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TECHNICAL NOTE

The Effect of Drifting Buoy Data on NCEP Numerical Weather Forecasts

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1. Introduction

There are generally about 600 to 800 drifting buoy data operationally available for use in analyses during each NCEP global atmospheric data assimilation cycle, depending on the analysis time. Figure 1 shows the distribution of these drifters over the global oceans. One can see that the drifters are about equally distributed over the midlatitude oceans of the Northern and Southern Hemispheres. They represent less than one percentage of the total NCEP global observation data base, which includes conventional surface and upper air observations over land and sea as well as a vast amount of satellite measurements of ocean surface winds, and upper air temperature and humidity data. Table 1 shows typical conventional surface marine observation data counts within + and - 3 hours of an analysis time of the NCEP global data assimilation cycle. Unlike ships and moored buoys which contain sea level pressure, wind, and temperature reports, most of the drifters contain only sea level pressure, with only a very small number (less than 40) of the drifters containing wind vector information.

The effect of the drifting buoy data on the NCEP numerical weather forecasts was investigated by Kistler (1996, personal communication) using the NCEP reanalysis data assimilation system for two months, January and July during the FGGE year, 1979 (see the Appendix for a summary of Kistler's test results). The present study further investigates the effect of drifting buoy data on the NCEP numerical weather forecasts using the most current operational global data assimilation system. Similar to the Kistler's work, a parallel global data assimilation experiment (PRV) was run excluding surface drifting buoy data from the operational NCEP analyses during the global data assimilation cycles for two selected periods, one in the winter month of January 1996, the other in the summer month of July, 1996. The elimination of the drifter data constitutes the sole difference between the PRV parallel run and the operational PRZ run in which the drifter data are used routinely.

The NCEP T62 global data assimilation system, details of which were given in Kanamitsu (1989) and Kanamitsu et al (1992), was used to investigate the impact of the drifting buoy data on analyses and forecasts. Basically, the assimilation system consists of a forecast model and an analysis scheme. The forecast model is a global spectral forecast model of triangular truncation with 62 waves for the horizontal spectral resolution. In the vertical it has 28 sigma layers. The forecast model includes identical parameterization of such physical processes as convection, precipitation, radiation, and boundary layer physics as those employed in the NCEP operational forecast T126 model. The assimilation experiment is proceeded by a six hour forward integration of the forecast model, starting from the beginning of the data assimilation period, to produce first guess fields of winds (u,v), temperatures (T), and specific humidity (q). The observations within a +/ - 3 hour window are then used to update the first guess fields and complete the analyses.

This process of a six hour model forecast followed by an analysis update is repeated four times a day, once every six hour interval, until the end of the total one month of the assimilation period. For each of the two parallel run experiments, five day forecasts were made at the 0000 UTC cycle of the daily data assimilation, so that there were a total of 31 cases of forecasts. In this study the forecasts valid at 24, 48, 72, 96, and 120 hours of the 31 forecast cases are used for comparison between the two parallel runs. Standard statistics of anomaly correlations and RMS forecast height errors are calculated for each of the two parallel forecasts. In addition, forecast errors of sea level pressures and 10 meter winds with reference to mid-latitude deep ocean buoys and tropical TOGA buoys for the two parallel experiments are compared. These results are discussed in Section 2. A summary concludes this report.

2. Results of the Parallel Experiments

Figure 2 shows the daily anomaly correlations for the 1000 mb height during the month of January 1996 for forecast day 3 (Fig. 2a), and day 5 (Fig. 2b) for the Northern Hemisphere, and day 3 (Fig. 2c), and day 5 (Fig. 2d) for the Southern Hemisphere. At the 1000 mb level, visual comparison of the PRZ (solid curves) anomaly correlations with those of PRV (dashed curves) shows that in general there is very small differences between the forecasts, with the overall forecast being slightly worse for the PRV experiment. However, occasionally there exist significant large differences between the two forecasts. For example during the period of January 13 to 22, 1996, anomaly correlations of the day 3 and day 5 forecasts for the PRV experiment are much worse than those of the PRZ experiment. This suggests that elimination of the drifting buoy data does have a small negative effect on the geopotential height forecasts at 1000 mb level.

The January 1996 monthly mean anomaly correlations for parallel PRV experiment are compared to those of the operational PRZ run, and these statistics are shown in Tables 2a (Northern Hemisphere) and Table 2b (Southern Hemisphere). Similarly, the January 1996 monthly mean statistics of bias and RMS forecast errors for the two parallels experiments are shown in Table 3a (Northern Hemisphere) and Table 3b (Southern Hemisphere). Inspection of the monthly mean anomaly correlations and RMS statistics also suggests that elimination of the drifter data has a small negative impact on the 1000 mb level height forecasts throughout the five day forecast period for the month of January, 1996. This impact is slightly more noticeable over the Southern Hemisphere than over the Northern Hemisphere at the 1000 mb level. At the 500 mb level, the statistics shown in Tables 2 and 3 seem to suggest that elimination of drifter data has a small positive impact on the height forecasts in the Northern Hemisphere. However, it should be emphasized that these differences of anomaly correlations and RMS height forecast errors between the two parallel forecasts are insignificantly small at 500 mb.

The above conclusion is further substantiated by the statistics of mean sea level pressure forecast errors and mean 10 meter wind forecast errors calculated by comparing model forecasts with the mid-latitude buoy observations (See Tables 4a and 4b). These mid-latitude deep ocean buoys are over the Northern Hemisphere with the majority of them located along the east coast and west coast of the United States. All of these buoy winds are adjusted to a height of 10 meters above the ocean surface. One can see from the error statistics shown in Tables 4a and 4b the differences between the two forecasts are very small, suggesting again that elimination of surface drifting buoy data leads to an insignificantly small negative impact on surface level wind and mass fields.

The results for the month of July 1996 are consistent with those of January 1996. Figure 3 shows daily anomaly correlations of the 1000 mb height for day 3 forecasts (Fig. 3a), and day 5 forecasts (Fig. 3b) for the Northern Hemisphere, and day 3 forecasts (Fig. 3c) and day 5 forecasts (Fig.3d) for the Southern Hemisphere for the month of July 1996. Visual inspection of the anomaly correlations between the solid curves (PRZ run) and dashed curves (PRV run) shows again that overall forecasts for the PRV are slightly worse over the Southern Hemisphere 1000 mb level for both day 3 and day 5 forecasts. Over the Northern Hemisphere, anomaly correlations between the two parallel forecasts are not as significantly different. These results are in good agreement with those for the January 1996 parallel experiments.

Results of comparison between the two parallel forecasts by inspecting the mean monthly anomaly correlations (Table 5), mean bias and RMS forecast height errors (Table 6), and mean seal level pressure forecast errors and 10 meter wind forecast errors (see Table 7 with reference to the mid-latitude deep ocean buoys) for the month of July 1996 are in good agreement with those discussed earlier for the month of January 1996, and therefore they will not be elaborated further here. The main conclusion can be drawn from the results shown in Table 5 through Table 7 is that elimination of the drifting buoy data causes a very small negative impact at 1000 mb over the Southern Hemisphere, but with virtually no impact over the Northern Hemisphere.

For the month of July 1996, mean RMS vector wind forecast errors with reference to the TOGA buoys were separately calculated for the Northern and Southern Hemispheres between the two parallel forecast experiments. These TOGA buoys are located between 20 °N and 20 °S latitudes in the tropics. The results are summarized in Table 8a and Table 8b. It clearly shows that elimination of drifting buoys has a negative impact on the Southern Hemisphere; the forecast 10 meter winds have a larger RMS error for the PRV experiment as compared to that of the PRZ experiment (see Table 8b). However, over the Northern Hemisphere, elimination of the drifter data leads to a smaller forecast error of the ocean surface 10 meter winds (see Table 8a).

3. Summary and Conclusions

The original intent of the surface drifter data impact test was to see what effects they might have on the NCEP analyses and forecasts if some percentage of the drifter data were eliminated in the data base. The results presented here, based on two months of data assimilation and forecast experiments, one for the winter month of January 1996 and the other for the summer month of July 1996, show that differences in short range forecasts between the assimilation experiment using all the drifting buoy data and the experiment using no drifting buoy data are not significant at all. Hence, it is clear that using (or excluding) only certain percentage of available drifter data will not have significant impacts on the forecasts in the mean. The results presented here are consistent with the results obtained from assimilation of satellite ocean surface wind data in various operational models. They are also consistent with the results of the drifting buoy tests during the 1979 FGGE period (Kistler, 1996, see Appendix).

Acknowledgments:

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REFERENCES

Kistler, R., (1996): Impact test of drifting buoys (personal communication, see Appendix)

Kanamitsu, M., (1989): Description of the NMC global data assimilation and forecast system, Weather and Forecasting, 4, pp 334-342.

Kanamitsu, M., and co-authors (1991): Recent changes implemented into the global forecast system at NMC, Weather and Forecasting, 6 , pp.422-435.

Table 1. Mean data counts available for indicated model run cutoff times after 0000, 0600, 1200 and 1800 UTC as a function of data type for March 1995. Time windows is +/- 3 hours.

	0000 UTC	0600 UTC	1200 UTC	1800 UTC
Marine Ships	678	627	701	656
C-Man Platform	319	322	313	311
Moored Buoys	540	536	535	529
Drifting Buoys	567	658	795	740

Table 2a. Northern Hemisphere monthly mean anomaly Correlations of 1000 mb and 500 mb Height forecasts from 24 to 120 hours for January 1996

Forecast Hours	PRZ (OPNL)		PRV (w/o Drifter Data)	
	1000 mb	500 mb	1000 mb	500 mb
24	.9757	.9894	.9749	.9896
48	.9369	.9628	.9357	.9640
72	.8782	.9159	.8748	.9153
96	.7966	.8447	.7923	.8421
120	.6946	.7582	.6894	.7566

Table 2b. Southern Hemisphere monthly mean anomaly Correlations of 1000 mb and 500 mb Height forecasts from 24 to 120 hours for January 1996

Forecast Hours	PRZ (OPNL)		PRV (w/o Drifter Data)	
	1000 mb	500 mb	1000 mb	500 mb
24	.9379	.9669	.9355	.9678
48	.8706	.9171	.8649	.9158
72	.7868	.8443	.7779	.8396
96	.6889	.7648	.6794	.7585
120	.5848	.6724	.5754	.6613

Table 3a. Northern Hemisphere 1000 mb and 500 mb mean forecast height errors (meters) From 24 to 120 hours for the month of January 1996.

Forecast Hours	PRZ (OPNL)				PRV (w/o Drifter Data)			
	1000 mb		500 mb		1000 mb		500 mb	
	RMS	Bias	RMS	Bias	RMS	Bias	RMS	Bias
24	17.80	0.26	17.72	-0.43	17.96	0.12	17.51	.04
48	28.58	0.77	32.47	1.21	28.68	0.56	32.01	2.03
72	39.08	0.13	47.69	1.80	39.53	-0.12	47.96	2.68
96	49.75	-0.83	63.63	2.08	50.39	-1.22	64.28	2.84
120	60.70	-1.29	78.87	2.58	61.31	-1.92	79.08	2.96

Table 3b. Southern Hemisphere 1000 mb and 500 mb mean forecast height errors (meters) from 24 to 120 hours for the month of January 1996.

Forecast Hours	PRZ (OPNL)				PRV (w/o Drifter Data)			
	1000 mb		500 mb		1000 mb		500 mb	
	RMS	Bias	RMS	Bias	RMS	Bias	RMS	Bias
24	20.42	1.25	22.58	-2.60	20.39	1.43	21.52	-1.76
48	29.61	1.03	35.49	-3.75	29.60	1.54	34.46	-2.24
72	37.82	1.27	47.77	-3.79	38.08	1.73	47.05	-2.31
96	45.76	1.36	58.65	-3.69	46.08	1.95	58.00	-2.19
120	52.64	1.41	68.96	-3.72	52.82	2.06	68.74	-2.22

Table 4a. Mean sea level pressure forecast errors (mb) for the month of January 1996 with reference to Northern Hemisphere mid-latitude deep ocean buoys

Forecast Hours	No. of buoy Observations	PRZ (OPNL)		PRV (w/o Drifter Data)	
		RMS	Bias	RMS	Bias
24	2427	2.51	-0.13	2.50	-0.27
48	2427	3.73	-0.29	3.84	-0.47
72	2280	5.20	-0.11	5.46	-0.09
96	2173	6.67	0.45	6.59	0.36
120	2063	8.19	0.23	7.55	0.26

Table 4b. Mean RMS vector wind errors (m/sec) for the month of January 1996 with reference to Northern Hemisphere mid-latitude deep ocean buoys

Forecast Hours	No. of Buoys	PRZ (OPNL)	PRV (w/o Drifters)
24	2976	5.31	5.20
48	2978	6.31	6.34
72	2958	7.68	7.75
96	2976	8.00	8.12
120	3028	9.55	9.50

Table 5a. Northern Hemisphere monthly mean anomaly Correlations of 1000 mb and 500 mb Height forecasts from 24 to 120 hours for July 1996

Forecast Hours	PRZ (OPNL)		PRV (w/o Drifter Data)	
	1000 mb	500 mb	1000 mb	500 mb
24	.9502	.9757	.9511	.9757
48	.8804	.9334	.8803	.9334
72	.8065	.8685	.8091	.8703
96	.7002	.7772	.7039	.7814
120	.5935	.6585	.5926	.6636

Table 5b. Southern Hemisphere monthly mean anomaly Correlations of 1000 mb and 500 mb Height forecasts from 24 to 120 hours for July 1996

Forecast Hours	PRZ (OPNL)		PRV (w/o Drifter Data)	
	1000 mb	500 mb	1000 mb	500 mb
24	.9684	.9796	.9663	.9783
48	.9226	.9399	.9175	.9373
72	.8558	.8843	.8498	.8797
96	.7789	.8094	.7725	.8052
120	.6797	.7136	.6742	.7089

Table 6a. Northern Hemisphere 1000 mb and 500 mb mean forecast height errors (meters) From 24 to 120 hours for the month of July 1996.

Forecast Hours	PRZ (OPNL)				PRV (w/o Drifter Data)			
	1000 mb		500 mb		1000 mb		500 mb	
	RMS	Bias	RMS	Bias	RMS	Bias	RMS	Bias
24	13.50	0.50	13.56	-1.64	13.38	0.54	13.38	-1.46
48	21.01	-0.44	22.50	-4.05	21.11	-0.13	22.17	-3.60
72	26.95	-0.79	31.55	-6.07	26.79	-0.49	30.89	-5.61
96	33.64	-0.68	40.57	-7.36	33.27	-0.74	39.86	-7.23
120	38.88	-0.80	49.19	-8.47	38.57	-0.93	48.44	-8.35

Table 6b. Southern Hemisphere 1000 mb and 500 mb mean forecast height errors (meters) from 24 to 120 hours for the month of July 1996.

Forecast Hours	PRZ (OPNL)				PRV (w/o Drifter Data)			
	1000 mb		500 mb		1000 mb		500 mb	
	RMS	Bias	RMS	Bias	RMS	Bias	RMS	Bias
24	22.78	1.24	25.66	-0.84	23.34	1.23	25.87	-1.30
48	35.66	2.57	43.28	1.16	36.35	2.36	43.19	0.30
72	47.51	2.73	59.17	2.28	48.05	2.85	59.06	1.48
96	58.71	1.62	75.44	2.30	58.87	2.37	74.86	1.80
120	70.14	1.18	92.23	2.84	70.08	2.17	91.11	2.44

Table 7a. Mean sea level pressure forecast errors (mb) for the month of July 1996 with reference to Northern Hemisphere mid-latitude ocean buoys

Forecast Hours	No. of buoy Observations	PRZ (OPNL)		PRV (w/o Drifter Data)	
		RMS	Bias	RMS	Bias
24	3637	1.64	0.27	1.60	0.26
48	3623	2.29	0.38	2.26	0.33
72	3630	2.88	0.27	2.80	0.15
96	3631	3.37	0.09	3.31	0.04
120	3632	3.93	-0.36	3.91	-0.30

Table 7b. Mean RMS vector wind errors (m/sec) for the month of July 1996 with reference to Northern Hemisphere mid-latitude deep ocean buoys

Forecast Hours	No. of Buoys	PRZ (OPNL)	PRV (w/o Drifters)
24	3637	3.71	3.71
48	3623	4.39	4.33
72	3630	4.82	4.76
96	3631	5.23	5.13
120	3632	5.66	5.61

Table 8a. Mean RMS vector wind errors (m/sec) for the month of July 1996 with reference to Northern Hemisphere TOGA buoys

Forecast Hours	No. of Buoys	PRZ (OPNL)	PRV (w/o Drifters)
24	485	3.60	3.57
48	485	3.68	3.64
72	485	3.88	3.84
96	488	4.10	4.03
120	493	4.24	4.21

Table 8b. Mean RMS vector wind errors (m/sec) for the month of July 1996 with reference to Southern Hemisphere TOGA buoys

Forecast Hours	No. of Buoys	PRZ (OPNL)	PRV (w/o Drifters)
24	453	2.97	3.01
48	436	3.27	3.28
72	449	3.32	3.44
96	447	3.31	3.37
120	449	3.50	3.56

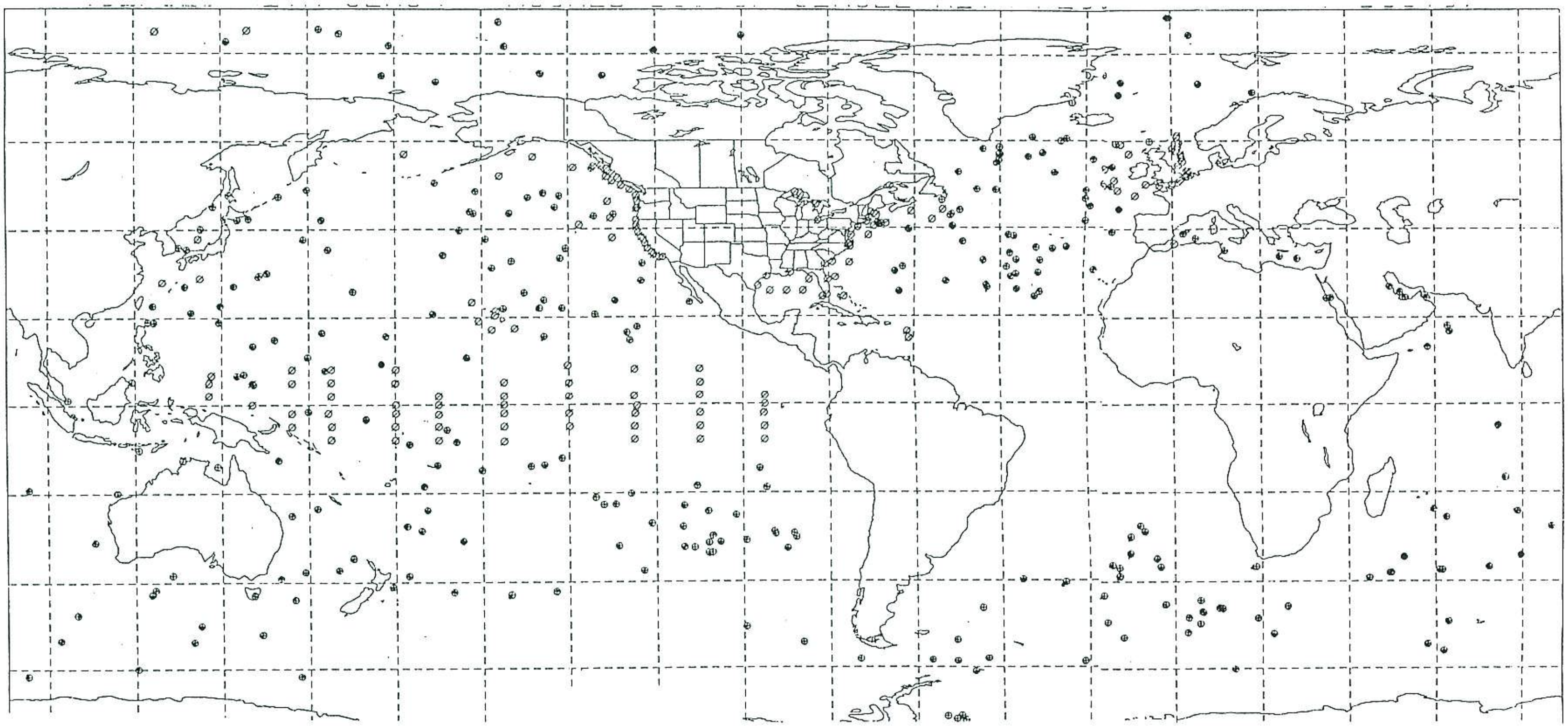

Figure 1. Typical distribution of surface buoy observations. The circles with slash indicate locations of moored buoys, and the circles with plus indicate the locations of drifting buoys.

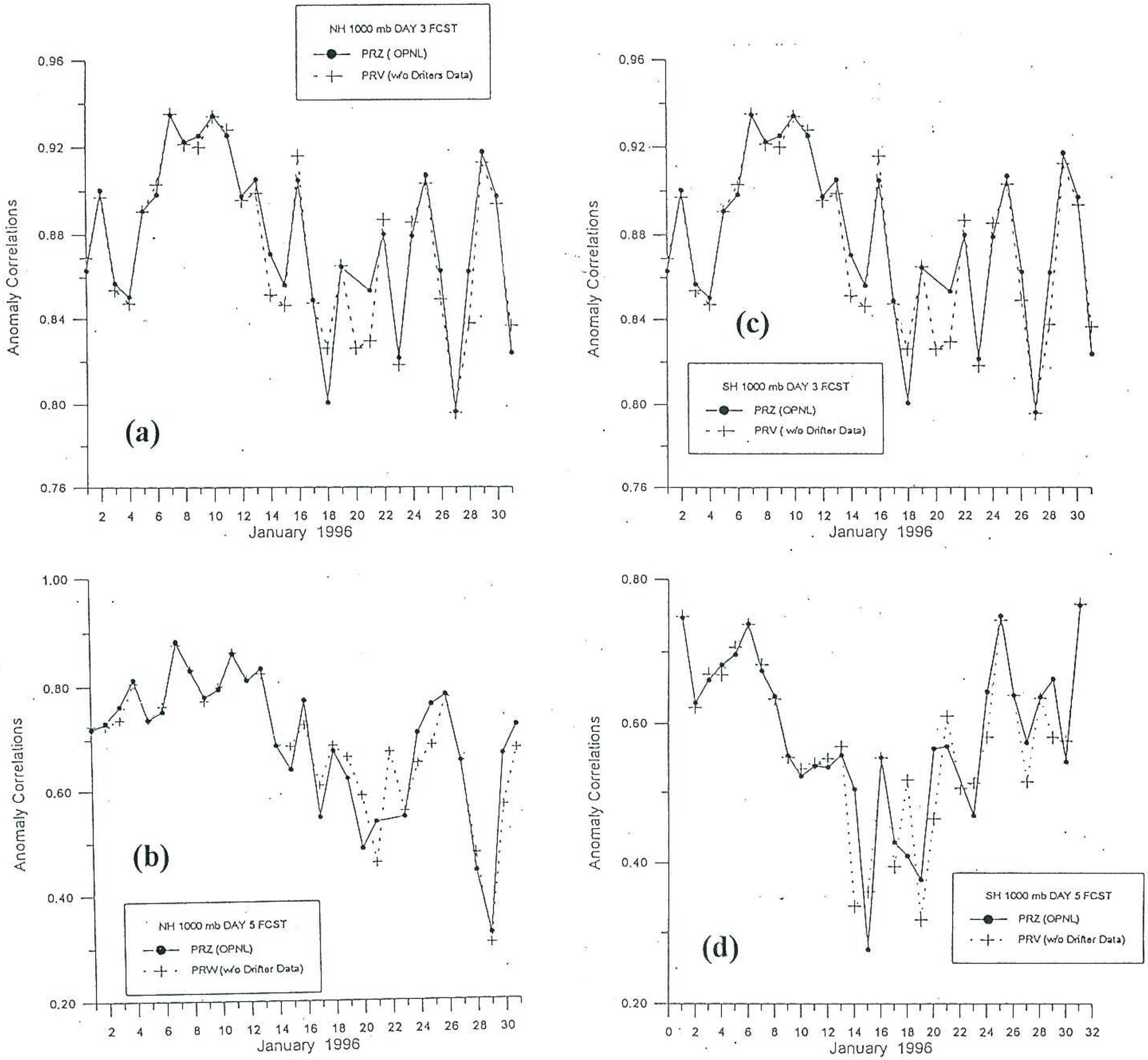

Figure 2. 1000 mb Height Anomaly Correlations for January 1996.

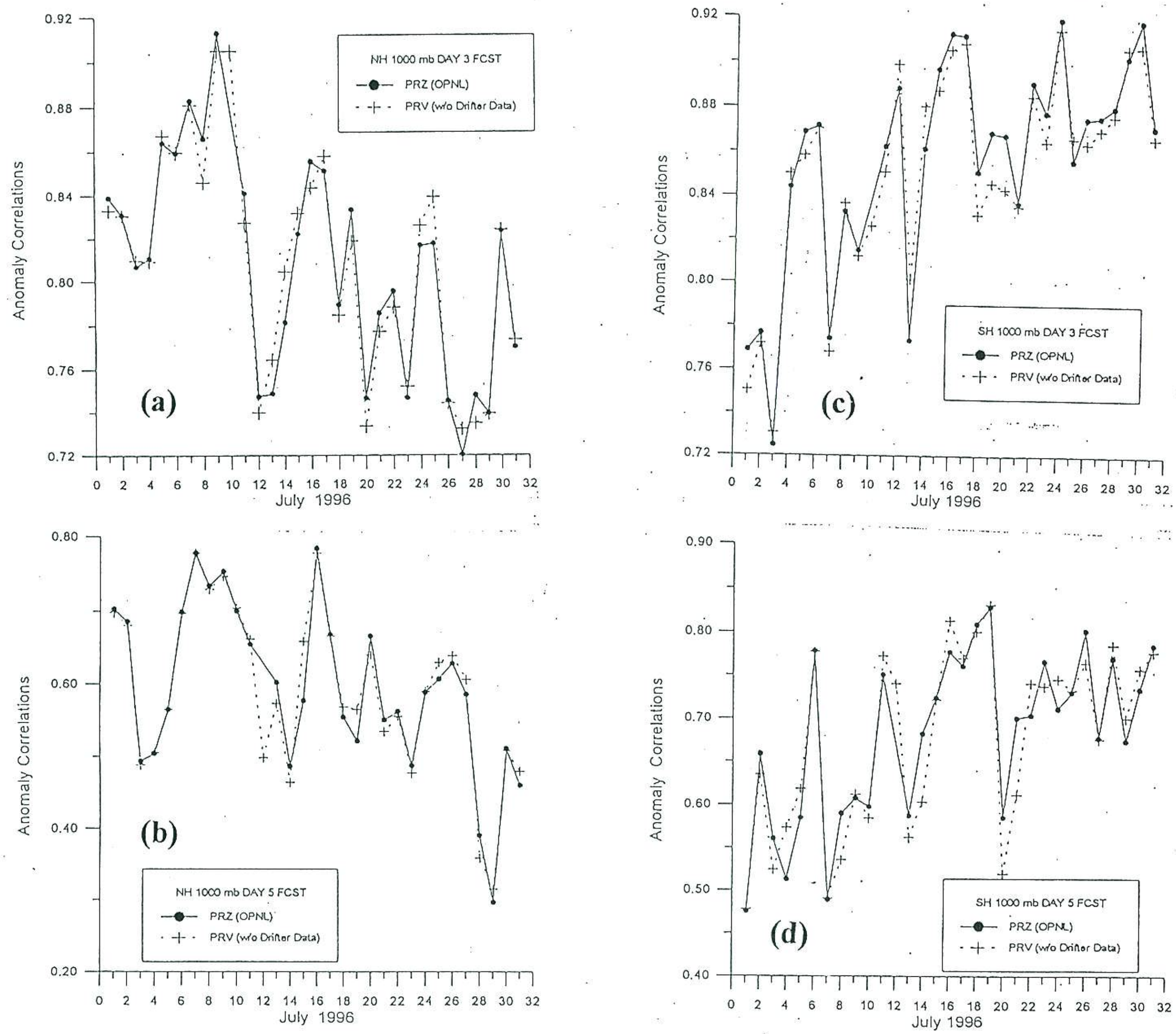

Figure 3. 1000 mb Height Anomaly Correlations for July 1996.

APPENDIX

Impact Test of Drifting Buoys

The Reanlysis data assimilation system was used to test the impact of drifiting buoys (DRIBU's) for two months, January (7901) and July (7907) during the FGGE year, 1979. The control was the official run of the Reanalysis. The impact test run, No-DRIBU, was identical except that DRIBU's were excluded.

As is done for operational implimentations, the impact was measured by comparing the relative skill of global predictions. Anomaly correlation(AC) and root-mean-square error(RMS) of predicted geoptential height fields and the verifying analyses of each respective assimlation system were compiled for both hemispheres (N-Hem,S-Hem) at 1000 mb and 500 mb, every 24 hours through 5 days (024 048 072 096 120) for daily predictions originating at 0000 GMT.

Results

Tables 1 and 2 compare the 7901 RMS and AC, respectively, while Tables 3 and 4 are the 7907 respective tables.

The results for Jan 1979 (7901) show little differentiation. Most of the AC scores table 3 are identical. The RMS scores in Table 1 displays mixed results The N-Hem scores are a virtual tie. The S-Hem scores reverse sense: postive impact at 500mb and negative at 1000mb.

The Jul 1979 RMS scores in Table 2 are mixed across the hemispheres. Both levels of N-Hem scores display a slight postive impact. The S-Hem 1000mb scores are more decidely negative at all time, but the 500mb scores reverse from postive to negative in time.

The N-Hem Jul 79 AC scores in table 4 are a tie. Both levels of S-Hem scores indicate negative impact at 24 hours that diminishes in time, reversing to postive impact at 1000mb, and a tie at 072 at 500 mb.

Discussion

One of the original rationales for the deployment of DRIBU's was to act as a "reference" level for the satellite satellite temperature soundings. This mind set of " reference level" arose from the historical use of two dimensional grid point analysis techniques operating on mandatory pressure levels as the basis of objective analyses used for NWP. Having the withdrawal of a source of data produce mixed-to-little impact indicates that the data are basically redundant. This is partically true in a 3D-VAR analysis such as the SSI, where all the data are considered at the same time, and the necessity of a "reference level" is obviated.

Table 1. Jan 79 RMS comparison

7901:N-Hem:1000:024:	RMS avg	No-DRIBU	18.61	Control	18.64
7901:N-Hem:1000:048:	RMS avg	No-DRIBU	29.83	Control	30.00
7901:N-Hem:1000:072:	RMS avg	No-DRIBU	40.20	Control	40.41
7901:N-Hem:1000:096:	RMS avg	No-DRIBU	52.16	Control	52.36
7901:N-Hem:1000:120:	RMS avg	No-DRIBU	64.02	Control	63.99
7901:N-Hem:500:024:	RMS avg	No-DRIBU	18.96	Control	19.08
7901:N-Hem:500:048:	RMS avg	No-DRIBU	32.73	Control	32.81
7901:N-Hem:500:072:	RMS avg	No-DRIBU	47.53	Control	47.58
7901:N-Hem:500:096:	RMS avg	No-DRIBU	64.90	Control	64.81
7901:N-Hem:500:120:	RMS avg	No-DRIBU	80.84	Control	80.64
7901:S-Hem:1000:024:	RMS avg	No-DRIBU	22.52	Control	22.76
7901:S-Hem:1000:048:	RMS avg	No-DRIBU	32.95	Control	33.82
7901:S-Hem:1000:072:	RMS avg	No-DRIBU	42.18	Control	43.13
7901:S-Hem:1000:096:	RMS avg	No-DRIBU	48.81	Control	50.10
7901:S-Hem:1000:120:	RMS avg	No-DRIBU	54.94	Control	56.15
7901:S-Hem:500:024:	RMS avg	No-DRIBU	26.16	Control	25.68
7901:S-Hem:500:048:	RMS avg	No-DRIBU	40.71	Control	40.11
7901:S-Hem:500:072:	RMS avg	No-DRIBU	54.05	Control	52.77
7901:S-Hem:500:096:	RMS avg	No-DRIBU	64.72	Control	63.55
7901:S-Hem:500:120:	RMS avg	No-DRIBU	74.46	Control	73.20

Table 2. Jul 79 RMS comparison

7907:N-Hem:1000:024:	RMS avg	No-DRIBU	14.64	Control	13.52
7907:N-Hem:1000:048:	RMS avg	No-DRIBU	22.16	Control	21.55
7907:N-Hem:1000:072:	RMS avg	No-DRIBU	29.18	Control	28.86
7907:N-Hem:1000:096:	RMS avg	No-DRIBU	35.02	Control	34.89
7907:N-Hem:1000:120:	RMS avg	No-DRIBU	40.53	Control	40.54
7907:N-Hem:500:024:	RMS avg	No-DRIBU	16.34	Control	14.69
7907:N-Hem:500:048:	RMS avg	No-DRIBU	25.82	Control	24.46
7907:N-Hem:500:072:	RMS avg	No-DRIBU	34.99	Control	34.10
7907:N-Hem:500:096:	RMS avg	No-DRIBU	43.79	Control	43.54
7907:N-Hem:500:120:	RMS avg	No-DRIBU	51.48	Control	51.80
7907:S-Hem:1000:024:	RMS avg	No-DRIBU	28.23	Control	29.53
7907:S-Hem:1000:048:	RMS avg	No-DRIBU	42.93	Control	47.62
7907:S-Hem:1000:072:	RMS avg	No-DRIBU	58.05	Control	64.27
7907:S-Hem:1000:096:	RMS avg	No-DRIBU	71.60	Control	76.54
7907:S-Hem:1000:120:	RMS avg	No-DRIBU	81.78	Control	86.30
7907:S-Hem:500:024:	RMS avg	No-DRIBU	32.73	Control	29.27
7907:S-Hem:500:048:	RMS avg	No-DRIBU	52.36	Control	52.02
7907:S-Hem:500:072:	RMS avg	No-DRIBU	71.74	Control	74.43
7907:S-Hem:500:096:	RMS avg	No-DRIBU	89.51	Control	91.93
7907:S-Hem:500:120:	RMS avg	No-DRIBU	104.13	Control	106.32

Table 3. Jan 79 AC comparison

7901:N-Hem:1000:024:	AC avg	No-DRIBU	0.98	Control	0.98
7901:N-Hem:1000:048:	AC avg	No-DRIBU	0.94	Control	0.94
7901:N-Hem:1000:072:	AC avg	No-DRIBU	0.89	Control	0.89
7901:N-Hem:1000:096:	AC avg	No-DRIBU	0.81	Control	0.81
7901:N-Hem:1000:120:	AC avg	No-DRIBU	0.72	Control	0.72
7901:N-Hem:500:024:	AC avg	No-DRIBU	0.99	Control	0.99
7901:N-Hem:500:048:	AC avg	No-DRIBU	0.97	Control	0.97
7901:N-Hem:500:072:	AC avg	No-DRIBU	0.93	Control	0.92
7901:N-Hem:500:096:	AC avg	No-DRIBU	0.86	Control	0.86
7901:N-Hem:500:120:	AC avg	No-DRIBU	0.78	Control	0.78

7901:S-Hem:1000:024:	AC	avg	No-DRIBU	0.90	Control	0.91
7901:S-Hem:1000:048:	AC	avg	No-DRIBU	0.79	Control	0.79
7901:S-Hem:1000:072:	AC	avg	No-DRIBU	0.65	Control	0.66
7901:S-Hem:1000:096:	AC	avg	No-DRIBU	0.55	Control	0.54
7901:S-Hem:1000:120:	AC	avg	No-DRIBU	0.43	Control	0.43
7901:S-Hem:500:024:	AC	avg	No-DRIBU	0.94	Control	0.95
7901:S-Hem:500:048:	AC	avg	No-DRIBU	0.86	Control	0.87
7901:S-Hem:500:072:	AC	avg	No-DRIBU	0.75	Control	0.76
7901:S-Hem:500:096:	AC	avg	No-DRIBU	0.63	Control	0.65
7901:S-Hem:500:120:	AC	avg	No-DRIBU	0.51	Control	0.52

Table 4. Jul 79 AC comparison

7907:N-Hem:1000:024:	AC	avg	No-DRIBU	0.92	Control	0.95
7907:N-Hem:1000:048:	AC	avg	No-DRIBU	0.85	Control	0.87
7907:N-Hem:1000:072:	AC	avg	No-DRIBU	0.76	Control	0.77
7907:N-Hem:1000:096:	AC	avg	No-DRIBU	0.64	Control	0.66
7907:N-Hem:1000:120:	AC	avg	No-DRIBU	0.51	Control	0.52
7907:N-Hem:500:024:	AC	avg	No-DRIBU	0.95	Control	0.98
7907:N-Hem:500:048:	AC	avg	No-DRIBU	0.90	Control	0.93
7907:N-Hem:500:072:	AC	avg	No-DRIBU	0.83	Control	0.85
7907:N-Hem:500:096:	AC	avg	No-DRIBU	0.73	Control	0.74
7907:N-Hem:500:120:	AC	avg	No-DRIBU	0.61	Control	0.61
7907:S-Hem:1000:024:	AC	avg	No-DRIBU	0.91	Control	0.93
7907:S-Hem:1000:048:	AC	avg	No-DRIBU	0.84	Control	0.83
7907:S-Hem:1000:072:	AC	avg	No-DRIBU	0.73	Control	0.70
7907:S-Hem:1000:096:	AC	avg	No-DRIBU	0.60	Control	0.58
7907:S-Hem:1000:120:	AC	avg	No-DRIBU	0.50	Control	0.48
7907:S-Hem:500:024:	AC	avg	No-DRIBU	0.92	Control	0.96
7907:S-Hem:500:048:	AC	avg	No-DRIBU	0.83	Control	0.86
7907:S-Hem:500:072:	AC	avg	No-DRIBU	0.71	Control	0.72
7907:S-Hem:500:096:	AC	avg	No-DRIBU	0.58	Control	0.58
7907:S-Hem:500:120:	AC	avg	No-DRIBU	0.46	Control	0.46

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