

# Weather: ships sail safely

## *Port decision making with operational oceanographic forecasts*

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## Overview

### **OMC International & Dynamic UKC®**

*what is dynamic under keel clearance?*

### **Port Hedland**

*operational iron-ore export planning*

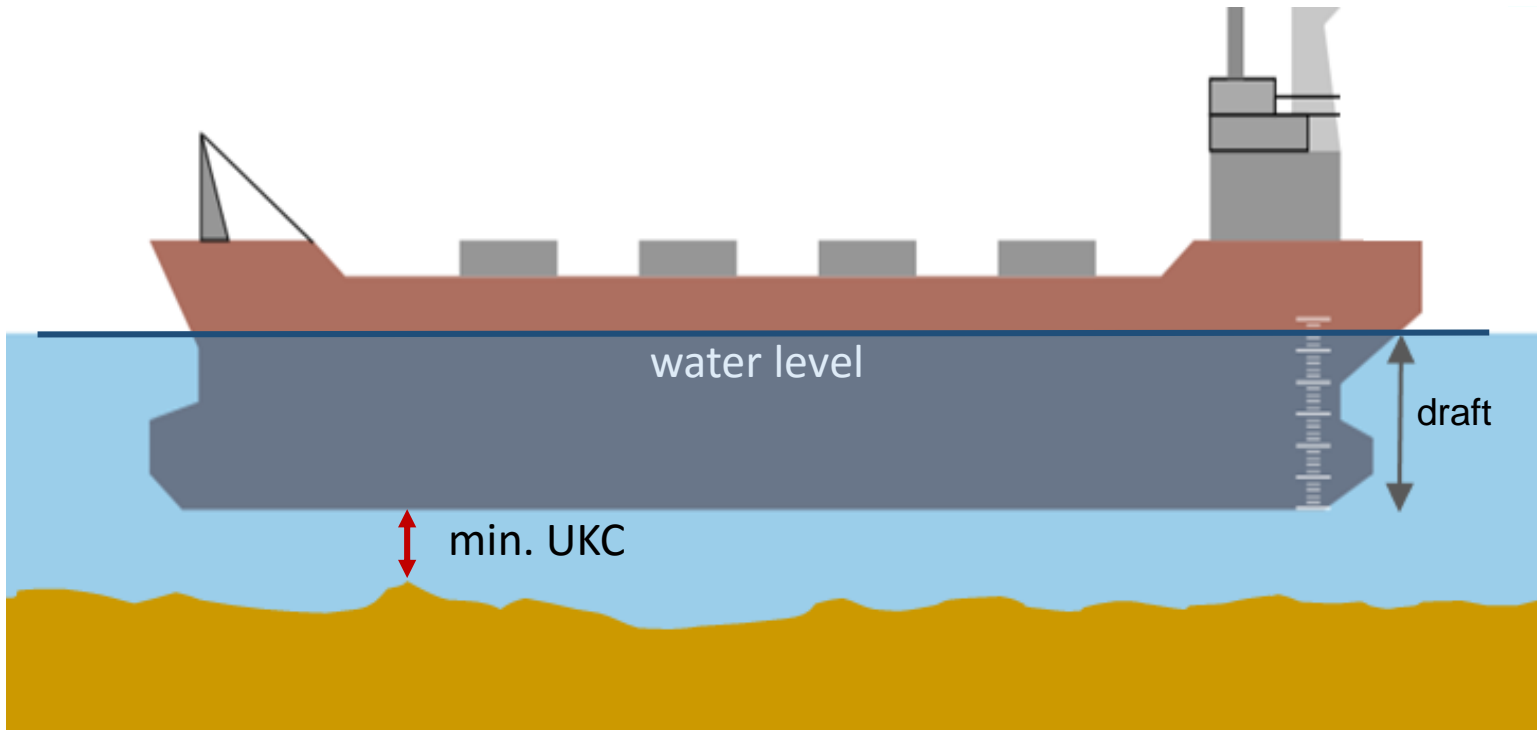
### **Port of Geelong**

*predicting the water levels*

### **Conclusion**

*forecasts for efficiency & safety*

# Under Keel Clearance



- Vertical navigation – safe under keel clearance to minimise grounding risk
- Vessel movement planning depends on the weather (among other things)
- Large vessels are often restricted to sail only near high tide, due to their size



Port Hedland: WOZMAX

330 m LOA

57 m Beam

250,000 DWT

17.5 – 19 m draft  
(approx. 6 stories)



Melbourne CBD:

Eureka Tower

297.3 m high

90 stories

200,000 tonnes



**97%** of Australia's iron ore is exported under DUKC® advice.  
(representing approx. \$80 Billion trade value per annum)



## Insufficient UKC!

### Dynamic UKC®:

- Water depth to seabed
- Ship squat (reverse wing)
- Vessel motion due to swells



*The MV Smart seen in two halves in Richards Bay, South Africa.  
Image courtesy Subtech Group – [gcaptain.com](http://gcaptain.com)*

## How Operational Oceanography is used in DUKC®

### **In-situ observations for dynamic decision support**

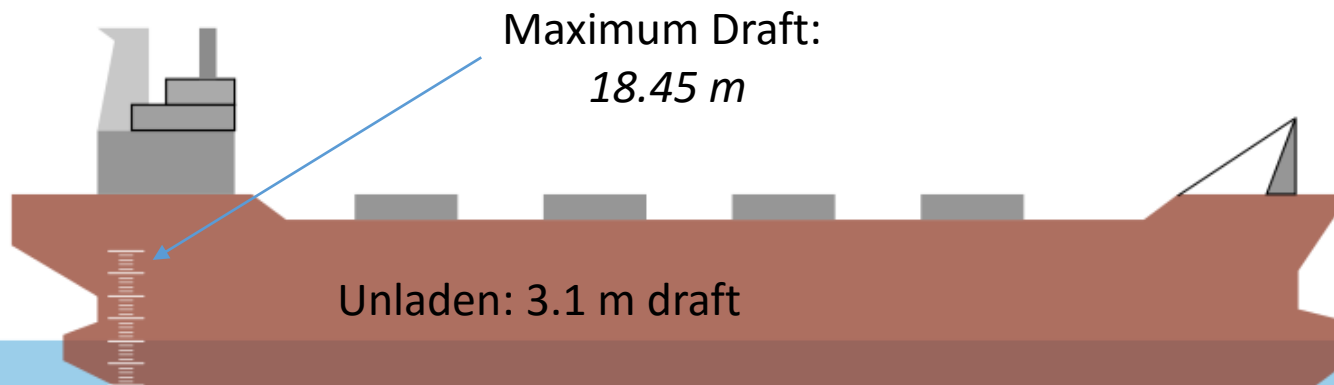
- Water levels
- Spectral waves

### **Routine forecasts to inform 24/7 operations**

- *MetOcean Solutions*
  - SWAN, WW3, ROMS
- *Australian Bureau of Meteorology*
  - AUSWAVE, OceanMAPS aggregate [soon]

## Operational decision making - Planning

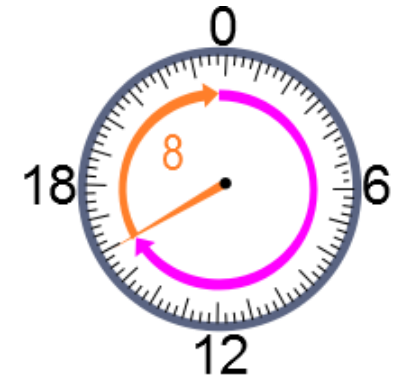
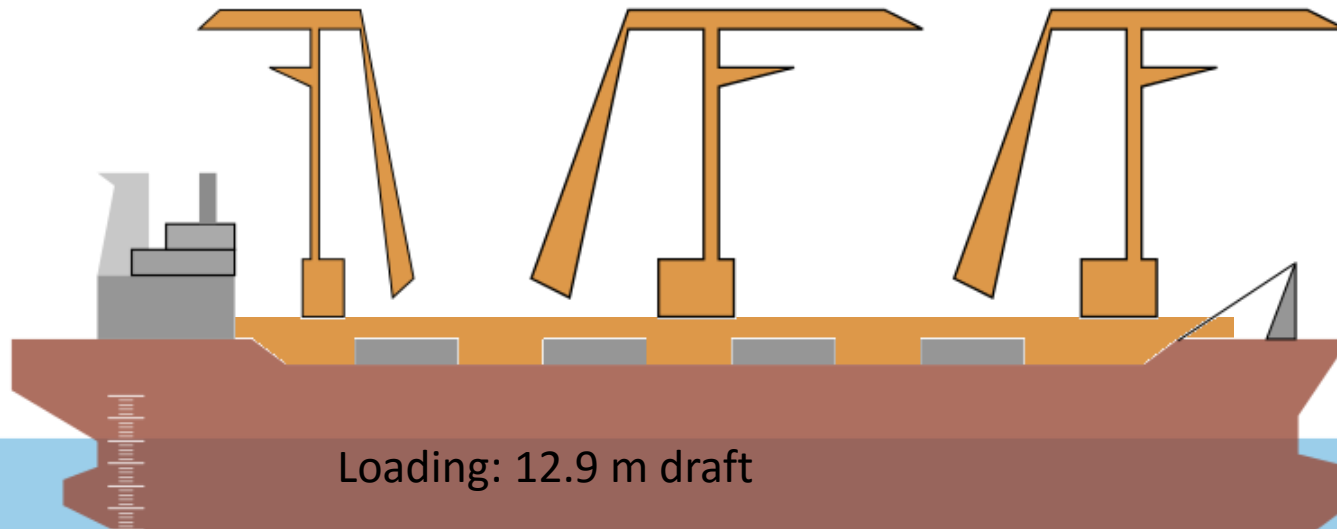
Maximum safe sailing draft is estimated using DUKC®,  
e.g. 2 tides ahead.  
Loading cargo begins.



## Operational decision making - Loading

Loading in progress

Final draft is selected based on DUKC® advice



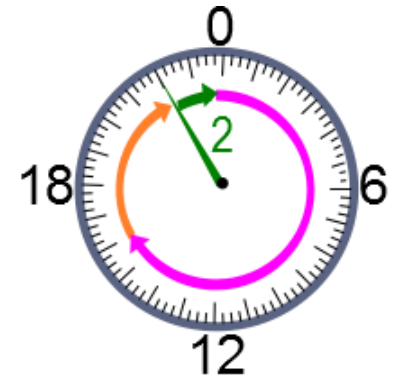
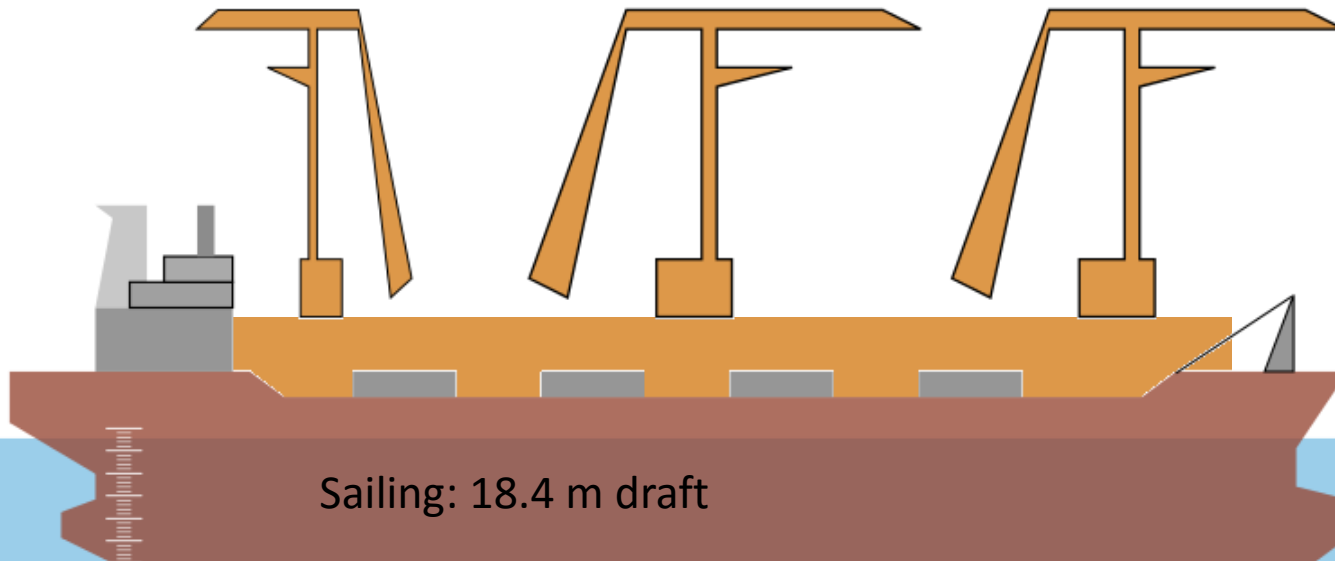


## Operational decision making - Sailing

Final draft is checked

Sailing slot is confirmed with DUKC® advice

Ship makes ready to sail...

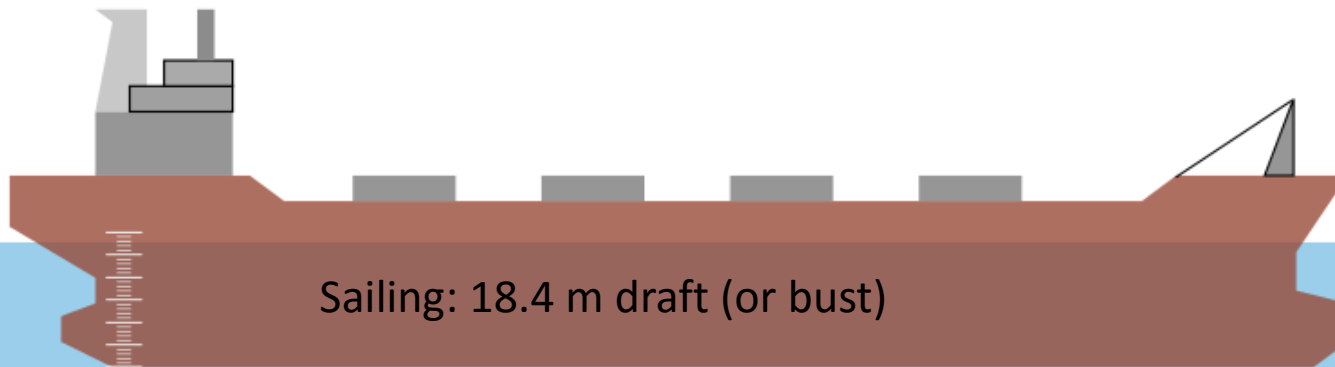


## Challenges

The ship has been loaded to the 8 hour draft  
– have conditions changed since then?

Many export ports don't have unloading facilities.

A delay to shipping comes at opportunity and/or financial cost  
- hope the next tide is more favourable...

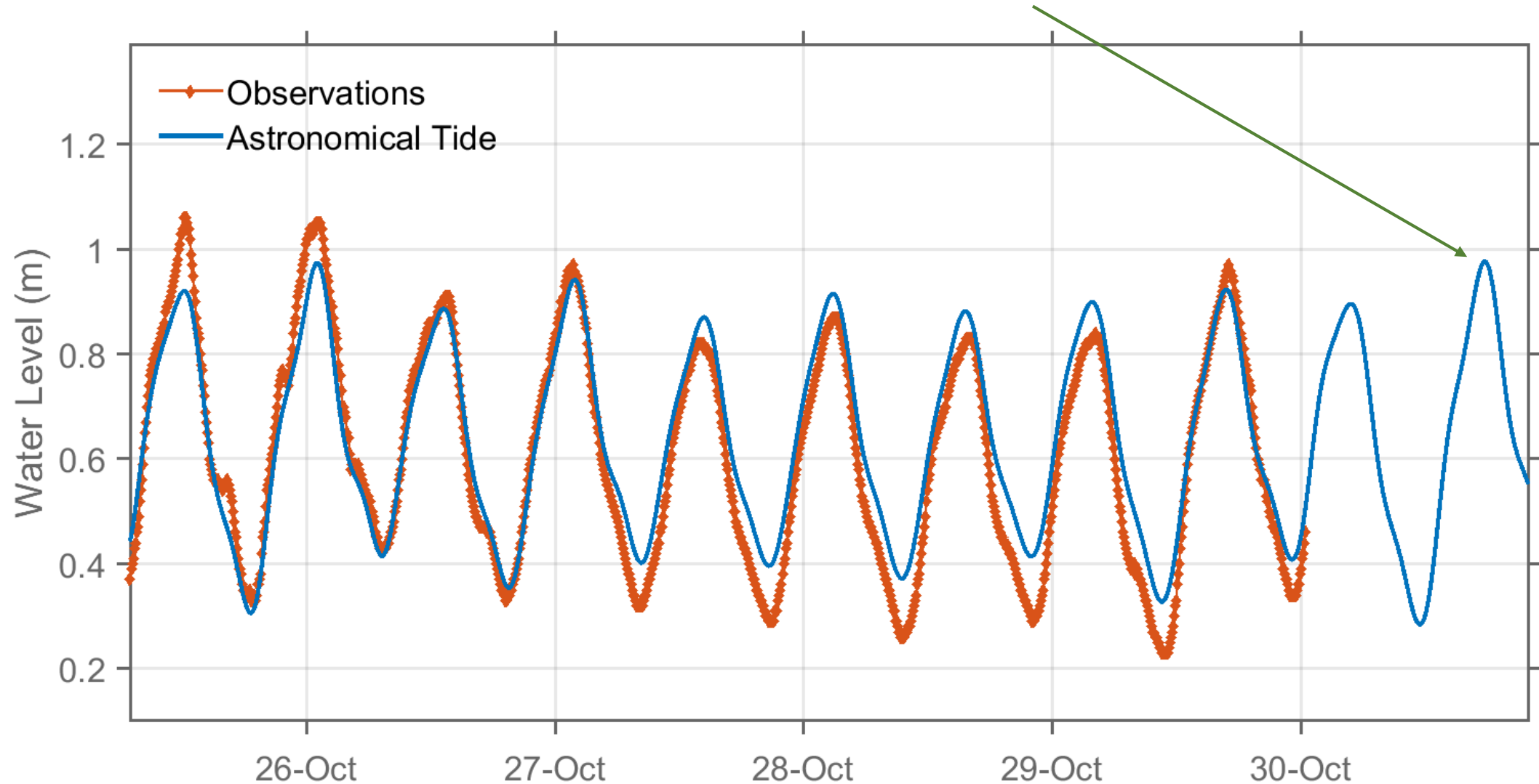


## Port of Geelong



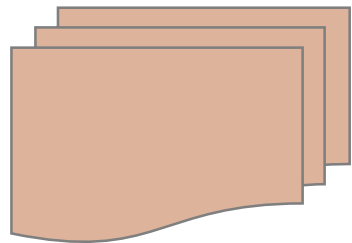
- Victoria's biggest bulk cargo port.
- Handled 651 ships in 2015/2016 year.
- 15.2 million gross tons on the year.
- Handles crude oil, petroleum, woodchips, fertiliser and grain.
- Tidal range around 1 meter

*What's the safe margin for sailing on this tide?*

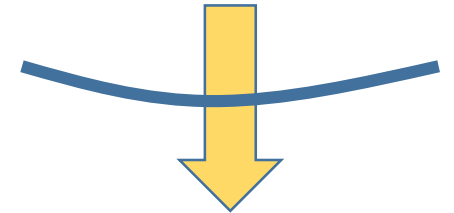




## Predictor – Climate Statistics

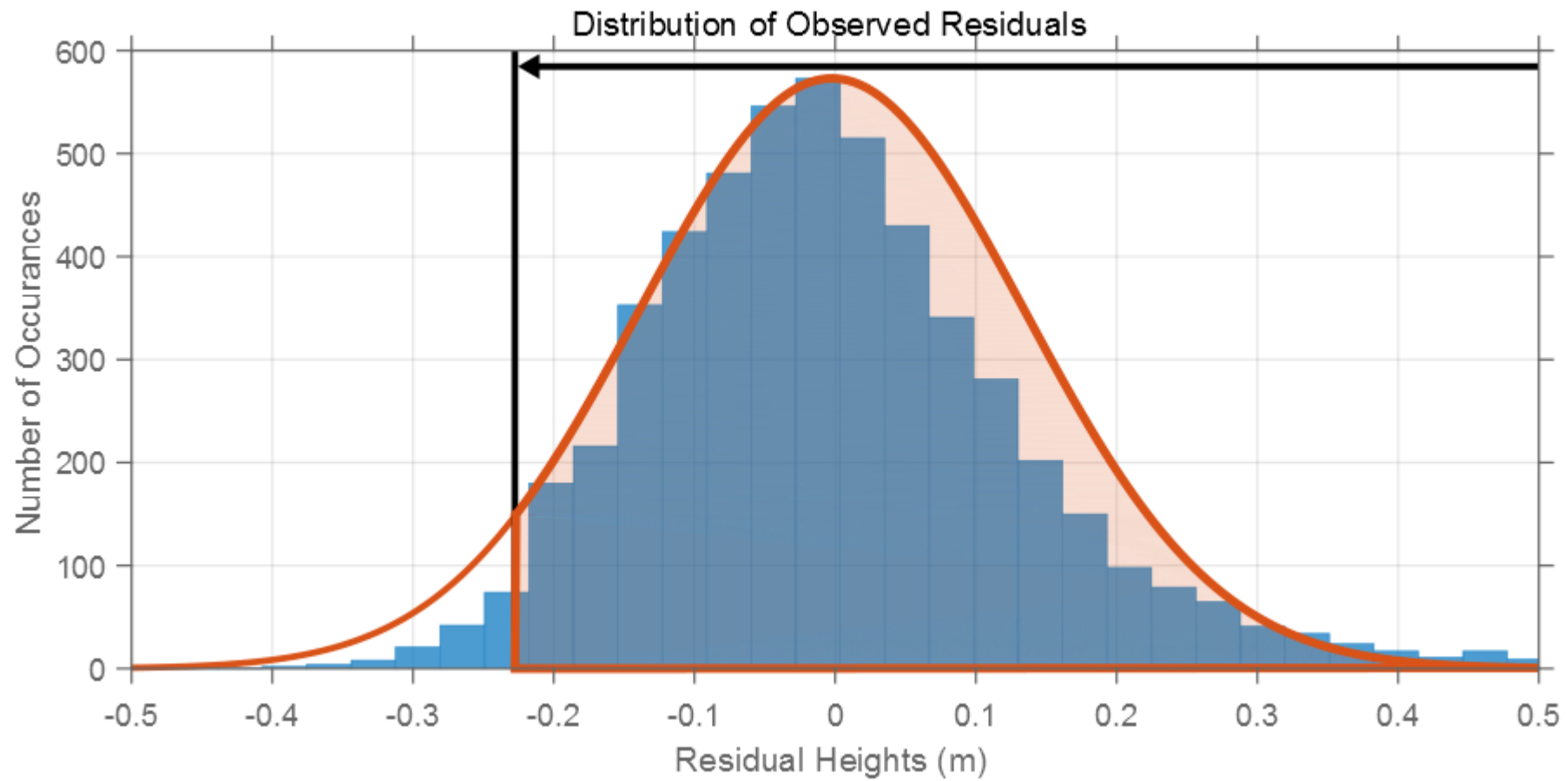


Historical  
Observations



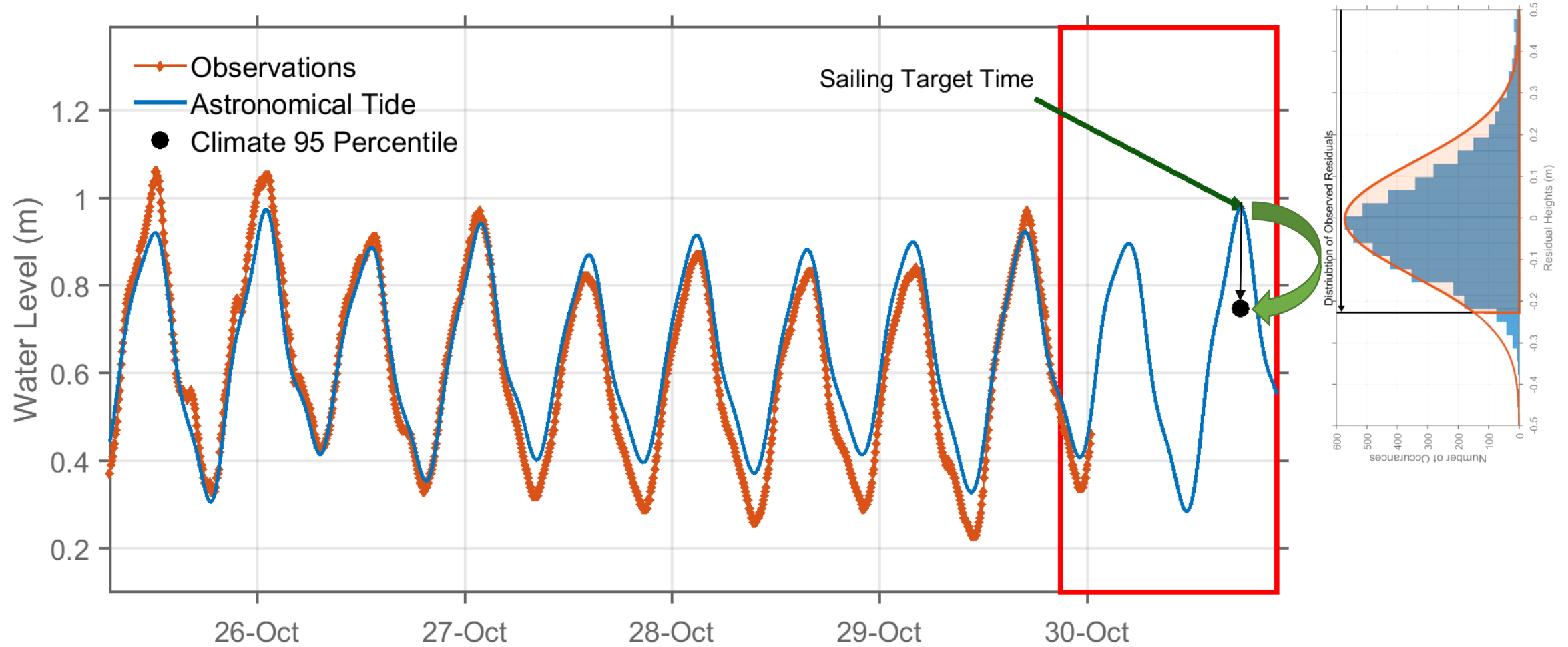
Sea level fall  
allowance

## History

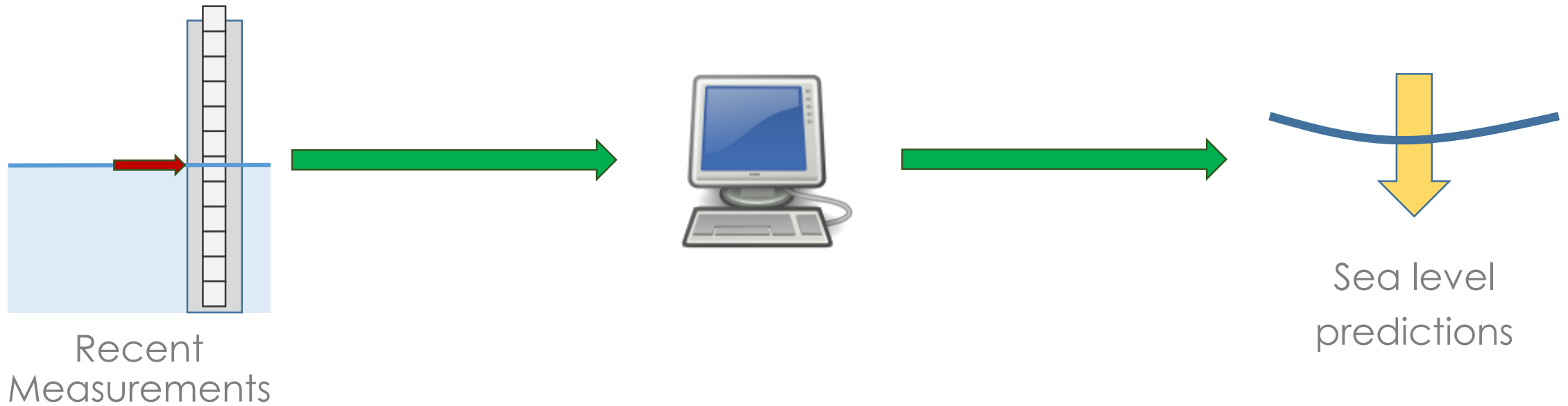


95th percentile margin: 22 cm

# Observations

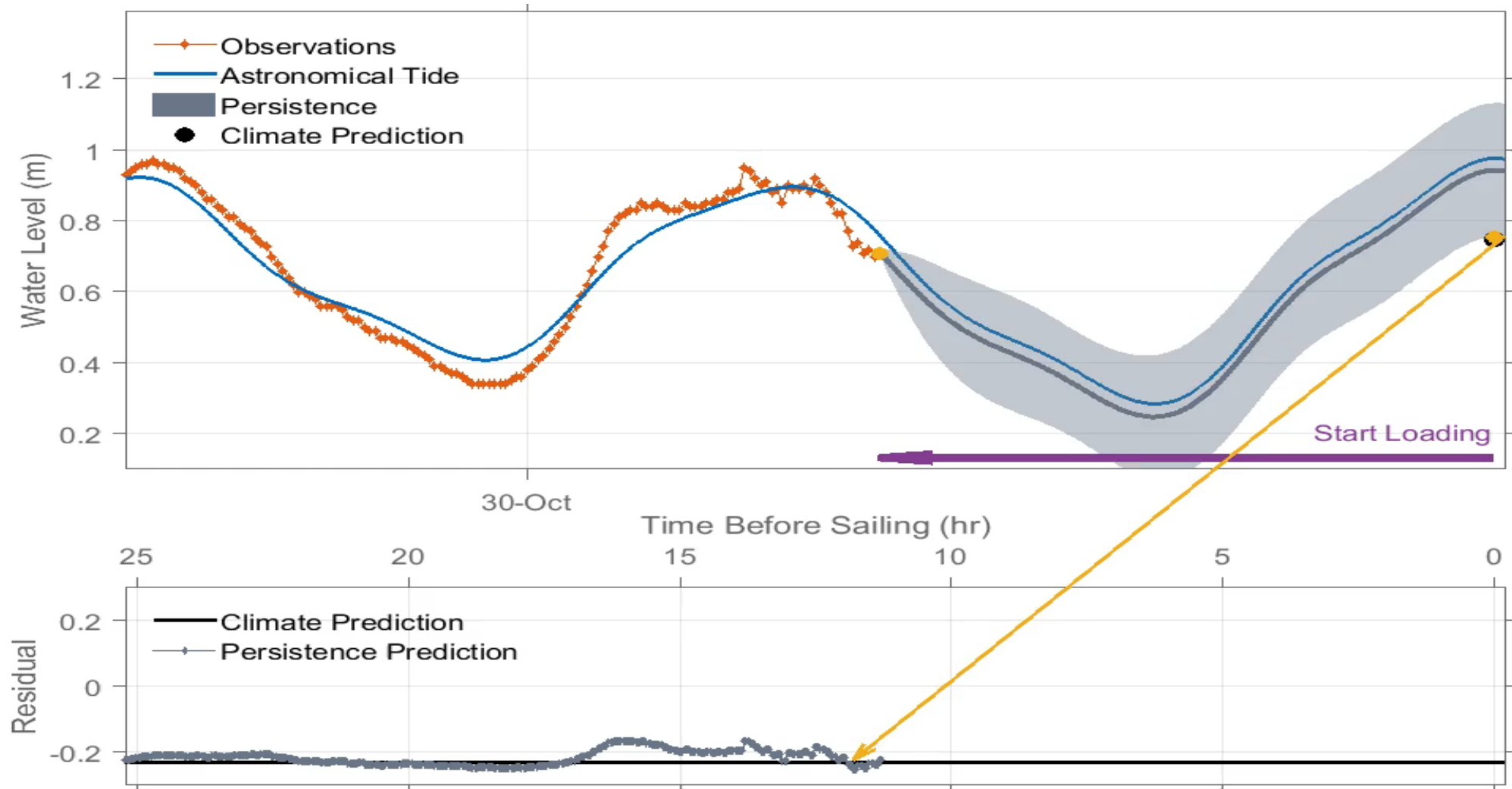


## Predictor – observation persistence

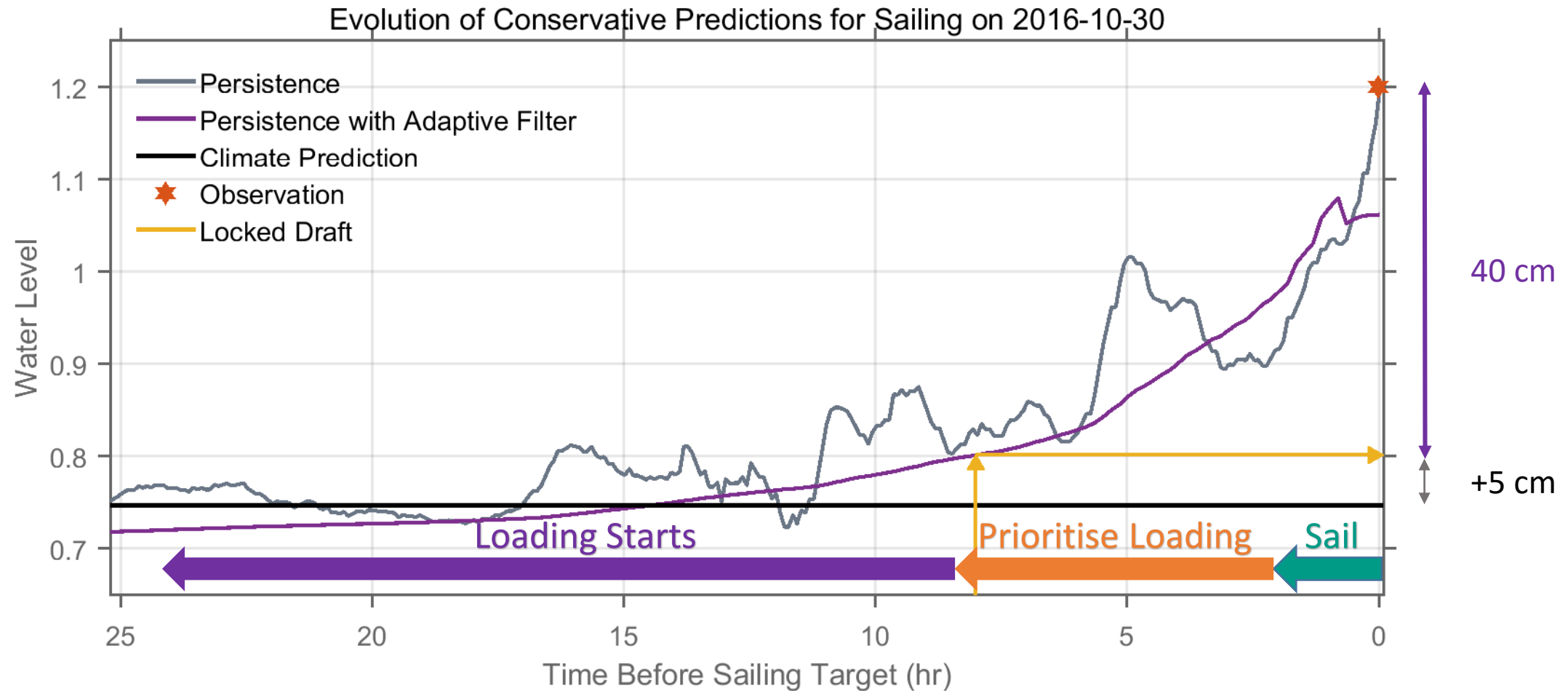




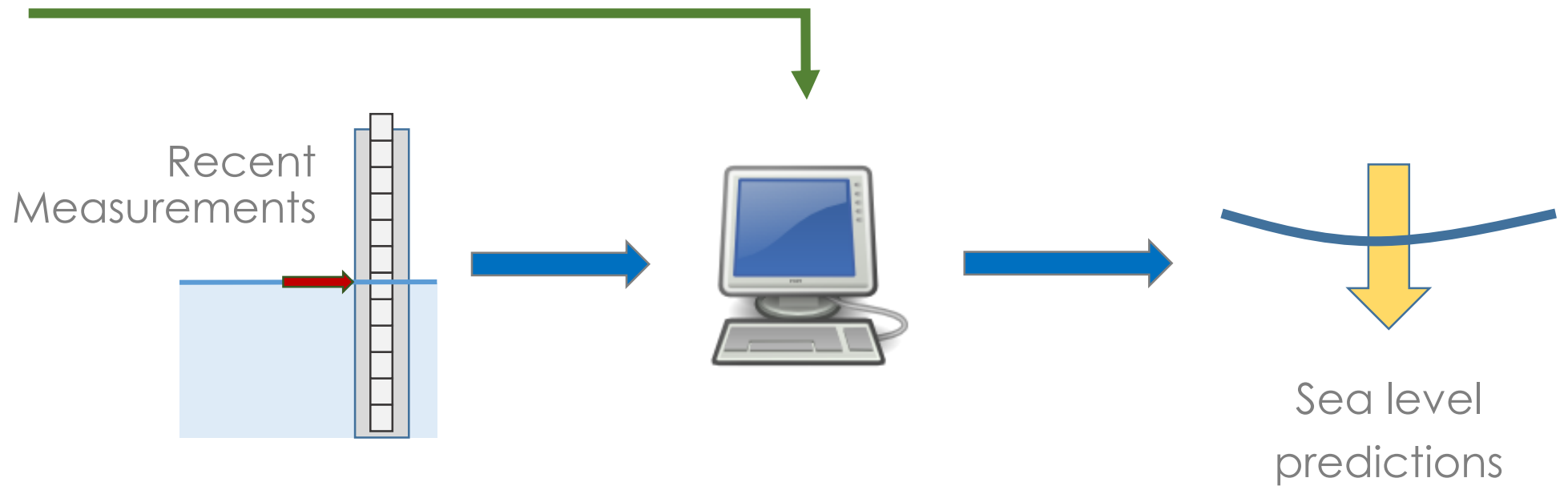
## Predictor – observation persistence (vs. Climate)



## Persistence Predictions with real-time smoothing

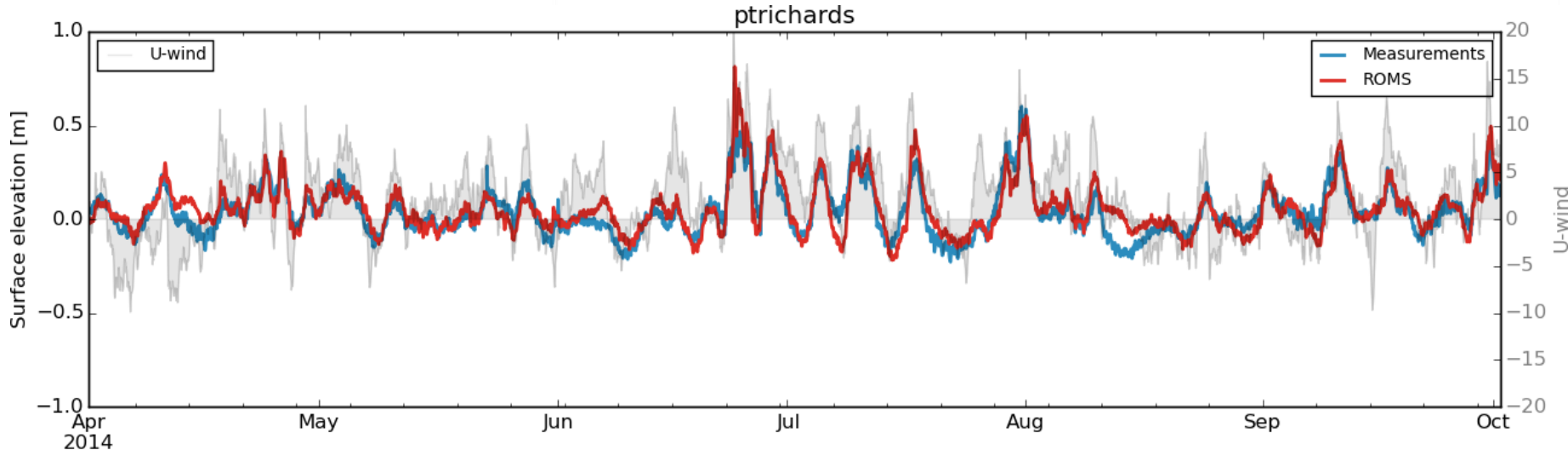
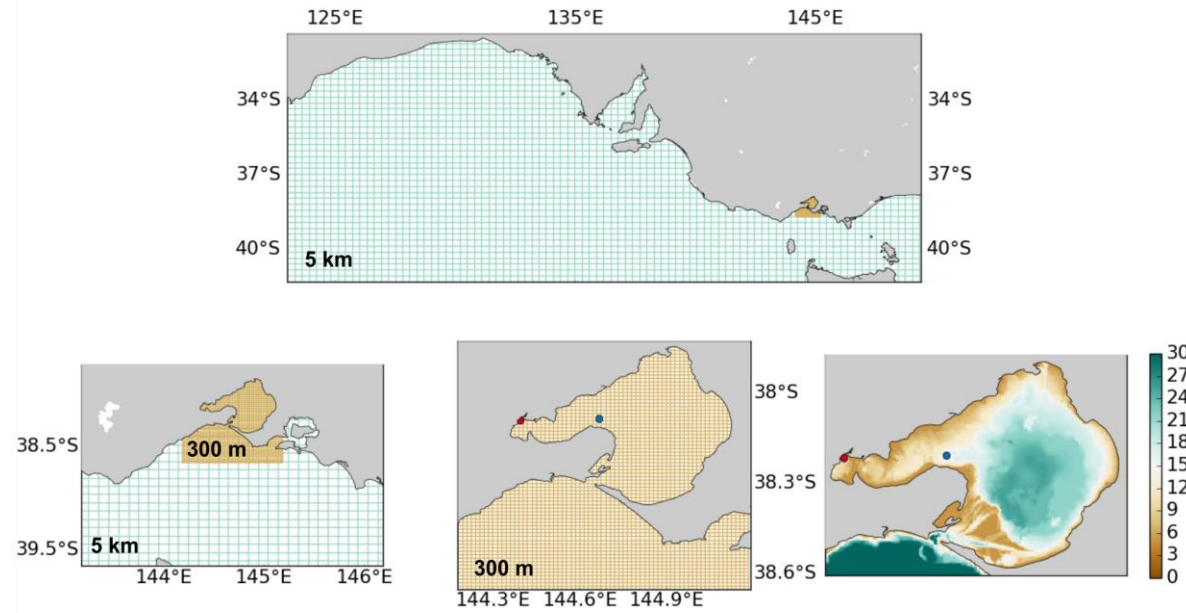


## Predictor – forecasts & observations



# MetOcean Solutions ROMS forecast

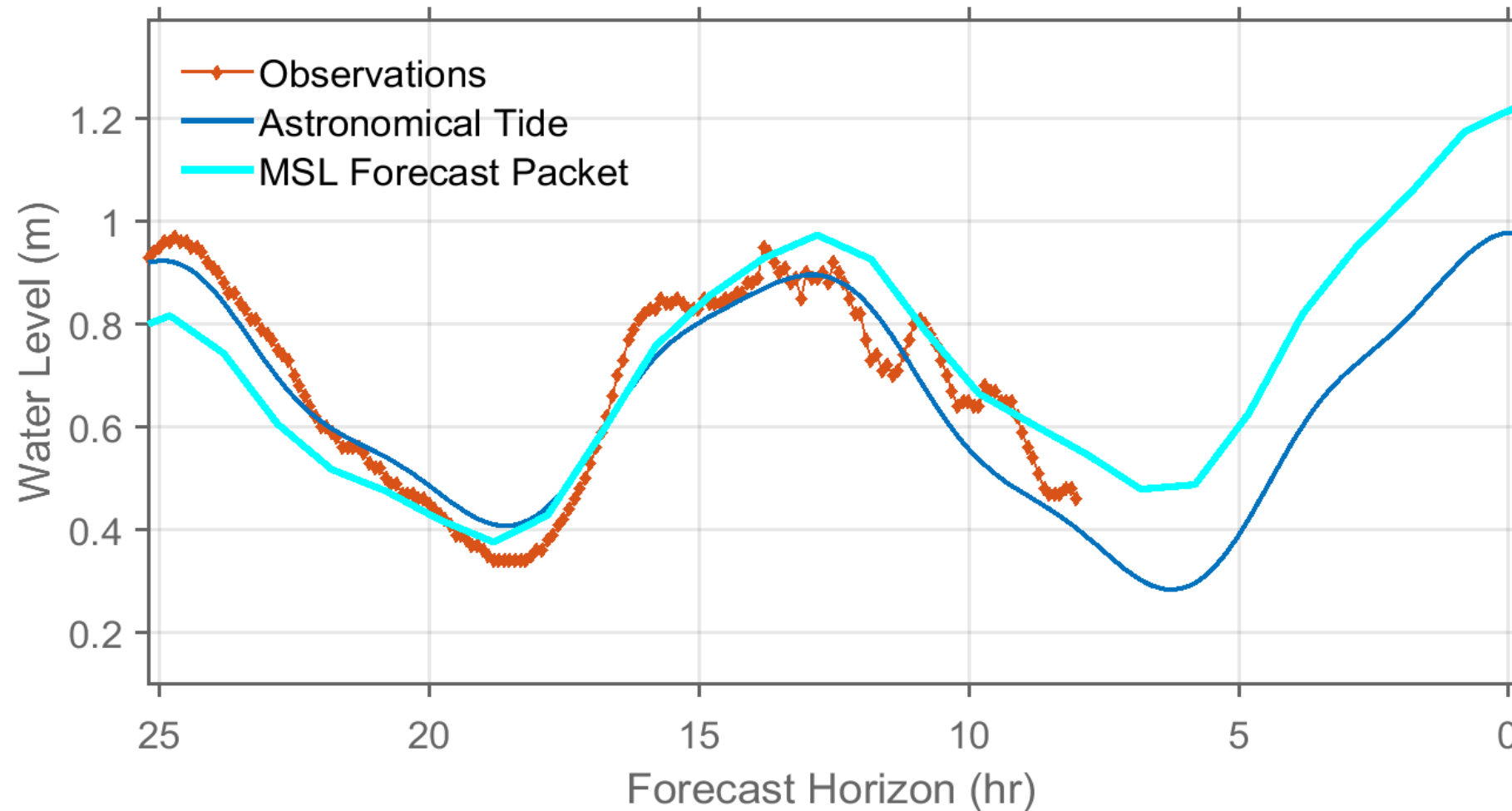
The Climate  
Forecast System  
Reanalysis  
(NCEP): winds  
and mean sea  
level pressure



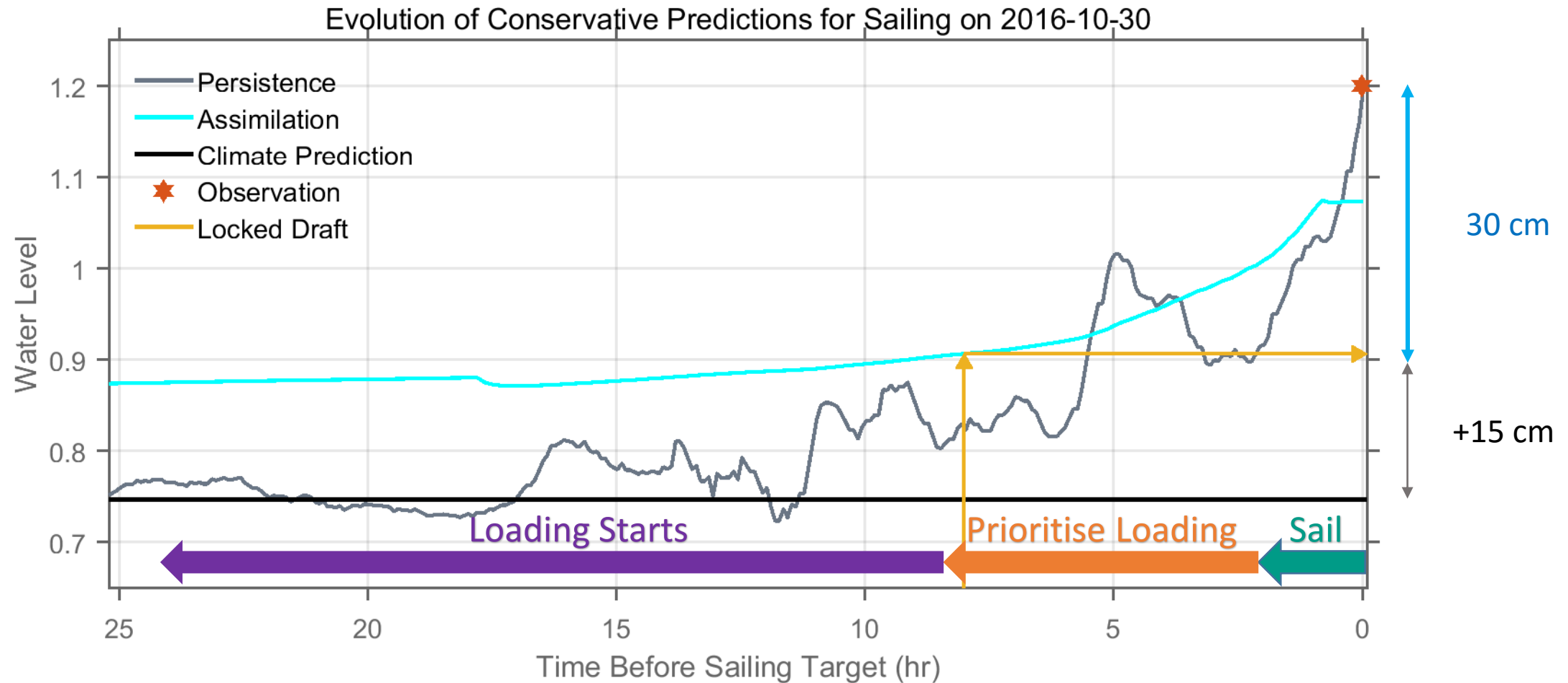
METOCLEAN  
SOLUTIONS



# MetOcean Solutions ROMS forecasts



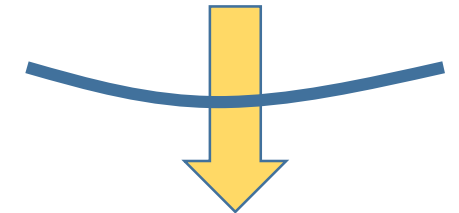
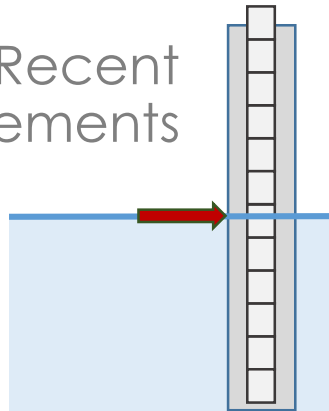
## Predictions with Numerical Forecast (MetOcean Solutions)



## Predictor – forecasts & observations



Recent  
Measurements



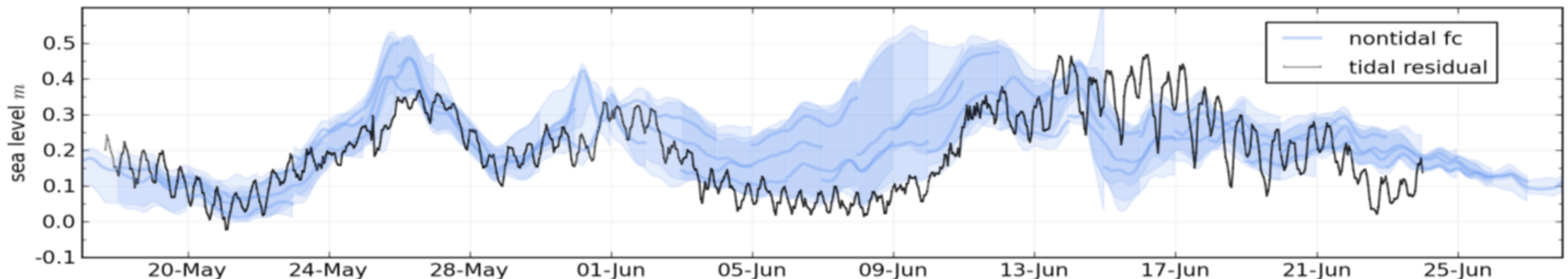
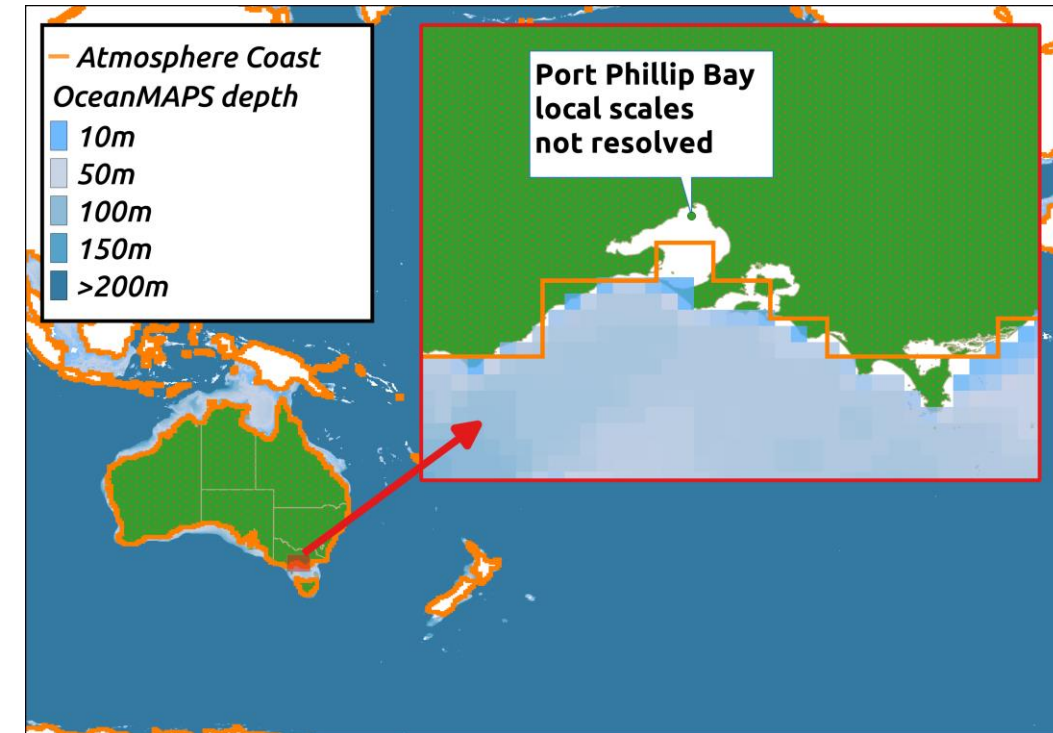
Sea level  
predictions



# Aggregate Sea Level Forecast

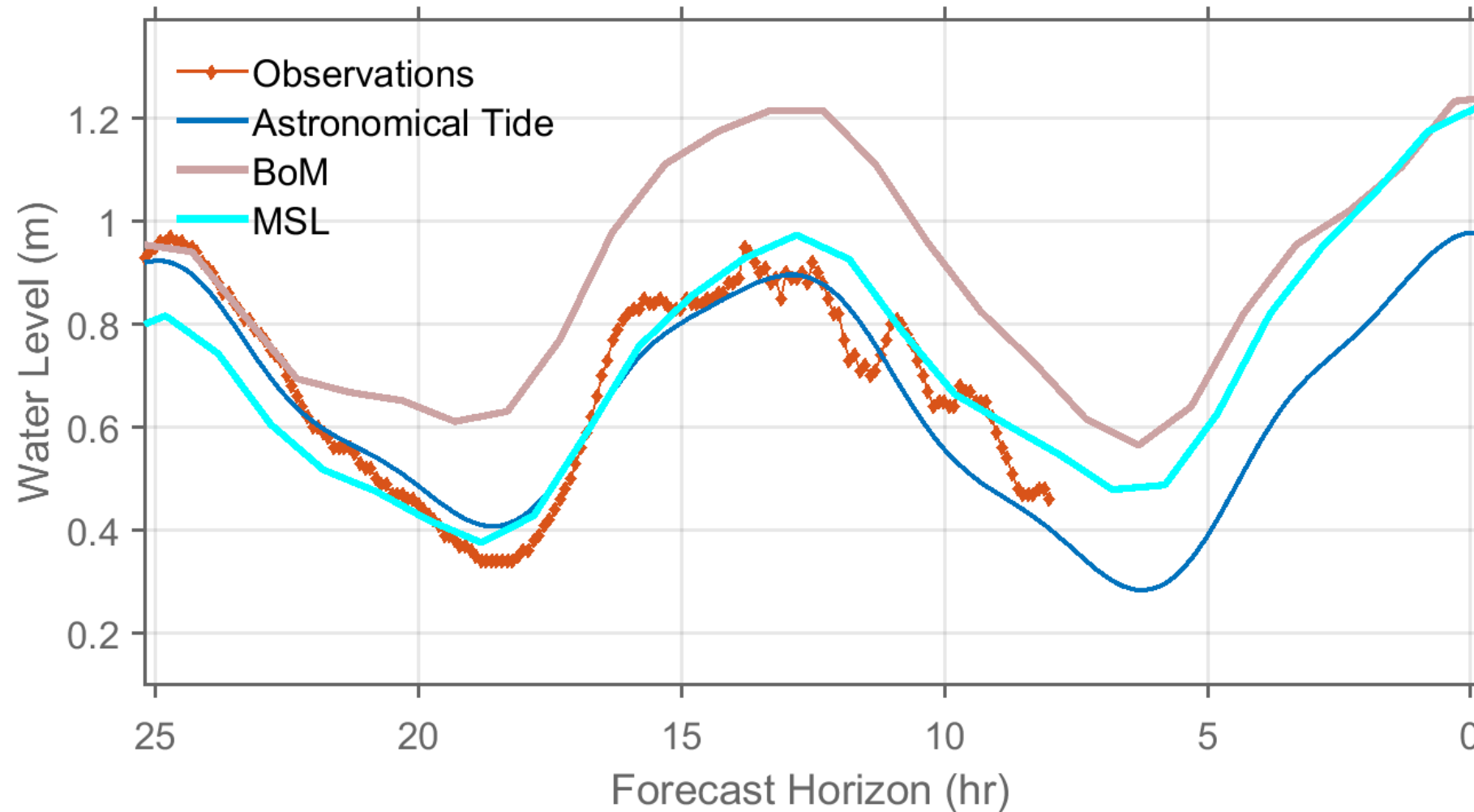


BlueLink/OceanMAPS: circulation  
(mesoscale circulation in the mid- high-latitudes)  
Inverse barometer approximation

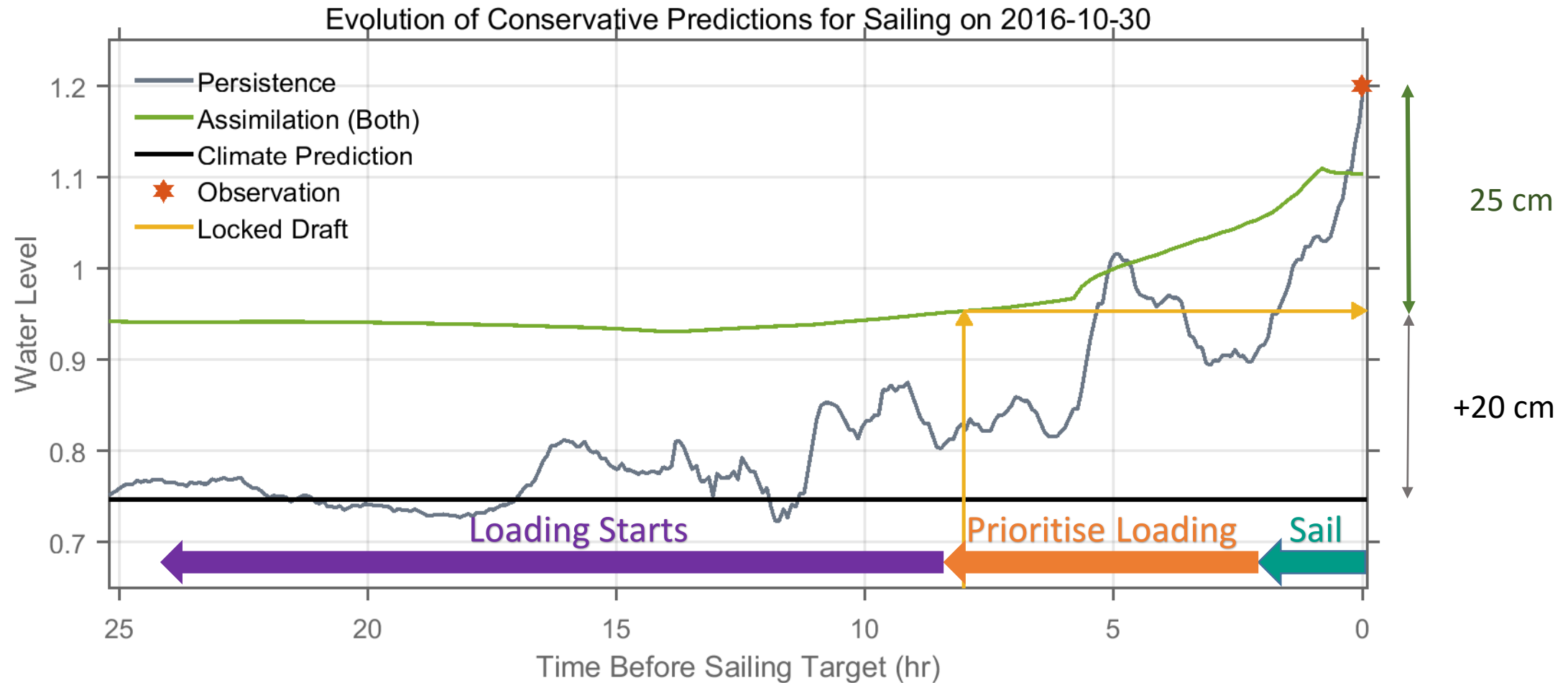




# MetOcean Soln. + BoM Aggregate Sea Level Forecasts



## Predictions with Numerical Forecasts (Both)



## The impact of Operational Oceanography

Average 8-hour predictions – cargo left on the dock:

- Climate: 22 cm
- Measured: 15 cm
- Measured + 1xForecast: 12.5 cm
- Measured + 2xForecast : 11.5 cm

*45% better than climate*

from 349 high tides in 6 months

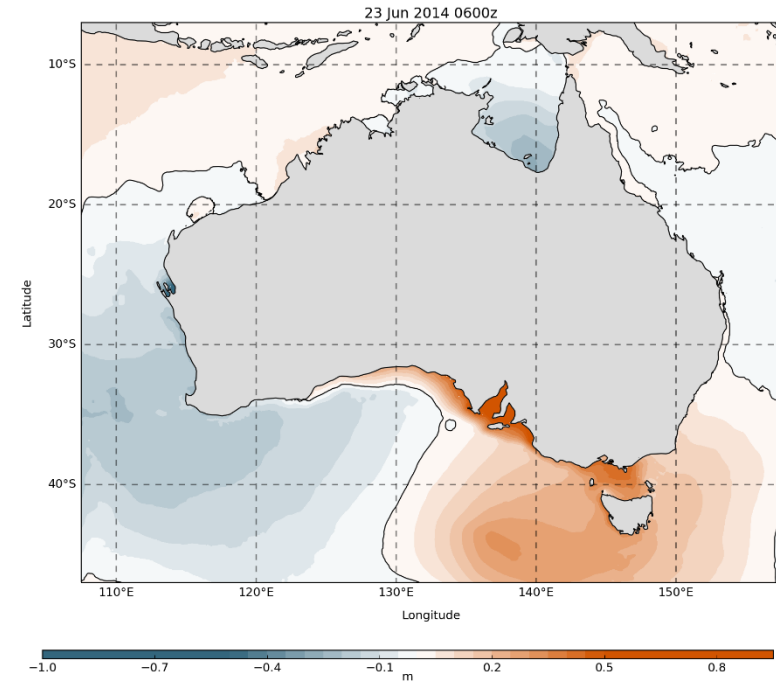
1 cm of draft ~ 30 to 150 tonnes of cargo (ship dependant)

*\$10,000's per cm, per ship, per tide...*

# National Storm Surge system



- **Run routinely**
  - 72-hour forecast every 6 hours
- **Forced with ACCESS-R MSLP and wind stress**
- **Forecasts for entire Australian coastline**
- **ROMS**
  - 2D barotropic mode
  - Open boundary conditions
  - Coastal resolution ~2.5km
- **Wave set-up (AUSWAVE-R) and tides calculated separately and added to surge**



Climate:	22 cm
Measured:	15 cm
Measured + 1xForecast:	12.5 cm
Measured + 2xForecast :	11.5 cm
Measured + 3xForecast :	?? cm

## Conclusions

Accurate & reliable water level forecasts can improve port cargo throughput

**MetOcean Solutions** are providing skilful forecasts for the Port of Geelong

**BoM** also produce skilful forecasts for the Australian region, including the Port Phillip Bay region

Port operational **efficiency & safety** can benefit from multiple guidance



