Quantifying cross-border lead time for coastal wave forecasts in the South China Sea

Speaker: Ho Jun Ang

Email: 26h1313@ubd.edu.bn

يونيرسيتي بروني دارالسلام
UNIVERSITI BRUNEI DARUSSALAM

Background

Regional Context:

- Monsoon systems, storms, and remotely generated swell can send energetic waves across the South China Sea.
- An upstream station may observe the same event many hours before it reaches another coastline.



Current gap:

- The region does not yet have a consistent way to measure that cross-border warning value.
- Station location, data availability, and physical relevance are often treated as one problem even though they require different responses.



Solution:

- Use transparent diagnostics to quantify where upstream information is meaningful, how much lead time it provides, and which observing assets matter most.

Project Objectives

1. Quantify useful lead time:

- Measure whether candidate upstream areas improve the , Hrelationship with a selected coast at positive time lags.

2. Test physical credibility:

- Reject apparent predictors that lack lead gain, distance coherence, or a plausible propagation speed.

3. Assess observing readiness:

- Overlay verified station metadata so physical value, instrument coverage, and access status can be assessed separately.

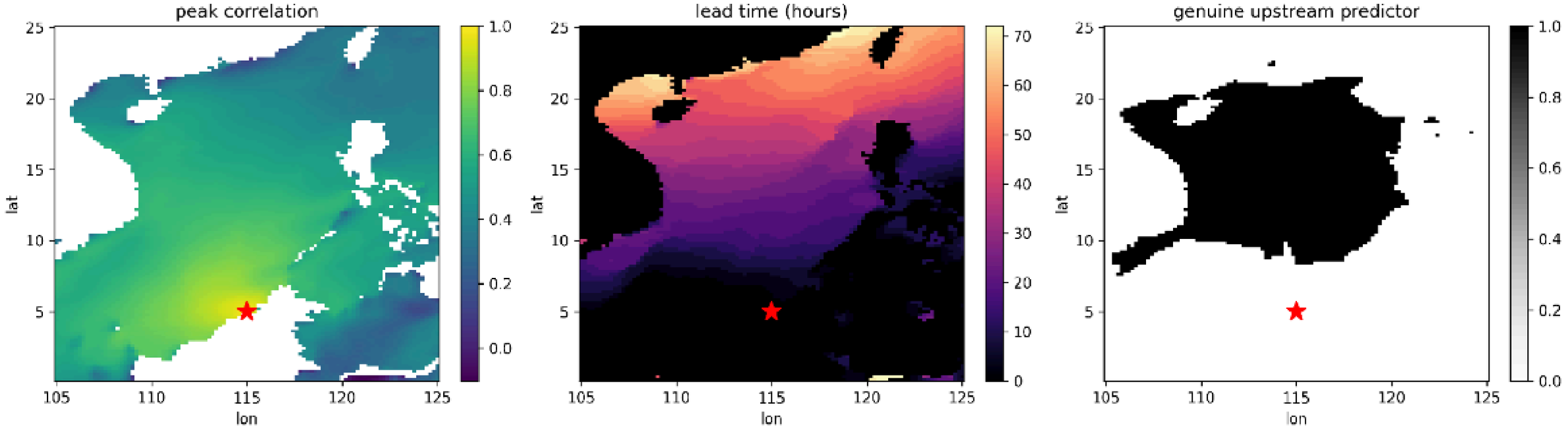
4. Demonstrate practical sharing:

- Test a lightweight exchange of derived indicators before asking partners to share complete national observation records.

The project evaluates the value of existing information. It does not claim to invent a new wave forecasting model.

Preliminary South China Sea Test

2023–2024 northeast monsoon, open-water target near Brunei



27.3%
of the domain passed predictor screens

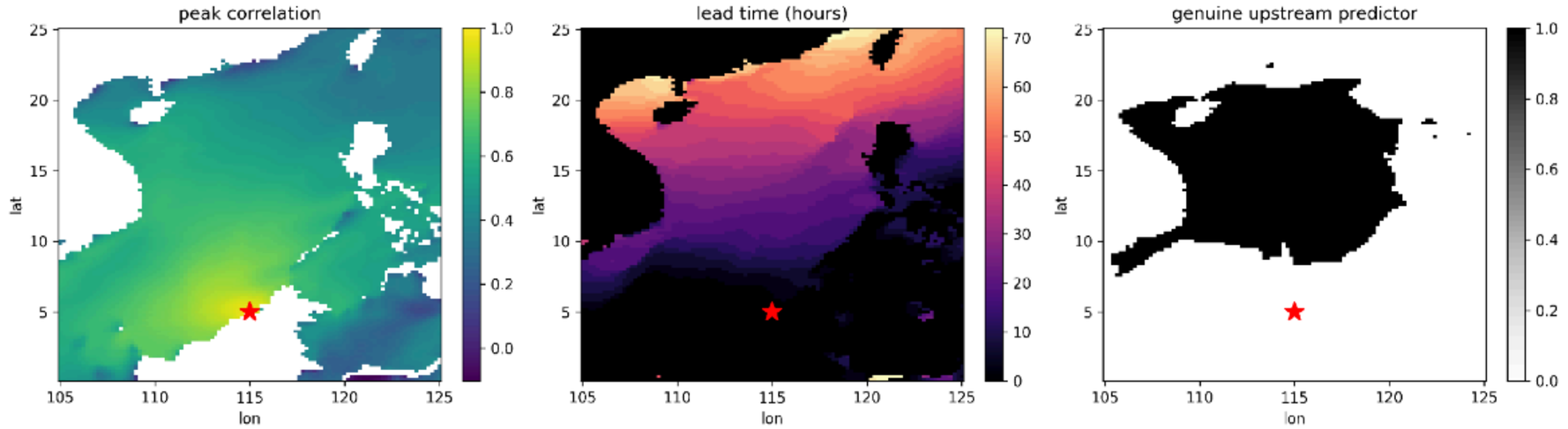
30 h
median lead time

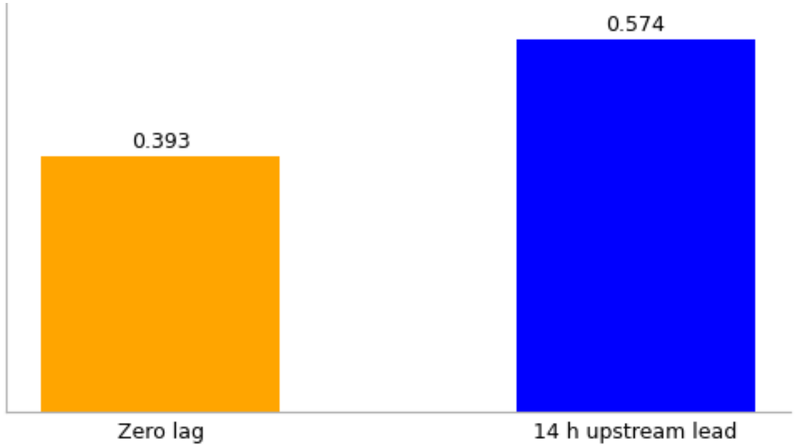
48 h
90th percentile

66 h
maximum lead time

Preliminary South China Sea Test

2023–2024 northeast monsoon, open-water target near Brunei





90.2%

of top 5% wave-height events classified as swell dominated

Correlation rises by 0.181 when the upstream buoy leads by 14 hours

R^2=0.90

distance–lag relationship

8.8 m/s

implied propagation speed

Research Questions and Scope

1. Where does upstream wave information improve understanding of conditions at a selected coast?

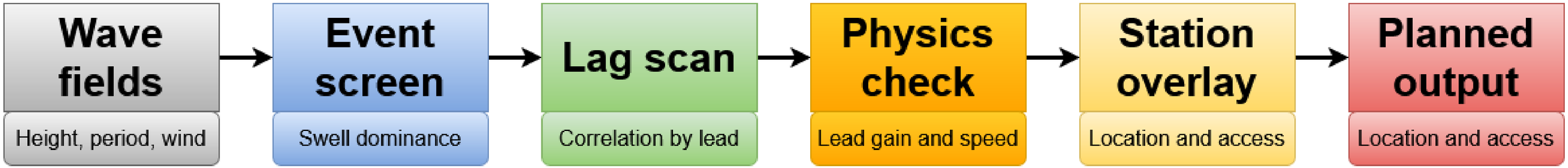
2. How much warning time remains after the signal passes the physical screening tests?

3. Which high-value regions have an accessible station, an inaccessible station, or no instrument?

4. Can partners exchange useful derived indicators without transferring all raw observations at the start?

Multiple northeast monsoon seasons, selected ASEAN coastlines, and a sensitivity comparison with ERA5 if required (for scope)

Proposed Analysis Workflow



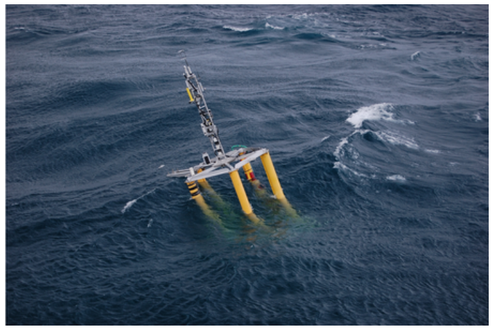
For proposed screen:

-Positive lead gain

-Coherent distance pattern

-Plausible propagation

Regional Data-to-Warning Architecture





Open wave products

Copernicus Marine, ERA5 or WW3

Partner observations

Buoys, coastal stations, metadata

Regional processing

- Event screen
- Lag scan
- Physical check
- Station overlay

Shared indicator packet

- Lead time
- Upstream status
- Confidence
- Access flag

Partner agencies

Local interpretation and station decisions

Scientific and Practical Value

Scientific Contribution:

- A repeatable way to measure cross-border lead time
- The project would produce lead-time maps and a bilateral matrix that show where an upstream signal improves the relationship with a target coast.
- Physical screening reduces the risk of treating simultaneous weather forcing as useful propagation.

Practical Contribution:

- Clearer choices for sharing and station investment
- By separating physical value from access status, the project can distinguish a missing instrument from a useful station whose data are not yet shared.
- That distinction supports more specific recommendations for data access, network coverage, and future station placement.

Note:

- The project evaluates warning value. It does not replace national forecasting or operational warning systems.

Planned Project Outputs

1. Lead-time atlas:

- Where does earlier information exist?
- Peak correlation, best lead time, and predictor mask

2. Priority map:

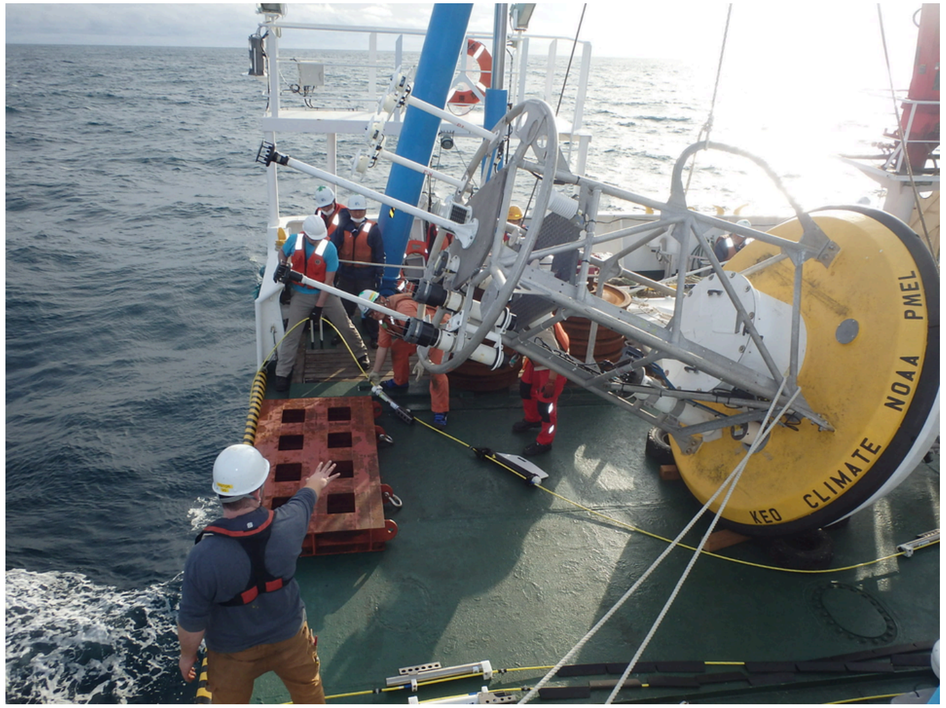
- Where should sharing or investment start?
- High-value stations and uncovered regions

3. Station inventory

- Which assets are usable now?
- Position, variables, operator, and access status

4**. Demonstrator:**

- How will partners exchange indicators?
- Lead time, upstream status, confidence, and access flag



Potential Partner Inputs

1. Metadata:

- Station positions Access status
- Maps existing assets and reveals access gaps

2. Test:

- Pilot the proposed indicator exchange
- Refines usability, confidence cues, and local interpretation

3. **Review**

- Method review local interpretation
- Checks local relevance and supports credible interpretation



THANK YOU

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