Introduction to the Ocean Research Stations (ORSs) in Korea and application activities

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Overview

- Program: “Construction of Ocean Research Station and their Application Studies”
  by KIOST (Korea Institute of Ocean Science & Technology)
- Fund: MOF (Ministry of Oceans and Fisheries)
- Own and Operation: KHOA (Korea Hydrographic and Observation Agency)
- 3 Ocean Research Stations (ORSs)
  - Ieodo ORS (Jun. 2003)
  - Gageocho ORS (Oct. 2009)
  - Socheongcho ORS (Oct. 2014)
- Features
  - Steel structure and fixed ocean platform (jacket & deck)
  - Powered by hybrid system (solar, wind + diesel generators)
  - Scientists can stay for several days in the ORSs
Features

- Large offshore structure with scientific facilities
  - In-situ laboratory
    - Measuring physical parameters, preprocessing of samples
    - in-situ experiment
  - Expandability
    - install new sensors from interdisciplinary field
    - replacement up-to-dated sensors, user modifying sensors,…
- Long life span
  - 50~100 years
- Long-term time series data
- Stable against extreme weather conditions
  - 70 m/s gust wind speed, 21 m wave height
  - Typhoons, tropical storms, etc.
Main applications

▪ Improving comprehensive ocean and weather observations
▪ Providing core scientific information and data for the global environmental change studies
▪ Investigating typhoon dynamics
▪ Providing basic information for fisheries and ocean prediction as well as regional ocean studies
▪ Functioning as a ground station of satellite ocean remote sensing work
▪ Investigating movement and distribution of atmospheric constituents such as Asian dust (yellow dust)
Where are the Ocean Research Stations?

- Socheongcho ORS (SORS)
  - 37 km south of Socheong Island
  - Depth: 50 m
  - Completed in Oct. 2014

- Yellow Sea Buoy (YSB)
  - 190 km west of Gunsan city
  - Depth: 80 m
  - Moored in Sep. 2007

- Gageocho ORS (GORS)
  - 47 km south-west of Gageo Island
  - Depth: 15 m
  - Completed in Oct. 2009

- Ieodo ORS (IORS)
  - 149 km south-west of Mara Island of Jeju
  - Depth: 41 m
  - Completed in Jun. 2003
Location

- Located in the Yellow Sea & East China Sea
- On the track of major typhoons affecting the Korean peninsula (about half of the typhoons had passed the IORS)
- Affected by fresh water (Changjiang diluted water (CDW))
- No Land around the IORS within 150 km
The IORS

- Depth: 41 m (Total Height: 77 m)
- Total area: 1,345 m²
- Total weight: 3,400 tonnes
- Instruments: 35 different kinds
  (atmospheric, oceanic, environmental, structural)
The IORS : Heli-Deck

- Heli-Deck which can let researchers to get easy access to the IORS
- Search and rescue
- Atmospheric experiments
The IORS: Roof Deck

- Light house, MET. tower & table, wind turbine, and solar panels
- Satellite antenna for data transmission
The IORS : Roof Deck

- Wind Monitor
- Thermometer & Hygrometer
- Barometer
- Pyranometer
- Ultraviolet Radiometer
- Sunshine Duration Meter
- Rain Gauge
- Ceilometer
- Present Weather Detector
- Radioactivity Sensor

Wave Radar

Camera

Meteorological Tower

Spectroradio Meter

IR Thermometer
The IORS : Main Deck

- Control room, battery & switch gear room
- Scientist accommodation and bath
- Kitchen and conference room
- 12 peoples can stay for more than 2-wks without additional supplies
The IORS: Cellar Deck

- Diesel generator, desalinator, purifier
- Small boat and underwater activity supporting equipments

Cellar Deck

- Diesel Generator
- Desalinator
- Fog Horn
- Winch
- Boat

Weight (100 kg)
The IORS : Intermediate Deck

- Winch system for underwater monitoring sensors (CTD, turbidity & fluorescence sensors, ...)

Intermediate Deck

CSAT (flux)  
NW & SE

Weight (100 kg)
The IORS: Bottom Deck & boat landing

Bottom Deck

Boat Landing

Observation platform

NW & SE

CTD (5m)

CTD (10m)

CTD (20m)

CTD (30m)

CTD (40m)

Weight (100 kg)
Science themes related to the IORS
**Sensors**

<table>
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<tr>
<th>Instrumets / Models</th>
<th>Parameters</th>
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<tr>
<td>Wind Monitor/ 01506</td>
<td>Wind Speed &amp; Direction,</td>
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<tr>
<td>Ultrasonic Wind / VENTUS</td>
<td>Wind Speed &amp; Direction,</td>
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<tr>
<td>Anemometer / HMP155</td>
<td>Temp, Humidity</td>
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<tr>
<td>Barometer / PTB210B</td>
<td>Atmospheric pressure</td>
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<tr>
<td>Insolation Sensor / CMP21</td>
<td>Insolation</td>
</tr>
<tr>
<td>Sunshine Sensor / CSD3</td>
<td>Duration of sunshine</td>
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<tr>
<td>Ultraviolet solar radiation Sensor / CUV5</td>
<td>Ultraviolet rays</td>
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<td>Rainfall Sensor / ERG(H)</td>
<td>Rainfall</td>
</tr>
<tr>
<td>Visibility meter / PWD-22</td>
<td>Visibility</td>
</tr>
<tr>
<td>Ceilometer / CL31</td>
<td>Cloud</td>
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<tr>
<td>Multi weather sensor / WS600</td>
<td>Wind, Temp, Humidity, Atmospheric pressure</td>
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<tr>
<td>3dimension wind / CSAT3</td>
<td>3dimension wind</td>
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<tr>
<td>Ultafine particles sensor / FH62C14</td>
<td>PM2.5 monitoring</td>
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<tr>
<td>O3 analyzer / 49i</td>
<td>O3 monitoring</td>
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<tr>
<td>Gas Analyzer / EC-150</td>
<td>CO2, H2O</td>
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<td>Environmental radiation / EFRD 3500</td>
<td>Environmental radiation</td>
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<tr>
<td>Black carbon sensor / 5012</td>
<td>BC monitoring</td>
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<td>CO, CO2, H2O, CH4 monitoring / G2401</td>
<td>CO, CO2, H2O, CH4 monitoring</td>
</tr>
<tr>
<td>Accelerometer / Accelerometer</td>
<td>Structure acceleration</td>
</tr>
<tr>
<td>Clinometer / Clinometer</td>
<td>Structure gradient</td>
</tr>
<tr>
<td>GNSS / GR25</td>
<td>Structure displacement</td>
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</tbody>
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**Oceanographic**

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<th>Instruments / Models</th>
<th>Parameters</th>
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<tr>
<td>WAVE RADAR / SM-050</td>
<td>Wave, Period, Wave direction, Spectrum</td>
</tr>
<tr>
<td>Range Finder / SM-140</td>
<td>Sea level height, Wave, Period</td>
</tr>
<tr>
<td>Hyperspectral Radiometer / RAMSES</td>
<td>Intensity of radiation</td>
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<tr>
<td>CTD / RBR Concerto CTD</td>
<td>Temperature &amp; Salinity</td>
</tr>
<tr>
<td>ADCP / WHS300</td>
<td>Stratification velocity</td>
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<td>Sea Prism / Spectro-Photometer</td>
<td>Ocean color</td>
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<td>Underwater sound Sensor</td>
<td>Underwater sound monitoring</td>
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<tr>
<td>Fluorometer / ECO FLNTU</td>
<td>Chlorophyll</td>
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<tr>
<td>UV fluorometer / MicroFlu-CDOM</td>
<td>Colored dissolved organic matter</td>
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<tr>
<td>Profiling sensors / 19plus&amp;Auxiliary</td>
<td>Water Temp, Salinity, PAR, Fluorescence, DO</td>
</tr>
<tr>
<td>Surface CT sensor / SBE37SM &amp; SBE39</td>
<td>Surface Water Temp &amp; Salinity</td>
</tr>
<tr>
<td>UV NITRATE Sensor/SUNA V2</td>
<td>Nitrate</td>
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<tr>
<td>Fluorometer / In situ FIRe</td>
<td>Fluorescence</td>
</tr>
<tr>
<td>IR Sensor / KT19.85 II</td>
<td>Surface Water Temp (IR)</td>
</tr>
<tr>
<td>DO Sensor / 43</td>
<td>Dissolved oxygen</td>
</tr>
<tr>
<td>Fast Ocean system / FRRf</td>
<td>Fluorescence Profile</td>
</tr>
</tbody>
</table>
Time-series Data (IORS)
Time-series Data (IORS)

- Malfunction (Software problem)
- Malfunction (Memory trouble)
- Malfunction (need to replacement)

[Graph showing time-series data with annotations for different parameters with malfunction points marked]
Time-series Data (IORS)

- Malfunction
- Typhoon & Maintenance
- Typhoon & Maintenance & QC
- Typhoon (Muifa)
- Typhoon (Bolaven & Tembin)
Data (CTD mooring ➔ Temperature profile, 2015~2016)

SOR (37.5°N)

IORS (32°N)
Typhoon Monitoring

Chaba (1618), 5, Oct. 2016

- **Wind Speed**
  - Max = 41.1 m/s
  - Time: 10-04 22:58
  - Max = 38.22 m/s
  - Time: 10-04 23:55

- **Air Pressure**
  - Min = 986.2 mbar
  - Time: 10-04 11:15

- **Air Temperature**
  - Max = 27.4 °C
  - Time: 10-03 12:06
  - Min = 17.1 °C
  - Time: 10-08 16:15

- **Wave Height**
  - Max = 9.7 m
  - Time: 10-05 01:01
  - Max = 6.2 m
  - Time: 10-05 01:01

- **Water Temperature**
  - Temperature range from 15 to 30 °C
ORS in-situ Measurement and Maintenance

How often? ➔ +1 times per one month
How long? ➔ for 5~7 days

CTD Profiling (+2 times a day)

Water Sampling (+2 times a day)

Plankton Sampling (+2 times a day)
Data (Sea Temperature Profile, 2016)

Socheongcho ORS

Ieodo ORS
Data (Salinity, 2016)

Socheongcho ORS

Ieodo ORS
Data (Temperature & Salinity, 2016)
Data (Dissolved Oxygen [umol/kg], 2016)
Data (Fluorescence [mg/m³], 2016)

Socheongcho ORS

Ieodo ORS
Data (Primary Production)

In-Situ FIRe ➔ fluorescence at sea surface

FRRF ➔ fluorescence profile with depth

In-situ Cultivation: (using C14 isotope method)
Observation (R.V. Eardo)

Temperature

Salinity

CDW

31.6°C

27 psu
Ocean Mixed Layer

21 Apr. 2015

15 Oct. 2015

Water Depth (m)

MLD_d0.2°C

Date (month)

Correlation Coef. (r)

Mixed Layer Depth (m)

After 25-hour low-pass filtering

r=0.53 (lag=9 hour)

Trend: +2.6 m/month

detrended MLD

r_max=0.53 (9hr lag)

Lag (days)
Validation of the Model & Remote Sensing Data

Reanalysis data
(HYCOM, FNMOC-M, JCOPE2)

Remote sensing data
(OSTIA, G1SST, AVHRR, FNMOC-S)
Air-Sea Interaction Study

- Air-Sea interaction study
- Development of the IORS optimized observation and post-processing algorithm
  ➔ Numerical model (Coarse3.0, etc)
Data (http://www.khoa.go.kr/koofs/eng/observation/obs_real.do)
Summary & Suggestion

- The first ORSs in Korea, Ieodo, had been completed in 2003 and have produced more than 10 years of data.
- **3 ORSs are now in operation** including the GORS and SORS.
- Equipped with more than 30 different kinds of instruments.
- The IORS is located on the main track of typhoons.
- High risk, but high return. The ORSs are producing unique observation data.
- There are about **20 on-going research subjects** for the ORSs
- We are willing to collaborate with any researchers and institutes who have research topics related to the ORSs

**Refer to the poster: S13-P6 (Title : The present and future of Ocean Research Stations (ORSs) of the Korea Hydrographic and Oceanographic Agency (KHOA), by Chungho Lee)

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Thank you