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# Technical Procedures Bulletin

**Subject: Wave Forecasting for Alaskan Waters**

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This bulletin, prepared by Dr. Y. Y. Chao, Mr. L. D. Burroughs, and Dr. H. L. Tolman of the Marine Modeling and Analysis Branch (MMAB), Environmental Modeling Center (EMC), National Centers for Environmental Prediction (NCEP), describes automated wave guidance for waters surrounding Alaska alphanumeric and Gridded Binary (GRIB) formats. This guidance was implemented operationally on the new IBM computer in January 2000.

The AKW is based on the NOAA WAVEWATCH-III (NWW3) which is described in detail in Technical Procedures Bulletin (TPB) 494 (Chen, Burroughs, and Tolman 2003) and Tolman (2002). The domain extends from 160°E - 124°W by 45°N - 75°N with a grid resolution of 0.50° x 0.25° in the longitudinal and latitudinal directions.

Various graphics and text products for the AKW are available at http://polar.wwb.noaa.gov/waves, and available for anonymous ftp at ftp://polar.wwb.noaa.gov/pub/waves.

The following wind and wave parameters are available in GRIB format at the web site above and on AWIPS as GRIB bulletins: Hs, Dm, Tm, peak wave period and direction, wind sea peak period and direction, wind speed and direction, and u- and v-wind components.

Spectral text bulletins for the AKW are available at the web site above. These files are in ASCII and are available by anonymous ftp from the directory ftp://polar.wwb.noaa.gov/pub/waves. These bulletins have been implemented on AWIPS, but with a condensed format necessitated by the capabilities of the communications gateway and display capabilities of AWIPS.

The AKW wave guidance is generated four times daily our to 168-h based on the 0000, 0600, 1200 and 1800 UTC cycles of the of the Global Forecast System.

**Technical Procedures Bulletin No. 456 is now operationally obsolete.**

LeRoy Spayd
Chief, Training and
Professional Development
Core

# WAVE FORECASTING FOR ALASKAN WATERS

By
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## 1. Introduction

In order to predict wave conditions adequately over the continental shelf and near land boundaries, a regional model which has higher resolution in grid space and possibly in spectral components is required. The regional model also must calculate rigorously the effects of submarine bottom conditions and any currents which may exist on wave growth, transformation and dissipation. A global-scale wave model usually is designed only to provide the general wave pattern over the deep ocean. It does not provide information accurate enough to describe small-scale, complex wave patterns near the coastal areas.

The Alaska Waters (AKW) regional wave model was designed to fill the needs of the Alaska Region which had requested that the area all the waters that surround Alaska. The boundary conditions are provided by the NOAA WAVEWATCH III (NWW3).

The AKW is based on the NWW3 which is described in detail in Technical Procedures Bulletin (TPB) 494 (Chen, Burroughs, and Tolman 2003) and Tolman (2002). The NWW3 provides the boundary conditions to the AKW. The domain extends from 160°E - 124°W by 45°N - 75°N with a grid resolution of 0.50° x 0.25° in the longitudinal and latitudinal directions.

Various graphics and text products for the AKW are available at

http://polar.wwb.noaa.gov/waves,

and are available from anonymous ftp at

ftp://polar.wwb.noaa.gov/pub/waves.

The following wind and wave parameters are available in GRIB format at the ftp site above and on AWIPS as GRIB bulletins: $H_s$, $D_m$, $T_m$, peak wave period and direction, wind sea peak period and direction, wind speed and direction, and u- and v-wind components.

Spectral text bulletins for the AKW are available at both web sites above. These files are in ASCII text format. These bulletins have also been implemented on AWIPS, but with a condensed format necessitated by the capabilities of the communications gateway and display capabilities of AWIPS. See fig. 1 for a sample bulletin and Table 1 for the list of points having spectral wave bulletins, their locations, and their bulletin headers.

The AKW wave guidance is generated four times a day out to 168 hours based on the 0000, 0600, 1200 and 1800 UTC cycles of the Global Forecast System (GFS; Kanamitsu *et al.* 1991 and Caplan *et al.* 1997).

## 2. Model Description

Regional wave forecasts for Alaska waters are generated at NCEP by using the AKW model. Fields of directional frequency spectra in 24 directions and 25 frequencies are generated at one hour intervals up to 168 hours. The 24 directions begin at 90 degrees to the east and have a directional resolution of 15 degrees. The 25 frequencies used by the AKW are given by bin in Table 2.

Figure 2 shows the domain of interest and the depth field which is derived from bathymetric data available from the National Geophysical Data Center. Required input, wave spectral data for the

boundary grid points of the AKW, are obtained by linearly interpolating the spectra of neighboring grids of the NWW3.

The wind fields driving the model are obtained from the output of NCEP's operational Global Data assimilation System (GDAS) and the GFS. The wind fields are constructed directly from spectral coefficients of the lowest sigma level at 0.5° x 0.5° longitude and latitude resolution, and are interpolated to the resolution of the wave model grid. They are converted to 10 m winds by using a neutrally stable logarithmic profile. Air and sea temperature data are obtained from the lowest sigma level air temperatures of the GFS and the sea surface temperature analysis available from the it and used in the AKW's wave growth parameterization.

Finally, the wave model incorporates a dynamically updated ice coverage field in the region. These data are obtained from NCEP's operational automated passive microwave sea ice concentration analysis (Grumbine 1996; updated daily). Ocean currents are not considered in the model at the present.

The model runs four times daily on the 0000, 0600, 1200 and 1800 UTC cycles. GDAS wind fields from the previous 12 hours at 3-h intervals (analyses and 3-h forecasts) are used for a 12-h wave hindcast. Winds from the GFS at 3-h intervals out to 168 hours are used to produce wave forecasts up to 168 hours at hourly intervals.

**3. Performance Evaluation**

The AKW was extensively evaluated prior to its implementation in January 2000 and continues to be evaluated on a regular basis. It has been consistently shown to have less error and higher correlation with observations than similar models.

**4. Available Products and Dissemination**

The following wind and wave parameters are currently available in GRIB format at

ftp://polar.wwb.noaa.gov/pub/waves,

and became available on AWIPS in software build 5.2.2: $H_s$, $D_m$, $T_m$, peak wave period and direction, wind sea peak period and direction, wind speed and direction, and u- and v-wind components. Spectral text bulletins are also available on the web at the site above and are on AWIPS.

**a. GRIB bulletins**

GRIB bulletins are available for use in AWIPS. Table 3 gives the bulletin headers and their meaning. Bulletins are available at 6-h intervals from 00- through 72-h and at 12-h intervals from 72- through 168-h. Available parameters are $H_s$, $D_m$, $T_m$, peak wave period and direction, wind sea peak wave period and direction, and u and v components of the wind velocity. A 0.50 x 0.25 degree lon./lat. grid is used with a domain from 160°E -124°W and 45°N - 75°N.

**b. Alphanumeric spectral messages for the INTERNET**

Spectral text bulletins are presented for numerous points of the AKW. These bulletins are in ASCII and are available on the INTERNET at present, and, in AWIPS (see section **c** below). The line length of the table is 130 characters by 100 lines. The header of the table identifies the output location, the generating model and the run date and cycle of the data presented. At the bottom of the table, a legend is printed. The table consists of 8 columns. The first column gives the time of the model results with a day and hour (the corresponding month and year can be deduced from the header information. The second column presents the overall significant wave height ($H_s$), the number of individual wave fields with a wave height over 0.15 m that could not be tracked in the

table (x). Individual wave fields in the spectrum are identified by using a partitioning scheme similar to that of Gerling (1992). In the remaining six columns individual wave fields identified with their wave height ($H_s$), peak wave period ($T_p$) and mean wave direction (dir, direction in which waves travel relative to North). Generally, each separate wave field is tracked in its own column. Such tracking, however is not guaranteed to work all the time. An asterisk (*) in a column identifies that the wave field is at least partially under the influence of the local wind, and, therefore, most likely part of the local wind sea. All other wave fields are pure swell.

**c. Spectral text bulletins for AWIPS**

The format for the spectral text bulletins sent to AWIPS is generally the same as that for the web, except that the period is to the nearest second, the wave heights are to the nearest foot, the direction is from (meteorological, rather than oceanographic), the number of fields that couldn't be tracked is not given, and the asterisk indicating when a wave field is, at least, partially under the influence of the local wind is not shown. The bulletin width is 69 characters, which is a legacy of the teletype era and the display capability of AWIPS. A sample bulletin is shown in fig. 1 and the list of points for the AKW is given in Table 1.

**5. References**


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1. H. L. Tolman is a contractor with SAIC

2. OMB Contribution No. 171

**Table 1**. Name, location, and header information for spectral text bulletins associated with the AKW regional wave model.

| Station Name | Position (N and W, except where indicated) | | AWIPS and WMO Header |
|---|---|---|---|
| | Latitude | Longitude | |
| **Points for Wave Spectra from the Alaska Waters (AKW) Regional Wave Model** | | | |
| Eastern Gulf of Alaska Points | | | |
| 46004 | 50.97 | 135.80 | AGGA47 KWBJ OSBA01 |
| 46184 | 53.90 | 138.87 | AGGA47 KWBJ OSBA02 |
| 46205 | 54.17 | 134.33 | AGGA47 KWBJ OSBA03 |
| 46207 | 50.86 | 129.91 | AGGA47 KWBJ OSBA04 |
| 46208 | 52.50 | 132.70 | AGGA47 KWBJ OSBA05 |
| 46083 | 58.25 | 138.00 | AGGA47 KWBJ OSBA06 |
| 46084 | 56.39 | 136.16 | AGGA47 KWBJ OSBA07 |
| 46082 | 59.61 | 143.67 | AGGA47 KWBJ OSBA08 |
| Canadian Points | | | |
| 46005 | 46.10 | 131.00 | AGPZ47 KWBJ OSBA01 |
| 46029 | 46.12 | 124.50 | AGPZ47 KWBJ OSBA02 |
| 46036 | 48.35 | 133.92 | AGPZ47 KWBJ OSBA03 |
| 46041 | 47.34 | 124.67 | AGPZ47 KWBJ OSBA04 |
| 46132 | 49.73 | 127.92 | AGPZ47 KWBJ OSBA05 |
| 46206 | 48.84 | 126.00 | AGPZ47 KWBJ OSBA06 |
| Western Gulf of Alaska Points | | | |
| 46001 | 56.30N | 148.30W | AGGA48 KWBJ OSBA01 |
| 46066 | 52.65 | 155.00 | AGGA48 KWBJ OSBA02 |
| 46072 | 52.02 | 172.10 | AGGA48 KWBJ OSBA03 |
| 46080 | 58.00 | 150.00 | AGGA48 KWBJ OSBA04 |
| Bering Sea Points | | | |
| 46035 | 57.00 | 177.70 | AGPN48 KWBJ OSBA01 |

Notes:

1. The WMO/AWIPS headers follow the form given for oceanographic data, *i.e.*, $AGA_1A_2i_1i_2$, where $i_1$ is 4 and always means spectral wave data.

2. $i_2$ is the geographic location, where:

   0 - means Pacific Ocean, particularly in proximity to U.S. held islands (Hawaii and Guam's areas of responsibility)
   1 - means proximity to NE Atlantic States from Virginia northward
   2 - means proximity to SE Atlantic States from North Carolina southward and Puerto Rico
   4 - means proximity to southern Gulf of Mexico states
   6 - means proximity to Pacific States and southern British Columbia
   7 - means proximity to Panhandle of Alaska and northern British Columbia (Juneau's areas of responsibility)

8 - means proximity to southern and southwestern Alaska (Anchorage's areas of responsibility)

3. $A_1A_2$ is used by the originating office (NCEP/NCO) to identify the oceanic area of the point, where:

   NT - Western Atlantic
   GX - Gulf of Mexico
   CA - Caribbean Sea
   PZ - Eastern Pacific
   GA - Gulf of Alaska
   PN - North Pacific including Bering Sea
   AC - Arctic Ocean
   HW - Hawaiian Waters
   PW - Western Pacific
   XT - Tropical Belt
   PS - South Pacific

4. The AWIPS identifier form is NNNxxx: where NNN is OSB - Oceanographic Spectral Bulletin, and xxx takes the form: mnn - where m is the wave model and nn is the number of the point in a given geographic location according to note 2 above. nn can range from 01 - 99.

5. m is the wave model where:

   N is the NOAA WAVEWATCH III global wave model
   A is the Alaska Waters regional wave model
   W is the Western North Atlantic regional wave model
   H is the North Atlantic Hurricane regional wave model
   E is the Eastern North Pacific regional wave model
   P is the Eastern Pacific Hurricane regional wave model
   X is the Western North Pacific regional wave model
   T is the Western Pacific Typhoon regional wave model

**Table 2**. The center frequencies and corresponding band widths with center period by frequency bin.

| bin number | center frequency (Hz) | frequency band width (Hz) | center period (s) |
|---|---|---|---|
| 1 | .0418 | .00399 | 23.94 |
| 2 | .0459 | .00439 | 21.76 |
| 3 | .0505 | .00482 | 19.79 |
| 4 | .0556 | .00531 | 17.99 |
| 5 | .0612 | .00584 | 16.35 |
| 6 | .0673 | .00642 | 14.87 |
| 7 | .0740 | .00706 | 13.51 |
| 8 | .0814 | .00777 | 12.29 |
| 9 | .0895 | .00855 | 11.17 |
| 10 | .0985 | .00940 | 10.15 |
| 11 | .1083 | .01034 | 9.23 |
| 12 | .1192 | .01138 | 8.39 |
| 13 | .1311 | .01251 | 7.63 |
| 14 | .1442 | .01376 | 6.93 |
| 15 | .1586 | .01514 | 6.30 |
| 16 | .1745 | .01666 | 5.73 |
| 17 | .1919 | .01832 | 5.21 |
| 18 | .2111 | .02015 | 4.74 |
| 19 | .2322 | .02217 | 4.31 |
| 20 | .2555 | .02438 | 3.91 |
| 21 | .2810 | .02682 | 3.56 |
| 22 | .3091 | .02951 | 3.24 |
| 23 | .3400 | .03246 | 2.94 |
| 24 | .3740 | .03570 | 2.67 |
| 25 | .4114 | .03927 | 2.43 |

**Table 3**. WMO GRIB bulletin header descriptors.

| $T_1$ | $T_2$[1] | $A_1$[2] | $A_2$ | dd | Station id |
|---|---|---|---|---|---|
| O | A<br>B<br>C<br>J<br>K<br>M<br>N<br>P<br>Y | N | A<br>C<br>E<br>G<br>I<br>J<br>K<br>L<br>M<br>X<br>N<br>Y<br>O<br>P<br>Q<br>Z<br>R<br>S<br>T<br>U | 88 | KWBJ |

Where:

$T_1$ is the bulletin type descriptor: O - oceanographic.
$T_2$ is the parameter descriptor, see notes below.
$A_1$ is the grid and domain descriptor: N - 0.50° x 0.25° lon/lat grid over domain from 160E - 124W and 45N - 75N.
$A_2$ is the forecast hour descriptor, see notes below.
dd is the surface descriptor: 88 - ocean surface.

Notes:

1. Parameter descriptors

A - u-wind component
B - v-wind component
C - Total significant wave height
J - Peak wave period
K - Peak wave direction
M - Peak wind sea period
N - peak wind sea direction
P - $D_m$
Y - $T_m$

2. Forecast hour descriptors at 6-h intervals from 0- to 72-h and at 12-h intervals from 72- to 168-h.

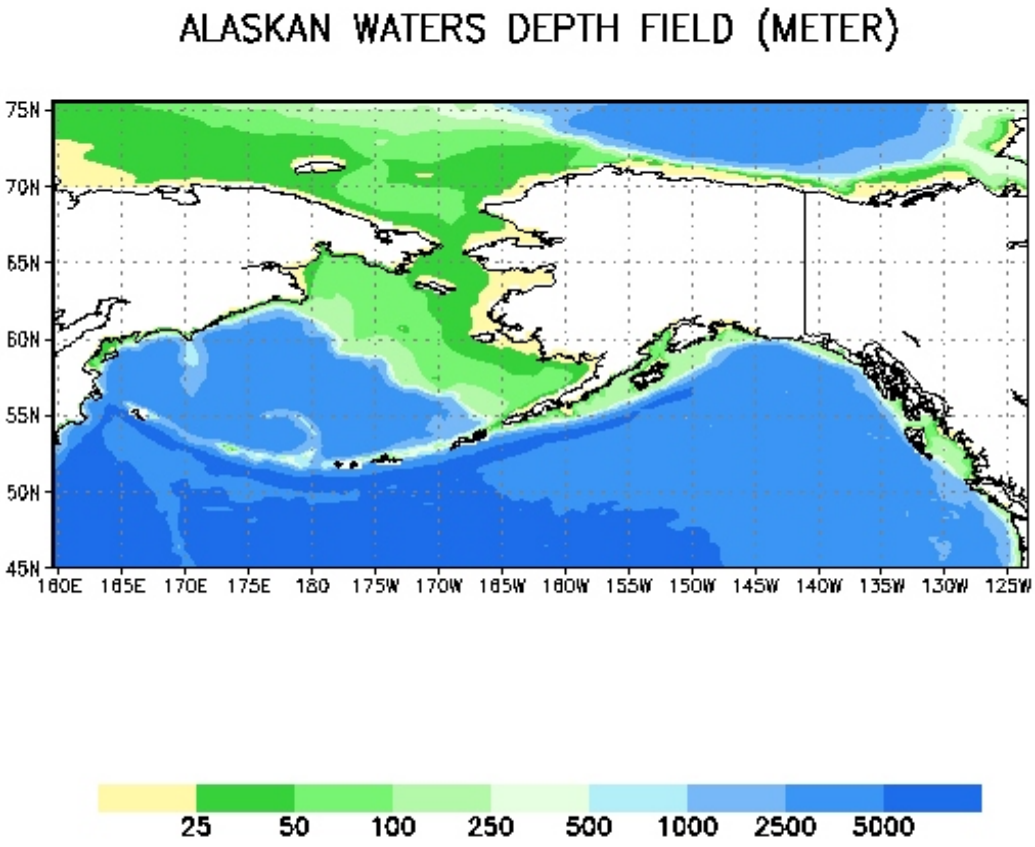


Figure 1. Alaska waters regional wave model domain showing depth in meters.