ASTD Data

The [Cooperative Agreement among the Arctic States Regarding Arctic Ship Traffic Data Sharing](#) outlines access to ASTD and use of its data.

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1.1: Prepared in January 2019.
1.2: Updated in April 2020
1.3: Updated in January 2021.

ASTD Data

The ASTD Database contains information from three main data sources. They are:

- AIS information from ships operating in the Arctic, collected by satellites and land stations from Norway and USA. With the AIS information, data can be sought from other data sources and fed to ASTD.
  - IHS Database: Since 1760 Lloyds Register collected information on ships. Lloyds Register maintained a collective ship registry. In 2009 IHS acquired Lloyds Register. IHS Fairplay is a company servicing the IMO for a database of ships. The AIS information contains *IMO numbers.* An IMO number is a unique number to each ship. The IMO ship identification number scheme was introduced in 1987 as a measure to enhance ship safety and security. It assigned a permanent number to each ship for identification purposes. That number would remain unchanged through the ships life. These numbers appear on Port State Control required ships documentation such as the CSR – Continuous Synopsis Record, ISM and ISPS certificates.
  - DNV-GL: Information from DNV-GL on fuel has been correlated into ASTD.

AIS DATA

IHS FAIRPLAY & DNV GL
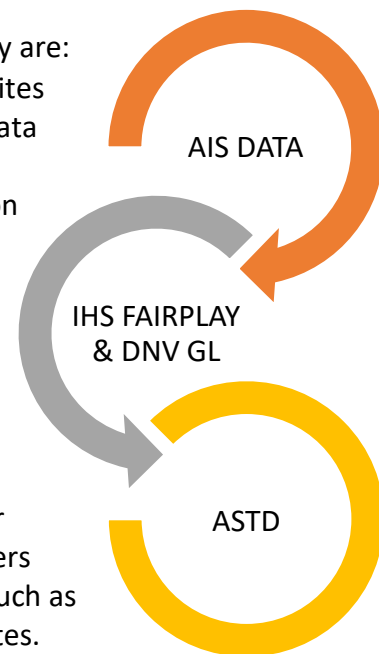
ASTD

ASTD Data Access Levels

ASTD data is provided on three access levels, Level I, Level II and Level III

ASTD DATA - LEVEL COMPARISON				
	Level 1	**Level 2**	**Level 3**	*Note*
mmsi	YES	NO	NO	*MMSI Number*
imonumber	YES	NO	NO	*IMO Number*
shipid	NO	YES	YES	*Ship number in the file downloaded. Unique to each month - not the whole year.*
date_time_utc	YES	YES	YES	*Date of signal*
vesselname	YES	NO	NO	*Name of vessel*
flagname	YES	YES	YES	*Flag of the ship or ship registry*
iceclass	YES	YES	YES	*Ice class*
astd_cat	YES	YES	YES	*Ship type according to the ASTD Category where over 200 ship types are aggregated to 13 ship types. Click this link to read more.*
lloyds3_cat	YES	YES	NO	*Ship types according to Lloyds/IHS Category 3 where over 200 ship types are aggregated to around 50 ship types.*

lloyds5_cat	YES	NO	NO	*Ship types according to Lloyds/IHS Category 5 - A detailed list of over 200 ship types where each ship is identified.*
sizegroup_gt	YES	YES	YES	*Size (7 groups)*

Size groups are: **1:** *<1000 GT* **2:** *1000-4999 GT* **3:** *5000-9999 GT* **4:** *10000-24999 GT* **5:** *25000-49999 GT* **6:** *50000-99999 GT* **7:** *>= 100000 GT*

fuelquality	YES	YES	YES	*Type of fuel used (6 categories)*

Fuel types are: *Note: Fuel data after 1 Jan 2020 are not 100% accurate due to new fuel definitions.*   0 = Distillate marine fuel (MGO/MDO)   1= Residual marine fuel and heavy distillate (ISO-F-10 - 80)   2= Residual marine fuel (IFO-F-80 - 180) Heavy fuel oil   3= Residual marine fuel (IFO-F-180 - 380 or above) Heavy   4= Liquide gas propelled ships (LNG)   5=Battery power

fuelcons	YES	YES	YES	*Fuel Consumption*
co	YES	YES	YES	*Carbon monoxide*
co2	YES	YES	YES	*Carbon dioxide*
so2	YES	YES	YES	*Sulfur dioxide*
pm	YES	YES	YES	*Particulate matter*
nox	YES	YES	YES	*Nitric oxide*
n2o	YES	YES	YES	*Nitrous oxide*
nmvoc	YES	YES	YES	*Non-methane volatile organic compounds emission*
ch4	YES	YES	YES	*Methane*
blackcarbon	YES	YES	YES	*Black carbon*
organiccarbon	YES	YES	YES	*Organic carbon*
oilbilgewater	YES	YES	YES	*Oily Bilge Water*
blackwater	YES	YES	YES	*Blackwater*
greywater	YES	YES	YES	*Greywater*
garbage	YES	YES	YES	*Garbage*
dist_nextpoint	YES	YES	YES	*Distance to next point*
sec_nextpoint	YES	YES	YES	*Seconds to next point*
longitude	YES	YES	YES	*Longtitude*
latitude	YES	YES	YES	*Latitude*
Example: December 2013 Download:				
File format	ZIP	CSV	CSV	*Format downloaded from ASTD*
File size	258 mg (1,97 gb)	1,69 gb	1,58 gb	Size of file downloaded

What is AIS

Automatic Identification Systems (AIS) is technology onboard ships to provide information about the ships type, position (recorded every 6 minutes in ASTD), course, speed, navigational status and other safety-related information. The information is sent automatically to appropriately equipped shore stations, other ships and to satellites. This information is fed into the ASTD Database.

IMO regulation 19 of SOLAS requires AIS to be fitted aboard all ships of 300 gross tonnage and upwards engaged on international voyages; cargo ships of 500 gross tonnage and upwards not engaged on international voyages; and all passenger ships irrespective of size. The requirement became effective for all ships by 31 December 2004.

AIS Class A and B

Two types of AIS transponders are available, Class A and Class B. Class B transponders have been developed to provide the safety and navigation benefits of AIS to smaller vessels with lower cost and simpler installation when compared to Class A. The signal from Class A is stronger and therefore picked up by more land-based stations or Satellite-AIS. Class B also sends fewer messages.

The frequency of AIS signals from Class A depends on the ships position and speed. For example, a ships at the speed of 23 knots sends signals every 2 seconds, whilst ships sailing on between 0-14 knots sends a signal every 10 seconds. AIS receivers vary, but Class A transponders are prioritized to Class B. Therefore, signals from Class B are not recorded as frequently – its signal is only picked up when there is room on the AIS channel receiving the signals. However, the frequency is still very high and very adequate for safety of smaller ships.

AIS signals from all ships is included in ASTD.

AIS Limitations

AIS data in the ASTD system does not cover 100% of all ship traffic, but data quality is very high. This has been confirmed by comparing data from other sources, including national collected information. Identifying smaller pleasure craft and fishing vessels can be challenging because of limitation ion registries and AIS information.

Numerous factors can affect AIS messages, including:
- Technical failure due to faulty infrastructure (vessel and data flow).
- Erroneous onboard installation (vessel infrastructure)
- Problems with data links/networks
- AIS signals being manipulated
- Data noise
- Challenges regarding data coverage
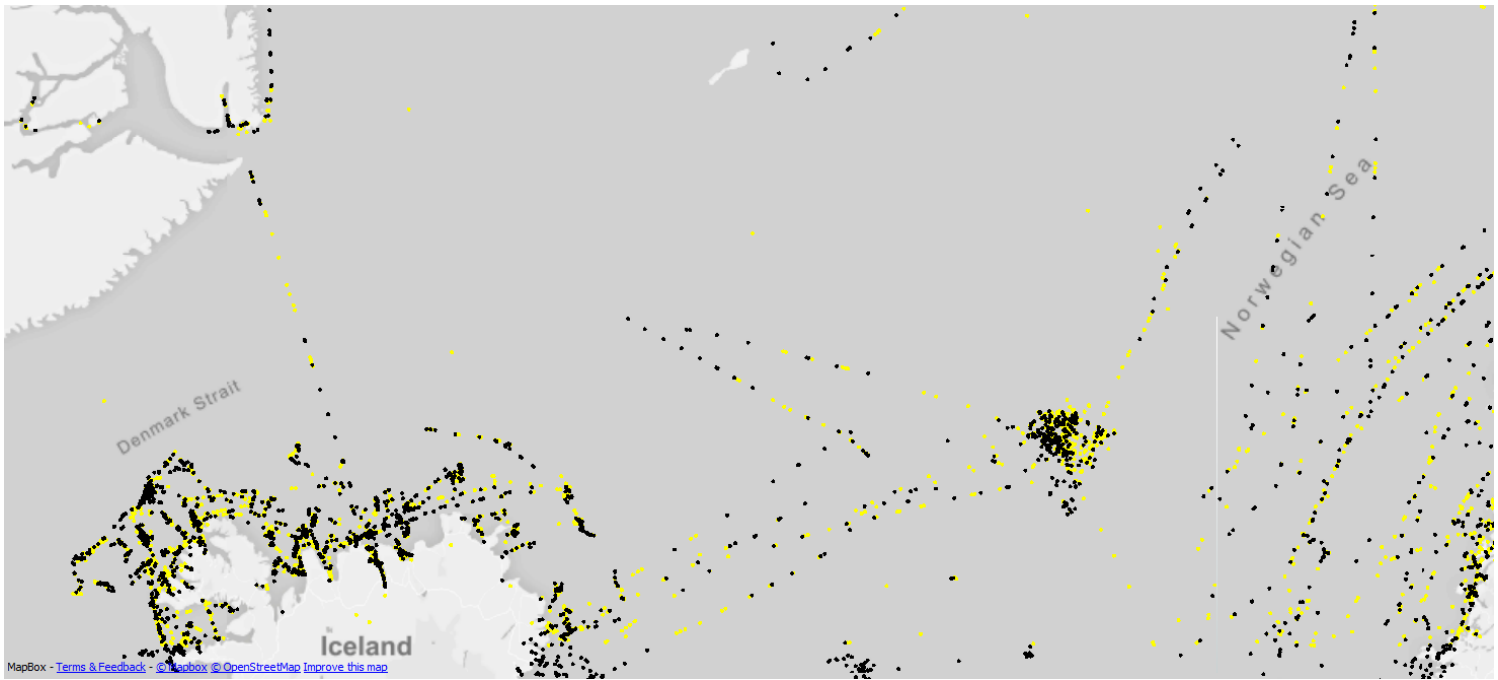
ASTD Data Collection

The data in ASTD is provided by Norway and USA. Norway has around 50 AIS land-based stations that collect AIS signals, collecting information to around 40-60nm from the coast. These base-stations are located along the Norwegian coastline and in Svalbard. Norway also collects information with four AIS-satellites. USA also provides data for ASTD with 19 satellites orbiting the Arctic. Data in the ASTD is supplemented with information from other data sources, including IHF information about ships, and information from DNV-GL.
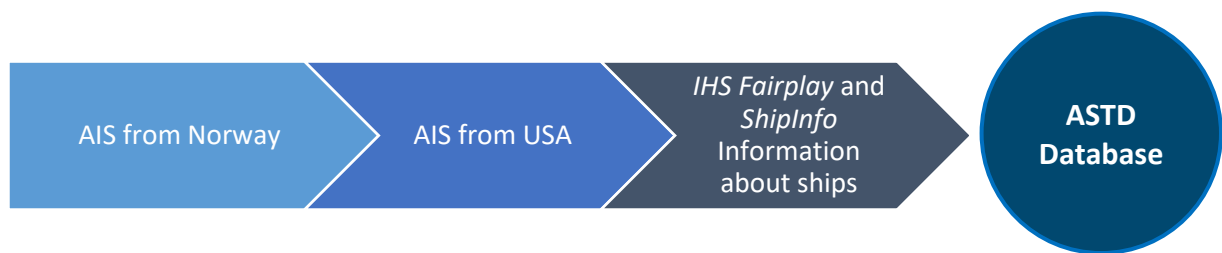
The image below shows how the data from USA (yellow dots) supplement the Norwegian data (black dots) to give ASTD a more detailed coverage – therefore providing more accurate information.

ASTD Data quality/accuracy

The data in ASTD is very accurate. The data collected is vast, hundreds of gigabytes every year. Approximately 4 million records are added to the database every 24 hours. As outlined above, AIS signals are not 100% accurate, there are many variables which effect databases like ASTD. There are many other data sources like ASTD, and when comparing data between them, the information might not be 100% aligned. This could for example be differences in satellites who collect AIS signals. However, data quality in ASTD is _very high_.

Ice data is collected from National Show and Ice Data Center (NSIDC) and processed by the NCA to fit the purpose. Data is collected on a monthly basis.

Data calculations

Certain data in ASTD is based on calculations with algorithms inserted to the database. These algorithms were prepared in a very comprehensive work by Norway when information from thousands of ships operating in the Arctic was collected.

This includes all the information in the _Statistics_ section in _Arctic area traffic_.

One example is statistics on fuel consumption. The calculation is prepared for _each ship_. The algorithm utilizes the information from AIS to determine the engine the ship uses, find its KW numbers, adds the speed the vessels travels and calculates the fuel consumption. Where the fuel type is unknown, it is filled in by looking at a "sister ship" or similar ships (RPM engine).

The fuel consumption is also used to calculate information about emissions from ships. The box to the right shows how emissions are calculated. ASTD has many types of emissions from ships and is capable of showing these emissions in a certain time and for certain areas.

Ship types aggregation

Asa a main rule, ships need to be registered to be eligible to navigate. Each ship is designated a ship type. ASTD utilizes the IHS Markit StatCode 5 Shiptype Coding System to categorize ship types. IHS has 5 category levels which are then aggregated from around 230 ship types to 15.

For example, level 5 of the IHS Fairplay information has over 10 different types of chemical tankers, including Vegetable Oil tanker and Wine tanker. This information is aggregated to Chemical tankers in the ASTD ship types.

$$E_{i,j} = \sum_{t=0}^{t=n} \left(\left(P_{ME_i} * \left(\frac{SOG_{i,t}}{V_{max_i}} \right)^3 * EF_{ME_{j,k,l,m}} + D_{AE_{p,i}} * EF_{AE_{j,k,l,m}} + D_{BO_{p,i}} * EF_{BO_{j,m}} \right) * 1 \text{ hour} \right)$$

Where:

i = ship

j = pollutant

t = time (operating hour, h)

k = engine type

l = engine tier

m = fuel type

p = phase

$E_{i,j}$ = emissions (g) for ship i and pollutant j

P_{ME_i} = main engine power (kW) for ship i

$SOG_{i,t}$ = speed over ground (knots) for ship i at time t

V_{MAX_i} = maximum speed (knots) for ship i

$EF_{ME_{j,k,l,m}}$ = main engine emission facor (g/kWh) for pollutant j, engine type k, engine tier l, and fuel type m

$D_{AE_{p,t}}$ = auxiliary engine power demand (kW) in phase p for ship i

$EF_{AE_{j,k,l,m}}$ = auxiliary engine emission factor (g/kWh) for pollutant j, engine type k, engine tier l, and fuel type m

$D_{BO_{p,i}}$ = boiler power demand (kW) in phase p for ship i

$EF_{BO_{j,m}}$ = boiler emission factor (g/kWh) for pollutant j and fuel type m

However, when downloading data, users with access of level 1 can get the information in Ship Type Level 5, and therefore analyse quite specific ship types. That availability is dependent on user rights.

A document that shows how the ship types are aggregated has been produced.

[The Ship type document is available to download here.](#)

Working with data

If data is downloaded - ASTD requires GIS analysis experts to work with data from the system.

Those who have access to ASTD can download data for analysis. The data can be downloaded on different formats, but .CSV is the most common format. CSV stands for comma-separated values and is a delimited text file that uses a comma to separate values. A CSV file stores tabular data in plain text. Each line of the file is a data record. Each record consists of one or more fields, separated by commas. Each .csv file can contain millions of rows and can be very large, up to many gigabytes in size. Smaller .csv files can be opened with Excel, but others require specialized programs to work with them, like CSV Explore, Python or SQL databases like MySQL and PostgreSQL. This work requires not only a data expert, but a powerful computer as well.

Keep this in mind when downloading large amounts of data.

However, smaller datasamples can be downloaded by regular users, not specific GIS experts, and analysed with Excel. One has to download data and convert from CSV but from there analysis can be performed.

Cleaning up data

 Please note that specific corrections are needed after downloading data to have as correct data as possible.

Satellites in orbit randomly pick up signals from far away, outside the Arctic area, if the atmospheric conditions are applicable. In the prefixed reports made directly from the system, we have filtered out all signals with less than 10 positions in one month. This means that ships with sailing time less than one hour in a whole month are filtered out and therefore not included in the report. This has very limited effects for the reports as most of the signals are from random ships that satellites pick up outside the area.

Please be aware that when downloading data you need to do this cleanup yourself as you are downloading raw data. We recommend cleaning up positions of less than 10 positions each month.

This pie chart is an example of data from a data provider. It shows that 42,9% of the data is from ships with less than 10 positions in one month. A large majority of this are signals picked up by error. Hence, filtering (clean-up) is needed before using the data for analysis.

# of positions per unique MMSI-201901-661
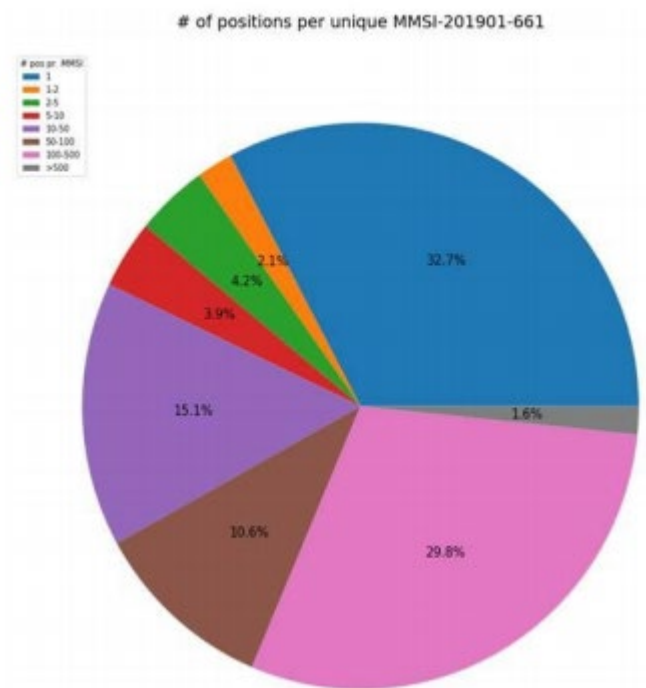
Citations

When using data from ASTD, this citation can be used:

PAME - Arctic Ship Traffic Data. (insert date when data is collected). Retrieved from ASTD.is.

Sources:

- http://www.imo.org/en/OurWork/Safety/Navigation/Pages/AIS.aspx
- https://www.oceantimemarine.com/class-a-and-class-b-automatic-identification-system-ais/