SHADOZ (Southern Hemisphere Additional Ozonesondes) and the Special Role of Tropical Ozonesondes

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50th Anniversary Celebration, 19 Sept 2019

KMI (Royal Meteorological Inst.), Uccle, Belgium

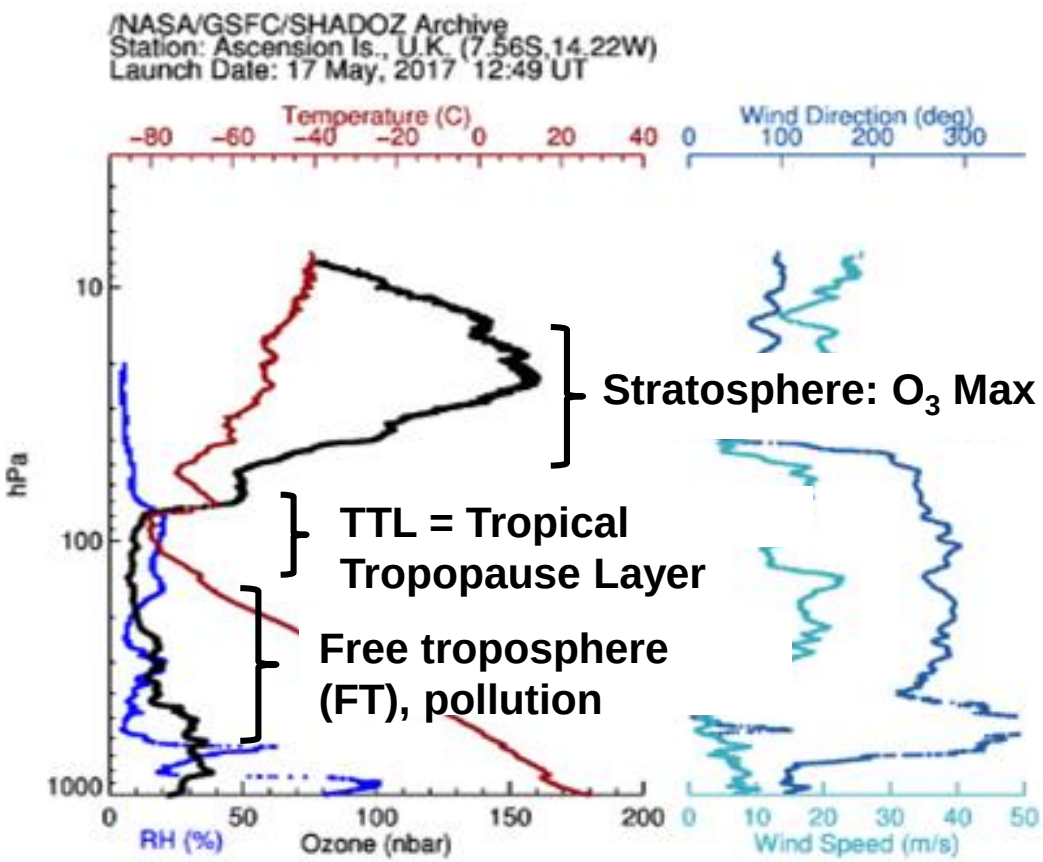
OUTLINE

- **Background – Why are Sonde Data Needed to Monitor Tropical Ozone?**

- **What/Why/Where/Who & How: SHADOZ Technological Achievements**
  - Origins of SHADOZ
  - Satellite validation over 20 years (1998-present)
  - 14 stations, > 20 sponsoring organizations, leveraged resources
  - With WMO & NDACC: Quality Assurance & Capacity Building
  - Quality Assurance: Reprocessed SHADOZ data released, > 8000 profiles, v6.0

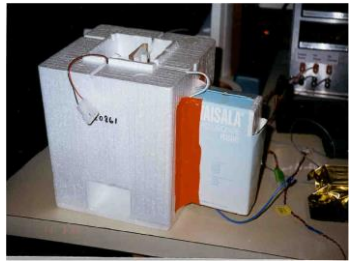
- **SHADOZ Scientific Achievements**
  - Current issues in Free Tropospheric (FT) & Lower Stratospheric trends
  - SHADOZ FT ozone trends – “gold standard” for satellite products
  - SHADOZ and LS ozone trends – integrating sondes & MLS ozone

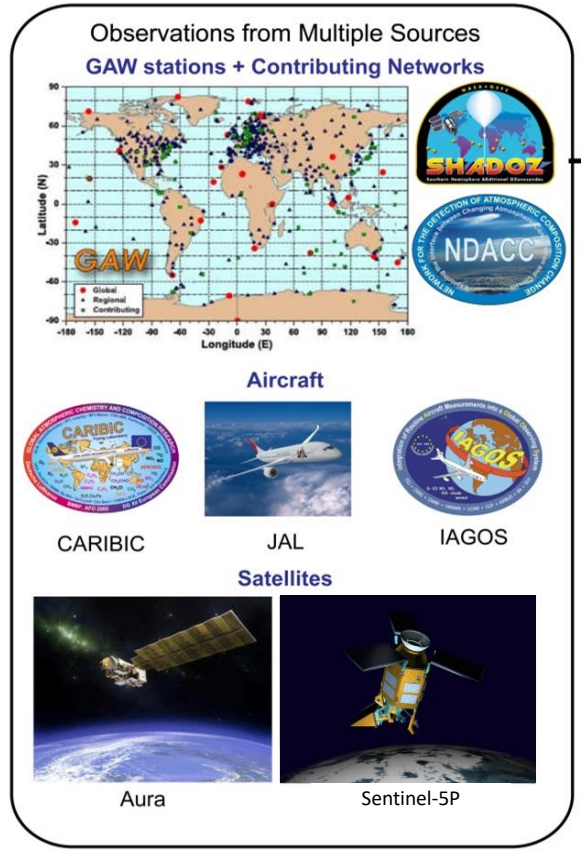
Why Sondes Needed for Tropical Ozone?



Electrochemical Concentration Cell (ECC) ozonesonde.

ECC sonde attached to a radiosonde →



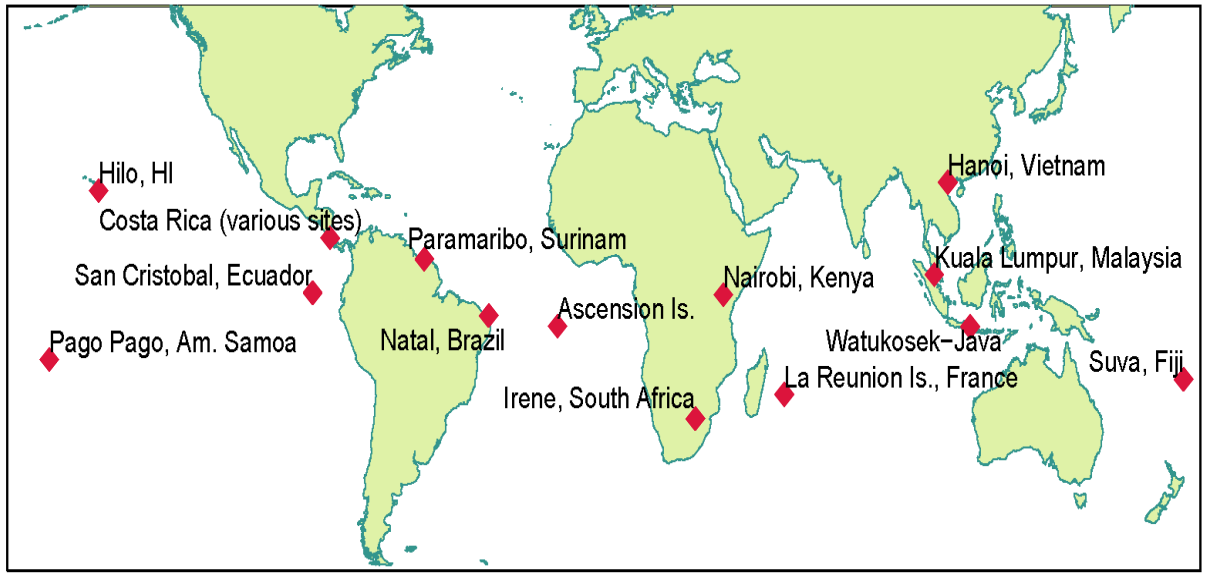


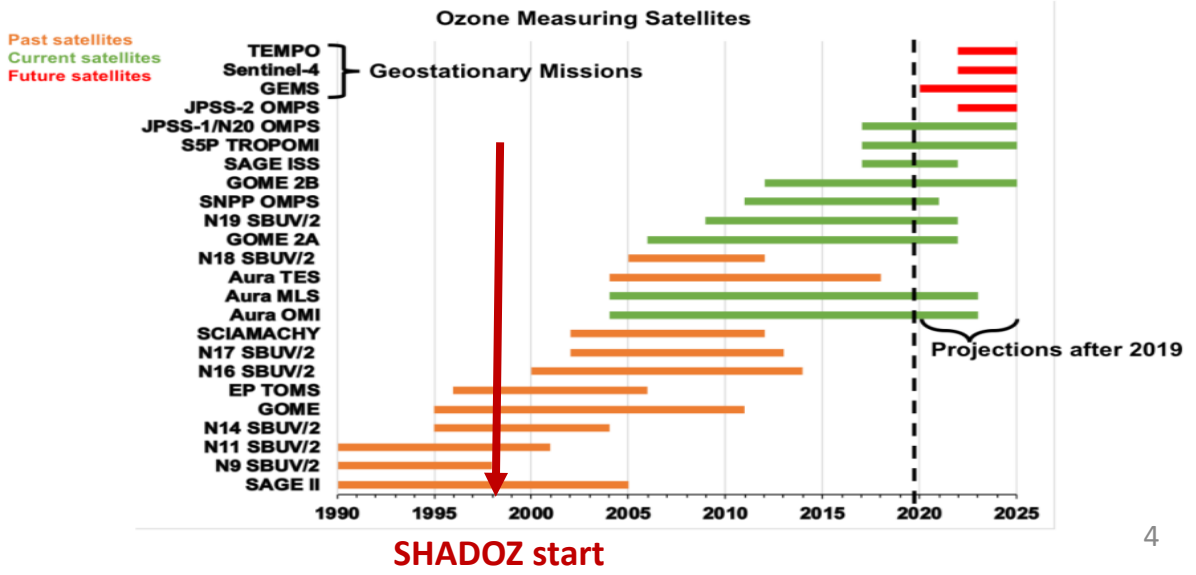
- *Left:* "Good" (stratospheric), "bad" (FT) ozone. **Tropical Tropopause Layer** ("TTL") is critical region at nexus of climate (temp, dynamics) and ozone change.
- *Right:* Compared to satellites (poor tropospheric sensitivity), lidar (clear sky only), sondes have ~100 m resolution to ~33 km, including TTL where most satellites have limited accuracy.

Why/When/Where/What/How SHADOZ

- "Strategic" ozonesonde network coordinates tropical launches for science:
- **1998:** 1 stable station, 8 intermittent stations, data not available
- **NOW:** 14 sites with 10-yr record (upper)
- Satellite "ground truth" (lower)
- Monitor O_3 trends for UNEP/WMO Assessments, Montreal Protocol
- 2009: NDACC & WMO/GAW affiliations
- https://tropo.gsfc.nasa.gov/shadoz

> 8000 O_3, PTU profiles, 1998-2019



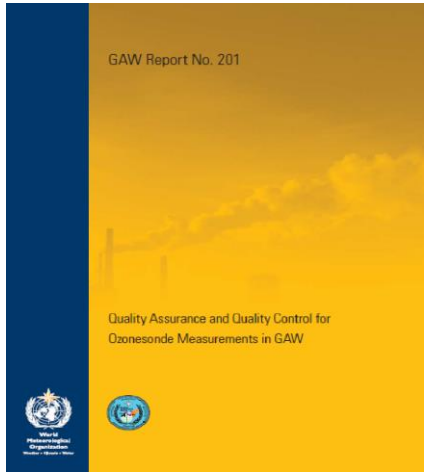


Quality Assurance & Capacity- Building in WMO-sponsored ASOPOS (2012-2019) & JOSIE-2017

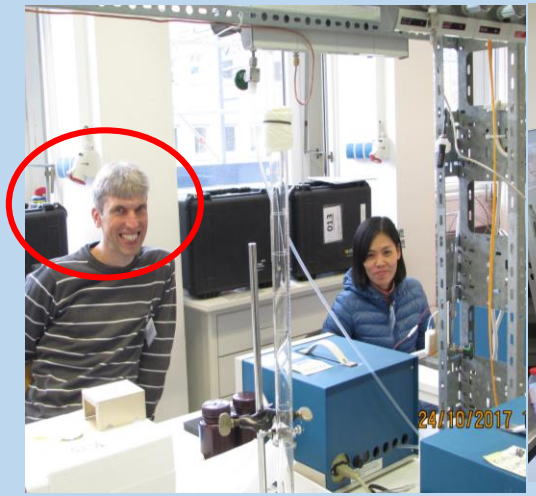
- JOSIE-2017 dedicated to SHADOZ operator training & evaluation of instruments & new KI solutions, procedures

- Series of ASOPOS meetings led to WMO Report 201 on Ozone-Sonde procedures. Also guidelines for Reprocessing of data, based on JOSIE 1996-2009 ➔

- Next! 2020 Update



2017 JOSIE-SHADOZ Sonde Testing & Training with UNEP Vienna Conv. Trust Fund & WMO Support



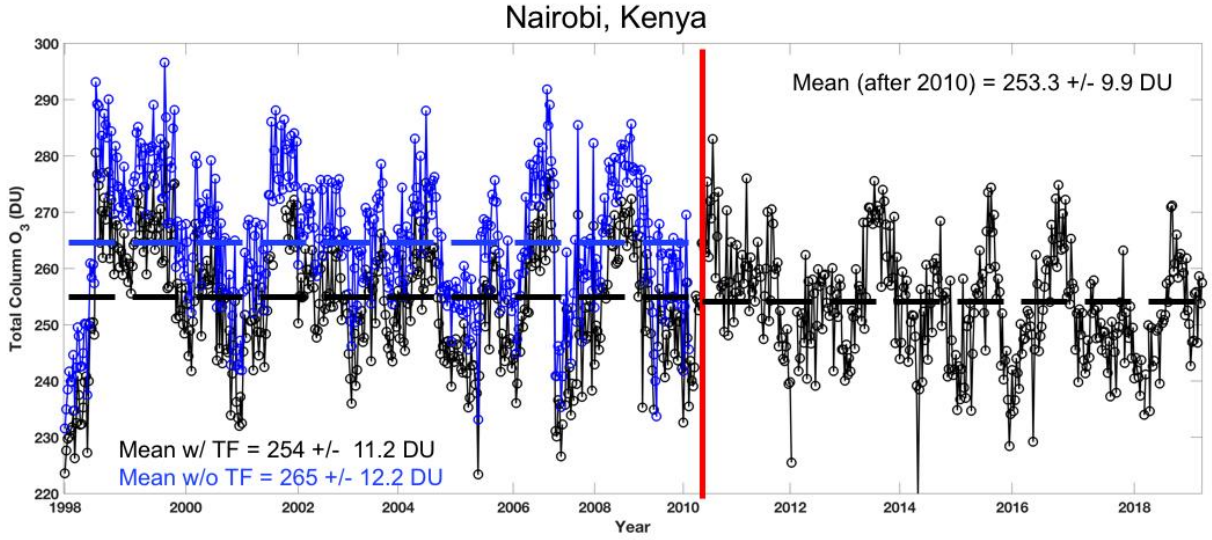
Bull. Am. Meteo. Soc., January 2019

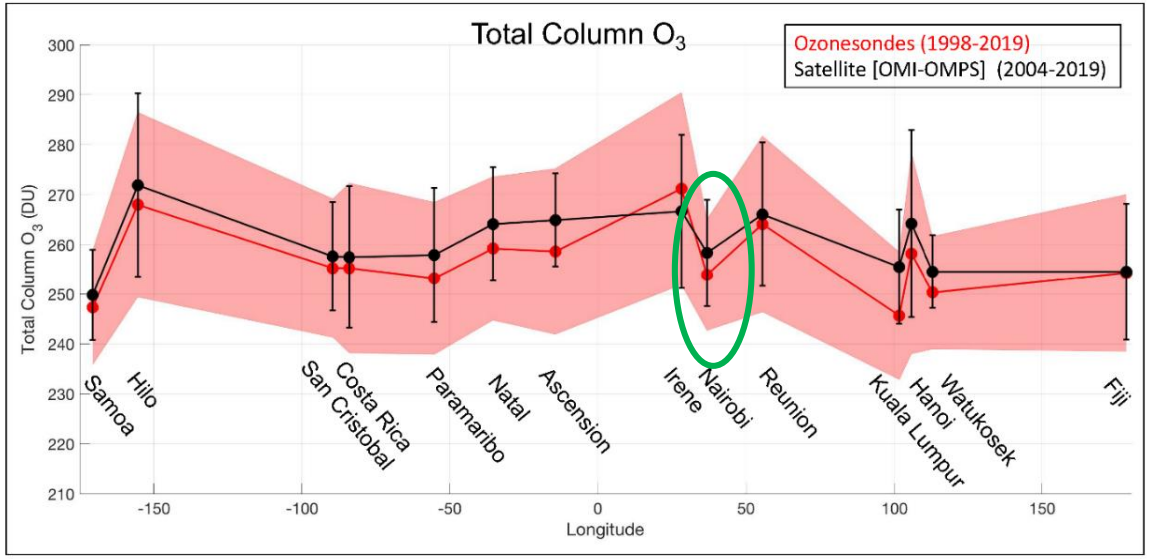
OZONESONDE QUALITY ASSURANCE

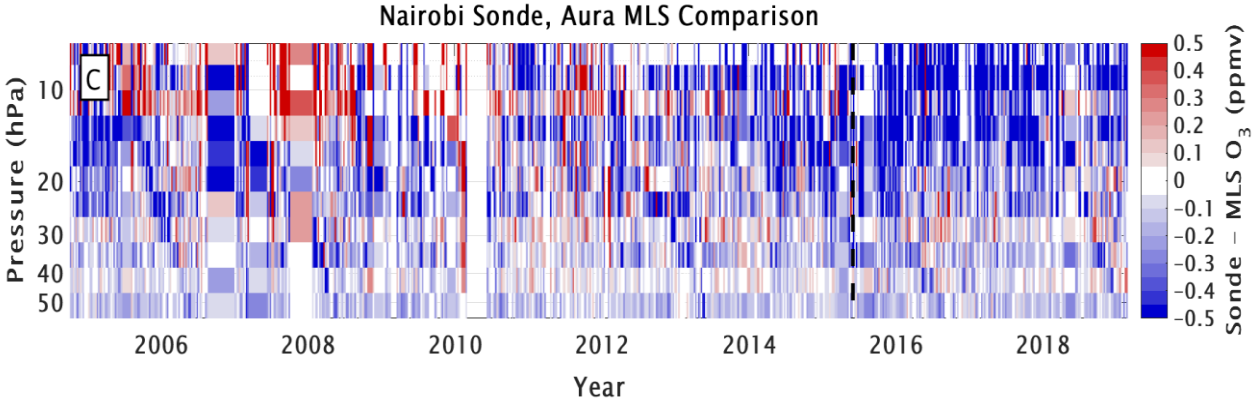
The JOSIE–SHADOZ (2017) Experience

Anne M. Thompson, Herman G. J. Smit, Jacquelyn C. Witte, Ryan M. Stauffer, Bryan J. Johnson, Gary Morris, Peter von der Gathen, Roeland Van Malderen, Jonathan Davies, Ankie Piters, Marc Allaart, Françoise Posny, Rigel Kivi, Patrick Cullis, Nguyen Thi Hoang Anh, Ernesto Corrales, Tshidi Machinini, Francisco R. da Silva, George Paiman, Kennedy Thiong'o, Zamuna Zainal, George B. Brothers, Katherine R. Wolff, Tatsumi Nakano, Rene Stübi, Gonzague Romanens, Gert J. R. Coetzee, Jorge A. Diaz, Sukarni Mitro, Maznorizan Mohamad, and Shin-Ya Ogino

Quality Assurance: Reprocessing of Every Profile! (Upper Left). Result: Better Agreement with Aura/MLS (Lower Left) and Total Column from OMI & OMPS (Lower Right)







TOTAL COLUMN O_3: All stations agree 5% or better, all but one 3% or better.
From SHADOZ data, 1998-2019
http://tropo.gsfc.nasa.gov/shadoz

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Current Issue in Free Troposphere (FT) Ozone

- Six sonde-model and validated satellite FT O_3 products analyzed for tropical trends by Gaudel, Cooper et al. (2018) diverge widely in regional pattern, magnitude, even sign
- What do SHADOZ sondes say?
- Run standard Multiple Linear Regression Model on SHADOZ time-series using 3 “combo-sites”

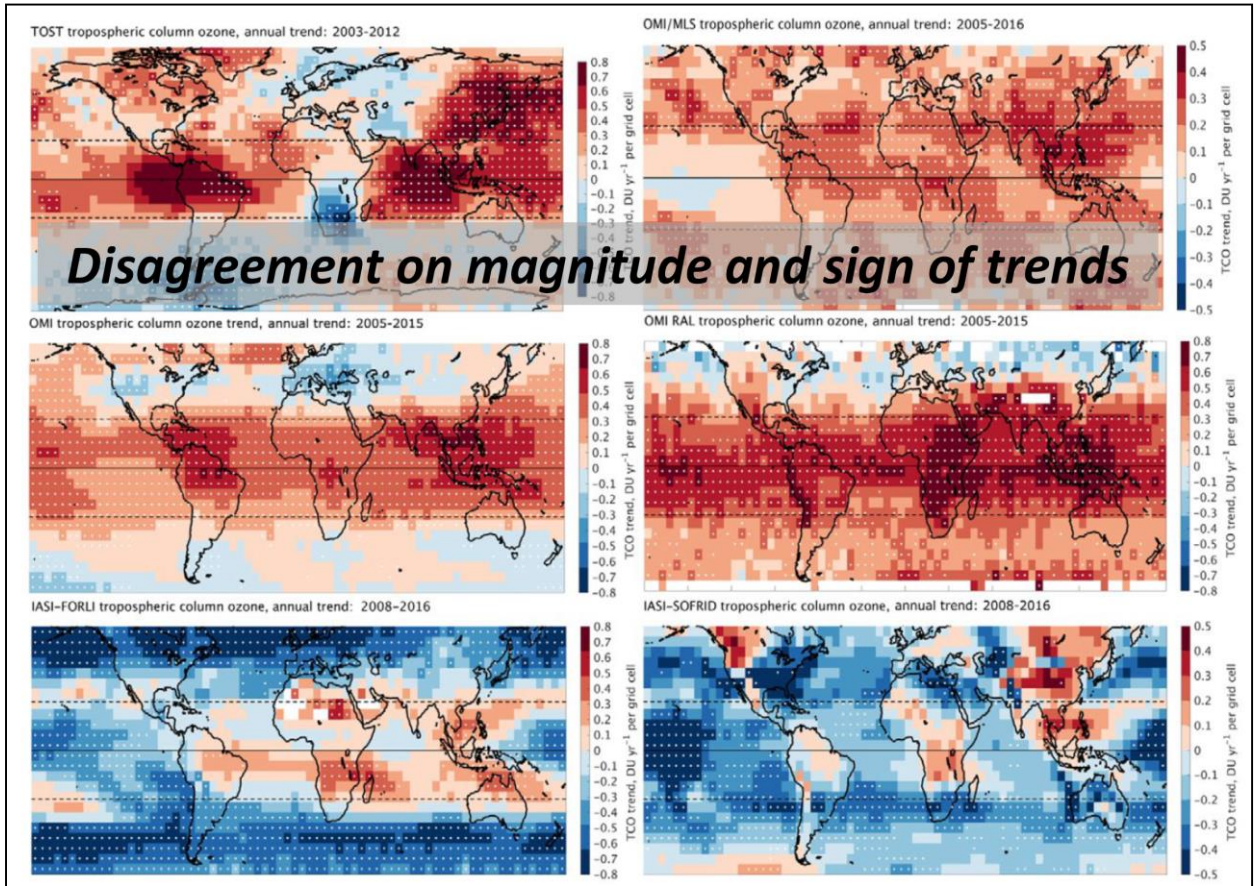

Figure 1. Figure 24 from Gaudel et al., (2018). A comparison of tropospheric column O_3 trends from five satellite and one ozonesonde product over ~10-15 year periods. Red indicates increases, and blue indicates decreases. Stipples show where trends are statistically significant.

ACKNOWLEDGMENTS!

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NASA HQ: M. Kurylo (1998-2008), K. Jucks (2008->) and J. Kaye

- **SHADOZ – 20 Years in 2018!** Partners in US Europe, Asia & Africa, with visible data & engaged in WMO/ NDACC O_3 "Community," maintain operations

THANK YOU, DATA USER COMMUNITY