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Issue 2
Revision 0
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MARSIS

Planning Tool Algorithms and Criteria to Select Operative Modes

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1 INTRODUCTION

The present technical report is an intermediate document, following the Operational Planning and Commanding Requirements (Technical Report N. MRS-009/005/03, 25/07/03), useful for the S/W designer to develop the SRS, IRS and other relevant documents needed for the complete S/W design.

The algorithm, the formulas and the input data used in this document are fully explained in the above report.

The input data to the operational planning tool are:

- The Science targets and their assumed characteristics
- The Orbits and the relevant parameters
- The magnetic field
- The available data rate
- The facet characterization model and associated statistical parameters (50-100 km radius)

While the expected output are:

- The selection of the most suitable band/bands (transmission frequencies)
- The operative mode selection (utilization of the monopole antenna)

The steps necessary to obtain the stated output have been divided as follows:

- Orbit segment classification useful for negotiation in case of conflicts (data rate, power requirements, manoeuvres, etc.) with S/C and other instruments.
- Ionosphere modeling
- Dynamic evaluation
- Operative mode selection criteria
- Definition of orbit timeline (operative mode selection and timeline)

The manual inputs are set by the operator and are described in the graphical interface that is implemented in chapter 10 of the present document. The processing is performed by the following blocks: Orbit segment classification, ionosphere modelling, dynamic evaluation, select operative modes, modes optimization, timelines generation.

The data base contains the orbit projection on Mars surface (SPICE Kernel), the surface statistical parameters, the surface and subsurface composition and coefficients, the science targets and the fixed inputs (constants and threshold that can be modified). The same data base will produce the planning in terms of timelines (operative modes, frequency etc)

Each step will be fully described in terms of input/output, flow chart and algorithms, when applicable, in the following sections.

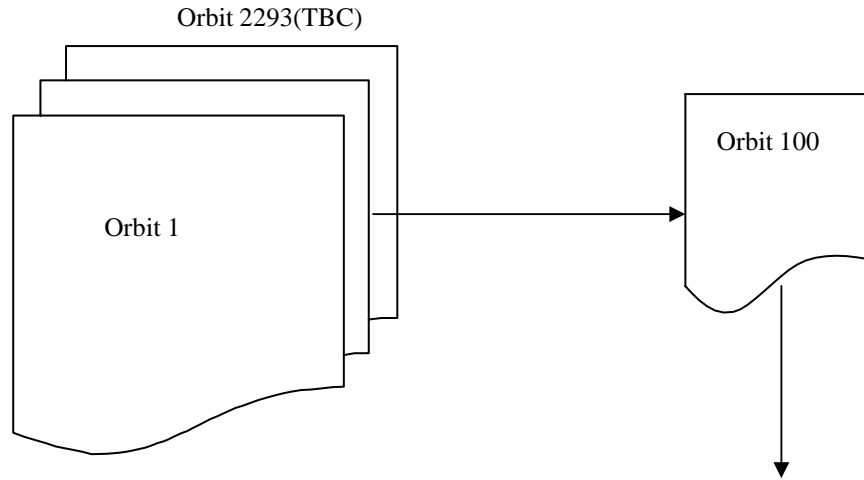
1.1 ANNEXES

<i>Annex</i>	<i>Issue</i>	<i>Thenical Report</i>	<i>Date</i>	<i>Description</i>
Annex-1	1.1	MRS-009/005/03	25/07/03	Operational Planning and Commanding Requirements



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2 ORBIT SEGMENT CLASSIFICATION



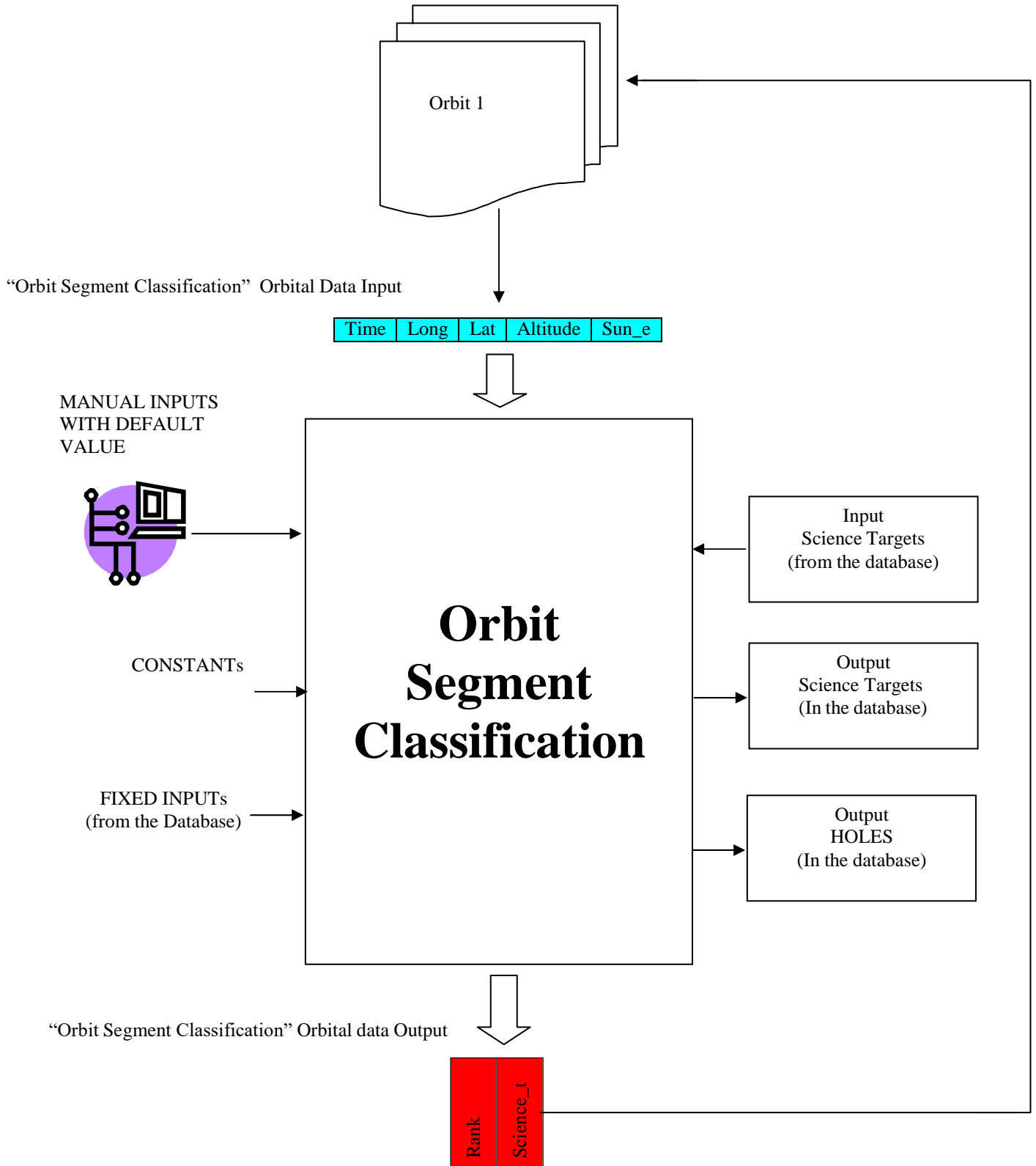
		1.8 MHz (Ch1)				3 MHz (Ch2)				4 MHz (Ch3)				5 MHz (Ch4)			
Time[sec]	*																
Long[deg]	*																
Lat[deg]	*																
Alt[Km]	*																
Sun_e [deg]	*																
Vtan[m/s]	*																
Rank [Index]	*																
Scienc_t[Index]	*																
fpm [Hz]	*																
Alt_tot_1 [dB]	*																
S_N_1 [dB]	*																
roughness_1 [m]	*																
depth_noise_1 [m]	*																
depth_clutter_1 [m]	*																
Mon_1 [Index]	*																
Stationary1[Index]	*																
Alt_tot_2 [dB]	*																
S_N_2 [dB]	*																
roughness_2 [m]	*																
depth_noise_2 [m]	*																
depth_clutter_2 [m]	*																
Mon_2 [Index]	*																
Stationary2[Index]	*																
Alt_tot_3 [dB]	*																
S_N_3 [dB]	*																
roughness_3 [m]	*																
depth_noise_3 [m]	*																
depth_clutter_3 [m]	*																
Mon_3 [Index]	*																
Stationary3[Index]	*																
Alt_tot_4 [dB]	*																
S_N_4 [dB]	*																
roughness_4 [m]	*																
depth_noise_4 [m]	*																
depth_clutter_4 [m]	*																
Mon_4 [Index]	*																
Stationary4[Index]	*																
Roughness_const[m]	*																
Warning[Index]	*																
Slope [rad]	*																
OPM [Index]	*																
T1 [Index]	*																
T2 [Index]	*																

In → "Orbit Segment Classification" Orbital Data Input

Out → "Orbit Segment Classification" Orbital data Output

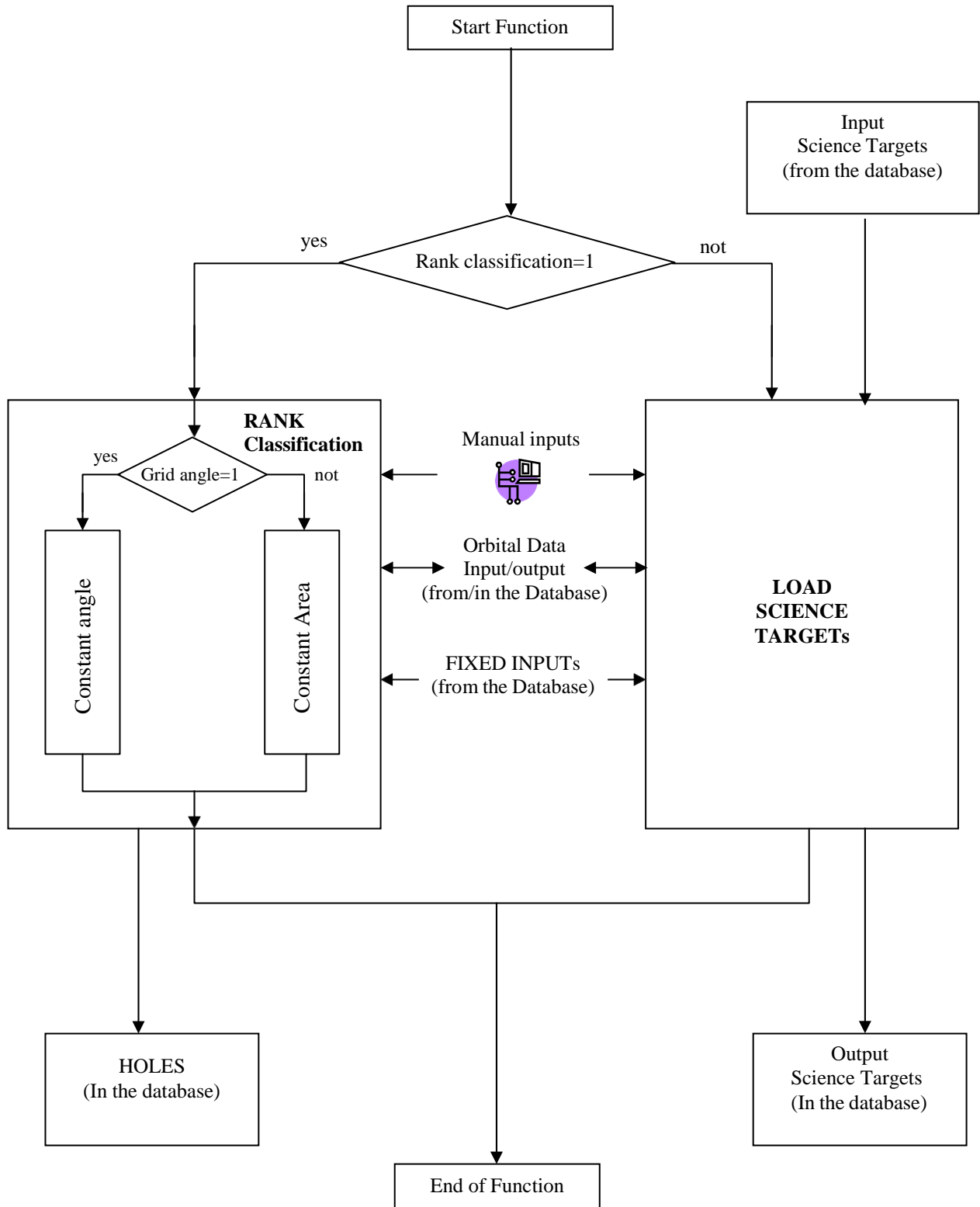


2.1 CONTEST





2.2 TOP LEVEL DATA FLOW

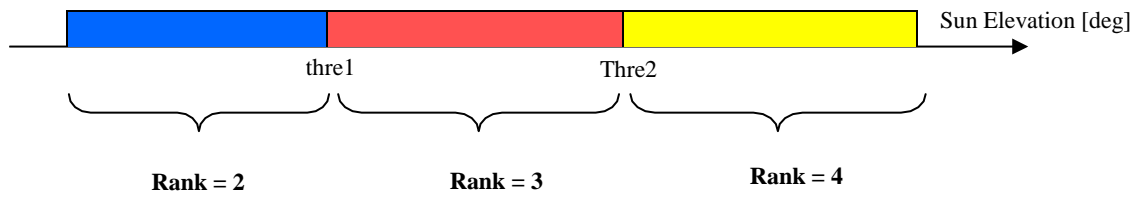




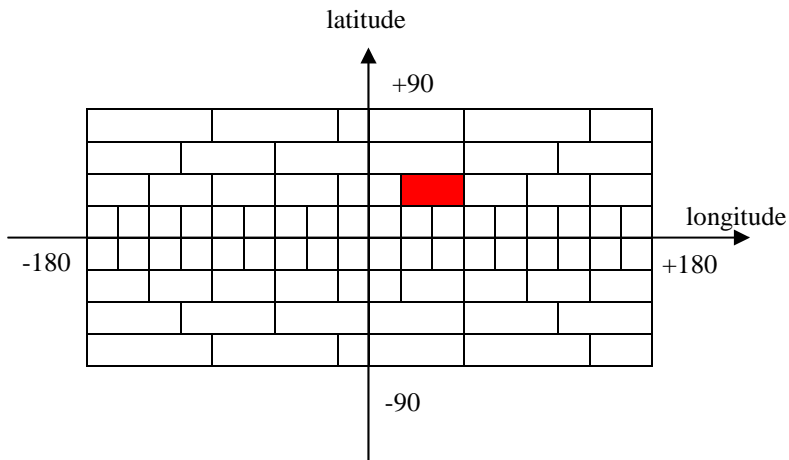
2.2.1 Rank Classification

INTRODUCTION

• Rank “2, 3, 4” Assignment



• Rank “1” Assignment

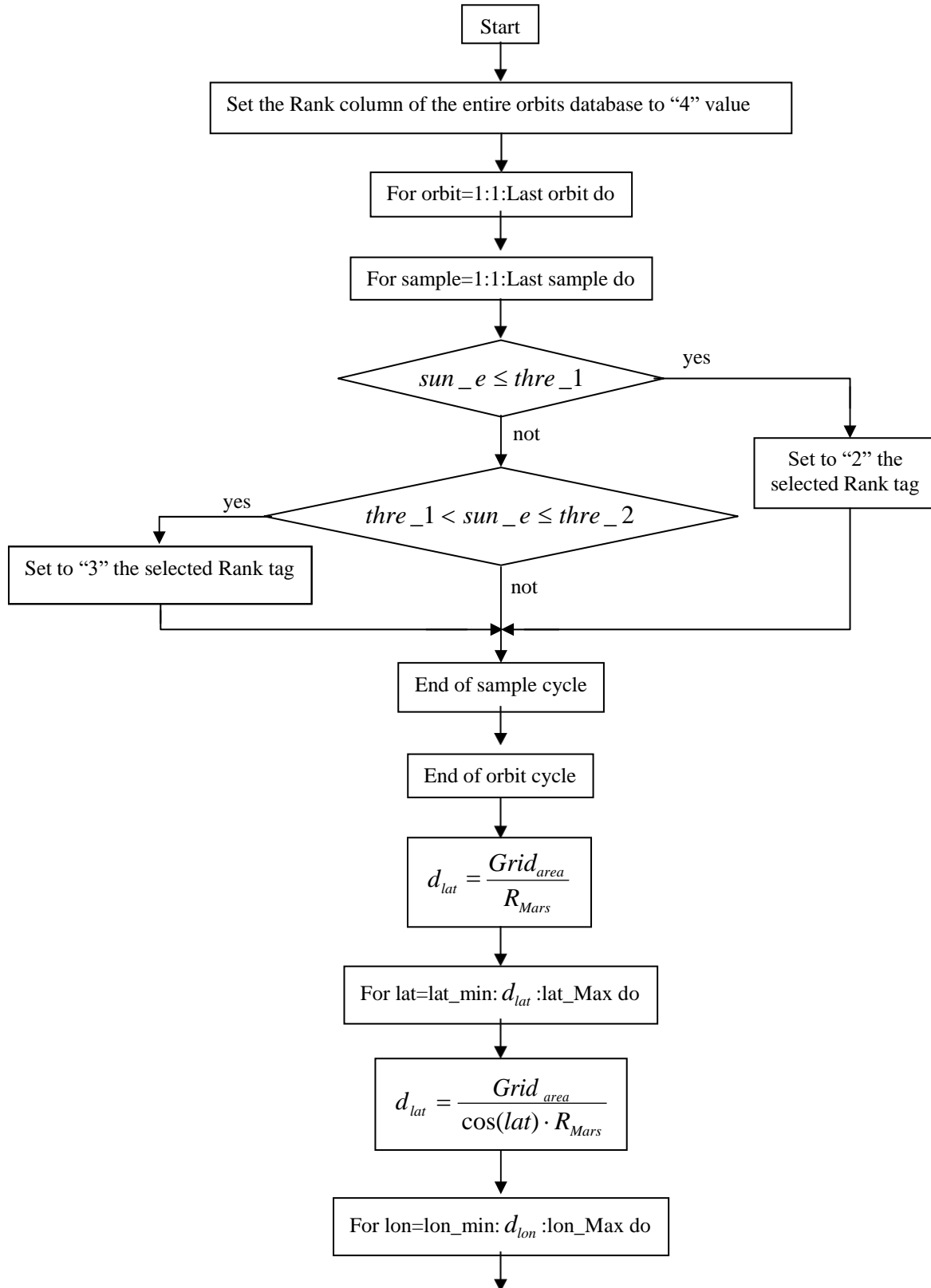


- The Martian surface is represented with a grid of cells whose dimensions can be of constant area or of constant angle. In figure is shown the constant area case.
- For each selected cell chose the best orbit's sample, in terms of Sun Elevation and altitude
- Set to “1” the Rank tag of the orbit's samples



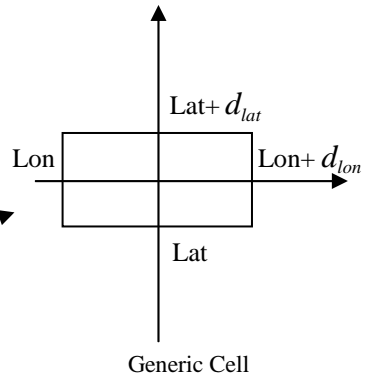
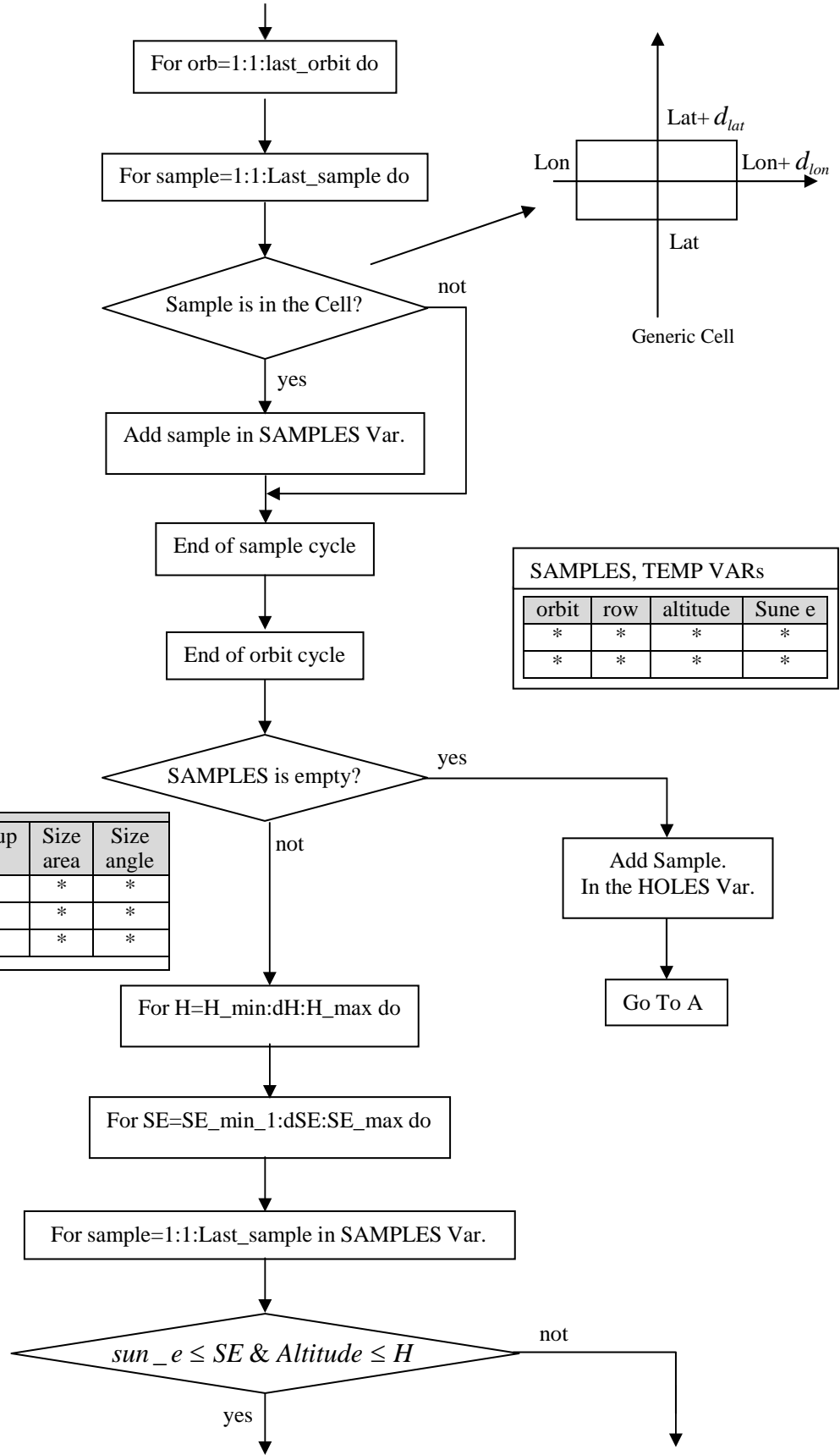
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2.2.1.1 Rank Classification with a grid of constant area





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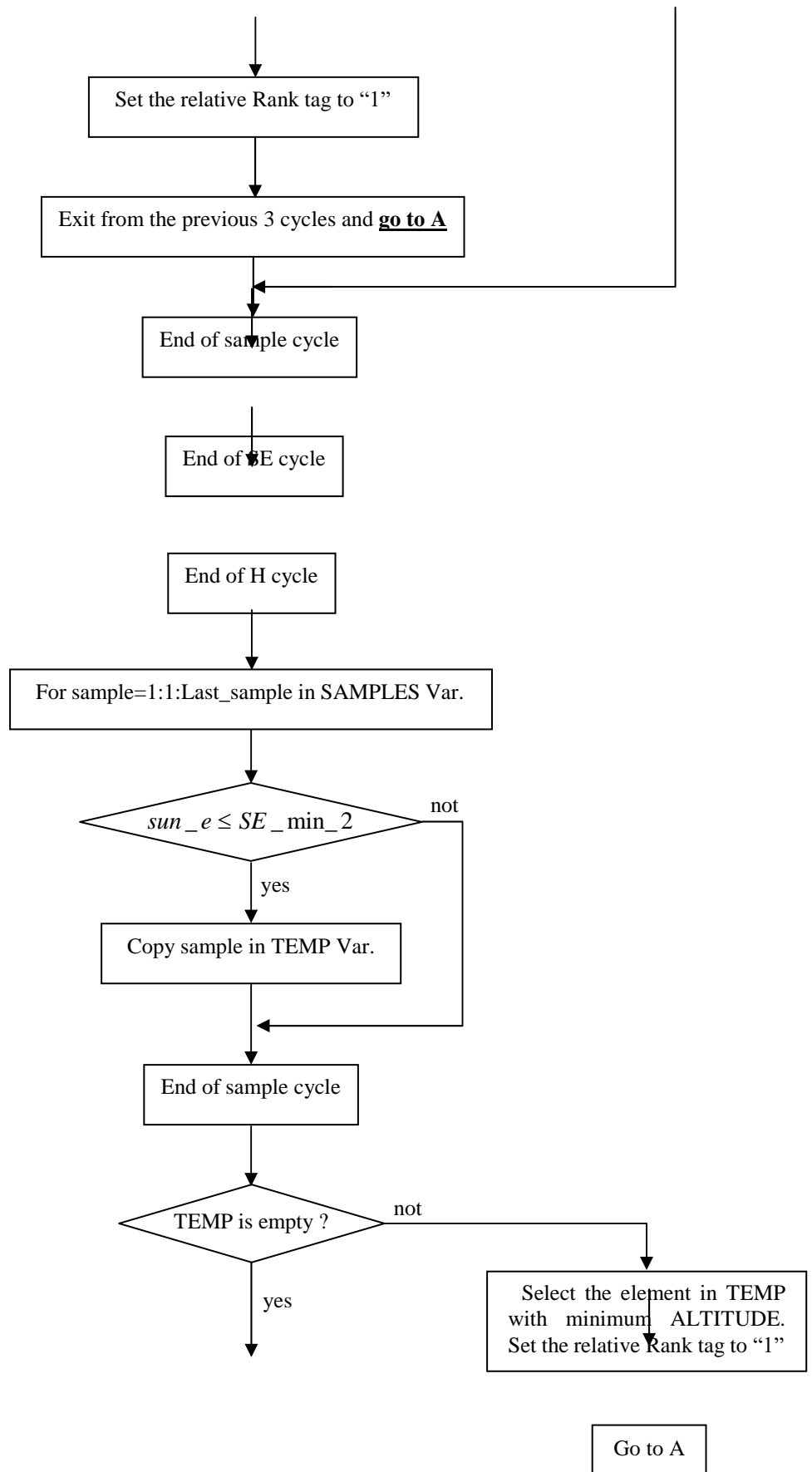


SAMPLES, TEMP VARs			
orbit	row	altitude	Sune e
*	*	*	*
*	*	*	*

HOLES					
Lat inf	Lon inf	Lat sup	Lon sup	Size area	Size angle
*	*	*	*	*	*
*	*	*	*	*	*
*	*	*	*	*	*

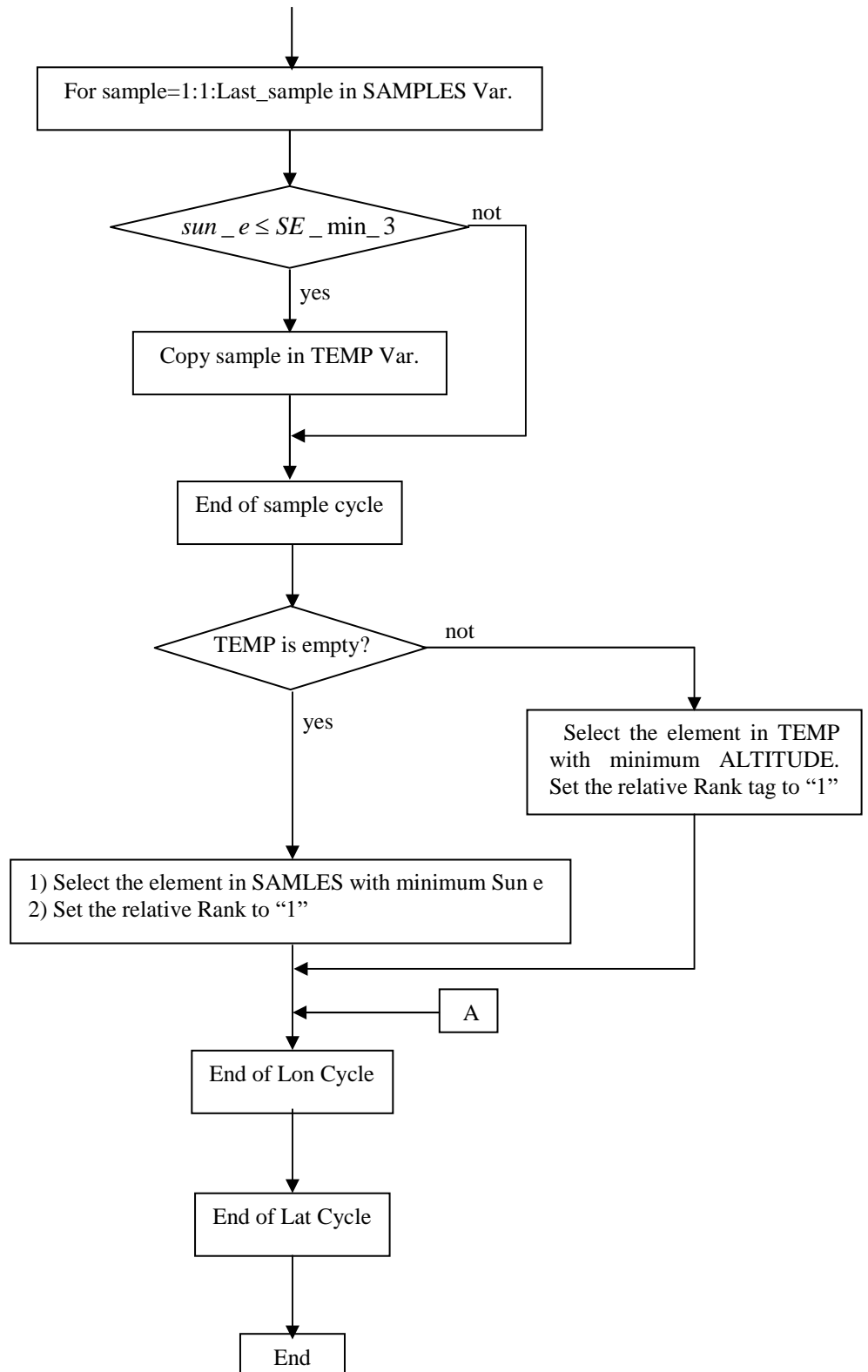


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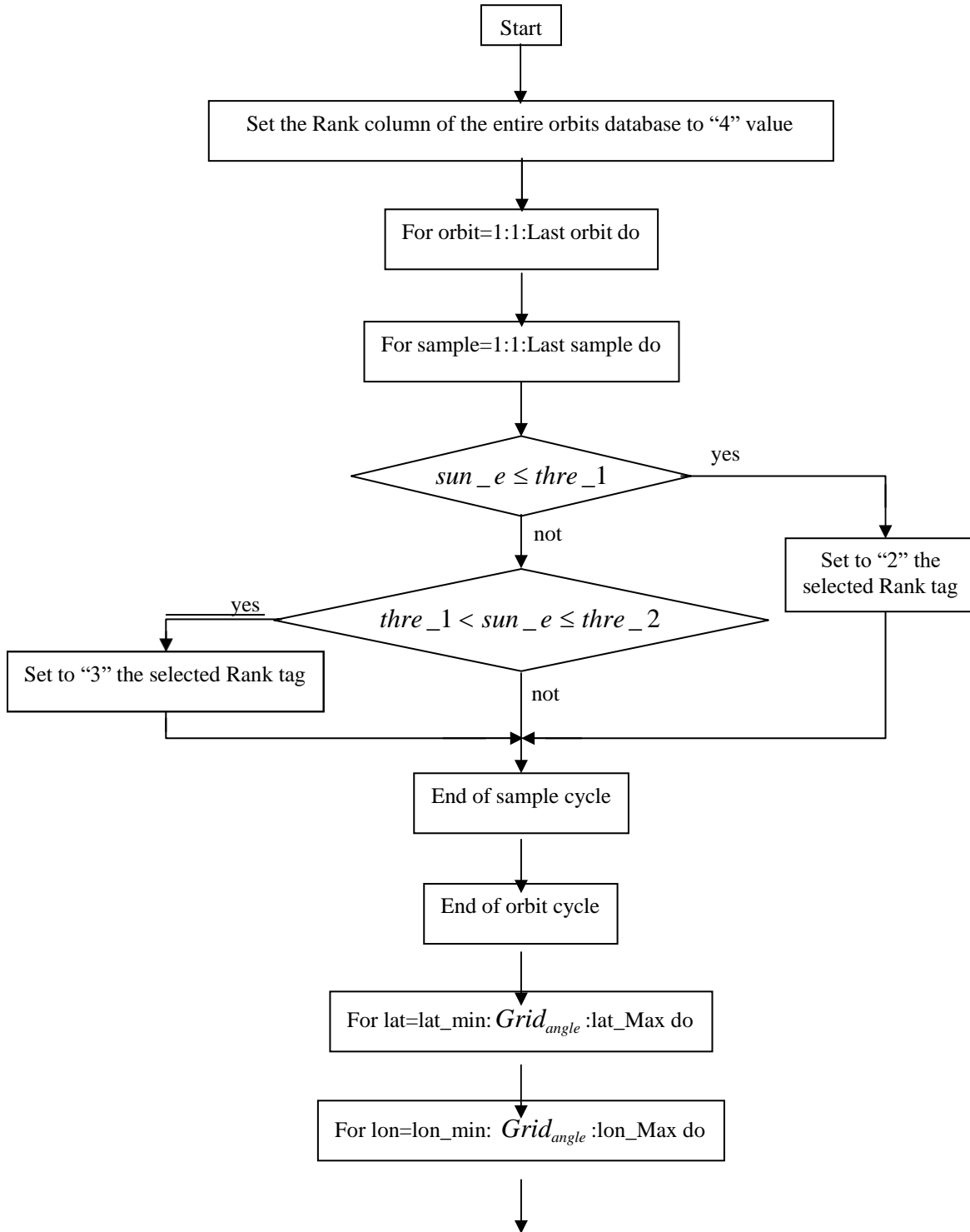
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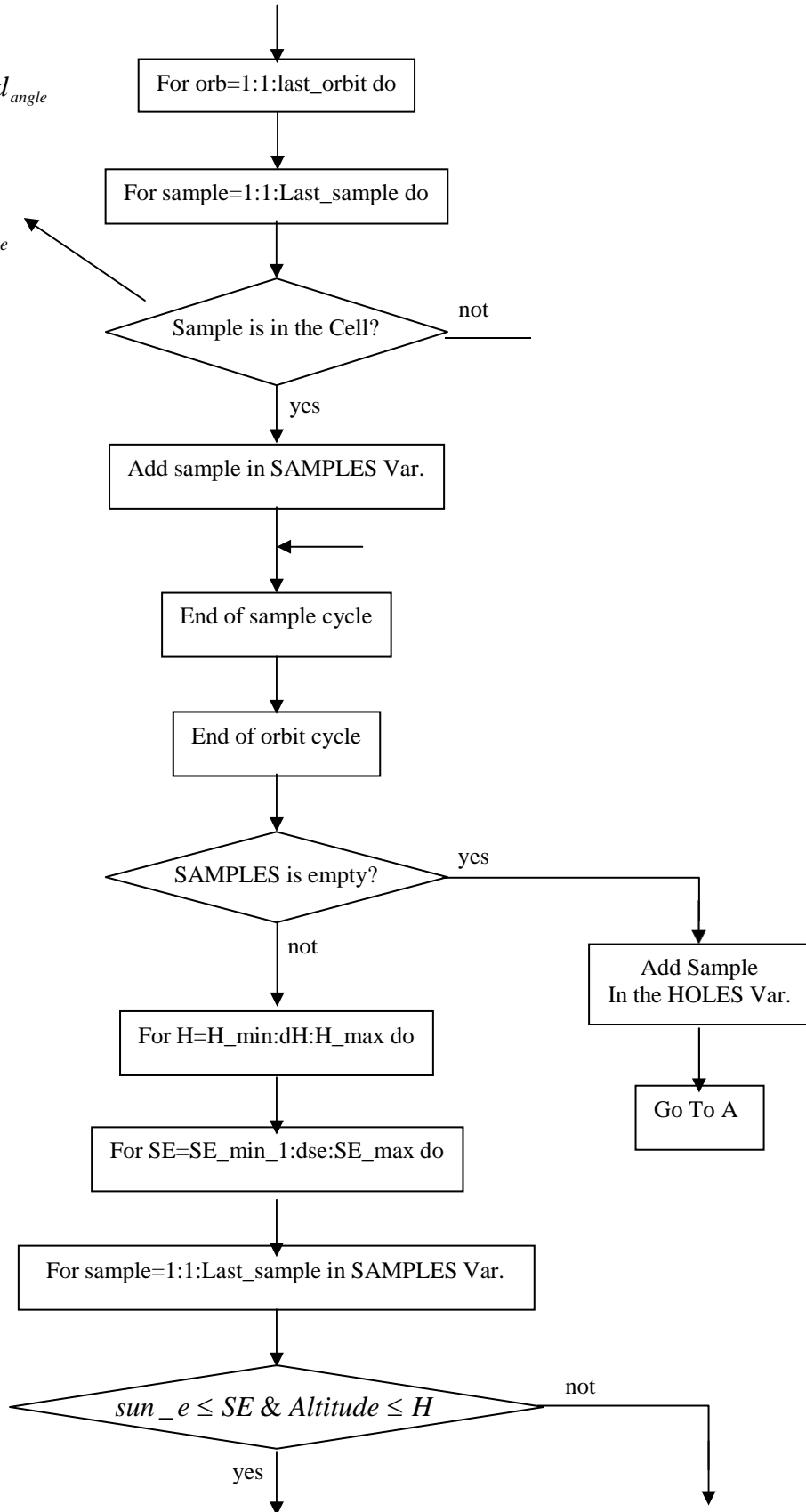
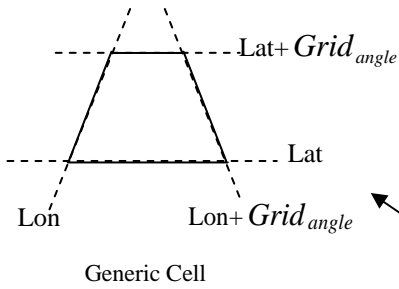
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2.2.1.2 Rank classification with a grid of constant angle



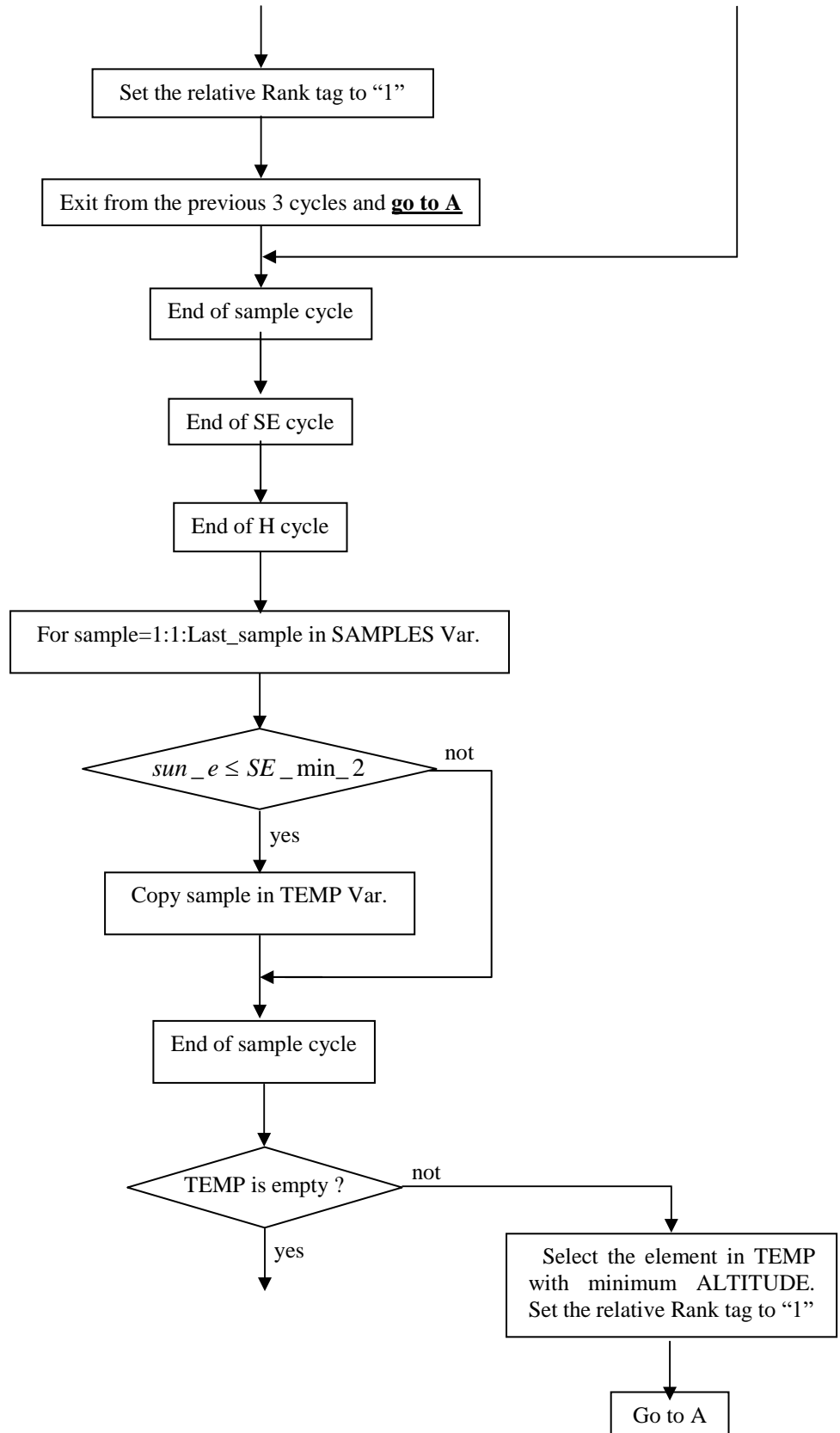


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For sample=1:1:Last_sample in SAMPLES Var.

$sun_e \leq SE_min_3$

Copy sample in TEMP Var.

End of sample cycle

TEMP is empty?

Select the element in TEMP with minimum ALTITUDE. Set the relative Rank tag to "1"

1) Select the element in SAMPLES with minimum Sun e
2) Set the relative Rank to "1"

A

End of Lon Cycle

End of Lat Cycle

End



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“RANK CLASSIFICATION”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

MANUAL INPUTs (With default value)

Symbol	Default value	External Units	Internal Units	Notes
Classification type	1	[boolean]	[boolean]	Rank Classification = 1 → Orbit Rank classification Rank Classification = 0 → Load Science target
Grid mode	0	[boolean]	[boolean]	Grid mode = 1 → Constant angle Grid (the area of the Cells is not constant) Grid mode = 0 → Constant area Grid (the area of the Cell is constant)
$Grid_{area}$ size	75	[Km]	→ [m]	Cell area dimension
$Grid_{angle}$ size	1.5	[deg]	→ [rad]	Cell angle dimension
H_min	250	[Km]	→ [m]	Minimum altitude (do not confuse with the minimum S/C working altitude)
H_max	500	[Km]	→ [m]	Maximum altitude (do not confuse with the maximum S/C working altitude)
dH	10	[Km]	→ [m]	Step size for the altitude
SE_min_1	-90	[deg]	→ [rad]	Minimum sun elevation for the Rank classification (first threshold)
SE_min_2	5	[deg]	→ [rad]	Minimum sun elevation for the Rank classification (second threshold)
SE_min_3	15	[deg]	→ [rad]	Minimum sun elevation for the Rank classification (third threshold)
SE_max	0	[deg]	→ [rad]	Maximum sun elevation for the Rank classification
dSE	1	[deg]	→ [rad]	Sun elevation step size
lon_min	-180	[deg]	→ [rad]	Minimum Longitude of investigation
lon_max	+180	[deg]	→ [rad]	Maximum Longitude of investigation
lat_min	-89	[deg]	→ [rad]	Minimum Latitude of investigation
lat_max	+89	[deg]	→ [rad]	Maximum Latitude of investigation

INTERNAL INPUT

Symbol	Units	Notes
Last_orbit	[Integer]	Last orbit in the database (it should be 2293)
Last_sample	[Integer]	Last sample is the last row in the generic orbit
d_{lat}, d_{lon}	[rad]	Step size for the latitude and the longitude
Lat	[rad]	Latitude of the sample
Lon	[rad]	Longitude of the sample
SE	[rad]	Sun elevation of the sample
Altitude	[m]	Altitude of the sampe

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units	Notes
Longitude	[deg]	→ [rad]	Longitude of the selected sample
Latitude	[deg]	→ [rad]	Latitude of the selected sample
H	[Km]	→ [m]	Space Craft altitude
Sun_e	[deg]	→ [rad]	Sun elevation value of the selected sample



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FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	External Units	Internal Units	CORISTA Nomenclature
100	thre_1	5	[deg]	→ [rad]	SunThresholdA
101	thre_2	40	[deg]	→ [rad]	SunThresholdB

COSTANTs (In the cod)

Symbol	Value	Units	Notes
R_{Mars}	3393500	[m]	Radius of Mars

ORBITAL DATA OUTPUTs (From the Database)

Symbol	Units
Rank tag	[Index]

OUTPUTs

Symbol	Units	Notes
HOLES	[Array of float numbers]	Coordinates of the Grid's Cell. Not covered from MARSIS



2.2.2 Load Science Targets

TARGETs LIST FROM THE DATABASE (Table A)

1 Hellas
Proposed by: Andrea C, on 15-Jan-2003
Coordinates:0,-80 20,60

.....

OUTPUT SCIENCE TARGETs, table in the DB (Table B)

SCIENCE TARGETS COVERAGE DATA AS OF: 02-Jan-1999

1 Hellas
Proposed by: Andrea C, on 15-Jan-2003
Coordinates:0,-80 20,60

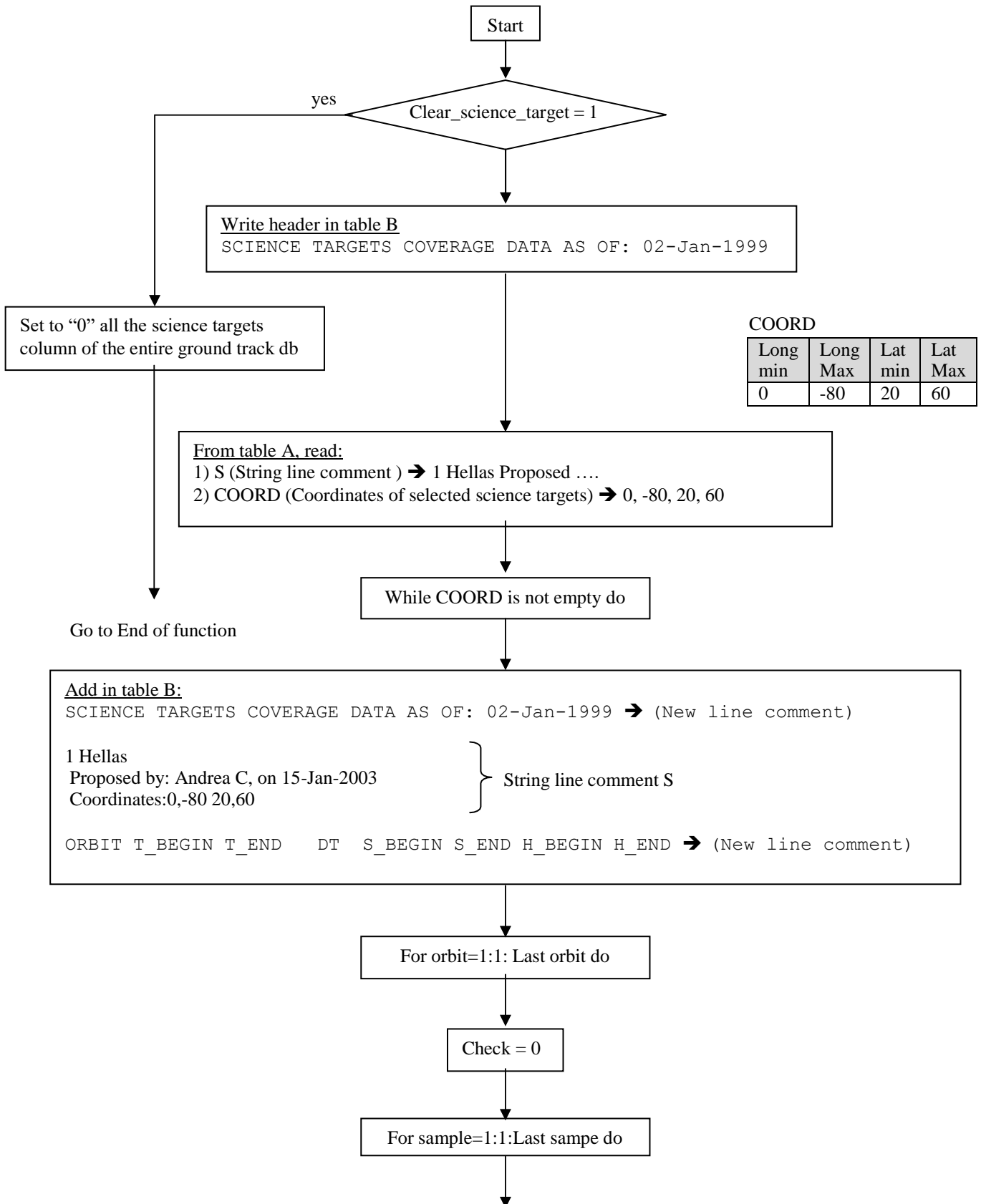
ORBIT	T_BEGIN	T_END	DT	S_BEGIN	S_END	H_BEGIN	H_END
8	3.48	8.49	5.01	47.1	36.9	318	514

.....



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2.2.2.1 Load Science Targets data flow

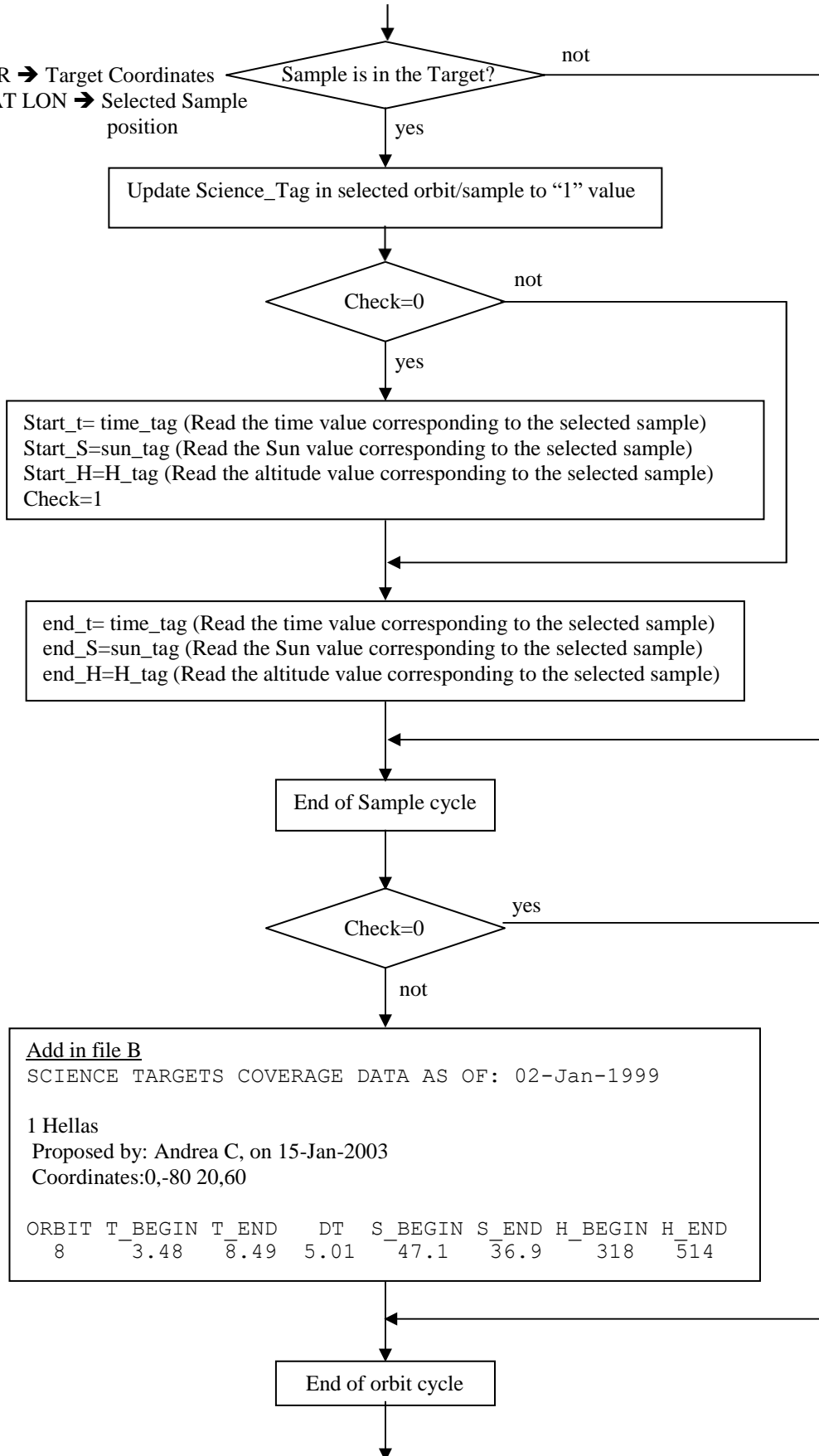




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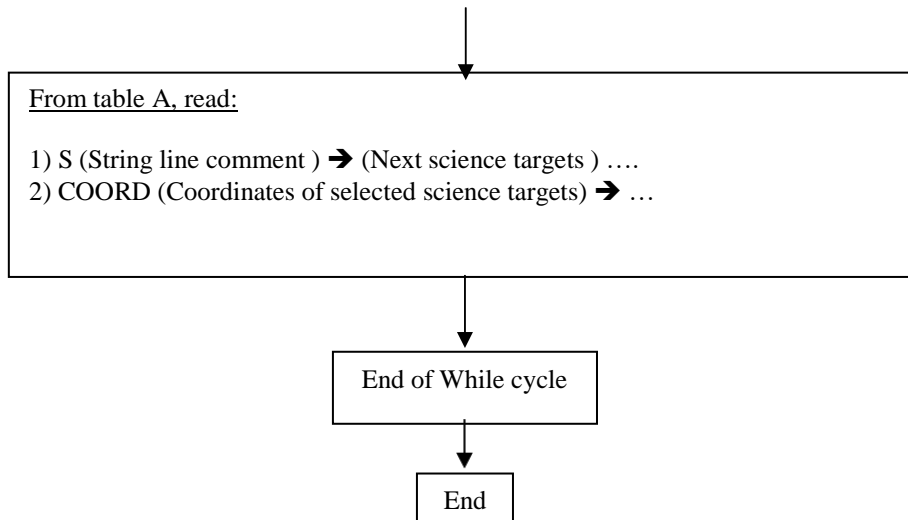
Use:

- 1) COORD VAR → Target Coordinates
- 2) SAMPLE LAT LON → Selected Sample position





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“LOAD SCIENCE TARGETS”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

INTERNAL INPUTs and/or INPUTs FROM OTHERS FUNCTIONs

Symbol	Units	Notes
Last_orbit	[Integer]	Last orbit in the database (2293 TBC)
Last_sample	[Integer]	Last sample, is the last row of the generic orbit

ORBITAL DATA INPUTs (From the Database)

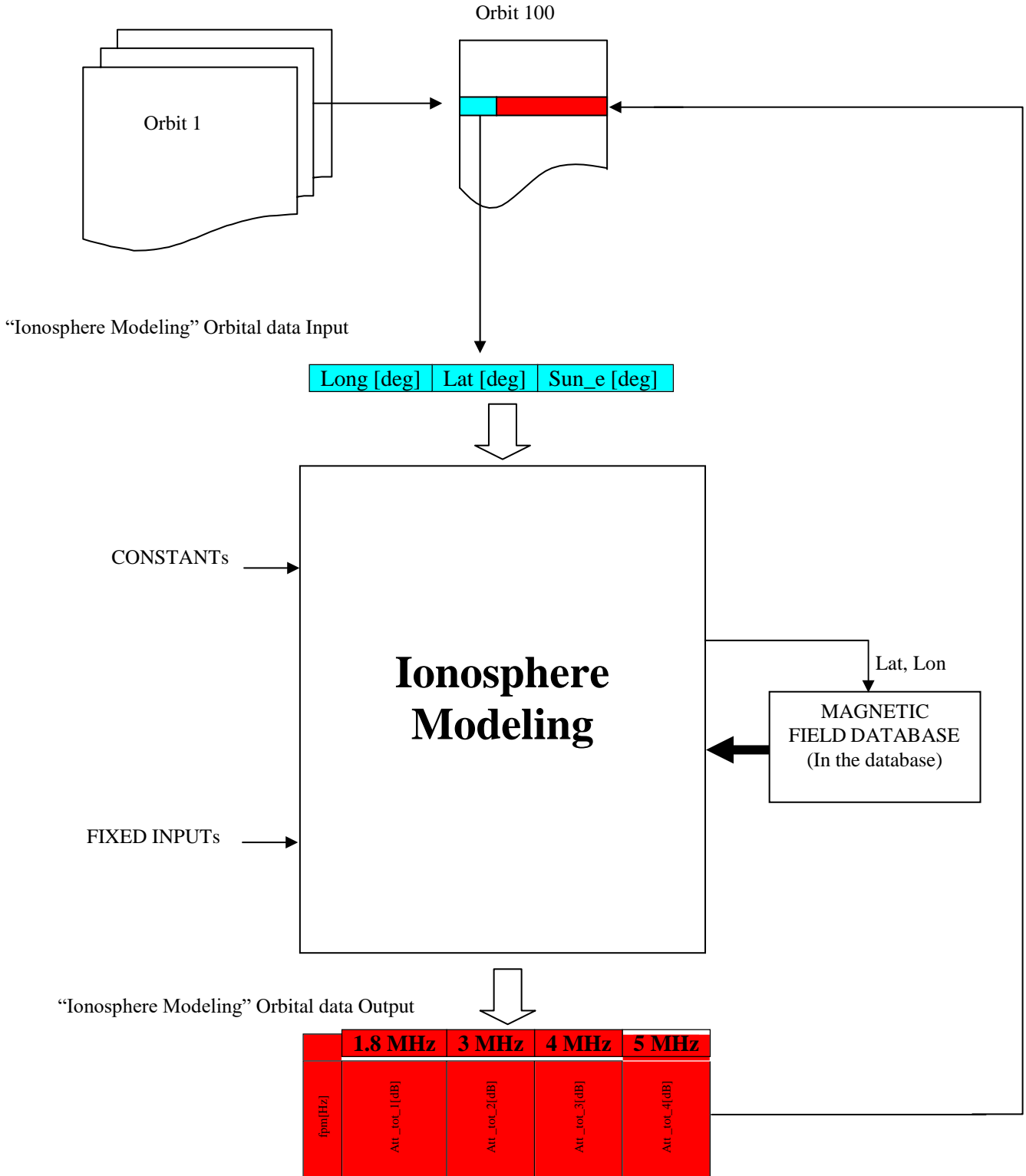
Symbol	External Units	Internal Units	Notes
Time	[sec]	No action	Time off Pericenter (Pericenter is Time=0)
Longitude	[deg]	→ [rad]	Longitude of the selected sample
Latitude	[deg]	→ [rad]	Latitude of the selected sample
SE	[deg]	→ [rad]	Sun elevation of the sample
Altitude	[Km]	→ [m]	Altitude of the sampe

ORBITAL DATA OUTPUTs (From the Database)

Symbol	Units	Notes
Science_t	[Index]	Science_t=0 → Sample doesn't pass over a science target Science_t=1 → Sample passes over a science target

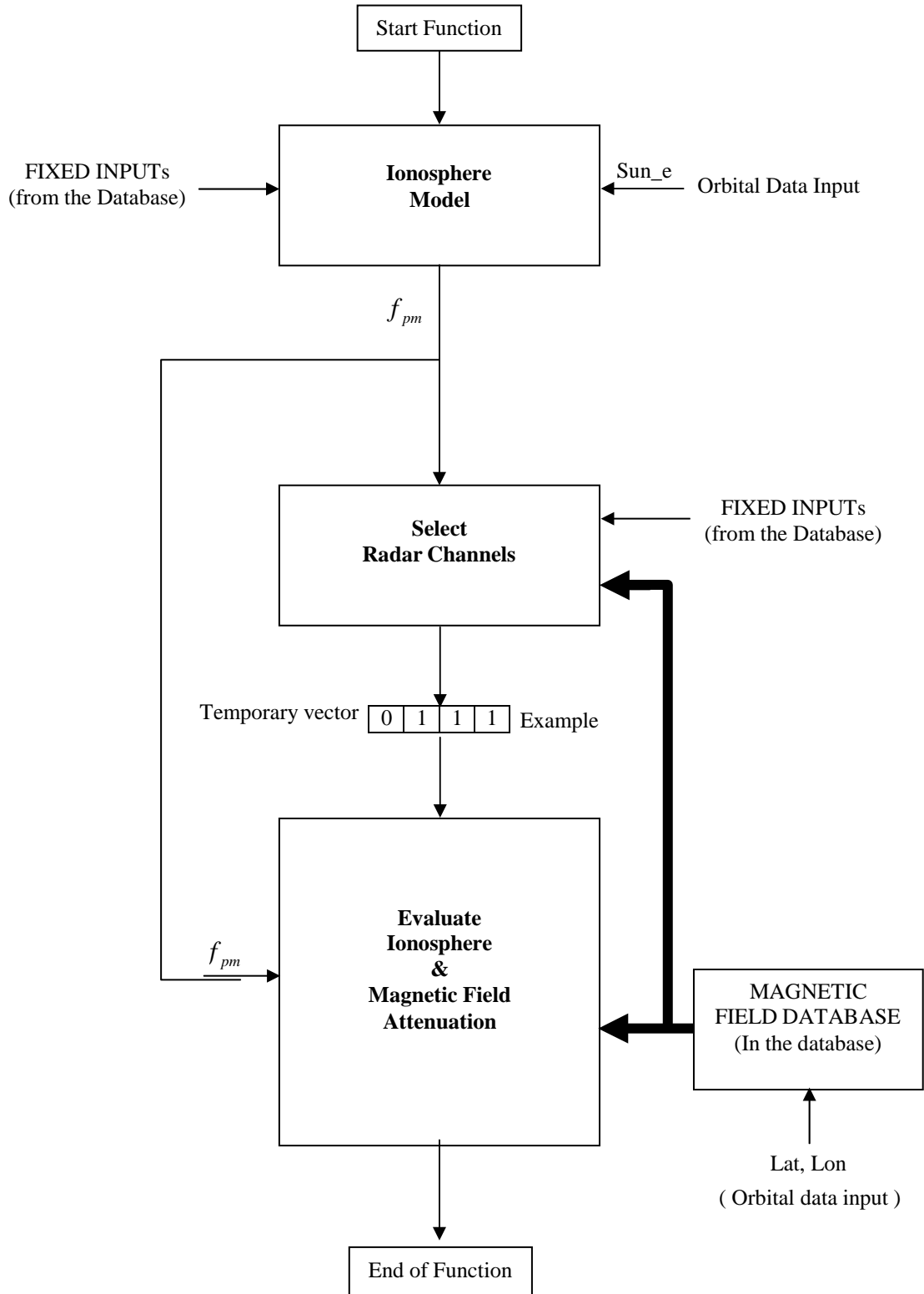


3.1 CONTEST



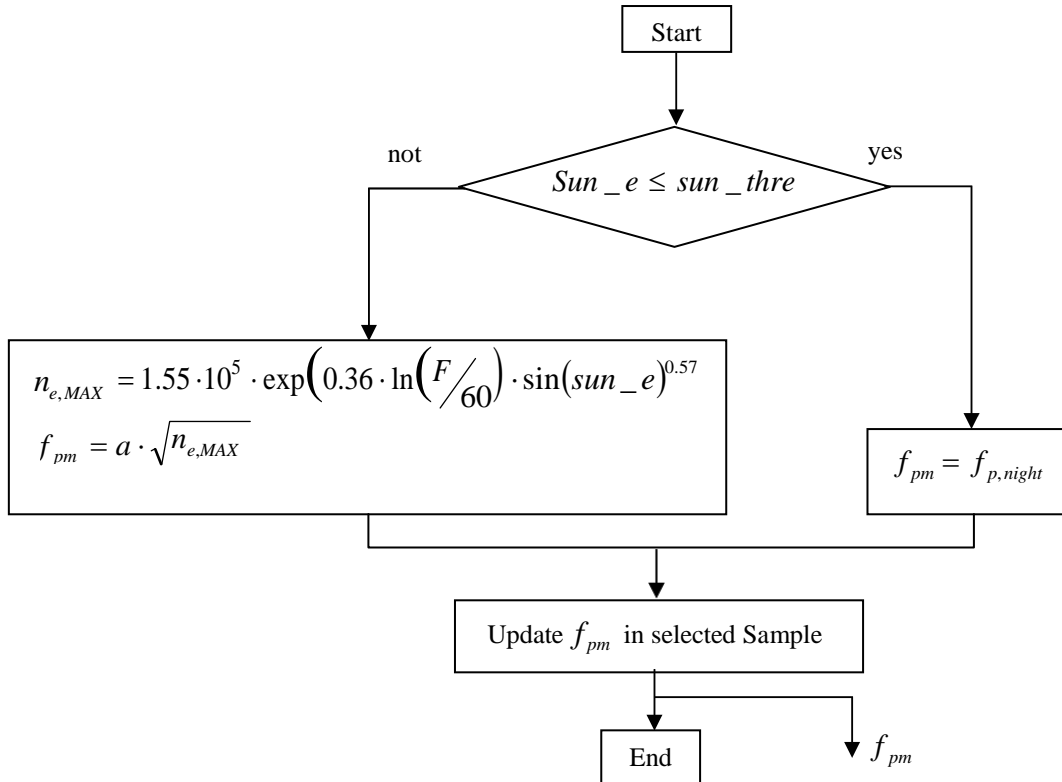


3.2 TOP LEVEL DATA FLOW





3.2.1 Ionosphere Model



“ IONOSPHERE MODEL”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units Transformation	Notes
Sun_e	[deg]	→[rad]	Sun Elevation value of the selected sample

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	External Units	Internal Units Transformation	CORISTA Nomenclature
200	a	8980	[]	No action	a
201	F	100	[]	No action	SolarFlux
202	Sun_thre	0	[deg]	→[rad]	SunThreschold
203	f _{p,night}	0.8	[MHz]	→[Hz]	PlasmaFrequencyAtNightSide

INTERNAL INPUTs

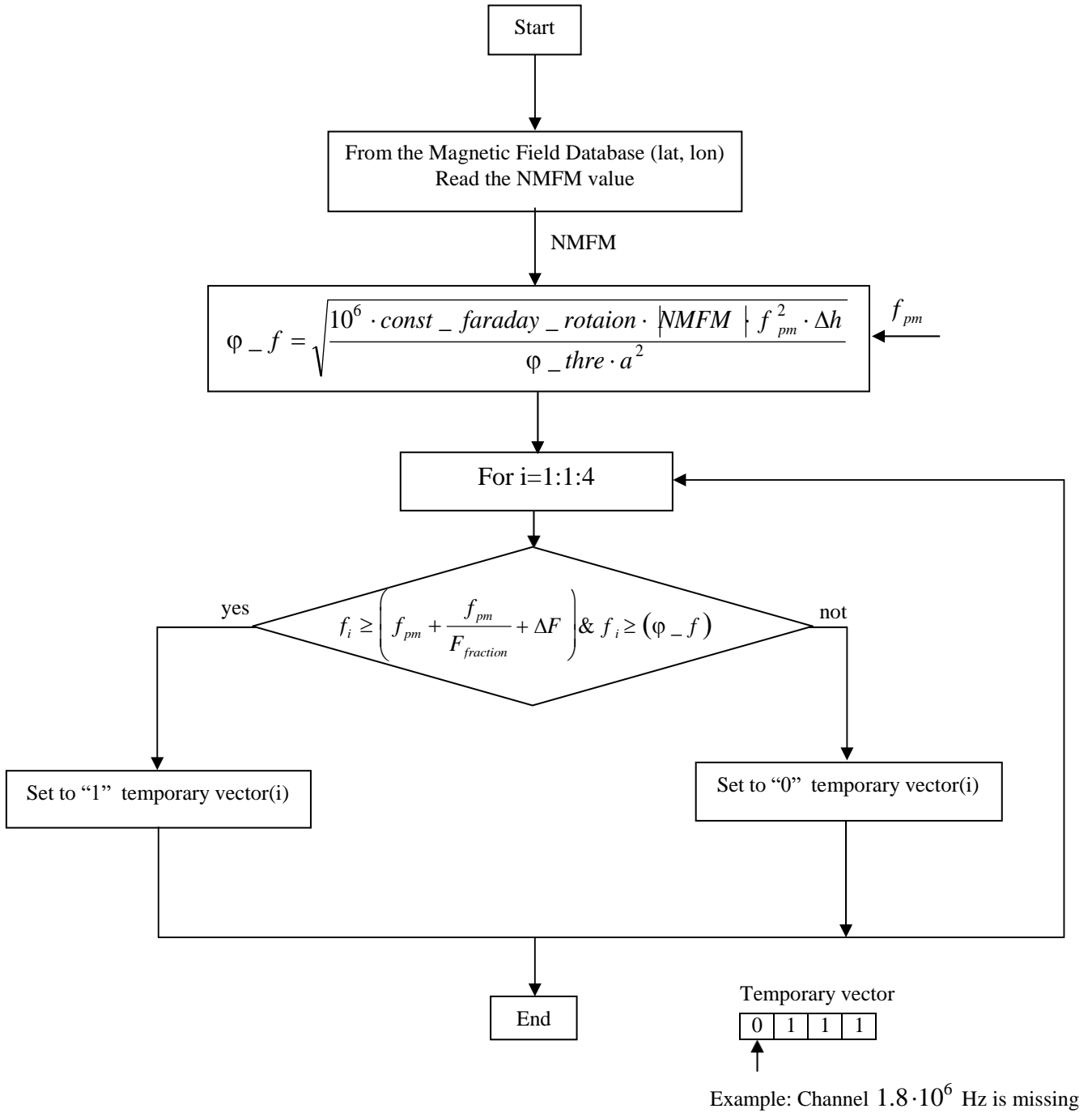
Symbol	Units	Notes
n _{e,MAX}	[el/cm ³]	Electron density model one

ORBITAL DATA OUTPUTs

Symbol	Internal Units	Notes
f _{pm}	[Hz]	Maximum plasma frequency



3.2.2 Select Radar Channels



Where: $f_1 = 1.8 \cdot 10^6$ Hz $f_2 = 3 \cdot 10^6$ Hz $f_3 = 4 \cdot 10^6$ Hz $f_4 = 5 \cdot 10^6$ Hz



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“SELECT RADAR CHANNEL”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	External Units	Internal Units Transformation	CORISTA Nomenclature
204	$F_{fraction}$	5	[]	No action	Ffraction
205	ΔF	0	[MHz]	→ [Hz]	ChannelMargin
206	const_faraday_rotation	$4.72 \cdot 10^4$	[]	No action	FaradayRotationConstant
207	Δh	20000	[m]	No action	IonosphereThickness
208	φ_{thre}	43	[deg]	→ [rad]	FaradayAngleApproximation
200	a	8980	[]	No action	a

Normal Magnetic Field (From the Database)

Symbol	External Units	Internal Units transformation	Notes
NMFM	[nT]	→ [T]	Normal Magnetic Field Magnitude

INTERNAL INPUTs

Symbol	Units	Notes
f_i	[Hz]	Radar frequency
Fpm	[Hz]	Maximum plasma frequency
$\varphi - f$	[Hz]	Frequency threshold for the selection of the operative frequencies

INTERNAL OUTPUTs

Symbol	Notes
Temp_vect	Temporary vector

POSSIBLE SCENARIOS FOR “Temp_vect”

- a)

1	1	1	1
---	---	---	---

 All available channels
- b)

0	1	1	1
---	---	---	---

 The channel 1.8 MHz is missing
- c)

0	0	1	1
---	---	---	---

 The channels (1.8 & 3) MHz are missing
- d)

0	0	0	1
---	---	---	---

 The channels (1.8 & 3 & 4) MHz are missing
- e)

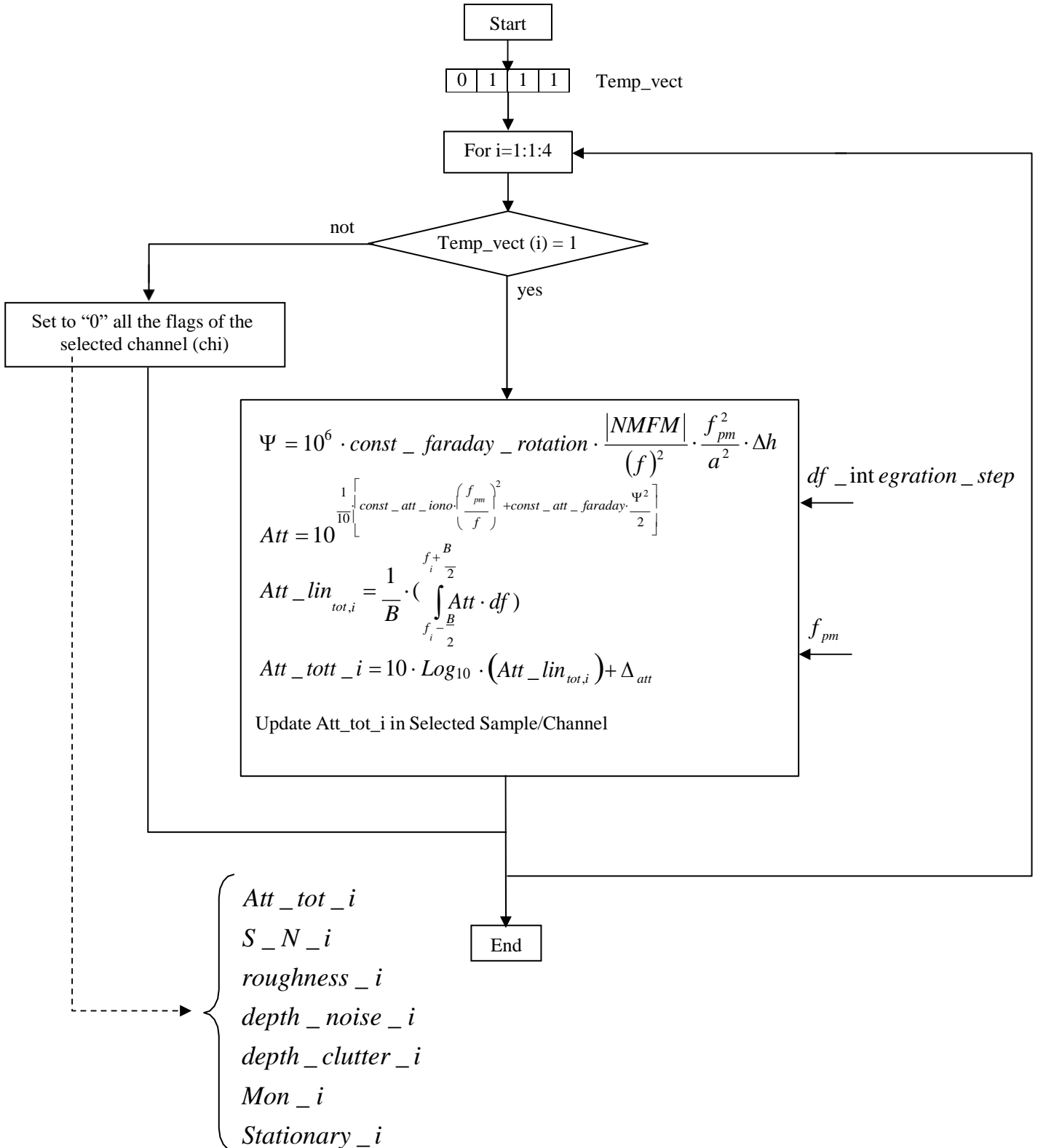
0	0	0	0
---	---	---	---

 All the Channels are not available



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3.2.3 Evaluate Ionosphere & Magnetic Attenuation





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“EVALUATE IONOSPHERE ATTENUATION”: INPUTS, OUTPUTS, CONSTANTS, VAR

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	External Units	Internal Units transformation	Notes
206	const_faraday_rotation	$4.72 \cdot 10^4$	[]	No action	FaradayRotationConstant
207	Δh	20000	[m]	No action	IonosphereThickness
209	const_att_iono	24	[]	No action	IonosphereAttenuationConstant
210	const_att_faraday	20	[]	No action	FaradayAttenuationConstant
211	B	1	[MHz]	→ [Hz]	ChirpBandwidth
212	Δ_{att}	0	[dB]	No action	MarginOfAttenuation
213	$df_integration_step$	2000	[Hz]	No action	IntegrationStep
200	a	8980	[]	No action	a

Normal Magnetic Field (From the Database)

Symbol	External Units	Internal Units transformation	Notes
NMFM	[nT]	→ [T]	Normal Magnetic Field Magnitude

INTERNAL INPUTs

Symbol	Units	Notes
f_{pm}	[Hz]	Maximum Plasma Frequency
Ψ	[rad]	Faraday Rotation angle
Att	[]	Linear attenuation
Att_lin _{tot,i}	[]	Linear attenuation in the Band
f_i	[Hz]	Frequency channel

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units Transformation	Notes
Lat	[deg]	→ [rad]	Latitude of the selected sample
Lon	[deg]	→ [rad]	Longitude of the selected sample

ORBITAL DATA OUTPUTs

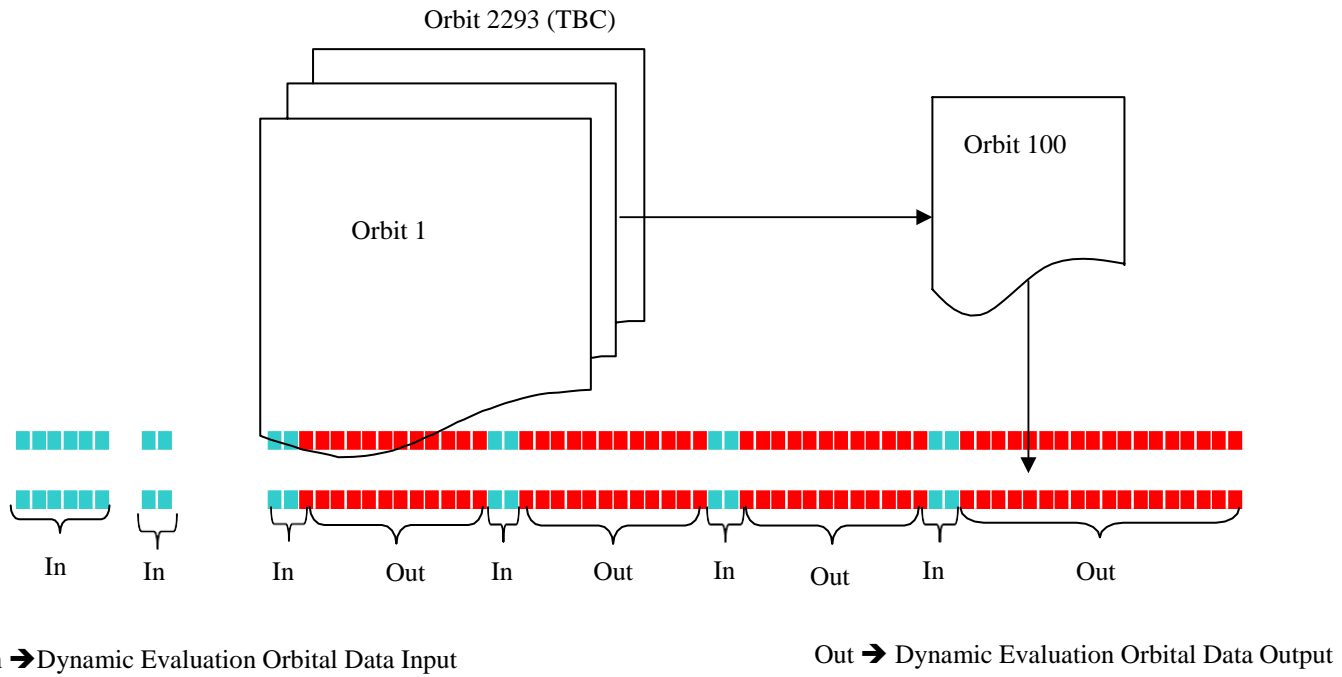
Symbol	Units	Notes
Att_tot_i	[dB]	Total attenuation in dB



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4 DYNAMIC EVALUATION





4.1 GEOMETRY

NADIR GEOMETRY (Surface power contribution)

Sub Surface Representation

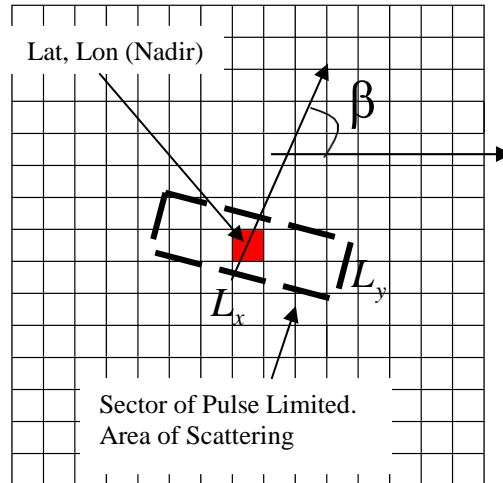


Fig. 1

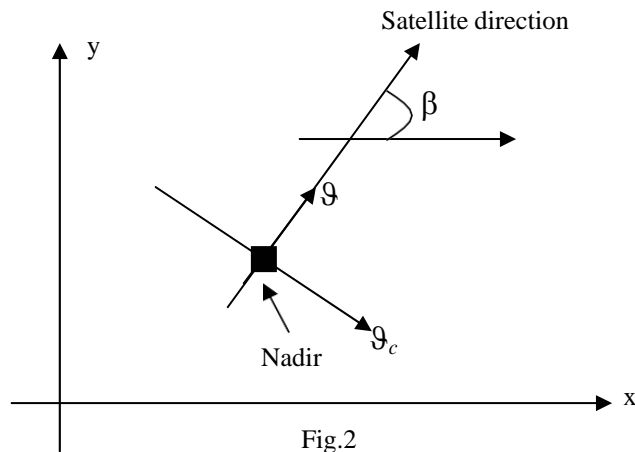


Fig.2



MEX/MARSIS

OFF NADIR GEOMETRY (Surface clutter contribution)

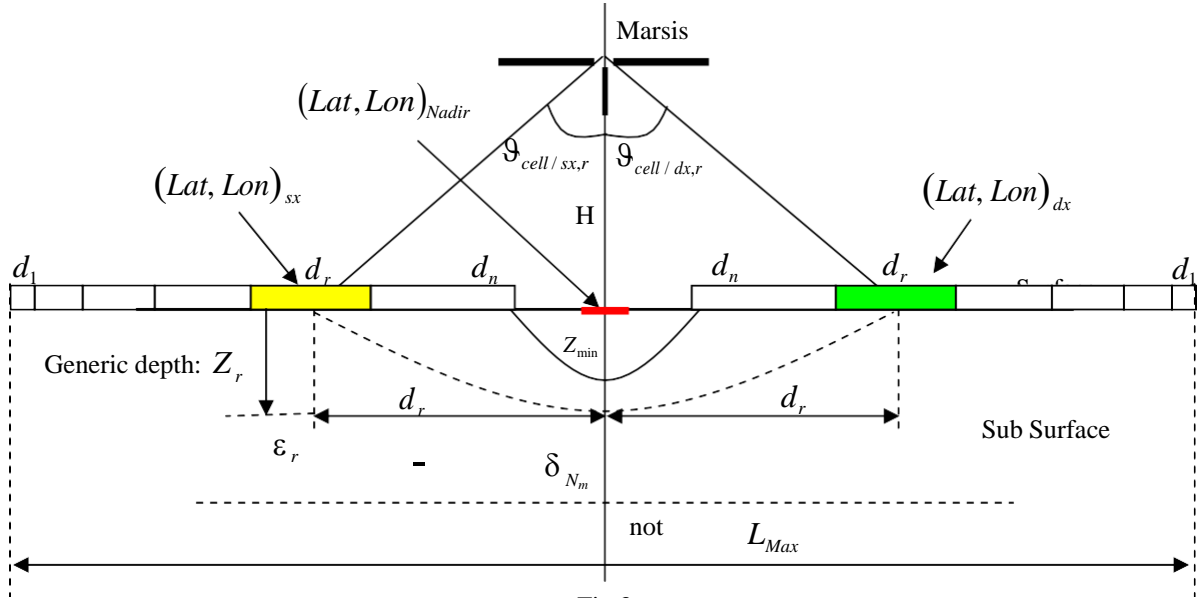


Fig.3

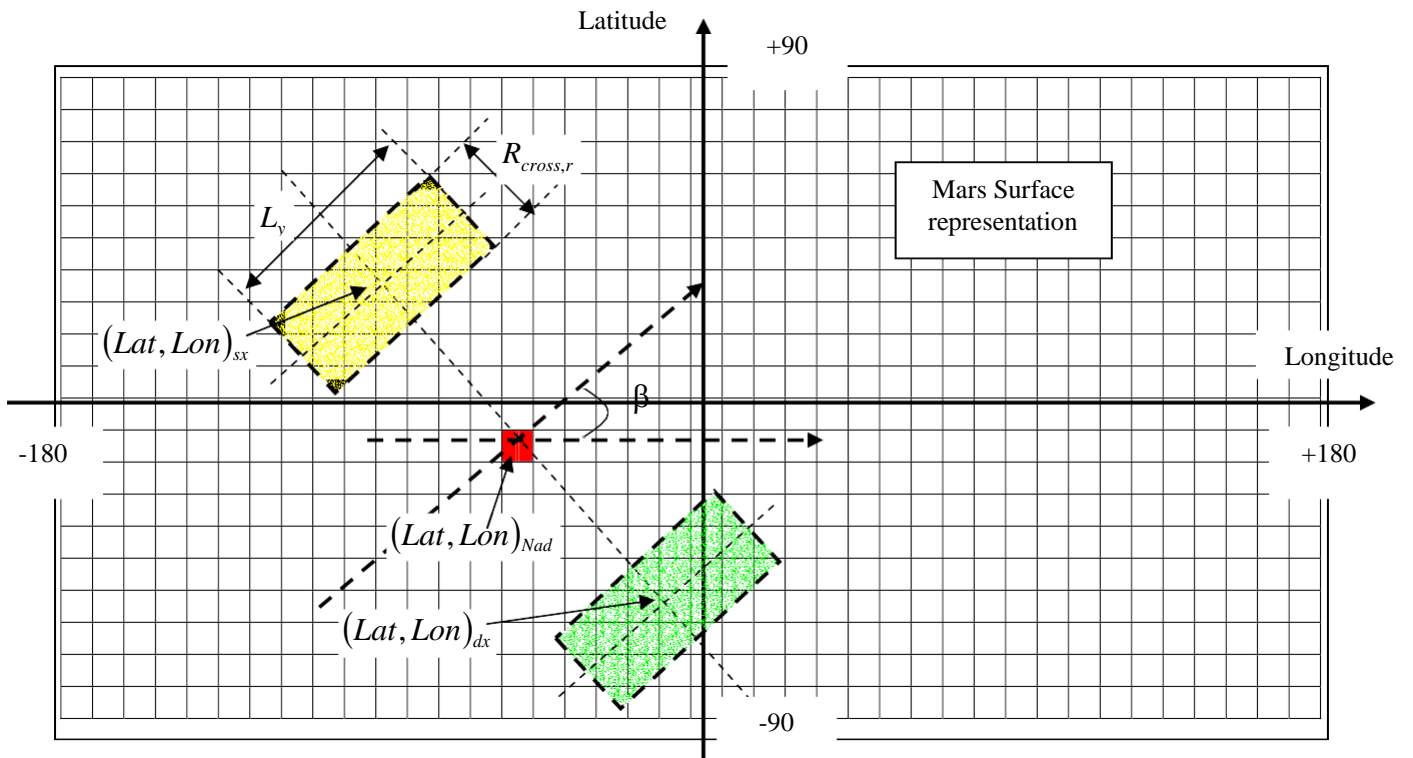
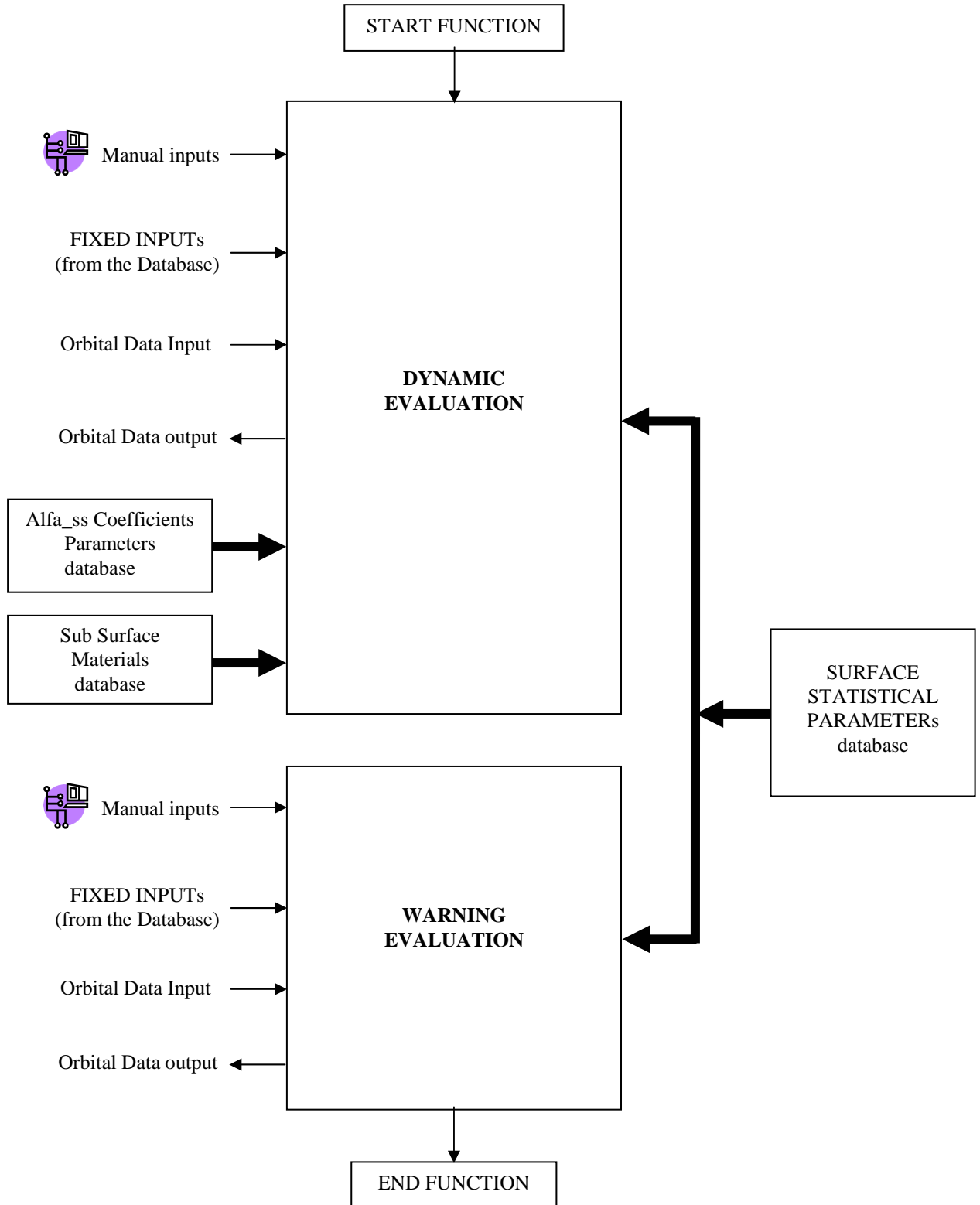


Fig. 4

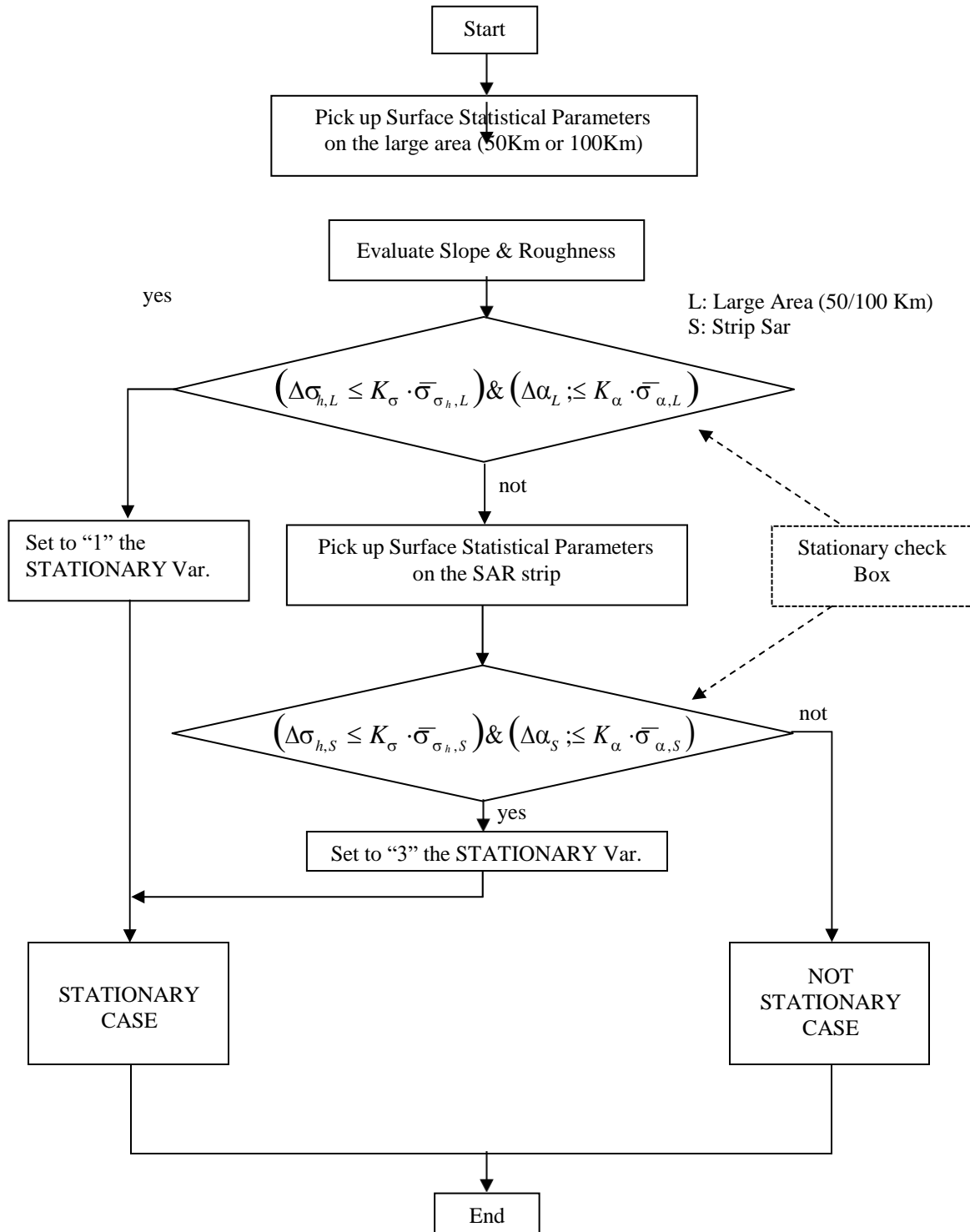


4.2 TOP LEVEL DATA FLOW





4.3 DYNAMIC EVALUATION





4.3.1 Evaluate Beta angle

$$5.: \beta = \arcsen \left(\frac{Lat_{next} - Lat}{\sqrt{(Lon_{next} - Lon)^2 + (Lat_{next} - Lat)^2}} \right)$$

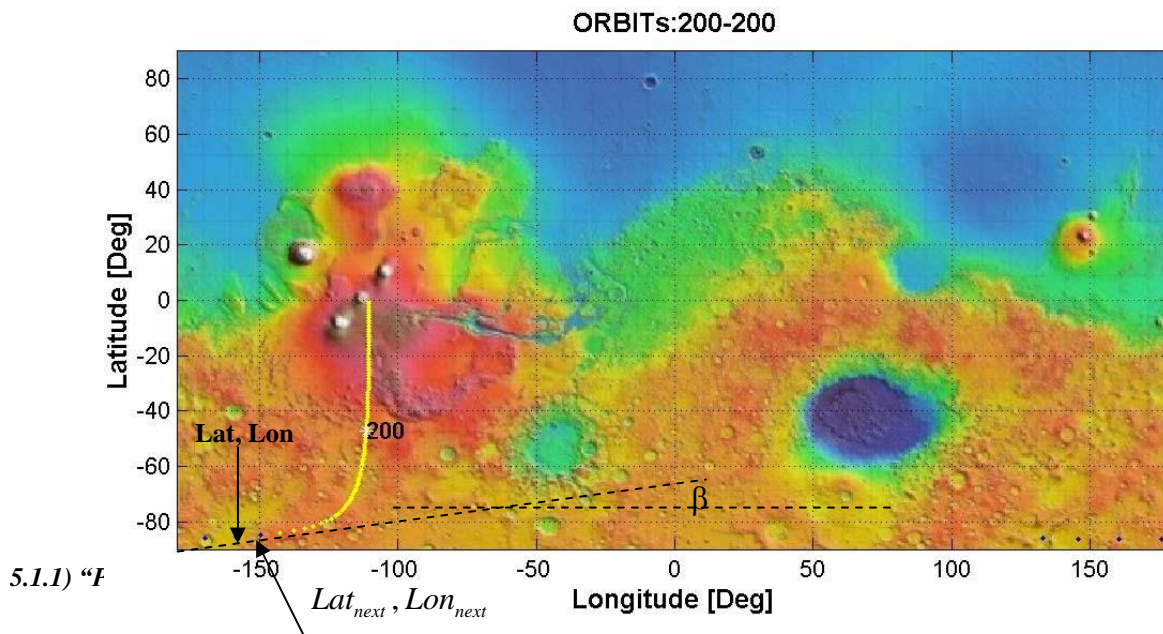


Fig. 5

"EVALUATE BETA ANGLE": INPUTS, OUTPUTS, CONSTANTS, VARIABLES

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units transformation	Notes
Lat	[deg]	→ [rad]	Latitude of the selected sample
Lon	[deg]	→ [rad]	Longitude of the selected sample
Lat_next	[deg]	→ [rad]	Latitude of the next sample
Lon_next	[deg]	→ [rad]	Longitude of the next sample

If the selected sample is the last one, then for the beta angle consider the previous value

INTERNAL OUTPUTs

Symbol	Units	Notes
β	[rad]	Satellite direction on the surface of Mars



4.3.2 Evaluate Geometric Areas dimensions

EVALUATE ALONG TRACK and CROSS TRACK RELOSLUTION

$$L_y = \sqrt{\frac{C \cdot H}{2 \cdot f_j}} + No \cdot \frac{V_{\tan}}{PRF} \text{ [m] (Cross track resolution)}$$

if $L_y < L_{s_min} \rightarrow L_y = L_{s_min}$

$$L_x = DPL = 2 \cdot \sqrt{2 \cdot H \cdot R_d} \text{ [m] (Along track resolution)}$$

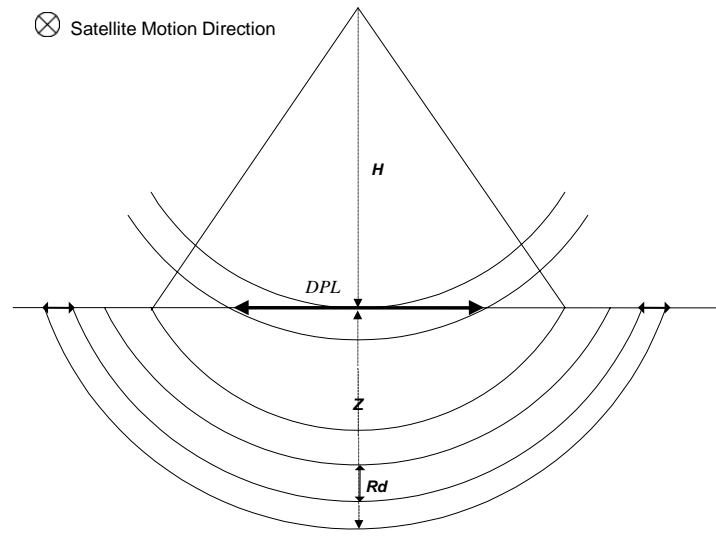
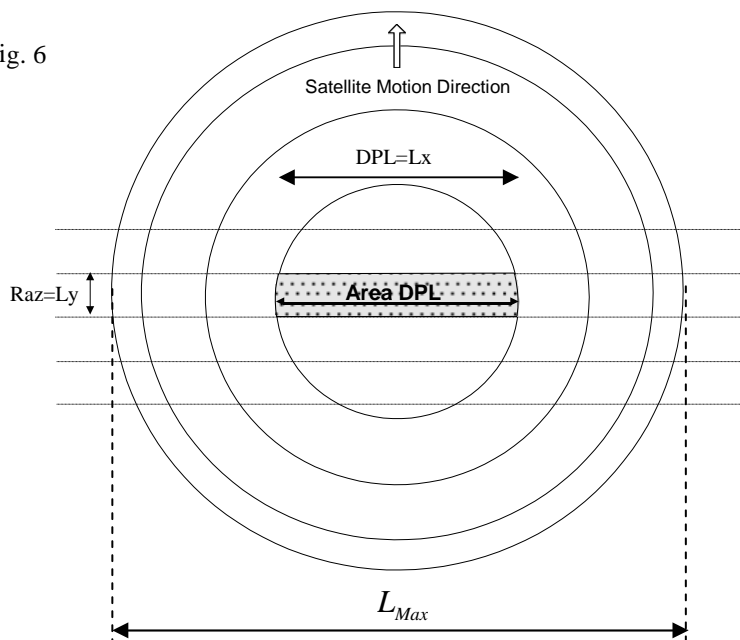


Fig. 6





MEX/MARSIS

"EVALUATE GEOMETRIC AREAS DIMENSIONS": INPUTS, OUTPUTS, CONSTANTS, VARIABLES

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units transformation	Notes
H	[Km]	→ [m]	Space Craft altitude
V_{tan}	[m/s]	No action	SC tangential velocity

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	External Units	Internal Units transformation	CORISTA Nomenclature
300	No	36	[]	No action	PRIOffset
301	PRF	127,267	[Hz]	No action	PRF
302	Ls_min	5.5	[Km]	→ [m]	MinSyntheticAperture
303	Rd	150	[m]	No action	RangeResolution
304	L_{Max}	150	[Km]	No action	SARStripDimension

INTERNAL INPUTs

Symbol	Units	Notes
f_j	[Hz]	Radar channel (frequency)

INTERNAL CONSTANTs (In the program)

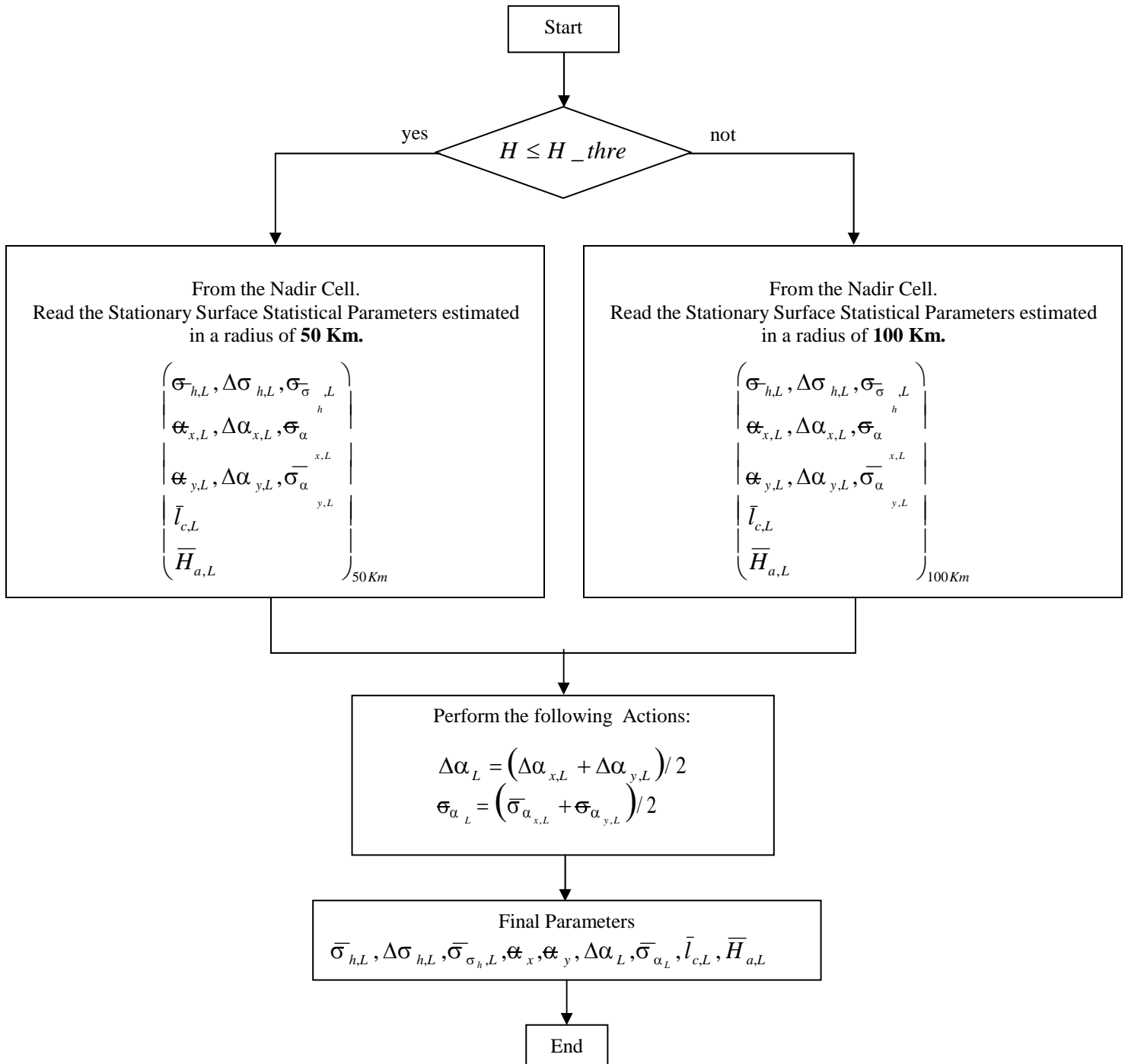
Symbol	Value	Units	Notes
C	$3 \cdot 10^8$	[m/s]	Speed of the light

INTERNAL OUTPUTs

Symbol	Units	Notes
L_x	[m]	Swath dimension along X coordinate
L_y	[m]	Swath dimension along Y coordinate



4.3.3 Pick Up Surface Statistical Parameters on the Large Area





MEX/MARSIS

"PICK UP SURFACE STATISTICAL PARAMETERS ON THE LARGE AREA": INPUTS, OUTPUTS, CONSTANTS, VAR.

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units Transformation	Notes
H	[Km]	→ [m]	Space Craft altitude

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	Units	Internal Units Transformation	CORISTA Nomenclature
305	<i>H_thre</i>	500	[Km]	→ [m]	HeighTreshold

INTERNAL OUTPUTs

Symbol	Units	Notes
$\bar{\sigma}_{h,L}$	[m]	Mean value of the roughness
$\Delta\sigma_{h,L}$	[m]	Maximum displacement of the roughness
$\sigma_{\sigma_h,L}$	[m]	Standard deviation of the Roughness
$\bar{\alpha}_{x,y,L}$	[deg]	Mean value of the surface inclination angle evaluated at 50/100 Km
$\Delta\alpha_L$	[deg]	Maximum displacement of the surface inclination angle
$\sigma_{\alpha,L}$	[deg]	Standard deviation of the surface inclination angle
$l_{c,L}$	[m]	Mean value of the correlation length
$\bar{H}_{a,L}$	[]	Mean value of the Hurst coefficient



4.3.4 Evaluate Slope and roughness

- a) $Slope_S = \alpha_{x,50/100} \cdot \cos(\beta) + \alpha_{y,50/100} \cdot \sin(\beta)$ [rad] Update in selected Orbit/Sample
- b) roughness_1 = $\overline{\sigma}_{h,50/100Km}$ Update in selected Orbit/Sample/Ch_1 (1.8MHz)
 roughness_2 = $\overline{\sigma}_{h,50/100Km}$ Update in selected Orbit/Sample Ch_2 (3MHz)
 roughness_3 = $\overline{\sigma}_{h,50/100Km}$ Update in selected Orbit/Sample Ch_4 (4MHz)
 roughness_4 = $\overline{\sigma}_{h,50/100Km}$ Update in selected Orbit/Sample Ch_4 (5MHz)
 roughness_const = $\overline{\sigma}_{h,50/100Km}$ Update in selected Orbit/Sample

”EVALUATE THE SLOPE & ROUGHNESS”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

INTERNAL INPUTs

Symbol	Units	Notes
β	[rad]	Satellite direction on the surface of Mars
$\overline{\alpha}_{x,y}$	[rad]	Mean value of the surface inclination angle evaluated at 50 Km

INTERNAL OUTPUTs

Symbol	Units	Notes
Slope	[rad]	Surface inclination angle
Roughness_1/2/3/4/const	[m]	Surface roughness

FIXED INPUTs

Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
306	Roughness_50	1	[Boolean]	Roughness50 = 1 → Roughness estimated at 50 Km Roughness50 = 0 → Roughness estimated at 100 Km
307	slope_50	1	[Boolean]	Slope_0 = 1 → Slope estimated at 50 Km Slope50 = 0 → Slope estimated at 100 Km

4.3.5 Stationary Check Box

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
308	$K\sigma$	4.5	[]	Kr
309	$K\alpha$	4.5	[]	Ki

INTERNAL INPUTs

Symbol	Units	Notes
$\Delta\sigma_{h,L/S}$	[m]	Maximum displacement for the roughness
$\Delta\alpha_{L/S}$	[rad]	Maximum displacement of the surface inclination angle
$\overline{\sigma}_{\sigma_{h,L/S}}$	[m]	Standard deviation of the roughness
$\overline{\sigma}_{\alpha_{L/S}}$	[rad]	Surface angle variance



4.3.6 Pick Up Surface Statistical Parameters on the Sar Strip

GEOMETRY

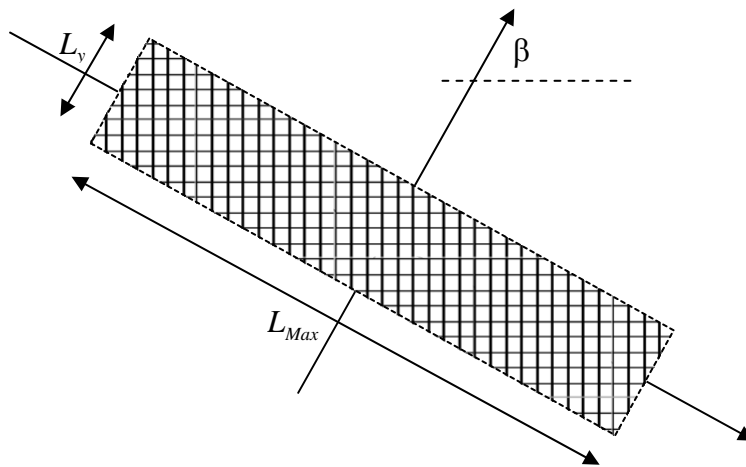
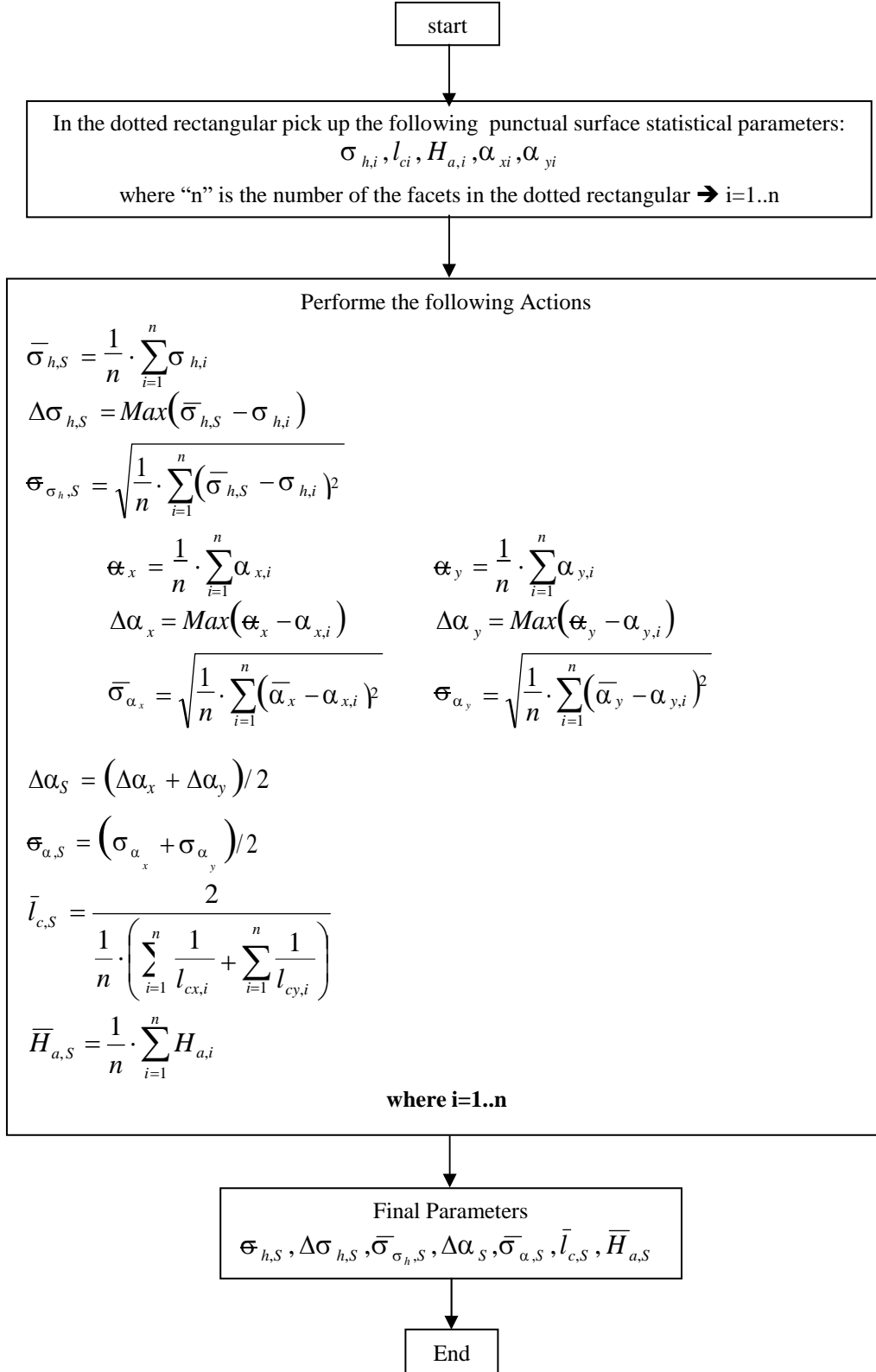


Fig. 7



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ALGORITHM





MEX/MARSIS

**”PICK UP SURFACE STATISTICAL PARAMETERS ON THE SAR STRIP”:
 INPUTS, OUTPUTS, CONSTANTS, VAR.**

INTERNAL INPUTS

Symbol	Units	Notes
$l_{c,i}$	[m]	Mean value of the Correlation length
$\alpha_{x,y,i}$	[rad]	Cell's inclination along X and Y direction
$\sigma_{h,i}$	[m]	Surface Roughness
$H_{a,i}$	[]	Hurst coefficients
β	[rad]	Satellite direction on the surface of Mars
L_y	[m]	Swath dimension along Y coordinate

FIXED INPUTS (From the Database)

Database Identifier	Symbol	Value	Units	Notes
304	L_{Max}	150	[Km]	SARStripDimension

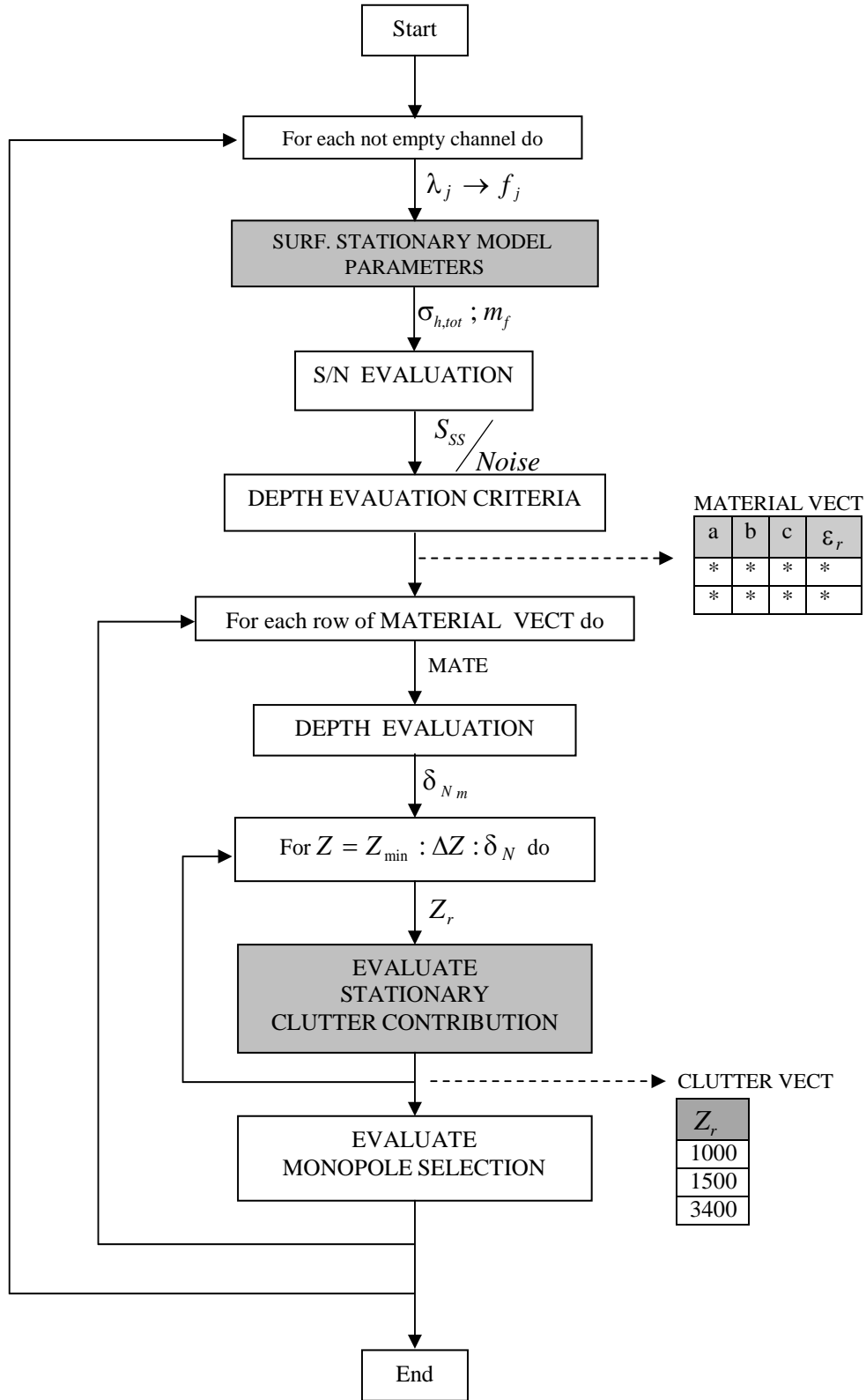
INTERNAL OUTPUTS

Symbol	Units	Notes
$\bar{\sigma}_{h,S}$	[m]	Mean value of the roughness
$\Delta\sigma_{h,S}$	[m]	Maximum displacement of the roughness
$\sigma_{\sigma_h,S}$	[m]	Standard deviation of the Roughness
$\Delta\alpha_S$	[rad]	Maximum displacement of the surface inclination angle
$\sigma_{\alpha,S}$	[rad]	Standard deviation of the surface inclination angle
$l_{c,S}$	[m]	Mean value of the correlation length
$\bar{H}_{a,S}$	[]	Mean value of the Hurst coefficient



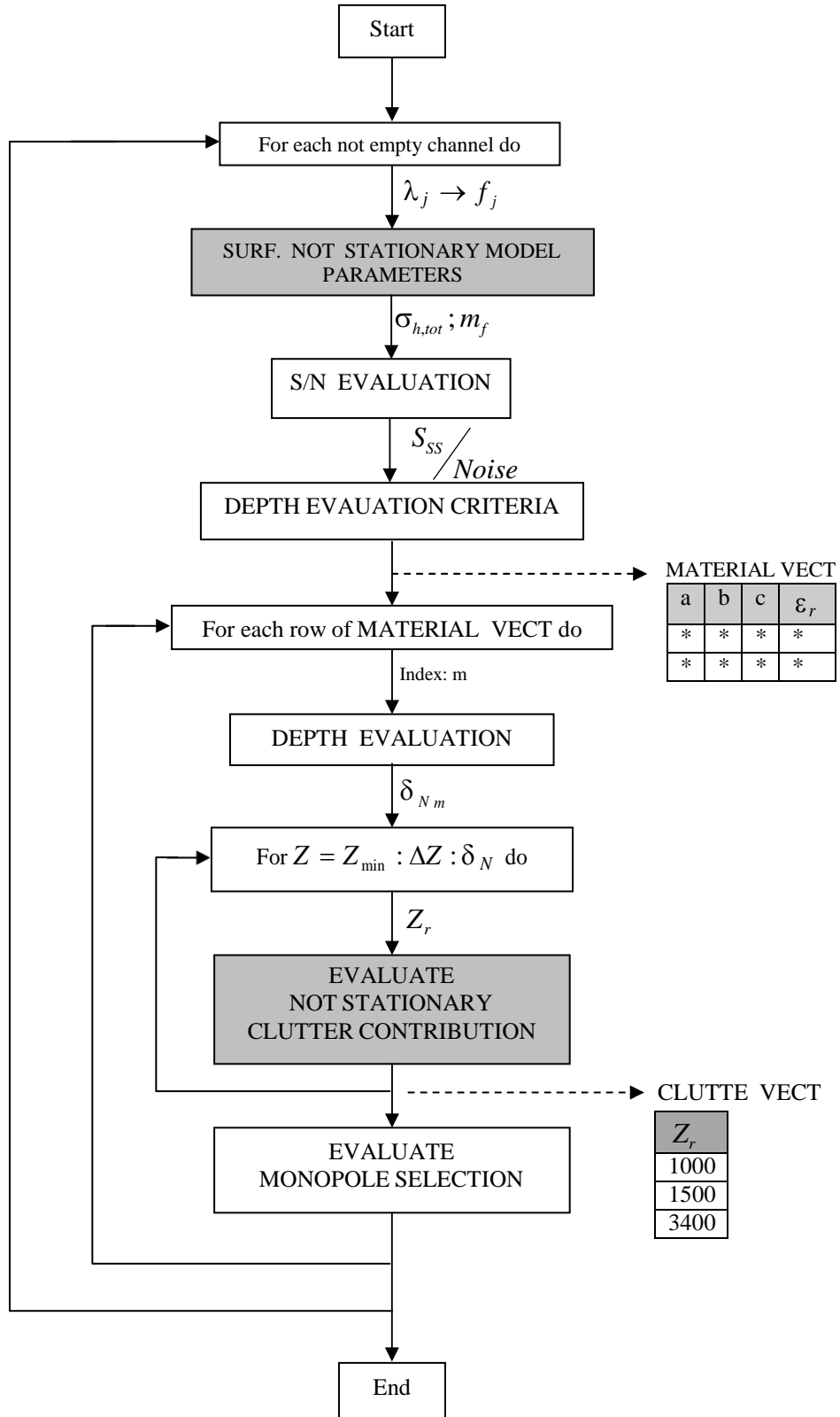
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4.3.7 Stationary Case





4.3.8 Not Stationary Case





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4.3.9 For each not empty channel do

If Channel is Empty → All the flags of the Channel are “0”

POSSIBLE SITUATIONS

- a) All the Channels are available. Useful frequencies: 1.8 MHz, 3 MHz, 4 MHz, 5MHz

1.8 MHz (ch1)	3 MHz (ch2)	4 MHz (ch3)	5 MHz (ch4)
* * * * *	* * * * *	* * * * *	* * * * *

* → Number

- b) Channel = 1.8 MHz is missing. Useful frequencies: 3 MHz, 4 MHz, 5MHz

1.8 MHz (ch1)	3 MHz (ch2)	4 MHz (ch3)	5 MHz (ch4)
0 0 0 0 0 0	* * * * *	* * * * *	* * * * *

- c) Channels = 1.8 MHz, 3 MHz are missing. Useful frequencies: 4MHz, 5MHz

1.8 MHz (ch1)	3 MHz (ch2)	4 MHz (ch3)	5 MHz (ch4)
0 0 0 0 0 0	0 0 0 0 0 0	* * * * *	* * * * *

- d) Channels = 1.8 MHz, 3 MHz, 4 MHz are missing. Useful frequency: 5MHz

1.8 MHz (ch1)	3 MHz (ch2)	4 MHz (ch3)	5 MHz (ch4)
0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	* * * * *

- e) Channels = 1.8 MHz, 3 MHz, 4 MHz, 5MHz are missing. Useful frequency: 5MHz

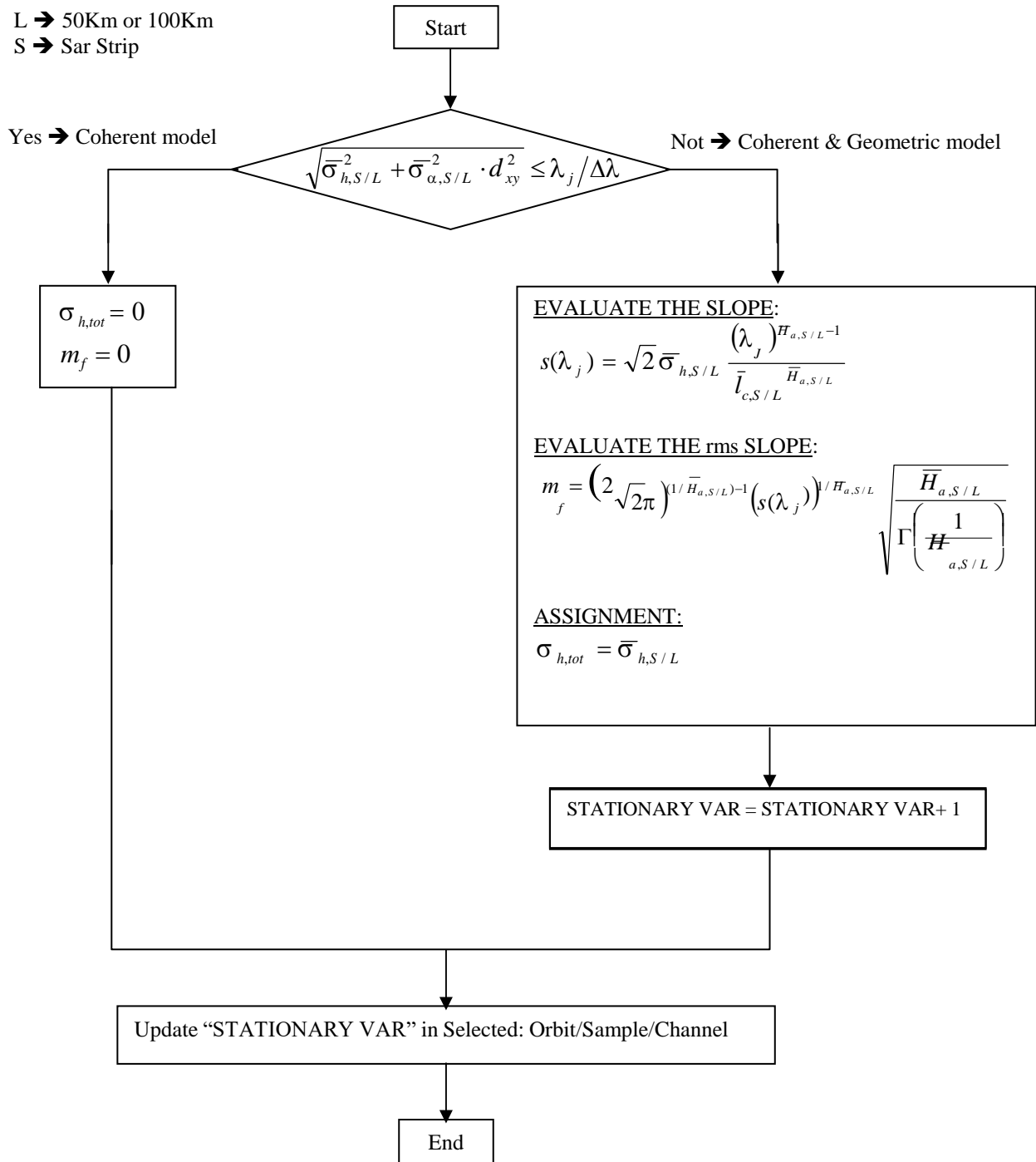
1.8 MHz (ch1)	3 MHz (ch2)	4 MHz (ch3)	5 MHz (ch4)
0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0	0 0 0 0 0 0

For this sample is not possible to apply the “Dynamic Evaluation function”, Select the next one.



4.3.10 Surface Stationary Model Parameters

L → 50Km or 100Km
 S → Sar Strip





“SURFACE STATIONARY MODEL PARAMETERS”: INPUTS, OUTPUTS, CONSTANTS, VAR.

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
310	d_{xy}	5000	[m]	CellDimension
311	Δy	8	[]	dLambda

INTERNAL INPUTs

Symbol	Units	Notes
$\lambda(j)$	[m]	Wave length
$s \lambda_j$	[rad]	Rms slope

SURFACE STATISTICA PARAMETERS DATABASE (from the database)

Symbol	Units	Notes
$l_{c,L/S}$	[m]	Correlation length along X and Y direction
$\sigma_{h,L/S}$	[m]	Roughness
$\overline{H}_{a,L/S}$	[]	Hurst coefficient
$\sigma_{\alpha,L/S}$	[rad]	Standard deviation of the Surface inclination angles

INTERNAL OUTPUTs

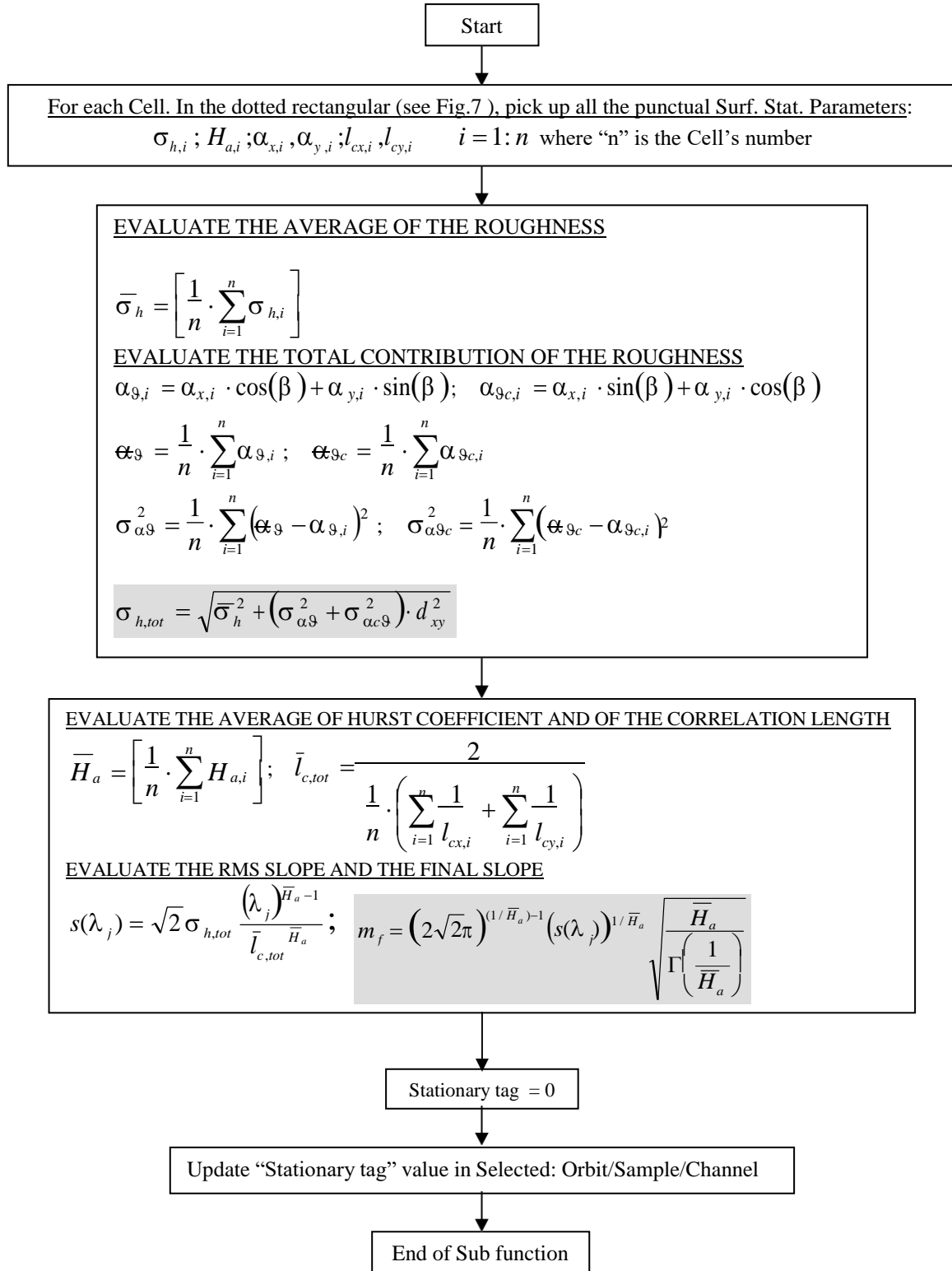
Symbol	Units	Notes
m_f	[rad]	Slope of the geom.. Opt.
$\sigma_{h,tot}$	[m]	Average of the roughness



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4.3.11 Surface Not Stationary Model Parameters

The dotted rectangular region dimensions, are function of the wave length





MEX/MARSIS

“SURFACE NOT STATIONARY MODEL PARAMETERS”: INPUTS, OUTPUTS, CONST. VAR

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
310	d_{xy}	5000	[m]	CellDimension

SURFACE STATISTICA PARAMETERS DATABASE (from the database)

Symbol	Units	Notes
$\sigma_{h,i}$	[m]	Roughness
$l_{cx/y,i}$	[m]	Correlation length
$H_{a,i}$	[]	Hurst coefficient
$\alpha_{x/y,i}$	[rad]	Cell inclination along X and Y direction

INTERNAL INPUTs and/or INPUTs FROM OTHERS SUB FUNCTIONS

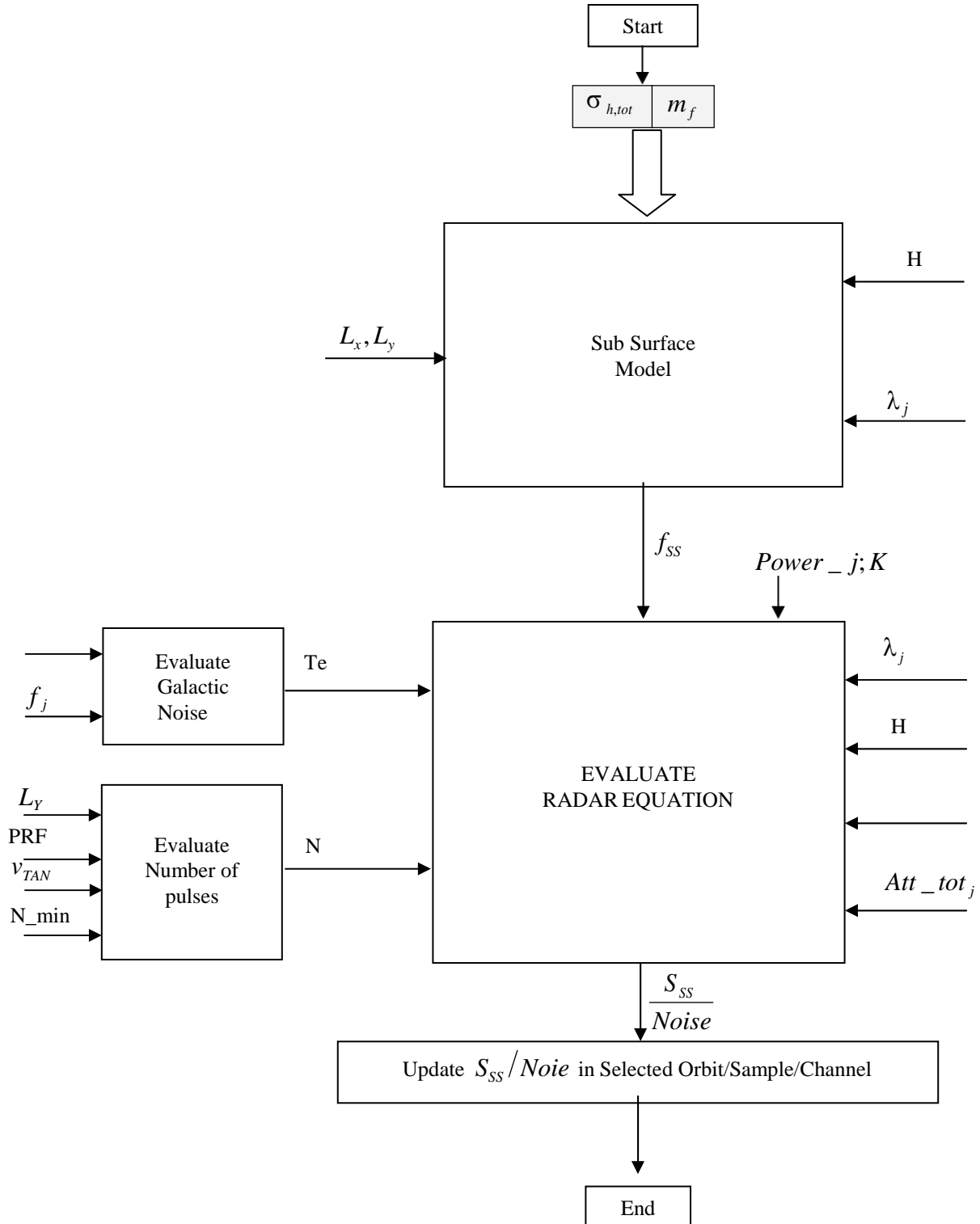
Symbol	Units	Notes
$s(\lambda_j)$	[rad]	Rms slope
λ_j	[m]	Wave length
β	[rad]	Satellite direction on the surface of Mars
$\overline{H_a}$	[]	Average of the Hurst coefficient
$l_{c,tot}$	[m]	Average of the Correlation length
$\overline{\sigma}_h$	[m]	Average of the roughness
$\alpha_{\theta_i}; \alpha_{\theta_{ci}}$	[rad]	Cell inclination angle along track and cross track
$\overline{\alpha}_{\theta}; \overline{\alpha}_{\theta_c}$	[rad]	Average of the Cells inclination angle, in the dotted square, along track and cross track
$\sigma_{\alpha_{\theta}}; \sigma_{\alpha_{\theta_c}}$	[rad]	Standard deviation of the Surface inclination angle, along track and cross track

INTERNAL OUTPUTs

Symbol	Units	Notes
m_f	[rad]	Slope of the geom.. Opt.
$\sigma_{h,tot}$	[rad]	Average of the roughness



4.3.12 Evaluate Signal to Noise





MEX/MARSIS

SUB SURFACE MODEL

$$f_{ss} = L_x \cdot L_y \cdot \left[\frac{e^{-4k_j^2 \sigma_{h,tot}^2}}{\sqrt{\frac{\lambda_j^2}{4\pi \cdot L_y^2} + \frac{L_y^2}{\pi \cdot H^2}} \sqrt{\frac{\lambda_j^2}{4\pi \cdot L_x^2} + \frac{L_x^2}{\pi \cdot H^2}}} + \frac{(1 - e^{-4k_j^2 \sigma_{h,tot}^2})}{\sqrt{\frac{\lambda_j^2}{4\pi \cdot L_y^2} + \frac{L_y^2}{\pi \cdot H^2} + 2m_f^2} \sqrt{\frac{\lambda_j^2}{4\pi \cdot L_x^2} + \frac{L_x^2}{\pi \cdot H^2} + 2m_f^2}} \right] [m^2]$$

where $k_j = \frac{2 \cdot \pi}{\lambda_j}$

$$f_{SS} (dB_{m^2}) = 10 \log_{10} f_{SS} (m^2)$$

EVALUATE GALACTIC NOISE

The equivalent noise temperature is:

$$T_e = T \cdot F = \alpha \cdot f_i^{-2.7}$$

EVALUATE NUMBER OF PULSES

The number of transmitted pulses in one frame is:

$$N = \left\lceil \frac{L_y}{V_{tan}} \cdot PRF \right\rceil$$

if $N < N_{min} \rightarrow N = N_{min}$

EVALUATE RADAR EQUATION

$$\frac{S_{SS}}{Noise} = \frac{1}{Att_{totj}} \cdot \frac{power_j \cdot \lambda_j^2 \cdot f_{SS}}{(4 \cdot \pi)^3 \cdot H^4 \cdot K \cdot T_e} \cdot \tau \cdot N \rightarrow [dB]$$

$$\frac{S_{SS}}{Noise} (dB) = 10 \log_{10} \frac{S_{SS}}{Noise} \text{ Update this value in Selected Sample Channel}$$



MEX/MARSIS

“EVALUATE SIGNAL TO NOISE”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	Units	Internal Units transformation	CORISTA Nomenclature
312		4,9	[]	→ multiplay per 10^{24}	KrouseNoiseModel
301	PRF	127,267	[Hz]	No action	PRF
313	N_min	160		No action	minPulses
314		250	[μ sec]	→ [sec]	TransmittedPulseDuration
315	Power_1	1.8	[dB_w]	No action	RadiatedPower1
316	Power_2	1.8	[dB_w]	No action	RadiatedPower2
317	Power_3	1.8	[dB_w]	No action	RadiatedPower3
318	Power_4	1.8	[dB_w]	No action	RadiatedPower4

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units transformation	Notes
H	[Km]	→ [m]	Space Craft altitude
Att_{tot_j}	[dB]	No action	Ionosphere and faraday attenuation
V_{tan}	[Km/s]	→ [m/Sec]	SC tangential velocity

CONSTANTs (In the program)

Symbol	Value	Units	Notes
K	1.38e-23	[joule/K]	Boltzmann constant

INTERNAL INPUTs

Symbol	Units	Notes
m_f	[rad]	Slope of the geom. Opt.
$\sigma_{h,tot}$	[m]	Average of roughness
L_x	[m]	Swath dimension along X coordinate
L_y	[m]	Swath dimension along Y coordinate
f_j	[Hz]	Radar channel (frequency)
λ_i	[m]	Wave length
Te	[K]	Equivalent Noise Temperature
f_{ss}	dB_m^{-2}	Sub Surface Power value
N	[]	Number of transmitted pulses
K_j	[]	Wave length number

INTERNAL OUTPUTs

Symbol	Units	Accuracy	Notes
$S_{ss}/Noise$	dB	Float	Signal to Noise



MEX/MARSIS

4.3.13 Depth Evaluation Criteria

INPUT MASK

<input type="checkbox"/>	Single Environmental
	50% Porosity (50%, 20 %)
	III Material (I, II, III)
	D/I Interface (D/I, I/W)
<input checked="" type="checkbox"/>	Complete Environmental

α_{SS} COEFFICIENTS PARAMETERS

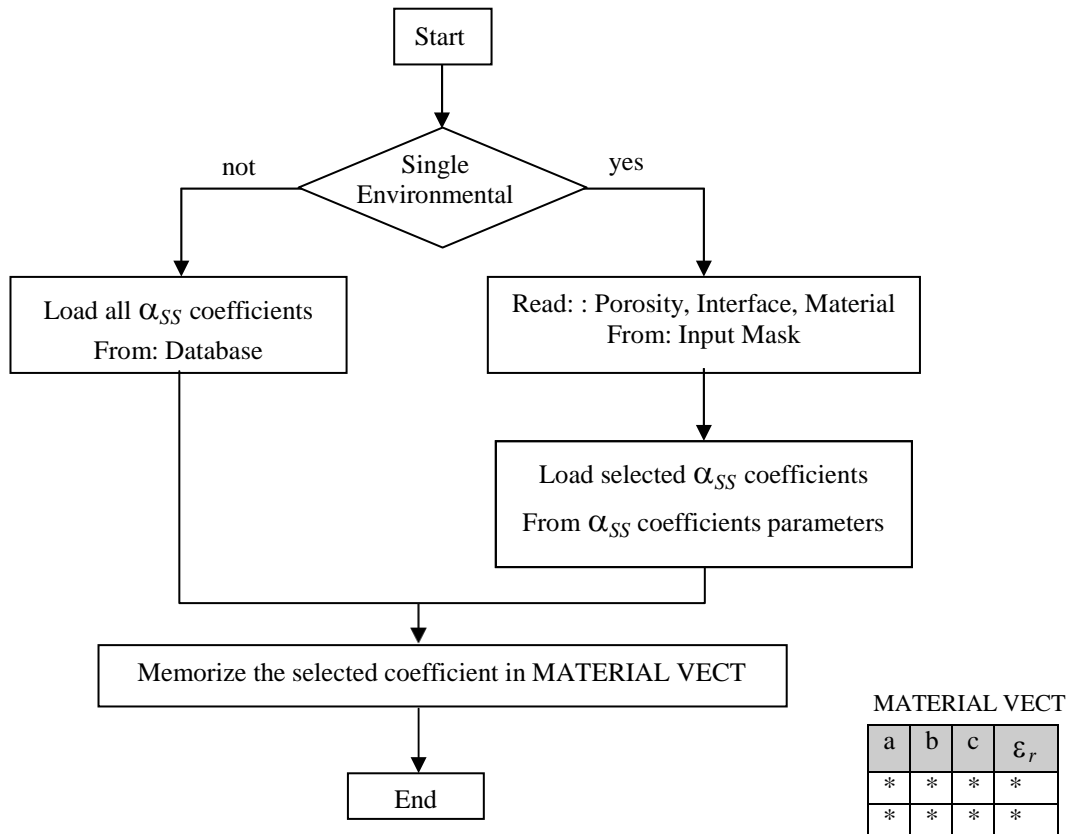
		Dense basalte I-1			Dense basalte II-2			Layered basalt III		
		a	b	c	a	b	c	a	b	c
	ϵ_r	5			9			7.1		
I/W	50 %	0.02	-2.97	-1.52	-1.23	-3	-14.53	-0.66	-2.99	-6.14
	20 %	-8.23	-3.03	-1.58	-9.98	-3.05	-15.53	-9.25	-3.04	-6.48
D/I	50 %	-8.09	-3.30	-1.39	-14.44	-3.41	-13.67	-11.91	-3.37	-5.71
	20 %	-19.54	-3.17	-1.52	-25.74	-3.2	-15.17	-23.27	-3.18	-6.31

Default material, porosity, interface ←



MEX/MARSIS

DEPTH EVALUATION CRITERIA DATA FLOW



“DEPTH EVALUATION CRITERIA”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

MATERIAL DATABASE (From the Database)

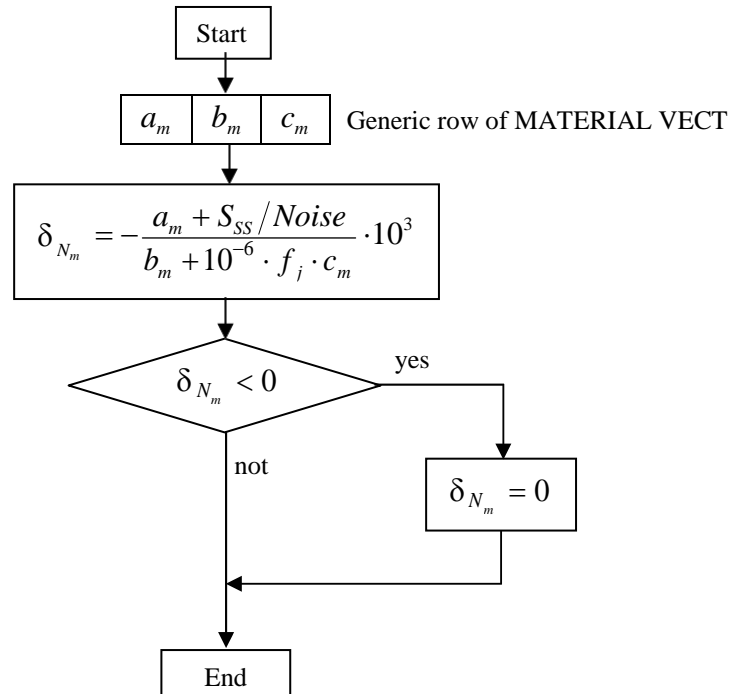
Symbol	Notes
a, b, c	Material model parameters
ϵ_r	Dielectric constant

MANUAL INPUTs (With default value)

Symbol	Value	Units	Notes
Single Environmental	0	[boolean]	1 → Consider only one material 0 → Consider all the possible materials
Porosity	50	[Index]	Porosity of the interface (50%, 20%)
Material	3	[Index]	Type of material (1,2,3)
Interface	1	[Index]	Interface Type (D/I → 1, I/W → 0)



4.3.14 Depth Evaluation



”DEPTH EVALUATION”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

INTERNAL INPUTS

Symbol	Units	Notes
a_m, b_m, c_m		Material model parameters
f_j	[Hz]	Radar channel (frequency)
$S_{SS}/Noise$	[dB]	Signal to Noise

INTERNAL OUTPUTS

Symbol	Units	Notes
δ_{N_m}	[m]	Penetration depth

4.3.15 Depth For Cycle

Read Z_{\min} and ΔZ from the fixed input table

FIXED INPUTS (From the Database)

Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
319	Z_{\min}	1000	[m]	StartingInvestigationDepth
320	ΔZ	150	[m]	DepthStep



MEX/MARSIS

4.3.16 Evaluate Stationary Clutter Contribution

EVALUATE CROSS TRACK DIMENSION

$$R_{cross,r} = R_d \cdot \sqrt{\frac{H}{2 \cdot Z_r}} [m]$$

INCREASE SURFACE INCLINATION ANGLE

$$\alpha_{c/\delta} = k_alfa_angle \cdot \bar{\sigma}_{\alpha,S/L}$$

EVALUATE CLUTTER CONTRIBUTION

$$f^S = 2 \cdot L^y \cdot R^{cross,r} \cdot \left[\frac{e^{-4k_j^2 \sigma_{h,tot}^2} \cdot e^{-\frac{\left(\frac{\sqrt{2Z_r \sqrt{R_d}}}{H} - \alpha_{c/\delta}\right)^2}{\lambda^2 Z_r}}}{2\pi H \cdot 10^3 R^2} + \left(1 - e^{-4k_j^2 \sigma_{h,tot}^2}\right) \cdot e^{-\frac{\left(\frac{\sqrt{2Z_r \sqrt{R_d}}}{H} - \alpha_{c/\delta}\right)^2}{\lambda^2 Z_r}}}{2\pi H \cdot \frac{R^2}{j_r} + 2 \cdot m_f^2} \right] \cdot \left[\frac{1}{\sqrt{2 \cdot \pi \cdot H}} \cdot \frac{\lambda_j^2 \cdot Z_r}{R_d^2} \sqrt{\frac{\lambda_j^2}{4\pi \cdot R_{cross,r}^2} + \frac{R_{cross,r}^2}{\pi \cdot H^2}} + \frac{1}{\sqrt{2 \cdot \pi \cdot H}} \cdot \frac{\lambda_j^2 \cdot Z_r}{R_d^2} + 2m_f^2 \cdot \sqrt{\frac{\lambda_j^2}{4 \cdot \pi \cdot R_{cross,r}^2} + \frac{R_{cross,r}^2}{\pi \cdot H^2} + 2 \cdot m_f^2} \right]$$

where:

$$k_j = \frac{2 \cdot \pi}{\lambda_j}$$

$$f_s [dB_{m^2}] = 10 \log_{10} (f [m^2])$$

EVALUATE SUB SURFACE POWER

- $A_{TT} = -a_m - \frac{Z_r}{10^3} \cdot (b^m + 10^{-6} \cdot f_j \cdot c_m)$ [dB] if $A_{tt} < 0$ then $A_{tt} = 0$
- if $(f_s \geq f_{SS} - A_{tt} + \Delta A_{tt})$ then (Memorize Z_r in CLUTTER_VECT)



MEX/MARSIS

”EVALUATE STATIONARY CLUTTER”: INPUTS, OUTPUTS, CONSTANTS, VAR.

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
303	R_d	150	[m]	RangeResolution
321	K_alfa_angle	3	[]	AlfaAngleCoefficient
322	ΔA_{tt}	0	[dB]	SubSurfacePowerMargin

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units Transformation	Notes
H	[Km]	→ [m]	Space Craft altitude

INTERNAL INPUTs

Symbol	Units	Notes
m_f	[rad]	Slope of the geom. Opt.
$\sigma_{h,tot}$	[m]	Average of roughness
λ_i	[m]	Wave length
f_j	[Hz]	Radar channel (frequency)
f_s	dB_{m^2}	Surface Power value
f_{SS}	dB_{m^2}	Sub Surface Power value
$R_{cross,r}$	[m]	Cross track size
L_Y	[m]	Swath dimension along Y coordinate
Z_r	[m]	Depth
$\alpha_{C/\delta}$	[rad]	Surface inclination angle
$\sigma_{\alpha,L/S}$	[rad]	Surface angle variance
A_{tt}	[dB]	Sub surface attenuation, corresponding to the Z_i depth
a_m, b_m, c_m		Material coefficients
ϵ_r		Dielectric constant
K_j		Wave length number

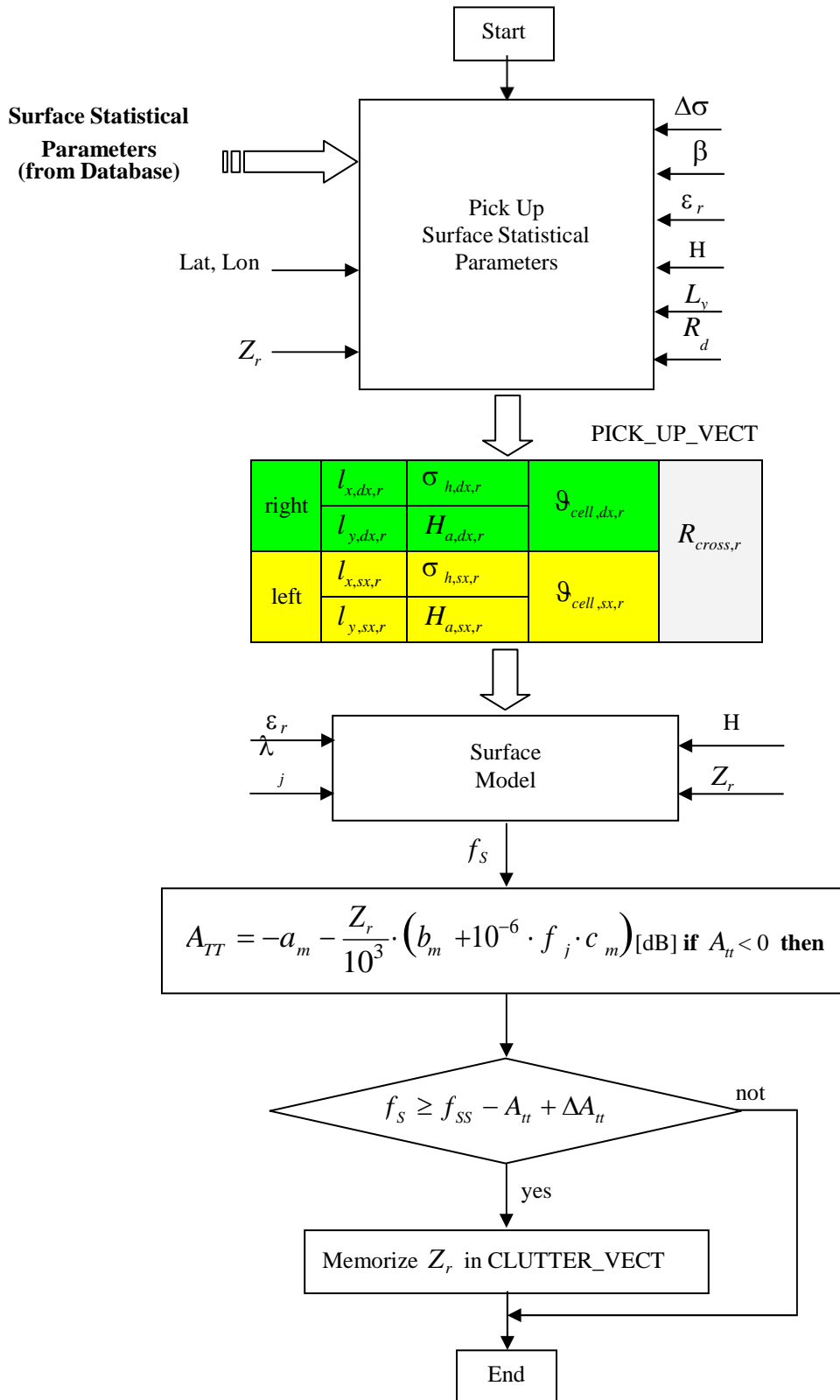
INTERNAL OUTPUTs

Symbol	Units	Notes
CLUTTER_VECT	[m]	Collection of depths where the clutter is bigger of the signal



MEX/MARSIS

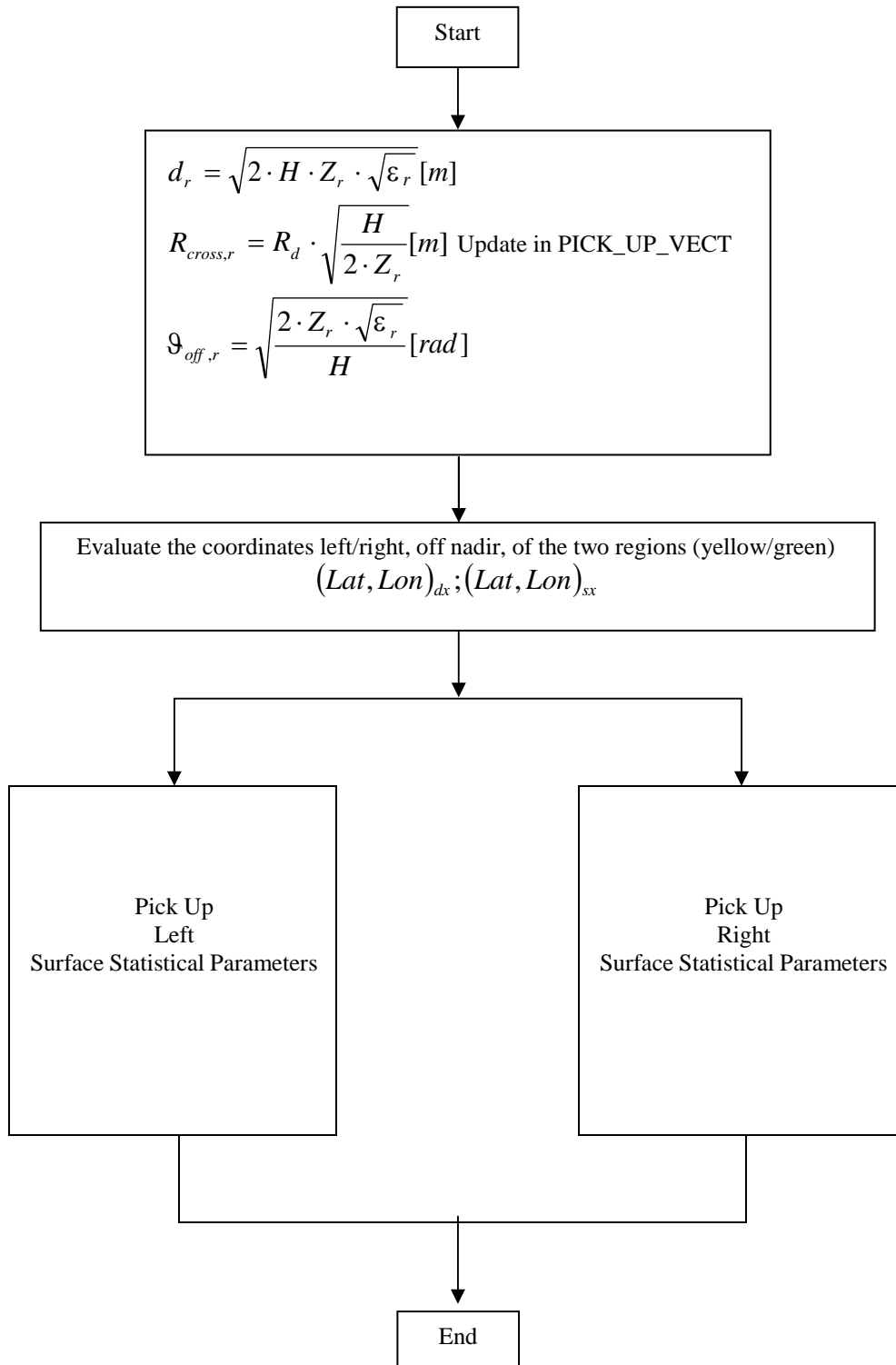
4.3.17 Evaluate Not Stationary Clutter Contribution





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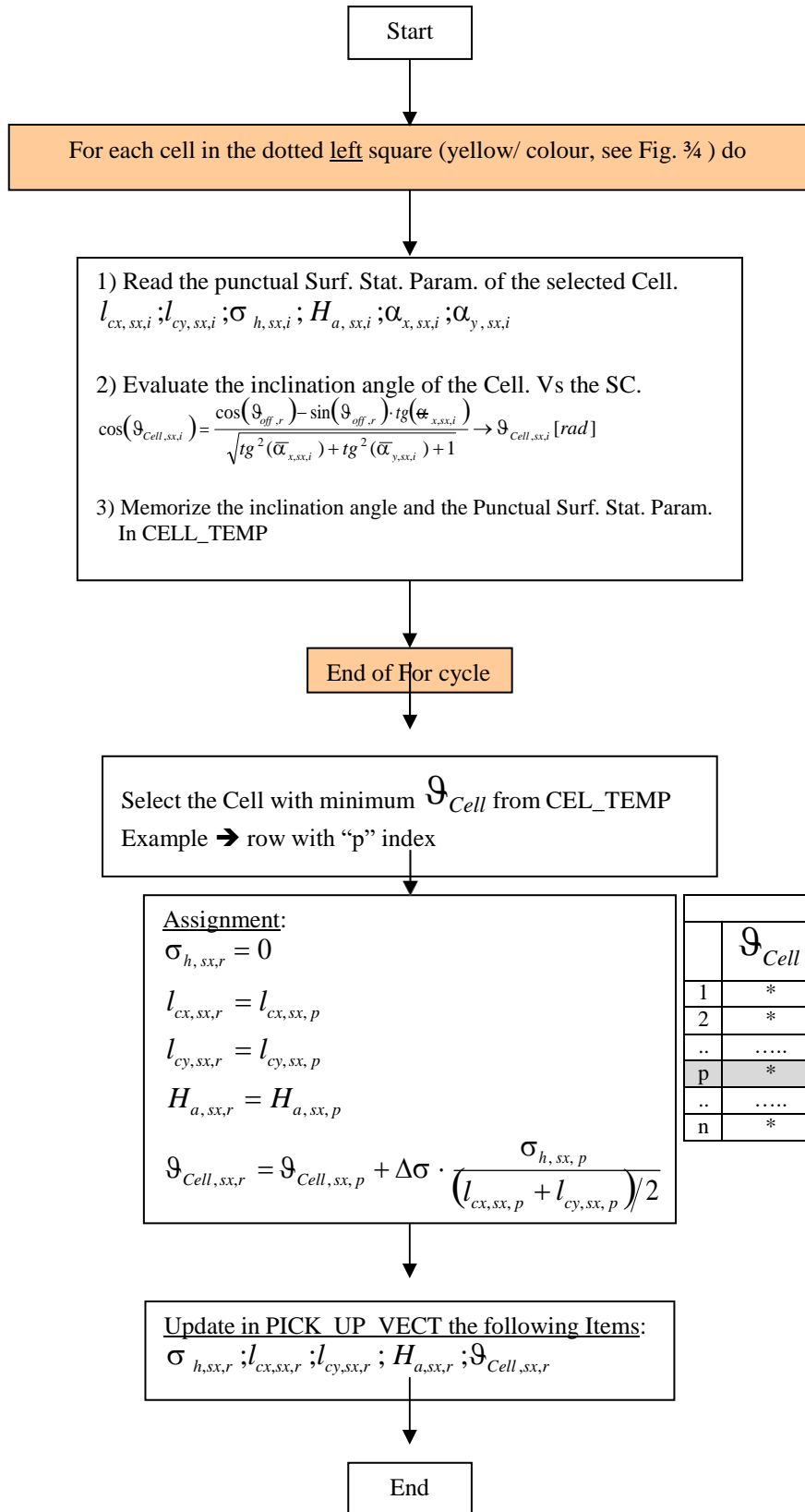
PICK UP SURFACE STATISTICAL PARAMETERS – GENERAL OVERVIEW -





MEX/MARSIS

Pick Up Left Surface Statistical Parameters Data Flow

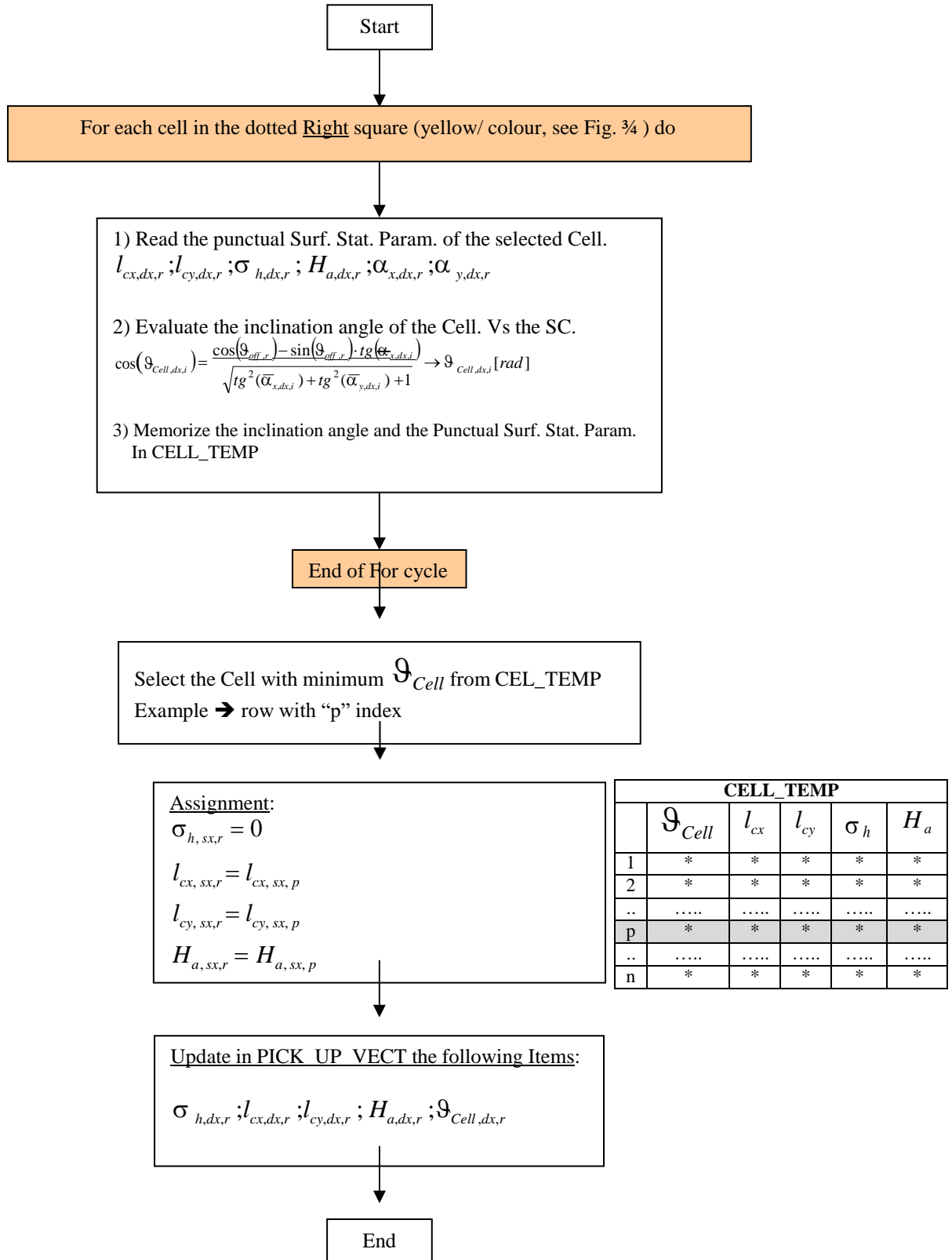


CELL_TEMP					
	ϑ _{Cell}	l _{cx}	l _{cy}	σ _h	H _a
1	*	*	*	*	*
2	*	*	*	*	*
..
p	*	*	*	*	*
..
n	*	*	*	*	*



MEX/MARSIS

Pick Up Right Surface Statistical Parameters Data Flow





MEX/MARSIS

SURFACE MODEL

EVALUATE THE right, SLOPE AND THE rms SLOPE

$$s(\lambda_j)_{dx,r} = \sqrt{2} \sigma_{h,dx,r} \frac{(\lambda_j)^{H_{a,dx,r}-1}}{\left(\frac{l_{cx,dx,r} + l_{cy,dx,r}}{2}\right)^{H_{a,dx,r}}} \quad m_{f,dx,r} = (2\sqrt{2}\pi)^{(1/H_{a,dx,r})-1} (s(\lambda_j)_{dx,r})^{1/H_{a,dx,r}} \sqrt{\frac{H_{a,dx,r}}{\Gamma\left(\frac{1}{H_{a,dx,r}}\right)}}$$

EVALUATE THE left, SLOPE AND THE rms SLOPE

$$s(\lambda_j)_{sx,r} = \sqrt{2} \sigma_{h,sx,r} \frac{(\lambda_j)^{H_{a,sx,r}-1}}{\left(\frac{l_{cx,sx,r} + l_{cy,sx,r}}{2}\right)^{H_{a,sx,r}}} \quad m_{f,sx,r} = (2\sqrt{2}\pi)^{(1/H_{a,sx,r})-1} (s(\lambda_j)_{sx,r})^{1/H_{a,sx,r}} \sqrt{\frac{H_{a,sx,r}}{\Gamma\left(\frac{1}{H_{a,sx,r}}\right)}}$$

EVALUATE THE POWER CONTRIBUTION left/right

$$f_{S,dx,r} = L_y \cdot R_{cross,r} \cdot \left(\frac{e^{-\frac{(\theta_{coll,dx,r})^2}{\frac{1}{\lambda_j^2 Z_r} \cdot \frac{1}{2\pi H} R_d^2}}}{\sqrt{\frac{1}{2 \cdot \pi \cdot H} \cdot \frac{\lambda_j^2 \cdot Z_r}{R_d^2}} \cdot \sqrt{\frac{\lambda_j^2}{4\pi \cdot R_{cross,r}^2} + \frac{R_{cross,r}^2}{\pi \cdot H^2}}} + \frac{(1 - e^{-\frac{(\theta_{coll,dx,r})^2}{\frac{1}{\lambda_j^2 Z_r} \cdot \frac{1}{2\pi H} R_d^2 + 2m_{f,dx,r}^2}})}{\sqrt{\frac{1}{2 \cdot \pi \cdot H} \cdot \frac{\lambda_j^2 \cdot Z_r}{R_d^2} + 2 \cdot m_{f,dx,r}^2}} \cdot \sqrt{\frac{\lambda_j^2}{4 \cdot \pi \cdot R_{cross,r}^2} + \frac{R_{cross,r}^2}{\pi \cdot H^2} + 2 \cdot m_{f,dx,r}^2}} \right)$$

$$f_{S,sx,r} = L_y \cdot R_{cross,r} \cdot \left(\frac{e^{-\frac{(\theta_{coll,sx,r})^2}{\frac{1}{\lambda_j^2 Z_r} \cdot \frac{1}{2\pi H} R_d^2}}}{\sqrt{\frac{1}{2 \cdot \pi \cdot H} \cdot \frac{\lambda_j^2 \cdot Z_r}{R_d^2}} \cdot \sqrt{\frac{\lambda_j^2}{4\pi \cdot R_{cross,r}^2} + \frac{R_{cross,r}^2}{\pi \cdot H^2}}} + \frac{(1 - e^{-\frac{(\theta_{coll,sx,r})^2}{\frac{1}{\lambda_j^2 Z_r} \cdot \frac{1}{2\pi H} R_d^2 + 2m_{f,sx,r}^2}})}{\sqrt{\frac{1}{2 \cdot \pi \cdot H} \cdot \frac{\lambda_j^2 \cdot Z_r}{R_d^2} + 2 \cdot m_{f,sx,r}^2}} \cdot \sqrt{\frac{\lambda_j^2}{4 \cdot \pi \cdot R_{cross,r}^2} + \frac{R_{cross,r}^2}{\pi \cdot H^2} + 2 \cdot m_{f,sx,r}^2}} \right)$$

where:

$$k_j = \frac{2 \cdot \pi}{\lambda_j}$$

$$f_{S,r} [dB_{m^2}] = 10 \log_{10} (f_{S,dx,r} \cdot f_{S,sx,r})$$



MEX/MARSIS

”EVALUATE NOT STAT. CLUTTER CONTRIBUTION”: INPUTS, OUTPUTS, CONSTANTS, V.

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units transformation	Notes
H	[Km]	→ [m]	Space Craft altitude
Lat	[deg]	→ [rad]	Latitude of the selected sample
Lon	[deg]	→ [rad]	Longitude of the selected sample
$(Lat, Lon)_{dx/sx}$	[deg]	→ [rad]	Coordinates right/left of the regions off nadir

SURFACE STATISTICA PARAMETERS DATABASE (from the database)

Symbol	Units	Notes
σ_h	[m]	Roughness (right/left) along X direction
$l_{x/y}$	[m]	Correlation length
H_a	[]	Hurst coefficient
$\alpha_{x/y}$	[rad]	Cell inclination along X and Y direction

INTERNAL INPUTs and/or INPUTs FROM OTHERS FUNCTIONS

Symbol	Units	Notes
m_f	[rad]	Slope of the geom. Opt.
ϵ_r	[]	Dielectric constant
λ_i	[m]	Wave length
β	[rad]	Satellite direction on the surface of Mars
$R_{cross,r}$	[m]	Cross track size
L_y	[m]	Swat dimension along Y coordinate
Z_r	[m]	Depth
f_j	[Hz]	Radar channel (frequency)
d_r	[m]	Distance from the nadir and the Generic region off nadir
θ_{off_r}	[rad]	Angle off nadir
$\theta_{(cell)}$	[rad]	Cell inclination versus the Satellite
$S \lambda_j$	[rad]	Rms slope
ΔA_{tt}	[dB]	
A_{tt}	[dB]	Sub surface attenuation, corresponding to the Z_{i_depth}
f_{SS}	dB_m^2	Sub Surface Power value
a_m, b_m, c_m	[]	Material coefficients



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FIXED INPUTs (From the Database)

Datarate Identifier	Symbol	Value	Units	CORISTA Nomenclature
303	R_d	150	[m]	RangeReslolution
323	$\Delta\sigma$	2	[]	DeltaSigma

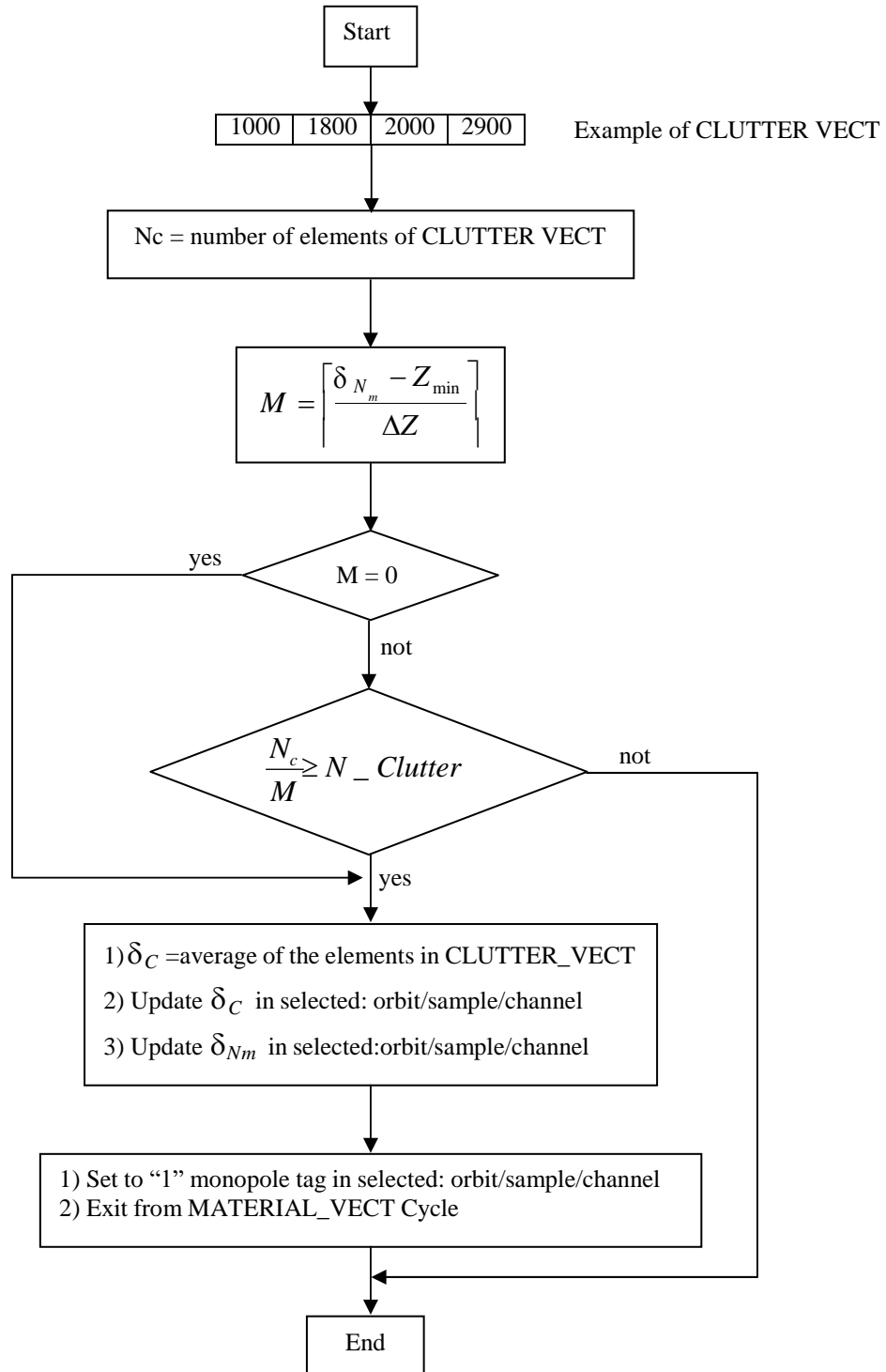
INTRNAL OUTPUTs

Symbol	Units	Notes
f_s	dB_m^2	Geometric contribution of the off nadir surface



MEX/MARSIS

4.3.18 Evaluate Monopole Selection





"EVALUATE MONOPOLE SELECTION" INPUTS, OUTPUTS, CONSTANTS, VARIABLES

MANUAL INPUTs (With default value)

Symbol	Default value	Units	Notes
N_Clutter	1	[Index]	Percentage number of clutter cancellation requests for the selection of the monopole

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
319	Z_{\min}	1000	[m]	StartingInvestigationDepth
320	ΔZ	150	[m]	DepthStep

INTERNAL INPUTs

Symbol	Units	Notes
δ_{N_m}	[m]	Maximum penetration depth
N_c	[]	Number of requests for Clutter cancellation
M	[]	Number of investigations of the Surface Clutter contributions
CLUTTER_VECT	[m]	List of depths

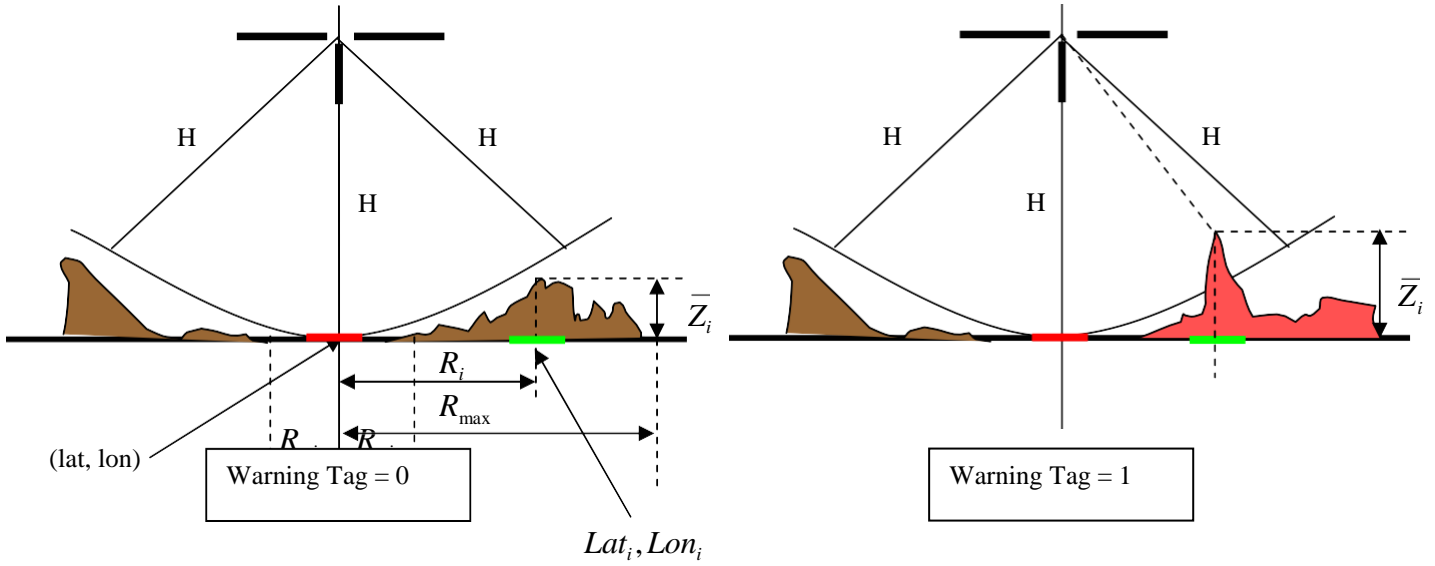
INTERNAL OUTPUTs

Symbol	Units	Notes
δ_C	[m]	Maximum Penetration depth if Monopole cancellation is not applied
δ_{Nm}	[m]	Maximum penetration depth if there is only Galactic noise

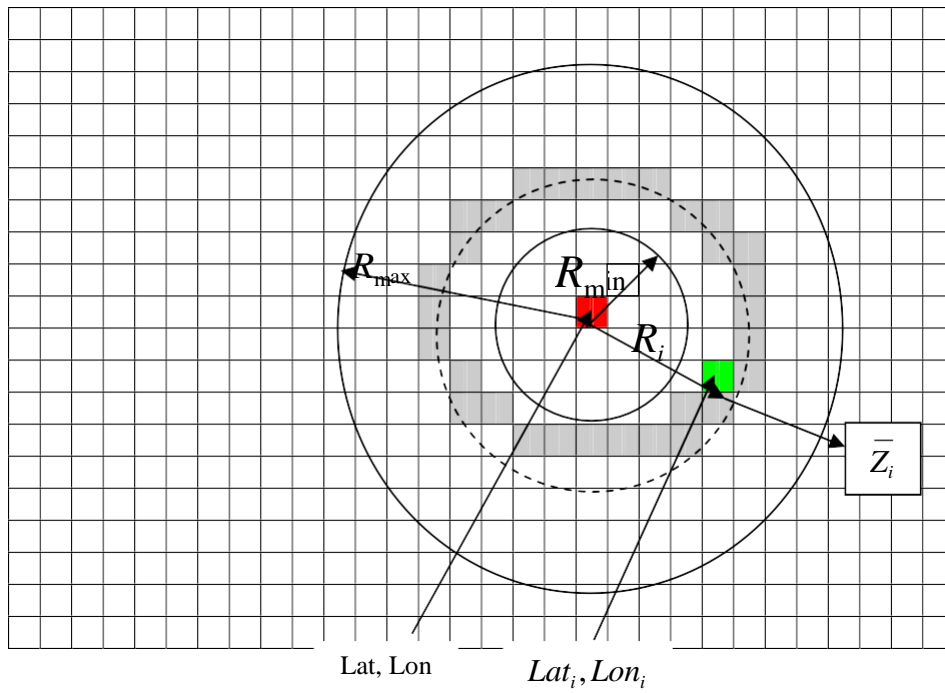


4.4 WARNING EVALUATION

GEOMETRY



Surface Representation





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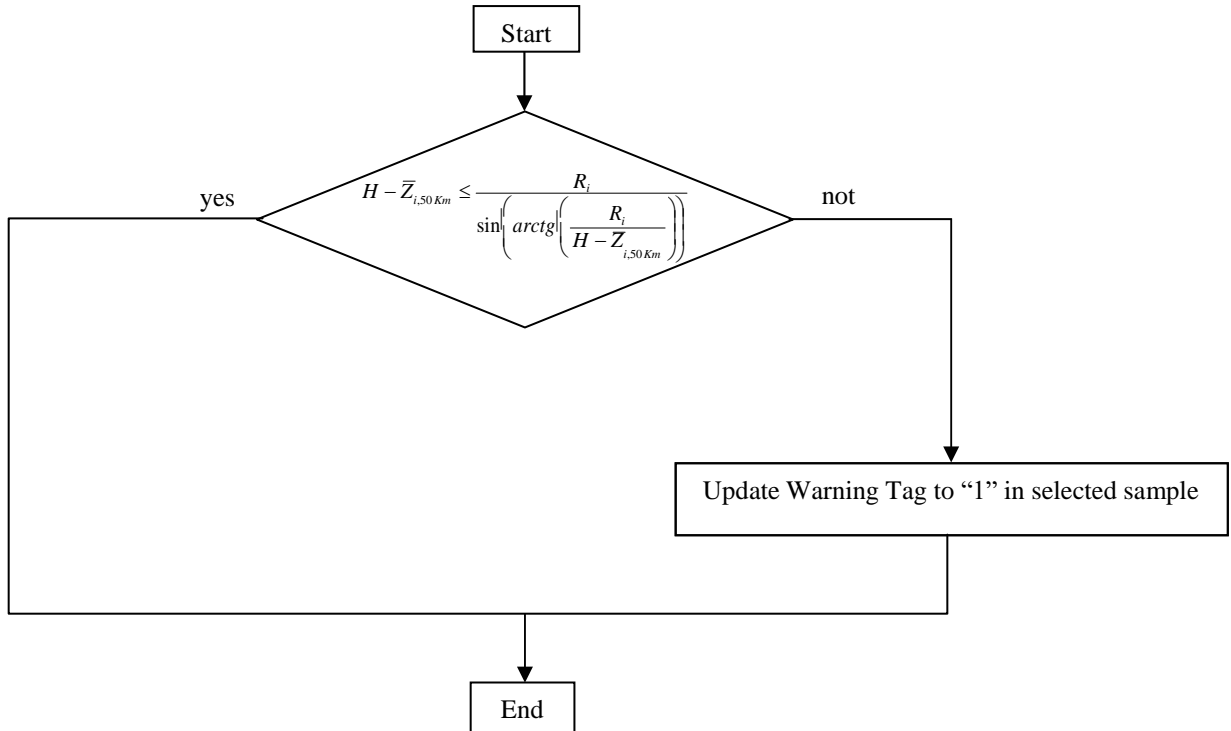
ALGORITHM

$$R_i = R_{\min} : \Delta R : R_{\max}$$

Pick Up all the \bar{Z}_i (Mean value of the facet plane) in the dotted circle of Radius R_i [m]

$$R_i \rightarrow (Lat_i, Lon_i) \rightarrow \bar{Z}_i$$

For the generic Cell on the dotted circle, apply the following Criteria:



”WARNING EVALUATION”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units transformation	Notes
Lat	[deg]	→ [rad]	Latitude of the selected sample
Lon	[deg]	→ [rad]	Longitude of the selected sample
H	[Km]	→ [m]	Space Craft altitude

FIXED INPUTs (From the Database)

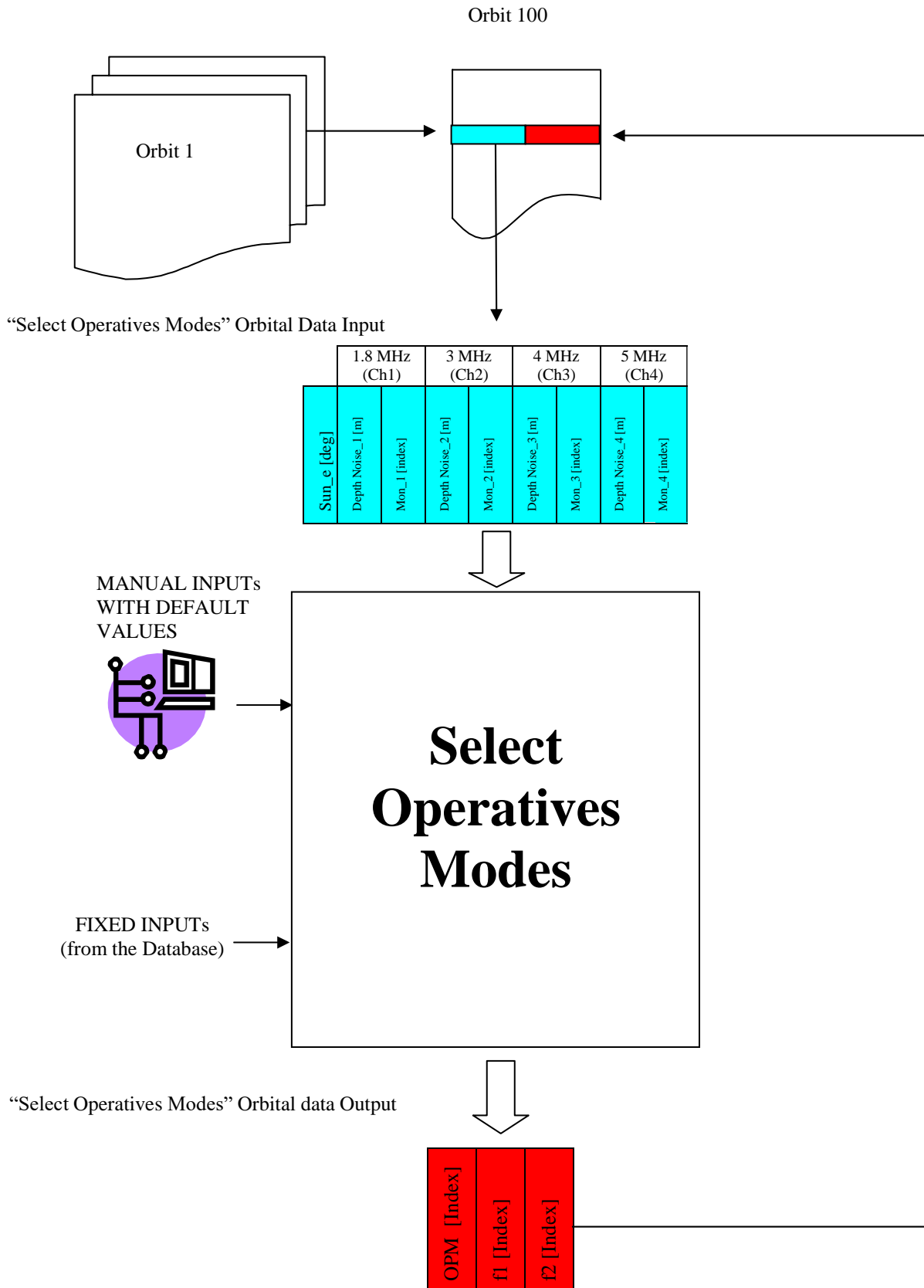
Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
324	R_{\min}	10000	[m]	MinWarningDistance
325	R_{\max}	150000	[m]	MaxWarningDistance

SURFACE STATISTICAL PARAMETERS (From the database)

Symbol	Units	Notes
\bar{Z}_i	[m]	Mean value of the plane

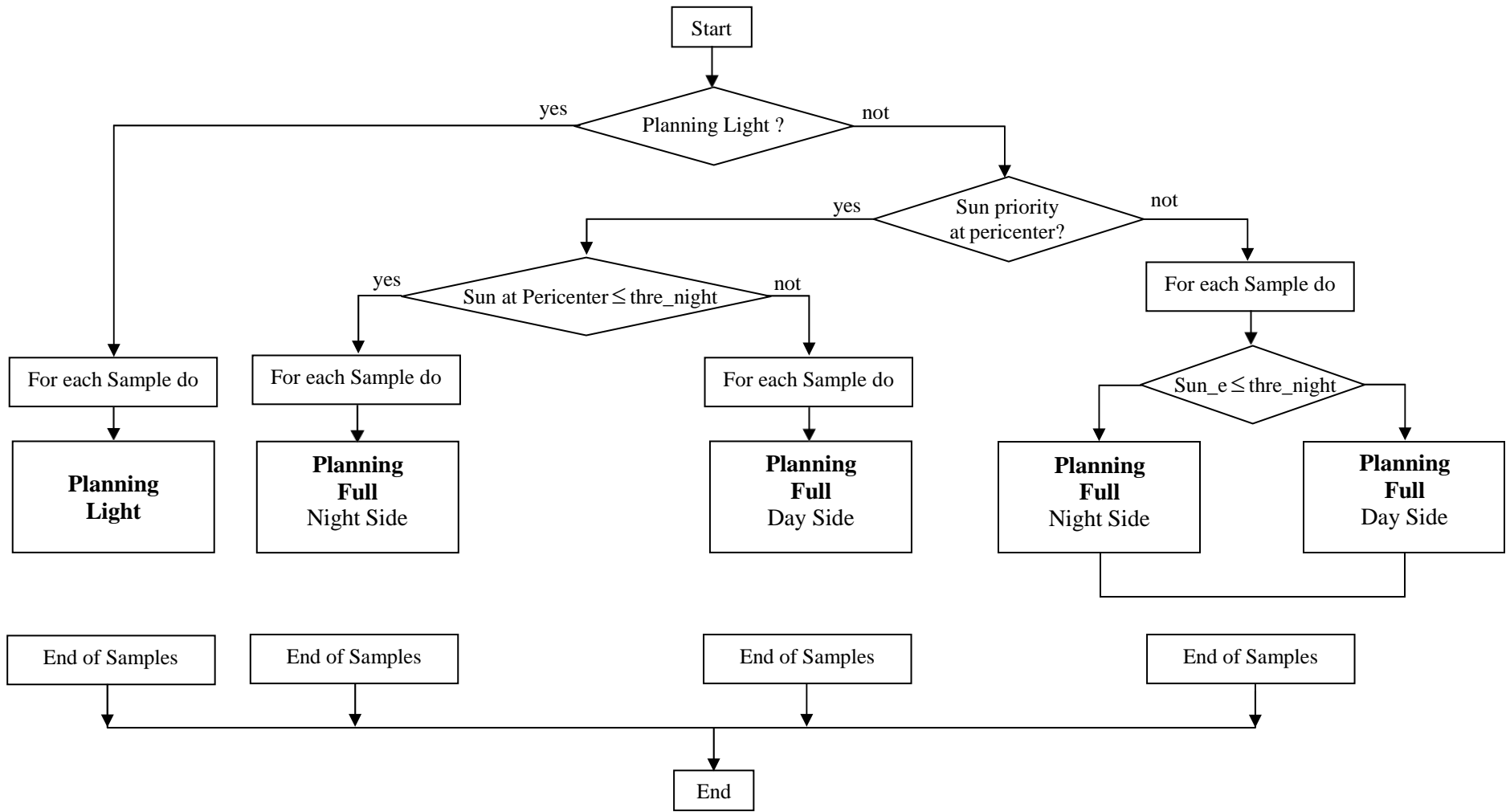


5.1 CONTEST





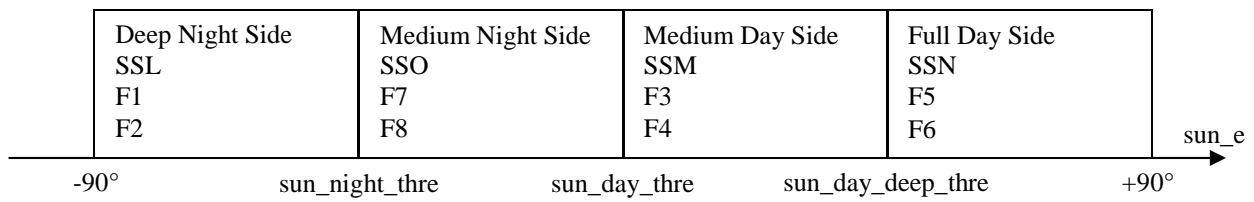
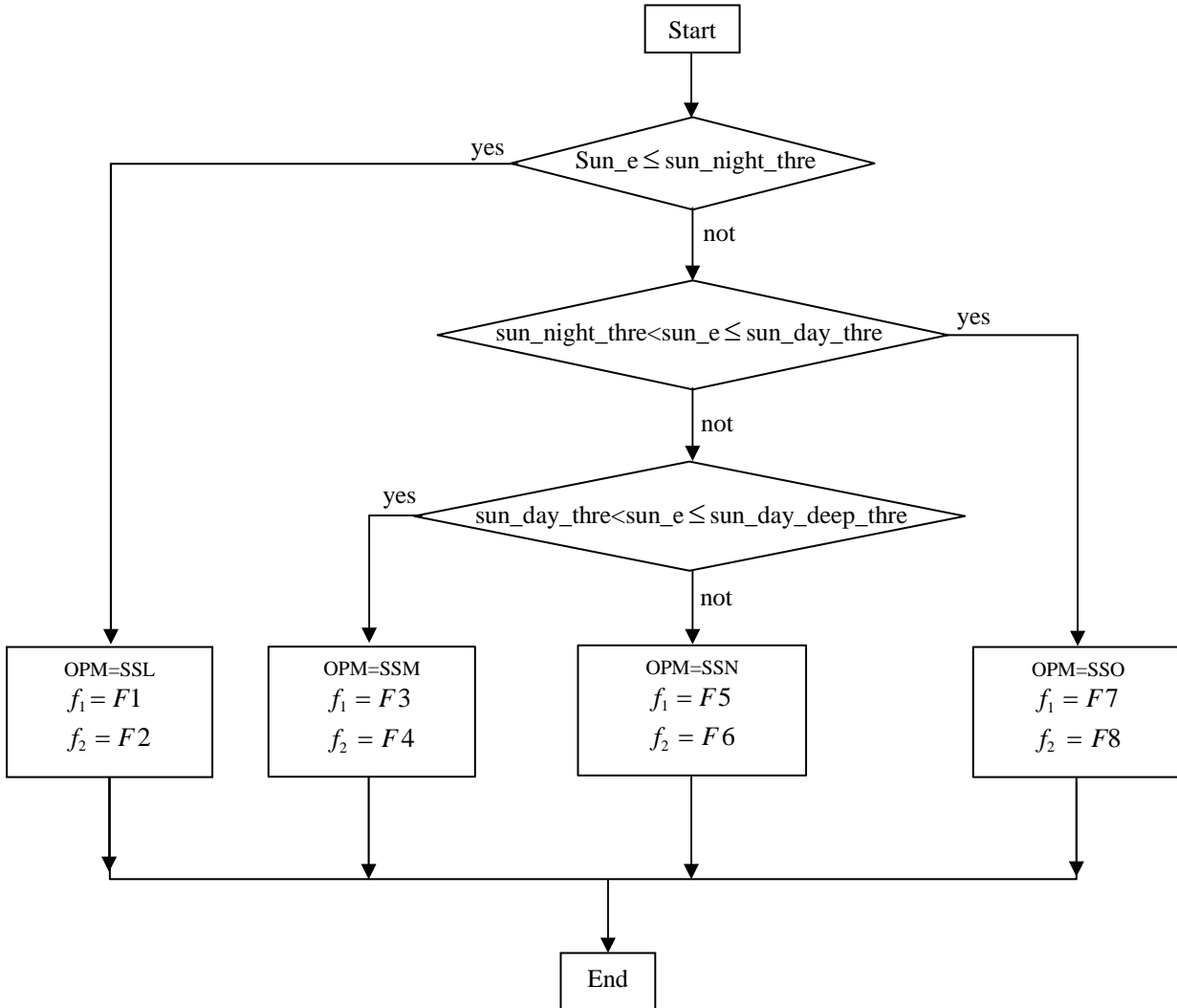
5.2 TOP LEVEL DATA FLOW





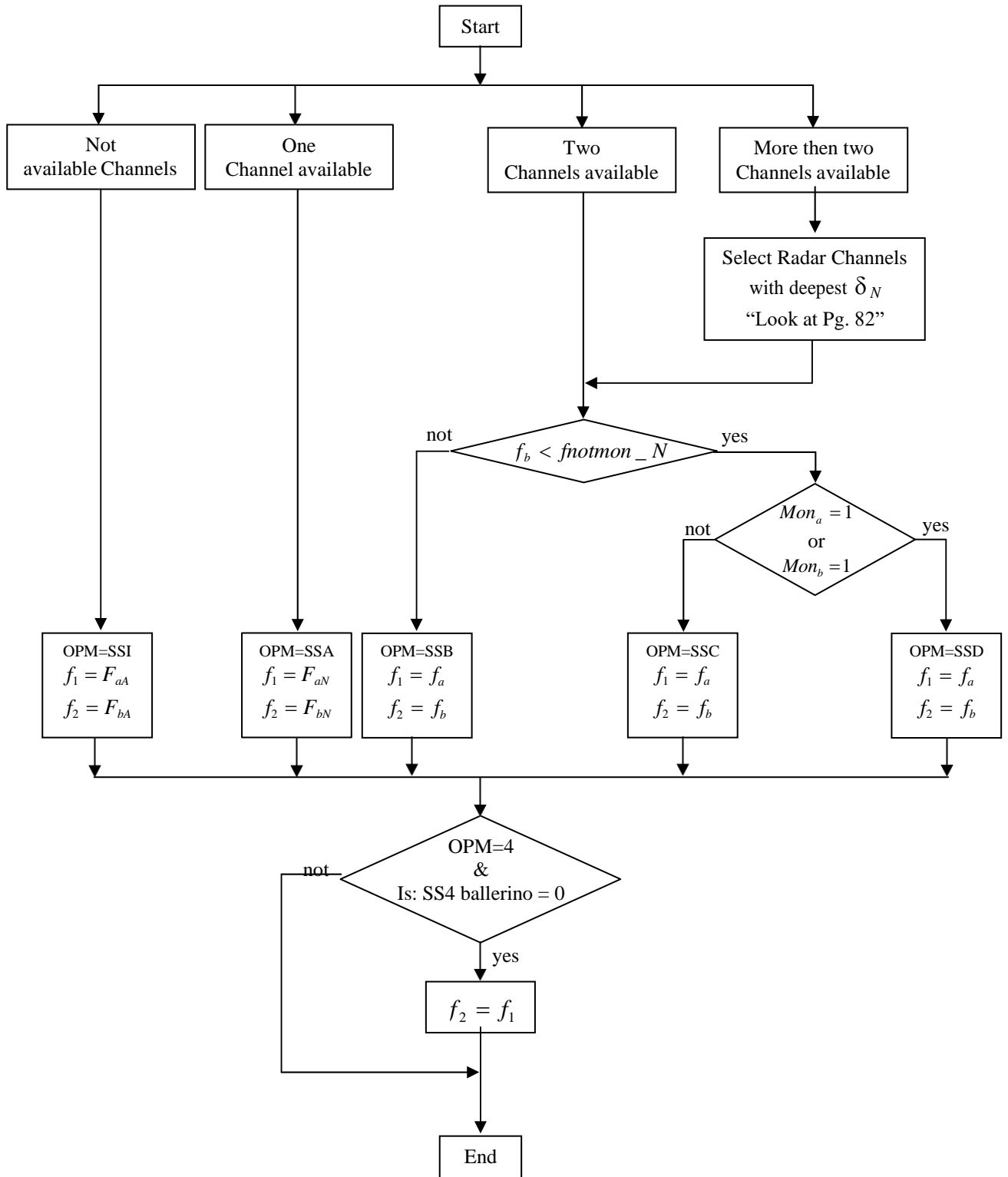
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5.2.1 "Planning Light"





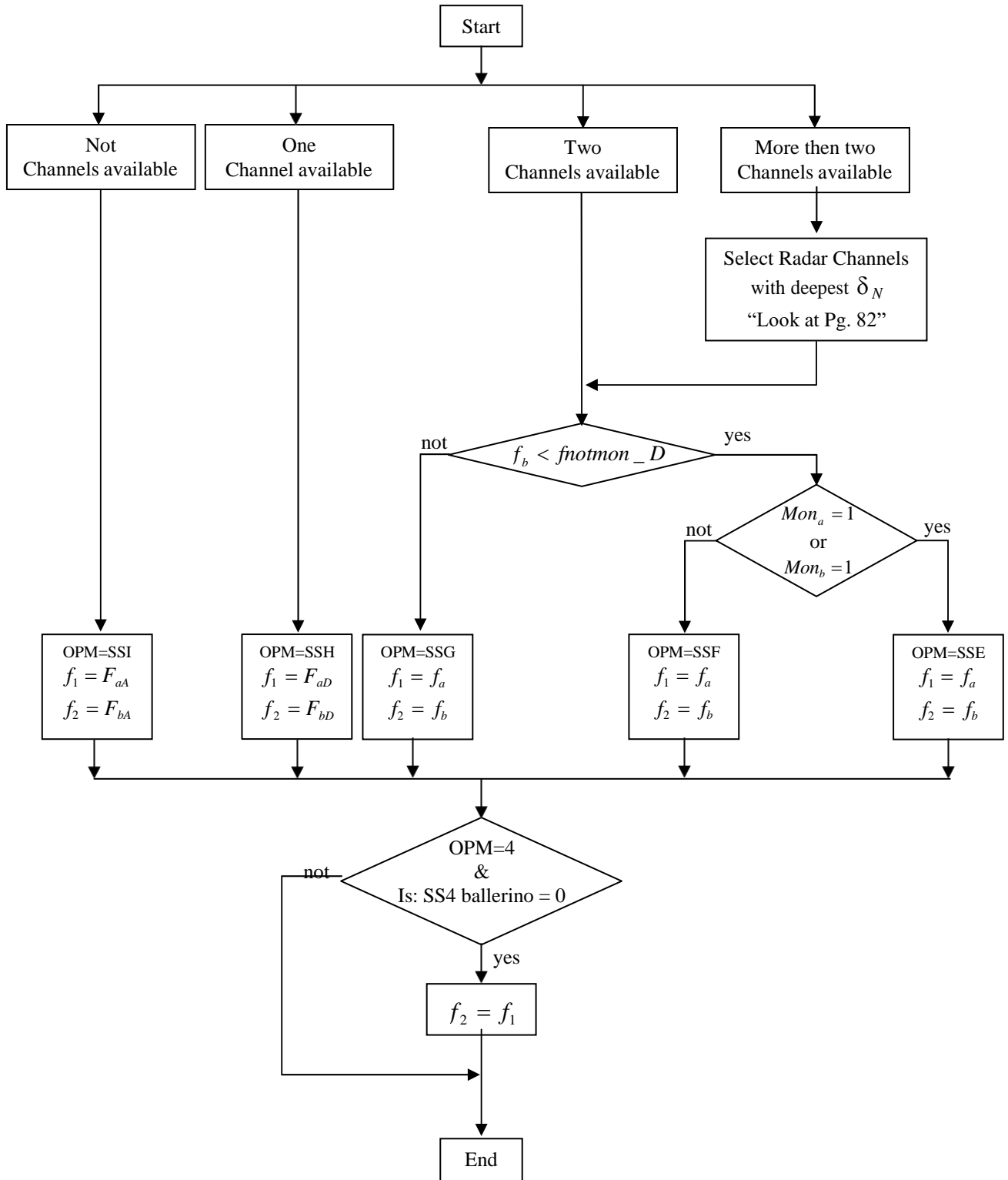
5.2.2 “Planning Full” Night Side with priority at pericenter





MEX/MARSIS

5.2.3 “Planning Full” Day Side with priority at pericenter





5.2.4 Select Radar Channels with deepest penetration depths

Possible cases:

- a)

Ch1	Ch2	Ch3	Ch4
-----	-----	-----	-----

 Cha = Ch1 (Deepest penetration depth " δ_N ")
↑
Cha
↑
Chb
 Chb = Ch2 (In order to have consecutive frequencies)
- b)

Ch1	Ch2	Ch3	Ch4
-----	-----	-----	-----

 Ch2 has the deepest penetration depth.
↑
↑
↑
If Ch3_depth > Ch1_depth then Cha = Ch2 and Chb = Ch3
else → Cha = Ch1 and Chb = Ch2
- b)

Ch1	Ch2	Ch3	Ch4
-----	-----	-----	-----

 Ch3 has the deepest penetration depth.
↑
↑
↑
If Ch4_depth > Ch3_depth then Cha = Ch3 and Chb = Ch4
else Cha = Ch2 and Chb = Ch3
- c)

Ch1	Ch2	Ch3	Ch4
-----	-----	-----	-----

 Cha = Ch3 (In order to have consecutive frequencies)
↑
↑
 Chb = Ch4 (It has the deepest penetration depth)



MEX/MARSIS

“SELECT OPERATIVES MODES”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

MANUAL INPUT

Symbol	Default value	Notes
Planning Light	0	0 → Planning Tool Full 1 → Planning Tool Light
Sun Priority at pericenter	0	0 → The priority is given by the sun elevation value of selected orbit sample 1 → The priority is given by the sun elevation value of the pericenter orbit sample

ORBITAL DATA INPUTs (From the Database)

Symbol	External Units	Internal Units transformation	Notes
Sun_e	[deg]	→ [rad]	Sun Elevation value of the selected sample
Depth_Noise_j	[m]	No action	Penetration depth of the selected Radar channel
Mon_j	[index]	No action	Monopole tag value

OPERATION MODE IN FIXED INPUTs IDENTIFIER

OPERATION MODE	ID (dec)
No Operation	0
SS1	1
SS2	2
SS3	3
SS4	4
SS5	5
ACTI. IONO	6
REC. ONLY.	7
CALIBR.	8

FREQUENCIES IN FIXED INPUTs IDENTIFIER

Frequency	Units	ID (dec)
1.8	[MHz]	0
3	[MHz]	1
4	[MHz]	2
5	[MHz]	3

ORBITAL OUTPUTs

Symbol	Internal Units	Notes
OPM	[index]	Operative Mode
f_1	[index]	First Radar frequency ($f_1 \leq f_2$)
f_2	[index]	Second Radar frequency



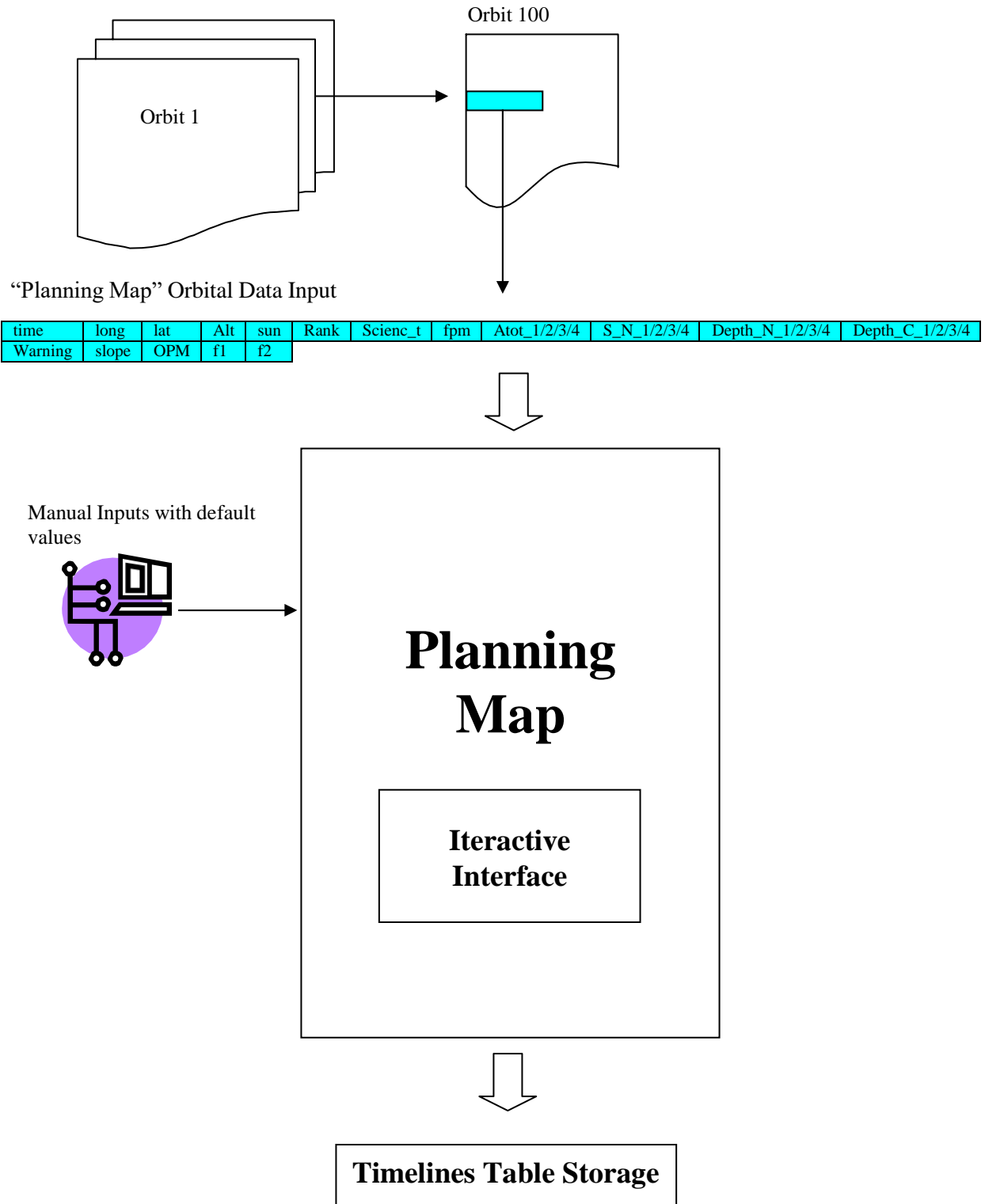
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FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	External Units	Internal Units transformation	CORISTA Nomenclature
400	thre_night	5	[deg]	→ [rad]	NightTreshold
401	sun_night_thre	-5	[deg]	→ [rad]	SunNightTH
402	sun_day_thre	5	[deg]	→ [rad]	SunDayTH
403	sun_day_deep_thre	30	[deg]	→ [rad]	SunDeepDayTH
404	fnotmon_D	5	[MHz]	→ [Hz]	MaxMonopoleFreqDay
405	fnotmon_N	5	[MHz]	→ [Hz]	MaxMonopoleFreqNight
406	F_{aN}	2	[index]	No action	f1N
407	F_{bN}	3	[index]	No action	f2N
408	F_{aD}	2	[index]	No action	f1D
409	F_{bD}	3	[index]	No action	f2D
410	F_{aA}	0	[index]	No action	f1nc
411	F_{bA}	0	[index]	No action	f2nc
412	F1	0	[index]	No action	F1
413	F2	1	[index]	No action	F2
414	F3	2	[index]	No action	F3
415	F4	3	[index]	No action	F4
416	F5	2	[index]	No action	F5
417	F6	3	[index]	No action	F6
418	F7	1	[index]	No action	F7
419	F8	2	[index]	No action	F8
420	SS4 ballerino	0	[index]	No action	SS4 Dancer = 0 → SS4 with one freq. SS4 Dancer = 1 → SS4 with two freq.
421	SSA	3	[index]	No action	SSA
422	SSB	3	[index]	No action	SSB
423	SSC	3	[index]	No action	SSC
424	SSD	4	[index]	No action	SSD
425	SSE	2	[index]	No action	SSE
426	SSF	2	[index]	No action	SSF
427	SSG	2	[index]	No action	SSG
428	SSH	1	[index]	No action	SSH
429	SSI	0	[index]	No action	SSI
430	SSL	3	[index]	No action	SSL
431	SSM	1	[index]	No action	SSM
432	SSN	2	[index]	No action	SSN
433	SSO	3	[index]	No action	SSO

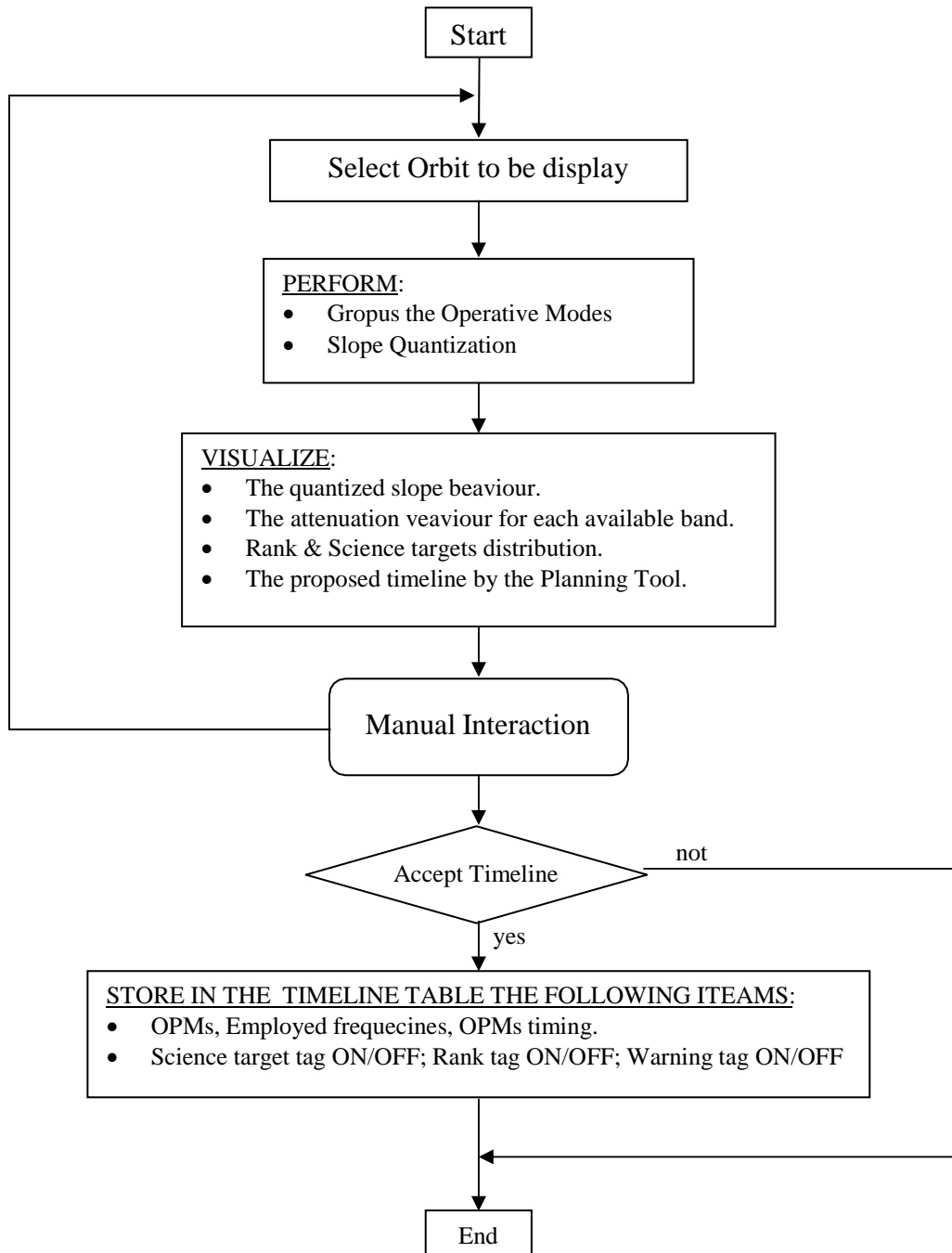


6.1 CONTEST





6.2 TOP LEVE DAT FLOW





MEX/MARSIS

“MODES OPTIMIZATION”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

MANUAL INPUT

Symbol	Default value	External Units	Internal Units transformation	Notes
Slope quantization step	1	[deg]	→ [rad]	Slope Quantization value

ORBIT TABLE INPUTs (From the Database)

Symbol	External Units	Internal Units transformation	Notes
Time	[min]	→ [sec]	Time off pericenter
Slope	[rad]	No action	Surface Slope
OPM	[Index]	No action	Operative Mode
f1	[Index]	No action	“first frequency”
f2	[Index]	No action	“second frequency”

BAND (Ba) EVALUATION

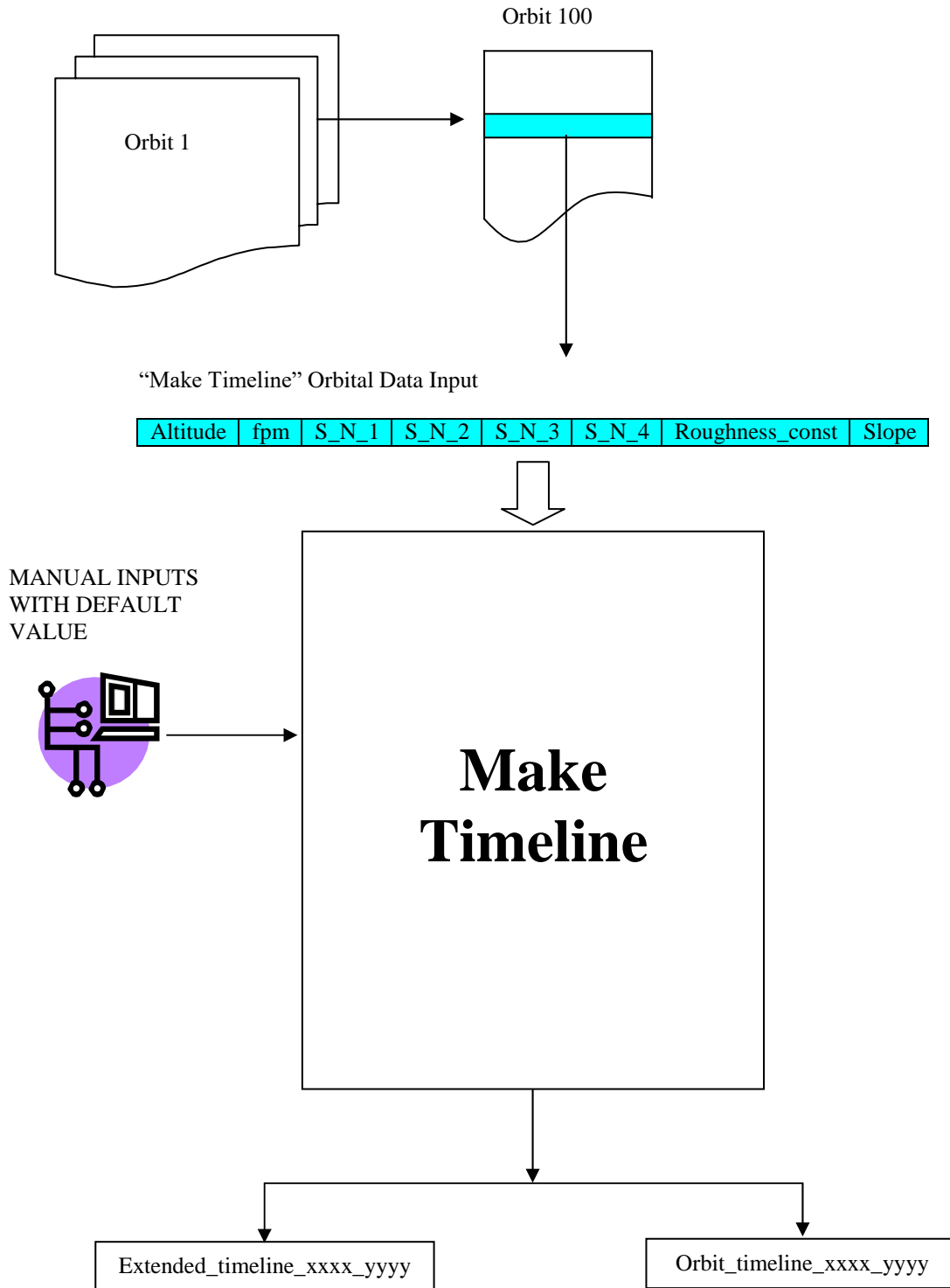
The Band (Ba) is related to the frequency (f1/2_E) that produce the highest data rate on the bus OBDH as shown below

OPM	MIRA BAND
SS1	f1 → Ba
SS2	
SS3	
SS4	f2 → Ba
SS5	

f1/2 (MHz)	→	Ba
1.8	→	1
3	→	2
4	→	3
5	→	4

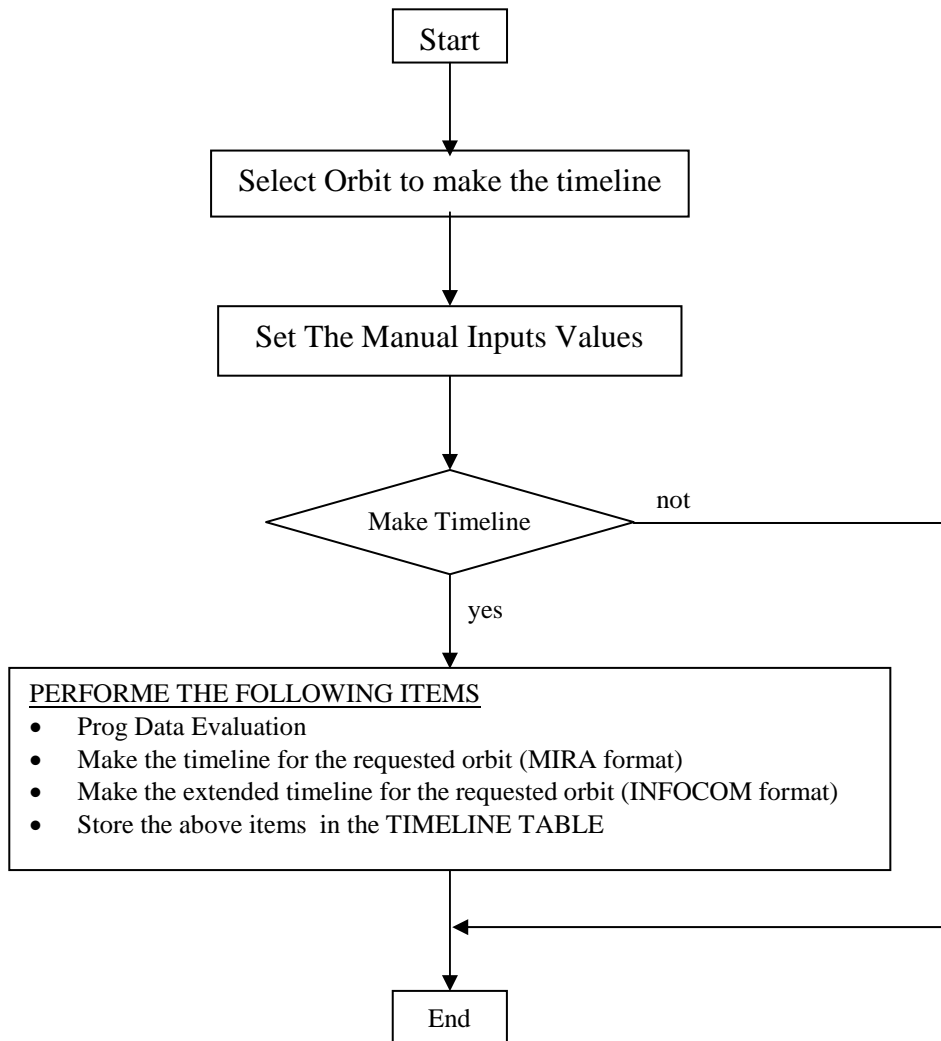


7.1 CONTEST





7.2 TOP LEVEL DATA FLOW





MEX/MARSIS

7.3 PROG DATA

PROG DATA LIST TO EVALUATE

Parameter	Freq_1				Freq_2				Frequency Independently				Units
	Minimum	Maximum	Mean	rms	Minimum	Maximum	Mean	rms	Minimum	Maximum	Mean	rms	
Plasma Frequency	not	not	not	not	not	not	not	not	yes	yes	yes	yes	[Hz]
Surface roughness constant	not	not	not	not	not	not	not	not	yes	yes	yes	yes	[m]
Slope	not	not	not	not	not	not	not	not	yes	yes	yes	yes	[rad]
SC Altitude	not	not	not	not	not	not	not	not	yes	yes	yes	not	[m]
Signal to Noise per channel	yes	yes	yes	yes	yes	yes	yes	yes	not	not	not	not	[dB]

RANGE TO COMPUTE THE GENERIC ELEMENT

Time	Altitude	fpm	S/N_1	S/N_2	Rough const	Slope	Comments
*	*	*	*	*	*	*	Activity 1
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	Activity 2
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	Generic Activity i=1 ÷ N N=7 (elements)
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	Activity 3
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	
*	*	*	*	*	*	*	

GENERIC PARAMETER (P) COMPUTATION

$$P_minimum = \min[P_1 \dots P_N]$$

$$P_maximum = \max[P_1 \dots P_N]$$

$$P = \frac{1}{N} \cdot \sum_{i=1}^N P_i$$

$$P_rms = \sqrt{\frac{1}{N} \cdot \sum_{i=1}^N (\bar{P} - P_i)^2}$$



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7.4 TIMELINE OF EXAMPLE (orbit 100)

ORBIT TIMELINE (MIRA Data Format)

Identifier Start End Comment
 0100-0100-SSRA 100 100 ssra variable rate test

Orbit	Point	Rank	Instr	Activ	Start	End	Targ	offdeg	Band	RDF
100	NOP	3	SSRA	STBY	-27.00	-23.00				
100	NOP	3	SSRA	PREO	-23.00	-18.00				
100	NAD	3	SSRA	AIS	-18.00	-13.00	ALONG	-1.75	1	1
100	NAD	3	SSRA	SS3	-13.00	-7.00	ALONG	-1.75	1	1
100	NAD	3	SSRA	SS3	-7.00	-6.00	ALONG	-1.75	2	1
100	NAD	3	SSRA	SS3	-6.00	2.00	ALONG	-1.75	3	1
100	NAD	3	SSRA	SS3	2.00	8.00	ALONG	-1.75	3	1
100	NAD	3	SSRA	SS4	8.00	13.00	ALONG	-1.75	1	1
100	NAD	3	SSRA	AIS	13.00	18.00	ALONG	-1.75	1	1
100	NOP	3	SSRA	POST	18.00	24.00				

EXTENDEED TIMELINE (INFOCOM Data Format)

ORBIT=0100
 Science target=1; Rank=1, Warning=1; Data volume=100.13[Mbit]
 -18 [AIS] -13.00
 -13.00(800) [SS3; SE=-37°:5°; f_1=1.8 f_2=3.0 Ba=1; dt= 6.00] (500) -7.00
 -7.00(530) [SS3; SE=10°: 25°; f_1=3.0 f_2=4.0 Ba=2; dt= 1.00] (600) -6.00
 -6.00(625) [SS3; SE= 30°: 60°; f_1=4.0 f_2=5.0 Ba=3; dt= 8.00] (680) 2.00
 2.00 (700) [SS3; SE= 63°: 68°; f_1=4.0 f_2=5.0 Ba=3; dt= 6.00] (750) 8.00
 8.00(770) [SS4; SE= -10°: -20°; f_1=1.8 f_2=3.0 Ba=1; dt= 5.00] (820) 13.00
 13 [AIS] 18.00



7.5 RULES TO FOLLOW TO COMPILE THE ORBIT TIMELINE “MIRA MIRA Format”

1) Second Row “Text Format”

It is specified the orbit range, in the example only the orbit 100 is compiled so the range is 100-100

2) Column “orbit”

In every row is specified the activity to perform within the orbit. In this case only one orbit (100) is considered. Set to 100 all the values of the column.

3) Column “point”

The possible values of this tag are:

- a) NOP (Not Pointing is required) → Marsis doesn't produce scientific data (in preparation)
- b) NAD (Nadir Pointing is required) → Marsis produce scientific data (in operation)

NOP will be associated to the following activities:

- a) STBY (Standby → switch on MARSIS),
- b) PREO (Pre Operations → load OST and PT),
- c) POST (Post Operations → switch off MARSIS).

NAD will be associated to the following activities:

- a) AIS (Active Ionosphere Sounding mode),
- b) SS1, SS2, SS3, SS4, SS5 (Sub Surface Sounding Modes),
- c) CAL (Calibration),
- d) REC (Receive only mode).

4) Rank “column” (do not confuse with the Rank classification of the Planning Tool)

Actually this value is fixed to 3 for every activity.

5) Instr “column”

This parameter indicates the name of the instrument SSRA (old name of MARSIS), is fixed for every activity.

6) Activ “column” (Activ is the abbreviation of Activity)

The different activities are listed in this column, the sequences is:

STBY

PREO

- Sequences of Operative Modes (AIS, CAL, REC, SS1, SS2, SS3, SS4, SS5) -

POST

For the selection of: CAL, REC, SS1, SS2, SS3, SS4, SS5 see the Orbit Table.

AIS will be performed only if the “AIS tag” is ON in “Manual Inputs”, in this case it will be performed before and after: SSX (X=1-5), REC, CAL.

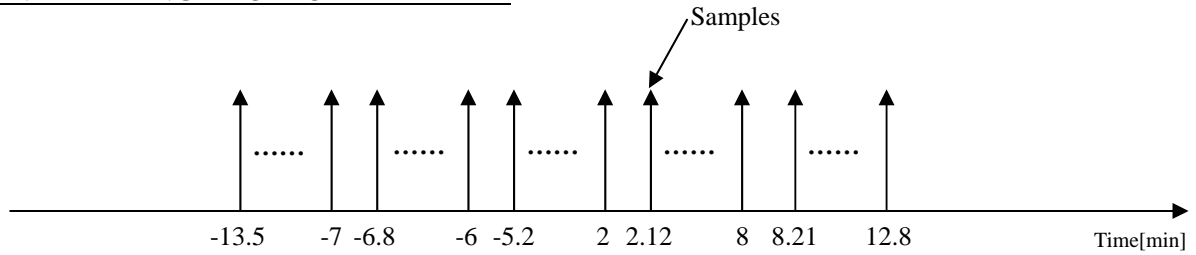
7) Start/End “Column” (Start time and End time of the activity)

Those columns specified the starting time and the ending time of each activities. NO GAPS (on time) ARE ALLOWED, see figures below:

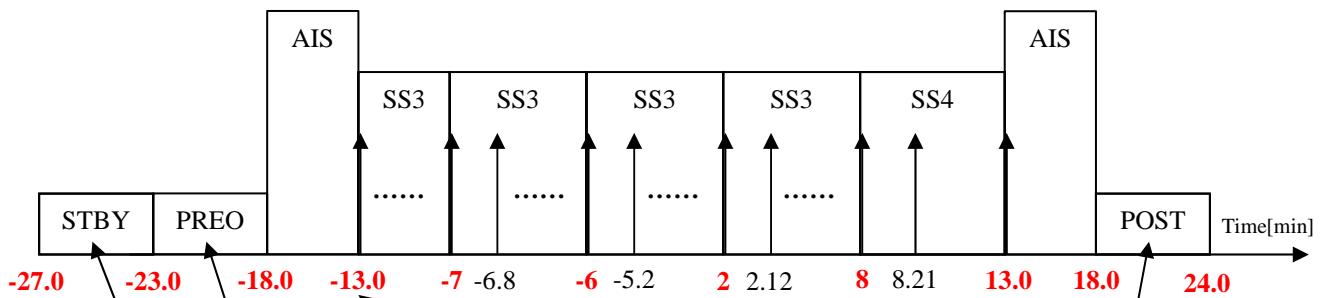


MEX/MARSIS

ORIGINAL TIMING FROM ORBIT TABLE



ADJUSTED TIMING

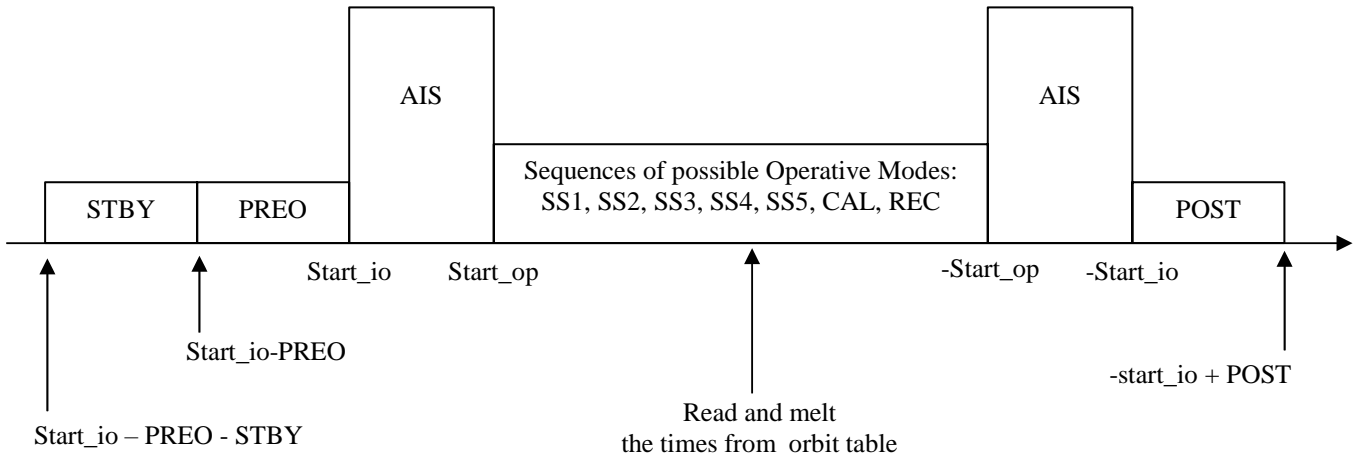


- It was -13.5, for the new value (-13.0) read, from the manual inputs, the start_op tag
- It was 12.8, for the new value (13.0) read, from the manual inputs the start_op tag, and Chang the sign
- If you want to perform AIS, it will start at Start_io (that is the time specified in manual inputs, in this case the value is -18)
- If you want to perform AIS, it will start at -Start_io (that is the time specified in manual inputs, in this case the value is 18)
- PREO is always performed and it will start 5 minutes (this time is specified in fixed input with the tag PREO) before the first operation (in this case the first operation is AIS)
- STBY is always performed and it will start 4 minutes (this time is specified in fixed input with the tag STBY) before PREO
- POST is always performed and it will stop 6 minutes (this time is specified in fixed input with the tag POST) after the last operation (in this case the last operation is AIS)

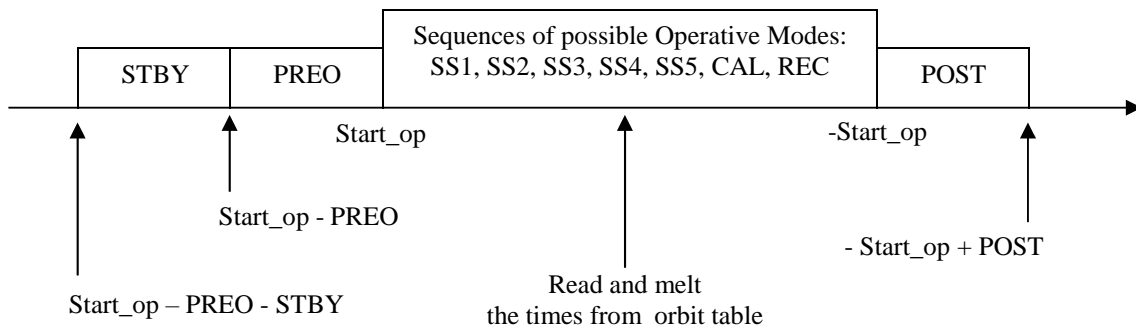


MEX/MARSIS

GENERAL TIMING WITH Active Ionosphere Sounding Mode

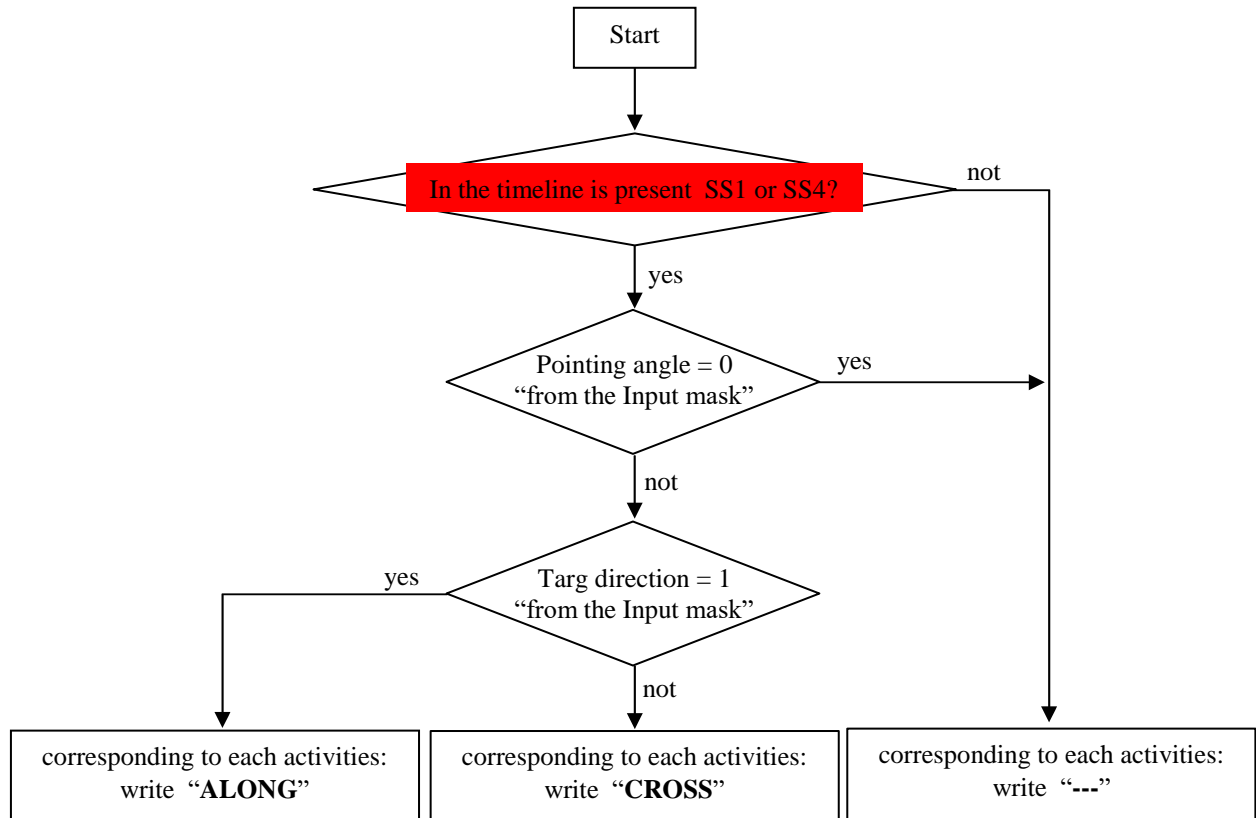


GENERAL TIMING WITHOUT Active Ionosphere Sounding Mode





8) Targ “Column”



9) Offdeg “Column”

In this column the value of the pointing must be specified for each “Targ”. Read the value from POINTING_ANGLE (Manual Inputs)

10) Band “Column”

In this column, for each activity (AIS, CAL, REC, SSX, X=1-5) we have to specify the frequency that produce the highest data rate. In order to do this read the Band value (Ba) from “Orbit Table”. For the following Operative Modes: AIS, CAR, REC the band (Ba) is fixed to 1.

11) RDF “Column”

For each activity (AIS, CAL, REC, SSX, X=1-5) write “1” in the RDF Column tag if the RDF tag value (Manual Inputs) is “1” otherwise write “0”



7.6 RULES TO FOLLOW TO COMPILE THE EXTENDED TIMELINE "INFOCOM Format"

- 1) In the first row write the orbit code
- 2) In the second row some useful information will be displayed, using the above criteria:

Science target = 1 if there is at least one sample in "Orbit Table" with Science_t=1, else Science target = 0.

Rank = 1 if there is at least one sample in "Orbit Table" with Rank=1, else Rank = 0.

Warning = 1 if there is at least one sample in "Orbit Table" with Warning=1, else Warning=0.

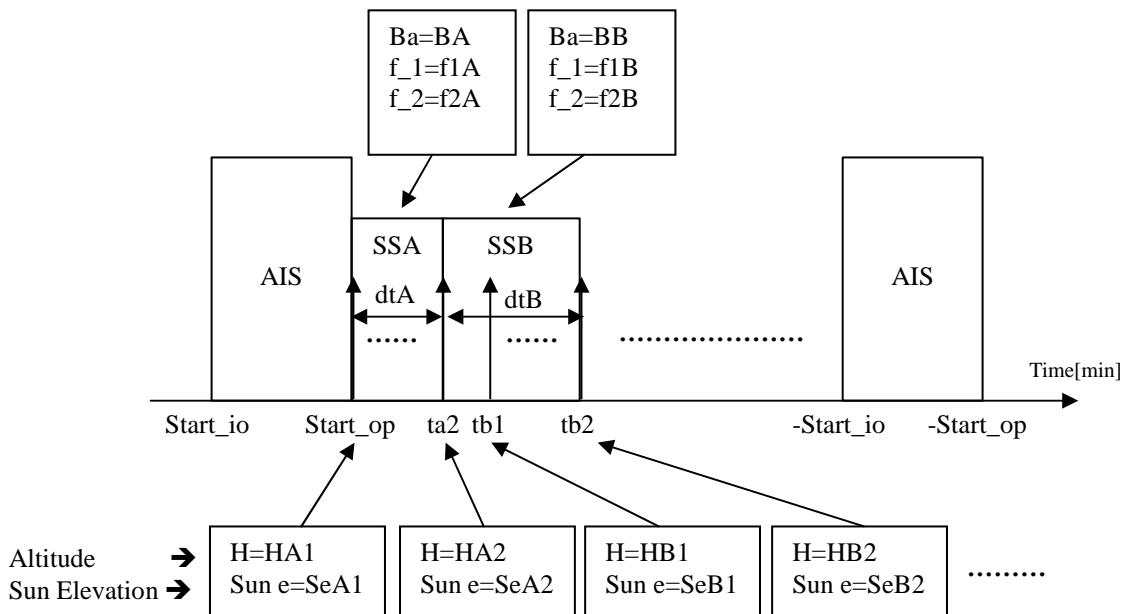
For the evaluation of the data volume produced from the timeline, see the procedure "Evaluate Data Volume" in the next paragraph.

- 3) The data format of the file if AIS is performed (see at AIS manual inputs) is:

```
Start_io [AIS] Start_op
Start_op (HA1) [SSA; SE=SeA1 : SeA2; f_1=f 1A f_2=f2A Ba=BA; dt=dtA] (HA2) ta2
      ta2 (HB1) [SSB; SE=SeB1 : SeB2; f_1=f 1B f_2=f2B Ba=BB; dt=dtB] (HB2) tb2
```

.....

```
-Start_op [AIS] -Start_io
```





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Where

SSA, SSB → generics Operatives Modes

dtA, dtB → duration of the single activities in [minutes]

4) The data format of the file if AIS is not performed (see at AIS manual inputs) is:

Start_op (HA1) [SSA; SE=SeA1 : SeA2; f_1=f 1A f_2=f2A Ba=BA; dt=dtA] (HA2) ta2
ta2 (HB1) [SSB; SE=SeB1 : SeB2; f_1=f 1B f_2=f2B Ba=BB; dt=dtB] (HB2) tb2

.....



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“MAKE TIMELINE”: INPUTS, OUTPUTS, CONSTANTS, VARIABLES

MANUAL INPUT

Symbol	Default value	Notes
Orbit to process	****	Orbit to process for the timeline
Start Operative time	-13.00	Start Operative time of the timeline
End Operative time	+13.00	End Operative time of the timeline
Active AIS	1	AIS=1 → Perform Active Ionosphere Sounding AIS=0 → Don't Perform Ionosphere Sounding
RDF	1	RDF=1 → Collect Row Data RDF=0 → Don't Collect Row Data
POINTING_ANGLE	-1.75	Request of pointing angle for the monopole
TARG DIRECTION	1	1 → ALONG 0 → CROSS

ORBIT TABLE INPUTs (From the Database)

Symbol	Units	Notes
Altitude	[Km]	Space Craft altitude
fpm	[Hz]	Plasma frequency
S_N_1	[dB]	Rank Classification tag
S_N_2	[dB]	Science Target tag
S_N_3	[dB]	Warning tag
S_N_4	[dB]	Final Operative Mode
Roughness_const	[m]	Constant roughness
Slpoe	[rad]	Slope along the SC direction

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Values	Units	CORISTA NOMENCLATURE
600	STBY	4	[min]	STBY
601	PREO	5	[min]	PREO
602	POST	6	[min]	POST
603	BFNOP	0	[Kbps]	BFNOP
604	BFSTBY	0.1	[Kbps]	BFSTBY
605	BFPREO	0.1	[Kbps]	BFPREO
606	BFPOST	0.1	[Kbps]	BFPOST
607	BFCAL	25.23	[Kbps]	BFCAL
608	BFREC	25.23	[Kbps]	BFREC
609	BFAIS	33.45	[Kbps]	BFAIS
610	BFSS1	32	[Kbps]	BFSS1
611	BFSS2	16	[Kbps]	BFSS2
612	BFSS3	48	[Kbps]	BFSS3
613	BFSS4	80	[Kbps]	BFSS4
614	BFSS5	48	[Kbps]	BFSS5
615	AuxDatarate	2.3	[Kbps]	AuxDatarate
616	RawDatarate	4	[Kbps]	RawDatarate



8 GLOBAL INPUTS

8.1 PLANNING TOOL PARAMETER TABLE (Fixed input from the database)

Function	Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
Orbit Segment Classification	100	thre_1	5	[deg]	SunThresholdA
	101	thre_2	40	[deg]	SunThresholdB
Ionosphere Modeling	200	a	8980	[]	a
	201	F	100	[]	SolarFlux
	202	Sun_thre	0	[deg]	SunThreshold
	203	$f_{p,night}$	0.8	[MHz]	PlasmaFrequencyAtNightSide
	204	$F_{fraction}$	5	[]	Ffraction
	205	ΔF	0	[MHz]	ChannelMargin
	206	const_faraday_rotation	$4.72 \cdot 10^4$	[]	FaradayRotationConstant
	207	Δh	20000	[m]	IonosphereThickness
	208	ϕ_thre	43	[deg]	FaradayAngleApproximation
	209	const_att_iono	24	[]	IonosphereAttenuationConstant
	210	const_att_faraday	20	[]	FaradayAttenuationConstant
	211	B	1	[MHz]	ChirpBandwidth
	212	Δ_{att}	0	[dB]	MarginOfAttenuation
213	$df_integration_step$	2000	[Hz]	IntegrationStep	
Make Timeline	600	STBY	4	[min]	STBY
	601	PREO	5	[min]	PREO
	602	POST	6	[min]	POST
	603	BF_NOP	0	[Kbps]	BFNOP
	604	BF_STBY	0.1	[Kbps]	BFSTBY
	605	BF_PREO	0.1	[Kbps]	BFPREO
	606	BF_POST	0.1	[Kbps]	BFPOST
	607	BF_CAL	25.23	[Kbps]	BFCAL
	608	BF_REC	25.23	[Kbps]	BFREC
	609	BF_AIS	33.45	[Kbps]	BFAIS
	610	BF_SS1	32	[Kbps]	BFSS1
	611	BF_SS2	16	[Kbps]	BFSS2
	612	BF_SS3	48	[Kbps]	BFSS3
	613	BF_SS4	80	[Kbps]	BFSS4
614	BF_SS5	48	[Kbps]	BFSS5	
615	AUX_DATARATE	2.3	[Kbps]	AuxDatarate	
616	RAW_DATA	4	[Kbps]	RawDatarate	



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Function	Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
Dynamic Evaluation	300	N_0	36	[]	PRIOffset
	301	PRF	127.267	[Hz]	PRF
	302	Ls_min	5,5	[Km]	MinSyntheticAperture
	303	R_d	150	[m]	RangeResolution
	304	LMax	150	[Km]	SARStripDimension
	305	H_thre	500	[Km]	HeighTreshold
	306	Roughness_50	1	[Boolean]	Roughness50 = 1 → Roughness at 50 Km Roughness50 = 0 → Roughness at 100 Km
	307	slope_50	1	[Boolean]	Slope_0 = 1 → Slope estimated at 50 Km Slope50 = 0 → Slope estimated at 100 Km
	308	$K\sigma$	4.5	[]	Kr
	309	$K\alpha$	4.5	[]	Ki
	310	d_{xy}	5000	[m]	CellDimension
	311	Δy	8	[]	dLambda
	312		4.9	[]	KrouseNoiseModel
	313	N_min	160	[Integer]	minPulses
	314		250	[μ sec]	TransmittedPulseDuration
	315	Power_1	1.8	[dB_w]	RadiatedPower1
	316	Power_2	1.8	[dB_w]	RadiatedPower2
	317	Power_3	1.8	[dB_w]	RadiatedPower3
	318	Power_4	1.8	[dB_w]	RadiatedPower4
	319	Z_{min}	1000	[m]	StartingInvestigationDepth
	320	ΔZ	150	[m]	DepthStep
	321	K_alfa_angle	3	[]	AlfaAngleCoefficient
	322	ΔA_{tt}	0	[dB]	SubSurfacePowerMargin
	323	$\Delta\sigma$	2		DeltaSigma
	324	R_{min}	10000	[m]	MinWarningDistance
325	R_{Max}	150000	[m]	MaxWarningDistance	



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Function	Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
Select OPM	400	thre_night	5	[deg]	NightTreshold
	401	sun_night_thre	-5	[deg]	SunNightTH
	402	sun_day_thre	5	[deg]	SunDayTH
	403	sun_day_deep_thre	30	[deg]	SunDeepDayTH
	404	fnotmon_D	5	[MHz]	MaxMonopoleFreqDay
	405	fnotmon_N	5	[MHz]	MaxMonopoleFreqNight
	406	F_{aN}	2	[index]	f1N
	407	F_{bN}	3	[index]	f2N
	408	F_{aD}	2	[index]	f1D
	409	F_{bD}	3	[index]	f2D
	410	F_{aA}	0	[index]	f1nc
	411	F_{bA}	0	[index]	f2nc
	412	F1	0	[index]	F1
	413	F2	1	[index]	F2
	414	F3	2	[index]	F3
	415	F4	3	[index]	F4
	416	F5	2	[index]	F5
	417	F6	3	[index]	F6
	418	F7	1	[index]	F7
	419	F8	2	[index]	F8
	420	SS4 ballerino	0	[index]	SS4 Dancer = 0 → SS4 with one freq. SS4 Dancer = 1 → SS4 with two freq.
	421	SSA	3	[index]	SSA
	422	SSB	3	[index]	SSB
	423	SSC	3	[index]	SSC
	424	SSD	4	[index]	SSD
	425	SSE	2	[index]	SSE
	426	SSF	2	[index]	SSF
	427	SSG	2	[index]	SSG
	428	SSH	1	[index]	SSH
	429	SSI	0	[index]	SSI
	430	SSL	3	[index]	SSL
	431	SSM	1	[index]	SSM
	432	SSN	2	[index]	SSN
433	SSO	3	[index]	SSO	



8.2 MANUAL INPUTS

Function	Symbol	Default	Units	Notes
Orbit Segment Classification	Classification type	1	[boolean]	Rank Classification = 1 → Orbit Rank classification Rank Classification = 0 → Load Science target
	Grid mode	0	[boolean]	Grid mode = 1 → Constant angle Grid (the area of the Cells is not constant) Grid mode = 0 → Constant area Grid (the area of the Cell is constant)
	<i>Grid_{area}</i> size	75	[Km]	Cell area dimension
	<i>Grid_{angle}</i> size	1.5	[deg]	Cell angle dimension
	H_min	250	[Km]	Minimum altitude (do not confuse with the minimum S/C working altitude)
	H_max	500	[Km]	Maximum altitude (do not confuse with the maximum S/C working altitude)
	dH	10	[Km]	Step size for the altitude
	SE_min_1	-90	[deg]	Minimum sun elevation for the Rank classification (first threshold)
	SE_min_2	5	[deg]	Minimum sun elevation for the Rank classification (second threshold)
	SE_min_3	15	[deg]	Minimum sun elevation for the Rank classification (third threshold)
	SE_max	0	[deg]	Maximum sun elevation for the Rank classification
	dSE	1	[deg]	Sun elevation step size
	lon_min	-180	[deg]	Minimum Longitude of investigation
	lon_max	+180	[deg]	Maximum Longitude of investigation
	lat_min	-89	[deg]	Minimum Latitude of investigation
lat_max	+89	[deg]	Maximum Latitude of investigation	
Dynamic Evaluation	N_Clutter	1	[Index]	Percentage number of clutter cancellation requests for the selection of the monopole
	Single Environmental	0	[Boolean]	1 → Consider only one material 0 → Consider all the possible materials
	Porosity	50	[Index]	Porosity of the interface (50%, 20%)
	Material	3	[Index]	Type of material (1,2,3)
	Interface	1	[Index]	Interface Type (D/I → 1, I/W → 0)



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Function	Symbol	Default	Units	Notes
Select Operative Mode	Planning Light	0	[index]	0 → Planning Tool Full 1 → Planning Tool Light
	Sun priority at pericenter	0	[index]	0 → The priority is given by the sun elevation value of selected orbit sample 1 → The priority is given by the sun elevation value of the pericenter orbit sample
Planning Map	Slope quantization s	1	[deg]	Slpoe quantization step
Make Timeline	Orbit to process		[Index]	Timeline orbit code
	Start operative time	-13.00	[minutes]	Start Operative time
	End operative time	+13.00	[minutes]	End Operative time
	AIS duration	+5	[minutes]	Active Ionosphere Sounding duration
	AIS	1	[boolean]	AIS=1 → Yes Active Ionosphere Sounding AIS=0 → Not Active Ionosphere Sounding
	RDF	1	[boolean]	RDF=1 → Yes Row Data RDF=0 → Not Row Data
	POINTING_ANGLE	-1.75	[deg]	Request of pointing angle for the monopole
TARG DIRECTION	1	[boolean]	1 → ALONG 0 → CROSS	

8.3 ORBITAL DATA INPUTS

Symbol	Internal Units	Notes
Time	[sec]	Time off Pericenter
Longitude	[deg]	Longitude of the projected orbit sample
Latitude	[deg]	Latitude of the projected orbit sample
Altitude	[Km]	Altitude of the Space Craft
Sun elevation	[deg]	Sun elevation value over the Mars surface
Tangential V	[m/s]	Tangential velocity of the Space craft

8.4 TARGETs list from the Database

1 Hellas
 Proposed by: Andrea C, on 15-Jan-2003
 Coordinates:0,-80 20,60



8.5 SURFACE STATISTICAL PARAMETERS - Cell of 5Kmx5Km –

	Symbol	Units	Notes
Punctual Surface Statistical Parameters	l_{cx}	[m]	Correlation length along X
	l_{cy}	[m]	Correlation length along Y
	l_c	[m]	Mean value of the correlation length
	α_x	[deg]	Cell's inclination along X
	α_y	[deg]	Cell's inclination along Y
	σ_h	[m]	Surface Roughness
	H_a	[]	Hurst coefficients
	Z	[m]	Mean value of the plane
	NMFM	[nT]	Normal Magnetic Field Magnitude
Global Surface Parameters For 50Km and 100 Km Raious region	$\overline{\sigma}_h$	[m]	Mean value of the roughness
	$\Delta\sigma_h$	[m]	Maximum displacement of the roughness
	σ_{σ_h}	[m]	Standard deviation of the Roughness
	α_x	[rad]	Mean value of the surface inclination angle
	$\Delta\alpha_x$	[rad]	Maximum displacement of the surface inclination angle
	σ_{α_x}	[deg]	Standard deviation of the surface inclination angle
	α_y	[deg]	Mean value of the surface inclination angle
	$\Delta\alpha_y$	[rad]	Maximum displacement of the surface inclination angle
	$\overline{\sigma}_{\alpha_y}$	[rad]	Standard deviation of the surface inclination angle
	\overline{H}_a	[]	Mean value of the Hurst coefficient
	l_c	[m]	Mean value of the correlation length



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8.6 SUB SURFACE MATERIALS - Cell of 5Kmx5Km -

Symbol	Possible Values	Units	Notes
ϵ_R	5; 7.1; 9	[]	Dielectric Constant of the Sub surface estimated material
Interface	1 → I/W 2 → D/I	[Integer]	Type of Interface. I/W (Ice, Water) or D/I (Dry, Ice)
Porosity	50; 20	[%]	Percentage of porosity

8.7 α_{SS} COEFFICIENTS PARAMETERS

		Dense basalte I-1			Dense basalte II-2			Layered basalt III		
		a	b	c	A	b	c	a	b	c
	ϵ_r	5	0	0	9	0	0	7.1	0	0
I/W	50 %	0.02	-2.97	-1.52	-1.23	-3	-14.53	-0.66	-2.99	-6.14
	20 %	-8.23	-3.03	-1.58	-9.98	-3.05	-15.53	-9.25	-3.04	-6.48
D/I	50 %	-8.09	-3.30	-1.39	-14.44	-3.41	-13.67	-11.91	-3.37	-5.71
	20 %	-19.54	-3.17	-1.52	-25.74	-3.2	-15.17	-23.27	-3.18	-6.31



9 GLOBAL OUTPUTS

9.1 ORBITAL DATA OUTPUTS

Symbol	Units	Notes
Rank	[Index]	Rank classification (Value:1,2,3,4)
Science_t	[bit]	Science targets (Values: 1, 0)
fpm	[Hz]	Maximum plasma frequency
Att_tot	[dB]	Ionosphere attenuation + Faraday attenuation
S_N	[dB]	Signal to Noise
Roughness	[m]	Roughness
Depth_noise	[m]	Penetration depth (noise limitation)
Depth_clutter	[m]	Penetration depth (clutter limitation)
Mon	[bit]	Monopole Selection (Values: 1, 0)
Stationary	[integer]	0➔ Not stationary Surface 1➔ Stationary on a large scale, coherent 2➔ Stationary on a large scale, coherent+ geometric 3➔ Local stationary, coherent 4➔ Local stationary, coherent + geometric
Roughness_const	[m]	Constant roughness
Warning	[bit]	Constant roughness (Values: 1, 0)
Slope	[rad]	Starting/Ending Slope
OPM	[Integer]	Starting/Ending Operative Mode
f1	[MHz]	First Radar Channel (Starting/Ending)
f2	[MHz]	Second Radar Channel (Starting/Ending)

9.2 HOLES

Lat inf	Lon inf	Lat sup	Lon sup	Size	Size
SX	SX	SX	SX	area	angle
*	*	*	*	*	*
*	*	*	*	*	*
*	*	*	*	*	*

9.3 OUTPUT SCIENCE TARGETs (table in the DB)

```

SCIENCE TARGETS COVERAGE DATA AS OF: 02-Jan-1999

1 Hellas
Proposed by: Andrea C, on 15-Jan-2003
Coordinates:0,-80 20,60

ORBIT T_BEGIN T_END DT S_BEGIN S_END H_BEGIN H_END
      8      3.48  8.49  5.01  47.1  36.9  318  514
.....

```



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9.4 EXTENDED TIMELINE

ORBIT=0100
 Science target=1; Rank=1, Warning=1
 -18 [AIS] -13.00
 -13.00(800) [SS3; SE=-37°:5°; f_1=1.8 f_2=3.0 Ba=1; dt= 6.00] (500) -7.00
 -7.00(530) [SS3; SE=10°: 25°; f_1=3.0 f_2=4.0 Ba=2; dt= 1.00] (600) -6.00
 -6.00(625) [SS3; SE= 30°: 60°; f_1=4.0 f_2=5.0 Ba=3; dt= 8.00] (680) 2.00
 2.00 (700) [SS3; SE= 63°: 68°; f_1=4.0 f_2=5.0 Ba=3; dt= 6.00] (750) 8.00
 8.00(770) [SS4; SE= -10°: -20°; f_1=1.8 f_2=3.0 Ba=1; dt= 5.00] (820) 13.00
 13 [AIS] 18.00

9.5 MARSIS FILE

Identifier	Start	End	Comment							
0100-0100-SSRA	100	100	ssra variable rate test							
Orbit	Point	Rank	Instr	Activ	Start	End	Targ	offdeg	Band	RDF
100	NOP	3	SSRA	STBY	-27.00	-23.00				
100	NOP	3	SSRA	PREO	-23.00	-18.00				
100	NAD	3	SSRA	AIS	-18.00	-13.00	ALONG	-1.75	1	1
100	NAD	3	SSRA	SS3	-13.00	-7.00	ALONG	-1.75	1	1
100	NAD	3	SSRA	SS3	-7.00	-6.00	ALONG	-1.75	2	1
100	NAD	3	SSRA	SS3	-6.00	2.00	ALONG	-1.75	3	1
100	NAD	3	SSRA	SS3	2.00	8.00	ALONG	-1.75	3	1
100	NAD	3	SSRA	SS4	8.00	13.00	ALONG	-1.75	1	1
100	NAD	3	SSRA	AIS	13.00	18.00	ALONG	-1.75	1	1
100	NOP	3	SSRA	POST	18.00	24.00				



10 GRAPHICAL INTERFACE

All the Gui details provides in this chapter are to be considered as suggestion only. The practical implementation shall be agreed with the supplier.

CLASSIFICATION UTILITY	PLANNING UTILITY				
Classification (Rank & Science Targets)	Ionosphere Modeling	Dynamic Evaluation	Select Operative Modes	Planning Map	Make Timeline
<div data-bbox="134 788 470 1081"> <p>Define Orbits Range</p> <p><input type="text" value="100"/> First orbit</p> <p><input type="text" value="110"/> Last orbit</p> <p><input type="text" value="5"/> Orbit Step size</p> </div> <div data-bbox="167 1180 437 1279"> <p>RUN Classification</p> </div>	<div data-bbox="845 797 1227 1041"> <p>Define Orbits Range</p> <p><input type="text" value="100"/> First orbit</p> <p><input type="text" value="110"/> Last orbit</p> </div> <div data-bbox="879 1202 1147 1301"> <p>RUN Planning</p> </div>				



MEX/MARSIS

CLASSIFICATION MASK

Classification (Rank & Science t)	Ionosphere Modeling	Dynamic Evaluation	Select Operative Modes	Planning Map	Make Timeline
Rank Classification			Load Science Targets		
<p>Set Working Mode</p> <p><input checked="" type="checkbox"/> Grid Area Mode</p> <p><input type="text" value="75"/> Grid Area Size [Km]</p> <p><input type="checkbox"/> Grid Angle mode</p> <p><input type="text" value="1,5"/> Grid Angle size [deg]</p>					
<p>Define Mars Classification Area</p> <p><input type="text" value="-89"/> Lat_min [deg]</p> <p><input type="text" value="+89"/> Lat_Max [deg]</p> <p><input type="text" value="-180"/> Lon_min [deg]</p> <p><input type="text" value="180"/> Lon_Max [deg]</p>					
<p>Set Parameters</p> <p><input type="text" value="250"/> H_min [Km]</p> <p><input type="text" value="500"/> H_Max [Km]</p> <p><input type="text" value="10"/> dH [Km]</p> <p><input type="text" value="-90"/> SE_min_1 [deg]</p> <p><input type="text" value="5"/> SE_min_2 [deg]</p> <p><input type="text" value="15"/> SE_min_3 [deg]</p> <p><input type="text" value="0"/> SE_max</p> <p><input type="text" value="1"/> dSE [deg]</p>					
<input type="checkbox"/> Enable Function			<input type="checkbox"/> Enable Function		



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IONOSPHERE MODELING MASK

Classification (Rank & Science t)	Ionosphere Modeling	Dynamic Evaluation	Select Operative Modes	Planning Map	Make Timeline
<p>NO MANUAL INPUT</p> <p><input type="checkbox"/> Enable Function</p>					



MEX/MARSIS

DYNAMIC EVALUATION MASK

Classification (Rank & Science t)	Ionosphere Modeling	Dynamic Evaluation	Select Operative Modes	Planning Map	Make Timeline
<div style="border: 1px solid black; padding: 10px; margin: 10px auto; width: 80%;"><p style="text-align: center;">Set Environmental Parameters</p><p><input type="text" value="1"/> Monopole threshold [Index]</p><div style="border: 1px solid black; padding: 5px; margin-top: 10px;"><p style="text-align: center;">Single Environmental</p><p><input checked="" type="checkbox"/> <input type="text" value="50%"/> Porosity (50%, 20 %)</p><p><input type="text" value="III"/> Material (I, II, III)</p><p><input type="text" value="D/I"/> Interface (D/I, I/W)</p><hr style="border-top: 1px dashed black;"/><p><input type="checkbox"/> Complete Environmental</p></div><p style="text-align: center; margin-top: 10px;"><input type="checkbox"/> Enable Function</p></div>					



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SELECT OPERATIVE MODES MASK

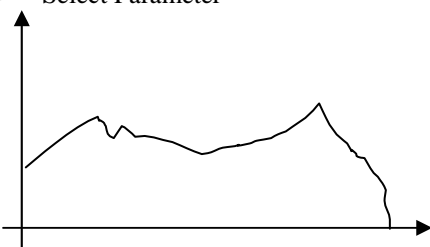
Classification (Rank & Science t)	Ionosphere Modeling	Dynamic Evaluation	Select Operative Modes	Planning Map	Make Timeline
<div data-bbox="592 633 1083 862" style="border: 1px solid black; padding: 10px; margin: 10px auto; width: fit-content;"><p>Set Working Mode</p><p><input type="checkbox"/> Planning Tool Light</p><p><input type="checkbox"/> Sun Priority at Pericenter</p></div> <p style="text-align: center;"><input type="checkbox"/> Enable Function</p>					



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PLANNING MAP MASK

Classification (Rank & Science t)	Ionosphere Modeling	Dynamic Evaluation	Select Operative Modes	Planning Map	Make Timeline
<div data-bbox="288 689 810 1084" data-label="Figure"><p>Plot Parameters</p><ul style="list-style-type: none">Select Parameter</div> <div data-bbox="1023 689 1390 734" data-label="Text"><p>1 Slope quantization [deg]</p></div>					



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MAKE TIMELINE MASK

Classification (Rank & Science t)	Ionosphere Modeling	Dynamic Evaluation	Select Operative Modes	Planning Map	Make Timeline		
<table border="1"><tr><td><p>Set Working Mode</p><p><input checked="" type="checkbox"/> Active Ionosphere Mode</p><p><input checked="" type="checkbox"/> Row Data Flag</p></td><td><p>Set Parameters</p><p><input type="text" value="-13"/> Start Operation [min]</p><p><input type="text" value="+13"/> End Operation [min]</p><p><input type="text" value="+1"/> AIS duration [min]</p><hr/><p><input type="text" value="-1.75"/> Pointing Angle</p><p><input checked="" type="checkbox"/> ALONG Track</p><p><input type="checkbox"/> CROSS Track</p></td></tr></table> <p><input type="checkbox"/> Enable Function</p>						<p>Set Working Mode</p> <p><input checked="" type="checkbox"/> Active Ionosphere Mode</p> <p><input checked="" type="checkbox"/> Row Data Flag</p>	<p>Set Parameters</p> <p><input type="text" value="-13"/> Start Operation [min]</p> <p><input type="text" value="+13"/> End Operation [min]</p> <p><input type="text" value="+1"/> AIS duration [min]</p> <hr/> <p><input type="text" value="-1.75"/> Pointing Angle</p> <p><input checked="" type="checkbox"/> ALONG Track</p> <p><input type="checkbox"/> CROSS Track</p>
<p>Set Working Mode</p> <p><input checked="" type="checkbox"/> Active Ionosphere Mode</p> <p><input checked="" type="checkbox"/> Row Data Flag</p>	<p>Set Parameters</p> <p><input type="text" value="-13"/> Start Operation [min]</p> <p><input type="text" value="+13"/> End Operation [min]</p> <p><input type="text" value="+1"/> AIS duration [min]</p> <hr/> <p><input type="text" value="-1.75"/> Pointing Angle</p> <p><input checked="" type="checkbox"/> ALONG Track</p> <p><input type="checkbox"/> CROSS Track</p>						