MARSIS

Planning Tool Algorithms and Criteria to Select Operative Modes

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CONTENTS

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:

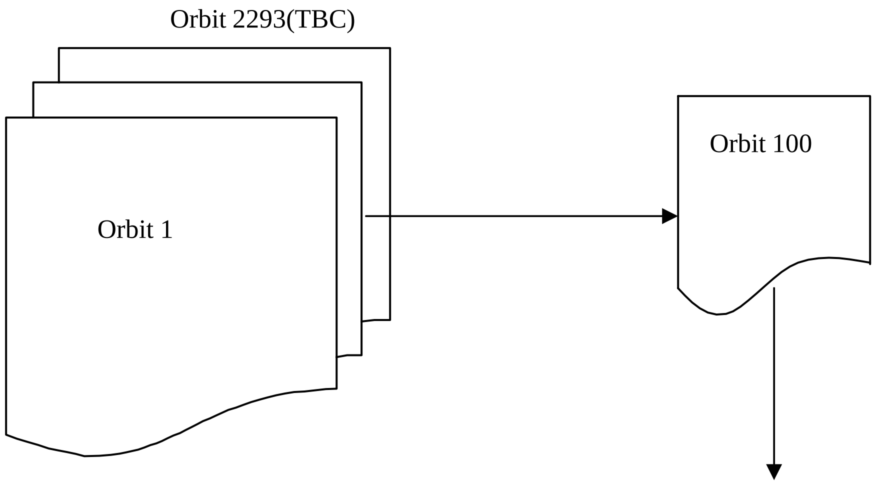
- Orbit segment classification useful for negotiation in case of conflicts (data rate, power requirements, manoeuvres, etc.) with S/C and other instruments.
- Ionosphere modeling
- Dynamic evaluation
- Operative mode selection criteria
- Definition of orbit timeline (operative mode selection and timeline)

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

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

2 ORBIT SEGMENT CLASSIFICATION



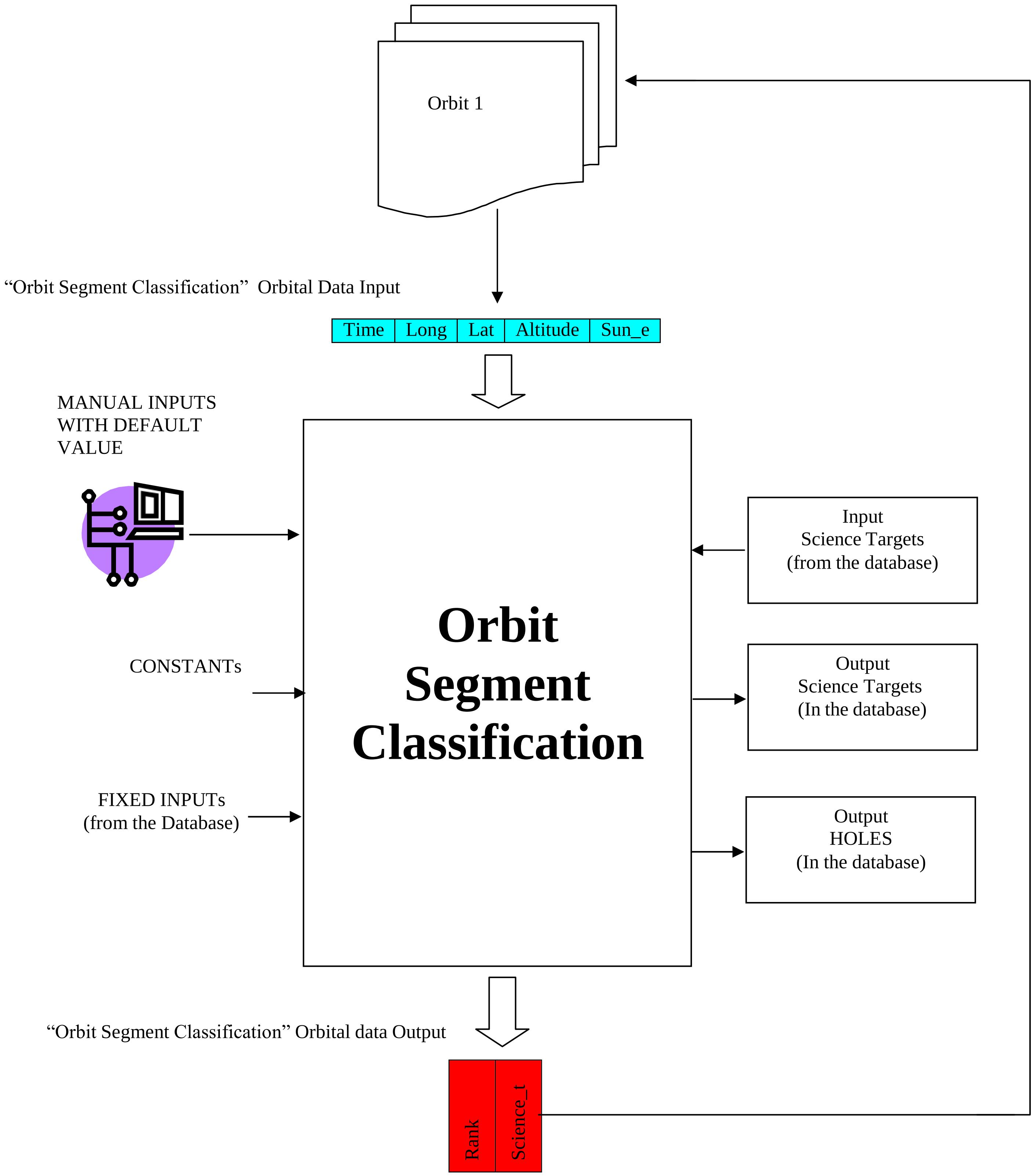
									1.8 MHz (Ch1)							3 MHz (Ch2)							4 MHz (Ch3)							5 MHz (Ch4)												
Time[sec]	Long[deg]	Lat[deg]	Altit[Km]	Sun_e [deg]	Vtan[m/s]	Rank [Index]	Scienc_t[Index]	fpm [Hz]	Att_tot_1 [dB]	S_N_1 [dB]	roughness_1 [m]	depth_noise_1[m]	depth_clutter_1[m]	Mon_1 [Index]	Stationary1[Index]	Att_tot_2 [dB]	S_N_2 [dB]	roughness_2 [m]	depth_noise_2[m]	depth_clutter_2[m]	Mon_2 [Index]	Stationary2[Index]	Att_tot_3 [dB]	S_N_3 [dB]	roughness_3 [m]	depth_noise_3[m]	depth_clutter_3[m]	Mon_3 [Index]	Stationary3[Index]	Att_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]	Slpoe [rad]	OPM [Index]	f1 [Index]	f2 [Index]
*	*	*	*	*		*	*																																			
*	*	*	*	*		*	*																																			
*	*	*	*	*		*	*																																			
*	*	*	*	*		*	*																																			
*	*	*	*	*		*	*																																			

In Out

In ➔"Orbit Segment Classification" Orbital Data Input

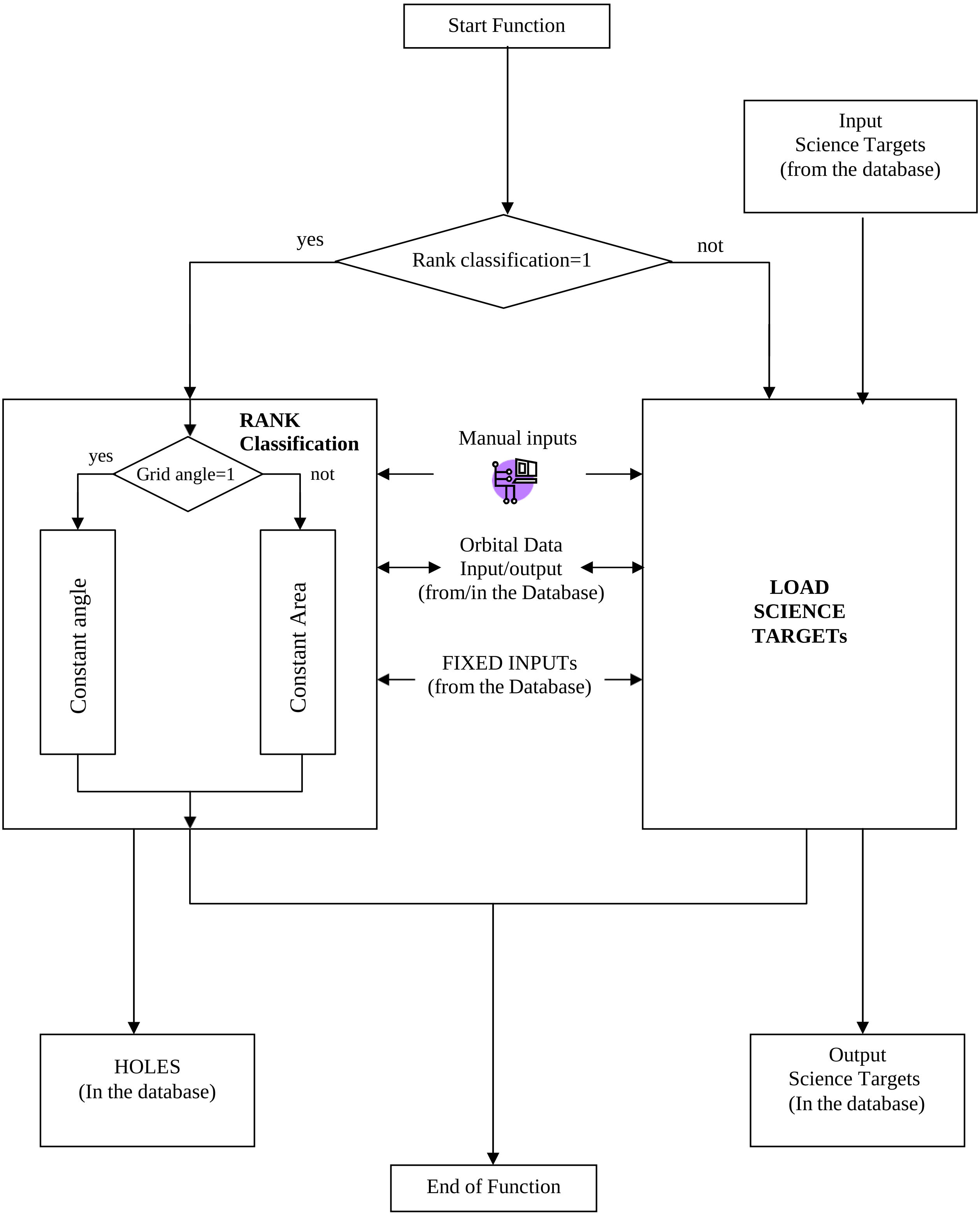
Out ➔ "Orbit Segment Classification" Orbital data Output

2.1 CONTEST



Orbit 1
“Orbit Segment Classification” Orbital Data Input
Time
Long
Lat
Altitude
Sun_e
MANUAL INPUTS
WITH DEFAULT
VALUE
CONSTANTs
FIXED INPUTs
(from the Database)
Orbit
Segment
Classification
Input
Science Targets
(from the database)
Output
Science Targets
(In the database)
Output
HOLES
(In the database)
“Orbit Segment Classification” Orbital data Output
Rank
Science_t

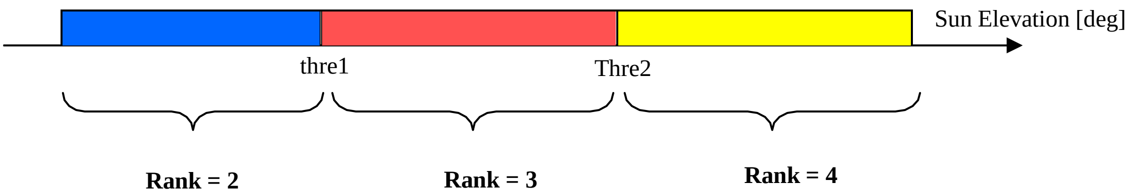
2.2 TOP LEVEL DATA FLOW



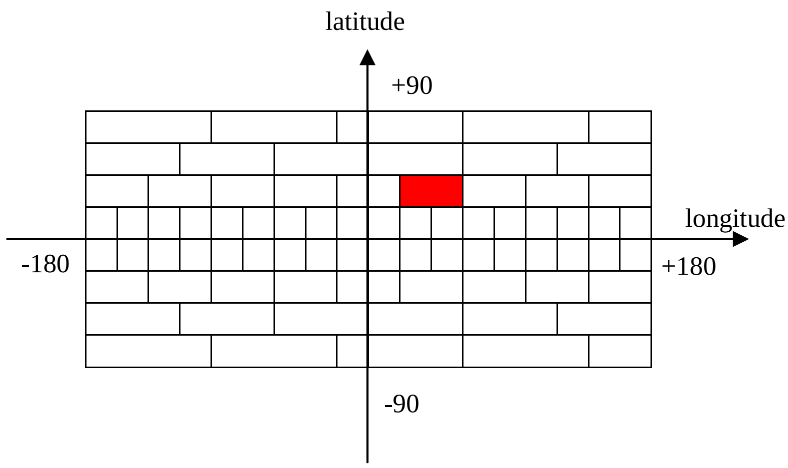
2.2.1 Rank Classification

INTRODUCTION

- **Rank "2, 3, 4" Assignment**

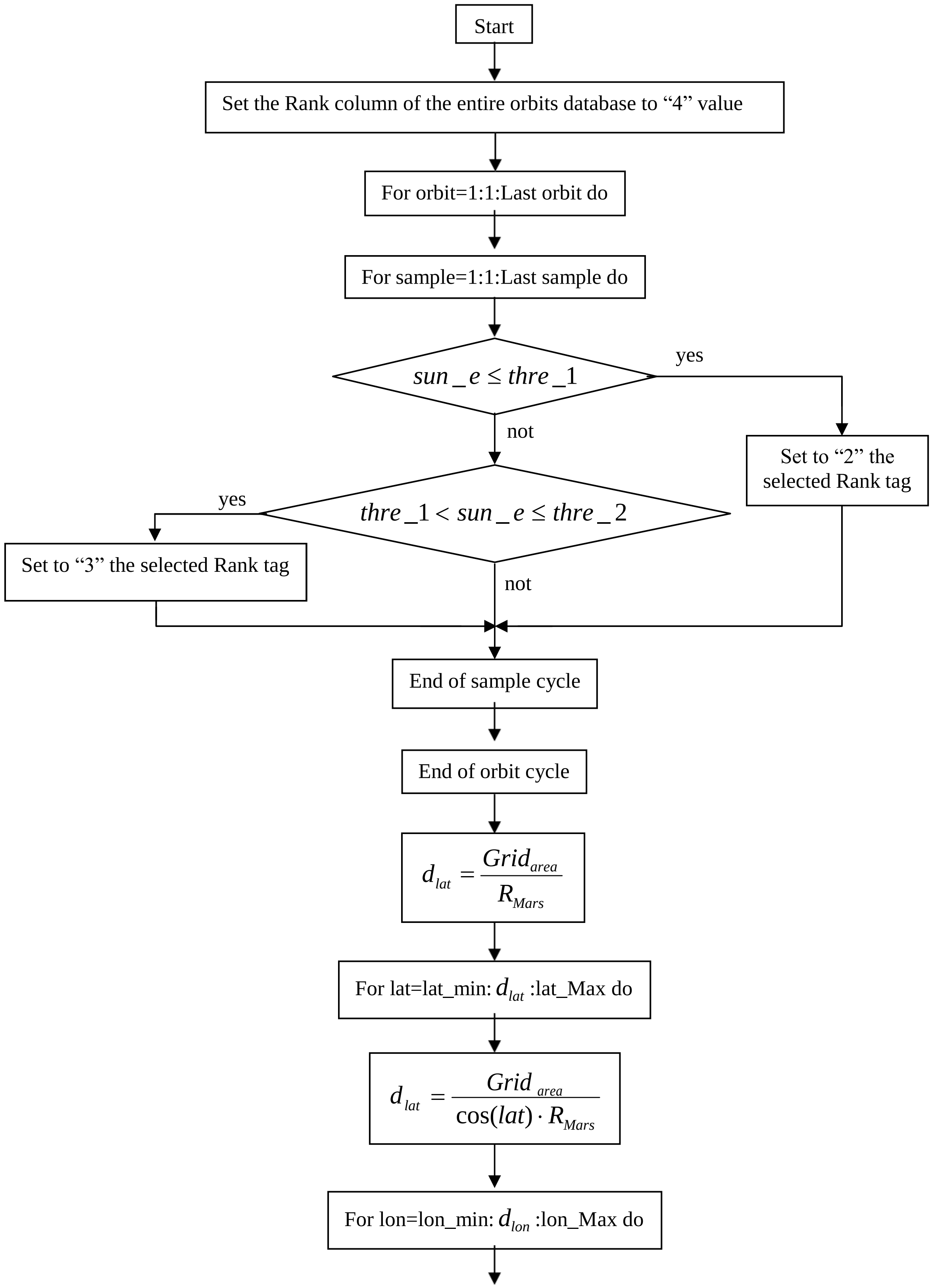


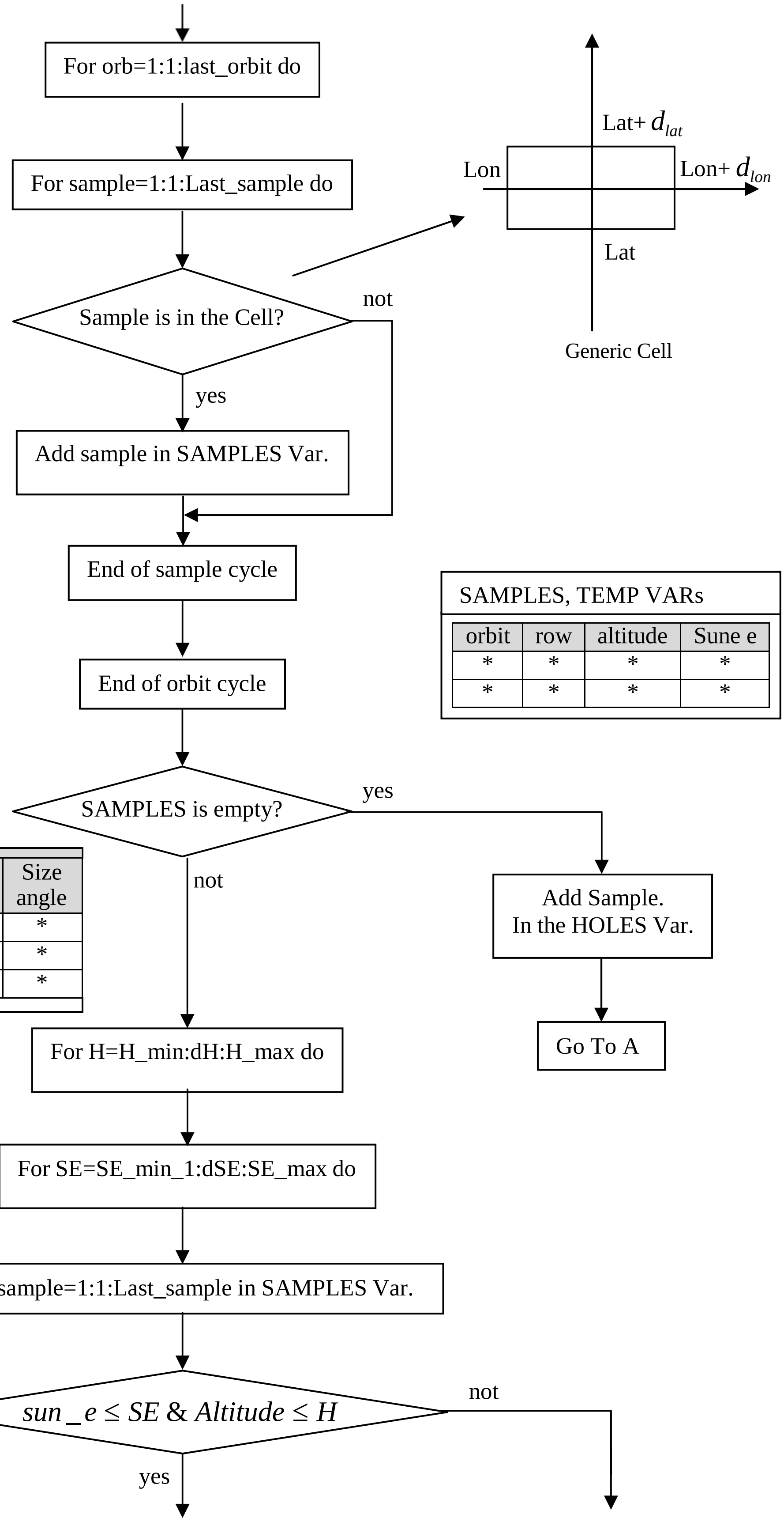
- **Rank "1" Assignment**



- 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

2.2.1.1 Rank Classification with a grid of constant area



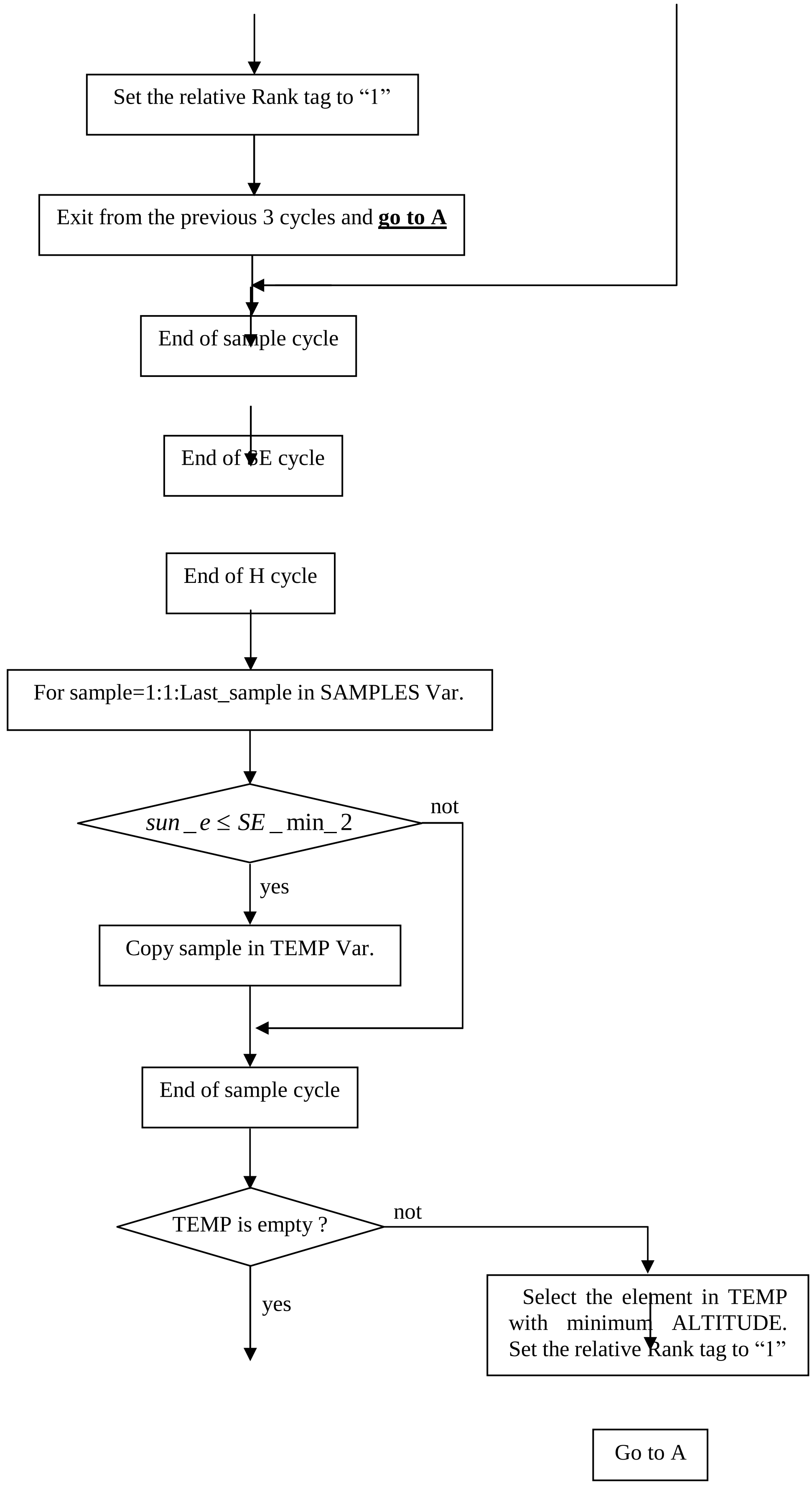


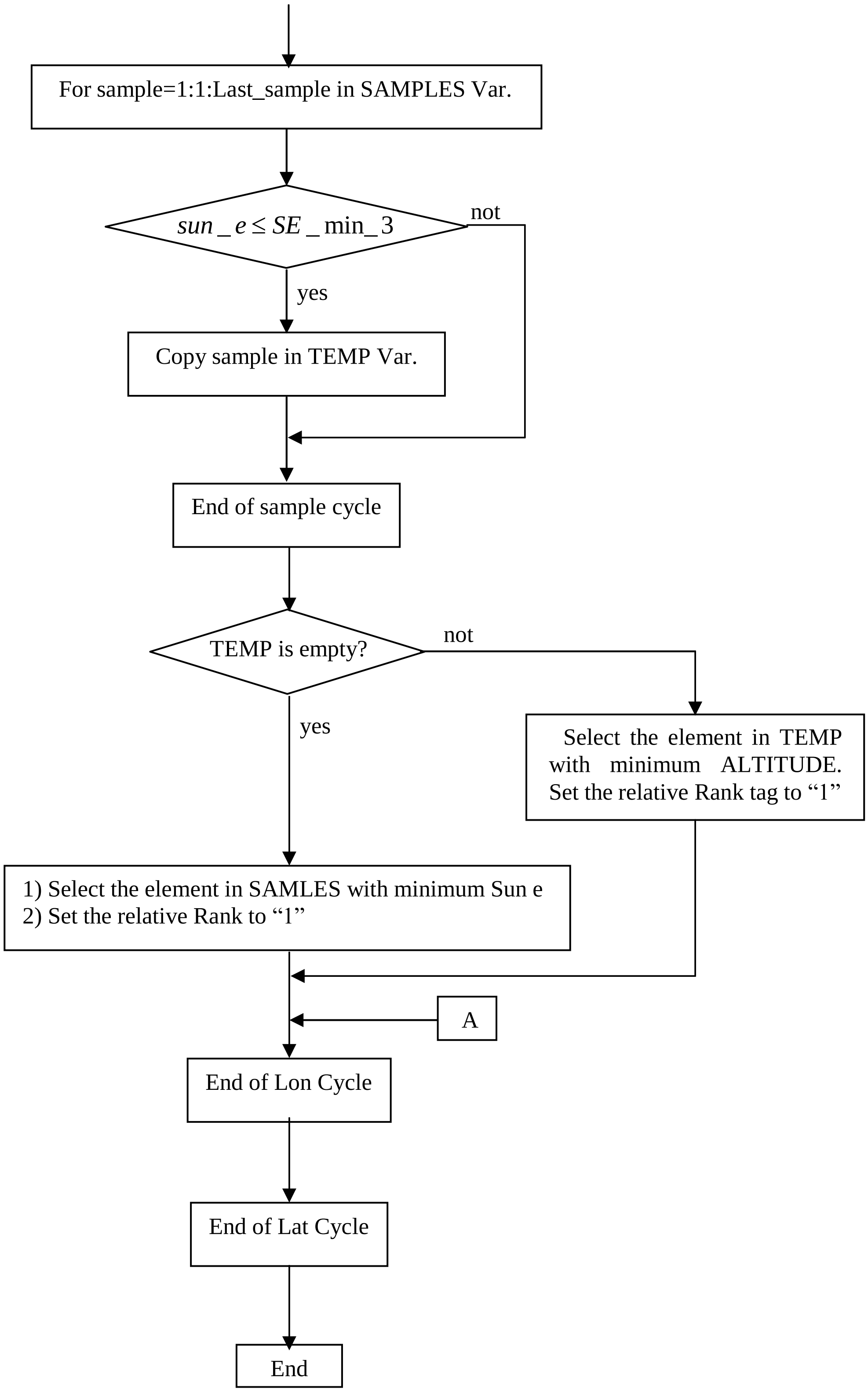
SAMPLES, TEMP VARs

orbit	row	altitude	Sune e
*	*	*	*
*	*	*	*

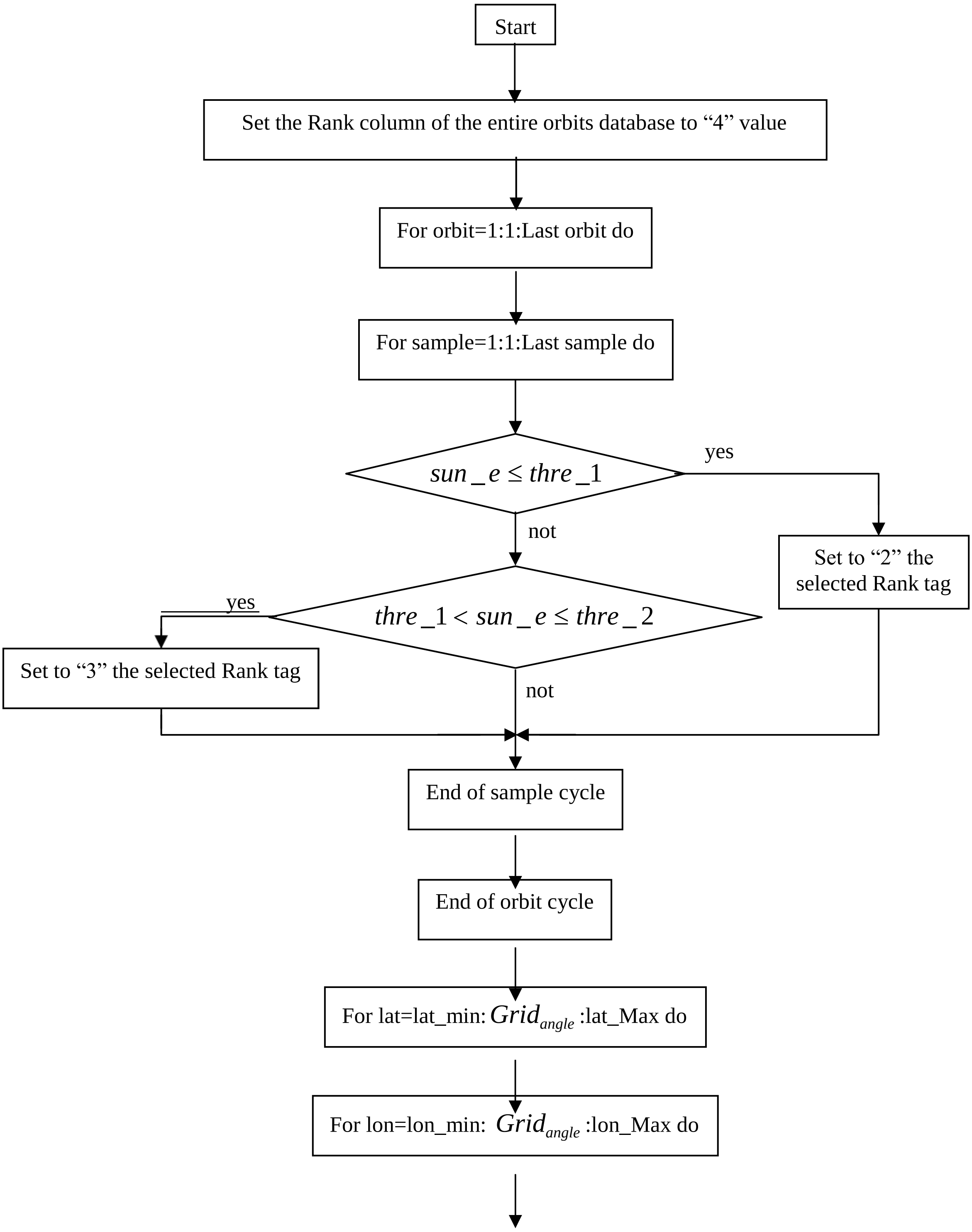
HOLES

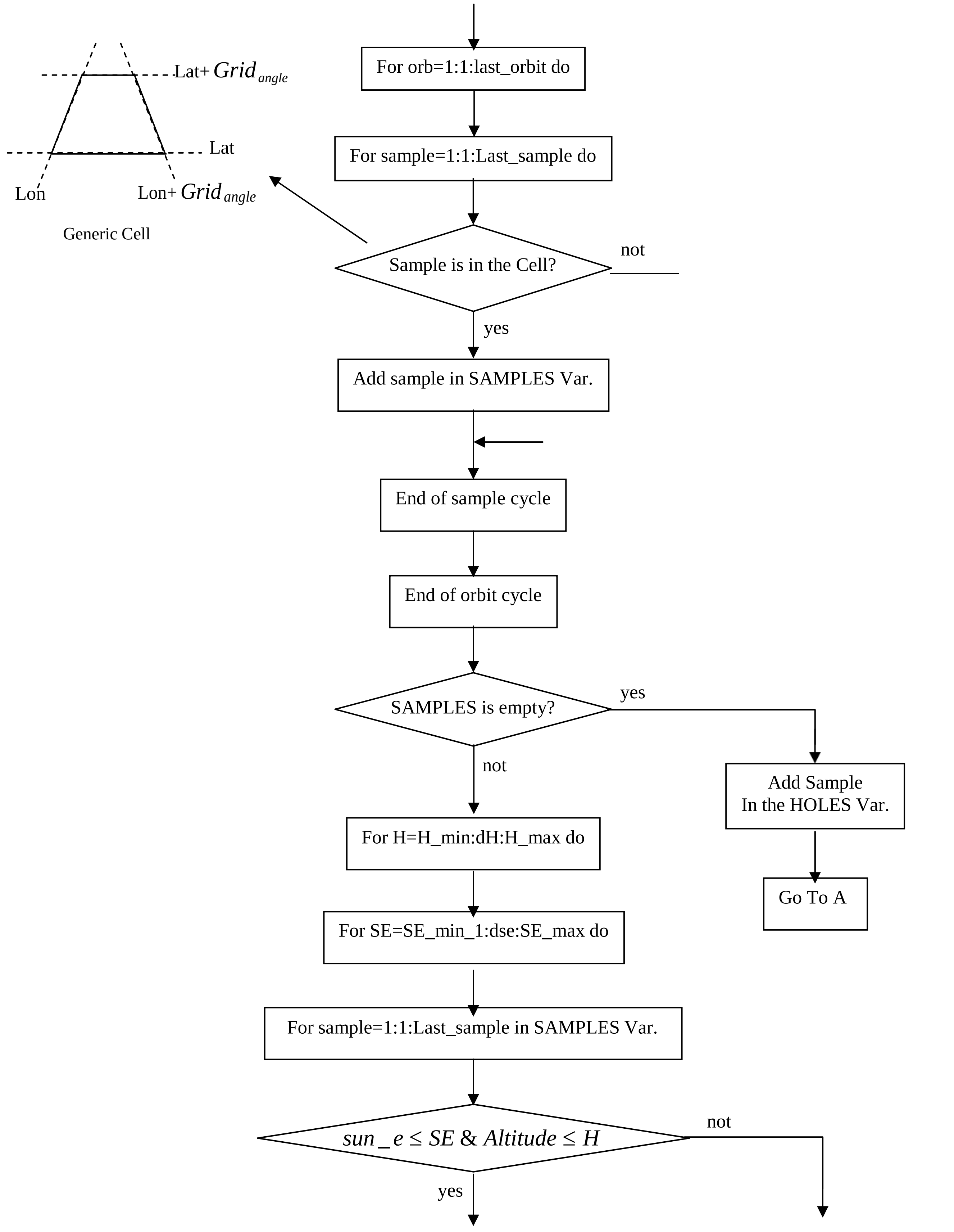
Lat inf	Lon inf	Lat sup	Lon sup	Size area	Size angle
*	*	*	*	*	*
*	*	*	*	*	*
*	*	*	*	*	*

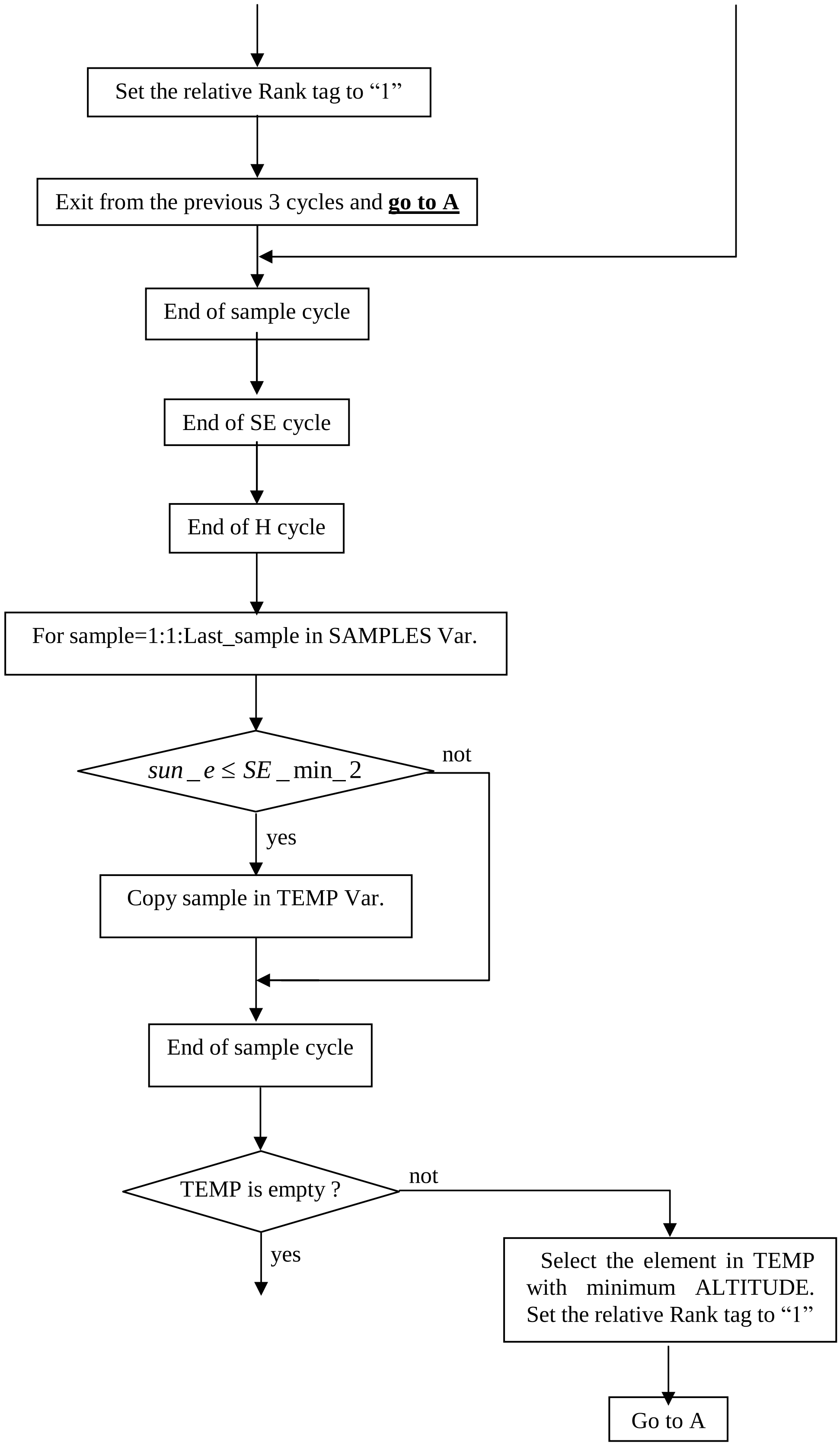

Set the relative Rank tag to “1”
Exit from the previous 3 cycles and **go to A**
End of sample cycle
End of SE cycle
End of H cycle
For sample=1:1:Last_sample in SAMPLES Var.
$sun\_e \leq SE\_min\_2$
not
yes
Copy sample in TEMP Var.
End of sample cycle
TEMP is empty ?
not
yes
Select the element in TEMP with minimum ALTITUDE. Set the relative Rank tag to “1”
Go to A

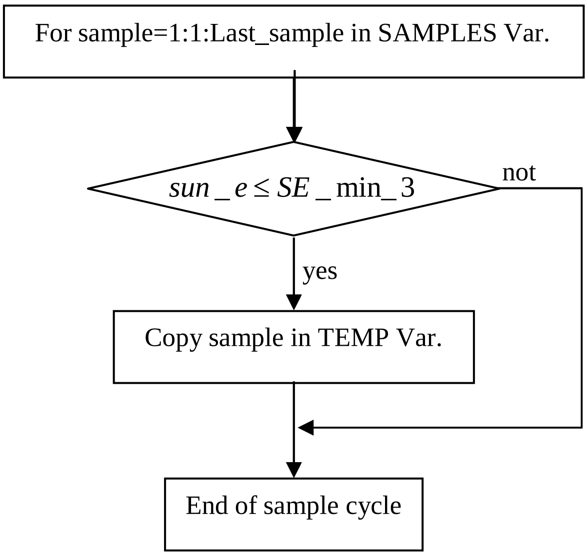

For sample=1:1:Last_sample in SAMPLES Var.
$sun\_e \leq SE\_min\_3$
not
yes
Copy sample in TEMP Var.
End of sample cycle
TEMP is empty?
not
yes
Select the element in TEMP with minimum ALTITUDE. Set the relative Rank tag to "1"
1) Select the element in SAMLES with minimum Sun e
2) Set the relative Rank to "1"
A
End of Lon Cycle
End of Lat Cycle
End

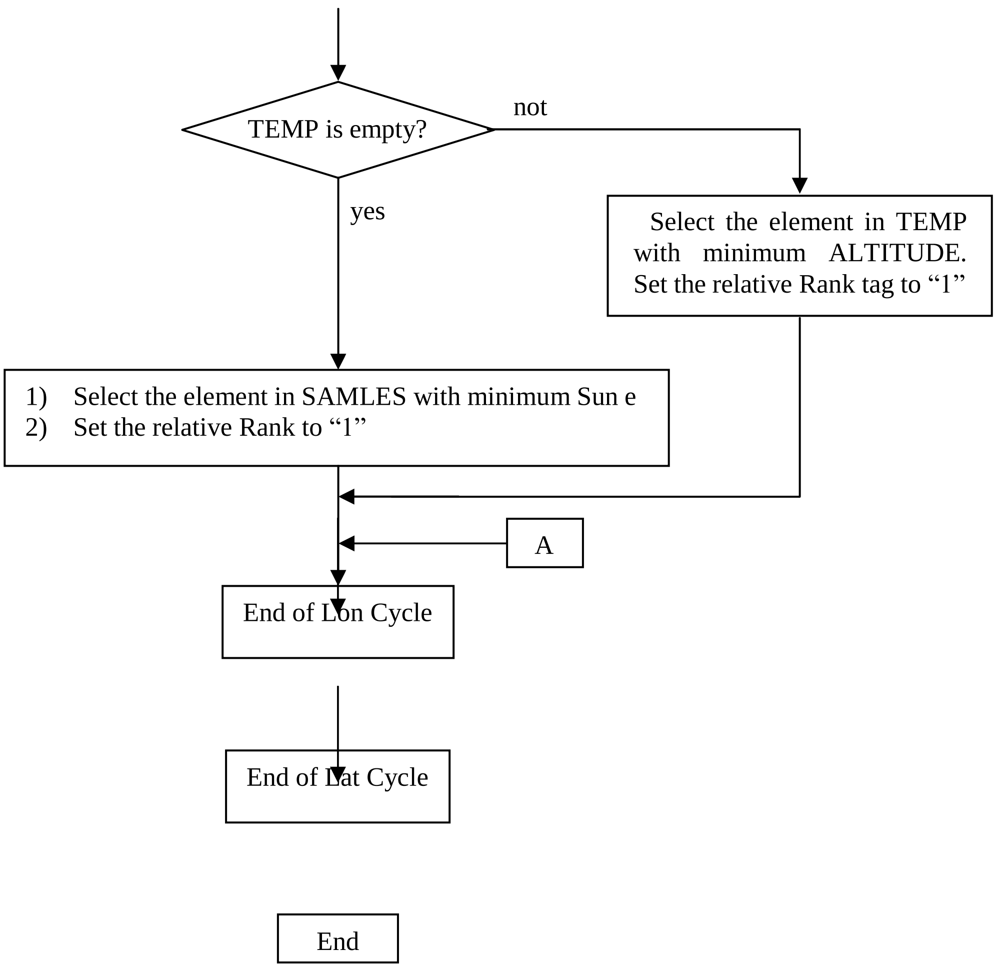
2.2.1.2 *Rank classification with a grid of constant angle*




Lat+ Grid angle
Lat
Lon
Lon+ Grid angle
Generic Cell
For orb=1:1:last_orbit do
For sample=1:1:Last_sample do
Sample is in the Cell?
not
yes
Add sample in SAMPLES Var.
End of sample cycle
End of orbit cycle
SAMPLES is empty?
yes
not
Add Sample
In the HOLES Var.
Go To A
For H=H_min:dH:H_max do
For SE=SE_min_1:dse:SE_max do
For sample=1:1:Last_sample in SAMPLES Var.
sun_e ≤ SE & Altitude ≤ H
not
yes


Set the relative Rank tag to "1"
Exit from the previous 3 cycles and go to A
End of sample cycle
End of SE cycle
End of H cycle
For sample=1:1:Last_sample in SAMPLES Var.
$sun\_e \leq SE\_min\_2$
not
yes
Copy sample in TEMP Var.
End of sample cycle
TEMP is empty ?
not
yes
Select the element in TEMP with minimum ALTITUDE. Set the relative Rank tag to "1"
Go to A


For sample=1:1:Last_sample in SAMPLES Var.
sun_e ≤ SE_min_3
not
yes
Copy sample in TEMP Var.
End of sample cycle


TEMP is empty?
not
yes
Select the element in TEMP with minimum ALTITUDE. Set the relative Rank tag to "1"
1) Select the element in SAMLES with minimum Sun e
2) Set the relative Rank to "1"
A
End of Lon Cycle
End of Lat Cycle
End

"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

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

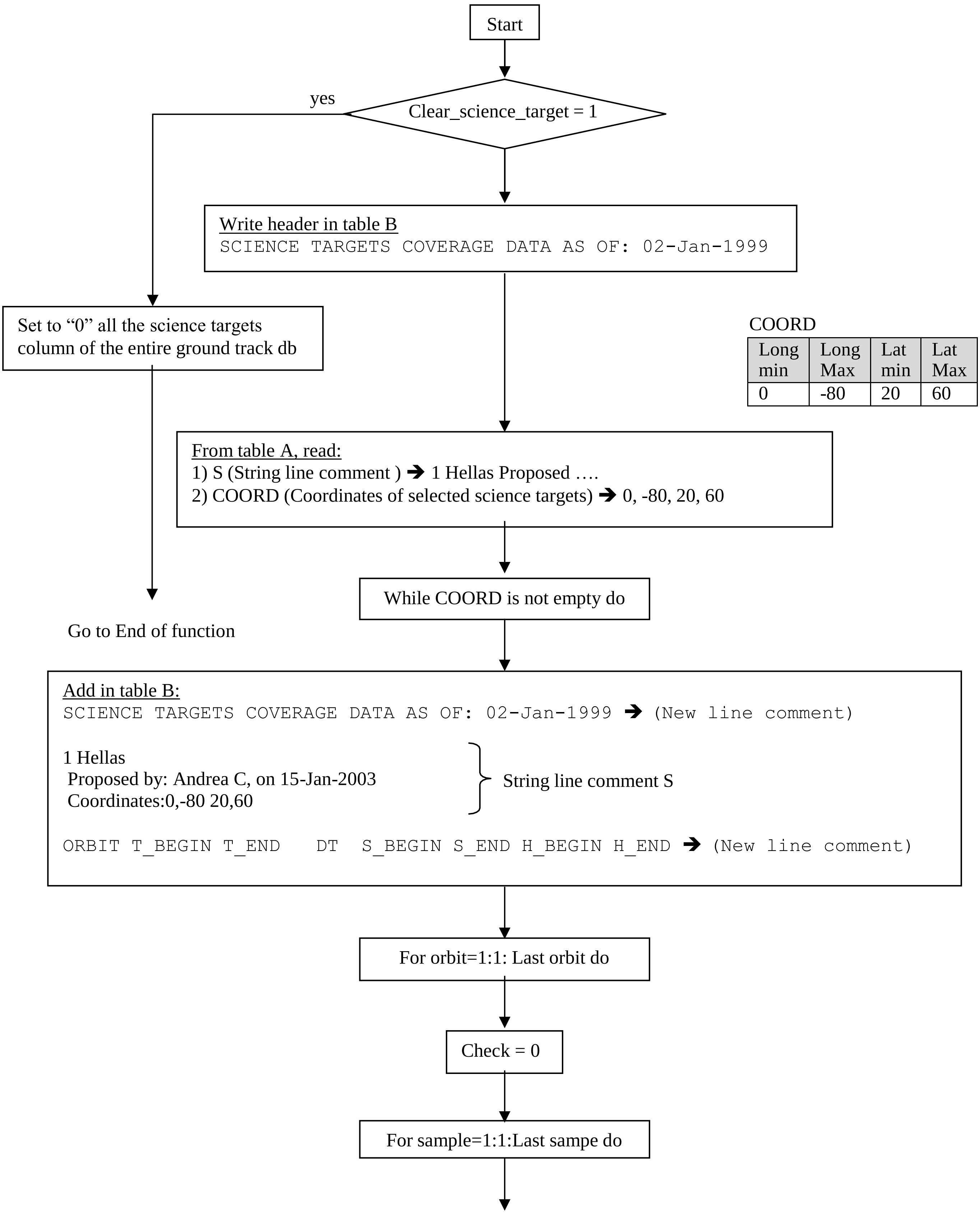
<u>TARGETs LIST FROM THE DATABASE (Table A)</u>

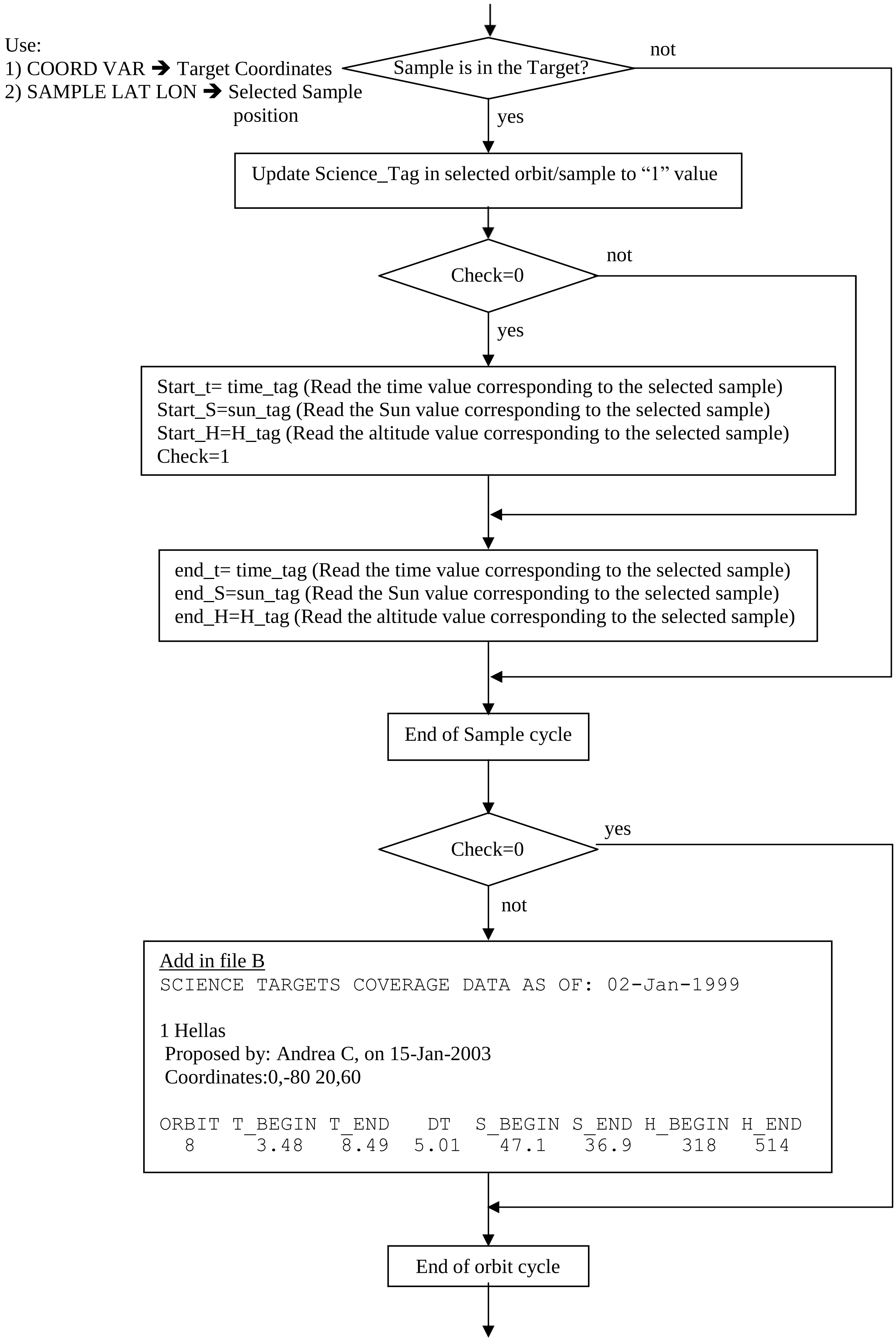
```
1 Hellas
 Proposed by: Andrea C, on 15-Jan-2003
 Coordinates:0,-80 20,60
…………………………………..
```

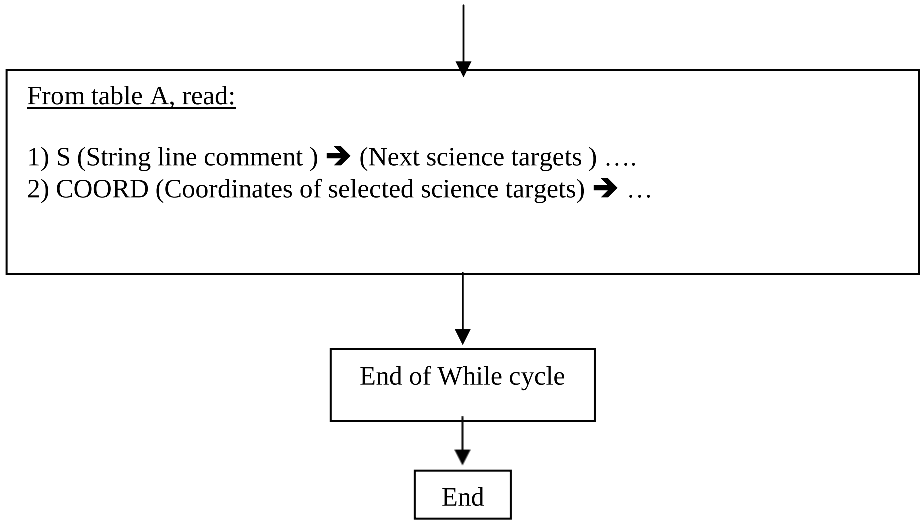
<u>OUTPUT SCIENCE TARGETs, table in the DB (Table B)</u>

```
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
   ……………………………………………………………………………………………………
```

2.2.2.1 Load Science Targets data flow




Use:
1) COORD VAR → Target Coordinates
2) SAMPLE LAT LON → Selected Sample position
Sample is in the Target?
not
yes
Update Science_Tag in selected orbit/sample to "1" value
Check=0
not
yes
Start_t= time_tag (Read the time value corresponding to the selected sample)
Start_S=sun_tag (Read the Sun value corresponding to the selected sample)
Start_H=H_tag (Read the altitude value corresponding to the selected sample)
Check=1
end_t= time_tag (Read the time value corresponding to the selected sample)
end_S=sun_tag (Read the Sun value corresponding to the selected sample)
end_H=H_tag (Read the altitude value corresponding to the selected sample)
End of Sample cycle
Check=0
yes
not
Add in file 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
End of orbit cycle



"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

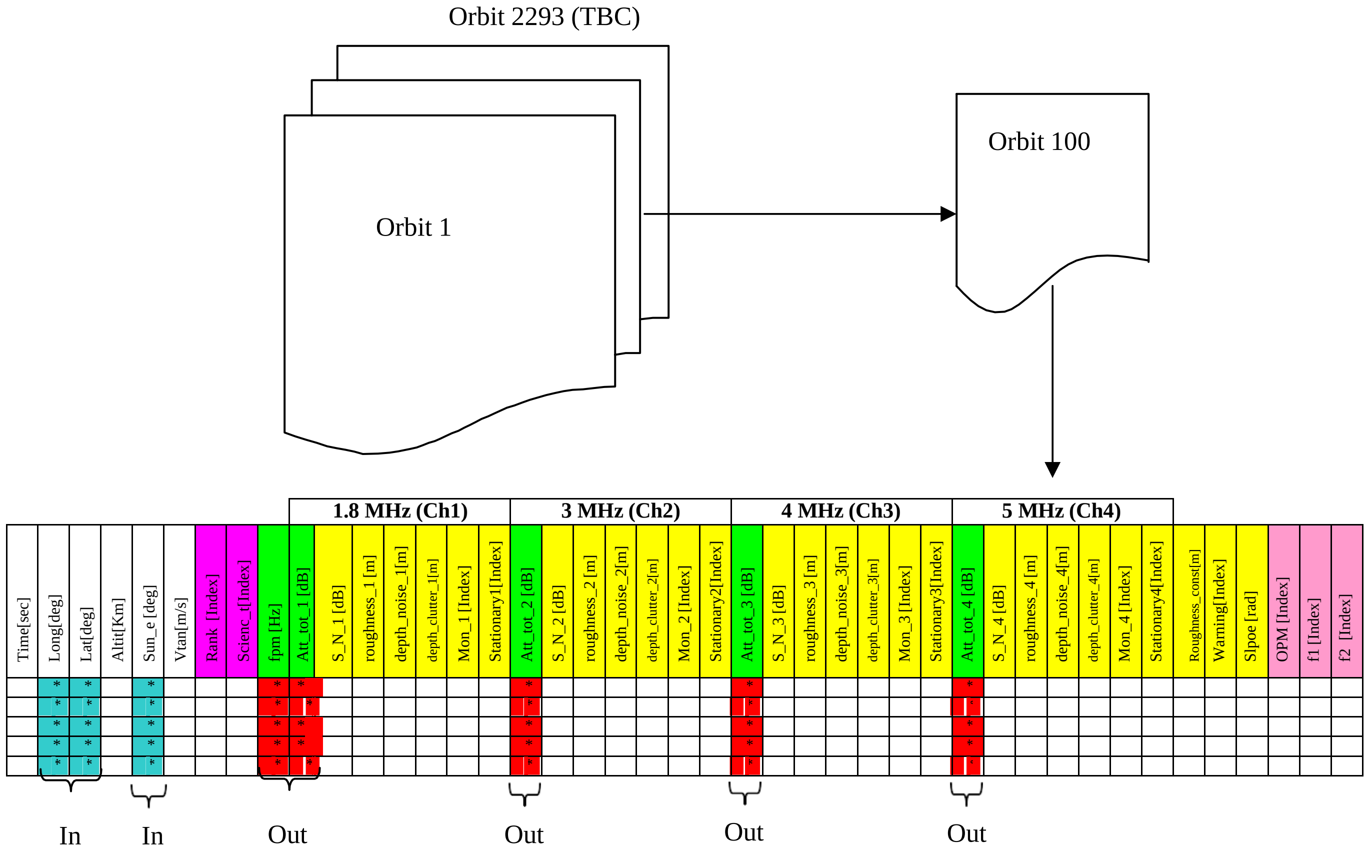
ORBITAL DATA INPUTs (From the Database)

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

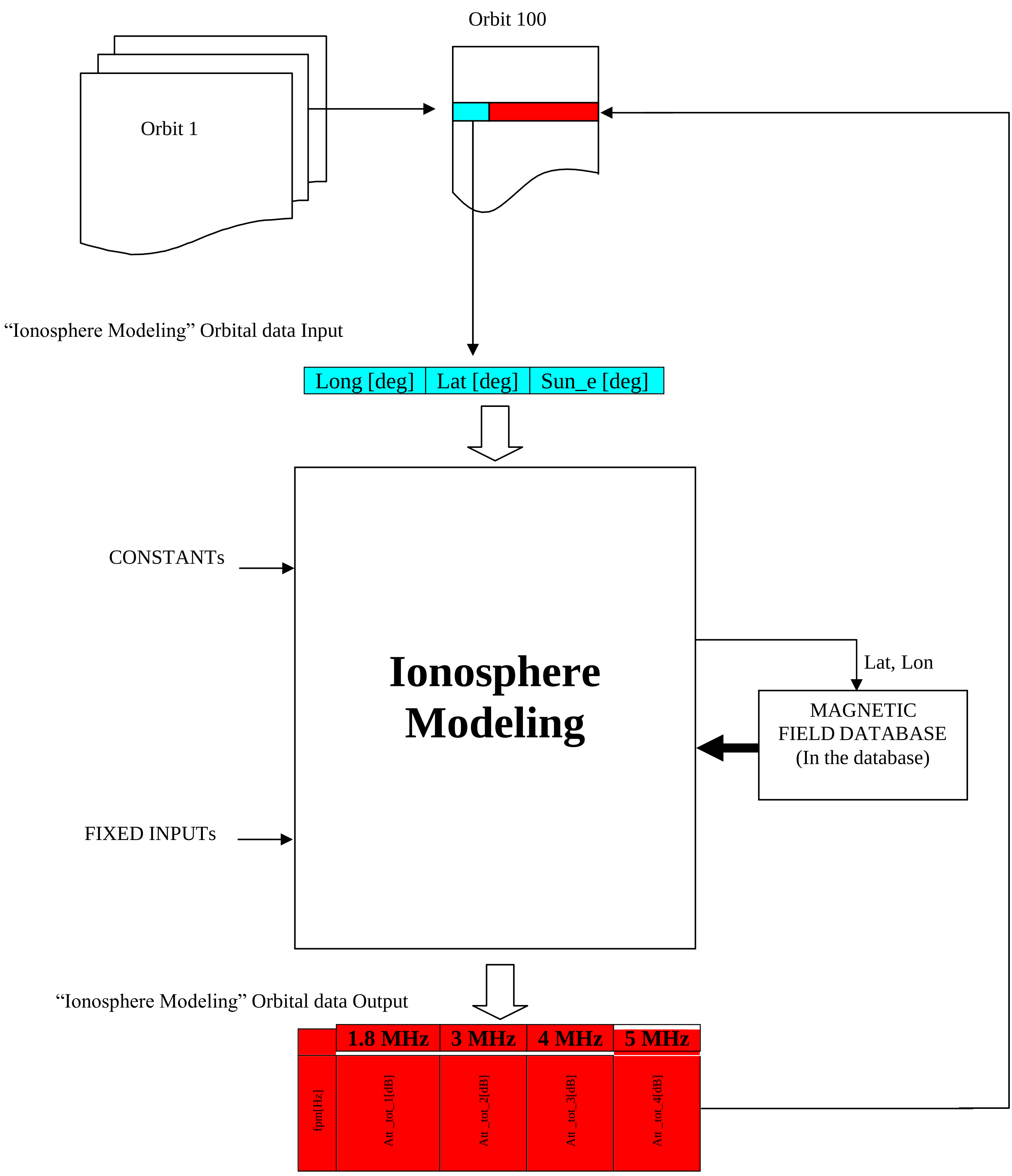
3 IONOSPHERE MODELING



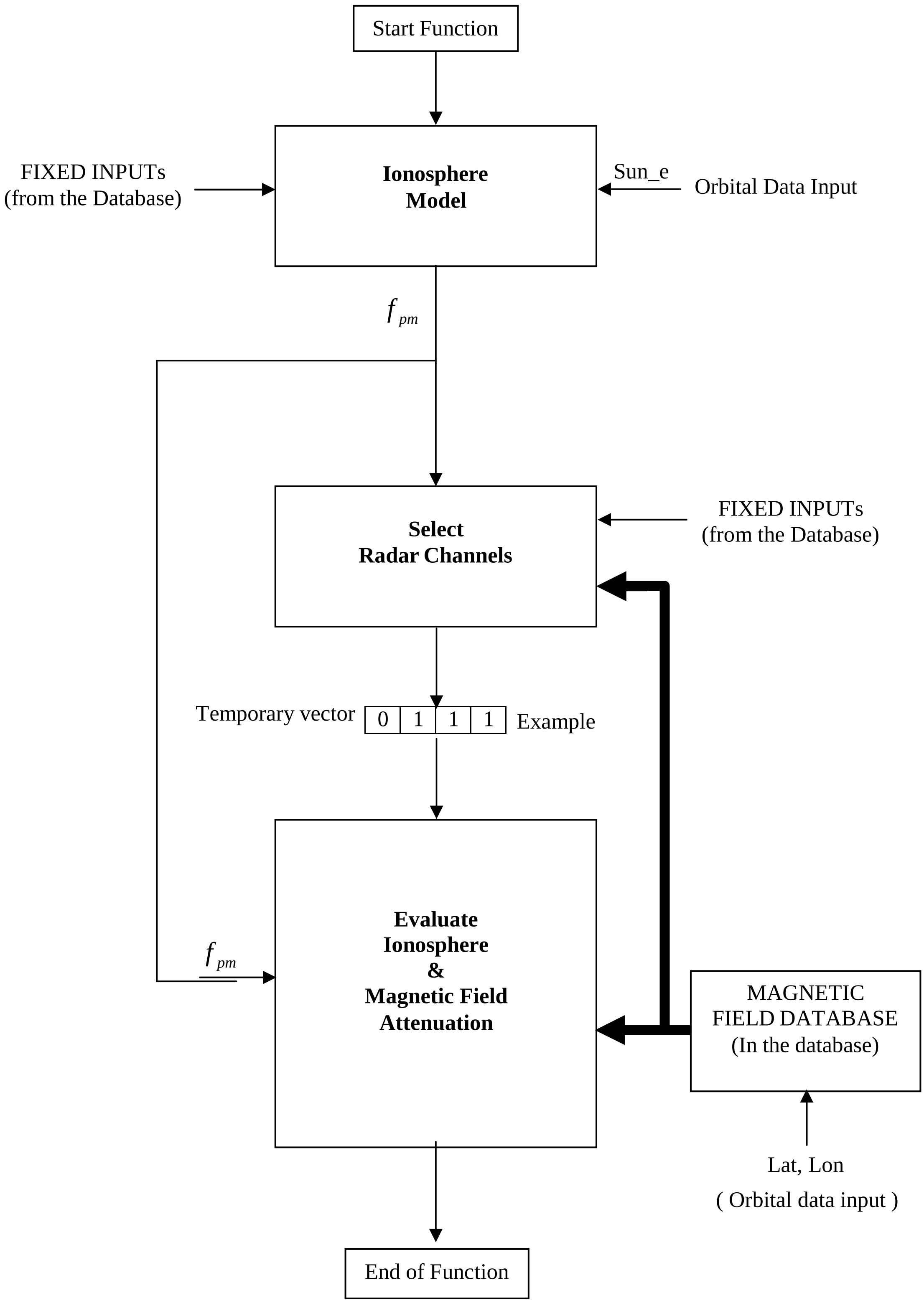
In ➔"Ionosphere Modeling" Orbital Data Input

Out ➔ "Ionosphere Modeling" orbital data Output

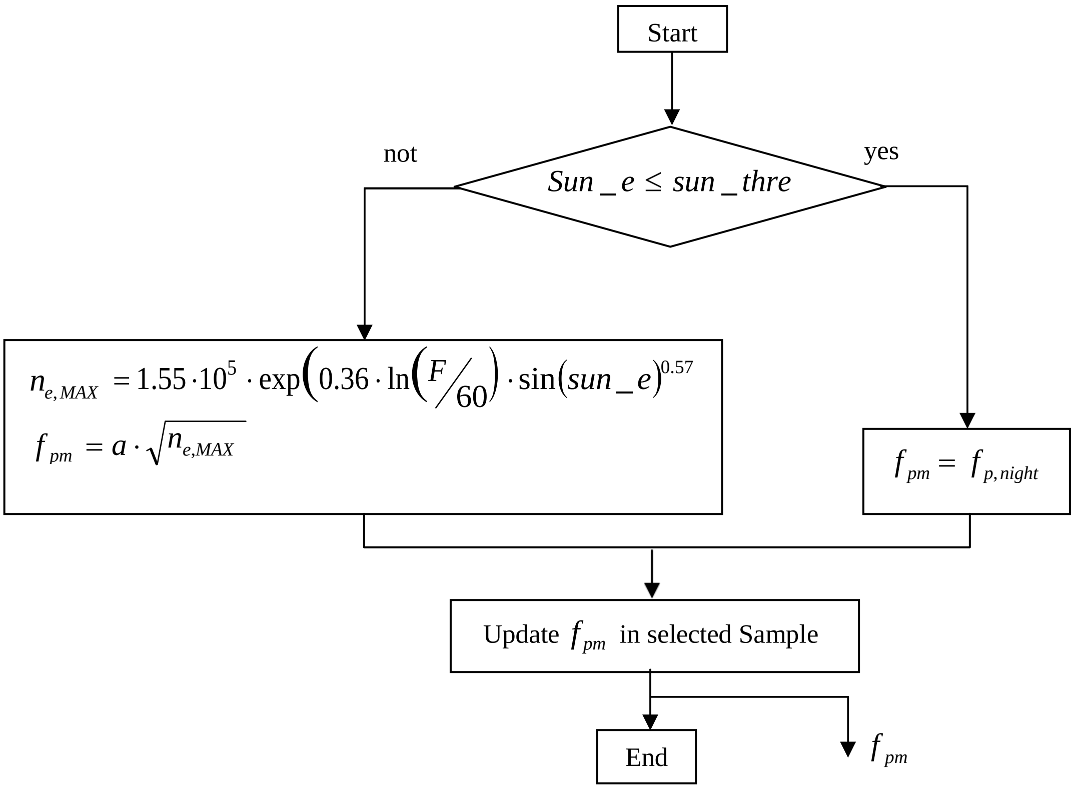
3.1 CONTEST


Orbit 100
Orbit 1
"Ionosphere Modeling" Orbital data Input
Long [deg]
Lat [deg]
Sun_e [deg]
CONSTANTs
Ionosphere Modeling
Lat, Lon
MAGNETIC FIELD DATABASE (In the database)
FIXED INPUTs
"Ionosphere Modeling" Orbital data Output
1.8 MHz
3 MHz
4 MHz
5 MHz
fpm[Hz]
Att_tot_1[dB]
Att_tot_2[dB]
Att_tot_3[dB]
Att_tot_4[dB]

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

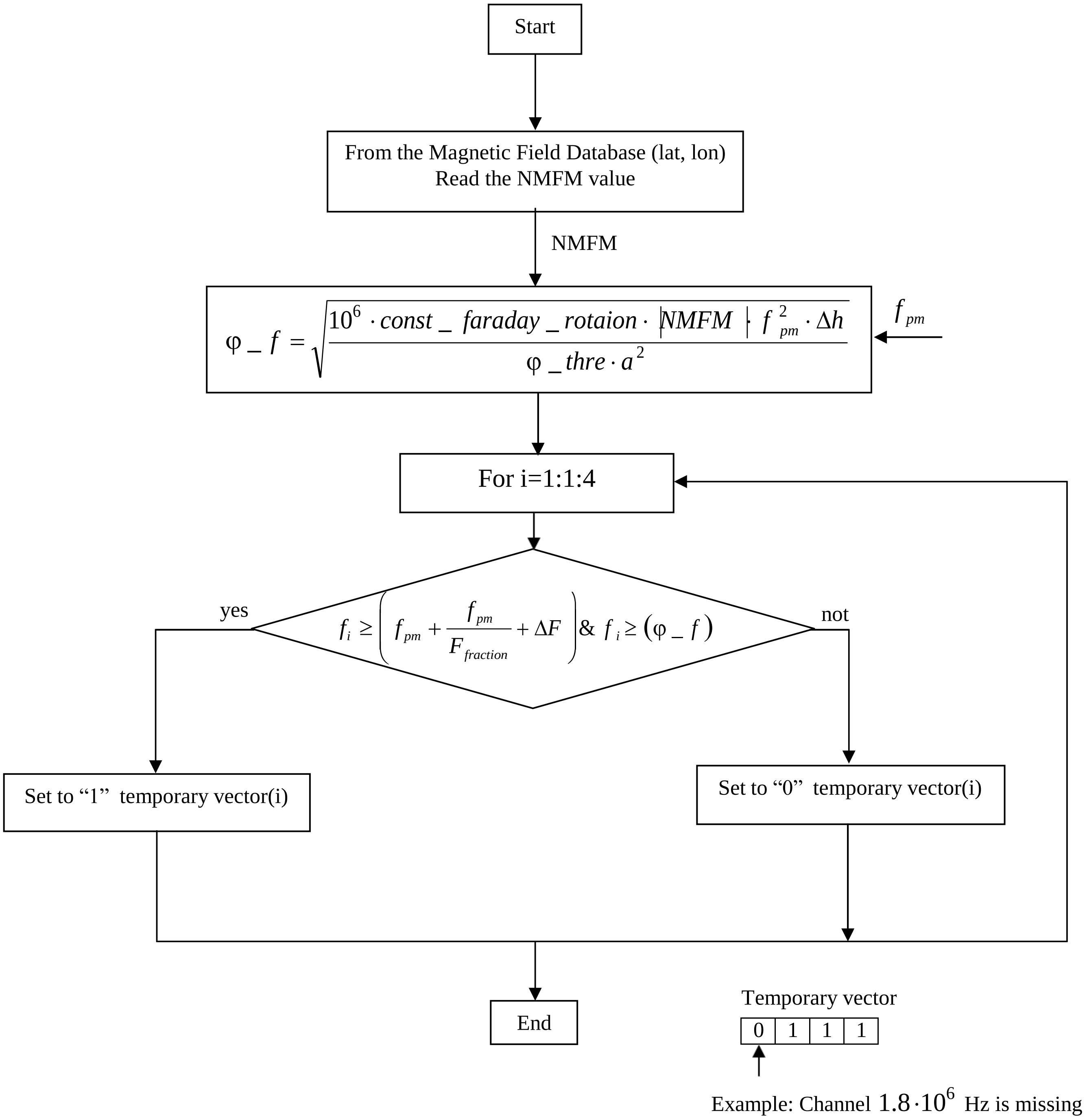
INTERNAL INPUTs

Symbol	**Units**	**Notes**
$n_{e,MAX}$	$\left[el/cm^3\right]$	Electron density model one

ORBITAL DATA OUTPUTs

Symbol	**Internal Units**	**Notes**
f_{pm}	[Hz]	Maximum plasma frequency

3.2.2 Select Radar Channels



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

"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	Exteranl 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
φ_f	[Hz]	Frequency threshold for the selection of the operative frequencies

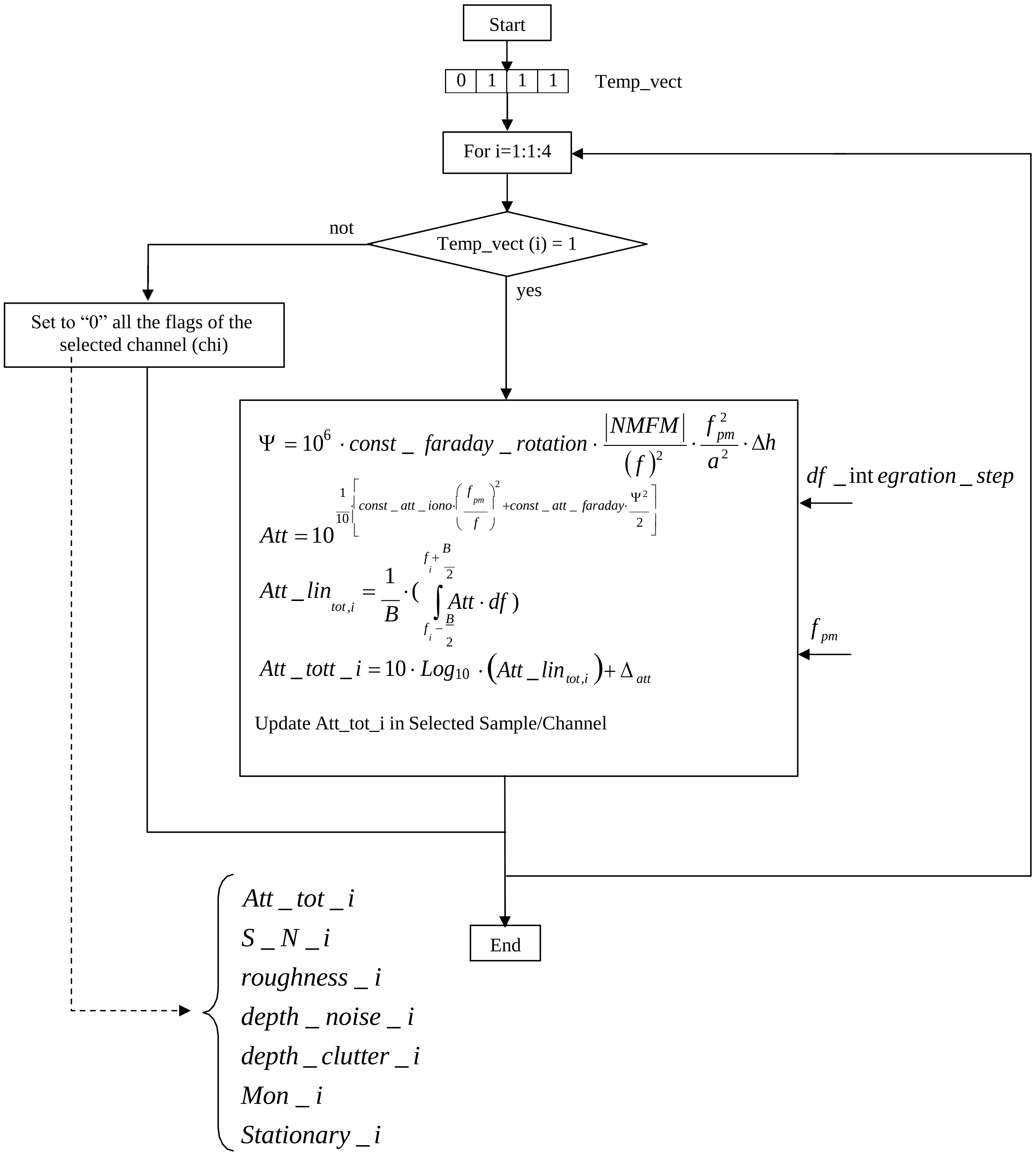
INTERNAL OUTPUTs

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

3.2.3 Evaluate Ionosphere & Magnetic Attenuation



"EVALUATE IONOSPHERE ATTENUATION": INPUTS, OUTPUTS, CONSTANTS, VAR

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	Exteranl 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	Exteranl 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

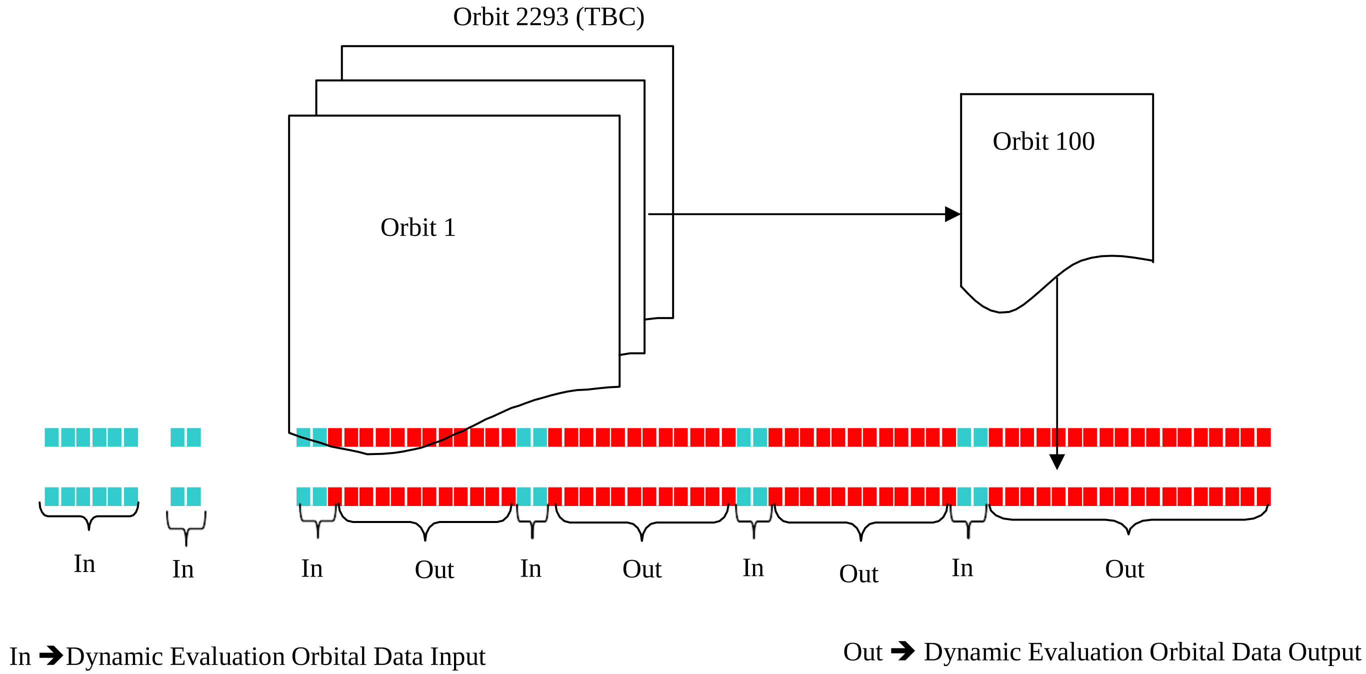
ORBITAL DATA INPUTs (From the Database)

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

4 DYNAMIC EVALUATION



4.1 GEOMETRY

NADIR GEOMETRY (Surface power contribution)

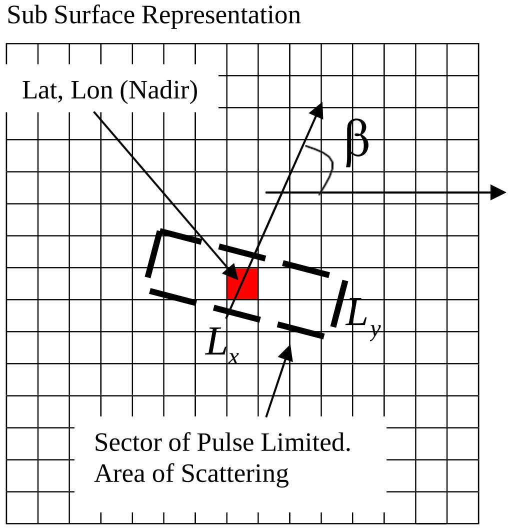


Fig. 1

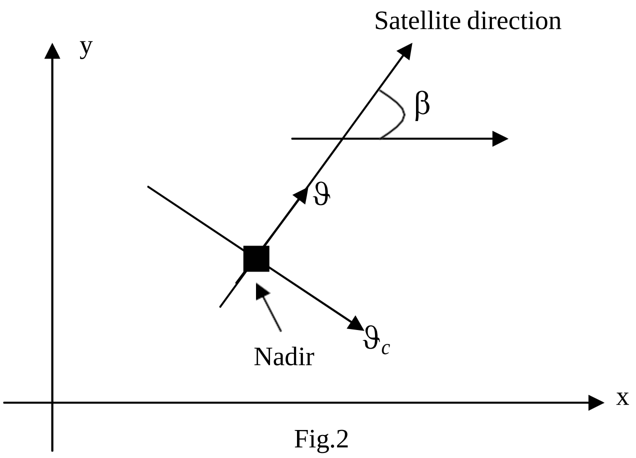


Fig.2

OFF NADIR GEOMETRY (Surface clutter contribution)

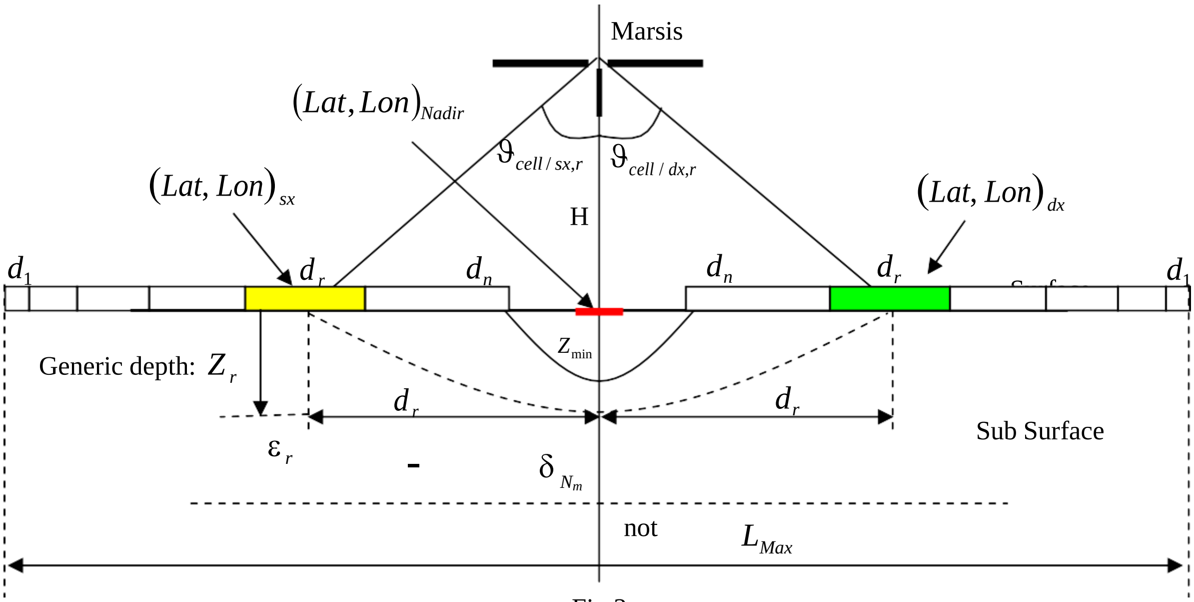


Fig.3

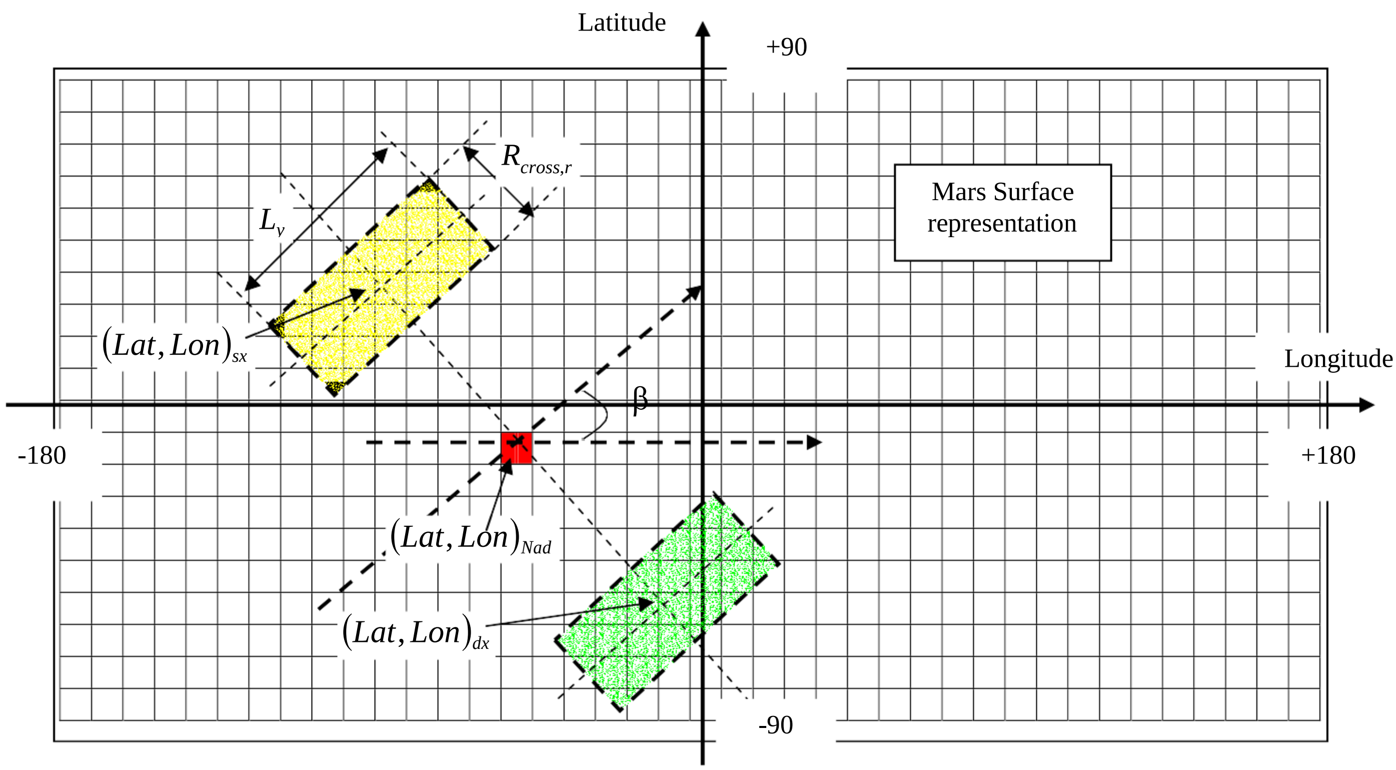
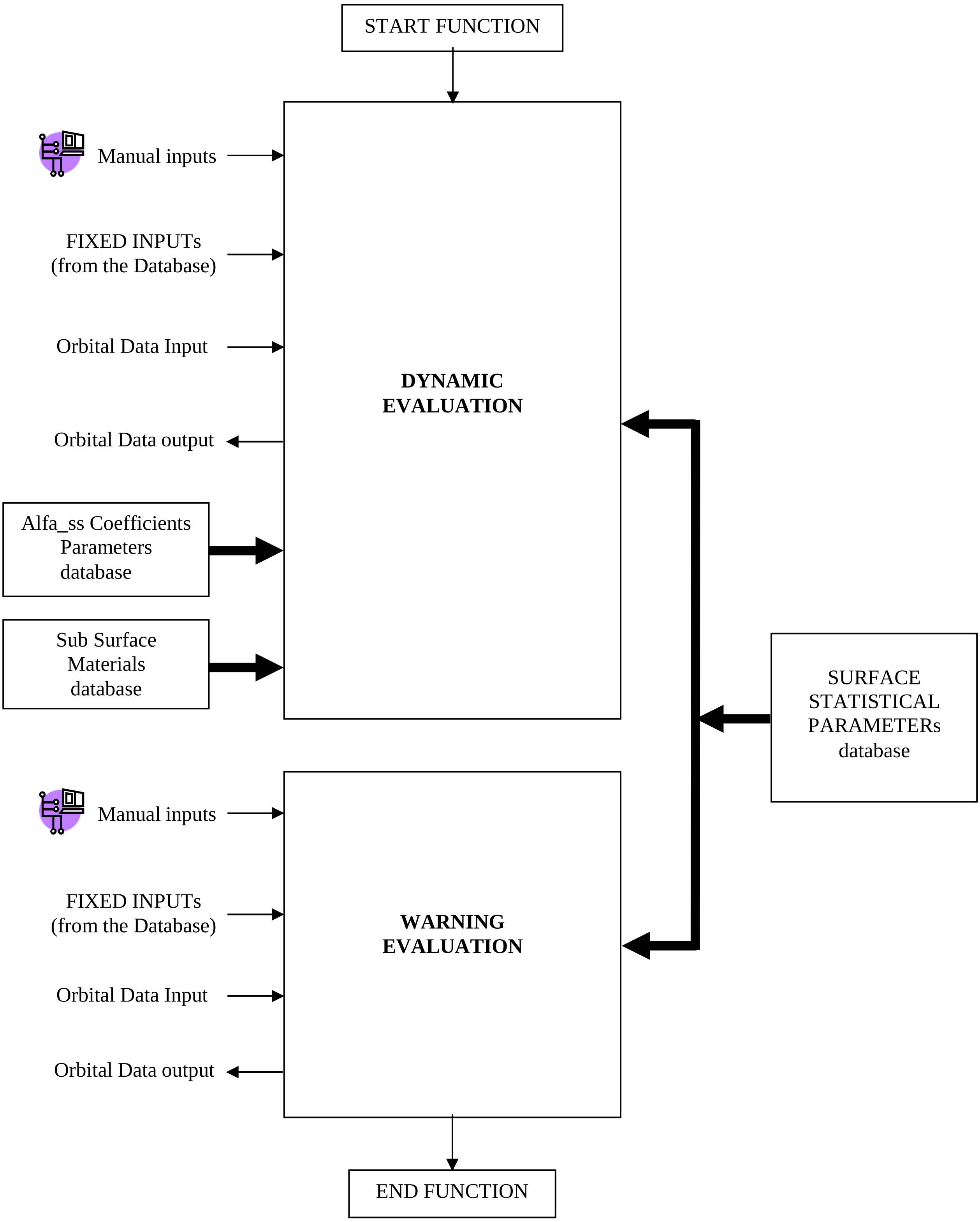
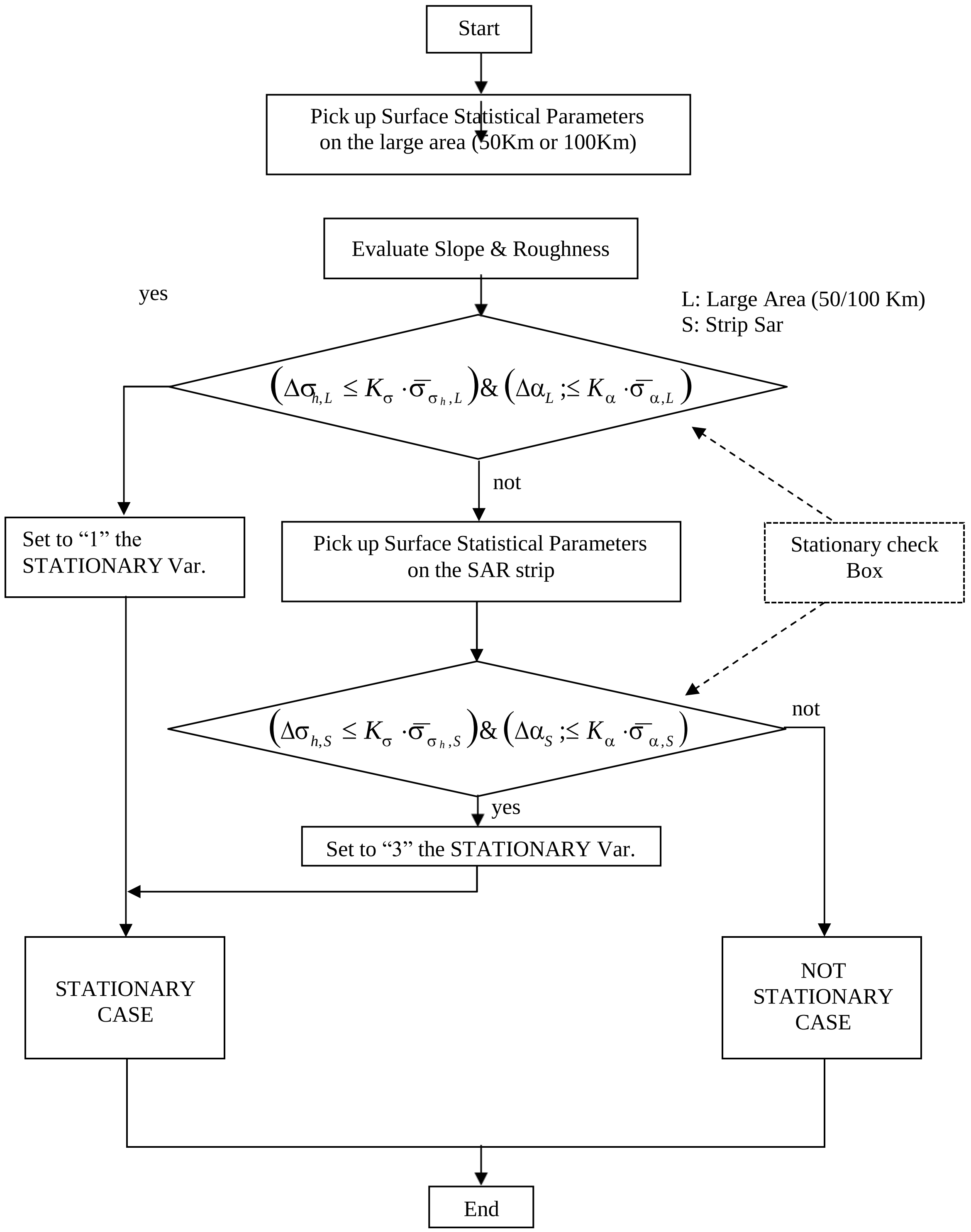


Fig. 4

4.2 TOP LEVEL DATA FLOW



4.3 DYNAMIC EVALUATION



4.3.1 Evaluate Beta angle

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

5.1.1) “F

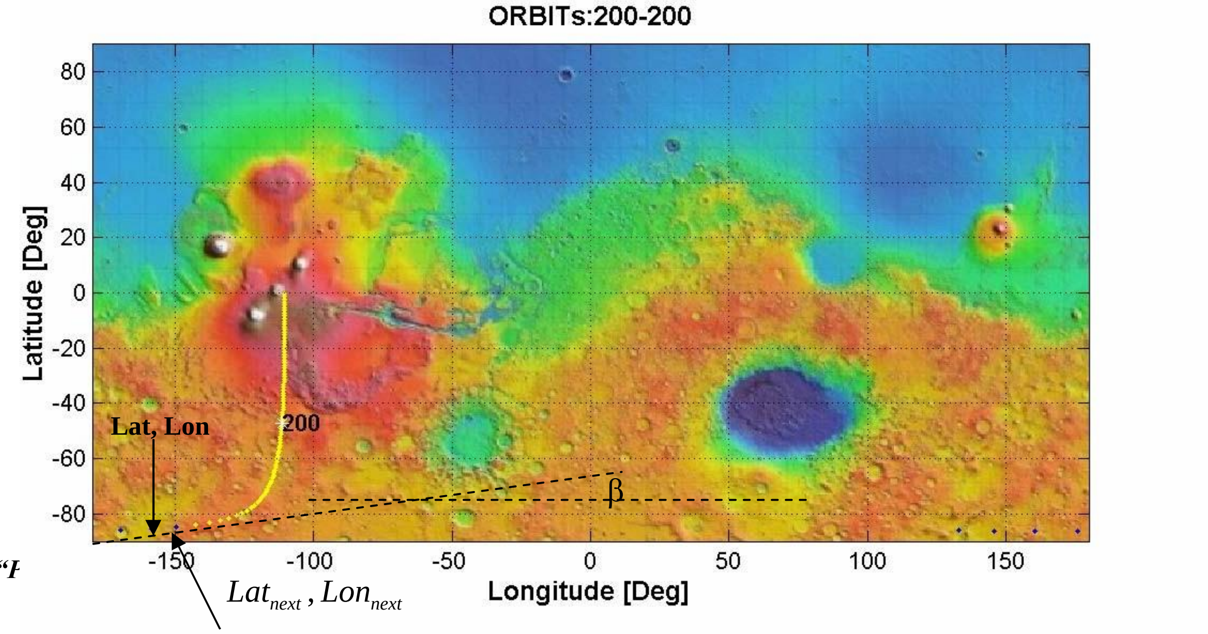


Fig. 5

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

<u>ORBITAL DATA INPUTs (From the Database)</u>

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

<u>INTERNAL OUTPUTs</u>

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

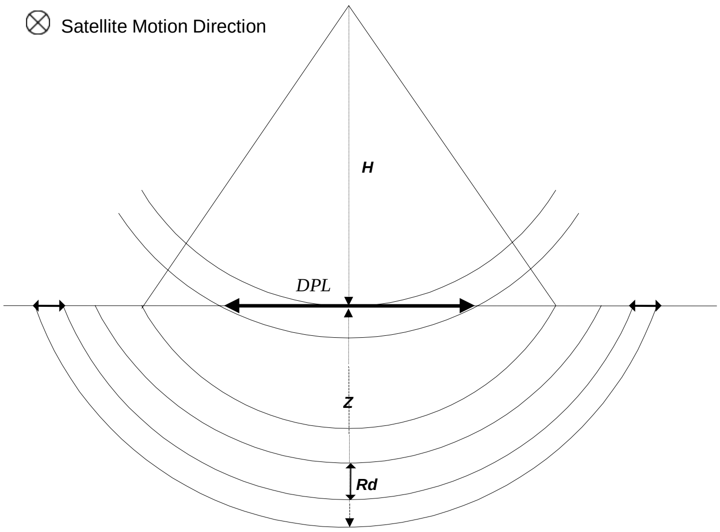
4.3.2 Evaluate Geometric Areas dimensions

<u>EVALUATE ALONG TRACK and CROSS TRACK RELOSLUTION</u>

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

if L_y <Ls_min ➔ L_y =Ls_min

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



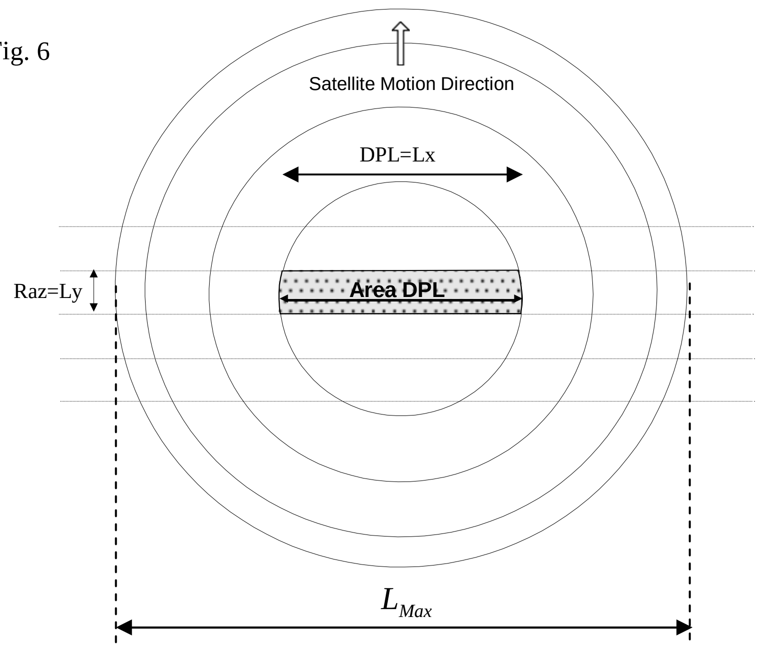


Fig. 6

"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)

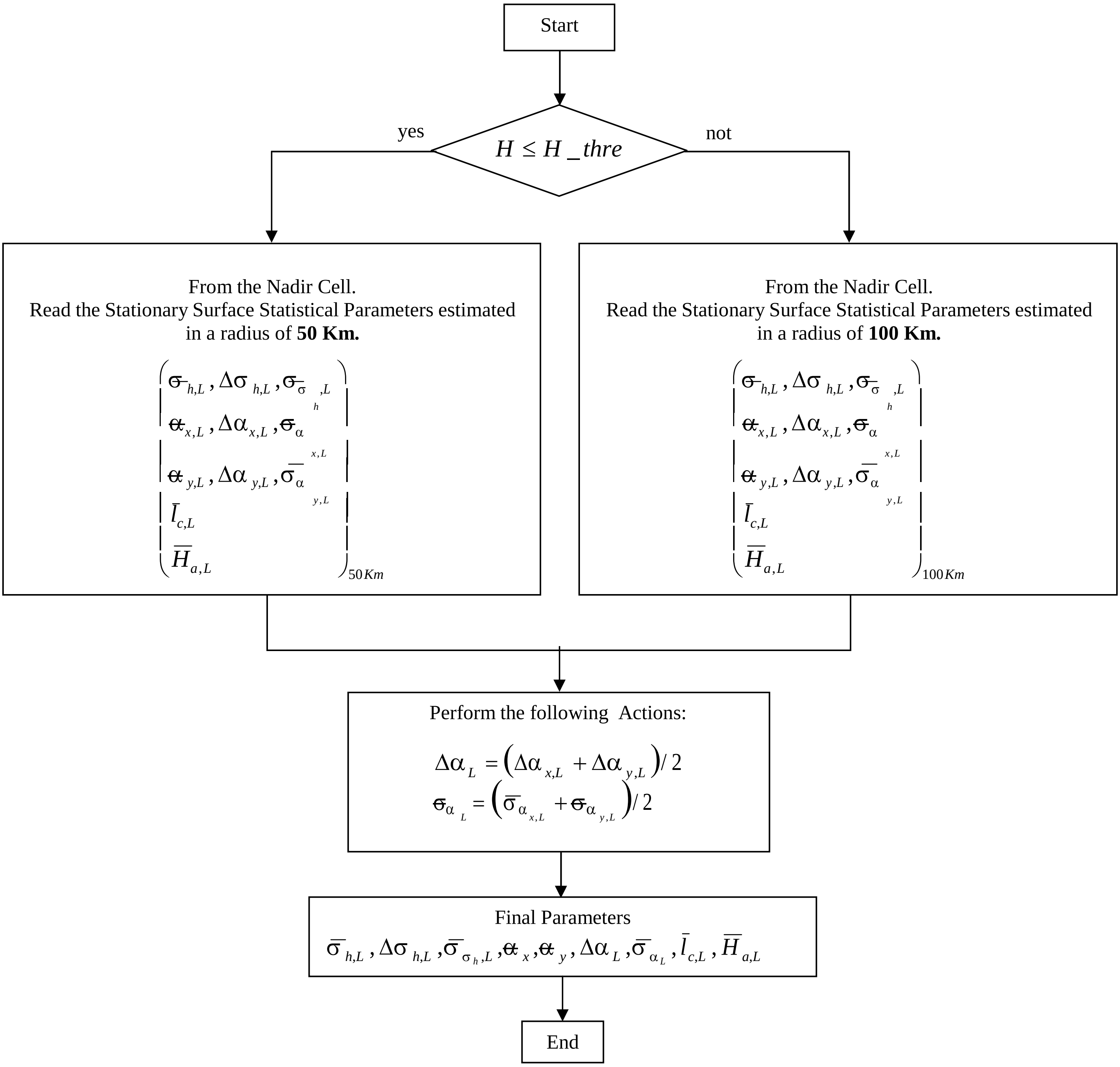
INTERNAL CONSTANTs (In the program)

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



"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	H_thre	500	[Km]	→ [m]	HeighTreshold

INTERNAL OUTPUTs

Symbol	Units	Notes
$\sigma_{h,L}$	[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
$\alpha_{x,y,L}$	[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
$\overline{H}_{a,L}$	[ ]	Mean value of the Hurst coefficient

4.3.4 Evaluate Slope and roughness

a) $Slope\_S = \bar{\alpha}_{x,50/100} \cdot \cos(\beta) + \bar{\alpha}_{y,50/100} \cdot \sin(\beta)$ [rad] Update in selected Orbit/Sample

b) roughness_1= $\bar{\sigma}_{h,50/100Km}$ Update in selected Orbit/Sample/Ch_1 (1.8MHz)

roughness_2= $\bar{\sigma}_{h,50/100Km}$ Update in selected Orbit/Sample Ch_2 (3MHz)

roughness_3= $\bar{\sigma}_{h,50/100Km}$ Update in selected Orbit/Sample Ch_4 (4MHz)

roughness_4= $\bar{\sigma}_{h,50/100Km}$ Update in selected Orbit/Sample Ch_4 (5MHz)

roughness_const= $\bar{\sigma}_{h,50/100Km}$ 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
$\bar{\alpha}_{x,y}$	[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
$\bar{\sigma}_{\sigma_{h,L/S}}$	[m]	Standard deviation of the roughness
$\bar{\sigma}_{\alpha,L/S}$	[rad]	Surface angle variance

4.3.6 Pick Up Surface Statistical Parameters on the Sar Strip

GEOMETRY

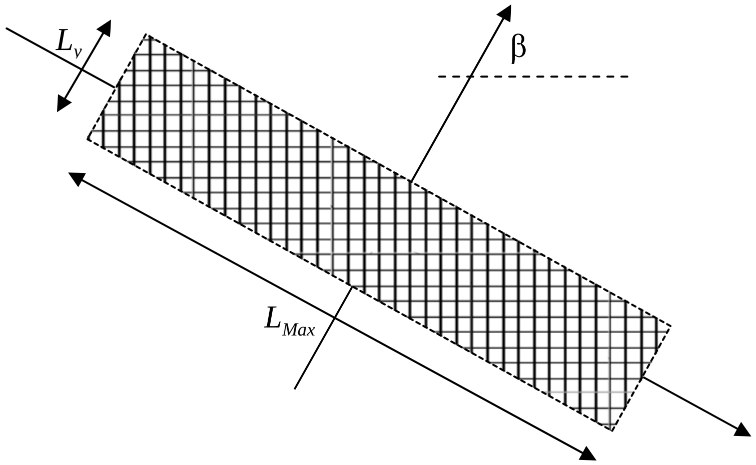


Fig. 7

ALGORITHM

start

↓

In the dotted rectangular pick up the following punctual surface statistical parameters:

$$\sigma_{h,i}, l_{ci}, H_{a,i}, \alpha_{xi}, \alpha_{yi}$$

where "n" is the number of the facets in the dotted rectangular ➔ i=1..n

↓

Performe the following Actions

$$\bar{\sigma}_{h,S} = \frac{1}{n} \cdot \sum_{i=1}^{n} \sigma_{h,i}$$

$$\Delta\sigma_{h,S} = Max\left(\bar{\sigma}_{h,S} - \sigma_{h,i}\right)$$

$$\bar{\sigma}_{\sigma_h,S} = \sqrt{\frac{1}{n} \cdot \sum_{i=1}^{n} \left(\bar{\sigma}_{h,S} - \sigma_{h,i}\right)^2}$$

$$\bar{\alpha}_x = \frac{1}{n} \cdot \sum_{i=1}^{n} \alpha_{x,i} \qquad \bar{\alpha}_y = \frac{1}{n} \cdot \sum_{i=1}^{n} \alpha_{y,i}$$

$$\Delta\alpha_x = Max\left(\bar{\alpha}_x - \alpha_{x,i}\right) \qquad \Delta\alpha_y = Max\left(\bar{\alpha}_y - \alpha_{y,i}\right)$$

$$\bar{\sigma}_{\alpha_x} = \sqrt{\frac{1}{n} \cdot \sum_{i=1}^{n} \left(\bar{\alpha}_x - \alpha_{x,i}\right)^2} \qquad \bar{\sigma}_{\alpha_y} = \sqrt{\frac{1}{n} \cdot \sum_{i=1}^{n} \left(\bar{\alpha}_y - \alpha_{y,i}\right)^2}$$

$$\Delta\alpha_S = \left(\Delta\alpha_x + \Delta\alpha_y\right)/2$$

$$\bar{\sigma}_{\alpha,S} = \left(\sigma_{\alpha_x} + \sigma_{\alpha_y}\right)/2$$

$$\bar{l}_{c,S} = \frac{2}{\frac{1}{n} \cdot \left(\sum_{i=1}^{n} \frac{1}{l_{cx,i}} + \sum_{i=1}^{n} \frac{1}{l_{cy,i}}\right)}$$

$$\bar{H}_{a,S} = \frac{1}{n} \cdot \sum_{i=1}^{n} H_{a,i}$$

where i=1..n

↓

Final Parameters

$$\bar{\sigma}_{h,S}, \Delta\sigma_{h,S}, \bar{\sigma}_{\sigma_h,S}, \Delta\alpha_S, \bar{\sigma}_{\alpha,S}, \bar{l}_{c,S}, \bar{H}_{a,S}$$

↓

End

”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

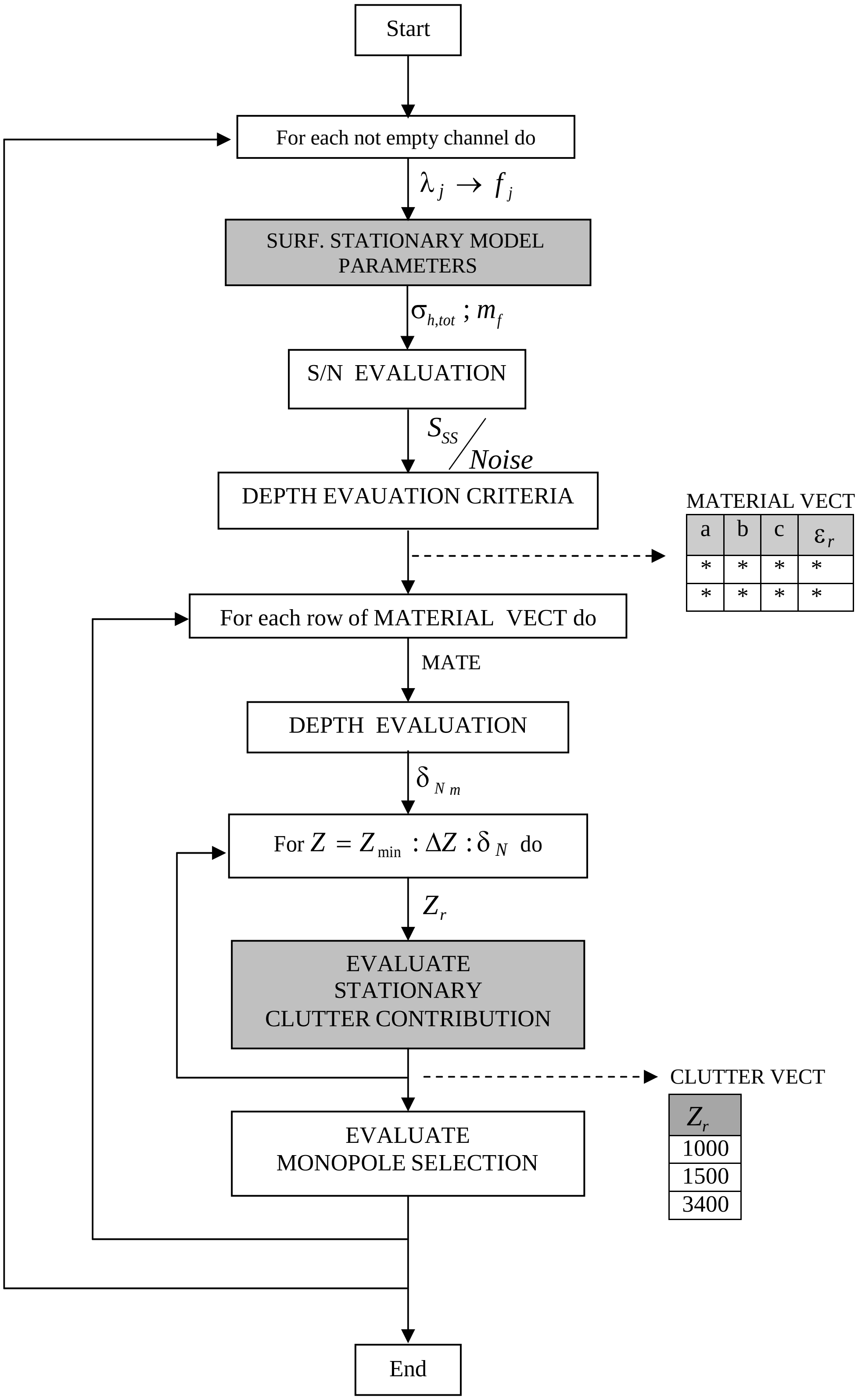
FIXED INPUTs (From the Database)

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

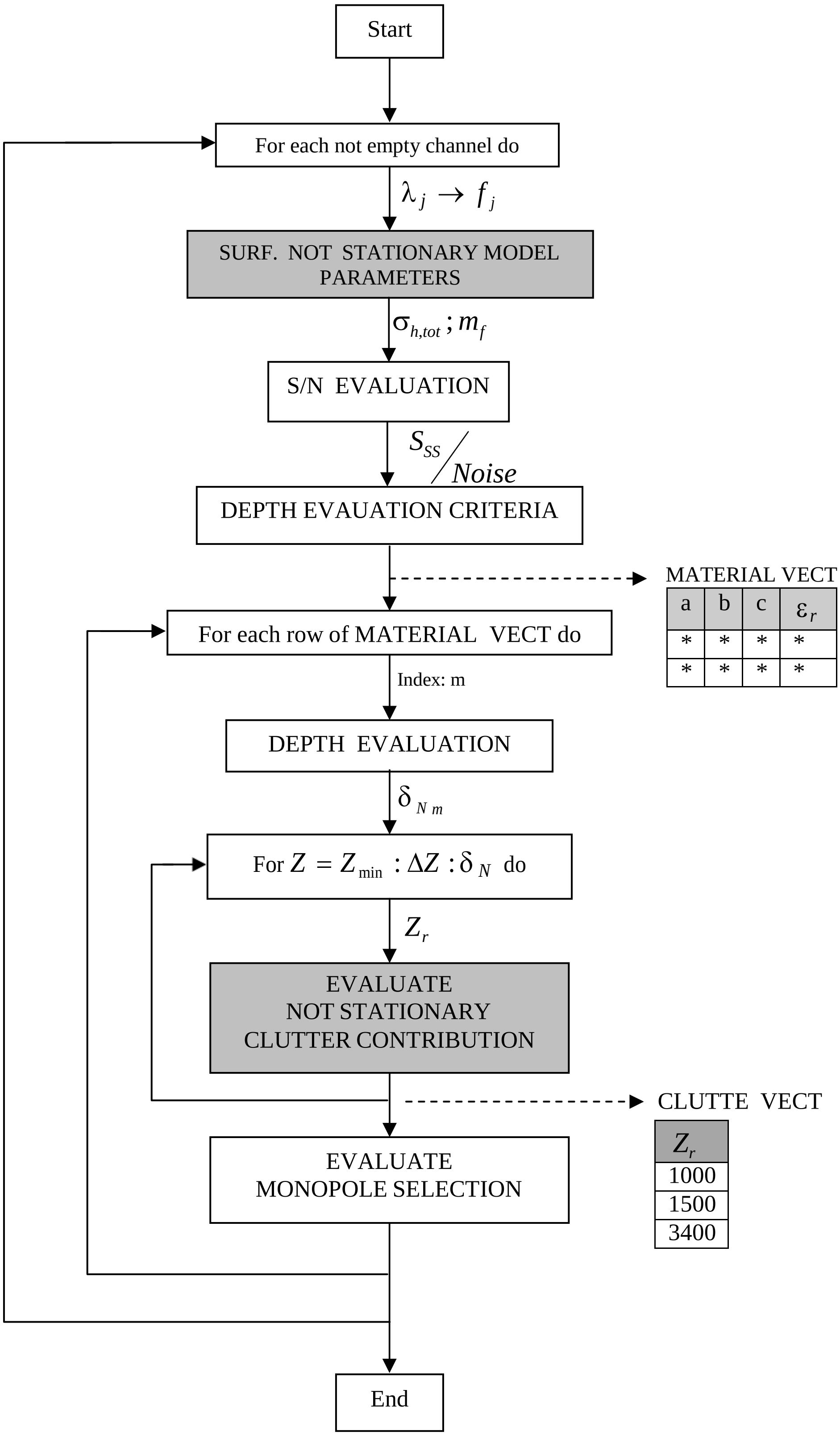
INTERNAL OUTPUTs

Symbol	Units	Notes
$\sigma_{h,S}$	[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
$\overline{H}_{a,S}$	[ ]	Mean value of the Hurst coefficient

4.3.7 Stationary Case



4.3.8 Not Stationary Case



4.3.9 For each not empty channel do

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

<u>POSSIBLE SITUATIONS</u>

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

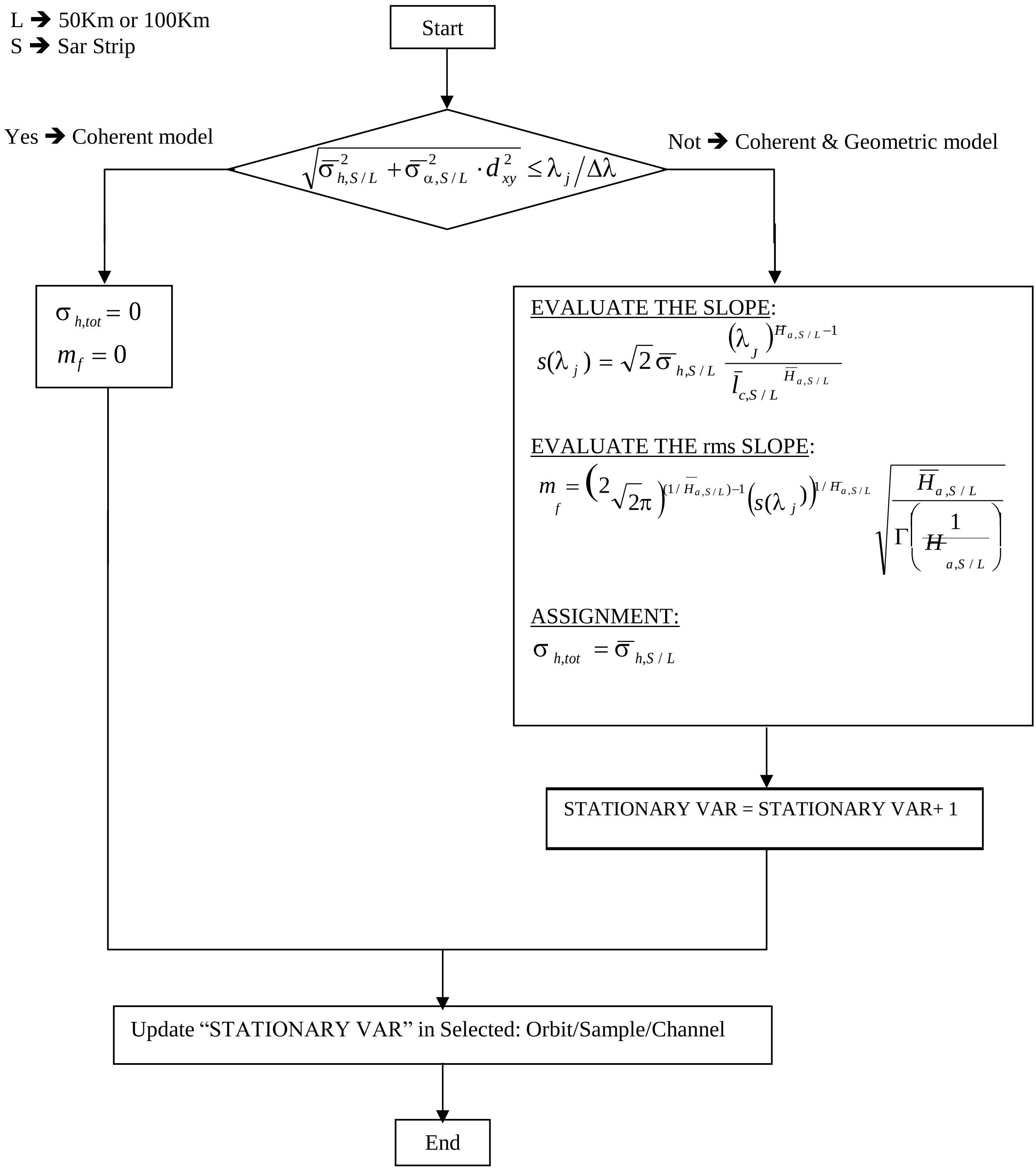
1.8 MHz (ch1)						3 MHz (ch2)						4 MHz (ch3)						5 MHz (ch4)					
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*	*	*	*	*	*

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



“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 STATISCTICA 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

4.3.11 Surface Not Stationary Model Parameters

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

Start

For each Cell. In the dotted rectangular (see Fig.7), pick up all the punctual Surf. Stat. Parameters:

$\sigma_{h,i}\,;\,H_{a,i}\,;\alpha_{x,i}\,,\alpha_{y,i}\,;l_{cx,i}\,,l_{cy,i}$ $\quad i=1:n$ where "n" is the Cell's number

EVALUATE THE AVERAGE OF THE ROUGHNESS

$$\bar{\sigma}_h = \left[\frac{1}{n}\cdot\sum_{i=1}^{n}\sigma_{h,i}\right]$$

EVALUATE THE TOTAL CONTRIBUTION OF THE ROUGHNESS

$$\alpha_{\vartheta,i} = \alpha_{x,i}\cdot\cos(\beta)+\alpha_{y,i}\cdot\sin(\beta);\quad \alpha_{\vartheta c,i} = \alpha_{x,i}\cdot\sin(\beta)+\alpha_{y,i}\cdot\cos(\beta)$$

$$\bar{\alpha}_{\vartheta} = \frac{1}{n}\cdot\sum_{i=1}^{n}\alpha_{\vartheta,i}\,;\quad \bar{\alpha}_{\vartheta c} = \frac{1}{n}\cdot\sum_{i=1}^{n}\alpha_{\vartheta c,i}$$

$$\sigma^2_{\alpha\vartheta} = \frac{1}{n}\cdot\sum_{i=1}^{n}\left(\bar{\alpha}_{\vartheta}-\alpha_{\vartheta,i}\right)^2\,;\quad \sigma^2_{\alpha\vartheta c} = \frac{1}{n}\cdot\sum_{i=1}^{n}\left(\bar{\alpha}_{\vartheta c}-\alpha_{\vartheta c,i}\right)^2$$

$$\sigma_{h,tot} = \sqrt{\bar{\sigma}_h^2+\left(\sigma^2_{\alpha\vartheta}+\sigma^2_{\alpha c\vartheta}\right)\cdot d^2_{xy}}$$

EVALUATE THE AVERAGE OF HURST COEFFICIENT AND OF THE CORRELATION LENGTH

$$\bar{H}_a = \left[\frac{1}{n}\cdot\sum_{i=1}^{n}H_{a,i}\right];\quad \bar{l}_{c,tot} = \frac{2}{\frac{1}{n}\cdot\left(\sum_{i=1}^{n}\frac{1}{l_{cx,i}}+\sum_{i=1}^{n}\frac{1}{l_{cy,i}}\right)}$$

EVALUATE THE RMS SLOPE AND THE FINAL SLOPE

$$s(\lambda_j) = \sqrt{2}\,\sigma_{h,tot}\,\frac{\left(\lambda_j\right)^{\bar{H}_a-1}}{\bar{l}_{c,tot}^{\;\bar{H}_a}}\,;\quad m_f = \left(2\sqrt{2\pi}\right)^{(1/\bar{H}_a)-1}\left(s(\lambda_j)\right)^{1/\bar{H}_a}\sqrt{\frac{\bar{H}_a}{\Gamma\left(\frac{1}{\bar{H}_a}\right)}}$$

Stationary tag = 0

Update "Stationary tag" value in Selected: Orbit/Sample/Channel

End of Sub function

"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 STATISCTICA 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

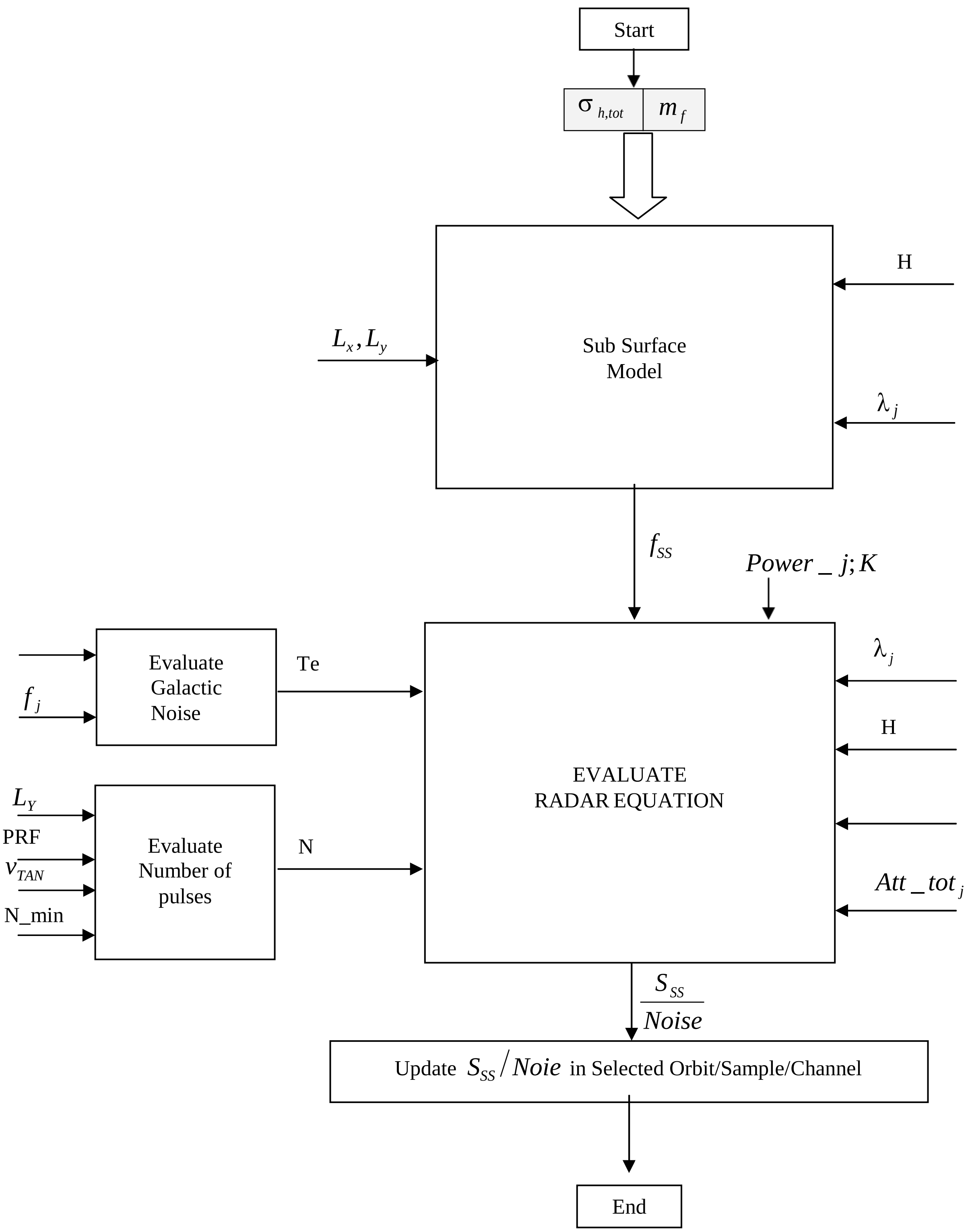
INTERNAL INPUTs and/or INPUTs FROM OTHERS SUB FUNCTIONs

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
$\alpha_{\vartheta i};\alpha_{\vartheta ci}$	[rad]	Cell inclination angle along track and cross track
$\overline{\alpha}_{\vartheta};\overline{\alpha}_{\vartheta c}$	[rad]	Average of the Cells inclination angle, in the dotted square, along track and cross track
$\sigma_{\alpha\vartheta};\sigma_{\alpha\vartheta c}$	[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



SUB SURFACE MODEL

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

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

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

EVALUATE GALACTIC NOISE

The equivalent noise temperature is:

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

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 ➔ N=N_min

EVALUATE RADAR EQUATION

$$\frac{S_{SS}}{Noise} = \frac{1}{Att\_tot_j} \cdot \frac{power\_j \cdot \lambda_j^2 \cdot f_{SS}}{(4 \cdot \pi)^3 \cdot H^4 \cdot K \cdot T_e} \cdot \tau \cdot N$$ ➔ [dB]

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

"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	[ ]	➔ muliplay per 10^{24}	KrouseNoiseModel
301	PRF	127,267	[Hz]	No action	PRF
313	N_min	160		No action	minPulses
314		250	$[\mu\,\text{sec}]$	➔ [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

4.3.13 Depth Evaluation Criteria

INPUT MASK

☐ **Single Environmental**

50% Porosity (50%, 20 %)

III Material (I, II, III)

D/I Interface (D/I, I/W)

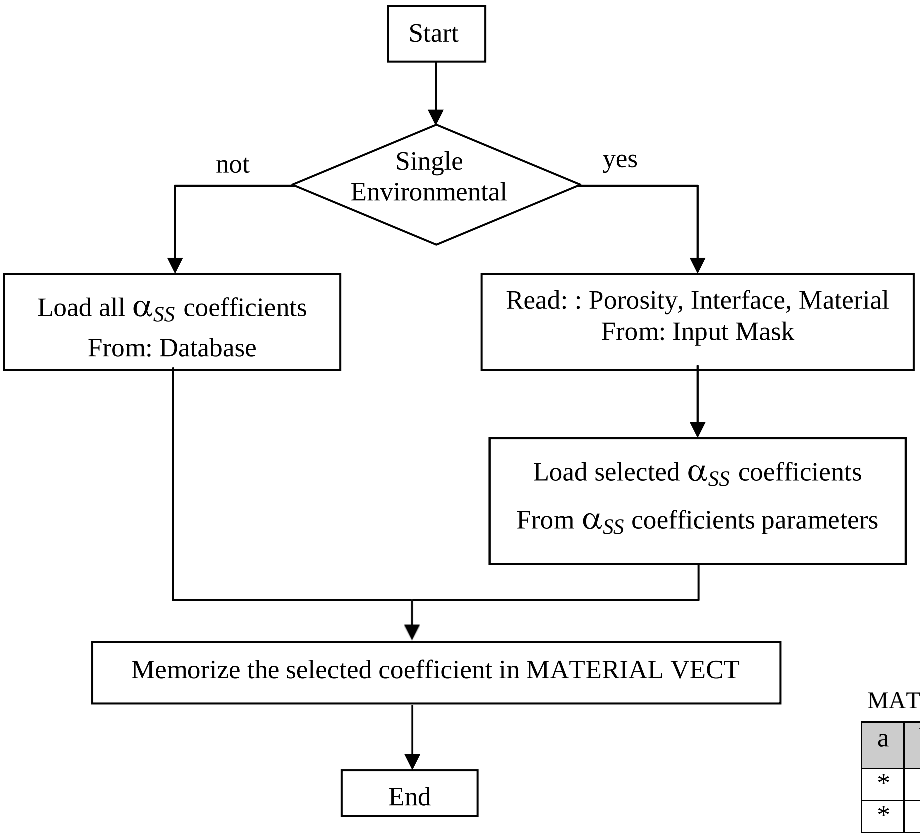
■ **Complete Environmental**

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

DEPTH EVALUATION CRITERIA DATA FLOW



MATERIAL VECT

a	b	c	ε_r
*	*	*	*
*	*	*	*

"DEPTH EVALUATION CRITERIA": INPUTS, OUTPUTS, CONSTANTS, VARIABLES

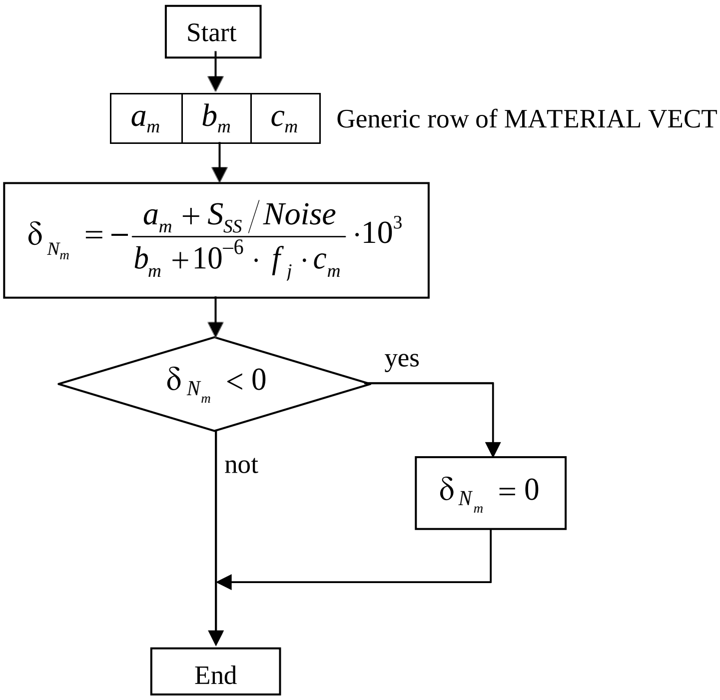
MATERIAL DATABASE (From the Database)

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 mateirals
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

4.3.16 Evaluate Stationary Clutter Contribution

EVALUATE CROSS TRACK DIMENSION

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

INCRESE SURFACE INCLINATION ANGLE

$$\alpha_{c/\delta} = k\_alfa\_angle \cdot \overline{\sigma}_{\alpha,S/L}$$

EVALUATE CLUTTER CONTRIBUTION

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

where:

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

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

EVALUATE SUB SURFACE POWER

- $A_{TT} = -a_m - \frac{Z_r}{10^3} \cdot \left(b^m + 10^{-6} \cdot f_j \cdot c_m\right)$ [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)

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

FIXED INPUTs (From the Database)

Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
303	R_d	150	[m]	RangeReslolution
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

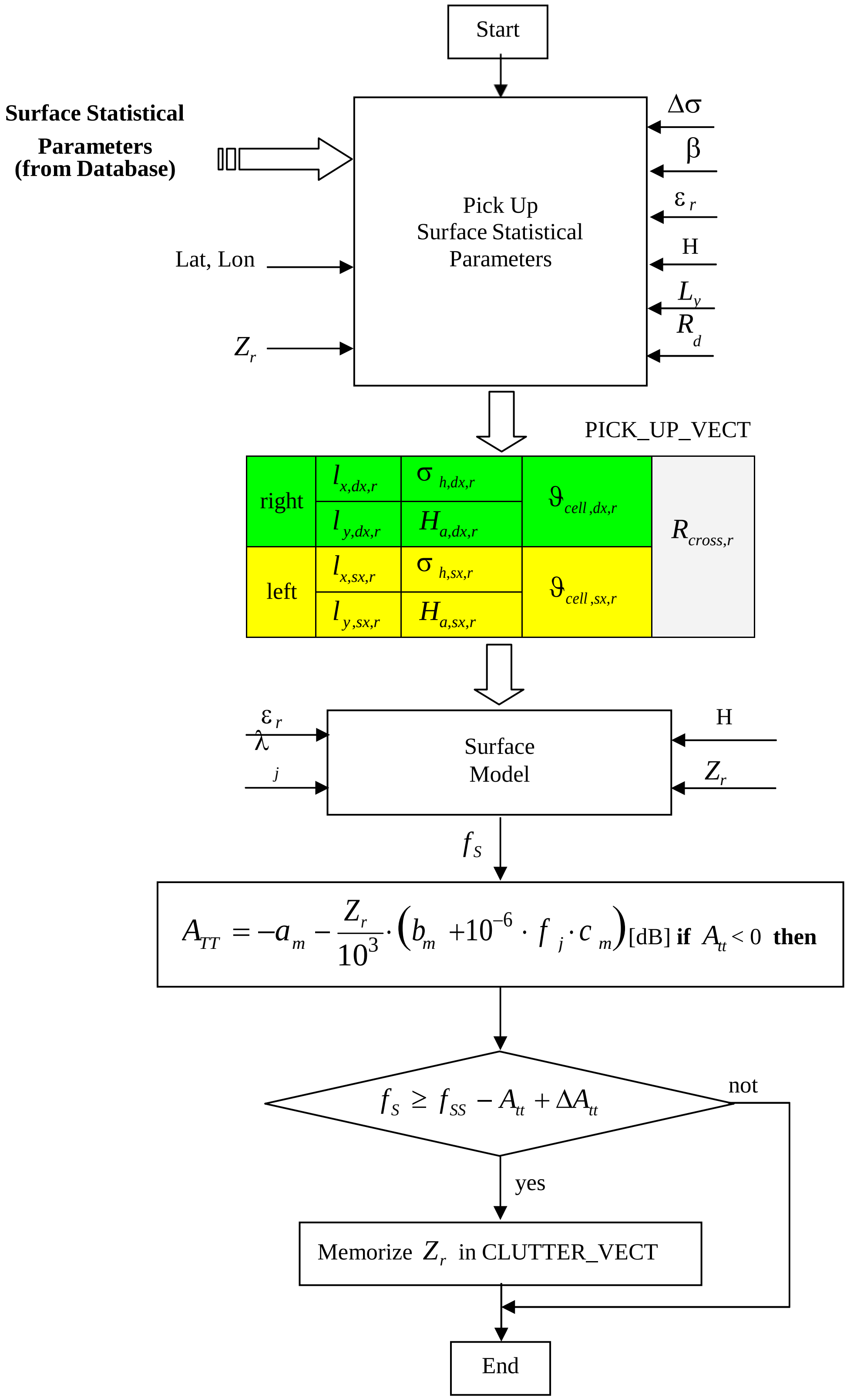
INTERNAL INPUTs

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
$\bar{\sigma}_{\alpha,L/S}$	[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

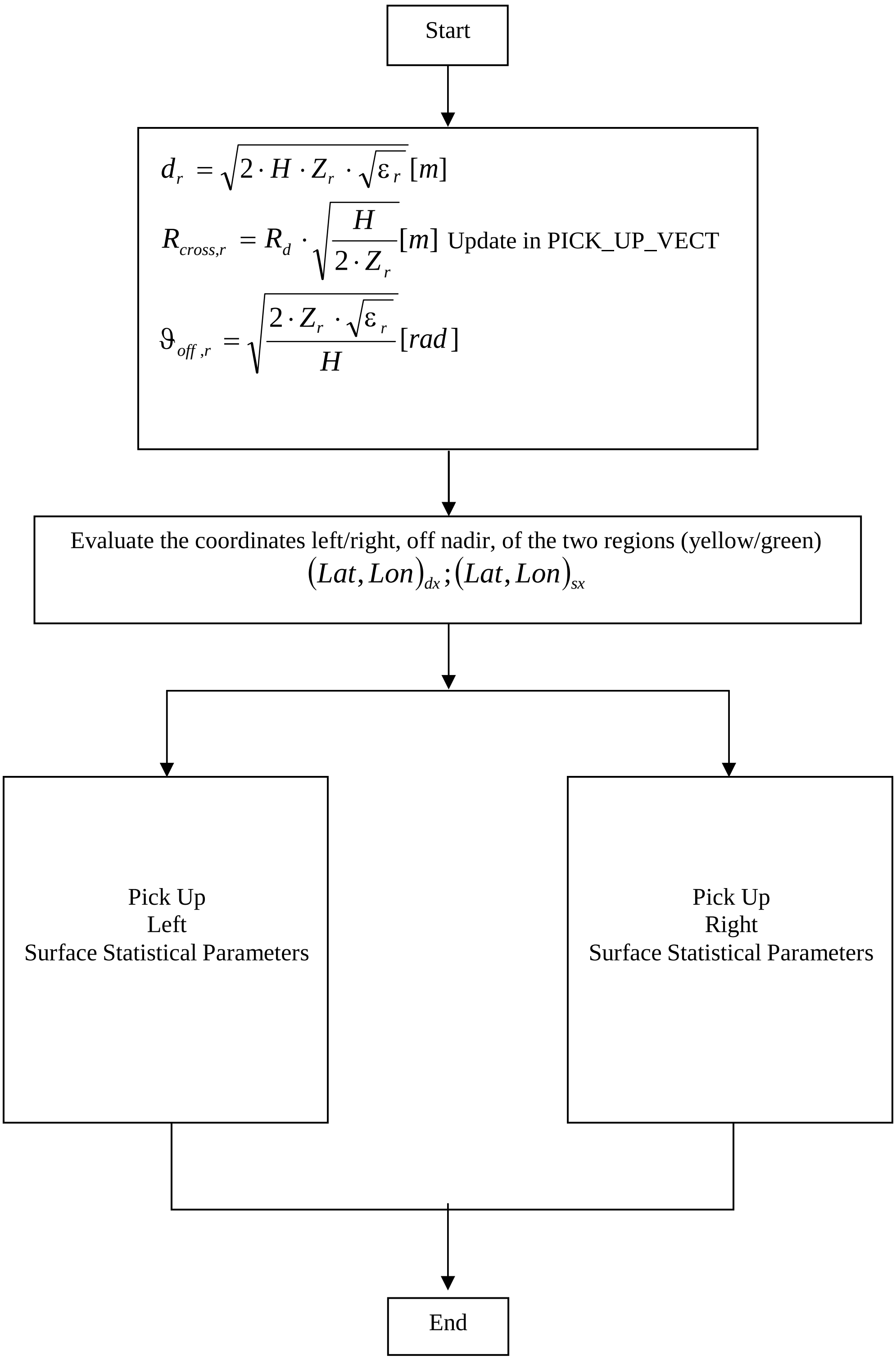
INTERNAL OUTPUTs

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

4.3.17 Evaluate Not Stationary Clutter Contribution



PICK UP SURFACE STATISTICAL PARAMETERS – GENARAL OVERVIEW -



Pick Up Left Surface Statistical Parameters Data Flow

Start

↓

For each cell in the dotted left square (yellow/ colour, see Fig. ¾) do

↓

1) Read the punctual Surf. Stat. Param. of the selected Cell.
$l_{cx,sx,i}$; $l_{cy,sx,i}$; $\sigma_{h,sx,i}$; $H_{a,sx,i}$; $\alpha_{x,sx,i}$; $\alpha_{y,sx,i}$

2) Evaluate the inclination angle of the Cell. Vs the SC.

$$\cos(\vartheta_{Cell,sx,i}) = \frac{\cos(\vartheta_{off,r}) - \sin(\vartheta_{off,r}) \cdot tg(\alpha_{x,sx,i})}{\sqrt{tg^2(\alpha_{x,sx,i}) + tg^2(\alpha_{y,sx,i}) + 1}} \rightarrow \vartheta_{Cell,sx,i}\,[rad]$$

3) Memorize the inclination angle and the Punctual Surf. Stat. Param. In CELL_TEMP

↓

End of For cycle

↓

Select the Cell with minimum ϑ_{Cell} from CEL_TEMP
Example ➔ row with "p" index

↓

Assignment:

$\sigma_{h,sx,r} = 0$

$l_{cx,sx,r} = l_{cx,sx,p}$

$l_{cy,sx,r} = l_{cy,sx,p}$

$H_{a,sx,r} = H_{a,sx,p}$

$$\vartheta_{Cell,sx,r} = \vartheta_{Cell,sx,p} + \Delta\sigma \cdot \frac{\sigma_{h,sx,p}}{\left(l_{cx,sx,p} + l_{cy,sx,p}\right)/2}$$

CELL_TEMP

	ϑ_{Cell}	l_{cx}	l_{cy}	σ_h	H_a
1	*	*	*	*	*
2	*	*	*	*	*
..	…..	…..	…..	…..	…..
p	*	*	*	*	*
..	…..	…..	…..	…..	…..
n	*	*	*	*	*

↓

Update in PICK_UP_VECT the following Items:
$\sigma_{h,sx,r}$; $l_{cx,sx,r}$; $l_{cy,sx,r}$; $H_{a,sx,r}$; $\vartheta_{Cell,sx,r}$

↓

End

Pick Up Right Surface Statistical Parameters Data Flow

Start

For each cell in the dotted Right square (yellow/ colour, see Fig. ¾) do

1) Read the punctual Surf. Stat. Param. of the selected Cell.
$l_{cx,dx,r}$; $l_{cy,dx,r}$; $\sigma_{h,dx,r}$; $H_{a,dx,r}$; $\alpha_{x,dx,r}$; $\alpha_{y,dx,r}$

2) Evaluate the inclination angle of the Cell. Vs the SC.

$$\cos(\vartheta_{Cell,dx,i}) = \frac{\cos(\vartheta_{off,r}) - \sin(\vartheta_{off,r}) \cdot tg(\alpha_{x,dx,i})}{\sqrt{tg^2(\bar{\alpha}_{x,dx,i}) + tg^2(\bar{\alpha}_{y,dx,i}) + 1}} \rightarrow \vartheta_{Cell,dx,i}\,[rad]$$

3) Memorize the inclination angle and the Punctual Surf. Stat. Param. In CELL_TEMP

End of For cycle

Select the Cell with minimum ϑ_{Cell} from CEL_TEMP
Example ➔ row with "p" index

Assignment:

$\sigma_{h,sx,r} = 0$

$l_{cx,sx,r} = l_{cx,sx,p}$

$l_{cy,sx,r} = l_{cy,sx,p}$

$H_{a,sx,r} = H_{a,sx,p}$

CELL_TEMP

	ϑ_{Cell}	l_{cx}	l_{cy}	σ_h	H_a
1	*	*	*	*	*
2	*	*	*	*	*
..	…..	…..	…..	…..	…..
p	*	*	*	*	*
..	…..	…..	…..	…..	…..
n	*	*	*	*	*

Update in PICK_UP_VECT the following Items:

$\sigma_{h,dx,r}$; $l_{cx,dx,r}$; $l_{cy,dx,r}$; $H_{a,dx,r}$; $\vartheta_{Cell,dx,r}$

End

SURFACE MODEL

EVALUATE THE right, SLOPE AND THE rms SLOPE

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

EVALUATE THE left, SLOPE AND THE rms SLOPE

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

EVALUATE THE POWER CONTRIBUTION left/right

$$\mathrm{f}_{S,dx,r} = L_y \cdot R_{cross,r}\cdot\left(\frac{e^{-4k_j^2\cdot\sigma_{h,dx,r}^2}\cdot e^{\frac{-(\vartheta_{cell,dx,r})^2}{\frac{1}{2\cdot\pi\cdot H}\frac{\lambda_j^2\cdot Z_r}{R_d^2}}}}{\sqrt{\frac{1}{2\cdot\pi\cdot H}\frac{\lambda_j^2\cdot Z_r}{R_d^2}}\cdot\sqrt{\frac{\lambda_j^2}{4\pi\cdot R^2_{cross,r}}+\frac{R^2{}_{cross,r}}{\pi\cdot H^2}}}+\frac{\left(1-e^{-4k_j^2\sigma_{h,dx,r}^2}\right)\cdot e^{\frac{-(\vartheta_{cell,dx})^2}{\frac{1}{2\cdot\pi\cdot H}\frac{\lambda_j^2\cdot Z_r}{R_d^2}+2\cdot m_{f,dx,r}^2}}}{\sqrt{\frac{1}{2\cdot\pi\cdot H}\cdot\frac{\lambda_j^2\cdot Z_r}{R_d^2}+2\cdot m_{f,dx,r}^2}\cdot\sqrt{\frac{\lambda_j^2}{4\cdot\pi\cdot R^2_{cross,r}}+\frac{R^2{}_{cross,r}}{\pi\cdot H^2}+2\cdot m_{f,dx,r}^2}}\right)$$

$$\mathrm{f}_{S,sx,r} = L_y \cdot R_{cross,r}\cdot\left(\frac{e^{-4\cdot k_j^2\cdot\sigma_{h,sx,r}^2}\cdot e^{\frac{-(\vartheta_{cell,sx,r})^2}{\frac{1}{2\cdot\pi\cdot H}\frac{\lambda_j^2\cdot Z_r}{R_d^2}}}}{\sqrt{\frac{1}{2\cdot\pi\cdot H}\frac{\lambda_j^2\cdot Z_r}{R_d^2}}\cdot\sqrt{\frac{\lambda_j^2}{4\cdot\pi\cdot R^2_{cross,r}}+\frac{R^2{}_{cross,r}}{\pi\cdot H^2}}}+\frac{\left(1-e^{-4\cdot k_j^2\cdot\sigma_{h,sx,r}^2}\right)\cdot e^{\frac{-(\vartheta_{cell,sx})^2}{\frac{1}{2\cdot\pi\cdot H}\frac{\lambda_j^2\cdot Z_r}{R_d^2}+2\cdot m_{f,sx,r}^2}}}{\sqrt{\frac{1}{2\cdot\pi\cdot H}\cdot\frac{\lambda_j^2\cdot Z_r}{R_d^2}+2\cdot m_{f,sx,r}^2}\cdot\sqrt{\frac{\lambda_j^2}{4\cdot\pi\cdot R^2_{cross,r}}+\frac{R^2{}_{cross,r}}{\pi\cdot H^2}+2\cdot m_{f,sx,r}^2}}\right)$$

where:

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

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

"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 STATISCTICA 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
$\vartheta(cell)$	[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

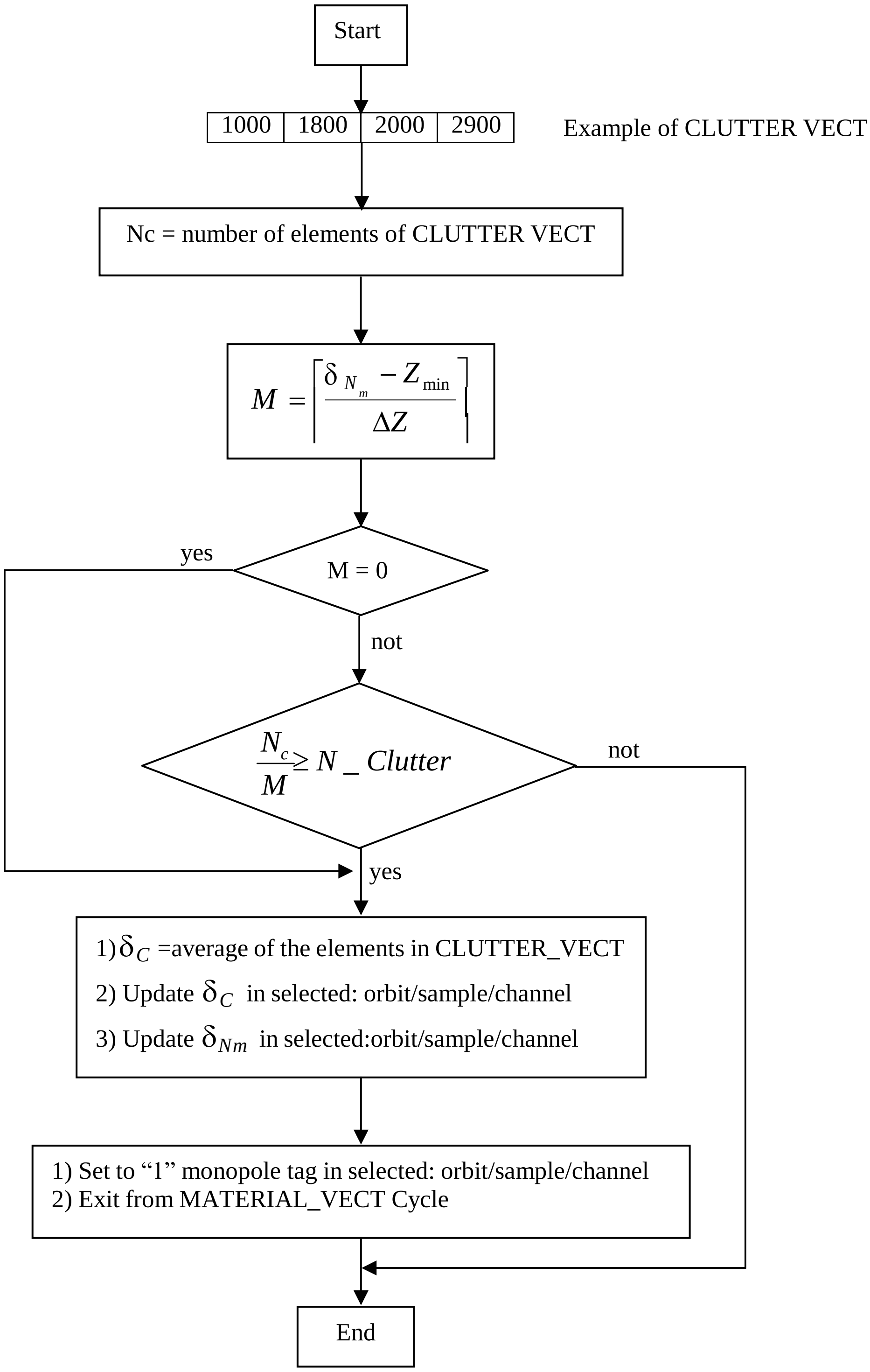
FIXED INPUTs (From the Database)

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

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

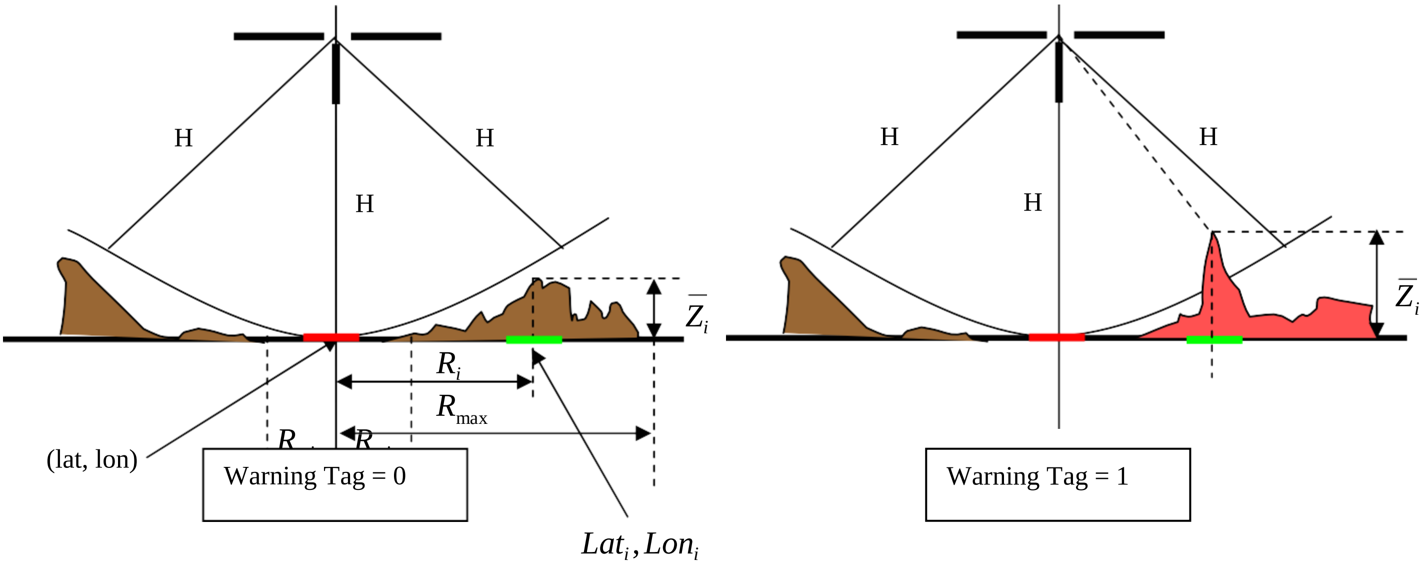
Symbol	Units	Notes
δ_{N_m}	[m]	Maximum penetration depth
N_c	[ ]	Number of requests for Clutter cancellation
M	[ ]	Number of investigations of the Surface Clutter contributions
CLUTTER_VECT	[m]	List of depths

INTERNAL OUTPUTs

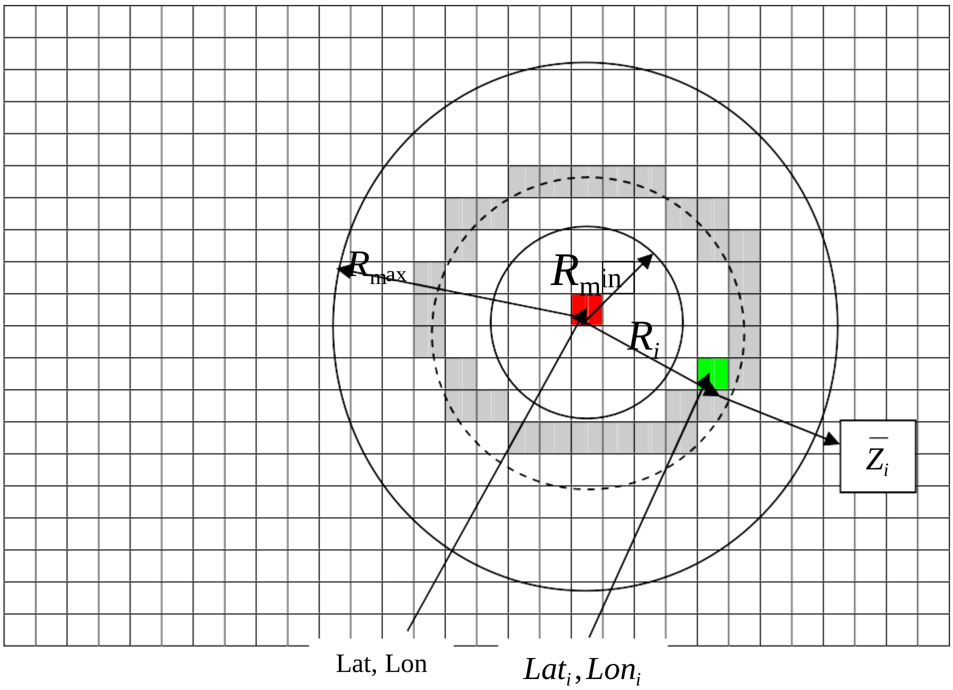
Symbol	Units	Notes
δ_C	[m]	Maximum Penetration depth if Monopole cancellation is not applied
δ_{Nm}	[m]	Maximum penetration depth if there is only Galactic noise

4.4 WARNING EVALUATION

GEOMETRY



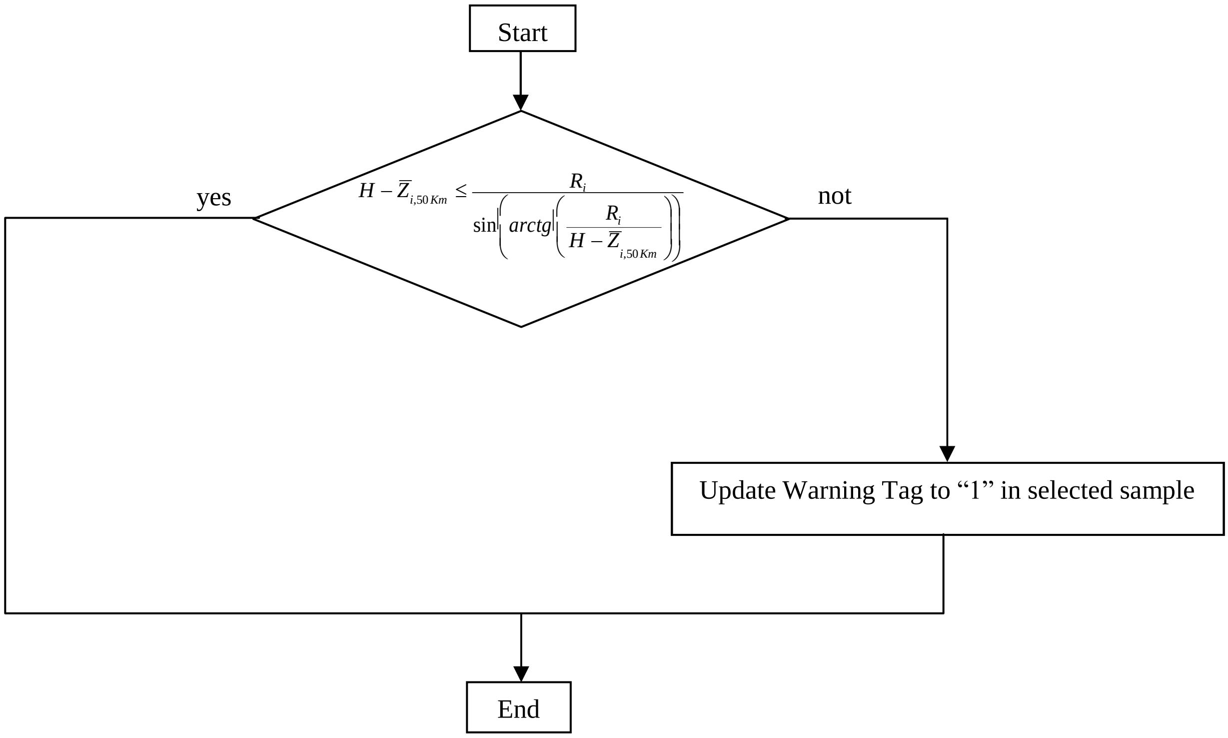
Surface Representation



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)

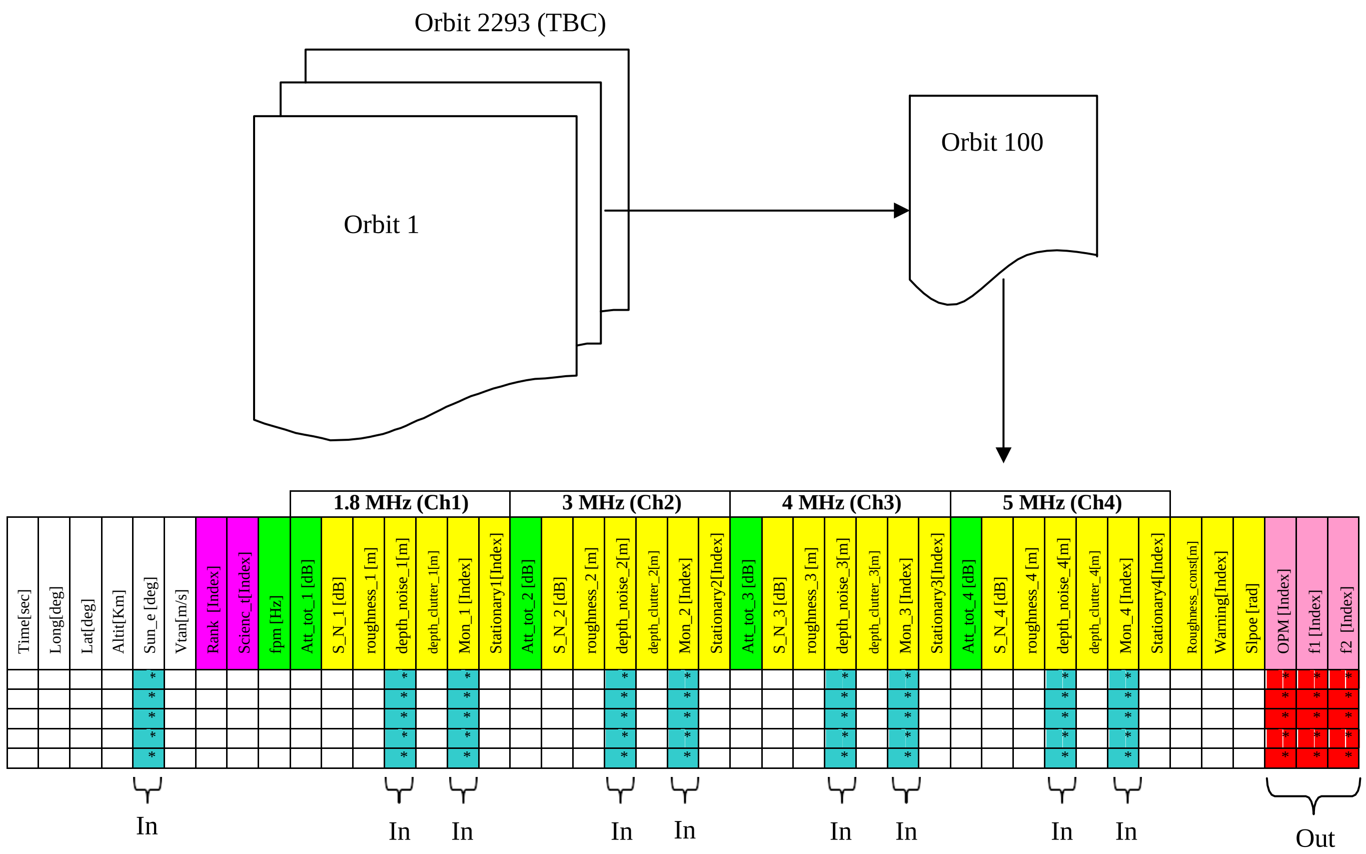
Database Identifier	Symbol	Value	Units	CORISTA Nomenclature
324	$R_{\min}$	10000	[m]	MinWarningDistance
325	R_{Max}	150000	[m]	MaxWarningDistance

SURFACE STATISTICAL PARAMETERS (From the database)

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

5 SELECT OPERATIVES MODES

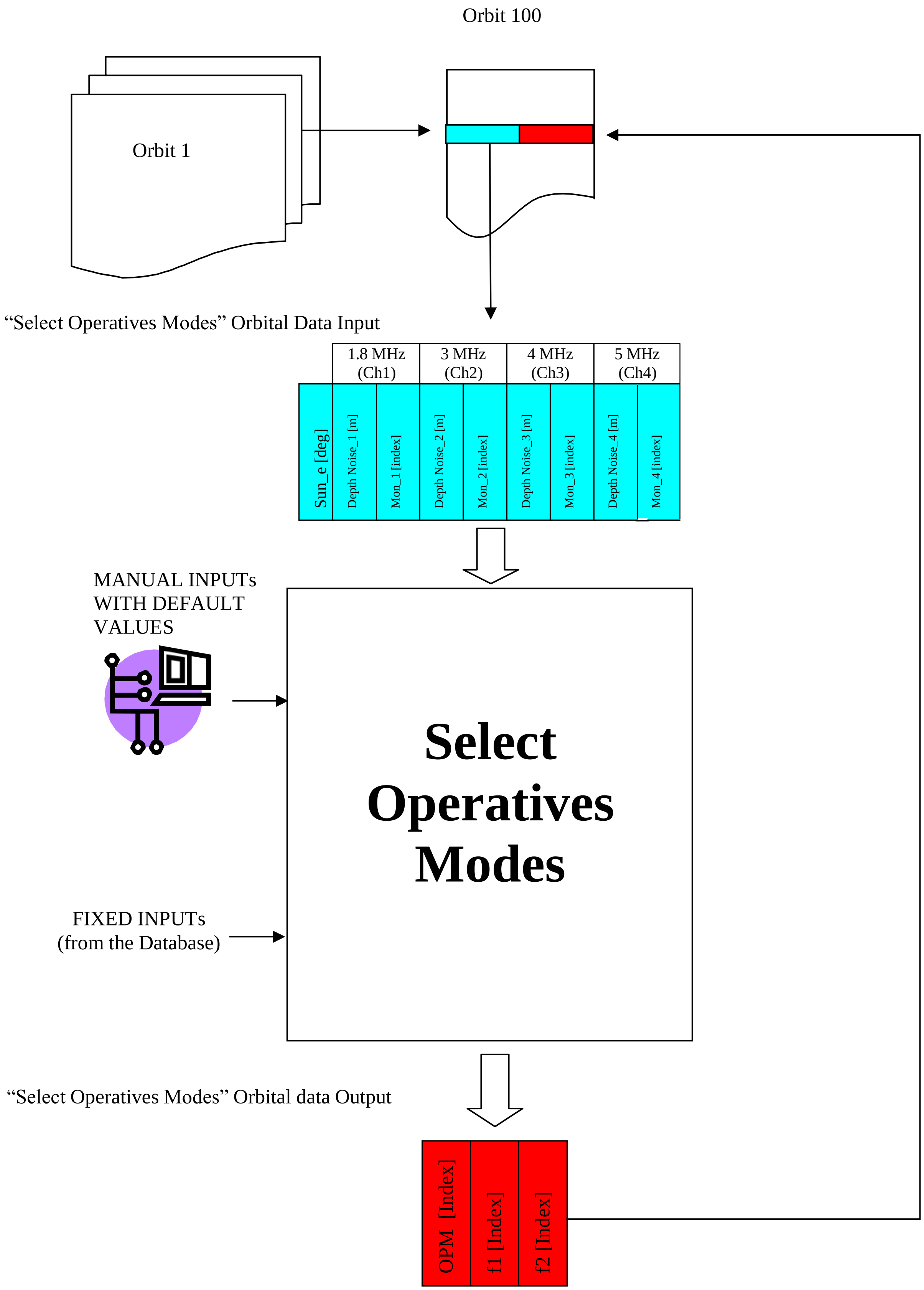
3



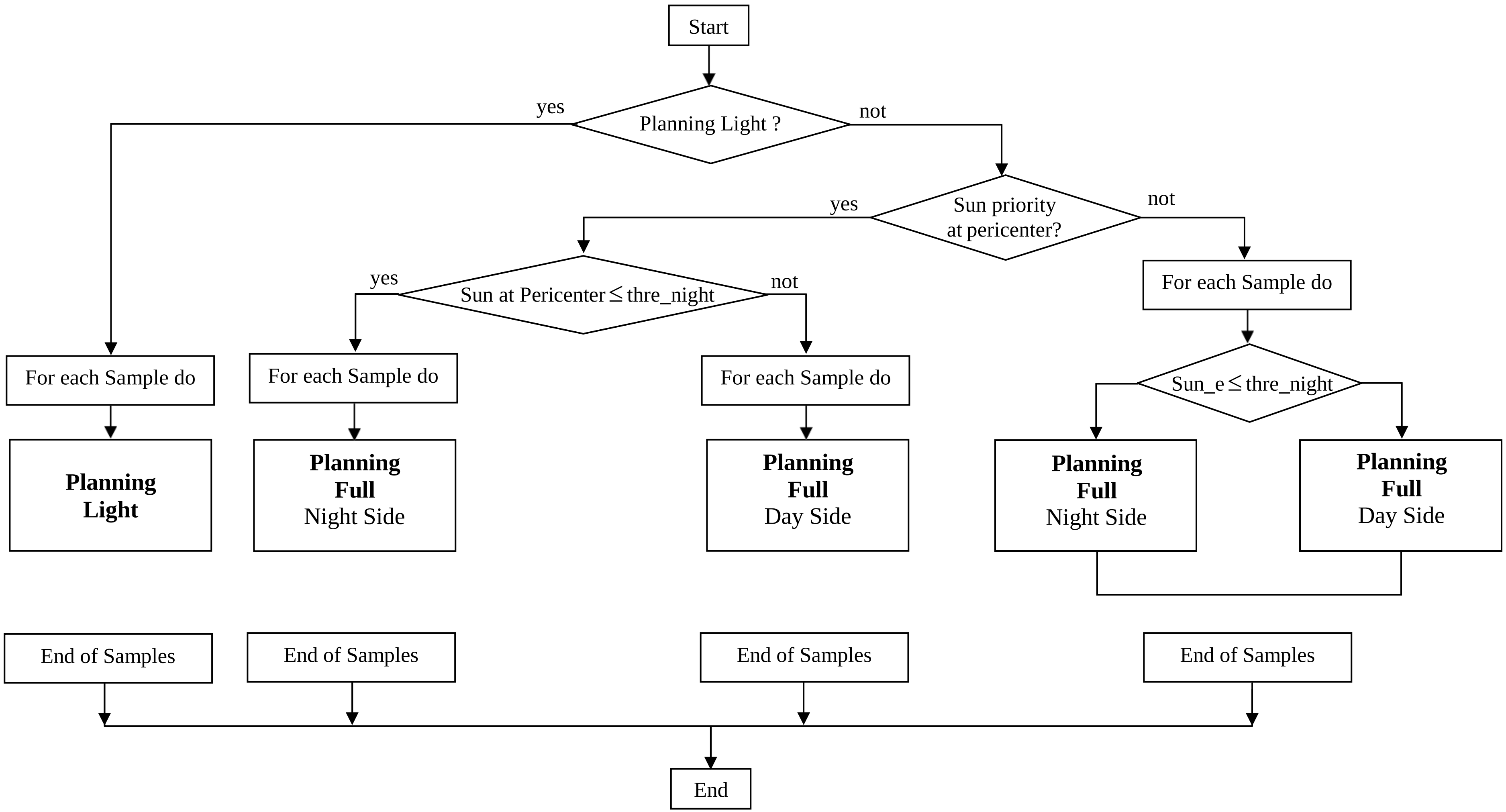
In ➔"Select Operatives Modes" Orbital Data Input

Out ➔ "Select Operatives Modes" Orbital data Ou

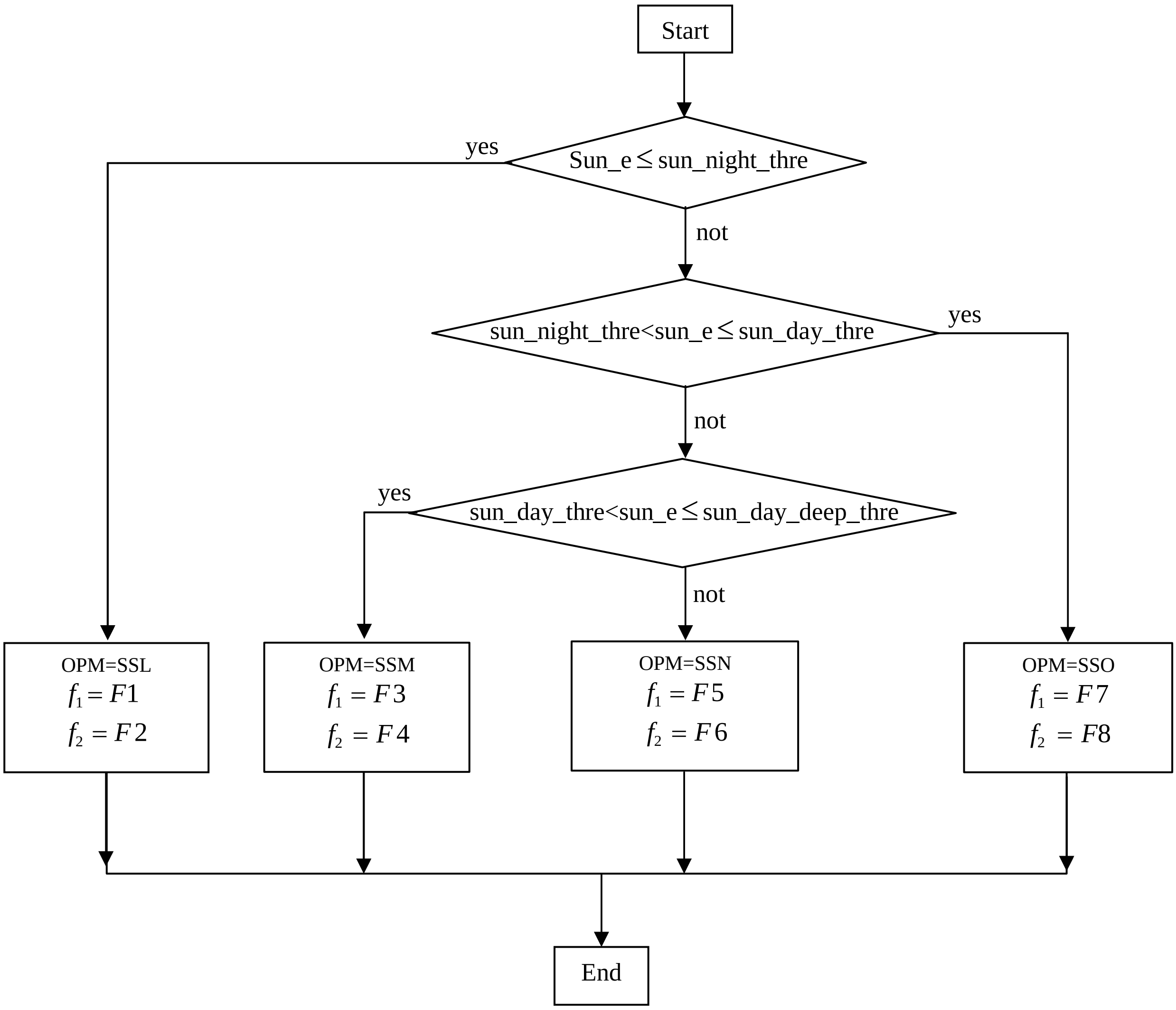
5.1 CONTEST

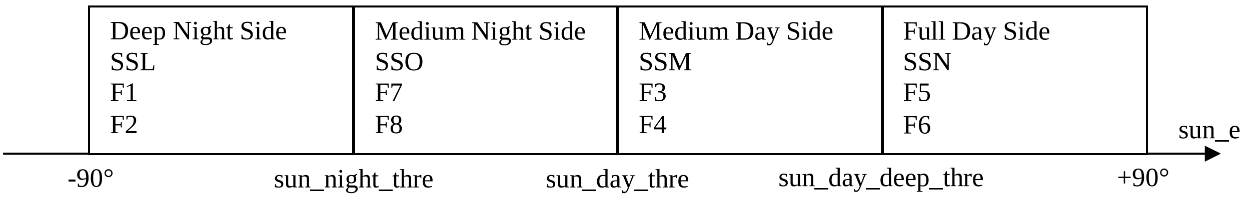

Orbit 100
Orbit 1
"Select Operatives Modes" Orbital Data Input
1.8 MHz (Ch1)
3 MHz (Ch2)
4 MHz (Ch3)
5 MHz (Ch4)
Sun_e [deg]
Depth Noise_1 [m]
Mon_1 [index]
Depth Noise_2 [m]
Mon_2 [index]
Depth Noise_3 [m]
Mon_3 [index]
Depth Noise_4 [m]
Mon_4 [index]
MANUAL INPUTs
WITH DEFAULT
VALUES
Select
Operatives
Modes
FIXED INPUTs
(from the Database)
"Select Operatives Modes" Orbital data Output
OPM [Index]
f1 [Index]
f2 [Index]

5.2 TOP LEVEL DATA FLOW

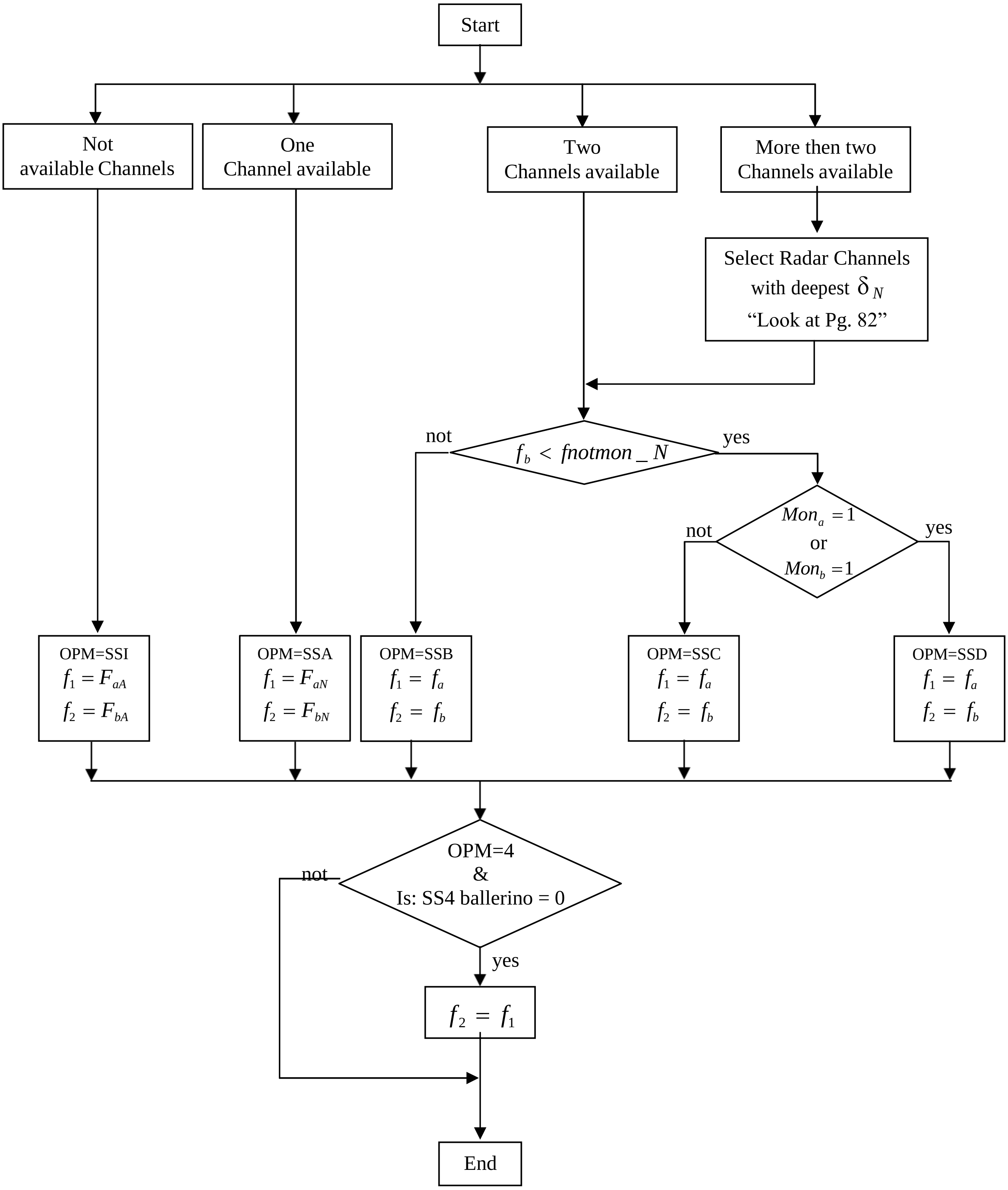


5.2.1 “Planning Light”

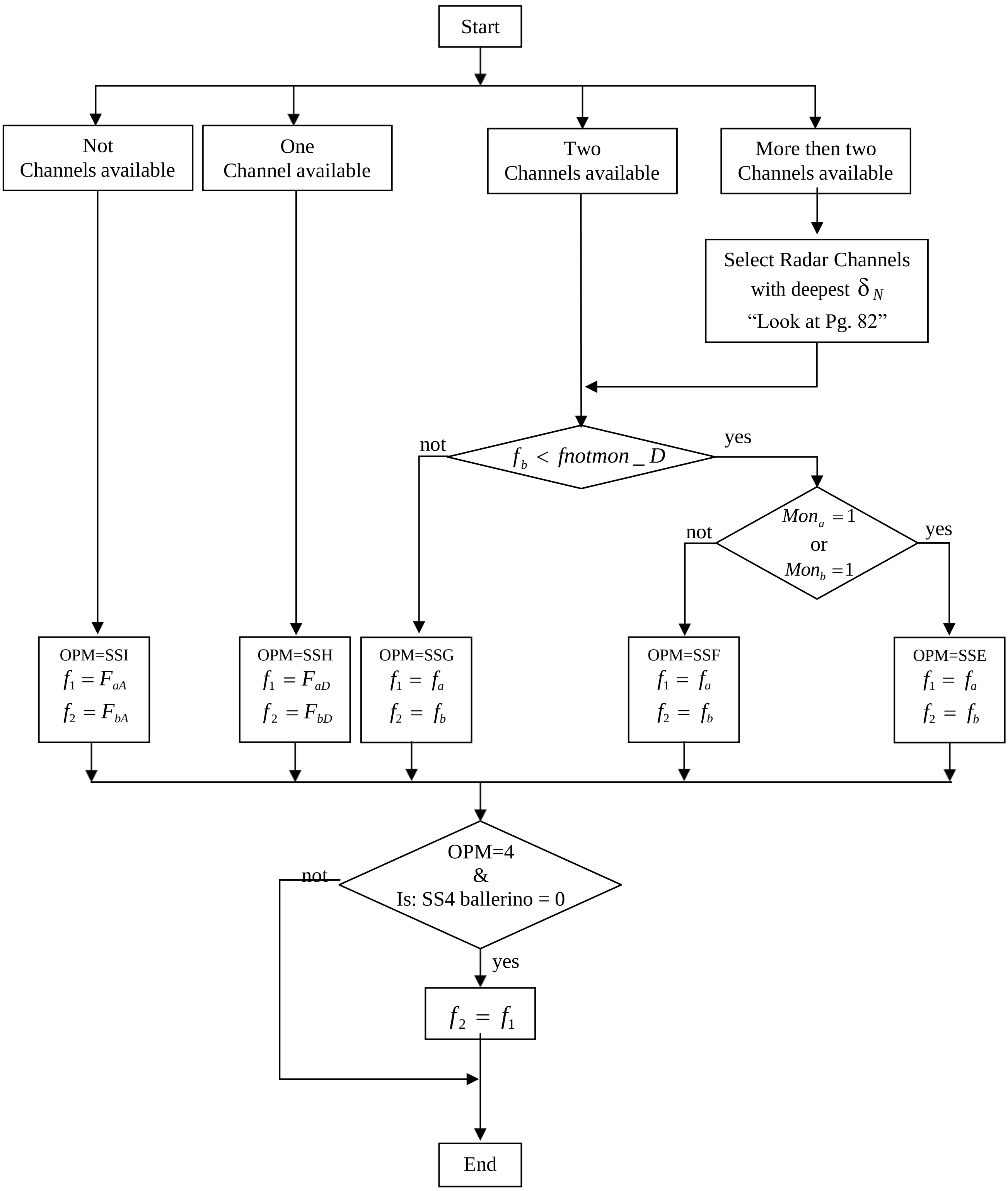




5.2.2 "Planning Full" Night Side with priority at pericenter



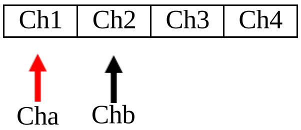
5.2.3 "Planning Full" Day Side with priority at pericenter



5.2.4 Select Radar Channels with deepiest penetration depths

<u>Possible cases:</u>

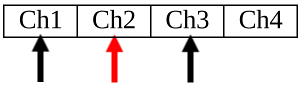
a)



Cha = Ch1 (Deepest penetration depth "δ_N ")

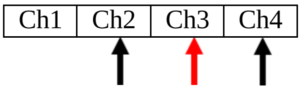
Chb = Ch2 (In order to have consecutive frequencies)

b)



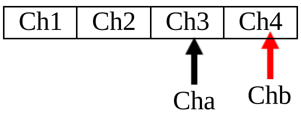
Ch2 has the deepest penetration depth.
If Ch3_depth > Ch1_depth **then** Cha = Ch2 and Chb = Ch3
else ➔ Cha = Ch1 and Chb = Ch2

b)



Ch3 has the deepest penetration depth.
If Ch4_depth > Ch3_depth **then** Cha = Ch3 and Chb = Ch4
else Cha = Ch2 and Chb = Ch3

c)



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

"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 IMPUTs IDENTIFIER

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

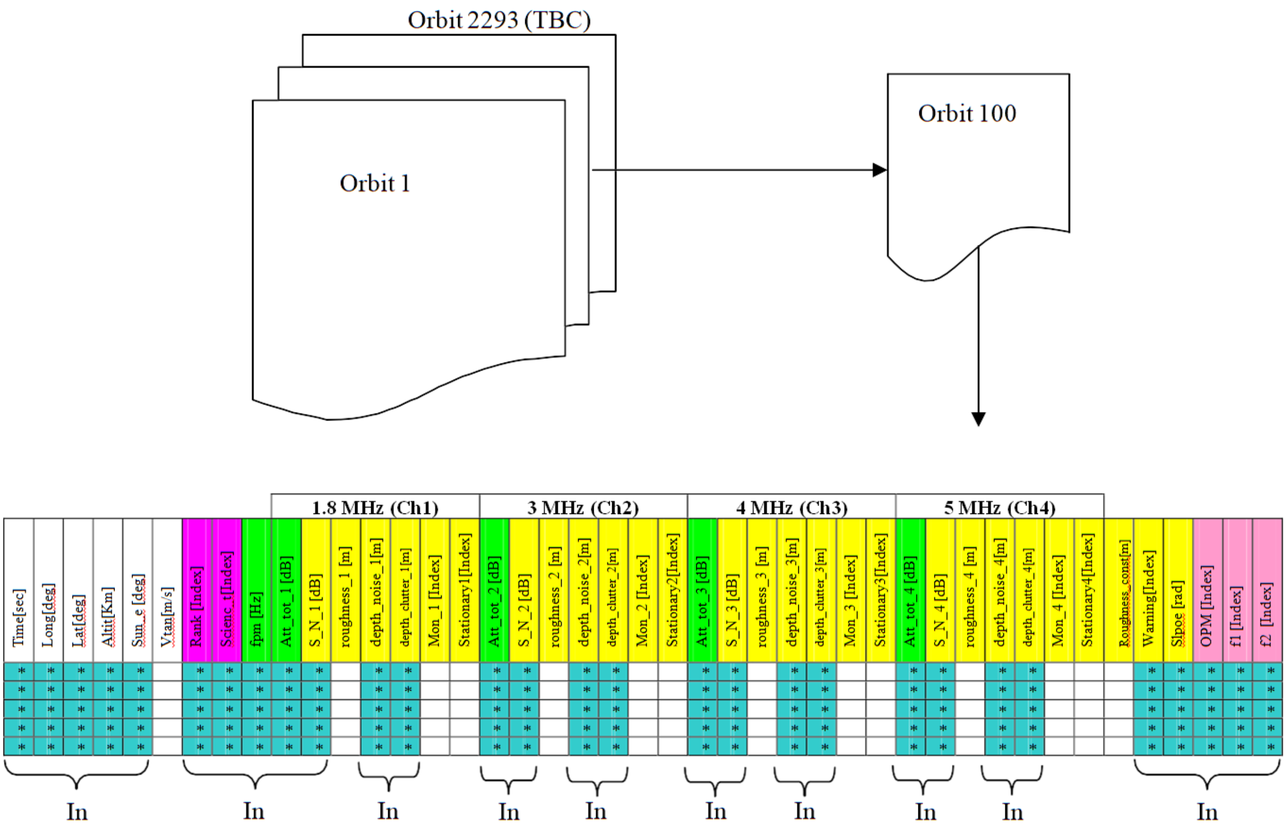
ORBITAL OUTPUTs

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

FIXED INPUTs (From the Database)

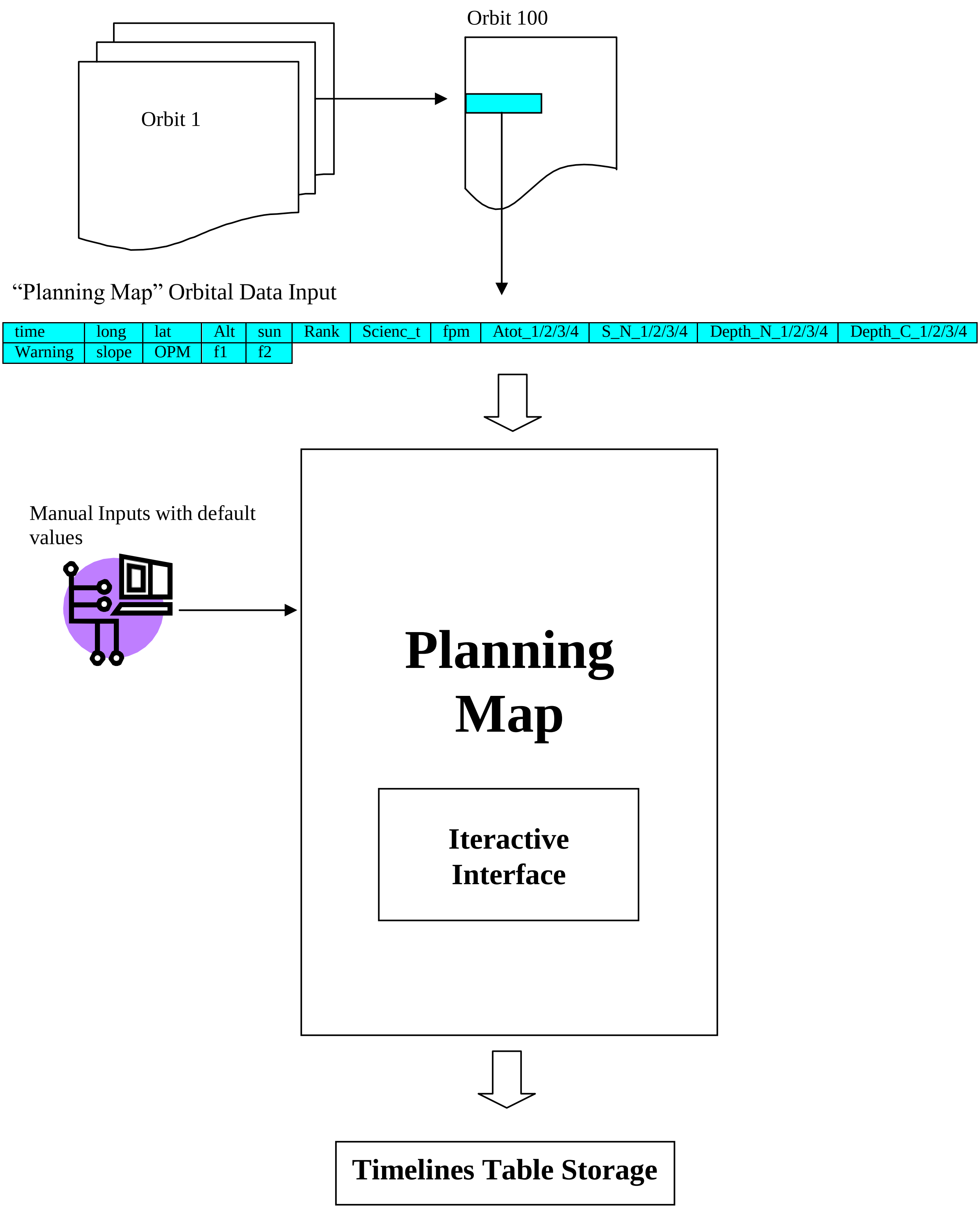
Database Identifier	Symbol	Value	External Units	Internal Units transformation	CORISTA Nomenclature
400	thre_night	5	[deg]	→ [rad]	NightTreshold
401	sun_night_thre	-5	[deg]	→ [rad]	SunNightTH
402	sun_day_thre	5	[deg]	→ [rad]	SunDayTH
403	sun_day_deep_thre	30	[deg]	→ [rad]	SunDeepDayTH
404	fnotmon_D	5	[MHz]	→ [Hz]	MaxMonopoleFreqDay
405	fnotmon_N	5	[MHz]	→ [Hz]	MaxMonopoleFreqNight
406	F_{aN}	2	[index]	No action	fiN
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 PLANNING MAP

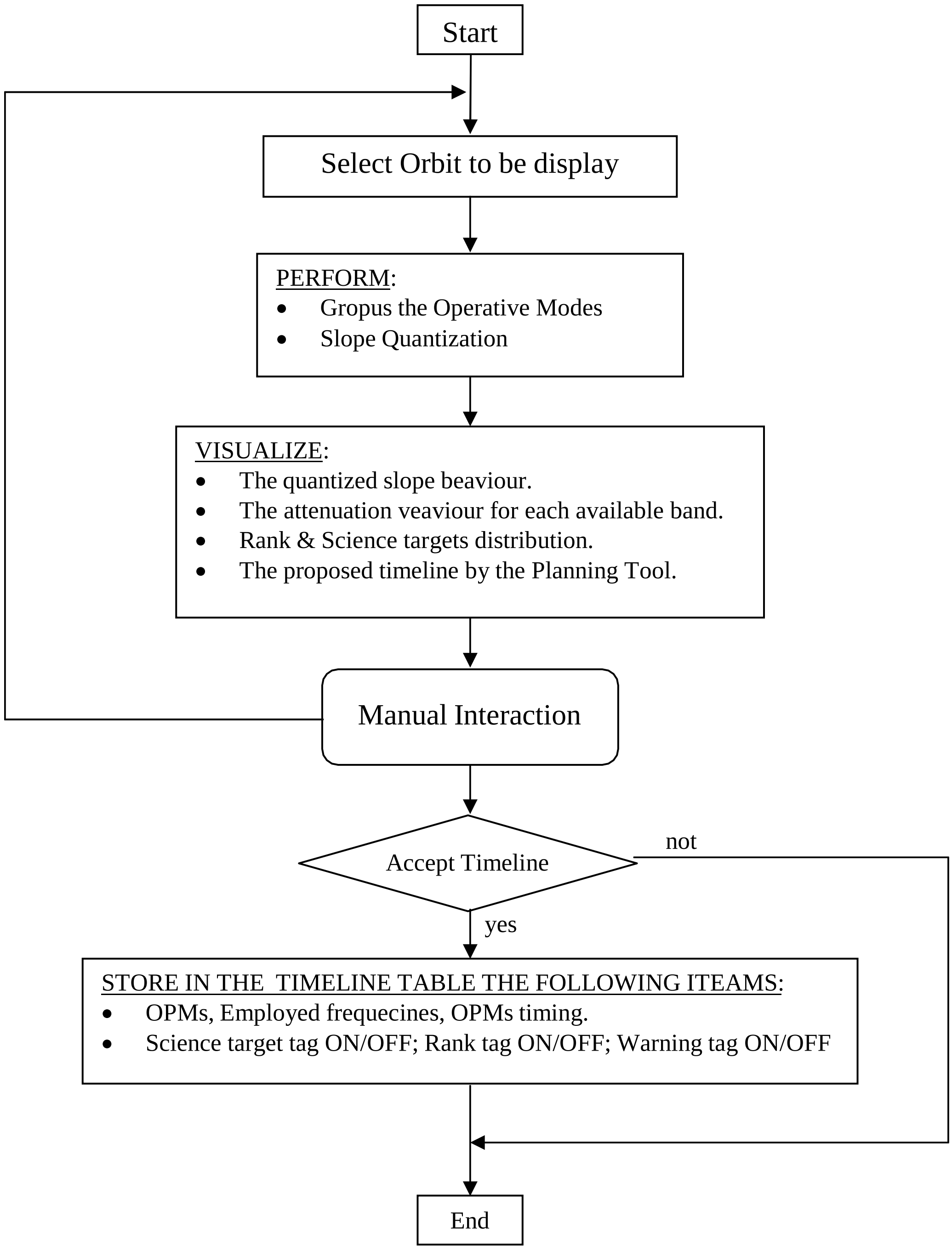


In ➔ "Planning Map" Orbital Data Input

6.1 CONTEST

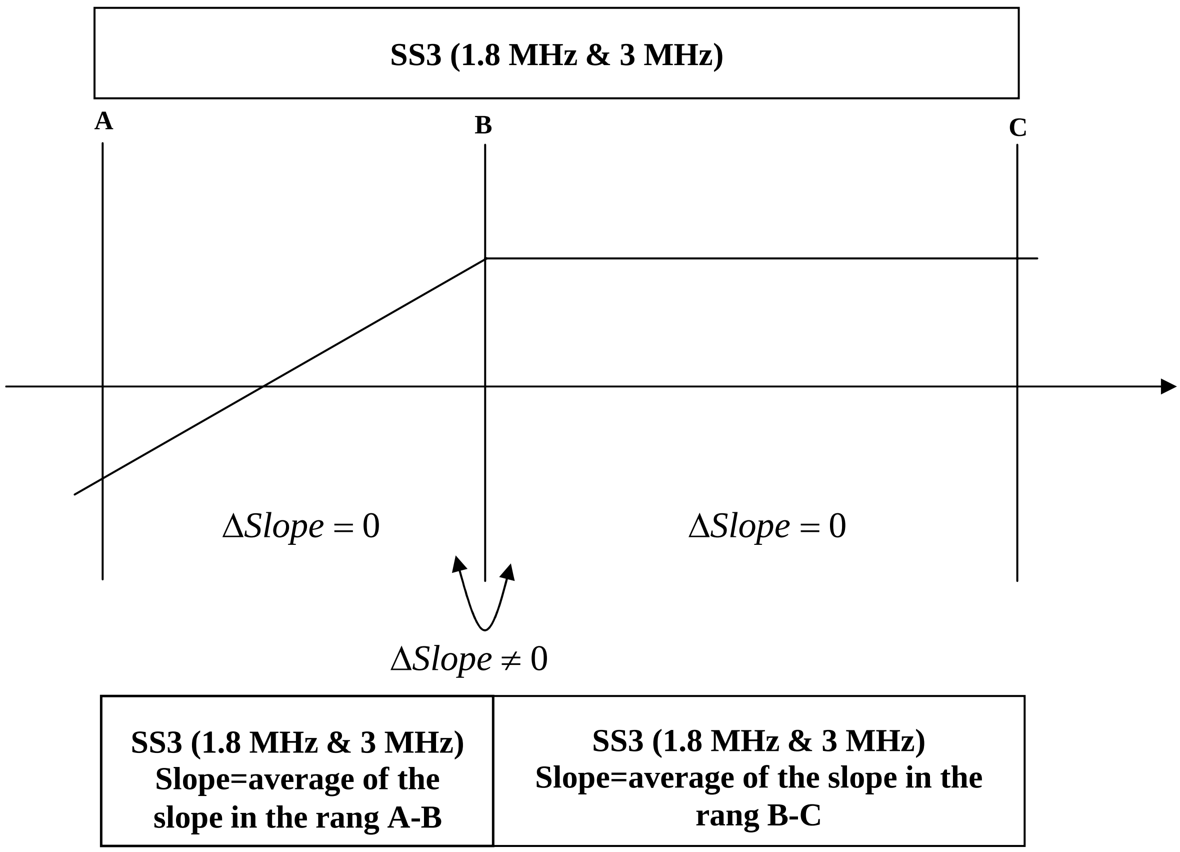

Orbit 100
Orbit 1
“Planning Map” Orbital Data Input
time
long
lat
Alt
sun
Rank
Scienc_t
fpm
Atot_1/2/3/4
S_N_1/2/3/4
Depth_N_1/2/3/4
Depth_C_1/2/3/4
Warning
slope
OPM
f1
f2
Manual Inputs with default values
Planning Map
Iteractive Interface
Timelines Table Storage

6.2 TOP LEVE DAT FLOW



6.3 SLOPE QUANTIZATION ALGORITHM

$\Delta Slope = |Slope_i - Slpoe_{i+1}|$ Where "i" is the sample



If the variation $\Delta Slope$ is bigger then the value set in the manual input mask, then it is necessary to split the OPM into two OPMs

"MODES OPTIMIZATION": INPUTS, OUTPUTS, CONSTANTS, VARIABLES

MANUAL INPUT

Symbol	Default value	External Units	Internal Units transformation	Notes
Slope quantization step	1	[deg]	➔ [rad]	Slope Quantizatio 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"

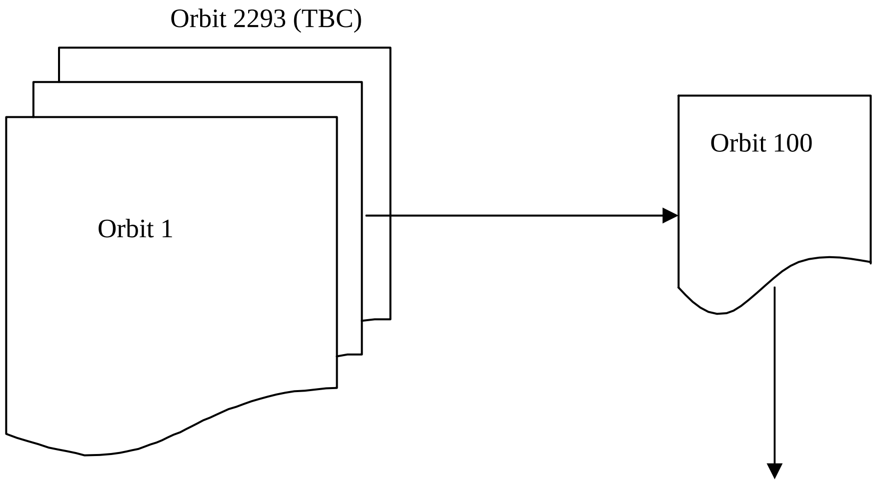
BAND (Ba) EVALUATION

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

<table>
<tr><th>OPM</th><th>MIRA BAND</th></tr>
<tr><td>SS1</td><td rowspan="3">f1➔ Ba</td></tr>
<tr><td>SS2</td></tr>
<tr><td>SS3</td></tr>
<tr><td>SS4</td><td rowspan="2">f2 ➔ Ba</td></tr>
<tr><td>SS5</td></tr>
</table>

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

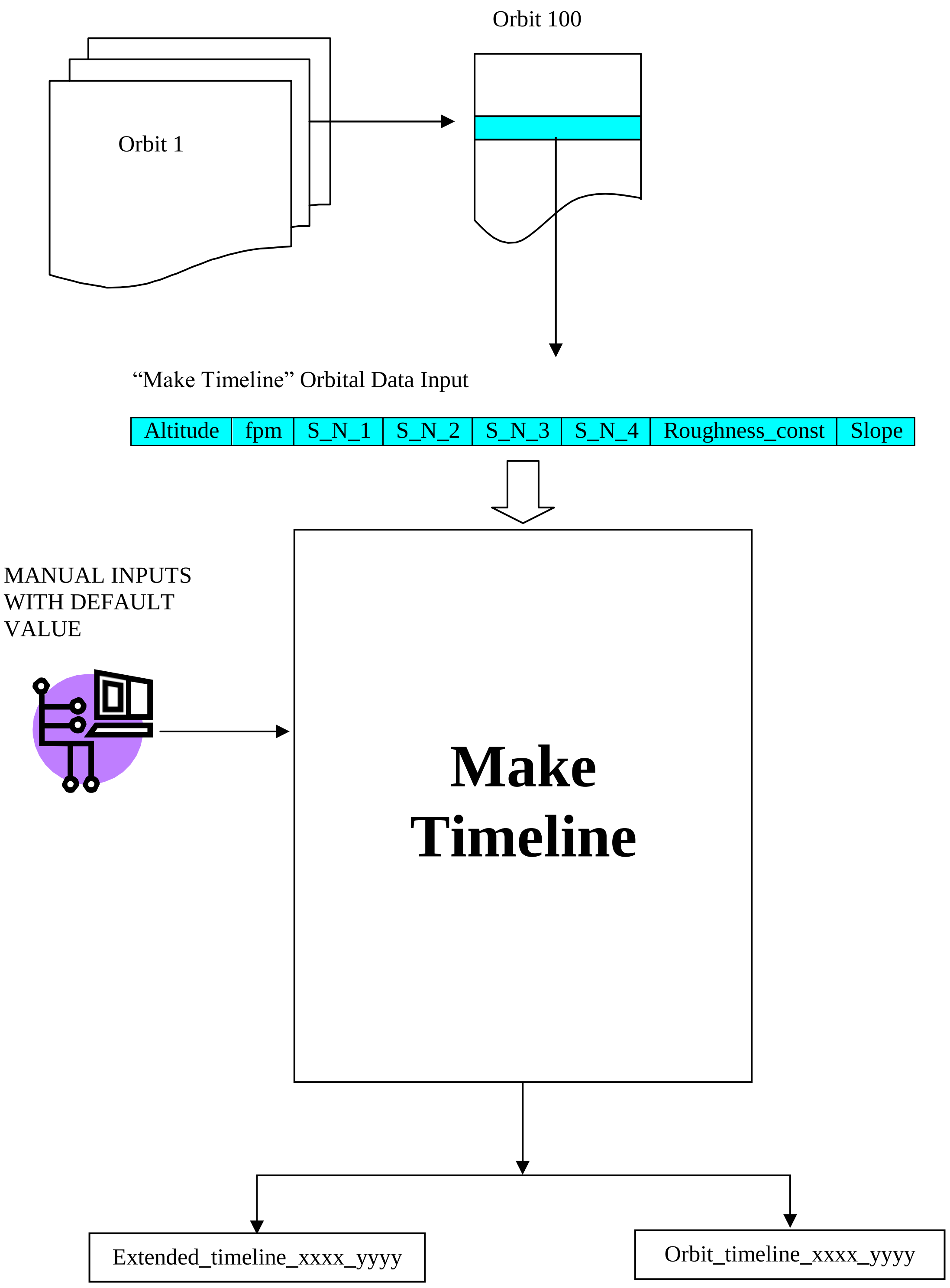
7 MAKE TIMELINE



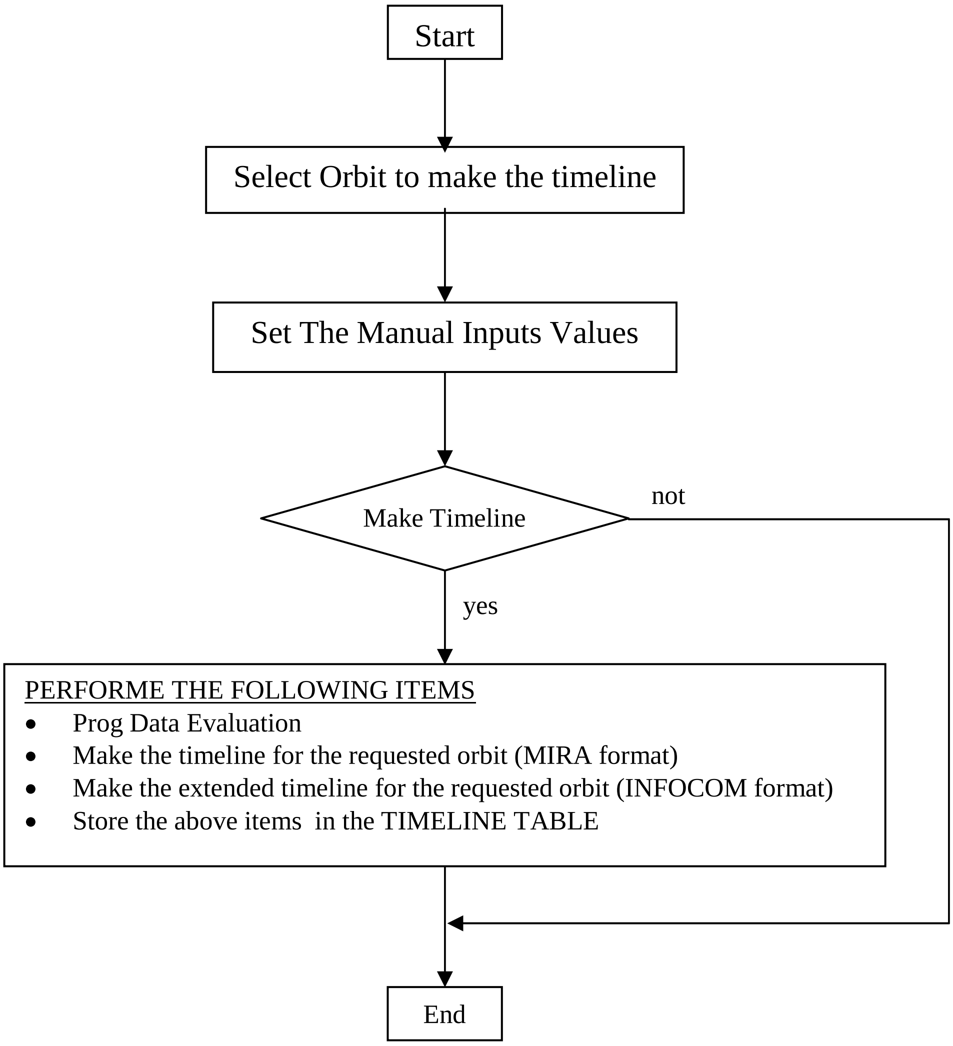
									1.8 MHz (Ch1)							3 MHz (Ch2)							4 MHz (Ch3)							5 MHz (Ch4)												
Time[sec]	Long[deg]	Lat[deg]	Altit[Km]	Sun_e [deg]	Vtan[m/s]	Rank [Index]	Scienc_t[Index]	fpm [Hz]	Att_tot_1 [dB]	S_N_1 [dB]	roughness_1 [m]	depth_noise_1[m]	depth_clutter_1[m]	Mon_1 [Index]	Stationary1[Index]	Att_tot_2 [dB]	S_N_2 [dB]	roughness_2 [m]	depth_noise_2[m]	depth_clutter_2[m]	Mon_2 [Index]	Stationary2[Index]	Att_tot_3 [dB]	S_N_3 [dB]	roughness_3 [m]	depth_noise_3[m]	depth_clutter_3[m]	Mon_3 [Index]	Stationary3[Index]	Att_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]	Slpoe [rad]	OPM [Index]	f1 [Index]	f2 [Index]
			*					*		*							*							*							*						*		*			
			*					*		*							*							*							*						*		*			
			*					*		*							*							*							*						*		*			
			*					*		*							*							*							*						*		*			
			*					*		*							*							*							*						*		*			
			In					In		In							In							In							In						In		In			

In ➔"Make Timeline " Orbital Data Input

7.1 CONTEST


Orbit 100
Orbit 1
“Make Timeline” Orbital Data Input
Altitude
fpm
S_N_1
S_N_2
S_N_3
S_N_4
Roughness_const
Slope
MANUAL INPUTS WITH DEFAULT VALUE
Make Timeline
Extended_timeline_xxxx_yyyy
Orbit_timeline_xxxx_yyyy

7.2 TOP LEVEL DATA FLOW



7.3 PROG DATA

PROG DATA LIST TO EVALUATE

	Freq_1				**Freq_2**				**Frequency Independently**				
Parameter	Minimum	Maximum	Mean	rms	Minimum	Maximum	Mean	rms	Minimum	Maximum	Mean	rms	Units
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

$$P\_\min imum = \min[P_1 \ldots P_N]$$

$$P\_\max imum = \min[P_1 \ldots P_N]$$

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

$$P\_rms = \sqrt{\frac{1}{N} \cdot \sum_{i=1}^{N} \left(\overline{P} - P_i\right)^2}$$

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).

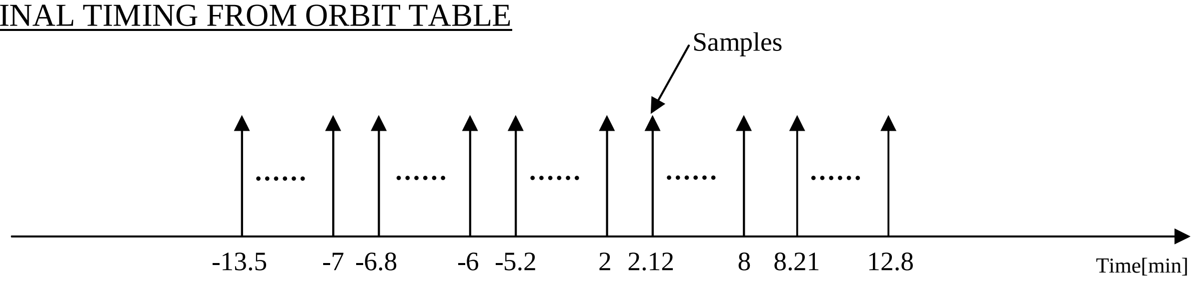
4) **Rank "column"** (do not confuse with the Rank classification of the Planning Tool)
Actually this value is fixed to 3 for every activity.

5) **Instr "column"**
This parameter indicates the name of the instrument SSRA (old name of MARSIS), is fixed for every activity.

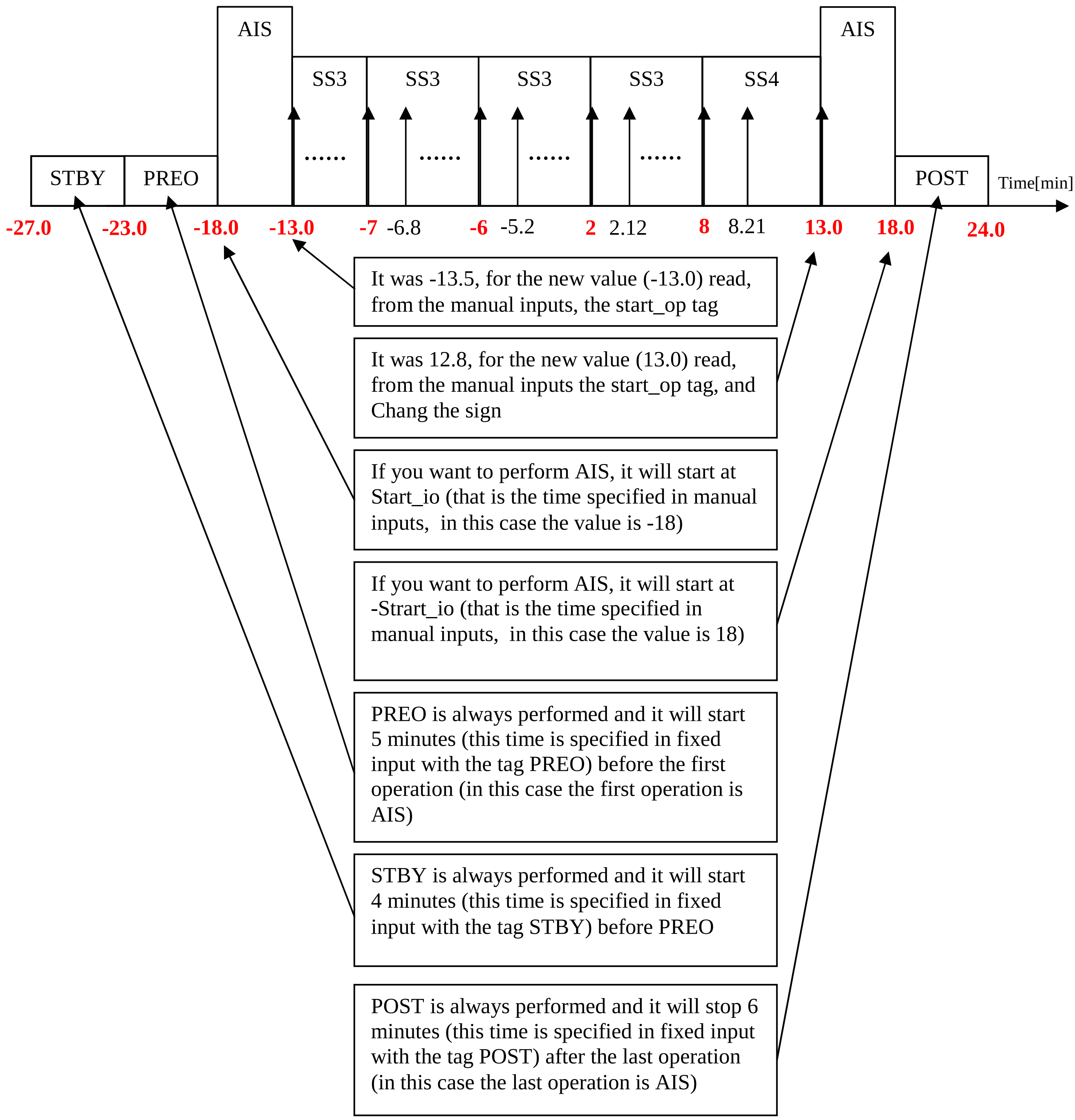
6) **Activ "column"** (Activ is the abbreviation of Activity)
The different activities are listed in this column, the sequences is:
STBY
PREO
- Sequences of Operative Modes (AIS, CAL, REC, SS1, SS2, SS3, SS4, SS5) -
POST
For the selection of: CAL, REC, SS1, SS2, SS3, SS4, SS5 see the Orbit Table.
AIS 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:

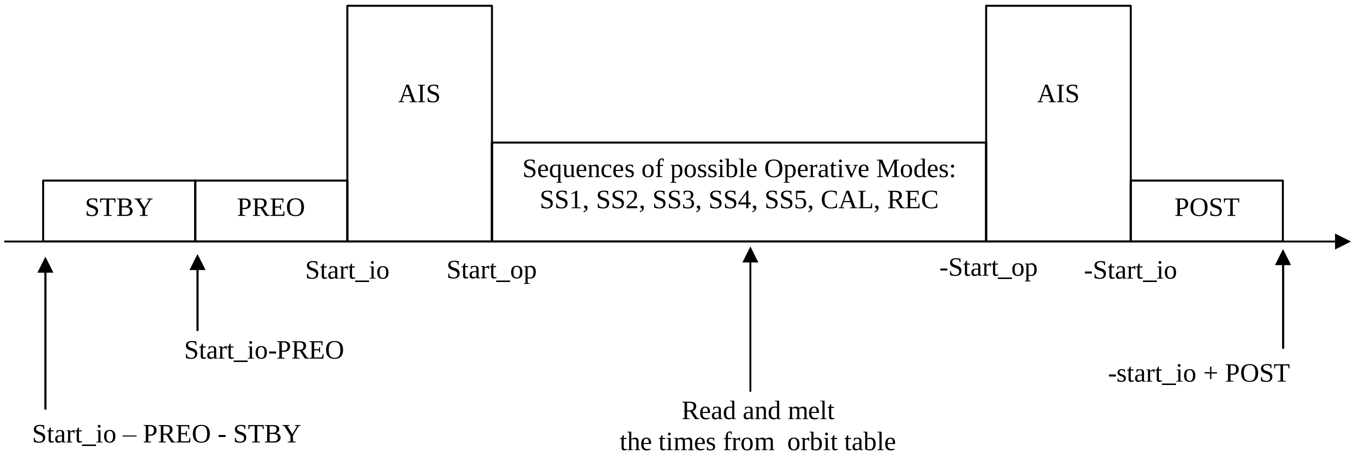
ORIGINAL TIMING FROM ORBIT TABLE



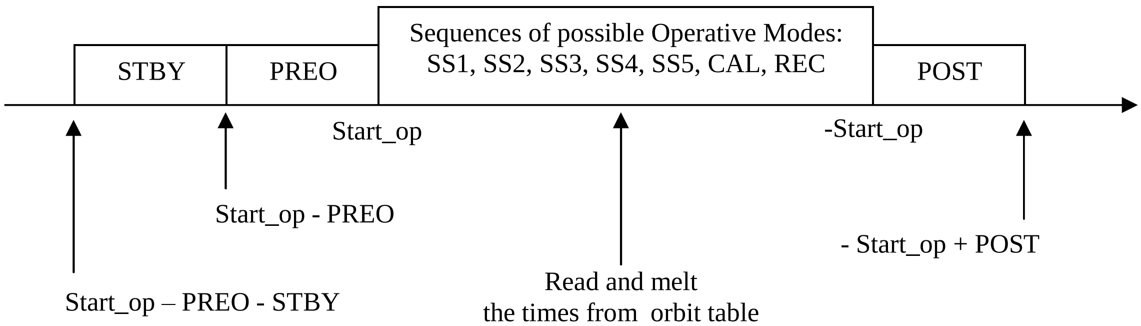
ADGJUSTED TIMING



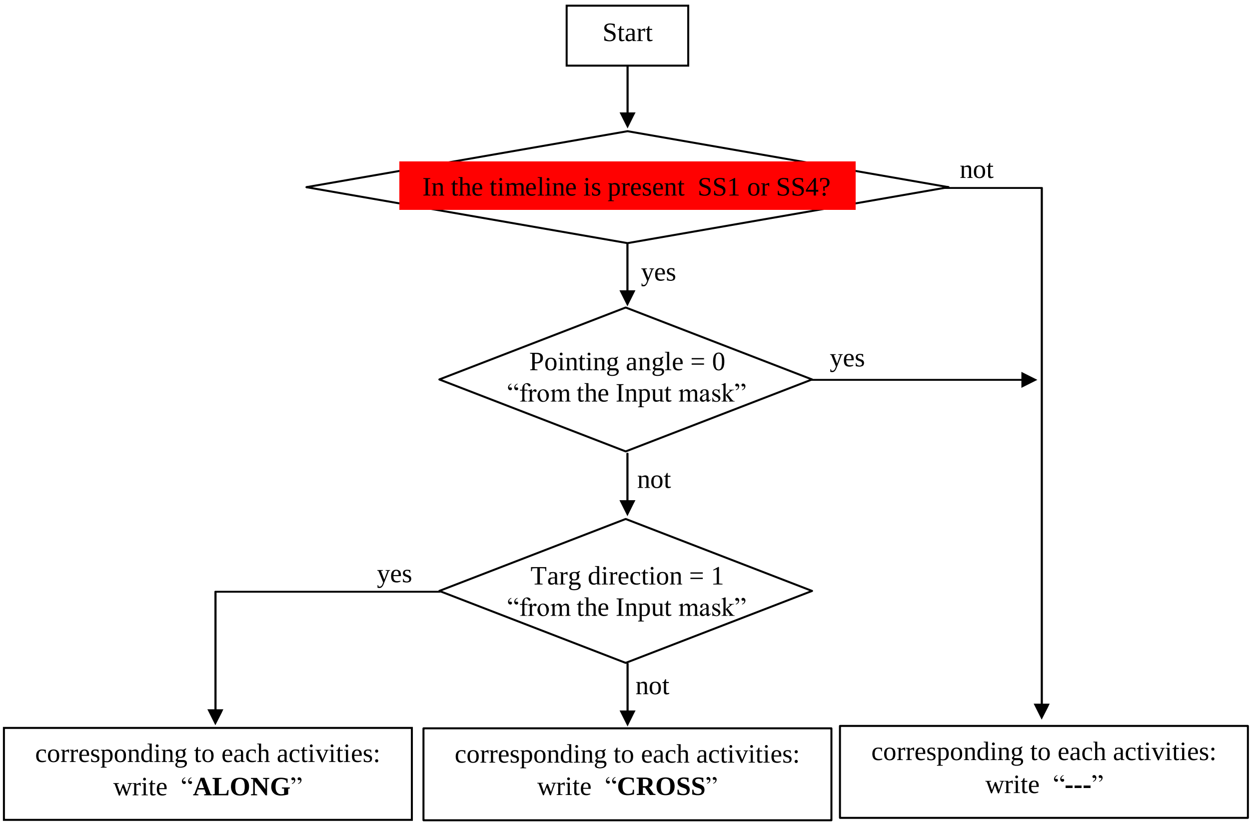
GENERAL TIMING WITH Active Ionosphere Sounding Mode



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.

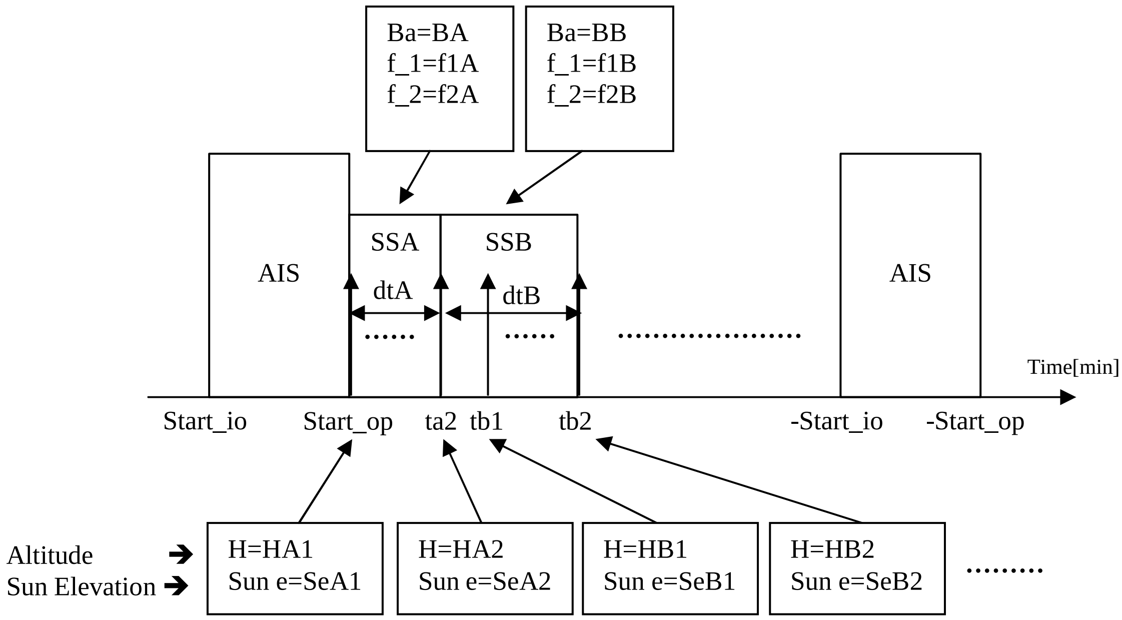
   For the evaluation of the data volume produced from the timeline, see the procedure "Evaluate Data Volume" in the next paragraph.

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



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

…………………………………………………………………..

"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]	SunThreschold
	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

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	$[\mu \sec]$	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

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]	fiN
	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)
	$Grid_{area}$ size	75	[Km]	Cell area dimension
	$Grid_{angle}$ 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)

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
	$\overline{\sigma}_{\sigma_h}$	[m]	Standard deviation of the Roughness
	$\overline{\alpha}_x$	[rad]	Mean value of the surface inclination angle
	$\Delta\alpha_x$	[rad]	Maximum displacement of the surface inclination angle
	$\overline{\sigma}_{\alpha_x}$	[deg]	Standard deviation of the surface inclination angle
	$\overline{\alpha}_y$	[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

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 (Valuse: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 sx	Lon inf sx	Lat sup sx	Lon sup sx	Size area	Size 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
   ..............................................................
```

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**
Define Orbits Range 100 First orbit 110 Last orbit 5 Orbit Step size **RUN Classification**	**Define Orbits Range** 100 First orbit 110 Last orbit **RUN Planning**				

CLASSIFICATION MASK

Classification (Rank & Science t)	Ionosphere Modeling	Dynamic Evaluation	Select Operative Modes	Planning Map	Make Timeline

Rank Classification

Set Working Mode

☒ Grid Area Mode

[75] Grid Area Size [Km]

☐ Grid Angle mode

[1,5] Grid Angle size [deg]

Define Mars Classification Area

[-89] Lat_min [deg]

[+89] Lat_Max [deg]

[-180] Lon_min [deg]

[180] Lon_Max [deg]

Set Parameters

[250] H_min [Km]

[500] H_Max [Km]

[10] dH [Km]

[-90] SE_min_1 [deg]

[5] SE_min_2 [deg]

[15] SE_min_3 [deg]

[0] SE_max

[1] dSE [deg]

☐ Enable Function

Load Science Targets

☐ Enable Function

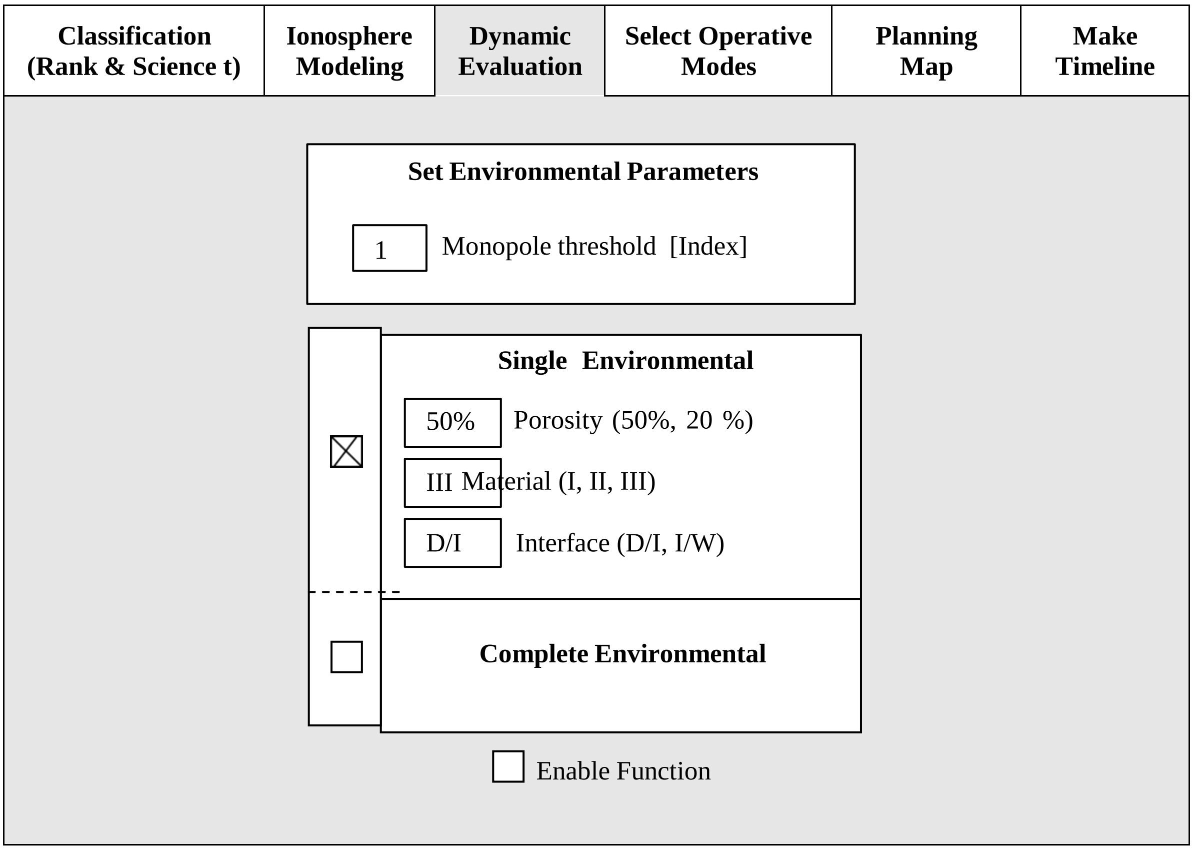
IONOSPHERE MODELING MASK

Classification (Rank & Science t)	Ionosphere Modeling	Dynamic Evaluation	Select Operative Modes	Planning Map	Make Timeline

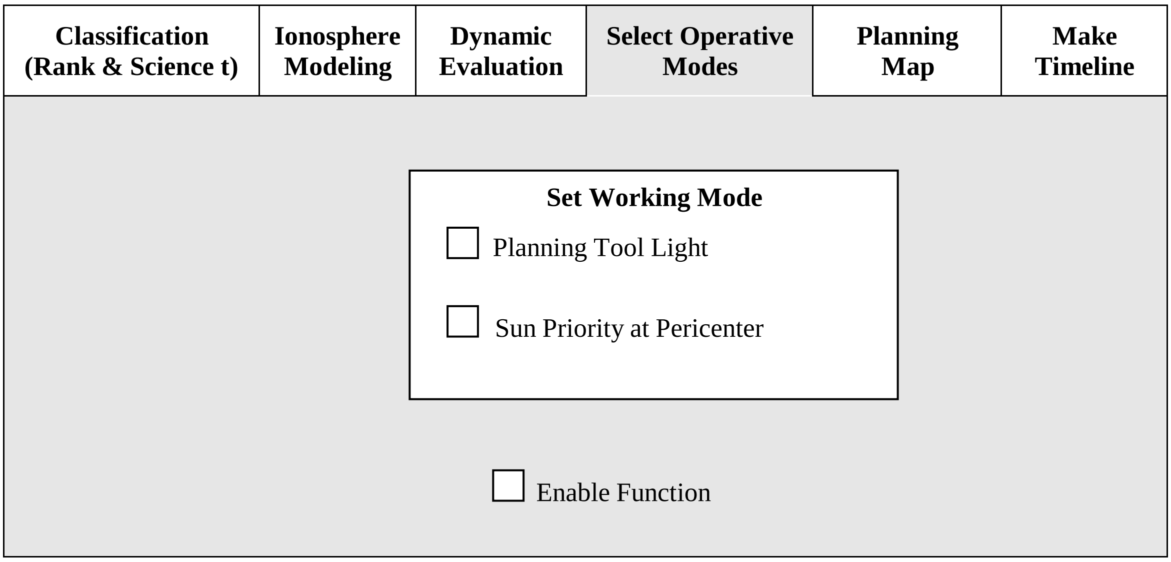
NO MANUAL INPUT

☐ Enable Function

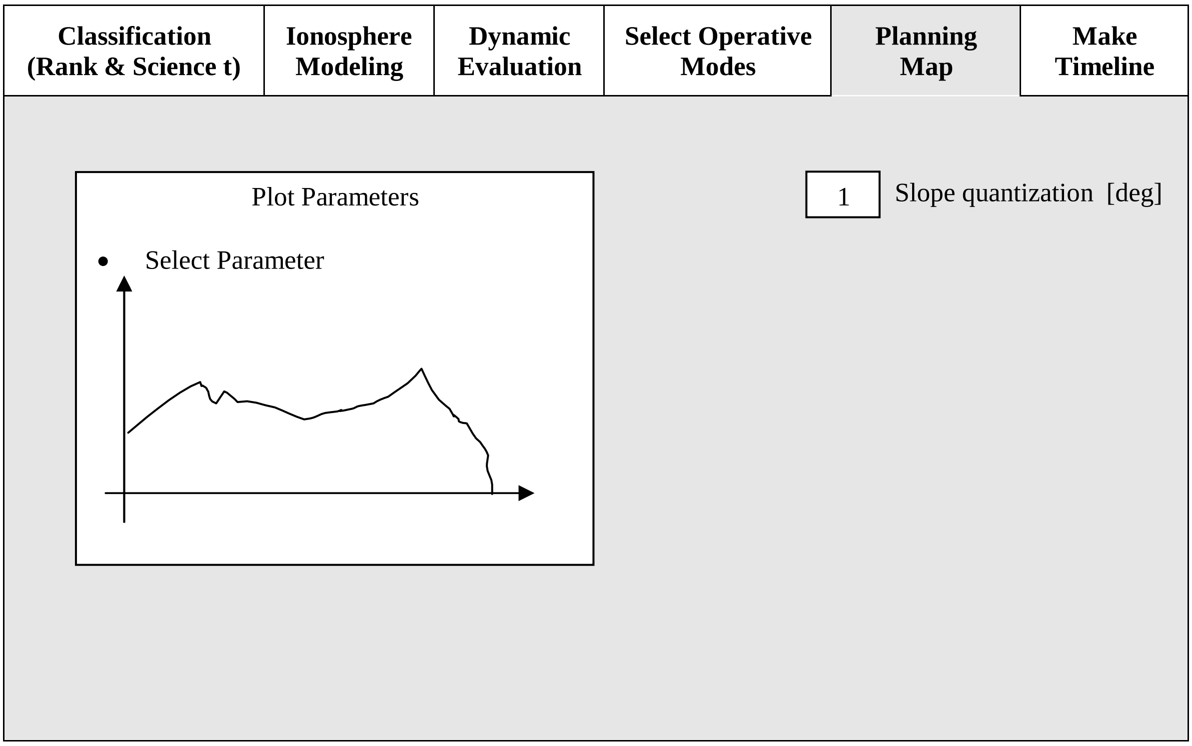
DYNAMIC EVALUATION MASK



SELECT OPERATIVE MODES MASK



PLANNING MAP MASK



MAKE TIMELINE MASK