Software Test Description for the Polar Ice Prediction System 2.0

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Software Test Description for the Polar Ice Prediction System 2.0

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Since 1987, the Fleet Numerical Meteorology and Oceanography Center (FNMOC) has been running sea ice forecasting systems in various regions of Navy interest (the Central Arctic, the Barents Sea, and the Greenland Sea). The Polar Ice Prediction System Version 1.1 predicts sea ice conditions in the Arctic basin, the Barents Sea, and the Greenland Sea at a resolution of 127 km. Two regional sea ice forecast systems, the Polar Ice Prediction System – Barents Sea (RPIPS-B) and the Polar Ice Prediction System – Greenland Sea (RPIPS-G), also predict sea ice conditions in the Barents and Greenland Seas, respectively, at a higher resolution of 20–25 km. In 1995, the Naval Research Laboratory delivered to FNMOC a coupled ice-ocean system, the Polar Ice Prediction System Version 2.0 (PIPS2.0), which predicts sea ice conditions for most of the ice-covered regions in the Northern Hemisphere. PIPS2.0 will replace the three existing operational forecast systems when it completes the final operational testing phase at FNMOC. PIPS2.0 uses as its basis the Hibler ice model and the Cox ocean model. PIPS2.0 has a resolution of approximately a quarter of a degree, which is equivalent to the resolution of the operational regional systems (RPIPS-B and RPIPS-G). This report describes the test cases and test procedures necessary to execute PIPS2.0.
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SOFTWARE TEST DESCRIPTION FOR THE POLAR ICE PREDICTION SYSTEM 2.0 (PIPS2.0)

1.0 SCOPE

1.1 Identification

This software test description (STD) describes the test cases and test procedures necessary to perform formal qualification testing of the computer software configuration item (CSCI) identified as the Polar Ice Prediction System 2.0 (PIPS2.0). This STD has been prepared in accordance with the guidelines set forth by the Fleet Numerical Meteorology and Oceanography Center (FNMOG). These guidelines are based on the data item description (DID) DI-MCCR-800015A of DOD-STD-2167A.

1.2 System Overview

PIPS2.0 was developed to provide forecasts of ice drift velocity, ice thickness, and ice concentration for most ice-covered regions in the northern hemisphere. This includes the area from the North Pole south to approximately 30° N. Previous operational versions of PIPS relied on an external source for required oceanic forcing. PIPS2.0, however, is largely a self-contained model with the required oceanic forcing being computed within the model itself. Two independent models were merged to form PIPS2.0. *The Hibler Viscous-Plastic Sea Ice Model* (Hibler 1979; 1980), which provides the ice prediction output and *The Cox Ocean Model* (Cox 1984), which provides the ocean forcing required as input for the Hibler Ice Model.

To accomplish the merger, the models were first independently adapted to the required prediction basin (Preller and Posey 1989) and then joined by a common driver routine (Preller et al. 1996). Information between the coupled models is exchanged via common blocks.

1.3 Overview

This STD provides descriptions of the test cases and test procedures necessary to perform formal qualification testing of PIPS2.0. Two test cases are presented: one in which PIPS2.0 is run out for 24 hrs, and the second in which PIPS is run out for 5 days. Pretest hardware and software procedures are provided in Sec. 2.0. Section 3.0 identifies the two test cases and for each, describes the initialization, inputs, expected results, and the procedure for evaluating the results. In Secs. 3.1.5 and 3.2.5 the step-by-step procedure for running the test cases are given. Abbreviations and acronyms used in this document are listed in Sec. 4.0. As per FNMOG Instruction 5234.5, inapplicable paragraphs have been removed and the remaining paragraphs renumbered so that the document paragraph numbers are sequential.

1
2.0 FORMAL QUALIFICATION TEST PREPARATIONS

2.1 Test Case 1: 1-Day Forecast Run

2.1.1 Test Case 1: Pretest Procedures

2.1.1.1 Hardware Preparation

PIPS2.0 is designed to run on a UNIX host platform. Host specifics have been kept to a minimum. No hardware preparation is necessary.

2.1.1.2 Software Preparation

The PIPS2.0 software will be provided via disk file. Along with the source code are several include files that must be in the same directory for compilation. The required files are listed below:

<table>
<thead>
<tr>
<th>Source Code</th>
<th>Include Files (Common Blocks)</th>
<th>Include Files (Parameters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pips2_final.f</td>
<td>bg.com levitus.com rrv.com ice.par</td>
<td></td>
</tr>
<tr>
<td></td>
<td>corsp.com mask.com scalar.com ocean.par</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cox2.com oceans.com snow.com odam.par</td>
<td></td>
</tr>
<tr>
<td></td>
<td>curnts.com onedim.com step.com qmax.par</td>
<td></td>
</tr>
<tr>
<td></td>
<td>diffu3.com press.com stevsp.com relax.par</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fields.com rad.com tstep.com</td>
<td></td>
</tr>
<tr>
<td></td>
<td>force.com rfor.com tstop.com</td>
<td></td>
</tr>
<tr>
<td></td>
<td>fullwd.com rfor2.com worksp1.com</td>
<td></td>
</tr>
<tr>
<td></td>
<td>grow.com rstrt.com worksp2.com</td>
<td></td>
</tr>
</tbody>
</table>

Create the PIPS2.0 executable \texttt{pips2.out} with the UNIX cf77 Fortran compiler. The following compiling command and options are recommended:\footnote{cf77 options: \texttt{-Zp} auto tasking and maximum vectorization; \texttt{[-Wd"-l file t"]} dependence analyzer names listing file \texttt{file}; \texttt{[-W"-o zeroinc -d p -m 4"]} Fortran compiler optimizations option assumes constant increment variables can be incremented by zero generating conditional vector code, disable double precision making any double precisions single, and lowest message level of 4 (includes errors, warnings, cautions, notes).}

\texttt{cf77 -Zp -Wd-1 pips2_final.L -q t -Wf-o zeroinc -d p -m 4 pips2_final3.f -o pips2.out}

2.2 Test Case 2: 5-Day Forecast Runs

2.2.1 Test Case 2: Pretest Procedures

Test Case 2 test preparations are identical to those required for Test Case 1. See Sec. 2.1.1.
3.0 FORMAL QUALIFICATION TEST DESCRIPTIONS

3.1 Test Case 1: 1-Day Forecast Run

Test Case 1 is run to verify that PIPS2.0 produces the results expected for a typical 24-hr forecast. The run is for Oct 1, 1992. The Navy Operational Global Atmospheric Prediction System (NOGAPS) data for that day and restart files from the previous day (Sep 30, 1992) are input.

3.1.1 Test Case 1: Initialization

Test Case 1 is initialized with the previous day's model run, including the ice and ocean model restart files and the currents for the last two timesteps; and with the monthly river rate and historical Levitus temperatures and salinities. It is forced using NOGAPS atmospheric data. A land/sea mask and a file of gridpoints are also required. All initialization data are provided to PIPS2.0 via disk files.

The initialization files for this first test case are provided as a part of the PIPS2.0 software delivery. The files are:

- 920930_u.res  PIPS2.0 ice model restart file output from Sep 30, 1992
- fort_09.21    PIPS2.0 ocean model restart file output from Sep 30, 1992
- for010_09d_u2.dat  PIPS2.0 ocean model output currents from Sep 30, 1992
- river_oct.dat  October river rates for the model region
- for018_tu_10.dat  Levitus October temperatures interpolated to the model gridpoints
- for018_su_10.dat  Levitus October salinities interpolated to the model gridpoints
- p921001u.dat  NOGAPS Oct 1, 1992 atmospheric data
- mask_u.dat  Land/sea mask for the model grid
- newlatu.dat  Latitude/longitude in Earth-oriented spherical coordinates for the model gridpoints

3.1.2 Test Case 1: Test Inputs

Test inputs are entered via the run shellscript. They are entered directly following the program execution command as free-format input in a prescribed order. The following five inputs are required (their test case input values are in brackets):

- itstep  [ 8 ] Number of timesteps for run
- pltstp  [ 8 ] Interval in timesteps at which to plot
- prtstp  [ 8 ] Interval in timesteps at which to print
- irstrt  [ 1 ] Restart indicator; 1 for restart, 0 for climatology restart
- idtg   [92100100 ] 8-character date-time-group of the model run, YYMMDDHH
The input values must be entered in the following order (commas are optional):

```
itstep, pltstp, prtstp, irstrt, idtg
```

### 3.1.3 Test Case 1: Expected Test Results

#### 3.1.3.1 Screen Output

Screen data provides a quick look at the PIPS2.0 run. Displayed are ice thickness, ice outflow, and ice growth rate values, as well as intermediate timestep information. Portions of the expected screen output from Test Case 1 is shown in App. A.

#### 3.1.3.2 File Output

Test Case 1 files output include a file formatted specifically for post PIPS2.0 graphics plotting, a currents file that may be used for plotting but is also used for initialization of the next model run, and two restart files, one from the ocean model portion of PIPS2.0 and the other from the ice model portion. Both restart files are used solely as restart initialization data for the next day's model run. The four files output from Test Case 1 are:

- `921001_final.dat` Graphics data
- `for010_1001_final.dat` Ocean model output currents
- `fort_921001_final.21` Ocean model restart data
- `921001_final.res` Ice model restart data

Geostrophic wind, ice thickness, ice drift, ice concentration, ocean current, and ocean temperature results for the last timestep of Test Case 1 are shown in App. B, Figs. B-1 through B-6, respectively. These results are instantaneous values and are not averaged over the course of the day. Units of each are listed on the plot, except for ice concentration, which is in percentage of cell covered with ice.

Two points on the model grid have been chosen from these plots to extract quantitative values of the model results. Point 1 (142,126) is located in the Beaufort Sea area and point 2 (202,166) is located in the Central Arctic. The locations of the points are shown on the hatched grid showing every fourth gridpoint in Fig. 1. Expected results for the two points are shown in Table 1.

### 3.1.4 Test Case 1: Criteria for Evaluating Results

Test Case 1 results are evaluated by comparing output data plots and by comparing selected output data values. Wind, ice, and ocean current velocity vectors; ice thickness and ice concentration contours; and temperature contours at 15 m should coincide with the vectors and contours displayed in App. B. Extracted data values from the output graphics and ocean currents files should match those listed in Table 1 to the accuracy presented.

### 3.1.5 Test Case 1: Test Procedure

The Test Case 1 procedure consists of running the PIPS2.0 model (steps 1 through 4), and then extracting output to be used in the comparison of the expected results (steps 5 and 6). It is convenient
Fig. 1 — PIPS2.0 model grid showing locations of points 1 and 2

Table 1 — Expected Model Output Values for Points 1 and 2

<table>
<thead>
<tr>
<th></th>
<th>Point 1 (142,126)</th>
<th>Point 2 (202,166)</th>
</tr>
</thead>
<tbody>
<tr>
<td>u component of geostrophic wind (m/s)</td>
<td>-3.60765</td>
<td>12.3593</td>
</tr>
<tr>
<td>v component of geostrophic wind (m/s)</td>
<td>7.77270</td>
<td>6.88655</td>
</tr>
<tr>
<td>ice thickness (m)</td>
<td>4.39412E-02</td>
<td>3.08821</td>
</tr>
<tr>
<td>u component of ice drift (m/s)</td>
<td>-2.23710E-02</td>
<td>0.197808</td>
</tr>
<tr>
<td>v component of ice drift (m/s)</td>
<td>6.41437E-02</td>
<td>3.06618E-02</td>
</tr>
<tr>
<td>ice concentration (1:100%)</td>
<td>0.166745</td>
<td>0.844092</td>
</tr>
</tbody>
</table>

to use a shellscript to perform the functions necessary for running PIPS2.0. Appendix C contains the shellscript that may be used for running Test Case 1. It is assumed that this shellscript is located in the same directory as the executable and the input and output files. Path names would have to be included with filenames if different directories are used.

1) Assign the logical units used for PIPS2.0 execution. Begin by clearing any logical units that were previously assigned using the assign -R command.

assign -R
Then assign the unit numbers to be used by PIPS2.0 as ieee data format using the following command:

```
assign -F f77 -N ieee u:<unit #>
```

Repeat the command for unit numbers 10 through 16 and 30, 31, and 33.

2) Assign the input data files to specific logical unit numbers:

<table>
<thead>
<tr>
<th>File</th>
<th>Unit #</th>
</tr>
</thead>
<tbody>
<tr>
<td>for018_tu_10.dat</td>
<td>10</td>
</tr>
<tr>
<td>for018_su_10.dat</td>
<td>11</td>
</tr>
<tr>
<td>p921001u.dat</td>
<td>12</td>
</tr>
<tr>
<td>for010_09d_u2.dat</td>
<td>13</td>
</tr>
<tr>
<td>newlatu.dat</td>
<td>14</td>
</tr>
<tr>
<td>mask_u.dat</td>
<td>15</td>
</tr>
<tr>
<td>920930_u.res</td>
<td>16</td>
</tr>
<tr>
<td>fort_09.21</td>
<td>18</td>
</tr>
<tr>
<td>river_oct.dat</td>
<td>19</td>
</tr>
</tbody>
</table>

This may done in UNIX using the `ln` command, linking a file to the default file for the specific logical unit number.

```
ln <filename > fort.<unit#>
```

3). Run the model. Enter the model execution name, followed by the input data values.

```
pips2_c.out
```

```
8 8 8 1 92100100
```

4) Output data is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

<table>
<thead>
<tr>
<th>Unit #</th>
<th>File</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>for010_1001_final.dat</td>
</tr>
<tr>
<td>31</td>
<td>921001_final.dat</td>
</tr>
<tr>
<td>32</td>
<td>921001_final.res</td>
</tr>
<tr>
<td>33</td>
<td>fort_921001_final.21</td>
</tr>
</tbody>
</table>
This renaming may be done in UNIX using the `mv` command, moving a file out of its default logical unit filename to its new filename.

```
mv fort.<unit#> <filename >
```

5) Use externally supplied routines to generate output plots. Four plots are made using data from the graphics output file `921001_final.dat`, and two plots are made using data from the ocean model current file `for010_1001_final.dat`. Table 2 lists plots and the output fields from the files to be plotted. The `921001_final.dat` and `for010_1001_final.dat` file formats are provided in App. D.

6) Using externally supplied software, extract values for point 1 (142,126) and point 2 (202,166) of the $u$ component of geostrophic wind, the $v$ component of geostrophic wind, ice thickness, the $u$ component of ice drift, the $v$ component of ice drift, and ice concentration from the graphics file `921001_final.dat`. The fields to extract from are the same as those listed in Table 2.

### 3.1.6 Test Case 1: Assumptions and Constraints

It is assumed that externally supplied graphics software is available for generating output plots. There are no additional assumptions and constraints.

### 3.2 Test Case 2: 5-Day Forecast Runs

Test Case 2 is run to verify that PIPS2.0 continues to produce the results expected for a succession of daily forecasts. Relying upon the forecast and restart files output from Test Case 1, PIPS2.0 is run for 4 additional days. NOGAPS data for the 4 days and the restart files from Test Case 1 are input.

<table>
<thead>
<tr>
<th>Plot</th>
<th>File</th>
<th>Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geostrophic wind vectors with a maximum vector of approximately 3/4&quot; representing 0.500E+02 m/s</td>
<td>921001_final.dat</td>
<td>GAIRX, GAIRY</td>
</tr>
<tr>
<td>Ice thickness contours from 0.2 to 6.0 m with a contour interval of 0.2 m</td>
<td>921001_final.dat</td>
<td>HEFF</td>
</tr>
<tr>
<td>Ice velocity vectors with a maximum vector of approximately 3/4&quot; representing 0.300E+02 cm/s</td>
<td>921001_final.dat</td>
<td>UICE, VICE</td>
</tr>
<tr>
<td>Ice concentration contours from 0.2 to 1.0 with a contour interval of 0.1 (1:100%)</td>
<td>921001_final.dat</td>
<td>AREA1</td>
</tr>
<tr>
<td>Ocean current vectors with a maximum vector of approximately 3/4&quot; representing 0.200E+02 cm/s</td>
<td>for010_1001_final.dat</td>
<td>UTEMP, VTEMP</td>
</tr>
<tr>
<td>Temperature contours at 15 m from -2.0 to 28.0°C with a contour interval of 1.0°C</td>
<td>for010_1001_final.dat</td>
<td>TMP</td>
</tr>
</tbody>
</table>
3.2.1 Test Case 2: Initialization

Test Case 2 is initialized with the model output from Test Case 1 and with the monthly river rate and historical Levitus temperatures and salinities. It is forced using NOGAPS atmospheric data. The land/sea mask and file of gridpoints are also required. All initialization data are provided to PIPS2.0 via disk files.

The initialization files, other than the Test Case 1 output files, are provided as a part of the PIPS2.0 software delivery. The river rates, land/sea mask, and gridpoints are the same files input for Test Case 1. The initialization files are:

- 921001_final.res: PIPS2.0 ice model restart file output Test Case 1
- fort_921001_final.21: PIPS2.0 ocean model restart file output from Test Case 1
- for010_1001_final.dat: PIPS2.0 ocean model output currents from Test Case 1
- river_oct.dat: October river rates for the model region
- for018_tu_10.dat: Levitus October temperatures interpolated to the model gridpoints
- for018_su_10.dat: Levitus October salinities interpolated to the model gridpoints
- p921002u.dat: NOGAPS Oct 2, 1992 atmospheric data
- p921003u.dat: NOGAPS Oct 3, 1992 atmospheric data
- p921004u.dat: NOGAPS Oct 4, 1992 atmospheric data
- p921005u.dat: NOGAPS Oct 5, 1992 atmospheric data
- mask_u.dat: Land/sea mask for the model grid
- newlatu.dat: Latitude/longitude in Earth-oriented spherical coordinates for the model gridpoints

3.2.2 Test Case 2: Test Inputs

Test inputs are entered via the run shellscript. Four input values are entered directly following each run execution as free-format input in a prescribed order. The following five inputs, in order, are required (the values for each run are shown in brackets):

- itstep: Number of timesteps for run [8] [8] [8] [8]
- pltstp: Interval in timesteps at which to plot [8] [8] [8] [8]
- prtstp: Interval in timesteps at which to write [8] [8] [8] [8]
- irstrt: Restart indicator; 1 for restart, 0 for climatology restart [8] [8] [8] [8]
- idtg: 8-character date-time-group of the model run, YYMMDDHH [92100200] [92100300] [92100400] [92100500]
3.2.3 Test Case 2: Expected Test Results

3.2.3.1 Screen Output

Screen data provides a quick look at the PIPS2.0 run. Displayed are ice thickness, outflow, and ice growth rate values, as well as intermediate timestep information. Portions of the expected screen output from Test Case 2 is shown in App. E.

3.2.3.2 File Output

Each of the four PIPS2.0 runs in Test Case 2 produce four output files. The files for each run include a file formatted specifically for post PIPS2.0 graphics plotting, a currents file that may be used for plotting but is also used for initialization of the next model run, and two restart files, one from the ocean model portion of PIPS and the other from the ice model portion. Restart files are used solely as restart initialization data for the next day’s model run. The four sets of files output from the Test Case 2 are:

<table>
<thead>
<tr>
<th>Ice Restart Data</th>
<th>Ocean Restart Data</th>
<th>Ocean Output Currents</th>
<th>Graphics Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>921002_final.res</td>
<td>for_921002_final.21</td>
<td>for010_1002_final.dat</td>
<td>921002_final.dat</td>
</tr>
<tr>
<td>921003_final.res</td>
<td>for_921003_final.21</td>
<td>for010_1003_final.dat</td>
<td>921003_final.dat</td>
</tr>
<tr>
<td>921004_final.res</td>
<td>for_921004_final.21</td>
<td>for010_1004_final.dat</td>
<td>921004_final.dat</td>
</tr>
<tr>
<td>921005_final.res</td>
<td>for_921005_final.21</td>
<td>for010_1005_final.dat</td>
<td>921005_final.dat</td>
</tr>
</tbody>
</table>

Geostrophic wind, ice thickness, ice drift, ice concentration, ocean current, and ocean temperature results for the last timestep of the last day (day 5) of Test Case 2 are shown in App. F, Figs. F-1 through F-6, respectively. These results are instantaneous values and are not averaged over the course of the day. Units of each are listed on the plot, except for ice concentration, which is in percentage of cell covered with ice.

The same two points on the model grid that were chosen in Test Case 1 have been chosen to extract quantitative values from the fifth day’s plots. The locations of the points were shown on the hatched grid showing every fourth gridpoint in Sec. 3.1.3, Fig. 1. Expected results from day 5 for the two points are shown below in Table 3.

<table>
<thead>
<tr>
<th></th>
<th>Point 1 (142,126)</th>
<th>Point 2 (202,166)</th>
</tr>
</thead>
<tbody>
<tr>
<td>u component of geostrophic wind (m/s)</td>
<td>-0.615954</td>
<td>0.829795</td>
</tr>
<tr>
<td>v component of geostrophic wind (m/s)</td>
<td>-3.84163</td>
<td>-3.98314</td>
</tr>
<tr>
<td>ice thickness (m)</td>
<td>0.187806</td>
<td>3.05782</td>
</tr>
<tr>
<td>u component of ice drift (m/s)</td>
<td>02.27331E-02</td>
<td>3.16991E-02</td>
</tr>
<tr>
<td>v component of ice drift (m/s)</td>
<td>2.66174E-02</td>
<td>-5.75908E-02</td>
</tr>
<tr>
<td>ice concentration (1:100%)</td>
<td>0.268280</td>
<td>0.833614</td>
</tr>
</tbody>
</table>
3.2.4 Test Case 2: Criteria for Evaluating Results

Test Case 2 results are evaluated by comparing output data plots and by comparing selected output data values. Wind, ice, and ocean current velocity vectors; ice thickness and ice concentration contours; and temperature contours at 15 m should coincide with the vectors and contours displayed in App. F. Extracted data values from the output graphics and ocean currents files should match those listed in Table 3 to the accuracy presented.

3.2.5 Test Case 2: Test Procedure

The Test Case 2 procedure is very similar to Test Case 1, except that PIPS2.0 is run four times. Each time it is run, the input and output filenames must be attached to the correct logical unit numbers. The procedure consists of the runnings of PIPS2.0 (steps 1 through 13), and then extracting output to be used in the comparison of the expected results (steps 14 and 15). A shellscript is suggested to perform the functions necessary for the model runs. Appendix G contains the shellscript that may be used for running Test Case 2. It is assumed that this shellscript is located in the same directory as the executable and the input and output files. Path names would have to be included with filenames if different directories are used.

1) Assign the logical units used for PIPS2.0 execution. Begin by clearing any logical units that were previously assigned using the assign -R command.

```
assign -R
```

Then assign the unit numbers to be used by PIPS2.0 as iee data format using the following command:

```
assign -F f77 -N iee u:<unit #>
```

Repeat the command for unit numbers 10 through 15 and 30 and 31.

2) Assign the input data files for run 1 to specific logical unit numbers:

<table>
<thead>
<tr>
<th>File</th>
<th>Unit #</th>
</tr>
</thead>
<tbody>
<tr>
<td>for018_tu_10.dat</td>
<td>10</td>
</tr>
<tr>
<td>for018_su_10.dat</td>
<td>11</td>
</tr>
<tr>
<td>p921002u.dat</td>
<td>12</td>
</tr>
<tr>
<td>for010_1001_final.dat</td>
<td>13</td>
</tr>
<tr>
<td>newlatu.dat</td>
<td>14</td>
</tr>
<tr>
<td>mask_u.dat</td>
<td>15</td>
</tr>
<tr>
<td>921001_final.res</td>
<td>16</td>
</tr>
<tr>
<td>for_921001_final21</td>
<td>18</td>
</tr>
<tr>
<td>river_oct.dat</td>
<td>19</td>
</tr>
</tbody>
</table>
This may be done in UNIX using the `ln` command, linking a file to the default file for the specific logical unit number.

```
ln <filename > fort.<unit#>
```

3) Run the model. Enter the model execution name, followed by the input data values for run 1.

```
pips2_c.out
8 8 8 1 92100200
```

4) Intermediate output data from run 1 is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

<table>
<thead>
<tr>
<th>Unit #</th>
<th>File</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>for010_1002_final.dat</td>
</tr>
<tr>
<td>31</td>
<td>921002_final.dat</td>
</tr>
<tr>
<td>32</td>
<td>921002_final.res</td>
</tr>
<tr>
<td>33</td>
<td>fort_921002_final.21</td>
</tr>
</tbody>
</table>

This renaming may be done in UNIX using the `mv` command, moving a file out of its default logical unit filename to its new filename.

```
mv fort.<unit#> <filename >
```

5) Assign the input data files for run 2 to specific logical unit numbers:

<table>
<thead>
<tr>
<th>File</th>
<th>Unit #</th>
</tr>
</thead>
<tbody>
<tr>
<td>for018_tu_10.dat</td>
<td>10</td>
</tr>
<tr>
<td>for018_su_10.dat</td>
<td>11</td>
</tr>
<tr>
<td>p921003u.dat</td>
<td>12</td>
</tr>
<tr>
<td>for010_1002_final.dat</td>
<td>13</td>
</tr>
<tr>
<td>newlatu.dat</td>
<td>14</td>
</tr>
<tr>
<td>mask_u.dat</td>
<td>15</td>
</tr>
<tr>
<td>921002_final.res</td>
<td>16</td>
</tr>
<tr>
<td>fort_921002_final.21</td>
<td>18</td>
</tr>
<tr>
<td>river_oct.dat</td>
<td>19</td>
</tr>
</tbody>
</table>

This may be done in UNIX using the `ln` command, linking a file to the default file for the specific logical unit number.
6) Run the model. Enter the model execution name, followed by the input data values for run 2.

```
pips2_c.out
8 8 8 1 92100300
```

7) Intermediate output data from run 2 is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

<table>
<thead>
<tr>
<th>Unit #</th>
<th>File</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>for010_1003_final.dat</td>
</tr>
<tr>
<td>31</td>
<td>921003_final.dat</td>
</tr>
<tr>
<td>32</td>
<td>921003_final.res</td>
</tr>
<tr>
<td>33</td>
<td>fort_921003_final.21</td>
</tr>
</tbody>
</table>

This renaming may be done in UNIX using the `mv` command, moving a file out of its default logical unit filename to its new filename.

8) Assign the input data files for run 3 to specific logical unit numbers:

<table>
<thead>
<tr>
<th>File</th>
<th>Unit #</th>
</tr>
</thead>
<tbody>
<tr>
<td>for018_tu_10.dat</td>
<td>10</td>
</tr>
<tr>
<td>for018_su_10.dat</td>
<td>11</td>
</tr>
<tr>
<td>p921004u.dat</td>
<td>12</td>
</tr>
<tr>
<td>for010_1003_final.dat</td>
<td>13</td>
</tr>
<tr>
<td>newlatu.dat</td>
<td>14</td>
</tr>
<tr>
<td>mask_u.dat</td>
<td>15</td>
</tr>
<tr>
<td>921003_final.res</td>
<td>16</td>
</tr>
<tr>
<td>fort_921003_final.21</td>
<td>18</td>
</tr>
<tr>
<td>river_oct.dat</td>
<td>19</td>
</tr>
</tbody>
</table>

This may be done in UNIX using the `ln` command, linking a file to the default file for the specific logical unit number.

9) Run the model. Enter the model execution name, followed by the input data values for run 3.

```
pips2_c.out
8 8 8 1 92100400
```
10) Intermediate output data from run 3 is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

<table>
<thead>
<tr>
<th>Unit #</th>
<th>File</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>for010_1004_final.dat</td>
</tr>
<tr>
<td>31</td>
<td>921004_final.dat</td>
</tr>
<tr>
<td>32</td>
<td>921004_final.res</td>
</tr>
<tr>
<td>33</td>
<td>fort_921004_final.21</td>
</tr>
</tbody>
</table>

This renaming may be done in UNIX using the mv command, moving a file out of its default logical unit filename to its new filename.

11) Assign the input data files for run 4 to specific logical unit numbers:

<table>
<thead>
<tr>
<th>File</th>
<th>Unit #</th>
</tr>
</thead>
<tbody>
<tr>
<td>for018_tu_10.dat</td>
<td>10</td>
</tr>
<tr>
<td>for018_su_10.dat</td>
<td>11</td>
</tr>
<tr>
<td>p921005u.dat</td>
<td>12</td>
</tr>
<tr>
<td>for010_1004_final.dat</td>
<td>13</td>
</tr>
<tr>
<td>newlatu.dat</td>
<td>14</td>
</tr>
<tr>
<td>mask_u.dat</td>
<td>15</td>
</tr>
<tr>
<td>921004_final.res</td>
<td>16</td>
</tr>
<tr>
<td>fort_921004_final.21</td>
<td>18</td>
</tr>
<tr>
<td>river_oct.dat</td>
<td>19</td>
</tr>
</tbody>
</table>

This may be done in UNIX using the ln command, linking a file to the default file for the specific logical unit number.

12) Run the model. Enter the model execution name, followed by the input data values for run 4.

```
pips2_c.out
8 8 8 1 92100500
```

13) The final output data for Test Case 2 is written to specific logical units. Following execution, rename these files from their default file to the following filenames:

<table>
<thead>
<tr>
<th>Unit #</th>
<th>File</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>for010_1005_final.dat</td>
</tr>
<tr>
<td>31</td>
<td>921005_final.dat</td>
</tr>
<tr>
<td>32</td>
<td>921005_final.res</td>
</tr>
<tr>
<td>33</td>
<td>fort_921005_final.21</td>
</tr>
</tbody>
</table>
This renaming may be done in UNIX using the `mv` command, moving a file out of its default logical unit filename to its new filename.

14) Use externally supplied routines to generate output plots. Four plots are made using data from the graphics output file, 921005_final.dat, and two plots are made using data from the ocean model currents file, for010_1005_final.dat. Table 4 lists plots and the output fields from the files to be plotted. The 921005_final.dat and for010_1005_final.dat file formats are provided in App. D.

16) Using externally supplied software, extract values for point 1 (142,126) and point 2 (202,166) of the u component of geostrophic wind, the v component of geostrophic wind, ice thickness, the u component of ice drift, the v component of ice drift, and ice concentration from the graphics file, 921005_final.dat. The fields to extract from are the same as those listed in Table 4.

### 3.2.6 Test Case 2: Assumptions And Constraints

For Test Case 2, it is assumed that its execution follows Test Case 1 and that the results from Test Case 1 were evaluated and found to be correct. As in Test Case 1, it is assumed that externally supplied graphics software is available for generating output plots.

### 4.0 NOTES

#### 4.1 Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI</td>
<td>Computer Software Configuration Item</td>
</tr>
<tr>
<td>DID</td>
<td>Data Item Description</td>
</tr>
<tr>
<td>FNMOC</td>
<td>Fleet Numerical Meteorology and Oceanography Center</td>
</tr>
</tbody>
</table>

### Table 4 — Output Plotting Data Fields for Test Case 2

<table>
<thead>
<tr>
<th>Plot</th>
<th>File</th>
<th>Fields</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geostrophic wind vectors with a maximum vector of approximately 3/4&quot; representing 0.50E +02 m/s</td>
<td>921005_final.dat</td>
<td>GAIRX, GAIRY</td>
</tr>
<tr>
<td>Ice thickness contours from 0.2 to 6.0 m with a contour interval of 0.2 m</td>
<td>921005_final.dat</td>
<td>HEFF</td>
</tr>
<tr>
<td>Ice velocity vectors with a maximum vector of approximately 3/4&quot; representing 0.300E+02 cm/s</td>
<td>921005_final.dat</td>
<td>UICE, VICE</td>
</tr>
<tr>
<td>Ice concentration contours from 0.2 to 1.0 with a contour interval of 0.1 (1:100%)</td>
<td>921005_final.dat</td>
<td>AREA1</td>
</tr>
<tr>
<td>Ocean current vectors with a maximum vector of approximately 3/4&quot; representing 0.200E+02 cm/s</td>
<td>for010_1005_final.dat</td>
<td>UTEMP, VTEMP</td>
</tr>
<tr>
<td>Temperature contours at 15 m from -2.0 to 28.0°C with a contour interval of 1.0°C</td>
<td>for010_1005_final.dat</td>
<td>TMP</td>
</tr>
</tbody>
</table>
I/O  input/output
NOAA  National Oceanic and Atmospheric Administration
NOGAPS  Navy Operational Global Atmospheric Prediction System
NRL  Naval Research Laboratory
PIPS2.0  Polar Ice Prediction System 2.0
SDD  Software Design Document
STD  Software Test Description

5.0 SUMMARY AND CONCLUSIONS

Since 1987, FNMOC has been running sea ice forecasting systems in various regions of Navy interest (the Central Arctic, the Barents Sea, and the Greenland Sea). The PIPS1.1 system predicts sea ice conditions in the Arctic basin, the Barents Sea, and the Greenland Sea at a resolution of 127 km. Two regional sea ice forecast systems, the Polar Ice Prediction System – Barents Sea (RPIPS-B) and the Polar Ice Prediction System – Greenland Sea (RPIPS-G), also predict sea ice conditions in the Barents and the Greenland Seas, respectively, at a higher resolution of 20–25 km. In 1995, NRL delivered to FNMOC a coupled ice-ocean system, PIPS2.0, which predicts sea ice conditions for most of the ice-covered regions in the Northern Hemisphere. PIPS2.0 will replace the existing three operational forecast systems when it completes the final operational testing phase at FNMOC. PIPS2.0 uses as its basis the Hibler ice model (Hibler 1979, 1980) and the Cox ocean model (Cox 1984). PIPS2.0 has a resolution of approximately a quarter of a degree, which is equivalent to the resolution of the operational regional systems and each of its subroutines.

6.0 ACKNOWLEDGMENT

This work was funded by the U.S. Space and Naval Warfare Systems Command, Program Element 0603207N.

7.0 REFERENCES


Appendix A

SCREEN OUTPUT FROM TEST CASE 1

Screen output from Test Case 1

| NO OF ITERATIONS ARE: | 842 |
| MAX ERROR FOR U AND V: | 0.49885E-05 |

| NO OF ITERATIONS ARE: | 454 |
| MAX ERROR FOR U AND V: | 0.49907E-05 |

| NO OF ITERATIONS ARE: | 322 |
| MAX ERROR FOR U AND V: | 0.49858E-05 |

**SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE**

| TIME STEP | 1 |
| IDTG | -92100100 |

1

TS= 13105 YEAR= 0.75 DAY=273.0 ENERGY= 7.499125E-01 DTEMP= 4.259456E-08 DSALT= 5.296078E-13 SCANS= 9

TS= 13106 YEAR= 0.75 DAY=273.0 ENERGY= 7.499125E-01 DTEMP= 4.206545E-08 DSALT= 4.636091E-13 SCANS= 9

TS= 13107 YEAR= 0.75 DAY=273.1 ENERGY= 7.499124E-01 DTEMP= 4.211986E-08 DSALT= 4.709168E-13 SCANS= 8

TS= 13108 YEAR= 0.75 DAY=273.1 ENERGY= 7.499140E-01 DTEMP= 4.204583E-08 DSALT= 4.643297E-13 SCANS= 4

TS= 13109 YEAR= 0.75 DAY=273.1 ENERGY= 7.499198E-01 DTEMP= 4.206418E-08 DSALT= 4.685972E-13 SCANS= 5

TS= 13110 YEAR= 0.75 DAY=273.1 ENERGY= 7.499276E-01 DTEMP= 4.202412E-08 DSALT= 4.654541E-13 SCANS= 4

| NO OF ITERATIONS ARE: | 590 |
| MAX ERROR FOR U AND V: | 0.49924E-05 |

| NO OF ITERATIONS ARE: | 524 |
| MAX ERROR FOR U AND V: | 0.49585E-05 |

| NO OF ITERATIONS ARE: | 344 |
| MAX ERROR FOR U AND V: | 0.49691E-05 |

**SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE**

| TIME STEP | 2 |
| IDTG | -92100103 |

1
Screen output from Test Case 1

TS= 13111 YEAR= 0.75 DAY=273.1 ENERGY= 7.499540E-01 DTEMP= 2.498667E-08 DSALT= 1.127778E-12 SCANS= 7
TS= 13112 YEAR= 0.75 DAY=273.2 ENERGY= 7.499540E-01 DTEMP= 2.441735E-08 DSALT= 1.056485E-12 SCANS= 7
TS= 13113 YEAR= 0.75 DAY=273.2 ENERGY= 7.499727E-01 DTEMP= 2.447353E-08 DSALT= 1.063122E-12 SCANS= 4
TS= 13114 YEAR= 0.75 DAY=273.2 ENERGY= 7.499913E-01 DTEMP= 2.440174E-08 DSALT= 1.055803E-12 SCANS= 4
TS= 13115 YEAR= 0.75 DAY=273.2 ENERGY= 7.500136E-01 DTEMP= 2.442698E-08 DSALT= 1.059808E-12 SCANS= 3
TS= 13116 YEAR= 0.75 DAY=273.3 ENERGY= 7.500346E-01 DTEMP= 2.438918E-08 DSALT= 1.055728E-12 SCANS= 4

NO OF ITERATIONS ARE: 349
MAX ERROR FOR U AND V: 0.49425E-05

NO OF ITERATIONS ARE: 360
MAX ERROR FOR U AND V: 0.49731E-05

NO OF ITERATIONS ARE: 219
MAX ERROR FOR U AND V: 0.49668E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE
179.759728470  137.007813316  4.69987748431
0TIME STEP - 3 IDTG -92100106
1
TS= 13117 YEAR= 0.75 DAY=273.3 ENERGY= 7.500827E-01 DTEMP= 2.932740E-08 DSALT= 5.379423E-13 SCANS= 4
TS= 13118 YEAR= 0.75 DAY=273.3 ENERGY= 7.500827E-01 DTEMP= 2.875357E-08 DSALT= 4.660885E-13 SCANS= 4
TS= 13119 YEAR= 0.75 DAY=273.3 ENERGY= 7.501069E-01 DTEMP= 2.881068E-08 DSALT= 4.735197E-13 SCANS= 4
TS= 13120 YEAR= 0.75 DAY=273.3 ENERGY= 7.501317E-01 DTEMP= 2.873786E-08 DSALT= 4.666676E-13 SCANS= 5
TS= 13121 YEAR= 0.75 DAY=273.4 ENERGY= 7.501556E-01 DTEMP= 2.876242E-08 DSALT= 4.711978E-13 SCANS= 4
TS= 13122 YEAR= 0.75 DAY=273.4 ENERGY= 7.501795E-01 DTEMP= 2.872376E-08 DSALT= 4.676426E-13 SCANS= 4

NO OF ITERATIONS ARE: 481
MAX ERROR FOR U AND V: 0.49672E-05

NO OF ITERATIONS ARE: 384
MAX ERROR FOR U AND V: 0.49542E-05

NO OF ITERATIONS ARE: 255
MAX ERROR FOR U AND V: 0.49961E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE
184.206614082  68.2583842359  1.19808153307
0TIME STEP - 4 IDTG -92100109
1
Screen output from Test Case 1

<table>
<thead>
<tr>
<th>TS</th>
<th>YEAR</th>
<th>DAY</th>
<th>ENERGY</th>
<th>DTEMP</th>
<th>DSALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>13123</td>
<td>0.75</td>
<td>273.4</td>
<td>7.502247E-01</td>
<td>2.743758E-08</td>
<td>5.476528E-13</td>
</tr>
<tr>
<td>13124</td>
<td>0.75</td>
<td>273.4</td>
<td>7.502247E-01</td>
<td>2.683961E-08</td>
<td>4.704995E-13</td>
</tr>
<tr>
<td>13125</td>
<td>0.75</td>
<td>273.4</td>
<td>7.502452E-01</td>
<td>2.689894E-08</td>
<td>4.781985E-13</td>
</tr>
<tr>
<td>13126</td>
<td>0.75</td>
<td>273.5</td>
<td>7.502664E-01</td>
<td>2.682667E-08</td>
<td>4.713687E-13</td>
</tr>
<tr>
<td>13127</td>
<td>0.75</td>
<td>273.5</td>
<td>7.502856E-01</td>
<td>2.685248E-08</td>
<td>4.759470E-13</td>
</tr>
<tr>
<td>13128</td>
<td>0.75</td>
<td>273.5</td>
<td>7.503057E-01</td>
<td>2.681414E-08</td>
<td>4.723406E-13</td>
</tr>
</tbody>
</table>

NO OF ITERATIONS ARE: 468
MAX ERROR FOR U AND V: 0.49850E-05

NO OF ITERATIONS ARE: 343
MAX ERROR FOR U AND V: 0.49239E-05

NO OF ITERATIONS ARE: 281
MAX ERROR FOR U AND V: 0.49223E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE
199.780837775 107.676099214 1.29458885460

0TIME STEP - 5 IDTG -92100112 1

<table>
<thead>
<tr>
<th>TS</th>
<th>YEAR</th>
<th>DAY</th>
<th>ENERGY</th>
<th>DTEMP</th>
<th>DSALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>13129</td>
<td>0.75</td>
<td>273.5</td>
<td>7.503446E-01</td>
<td>2.941340E-08</td>
<td>5.530029E-13</td>
</tr>
<tr>
<td>13130</td>
<td>0.75</td>
<td>273.5</td>
<td>7.503447E-01</td>
<td>2.883928E-08</td>
<td>4.811789E-13</td>
</tr>
<tr>
<td>13131</td>
<td>0.75</td>
<td>273.6</td>
<td>7.503646E-01</td>
<td>2.889776E-08</td>
<td>4.891239E-13</td>
</tr>
<tr>
<td>13132</td>
<td>0.75</td>
<td>273.6</td>
<td>7.503854E-01</td>
<td>2.882578E-08</td>
<td>4.824433E-13</td>
</tr>
<tr>
<td>13133</td>
<td>0.75</td>
<td>273.6</td>
<td>7.504062E-01</td>
<td>2.884888E-08</td>
<td>4.862763E-13</td>
</tr>
<tr>
<td>13134</td>
<td>0.75</td>
<td>273.6</td>
<td>7.504280E-01</td>
<td>2.881341E-08</td>
<td>4.833621E-13</td>
</tr>
</tbody>
</table>

NO OF ITERATIONS ARE: 451
MAX ERROR FOR U AND V: 0.49823E-05

NO OF ITERATIONS ARE: 331
MAX ERROR FOR U AND V: 0.49262E-05

NO OF ITERATIONS ARE: 292
MAX ERROR FOR U AND V: 0.49405E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE
201.567416329 86.1071302330 1.7555531729
0TIME STEP - 6 IDTG -92100115
1
Screen output from Test Case 1

<table>
<thead>
<tr>
<th>TS</th>
<th>YEAR</th>
<th>DAY</th>
<th>ENERGY</th>
<th>DTEMP</th>
<th>DSALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>13135</td>
<td>0.75</td>
<td>273.6</td>
<td>7.504754E-01</td>
<td>2.696963E-08</td>
<td>5.738526E-13</td>
</tr>
<tr>
<td>13136</td>
<td>0.75</td>
<td>273.7</td>
<td>7.504754E-01</td>
<td>2.628854E-08</td>
<td>4.920304E-13</td>
</tr>
<tr>
<td>13137</td>
<td>0.75</td>
<td>273.7</td>
<td>7.505024E-01</td>
<td>2.623886E-08</td>
<td>4.902659E-13</td>
</tr>
<tr>
<td>13138</td>
<td>0.75</td>
<td>273.7</td>
<td>7.505304E-01</td>
<td>2.616848E-08</td>
<td>4.836784E-13</td>
</tr>
<tr>
<td>13139</td>
<td>0.75</td>
<td>273.7</td>
<td>7.505608E-01</td>
<td>2.619355E-08</td>
<td>4.880454E-13</td>
</tr>
<tr>
<td>13140</td>
<td>0.75</td>
<td>273.8</td>
<td>7.505920E-01</td>
<td>2.616017E-08</td>
<td>4.853268E-13</td>
</tr>
</tbody>
</table>

NO OF ITERATIONS ARE: 444
MAX ERROR FOR U AND V: 0.49549E-05

NO OF ITERATIONS ARE: 293
MAX ERROR FOR U AND V: 0.48847E-05

NO OF ITERATIONS ARE: 258
MAX ERROR FOR U AND V: 0.49266E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE

<table>
<thead>
<tr>
<th>TIME STEP</th>
<th>IDTG</th>
<th>213.781007584</th>
<th>135.269304186</th>
<th>2.52517726506</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>TS</th>
<th>YEAR</th>
<th>DAY</th>
<th>ENERGY</th>
<th>DTEMP</th>
<th>DSALT</th>
</tr>
</thead>
<tbody>
<tr>
<td>13141</td>
<td>0.75</td>
<td>273.8</td>
<td>7.506628E-01</td>
<td>2.724768E-08</td>
<td>5.688433E-13</td>
</tr>
<tr>
<td>13142</td>
<td>0.75</td>
<td>273.8</td>
<td>7.506628E-01</td>
<td>2.674181E-08</td>
<td>4.983992E-13</td>
</tr>
<tr>
<td>13143</td>
<td>0.75</td>
<td>273.8</td>
<td>7.507027E-01</td>
<td>2.680039E-08</td>
<td>5.067210E-13</td>
</tr>
<tr>
<td>13144</td>
<td>0.75</td>
<td>273.8</td>
<td>7.507432E-01</td>
<td>2.673130E-08</td>
<td>5.006573E-13</td>
</tr>
<tr>
<td>13145</td>
<td>0.75</td>
<td>273.9</td>
<td>7.507864E-01</td>
<td>2.675298E-08</td>
<td>5.048715E-13</td>
</tr>
<tr>
<td>13146</td>
<td>0.75</td>
<td>273.9</td>
<td>7.508296E-01</td>
<td>2.663977E-08</td>
<td>4.980868E-13</td>
</tr>
</tbody>
</table>

NO OF ITERATIONS ARE: 487
MAX ERROR FOR U AND V: 0.49771E-05

NO OF ITERATIONS ARE: 397
MAX ERROR FOR U AND V: 0.49661E-05

NO OF ITERATIONS ARE: 250
MAX ERROR FOR U AND V: 0.49881E-05

SQUARE VELOCITY, SQ. VELOCITY DIFFERENCE, MAX CHANGE

<table>
<thead>
<tr>
<th>TIME STEP</th>
<th>IDTG</th>
<th>188.96731798</th>
<th>74.8683730357</th>
<th>1.38760318151</th>
</tr>
</thead>
</table>

| OUTPUT FOR DTG - 92100121 | STEP - 8 |

OUTPUT FOR DTG - 92100121
STEP - 8

NET ICE THICKNESS - 21800.5586261
NET ICE THICKNESS - -0.116415321827E-09
Screen output from Test Case 1

OUTFLOW FOR THIS TIME STEP 0.0000E+00
NET OUTFLOW     0.0000E+00

ICE GROWTH FOR THIS TIME STEP 0.2251E+01
NET ICE GROWTH 0.2251E+01
OPEN WATER GROWTH 0.2231E+00
NET OPEN WATER GROWTH 0.2231E+00
OPEN WATER GROWTH 0.1449E+05
NET OPEN WATER GROWTH 0.1449E+05

STOP
Appendix B

OUTPUT PLOTS FROM TEST CASE 1

Fig. B-1 — Geostrophic wind velocity for day 1
Fig. B-2 — Ice thickness for day 1
Fig. B-3 — Ice velocity for day 1
Fig. B-4 — Ice concentration for day 1
Fig. B-5 — Ocean current for day 1
Fig. B-6 — Ocean temperature for day 1
Appendix C

RUN SHELLSCRIPT FOR TEST CASE 1

```bash
# assign -R
assign -F f77 -N iee e u:10
assign -F f77 -N iee e u:11
assign -F f77 -N iee e u:12
assign -F f77 -N iee e u:13
assign -F f77 -N iee e u:14
assign -F f77 -N iee e u:15
#
assign -F f77 -N iee e u:30
assign -F f77 -N iee e u:31
#
ln for018_tu_10.dat  fort.10
ln for018_su_10.dat  fort.11
ln p921001u.dat      fort.12
ln for010_09d_u2.dat fort.13
ln newlatu.dat       fort.14
ln mask_u.dat         fort.15
ln 920930d_u.res     fort.16
ln fort_09.21        fort.18
ln river_oct.dat     fort.19
#
pips2_c.out <<'EOD'
litstep, pltstp, prtstp, irstrt, idtg
'EOD'
#
mv fort.30 for010_1001_final.dat
mv fort.31 921001_final.dat
mv fort.33 921001_final.res
mv fort.34 fort_921001_final.21
exit
```
Appendix D

FILE FORMATS FOR PLOTTING

File formats for the graphics output file YYMMDD_final.dat, and the ocean model currents file for 010_MMDD_final.dat, are shown below. See Table 2 for descriptions of the plots to be generated.

<table>
<thead>
<tr>
<th>GRAPHICS FILE FORMAT YYMMDD.dat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>1 GAIRX(IMTP1,JMTP1)</td>
</tr>
<tr>
<td>2 Gairy(IMTP1,JMTP1)</td>
</tr>
<tr>
<td>3 HEFF(IMT,JMT)</td>
</tr>
<tr>
<td>4 UICE(IMTP1,JMTP1)</td>
</tr>
<tr>
<td>5 VICE(IMTP1,JMTP1)</td>
</tr>
<tr>
<td>6 AREA1(IMT,JMT)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OCEAN CURRENTS FILE FORMAT for 010_mmd.dat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>2 records for 2 to JMTM1</td>
</tr>
<tr>
<td>J1, IIT</td>
</tr>
<tr>
<td>UTEMP(IMT),VTEMP(IMT),TMP(IMT,2)</td>
</tr>
<tr>
<td>2 records for 2 to JMTM1</td>
</tr>
<tr>
<td>J1, IIT</td>
</tr>
<tr>
<td>UTEMP(IMT),VTEMP(IMT),TMP(IMT,2)</td>
</tr>
<tr>
<td>GICE, SHICE, FW1</td>
</tr>
</tbody>
</table>
Appendix E

SCREEN OUTPUT FROM TEST CASE 2

Portions of screen output from Test Case 2

Skipping... ........................................ Day 2
0TIME STEP - 1 IDT G -92100200

1
TS= 13153 YEAR= 0.75 DAY=274.0 ENERGY= 7.511206E-01 DTEMP= 2.082268E-08 DSALT= 5.986000E-13 SCANS= 9
Skipping...
0TIME STEP - 2 IDT G -92100203

1
TS= 13159 YEAR= 0.75 DAY=274.1 ENERGY= 7.513016E-01 DTEMP= 2.286396E-08 DSALT= 5.788567E-13 SCANS= 11
Skipping...
0TIME STEP - 3 IDT G -92100206 1

TS= 13165 YEAR= 0.75 DAY=274.3 ENERGY= 7.514662E-01 DTEMP= 2.759143E-08 DSALT= 5.836265E-13 SCANS= 5
Skipping...
0TIME STEP - 4 IDT G -92100209

1
TS= 13171 YEAR= 0.75 DAY=274.4 ENERGY= 7.516268E-01 DTEMP= 2.552282E-08 DSALT= 5.963231E-13 SCANS= 3
Skipping...
0TIME STEP - 5 IDT G -92100212

1
TS= 13177 YEAR= 0.75 DAY=274.5 ENERGY= 7.517591E-01 DTEMP= 2.747135E-08 DSALT= 5.950183E-13 SCANS= 5
Skipping...
0TIME STEP - 6 IDT G -92100215

1
TS= 13183 YEAR= 0.75 DAY=274.6 ENERGY= 7.518779E-01 DTEMP= 2.459285E-08 DSALT= 5.951503E-13 SCANS= 5
Skipping...
0TIME STEP - 7 IDT G -92100218

1
TS= 13189 YEAR= 0.75 DAY=274.8 ENERGY= 7.519474E-01 DTEMP= 2.529425E-08 DSALT= 6.000485E-13 SCANS= 8
Skipping...
0TIME STEP - 8 IDT G -92100221

1OUTPUT FOR DT G - 92100221 STEP - 8
0TOTAL ICE THICKNESS - 21810.6851277
NET ICE THICKNESS - 0.000000000000E+00

30
Portions of screen output from Test Case 2

OUTFLOW FOR THIS TIME STEP 0.0000E+00
NET OUTFLOW 0.0000E+00

ICE GROWTH FOR THE TIME STEP 0.3126E+01
NET ICE GROWTH 0.3126E+01
OPEN WATER GROWTH 0.5390E+00
NET OPEN WATER GROWTH 0.5390E+00
OPEN WATER GROWTH 0.1450E+05
NET OPEN WATER GROWTH 0.1450E+05

1
TS= 13195 YEAR= 0.75 DAY=274.9 ENERGY= 7.520047E-01 DTEMP= 1.863790E-08 DSALT= 
6.062751E-13 SCANS= 5
Skipping...
STOP executed at line 641 in Fortran routine 'DRIVER'
Skipping... ------------------------------------------ Day 3
0TIME STEP - 1 IDTG -92100300

1
TS= 13201 YEAR= 0.75 DAY=275.0 ENERGY= 7.521201E-01 DTEMP= 2.010657E-08 DSALT= 
6.397140E-13 SCANS= 8
Skipping...
0TIME STEP - 2 IDTG -92100303

1
TS= 13207 YEAR= 0.75 DAY=275.1 ENERGY= 7.523322E-01 DTEMP= 2.203298E-08 DSALT= 
6.209074E-13 SCANS= 6
Skipping...
0TIME STEP - 3 IDTG -92100306

1
TS= 13213 YEAR= 0.75 DAY=275.3 ENERGY= 7.525339E-01 DTEMP= 2.671875E-08 DSALT= 
6.230552E-13 SCANS= 6
Skipping...
0TIME STEP - 4 IDTG -92100309

1
TS= 13219 YEAR= 0.75 DAY=275.4 ENERGY= 7.527034E-01 DTEMP= 2.464994E-08 DSALT= 
6.338714E-13 SCANS= 5
Skipping...
0TIME STEP - 5 IDTG -92100312

TS= 13225 YEAR= 0.75 DAY=275.5 ENERGY= 7.528201E-01 DTEMP= 2.678573E-08 DSALT= 
6.361652E-13 SCANS= 6
Skipping...
0TIME STEP - 6 IDTG -92100315

1
TS= 13231 YEAR= 0.75 DAY=275.6 ENERGY= 7.529346E-01 DTEMP= 2.379098E-08 DSALT= 
6.304884E-13 SCANS= 4
Skipping...
0TIME STEP - 7 IDTG -92100318

1
TS= 13237 YEAR= 0.76 DAY=275.8 ENERGY= 7.530127E-01 DTEMP= 2.458737E-08 DSALT= 
6.382469E-13 SCANS= 4
Skipping...
0TIME STEP - 8 IDTG -92100321

OUTPUT FOR DTG - 92100321 STEP - 8
0TOTAL ICE THICKNESS - 21822.2107373
NET ICE THICKNESS - 0.000000000000E+00
Portions of screen output from Test Case 2

```
OUTFLOW FOR THIS TIME STEP  0.0000E+00
NET OUTFLOW    0.0000E+00

ICE GROWTH FOR THIS TIME STEP  0.3594E+01
NET ICE GROWTH    0.3594E+01
OPEN WATER GROWTH  0.3597E+00
NET OPEN WATER GROWTH  0.3597E+00
OPEN WATER GROWTH  0.1450E+05
NET OPEN WATER GROWTH  0.1450E+05

TS= 13243 YEAR= 0.76 DAY=275.9 ENERGY= 7.530591E-01 DTEMP= 1.762976E-08 DSALT= 6.494574E-13 SCANS= 7

Skipping...

STOP

Skipping... .............................................................. Day 4

0TIME STEP - 1 IDTG -92100400

1
TS= 13249 YEAR= 0.76 DAY=276.0 ENERGY= 7.530519E-01 DTEMP= 2.101294E-08 DSALT= 6.611956E-13 SCANS= 6

Skipping...

0TIME STEP - 2 IDTG -92100403

1
TS= 13255 YEAR= 0.76 DAY=276.1 ENERGY= 7.530418E-01 DTEMP= 2.153834E-08 DSALT= 6.558387E-13 SCANS= 6

Skipping...

0TIME STEP - 3 IDTG -92100406

1
TS= 13261 YEAR= 0.76 DAY=276.3 ENERGY= 7.530891E-01 DTEMP= 2.562912E-08 DSALT= 6.584157E-13 SCANS= 8

Skipping...

0TIME STEP - 4 IDTG -92100409

1
TS= 13267 YEAR= 0.76 DAY=276.4 ENERGY= 7.532129E-01 DTEMP= 2.457216E-08 DSALT= 6.729132E-13 SCANS= 6

Skipping...

0TIME STEP - 5 IDTG -92100412

TS= 13273 YEAR= 0.76 DAY=276.5 ENERGY= 7.533696E-01 DTEMP= 2.661560E-08 DSALT= 6.605290E-13 SCANS= 6

Skipping...

0TIME STEP - 6 IDTG -92100415

1
TS= 13279 YEAR= 0.76 DAY=276.6 ENERGY= 7.535489E-01 DTEMP= 2.374561E-08 DSALT= 6.543791E-13 SCANS= 8

Skipping...

0TIME STEP - 7 IDTG -92100418

1
TS= 13285 YEAR= 0.76 DAY=276.8 ENERGY= 7.537497E-01 DTEMP= 2.538295E-08 DSALT= 6.544780E-13 SCANS= 9

Skipping...

0TIME STEP - 8 IDTG -92100421

OUTPUT FOR DTG -92100421 STEP - 8

0TOTAL ICE THICKNESS - 21836.3388781
NET ICE THICKNESS - 0.000000000000E+00
```
Portions of screen output from Test Case 2

```
OUTFLOW FOR THIS TIME STEP  0.0000E+00
NET OUTFLOW  0.0000E+00
ICE GROWTH FOR THIS TIME STEP  0.3941E+01
NET ICE GROWTH  0.3941E+01
OPEN WATER GROWTH  0.4080E+00
NET OPEN WATER GROWTH  0.4080E+00
OPEN WATER GROWTH  0.1451E+05
NET OPEN WATER GROWTH  0.1451E+05
1
TS= 13291 YEAR= 0.76 DAY=276.9 ENERGY= 7.539827E-01 DTEMP= 1.804933E-08 DSALT= 6.585811E-13 SCANS= 8
Skipping...
STOP
Skipping...
```

Day 5

```
0TIME STEP -  1  IDTG -92100500
1
TS= 13297 YEAR= 0.76 DAY=277.0 ENERGY= 7.541512E-01 DTEMP= 2.057497E-08 DSALT= 6.632686E-13 SCANS= 7
Skipping...
0TIME STEP -  2  IDTG -92100503
1
TS= 13303 YEAR= 0.76 DAY=277.1 ENERGY= 7.542590E-01 DTEMP= 2.063420E-08 DSALT= 6.511868E-13 SCANS= 9
Skipping...
0TIME STEP -  3  IDTG -92100506
TS= 13309 YEAR= 0.76 DAY=277.3 ENERGY= 7.544229E-01 DTEMP= 2.456062E-08 DSALT= 6.440744E-13 SCANS= 7
Skipping...
0TIME STEP -  4  IDTG -92100509
1
TS= 13315 YEAR= 0.76 DAY=277.4 ENERGY= 7.546550E-01 DTEMP= 2.324119E-08 DSALT= 6.407560E-13 SCANS= 6
Skipping...
0TIME STEP -  5  IDTG -92100512
1
TS= 13321 YEAR= 0.76 DAY=277.5 ENERGY= 7.549248E-01 DTEMP= 2.559010E-08 DSALT= 6.486002E-13 SCANS= 7
Skipping...
0TIME STEP -  6  IDTG -92100515
1
TS= 13327 YEAR= 0.76 DAY=277.6 ENERGY= 7.552267E-01 DTEMP= 2.269537E-08 DSALT= 6.434174E-13 SCANS= 9
Skipping...
0TIME STEP -  7  IDTG -92100518
1
TS= 13333 YEAR= 0.76 DAY=277.8 ENERGY= 7.555203E-01 DTEMP= 2.445058E-08 DSALT= 6.609702E-13 SCANS= 9
Skipping...
0TIME STEP -  8  IDTG -92100521
1
OUTPUT FOR DTG - 92100521  STEP -  8
0TOTAL ICE THICKNESS - 21853.1228443
NET ICE THICKNESS - 0.000000000000E+00
```
Portions of screen output from Test Case 2

- OUTFLOW FOR THIS TIME STEP: 0.0000E+00
- NET OUTFLOW: 0.0000E+00
- ICE GROWTH FOR THIS TIME STEP: 0.3655E+01
- NET ICE GROWTH: 0.3655E+01
- OPEN WATER GROWTH: 0.3352E+00
- NET OPEN WATER GROWTH: 0.3352E+00
- OPEN WATER GROWTH: 0.1452E+05
- NET OPEN WATER GROWTH: 0.1452E+05

TS = 13339 YEAR = 0.76 DAY = 277.9 ENERGY = 7.557604E-01 DTEMP = 1.949153E-08 DSALT = 6.507655E-13 SCANS = 27

Skipping...

STOP
Appendix F

OUTPUT PLOTS FROM TEST CASE 2

Fig. F-1 — Geostrophic wind velocity for day 5
ICE THICKNESS (m) 92100500

CONTOUR FROM 0.20000 TO 6.00000 CONTOUR INTERVAL OF 0.20000 PT (3.3) = 0

Fig. F-2 — Ice thickness for day 5
Fig. F-3 — Ice velocity for day 5
Fig. F-4 — Ice concentration for day 5
Fig. F-5 — Ocean current for day 5
Fig. F-6 — Ocean temperature for day 5
# Run 1: Day 2 - October 2, 1992
#
assign -R
assign -F f77 -N ieee u:10
assign -F f77 -N ieee u:11
assign -F f77 -N ieee u:12
assign -F f77 -N ieee u:13
assign -F f77 -N ieee u:14
assign -F f77 -N ieee u:15
#
assign -F f77 -N ieee u:30
assign -F f77 -N ieee u:31
#
ln for018_tu_10.dat for.10
ln for018_su_10.dat for.11
ln p921002u.dat for.12
ln for010_1001_final.dat for.13
ln newlatu.dat for.14
ln mask_u.dat for.15
ln 921001_final.res for.16
ln fort_921001_final.21 for.18
ln river_oct.dat for.19
#
# pips2_c.out <<'EOD'
 8 8 8 1 92100200       !itstep, pltsp, prtsp, irstrt, idtg
'EOD'
#
mv fort.30 for010_1002_final.dat
mv fort.31 921002_final.dat
mv for.33 921002_final.res
mv fort.34 for_921002_final.21
#
# Run 2: Day 3 - October 3, 1992
#
ln p921003u.dat for.12
ln for010_1002_final.dat for.13
ln 921002_final.res for.16
ln   fort_921002_final.21   fort.18
#
#
pips2_c.out <<'EOD'
  8 8 8 1 92100300    !itstep, pltstp, prtstp, irstrt, idtg
'EOD'
#
mv   fort.30   for010_1002_final.dat
mv   fort.31   921003_final.dat
mv   fort.33   921003_final.res
mv   fort.34   fort_921003_final.21
#
#
#    Run 3: Day 4 - October 4, 1992
#
ln   p921004u.dat   fort.12
ln   for010_1003_final.dat   fort.13
ln   921003_final.res   fort.16
ln   fort_921003_final.21   fort.18
#
pips2_c.out <<'EOD'
  8 8 8 1 92100400    !itstep, pltstp, prtstp, irstrt, idtg
'EOD'
#
mv   fort.30   for010_1004_final.dat
mv   fort.31   921004_final.dat
mv   fort.33   921004_final.res
mv   fort.34   fort_921004_final.21
#
#
#    Run 4: Day 5 - October 5, 1992
#
ln   p921005u.dat   fort.12
ln   for010_1004_final.dat   fort.13
ln   921004_final.res   fort.16
ln   fort_921004_final.21   fort.18
#
pips2_c.out <<'EOD'
  8 8 8 1 92100500    !itstep, pltstp, prtstp, irstrt, idtg
'EOD'
#
mv   fort.30   for010_1005_final.dat
mv   fort.31   921005_final.dat
mv   fort.33   921005_final.res
mv   fort.34   fort_921005_final.21

exit