



IcingCalculator 1.0

A Simple Java-Based Computer Tool for Determining Ice Accretion and the Need for Freezing Spray Advisories or Warnings

NATIONAL WEATHER SERVICE FORECAST OFFICE, SEATTLE WA

Dec 6, 2010
Jay A. Albrecht
Lead Forecaster

IcingCalculator 1.0

A Simple Java-Based Computer Tool for Determining Ice Accretion and the Need for Freezing Spray Advisories or Warnings

Overview:

Sea spray icing can be a serious hazard to marine operations. A large buildup of ice on the surface of a boat or ship can make it unstable and subject to capsizing. The problem is particularly dangerous for smaller vessels; not as much ice is required to make a small boat unstable, and smaller vessels -sitting closer to the sea surface- are more exposed to sea spray. Guest, 2005 provides a good summary of the causes, effects, forecasting, and mitigation of sea spray icing. While sea spray is most common at high latitudes, freezing spray also occurs during arctic outbreaks in the inland waters of western Washington State and in the coastal waters of the northeastern United States.

Nomograms (Guest, 2005, Overland, et.al., 1986, and Curtis) provide a quick way for producing freezing spray and ice accretion forecasts. Guidance products produced by the National Center for Environmental Prediction (as described by Feit) show areas where vessel icing is occurring or expected (Figure 1) and are useful in showing threatened areas on a large scale. IcingCalculator 1.0 gives forecasters a quick way of making multiple ice accumulation computations at a local level when freezing spray threatens their area of responsibility.

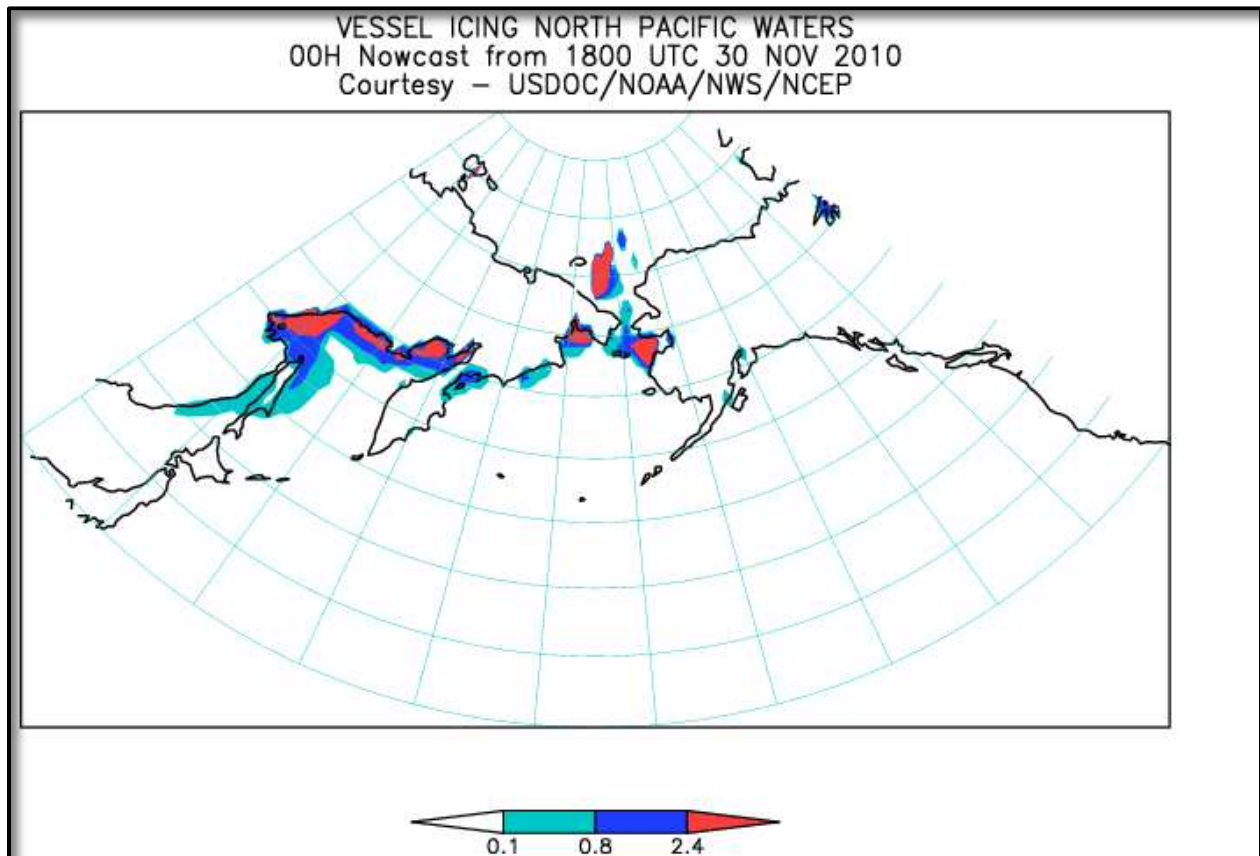


FIGURE 1. SAMPLE NCEP VESSEL ICING PRODUCT

IcingCalculator 1.0 is a simple Java-based Graphical User Interface (Figure 2) that allows marine forecasters to determine ice accretion rates in inches per hour given air temperature (degrees F), sea surface temperature (degrees F), and wind speed (knots). The algorithm (described in Feit) is the same as that used by the National Center for

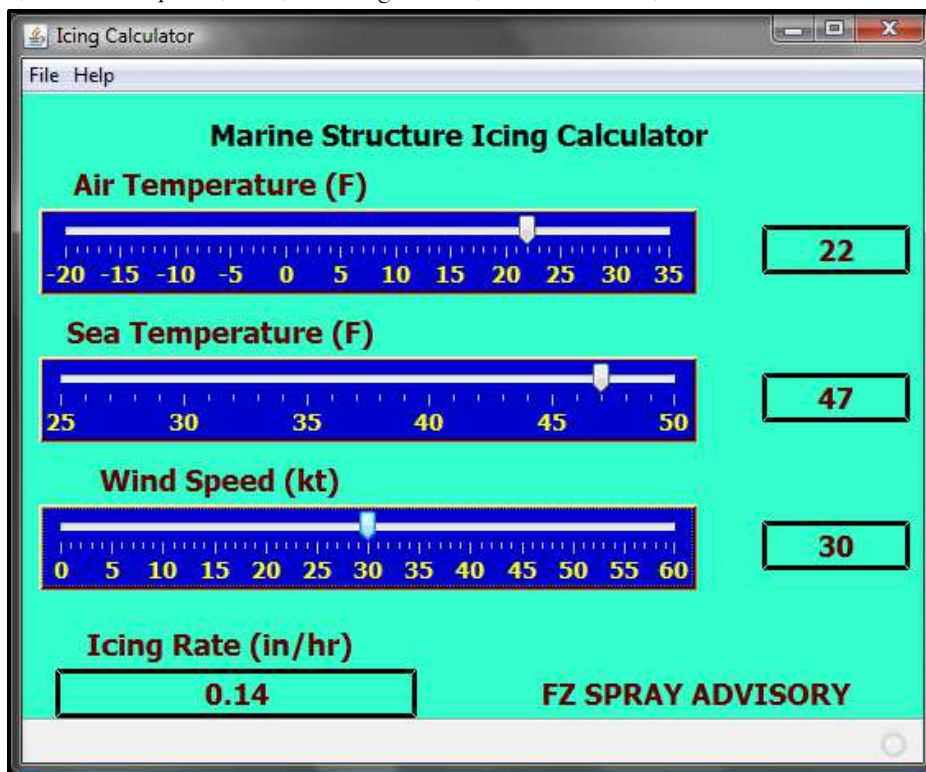


FIGURE 2. ICINGCALCULATOR 1.0 GRAPHICS USER INTERFACE

Environmental Prediction. In addition to providing ice accretion rates, IcingCalculator recommends the issuance of a Freezing Spray Advisory or a Freezing Spray Warning dependent on predicted ice accretion rates and is based on National Weather Service standards as of 2010.

IcingCalculator 1.0 will run on any operating system where the Java run-time environment (version jre-1.6 or greater) is installed. It can be run on personal computers, Linux or Unix workstations, and the National Weather

Service AWIPS system.

Installing and Using IcingCalculator:

Download IcingCalculator.tar, and then extract it to an appropriate location on your computer. To run the application, you will need to have the latest Java run time environment installed (jre-1.6 or higher). On a personal computer running Microsoft Windows, you can use freely available compression software such as 7-Zip or WinZip to extract the files. On a Linux workstation, open a command prompt, change directory to the location you placed the tar file, then type:

```
tar -xvf IcingCalculator.tar
```

Note that most Linux distributions contain a variety of compression and decompression utilities that can be used.

To install the application onto a NWS AWIPS system, it is recommended that the application be placed into /awips/dev/localapps so that the files will be preserved in a system upgrade.

IcingCalculator.tar contains required Java libraries, IcingCalculator.jar (the Java executable) and icons (FZPY.png for UNIX/Linux systems and FZPY.bmp for MS Windows systems). In Linux, you will need to make the .jar file executable by typing: `chmod a+x IcingCalculator.jar` in a command prompt from within the installed directory.

Once installed, you can create a desktop shortcut and assign FZPY.png or FZPY.bmp as the icon (depending on your operating system). Linux users will need to set up the executable in a shortcut (like in a KDE Panel button or one of various menus) by typing the full path to the Java run time environment and the program executable. For example, in AWIPS if installed as described above, this might be:

```
/usr/local/jre-1.6.0_13/bin/java -jar /awips/dev/localapps/IcingCalculator/IcingCalculator.jar
```

When you start the program, the GUI – as shown in Figure 2 – will be displayed. Use the slider bars to select your air temperature, sea surface temperature, and wind speed values. Forecasts will be immediately displayed in the text boxes at the bottom of the GUI as the slider bars are moved.

Assumptions:

IcingCalculator 1.0 assumes that the freezing point of sea water is -1.7 C , consistent with typical values found in Alaskan waters. The program will under forecast ice accretion rates in areas with brackish water or near the mouths of rivers that have significant fresh water discharge.

The program assumes that ice accretion will not be a significant problem when wind speed is less than 15 knots. While forecast ice accretion values will be provided when winds are less than 15 knots, it will not recommend the issuance of freezing spray advisories or warnings. Of course, spray should not be a large issue when wind speeds are light.

Program results are consistent with guidance products issued by the National Center for Environmental Prediction.

Methodology:

Given air temperature T_a , sea surface temperature T_s , the freezing temperature of sea water T_f , and wind speed V_a , ice accretion rate I is determined using:

$$I = a_0P + a_1P^2 + a_2P^3$$

Where:

$$P = V_a \left(\frac{T_f - T_a}{1 + 0.4(T_s - T_f)} \right)$$

$$a_0 = 2.73 \times 10^{-2}$$

$$a_1 = 2.91 \times 10^{-4}$$

$$a_2 = 1.84 \times 10^{-6}$$

Calculations involve wind speeds in $m\ s^{-1}$ and temperatures in $^{\circ}\text{C}$. Ice accumulation rates are returned in $cm\ hr^{-1}$. Conversions from and to kt, $^{\circ}\text{F}$, and $in\ hr^{-1}$ are made for display purposes.

References:

Curtis, J., Techniques for Forecasting Freezing Spray at WFO Anchorage, National Weather Association Marine Committee, <http://www.nwas.org/committees/smos/FreezingSpray.htm> .

Feit, D.M., An Operational Forecast System for Superstructure Icing, OPC Contribution No. 18, NOAA/NWS Ocean Products Center, Camp Springs, MD.

Guest, P. S. 2005. Vessel Icing, Marine Weather Log, vol. 49, no. 3.

Guest, P. S., 2001. Vessel Icing, US Navy Postgraduate School Training Material, <http://www.weather.nps.navy.mil/~psguest/polarmet/vessel/description.html> .

Overland, J.E., C.H. Pease, R.W. Preisendorfer and A.L. Comiskey, 1986: Prediction of vessel icing. Journal of Climate and Applied Meteorology, pp. 25, 1793-1806.

Program Code:

IcingCalculator 1.0 was written in Java using the Netbeans 6.9.1 Interactive Development Environment (free download from www.netbeans.org). Contact the author (jay.albrecht@noaa.gov) for a copy of the source code.