Global vessel traffic model

Øystein Olsen

Keywords

Skip

Trafikkmodell

AIS

Vekst

Variasjon

Approved by

Richard B. Olsen   Project Manager

Johnny Bardal   Director

English summary

A global vessel traffic model is necessary to assess the performance of future satellite AIS systems. This document describes such a model and how it was developed. In most areas, this model utilizes AIS data recorded by AISSat-1 and the NORAIS receiver on the International Space Station. In areas with high vessel densities it makes use of data from other sources like the Norwegian Coastal Administration.

The model includes transmitted signal strengths and frequencies. Plots of the variation in transmission frequencies as a function of the transmission frequency indicate that there might be at least three major producers of AIS equipment.

The model has been extrapolated into the years 2014, 2017, 2025 and 2032 by using regional growth rates and known regulatory changes.

Sammendrag

Det er nødvendig med en global trafikkmodell for å simulere ytelsen til fremtidige satellitt AIS systemer. Dette dokumentet beskriver en slik modell og hvordan den ble utviklet. Modellen bruker i de fleste områder AIS data fra AISSat-1 og NORAIS mottakeren på den internasjonale romstasjonen. I områder med høy skipstetthet brukes andre kilder, for eksempel Kystverket.

Modellen inkluderer utsendt effekt og frekvens. Plott av variasjoner i utsendt frekvens som funksjon av utsendt frekvens indikerer at det er minst tre store produsenter av AIS utstyr for skip.

Modellen har blitt ekstrapolert til årene 2014, 2017, 2025 og 2032 ved å ta hensyn til regionale vekstrater og endringer i krav til hvilke skip som må bære AIS.

Contents

1   Introduction

This document describes how global traffic models were derived from available data sources and the assumptions used to predict future traffic conditions. This document also includes user manuals and calling examples for programs used to derive the traffic models. Those programs were developed together with the AISDET [1] tool for simulating reception of signals from the Automatic Identification System (AIS) in low Earth orbit.

The purpose of these models has mainly been to support the simulation of future satellite AIS systems [2], [3] through AISDET. This work acts as an update to the corresponding report in the European Space based AIS (ESPAIS) [4] project, which was written before global satellite AIS data were available.

2   Vessel distribution from satellite data

AIS[5] is an anti-collision system used by many different types of vessels. It is designed to work through vessel to vessel communication on the maritime VHF band. The transmission protocol, SOTDMA[1], takes care to avoid message collisions, but it only works between vessels that can see one another. A satellite will therefore see many uncoordinated vessels due to its large field of view, and with a large number of vessels the satellite will receive messages transmitted during the same transmission interval. It is very unlikely that any vessel will be detected because of this effect in high traffic zones like the North Sea. Atmospheric and ionospheric conditions affect the reception of AIS messages in space. Messages may be lost because of Faraday rotation and polarization mismatch loss. The installation of the AIS equipment itself may degrade the transmitted signal strength from its nominal value. Hence, the space based AIS sensors do not detect every vessel during an orbit.

It is therefore not sufficient to count the number of vessels seen by a satellite to derive a global vessel model; the detection probability must be known too. One way to derive detection probabilities would be to use identical satellites observing the same areas under the same geometries within a short time span. A similar procedure can be used with a single satellite and repeat pass observations, but care must be taken to ensure similar conditions between each pass.

2.1   Algorithm

The following algorithm was adopted to compute detection probabilities, and at the same derive a vessel distribution.

- Divide the world into 1x1 degree cells. Any area that is significantly smaller than the satellite's field of view will do.

---

[1] SOTDMA: Self-Organized Time Division Multiple Access

- Select a large set of data, for example one month.
- Computationally limit the field of view to an along track oriented box with all sides equal to 60% of the full field of view. The purpose of this box is to ensure that repeat passes have similar geometries.
- Compute when each cell is visible within the satellite's boxed field of view.
- Extract consecutive passes for each cell, i.e. the time between the first pass and second pass must be equal to the period of the orbit.
- For each pair of passes for each cell: Extract all messages received within the first and second pass. The first pass is used to identify the vessels within each cell. The second pass is used to compute the detection probability by simply identifying the fraction of vessels seen in the second pass out of those seen the first. This algorithm does not require that the vessels detected in the second pass are still within the cell. Some vessels may have moved outside the cell since the first pass.
- Each cell then gets assigned the average number of detected vessels per pass and an average detection probability. The vessel model is created by sampling from these cells using observed positions to avoid 1x1 degree blocks in the final distribution. This step is done for each possible repetition rate.

There are some problems with this algorithm: Vessels may change repetition rates between and even during passes. Vessels that transmit with too low power to be detected will not be included in the model. There are areas where the detection probability is too low to give any meaningful statistics. These areas must be excluded from the model, and are shown as green, blue and cyan in Figure 2.1. Finally, vessels that transmit once every third minute are difficult to detect, and the observations do not give sufficient data to derive a traffic model. The number of vessels that transmit every third minute was therefore scaled to ensure similar numbers as seen in areas with known distributions.

2.2 Detection probabilities and vessel distribution maps

Figure 2.1 shows the detection probabilities derived using the algorithm described in section 2.1. This figure is based on AIS data received by the International Space Station (ISS) during March 2011. March 2011 was selected because there was very little interference from other equipment on the ISS. Communication on one of S-band antennas on the station tends to interfere with the AIS receiver. The effect of this interference can be seen by comparing Figure 2.1 and Figure 2.2, which is based on data recorded in August 2011.

Appendix A.1 shows the commands that created the vessel density maps shown in this section.
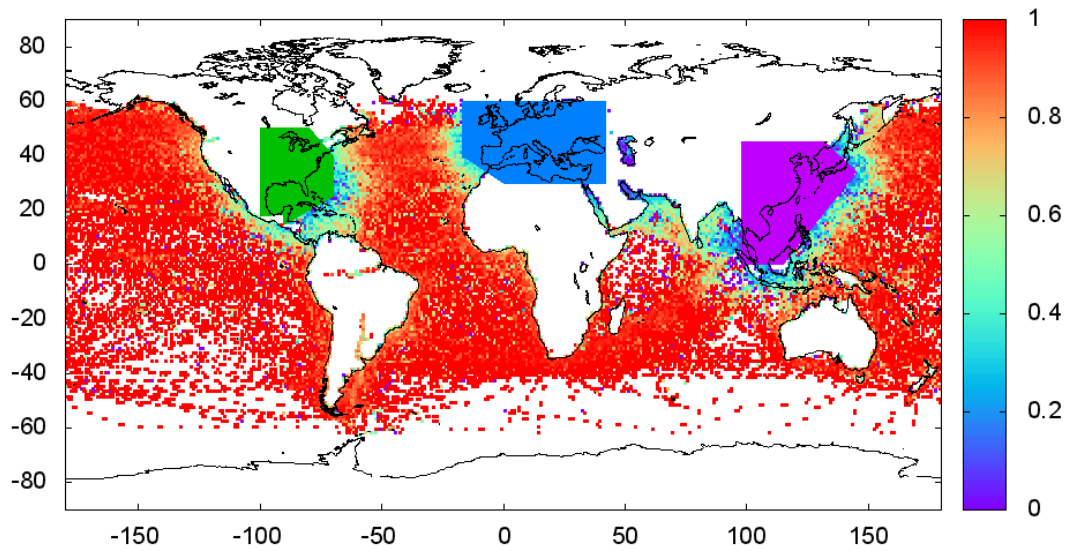
Figure 2.1   Average repeat-pass detection probabilities during March 2011 using AIS data from the ISS.
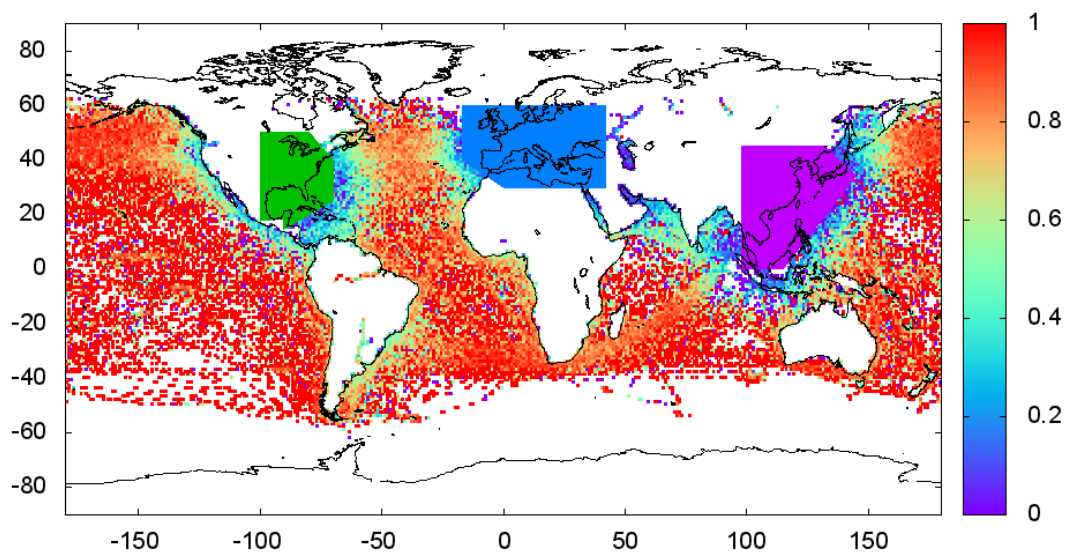

Figure 2.2   Average repeat-pass detection probabilities during August 2011 using AIS data from the ISS.

Figure 2.3 and Figure 2.4 show vessel distribution maps from the same periods as Figure 2.1 and Figure 2.2 respectively. The maps are logarithmic and show the average number of vessels seen per pass. The total number of vessels in these monthly maps varies from 19.000 to 21.000 through 2011. About 43.000 vessels are located with the green, blue and cyan colored high traffic zones.

The most obvious changes between these two maps are visible in the North - Pacific. The vessel lanes appear to be split in two during the winter, and the shortest route is disregarded in favor of routes closer to the coast and routes further south.
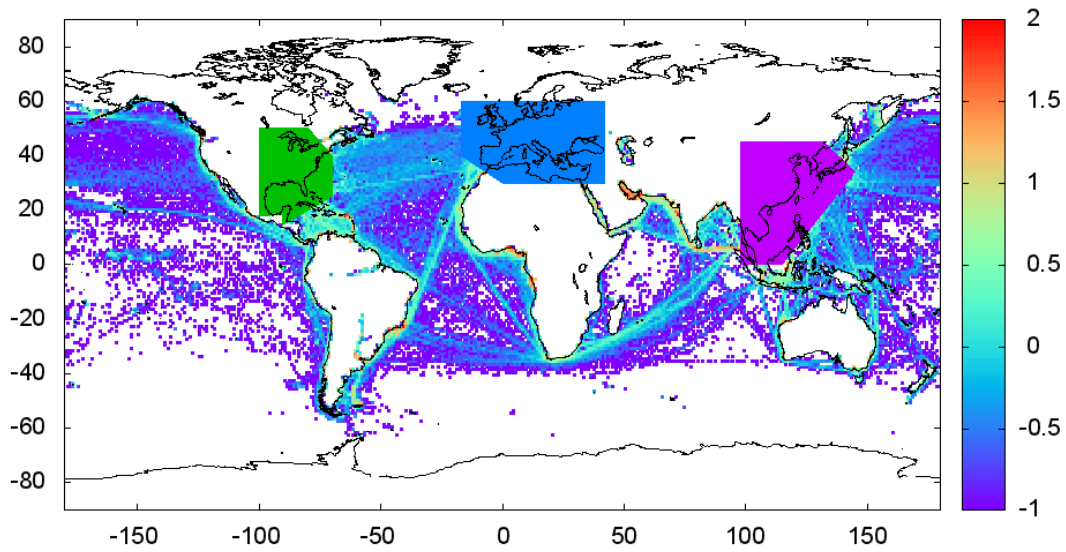
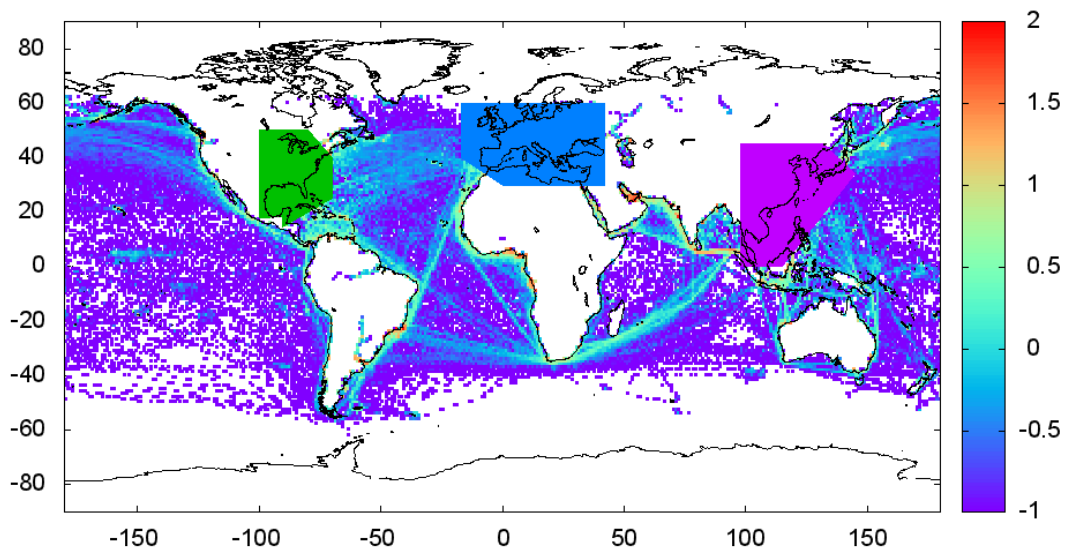*Figure 2.3   Vessel density map, March 2011*

Figure 2.4   Vessel density map, August 2011

There is another interesting change in the Pacific Ocean between January 2011 (Figure 2.5) and March 2011, Figure 2.3. The fleet seen near the equator at 150°W in the figures from March was located 15° further south and 20° further east in January. Half of the fleet had moved to the current position in February.
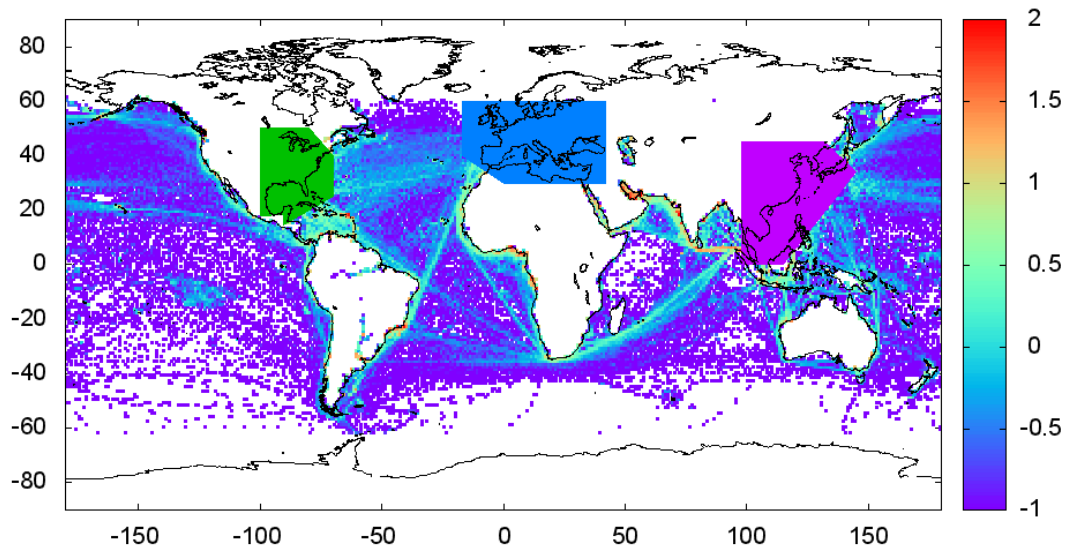
Figure 2.5   Vessel density map, January 2011

3   High vessel density traffic zones

The vessel lists in the high traffic zones are not based on satellite data, but on the other sources.
The Norwegian Coastal Administration has access to data from land, sea and air based platforms.
These platforms cover much of the Gulf of Mexico and Europe as shown in Figure 3.1. The
coverage is not continuous, but a couple of weeks of data usually give complete coverage.

See appendix A.2 to for commands to generate vessel lists in these areas. That program divides
these zones into cells of 1×1 degrees, and then attempts to detect missing data within each cell.
The final model is based on an average of each cell using only those days when there was data
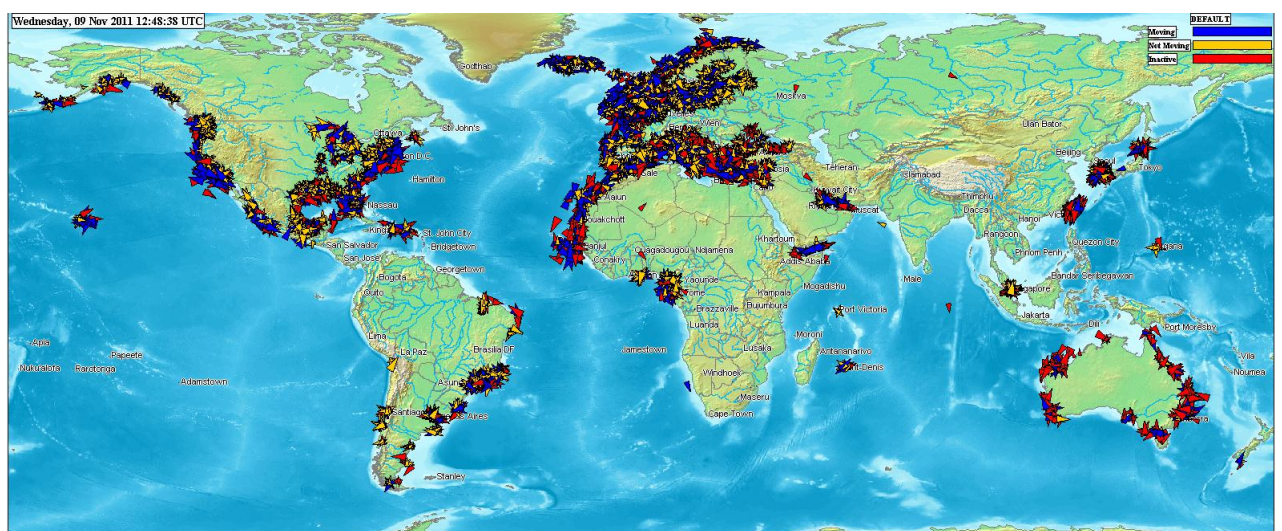available in the cell.

Figure 3.1   Land, sea and air based observations

South East Asia is the most difficult area to derive a traffic model for. The total number of vessels was assumed to be proportional to the Gross Domestic Product (GDP) for the costal nations in the region. The appropriate scaling factor was derived using known numbers for Europe and North America, which results in approximately 10.000 vessels in South East Asia area. These vessels were distributed along the vessel lanes seen in International Comprehensive Ocean-Atmosphere Data Set (ICOADS).

4   Transmitter characteristics

The AIS transponders do not necessarily transmit at the nominal frequency and power levels given in the specification[5]. This may be due to faulty equipment or incorrect installation. The receivers on AISSat-1 and ISS measure the received frequency shift and the signal strength of each message. This information can be used to derive distributions of transmitted frequencies and signal strengths.

4.1   Transmitted frequencies

To compute the transmitted frequency, it is necessary to know the relative velocity of the satellite with respect to the vessel and the received frequency. This relative velocity is used to compute the Doppler shift of the received signal, and thereby reconstruct the transmitted frequency from the received frequency.

A vessel's speed and course over ground introduces a small Doppler shift, which is at most 5Hz for a vessel moving at 20 knots. This together with Figure 4.3 and Figure 4.4 shows that the vessel speed can be ignored. Figure 4.1 gives the distribution of transmitted frequency offsets from the nominal AIS frequencies. It is based on vessels that were seen at least 10 times during a single pass and where the post fit residuals were less than 50Hz. The second peak at 300 Hz is detectable, but not nearly as prominent if the distribution is based on data from the South Pacific Ocean only. Figure 4.3 seem to indicate that there are at least three different major suppliers of AIS equipment. Two of these suppliers produce equipment that transmit at essentially the same frequency, but with different precisions. The last supplier's equipment transmits with high precision, but its transmission frequency is offset from the other two.

Figure 4.1   Distribution of transmitted frequency offset (Hz) for approximately 10,000 vessels using data from AISSat-1. The second peak at 300 Hz is seen in data from the receiver on ISS too.
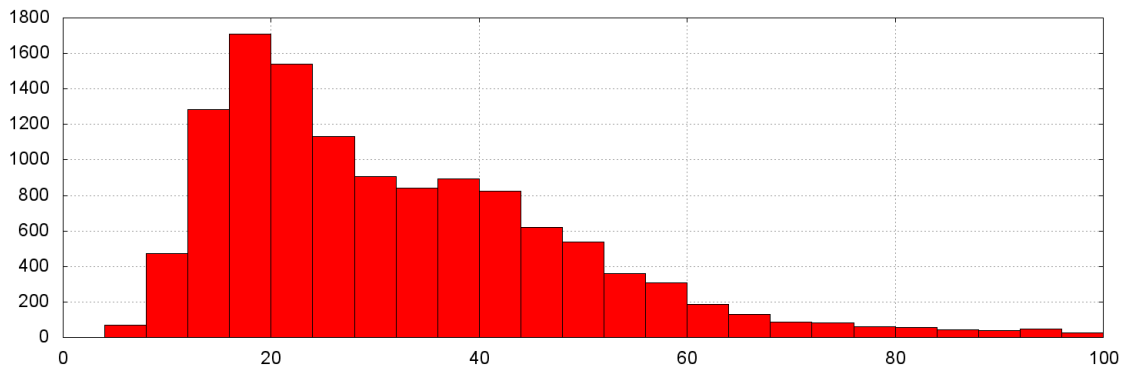

Figure 4.2   Distribution of standard deviations of the transmitted frequency (Hz) for the same vessels as those in Figure 4.1.
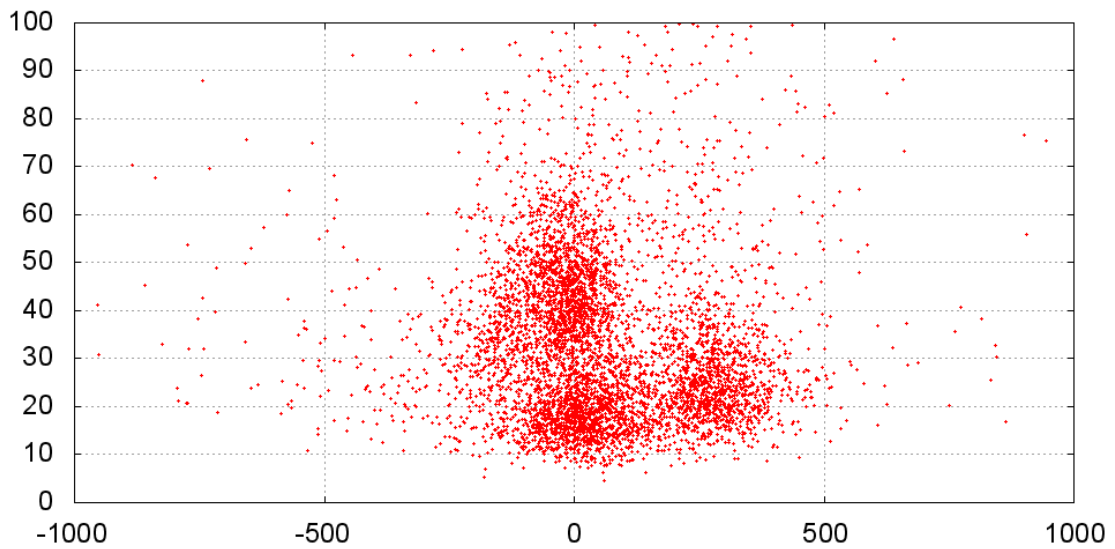

Figure 4.3   Plot of the standard deviation of the residuals (Hz) as function of the transmitted frequency offset (Hz).

4.2 Transmitted signal strengths

It is significantly more complicated to compute transmitted signal strengths using satellite measurements. There are several reasons for this:

The first problem is that the transmitting antenna patterns are not necessarily well known. It depends on the vessel orientation relative to satellite, antenna type and where the antenna is installed on the vessel. This information varies from vessel to vessel with sea state and time. This section assumes for simplicity that all transmissions utilize vertical $5/8\lambda$ dipole antennas (λ being the AIS signal wave length).

Fading caused by reflection from the sea requires knowledge about the sea state at the time of transmission, which is difficult to model globally. The magnitude of this effect is typically up to a couple of dB.

There are two effects associated with the ionosphere. Faraday rotation causes a variable polarization mismatch loss for linear polarized satellite antennas, and it depends on the Total Electron Content (TEC) in the ionosphere along the line of sight. This can be computed using global ionosphere maps publish by the Centre for Orbit Determination in Europe (CODE). They produce global maps every second hour and those maps can be used assuming a relatively stable ionosphere. Scintillation is even more difficult to take into account. Its effect on the received signal strength can be more than 10 dB, and it cannot be predicted analytically on even short timescales. Scintillation can best be described as a Nagakami-m[6] distribution, but its standard deviation varies strongly with the time of day and with geographic coordinates relative to the pole and sub-solar points.

Even though it is not possible to compute the transmitted signal strength for each message, it is still possible to estimate the transmission strength of some of the vessels:

- First select vessels in low traffic zones, since the distribution would be skewed towards vessels with high transmission powers in high traffic zones
- For each message subtract the satellite antenna gain from the received signal[2]
- Add free space loss
- Add the median value of polarization losses, which is 3dB for AISSat-1
- Subtract vessel antenna gain assuming a vertical $5/8\lambda$ dipole to find an estimate of the transmitted signal strength
- Assume that any remaining time dependent losses have a constant median value. This value determines the location of the peak in Figure 4.4, but does not change the shape of the distribution. The current traffic model has this value set to zero for simplicity.
- Collect all messages per vessels and select the message with the median signal strength for each ship

---

[2] AISSat-1 has been modeled using NEC-Win and the numerical antenna pattern has been compared to measurements of the antenna gain

Figure 4.4 shows the resulting histogram of transmission strengths per vessel using the above algorithm. This algorithm includes neither line nor filter losses, since the received signal strength measurements have been calibrated on ground to known transmission strengths. In other words, the receiver on AISSat-1 outputs the strength of the signal before any line or filter losses.
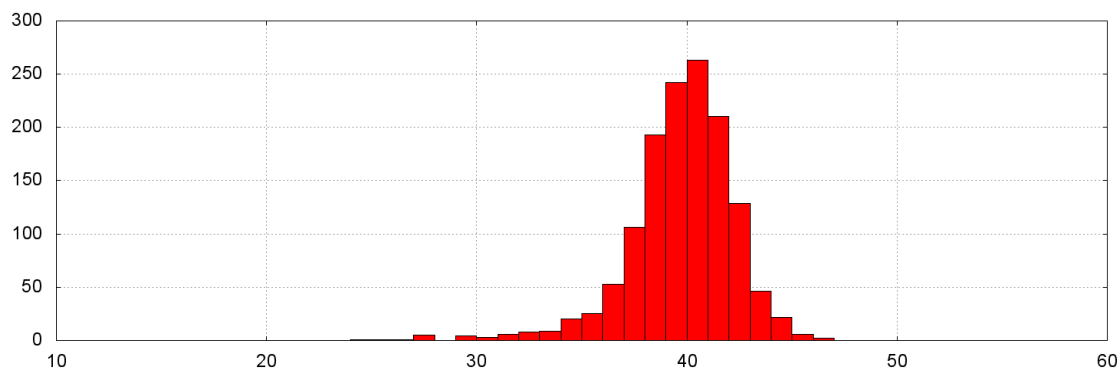

Figure 4.4   Histogram of transmission strengths (dBm) for approximately 1000 vessels

4.2.1   Link budget

The link budget should be computed as follows when using the current traffic model:

- Compute vessel antenna gain using the elevation of the satellite from the vessel
- Compute free space loss
- Compute Faraday rotation and thereby the polarization mismatch loss
- Subtract satellite line and filter losses
- Compute satellite antenna gain
- Model any remaining time dependent losses, but ensure that their median values are identical to the value used to derive the model, i.e. zero.

5   Global Vessel Traffic Model

The current vessel model has almost 64 000 active vessels worldwide, and the epoch of this model is July 2011. It is stored in a text file with 7 columns:

1. Latitude [-90°, 90°]
2. Longitude [0°, 360°]
3. Distance to coast (km)
4. Repetition rate (messages per minute)
5. Nominal transmission interval in slots
6. Transmitted signal strength (dBm)
7. Frequency offset of transmission (Hz)

Figure 5.1 illustrates the locations the vessels is this model. The commands used to create this model are given in section A.1 through A.3.
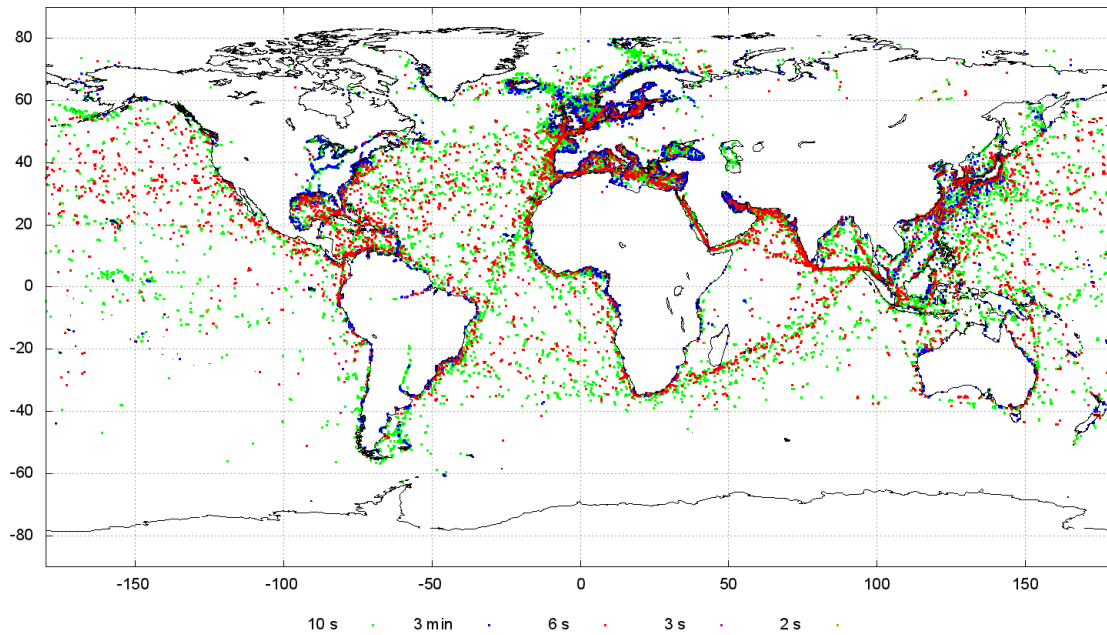
Figure 5.1   Traffic model color coded by repetition rate

5.1   Projecting the traffic model into the future

To estimate the performance of future AIS satellites, it is necessary to have traffic models that are relevant during the lifetimes of the satellites. There are several factors that affect the number of active AIS transponders. This section uses a set of common numbers and assumptions derived by FFI, Centre National d'Etudes Spatiales (CNES) and the European Space Agency (ESA).

In the short term, several regulatory changes will increase the number vessels sharply. Directive 2009/17/EF of the European Parliament [7] requires that all European fishing vessels larger than 15 must carry class A AIS transponders. It will be in force by May 2014. Approximately 9500 European Union fishing vessels fall under this regulation. We decided to assume that half of the vessels are out at sea during any given time. These vessels were added in waters near Europe and the north-western part of Africa, where most EU fishing vessels can be found.

Other regulatory changes in Europe and the Americas forces river vessels to carry class A AIS transponders. This adds approximately 8500 vessel in Europe and 6700 vessels in the Americas.

In the long term, economic growth and thereby increasing transport on the seas together with decreasing prices of AIS transponders should increase the number of commercial and leisure boats that carry class A transponders. We therefore expect to find different rates in different regions of the world, although finding correct rates are effectively impossible. For simplicity, we decided on low a growth scenario with 2% yearly growth in the open seas, 1% growth in littoral waters near Europe, North America and Japan and 3% growth in littoral waters elsewhere. The program *vessel_list_scale* scales vessel lists according to user selected regions and growth rates.

The vessel models for the year 2014, 2017, 2025 and 2032 contain respectively 86 000, 90 000, 101 000 and 114 000 vessels.
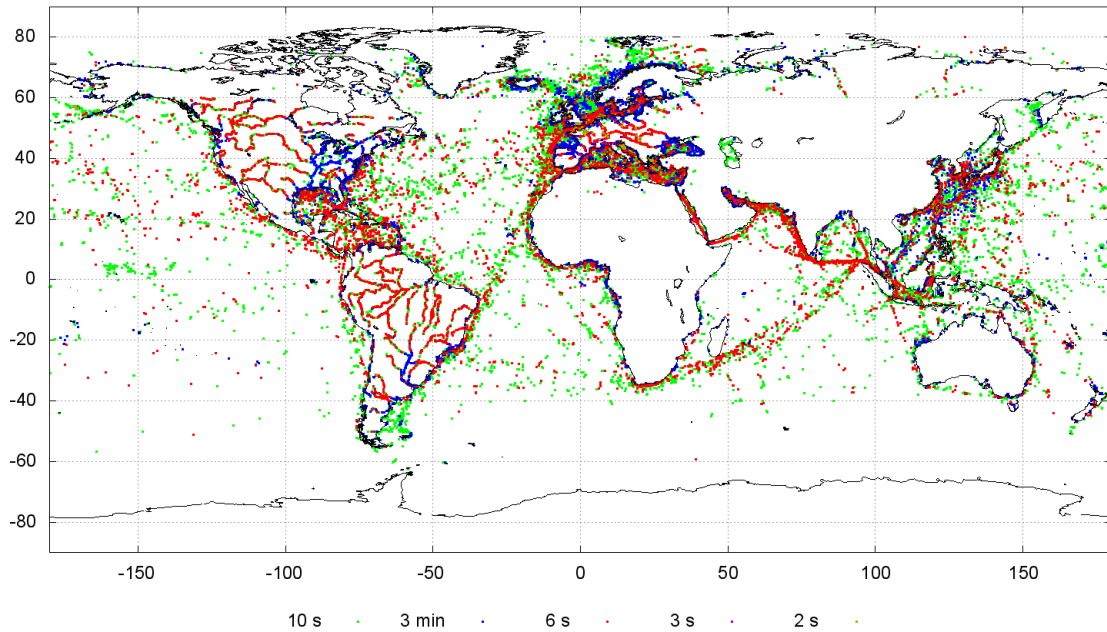

Figure 5.2   2025 traffic model color coded by repetition rate

5.2   Example of yearly variation

These vessel lists assume that the traffic conditions have no temporal variability. This is clearly not valid. Passenger vessels for example are much more likely to be out sailing during day than during the night. Seasonal weather conditions also affects where the vessels sail. Figure 5.3 through Figure 5.8 show average traffic densities during 2011 in the Norwegian and Barents Sea. These figures show the average number of vessels seen per day within cell of 1×1 arc minutes with a 10-based logarithmic color scale. These maps make use of AIS data recorded by AISSat-1.
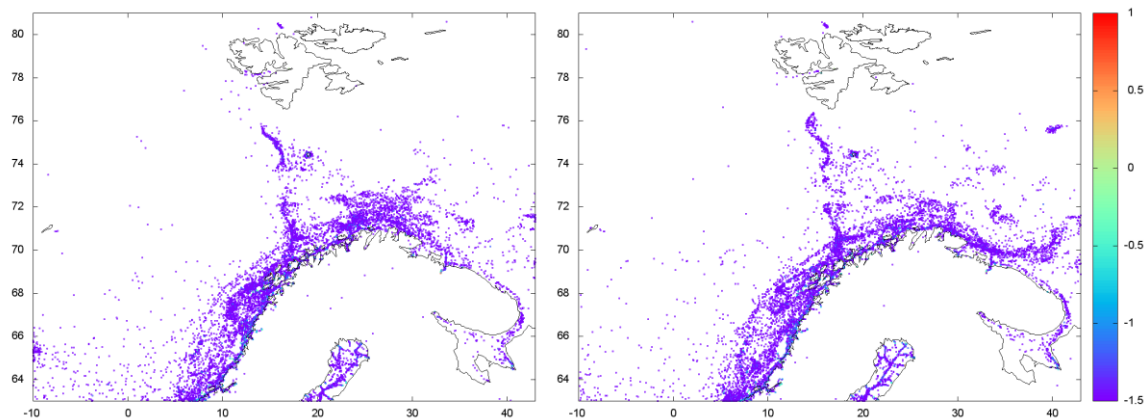

Figure 5.3   Vessel distribution in the Norwegian Sea during January and February
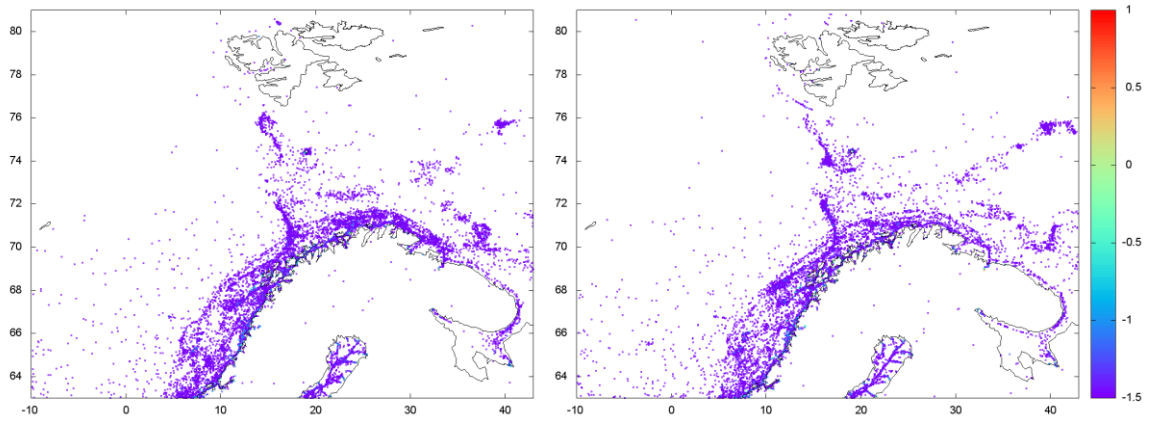
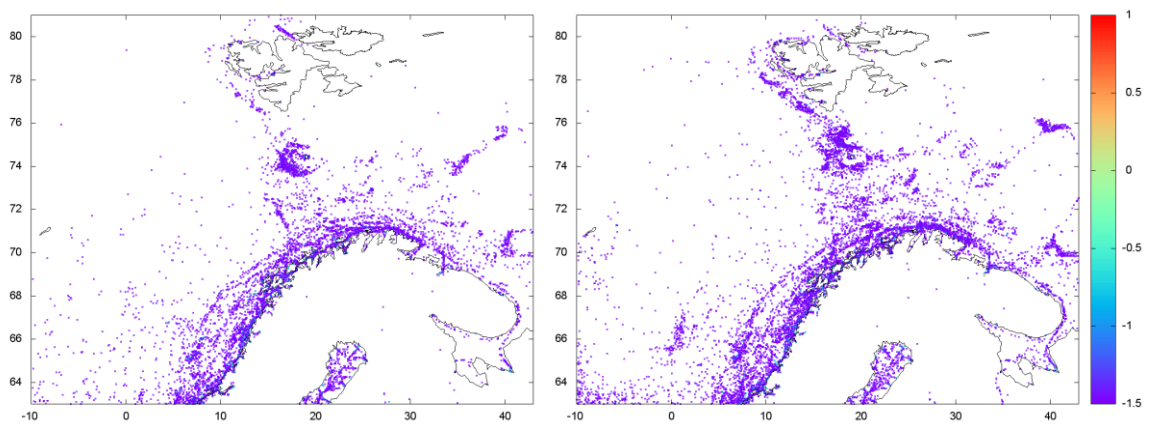*Figure 5.4   Vessel distribution in the Norwegian Sea during March and April*

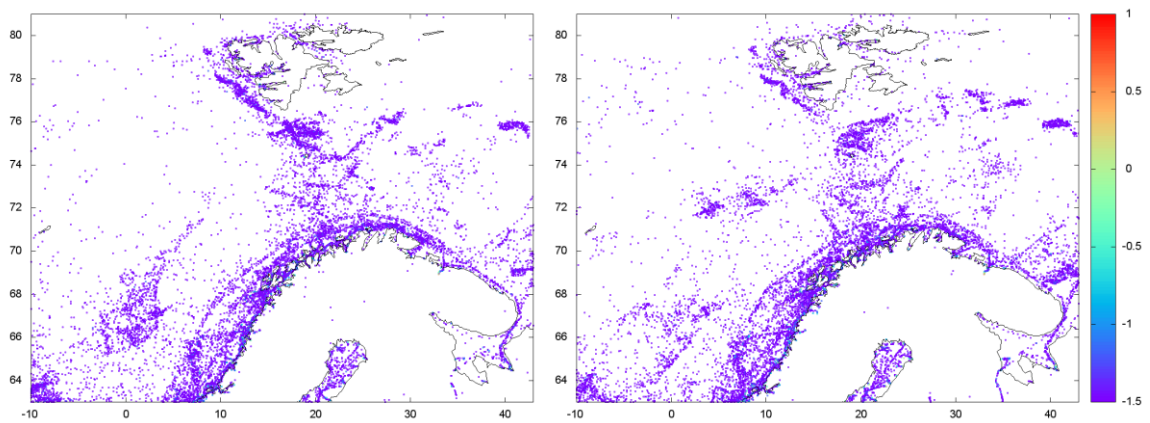*Figure 5.5   Vessel distribution in the Norwegian Sea during May and June*

Figure 5.6   Vessel distribution in the Norwegian Sea during July and August
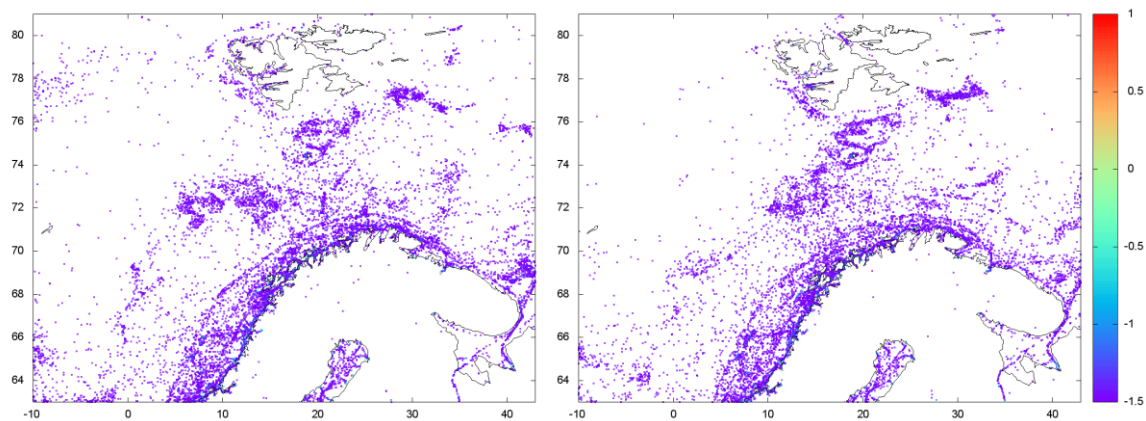
Figure 5.7   Vessel distribution in the Norwegian Sea during September and October
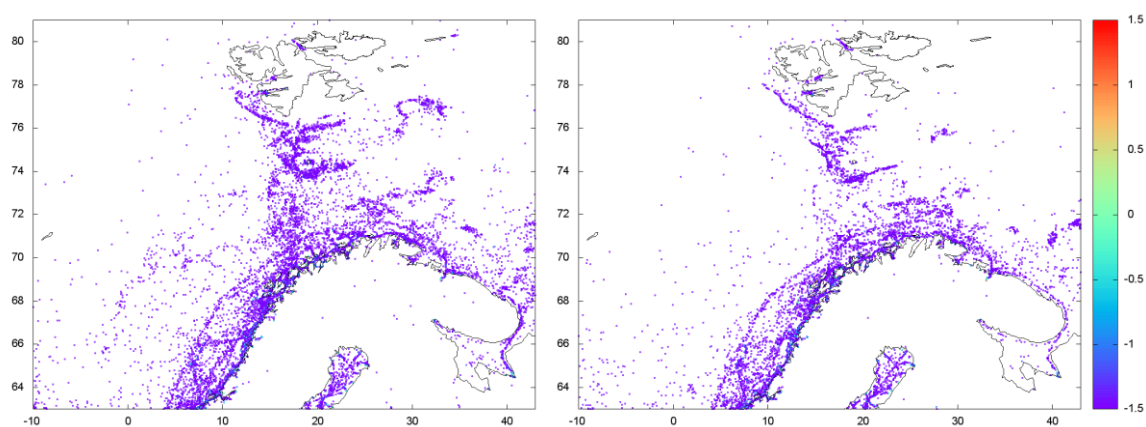

Figure 5.8   Vessel distribution in the Norwegian Sea during November and December

5.3   Class B vessels

Class B AIS equipment [5] can be used by any vessel not required to carry class A. This includes leisure boats and small fishing vessels. Class B transponders transmit at a lower power level than class A transponders and with a lower repetition rate. It is therefore not likely that AIS satellites detect a significant fraction of the number of class B vessels. Still, the transmissions from these vessels interfere with the reception of messages from class A vessels by AIS satellites. It is therefore necessary to have traffic models for these vessels too.

AIS data from AISSat-1, ISS and the Norwegian Coastal Administration show that most vessels with class B equipment stay close to the coast. The number of vessels with class B equipment varies significantly throughout the year and increases from year to year. It is therefore not possible to generate a single meaningful traffic model for class B vessels. The program *vessel_list_scale* was used to create class B lists by assuming a scaling factor of almost zero for the open seas and an appropriate factor near the coast to let the number of class B vessels be around 10% of the number of class A vessels. It was also used to generate lists with 10 000, 20 000 and 50 000 class B vessels.

6   Summary

This document provides a summary of the current distribution of AIS equipped vessels and estimates of future changes due to economic growth and regulation changes.

The model has approximately 64 000 vessels with class A equipment sailing at any given time. This increases to 86 400 in 2014 with most of the increase due to regulatory changes in Europe and North America. Assuming relatively slow growth and no further regulatory changes increases the number to 101 000 in 2025 and 114 000 in 2032.

Appendix A   Creating a vessel list

This appendix steps through the commands used to create the vessel lists, while Appendix B provides manuals for programs used in these steps.

A.1   Vessel density maps

The first two steps create a vessel list using AIS data, see chapter 2 and appendices B.1 and B.2.

$ sqlmap --idir /home/oyo --epoch 2011-03-01 10:00:00.000 --times 0 2678400 -iss --tle $(ls -m *tle)

$ vessel_list_sqlmap --idir /home/oyo --s density_map.txt --c coast_global.dat --dbm rssi.txt --fsi fsi.txt

The output will be a file called *vessel_list_sqlmap.list,* which covers the areas described in section 2.2. The figures in that section were generated using the plotting program *gnuplot* and the gnuplot script *plot_density.gp.* That script is included with the software in the examples folder.

A.2   High traffic zones

The following command (B.3) creates a vessel list of class B vessels:

$ vessel_list --ffiidir /home/oyo/ --a aisonline_classb_2011_24h.txt --dbm rssiv.txt --fsi fsi.txt --classB --vsl vessel_list_2011_classB.list --c coast_global.dat --s Active_last_24_hours_20110721_speed_00.tsv,Active_last_24_hours_20110721_speed_00_14.tsv,Active_last_24_hours_20110721_speed_14_23.tsv,Active_last_24_hours_20110721_speed_23.tsv

The result from the previous command is used when creating class A vessel lists for each of the high traffic zones (chapter 3). Only the command for Europe is given, since the commands for the other areas are almost identical:

$ vessel_list --ffiidir /home/oyo/ --a aisonline_europe_2011.txt --b vessel_list_2011_classB.list --dbm rssiv.txt --fsi fsi.txt --vsl vessel_list_2011_europe.list --c coast_global.dat --s Active_last_24_hours_20110721_speed_00.tsv,Active_last_24_hours_20110721_speed_00_14.tsv,Active_last_24_hours_20110721_speed_14_23.tsv,Active_last_24_hours_20110721_speed_23.tsv

A.3   Merging lists

The final vessel list for 2011 was put together by merging (B.4) the lists created in the previous steps.

$ vessel_list_merge --l vessel_list_sqlmap.list, vessel_list_europe.list, vessel_list_useast.list --vsl vessel_list_2011.list

A.4 Scaling vessel lists

It was necessary to scale (B.5) the 2011 vessel list to generate vessel lists for the years 2014, 2017, 2025 and 2032. All the commands to scale lists are similar:

$ vessel_list_merge   --v2 vessel_list_2011.list --f 1.19, 1.13 --dbm dbm.txt --fsi fsi.txt --c coast_global.dat --q polygon_developed1.plg,polygon_developed2.plg --vsl vessel_list_developing_2017.list

Appendix B   Software manuals

These programs have been compiled to run on Linux and Windows and must be executed from a command prompt. The only external dependency is the postgresql program *psql*, which must be installed in */usr/bin/* on Linux and in *C:\pgsql\bin* on Windows.

B.1   sqlmap

NAME
sqlmap - Creates a global vessel density map using AIS data from either AISSat-1 or the ISS

SYNOPSIS
sqlmap [OPTIONS...]

DESCRIPTION
This program creates vessel density maps using AIS data from either the ISS or from AISSat-1. It generates two types of output, which are both used by the program "vessel_list_sqlmap":

1) A text file that contains global density maps for different repetition rates. This file will be called "density_map.txt".
2) A set of files for each 1x1 degree cell that contains at least one detected vessel. These files count the number of vessels within the cells and where they were seen with a resolution of 1x1 arc minute. It is necessary to create a folder named "maps" in the working folder before running this program.

OPTIONS
 --idir <install prefix>

>   Path to where the Heliosat2 tools, libraries and data are installed. It can be set through the environment variable HSIDIR.

--wdir <work directory>

>   Work directory, which can be set through the environment variable HSWDIR. It will default to the directory from which the program was called.

--epoch <date and time>

>   Epoch (UTC) from which all internal calculations is referenced. The recommended format is:

>   "yyyy-MM-dd hh:mm:ss.zzz"

>   The execution of the program will stop if the date and time cannot be parsed.

--times <ti tf>

>   Start and stop time in seconds since the epoch.

--tle <file1, ..., fileN>

        A comma separated list of two line TLE files, which will be use to propagate the orbit over the interval defined by the previous options.

--iss

        Use AIS data from ISS instead of data from AISSat-1, which is the default.

--fl

        Make the field of view box a rectangle with the longest side along the ground track and as long as possible,

--h

        This help information

COPYRIGHT INFORMATION

B.2 vessel_list_sqlmap

NAME

vessel_list_sqlmap - Creates a vessel list using the output from the program *sqlmap*

SYNOPSIS

vessel_list_sqlmap [OPTIONS...]

DESCRIPTION

This program takes the output from sqlmap and creates a vessel list outside high traffic zones

OPTIONS

--idir <install prefix>

>Path to where the Heliosat2 tools, libraries and data are installed. It can be set through the environment variable HSIDIR.

--wdir <work directory>

>Work directory, which can be set through the environment variable HSWDIR. It will default to the directory from which the program was called.

--ffiidir <install prefix>

>Path to where AISDET2 is installed. It defaults to the value set by --idir. It can also be set through the environment variable FFIIDIR.

--s <file>

>Result from sqlmap, i.e. "density_map.txt"

--c <file>

>Global coastline file

--dbm <file>

>The first column of this file must contain a list of transmitted signal strengths (dBm). It will be used to create a similar distribution of transmitted signal strengths for the final vessel list. The file does not have to be sorted.

--fsi <file>

>The first column of this file must contain a list of frequency transmission offsets (Hz). It will be used to create a similar distribution of transmission offsets for the final vessel list. The file does not have to be sorted.

--h

>This help information

B.3   vessel_list

NAME

vessel_list - Creates a vessel list using different sources

SYNOPSIS

vessel_list [OPTIONS...]

DESCRIPTION

This program creates a vessel list with frequency offsets and transmission strengths using either old AISDET vessel lists or export files retrieved from aisonline.com.

OPTIONS

--ffiidir <install prefix>

> Path to where AISDET2 is installed. It can also be set through the environment variable FFIIDIR or through --idir.

--v1 <file1, ..., fileN>

> Comma separated vessel list file, v1.0

--a <file>

> A file with a polygon and a list of export files from aisonline.com. The export files must contain IMO/MMSI number, latitude and longitude for each vessel. The first two lines in these export files must define the number of vessels in the file and a header, which is not used by this program. The software comes with examples of valid files. It is necessary to clean up the files on Linux:

```
for file in *.tsv
do
echo $file
sed -ie 's/.$//' $file
sed -ie 's/°/_/g' $file
sed -ie '/^$/d' $file
done && rm -f *.tsve
```

--b <file>

> This optional vessel list (v2.0) is used to remove class B vessels from the generated vessel list.

--s <file1,file2,file3,file4>

Comma separated list of files used to distribute the list into vessels at rest, speed below 14knots, speed between 14 and 23 knots and speeds above 23 knots. These files must be set when using the --a option. The format must be the same as the export files provided through the --a option.

--c \<file\>

Global coastline file required by --a option.

--dbm \<file\>

The first column of this file must contain a list of transmitted signal strengths (dBm). It will be used to create a similar distribution of transmitted signal strengths for the final vessel list. The file does not have to be sorted.

--fsi \<file\>

The first column of this file must contain a list of frequency transmission offsets (Hz). It will be used to create a similar distribution of transmission offsets for the final vessel list. The file does not have to be sorted.

--vsl \<file\>

Name of new vessel list

--classB

Force the new vessel list to be a list for class B vessels

--h

This help information

COPYRIGHT INFORMATION

Copyright (C) 2002 -, Øystein Olsen, dr.scient.
Contact information: oystein.olsen@ffi.no

B.4 vessel_list_merge

NAME

vessel_list_merge - Merges vessel lists into a single list

SYNOPSIS

vessel_list_merge [OPTIONS...]

DESCRIPTION

This program merges several vessel lists into a single vessel list.

OPTIONS

--l <file1, ..., fileN>

> A comma-separated list of vessel list files (v2.0). These vessel files start with a polygon that defines where this list is valid, and the order if this argument is important since any vessels within the polygons in file2, ..., fileN will be removed before these files are loaded.

--a <file1, ..., fileN>

> Append these vessel files to the result of --l

--vsl <file>

> Name of new vessel list

--h

> This help information

COPYRIGHT INFORMATION

Copyright (C) 2002 -, Øystein Olsen, dr.scient.

Contact information: oystein.olsen@ffi.no

B.5 vessel_list_scale

NAME

vessel_list_scale - Scales a vessel list.

SYNOPSIS

vessel_list_scale [OPTIONS...]

DESCRIPTION

vessel_list_scale is used to scale a vessel list with a specific fraction. If this fraction is less than 1.0, each vessel will be kept with a probability equal to the fraction.

OPTIONS

--v1 <file1>

> Vessel list file, v1.0

--v2 <file2>

> Vessel list file, v2.0

--f <val1(, val2)>

> One or two comma separated scaling factors. Using two factors tells this program to use the first factor within 200nm from the coast and second factor beyond 200nm. Two factors require therefore the option --c

--dbm <file>

> The first column of this file must list transmission strengths (dbm) for a set of vessels. It does not have to be sorted. This option is only used if any of the scaling factors are larger than 1.0.

--fsi <file>

> The first column of this file must list transmission frequencies (Hz) for a set of vessels. It does not have to be sorted. This option is only used if any of the scaling factors are larger than 1.0.

--c <file>

> Global coastline file

--p <file>

> This program will remove all vessels outside this polygon if set.

--q <file1,file2, ... , fileN>

> This program will remove all vessels inside these polygons if set.

--r <val1 val2 val3 val4 val5>

        Force distribution of repetition intervals. This is optional and only used with --v1. It will be overwritten if --classB is set.

--classB

        Force the vessel list to be class B.

--vsl <file>

        Name of new vessel list

--h

        This help information

COPYRIGHT INFORMATION

Copyright (C) 2002 -, Øystein Olsen, dr.scient.

Contact information: oystein.olsen@ffi.no

Bibliography

[1] Øystein Olsen, "AISDET 2.0 User manual" in FFI report 2011/02300, 2011/07/01.

[2] Knut Svenes, Torkhild Eriksen, Andreas Nordmo Skauen, and Øystein Olsen, "SAT-AIS modeling in preparation for Phase B1 studies report - evaluation of a nanonsat option for ESA's SAT-AIS initiative" in *FFI report 2012/00065*, 2012/01/12.

[3] Øystein Olsen, "ESPAIS AIS System Study - Payload Performance Analysis Report", 2010/02.

[4] Øystein Olsen, "ESPAIS AIS system Study - Maritime traffic Characterization", 2010/02.

[5] "Technical characteristics for an automatic identification system using time-division multiple access in the VHF maritime mobile band" in Recommendation ITU-R M.1371-4 ITU, 2010/04.

[6] Robert K.Crane, "Ionospheric Scintillation".

[7] "Directive 2009/17/EF of the European Parliament", 2012/04/23.