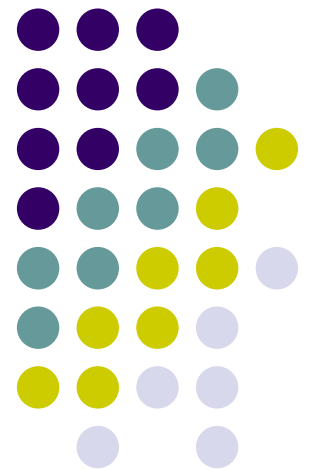


# Overview of U.S. Commitments under MARPOL Annex VI



Walker Smith and Angela Bandemehr  
U.S. Environmental Protection Agency

April 16, 2010  
Veracruz, Mexico



# Overview



- Recent Annex VI Amendments
- U.S./Canada/France Emission Control Area
- Emission Control Area Designation Criteria

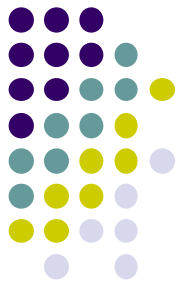


# International Marine Standards



- United Nations
  - International Maritime Organization (IMO)
  - MARPOL – International Convention on the Prevention of Pollution from Ships
  - [www.imo.org](http://www.imo.org)
- MARPOL Annex VI (Air Pollution from Ships)
  - Adopted in 1997
  - IMO treaty that sets international air pollution standards for ships





# Recent Annex VI Amendments

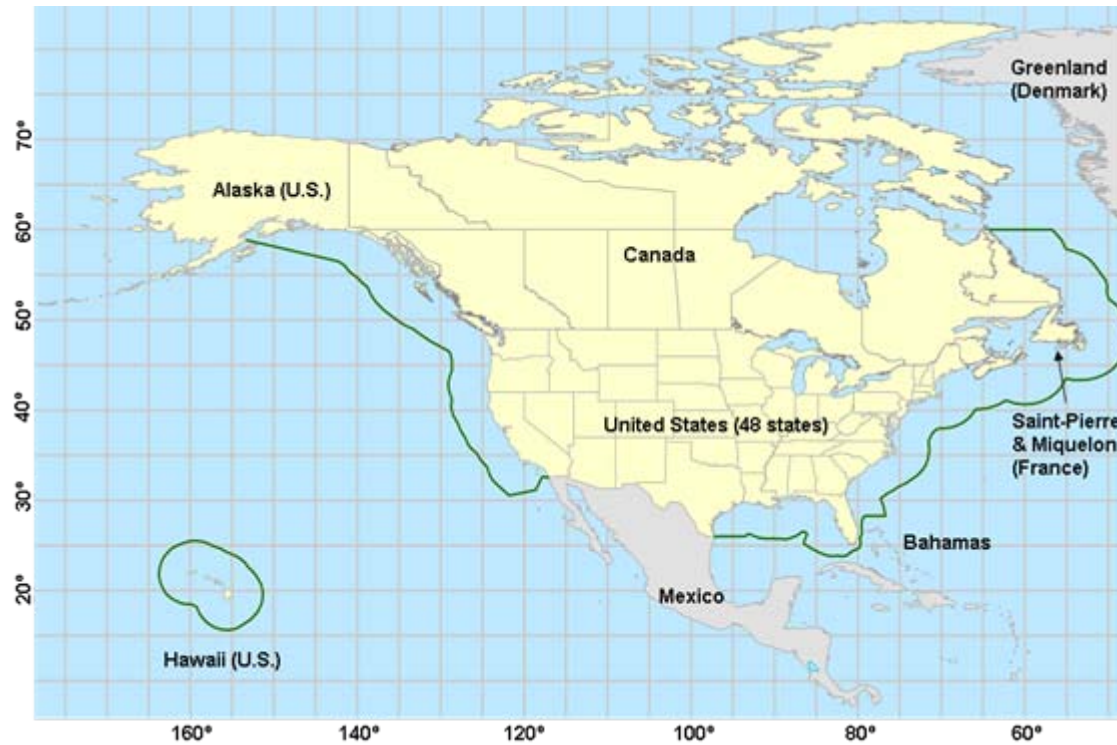
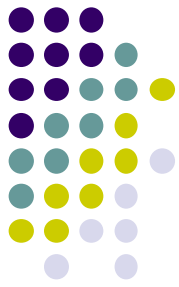
- Annex VI amendments (enter into force July 2010)
- Global NO<sub>x</sub> Controls
  - Tier 2: ~20% reduction below Tier 1 for new vessels (2011)
  - Existing engine standards
- Global PM and SO<sub>x</sub> controls
  - 2012: 3.50% fuel sulfur
  - 2020: 0.50% fuel sulfur
    - Could be delayed to 2025; subject to 2018 fuel availability review
- A country (or countries) can propose to designate an Emission Control Area, where more stringent standards apply

# U.S./Canada/France Emission Control Area (ECA)

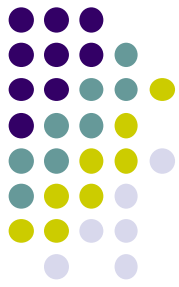


- On March 27, 2009, the U.S. and Canada Governments submitted a joint ECA proposal
- On March 26, 2010, at MEPC 60, the Committee adopted the proposal and designated an ECA for specific portions of the coastal waters of the United States, Canada and France
- [www.epa.gov/otaq/oceanvessels.htm](http://www.epa.gov/otaq/oceanvessels.htm)

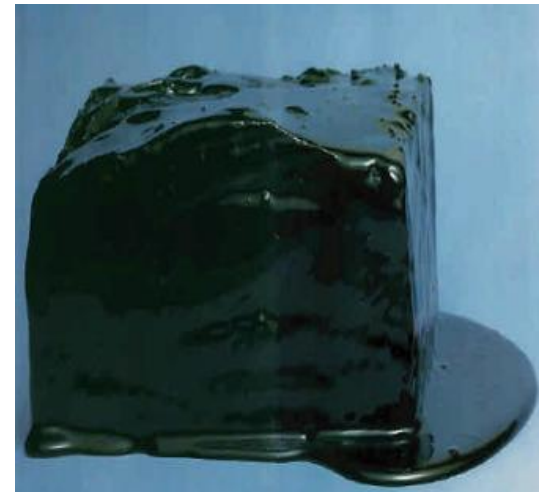
# North American ECA



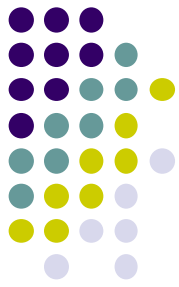
# Emission Control Area Standards



- ECA NOx Controls
  - Tier 3 NOx 80% reduction new vessels (2016)
- ECA PM and SOx Controls
  - 1.00% Fuel Sulfur (2012)
  - 0.10% Fuel Sulfur (2015)
    - Up to 96% reduction in SOx
    - ~85% reduction in PM



# ECA Designation

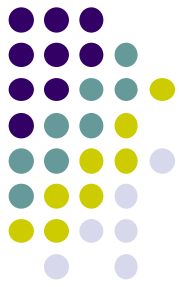


- Country must be party to MARPOL Annex VI
- Develop ECA proposal
  - Eight designation criteria

*An Emission Control Area should be considered for adoption by the [IMO] if supported by a demonstrated need to prevent, reduce, and control emissions of NO<sub>x</sub> or SO<sub>x</sub> and particulate matter or all three types of emissions ... from ships. (Appendix III, para 1.3)*

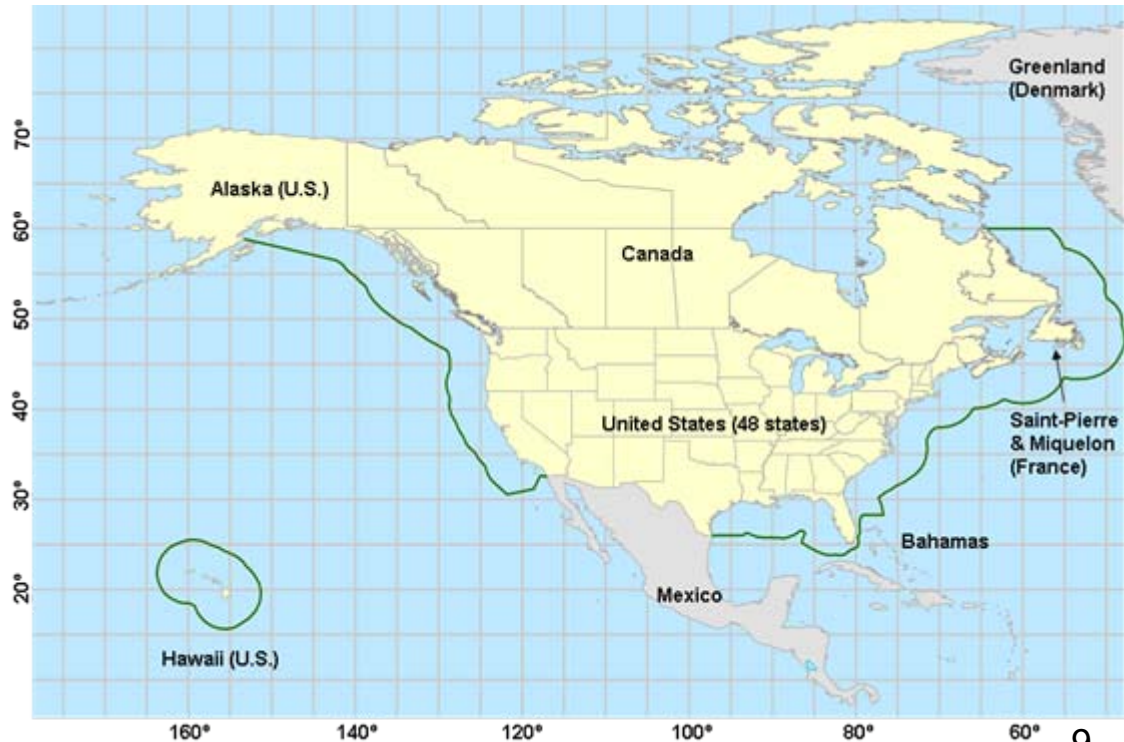


# Criterion 1



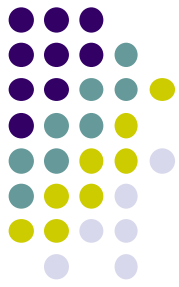
*a clear delineation of the proposed area of application, along with a reference chart on which the area is marked;*

- The proposal included a chart and general description of the proposed area. At MEPC 59, we were directed to provide more specific coordinates for the area.
- France is part of the ECA on behalf of the Saint Pierre and Miquelon archipelago



# Criterion 2

*the type or types of emission(s) that is or are being proposed for control (i.e. NO<sub>x</sub> or SO<sub>x</sub> and particulate matter or all three types of emissions);*

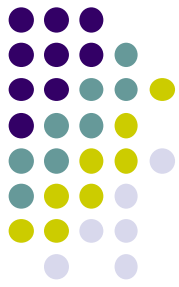


- The proposal included a statement that “the United States and Canadian Governments propose designation of an ECA to control emissions of NO<sub>x</sub>, SO<sub>x</sub> and PM.”
- The proposal described these pollutants and their derivatives (ground level ozone, indirect PM, deposition of nitric and sulphuric acids) and their impacts on human health and the environment

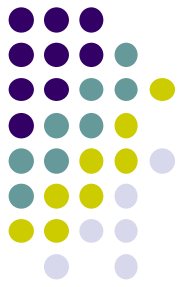
# Criterion 3

*a description of the human populations and environmental areas at risk from the impacts of ship emissions;*

- The proposal described the U.S. geography and population distribution
- More than half of the U.S. population lives in coastal regions, where there is the highest exposure to ship emissions



# Criterion 4



*an assessment that emissions from ships operating in the proposed area of application are contributing to ambient concentrations of air pollution or to adverse environmental impacts. Such assessment shall include a description of the impacts of the relevant emissions on human health and the environment, such as adverse impacts to terrestrial and aquatic ecosystems, areas of natural productivity, critical habitats, water quality, human health, and areas of cultural and scientific significance, if applicable. The sources of relevant data including methodologies used shall be identified;*

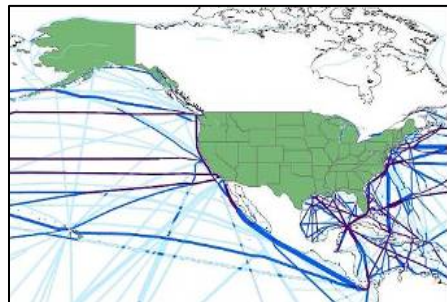
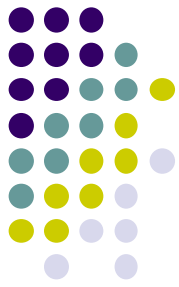
- A number of approaches could be used to address this criterion

# U.S. Approach to Criterion 4

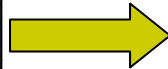


- Although an assessment of impacts of ship emissions on human health and the environment does not require detailed modeling, the USG performed inventory and air quality modeling, as well as benefits analysis, to estimate the contribution of ships to ambient concentrations of NO<sub>x</sub>, SO<sub>x</sub>, and particulate matter.
  - The following slides summarize this methodology
- However, other methodologies can be used for this analysis
  - North Sea and Baltic SECA proposals did not quantify human health impacts

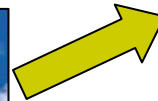
# U.S. Impact Modeling



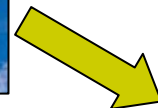
Emissions  
Inventory



Air Quality  
Modeling

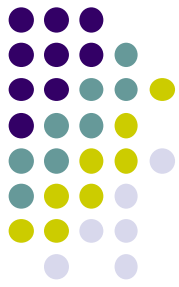


Health Effects  
Modeling

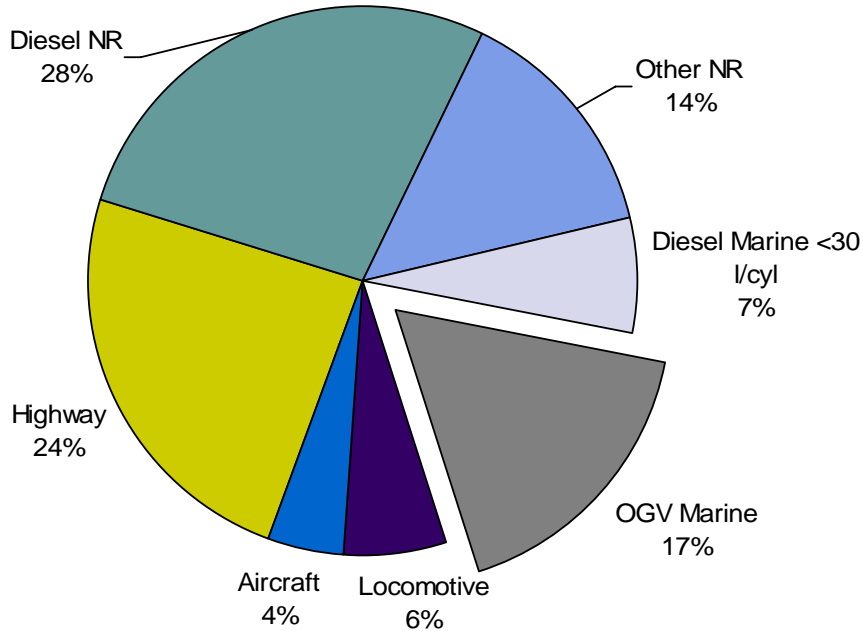


Ecosystem  
Results

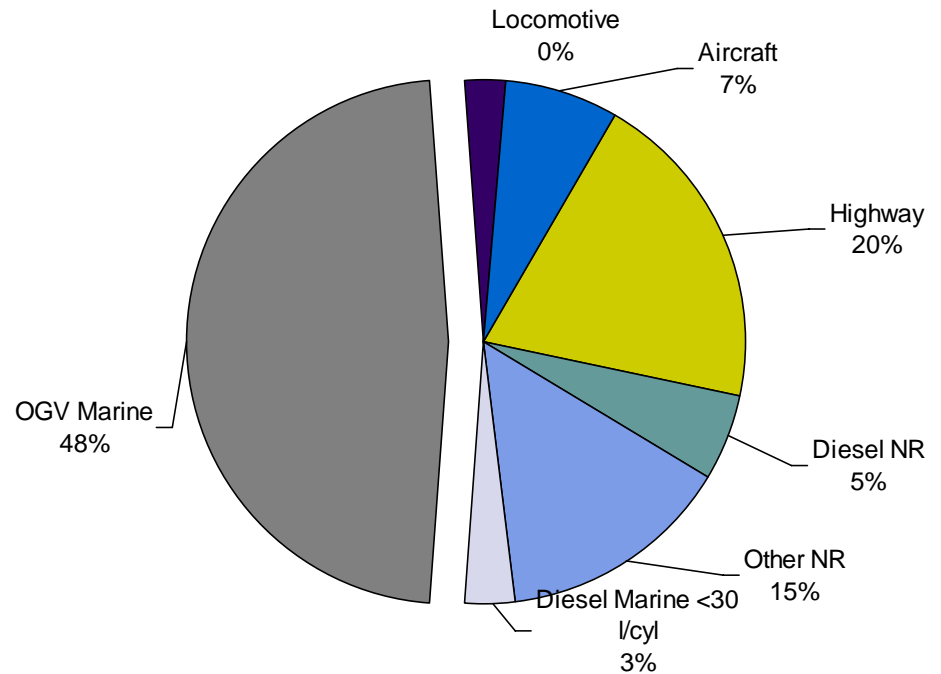
# Ship Contribution to U.S. PM Inventory



## 2009 Mobile Source PM2.5 Inventory



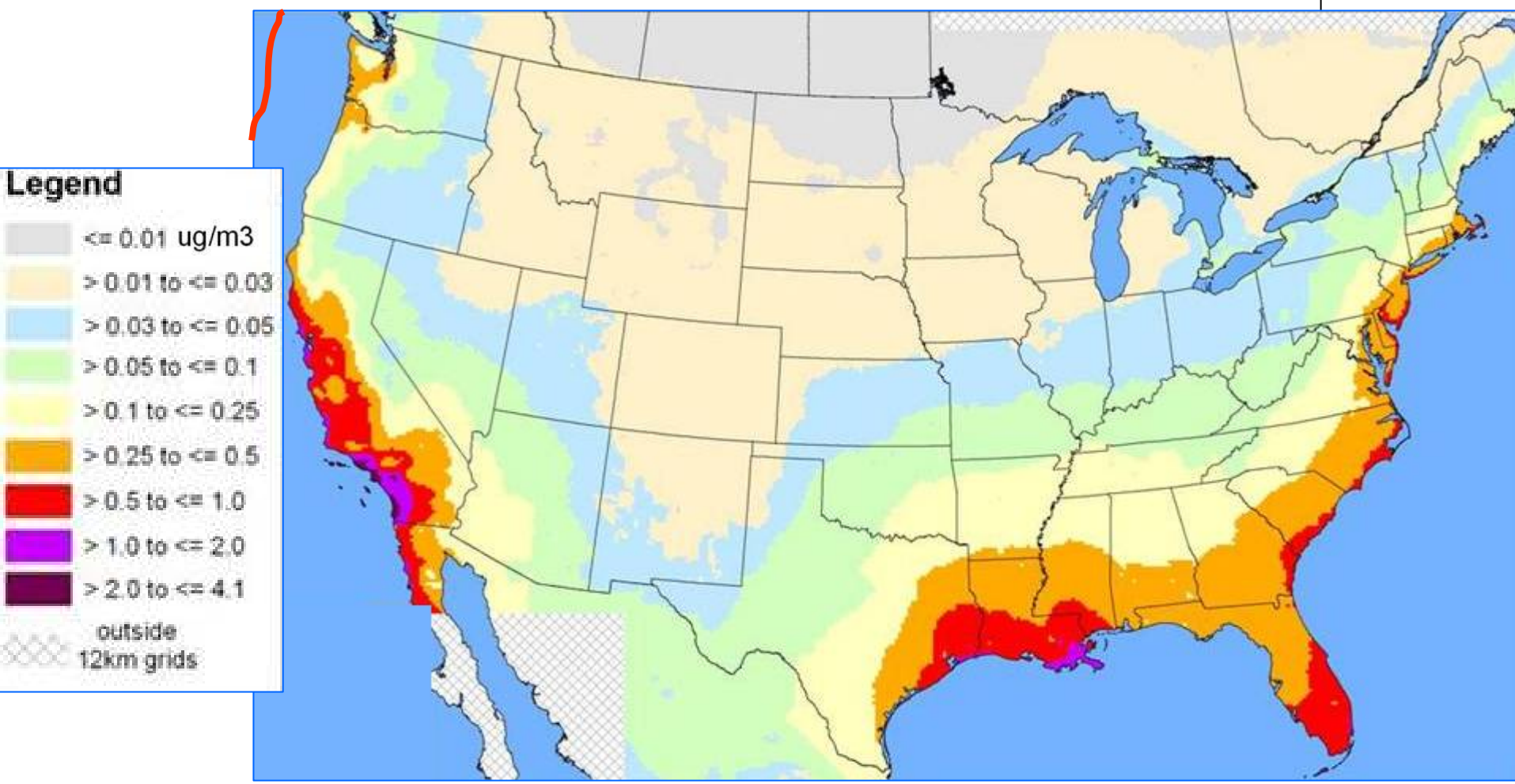
## 2030 Mobile Source PM2.5 Inventory



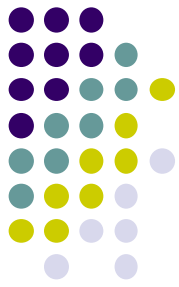
Source of inventory estimates: C3 Marine NPRM (July, 2009)  
 Does not reflect IMO MARPOL Annex VI Amendments (October 2008)



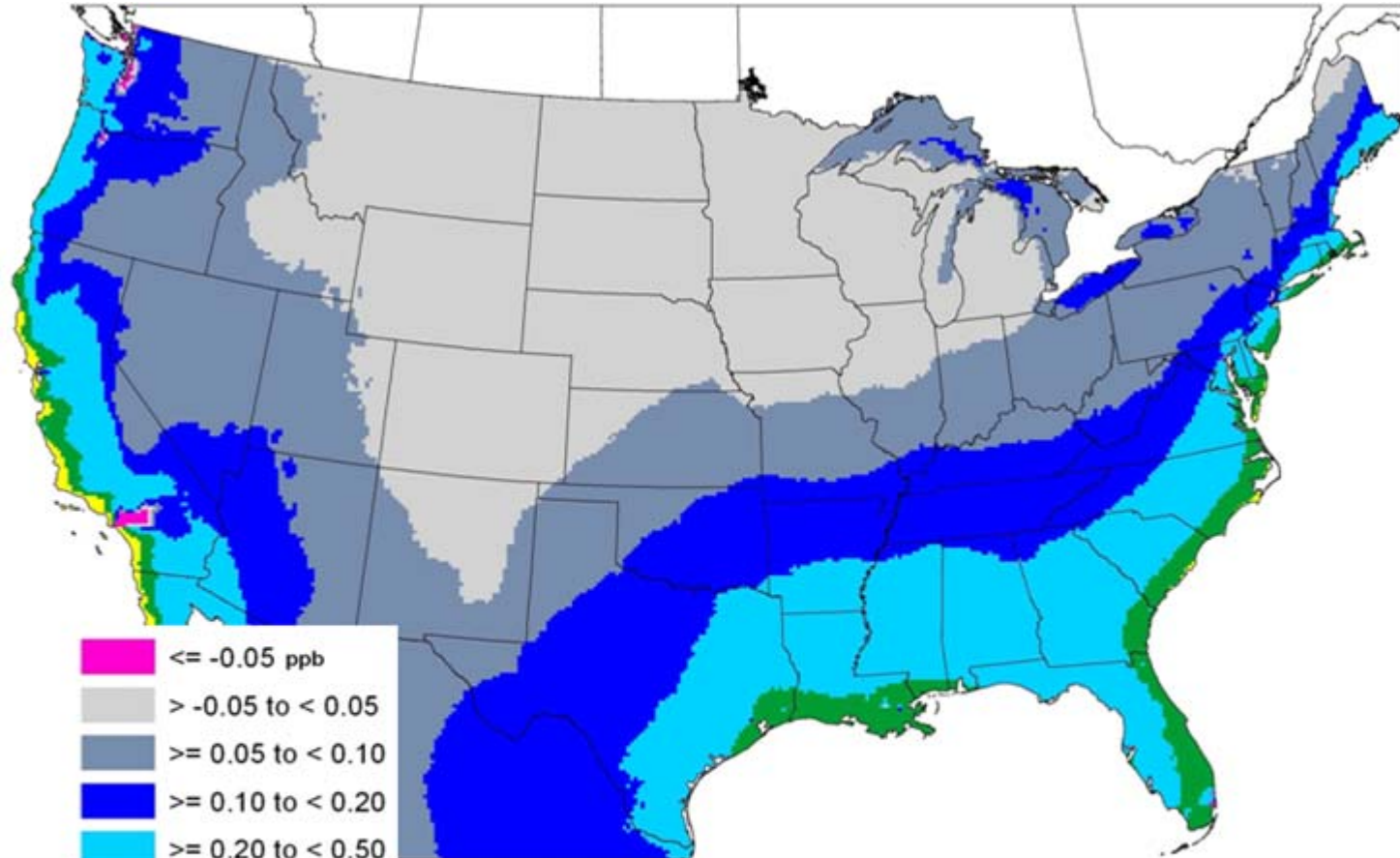
# 2020 Potential ECA PM<sub>2.5</sub> Reductions







# 2020 Potential ECA Ozone Reductions



**Ozone (Smog) reductions from the proposed ECA reach well into the U.S. interior**

# Human Health Impacts



## Estimated PM<sub>2.5</sub>- and Ozone-Related Human Health Impacts Associated with Ship Emissions in the U.S. and Canada

Health Effect	2020 Annual Ship-Related Incidence	2020 Annual Reduction in Ship-Related Incidence with an ECA <sup>a</sup>
Premature Mortality <sup>b</sup>	8,100 – 21,000	5,500 – 14,000
Chronic Bronchitis	5,500	3,900
Hospital Admissions <sup>c</sup>	11,000	4,800
Emergency Room Visits	6,700	3,800
Acute Bronchitis	13,000	9,300
Acute Respiratory Symptoms	8,900,000	4,900,000

<sup>a</sup> Based on ship emission inventory reductions due to switching from 2.7% sulphur residual fuel to 0.1% sulphur distillate fuel and an overall fleet NO<sub>x</sub> reduction in the ECA of 23%, in 2020, from Tier II levels. In the long term, a 75% reduction in NO<sub>x</sub> emissions from Tier II levels would be expected in the ECA.

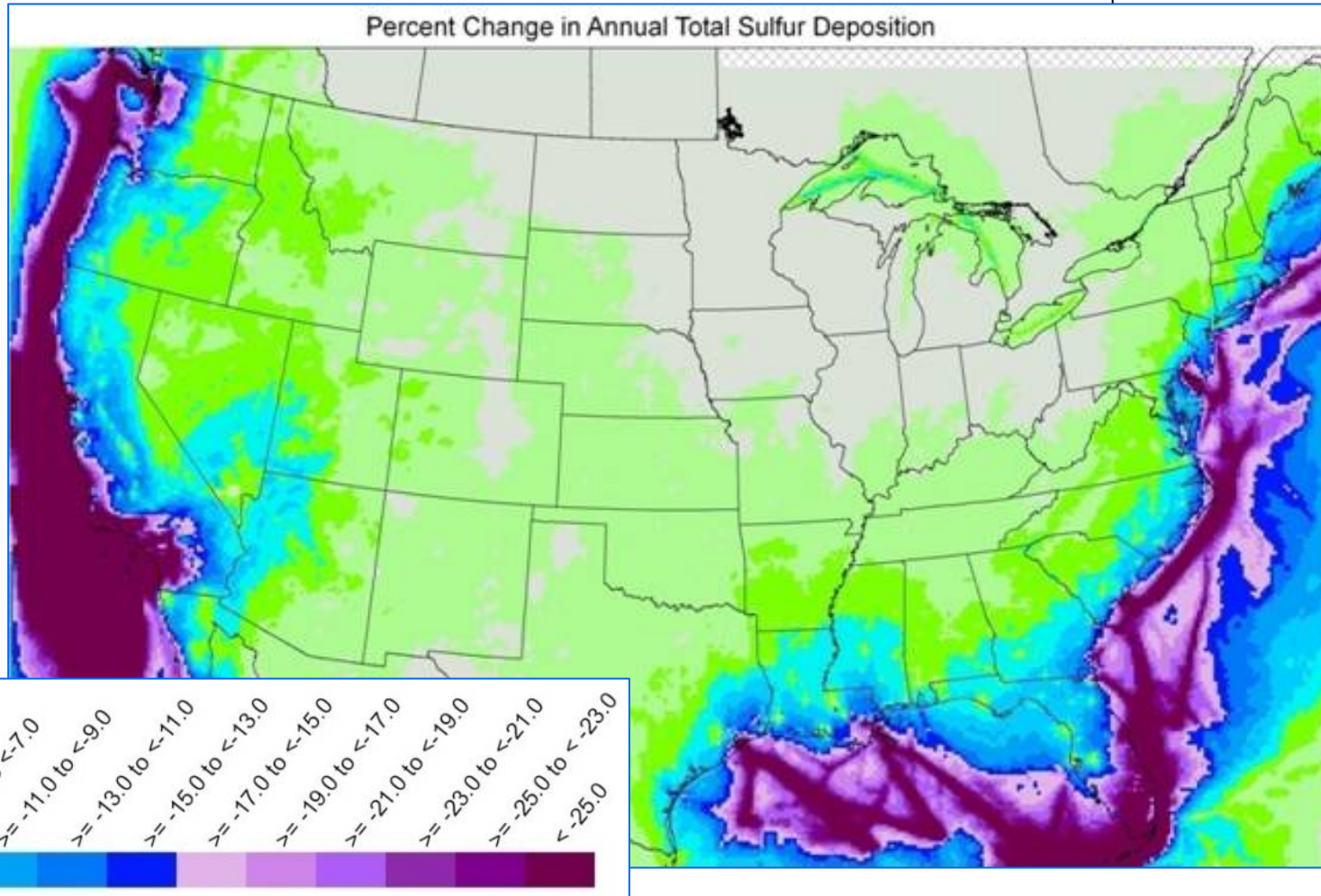
<sup>b</sup> Includes both PM<sub>2.5</sub>- and ozone-related estimates of premature mortality. The range is based on the high- and low-end estimate of incidence derived from several alternative studies used to estimate PM<sub>2.5</sub>- and ozone-related premature mortality in the U.S.

<sup>c</sup> Includes estimates of both cardiovascular- and respiratory-related hospital admissions.

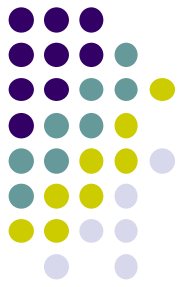
# 2020 Potential Sulfur Deposition Reductions



**Improvements  
in deposition  
for marine and  
terrestrial  
ecosystems**



# Criterion 5

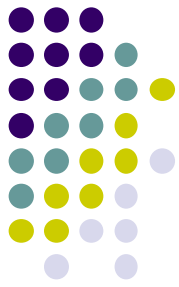


*relevant information, pertaining to the meteorological conditions in the proposed area of application, to the human populations and environmental areas at risk, in particular prevailing wind patterns, or to topographical, geological, oceanographic, morphological, or other conditions that contribute to ambient concentrations of air pollution or adverse environmental impacts;*

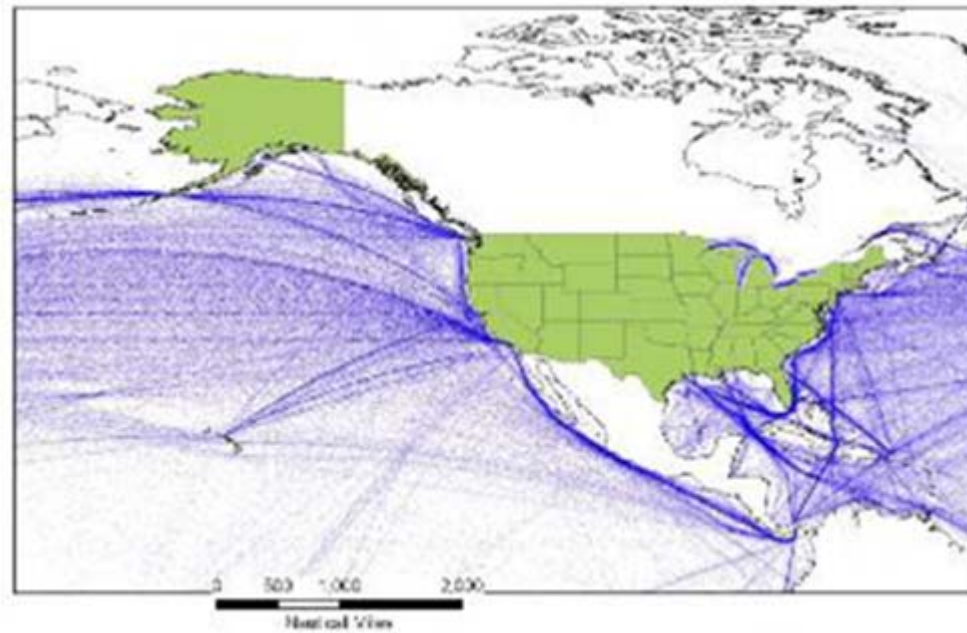
- The relevant meteorological data are included in the U.S. air quality model
- The proposal describes meteorological conditions in the U.S. including wind trajectory data for U.S. coasts

# Criterion 6

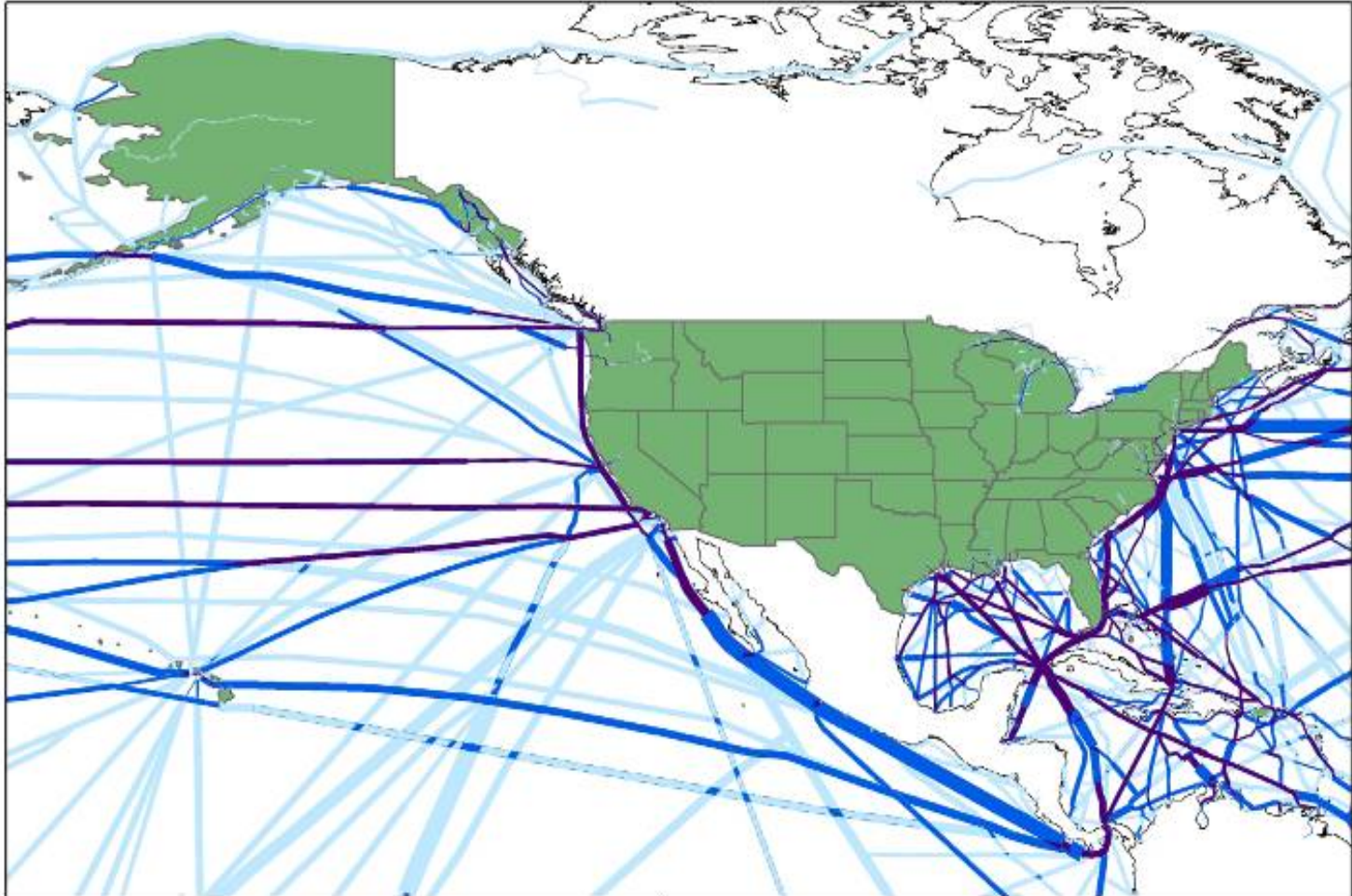
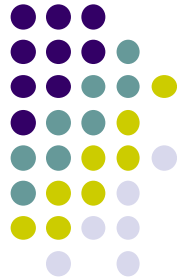
*the nature of the ship traffic in the proposed Emission Control Area, including the patterns and density of such traffic;*



- The relevant ship position data are included in the U.S. air quality model
- The proposal describes shipping traffic near the U.S.



# Location of OGV Emissions

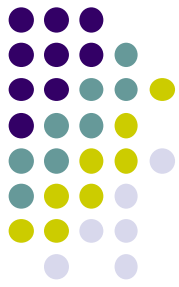


SO<sub>x</sub> (kg / 16 km<sup>2</sup>)

0	500 - 2,000
0 - 500	> 2,000

N  
0 375 750 1,500  
Nautical Miles

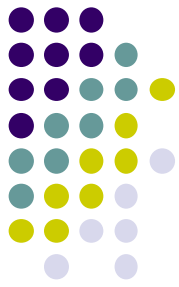
# Criterion 7



*a description of the control measures taken by the proposing Party or Parties addressing land-based sources of NO<sub>x</sub>, SO<sub>x</sub> and particulate matter emissions affecting the human populations and environmental areas at risk that are in place and operating concurrent with the consideration of measures to be adopted in relation to provisions of regulations 13 and 14 of Annex VI; and*

- The proposal presented an overview of the land-based emission control programs in the U.S.
- The proposal noted that “as land-based sources of emissions are increasingly controlled, the contribution of ship emissions to public health and environmental impacts would increase without action to reduce ship emissions.”

# Criterion 8



*the relative costs of reducing emissions from ships when compared with land-based controls, and the economic impacts on shipping engaged in international trade.*

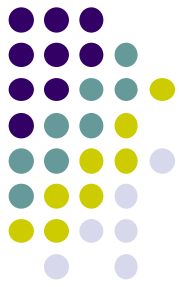
- The proposal describes cost estimates for the engine and fuel standards
- Cost per tonne of emission reduction compared favorably with land-based emission control programs

## **Cost per Tonne of the Proposed ECA**

<b>Pollutant</b>	<b>ECA</b>	<b>Land-Based</b>
NOx	\$2,600/tonne	\$200-\$12,000/tonne
SOx	\$1,200/tonne	\$200-\$6,000/tonne
PM	\$11,000/tonne	\$2,000-\$50,000/tonne



# Cost Studies

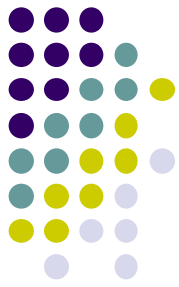


- We performed studies of incremental costs both on a per unit and aggregate basis
- ICF engineering cost study
  - Incremental engine and vessel costs due to exhaust emission and fuel sulfur standards
  - Combined with vessel information to develop aggregate costs
- EnSys refinery modeling
  - Incremental fuel costs from switching from residual fuel to lower sulfur distillate fuel in the ECA
  - Combined with emission (fuel) inventory modeling to develop aggregate costs

# Refinery Modeling



- ECA volume will increase global distillate demand less than 0.9%
- U.S. used the Ensys WORLD model to estimate refinery capacity expansions & prices
  - Same model used by IMO
  - Estimates a price spread between residual and distillate of \$145/ton
  - Total new investment 3 coking units, 3 hydrocrackers, and 2 hydrotreaters
- Earlier modeling contained sensitivity runs for including Mexico in the North American ECA (showed little impact on per tonne fuel costs)

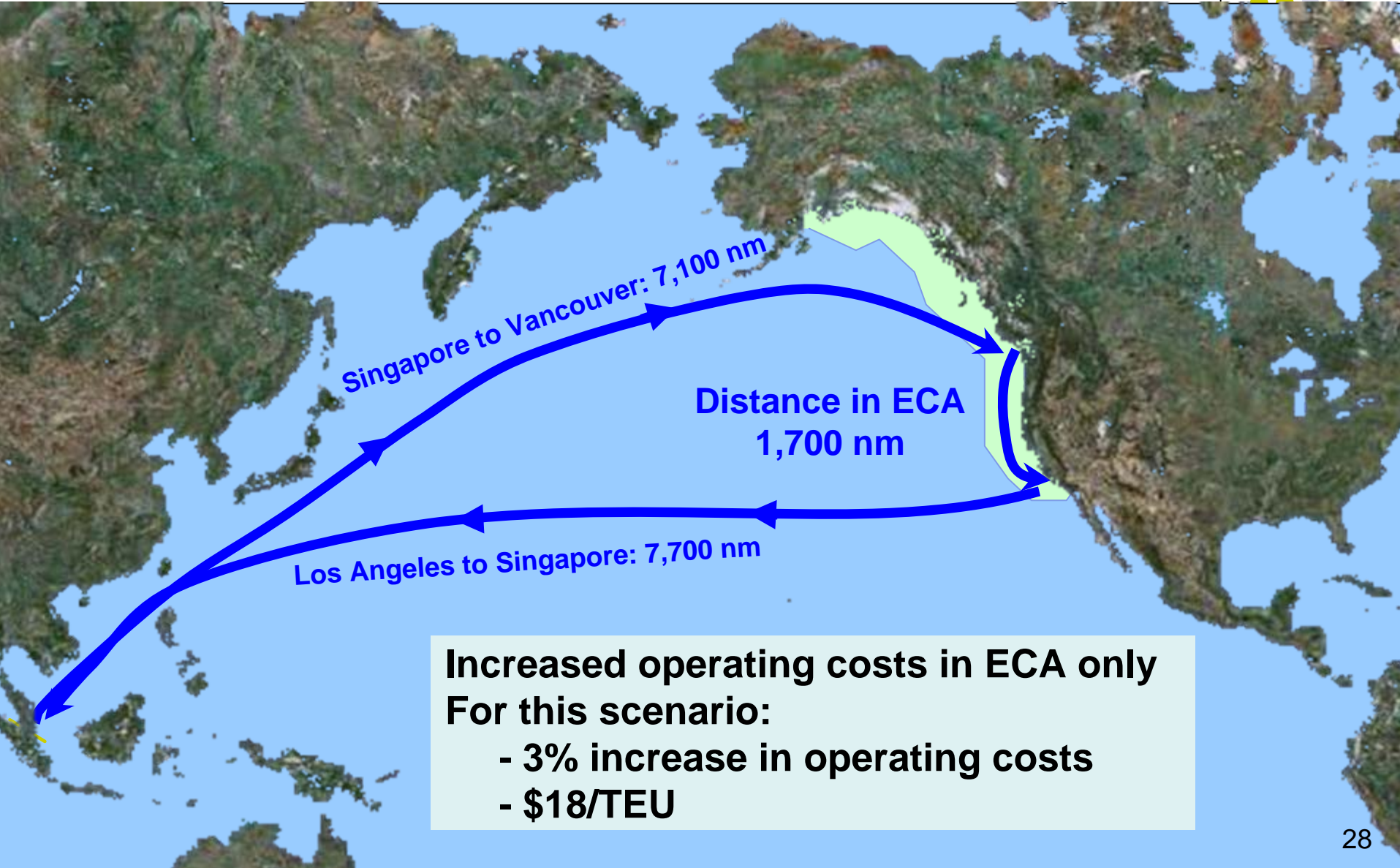


# WORLD Fuel Cost Results

Case	WTI Crude Oil (\$/bbl)	IFO 380 Residual (\$/tonne)	MGO Distillate (\$/tonne)	Differential (\$/tonne)
May 4, 2009 Spot Prices ( <a href="http://www.bunkerworld.com/prices">www.bunkerworld.com/prices</a> )				
Singapore	\$54	\$314	\$457	\$143
Houston		\$304	\$450*	\$146
Rotterdam		\$292	\$452	\$160
Fujairah		\$304	\$509	\$205
<b>2020 WORLD Cost Projection</b>				
<b>WORLD</b>	<b>\$57</b>	<b>\$322</b>	<b>\$468</b>	<b>\$145</b>

\* MGO price is not reported for Houston. This estimate is based on adjusting the reported MDO price upward by 4% which is the average of price increase for MGO relative to MDO for Singapore and Rotterdam (MDO price is not reported for Fujairah)

# Example Cost Scenario



Singapore to Vancouver: 7,100 nm

Distance in ECA  
1,700 nm

Los Angeles to Singapore: 7,700 nm

**Increased operating costs in ECA only  
For this scenario:**

- 3% increase in operating costs
- \$18/TEU

# Moving Forward



- Ship operators and ports in the Gulf will be affected by the North American ECA
  - Standards apply to all oceangoing vessels
  - Increased demand for lower sulfur fuels
- The U.S. is prepared to partner with Mexico for ongoing information exchange and dialogue on marine emissions
- The U.S. feels the MARPOL Annex VI standards are a good tool for addressing marine emissions