QOS 2021

October 3 (Sunday) - 9 (Saturday), 2021

Online Meeting

QUADRENNIAL OZONE SYMPOSIUM

[SAT2_26] Update on Lauder Ozonesonde Homogenisation

Richard Querel[1], Hisako Shiona[1], Alex Geddes[1], Deniz Poyraz[2], and Roeland Van Malderen[2]

[1]National Institute of Water & Atmospheric Research (NIWA), Lauder, New Zealand

[2]Royal Meteorological Institute of Belgium (RMI), Brussels, Belgium

Since 1986, there have been ~2000 ECC ozonesondes flown from Lauder, New Zealand.

Ozonesonde type changes

During that 35 year timeseries, there have been a number of changes.

Ozonesonde type changes:

Science Pump (4A/5A/6A)

- ECC 4A (Aug 1986 – Oct 1989)
- ECC 5A (1988 (x3), Aug 1989 – 1995, 1996 (x2), 1997 (x2))
- ECC 6A (1997, 2 flights)

EnSci (1Z/2Z/Z)

- ECC 1Z (May 1994 – present)
- ECC 2Z (2000 (x1), 2001 – present)
- ECC Z (Nov 2011 – present)

Sensing solution changes changes

Sensing solution changes:

- SST1% (Aug 1986 – Jul 1996, + 3 flights for comparison)
- SST0.5% (Aug 1996 – present)
- Note: cathode solution was 2.5ml instead of 3ml in 1986. Anode solution is always 1.5ml.

Radiosonde and data interface changes

Radiosonde changes:

- 1680 MHz VIZ (baroswitch, hypsometer) (1986 – 1989)
- Vaisala RS80-15(GE) (1989 –)
- Vaisala RS80-PTU (2Z)
- Vaisala RS92SGPW (2007 – 2018)
- Vaisala RS41SGP (2015 – present)
- Vaisala RS80-15H (FPH sonde, 2004 – 2009)
- I-met-1-RSB (FPH sonde, 2009 – present)

Data interface:

- TMAX-HMOS interface (1Z, 1989 –
- Vaisala RSA11 Ozone interface kit, OIF-11 (RS80)
- Vaisala OIF-92 (1Z, May 2007 – 2018)
- Vaisala OIF411 (2015 – present)
- EnSci V2C & V2D interface (2Z, present)

Other items of note

Installation of an air conditioner in the ozonesonde preparation lab (prior lab PTU values estimated using average values).

Above burst height ozone extrapolation uses a climatology based on Lauder microwave radiometer data (1992-1998).

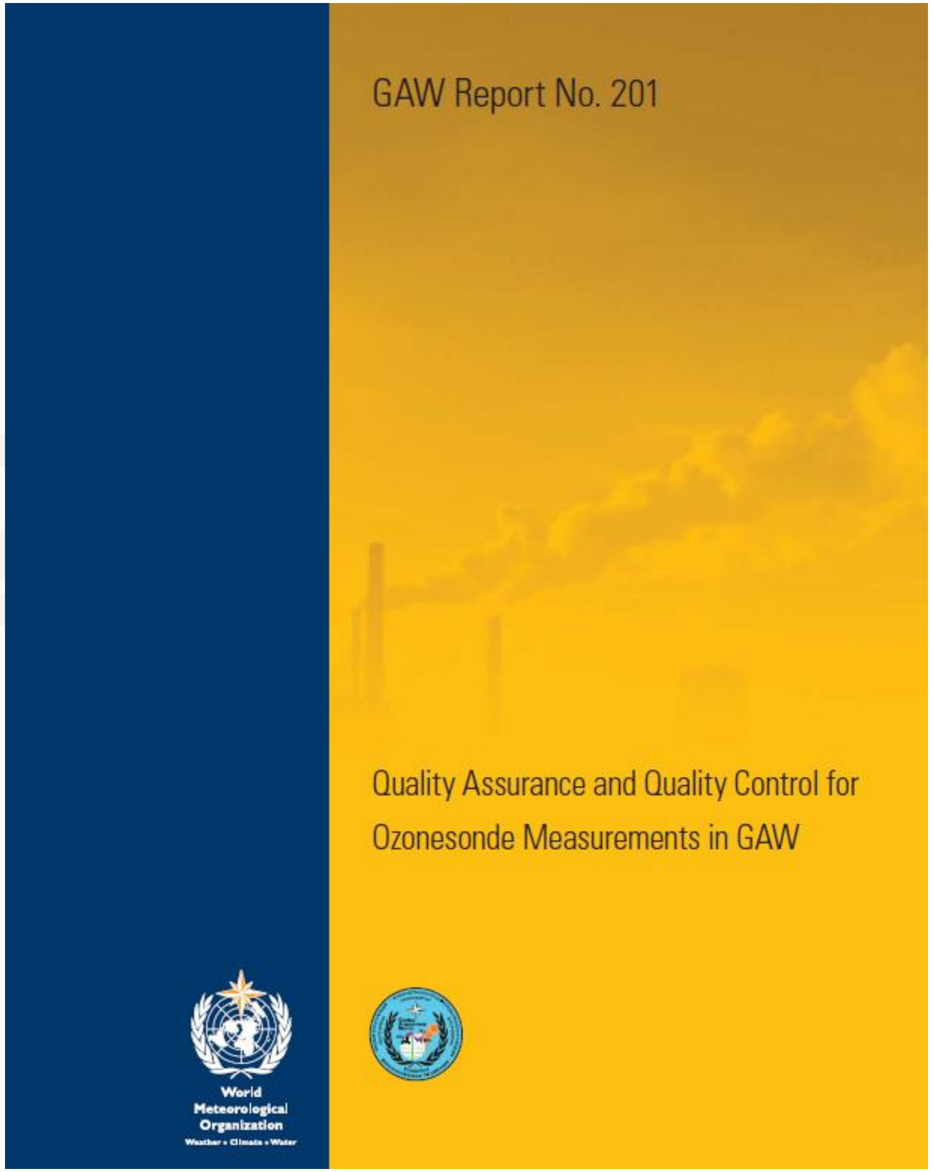
O3S DQA Ozonesonde homogenisation

Ozonesonde homogenization guidelines were reported in GAW 201, “Quality Assurance and Quality Control for Ozonesonde Measurements in GAW”, in 2014.

Prescribed transfer functions for dealing with solution changes and box temperature sensor location changes are each specifically described along with uncertainty calculations.

This was also known as the ASOPOS report, “Assessment of Standard Operating Procedures for OzoneSondes”.

https://library.wmo.int/index.php?lvl=notice_display&id=19463



ASOPOS and HEGIFTOM

HEGIFTOM is the Harmonization and Evaluation of Ground Based Instruments for Free Tropospheric Ozone Measurements.

As part of HEGIFTOM, researchers at RMI have developed Python tools for reprocessing ozonesondes and applying the required transfer functions to harmonise the ozonesondes data sets.

The RMI ozonesonde processing code is here:
https://github.com/denizpoyraz/o3s-dqa-homogenization

Prior to reprocessing

Some of the early TMAX-board flights recorded partial pressure directly in the telemetry so these needed to have the ECC cell current recovered by back-calculation.

Meta data such as instrument changes and lab conditions were collected for the entire timeseries.

Fundamental files with this raw cell current and box temperatures were produced as input files for the NIWA and RMI ozonesonde homogenisation tools.

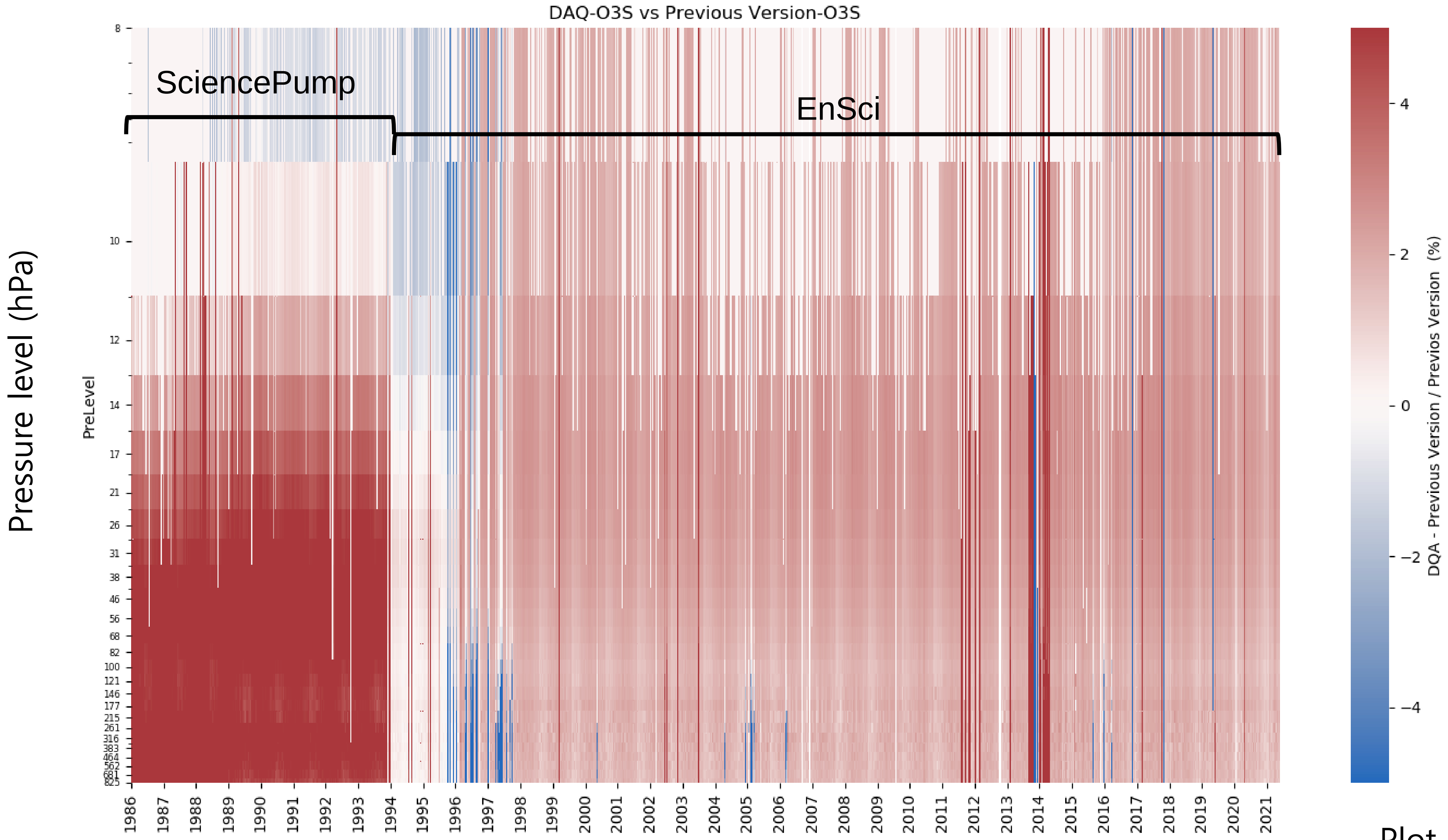
Some corrections are yet to be applied, like exclusively using GPS height rather than pressure-derived altitude. The earlier radiosondes had no on-board GPS, so this then requires some guess-work….

Homogenised timeseries plots

The following few slides have plots of the full ozonesonde profile timeseries. Each plot shows the contribution of a specific homogenisation transfer function, followed by a total difference between the homogenised and original timeseries.

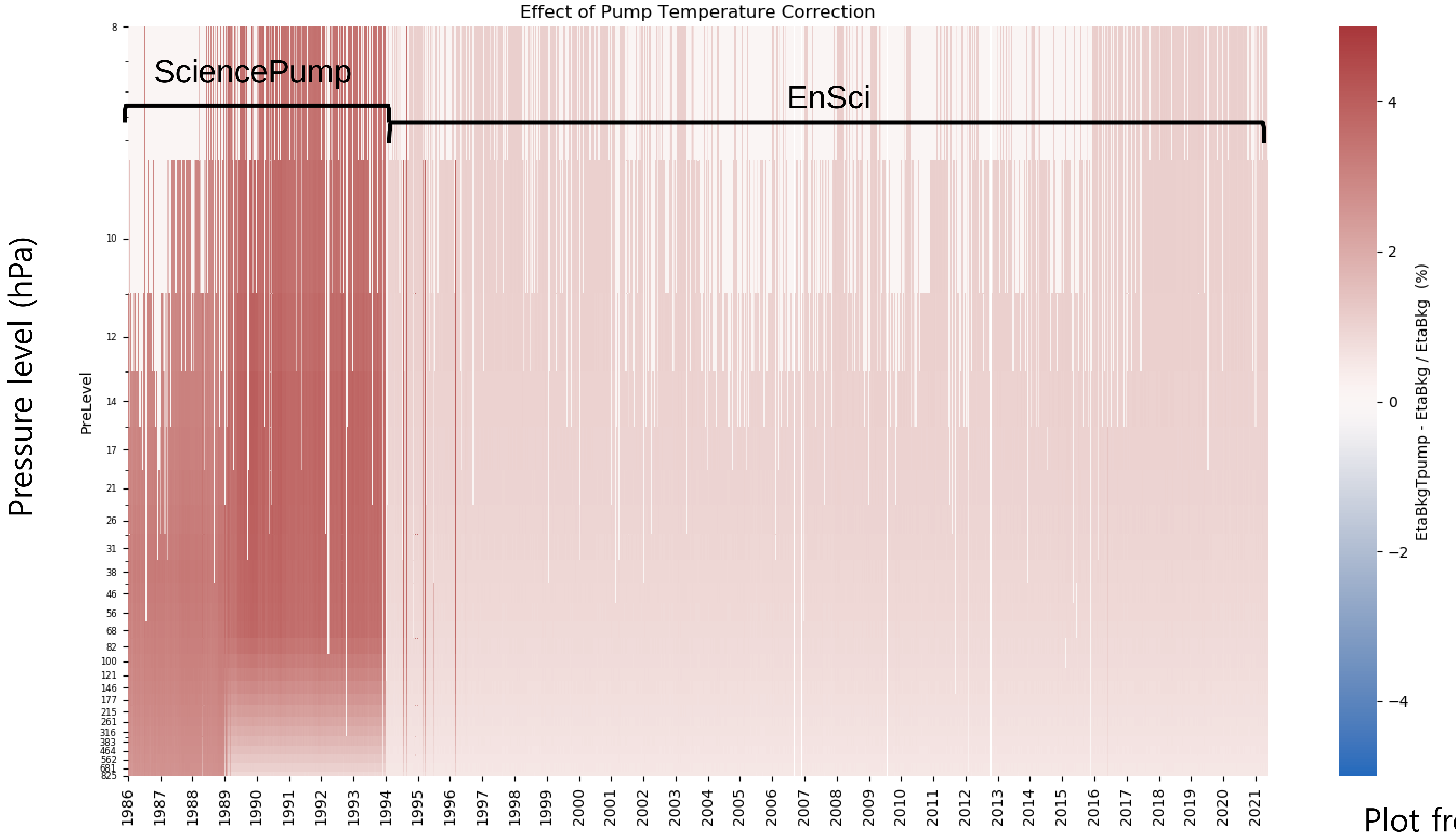
These difference plots show the RMI homogenisation products versus the original Lauder ozonesondes profiles.

% difference between RMI profiles vs NIWA original profiles



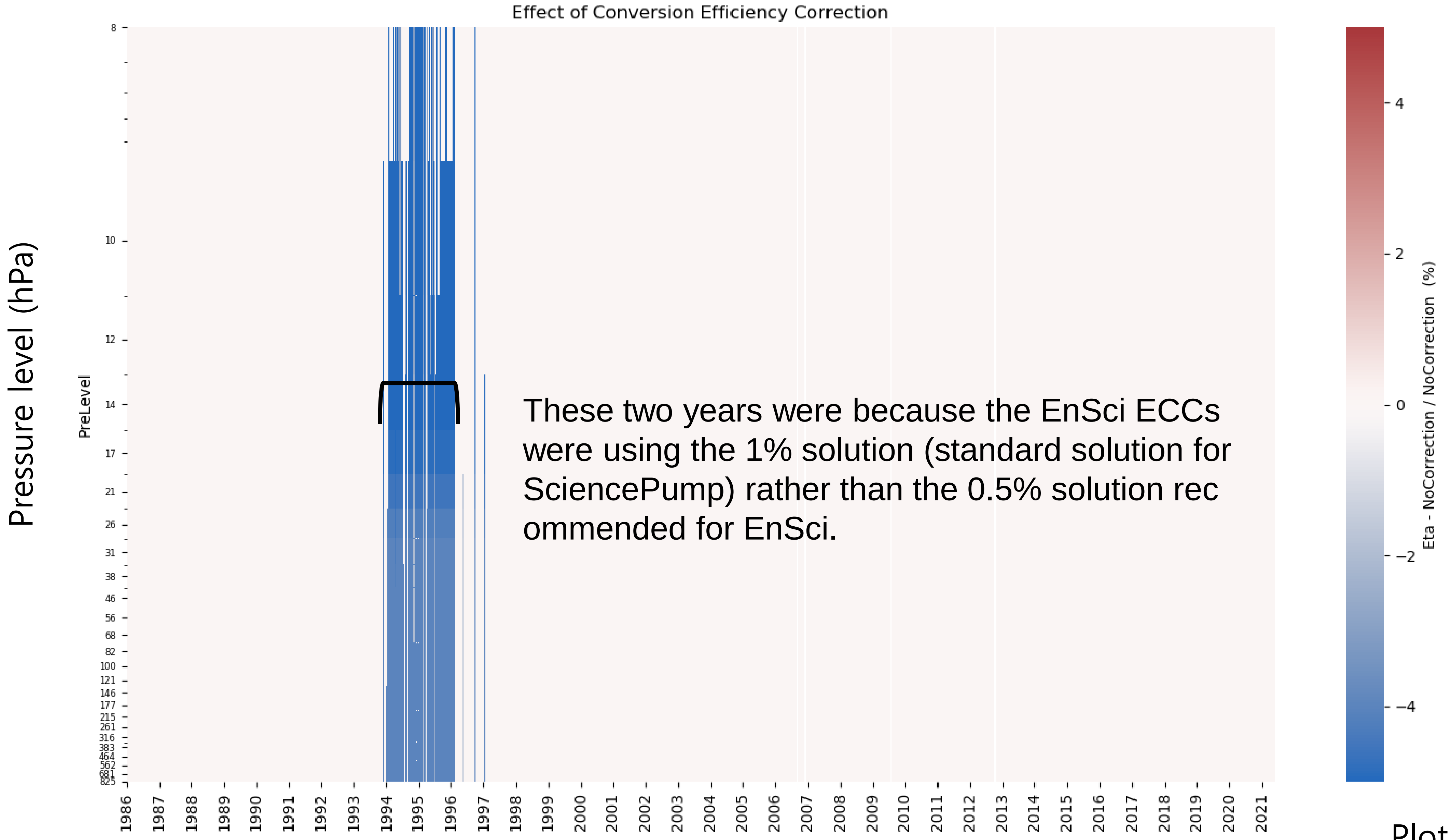
Plot from RMI

Effect of pump temperature correction in RMI processing vs NIWA original



Plot from RMI

Conversion efficiency correction RMI profiles vs NIWA original profiles

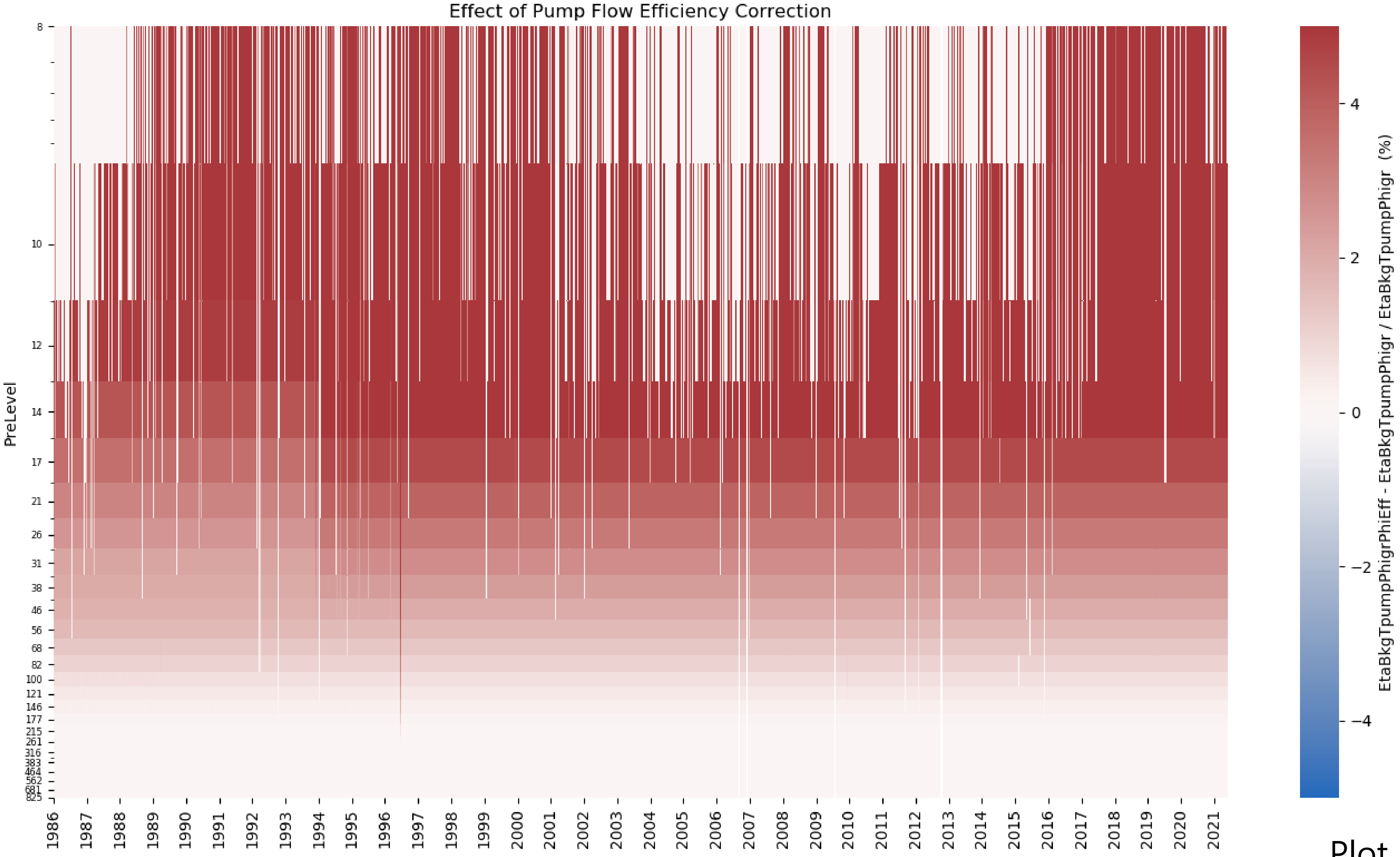


These two years were because the EnSci ECCs were using the 1% solution (standard solution for SciencePump) rather than the 0.5% solution rec ommended for EnSci.

Plot from RMI

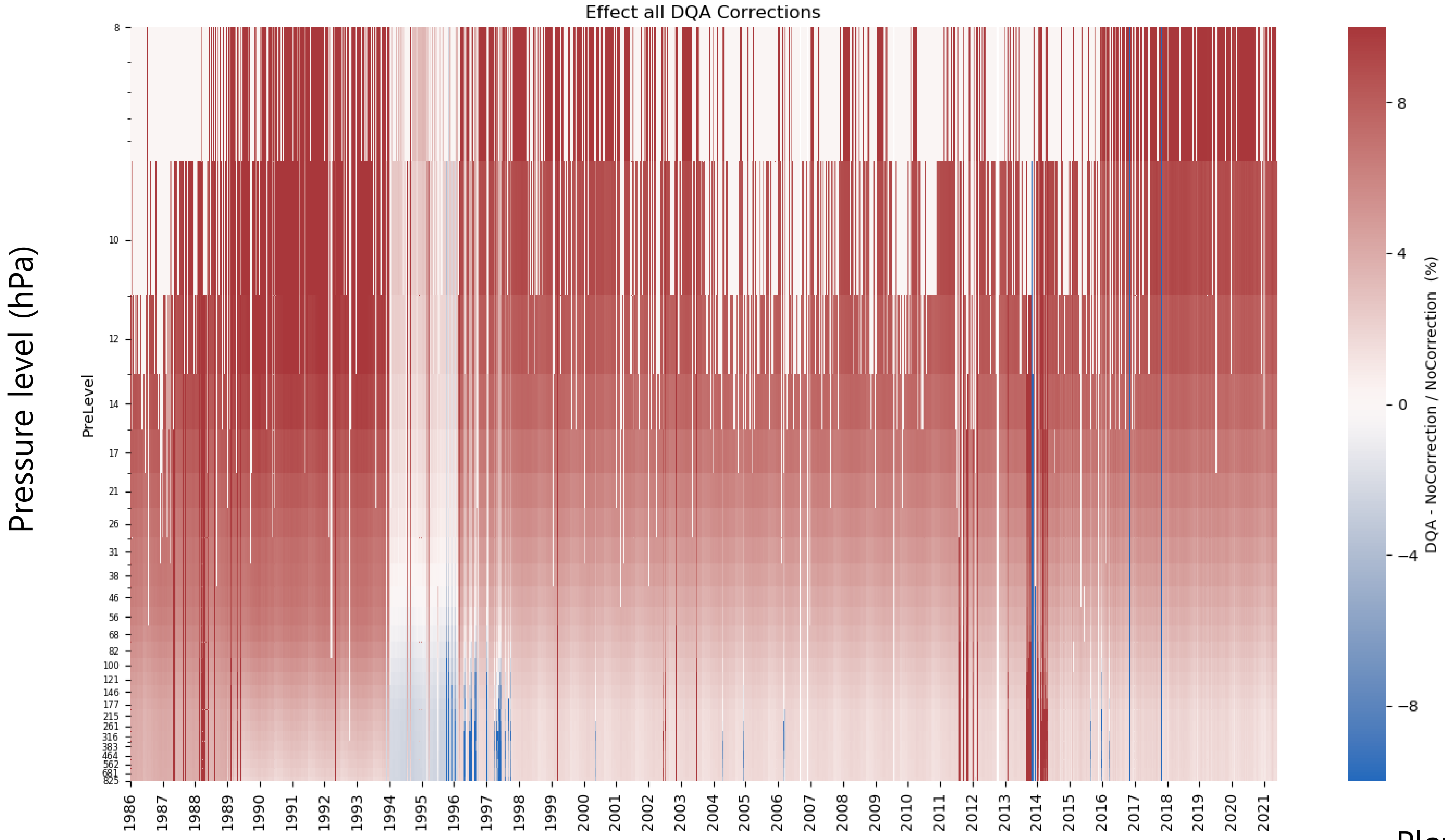
Effect of pump flow corrections in RMI profiles vs NIWA original

Pressure level (hPa)



Plot from RMI

Effect of all corrections in RMI profiles versus NIWA original profiles



Plot from RMI

Plots of ozonesondes as compared with satellite data sets

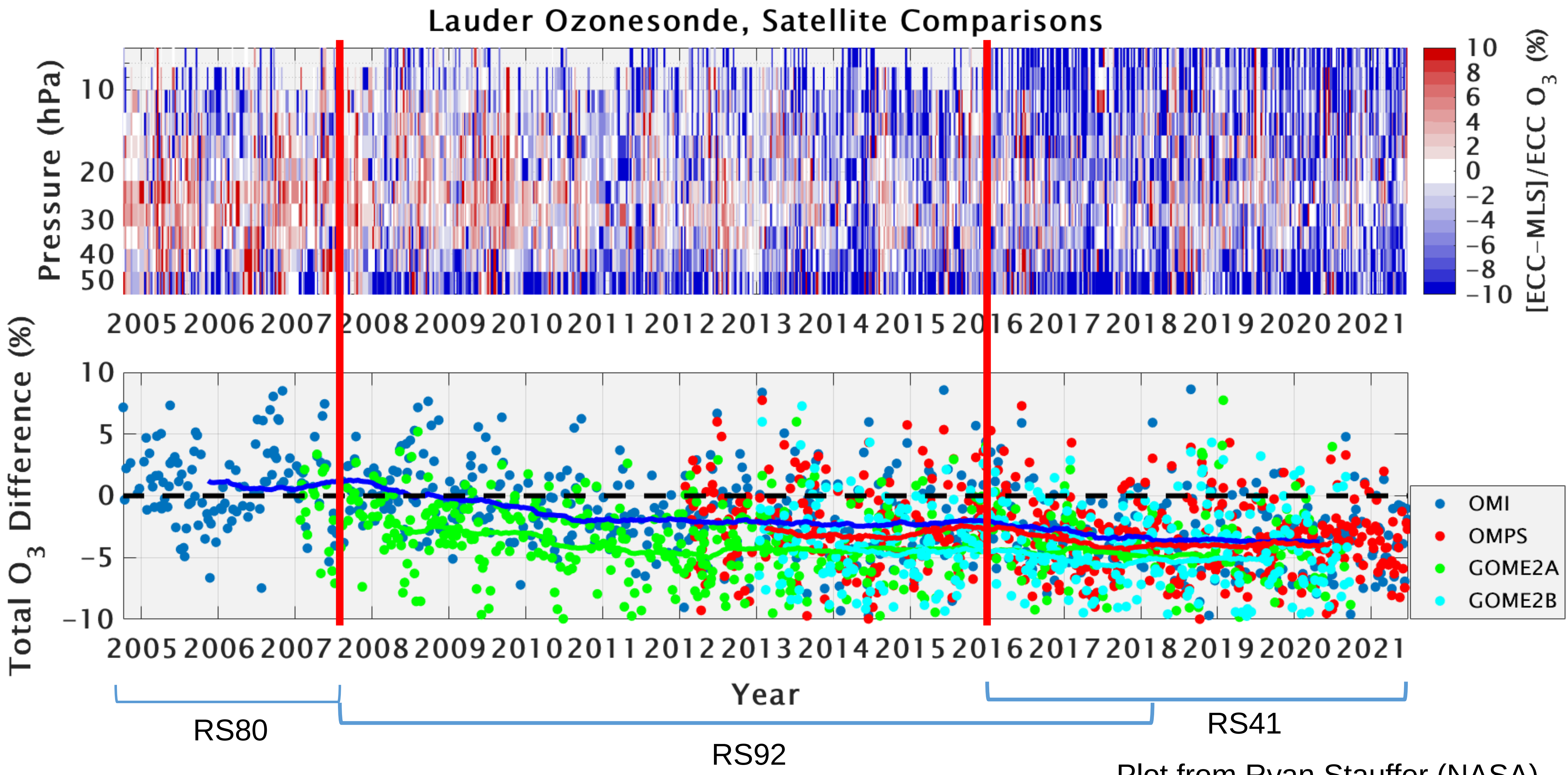
The following plots were generated by Ryan Stauffer (NASA).

They compare the upper end of the ozonesonde profiles (<50 hPa) with MLS v5.

The lower panel shows the total column ozone difference (%) between the ozonesondes and OMI, OMPS, GOME2A and GOME2B, respectively.

The timeseries plots are from 2005 to present to match the available MLS dataset.

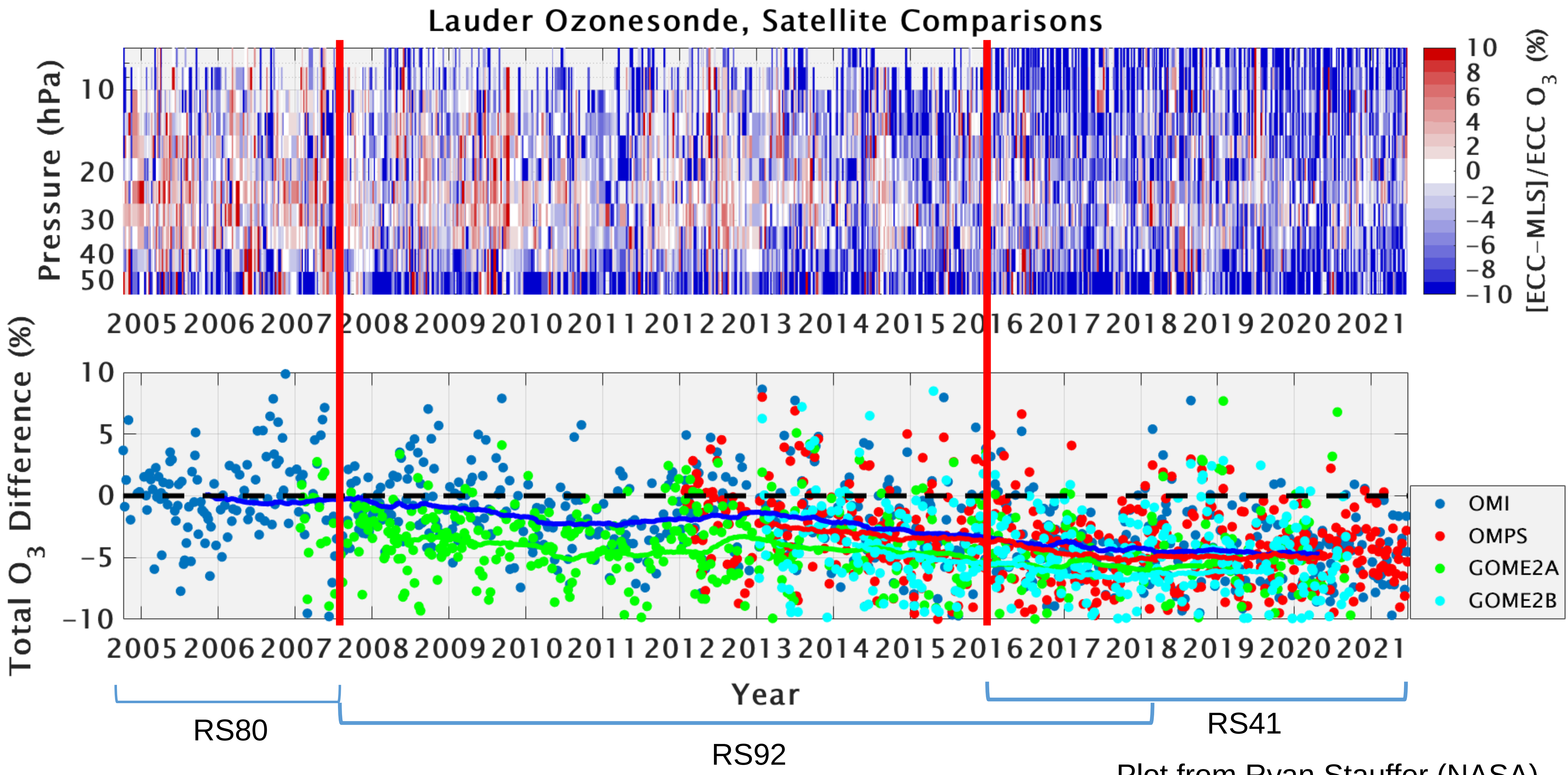
Original Lauder ozonesondes (from WOUDC)



Plot from Ryan Stauffer (NASA)

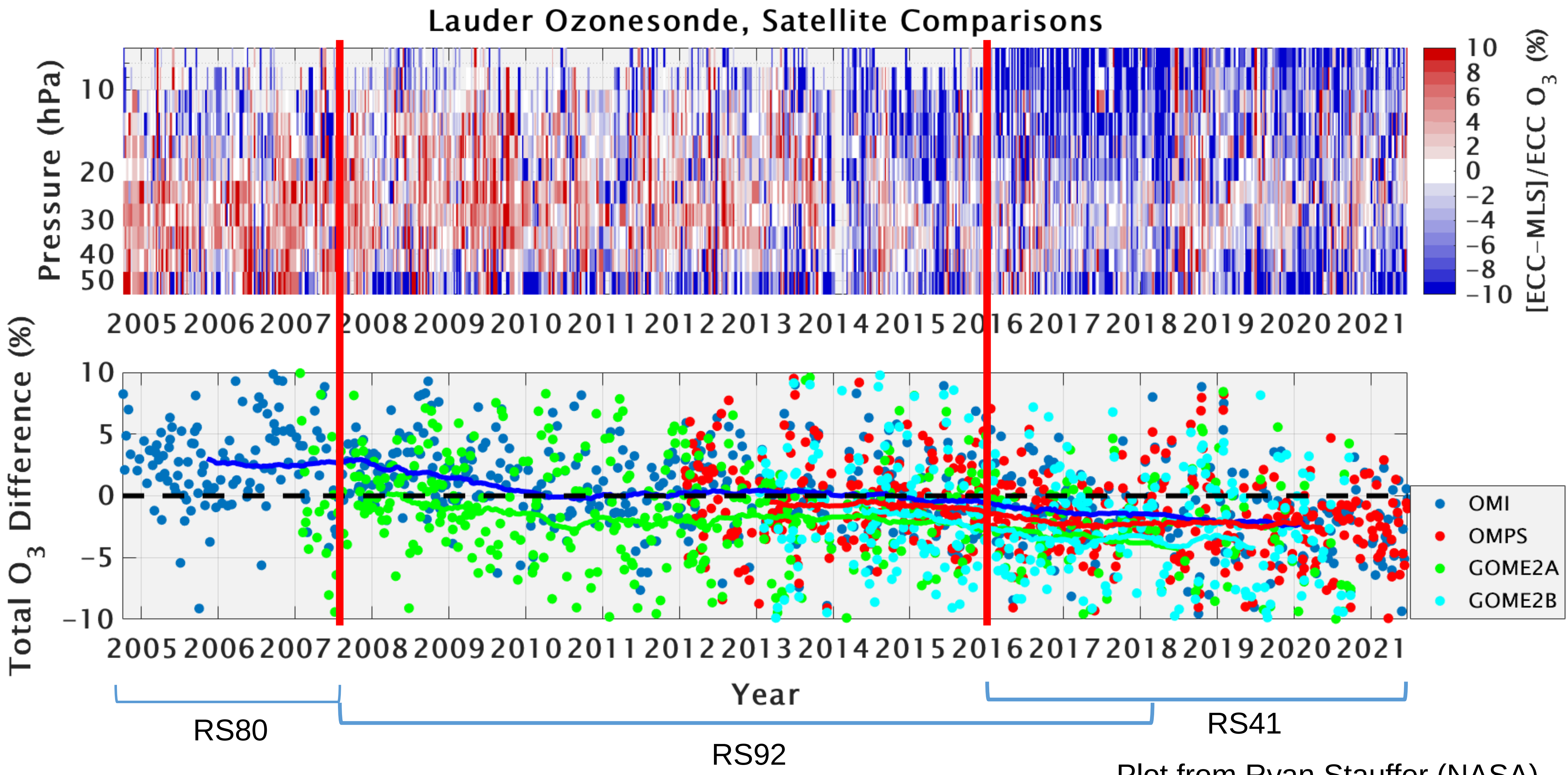
NIWA homogenisation of Lauder ozonesondes (V1)

QUADRENNIAL OZONE SYMPOSIUM



Plot from Ryan Stauffer (NASA)

RMI homogenisation of Lauder ozonesondes (V1)



Plot from Ryan Stauffer (NASA)

Comparison between ozonesondes and satellite data sets

Reasons for the drift in the satellite comparison plot:

From 2005 to 2021, exclusively EnSci ECCs have been used at Lauder, with the recommended 0.5%/half-buffer sensing solution.

RS80 (2005 to 2007), RS92 (2007 to 2018), RS41 (2015 to present)
(ranges marked on the plot as red vertical lines).

In all of these processed profiles, the pressures are used, not GPS heights.

Possibly the climatology being used for above burst-height extrapolation of ozone fails to properly account for recovering stratospheric ozone.

Have the transfer functions been applied correctly?

Or maybe there is a Southern Hemisphere bias with the satellite comparison data sets?
Both the Lauder (45 S) and Macquarie Island (56 S) ozonesonde timeseries each have a similar drift over this same period. (Note: Macquarie Island uses 6A ECCs not EnSci.)

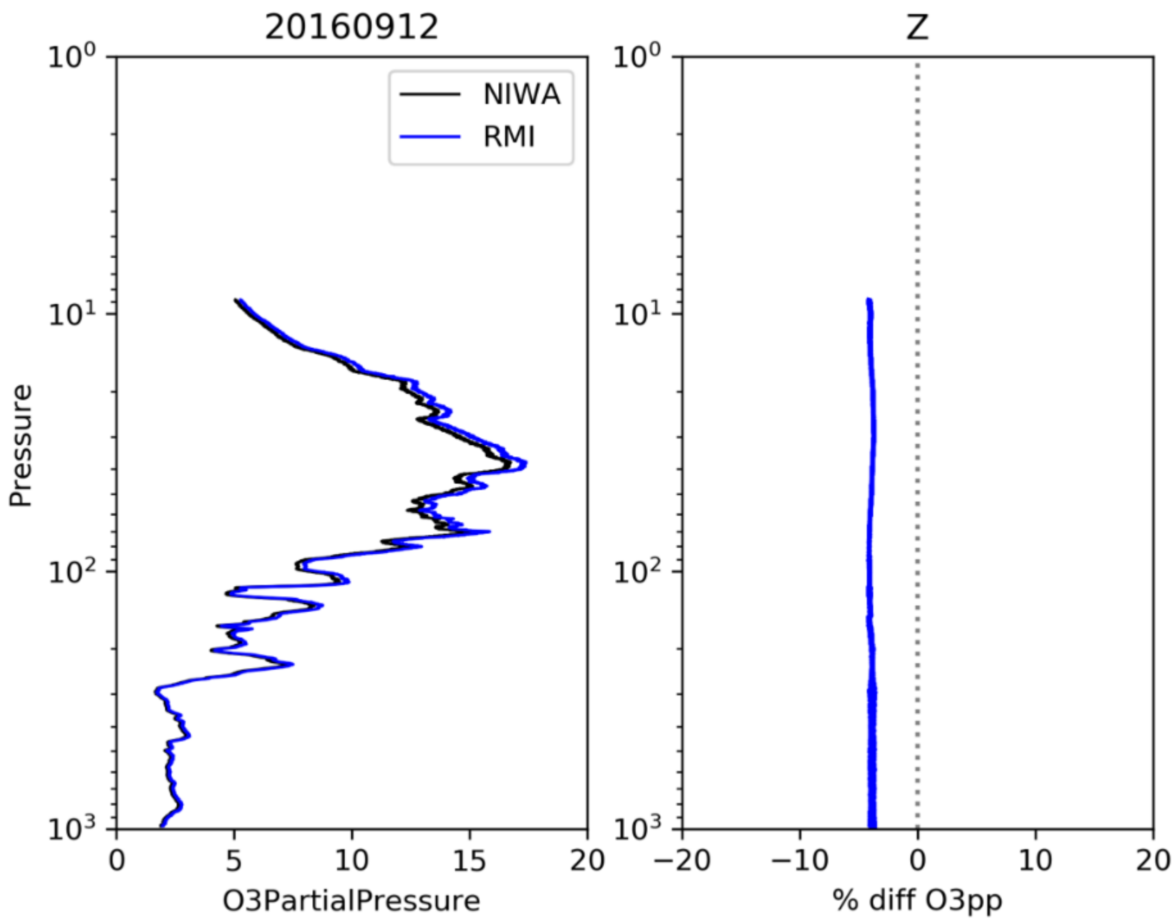
Comparison between ozonesondes and satellite data sets

In the original Lauder data set, from about 2008, there is a clear drift, of approximated -3 to -4% per decade relative to OMI and OMPS, a near constant negative offset for GOME2A and GOME2B.

For the NIWA homogenisation reprocessing most of these relationships are about the same as the NIWA original.

For the RMI homogenisation, the result seems to be a constant positive offset to all of the difference curves, bringing the overall differences closer to zero over the range plotted, but still exhibiting the same drift over the duration of the plot.

Example difference, NIWA and RMI homogenised



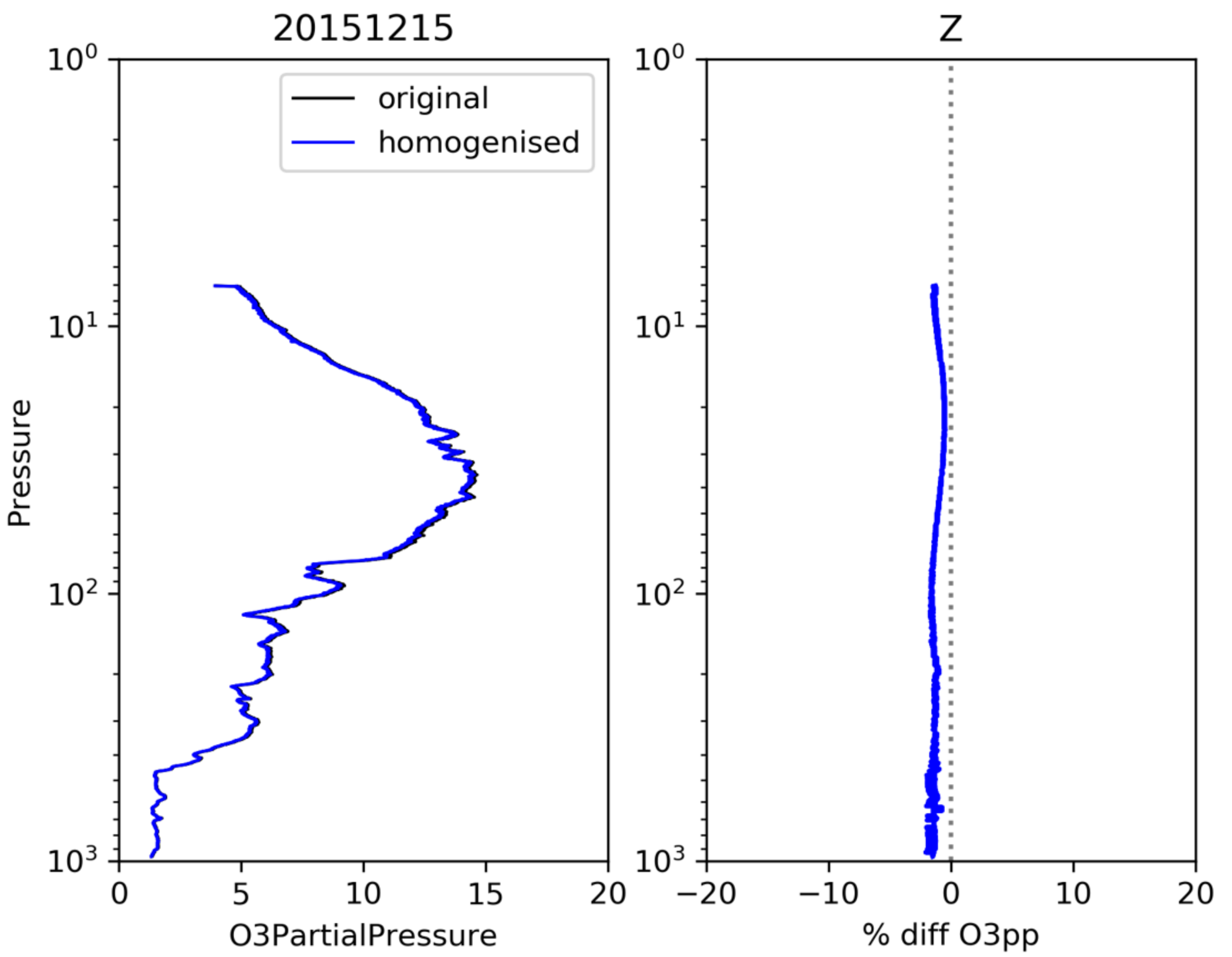
Ongoing work

Verification is underway to compare the NIWA and RMI output, to confirm that the correct transfer functions are being applied in a consistent way.

Contributions from each of the transfer functions are being assessed.

It seems that box temperature corrections due to thermistor placement in different iterations of ECCs has the largest effect on resulting ozone.

Example difference, NIWA homogenised and original



Contact

Please contact me if you have questions or suggestions

Richard.Querel@niwa.co.nz

www.niwa.co.nz/lauder