

THE TRIALS AND TRIUMPHS OF SHADOZ (SOUTHERN HEMISPHERE ADDITIONAL OZONESONDES):

THE WHO'S WHO OF TROPICAL OZONE PROFILES



Jacque Witte (NASA/GSFC, SSAI)
Anne Thompson (NASA/GSFC)
Bryan Johnson (NOAA/GMD)
Samuel Oltmans (NOAA/GMD)
Patrick Cullis (NOAA/GMD, CIRES)
Chance Sterling (NOAA/GMD, CIRES)
Allen Jordan (NOAA/GMD, CIRES)
Herman Smit (FZ-Juelich, Germany)

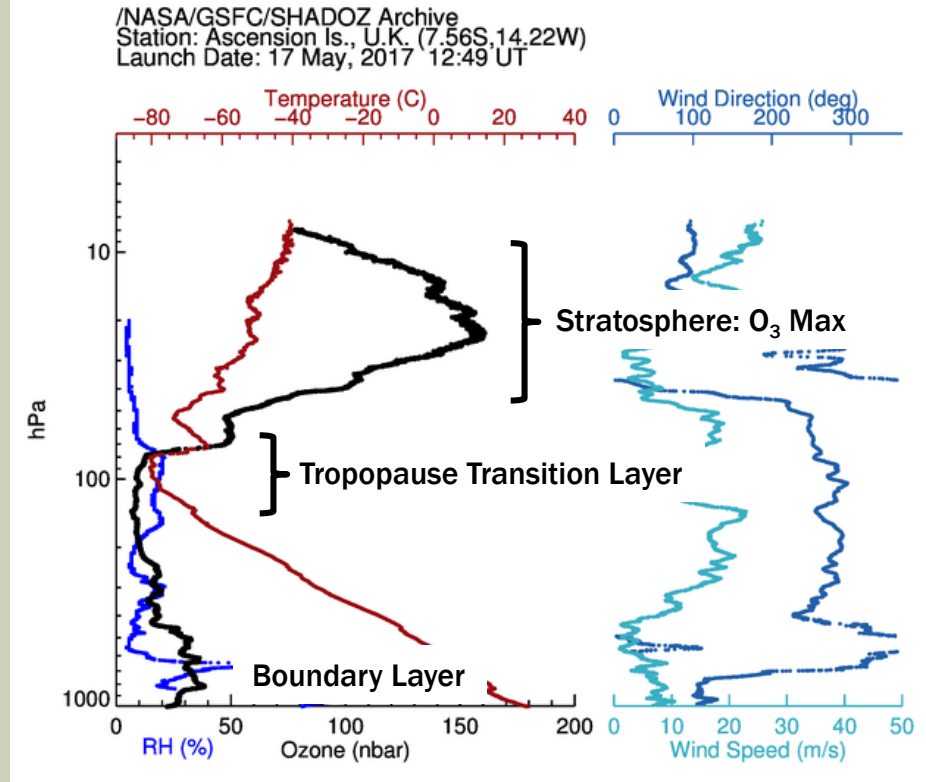
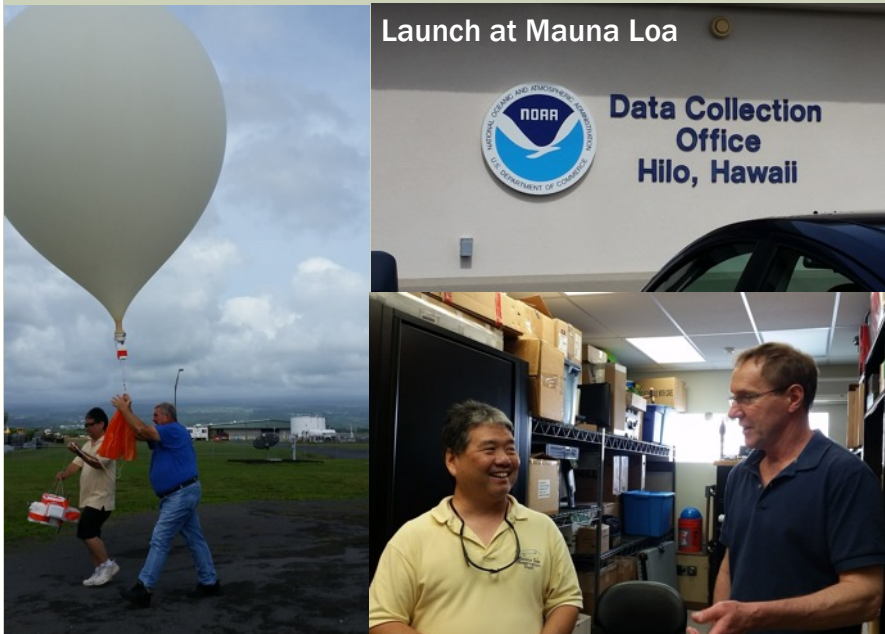
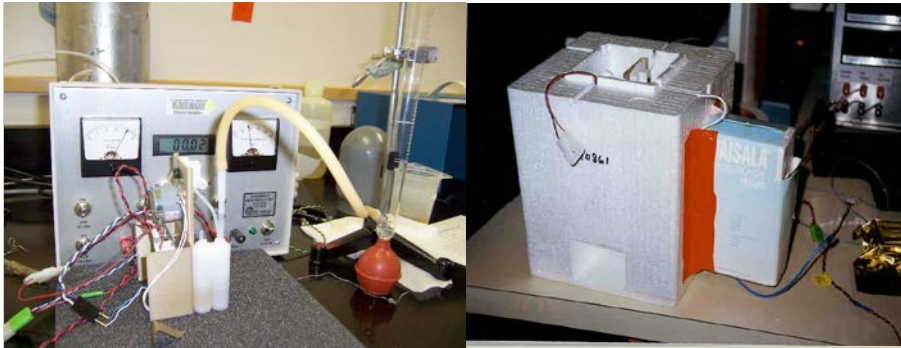


ROADMAP



- Ozonesondes – why they are awesome!
- (1) Reprocessing in a nutshell
 - Witte et al., JGR, doi:10.1002/2016JD026403 [2017]
 - Sterling et al., AMT, doi:10.5194/amt-2017-397 [2018]
- (2) Evaluation highlight
 - Thompson et al., JGR, doi:10.1002/2017jd027406 , [2017]
 - Thompson et al., BAMS, submitted, [2018]
- (3) Uncertainty highlight
 - Witte et al., JGR, doi:10.1002/2017JD027791, [2018]
- Recap

ELECTROCHEMICAL CONCENTRATION CELL (ECC) OZONESONDES

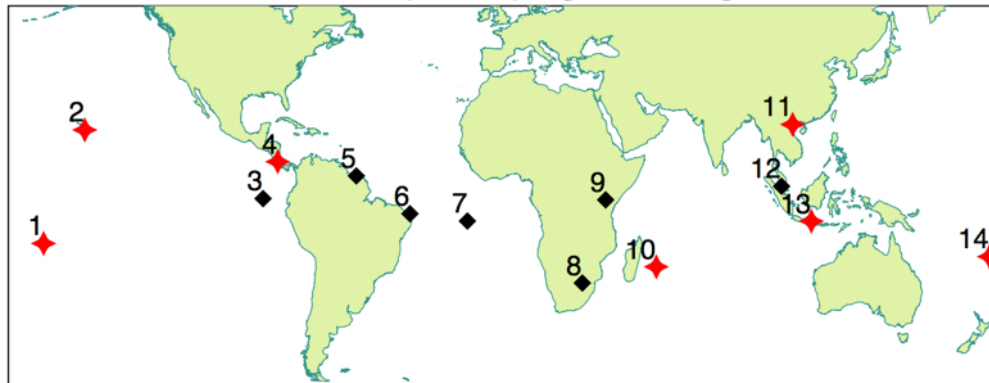


- High vertical resolution from the surface to 35km
- Easy to operate
- Launch anywhere, anytime

(1) REPROCESSING SHADOZ DATA RECORDS



SHADOZ Sites: <https://tropo.gsfc.nasa.gov/shadoz>



- | | |
|------------------------------|------------------------------|
| 1=Am. Samoa | 8=Irene, S. Africa |
| 2=Hilo, HI | 9=Nairobi, Kenya |
| 3=San Cristobal | 10=La Reunion, France |
| 4=Costa Rica (various sites) | 11=Hanoi, Vietnam |
| 5=Paramaribo, Surinam | 12=Kuala Lumpur, Malaysia |
| 6=Natal, Brazil | 13=Watukosek-Java, Indonesia |
| 7=Ascension Is. U.K. | 14=Suva, Fiji |

★ = NOAA supported stations (50% of SHADOZ sites)

Since 1998 ~ 20 years of archiving.



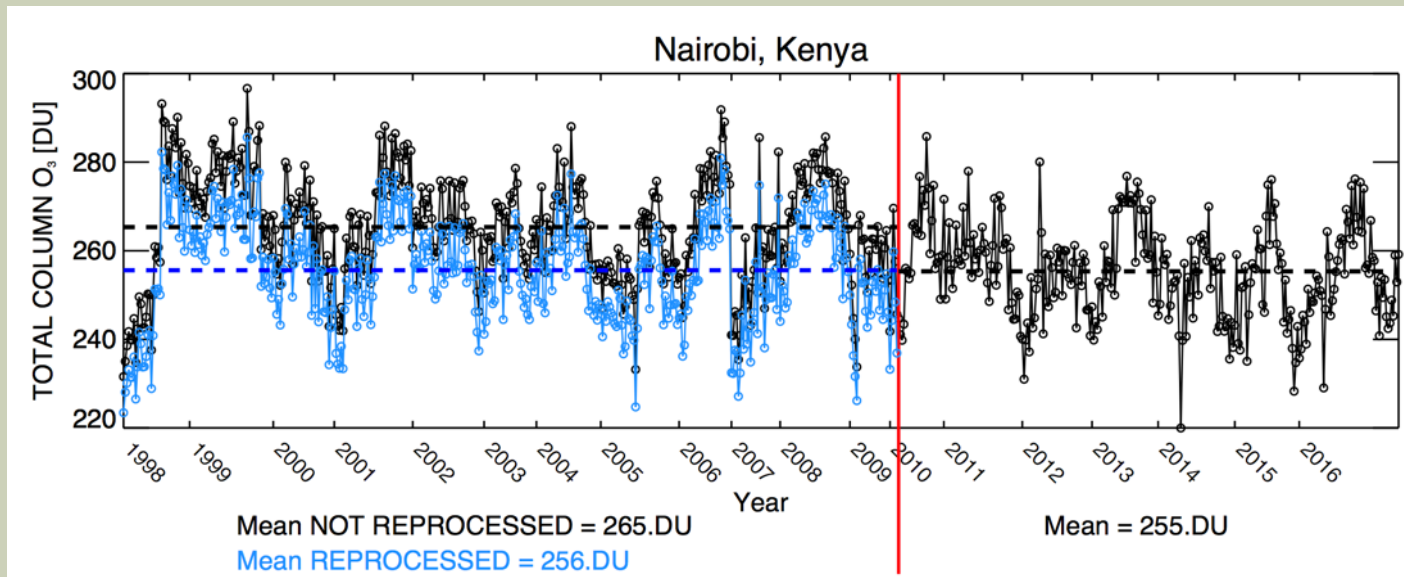
Launch at Nairobi, Kenya



Launch at Paramaribo, Surinam

WHAT ARE THE ISSUES?

- Instrumentation and operating procedures vary
 - Introduce inhomogenities
- Reprocessing can be hampered by incomplete metadata reporting
- Non-standard solution recipes
 - One size does NOT fit all – ozone response vary



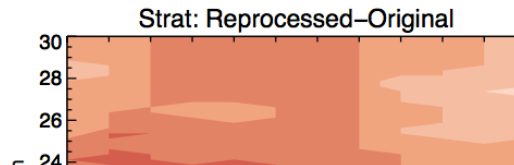
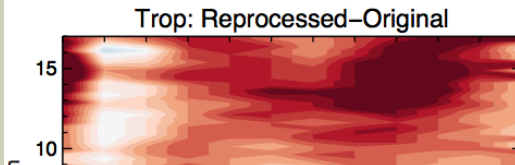
REPROCESSING IN A NUTSHELL

**Major
Impact
(> 10%)**

1998-2016
monthly mean
annual cycle

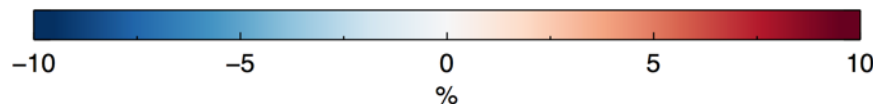
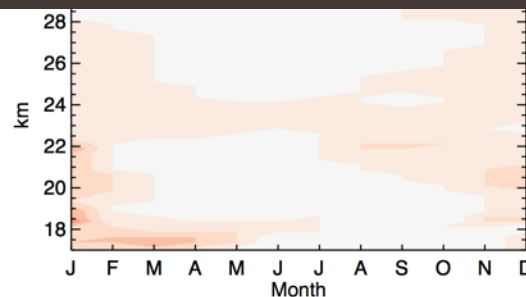
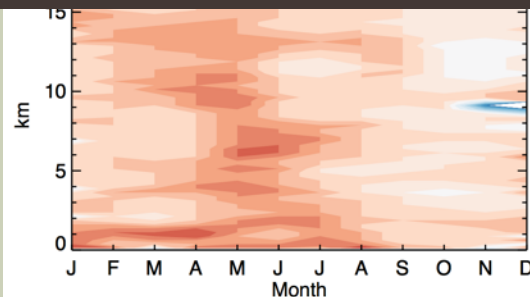
**Minor
Impact**

Watukosek–Java(7.6S,113E)



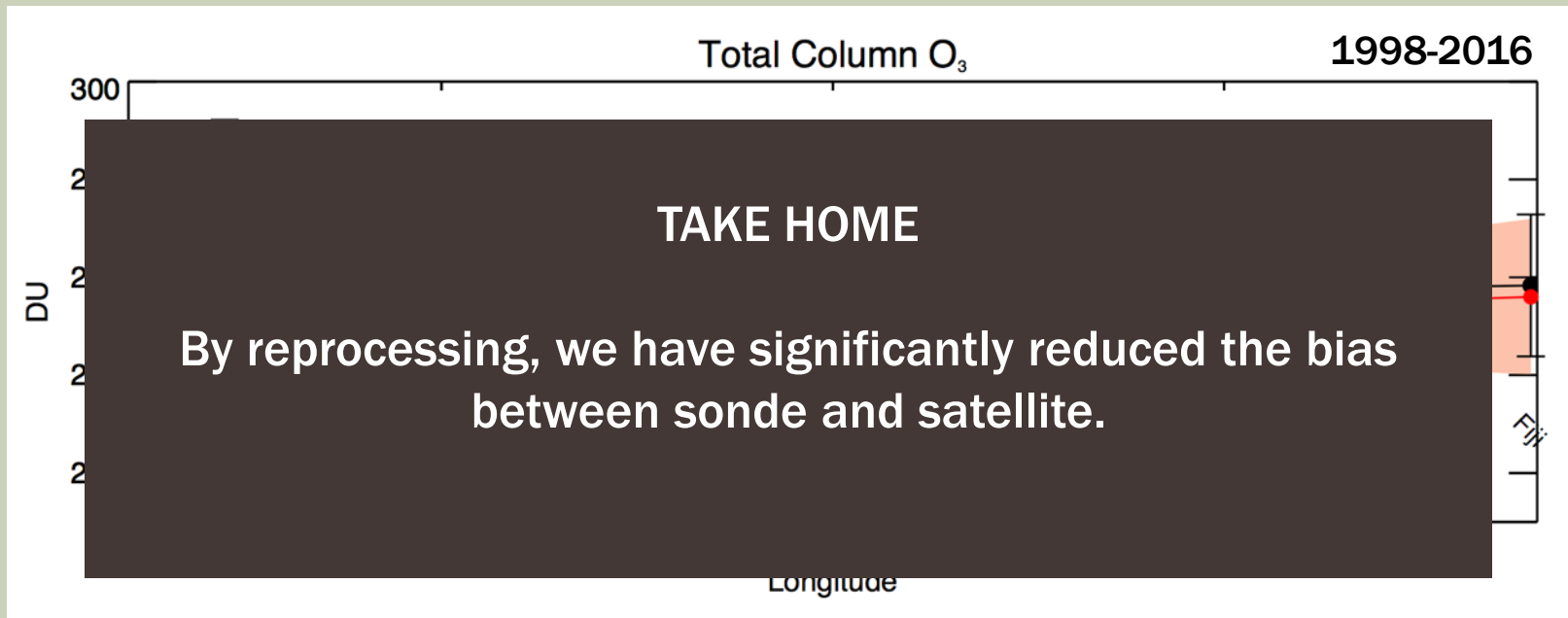
TAKE HOME

Reprocessing is not homogeneous.
It is site dependent and profile dependent.



(2) EVALUATION HIGHLIGHT 12 OF 14 STATIONS ARE WITHIN 2% OF NASA AND NOAA SATELLITES (TOMS, OMI, OMPS)

Red = $\pm 1\sigma$ Sonde Black = $\pm 1\sigma$ Satellite



Thompson et al., 2017

- Reprocessing achieves up to 5% total ozone accuracy – includes independent ground-based instruments, i.e. Dobson, Brewer
- Compared with 1st SHADOZ evaluation [Thompson et al., 2003], where Satellite-Sonde offsets > 10% at half the sites

(3) UNCERTAINTY HIGHLIGHTS

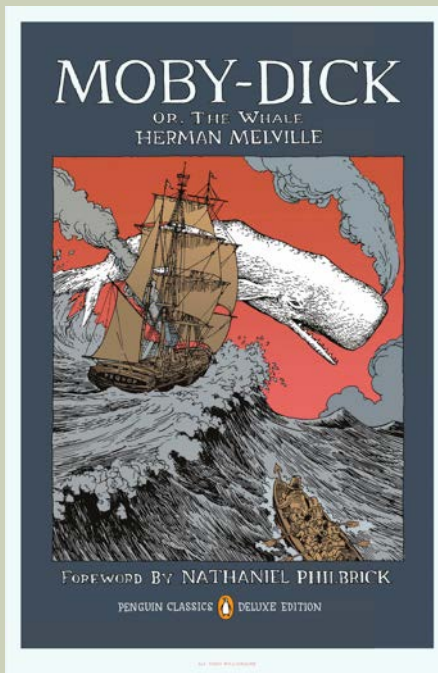


George Paiman: Paramaribo, Surinam Operator

VERTICAL OZONE PROFILE UNCERTAINTY: THE WHITE WHALE IN THE OZONESONDE COMMUNITY

■ White Whale

- “An objective that is relentlessly or obsessively pursued but difficult to achieve” – *Oxford Dictionary*

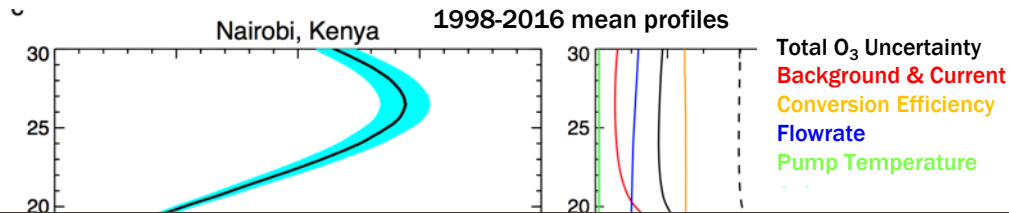


$$\frac{\Delta P_{O_3}}{P_{O_3}} = \sqrt{\frac{(\Delta I_M)^2 + (\Delta I_B)^2}{(I_M + I_B)} + \left(\frac{\Delta \eta_c}{\eta_c}\right)^2 + \left(\frac{\Delta \Phi_P}{\Phi_P}\right)^2 + \left(\frac{\Delta T_P}{T_P}\right)^2}$$

WMO/GAW #201, 2014

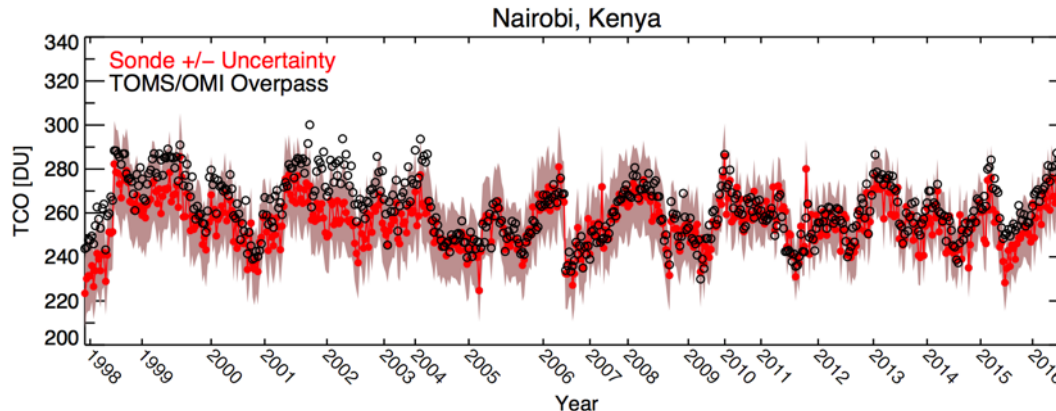
$$\begin{aligned} O_3 \text{ Uncertainty} = & \Delta O_3 \text{ Background} + \Delta O_3 \text{ Current} + \\ & \Delta \text{Conversion Efficiency} + \\ & \Delta \text{Flowrate} + \\ & \Delta \text{Pump Temperature} + \\ & \Delta \text{Transfer Function} \end{aligned}$$

UNCERTAINTY HIGHLIGHT



TAKE HOME

After ~50 years we can provide uncertainties!



RECAP: WHERE TO FIND THE ESSENTIAL DETAILS

1. Reprocessing

- Witte et al., JGR, doi:10.1002/2016JD026403 [2017]
- NOAA Reprocessing: Sterling et al., AMT, doi:10.5194/amt-2017-397 [2018]

2. Evaluation

- Thompson et al., JGR, doi:10.1002/2017jd027406 [2017]
- JOSIE-2017: Thompson et al., BAMS, submitted, [2018]

3. Uncertainties: Witte et al., JGR, doi:10.1002/2017JD027791 [2018]



JOSIE = JUELICH [GERMANY] OZONE SONDE INTERCOMPARISON EXPERIMENT

- Oct/Nov 2017
- Evaluate WMO operating procedures, training, test new solutions & instruments
- 8 SHADOZ operators participated, thanks to WMO/UNEP funding support
- **POSTER SESSION: P11**
- Also see **POSTER P57** (NOAA's reprocessing efforts)

