A Post-2013 Dropoff in Total Ozone at a Third of Global Ozonesonde Stations: *Electrochemical Concentration Cell (ECC) Instrument Artifacts?*

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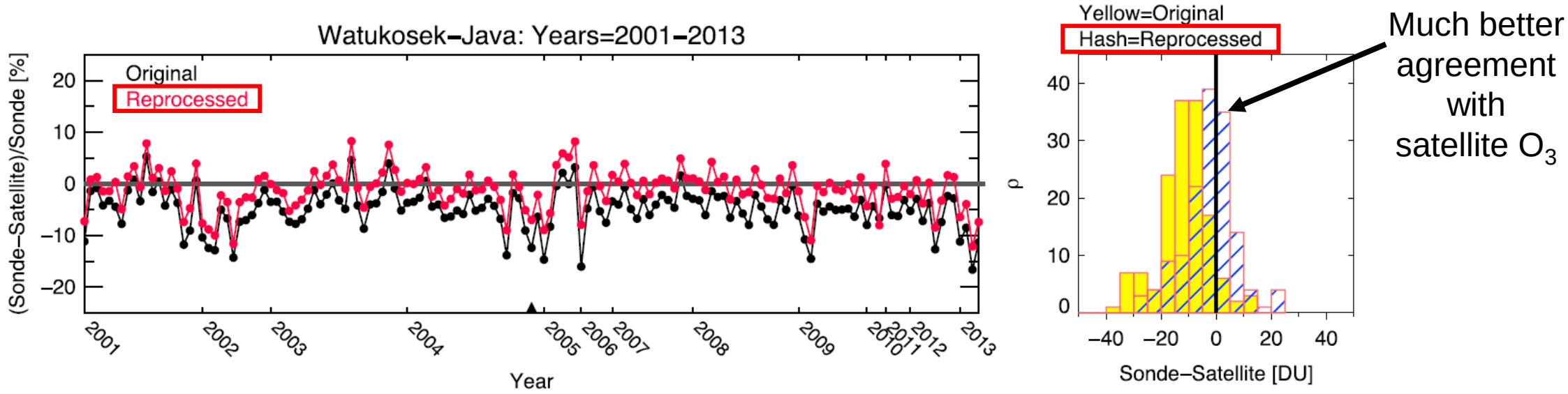
Talk Roadmap

- A drop in total and stratospheric O_3 at 14 global ECC stations
  - Ozonesonde data homogenization in 2015-2017: Successful, but hints of an emerging problem with the data
  - Examples from affected Hilo and Samoa, and unaffected Boulder NOAA stations

- What are we doing about it?
  - Assessment of Standard Operating Procedures for OzoneSondes (ASOPOS) expert panel “Task Teams”
  - Metadata collection, lab analyses, goal of “solving” the cause of the drop

Ozonesonde Data Homogenization Success



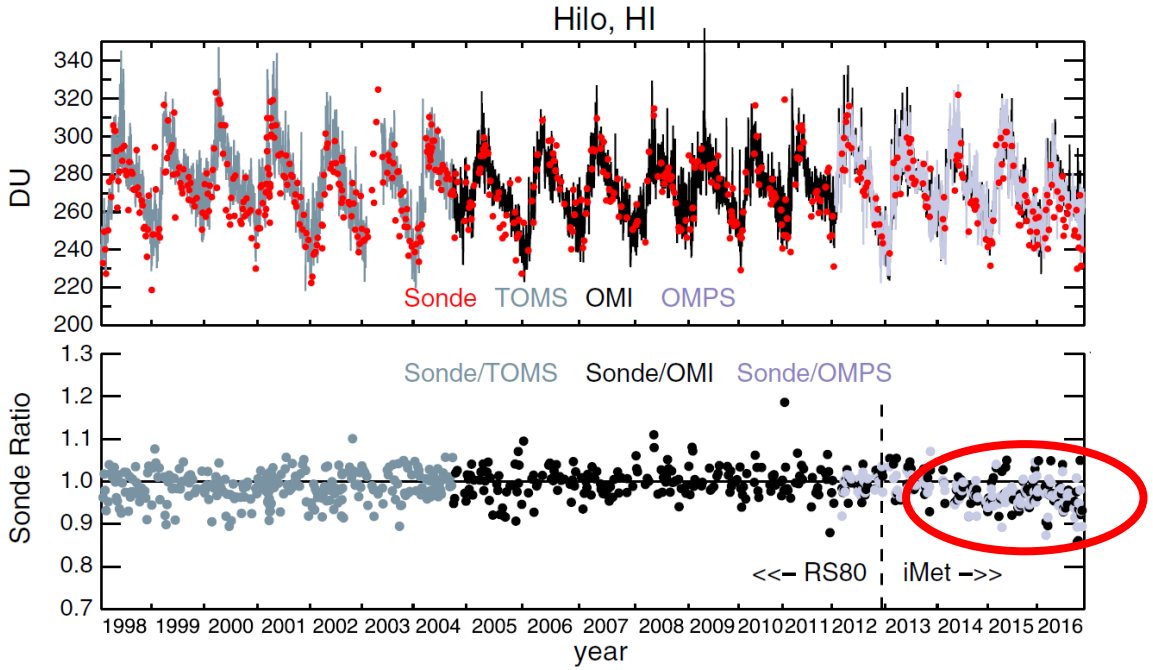
Witte et al. (2017; JGR)

Since 2015, about three dozen global ozonesonde stations have homogenized their data using ASOPOS-recommended procedures (based on lab and field testing)

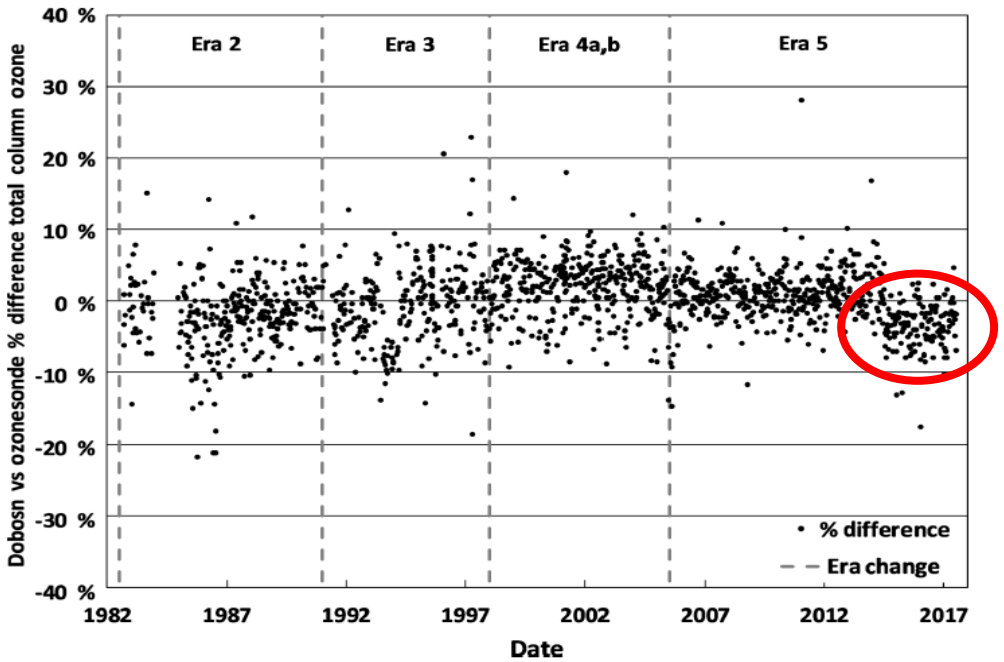
Homogenization accounts for non-standard ozonesonde sensing solutions, radiosonde errors, and varying ozonesonde preparation that causes discontinuities in a station's record

Above example shows Indonesian station homogenized to account for a non-standard sensing solution. **Homogenization greatly improves sonde comparisons with independent data**

Hints of an Emerging Low Bias (Hilo, HI)



Thompson et al. (2017; JGR)



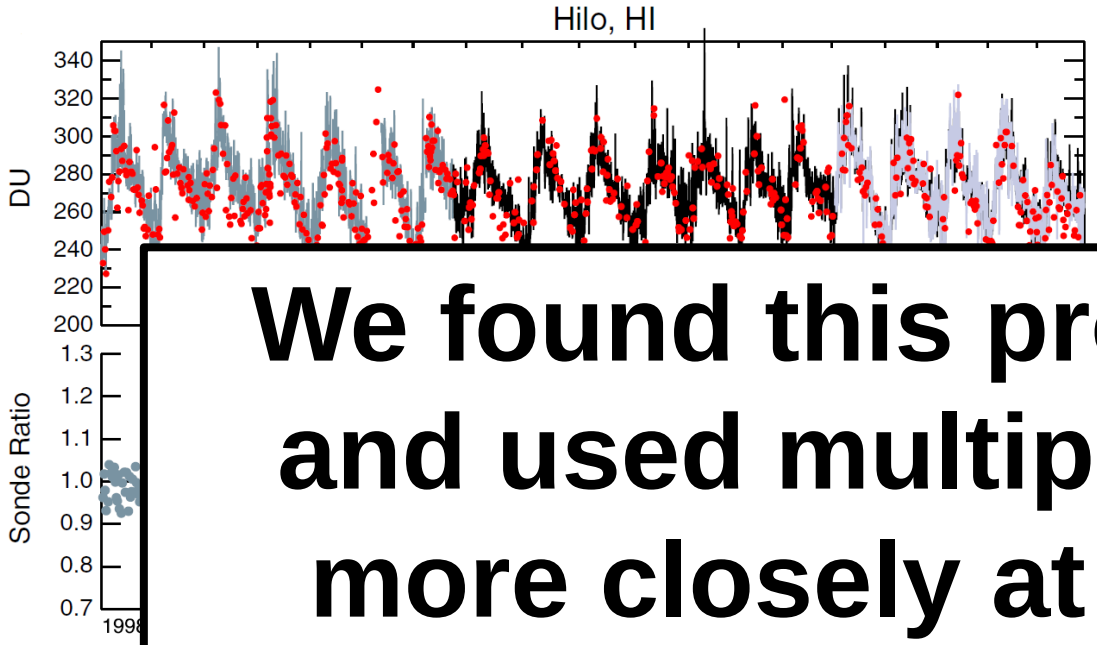
Sterling et al. (2018; AMT)

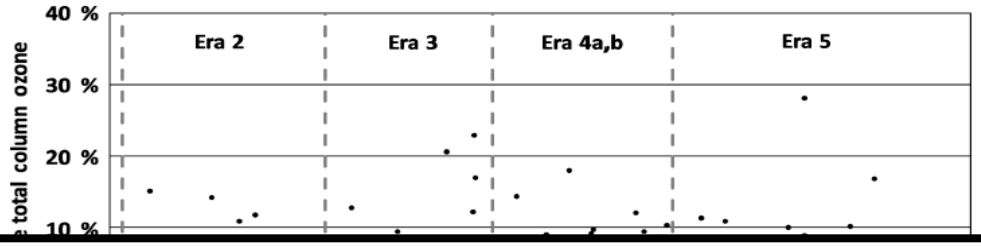
Papers that presented results with newly homogenized ozonesonde data noted low biases in some of the most recent data. Homogenization ensures that this is an instrumental problem!

Left: Hilo, HI, sondes after 2014 show a total column O_3 low bias compared to two satellites

Right: The same issue is noticed in comparisons with the ground-based Dobson spectrometer

Hints of an Emerging Low Bias (Hilo, HI)





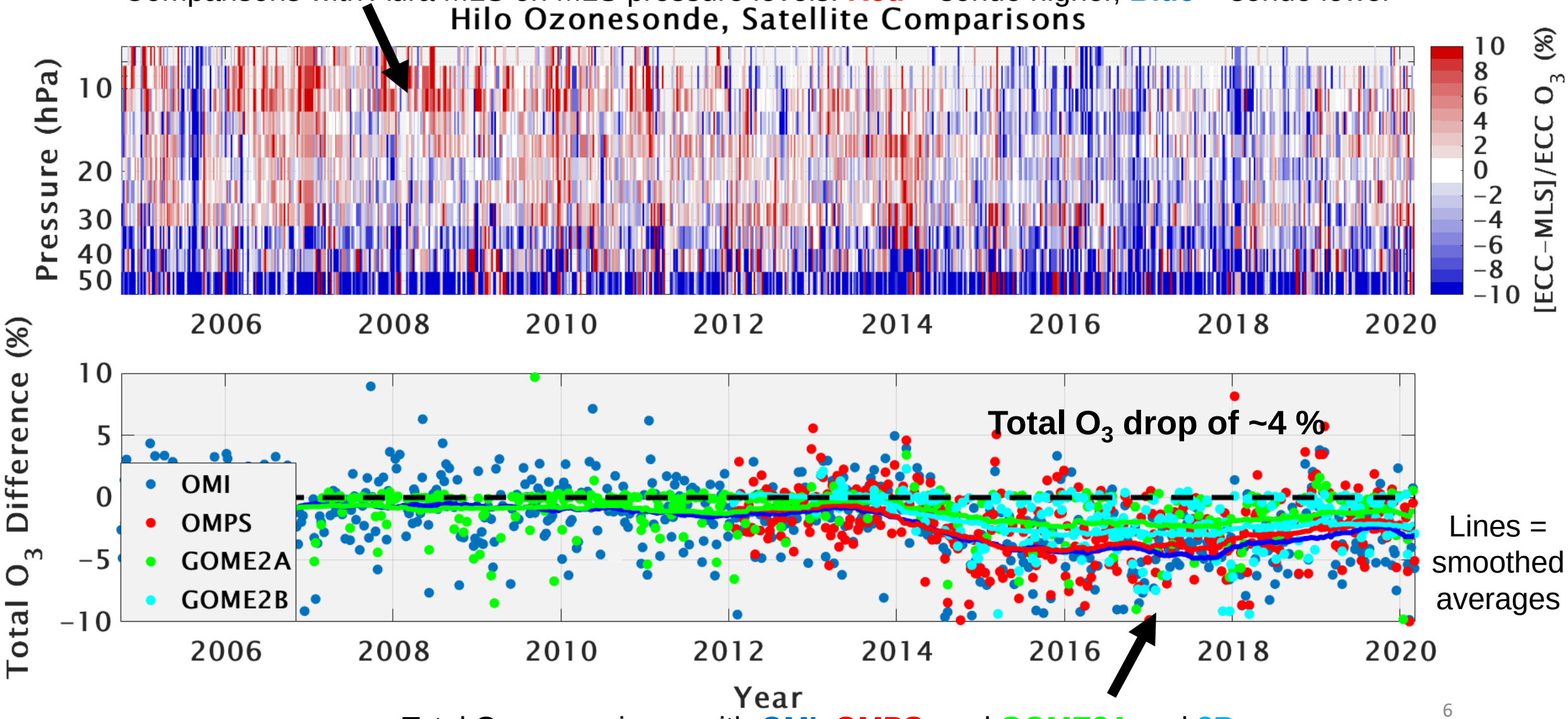
We found this problem at several sites, and used multiple instruments to look more closely at the records of global ozonesonde stations for similar behavior

Pape in some of the most recent data. Homogenization ensures that this is an instrumental problem!

Left: Hilo, HI, sondes after 2014 show a total column O_3 low bias compared to two satellites
Right: The same issue is noticed in comparisons with the ground-based Dobson spectrometer

The Drop at Hilo, HI (19° N)

Comparisons with Aura MLS on MLS pressure levels. **Red** = sonde higher, **Blue** = sonde lower

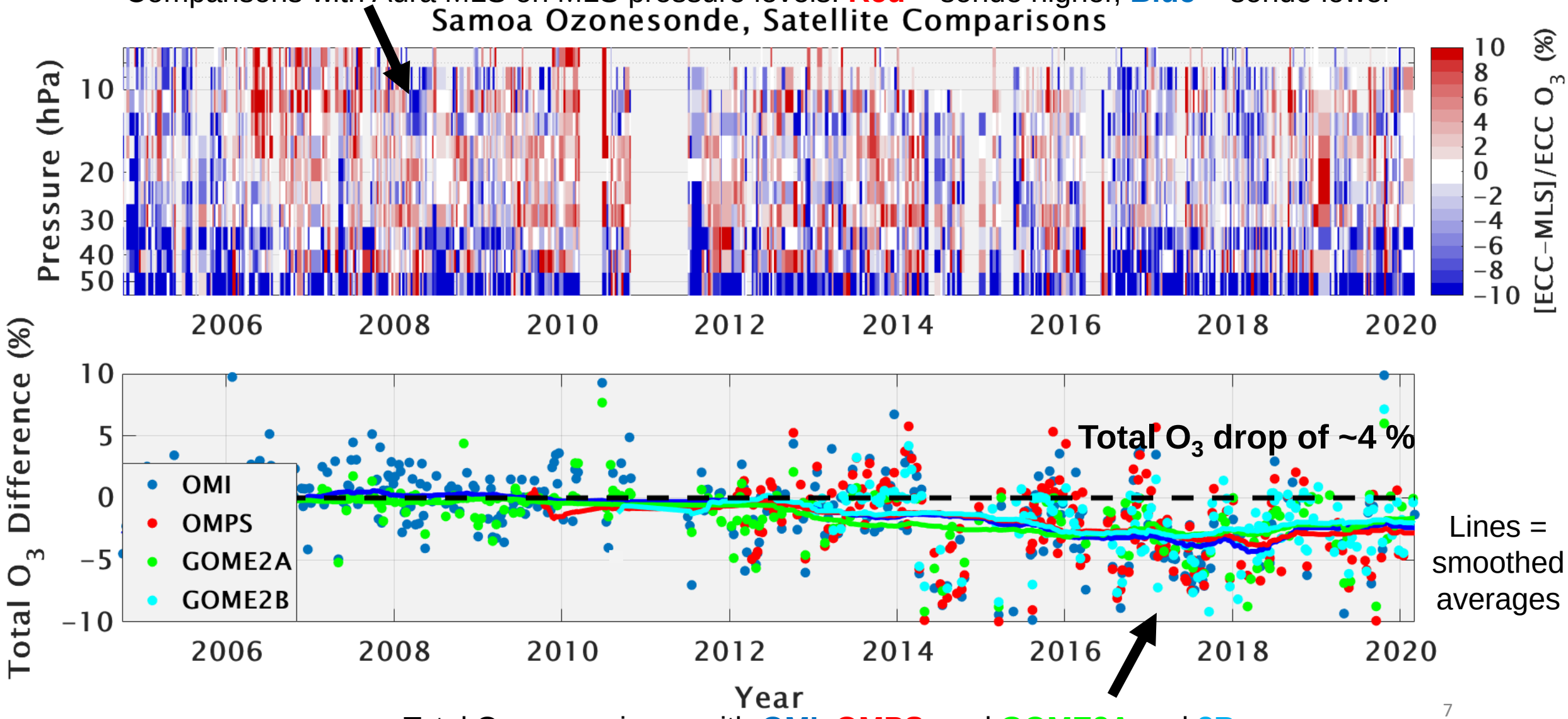


Lines = smoothed averages

Total O_3 comparisons with **OMI**, **OMPS**, and **GOME2A** and **2B** overpasses

The Drop at Samoa (14° S)

Comparisons with Aura MLS on MLS pressure levels. **Red** = sonde higher, **Blue** = sonde lower



Lines = smoothed averages

Total O_3 comparisons with **OMI**, **OMPS**, and **GOME2A** and **2B** overpasses

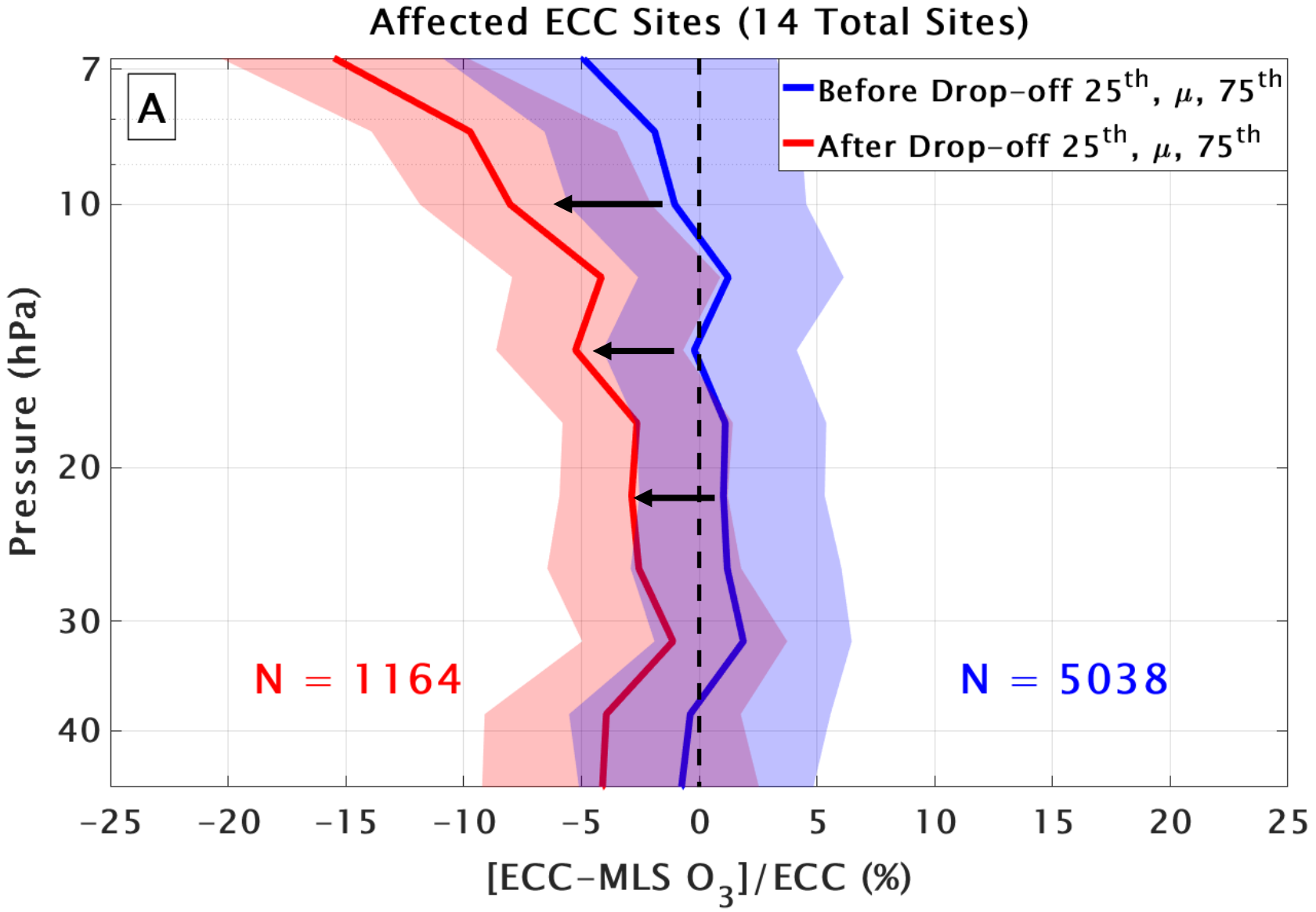
Stratospheric O_3 Measurement Drop (Aura MLS)

In total, **14 global stations** show this "dropoff" behavior

Ozonesondes show a **5-10 % drop** in stratospheric O_3 relative to Aura MLS

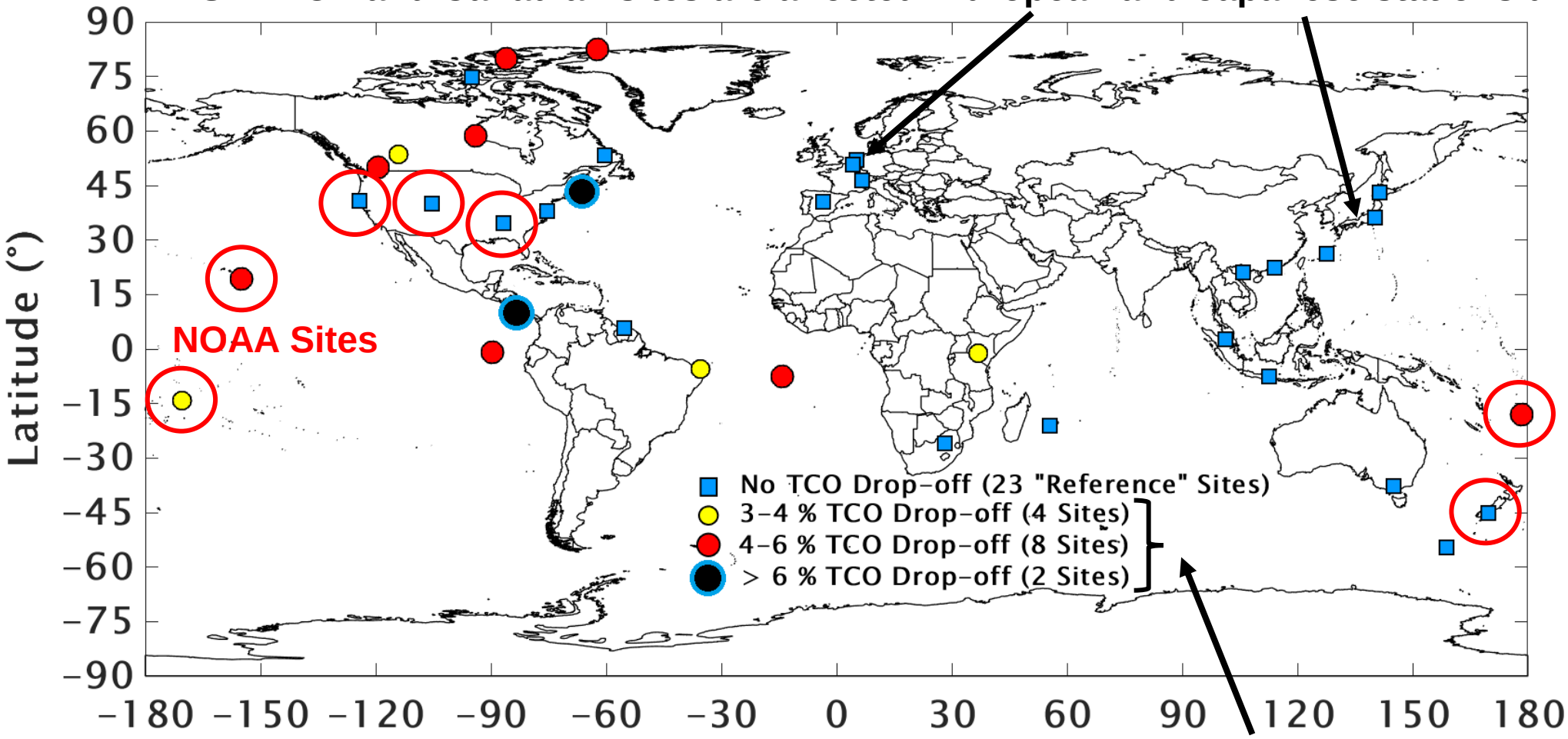
Note the excellent comparisons with MLS **before the drop**

Problem does not appear to affect the troposphere at most sites (Costa Rica may be an exception)



Where do we find this problem?

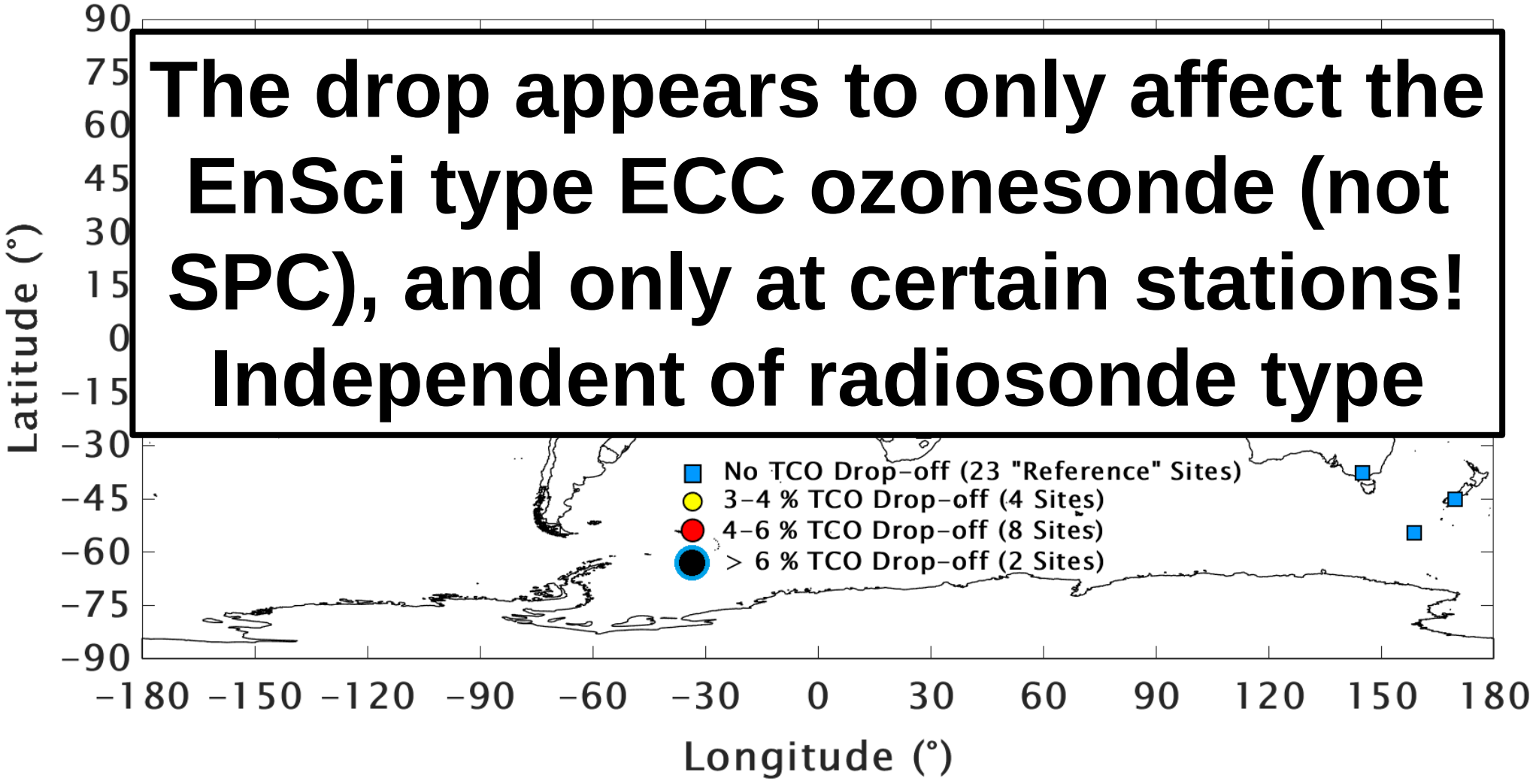
SHADOZ and Canadian sites are affected. European and Japanese stations unaffected



Currently 52 stations analyzed. 37 sites appear here and in the Stauffer et al. (2020) GRL paper

14 stations with ≥ 3 % total column O_3 (TCO) drop

Where do we find this problem?

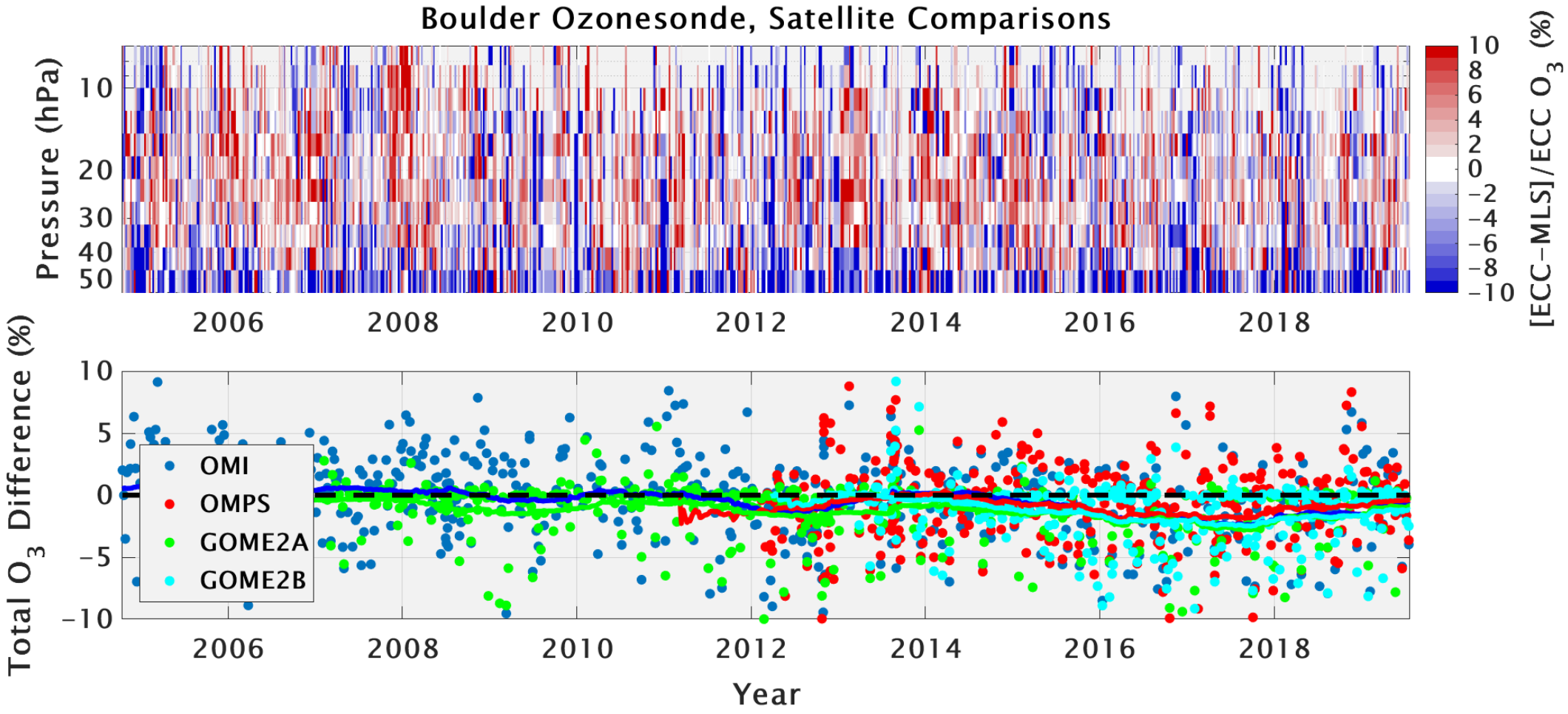


The drop appears to only affect the EnSci type ECC ozonesonde (not SPC), and only at certain stations! Independent of radiosonde type

Unaffected Station: Boulder, CO (40° N)

Boulder ozonesondes compare very well against satellite total and stratospheric O_3

Boulder launches the same **EnSci** ozonesonde as affected stations!



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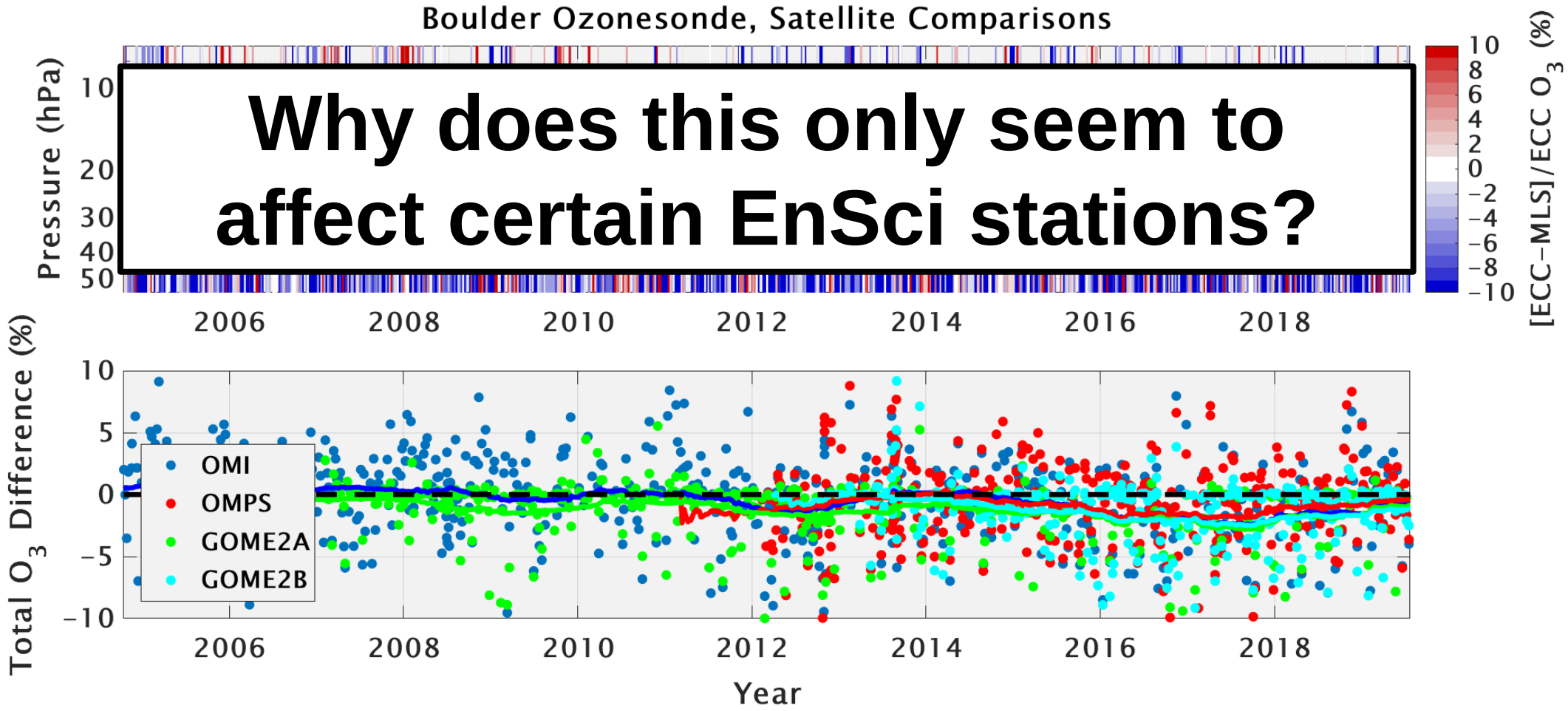

Why does this only seem to affect certain EnSci stations?

ASOPOS Effort to Solve the Drop Problem

- Coincident with preparation of new ASOPOS 2.0 report on ECC ozonesonde SOP and data quality

ASOPOS WMO/GAW Report no. 201

- Four “Task Teams”
  1. Metadata: Station surveys, ECC performance
  2. Data Analysis: Additional comparisons with satellite, lidar, Brewers/Dobsons, “flagging” of affected data
  3. Laboratory Testing: Comparisons with older EnSci ECCs, pump flow, ion bridge, KI solutions
  4. Communication: Outreach to stations and users, advice on how to use affected data

ASOPOS 2.0 in Brussels, Sep 2019

Summary

- A drop of ~3-7 % total column O_3 is found at 14 of 52 ECC ozonesonde stations starting in 2014-2016: Implications for ozonesonde total and stratospheric O_3 trend calculations

- The drop only appears to affect EnSci ECCs (not SPC ECCs), and only at certain NOAA/Global EnSci stations

- ASOPOS is currently working to solve this problem, and discussing what to do with affected data

- *Homogenized data with a drop are still more reliable than un-homogenized!*

Thank You! Select References:

- **ECC O_3 Drop:** Stauffer, R. M., Thompson, A. M., Kollonige, D. E., Witte, J. C., Tarasick, D. W., Davies, J., et al. (2020). A post-2013 dropoff in total ozone at a third of global ozonesonde stations: Electrochemical concentration cell instrument artifacts? *Geophysical Research Letters*, 47, e2019GL086791. https://doi.org/10.1029/2019GL086791

- **SHADOZ Reprocessed Data:** Witte, J. C., et al. (2017), First reprocessing of Southern Hemisphere ADditional OZonesondes (SHADOZ) profile records (1998–2015): 1. Methodology and evaluation, *J. Geophys. Res. Atmos.*, 122, 6611– 6636, doi:10.1002/2016JD02603.

- **NOAA Homogenized Data:** Sterling, C. W., et al. (2018), Homogenizing and estimating the uncertainty in NOAA's long-term vertical ozone profile records measured with the electrochemical concentration cell ozonesonde, *Atmos. Meas. Tech.,* 11, 3661–3687, https://doi.org/10.5194/amt-11-3661-2018

- **ASOPOS WMO/GAW Report no. 201:** Smit, H. G. J., & the Panel for the Assessment of Standard Operating Procedures for Ozonesondes (ASOPOS) (2014). Quality assurance and quality control for ozonesonde measurements in GAW, World Meteorological Organization. GAW Report, 201. Available at. http://www.wmo.int/pages/prog/arep/gaw/documents/FINAL_GAW_201_Oct_2014.pdf