Evolution of the TAO Data Analyst

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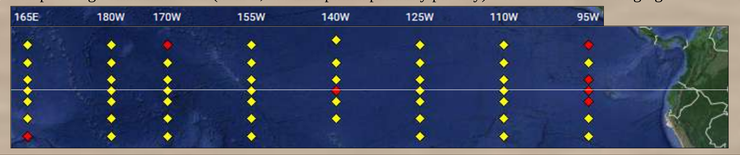
INTRODUCTION

As the Tropical Atmosphere-Ocean (TAO) array has evolved over the years in support of El Niño and the Southern Oscillation, so have the TAO Data Analyst's duties. The major transition began when operational responsibility of the TAO program transferred from the National Oceanic and Atmospheric Administration's (NOAA) Pacific Marine Environmental Lab (PMEL) to NOAA's National Data Buoy Center (NDBC) in 2006. Prior to the transition, PMEL had designed, deployed, and maintained the Autonomous Temperature Line Acquisition System (ATLAS) buoys for the TAO program. With the transfer of the program, NDBC made it a priority to upgrade the technology. The TAO Refresh system uses commercial off-the-shelf components and has increased the frequency and volume of meteorological and oceanographic data available. The Legacy ATLAS buoys, transmitting data via Argos, typically reported less than 100 data points per buoy per day. Refresh buoys, by contrast, use the Iridium satellite network for transmission that allows for hourly receipt of high-resolution data (over 2,000 data points per buoy per day) with 10-minute averaging.



CONTENTS

1) BUOY AND SENSOR LIFECYCLE

Pre-Deployment

- **Databases**: TAO Analysts track all equipment used in several databases collaborating with several departments at NDBC
- **Quality Checks**: Sensors must work independently, as part of a system, and must compare well to a reference test station (see below).



Deployment/Recovery

- Logs provided by technicians in the field show what, where, and when sensors were deployed/recovered. Discrepancies between these logs and previous records become an immediate priority for the TAO Data Analysts to rectify.

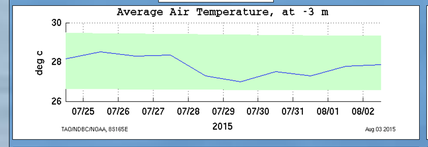


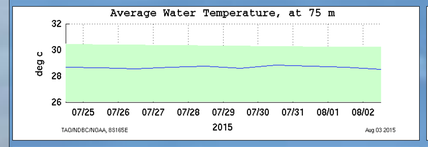
2) IMPROVED REAL-TIME QUALITY CONTROL

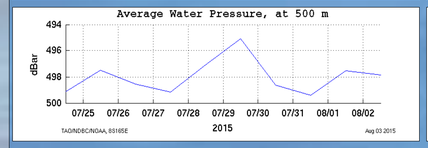
More Data → Increased Visualization → Increased Awareness

- **Surface Data**: Identification of rain events, diurnal cycles, and other air mass changes
- **Sub-Surface Data**: Identification of ocean current movement, upwelling, and vandalism signatures
- **Erroneous Data**: Erratic trends, chronic spiking, and drifting measurements

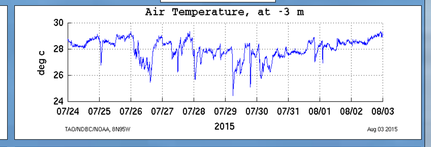
LEGACY

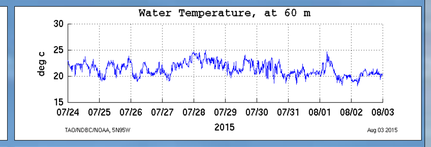


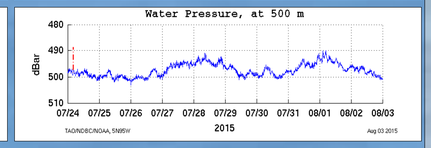




REFRESH



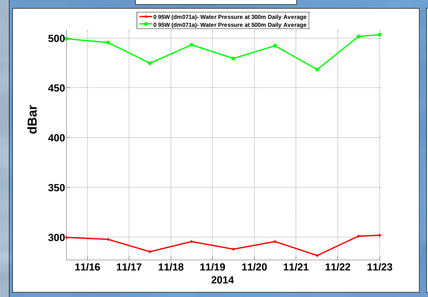




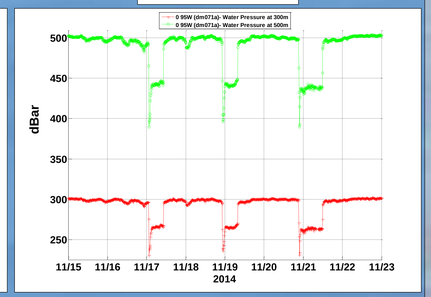
Vandalism Data Signatures: Daily Averages vs. High Resolution

- Identification Time: 2-3 days vs. less than 24 hours
- Ability to distinguish between vandalism and strong currents
- Provides hard evidence when building a legal case against perpetrators, leading to potential prosecution

DAILY AVERAGES



HIGH RESOLUTION



Cameras on TAO Buoys

- Images transmitted once per hour help identify ships committing vandalism against TAO buoys
- High-resolution images saved every 20 minutes, can be requested by TAO Data Analysts
- Provides critical hard evidence for prosecution cases



3) RECORD MAINTENANCE

Routine Tasks

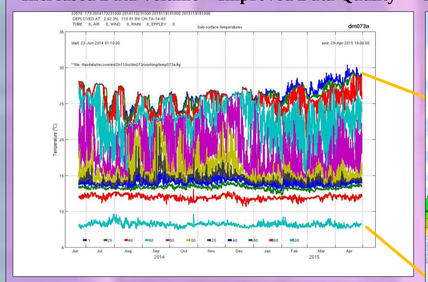
- **Daily**: Flagging erroneous data, identifying failing sensors and vandalism events, and keeping track of any changes to the status of TAO buoys
- **Weekly**: Performance statistics and data release status of the TAO buoy array, updates on any TAO systems in the pre-deployment stage, and deployments/services/recoveries of active TAO buoys
- **Monthly**: TAO array deployment information and average data availability statistics for both active TAO buoys and every sensor type

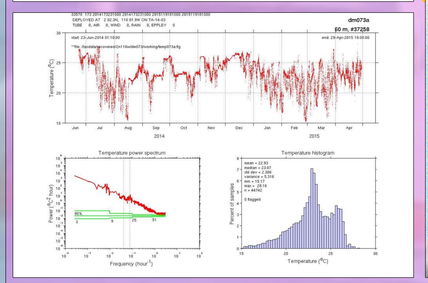
Periodic Tasks

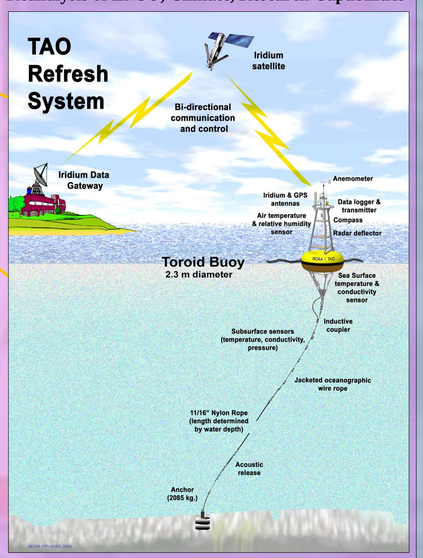
- **Pre-deployment**: Review Buoy Deployment Plans for each buoy scheduled for deployment, including analysis of sensor performance compared to a reference system
- **Deployment**: Review deployment/service/recovery logs sent by technicians, and compare them against database records
- **Post-deployment**: Trip Reports to summarize deployments/services/recoveries, archiving data downloaded directly from TAO buoy sensors for later QC and processing

4) DELAYED-MODE ANALYSIS

- Raw data downloaded and processed directly from sensors upon recovery
- ~10% data increase
- Replacing real-time subsurface measurements with sensor downloads improves quality of data archives
- ADCP (Current) and CTD data processing opportunity
- **Increased Data Volume + Improved Data Quality → Reanalysis of ENSO, Climate, Research Capabilities**







5) PLANNING FOR THE FUTURE

- Further increase data quality and quantity for TAO data users
- Enhance QC capabilities amidst an increased volume of data
- Streamline delayed-mode QC and processing (Standard, Flux, ADCP, CTD)

ACKNOWLEDGEMENTS

We would like to thank Karen Grissom for her leadership and vision, which has resulted in the upgrade of the TAO buoy array with Refresh technology. We would also like to thank Robert Weir for his invaluable contributions to the TAO Team's array of record-keeping and analysis tools. Finally, we would like to thank Ryan Beets, our former Lead TAO Data Analyst, for his mentorship and patience in educating the current TAO Team in all manner of TAO data quality control.