CHARACTERISTICS OF NON-LINEAR INTERNAL WAVES NEAR THE NUSA PENIDA SILL, LOMBOK STRAIT, AND THE INFLUENCE OF THE INDONESIAN THROUGHFLOW

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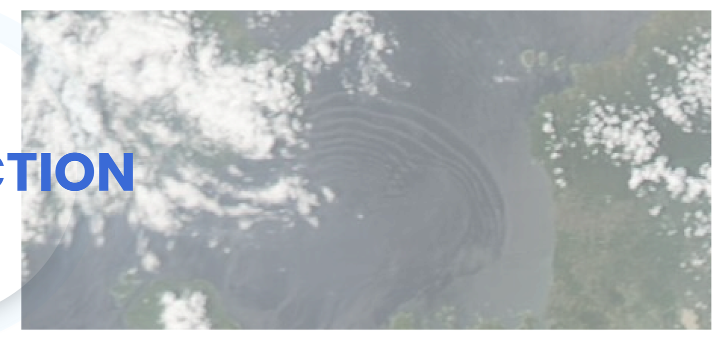
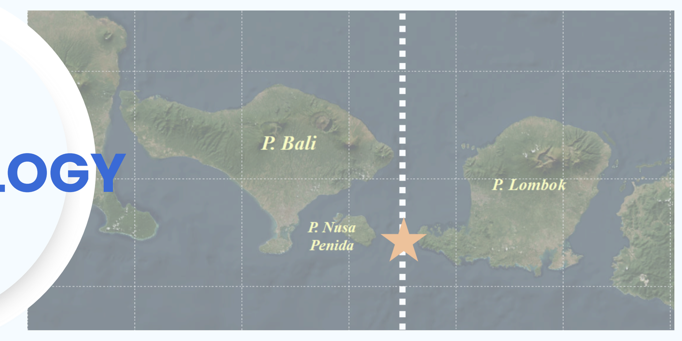
1 INTRODUCTION



Internal waves, primarily observed as **nonlinear internal waves (NLIWs)** (Brandt et al., 1996) are **waves generating and propagating beneath the surface** of stratified seawaters. These waves are also **commonly observed in the Lombok Strait** (Susanto et al., 2005), where they generate and propagate near the Nusa Penida Sill at **similar depths along the Indonesian Throughflow (ITF) pathway**.

This study incorporated **numerical simulations with realistic forcings**—rather than idealized scenarios (Aiki et al., 2011; Gong et al., 2022)—specifically aimed at **investigating the characteristics of NLIWs, their variability, and their interplay with the ITF and tides** in the Lombok Strait.

2 METHODOLOGY



Model
- MITgcm
- 3D, Non-hydrostatic

Time and Region of Interest
- June 2004 - May 2005
- 114,1°–117,1°E 7,5°–9,5°S

Bathymetry
- Boundary - TPXO9
- Base/Internal - Batnas

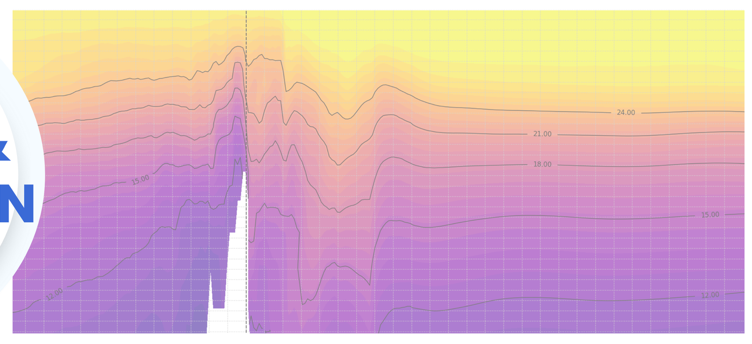
Initial Condition
- Copernicus - U, V, T, S

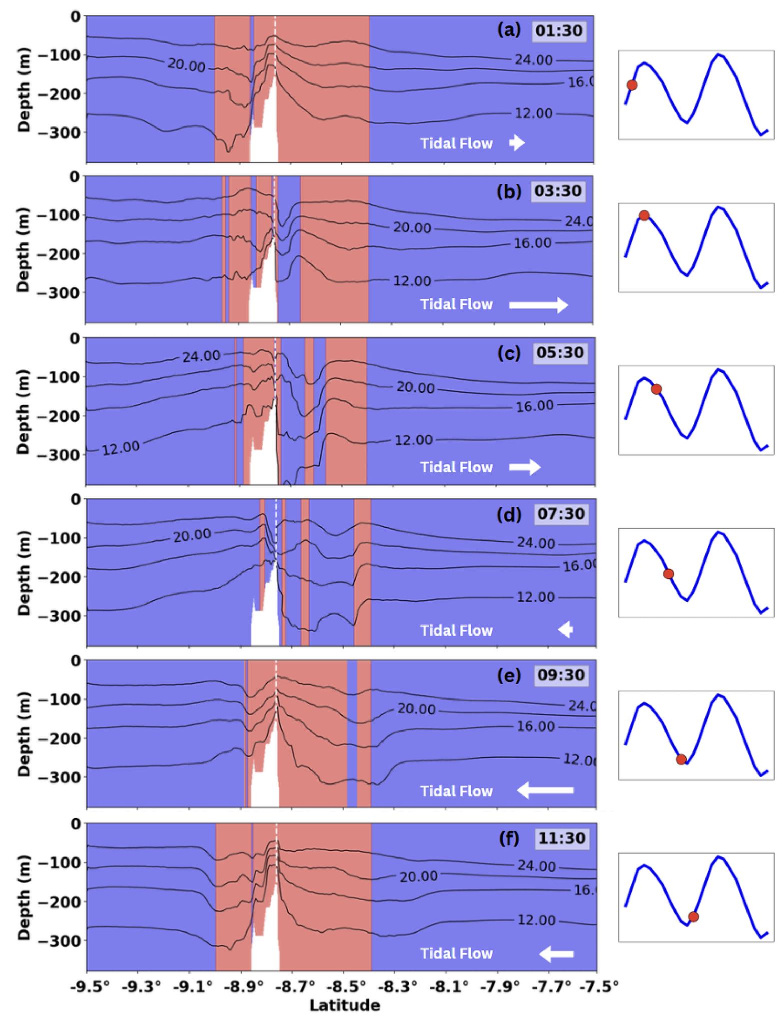
Boundary Condition
- HYCOM - U, V, T, S
- Tides - TPXO9, 10 Comp.

Grids, Timestep
- 450 x-grid (W-E)
- 300 y-grid (S-N)
- $\Delta x = \Delta y = 1/150^{\circ} \sim 750$m
- 44 z-grid (depth layers)
- max Δz = 274m
- Δt = 15 s

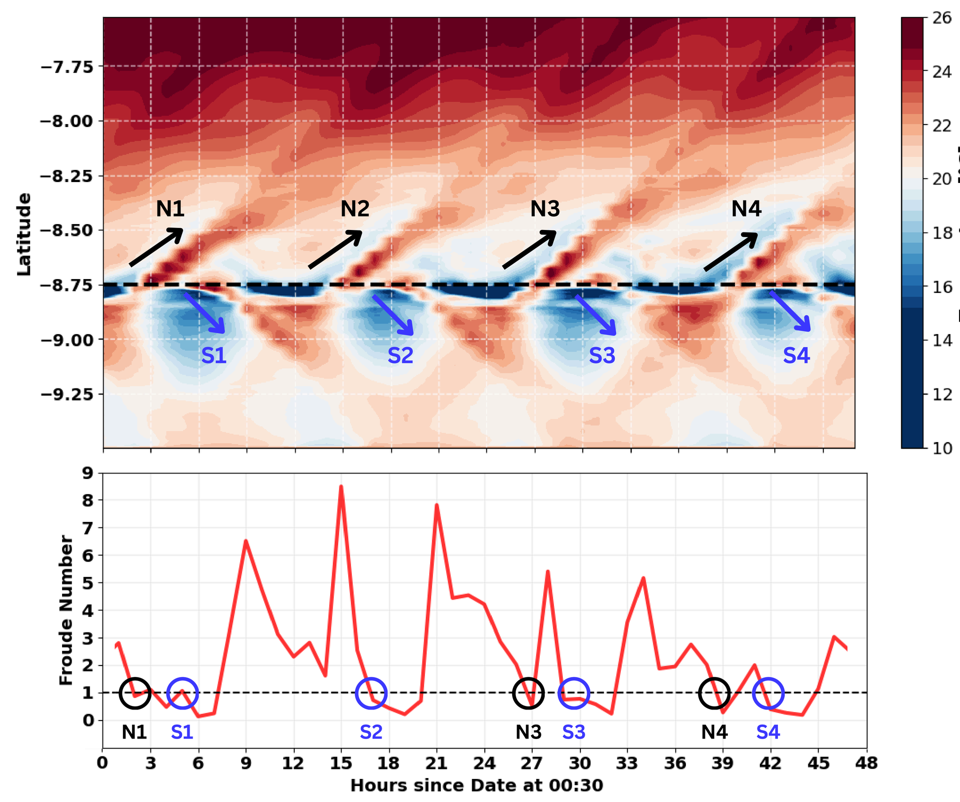
Forcings (Atmospheric)
Winds, air temp., precipitation, specific humidity, downward shortwaves and longwaves.

3 RESULTS & DISCUSSION

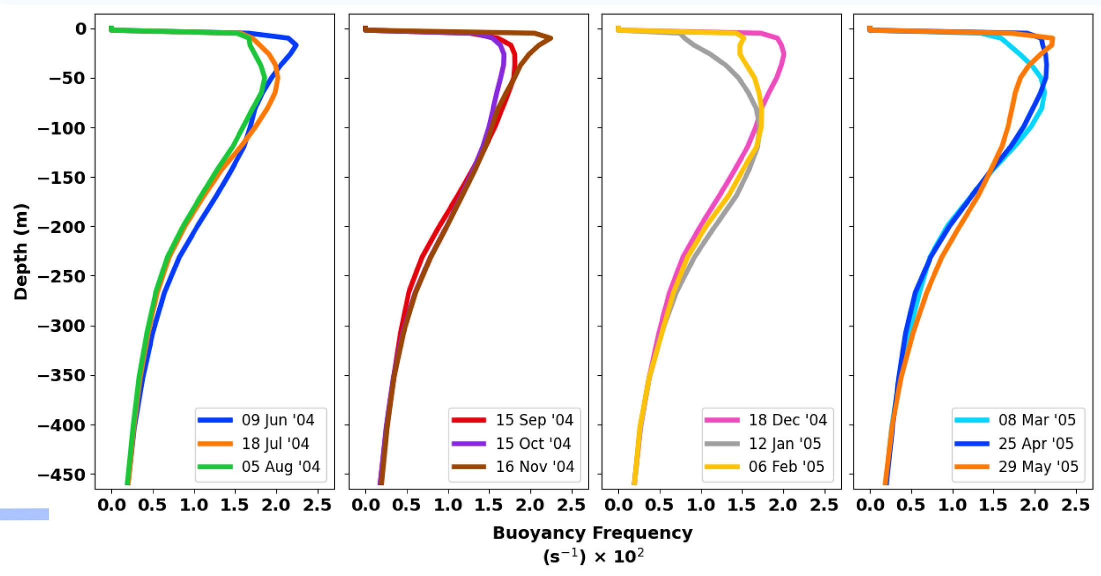


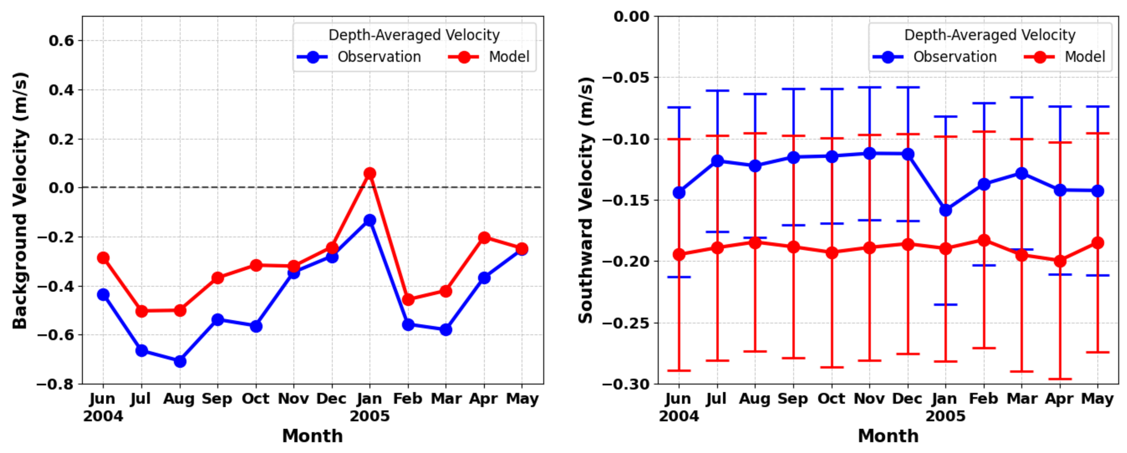


NLIW **generation mechanism** is **leewave evolution** and **controlled by semidiurnal tide**. Generation area seems to be near the Nusa Penida Sill, between latitude 8,6°–8,9° S

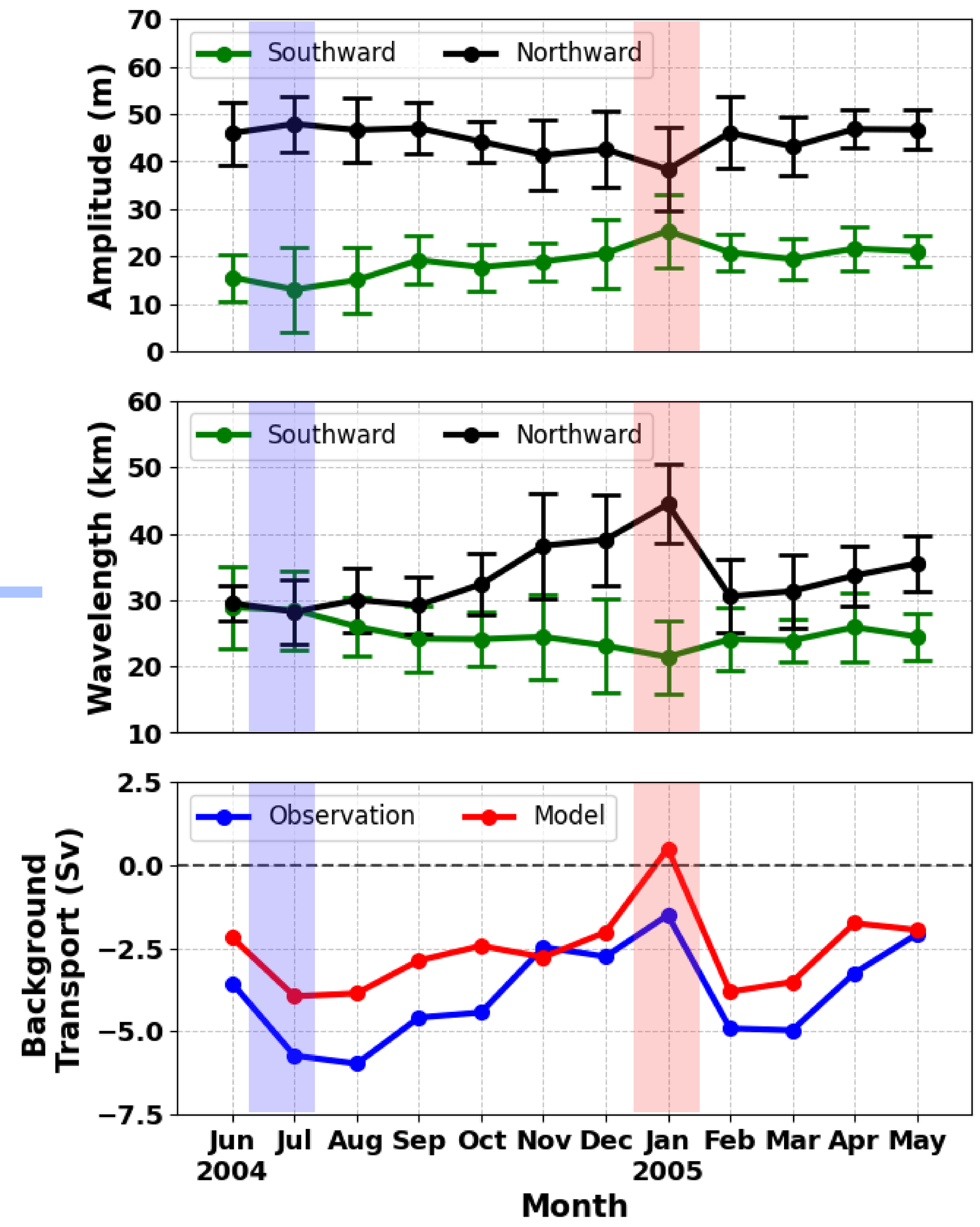


Events where a flow transitions from supercritical (Froude Nr. G >1) to subcritical (G <1) is called a hydraulic jump. Generation or the **'release' time of NLIWs coincides with hydraulic jump events** (Zhuang et al., 2024).

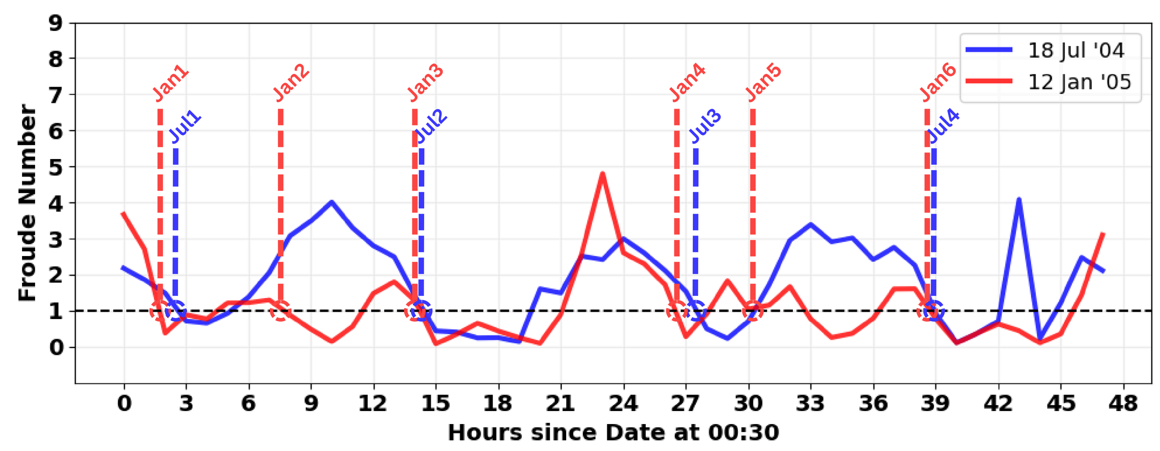




Monthly variability of **stratification profile** and **tidal current speed** is found to be **insignificant**.

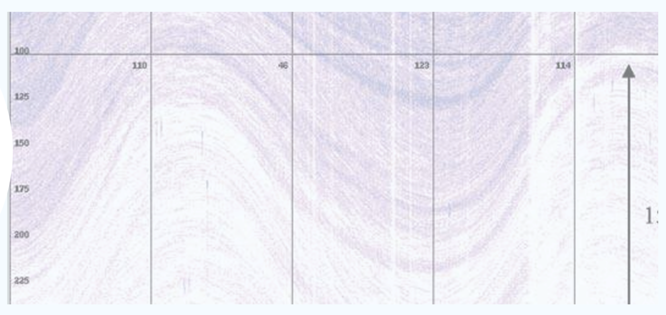


In months with **strong (weak) ITF**, **northward-propagating NLIWs** have **larger (smaller) amplitudes** and **shorter (longer) wavelengths**. **Southward-propagating NLIWs** exhibit the **opposite trend**.



An indication that **stronger ITF** causes NLIW generation/release to be **less frequent and slower**.

4 SUMMARY



- **NLIWs near the Nusa Penida Sill are generated through lee wave evolution, predominantly driven by the semidiurnal tide.**
- **Variations in NLIW parameters are closely linked to the strength of the ITF.**
- **Northward-propagating NLIWs: larger amplitudes and shorter wavelengths during strong ITF months; the opposite during weak ITF.**
- **Southward-propagating NLIWs: exhibit the reverse trend.**
- **The ITF exerts a stronger influence on NLIW characteristics than stratification or tides.**

References:
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