Criteria for defining the swath

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1 General information

This note accounts for the dual pol scheme with 2-step processing ; therefore it defines 2 dwell lines :

- DWp is the dwell line for full swath according to a criterium on the std of retrieved soil moisture ;
- DWq is the dwell line for narrow swath where vegetation thickness can be retrieved with adequate std in the 1rst step of retrieval.

The formulas have been obtained by fitting simple functions to results obtained using a simulation tool. Their tested validity range is :

- Flight altitude alt :660-770 km
- Spacing ratio esp : 0.81-0.89
- Element number nel :21-27
  (In the simulation, 0.5 has been added when computing the arm length)
- Tilting angle til : 0 - 50°
- Steering angle : 30°

2 Fitting formulas

The formulas had to be changed in order to warrant their robusstness in the whole tilt angle 0 50° range. They are copied below directly from the routine.

```
        para=inp;      tp15=max(-329+10.6*para, -1600+42*para);
        para=til;      tp25=max(0, 50-0.5*(38-para).^2);
        para=nel;      tp35=p3(1)*para + p3(2);
        para=esp;      tp45=p4(1)*para + p4(2);
        para=alt;      tp55=p5(1)*para.^2 + p5(2)*para+p5(3);
        para=dip;      tp65=min(-12+(para-1)*22,-45*(para-2.8));
        para=tp15+tp25+tp35+tp45+tp55+tp65;
        pfit=p7(1)*para.^2 + p7(2)*para+p7(3);
with
        p3 =     9.37107   -246.55689
        p4 =    -8.72127      7.44256
        p5 =    -0.00297      4.45145   -1659.01908
        p7 =     0.00115      0.43495      60.39551

        para=inq;      tq15=min(q1(1)*para.^2+q1(2)*para+q1(3), 850);
        para=til;      tq25=q2(1)*para+q2(2);
        para=nel;      tq35=q3(1)*para+q3(2);
        para=esp;      tq45=q4(1)*para+q4(2);
        para=alt;      tq55=q5(1)*para.^2+q5(2)*para+q5(3);
        para=diq;      tq65=q6(1)*para+q6(2);
        qfit=tq15+tq25+tq35+tq45+tq55+tq65;
with
        q1 =     0.60149    -60.13964   1972.02625
        q2 =    -0.24587      9.33061
        q3 =    14.16957   -342.46461
        q4 = -1172.02750   1000.18515
        q5 =    -0.00174      3.10584   -1328.39844
        q6 =    -5.56552     39.11539
```

In these formulas :

- Alt, esp, nel, til as indicated above, in the same units
- inp / inq are average incidence angle° for whole swath/ narrow swath **(see note below);**
- dip/ diq are ranges of incidence angles° for the whole swath/ narrow swath **(see note below);**
- pfit and qfit are approximations provided for DWp and DWq (km). Correlation coefficients are about 0.97 ; rms differences are about 19 and 24 km.

Then the operating procedure should be :

- For a given configuration, compute DW over the whole available swath as well as the corresponding average incidence angle inc
- Define the half swaths as values where DW = pfit and qfit, respectively. An accuracy of 10 km is adequate.

Notes :

- Unlike the formulas in the previous version, the average incidence angle now is the **actual unweighted average** over all incidence values within the dwell line ; the range parameter is the **standard deviation** of incidence angles over the dwell line. It was not found possible to keep the simplified definition as before, due to tilt angle range extending purposes. For computing these quantities, a step of 20 km along the dwell lione is adequate.
- It might happen that the value obtained from pfit is **very small**, or even **negative**. This simply would mean that, in the corresponding configuration, geometrical limitations (alias or spatial resolution boundaries) enter into action before the uncertainty requirement is met. In such cases the swath should simply be estimated as the widest available width in the FOV, acounting for geometrical limitations.
- It may also happen that qfit is larger than the largest available length (i.e. over the track). This cannot be helped and means that the configuration is not suitable.

Both cases are expected to occur more and more frequently at lower tilt angles.

The table below is provided for verification purposes.

	ALT	ESP	NEL	TIL	INCP	INCQ	DIP	DIQ		pfit		qfit
	670	0.89	24	30	39.4	33.3	0.9	8.5		90		559
	670	0.89	27	30	39.2	31.5	1.1	9.2		109		635
	715	0.81	21	30	40.5	30.8	0.8	7.5		89		698
	715	0.81	24	30	44.1	33.0	1.5	7.3		243		697
	715	0.81	27	30	44.1	31.7	1.5	8.1		273		762
	715	0.85	21	30	43.0	35.5	0.9	6.8		163		564
	715	0.85	24	30	42.2	34.3	1.4	7.6		167		624
	715	0.85	27	30	42.2	31.2	1.4	9.1		192		720
	715	0.89	21	30	40.1	33.6	0.7	7.5		85		548
	715	0.89	24	30	39.9	33.2	0.8	8.2		101		595
	715	0.89	27	30	39.6	32.8	1.0	8.8		120		642
	760	0.81	21	30	38.2	27.7	0.5	7.7		74		792
	760	0.81	24	30	43.5	34.3	1.1	7.0		213		698
	760	0.81	27	30	44.3	32.0	1.7	8.1		290		779
	760	0.85	21	30	40.7	32.2	0.7	7.2		94		647
	760	0.85	24	30	43.2	34.2	1.3	7.4		205		651
	760	0.85	27	30	42.8	32.9	1.4	8.2		218		714
	760	0.89	21	30	40.8	33.9	0.7	7.1		97		568
	760	0.89	24	30	40.0	33.6	0.9	7.7		105		613
	760	0.89	27	30	39.8	32.0	1.0	8.8		124		682
	670	0.81	21	35	42.7	35.8	0.9	6.4		163		574

The method implies that both simulation tools provide close results. For the record, here is what was used :

- Earth radius 6370 km
- Blackmann window width=0.73 λ/L
- Guard angular width from the aliases images = 0.8 λ/L
- No FOV restriction for the pattern gain
- FOV restriction from reconstruction zone (hexagon)
- Spatial resolution criteria : mean size <= 50 km, elongation ratio <= 1.5
- Pixel characteristics computed in the tangent plane
- The pattern corresponds to a simulated dipole/cavity antenna, matched to the 3 dB width computed from a spacing ratio assumed equal to the antenna size.
- Scene simulation : soil moisture Ws=0.2 ; vegetation cover 2 kg/m2
- Narrow swath requirement : σ(Wv)=0.3 kg/m2.
- Radiometric sensitivity : I used a factor about 20% too high for the window factor, and a sampling factor of 1.90 (whereas hopefully it will be rather 1.81). On the other hand the sky part has been considered when computing the scene temperature, and the filter factor =1.17 was included. The assumed noise figure was 2.4 dB. All in all, that may be considered as a somewhat optimistic estimate, which very nearly amounts to requiring around 0.038 rather than 0.040 for the measured soil moisture std.

N	ALT	ESP	NEL	TIL	INCP	INCQ	DIP	DIQ	DWP	pfit	DWQ	qfit
170	670	0.89	24	30	39.4	33.3	0.9	8.5	100	90	560	559
171	670	0.89	27	30	39.2	31.5	1.1	9.2	120	109	600	635
172	715	0.81	21	30	40.5	30.8	0.8	7.5	180	89	720	698
173	715	0.81	24	30	44.1	33.0	1.5	7.3	260	243	720	697
174	715	0.81	27	30	44.1	31.7	1.5	8.1	260	273	760	762
175	715	0.85	21	30	43.0	35.5	0.9	6.8	140	163	560	564
176	715	0.85	24	30	42.2	34.3	1.4	7.6	200	167	620	624
177	715	0.85	27	30	42.2	31.2	1.4	9.1	200	192	720	720
178	715	0.89	21	30	40.1	33.6	0.7	7.5	80	85	540	548
179	715	0.89	24	30	39.9	33.2	0.8	8.2	100	101	580	595
180	715	0.89	27	30	39.6	32.8	1.0	8.8	120	120	620	642
181	760	0.81	21	30	38.2	27.7	0.5	7.7	120	74	760	792
182	760	0.81	24	30	43.5	34.3	1.1	7.0	220	213	760	698
183	760	0.81	27	30	44.3	32.0	1.7	8.1	300	290	820	779
184	760	0.85	21	30	40.7	32.2	0.7	7.2	120	94	620	647
185	760	0.85	24	30	43.2	34.2	1.3	7.4	220	205	640	651
186	760	0.85	27	30	42.8	32.9	1.4	8.2	220	218	720	714
187	760	0.89	21	30	40.8	33.9	0.7	7.1	100	97	560	568
188	760	0.89	24	30	40.0	33.6	0.9	7.7	120	105	600	613
189	760	0.89	27	30	39.8	32.0	1.0	8.8	140	124	660	682
190	670	0.81	21	35	42.7	35.8	0.9	6.4	160	163	580	574

Fit quality : std=24 & 19 km ; corr coefficient # 0.97