

## TOAR-II HEGIFTOM: Description of homogenized ozonesonde free-tropospheric ozone time series

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v1	Roeland Van Malderen	RMI	roeland.vanmalderen@meteo.be	26/10/2022
v2	Roeland Van Malderen	RMI	roeland.vanmalderen@meteo.be	26/01/2023
v3	Roeland Van Malderen	RMI	roeland.vanmalderen@meteo.be	05/10/2023
v4	Roeland Van Malderen	RMI	roeland.vanmalderen@meteo.be	16/03/2026
v5	Roeland Van Malderen	RMI	roeland.vanmalderen@meteo.be	19/05/2026

### Availability

The homogenized ozonesonde time series for 46 sites are available on the ftp-server “ftp-me.oma.be”, accessible with account name “ozonesondes” and password “OzonFeb2021:”. In the “ozonesondes” directory, every station has a directory with its name, in which the ascii data formats can be found. The GEOMS-HDF data can be found in the subdirectory “GEOMS-HDF” from the “ozonesondes” directory. In case of problems with connecting to the ftp-server, you can contact [roeland.vanmalderen@meteo.be](mailto:roeland.vanmalderen@meteo.be). The data is in any of the existing database formats:

- **WOUDC** (<https://woudc.org/home.php>, <https://guide.woudc.org/en/#334-category-ozonesonde>, <https://woudc.org/archive/Documentation/Examples-extCSV/Ozonesonde.csv>, with Python library code available on <https://github.com/woudc/woudc-extcsv>),
- **NASA-AMES** (from NDACC <http://www.ndacc.org>, see <https://ndacc.larc.nasa.gov/data/formats/>),
- **SHADOZ** (<https://tropo.gsfc.nasa.gov/shadoz/>)
- **GEOMS-HDF** (v003, see <https://evdc.esa.int/documentation/geoms/>). The data of the homogenized ozonesonde time series in this format can be found as .zip files in the directory ozonesondes/GEOMS-HDF/.

### Data field description

- The minimum data fields that are/should be available are time (s), pressure (hPa), geopotential height (m), temperature (°C), relative humidity (%), pump temperature (°C), ozone partial pressure (mPa), relative uncertainty in ozone partial pressure, wind speed (m/s), and wind direction (degrees), and ozone current (µA). Additional fields possibly

available nowadays are GPS height (m), latitude, longitude, pump motor current (mA), and pump motor voltage (V).

- Metadata are available in the headers of the data files and describe the site location, identify the hardware used (manufacturer, model and number of radiosonde, interface, ozonesonde), describe most aspects of the ozonesonde pre-flight preparation and its behaviour during preparation (e.g. background current, pump flow rate, ozonesonde response time), and give details about the processing used (e.g. pump efficiency correction table used). Data quality indicators (e.g. total ozone normalization factor compared to co-located Brewer/Dobson/SAOZ spectrophotometer) might also be present in the metadata header.

## Description of homogenization procedure

The aim of the homogenization is twofold: (i) to correct for biases related to instrumental (such as sonde type or sensing solution strength) or processing changes to reduce the uncertainty (from 10–20% down to 5–10 %), and (ii) provide an uncertainty estimate for every single ozone partial pressure measurement in the profile. The homogenization procedure and guidelines can be found in Annexes C and D of GAW Report No. 268, 2021: Smit, H.G.J., and Thompson, A.M., and the ASOPOS 2.0 Panel, "Ozonesonde Measurement Principles and Best Operational Practices. ASOPOS 2.0 (Assessment of Standard Operating Procedures for Ozonesondes)", WMO Global Atmosphere Watch Report Series, No. 268, World Meteorological Organization, Geneva, <https://library.wmo.int/idurl/4/57720>. The first edition of the guidelines (Dated January 2012) can be found at <https://www.wccos-josie.org/en/o3s-dqa>, and a Python code that can be used for the homogenization is available at <https://github.com/denizpoyraz/o3s-dqa-homogenization/>.

## Data management

### Flagging

- Data cleaning like outlier removal is not systematically applied by every ozonesonde PI; some guidelines exist, but have not been generally implemented across the ozonesonde network.
- A data flagging scheme is proposed on pages 67-68 of GAW Report No. 268, but has not been systematically implemented in the archived data files.
- The total ozone normalization factor w.r.t. a co-located total ozone measuring instrument, if present, is included in the data file header as data quality indicator.

### Uncertainties

- Every ozone partial pressure measurement  $P_{O_3}$  in the ozone profile has an associated uncertainty  $\Delta P_{O_3}$ , following the homogenization guidelines as referred to here above (to be more specific: formula E-3-1 on page 39 in the GAW Report No. 268).
- As the homogenization should have removed all known systematic biases in the ozonesonde time series, the resulting uncertainty should represent only the contribution from random errors.

### Traceability

Implementing the homogenization scheme ensures that the processed ozonesonde time series are traceable to the reference ozone photometer OPM (a fast dual-beam UV photometer, Proffitt and

McLaughlin, 1983) in the simulation chamber of the World Calibration Centre for Ozonesondes (WCCOS) at FZ-Jülich, with a 1-s response, precision = 0.025 mPa, and uncertainty = 2% – 3%. Since 1996, activities to improve the quality of balloon-borne ozone soundings have been conducted at WCCOS through Jülich OzoneSonde Intercomparison Experiment (JOSIE) campaigns (<https://www.wccos-josie.org/en/josie>) [Smit et al., 2007; Thompson et al., 2019] and in the WMO/BESOS (Balloon Experiment on Standards for Ozonesondes) campaign [Deshler et al., 2008], in which traceability to the OPM instrument could be established, under the condition of applying the Standard Operating Procedures (SOPs) at the station.

### *Internal consistency*

As the homogenized ozonesonde time series are traceable to the reference ozone photometer OPM, they should be internally consistent within the network. Several publications (see next section) have shown that the homogenization increased the consistency among different networks of ozonesondes with respect to the non-homogenized datasets.

### *External consistency*

In publications describing the homogenization at ozonesonde sites, e.g. the Southern Hemispheric Additional Ozonesondes (SHADOZ) network [1,2,3,4], the Canadian network [5], the US network [4], Arctic sites [6], and some individual sites [7, 8, 9, 10], a comparison with other techniques (mainly measuring total ozone amounts) is made to assess the improvement of the homogenization.

1. Witte, J. C., et al., First reprocessing of Southern Hemisphere ADditional OZonesondes (SHADOZ) profile records (1998-2015) 1: Methodology and evaluation, *J. Geophys. Res.*, 122, doi: 10.1002/2016JD026403 (2017).
2. Thompson, A. M., et al., First reprocessing of Southern Hemisphere ADditional OZonesondes (SHADOZ) Ozone Profiles (1998-2016). 2. Comparisons with satellites and ground-based instruments, *J. Geophys. Res.*, 122, doi: 10.1002/2017JD027406 (2017).
3. Witte, J. C., et al., First reprocessing of Southern Hemisphere Additional Ozonesondes (SHADOZ) Profile Records. 3. Uncertainty in ozone profile and total column, *J. Geophys. Res.*, 123(6), 3243-3268, doi: 10.1002/2017JD027791 (2018).
4. Sterling, C. W., et al., Homogenizing and estimating the uncertainty in NOAA's long-term vertical ozone profile records measured with the electrochemical concentration cell ozonesonde, *Atmos. Meas. Tech.*, 11, 3661–3687, doi: 10.5194/amt-11-3661-2018 (2018).
5. Tarasick, D. W., et al., A re-evaluated Canadian ozonesonde record: measurements of the vertical distribution of ozone over Canada from 1966 to 2013, *Atmos. Meas. Tech.*, 9, 195–214, doi: 10.5194/amt-9-195-2016 (2016).
6. Nilsen, K., Kivi, R., Laine, M., Poyraz, D., Van Malderen, R., von der Gathen, P., Tarasick, D.W., Thölix, L & Jepsen, N., Time-varying trends from Arctic ozonesonde time series in the years 1994–2022. *Sci. Rep.* 14, 27683, doi: 10.1038/s41598-024-75364-7 (2024).
7. Van Malderen, R., et al., On instrumental errors and related correction strategies of ozonesondes: possible effect on calculated ozone trends for the nearby sites Uccle and De Bilt, *Atmos. Meas. Tech.*, 9, 3793–3816, doi: 10.5194/amt-9-3793-2016 (2016).
8. Witte, J. C., et al., The NASA Wallops Flight Facility digital ozonesonde record: Reprocessing, uncertainties, and dual launches. *J. Geophys. Res.*, 124, 3565–3582, doi:10.1029/2018JD030098 (2019).

9. Ancellet, G., et al., Homogenization of the Observatoire de Haute Provence electrochemical concentration cell (ECC) ozonesonde data record: comparison with lidar and satellite observations, *Atmos. Meas. Tech.*, 15, 3105–3120, doi:10.5194/amt-15-3105-2022 (2022).
10. Zeng, G., Querel, R., Shiona, H., Poyraz, D., Van Malderen, R., Geddes, A., Smale, P., Smale, D., Robinson, J., and Morgenstern, O.: Analysis of a newly homogenised ozonesonde dataset from Lauder, New Zealand, *Atmos. Chem. Phys.*, 24, 6413–6432, doi:10.5194/acp-24-6413-2024 (2024).

Also note that the performance of the ozonesonde’s reference instrument in the Jülich simulation chamber has been assessed by comparing with IAGOS ozone measuring instruments in Smit et al. (2025).

### Data quality indicators

In the GAW Report No. 268, on page 71, the following table 5.1 with some data quality indicators based on the available (meta)data of the ozonesonde is presented.

**Table 5–1: Criteria to evaluate the reliability of vertical ozonesonde profiles made using the two major ozonesonde types used in GAW-ozonesonde networks. The here marked indicators are independent of the sensing solution types used but are related to the ozonesonde types deployed (For details see text in Section 5.2).**

Indicator	ECC SPC	ECC ENSCI-Z	Identifier in WOUDC
Total ozone normalization factor	0.9–1.1	0.9–1.1	TotalOzoneNormalizationFactor
Time to pump 100 ml [s]	25–35	25–35	FlowRateTime
Pump flowrate [ml/min]	170–240	170–240	PumpFlowRate
Response time (1/e) [s]	18–28	18–28	ResponseTimeFast
Pump temperature [K]	278–310	283–310	SampleTemperature
Background current before exposure to ozone [ $\mu$ A]	< 0.03	< 0.03	<b><math>I_{B0}</math></b>
Background current after exposure to ozone [ $\mu$ A]	< 0.07	< 0.07	<b><math>I_{B1}</math></b>
Pump motor current [mA]	50–120	50–120	PumpMotorCurrent
Pump motor voltage [V]	12–18	12–18	PumpMotorVoltage

The overall performance of the ozonesonde (see section 3.2 in GAW Report No. 268) can be summarized as

	Precision	Uncertainty
Troposphere	3%-5%	5% (in Tropics: 5-10%)
Stratosphere (< 28 km)	3%-5%	5%-10%

*List of homogenized sites (name, geographical location, period of observations)*

Site	Lat	Lon	Time range	#	Instrument	Homogenized?	Instrument PI	Contact
Alert, Canada	82.49	-62.34	1987 – 2024	1754	ECC	Yes	Jonathan Davies	<a href="mailto:Jonathan.Davies@ec.gc.ca">Jonathan.Davies@ec.gc.ca</a>
Eureka, Canada	79.98	-85.94	1992 – 2024	2083	ECC	Yes	Jonathan Davies	<a href="mailto:Jonathan.Davies@ec.gc.ca">Jonathan.Davies@ec.gc.ca</a>
Ny-Ålesund, Norway	78.92	11.93	1992 - 2024	2812	ECC	Yes	Raphael Köhler	<a href="mailto:Raphael.Koehler@awi.de">Raphael.Koehler@awi.de</a>
Thule, Greenland	76.53	-68.74	1992 - 2015	0	ECC	No	Nis Jepsen	<a href="mailto:nje@dmi.dk">nje@dmi.dk</a>
Resolute, Canada	74.7	-94.96	1966/1979 – 2024	2267	BM/ECC	Yes	Jonathan Davies	<a href="mailto:Jonathan.Davies@ec.gc.ca">Jonathan.Davies@ec.gc.ca</a>
Summit, Greenland	72.34	-38.29	2005 - 2017	0	ECC	No	Bryan Johnson	<a href="mailto:bryan.johnson@noaa.gov">bryan.johnson@noaa.gov</a>
Scoresbysund, Greenland	70.48	-21.97	1989 - 2024	1687	ECC	Yes	Guisella Gacitua	<a href="mailto:gga@dmi.dk">gga@dmi.dk</a>
Sodankylä, Finland	67.37	26.65	1994 - 2024	1510	ECC	Yes	Rigel Kivi	<a href="mailto:rigel.kivi@fmi.fi">rigel.kivi@fmi.fi</a>
Lerwick, United Kingdom	60.13	-1.18	1992 - 2024	1614	ECC	Yes	Norrie Lyall	<a href="mailto:norrie.lyall@metoffice.gov.uk">norrie.lyall@metoffice.gov.uk</a>
Churchill, Canada	58.74	-94.07	1973/1979 – Mar 2021	1790	BM/ECC	Yes	Jonathan Davies	<a href="mailto:Jonathan.Davies@ec.gc.ca">Jonathan.Davies@ec.gc.ca</a>
Edmonton, Canada	53.54	-114.1	1970/1979 – Mar 2021	2175	BM/ECC	Yes	Jonathan Davies	<a href="mailto:Jonathan.Davies@ec.gc.ca">Jonathan.Davies@ec.gc.ca</a>
Goose Bay, Canada	53.31	-60.36	1969/1980 – Mar 2021	2358	BM/ECC	Yes	Jonathan Davies	<a href="mailto:Jonathan.Davies@ec.gc.ca">Jonathan.Davies@ec.gc.ca</a>
Legionowo, Poland	52.4	20.97	1979/1993 - 2024	1847	OS/ECC	Yes	Bogumil Kois	<a href="mailto:Bogumil.Kois@imgw.pl">Bogumil.Kois@imgw.pl</a>
Lindenberg, Germany	52.21	14.12	1974/1992 present	0	OS/ECC	No	Peter Oelsner	<a href="mailto:Peter.Oelsner@dwd.de">Peter.Oelsner@dwd.de</a>
De Bilt, Netherlands	52.1	5.18	1992 – Jun 2024	1616	ECC	Yes	Ankie Piters	<a href="mailto:Ankie.piters@knmi.nl">Ankie.piters@knmi.nl</a>
Valentia, Ireland	51.94	-10.25	1994 - 2024	844	ECC	Yes	Michael Gill	<a href="mailto:michael.gill@met.ie">michael.gill@met.ie</a>
Uccle, Belgium	50.8	4.35	1969/1997 - 2024	4039	BM/ECC	Yes	Roeland Van Malderen	<a href="mailto:roeland.vanmalderen@meteo.be">roeland.vanmalderen@meteo.be</a>
Port Hardy	50.69	-127.38	2018 – 2024	258	ECC	Yes	Jonathan Davies	<a href="mailto:Jonathan.Davies@ec.gc.ca">Jonathan.Davies@ec.gc.ca</a>
Bratt's Lake, Canada	50.2	-104.7	2004 - 2011	0	ECC	No	David Tarasick	<a href="mailto:david.tarasick@canada.ca">david.tarasick@canada.ca</a>
Praha, Czech Republic	50.01	14.45	1994 - present	0	ECC	No, in progress	Pavla Skrivankova	<a href="mailto:pavla.skrivankova@chmi.cz">pavla.skrivankova@chmi.cz</a>
Kelowna, Canada	49.93	-119.4	2003 – Jun 2017	700	ECC	Yes	David Tarasick	<a href="mailto:david.tarasick@canada.ca">david.tarasick@canada.ca</a>
Hohenpeissenberg, Germany	47.8	11.01	1967 – 2024	6616	BM	Yes	Wolfgang Steinbrecht	<a href="mailto:Wolfgang.Steinbrecht@dwd.de">Wolfgang.Steinbrecht@dwd.de</a>
Payerne, Switzerland	46.49	6.57	1968/2002 - 2024	3374	BM/ECC	Yes	Eliane Maillard-Barras	<a href="mailto:Eliane.MaillardBarras@meteoswiss.ch">Eliane.MaillardBarras@meteoswiss.ch</a>
Egbert, Canada	44.23	-79.78	2004 - 2011	0	ECC	No	David Tarasick	<a href="mailto:david.tarasick@canada.ca">david.tarasick@canada.ca</a>
Haute Provence, France	43.94	5.71	1991 – 2024	1541	ECC	Yes	Sophie Godin-Beekmann	<a href="mailto:sophie.godin-beekmann@latmos.ipsl.fr">sophie.godin-beekmann@latmos.ipsl.fr</a>
Yarmouth, Canada	43.87	-66.11	2003 – 2024	959	ECC	Yes	Jonathan Davies	<a href="mailto:Jonathan.Davies@ec.gc.ca">Jonathan.Davies@ec.gc.ca</a>
Sapporo, Japan	43.06	141.33	1967/2010 - 2017	0	KC/ECC	No	Masamichi Nakamura	<a href="mailto:mnakamura@met.kishou.go.jp">mnakamura@met.kishou.go.jp</a>
L'Aquila, Italy	42.3	13.31	1994 – 2024	380	ECC	Yes	Vincenzo Rizi	<a href="mailto:vincenzo.rizi@aquila.inf.n.it">vincenzo.rizi@aquila.inf.n.it</a>
Trinidad Head, California, USA	40.8	-124.16	1997 – 2024	1392	ECC	Yes	Patrick Cullis	<a href="mailto:patrick.cullis@noaa.gov">patrick.cullis@noaa.gov</a>
Madrid, Spain	40.47	-3.58	1994 - 2024	1277	ECC	Yes	Ana Diaz Rodriguez	<a href="mailto:adiazr@aemet.es">adiazr@aemet.es</a>
Boulder, Colorado, USA	40	-105.25	1967 – 2024	2112	ECC	Yes	Patrick Cullis	<a href="mailto:patrick.cullis@noaa.gov">patrick.cullis@noaa.gov</a>
Beltsville, Maryland, USA	39.05	-76.88	2006 - 2022	289	ECC	Yes	Ryan Stauffer	<a href="mailto:ryan.m.stauffer@nasa.gov">ryan.m.stauffer@nasa.gov</a>
Wallops Island, Virginia, USA	37.93	-75.48	1995 – 2023	1614	ECC	Yes	Ryan Stauffer	<a href="mailto:ryan.m.stauffer@nasa.gov">ryan.m.stauffer@nasa.gov</a>
Tateno (Tsukuba), Japan	36.06	140.13	1969/2010 present	0	KC/ECC	No	Masamichi Nakamura	<a href="mailto:mnakamura@met.kishou.go.jp">mnakamura@met.kishou.go.jp</a>
Pohang (South Korea)	36.03	129.38	1995 - present	0	ECC	No	Daegeun Shin	<a href="mailto:shingeun@korea.kr">shingeun@korea.kr</a>

Huntsville, Alabama, USA	34.72	-86.64	1999 - 2019	0	ECC	No	Bryan Johnson	<a href="mailto:bryan.johnson@noaa.gov">bryan.johnson@noaa.gov</a>
Nainital, India	29.35	79.46	2011 - ???	0	ECC	No	Manish Naja	<a href="mailto:manish@aries.res.in">manish@aries.res.in</a>
New Delhi, India	28.49	77.16	1971 – 2016 ?	0	IND/ECC ?	No	???	???
Izana, Tenerife, Spain	28.3	-16.5	1995 - 2024	1513	ECC	Yes	Idoya Trasobares	<a href="mailto:etrasobaresm@aemet.es">etrasobaresm@aemet.es</a>
Naha, Japan	26.21	127.69	1989/2009 - 2017	0	KC/ECC	No	Masamichi Nakamura	<a href="mailto:mnakamura@met.kishou.go.jp">mnakamura@met.kishou.go.jp</a>
Taipei, Taiwan	25.02	121.48	2000 - present	0	???	No	???	???
Hong Kong, China	22.31	114.17	2000 - present	0	ECC	No	Y.K. Leung	<a href="mailto:jykleung@hko.gov.hk">jykleung@hko.gov.hk</a>
Hanoi, Vietnam	21.01	105.8	2004 – Feb 2024	396	ECC	Yes	Shin-Ya Ogino	<a href="mailto:ogino-sy@jamstec.go.jp">ogino-sy@jamstec.go.jp</a>
Hilo, Hawaii, USA	19.43	-155.04	1982 – 2024	1952	ECC	Yes	Patrick Cullis	<a href="mailto:patrick.cullis@noaa.gov">patrick.cullis@noaa.gov</a>
Pune, India	18.55	73.86	1968 – 2011 ???	0	IND	No	???	???
Costa Rica	9.94	-84.04	2005 – Mar 2024	710	ECC	Yes	Ryan Stauffer	<a href="mailto:ryan.m.stauffer@nasa.gov">ryan.m.stauffer@nasa.gov</a>
Palau	7.3	134.5	2016 – present	0	ECC	Yes	Katrin Müller	<a href="mailto:katrin.mueller@awi.de">katrin.mueller@awi.de</a>
Paramaribo, Suriname	5.8	-55.21	1999 - 2024	932	ECC	Yes	Ankie Piters	<a href="mailto:ankie.piters@knmi.nl">ankie.piters@knmi.nl</a>
Kuala Lumpur, Malaysia	2.73	101.27	1998 - 2022	501	ECC	Yes	Ahmad Fairudz Jamaluddin	<a href="mailto:fairudz@met.gov.my">fairudz@met.gov.my</a>
Quito, Ecuador	-0.92	-78.44	Oct 2021 - 2024	36	ECC	Yes	Maria Cazorla	<a href="mailto:mcazorla@usfq.edu.ec">mcazorla@usfq.edu.ec</a>
San Cristobal, Ecuador	-0.92	-89.62	1998-2023	490	ECC	Yes	Maria Cazorla	<a href="mailto:mcazorla@usfq.edu.ec">mcazorla@usfq.edu.ec</a>
Nairobi, Kenya	-1.27	36.8	1998 – 2024	1055	ECC	Yes	Christian Felix	<a href="mailto:Christian.Felix@meteoswiss.ch">Christian.Felix@meteoswiss.ch</a>
Natal, Brazil	-5.42	-35.38	1998 – Aug 2023	743	ECC	Yes	Francisco Raimundo da Silva	<a href="mailto:fraimundo@crn.inpe.br">fraimundo@crn.inpe.br</a>
Watukosek, Java, Indonesia	-7.5	112.6	1998 - 2022	370	ECC	Yes	Ninong Komala	<a href="mailto:ninong.komala@brin.go.id">ninong.komala@brin.go.id</a>
Ascension Island, United Kingdom	-7.58	-14.24	1998 – 2023	891	ECC	Yes	Ryan Stauffer	<a href="mailto:ryan.m.stauffer@nasa.gov">ryan.m.stauffer@nasa.gov</a>
Pago Pago, American Samoa	-14.23	-170.56	1986 – 2024	1185	ECC	Yes	Patrick Cullis	<a href="mailto:patrick.cullis@noaa.gov">patrick.cullis@noaa.gov</a>
Suva, Fiji	-18.13	178.4	1997 – Aug 2024	527	ECC	Yes	Patrick Cullis	<a href="mailto:patrick.cullis@noaa.gov">patrick.cullis@noaa.gov</a>
Réunion Island, France	-21.06	55.48	1998 - 2023	845	ECC	Yes	Jérôme Brioude	<a href="mailto:jerome.brioude@univ-reunion.fr">jerome.brioude@univ-reunion.fr</a>
Irene, South Africa	-25.9	28.22	1998 – May 2024	439	ECC	Yes	Thumeka Mkololo	<a href="mailto:thumeka.mkololo@weathersa.co.za">thumeka.mkololo@weathersa.co.za</a>
Easter Island, Chile	-27.17	-109.42	1998 - present	0	ECC	No	Juan Sebastian Crespo Fuentes	<a href="mailto:juan.crespo@dgac.gob.cl">juan.crespo@dgac.gob.cl</a>
Broadmeadows, Australia	-37.69	144.95	1965/1989 present	0	BM/ECC	No	Matt Tully	<a href="mailto:matt.tully@bom.gov.au">matt.tully@bom.gov.au</a>
Lauder, New Zealand	-45	169.68	1986 – 2024	2153	ECC	Yes	Richard Querel	<a href="mailto:Richard.Querel@niwa.co.nz">Richard.Querel@niwa.co.nz</a>
Macquarie Island, Australia	-54.5	158.95	1994 - present	0	ECC	No	Matt Tully	<a href="mailto:matt.tully@bom.gov.au">matt.tully@bom.gov.au</a>
Ushuaia, Argentina	-54.82	-68.32	2008 - present	0	ECC	No	Gerardo Carbajal Benitez	<a href="mailto:gcarbajal@smn.gob.ar">gcarbajal@smn.gob.ar</a>
Marambio, Antarctica	-64.24	-56.62	1989 - 2019	0	ECC	No	Rigel Kivi	<a href="mailto:rigel.kivi@fmi.fi">rigel.kivi@fmi.fi</a>
Dumont d'Urville, Antarctica	-66.7	140	1991 - present	0	ECC	No	Julien Jumelet	<a href="mailto:jumelet@latmos.ipsl.fr">jumelet@latmos.ipsl.fr</a>
Davis, Antarctica	-68.58	77.97	2003 - present	0	ECC	No	Matt Tully	<a href="mailto:matt.tully@bom.gov.au">matt.tully@bom.gov.au</a>
Bharati, Antarctica	-69.2	76.2	2016 - present	0	ECC	No	???	???
Syowa, Antarctica	-69	39.58	1966 - present	0	KC/ECC	No	Masamichi Nakamura	<a href="mailto:mnakamura@met.kishou.go.jp">mnakamura@met.kishou.go.jp</a>
Neumayer, Antarctica	-70.62	-8.37	1992 - present	0	ECC	No	Raphael Köhler	<a href="mailto:Raphael.Koehler@awi.de">Raphael.Koehler@awi.de</a>
McMurdo, Antarctica	-77.85	166.67	1986- Oct 2010	822	ECC	Yes	Terry Deshler	<a href="mailto:deshler@uwyo.edu">deshler@uwyo.edu</a>
Belgrano, Antarctica	-77.87	-34.63	2016 - present	0	ECC	No	Margarita Yela	<a href="mailto:yelam@inta.es">yelam@inta.es</a>
South Pole, Antarctica	-90	169.68	1967 – Sep 2023	2360	ECC	Yes	Patrick Cullis	<a href="mailto:patrick.cullis@noaa.gov">patrick.cullis@noaa.gov</a>

## References (if not given in the text already)

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