NWP SAF

Satellite Application Facility
for Numerical Weather Prediction

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Cloud detection for the Advanced Infrared Radiometer Sounder (Part II)

- Figures

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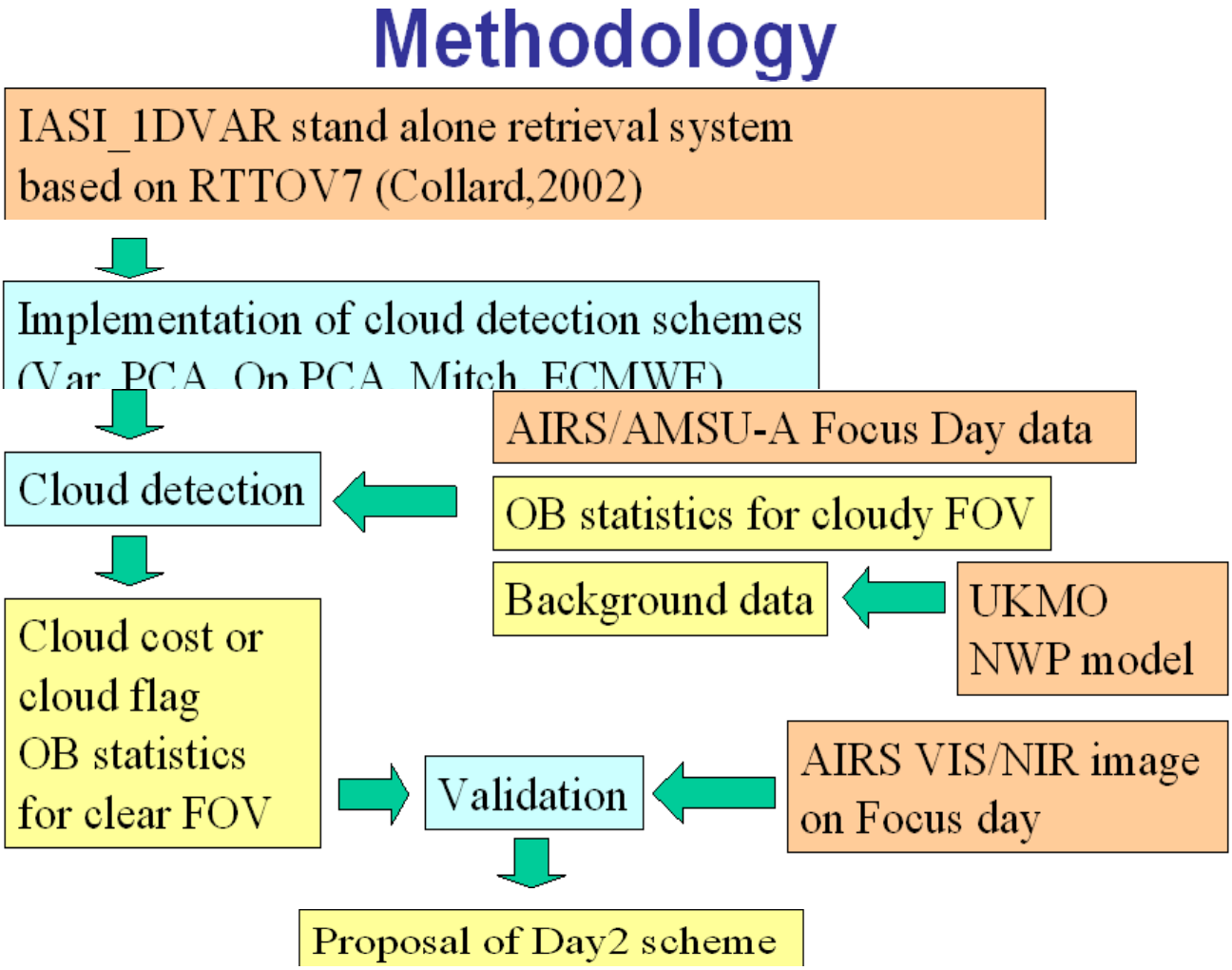


Fig.1 Illustrating the cloud detection study with real AIRS/AMSU data.

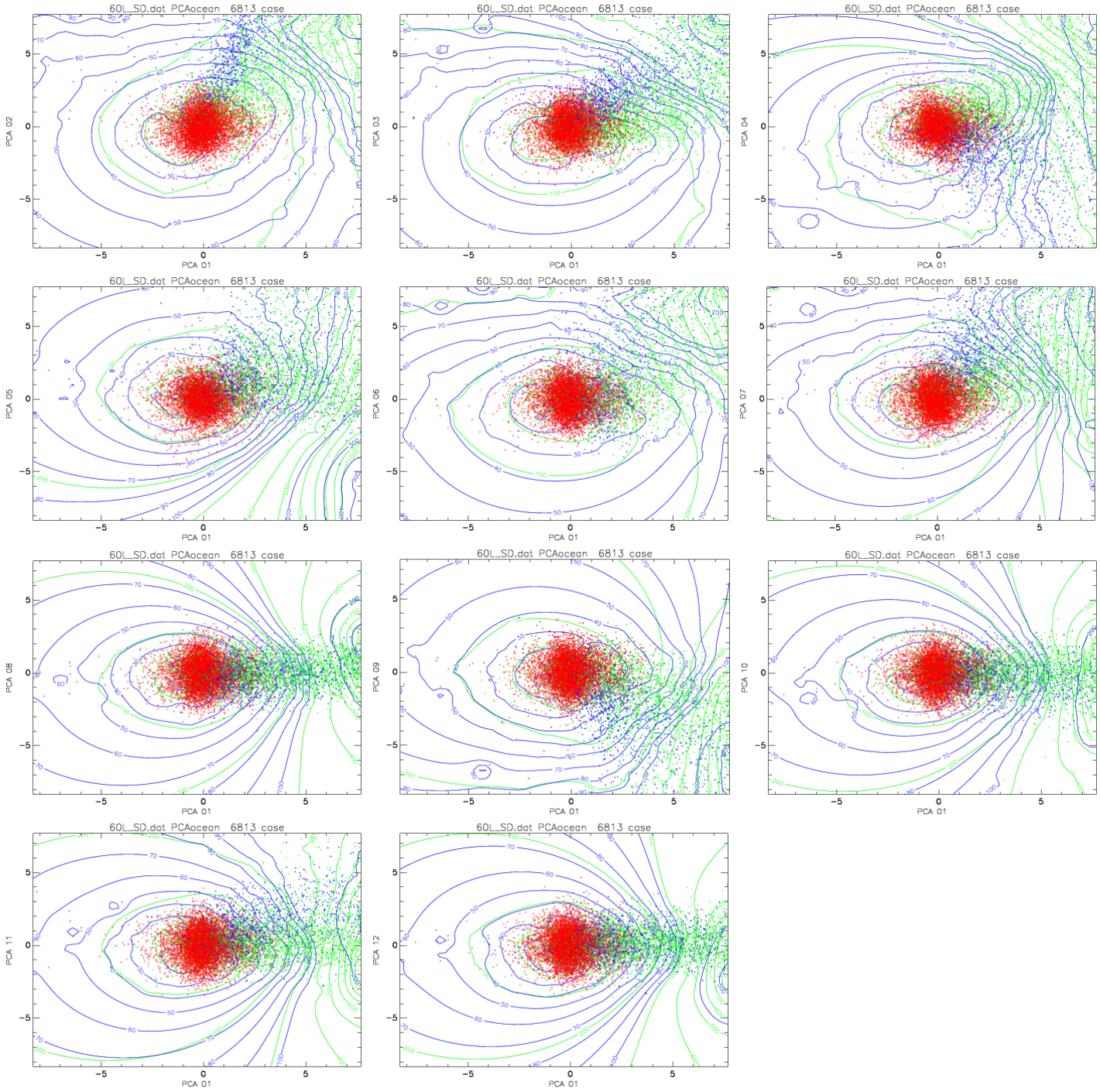


Fig.2 PCA components of O-B difference simulated for ECMWF profile dataset for mix02 channel set. Horizontal axis is for the first component and vertical axis for the another component. Red plots are for clear case and green for cloudy and total liquid water excess total ice water case, and blue are for cloudy and total ice water excess total water cloud case. Blue contours are mean ice water content (kg/m^2), Green contours for mean liquid water content (kg/m^2). Each PCA value is normalized by square root of the eigen value.

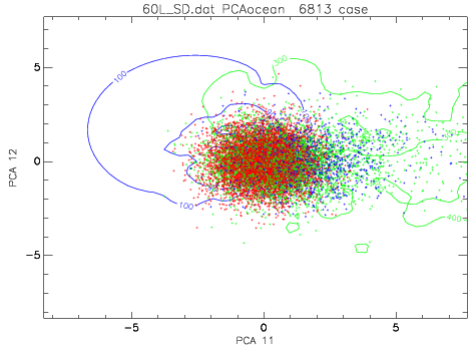


Fig.3 As Fig.2, but for the last two components.

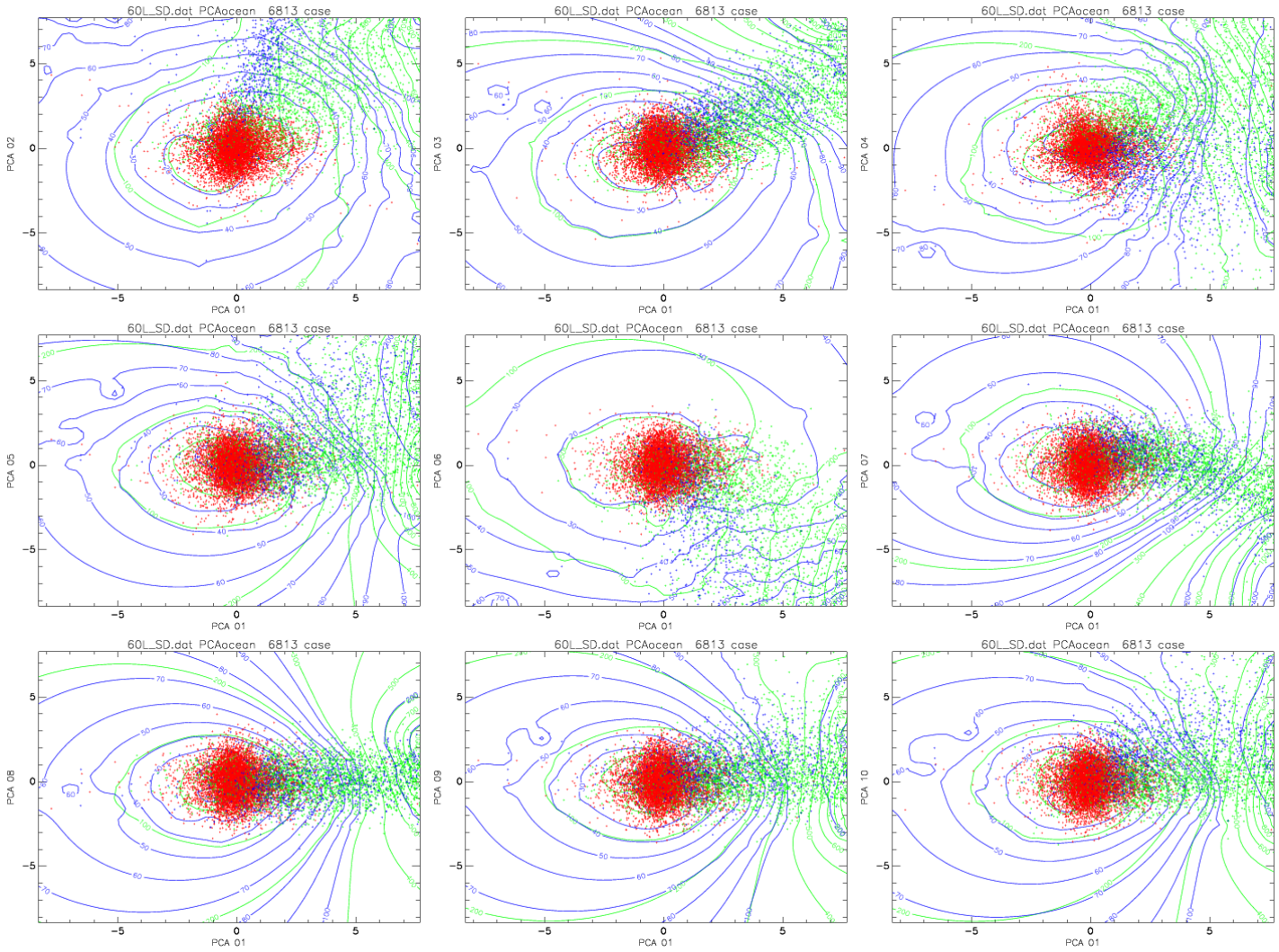


Fig.4 As Fig.2, but for sound02 channel set.

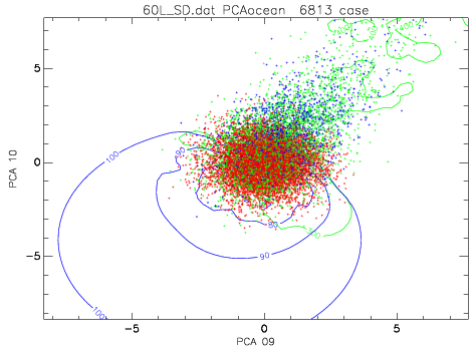


Fig.5 As Fig.4, but for the last two components.

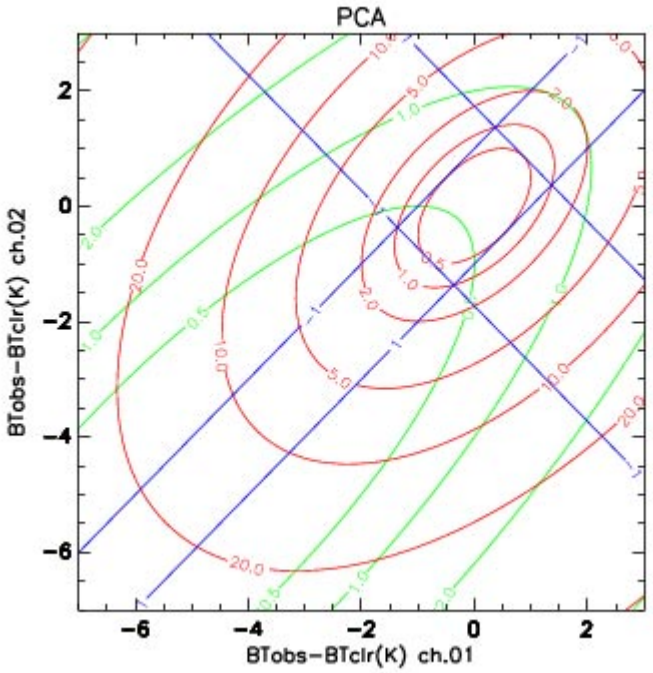


Fig.6 Illustrating the concept of PCA scheme in the case of using two channels. Horizontal and vertical axes are brightness temperature difference for channel 1 and channel 2, respectively. Red contours mean cloud cost of clear FOV and green contours the cost of cloudy FOV. Blue lines denote threshold of PCA scheme and rectangular area surrounded by the four blue lines is declared as clear. Mean brightness temperature difference is 5K for both channels and the covariance of cloud probability is $25K^2$ for diagonal elements and $20K^2$ for off-diagonal elements, and the covariance of clear probability is $1K^2$ for diagonal elements and $0.5K^2$ for off diagonal elements.

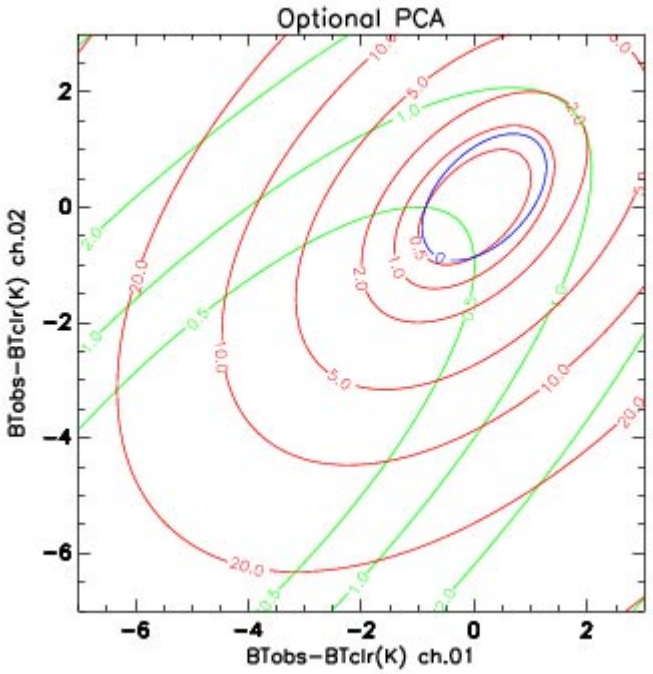


Fig.7 Illustrating the concept of Optional PCA scheme in the case of using two channels. Horizontal and vertical axes are brightness temperature difference for channel 1 and channel 2, respectively. Red contours mean cloud cost of clear FOV and green contours the cost of cloudy FOV. Blue lines denote threshold of Optional PCA scheme and elliptical area surrounded by the blue line is declared as clear. Given statistical parameters are same as Fig.6.

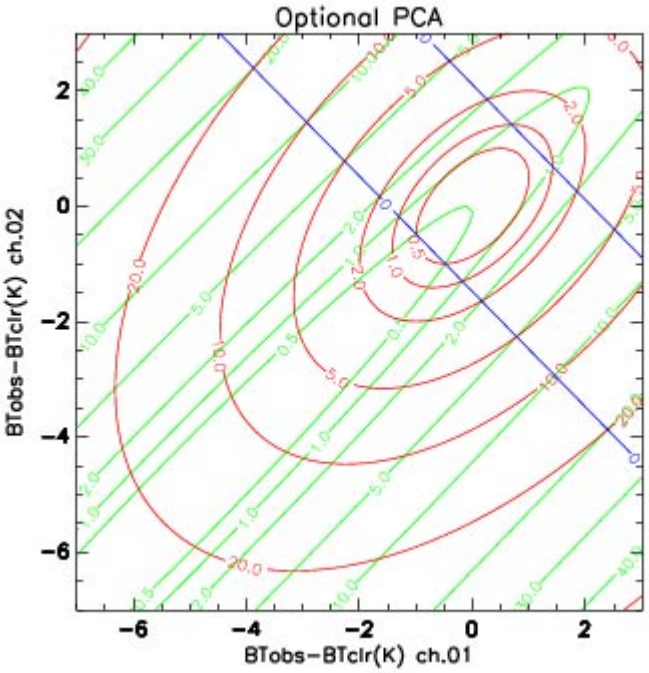
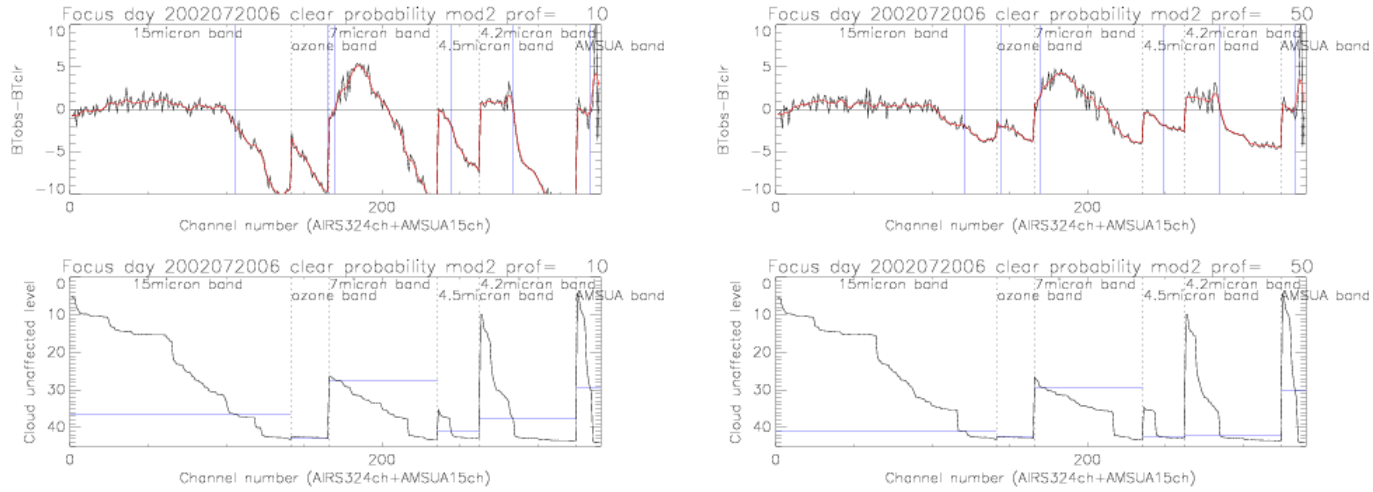
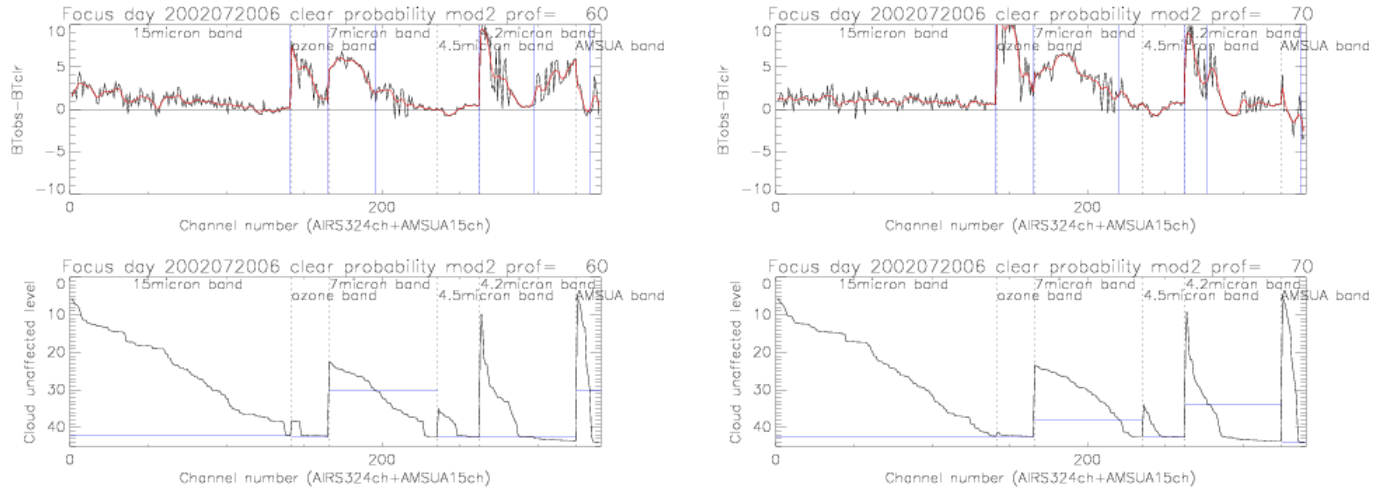


Fig.8 Illustrating an example of the Optional PCA scheme for a special case. Mean brightness temperature difference is 5K for both channels and the covariance of cloud probability is $25K^2$ for diagonal elements and $24.5K^2$ for off-diagonal elements, and the covariance of clear probability is $1K^2$ for diagonal elements and $0.5K^2$ for off diagonal elements.



a)

b)



c)

d)

Fig.9 Illustration of ECMWF scheme. Ordinate axis of upper chart means channel number sorted by cloud unaffected pressure and the abscissa means brightness temperature difference between observation minus background value. Thin black line shows original value and thick red line shows smoothed one filtered by a Low-Pass Filter. Black solid vertical line means border between clear channels and cloudy channels. Each spectral bands processed independently are devided by dashed black vertical lines. Abscissa of lower chart means cloud unaffected level derived from assuming black body cloud and the level is represented by NWP vertical model levels. Solid black line means the cloud top level corresponds to that of highest cloudy channel each spectral band.

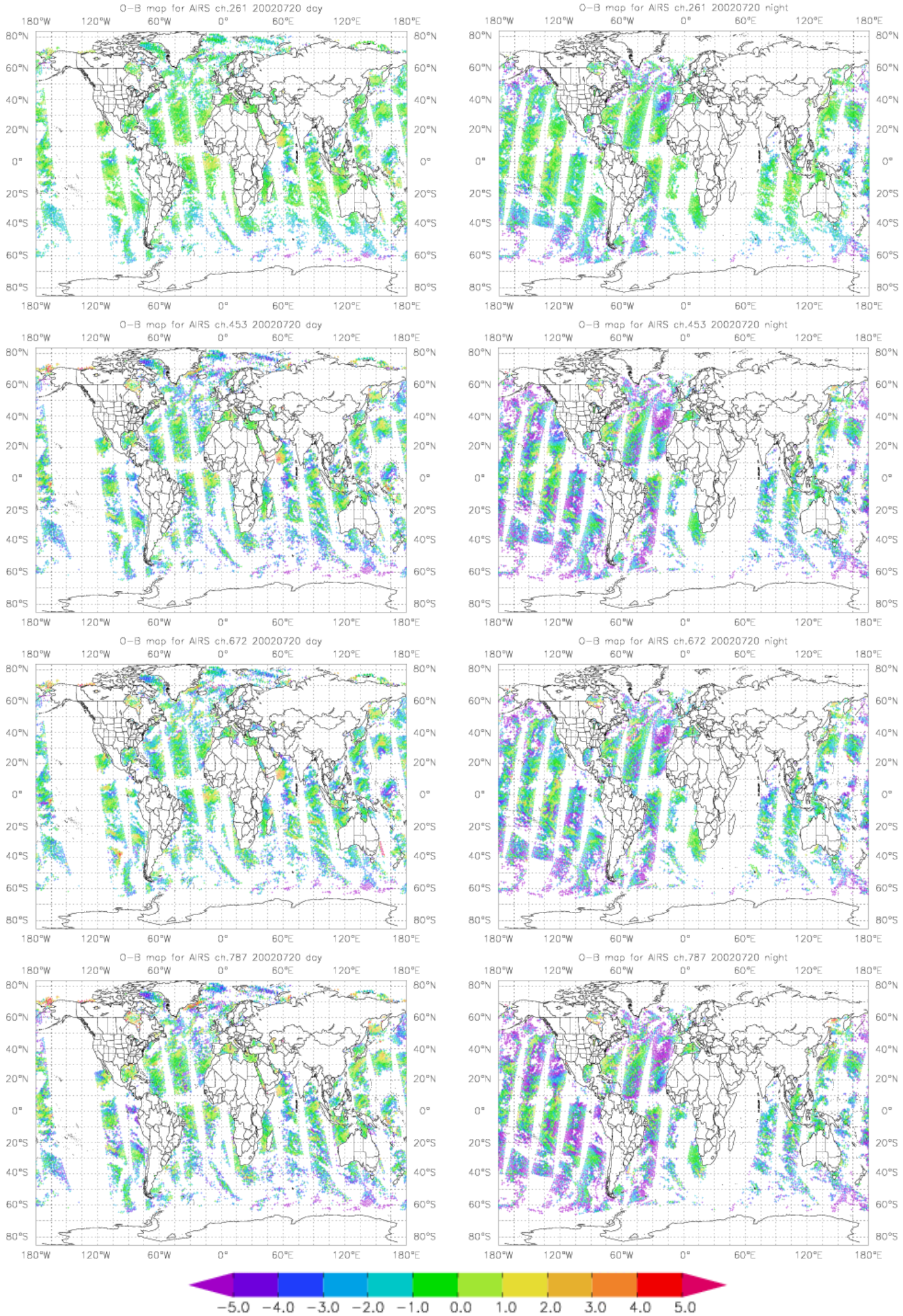


Fig.10-1 O-B difference (K) of cloud deteshort wave sounding channels, AIRS ch.261, ch.453, ch.672, and ch.787. Left figures are for daytime and right figures for night.

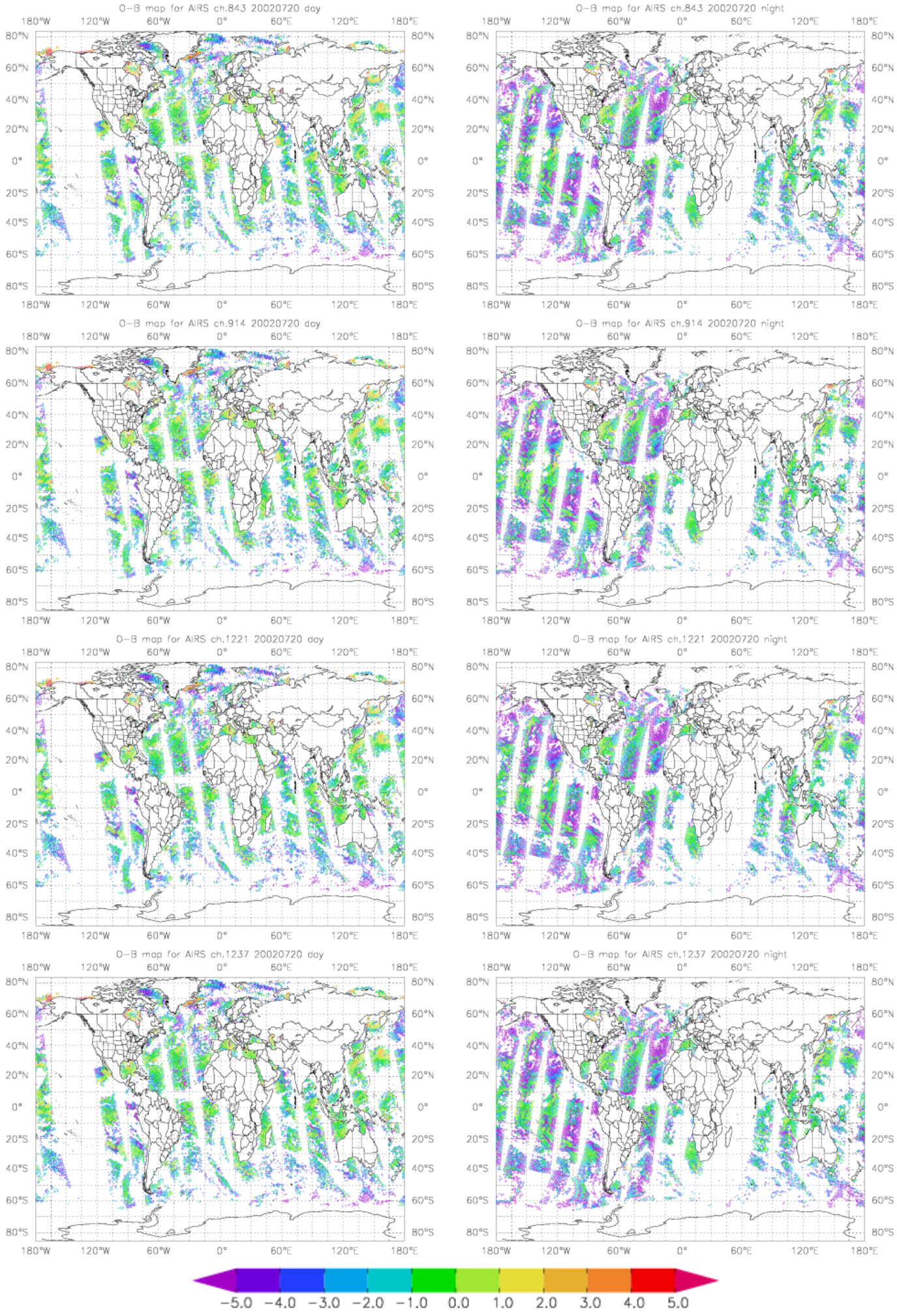


Fig.10-2 As Fig.10-1, but for AIRS ch.843, ch.914, ch.1221, and ch.1237.

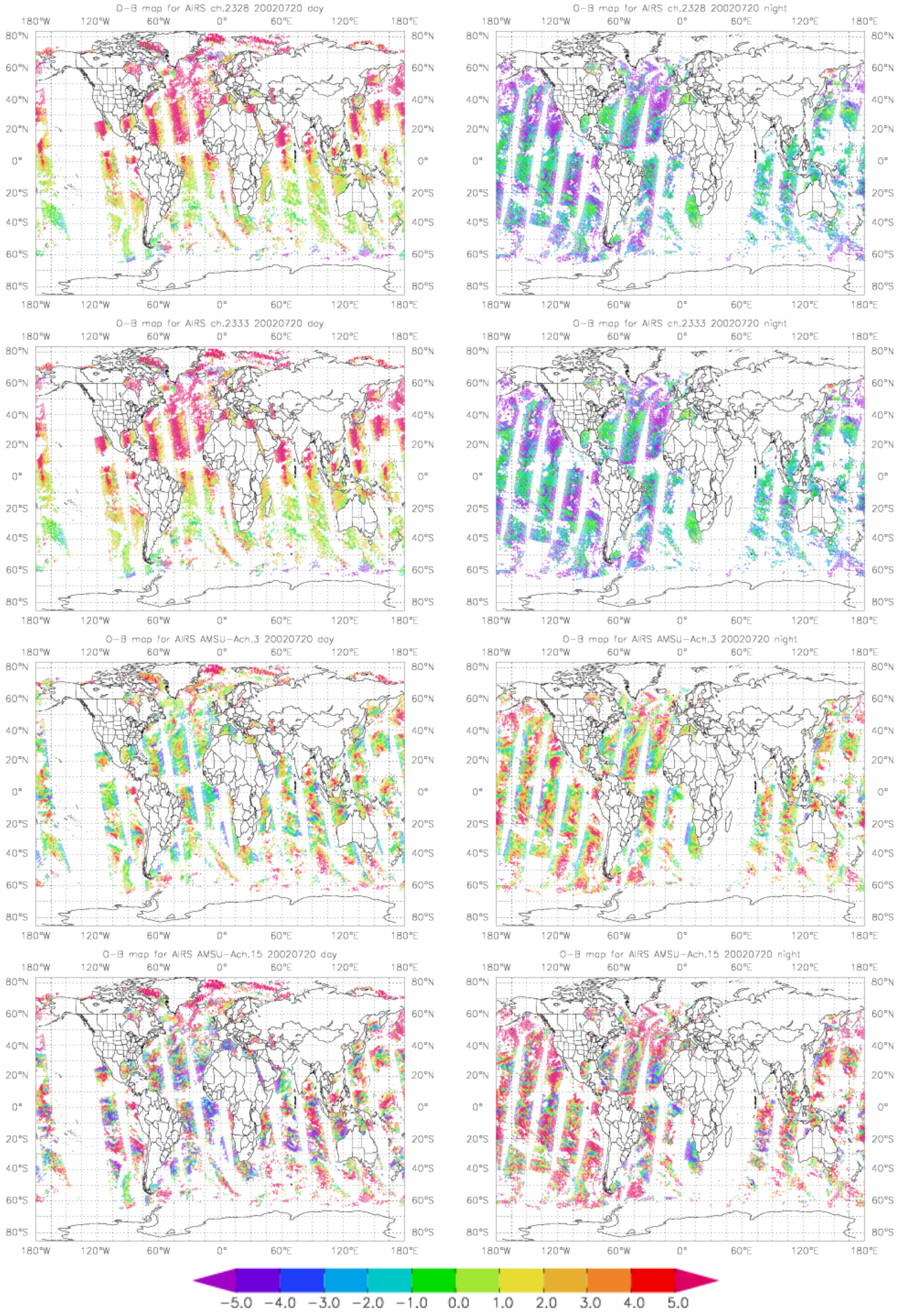


Fig.10-3 As Fig.10-1, but for AIRS ch.2328, ch.2333, and AMSU-A ch.3, and c.15ch.15.

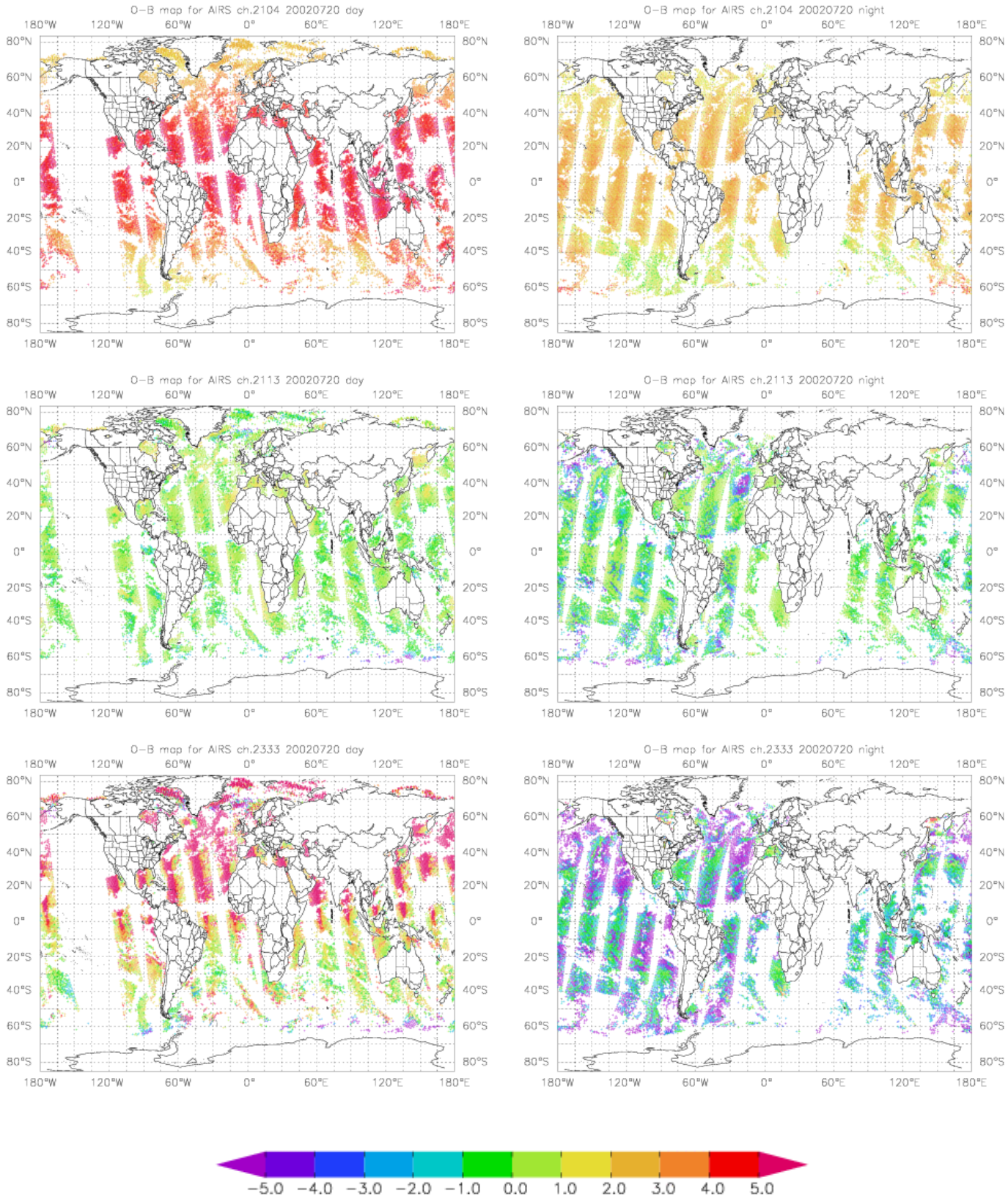


Fig.11 O-B difference (K) of short wave sounding channels, ch.2104 (upper), ch.2113 (middle), and ch.2333 (lower). Left figures are for daytime and right figures for night.

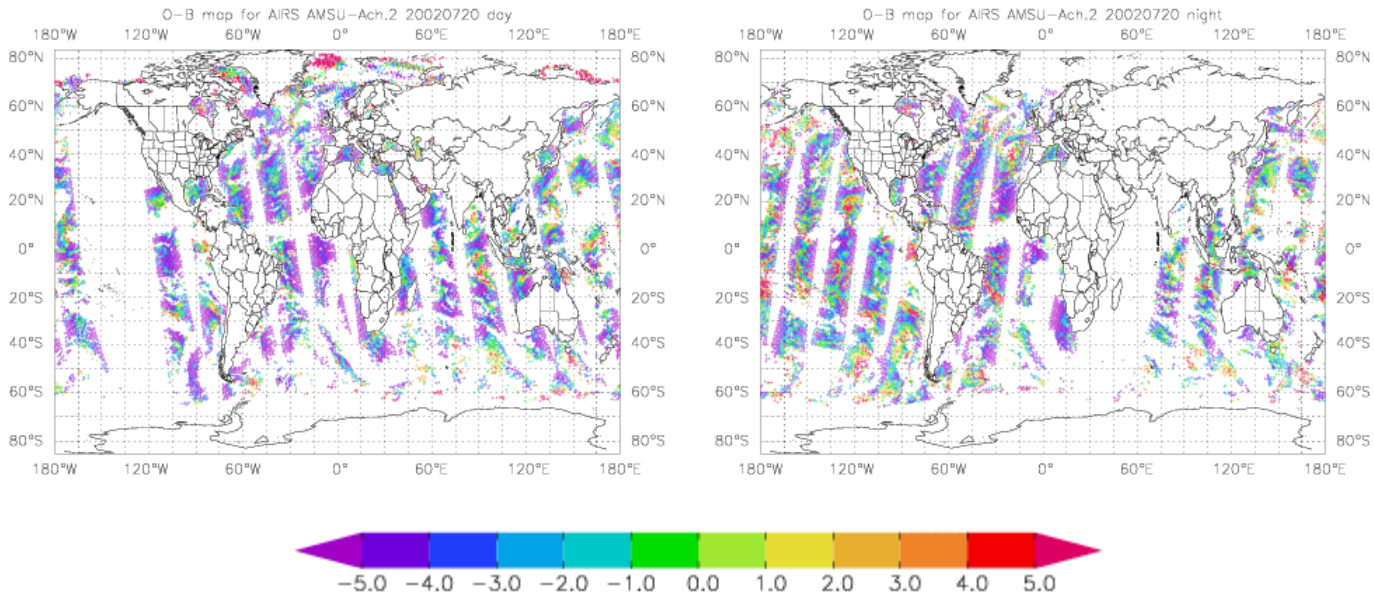


Fig.12 O-B difference (K) of AMSU-A ch.2. Left figures are for daytime and right figures for night.

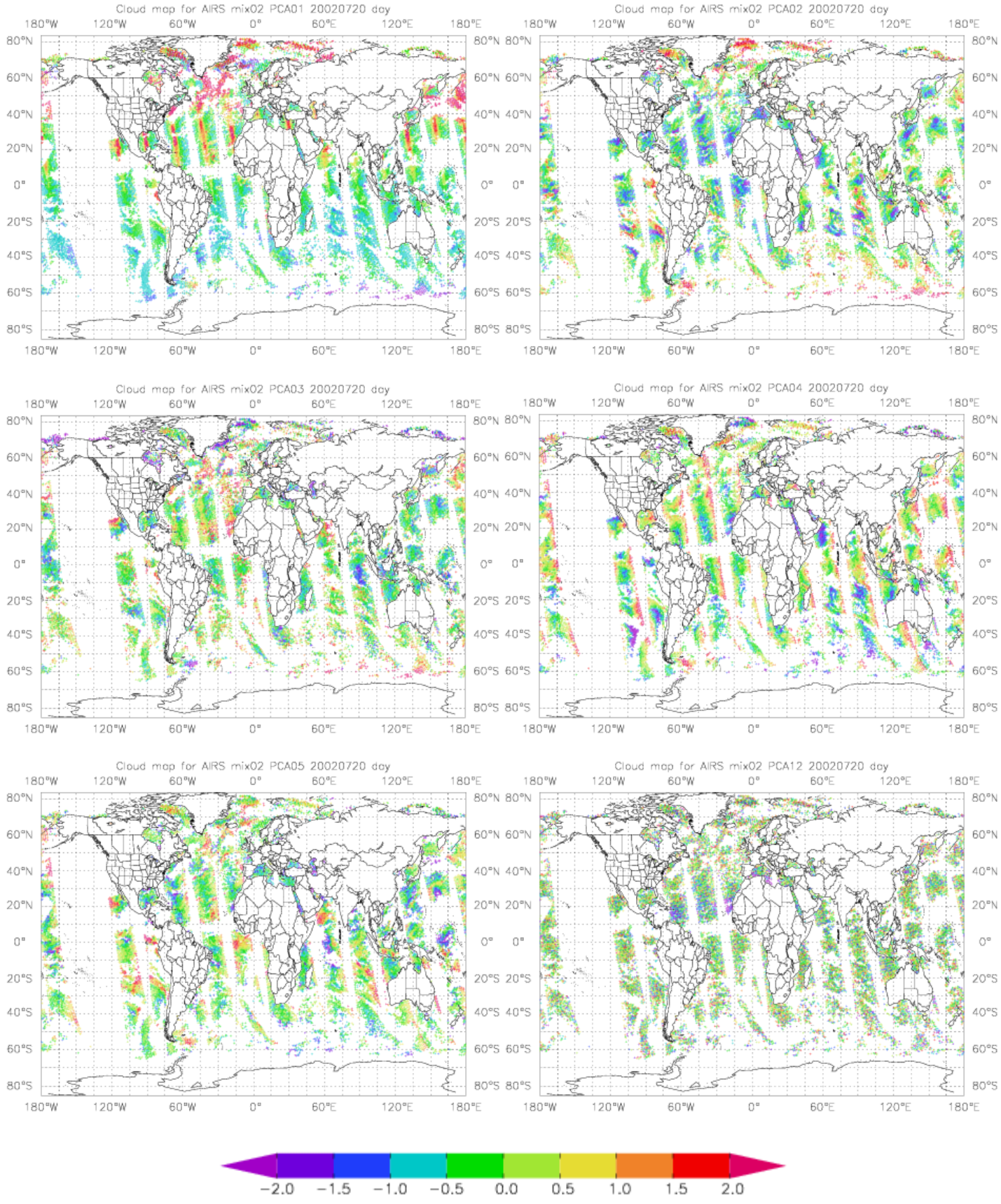


Fig.13-1 PCA components for cloud characterization with mix02 channel set for the daytime. The first five components and the last component are shown. Red color means positive value and violet means negative value.

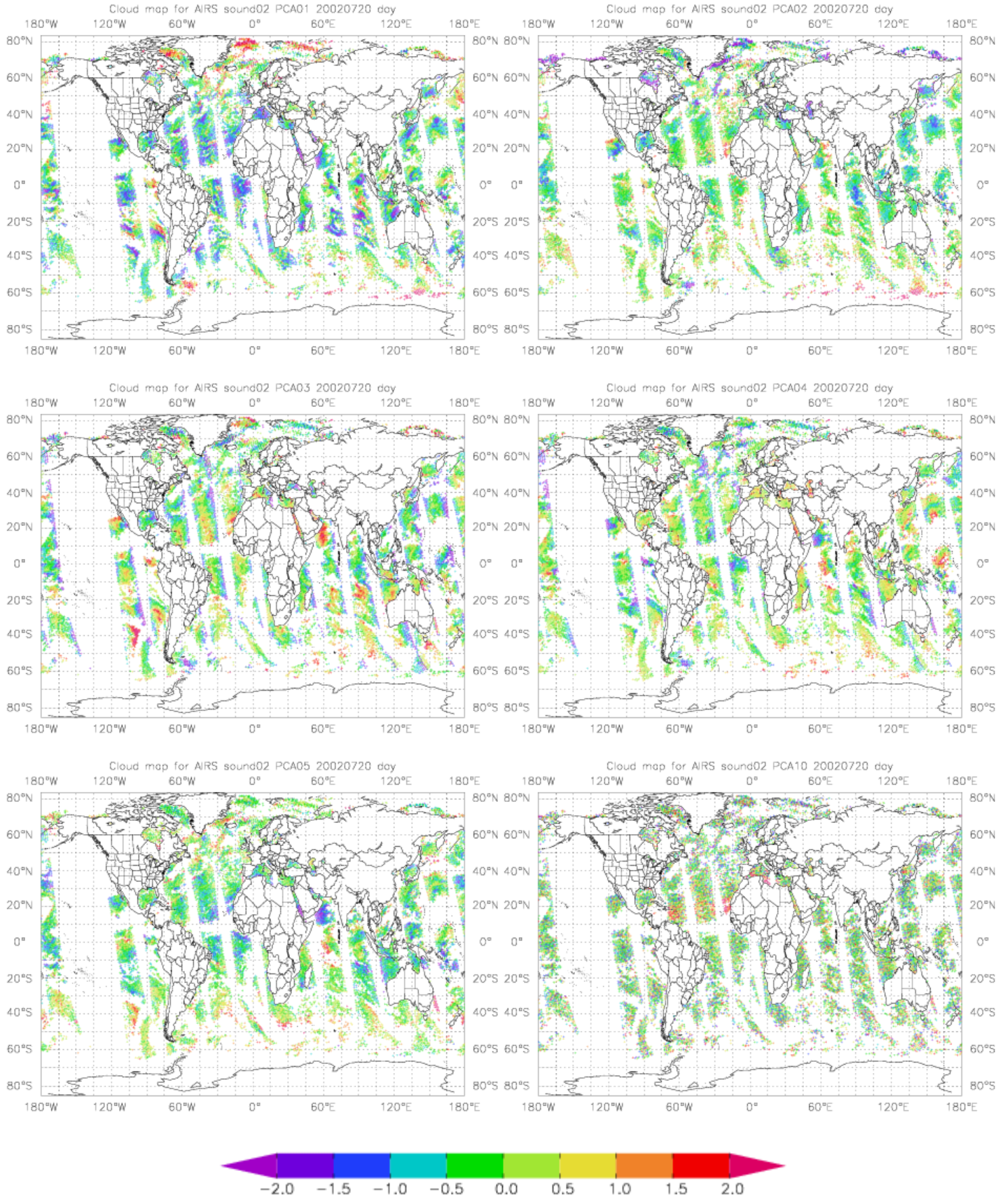


Fig.13-2 As Fig.13-1, but for sound02 channel set.

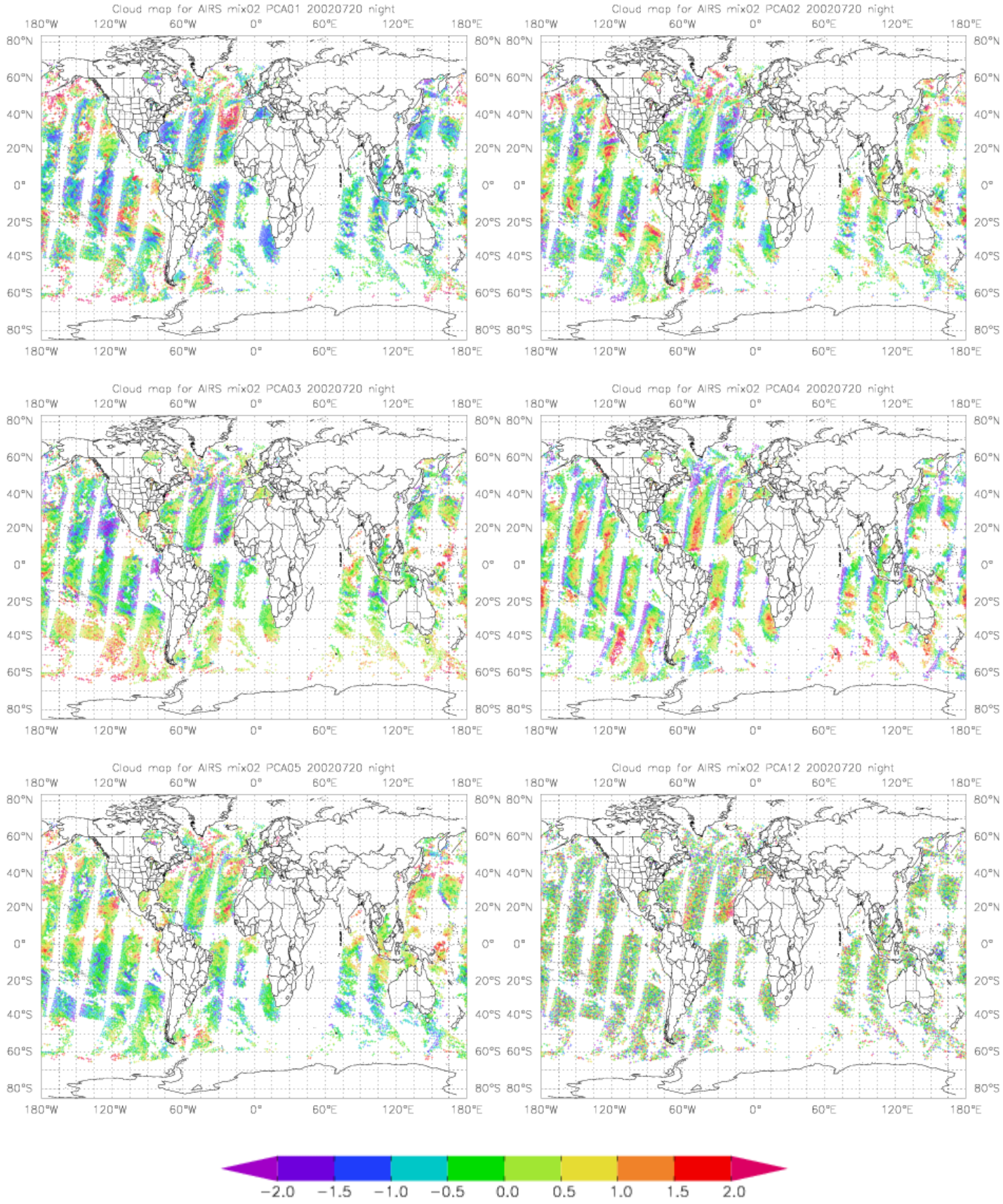


Fig.14-1 As Fig.13-1, but for the nighttime.

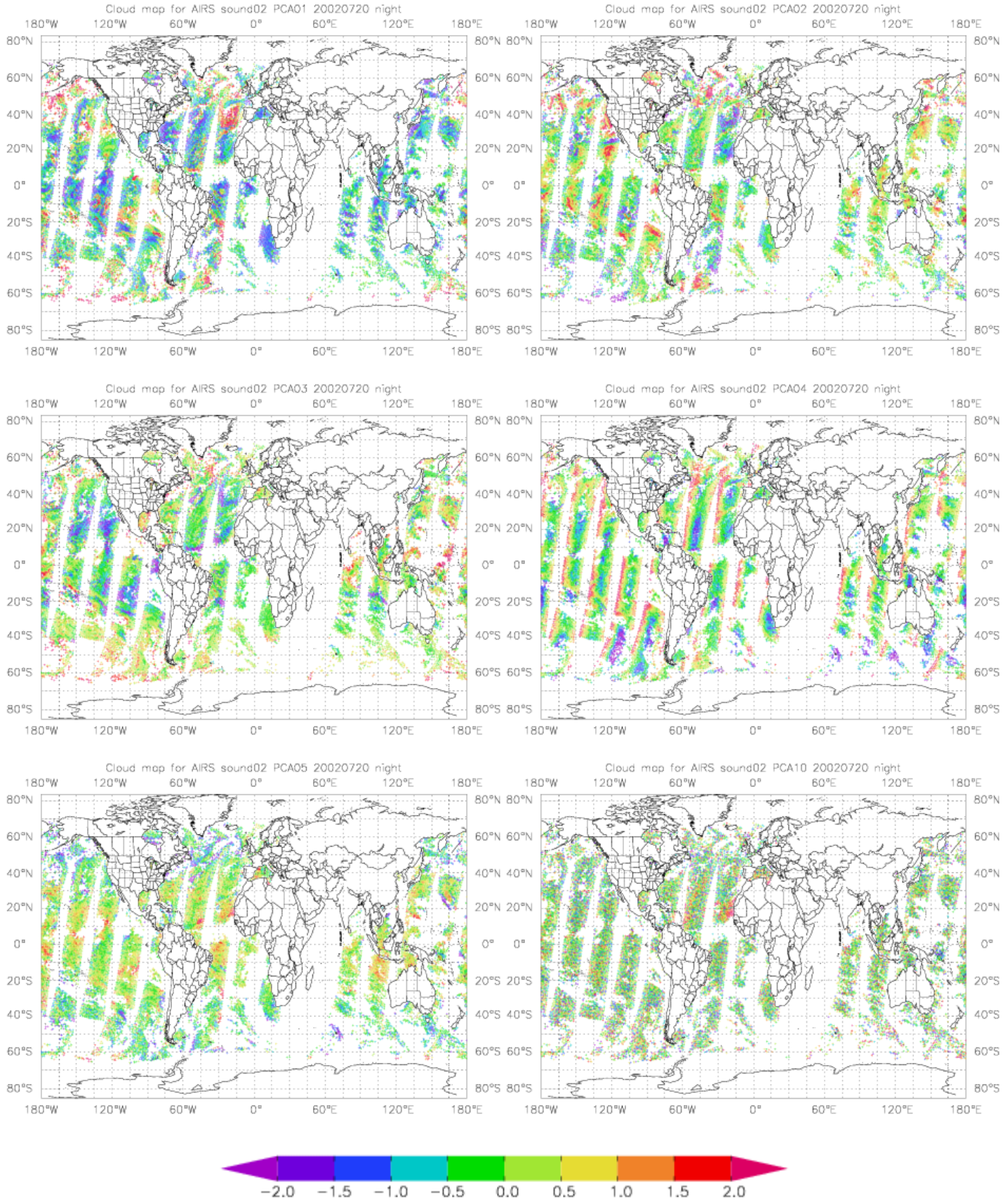


Fig.14-2 As Fig.14-1, but for sound02 channel set.

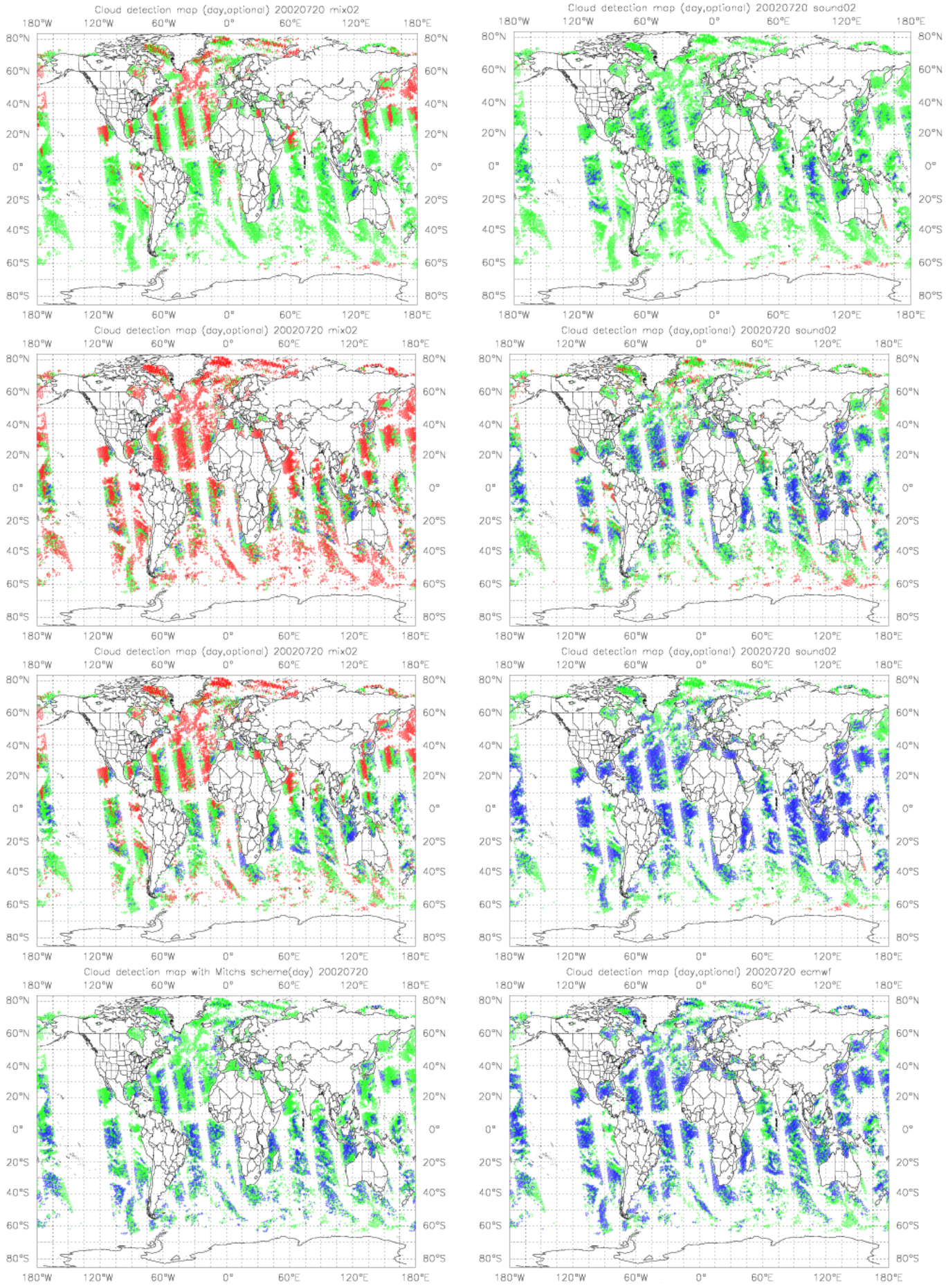


Fig.15-1 Cloud detection map in the daytime. Blue is clear and green is cloudy. Red area means cloudy with cloud cost for Var scheme, maximum partial cloud cost for PCA, and difference of clear cost and cloudy cost for Optional PCA scheme lager than 20. The three upper rows are for Optional PCA scheme (upper), PCA scheme (middle), and Var scheme (low). Lefts are for mix02 channel set and rights for sound02 channel set. The left of the lowest row is for Mitch scheme and the right of the lowest row for ECMWF scheme.

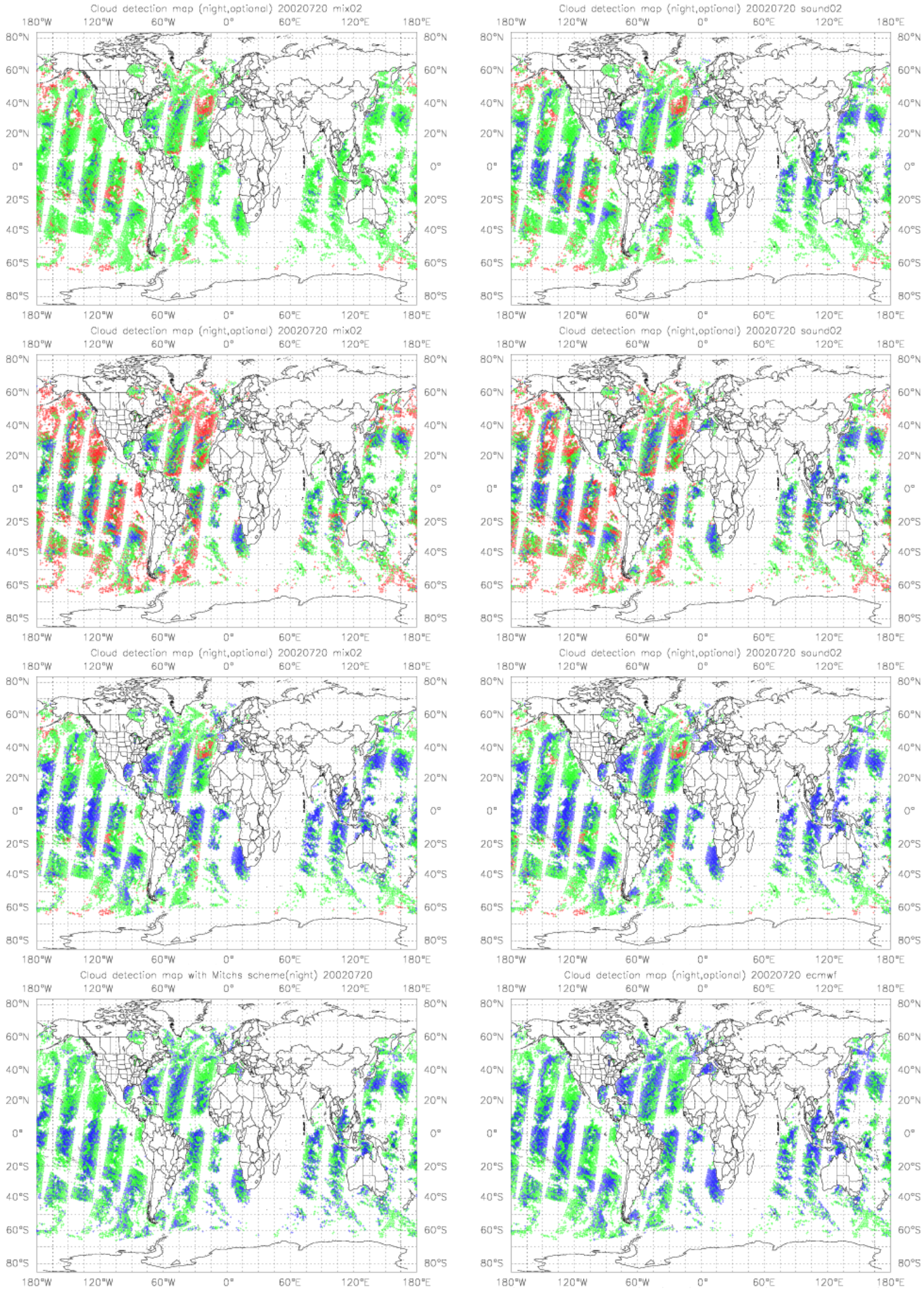


Fig.15-2 As Fig.15-1, but for nighttime.

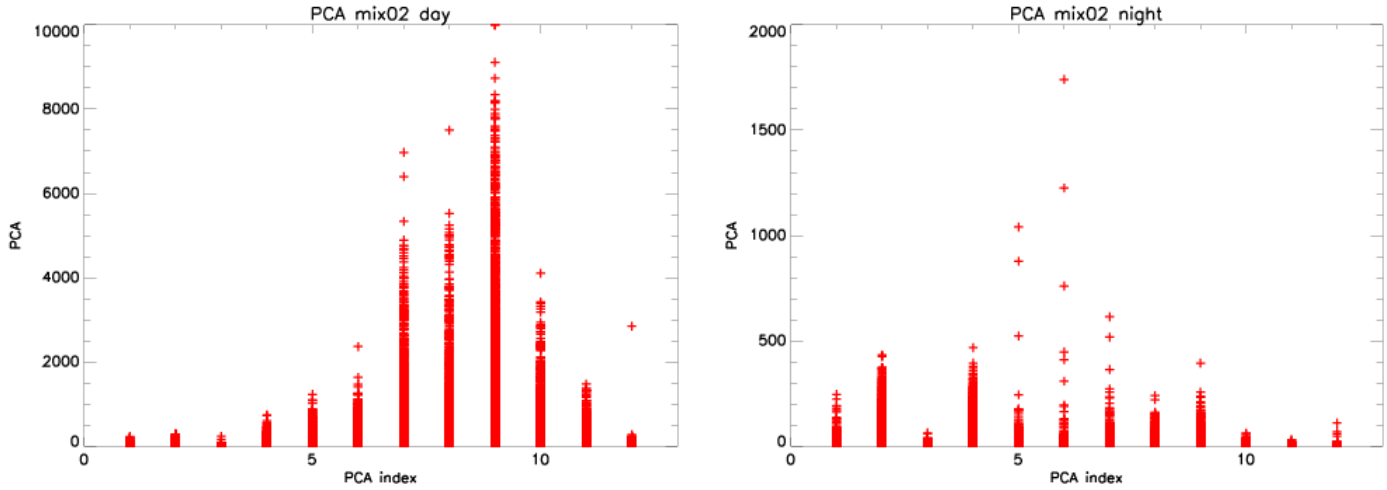


Fig.16-1 Cloud costs for each PCA component (PCA01-12) with mix02 channel set for all (clear and cloudy) case. Left:daytime, Right:nighttime.

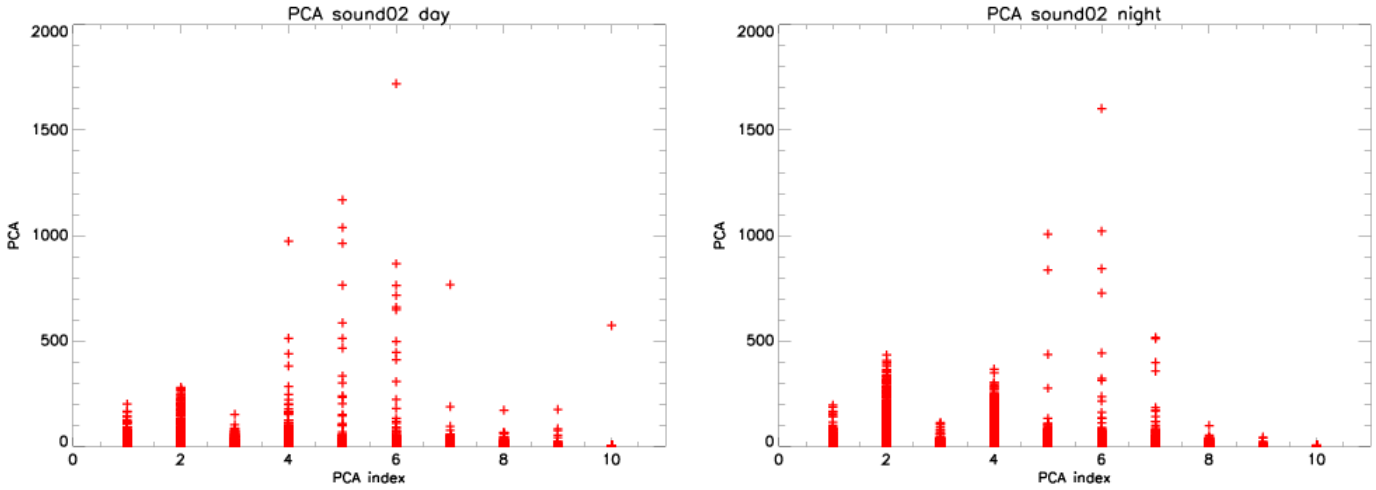


Fig.16-2 As Fig.16-1, but for sound02 channel set.

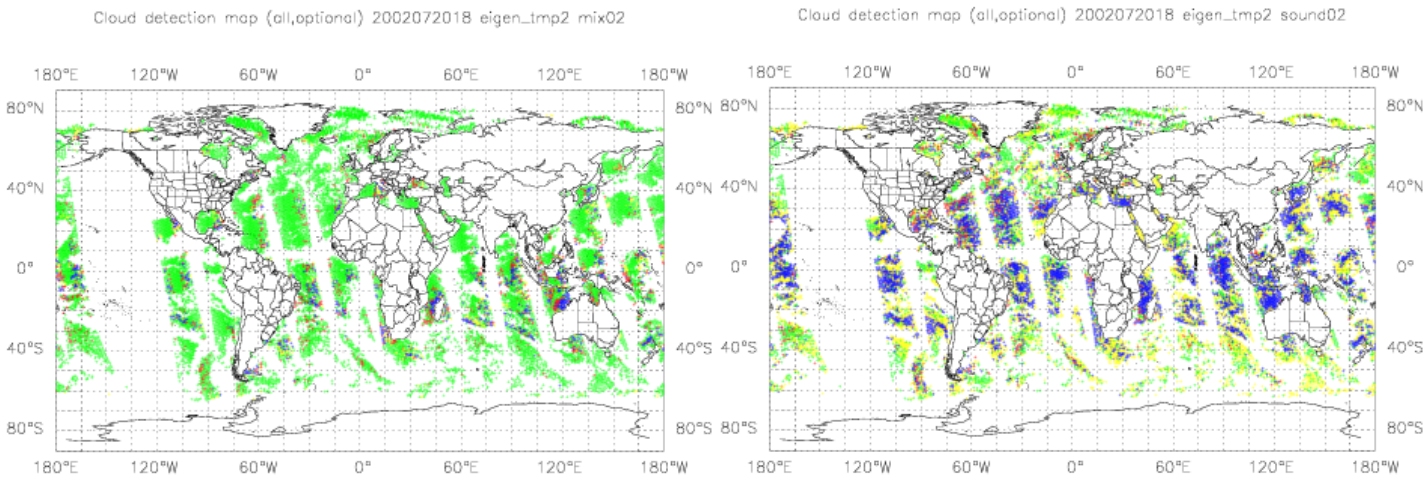


Fig.17-1 Dependency of cloud detection to used PCA components in PCA scheme in the daytime. Blue:clear (PCA01-09<2.0), Green: cloudy (PCA01-09>2.0), Yellow: cloudy (PCA01-06>2.0, PCA07-09<2.0), Red:cloudy (PCA01-06<2.0, PCA07-09>2.0). Left is for mix02 channel set and right for sound02 channel set.

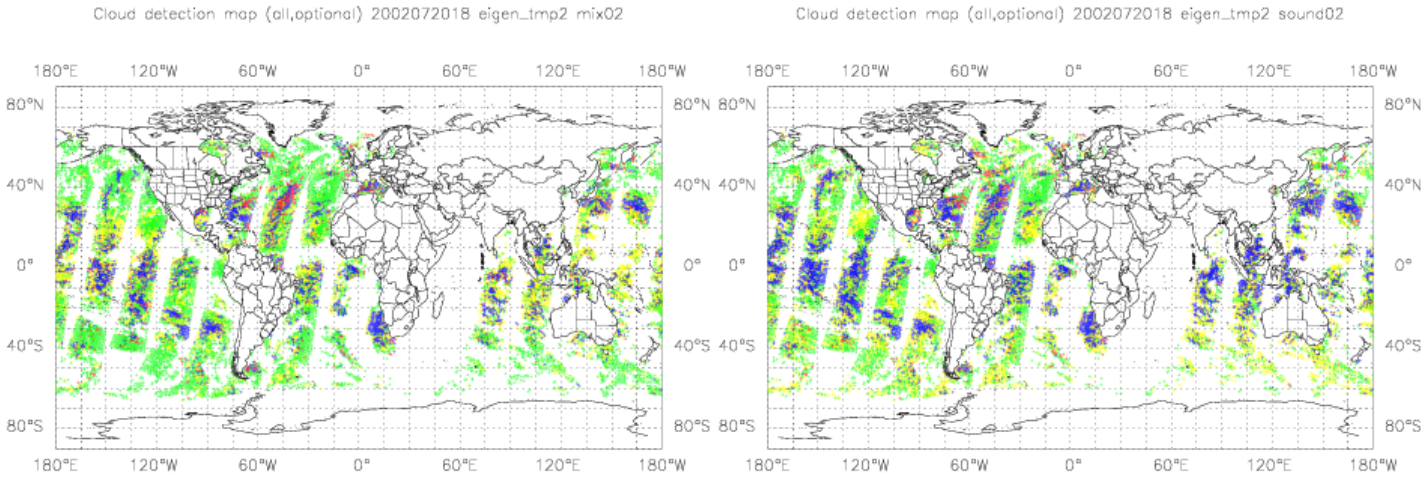


Fig.17-2 As Fig.17-1, but for the nighttime.

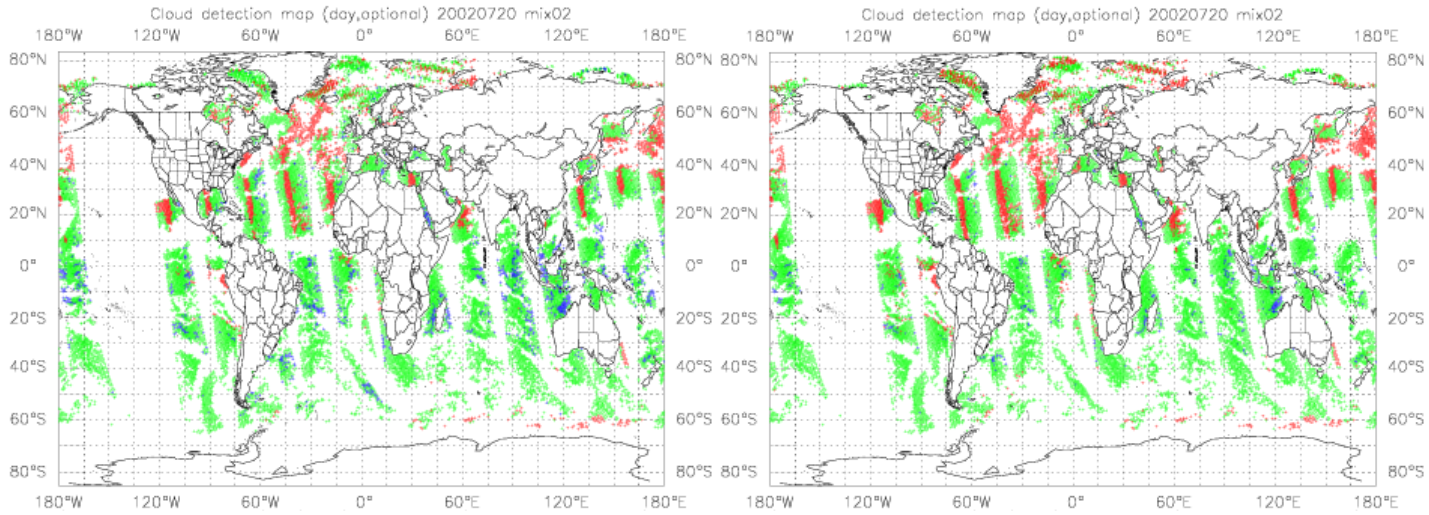


Fig.18-1 Cloud detection map with mix02 channel set with Optional PCA scheme in the daytime. Left:with cloud probability in the nighttime, Right:with cloud probability in the daytime.

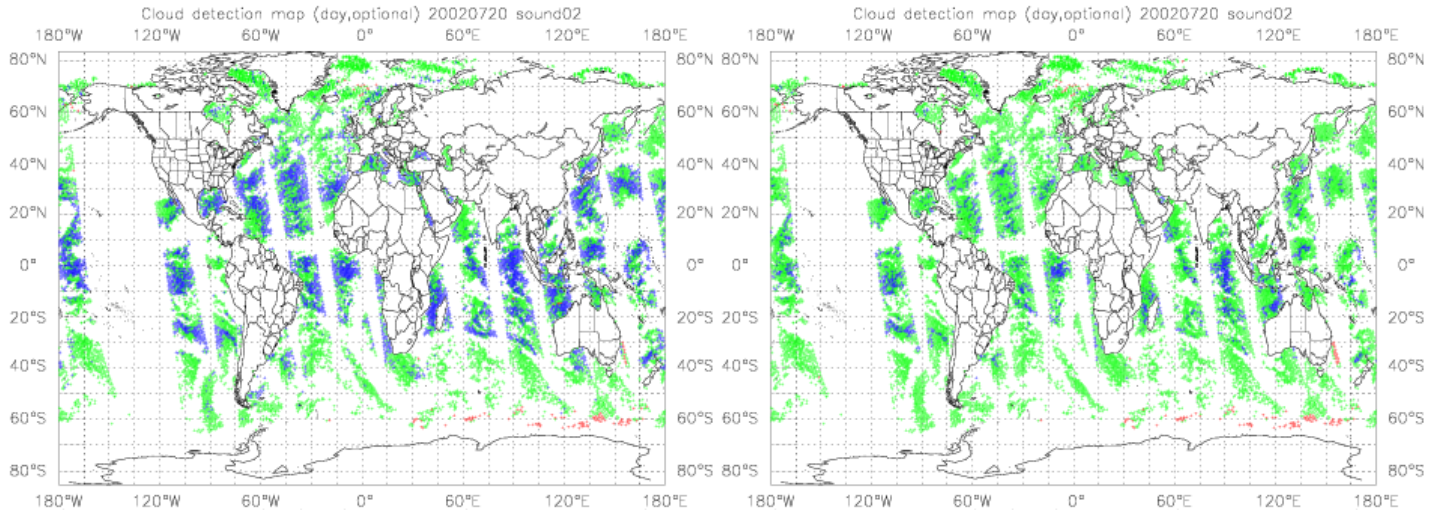


Fig.18-2 As Fig.18-1, but for sound02 channel set in the daytime.

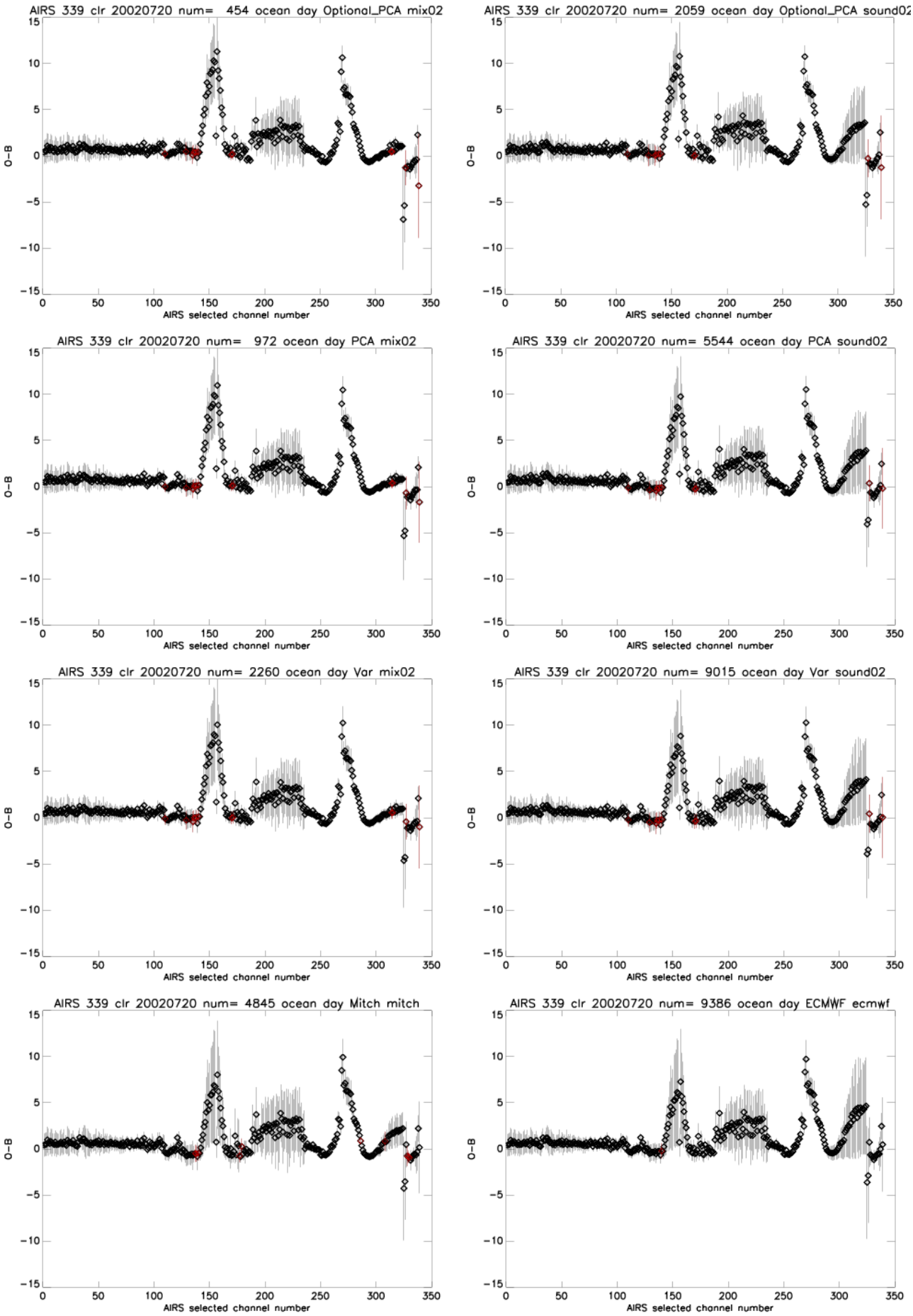


Fig.19 Mean and standard deviation of O-B difference of clear FOV for all distributed AIRS channels and AMSU-A channels.in the daytime. Red channels are used channels in the cloud detection. The three upper rows are for Optional PCA scheme (upper), PCA scheme (middle), and Var scheme (low). Lefts are for mix02 channel set and rights for sound02 channel set. The left of the lowest row is for Mitch scheme and the right of the lowest row for ECMWF scheme.

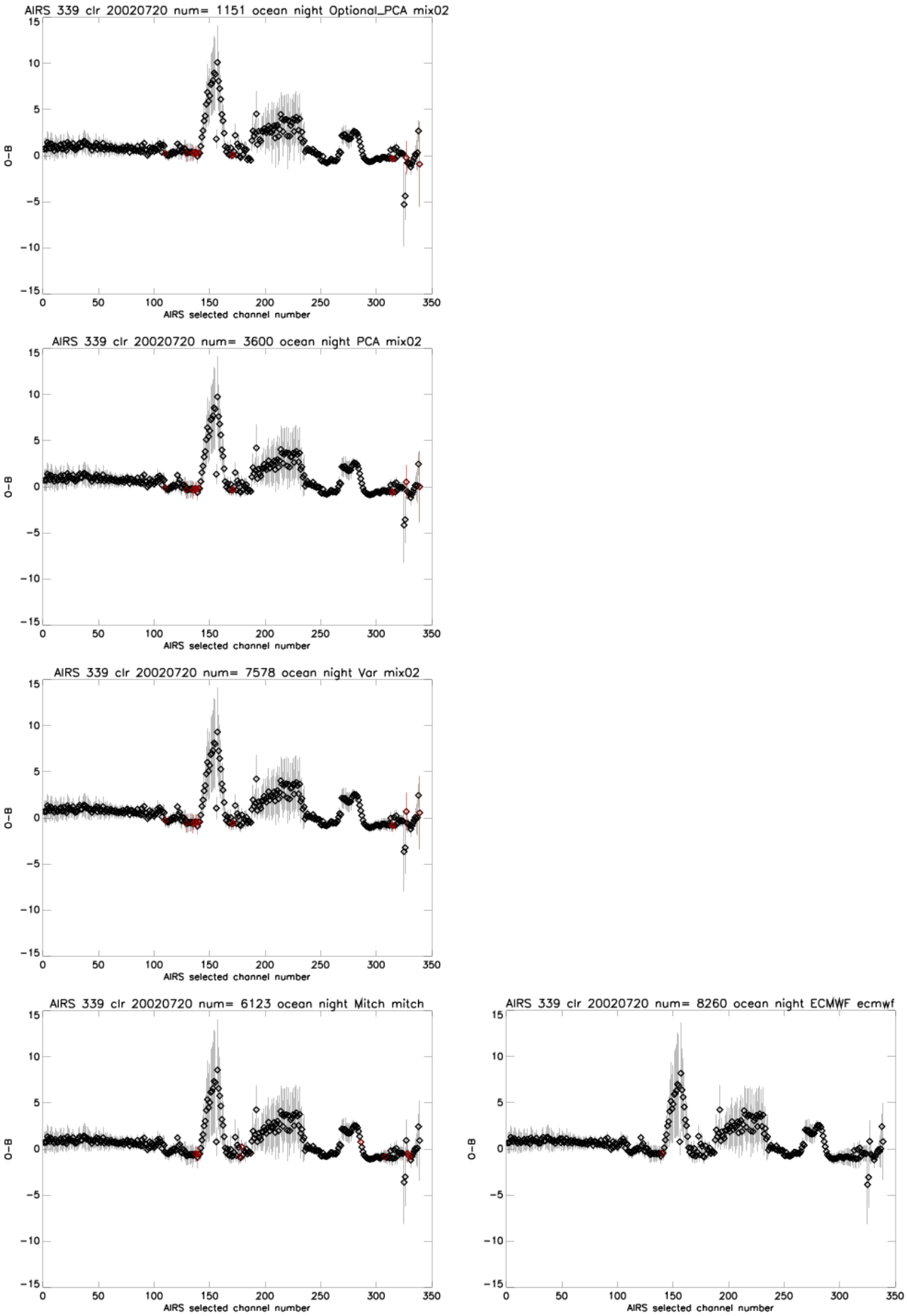


Fig.20 As Fig.19, but for in the nighttime. The results for mix02 channel set with Optiona PCA, PCA, and Var schemes are shown.

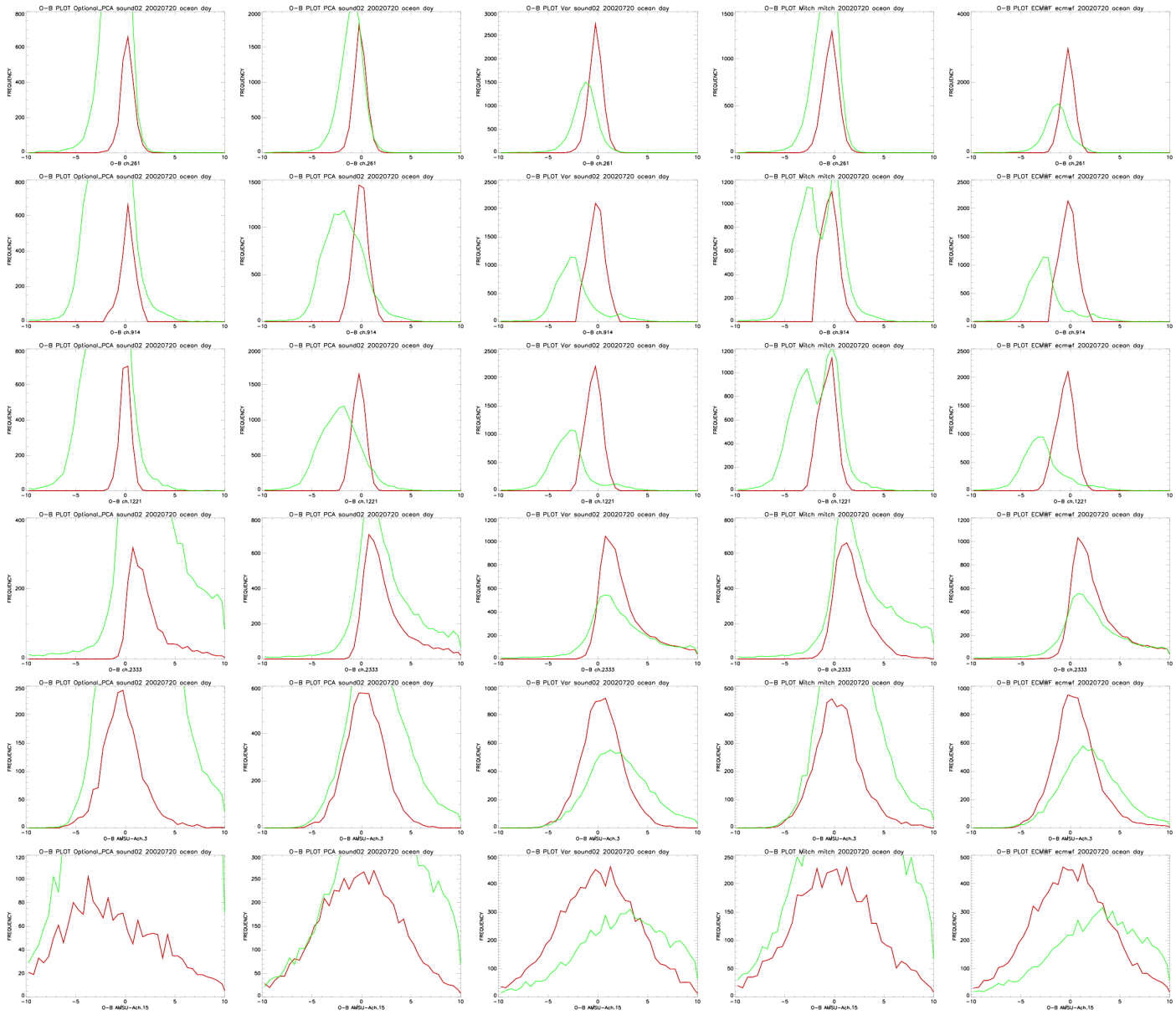


Fig.21-1 O-B histogram for selected channels for clear case (red) and for cloudy case (green) with each schemes in the daytime. The channels are AIRS ch.261, ch.914, ch.1221, ch.2333, and AMSU-A ch.3, and ch.15 from top to bottom.

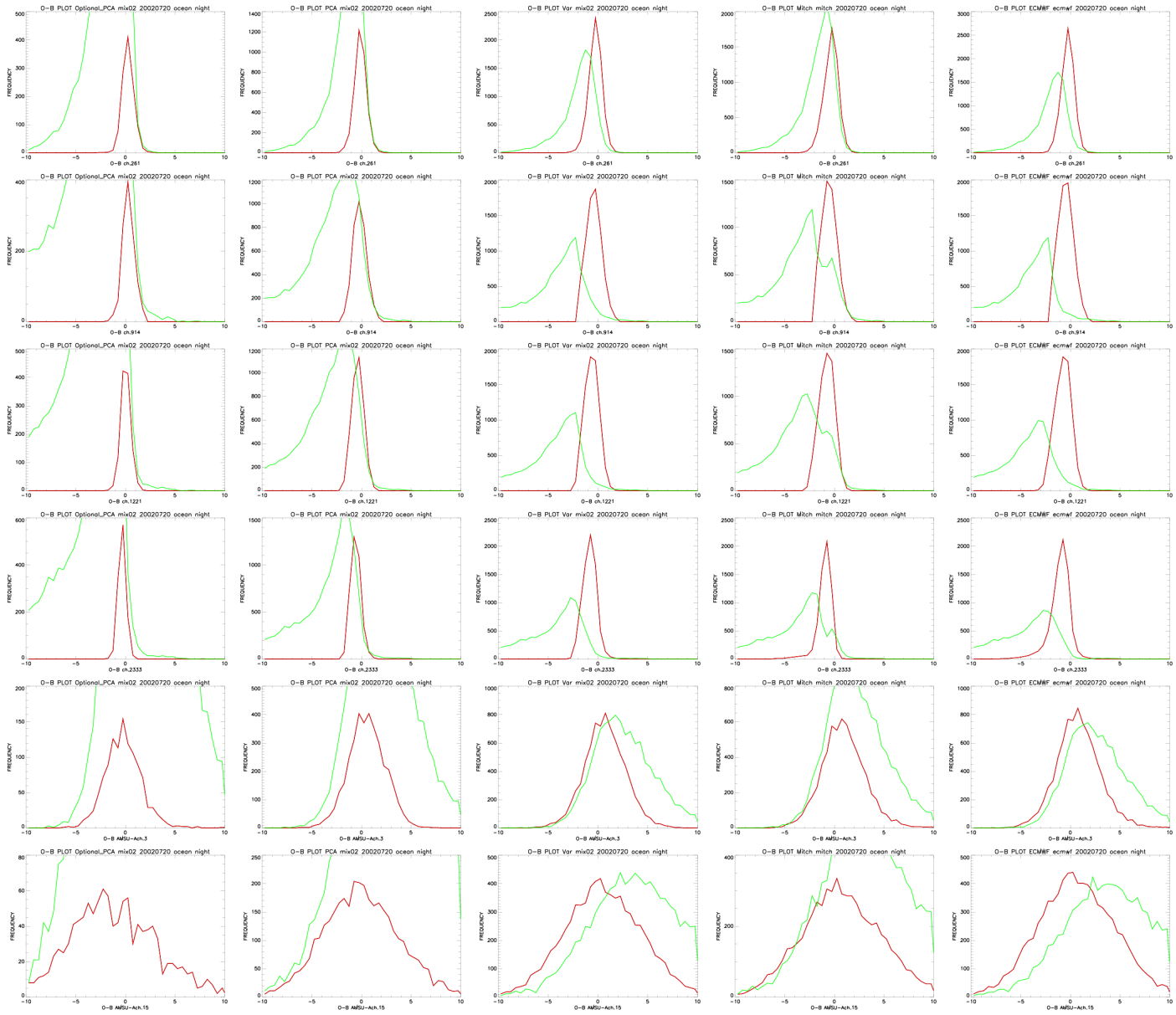


Fig.21-2 As Fig.21-1, but for the nighttime

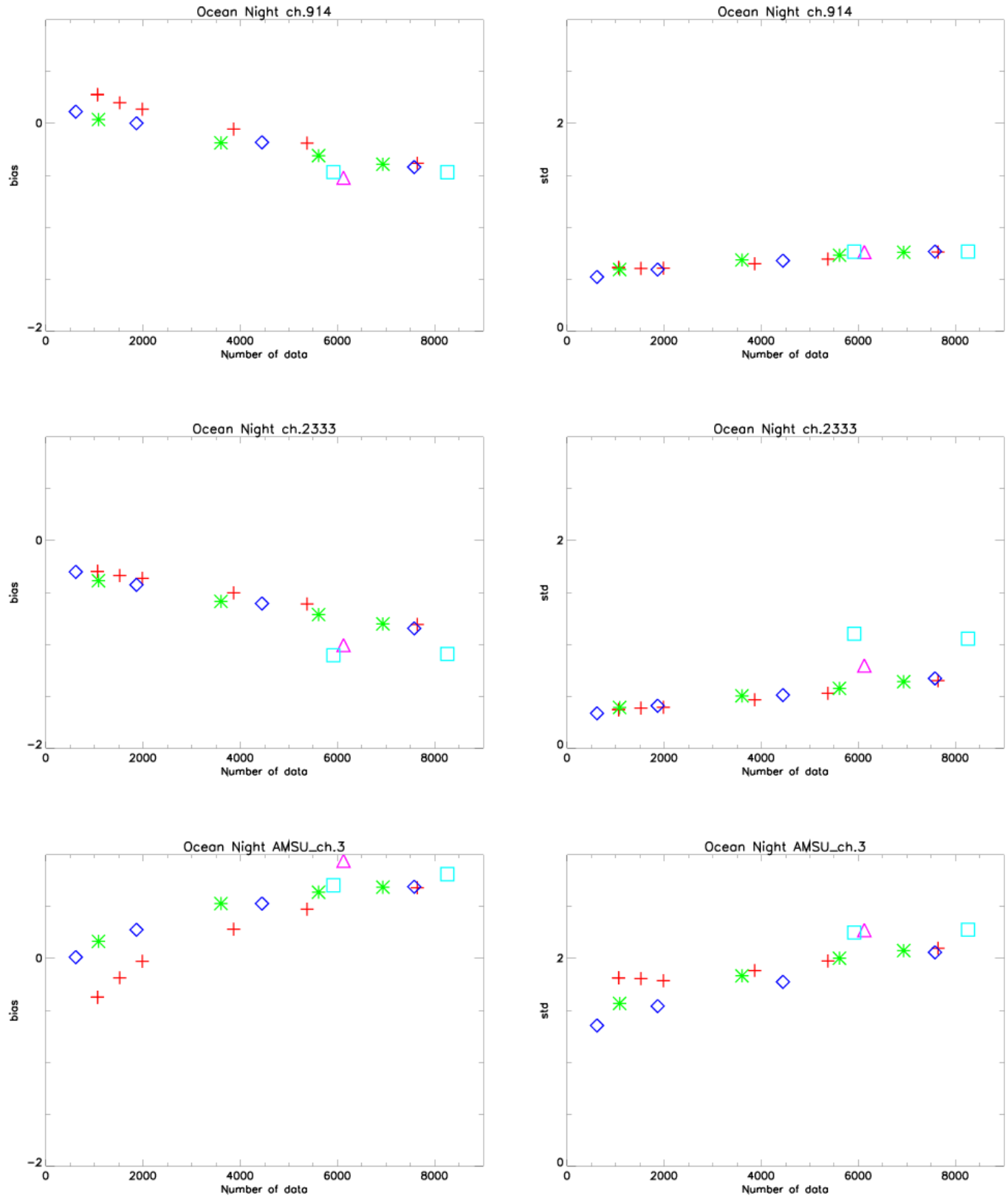


Fig.22 Dependency of O-B statistics, i.e., mean (left) and standard deviation (right), in the nighttime against normalized by number of clear FOVs for each scheme. Channels are AIRS ch.914 (upper), ch.2333 (middle), and AMSU-A ch.3 (lower). Red plus is for Optional PCA scheme, green cross for PCA scheme, blue diamond for Var scheme, violet triangle for Mitch's scheme, and light blue square for ECMWF scheme.

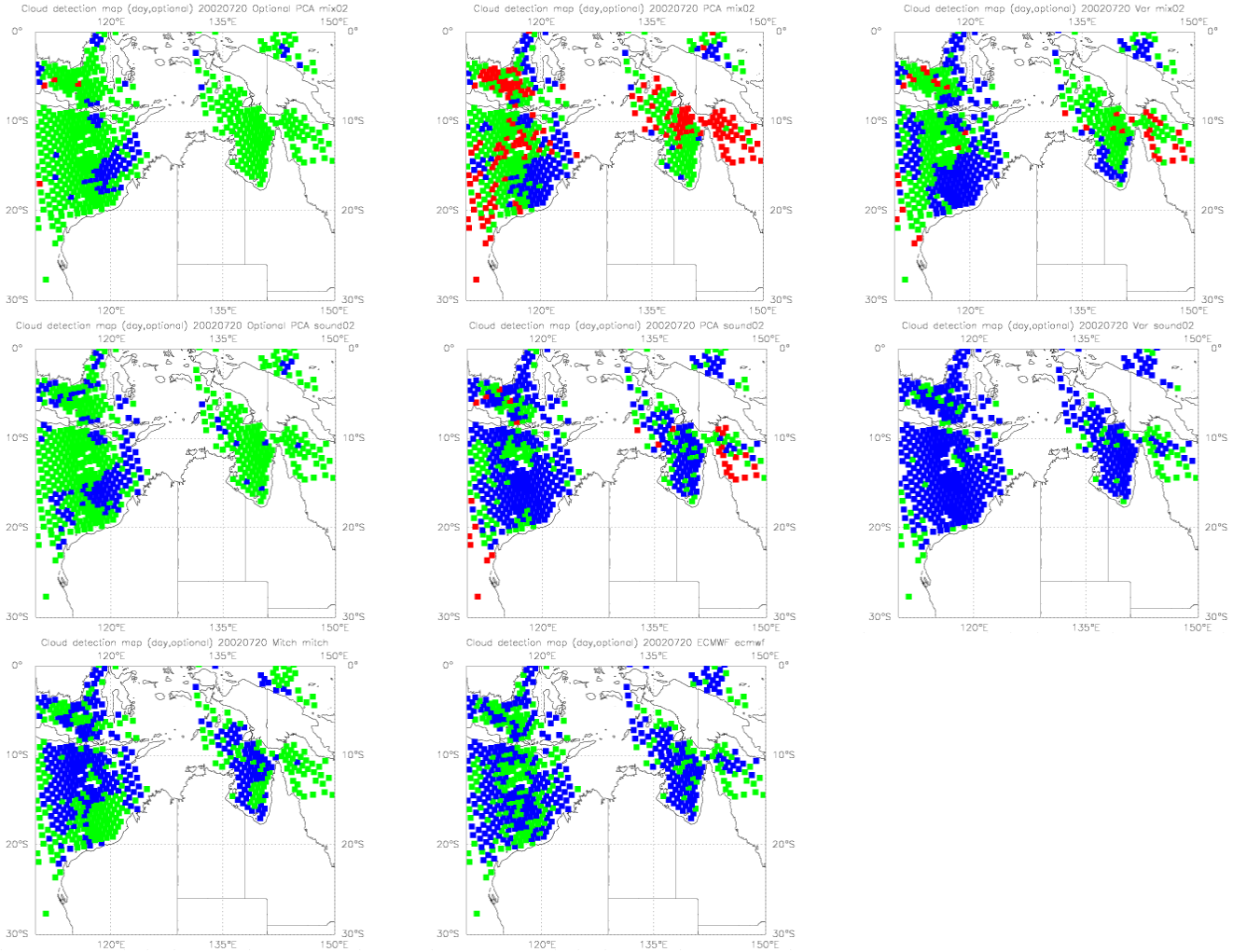


Fig.23-1 Case study around Australia (30S-0S, 110E-150E in the daytime. Cloud detection map. Upper (mix02 channel set) and middle (sound02 channel set) rows are for Optional PCA scheme (left), PCA scheme (middle), and Var scheme (right). The lower figures are for Mitch's scheme (left) and ECMWF scheme (middle).

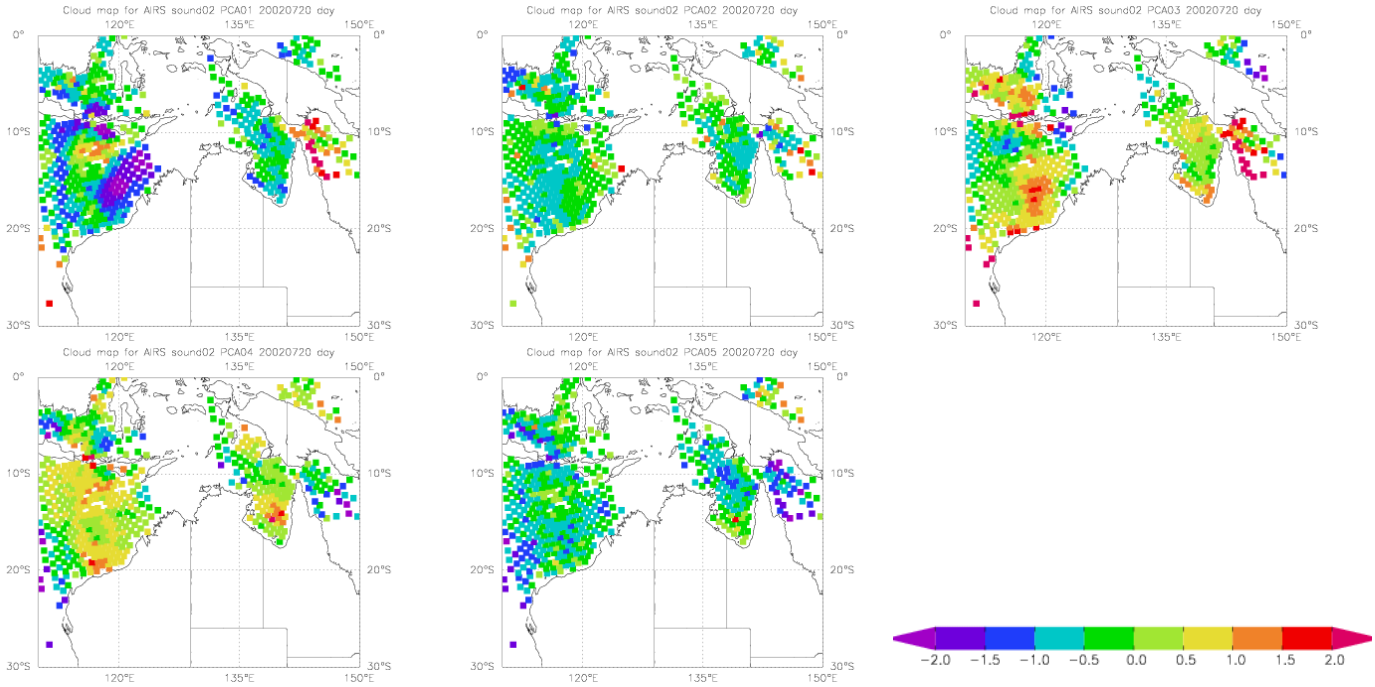


Fig.23-2 Case study around Australia. The first five PCA components for cloud characterization with sound02 chanel set. Red means large value and violet small value.

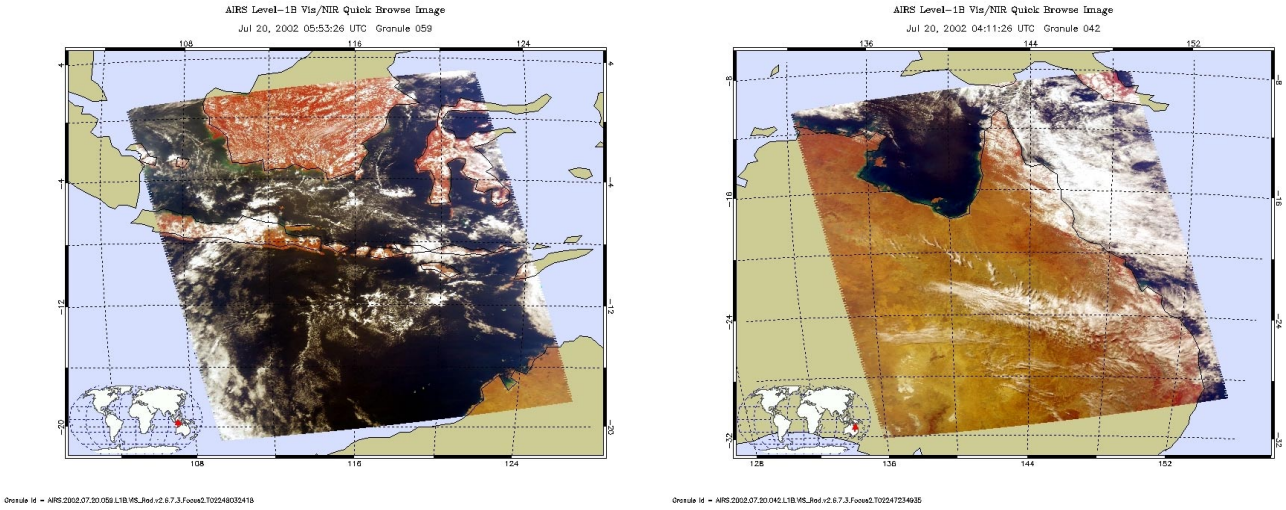


Fig.23-3 Case study around Australia. AIRS level-1B VIS/NIR false composite image provided by NASA Goddard Earth Science DAAC.

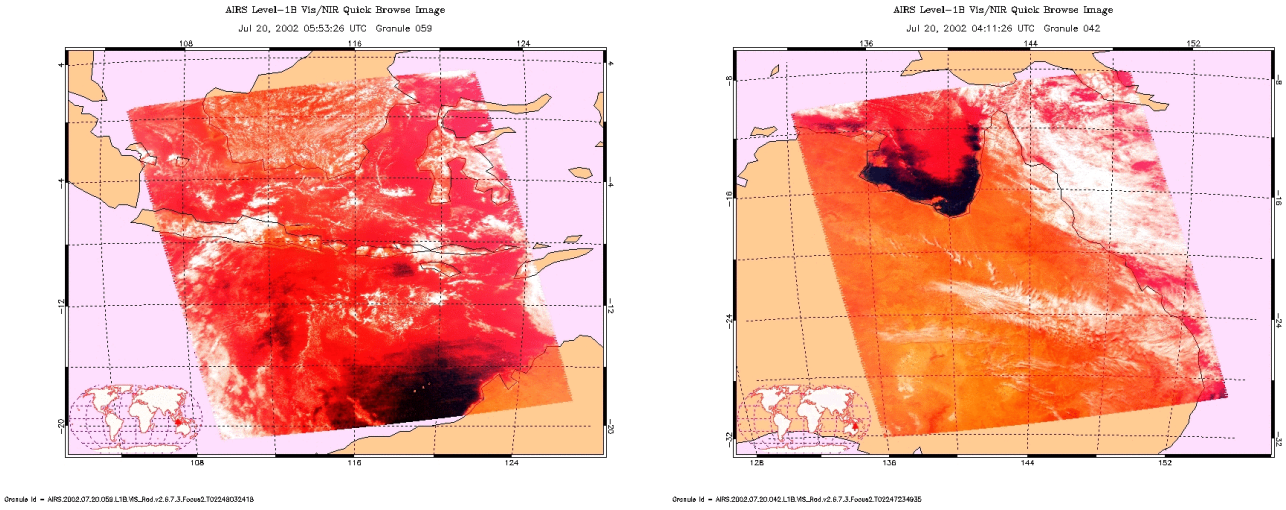


Fig.23-4 Case study around Australia. AIRS VIS/NIR enhanced image.

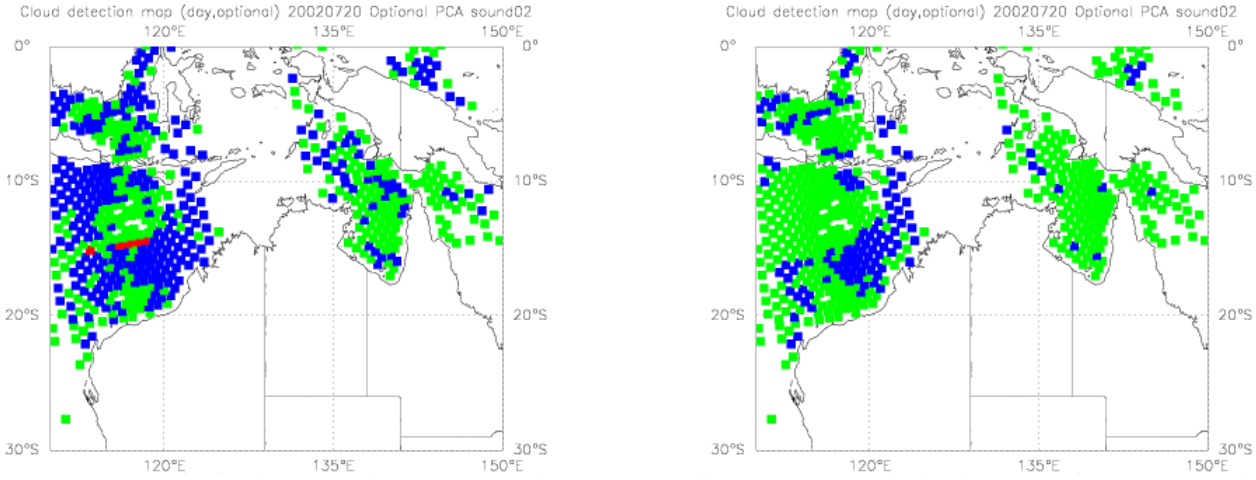


Fig.23-5 Cloud detection map with sound02 channel set with case study. Left:with cloud probability in the nighttime, Right:with cloud probability in the daytime.

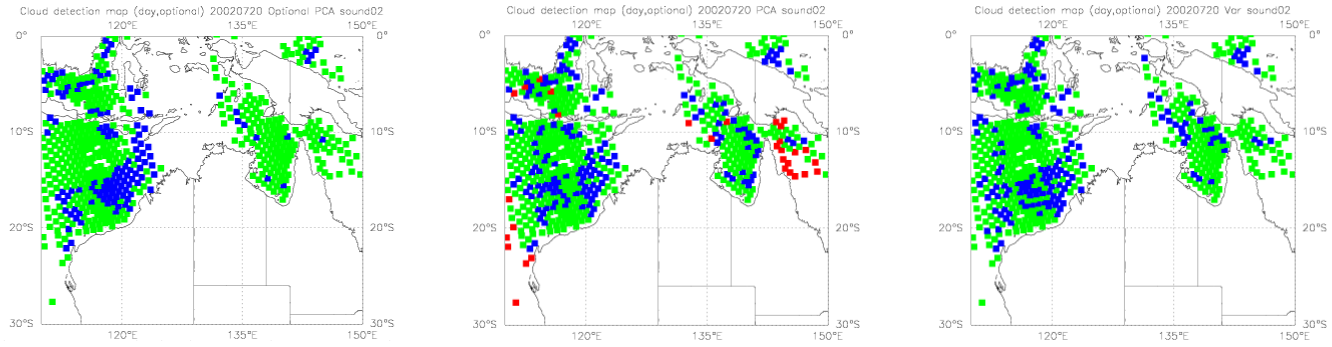


Fig.23-6 Cloud detection map after adjusting thresholds so that the number of clear FOVs declared by each scheme is about 2050, i.e. 12% of all ocean FOVs. Left: Optional PCA scheme, Center: PCA scheme, and Right: Var scheme. Sound02 channel set is used.

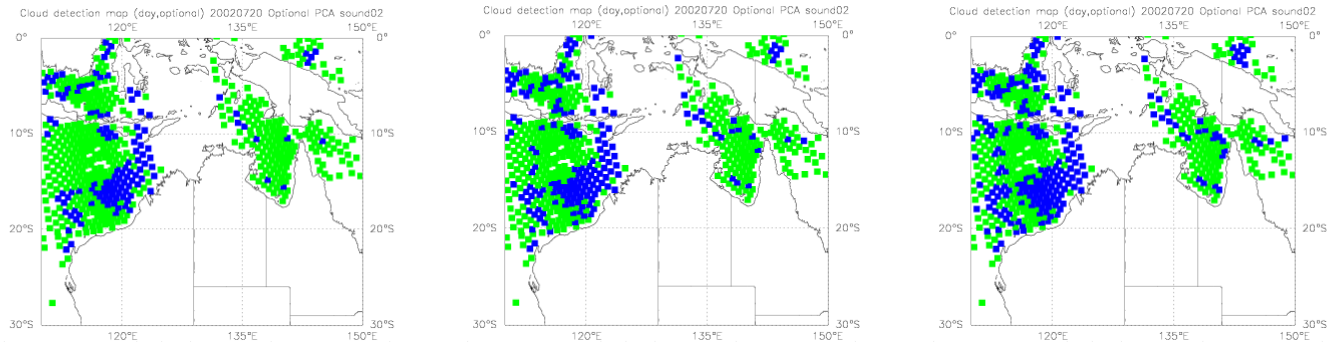


Fig.23-7 Cloud detection map with Optional PCA scheme with different thresholds. Left: 0.0 (declared clear FOVs of about 2050), Center: 0.05 (declared clear FOVs of about 2800), and Right: 0.10 (declared clear FOVs of about 3550). Sound02 channel set is used.

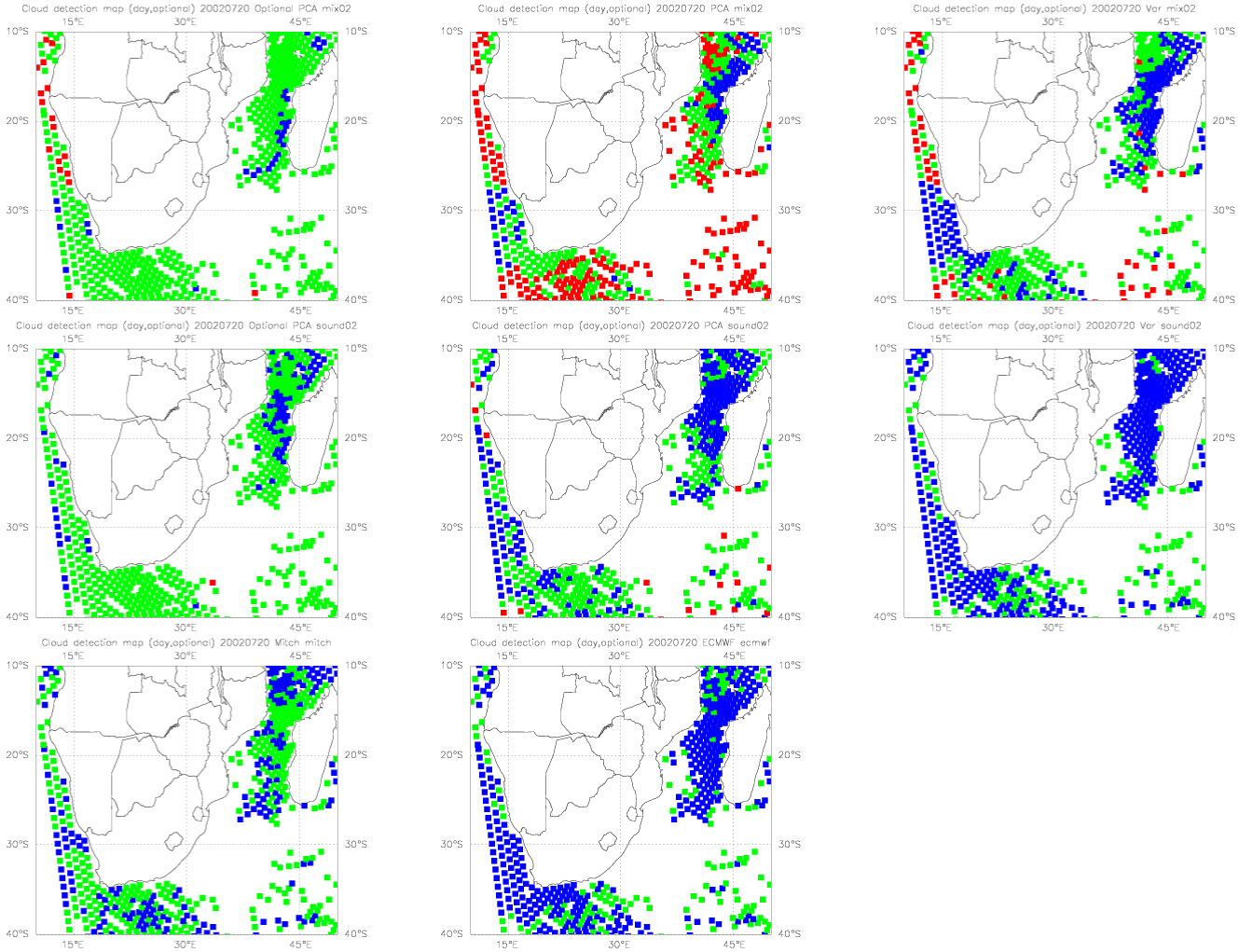


Fig.24-1 As Fig.23-1, but for around South Africa (40S-10S, 10E-50E) in the daytime.

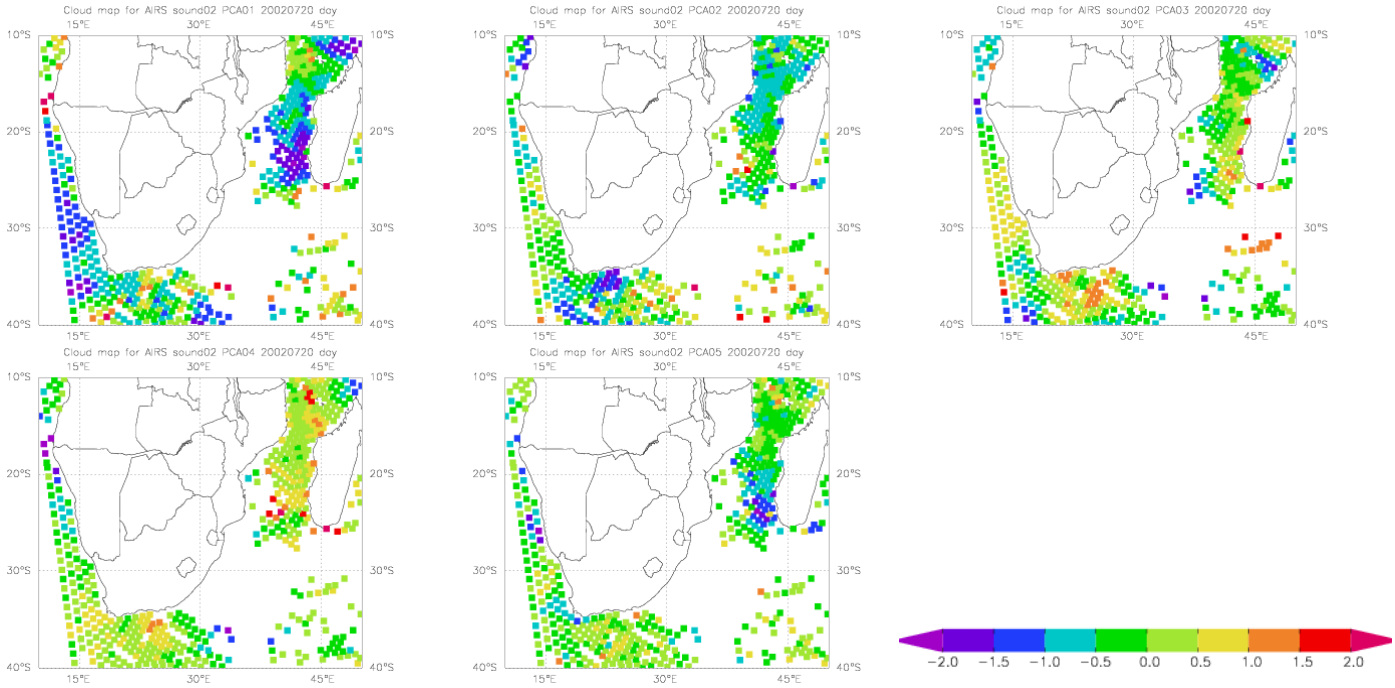


Fig.24-2 As Fig.23-2, but for around South Africa (40S-10S, 10E-50E) in the daytime.

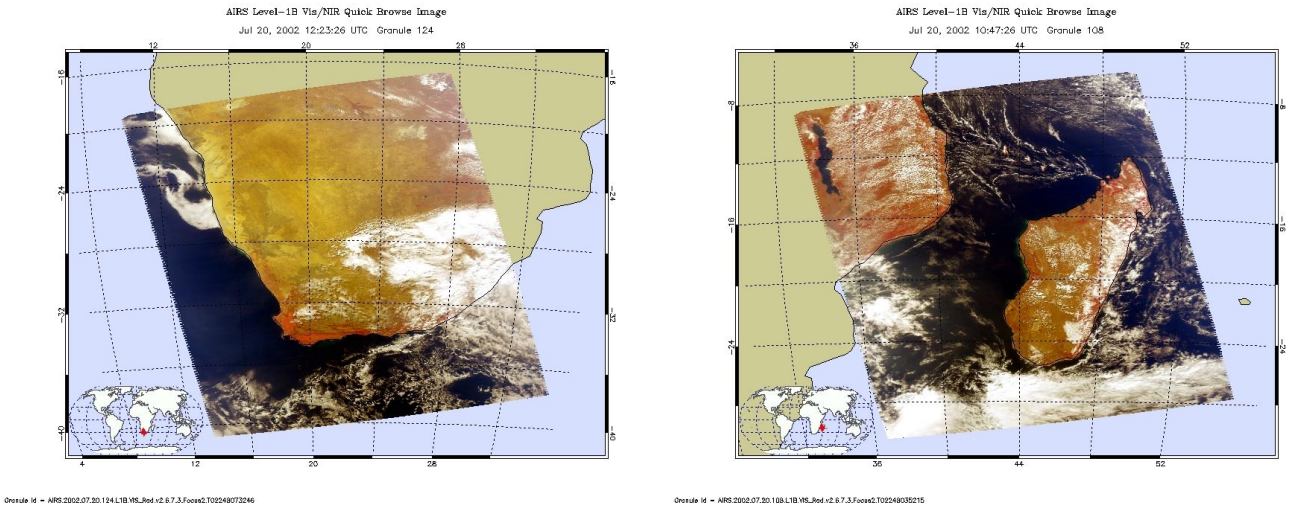


Fig.24-3 As Fig.23-3, but for around South Africa (40S-10S, 10E-50E) in the daytime.

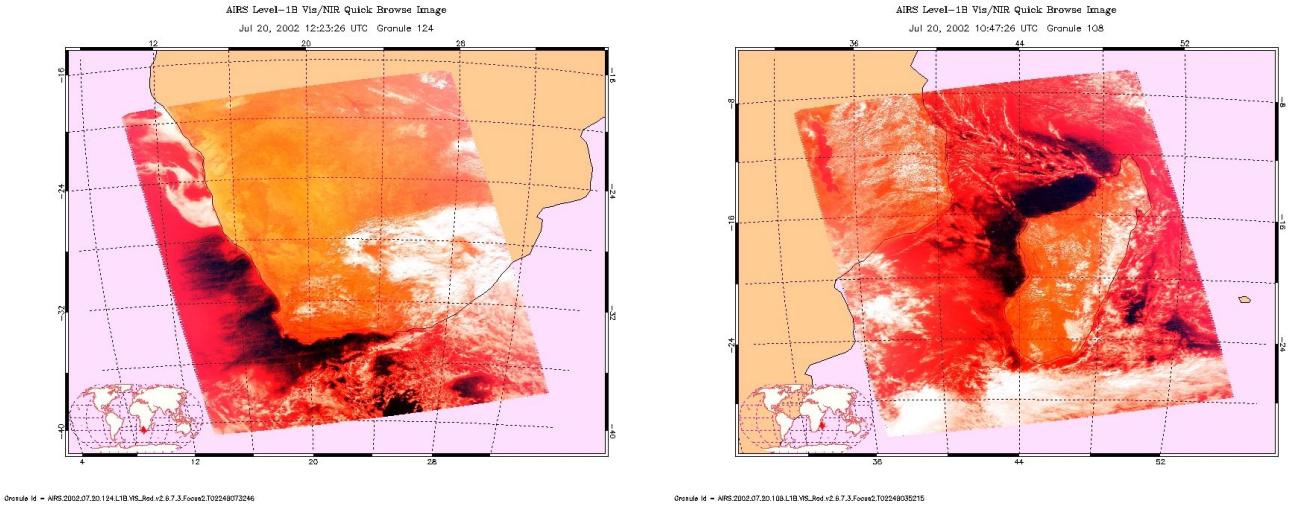


Fig.24-4 As Fig.23-4, but for around South Africa (40S-10S, 10E-50E) in the daytime.

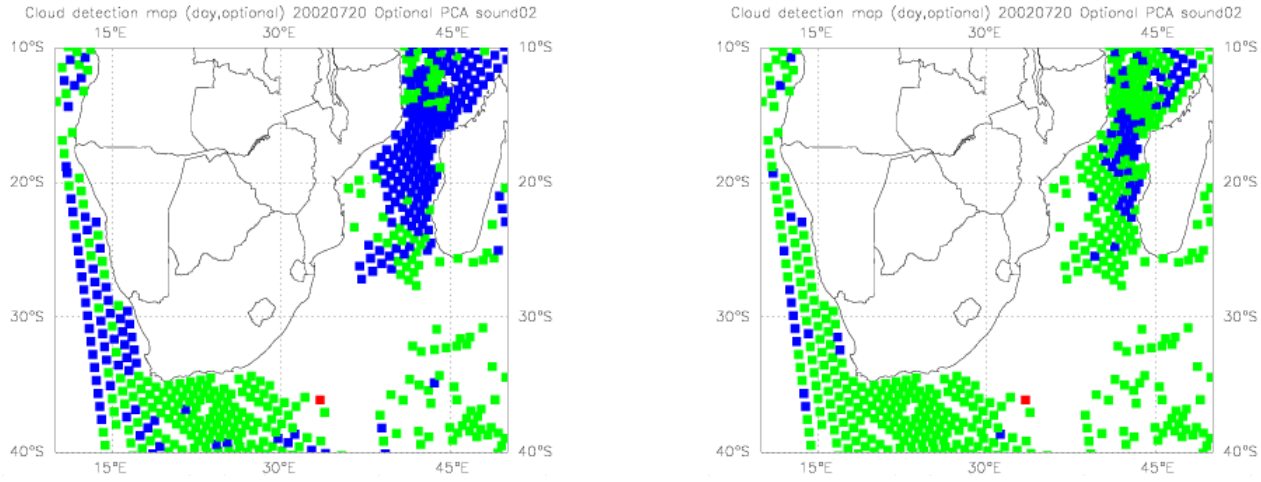


Fig.24-5 Cloud detection map with sound02 channel set with case study. Left:with cloud probability in the nighttime, Right:with cloud probability in the daytime.

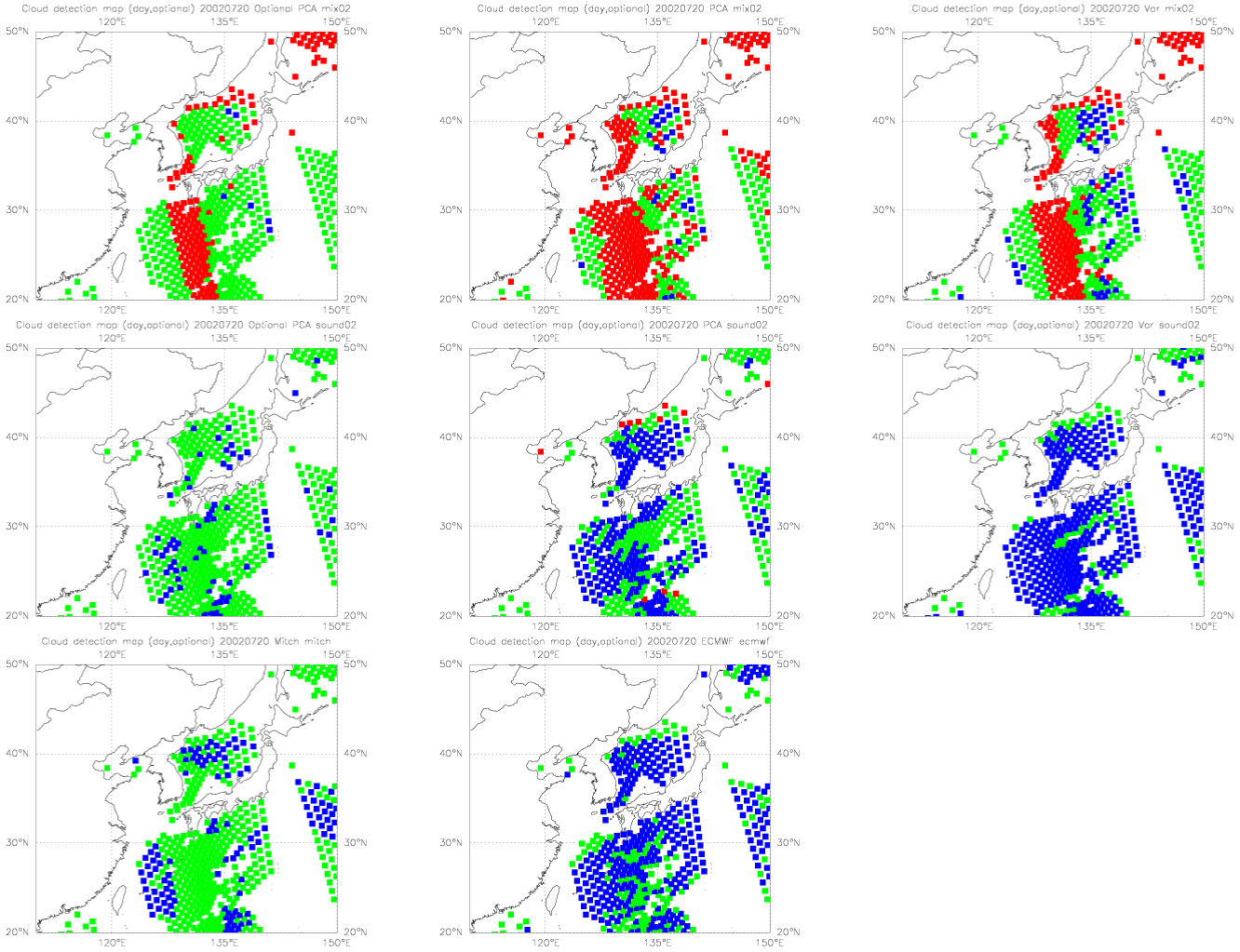


Fig.25-1 As Fig.23-1, but for around Japan (20N-50N, 110E-150E) in the daytime.

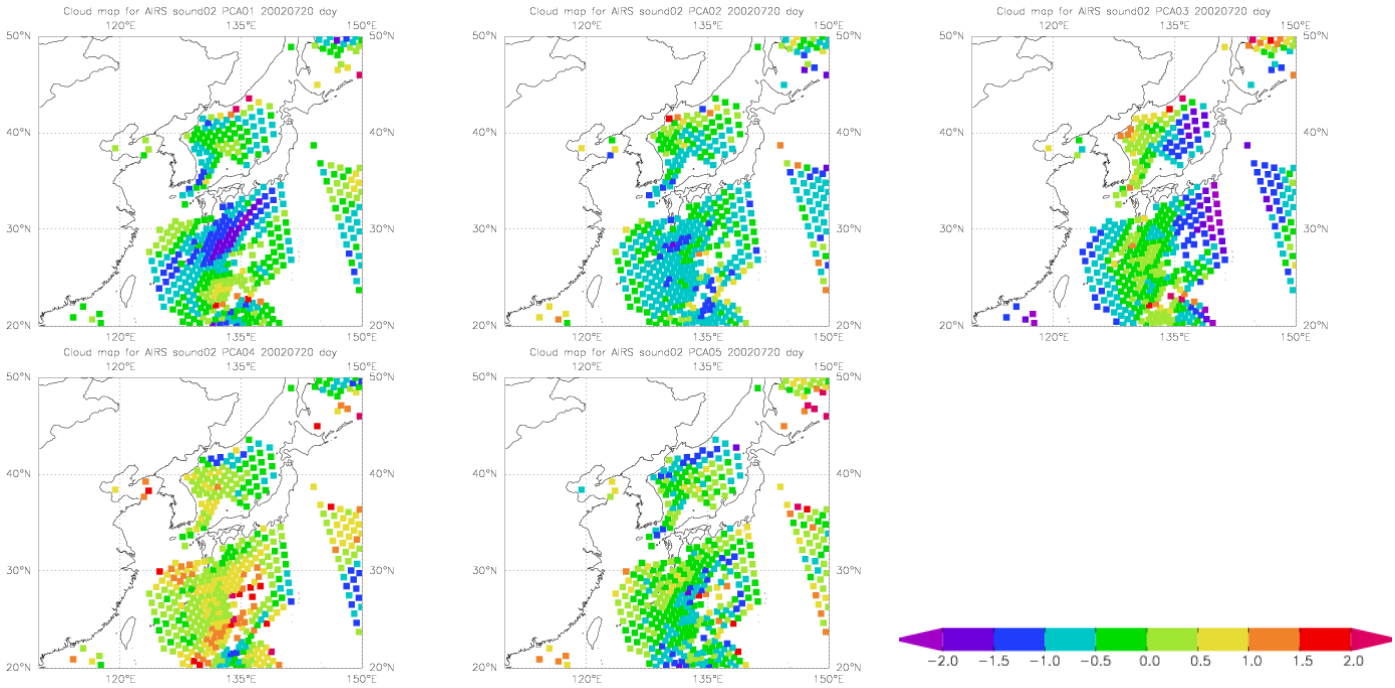


Fig.25-2 As Fig.23-2, but for around Japan (20N-50N, 110E-150E) in the daytime.

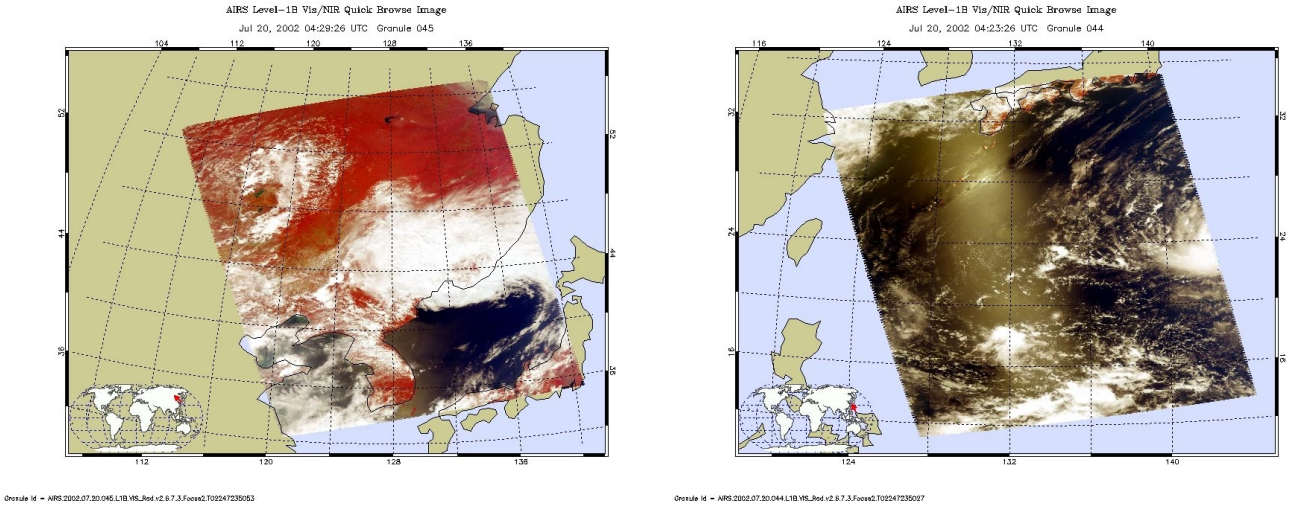


Fig.25-3 As Fig.23-3, but for around Japan (20N-50N, 110E-150E) in the daytime.

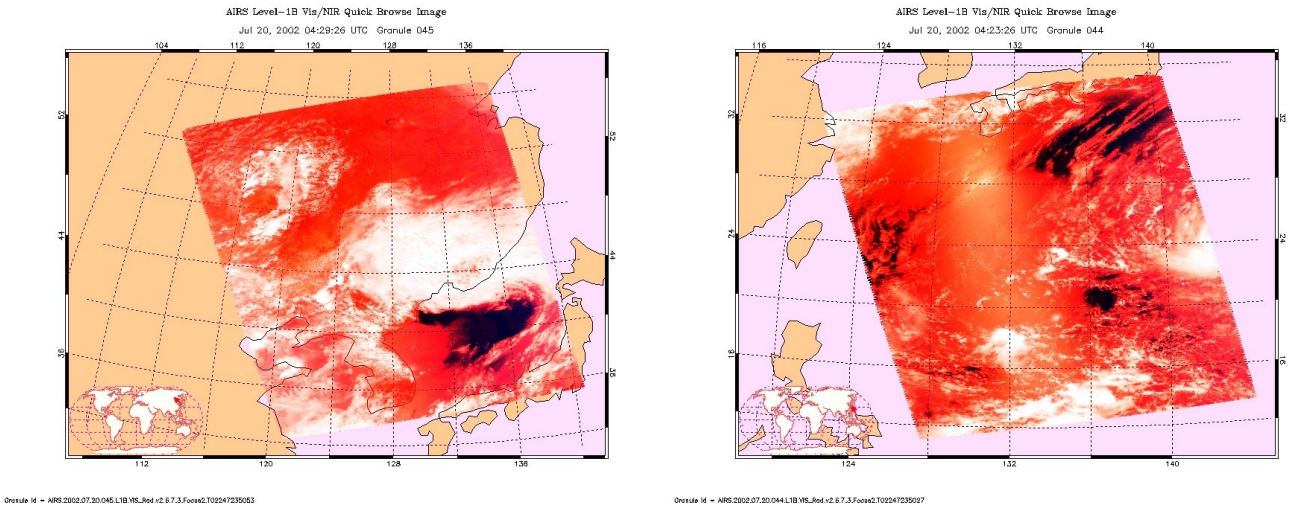


Fig.25-4 As Fig.23-4, but for around Japan (20N-50N, 110E-150E) in the daytime.

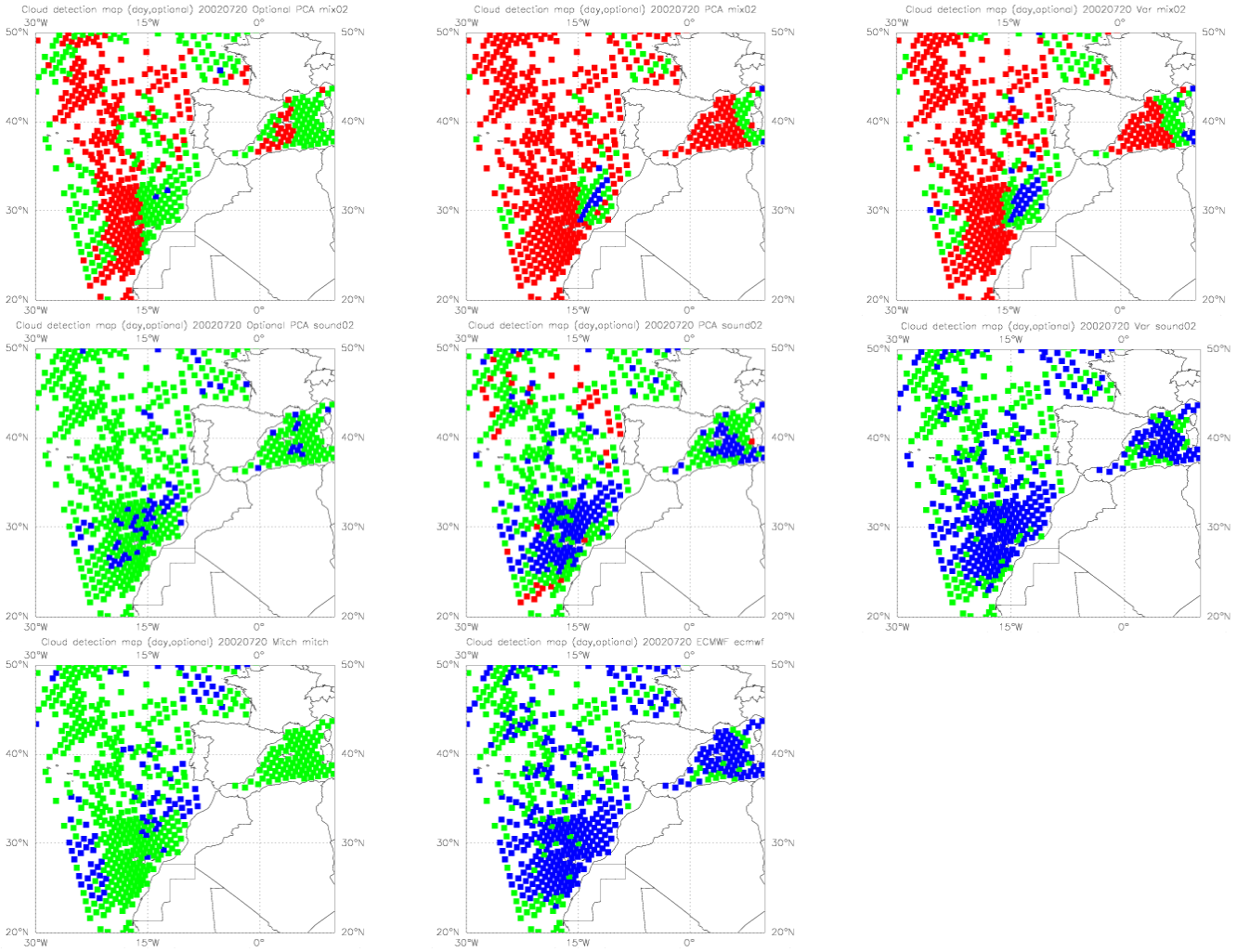


Fig.26-1 As Fig.23-1, but for around Spain (20N-50N, 30W-10E) in the daytime.

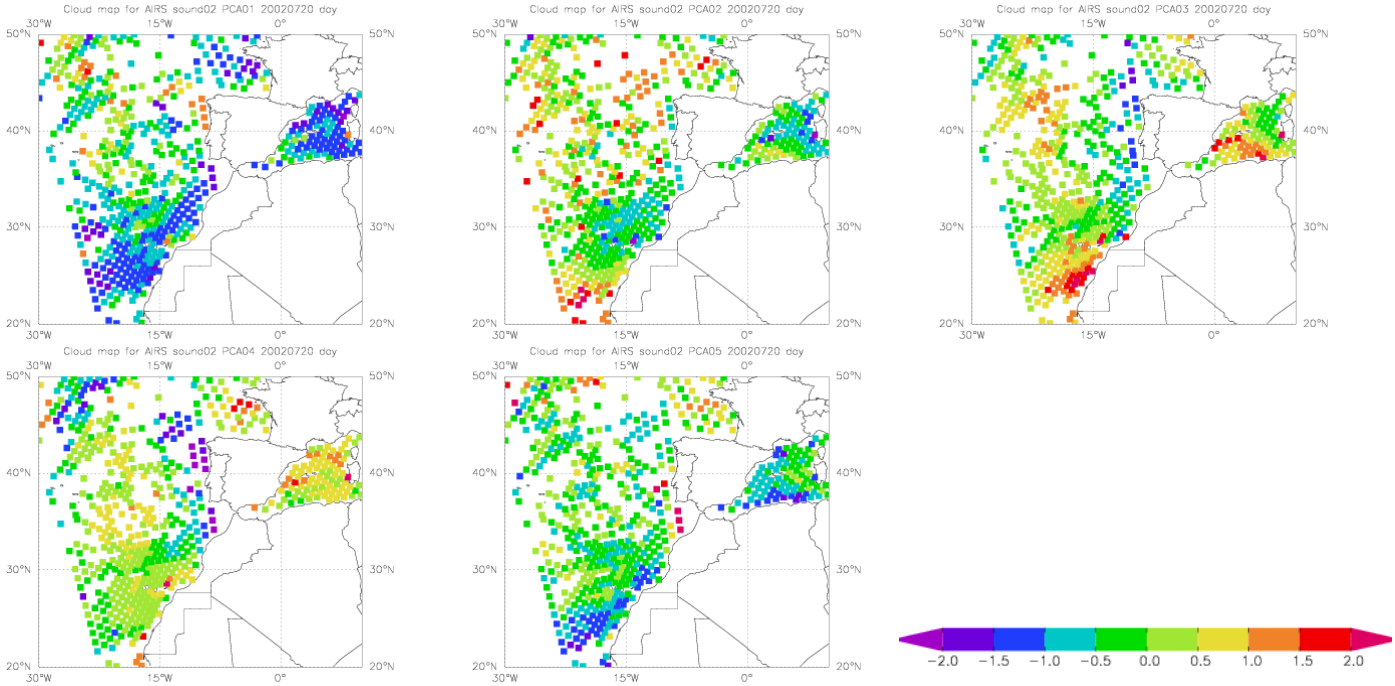


Fig.26-2 As Fig.23-2, but for around Spain (20N-50N, 30W-10E) in the daytime.

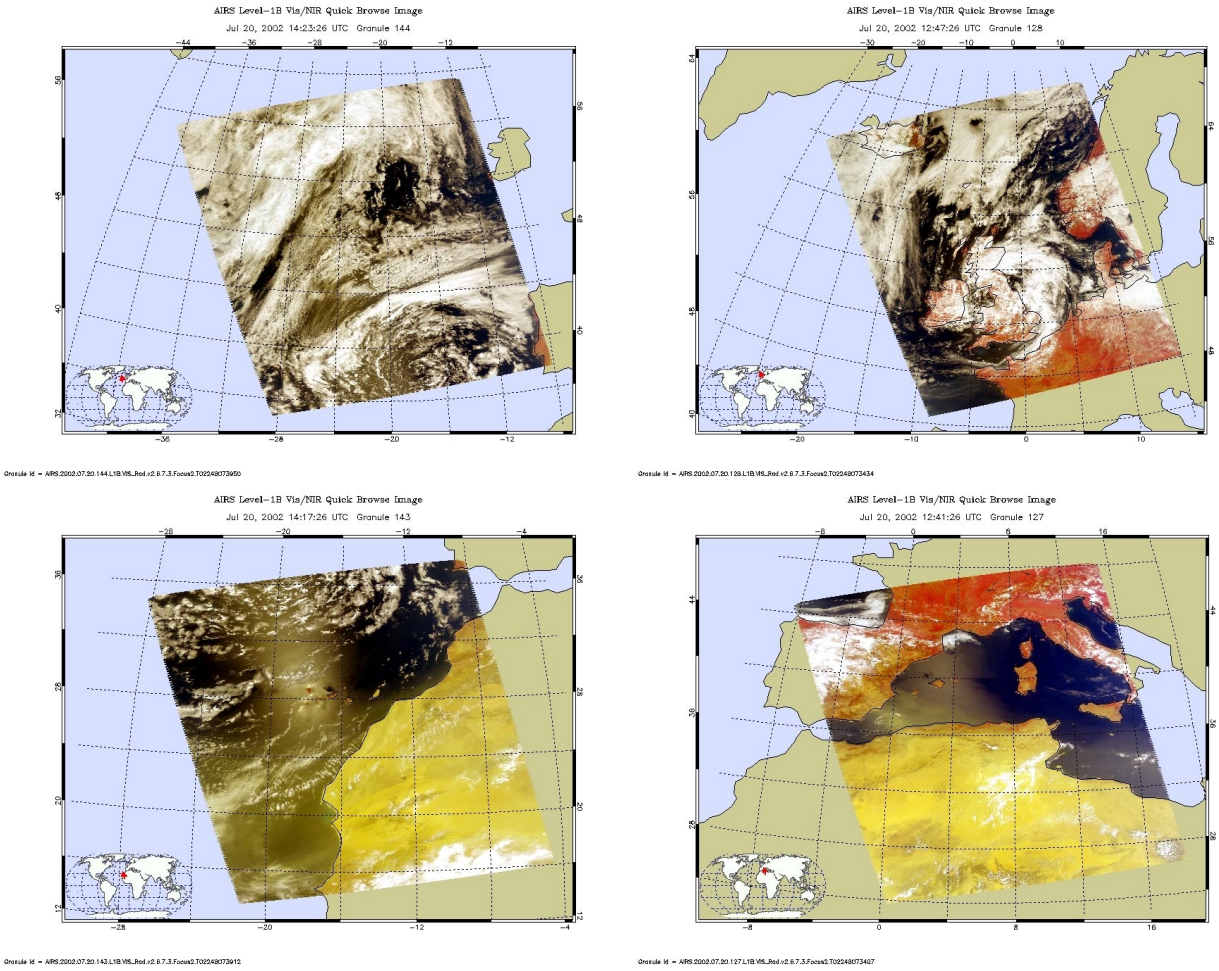


Fig.26-3 As Fig.23-3, but for around Spain (20N-50N, 30W-10E) in the daytime.

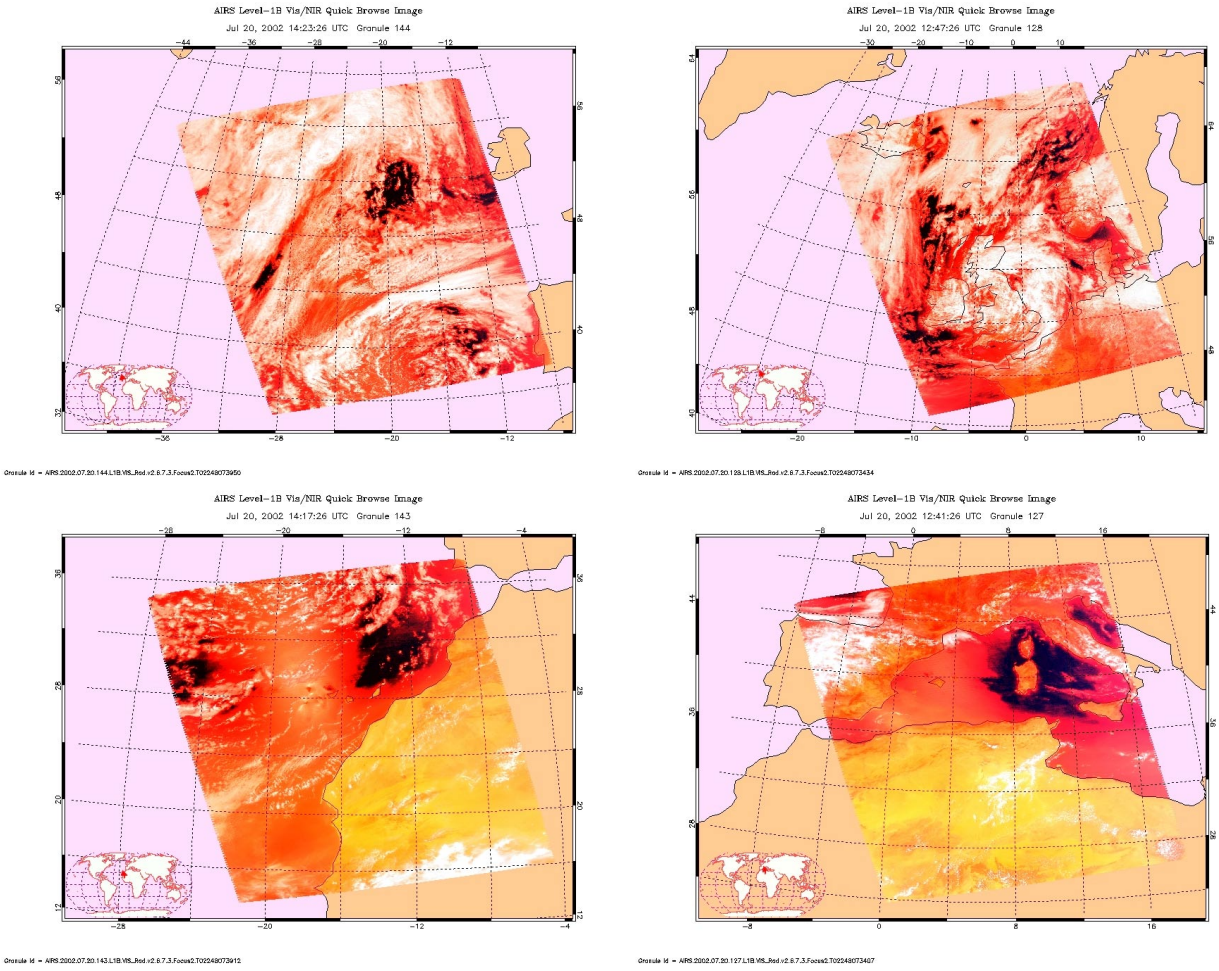


Fig.26-4 As Fig.23-4, but for around Spain (20N-50N, 30W-10E) in the daytime.

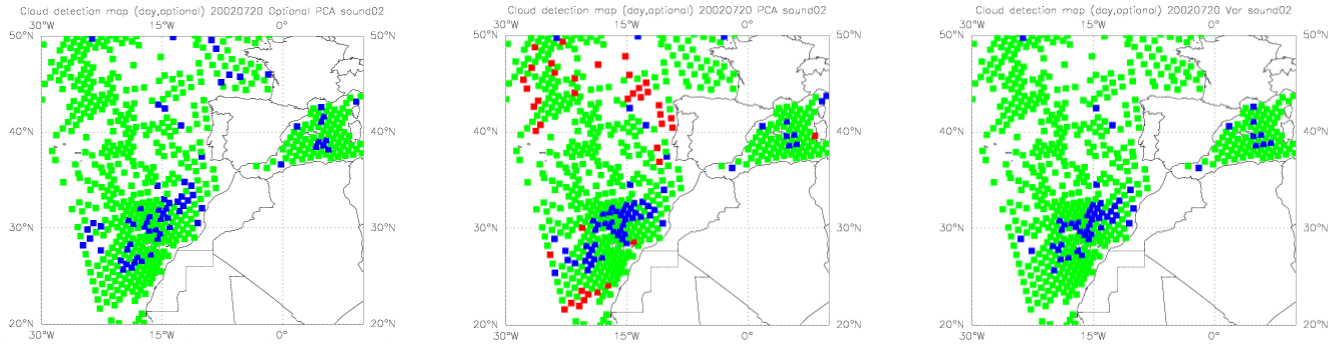


Fig.26-5 Cloud detection map after adjusting thresholds so that the number of clear FOVs declared by each scheme is about 2050, i.e. 12% of all ocean FOVs. Left: Optional PCA scheme, Center: PCA scheme, and Right: Var scheme. Sound02 channel set is used.

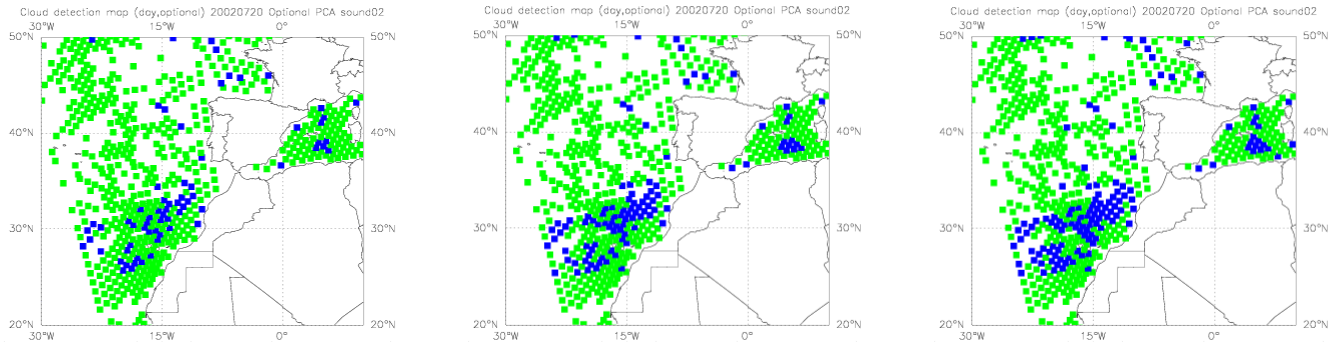


Fig.26-6 Cloud detection map with Optional PCA scheme with different thresholds. Left: 0.0 (declared clear FOVs of about 2050), Center: 0.05 (declared clear FOVs of about 2800), and Right: 0.10 (declared clear FOVs of about 3550). Sound02 channel set is used.

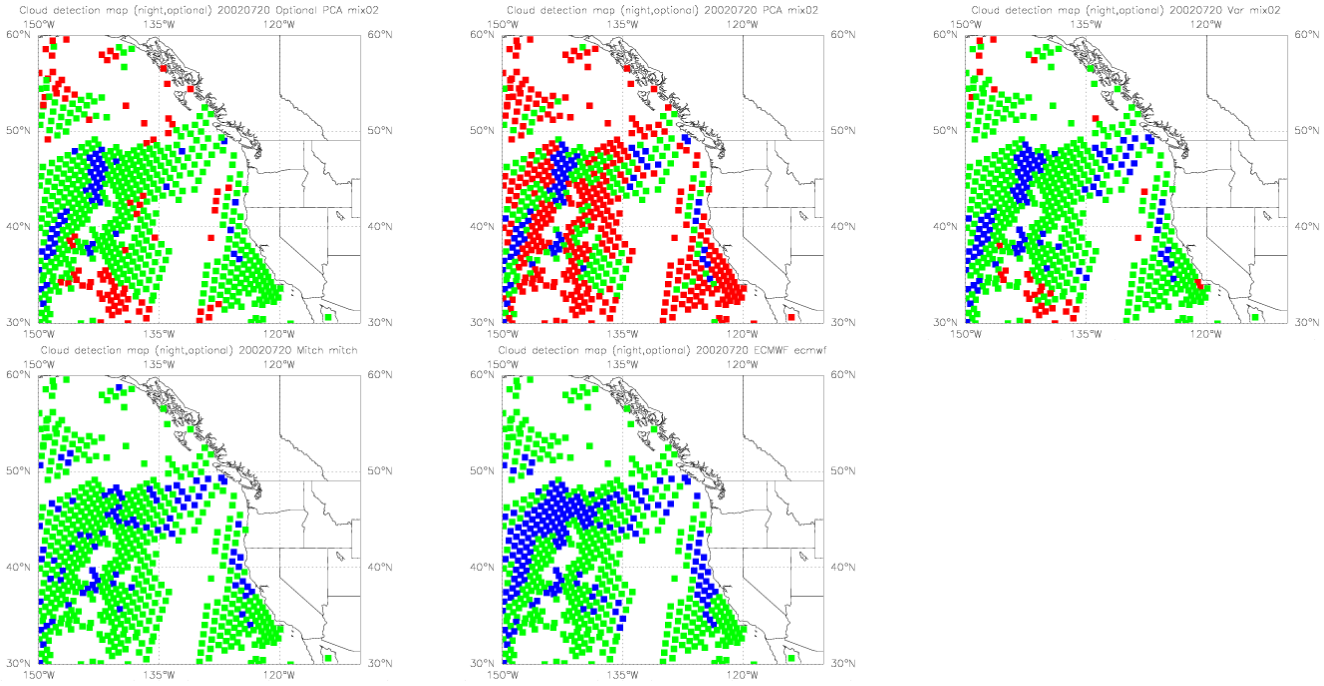


Fig.27-1 Case study in the North East Pacific (30N-60N, 150W-110W) in the nighttime. Cloud detection map. Upper rows are for Optional PCA scheme (left), PCA scheme (middle), and Var scheme (right) for mix02 channel set. The lower figures are for Mitch's scheme (left) and ECMWF scheme (middle).

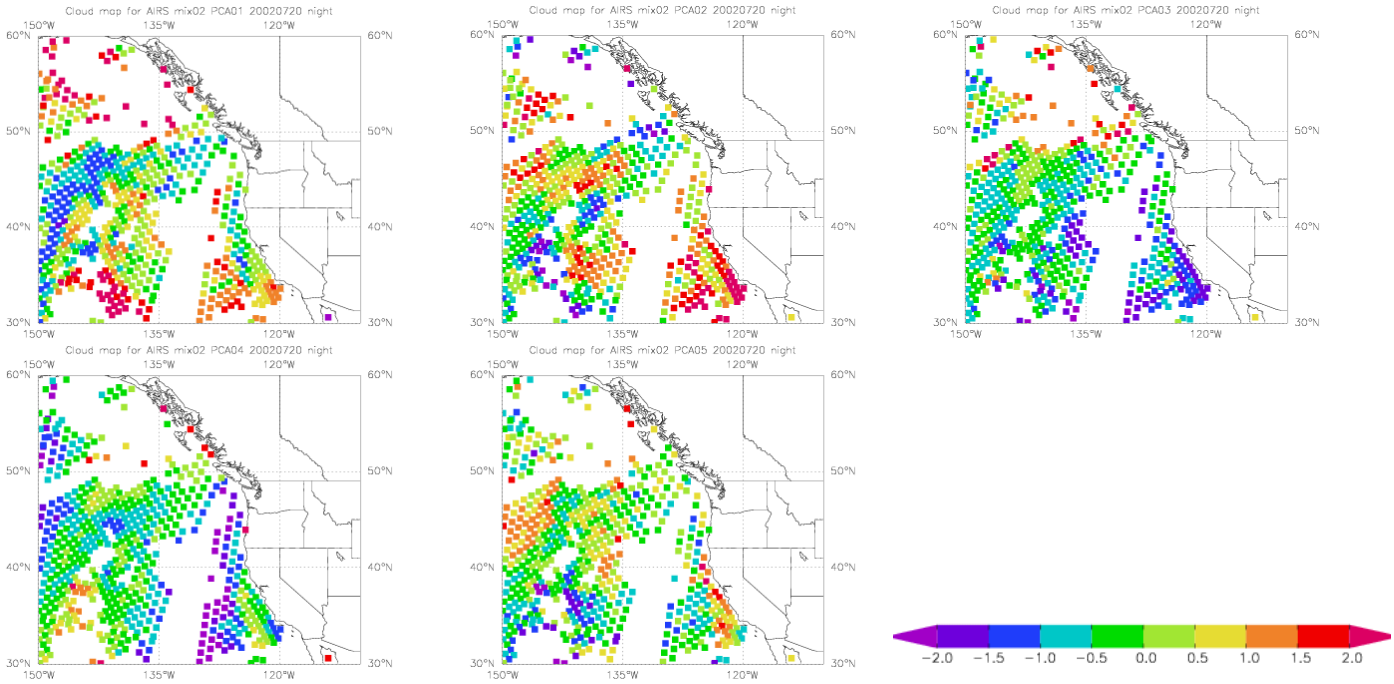


Fig.27-2 Case study in the North East Pacific (30N-60N, 150W-110W) in the nighttime. The first five PCA components for cloud characterization with mix02 channel set. Red means large value and violet small value.

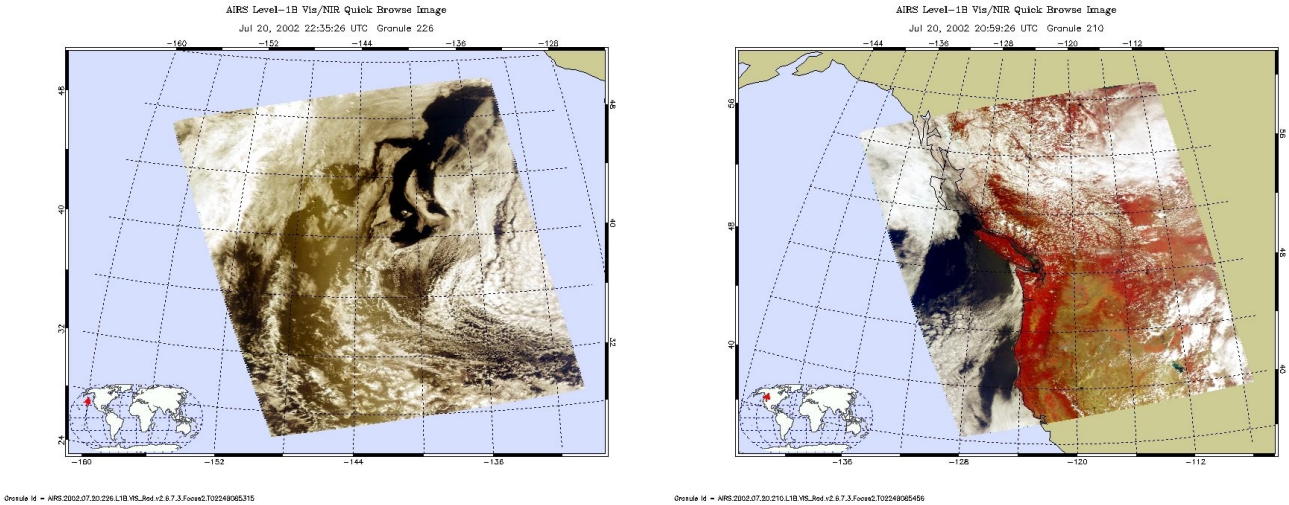


Fig.27-3 As Fig.23-3, but for North East Pacific (30N-60N, 150W-110W) in the daytime.

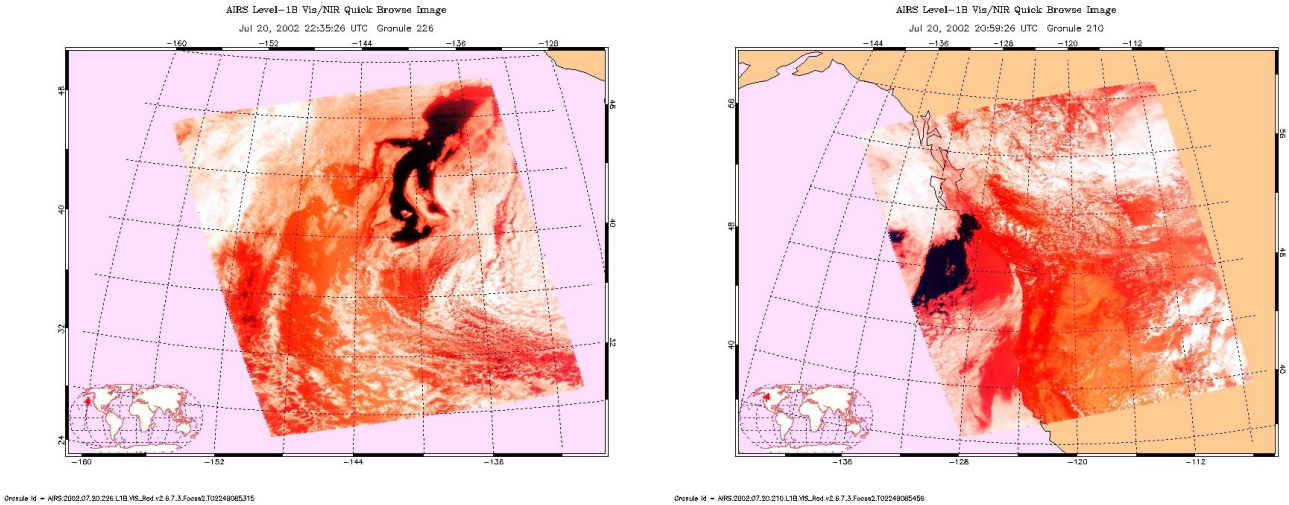


Fig.27-4 As Fig.23-4, but for North East Pacific (30N-60N, 150W-110W) in the daytime.

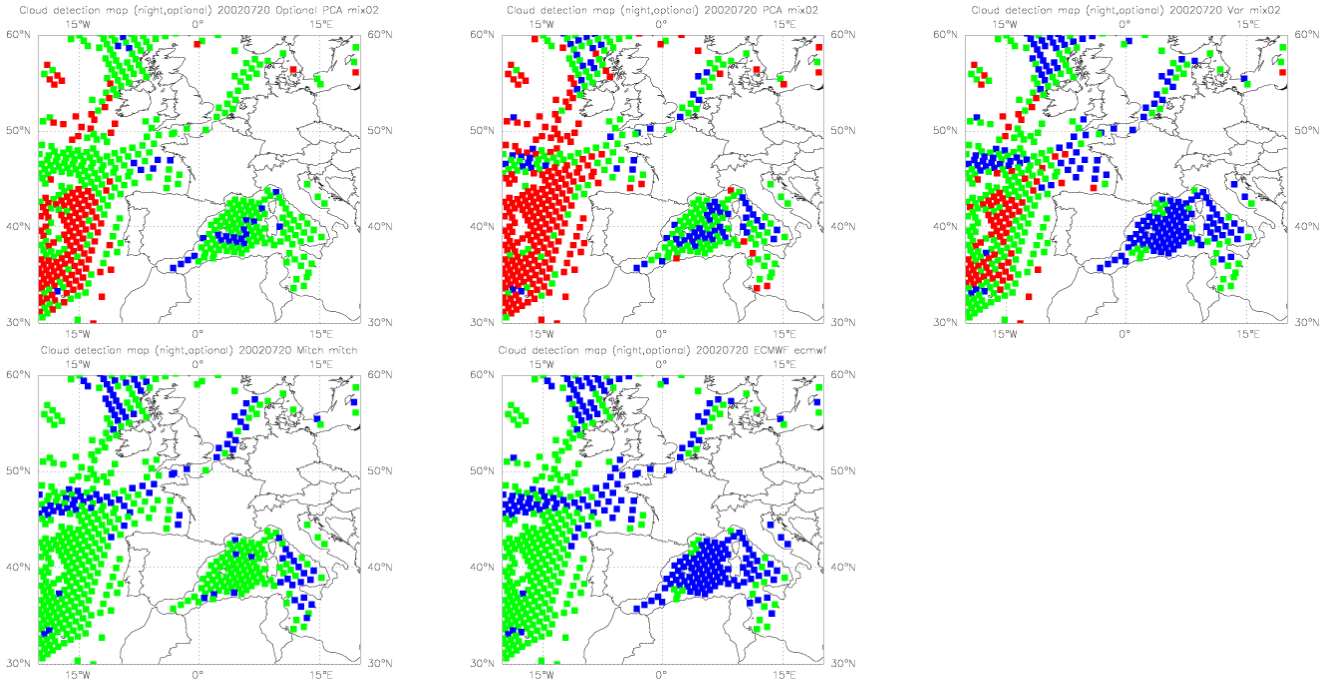


Fig.28-1 As Fig.27-1, but for around Western Europe (30N-60N, 20W-20E) in the nighttime.

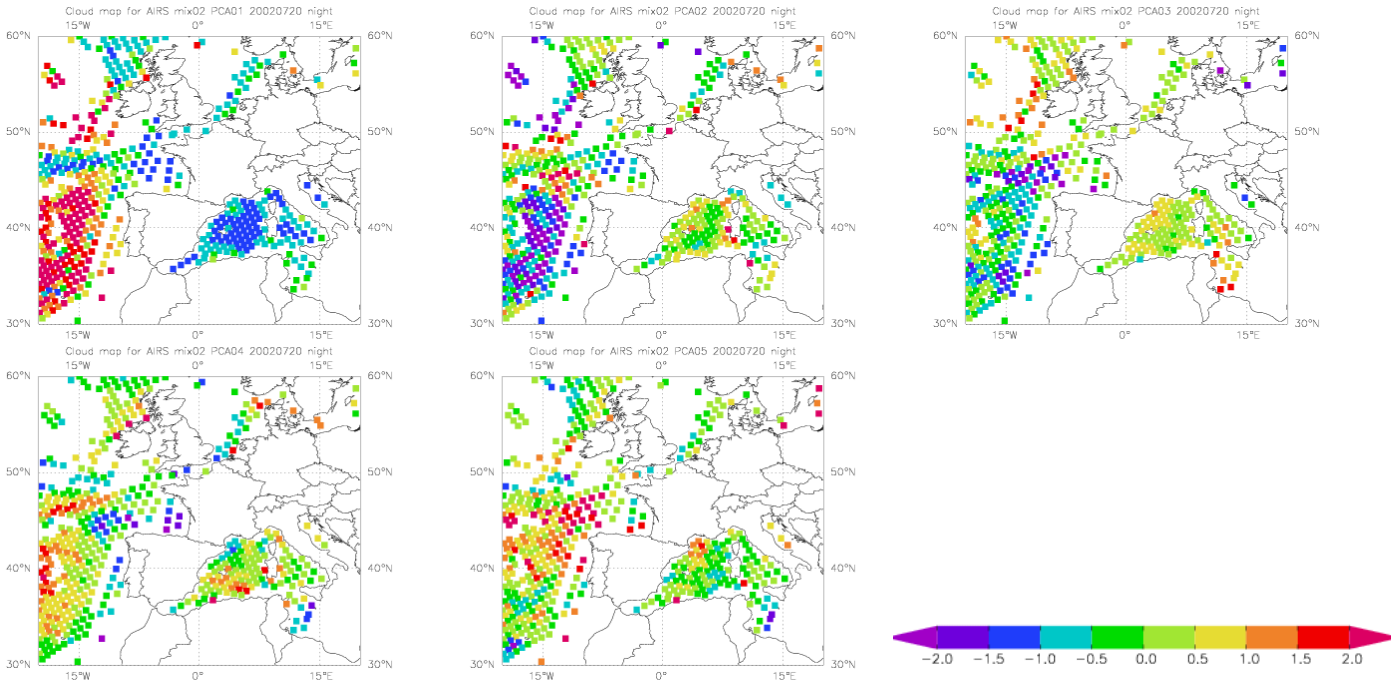
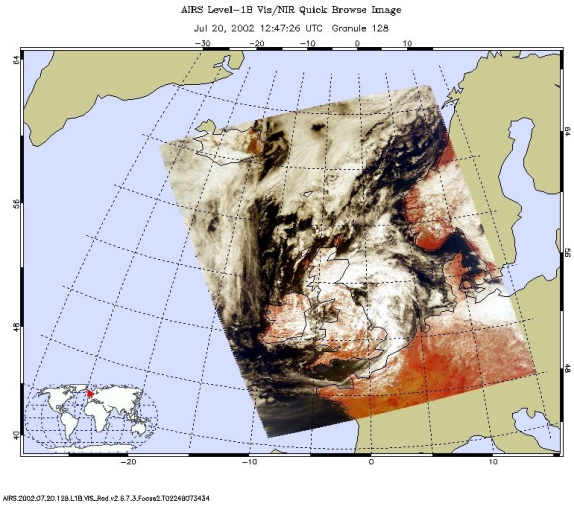


Fig.28-2 As Fig.27-2, but for around Western Europe (30N-60N, 20W-20E) in the nighttime.



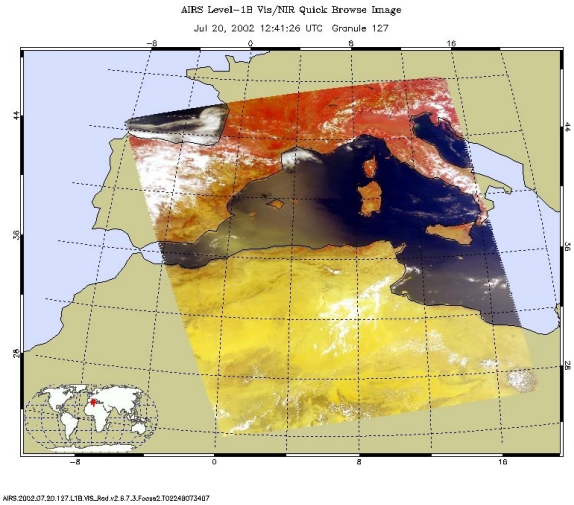
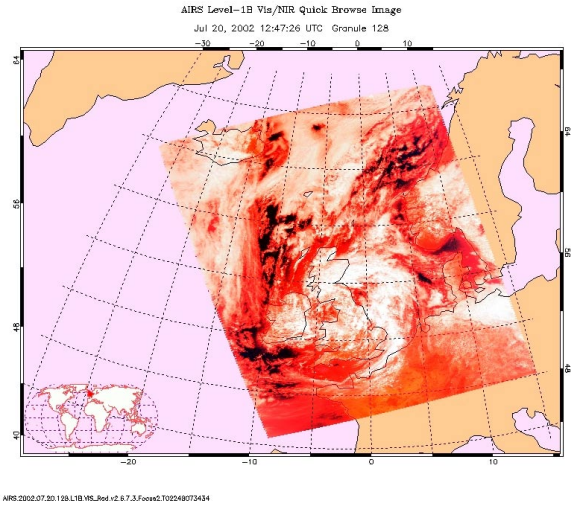


Fig.28-3 As Fig.27-3, but for around Western Europe (30N-60N, 20W-20E) in the daytime.



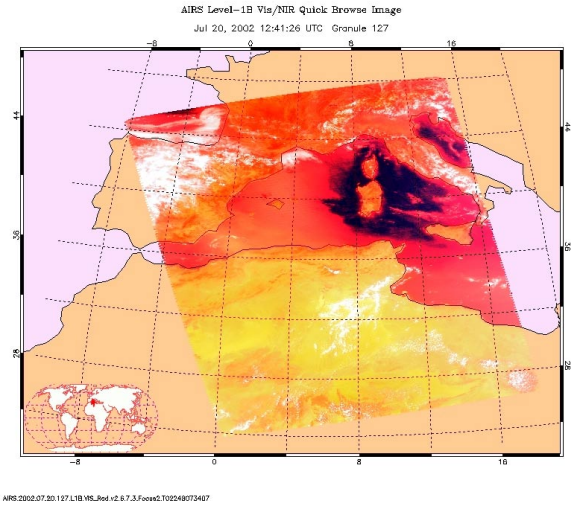


Fig.28-4 As Fig.27-4, but for around Western Europe (30N-60N, 20W-20E) in the daytime.

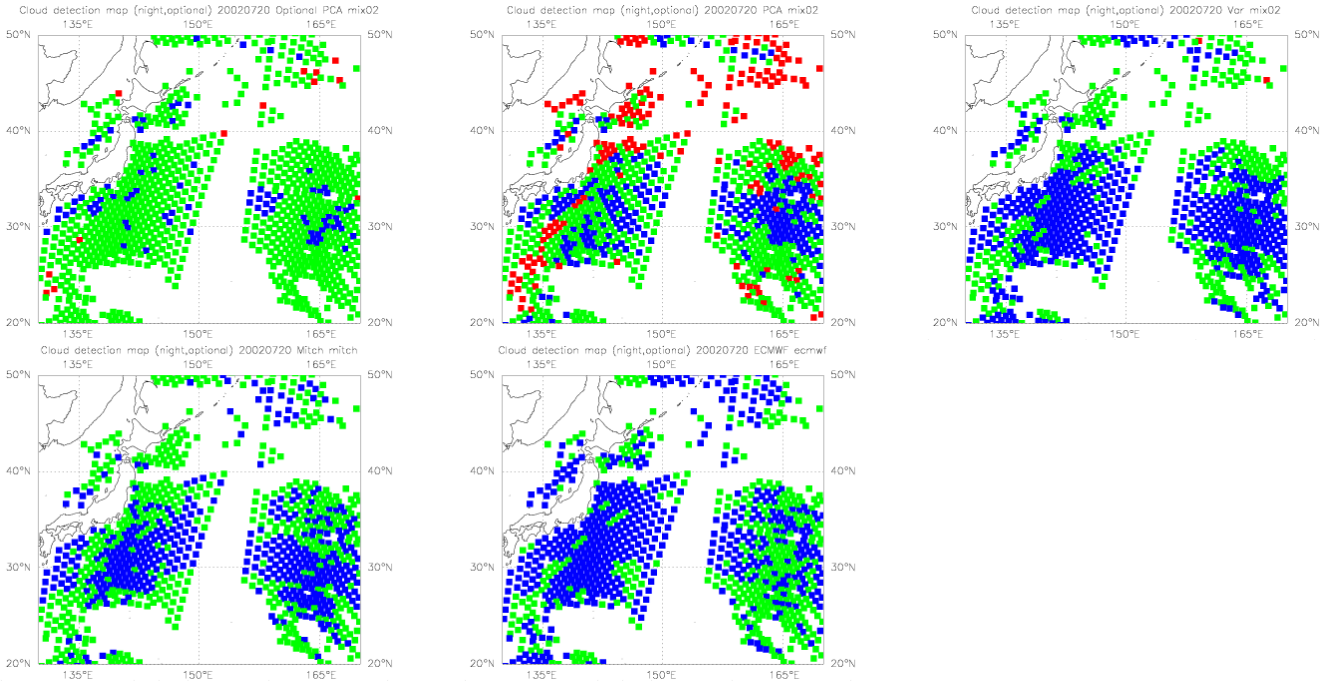


Fig.29-1 As Fig.27-1, but for North West Pacific (20N-50N, 130E-170E) in the nighttime.

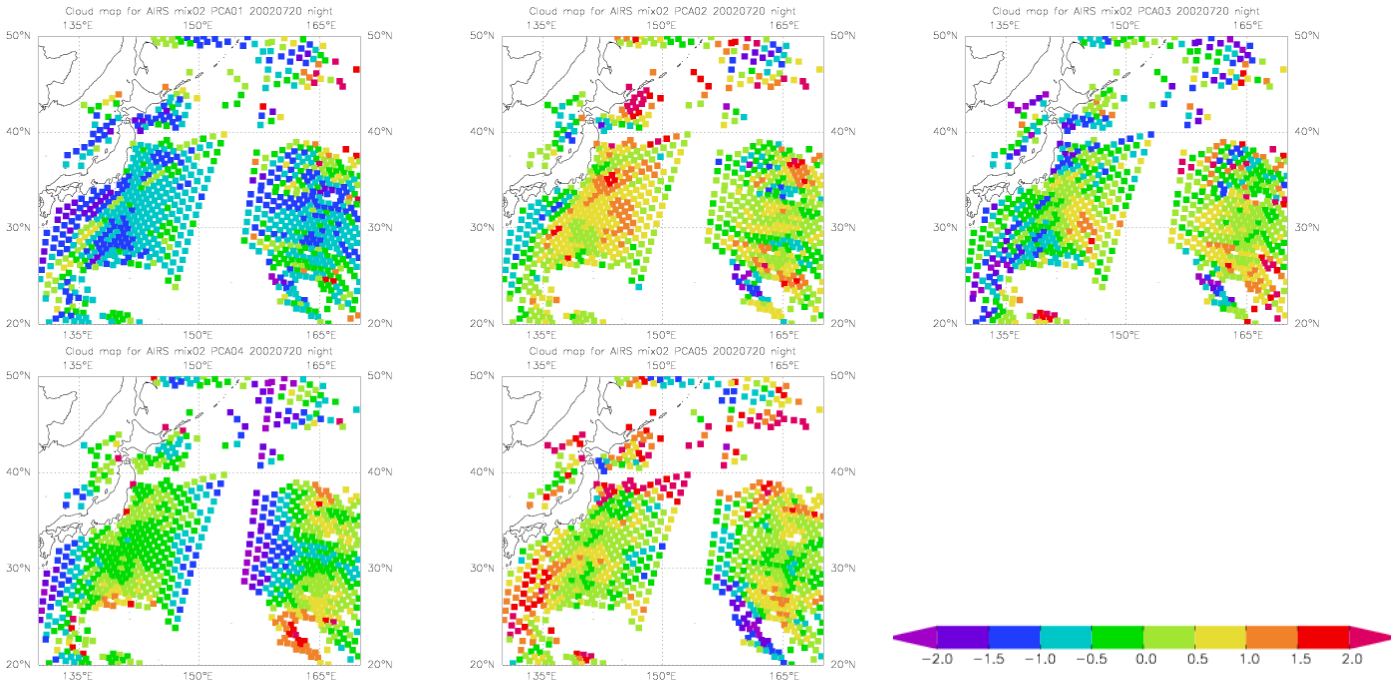
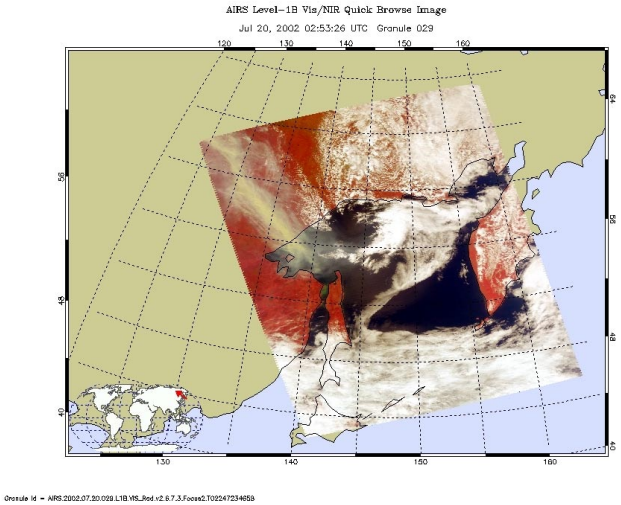


Fig.29-2 As Fig.27-2, but for North West Pacific (20N-50N, 130E-170E) in the nighttime.



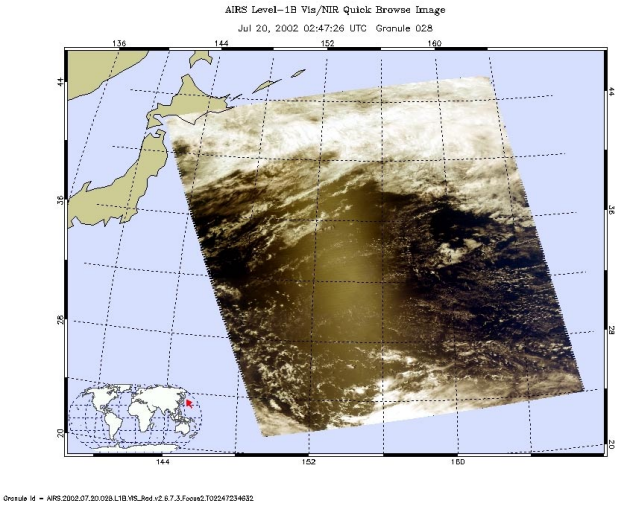
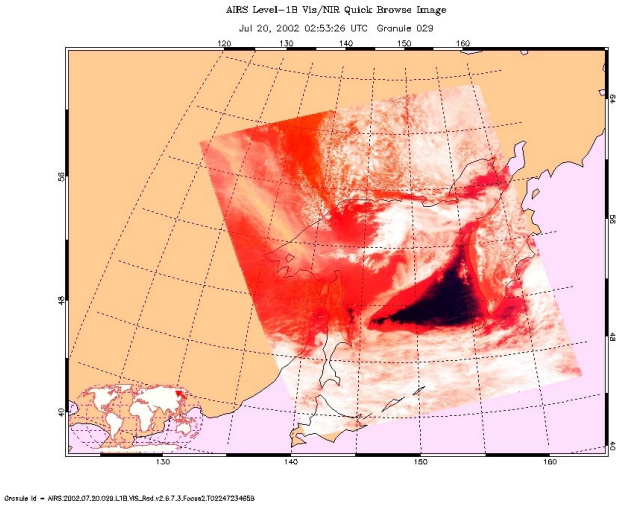


Fig.29-3 As Fig.27-3, but for North West Pacific (20N-50N, 130E-170E) in the daytime.



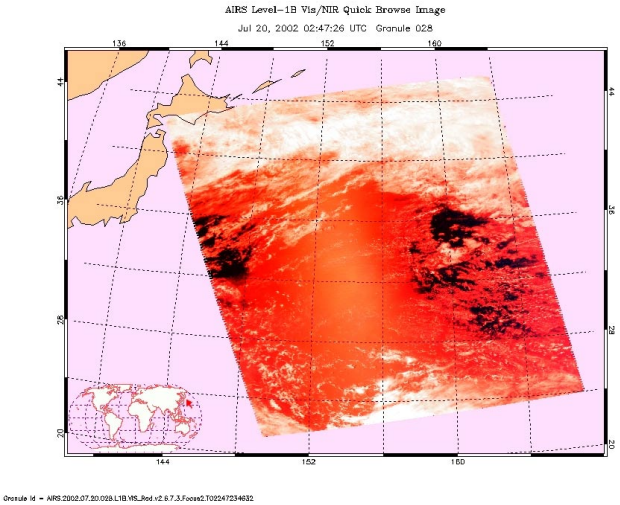


Fig.29-4 As Fig.27-4, but for North West Pacific (20N-50N, 130E-170E) in the daytime

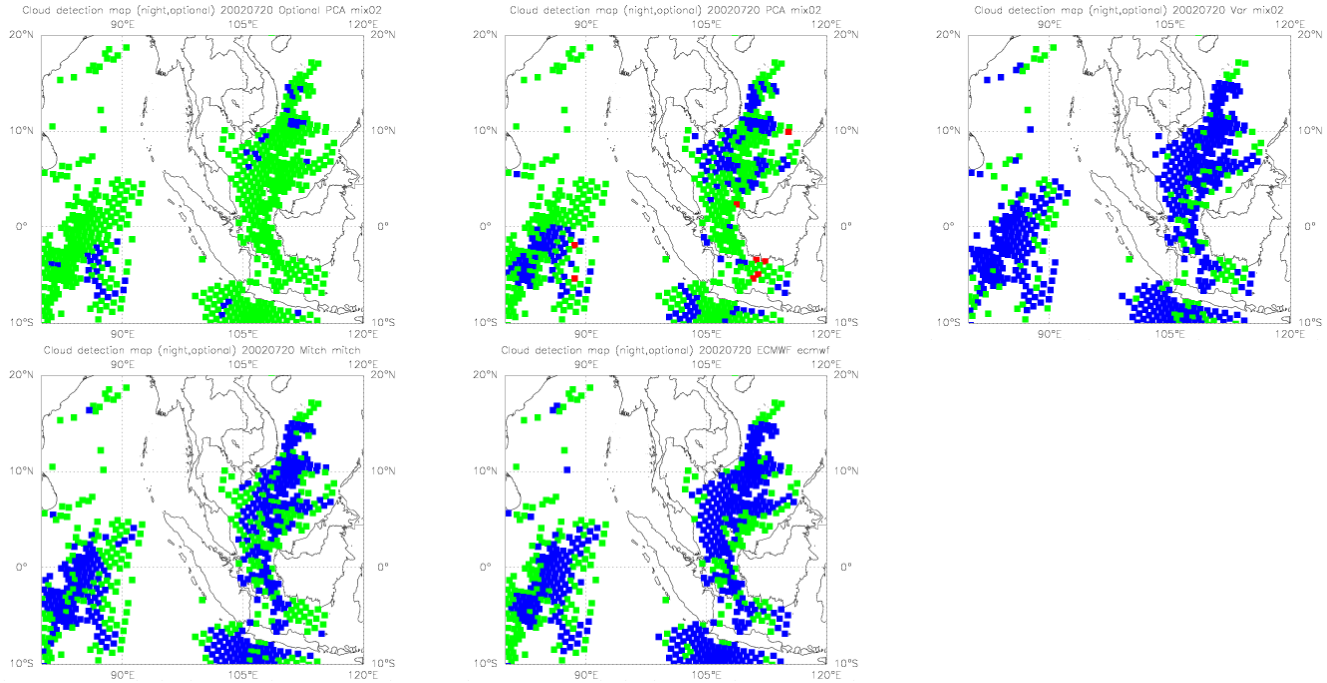


Fig.30-1 As Fig.27-1, but for around Indonesia (10S-20N, 80E-120E) in the nighttime.

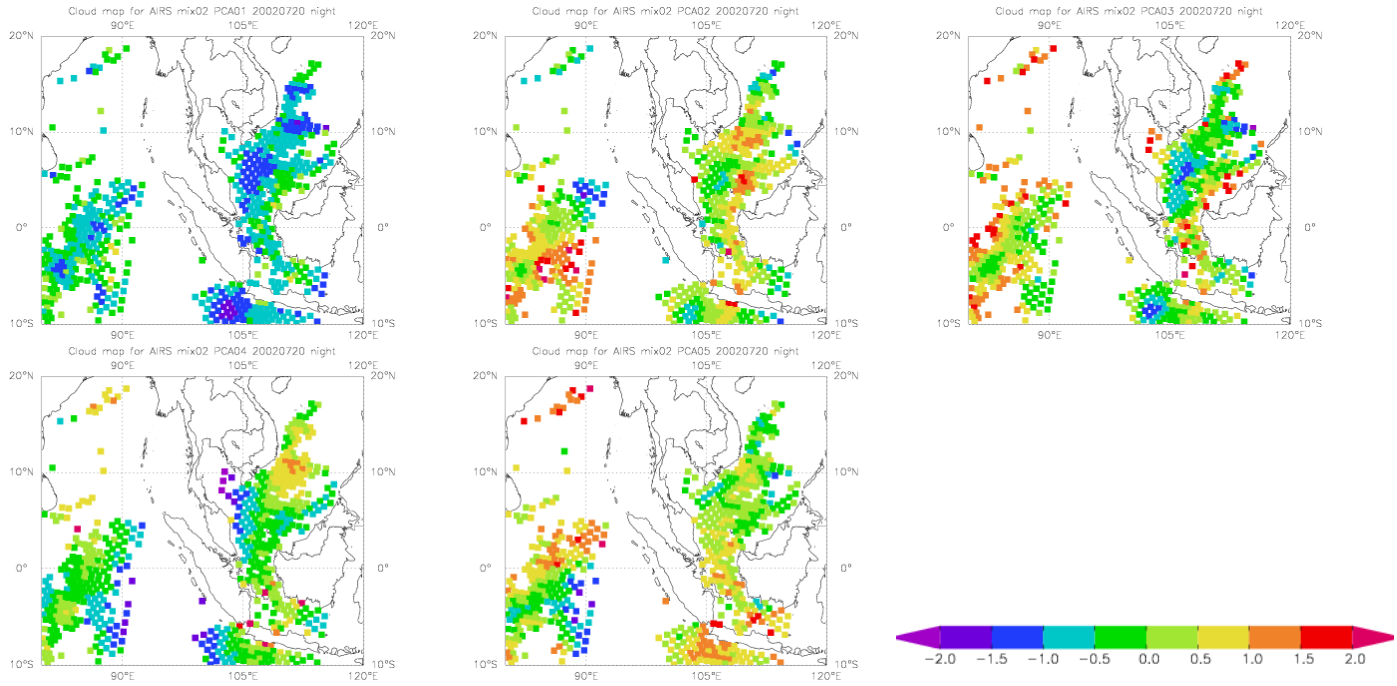


Fig.30-2 As Fig.27-2, but for around Indonesia (10S-20N, 80E-120E) in the nighttime.

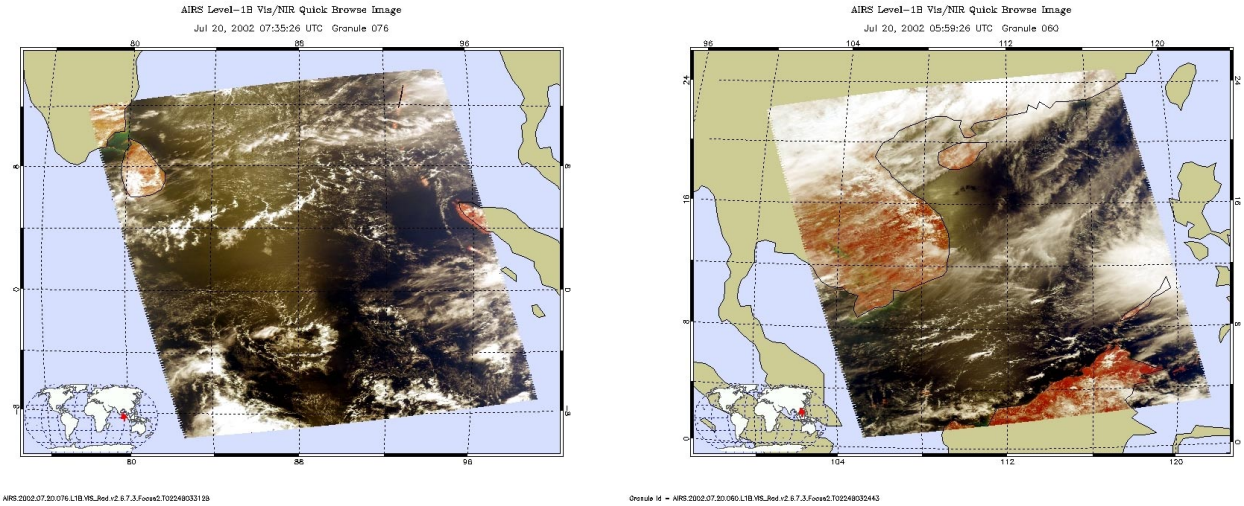


Fig.30-3 As Fig.27-3, but for around Indonesia (10S-20N, 80E-120E) in the daytime.

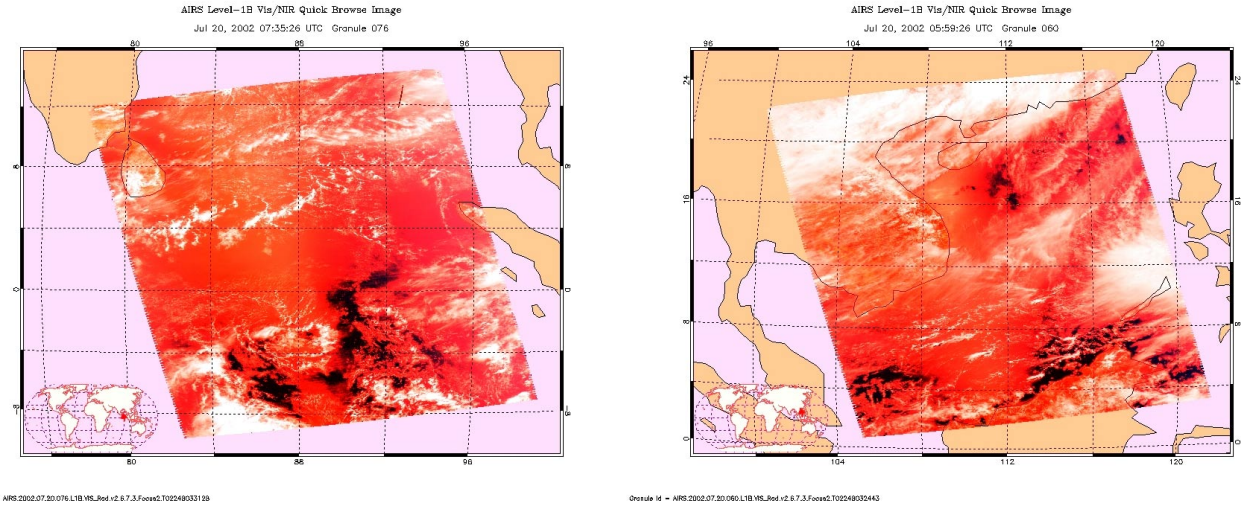


Fig.30-4 As Fig.27-4, but for around Indonesia (10S-20N, 80E-120E) in the daytime.

Table 1 AIRS channels and the central wave numbers for 324ch selected channels

selected ch. #	ch. #	wave number (1/cm)	selected ch. #	ch. #	wave number (1/cm)	selected ch. #	ch. #	wave number (1/cm)	selected ch. #	ch. #	wave number (1/cm)	selected ch. #	ch. #	wave number (1/cm)
1	1	649.858	66	151	693.311	131	484	804.765	196	1488	1351.522	261	1939	2251.563
2	6	651.053	67	156	694.683	132	497	809.563	197	1500	1357.775	262	1941	2253.491
3	7	651.293	68	157	694.958	133	528	821.227	198	1519	1367.801	263	1946	2258.325
4	10	652.013	69	159	695.509	134	587	844.327	199	1520	1368.333	264	1947	2259.294
5	11	652.253	70	162	696.336	135	672	871.621	200	1538	1377.982	265	1948	2260.264
6	15	653.216	71	165	697.166	136	787	917.677	201	1545	1381.772	266	1958	2270.009
7	16	653.457	72	168	697.998	137	791	919.119	202	1565	1392.722	267	1971	2282.800
8	17	653.699	73	169	698.276	138	843	938.296	203	1574	1397.708	268	1973	2284.780
9	20	654.424	74	170	698.554	139	870	948.581	204	1583	1402.730	269	1988	2299.739
10	21	654.667	75	172	699.111	140	914	965.842	205	1593	1408.355	270	1995	2306.784
11	22	654.909	76	173	699.389	141	950	979.552	206	1614	1420.318	271	2084	2364.970
12	24	655.394	77	174	699.668	142	1003	1001.827	207	1627	1427.827	272	2085	2365.928
13	27	656.124	78	175	699.947	143	1012	1005.709	208	1636	1433.074	273	2097	2377.487
14	28	656.367	79	177	700.506	144	1019	1008.749	209	1644	1437.771	274	2098	2378.456
15	30	656.855	80	179	701.066	145	1024	1010.931	210	1652	1442.499	275	2099	2379.425
16	36	658.323	81	180	701.346	146	1030	1013.562	211	1669	1469.462	276	2100	2380.395
17	39	659.059	82	182	701.907	147	1038	1017.091	212	1674	1472.547	277	2101	2381.366
18	40	659.305	83	185	702.751	148	1048	1021.537	213	1681	1476.887	278	2103	2383.310
19	42	659.798	84	186	703.033	149	1069	1030.996	214	1694	1485.016	279	2104	2384.283
20	51	662.023	85	190	704.162	150	1079	1035.561	215	1708	1493.871	280	2106	2386.232
21	52	662.271	86	192	704.727	151	1082	1036.938	216	1717	1499.618	281	2107	2387.208
22	54	662.768	87	193	705.011	152	1083	1037.398	217	1723	1503.474	282	2108	2388.184
23	55	663.017	88	198	706.430	153	1088	1039.703	218	1740	1514.505	283	2109	2389.161
24	56	663.266	89	201	707.285	154	1090	1040.628	219	1748	1519.752	284	2110	2390.140
25	59	664.014	90	204	708.142	155	1092	1041.554	220	1751	1521.729	285	2111	2391.118
26	62	664.764	91	207	709.001	156	1095	1042.947	221	1756	1525.035	286	2112	2392.098
27	63	665.015	92	210	709.862	157	1104	1056.594	222	1763	1543.147	287	2113	2393.079
28	68	666.270	93	213	710.725	158	1111	1059.937	223	1766	1545.182	288	2114	2394.060
29	69	666.522	94	215	711.302	159	1115	1061.856	224	1771	1548.584	289	2115	2395.042
30	71	667.025	95	216	711.591	160	1116	1062.337	225	1777	1552.687	290	2116	2396.025
31	72	667.278	96	218	712.169	161	1119	1063.782	226	1780	1554.746	291	2117	2397.009
32	73	667.530	97	221	713.038	162	1120	1064.264	227	1783	1556.811	292	2118	2397.994
33	74	667.783	98	224	713.909	163	1123	1065.714	228	1794	1564.426	293	2119	2398.979
34	75	668.035	99	226	714.491	164	1130	1069.112	229	1800	1568.610	294	2120	2399.966
35	76	668.289	100	227	714.782	165	1138	1073.020	230	1803	1570.711	295	2121	2400.953
36	77	668.542	101	232	716.242	166	1142	1074.984	231	1806	1572.816	296	2122	2401.941
37	78	668.795	102	239	718.297	167	1178	1092.974	232	1812	1577.044	297	2123	2402.929
38	79	669.049	103	248	720.956	168	1199	1103.732	233	1826	1586.995	298	2128	2407.886
39	80	669.303	104	250	721.550	169	1206	1107.362	234	1843	1599.242	299	2134	2413.861
40	82	669.811	105	251	721.847	170	1221	1115.218	235	1852	1605.800	300	2141	2420.869
41	83	670.065	106	252	722.145	171	1237	1123.713	236	1865	2182.428	301	2145	2447.250
42	84	670.320	107	253	722.442	172	1252	1131.787	237	1866	2183.334	302	2149	2451.357
43	86	670.830	108	256	723.337	173	1260	1136.138	238	1867	2184.242	303	2153	2455.477
44	92	672.365	109	257	723.635	174	1263	1217.496	239	1868	2185.150	304	2164	2466.877
45	93	672.621	110	261	724.833	175	1266	1219.020	240	1869	2186.058	305	2189	2493.174
46	98	673.907	111	262	725.133	176	1278	1225.152	241	1872	2188.789	306	2197	2501.704
47	99	674.164	112	267	726.636	177	1285	1228.758	242	1873	2189.700	307	2209	2514.607
48	101	674.680	113	272	728.146	178	1290	1231.346	243	1875	2191.526	308	2226	2533.107
49	104	675.456	114	295	734.467	179	1301	1237.078	244	1876	2192.440	309	2234	2541.905
50	105	675.715	115	299	735.699	180	1304	1238.650	245	1877	2193.355	310	2280	2562.180
51	108	676.493	116	300	736.008	181	1329	1251.909	246	1881	2197.021	311	2318	2601.584
52	110	677.013	117	305	737.556	182	1371	1286.057	247	1882	2197.939	312	2321	2604.748
53	111	677.273	118	308	738.487	183	1382	1292.296	248	1883	2198.858	313	2325	2608.978
54	113	677.794	119	309	738.798	184	1400	1302.633	249	1884	2199.778	314	2328	2612.160
55	116	678.578	120	310	739.109	185	1401	1303.212	250	1897	2211.807	315	2333	2617.482
56	117	678.839	121	318	741.609	186	1402	1303.791	251	1901	2215.534	316	2339	2623.896
57	123	680.412	122	321	742.551	187	1403	1304.371	252	1911	2224.906	317	2348	2633.579
58	124	680.675	123	325	743.810	188	1415	1311.370	253	1917	2230.566	318	2353	2638.990
59	128	681.729	124	333	746.341	189	1424	1316.667	254	1918	2231.512	319	2355	2641.160
60	129	681.993	125	338	747.932	190	1449	1331.599	255	1921	2234.355	320	2357	2643.334
61	138	689.770	126	355	753.390	191	1455	1335.231	256	1923	2236.254	321	2363	2649.879
62	139	690.041	127	362	755.660	192	1466	1340.212	257	1924	2237.205	322	2370	2657.556
63	144	691.400	128	375	759.912	193	1471	1342.765	258	1928	2241.016	323	2371	2658.656
64	145	691.672	129	453	793.539	194	1477	1345.842	259	1937	2249.638	324	2377	2665.278
65	150	693.037	130	475	801.474	195	1479	1346.871	260	1938	2250.600			

Table 2 Cloud detection channel set

Channel set	Selected channels
SOUND02	AIRS ch.261(724.533cm-1,13.80micron), ch.453(793.182cm-1,12.61micron), ch.672(871.298cm-1,11.48micron), ch.787(917.569cm-1,10.90micron), ch.843(938.183cm-1,10.66micron), ch.914(965.722cm-1,10.35micron), ch.1221(1115.06cm-1,8.96micron), ch.1237(1123.55cm-1,8.90micron), AMSU-A ch.3(50.3GHz), ch.15(89.0GHz)
MIX02	SOUND02 + AIRS ch.2328(2611.84cm-1,3.83micron), ch.2333(2617.16cm-1,3.82micron)

Table 3.1 Principal Component Analysis for pure clear case with mix02 channel set and statistics and PCA for cloudy case in the PCA space.

a) clear ocean	6813case			mix02							
					AIRS					AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.2328	ch.2333	ch.3	ch.15
meanO-B	-0.123	-0.220	-0.264	-0.144	-0.143	-0.133	-0.092	-0.097	-0.045	-0.041	0.068	0.844
stdO-B	0.998	1.725	1.679	1.714	1.719	1.704	1.692	1.699	1.846	1.874	2.476	5.151
eigen.v												
31.159	-0.080	-0.146	-0.143	-0.118	-0.113	-0.105	-0.078	-0.080	-0.042	-0.039	0.328	0.889
24.236	-0.133	-0.272	-0.242	-0.316	-0.321	-0.321	-0.326	-0.327	-0.349	-0.352	-0.155	-0.249
2.662	-0.166	-0.228	-0.252	-0.068	-0.048	-0.027	0.051	0.050	0.176	0.189	0.796	-0.379
2.199	0.301	0.383	0.462	0.066	0.030	0.000	-0.139	-0.137	-0.353	-0.379	0.483	-0.058
0.229	0.110	-0.229	0.672	-0.333	-0.303	-0.248	-0.082	-0.079	0.318	0.325	-0.025	-0.007
0.114	-0.904	0.052	0.372	0.075	0.074	0.061	0.020	0.047	-0.091	-0.127	0.007	0.007
0.075	-0.166	0.798	-0.231	-0.205	-0.217	-0.203	-0.126	-0.175	0.203	0.255	-0.005	-0.004
0.054	-0.021	-0.075	0.020	0.159	0.116	0.145	0.354	-0.890	0.110	0.059	0.001	0.001
0.050	0.019	0.091	-0.005	-0.339	-0.223	-0.161	0.837	0.178	-0.131	-0.227	-0.002	-0.002
0.044	-0.001	-0.023	0.002	0.745	-0.359	-0.537	0.093	0.046	0.106	-0.068	0.001	0.000
0.043	0.001	0.014	-0.015	0.091	-0.681	0.646	-0.056	0.020	0.223	-0.238	-0.002	0.000
0.042	0.010	0.014	-0.023	-0.125	0.284	-0.159	-0.069	0.003	0.693	-0.626	-0.001	0.000
					PCA component for clear case							
	1	2	3	4	5	6	7	8	9	10	11	12
meanO-B_e	0.918	0.145	-0.133	-0.216	-0.036	-0.019	-0.001	0.002	0.000	0.005	0.002	0.001
normalize	0.164	0.030	-0.082	-0.146	-0.076	-0.055	-0.005	0.008	0.000	0.025	0.008	0.003
b) cloudy ocean	6813case											
meanO-B	6.072	14.823	5.803	-2.450	6.278	13.763	11.956	3.789	-9.047	-0.327	2.161	0.178
stdO-B	3.706	8.708	4.124	5.035	5.995	10.052	8.625	2.750	6.472	0.890	1.887	0.814
eigen.v												
314.097	-0.128	-0.468	-0.196	0.178	-0.251	-0.520	-0.458	-0.147	0.349	0.015	-0.086	-0.008
65.351	0.303	0.252	0.208	0.435	-0.480	0.465	-0.343	-0.055	0.201	0.000	-0.064	-0.031
6.824	0.433	0.032	0.225	0.600	0.295	-0.449	0.135	0.061	-0.261	0.100	-0.106	0.032
4.223	-0.003	0.789	-0.449	-0.076	-0.003	-0.333	-0.154	-0.096	0.071	0.077	-0.117	-0.035
1.943	-0.809	0.203	0.366	0.336	-0.081	-0.065	0.105	-0.017	-0.058	0.082	-0.160	0.019
1.456	0.143	0.200	0.688	-0.428	-0.149	-0.383	-0.118	0.004	0.159	-0.109	0.249	0.012
1.001	-0.128	0.096	-0.061	0.305	0.418	0.073	-0.107	-0.131	0.284	-0.384	0.659	-0.078
0.666	-0.074	-0.005	0.165	-0.132	0.518	0.172	-0.716	0.119	-0.193	0.211	-0.182	-0.100
0.614	0.069	-0.038	0.125	-0.054	0.165	0.055	0.214	-0.555	0.253	0.255	-0.169	-0.658
0.539	0.001	-0.006	0.020	-0.035	-0.048	-0.034	-0.098	-0.245	-0.353	-0.801	-0.349	-0.190
0.526	-0.050	-0.007	-0.088	0.055	-0.217	-0.100	-0.020	0.598	-0.152	-0.016	0.194	-0.715
0.523	0.039	0.037	0.063	-0.003	0.267	0.036	0.157	0.453	0.637	-0.255	-0.469	0.020

Table 3.2 As Table 3.1, but for sound02 channel set.

a) clear ocean	6813case			sound02						
					AIRS				AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.3	ch.15
meanO-B	-0.123	-0.220	-0.264	-0.144	-0.143	-0.133	-0.092	-0.097	0.068	0.844
stdO-B	0.998	1.725	1.679	1.714	1.719	1.704	1.692	1.699	2.476	5.151
eigen.v										
31.106	-0.074	-0.132	-0.131	-0.102	-0.096	-0.088	-0.061	-0.062	0.335	0.901
18.535	-0.171	-0.338	-0.306	-0.372	-0.375	-0.373	-0.369	-0.370	-0.151	-0.221
2.584	-0.054	-0.077	-0.080	-0.022	-0.014	-0.005	0.025	0.025	0.919	-0.371
1.309	0.382	0.411	0.588	-0.079	-0.132	-0.173	-0.365	-0.363	0.138	0.036
0.151	-0.269	-0.492	0.713	-0.222	-0.154	-0.073	0.210	0.235	-0.016	-0.003
0.106	0.863	-0.420	-0.114	-0.114	-0.075	-0.025	0.155	0.150	-0.009	-0.007
0.060	0.004	0.517	-0.127	-0.461	-0.366	-0.268	0.261	0.479	-0.008	-0.006
0.053	0.007	-0.077	0.006	0.110	0.072	-0.019	-0.750	0.644	0.002	0.001
0.044	0.002	0.029	-0.007	-0.715	0.303	0.606	-0.153	-0.068	-0.002	0.000
0.043	-0.003	0.010	-0.007	0.215	-0.757	0.614	-0.063	-0.006	-0.002	0.000
				PCA component for clear case						
	1	2	3	4	5	6	7	8	9	10
meanO-B_e	0.908	0.206	-0.204	-0.130	-0.028	0.012	-0.002	-0.001	-0.005	0.002
normalize	0.163	0.048	-0.127	-0.114	-0.073	0.037	-0.009	-0.004	-0.024	0.009
b) cloudy ocean	6813case									
meanO-B	5.216	15.945	4.133	-0.272	4.901	-16.637	-0.181	0.365	1.439	2.771
stdO-B	3.344	9.407	3.800	2.869	3.806	11.545	1.783	0.805	1.385	2.233
eigen.v										
245.480	-0.144	-0.591	-0.157	0.075	-0.213	0.733	0.027	-0.016	-0.060	-0.112
23.091	-0.442	0.093	-0.553	-0.483	0.317	0.042	0.306	-0.031	0.116	0.216
4.494	0.117	0.722	-0.286	0.361	-0.042	0.477	0.066	0.075	-0.098	-0.058
2.157	-0.645	0.177	-0.053	-0.054	-0.471	-0.194	-0.292	0.013	-0.206	-0.398
1.810	-0.544	0.110	0.642	0.243	0.209	0.184	0.302	0.027	0.089	0.209
1.424	0.188	0.270	0.390	-0.723	-0.293	0.339	-0.057	-0.090	0.044	0.058
0.681	0.044	-0.021	0.137	-0.201	0.553	0.092	-0.026	0.226	-0.631	-0.419
0.656	-0.135	0.043	0.000	0.017	0.395	0.192	-0.829	-0.115	0.255	0.146
0.536	0.031	0.015	0.037	-0.061	0.109	0.034	0.097	0.423	0.668	-0.589
0.526	-0.027	-0.044	-0.031	-0.045	-0.165	-0.010	-0.156	0.861	-0.112	0.434

Table 4 Summary of cloud detection schemes

Scheme name	FOV / Ch.[1)]	Used bands	Background	Background Cov.	Cloudy Probability
Var	FOV	LIR, MIR, SIR, MW[2)]	T,q,O_3,Tskin,Vs[4)]	Used (Constant)	Not used
PCA	FOV	LIR, MIR, SIR, MW	T,q,O_3,Tskin,Vs	Used (Constant)	Not used
Optional PCA	FOV	LIR, MIR, SIR, MW	T,q,O_3,Tskin,Vs	Used (Constant)	Used
Mitch	FOV	LIR, MIR, SIR, MW	SST[5)]	Not used	Not used
ECMWF	Ch.	LIR (, MIR, SIR, MW)[3)]	T,q,O_3,Tskin,Vs	Not used	Not used

Note:

1) FOV for cloud detection for FOV, Ch for cloud detection for ch.

2) LIR for longwave infrared, MIR for midwave infrared, SIR for shortwave infrared, MW for microwave infrared

3) The result for LIR band is used in this study

4) T for temperature profile, q for water vapor profile, O3 for ozone profile, Tskin for skin temperature, Vs for surface wind speed

5) Tskin is used as SST

Table 5 Statistics of clear O-B difference for ocean night case

Ocean night

Scheme name	Channel set	Number & Ratio of Clear FOVs	ch.914			ch.2333			AMSU ch.3		
			Mean	SD	Skew	Mean	SD	Skew	Mean	SD	Skew
Var	MIX02	7578 (40%)	-0.42	0.77	0.46	-0.85	0.67	0.36	0.69	2.06	0.84
PCA	MIX02	3600 (19%)	-0.19	0.68	0.38	-0.59	0.50	0.36	0.53	1.83	0.36
Optional PCA	MIX02	1060 (6%)	0.28	0.61	-0.27	-0.30	0.37	-0.09	-0.37	1.81	1.42
Mitch		6123 (32%)	-0.52	0.76	0.50	-1.01	0.80	-1.00	0.94	2.28	1.98
ECMWF		8260 (43%)	-0.47	0.76	0.48	-1.09	1.05	-1.19	0.82	2.28	1.92

Table 6 Execution time (unit: sec) for cloud detection of 10 profiles

Scheme name	Var	PCA	Optional PCA	Mitch	ECMWF
Exec. Time (sec)	29	28	31	28	41

Table 7 PCA values in the clear case for ocean daytime with mix02 channel set

ocean	day	992case		mix02								
					AIRS						AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.2328	ch.2333	ch.3	ch.15
meanO-B	-0.003	-0.124	-0.247	0.068	0.118	0.168	0.063	0.126	0.370	0.376	-0.700	-1.694
eigen.v												
24.058	-0.073	-0.151	-0.154	-0.107	-0.098	-0.090	-0.052	-0.054	0.002	0.007	0.301	0.907
3.065	0.223	0.391	0.331	0.355	0.346	0.330	0.286	0.286	0.223	0.216	0.117	0.244
1.270	-0.031	0.046	-0.085	0.043	0.056	0.056	0.036	0.041	-0.056	-0.069	-0.931	0.322
0.496	0.290	0.268	0.603	-0.060	-0.089	-0.117	-0.229	-0.211	-0.405	-0.426	0.011	0.117
0.170	0.105	-0.247	0.535	-0.263	-0.249	-0.209	-0.073	-0.082	0.452	0.472	-0.166	0.021
0.091	0.909	-0.037	-0.386	-0.051	-0.066	-0.099	-0.034	0.023	0.052	0.050	-0.021	-0.015
0.056	0.111	-0.696	0.240	0.010	0.056	0.069	0.307	0.483	-0.217	-0.253	0.010	-0.007
0.032	-0.093	0.436	-0.056	-0.331	-0.359	-0.298	0.098	0.678	-0.028	-0.030	0.010	-0.008
0.018	0.021	0.111	-0.006	-0.230	-0.136	-0.064	0.858	-0.411	-0.037	-0.070	0.003	-0.005
0.007	-0.022	-0.039	0.006	0.777	-0.533	-0.290	0.100	-0.022	-0.085	0.090	-0.012	0.006
0.005	0.035	0.005	-0.003	-0.136	-0.491	0.718	-0.053	-0.002	-0.352	0.312	0.003	-0.001
0.005	-0.005	-0.002	0.010	-0.038	0.343	-0.340	0.046	0.009	-0.629	0.606	-0.007	0.001
					PCA component							
	1	2	3	4	5	6	7	8	9	10	11	12
meanO-B_e	-1.731	-0.287	0.103	-0.774	0.225	0.149	-0.046	-0.077	-0.086	-0.051	0.036	-0.020
normalize	-0.353	-0.164	0.091	-1.099	0.547	0.492	-0.192	-0.435	-0.642	-0.609	0.487	-0.289

Table 8 PCA values in the clear case for ocean nighttime with mix02 channel set

ocean	night	3625case		mix02								
					AIRS						AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.2328	ch.2333	ch.3	ch.15
meanO-B	-0.137	-0.346	-0.370	-0.274	-0.236	-0.195	-0.390	-0.329	-0.543	-0.591	0.542	0.043
eigen.v												
19.109	-0.072	-0.149	-0.149	-0.111	-0.104	-0.097	-0.063	-0.064	-0.023	-0.019	0.352	0.886
2.744	0.234	0.393	0.337	0.353	0.342	0.326	0.288	0.288	0.191	0.185	0.197	0.233
1.135	-0.010	0.012	-0.115	0.050	0.064	0.070	0.095	0.093	0.027	0.026	-0.902	0.376
0.516	-0.322	-0.314	-0.473	0.044	0.076	0.100	0.197	0.200	0.461	0.491	0.095	-0.120
0.158	-0.130	-0.185	0.727	-0.234	-0.227	-0.186	-0.091	-0.065	0.336	0.373	-0.110	0.054
0.087	-0.885	0.240	0.154	0.169	0.163	0.146	-0.104	-0.102	-0.122	-0.147	0.007	0.026
0.045	0.149	0.396	-0.207	0.119	0.094	0.011	-0.445	-0.619	0.289	0.297	-0.039	0.024
0.033	0.105	-0.685	0.179	0.357	0.350	0.303	-0.102	-0.349	-0.074	-0.088	-0.011	0.011
0.020	0.040	-0.071	-0.007	0.142	0.062	0.007	-0.790	0.587	0.010	0.021	-0.007	0.006
0.007	-0.025	-0.025	-0.001	0.773	-0.360	-0.505	0.106	-0.004	-0.045	0.060	-0.009	0.004
0.006	0.013	0.014	-0.013	0.116	-0.718	0.683	-0.049	-0.025	-0.025	0.019	0.002	0.000
0.006	-0.003	0.011	-0.001	-0.049	0.061	0.026	0.000	-0.007	-0.728	0.681	0.000	0.000
					PCA component							
	1	2	3	4	5	6	7	8	9	10	11	12
meanO-B_e	0.489	-0.837	-0.573	-0.358	-0.437	0.100	-0.113	0.158	0.060	-0.070	0.033	-0.013
normalize	0.112	-0.505	-0.538	-0.499	-1.100	0.340	-0.532	0.870	0.426	-0.816	0.431	-0.181

Table 9 PCA values in the clear case for ocean daytime with sound02 channel set

ocean	day	5673case		sound02						
					AIRS				AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.3	ch.15
meanO-B	-0.150	-0.391	-0.480	-0.203	-0.149	-0.102	-0.293	-0.210	0.385	-0.133
eigen.v										
25.561	-0.081	-0.155	-0.157	-0.118	-0.111	-0.102	-0.069	-0.071	0.339	0.885
3.030	0.246	0.407	0.364	0.363	0.350	0.336	0.296	0.292	0.158	0.276
1.260	-0.024	-0.008	-0.089	0.028	0.042	0.052	0.073	0.081	-0.919	0.360
0.452	0.335	0.255	0.643	-0.184	-0.215	-0.239	-0.355	-0.347	-0.122	0.101
0.117	0.636	0.345	-0.630	0.088	0.055	-0.027	-0.173	-0.194	0.010	-0.011
0.085	0.630	-0.546	0.107	-0.197	-0.161	-0.095	0.323	0.337	0.004	-0.026
0.036	-0.130	0.568	-0.106	-0.383	-0.379	-0.296	0.282	0.438	0.019	-0.014
0.021	0.013	-0.058	0.001	0.110	0.050	-0.043	-0.735	0.663	0.003	0.001
0.008	0.030	0.045	-0.012	-0.765	0.319	0.541	-0.127	0.000	0.010	-0.004
0.006	0.020	0.011	-0.018	0.168	-0.735	0.652	-0.075	-0.013	0.002	-0.002
					PCA component					
	1	2	3	4	5	6	7	8	9	10
meanO-B_e	0.247	-0.655	-0.408	-0.248	0.146	-0.019	-0.153	0.072	0.078	0.036
normalize	0.049	-0.376	-0.364	-0.369	0.427	-0.066	-0.806	0.501	0.889	0.468

Table 10 PCA values in the clear case for ocean nighttime with sound02 channel set

ocean	night	5219case		sound02						
					AIRS				AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.3	ch.15
meanO-B	-0.199	-0.482	-0.548	-0.391	-0.348	-0.305	-0.488	-0.419	0.743	0.726
eigen.v										
21.356	-0.075	-0.151	-0.154	-0.116	-0.109	-0.101	-0.067	-0.068	0.358	0.881
2.837	0.241	0.415	0.377	0.363	0.348	0.331	0.284	0.283	0.212	0.243
1.241	0.013	0.021	-0.079	0.047	0.061	0.067	0.094	0.093	-0.901	0.393
0.414	0.338	0.233	0.654	-0.195	-0.226	-0.245	-0.338	-0.343	-0.119	0.097
0.109	0.781	0.199	-0.571	0.032	0.008	-0.048	-0.083	-0.110	0.033	-0.028
0.079	0.441	-0.631	0.253	-0.184	-0.154	-0.079	0.343	0.401	0.010	-0.026
0.035	-0.123	0.557	-0.103	-0.397	-0.373	-0.293	0.291	0.443	0.021	-0.017
0.021	0.009	-0.032	-0.008	0.105	0.037	-0.019	-0.753	0.647	-0.003	0.004
0.007	0.036	0.031	-0.005	-0.760	0.302	0.561	-0.116	-0.011	0.009	-0.004
0.006	0.017	0.012	-0.015	0.183	-0.746	0.637	-0.048	-0.025	0.000	0.000
					PCA component					
	1	2	3	4	5	6	7	8	9	10
meanO-B_e	1.252	-0.741	-0.498	-0.018	0.152	-0.120	-0.138	0.068	0.067	0.028
normalize	0.271	-0.440	-0.447	-0.028	0.462	-0.426	-0.738	0.469	0.770	0.364

Table 11 PCA values in the cloudy case for ocean daytime with mix02 channel set

ocean	day	16321case		mix02								
					AIRS						AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.2328	ch.2333	ch.3	ch.15
meanO-B	-0.825	-1.526	-1.337	-1.487	-1.435	-1.375	-1.714	-1.623	4.426	4.710	1.566	2.475
eigen.v												
72.555	0.021	0.033	0.028	0.035	0.035	0.033	0.021	0.021	0.668	0.697	0.105	0.224
53.081	-0.100	-0.191	-0.173	-0.208	-0.208	-0.204	-0.199	-0.200	-0.120	-0.118	0.331	0.761
18.698	-0.128	-0.267	-0.213	-0.332	-0.335	-0.332	-0.350	-0.348	0.135	0.144	-0.255	-0.432
2.624	-0.089	-0.082	-0.302	0.039	0.061	0.077	0.125	0.132	0.005	0.002	-0.839	0.381
2.305	0.365	0.272	0.686	-0.036	-0.081	-0.124	-0.270	-0.282	-0.026	-0.012	-0.326	0.198
0.506	0.628	0.473	-0.589	0.034	0.002	-0.061	-0.105	-0.119	0.025	-0.035	0.051	-0.022
0.175	-0.618	0.541	-0.099	0.233	0.186	0.117	-0.344	-0.305	0.018	-0.029	-0.011	0.011
0.118	-0.221	0.537	0.056	-0.465	-0.389	-0.222	0.241	0.427	-0.031	0.041	-0.013	0.008
0.032	0.048	-0.076	-0.007	0.170	0.028	-0.102	-0.706	0.662	-0.091	0.087	0.004	-0.001
0.017	-0.010	0.021	-0.034	0.186	-0.016	-0.167	0.130	-0.113	-0.687	0.659	0.001	-0.004
0.012	-0.065	0.006	0.016	0.604	-0.146	-0.700	0.214	0.029	0.196	-0.184	-0.007	0.003
0.008	0.016	-0.009	-0.012	0.377	-0.791	0.480	-0.028	-0.022	0.001	-0.001	0.000	0.000
					PCA component							
	1	2	3	4	5	6	7	8	9	10	11	12
meanO-B_e	6.633	3.472	3.202	-0.420	-0.566	-0.080	0.078	-0.206	0.076	0.019	-0.119	0.009
normalize	0.779	0.477	0.741	-0.259	-0.373	-0.112	0.185	-0.602	0.428	0.145	-1.067	0.106

Table 12 PCA values in the cloudy case for ocean nighttime with mix02 channel set

ocean	night	15500case		mix02								
					AIRS						AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.2328	ch.2333	ch.3	ch.15
meanO-B	-1.593	-3.217	-2.668	-3.616	-3.606	-3.539	-3.936	-3.850	-4.045	-4.130	2.373	4.430
eigen.v												
109.759	-0.116	-0.253	-0.204	-0.305	-0.309	-0.308	-0.316	-0.317	-0.318	-0.321	0.183	0.399
32.036	0.061	0.128	0.096	0.155	0.156	0.154	0.168	0.166	0.133	0.135	0.400	0.804
6.454	-0.389	-0.399	-0.480	-0.128	-0.089	-0.050	0.062	0.064	0.449	0.471	0.042	0.001
2.615	-0.009	0.028	0.147	-0.025	-0.037	-0.044	-0.066	-0.065	0.043	0.047	0.882	-0.427
0.892	-0.185	0.037	-0.629	0.209	0.236	0.244	0.241	0.230	-0.328	-0.399	0.152	-0.101
0.469	0.764	0.254	-0.505	-0.125	-0.134	-0.157	0.004	-0.022	0.147	0.115	0.043	-0.019
0.156	0.407	-0.749	0.187	-0.091	-0.033	0.045	0.314	0.310	-0.156	-0.073	0.039	-0.029
0.122	-0.210	0.356	0.100	-0.515	-0.367	-0.181	0.468	0.399	-0.035	-0.082	-0.002	-0.007
0.032	0.011	-0.016	0.005	-0.152	0.060	0.216	0.613	-0.742	0.005	0.009	0.000	0.001
0.015	0.054	0.016	-0.008	-0.635	0.196	0.661	-0.332	0.064	0.050	-0.027	0.005	0.002
0.011	-0.016	0.069	-0.043	-0.075	0.103	-0.026	-0.007	0.011	-0.717	0.680	0.003	-0.003
0.007	-0.009	-0.013	0.018	-0.317	0.780	-0.524	0.044	0.012	0.083	-0.083	0.000	0.000
					PCA component							
	1	2	3	4	5	6	7	8	9	10	11	12
meanO-B_e	12.130	-0.321	-0.005	0.254	0.439	-0.180	0.024	-0.189	-0.021	0.128	-0.019	-0.017
normalize	1.158	-0.057	-0.002	0.157	0.465	-0.263	0.061	-0.540	-0.115	1.033	-0.184	-0.193

Table 13 PCA values in the cloudy case for ocean daytime with sound02 channel set

ocean	day	11640case		sound02						
					AIRS				AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.3	ch.15
meanO-B	-1.083	-1.960	-1.663	-1.980	-1.930	-1.864	-2.256	-2.163	1.949	3.391
eigen.v										
57.990	-0.077	-0.155	-0.145	-0.175	-0.176	-0.174	-0.173	-0.174	0.368	0.813
26.077	-0.141	-0.292	-0.244	-0.355	-0.357	-0.353	-0.355	-0.354	-0.239	-0.385
3.141	0.130	0.102	0.391	-0.049	-0.074	-0.094	-0.154	-0.163	0.786	-0.368
3.007	-0.355	-0.250	-0.641	0.029	0.072	0.115	0.259	0.272	0.432	-0.231
0.648	-0.623	-0.480	0.586	-0.040	-0.010	0.053	0.114	0.127	-0.060	0.033
0.200	-0.621	0.519	-0.089	0.241	0.190	0.122	-0.358	-0.315	-0.007	0.003
0.151	-0.227	0.558	0.060	-0.458	-0.383	-0.221	0.234	0.416	-0.017	0.013
0.036	-0.048	0.079	0.002	-0.170	-0.018	0.109	0.704	-0.674	-0.003	0.000
0.015	-0.064	0.015	0.005	0.619	-0.115	-0.734	0.246	-0.008	-0.006	0.002
0.008	-0.015	0.009	0.011	-0.398	0.796	-0.454	0.015	0.024	0.000	0.000
					PCA component					
	1	2	3	4	5	6	7	8	9	10
meanO-B_e	5.881	2.976	0.408	0.413	0.106	0.220	-0.309	-0.074	-0.145	-0.006
normalize	0.772	0.583	0.230	0.238	0.132	0.492	-0.796	-0.392	-1.185	-0.068

Table 14 PCA values in the cloudy case for ocean nighttime with sound02 channel set

ocean	night	13906case		sound02						
					AIRS				AMSU-A	
	ch.261	ch.453	ch.672	ch.787	ch.843	ch.914	ch.1221	ch.1237	ch.3	ch.15
meanO-B	-1.736	-3.496	-2.865	-3.955	-3.950	-3.881	-4.305	-4.220	2.507	4.677
eigen.v										
89.465	-0.131	-0.280	-0.231	-0.329	-0.334	-0.332	-0.336	-0.336	0.228	0.494
32.369	0.097	0.190	0.154	0.213	0.212	0.209	0.216	0.215	0.376	0.750
3.543	-0.485	-0.374	-0.616	0.051	0.112	0.164	0.311	0.313	-0.080	0.053
2.692	0.123	0.050	0.000	0.000	-0.003	-0.007	-0.023	-0.024	-0.890	0.434
0.556	0.618	0.329	-0.706	-0.007	-0.015	-0.046	0.026	-0.003	0.081	-0.047
0.214	-0.496	0.542	-0.211	0.296	0.219	0.114	-0.373	-0.357	-0.016	0.010
0.136	-0.305	0.583	0.040	-0.465	-0.349	-0.203	0.332	0.274	-0.020	0.006
0.034	-0.009	0.024	-0.009	0.174	-0.061	-0.236	-0.616	0.728	-0.001	0.000
0.016	0.049	0.008	-0.006	-0.635	0.191	0.660	-0.335	0.099	0.007	0.000
0.008	-0.010	-0.002	0.011	-0.325	0.788	-0.521	0.040	0.009	-0.001	0.000
					PCA component					
	1	2	3	4	5	6	7	8	9	10
meanO-B_e	11.519	-1.147	0.019	-0.356	-0.051	0.208	-0.218	0.008	0.141	-0.021
normalize	1.218	-0.202	0.010	-0.217	-0.068	0.449	-0.592	0.046	1.107	-0.244