Vessel tracking using Automatic Identification System data in the Arctic

Torkild Eriksen and Øystein Olsen
ShipArc2015
Malmø, 26 August 2015
Content

• Use of SAT-AIS data from AISSat-1 and AISSat-2 for trend analysis as well as situational awareness

• Number of ships per month north of 67°
  – In the entire area north of 67° (Arctic)
  – In sectors of 45° longitude
  – By flag state
  – By ship type

• Number of ships through the Northeast Passage

• Ship densities and tracks

• Quality of SAT-AIS service
Views on the Arctic, sea ice, and ship traffic

Maps courtesy Devold/Ousland, National Geographic, Arctic Portal, and Google Earth
Number of ships per month
- 5 years; class A, B, and total number of ships

Number of ships north of 67°N per month

Time (month, year)

- Class A
- Class B
- Total
Number of ships per month - 4 years; monthly trend lines (August example)

Number of ships north of 67°N per month

- $y = 200x + 1418$
- $y = 128x + 1234$
- $y = 73x + 184$

<table>
<thead>
<tr>
<th>Year</th>
<th>Class A</th>
<th>Class B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>8</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>2012</td>
<td>12</td>
<td>15</td>
<td>27</td>
</tr>
<tr>
<td>2013</td>
<td>16</td>
<td>20</td>
<td>36</td>
</tr>
<tr>
<td>2014</td>
<td>20</td>
<td>25</td>
<td>45</td>
</tr>
</tbody>
</table>

Time (month, year):
- 8 2011
- 8 2012
- 8 2013
- 8 2014
Number of ships per month
- Average annual growth (from trend lines)

Average annual growth in number of ships north of 67°N by month

Time (month)

Growth (ships/year)

Class A
Class B
Total

1 2 3 4 5 6 7 8 9 10 11 12
Number of ships per month
- 2015; Observations and prediction intervals

Number of ships observed north of 67°N per month with prediction interval of estimates for 2015

<table>
<thead>
<tr>
<th>Time (month)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ships</td>
<td>1000</td>
<td>1500</td>
<td>123456789 1011123456789101112</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Graph shows the number of ships observed per month, with a prediction interval for 2015.
Number of ships per month - 2015; Observations and prediction intervals

Number of ships observed north of 67°N per month with prediction interval of estimates for 2015

<table>
<thead>
<tr>
<th>Time (month)</th>
<th>Number of ships</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class A</td>
</tr>
<tr>
<td>1</td>
<td>2500</td>
</tr>
<tr>
<td>2</td>
<td>2000</td>
</tr>
<tr>
<td>3</td>
<td>1500</td>
</tr>
<tr>
<td>4</td>
<td>1000</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>0</td>
</tr>
</tbody>
</table>
Number of ships per month
- 5 years; by ship type

![Graph showing the number of ships per month by ship type from 2011 to 2015. The x-axis represents the months from 2011 to 2015, and the y-axis represents the number of vessels north of 67°N. The graph includes lines for different ship types: Other, Fishing, Pleasure, Tug, Cargo, Passenger, and Tanker.](image-url)
Geographic distribution in 45°-lon sectors - 5 years; total number of ships

Total number of ships per month north of 67°N in 45° sectors

Number of ships

-157.5 -112.5 -67.5 -22.5 22.5 67.5 112.5 157.5

Time (month, year)

2010 2011 2012 2013 2014 2015
Geographic distribution in 45°-Ion sectors - 5 years; total number of ships (zoom)
Geographic distribution in 45°-lon sectors - growth in total numbers from 2013 to 2014

<table>
<thead>
<tr>
<th></th>
<th>-157.5</th>
<th>-112.5</th>
<th>-67.5</th>
<th>-22.5</th>
<th>22.5</th>
<th>67.5</th>
<th>112.5</th>
<th>157.5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>-2</td>
<td>204</td>
<td>9</td>
<td>0</td>
<td>1</td>
<td>217</td>
</tr>
<tr>
<td>Feb</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>-10</td>
<td>163</td>
<td>-10</td>
<td>1</td>
<td>2</td>
<td>153</td>
</tr>
<tr>
<td>Mar</td>
<td>-2</td>
<td>0</td>
<td>3</td>
<td>-15</td>
<td>218</td>
<td>29</td>
<td>-2</td>
<td>0</td>
<td>231</td>
</tr>
<tr>
<td>Apr</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>-25</td>
<td>204</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>198</td>
</tr>
<tr>
<td>May</td>
<td>1</td>
<td>-1</td>
<td>9</td>
<td>-7</td>
<td>141</td>
<td>9</td>
<td>8</td>
<td>-2</td>
<td>158</td>
</tr>
<tr>
<td>Jun</td>
<td>4</td>
<td>-2</td>
<td>10</td>
<td>1</td>
<td>142</td>
<td>85</td>
<td>8</td>
<td>3</td>
<td>251</td>
</tr>
<tr>
<td>Jul</td>
<td>-10</td>
<td>-5</td>
<td>23</td>
<td>36</td>
<td>144</td>
<td>108</td>
<td>9</td>
<td>12</td>
<td>317</td>
</tr>
<tr>
<td>Aug</td>
<td>2</td>
<td>5</td>
<td>18</td>
<td>29</td>
<td>195</td>
<td>149</td>
<td>14</td>
<td>27</td>
<td>439</td>
</tr>
<tr>
<td>Sep</td>
<td>4</td>
<td>2</td>
<td>15</td>
<td>11</td>
<td>166</td>
<td>157</td>
<td>23</td>
<td>27</td>
<td>405</td>
</tr>
<tr>
<td>Oct</td>
<td>-1</td>
<td>1</td>
<td>11</td>
<td>1</td>
<td>164</td>
<td>117</td>
<td>-6</td>
<td>1</td>
<td>288</td>
</tr>
<tr>
<td>Nov</td>
<td>-3</td>
<td>0</td>
<td>16</td>
<td>12</td>
<td>153</td>
<td>4</td>
<td>0</td>
<td>-1</td>
<td>181</td>
</tr>
<tr>
<td>Dec</td>
<td>-1</td>
<td>3</td>
<td>5</td>
<td>-12</td>
<td>138</td>
<td>31</td>
<td>0</td>
<td>-2</td>
<td>162</td>
</tr>
<tr>
<td>Total</td>
<td>-4</td>
<td>6</td>
<td>123</td>
<td>19</td>
<td>2032</td>
<td>695</td>
<td>58</td>
<td>71</td>
<td>3000</td>
</tr>
</tbody>
</table>
Geographic distribution in 45°-lon sectors - growth in total between 2011 and 2014

Annual growth in total number of ship-months per year north of 67°N

Time (year)

Growth (ship-months/year)

2012 2013 2014

-157.5 -112.5 -67.5 -22.5 22.5 67.5 112.5 157.5
Geographic distribution in 45°-lon sectors - growth in total between 2011 and 2014 (zoom)

Annual growth in total number of ship-months per year north of 67°N

-157.5 -112.5 -67.5 -22.5 22.5 67.5 112.5 157.5
Geographic distribution in 45°-lon sectors - relative growth in total between 2011 and 2014

Annual growth in total number of ship-months per year north of 67°N

[Graph showing annual growth in total number of ship-months per year north of 67°N from 2011 to 2014]
Number of ships counted by flag state
- August 2014 in the entire Arctic north of 67°N

- NO: 1002
- RU: 561
- Entire area
- Other: 149
- MH: 15
- FR: 15
- DE: 11
- GB: 21
- AG: 17
- VC: 15
- FO: 31
- CA: 34
- GL: 31
- DK: 35
- MT: 38
- PA: 44
- NL: 46
- US: 46
- BS: 47
- IS: 48
- noFl: 54
- RU; 561
Number of ships counted by flag state - August 2014 in sectors of 45° longitude
Ships crossing the Northeast Passage
- 5 years; Count of ships per month
Ships crossing the Northeast Passage - 5 years; Total ship-months with uncertainty

Observed total annual ship-months with prediction interval as well as prediction for 2015

Year (2010+axis value)

Observations (ship-months/year)
Seasonal variations in ship tracks

August 2014

February 2015

November 2014

May 2015

Background map courtesy of Google Earth
Annual ship densities in July 2011 - 2014
Ship tracks on 14 August 2014

Ship photos courtesy of MarineTraffic. Background map courtesy of Google Earth
Ship positions coloured by the number of observations for each ship
Quality of service parameters distributions

Histogram of messages received per ship (bin size: 10)
- Data: Plat_2_U_1
- Polygon: 067.090N -100.0100E
- Date: 2014-06-14
- n_uniqMSI: 1122 of 1128

Histogram of observations per ship
- n_obs avg: 13.7
- median: 13.0

Histogram of max time gap between observations per ship
- dT_max avg: 9.1 h
- median: 6.7 h

Cumulative histogram of max time gap between observations per ship
- 50%: 15 hours
- 70%: 20 hours
- 90%: 25 hours
Summary

- The number of reporting ships per month has varied from 1073 (December 2010) to 2272 ships (August 2014).
- The growth in number of reporting ships varies with month; from 113 at the minimum in November to 201 ships/year at the maximum in July.
- The growth is partly due to changes in regulations, i.e. EC 1224/2009 (the Control Regulation) by 31 May 2014 all fishing vessels above 15m.
- The highest number of ships are in the 0-45°E sector, 1723 of 2272 ships in August 2014. The annual growth has been around 10%.
- The highest relative growth is in the following three eastern sectors, having an average growth between 15% and 24% per year.
- Monthly ship-type counts give 600 fishing vessels, 430 cargo ships, 120 tankers, 100 passenger ships, 100 tugs and 280 other ships (in 2014).
- Up to 1200 vessels are observed per day, of which 1100 are using AIS Class A and 100 Class B.
- The median number of position updates per ship per day are typically 13 and the largest daily time gaps are smaller than 6.7 hours.
Number of ships counted by flag state
- August 2014 by sector

Number of vessels v.s. month and flag in the sectors
Class A, August 2014

Class B, August 2014