Technical Report No. 19

APL Subcontract No. 605798-S-L

CDR Phase

SSUSI Dayside F_2-Region Algorithm Language-Independent Description

Version 1.4

Prepared for

Applied Physics Laboratory
Laurel, MD 20723

Prepared by

J. S. Evans
D. J. Strickland
K.C.Wright

Computational Physics, Inc.
Fairfax, VA 22031

May 1996

SSUSI Dayside F_2-Region Algorithm LID

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1. Introduction

This document provides a language-independent description (LID) of the SSUSI Dayside F_2-Region algorithm. The purpose of the LID is to provide a detailed outline of the steps required to calculate the Dayside environmental data products and their associated uncertainties using any programming language. Section 1 provides a brief discussion of the required inputs and the essential outputs of the dayside disk and dayside limb algorithms. Section 2 gives a detailed description of the steps required to derive dayside disk and limb data products and their corresponding uncertainties. Finally, in Section 3, we provide a detailed description of the data table algorithms, the Discrete Inverse Theory Function, and any supporting functions required by the SSUSI Dayside F_2-Region Algorithm.

1.1 The SSUSI Dayside F_2-Region Algorithm

The SSUSI Dayside F_2-Region algorithm accepts specific Ultra-Violet intensities on a pixel-by-pixel basis, and generates the output products listed below for each pixel. A pixel which represents a measurement made while viewing the Earth's hard disk is referred to as a disk pixel. A pixel which represents a measurement made while viewing the Earth's limb actually includes a complete set of measurements made when viewing from the largest tangent altitude down to the Earth's hard disk.. The output products for an individual pixel do not represent the entire dayside portion of the observing region. However, when the output products for all pixels in the dayside are superimposed over a model of the Earth, the dayside region is well described.

The Dayside F_2-Region Algorithm is divided into disk and limb subsections in the derivations provided in Section 2 below. Our intent is to clearly identify the steps required to calculate data products for both disk and limb pixels. Although some derivations are similar, disk and limb pixels should be treated as entirely separate entities.

1.1.1 Dayside Disk

The dayside disk algorithm processes sensor data which are calibrated, geolocated, and rectified. The disk algorithm utilizes look-up tables generated from first principles science codes to rapidly calculate dayside disk F_2-Region data products from disk measurements of daytime atomic and molecular UV emissions. The data products derived by the day disk algorithm are

(1) QEUV	Solar EUV flux (erg cm^{-2} s^{-1})
(2) ROVCDN2VCD	Ratio of O and N_2 vertical column densities (dimensionless).
(3) NmF2	F_2-Region Peak Density (cm^{-3})
(4) hmF2	F_2-Region Height of the Peak Density (km)
(5) TEC	F_2-Region Total Electron Content (10^{16} e^{-} m^{-2})
(6) foF2	F_2-Region Plasma Frequency (s^{-1}).

1.1.2 Dayside Limb

The dayside limb algorithm processes SIS scan data for the limb portion of the SDR grid. The limb algorithm utilizes some look-up tables in combination with an inversion algorithm to calculate dayside limb F_2-Region data products. The derived data products are

(1) N2	Density profile of molecular nitrogen (cm^{-3}).
(2) O2	Density profile of molecular oxygen (cm^{-3}).
(3) O	Density profile of atomic oxygen (cm^{-3}).
(4) Texo	Temperature of the exobase (K).
(5) ROVCDN2VCD	Ratio of O and N_2 vertical column densities (dimensionless).
(6) NmF2	F_2-Region Peak Density (cm^{-3})
(7) hmF2	F_2-Region Height of the Peak Density (km)
(8) TEC	F_2-Region Total Electron Content (10^{16} e^- m^{-2})
(9) foF2	F_2-Region Plasma Frequency (s^{-1}).

1.2 Goals of the Language-Independent Description

The driving force behind the Language-Independent Description (LID) is the desire to preserve the intellectual knowledge which lies at the foundation of most scientific software. A LID attempts to form an agreement (or "contract" if you will) between the theorist and the implementor. The role of the theorist in creating the LID is to specify the algorithm completely, leaving no room for interpretation on the part of the implementor. The role of the implementor is to take the LID and develop it into an operational system, meeting the requirements of the particular system with respect to design methodology, maintainability, speed, and so on.

Modern programming languages do not serve as an optimal medium for LID expression. Programming languages often impose a syntax which constrains the expressive ability of the LID author. In addition, programming languages can be complex and can possess hidden subtleties. The syntax alone can place a double-requirement upon the author, because the author is forced to become both a theorist and a programmer. In the modern world, where computer programming languages and computer architectures are in a state of constant evolution, tying the expression of knowledge to a programming language can be a costly and error-prone mistake.

To summarize then, the SSUSI Dayside F_2-Region Algorithm Language-Independent Description attempts to:

- Clearly, and without interpretation, express the derivations of the Dayside F_2-Region Algorithm data products.

- Provide an easily understood sequence of calculations which are broken down into "atomic" steps.

- Immortalize the algorithm by transcending any particular programming language or computer architecture, thereby preserving the knowledge and portability.

- Provide a basis for testing, in that test cases can be based upon the LID, and expected results can be computed by an external method (verification from an external source).

- Enhance requirements traceability. Since each step in the LID is “atomic” and labeled, the implementor can easily document where and how each step is accomplished. This forms a cross-reference between the code and the LID.

- Enhance maintainability. Due to the labeling of the steps in the LID, a maintainer of the code should be able to easily identify where changes should be made, and where they should not.

- Leave sufficient room for creativity on the part of the implementor, so that coding the algorithm in a programming language does not become a robotic process.

1.3 Credits

Although this document stands alone as the Language-Independent Description of the SSUSI Dayside F_2-Region Algorithm, its format and design are intended to be consistent with the SSUSI Auroral E-Region Algorithm LID and the SSUSI Nightside F_2-Region Algorithm LID prepared by the Johns Hopkins University Applied Physics Laboratory.