



# Port Emissions and Effects on Health

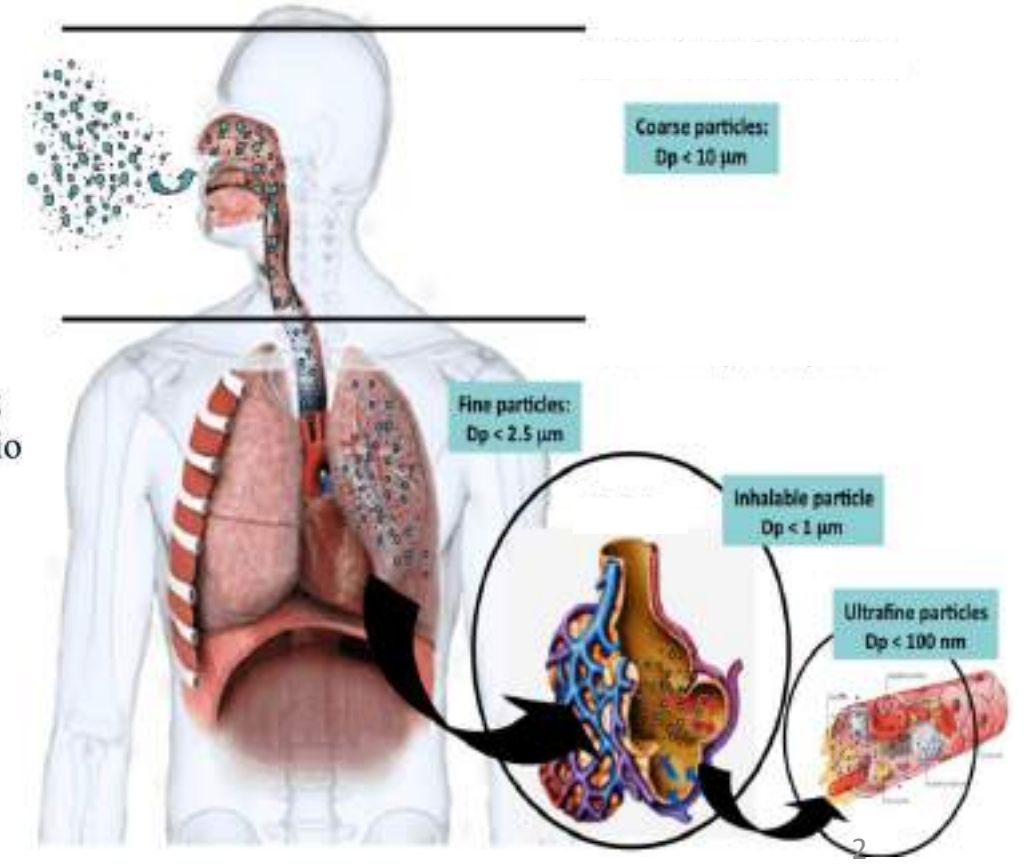
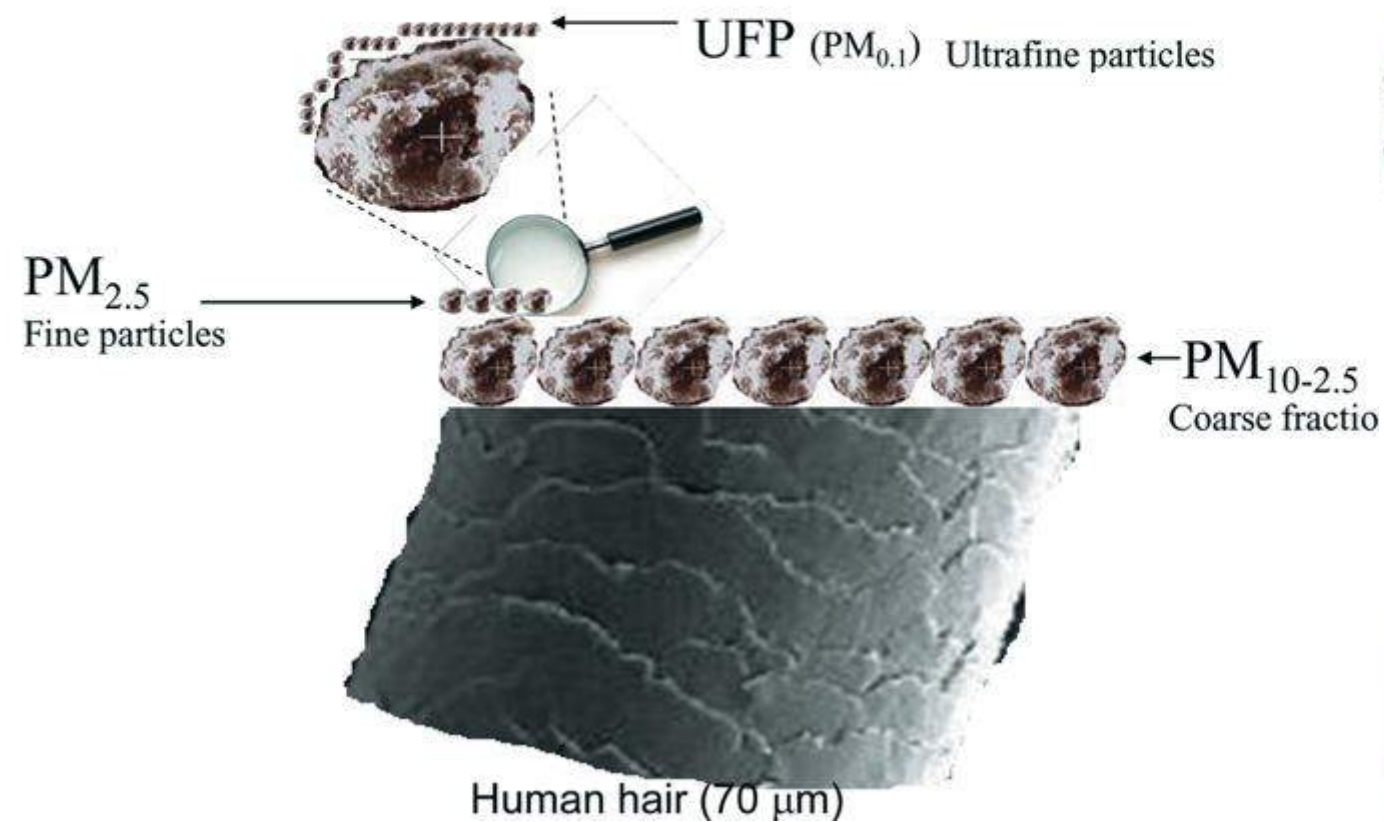
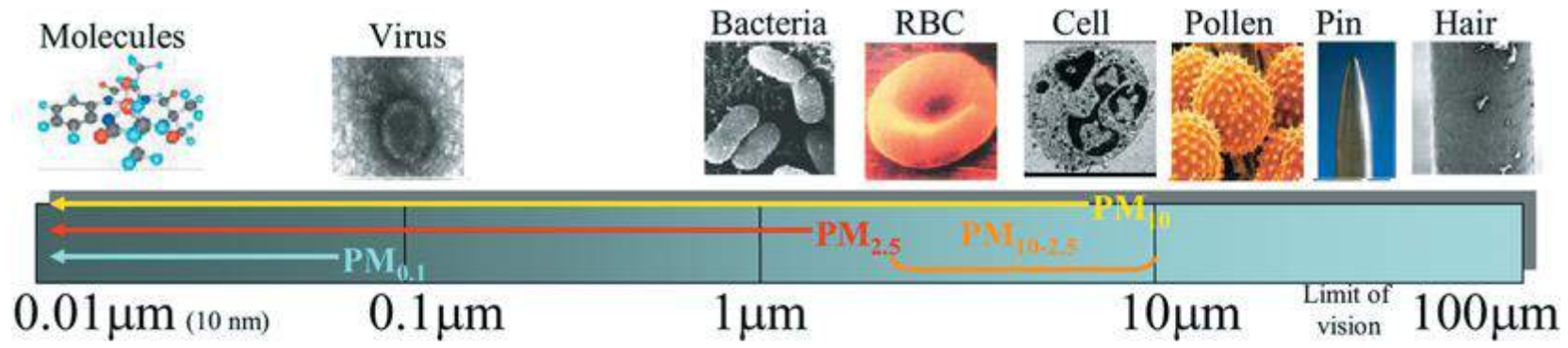
Dr Matt Loxham

Faculty of Medicine



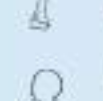
University of Southampton

OceanWise Workshop 26<sup>th</sup> November 2019

# Airborne Particulate Matter



# How does air pollution affect us?

	<b>Brain:</b> Stroke, Dementia, Parkinson's Disease
	<b>Eye:</b> Conjunctivitis, Dry Eye Disease, Blepharitis, Cataracts
	<b>Heart:</b> Ischemic Heart Disease, Hypertension, Congestive Heart Failure, Arrhythmias
	<b>Lung:</b> Chronic Obstructive Pulmonary Disease, Asthma, Lung Cancer, Chronic Laryngitis, Acute and Chronic Bronchitis
	<b>Liver:</b> Hepatic Steatosis, Hepatocellular carcinoma
	<b>Blood:</b> Leukemia, Intravascular Coagulation, Anemia, Sickle Cell Pain Crises
	<b>Fat:</b> Metabolic Syndrome, Obesity
	<b>Pancreas:</b> Type I and II Diabetes
	<b>Gastrointestinal:</b> Gastric Cancer, Colorectal Cancer, Inflammatory Bowel Disease, Crohn's Disease, Appendicitis
	<b>Urogenital:</b> Bladder Cancer, Kidney Cancer, Prostate Hyperplasia
	<b>Joints:</b> Rheumatic Diseases
	<b>Bone:</b> Osteoporosis, Fractures
	<b>Nose:</b> Allergic Rhinitis
	<b>Skin:</b> Atopic Skin Disease, Skin Aging, Urticaria, Dermographism, Seborrhea, Acne

Allergy: allergic sensitization

Blood and blood vessels: endothelial dysfunction, atherosclerosis, thrombosis, impaired hemoglobin formation; carboxyhemoglobinemia

Bone: bone demineralization

Brain: cognitive dysfunction; impaired psychomotor development and intelligence development; social stress; mood disorders; unfavorable emotional symptoms

Cancer: shortened telomere length; detrimental expression of genes involved in DNA damage and repair; inflammation; immune and oxidative stress response; epigenetic effects

Diabetes and metabolism: increased glycosylated hemoglobin, insulin resistance, leptin, and endothelin-1 levels; lower glucagon-like peptide-1, ghrelin, and glucagon levels

Eye: increased tearing (acutely) and drying (chronically)

Heart: changes in heart rate, BP, and vascular tone; reduced heart rate variability; conduction defects

Kidney: decreased glomerular filtration rate; increased mortality in patients undergoing dialysis

Respiratory tract: cough, phlegm, difficulty breathing, and bronchial hyperresponsiveness; exacerbations of many respiratory conditions; impeded lung development; transformation of asthma into COPD; decreased exercise performance; decreased spirometric measurements (lung function)

Reproductive: premature birth; low birth weight; poor sperm quality; impaired fetal growth; intrauterine inflammation; reduced fertility rates; increased risk of miscarriage, spontaneous abortions, premature rupture of membranes, and preeclampsia. Exposure during pregnancy is associated with childhood neoplasms and childhood asthma

Skin: aging

Sleep: associated with increased sleep apnea symptoms

Overall: shortened life expectancy, with additive or multiplicative effects in vulnerable persons

# PM Regulations

Source	PM <sub>10</sub> ( $\mu\text{g}/\text{m}^3$ )		PM <sub>2.5</sub> ( $\mu\text{g}/\text{m}^3$ )	
	1 year	24 hours	1 year	24 hours
WHO [2]	20	50	10	25
European Union	40	50	25	
United States	50	150	12	35
California	20	50	15	65
Japan		100	12	65
Brazil	50	150		
Mexico	50	120	15	65
South Africa	60	180	15	65
India (sensitive populations/ residential/industrial)	50/60/120			
China (Classes I/II/III)	40/100/150	50/150/250		35

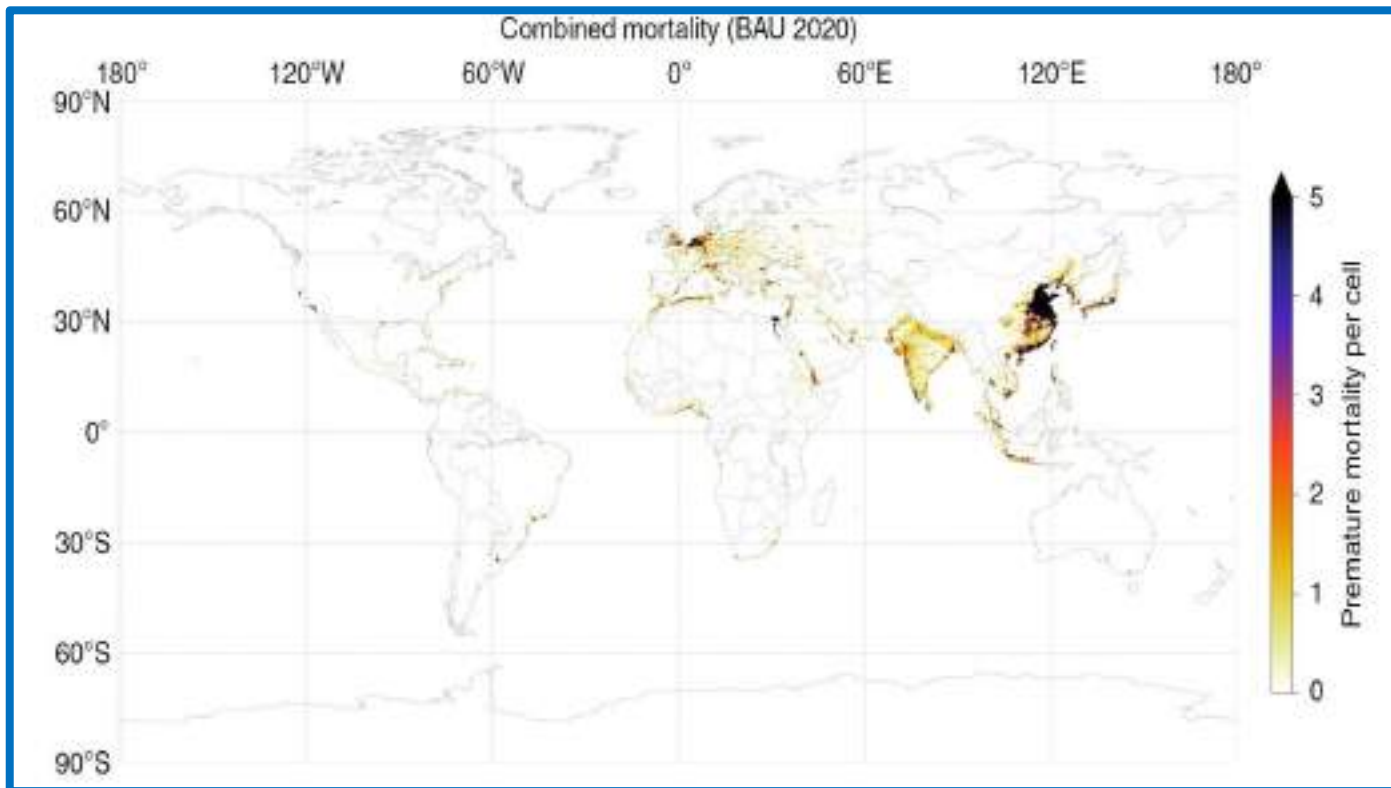


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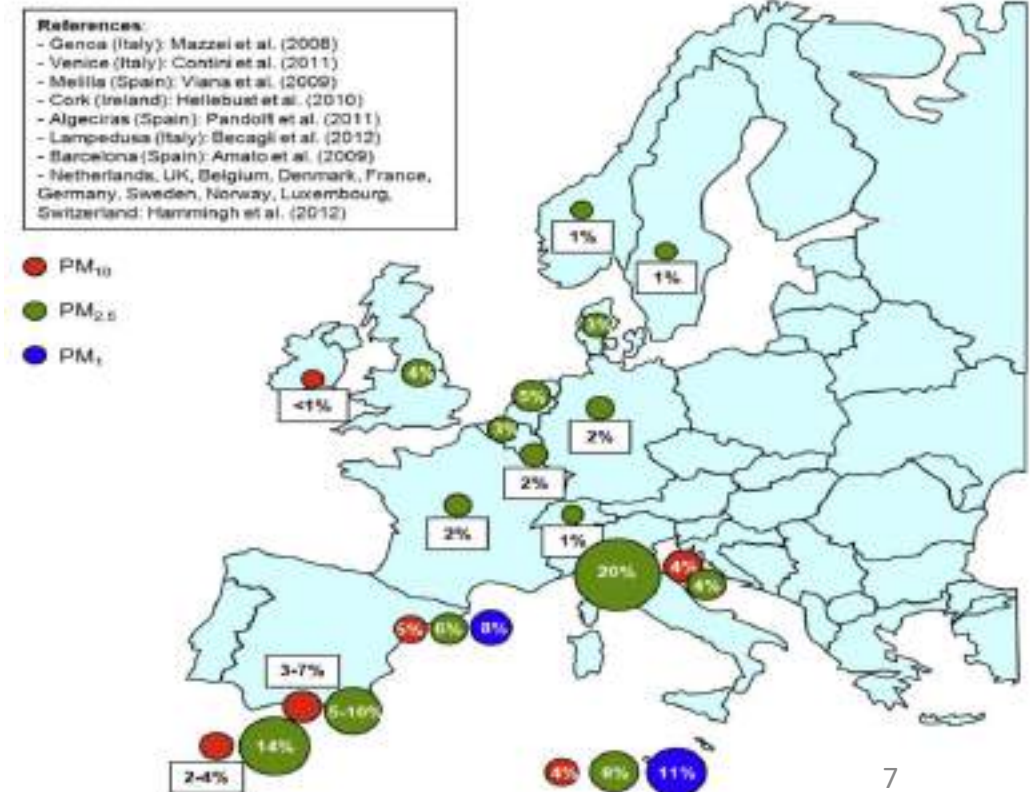


# Shipping PM and health

- Ocean-going ships emit ~1.5 million tonnes respirable PM.
- 403,000 premature deaths, generally lung cancer (54,000) and CV (349,000) deaths, attributable to shipping-related fine PM.
- 14 million cases of childhood asthma per year.



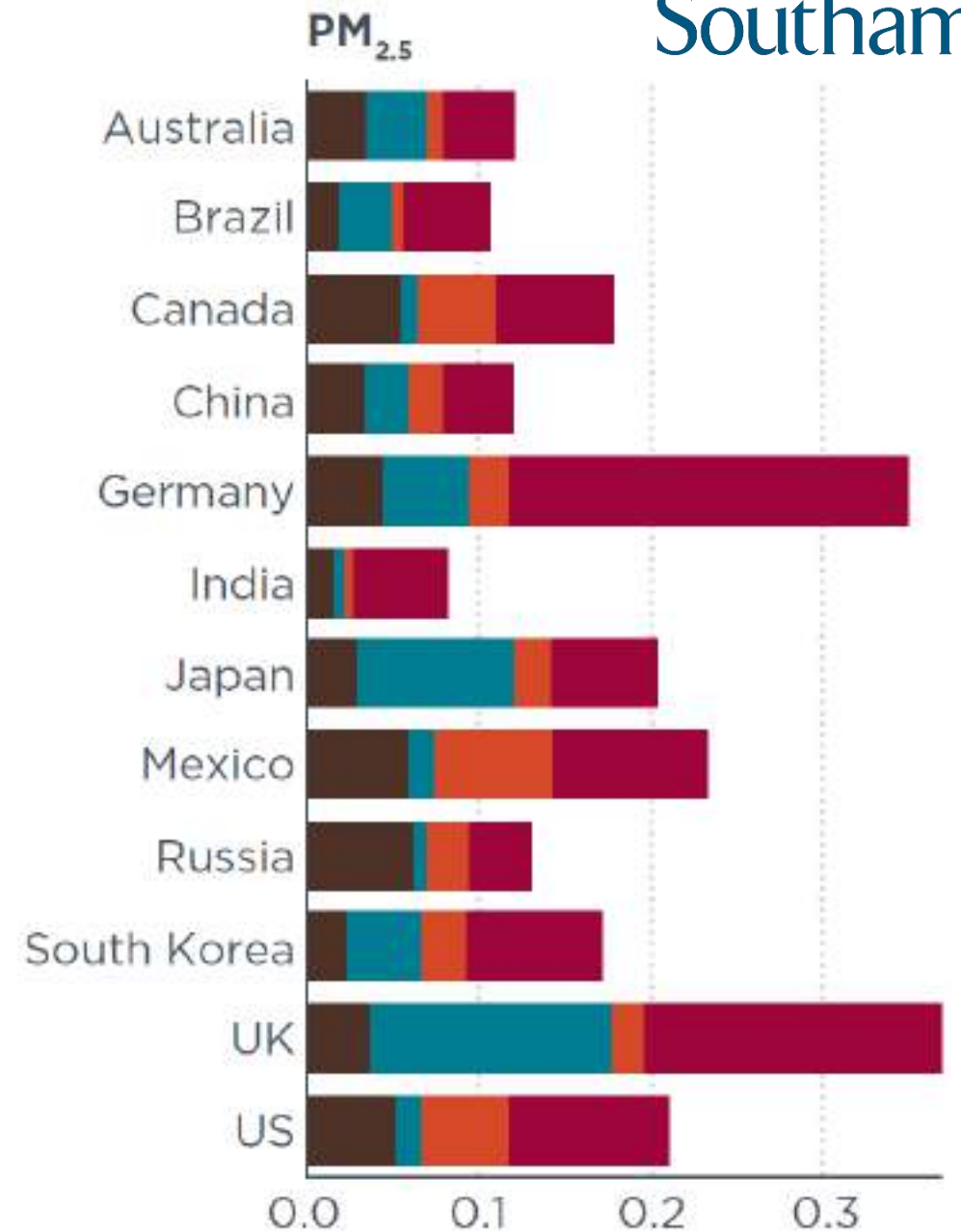
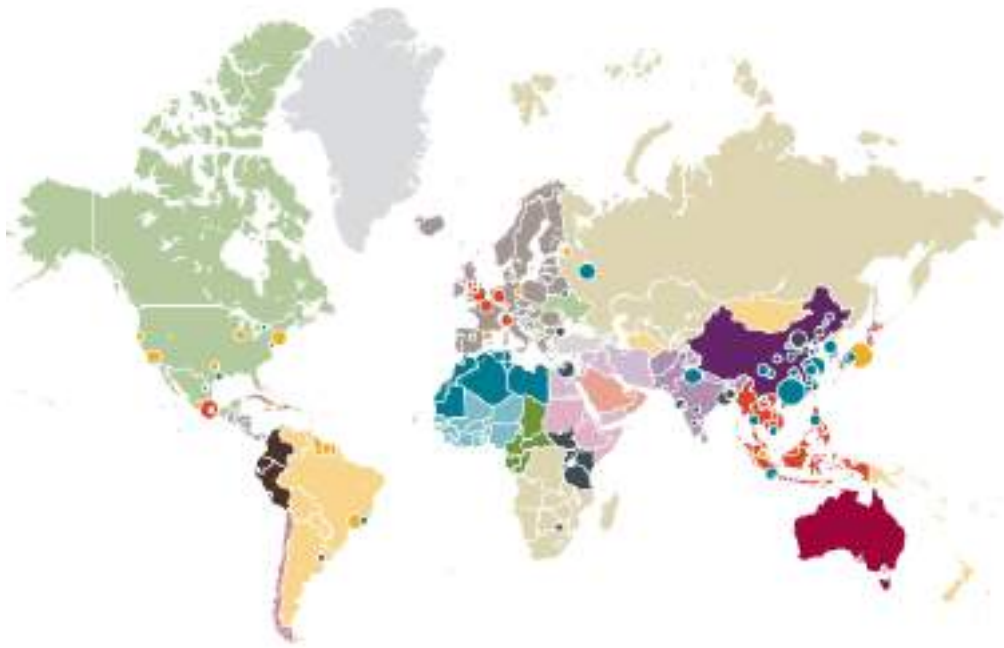
Sofiev et al (2018) Nature Communications 9:406



Viana et al (2014) Atmospheric Environment 90:96

# A GLOBAL SNAPSHOT OF THE AIR POLLUTION-RELATED HEALTH IMPACTS OF TRANSPORTATION SECTOR EMISSIONS IN 2010 AND 2015

SUSAN ANENBERG, JOSHUA MILLER, DAVEN HENZE, RAY MOLIARES





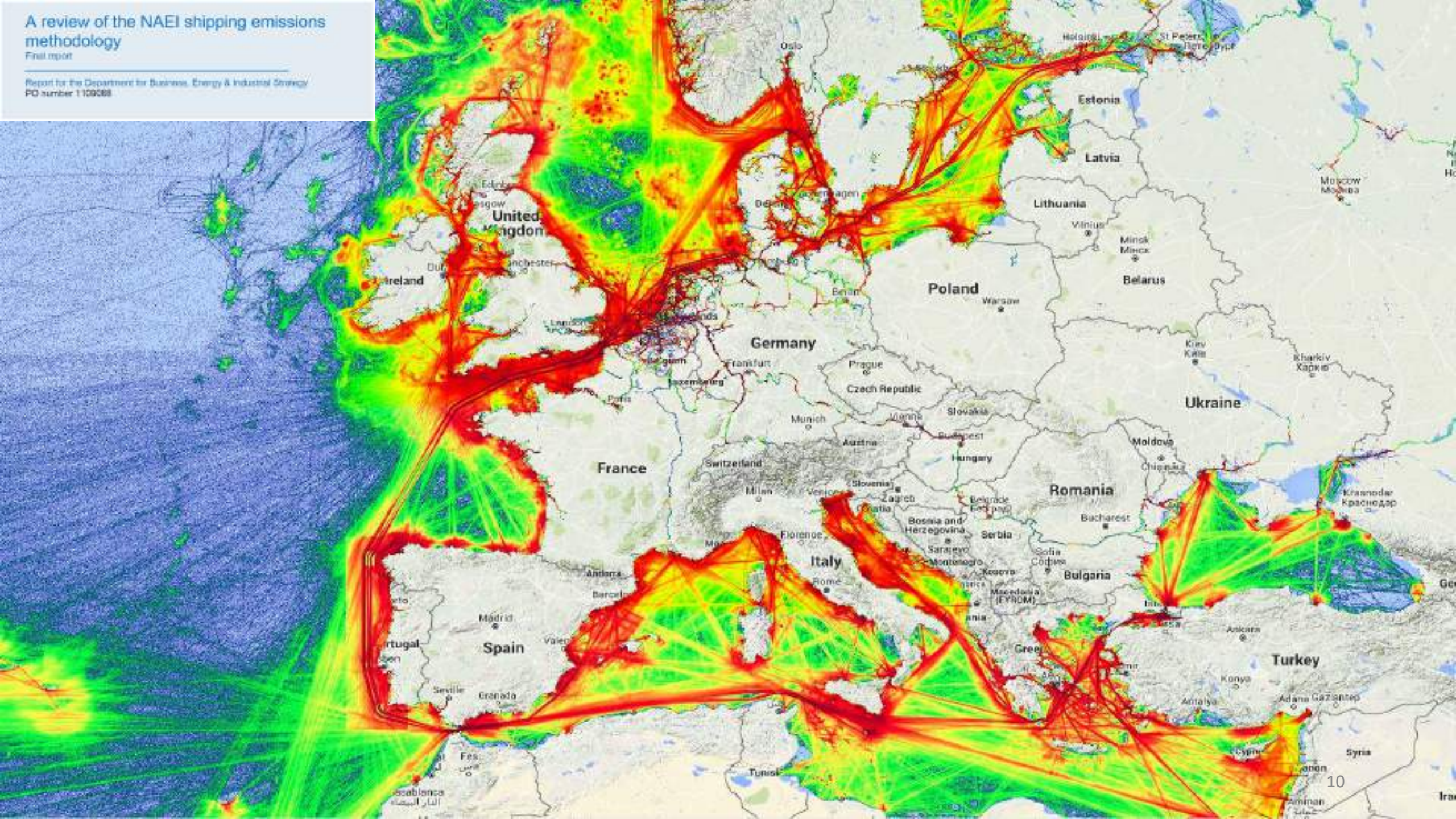
# The contribution of shipping to UFPM

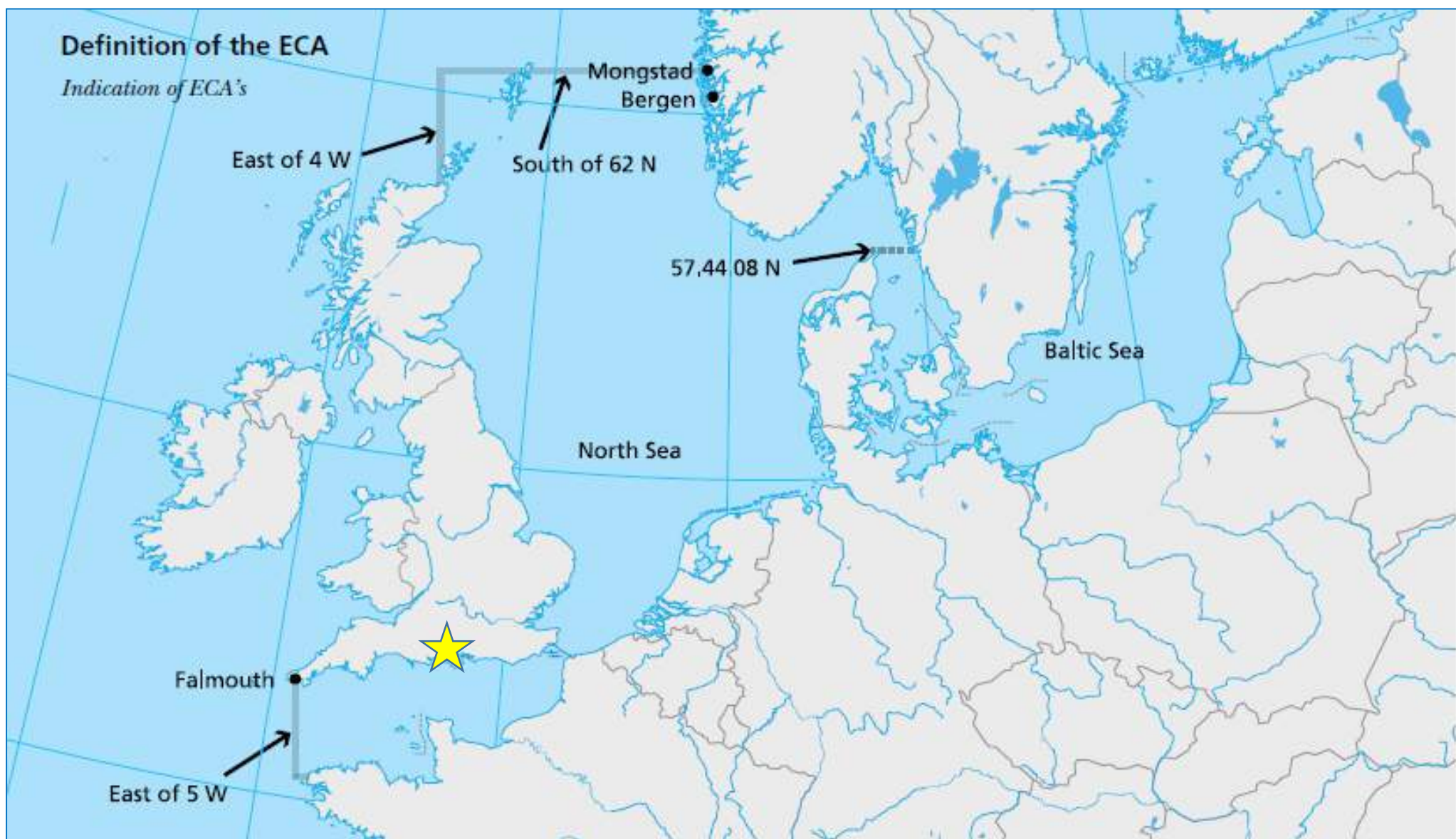
- 65-70% of PNC of up to 50,000 particles/cm<sup>3</sup> attributed to shipping when wind was blowing towards coast. Gonzales et al (2011) Atmospheric Environment 45(28)
- Similarly in Cork, Ireland, up to 212,000 particles/cm<sup>3</sup>. Healy et al (2009) Atmospheric Environment 43(40)
- Near port of LA, port-related activities (shipping, train/road haulage) contributed 11x more PM mass and 38x more PM number than non-port roads. Mousavi et al (2018) Atmospheric Environment 195
- 50 m from hotelling ships in Italy, 50% of the particles by number, but much less by mass, come from ship emissions. Merico et al (2016) Atmospheric Environment 139
- Ship ultrafine PM also travel long distances – make up 19% of particle number up to 60km from Danish shipping lane, and increase PC from 2,000 → 20,000 particles/cm<sup>3</sup> 20km away from Calais Kivekas et al (2014) Atmospheric Chemistry and Physics 14, Ledoux et al (2018) Journal of Environmental Sciences 71

# A review of the NAEI shipping emissions methodology

Final report

Report for the Department for Business, Energy & Industrial Strategy  
PO number 1100268





**Within SECA (and all EU ports) – 0.1% sulphur OR HFO with exhaust cleaning**

**Outside SECA – 3.5% sulphur (0.5% in 2020)**



**1,700,000 cruise ship passengers per year**



**820,000 road vehicle imports/exports per year**



**20,000,000 tons of crude oil per year at Fawley**



**1,500,000 shipping containers per year**

Review

## Vanadium Compounds as PTP Inhibitors

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## Role of Oxidative Stress in the Action of Vanadium Phosphotyrosine Phosphatase Inhibitors

REDOX INDEPENDENT ACTIVATION OF NF- $\kappa$ B\*

(Received for publication, December 5, 1996, and in revised form, February 19, 1997)

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Jeffrey A. Ledbetter, and Gary L. Schieven<sup>§</sup>**

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# Future Work

- Mechanistic toxicology
  - Different cell types
  - Alternative endpoints
- Source apportionment to determine impact of ship emissions on airborne PM across Southampton
- More spatially resolved monitoring of ship emissions across the Southampton area

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**Associated British Ports,  
Southampton**

Thank you!  
Any Questions?

