SG06_VS02
Topic: Adaptation of SAFOSI sea ice processing system to southern hemisphere

Objective:
Development, test and implementation of monthly SSM/I based tie points valid for Antarctic conditions. Identify suitable data sources and develop validation methodology for the Antarctic. Test and update probability distribution functions for SSM/I derived ice edge and ice type for use in the multi-sensor high latitude production system.

It was later decided to apply the method to the Arctic, so Arctic tie-points are included in this report as well. The updated probability distribution functions for SSM/I derived ice edge and ice type will consequently be calculated by met.no from the data files generated during this project.

Leif Toudal Pedersen
Ørsted-DTU
Technical University of Denmark

Technical University of Denmark Wednesday, February, 2006

Technical University of Denmark Wednesday, February, 2006

Table of Contents

1. Introduction

1.1 From OSI-SAF proposal:

Objective:
Development, test and implementation of monthly SSM/I based tie points valid for Antarctic conditions. Identify suitable data sources and develop validation methodology for the Antarctic. Test and update probability distribution functions for SSM/I derived ice edge and ice type for use in the multi-sensor high latitude production system.

Rationale:
The SAF on Ocean and Sea Ice (SAFOSI) is extending its ice products to global coverage. While the existing parameters for the Northern HL area (covering the Atlantic part of the Arctic) support the extension to hemispheric coverage, no such parameters have been derived for the Southern hemisphere. Considering the age of the Quikscat/Seawinds platform and the fact that no follow-up will be implemented, the primary instrument for the Southern hemisphere will be SSM/I for the short term. In the EPS phase of the project, naturally, support for ASCAT data will be implemented. The SAFOSI system uses tie points for concentration retrievals and probability distribution functions (currently Gaussians) for use in the Bayesian framework multi-sensor procedure.

The tie point study will use archived gridded SSM/I brightness temperatures and reanalysis NWP model output over a period of minimum 2 years to derive a dataset of monthly tie point emissivities for open water, type A and type B sea ice. It has been shown by several workers that the differences between the SSM/I instruments are negligible in the context of sea ice retrieval. Provided a sufficiently automated tie point extraction method is developed the analysis may therefore use a time series spanning several SSM/I instruments without consideration of inter-sensor differences.

The investigation of the probability distribution functions used in the multi-sensor technique will use the same data and is therefore very efficiently included in the study if properly planned for in the initial phases.

Validation is an important aspect of the SAF product definitions. However comparably few sources of reference sea ice information exist which have an acceptable level of quality, coverage and processing. This is very different to the situation in the Northern Hemisphere, where numerous high level products of high quality are available. Therefore, a study of the available sources of reference information and the drafting of a suitable validation methodology – if necessary not excluding the use of high quality low-level satellite observations – is requested. The selected procedure must seek to keep the required work to an acceptable minimum while maximising the spatial and temporal coverage as well as the quality of the reference data.

This project will provide an improved foundation to the proposed re-analysis study, planned for start in autumn 2005. Therefore, the start of this project should take place as soon as possible in order for consolidated system implementation and upgrades to be available in time.

Qualifications:
Experience with atmospheric and sea ice remote sensing in polar regions. The Oersted Institute of the Technical University of Denmark have responded to the proposal. The institute has a long experience of sea ice retrieval covering both hemispheres in specific and microwave based observations of the cryosphere in general. It is therefore considered highly qualified.

Practical considerations:

The project is not dependent on specific infrastructure or facilities available at DMI or met.no. It is thought that a well-planned associated scientist (AS) project may be the more efficient option.

Time and duration:
Total duration is 3-4 months as Associated Scientist at the candidates home institutions. A Visiting Scientist project is not envisaged given the present candidate. Provisional time frame is early 2005.

Costs:
The total cost can be estimated as either of the following (2004 economic conditions, total cost of 4 months of AS activity given in parentheses):

Travel	*VS allowance*	*Associated Scientist payment*	*Total*
1 meeting involving scientists from met.no, DTU, DMI 1000 Euro	0	4 months 4 x 5186.68 EUR	21.7 kEuro

Resources:
Archived SSM/I data are available from National Snow and Ice Data Center at no cost. The SAF should contribute ECMWF reanalyses covering the Antarctic for the agreed study period.

Deliverables:
1) Documentation of the scientific method and technical solution as well as recommendations on regular operational validation in the form of a SAF visiting scientist report. – This report
2) Tie point data set. – included in this report
3) Datasets of collocated SSM/I brightness temperatures, corrected emissivities and ECMWF data for every 5th day of the period 1995-2004.

2. Theoretical background for emissivity calculations:

Emissivity calculations from ECMWF atmosphere data and SSM/I measurements are based on the radiative transfer equation (after Wentz, 2001)

$$T_B = T_{up} + \tau\left[\varepsilon T_s + (1-\varepsilon)(T_{dn} + \tau T_{sky})\right]$$

Where
T_B is the SSM/I measurement
T_{up} is the upwelling atmospheric radiadion
T_{dn} is the downwelling atmospheric radiadion
τ is the atmospheric opacity
T_{sky} is the deep sky background (2.7K)
T_s is emissive "surface" temperature which here is calculated as Ts=0.6*272.1+0.4*Tsi following Svendsen et al. The purpose was to generate ice tie point emissivities, and this method is used for all data, ice and/or ocean. For Tsi we use 2m air temperature from ECMWF. 272.1K is typical temperature of water near or under the ice.

ε is the emissivity

Which can be solved for the emissivity ε:

$$\varepsilon = \frac{\frac{T_B - T_{up}}{\tau} - (T_{dn} + \tau T_{sky})}{T_s - (T_{dn} + \tau T_{sky})}$$

The upwelling and downwelling radiances as well as the atmospheric opacity are calculated according to the simplified radiative transfer model of Wents (2001). Input data for the calculations are daily averaged 3-hourly ECMWF fields of surface winds, surface temperature and atmospheric humidity.

The skin temperatures from ECMWF were found to contain spurious values, so the 2m temperatures were used as described above.

The radiative transfer model.

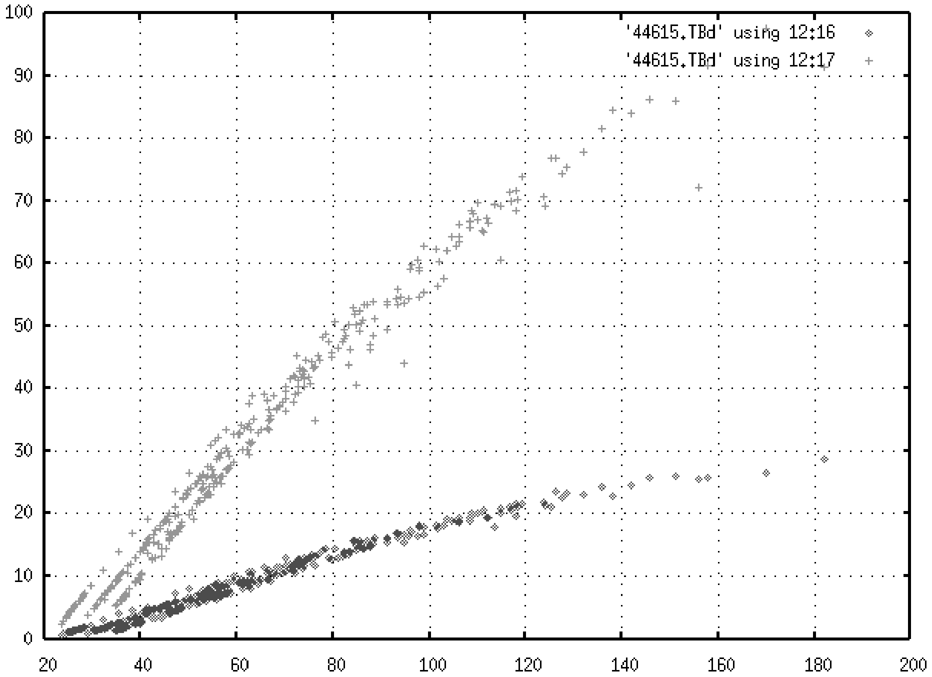
Radiative transfer theory provides the relationship between the observed brightness temperatures T_B (K) and some geophysical parameters. A model describing this relationship is known as a forward model, and here a forward model described by Wentz 2002 has been used. The model describes the connection between 4 geophysical parameters (wind, water vapor, liquid water and sea surface temperature) and the brightness temperatures measured by the AMSR. The model described by Wentz 2002 is only valid for surfaces covered by open water, so the model has to be expanded to take ice covered surfaces in to account. We use the SSM/I model for the lower frequency channels, and the 89 GHz AMSR parameterizations for the 85 GHz channels.

Ice concentrations

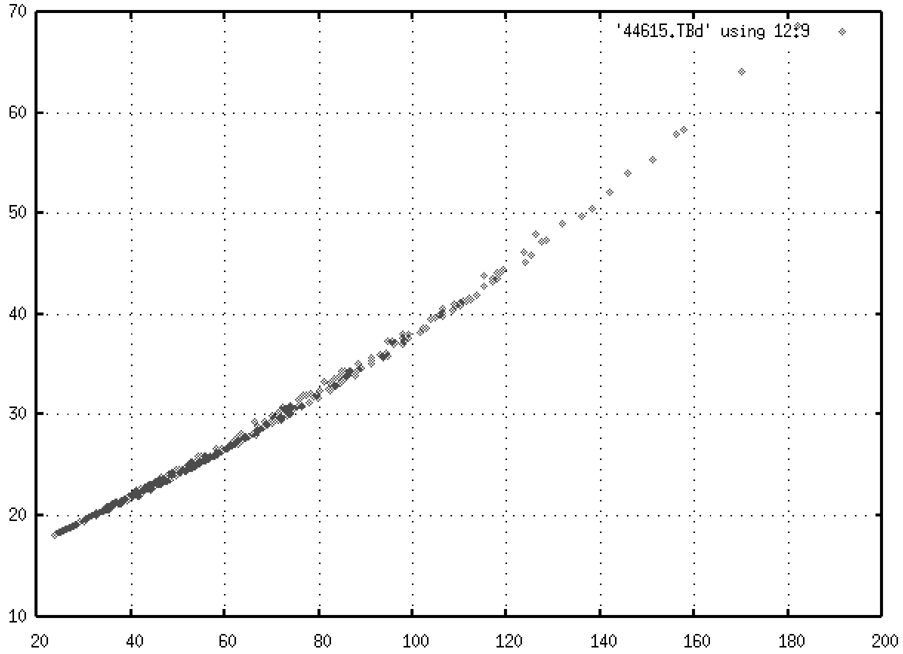
The ice concentrations from the ECMWF dataset were used, but it should be seriously considered to calculate independent ice concentrations since the ones included in the ECMWF data seems to be strange. They could be climatology or weekly values??

Kern 85 GHz corrections

The Wentz 89 GHz AMSR model was considered more consistent with the Wents SSM/I model so we decided to use that rather than the Kern 85 GHz corrections.

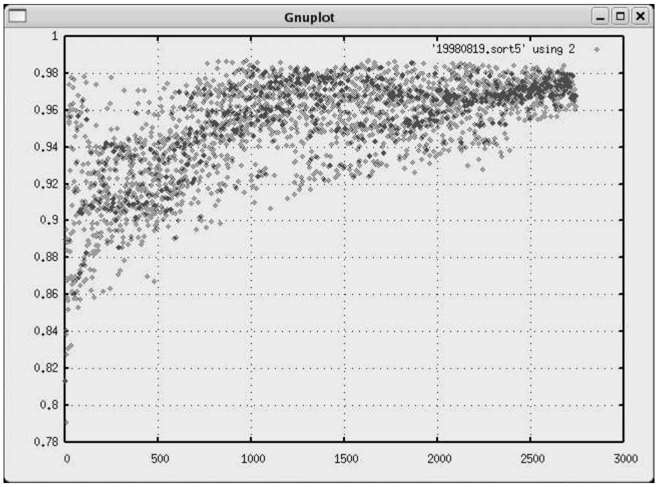


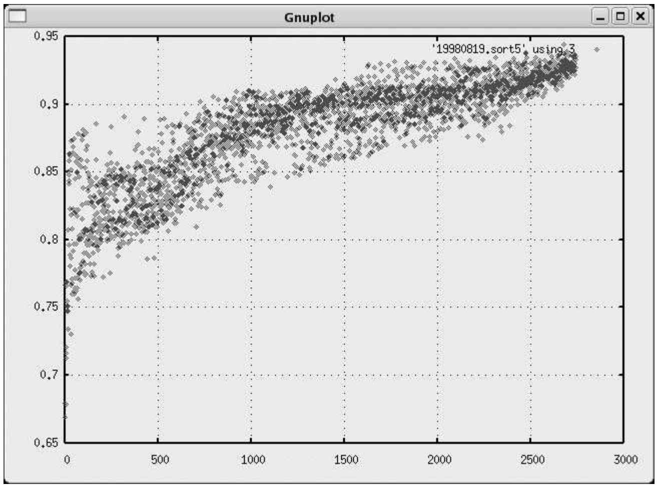
Relationship between TBd and Kern corrections for 85V (Red) and 85H(Green)



Relationship between TBd 85 (AMSR-model) and TBd 37 (SSMI-model)

3. PCA for tie point determination





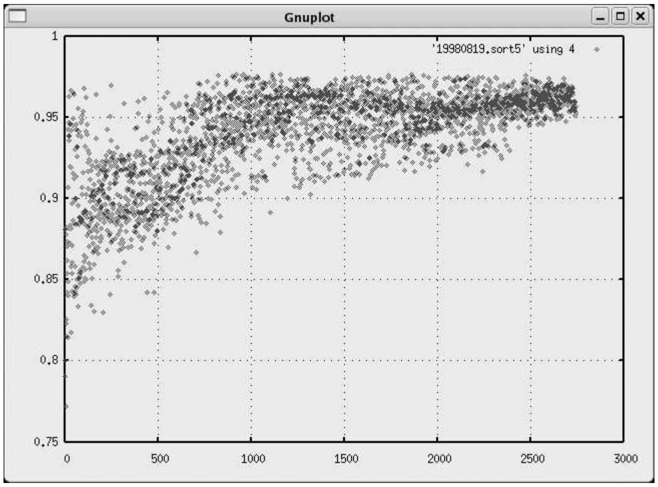
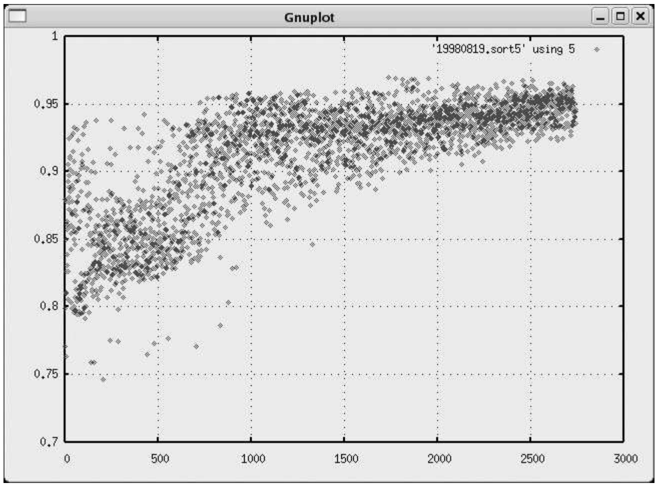


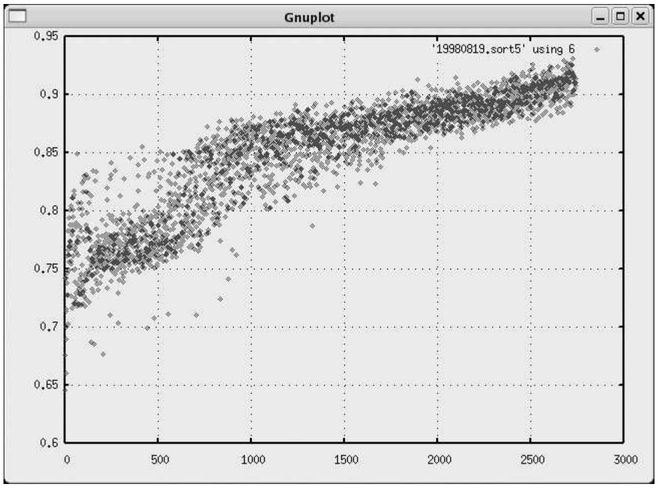
Figure 1.

Relationship between PC1 and the 5 lower SSM/I channels. PC analysis for lower 5 channels only.

19980819.

Ice only (ECMWF ice >0.95)





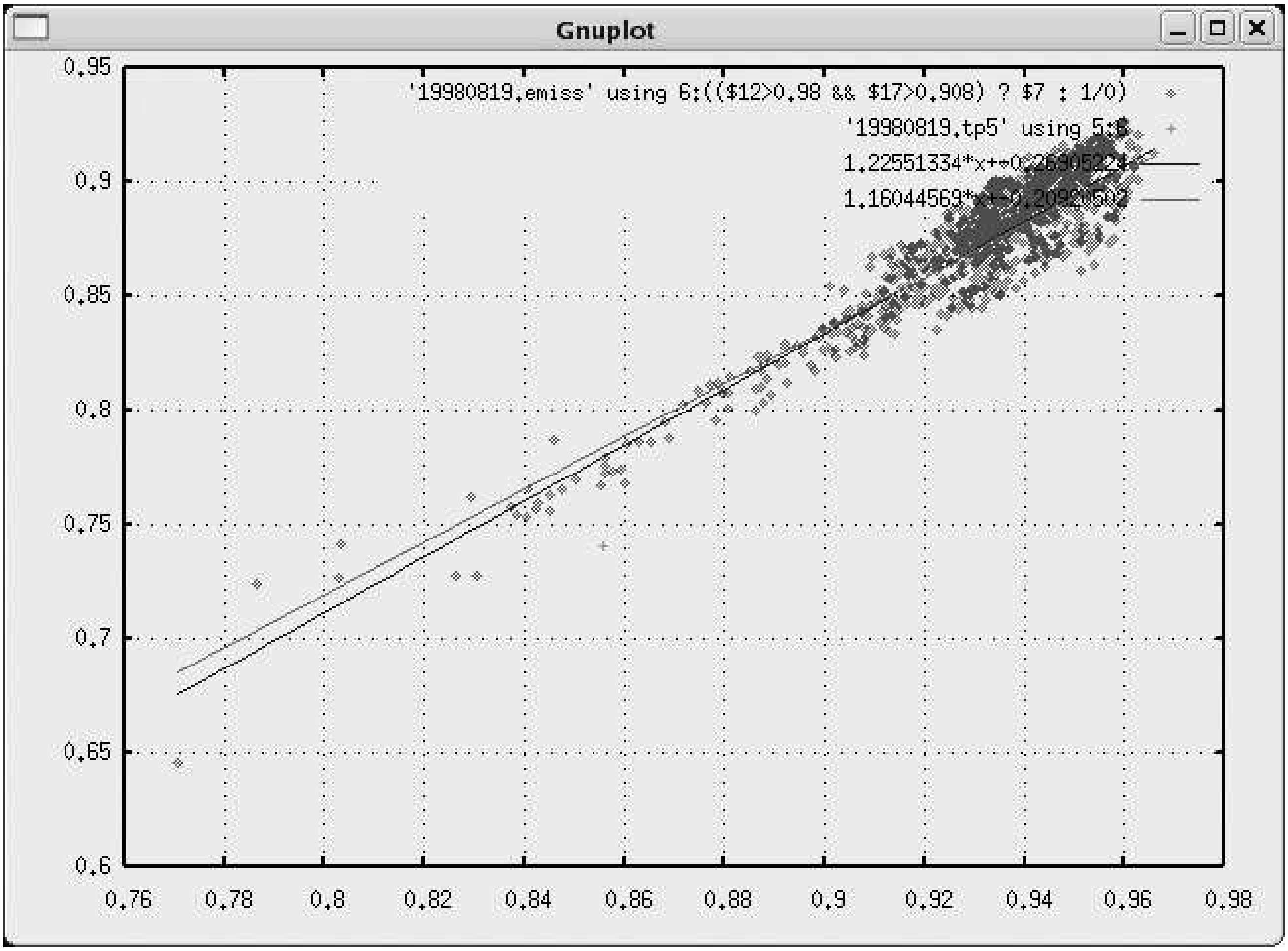


Figure 2. 37V vs 37 H for ice area of 19980819. Blue line is for PC from all 7 channels, purple line is from lower 5 channels only.

Tie points are determined from the covariance matrix of the corrected emissivities. All datapoints with an ice concentration larger that 0.96 were used.
The covariance matric was calculated
The eigenvectors were calculated
The 1st principal component was calculated, and data were sorted according to this.
The ice line was determined as a line through the mean of the lower 1 percentile and through the mean of the upper 1 percentile of the data. The Upper 1 percentile point can be interpreted as the FY ice point in the Arctic and the lower 1 percentile point as the MY point. For Antarctic conditions the ice types are referred to as type A and type B.

Tie points are calculated independently for

- 85H/85V
- 37V/19V (Bootstrap alg)
- 37H/37V/19V (Nasa team)
- Bristol alg in Bristol coordinates

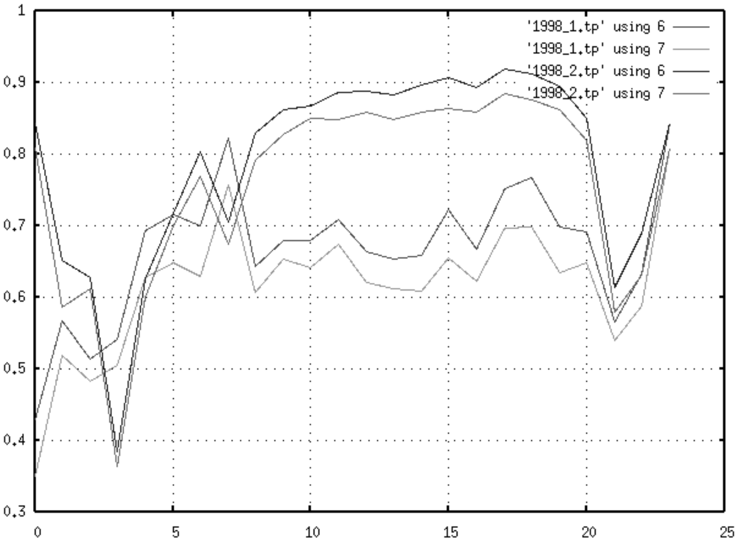


Figure 3. Seasonal development of 85 GHz tiepoints for two ice types. (2. and 17. day of the month) (20 ~ early Nov) (6 is 85V, 7 is 85H)

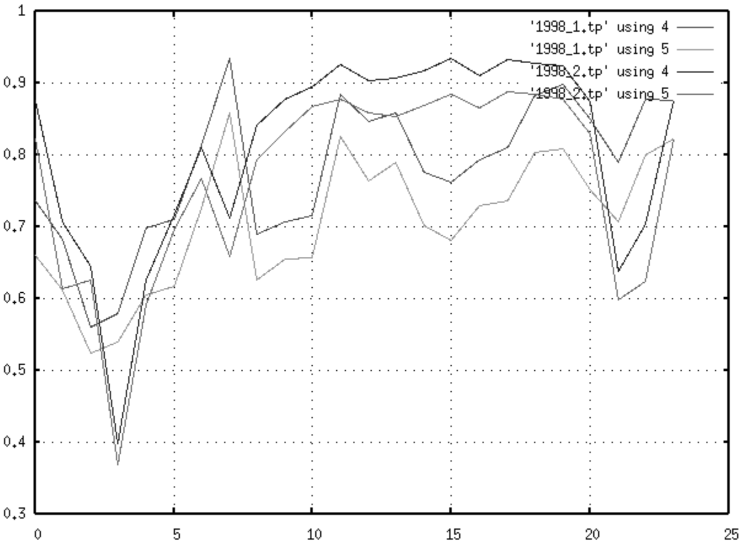


Figure 3. Seasonal development of 37 GHz tiepoints for two ice types. (2. and 17. day of the month) (20 ~ early Nov) (4 is 37V, 5 is 37H)

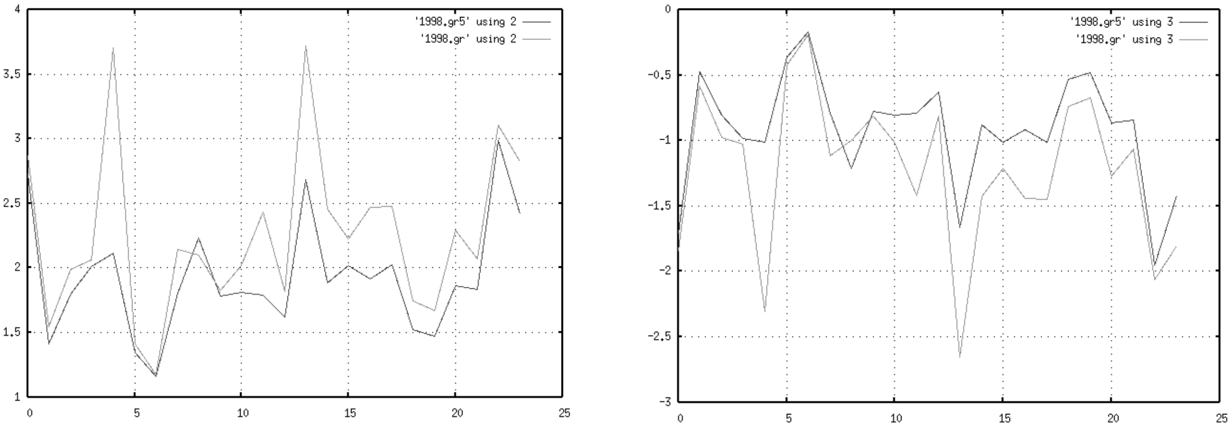
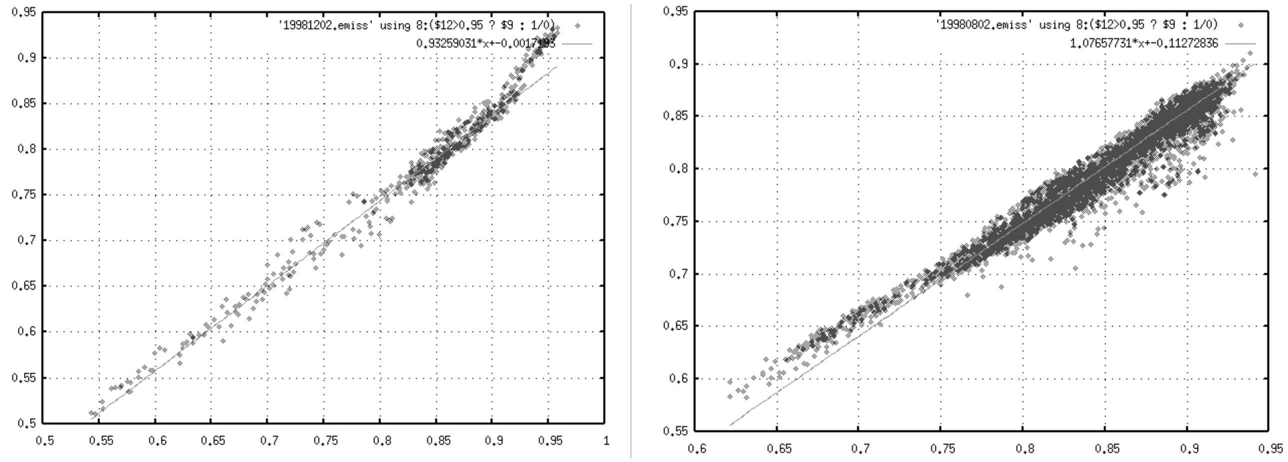
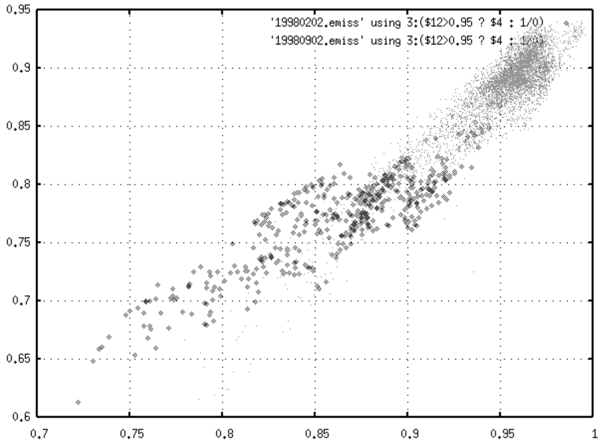


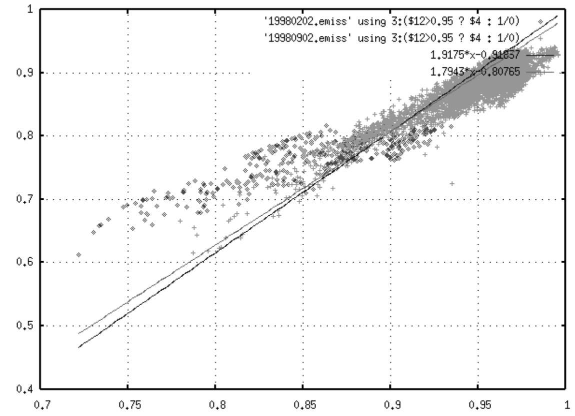
Figure 4. Seasonal development of GR ice line. 2nd and 17th day of the month. (10 ~Early June, 20 ~ early Nov)



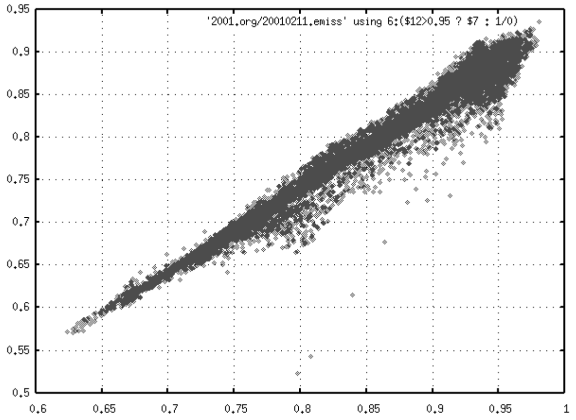
85 GHz plot of ice points and the tie point line from PC analysis (December and August 1998) (Antarktis)



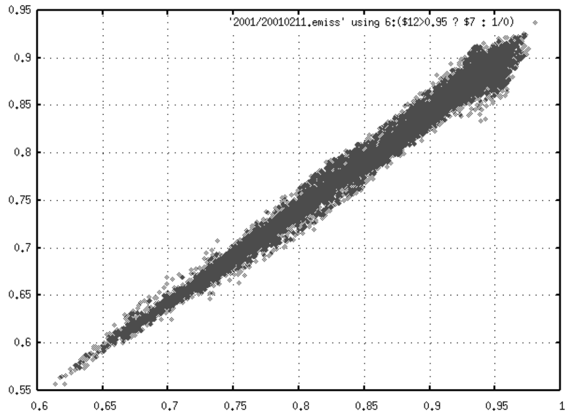
19V vs 37V (feb + Aug) 1998 (Antarktis)



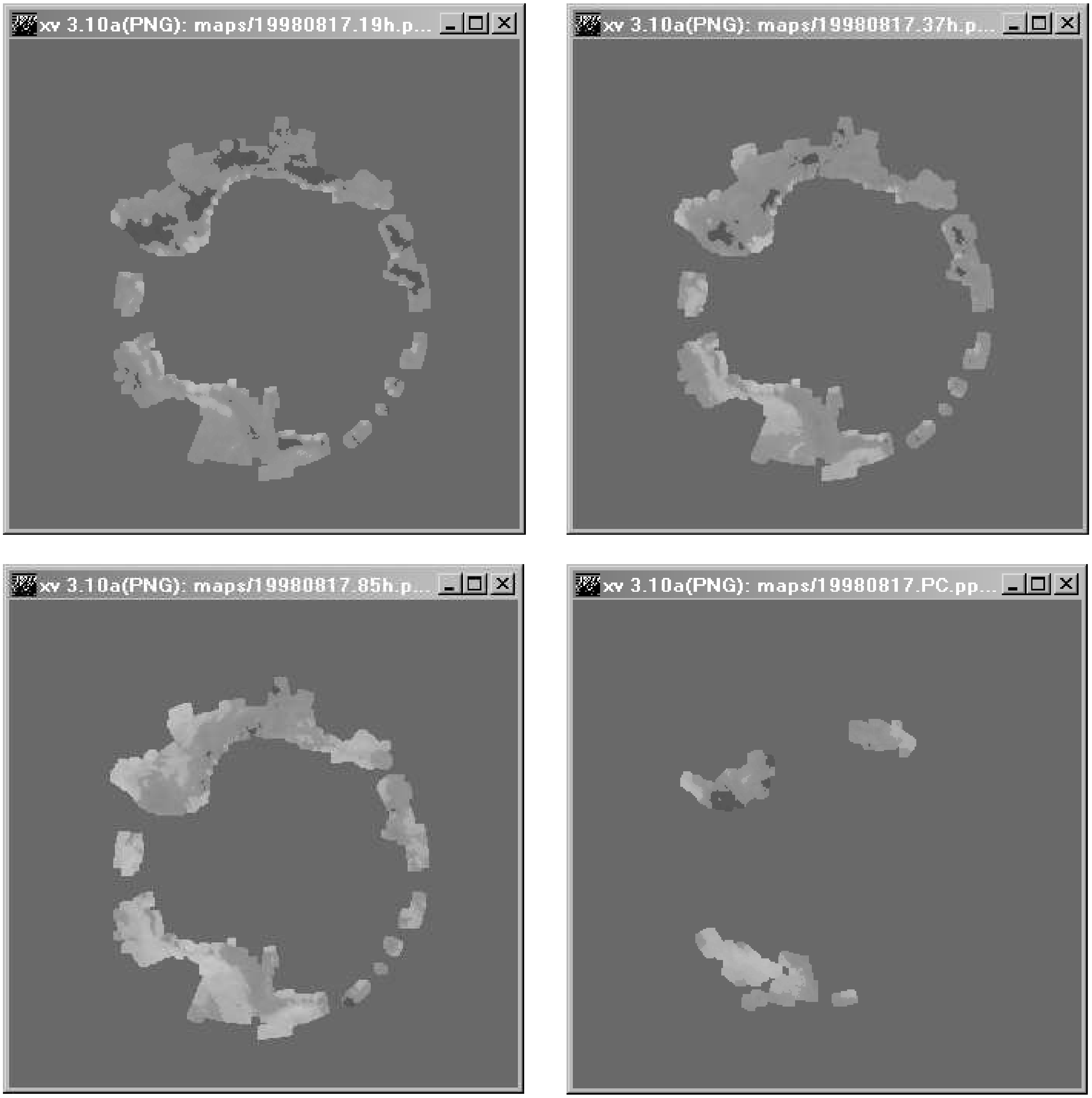
37V vs 37H and 5 channel PC line (Antarktis)



85H vs 85V for ECMWF ice >0.95 (Arctis)



85H vs 85V for NASA-Team ice >0.95 (Arctis)



Distribution of emissivities and PC1

4. Antarctic Tie points

4.1 Tie points for GR algorithm.

The tiepoints are derived by merging daily mean values for each month (every 5th day) of the 10 years 1995-2004. Days 1, 6, 11, 16, 21, 26 of each month was used.

Month	19B	37B	19A	37A			S19B	S37B	S19A	S37A		
1	227.51	194.50	263.36	254.63	0.00	0.00	9.96	10.53	3.60	7.31	0.00	0.00
2	217.42	188.38	251.64	238.15	0.00	0.00	11.90	12.58	9.72	12.82	0.00	0.00
3	222.42	200.79	252.87	244.93	0.00	0.00	14.59	13.94	6.31	8.74	0.00	0.00
4	228.27	208.51	257.42	253.46	0.00	0.00	11.75	11.26	2.63	2.81	0.00	0.00
5	226.24	205.18	259.18	254.72	0.00	0.00	9.62	8.03	2.36	2.45	0.00	0.00
6	230.14	206.90	258.75	253.98	0.00	0.00	7.88	5.98	1.95	2.04	0.00	0.00
7	231.74	208.94	259.23	254.30	0.00	0.00	7.34	6.75	1.94	2.19	0.00	0.00
8	230.99	211.00	259.77	254.50	0.00	0.00	5.91	6.48	1.74	2.10	0.00	0.00
9	232.78	214.20	259.64	254.46	0.00	0.00	6.43	8.33	2.30	2.26	0.00	0.00
10	237.19	220.94	261.84	257.06	0.00	0.00	6.28	9.24	1.54	1.74	0.00	0.00
11	239.93	217.75	263.84	259.33	0.00	0.00	8.60	16.08	2.93	2.73	0.00	0.00
12	237.29	207.37	265.94	260.09	0.00	0.00	7.51	14.49	1.64	3.10	0.00	0.00

Table 1a. Monthly mean uncorrected Tb tiepoints for GR algorithm. Columns are: 19B: 19 GHz V pol tiepoint for ice type B, 37B: 37 GHz V pol tiepoint for ice type B, 19A: 19 GHz V pol tiepoint for ice type A, 37A: 37 GHz V pol tiepoint for ice type A. The columns S19A, S37A, S19B, S37B are the standard deviations of the daily means of the years 1995-2004. These standard deviations are only useful for identifying months where substantial differences between years were found.

Month	19B	37B	19A	37A			S19B	S37B	S19A	S37A		
1	0.8204	0.6596	0.9654	0.9279	0.0000	0.0000	0.0396	0.0461	0.0145	0.0322	0.0000	0.0000
2	0.7815	0.6341	0.9236	0.8609	0.0000	0.0000	0.0461	0.0537	0.0389	0.0564	0.0000	0.0000
3	0.8123	0.7007	0.9454	0.9108	0.0000	0.0000	0.0613	0.0651	0.0300	0.0462	0.0000	0.0000
4	0.8498	0.7504	0.9792	0.9676	0.0000	0.0000	0.0472	0.0492	0.0112	0.0127	0.0000	0.0000
5	0.8423	0.7362	0.9846	0.9713	0.0000	0.0000	0.0359	0.0332	0.0063	0.0071	0.0000	0.0000
6	0.8578	0.7436	0.9840	0.9694	0.0000	0.0000	0.0317	0.0260	0.0050	0.0047	0.0000	0.0000
7	0.8659	0.7547	0.9869	0.9721	0.0000	0.0000	0.0273	0.0306	0.0064	0.0073	0.0000	0.0000
8	0.8628	0.7642	0.9848	0.9679	0.0000	0.0000	0.0232	0.0305	0.0062	0.0063	0.0000	0.0000
9	0.8684	0.7770	0.9830	0.9663	0.0000	0.0000	0.0250	0.0390	0.0075	0.0061	0.0000	0.0000
10	0.8793	0.7998	0.9835	0.9681	0.0000	0.0000	0.0220	0.0420	0.0034	0.0032	0.0000	0.0000
11	0.8812	0.7756	0.9815	0.9664	0.0000	0.0000	0.0337	0.0730	0.0116	0.0115	0.0000	0.0000
12	0.8617	0.7194	0.9786	0.9559	0.0000	0.0000	0.0300	0.0648	0.0064	0.0144	0.0000	0.0000

Table 1b. Monthly mean corrected emissivity tiepoints for GR algorithm. Columns are: 19B: 19 GHz V pol tiepoint for ice type B, 37B: 37 GHz V pol tiepoint for ice type B, 19A: 19 GHz V pol tiepoint for ice type A, 37A: 37 GHz V pol tiepoint for ice type A. The columns S19A, S37A, S19B, S37B are the standard deviations of the daily means of the years 1995-2004. These standard deviations are only useful for identifying months where substantial differences between years were found.

Table 2 (next page) shows for each day of 1997 the variations perpendicular to the ice line. Note that in general the scaled variability using corrected emissivity data is slightly smaller than using uncorrected data. The data were calculated using June tiepoints for the entire year, which explains the systematic variations to larger mean errors in the southern spring and summer. Uncertainties at low ice concentrations due to uncorrected atmospheric variability ca. 10%, and approx. 6% at high concentrations. This might indicate that the NASA team ice concentrations used to find ice and water still includes some low ice concentrations due to problems with the weather filter? The uncertainty estimates should be considered worst case, and can be reduced using orbit data and better temporal match between satellite data and ECMWF data. The current data are daily values corrected by daily mean ECMWF data.

Emissivities				Tb						Distances			
Di	SDi	Dw	SDw	Di	SDi	Dw	SDw	NI	NW	ei-w	Ti-w	ei-i	Ti-i
0.014	0.0146	-0.177	0.0162	5.9	3.44	-39.6	3.85	840	23344	-0.092	-0.097	-0.082	-0.087
0.028	0.0182	-0.179	0.0154	9.3	4.28	-39.8	3.56	1002	23970	-0.086	-0.089	-0.102	-0.108
0.016	0.0160	-0.179	0.0132	6.5	3.79	-40.2	3.18	1000	24945	-0.074	-0.079	-0.090	-0.094
0.015	0.0194	-0.179	0.0143	6.1	4.55	-40.1	3.41	901	22896	-0.080	-0.085	-0.108	-0.113
0.029	0.0157	-0.180	0.0129	9.4	3.68	-40.2	3.06	928	26522	-0.072	-0.076	-0.087	-0.092
0.018	0.0168	-0.181	0.0137	6.7	4.00	-40.4	3.15	876	26990	-0.076	-0.078	-0.093	-0.099
0.007	0.0227	-0.181	0.0141	3.6	5.52	-40.2	3.22	858	27499	-0.078	-0.080	-0.125	-0.137
-0.010	0.0226	-0.180	0.0138	-1.1	5.49	-40.1	3.16	859	27579	-0.077	-0.079	-0.126	-0.137
-0.014	0.0208	-0.180	0.0137	-1.8	5.09	-40.0	3.13	844	28102	-0.076	-0.078	-0.116	-0.127
-0.016	0.0200	-0.180	0.0135	-1.9	4.90	-40.1	2.99	839	28620	-0.075	-0.075	-0.111	-0.122
-0.015	0.0193	-0.179	0.0133	-2.2	4.86	-40.3	3.06	872	28953	-0.074	-0.076	-0.108	-0.121
-0.010	0.0200	-0.176	0.0134	-2.2	5.20	-39.3	2.97	920	29038	-0.076	-0.076	-0.113	-0.132
-0.019	0.0191	-0.177	0.0135	-2.7	4.96	-39.5	3.00	885	28921	-0.076	-0.076	-0.108	-0.126
-0.018	0.0195	-0.177	0.0137	-3.3	5.02	-39.6	3.14	732	28711	-0.077	-0.079	-0.110	-0.127
-0.009	0.0174	-0.177	0.0139	-2.3	4.14	-39.4	3.09	750	28203	-0.078	-0.078	-0.099	-0.105
-0.016	0.0170	-0.178	0.0142	-2.0	4.20	-39.6	3.23	400	27408	-0.080	-0.082	-0.096	-0.106
-0.006	0.0162	-0.177	0.0134	-0.6	3.58	-40.0	3.05	289	26845	-0.076	-0.076	-0.091	-0.090
-0.003	0.0104	-0.179	0.0117	-0.4	2.36	-40.1	2.79	327	25954	-0.065	-0.070	-0.058	-0.059
-0.003	0.0128	-0.176	0.0127	-1.4	3.01	-39.6	2.88	604	25562	-0.072	-0.073	-0.072	-0.076
-0.011	0.0148	-0.177	0.0132	-3.3	3.72	-39.7	3.14	977	24495	-0.075	-0.079	-0.084	-0.094
-0.010	0.0111	-0.178	0.0114	-2.5	3.02	-39.9	2.83	1264	23487	-0.064	-0.071	-0.063	-0.076
-0.011	0.0086	-0.176	0.0132	-2.3	2.56	-40.0	2.94	1430	22786	-0.075	-0.073	-0.049	-0.064
-0.007	0.0094	-0.176	0.0125	-1.7	2.55	-39.9	2.85	989	21666	-0.071	-0.071	-0.053	-0.064
-0.006	0.0121	-0.176	0.0149	-2.1	3.03	-40.0	3.52	1062	21019	-0.085	-0.088	-0.069	-0.076
-0.008	0.0104	-0.176	0.0149	-2.3	2.77	-40.1	3.34	1724	19881	-0.085	-0.083	-0.059	-0.069
-0.006	0.0113	-0.175	0.0123	-2.1	2.94	-39.6	2.89	1967	18339	-0.071	-0.073	-0.065	-0.074
-0.009	0.0103	-0.174	0.0143	-2.1	2.95	-39.6	3.43	1954	17589	-0.082	-0.087	-0.059	-0.075
-0.006	0.0126	-0.174	0.0164	-1.4	3.34	-39.6	3.81	1863	16940	-0.094	-0.096	-0.073	-0.084
-0.003	0.0134	-0.172	0.0164	-0.8	3.38	-39.0	3.82	2139	15383	-0.095	-0.098	-0.078	-0.087
-0.008	0.0099	-0.174	0.0138	-2.4	2.73	-39.3	3.23	1657	14908	-0.080	-0.082	-0.057	-0.069
-0.006	0.0107	-0.174	0.0157	-1.5	2.86	-39.3	3.50	1732	14057	-0.090	-0.089	-0.062	-0.073
-0.004	0.0111	-0.173	0.0180	-1.4	2.81	-39.1	4.28	2235	13484	-0.104	-0.109	-0.064	-0.072
-0.003	0.0104	-0.172	0.0172	-1.2	2.60	-39.1	4.10	3263	12782	-0.100	-0.105	-0.061	-0.067
-0.003	0.0106	-0.174	0.0160	-1.0	2.73	-38.8	3.49	2930	12109	-0.092	-0.090	-0.061	-0.070
-0.002	0.0118	-0.170	0.0186	-1.0	2.77	-38.8	4.37	2948	11332	-0.109	-0.113	-0.069	-0.071
-0.002	0.0108	-0.172	0.0169	-0.7	2.76	-39.0	3.99	3253	10812	-0.098	-0.102	-0.063	-0.071
-0.001	0.0121	-0.171	0.0176	-1.0	3.00	-38.8	4.05	3016	10167	-0.103	-0.104	-0.071	-0.077
-0.002	0.0116	-0.169	0.0200	-1.0	2.85	-38.8	4.77	3238	9651	-0.118	-0.123	-0.069	-0.074
-0.003	0.0110	-0.171	0.0148	-0.7	2.85	-38.7	3.31	3958	8861	-0.087	-0.086	-0.064	-0.074
-0.003	0.0107	-0.168	0.0187	-0.5	2.86	-38.2	4.25	4932	8313	-0.111	-0.111	-0.064	-0.075
-0.003	0.0101	-0.169	0.0179	-0.9	2.60	-38.9	4.14	5099	7996	-0.106	-0.106	-0.060	-0.067
-0.004	0.0104	-0.169	0.0224	-1.3	2.58	-38.1	5.15	5262	7799	-0.132	-0.135	-0.062	-0.068
-0.006	0.0097	-0.168	0.0177	-1.5	2.67	-38.1	4.11	5363	7665	-0.105	-0.108	-0.058	-0.070
-0.002	0.0115	-0.174	0.0144	-1.2	2.95	-38.7	3.30	5061	7364	-0.083	-0.085	-0.066	-0.076
-0.004	0.0104	-0.170	0.0155	-1.3	2.72	-38.6	3.73	5533	6909	-0.092	-0.097	-0.061	-0.071
-0.003	0.0096	-0.167	0.0222	-0.8	2.81	-37.9	5.13	5967	7068	-0.133	-0.135	-0.058	-0.074
-0.004	0.0101	-0.168	0.0167	-1.0	2.72	-38.5	3.92	5677	6546	-0.099	-0.102	-0.060	-0.071
-0.005	0.0103	-0.168	0.0168	-1.4	2.72	-38.2	3.87	4713	6375	-0.100	-0.101	-0.061	-0.071
-0.004	0.0089	-0.169	0.0184	-0.8	2.37	-38.9	4.37	5562	5951	-0.109	-0.112	-0.053	-0.061
-0.004	0.0098	-0.171	0.0189	-0.9	2.52	-38.0	4.41	5767	6004	-0.111	-0.116	-0.057	-0.066
-0.004	0.0093	-0.171	0.0170	-0.9	2.46	-38.8	3.94	5720	5938	-0.099	-0.102	-0.054	-0.063
-0.006	0.0105	-0.172	0.0178	-1.4	2.57	-39.0	3.85	4641	5984	-0.103	-0.099	-0.061	-0.066
-0.006	0.0089	-0.171	0.0174	-1.2	2.28	-38.6	4.01	3863	5738	-0.102	-0.104	-0.052	-0.059
-0.005	0.0091	-0.175	0.0163	-1.0	2.25	-39.4	3.81	4122	6048	-0.093	-0.097	-0.052	-0.057
-0.004	0.0096	-0.175	0.0165	-0.5	2.31	-39.4	3.78	5056	6870	-0.094	-0.096	-0.055	-0.059
-0.005	0.0083	-0.174	0.0156	-0.6	2.05	-39.9	3.83	5118	6467	-0.090	-0.096	-0.048	-0.051
-0.004	0.0086	-0.175	0.0154	-0.5	2.13	-38.6	3.50	5200	6690	-0.088	-0.091	-0.049	-0.055
-0.005	0.0084	-0.175	0.0138	-0.1	2.20	-39.2	3.34	5014	6979	-0.078	-0.085	-0.048	-0.056
-0.004	0.0075	-0.175	0.0142	0.1	2.03	-40.3	3.47	5276	7525	-0.081	-0.086	-0.043	-0.050
-0.003	0.0090	-0.175	0.0183	0.3	2.20	-39.2	4.16	4655	7247	-0.105	-0.106	-0.051	-0.056
-0.003	0.0086	-0.179	0.0148	0.8	2.22	-39.4	3.21	3195	8378	-0.083	-0.081	-0.048	-0.056
-0.002	0.0080	-0.173	0.0154	1.0	2.11	-39.0	3.56	2108	8758	-0.089	-0.091	-0.046	-0.054
-0.004	0.0116	-0.176	0.0153	0.8	2.87	-39.8	3.50	1548	9001	-0.087	-0.088	-0.066	-0.072
-0.001	0.0109	-0.176	0.0166	1.5	2.74	-39.0	3.80	1268	9498	-0.094	-0.097	-0.062	-0.070
0.000	0.0142	-0.176	0.0144	2.2	3.48	-39.7	3.51	1239	10224	-0.082	-0.088	-0.080	-0.088
0.007	0.0194	-0.178	0.0149	4.0	4.49	-40.0	3.72	1179	11399	-0.084	-0.093	-0.109	-0.112
0.011	0.0150	-0.179	0.0139	5.1	3.59	-40.1	3.12	1302	12086	-0.078	-0.078	-0.084	-0.090
0.006	0.0144	-0.177	0.0153	4.0	3.38	-39.6	3.54	1501	13268	-0.086	-0.089	-0.081	-0.085
0.010	0.0158	-0.179	0.0144	4.9	3.73	-40.0	3.34	1782	13862	-0.081	-0.083	-0.088	-0.093
0.020	0.0199	-0.178	0.0147	7.1	4.77	-39.4	3.40	1734	15503	-0.082	-0.086	-0.112	-0.121
0.014	0.0173	-0.180	0.0146	5.7	4.10	-39.9	3.37	1744	16899	-0.081	-0.084	-0.096	-0.103
0.024	0.0174	-0.178	0.0142	8.0	4.07	-39.4	3.33	1727	18990	-0.080	-0.085	-0.098	-0.103

Table 2. Test of GR Ghz tie-points. The columns are:
Di is mean distance from ice data to ice line (should be 0). (Emissivity)
Sdi is standard deviation of distance from ice points to ice line. (Emissivity)
Dw is mean distance from water points to ice line
Sdw is standard deviation of distance from water points to ice line. (Emissivity)
The following 4 columns are similar but for uncorrected Tb tie-points
NI and NW are number of observations of ice (C>0.96) and W (C=0) respectively
ei-w is standard deviation of ice-water distance scaled by ice-water distance (essentially uncertainty in ice concentration for water areas. Ti-w is similar for uncorrected brightness temperature data.
ei-i is standard deviation of ice-ice distance scaled by ice-water distance (essentially uncertainty in ice concentration at high concentrations) Ti-i is similar for uncorrected brightness temperatures.
The yellow/white sections each covers the 6 days of a calender month from January through December 1997.

4.2 Tie points for BR algorithm.

The tiepoints are derived by merging daily mean values for each month (every 5th day) of the 10 years 1995-2004. Days 1, 6, 11, 16, 21, 26 of each month was used.

Month	1-A	2-A	1-B	2-B			S1A	S2A	S1B	S2B		
1	647.88	107.96	498.49	97.88	647.88	107.96	18.16	2.44	24.63	11.45	18.16	2.44
2	593.06	101.02	477.59	94.70	593.06	101.02	67.73	11.97	50.01	12.56	67.72	11.97
3	619.86	101.34	511.37	95.51	619.86	101.34	22.43	3.12	33.88	5.92	22.44	3.12
4	644.05	102.67	528.22	95.78	644.05	102.67	7.77	1.37	27.42	6.49	7.77	1.37
5	648.38	103.62	520.46	94.41	648.38	103.62	5.00	1.12	19.57	6.34	5.01	1.12
6	649.17	104.10	525.57	97.41	649.17	104.10	3.95	1.03	14.30	4.96	3.96	1.03
7	648.48	103.78	529.86	97.02	648.48	103.78	3.71	0.80	14.79	5.10	3.76	0.80
8	649.29	103.99	531.98	95.15	649.29	103.99	4.25	0.80	13.49	4.68	4.28	0.80
9	648.83	104.01	538.32	94.73	648.83	104.01	4.29	1.04	17.49	6.02	4.31	1.04
10	654.58	104.83	554.23	95.02	654.58	104.83	3.91	0.92	18.75	5.37	3.90	0.92
11	660.27	106.27	549.77	99.61	660.27	106.27	4.22	0.95	32.58	5.74	4.23	0.95
12	660.30	107.50	528.57	101.52	660.30	107.50	8.27	1.77	31.78	6.03	8.27	1.77

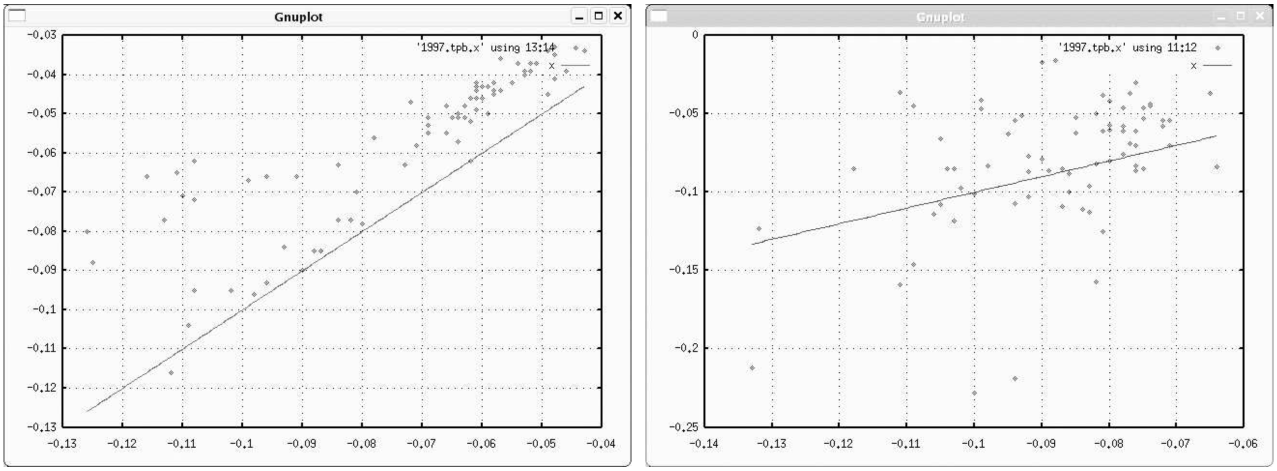
Table 1. Monthly mean uncorrected "Tb" tiepoints for Bristol algorithm. Columns are: 1-A: BR-1 tiepoint for ice type A, 2-A: BR-2 tiepoint for ice type A, 1-B: BR-1 tiepoint for ice type B, 2-B: BR-2 tiepoint for ice type B. The S columns are the standard deviations of the daily means of the years 1995-2004. These standard deviations are only useful for identifying months where substantial differences between years were found.

$$B1 = 37V+1.045*37H+0.525*19V$$
$$B2 = 0.9164*19V-37V+0.4965*37H$$

Table 2 (next page) shows for each day of 1997 the variations perpendicular to the ice line.
Data for the GR algorithm with corrected emissivities are shown for comparison under the "Emissivity", "ei" and "ew" -headings.
Note that in general the scaled variability using corrected emissivity data is slightly smaller than using uncorrected data. The data were calculated using June tiepoints for the entire year, which explains the systematic variations to larger mean errors in the southern spring and summer. Uncertainties at low ice concentrations due to uncorrected atmospheric variability ca. 10%, and approx. 6% at high concentrations. This might indicate that the NASA team ice concentrations used to find ice and water still includes some low ice concentrations due to problems with the weather filter? The uncertainty estimates should be considered worst case, and can be reduced using orbit data and better temporal match between satellite data and ECMWF data. The current data are daily values corrected by daily mean ECMWF data.

Emissivities (GR)				Tb						Distances			
Di	SDi	Dw	SDw	Di	SDi	Dw	SDw	NI	NW	ei-w	Ti-w	ei-i	Ti-i
0.014	0.0146	−0.177	0.0162	5.9	4.72	−61.3	5.36	840	23344	−0.092	−0.087	−0.082	−0.077
0.028	0.0182	−0.179	0.0154	10.7	5.84	−61.2	6.12	1002	23970	−0.086	−0.100	−0.102	−0.095
0.016	0.0160	−0.179	0.0132	6.9	5.89	−65.1	2.96	1000	24945	−0.074	−0.045	−0.090	−0.090
0.015	0.0194	−0.179	0.0143	6.1	6.07	−63.6	3.61	901	22896	−0.080	−0.057	−0.108	−0.095
0.029	0.0157	−0.180	0.0129	12.1	5.42	−64.1	3.43	928	26522	−0.072	−0.054	−0.087	−0.085
0.018	0.0168	−0.181	0.0137	10.3	5.61	−66.5	2.02	876	26990	−0.076	−0.030	−0.093	−0.084
0.007	0.0227	−0.181	0.0141	8.1	5.73	−64.7	2.95	858	27499	−0.078	−0.046	−0.125	−0.088
−0.010	0.0226	−0.180	0.0138	3.9	5.03	−62.7	4.34	859	27579	−0.077	−0.069	−0.126	−0.080
−0.014	0.0208	−0.180	0.0137	2.8	4.35	−65.4	4.01	844	28102	−0.076	−0.061	−0.116	−0.066
−0.016	0.0200	−0.180	0.0135	2.2	4.24	−64.9	3.01	839	28620	−0.075	−0.046	−0.111	−0.065
−0.015	0.0193	−0.179	0.0133	1.9	4.01	−64.8	2.84	872	28953	−0.074	−0.044	−0.108	−0.062
−0.010	0.0200	−0.176	0.0134	2.1	4.74	−61.2	5.29	920	29038	−0.076	−0.086	−0.113	−0.077
−0.019	0.0191	−0.177	0.0135	1.3	4.53	−62.5	4.39	885	28921	−0.076	−0.070	−0.108	−0.072
−0.018	0.0195	−0.177	0.0137	−0.1	4.65	−65.7	2.43	732	28711	−0.077	−0.037	−0.110	−0.071
−0.009	0.0174	−0.177	0.0139	0.6	4.16	−62.0	4.70	750	28203	−0.078	−0.076	−0.099	−0.067
−0.016	0.0170	−0.178	0.0142	−0.2	4.29	−65.2	2.77	400	27408	−0.080	−0.042	−0.096	−0.066
−0.006	0.0162	−0.177	0.0134	1.5	4.08	−61.7	5.13	289	26845	−0.076	−0.083	−0.091	−0.066
−0.003	0.0104	−0.179	0.0117	1.1	2.78	−65.5	2.40	327	25954	−0.065	−0.037	−0.058	−0.042
−0.003	0.0128	−0.176	0.0127	0.5	3.01	−63.6	3.71	604	25562	−0.072	−0.058	−0.072	−0.047
−0.011	0.0148	−0.177	0.0132	−1.6	4.00	−63.8	3.41	977	24495	−0.075	−0.053	−0.084	−0.063
−0.010	0.0111	−0.178	0.0114	−1.0	2.91	−60.8	5.11	1264	23487	−0.064	−0.084	−0.063	−0.048
−0.011	0.0086	−0.176	0.0132	−2.1	2.75	−61.0	5.19	1430	22786	−0.075	−0.085	−0.049	−0.045
−0.007	0.0094	−0.176	0.0125	−1.7	2.49	−62.8	4.40	989	21666	−0.071	−0.070	−0.053	−0.040
−0.006	0.0121	−0.176	0.0149	−1.5	3.35	−63.0	3.92	1062	21019	−0.085	−0.062	−0.069	−0.053
−0.008	0.0104	−0.176	0.0149	−1.9	3.23	−63.9	3.30	1724	19881	−0.085	−0.052	−0.059	−0.050
−0.006	0.0113	−0.175	0.0123	−1.6	3.22	−63.5	3.43	1967	18339	−0.071	−0.054	−0.065	−0.051
−0.009	0.0103	−0.174	0.0143	−2.4	2.77	−64.0	3.19	1954	17589	−0.082	−0.050	−0.059	−0.043
−0.006	0.0126	−0.174	0.0164	−1.4	3.94	−62.9	3.39	1863	16940	−0.094	−0.054	−0.073	−0.063
−0.003	0.0134	−0.172	0.0164	−0.9	3.52	−62.7	3.93	2139	15383	−0.095	−0.063	−0.078	−0.056
−0.008	0.0099	−0.174	0.0138	−2.1	2.71	−60.9	3.67	1657	14908	−0.080	−0.060	−0.057	−0.044
−0.006	0.0107	−0.174	0.0157	−1.7	3.12	−60.3	4.76	1732	14057	−0.090	−0.079	−0.062	−0.052
−0.004	0.0111	−0.173	0.0180	−1.5	3.07	−60.9	5.15	2235	13484	−0.104	−0.085	−0.064	−0.050
−0.003	0.0104	−0.172	0.0172	−0.9	2.65	−59.7	6.00	3263	12782	−0.100	−0.101	−0.061	−0.044
−0.003	0.0106	−0.174	0.0160	−0.9	2.95	−60.2	4.65	2930	12109	−0.092	−0.077	−0.061	−0.049
−0.002	0.0118	−0.170	0.0186	−1.0	3.12	−56.4	8.24	2948	11332	−0.109	−0.146	−0.069	−0.055
−0.002	0.0108	−0.172	0.0169	−0.7	3.05	−59.8	4.98	3253	10812	−0.098	−0.083	−0.063	−0.051
−0.001	0.0121	−0.171	0.0176	−0.6	3.39	−58.3	4.94	3016	10167	−0.103	−0.085	−0.071	−0.058
−0.002	0.0116	−0.169	0.0200	−0.6	3.11	−60.5	5.14	3238	9651	−0.118	−0.085	−0.069	−0.051
−0.003	0.0110	−0.171	0.0148	−0.3	3.40	−59.3	6.48	3958	8861	−0.087	−0.109	−0.064	−0.057
−0.003	0.0107	−0.168	0.0187	−0.3	3.12	−61.8	9.80	4932	8313	−0.111	−0.159	−0.064	−0.051
−0.003	0.0101	−0.169	0.0179	−0.7	2.87	−62.7	7.15	5099	7996	−0.106	−0.114	−0.060	−0.046
−0.004	0.0104	−0.169	0.0224	−1.5	2.86	−62.7	7.74	5262	7799	−0.132	−0.123	−0.062	−0.046
−0.006	0.0097	−0.168	0.0177	−1.7	2.93	−66.1	4.39	5363	7665	−0.105	−0.066	−0.058	−0.044
−0.002	0.0115	−0.174	0.0144	−0.9	3.08	−64.6	6.19	5061	7364	−0.083	−0.096	−0.066	−0.048
−0.004	0.0104	−0.170	0.0155	−1.5	2.80	−65.4	6.76	5533	6909	−0.092	−0.103	−0.061	−0.043
−0.003	0.0096	−0.167	0.0222	−0.7	2.82	−63.1	13.39	5967	7068	−0.133	−0.212	−0.058	−0.045
−0.004	0.0101	−0.168	0.0167	−1.1	2.88	−67.6	3.19	5677	6546	−0.099	−0.047	−0.060	−0.043
−0.005	0.0103	−0.168	0.0168	−1.8	2.78	−60.6	13.85	4713	6375	−0.100	−0.228	−0.061	−0.046
−0.004	0.0089	−0.169	0.0184	−1.0	2.62	−68.1	3.07	5562	5951	−0.109	−0.045	−0.053	−0.039
−0.004	0.0098	−0.171	0.0189	−1.6	2.48	−68.4	2.48	5767	6004	−0.111	−0.036	−0.057	−0.036
−0.004	0.0093	−0.171	0.0170	−1.3	2.50	−68.3	2.82	5720	5938	−0.099	−0.041	−0.054	−0.037
−0.006	0.0105	−0.172	0.0178	−2.1	2.73	−64.7	7.64	4641	5984	−0.103	−0.118	−0.061	−0.042
−0.006	0.0089	−0.171	0.0174	−2.0	2.54	−64.5	6.26	3863	5738	−0.102	−0.097	−0.052	−0.039
−0.005	0.0091	−0.175	0.0163	−1.6	2.49	−66.5	3.40	4122	6048	−0.093	−0.051	−0.052	−0.037
−0.004	0.0096	−0.175	0.0165	−1.1	2.54	−60.9	13.34	5056	6870	−0.094	−0.219	−0.055	−0.042
−0.005	0.0083	−0.174	0.0156	−1.2	2.27	−68.3	1.13	5118	6467	−0.090	−0.017	−0.048	−0.033
−0.004	0.0086	−0.175	0.0154	−1.0	2.35	−68.3	1.11	5200	6690	−0.088	−0.016	−0.049	−0.034
−0.005	0.0084	−0.175	0.0138	−1.0	2.35	−66.8	3.89	5014	6979	−0.078	−0.058	−0.048	−0.035
−0.004	0.0075	−0.175	0.0142	−1.2	2.33	−67.9	2.57	5276	7525	−0.081	−0.038	−0.043	−0.034
−0.003	0.0090	−0.175	0.0183	−0.9	2.37	−64.5	6.98	4655	7247	−0.105	−0.108	−0.051	−0.037
−0.003	0.0086	−0.179	0.0148	−0.4	2.45	−60.0	6.76	3195	8378	−0.083	−0.113	−0.048	−0.041
−0.002	0.0080	−0.173	0.0154	0.0	2.47	−62.9	5.40	2108	8758	−0.089	−0.086	−0.046	−0.039
−0.004	0.0116	−0.176	0.0153	−0.1	3.29	−59.4	5.07	1548	9001	−0.087	−0.085	−0.066	−0.055
−0.001	0.0109	−0.176	0.0166	0.9	3.37	−54.6	5.84	1268	9498	−0.094	−0.107	−0.062	−0.062
0.000	0.0142	−0.176	0.0144	1.0	4.37	−56.2	8.85	1239	10224	−0.082	−0.157	−0.080	−0.078
0.007	0.0194	−0.178	0.0149	3.4	6.05	−58.0	6.47	1179	11399	−0.084	−0.111	−0.109	−0.104
0.011	0.0150	−0.179	0.0139	4.1	4.77	−62.0	3.78	1302	12086	−0.078	−0.061	−0.084	−0.077
0.006	0.0144	−0.177	0.0153	2.9	4.25	−61.0	5.35	1501	13268	−0.086	−0.088	−0.081	−0.070
0.010	0.0158	−0.179	0.0144	4.7	5.01	−58.6	7.34	1782	13862	−0.081	−0.125	−0.088	−0.085
0.020	0.0199	−0.178	0.0147	7.5	7.00	−60.5	4.99	1734	15503	−0.082	−0.082	−0.112	−0.116
0.014	0.0173	−0.180	0.0146	5.8	5.76	−62.2	3.81	1744	16899	−0.081	−0.061	−0.096	−0.093
0.024	0.0174	−0.178	0.0142	9.5	5.94	−62.0	4.93	1727	18990	−0.080	−0.080	−0.098	−0.096

Table 2. Test of Bristol tie-points. The columns are:
Di is mean distance from ice data to ice line (should be 0). (Emissivity)
Sdi is standard deviation of distance from ice points to ice line. (Emissivity)
Dw is mean distance from water points to ice line
Sdw is standard deviation of distance from water points to ice line. (Emissivity)
The following 4 columns are similar but for uncorrected Tb tie-points
NI and NW are number of observations of ice (C>0.96) and W (C=0) respectively
ei-w is standard deviation of ice-water distance scaled by ice-water distance (essentially uncertainty in ice concentration for water areas. Ti-w is similar for uncorrected brightness temperature data.
ei-i is standard deviation of ice-ice distance scaled by ice-water distance (essentially uncertainty in ice concentration at high concentrations) Ti-i is similar for uncorrected brightness temperatures.
The yellow/white sections each covers the 6 days of a calender month from January through December 1997.



Ice ***Water***

Figure 1. Comparison of Bristol and GR algorithms. The plots show calculated uncertainty in ice concentration for GR algorithm (x-axis) and Bristol algorithm (y-axis). For high ice concentrations, the Bristol algorithm performs systematically better than the GR. For open water, the algorithms are more similar in performance. Each point corresponds to one days data from 1997.

4.2.1 Corrected 3-channel tie-points for the Bristol algorithm.

The following table show 19V, 37V and 37H tiepoints for icetype A and B

Month	19V-B	37V-B	37H-B	19V-A	37V-A	37H-A	Stdev.					
1	0.8606	0.6919	0.6087	0.9393	0.8961	0.8491	0.0344	0.0572	0.0533	0.0525	0.0850	0.0870
2	0.8659	0.7439	0.6545	0.8258	0.7366	0.6829	0.0609	0.0790	0.0729	0.0951	0.1243	0.1196
3	0.9070	0.8109	0.7192	0.8459	0.7733	0.7162	0.0505	0.0602	0.0571	0.0836	0.1142	0.1113
4	0.9229	0.8269	0.7359	0.9100	0.8757	0.8290	0.0342	0.0456	0.0432	0.0706	0.1019	0.1051
5	0.9195	0.8194	0.7258	0.9228	0.8989	0.8561	0.0384	0.0633	0.0535	0.0601	0.0836	0.0888
6	0.9167	0.8094	0.7155	0.9378	0.9190	0.8778	0.0427	0.0593	0.0507	0.0442	0.0606	0.0658
7	0.9249	0.8233	0.7272	0.9382	0.9186	0.8775	0.0376	0.0605	0.0558	0.0429	0.0607	0.0649
8	0.9189	0.8161	0.7173	0.9499	0.9373	0.8968	0.0359	0.0529	0.0507	0.0244	0.0257	0.0266
9	0.9151	0.8175	0.7135	0.9554	0.9423	0.9015	0.0364	0.0512	0.0508	0.0235	0.0280	0.0308
10	0.9209	0.8356	0.7291	0.9584	0.9481	0.9059	0.0278	0.0399	0.0408	0.0192	0.0181	0.0203
11	0.9140	0.8126	0.7073	0.9609	0.9463	0.9030	0.0315	0.0615	0.0575	0.0252	0.0383	0.0416
12	0.8884	0.7452	0.6506	0.9667	0.9488	0.9033	0.0315	0.0683	0.0566	0.0124	0.0159	0.0204

Table 3a. Corrected emissivities at the 3 Bristol frequencies.

Month	19V-B	37V-B	37H-B	19V-A	37V-A	37H-A	Stdev.					
1	237.45	201.77	183.24	256.97	247.53	237.10	8.54	12.83	12.00	12.94	19.03	19.53
2	237.50	212.06	192.24	227.73	210.45	198.52	15.30	17.87	16.52	24.16	28.69	27.74
3	243.87	223.35	203.18	230.25	216.34	203.77	11.40	12.41	11.73	19.50	24.05	23.33
4	245.23	224.37	204.51	241.75	234.62	224.42	7.89	9.91	9.36	16.23	21.21	21.89
5	245.14	223.45	202.95	243.61	238.39	229.05	8.60	13.18	11.26	14.03	17.53	18.60
6	244.39	221.15	200.55	247.50	243.03	234.04	9.56	12.37	10.50	10.79	13.28	14.36
7	246.56	224.36	203.25	247.22	242.54	233.57	9.11	12.84	11.80	10.22	12.92	13.76
8	244.08	221.71	200.06	249.73	246.25	237.41	8.07	10.84	10.09	6.98	6.83	6.76
9	244.52	223.37	200.45	251.72	248.01	239.09	8.49	10.98	10.49	6.02	6.34	6.79
10	247.15	228.52	204.96	254.97	251.91	242.58	6.80	8.63	9.04	4.82	4.16	4.51
11	247.66	225.62	202.19	258.49	254.60	244.97	7.77	13.74	13.25	6.50	8.44	9.08
12	243.10	212.36	191.26	262.52	257.99	247.84	7.04	14.36	12.25	4.42	4.21	4.91

Table 3b. Uncorrected brightness temperatures at the 3 Bristol frequencies.

4.3 Tie points for 85 Ghz algorithm.

The tiepoints are derived by merging daily mean values for each month (every 5th day) of the 10 years 1995-2004. Days 1, 6, 11, 16, 21, 26 of each month was used.

Month	VA	HA	VB	HB			SVA	SHA	SVB	SHB		
1	245.92	239.56	189.47	181.76	0.00	0.00	9.65	11.06	8.29	8.15	0.00	0.00
2	231.19	222.67	191.86	183.17	0.00	0.00	24.13	24.89	19.02	18.68	0.00	0.00
3	241.65	232.52	196.62	187.84	0.00	0.00	9.42	10.61	10.42	9.53	0.00	0.00
4	249.39	241.76	197.77	188.30	0.00	0.00	3.74	4.61	9.80	9.01	0.00	0.00
5	250.80	243.66	196.43	188.39	0.00	0.00	3.12	3.36	8.08	7.65	0.00	0.00
6	250.57	243.45	197.64	189.21	0.00	0.00	2.91	3.23	6.83	6.83	0.00	0.00
7	250.21	242.89	196.87	188.52	0.00	0.00	3.14	3.33	7.09	6.55	0.00	0.00
8	250.79	243.48	198.38	188.28	0.00	0.00	3.16	3.57	7.70	7.22	0.00	0.00
9	250.61	242.92	203.07	192.66	0.00	0.00	2.88	3.42	8.26	7.91	0.00	0.00
10	252.71	245.13	208.29	197.26	0.00	0.00	2.48	2.79	9.86	9.09	0.00	0.00
11	254.95	247.65	203.33	193.35	0.00	0.00	3.09	4.13	13.71	12.77	0.00	0.00
12	252.40	244.56	192.45	183.55	0.00	0.00	6.83	8.37	10.22	9.98	0.00	0.00

Table 4a. Monthly mean uncorrected Tb tiepoints for 85 Ghz algorithm. Columns are: VA: 85 Ghz V pol tiepoint for ice type A, HA: 85 Ghz H pol tiepoint for ice type A, VB: 85 Ghz V pol tiepoint for ice type B, HB: 85 Ghz H pol tiepoint for ice type B. The columns SVA, SHA, SVB, SHB are the standard deviations of the daily means of the years 1995-2004. These standard deviations are only usefull for identifying months where substantial differences between years were found.

Month	VA	HA	VB	HB			SVA	SHA	SVB	SHB		
1	0.8677	0.8324	0.5657	0.5236	0.0000	0.0000	0.0490	0.0556	0.0444	0.0443	0.0000	0.0000
2	0.8057	0.7599	0.5870	0.5390	0.0000	0.0000	0.0896	0.0923	0.0632	0.0615	0.0000	0.0000
3	0.8803	0.8330	0.6347	0.5879	0.0000	0.0000	0.0571	0.0634	0.0568	0.0522	0.0000	0.0000
4	0.9416	0.9037	0.6680	0.6192	0.0000	0.0000	0.0150	0.0202	0.0428	0.0379	0.0000	0.0000
5	0.9465	0.9110	0.6532	0.6113	0.0000	0.0000	0.0087	0.0104	0.0305	0.0274	0.0000	0.0000
6	0.9432	0.9079	0.6646	0.6214	0.0000	0.0000	0.0089	0.0113	0.0330	0.0313	0.0000	0.0000
7	0.9440	0.9079	0.6636	0.6209	0.0000	0.0000	0.0087	0.0104	0.0331	0.0299	0.0000	0.0000
8	0.9428	0.9067	0.6794	0.6283	0.0000	0.0000	0.0095	0.0115	0.0427	0.0445	0.0000	0.0000
9	0.9398	0.9019	0.6956	0.6428	0.0000	0.0000	0.0082	0.0118	0.0384	0.0352	0.0000	0.0000
10	0.9432	0.9054	0.7075	0.6506	0.0000	0.0000	0.0066	0.0095	0.0520	0.0498	0.0000	0.0000
11	0.9412	0.9042	0.6637	0.6112	0.0000	0.0000	0.0098	0.0146	0.0716	0.0667	0.0000	0.0000
12	0.9095	0.8674	0.5843	0.5358	0.0000	0.0000	0.0361	0.0432	0.0623	0.0648	0.0000	0.0000

Table 4b. Monthly mean corrected emissivity tiepoints for 85 Ghz algorithm. Columns are: VA: 85 Ghz V pol tiepoint for ice type A, HA: 85 Ghz H pol tiepoint for ice type A, VB: 85 Ghz V pol tiepoint for ice type B, HB: 85 Ghz H pol tiepoint for ice type B. The columns SVA, SHA, SVB, SHB are the standard deviations of the daily means of the years 1995-2004. These standard deviations are only usefull for identifying months where substantial differences between years were found.

Table 5 (next page) shows for each day of 1997 the variations perpendicular to the ice line. Note that in general the scaled variability using corrected emissivity data is smaller than using uncorrected data. This is particularly true for water points but less significant for ice points (as expected). The data were calculated using June tiepoints for the entire year, which explains the systematic variations to larger mean errors in the southern spring and summer.

Emissivities				Tb						Distances			
Di	SDi	Dw	SDw	Di	SDi	Dw	SDw	NI	NW	ei-w	Ti-w	ei-i	Ti-i
-0.003	0.0080	0.136	0.0316	-0.8	1.43	23.4	5.88	840	23344	0.232	0.251	0.059	0.061
-0.004	0.0097	0.135	0.0356	-0.8	1.83	23.2	7.11	1002	23970	0.265	0.307	0.072	0.079
0.001	0.0116	0.135	0.0314	-0.5	1.90	24.0	6.40	1000	24945	0.233	0.267	0.086	0.079
0.003	0.0129	0.140	0.0422	0.1	2.23	24.3	7.92	901	22896	0.302	0.326	0.093	0.092
-0.004	0.0102	0.127	0.0343	-1.3	1.64	21.7	6.58	928	26522	0.270	0.304	0.080	0.075
-0.003	0.0114	0.138	0.0352	-1.0	2.02	23.7	6.53	876	26990	0.256	0.275	0.083	0.085
-0.006	0.0092	0.140	0.0377	-1.2	1.76	23.7	7.22	858	27499	0.269	0.305	0.066	0.074
-0.006	0.0063	0.127	0.0360	-0.9	1.28	21.9	6.66	859	27579	0.283	0.305	0.050	0.058
-0.001	0.0074	0.127	0.0369	-0.3	1.45	21.7	6.60	844	28102	0.289	0.304	0.058	0.067
-0.003	0.0060	0.130	0.0348	-0.8	1.10	22.2	6.35	839	28620	0.268	0.286	0.046	0.049
0.000	0.0054	0.129	0.0347	-0.1	1.00	22.9	6.75	872	28953	0.269	0.295	0.042	0.044
-0.001	0.0058	0.116	0.0356	0.1	1.19	20.1	6.32	920	29038	0.306	0.315	0.050	0.059
-0.002	0.0055	0.117	0.0332	-0.8	1.04	20.2	6.42	885	28921	0.282	0.318	0.047	0.051
0.003	0.0071	0.121	0.0388	0.0	1.27	21.2	7.04	732	28711	0.320	0.333	0.059	0.060
0.005	0.0094	0.116	0.0362	1.2	1.95	19.8	6.46	750	28203	0.311	0.326	0.081	0.098
0.007	0.0084	0.124	0.0396	0.6	1.37	21.2	7.03	400	27408	0.319	0.332	0.067	0.065
0.000	0.0066	0.126	0.0285	-0.1	1.23	22.7	5.54	289	26845	0.226	0.244	0.052	0.054
0.004	0.0054	0.125	0.0366	0.7	1.10	21.8	7.34	327	25954	0.292	0.338	0.043	0.051
0.005	0.0055	0.124	0.0283	1.1	1.12	22.0	5.57	604	25562	0.227	0.253	0.044	0.051
0.001	0.0073	0.116	0.0341	0.3	1.56	20.4	6.62	977	24495	0.294	0.325	0.063	0.077
0.000	0.0071	0.119	0.0336	0.0	1.43	21.0	6.72	1264	23487	0.282	0.321	0.060	0.068
0.004	0.0089	0.130	0.0314	0.6	1.67	23.9	5.80	1430	22786	0.242	0.243	0.069	0.070
0.006	0.0097	0.129	0.0360	1.3	1.96	23.8	6.72	989	21666	0.278	0.283	0.075	0.082
0.006	0.0083	0.132	0.0312	1.3	1.72	24.1	5.98	1062	21019	0.236	0.248	0.063	0.071
0.004	0.0094	0.129	0.0364	1.0	1.96	23.6	6.60	1724	19881	0.282	0.279	0.073	0.083
0.003	0.0079	0.120	0.0302	0.6	1.65	21.8	5.88	1967	18339	0.253	0.270	0.066	0.076
0.009	0.0090	0.127	0.0295	1.5	1.42	23.5	6.12	1954	17589	0.232	0.260	0.071	0.060
0.004	0.0103	0.123	0.0296	1.0	2.12	22.9	6.03	1863	16940	0.241	0.264	0.083	0.093
0.005	0.0094	0.124	0.0376	1.2	1.88	22.7	7.62	2139	15383	0.303	0.335	0.076	0.083
0.006	0.0073	0.124	0.0309	1.2	1.42	22.4	6.42	1657	14908	0.249	0.286	0.059	0.064
0.007	0.0078	0.128	0.0326	1.4	1.56	22.7	5.80	1732	14057	0.255	0.255	0.061	0.069
0.007	0.0080	0.130	0.0347	1.5	1.58	23.7	6.96	2235	13484	0.266	0.294	0.061	0.067
0.004	0.0066	0.137	0.0301	0.8	1.38	25.4	5.96	3263	12782	0.219	0.234	0.048	0.054
0.005	0.0072	0.125	0.0374	1.1	1.49	21.3	6.68	2930	12109	0.299	0.314	0.058	0.070
0.007	0.0098	0.131	0.0417	1.4	1.98	24.5	7.77	2948	11332	0.318	0.317	0.074	0.081
0.006	0.0079	0.121	0.0325	1.1	1.60	22.2	6.69	3253	10812	0.269	0.301	0.065	0.072
0.005	0.0082	0.119	0.0274	1.1	1.63	21.9	4.76	3016	10167	0.230	0.218	0.069	0.075
0.004	0.0083	0.125	0.0352	0.9	1.75	23.8	7.16	3238	9651	0.281	0.301	0.066	0.074
0.003	0.0095	0.118	0.0318	0.5	1.95	21.4	5.73	3958	8861	0.270	0.268	0.081	0.091
0.004	0.0090	0.111	0.0303	0.8	1.83	20.6	6.16	4932	8313	0.272	0.299	0.081	0.089
0.005	0.0088	0.133	0.0316	1.1	1.74	25.4	5.33	5099	7996	0.238	0.210	0.066	0.068
0.007	0.0077	0.124	0.0336	1.6	1.58	22.5	6.70	5262	7799	0.270	0.298	0.062	0.070
0.008	0.0076	0.111	0.0333	1.7	1.53	20.3	6.33	5363	7665	0.301	0.312	0.069	0.075
0.006	0.0083	0.122	0.0408	1.4	1.73	21.0	7.38	5061	7364	0.335	0.351	0.068	0.082
0.008	0.0079	0.125	0.0313	1.7	1.63	23.3	6.90	5533	6909	0.250	0.297	0.063	0.070
0.007	0.0096	0.110	0.0347	1.4	1.90	20.4	7.48	5967	7068	0.315	0.366	0.087	0.093
0.008	0.0085	0.110	0.0297	1.6	1.72	20.9	5.85	5677	6546	0.268	0.280	0.077	0.082
0.013	0.0085	0.113	0.0272	2.6	1.77	21.2	6.01	4713	6375	0.241	0.284	0.075	0.084
0.009	0.0082	0.123	0.0251	1.9	1.65	23.8	4.96	5562	5951	0.205	0.208	0.067	0.069
0.012	0.0081	0.114	0.0290	2.5	1.69	19.7	5.93	5767	6004	0.255	0.301	0.071	0.086
0.011	0.0078	0.121	0.0387	2.2	1.55	22.3	7.19	5720	5938	0.320	0.323	0.065	0.070
0.013	0.0078	0.127	0.0357	2.6	1.55	23.2	5.85	4641	5984	0.280	0.252	0.061	0.067
0.015	0.0079	0.117	0.0312	3.3	1.62	21.2	5.79	3863	5738	0.266	0.273	0.067	0.076
0.013	0.0076	0.124	0.0348	2.7	1.60	22.3	7.19	4122	6048	0.280	0.323	0.061	0.072
0.011	0.0080	0.125	0.0289	2.2	1.56	21.9	5.38	5056	6870	0.231	0.246	0.064	0.071
0.010	0.0082	0.134	0.0289	2.0	1.66	25.5	5.70	5118	6467	0.216	0.223	0.061	0.065
0.008	0.0076	0.107	0.0379	1.8	1.53	17.8	7.05	5200	6690	0.352	0.397	0.071	0.086
0.011	0.0081	0.111	0.0339	2.2	1.63	19.4	6.59	5014	6979	0.305	0.339	0.073	0.084
0.014	0.0094	0.123	0.0307	2.8	1.94	23.8	5.84	5276	7525	0.249	0.245	0.076	0.081
0.013	0.0078	0.112	0.0339	2.9	1.59	19.9	6.53	4655	7247	0.303	0.329	0.069	0.080
0.013	0.0080	0.122	0.0359	2.6	1.55	20.0	6.14	3195	8378	0.293	0.307	0.066	0.078
0.013	0.0073	0.116	0.0335	2.5	1.46	20.8	6.33	2108	8758	0.289	0.304	0.063	0.070
0.009	0.0087	0.131	0.0351	1.6	1.75	23.5	6.58	1548	9001	0.269	0.281	0.067	0.075
0.006	0.0080	0.121	0.0321	1.1	1.54	20.6	7.16	1268	9498	0.264	0.347	0.066	0.074
0.008	0.0117	0.134	0.0372	1.3	2.25	23.9	7.05	1239	10224	0.279	0.295	0.088	0.094
0.001	0.0160	0.123	0.0350	-0.2	2.83	21.5	6.31	1179	11399	0.284	0.293	0.130	0.132
0.002	0.0137	0.133	0.0285	0.2	2.48	22.9	4.95	1302	12086	0.215	0.216	0.103	0.108
0.003	0.0117	0.133	0.0333	0.2	2.09	23.3	6.26	1501	13268	0.250	0.269	0.088	0.090
0.003	0.0115	0.131	0.0318	0.3	2.08	22.7	5.71	1782	13862	0.242	0.251	0.087	0.091
0.005	0.0137	0.123	0.0376	0.8	2.55	20.7	6.99	1734	15503	0.305	0.338	0.112	0.123
0.003	0.0130	0.131	0.0430	0.2	2.24	22.0	8.16	1744	16899	0.329	0.370	0.100	0.102
0.000	0.0131	0.126	0.0430	-0.3	2.19	21.1	8.64	1727	18990	0.341	0.409	0.104	0.104

Table 5. Test of 85 Ghz tie-points. The columns are:
Di is mean distance from ice data to ice line (should be 0). (Emissivity)
Sdi is standard deviation of distance from ice points to ice line. (Emissivity)
Dw is mean distance from water points to ice line
Sdw is standard deviation of distance from water points to ice line. (Emissivity)
The following 4 columns are similar but for uncorrected Tb tie-points
NI and NW are number of observations of ice (C>0.96) and W (C=0) respectively
ei-w is standard deviation of ice-water distance scaled by ice-water distance (essentially uncertainty in ice concentration for water areas. Ti-w is similar for uncorrected brightness temperature data.
ei-i is standard deviation of ice-ice distance scaled by ice-water distance (essentially uncertainty in ice concentration at high concentrations) Ti-i is similar for uncorrected brightness temperatures.
The yellow/white sections each covers the 6 days of a calender month from January through December 1997.

4.4 Water minimum Tb tiepoints

The following tables contain monthly mean minimum Tb tie-points defined as a certain percentile of the lowest Tb's (The sum of 19V, 22V, 37V and 37H).

N001.x

1	178.57	102.92	188.90	202.71	132.68	234.91	178.37
2	178.27	102.82	187.98	202.41	132.90	234.38	178.13
3	178.17	102.81	187.45	202.47	133.24	233.90	177.45
4	178.45	103.35	187.33	202.52	133.93	233.59	177.57
5	178.50	103.10	186.82	202.63	133.94	233.29	177.44
6	178.17	102.44	186.51	202.48	133.50	233.14	176.16
7	178.09	102.51	186.27	202.33	133.49	233.32	177.00
8	178.15	102.76	186.30	202.35	133.62	233.10	176.73
9	178.06	102.92	186.25	202.26	134.09	232.47	176.94
10	178.03	103.35	186.96	201.88	133.39	233.11	177.78
11	178.35	103.39	187.58	202.37	133.50	233.82	178.20
12	178.38	103.22	188.28	202.47	133.50	234.42	178.93

Table 6: The 1% percentile (mean of 10 years and 6 days per month)

N005.x

1	179.95	106.08	191.09	203.68	136.07	236.33	184.34
2	179.69	106.25	190.42	203.27	136.28	235.93	183.98
3	179.53	105.90	190.27	203.43	136.28	235.52	183.48
4	179.74	106.55	189.57	203.63	137.92	234.70	183.46
5	179.65	106.05	188.62	203.43	137.45	234.83	183.14
6	179.51	105.81	188.52	203.21	137.06	234.24	181.72
7	179.71	105.69	188.47	203.41	136.94	234.13	181.52
8	179.54	106.03	188.45	203.11	137.10	234.35	182.29
9	179.35	106.08	188.58	203.26	137.24	234.44	182.74
10	179.24	106.53	188.84	203.15	137.42	234.10	182.75
11	179.46	106.41	189.93	203.24	136.84	235.16	184.21
12	179.78	106.53	190.63	203.48	136.75	236.00	185.26

Table 7: The 5% percentile (mean of 10 years and 6 days per month)

N010.x

1	180.54	107.24	192.23	204.47	138.02	237.72	188.41
2	180.26	107.18	191.55	204.20	138.25	237.42	188.16
3	180.42	107.75	191.44	204.08	138.45	236.64	187.77
4	180.46	108.05	190.91	203.55	139.75	235.84	187.36
5	180.36	107.52	190.15	204.28	139.38	235.68	186.99
6	180.47	107.72	190.19	204.04	138.76	234.81	184.69
7	180.51	107.78	189.80	203.94	139.16	234.84	185.12
8	180.37	107.77	189.79	203.88	139.31	235.12	185.16
9	180.17	108.35	189.99	203.86	139.77	234.89	185.87
10	180.29	108.53	190.31	203.74	139.34	234.96	186.50
11	180.34	108.17	190.86	204.17	139.46	236.07	187.63
12	180.39	108.18	192.32	204.14	139.00	236.93	188.50

Table 8: The 10% percentile (mean of 10 years and 6 days per month)

N0-1.x

1	178.19	102.10	188.04	202.26	131.47	234.21	175.94
2	177.96	102.19	187.02	201.91	131.68	233.24	174.90
3	177.83	102.09	186.51	201.89	132.06	232.97	175.15
4	177.94	102.20	186.21	202.12	132.78	232.83	175.49
5	177.88	101.95	185.96	202.06	132.63	232.87	175.55
6	177.77	101.54	185.60	202.08	132.39	232.78	174.92
7	177.71	101.60	185.38	201.97	132.51	232.57	174.94
8	177.65	101.76	185.38	201.85	132.62	232.69	175.34
9	177.47	101.95	185.37	201.67	132.64	232.36	175.22
10	177.47	102.40	185.86	201.60	132.71	232.72	176.30
11	177.76	102.35	186.72	201.94	132.45	233.41	176.55
12	178.10	102.27	187.52	202.22	132.07	233.83	176.24

Table 9: The 0-1% percentile (mean of 10 years and 6 days per month) (Mean of lowest 1%)

```
N1-5.x
  1    179.16  104.14  189.82  203.08  133.89  235.56  180.73
  2    178.91  104.20  189.11  202.80  134.06  234.93  180.13
  3    178.78  104.23  188.47  202.75  134.56  234.46  180.08
  4    179.02  104.63  188.16  202.97  135.50  234.09  180.13
  5    178.90  104.25  187.64  202.91  135.34  233.84  179.63
  6    178.73  103.73  187.21  202.84  134.88  233.72  178.82
  7    178.72  103.83  187.05  202.79  135.05  233.55  178.89
  8    178.69  104.03  187.09  202.66  135.18  233.55  179.09
  9    178.59  104.41  187.21  202.50  135.30  233.33  179.38
 10    178.47  104.66  187.52  202.35  135.20  233.55  180.01
 11    178.73  104.57  188.43  202.67  134.93  234.39  180.67
 12    179.03  104.56  189.31  202.96  134.65  235.00  180.92
```

Table 10: The 1-5% percentile (mean of 10 years and 6 days per month) (Mean of all data between 1 and 5% percentile)

The typical number of datapoints between 0 and 1% is 250, corresponding to 25000 datapoints per day in total. More points during summer and less during winter. A 10-year, 6 days per month average value is thus based on approximately 15000 datapoints for the 0-1 percentile data.

5. Arctic tie points

5.1 Comiso GR algorithm tie-points:

Month	19V	37V	19V	37V								
1	0.8345	0.6652	0.9830	0.9687	0.0000	0.0000	0.0176	0.0263	0.0116	0.0126	0.0000	0.0000
2	0.8281	0.6576	0.9787	0.9628	0.0000	0.0000	0.0156	0.0235	0.0071	0.0070	0.0000	0.0000
3	0.8243	0.6548	0.9801	0.9632	0.0000	0.0000	0.0128	0.0187	0.0056	0.0049	0.0000	0.0000
4	0.8278	0.6638	0.9808	0.9653	0.0000	0.0000	0.0141	0.0225	0.0046	0.0059	0.0000	0.0000
5	0.8436	0.6881	0.9880	0.9743	0.0000	0.0000	0.0149	0.0226	0.0050	0.0057	0.0000	0.0000
6	0.8972	0.7593	0.9894	0.9881	0.0000	0.0000	0.0301	0.0460	0.0050	0.0093	0.0000	0.0000
7	0.9107	0.7922	1.0024	1.0100	0.0000	0.0000	0.0223	0.0621	0.0091	0.0098	0.0000	0.0000
8	0.8536	0.6902	0.9914	0.9973	0.0000	0.0000	0.0448	0.0759	0.0104	0.0107	0.0000	0.0000
9	0.8173	0.6724	0.9705	0.9743	0.0000	0.0000	0.0282	0.0394	0.0073	0.0083	0.0000	0.0000
10	0.8393	0.6928	0.9716	0.9676	0.0000	0.0000	0.0219	0.0264	0.0100	0.0072	0.0000	0.0000
11	0.8438	0.6828	0.9868	0.9733	0.0000	0.0000	0.0225	0.0267	0.0054	0.0055	0.0000	0.0000
12	0.8394	0.6673	0.9854	0.9719	0.0000	0.0000	0.0173	0.0250	0.0051	0.0053	0.0000	0.0000

Table 6. GR tie-points (corrected emissivities). First 2 columns are MY, next 2 are FY.

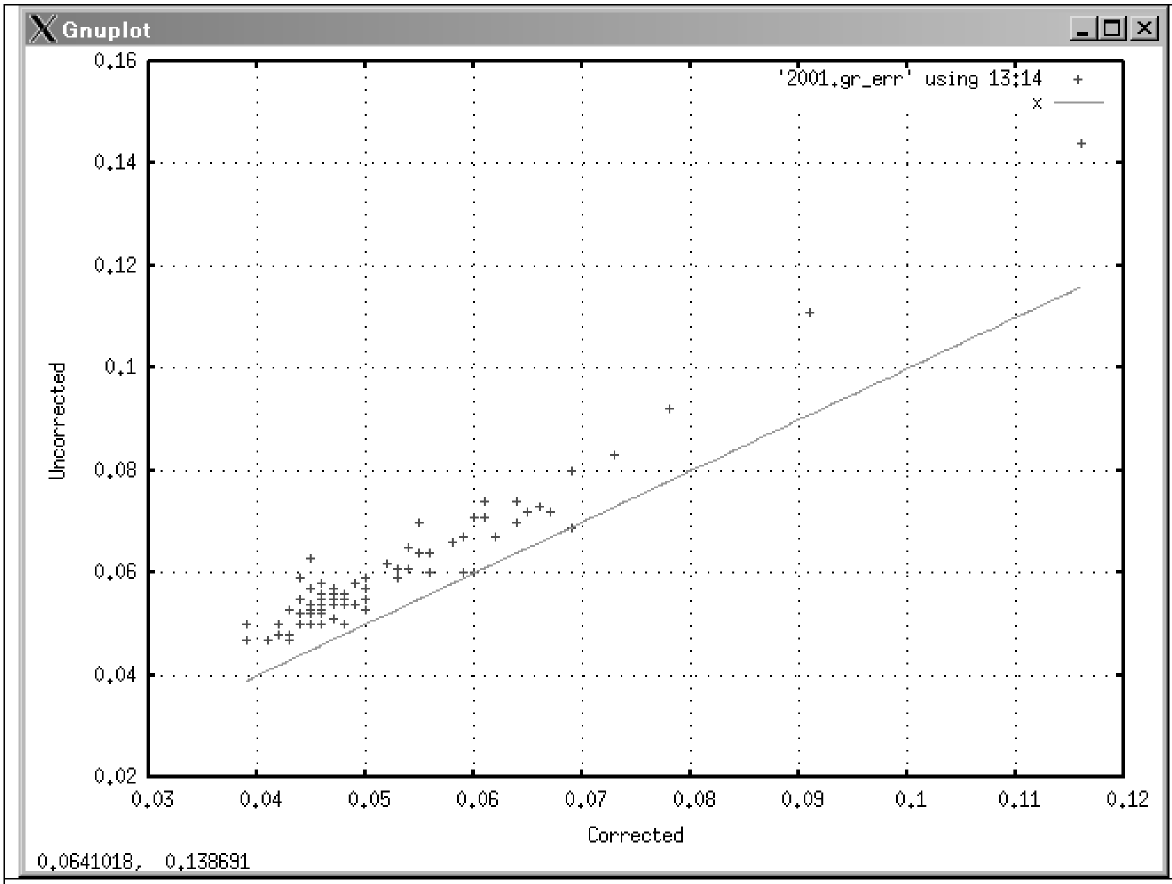
Month	19V	37V	19V	37V								
1	219.09	184.76	257.59	252.88	0.00	0.00	4.84	6.37	3.24	3.36	0.00	0.00
2	216.92	182.59	256.54	251.59	0.00	0.00	3.68	5.15	2.97	3.01	0.00	0.00
3	216.86	182.73	258.84	253.74	0.00	0.00	2.23	4.02	2.52	2.82	0.00	0.00
4	221.02	187.62	262.34	257.79	0.00	0.00	4.57	6.08	2.87	3.27	0.00	0.00
5	229.81	197.55	267.37	263.32	0.00	0.00	4.64	6.10	2.35	2.57	0.00	0.00
6	247.06	217.80	271.45	270.45	0.00	0.00	7.65	10.57	1.65	3.15	0.00	0.00
7	250.72	225.58	276.16	277.06	0.00	0.00	5.51	13.92	2.14	2.14	0.00	0.00
8	236.56	202.76	273.28	273.98	0.00	0.00	11.17	17.04	2.46	2.35	0.00	0.00
9	224.21	195.22	267.11	267.62	0.00	0.00	6.62	8.14	3.08	3.48	0.00	0.00
10	225.76	195.88	261.26	259.56	0.00	0.00	5.84	6.55	1.87	2.94	0.00	0.00
11	223.84	190.88	260.03	255.54	0.00	0.00	4.77	5.71	1.73	1.89	0.00	0.00
12	221.15	186.01	258.62	254.07	0.00	0.00	4.39	6.11	1.95	2.30	0.00	0.00

Table 7. GR tie-points (uncorrected Tbs). First 2 columns are MY, next 2 are FY.

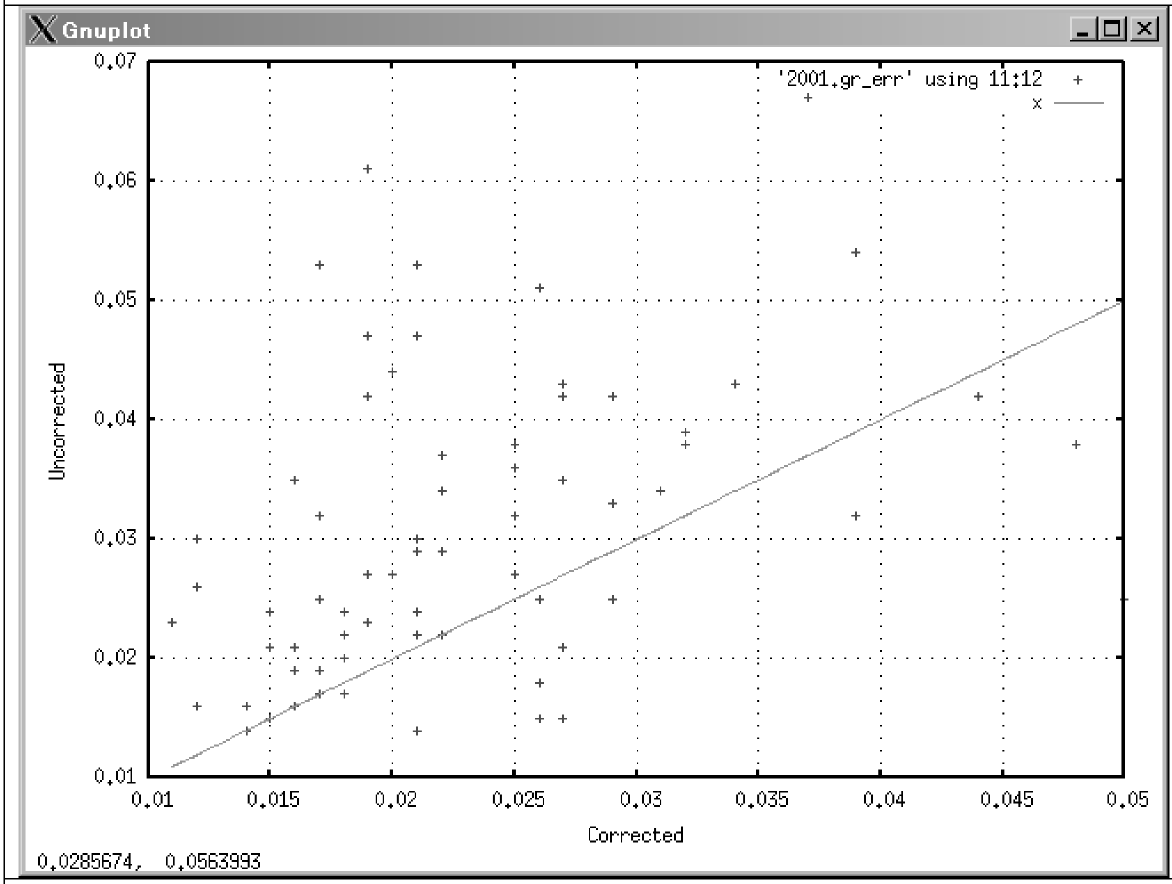
5.1.1 Test of GR tie-points for Northern Hemisphere

Emissivities				Tb				Distances					
Di	SDi	Dw	SDw	Di	SDi	Dw	SDw	NI	NW	ei-w	Ti-w	ei-i	Ti-i
-0.003	0.0101	0.210	0.0045	-0.6	2.42	44.8	1.08	12226	594	0.021	0.024	0.048	0.054
-0.002	0.0102	0.204	0.0053	-0.5	2.40	44.0	2.24	12418	594	0.026	0.051	0.050	0.055
-0.002	0.0096	0.215	0.0045	-0.7	2.29	45.4	1.31	12690	594	0.021	0.029	0.045	0.050
-0.004	0.0094	0.201	0.0096	-0.9	2.34	42.8	1.62	10260	586	0.048	0.038	0.047	0.055
-0.004	0.0101	0.209	0.0033	-1.2	2.43	43.5	0.72	13688	594	0.016	0.016	0.048	0.056
-0.005	0.0099	0.211	0.0057	-1.2	2.38	43.8	0.90	12399	593	0.027	0.021	0.047	0.054
-0.005	0.0102	0.206	0.0033	-0.7	2.36	44.5	0.85	12855	594	0.016	0.019	0.050	0.053
-0.003	0.0096	0.206	0.0040	-0.9	2.29	44.8	1.02	12933	594	0.019	0.023	0.047	0.051
-0.005	0.0096	0.207	0.0046	-0.8	2.39	43.5	1.60	11503	594	0.022	0.037	0.046	0.055
-0.004	0.0086	0.203	0.0079	-0.9	2.30	43.2	2.32	12765	594	0.039	0.054	0.043	0.053
-0.005	0.0092	0.203	0.0043	-1.0	2.33	43.4	0.96	12014	594	0.021	0.022	0.045	0.054
-0.006	0.0094	0.203	0.0064	-1.1	2.22	44.4	1.74	10243	594	0.032	0.039	0.046	0.050
-0.006	0.0089	0.211	0.0036	-1.2	2.21	46.0	0.89	11458	594	0.017	0.019	0.042	0.048
-0.006	0.0093	0.203	0.0043	-0.9	2.42	44.7	0.98	12686	591	0.021	0.022	0.046	0.054
-0.005	0.0099	0.207	0.0036	-0.7	2.50	45.0	1.12	10685	594	0.017	0.025	0.048	0.055
-0.005	0.0099	0.209	0.0054	-1.0	2.57	45.5	0.66	13018	594	0.026	0.015	0.047	0.056
-0.005	0.0093	0.207	0.0038	-0.9	2.38	45.0	0.88	14757	594	0.018	0.020	0.045	0.053
-0.004	0.0095	0.208	0.0031	-0.6	2.38	45.2	0.93	14212	594	0.015	0.021	0.046	0.053
-0.004	0.0099	0.197	0.0053	-0.3	2.53	42.8	1.78	12853	594	0.027	0.042	0.050	0.059
-0.005	0.0094	0.205	0.0038	-0.2	2.48	44.7	1.21	13907	592	0.019	0.027	0.046	0.056
-0.006	0.0096	0.201	0.0033	0.2	2.47	44.1	0.74	13804	594	0.017	0.017	0.048	0.056
-0.004	0.0091	0.208	0.0054	0.7	2.41	44.1	1.09	13309	594	0.026	0.025	0.044	0.055
-0.004	0.0094	0.215	0.0056	1.1	2.38	45.3	0.82	11979	594	0.026	0.018	0.044	0.052
-0.004	0.0084	0.215	0.0025	1.4	2.10	44.7	1.18	13118	594	0.012	0.026	0.039	0.047
-0.004	0.0089	0.217	0.0039	1.7	2.10	44.2	0.76	12793	594	0.018	0.017	0.041	0.047
-0.002	0.0084	0.217	0.0058	2.5	2.10	42.2	1.47	12793	594	0.027	0.035	0.039	0.050
-0.002	0.0090	0.215	0.0042	2.7	2.19	43.7	1.16	11791	594	0.020	0.027	0.042	0.050
-0.001	0.0093	0.215	0.0033	3.4	2.24	44.8	0.68	11545	594	0.015	0.015	0.044	0.050
-0.001	0.0096	0.216	0.0053	3.6	2.32	44.4	1.18	10996	594	0.025	0.027	0.045	0.052
-0.001	0.0090	0.211	0.0046	3.9	2.08	44.6	1.51	9228	594	0.022	0.034	0.043	0.047
-0.003	0.0098	0.212	0.0053	3.8	2.27	44.1	1.66	7187	594	0.025	0.038	0.046	0.052
-0.002	0.0118	0.211	0.0052	4.1	2.80	43.7	1.55	7432	594	0.025	0.036	0.056	0.064
-0.002	0.0119	0.216	0.0037	4.3	2.79	43.6	2.30	8021	594	0.017	0.053	0.055	0.064
0.000	0.0125	0.215	0.0036	4.6	2.78	42.4	1.34	4890	594	0.017	0.032	0.058	0.066
0.000	0.0129	0.212	0.0047	4.7	2.94	39.8	0.88	6634	594	0.022	0.022	0.061	0.074
-0.002	0.0129	0.218	0.0025	4.2	2.94	44.0	1.33	6704	594	0.012	0.030	0.059	0.067
-0.007	0.0155	0.213	0.0040	3.2	3.53	42.4	1.77	2744	594	0.019	0.042	0.073	0.083
-0.005	0.0150	0.216	0.0032	3.5	3.35	41.7	0.88	2925	594	0.015	0.021	0.069	0.080
-0.008	0.0135	0.220	0.0041	3.0	3.04	43.1	2.03	1995	594	0.019	0.047	0.061	0.071
-0.019	0.0112	0.216	0.0033	0.7	2.66	42.8	1.01	923	592	0.015	0.024	0.052	0.062
-0.018	0.0116	0.215	0.0031	1.0	2.66	43.9	0.72	533	594	0.014	0.016	0.054	0.061
-0.019	0.0128	0.214	0.0030	1.0	2.95	41.7	0.58	475	594	0.014	0.014	0.060	0.071
-0.010	0.0141	0.210	0.0036	2.7	3.11	43.1	0.82	1047	593	0.017	0.019	0.067	0.072
-0.016	0.0108	0.218	0.0042	1.1	2.26	41.6	2.52	632	594	0.019	0.061	0.049	0.054
-0.002	0.0195	0.216	0.0035	4.6	4.58	41.1	0.87	1207	594	0.016	0.021	0.091	0.111
-0.008	0.0170	0.217	0.0044	3.2	3.84	41.5	1.94	964	593	0.021	0.047	0.078	0.092
-0.003	0.0249	0.215	0.0059	4.6	5.90	40.9	1.77	933	594	0.027	0.043	0.116	0.144
-0.022	0.0102	0.216	0.0064	0.0	2.30	40.2	1.69	738	594	0.029	0.042	0.047	0.057
-0.021	0.0117	0.213	0.0061	-0.5	2.80	39.8	1.01	731	594	0.029	0.025	0.055	0.070
-0.025	0.0100	0.216	0.0026	-1.0	2.46	42.4	0.69	634	594	0.012	0.016	0.046	0.058
-0.027	0.0098	0.218	0.0070	-1.9	2.55	40.4	1.55	465	594	0.032	0.038	0.045	0.063
-0.027	0.0093	0.211	0.0044	-2.2	2.41	40.9	0.57	496	592	0.021	0.014	0.044	0.059
-0.028	0.0096	0.212	0.0033	-2.7	2.51	44.0	1.52	547	594	0.016	0.035	0.045	0.057
-0.023	0.0132	0.204	0.0037	-2.2	3.03	43.1	0.94	418	594	0.018	0.022	0.064	0.070
-0.022	0.0107	0.211	0.0044	-1.9	2.46	43.4	2.32	545	593	0.021	0.053	0.050	0.057
-0.021	0.0110	0.219	0.0047	-2.1	2.40	44.9	1.31	620	593	0.022	0.029	0.050	0.053
-0.017	0.0100	0.212	0.0038	-1.2	2.19	42.6	1.04	977	594	0.018	0.024	0.047	0.051
-0.010	0.0092	0.212	0.0079	-0.2	2.03	42.3	2.85	2795	594	0.037	0.067	0.043	0.048
-0.007	0.0096	0.199	0.0078	-0.2	2.15	43.0	1.39	2129	594	0.039	0.032	0.048	0.050
-0.007	0.0100	0.202	0.0044	0.1	2.23	42.1	1.57	4645	594	0.022	0.037	0.050	0.053
-0.006	0.0106	0.217	0.0058	0.1	2.65	45.4	0.70	3519	594	0.027	0.015	0.049	0.058
-0.004	0.0107	0.201	0.0043	0.4	2.62	44.2	1.34	4941	594	0.021	0.030	0.053	0.059
-0.007	0.0122	0.188	0.0020	-0.2	2.90	40.3	0.92	5059	594	0.011	0.023	0.065	0.072
-0.004	0.0112	0.210	0.0042	0.3	2.67	44.1	1.92	6772	594	0.020	0.044	0.053	0.061
-0.001	0.0112	0.199	0.0050	0.4	2.59	43.3	1.39	8969	594	0.025	0.032	0.056	0.060
-0.005	0.0123	0.192	0.0085	0.6	3.03	40.9	1.72	6311	594	0.044	0.042	0.064	0.074
-0.002	0.0125	0.201	0.0059	1.2	2.83	42.0	1.39	9516	594	0.029	0.033	0.062	0.067
-0.001	0.0128	0.214	0.0045	1.2	2.71	45.1	1.01	8923	594	0.021	0.022	0.060	0.060
0.000	0.0112	0.206	0.0044	1.2	2.75	42.2	0.92	8006	594	0.021	0.022	0.054	0.065
0.002	0.0129	0.195	0.0098	0.7	3.06	42.0	1.06	6917	594	0.050	0.025	0.066	0.073
0.001	0.0135	0.196	0.0066	0.6	2.95	42.7	1.82	6864	594	0.034	0.043	0.069	0.069
0.000	0.0121	0.203	0.0063	0.2	2.69	44.6	1.51	8945	594	0.031	0.034	0.059	0.060

Table. Test of GR Ghz tie-points. The columns are:
Di is mean distance from ice data to ice line (should be 0). (Emissivity)
Sdi is standard deviation of distance from ice points to ice line. (Emissivity)
Dw is mean distance from water points to ice line
Sdw is standard deviation of distance from water points to ice line. (Emissivity)
The following 4 columns are similar but for uncorrected Tb tie-points
NI and NW are number of observations of ice (C>0.96) and Water (selected areas in the North Atlantic and North Pacific) respectively
ei-w is standard deviation of ice-water distance scaled by ice-water distance (essentially uncertainty in ice concentration for water areas. Ti-w is similar for uncorrected brightness temperature data.
ei-i is standard deviation of ice-ice distance scaled by ice-water distance (essentially uncertainty in ice concentration at high concentrations) Ti-i is similar for uncorrected brightness temperatures.
The yellow/white sections each covers the 6 days of a calender month from January through December 1997.



Ei-i vs. Ti-i, variability in ice concentration for each 5-day period, ice points only (85 GHz tiepoints)



Ei-w vs. Ti-w, variability in ice concentration for each 5-day period, water points only (85 GHz tiepoints)

5.2 Bristol algorithm

Bristol channels:

Month	19V	37V	37H	19V	37V	3H7						
1	0.9359	0.7811	0.7070	0.8765	0.8168	0.7776	0.0185	0.0355	0.0316	0.0420	0.0759	0.0777
2	0.9307	0.7707	0.6934	0.8584	0.7833	0.7436	0.0115	0.0370	0.0339	0.0334	0.0639	0.0654
3	0.9318	0.7900	0.7105	0.8474	0.7649	0.7239	0.0171	0.0580	0.0547	0.0252	0.0470	0.0496
4	0.9254	0.7938	0.7165	0.8583	0.7784	0.7363	0.0375	0.0684	0.0585	0.0484	0.0795	0.0817
5	0.9228	0.8133	0.7355	0.9038	0.8553	0.8184	0.0504	0.0997	0.0827	0.0596	0.0992	0.1047
6	0.9411	0.8285	0.7416	0.9597	0.9633	0.9377	0.0297	0.0657	0.0502	0.0264	0.0417	0.0465
7	0.9263	0.8139	0.7353	0.9683	0.9875	0.9662	0.0196	0.0568	0.0494	0.0111	0.0109	0.0117
8	0.8888	0.7339	0.6584	0.9415	0.9567	0.9329	0.0240	0.0555	0.0555	0.0324	0.0559	0.0592
9	0.8788	0.7611	0.6960	0.9249	0.9334	0.9081	0.0375	0.0720	0.0685	0.0355	0.0621	0.0663
10	0.9343	0.8467	0.7767	0.9069	0.8939	0.8626	0.0320	0.0630	0.0593	0.0399	0.0811	0.0853
11	0.9515	0.8426	0.7700	0.8830	0.8341	0.7964	0.0211	0.0366	0.0332	0.0393	0.0729	0.0756
12	0.9473	0.8048	0.7324	0.8869	0.8337	0.7966	0.0085	0.0266	0.0247	0.0378	0.0701	0.0722

Table 8. Bristol tie-points (corrected emissivities). First 3 columns are MY, next 3 are FY.

Month	19V	37V	37H	19V	37V	3H7						
1	244.12	210.30	194.33	230.47	218.70	210.22	4.82	8.18	7.34	11.16	17.38	17.73
2	242.87	208.02	191.33	225.07	210.45	201.89	3.10	8.40	7.66	8.59	14.25	14.56
3	245.55	214.46	197.14	223.14	207.19	198.32	5.14	13.54	12.73	6.09	10.30	10.83
4	247.01	218.17	201.17	229.19	213.46	204.26	10.08	16.03	13.79	13.47	19.10	19.57
5	250.39	226.55	209.32	246.01	236.19	228.03	12.92	22.72	18.96	16.90	24.40	25.64
6	257.88	233.28	214.20	264.68	265.34	259.77	7.32	14.65	11.30	7.54	10.59	11.68
7	254.61	230.57	213.51	267.92	271.82	267.31	4.86	12.87	11.26	2.99	2.72	2.90
8	245.15	212.50	196.00	260.70	264.18	259.12	6.10	12.51	12.56	8.31	12.81	13.55
9	239.63	215.19	200.89	255.29	257.68	252.17	9.17	15.74	14.90	10.07	15.13	16.08
10	249.68	230.37	214.96	247.76	245.77	238.89	7.88	14.08	13.26	12.28	20.61	21.54
11	250.62	226.21	210.40	236.82	227.38	219.14	5.46	8.64	7.88	10.59	17.21	17.77
12	247.25	215.74	200.09	234.30	223.72	215.65	2.58	6.07	5.63	10.31	16.43	16.78

Table 9. Bristol tie-points (uncorrected Tbs). First 3 columns are MY, next 3 are FY.

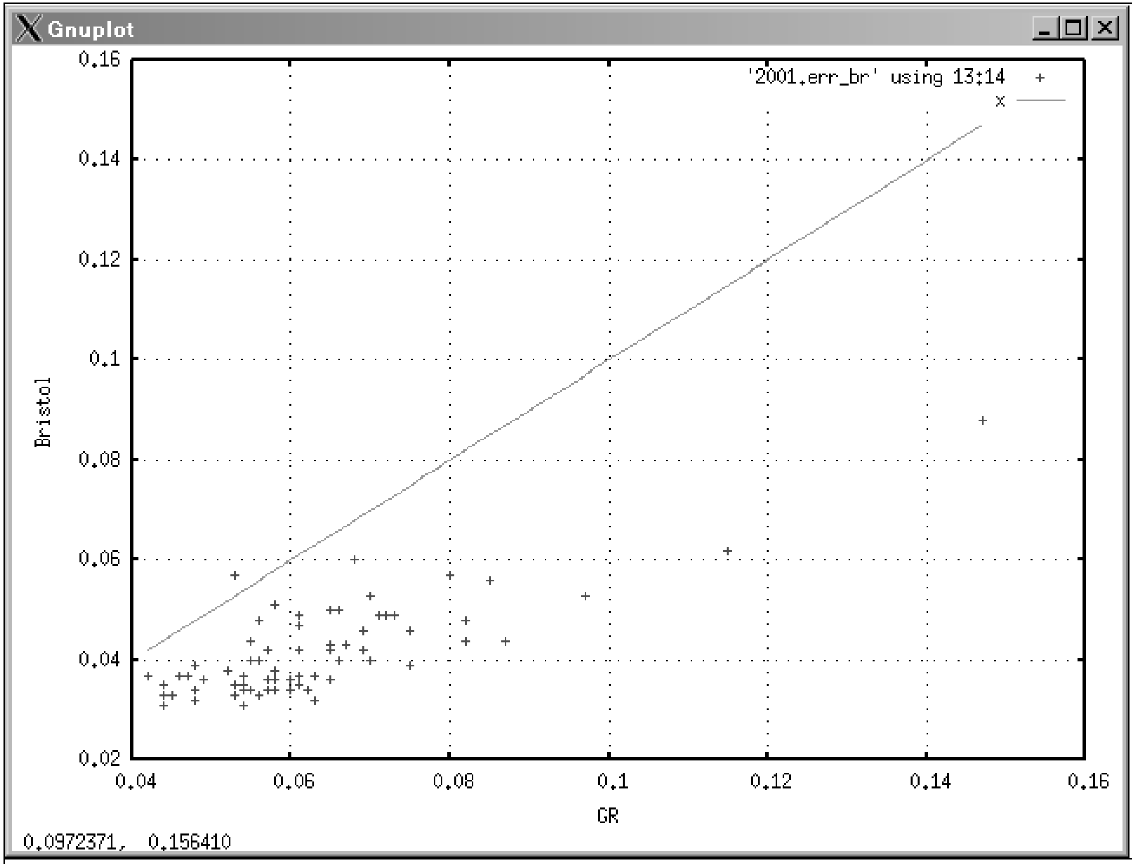
Month	B1-FY	B2-FY	B1-MY	B2-MY								
1	648.06	103.77	481.06	102.49	36.76	36.76	8.02	1.60	14.14	2.84	nan	nan
2	645.51	103.50	475.50	101.96	36.76	36.76	6.41	1.02	11.29	2.02	nan	nan
3	649.42	104.19	475.29	101.73	36.76	36.76	5.96	1.23	8.49	1.48	nan	nan
4	659.32	106.26	487.37	103.02	36.76	36.76	8.94	1.45	13.90	2.28	nan	nan
5	674.24	107.83	511.76	105.27	36.76	36.76	6.32	1.10	14.14	2.39	nan	nan
6	693.07	109.30	560.78	109.92	36.76	36.76	7.01	0.97	24.38	3.87	nan	nan
7	709.11	111.86	571.25	109.26	36.76	36.76	6.10	1.25	34.78	4.94	nan	nan
8	702.03	110.87	524.43	107.86	36.76	36.76	6.28	1.29	39.26	4.44	nan	nan
9	685.15	107.71	505.34	101.82	36.76	36.76	8.30	1.54	19.24	3.27	nan	nan
10	667.07	104.41	507.03	102.71	36.76	36.76	8.06	1.04	15.45	3.14	nan	nan
11	654.73	104.18	496.04	103.79	36.76	36.76	4.81	1.04	13.12	3.09	nan	nan
12	650.69	103.86	484.92	103.74	36.76	36.76	4.96	0.76	13.20	2.78	nan	nan

Table 10. Bristol tie-points (uncorrected Bristol coordinates). First 2 columns are MY, next 2 are FY.

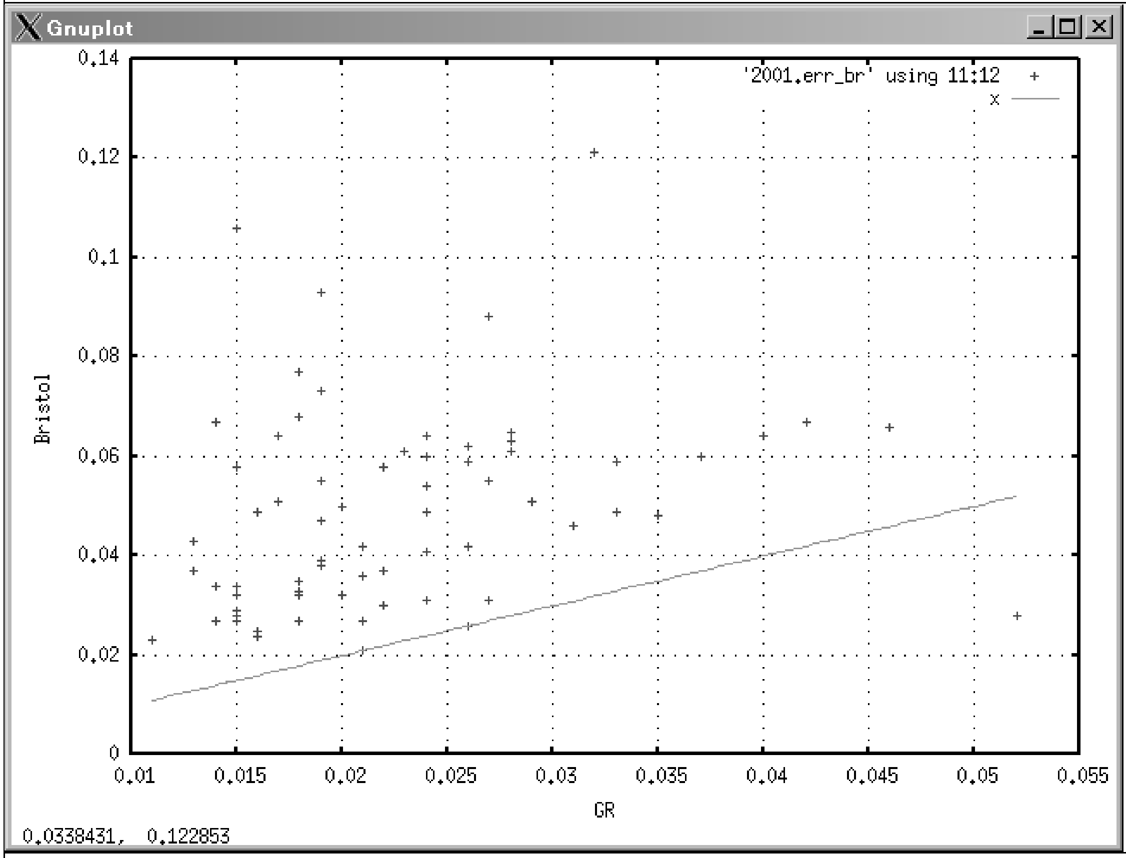
5.2.1 Test of Bristol tie-points for Northern Hemisphere

	Emissivities			Tb					Distances				
Di	SDi	Dw	SDw	Di	SDi	Dw	SDw	NI	NW	ei-w	Ti-w	ei-i	Ti-i
0.005	0.0116	0.190	0.0040	-0.5	2.55	72.6	2.62	12226	594	0.021	0.036	0.061	0.035
0.006	0.0121	0.185	0.0052	-0.4	2.49	68.7	4.34	12418	594	0.028	0.063	0.065	0.036
0.006	0.0114	0.196	0.0040	-0.7	2.45	72.5	3.01	12690	594	0.021	0.042	0.058	0.034
0.004	0.0110	0.182	0.0083	-1.5	2.48	67.9	4.45	10260	586	0.046	0.066	0.060	0.036
0.003	0.0119	0.190	0.0030	-1.3	2.52	69.0	1.68	13688	594	0.016	0.024	0.063	0.037
0.002	0.0110	0.192	0.0046	-1.6	2.49	70.0	4.45	12399	593	0.024	0.064	0.057	0.036
0.003	0.0118	0.187	0.0029	-1.1	2.32	71.7	2.32	12855	594	0.015	0.032	0.063	0.032
0.005	0.0112	0.187	0.0038	-1.0	2.46	71.3	2.25	12933	594	0.020	0.032	0.060	0.034
0.003	0.0105	0.188	0.0042	-1.5	2.33	69.8	4.05	11503	594	0.022	0.058	0.056	0.033
0.004	0.0099	0.184	0.0074	-1.5	2.25	68.5	4.40	12765	594	0.040	0.064	0.053	0.033
0.002	0.0101	0.184	0.0039	-1.7	2.29	67.4	2.85	12014	594	0.021	0.042	0.055	0.034
0.002	0.0105	0.184	0.0060	-2.0	2.37	70.5	3.43	10243	594	0.033	0.049	0.057	0.034
0.002	0.0103	0.191	0.0034	-1.7	2.36	75.0	2.47	11458	594	0.018	0.033	0.054	0.031
0.002	0.0099	0.185	0.0039	-1.4	2.62	71.4	1.94	12686	591	0.021	0.027	0.054	0.037
0.004	0.0110	0.189	0.0033	-1.3	2.70	70.7	2.50	10685	594	0.018	0.035	0.058	0.038
0.004	0.0110	0.190	0.0046	-1.4	2.61	73.4	2.30	13018	594	0.024	0.031	0.058	0.036
0.003	0.0101	0.188	0.0034	-1.1	2.45	71.8	2.28	14757	594	0.018	0.032	0.054	0.034
0.004	0.0102	0.188	0.0029	-0.9	2.46	72.4	2.09	14212	594	0.015	0.029	0.054	0.034
0.004	0.0101	0.179	0.0050	-1.1	2.69	66.6	4.30	12853	594	0.028	0.065	0.056	0.040
0.003	0.0099	0.186	0.0036	-0.8	2.51	72.0	2.76	13907	592	0.019	0.038	0.053	0.035
0.002	0.0095	0.182	0.0029	-0.5	2.58	68.7	1.70	13804	594	0.016	0.025	0.052	0.038
0.003	0.0093	0.189	0.0049	-0.1	2.49	68.7	2.90	13309	594	0.026	0.042	0.049	0.036
0.004	0.0093	0.196	0.0053	0.1	2.45	72.8	2.25	11979	594	0.027	0.031	0.048	0.034
0.004	0.0086	0.196	0.0025	0.7	2.18	70.2	3.04	13118	594	0.013	0.043	0.044	0.031
0.004	0.0087	0.198	0.0036	1.1	2.28	70.1	1.87	12793	594	0.018	0.027	0.044	0.033
0.005	0.0084	0.198	0.0053	1.7	2.44	66.5	3.65	12793	594	0.027	0.055	0.042	0.037
0.005	0.0087	0.196	0.0042	1.8	2.44	69.2	1.46	11791	594	0.021	0.021	0.044	0.035
0.006	0.0090	0.195	0.0028	2.6	2.64	72.4	2.05	11545	594	0.015	0.028	0.046	0.037
0.006	0.0093	0.197	0.0047	3.1	2.60	69.7	3.44	10996	594	0.024	0.049	0.047	0.037
0.006	0.0086	0.192	0.0047	2.9	2.32	69.9	3.78	9228	594	0.024	0.054	0.045	0.033
0.004	0.0093	0.193	0.0051	2.8	2.65	68.6	4.03	7187	594	0.026	0.059	0.048	0.039
0.004	0.0117	0.192	0.0049	3.3	3.28	67.4	4.18	7432	594	0.026	0.062	0.061	0.049
0.004	0.0121	0.196	0.0029	3.3	3.24	68.8	7.29	8021	594	0.015	0.106	0.061	0.047
0.004	0.0128	0.196	0.0033	3.7	3.24	65.0	4.17	4890	594	0.017	0.064	0.065	0.050
0.004	0.0135	0.193	0.0038	3.7	3.59	67.2	3.37	6634	594	0.020	0.050	0.070	0.053
0.002	0.0131	0.199	0.0026	3.9	3.60	72.1	2.70	6704	594	0.013	0.037	0.066	0.050
-0.003	0.0166	0.194	0.0036	2.5	3.83	67.9	3.74	2744	594	0.019	0.055	0.085	0.056
-0.001	0.0158	0.197	0.0030	2.3	3.76	65.8	2.22	2925	594	0.015	0.034	0.080	0.057
-0.003	0.0145	0.200	0.0037	1.7	3.31	68.3	4.65	1995	594	0.018	0.068	0.073	0.049
-0.015	0.0105	0.197	0.0028	0.1	3.89	68.7	4.58	923	592	0.014	0.067	0.053	0.057
-0.015	0.0113	0.196	0.0028	1.5	3.62	70.3	1.89	533	594	0.014	0.027	0.058	0.051
-0.015	0.0133	0.195	0.0030	1.3	3.91	65.1	1.78	475	594	0.015	0.027	0.068	0.060
-0.004	0.0157	0.191	0.0036	2.1	2.96	67.0	2.52	1047	593	0.019	0.038	0.082	0.044
-0.013	0.0109	0.199	0.0038	1.0	2.86	64.6	6.01	632	594	0.019	0.093	0.055	0.044
0.005	0.0225	0.196	0.0029	3.7	4.13	66.5	3.87	1207	594	0.015	0.058	0.115	0.062
0.000	0.0192	0.198	0.0036	2.8	3.49	66.1	5.10	964	593	0.018	0.077	0.097	0.053
0.007	0.0287	0.195	0.0048	4.6	5.77	65.6	4.23	933	594	0.024	0.064	0.147	0.088
-0.011	0.0129	0.197	0.0054	0.2	2.65	62.9	5.56	738	594	0.027	0.088	0.065	0.042
-0.011	0.0140	0.195	0.0058	-0.3	2.99	61.4	3.13	731	594	0.029	0.051	0.072	0.049
-0.015	0.0120	0.196	0.0027	-0.1	2.95	69.6	2.40	634	594	0.014	0.034	0.061	0.042
-0.018	0.0112	0.199	0.0065	-1.1	3.06	64.1	3.79	465	594	0.033	0.059	0.056	0.048
-0.017	0.0110	0.192	0.0036	-1.5	2.82	67.2	3.14	496	592	0.019	0.047	0.057	0.042
-0.019	0.0107	0.193	0.0032	-2.2	2.89	73.0	3.71	547	594	0.017	0.051	0.055	0.040
-0.016	0.0139	0.186	0.0035	-2.3	3.04	65.7	2.57	418	594	0.019	0.039	0.075	0.046
-0.013	0.0120	0.192	0.0044	-2.0	2.57	70.1	4.28	545	593	0.023	0.061	0.063	0.037
-0.011	0.0123	0.199	0.0039	-2.0	2.43	72.4	2.73	620	593	0.019	0.038	0.062	0.034
-0.008	0.0104	0.192	0.0030	-1.4	2.10	68.5	3.35	977	594	0.016	0.049	0.054	0.031
-0.003	0.0093	0.194	0.0063	-0.2	2.16	67.0	8.12	2795	594	0.032	0.121	0.048	0.032
0.000	0.0097	0.181	0.0066	0.0	2.44	65.9	3.93	2129	594	0.037	0.060	0.054	0.037
0.001	0.0099	0.184	0.0043	0.2	2.37	64.6	3.88	4645	594	0.024	0.060	0.054	0.037
0.001	0.0107	0.197	0.0051	-0.1	2.56	73.4	1.87	3519	594	0.026	0.026	0.054	0.035
0.003	0.0111	0.183	0.0040	0.0	2.62	70.6	2.62	4941	594	0.022	0.037	0.061	0.037
0.001	0.0118	0.170	0.0018	-0.7	2.65	62.6	1.45	5059	594	0.011	0.023	0.069	0.042
0.004	0.0126	0.191	0.0037	0.3	2.70	67.6	4.96	6772	594	0.019	0.073	0.066	0.040
0.007	0.0127	0.181	0.0044	0.4	2.71	67.8	2.76	8969	594	0.024	0.041	0.070	0.040
0.003	0.0125	0.175	0.0074	0.5	3.06	63.0	4.20	6311	594	0.042	0.067	0.071	0.049
0.006	0.0126	0.182	0.0052	1.5	3.01	65.3	4.01	9516	594	0.028	0.061	0.069	0.046
0.007	0.0127	0.194	0.0042	1.4	3.21	74.1	2.25	8923	594	0.022	0.030	0.065	0.043
0.008	0.0126	0.188	0.0040	0.6	2.86	66.2	1.98	8006	594	0.022	0.030	0.067	0.043
0.010	0.0145	0.178	0.0093	0.2	3.10	64.5	1.83	6917	594	0.052	0.028	0.082	0.048
0.009	0.0154	0.177	0.0063	0.3	2.96	66.8	3.19	6864	594	0.035	0.048	0.087	0.044
0.008	0.0138	0.184	0.0058	0.1	2.78	71.3	3.31	8945	594	0.031	0.046	0.075	0.039

Table. Test of Bristol tie-points. The columns are:
Di is mean distance from ice data to ice line (should be 0). (GR Emissivity)
Sdi is standard deviation of distance from ice points to ice line. (GR Emissivity)
Dw is mean distance from water points to ice line (GR Emissivity)
Sdw is standard deviation of distance from water points to ice line. (GR Emissivity)
The following 4 columns are similar but for uncorrected Bristol tie-points
NI and NW are number of observations of ice (C>0.96) and Water (selected areas in the North Atlantic and North Pacific) respectively
ei-w is standard deviation of ice-water distance scaled by ice-water distance (essentially uncertainty in ice concentration for water areas with the GR alg). Ti-w is similar for uncorrected Bristol data.
ei-i is standard deviation of ice-ice distance scaled by ice-water distance (essentially uncertainty in ice concentration at high concentrations with the GR alg) Ti-i is similar for uncorrected Bristol data.
The yellow/white sections each covers the 6 days of a calender month from January through December 1997.



GR vs. Bristol, variability in ice concentration for each 5-day period, ice points only
Bristol algorithm has less noise



GR vs. Bristol, variability in ice concentration for each 5-day period, ice points only
GR alg has less noise.

5.3 85 GHz algorithm

Month	85V	85H	85V	85H								
1	0.8563	0.8178	0.6739	0.6383	0.0000	0.0000	0.1460	0.1475	0.1528	0.1543	0.0000	0.0000
2	0.8954	0.8568	0.6383	0.6020	0.0000	0.0000	0.0998	0.1019	0.1090	0.1101	0.0000	0.0000
3	0.8984	0.8604	0.6517	0.6139	0.0000	0.0000	0.0985	0.0991	0.1055	0.1067	0.0000	0.0000
4	0.9087	0.8668	0.6609	0.6225	0.0000	0.0000	0.0823	0.0838	0.0876	0.0877	0.0000	0.0000
5	0.8725	0.8309	0.6881	0.6493	0.0000	0.0000	0.1316	0.1341	0.1402	0.1446	0.0000	0.0000
6	0.6927	0.6508	0.8682	0.8417	0.0000	0.0000	0.1576	0.1657	0.1634	0.1720	0.0000	0.0000
7	0.6453	0.5694	0.9457	0.9151	0.0000	0.0000	0.0885	0.0920	0.0703	0.0752	0.0000	0.0000
8	0.6539	0.5904	0.8766	0.8404	0.0000	0.0000	0.1511	0.1596	0.1626	0.1698	0.0000	0.0000
9	0.8449	0.7981	0.6187	0.5862	0.0000	0.0000	0.1155	0.1192	0.1324	0.1317	0.0000	0.0000
10	0.8723	0.8270	0.6129	0.5793	0.0000	0.0000	0.1164	0.1158	0.1301	0.1282	0.0000	0.0000
11	0.8926	0.8553	0.6253	0.5900	0.0000	0.0000	0.1307	0.1316	0.1328	0.1316	0.0000	0.0000
12	0.9056	0.8698	0.6164	0.5823	0.0000	0.0000	0.1135	0.1167	0.1208	0.1207	0.0000	0.0000

Table 11. 85GHz tie-points (corrected emissivities). First 2 columns are FY, next 2 are MY.

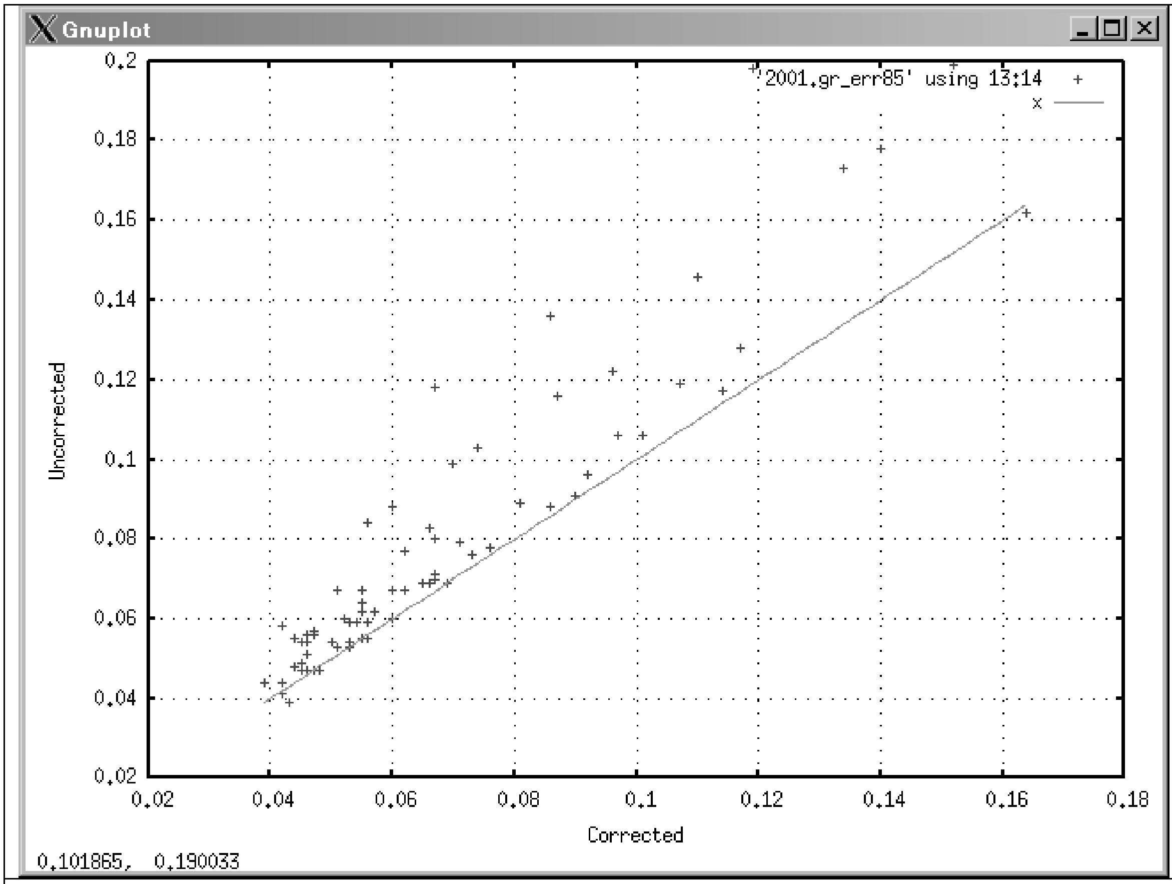
Month	85V	85H	85V	85H								
1	231.19	223.42	191.79	184.53	0.00	0.00	31.52	31.95	32.78	33.10	0.00	0.00
2	239.38	231.59	183.43	175.99	0.00	0.00	21.94	22.38	23.45	23.71	0.00	0.00
3	241.47	233.90	187.58	179.89	0.00	0.00	21.64	21.78	23.49	23.82	0.00	0.00
4	245.94	237.71	194.04	186.34	0.00	0.00	17.36	17.75	18.89	19.00	0.00	0.00
5	243.97	236.31	208.60	201.41	0.00	0.00	25.50	26.16	27.60	28.57	0.00	0.00
6	218.48	211.54	248.29	243.93	0.00	0.00	27.16	28.47	27.95	29.43	0.00	0.00
7	216.17	204.71	262.54	257.80	0.00	0.00	14.49	14.28	10.96	11.80	0.00	0.00
8	216.21	206.29	250.92	245.25	0.00	0.00	23.51	24.46	26.05	27.20	0.00	0.00
9	240.90	232.73	198.75	193.01	0.00	0.00	19.74	20.61	25.07	24.96	0.00	0.00
10	239.61	230.83	187.26	180.70	0.00	0.00	23.97	23.91	25.69	25.31	0.00	0.00
11	241.20	233.84	185.98	178.94	0.00	0.00	26.70	26.90	27.70	27.47	0.00	0.00
12	242.66	235.50	181.02	174.14	0.00	0.00	23.36	23.91	25.94	25.97	0.00	0.00

Table 12. 85GHz tie-points (uncorrected Tbs). First 2 columns are FY, next 2 are MY.

5.3.1 Test of 85 GHz tie-points for Northern Hemisphere

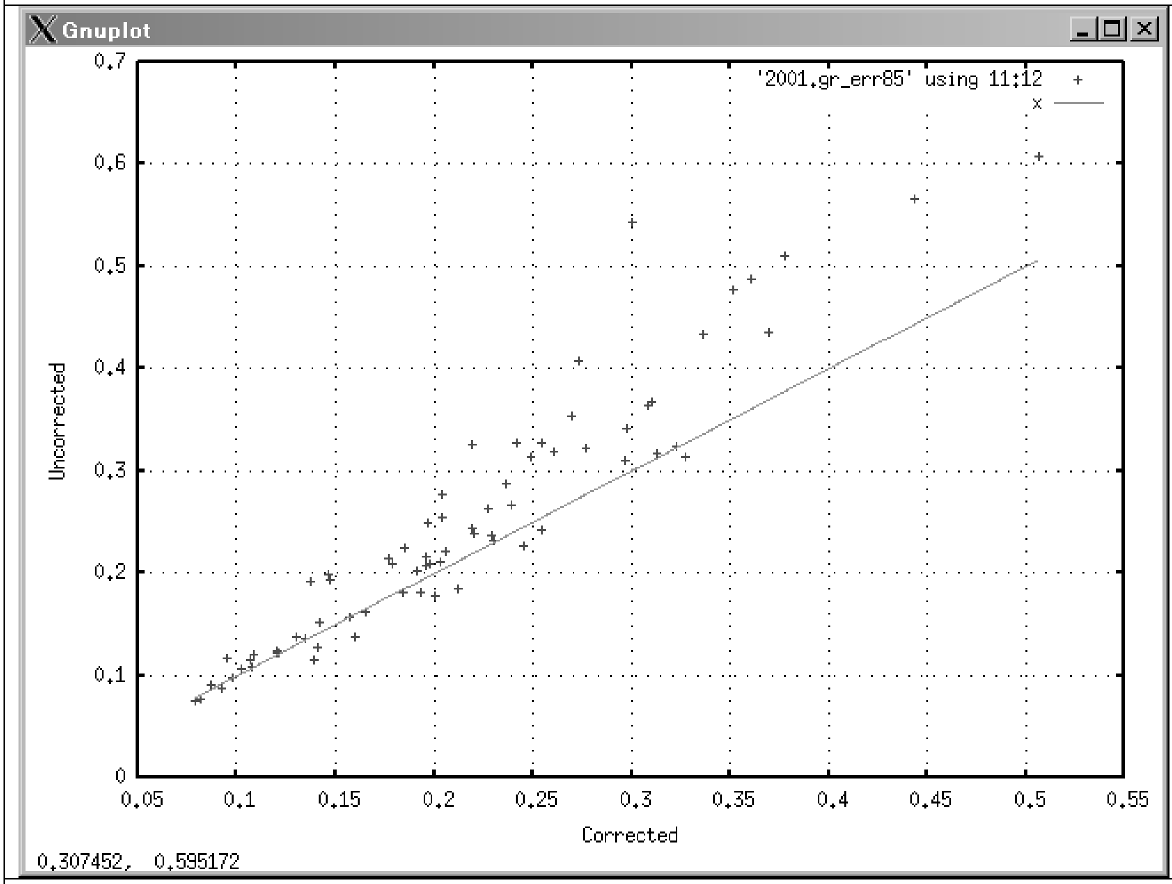
	Emissivities			Tb					Distances				
Di	SDi	Dw	SDw	Di	SDi	Dw	SDw	NI	NW	ei-w	Ti-w	ei-i	Ti-i
-0.001	0.0078	0.157	0.0211	-0.1	1.58	29.2	3.96	12226	594	0.135	0.136	0.050	0.054
-0.001	0.0082	0.112	0.0221	-0.2	1.67	22.1	5.49	12418	594	0.197	0.249	0.073	0.076
0.000	0.0068	0.150	0.0286	0.1	1.40	26.1	5.27	12690	594	0.191	0.202	0.045	0.054
0.002	0.0056	0.129	0.0328	0.5	1.15	24.0	5.81	10260	586	0.254	0.243	0.044	0.048
0.001	0.0063	0.133	0.0189	0.1	1.24	22.3	3.40	13688	594	0.142	0.152	0.047	0.056
0.002	0.0064	0.139	0.0436	0.5	1.31	23.5	7.45	12399	593	0.313	0.317	0.046	0.056
0.002	0.0073	0.143	0.0186	0.5	1.47	27.9	3.84	12855	594	0.130	0.138	0.051	0.053
0.002	0.0064	0.138	0.0149	0.4	1.28	27.2	2.92	12933	594	0.108	0.108	0.046	0.047
0.005	0.0066	0.148	0.0274	1.1	1.29	26.3	5.92	11503	594	0.185	0.225	0.045	0.049
0.005	0.0076	0.134	0.0240	1.1	1.51	24.5	5.15	12765	594	0.179	0.210	0.057	0.062
0.006	0.0075	0.115	0.0225	1.3	1.48	21.6	4.50	12014	594	0.196	0.208	0.065	0.069
0.006	0.0072	0.138	0.0165	1.2	1.47	27.5	3.41	10243	594	0.120	0.124	0.053	0.053
0.003	0.0075	0.165	0.0162	0.6	1.53	32.6	3.20	11458	594	0.098	0.098	0.045	0.047
0.003	0.0077	0.146	0.0116	0.7	1.56	29.4	2.20	12686	591	0.079	0.075	0.053	0.053
0.004	0.0080	0.120	0.0237	0.9	1.65	23.1	4.84	10685	594	0.198	0.209	0.067	0.071
0.002	0.0084	0.150	0.0211	0.4	1.70	29.0	3.72	13018	594	0.141	0.128	0.056	0.059
0.002	0.0078	0.143	0.0172	0.4	1.53	28.1	3.42	14757	594	0.121	0.122	0.055	0.055
0.003	0.0071	0.148	0.0142	0.5	1.38	29.3	3.43	14212	594	0.095	0.117	0.048	0.047
0.005	0.0071	0.108	0.0281	1.1	1.45	21.2	6.76	12853	594	0.261	0.319	0.066	0.069
0.005	0.0069	0.148	0.0158	0.9	1.38	29.5	3.44	13907	592	0.107	0.116	0.047	0.047
0.005	0.0071	0.126	0.0116	0.9	1.39	25.6	2.22	13804	594	0.092	0.087	0.056	0.055
0.006	0.0072	0.131	0.0205	1.1	1.45	23.5	3.68	13309	594	0.157	0.157	0.055	0.062
0.007	0.0070	0.150	0.0220	1.4	1.42	26.1	5.22	11979	594	0.146	0.199	0.046	0.054
0.005	0.0078	0.117	0.0238	1.0	1.55	19.2	4.88	13118	594	0.204	0.254	0.067	0.080
0.006	0.0077	0.141	0.0233	1.0	1.46	21.7	3.55	12793	594	0.165	0.163	0.055	0.067
0.007	0.0079	0.141	0.0287	1.1	1.51	17.9	4.95	12793	594	0.204	0.277	0.056	0.084
0.008	0.0082	0.125	0.0250	1.2	1.56	18.8	3.36	11791	594	0.200	0.179	0.066	0.083
0.007	0.0084	0.159	0.0254	0.9	1.61	27.2	3.74	11545	594	0.160	0.138	0.053	0.059
0.005	0.0082	0.131	0.0267	0.4	1.58	20.6	4.35	10996	594	0.203	0.211	0.062	0.077
0.006	0.0089	0.117	0.0241	0.5	1.64	21.0	4.65	9228	594	0.206	0.221	0.076	0.078
0.006	0.0098	0.113	0.0335	0.3	1.65	18.8	5.86	7187	594	0.297	0.311	0.086	0.088
0.004	0.0107	0.110	0.0327	-0.2	1.93	18.2	6.24	7432	594	0.298	0.342	0.097	0.106
0.004	0.0107	0.133	0.0501	-0.2	1.86	20.9	10.65	8021	594	0.378	0.510	0.081	0.089
0.005	0.0144	0.103	0.0362	-0.2	2.45	13.7	6.57	4890	594	0.352	0.478	0.140	0.178
0.005	0.0123	0.176	0.0487	-0.3	2.03	20.5	6.59	6634	594	0.277	0.322	0.070	0.099
0.002	0.0123	0.137	0.0301	-1.1	1.87	20.6	6.72	6704	594	0.219	0.326	0.090	0.091
0.003	0.0140	0.120	0.0304	-0.8	2.17	16.9	5.54	2744	594	0.254	0.327	0.117	0.128
0.010	0.0168	0.110	0.0260	0.4	2.70	13.6	3.89	2925	594	0.236	0.287	0.152	0.199
0.009	0.0147	0.137	0.0342	-0.2	2.18	18.4	5.78	1995	594	0.249	0.314	0.107	0.119
0.008	0.0216	0.132	0.0486	-0.7	3.07	18.9	8.22	923	592	0.370	0.435	0.164	0.162
-0.006	0.0133	0.132	0.0244	-2.4	2.22	21.0	3.82	533	594	0.184	0.182	0.101	0.106
-0.005	0.0144	0.107	0.0210	-2.4	2.36	13.6	2.94	475	594	0.196	0.216	0.134	0.173
0.000	0.0127	0.111	0.0253	-1.2	2.14	18.3	4.83	1047	593	0.227	0.264	0.114	0.117
-0.003	0.0120	0.109	0.0328	-2.0	1.96	13.4	7.29	632	594	0.300	0.543	0.110	0.146
0.004	0.0115	0.132	0.0407	-0.9	1.85	16.0	5.81	1207	594	0.308	0.364	0.087	0.116
0.000	0.0121	0.127	0.0427	-1.3	1.92	15.7	6.82	964	593	0.336	0.433	0.096	0.122
-0.002	0.0101	0.137	0.0426	-1.6	1.73	16.8	6.18	933	594	0.310	0.367	0.074	0.103
-0.003	0.0098	0.114	0.0505	-1.6	1.65	12.1	6.84	738	594	0.443	0.565	0.086	0.136
-0.003	0.0106	0.089	0.0323	-1.5	1.77	8.9	4.36	731	594	0.361	0.487	0.119	0.198
-0.008	0.0076	0.162	0.0287	-2.6	1.30	22.9	4.91	634	594	0.177	0.215	0.047	0.057
-0.008	0.0086	0.130	0.0314	-2.3	1.63	13.7	4.50	465	594	0.242	0.328	0.067	0.118
-0.006	0.0081	0.135	0.0435	-1.9	1.54	17.6	5.71	496	592	0.323	0.324	0.060	0.088
-0.006	0.0087	0.161	0.0385	-1.8	1.62	27.4	7.28	547	594	0.239	0.266	0.054	0.059
-0.003	0.0087	0.095	0.0218	-1.0	1.64	17.1	3.98	418	594	0.230	0.232	0.092	0.096
-0.001	0.0068	0.147	0.0215	-0.8	1.24	24.2	4.69	545	593	0.147	0.194	0.046	0.051
-0.003	0.0086	0.157	0.0333	-1.0	1.61	25.2	4.66	620	593	0.212	0.185	0.055	0.064
-0.001	0.0065	0.147	0.0337	-0.4	1.25	22.8	5.41	977	594	0.229	0.238	0.044	0.055
0.000	0.0052	0.125	0.0630	0.0	1.06	18.2	11.08	2795	594	0.506	0.607	0.042	0.058
-0.001	0.0062	0.104	0.0254	-0.3	1.21	20.1	4.57	2129	594	0.245	0.227	0.060	0.060
0.000	0.0066	0.093	0.0253	-0.2	1.26	16.1	6.56	4645	594	0.273	0.408	0.071	0.079
0.001	0.0067	0.172	0.0240	0.1	1.30	29.7	3.40	3519	594	0.139	0.115	0.039	0.044
0.002	0.0058	0.138	0.0150	0.2	1.15	28.0	3.39	4941	594	0.109	0.121	0.042	0.041
0.003	0.0072	0.108	0.0094	0.5	1.46	20.8	1.90	5059	594	0.087	0.091	0.067	0.070
0.000	0.0058	0.111	0.0298	-0.1	1.16	19.2	6.81	6772	594	0.270	0.354	0.052	0.060
0.000	0.0060	0.112	0.0217	0.0	1.17	21.9	3.96	8969	594	0.193	0.181	0.053	0.054
0.001	0.0070	0.101	0.0330	-0.3	1.30	18.7	5.88	6311	594	0.327	0.314	0.069	0.069
-0.003	0.0072	0.120	0.0264	-0.8	1.44	21.4	5.22	9516	594	0.219	0.244	0.060	0.067
-0.002	0.0074	0.177	0.0145	-0.5	1.43	32.1	2.50	8923	594	0.082	0.078	0.042	0.044
0.002	0.0054	0.105	0.0231	0.4	1.12	16.8	4.01	8006	594	0.220	0.239	0.051	0.067
0.003	0.0063	0.101	0.0138	0.7	1.26	19.0	3.63	6917	594	0.137	0.192	0.062	0.067
0.002	0.0065	0.123	0.0125	0.3	1.31	24.7	2.63	6864	594	0.102	0.107	0.053	0.053
0.001	0.0063	0.146	0.0176	0.0	1.15	29.7	3.65	8945	594	0.120	0.123	0.043	0.039

Table. Test of 85 GHz tie-points. The columns are:
Di is mean distance from ice data to ice line (should be 0). (Emissivity)
Sdi is standard deviation of distance from ice points to ice line. (Emissivity)
Dw is mean distance from water points to ice line
Sdw is standard deviation of distance from water points to ice line. (Emissivity)
The following 4 columns are similar but for uncorrected Tb tie-points
NI and NW are number of observations of ice (C>0.96) and Water (selected areas in the North Atlantic and North Pacific) respectively
ei-w is standard deviation of ice-water distance scaled by ice-water distance (essentially uncertainty in ice concentration for water areas. Ti-w is similar for uncorrected brightness temperature data.
ei-i is standard deviation of ice-ice distance scaled by ice-water distance (essentially uncertainty in ice concentration at high concentrations) Ti-i is similar for uncorrected brightness temperatures.
The yellow/white sections each covers the 6 days of a calender month from January through December 1997.



0.101865, 0.190033

Ei-i vs. Ti-i, variability in ice concentration for each 5-day period, ice points only (85 GHz tiepoints)



0.307452, 0.595172

Ei-w vs. Ti-w, variability in ice concentration for each 5-day period, water points only (85 GHz tiepoints)

5.4 Mean value of all tiepoints

Month	19V	19H	22V	37V	37H	85V	85H	B1	B2									
1	0.6473	0.3696	0.6630	0.7208	0.4590	0.8375	0.6196	460.14	35.38	0.0162	0.0268	0.0204	0.0149	0.0308	0.0167	0.0449	12.15	3.58
2	0.6463	0.3685	0.6625	0.7181	0.4544	0.8349	0.6143	457.59	34.97	0.0135	0.0237	0.0169	0.0126	0.0279	0.0139	0.0394	11.27	3.41
3	0.6424	0.3623	0.6586	0.7163	0.4502	0.8347	0.6118	456.57	34.23	0.0121	0.0231	0.0161	0.0118	0.0290	0.0142	0.0421	11.80	3.51
4	0.6362	0.3520	0.6519	0.7126	0.4418	0.8343	0.6042	454.44	33.12	0.0114	0.0200	0.0158	0.0118	0.0265	0.0154	0.0424	9.53	2.71
5	0.6300	0.3439	0.6461	0.7103	0.4386	0.8348	0.6058	458.71	33.65	0.0077	0.0169	0.0126	0.0110	0.0276	0.0160	0.0457	11.70	3.09
6	0.6275	0.3378	0.6463	0.7074	0.4300	0.8389	0.6063	460.89	34.17	0.0072	0.0152	0.0138	0.0108	0.0247	0.0175	0.0466	11.44	3.00
7	0.6275	0.3383	0.6453	0.7105	0.4376	0.8432	0.6193	471.46	36.84	0.0074	0.0151	0.0145	0.0111	0.0252	0.0165	0.0446	11.72	3.12
8	0.6290	0.3430	0.6492	0.7093	0.4392	0.8411	0.6189	472.39	37.65	0.0093	0.0190	0.0178	0.0128	0.0290	0.0160	0.0459	12.99	3.30
9	0.6306	0.3474	0.6496	0.7090	0.4413	0.8367	0.6138	467.01	36.47	0.0118	0.0242	0.0198	0.0154	0.0366	0.0202	0.0561	15.43	3.98
10	0.6341	0.3544	0.6530	0.7113	0.4473	0.8366	0.6195	462.67	35.49	0.0125	0.0237	0.0208	0.0152	0.0340	0.0208	0.0561	12.99	3.43
11	0.6388	0.3584	0.6549	0.7155	0.4512	0.8360	0.6172	460.00	34.69	0.0111	0.0231	0.0161	0.0136	0.0338	0.0170	0.0496	14.58	3.96
12	0.6472	0.3702	0.6637	0.7208	0.4600	0.8386	0.6230	461.00	35.58	0.0155	0.0270	0.0201	0.0148	0.0326	0.0183	0.0491	12.97	3.76

Table 13. Mean value of all water points (corrected emissivities)

Month	19V	19H	22V	37V	37H	85V	85H	B1	B2									
1	0.9261	0.8604	0.9086	0.8551	0.8006	0.7684	0.7275	578.59	102.01	0.0088	0.0095	0.0103	0.0162	0.0157	0.0175	0.0165	9.77	0.75
2	0.9206	0.8548	0.9025	0.8453	0.7900	0.7629	0.7209	572.84	101.67	0.0073	0.0076	0.0085	0.0129	0.0122	0.0155	0.0141	7.30	0.54
3	0.9196	0.8537	0.9013	0.8432	0.7868	0.7651	0.7214	575.05	102.12	0.0055	0.0058	0.0063	0.0092	0.0086	0.0134	0.0118	5.01	0.71
4	0.9223	0.8562	0.9038	0.8468	0.7892	0.7734	0.7273	584.40	103.38	0.0068	0.0083	0.0082	0.0133	0.0133	0.0166	0.0152	8.89	0.75
5	0.9327	0.8675	0.9153	0.8648	0.8065	0.7898	0.7428	604.81	105.30	0.0079	0.0082	0.0090	0.0123	0.0119	0.0151	0.0155	8.62	0.78
6	0.9557	0.8947	0.9424	0.9063	0.8492	0.8175	0.7730	636.59	107.32	0.0103	0.0130	0.0120	0.0184	0.0198	0.0253	0.0251	10.90	0.98
7	0.9469	0.8839	0.9385	0.9168	0.8605	0.8613	0.8132	643.89	104.81	0.0089	0.0118	0.0107	0.0226	0.0258	0.0481	0.0517	12.31	1.81
8	0.9159	0.8476	0.9014	0.8512	0.7964	0.8048	0.7640	609.34	105.15	0.0259	0.0283	0.0324	0.0531	0.0534	0.0573	0.0579	28.38	1.78
9	0.8891	0.8236	0.8727	0.8228	0.7761	0.7805	0.7502	587.21	102.06	0.0175	0.0198	0.0219	0.0361	0.0368	0.0464	0.0456	19.89	0.94
10	0.9075	0.8396	0.8902	0.8377	0.7860	0.7551	0.7191	583.51	102.27	0.0168	0.0177	0.0189	0.0296	0.0289	0.0357	0.0343	14.83	0.88
11	0.9289	0.8624	0.9121	0.8627	0.8105	0.7727	0.7345	590.03	103.12	0.0129	0.0143	0.0148	0.0242	0.0243	0.0261	0.0255	12.57	0.57
12	0.9276	0.8614	0.9100	0.8563	0.8030	0.7650	0.7258	581.62	102.64	0.0089	0.0094	0.0104	0.0171	0.0163	0.0207	0.0192	9.70	0.85

Table 14. Mean value of all ice points (corrected emissivities)

5.5 Minimum water tiepoints (Tb)

Monthly mean of all water points. (Only data from days 01, 06, 11, 16, 21, 26 of the months are used.

Definition of water points in the North Atlantic and the North Pacific:

```
      if(lat.gt.67..and.lat.lt.77..and.lon1.gt.0..and.lon1.lt.10.) iwx=1
      if(lat.gt.60..and.lat.lt.63..and.lon1.gt.-36..and.lon1.lt.-22.) iwx=1
      if(lat.gt.53..and.lat.lt.56..and.lon1.gt.-180..and.lon1.lt.-170.) iwx=1
```

Month	19V	19H	22V	37V	37H	85V	85H
1	178.74	105.17	187.09	202.52	136.47	233.50	179.76
2	178.55	104.67	187.03	202.07	135.23	233.21	179.21
3	178.75	105.02	187.30	202.33	135.49	233.58	179.68
4	178.38	104.33	187.71	202.40	135.35	234.20	179.75
5	176.34	103.42	187.75	199.73	133.04	232.81	180.45
6	177.90	105.78	191.36	200.77	134.54	235.57	185.88
7	183.27	111.06	200.34	205.66	138.90	243.54	197.19
8	183.13	110.89	200.03	205.29	138.44	243.15	195.93
9	181.25	108.89	195.35	204.04	137.80	239.84	190.79
10	180.21	107.93	192.33	203.54	137.83	237.70	188.37
11	179.68	106.85	189.36	203.17	137.51	235.26	183.82
12	179.38	106.59	188.41	202.90	137.71	234.17	182.34

Table 1. 1% percentile

Month	19V	19H	22V	37V	37H	85V	85H
1	179.76	106.98	188.26	203.37	138.76	234.17	183.01
2	179.36	106.48	188.15	202.71	137.58	233.57	182.07
3	179.38	106.62	188.64	202.80	137.47	234.11	182.33
4	179.27	106.16	188.69	203.03	137.48	234.91	182.98
5	176.89	104.81	188.56	200.42	135.10	233.60	183.67
6	178.55	107.18	192.54	201.43	136.37	236.60	189.33
7	183.93	112.68	201.65	206.62	141.36	244.85	201.12
8	184.00	112.51	201.45	206.26	140.58	244.79	200.28
9	182.22	110.63	197.28	204.87	139.76	241.26	194.50
10	180.94	109.31	193.77	204.29	139.53	238.99	191.70
11	180.48	108.34	190.88	203.92	139.47	236.48	187.10
12	180.37	108.44	189.55	203.93	139.86	234.95	185.16

Table 2. 5% percentile

Month	19V	19H	22V	37V	37H	85V	85H
1	180.37	108.46	188.94	203.92	140.51	234.68	185.34
2	180.05	107.76	188.91	203.31	139.05	234.08	183.69
3	179.99	107.74	189.41	203.42	139.07	234.52	184.44
4	179.61	106.77	189.38	203.56	138.55	235.38	184.56
5	177.39	105.78	189.40	200.99	136.43	234.25	185.94
6	178.95	108.07	193.23	201.90	137.68	237.58	192.06
7	184.48	113.43	202.39	207.50	142.93	246.11	204.39
8	184.55	114.13	202.43	206.98	143.08	245.69	204.11
9	182.90	111.91	198.44	205.57	141.24	242.16	197.54
10	181.52	110.63	194.42	204.83	141.44	239.36	193.91
11	181.01	109.42	191.82	204.47	140.87	237.25	189.57
12	180.89	109.35	190.36	204.34	141.19	235.58	187.05

Table 3. 10% percentile

Month	19V	19H	22V	37V	37H	85V	85H
1	178.64	104.99	186.88	202.45	136.32	233.25	179.34
2	178.39	104.43	186.97	201.92	134.87	233.02	178.81
3	178.62	104.82	187.17	202.19	135.18	233.48	179.35
4	178.28	104.04	187.51	202.30	134.89	234.17	179.44
5	179.27	105.03	190.77	203.03	135.03	236.61	183.09
6	180.80	107.42	194.46	204.08	136.62	239.43	188.71
7	183.16	110.97	200.17	205.51	138.71	243.30	196.87
8	183.06	110.74	199.89	205.22	138.18	243.02	195.45
9	181.20	108.69	195.26	203.85	137.31	239.75	190.27
10	180.08	107.73	192.01	203.32	137.54	237.56	188.06
11	179.47	106.52	189.01	203.11	137.07	235.21	183.75
12	179.23	106.33	188.15	202.92	137.30	234.16	181.89

Table 4. 0-1% percentile

Month	19V	19H	22V	37V	37H	85V	85H
1	179.21	106.02	187.63	202.99	137.65	233.81	181.37
2	178.95	105.57	187.63	202.39	136.37	233.34	180.38
3	179.02	105.68	188.07	202.53	136.36	233.85	180.95
4	178.80	105.09	188.25	202.74	136.26	234.70	181.41
5	179.62	105.82	191.37	203.46	136.21	237.18	185.08
6	181.17	108.26	195.12	204.53	137.84	240.16	190.99
7	183.55	111.83	200.83	206.13	140.23	244.17	199.29
8	183.51	111.71	200.67	205.77	139.62	243.86	198.01
9	181.76	109.80	196.34	204.43	138.70	240.54	192.62
10	180.61	108.68	193.01	203.81	138.69	238.31	189.98
11	180.00	107.46	190.17	203.52	138.36	236.02	185.60
12	179.88	107.38	189.14	203.33	138.51	234.69	183.63

Table 5. 1-5% percentile

6. Format of collocation files

1	lat	Latitude
2	lon	Longitude
3	e19V	(Calculated emissivity from SSM/I measurements and 24H avg. ECMWF data)
4	e19H	(Calculated emissivity from SSM/I measurements and 24H avg. ECMWF data)
5	e22V	(Calculated emissivity from SSM/I measurements and 24H avg. ECMWF data)
6	e37V	(Calculated emissivity from SSM/I measurements and 24H avg. ECMWF data)
7	e37H	(Calculated emissivity from SSM/I measurements and 24H avg. ECMWF data)
8	e85V	(Calculated emissivity from SSM/I measurements and 24H avg. ECMWF data)
9	e85H	(Calculated emissivity from SSM/I measurements and 24H avg. ECMWF data)
10	T2(i,j)/270.,	(ECMWF 2m temp normalized by 270K)
11	wind	(ECMWF)
12	cice	(Nasa Team ice conc calculated from Tb data)
13	xwv	(ECMWF)
14	xclw	(ECMWF)
15	tau 19	(Wentz SSM/I model)
16	tau 22	(Wentz SSM/I model)
17	tau 37	(Wentz SSM/I model)
18	tau 85	(Wentz AMSR model)
19	R3785	(Bremen algorithm – useless in this form)
20	Tb19V	(SSM/I data from NSIDC CD)
21	Tb19H	(SSM/I data from NSIDC CD)
22	Tb22V	(SSM/I data from NSIDC CD)
23	Tb37V	(SSM/I data from NSIDC CD)
24	Tb37H	(SSM/I data from NSIDC CD)
25	Tb85V	(SSM/I data from NSIDC CD)
26	Tb85H	(SSM/I data from NSIDC CD)
27	TDN 19	(Wentz SSM/I model)
28	TDN 22	(Wentz SSM/I model)
29	TDN 37	(Wentz SSM/I model)
30	TDN 85	(Wentz AMSR model)
31	cice1	(ECMWF ice conc)
32	tskin	(ECMWF skin temp)
33	T2	(ECMWF 2 m temp)

Table 1. List of columns in YYYYMMDD.emiss file. (Output file from emissivity analysis (readtb.f))

7. Software listing –

7.1 emissivity calculations (readtb.f):

```
      integer date(7)
      real tb(22),tbmean(22),n(22)
      real Wu(320,161),Wv(320,161),T2(320,161),MSL(320,161)
      real TWC(320,161),PWC(320,161),ST(320,161),CI(320,161)
      real lat,lon,line,smpl,lon1
      real*8 tbs(7),e(7),taus(7),tbds(7)
      real wind,windu,windv,wv1,wv2,tskin,cice,clw,wvap
      integer*4 indx
      integer*2 array(104912),mask(316,332),ii(2)
c
c     ****** read mask ******

      open(12, file='landmask.stb',
     &     recl=209824, access='direct',form='unformatted',err=999)
      read(12,rec=1,err=999) (array(k), k=1,104912)
 174  continue
      do 2002 k=1,104912
         ii(1)=array(k)
         m=mod(k-1,316)+1
         l=(k-m-1)/316+1
         mask(m,l)=ii(1)
 2002 continue

c      do 2003 k=1,332
c         write(36,2004) (mask(i,k),i=1,316)
c 2003 continue
c 2004 format(316i4)
c      write(6,*) 'mask read'
c
c     ****** Initialize met data arrays ******
c
      call readmet(Wu,Wv,T2,MSL,TWC,PWC,ST,CI)
c
c     ****** read Tb data line ******
c
      open(15,file='dumpTb')


 100  continue

      read(15,*,end=999) (date(i),i=1,4),indx,line,smpl,(tb(j),j=1,22)
      il=ifix(line)
      is=ifix(smpl)
      if(mask(is,il).gt.1) goto 100
      tbs(1)=tb(7)
      tbs(2)=tb(8)
      tbs(3)=tb(9)
      tbs(4)=tb(11)
      tbs(5)=tb(12)
      tbs(6)=tb(13)
      tbs(7)=tb(18)
c
c     ****** locate Tb data in met grid (tested OK!) ******
c
c      call locate(2,2,1,smpl,line,lat,lon)
      call locate(2,2,1,line,smpl,lat,lon)
      lon1=lon
      if(lon.gt.180.) lon=lon-360

      j=ifix((90.-lat)/1.125)+1
      i=ifix((lon+180.)/1.125)+1
c      write(6,*) lat,lon,line,smpl,i,j
c
c     ****** extract met parameters at location ******
c
      windu=Wu(i,j)
      windv=Wv(i,j)
      wind=sqrt(wundu**2+windv**2)
      wv1=TWC(i,j)
      wv2=PWC(i,j)
      tskin=T2(i,j)
      cice=CI(i,j)
      xclw=wv1-wv2
```

```
      xwv =wv2
      x3785=((e(4)-e(5))/(e(6)-e(7)))
      if(x3785.gt.0.) R3785=log(x3785)+0.3
c
c     ****** calculate emissivities ******
c
      wvap=xwv
c      clw=xclw
      clw=0.

      call emiss(tbs,wind,wvap,clw,tskin,cice,e,taus,tbds)
      if(taus(1).gt.0.955.and.cice.gt.0.9) write(27,120) lat,lon,
     &     (e(i),i=1,7),R3785
c      if(cice.lt.0.005) goto 100
      do 117 k=1,5
      if(e(k).lt.0.1.or.e(k).gt.1.1) goto 100
      if(R3785.lt.-5.or.R3785.gt.5.) goto 100
      if(x3785.le.0.) goto 100
 117  continue
c
c     ****** write out result ******
c
      write(6,120) lat,lon1,(e(k),k=1,7),T2(i,j)/272.,wind,cice,xwv,
     &     xclw,taus(1),taus(3),taus(5),taus(7),R3785,tb(7),tb(8),tb(9),
     &     tb(11),tb(12),tb(13),tb(18),tbds(1),tbds(3),tbds(5),tbds(7)
c      write(26,120) iys,ims,ids,juls,Tbds(1),tau(1),tau(2),tau(3),ts
 120  format(2f9.2,2x,7f8.4,2x,f8.3,f6.1,f6.2,f6.1,f6.3,2x,4f7.3,f7.2,
     &     2x,7f7.1,2x,4f6.1)

      write(36,320) lat,lon1,tb(7),tb(8),tb(9),tb(11),tb(12),
     &     tb(13),tb(18)
 320  format(2f9.2,7f10.3)
      if(e(3).lt.0.8) goto 100
      if(e(6).gt.0.8) goto 100
      write(37,120) lat,lon1,(e(k),k=1,7),T2(i,j)/272.,wind,cice,xwv,
     &     xclw,taus(1),taus(3),taus(5),taus(7),R3785,tb(7),tb(8),tb(9),
     &     tb(11),tb(12),tb(13),tb(18),tbds(1),tbds(3),tbds(5),tbds(7)
      goto 100

 999  continue
      stop
      end


      Subroutine readmet(Wu,Wv,T2,MSL,TWC,PWC,ST,CI)

      real Wu(320,161),Wv(320,161),T2(320,161),MSL(320,161)
      real TWC(320,161),PWC(320,161),ST(320,161),CI(320,161)

      real windu(320,161),windv(320,161),t2m(320,161)
      real wind(320,161),mslp(320,161),wvap(320,161)
      real clw(320,161),tsurf(320,161),ice(320,161)
c
c     ****** clear biffers ******
c
      do 101 l=1,161
         do 100 m=1,320
            Wu(320,161)=0.
            Wv(320,161)=0.
            T2(320,161)=0.
            MSL(320,161)=0.
            TWC(320,161)=0.
            PWC(320,161)=0.
            ST(320,161)=0.
            CI(320,161)=0.
 100     continue
 101  continue
      open(16,file='dumpMet')

c
c     ****** read and average data (8 sets of each) ******
c

      do 150 k=1,8
c
c     ****** Wind u ******
c
      read(16,*) n1,n2
      do 110 l=1,161
            read(16,*) (windu(m,l),m=1,320)
```

```
 110  continue
      do 1102 l=1,161
         do 1101 m=1,320
            Wu(m,l)=Wu(m,l)+windu(m,l)/8.
 1101    continue
 1102 continue
c
c     ****** Wind v ******
c
      read(16,*) n1,n2
      do 111 l=1,161
            read(16,*) (windv(m,l),m=1,320)
 111  continue
      do 1112 l=1,161
         do 1111 m=1,320
            Wv(m,l)=Wv(m,l)+windv(m,l)/8.
 1111    continue
 1112 continue
c
c     ****** T2m ***
c
      read(16,*) n1,n2
      do 112 l=1,161
            read(16,*) (t2m(m,l),m=1,320)
 112  continue
      do 1122 l=1,161
         do 1121 m=1,320
            T2(m,l)=T2(m,l)+t2m(m,l)/8.
 1121    continue
 1122 continue
c
c     ****** mslp ******
c
      read(16,*) n1,n2
      do 113 l=1,161
            read(16,*) (mslp(m,l),m=1,320)
 113  continue
      do 1132 l=1,161
         do 1131 m=1,320
            MSL(m,l)=MSL(m,l)+mslp(m,l)/8.
 1131    continue
 1132 continue
c
c     ****** TWC ******
c
      read(16,*) n1,n2
      do 114 l=1,161
            read(16,*) (wvap(m,l),m=1,320)
 114  continue
      do 1142 l=1,161
         do 1141 m=1,320
            TWC(m,l)=TWC(m,l)+wvap(m,l)/8.
 1141    continue
 1142 continue
c
c     ****** PWC ******
c
      read(16,*) n1,n2
      do 115 l=1,161
            read(16,*) (clw(m,l),m=1,320)
 115  continue
      do 1152 l=1,161
         do 1151 m=1,320
            PWC(m,l)=PWC(m,l)+clw(m,l)/8.
 1151    continue
 1152 continue
c
c     ****** ST (skin temp) ******
c
      read(16,*) n1,n2
      do 116 l=1,161
            read(16,*) (tsurf(m,l),m=1,320)
 116  continue
      do 1162 l=1,161
         do 1161 m=1,320
            ST(m,l)=ST(m,l)+tsurf(m,l)/8.
 1161    continue
 1162 continue
c
c     ****** ST (skin temp) ******
```

```
c
      read(16,*) n1,n2
      do 117 l=1,161
            read(16,*) (ice(m,l),m=1,320)
 117  continue
      do 1172 l=1,161
         do 1171 m=1,320
            CI(m,l)=CI(m,l)+ice(m,l)/8.
 1171    continue
 1172 continue




 150  continue

      return
      end


        subroutine locate(gtype,ihem,itrans,si,sj,lat,lon)
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c
c LOCATE - This program transforms I,J coordinates of an SSM/I grid cell
c          to latitude and longitude coordinates. This program provides
c          the inverse functions as well. LOCATE interfaces to the revised
c          forms of the subroutines, MAPXY and MAPLL.
c
c  User-defined Paramters:
c
c     gtype   : Integer supplied by the user to describe one of the two
c               grid cell dimensions (1=12.5 km, 2=25.0 km).
c
c     ihem    : Integer supplied by the user to describe one of the two
c               polar regions (1=North , 2=South)
c
c     itrans  : Integer supplied by the user to describe the type of
c               transformation LOCATE will perform (1=I,J-to-Lat,Lon;
c               2=Lat,Lon-to-I,J)
c
c     i,j     : Integers supplied by the user when itrans = 1. These
c               integers describe the position of a cell in an SSM/I grid.
c
c     lat,lon : Reals supplied by the user when itrans = 2. These
c               integers describe the latitude and longitude in an SSM/I
c               grid which LOCATE will transform to an I,J grid cell position.
c               Note: All latitudes and longitudes must be entered as
c                     positive numbers!
c
c  Internal:
c
c     x,y     : Distance in kilometers from the origin of the grid
c               (ie., pole).
c
c     alat,
c     alon    : Computed latitude and longitude returned from MAPXY.
c
c     SGN     : Sign of the latitude (positive = north latitude,
c               negative = south latitude)
c
c     delta   : Meridian offset for the SSM/I grids (0 degrees for
c               the South Polar grids; 45 degrees for the North Polar
c               grids.
c
c     kk      : Integer variable used for reorientation of the grid. The
c               grid is 'flipped' in the Y direction for transformations.
c
c     SLAT    : Standard latitude for the SSM/I grids is 70 degrees.
c
c     numy    : Number of lines in an SSM/I grid. This attribute varies
c               for each of the six grids.
c
c     cell    : Size of the SSM/I grid ( 12.5 km, 25.0 km)
c
c     xydist  : Distance from the origin of the grid in the cartesian plane.
c               The x-y coordinates for the edge of the lower left pixel
c               is (3850.0, 5350.0) for the northern grids and
c               (3950.0, 3950.0) for the southern grids.
c
c     RE      : Radius of the earth in kilometers.
```

```
c
c     E       : Eccentricity of the Hughes ellipsoid
c
c     E2      : Eccentricity squared
c
c     PI      : Pi
c  Written by  V.J.Troisi - January, 1990
c  Updated by  N.A.Sandoval - November, 1995 - Switched i,j in the
c              equation to be consistent i-row, j-column.
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc


        real SLAT,E,RE,PI
        real alat,alon,x,y,si,sj,skk
        integer ihem,gtype
        real lat, lon
        real SGN, delta
        integer numy(2,3)
        real cell(2), xydist(2,2)
        data numy / 896, 664, 448, 332, 224, 166 /
        data cell     / 12.5 , 25.0 /
        data xydist   / 3850.0 , 5350.0 , 3950.0 , 3950 /

        SLAT = 70.
        RE = 6378.273
        E2 = .006693883
        PI = 3.141592654
        E =  sqrt(E2)
c
c
c Define the sign and meridian offset (delta) for the SSM/I grids.
c
        if (ihem.eq.1) then
           SGN   = 1.0
           delta = 45.
        else
           SGN   = -1.0
           delta = 0.0
        endif
c
c Start translation
c
        if (itrans.eq.1) then
c
c
c Convert I,J pairs to x and y distances from origin. For some image
c display programs, the grid will be 'flipped' in the 'Y' direction.
c+
c Changed j for i and i for j to be consistant, NAS (11/95).
c-
             x=((sj-1.)*cell(gtype))-(xydist(1,ihem)-cell(gtype)/2.)
             skk=numy(ihem,gtype)-(si-1.)
             y=((skk-1.)*cell(gtype))-(xydist(2,ihem)-cell(gtype)/2.)
c
c Transform x and y distances to latitude and longitude
c
c             write(6,*) si,sj,x,y
             call mapxy (x,y,alat,alon,SLAT,SGN,E,RE)
c
c Transform radians to degrees.
c
             alon=alon*180./PI
             alat=alat*180./PI
             alon=alon-delta
c
c Convert longitude to positive degrees
c
             if (alon.le.0.0) alon=alon+360.
             if (alon.ge.360.0) alon=alon-360.
c
             lat=alat
             lon=alon
c
c Print the latitude and longitude for the center of the I,J cell.
c
c             print *,alat,alon
       else
c
c Obtain the latitude and longitude pair and transform to cell where
c that pair is located.
```

```
c
c             print *,'Enter latitude and longitude (positive values):'
c             read *,lat,lon
c
c Transform degrees to radians
c
             alat=abs(lat)*PI/180.
             alon=(lon+delta)*PI/180.
c
c Transform latitude and longitude to x and y distances from origin
c
           call mapll (x,y,alat,alon,SLAT,SGN,E,RE)
c
c Convert x and y distances from origin to I,J pair (ii,jj)
c
             si=(x+xydist(1,ihem)-cell(gtype)/2.)/cell(gtype)+1.
             sj=(y+xydist(2,ihem)-cell(gtype)/2.)/cell(gtype)+1.
c
c Flip grid orientation in the 'Y' direction
c
             skk=numy(ihem,gtype)-(sj-1)
c
c Print the I,J location of the cell.
c
c             print *,ii,kk
             sj=si
             si=skk
          endif
      end

      SUBROUTINE MAPLL (X,Y,ALAT,ALONG,SLAT,SGN,E,RE)
C$*****************************************************************************
C$                                                                            *
C$                                                                            *
C$    DESCRIPTION:                                                            *
C$                                                                            *
C$    This subroutine converts from geodetic latitude and longitude to Polar  *
C$    Stereographic (X,Y) coordinates for the polar regions.  The equations   *
C$    are from Snyder, J. P., 1982,  Map Projections Used by the U.S.         *
C$    Geological Survey, Geological Survey Bulletin 1532, U.S. Government     *
C$    Printing Office.  See JPL Technical Memorandum 3349-85-101 for further  *
C$    details.                                                                *
C$                                                                            *
C$                                                                            *
C$    ARGUMENTS:                                                              *
C$                                                                            *
C$    Variable    Type        I/O    Description                              *
C$                                                                            *
C$    ALAT       REAL*4        I     Geodetic Latitude (degrees, +90 to -90)  *
C$    ALONG      REAL*4        I     Geodetic Longitude (degrees, 0 to 360)   *
C$    X          REAL*4        O     Polar Stereographic X Coordinate (km)    *
C$    Y          REAL*4        O     Polar Stereographic Y Coordinate (km)    *
C$                                                                            *
C$                                                                            *
C$                  Written by C. S. Morris - April 29, 1985                  *
C$                  Revised by C. S. Morris - December 11, 1985               *
C$                                                                              *
C$                  Revised by V. J. Troisi - January 1990                    *
C$                  SGN - provides hemisphere dependency (+/- 1)              *
C$                 Revised by Xiaoming Li - October 1996                     *
C$                 Corrected equation for RHO                                *
C$*****************************************************************************
      REAL*4 X,Y,ALAT,ALONG,E,E2,CDR,PI,SLAT,MC
C$*****************************************************************************
C$                                                                            *
C$    DEFINITION OF CONSTANTS:                                                *
C$                                                                            *
C$    Conversion constant from degrees to radians = 57.29577951.              *
      CDR=57.29577951
      E2=E*E
C$    Pi=3.141592654.                                                         *
      PI=3.141592654
C$                                                                            *
C$*****************************************************************************
C     Compute X and Y in grid coordinates.
      IF (ABS(ALAT).LT.PI/2.) GOTO 250
      X=0.0
      Y=0.0
      GOTO 999
  250 CONTINUE
```

```
      T=TAN(PI/4.-ALAT/2.)/((1.-E*SIN(ALAT))/(1.+E*SIN(ALAT)))**(E/2.)
      IF (ABS(90.-SLAT).LT.1.E-5) THEN
      RHO=2.*RE*T/((1.+E)**(1.+E)*(1.-E)**(1.-E))**(1/2.)
      ELSE
      SL=SLAT*PI/180.
      TC=TAN(PI/4.-SL/2.)/((1.-E*SIN(SL))/(1.+E*SIN(SL)))**(E/2.)
      MC=COS(SL)/SQRT(1.0-E2*(SIN(SL)**2))
      RHO=RE*MC*T/TC
      END IF
      Y=-RHO*SGN*COS(SGN*ALONG)
      X= RHO*SGN*SIN(SGN*ALONG)
  999 CONTINUE
      END


      SUBROUTINE MAPXY (X,Y,ALAT,ALONG,SLAT,SGN,E,RE)
C$*****************************************************************************
C$                                                                            *
C$                                                                            *
C$    DESCRIPTION:                                                            *
C$                                                                            *
C$    This subroutine converts from Polar Stereographic (X,Y) coordinates     *
C$    to geodetic latitude and longitude for the polar regions. The equations *
C$    are from Snyder, J. P., 1982,  Map Projections Used by the U.S.         *
C$    Geological Survey, Geological Survey Bulletin 1532, U.S. Government     *
C$    Printing Office.  See JPL Technical Memorandum 3349-85-101 for further  *
C$    details.                                                                *
C$                                                                            *
C$                                                                            *
C$    ARGUMENTS:                                                              *
C$                                                                            *
C$    Variable    Type        I/O    Description                              *
C$                                                                            *
C$    X          REAL*4        I     Polar Stereographic X Coordinate (km)    *
C$    Y          REAL*4        I     Polar Stereographic Y Coordinate (km)    *
C$    ALAT       REAL*4        O     Geodetic Latitude (degrees, +90 to -90)  *
C$    ALONG      REAL*4        O     Geodetic Longitude (degrees, 0 to 360)   *
C$                                                                            *
C$                                                                            *
C$                  Written by C. S. Morris - April 29, 1985                  *
C$                  Revised by C. S. Morris - December 11, 1985               *
C$                                                                            *
C$                  Revised by V. J. Troisi - January 1990
C$                  SGN - provide hemisphere dependency (+/- 1)
C$
C$*****************************************************************************
      REAL*4 X,Y,ALAT,ALONG,E,E2,CDR,PI
C$*****************************************************************************
C$                                                                            *
C$    DEFINITION OF CONSTANTS:                                                *
C$                                                                            *
C$    Conversion constant from degrees to radians = 57.29577951.              *
c      write(6,*) 'xy ',x,y
      CDR=57.29577951
      E2=E*E
C$    Pi=3.141592654.                                                         *
      PI=3.141592654
C$                                                                            *
C$*****************************************************************************
      SL = SLAT*PI/180.
  200 RHO=SQRT(X**2+Y**2)
      IF (RHO.GT.0.1) GOTO 250
      ALAT=90.*SGN
      ALONG=0.0
      GOTO 999
  250 CM=COS(SL)/SQRT(1.0-E2*(SIN(SL)**2))
      T=TAN((PI/4.0)-(SL/(2.0)))/((1.0-E*SIN(SL))/
     C(1.0+E*SIN(SL)))**(E/2.0)
      IF (ABS(SLAT-90.).LT.1.E-5) THEN
      T=RHO*SQRT((1.+E)**(1.+E)*(1.-E)**(1.-E))/2./RE
      ELSE
      T=RHO*T/(RE*CM)
      END IF
      CHI=(PI/2.0)-2.0*ATAN(T)
      ALAT=CHI+((E2/2.0)+(5.0*E2**2.0/24.0)+(E2**3.0/12.0))*SIN(2*CHI)+
     C((7.0*E2**2.0/48.0)+(29.0*E2**3/240.0))*SIN(4.0*CHI)+
     C(7.0*E2**3.0/120.0)*SIN(6.0*CHI)
      ALAT=SGN*ALAT
      ALONG=ATAN2(SGN*X,-SGN*Y)
      ALONG=SGN*ALONG
```

```
c       write(6,*) 'xy ',alat,along
  999 CONTINUE
      END
C
C
      subroutine emiss(tbs,wind,twv,xclw,Ts,cice,e,taus,tbds)
c-----------------------------------------------------------------------
c
c     Calculate emissivities at SSM/I frequencies from Tbs and ECMWF data
c
c     Tbs(5)  real*8     ssmi measurements (19v,19h,22v,37v,37h)
c     wind    real       wind speed
c     twv     real       total water vapour content
c     xclw    real       liquid water water
c     Ts      real       surface temperature
c     cice    real       total ice concentration
c     e(5)    real*8     emissivities (19v,19h,22v,37v,37h)
c     tau(3)  real*8     atmospheric opacity (19,22,37)
c     tbd(3)  real*8     downwelling temp (19,22,37)
c
c-----------------------------------------------------------------------
c
      real*8 tbd(3),tau(3),tbs(5),Tbu(3)
      real*8 tbds(7),taus(7),e(7),Tbus(7)
      real*8 tbda(8),taua(8),Tbua(8)
      real tb(6)
      real sst,wind,wv,wliq,windu,windv,mslp,t2m,twv,xclw
      real cice
      integer iy,im,id,jul
      integer iys,ims,ids,juls
      teta=53.


 100  continue

      wliq=xclw
      wv=twv
c
c     ****** radiative transfer model ******
c
      call ssmimodel(Ts,wind,wv,wliq,teta,tb,tau,Tbd,Tbc,Tbu)
c      write(6,*) 'aaa',Ts,wind,wv,wliq,tau(1)
      call amsrmodel(Ts,wind,wv,wliq,teta,tba,taua,tbda,tbca,Tbua)
      taus(1)=tau(1)
      taus(2)=tau(1)
      taus(3)=tau(2)
      taus(4)=tau(3)
      taus(5)=tau(3)
      taus(6)=taua(8)
      taus(7)=taua(8)

      tbds(1)=tbd(1)
      tbds(2)=tbd(1)
      tbds(3)=tbd(2)
      tbds(4)=tbd(3)
      tbds(5)=tbd(3)
      tbds(6)=tbda(8)
      tbds(7)=tbda(8)

      Tbus(1)=Tbu(1)
      Tbus(2)=Tbu(1)
      Tbus(3)=Tbu(2)
      Tbus(4)=Tbu(3)
      Tbus(5)=Tbu(3)
      Tbus(6)=Tbua(8)
      Tbus(7)=Tbua(8)
c
c     ****** NANSEN paper emissive temp ******
c
      Tsx=0.6*272.1+0.4*Ts
c
c     ****** calculate emissivities ******
c
      do 110 n=1,7
         e(n)=-1.
         if(tbs(n).lt.50) goto 110
         e(n)=(tbs(n)-Tbus(n))/taus(n) - Tbds(n)-taus(n)*Tbc
         e(n)=e(n)/(Tsx-Tbds(n)-taus(n)*Tbc)
 110  continue
c      write(46,120) iys,ims,ids,juls,(e(i),i=1,5)
```

```
      if(e(1).lt.0.) goto 200
      write(26,120) tb(1),tbs(1),tbds(1),Tbus(1),taus(1),e(1),tb(2),
     &     tbs(2),tbds(2),Tbus(2),taus(2),e(2),tb(3),tbs(3),tbds(3),
     &     Tbus(3),taus(3),e(3),Ts,wind,wv,wliq,cice,tsx,Tbc
c       if(tau(1).gt.0.955) write(27,120) iys,ims,ids,juls,(e(i),i=1,5)
 120  format(3(4f6.1,2f7.3,'        '),(3f7.1,2f8.3),2f7.1)

 200  continue
      return
      end


      subroutine ssmimodel(Ts,wind,wv,wliq,teta,tb,tau,Tbd,Tbc,Tbu)

      real Ts,wind,wv,wliq,tb(6),teta,sst

      real*8 al(3),av(3),Tu(3),Td(3),Tbu(3),Tbd(3),tau(3)
      real*8 Tv,Tl,ao(3),sigm2(3),omg(6),MM1(6),MM2(6),Ew(6)
      real*8 E(6),E0(6),sec

      real*8 eps0(6)/162.53,83.88,166.99,86.98,186.31,101.42/
      real*8 eps1(6)/-25.7E-2,-52.22E-2,-34.08E-2,-59.52E-2,
     &     -56.37E-2,-85.88E-2/
      real*8 eps2(6)/17.29E-3,18.76E-3,17.35E-3,19.38E-3,
     &     14.81E-3,20.76E-3/
      real*8 eps3(6)/-11.77E-5,-9.25E-5,-10.36E-5,-8.99E-5,
     &     -2.96E-5,-7.07E-5/
      real*8 eps4(6)/21.62E-1,-14.72E-1,21.64E-1,-15.15E-1,
     &     21.23E-1,-17.01E-1/
      real*8 eps5(6)/.7E-2,.21E-2,.75E-2,.3E-2,1.17E-2,0.55E-2/
      real*8 eps6(6)/.045,-.016,.045,-.016,.041,-.019/
      real*8 eps7(6)/.14E-4,-1.1E-4,0.02E-4,-1.17E-4,-0.71E-4,-1.27E-4/
      real*8 beta(6)/-0.81E-4,.81E-4,-.87E-4,.87E-4,-1.19E-4,1.05E-4/
      real*8 mju(6)/0.41E-5,-0.13E-5,0.54E-5,-0.16E-5,1.25E-5,-0.29E-5/
      real*8 m1(6)/.46E-3,3.01E-3,.34E-3,3.2E-3,-0.09E-3,3.91E-3/
      real*8 m2(6)/3.78E-3,7.5E-3,3.48E-3,7.39E-3,2.38E-3,7.E-3/
      real*8 offs(6)/.78,2.1,0.78,0.,-1.68,0.13/

      real*8 c0(3)/240.58,242.04,239.55/
      real*8 c1(3)/305.96E-2,297.16E-2,248.15E-2/
      real*8 c2(3)/-764.41E-4,-769.38E-4,-438.59E-4/
      real*8 c3(3)/885.95E-6,931.80E-6,278.71E-6/
      real*8 c4(3)/-40.8E-7,-44.85E-7,-3.23E-7/
      real*8 c5(3)/0.6,0.2,0.6/
      real*8 c6(3)/-0.16,-0.15,-0.57/
      real*8 c7(3)/-2.13E-2,-7.51E-2,-2.61E-2/
      real*8 a0(3)/11.8,13.01,28.1/
      real*8 av1(3)/2.23E-3, 6.16E-3, 1.85E-3/
      real*8 av2(3)/0.0E-5,  0.67E-5, 0.17E-5/
      real*8 eta(3)/0.688,0.739,1./

      sec=1./cos(teta/57.2957795)
      sst=Ts

         Tl=(sst+273.)/2.
         al(3)=0.208*(1-0.026*(Tl-283))*wliq
         al(2)=0.3751*al(3)
         al(1)=0.2858*al(3)

         do 110 k=1,3
            av(k)=av1(k)*wv + av2(k)*(wv**2)
c            write(6,*) av(k),av1(k),av2(k),wv
 110     continue

         Tv=273.16+0.8337*wv-3.029*(wv**3.33)/100000.
         if(wv.gt.48) Tv=301.16

         do 120 k=1,3
            Td(k)=c0(k)+c1(k)*wv+c2(k)*(wv**2)+c3(k)*(wv**3)+
     &           c4(k)*(wv**4)+c5(k)*(sst-Tv)
            Tu(k)=Td(k)+c6(k)+c7(k)*wv
            ao(k)=(a0(k)/Td(k))**1.4
            tau(k)=exp(-sec*(ao(k)+av(k)+al(k)))
            Tbu(k)=(1.-tau(k))*Tu(k)
            Tbd(k)=(1.-tau(k))*Td(k)
c            write(6,*) ,k,Tbu(k),Tbd(k),tau(k),
c     &           ao(k),av(k),al(k)
 120        continue

            Tbc=2.7
```

```
            do 130 k=1,3
            sigm2(k)=0.00522*eta(k)*wind
            x=sigm2(k)-68.*(sigm2(k)**3)
            if(x.gt.0.07) x=0.07
            omg(2*k-1)=1.+2.5*x*tau(k)**3
            omg(2*k)=1.+6.1*x*tau(k)**2
c            write(6,*) k,sigm2(k),omg(2*k-1),omg(2*k)
 130        continue

            do 140 k=1,6
            MM1(k)=m1(k)+beta(k)*(teta-53.)+mju(k)*(sst-288.)
            MM2(k)=m2(k)+beta(k)*(teta-53.)+mju(k)*(sst-288.)
            if(wind.lt.7.) Ew(k)=m1(k)*wind
            if(wind.ge.7..and.wind.le.12.) Ew(k)=m1(k)*wind+
     &           0.5*(MM2(k)-MM1(k))*(wind-7.)**2/(12.-7.)
            if(wind.gt.12.) Ew(k)=MM2(k)*wind-
     &           0.5*(MM2(k)-MM1(k))*(12.+7.)
 140        continue

            t=sst-273.16
            q=teta-51.

            do 150 k=1,6
               E0(k)= eps0(k)+eps1(k)*t+eps2(k)*(t**2)+eps3(k)*(t**3)
c               write(6,*) k,E0(k)
               E0(k)=E0(k) +    eps4(k)*q+eps5(k)*t*q+eps6(k)*(q**2)
c               write(6,*) k,E0(k)
               E0(k)=(E0(k) +    eps7(k)*(t**2)*q)/sst
               E(k)=E0(k)+Ew(k)
c               write(6,*) k,E0(k),E(k),Ew(k)
 150        continue

            do 160 k=1,6
               ka=(k+1)/2
               tb(k)=Tbu(ka)+tau(ka)*(E(k)*sst+(1.-E(k))*(omg(k)*Tbd(ka)
     &             + tau(ka)*Tbc))
c               write(6,*) k,ka,Tbu(ka),tau(ka),E(k),omg(k),Tbd(ka),Tbc
 160        continue
            return
            end

      subroutine amsrmodel(Ts,wind,wv,wliq,teta,tb,tau,Tbd,Tbc,Tbu)

      real Ts,wind,wv,wliq,tb(6),teta,sst

      real*8 Tu(8),Td(8),Tbu(8),Tbd(8),tau(8)
      real*8 AO(8),AL(8),AR(8),AV(8)



      real*8 al1(8)/0.0078,0.0183,0.0556,0.0891,0.2027,
     &     0.3682,0.4021,0.9693/
      real*8 al2(8)/0.0303,0.0298,0.0288,0.0281,0.0261,
     &     0.0236,0.0231,0.0146/
      real*8 al3(8)/0.0007,0.0027,0.0113,0.0188,0.0425,
     &     0.0731,0.0786,0.1506/
      real*8 al4(8)/0.0000,0.0060,0.0040,0.0020,-.0020,
     &     -.0020,-.0020,-.0020/
      real*8 al5(8)/1.2216,1.1795,1.0636,1.0220,0.9546,
     &     0.8983,0.8943,0.7961/
      real*8 b0(8)/239.50E+0,  239.51E+0,  240.24E+0,  241.69E+0,
     &     239.45E+0,  242.10E+0,  245.87E+0,  242.58E+0/
      real*8 b1(8)/213.92E-2,  225.19E-2,  298.88E-2,  310.32E-2,
     &     254.41E-2,  229.17E-2,  250.61E-2,  302.33E-2/
      real*8 b2(8)/-460.60E-4, -446.86E-4, -725.93E-4, -814.29E-4,
     &     -512.84E-4, -508.05E-4, -627.89E-4, -749.76E-4/
      real*8 b3(8)/ 457.11E-6,  391.82E-6,  814.50E-6,  998.93E-6,
     &     452.02E-6,  536.90E-6,  759.62E-6,  880.66E-6/
      real*8 b4(8)/ -16.84E-7,  -12.20E-7,  -36.07E-7,  -48.37E-7,
     &     -14.36E-7,  -22.07E-7,  -36.06E-7,  -40.88E-7/
      real*8 b5(8)/   0.50E+0,    0.54E+0,    0.61E+0,    0.20E+0,
     &     0.58E+0,    0.52E+0,    0.53E+0,    0.62E+0/
      real*8 b6(8)/  -0.11E+0,   -0.12E+0,   -0.16E+0,   -0.20E+0,
     &     -0.57E+0,   -4.59E+0,  -12.52E+0,   -0.57E+0/
      real*8 b7(8)/  -0.21E-2,   -0.34E-2,   -1.69E-2,   -5.21E-2,
     &     -2.38E-2,   -8.78E-2,  -23.26E-2,   -8.07E-2/
      real*8 ao1(8)/   8.34E-3,    9.08E-3,   12.15E-3,   15.75E-3,
     &     40.06E-3,  353.72E-3, 1131.76E-3,   53.35E-3/
      real*8 ao2(8)/  -0.48E-4,   -0.47E-4,   -0.61E-4,   -0.87E-4,
```

```
     &     -2.00E-4,  -13.79E-4,   -2.26E-4,   -1.18E-4/
      real*8 av1(8)/   0.07E-3,    0.18E-3,    1.73E-3,    5.14E-3,
     &     1.88E-3,    2.91E-3,    3.17E-3,    8.78E-3/
      real*8 av2(8)/   0.00E-5,    0.00E-5,   -0.05E-5,    0.19E-5,
     &     0.09E-5,    0.24E-5,    0.27E-5,    0.80E-5/
      real r0v(8)/ -0.27E-3,  -0.32E-3,  -0.49E-3,  -0.63E-3,
     &     -1.01E-3, -1.20E-3, -1.23E-03, -1.53E-3/
      real r0h(8)/0.54E-3,   0.72E-3,   1.13E-3,   1.39E-3,
     &     1.91E-3,  1.97E-3,  1.97E-03,  2.02E-3/
      real r1v(8)/-0.21E-4,  -0.29E-4,  -0.53E-4,  -0.70E-4,
     &     -1.05E-4, -1.12E-4, -1.13E-04, -1.16E-4/
      real r1h(8)/   0.32E-4,   0.44E-4,   0.70E-4,   0.85E-4,
     &     1.12E-4,  1.18E-4,  1.19E-04,  1.30E-4/
      real r2v(8)/ -2.10E-5,  -2.10E-5,  -2.10E-5,  -2.10E-5,
     &     -2.10E-5, -2.10E-5, -2.10E-05, -2.10E-5/
      real r2h(8)/-25.26E-6, -28.94E-6, -36.90E-6, -41.95E-6,
     &     -54.51E-6, -5.50E-5, -5.50E-5,  -5.50E-5/
      real r3v(8)/   0.00E-6,   0.08E-6,   0.31E-6,   0.41E-6,
     &      0.45E-6,  0.35E-6,  0.32E-06, -0.09E-6/
      real r3h(8)/   0.00E-6,  -0.02E-6,  -0.12E-6,  -0.20E-6,
     &     -0.36E-6, -0.43E-6, -0.44E-06, -0.46E-6/
      real m1v(8)/0.00020, 0.00020, 0.00140, 0.00178,
     &     0.00257, 0.00260, 0.00260, 0.00260/
      real m1h(8)/0.00200, 0.00200, 0.00293, 0.00308,
     &     0.00329, 0.00330, 0.00330, 0.00330/
      real m2v(8)/0.00690, 0.00690, 0.00736, 0.00730,
     &     0.00701, 0.00700, 0.00700, 0.00700/
      real m2h(8)/0.00600, 0.00600, 0.00656, 0.00660,
     &     0.00660, 0.00660, 0.00660, 0.00660/
      real TC/2.7/

c      write(37,*) 'amsrmodel called '

      T_ow=Ts
      T_is=Ts
      C_is=0.
      C_ow=(1.-C_is)

      sec=1./cos(teta/57.2957795)
      T_S_mix=C_is*T_is+C_ow*T_ow
      T_L=(T_S_mix+273.)/2.

c%************************
c% Model
c%************************
c% Model for the Atmosphere

      T_V=301.16
      if( wv.le.48.) T_V=273.16+0.8337*wv-3.029E-5*(wv**3.33)

      temp_test=abs(T_S_mix-T_V)

      if(temp_test.le.20.) then
         sig_TS_TV=1.05*(T_S_mix-T_V)*(1-((T_S_mix-T_V)**2)/1200)
      else
         sig_TS_TV=sign(14,(T_S_mix-T_V))
      endif

      do 100 k=1,8
         Td(k)=b0(k)+(b1(k)*wv)+(b2(k)*(wv**2))+(b3(k)*(wv**3))+
     &        (b4(k)*(wv**4))+(b5(k)*sig_TS_TV)
         Tu(k)=Td(k)+b6(k)+b7(k)*wv
         AO(k)=ao1(k)+ao2(k)*(Td(k)-270.)
         AV(k)=av1(k)*wv+av2(k)*(wv**2)
         AL(k)=al1(k)*(1.-al2(k)*(T_L-283.))*wliq
         tau(k)=exp(-sec*(AO(k)+AV(k)+AL(k)))
         Tbu(k)=Tu(k)*(1.-tau(k))
         Tbd(k)=Td(k)*(1.-tau(k))
 90      format(14f10.4)
 100  continue
c         write(37,90) Ts,wind,wv,wliq,AO(8),AL(8),AV(8),tau(8),Td(8),
c     &     AO(5),AL(5),AV(5),tau(5),td(5)

      return
      end
```

7.2 Software – covariance calculations (cover.f)*

```
      integer date(7)
      real tb(22),tbmean(22),n(22)
      real Wu(320,161),Wv(320,161),T2,MSL(320,161)
      real TWC(320,161),PWC(320,161),ST(320,161),CI(320,161)
      real lat,lon,line,smpl,lon1
      real*8 tbs(7),e(7),taus(7),tbds(7)
      real wind,windu,windv,wv1,wv2,tskin,cice,clw,wvap
      integer*4 indx
      character*1 jobz/'V'/
      character*1 uplo/'U'/
      double precision  emis(100000,3),cov(3,3),a(3,3),w(3),z(3,3)
      double precision emiw(100000,3),covw(3,3),aw(3,3),ww(3)
      double precision work(100),memis(3)/3*0d0/,memiw(3)/3*0d0/
      real tbo(100000,3),ciceo(100000)
      real*8 dstak(1000000)
      common/CSTAK/ dstak
      nx=0
      nw=0

 100  continue
      open(17, file='covar.x')
      read(5,120,end=200) lat,lon1,(e(k),k=1,7),T2,wind,cice,
     &     xwv,xclw,taus(1),taus(3),taus(5),taus(7),R3785,tb(7),tb(8),
     &     tb(9),tb(11),tb(12),tb(13),tb(18),tbds(1),tbds(3),tbds(5),
     &     tbds(7)

 120  format(2f9.2,2x,7f8.4,2x,f8.3,f6.1,f6.2,f6.1,f6.3,2x,4f7.3,f7.2,
     &     2x,7f7.1,2x,4f6.1)
         if(cice.gt.0.96) then
            nx=nx+1
            emis(nx,1)=e(1)
            emis(nx,2)=e(4)
            emis(nx,3)=e(5)
            memis(k)=e(1)+e(4)+e(5)

            ciceo(nx)=cice
            tbo(nx,1)=tb(7)
            tbo(nx,2)=tb(11)
            tbo(nx,3)=tb(12)

            if(nx.gt.100000) goto 200
         endif

         if(cice.lt.0.001) then
         nw=nw+1
            emiw(nw,1)=e(1)
            emiw(nw,2)=e(4)
            emiw(nw,3)=e(5)
            memiw(k)=e(1)+e(4)+e(5)
      endif
      goto 100
c
c      ****** calculate mean and covariances ******
c
 200  continue

      call corrs(emiw,nw,3,100000,1000000,0,covw,3)
      call corrs(emis,nx,3,100000,1000000,0,cov,3)

      do 340 k=1,3
            memis(k)=memis(k)/float(nx)
            memiw(k)=memiw(k)/float(nw)
 340  continue
      do 300 l=1,3
      write(6,141) l,(memis(l)),(cov(l,k),k=1,3)
      do 290 k=1,3
         a(k,l)=cov(k,l)
         aw(k,l)=covw(k,l)
 290  continue
 300  continue
      write(6,*) ' '

 140  format(i5,7f10.6)
 141  format(i5,f10.4,7f10.6)
c
```

```
c      ****** calculate eigenvectors ******
c
      call dsyev(jobz,uplo,3,a,3,w,work,100,info)
      call dsyev(jobz,uplo,3,aw,3,ww,work,100,info)
      write(6,*) info,nx,nw
c
c      ****** calculate pc1 for water and for ice ******
c
      do 400 l=1,3
      write(6,141) l,w(l),(a(l,k),k=1,3)
 400  continue
      write(6,*) ' '
      do 480 k=1,nx
      pc1i=0.
      do 450 l=1,3
         pc1i=pc1i+a(3,l)*emis(k,l)
 450  continue
      if(ciceo(k).lt.0.95) goto 470
      write(17,460) pc1i,(emis(k,l),l=1,3),(tbo(k,m),m=1,3)
 460  format(f9.4,3f8.4,3f7.1)
 470  continue
 480  continue

 500  format(a3,f11.8,'*x+',f11.8,' , ',f11.8,'*x+',f11.8)
      stop
      end
```

```
      real emis(100000,7), tbo(100000,7), pci(100000)
      real*8 p00(7)/7*0d0/,p95(7)/7*0d0/,t95(7)/7*0d0/,t00(7)/7*0d0/
c      real*8

      k=1

 400  continue
      read(5,460,end=500) pci(k),(emis(k,l),l=1,2),(tbo(k,m),m=1,2)
 460  format(f9.4,2f8.4,2f7.1)
      k=k+1
      goto 400

 500  continue
      k=k-1
      kx=k
      if(k.lt.2000) kx=2000
      if(k.gt.5000) kx=5000
c      n95=ifix(0.99*kx)
      n05=ifix(0.01*kx)
      n95=k-n05

      x1=0.
      do 520 l=n95,k
         x1=x1+1
         do 510 m=1,2
            p95(m)=p95(m)+emis(l,m)
            t95(m)=t95(m)+tbo(l,m)
 510     continue
 520  continue
      do 530 m=1,2
         p95(m)=p95(m)/x1
         t95(m)=t95(m)/x1
 530  continue
      x95=x1

      x1=0.
      do 570 l=1,n05
         x1=x1+1
         do 560 m=1,2
            p00(m)=p00(m)+emis(l,m)
            t00(m)=t00(m)+tbo(l,m)
 560     continue
c             write(6,*) l,m,emis(l,2),tbo(l,2),p00(2),t00(2)
 570  continue
      do 580 m=1,2
         p00(m)=p00(m)/x1
         t00(m)=t00(m)/x1
 580  continue


      write(6,630) (p00(m),m=1,2),(t00(n),n=1,2),
     &     (p95(m),m=1,2),(t95(n),n=1,2),x1,x95
c      write(6,630) (p95(m),m=1,3),(t95(n),n=1,3),x95

 630  format(2(2f9.4,2f8.2),2f6.0)

      stop
      end
```

```
     real e(4),tb(4)
     real esum(6,12),tbsum(6,12),e2(6,12),tb2(6,12),xm(12)


     do 100 k=1,12
        do 99 l=1,6
           esum(l,k)=0.
           tbsum(l,k)=0.
           e2(l,k)=0.
           tb2(l,k)=0.
99      continue
        xm(k)=0.
100  continue


110  continue
     read(5,*,end=135) im,id,e(1),e(2),tb(1),tb(2),e(3),e(4),
    &     tb(3),tb(4),x0,x95

     do 130 l=1,4
        esum(l,im)=esum(l,im)+e(l)
        e2(l,im)=e2(l,im)+e(l)**2
        tbsum(l,im)=tbsum(l,im)+tb(l)
        tb2(l,im)=tb2(l,im)+tb(l)**2
        if(l.eq.1) xm(im)=xm(im)+1.
        if(im.eq.9.and.l.eq.1) write(6,*) im,xm(im),e(1),
    &        esum(1,im),tbsum(1,im),xm(1)
130  continue
     goto 110

135  continue

     do 150 k=1,12
        do 140 l=1,6
           esum(l,k)=esum(l,k)/xm(k)
           e2(l,k)=e2(l,k)/xm(k)
           e2(l,k)=sqrt(e2(l,k)-esum(l,k)**2)
           tbsum(l,k)=tbsum(l,k)/xm(k)
           tb2(l,k)=tb2(l,k)/xm(k)
           tb2(l,k)=sqrt(tb2(l,k)-tbsum(l,k)**2)

140     continue
        write(16,200) k,(esum(i,k),i=1,6),(e2(i,k),i=1,6)
        write(17,201) k,(tbsum(i,k),i=1,6),(tb2(i,k),i=1,6)
150  continue
200  format(i3,2x,6f8.4,2x,6f8.4)
201  format(i3,2x,6f8.2,2x,6f8.2)
     stop
     end
```

7.5 Software – statistics calculations (stdev_*.f)

```
      integer date(7)
      real*8 tb(22),tbmean(22),n(22)
      real lat,lon,line,smpl,lon1
      real*8 tbs(7),e(7),taus(7),tbds(7)
      real wind,windu,windv,wv1,wv2,tskin,cice,clw,wvap
      integer*4 indx
      real*8  emis(1000000,2)
      real*8 tbi(1000000,2),tbw(1000000,2)
      double precision emiw(1000000,2)
      double precision work(100),memis(4)/4*0d0/,memiw(4)/4*0d0/
      double precision memis2(4)/4*0d0/,memiw2(4)/4*0d0/
      real*8 dew/0d0/,dew2/0d0/,dtw/0d0/,dtw2/0d0/,dei/0d0/
      real*8 dei2/0d0/,dti/0d0/,dti2/0d0/
      real tbo(1000000,2),ciceo(1000000)
      real*8 dstak(1000000)
      real*8 tiept(12,4),tiepe(12,4)
      common/CSTAK/ dstak
      nx=0
      nw=0
      open(27, file='tp2.e')
      open(28, file='tp2.t')
      do 90 l=1,12
         read(27,*) i,(tiepe(l,j),j=1,4)
c         write(6,*) (tiepe(l,j),j=1,4)
         read(28,*) i,(tiept(l,j),j=1,4)
c         write(6,*) (tiept(l,j),j=1,4)

 90   continue
c      write(6,*) (tiepe(l,j),j=1,4)
c      write(6,*) (tiept(l,j),j=1,4)

      m=2

 100  continue

      read(5,*,end=200) lat,lon1,(e(k),k=1,7),T2,wind,cice,
     &     xwv,xclw,taus(1),taus(3),taus(5),taus(7),R3785,tb(7),tb(8),
     &     tb(9),tb(11),tb(12),tb(13),tb(18),tbds(1),tbds(3),tbds(5),
     &     tbds(7)

 120  format(2f9.2,2x,7f8.4,2x,f8.3,f6.1,f6.2,f6.1,f6.3,2x,4f7.3,f7.2,
     &     2x,7f7.1,2x,4f6.1)
      if(lat.lt.60.) goto 100
c      write(6,*) nx,nw,cice

c
c     ****** ice ******
c
      if(cice.gt.0.96) then
         nx=nx+1
         emis(nx,1)=e(1)
         emis(nx,2)=e(4)
         tbi(nx,1)=tb(7)
         tbi(nx,2)=tb(11)
c         write(6,*) nx,e(1),e(4),tb(7),tb(11)
         memis(1)=memis(1)+emis(nx,1)
         memis(2)=memis(2)+emis(nx,2)
         memis2(1)=memis2(1)+emis(nx,1)**2
         memis2(2)=memis2(2)+emis(nx,2)**2
         memis(3)=memis(3)+tbi(nx,1)
         memis(4)=memis(4)+tbi(nx,2)
         memis2(3)=memis2(3)+tbi(nx,1)**2
         memis2(4)=memis2(4)+tbi(nx,2)**2
         call dist(e(1),e(4),tiepe(m,1),tiepe(m,2),tiepe(m,3),
     &        tiepe(m,4),de)
         call dist(tb(7),tb(11),tiept(m,1),tiept(m,2),tiept(m,3),
     &        tiept(m,4),dt)
         dei=dei+de
         dei2=dei2+de**2
         dti=dti+dt
         dti2=dti2+dt**2
         if(nx.gt.1000000) goto 200
      endif
c
c      ****** water ******
```

```
c
      iwx=0
      if(lat.gt.67..and.lat.lt.77..and.lon1.gt.0..and.lon1.lt.10.) iwx=1
      if(lat.gt.60..and.lat.lt.63..and.lon1.gt.-36..and.lon1.lt.-22.)
     &     iwx=1
      if(lat.gt.53..and.lat.lt.56..and.lon1.gt.-180..and.lon1.lt.-170.)
     &     iwx=1
      if(iwx.eq.1) then
c      if(cice.lt.0.15.and.lat.gt.65.) then
         nw=nw+1
         emiw(nw,1)=e(1)
         emiw(nw,2)=e(4)
         tbw(nw,1)=tb(7)
         tbw(nw,2)=tb(11)
c         write(6,*) lat,lon1,tb(7),tb(11),cice
         memiw(1)=memiw(1)+emiw(nw,1)
         memiw(2)=memiw(2)+emiw(nw,2)
         memiw2(1)=memiw2(1)+emiw(nw,1)**2
         memiw2(2)=memiw2(2)+emiw(nw,2)**2
         memiw(3)=memiw(3)+tbw(nw,1)
         memiw(4)=memiw(4)+tbw(nw,2)
         memiw2(3)=memiw2(3)+tbw(nw,1)**2
         memiw2(4)=memiw2(4)+tbw(nw,2)**2
         call dist(e(1),e(4),tiepe(m,1),tiepe(m,2),tiepe(m,3),
     &        tiepe(m,4),de)
         call dist(tb(7),tb(11),tiept(m,1),tiept(m,2),tiept(m,3),
     &        tiept(m,4),dt)
         dew =dew+de
         dew2=dew2+de**2
         dtw =dtw+dt
         dtw2=dtw2+dt**2
      endif
      goto 100
c
c     ****** calculate mean and covariances ******
c
 200  continue

      do 340 k=1,4
         memis(k)=memis(k)/float(nx)
         memiw(k)=memiw(k)/float(nw)
         memis2(k)=memis2(k)/float(nx)
         memiw2(k)=memiw2(k)/float(nw)
         memis2(k)=sqrt(memis2(k)-memis(k)**2)
         memiw2(k)=sqrt(memiw2(k)-memiw(k)**2)
 340  continue
      dew =-dew/float(nw)
      dew2=dsqrt((dew2/float(nw))-dew**2)
      dei =dei/float(nx)
      dei2=dsqrt((dei2/float(nx))-dei**2)

      dtw =-dtw/float(nw)
      dtw2=dsqrt((dtw2/float(nw))-dtw**2)
      dti =dti/float(nx)
      dti2=dsqrt((dti2/float(nx))-dti**2)
c
c      ****** write result ******
c
c     write(6,141) (memis(i),i=1,4),(memiw(i),i=1,4),
c    &     (memis2(i),i=1,4),(memiw2(i),i=1,4),
c    &     dei,dei2,dew,dew2,dti,dti2,dtw,dtw2,nx,nw
      write(6,142) dei,dei2,dew,dew2,dti,dti2,dtw,dtw2,nx,nw,
     &     dew2/dew,dtw2/dtw,dei2/dew,dti2/dtw
 140  format(i5,7f10.2)
 141  format(4(2f7.3,2f7.1,1x),2(f9.3,f9.4,1x),2(f8.1,f9.2,1x),
     &     2i6,4f9.3)
 142  format(2(f9.3,f9.4,1x),2(f8.1,f9.2,1x),
     &     2i6,4f9.3)
      stop
      end

      subroutine dist(x0,y0,x1,y1,x2,y2,d)
c-------------------------------------------------------------------
c
c      Calculate distance from point (x0,y0) to line through (x1,y1)
c      and (x2,y2)
c
c
c
      real*8 x1,y1,x2,y2,x0,y0
```

```
real d
d=((x2-x1)*(y1-y0)-(x1-x0)*(y2-y1))
d=d/sqrt((x2-x1)**2+(y2-y1)**2)

return
end
```

8. References

[1]. Frank J. Wentz and Thomas Meissner. AMSR Ocean Algorithm. Algorithm Theoretical Basis Document (ATBD). Remote Sensing Systems. California, U.S. Version 2. November 2. 2002.

[2]. Frank J. Wentz. A model function for ocean microwave brightness temperatures. Journal of Geophysical Research. Vol. 88(nr. C3): 1892-1908. 1983.

[3]. Frank J. Wentz. A well-calibrated ocean algorithm for special sensor microwave/imager. Journal of geophysical research. Vol. 102(nr. C4):8703-8718. April 1997.

[4]. Leif Toudal Pedersen. Retrieval of sea ice concentration by means of microwave radiometry. Technical Report LD81, EMI, The Technical University of Denmark, Lyngby, Denmark, February 1991.

[5]. C.D. Rodgers. Retrieval of atmospheric temperature and composition from remote measurements of thermal radiation. Reviews of Geophysics and Space Physics. Vol. 14(nr. 4): 609-624, November 1976.

[6]. NASDA. AMSR-E Data Users Handbook. Technical Report NCX-030021. 1st Edition. July 2003.

[7]. Josefino C Comiso, Donald J. Cavalieri, Claire L. Parkinson and Per Gloersen. Passive microwave algorithms for sea ice concentration: A comparison of two techniques. Remote Sens. Environ., Vol 60:357-384, 1997

[8]. Donald J. Cavalieri and Josefino C. Comiso. Algorithm Theoretical Basis Document (ATBD) for the AMSR-E Sea Ice Algorithm. Laboratory for Hydrospheric Processes, NASA Goddard Space Flight Center, Maryland. December 1, 2000