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GFS-BASED MOS WIND,TEMPERATURE, AND DEWPOINT TEMPERATURE GUIDANCE FOR MARINE LOCATIONS IN THE UNITED STATES

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1. INTRODUCTION

The Meteorological Development Laboratory (MDL) of the National Weather Service (NWS) has developed regression equations to predict the wind direction, wind speed, air temperature, dewpoint temperature and maximum and minimum temperature at marine locations. The equations were derived by applying the Model Output Statistics (MOS) technique (Glahn and Lowry 1972) to output from the Global Forecast System (GFS) numerical weather prediction model (formerly know as the Aviation (AVN) model) (Kanamitsu 1989, Kanamitsu et al. 1991, Iredell and Caplan 1997, Caplan and Pan 2000). The new equations are applied at approximately 121 National Data Buoy Center (NDBC) buoys and Coastal Marine Automated Network (C-MAN) stations (Table 2 – end of document).

The MOS wind and temperature/dewpoint guidance is available for projections valid every 3-h from 6 to 84 hours after the initial model times of 0000, 0600, 1200 and 1800 Universal Coordinated Time (UTC).Wind forecasts at these stations have replaced forecasts based on another statistical technique **(**Burroughs 1991**)** known as the modified perfect-prog approach, which used output from the Nested Grid Model (NGM). The NGM-based guidance was only available for 62 stations, and for 6-h projections valid from 6 to 48 hours after the initial model times of 0000 and 1200 UTC.

2. METHOD

The MOS approach uses multiple linear regression to establish relationships between predictand data (station weather observations) and predictor data (output from numerical models, station observations, and climatic data). The predictands for wind are the u- and v- wind components and the wind speed. Regression equations for the u- and v- wind components and wind speed are developed simultaneously for a given projection. Predictors which correlate the highest with any of the predictands, when combined with the other predictors already selected, are chosen as terms in the regression equation. Predictors are chosen until none contributes more than 0.5% to the total reduction of variance or until a pre-determined number of predictors are chosen. The wind direction is predicted by using the u- and v- wind components. Wind speed is used as a separate predictand due to under-forecasting of the speed by the individual components.

The predictands for temperature/dewpoint are the air temperature and dewpoint temperature as well as the max/min temperature. Regression equations for temperature and dewpoint are developed simultaneously for several projections at once. As a consequence of simultaneous development applied to both temperature/dewpoint/max/min and wind speed/wind components, the same predictors are used in the equation for all predictands with only the coefficients being different. As an example, at the 0000 and 1200 UTC cycles the 6-, 9-,12-, and 15-h projections of temperature and dewpoint are developed simultaneously, resulting in 8 predictands. Each of the 8 regression equations has the same predictors; however, all have different coefficients.

3. DEVELOPMENT

a. Seasons

The developmental data set obtained for wind for the majority of stations was from January 1997 through October 2002. The data set obtained for temperature/dewpoint was from September 1997 through October 2003. Some stations became active during the middle of this period and a complete data set was not available. Equations were developed for both parts of a stratified sample composed of a cool season (October-March) and a warm season (April-September). An additional 15 days on each end of a season were added, thereby smoothing the transition between seasons. Development of equations valid at individual stations typically requires a minimum of 2 years of data. This requirement refers to both the observations and the model data. Model data was available for the projections from 6 through 78 hours from1997 through 2003. Model for the 81- and 84-h projections was available from July 2000 through 2003.

b. Predictands

NDBC archives reports of hourly data from all stations within their system. The historical sample of data used for the development of forecast equations was obtained from the NDBC website (http://www.ndbc.noaa.gov). Wind speed, wind direction, and air temperature are reported each hour, while dewpoint temperature is observed at only 47 of the 121 NDBC sites. The u- and v- wind components are computed from the wind speed and direction observations. The wind and temperature/dewpoint observations were used for the hours of 0000, 0300, 0600, 0900, 1200, 1500, 1800 and 2100 UTC. These observations were then used to form predictands valid at projections from 6 to 84 hours from the initial model times.

c. Predictors

Predictors available for the development of forecast equations originate from three possible sources: GFS model variables interpolated to the station, surface observations, and climatic variables. The climate predictors were the first and second harmonics of the day of the year. All the predictors from the GFS model were space smoothed by using a 25-point filter to reduce the noise of the model forecasts at small scales. The model variables and surface observations used as predictors are described below for both wind and temperature/dewpoint developments.

i. Wind Direction and Speed

The GFS forecast of u- and v- wind and wind speed from 10 m as well as 1000-, 925-, 850-, 700-, and 500-mb levels were used as predictors. Other model variables included were the relative vorticity, vertical velocity, and relative mass divergence from the levels of 925, 850, 700, and 500 mb. The model forecasts of atmospheric stability through the layers 1000-925 mb, 1000-850 mb, and 1000-700 mb were also potential predictors. Mean relative humidity was available through the layers 1000-850 mb, 850-700 mb, and through the 1.0-0.44 sigma layer from 1-.44 sigma. In addition, the K-index was also available as a potential predictor. Model predictors were valid at the concurrent time as the predictand with the exception of the 81- and 84-h forecast projections. Due to a lack of sufficient model data at 81 and 84 hours the predictors from the 78-h projection were used as 81- and 84-h predictors. The observations that were used as predictors were the u- and v- wind components and the wind speed. The observations were only used as predictors for the 6-, 9-, 12-, and 15-h forecast equations. The observations used were valid 3 hours after the initial model times of 0000, 0600, 1200, and 1800 UTC.

At the early projections (6 to 15 hours), the most common predictors included in the forecast equations are the 3-h observations and the model forecasts of the u- and v- wind components and wind speed at 10 m. In later projections the model forecasts of u- and v- wind components and wind speed at 10 m are most common. The 925-mb relative vorticity is also frequently included in the forecast equations at later projections as well as the first and second harmonics of the day of the year.

ii. Temperature/Dewpoint/Max/Min

The temperature/dewpoint/max/min development included GFS model variables of 2 m temperature, 2 m dewpoint temperature, and 2 m relative humidity, as well as temperature and dewpoint from the 1000, 925, 850, and 700 mb pressure levels. Atmospheric thickness for the 1000-850 mb, 850-700 mb, 1000-700 mb, 700-500 mb, and 850-500 mb layers was also available. Other model predictors included the mean relative humidity, precipitation amount, pressure tendency, low and mid-level lapse rate, and K-index. In addition, the u- and vwind components and wind speed, relative vorticity, and vertical velocity for several pressure levels were available as predictors. The observations used were the temperature and dewpoint temperature as well as the 10 m u- and v- wind components and wind speed, valid at 3 hours after initial model time.

In addition to including model variables for the predictand-valid projections, model predictors valid for the previous projection and three subsequent projections are also made available during equation development. For example, when making regression equations for the 15-, 18-, 21-, 24- and 27-h projections, model variables for those projections as well as the 12-, 30-, 33-, and 36-h projections are included for potential selection.

d. Equation Development

Each of the approximately 121 buoy and C-MAN stations have their own individual forecast equation valid for the particular season and forecast projection in question. The only current exception to this is for the buoys in Lake Superior and Lake Huron during the cool season. The three Lake Superior buoys each use an equation based on a combined development sample of wind predictand data from all the buoy and C-MAN stations in Lake Superior. The two buoys in Lake Huron use an equation based on a development sample of wind predictand data for both stations combined. This procedure was performed because of the limited sample of predictand data available in this region due to the removal of the buoys in the cool season. Temperature/dewpoint/max/min equations were not developed for the three Lake Superior and two Lake Huron buoys during the cool season. Because C-MAN stations are land sites, their sample is not affected and they still use single station equations. During the warm season, each station has its own forecast equation.

Recall that each of the predictand equations is developed simultaneously. The predictor with the overall highest correlation with any of the predictands is chosen as the first predictor and incorporated into an equation for all of the predictands. The predictor with the next highest correlation with a predictand in combination with the previously chosen predictor is then added to the equation. This process continues until a pre-determined number of predictors is chosen or until none of the remaining predictors can reduce the variance of any one predictand by more than 0.5%. As a consequence of the simultaneous development only the predictor coefficients are different for the predictands.

i. Wind

For the 6-, 9-, 12-, and 15-h projections of the wind forecasts, a second set of equations is developed. These equations do not have observations included as predictors. Those which have observations are known as "primary" equations and those that do not are known as "secondary" equations. The secondary equations are used when observations are not available as predictors during real-time forecast guidance preparation.

ii. Temperature/Dewpoint/Max/Min

As was previously indicated, equations for the temperature and dewpoint temperature are developed simultaneously for several projections. The groupings of projections for simultaneous development for a given model cycle are shown in the table below. These groupings are designed to isolate days from nights in equation development.

Cycle	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
0000,1200 UTC	6-, 9-, 12-, 15-h	15-, 18-, 21- ,24-, 27-h	27-, 30-, 33-, 36-, 39-h	39-,42-,45- ,48-,51-h	51-, 54-, 57-, 60-, 63-h	63-, 66-, 69-, 72-, 75-h	75-, 78-, 81-, 84-h	
0600,1800 UTC	6-, 9-h	9-, 12-, 15-, 18-, 21-h	21-, 24-, 27-, 30-, 33-h	33-, 36-, 39-, 42-, 45-h	45- ,48-, 51-, 54-, 57-h	57-, 60-, 63-, 66-, 69-h	69-, 72-, 75-, 78-, 81-h	81-, 84-h

Table 1. Forecast projection groupings for simultaneous development for each of the four model cycles.

At the 0000 and 0600 UTC cycle the max temperature equation is included in Groups 2, 4, and 6 and the min temperature equation is included in Groups 3, 5, and 7. For the 1200 and 1800 UTC cycle the max temperature equation is included in Groups 3, 5, and 7 and the min temperature equation is included in Groups 2, 4, and 6.

Temperature and dewpoint secondary equations are developed for the 6-, 9-, 12-, 15-, 18-, 21-, 24-, 27-, 30-, 33-, 36- and 39-h projections of the 0000, and 1200 UTC cycles. Secondary equations are developed for the 6-, 9-, 12-, 15-, 18-, 21-, 24-, 27-, 30-, and 33-h projections of the 0600 and 1800 UTC cycles. The usage of primary versus secondary equations follows the same standards as the wind equations.

e. Post-Processing

i. . Wind

A number of post-processing measures are performed on the forecasts of u- and v- wind components and wind speed before they are disseminated. The first step inflates the wind speed forecasts (Carter and Schwartz 1985). This process increases the frequency of strong and weak wind forecasts, thereby increasing the standard deviation of the wind speed forecast distribution. In doing so, the mean absolute error of the wind speed forecasts is increased, while more forecasts of strong winds are generated.

Next, the wind direction is computed from the u- and v- wind components of the wind speed. The wind speed is also checked to be sure it is non-negative due to the inflation routine which could conceivably "create" negative wind speeds by decreasing the value of some low wind speeds. Finally, when the wind speed is less than 0.5 knots, the wind direction is set as "calm".

A new routine developed specifically for the marine wind guidance adjusts the forecast wind speeds to be consistent with a wind speed measured at 10 m. The 10 m height is not only a WMO standard, but also the observing height for all National Weather Service Automated Surface Observing System (ASOS) stations. However, many of the NDBC buoys measure wind speed at a height of 5 m, while C-MAN stations measure wind speeds at varying heights. The adjustment performed on the wind speed forecast is based upon the power law wind profile (Hsu et al. 1994):

$$u_2 = u_1 \left(\frac{z_2}{z_1} \right)^{0.11} \quad (1)$$

where u_1 and u_2 are the forecast wind speed before and after the correction, respectively; z_1 and z_2 are the original observation height and the adjustment height (10 m), respectively; and the power of 0.11 is a constant derived empirically from near-neutral conditions over water.

iii. Temperature/Dewpoint/Max/Min

Given the projection groupings for simultaneous development, the last projection of one group and first projection of a subsequent group are coincident. However, because these overlapping projections are in different groups, they have different equations and subsequently, different forecasts. Once forecasts are made, the forecasts from the overlapping projections in each group are averaged together, and the averaged forecast is used for that projection.

After overlapping projections are averaged, the temperature at all projections is compared to the dewpoint temperature at the same projection. If the temperature is less than the dewpoint temperature the temperature and dewpoint are averaged and the average value is assumed for both the temperature and the dewpoint.

After temperature and dewpoint have been checked, the max/min is checked for consistency with the individual 3-h temperature forecasts. Namely, the maximum temperature is ensured to be greater than or equal to each of the 3-h forecasts while the minimum is ensured to be less than or equal to each of the 3-h forecasts. If the max (min) is not greater (less) than the each of the 3-h temperatures, it will be set equal to the highest (lowest) 3-h temperature.

Then, the maximum (minimum) temperature is checked for consistency with the preceding and subsequent minimum (maximum) temperature.

4. OPERATIONS AND DISSEMINATION

The operational guidance for the 6- through 84-h projections from the 0000, 0600, 1200, and 1800 UTC forecast cycles is issued in a set of alphanumeric messages. These messages are disseminated through the Telecommunications Gateway to the Satellite Broadcast Network, Family of Services, Tropical Prediction Center, Ocean Prediction Center, National Data Buoy Center, National Ocean Service, and the National Centers for Environmental Prediction. These messages are distributed with World Meteorological Organization headers (Table 2 – end of document). The alphanumeric message is described in Section 5. This guidance supplements the current MOS wind guidance (Sfanos 2000) and temperature guidance based on the GFS model. The forecast guidance is also issued in a binary format, for use, most notably, by the NWS forecasters. Although max/min temperature are not included in the alphanumeric marine message, max/min forecast guidance is included in the binary format known as BUFR (http://www.nws.noaa.gov/mdl/synop/bufr.htm). In addition, 91 of the 121 marine sites have probability of thunderstorm and conditional probability of severe thunderstorms given in this binary message. Thunderstorm forecasts are not in the alphanumeric messages.

5. FORECASTER TIPS

Given the adjustment of the wind speed forecasts based upon the anemometer height, users of these forecasts are advised that the adjustment is derived from idealized conditions and applied universally to all buoys. This adjustment may not be appropriate for all conditions, and users should make themselves aware of situations when this may be the case. In addition, the variability among anemometer heights will likely dictate the situation when this adjustment may or may not be appropriate. Users should also note that forecasts for buoys in Lake Superior and Lake Huron during the cool season are based on equations developed for a region. However, the adjustment made at each of these buoys is based upon the anemometer height of that individual buoy.

The MOS wind speed, wind direction, temperature, and dewpoint temperature forecasts are based on the GFS model output. When using a statistical technique such as MOS, forecast accuracy is only as good as the information input by the forecast model. If a user of these forecasts feels that the model may be in error, they should adjust the forecasts accordingly. The MOS technique is known to account for some model biases; however, it cannot account for a bad model forecast.

When observations are not available in real time secondary equations are used in making forecasts as described in Section 3d. The skill of these secondary forecasts may be less than those if primary equations were used.

6. THE ALPHANUMERIC MESSAGE

The alphanumeric message containing the GFS MOS wind speed, wind direction, air temperature, and dewpoint temperature guidance at marine locations is the first to present the guidance for projections every 3 hours from 6 to 84 hours. Historically, the message has been limited to a 69 character width. Consequently, the message containing the marine wind speed, wind direction, temperature, and dewpoint forecasts at all 27 forecast projections is a modification of the current GFS MOS message available for land stations (Dallavalle and Erickson 2001). The marine message contains the forecasts of wind speed, wind direction, temperature, and dewpoint temperature at the site, as well as a wind speed adjusted to be consistent with 10 m. The most significant change to the format of marine message and this message is that the additional forecast projections (69- to 84-h) are in a second block of text placed below the 6- to 66-h projections.

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44013   GFS MOS GUIDANCE    1/02/2003  0600 UTC
DT  /JAN   2      /JAN   3                  /JAN   4                 /
HR    12 15 18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00
TMP    4 15 23 27 25 24 23 21 22 28 35 36 32 29 27 28 30 37 41 39 37
DPT   -5  0  5 10 12 14 14 14 13 13 13 14 16 19 21 22 25 29 32 32 30
WD    36 01 03 06 07 07 06 06 05 07 04 01 34 33 32 32 32 32 31 31 32
WS    09 08 05 04 06 06 09 10 09 06 04 07 04 06 08 09 12 15 17 16 15
WS10  11 10 07 06 08 08 11 12 11 08 06 09 06 08 10 11 14 17 19 18 17

DT  /JAN   5
HR    03 06 09 12 15 18
TMP   37 36 33 34 34 37
DPT   30 29 27 27 28 31
WD    30 32 03 10 09 11
WS    11 08 03 02 02 03
WS10  13 10 05 04 04 05
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Figure 1. Sample alphanumeric message of the marine MOS guidance.

In this example (Figure 1), the message is valid for the buoy east of Boston, MA (44013). All stations are identified by the NDBC assigned call letters. The "GFS MOS GUIDANCE" appearing on the same line as the station call letters identifies the message contents. The date of the forecast cycle during which the message is issued follows this information. The form of mm/dd/yyyy where mm is the month (1 through 12), dd is the day (1 through 31), and yyyy is the four-digit year is used. The forecast cycle is identified by the standard 0000, 0600, 1200 or 1800 UTC. In this example, the MOS guidance for 44013 was issued from the 0600 UTC forecast cycle of the GFS on January 2, 2003.

The DT and HR lines denote the date and hour at which the forecasts are valid. The DT line indicates the day of the month. Note that the month is denoted by the standard three or four letter abbreviation. For wind direction and speed, the date and hour denote the specific time that the forecasts are valid. These forecasts are valid every 3 hours until 84 hours after initial time. Note that the DT and HR lines for the forecasts valid 69 hours after the initial time and later are in the second block of text.

The air temperature (TMP) and dewpoint temperature (DPT) forecasts are given in degrees Fahrenheit. For temperature and dewpoint , missing forecasts are denoted by 999.

The station wind direction (WD) and speed (WS) forecasts are for winds at the height of the anemometer. The wind direction is given in tens of degrees and varies from 01 (10 degrees) to 36 (360 degrees). The normal meteorological convention for specifying wind direction is followed. The wind speed is given in knots; the maximum speed allowed in the message is 98 knots. For both direction and speed, missing forecasts are denoted by 99. A calm wind is indicated by a wind direction and speed of 00.

The adjusted wind speed (WS10) is a forecast of wind speed at a height of 10 m above the surface. It is derived from the wind speed forecast given by WS. The adjustment is described in Section 3e.

7. REFERENCES

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Pacific Region - FQPA20 KWNO MMGHI1			
Call letters	**Station Name**	**Latitude**	**Longitude**
51001	Nothwest Hawaii	23.40	162.27
51002	Southwest Hawaii	17.15	157.79
51003	West Hawaii	19.16	160.74
51004	Southeast Hawaii	17.44	152.52

Northeast Region - FQUS21 KWNO MMGNE1			
Call letters	**Station Name**	**Latitude**	**Longitude**
44004	East Cape May	38.50	70.47
44005	Gulf of Maine	43.17	69.22
44007	Portland	43.53	70.14
44008	Nantucket	40.50	69.43
44009	Delaware Bay	38.46	74.70
44011	Georges Bank	41.09	66.59
44013	Boston	42.35	70.69
44014	Virginia Beach	36.58	74.84
44025	Long Island	40.25	73.17
ALSN6	Ambrose Light Station	40.46	73.83
BUZM3	Buzzards Bay Light Station	41.40	71.03
CHLV2	Chesapeake Light Station	36.91	75.71
IOSN3	Isle of Shoals	42.97	70.62
MDRM1	Mount Desert Rock	43.97	68.13
MISM1	Mantinicus Rock	43.78	68.86
TPLM2	Thomas Point	38.90	76.44

Southeast Region - FQUS22 KWNO MMGSE1			
Call letters	**Station Name**	**Latitude**	**Longitude**
41001	East Hatteras	34.68	72.23
41002	South Hatteras	32.27	75.42
41004	Edisto	32.50	79.10
41008	Grays Reef	31.40	80.87
41009	Canaveral	28.50	80.18
41010	Canaveral East	28.89	78.52
CLKN7	Cape Lookout	34.62	76.52
DSLN7	Diamond Shoals Light Station	35.15	75.30
DUCN7	Duck Pier	36.18	75.75
FBIS1	Folly Island	32.68	79.89
FPSN7	Frying Pan Shoals	33.49	77.59
FWYF1	Fowey Rocks	25.59	80.10
LKWF1	Lake Worth	26.61	80.03
LONF1	Long Key	24.84	80.86
SANF1	Sand Key	24.46	81.88
SAUF1	St. Augustine	29.86	81.26
SMKF1	Sombrero Key	24.63	81.11
SPGF1	Settlement Point	26.70	79.00

Table 2. GFS MOS guidance forecast headers for marine locations with station call letters, station name, and latitude and longitude (in degrees). All latitudes are North and all longitudes are West.

Great Lakes Region - FQUS23 KWNO   MMGGL1

Call letters	Station Name	Latitude	Longitude
45001	Mid Superior	48.06	87.78
45002	North Michigan	45.33	86.42
45003	North Huron	45.35	82.84
45004	East Superior	47.56	86.55
45005	West Erie	41.68	82.4
45006	West Superior	47.32	89.87
45007	South Michigan	42.67	87.02
45008	South Huron	44.28	82.42
ABAN6	Alexandria Bay	44.33	75.93
DBLN6	Dunkirk	42.49	79.35
DISW3	Devils Island	47.08	90.73
GLLN6	Galloo Island	43.89	76.45
PILM4	Passage Island	48.22	88.37
ROAM4	Rock of Ages	47.87	89.31
SBIO1	South Bass Island	41.63	82.84
SGNW3	Sheboygan	43.75	87.69
STDM4	Stannard Rock	47.18	87.22
SUPN6	Superior Shoals	44.47	75.80

Gulf of Mexico Region - FQUS24 KWNO   MMGGF1

Call letters	Station Name	Latitude	Longitude
42001	Mid Gulf	25.92	89.68
42002	West Gulf	25.90	93.59
42003	East Gulf	25.88	85.95
42007	Biloxi	30.09	88.77
42019	Freeport	27.92	95.36
42020	Corpus Christi	26.95	96.70
42035	Glaveston	29.25	94.41
42036	West Tampa	28.51	84.51
42039	Pensacola	28.80	86.06
42040	South Dauphin Island	29.21	88.20
42041	North Mid Gulf	27.22	90.42
BURL1	Southwest Pass	28.90	89.43
CDRF1	Cedar Key	29.14	83.03
CSBF1	Cape San Blas	29.67	85.36
DPIA1	Dauphin Island	30.25	88.07
DRYF1	Dry Tortugas	24.64	82.86
GDIL1	Grand Isle	29.27	89.96
KTNF1	Keaton Beach	29.82	83.59
MLRF1	Molasses Reef	25.01	80.38
PTAT2	Point Aransas	27.83	97.05
SRST2	Sabine	29.67	94.05
VENF1	Venice	27.07	82.45

Table 2. continued. GFS MOS guidance forecast headers for marine locations.

Northwest Region - FQUS25 KWNO MMGNW1

Call letters	Station Name	Latitude	Longitude
46002	Oregon	42.57	130.32
46005	Washington	46.05	131.02
46029	Col River Bar	46.12	124.51
46041	Cape Elizabeth	47.34	124.75
46050	Yaquina Bay	44.62	124.53
CARO3	Cape Arago	43.34	124.38
DESW1	Destruction Island	47.68	124.49
NWPO3	Newport	44.61	124.07
SISW1	Smith Island	48.32	122.84
TTIW1	Tatoosh Island	48.39	124.74
WPOW1	West Point	47.66	122.44

Southwest Region - FQUS26 KWNO MMGSW1

Call letters	Station Name	Latitude	Longitude
46006	Se Papa	40.84	137.49
46011	Santa Maria	34.88	120.87
46012	Half Moon Bay	37.45	122.7
46013	Bodega	38.23	123.33
46014	PointArena	39.22	123.97
46022	Eel River	40.72	124.52
46023	Point Arguello	34.71	120.97
46025	Catalina Ridge	33.75	119.08
46026	San Francisco	37.75	122.82
46027	St. Georges	41.85	124.38
46028	Cape San Martin	35.74	121.89
46030	Blunts Reef	40.42	124.53
46042	Monterey	36.75	122.42
46047	Tanner Banks	32.43	119.53
46053	Santa Barbara East	34.24	119.85
46054	Santa Barbara West	34.27	120.45
46059	California	37.98	130.00
46062	Point San Luis	35.10	121.01
46063	Point Conception	34.25	120.66
PTAC1	Point Arena	38.96	123.74
PTGC1	Point Arguello	34.58	120.65

Alaska Region - FQAK37 KWNO MMGAK1

Call letters	Station Name	Latitude	Longitude
46001	Gulf of Alaska	56.30	148.17
46035	Bering Sea	57.08	177.78
46060	North Prince William Sound	60.58	146.83
46061	South Prince William Sound	60.22	146.83
AUGA2	Augustine Island	59.38	153.35
BLIA2	Blight Reef Light	60.84	146.88
DRFA2	Drift River Terminal	60.55	152.14
FFIA2	Five Finger	57.27	133.63
MRKA2	Middle Rock Light	61.08	146.66
PILA2	Pilot Rock	59.74	149.47
POTA2	Potato Point	61.06	146.70

Table 2. concluded. GFS MOS guidance forecast headers for marine locations.