WIND/STICS Level 2 Data Release Notes

Susan T. Lepri, Jim M. Raines, Jacob R. Gruesbeck and Jon W. Thomas

Introduction

The Suprathermal Ion Composition Spectrometer (STICS) is a time of flight (TOF) plasma mass spectrometer, capable of identifying mass and mass per charge for incident ions up to 200 keV/e. It uses an electrostatic analyzer to admit ions of a particular energy per charge (E/Q) into the TOF chamber. The E/Q voltage is stepped through 32 values, sitting at each value for approximately 24 sec., to measure ions over the full E/Q range of 6 - 200 keV/e. Ions then pass through a carbon foil and TOF chamber, before finally impacting on a solid-state detector (SSD) for energy measurement. STICS combines these three measurements of E/Q, TOF and residual energy, producing PHA words. This triple-coincidence technique greatly improves the signal to noise ratio in the data. Measurements of E/Q and TOF without residual energy also produce PHA words. These double-coincidence measurements are characterized by better statistics since ions whose energy does not allow them to be registered by the SSD can still be counted in double-coincidence measurements. However, ion identification in double-coincidence measurements are limited to a select number of ions that are well separated in E/Q - TOF space.

The STICS instrument provides full 3D velocity distribution functions, through a combination of multiple telescopes and spacecraft spin. The instrument includes 3 separate TOF telescopes that view 3 separate latitude sectors, as shown in Figure 1. In addition, the WIND spacecraft spins, allowing the 3 telescopes to trace out a nearly 4π steradian viewing area. The longitudinal sectors are shown in Figure 2. The solar direction is in sectors 8-10 while the earthward direction is in sectors 0-2.

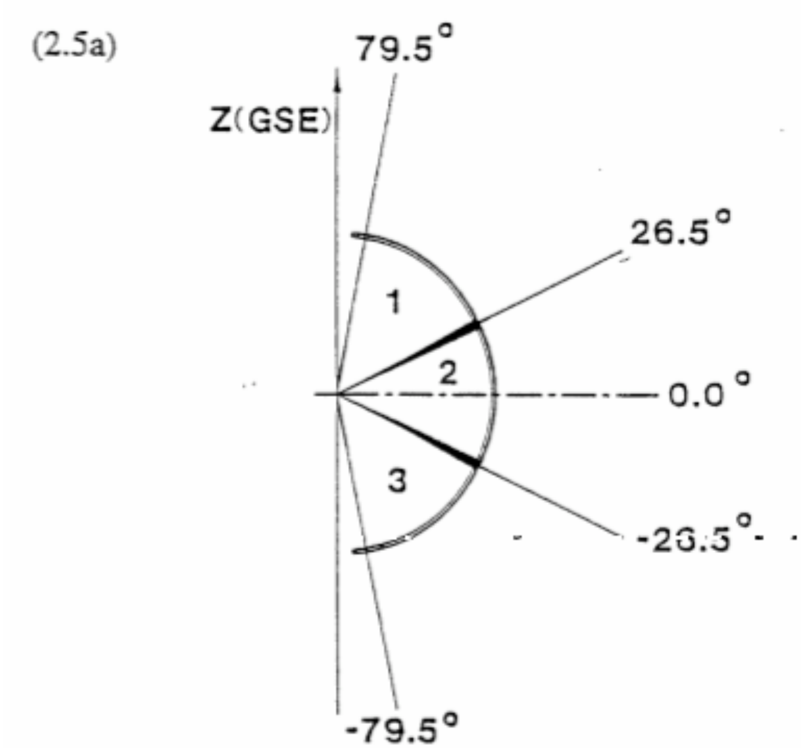

Figure 1. STICS is composed of 3 separate telescopes that view 3 different latitudinal ranges in and out of the ecliptic plane (Adapted from Chotoo et al. 1998).

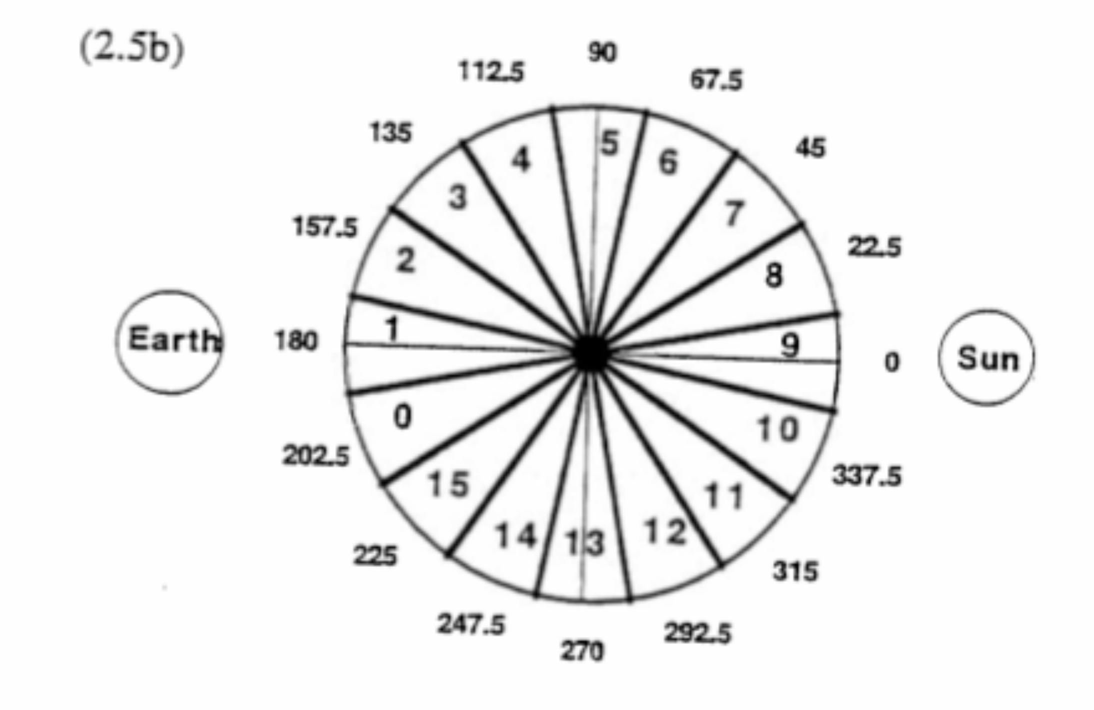

Figure 2. STICS spins through 360 degrees during one measurement cycle sweeping out 16 sectors in space. Sectors 8-10 include the solar direction (Adapted from Chotoo et al. 1998).

Method

Since STICS does not measure mass and mass per charge directly, some interpretation of the measurements is required to assign individual event counts to particular ions. Full event (PHA) words from an entire day of measurements are accumulated then assigned to individual ions via an inversion method, which preserves the statistical properties of the measurements. After assignment, these counts vs. E/Q curves are transformed to distribution function, phase space density as a function of velocity.

Though this analysis procedure is applicable to a wide range of ions, only proton distribution functions are currently released at the production level.

Instrumental effects

STICS does not apply a post-acceleration voltage to boost ion energy, so low mass ions do not have enough kinetic energy at the lower E/Q steps to trigger the solid state detector and produce a full, triple-coincidence measurement. This produces a sharp cutoff a lower velocities in the phase space density curve. This cutoff is also mass dependent, making it slightly different for protons and alphas particles. Heavier and/or higher charge state ions have considerably more kinetic energy for a given E/Q and thus can be measured. Ions that do not have sufficient energy to produce a triple-coincidence measurement often produce a double-coincidence measurement, allowing extension of STICS distributions to lower energy, at the expense of increased noise and difficulty of assignment to particular ions.

STICS measures ions from an energy regime significantly above the normal solar wind. The flux of particles in this range will vary considerably with solar wind density, velocity and thermal velocity, as well as due to many other solar phenomena (e.g. CMEs). Lower statistics of suprathermal populations frequently result in distribution functions that are not continuous in v and time periods where there are insufficient counts from which to assemble quality distribution functions.

Data Description

The wtdcLV2_distfunc*.dat files replace the older wtlv2_deliv_distfunc*.dat files. Improvements in our analysis techniques have led to the latest release.

The wtdcLV2 files in the current contain double-coincidence measurements of H+.

The wtdcLV2_distfunc_*.dat files contain 3D phase space density distribution, A(v) (currently in arbitrary units) functions, for H+. There are 512 values for A(v) for each time step, corresponding to each directional sector (values 0-15 as shown above total 16 total directions) and each Deflection Voltage Step (DVS) corresponding to a set E/q value (32 total voltage steps per sector). Subsequent time steps follow the same pattern.

The filenames includes the date of the observations, in yyyy_doy_doy format. For example, wtdcLV2_distfunc_2005_101-101.dat is data for 11 Apr 2005.

Values that cannot be properly calculated are filled with value of -1.0.

The columns in these files are as follows:

year -- calendar year

doy -- day of year , e.g. doy 101 in 2005 is April 11th.

sector – this refers to the observation direction in the ecliptic plane (as shown in Figure 2)

DVS—deflection voltage step, 32 steps in total

e/q -- energy per charge (keV/e). Provided for convenience only.

v -- the center of the velocity bin in km/s, calculated from E/Q and the M/Q of the ion.

Ion—the ion measured

A -- the phase space density, in arbitrary units, at the corresponding velocity bin

Calibration Notes

STICS was calibrated prior to launch with ion accelerators at both NASA GSFC and at the University of Bern in Switzerland (facility details can be found in Ghielmetti et al.,1983). Goddard tests included measuring the instrument response to H+, He+, C+, C2+, N+, N2+, O2+, and Ne2+. Beam measurements at Bern included H+, He+, C+, O+, Ne+, Ne3+, Ar4+, and Kr5+. Post-launch, it was cross calibrated with helium solar wind data from WIND-MASS and WIND-EPACT-STEP. The Time-of-Flight efficiencies were compared with those on Geotail EPIC-STICS (heritage) and Ulysses SWICS.

Further SMS calibration details can be found in Chotoo, 1998.

Contacts

For science questions relating to STICS, contact Sue Lepri (slepri@umich.edu), SMS Instrument Scientist. For data and instrument operations questions, contact Jim Raines (jraines@umich.edu), SMS Instrument Engineer.

References

Gloeckler, et. al., "The Solar Wind and Suprathermal Ion Composition Investigation on the WIND Spacecraft", Space Science Reviews, 71, p79-124, 1995.
Ghielmetti, A. G., et al., Calibration System for Satellite and Rocket-borne Ion Mass Spectrometers in the Energy Range from 5 eV/charge to 100keV/charge, Rev. Sci. Instr., 54(5), 425-436, 1983.
Chotoo, K., Measurements of H+, He2+, He+ in Corotating Interaction Regions at 1 AU, PhD Thesis, 1998.

Revision History

Rev	Date	Author(s)	Description
	04Dec2007	JMR/STL	Initial writing.
A	18Dec2007	STL	Addition of calibration notes.
B	01Apr2010	STL/JMR	Release of double coincidence measurements.