The Buoyage Equipment for Skin Temperature (BEST),
A New Instrument for In-situ Calibration and Validation of Thermal Remote Sensing

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Outline

• Introduction
• The Instrument
• The Applications on Calibration & Validation
• Other Potential Applications
Introduction

The Sea Surface Temperature (SST) is one of the most important physical parameters of the ocean. The SST data are widely used in many subjects of meteorology and oceanography.

With several decades development, the satellite remote sensing technology has become the main approach for global or regional SST data collection and plays more and more irreplaceable role on oceanography and meteorology studies.
Introduction

The satellite measured SST is more closely related to the skin SST than the subsurface bulk SST. It is not convective to validate the satellite measured SST with the subsurface bulk temperature.

It is necessary to measure the skin temperature for calibration of the satellite thermal signals and for validation of satellite measured SST. However, it is not easy to accurately measure the Skin SST of waters as the skin layer is very thin.
It is a hard task to accurately measure the Skin SST.

Definition of Skin SST by GHRSST (https://www.ghrsst.org/science-and-applications/sst-definitions/)
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The Instrument

- This new instrument uses thousand of thermistors as the temperature sensors, which are arranged in line with distance of 0.6mm, and integrated in a pole. The pole is vertically floated on water with about 100~200mm in length on the air. The instrument can synchronously to measure the temperature of the bottom layer of the air, the skin layer and subsurface layer of the water. It is the first temperature instrument for air-sea interaction boundary layers with vertical spatial resolution of submillimeter.
The instrument is designed to measure Temp. from -30 to 100 °C. Theoretically the measurement accuracy can be 0.01K.

The relationship between Voltage and Temp. can be described by the following table:

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Resistance (Ω)</th>
<th>Voltage (xVref)</th>
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</thead>
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<td>830.86</td>
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<tr>
<td>100.0</td>
<td>720.84</td>
<td>0.4328</td>
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</table>
The relationship between Voltage and T
Version 1:
0.9mm resolution,
130cm in length.
Detector pole

Simplified Version

balance board

buoyage

CPU

Detector pole
Mean Signal at 30 C
The Accuracy is better than 0.05K

\[ y = 9.75x^2 + 35.912x + 4.0793 \]

\[ R^2 = 0.9999 \]
An improved version, with heat-isolated CPU part and white plastic cover for keeping from sun heating
Other designed version
Advantage of BEST

• Measure the skin SST and bulk SST Synchronously;
• Could measure the temperature of the air bottom;
• High measurement accuracy: 0.05K;
• Fast measurement: detect T every second;
• Measure T from 7 ~ 30 days continuously.
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The Applications on Cal. & Val.

- The new instrument, BEST, can significantly improve the accuracy of skin SST measurement and provide in-situ calibration for thermal camera. With improving the skin SST accuracy and spatial match between in-situ and satellite data, BEST will be play a key role on:
  - 1. In-situ calibration for satellite thermal sensors;
  - 2. In-situ val. of satellite remotely sensed SST;
In-situ Calibration/Validation

The present Cal/Val methods for remote sensing generally use the in-situ data measured at single points, while the satellite data are from an area (e.g. 1km²). The two datasets are not spatially matched, resulting in the present Cal/Val not convincing.
Improvement of the cal/Val: increase the spatial matching of in-situ measurement to satellite observation. A thermal camera, which can be calibrated in-situ by the new instrument, can be employed for measuring skin SST of a stripe across pixels, instead of skin SST at single points.
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Other Potential Applications

• 1. Development of SST algorithm
• 2. Study on the relationship of skin and bulk SST;
• 3. Air-sea interaction studies
2. Study on the relationship of skin and bulk SST: the new instrument can measure the skin SST and bulk SST synchronously, useful for mixture, heat flux......
3. Air-sea interaction studies

• This new instrument is the first temperature detector for air-sea interaction boundary layers with vertical spatial resolution of submillimeter. It can provide subtle measurement of $T$ for air-sea boundary layers, measure the real interaction temperatures of the sea and the air. It should be helpful for our further and better understanding of the ocean, the climate, the earth system, and for better weather forecasting.