

The European Commission's science and knowledge service

Joint Research Centre

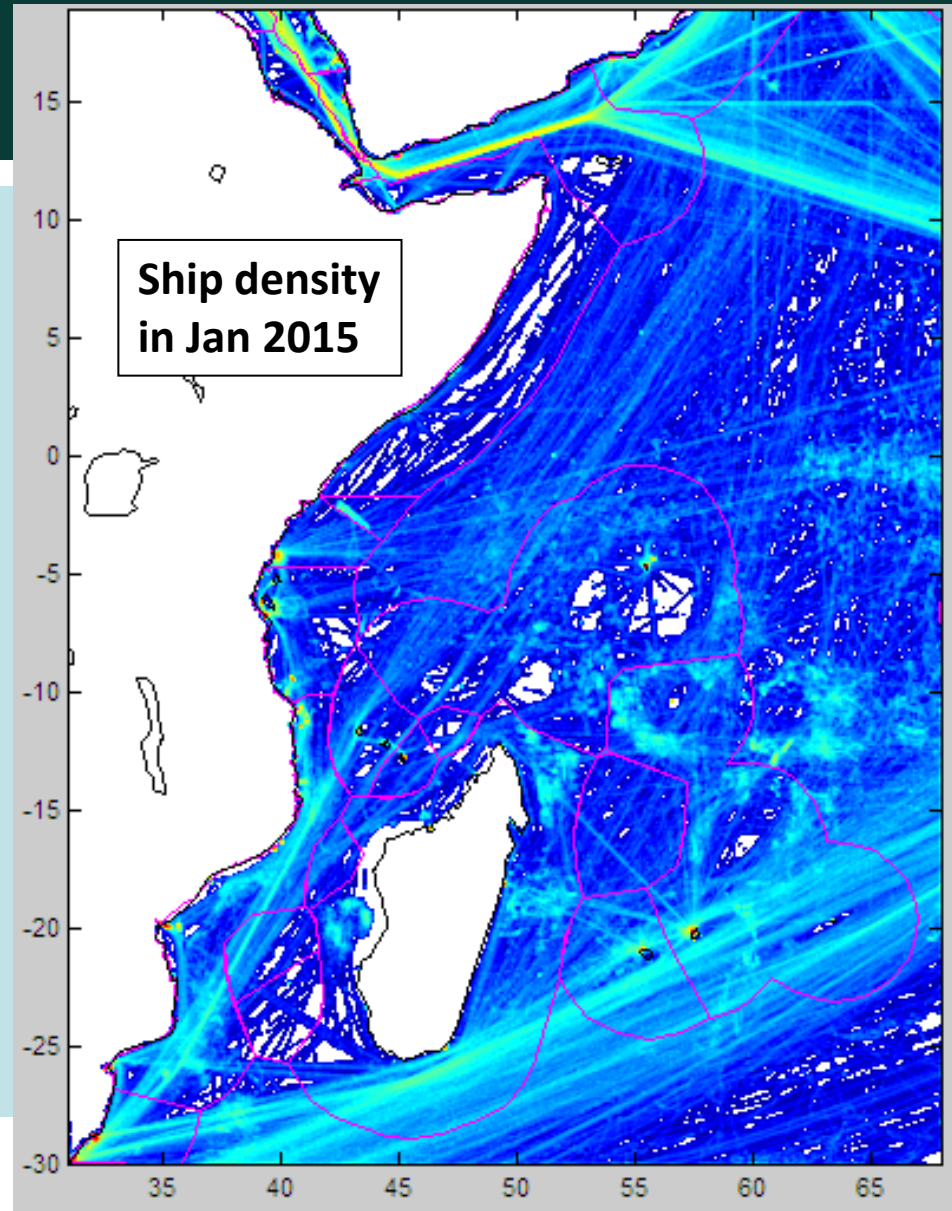
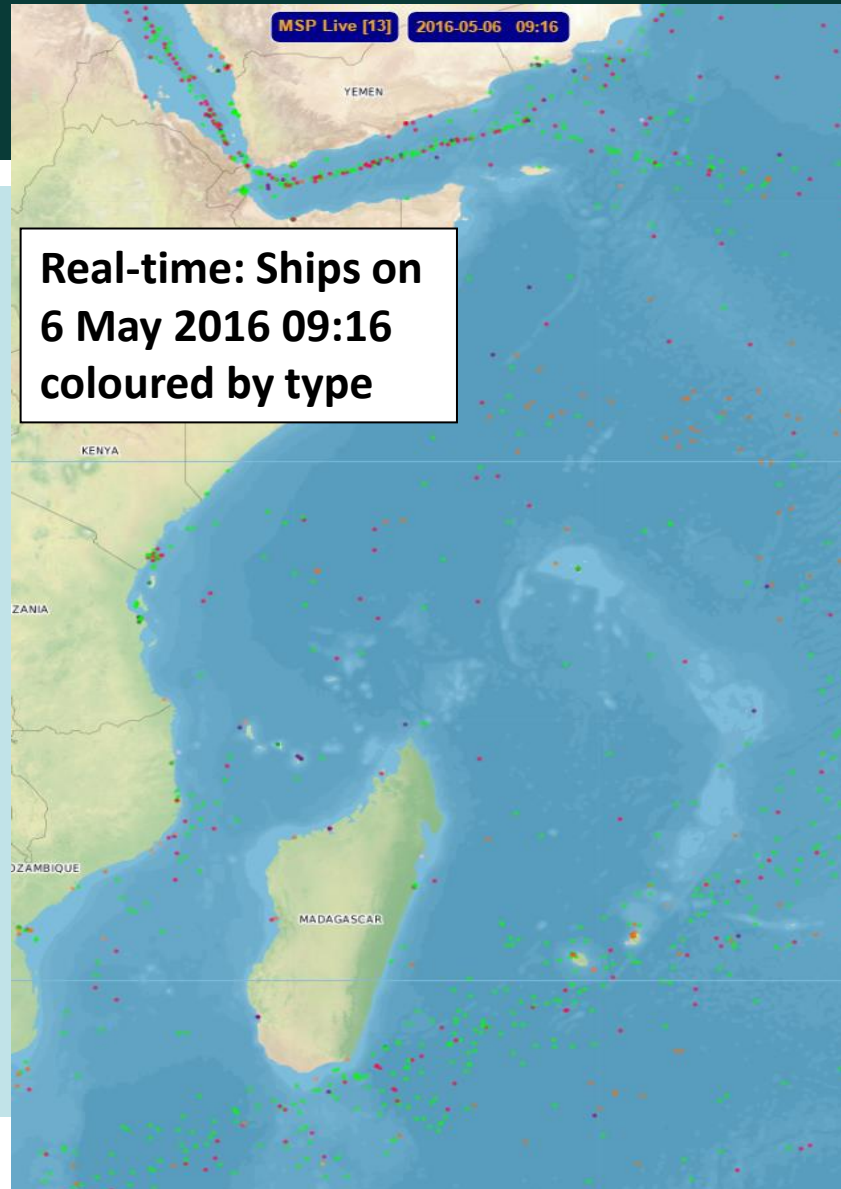


Challenges in using AIS data to make ship density maps

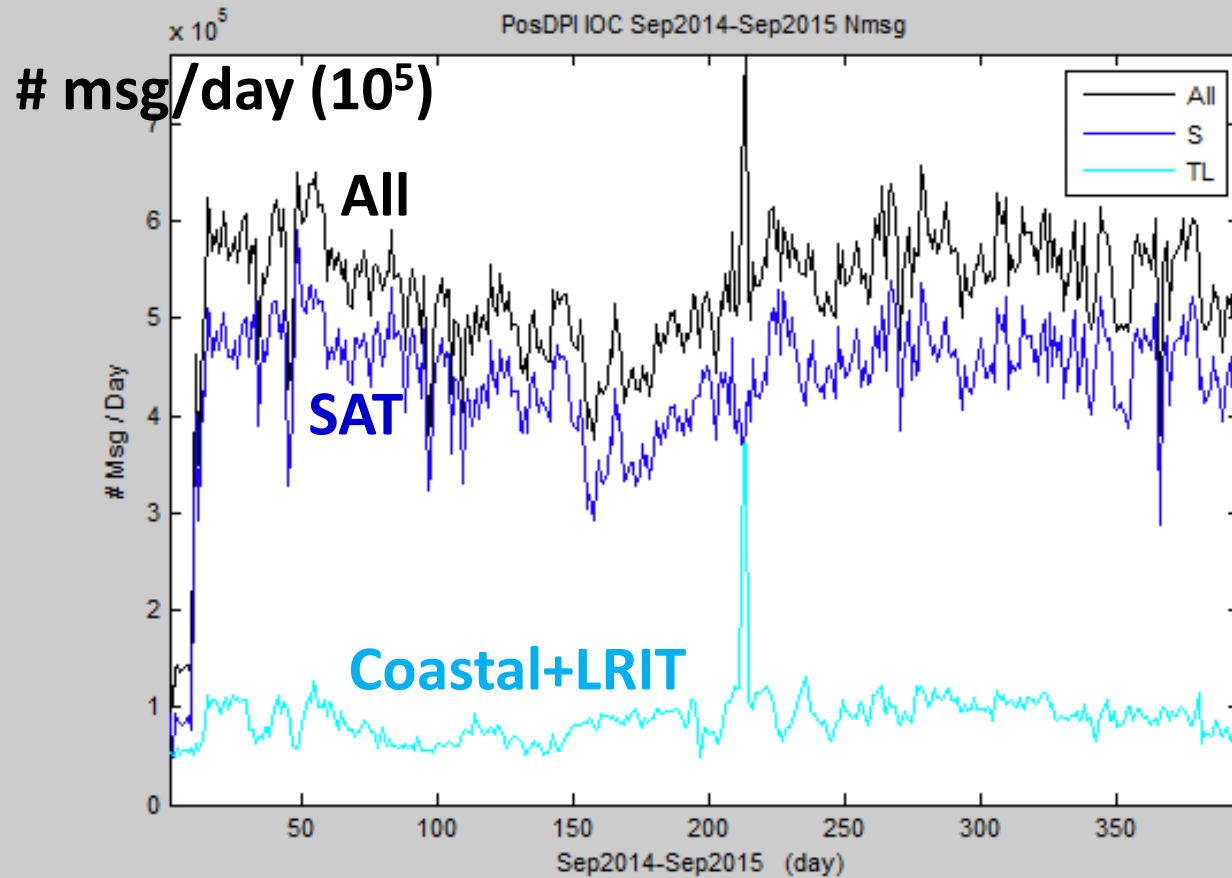
Harm Greidanus

Shipping density maps from AIS signals, DG MARE - Brussels, 7 Sep 2017

1. From AIS messages to ship density maps



1. From AIS messages to ship density maps



- Data from PMAR project
- 1 full year
- Up to 17 AIS satellites (NCA/FFI, LuxSpace, Orbcom, exactEarth, SpaceQuest)
- Coastal AIS (MSSIS)
- LRIT (EMSA)
- 550k position msg/day
- 1,600 MMSI daily

2. Interpolation of ship track

- From position samples irregularly spaced in time (the AIS messages)
- To regular sampled track
- Assuming no data errors (only data gaps)

t_1^0 t_2^0 t_3^0 t_4^0
seconds

hours

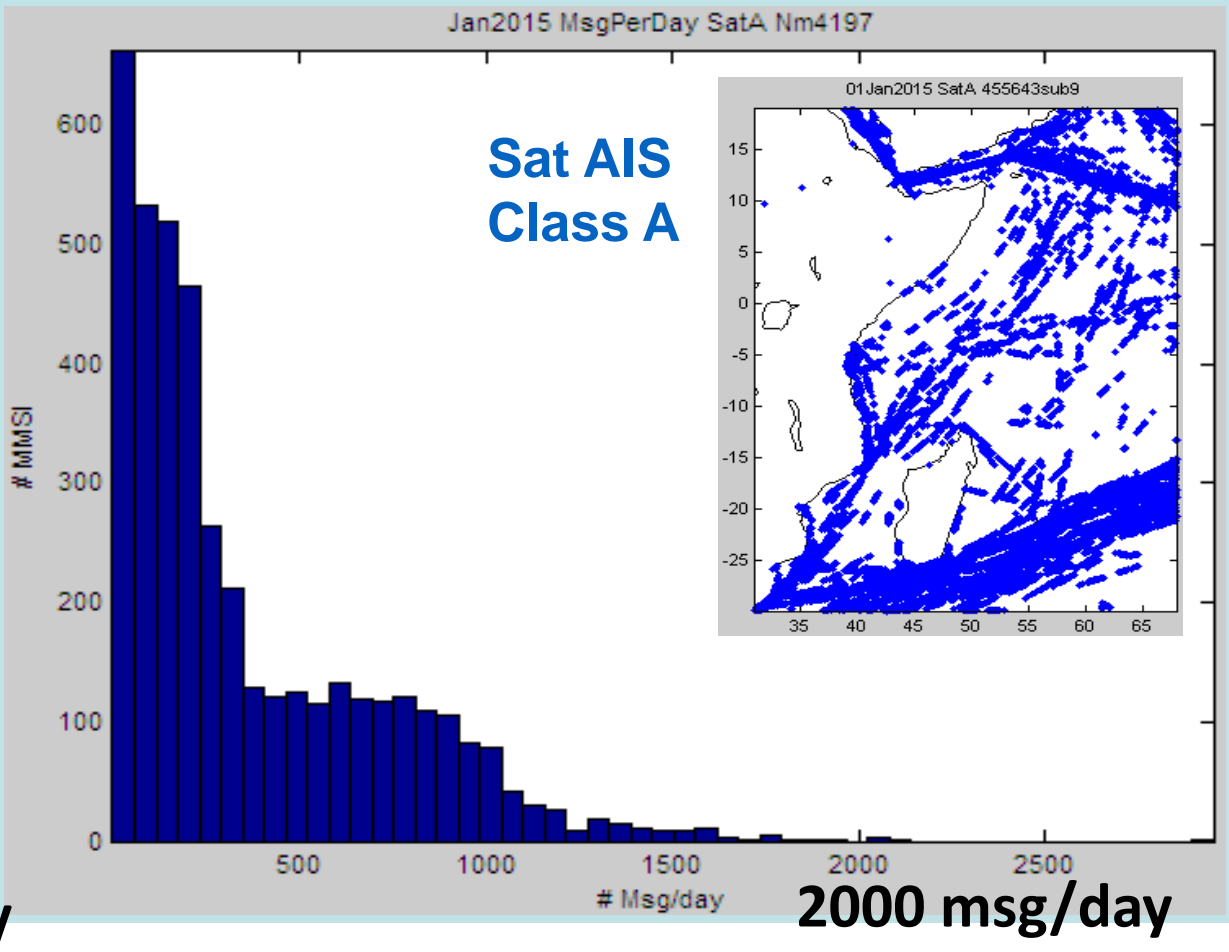
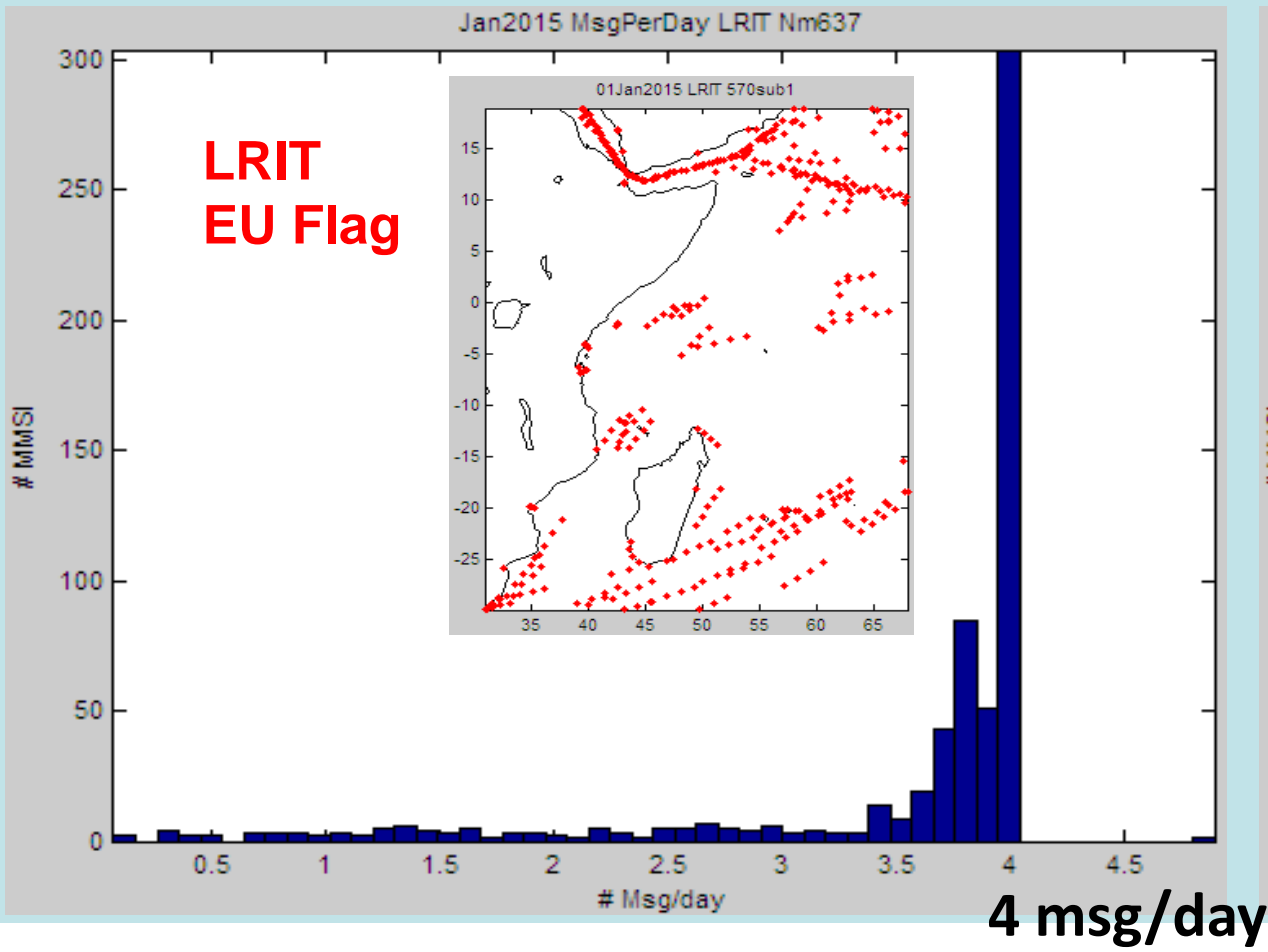
t_5^0 t_6^0 t_7^0
seconds

2. Interpolation of ship track

- Thousands of msg/day from some ships down to a few from others
- Linear, or some curve fitting?
- Use only positions, or also speed, course?
- Use ship movement model (physics; ship type)?
- How far (long) to extrapolate, max time gap?
- Use established behaviour (routes)?

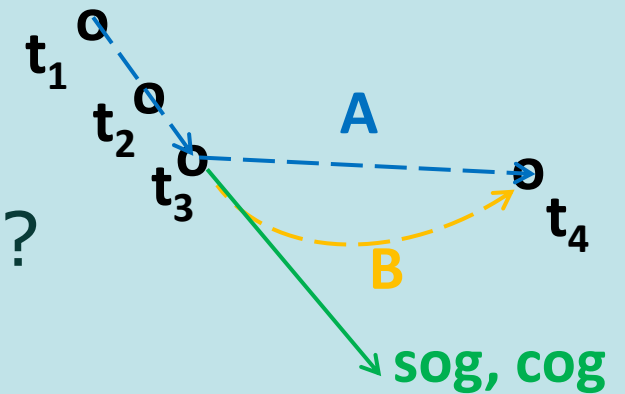
2. Interpolation of ship track

Histogram of # msg / day per MMSI



2. Interpolation of ship track

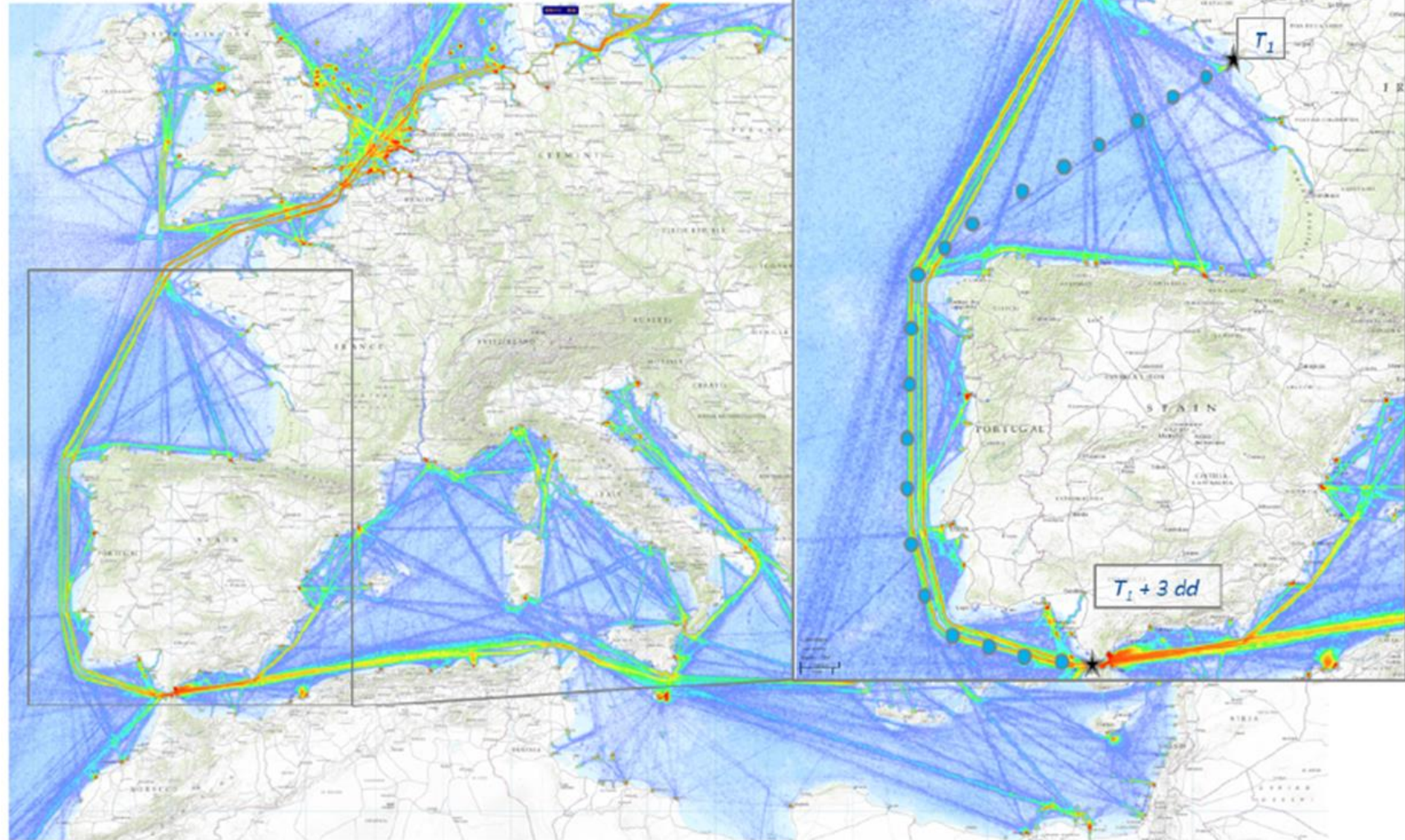
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2. In Historical LRIT data can be used to predict where a vessel will be up to a few days in advance

Routes of cargo ships

LRIT data provided by the EU LRIT CDC Contributing States



Zampieri A., Vespe M., Westra M., Alvarez M., Greidanus H., 'A future for historical LRIT data', International Maritime Organization (IMO) – Maritime Safety Committee (MSC) 95th session, London, 2015

3. Data errors

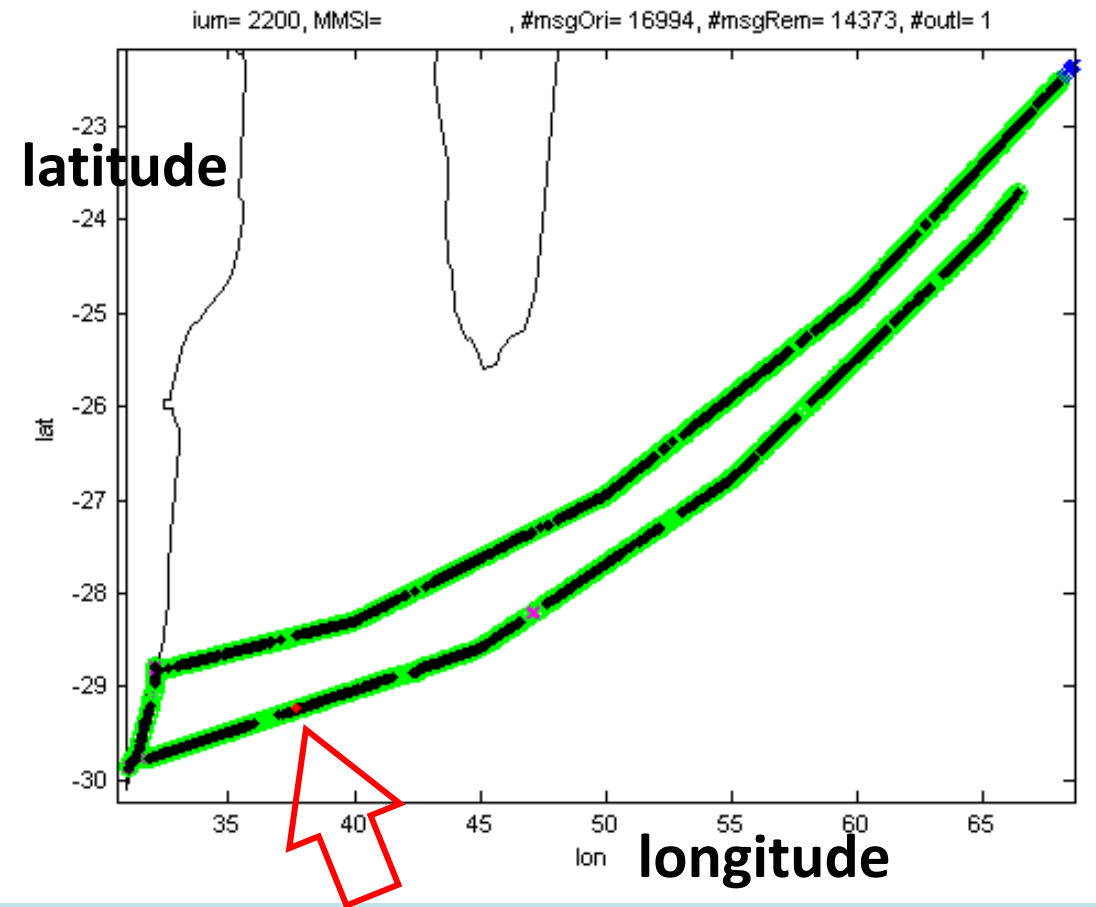
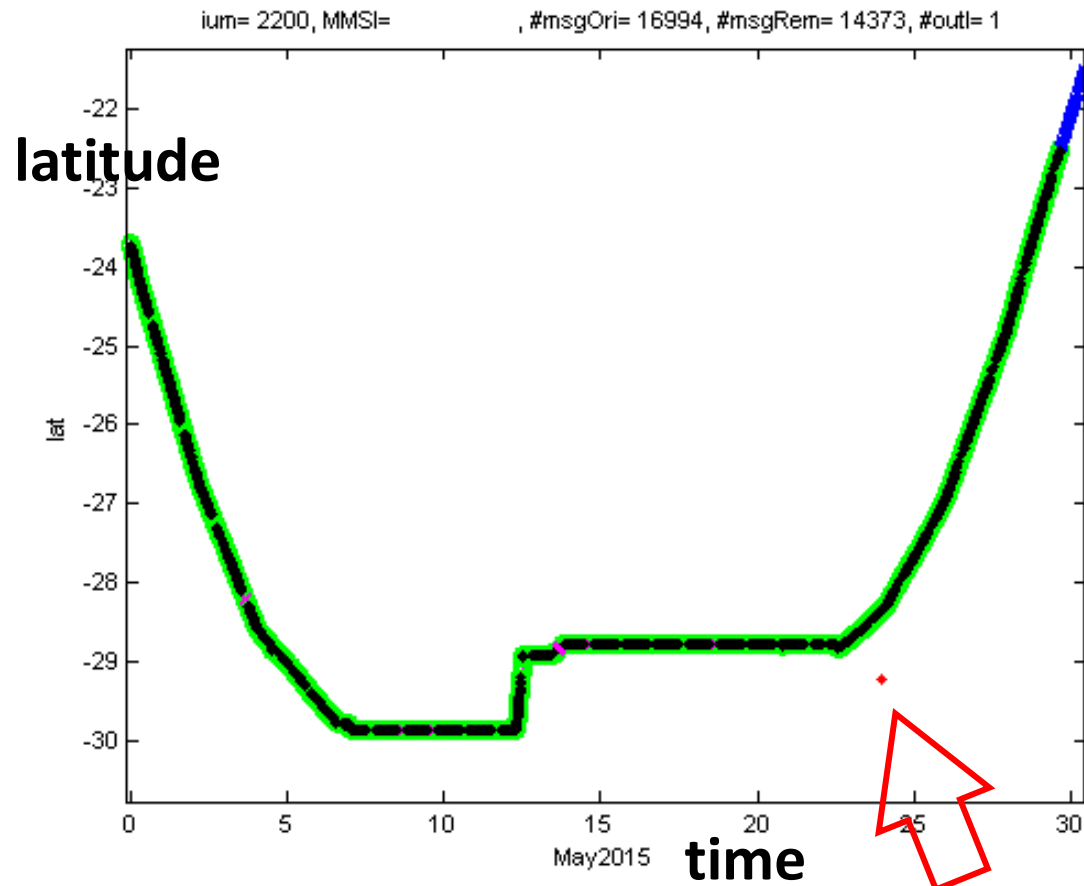
- Random, incidental errors
- Systematic, repetitive errors

3. Data errors – Random

Random, incidental errors

- Single outlier points
- In MMSI, position, time (, sog, cog, ...)
 - Positions on land; impossible heading-course vs. speed
- Due to transmission: seen by >1 receiver
- Due to reception: quite different error rates for different satellites

3. Data errors – Outliers



3. Data errors – Random

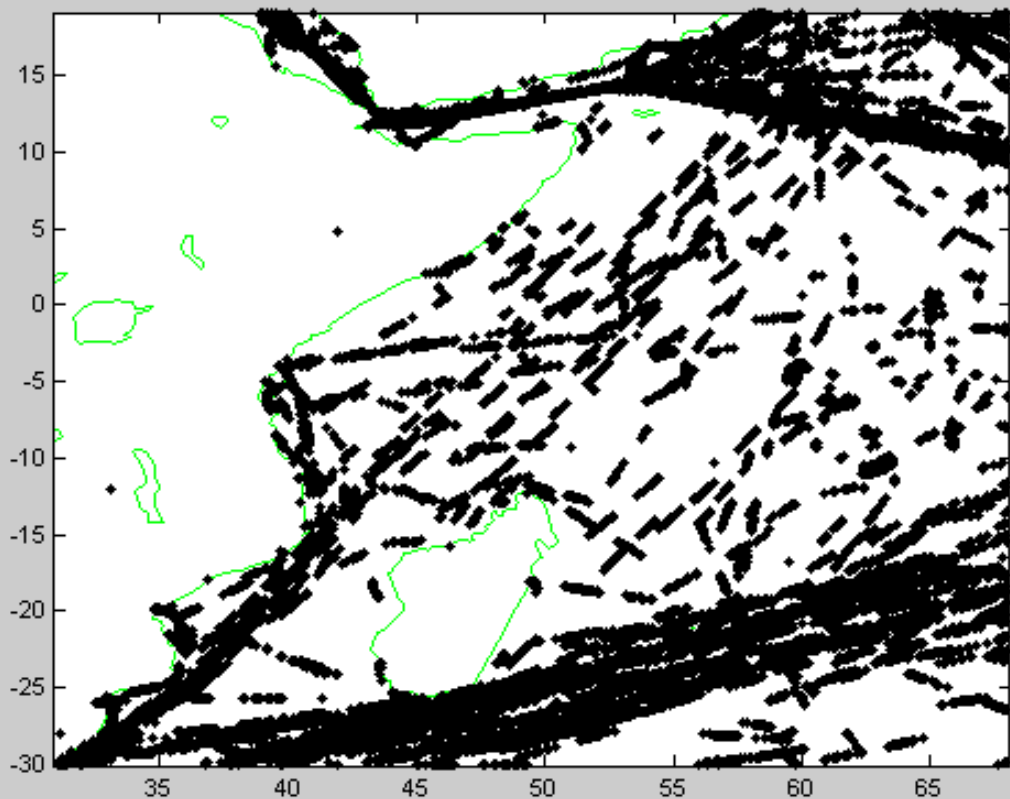
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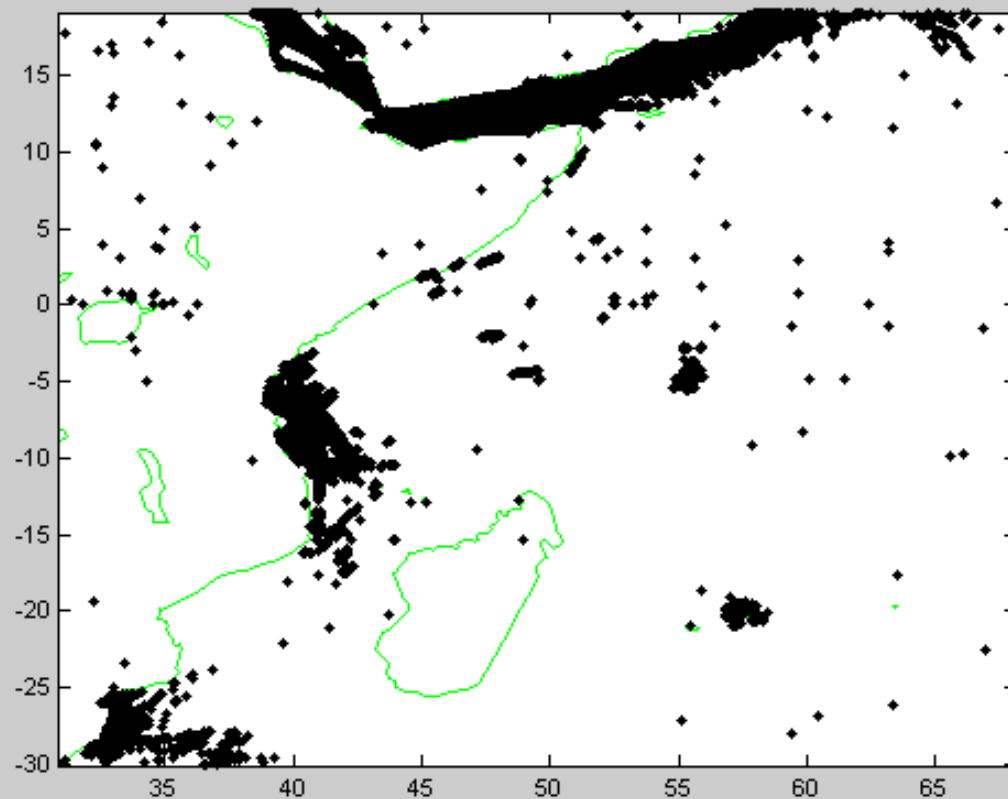
3. Data errors – Random, receiver side

All msg in one month for a certain receiver

IOC, Apr2015, plat= 3, #days= 30, #dayseen= 1, #msg= 293374



IOC, Aug2015, plat= 1, #days= 31, #dayseen= 31, #msg= 1509012



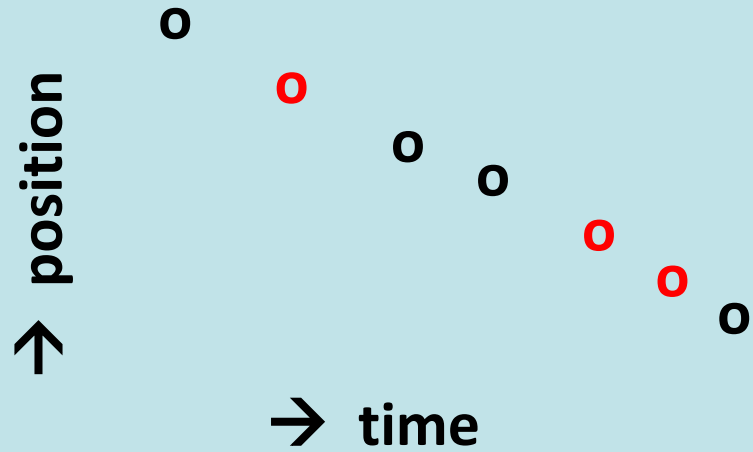
3. Data errors – Systematic

Systematic, repetitive errors

- Receiver side
 - Clock offset, drift, jumps
 - Both on satellite (sec-min offsets) and on coastal (local PC, hours offset)
- Ship side – ‘noisy’ MMSIs
 - Always wrong value of some field (e.g., longitude always negative; course off by 90 deg)
 - Many errors in some field
 - Can be impossible to recognise in geo-box

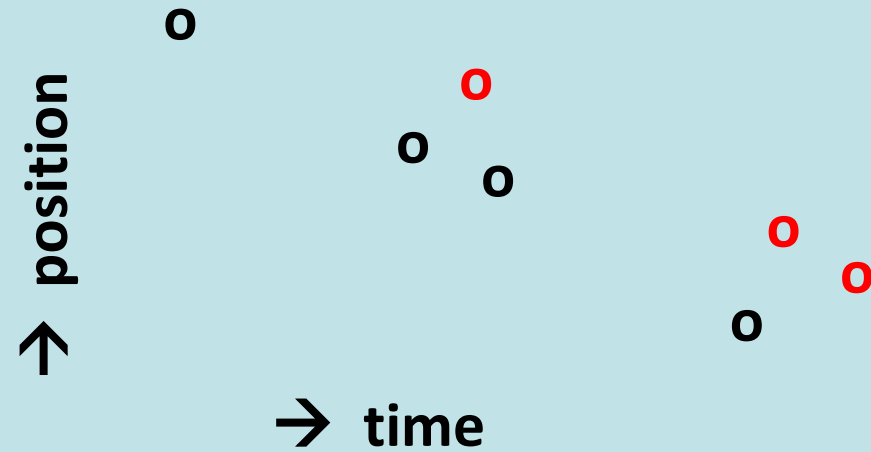
3. Data errors – Clock

Occurrence and impact of clock errors



Platform 1

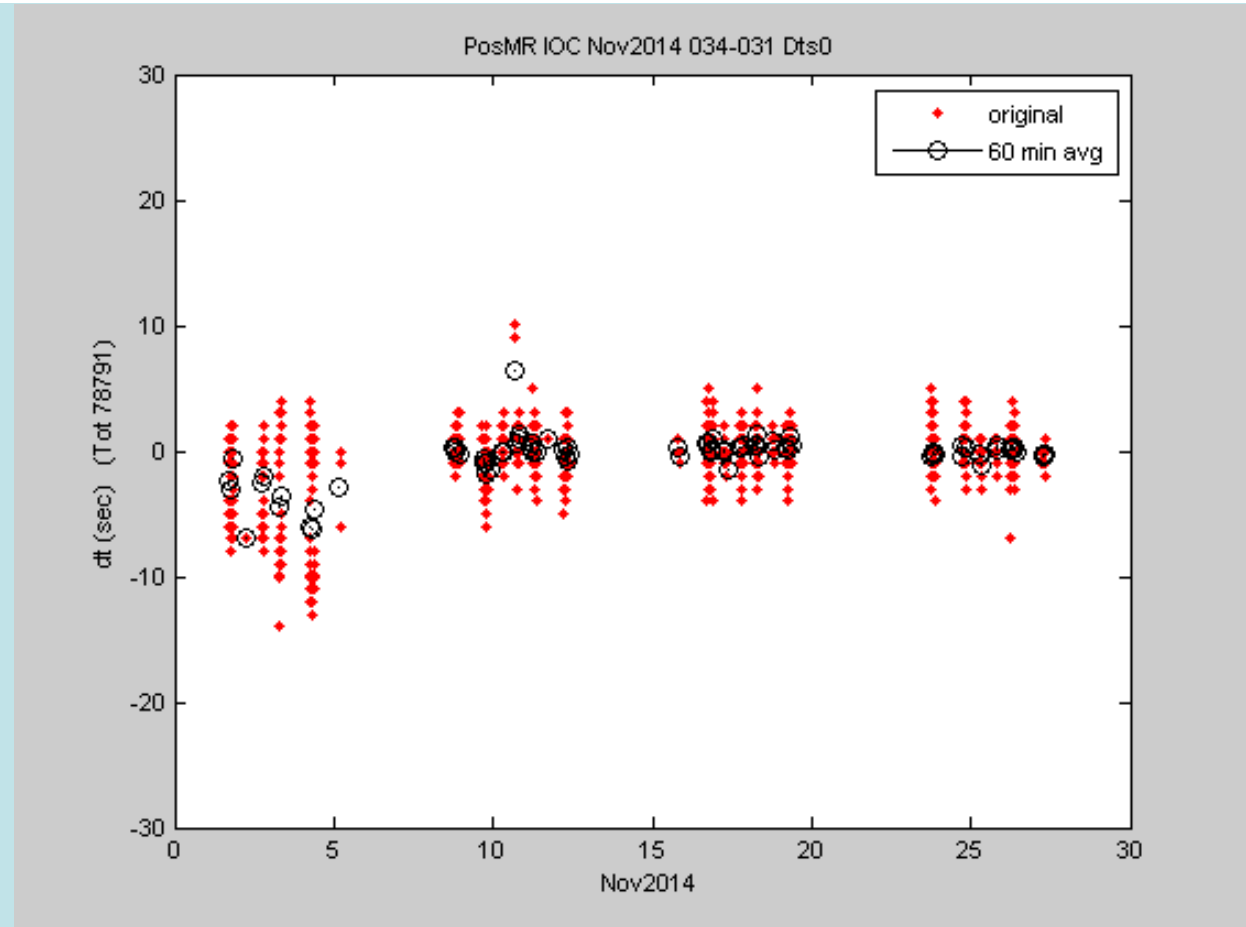
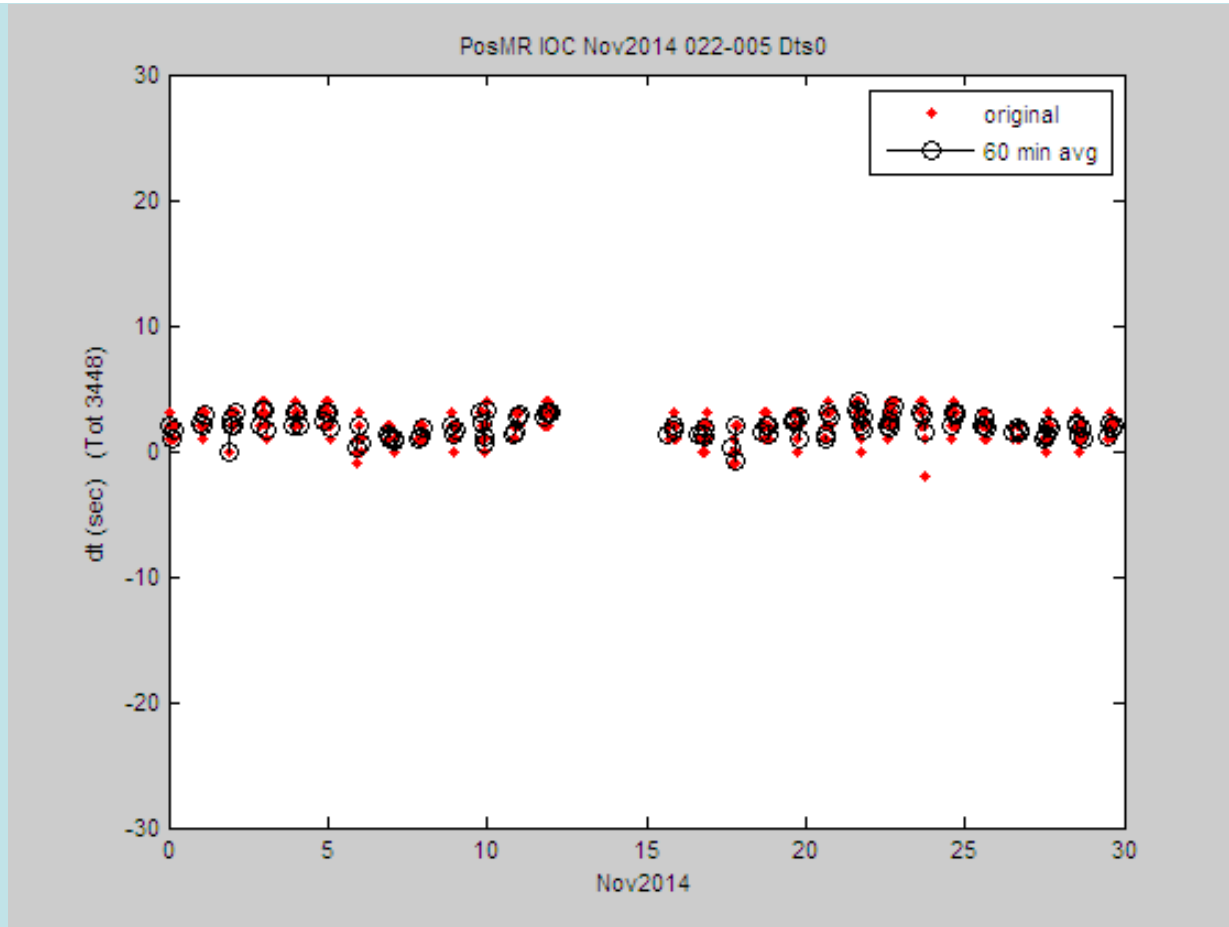
Platform 2



Time error in Platform 2

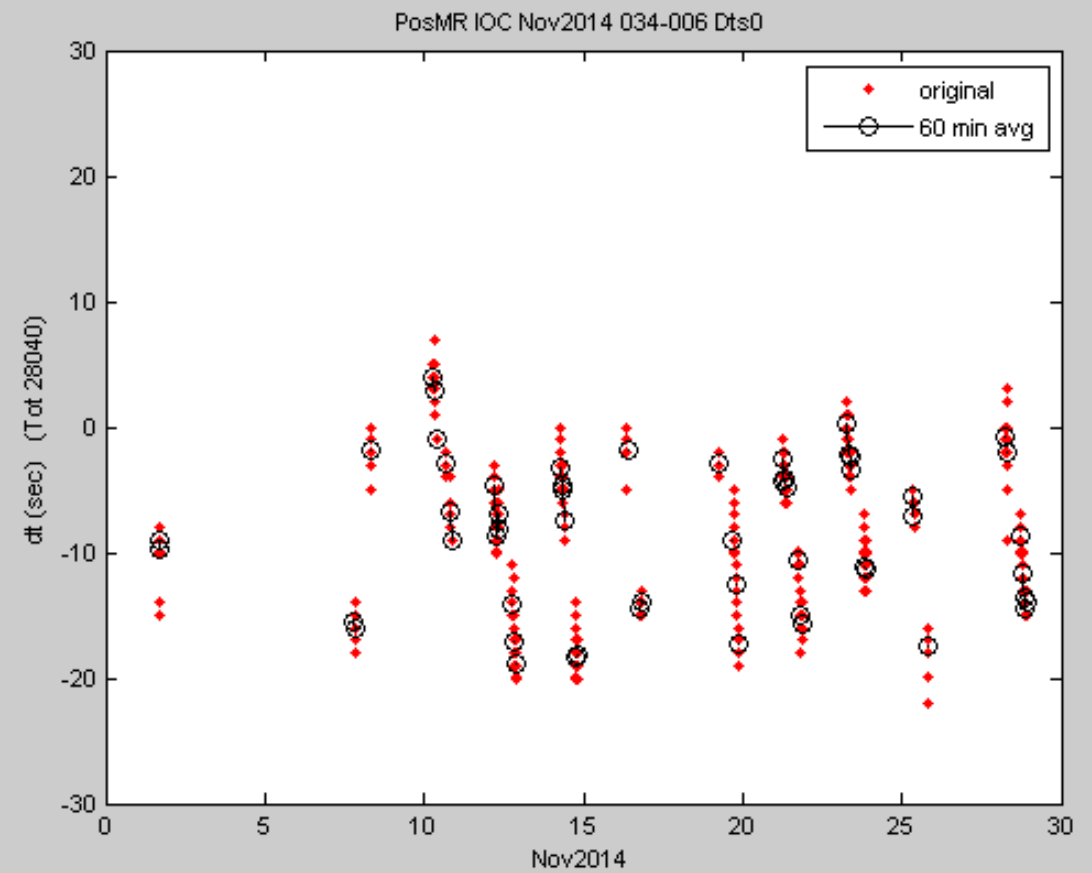
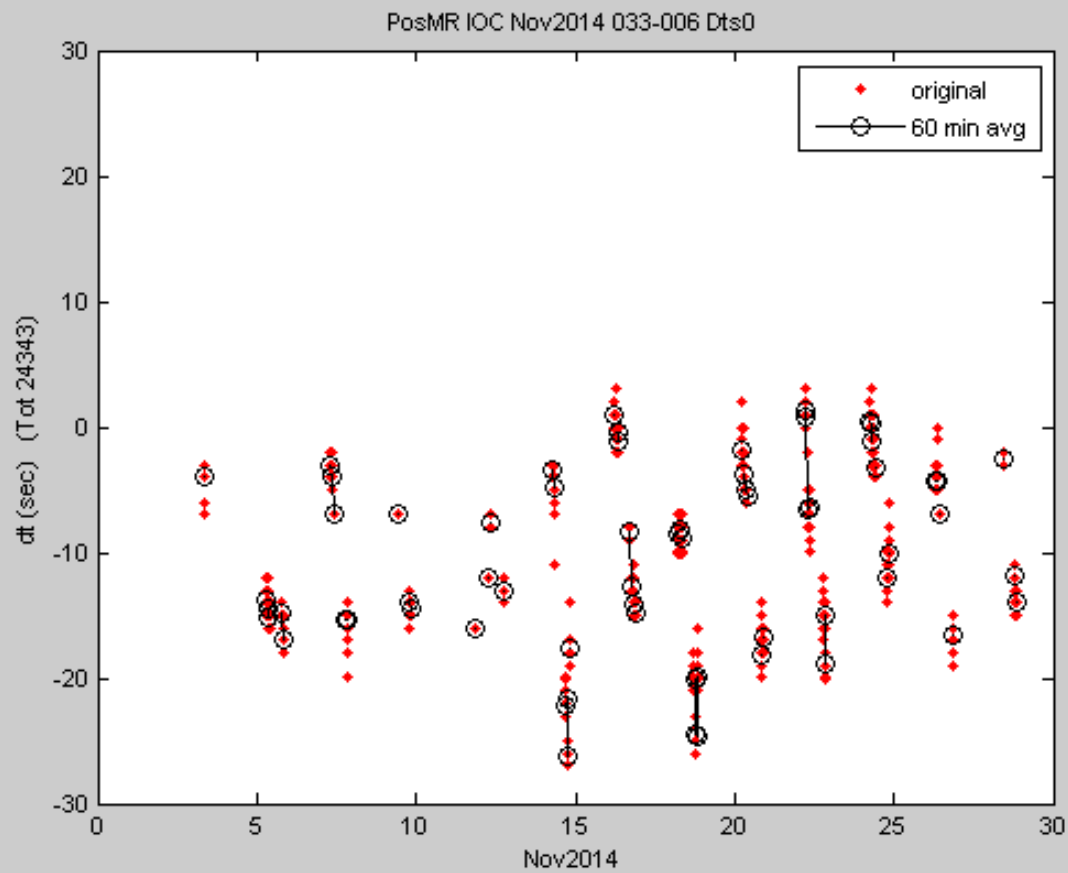
3. Data errors – Clock

Time difference for identical msg between 2 sats



3. Data errors – Clock

Time difference for identical msg between 2 sats



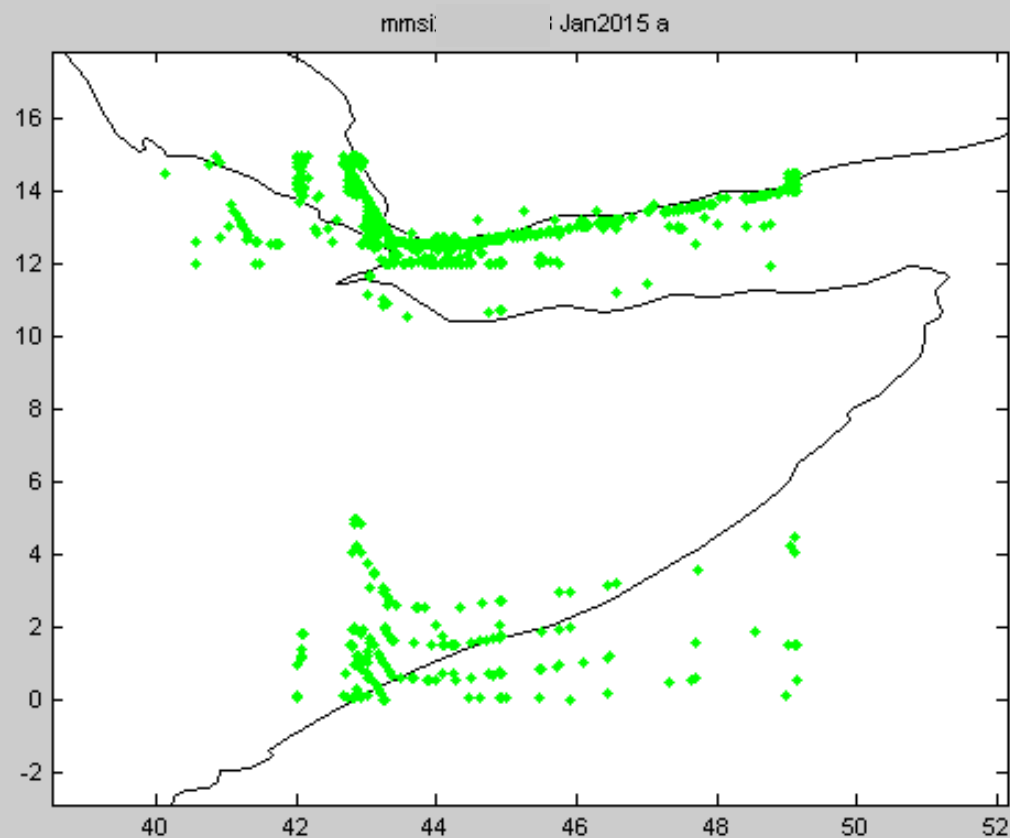
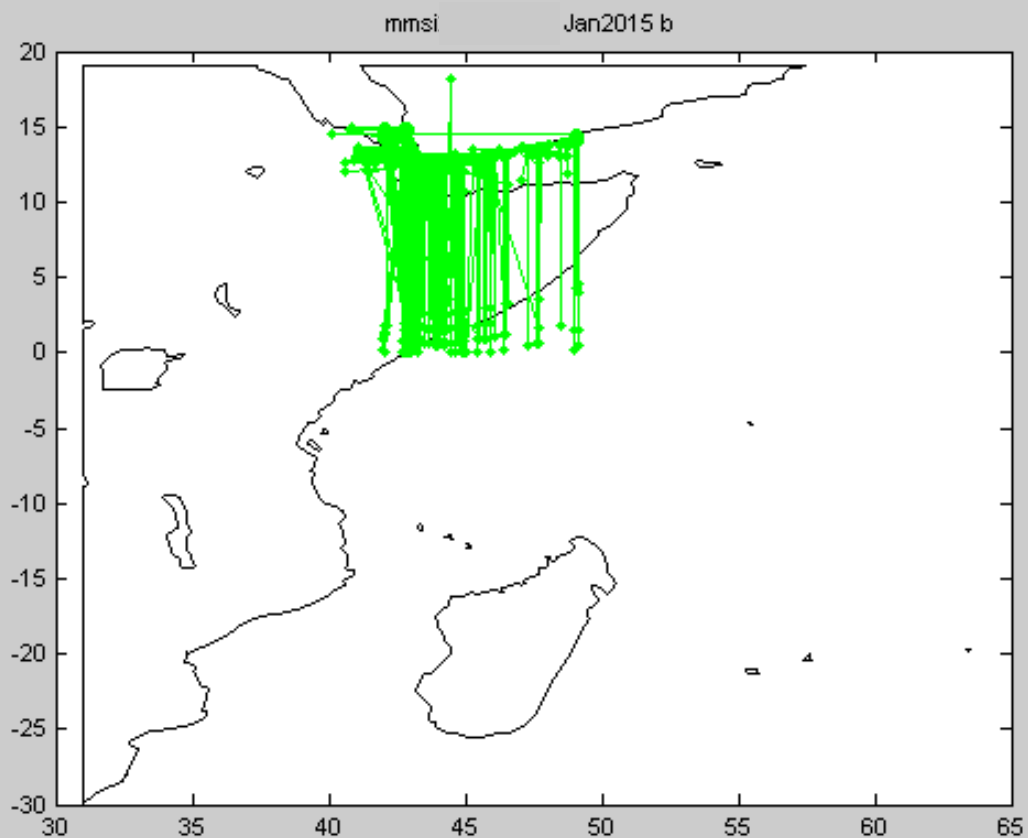
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 - Always wrong value of some field (e.g., longitude always negative; course off by 90 deg)
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3. Data errors – Noisy MMSI

All positions of one MMSI in 1 month



4. AIS verification

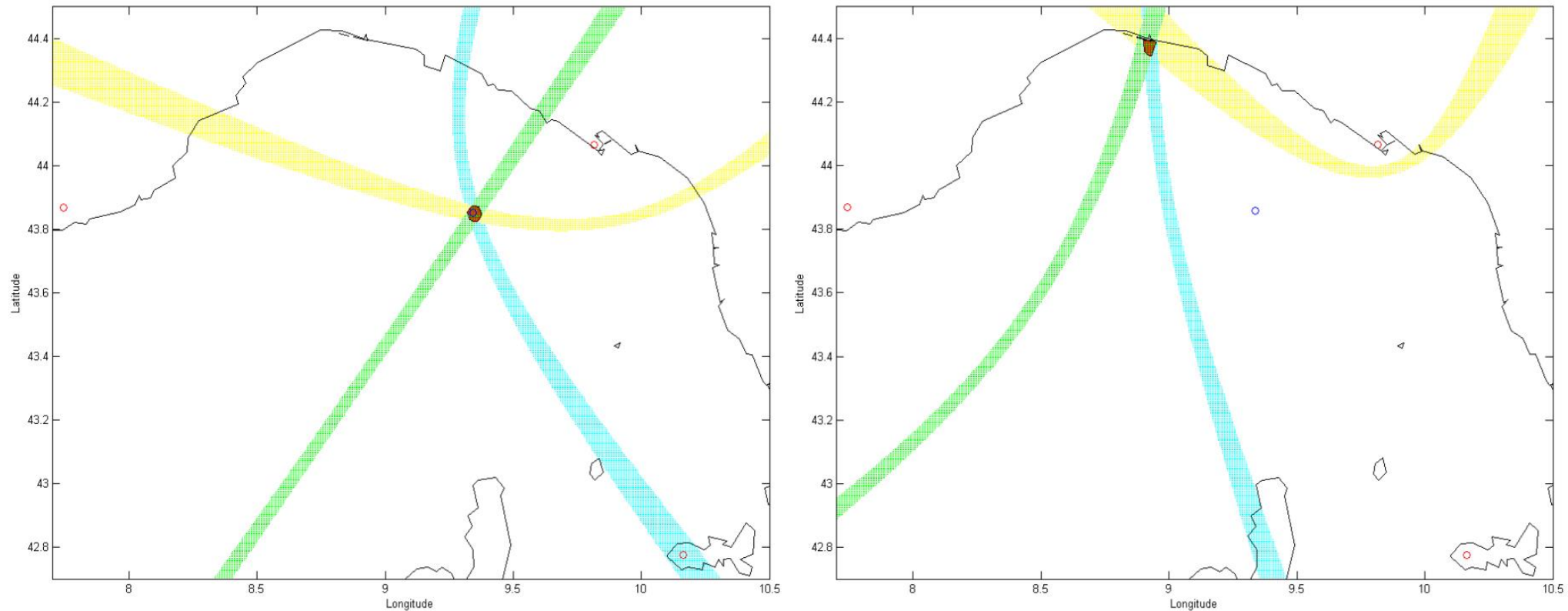
Coastal

- Time difference of arrival localisation by 3 receivers to verify position
- Off-switching by measuring RF signal level as function of distance

Satellite

- Reject msg with position outside reception area
- Localisation by Doppler and other RF signal properties

4. AIS verification – Coastal TDOA



Papi, F., Tarchi, D., Vespe, M., Oliveri, F., Borghese, F., Aulicino, G., & Vollero, A., 'Radiolocation and tracking of automatic identification system signals for maritime situational awareness'. IET Radar, Sonar & Navigation 9 (5), 568-580, 2015

4. AIS verification

Coastal

- Time difference of arrival localisation by 3 receivers to verify position
- Off-switching by measuring RF signal level as function of distance

Satellite

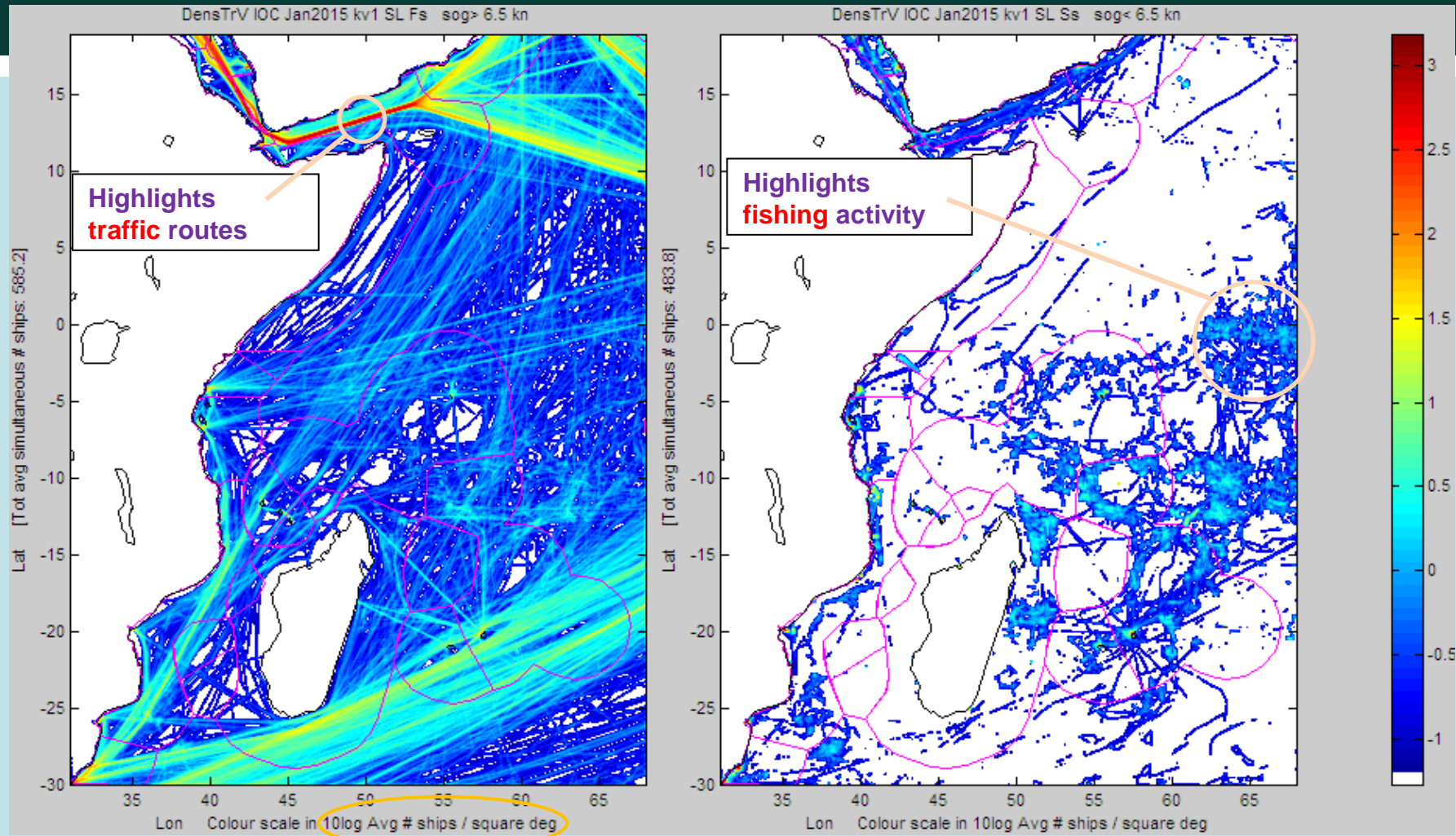
- Reject msg with position outside reception area
- Localisation by Doppler and other RF signal properties

5. Some results

Fast moving, > 6.5 kn

Slow moving, < 6.5 kn

**Selection
only
on speed**



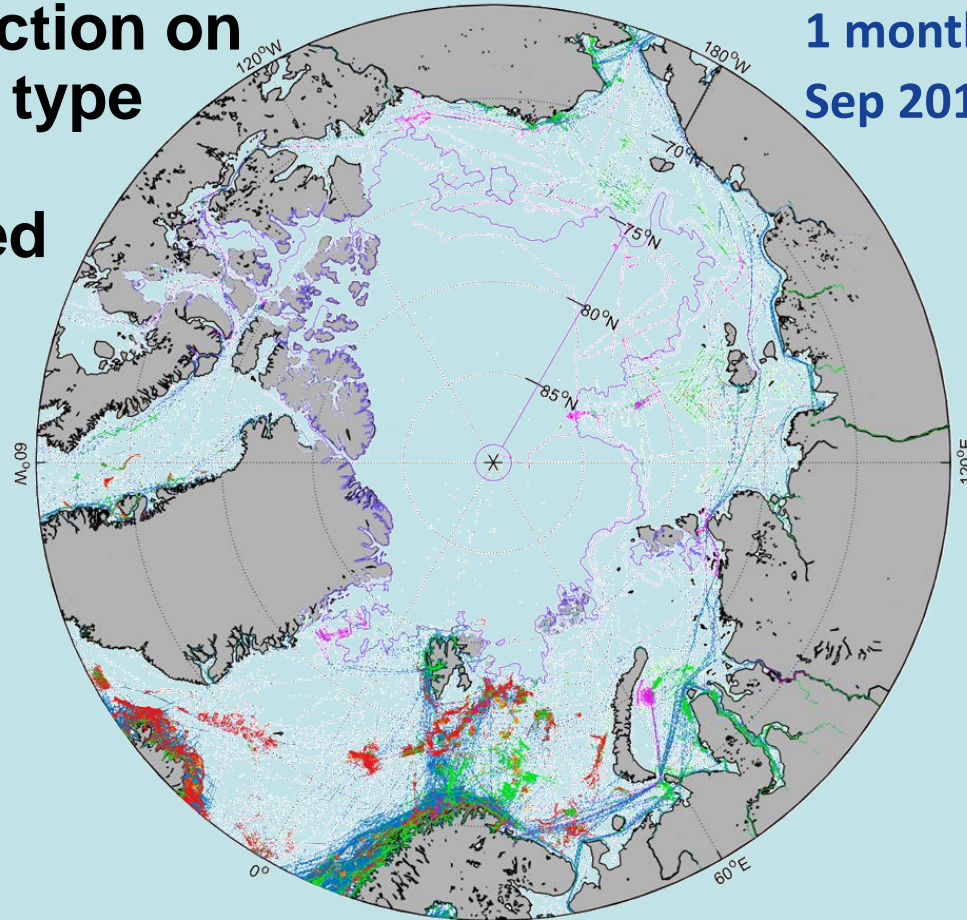
Note units: log average # ships / square degree

5. Some results

**Selection on
ship type
and
speed**

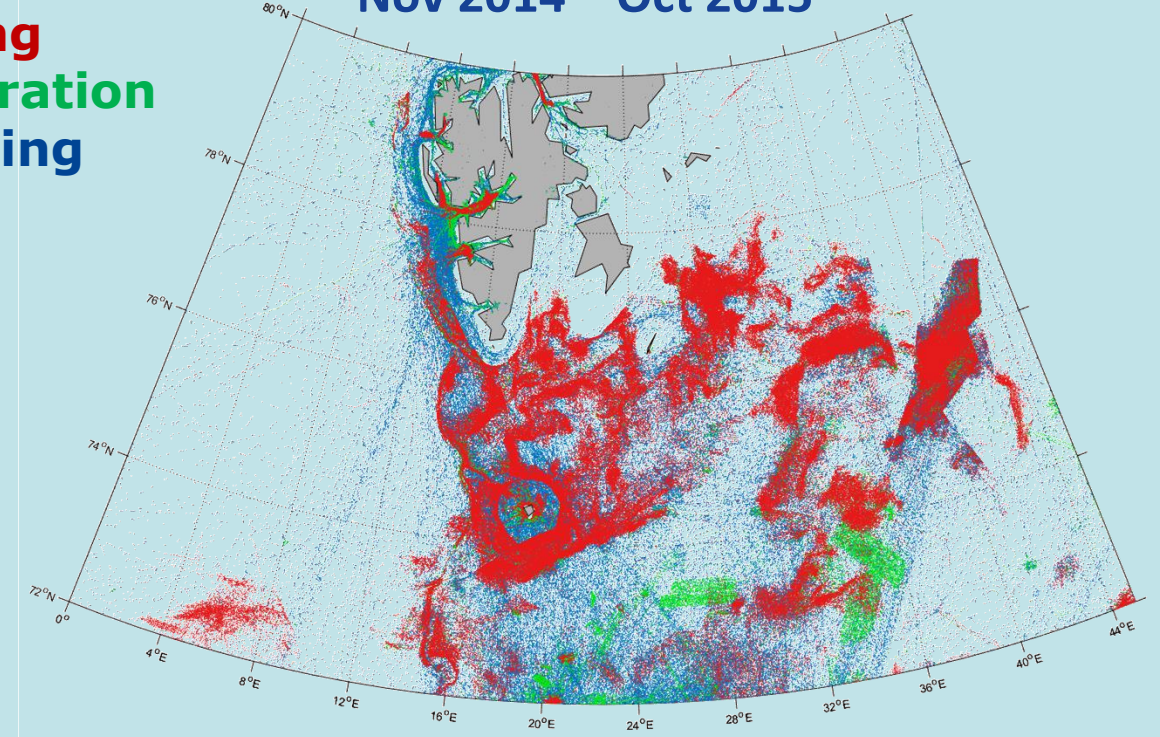
Time period: from 2014-09-01 to 2014-09-30

**1 month,
Sep 2014**



Fishing
Exploration
Shipping

**1 year,
Nov 2014 – Oct 2015**

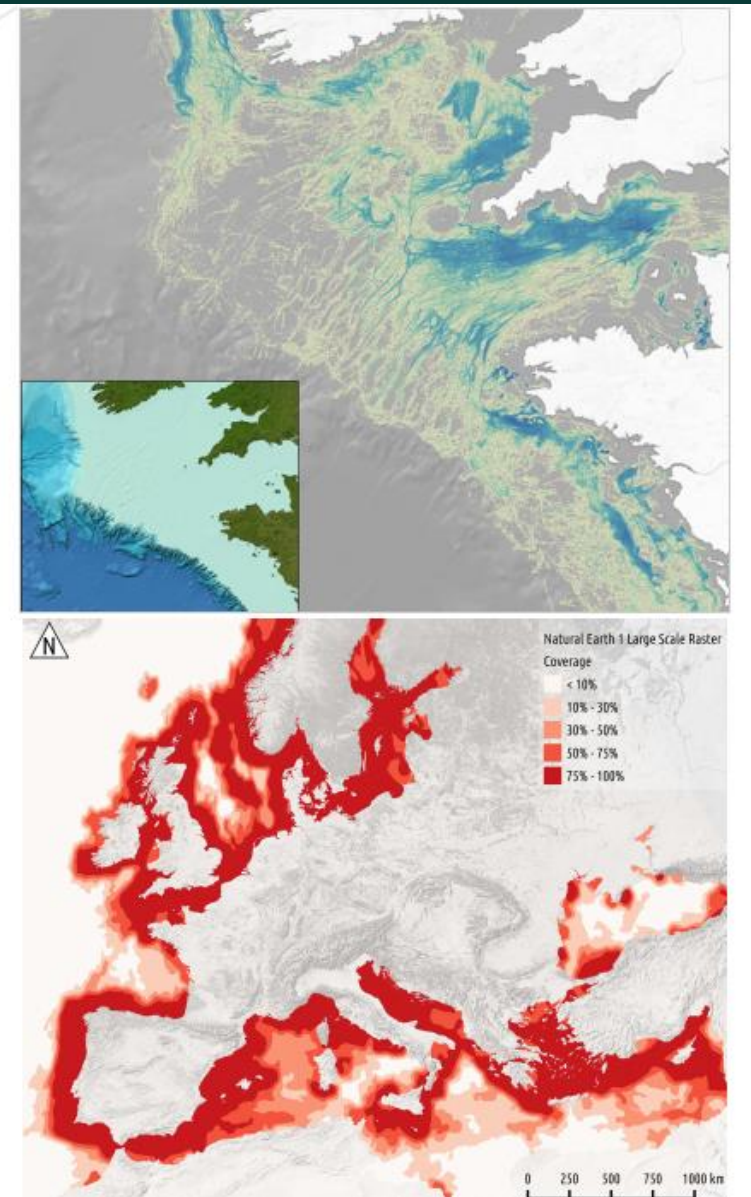
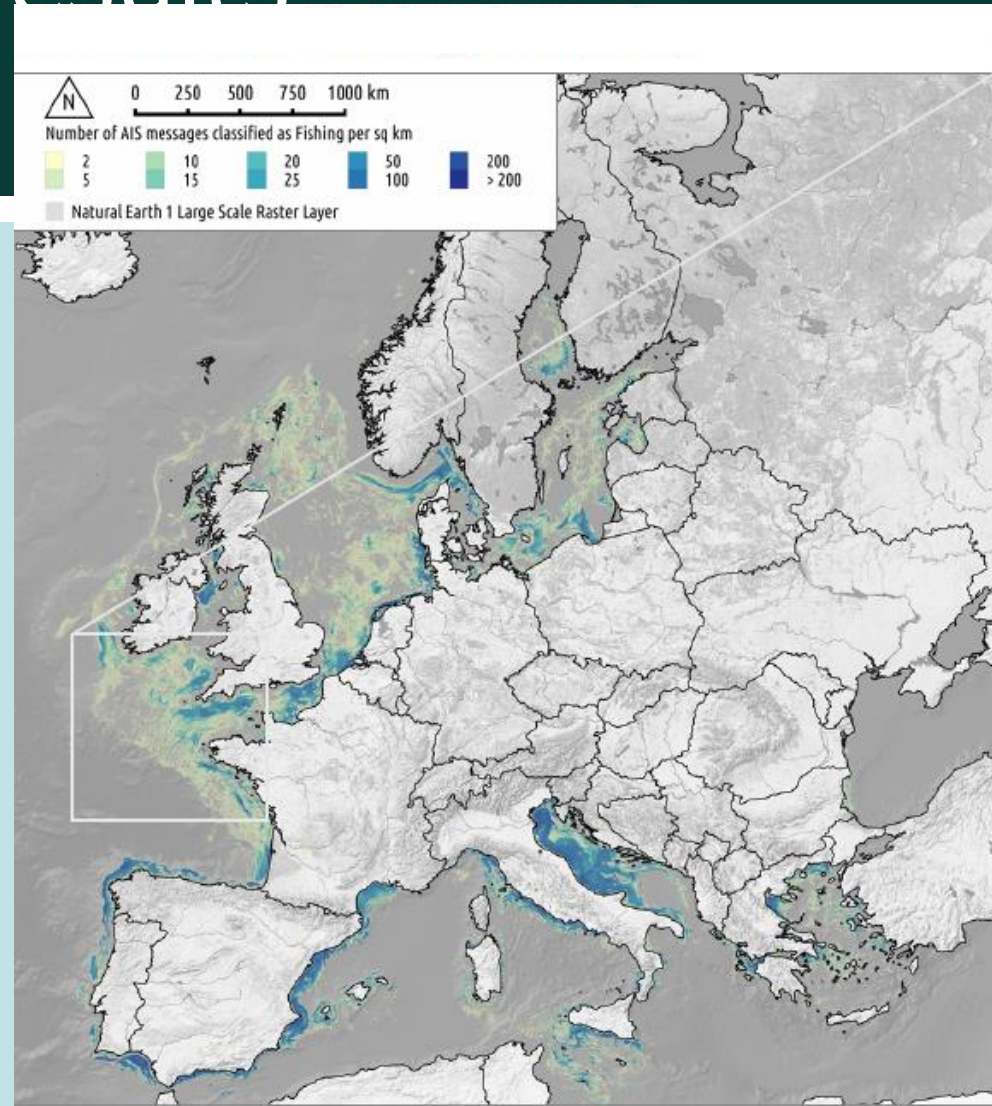


Data: Satellite AIS from Norwegian Coastal Administration / FFI

Vespe M., Greidanus H., Santamaria C., Barbas T., 'Knowledge Discovery of Human Activities at Sea in the Arctic using Remote Sensing and Vessel Tracking Systems', Int. Conf. on Safe and Sustainable Shipping in a Changing Arctic Environment (ShipArc 2015), Malmö, Sweden, 2015

5. Some results

Selection on ship type and on speed with limits set per individual ship



Michele Vespe, Maurizio Gibin, Alfredo Alessandrini, Fabrizio Natale, Fabio Mazzarella, Giacomo C. Osio, Journal of Maps Vol. 12, Iss. sup1, 2016, Mapping EU fishing activities using ship tracking data, <http://dx.doi.org/10.1080/17445647.2016.1195299>



Thank you

Any questions?

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