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Subject: GFS Global Vessel Icing Guidance Product

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This bulletin, prepared by L. D. Burroughs of the Marine Modeling and Analysis Branch (MMAB), Environmental Modeling Center (EMC), National Centers for Environmental Prediction (NCEP), describes automated global vessel icing guidance provided in graphic and GRIB formats.

The GFS Global Vessel Icing Guidance will be implemented in early 2004. It is an improvement and extension of the current vessel icing guidance which covers the northern hemisphere and uses the 1000 hPa wind speed and air temperature and the Reynolds sea surface temperature. The guidance uses an algorithm developed by Overland *et al.* (1986), runs four times per day at 00, 06, 12, and 18Z, provides a nowcast and forecasts out to 7 days at 3-h intervals with outputs in GRIB and facsimile graphics.

The differences between the current system and the improved system include:

(1) Extended the model to a global 1.0 x 1.0 degree longitude/latitude grid to include Antarctic danger zones.

(2) Changed inputs to GFS 10 m wind speed and 2 m air temperature and sea surface temperature from the RTG_SST.

(3) Regional animated and still graphics are available at

http://polar.ncep.noaa.gov/vessel.icing/experimental. These files are available by anonymous ftp in gif format at

ftp://polar.ncep.noaa.gov/pub/vessel.icing/experimental a in GRIB formats at

ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/omb/prod/sice.yyyymmdd, where yyyy - year; mm - month; dd - day. There are three types of GRIB files: global 1x1 deg files - sice.thhz.siceg; northern hemisphere 1x1 deg files - sice.thhz.siceg_1x1.all; Alaska Mercator - sice.thhz.siceg_akw; where hh - cycle time (00, 06, 12, 18 UTC).

(4) GRIB bulletins will be available in AWIPS Build OB5 which is due to be distributed in the Spring of 2005. Graphics are available on NAWIPS, and will remain available on AKFAX until that system is replaced or disestablished.

Technical Procedures Bulletin No. 366 is now operationally obsolete.

GFS Global Vessel Icing Guidance[1]

by L. D. Burroughs

1. INTRODUCTION

Vessel icing is serious safety threat to any vessel at sea. It can add enormous weight to the superstructure which can cause the vessel to capsize and sink. Long before sinking a vessel, it can become a serious safety hazard which can endanger the crew of the vessel and/or freeze up the machinery used to move cargo which can increase the time it takes to offload and on-load cargo, and this can cause economic problems for producers, transporters, and consumers.

The vessel icing guidance was first implemented in 1985. It used an empirical procedure developed by Wise and Comisky (1980) and was run on a seasonal basis from November through May. Inputs to the system were the1000 hPa wind speed (S) and air temperature (Ta) from the then Medium Range Forecast (MRF; Caplan *et al.* 1997), now Global Forecast System (GFS) and the Reynolds Sea Surface Temperature (SST; Reynolds and Smith 1994). The inputs remained the same until 2003. A facsimile product was sent out on AKFAX once per day at 00Z with a nowcast and forecasts out to 48 hours at 12-h intervals. In 1987, this guidance was upgraded by using a new procedure developed by the Pacific Marine Environmental Laboratory (PMEL; Overland *et al.* 1986). In 1988, the Ocean Prediction Center (OPC) requested that the guidance be extended to the entire Northern Hemisphere, be run twice a day at 00 and 12Z, and be extended to 72hours at 12-h intervals. The extension out to 72-h was also done for the Alaska facsimile product.

No further changes were made until 1998 and 1999 when the code was upgraded to meet Y2K standards, was converted from FORTRAN77 to FORTRAN90 and to run on NCEP's Cray mainframe computers. During the conversion to FORTRAN90 an error in a conversion factor in the code was discovered and corrected. With that correction the vessel icing fields became more coherent and believable.

In 2002, the OPC requested that the forecast interval be reduced from 12-h to 3-h and the forecasts be extended to 5 days. At the same time, the Office of Climate, Weather, and Water Services (OCWWS) increased the outlook requirement from 5 to 7 days, and the GFS cycle times also increased from 2 to 4 cycles per day. The vessel icing guidance software was redesigned to take advantage of the 4 cycle GFS and to produce a nowcast and forecasts out to 7 days at 3-h intervals. This guidance was implemented in September 2002, but only on the 00 and 12Z cycles. Approval was required to increase to 4 cycles operationally; this was received in early 2003, and the two additional cycles were implemented in March 2003. The Alaska facsimile products continued as before, but the cycle times were increased.

The global system incorporates the following changes to the guidance:

- Expanded to a global 1.0 x 1.0 degree longitude/latitude grid to include vessel icing dangers around Antarctica.

[1] MMAB Technote No. 236

- Changed inputs to 10 m wind speed, 2 m air temperature, and SST from the RTG_SST.

- Outputs
  - Global and regional animated and still graphics available on web at http://polar.ncep.noaa.gov/vessel.icing/experimental

  - Global and regional animated and still gif images are available by anonymous ftp from ftp://polar.ncep.noaa.gov/pub/vessel.icing/experimental

  - GRIB files are available by anonymous ftp from ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/omb/prod/sice.yyyymmdd, where yyyy - year; mm - month; dd - day. There are three types of GRIB files: global 1x1 deg files - sice.thhz.siceg; northern hemisphere 1x1 deg files - sice.thhz.siceg_1x1.all; Alaska Mercator - sice.thhz.siceg_akw; where hh - cycle time (00, 06, 12, 18 UTC).

  - Northern hemisphere GRIB for AWIPS to be available with AWIPS Operational Build (OB 5) which is due to be distributed in the Spring of 2005.

  - Graphics are available in NAWIPS as well.

  - Alaska Regional Mercator GRIB field for facsimile products will be available until AKFAX is replaced or disestablished.

The GFS Global Vessel Guidance System is to be implemented early in 2004. Technical Procedures Bulletin No. 366 is, hereby, superceded.

2. GFS GLOBAL VESSEL ICING GUIDANCE

Global vessel icing guidance is computed by using an algorithm developed by PMEL (Overland *et al.* 1986) which is a cubic fit to data from three inputs. The inputs are the GFS 10 m wind speed and 2 m air temperature and SST from the RTG_SST (Thiébaux *et al.* 2001). The wind speed is limited to 100 ms^{-1} or less; air temperature is constrained to be between 0.0 and -40.0° Celsius, and water temperature is restricted to be between -1.7 and 12.0° Celsius (the lower limit is determined by the freezing point of sea water at 32 .0 psu). The icing is also constrained to be over water only, but is computed over lakes, estuaries, bays, gulfs, seas, and ocean basins, so long as open water grid points are available.

Vessel icing is computed on a global 1.0 by 1.0 degree longitude/latitude grid for water points between 90.0 degrees North and 90.0 degrees South. A nowcast and forecasts out to 7 days are produced at intervals of 3-h. The guidance is produced 4 times a day from the 0000, 0600, 1200, and 1800 UTC cycles.

3. AVAILABLE PRODUCTS AND DISSEMINATION

The vessel icing products are disseminated on the web as graphical stills and animations, on NAWIIPS in graphical formats, on AWIPS as GRIB bulletins, and as a facsimile graphic for Alaska.

a. Dissemination on the web

The vessel icing is available for ftp from the NCEP operational web site

ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/omb/prod.

Three days of data are provided. Each day has a separate directory name with the form

sice.yyyymmdd, where yyyy is the year, mm is the month, and dd is the day; the files are

sice.thhz.siceg - global 1 x 1 deg lon/lat GRIB file with nowcast and forecasts out to 7 days at 3-h intervals;
sice.thhz.siceg_1x1.all - northern hemispheric 1 x 1 deg lon/lat GRIB file with nowcast and forecasts out to 7 days at 3-h intervals;
sice.thhz.siceg_akw - Alaska regional Mercator GRIB file with nowcast and forecasts out to 3 days at 12-h intervals,
where hh is the cycle time (00, 06, 12, 18 UTC).

Regional and global gif images and animations as well as a description of the system is available at the MMAB non-operational web site located at

http://polar.ncep.noaa.gov/vessel.icing;

These images and animations may also be ftp'd from

ftp://polar.ncep.noaa.gov/pub/vessel.icing.

b. GRIB Bulletins for AWIPS

GRIB bulletins for the northern hemisphere are available for use in AWIPS. Table 1 gives the bulletin headers and their meaning. Bulletins are available at 3-h intervals from 03- through 24-h, at 6-h intervals from 30- through 72-h and at 12-h intervals from 84- through 168-h. Vessel Icing is given in m/s. To convert from m/s to cm/h or in/3-h, multiply by 360,000 or 425,196.85, respectively. The latter are more practical measurements of vessel ice accretion. A 1.0 ° x 1.0° lon./lat. grid is used with a domain from 0 ° - 360°E and 0° to 90°N.

c. Alaska Regional Facsimile Charts

Alaska regional facsimile charts will continue to be sent out until no longer deemed necessary. Charts are available at 12-h intervals from 00 - 72 hours. The charts are on a Mercator projection.

4. Forecaster Considerations

Superstructure ice accretion depends on sea temperature, air temperature, wind speed (and/or the vessel's speed), and the freezing point of sea water. For any ice accretion to occur, the air temperature must be below freezing. Once the air temperature reaches freezing, the sea temperature and wind speed and/or vessel speed become important. The lower the sea surface temperature, the easier it is for ice accretion to occur, and the faster it will occur. The faster the

wind speed and/or vessel speed, the faster the ice will accumulate, particularly if the vessel is moving into the wind. Ice accretion will take place less readily if the vessel is moving downwind.

It should be noted that the wind speed does not have to be very fast, if the vessel's speed is high, to develop significant ice accretion. Indeed, the wind speed can be calm, if the vessel's speed is high, and significant, dangerous, ice accretion can occur!

5. REFERENCES

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Thiébaux, H. J., B. Katz, W. Wang, and L. D. Burroughs, 2001: Realtime global sea surface temperature analysis RTG_SST. *NWS Technical Procedures Bulletin No.* 477, NOAA, U.S. Department of Commerce. [Available at http://polar.ncep.noaa.gov/mmab/tpbs/rtg_sst_tpb]

Table 1. WMO GRIB bulletin header descriptors.

T_1	T_2[1]	A_1[2]	A_2	dd	Station id
O	U	I	B C D E F G H I J K L M X N Y O P Q Z R S T U	88	KWBJ

Where:

T_1 is the bulletin type descriptor: O - oceanographic.
T_2 is the parameter descriptor, U - vessel icing.
A_1 is the grid and domain descriptor: I - 1.0° x 1.0° lon/lat grid over domain from 0 - 360E and 0 - 90N.
A_2 is the forecast hour descriptor, see notes below.
dd is the surface descriptor: 88 - ocean surface.

Notes:

1. Forecast hour descriptors at 3-h intervals from 3- to 24-h, at 6-h intervals from 30- to 72-h, and at 12-h intervals from 84- to 168-h.