# IFEX GOAL 2

## 4. Doppler Wind Lidar (DWL) SAL Module

**Program Significance:**

Installation of a multi-agency (Navy, Army and NASA) pulsed 2-micron coherent-detection Doppler wind profiling lidar system (DWL) onboard NOAA-42 is anticipated prior to the 2013 Atlantic hurricane season. This instrument, referred to as the P3DWL, was flown on board a Navy P3 in 2008 during typhoon research in the western Pacific. The P3DWL includes a compact, packaged, coherent Doppler lidar transceiver and a biaxial scanner that enables scanning above, below and ahead of the aircraft. The transceiver puts out 2 mJ eyesafe pulses at 500 Hz.

The P3DWL will have the capability to detect winds and aerosols both above (up to ~14 km in the presence of high level cirrus) and below (down to ~100 m above the ocean surface) the aircraft flight level (typically 3 -5 km). The vertical resolution of these retrievals will be ~50 m with a horizontal spacing ~2 km for u, v, and w wind profiles. There is an anticipated data void region ~300 m above and below the aircraft. Given the P3DWL's operating wavelength (~2 microns), the instrument requires aerosol scatterers in the size range of ~1+ microns and while measurements within and below optically thin or broken clouds are frequent, there is limited capability in the presence of deep, optically thick convection. Therefore, it is anticipated that the optimal environments for conducting the P-3 DWL module will be in the periphery of the TC inner core, moat regions in between rainbands, the hurricane eye, the ambient tropical environment around the storm, and the Saharan Air Layer (SAL). Options for this module will primarily focus on these environments in and around the storm. The P3DWL will require an onboard operator during each mission.

**Objectives:**

The main objectives of the P-3 DWL SAL Module are to:

- Characterize the suspended Saharan dust and mid-level (~600-800 hPa) easterly jet that are associated with the SAL with a particular focus on SAL-TC interactions;
- Observe possible impingement of the SAL's mid-level jet and suspended dust along the edges of the storm's (AEW's) inner core region (R=~150 km);
- Quantify the capabilities of the operational coupled model forecast system to accurately capture and represent both the SAL's mid-level dry air (sampled by GPS dropsondes) and its ~600-800 mb mid-level easterly jet (sampled by GPS dropsondes and the P3DWL);

**Links to IFEX:**

This experiment supports the following NOAA IFEX goals:

**Goal 1**: Collect observations that span the TC lifecycle in a variety of environments;

**Goal 2**: Development and refinement of measurement technologies;

**Goal 3**: Improve our understanding of the physical processes important in intensity change for a TC at all stages of its lifecycle;

**Model Evaluation Component:**

The SAL's mid-level easterly jet and low- to mid-level dry air will be sampled using a combination of observations collected from GPS dropsondes and the P3DWL. Thermodynamic and kinematic observations that are collected during this module will be used to evaluate the robustness of the operational coupled model forecast system to represent the SAL's low humidity and embedded mid-level easterly jet. Data assimilation (DA) provides a natural platform to compare model output to observations by accounting for the underlying uncertainties of observations and model in a statistical framework. Normalization of model-observation differences by the total expected uncertainty allows for the identification of areas where lack of model performance is statistically the most significant. Furthermore, the high-resolution, three-dimensional analyses that DA produces provide the best estimate of the SAL's thermodynamic and kinematic structure within the modeling framework. Such analyses can be directly compared to operational model output to understand how well the SAL structure is represented in operational models and the consequences for subsequent model forecasts.

**Mission Description:**

This P-3 DWL SAL Module is designed to utilize the WP-3D aircraft [P3DWL, at the maximum allowable flight-level (~12,000-19,000 ft) in the periphery of the storm and GPS dropsonde data]. Although this module is not a standalone experiment, it could be included as a module within any of the following HRD research missions: TC Genesis Experiment, TC Shear Experiment, TC Diurnal Cycle Experiment, SALEX-Arc Cloud Module, Rapid Intensity Experiment, or as part of operational NHC-EMC-HRD Tail Doppler Radar (TDR) missions. This module will target sampling of the SAL's suspended dust and mid-level jet by the P3DWL and can be conducted between the edges of the storm's (AEW's) inner core convection (deep convection) to points well outside (several hundred kilometers) of the TC environment during the inbound or outbound ferry to/from the storm (no minimum leg lengths are required). For fuel considerations, the outbound ferry is preferable and the optimal flight-level is ~500 mb (~19,000 ft) or as high as possible. The P3DWL should be set to the downward looking and full scan modes. GPS dropsonde sampling along the transect will be used to observe the SAL's thermodynamics and winds as well as to validate the P3DWL's wind retrievals. Drop points should be spaced at ~25-50 nm increments near the region where the SAL is impinging on the storm/AEW and spaced at 50-75 nm increments farther from the storm (Fig. 4-1). GPS dropsonde spacing will determined on a case by case basis at the LPS's discretion.

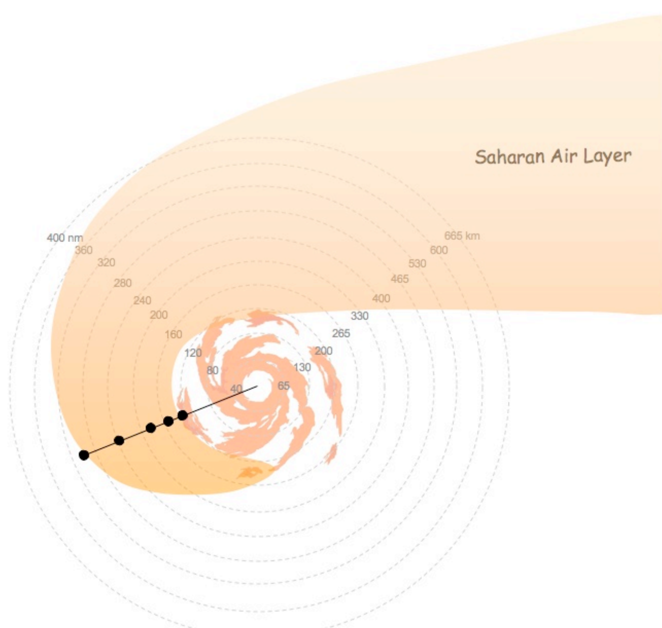


**Fig. 4-1:** Sample WP-3D flight track during the ferry to/from the storm and GPS dropsonde points for the P-3DWL SAL module.

**Analysis Strategy**

This experiment seeks to observe and characterize the suspended Saharan dust and mid-level easterly jet that are associated with the Saharan Air Layer (with a particular focus on SAL-TC interactions) and to observe possible impingement of the SAL's mid-level jet and suspended dust along the edges of a storm's (AEW's) inner core convection (deep convection). Wind and aerosol information from the P-3DWL will be used to diagnose the 3-dimensional kinematic and aerosol structure of the SAL and to document the evolution of this structure as at various distances from the storm environment. When available, this information will be compared to thermodynamic retrievals from AIRS on the NASA Aqua satellite and 3-dimensional aerosol information from the NASA CALIPSO satellite.