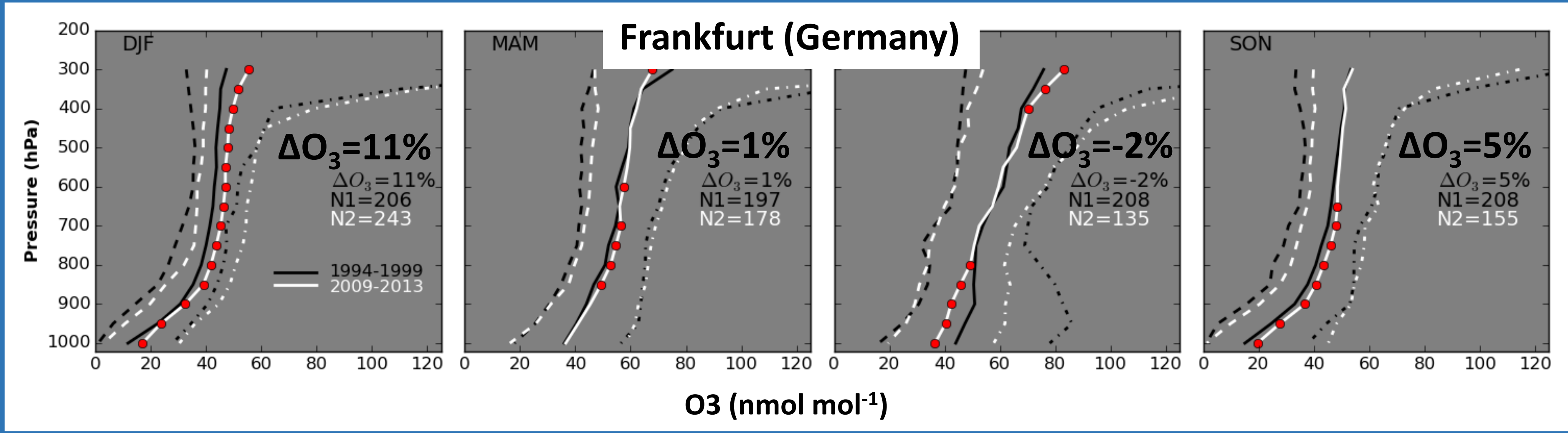
Profiles of ozone over 2 sites in Western Europe: increase in winter and decrease in summer

Winter | Spring | Summer | Autumn





- 1994-2004
- 2005-2013

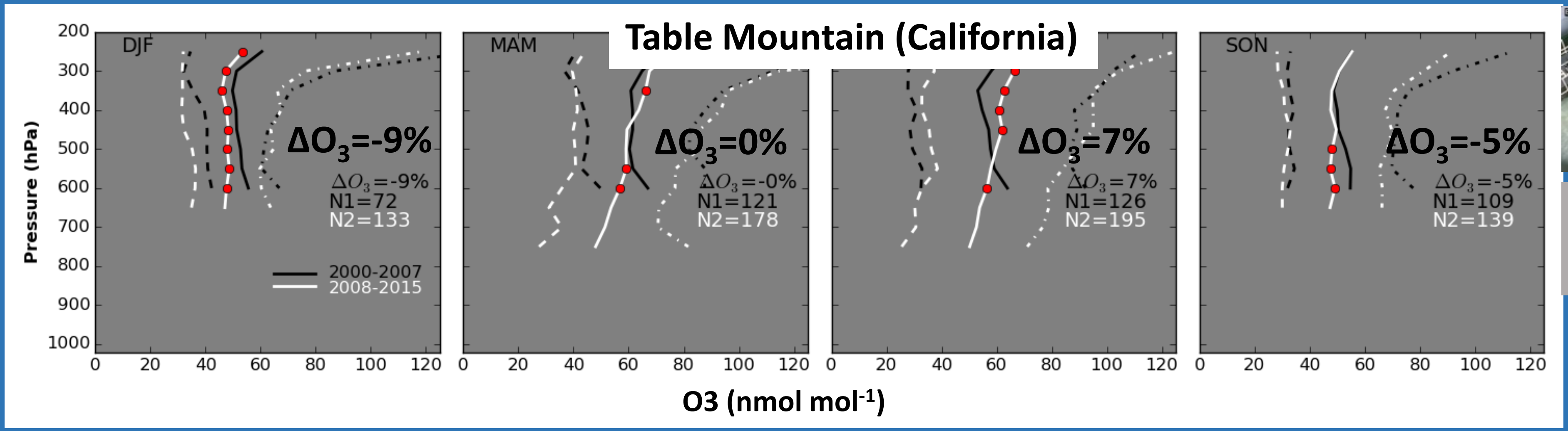


- 1994-1999
- 2009-2013

Commercial Aircraft IAGOS

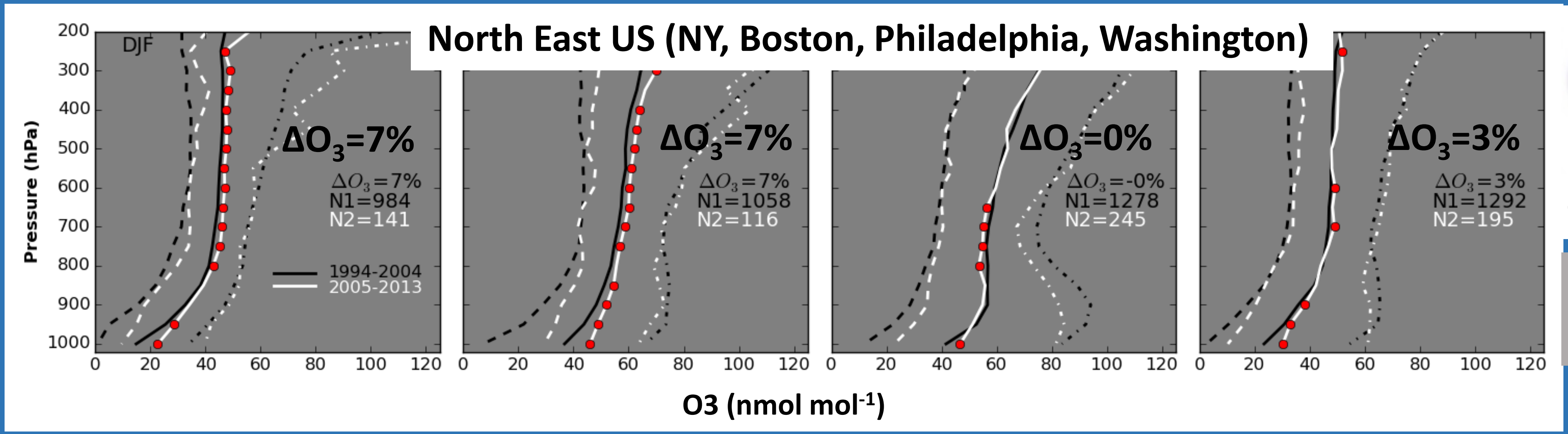
Profiles of ozone over 2 sites in US: increase in winter and decrease in summer for Eastern US, decrease in winter and increase in summer for Western US

Winter Spring Summer Autumn



Lidar

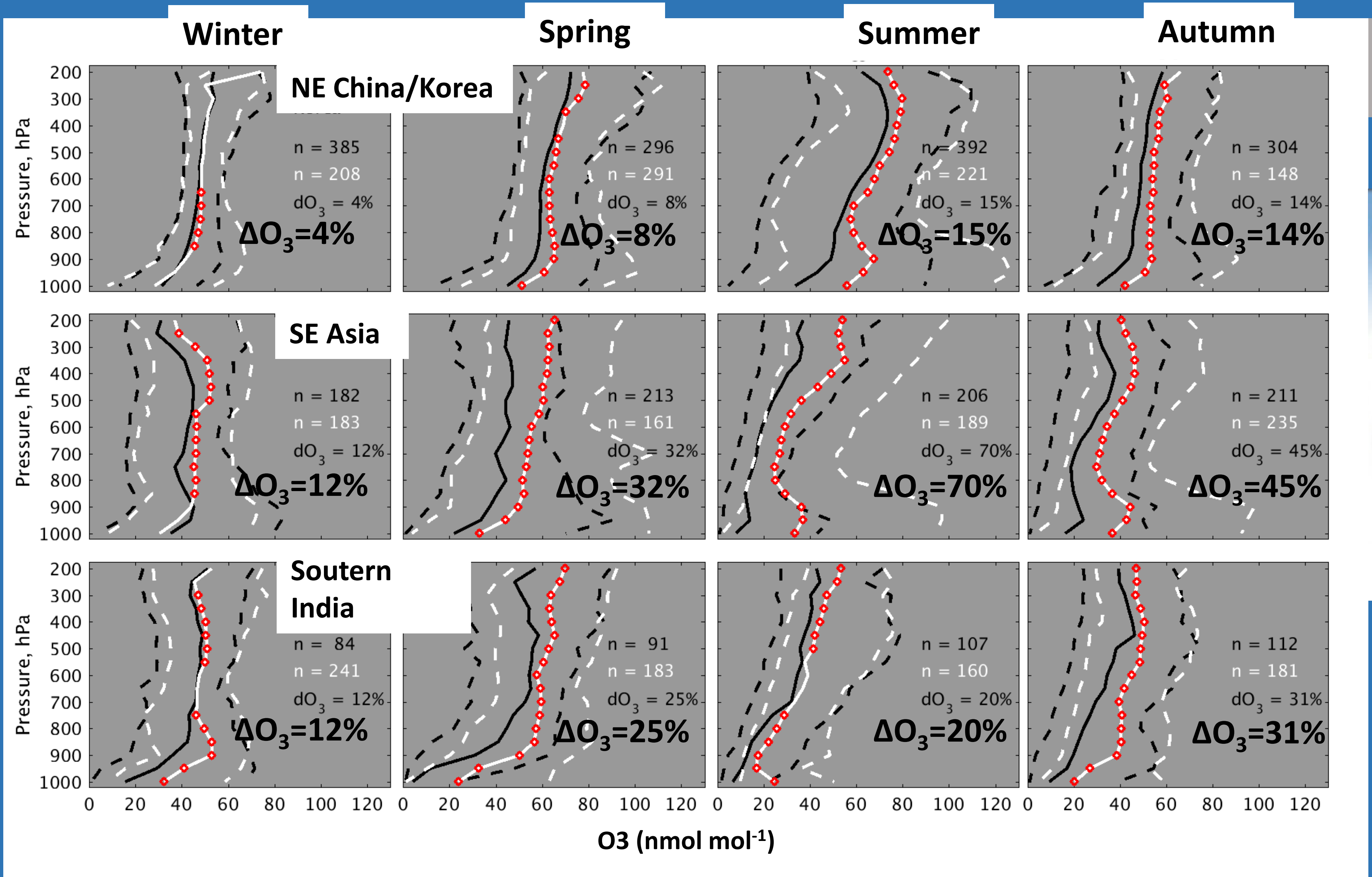
- 2000-2007
- 2008-2015



Commercial Aircraft IAGOS

- 1994-2004
- 2005-2013

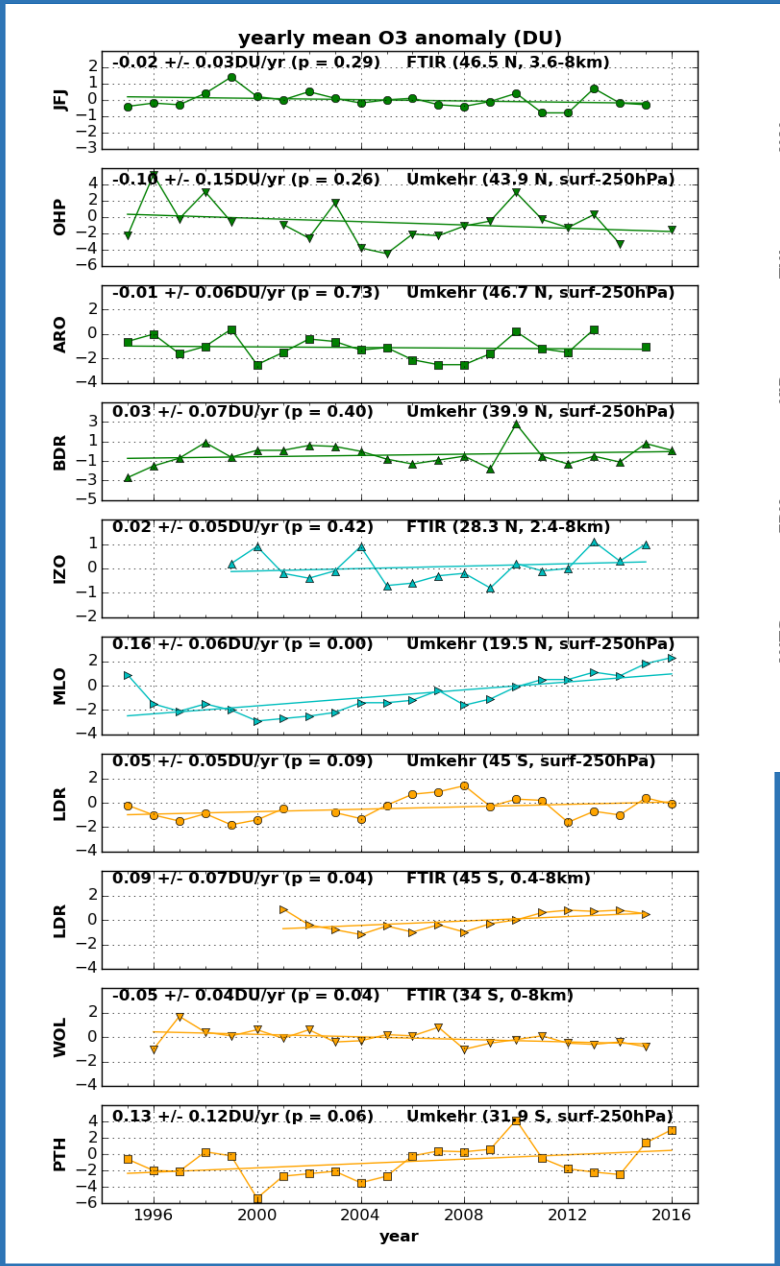
Profiles of ozone over 3 regions in Asia: increase for all seasons and regions

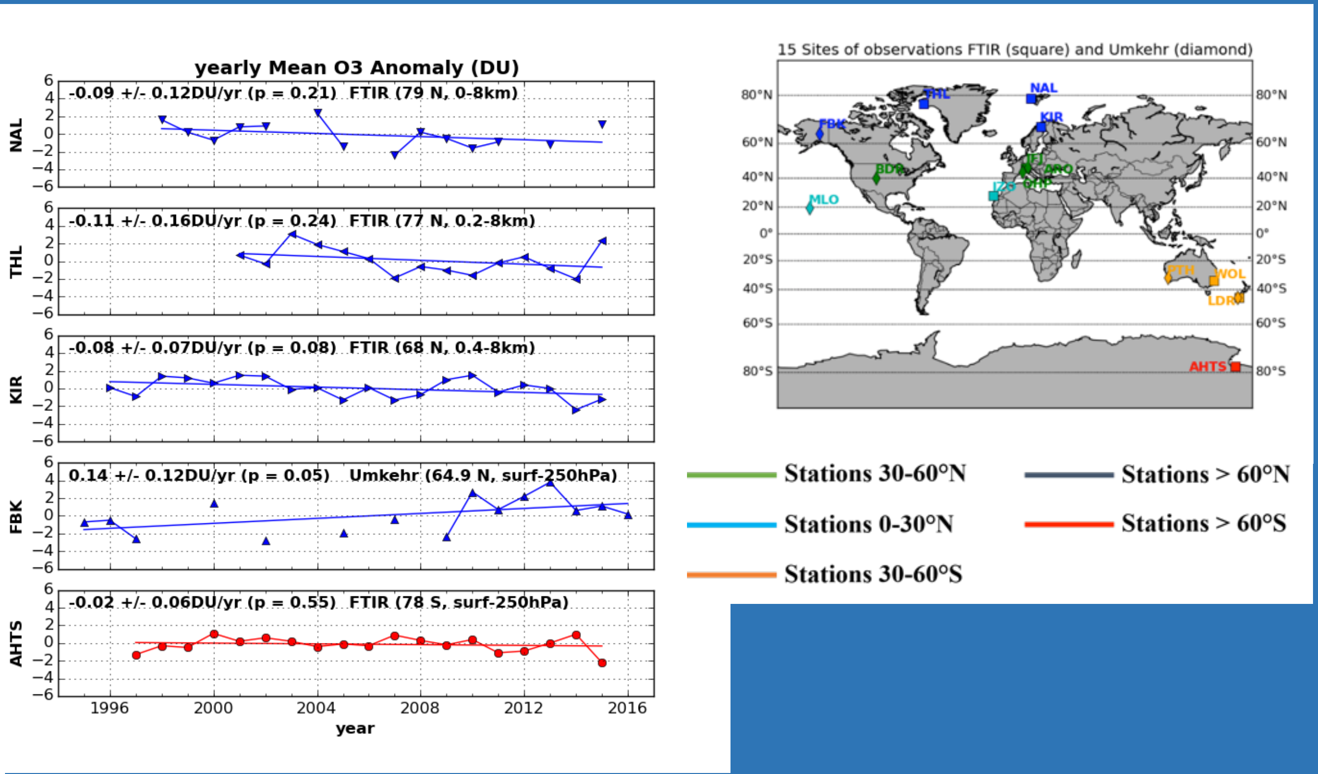


- 1994-2004
- 2005-2014

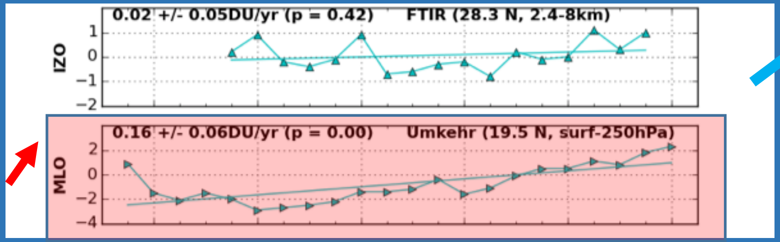
Sondes

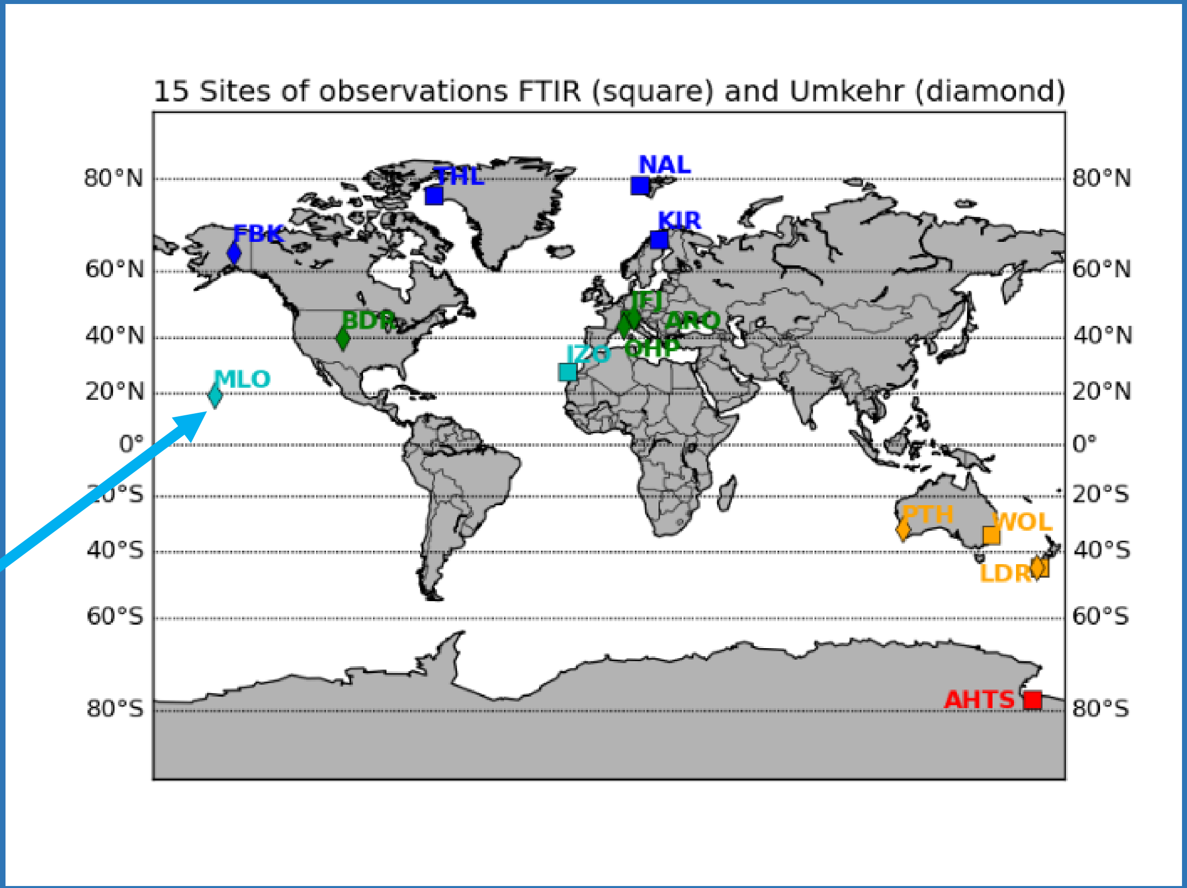
Commercial Aircraft IAGOS



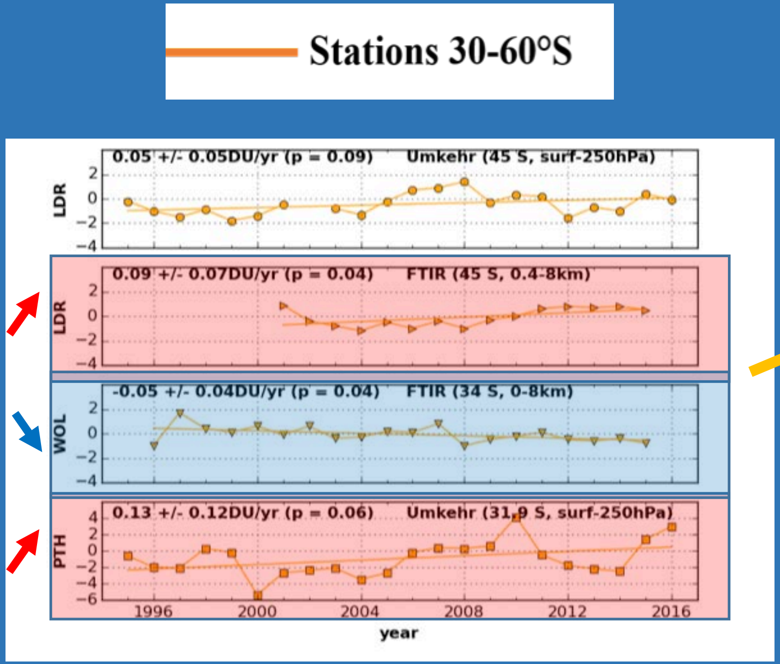


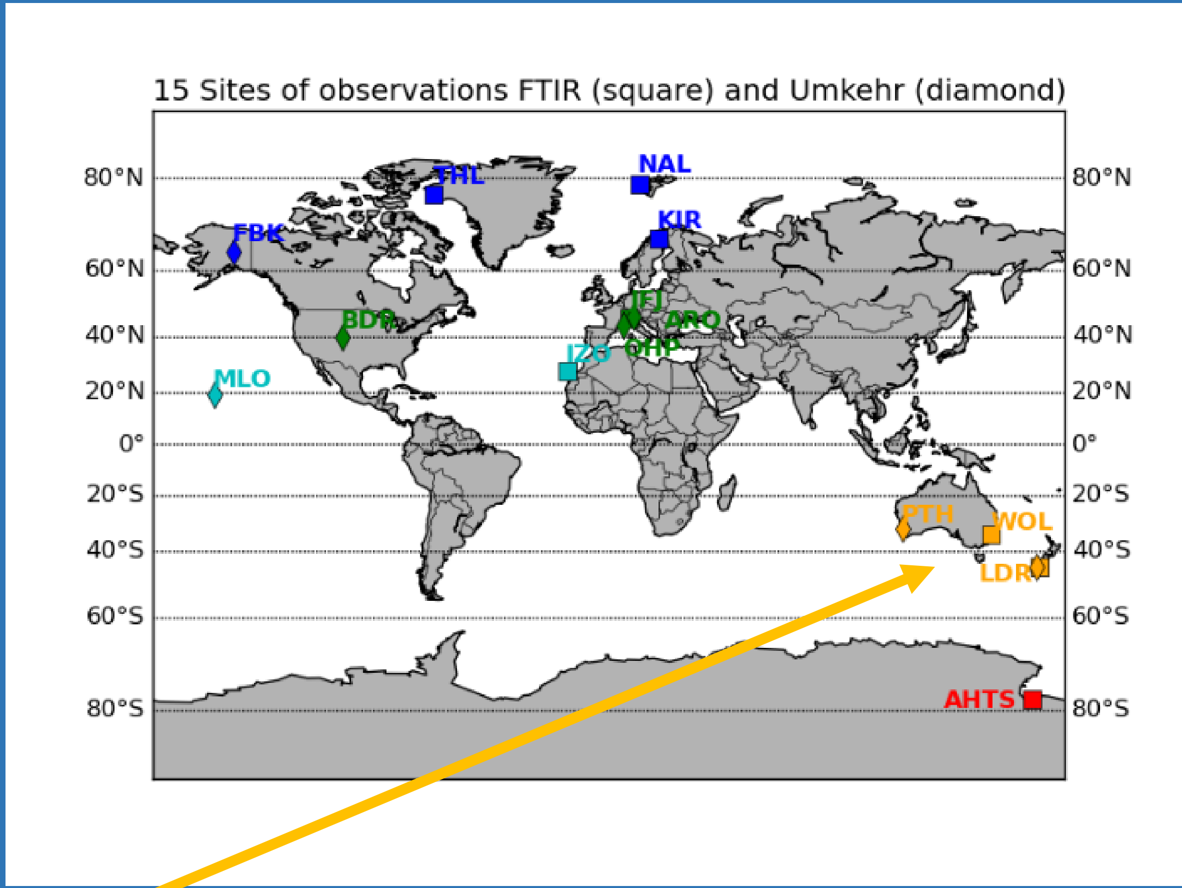
Time series of tropospheric column ozone (TCO) from the ground



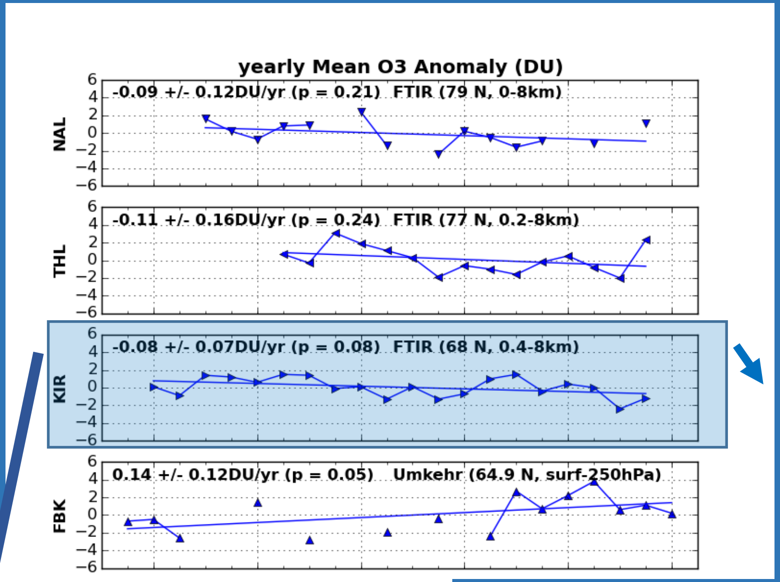


Increase of tropospheric column ozone (TCO) over Mauna Loa

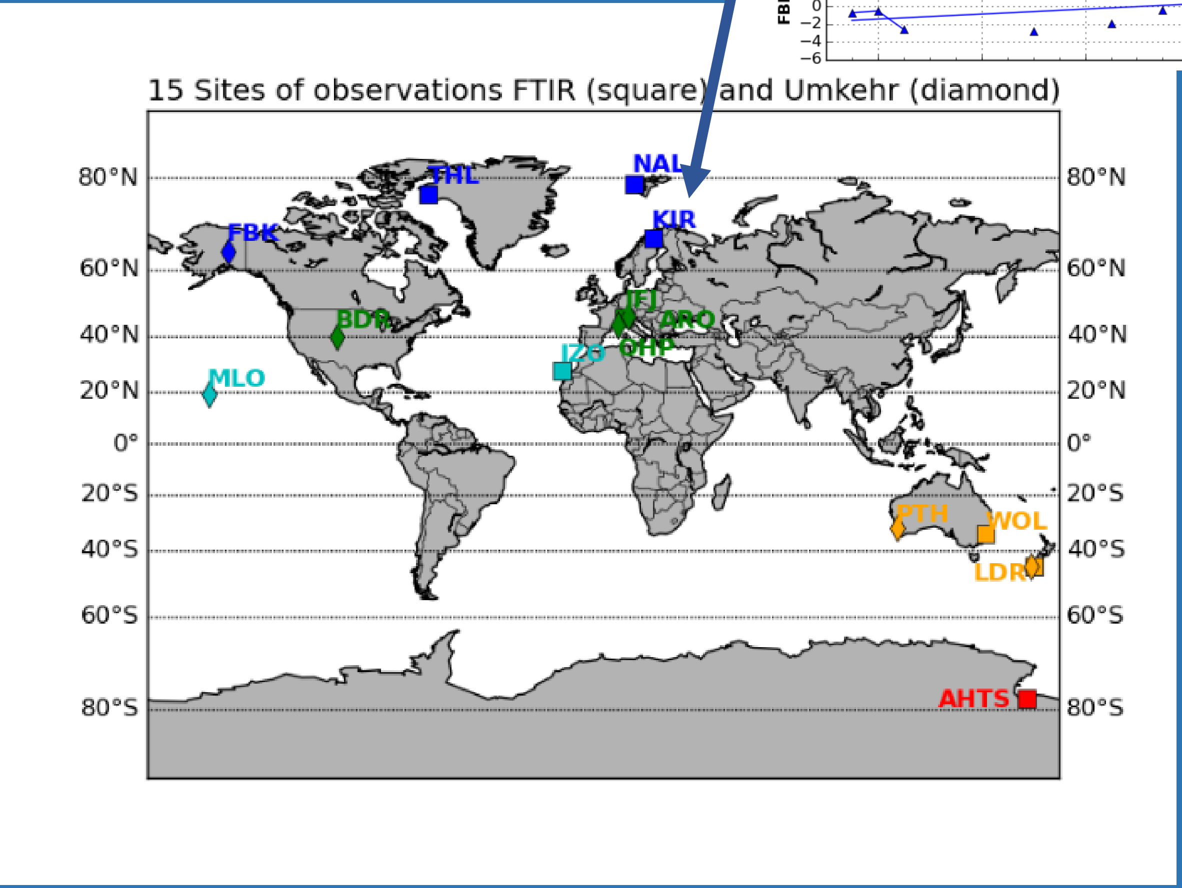




Increase of tropospheric column ozone (TCO) over Lauder and Perth
Decrease of TCO over Wollongong



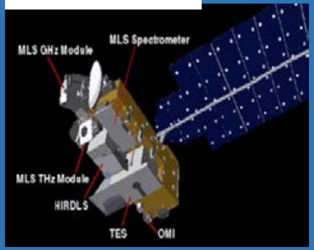
Stations > 60°N

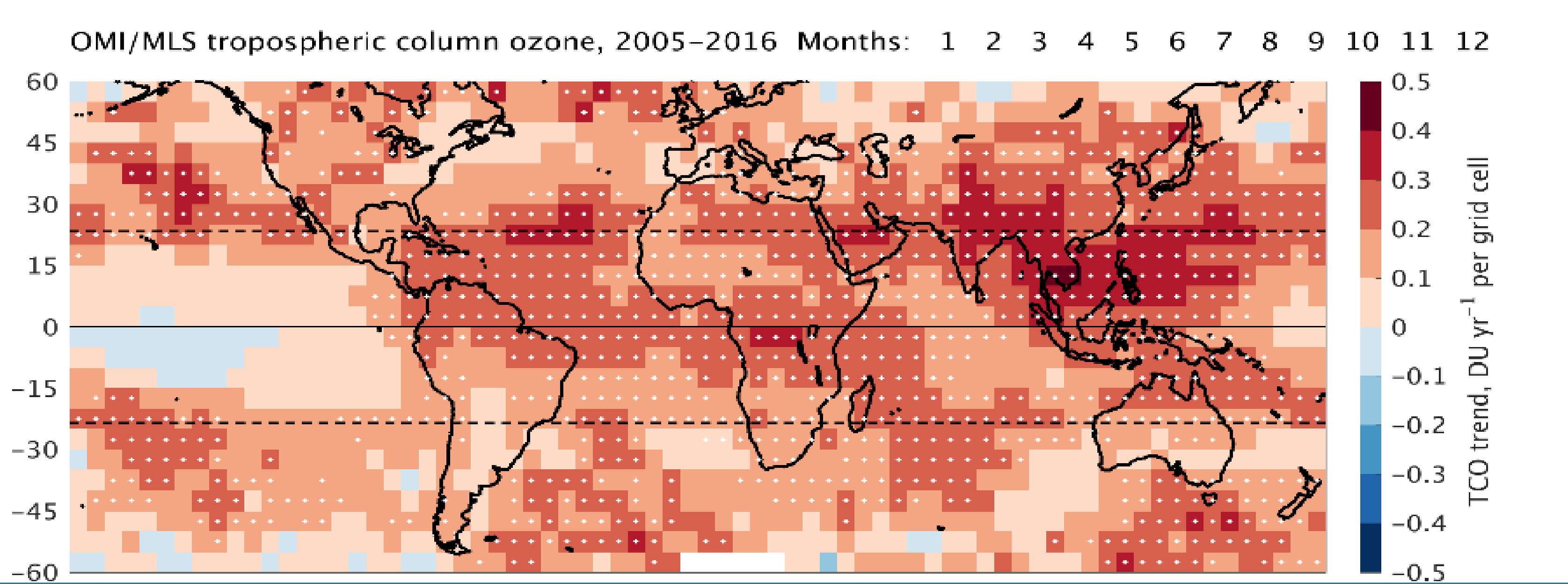


Decrease of tropospheric column ozone (TCO) over Kiruna (Sweden)

Global tropospheric column ozone (TCO) using Satellite data

Satellite

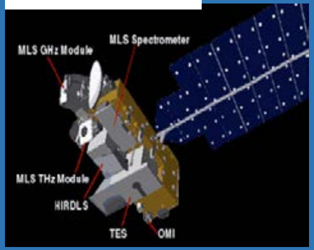


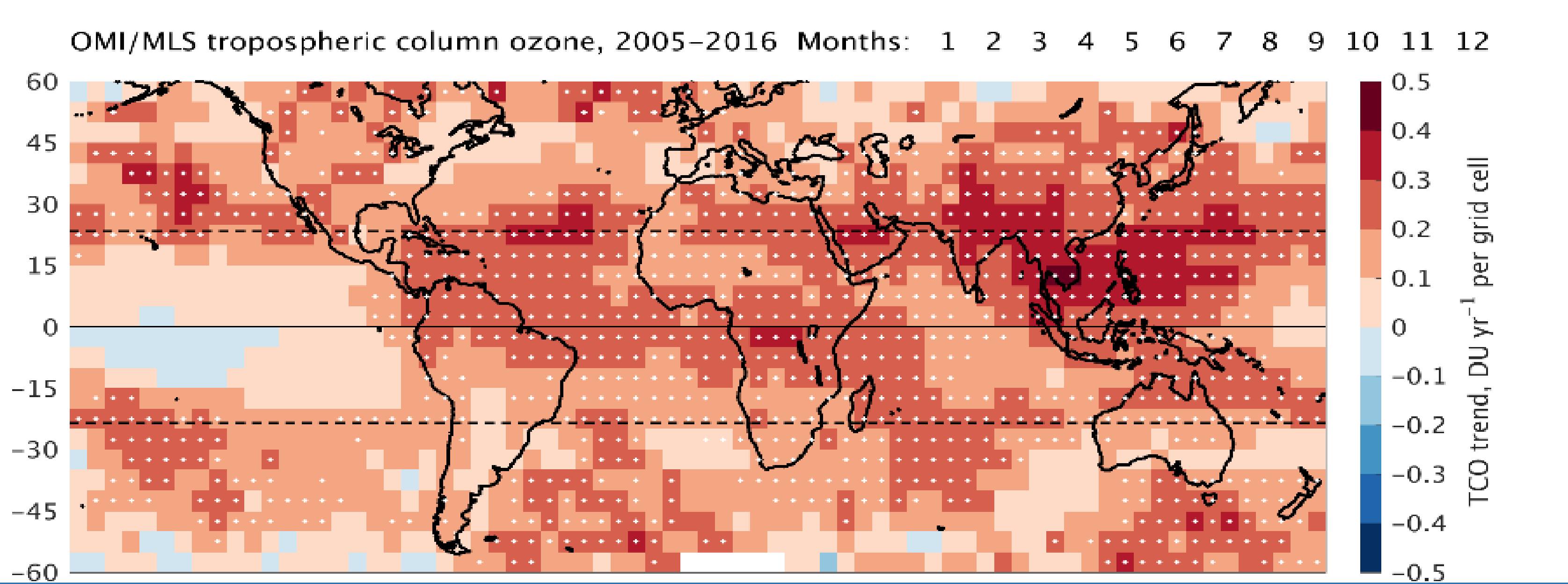


UV-vis

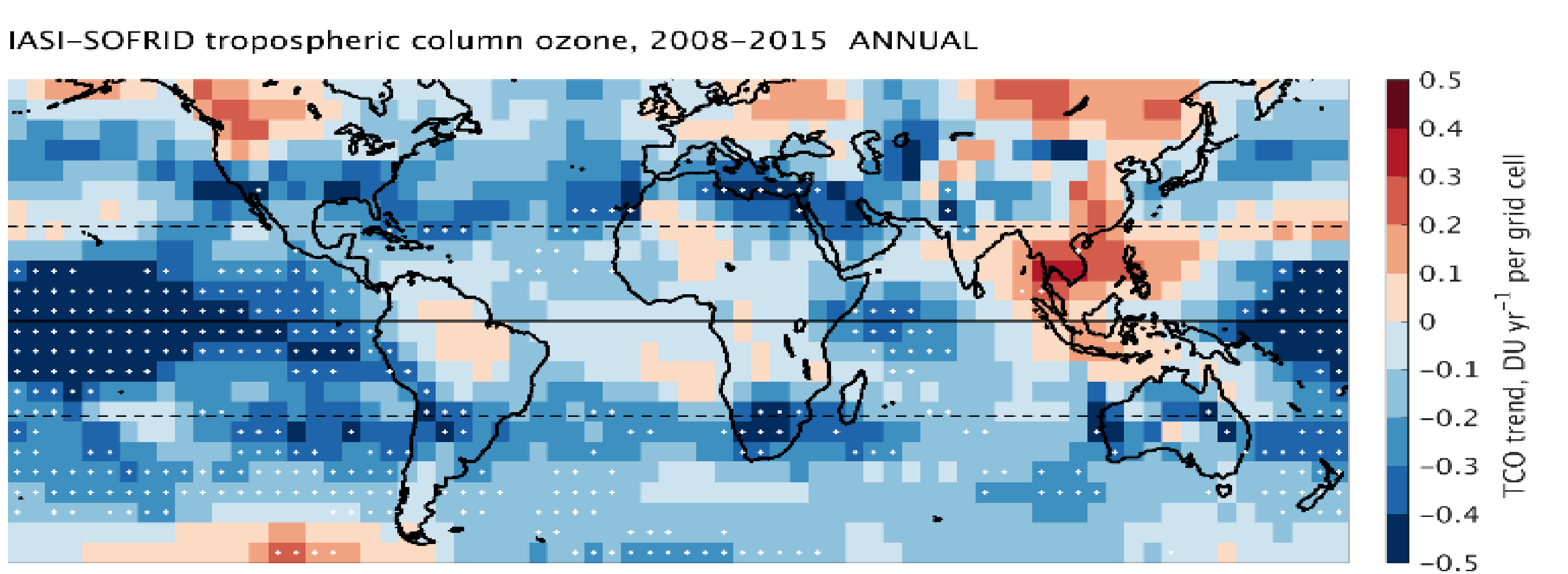
Global tropospheric column ozone (TCO) using Satellite data: discrepancies

Satellite





UV-vis

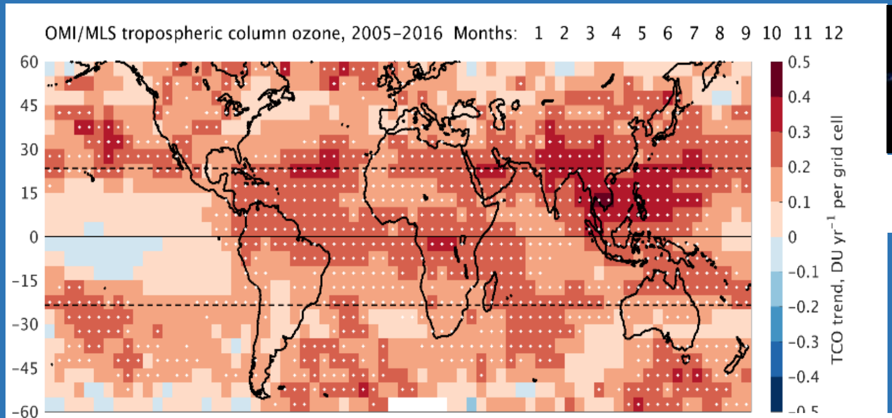


IR

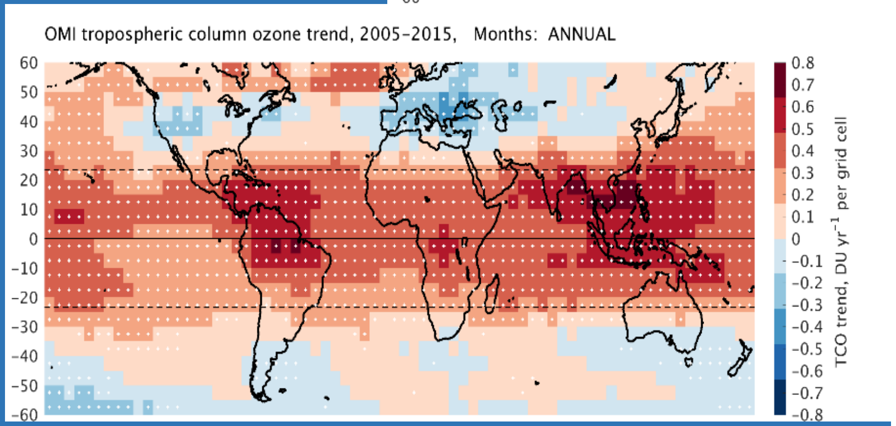
Global tropospheric column ozone (TCO) using Satellite data: discrepancies

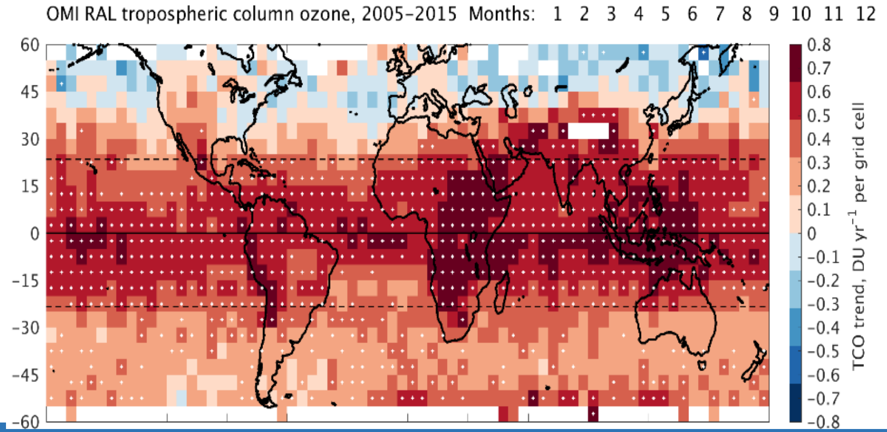
Satellite

3 retrievals from OMI

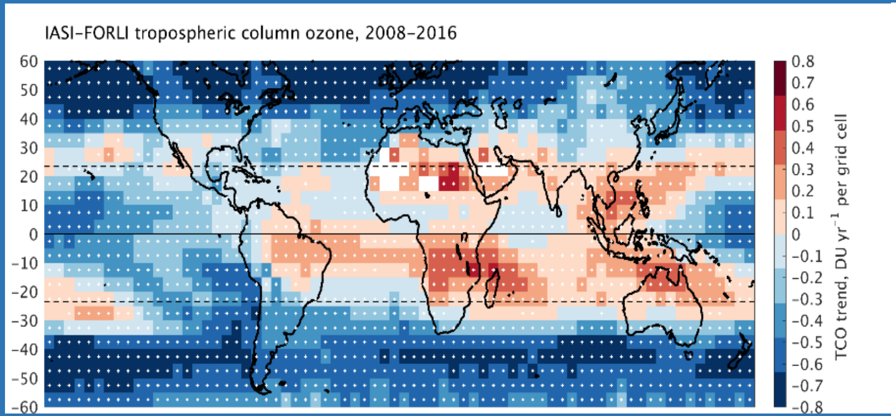


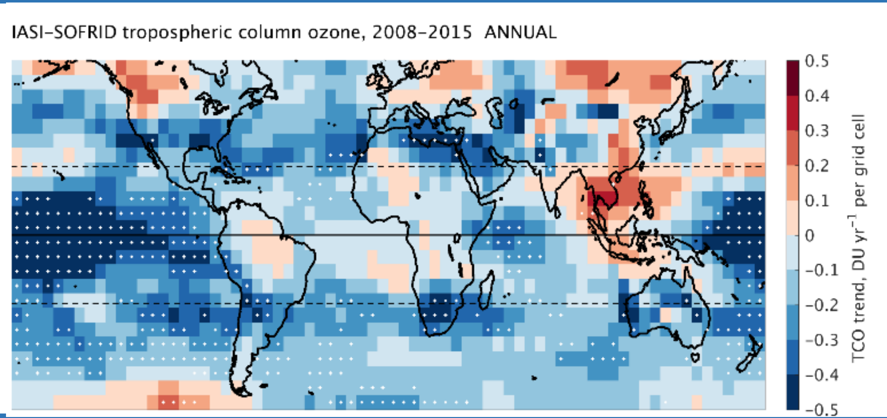
UV-vis





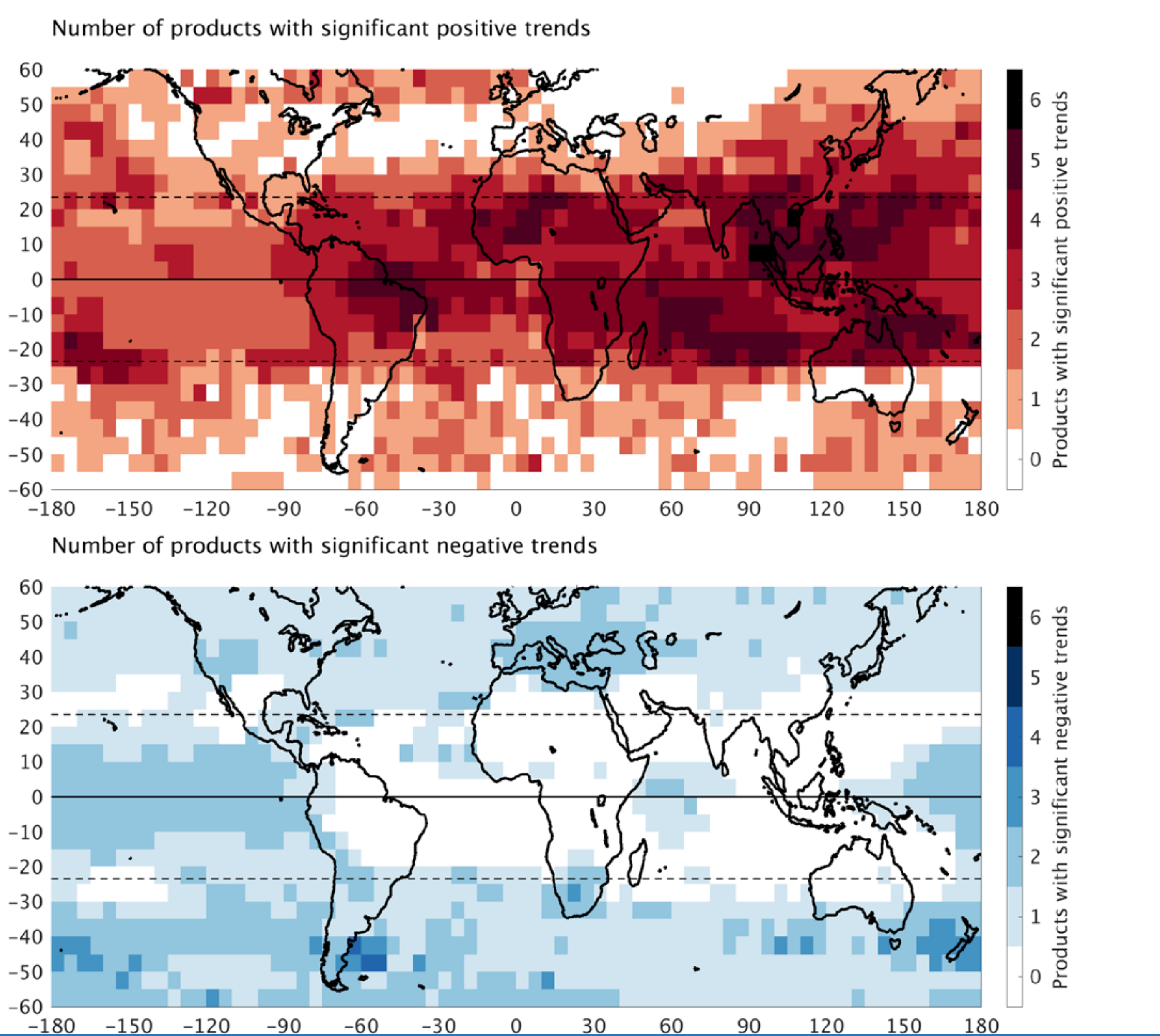
2 retrievals from IASI





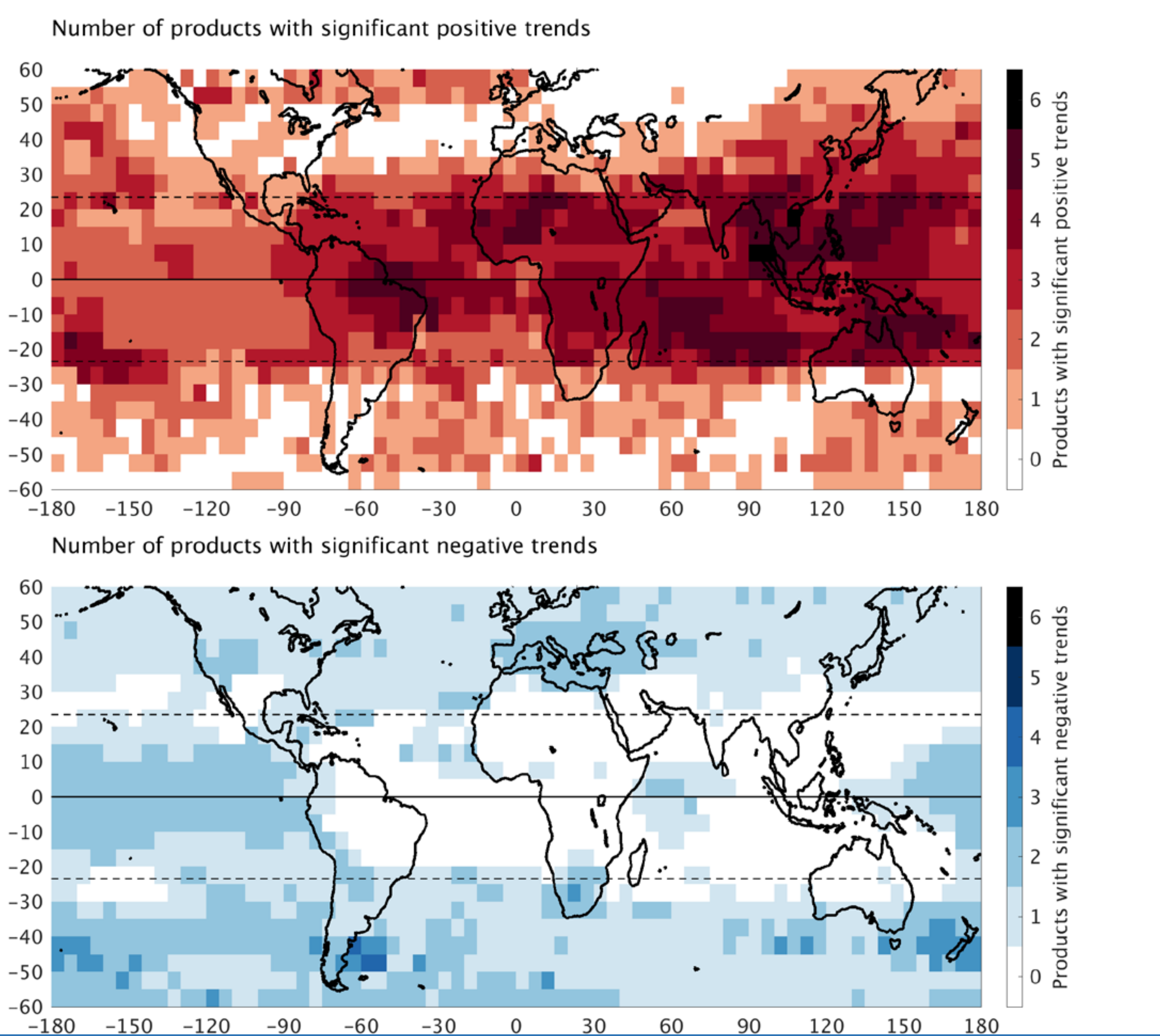
IR

Global tropospheric column ozone (TCO) using Satellite data: agreement



Number of products with statistically significant
- positive (red) trend
- negative (blue) trend
in each 5° x 5° grid cell

Global tropospheric column ozone (TCO) using Satellite data: agreement



Number of products with statistically significant

- positive (red) trend

- negative (blue) trend

in each 5° x 5° grid cell

Very new exciting result:

For the first time, the ozone burden for 2014-2016 has been calculated from 5 satellite products: **296 Tg**, with a range of 285-310 Tg, or **± 4%**.