

INSTANT-LEG#1

Makassar Moorings

Cruise Report; Arnold L. Gordon

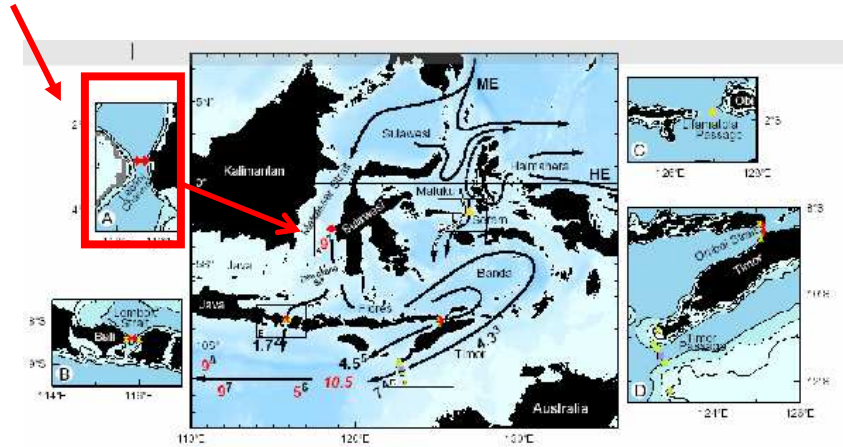
Baruna Jaya I

Start: Jakarta, 24 November 2006

Intermediate: Balikpapan, 30 November 2006

End: Bitung, 2 December, 2006

Makassar

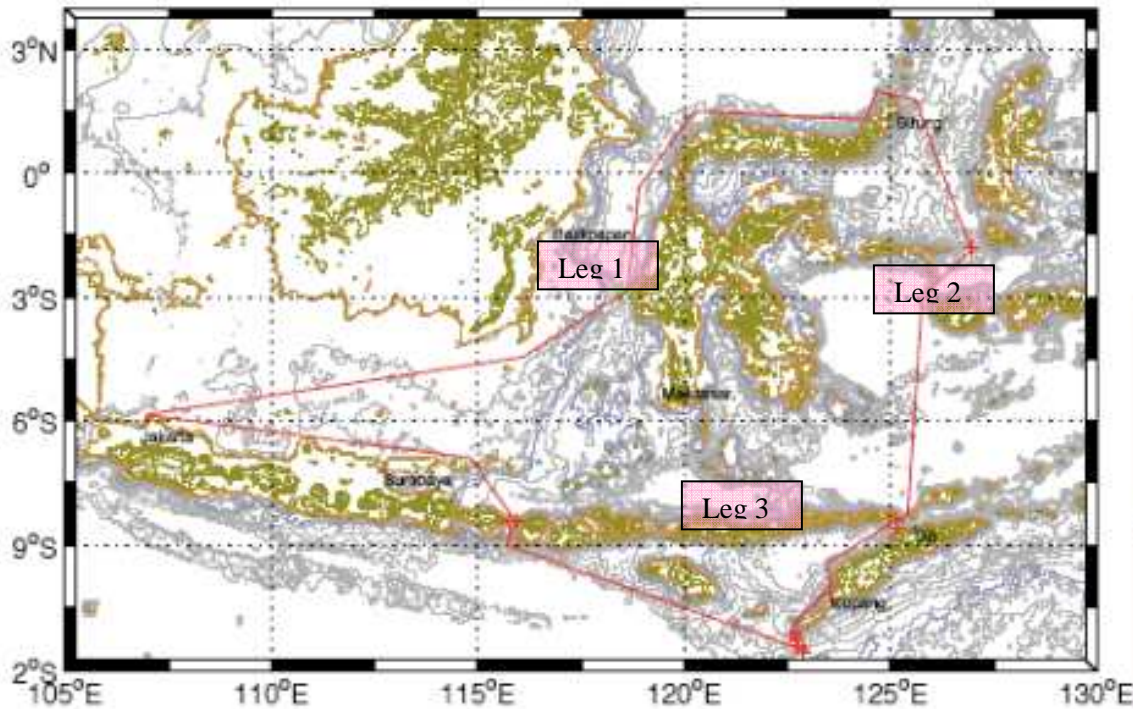


I Introduction:

[A] INSTANT Scientific Objectives: The aim of INSTANT is to directly measure the leakage of warm and fresh waters from the western equatorial Pacific into the South Indian Ocean via the Indonesian passages. The size and depth distribution of this Indonesian Throughflow (ITF) has not been well determined, and this has led to ambiguity of the mean and variability of the ITF. The INSTANT project will consist of a 3-year deployment of *in situ* velocity, temperature and salinity data from the sea-floor to the surface in the major inflow and outflow straits that make up the Indonesian choke point. The array is designed to measure the mass, heat and freshwater transports that flow into and out of the Indonesian Seas. Five nations compose the INSTANT collaboration: Indonesia, France, the Netherlands, the USA and Australia. The Indonesian Ministry of Marine and Fisheries is sponsoring the Indonesian involvement. Timor Leste kindly provided permission to deploy the southern Ombai mooring in their territorial waters.

The INSTANT Recovery cruise November-December 2006 aboard the Baruna Jaya 1 is a circum-Sulawesi cruise, [Figure 1].

Figure 1 : The Circum-Sulawesi INSTANT Recovery Cruise [November-December 2006]



[B] INSTANT Leg 1 Objectives

There are 3 objectives of INSTANT leg #1:

1. To recover the two INSTANT Makassar moorings in the Labani channel near 2°50'S.
2. Redeploy the Makassar West Mooring, which will be referred to as the NOAA-ITF mooring. It will be deployed at the target mid-way between MAK WEST 1 and 2 [at 2° 51.11'S; 118° 27.33'E], assume at a depth of 2130 m.
3. CTD yo-yo [time series] stations near Makassar West mooring.

[C] The Plan: the following Plan was presented by A.L.Gordon to the Indonesian researchers on 25 November. It is noted that the Plan is subject to change as realities of weather & waves plus equipment & people affect the situation

Arrive at the site of MAK-WEST2: 2° 50.298'S; 118° 27.377'E, between 2000 and 2400 27 November

Upon arrival:[*first: can we communicate with MAK-WEST?*]

Activity 1: At a position no closer to MAK-WEST than 2 km, we carry out repeat CTD [or as often referred to: “Yo-Yo” CTD] to a depth ~500 m, with water samples in the upper 250 m [for Chl-a, as requested by BRKP]. The time needed for each stations is about 1 hour. “Repeat” means: a station once every other hour [or 2 hour]. So that one hour station; one hour water sampling and rest. We could go to a 2 hour or every third hour repeat cycle. The details of Activity 1 is up to the head of the CTD team [Endro]. The Yo-Yo time series will reveal the tidal effect on stratification of the thermocline [heaving; changes in dT/dp ; ‘steps’].

Activity 2: Beginning ~0530 28 November: Retrieval of MAK-WEST1. The procedures for mooring recovery will be established by mooring team: Phil Adams, Bruce Huber Lindsay Pender. These procedures will be discussed so all understand what needs to be done, safety and efficiently.

Activity 3: Go to and retrieve MAK-EAST2: $2^{\circ} 51.378'S$; $118^{\circ} 37.745'E$. Afternoon of 28 November.

Activity 4: Upon conclusion of the retrieval of MAK-EAST2, ~ 1700 on 28 November, head back to the MAK-WEST1 position, where continuation of the CTD Yo-Yo time series will continue, until ~1100 on 29 November. That time series along with the 27 November time series will provide maybe 7 to 9 CTD stations. During this time the mooring team will tend to the mooring equipment and its data, and prepare for Activity 5.

Activity 5: Directly after lunch on the 29th November the mooring team will re-deploy a mooring at the MAK-WEST site. After deployment the exact mooring position is determined by ‘triangulation’. This mooring is the beginning of a long term measurement of the Indonesian throughflow [Makassar Strait carries ~80% of the total ITF]. Activity 5 should be completed by ~1800 29 November at which time we head for Balikpapan, but there may be opportunity for a few more CTD Yo-Yo at MAK-WEST.

[D] See Word File: PARTICIPANTINSTANT_MAK06.doc for photos and names of the officers, crew and scientists on INSTANT leg 1

II Makassar Moorings

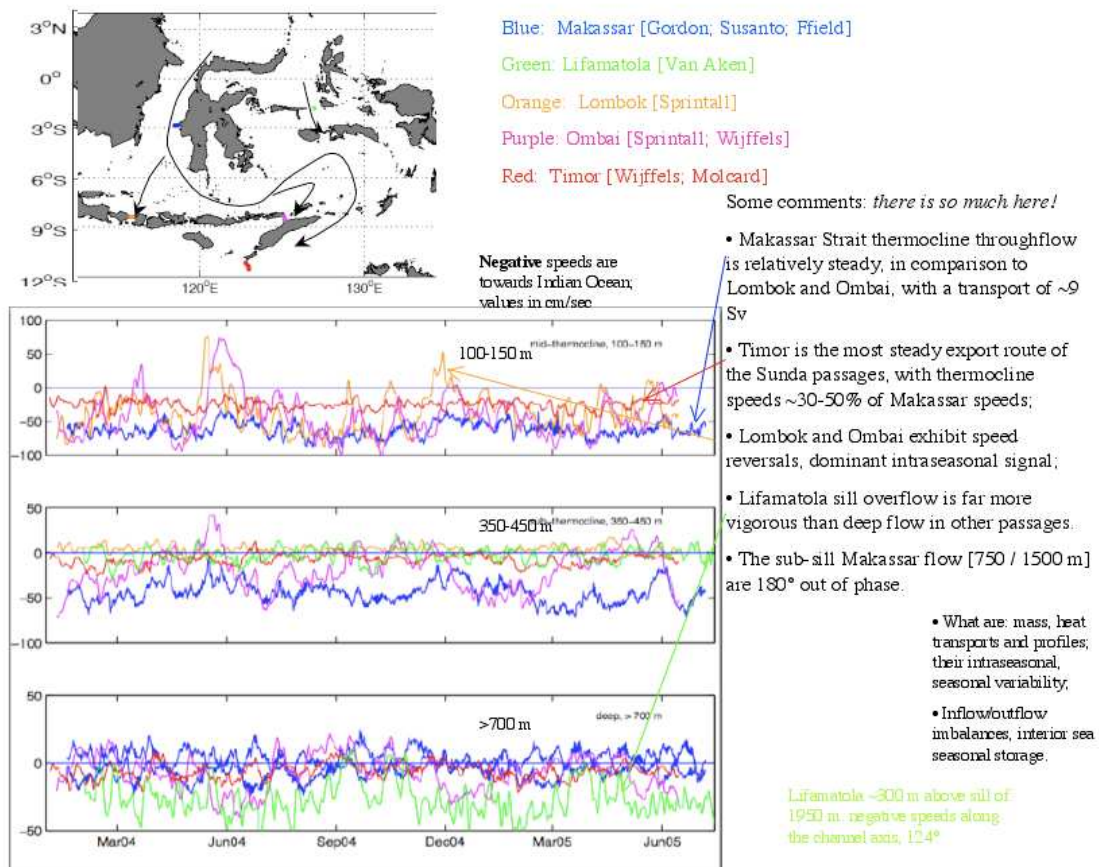
[A] Background to the Makassar Moorings and the 1st 1.5 years of INSTANT data:

It is estimated that Makassar Strait carries about 80% of the total Indonesian throughflow estimated as 10-12 Sv. It accounts for an even higher percentage of the ITF within the surface and thermocline, as the eastern pathways may be dominated by the deep overflow across the Lifamatola sill, estimated as 1.5 to 2.5 Sv. The two INSTANT Makassar moorings are deployed near $2.9^{\circ}S$ within the Labani Channel, a 2000 m deep,

45 km wide constriction in Makassar Strait. West of the Labani channel is a <10 m deep coral reef rimming a broad promontory of generally <30 m deep, confining the throughflow to the Labani channel. The 1996-98 data indicates that the flow along the western side of Labani is stronger than that along the eastern side. A southward speed maximum was found in the thermocline, 150-200 m interval. Seasonal reversal of the flow in the upper 50 m is evident. The estimated transport in 1997 was ~8 Sv. The first 1.5 years of the INSTANT Makassar data set reveals much the same along channel speeds and shear as found in 1997, though with a slightly higher estimated transport closer of ~9 Sv. The strong El Niño of 1997 may have depressed the Makassar throughflow at that time.

The combined INSTANT mooring time series is shown as Figure 2 [taken from an INSTANT article in CLIVAR Exchanges, 2006].

Figure 2: A composite view of the along-axis speeds [cm/sec; tides removed] from select moorings within each passage as measured during the first 1.5 years of INSTANT. Negative speeds are towards Indian Ocean. Color coding: Blue: Makassar; Green: Lifamatola; Orange: Lombok; Purple: Ombai; Red: Timor.



[B] The Moorings of the 2nd 1.5 years of Makassar INSTANT

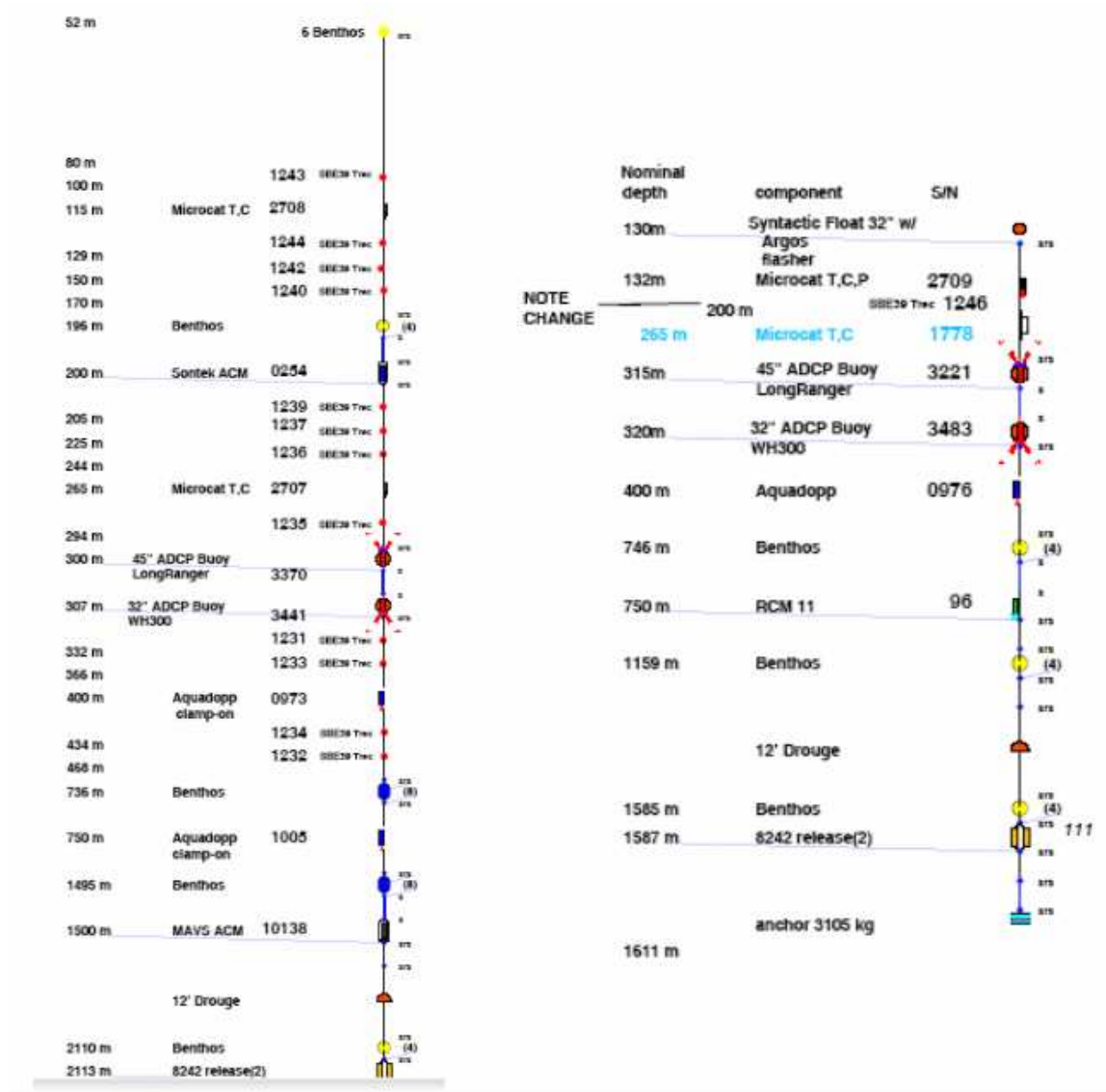
Mooring	Latitude	Longitude	Depth	deployed
MAK-EAST2	2° 51.378'S; 118° 37.745'E;	1613 m;		10 July 2005
MAK-WEST2	2° 50.298'S; 118° 27.377'E;	2133 m;		10 July 2005

Comments:

- The '2' designation refers to the second deployment of the INSTANT Mak moorings on 10 July 2005. The 1st deployment [January 2004 – July 2005] is designated as MAK-WEST 1 and MAK-East 1.
- MAK-EAST2: There is some uncertainty in the triangulated position and the actual position may be ~300 m to the south of the coordinated given above. MAK-EAST 1 was at 2°51.522'S; 118°37.734'E.
- The INSTANT MAK-East1 deployed in January 2004 was set 532 m south of the Arlindo MAK-2 [December 1996-February 1998; 2°51.24'S; 118°37.69'E, 1611 m].
- MAK-WEST2 [2° 50.298'S; 118° 27.377'E; 2133 m] is 1.6 nm north of MAK-WEST 1 [2°51.888'S; 118°27.276'E, at 2117 m]. MAK-West was set 555 m SW from Arlindo MAK-1 [December 1996- July 1998; 2°51.69'S; 118°27.51'E, 2137 -m].
- The INSTANT moorings are separated by ~19.4 km, within the ~45 km wide Labani channel.

The configurations of the MAK 2 moorings are shown in figure 3.

Figure 3 The re-deployed INSTANT MAKs, MAK-WEST2 [left panel] and MAK-EAST2 [right panel]



The tidal currents during the Makassar recovery cruise are at neap tide [see moon phase information, below], the minimum of the fortnightly cycle. The recovery of the two Makassar moorings are scheduled for 28 November; the deployment of the NOAA-ITF mooring is scheduled for 29 November 2006.

New Moon 1st Quarter Full Moon 3rd Quarter

Time [universal]

 d h:m d h:m d h:m d h:m

Nov. 20 22:18 Nov. 28 6:29 Dec 5 0:25 Dec 12 14:32

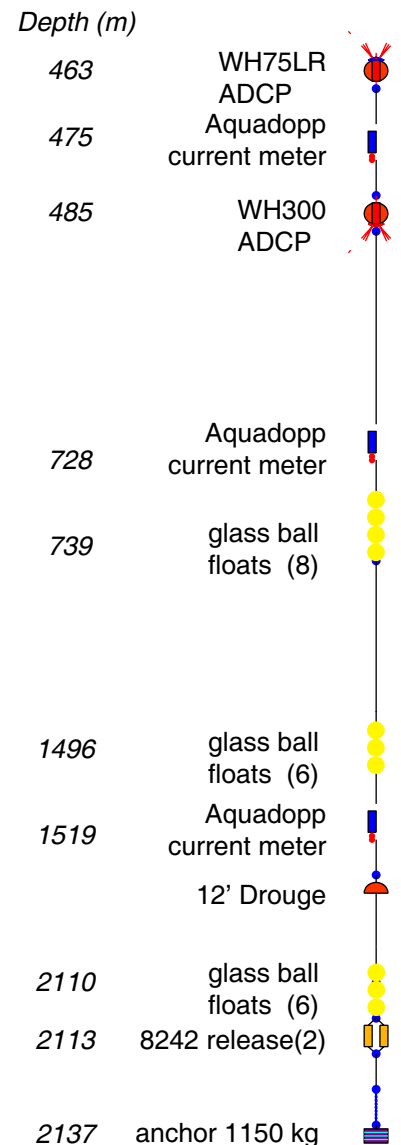
[C] NOAA ITF Mooring

The NOAA mooring will be placed between the locations of MAK-WEST1 and MAK-WEST2, at 2°51.11'S; 118°27.33'E [2°51'06.6"S; 118°27'19.8"E], about 0.8 nm south of MAK-WEST2. A transfer function based on the Arlindo and INSTANT time series will allow the MAK-WEST data to be converted to a full Makassar ITF. The MAK-EAST is very close to a constant 80% of MAK-WEST along channel speeds.

The NOAA ITF mooring has instruments placed well below the high-velocity core of the throughflow. The mooring will be instrumented as shown schematically in Figure 4 [to the right]. An upward-looking RDI Longranger ADCP will provide velocity profiles from approximately 500 m to near the surface, resolving the bulk of the throughflow velocity field without being subjected to the blowover associated with the large velocities in the thermocline. Additional current meters, including an RDI 300 kHz Workhorse ADCP, will provide velocity measurements throughout the remainder of the water column. Dual acoustic releases will be used to give an added measure of reliability. The ADCPs are mounted in syntactic foam buoys with in-line mooring cages. Backup flotation is provided by distributed glass ball floats in plastic hard hats.

All of the instruments will be equipped with battery and memory capacity for a 2 year deployment. For the ADCPs, this entails using a sampling rate of one ensemble per hour. The Aquadopps will also be set for hourly sampling, but they can also record bursts of higher frequency samples for diagnostic purposes. The releases will be prepared for 4 year endurance.

The ADCPs, syntactic foam buoys, and Aquadopp current meters will be provided by LDEO after recovery of the INSTANT moorings. We are requesting funds to purchase 2 ORE 8242 acoustic releases, 20 17" Benthos glass ball floats, mooring line, shackles, batteries, anchor, and related hardware which will not be available from recovery of the INSTANT MAK moorings.



III CTD Program:

As we are likely to arrive at the first mooring site, MAK-WEST2 in the evening ~7 pm, 27 November, we will commence with yo-yo CTD, once every three hours to a depth of 500 meters. The CTD stations will be ~1.2 nm to the east of Mak-WEST2, returning to the position as we drift more than 10 nm away from initial station. See Plan above.

IV Chronological Narrative & Comments

Chronological Narrative; all times are local; we advanced clocks 1 hour relative to Jakarta time on evening of 5 July, putting us on Wita time, GMT+8.

24 to 27 November 2006, Friday to Monday, Jakarta to MAK Moorings. We departed Jakarta slightly after 3 pm Friday, 24th November 2006, proceeding eastward at rate of generally at 10 kts. Clocks advanced 1 hour at ~12 pm, 26 November. Meeting was held at 2 pm 26th with ship officers, crew and scientists about the mooring recovery and deployment procedures. A.Gordon gave two introduction to physical oceanography lectures to the BRKP on the 27th and presented the general plan for the cruise on the 25th.

Evening of 27 November: Begin Yo-Yo CTD at site near Mak-West2 at 2030 local time. Unfortunately we were not able to communicate with the release when we tried at 7-8 pm. The ship is noisy and we might not have heard 'reply' from the release.

28 November, Tuesday. [Recovery of MAK- WEST2 & EAST2]: Three CTD with water samples during the night, last ended at 2:45 am [all times are local]. At 4:30 am we headed for the MAK-WEST2 site. We heard the release at ~5:20 am, having sonar off did the trick. Released at 5:30, spotted at 5:36 AM. Good weather, 2' waves, ~ 5 kt wind. Sun rise ~5:45 am. Top floatation on deck at 6:59 am. Completion of MAK-WEST2 recovery at 8:58 am, about 3.5 hours since release.

Squall as we head for MAK-EAST2, heavy rain, wind ~20 kts, waves ~5', visibility ~1 km, so we will have to wait it out before dealing with MAK-EAST2. In continued squall [improved visibility] MAK-EAST2 was popped at 10:42 am, sight at 10:45 am, very close to the ship. Small rubber boat snagged it around 11:05 and the retrieval began. Top float in at 11:25 am. Recovery completed 12:44 am. Whereas MAK-WEST2 had little bio fouling, MAK-EAST2 had 'sticks' of something on one side of the WHO 32" float and on at least one of the 750 m Benthos floats, also on one side. Was this side downstream? The long ranger ball had the various attached bio.

Following the mooring recovery a series of CTD with water samples for productivity were obtained into the late morning of 29 November. The data from the

moored instruments were downloaded and preparations for tomorrow's deployment of the NOAA-ITF mooring began.

29 November NOAA-MAK:

The target site for the NOAA mooring is between the locations of MAK-WEST1 and MAK-WEST2, at $2^{\circ}51.11'S$; $118^{\circ}27.33'E$ [**TARGET: $2^{\circ}51'06.6''S$; $118^{\circ}27'19.8''E$** , about 0.8 nm south of MAK-WEST2]. As the current at MAK-WEST2 based on the mooring CTD period is towards the SE between 1.0 and 2.0 kts, and that we want an ~0.5 kt relative motion to the surface ocean flow, we plan to back down on the NOAA-ITF deployment, beginning about 1 nm northwest of MAK-WEST2, which was at, $2^{\circ}50'17.88''S$; $118^{\circ}27'22.62''E$, and head northwest at 0.5 kt relative to the surface to 'fall-back' on the target [mid-way between the MAK 2s]. The deployment begins at **$2^{\circ}48'30''S$; $118^{\circ}25'00''E$** about 2.88 nm from target. For a movement towards the NW of 0.5 kt relative to a current of 1.8 kt current to the SE we have 2.22 hours 2 hours and 13 minutes.

In the afternoon the NOAA-ITF mooring was deployed with the target given above. The operation began at 1:21 pm, ended at 4:30 pm. Mid-way we had to shift eastward as the ship drift was to the south not to the southeast. We were on a course to deploy at the target, but when the anchors were released we were to the south of the target, closer to MAK-EAST1.

NOAA-ITF was deployed at **$2^{\circ}51'31.98''S$; $118^{\circ}27'50.88''E$** . Triangulation began at 5:20 pm.ended successfully at 6:30 pm. Listening from the bow works fine, even with the sonar on.

NOAA-ITF is ~0.45 nm to the south; ~0.50 nm to the east, or about 0.67 nm to the SE of the target. It is close to MAK-WEST1 of $2^{\circ}51.888'S$; $118^{\circ}27.276'E$ and to Arlindo MAK-1 of $2^{\circ}51.69'S$; $118^{\circ}27.51'E$.

Triangulation value: **$2^{\circ}51.883'S$; $118^{\circ}27.776'E$** . This is further south than mentioned above [anchor release, but its fall back and southward current. Depth 2197 m.

Thursday, 30 November: Packing and to Balikpapan.

V Conclusion: Data Return

Excellent data return! Everything worked but the downward looking WorkHorse ADCP placed directly below the upward looking long range ADCP near 300 m depth on MAK-WEST2, but then there was a current meter at 400 m within the its intended range of coverage. Most importantly was the long rangers worked, as they cover the thermocline, The t-pods provided a more complete record that achieved in the first 1.5

years, but some did not cover the full period of the MAK2 deployment.

What a wealth of data, nearly a 3 year record of the Makassar contribution to the ITF. In legs 2 and 3 of the cruise the INSTANT moorings in the other key ITF passages will be recovered. If all goes well we will have a fantastic observational data set. We all look forward to delving into these data in the coming years to produce a deeper understanding of the ITF, its forcing and of its regional and larger scale impact.

And the NOAA-ITF mooring was successfully deployed to allow continuation of the INSTANT Makassar time series.

VI Acknowledgements:

The ship crew went out of their way to help achieve the cruise objectives and make the science team comfortable. Capt. Gjas Seonarno and his officers did a fine job of ship handling during the mooring deployments. The Indonesian scientific and technical staff from BRKP [Eva Mustikasari, Restu Nur Afi Ati, Aida Heriati, Bayu Priyono] and BPPT [Endro S., M. Djakfar, Fatkhurohman, Jonathan Rori, Rosul, Anan, Iwan Eka, Bayu S., Kusni Eddy, Mustopa] were invaluable in the mooring operation and they obtained important CTD and productivity data that will aid in our understanding of the processes within the Labani Channel.

The CSIRO mooring team, Lindsey Pender and Phillip Adam were always cheerful with an impressive level of competence. Lamont's Bruce Huber with his remarkable range of knowledge facilitated all aspects of our endeavors. R. Dwi Susanto did a fine job of aiding in communications and organization.

On a personal note: Since late 1991 I've been on six cruises of the Baruna Jaya 1, two on Baruna Jaya 4. I've enjoyed meeting the Indonesian people, those on the ship, those at the government agencies and at the universities. They are a kind, gentle people, with pleasant personalities; their strong technical skills offered much support to my research in Indonesian waters, for which I thank them.

«GreetingLine»

30 November 2006