UK shipping inventory
TFEIP meeting
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Agenda

- Background and previous shipping inventory
- New methodology summary
- Results: key changes in emissions compared to 2017 UK’s National Atmospheric Emissions Inventory
Background to Update

Split of **domestic shipping emissions** and **international shipping emissions**

The new shipping model estimates replaced the existing UK NAEI estimates for:
- National Navigation (source category 1A3dii), the main category of domestic voyages for coastwise shipping.
- Fishing vessels (source category 1A4ciii), within and outside of UK waters.

Existing estimates from the NAEI are proposed to continue to be used for:
- Inland waterways (source category 1A3dii) includes sailing boats with auxiliary engines, motorboats / workboats, personal watercraft and inland-goods carrying vessels used on rivers, canals and for recreational use off the UK coast.
- Naval vessels (source category 1A5b).
- Shipping between UK and Gibraltar.
Key pollutants are SO\textsubscript{2}, NOx, PM, VOC from in-engine fuel combustion

Two marine fuels within NAEI are heavy fuel oil (HFO) and marine diesel oil (MDO)

Future projections illustrate that liquefied natural gas (LNG) has increasing use as a marine fuel

Existing NAEI domestic shipping emissions estimates are based on a detailed shipping model in Entec (2010)

- a bottom-up Tier 3 inventory based on a database of vessel movements for the year 2007 that indicated vessel departure port and arrival ports and also covered vessels transiting through UK waters

- Fuel consumption and emissions for years 1990 - 2006 and 2008 to the latest year DfT port statistics are used as proxies to backcast and forecast 2007 estimates

Existing NAEI approach: international shipping fuel consumption derived as [DUKES total marine fuel sales] - [modelled estimates of UK domestic shipping] → i.e. overall a fuel sales approach
Previous shipping inventory in NAEI good but has limitations

- **Good**
  - Bottom-up tier 3 method based on Lloyd’s (LMIU) data
  - Domestic/international split by port origin/arrival
  - Detailed consideration of vessel types, engines, fuels
  - Spatially distributed (5x5km) based on *estimated* routes
  - 2007 base year of activity data

- **Limitations**
  - **Incomplete**: poor capture of vessels not engaged in international trade (smaller vessels, fishing vessels, offshore, service)
  - **Accuracy could be improved**: Blanket assumptions on vessel speeds (→ engine loads)
  - **Spatial accuracy could be improved**: No capture of *actual* vessel routes limits spatial granularity
    - E.g. poor understanding of vessels starting/finishing at same port

Agenda

- Shipping sector background and existing shipping inventory
- **New methodology summary**
- Results: key changes in emissions compared to existing NAEI
New methodology summary (1)

- New bottom-up methodology using terrestrial Automatic Identification System (AIS) activity data from the Maritime and Coastguard Agency (+more recent 2014 base year)

- Emission factors updated for most pollutants to match International Maritime Organization global inventory

- Minor changes to approach to estimate time series back to 1990 from base year – still using trends in DfT statistics as proxies for activity trends.

- NAEI estimates for inland waterways updated to account for new model
- No change to existing NAEI estimates for naval, to/from Gib./OTs
- Forecasts now account for four major ports’ specific growth forecasts
Benefits of new methodology

More complete activity dataset: improved domestic vessel coverage and actual routes travelled

Domestic class A position density

Inter-island passenger

Offshore

Fishing

Service

Offshore

Entec (2010)
New methodology summary (2)

- Highly granular raw activity data
  - Vessels uniquely identified
  - Vessel positions up to every 3 seconds when in range of terrestrial AIS network
  - Unknown route (+destination) of vessels after leaving range of terrestrial AIS

- Emissions estimated for every vessel position, accounting for:
  - Vessel type, engine power (main, auxiliary, boilers) of each vessel
  - Engine load, accounting for speed and draught at each position
  - Time (duration) until next position
  - Speed dependent emission factors
  - Location (at berth, at sea in a sulphur control area or not)

- Consecutive vessel positions linked as passages, allocated UK domestic / crown dependencies / UK international / transit
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Key headlines

- More complete activity dataset for vessels on domestic voyages, including vessel categories not previously covered
- Improved engine emission calculation, and accounts for source not previously covered
- Increased domestic emissions compared to existing NAEI
- Model estimates compare well to leading academics’ European shipping inventories
- Low uncertainty emission calculation for most large vessels (85% of total emissions)
- More robust spatial allocation of inventory
- Results are sensitive to the approach taken to define domestic/international
  - High uncertainty in dom./int. allocation when vessels go out of AIS range
Increased (2.5x) 2014 fuel consumption compared to existing NAEI Results sensitive to approach taken to define domestic/international DOM Domestic CD Crown Dependencies

- Fuel oil
- Gas oil (722 kt)

New model DOM+CD
- Fuel oil
- Gas oil (1811 kt)

In addition to fuel oil and gas oil, inland waterways also includes approx. similar quantities of DERV and petrol as gas oil.

CD adds ~1.5% fuel consumption

Scope of new model:
- 1A4ciii Fishing
- 1A3dii Domestic Water-borne navigation (non-fishing)
- Between UK and Overseas Territories
- Naval
- Inland waterways
Results

Domestic NOx emissions (NECD scope match)
Included: National navigation (inc. inland waterways) + fishing + naval + Gib.
Excluded: Crown Dependencies, OTs other than Gib.

- NECA taken into account
Domestic SO$_2$ emissions (NECD scope match)
Included: National navigation (inc. inland waterways) + fishing + naval + Gib.
Excluded: Crown Dependencies, OTs other than Gib.
Domestic PM$_{2.5}$ emissions (NECD scope match)
Included: National navigation (inc. inland waterways) + fishing + naval + Gib.
Excluded: Crown Dependencies, OTs other than Gib.

2017 shipping inventory
Including shipping emissions for 1A3dii, 1A4ciii and 1A5b (excluding military aircraft)

2018 shipping inventory
Including shipping emissions for 1A3dii, 1A4ciii and 1A5b (excluding military aircraft)
Results

Domestic NMVOC emissions (NECD scope match)
Included: National navigation (inc. inland waterways) + fishing + naval + Gib.
Excluded: Crown Dependencies, OTs other than Gib.

2018 shipping inventory
Including shipping emissions for 1A3dii, 1A4ciii and 1A5b (excluding military aircraft)

2017 shipping inventory
Including shipping emissions for 1A3dii, 1A4ciii and 1A5b (excluding military aircraft)
Shipping inventory – reporting

- **Previous approach:**
  - Domestic: NAEI inventory for domestic (fuel used estimate)
  - International (memo item): [DUKES total] minus [Domestic]
  → Total domestic+international matches DUKES total marine fuel sold

- **New approach:**
  - Domestic: New shipping model (fuel used estimate)
  - International (memo item): DUKES international (fuel sold estimate)
  → Total domestic+international will not match DUKES total marine fuel sold


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