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How to Produce and Use the X-factor Table

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1 Introduction

Retrieving the normalized radar backscatter (σ^0) from QuikSCAT includes calculating the integral form of the radar equation. This is too computationally intensive for real time evaluation. For this reason, a lookup table is used for X where $\sigma^0 = P_r/X$ and P_r is the power returned to the satellite. This document contains information on how to use *Xfactor7* to produce a table, and how to find X using this table.

2 Using *Xfactor7* to produce a table

Producing a table using *Xfactor7* is fairly straight forward. All of the inputs are described in table 1. Producing a perturbation table for one mode and beam requires between 1 and 2 days of CPU time[1], and producing a nominal table requires about 1 hr. of CPU time. If it is necessary to produce a table faster than that, it can be divided into parallel processes. Each parallel process should cover the complete azimuth range and whatever portion of the orbit time range is desired for the output files to concatenate properly.

3 Retrieving X from the table

The first step in retrieving X from the table is to calculate the baseband frequency of the electrical bore-sight, Δf_{pert}, in frequency bins. The electrical bore-sight must be defined the same as it was when the table was generated[2]. The elevation of the local topography, h_{topo} must be found from a topography map. Then

$$X = X_{nom} + A + B \cdot \Delta f + C \cdot \Delta f^2 + D \cdot \Delta f^3 + 10 \log(G) \tag{1}$$

[1] This is on a 200 MHz HP workstation.

[2] The elevation angles of the electrical bore-sights are 39.85° and 45.95° for the inner and outer beams respectively. The azimuth angle of the electrical bore-sight is 0.15° from the mechanical bore-sight for both beams.

Table 1: Description of inputs for *Xfactor7*.

Input	Description
Program mode	(1) The table program mode for producing tables. (2) The single mode is for calculating X for a single orbit time, azimuth angle, and set of perturbations.
beam	(1) The inner beam of the antenna or horizontal polarization. (2) The outer beam of the antenna or vertical polarization.
resolution mode	The resolution mode determines the width of the slices and the effective gate width.
table type	(1) The nominal table is used when X_{nom} is all that needs to be calculated. (2) The perturbation table contains all of the data needed to retrieve X and the slice centers.
orbit parameters	This gives an opportunity to change the nominal orbit parameters. All of the perturbations used to calculate the Δf coefficients are centered around these nominal orbit parameters.
roll, pitch, and yaw	This is the nominal roll, pitch, and yaw. These are the values used to calculate X_{nom} and the perturbations in attitude used to produce the Δf coefficients are centered around these values.
elevation grid spacing	This is the spacing in elevation angle for the integration grid. The recommended values are 0.025 for all modes, inner beam. For modes 2 through 8, outer beam, 0.02 is recommended. For mode 1, outer beam, 0.01 is recommended.
elevation resolution enhancement	This is the factor by which the resolution is enhanced, using linear interpolation, in the elevation direction before integrating. The recommended value is 2. For better accuracy, this number could be increased.
azimuth grid spacing	This is the spacing in azimuth angle for the integration grid. The recommended value is 0.4 for all modes, both beams.
azimuth resolution enhancement	This is the factor by which the resolution is enhanced, using linear interpolation, in the azimuth angle direction before integrating. The recommended value is 1. Tests results indicate that accuracy decreases if this number is increased.
azimuth angle data	These numbers tell the program which azimuth angles to produce the table for. In general, the table goes from 0 to 350 with an increment of 10 degrees between each angle.
orbit time data	These numbers tell the program which orbit times to produce the table for. In general, the table goes from 0 to 5890 with 190 seconds between each point. For parallel processing, each processes could cover a different range of orbit times.
output file number	This number is mainly used to make it possible for the outputs of parallel processes to be written in the same directory. The number entered determines the final two digits of the output file name.

where $\Delta f = \Delta f_{pert} + S \cdot h_{topo}$, and X_{nom}, A, B, C, D, G, and S are contained in the X-table. X is in dB and the argument including G is optional. Data for all 12 slices and the egg is included in the table. The egg is defined to be the sum of slices 2 through 11.

4 Retrieving the slice centers from the table

The azimuth angle, ϕ, and elevation angle, θ, of the slice centers can also be found using the X-table:

$$\theta = \theta_0 + A_\theta + B_\theta \cdot \Delta f, \tag{2}$$

and

$$\phi = \phi_0 + A_\phi + B_\phi \cdot \Delta f. \tag{3}$$

The same Δf is used as was used in calculating X. θ_0 is the elevation angle of the electrical bore-sight and ϕ_0 is the azimuth angle of the mechanical bore-sight. The X-table contains A_θ, B_θ, A_ϕ, and B_ϕ. The elevation of the local topography must be included in the radius of the Earth for the conversion from elevation and azimuth angles to latitude and longitude.

5 The Format of the Perturbation and Nominal Tables

Either a nominal or a perturbation table can be produced by *Xfactor7*. The name of the ASCII file containing the table will be *Xpert<mode><beam>_<number>* for a perturbation table, or the *pert* will be replaced by a *nom* for the nominal table. (i.e. For a perturbation table for mode 6, outer beam, with an output file number of 1, the file name would be *Xpert62_01*.)

- Both the Xpert... and the Xnom... files have $32 \cdot 36 = 1152$ rows:
  - The first 36 rows correspond to orbit time 0,
  - The next 36 rows correspond to orbit time 190,
  - ...
  - The final 36 rows correspond to orbit time 5890.
- For each section of 36 rows,
  - The first row corresponds to azimuth angle = 0,
  - The next row corresponds to azimuth angle = 10,
  - ...
  - The final row corresponds to azimuth angle = 350.
- Table 2 describes the format for each row in the perturbation table.
- Table 3 describes the format for each row in the nominal table.

Table 2: The format of each row in the perturbation table

Column	Description
1	orbit time
2	azimuth angle
3, 13, ..., 113	X_{nom} for slices 1, 2, ..., 12
4, 14, ..., 114	G for slices 1, 2, ..., 12
5, 15, ..., 115	A for slices 1, 2, ..., 12
6, 16, ..., 116	B for slices 1,2, ..., 12
7, 17, ..., 117	C for slices 1, 2, ..., 12
8, 18, ..., 118	D for slices 1, 2,..., 12
9, 19, ..., 119	A_ϕ for slices 1, 2, ..., 12
10, 20, ..., 120	B_ϕ for slices 1, 2, ..., 12
11, 21, ..., 121	A_θ for slices 1, 2, ..., 12
12, 22, ..., 122	B_θ for slices 1, 2, ..., 12
123, 124, ..., 127	X_{nom}, A, B, C, and D for the egg
128, 129	Doppler frequency and range
130	"S" for topography correction

Table 3: The format of each row in the nominal table

Column	Description
1	orbit time
2	azimuth angle
3, 5, ..., 25	X_{nom} for slices 1, 2, ..., 12
4, 6, ..., 26	G for slices 1, 2, ..., 12
27	X_{nom}
28, 29	Doppler frequency and range
30	"S" for topography correction