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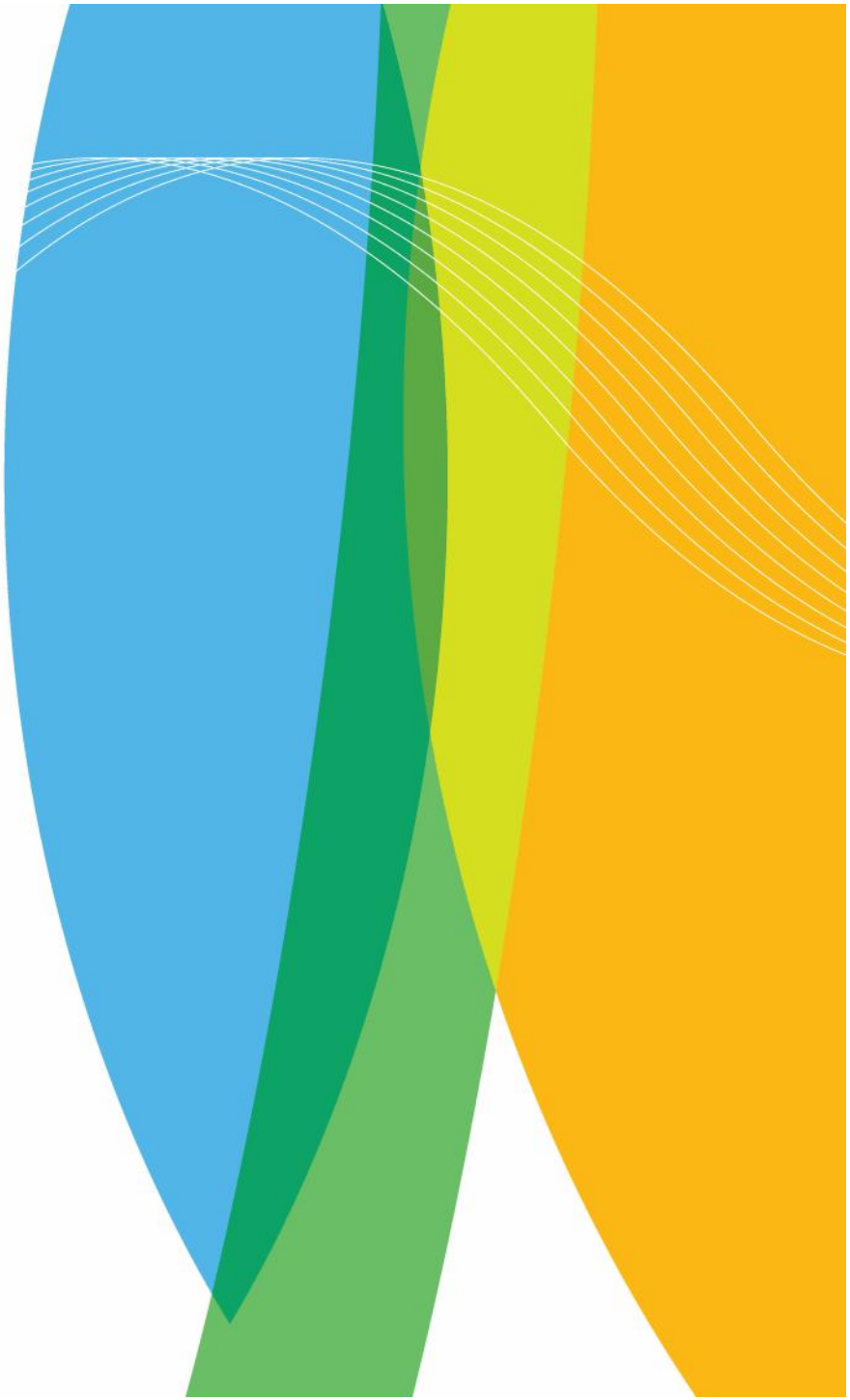
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

NO_x emission estimates of marine traffic

”Prelude for an automated process”

Jukka-Pekka Jalkanen
Air Quality, Dispersion Modelling Group
Finnish Meteorological Institute



Interreg IIIA

Outline

- **Motivation**
- **Introduction to Automatic Identification System (AIS)**
- **Description of the system under development**
- **Preliminary results**
- **Future plans**

Why bother?

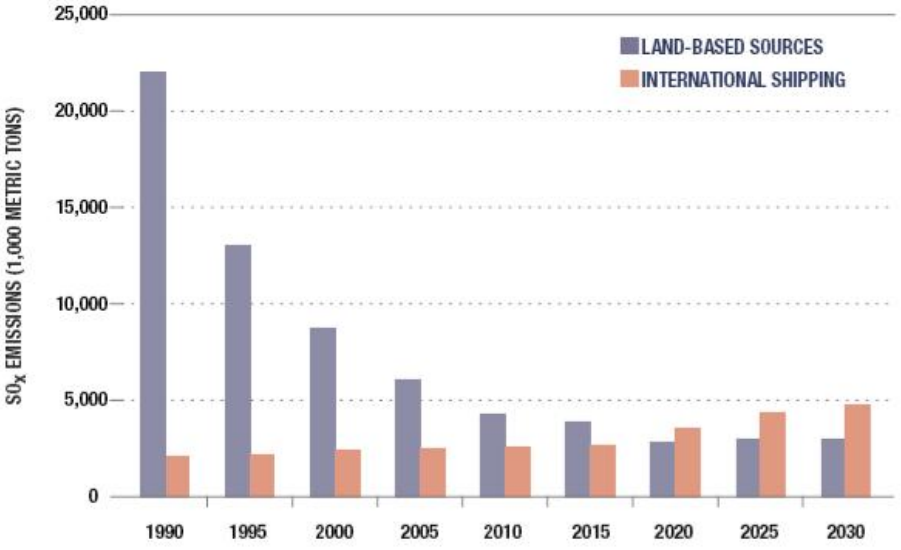


FIGURE ES-2. Inventories and Projections of SO_x Emissions in Europe from Land-based and International Shipping Sources (EC 2005)

FIGURE ES-3. Inventories of NO_x Emissions in Europe from Land-based and International Shipping Sources (EC 2005)

International Council on Clean Transportation: “Air Pollution and Greenhouse Gas Emissions from Ocean-going Ships”, 2007, pages 8-9

Automatic Identification System

- **Built originally for collision avoidance**
- **IMO: Mandatory for ships GRT > 300**
- **Short data bursts on two VHF radio channels**
- **Transmitted every few seconds**
  - How often depends on the speed of the vessel
  - Millions of messages/day
- **Several types of messages**
  - Position reports, ship ID data...
  - Receiving stations maintained by the Finnish Maritime Administration (FMA)

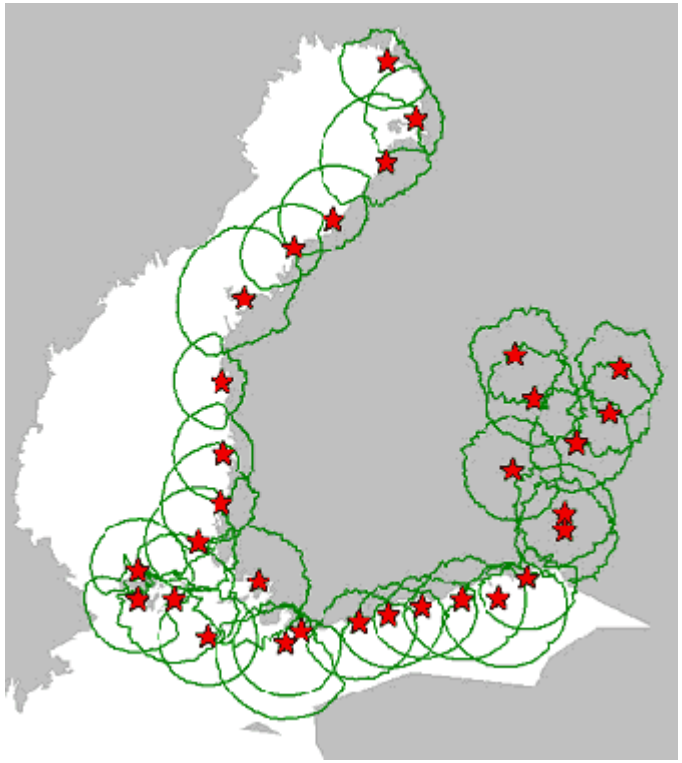


Image by FMA
http://www.fma.fi/toiminnot/meriliikenteenohjaus/?cat=ais&page=

An example of an AIS message

!AIVDM,1,1,,A,1D7eHF04RUQPqb@R3NE<<9fv06qH,0*22

- Position report consisting of a header (ID number, sequence number, radio channel), message and a checksum
- Decoded message

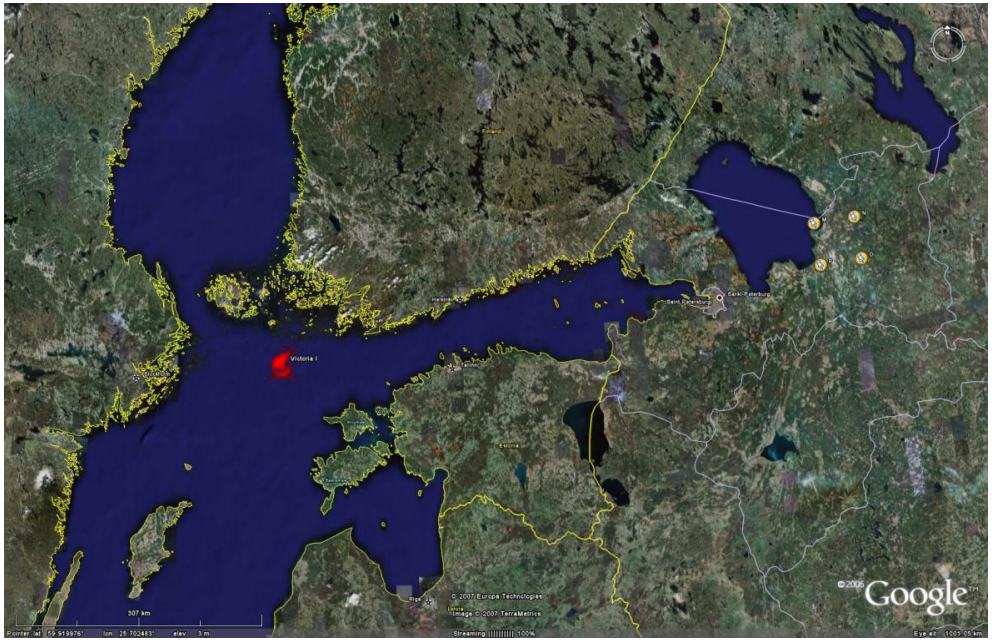
  MMSI*: 276519000 - VICTORIA I

  Speed (SOG): 16.5 knots

  Course (COG): 312.0 deg

  Lon: 21.16833 E deg

  Lat: 59.51417 N deg



* MMSI = Mobile Maritime Service Identity

Description of the pilot system

- **Receive & decode AIS messages**
- **Identify & locate ships using AIS**
  - Who? What kind? Where? When?
  - Obtain detailed technical description of the vessel
- **Emission estimate based on engine power level**
  - What? How much?
- ***Model the long range transport in the atmosphere***
- ***Estimate deposition of nitrates***

What is needed?

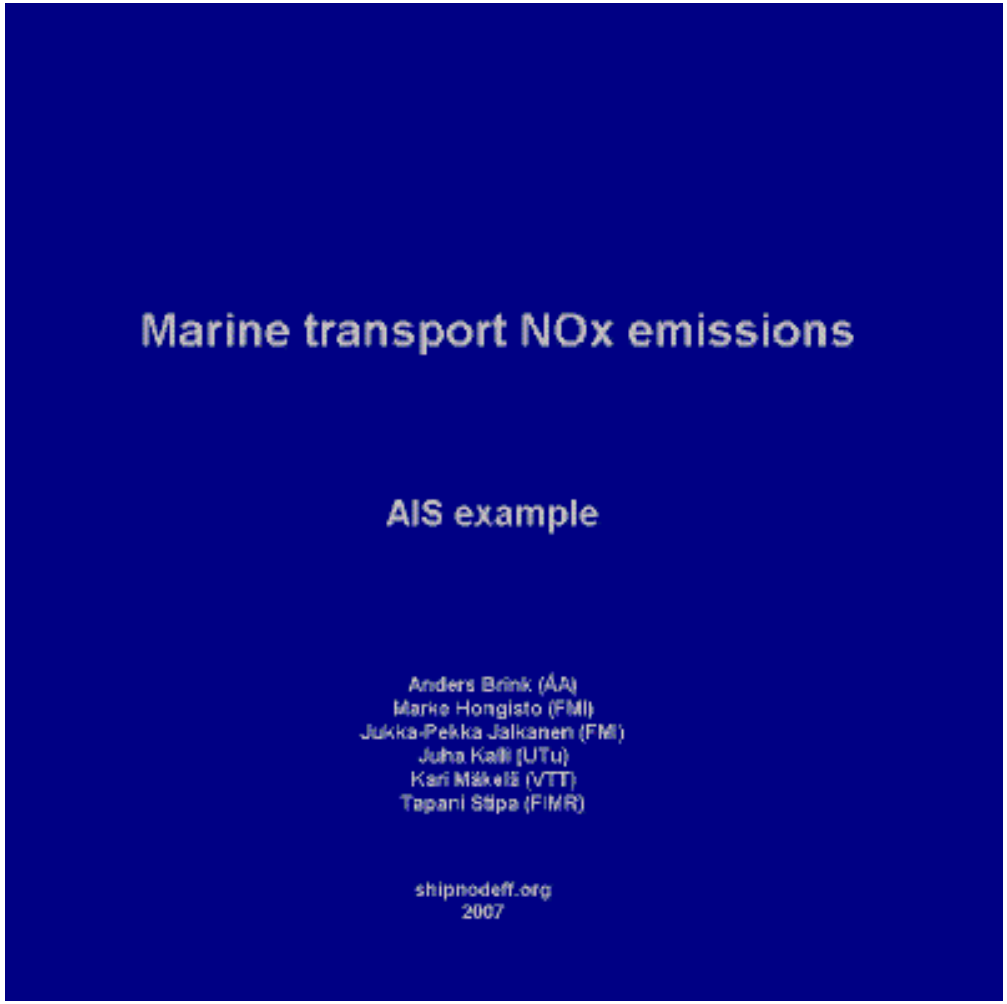
- **Technical description of vessels**
  - Primary source: Self-updating, internal database of ships
    - Currently >12 000 vessels
  - Secondary source: Lloyds register
    - Physical dimensions, tonnage, date of build
    - Main & Aux engines; number, model, type, power output
    - Design speed, hull type
  - Additional data needed
    - Emission certificates
    - Emission abatement systems
      - Currently 13 techniques included (SCR, DWI, HAM...)
- **Database failure (Not found, network error, inconsistent data)**
  - AIS information (physical dimensions) + ship type specific averages
  - Typical values for 15 different ship types used only as a last resort
  - No info available? → Treat as a tug/dredger/pilot vessel

Emission estimates for NO_x

- **Current power usage**
  - Design speed vs. current speed
  - Ship type specific profiles: Auxiliary engines
    - Generator use: Passenger ship vs. cargo ship
  - Boilers, refrigerators
  - Cruising, hoteling, manouvering...
- **Emission abatement**
  - Certificate? → Use certified NO_x output value
  - Abatement systems? → Reduction factors
  - No abatement systems OR unknown? → Apply full values for NO_x output

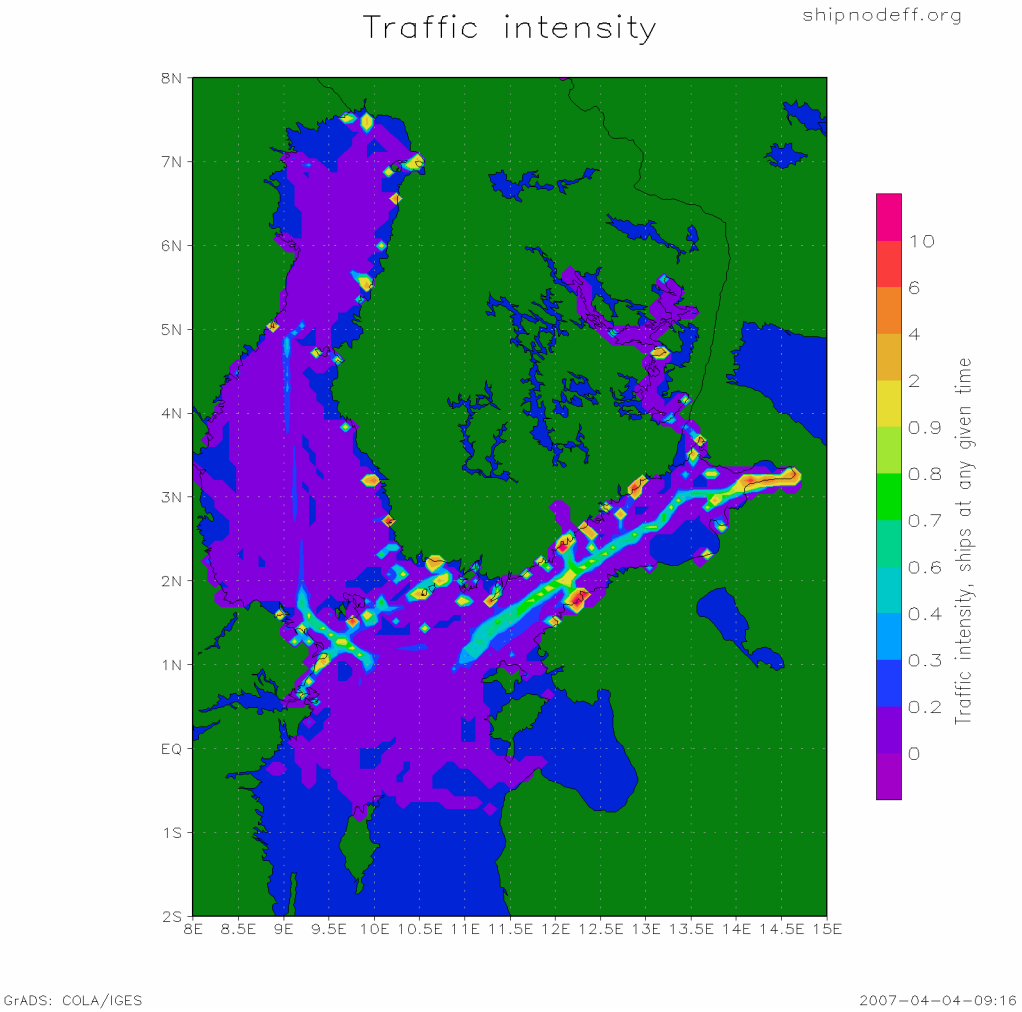
Example of results, 1

- **Emissions (NO_x) on the map as a function of time**
  - Map grid of ~ 9 x 9 km, can be adjusted flexibly
  - Single grid square may contain emissions from several ships
- **AIS data from FMA, November 2006**
  - Coverage: Reception range of Finnish AIS stations
    - 1 second of animation = 37 min in real time



Example of results, 2

- **Traffic intensity plots**
- **Ship routes**
- **Fuel consumption**
- **Emissions**
  - Currently NO_x
  - Planned: SO_x, PM, VOC, CO, CO_2
  - Graphical or numerical output



To do list

- **Weather conditions**
  - Affect both emission estimates and long range tranport of NO_x
- **Shore side electricity use & emissions in ports**
- **Inclusion of atmospheric transport model**
- **Analysis tool (Historical + Real-time situation)**
- **SO_x, CO, CO_2, PM, VOC...**
- **Expand coverage**
  - Finnish AIS stations
  - Baltic Sea
  - ...and beyond?

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Thank you

Finnish Meteorological Institute

Finnish Institute of Marine Research

University of Turku, Center for Maritime Studies

Åbo Akademi

Technical Research Center, Finland

Finnish Maritime Administration

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