

THEMIS

THEMIS Probe STATE File Definition

THM-SOC-102
November 02, 2006

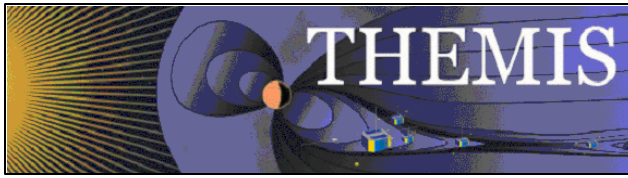
Matt Davis, THEMIS Science Software

Dr. Davin Larson, THEMIS SST

Dr. Manfred Bester, THEMIS Mission Operations Manager

David A. King, THEMIS Science Software Manager

Vassilis Angelopoulos, THEMIS Principal Investigator



Document Revision Record

Rev.	Date	Description of Change	Revised By
-	8/9/2006	Draft	-
-	2006/09/18	Signature release	
-	2006/09/29	Lowercase variables	Signatories
	2007/04/20	V00, V01, V02, V03 descriptions and sources	Matt Davis

Distribution List

Name	Email
Jim Lewis, U.C. Berkeley	jwl@ssl.berkeley.edu
Matt Davis, U.C. Berkeley	mattd@ssl.berkeley.edu
Dr. John Bonnell, U.C. Berkeley	jbonnell@ssl.berkeley.edu
Dr. James McFadden	mcfadden@ssl.berkeley.edu
Dr. Tai Phan, U.C. Berkeley	phan@ssl.berkeley.edu
Dr. Ellen Taylor, U.C. Berkeley	ertaylor@ssl.berkeley.edu
Dr. Uli Auster, TUBS	uli.auster@tu-bs.de
Dr. Alain Roux, CETP	Alain.Roux@cetp.ipsl.fr
Dr. Krishan Khurana, UCLA	kkhurana@igpp.ucla.edu
Dr. Dave Sibeck, NASA GSFC	david.g.sibeck@nasa.gov

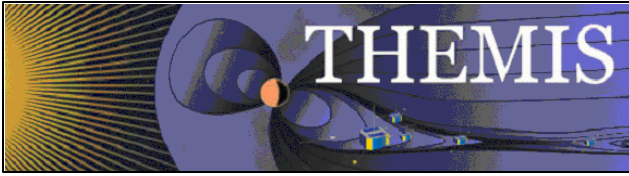


Table of Contents

DOCUMENT REVISION RECORD2

DISTRIBUTION LIST2

1. INTRODUCTION.....4

 1.1 Purpose and Scope.....4

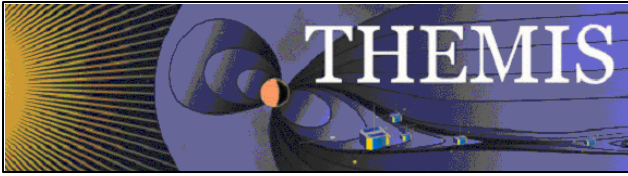
 1.2 Applicable Documents.....4

2. DEFINITIONS.....5

 2.1 THEMIS STATE file: File type, quantities, varnames and resolution5

 2.2 THEMIS STATE file versions: Predictive, Intermediate, Preliminary and Definitive5

 2.3 THEMIS STATE file data sources and processing6



1. Introduction

1.1 Purpose and Scope.

THEMIS Level 1 probe data (herein termed L1DAT.cdf), contain time ordered, uncompressed data and packet header information in raw state but are in raw (un-calibrated), telemetry units and in sensor coordinates. For the purpose of producing physical quantities two files and a piece of code are necessary: A calibration file (herein termed CAL.cdf), a probe STATE file (herein termed STATE.cdf) and a piece of IDL code that reads the three files, calibrates and transforms the data into the proper coordinate system and produces physical quantities. The purpose of this document is to define the Probe STATE files and the processing steps that are required to generate them.

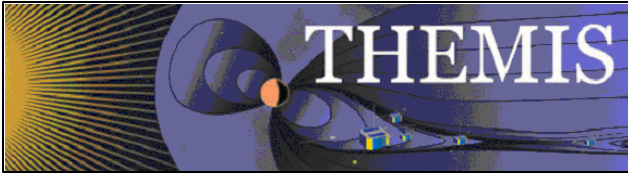
The STATE file will to be used by THEMIS scientists to perform tasks that include (but are not limited to):

1. Obtain position and attitude information of the probes and experiments for science analysis (instrument view directions, probe positions in absolute space and relative to each other).
2. Despin sensor data into a common coordinate system for detailed multi-instrument studies on the same probe.
3. Obtain position and attitude information for transforming the data into geophysical coordinates of interest, such as GSE and GSM.
4. Predictive, preliminary and final conversion into physical units.

It is therefore expected that multiple versions of the same file, all complete but of increasing fidelity, will be produced, and a method for identifying version numbers and processing levels is necessary, and is outlined below.

1.2 Applicable Documents.

- | | |
|---------------------------------------|---------------------------------------|
| 1. THM_SYS_012_PDMP | THEMIS Project Data Management Plan |
| 2. THM_SOC_101_TIME | THEMIS TIME Definition |
| 3. THM_SOC_105_FIELDS_L1_VARNAAMES | THEMIS FIELDS Variable Name Def's |
| 4. THM_SOC_108_PARTICLES_L1_VARNAAMES | THEMIS ESA/SST Variable Name Def's |
| 5. THM_SOC_108_GMAG_L2_VARNAAMES | THEMIS GMAG Variable Name Def's |
| 6. THM_SOC_109_ASI_L1_VARNAAMES | THEMIS ASI Variable Name Definitions |
| 7. THM_SOC_110_COORDINATES | THEMIS Coordinate Systems Definitions |
| 8. THM_SOC_111_SUNSENSPROC | THEMIS SUN SENSOR Science Processing |
| 9. THM_SOC_112_ATTPAIPROC | THEMIS Science ATT & Inertia Determ. |
| 10. THM_SOC_113_FGM_CALPROC | THEMIS FGM CAL File and Processing |
| 11. THM_SOC_114_SCM_CALPROC | THEMIS SCM CAL File and Processing |
| 12. THM_SOC_115_EFI_CALPROC | THEMIS EFI CAL File and Processing |
| 13. THM_SOC_116_ESA_CALPROC | THEMIS ESA CAL File and Processing |
| 14. THM_SOC_117_SST_CALPROC | THEMIS SST CAL File and Processing |
| 15. THM_OGS_431M | OGS Ephemeris File Definition |



2. Definitions

2.1 THEMIS STATE file: File type, quantities, varnames and resolution

THEMIS Probe STATE file is a CDF file, named “th[a-e]_state_yyyyddmm_vxx.cdf”, provided daily, that contains the following quantities, at 1min resolution:

Orbit quantities:

1. Probe Cartesian position XYZ [km], R*4, in GEI. VARNAME=th[a-e]_pos
2. Probe Cartesian velocity Vxyz [km/s], R*4, in GEI. VARNAME= th[a-e]_vel
3. Maneuver status code Man [none], UINT4, VARNAME=th[a-e]_man
This is identical to the parameter Maneuver Status Code in THM_OGS_431M
The lowest 6 decimal integers represent the coding listed in the above Ephemeris document. Specifically:
zero= no maneuver
non-zero = maneuver of some type or another listed in the document above
4. Region of Interest, ROI flag [none], UINT4, VARNAME=th[a-e]_roi
This is identical to the parameter “Space Environment Region Crossing Status Code” described in THM_OGS_431M. Specifically, the lowest 18 bits represent the regions of interest. Least significant is the first region of interest (Earth Shadow), next one is the second region of interest (Lunar Shadow) etc.

Attitude (ATT) angles

5. Probe Spin Axis Right Ascension [deg], R*4, in GEI. VARNAME= th[a-e]_spinras
6. Probe Spin Axis Declination [deg], R*4, in GEI. VARNAME= th[a-e]_spindec

Principal Axis of Inertia (PAI) angles,

7. Probe Spin Axis Euler ZYZ angle alpha [deg], R*4, in Probe (Geometric) Coordinates. Defines first rotation about Z_geom-axis and is essentially the azimuth of the Spin Axis in the Geometric coordinate system. VARNAME= th[a-e]_spinalpha
8. Probe Spin Axis Euler ZYZ angle beta [deg], R*4, in Probe Coordinates. Defines next rotation about Y' axis and is essentially the colatitude of the Spin Axis in the Geometric coordinate system. VARNAME= th[a-e]_spinbeta

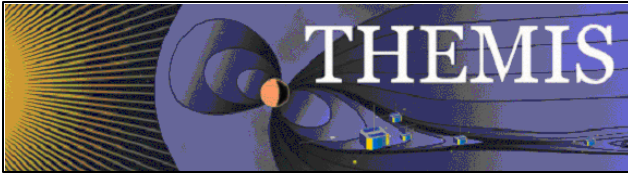
SUNPULSE quantities

9. Probe Spin Period [sec], R*4. VARNAME= th[a-e]_spinper
10. Probe Spin Phase [deg], R*4. VARNAME= th[a-e]_spinphase

2.2 THEMIS STATE file versions: Predictive (V00), Intermediate (V01), Preliminary (V02) and Definitive (V03)

THEMIS Predictive STATE file, termed _V00, shall contain predictive information on elements 1-6 in section 2.1 (namely: position, velocity, maneuver flag, region of interest flag and attitude) and its *purpose* shall be limited to preliminary viewing of L0 or L1 data as necessary and checkout of processing routines. It is *expected* daily through automated processing.

THEMIS Intermediate STATE file, termed _V01, shall contain predictive information on all elements except _spinper and _spinphase, which shall be definitive, produced from SUNPULSE telemetry processing. Its *purpose* shall be limited and post-pass science validation of probe data as necessary, without waiting for definitive orbit and definitive attitude determination. It is *expected* shortly after each contact (< 6hrs after receipt of data) through automated processing.



THEMIS Preliminary STATE file, termed `_V02`, shall contain predictive information on attitude and principal inertial axis and definitive information on all other elements. Its *purpose* shall be to feed into the UCLA code to produce definitive attitude quantities. It is *expected* shortly after a post-pass orbit determination (OD) event is completed for that day (<1day after receipt of data).

THEMIS Definitive STATE file, termed `_V03`, shall contain definitive information on all elements. Its *purpose* shall be to conduct science analysis, transform the data into appropriate coordinate systems. It is *expected* to be available automatically after completion of the science attitude determination process (<1day after receipt of data).

Note 1: Intermediate and preliminary attitude information shall be determined from MOC processing rather than last good attitude measurement. This means that a previous day's V03 file may have more accurate attitude information from a current day's V02 file, and that there will likely be a large (order of 1deg) discontinuity between these two attitudes across the day boundary.

Note 2: Intermediate and preliminary principal axis information shall be determined from spin balance data pre-launch and shortly after launch, and from the last day's measurements thereafter, with the possible exception of boom deploys when multiple determinations might be necessary.

2.3 THEMIS STATE file data descriptions, sources and processing

The STATE file shall be processed utilizing the following sources:

1. STATE_V00:

The THEMIS Flight Dynamics Facility produces predictive ephemeris ASCII files containing information on quantities 1-6 from section 2.1, namely: vehicle position (`_pos`), velocity (`_vel`), attitude (`_spinras` and `_spindec`), maneuver flags (`_man`) and region of interest flags (`_roi`), herein referred to as: `_ephem_pre.dat`. These files are converted into V00 CDF files using an IDL routine called `make_probe_state_cdf.pro`, which can be found in the THEMIS Subversion repository (`idl/thmsoc/state/make_probe_state_cdf.pro`).

2. STATE_V01:

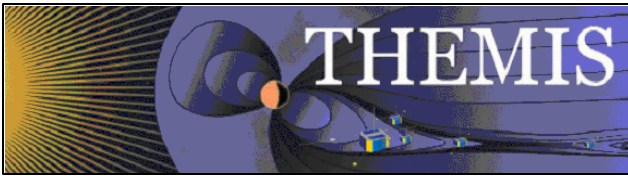
Science Operations reads in and cross-checks probe telemetry packets and IDPU telemetry packets, ensures SUNPULSE information consistency. It then uses the SUNPULSE times to compute spinper and spinphase. This computation process is herein termed: `SUNSENSPROC` and is documented in `THM_SOC_111_SUNSENSPROC.DOC`

3. STATE_V02:

The THEMIS Flight Dynamics Facility produces definitive ephemeris ASCII files containing information on quantities 1-6 from section 2.1, namely: vehicle position (`_pos`), velocity (`_vel`), attitude (`_spinras` and `_spindec`), maneuver flags (`_man`) and region of interest flags (`_roi`), herein referred to as: `_ephem_def.dat` files. These files are converted into V03 CDF files using an IDL routine called `make_probe_state_cdf.pro`, which can be found in the THEMIS Subversion repository (`idl/thmsoc/state/make_probe_state_cdf.pro`).

4. STATE_V03:

Code written by UCLA reads-in definitive position and preliminary probe attitude and utilizes preliminary L1 FGM sensor data, the latest FGM CAL.CDF data and other information (sensor coordinates) to determine definitive ATT and PAI information. This code utilizes models of Earth's magnetic field and determines probe fine attitude and geometric to spin axis angles with far greater accuracy than the mission operations code `MSSAS`. The code shall be tested at UCLA and transferred to UCB for operational use. It is herein referred to as `ATTPAIPROC` and is described in detail in: `THM_SOC_111_ATTPAIPROC.DOC`



THEMIS State file processing:

Figures 1-4 describe the process of producing the various versions of the STATE file from above sources.

