SABER Nighttime Atomic Oxygen and Atomic Hydrogen Profiles Data Set ReadMe

1.0 Introduction

This document provides information for the data set of Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) nighttime atomic oxygen scan profiles. The SABER instrument flies onboard the Thermosphere-Ionophere-Mesosphere Energetics and Dynamics (TIMED) satellite which was launched in December 2001 and began making measurements in January 2002. The SABER Radiometry instrument is a limb scanning radiometer that records vertical profiles (~1500 per day) of infrared emission from approximately 400 km tangent altitude down to the Earth's surface in ten distinct channels from 1.27 to 15 µm at approximately 0.2 km altitude spacing.

The data files include profiles of nighttime atomic oxygen and atomic hydrogen volume mixing ratios, along with associated metadata, derived from SABER Level 2 version 2.07 standard products using a newer algorithm and updated reaction rates than those used in SABER standard processing. The updated atomic oxygen calculations are described in the first paper listed in the References section below.

1.1 Data Location

This README file and the data files are available via anonymous ftp from
ftp://saber.gats-inc.com/Version2_0/SABER_atox/

1.2 Contacts

Data questions: Linda Hunt, linda.hunt@ssaihq.com
Associate PI: Marty Mlynczak, m.g.mlynczak@nasa.gov

1.3 TIMED Data "Rules of the Road & Access Policies"

- Mission scientific and model results are open to all.
- Users should contact the PI or designated team member of an instrument or modeling group early in an analysis project to discuss the appropriate use of instrument data or model results. This applies to TIMED mission team members, guest investigators, and other members of the scientific community or general public.
- Users who wish to publish the results derived from TIMED data should normally offer co-authorship to the PI (Dr. James M. Russell III, JAMES.RUSSELL@HAMPTONU.EDU) or Associate PI (Dr. Martin G. Mlynczak, m.g.mlynczak@nasa.gov) or their designated team member. Co-authorship may be declined. Appropriate acknowledgement to institutions, personnel, data sources, and funding agencies should be given.
- Users should heed the caveats of investigators as to the interpretation and limitations of data or model results. Investigators supplying data or models may insist that such caveats be published, even if co-authorship is declined. Data and model version numbers should also be specified.
- Pre-prints of publications and conference abstracts should be widely distributed to interested parties within the mission and related projects.

See http://www.timed.jhuapl.edu/scripts/mdc_rules.pl

2.0 Data Set Description

This data set contains profiles of nighttime atomic oxygen and atomic hydrogen volume mixing ratio derived from SABER instrument scan data that are interpolated onto a 16-level approximately logarithmic pressure grid from 0.01 to 3.e-4 hPa. Each profile includes several related parameters, including the date and time, orbit and scan or event number, latitude and longitude, ozone concentration, altitude, solar

zenith angle, solar local time, temperature, and density. Some parameters are reported on a per scan basis while others are specified for each pressure level of the scan. The latititude, longitude, time, solar local time, and solar zenith angle values are the value along the scan at an altitude of 90 km. Data along the scan at each level in the pressure grid are provided for atomic oxygen, atomic hydrogen, ozone, kinetic temperature, and altitude.

The profiles are organized into files with one file per yaw year, where a yaw year consists of the six TIMED/SABER yaw cycles of approximately 60 days each that correspond most closely to a calendar year. For more information about yaw maneuvers and their dates, see http://www.timed.jhuapl.edu/WWW/mission/yaws/yaws.php

Details of the methodologies used for calculating the [O] and [H] volume mixing ratios can be found in the Mlynczak 2018 paper cited below.

2.1 Version History

V1.0 is the original version.
V1.01 modified the event number to account for all events in an orbit, where previously only non-missing events were included in the files.
V1.02 revised the time units to go back to the original SABER definition to match the documentation
Version changes for subsequent versions will be documented here.

3.0 Data Format and Packaging

The data files are written in NetCDF format using the IDL programming language version 8.7.1, which is built with NetCDF version 4.3.2. NetCDF incorporates features that allow for the file contents to be self-documenting. The file level attributes (global attributes) and variable attributes defined for these files are written in the file header, and includes declarations for the dimensions, variables definitions, and attributes or metadata associated with the file. An example of this information from one of the files, as generated by the NetCDF ncdump utility, is shown at the end of this document. In addition, an IDL program is provided to illustrate reading and plotting the data in the file. See the Read Software section below.

4.0 Science Parameters

The primary parameters in these files are volume mixing ratios of atomic oxygen and atomic hydrogen. The files also include several associated metadata parameters, including scan vectors of altitude, temperature, density, and ozone concentration obtained from the 9.6 μm channel. The scan tangent point geographic latitude and longitude, solar local time and solar zenith angle, along with the year, day, and time since midnight UT in milliseconds and the SABER orbit and event (scan) number are also provided.

5.0 Read Software

An IDL program, read_atox_athy_profiles.pro, is provided in the data directory to illustrate reading the data in one of the yearly files and creating a plot of the atomic oxygen data in the file.

6.0 Additional Information

6.1 Data Set Updates

This data set will be updated with a new file added annually at the end of each yaw year, once all orbits through the end of the yaw year are available from the SABER processing system.

6.2 References

- Mlynczak, M. G., Hunt, L. A., Russell, J. M., III & Marshall, B. T. (2018). Updated SABER Night Atomic Oxygen and Implications for SABER Ozone and Atomic Hydrogen. *Geophysical Research Letters*, 45. https://doi.org/10.1029/2018GL077377
- Russell, J. M., III, M. G. Mlynczak, L. L. Gordley, J. J. Tansock Jr., and R. W. Esplin (1999), Overview of the SABER experiment and preliminary calibration results, Proc. SPIE, 3756, 277, doi:10.1117/12.366382.

Example Data File Header (from the NetCDF ncdump utility)

```
netcdf atox_athy_night_YY2019_V1.01 {
dimensions:
        scans = 322908 ;
        pressure = 16 ;
variables:
        float pressure(pressure) ;
                pressure:units = "hPa" ;
                pressure:comment = "pressure levels on which scan values are reported (3.0e-4 to 1.0e-2 hPa)" ;
        short year(scans) ;
                year:units = "unitless" ;
                year:comment = "year of scan" ;
        short day(scans) ;
                day:units = "unitless" ;
                day:comment = "day of year of scan" ;
        int orbit(scans) ;
                orbit:units = "unitless" ;
                orbit:comment = "SABER/TIMED orbit number (1-based)" ;
        short event(scans) ;
                event:units = "unitless" ;
                event:comment = "scan event number within the orbit (1-based)" ;
        float lat(scans) ;
                lat:standard_name = "latitude" ;
                lat:comment = "scan tangent point geographic latitude at 90 km" ;
                lat:units = "decimal degrees east" ;
        float lon(scans) ;
                lon:standard_name = "longitude" ;
                lon:comment = "scan tangent point geographic longitude at 90 km" ;
        float time(scans) ;
                time:units = "msec" ;
                time:comment = "msec since midnight of the day in which the orbit started, at 90 km" ;
        float slt(scans) ;
                slt:units = "msec" ;
                slt:comment = "scan tangent point solar local time, at 90 km" ;
                slt:_FillValue = -999.f ;
        float sza(scans) ;
                sza:units = "degrees" ;
                sza:comment = "scan tangent point solar zenith angle at 90 km" ;
                sza:_FillValue = -999.f ;
        float qatox(scans, pressure) ;
                qatox:units = "unitless" ;
                qatox:comment = "derived atomic oxygen volume mixing ratio" ;
                qatox:_FillValue = -999.f ;
        float qathy(scans, pressure) ;
                qathy:units = "unitless" ;
                qathy:comment = "derived atomic hydrogen volume mixing ratio" ;
                qathy:_FillValue = -999.f ;
        float o3conc(scans, pressure) ;
                o3conc:units = "cm^-3" ;
                o3conc:comment = "SABER ozone concentration" ;
                o3conc:_FillValue = -999.f ;
        float alt(scans, pressure) ;
                alt:units = "km" ;
                alt:comment = "altitude" ;
                alt:_FillValue = -999.f ;
        float ktemp(scans, pressure) ;
                ktemp:units = "degrees Kelvin" ;
```

```
                ktemp:comment = "kinetic temperature" ;
                ktemp:_FillValue = -999.f ;
        float density(scans, pressure) ;
                density:units = "molecules/cm^3" ;
                density:comment = "atmospheric density" ;
                density:_FillValue = -999.f ;

// global attributes:
                :institution = "NASA Langley Research Center" ;
                :comment = "Data contact:  Linda.A.Hunt@nasa.gov" ;
                :title = "SABER Nighttime Atomic Oxygen, Atomic Hydrogen and related data for yaw year 2018" ;
                :comment2 = "Yaw year is the period of time from one January yaw date to the January yaw in the
next year" ;
                :source = "Derived from SABER version 2.0 infrared emission data" ;
                :comment3 = "Version 1.0.1 - correction to some units and fill values" ;
                :comment4 = "Version 1.02 - modified time to report in SABER standard representation for time,
                  msec since midnight on day orbit began" ;
```