Modifications to ADCIRC v49.64+ for ICE Coverage

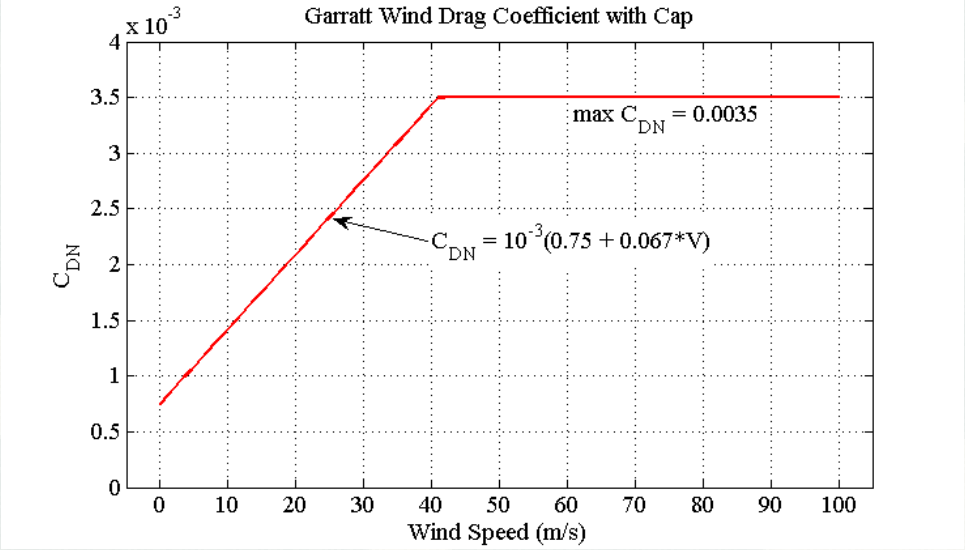
Chris Massey, Ph.D.
Ray Chapman, Ph.D.
ERDC-CHL

How Ice Coverage is Implemented

Ice coverage in ADCIRC was added as a way to modify the wind drag values. In no other way is ice coverage considered during ADCIRC's computational process.

ADCIRC Default Wind Drag Formula

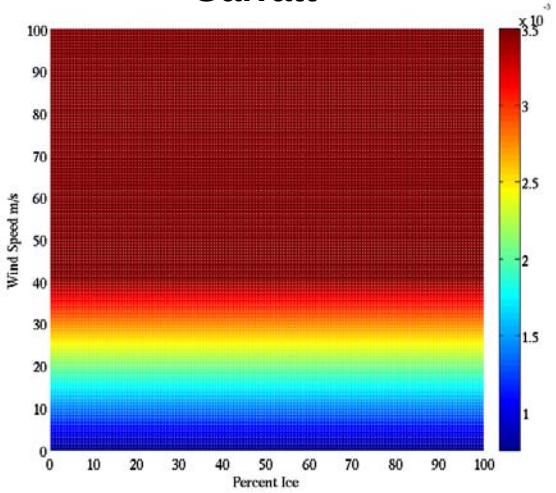
ADCIRC uses a Garratt formulation for wind drag coefficients and applies an upper limit of 0.0035 to this coefficient.



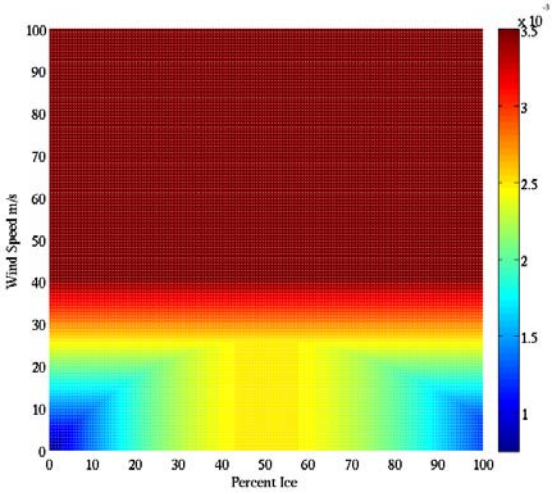
Garratt, J. R., 1977: Review of Drag Coefficients over Oceans and Continents. *Mon. Wea. Rev.*, **105**, 915–929.

Garratt + ICE CUBE Drag Formula

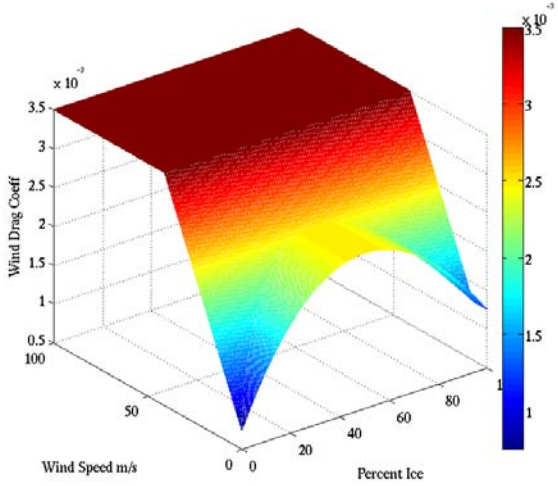
Garratt



Garratt + ICE CUBE



Garratt + ICE CUBE



Ice coverage effects are modeled in a drag formula (ICE CUBE) that is a cubic polynomial in ice percentage. The maximum drag coefficient value, between Garratt (based on wind speed) and ICE CUBE (based on % of ice) is what is used by ADCIRC.

pic = percent ice coverage

ICE CUBE

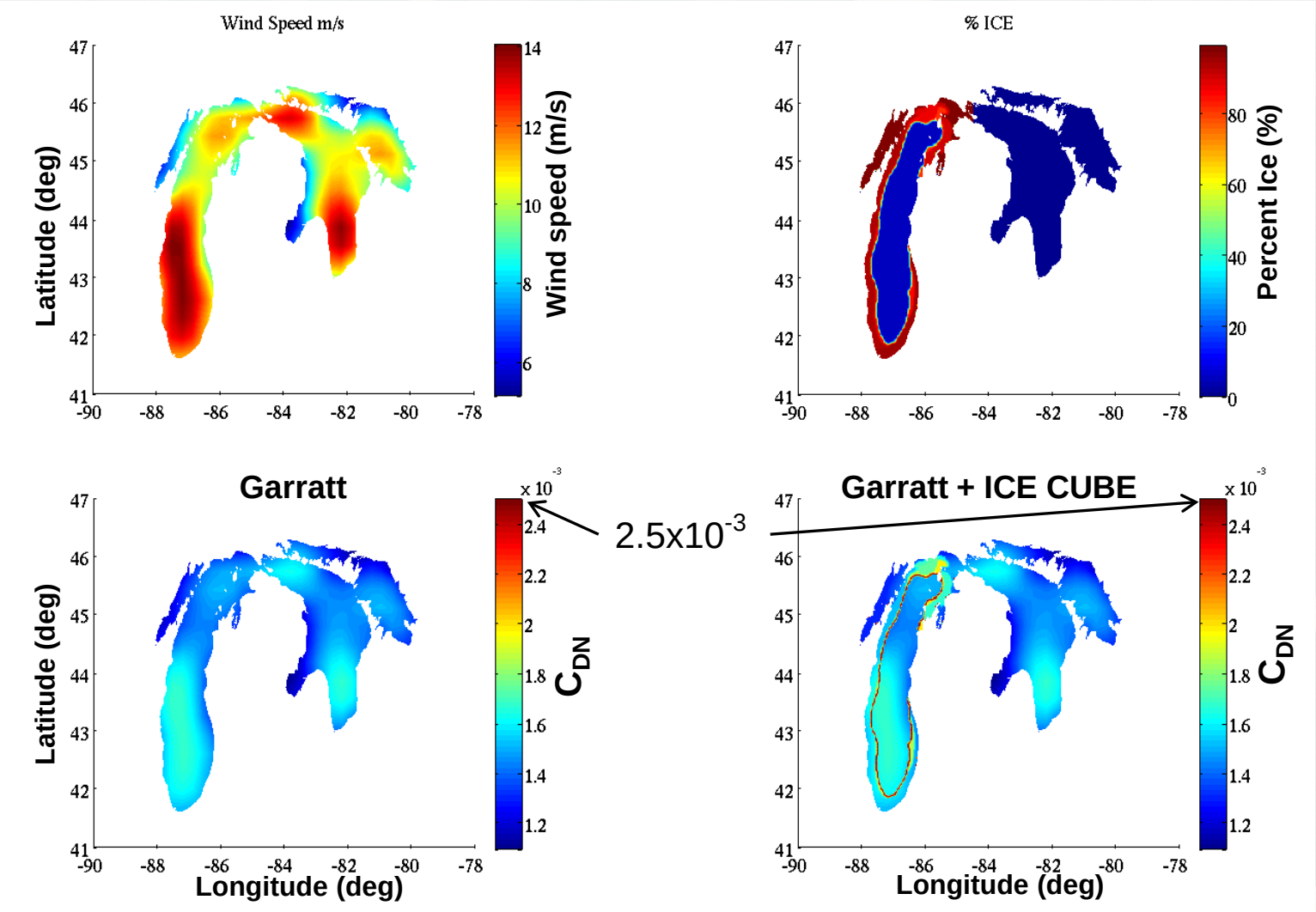
When pic = 0 the drag coefficient is equal to the minimum value for Garratt (.000075)

When pic = 50 it has a value of 0.0025 and a zero gradient

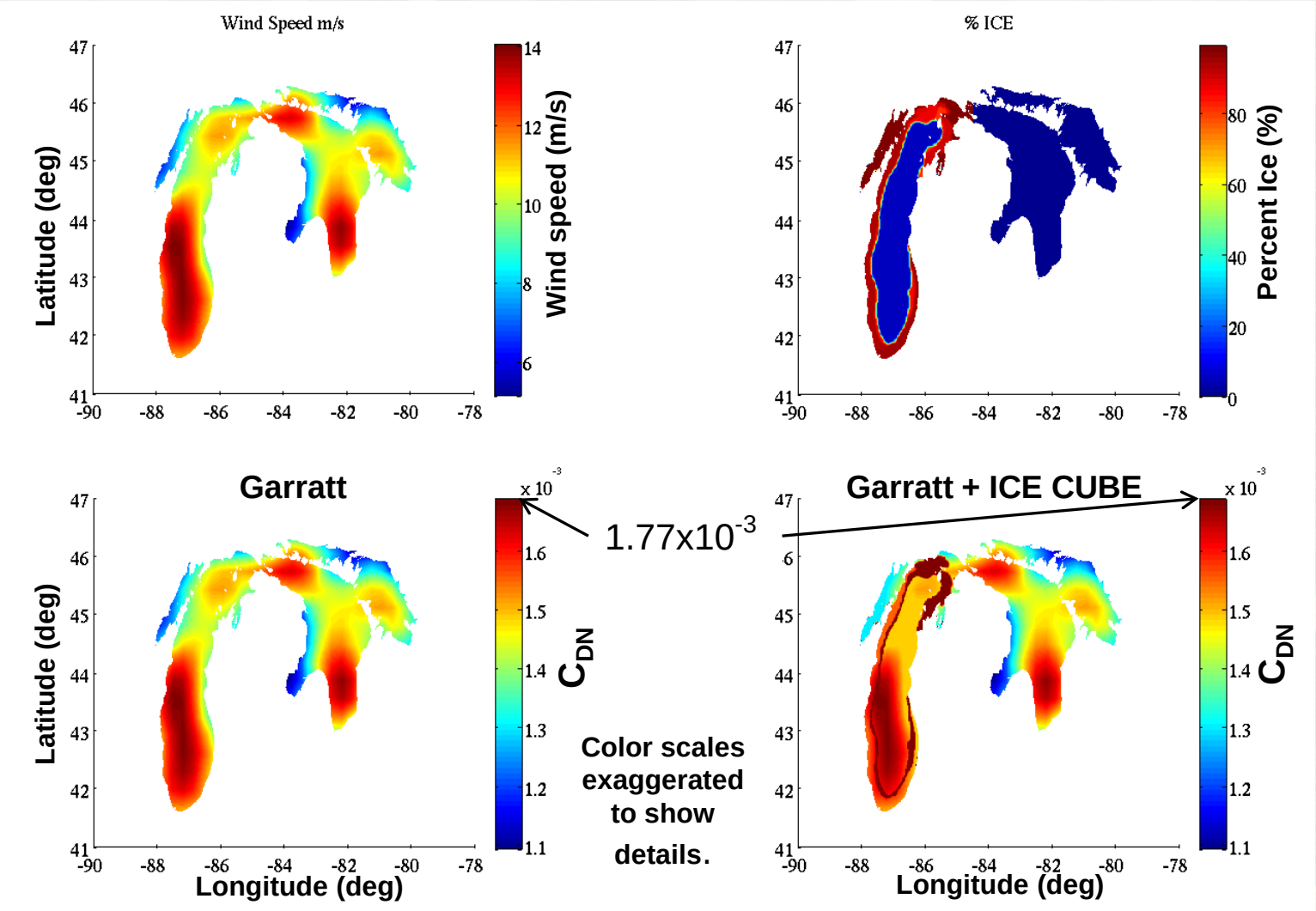
When pic = 100 it has a value of 0.00125.

This represents a some what smooth transition between Garratt for low ice values and low winds

Wind Speed, Ice Concentration and Drag Coefficients



Wind Speed, Ice Concentration and Drag Coefficients



ADCIRC Model Parameter File (fort.15)

See adcirc.org for full descriptions of all parameters and input/output files (except for ice).

Ice coverage is indicated by setting NWS = 1000+ your normal wind type option. OWI formatted Ice is 12000.

Set the time increment for winds (WTIMIC) and ice coverage (CICE_TIMIN). Both are measured in seconds.

```
GreatLakes_v3                ! 32 CHARACTER ALPHANUMERIC RUN DESCRIPTION
STORM04E_1985                ! 24 CHARACTER ALPANUMERIC RUN IDENTIFICATION
 1                      ! NFOVER - NONFATAL ERROR OVERRIDE OPTION
 1                      ! NABOUT - ABREVIATED OUTPUT OPTION PARAMETER
 1                      ! NSCREEN - OUTPUT TO UNIT 6 PARAMETER
 0                      ! IHOT - HOT START OPTION PARAMETER
 2                      ! ICS - COORDINATE SYSTEM OPTION PARAMETER
 0                      ! IM - MODEL RUN TYPE: 0=2DDI, 1=3DL(VS), 2=3DL(DSS)
 1                      ! NOLIBF - NONLINEAR BOTTOM FRICTION OPTION
 1                      ! NOLIFA - OPTION TO INCLUDE FINITE AMPLITUDE TERMS
 1                      ! NOLICA - OPTION TO INCLUDE CONVECTIVE ACCELERATION TERMS
 1                      ! NOLICAT - OPTION TO CONSIDER TIME DERIVATIVE OF CONV ACC TERMS
 0                      ! NWP - VARIABLE BOTTOM FRICTION AND LATERAL VISCOSITY OPTION PARAMETER
 1                      ! NCOR - VARIABLE CORIOLIS IN SPACE OPTION PARAMETER
 1                      ! NTIP - TIDAL POTENTIAL OPTION PARAMETER
12012                    ! NWS - WIND STRESS AND BAROMETRIC PRESSURE OPTION PARAMETER
 1                      ! NRAMP - RAMP FUNCTION OPTION
 9.81000000             ! G - ACCELERATION DUE TO GRAVITY - DETERMINES UNITS
 0.01                   ! TAU0 - WEIGHTING FACTOR IN GWCE
 0.50                        ! DT - TIME STEP (IN SECONDS)
 0.00                        ! STATIM - STARTING SIMULATION TIME IN DAYS
 0.00                        ! REFTIME - REFERENCE TIME FOR NODAL FACTORS AND EQUILIBRIUM ARGS
 3600.0  86400.0             ! WTIMINC, CICE_TIMINC
 11.90                       ! RNDAY - TOTAL LENGTH OF SIMULATION (IN DAYS)
 1.0                         ! DRAMP - DURATION OF RAMP FUNCTION (IN DAYS)
 0.350 0.300 0.350           ! TIME WEIGHTING FACTORS FOR THE GWCE EQUATION
 2.0 12 12 0.05              ! H0 - MINIMUM CUTOFF DEPTH
  -87.00 44.00               ! SLAM0,SFEA0 - CENTER OF CPP PROJECTION
 0.00150  1.0000  10.0000  0.3333        ! FFACTOR, HBREAK, FTHETA, FGAMMA
 2.0                        ! ESL - LATERAL EDDY VISCOSITY COEFFICIENT; IGNORED IF NWP =1
 0.00003                    ! CORI - CORIOLIS PARAMETER - IGNORED IF NCOR = 1

(Continued  Below)
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These are the only changes required in the fort.15 file in order to use ice coverage.

ADCIRC Model Parameter File (fort.15)

```
(Continued above)

8                              ! NTIF - TOTAL NUMBER OF TIDAL POTENTIAL CONSTITUENTS BEING FORCED
M2
   0.24233900  0.000140518902509  0.695  0.968  150.006
S2
   0.11303300  0.000145444104333  0.695  1.000    0.000
N2
   0.04639800  0.000137879699487  0.693  0.968   87.491
K1
   0.14156500  0.000072921158358  0.736  1.101  326.375
O1
   0.10051400  0.000067597744151  0.695  1.164  185.230
Q1
   0.01925600  0.000064958541129  0.695  1.164  122.716
P1
   0.04683400  0.000072522945975  0.706  1.000   29.661
K2
   0.03070400  0.000145842317201  0.693  1.275  112.301
0                              ! NBFR - TOTAL NUMBER OF FORCING FREQUENCIES ON OPEN BOUNDARIES
100.0                          ! ANGINN : INNER ANGLE THRESHOLD
1 1.0 11.9 1800                ! NOUTE,TOUTSE,TOUTFE,NSPOOLE:ELEV STATION OUTPUT INFO (UNIT 61)
  10
-88.0039   44.5429     !  Green Bay
-87.5900   45.0950     !  Menominee
-87.3133   44.7950     !  Sturgeon Bay Canal
-87.4970   44.4633     !  Kewaunee
-87.8867   43.0017     !  Milwaukee
-87.5034   41.7139     !  Calumet Harbor
-86.2112   42.7681     !  Holland
-86.4589   43.9465     !  Ludington
-85.8715   45.9519     !  Port Inland
-84.7603   45.8009     !  Mackinaw City

(Continued Below)
```

Elevation stations fort.61

ADCIRC Model Parameter File (fort.15)

Velocity stations fort.62

Meteorology Stations will also output ice coverage.

fort.71 – met. station wind speed
fort.72 – met. station pressure
fort.91 – met. Station ice coverage

Global Meteorology will also output ice coverage.

fort.73 – global wind speed
fort.74 – global surface pressure
fort.93 – global ice coverage

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(Continued Above)

1 1.0 11.9 1800          ! NOUTV,TOUTSV,TOUTFV,NSPOOLV:VEL STATION OUTPUT INFO (UNIT 62)
   1
-88.0039   44.5429      !  Green Bay
1 1.0 11.9 1800          ! NOUTM,TOUTSM,TOUTFM,NSPOOLM:MET STATION OUTPUT INFO (UNITS 71/72 & 91)
   2
-88.0039   44.5429      !  Green Bay
-87.5034   41.7139      !  Calumet Harbor
1  1.0 11.90 7200        ! NOUTGE,TOUTSGE,TOUTFGE,NSPOOLGE : GLOBAL ELEVATION  (UNIT 63)
1  1.0 11.90 7200        ! NOUTGV,TOUTSGV,TOUTFGV,NSPOOLGV : GLOBAL VELOCITY (UNIT 64)
1  1.0 11.90 7200        ! NOUTGW,TOUTSGW,TOUTFGW,NSPOOLGW : GLOBAL METEROLOGY (UNITS 73/74 & 93)
9                        ! NHARF - NUMBER OF FREQENCIES IN HARMONIC ANALYSIS
STEADY                   ! HAFNAM - ALPHA DESCRIPTOR FOR CONSTITUENT NAME
0.00000000000000 1.000 0.000        ! FREQUENCY, NODAL FACTOR, EQUILIBRIUM ARGUMENT (DEG)
M2
0.00014051891708 1.000 0.000
S2
0.00014544411942 1.000 0.000
N2
0.00013788000000 1.000 0.000
K1
0.00007292116592 1.000 0.000
O1
0.00006759775116 1.000 0.000
Q1
0.00006495900000 1.000 0.000
P1
0.00007252294600 1.000 0.000
K2
0.00014584200000 1.000 0.000
120.0 150.0 360 0.0      ! THAS,THAF,NHAINC,FMV - HARMONIC ANALYSIS PARAMETERS
1 1 1 1                  ! NHASE,NHASV,NHAGE,NHAGV - CONTROL HARMONIC ANALYSIS AND OUTPUT TO UNITS 51-54
1 7200                   ! NHSTAR,NHSINC - HOT START FILE GENERATION PARAMETERS
1 0 1.00E-08 75          ! ITITER, ISLDIA, CONVCR, ITMAX - ALGEBRAIC SOLUTION PARAMETERS
```

ADCIRC Ice Input Files

Currently ice coverage input files have the same format as the pressure files for NWS=12, OWI PBL formatted. These files contain regularly gridded data that gets interpolated by ADCIRC onto the computation nodes.

A fort.25 file is used to provide settings for ice input file. This file is handled just like a fort.22 file for NWS=12. The actual ice coverage files must be named fort.225 (and fort.227).

fort.25 file

```
1     ! # of ICE fields (Basin/Region)
0     ! # of Blank Ice Snaps to insert
```

If you had a basin and region ice coverage, then you would set this to 2 and the regional ice file would be called fort.227.

This control allows for ADCIRC to start before ice coverage values are available in the fort.225 file. A value of zero percent ice is used for these blank snaps.

ADCIRC Ice Output Files

The global ice coverage output file is (fort.93). It contains the percentage of ice coverage at every node in the ADCIRC mesh. It has the same format as a global elevation file (fort.63) or global pressure file (fort.73). Output start, stop, and frequency is controlled by the setting for the global meteorology outputs (fort.73/.74).

The station ice coverage output file is (fort.91). It contains the percentage of ice coverage at the station location. It has the same format as an elevation station file (fort.61) or a met. pressure station file (fort.71). Output start, stop, and frequency is controlled by the setting for the meteorology station outputs (fort.71/.72).