



***Unlocking the Stratosphere®***

**UND SOaRS | March 12, 2024**

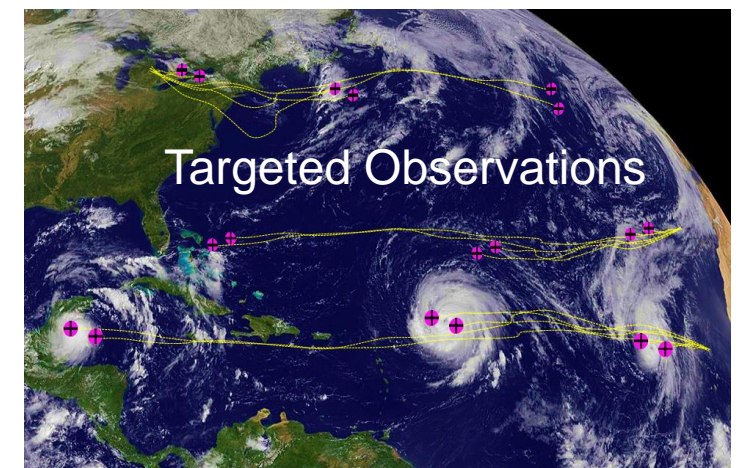
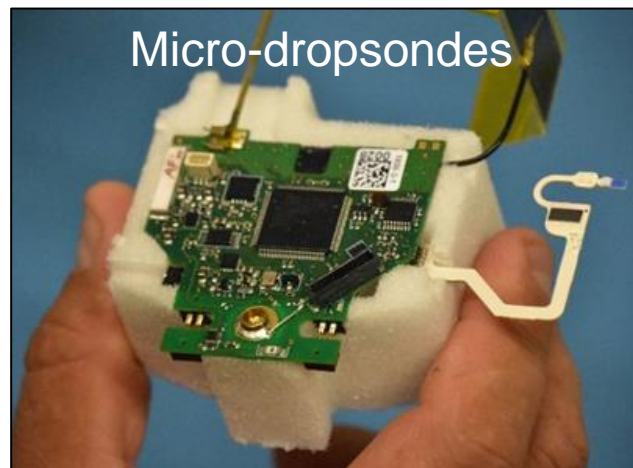
***Micro-dropsondes from the Stratosphere  
for Targeted Atmospheric Data Collection***

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# Introducing StratoSolutions, Inc.

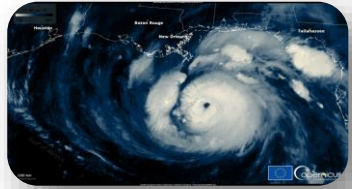
New company set to **Unlock the Stratosphere** using fixed wing High Altitude Pseudo Satellites (HAPS) and High-Altitude Balloons (HAB) using world leading key enabling technologies and expertise covering all core design areas.

**Primary Mission:** Targeted meteorological observations over remote regions of the globe.



# The Problem – Predicting Extreme Weather Events

**Extreme weather is costing the global economy over \$138 Billion per year<sup>1</sup>.**



## Tropical cyclones

- 2017 Storm Harvey resulted in **\$97B in economic losses<sup>1</sup>**.



## Deep freeze

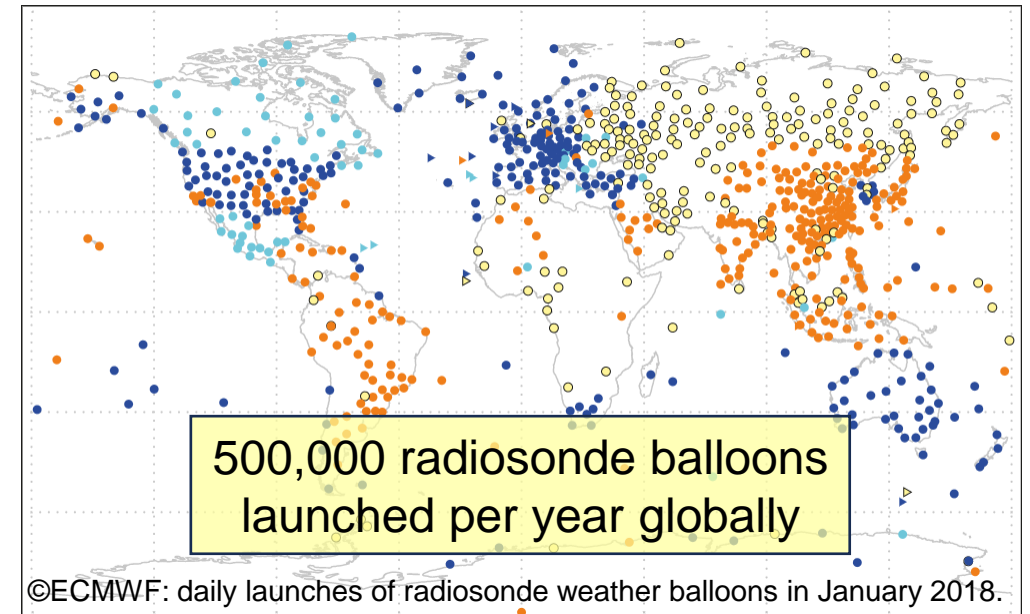
- Power generation fails to meet demand.
- Texas' 2021 deep freeze caused **\$10B in insured losses<sup>2</sup>**.



## Extreme precipitation

- Atmospheric rivers cause flooding and drought through water mis-management.
- US west coast - **\$1B in damages/yr<sup>3</sup>**.

**Forecast Challenge:** The global meteorological observation system is incomplete, there are large gaps over oceans and remote areas.



<sup>1</sup> WMO Atlas of Mortality & Economic Losses from Weather & Climate Extremes (WMO-No. 1267)

<sup>2</sup> Federal Reserve bank Dallas April 15, 2021

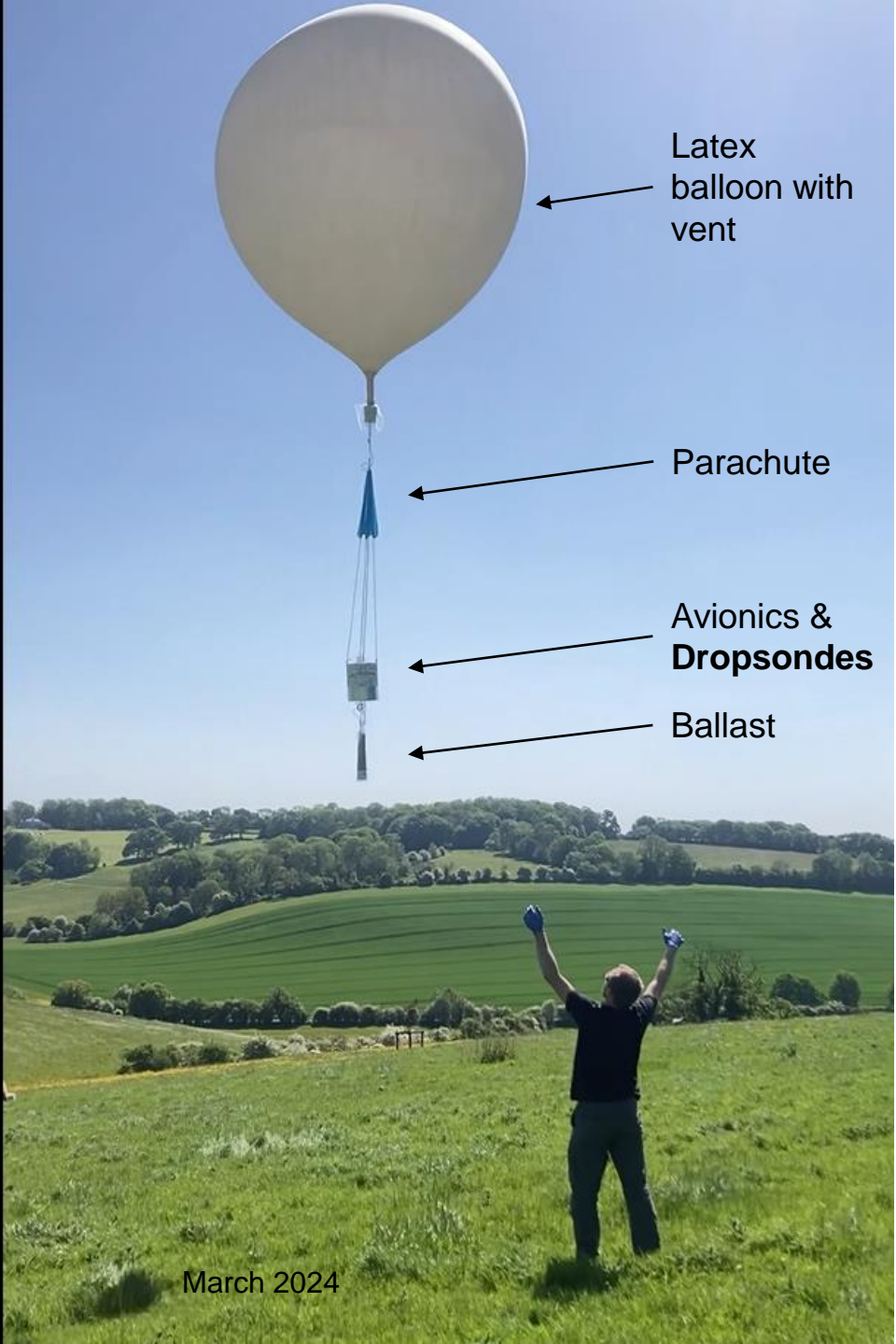
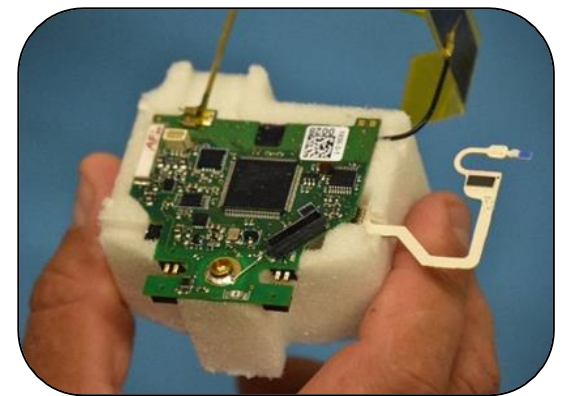
<sup>3</sup> Atmospheric rivers drive flood damages in western United States, Science Advances, Dec 2019.

# StratoSonde<sup>®</sup> Balloon System

## Dropsondes from the Stratosphere.

- Low-cost, long endurance stratospheric balloon.
- Navigates by changing altitude.
- Balloon typically lasts 5 days.
- Carries 10 micro-dropsondes.
- High resolution starting from the stratosphere all the way down to sea-level.
- System collects weather data in near-real time.

**Key innovation:**  
Compact storage of tiny dropsondes,  
each weighing <20g.



Latex  
balloon with  
vent

Parachute

Avionics &  
**Dropsondes**

Ballast

# Cabo Verde Project Objectives

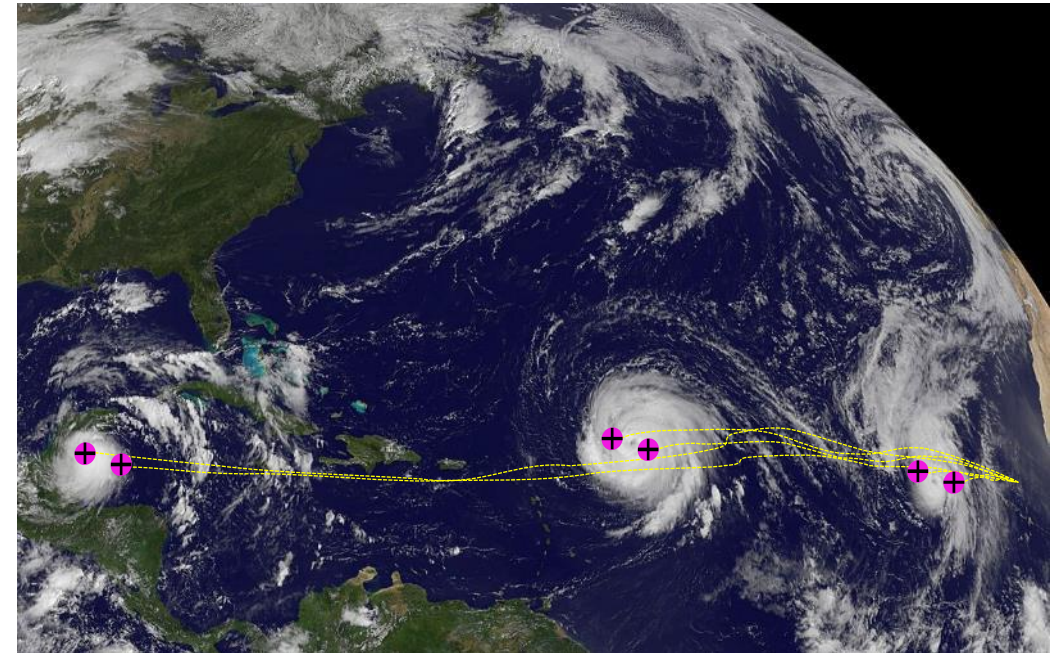
The StratoSonde lighter-than-air, uncrewed system combines a low-cost, <6lb, self-navigating High-Altitude Balloon (HAB) with a micro-dropsonde dispensing system, to enable meteorological observations over remote areas of the globe by dispensing micro-dropsondes from the stratosphere.

## Aims:

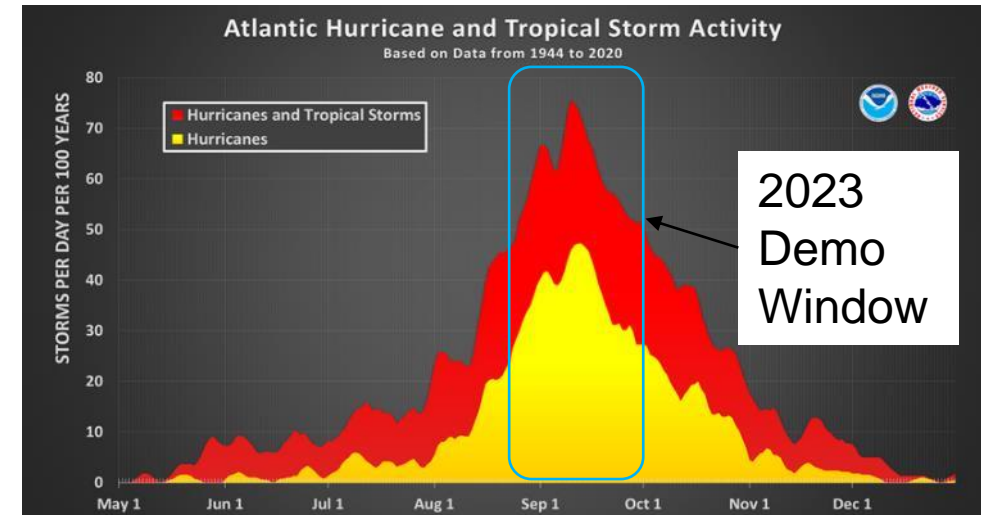
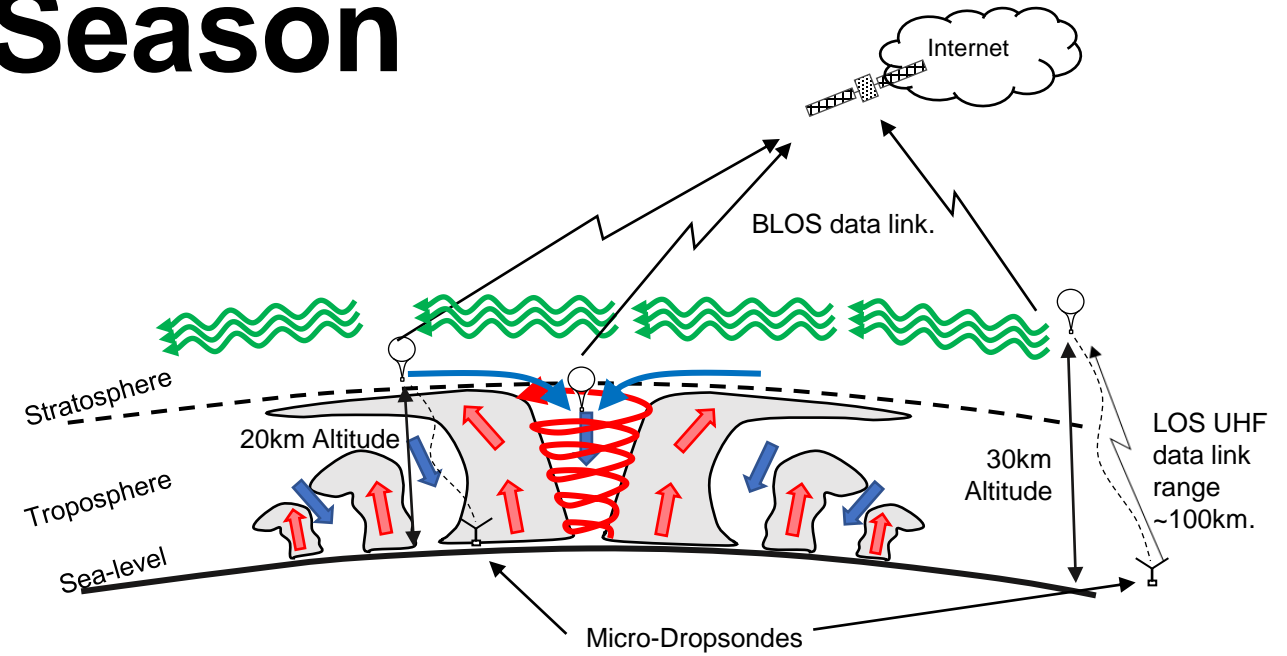
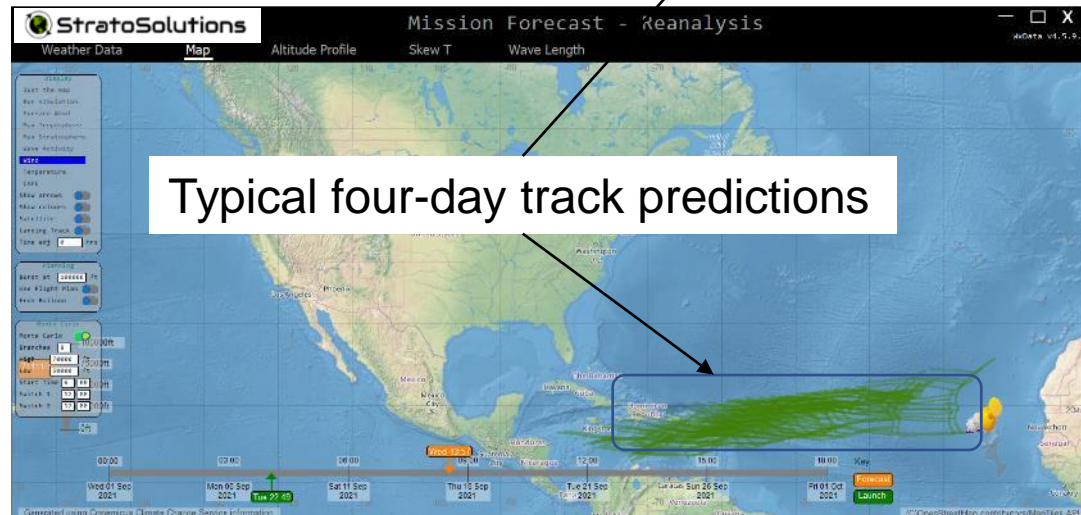
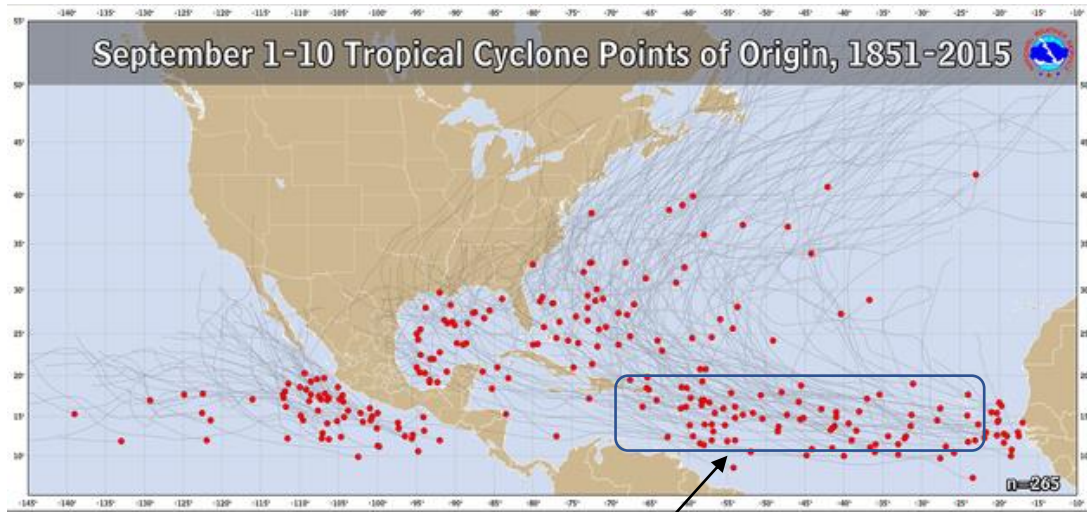
- ✓ 1. Demonstrate a mini-dropsonde system on a HAB platform.
- ✓ 2. Develop a flight plan for targeted observations operations over extreme weather.
- ✓ 3. Conduct flight tests and collect data over identified extreme weather.
- ✓ 4. Analyze the dropsonde generated data.
- 5. Assimilate data into weather models and compare resulting forecasts against existing forecasts and actual weather conditions.
- 6. Assess overall impact and usefulness of targeted weather observations using mini-dropsonde systems on HABs.

Project focus: observation data gathering over remote areas of the Atlantic Ocean.

- Field trials during the **Atlantic Hurricane Season**
- **Targeted** observation data from **tropical storms and tropical depressions**.



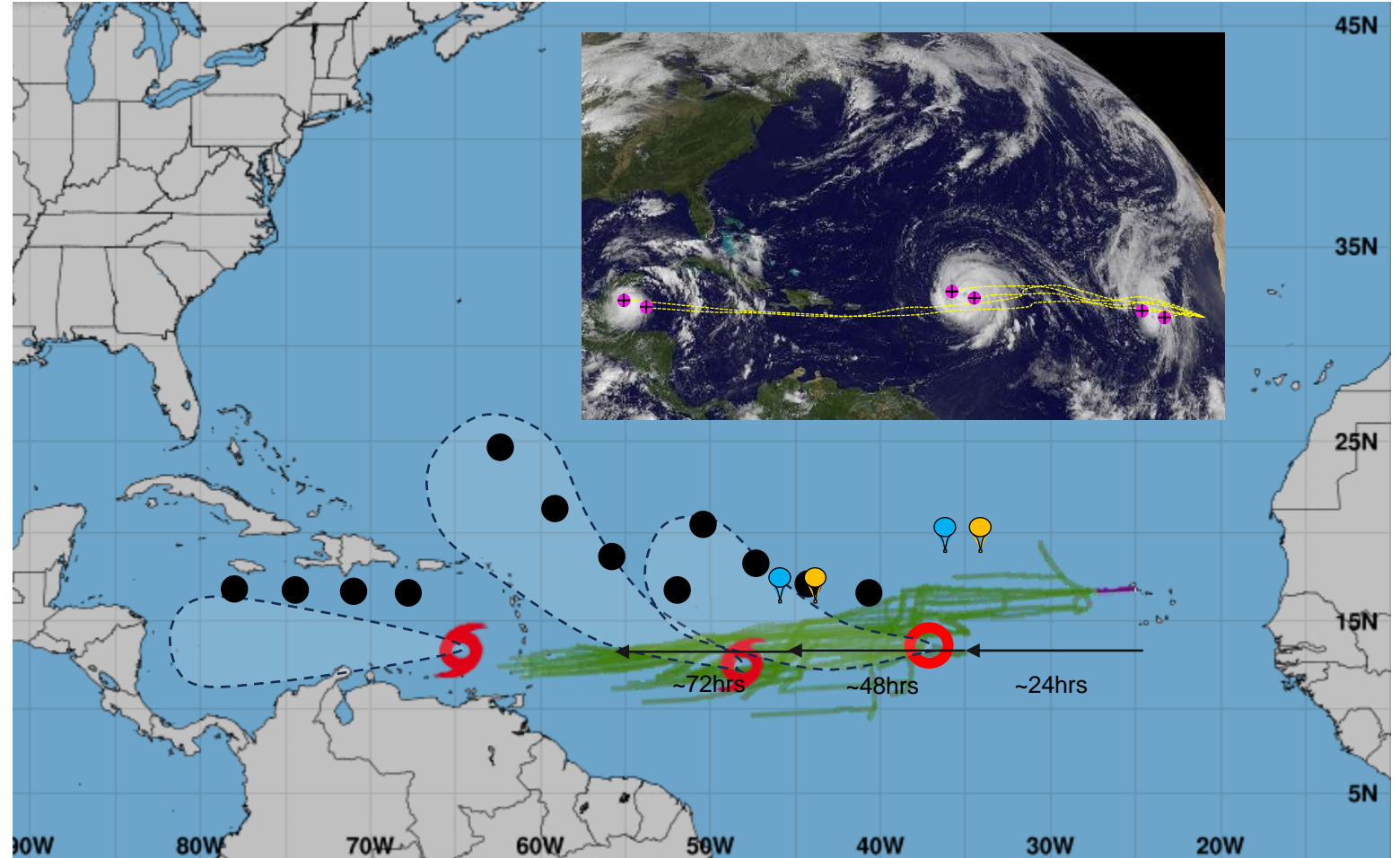
# Atlantic Hurricane Season



# Baseline Tactics

Based on National Hurricane Centre 2-day and 7-day Tropical Weather Outlook:

- Plot possible intercepts with features of interest
- Target tropical waves/depressions which may or may not form tropical storms.
- Determine optimum day and likely time to launch balloon pair for intercept.
- Balloons launched ~6hrs apart.
- Potentially a second pair launched 24hrs later to re-intercept developing storm.



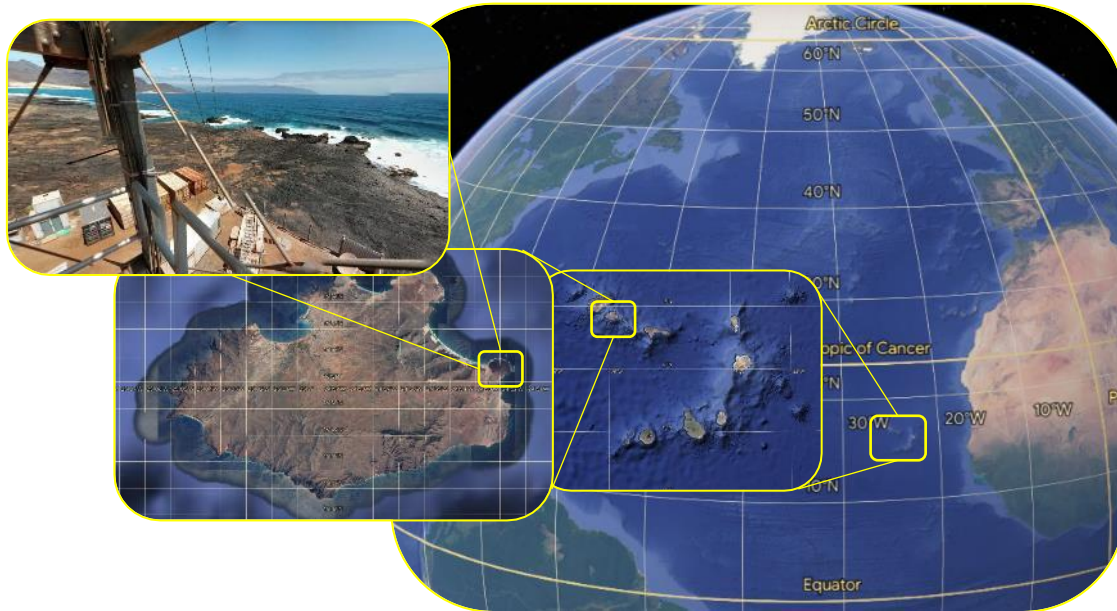
Current Disturbances and Seven-Day Cyclone Formation Chance:  < 40%  40-60%  > 60%

Tropical or Sub-Tropical Cyclone:  Depression  Storm  Hurricane

 Post-Tropical Cyclone or Remnants

# Logistics – September 2023 Campaign

## Cape Verde Atmospheric Observatory, CVAO



Grateful for support from **Dr Katie Read**, University of York (UOY) and the **Cape Verde Atmospheric Observatory** for permission to use their logistics chain and facility for StratoSonde HAB preparation and balloon launches.

- Balloons, helium and other equipment shipped in UOY logistics container in July.
- 6x 100litre (26 US gallon) plastic crates of equipment
- 7x 100litre cardboard boxes containing HAB systems
- 1x 30litre (8 US gallon) crate containing batteries
- 7x 1.6m (5ft) Helium cylinders
- 500kg (1100lbs) freight including helium and ballast

### Permit from Cape Verde CAA for balloon launches:

- Approval for release 24hr/day, 7-days per week
- Simple deconfliction with Mindelo airport
- Daily HRD Tropical Weather Map Discussion





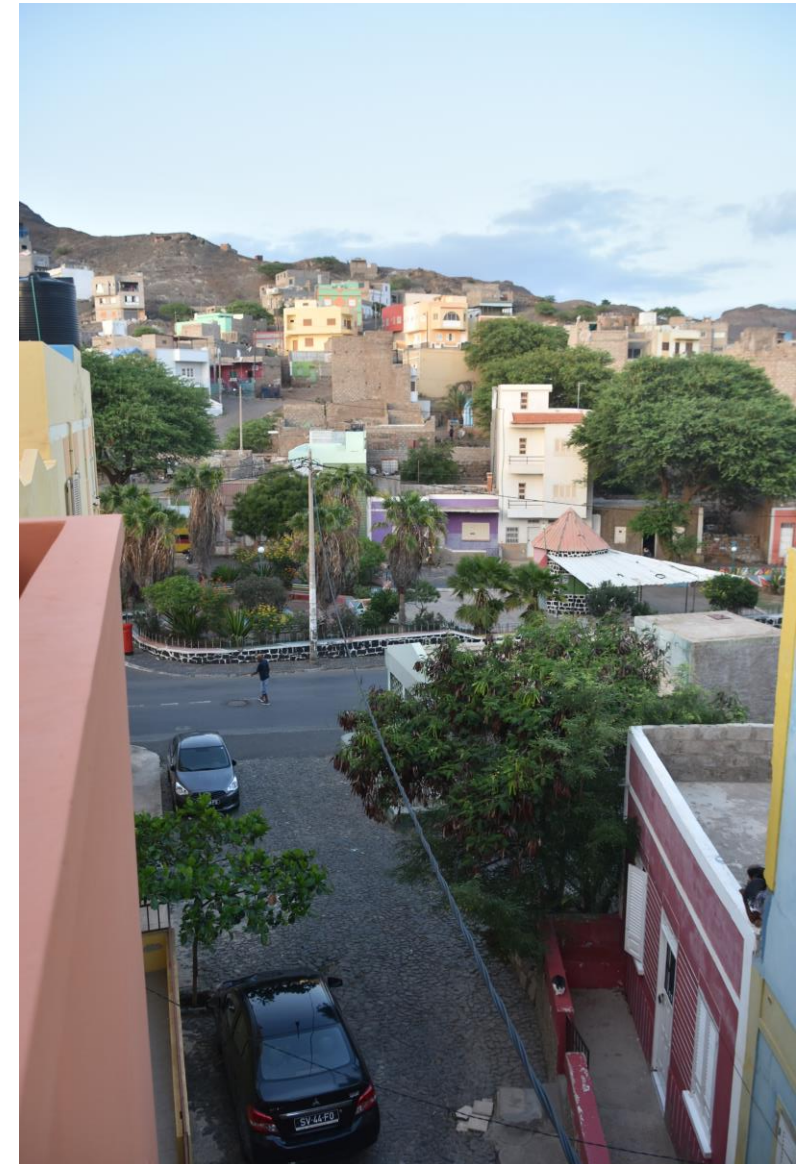
# Location



Cabo Verde Atmospheric Observatory, São Vicente, Cabo Verde

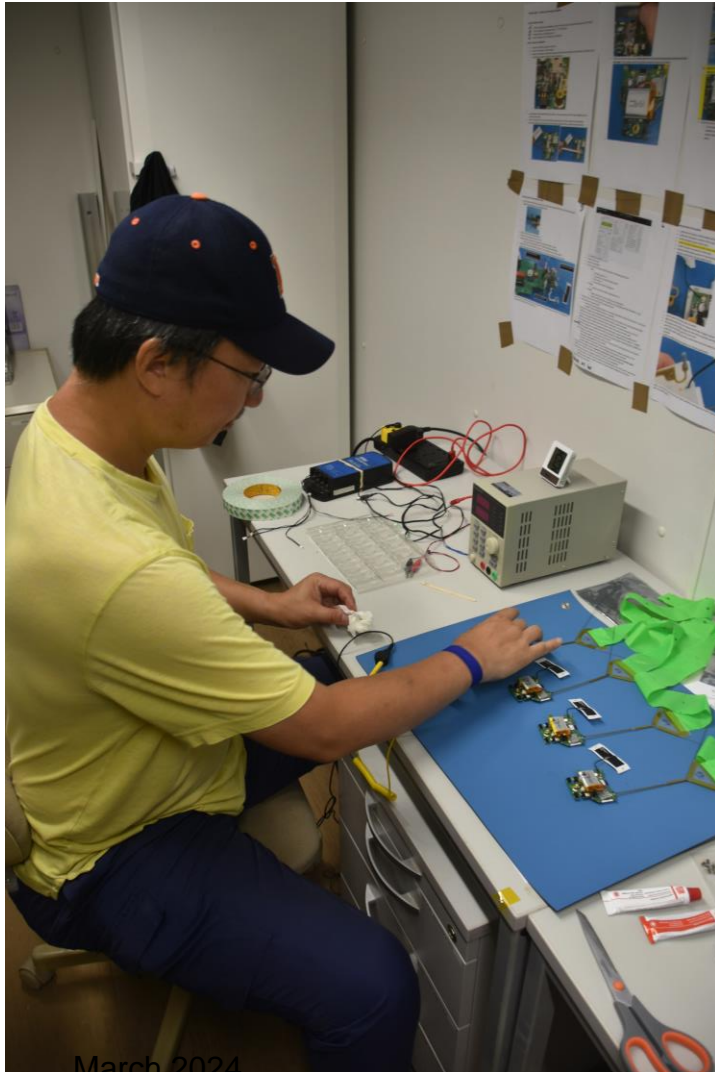
March 2024

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Mindelo, São Vicente

# Flight Prep



March 2024



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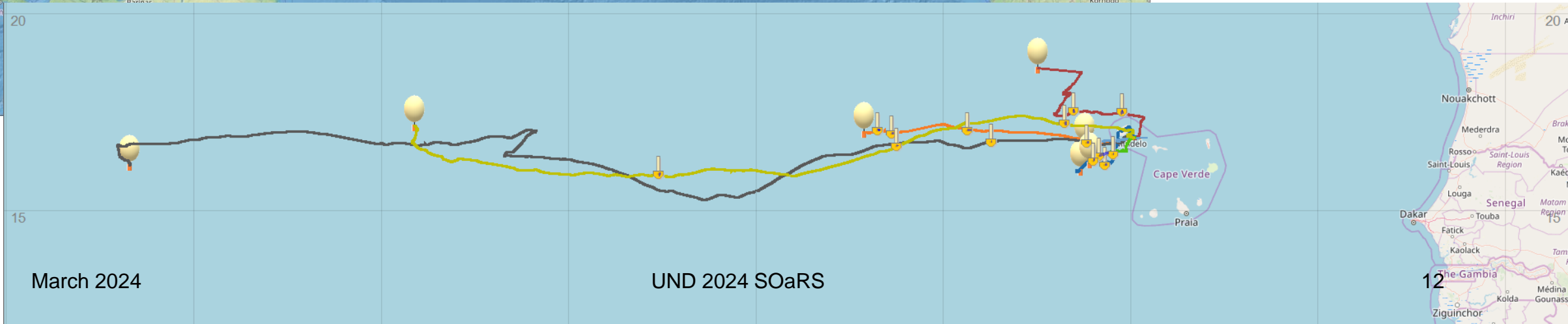


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# Launch



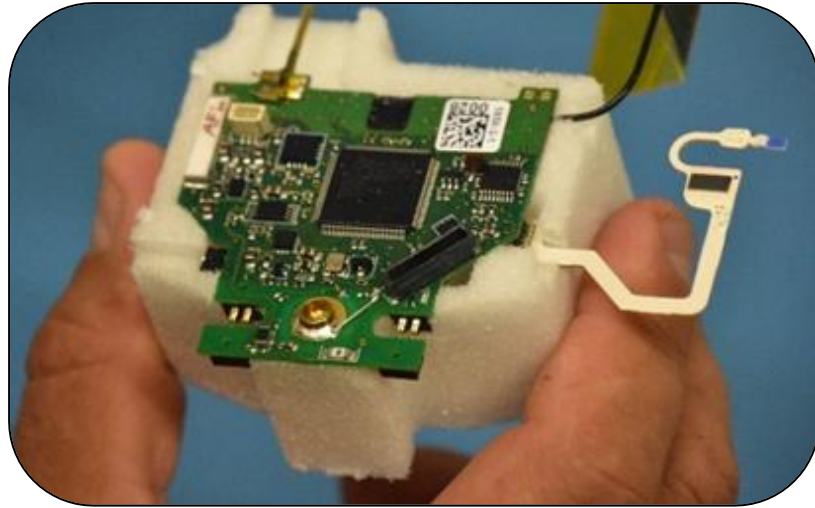
# StratoSonde Tracks for September 2023



# StratoSonde Launch Video



# Micro-Dropsondes



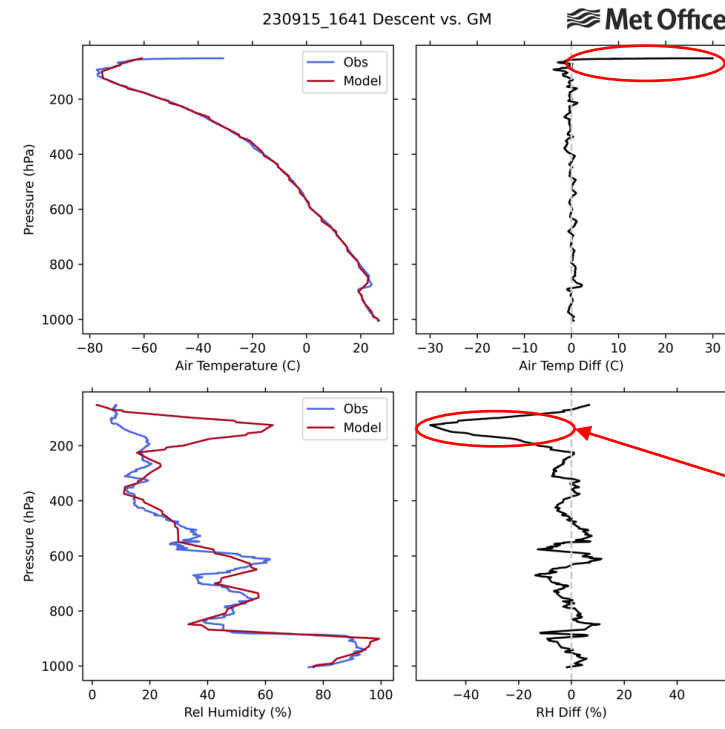
## Sensors

- **Air Temperature:** fast response Resistance Temperature Detector (RTD).
- **Relative Humidity (RH):** capacitive RH sensor and heating resistor for fast recovery after condensation.
- **Wind Speed and Direction:** GNSS receiver.
- **Barometric pressure:** full atmospheric range pressure sensor.

## Data validation analysis partners

- University of North Dakota (UND).
- UK Met Office (UKMO).
- Imperial College London.
- WeatherExtreme.

Undertaking comparison studies with global model forecasts and independent radiosonde observations.



Initial release from warm dispenser.

- We reject first 20s of data.

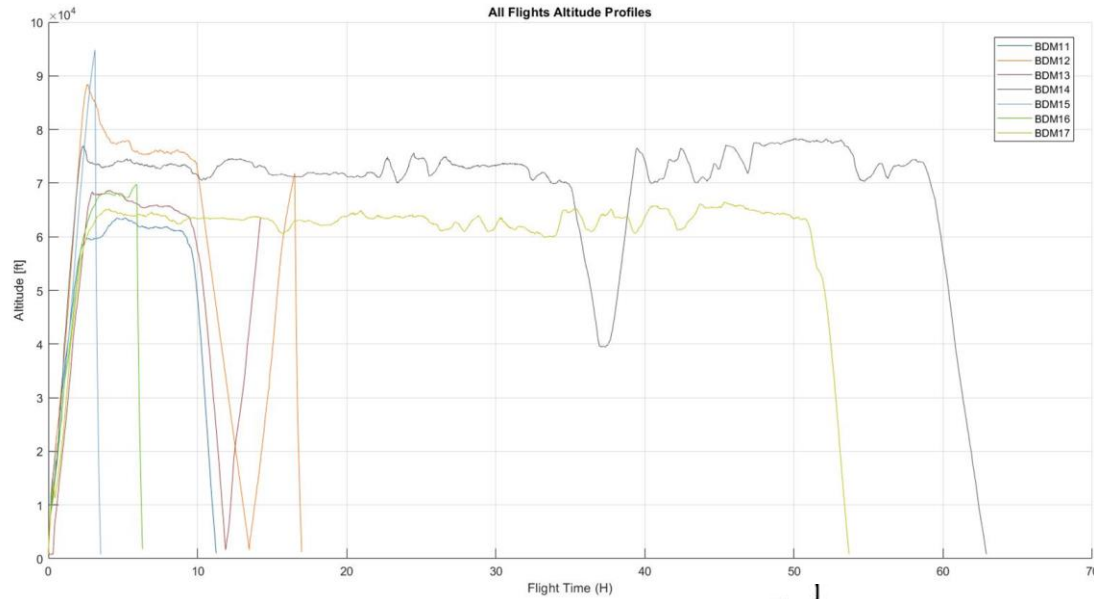
High resolution:

- 1000-2000 data points per drop:

RH sensor becomes unresponsive below -60C.

- Limitation in RH measurements in and near the tropopause.

# Key Lessons & System Improvements



## Flight control

- Troposphere is violent
  - Climb quickly but don't overshoot – larger vent needed for “hand-brake turn”
  - Can over-react to turbulence, venting He too soon – effective tuning later in flights
- Latex balloons provide a drifting capability for high-density data gathering
  - Other envelope types to provide more targeted observations / navigation - and higher power / longer endurance

## Reliability

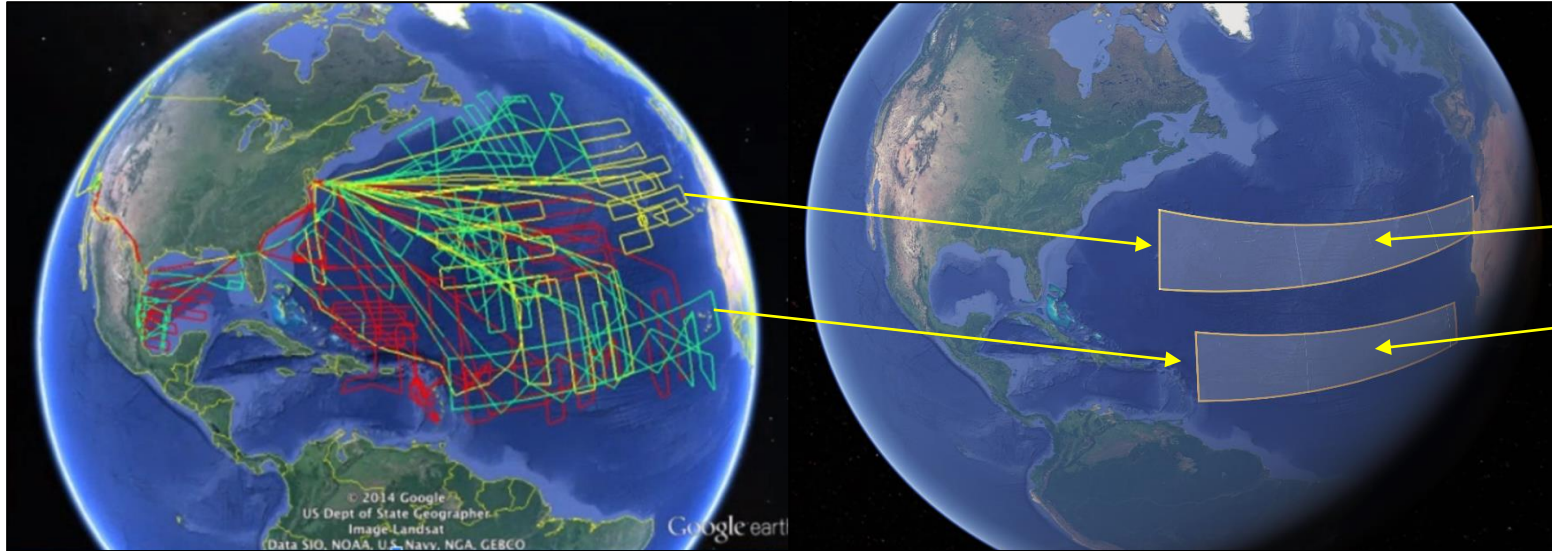
Ballast bags were unreliable

- Flight-line fix implemented for next year's trial
- Next iteration of StratoSondes

March 2024



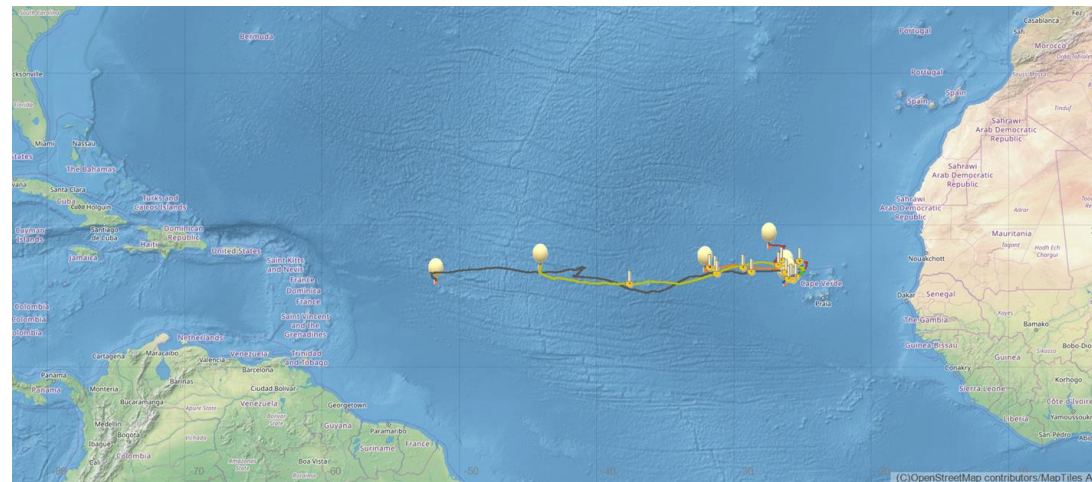
# What Critical Gaps Does the StratoSonde System Fill?



Canary Islands  
Observation Corridor

Cabo Verde Observation  
Corridor

Observations from remote regions:  
**Per data set, the StratoSonde dropsonde capability costs less than the operating cost of conventional radiosondes.**



Snapshot of  
StratoSonde balloons  
crossing the Atlantic  
in September 2023.



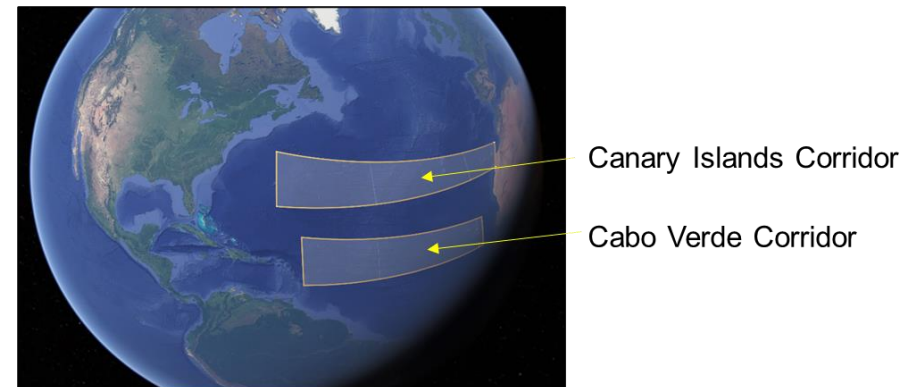
# Significant Challenges

## Short term goals for 2024 - 2025:

- To provide low-cost **pilot services** from **Cabo Verde** and expand to include the **Canary Islands** throughout the **Atlantic Hurricane season**.
- Provide observations to **operational forecast centres** in near-real-time for **assimilation** into NWP models.
- Expansion of services to **East and West Pacific Ocean**.
- Explore other use cases including:
  - Atmospheric Rivers.
  - Polar summer and winter observations.

## Challenges:

- Identification of R&D and operational **collaboration partners** within NOAA for.
  - **data value assessment** studies.
  - development of, and testing against **priority operational use cases**.
  - support development of an action plan towards **data assimilation** in NWP models.
- Funding short falls to achieve objectives.



# Thank You

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