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Centuries of Data: the US Dobson Station network reevaluated

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NOAA and its predecessors have operated a network of Dobson ozone spectrophotometers monitoring the thickness of the ozone layer starting in 1957 at Mauna Loa observatory. This network consists of 14 stations today. A complete list of the stations and the operational status of each is displayed in Table 1. The data processing for this network was developed for computers and operating systems which are becoming more and more difficult to maintain. The decision was made to adopt the software package designed by the Japanese Meteorological Agency (JMA). At this time, all operational stations data is being processed and reported using the WinDobson software, and all historical data has been converted to the WinDobson format – about **600** years combined of data. A study is being performed to evaluate the changes introduced into the data record by conversion to a system with different parameters.

Table1. Current Stations in the NOAA Network using Dobson Ozone Spectrophotometers

Station	Station Established	Current Operating Organization	Automation
Mauna Loa GMD Observatory	1957	NOAA	JMA full
South Pole	1961	NOAA	Encoder
Bismarck, North Dakota	1963	NOAA	Encoder
Caribou, Maine	1963	NOAA	Encoder
Nashville, Tennessee	1963	NOAA	Encoder
Fairbanks, Alaska	1964	NOAA; University of Alaska	JMA Full
Boulder, Colorado	1966	NOAA	JMA Full
Wallops Is., Virginia	1967	NOAA; NASA	Encoder
Barrow GMD Observatory	1973	NOAA	Encoder
American Samoa, GMD Observatory	1975	NOAA	Encoder
Haute Provence, France	1983	NOAA; Centre National de la Recherche Scientifique,	JMA Full
Fresno and Hanford, California	1983	NOAA	Encoder
Perth, Australia	1984	NOAA; Australian Bureau Meteorology	NOAA Full
Lauder, New Zealand	1987	NOAA; NIWA	JMA Full

The software used by NOAA was a process of many steps with intermediate files and programs. The process has evolved from the original processing by hand in the late 1950s to the set of programs designed in the earlier 1990s. The JMA software was also developed in the 1990s (but kept current) in parallel with the development of the automated Dobson instruments used by the JMA (and now NOAA). The package allows for almost real-time analysis of the observations, allowing an observer to view the results of the observation with respect to others taken at the site in the recent past and from satellite, and compared to the climatological record.

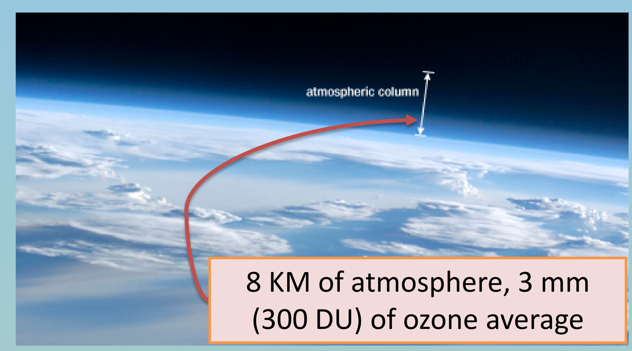
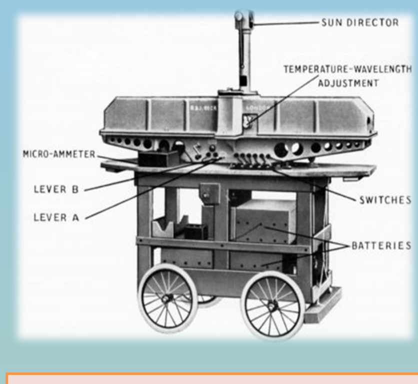


Image Science and Analysis Laboratory, NASA-Johnson Space Center. "The Gateway to Astronaut Photography of Earth." ISS011-E-5487



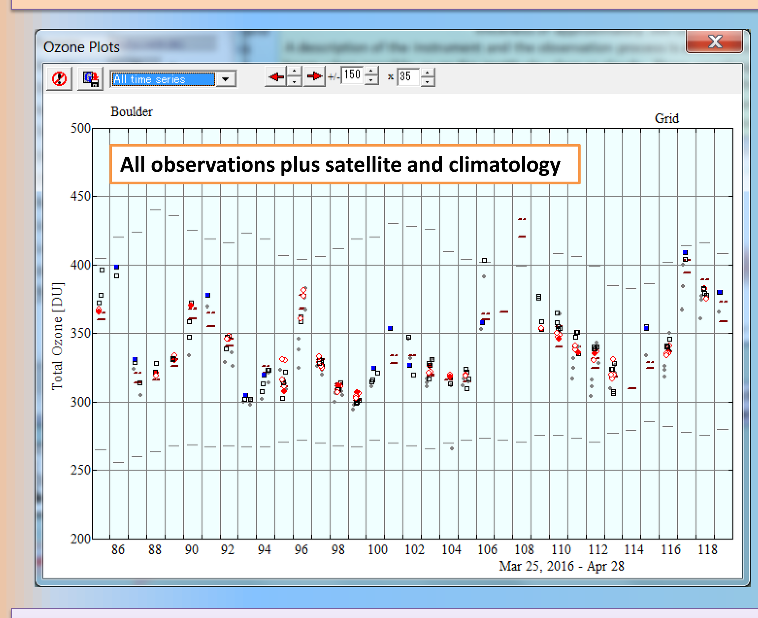
1930s Dobson

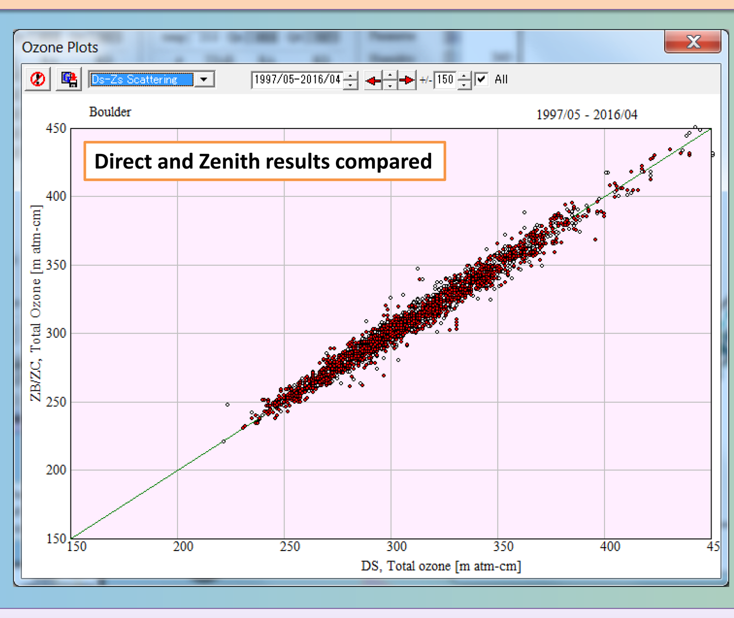
Encoder equipped Dobson

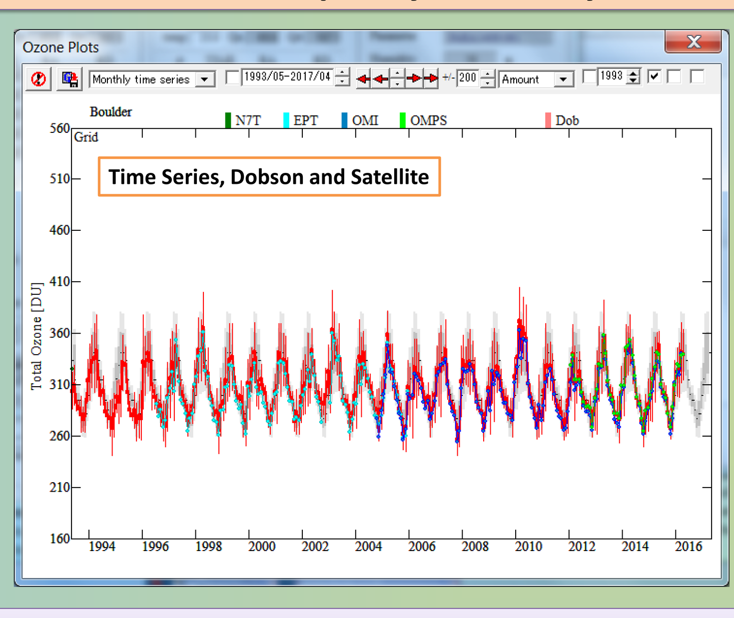
Fully automated JMA

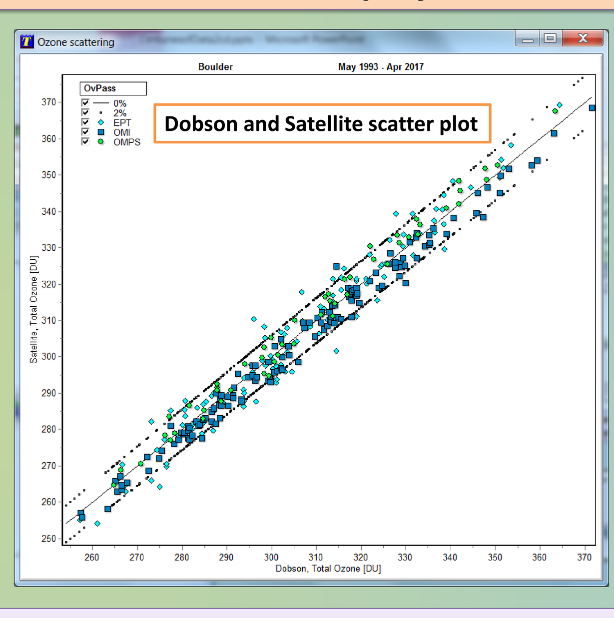
The Dobson instrument makes measurements of the relative difference of the intensity of UV light in the region 305-340NM, using selected pairs of wavelengths. The measurements are processed with the time and place information and laboratory determined ozone absorption coefficients to produce a number that is representative of the thickness of the ozone layer above the station, often called total column ozone (TCO). TCO is normally expressed in Dobson Units (DU) – the thickness of the equivalent pure ozone at Sea Level pressure and zero degrees Celsius temperature. Note that the worldwide average thickness of approximately 300 Dobson units corresponds to 3 millimeters (three stacked dimes).
The observations are made on the direct solar beam when possible, or on the zenith sky, clear or cloudy. Three wavelength pairs (A, C and D) are normally used in combinations selected based on the sun's zenith angle and the sky conditions. A fourth wavelength pair (C') in the visible is used in combination with the C pair for zenith observations only. The reduction of the direct sun observations is a straight forward application of Beer's Law, but the zenith observations are reduced to TCO using a statistical scheme based on quasi-simultaneous measurements on the direct sun and zenith – see P-29.

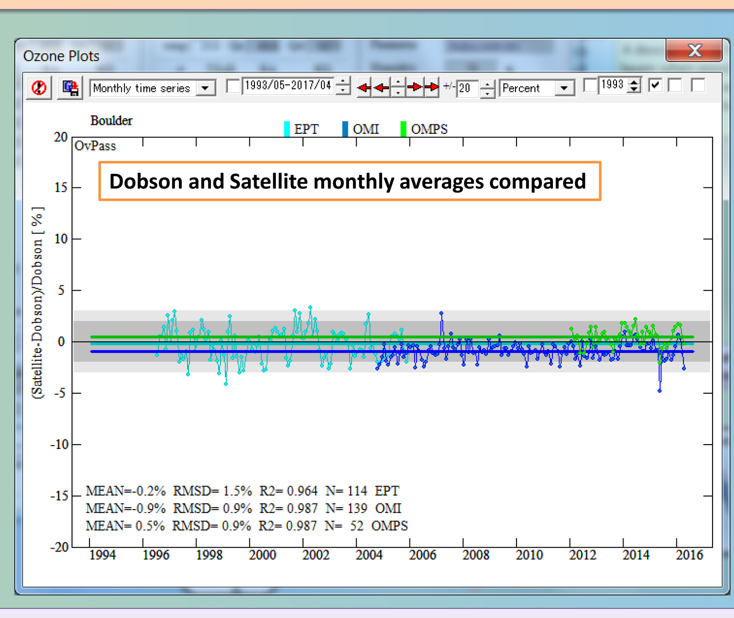
Some of the data quality and analysis tools of Windobson are displayed below.

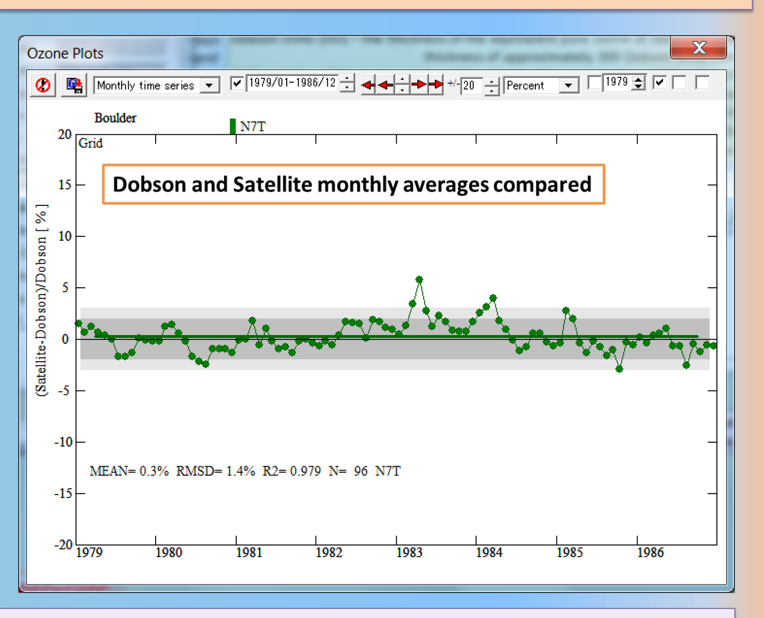




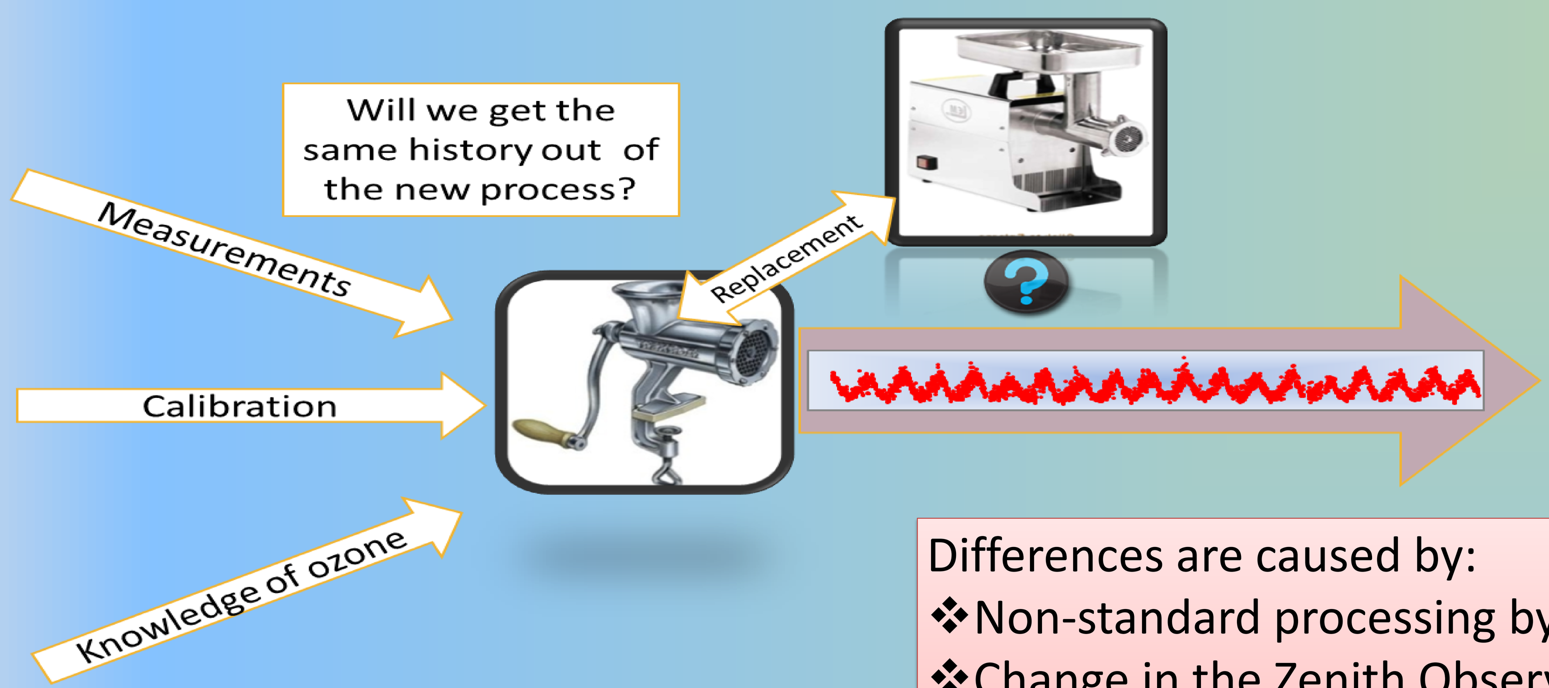




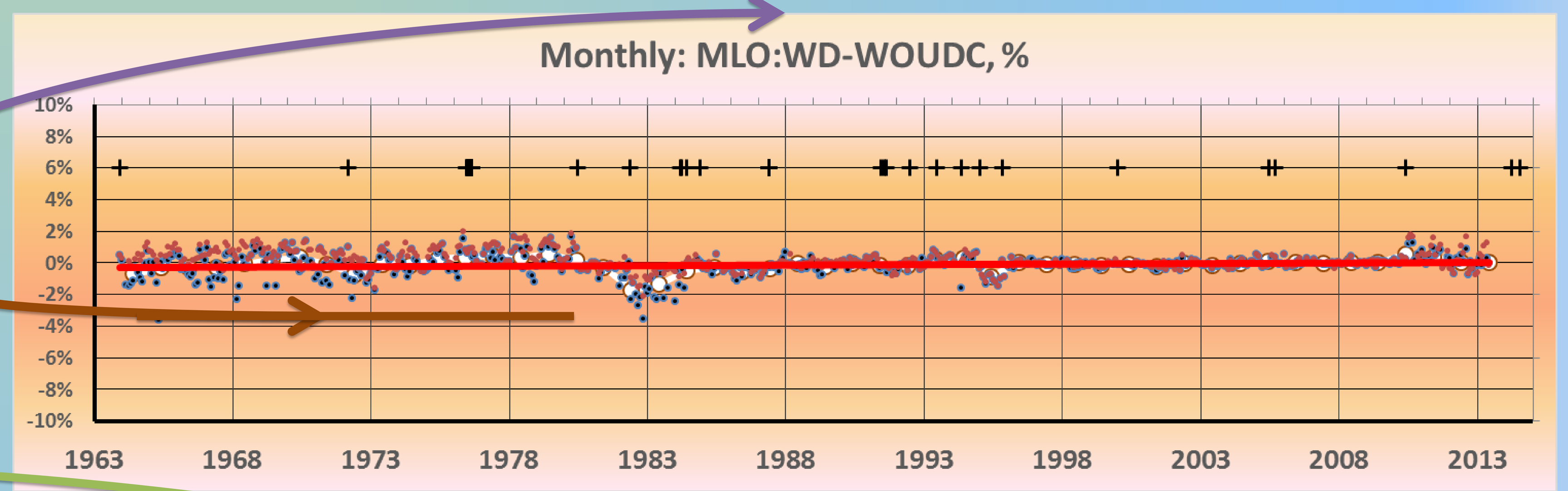




Comparing the original NOAA record and the new record produced by WinDobson has two parts: the individual observations and the open archive used by researchers. The archive of NOAA ozone (World ozone and Data Center) consists of one value per day (NOAA: Select Value, WinDobson: Representative). WinDobson was used to produce a representative value for each observing day, and this was compared to the select value retrieved from the archive. The results of that comparison for several long term stations are displayed below. There are differences, and to understand those difference required study of the history of the instrument and the data processing stream.



Time Series of the monthly differences between the TOC values in the WOUDC and in Windobson databases. Blue dots are monthly averages using all observations types, Red are using direct sun only, White is annual averages. Plus symbols indicate instrument calibration changes.



Differences are caused by:
- Non-standard processing by the NOAA processing.
- Change in the Zenith Observations algorithm in WinDobson – an improvement – **See Poster 29**.
- Change in which observation was reported for the day.
- Past updates in the data due to calibration changes not reflected in archive.