Saturn Scatterometry Rev 290

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- Sequence: s101
- Rev: 290
- Observation Id: sa_290_1
- Target Body: Saturn

1 Introduction

This memo describes one of the Cassini RADAR activities for the s101 sequence of the Saturn Tour. A sequence design memo provides the science context of the scheduled observations, an overview of the pointing design, and guidelines for preparing the RADAR IEB. A 3-hour warmup occurs first using the parameters shown in table 3.

2 CIMS and Division Summary

CIMS ID	Start	End	Duration	Comments
290SA_WARMUP001_RIDER	2017-238T18:34:00	2017-239T01:20:24	06:46:24.0	
290SA_2CMMAP001_PIE	2017-239T01:20:24	2017-239T03:20:24	02:00:0.0	

Table 1: sa_290_1 CIMS Request Sequence

Each RADAR observation is represented to the project by a set of requests in the Cassini Information Management System (CIMS). The CIMS database contains requests for pointing control, time, and data volume. The CIMS requests show a high-level view of the sequence design.

The CIMS requests form the basis of a pointing design built using the project pointing design tool (PDT). The details of the pointing design are shown by the PDT plots on the corresponding tour sequence web page. (See https://cassini.jpl.nasa.gov/radar.) The RADAR pointing sequence is ultimately combined with pointing sequences from other instruments to make a large merged c-kernel. C-kernels are files containing spacecraft attitude data.

A RADAR tool called RADAR Mapping and Sequencing Software (RMSS) reads the merged c-kernel along with other navigation data files, and uses these data to produce a set of instructions for the RADAR observation. The RADAR instructions are called an Instrument Execution Block (IEB). The IEB is produced by running RMSS with a radar config file that controls the process of generating IEB instructions for different segments of time. These segments of time are called divisions with a particular behavior defined by a set of division keywords in the config file. Table 2 shows a summary of the divisions used in this observation. Subsequent sections will show and discuss the keyword selections made for each division. Each division table shows a set of nominal parameters that are determined by the operating mode (eg., distant scatterometry, SAR low-res inbound). The actual division parameters from the config file are also shown, and any meaningful mismatches are flagged.

Division	Name	Start	Duration	Data Vol	Comments
a	distant_warmup	-7:50:0.0	06:18:0.0	22.5	Warmup
b	distant_radiometer	-1:32:0.0	00:05:0.0	0.3	Radiometer quick-steps
c	distant_radiometer	-1:27:0.0	00:57:0.0	6.8	Radiometer Only
d	scat_rings	-0:30:0.0	00:04:0.0	20.4	Scatterometer Sounding with Chirp
e	scat_rings	-0:26:0.0	00:04:0.0	8.4	Scatterometer Sounding with Tone
f	scat_rings	-0:22:0.0	00:04:0.0	20.4	Scatterometer Sounding with Chirp
g	scat_rings	-0:18:0.0	00:04:0.0	8.4	Scatterometer Sounding with Tone
h	scat_rings	-0:14:0.0	00:02:0.0	9.0	Scatterometer Sounding with Chirp
i	scat_rings	-0:12:0.0	00:02:0.0	9.0	Scatterometer Sounding with Chirp
j	scat_rings	-0:10:0.0	00:04:0.0	9.6	Scatterometer Sounding with Tone
k	scat_rings	-0:06:0.0	00:03:0.0	8.1	Scatterometer Sounding with Chirp
l	scat_rings	-0:03:0.0	00:01:0.0	2.5	Scatterometer Sounding with Chirp
m	scat_rings	-0:02:0.0	00:04:0.0	12.0	Scatterometer Sounding with Tone
n	scat_rings	00:02:0.0	00:01:0.0	2.5	Scatterometer Sounding with Chirp
o	scat_rings	00:03:0.0	00:03:0.0	8.1	Scatterometer Sounding with Chirp
p	scat_rings	00:06:0.0	00:04:0.0	9.6	Scatterometer Sounding with Tone
q	scat_rings	00:10:0.0	00:02:0.0	9.0	Scatterometer Sounding with Chirp
r	scat_rings	00:12:0.0	00:02:0.0	9.0	Scatterometer Sounding with Chirp
s	scat_rings	00:14:0.0	00:04:0.0	8.4	Scatterometer Sounding with Tone
t	scat_rings	00:18:0.0	00:04:0.0	16.8	Scatterometer Sounding with Chirp
u	scat_rings	00:22:0.0	00:04:0.0	6.0	Scatterometer Sounding with Tone
v	scat_rings	00:26:0.0	00:04:0.0	16.8	Scatterometer Sounding with Chirp
w	scat_rings	00:30:0.0	00:04:0.0	6.0	Scatterometer Sounding with Tone
x	distant_radiometer	00:34:0.0	00:46:0.0	5.5	Radiometer Only
Total				235.1	

Table 2: Division summary. Data volumes (Mbits) are estimated from maximum data rate and division duration.

Name	Nominal	Actual	Mismatch	Comments
mode	radiometer	radiometer	no	
start_time (min)	varies	-470.0	no	
end_time (min)	varies	-92.0	no	
time_step (s)	varies	5400.0	no	Used by radiometer only modes - saves commands
bem	00100	00100	no	
baq	don't care	5	no	
csr	6	6	no	6 - Radiometer Only Mode
noise_bit_setting	don't care	4.0	no	
dutycycle	don't care	0.38	no	
prf (Hz)	don't care	1000	no	
tro	don't care	0	no	
number_of_pulses	don't care	8	no	
n_bursts_in_flight	don't care	1	no	
percent_of_BW	don't care	100.0	no	
auto_rad	on	on	no	
rip (ms)	34.0	34.0	no	
max_data_rate	0.248	0.992	yes	Kbps - set for slowest burst period
interleave_flag	off	off	no	
interleave_duration (min)	don't care	10.0	no	

Table 3: sa_290_1 Div a distant_warmup block

Name	Nominal	Actual	Mismatch	Comments
mode	scatterometer	scatterometer	no	
start_time (min)	varies	-30.0	no	
end_time (min)	varies	-26.0	no	
time_step (s)	don't care	24.0	no	manually set
bem	00100	00100	no	
baq	varies	5	no	
csr	8	0	yes	0 - fixed attenuator
noise_bit_setting	varies	4.0	no	
dutycycle	0.70	0.70	no	
prf (Hz)	don't care	500	no	
tro	don't care	6	no	
number_of_pulses	don't care	18	no	
n_bursts_in_flight	1	1	no	
percent_of_BW	100	90.0	yes	90 - reduced slightly to provide more pointing margin
auto_rad	on	on	no	
rip (ms)	34.0	34.0	no	
max_data_rate	varies	85.000	no	
interleave_flag	off	off	no	
interleave_duration (min)	don't care	6.8	no	

Table 4: sa_290_1 Div d scat_rings block

3 Overview

This observation is a combined active and passive sounding of the Saturn upper atmosphere during a proximal orbit that brought the spacecraft relatively close at closest approach. The spacecraft is always pointed at Saturn center. Active mode is confied to about one hour centered on closest approach. The receive window is centered on the surface defined in the SPICE pck file. The definition used corresponds to the 1 bar pressure level in Saturn's atmosphere. The receive window then extends far enough up and down from this surface to cover the expected range of altitudes where we might expect methane clouds or water clouds to have scattering droplets. Similar to atmospheric probe measurements on Titan, we alternate chirp and tone transmissions to provide different tradeoffs of SNR and resolution. The tone transmissions have the smallest bandwidth (just doppler spread), the lowest noise level, and therefore the highest SNR with the best detection threshold. Tone transmissions, however, are limited in range resolution by the pulse width. Also, only a single pulse is transmitted to avoid range ambiguities. The chirp transmissions provide better range resolution through pulse compression, but the noise floor is higher and SNR lower than the tone measurements. Table 4 shows the parameters used during an active chirp segment. Table 5 shows the parameters used during an active tone segment. Specialized processing will be needed for this data set.

4 Revision History

1. Apr 16, 2017: Initial Release

Name	Nominal	Actual	Mismatch	Comments
mode	scatterometer	scatterometer	no	
start_time (min)	varies	-26.0	no	
end_time (min)	varies	-22.0	no	
time_step (s)	don't care	30.0	no	manually set
bem	00100	00100	no	
baq	varies	5	no	
csr	8	0	yes	0 - fixed attenuator
noise_bit_setting	varies	4.0	no	
dutycycle	0.70	0.70	no	
prf (Hz)	don't care	600	no	
tro	don't care	6	no	
number_of_pulses	don't care	1	no	1 - avoids range ambiguities
n_bursts_in_flight	1	1	no	
percent_of_BW	100	0.0	yes	0 - tone transmission
auto_rad	on	on	no	
rip (ms)	34.0	34.0	no	
max_data_rate	varies	35.000	no	
interleave_flag	off	off	no	
interleave_duration (min)	don't care	6.8	no	

Table 5: sa_290_1 Div e scat_rings block

5 Acronym List

ALT	Altimeter - one of the radar operating modes
BAQ	Block Adaptive Quantizer
CIMS	Cassini Information Management System - a database of observations
Ckernel	NAIF kernel file containing attitude data
DLAP	Desired Look Angle Profile - spacecraft pointing profile designed for optimal SAR performance
ESS	Energy Storage System - capacitor bank used by RADAR to store transmit energy
IEB	Instrument Execution Block - instructions for the instrument
ISS	Imaging Science Subsystem
IVD	Inertial Vector Description - attitude vector data
IVP	Inertial Vector Propagator - spacecraft software, part of attitude control system
INMS	Inertial Neutral Mass Spectrometer - one of the instruments
NAIF	Navigation and Ancillary Information Facility
ORS	Optical Remote Sensing instruments
PDT	Pointing Design Tool
PRI	Pulse Repetition Interval
PRF	Pulse Repetition Frequency
RMSS	Radar Mapping Sequencing Software - produces radar IEB's
SAR	Synthetic Aperture Radar - radar imaging mode
SNR	Signal to Noise Ratio
SOP	Science Operations Plan - detailed sequence design
SOPUD	Science Operations Plan Update - phase of sequencing when SOP is updated prior to actual sequencing
SSG	SubSequence Generation - spacecraft/instrument commands are produced
SPICE	Spacecraft, Instrument, C-kernel handling software - supplied by NAIF to use NAIF kernel files.
TRO	Transmit Receive Offset - round trip delay time in units of PRI