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# Evaluation of the Homogeneity of Cloud Cover Climatology in Large Scale Regions

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## PREFACE

This technical note documents a study AFCCC conducted to evaluate the homogeneity of cloud cover distributions within 19 regions known as Consolidated Evaluation Groupings (CEGs). This technical note documents a study AFCCC completed to evaluate the homogeneity of cloud cover distributions within 19 regions known as Consolidated Evaluation Groupings (CEGs). The sizes of these CEGs vary widely and are composed of a variable number of smaller regions known as Post Mission Evaluation regions (PMEs). AFCCC computed the monthly cloud-cover frequency distributions for each of the CEGs and PMEs from the Air Force's Real Time Nephanalysis (RTNEPH) database. In addition, AFCCC conducted a statistical comparison of the PMEs within each CEG to measure the homogeneity of the cloud climatology.

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EVALUATION OF THE HOMOGENEITY OF CLOUD COVER  
CLIMATOLOGY IN LARGE SCALE REGIONS

Chapter 1

INTRODUCTION

**1.1 Background.** AFCCC (formerly designated USAFETAC) completed a study to evaluate the homogeneity of cloud cover distributions within 19 regions known as Consolidated Evaluation Groupings (CEGs). The sizes of these CEGs vary widely and are composed of a variable number of smaller regions known as Post Mission Evaluation regions (PMEs). AFCCC computed the monthly cloud-cover frequency distributions for each of the CEGs and PMEs from the Air Force's Real Time Nephanalysis (RTNEPH)

database. In addition, AFCCC conducted a statistical comparison of the PMEs within each CEG to measure the homogeneity of the cloud climatology. The appendix contains a listing of the PMEs within each CEG.

Cloud climatology can vary greatly over very small distances, so caution must be used in concluding that the climatology in a given region is homogeneous. This study is a measure of the similarity of large-scale climatological features.

Chapter 2

STATISTICAL METHODS

**2.1 Comparison of Distributions.** Testing the hypothesis, "Are two distributions statistically similar?" is not straightforward since the term similar is not precisely defined. The usual test hypothesis for comparing two distributions is, "Are two distributions statistically the same?" The chi-square test is used to evaluate this hypothesis. For each data category, the expected number  $E_i$  of observations, assuming the test hypothesis is true, is compared against the observed number of observations,  $O_i$ . The chi-square statistic,  $\chi^2$  is then calculated using (Fleiss, 1973):

$$\chi^2 = \sum_{i=1}^N \frac{(E_i - O_i)^2}{E_i}$$

where N is the total number of categories. This value is then compared against a critical value. If  $\chi^2$  exceeds this critical value, the test hypothesis is rejected.

There are several problems with the chi-square test. Primarily, it is very sensitive to sample size. Large sample sizes generally result in the test hypothesis being rejected; smaller samples result in the hypothesis being accepted. In addition, the test hypothesis is often too restrictive. Very often, the user is interested in knowing if two distributions are similar, not necessarily statistically identical. To overcome these two deficiencies, the phi-coefficient can be used. This coefficient is defined as (Fleiss, 1973):

$$\phi = \sqrt{\frac{\chi^2}{N}}$$

Values of the phi-coefficient close to zero indicate two distributions are nearly identical. Values around one indicate little similarity.

**2.2 Cloud Cover Data.** The cloud cover frequency distributions used in this study were initially divided into 21 classes. Class number 1 represented a cloud cover of zero percent. Class number 2 represented one to five percent, number 3 represented six to ten percent, and so on up to class number 21 which represented 100 percent cloud cover. The relative frequency of several classes was very small ( in many cases less than one percent). It is inadvisable to

compute the chi-square statistic when classes have a low count. To overcome this we combined the original 21 classes into six larger classes:

- Class 1 (Old Class 1)
- Class 2 (Old Classes 2, 3, 4, 5, 6)
- Class 3 (Old Classes 7, 8, 9, 10, 11)
- Class 4 (Old Classes 12, 13, 14, 15)
- Class 5 (Old Classes 16, 17, 18, 19, 20)
- Class 6 (Old Class 21)

Chi-square and phi-coefficient values were computed for the cloud-cover frequency distribution of each PME and the corresponding CEG it was located within. A large amount of data was processed, as the monthly sample corresponding size within each PME was on the order of  $10^6$ .

**2.3 Interpretation of the Phi-Coefficient.** The phi-coefficient is a relative measure of the similarity of two distributions. As a guide to interpreting its significance, we have provided a comparison of four distribution sets for different values of the phi-coefficient: 0.05 (Figure 1), 0.20 (Figure 2), 0.35 (Figure 3), and 0.50 (Figure 4).

As a further guide to interpreting the phi-coefficient, Figure 5 depicts a plot of the relative frequency distribution and the cumulative frequency distribution of values of phi computed in this study. Based on the plots in Figures 1 through 5, we selected a value of phi of 0.35 as the discriminant between similar and non-similar distributions. About three-quarters of the distributions in this study were therefore classified as similar. In evaluating whether the cloud-cover climatology of a given PME was similar to that of the large CEG we used the following criterion: If the value of phi is less than 0.35 for 8 out of the 12 months, the climatologies are *similar*, otherwise the climatologies are classified as *dissimilar*.

**2.4 Results.** Table 1 lists those PME regions whose cloud-cover climatologies are similar to its corresponding CEG (see the appendix for a definition of each CEG). Table 2 lists those PME regions whose cloud-cover climatologies are dissimilar to its

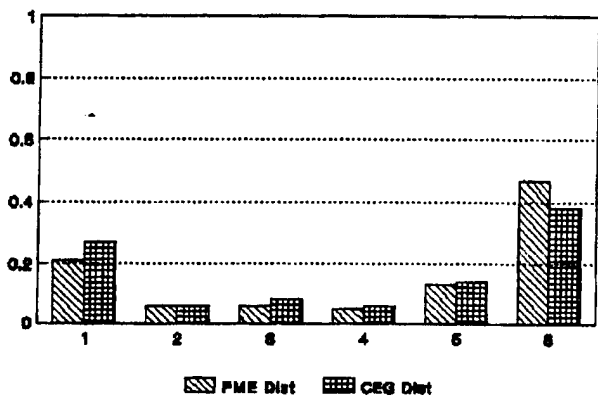


Figure 1. Comparison of two distributions with a phi-coefficient of 0.05.

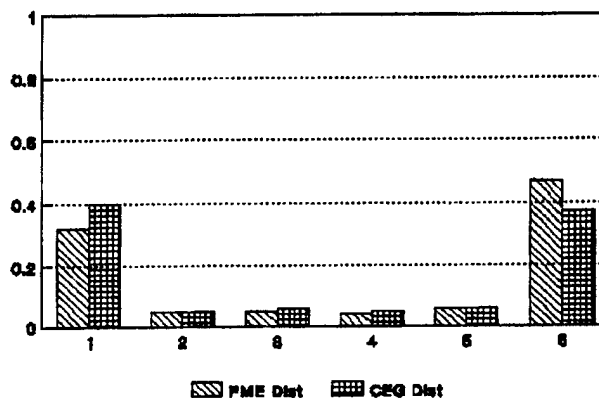


Figure 2. Comparison of two distributions with a phi-coefficient of 0.20.

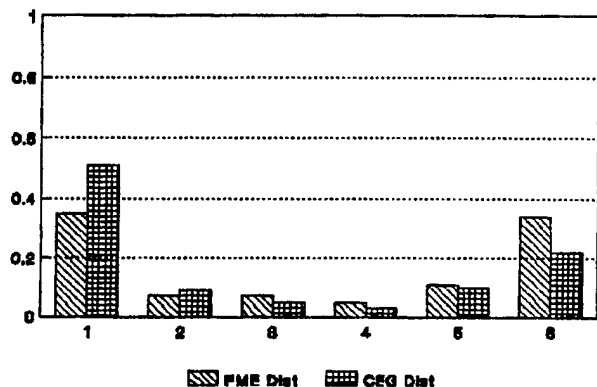


Figure 3. Comparison of two distributions with a phi-coefficient of 0.35.

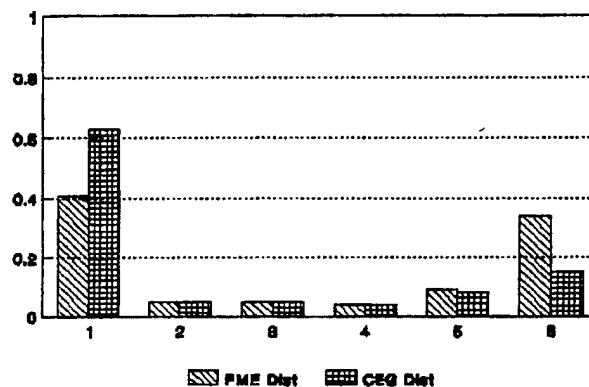


Figure 4. Comparison of two distributions with a phi-coefficient of 0.50.

### Distribution of Phi Coefficient

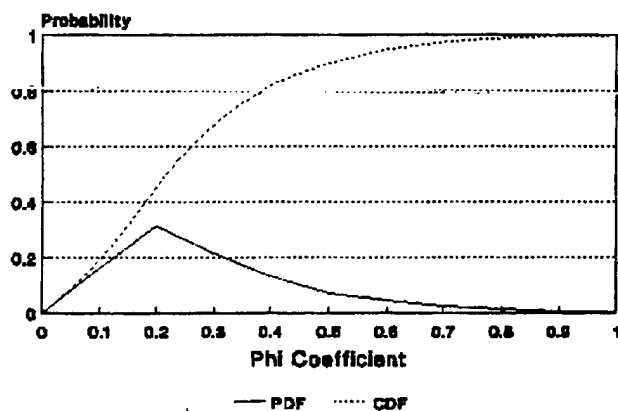


Figure 5. Frequency distribution of phi-coefficients.

corresponding CEG. We conducted further analysis on these PME regions, comparing them against the remaining 18 CEGs to determine if this PME might better belong in one of these other regions. (We made no consideration for the proximity of the PME region to the CEG). Table 4 lists those CEGs in which at least three additional months had a phi-coefficient lower than 0.35. In some cases, no acceptable substitutes were found. Finally, Table 5 is listing of the phi-coefficients computed, by month, for the comparison of each PME region with its originally assigned CEG.

Due to the large numbers of bad matches in CEG 1, we broke this region up into two CEGs: 1a and 20. CEG 1a excluded the two arctic regions (1111 Antarctica and 1121 Arctic Ocean) which were

transferred to CEG 20. The monthly values of phi for these two regions are listed in Table 6. The PME regions in CEG 1a now all showed similar climatologies. The new arctic CEG however indicated a poor fit. Because the climatologies of the two regions are 6 months out of phase, we also compared

results for a 6-month shift of region 1111. The comparison was still poor. There is some uncertainty if this indicates a real difference in climatology, or is an artifact of the RTNEPH, which has been shown to have difficulty discriminating between ice-cover and cloud-cover (Lowther et al., 1991).

**Table 1.** PME regions that had similar cloud cover climatologies to their corresponding CEGs.

CEG	PMEs
1	1111
2	117-124-125-126-127-512-514
3	111-112-113-114-116-211
4	152-212
5	118-141-143-145-154
6	115-151-221-222
7	323-324
8	144-146-147-415-417
9	312-313-321-931-932-933-934-935
10	723-732-741-913-914
11	721
12	915
13	413-414-1011
14	731-742-923
15	513
16	1012
17	133-134-1222-1243-1311-1312-1324-1334-1433-1434
18	135-422-1211-1223-1235-1241-1242-1313-1322-1323-1332-1333-1432
19	622-1212-1213-1214-1231-1232-1233-1321-1331-1421-1422

**Table 2.** PME regions that had dissimilar cloud cover climatologies with their corresponding CEG.

<b>CEG</b>	<b>PMEs</b>
1	121-122-123-214-511-1121
2	1221
3	<i>none</i>
4	213
5	119
6	<i>none</i>
7	142-325
8	153-416
9	311-314-315-322-936
10	743
11	612-621-624-711-712-722
12	911-912-921-937
13	411-412
14	731-742-923
15	513
16	1013
17	131-132
18	<i>none</i>
19	421-623-1234-1411

**Table 3.** Possible alternative CEG regions for PME regions listed in Table 2.

CEG	PME	No of bad months	Alternates [Number of bad months in ( )]
1	121	10	12(2), 5(7), 11(7), 14(7), 16(7)
	122	11	7(6), 11(7), 12(7), 5(8)
	123	11	12(6), 16(7), 19(7), 5(8), 7(8), 11(8), 14(8)
	214	7	12(1), 19(2), 18(3), 11(4)
	511	7	19(0), 12(2)
	1121	9	19(4), 14(5), 16(6)
2	1221	10	13(0), 17(0), 18(2), 11(4), 3(5)
4	213	6	<u>no satisfactory alternate</u>
5	119	6	10(0), 14(2), 16(2), 6(3)
7	142	8	5(3)
	325		18(2), 8(4), 12(4), 11(5), 13(5), 17(5), 2(6), 19(6)
8	153	7	5(4)
	416	6	5(4)
9	311	9	<u>no satisfactory alternate</u>
	314	7	<u>no satisfactory alternate</u>
	315	5	<u>no satisfactory alternate</u>
	322	6	16(3)
	936	7	7(4)
10	743	7	14(2), 5(4)
11	612	9	17(6)
	621		6(10)
	624	11	18(8)
	711	6	13(3), 17(3)
	712		2(1), 8(3), 12(3), 18(4)
	732	5	<u>no satisfactory alternate</u>
12	911	6	<u>no satisfactory alternate</u>
	912	6	11(2), 18(3)
	921	5	6(0), 10(1), 14(1)
	937	7	5(2), 14(4)
13	411	7	<u>no satisfactory alternate</u>
	412	5	<u>no satisfactory alternate</u>
14	611	5	5(3)
	922	5	10(3)
16	1013	12	4(1), 8(2), 3(3), 11(3), 18(3), 2(6), 6(6)
17	131	6	12(3), 18(4), 19(4)
	132	8	11(2), 12(4), 18(4), 19(4)
19	421	6	<u>no satisfactory alternate</u>
	623	5	14(0), 16(3)
	1234	6	16(0), 14(1), 5(3), 10(3)
	1411	6	<u>no satisfactory alternate</u>
	1412	5	<u>no satisfactory alternate</u>

**Table 4.** Listing of the phi-coefficients for the comparison, by month, of each PME region with its original CEG.

CEG	PME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	121	0.43	0.61	0.58	0.72	0.54	0.47	0.55	0.56	0.33	0.40	0.33	0.46
1	122	0.60	0.69	0.76	0.71	0.63	0.56	0.57	0.54	0.34	0.44	0.56	0.57
1	123	0.47	0.65	0.84	0.79	0.55	0.55	0.57	0.47	0.22	0.47	0.58	0.59
1	214	0.32	0.47	0.45	0.57	0.36	0.31	0.45	0.45	0.23	0.29	0.30	0.39
1	511	0.24	0.39	0.54	0.52	0.36	0.37	0.47	0.39	0.12	0.24	0.24	0.26
1	1111	0.16	0.28	0.35	0.39	0.30	0.27	0.35	0.28	0.38	0.21	0.23	0.20
1	1121	0.24	0.37	0.50	0.73	0.83	0.71	0.80	0.61	0.32	0.59	0.52	0.26
2	117	0.14	0.16	0.13	0.14	0.15	0.13	0.16	0.16	0.11	0.18	0.14	0.12
2	124	0.31	0.25	0.11	0.12	0.12	0.12	0.10	0.09	0.09	0.10	0.23	0.29
2	125	0.26	0.19	0.30	0.19	0.10	0.13	0.10	0.11	0.13	0.17	0.30	0.31
2	126	0.41	0.47	0.29	0.26	0.18	0.16	0.29	0.23	0.08	0.17	0.36	0.42
2	127	0.40	0.30	0.08	0.09	0.07	0.08	0.15	0.11	0.17	0.35	0.29	0.32
2	512	0.14	0.14	0.14	0.16	0.17	0.16	0.19	0.21	0.13	0.11	0.14	0.12
2	514	0.20	0.13	0.11	0.11	0.17	0.19	0.20	0.29	0.26	0.13	0.14	0.23
2	1221	0.50	0.52	0.36	0.28	0.36	0.39	0.43	0.48	0.42	0.31	0.46	0.54
3	111	0.14	0.16	0.12	0.05	0.34	0.19	0.21	0.18	0.15	0.27	0.18	0.22
3	112	0.14	0.10	0.11	0.14	0.22	0.06	0.17	0.17	0.19	0.28	0.12	0.15
3	113	0.12	0.08	0.07	0.08	0.16	0.09	0.13	0.16	0.15	0.20	0.10	0.10
3	114	0.21	0.15	0.10	0.12	0.21	0.09	0.15	0.20	0.12	0.14	0.13	0.19
3	116	0.15	0.13	0.30	0.14	0.10	0.15	0.14	0.22	0.14	0.13	0.19	0.16
3	211	0.22	0.22	0.26	0.21	0.17	0.18	0.22	0.26	0.22	0.23	0.24	0.23
4	152	0.25	0.25	0.25	0.19	0.22	0.10	0.25	0.27	0.15	0.33	0.22	0.21
4	212	0.07	0.08	0.07	0.05	0.05	0.02	0.05	0.07	0.04	0.08	0.08	0.07
4	213	0.21	0.28	0.29	0.33	0.40	0.36	0.50	0.45	0.47	0.38	0.24	0.23
5	118	0.46	0.24	0.18	0.12	0.12	0.29	0.26	0.28	0.12	0.23	0.41	0.52
5	119	0.42	0.29	0.28	0.10	0.25	0.51	0.55	0.56	0.48	0.14	0.17	0.40
5	141	0.16	0.14	0.18	0.09	0.12	0.14	0.09	0.09	0.09	0.15	0.14	0.16
5	143	0.27	0.20	0.23	0.19	0.22	0.34	0.26	0.29	0.33	0.17	0.23	0.33
5	145	0.32	0.26	0.19	0.07	0.12	0.24	0.38	0.39	0.24	0.10	0.17	0.34
5	154	0.33	0.30	0.31	0.14	0.13	0.19	0.22	0.20	0.12	0.08	0.21	0.30
6	115	0.34	0.31	0.28	0.22	0.18	0.30	0.37	0.28	0.35	0.26	0.33	0.37
6	151	0.19	0.19	0.24	0.15	0.20	0.35	0.23	0.18	0.09	0.14	0.16	0.09
6	221	0.13	0.13	0.07	0.16	0.15	0.34	0.36	0.30	0.37	0.14	0.15	0.11
6	222	0.28	0.23	0.25	0.14	0.09	0.13	0.14	0.13	0.15	0.19	0.22	0.27
7	142	0.17	0.35	0.38	0.37	0.38	0.56	0.64	0.56	0.47	0.32	0.26	0.21
7	323	0.14	0.09	0.12	0.18	0.23	0.15	0.08	0.05	0.13	0.27	0.26	0.17
7	324	0.08	0.19	0.17	0.07	0.19	0.46	0.28	0.28	0.36	0.34	0.30	0.06
7	325	0.90	0.43	0.46	0.72	0.65	0.31	0.23	0.09	0.29	0.87	1.09	0.90
8	144	0.11	0.09	0.05	0.08	0.08	0.11	0.20	0.18	0.19	0.13	0.07	0.09
8	146	0.24	0.23	0.21	0.23	0.21	0.19	0.14	0.25	0.26	0.23	0.32	0.31
8	147	0.11	0.15	0.15	0.11	0.10	0.08	0.23	0.06	0.13	0.11	0.08	0.19
8	153	0.57	0.62	0.61	0.50	0.37	0.21	0.27	0.15	0.31	0.43	0.41	0.29
8	415	0.47	0.40	0.31	0.16	0.10	0.11	0.08	0.15	0.19	0.30	0.38	0.52
8	416	0.35	0.36	0.38	0.45	0.39	0.25	0.19	0.26	0.25	0.36	0.32	0.26
8	417	0.33	0.33	0.29	0.32	0.30	0.23	0.43	0.33	0.23	0.29	0.38	0.38
9	311	0.67	0.59	0.43	0.23	0.24	0.37	0.55	0.49	0.44	0.32	0.41	0.61
9	312	0.29	0.22	0.21	0.15	0.04	0.47	0.65	0.58	0.58	0.05	0.30	0.34
9	313	0.15	0.14	0.12	0.05	0.21	0.19	0.12	0.19	0.31	0.37	0.26	0.14
9	314	0.33	0.37	0.39	0.24	0.09	0.37	0.36	0.41	0.51	0.19	0.18	0.39
9	315	0.08	0.09	0.06	0.35	0.25	0.55	0.68	0.65	0.53	0.32	0.14	0.03
9	321	0.15	0.21	0.33	0.06	0.15	0.07	0.34	0.14	0.33	0.37	0.19	0.21
9	322	0.61	0.71	0.72	0.34	0.09	0.25	0.33	0.41	0.42	0.12	0.26	0.69
9	931	0.21	0.25	0.26	0.16	0.11	0.05	0.07	0.07	0.28	0.13	0.39	0.23
9	932	0.24	0.25	0.16	0.17	0.21	0.25	0.33	0.29	0.21	0.34	0.30	0.18
9	933	0.13	0.02	0.04	0.20	0.15	0.35	0.66	0.63	0.40	0.20	0.07	0.09
9	934	0.04	0.10	0.09	0.10	0.10	0.12	0.19	0.28	0.24	0.08	0.04	0.07

Table 4 (continued).

CEG	PME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
9	935	0.31	0.28	0.15	0.24	0.17	0.26	0.40	0.46	0.42	0.19	0.23	0.28
9	936	0.13	0.08	0.10	0.46	0.44	0.48	0.50	0.38	0.36	0.37	0.13	0.12
10	723	0.05	0.08	0.12	0.16	0.16	0.16	0.16	0.12	0.15	0.10	0.13	0.11
10	732	0.08	0.06	0.06	0.12	0.15	0.06	0.14	0.12	0.07	0.06	0.04	0.06
10	741	0.51	0.50	0.43	0.19	0.13	0.26	0.30	0.31	0.19	0.07	0.23	0.50
10	743	0.42	0.40	0.28	0.12	0.25	0.51	0.55	0.74	0.53	0.29	0.12	0.42
10	913	0.21	0.19	0.04	0.17	0.30	0.32	0.29	0.29	0.32	0.12	0.09	0.13
10	914	0.24	0.27	0.16	0.10	0.13	0.14	0.14	0.14	0.15	0.14	0.11	0.08
11	612	0.63	0.72	0.75	0.53	0.23	0.50	0.63	0.64	0.42	0.23	0.26	0.42
11	621	0.80	0.82	0.82	0.89	0.61	0.43	0.42	0.35	0.41	0.53	0.69	0.67
11	624	0.72	0.74	0.78	0.72	0.48	0.35	0.36	0.35	0.28	0.40	0.55	0.68
11	711	0.16	0.10	0.04	0.28	0.43	0.55	0.60	0.65	0.40	0.37	0.18	0.17
11	712	0.43	0.41	0.37	0.16	0.21	0.39	0.43	0.38	0.08	0.07	0.08	0.32
11	713	0.26	0.26	0.22	0.23	0.12	0.16	0.26	0.26	0.09	0.13	0.07	0.07
11	721	0.18	0.18	0.20	0.22	0.38	0.27	0.26	0.13	0.26	0.22	0.17	0.13
11	722	0.35	0.35	0.34	0.16	0.20	0.40	0.47	0.44	0.44	0.07	0.12	0.32
12	911	0.48	0.45	0.29	0.23	0.09	0.32	0.40	0.38	0.15	0.20	0.43	0.44
12	912	0.57	0.56	0.34	0.21	0.10	0.38	0.42	0.27	0.16	0.33	0.50	0.61
12	915	0.13	0.04	0.14	0.16	0.26	0.33	0.38	0.33	0.22	0.29	0.11	0.12
12	921	0.33	0.17	0.15	0.21	0.29	0.44	0.57	0.58	0.93	0.45	0.19	0.26
12	937	0.42	0.43	0.35	0.08	0.25	0.24	0.26	0.45	0.63	0.37	0.23	0.38
13	411	1.25	1.22	0.95	0.57	0.23	0.30	0.35	0.42	0.17	0.25	0.62	1.17
13	412	0.40	0.40	0.54	0.52	0.21	0.21	0.24	0.26	0.11	0.13	0.15	0.37
13	413	0.14	0.10	0.10	0.07	0.16	0.09	0.12	0.19	0.13	0.27	0.23	0.16
13	414	0.31	0.31	0.26	0.14	0.10	0.18	0.21	0.27	0.39	0.12	0.07	0.27
13	1011	0.36	0.47	0.36	0.33	0.12	0.08	0.07	0.12	0.16	0.08	0.12	0.34
14	611	0.35	0.39	0.39	0.25	0.16	0.31	0.49	0.46	0.13	0.18	0.31	0.26
14	731	0.37	0.33	0.36	0.29	0.29	0.16	0.09	0.08	0.08	0.14	0.19	0.22
14	742	0.19	0.22	0.12	0.14	0.49	0.58	0.56	0.46	0.20	0.21	0.10	0.13
14	922	0.22	0.27	0.23	0.10	0.44	0.63	0.66	0.54	0.39	0.07	0.17	0.21
14	923	0.33	0.23	0.31	0.24	0.26	0.23	0.33	0.33	0.35	0.13	0.16	0.25
15	513	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	1012	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.06	0.05	0.03	0.03
16	1013	0.47	0.46	0.53	0.60	0.72	0.78	0.82	0.98	1.13	0.93	0.65	0.52
17	131	0.21	0.45	0.71	0.57	0.41	0.67	0.33	0.33	0.37	0.18	0.22	0.25
17	132	0.37	0.52	0.41	0.76	0.54	0.57	0.72	0.41	0.14	0.16	0.10	0.21
17	133	0.16	0.17	0.14	0.22	0.13	0.14	0.21	0.22	0.27	0.30	0.27	0.18
17	134	0.31	0.30	0.13	0.13	0.28	0.28	0.29	0.24	0.12	0.10	0.24	0.33
17	1222	0.19	0.08	0.14	0.11	0.13	0.19	0.21	0.17	0.05	0.17	0.22	0.16
17	1243	0.04	0.04	0.05	0.07	0.04	0.05	0.05	0.07	0.04	0.05	0.05	0.04
17	1311	0.08	0.09	0.10	0.15	0.17	0.16	0.12	0.16	0.23	0.14	0.18	0.19
17	1312	0.29	0.24	0.27	0.19	0.13	0.08	0.11	0.13	0.18	0.29	0.20	0.22
17	1324	0.25	0.21	0.13	0.13	0.21	0.28	0.39	0.32	0.15	0.12	0.18	0.27
17	1334	0.18	0.17	0.14	0.05	0.06	0.08	0.08	0.09	0.20	0.22	0.19	0.24
17	1433	0.06	0.04	0.03	0.02	0.04	0.07	0.11	0.09	0.19	0.05	0.04	0.07
17	1434	0.08	0.05	0.05	0.04	0.09	0.13	0.14	0.15	0.30	0.17	0.14	0.10
18	135	0.20	0.17	0.24	0.35	0.23	0.19	0.32	0.22	0.13	0.23	0.14	0.14
18	422	0.25	0.30	0.30	0.25	0.23	0.24	0.14	0.14	0.09	0.15	0.12	0.13
18	1211	0.31	0.28	0.20	0.17	0.22	0.26	0.26	0.20	0.12	0.08	0.08	0.22
18	1223	0.16	0.11	0.10	0.11	0.10	0.19	0.19	0.12	0.03	0.02	0.06	0.11
18	1235	0.11	0.06	0.03	0.04	0.14	0.20	0.23	0.22	0.11	0.12	0.12	0.09
18	1241	0.23	0.19	0.16	0.06	0.11	0.17	0.21	0.20	0.21	0.24	0.14	0.23
18	1242	0.12	0.12	0.12	0.17	0.22	0.21	0.23	0.24	0.25	0.09	0.13	0.12
18	1313	0.27	0.24	0.18	0.25	0.16	0.19	0.34	0.40	0.22	0.18	0.21	0.16
18	1322	0.12	0.13	0.16	0.22	0.31	0.41	0.50	0.53	0.22	0.19	0.16	0.12
18	1323	0.07	0.06	0.17	0.26	0.22	0.22	0.23	0.20	0.12	0.12	0.12	0.05
18	1333	0.18	0.15	0.14	0.11	0.07	0.09	0.11	0.15	0.16	0.09	0.15	0.15
18	1431	0.10	0.12	0.05	0.06	0.10	0.17	0.25	0.21	0.23	0.14	0.06	0.05
18	1432	0.16	0.14	0.18	0.11	0.20	0.20	0.14	0.17	0.11	0.07	0.12	0.13

Table 4 (continued).

CEG	PME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
19	421	0.15	0.21	0.18	0.13	0.32	0.52	0.46	0.53	0.44	0.47	0.42	0.13
19	622	0.62	0.58	0.54	0.32	0.08	0.19	0.13	0.13	0.10	0.19	0.22	0.45
19	623	0.26	0.28	0.24	0.37	0.45	0.17	0.19	0.30	0.38	0.41	0.40	0.22
19	1212	0.14	0.23	0.09	0.11	0.15	0.33	0.44	0.45	0.26	0.25	0.19	0.20
19	1213	0.14	0.15	0.05	0.06	0.05	0.06	0.04	0.09	0.10	0.05	0.06	0.15
19	1214	0.05	0.10	0.07	0.05	0.17	0.20	0.28	0.27	0.16	0.18	0.12	0.09
19	1231	0.45	0.63	0.41	0.31	0.18	0.12	0.10	0.06	0.15	0.09	0.26	0.44
19	1232	0.14	0.10	0.03	0.10	0.13	0.29	0.37	0.43	0.53	0.32	0.23	0.10
19	1233	0.30	0.27	0.16	0.10	0.11	0.20	0.32	0.30	0.46	0.13	0.15	0.26
19	1234	0.38	0.26	0.17	0.18	0.36	0.37	0.40	0.38	0.61	0.29	0.30	0.33
19	1321	0.15	0.12	0.07	0.08	0.09	0.04	0.04	0.05	0.11	0.10	0.15	0.07
19	1331	0.20	0.16	0.07	0.09	0.26	0.38	0.37	0.33	0.53	0.19	0.13	0.12
19	1411	0.13	0.30	0.15	0.17	0.48	0.70	0.62	0.76	0.57	0.47	0.32	0.06
19	1412	0.29	0.54	0.49	0.38	0.18	0.27	0.16	0.24	0.20	0.39	0.42	0.29
19	1421	0.34	0.26	0.20	0.14	0.20	0.09	0.16	0.12	0.13	0.17	0.13	0.06
19	1422	0.29	0.20	0.08	0.10	0.09	0.19	0.22	0.16	0.23	0.14	0.19	0.11

Table 5. Listing of the bad months for the CEGs that can be considered reasonable alternatives to the original CEGs (see Table 3).

OLD CEG	PME	CEG	NUMBER OF BAD MONTHS WITH INDIVIDUAL MONTHS LISTED
1	121	12	2 MAR APR
1	121	5	7 MAY JUN JUL AUG SEP OCT NOV
1	121	11	7 JAN FEB MAR APR MAY NOV DEC
1	121	14	7 FEB MAY JUN JUL AUG SEP OCT
1	121	16	7 MAY JUN JUL AUG SEP OCT NOV
1	122	7	6 FEB MAY JUL AUG OCT NOV
1	122	11	7 JAN FEB MAR APR MAY NOV DEC
1	122	12	7 JAN FEB MAR APR MAY NOV DEC
1	122	5	8 MAR APR MAY JUN JUL AUG SEP OCT
1	123	12	6 FEB MAR APR MAY NOV DEC
1	123	16	7 FEB MAR JUN JUL AUG SEP OCT
1	123	19	7 JAN FEB MAR APR SEP NOV DEC
1	123	5	8 MAR APR MAY JUN JUL AUG SEP OCT
1	123	7	8 JAN FEB MAY JUN JUL AUG OCT NOV
1	123	11	8 JAN FEB MAR APR MAY OCT NOV DEC
1	123	14	8 JAN FEB MAR APR MAY AUG SEP DEC
1	214	12	1 APR
1	214	19	2 SEP OCT
1	214	18	3 FEB APR DEC
1	214	11	4 FEB MAR APR DEC
1	511	19	0
1	511	12	2 MAR APR
1	1121	19	4 MAR APR MAY NOV
1	1121	14	5 JAN FEB MAR APR MAY
1	1121	16	6 JAN MAR APR AUG SEP OCT
2	1221	13	0
2	1221	17	0
2	1221	18	2 AUG SEP
2	1221	11	4 JUN JUL AUG SEP
2	1221	3	5 MAY JUN JUL AUG SEP
5	119	10	0
5	119	14	2 AUG SEP
5	119	16	2 JAN DEC
5	119	6	3 JUN SEP NOV
7	142	5	3 AUG NOV DEC

Table 5 (continued).

OLD CEG	PME	CEG	NUMBER OF BAD MONTHS WITH INDIVIDUAL MONTHS LISTED
7	325	18	2 FEB MAR
7	325	8	4 FEB MAR JUL AUG
7	325	12	4 JAN MAR JUN AUG
7	325	11	5 FEB MAR JUN JUL AUG
7	325	13	5 JAN FEB MAR APR DEC
7	325	17	5 JAN FEB MAR APR DEC
7	325	2	6 JAN FEB MAR APR JUN AUG
7	325	19	6 FEB MAY JUN JUL AUG OCT
8	.153	5	4 JUN JUL AUG SEP
8	416	5	4 JUN JUL AUG SEP
9	322	16	3 JUN JUL SEP
9	936	7	4 JUN JUL AUG SEP
10	743	14	2 JUN AUG
10	743	5	4 JAN FEB AUG OCT
11	612	17	6 JAN FEB MAR APR NOV DEC
11	621	6	10 JAN FEB MAR APR JUN JUL AUG SEP NOV DEC
11	624	18	8 JAN FEB MAR APR MAY OCT NOV DEC
11	711	13	3 JAN FEB DEC
11	711	17	3 JAN FEB DEC
11	712	2	1 JAN
11	712	8	3 JAN FEB MAR
11	712	12	3 MAY JUN JUL
11	712	18	4 JAN FEB MAR DEC
12	912	11	2 JUN JUL
12	912	18	3 JUN JUL AUG
12	921	6	0
12	921	10	1 APR
12	921	14	1 SEP
12	937	5	2 JAN APR
12	937	14	4 JAN FEB APR DEC
14	611	5	3 JUL AUG SEP
14	922	10	3 MAY JUN JUL

Table 5 (continued).

OLD - CEG	PME	CEG	NUMBER OF BAD MONTHS WITH INDIVIDUAL MONTHS LISTED
16	1013	4	1 DEC
16	1013	8	2 MAR DEC
16	1013	3	3 JAN FEB MAR
16	1013	11	3 JUL AUG SEP
16	1013	18	3 FEB MAR SEP
16	1013	2	6 JAN FEB MAR APR SEP DEC
16	1013	6	6 MAY JUN JUL AUG SEP OCT
17	131	12	3 JAN NOV DEC
17	131	18	4 MAR JUN NOV DEC
17	131	19	4 JAN OCT NOV DEC
17	132	11	2 APR OCT
17	132	12	4 JAN OCT NOV DEC
17	132	18	4 APR JUL SEP OCT
17	132	19	4 SEP OCT NOV DEC
19	623	14	0
19	623	16	3 JUL AUG SEP
19	1234	16	0
19	1234	14	1 SEP
19	1234	5	3 MAY JUN JUL
19	1234	10	3 JAN FEB DEC

**Table 6.** Listing of the phi-coefficients for the comparison, by month, of each PME region for the alternative CEGs.

CEG	PME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1a	121	0.21	0.22	0.22	0.23	0.21	0.17	0.12	0.16	0.17	0.17	0.13	0.19
1a	122	0.32	0.25	0.20	0.15	0.24	0.19	0.14	0.17	0.18	0.19	0.26	0.25
1a	123	0.21	0.21	0.27	0.23	0.19	0.24	0.16	0.13	0.12	0.23	0.29	0.26
1a	214	0.36	0.31	0.33	0.27	0.23	0.15	0.09	0.09	0.14	0.16	0.26	0.23
1a	511	0.11	0.12	0.10	0.11	0.10	0.08	0.08	0.09	0.08	0.08	0.09	0.12
20	1111	0.07	0.11	0.15	0.18	0.17	0.13	0.16	0.12	0.23	0.11	0.11	0.08
20	1121	0.64	0.70	0.67	0.88	0.81	0.58	0.64	0.63	0.58	0.93	0.91	0.65

## Appendix

### DEFINITION OF CONSOLIDATED EVALUATION GROUPS (CEGs)

<b>1. POLAR REGIONS</b>			
121	Kara Sea and Coast		
122	Laptev Sea and Coast		
123	Chukchi Sea and Coast		
214	Svalbard		
511	Greenland and Arctic Ocean		
1111	Antarctica		
1121	Arctic Ocean		
<b>2. SUBARCTIC REGION</b>			
117	Western Siberia		
124	Central Siberia		
125	Eastern Siberia		
126	Kamchatka and Kuril Islands		
127	Soviet Amur and Vladivostok		
512	Canada		
514	Mainland Alaska		
1221	Bering Sea and Aleutians		
<b>3. RUSSIAN REGION</b>			
111	Barents Sea Coast		
112	Western Russia		
113	Northwest Russia		
114	Moscow Rectangle		
116	Gorkiy - Sverdlovsk		
211	Scandinavia - Baltic Sea		
<b>4. NORTHERN EUROPEAN REGION</b>			
152	Northern Eastern Europe		
212	NW Europe - North Sea		
213	Iceland		
<b>5. NORTHERN CHINA REGION</b>			
118	Kazakhstan		
119	South Soviet Asia		
141	Northwest China		
143	North Central China		
154	North East China		
154	Mongolia		
<b>6. MEDITERRANEAN REGION</b>			
115	Southwest Russia		
151	Southern Eastern Europe		
221	Greece and Turkey		
222	W Mediterranean		
<b>7. INDIAN REGION</b>			
142	Tibet		
323	Northern India, Bangladesh		
324	Southern India		
325	Sri Lanka		
		<b>8. ASIAN EAST COASTAL REGION</b>	
		144	South Central Asia
		146	East China
		147	Southeast China
		153	North Korea
		415	Japan
		416	South Korea
		417	Taiwan
		<b>9. ARID REGION</b>	
		311	Israel and Adjacent States
		312	Iraq
		313	Arabian Peninsula
		314	Iran
		315	Egypt
		321	Pakistan
		322	Afghanistan
		931	W Sahara & Mauritania
		932	Morocco & Algeria
		933	Libya
		934	Mali & Niger
		935	Chad & Sudan
		936	Horn of Africa
		<b>10. SOUTHERN HEMISPHERE CONTINENTAL</b>	
		723	Southeast Brazil
		732	Bolivia & Paraguay
		741	Northern Argentina
		743	Uruguay
		913	Southeast Africa
		914	Madagascar
		<b>11. TROPICAL AMERICANA</b>	
		612	Central America
		621	Cuba
		624	Antilles & Bahamas
		711	Columbia & Northern Ecuador
		712	Venezuela & Guianas
		713	S Ecuador & S Colombia
		721	Northern Brazil
		722	Amazon Brazil
		<b>12. AFRICAN TROPICS</b>	
		911	Humid West Africa
		912	S Congo, S Gabon, S Za re
		915	Humid Central Africa
		921	Tanzania & S Kenya
		937	N Uganda & N Kenya
		<b>13. ASIAN TROPICS</b>	
		411	Southeast Asia
		412	Philippines
		413	N Indonesia & Malaysia
		414	S Indonesia
		1011	Papua New Guinea

**14. VARIED WEST COASTAL**

611 Mexico  
731 Peru & N Chile  
742 S Argentina & S Chile  
922 Angola & Namibia  
923 Union of South Africa

**15. UNITED STATES**

513 Contiguous United States

**16. AUSTRALIAN REGION**

1012 Australia  
1013 New Zealand

**17. HIGH LATITUDE SEAS**

1222 Gulf of Alaska  
1324 Iceberg Atlantic  
1312 Rockall Atlantic  
1311 Norwegian & Greenland Seas  
133 North Cape Area  
132 Barents Sea  
131 Sea of Okhotsk  
134 Komandorsky - Bering Sea  
1243 W Drake Passage Pacific  
1334 South Georgia Atlantic  
1433 Macquarie - Antipodes So

**18. MID-LATITUDE SEAS**

1223 Midway - California Pacific  
1323 Bermuda Atlantic  
1322 Sargasso Atlantic  
1313 Gibraltar Approaches  
135 Sea of Japan  
422 East China & Yellow Seas  
1211 Volcano Is., NW Pacific  
1242 Kermadec - Chatham Pacific  
1235 Easter Island Pacific  
1333 SW Atlantic  
1332 Tristan de Cunha Atlantic  
1432 SW Indian Ocean  
1431 Amsterdam Indian Ocean  
1241 Tasman Sea

**19. TROPICAL SEAS**

1212 Former Trust Pacific  
1213 Hawaii - Kingman Pacific  
1214 Clipperton Pacific  
622 Caribbean Sea  
623 Gulf of Mexico  
1321 Cape Verde Atlantic  
1412 Arabia Sea  
1411 Bay of Bengal  
421 South China Sea  
1231 Solomons - Samoa Pacific  
1232 Jarvis - Cook Pacific  
1233 French Polynesia  
1234 S Galapagos Pacific  
1331 Ascension Atlantic  
1422 Seychelles - Mauritius  
1421 Cocos Indian Ocean

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