SABER Cooling Rate Profiles Data Set ReadMe

1.0 Introduction

This file provides information for the data set of SABER cooling rate scan profiles for NO and CO_2 derived from the SABER Level 2 version 2.0 standard products.

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_cooling/
This file is in the Documentation subdirectory, and the data files are in the CO2_CoolingRate_Profiles and NO_CoolingRate_Profiles subdirectories.

1.2 Contacts

Data questions: Linda Hunt, Linda.A.Hunt@nasa.gov
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 scan profiles of cooling rates for NO and CO_2 in the thermosphere derived from SABER measurements. The Sounding of the Atmosphere using Broadband Emission Radiometry instrument is a limb scanning radiometer that records vertical profiles of infrared emission from approximately 300 km tangent altitude down to the Earth's surface in ten distinct channels from 1.27 to 15 µm. Infrared radiance profiles (W m^{-2} sr^{-1}) for NO at 5.3 µm are inverted to yield vertical profiles (~1500 per day) of infrared cooling rates (W m^{-3}) between 100 and 250 km at approximately 0.2 km altitude spacing. For CO_2, SABER processes radiative cooling rates in Kelvin per day; cooling rate profiles in W m^{-3} are then calculated from 100 to 140 km by applying the first law of thermodynamics.

The cooling rate profiles are vertically integrated to yield the flux (W m^{-2}) of infrared emission exiting the thermosphere, either to the atmosphere below or to space above. NO is integrated from 100-250

km and CO_2 is integrated from 100-139 km. The integrated flux for each scan profile is included in the file. There is one file for each calendar day of the SABER mission for each species.

Details of the methodologies used for calculating the NO and the CO_2 cooling rates can be found in the Mlynczak 2005 and 2010 papers cited below. Copies of these papers are included in the Documentation subdirectory of this project on the GATS ftp site.

2.1 Version History

V1.0 is the original version. Version changes for subsequent versions will be documented here.

3.0 Data Format and Packaging

There are two sets of files, one set for NO cooling rates and the other for CO_2 cooling rates, located in separate directories on the ftp site. For each species, there is one data file for each calendar day which contains the scan profiles from all the orbits that begin in that day.

The cooling rate scan profile data files are written in netCDF 3 format. An example of the file header information as generated by the netCDF ncdump utility, which includes declarations for the dimensions, variables and attributes of the file, is shown at the end of this document. An IDL program is provided to illustrate reading and plotting the variables in the file. See the Read Software section below.

4.0 Science Parameters

The primary parameters in these files are the cooling rate profiles for each scan and the integrated flux value for each profile. The files also include several metadata parameters, including vectors of altitude, scan tangent point geographic latitude and longitude, solar local time and solar zenith angle; the year, day, and time since midnight UT in milliseconds; and the SABER orbit and event (scan) number.

5.0 Read Software

An IDL program, read_profiles.pro, is provided in the Software subdirectory to illustrate reading the data in a cooling rate profile file and creating plots of the profile and flux data in the file.

6.0 Additional Information

6.1 Data Set Updates

This data set will be updated quarterly (January, April, July, October) once all orbits through the end of the previous quarter are available from the SABER processing system.

6.2 References

- 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.
- Mlynczak, M., et al. (2003), The natural thermostat of nitric oxide emission at 5.3 mm in the thermosphere observed during the solar storms of April 2002, Geophys. Res. Lett., 30(21), 2100, doi:10.1029/2003GL017693.
- Mlynczak, M. G., et al. (2005), Energy transport in the thermosphere during the solar storms of April 2002, J. Geophys. Res., 110, A12S25, doi:10.1029/2005JA011141. (Correction, J. Geophys. Res., 112, A02303, doi:10.1029/2006JA012008, 2007.)

- Mlynczak, M. G., et al. (2010), Observations of infrared radiative cooling in the thermosphere on daily to multiyear timescales from the TIMED/SABER instrument, J. Geophys. Res., 115, A03309, doi:10.1029/2009JA014713.

Example Data File Header (from the netCDF ncdump utility)

```
netcdf SABER_NO_PROFILE_FLUX_2017365_V1.0 {
dimensions:
        scans = 1448 ;
        alts = 151 ;
variables:
        float altitude(alts) ;
                altitude:units = "km" ;
                altitude:description = "1 km grid onto which data are interpolated (100-250 km)" ;
        short year ;
                year:units = "unitless" ;
                year:description = "Year of data observations in this file" ;
        short day ;
                day:units = "unitless" ;
                day:description = "Day of year of data observations in this file" ;
        int orbit(scans) ;
                orbit:units = "unitless" ;
                orbit:description = "SABER/TIMED orbit number (1-based)" ;
        short event(scans) ;
                event:units = "unitless" ;
                event:description = "Scan event number within the orbit (1-based)" ;
        float flux(scans) ;
                flux:units = "Watts/m^2" ;
                flux:description = "NO flux - Cooling rate integrated over the scan from 100-250 km" ;
        float tplatitude(scans, alts) ;
                tplatitude:standard_name = "latitude" ;
                tplatitude:description = "Scan tangent point geographic latitude" ;
                tplatitude:units = "degrees east (of Greenwich)" ;
        float tplongitude(scans, alts) ;
                tplongitude:standard_name = "longitude" ;
                tplongitude:description = "Scan tangent point geographic longitude between 0 and 360" ;
        float time(scans, alts) ;
                time:units = "msec" ;
                time:description = "SABER standard msec since midnight of the day in which the orbit started" ;
        float slt(scans, alts) ;
                slt:units = "msec" ;
                slt:description = "Scan tangent point solar local time; SABER reports SolarLT up to ~155 km" ;
                slt:_FillValue = -999.f ;
        float sza(scans, alts) ;
                sza:units = "degrees" ;
                sza:description = "Scan tangent point solar zenith angle; SABER reports SZA up to ~155 km" ;
                sza:_FillValue = -999.f ;
        float NOcool(scans, alts) ;
                NOcool:units = "Watts/m^3" ;
                NOcool:description = "Nitric oxide cooling rate profile" ;

// global attributes:
                :Platform = "TIMED: Themosphere Ionosphere Mesosphere Energetics and Dynamics" ;
                :Platform_URL = "http://www.timed.jhuapl.edu/WWW/index.php" ;
                :Instrument = "SABER: Sounding of the Atmosphere Using Broadband Emission Radiometry" ;
                :Instrument_URL = "http://saber.gats-inc.com" ;
                :PI_Name = "James M. Russell, III" ;
                :PI_Affiliation = "Center for Atmospheric Sciences, Hampton University, Hampton, VA" ;
                :PI_Contact = "james.russell@hamptonu.edu" ;
                :Co-PI_Name = "Martin G. Mlynczak" ;
                :Co-PI_Affiliation = "NASA Langley Research Center, Hampton, VA" ;
```

:Co-PI_Contact = "m.g.mlynczak@nasa.gov" ;
:References = "doi:10.1029/2009JA014713" ;
:Institution = "NASA Langley Research Center" ;
:Dataset_Name = "SABER_NO_PROFILE_FLUX" ;
:Dataset_Version = "V1.0" ;
:Dataset_Contact = "Linda.A.Hunt@nasa.gov" ;
:Dataset_Description = "SABER NO cooling rate daily profiles (W/m3) and fluxes (W/m2) derived
 from SABER infrared emission data" ;
:Dataset_SABER_Data_Version = "2.0" ;
:Dataset_File_Time_Resolution = "one day" ;
:File_Name = "SABER_NO_PROFILE_FLUX_2017365_V1.0.nc" ;
:File_Create_Time = "   20180202T030334" ;
:File_Time_Range = "Orbits beginning in day of year 365 of Year 2017" ;
:File_Title = "SABER NO cooling rate profiles and fluxes for Year: 2017 Day of year: 365" ;