CLIVAR: CLIMATE & OCEAN
variability, predictability and change

19th CLIVAR/IOC-GOOS Indian Ocean Region Panel Meeting

KUDOS (Korea-US InDian Ocean Scientific Research Program) & KIOS (Korea Indian Ocean Study)

SungHyun Nam and KUDOS friends
Seoul National University, Republic of Korea
KIOST, Korea + NOAA, US + Korea-US universities

08/02/2023
Research Highlight 1: Legacy

**Seychelles-Chagos Thermocline Ridge (SCTR)**

- A wind-forced doming of the thermocline between 5S and 15S with pronounced impacts on weather, climate, biogeochemistry, ecosystems, and fisheries
- Most extensive persistent upwelling region in the IO – distinct asymmetric pattern
- Ascending branch of southern cell in the meridional overturning circulation

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Hermes and Reason (2008), Yokoi et al. (2008), Vialard et al. (2009)

Schott et al. (2004)

Lee (2004)

Bindoff et al. (2007), Han et al. (2014)
Engage with IORP: 1 KUDOS (1/2)

KUDOS Workshops

- **KUDOS(2017)**: Nov 29-Dec 1, Seoul, Korea
- **KUDOS(2018)**: Nov 6-8, San Diego, CA, USA
- **KUDOS(2019)**: Nov 5-6, Busan, Korea
- **KUDOS(2022)**: Sep 22, Busan, Korea
- **KUDOS(2023)**: Feb 10, Perth, Australia

Proposal 1: Primary production variability and fate in the SCTR
Proposal 2: Food web dynamics and trophic transfer to support higher trophic level production in the SCTR
Proposal 3: Ocean dynamics controlling upwelling and vertical property fluxes in the SCTR
Proposal 4: Station K – continuous time-series observation at the SCTR
Engage with IORP: 1. KUDOS (2/2)

## KUDOS Workshops

- **KUDOS(2017)**: Nov 29-Dec 1, Seoul, Korea
  - What is the three-dimensional structure and temporal variability of the STC? How does upwelling and the relationship between wind, SST, and thermocline depth in the SCTR vary in relation to changes in the STC circulation on: 1) intraseasonal time scales related to the MJO; 2) seasonal time scales related to the monsoons; 3) interannual time scales related to the IOD; and 4) decadal and longer time scales?
  - What are physical drivers of the SCTR circulation and its temporal variability? How do local wind stress curl variations and remote wind-forced equatorial waves affect the three-dimensional SCTR circulation? How are the SCTR upwelling and subtopical subduction dynamics linked to the SEC/SECC, large-scale circulation in the Indian Ocean, and turbulent mixing processes?

### Proposal 1: Primary production variability and fate in the SCTR

### Proposal 2: Food web dynamics and trophic transfer to support higher trophic level production in the SCTR

### Proposal 3: Ocean dynamics controlling upwelling and vertical property flux in the SCTR

### Proposal 4: Station K – continuous time-series observation at the SCTR

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### Implementation Strategies

The existing Indian Ocean Observing System, including but not limited to the fixed RAMA mooring array and moving platforms like gliders, floats, and drifters, need to be maintained and enhanced to complement various satellite measurements. A pilot mooring and ultimately a new time series reference station (tentatively named “Station K”) consisting of multiple fixed and moving platforms should be developed, and a large number of drifters with a 100-m long TO sensor chain (GeoDrifters) should be deployed in and around the SCTR center. These experimental observations should be incorporated into IndOOS. In addition to operational space-borne and sustained in-situ measurements in IndOOS, short-term, process-oriented observations with multiple ADCP moorings, underwater gliders and wavegliders, ship-based water sampling (as sensor calibration as well as biogeochemical and physical measurements) should be conducted focusing on the SCTR region. The new Korean research vessel, RV *Isabu*, can be best utilized to conduct critical measurements and service key platforms in the region. Global and regional ocean models and coupled climate models can be used in combination with observational results to address scientific questions.
KIOS cruises, Station K, and RAMA

- Korea Indian Ocean Study (KIOS) cruises since **2017** targeting WIO
- Station K mooring + PIES since **2019** in the SCTR
- **RAMA** surface moorings and ADCP moorings
Engage with IORP: Observations (1/2)

KIOS cruises, Station K, and RAMA

- Korea Indian Ocean Study (KIOS) cruises since 2017 targeting WIO
- Station K mooring + PIES since 2019 in the SCTR
- RAMA surface moorings and ADCP moorings

### KIOS cruises

- **PIES (Leg-01)**
  - Deployed: May 8, 2019
  - Recovered: December 21, 2021
  - Position: 60E 58.8985', 7S 59.0247'
  - Water Depth: 3,074 m

- **C-PIES (Leg-02)**
  - Deployed: December 24, 2021
  - Recovered: (mid-2024?)
  - Position: 61E 00.4640', 7S 58.8960'
  - Water Depth: 3,120 m

### Station K mooring + PIES

- **Deployed: May 8, 2019**
- **Recovered: December 21, 2021**
- **Position: 61E 00.4011', 7S 58.8635'**
- **Water Depth: 3,070 m**

### RAMA surface moorings and ADCP moorings

- **Deployed: June 27, 2022**
- **Recovered: (mid-2024?)**
- **Position: 60E 57.2400', 7S 57.8160'**
- **Sediment trap (mid-2024?)**
- **Water Depth: 3,060~3,085 m**

### Additional Information

- **Position:**
  - **Leg 01:** 60E 58.5925', 7S 58.7443'
  - **Leg 02:** 60E 57.2400', 7S 57.8160'

- **Water Depth:**
  - **Leg 01:** 3,067 m
  - **Leg 02:** 3,060~3,085 m

- **Date Deployed/Recovered:**
  - **Leg 01:**
    - Deployed: December 24, 2021
    - Recovered: June 26, 2022
  - **Leg 02:**
    - Deployed: June 27, 2022
    - Recovered: (mid-2024?)
  - **Leg 03:**
    - Deployed: May 8, 2019
    - Recovered: December 21, 2021
KIOS cruises, Station K, and RAMA

- Korea Indian Ocean Study (KIOS) cruises since 2017 targeting WIO
- Station K mooring + PIES since 2019 in the SCTR
- RAMA surface moorings and ADCP moorings
Research Highlight 2: New Obs. (1/2)

**Year-to-year changes in isopycnals/water properties**

- Isotherms (e.g., D10, D15, D20) shoals up/down by ~100m over seasons and years
- Year-to-year changes in water properties at intermediate as well as surface water masses in the SCTR (~8S)
  
  (Ex) High oxygen SAMW found at the SCTR along 26.8 sigma-theta in 2019 and 2022 (but not 2021)
Year-to-year changes in isopycnals/water properties

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Nagura & McPhaden (2021)
Sound Scattering Layers Within and Beyond the Seychelles-Chagos Thermocline Ridge in the Southwest Indian Ocean

Myoungh Lee Kang¹, Jung-Hoon Kang², Minju Kim³, SungHyun Nam⁴, Yeon Choi⁵ and Dong-In Kang⁶,⁷

¹ Department of Maritime Police and Production System, Institute of Marine Industry, Gyeongsang National University, Tongyeong, South Korea, ² Risk Assessment Research Center, Korea Institute of Ocean Science and Technology, Goye, South Korea, ³ Department of Ocean Science, University of Science and Technology, Daejeon, South Korea, ⁴ School of Earth and Environmental Sciences, Research Institute of Oceanography, Seoul National University, Seoul, South Korea, ⁵ Marine Environmental Research Center, Korea Institute of Ocean Science and Technology, Busan, South Korea.

Tracing water mass fractions in the deep western Indian Ocean using fluorescent dissolved organic matter

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Clivar

Research Highlight 3: Publications

Marine Chemistry 216 (2020) 103720

Submit your article

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Societal Impacts and Capacity Development

✓ Tens of students and early career scientists have joined KIOS R/V Isabu cruise every year since 2017 (except 2020)

✓ Public engagements – better supported

✓ Continuous time-series observations at Station K, contributing to RAMA/IndOOS/IOGOOS/OceanSITES

✓ Potential for cornerstone of international collaboration for WIO and WIO-EIO connections through future multilateral cooperation system, contributing to IORP/IIOE-2/UNDOS 2021-2030
Thank You!

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Special Acknowledges to R/V Isabu (captain, all crews, and marine tech.)
OceanSITES visions for ocean time-series observations, core biogeochemical and ecosystem observations, and deep ocean observations