# Tropospheric column ozone variability from space: results from the first multi-instrument intercomparison

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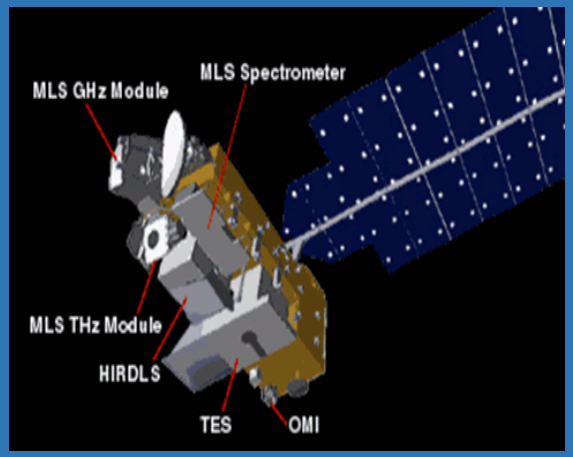




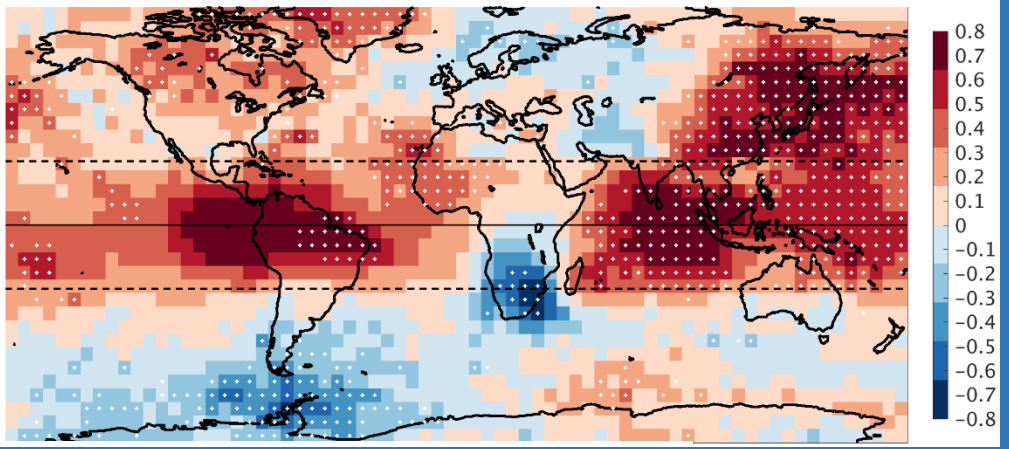
GMAC May 23, 2018

TOAR-Climate
Gaudel et al., 2018

**Thermal Tropopause**

**Surface**

**TOST** 2003-2012



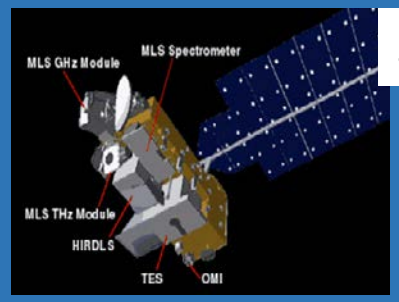


**+ HYSPLIT**

TOAR-Climate
Gaudel et al., 2018

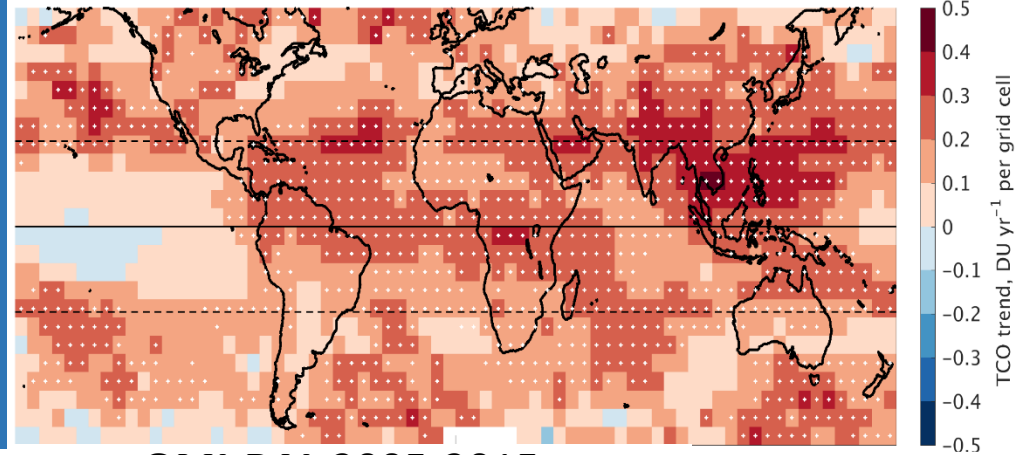
Thermal Tropopause

Surface

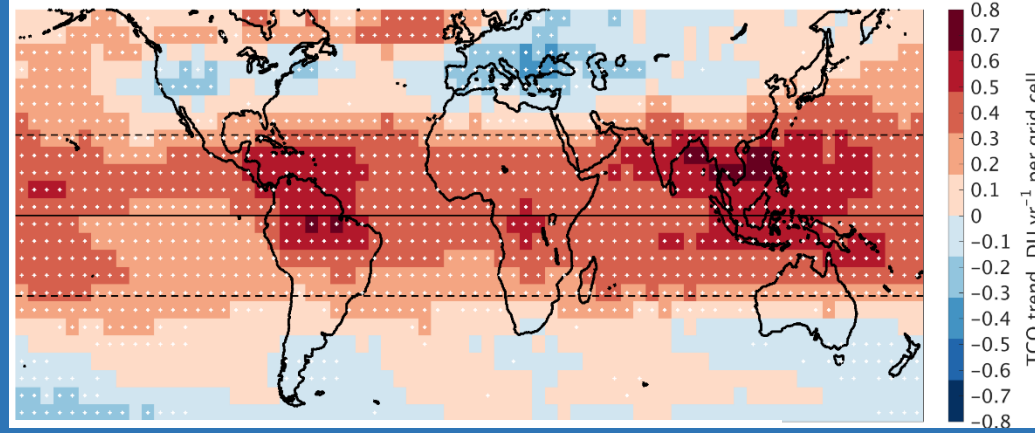



Satellite

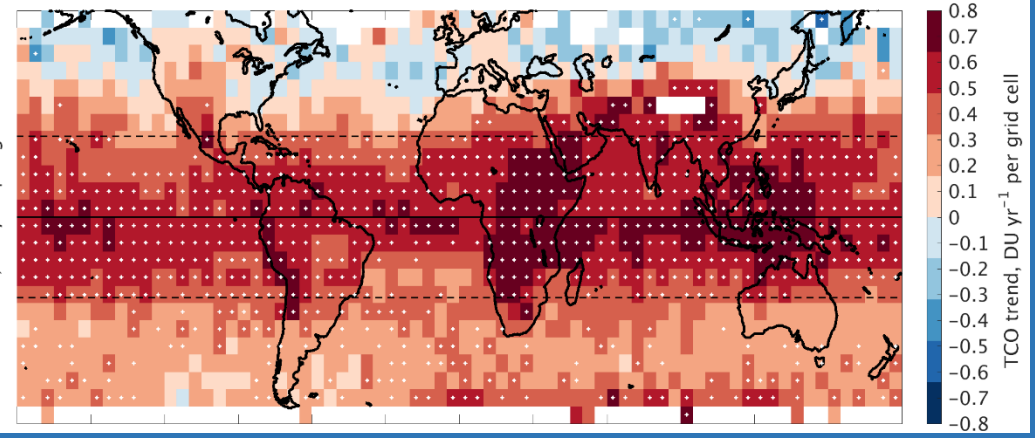
**OMI-MLS** 2005-2016




**OMI-SAO** 2005-2015



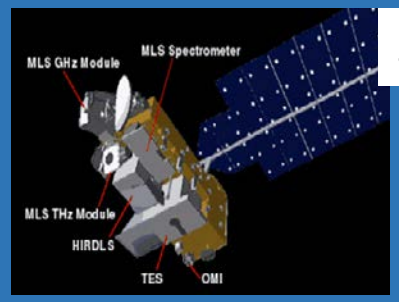

**OMI-RAL** 2005-2015



TOAR-Climate
Gaudel et al., 2018

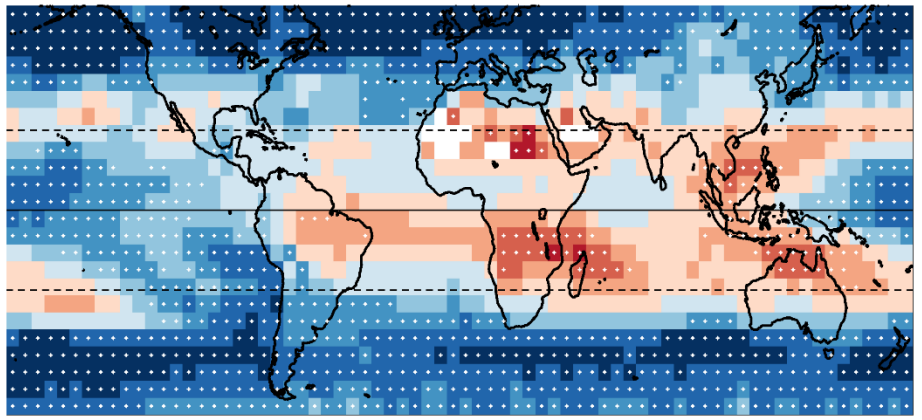
Thermal Tropopause

Surface

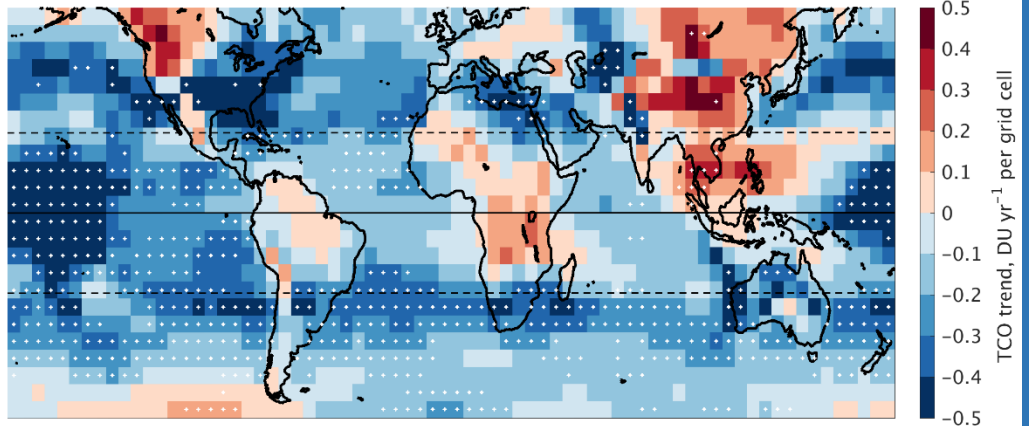



Satellite

**IASI-FORLI** 2008-2014




**IASI-SOFRID** 2008-2016

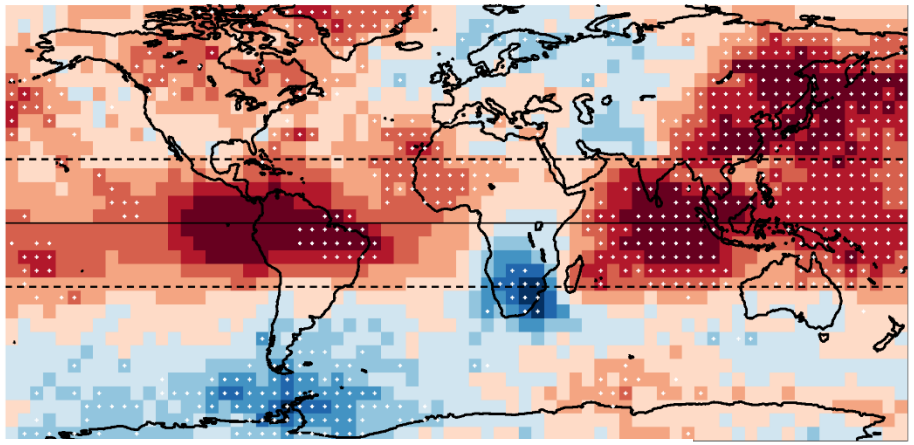


TOAR-Climate
Gaudel et al., 2018

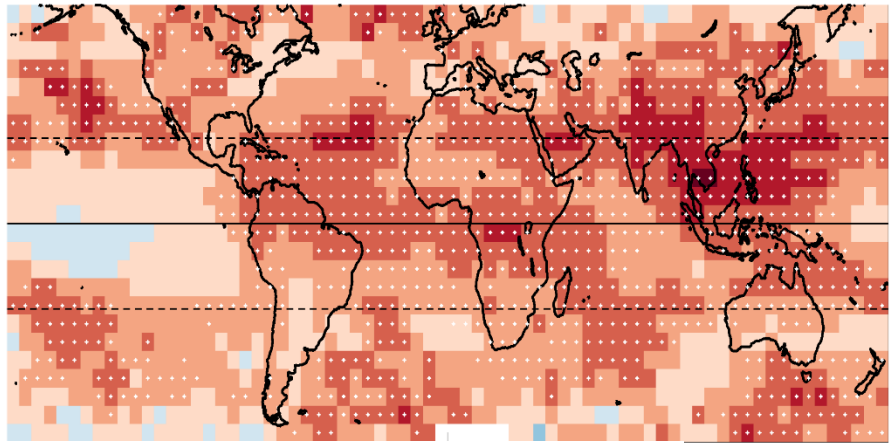
Thermal Tropopause

Surface

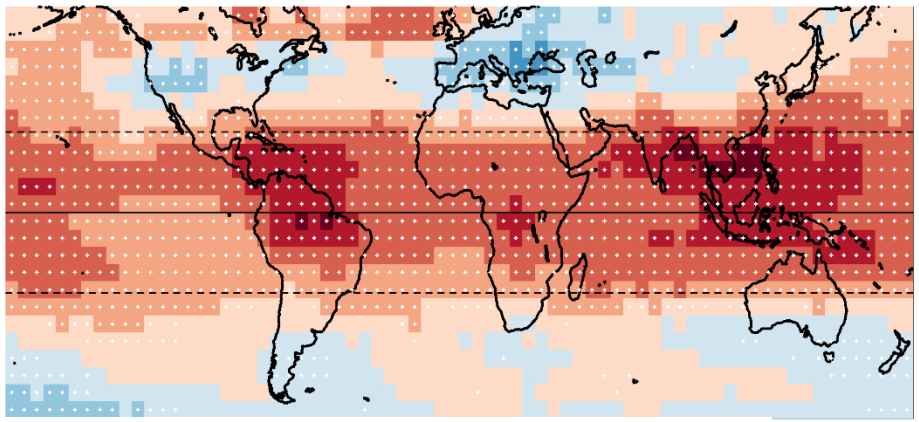
**TOST** 2003-2012



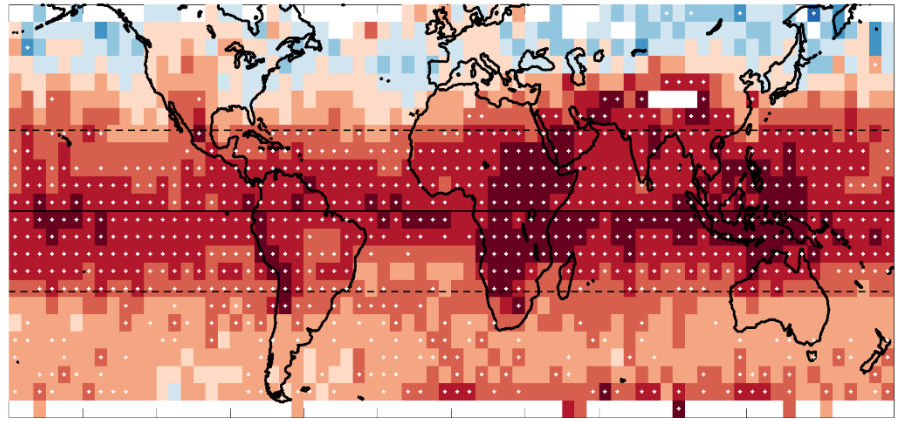
**OMI-MLS** 2005-2016



**OMI-SAO** 2005-2015



**OMI-RAL** 2005-2015



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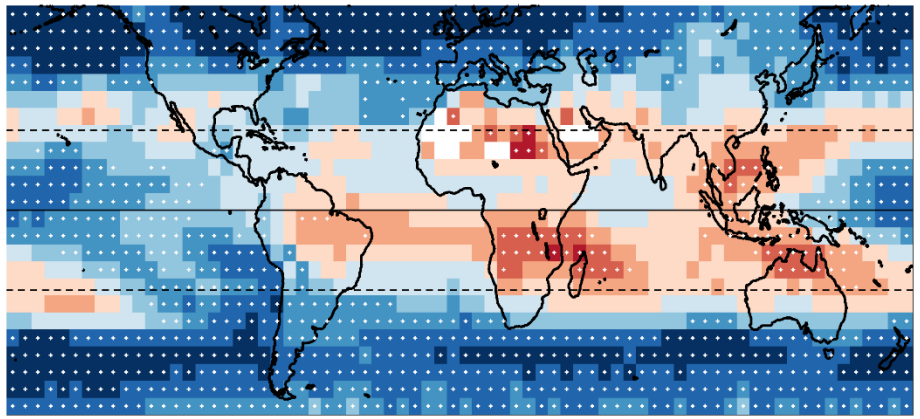
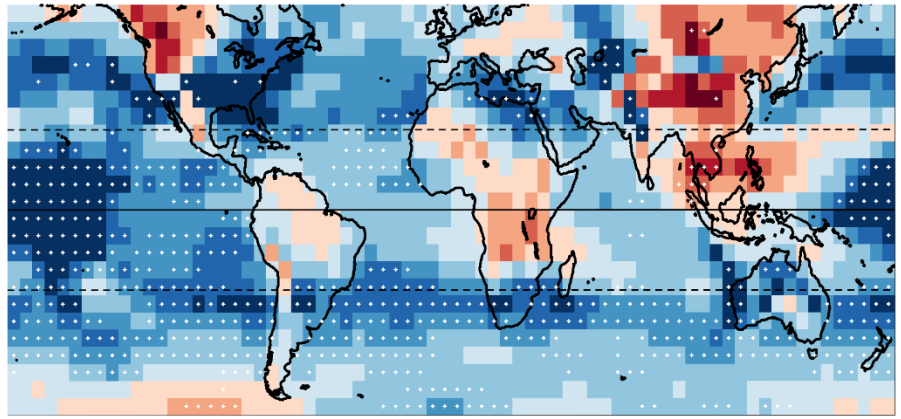


**IASI-SOFRID** 2008-2016

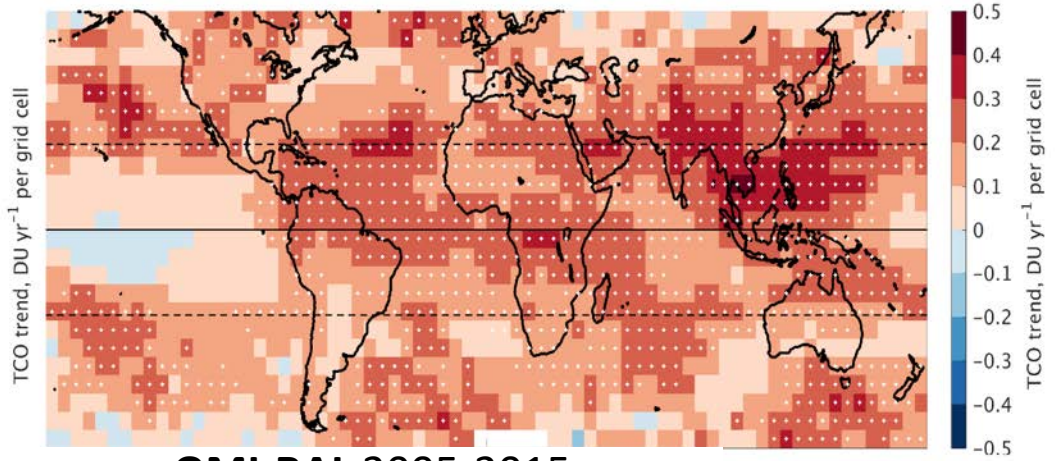


TOAR-Climate
Gaudel et al., 2018

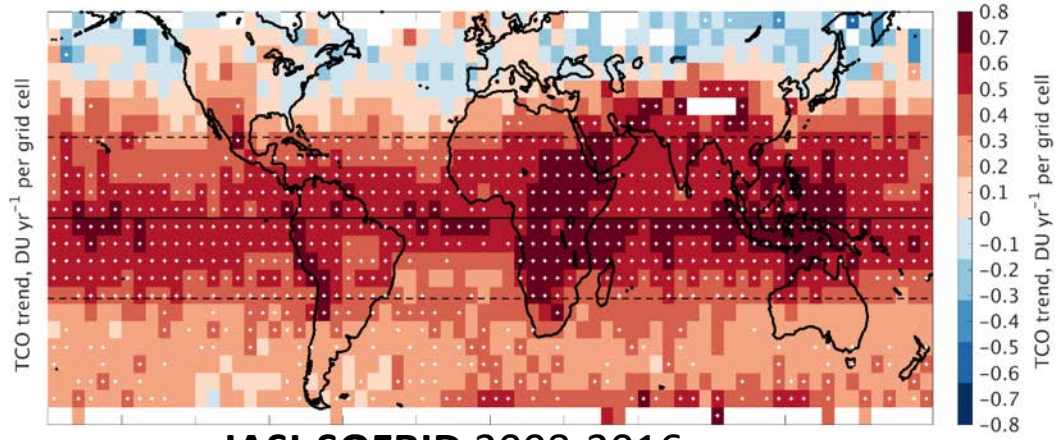
Thermal Tropopause

Surface

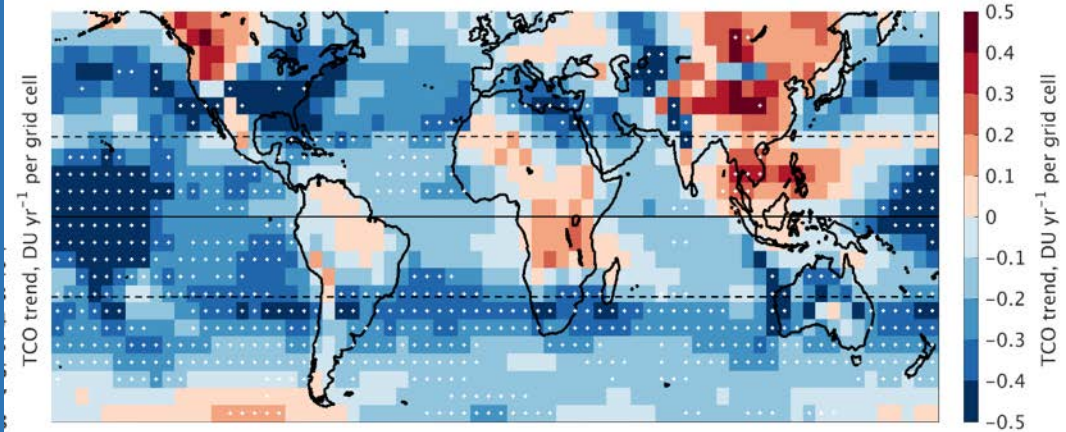
**OMI-MLS** 2005-2016




**OMI-RAL** 2005-2015



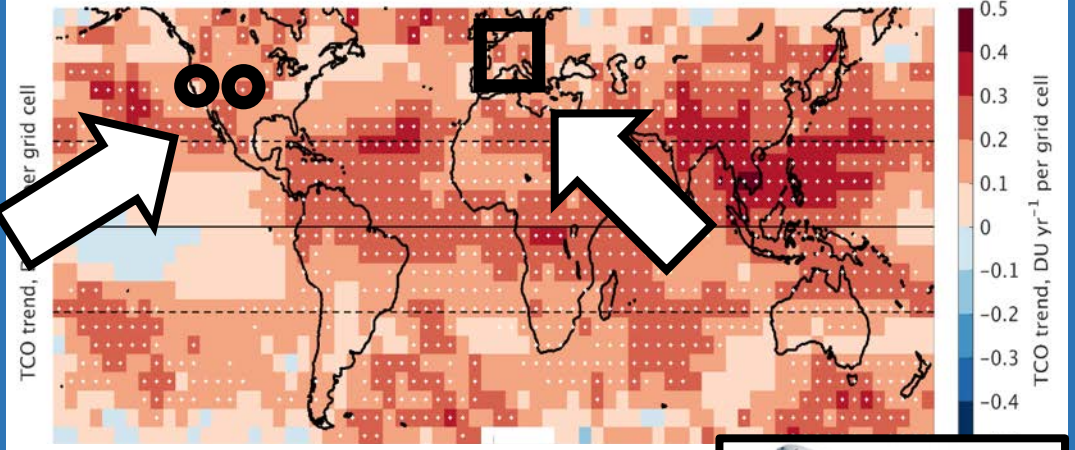

**IASI-SOFRID** 2008-2016



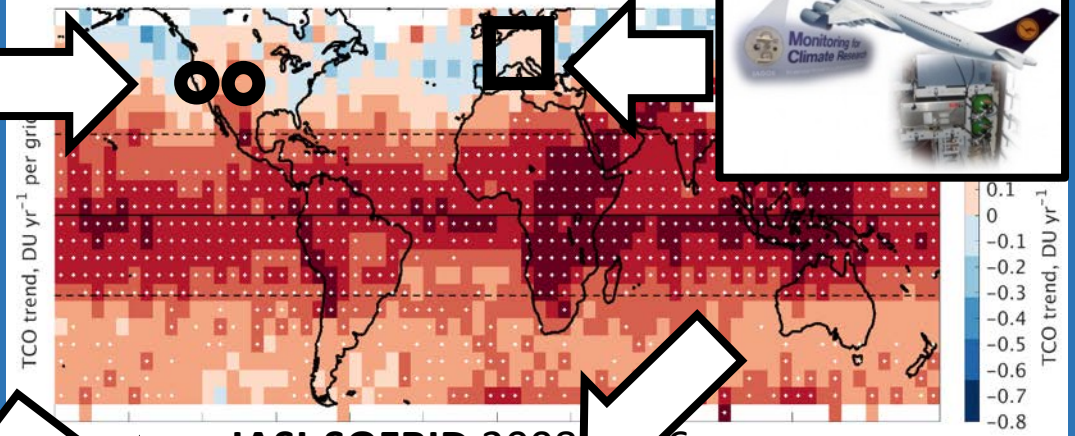
Thermal Tropopause

Surface

**OMI-MLS** 2005-2016



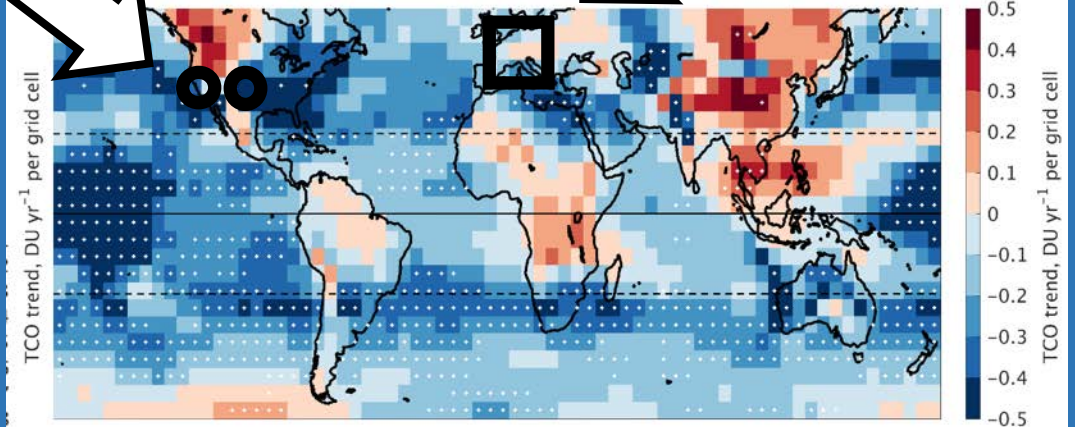

**OMI-RAL** 2005-2015







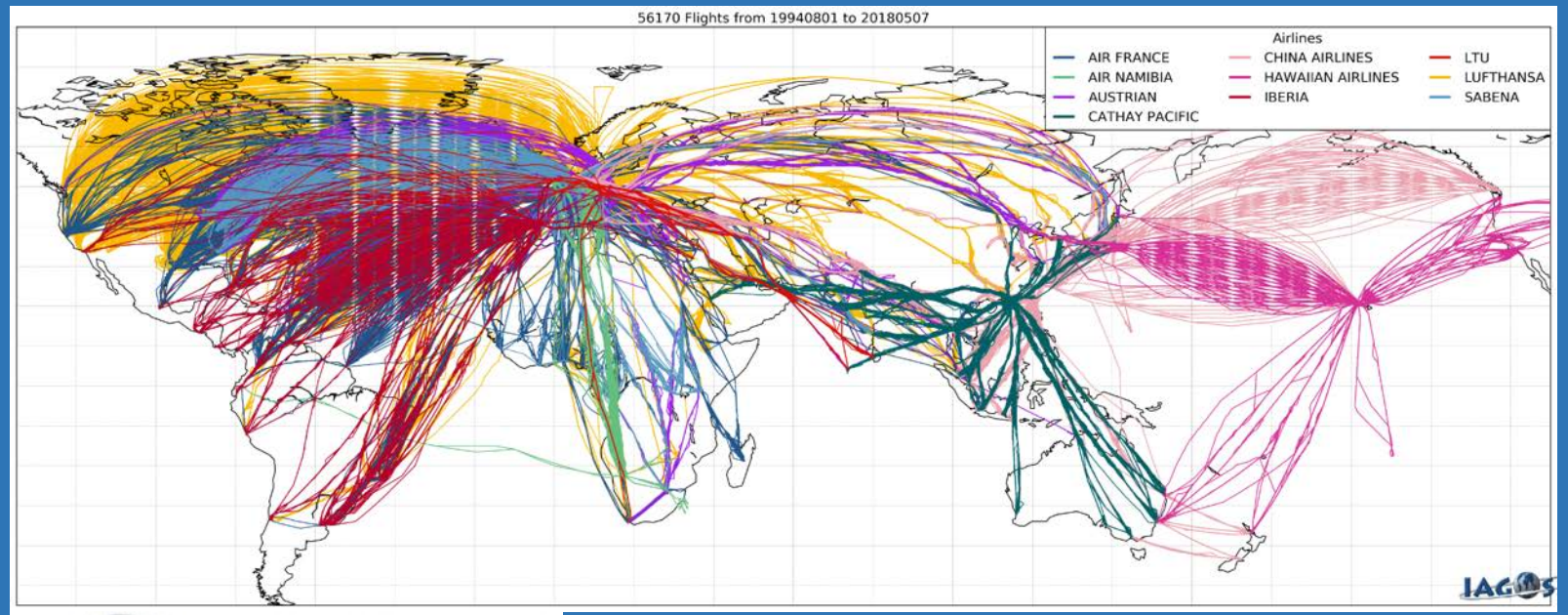
**IASI-SOFRID** 2008–2016



**Thermal Tropopause**

Dynamical Tropopause

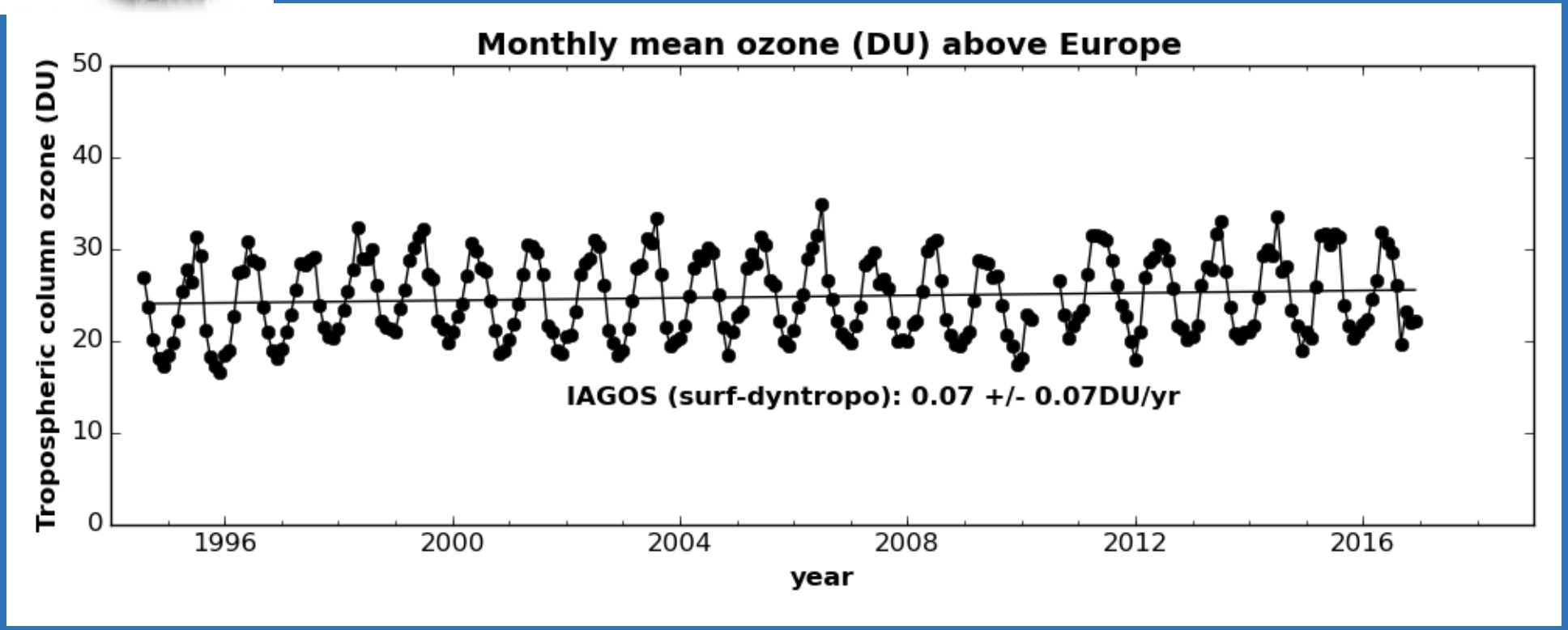
Surface



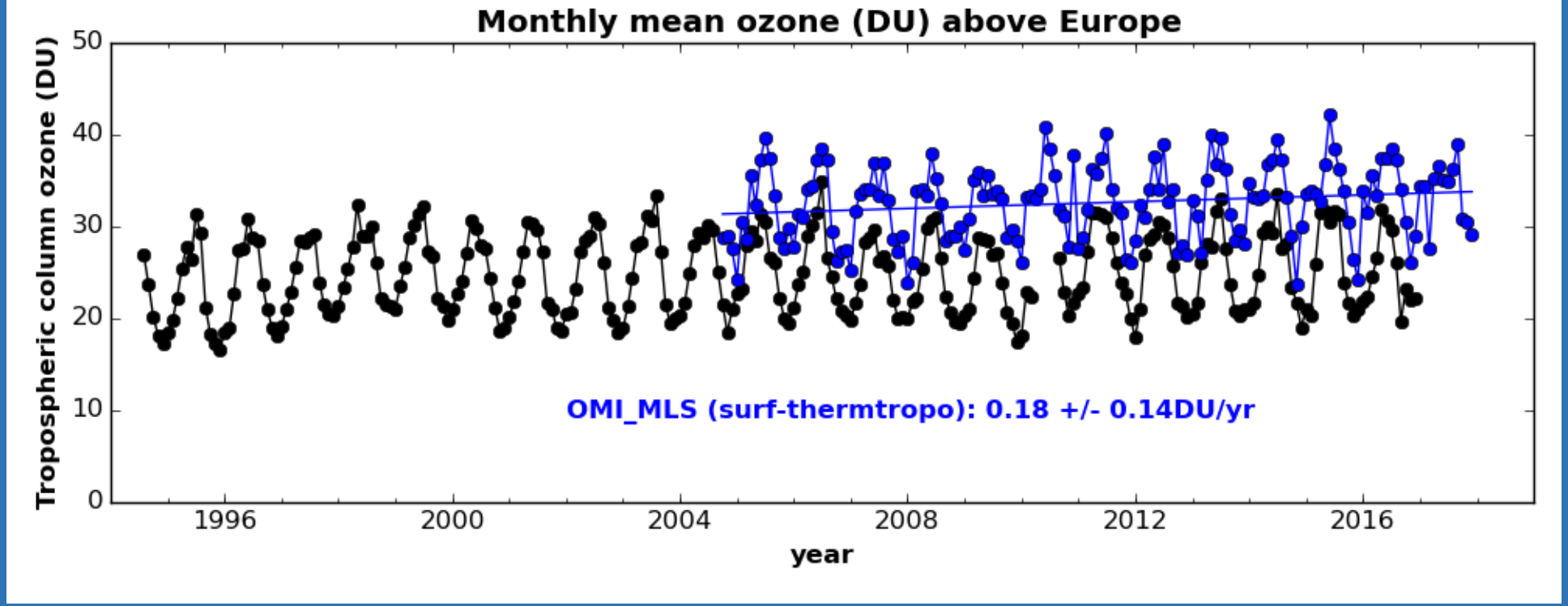


Commercial Aircraft IAGOS

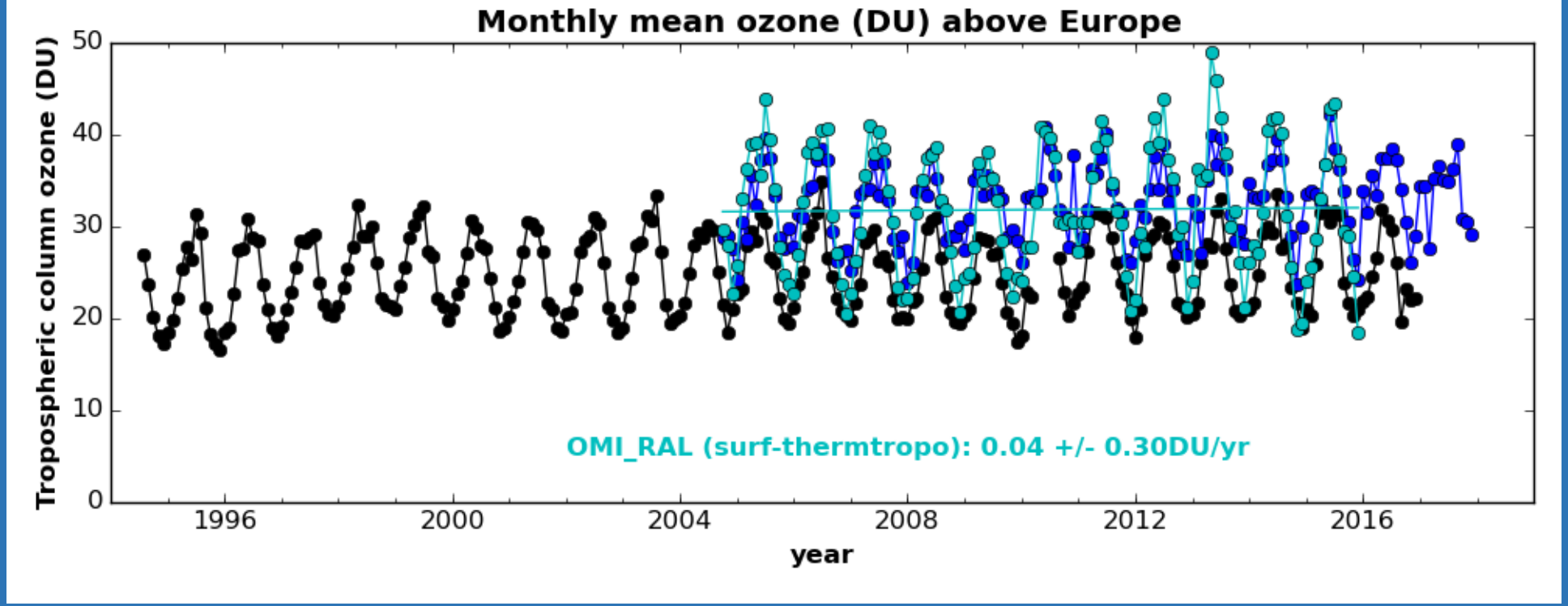

# No significant trend is found above western Europe with IAGOS data between 1994 and 2016



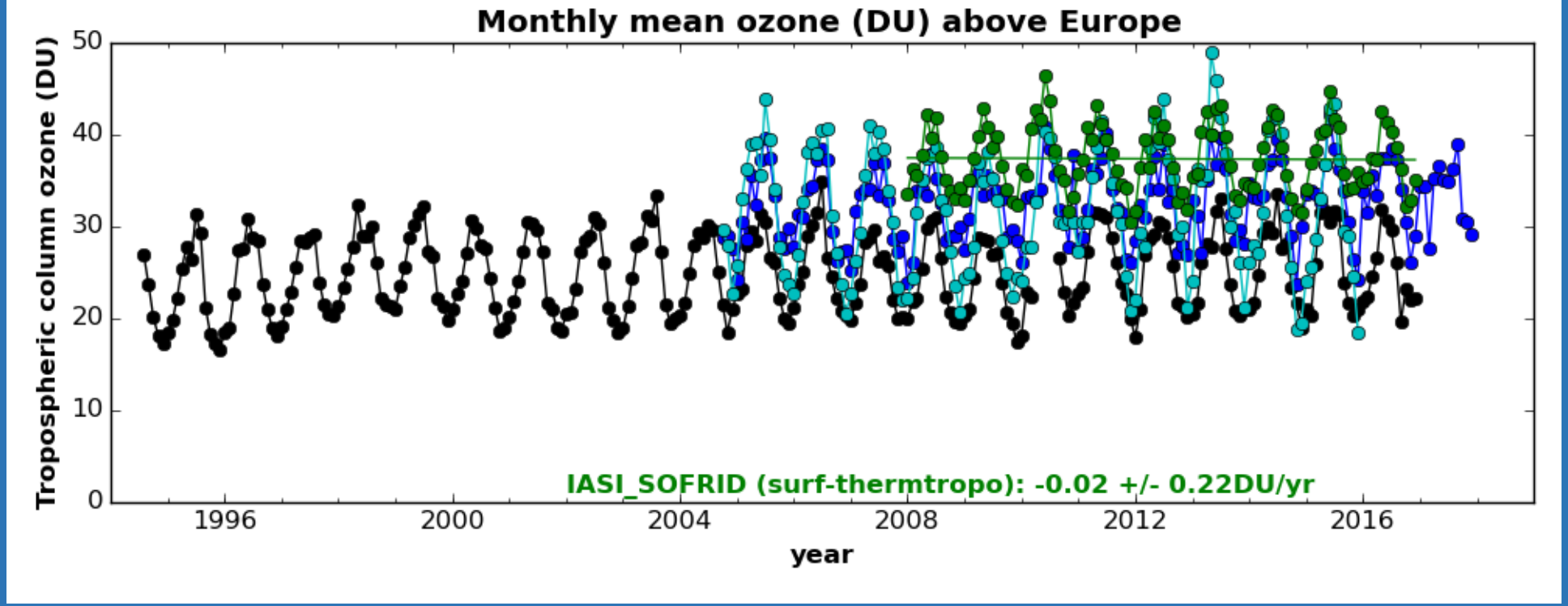

# A significant positive trend is found above western **Europe** with OMI/MLS data between 2004 and 2017

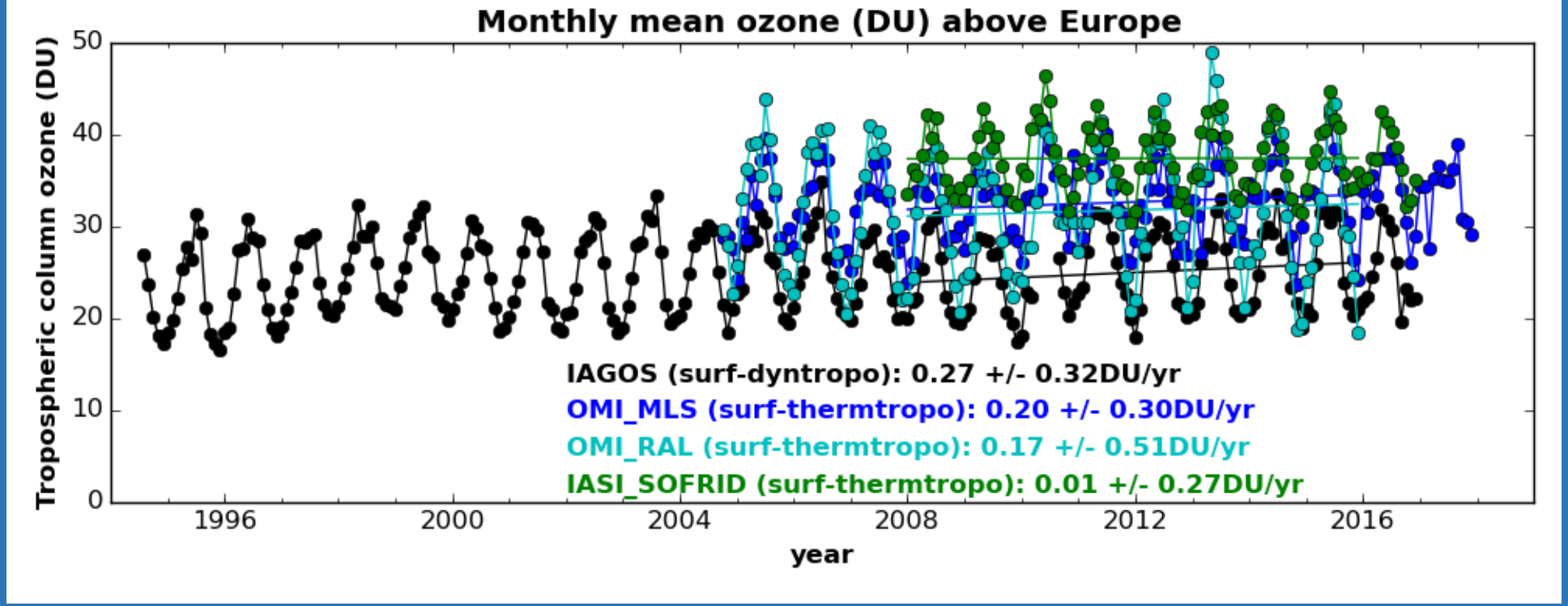

# No significant trend is found above western Europe with OMI-RAL data between 2004 and 2015

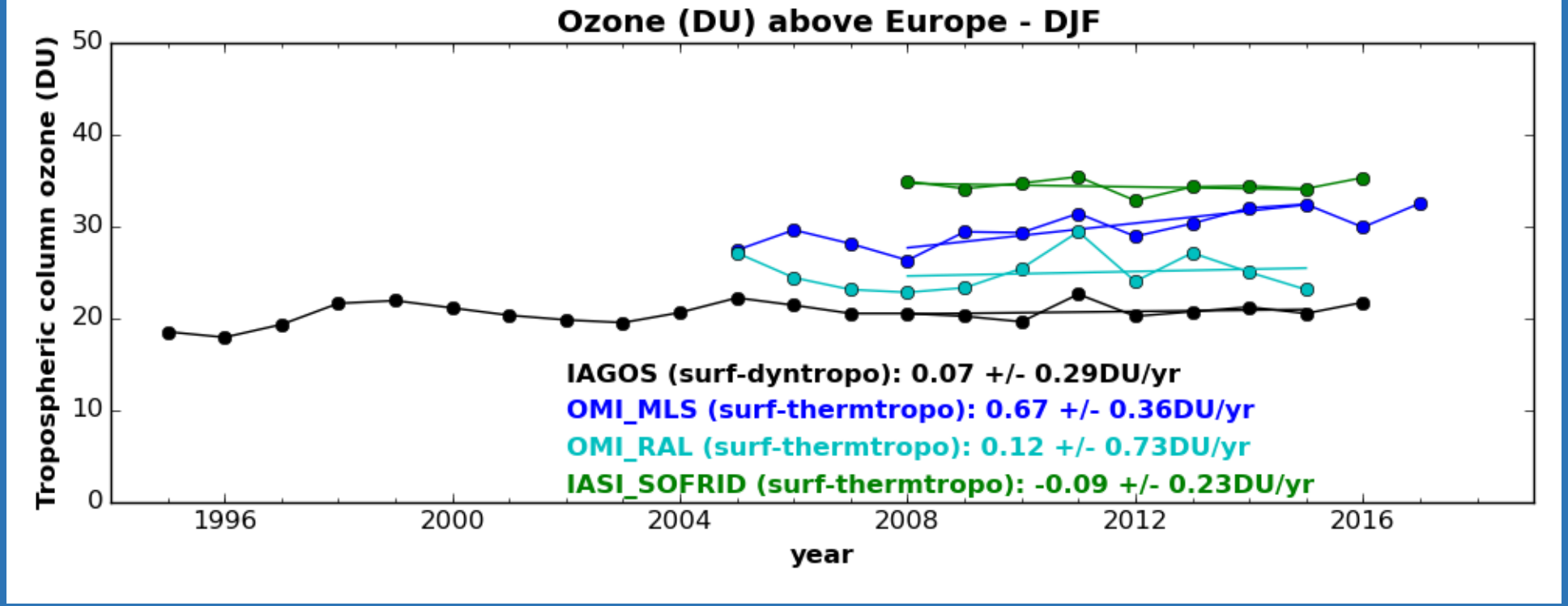

# No significant trend is found above western Europe with IASI-SOFRID data between 2008 and 2016

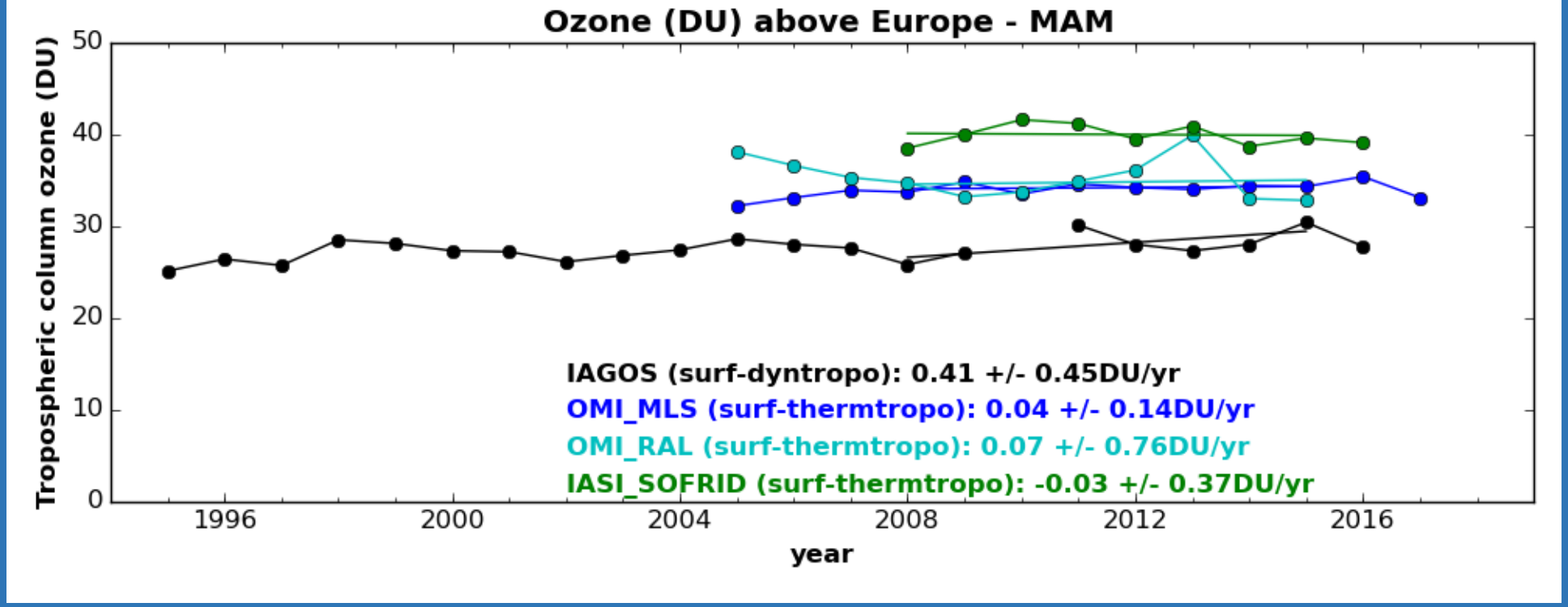

# No significant change is found above western Europe with all the data sets for the common period 2008 - 2015

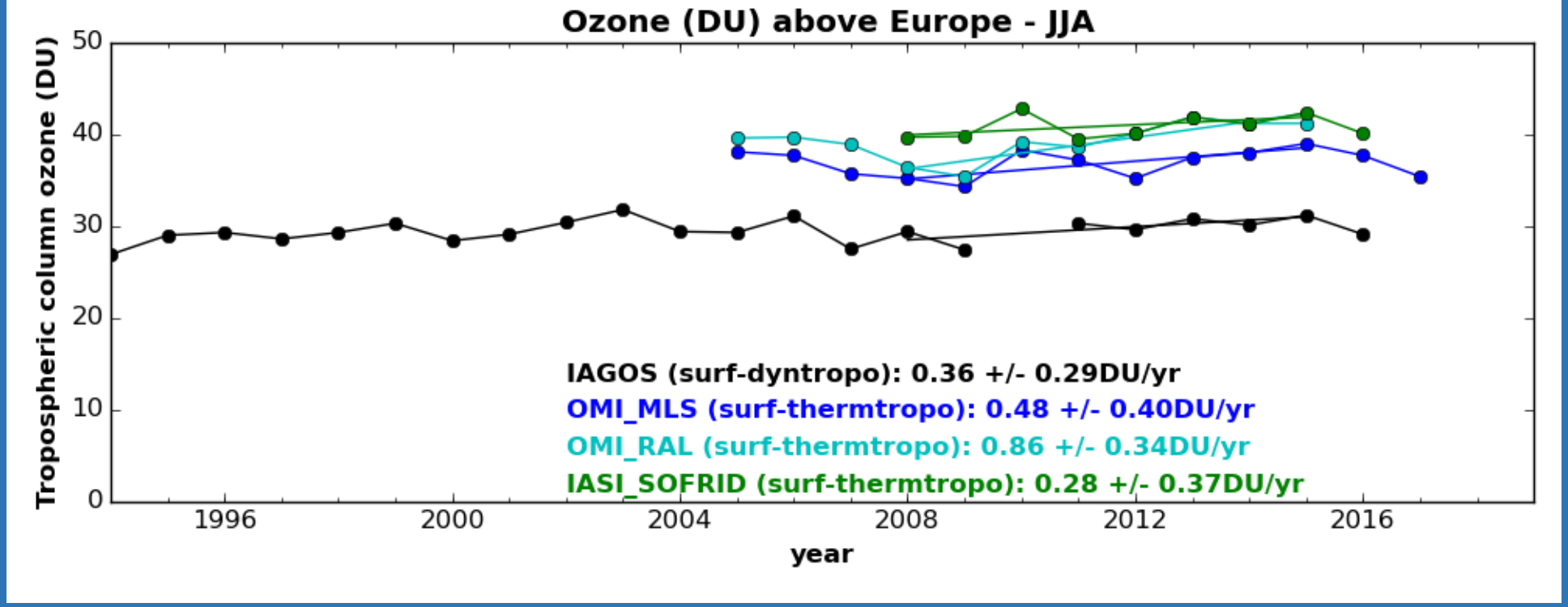

# In winter, a significant positive change is observed above Europe with OMI/MLS for the common period 2008 - 2015

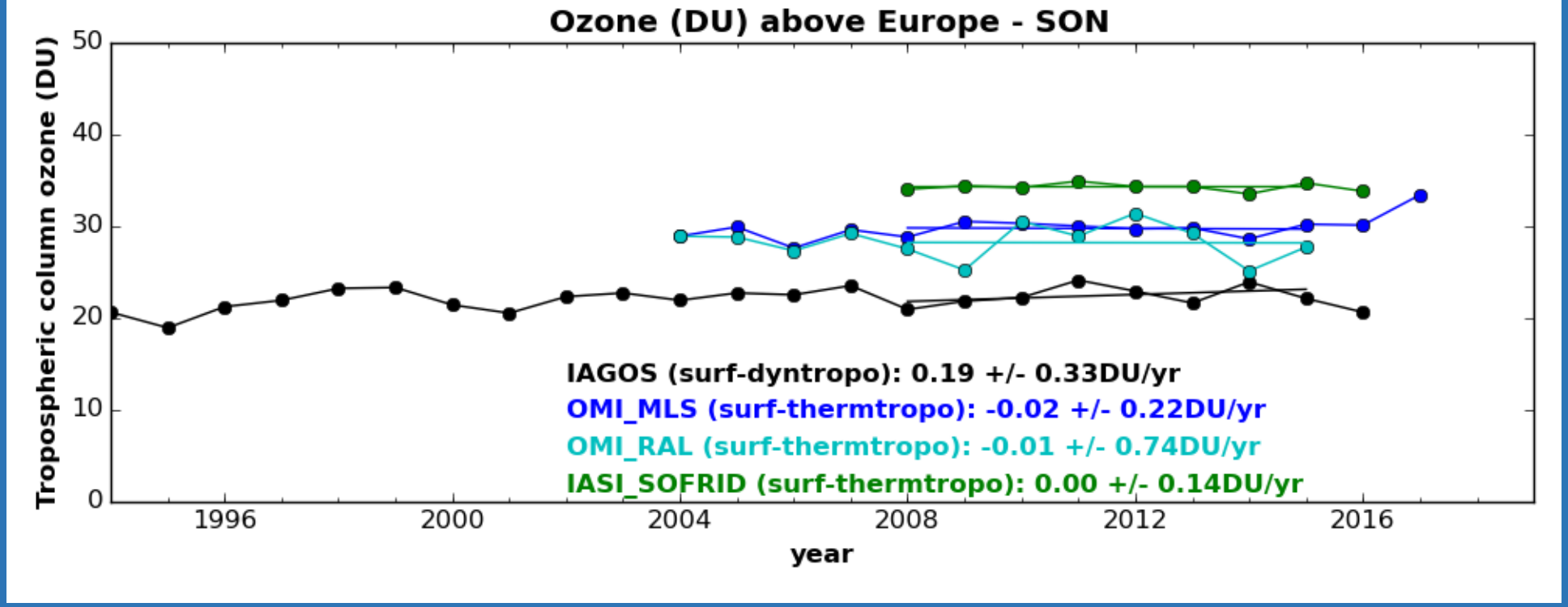

# In spring, no significant change is observed above Europe for the common period 2008 - 2015


In summer, a significant change is observed above **Europe**
with all the data sets
except IASI-SOFRID for the common period 2008 - 2015


# In fall, no significant change is observed above Europe for the common period 2008 - 2015

Thermal tropopause

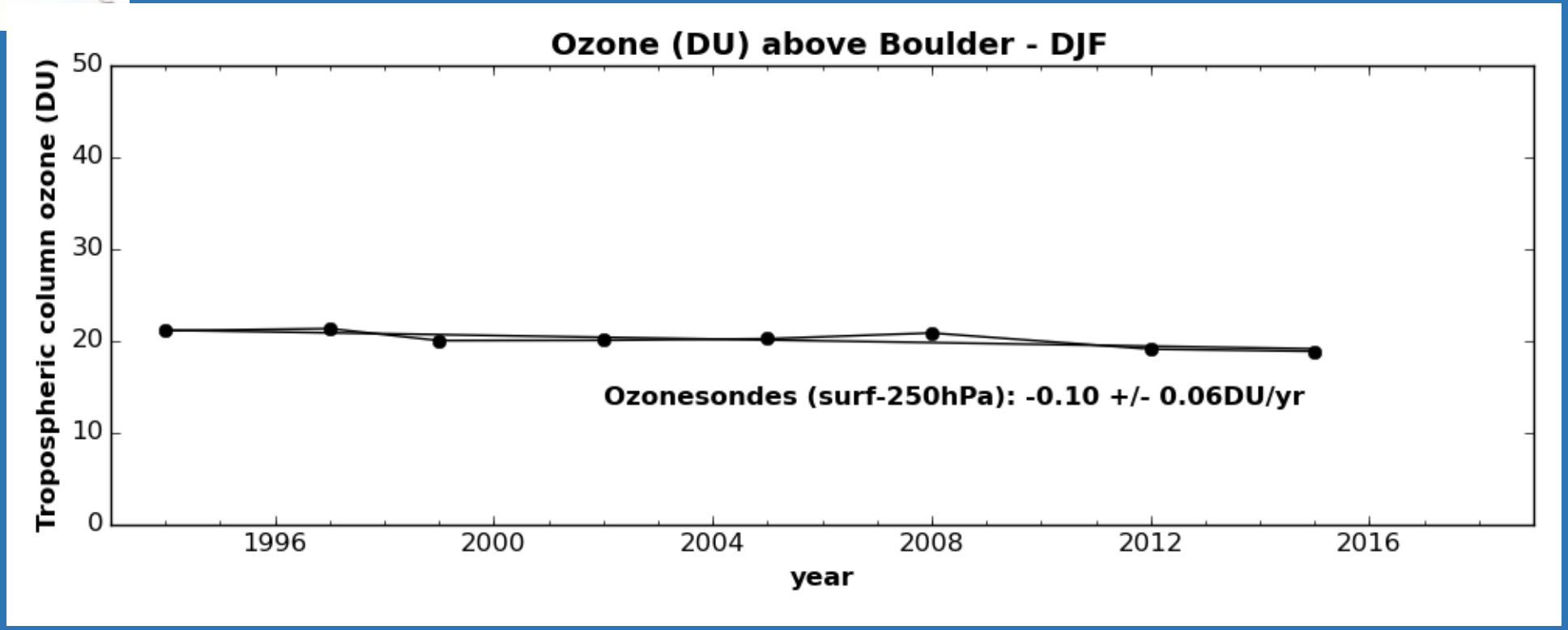
250 hPa

Surface

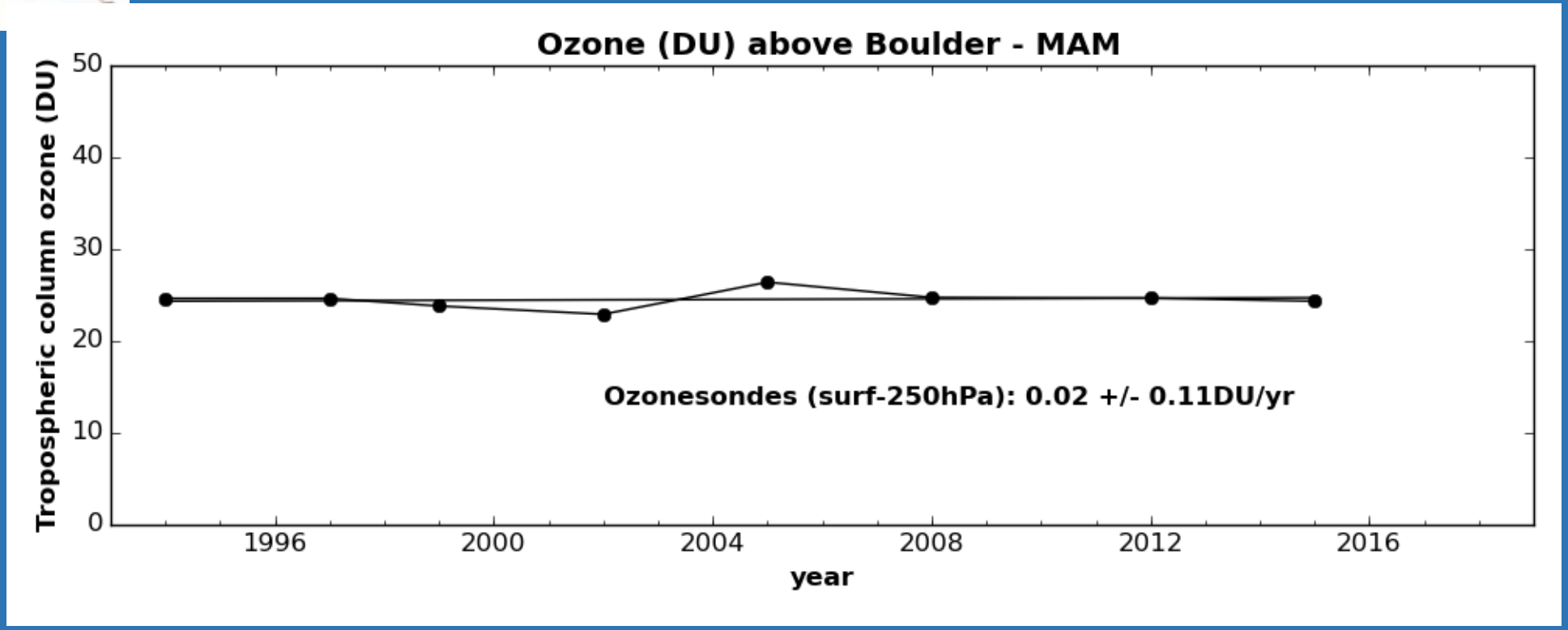
Trinidad Head

Boulder

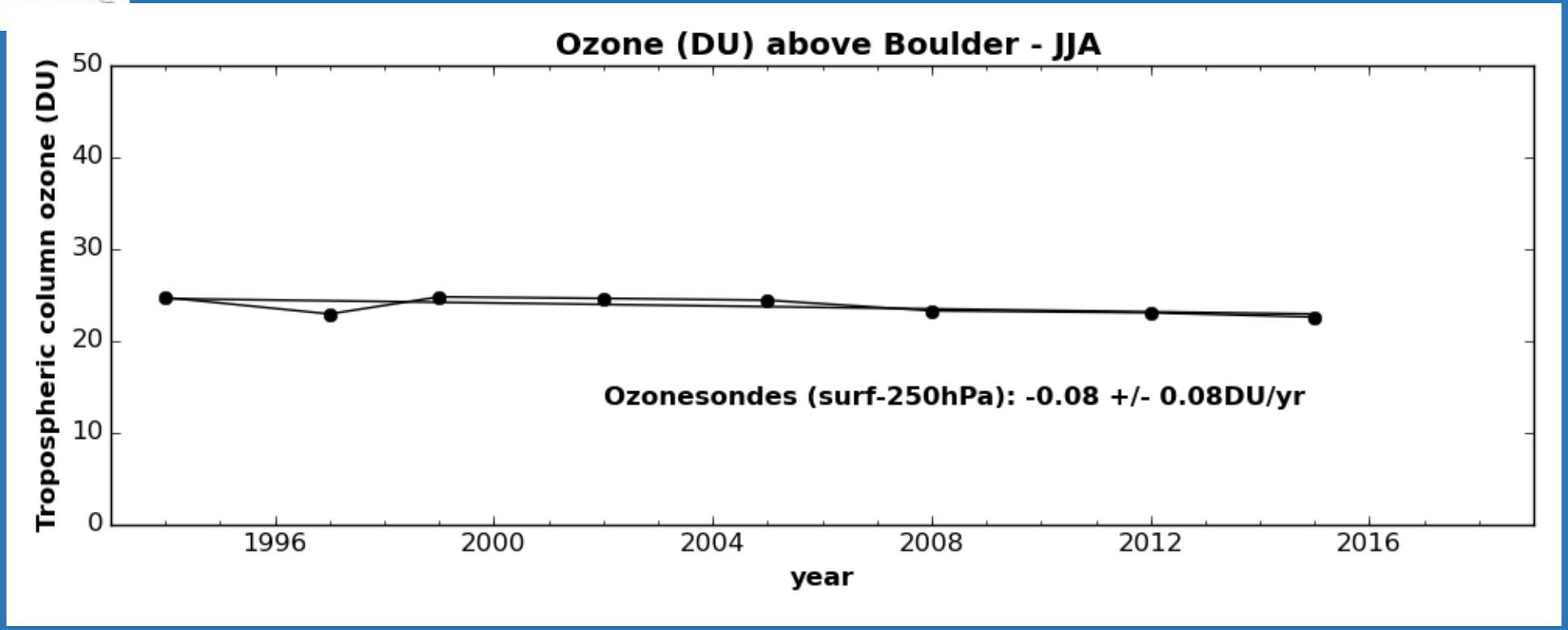
In winter, a significant negative change is observed above **Boulder** for the period 1994 - 2017



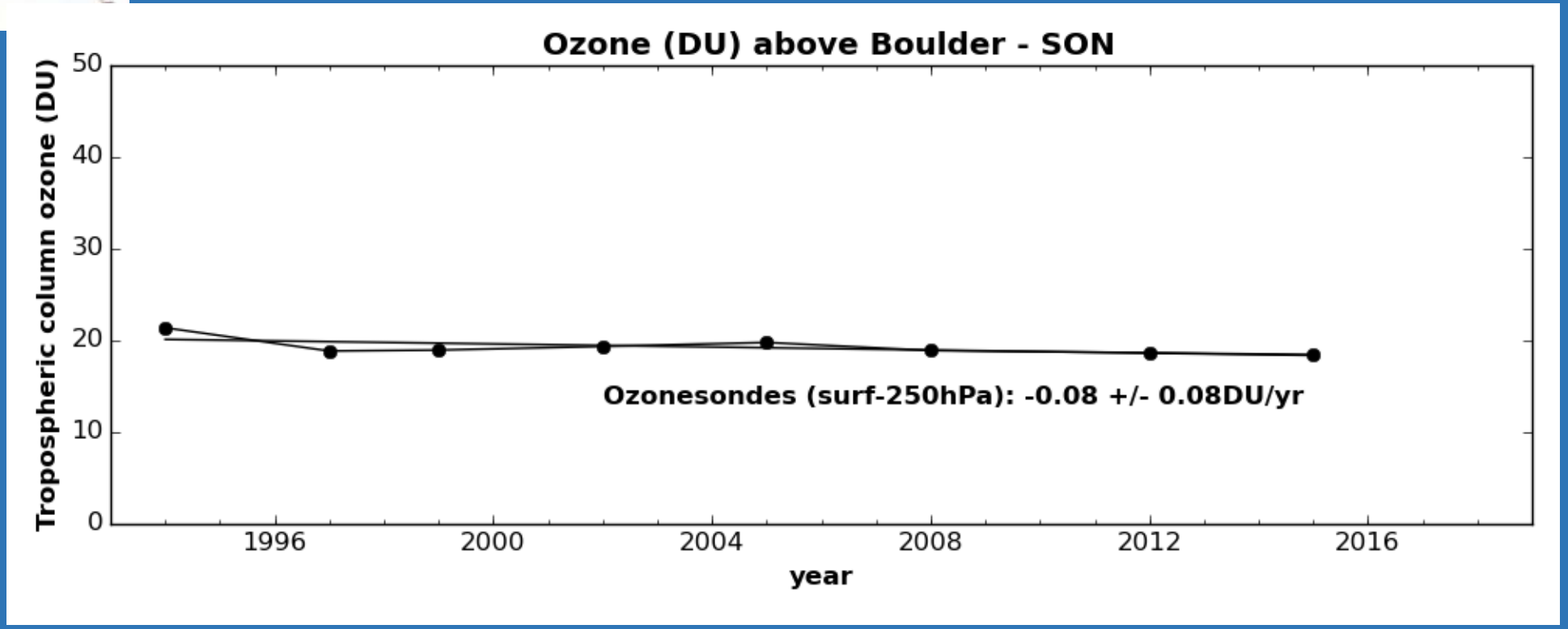
# In spring, no significant change is observed above Boulder with ozonesondes for the period 1994 - 2017



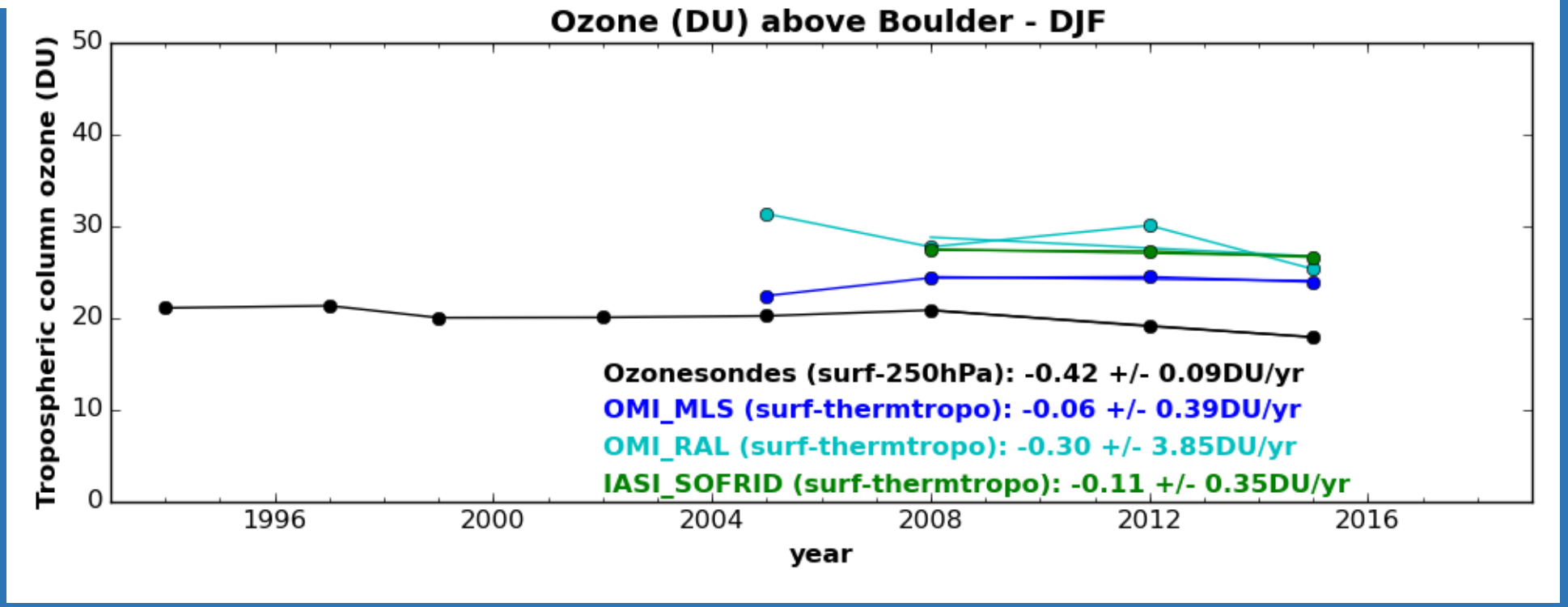
# In summer, no significant trend is observed above Boulder with the ozonesondes for the period 1994 - 2017



In fall, no significant trend is observed above **Boulder** for the period 1994 – 2017



## In winter, a significant negative change is observed above **Boulder** with ozonesondes for the common period 2008 – 2015

## OMI/MLS ozone variability is in good agreement with ozone variability measured with ozonesondes above **Boulder** for the common period 2008-2015


| Trends in DU $yr^{-1}$ | DJF | MAM | JJA | SON |
|---|---|---|---|---|
| Ozonesondes | **- 0.42 ± 0.09** | **- 0.03 ± 0.05** | **- 0.09 ± 0.16** | **0.00 ± 0.29** |
| OMI/MLS | - 0.06 ± 0.39 | **- 0.02 ± 0.08** | **- 0.11 ± 0.12** | **- 0.08 ± 0.33** |
| OMI-RAL | **- 0.30 ± 3.85** | 0.43 ± 1.33 | 0.84 ± 2.83 | 0.18 ± 5.88 |
| IASI-SOFRID | - 0.11 ± 0.35 | - 0.10 ± 1.03 | - 0.55 ± 1.96 | - 0.38 ± 0.94 |

## No significant trend is observed above **Trinidad Head** for the period **1997 - 2017**

| Trends in DU $yr^{-1}$ | DJF | MAM | JJA | SON |
|---|---|---|---|---|
| Ozonesondes | **- 0.01 ± 0.11** | **- 0.10 ± 0.20** | **0.05 ± 0.08** | **- 0.14 ± 0.14** |

## OMI/MLS ozone variability is in good agreement with ozone variability measured with ozonesondes above **Trinidad Head** for the common period **2008-2015**


### 1997 - 2017

| Trends in DU $yr^{-1}$ | DJF | MAM | JJA | SON |
|---|---|---|---|---|
| Ozonesondes | **- 0.01 ± 0.11** | **- 0.10 ± 0.20** | **0.05 ± 0.08** | **- 0.14 ± 0.14** |

### 2008 - 2015

| Trends in DU $yr^{-1}$ | DJF | MAM | JJA | SON |
|---|---|---|---|---|
| Ozonesondes | **- 0.20 ± 0.26** | **0.16 ± 2.18** | **0.08 ± 1.22** | **0.18 ± 1.29** |
| OMI/MLS | **- 0.18 ± 0.66** | **0.22 ± 0.74** | **0.02 ± 1.12** | **0.18 ± 1.28** |
| OMI-RAL | **- 0.21 ± 0.22** | 0.47 ± 1.00 | 0.35 ± 2.49 | - 0.23 ± 3.44 |
| IASI-SOFRID | 0.01 ± 1.05 | - 0.08 ± 0.85 | - 0.26 ± 0.32 | - 0.01 ± 0.47 |

# Conclusions

We are conducting the first evaluation of multiple satellite-detected tropospheric ozone products using a common database of in situ observations.

OMI/MLS performs relatively well over the period 2008-2015 based on annual data, but not for all seasons.

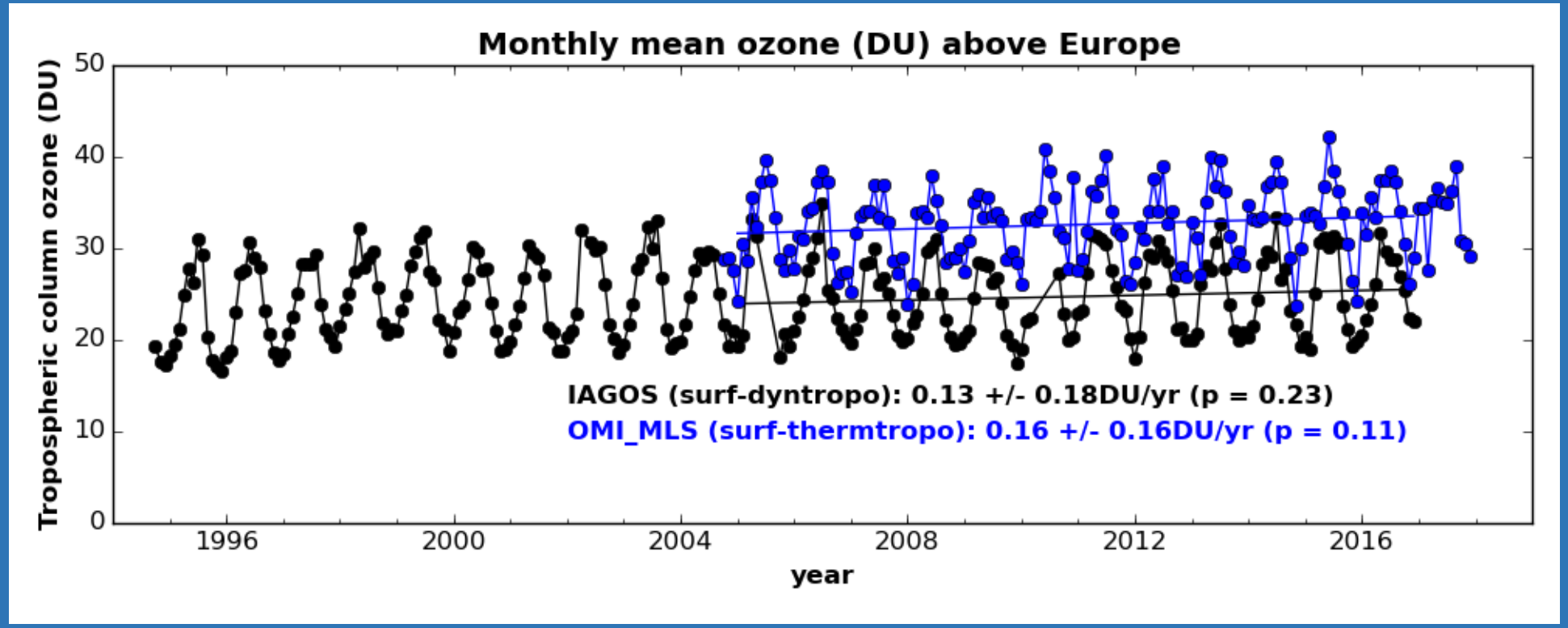
No product performs consistently well for all three evaluation regions.

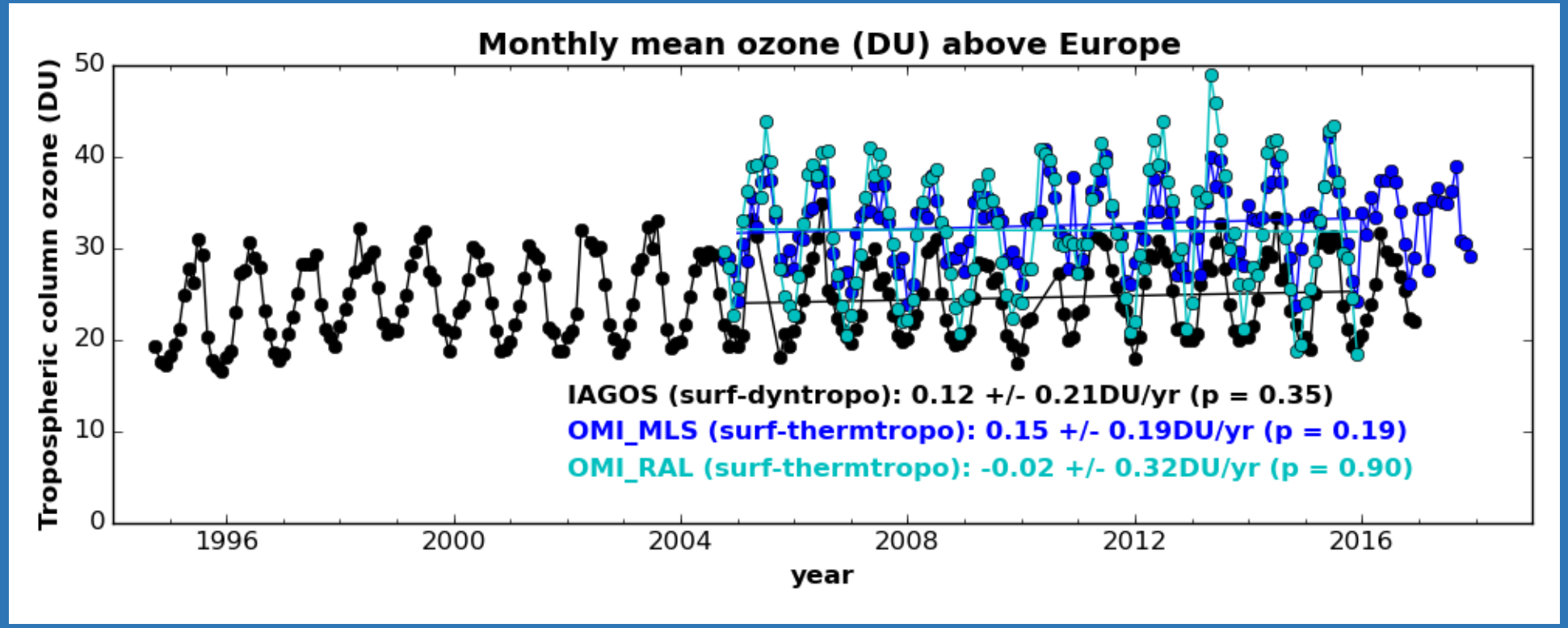
Our conclusions are limited by the 8-year evaluation period.

Stronger conclusions will be available once we have data for 2008-2018 (11 years).

Goal:  to produce a merged tropospheric ozone column product that draws on the regional strengths of each product.

# Supplementary Slides


Monthly mean ozone (DU) above Europe
Tropospheric column ozone (DU)
50
40
30
20
10
0
1996
2000
2004
2008
2012
2016
year
IAGOS (surf-dyntropo): 0.13 +/- 0.18DU/yr (p = 0.23)
OMI_MLS (surf-thermtropo): 0.16 +/- 0.16DU/yr (p = 0.11)


Monthly mean ozone (DU) above Europe
Tropospheric column ozone (DU)
50
40
30
20
10
0
1996
2000
2004
2008
2012
2016
year
IAGOS (surf-dyntropo): 0.12 +/- 0.21DU/yr (p = 0.35)
OMI_MLS (surf-thermtropo): 0.15 +/- 0.19DU/yr (p = 0.19)
OMI_RAL (surf-thermtropo): -0.02 +/- 0.32DU/yr (p = 0.90)