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Climate risk and disruptions in the maritime transport

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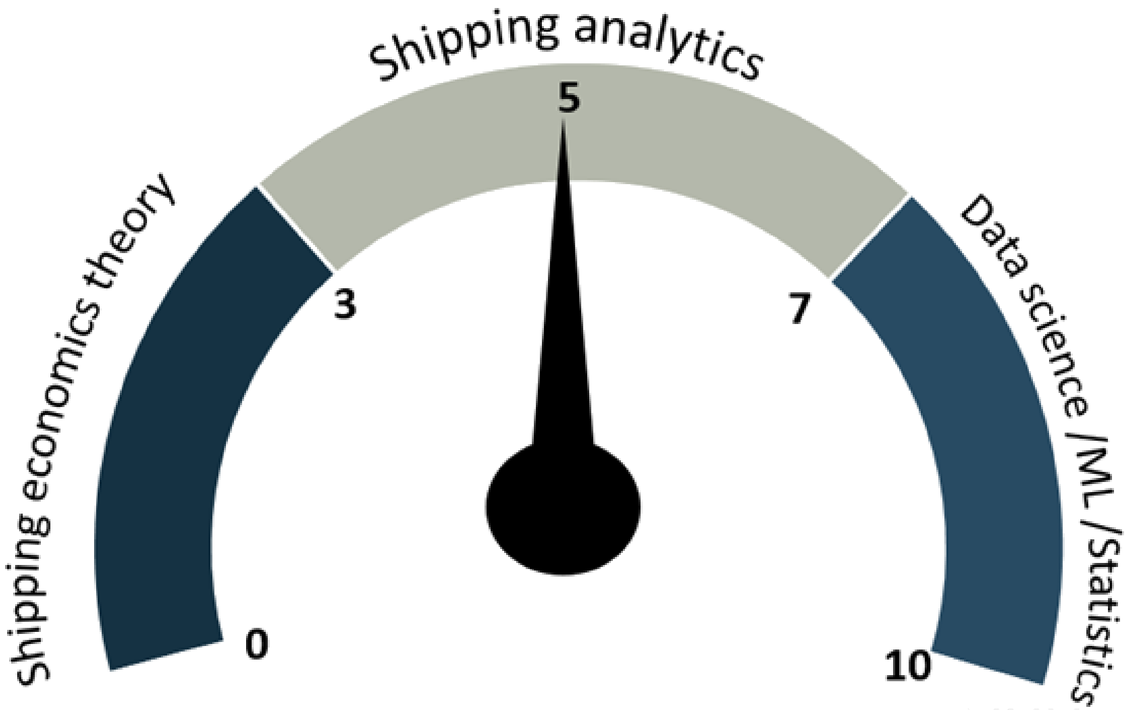
This lecture

Before break (45 min)

- **Sensitive maritime elements affected by climate**
- **Climate risk in maritime transport**
- **Case study 1**

After break (45 min)

- **Case study 1 cont.**
- **Case study 2 discussion (30 min)**



Today in the news

Tankers

Trump tells Nato: Tariff China to stop Russian war machine

US president threatens to quit Ukrainian peace efforts otherwise

Is US president Donald Trump (right) getting serious about Russia or does he prepare an exit ramp to quit Ukraine peace efforts? On the left, Armenian prime minister Nikol Pashinyan. (Photo: Daniel Torok/White House)

Harry Papachristou
TradeWinds correspondent | Athens

Updated 15 September 2025, 08:32

US president Donald Trump has challenged his Nato allies to impose punitive tariffs on China and abandon all remaining oil purchases from Russia if they want to keep Washington engaged in efforts to put an end to the war.

In a letter sent to all Nato countries, Trump urged alliance members to impose tariffs between 50% and 100% on China, to push Beijing into stopping Russian oil purchases.

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Learning outcomes

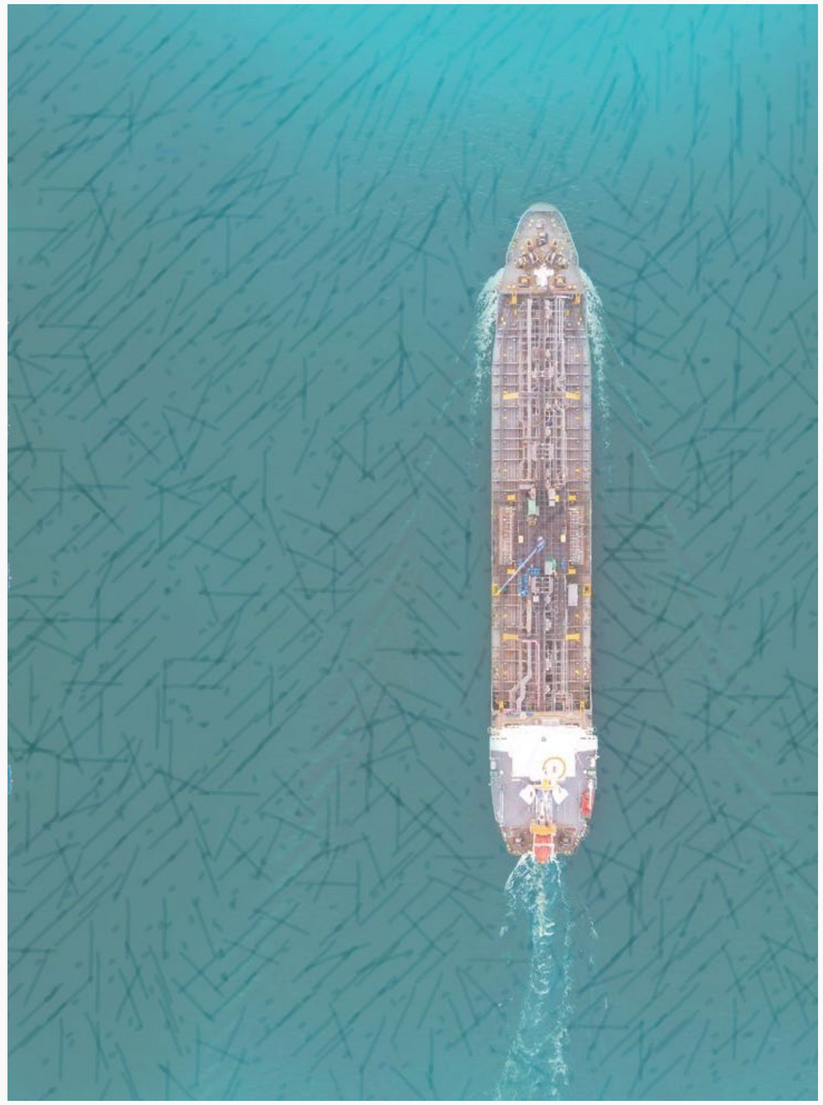
This lecture will help with the following learning outcomes:

Knowledge

- Is familiar with recent developments in data-driven analysis applied to the freight markets, ship operations, and more environmentally friendly operations
- **Skills**
- can communicate with industry practitioners using correct terminology
- considers the economic, political, and ethical issues relevant to the shipping industries

Competency

- exchanges opinions and experiences with others with a background in the field
- Communicates problems, methods and solutions from the analyses both in writing and oral



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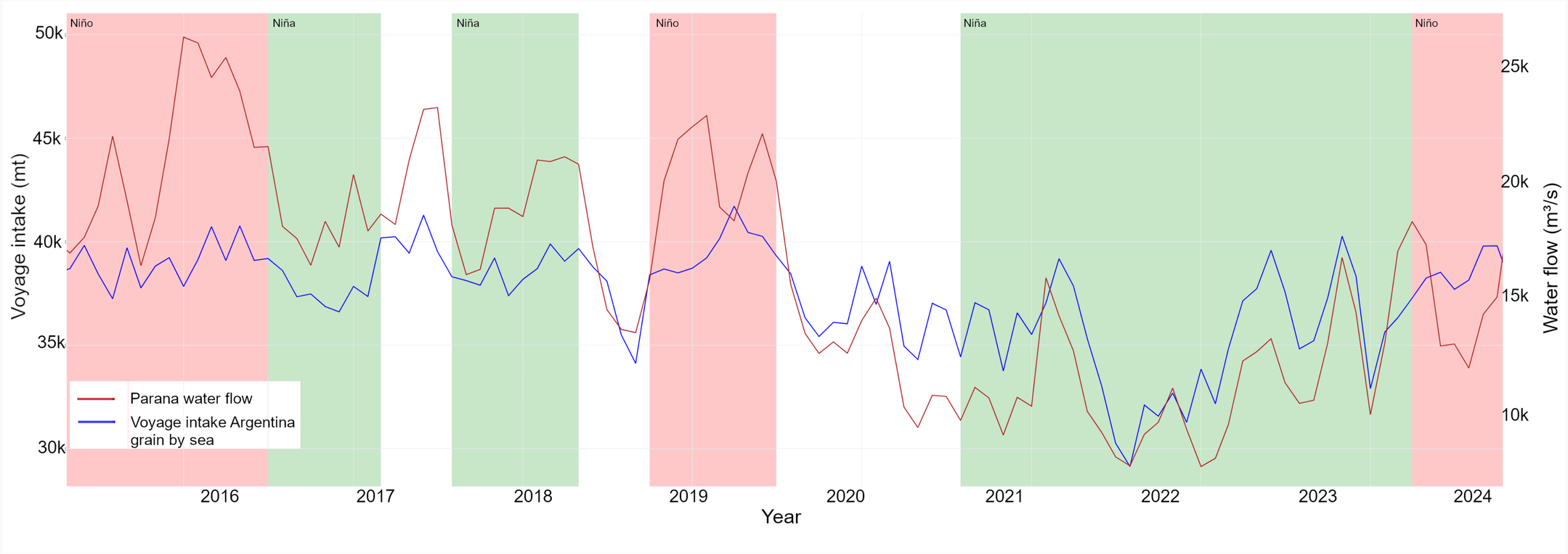
Sensitive maritime elements affected by climate

- Cargo
  - Coal - Instantaneous combustion when wet
  - Grains (Corn, Sorgun, Soybeans) - mold, fermentation and makes the cargo heavier
  - Iron Ore-cargo becomes heavier and it might become a fluid, affecting the ship’s stability.
- Ice
  - The vessel could get «trapped» at port
  - More fuel consumption
  - Risk of delay (relevant for laycan)
- Heavy weather (Tropical Cyclones, Storms)
  - More fuel consumption
  - Ports closure
- Canals and rivers
  - Draught limits due to water levels

Bulk cargo, the most exposed to weather elements

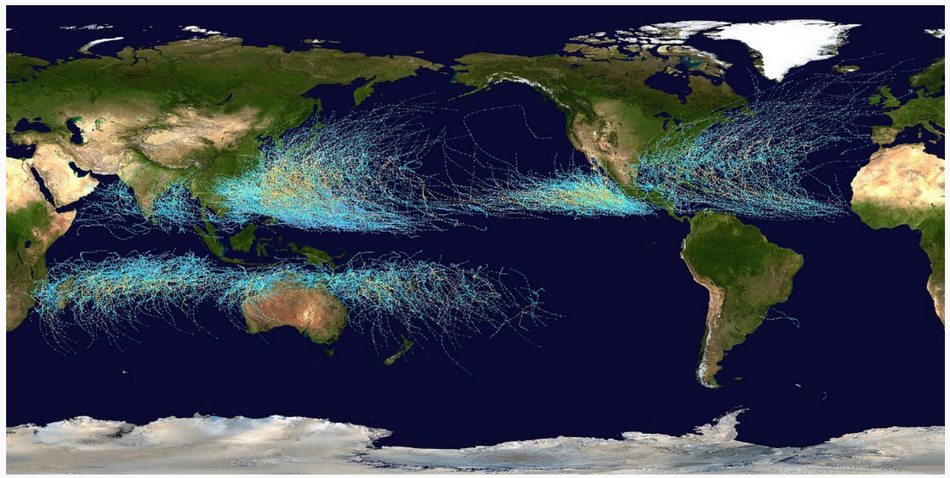
Bulk cargo, the most exposed to weather elements

Grains export out of the Paraná River



Bulk cargo, the most exposed to weather elements

Tropical phenomena



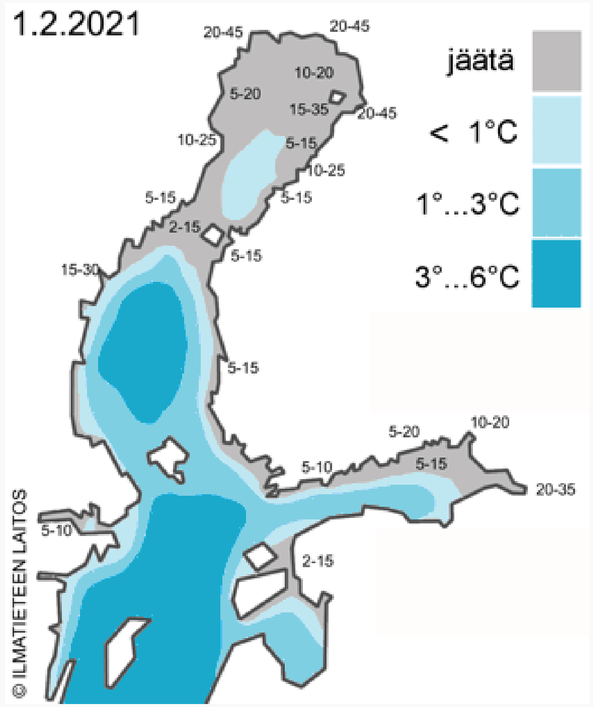
Source: Wikipedia. Tropical Cyclones.

Seasons

Name	Area	Period
Hurricanes	Caribbean – Atlantic	Jun - Sep
Typhoon	Australia area	Oct - Nov / Jan / Feb - Mar
Typhoon	Southwest Indian	Nov - Apr

Atmospheric pressure
Link

Ice

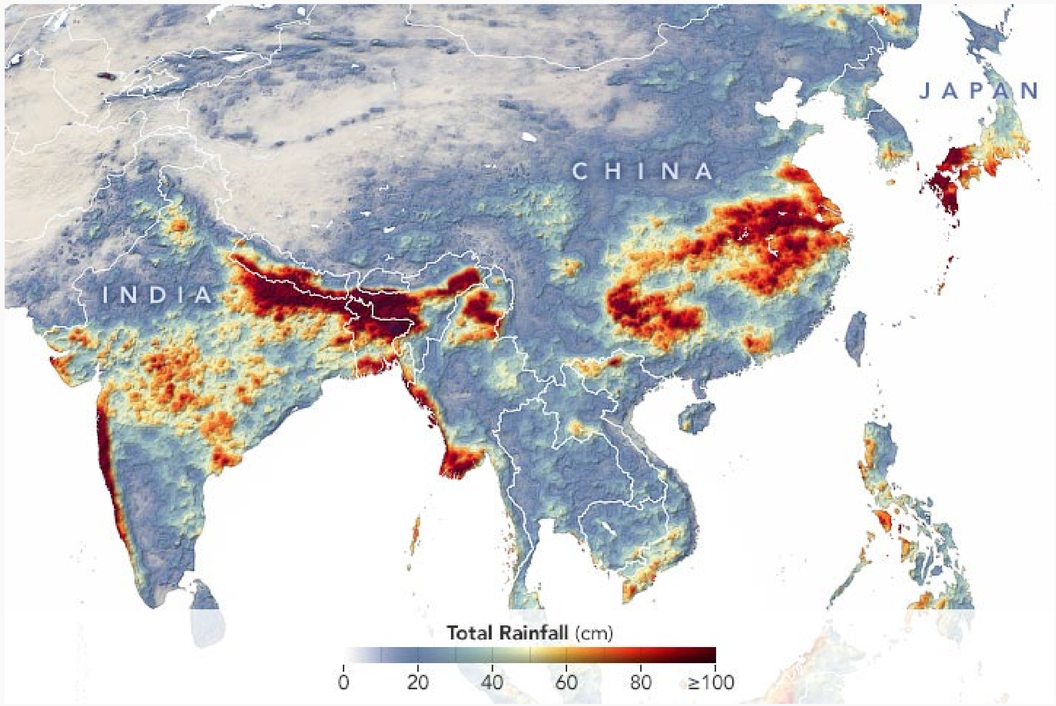


Source: Finnish Meteorological institute

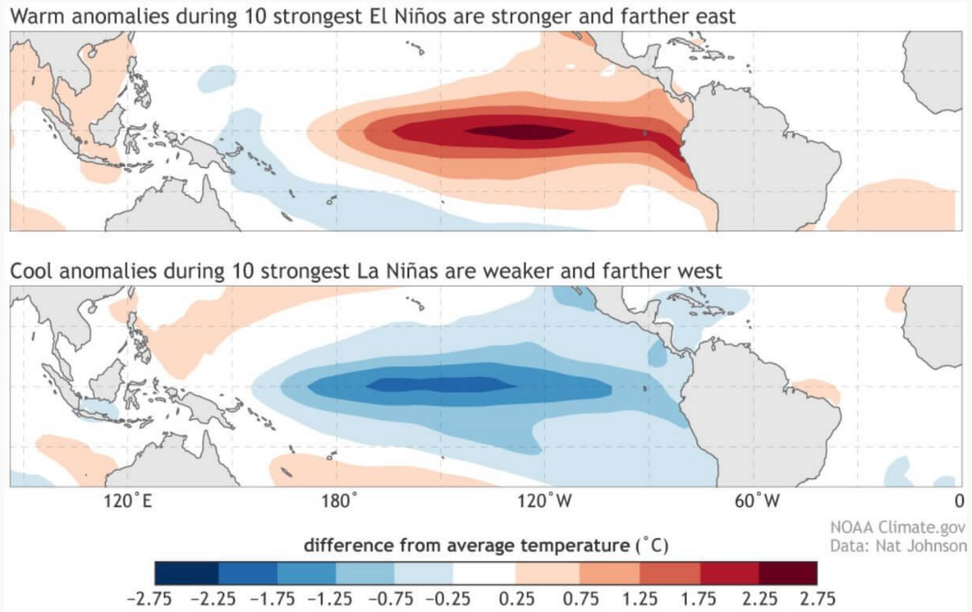
Source:transportgeography.org

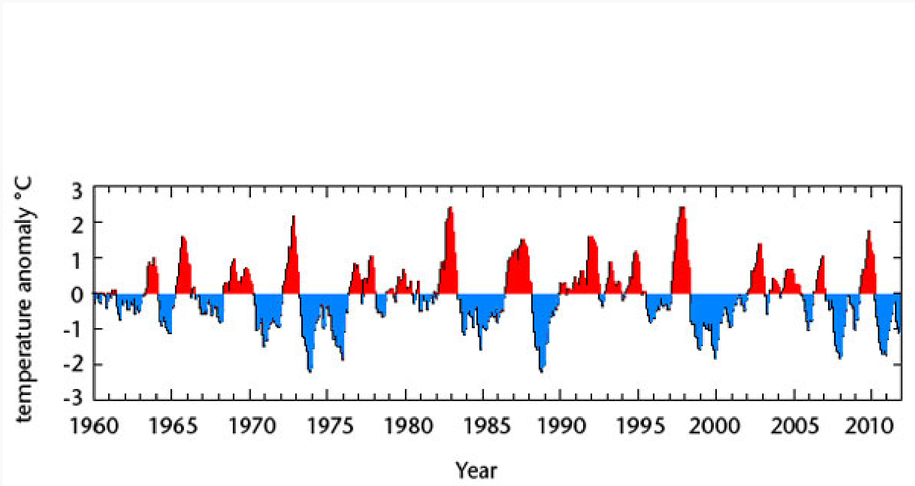
Monsoon

- May to September – strong winds and heavy rain may close ports and increase the fuel consumption
- October to April – weaker winds and dry season
- Some crops are planted in June to July and harvested in October to December (*Kharifs* Crops)
  - Rice, Maize, Soybeans
- Crops planted in November and December and harvested in March to April (*Rabi* Crops)
  - Wheat, barley



El Niño Southern Oscillation (ENSO)





Source: Met Office

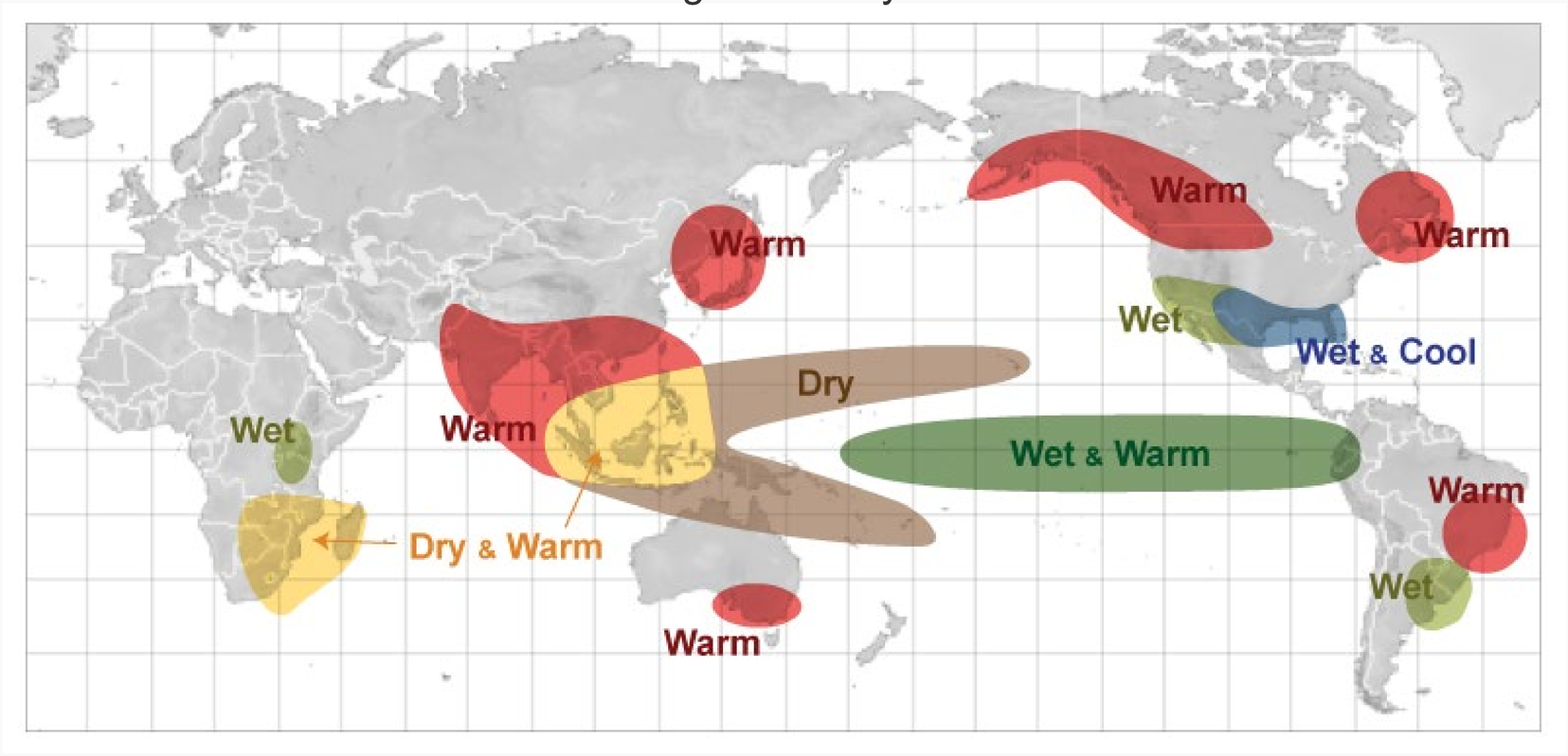
El Niño Southern Oscillation (ENSO)

From Australia Bureau of Meteorology

REGION		EL NIÑO YEARS		NON-EL NIÑO YEARS	
		NUMBER OF STORMS	INTENSITY	NUMBER OF STORMS	INTENSITY
North Atlantic		Large Decrease	Small Decrease	Small Increase	Small Increase
Eastern North Pacific		Slight Increase	Increase	Slight Decrease	Decrease
Western North Pacific	Eastern half	Increase	No Change	Decrease	No Change
	Western half	Decrease	No Change	Increase	No Change
Indian Ocean (North / South)		No Change	No Change	No Change	No Change
Australian Region	Western	Slight Decrease	No Change	Slight Increase	No Change
	Central and East	Decrease	Slight Decrease	Increase	Slight Increase
South / Central Pacific (>160°E)		Increase	Increase	Decrease	Slight Decrease

El Niño Southern Oscillation (ENSO)

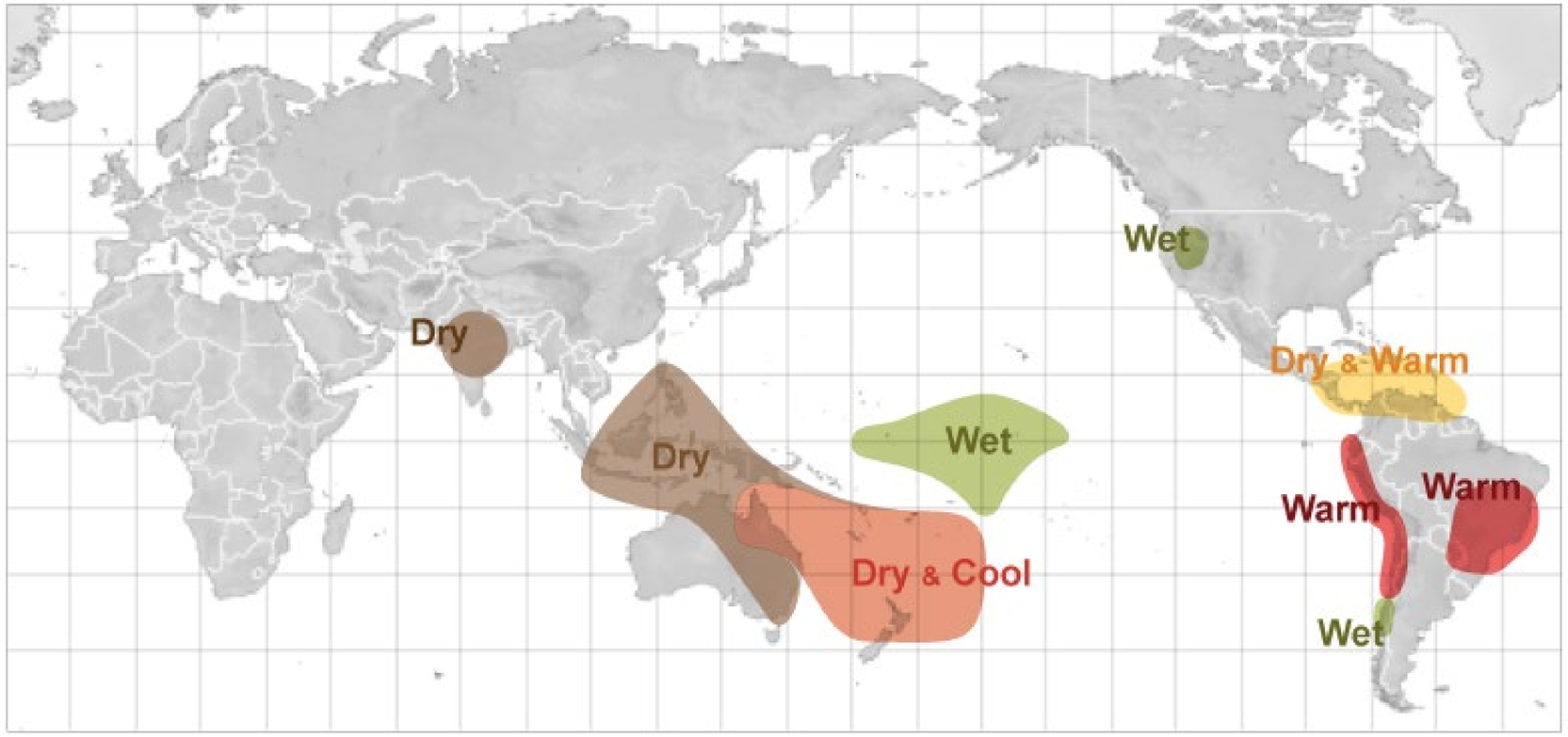
El Niño effects from December through February



Source: NOAA

El Niño Southern Oscillation (ENSO)

El Niño effects from June through August



Source: NOAA

El Niño Southern Oscillation (ENSO)

- Negatively correlated with the Gatun lake in the Panama Canal
- Correlated with Paraná river levels
- ENSO can help predict Panama Canal waiting times
- The risk of more extreme ENSO caused by Anthropogenic Climate Change (Cai et al., 2018) directly relates to the Panama Canal

El Niño Southern Oscillation (ENSO)

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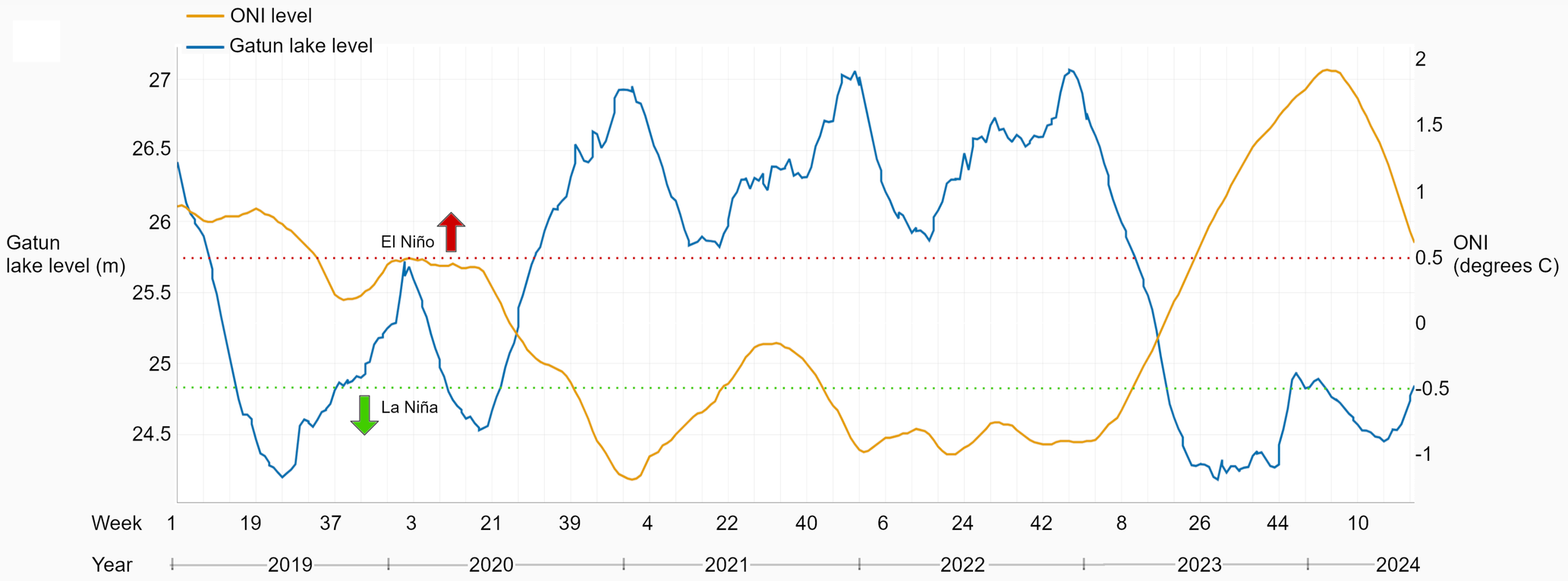


Climate and trade

Fuentes and Munim (2025)

- The Panama Canal restrict passage based on ENSO (draught restrictions or/and vessel limit per day)
- Upon restrictions more vessel reserve via slot bidding (4 M USD paid by an LNG in 2023)
- Low value cargo (e.g. Bulk carriers) have no other option than deviating via Cape Horn
- Extra miles add ups to transportation costs
- Higher penalized are Small Island Deveoping States (-0.11 GDP) and developing states (UNCTAD, 2024)
- On top of that, an exporting country is not very happy.... More on that for the case study.

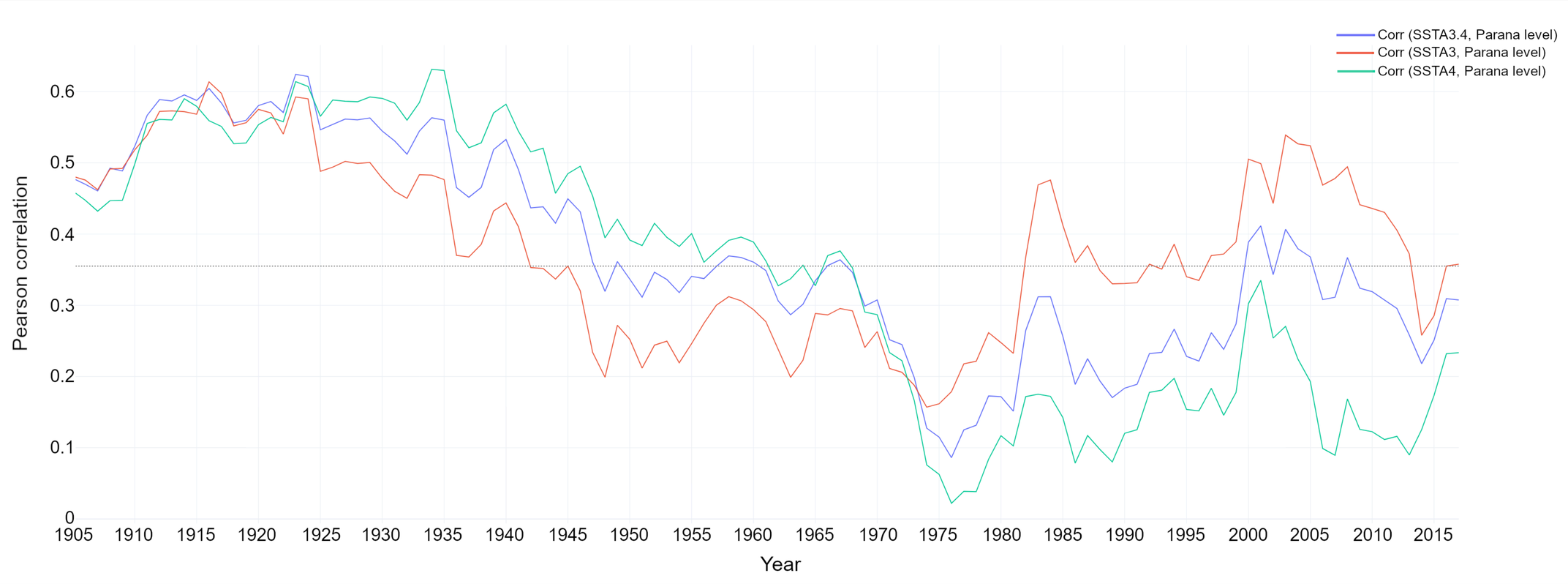
Table 6. Fixed effects regression result on CWT.

Variables	CWT (hours)		
	(1)	(2)	(3)
ONI 6 weeks lag	−3.859	−3.787***	−2.667***
	(2.978)	(1.151)	(0.704)
NeoPanamax transit	16.398***	16.258***	28.386***
	(2.744)	(1.893)	(3.263)
Northbound transit	9.343**	9.264***	10.001***
	(1.887)	(1.369)	(1.596)
Constant	37.398***	34.520***	28.147***
	(1.393)	(1.303)	(1.095)
Monthly fixed effects	No	Yes	Yes
Vessel type fixed effects	No	No	Yes
R-squared	0.041	0.050	0.286
F-statistic	100.200	838.200	860.200
Observations	7910	7910	7910
df	3	14	24

Notes: Clustered standard errors. Significance levels: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

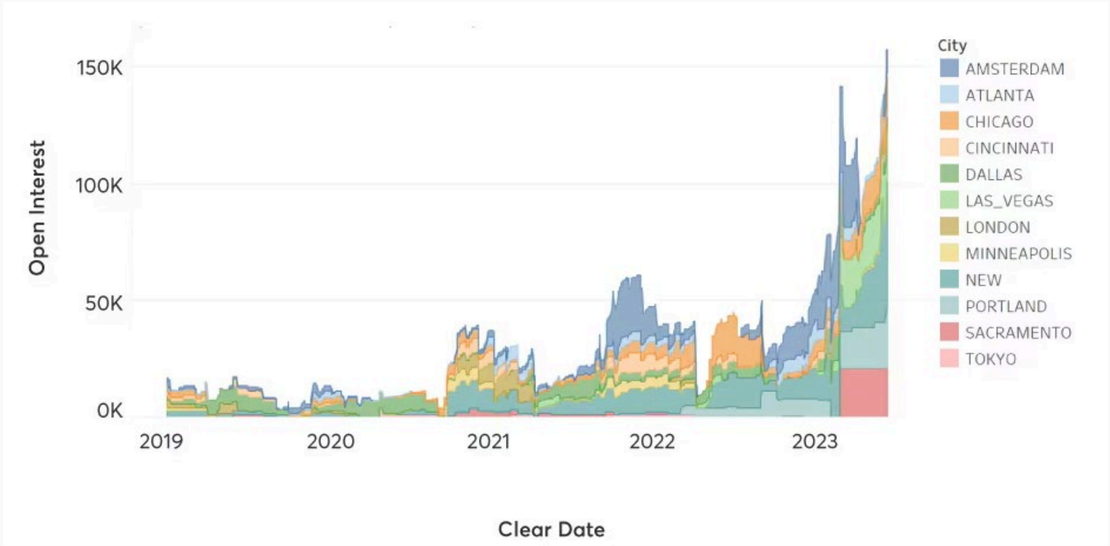
El Niño Southern Oscillation (ENSO)

Correlated with Paraná river levels



Weather derivatives

- Based on weather related indices
  - Heating Degree Days
  - Cooling Degree Days
  - Precipitation levels
  - Wind speed ... etc.
- Indices monitored on specific areas, mostly agricultural areas in the US
- Basis risk expected due to spatial differences
- ENSO affects different places at the same time, sometimes with contrary effects (lowe temperature vs droughts).



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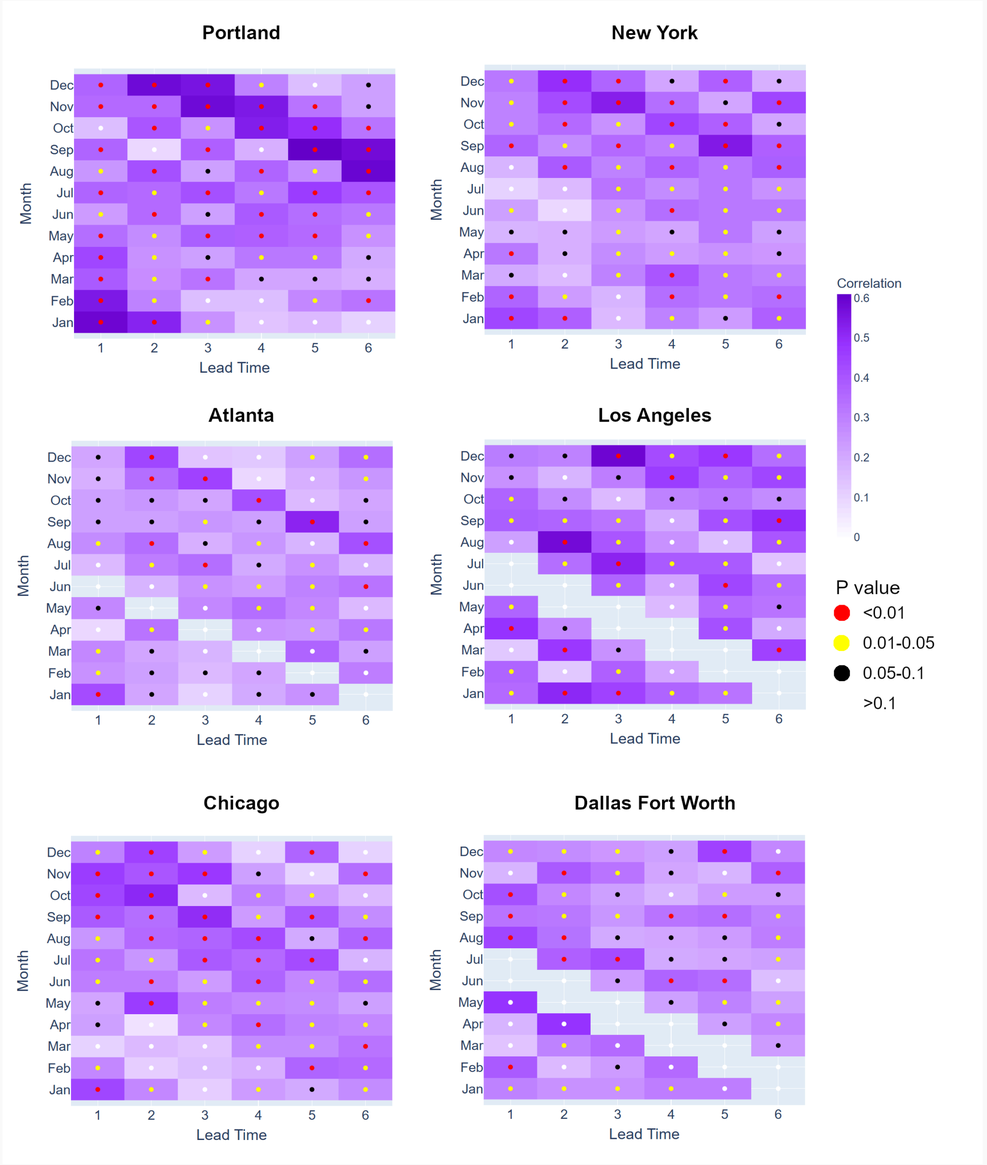
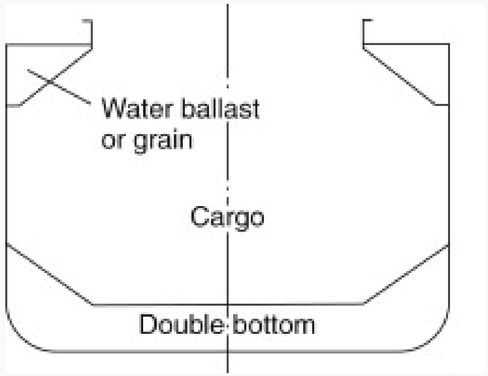


Stowage factor and draught limitations

- A vessel may either fill the grain capacity (volume) or the metric tonnes capacity (weight).
- The one filled out first is the limit of the vessel
- A 120k mt vessel may have a 130k m^3 capacity.
  - For a cargo of iron ore, the vessel may need 130k/0.40=325k mt to fill in the holds (beyond the weight limit)
  - For a cargo of soybean the vessel will fill the holds before reaching the cargo weight limit 130k/1.35=96k mt (it should deduct fuel, lubricants weights and constants)
- A vessel may be paid in $/tonnes so the weight vs volume difference may be reflected in the voyage freight.



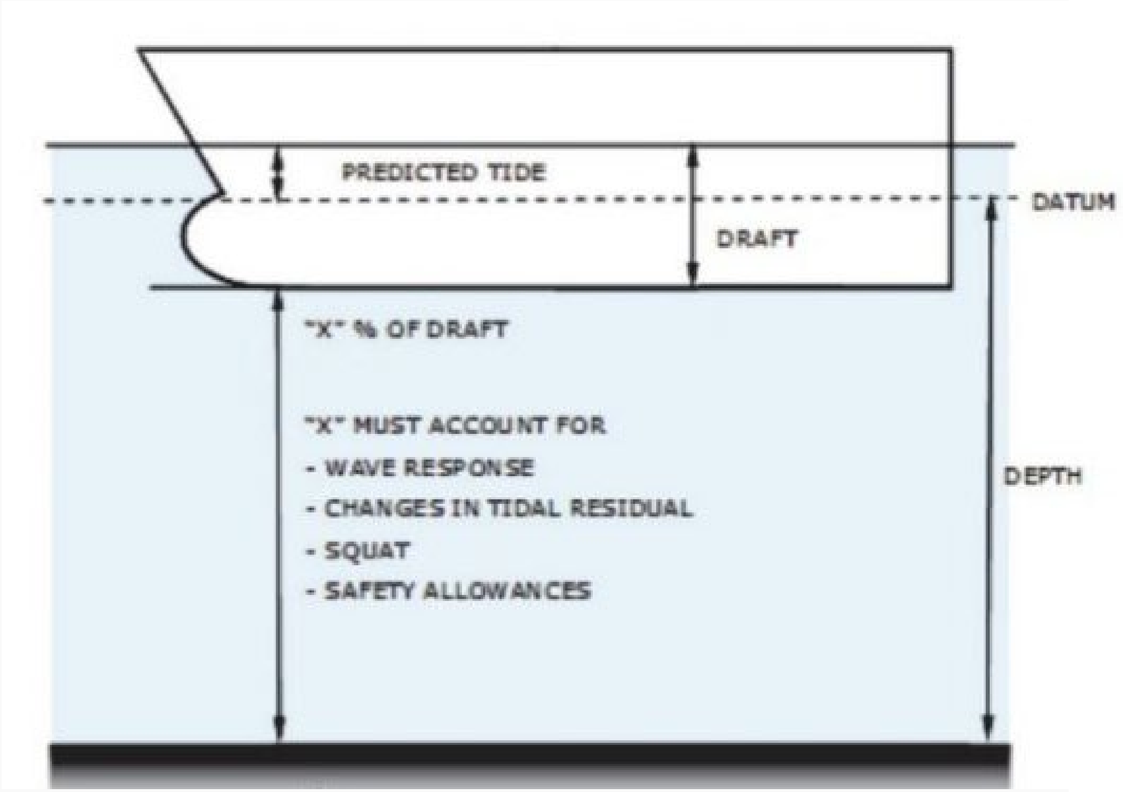
Source: Ship Construction, Eyres D.J. Chapter 3. 7ed.

- Iron Ore SF ~ 0.40 $\frac{m^3}{\mathrm{MT}}$
- Soybean SF ~ 1.35 $\frac{m^3}{\mathrm{MT}}$
- Fresh water SF = 1 $\frac{m^3}{\mathrm{MT}}$

Stowage factor (S.F): volume of cargo per metric tonne m^3/mt

Drought issues in the cargo load

- A vessel may have its draught limited due to depth (Parana) or due to water use limitations (PC)
- Max load might be conditioned on the draught limitation
- To estimate changes of loading one additional tonne of cargo in draft the Tonne per centimeter of inmersion (TPC) could be used.
  - Careful-TPC is not linear across the vessel draught as the vessel has different area shapes as it is loaded



Source: IHO

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gabrielfuentes.org

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Cai, W., Wang, G., Dewitte, B., Wu, L., Santoso, A., Takahashi, K., ... & McPhaden, M. J. (2018). Increased variability of eastern Pacific El Niño under greenhouse warming. *Nature*, *564*(7735), 201-206.

Fuentes, G., & Munim, Z. H. (2025). Climate influence on Panama Canal operations: Predicting canal water times with integrated environmental and operational data. *Transportation Research Part E: Logistics and Transportation Review*, *203*, 104319.

United Nations Conference on Trade and Development, 2024. Review of Maritime Transport 2024. United Nations, Geneva, https://unctad.org/publication/review-maritime-transport-2024. [UNCTAD/RMT/2024].

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Case 1


Maria Chiquita
Parque Nacional Chagres
Sabanitas
Salamanca
Piña
Gatún
Buena Vista
San Lorenzo Protected Forest
Limón
Palmas Bellas
Gatun Lake
Los Bravos
Caimitillo
Barro Colorado Island
Escobal
Panama Canal
Gamboa
Cuipo
Parque Nacional Soberania
San Miguelito
Parque Nacional Camino de Cruces
Ciricito
Cocoli
Panama City
Burunga
Arraiján
Vista Alegre
Fort Kobbe
Potrero Grande
La Chorrera
Cirí Grande
La Valdeza
Villa Rosario
Taboga
El Cacao
Capira District

Case 1

How Panama Canal's drought is threatening global shipping traffic (youtube.com)

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Case 1

Cost element	Voyage charter $/tonne	Time charter $/day
Cargo Handling	Charterer	
Voyage Expenses		
Operating expense	Owner	
Capital costs		

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Another Case

A cargo of soybeans is to be lifted in San Martin, Argentina. The vessel is nominated to pick up 49,500 mt of Soybeans MOLOO. Soybeans has an SF of **1.35 m³/mt.**

The vessel has the capacity of accommodating 53,806 of DWT out of which it has a Grain/Bale capacity of 65,500 m³. The vessel carries 650 tonnes of fuels and 350 tonnes of constants.

The contract is fixed as 15$/mt

Recent updates from agents in Argentina indicates that Paso Yaguaron is now limited to a maximum fresh water draught of 11.43 m. At 11.40 m, the vessel has a capacity of 45,000 DWT and a TPC of 56.4

1) How much cargo would you load (max draught) in m³ and mt?
2) What is the maximum that the vessel could load with the restriction?
3) How much money are you earning from this trip?
4) If the draught limit increases to 11.50 m. How much more are you earning?

Mid term survey is now available: it requries just 2 to 3 minutes
https://forms.office.com/e/kWCRfx5Pkn

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