

ESCO Request for Comments: ESDIS ATBD Template

Status of this Memo

This Request For Comments (RFC) document describes the Algorithm Theoretical Basis Document Template, as a proposal for standardizing the format and contents of these documents. Distribution of this memo is unlimited.

Change Explanation

This RFC does not update or change a previous RFC.

Copyright Notice

This is a work of the U.S. Government and is not subject to copyright protection in the United States. Foreign copyrights may apply.

Abstract

The Algorithm Theoretical Basis Document (ATBD) is a required document for every data product generated by NASA Earth Science missions. The purpose of the ATBD is to provide details of the physical theories, mathematical procedures, and assumptions behind the algorithms used to generate scientific data products. The ATBD is one of several documents that are crucial for helping data users to understand how the provenance and appropriate usage of the data. The ATBD provides a comprehensive explanation of how data products are created, the input data sources, and the algorithm's limitations. Transparency about the data production process helps scientists and other users understand the appropriate uses of the data product, and its limitations. The ATBD also serves as a quality assurance document, which undergoes formal reviews and updates, helping to ensure the ongoing accuracy and reliability of the algorithms.

In order to facilitate data producers in the completion of an ATBD, the IMPACT team at Marshall Space Flight Center developed a template, which underwent an ESCO community review. Following that review, the ATBD template was handed off to the ESDIS Mission Lifecycle Process (MLP) Working Group for further refinement. This version of the ATBD

template was produced by the MLP Working Group, and will be included in a template library maintained by that group to help DAAC staff and data producers satisfy various documentation requirements throughout the mission lifecycle process.

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This RFC proposes adoption of the ATBD Template by the NASA Earth Science community for standardizing Algorithm Theoretical Basis Documents.

Request for Comments

The Algorithm Theoretical Basis Document (ATBD) is a required document for NASA Earth Science missions. The purpose of the ATBD is to provide details of the physical theories, mathematical procedures, and assumptions behind the algorithms used to generate scientific data products. The ATBD is crucial for data users to understand how to use the data correctly, as it provides a comprehensive explanation of how data products are created, the input data sources, and the algorithm's limitations. Transparency about the data production process helps scientists and other users understand the appropriate uses of the data product, and its limitations. The ATBD also serves as a quality assurance document, which undergoes formal reviews and updates, helping to ensure the ongoing accuracy and reliability of the algorithms.

While most NASA Earth Science missions provide ATBDs for their data users, and most include the requisite information, a review of a representative sample of these documents from across ESDIS showed a good amount of variance in the formatting and the organization of content. As part of the effort to improve consistency of NASA Earth Science data products and associated documentation, the ESDIS Mission Lifecycle Working Group has adapted the ATBD template developed by the IMPACT team at Marshall Space Flight Center, to provide a template that data producers can use to create the ATBDs describing their data production processes.

This template provides the basic outline of an ATBD, and will help ensure that ATBD authors include required content. Template users are instructed to maintain the section order as it is in the template, but are encouraged to add or remove subsections as needed. This helps to ensure consistency, while allowing for some variation in the information that is included in the ATBD. In addition to an outline, the ATBD template provides instructions for completing each section.

ESDIS ATBD Template

Enter the Descriptive Title of your ATBD

<Project/Mission/Campaign Name><*Product Name or Subgroup(optional)*>_<Version No.>

***A.B. Author¹, B. C. Author², and D.E. Author³**

List authors by first name or initial followed by last name and separated by commas. Use superscript numbers to link affiliations. Use bold formatting. Add an “*” next to the corresponding author.

Hyperlink each author’s name to their ORCID. (Optional)

¹Affiliation for author 1

²Affiliation for author 2

³Affiliation for author 3

Affiliations should be preceded by superscript numbers corresponding to the author list.

Corresponding author: enter first and last name (provide email address in parentheses)

Include the name and email address of the corresponding author.

Key Points:

List key objectives of your research as presented in this ATBD.

Each objective is a short statement.

Release Date:

DOI:

Once the completed ATBD is submitted to the appropriate DAAC, the DAAC will register and obtain a DOI.

[Comment to Template Users: The title page should only include the elements listed above, along with any necessary images, institution-specific information, or disclaimers. In the rest of the document, replace blue text with your content. Feel free to structure subheadings as needed to present your information clearly, but do not alter the section order or section titles. We have included lists of tables or figures following the Table of Contents. Please provide a list of acronyms as the first Appendix. Be sure to add your ATBD title in the document header and shorten the title if needed. Once your ATBD is complete, remove any remaining blue text (such as this comment). We recommend following APA style. If you're unsure about formatting, refer

to the [AGU Grammar and Style Guide](#) or the Publication Manual of the American Psychological Association (Sixth Edition). This template is set to 1.5 spacing by default.]"

Table of Contents

Formatting Guidelines:

- Blue text is included to provide guidance for completing the template. Be sure all blue text is deleted in the final draft.
- Apply heading styles (e.g., Heading 1, Heading 2, etc.) to all section and subsection headers so that they are included in the table of contents.
- Update the table of contents when the ATBD is completed.
- Center and number all equations. For example:

$$CE = 2\Omega = (\sin\phi)v \quad (1)$$

$$\theta = T + \Gamma_{\mu}(Z - Z_{1000mb}) \quad (2)$$

- Tables must be numbered sequentially throughout the document; put captions above the table. For example:

Table 1. *Provide a caption that describes the information displayed in the table.*

Header 1	Header 2
Content 1.1	Content 2.1
Content 1.2	Content 2.2
Content 1.3	Content 2.3

- [Figures must be numbered sequentially; include a descriptive caption centered below the figure. For example:](#)

<Figure>

Figure 1. *Provide a caption that describes the figure.*

- Reference Tables and Figures appropriately in the text.

1 Introduction

The introduction should briefly describe analyses and key results, explain the purpose of the ATBD, and summarize the ATBD in plain language that can be understood even by non-technical people.

Keywords: keyword 1, keyword 2, keyword 3

Keywords are used to help indexers and search engines find relevant papers. Use standardized keywords where possible. GCMD keywords are best - https://gcmd.earthdata.nasa.gov/KeywordViewer/scheme/all?gtm_scheme=all

2 ATBD Version Description

Please provide the version number of the ATBD and a brief description of how this version differs from any previous versions. For example, if the algorithm has changed, this would indicate a major version update (e.g., from version 2.0 to version 3.0).

If this is the first version of the ATBD, simply state: “This is Version 1.0 of the <title>.”

Note: The version number refers to the ATBD itself, not the algorithm version. The algorithm version is detailed in Section 3.1, “Historical Perspective.”

3 Overview and Background Information

3.1 Historical Perspective

Provide a brief description of the algorithm's development history or lineage, outlining how the algorithm has evolved into its current form. This should include key milestones, updates, and improvements, such as changes in its methodology, assumptions, or input/output variables. Include the current algorithm version number. If appropriate, use a table to identify and summarize any changes between algorithm versions.

3.2 Instrument Characteristics

Provide a description of the instrument(s) used to obtain the data.

4 Algorithm Description

The following sections should serve as guidelines for the type of information to include in this section. Please use your best judgement about how to best organize and display the content.

4.1 Scientific Basis

This section should focus on the physical principles and geophysical phenomena that the algorithm is based on. It describes how real-world observations and physical processes (like atmospheric behavior, radiation, or electromagnetic interactions) are utilized to retrieve the product you're working on. This would include the underlying science behind your method, including any physics principles, such as laws of thermodynamics, radiation transfer, or the behavior of certain materials. Use subheadings as needed to organize the information.

4.1.2 Assumptions

Describe the assumptions and limitations inherent in this algorithm.

4.1.3 Mathematical Foundations

This section should focus on the mathematical theory that underpins the algorithm's formulation. It describes the mathematical structures and techniques, like linear algebra, differential equations, or statistical models, that are used to process the data. This would involve the precise mathematical formulation of the algorithm—how it translates scientific principles into a computational model or algorithm that can be implemented in software.

4.3 Algorithm Input Variables

The data that is used as input values must be listed in this section. When possible, a descriptive long name from the Climate and Forecast Standard Names (CF) or the Atmospheric Composition Variable Standard Name Convention (ACVSNC) should be provided. It is recommended to use International System of Units (SI) for all measurements. For dimensionless variables, indicate the unit as either “dimensionless” or “unitless.”

Include the source of the input variables (e.g., what instrument produced the data, at what processing level and/or calibration coefficient; if non-observational, include the name of the model or other system that produced the data).

If any variables are reported in non-SI units (e.g., ozone in Dobson units), provide an explanation for the choice of units. For instance, certain fields may adopt specific units for practical or historical reasons.

For each data source, include the DOI if available.

Table 2. *Provide an appropriate input variable table title caption*

Name	Long name	SI Unit	Source(s)
In Var 1	Input Variable 1	e.g., m ²	
In Var 2	Input Variable 2	e.g., s ⁻²	

4.4 Algorithm Output Variables

The data resulting from running the algorithm. These would be variables found in the data product released to the public. It is recommended to use International System of Units (SI) for all measurements. For dimensionless variables, indicate the unit as either “dimensionless” or “unitless”.

If any variables are reported in non-SI units (e.g., ozone in Dobson units), provide an explanation for the choice of units. For instance, certain fields may adopt specific units for practical or historical reasons.

For each data source, include the DOI if available.

Table 3. *Provide an appropriate output variable table title caption*

Name	Long name	Unit
Out Var 1	Output Variable 1	e.g., km ²
Out Var 2	Out Variable 2	e.g., degrees

5 Constraints on Data Usage

Describe the constraints or limitations on output data use based on the algorithm and the various assumptions made in producing the data product(s).

6 Algorithm and Data Assessment

Describe the known issues, caveats, best practices, error sources in connection with the algorithm.

6.1 Data Validation Uncertainties

Describe the uncertainties applicable to the validation methods and data used. This may include uncertainty in scientific or mathematical methods and/or errors associated with observational retrievals used for comparisons. Describe the scientific methods used or planned to assess and validate the algorithm's performance. This should include specific validation steps and procedures, and the details provided should align with the current maturity level of the algorithm.

6.2. Data Processing

If applicable, it is recommended to add a subsection describing the data pipeline - the steps or processes the data goes through from raw data acquisition, cleaning, transformation, analysis to generate the final product. Diagrams are highly recommended here.

7 Open-source Science Software and Data Access

7.1 Software Availability

Provide information about how to access and execute the algorithm's open-source code. This may include execution instructions, memory requirements, programming languages, dependencies, who to contact, software rights, and the link to the code.

7.2 Input Data Access

Provide the Uniform Resource Locator (URL) or location of the input data product(s) used by the algorithm. If available, provide the persistent identifier (e.g., DOI). Include any relevant information required to execute the algorithm source code with these inputs, such as configuration files and external data inputs.. Additionally, provide any access information like file format(s), access methods, and restrictions. If this information is already provided at a permanent location, include the link. Use a table if necessary to list the URL and description for each data product.

7.3 Output Data Access

Output data will be available via NASA's Earthdata Search application at <https://search.earthdata.nasa.gov> and <https://earthdata.nasa.gov>.

8 Acknowledgements

Include all contributions from people, organizations, funding programs, and other relevant sources.

9 Contributors

List all contributors to the development of the algorithm and this document, their roles, and affiliations.

10 Primary Point of Contact

Provide the contact information for the primary point of contact for this document. The following information should be included, and if possible, updated in the event the point of contact changes.

First Name, Last Name (required)

Identifier: (optional) – provide a unique identifier such as [ORCID](#)

Contact mechanism: (required) - phone number, email, etc.

Affiliation: (required) - name of associated organization

11 References

The list should contain the full citation of all references cited within the text. References for any data or software used should also be included. Helpful information related to reference formatting can be found in the [AGU Grammar and Style Guide](#). The following is an example of a reference in the proper style:

Deng, A., & Stauffer, D. R. (2006), On improving 4-km mesoscale model simulations. *Journal of Applied Meteorology and Climatology*, 45(3), 361–381. doi:10.1175/JAM2341.1

In-text citation style is (last name of author, YYYY) up to two authors. For more than 2 authors, use et al. after the first author. Example in-text references:

(Smith, 2020) - one author

(Doe & Smith, 2021) - two authors

(Doe et al., 2021) - three or more authors

12 Glossary

13 Appendix

This section is optional and provides a space for supplementary materials that support the main content of the ATBD but are too detailed or technical to be included in the body. This can include detailed mathematical derivations, acronyms, code snippets, extended tables or figures, additional test results, or references to external resources. Each appendix should be clearly labeled (e.g., Appendix A: Title) and referenced in the main text.

Maintenance

The ATBD Template will be maintained and updated by the ESDIS Mission Lifecycle Process Working Group.

Authors

IMPACT
MLP Working Group

Appendix A - Glossary

ATBD - Algorithm Theoretical Basis Document
ESDIS - Earth Science Data and Information Systems Project
IMPACT - Interagency Implementation and Advanced Concepts Team
MLP - Mission Lifecycle Process