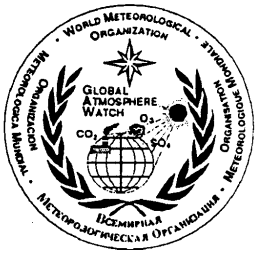
Environment Canada Environnement Canada

User Guide to the WMO/GAW World Ozone Data Centre

Version 3.1



Environment Canada

May 2013

Canada

Guide to the WMO/GAW
World Ozone Data Centre

Environment Canada*

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Guide to the WMO/GAW World Ozone Data Centre

Environment Canada*

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Foreword

This document describes the procedures for data submission and information about file format, structure and content. This guide is intended for use by both data originators (for data submission) and clients (information about reading data files).

The World Ozone Data Centre (WODC) is a subset of the World Ozone and Ultraviolet Radiation Data Centre. Use of terminology throughout this text will interchange between the World Ozone and Ultraviolet Radiation Data Centre (WOUDC) and the acronym WODC. Issues that refer to the general aspects of the Data Centre such as data reception or access, will use the acronym WOUDC. Issues specific to ozone such as form and content of specific data categories will use the WODC acronym.

The WOUDC web site is used to update information and serve as a virtual "bulletin board". As this guide is further developed, use the web site to retrieve the latest version.

IMPORTANT UPDATE: The data category, "Surface Ozone" is no longer available from the WODC. These data are archived and made available through the World Data Center for Greenhouse Gases, Japan Meteorological Agency, Tokyo, Japan (***http://gaw.kishou.go.jp/wdcgg.html***).

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Guide to the WMO/GAW World Ozone Data Centre

1. Introduction

The World Ozone Data Centre (WODC) began receiving international ozone data in 1961. The WODC has posted data in printed form in the publication *Ozone Data for the World* (Red-book) [1] beginning in 1964. The WODC continues to be funded and operated by the Canadian Government (Environment Canada) and has been since its inception. In 1992, Environment Canada agreed to accept ultraviolet radiation data as part of the data centre and the WODC changed its name to the World Ozone and Ultraviolet Radiation Data Centre (WOUDC). For the purposes of this guide book the acronym WODC will be used with the understanding that it represents the ozone portion of the WOUDC. When referencing issues pertinent to both ozone and UV, such as data file formats, then the acronym WOUDC will be used.

Although the WOUDC is operated by Environment Canada, it works under the auspices of the Global Atmosphere Watch (GAW) programme of the World Meteorological Organization (WMO). The WOUDC gets guidance from the WMO Scientific Advisory Groups (SAGs) for issues related to both ozone (SAG Ozone) for the WODC and UV (SAG UV) for the WUDC.

1.1 How to Use this Guide

This guidebook is intended for data originators who wish to submit data sets to the WOUDC and for users of the data who want to understand more about the data formats and content. The WOUDC uses the Internet as its main tool for data dissemination and so any updates to data products or changes occurring to the data centre as a whole will be posted on the WOUDC web site. Although this guide is intended to be used as a stand-alone document, changes are inevitable and the web site should be consulted for the most current version.

This guidebook is divided into three main sections: the application process for data submission, a description of the data submission format (which includes definitions for data category such as total column ozone, ozone sonde etc.) and data retrieval which includes data file security issues and access to ancillary and auxiliary information such as calibration histories for instruments and data quality indicators.

[1] The *Ozone Data for the World* red book is published by Environment Canada in conjunction with the World Meteorological Organization, Global Atmosphere Watch programme.

1.2 Access to the WOUDC Web and ftp sites

The WOUDC web site is maintained at: http://www.woudc.org and the WOUDC ftp site can be accessed either from the WOUDC web site or directly at:

Address:	ftp.tor.ec.gc.ca
Username:	woudc
Password:	woudc*

2. Data Submission Procedures

2.1 Application Process

Data originators are asked to follow the five steps below for arranging data submissions to the WOUDC for ozone (and/or UV) data sets.

Step 1: Write a Scientific Sponsorship Statement (SSS) or "data passport". This is an ASCII text file or a Portable Document Format (PDF) file which is intended to provide a detailed description of the data quality including instrument locations, observation schedules, calibration histories, quality control, measurement accuracy and all other information that the data originator wants to provide. It may also stipulate conditions under which the data may be used. The SSS file is an ASCII text file. Examples of the SSS are available at the WOUDC web site and the WOUDC UV Guide [1] may also be referenced.

Step 2: Submit the completed SSS document to the WOUDC by email. Also prepare an Agency Profile with details like your mailing and email address, primary contact person and the name of your agency or institute. The agency profile may also be sent by email or using the web form available at: ***http://www.woudc.org/data/UsingArchive/agency_form_e.html***. The profile should also include information about your observation program and the various instruments in use. Forms are available, for submission of this information, from the WOUDC web site at: ***http://www.woudc.org/data/submit_e.html.***

Step 3: Upon receipt of the SSS and agency profile information, the staff at the WOUDC will register your Agency. At this point, a data submission agreement will be established between the data originator and the WOUDC. If special agreements, provisos, or security restrictions are required, they will be established at this point. Refer to the Data Set Security Issues section of this document.

Step 4: The WOUDC will also assign an FTP account (with a personal username/password) to be used exclusively for data submission. Data may also be submitted on computer media such as CD-ROM or DVDs.

Step 5: Submit the data to your personal ftp account. It is recommended that the frequency of most data submissions be monthly. The WOUDC is capable of receiving data on a daily basis and can facilitate near real-time data submission. Contact the WOUDC for details.

3. Data File Submission

3.1 Introduction: Description of the WOUDC Data File Standard with Examples

NOTE: *it is expected that each agency will have submitted a Scientific Sponsorship Statement or "data passport". This text document outlines the details of the measurement program, calibration and instrument specific details as well as the data reduction and analysis procedures used to produce the final data product (file). Therefore, such details may be kept to a minimum within each data file, as the agency ID acts as the link to these documents.*

The WOUDC uses an ASCII text file format for both data submission and retrieval. This file format uses the standard Comma Separated Values (CSV) rules, but has extended them to include tables and comments. Thus, the documentation will refer to the WOUDC standard file format as "extended" CSV or simply extCSV. The extCSV file format supports metadata information and high resolution (both temporal and spatial) data. The staff at the WOUDC encourage originators of data to submit their data using this standard format to assist in the efficient processing of data sets.

ExtCSV files are divided into two main parts: a metadata section and a data content section. The metadata section can be considered a data file "header" as this portion is common to all files within the WOUDC in terms of table format and content. The data portion will be unique to the individual data categories (or types) such as total ozone or ozone sonde. Section 3.2 of this guide presents the metadata format and Section 3.3 is the content section. The data content section presents each data category (type) with the unique set of table definitions. Presently, the following data categories are defined: Lidar, Microwave, Ozone Sonde, Total Ozone and Umkehr.

3.2 The WOUDC extCSV Data File Definitions - Metadata

The WOUDC header presents a set of variables that uniquely describes the data to follow in that particular file, and that are common to all data sets independent of the specific WOUDC data category (such as total ozone or ozone sonde). The uniqueness of each field within the header is required such that if a duplicate data file is received, one or more of the header variables would have to have changed in order for this file to be accepted in to the data archive. Table 3.1 outlines the table names and the field (column) names for the metadata portion of the file format.

Static Metadata (*Only one occurrence or instance per file.*)		
Table Name	**Condition**	**Field (Column) Names**
CONTENT	***Required***	<Class,Category,Level,Form>
DATA_GENERATION	***Required***	<Date,Agency,Version,ScientificAuthority>
PLATFORM	***Required***	<Type,ID,Name,Country,GAW_ID>
INSTRUMENT	***Required***	<Name,Model,Number >

Dynamic Metadata (*At least one required per file, multiple occurrences are permitted.*)		
Table Name	***Condition***	**Field (Column) Names**
LOCATION	***Required***	<Latitude,Longitude,Height* >
TIMESTAMP	***Required***	<UTCOffset,Date,Time>

* Height is defined as the altitude, elevation or height of the defined Platform.

Table 3.2.1. The WOUDC Metadata Format Model

3.2.1 Metadata Format Rules

1. The order of the static metadata tables is fixed.
2. A table name is in UPPERCASE and denoted by the pound symbol (#) as the first character.
3. A table is comprised of three sections: a ***table name***, ***column*** (field) ***names*** and one or more ***data records***. Refer to Example 1.
4. Columns (fields) are separated (delimited) by commas within each record, including each column (field) name and datum.
5. Comments may appear anywhere within the file and are denoted by an asterisk (*). The asterisk is the first character.

```
*Example 1
#TABLENAME
Field1,Field 2,Field3
Datum1,Datum2,Datum3
```

3.2.2 Metadata Content Rules

1. Only ONE instrument may be represented in a file.
2. To report changes in time and space, more than one #LOCATION and #TIMESTAMP table is permitted. Since most data are considered from a stationary source, a single #LOCATION table is typically all that is required.
3. Further information about site conditions, meteorology, sky images etc. may be included as comments or by other tables generated at the discretion of the data originator. For example, if a data originator wishes to indicate an occurrence of a special note ("instrument was bumped while sampling") then a comment is probably reasonable. Dynamic variations occurring instantaneously such as meteorology (eg. sky or wind conditions) or the reporting of calibration data; would be represented in a table.

```
*Example 2
#SITE_METEOROLOGY
Date,Time,Temperature,Pressure,WindDirection,WindSpeed
```

Table 3.2 provides a definition for each field (column) giving the required name for each field and a description, which includes physical units.

TABLE	***Column***	**Description**
CONTENT	*Class*	The general type of data to follow. WOUDC would be used here.
	Category	Sub group of data submitted. For example: OzoneSonde or TotalOzone.
	Level	Data level. The level refers to the data product. Raw or primary data would be Level 0. Processed data, ready for publication is Level 1. Level 2 data is interpolated or re-gridded Level 1 data.
	Form	The version of the data format to follow. The initial specification for the *Form* (value=1) refers to the basic table descriptions. If an existing table is altered OR a new table added, the Form index will be increased. For example, a data table already defined with form=1, with a specific number of columns, then the addition of one or more columns to that table would require the *Form* value to be incremented by 1 for each change. The form (index) value is intended as a file format reader indicator of the type of data tables to follow, to assist programmers with reading the file. Changes to this index will be made through the WOUDC only.
DATA_ GENERATION	*Date*	Date when the file was processed or generated. Date is represented in the **ISO 8160** format standard, i.e. **yyyy-mm-dd**. Example 2000-12-31.
	Agency	The acronym of the submitting Agency. This is typically agreed upon by the data originator and the WOUDC during the Agency registration.
	Version	Data version specified by the submitting Agency. These versions have the form ***major.minor*** (eg. 3.2) where major values are incremented with changes to the processing algorithm and minor values are incremented when the characterisation or calibration values have changed. Note, minor values are reset to zero with changes to the processing algorithm.
	Scientific Authority	The ScientificAuthority is the person(s) responsible for the data quality at the submitting Agency.
PLATFORM	*Type*	Type of observing platform Stationary (STN) or Moving (Examples: Airborne (FLT), Ship borne (SHP) etc.). The default is STN. This field, for example, will accommodate the future inclusion of an onboard GPS on ozone sonde flights which records exact location throughout a flight. Thus, FLT would be selected instead of STN.
	ID	Unique station or flight ID assigned by the WOUDC to each registered platform. The ID number is a pointer to other information about the platform such as the observation programs, the different instruments in operation and related site information like the proximity to an urban centre and other background effects.
	Name	Platform Name. It is requested that an ASCII character name be used.
	Country	The country where the platform is located. ***Country*** is the 3-letter **ISO-3166** code. For example, Finland is FIN, Switzerland is CHE etc. Refer to the WOUDC web site for a listing: ***http://www.woudc.org/data/iso3166_e.html***
	GAW_ID	Applicable only to “stations” with the 5-digit WMO number.
INSTRUMENT	*Name*	Common name of instrument. For example, the Brewer spectrophotometer is called the "Brewer" whereas the Brewer-Mast ozone sonde is called the "Brewer-Mast". Refer to the WOUDC web site for a listing: ***http://www.woudc.org/data/Metadata/instruments_e.html***
	Model	Model ID where applicable. Refer to the WOUDC Instrument list:

		http://www.woudc.org/data/Metadata/instruments_e.html
	Number	Serial number of the instrument as assigned by the manufacturer.
LOCATION	*Latitude*	*Latitude* of the instrument. Typically an instrument is located at a fixed location and shares the platform latitude. The format is **decimal degrees** (deg.) to two significant decimals places with North positive and South negative.
	Longitude	*Longitude* of the instrument. Typically an instrument is located at a fixed location and shares the platform longitude. The format is **decimal degrees** (deg.) to two significant decimals places with East positive and West negative.
	Height	*Height* of the platform + instrument above sea level. Typically an instrument is located at a fixed location and shares the platform elevation. The format is metres above sea level (m.a.s.l.).
TIMESTAMP	*UTCOffset*	The UTCOffset is the amount of time to be SUBTRACTED from the local time in order to obtain UTC time (where East is positive and Local Time as defined by the data originator). This is equivalent to UTC=time-UTCOffset. *UTCOffset* is represented in the **ISO-8601** standard of **hh:mm:ss.** The default is to report time in UTC, thus UTCOffset=+00:00:00. If ***Time*** is not given in UTC in the Data Content section, then **Time** represents local time and the ***UTCOffset*** must be specified by a non-zero value.
	Date	The Date corresponding to the time code represented in the **ISO-8160** standard, **yyyy-mm-dd.**
	Time	Time is represented in the **ISO-8601** standard of **hh:mm:ss**. Refer to Section 3.3.7 for more information.

Table 3.2.2 The WOUDC extCSV Data File Description of the Tables and Fields - Metadata

3.2.3 An Example of an extCSV File Format Header

```
*SOFTWARE: SNDPRO 1.3
*TROPOPAUSE IN MB 320
*M.S.C.-O3 T1200

#CONTENT
Class,Category,Level,Form
WOUDC,OzoneSonde,1.0,1

#DATA_GENERATION
Date,Agency,Version,ScientificAuthority
1999-05-07,MSC,1.0,Jonathan Davies

#PLATFORM
Type,ID,Name,Country,GAW_ID
STN,315,Eureka,CAN,71917

#INSTRUMENT
Name,Model,Number
ECC,6a,6a2355

#LOCATION
Latitude,Longitude,Height
79.99,-85.94,10

#TIMESTAMP
UTCOffset,Date,Time
+00:00:00,1999-04-28,23:15:00
```

3.2.3 Additional Rules for extCSV Files

NOTE: If a datum is not being reported (because it either does not exist or was considered of poor quality, ***then the field is left blank***.

Example There are values for A, C and D but not B, thus B is left blank in the data record.

```
#TABLE
FieldA,FieldB,FieldC,FieldD
A,,C,D
```

Commas are not necessary at the end of a record where no data follow.

Example There are no values for C, D and E so no commas are necessary at the end of the data record.

```
#TABLE
FieldA,FieldB,FieldC,FieldD,FieldE
A,B
```

3.3 The WODC extCSV Data File Definitions – Data Content

Table 3.3.1 summarises the current data types or "categories" presently defined by the WODC. Each extCSV file requires **one** of these categories to be included in the CONTENT table under the field (column) heading "Category". Note the temporal range specifies the required amount of data within each file.

Category	WODC Usage	Temporal Range per file
Lidar	Data submission and retrieval.	Duration of one observation period (usually one local or two days yielding a single profile)
Microwave	To be defined.	Duration of one observation period (usually one local or two days yielding a single profile)
OzoneSonde	Data submission and retrieval.	Duration of sonde flight (typically a single flight)
TotalOzoneObs	Data submission and retrieval.	Usually within one local day
TotalOzone	Data submission and retrieval.	One month of daily summaries
UmkehrN14	At present: data retrieval only.	One month of daily summaries

Table 3.3.1 WODC Data Categories

Each category has a set of defined tables which includes the fields (columns) names, the order of the fields and the required units

3.3.1 Category: Lidar

NOTE: the Lidar tables have been directly extracted from the NASA-Ames 2160 formatted files [2a,b] used by Network for the Detection of Atmospheric Composition Change (NDACC) known formerly as NDSC.

TABLENAME	Field Names (in order)
#PROFILE_SUMMARY	Altitudes, MinAltitude,MaxAltitude,StartDate,StartTime,EndDate,EndTime, PulsesAveraged
#OZONE_PROFILE	Altitude,OzoneDensity,StandardError,RangeResolution,AirDensity,Temperature

Table: PROFILE_SUMMARY

Field Name	Definition
Altitudes	Number of retrieved levels (layers) reported
MinAltitude	Minimum altitude of profile in metres (m)
MaxAltitude	Maximum altitude of profile in metres (m)
StartDate	Start date determined by the observation period. ISO 8601format for **date yyyy-mm-dd** is used.
StartTime	Start time determined by the observation period. ISO 8601format for time **hh:mm:ss** is used.
EndDate	End date determined by the observation period. ISO 8601format for **date yyyy-mm-dd** is used.
EndTime	End time determined by the observation period. ISO 8601format for time **hh:mm:ss** is used.
PulsesAveraged	Number of pulses used to integrate profile

Table: OZONE_PROFILE

Field Name	Definition
Altitude	Laser altitude (range) in metres (m)
OzoneDensity	Ozone density (concentration) (molecules*cm^{-3})
StandardError	Estimated standard error of ozone concentration (molecules*cm^{-3})
RangeResolution	Range resolution in metres (m)
AirDensity	Density of the air (molecules*cm^{-3})
Temperature	Temperature (Kelvin)

Comments
Comments may appear through any file, and are considered to be a useful way to convey information considered relevant to the data contained within that particular file. Such information may include the instrument wavelengths used for the Rayleigh and Raman on/off settings. Also information about ozone sonde data used to derive the temperature profile may be added as comments. Note: ***Files translated (converted) from NASA-Ames format will have the entire header included at the end of the file as comments***.

An Example of Lidar Data in extCSV File Format

***NOTE:One Event per file**

```
* This file was generated by NA2110LI - version 1.0.
* Originating NASA-Ames file: NDSC\EUREKA\euo39302.cal
* --- NASA-Ames MNAME ---
* NDSC

#CONTENT
Class,Category,Level,Form
WOUDC,Lidar,1.0,1

#DATA_GENERATION
Date,Agency,Version,ScientificAuthority
1993-12-14,CRESTech,0.0,"(Carswell, A. I.), (carswell@lidar.ists.ca) 416-665-5418"

#PLATFORM
Type,ID,Name,Country,GAW_ID
STN,315,Eureka,CAN

#INSTRUMENT
Name,Model,Number
DIAL,Lotard,1

* --- NASA-Ames SCOM ---
* Data processed using version 2.0 software
* --- NASA-Ames NCOM ---
* Temperature and Density data above about 25 Km
* is lidar derivied. Temperature and density below
* 15-25 Km (maximum sonde height) is that given
* by the nearest in time Eureka radiosonde.
* Between the maximum sonde height up to
* around 25 Km the temperature and denisty is
* estimated by interpolationg between the sonde
* and lidar values.

#LOCATION
Latitude,Longitude,Height
80,-85.9,607

#TIMESTAMP
UTCOffset,Date,Time
+00:00:00,1993-02-10,13:11:00

#OZONE_SUMMARY
Altitudes,MinAltitude,MaxAltitude,StartDate,StartTime,EndDate,EndTime,PulsesAveraged
112,12150,45430,1993-02-10,13:11:00,,,1.26e+006

#OZONE_PROFILE
Altitude,OzoneDensity,StandardError,RangeResolution,AirDensity,Temperature
12150.,2.428e+012,4.67e+010,1000
12450.,2.761e+012,4.82e+010,1000
12750.,2.996e+012,5.02e+010,1000
… etc
```

3.3.2 Category: Microwave

NOTE: the Microwave tables are based on the data output from the Payerne, Switzerland meteorological station, operated by MeteoSwiss [3].

TABLENAME	Field Names (in order)
#PROFILE_SUMMARY	Levels,AveragingTime,ZenithAngle,NoiseTemperature,TTF,CalculatedSpectrum
#OZONE_PROFILE	Altitude,OzoneVMR,VariableError,FixedError,SmoothingError,TotalError, A-Priori,Temperature,Pressure

Table: PROFILE_SUMMARY

Field Name	Definition
Levels	Number of levels (layers) reported
AveragingTime	
ZenithAngle	Solar zenith angle (decimal degrees)
NoiseTemperature	Mean system noise temperature (K)
TTF	Tropospheric Transmission Factor (TTF)
CalculatedSpectrum	Sta. of Meas. - Calc. Spectrum (K)

Table: OZONE_PROFILE

Field Name	Definition
Altitude	Altitude in metres above sea level (m.a.s.l.)
OzoneVMR	Ozone VMR in ppm
VariableError,FixedError	Variable (stochastic) error for ozone VMR (ppm)
FixedError	Fixed (systematic) error for ozone VMR (ppm)
SmoothingError	Smoothing error (ppm)
TotalError	Total error (ppm)
A-priori	A-priori data contribution (%)
Temperature	Temperature profile used for retrieval (K)
Pressure	Pressure profile used for retrieval (Pa)

Comments

Comments may appear through any file, and are considered to be a useful way to convey information considered relevant to the data contained within that particular file. Note: ***Files translated (converted) from NASA-Ames format will have the entire header included at the end of the file as comments***.

An Example of Microwave Data in extCSV File Format

***NOTE:One Event per file**

```
* This file was originally received in NASA-Ames 2110 format and has been
* translated into WOUDC extCSV format using converter software XXX ver xx
*
* ------------------------------------------------------------------------
* NOTE: Original file header information is appended at the end of this file.
* ------------------------------------------------------------------------
*

#CONTENT
Class,Category,Level,Form
WOUDC,Microwave,1.0,1

#DATA_GENERATION
Date,Agency,Version,ScientificAuthority
2006-07-01,Meteoswiss,1.0,Dominique Ruffieux

#PLATFORM
Type,ID,Name,Country,GAW_ID
STN,156,Payerne,CHE

#INSTRUMENT
Name,Model,Number
SOMORA,???,???

#LOCATION
Latitude,Longitude,Height
46.82,6.95,491

* Observing technique: total power
* Center frequency: 142.175 GHz
* Inversion method: Optimal Estimation
* Temp. and press. profiles : CIRA 86 + daily NCEP + Payerne radiosondes
* A-priori profile: season standard atmosphere
* Measurement Error Cov.: variable, adjusted to wings BT
* A Priori Error Cov.: 0 - 1.5 ppm (correlation 3-5 km)

#TIMESTAMP
UTCOffset,Date,Time
+0:00:00,2005-10-09,00:18:00

*282.01 25 2005 10 9 0 18 30 46.82 6.95 491 52.0 2741 0.57 0.13
#PROFILE_SUMMARY
Levels,AveragingTime,ZenithAngle,NoiseTemperature,TTF,CalculatedSpectrum
25,30,52.0,2741,0.57,0.13

#OZONE_PROFILE
Altitude,OzoneVMR,VariableError,FixedError,SmoothingError,TotalError,A-Priori,
Temperature,Pressure
13000,0.40,0.01,0.05,0.28,0.29,18,213.75,172.92
15000,0.69,0.03,0.12,0.43,0.45,18,214.17,125.88
17000,1.29,0.05,0.18,0.44,0.48,17,213.04,91.56
…
73500,0.56,0.03,0.02,0.11,0.12,64,216.68,,0.03
76500,0.54,0.02,0.01,0.10,0.10,73,214.20,,0.02

#TIMESTAMP
```

```
UTCOffset,Date,Time
+0:00:00,2005-10-09,00:48:00

*282.03 25 2005 10 9 0 48 30 46.82 6.95 491 52.0 2748 0.57 0.13
#PROFILE_SUMMARY
Levels,AveragingTime,ZenithAngle,NoiseTemperature,TTF,CalculatedSpectrum
25,30,52.0,2748,0.57,0.13

#OZONE_PROFILE
Altitude,OzoneVMR,VariableError,FixedError,SmoothingError,TotalError,A-Priori,
Temperature,Pressure
13000,0.42,0.01,0.05,0.28,0.29,18,213.75,172.92
15000,0.74,0.03,0.11,0.43,0.45,17,214.17,125.88
17000,1.34,0.05,0.18,0.44,0.48,17,213.04, 91.56
…
70500,0.59,0.05,0.03,0.14,0.15,56,219.34,,0.04
73500,0.56,0.03,0.02,0.11,0.12,65,216.68,,0.03
76500,0.53,0.02,0.01,0.10,0.10,74,214.20,,0.02

etc ...

#TIMESTAMP
UTCOffset,Date,Time
+0:00:00,2005-10-09,23:47:00

*282.99 25 2005 10 9 23 47 25 46.82 6.95 491 52.0 2740 0.63 0.18
#PROFILE_SUMMARY
Levels,AveragingTime,ZenithAngle,NoiseTemperature,TTF,CalculatedSpectrum
25,25,52.0,2740,0.63,0.18

#OZONE_PROFILE
Altitude,OzoneVMR,VariableError,FixedError,SmoothingError,TotalError,A-
Priori,Temperature,Pressure
13000,0.34,0.01,0.04,0.28,0.29,24,211.78,174.52
15000,0.53,0.03,0.11,0.43,0.44,22,212.61,126.65
17000,1.01,0.05,0.16,0.43,0.46,21,211.64, 91.94
…
70500,0.55,0.06,0.03,0.14,0.15,56,219.34,,0.04
73500,0.53,0.03,0.02,0.11,0.12,66,216.68,,0.03
76500,0.52,0.02,0.01,0.10,0.10,76,214.20,,0.02

* RUFFIEUX D.,,,, MWAVE,,, PAYERNE,, OZONE,,, 09-Oct-2005 00:18:0009-Oct-2005
23:47:001001
* 47 2110
* RUFFIEUX, Dominique
* MeteoSwiss, Station Aerologique de Payerne, Switzerland
* Stratospheric Ozone Monitoring Radiometer (SOMORA) / Payerne
* NDSC / GAW
* 1 1
* 2005 10,9 2005 10 10
* 0.0 0.0
* Altitude (m)
* Fractional day (day of year)
* 8
* 1 1 1 1 1 1 1 100
* 99.99 99.99 99.99 99.99 99.99 999 999.99 9999.99
* Ozone VMR (ppm)
* Variable (stochastic) error for ozone VMR (ppm)
* Fixed (systematic) error for ozone VMR (ppm)
* Smoothing error (ppm)
```

```
* Total error (ppm)
* A-priori data contribution (%)
* Temperature profile used for retrieval (K)
* Pressure profile used for retrieval (Pa)
* 14
* 1 1 1 1 1 1 1 1 1 1 1 1 1
* 99 9999 99 99 99 99 999 99.99 99.99 999 99 9999 9.99 9.99
* Number of altitudes recorded in subsequent data records
* Year
* Month
* Day
* Hour (Time=UT)
* Minutes
* Averaging Time (Minutes)
* Latitude (Deg. north)
* Longitude (Deg. east)
* Altitude above sea level (m)
* Zenith angle (Deg.)
* Mean system noise temperature (K)
* Tropospheric Transmission Factor
* Std. of Meas. - Calc. Spectrum (K)
* 0
* 7
* Observing technique: total power
* Center frequency: 142.175 GHz
* Inversion method: Optimal Estimation
* Temp. and press. profiles : CIRA 86 + daily NCEP + Payerne radiosondes
* A-priori profile: season standard atmosphere
* Measurement Error Cov.: variable, adjusted to wings BT
* A Priori Error Cov.: 0 - 1.5 ppm (correlation 3-5 km)
```

3.3.3 Category: Ozone Sonde

NOTE: ***The two tables below relate to Section 3.2 pages 9-11 of this document (The WOUDC extCSV Data File Definitions – Metadata). There are changes for the specific values of the ozone sonde which are listed and described below.***

Static Metadata (Only one occurrence or instance per file.)		
Table Name	**Condition**	**Field (Column) Names**
CONTENT	***Required***	<Class,Category,Level,Form> "Form" shall = 2

Reason for change: Form (index) is the version of the data format. If an existing table is altered OR a new table added, the Form index will be increased by 1 for each change. The form (index) value is intended as a file format reader indicator of the type of data tables to follow, to assist programmers with reading the file. Changes to this index will be made through the WOUDC only. Consequently the additional and altering of the original tables in the ozone sonde format the "FORM" index value needs to change, in this case it shall be equal to 2 as of "Month Day, 2013". For details, please refer to Section 3.2.

Dynamic Metadata (*At least one required per file, multiple occurrences are permitted.*)		
Table Name	***Condition***	**Field (Column) Names**
TIMESTAMP	***Required***	<UTCOffset,Date,Time> "Time" shall be in UTC. "UTCOffset" shall be "+00:00:00" (zero)

Reason for change: The convention for ozone sonde is to report time in UTC (instead of local time) therefore the time is reported in UTC and the offset is recorded as zero.

NOTE: ***The ozone sonde experts within the WMO Scientific Advisory Group for Ozone are presently reviewing the tables and fields for inclusion of additional ozone sonde data. This will be an on-going exercise and data tables will be periodically updated as progress is made. Continue to check the WOUDC web site for updates to this guide.***

TABLENAME	**Field Names (in order)**
#PREFLIGHT_SUMMARY	Ib0,ib1,ib2,SolutionType,SolutionVolume,PumpFlowRate, OzoneSondeResponseTime
#RADIOSONDE	Manufacturer,Model,Number
#INTERFACE_CARD	Manufacturer,Model,Number
#SAMPLING_METHOD	TypeOzoneFreeAir,CorrectionWettingFlow, SurfaceOzone,DurationSurfaceOzoneExposure,LengthBG,WMOTropopausePressure,BurstOzonePressure,GroundEquipment,ProcessingSoftware
#PUMP_SETTINGS	MotorCurrent,HeadPressure,VacuumPressure
#PUMP_CORRECTION	Pressure,PumpCorrectionFactor
#FLIGHT_SUMMARY	IntegratedO3,CorrectionCode,SondeTotalO3,NormalizationFactor,BackgroundCorrection,SampleTemperatureType
#OZONE_REFERENCE	Name,Model,Number,Version,TotalO3,WLCode,ObsType,UTC_Mean
#PROFILE	Duration,Pressure,O3PartialPressure,Temperature,WindSpeed,WindDirection,LevelCode,GPHeight,RelativeHumidity,SampleTemperature,SondeCurrent,PumpMotorCurrent,PumpMotorVoltage,Latitude,Longitude,Height

#PROFILE_UNCERTAINTY	As in #PROFILE
#PRELAUNCH	As in #PROFILE
#DESELECTED DATA	As in #PROFILE

NOTES:

I. ***In the in the January 2013, GAW Report #201 (Quality Assurance and Quality Control for Ozonesonde Measurements in GAW), Section 4.8.2, p. 45; this field name "manufacturer" in the table #RADIOSONDE and #INTERFACE_CARD is known as "Name".***

II. ***The parameter "DurationSurfaceOzone" as listed in GAW-Report#201, at page 45 has been combined with "MinutesGroundO3" from the Table Sampling_Method into a new parameter now known as "DurationSurfaceOzoneExposure".***

Table: PREFLIGHT_SUMMARY

Field Name	Definition
Ib0	Background current of ozone sonde measured in the laboratory **before sonde is exposed to ozone** (μA).
Ib1	Background current of ozone sonde measured in the laboratory **after sonde is exposed to defined dose of ozone** (μA).
Ib2	Background current of ozone sonde measured at the field site **just prior to launch** (μA).
SolutionType	Chemical composition of sensing solution of ozone sonde.
SolutionVolume	Volume of sensing solution in ozone sonde cell (ml).
PumpFlowRate	Pump flow rate measured in the laboratory at surface conditions (corrected for moistening when possible: see section 3.2.4 of GAW Report #201 – ***http://www.wmo.int/pages/prog/arep/gaw/documents/GAW_201.pdf***) (cm^3/min)
OzonesondeResponseTime	Response time 1/e (in minutes) measured during the laboratory decay test.

Table: RADIOSONDE

Field Name	Definition
Manufacturer	Manufacturer of radiosonde flown with the ozone sensor. **Note:** In the in the January 2013, GAW Report #201 (Quality Assurance and Quality Control for Ozonesonde Measurements in GAW), Section 4.8.2, p. 45; this field name "Manufacturer" is known as "Name".
Model	Radiosonde model.
Number	Radiosonde serial number.

Table: INTERFACE_CARD

Field Name	Definition
Manufacturer	Manufacturer of interface card between radiosonde and ozone sensor.

	Note: In the in the January 2013, GAW Report #201 (Quality Assurance and Quality Control for Ozonesonde Measurements in GAW), Section 4.8.2, p. 45; this field name "Manufacturer" is known as "Name".
Model	Interface card model.
Number	Interface card serial number.

Table: SAMPLING_METHOD

Field Name	Definition
TypeOzoneFreeAir	Technique used to obtain ozone free air at the launch site just prior to launch (example would be "activated charcoal filter").
CorrectionWettingFlow	Factor applied to pump flow rate to compensate for using non-saturated air during pre-flight calibration.
SurfaceOzone	Surface ozone measured by independent method (ppbv).
DurationSurfaceOzoneExposure	Length of time ozone sonde was measuring (i.e. exposed to) surface ozone (min)
LengthBG	Distance (length) between the bottom of the balloon and the sonde payload or gondola (m).
WMOTropopausePressure	Ambient air pressure at the tropopause which is determined after WMO-definition (hPa).
BurstOzonePressure	Ozone partial pressure at balloon burst altitude (hPa).
GroundEquipment	Basic ground equipment in use.
ProcessingSoftware	Post flight processing software.

<u>NOTE:</u> The parameter "DurationSurfaceOzone" as listed in GAW-Report#201, at page 45 has been combined with "MinutesGroundO3" from the Table Sampling_Method into a new parameter now known as "DurationSurfaceOzoneExposure".

Table: PUMP_SETTINGS

Field Name	Definition
MotorCurrent	Electrical current through pump motor (mA).
HeadPressure	Maximum pressure when outlet of pump is stopped (hPa).
VacuumPressure	Minimum pressure when inlet of pump is stopped (hPa).

Table: PUMP_CORRECTION

Field Name	Definition
Pressure	Level Pressure in hecto-Pascals (hPa).
PumpCorrectionFactor	Correction applied to pump flow rate at corresponding pressure level.

Table: FLIGHT_SUMMARY

Field Name	Definition
IntegratedO3	Integrated ozone amount from launch platform to burst altitude (DU).
CorrectionCode	Code for the algorithm used to estimate the remaining ozone (calculated residual) above burst height to the top of atmosphere. (*Refer to the Residual Ozone (Correction) Algorithm*

	Code Table).
SondeTotalO3	Integrated + calculated residual (DU).
NormalizationFactor	The factor that the apparent ozone partial pressure measured by the sonde was multiply by in order to make the SondeTotalO3 value agree with the TotalO3 given in the OZONE_REFERENCE table. A negative factor indicates a value that was calculated but not applied.
BackgroundCorrection	The method used to account for the background current produced by the ozone sonde when no ozone is present.
SampleTemperatureType	The method used to calculate the temperature of the air being sampled by the ozone sonde. This can be an estimated value, a constant, or a measurement from a thermistor located in the box, pump or inlet tube.

Table: OZONE_REFERENCE

Field Name	Definition
Name	Common name of the total ozone reference instrument. For example "Brewer" or "TOMS". Refer to the WOUDC web site for a listing: ***http://www.woudc.org/data/Metadata/instruments_e.html***
Model	Model ID where applicable. Refer to the WOUDC Instrument list: ***http://www.woudc.org/data/Metadata/instruments_e.html***.
Number	Serial number of the instrument as assigned by the manufacturer.
Version	Data version specified by the submitting Agency. These versions have the form ***major.minor*** (eg. 3.2) where major values are incremented with changes to the processing algorithm and minor values are incremented when the characterisation or calibration values have changed. Note, minor values are reset to zero with changes to the processing algorithm.
TotalO3	Daily value of total column ozone amount (in Dobson Units, i.e., milli atm-cm) defined as the "best representative value". Typically in the order of DS, ZS and FM.
WLCode	Code to designate the wavelength pair(s) used for total ozone measurement.*
ObsType	Code to designate the type of total ozone measurement.*
UTC_Mean	The mean time of observations (in decimal hours, UTC).

* Refer to the Wavelength and Observation Codes Table on Pages 29-30.

Table: PROFILE

Field Name	Definition
Duration	Elapsed flight time since released as primary variable (s).
Pressure	Atmospheric pressure of each level in hecto-Pascals (hPa).
O3PartialPressure	Level partial pressure of ozone in milli-Pascals (mPa).
Temperature	Level Temperature in degrees Celsius (C).
WindSpeed	Wind speed in meters per second (m/s).
WindDirection	Wind direction in degrees.
LevelCode	Code for the level type (*Refer to Level Codes Table*).
GPHeight	Geopotential height in meters (m).
RelativeHumidity	Relative Humidity in percent (%).

SampleTemperature	Temperature where sample is measured in degrees Celsius (C).
SondeCurrent	Measured ozone sonde cell current (µA) with no corrections applied.
PumpMotorCurrent	Electrical current (mA) measured through the pump motor (if available).
PumpMotorVoltage	Applied voltage (V) measured across the pump motor (if available).
Latitude	Geographical latitude (for example from GPS) (-90 to +90 decimal degrees).
Longitude	Geographical longitude (for example from GPS) (-180 to +180 decimal degrees).
Height	Geographical height (for example from GPS) (meter above sea level - masl).

Table: PROFILE_UNCERTAINTY
Estimated uncertainty (if available) for each of the measured profile parameter in #PROFILE as a function of duration.

Field Name	Definition
Duration	Elapsed flight time as primary variable (s)
Pressure	Atmospheric pressure of each level in hecto-Pascals (hPa)
O3PartialPressure	Level partial pressure of ozone in milli-Pascals (mPa)
Temperature	Level Temperature in degrees Celsius (C)
WindSpeed	Wind speed in meters per second (m/s)
WindDirection	Wind direction in degrees
LevelCode	Placeholder for future use, leave as blank.
GPHeight	Geopotential height in meters (m)
RelativeHumidity	Relative Humidity in percent (%)
SampleTemperature	Temperature where sample is measured in degrees Celsius (C)
SondeCurrent	Measured ozone sonde current (no corrections applied)
PumpMotorCurrent	Electrical current (mA) measured through the pump motor (if available)
PumpMotorVoltage	Applied voltage (V) measured across the pump motor (if available)
Latitude	Geographical latitude (for example from GPS) (-90 to +90 degrees)
Longitude	Geographical longitude (for example from GPS) (-180 to +180 degrees)
Height	Geographical height (for example from GPS) (meter above sea level - masl)

Table: PRELAUNCH
Any data recorded by the telemetry (i.e. data acquisition) system prior to sonde release including pre-launch checks and surface measurements. Duration is relative to launch time and is therefore a negative value.

Field Name	Definition
Duration	Time before launch (s).
Pressure	Atmospheric pressure of each level in hecto-Pascals (hPa)
O3PartialPressure	Level partial pressure of ozone in milli-Pascals (mPa)
Temperature	Level Temperature in degrees Celsius (C)
WindSpeed	Wind speed in meters per second (m/s)
WindDirection	Wind direction in degrees
LevelCode	Placeholder for future use, leave as blank.
GPHeight	Geopotential height in meters (m)
RelativeHumidity	Relative Humidity in percent (%)

SampleTemperature	Temperature where sample is measured in degrees Celsius (C)
SondeCurrent	Measured ozone sonde current (no corrections applied)
PumpMotorCurrent	Electrical current (mA) measured through the pump motor (if available)
PumpMotorVoltage	Applied voltage (V) measured across the pump motor (if available)
Latitude	Geographical latitude (for example from GPS) (-90 to +90 degrees)
Longitude	Geographical longitude (for example from GPS) (-180 to +180 degrees)
Height	Geographical height (for example from GPS) (meter above sea level - masl)

Table: DESELECTED
Any data recorded from the ozonesonde but NOT reported in the PROFILE table.

This can include data that was rejected due to suspected telemetry or instrument problems; and data recorded after balloon termination (a descent profile). The table parameters are the same as in the PROFILE and PROFILE_UNCERTAINTY tables. O3PartialPressure may be calculated but is not mandatory.

Field Name	**Definition**
Duration	Elapsed flight time as primary variable (s)
Pressure	Atmospheric pressure of each level in hecto-Pascals (hPa)
O3PartialPressure	Level partial pressure of ozone in milli-Pascals (mPa)
Temperature	Level Temperature in degrees Celsius (C)
WindSpeed	Wind speed in meters per second (m/s)
WindDirection	Wind direction in degrees
LevelCode	Placeholder for future use, leave as blank.
GPHeight	Geopotential height in meters (m)
RelativeHumidity	Relative Humidity in percent (%)
SampleTemperature	Temperature where sample is measured in degrees Celsius (C)
SondeCurrent	Measured ozone sonde current (no corrections applied)
PumpMotorCurrent	Electrical current (mA) measured through the pump motor (if available)
PumpMotorVoltage	Applied voltage (V) measured across the pump motor (if available)
Latitude	Geographical latitude (for example from GPS) (-90 to +90 degrees)
Longitude	Geographical longitude (for example from GPS) (-180 to +180 degrees)
Height	Geographical height (for example from GPS) (meter above sea level - masl)

Code Tables for OzoneSonde

Residual Ozone (Correction) Algorithm Code Table

CorrectionCode	Algorithm
None (blank)	Unknown
0	None
1	Satellite derived climatology from SBUV. (after (McPeters, R.D., Labow, G.J., and Johnson, B.J. 1997 in JGR)
2	Constant mixing ratio extrapolated from value at burst height. The Residual Ozone (D.U.) = 7.892 * ozone partial pressure [mPa] at burst level.
3	Constant mixing ratio extrapolated from average of last 3 significant levels above 17 mbar (MSC method). The Residual Ozone (D.U.) = 7.892 * Total atmospheric pressure * (Average mixing ratio of last 3 levels) [mPa]
4	Constant mixing ratio extrapolated from value at burst height. The Residual Ozone (D.U.) = 7.892 * ozone partial pressure [mPa] at burst level. However, the height of the extrapolation is limited to 7hPa. If the balloon reaches a height beyond 7hPa, the profile is integrated up to 7hPa and then the ozone partial pressure, at that point (if it is a good datum), is multiplied by 7.892. If the balloon bursts below 7 hPa then the profile is extrapolated from the burst point.
5	A monthly mean vertical ozone profile climatology is calculated specifically for Lauder using Lauder ozone microwave radiometer data from 1992 to 1998. The climatology is similar to the McPeters/Labow climatology in that it is listed in 1hPa increments from 30 to 1hPa.
6	Climatology 2011: An MLS and sonde derived ozone climatology for satellite retrieval algorithms. (after McPeters, R.D., and Labow G.J., in JGR 2012).
7-98	To be defined by WOUDC
99	Other (not yet defined) Supplied by data originator.

Level Codes Table

Level Code	Description
None (blank)	Unknown
0	Regular level (point value/datum)
1	Standard level The 15 standard WODC levels are: 1000, 700, 500, 300, 200, 150, 100, 70, 50, 30, 20, 10, 7, 5, 3, 2 and 1 (hPa).
2	Significant level Surface, tropopause or other significant inflection point for ozone, temperature etc.
3	Standard and Significant Level.
4	Level average
Other codes	Further codes will be generated as required using the following simple model: Level Code Description 8 significant for temperature 16 significant for ozone 32 significant for RH E.g. a standard level which is significant for temperature and ozone would be 1+2+8+16 = 27

An Example of OzoneSonde Data in extCSV File Format

```
#CONTENT
Class,Category,Level,Form
WOUDC,OzoneSonde,1.0,2

#DATA_GENERATION
Date, Agency, Version, ScientificAuthority
2013-02-11, Environment Canada,1.0,Jonathan Davies

#PLATFORM
Type,ID,Name,Country,GAW_ID
STN,21,Stonyplain,CAN

#INSTRUMENT
Name,Model,Number
ECC,Z,Z14850

#LOCATION
Latitude,Longitude,Height
53.54,-114.1,766

#TIMESTAMP
UTCOffset,Date,Time
+00:00:00,2013-01-30,11:16:00

*EXAMPLE OF NEW OZONESONDE
*FILE FORMAT*
* ----- correction applied for 1% KI solution in ENSCI sonde ----------
* ----- correction applied for 2.5 cc of solution instead of 3.0 ---
* ----- residual ozone interpolated from 2011 MLS climatology (McPeters and
Labow) ---

#PREFLIGHT_SUMMARY
ib0,ib1,1b2,SolutionType,SolutionVolume,PumpFlowRate,OzoneSondeResponseTime
0.1,0.04,0.04,1%KIFullBuffer,2.5,214.36,0.34

#RADIOSONDE
Manufacturer,Model,Number
Vaisala,RS92-SGP,H0513477

#INTERFACE_CARD
Manufacturer,Model,Number
Vaisala,RSA921,G14513056

#SAMPLING_METHOD
TypeOzoneFreeAir,CorrectionWettingFlow,SurfaceOzone,
LengthBG,WMOTropopausePressure,BurstOzonePressure,GroundEquipment,ProcessingS
oftware
activated charcoal filter,0.98,20,30,295,13.099,DigiCORA III,SNDPRO 2.0

#PUMP_SETTINGS
MotorCurrent,HeadPressure,VacuumPressure
79.9,1600,200

#PUMP_CORRECTION
Pressure,Correction
2,1.16,
3,1.124
5,1.087,
```

```
10,1.054
20,1.033
30,1.024
50,1.015
100,1.01
200,1.007
300,1.005
500,1.002
1000,1.0

#FLIGHT_SUMMARY
IntegratedO3,CorrectionCode,SondeTotalO3,NormalizationFactor,BackgroundCorrec
tion,SampleTemeratureType
318.5,6,404.3,-0.984,Pressure_ib2,Pump_Intern

#OZONE_REFERENCE
Name,Model,Number,Version,TotalO3,WLCode,ObsType,UTC_Mean
Brewer,Single,55,1,398,9,0,19.6

#PROFILE
Duration,Pressure,O3PartialPressure,Temperature,WindSpeed,WindDirection,Level
Code,GPHeight,RelativeHumidity,SampleTemperature,SondeCurrent,PumpMotorCurren
t,PumpMotorVoltage,Latitude,Longitude,Height
0,924.59,1.973,-23.1,2.6,360,2,766,76,36.6,0.566924
2,924.13,1.973,-23.2,2.2,350,0,770,72,36.6,0.566904
4,923.46,1.992,-23.4,2.6,349,0,774,72,36.6,0.572229
6,922.56,1.992,-23.5,3,350,0,783,73,36.6,0.572192
8,921.21,1.982,-23.6,3.3,350,0,793,74,36.6,0.569459
10,919.86,1.981,-23.7,3.6,350,0,803,75,36.6,0.569403
...
7510,20.11,13.167,-61.2,13.2,64,0,26282,1,11.7,3.89304
7512,20.09,13.205,-61.1,13,64,0,26287,1,11.7,3.90423
7514,20.07,13.186,-61.1,12.8,64,0,26293,1,11.7,3.89851
7516,20.05,13.176,-61,12.6,65,0,26300,1,11.6,3.89697
7518,20.02,13.175,-60.9,12.4,65,0,26307,1,11.6,3.89685
7520,20,13.099,-61,12.2,65,2,26314,1,11.6,3.87421


#PROFILE_UNCERTAINTY
Duration,Pressure,O3PartialPressure,Temperature,WindSpeed,WindDirection,Level
Code,GPHeight,RelativeHumidity,SampleTemperature,SondeCurrent,PumpMotorCurren
t,PumpMotorVoltage,Latitude,Longitude,Height
```

***Note**: At present this is a placeholder for estimated uncertainty for each of the measured profile parameters listed here. Guidelines for this will be released probably first in 2014/2015*

```
#PRE_RELEASE
Duration,Pressure,O3PartialPressure,Temperature,WindSpeed,WindDirection,Level
Code,GPHeight,RelativeHumidity,SampleTemperature,SondeCurrent,PumpMotorCurren
t,PumpMotorVoltage,Latitude,Longitude,Height
-1275,925.16,,23.3,,,0,766,34.1,24.9,0.08,80.8,15.9,,,
-1260,925.07,,23.3,,,0,766,34.1,25.1,0.08,81.1,15.8,,,
-1245,925.24,,23.3,,,0,766,34.2,25.3,0.07,81.3,15.8,,,
-1230,925.16,,23.3,,,0,766,34.2,25.5,0.07,81.7,15.7,,,
-1215,925.2,,23.3,,,0,766,34.3,25.7,0.06,81.6,15.7,,,
-1200,925.17,,23.3,,,0,766,34,25.9,0.06,81.6,15.7,,,
-1185,925.21,,23.3,,,0,766,33.7,26,0.06,81.5,15.6,,,
...
-90,926.06,25.02,-22.1,,,0,766,60.2,31.6,0.680792238,72.9,15.5
-75,926.09,24.36,-22.1,,,0,766,60.7,31.6,0.662833689,72.5,15.6
-60,926.13,23.97,-22.1,,,0,766,58.8,31.6,0.65222182,73.5,15.5
-45,926.15,23.96,-22.1,,,0,766,60.4,31.7,0.651735862,72.4,15.6
-30,926.23,23.76,-22.1,,,0,766,60.4,31.7,0.646295662,73.1,15.7
-15,926.2,23.51,-22.1,,,0,766,60.7,31.7,0.639495413,72.9,15.7
0,926.3,23.37,-22.1,,,0,766,60.5,31.7,0.635687274,73.2,15.8

#DESELECTED
Duration,Pressure,O3PartialPressure,Temperature,WindSpeed,WindDirection,Level
Code,GPHeight,RelativeHumidity,SampleTemperature,SondeCurrent,PumpMotorCurren
t,PumpMotorVoltage,Latitude,Longitude,Height
7520,20,13.75,-61,12.2,65,0,26313,1,11.6
7522,19.98,13.72,-61,12,66,0,26319,1,11.6
7524,19.96,13.71,-61,11.8,66,0,26327,1,11.6
7526,19.93,13.71,-61,11.7,66,0,26336,1,11.6
7528,19.9,13.7,-61,11.5,66,0,26344,1,11.6
7530,19.88,13.68,-61,11.4,66,0,26352,1,11.6
7532,19.86,13.54,-61,11.3,66,0,26359,1,11.6
...
9910,7.29,0.19,-64.4,9.4,70,0,32505,1,-2.4
9912,7.29,0.19,-64.4,9.4,70,0,32506,1,-2.4
9914,7.29,0.19,-64.4,9.4,70,0,32507,1,-2.4
9916,7.29,0.19,-64.4,9.5,70,0,32509,1,-2.4
9918,7.29,0.19,-64.3,9.5,70,0,32510,1,-2.4
9920,7.29,0.19,-64.3,9.5,71,0,32511,1,-2.4
9922,7.29,0.19,-64.3,9.5,71,0,32512,1,-2.4
9924,7.29,0.19,-64.3,9.5,71,2,32513,1,-2.4
```

3.3.4 Category: TotalOzoneObs (Individual Daily Observations)

TABLENAME	Field Names (in order)
#OBSERVATIONS	Time,WLCode,ObsCode,Airmass,ColumnO3,StdDevO3,ColumnSO2,StdDevSO2
#DAILY_SUMMARY	WLCode,ObsCode,nObs,MeanO3,StdDevO3

Table: OBSERVATIONS

Field	Definition
Time	hh:mm:ss
WLCode	Code to designate the wavelength pair(s) used for total ozone measurement. (Code 0-7 are used for Dobson instruments only, 8 for Filter instruments only and 9 for Brewer instruments only.)
ObsCode	Code to designate the type of total ozone measurement.
Airmass	Relative slant path through atmosphere.
ColumnO3	Discrete total column ozone (O3) amount (in Dobson Units, i.e., milli atm-cm) measured at the time of observation.
StdDevO3	Standard Deviation of total column ozone measurement (where applicable)
ColumnSO2	Discrete total column sulphur dioxide (SO2) amount (in Dobson units, i.e., milli atm-cm) measured at the time of observation.
StdDevSO2	Standard Deviation of total column SO2 measurement (where applicable).

Table: DAILY_SUMMARY

Field	Definition
WLCode	Code to designate the wavelength pair(s) used for total ozone measurement. (Code 0-7 are used for Dobson instruments only, 8 for Filter instruments only and 9 for Brewer instruments only.)
ObsCode	Code to designate the type of total ozone measurement.
nObs	Number of observations used to calculate the total column ozone value
MeanO3	Mean value of total column ozone (O3) amount (in Dobson Units, i.e., milli atm-cm).
StdDevO3	Standard Deviation of total column ozone measurement (where applicable)

Wavelength and Observation Codes Table

WLCode	Description
0	AD wavelengths, ordinary setting
1	BD wavelengths, ordinary setting
2	CD wavelengths, ordinary setting
3	CC' wavelengths, ordinary setting
4	AD wavelengths, focused image
5	BD wavelengths, focused image
6	CD wavelengths, focused image
7	CC' wavelengths, focused image

8	Used to denote filter ozonemeter instruments
9	Used to denote Brewer spectrophotometer instruments
10-N	To be defined
ObsCode	**Description**
0 or DS	Direct Sun
1 or FM	Focused Moon
2 or ZB	Zenith Blue Sky
3 or ZS	Zenith Cloud (uniform stratified layer of small opacity)
4 or ZS	Zenith Cloud (uniform or moderately variable layer of medium opacity)
5 or ZS	Zenith Cloud (uniform or moderately variable layer of large opacity)
6 or ZS	Zenith Cloud (highly variable layer with or without precipitation)
7 or ZS	Zenith Cloud (fog)
8 or UV	Ozone derived from UV spectrum
9-N	To be assigned by the WOUDC. Data originators are encouraged to contact the WOUDC to register a new code when required.
GI	Total ozone value calculated from global irradiance (GI) type of measurement (specifically for Brewer instruments)

An Example of Total Ozone Observation Data in extCSV File Format

```
*Example of a single day of observations
*One observation day per file

#CONTENT
Class,Category,Level,Form
WOUDC,TotalOzoneObs,1.0,1

#DATA_GENERATION
Date,Agency,Version,ScientificAuthority
1999-05-07,MSC,1.0,J. Kerr

#PLATFORM
Type,ID,Name,Country,GAW_ID
STN,065,Toronto,CAN,71638

#INSTRUMENT
Name,Model,Number
Brewer,MKII,014

#LOCATION
Latitude,Longitude,Height
43.78,-79.47,198

#TIMESTAMP
UTCOffset,Date,Time
+00:00:00,1999-04-10

#OBSERVATIONS
Time,WLcode,ObsCode,Airmass,ColumnO3,StdDevO3,ColumnSO2,StdDevSO2
10:03:01,9,DS,2.39,350.0,2.0,1.13,0.02
10:25:11,9,DS,2.35,351.2,1.9,0.98,0.02
11:13:01,9,DS,2.21,348.4,1.5
…
17:03:23,9,DS,2.89,350.0,2.0,1.13,0.08
17:25:01,9,DS,2.99,350.8,2.2
17:50:01,9,DS,3.09,355.0,2.3
18:09:51,9,DS,3.29,351.4,2.7,2.13,0.6

#DAILY_SUMMARY
WLcode,ObsCode,nObs,MeanO3,StdDevO3
9,DS,9,350.0,2.0
```

3.3.5 Category: TotalOzone (Representative Daily Values)

TABLENAME	Field Names (in order)
#DAILY	Date,WLCode,ObsCode,ColumnO3,StdDevO3,UTC_Begin,UTC_End,UTC_Mean, nObs,mMu,ColumnSO2
#MONTHLY	Date,ColumnO3,StdDevO3,Npts

Table: DAILY

Field	Definition
Date	yyyy-mm-dd
WLCode	Code to designate the wavelength pair(s) used for total ozone measurement.*
ObsCode	Code to designate the type of total ozone measurement.*
ColumnO3	Daily value of total column ozone amount (in Dobson Units, i.e., milli atm-cm) defined as the "best representative value". Typically in the order of DS, ZS and FM.
StdDevO3	Is the estimated population standard deviation of the total column ozone measurements used for the daily value.
UTC_Begin	The starting time of observations (in decimal hours, UTC).
UTC_End	The ending time of observations (in decimal hours, UTC).
UTC_Mean	The mean time of observations (in decimal hours, UTC).
nObs	Number of observations used to calculate the total column ozone value.
mMu	The harmonic mean of the relative slant path through the ozone layer at 22Km ($\mu 1$) for each of the observations used to compute the daily value. It is a useful statistic in relation to the effects of uncertainties in the zero airmass extrapolations and in the generation of simulated data from independent data. $mMu=NN/\Sigma(1/\mu_i)$
ColumnSO2	The daily total column sulphur dioxide (SO2) amount calculated as the mean of the individual SO2 amounts (in Dobson Units, i.e., milli-atm-cm) from the same observation used for the O3 amount.

* Refer to the Wavelength and Observation Codes Table on Pages 29-30.

Table: MONTHLY

Field	Definition
Date	yyyy-mm-dd (The default value is the first day of the month)
ColumnO3	Daily value of total column ozone amount (in Dobson Units, i.e., milli atm-cm) defined as the "best representative value" in order of DS, ZS and FM.
StdDevO3	Standard Deviation of daily total column ozone measurement
Npts	The number of points (typically this is the number of daily averages) used to estimate the monthly mean ozone value.

An Example of Total Ozone Data in extCSV File Format

```
*Example of daily ozone values
*One month per file

#CONTENT
Class,Category,Level,Form
WOUDC,TotalOzone,1.0,1

#DATA_GENERATION
Date,Agency,Version,ScientificAuthority
1999-06-07,MSC,1.0,J. Kerr

#PLATFORM
Type,ID,Name,Country,GAW_ID
STN,065,Toronto,CAN,71638

#INSTRUMENT
Name,Model,Number
Brewer,MKII,014

#LOCATION
Latitude,Longitude,Height
43.78,-79.47,198

* NOTE: the date defaults to the first day of the month.
#TIMESTAMP
UTCOffset,Date,Time
+00:00:00,1999-04-01

* Precipitation on April 2, 28, 29

#DAILY
Date,WLCode,ObsCode,ColumnO3,StdDevO3,UTC_Begin,UTC_End,UTC_Mean,nObs,mMu,ColumnS
O2
1999-04-01,9,0,350.0,5.0,,,13.75,27,1.28,5.13
1999-04-03,9,0,341.1,4.1,,,12.75,19,1.12
1999-04-04,9,0,353.8,3.0,,,13.01,35,1.2
…
1999-04-26,9,0,355.0,5.0,,,13.05,37,1.21,3.33
1999-04-27,9,0,355.0,5.0,,,12.66,37,1.19
1999-04-30,9,0,369.0,5.0,,,13.7,25,1.3

#TIMESTAMP
UTCOffset,Date,Time
+00:00:00,1999-04-30

* NOTE: the date of the MONTHLY table defaults to the first day of the month.

#MONTHLY
Date,ColumnO3,StdDevO3,Npts
1999-04-01,350.0,5.0,13
```

3.3.6 Category: UmkehrN14 (Data retrieval ONLY)

TABLENAME	Field Names (in order)
#N14_VALUES	Date,H,L,WLCode,ObsCode,ColumnO3,N600,N650,N700,N740,N750,N770,N800,N830,N840,N850,N865,N880,N890,N900
#C_PROFILE	Date,H,L,ColumnO3Obs,ColumnO3Retr,Layer10,Layer9,Layer8,Layer7,Layer6Layer5,Layer4,Layer3,Layer2,Layer1,ITER,SX,SZA_1,nSZA,DFMRS,FEPS,RMSRES

Table: N14_VALUES

Field	Definition
Date	yyyy-mm-dd
H	Code for time of observation: 0=unkown, 1=AM and 2=PM.
L	Code for wavelength pair used for observation: 1=A wavelength pair 2=B wavelength pair 3=C wavelength pair 4=D wavelength pair 5=non sunobservation adjusted to DS observation
WLCode	Code to designate the wavelength pair(s) used for total ozone measurement. *
ObsCode	Code to designate the type of total ozone measurement. *
ColumnO3	Total amount of column ozone (in Dobson Units, i.e., milli atm-cm) applicable to the Umkehr observation.
N600 to N900	Log(I'/I + constant) to three decimal places (NNN) for the Solar Zenith Angle (_###)**. The SZA is given to the nearest tenth of a degree with the decimal point omitted. When Log(I'/I + constant) exceeds unity, the integer is omitted. For example: if Log(I'/I + constant)=1.231 then NNN is coded as 231. Missing data are indicated as -1.

* Refer to the Wavelength and Observation Codes Table on Pages 29-30.
** The Log(I'/I) + constant} mantissa only to 3 decimal places. The characteristic of the logarithm is inferred. The N values are given for the corresponding Solar Zenith Angles: 60, 65,70,74,75,77,80,83,84,86.5,88,89 and 90 degrees.

An Example of Umkehr N-value Data in extCSV File Format

```
*NOAA-CMDL is the Agency acronym for the National Oceanographic and
*Atmospheric Administration-Climate Monitoring and Diagnostics Laboratory

*One month per file

#CONTENT
Class,Category,Level,Form
WOUDC,UmkehrN14,1.0,1

#DATA_GENERATION
Date,Agency,Version,ScientificAuthority
1996-07-02,NOAA_CMDL,1.0, Gloria Koenig

#PLATFORM
Type,ID,Name,Country,GAW_ID
STN,067,Boulder,USA

#INSTRUMENT
Name,Model,Number
Dobson,Beck,082

#LOCATION
Latitude,Longitude,Height
40.03,-105.25,832

#TIMESTAMP
UTCOffset,Date,Time
-07:00:00,1992-10-07

#N14_VALUES
Date,H,L,WLCode,ObsCode,ColumnO3,N600,N650,N700,N740,N750,N770,N800,N830,N840,N850,
N865,N880,N890,N900
1992-10-07,1,1,0,0,268,-1,145,356,572,627,746,913,957,942,916,844,763,705,630
1992-10-07,1,3,0,0,268,467,538,645,768,800,877,44,231,295,343,363,344,316,271
1992-10-07,1,4,0,0,268,208,244,292,254,371,416,504,629,681,734,817,893,920,917
1992-10-07,2,1,0,0,244,-1,145,356,572,627,746,913,957,942,916,844,763,705,630
1992-10-07,2,3,0,0,244,467,538,645,768,800,877,044,231,295,343,363,344,316,271
…
1992-10-28,1,1,0,0,268,-1,145,356,572,627,746,913,957,942,916,844,763,705,630
1992-10-28,1,3,0,0,268,467,538,645,768,800,877,44,231,295,343,363,344,316,271
1992-10-28,1,4,0,0,268,208,244,292,254,371,416,504,629,681,734,817,893,920,917
1992-10-28,2,1,0,0,244,-1,145,356,572,627,746,913,957,942,916,844,763,705,630
1992-10-28,2,3,0,0,244,467,538,645,768,800,877,044,231,295,343,363,344,316,271

#TIMESTAMP
UTCOffset,Date,Time
-07:00:00,1992-10-28

#METEOROLOGY
Temperature,Pressure,Relative Humidity
,1642
```

Table: C_PROFILE

Field	Definition
Date	yyyy-mm-dd
H	Code for time of observation: 1=AM and 2=PM.
L	Clear zenith=3, Cloudy zenith=5 (used at Station 035, Arosa only)
ColumnO3Obs	Observed total column ozone analogous to TotalOzone (where Dobson Unit is milli-atm-cm)
ColumnO3Retr	Retrieved value for total ozone in Dobson Units. (Sum of retrieved individual layer amounts)
Layer10 - Layer1	Computed layer ozone amount in Dobson Units. The sum of Layers 10-1 = ColumnO3Retr value.
ITER	Number of iterations (2, 3, 4 or 5).
SX	A priori profile error covariance matrix used for processing. Where: U = Uniform covariance matrix C = Climatological covariance matrix.
SZA_1	Code used to indicate the first SZA where: 1=60, 2=65 and 3=70 degrees.
NSZA	Number of solar zenith angles: 9, 10, 11 or 12.
DFMRS	RMS fractional retrieval change from last iteration.
FEPS	RMS change in forcing vector from last iteration.
RMSRES	RMS fit residual

An Example of Umkehr Profile Data in extCSV File Format

```
*NOAA-CMDL is the Agency acronym for the National Oceanographic and
*Atmospheric Administration-Climate Monitoring and Diagnostics Laboratory

*Version 1 is approved 1995 C-Umkehr MK2V4CUM Program
*One month per file

#CONTENT
Class,Category,Level,Form
WOUDC,UmkehrN14,2.0,1

#DATA_GENERATION
Date,Agency,Version,ScientificAuthority
1996-07-02,NOAA_CMDL,1.0, Gloria Koenig

#PLATFORM
Type,ID,Name,Country,GAW_ID
STN,067,Boulder,USA

#INSTRUMENT
Name,Model,Number
Dobson,Beck,82

#LOCATION
Latitude,Longitude,Height
40.03,-105.25,832

#TIMESTAMP
UTCOffset,Date,Time
-07:00:00,1989-08-01

#C_PROFILE
Date,H,L,ColumnO3Obs,ColumnO3Retr,Layer10,Layer9,Layer8,Layer7,Layer6,Layer5,Laye
r4,Layer3,Layer2,Layer1
1989-08-01,1,3,292,291.4,1.22,2.7,8.56,24.5,47.7,66.3,64.8,34.6,18,23
1989-08-05,1,3,286,287.2,1.24,2.83,8.96,24.1,48.6,70.9,63.1,30.7,15.6,21.1
1989-08-05,2,3,286,287.1,1.23,2.75,8.53,23.8,50.4,71.6,61.7,30.2,15.6,21.2
1989-08-06,2,3,297,295.8,1.22,2.67,8.19,23.5,48.4,67.7,65.3,35.8,19.1,23.9
1989-08-08,1,3,296,294.7,1.24,2.84,9.15,25.7,47.1,64.9,64.8,35.9,19.2,24
1989-08-10,1,3,302,302,1.27,3.02,9.9,26.5,49.8,70.7,65.6,34.9,18.4,21.9
1989-08-14,1,3,296,295.3,1.26,2.95,9.39,25.3,46.4,66.8,66.4,35.4,18.5,23
1989-08-15,1,3,301,300.9,1.27,3.01,9.58,25.2,46.9,69.8,68.3,36,18.7,22.2
1989-08-24,1,3,299,297.6,1.28,3.03,9.51,25.7,45.7,64.6,66.7,37,19.9,24.3
1989-08-25,1,3,295,293.8,1.28,3.01,9.32,24.9,45.3,64.7,66.4,36,19.1,23.9
1989-08-28,2,3,293,290.3,1.27,2.92,8.78,23.4,42,61.8,65.8,37.3,20.5,26.4
1989-08-29,1,3,284,284.1,1.3,3.12,9.73,26,46.6,64,62.3,31.6,16.5,22.9
1989-08-31,1,3,281,280.8,1.29,3.04,9.24,24.9,46.2,63.9,62,30.9,16.1,23.2

#TIMESTAMP
UTCOffset,Date,Time
-07:00:00,1989-08-31

#METEOROLOGY
Temperature,Pressure,Relative Humidity
,1642
```

3.3.7 Representation of Time

It is suggested that vertical profile data (ozone sondes, microwave and lidar) be represented in a single file for each day. How time is represented within the file may be decided by the data originator provided that the convention used is consistent. For example, a single day may have one #TIMESTAMP table for the entire file which represents each datum with a specific time, within each defined table. The other option is to use the #TIMESTAMP table for each set of table data that is listed throughout the file. This convention would be used if the same ozone sonde device was used for multiple flights within one measurement day. *Remember, the convention must be consistent.*

If the data measurements occur over two days (this will often occur with lidar measurements), then the local day may be used provided that the appropriate UTCOffset is used. Typically, most data are reported in Universal Time (UTC), therefore, the day should be UTC as well. Thus the Timestamp table will have the default value of +00:00:00 for the UTC Offset. Total column ozone and Umkehr data, are daily representative values, reporting one month of data per file. Thus, each day of data will be one record. These files require a TIMESTAMP table at the beginning and end of the data table. The first TIMSTAMP table represents the first day of data reported and the second TIMESTAMP table represents the last day of data reported.

3.3.8 Units

Each category may represent a particular parameter using standard MKS nomenclature or units that have a well established history of use within a particular community. For example, the lidar community typically represents temperature in degrees Kelvin versus Celsius. Refer to Appendix A for unit conversion information [4].

3.3.9 Other formats

The staff at the WOUDC recognise that there may exist large sets of data available in other file formats. Assistance with the translation of these data into the extCSV maybe negotiated with the staff at the WOUDC. The WOUDC continues to accept and process data that are submitted in the old, 80-column format that was previously used by the WODC. File conversion programs are available from the WOUDC web and ftp sites to translate data from the 80-column format into extCSV and vice versa. Also, the WOUDC has agreements in place to support both the NASA-Ames 2110 or 2160 standards [2a,2b] and the NASA SHADOZ text formats. Refer to Section 3.4.2.
NOTE: All data files using other formatting conventions will be accepted, but will not be included in the main data archive until such time as the files can be re-formatted to the extCSV.

3.4 Additional Notes

3.4.1 Revisions

When submitting revised data sets, data originators are encouraged to indicate the revision details in the metadata table DATA_GENERATION. The date the data were processed and the version number are important indicators of these changes which are needed by the WOUDC for administration purposes and to users of the data to ensure that they have the latest version of the data. This information is critical in the tracking of updated data sets. For example, if a data set has been

reprocessed, two fields from the #DATA_GENERATION table should be updated; **Date** and **Version**.

3.4.2 Utility Programs (for file conversion) and Additional Assistance with the extCSV Data File Definitions

It is recognized that there are several other international data centres that also have an abundance of ozone data files. However, these files are formatted differently. Although in all cases, the data are stored as "ASCII flat text files." In most cases, the data are presented in a recognized form such as the NASA-Ames 2110 and 2160 style formats. Other examples represent a "native" format created at source by individual data originators such as the NASA SHADOZ format.

The staff at the WOUDC recognises, due to the extensive use of the aforementioned data formats, it is important to have the capability to translate these files into the WOUDC extCSV standard. Having the files appear in a consistent form is intended to make reading and using the files easier. In addition, the files maybe processed through a consistent set of QC/QA procedures used at the WOUDC to track each file and properly catalogue the metadata information. However, it must also be recognised that producing a "universal translator" is both time consuming and most likely, unproductive. The staff at the WOUDC have already created conversion programs to assist with some of these file formats. Refer to the WOUDC web site, Data link for information and access to these programs. The staff at the WOUDC are prepared to work with each data originator to assist him/her in their efforts to provide data to the WOUDC archive.

3.4.3 Quality Assurance and Data Plots

Once data have been submitted to the WOUDC, additional quality assurance will be performed by the staff at the WOUDC. This mainly involves value range checking and data file format checking. The staff at the WOUDC will contact data originators if any problems are discovered. In addition, some data categories (ex. OzoneSonde and TotalOzone) are routinely plotted and these images are published on the WOUDC web site for review. These plots are available at: ***http://www.woudc.org/data/graphs_e.html.***

3.4.4 Submission of Instrument Calibration Histories

The WMO Scientific Advisory Group for Ozone has identified the importance of a detailed record of instrument performance, especially for instruments that have produced data archived at the WOUDC. There are forms available from the WOUDC web site where information about inter-comparisons and calibrations can be submitted. Refer to the link: ***http://www.woudc.org/data/MetaQuery/InstCalForm_e.cfm***

4. Data Output, Retrieval and Security Issues

4.1 Annual Ozone Data Publication: *Ozone Data for the World (ODW)*

The WODC has been publishing ozone data since 1964. With advancements in technology, namely the extensive use of electronic data storage and the Internet, the printed form of the *Ozone Data for the World* "red book" was replaced in 2000 with the first release of the ozone data on CD-ROM. There were a total of five issues of ODW representing all data years up to 2003. In early 2006, the entire ozone archive was released on a single DVD format, representing the data years 1926-2005. Each additional release of the ODW DVD will maintain this format of the complete ozone archive, which will include the latest complete-year plus additional data for any other years, such as revisions. Contact the WOUDC for a copy of the DVD, at no charge.

4.2 Data Retrieval

The WOUDC data output is freely available for public use. The data are formatted using the extCSV standard and are arranged by data category. Information on how to access the data, including a search form are also available from the WOUDC web site under the Data link. The form is at: ***http://www.woudc.org/data_e.html***.

4.3 Security Issues

Although originators of data are encouraged to submit their data freely, with public access, there are special circumstances that may require a single user or group of users to have the ability to freely exchange data at a level of security which permits both read and write access to that specified group. An example is data that are to be used for an upcoming publication, but has yet to be released.

In response to this need for a higher level of security, special "secure" directories and user access through a specified username/password are available to interested individuals or groups. The general procedure to access these new directories by means of the File Transfer Protocol (FTP) will remain the same, just the username and password will be different. Files and documentation may then be freely exchanged within this second level and be protected from "public" viewing. These options are available to data originators. Refer to the options in the WOUDC Data Submission Agreement. The submission of data either to the "secure" or public directories is acceptable, the latter being preferred. Originators should note that users of public data are advised by the WOUDC to abide at all times by whatever stipulations the originator has requested. Refer to the Data User's Protocol Form available form the WOUDC web site under the link Data. To get special directory access, the user will have to complete the information and sign the Data User's Protocol Form before access is granted.

5. Contact Information

For further information, contact the WOUDC at:

World Ozone and Ultraviolet Radiation Data Centre
4905 Dufferin Street
Toronto, Ontario
M3H 5T4 CANADA

Email: woudc@ec.gc.ca

6. Acknowledgements

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7. References

[1] Wardle, D.I., E.W. Hare, E.J. Carty and V.E. Fioletov, The Guide to the WMO/GAW World Ultraviolet Radiation Data Centre (WUDC) Version 5.1, Atmospheric Environment Service, Environment Canada, 1998.
[2a] Gaines, S.E. and R.S. Hipskind, Format Specification for Data Exchange Version 1.0, NASA Ames Research Center publication, 1990.
[2b] Gaines, S.E. and R.S. Hipskind, Format Specification for Data Exchange Version 3.1, NASA Ames Research Center publication, 1998.
[3] Ruffieux, D., Personal communication, 2006
[4] Evans, WF.J., et al., Stratospheric Ozone Science in Canada: An agenda for research and Monitoring, ARD-87-3, 1983.

8. Appendix A – Units and Conversions tables

Units for Total Ozone

Micrometer at STP	1 µm @ STP	= 0.1 DU = 2.687 x 10^{19} molecules m^{-2} = 2.687 x 10^{15} molecules cm^{-2} = 1 part per million meter (1.0 ppmm at STP)
Dobson Unit, DU	1.0 DU	= 1 milli-atmosphere centimeter = 1 m atm-cm = 10^{-5} m of ozone at STP

NOTE: The unit µm at STP has been chosen for reporting Brewer measurements in order to minimize potential confusion when these results are inter-compared with Dobson measurements. Except when dealing with comparisons, it is proposed to drop the DU.

Units for Local Ozone Abundance

Table A.1: Quantities Specifying Local Ozone, SI Units and Vertical Integration

Table A.2: Commonly Used Units for Local Ozone, and their Interconversion

NOTE: SI units are preferred by purists, but there are few, if any, signs that the cgs system is about to disappear from spectroscopy or chemical kinetics.

Table A.1

Quantities Specifying Local Ozone, SI Units and Vertical Integration

density			concentration relative to local air [mixing ratio]		
number density	density	relative to STP [differentiated total]	by mass	by volume	partial pressure
m^{-3}	$kg.m^{-3}$	/ [STP]	/	/	Pa
n	ρ	s	m	v	p
////	$= n \cdot \frac{\rho^\circ M}{L}$	$= n \cdot \frac{1}{L}$	$=n \cdot \frac{M}{L} \cdot \frac{T^*}{P^*}$	$=n \cdot \frac{1}{L} \cdot \frac{T^*}{P^*}$	$=n \cdot \frac{P^\circ}{L} \cdot T^*$
$=\rho \cdot \frac{L}{\rho^\circ M}$	////	$= \rho \cdot \frac{1}{\rho^\circ M}$	$=\rho \cdot \frac{1}{\rho^\circ} \cdot \frac{T^*}{P^*}$	$=\rho \cdot \frac{1}{\rho^\circ M} \cdot \frac{T^*}{P^*}$	$=\rho \cdot \frac{P^\circ}{\rho^\circ M} \cdot T^*$
$=s \cdot L$	$= s \cdot \rho^\circ M$	////	$=s \cdot M \cdot \frac{T^*}{P^*}$	$=s \cdot \frac{T^*}{P^*}$	$=s \cdot P^\circ \cdot T^*$
$=m \cdot \frac{L}{M} \cdot \frac{P^*}{T^*}$	$=m \cdot \rho^\circ \cdot \frac{P^*}{T^*}$	$= m \cdot \frac{1}{M} \cdot \frac{P^*}{T^*}$	////	$=m \cdot \frac{1}{M}$	$=m \cdot \frac{P^\circ}{M} \cdot P^*$
$=v \cdot L \cdot \frac{P^*}{T^*}$	$=v \cdot \rho^\circ M \cdot \frac{P^*}{T^*}$	$= v \cdot \frac{P^*}{T^*}$	$=v \cdot M$	////	$=v \cdot P^\circ \cdot P^*$
$=p \cdot \frac{L}{P^\circ} \cdot \frac{1}{T^*}$	$=p \cdot \frac{\rho^\circ M}{P^\circ} \cdot \frac{1}{T^*}$	$= p \cdot \frac{1}{P^\circ} \cdot \frac{1}{T^*}$	$=p \cdot \frac{M}{P^\circ} \cdot \frac{1}{P^*}$	$=p \cdot \frac{1}{P^\circ} \cdot \frac{1}{P^*}$	////
$4.97\ 10^{18}$	$3.96\ 10^{-7}$	$1.85\ 10^{-7}$	$10\ 10^{-6}$	$6.03\ 10^{-6}$	$1.51\ 10^{-2}$ [a]
$\int n \cdot dz = L.x$	$\int \rho \cdot dz = \rho^\circ M.x$	$\int s \cdot dz = x$	$\int m \cdot dP = -Mg.x$	$\int v \cdot dP = -g.x$	$\int p \cdot d(\ln P) = -g \cdot x.$ [b]

P^o, $[T^o]$	- standard pressure and temperature	- $1.01325\ 10^5$ Pa, [273.15 K]
p^o	- density of air at SIP	- 1.293 $kg.m^{-3}$
L	- Loschmidt number	- $2.687\ 10^{25}\ m^{-3}$
g	- gravity acceleration	- 9.807 m s^{-2}
M	- ratio of mol. ,wts: ozone/air	- 1.657
x	- total ozone	- unit m [at stp.]
P, [T]	- local air pressure, temperature	- units Pa , K
$P^*=P/P^o$	- dimensionless (normalized) local temperature and pressure.	
$T^*=T/T^o$	These are the only variables in the above conversion matrix.	

a - Typical concentration at 25 km (2.5 kPa, 220 K)
b - Vertical integration to give total ozone (height z in metres).

Table A.2

Commonly Used Units for Local Ozone, and their Interconversion

	DENSITY			MIXING RATIO		PRESSURE
	10^{11} mol cm^{-3}	$\mu g.m^{-3}$	$DU.km^{-1}$	$\mu g.g^{-1}$	ppmv	μmb
10^{11} mol cm^{-3} = [= 10^{17}mol m^{-3}]	*	7.97	0.371	$0.0229 \frac{T}{P}$	$0.0138 \frac{T}{P}$	0.0138 T
1 $\mu g.m^{-3}$ = [= 10^{-9} $kg.m^{-3}$]	0.125	*	0.0467	$0.00287 \frac{T}{P}$	$0.00173 \frac{T}{P}$	0.00173 T
1 $DU.km^{-1}$ = [= 10^{-8} stp]	2.69	21.4	*	$0.0614 \frac{T}{P}$	$0.0370 \frac{T}{P}$	0.0370 T
1 $\mu g.g^{-1}$ = [=10^{-6} by mass]	$43.7 \frac{P}{T}$	$348 \frac{P}{T}$	$16.3 \frac{P}{T}$	*	0.603	0.603 P
1 ppmv = [=10^{-6} by volume]	$72.4 \frac{P}{T}$	$578 \frac{P}{T}$	$27.0 \frac{P}{T}$	1.657	*	P
1 μmb = [= 10^{-4} Pa]	$72.4 \frac{1}{T}$	$578 \frac{1}{T}$	$27.0 \frac{1}{T}$	$1.657 \frac{1}{P}$	$\frac{1}{P}$	*

Pressure (P) in millibars
Temperature (T) in kelvins.

Numbers in space brackets give the equivalent value in SI units.