

VOLTITUDE

Dropsondes From The Stratosphere: Targeted Observations Over Remote Regions Using Stratospheric Platforms.



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Unlocking the Stratosphere®

Voltitude Ltd has developed and is operating new upper air observation systems, using long endurance stratospheric platforms, which can navigate to remote regions of the globe and dispense tiny micro-dropsonde sensors. These systems offer great potential to support meteorological and climatological research and improve forecasting of extreme weather events.

The Upper Air Observation Challenge

Upper-air weather data is collected by radiosonde balloon launches which provide data near the location they are launched from. Currently, crewed aircraft are flown at huge expense over missions lasting 12-14 hours to collect data from remote areas. Space-based weather observation data is a critical input for global Numerical Weather Prediction (NWP) modelling as it provides huge horizontal coverage but poor vertical resolution in comparison to in-situ data from radiosondes or dropsondes.

The observation challenge is apparent from Fig 1, showing where ~500,000 radiosonde weather balloons are launched globally each year, mainly from wealthy land-based population centres. Large gaps exist over the oceans, remote areas and poorer countries.

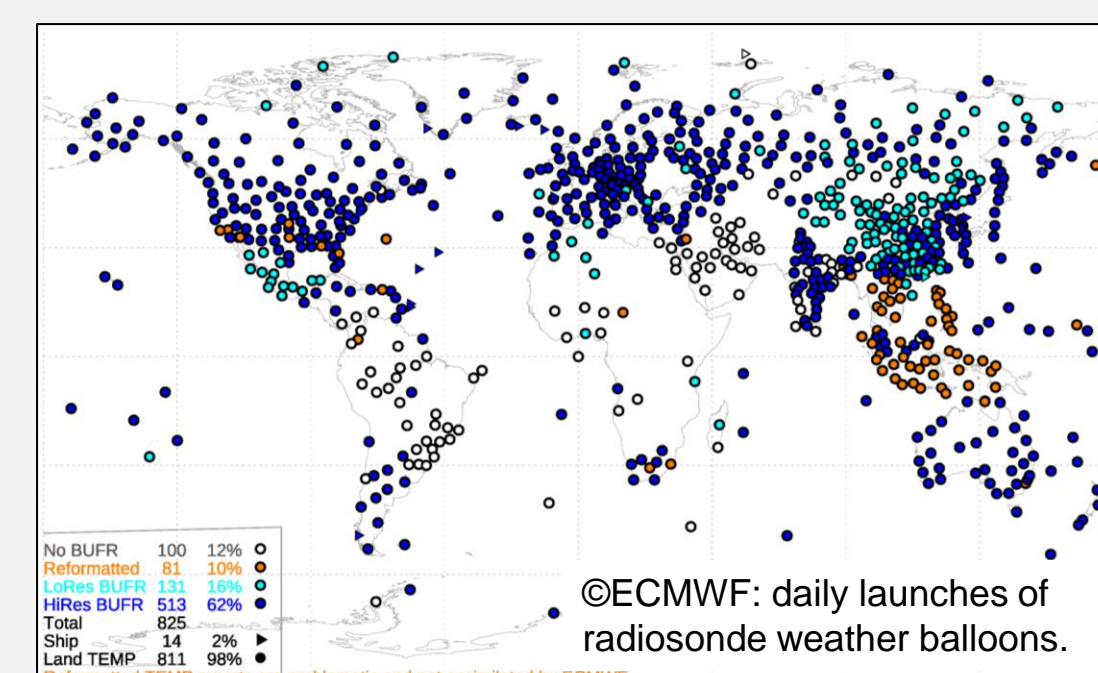


Fig. 1: Upper air observation network

Solution: Dropsondes from the Stratosphere

Voltitude is using stratospheric platforms to navigate to remote regions where they dispense tiny micro-dropsondes. Dispensed dropsondes, Fig 2, transmit weather data in high vertical resolution over the entire atmospheric column as they safely descend for ~20-min from the stratosphere to sea-level. Data received by the dispensing platform, over a UHF datalink, is disseminated via SATCOM, to data end users in near real-time.

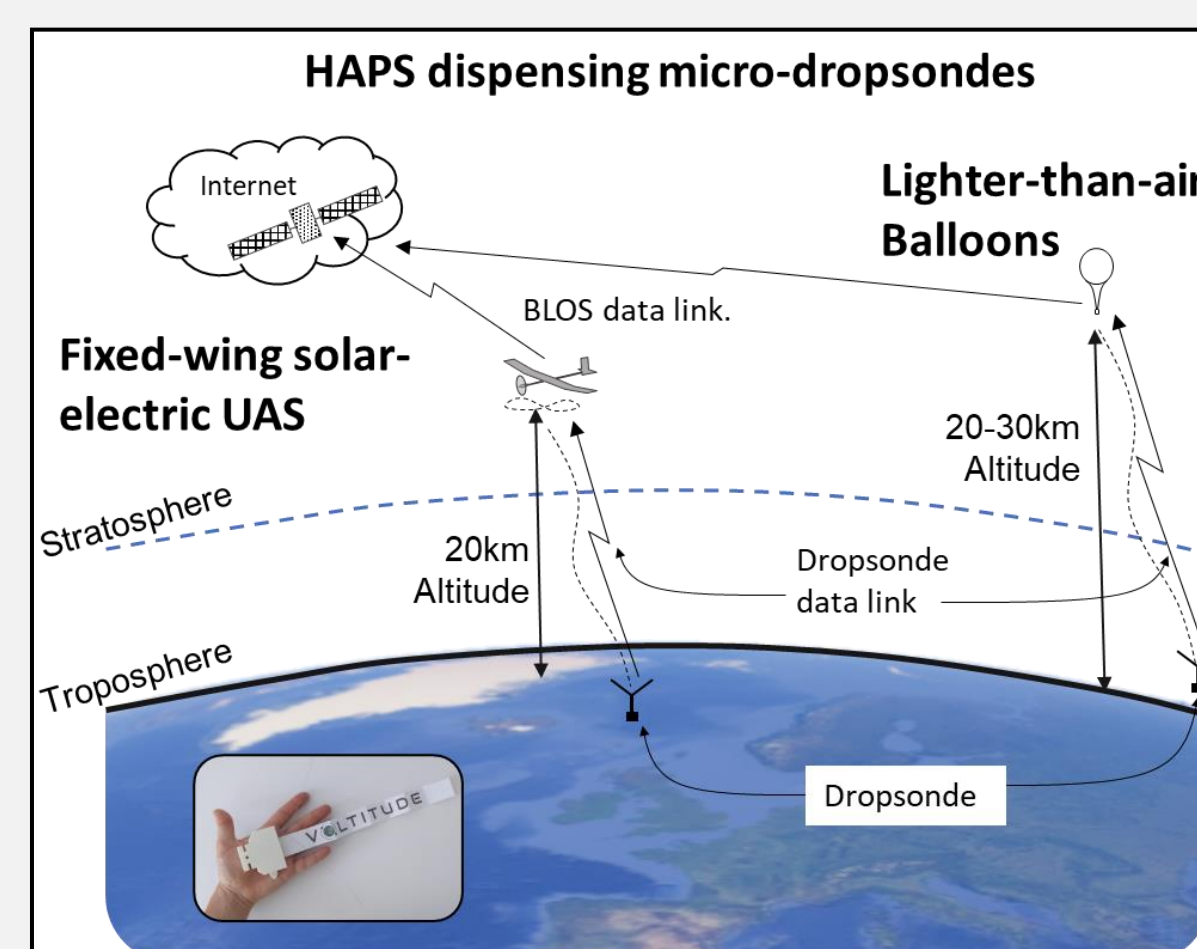


Fig. 2: StratoSonde CONOPS

Voltitude's dropsondes weigh less than 20g (Fig. 3) and "hibernate" in a dispenser system which is designed for long endurance flight in the stratosphere. Dropsondes are 'resuscitated' and dispensed automatically, or on demand, over targeted regions and meteorological features of interest.

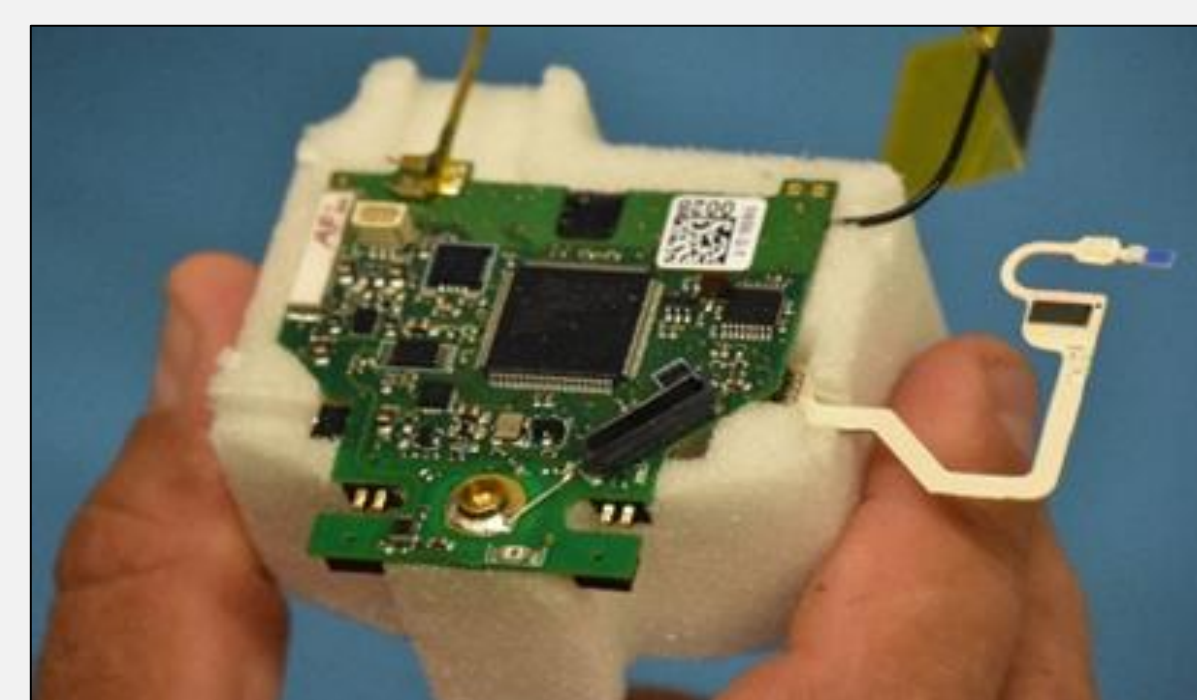


Fig. 3: Compact storage of micro-dropsondes in stratospheric dispenser

Key Innovation – Micro Dropsondes

Each dropsonde data set consist of between 1,000 and 2,000 vertical samples per drop and at sea-level, vertical resolution is <10m. Example data, and comparison shown with UK Met Office Unified Model are shown in Fig 4. for two dropsonde data sets over the mid-Atlantic. The dropsonde sensor specification is presented in Fig. 5.

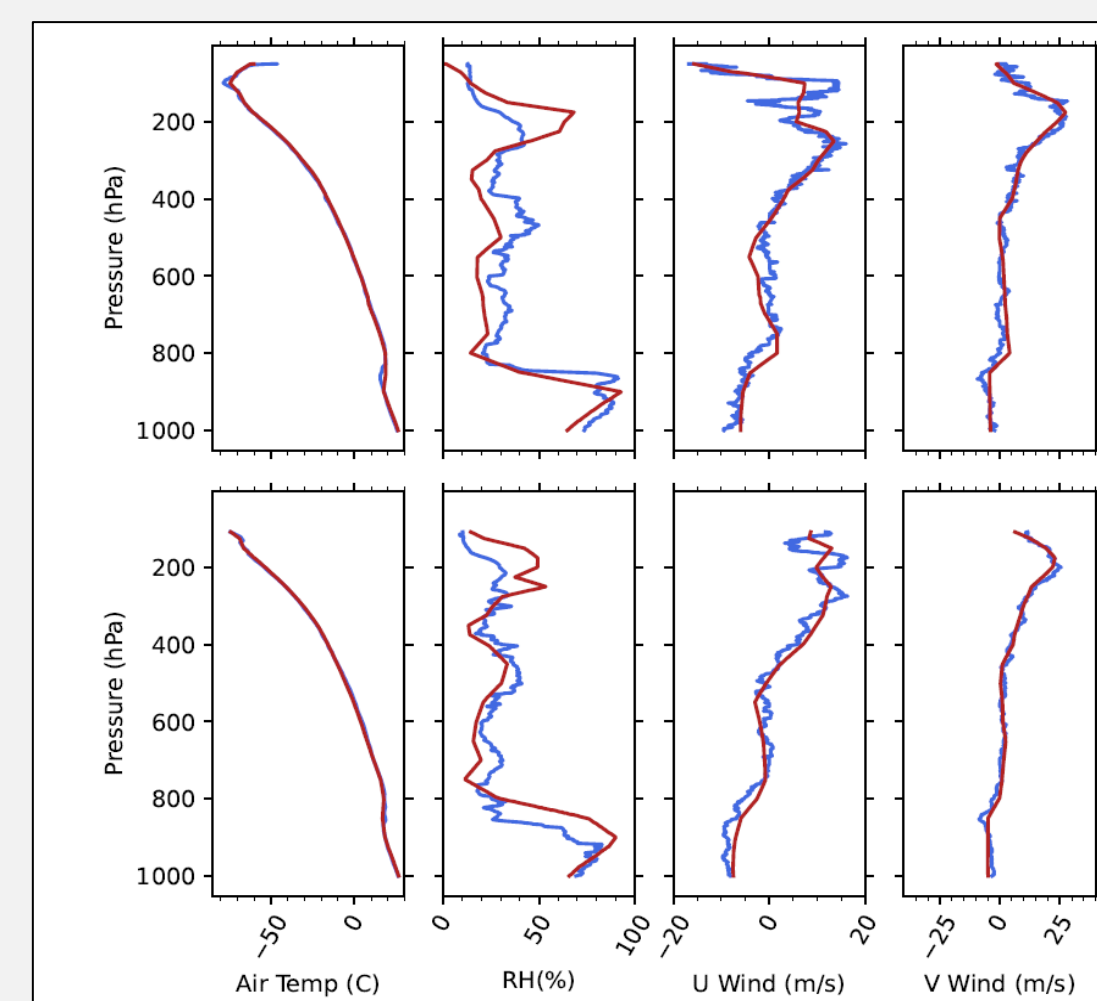


Fig. 4: Dropsonde data example (blue), comparison with Unified Model (red)

Variable	Units	Precision	Accuracy	Range
Unix Time	s	1	-	-
Pressure	mb	0.1	± 1	10 to 1100
Barometric Altitude	ft	1	-	-
GNSS Altitude	ft	1	-	-
Ground Speed	ms ⁻¹	0.001	± 0.1	0 to 180
Heading	degrees true	0.1	± 2	0 to 360
Longitude	°	1 × 10 ⁻⁷	-	-
Latitude	°	1 × 10 ⁻⁷	-	-
Air Temperature	°C	0.01	± 0.5	-100 to 60
Relative Humidity	%	0.1	± 5	0 to 100
Dew Point Temperature	°C	0.01	± 0.5	-100 to 60

Fig. 5: Dropsonde Specification

StratoSonde® Balloon System

The StratoSonde® is a new upper-air observation system, Fig. 6, combining a long endurance balloon with a new micro-dropsonde and dispensing system, to provide observations at low-cost from remote regions. The StratoSonde® balloon's total weight is less than 3kg (light category) and provides multi-day endurance in the stratosphere, navigating by selecting different wind layers to drift towards remote regions of interest.

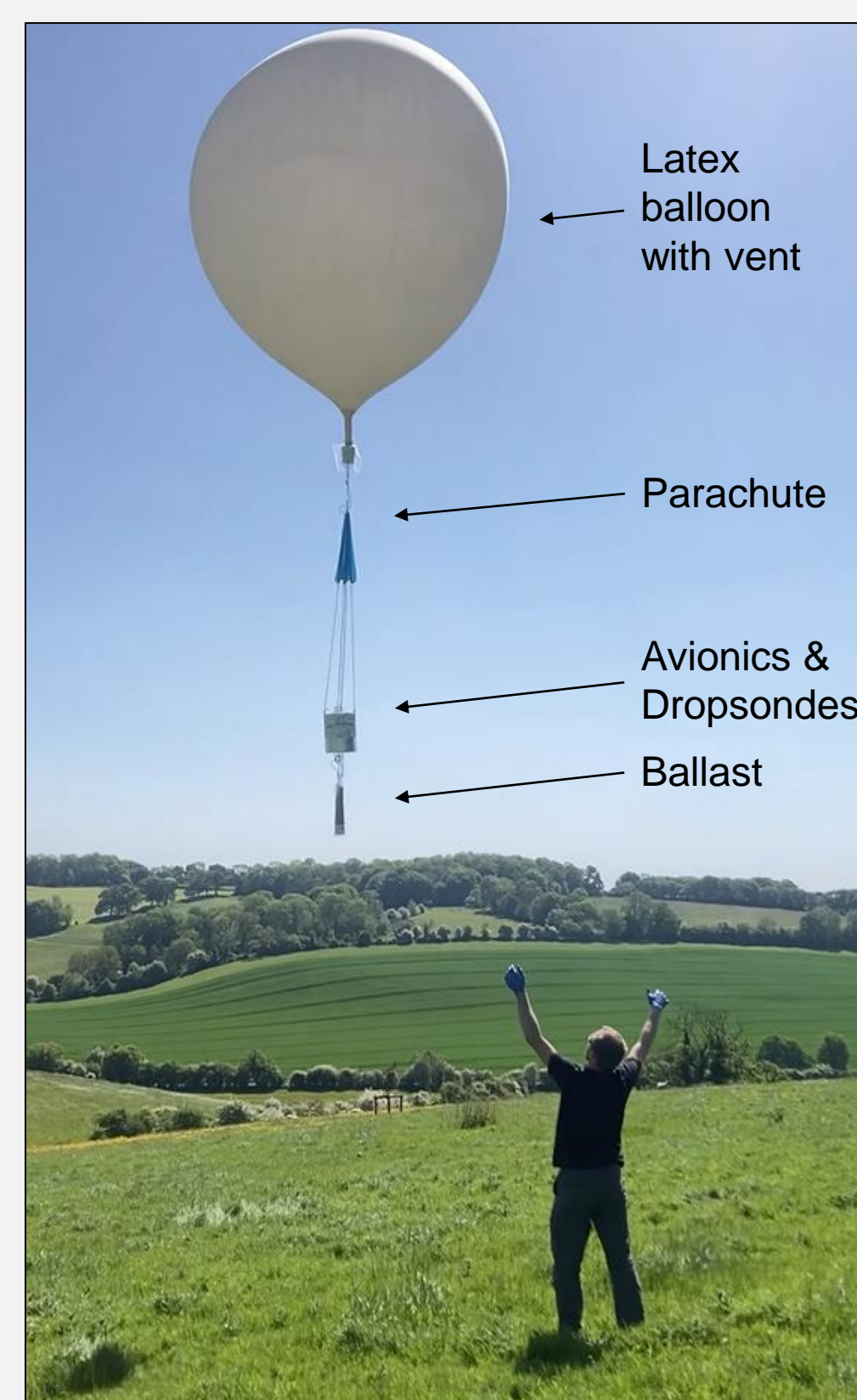


Fig. 6: StratoSonde® system launch

- Low-cost, long endurance balloon
- Navigates by changing altitude
- Balloon typically lasts 5 days
- Carries up to 10 micro-dropsondes
- Users receive weather data in near-real time
- Low plastic content and early adopters of new bio-degradable PCB material

The StratoSonde® system is being operated from the Cabo Verde islands, Fig 7, supporting Tropical Cyclone research.

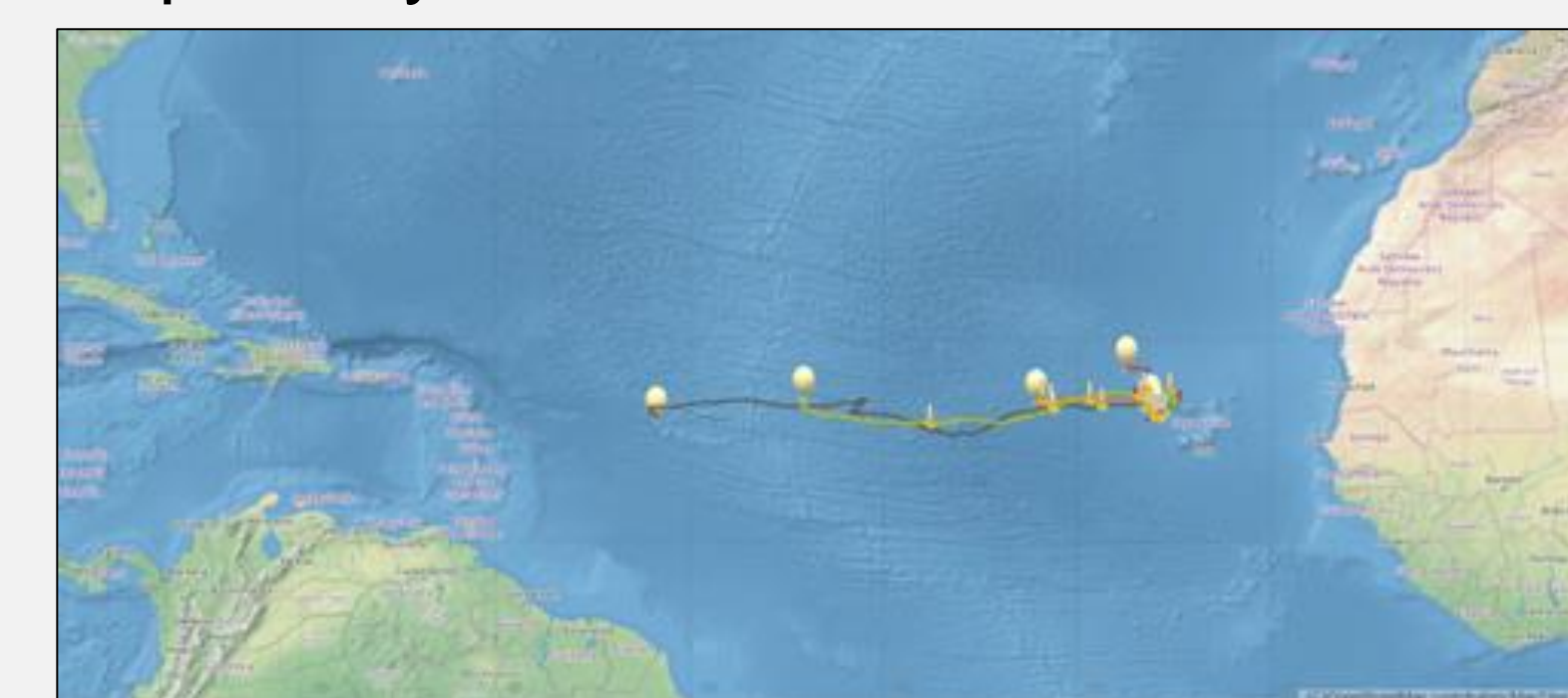


Fig. 7: Snapshot of tracks supporting tropical cyclone research in the Atlantic 2023 hurricane season.

StratoSat-25® Fixed Wing Solar Electric UAS

For precisely targeted observations, the Voltitude micro-dropsonde system can be implemented in an aerodynamic tubular housing for installation on other uncrewed air systems or drones. Each housing is a self-contained dispensing system with UHF receiver, SATCOM data link, and weighs less than 1kg when fully loaded with 32 dropsondes. Two pods are carried by the StratoSat-25, a new type of solar electric stratospheric aircraft (Fig. 8).



Fig. 8: StratoSat-25® solar electric aircraft

The current generation of fixed-wing solar-electric High-Altitude Pseudo Satellites (HAPS) have extremely restricted launch and recovery operating envelopes. They are too vulnerable to gusts and turbulence to support missions requiring regular and routine recovery to "restock" dispensable payloads. The StratoSat-25® overcomes this challenge with great expansion of the operating envelope with enhanced resilience to gusts and turbulence, without penalising stratospheric performance.

Research and Priority Use Cases

The StratoSonde® balloon system is providing seasonal and pilot services to our customers. The StratoSat-25® is being test flown to showcase the benefits of gust alleviation technology. Demonstrated services include:

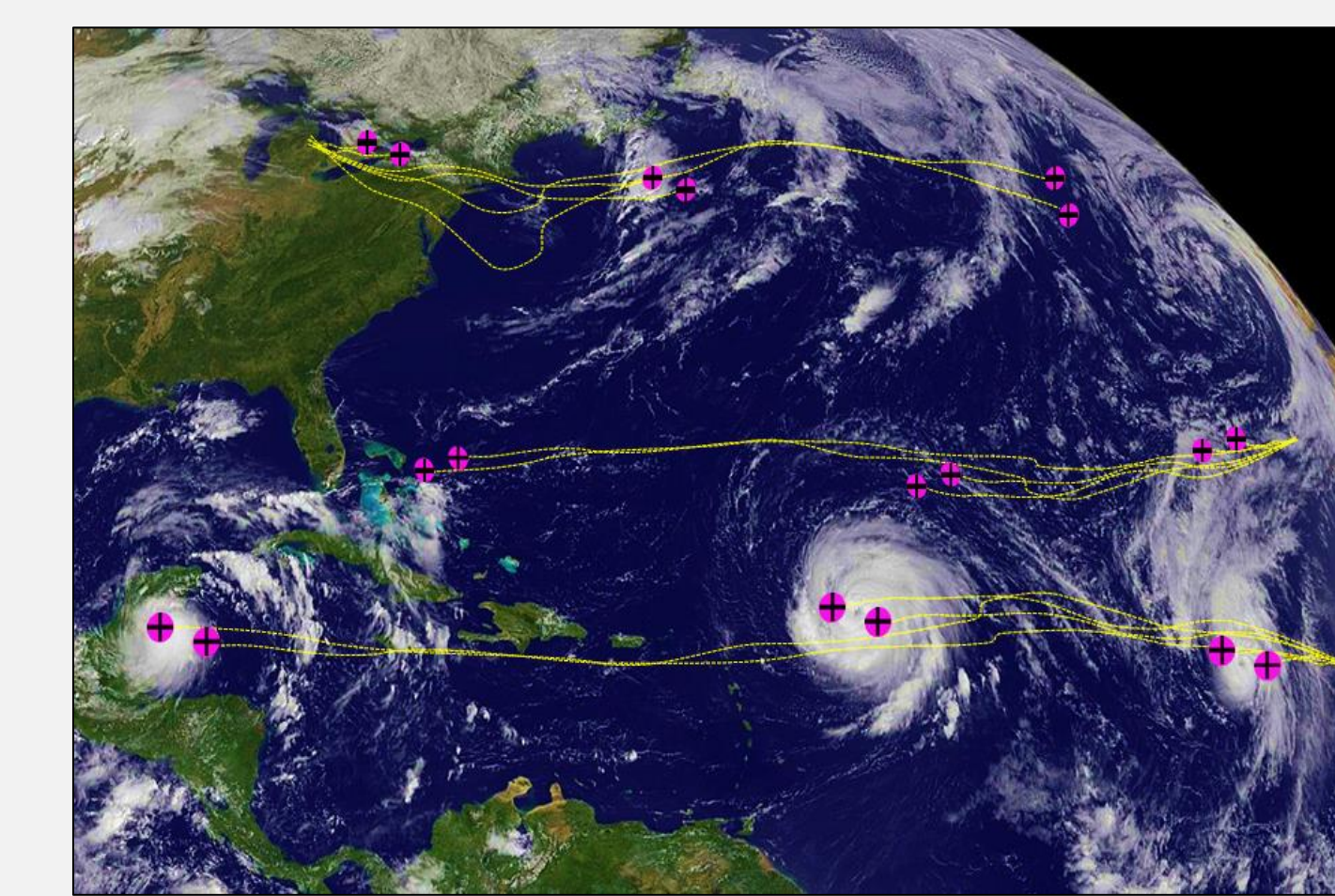


Fig. 9: Example research and use cases.

- 1) Tropical Cyclones:** Improving track prediction and intensification forecasting.
- 2) Extreme Precipitation:** Improving forecasted track and severity of north Atlantic autumn & winter storms affecting Europe, and northeast Pacific atmospheric rivers affecting the USA.
- 3) Polar Observations:** Forecasting polar depressions and sudden stratospheric warming research.

Complementary system services

- **StratoSonde® balloon:** low-cost high-density data over remote areas.
- **StratoSat-25®:** synchronous constellations providing targeted data.