

# The Stratospheric Water and Ozone Satellite Homogenized data set (SWOOSH):

## A long-term database for climate studies

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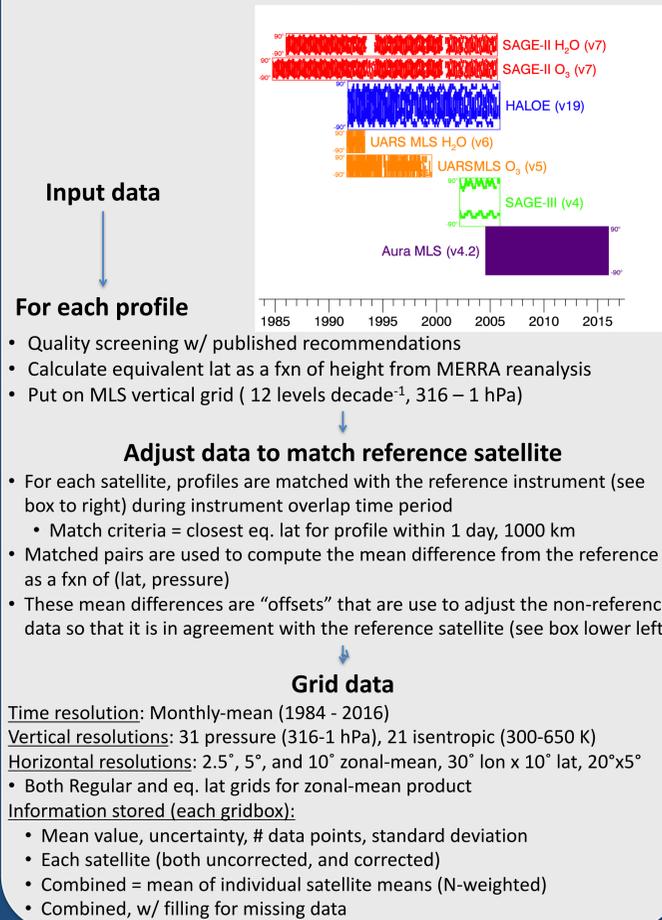


### Introduction

Vertical profiles of ozone from the upper troposphere to stratosphere have been retrieved from a number of limb sounding and solar occultation satellite instruments since the 1980's. In particular, measurements from the SAGE instruments, UARS MLS, UARS HALOE, and most recently Aura MLS, have provided overlapping data since 1984. In order to quantify interannual- to decadal-scale variability in ozone, it is necessary to have a uniform and homogenous record over the period of interest. With this in mind, we merged the aforementioned satellite measurements to create the Stratospheric Water and Ozone Satellite Homogenized (SWOOSH) data set, which contains vertically resolved zonal-mean (2.5°) monthly-mean water vapor and ozone concentration at levels covering the stratosphere.

This poster describes the process of merging the satellite data sets, which involves adjusting the data to a reference measurement using offsets calculated from coincident observations taken during instrument overlap periods. Along with the primary SWOOSH product (i.e., merged monthly-mean ozone and water vapor), a large amount of additional information is stored in SWOOSH, including the individual satellite records (both unadjusted and adjusted versions), uncertainty estimates, and other statistics such as the number of measurements and standard deviations. This poster presents examples of the types of information stored in SWOOSH.

### Constructing SWOOSH



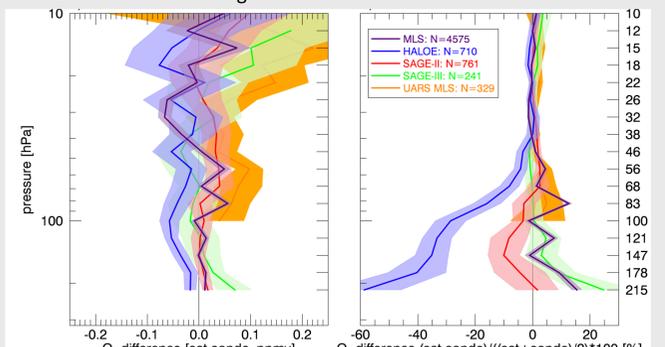
### Choosing a reference

- Rather than simply averaging a set of data to create a merged record, in SWOOSH the data from each satellite are adjusted to match the “most accurate” satellite.
- For ozone, the “most accurate” satellite is determined through comparison with ozonesonde matches.

Ozonesonde stations using in comparison

Station	Latitude	Longitude	# Soundings	Period
Alert (CAN)	82.5	-62.3	1028	1987-2011
Resolute (CAN)	74.7	-95.0	885	1978-2011
Uccle (BEL)	50.8	4.4	2299	1996-2013
Boulder (USA)	40.0	-105.3	698	1991-2015
Wallops (USA)	37.9	-75.5	1779	1970-2013
Hilo (USA)	19.4	-155.0	1717	1982-2013
Natal (BRA)	-5.5	-35.3	661	1979-2013
Samoa (USA)	-14.2	-170.6	992	1995-2013
Lauder (NZL)	-45.0	169.7	1275	1986-2008
Davis (ATA)	-68.6	78.0	270	2003-2013
Neumeyer (ATA)	-70.7	-8.3	1553	1992-2015

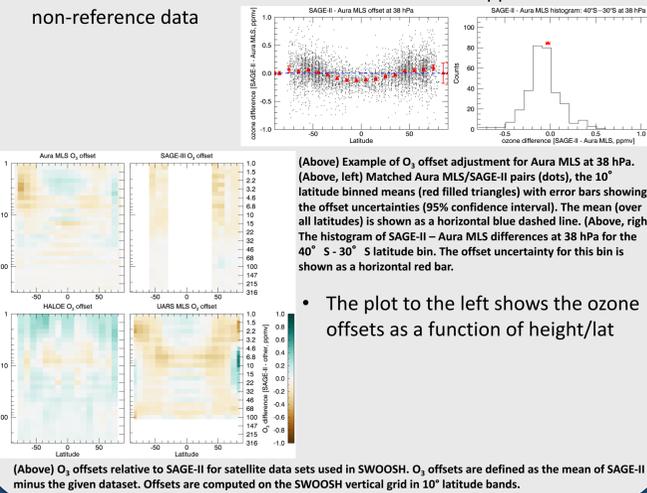
- The plot below compares the matched ozonesonde and satellite data sets as a function of height.



- SAGE-II is used as the reference measurement in SWOOSH, as it provides consistent agreement with ozonesondes and a long record of overlap with other satellites.
- Aura MLS is used as the reference for water vapor.

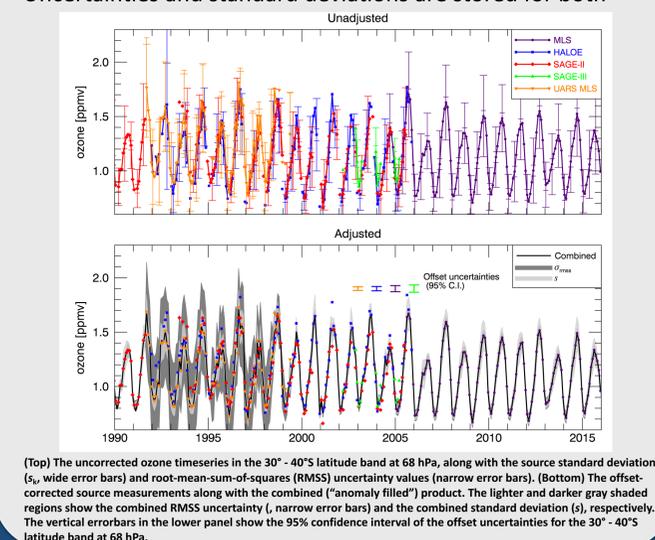
### The H in SWOOSH

- Satellite-satellite profile matches between the reference and non-reference are used to compute mean differences in 10° lat bins at each level.
- These mean differences are “offsets” that are then applied to the non-reference data



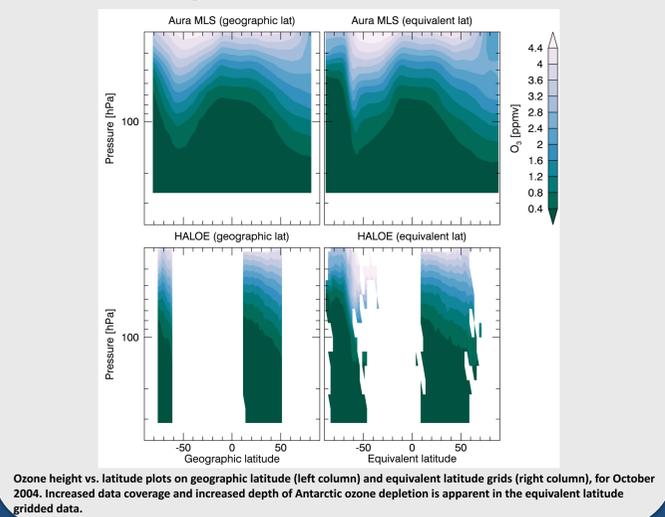
### Merging/Uncertainty example

- SWOOSH has individual satellite data and a merged product
- Uncertainties and standard deviations are stored for both



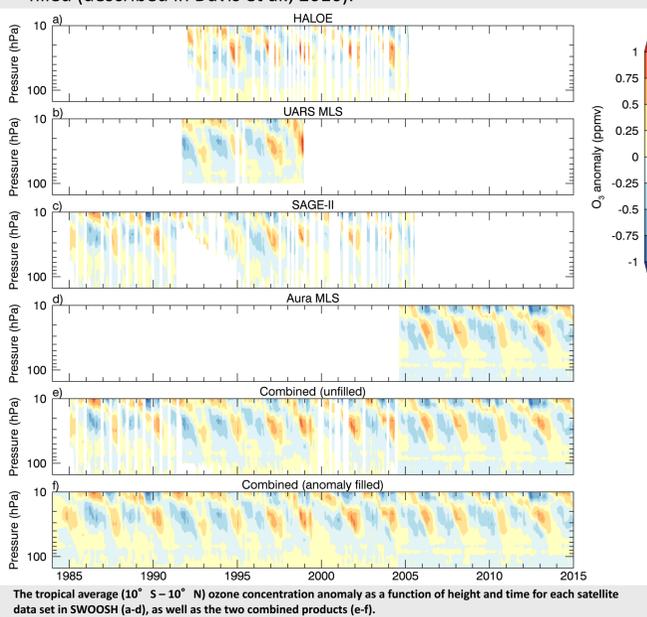
### Example (equivalent lat grid)

- In addition to the normal geographical latitude grid, SWOOSH data are also gridded on an equivalent latitude grid, computed separately at each level using MERRA PV.



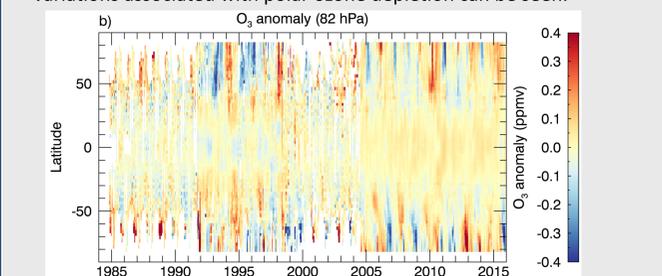
### Example (QBO & gap filling)

- This example illustrates the utility of having a combined record for studying phenomena like the quasi-biennial oscillation (QBO).
- Also shown is the “anomaly-filled” product where data gaps have been filled (described in Davis et al., 2016).

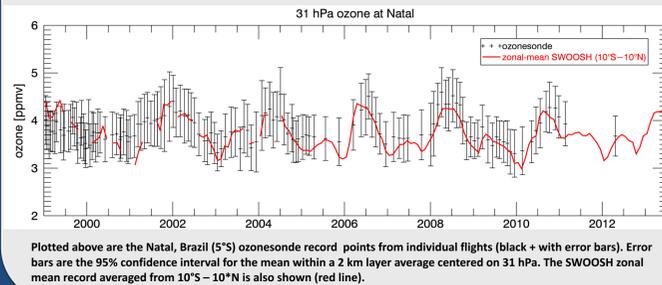


### Example (variability)

- The plot below shows interannual variability at 82 hPa.
- Variations associated with polar ozone depletion can be seen.



- Below is a comparison with the Natal, Brazil (5°S) ozonesonde record
- QBO-related variability is well captured by SWOOSH



### References

**SWOOSH overview paper:**  
 Davis, S. M., Rosenlof, K. H., Hassler, B., Hurst, D. F., Read, W. G., Vömel, H., Selkirk, H., Fujiwara, M., and Damadeo, R.: The Stratospheric Water and Ozone Satellite Homogenized (SWOOSH) database: a long-term database for climate studies, Earth Syst. Sci. Data, 8, 461-490, doi:10.5194/essd-8-461-2016, 2016.

**SWOOSH ozone evaluations:**  
 Tummon, F., et al. (2015). Intercomparison of vertically resolved merged satellite ozone data sets: interannual variability and long-term trends, *Atmospheric Chemistry and Physics*, 15(6), 3021-3043.  
 Hubert, D., et al. (2015). Ground-based assessment of the bias and long-term stability of fourteen limb and occultation ozone profile data records, *Atmos. Meas. Tech. Discuss.*, 2015, 6661-6757.  
 Harris, N. R. P., et al. (2015). Past changes in the vertical distribution of ozone - Part 3: Analysis and interpretation of trends, *Atmospheric Chemistry and Physics*, 15(17), 9965-9982.

### Get SWOOSH

Data available at <http://www.esrl.noaa.gov/csd/swoosh/>

### Conclusions

- SWOOSH provides a vertically-resolved homogenized and merged record of satellite stratospheric ozone and water vapor extending from the 1980's to present.
- SWOOSH should be useful for assessing interannual and longer-term variability and trends in ozone.
- SWOOSH will continue to be updated with Aura MLS data.
- Future work will investigate addition of OMPS-Limb data to SWOOSH as an eventual MLS replacement.