Description of TEMPEST-D Level 1 Data Files

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1. File contents and format

The TEMPEST-D data are calibrated, geolocated and output into an HDF5 file once per day. The data are stored in a structure called scan. The "scan" structure indicates that the data are organized in a 2-D array where each row is a complete scan. The 2-D variables are stored as Nscan x Nbeam, where Nscan is the number of scans in the file and Nbeam is the number of samples cross track within each scan. Nscan will be variable depending on the amount of data in the file, and Nbeam is typically 133. The antenna temperature and brightness temperature data are stored as a 3-D array in which the last dimension corresponds to the 5 radiometer channels. The spacecraft position and attitude data are each stored as 1-D arrays of length Nscan.

The variables in the structure have 3 fields, as follows:

- **data**: contains the numerical value of the variable
- **Description**: provides a short description of the variable
- **Units**: the units of the variable, (/) indicates no units

The contents of the file are given in Table 1.

Table 1: Contents of the TEMPEST-D Level 1 File

Variable	Description
scan.SCalt	data: [Nscan×1 single] Description: 'Spacecraft altitude at radiometer sample rate' Units: 'km'
scan.SClat	data: [Nscan×1 single] Description: 'Sub-spacecraft latitude at radiometer sample rate' Units: 'degrees'
scan.SClon	data: [Nscan×1 single] Description: 'Sub-spacecraft longitude at radiometer sample rate' Units: 'degrees'
scan.SCpitch	data: [Nscan×1 single] Units: 'degree'

	Description: 'Spacecraft orientation: counter-clockwise rotation about the S/C y-axis'
scan.SCroll	data: [Nscan×1 single] Units: 'degree' Description: 'Spacecraft orientation: counter-clockwise rotation about the S/C x-axis'
scan.SCyaw	data: [Nscan×1 single] Units: 'degree' Description: 'Spacecraft orientation: counter-clockwise rotation about the S/C z-axis'
scan.TA	data: [Nscan×Nbeam×5 single] Units: 'K' Description: 'Calibrated antenna temperature: CH1=181GHz,CH2=178GHz,CH3=174GHz,CH4=164GHz,CH5=87GHz'
scan.TB	data: [Nscan×Nbeam×5 single] Units: 'K' Description: 'Calibrated brightness temperature: CH1=181GHz,CH2=178GHz,CH3=174GHz,CH4=164GHz,CH5=87GHz'
scan.UTCtime	data: [Nscan×Nbeam double] Description: 'UTC time for each sample' Units: 'seconds since 1-1-2000 00:00:00'
scan.asds	data: [Nscan×1 single] Description: 'Ascending/Descending flag (asc=1,dsc=0)' Units: '/'
scan.binc	data: [Nscan×Nbeam single] Description: 'Boresight incidence angle at radiometer sample rate' Units: 'degrees'
scan.blat	data: [Nscan×Nbeam single] Description: 'Boresight latitude at radiometer sample rate' Units: 'degrees'
scan.blon	data: [Nscan×Nbeam single] Description: 'Boresight longitude at radiometer sample rate' Units: 'degrees'
scan.landmask	data: [Nscan×Nbeam single] Description: 'Ocean=0, Inland Water=1, Land=3 - resolution is 2 minutes' Units: '/'
scan.scanang	data: [Nscan×Nbeam single] Description: 'Scan angle from encoder' Units: 'degrees'

2. Dataset overview

Nominal cross-track scan data

The majority of the TEMPSET-D data are acquired in a nominal cross-track scanning mode. In this mode, TEMPEST-D maps the Earth with approximately an 800-km swath. An example of one day in the nominal mode is shown in Figure 1 for May 13, 2019 for the 87 GHz channel.
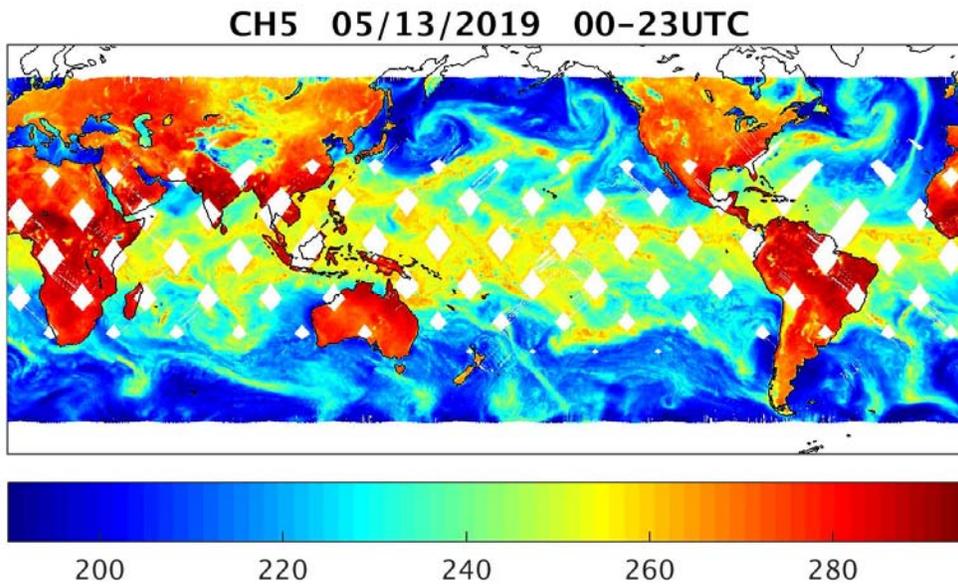

Figure 1. Example of TEMPEST-D 87 GHz data in the nominal cross-track scan mode.

Along-track scan data

Periodically, the spacecraft is yawed 92° to acquire a unique along-track scanning dataset. In this mode, each position along track is sampled at multiple incidence angles from -65 to +65°. The along track scanning typically is performed for 1-3 days. An example of this is shown in Figure 2 for Jan 29, 2019.
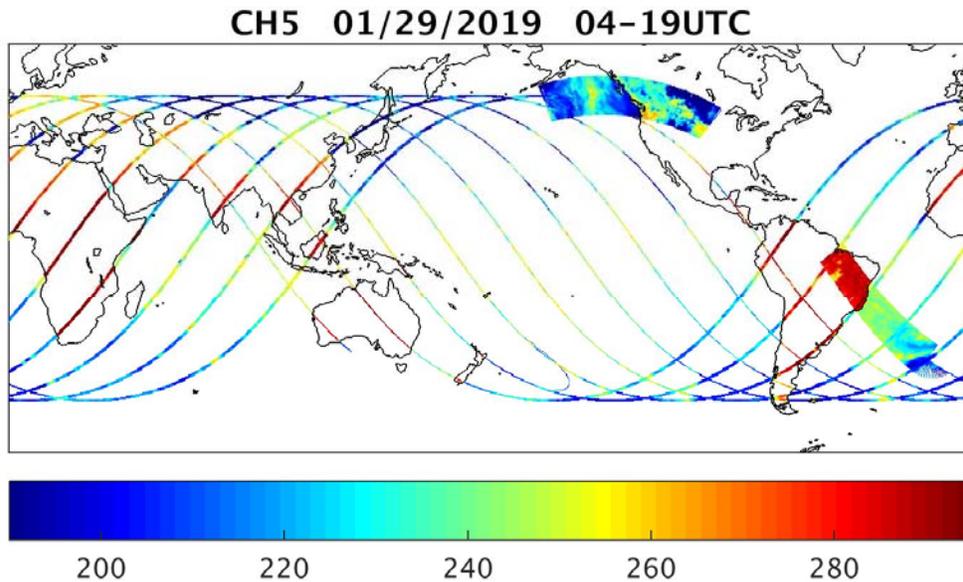
Figure 2. Example of TEMPEST-D 87 GHz data in the special along-track scan mode.

Missing data

TEMPEST-D is a technology demonstration mission with only one ground station that typically operates Monday through Friday. This means that we are not able to bring all the data to the ground. In a typical month, there will be about 7-15 days of data available.

The TEMPSET-D Cadet radio is in the crowded UHF band, meaning downloaded packets can often be corrupted. This results in gaps of a packet in size, which are about half a scan. An example of this is shown in Figure 3 below. The gaps are evident in the Indian Ocean and over Asia.

The TEMPST-D ground station is located at the NASA Wallops Flight Facility (WFF) in Virginia. To downlink data, the spacecraft must be rolled to point the UHF antenna on the spacecraft to the ground station. This points the instrument away from the Earth and results in a data gap centered on WFF. The gap contains most of the eastern US and extends into the Atlantic Ocean. An example of the gap is shown in Figure 4. It should be noted that this gap will only be present when downlinks are commanded, which is typically on weekdays. Data acquired on weekends will typically not have the gap at WFF, e.g. as in Figure 1.
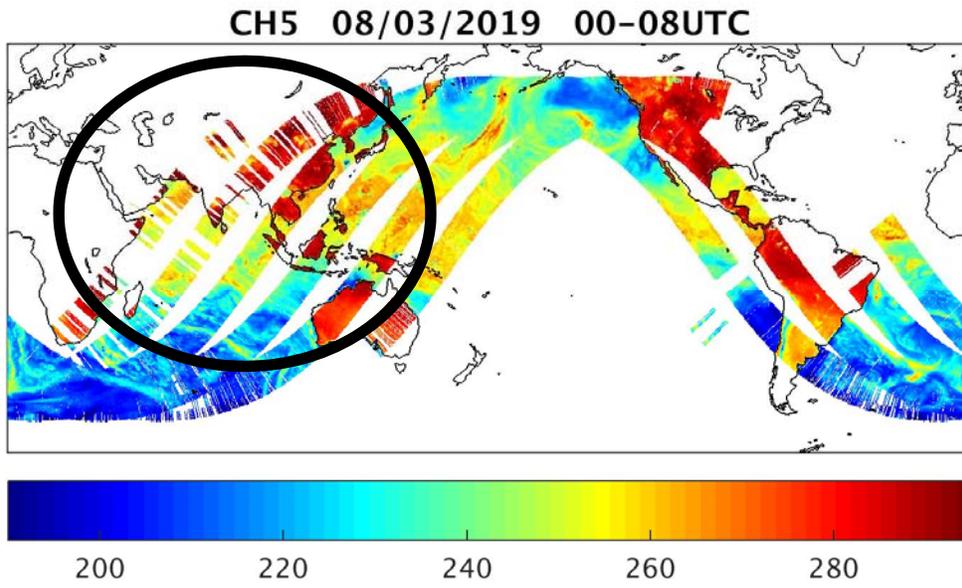
Figure 3. Example of missing or corrupted packets from the UHF downlink.
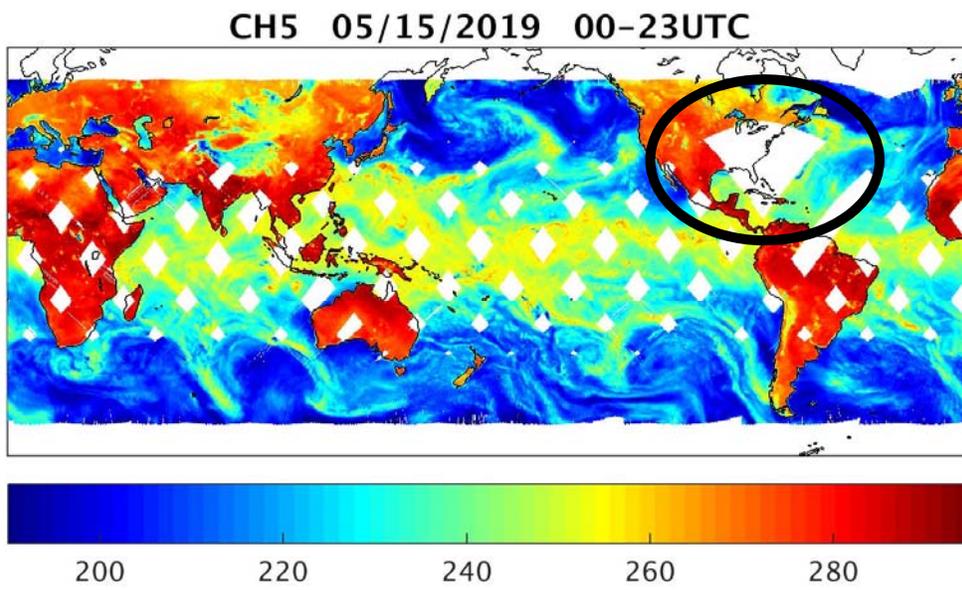

Figure 4. Example of the data gap over WFF from the re-orientation of the spacecraft.