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CRTM: Instrument Information for DMSP SSMIS Instruments

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Change History

Date	Author	Change
2009-01-07	P.van Delst	Initial release.

Abstract

This document describes the instrument frequency information for SSMIS used in the computation of instrument resolution transmittances from a line-by-line transmittance model. These instrument transmittances are then used to derive the fast model coefficients for the CRTM. The current transmittance production software assumes symmetrical bandpasses and, as such, the bandpasses for multiple sideband channels are averaged.

Keywords: SSMIS instrument frequencies, CRTM, fast model.

1 Introduction

The current CRTM Transmittance Production (TauProd) software relies upon microwave instrument bandpasses being symmetrical about the centre frequency. This setup was based on comparatively sparse frequency data from other instruments. Since the SSMIS actual has each bandpass measured, the expected differences in bandpasses are simply averaged to provide the required symmetrical frequency information. The TauProd software is being altered to accomodate non-symmetrical (i.e. real) bandpasses and use of the averaged SSMIS frequency data is merely an interim solution.

2 Sensor identification

The CRTM and WMO[3] sensor identifications for the SSMIS instruments are shown in table 2.1. As of October 2008 no satellite identifiers were available for the DMSP-19 and -20 missions.

Sensor	Platform	CRTM Sensor Id	WMO Sensor Id	WMO Satellite Id
SN01	DMSP-20	`ssmis_f20`		Unassigned
SN02	DMSP-16	`ssmis_f16`		249
SN03	DMSP-18	`ssmis_f18`	908	286
SN04	DMSP-17	`ssmis_f17`		285
SN05	DMSP-19	`ssmis_f19`		Unassigned

Table 2.1: Sensor and satellite identification for SSMIS on DMSP-16 to -20

3 Central Frequencies

No individual instrument central frequency measurements for the various SSMIS instruments (SN01-SN05) are available. As such, the same central frequencies are used for each SSMIS instrument. These are shown in table 3.1.

Channel	f_0 (GHz)	Channel	f_0 (GHz)
1	50.3	13	19.35
2	52.8	14	22.235
3	53.596	15	37.0
4	54.40	16	37.0
5	55.50	17	91.655
6	57.29	18	91.655
7	59.4	19	63.283248
8	150.0	20	60.792668
9	183.31	21	60.792668
10	183.31	22	60.792668
11	183.31	23	60.792668
12	19.35	24	60.792668

Table 3.1: Channel central frequencies used for all SSMIS instruments

4 Sideband Intermediate Frequencies

For modeling the SSMIS, the channels are divided into three types,

- Single passband channels (1-7,12-16)
- Double sideband channels (8-11,17-20)
- Quadruple sideband channels (21-24)

Single passband channels are defined as those whose bandwidth span the channel centre frequency, as shown in figure 4.1. In some cases for these channels stopbands are specified to reduce the effects of local oscillator noise; no information is currently available on whether or not any of the SSMIS single passband channels have stopbands.

Double sideband channels are shown schematically in figure 4.2. These channels are also referred to as folded passbands with the lower frequency sideband referred to as the lower sideband and the higher frequency sideband being the upper sideband.

Quadruple sideband channels are shown schematically in figure 4.3.

Note that all of the schematic channel definitions in figures 4.2 and 4.3 assume bandwidth symmetry about the central and first sideband offset frequencies.

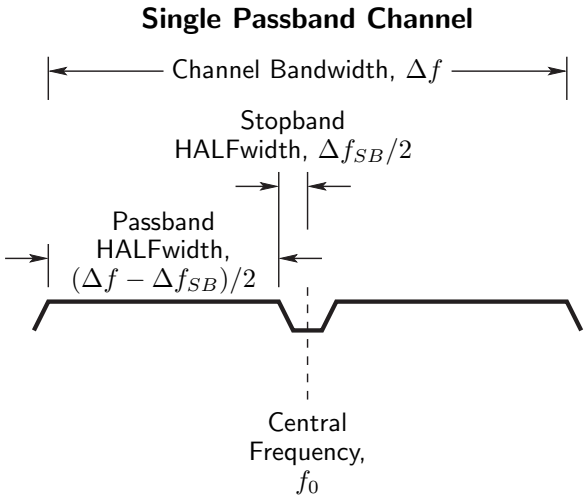

Figure 4.1: Schematic illustration of a single passband microwave channel

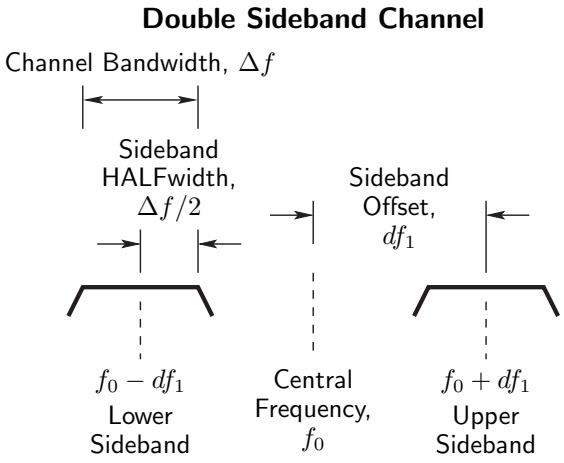

Figure 4.2: Schematic illustration of a double sideband microwave channel

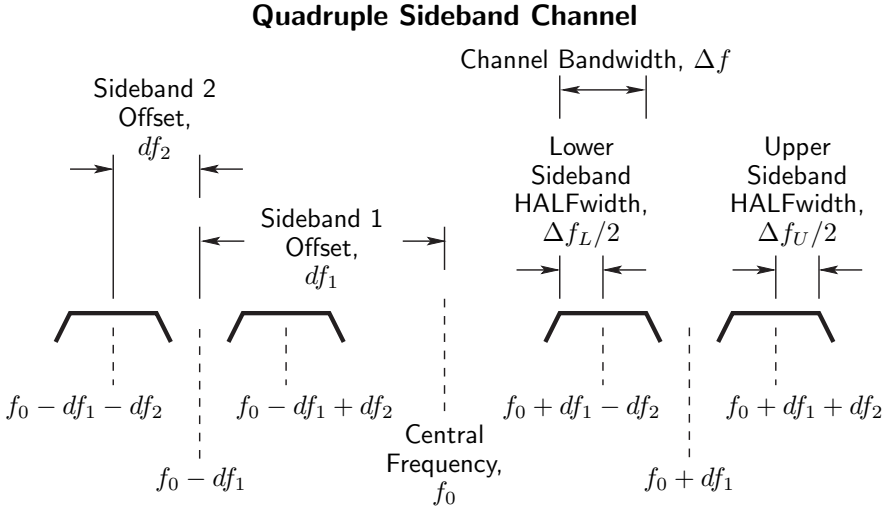

Figure 4.3: Schematic illustration of a quadruple sideband microwave channel

The sideband frequencies for the various SSMIS instruments are shown in table 4.1. These values were extracted from the Aerojet-supplied `SN`X`recpb.dat` datafiles where $X = 1...5$ and are similar to those listed in Table 2 "Basic Passband Parameters" in [1]. Negative and positive df_1 frequencies indicate the low and high frequency sides of f_0 respectively, and negative and positive df_2 frequencies indicate the low and high frequency sides of df_1 respectively.

The TauProd software requires sideband offset frequencies translated into intermediate frequencies as shown schematically in figure 4.4. With no stopbands, the single passband channel intermediate frequencies f_1 and f_2 were obtained using,

$$f_1 = 0 \tag{4.1}$$

$$f_2 = \frac{\Delta f}{2} \tag{4.2}$$

For double passband channels ($N = 2$), f_1 and f_2 were obtained using,

$$f_1 = \sum_{i=1}^{N} \left(|df_{1,i}| - \frac{\Delta f_i}{2} \right) \Big/ N \tag{4.3}$$

$$f_2 = \sum_{i=1}^{N} \left(|df_{1,i}| + \frac{\Delta f_i}{2} \right) \Big/ N \tag{4.4}$$

Similarly, for the quadruple passband channels ($N = 4$), the intermediate frequencies f_1, f_2, f_3, and f_4 were obtained using,

$$f_1 = \sum_{i=1}^{N} \left(|df_{1,i}| - |df_{2,i}| - \frac{\Delta f_i}{2} \right) \Big/ N \tag{4.5}$$

$$f_2 = \sum_{i=1}^{N} \left(|df_{1,i}| - |df_{2,i}| + \frac{\Delta f_i}{2} \right) \Big/ N \tag{4.6}$$

$$f_3 = \sum_{i=1}^{N} \left(|df_{1,i}| + |df_{2,i}| - \frac{\Delta f_i}{2} \right) \Big/ N \tag{4.7}$$

$$f_4 = \sum_{i=1}^{N} \left(|df_{1,i}| + |df_{2,i}| + \frac{\Delta f_i}{2} \right) \Big/ N \tag{4.8}$$

Channel	Sideband	df_1	df_2	Δf SN01	SN02	SN03	SN04	SN05
1	1	-	-	380.00	386.30	394.60	381.90	383.10
2	1	-	-	388.80	385.60	387.60	395.60	395.60
3	1	-	-	380.00	371.30	373.10	371.90	375.60
4	1	-	-	382.50	375.60	378.10	376.30	382.50
5	1	-	-	391.30	383.10	380.10	392.50	393.10
6	1	-	-	330.00	333.10	329.70	340.00	335.60
7	1	-	-	238.80	239.40	238.30	235.00	238.80
8	1	-1250.0	-	1642.00	1648.00	1646.00	1664.00	1658.00
	2	1250.0	-	1642.00	1648.00	1646.00	1664.00	1658.00
9	1	-6600.0	-	1526.00	1530.00	1532.00	1530.00	1540.00
	2	6600.0	-	1526.00	1530.00	1532.00	1530.00	1540.00
10	1	-3000.0	-	1019.00	1017.00	1021.00	1015.00	1023.00
	2	3000.0	-	1019.00	1017.00	1021.00	1015.00	1023.00
11	1	-1000.0	-	512.50	517.50	510.50	518.50	518.00
	2	1000.0	-	512.50	517.50	510.50	518.50	518.00
12	1	-	-	355.00	356.30	382.50	379.40	356.10
13	1	-	-	356.70	358.80	396.50	356.30	355.60
14	1	-	-	407.50	420.60	454.50	437.30	403.80
15	1	-	-	1615.00	1578.00	1567.00	1523.00	1598.00
16	1	-	-	1545.00	1542.00	1547.00	1548.00	1600.00
17	1	-900.0	-	1418.00	1432.00	1442.00	1445.00	1434.00
	2	900.0	-	1418.00	1432.00	1442.00	1445.00	1434.00
18	1	-900.0	-	1411.00	1401.00	1433.00	1410.00	1428.00
	2	900.0	-	1411.00	1401.00	1433.00	1410.00	1428.00
19	1	-285.271	-	1.3370	1.3402	1.3400	1.3400	1.3290
	2	285.271	-	1.3797	1.3574	1.3530	1.3600	1.3578
20	1	-357.892	-	1.3475	1.3420	1.3767	1.3800	1.3239
	2	357.892	-	1.3637	1.3739	1.3699	1.3800	1.3601
21	1	-357.892	-2.0	1.2835	1.2598	1.2698	1.2200	1.2859
	2	357.892	-2.0	1.2864	1.3342	1.2988	1.2900	1.2822
	3	-357.892	2.0	1.2775	1.2299	1.2370	1.2300	1.2857
	4	357.892	2.0	1.3059	1.3331	1.2898	1.3100	1.3020
22	1	-357.892	-5.5	2.6002	2.6165	2.6660	2.6200	2.6374
	2	357.892	-5.5	2.6337	2.6560	2.6748	2.6500	2.6197
	3	-357.892	5.5	2.5831	2.6110	2.6078	2.6000	2.5902
	4	357.892	5.5	2.6784	2.6673	2.6443	2.6500	2.6264
23	1	-357.892	-16.0	7.2085	7.0071	7.1978	7.2100	7.2112
	2	357.892	-16.0	7.4379	7.3953	7.3623	7.4500	7.4146
	3	-357.892	16.0	7.2367	7.1713	7.2644	7.4400	7.1748
	4	357.892	16.0	7.3778	7.4385	7.4065	7.4700	7.4035
24	1	-357.892	-50.0	27.0396	26.6289	26.9994	26.6000	27.2000
	2	357.892	-50.0	25.6700	26.0393	26.8986	26.8800	25.8226
	3	-357.892	50.0	26.8162	26.3255	26.4186	26.1900	26.9613
	4	357.892	50.0	26.4007	26.8787	26.2393	26.6400	26.0454

Table 4.1: Channel sideband offset frequencies and bandwidths for SSMIS instruments. All frequencies are in MHz.

For the quadruple sideband channels, the argument could be made that the bandwidth averaging should only occur for each set of two symmetrical sidebands rather than all four. As mentioned previously, this sideband bandwidth averaging is an interim solution until the TauProd software is updated and averaging over all sidebands was chosen only because it simplified the processing.

The averaged intermediate frequencies are shown in tables 4.2 to 4.6 for the SN01 to SN05 SSMIS instruments respectively.

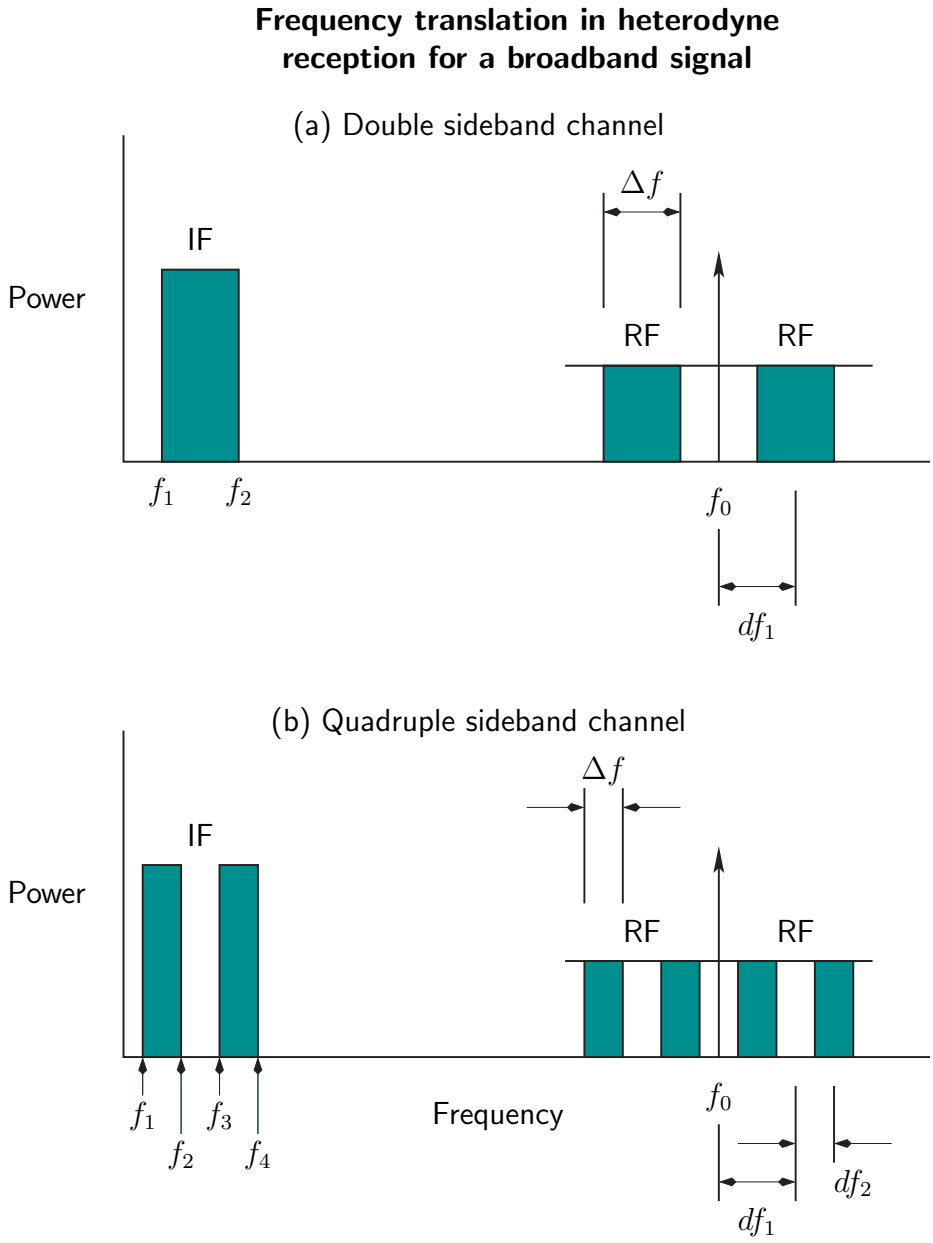

Figure 4.4: Definition of frequency translations used for SSMIS sidebands. Adapted from fig. 1.9b in [2]

Channel	N	f_1	f_2	f_3	f_4
1	1	0.0	0.19000	-	-
2	1	0.0	0.19440	-	-
3	1	0.0	0.19000	-	-
4	1	0.0	0.19125	-	-
5	1	0.0	0.19565	-	-
6	1	0.0	0.16500	-	-
7	1	0.0	0.11940	-	-
8	2	0.42900	2.07100	-	-
9	2	5.83700	7.36300	-	-
10	2	2.49050	3.50950	-	-
11	2	0.74375	1.25625	-	-
12	1	0.0	0.17750	-	-
13	1	0.0	0.17835	-	-
14	1	0.0	0.20375	-	-
15	1	0.0	0.80750	-	-
16	1	0.0	0.77250	-	-
17	2	0.19100	1.60900	-	-
18	2	0.19450	1.60550	-	-
19	2	0.28459183	0.28595017	-	-
20	2	0.35721420	0.35856980	-	-
21	4	0.35524784	0.35653616	0.35924784	0.36053616
22	4	0.35108007	0.35370392	0.36208008	0.36470393
23	4	0.33823439	0.34554961	0.37023439	0.37754961
24	4	0.29465119	0.32113281	0.39465119	0.42113281

Table 4.2: Averaged intermediate frequencies for the SN01 SSMIS (DMSP-20). All frequencies are in GHz.

Channel	N	f_1	f_2	f_3	f_4
1	1	0.0	0.19315	-	-
2	1	0.0	0.19280	-	-
3	1	0.0	0.18565	-	-
4	1	0.0	0.18780	-	-
5	1	0.0	0.19155	-	-
6	1	0.0	0.16655	-	-
7	1	0.0	0.11970	-	-
8	2	0.42600	2.07400	-	-
9	2	5.83500	7.36500	-	-
10	2	2.49150	3.50850	-	-
11	2	0.74125	1.25875	-	-
12	1	0.0	0.17815	-	-
13	1	0.0	0.17940	-	-
14	1	0.0	0.21030	-	-
15	1	0.0	0.78900	-	-
16	1	0.0	0.77100	-	-
17	2	0.18400	1.61600	-	-
18	2	0.19950	1.60050	-	-
19	2	0.28459660	0.28594540	-	-
20	2	0.35721302	0.35857098	-	-
21	4	0.35524737	0.35653662	0.35924737	0.36053662
22	4	0.35107315	0.35371085	0.36207315	0.36471085
23	4	0.33826547	0.34551852	0.37026548	0.37751852
24	4	0.29465795	0.32112605	0.39465795	0.42112605

Table 4.3: Averaged intermediate frequencies for the SN02 SSMIS (DMSP-16). All frequencies are in GHz.

Channel	N	f_1	f_2	f_3	f_4
1	1	0.0	0.19730	-	-
2	1	0.0	0.19380	-	-
3	1	0.0	0.18655	-	-
4	1	0.0	0.18905	-	-
5	1	0.0	0.19005	-	-
6	1	0.0	0.16485	-	-
7	1	0.0	0.11915	-	-
8	2	0.42700	2.07300	-	-
9	2	5.83400	7.36600	-	-
10	2	2.48950	3.51050	-	-
11	2	0.74475	1.25525	-	-
12	1	0.0	0.19125	-	-
13	1	0.0	0.19825	-	-
14	1	0.0	0.22725	-	-
15	1	0.0	0.78350	-	-
16	1	0.0	0.77350	-	-
17	2	0.17900	1.62100	-	-
18	2	0.18350	1.61650	-	-
19	2	0.28459775	0.28594425	-	-
20	2	0.35720535	0.35857865	-	-
21	4	0.35525507	0.35652892	0.35925507	0.36052893
22	4	0.35106789	0.35371611	0.36206789	0.36471611
23	4	0.33823812	0.34554587	0.37023812	0.37754587
24	4	0.29457251	0.32121149	0.39457251	0.42121149

Table 4.4: Averaged intermediate frequencies for the SN03 SSMIS (DMSP-18). All frequencies are in GHz.

Channel	N	f_1	f_2	f_3	f_4
1	1	0.0	0.19095	-	-
2	1	0.0	0.19780	-	-
3	1	0.0	0.18595	-	-
4	1	0.0	0.18815	-	-
5	1	0.0	0.19625	-	-
6	1	0.0	0.17000	-	-
7	1	0.0	0.11750	-	-
8	2	0.41800	2.08200	-	-
9	2	5.83500	7.36500	-	-
10	2	2.49250	3.50750	-	-
11	2	0.74075	1.25925	-	-
12	1	0.0	0.18970	-	-
13	1	0.0	0.17815	-	-
14	1	0.0	0.21865	-	-
15	1	0.0	0.76150	-	-
16	1	0.0	0.77400	-	-
17	2	0.17750	1.62250	-	-
18	2	0.19500	1.60500	-	-
19	2	0.28459600	0.28594600	-	-
20	2	0.35720200	0.35858200	-	-
21	4	0.35526075	0.35652325	0.35926075	0.36052325
22	4	0.35107700	0.35370700	0.36207700	0.36470700
23	4	0.33819575	0.34558825	0.37019575	0.37758825
24	4	0.29460325	0.32118075	0.39460325	0.42118075

Table 4.5: Averaged intermediate frequencies for the SN04 SSMIS (DMSP-17). All frequencies are in GHz.

Channel	N	f_1	f_2	f_3	f_4
1	1	0.0	0.19155	-	-
2	1	0.0	0.19780	-	-
3	1	0.0	0.18780	-	-
4	1	0.0	0.19125	-	-
5	1	0.0	0.19655	-	-
6	1	0.0	0.16780	-	-
7	1	0.0	0.11940	-	-
8	2	0.42100	2.07900	-	-
9	2	5.83000	7.37000	-	-
10	2	2.48850	3.51150	-	-
11	2	0.74100	1.25900	-	-
12	1	0.0	0.17805	-	-
13	1	0.0	0.17780	-	-
14	1	0.0	0.20190	-	-
15	1	0.0	0.79900	-	-
16	1	0.0	0.80000	-	-
17	2	0.18300	1.61700	-	-
18	2	0.18600	1.61400	-	-
19	2	0.28459930	0.28594270	-	-
20	2	0.35722100	0.35856300	-	-
21	4	0.35524753	0.35653648	0.35924753	0.36053648
22	4	0.35108279	0.35370121	0.36208279	0.36470121
23	4	0.33824149	0.34554251	0.37024149	0.37754251
24	4	0.29463834	0.32114566	0.39463834	0.42114566

Table 4.6: Averaged intermediate frequencies for the SN05 SSMIS (DMSP-19). All frequencies are in GHz.

References

[1] Gay, M., J. Park, S. Gillespie, and B. Robbins. SSMIS Passband Characterization for Forward Modeling. Technical Report 11892, Aerojet, 2001.

[2] Janssen, M.A., editor. *Atmospheric remote sensing by microwave radiometry.* Wiley, New York, NY, USA, 1993.

[3] WMO Common Code Tables. Common Code Tables at `http://www.wmo.int/pages/prog/www/WMOCodes/OperationalCodes.html`, Oct. 2008.