Air Chemistry in the Gulf of Mexico Oil Spill Area
NOAA WP-3D Airborne Chemical Laboratory Flights of 8 and 10 June 2010

Fig 1. A NOAA WP-3D Orion research aircraft, equipped as a flying air chemistry laboratory departs on a research mission.

The Mission

As a part of a multi-agency response to the Deepwater Horizon/BP oil spill, NOAA conducted two aircraft flights to characterize air quality in the Gulf of Mexico near the spill site. At the time it was called on for this mission, the NOAA WP-3D aircraft, equipped with an extensive suite of in-situ chemical sensors (see below), was in California as part of a large field study of climate change and air quality issues. A need was recognized for a more systematic and extensive survey of atmospheric loadings of hydrocarbon and other organic species air pollution in the Gulf of Mexico to complement existing efforts by OSHA and EPA to assess risk to workers at sea and to the public ashore. Consequently, the WP-3D aircraft was temporarily deployed to MacDill Air Force Base in Tampa, Florida from where it was flown within and above the marine boundary layer over the Gulf of Mexico on 8 and 10 June 2010.

Aircraft Instrumentation

For the flights over the Gulf, the aircraft was equipped with an extensive array of scientific instrumentation to characterize both gas phase and particulate air pollution. In addition to sensors to quantify atmospheric loadings of a wide range of pollution, the aircraft was also equipped with a large complement of meteorological sensors to characterize the physical state of the atmosphere. A special emphasis was placed on quantifying the organic pollutants present in the air. The aircraft was equipped with a Proton Transfer Reacton Mass Spectrometer and an Aerosol Mass Spectrometer, which allowed gaseous and particulate organic pollution to be quantified continuously in flight. In addition, 72 canister samples were collected on each flight for later laboratory analysis, which extended the list of organic contaminants that could be quantified in the Gulf air. The instrumentation on the aircraft is described in more detail below.

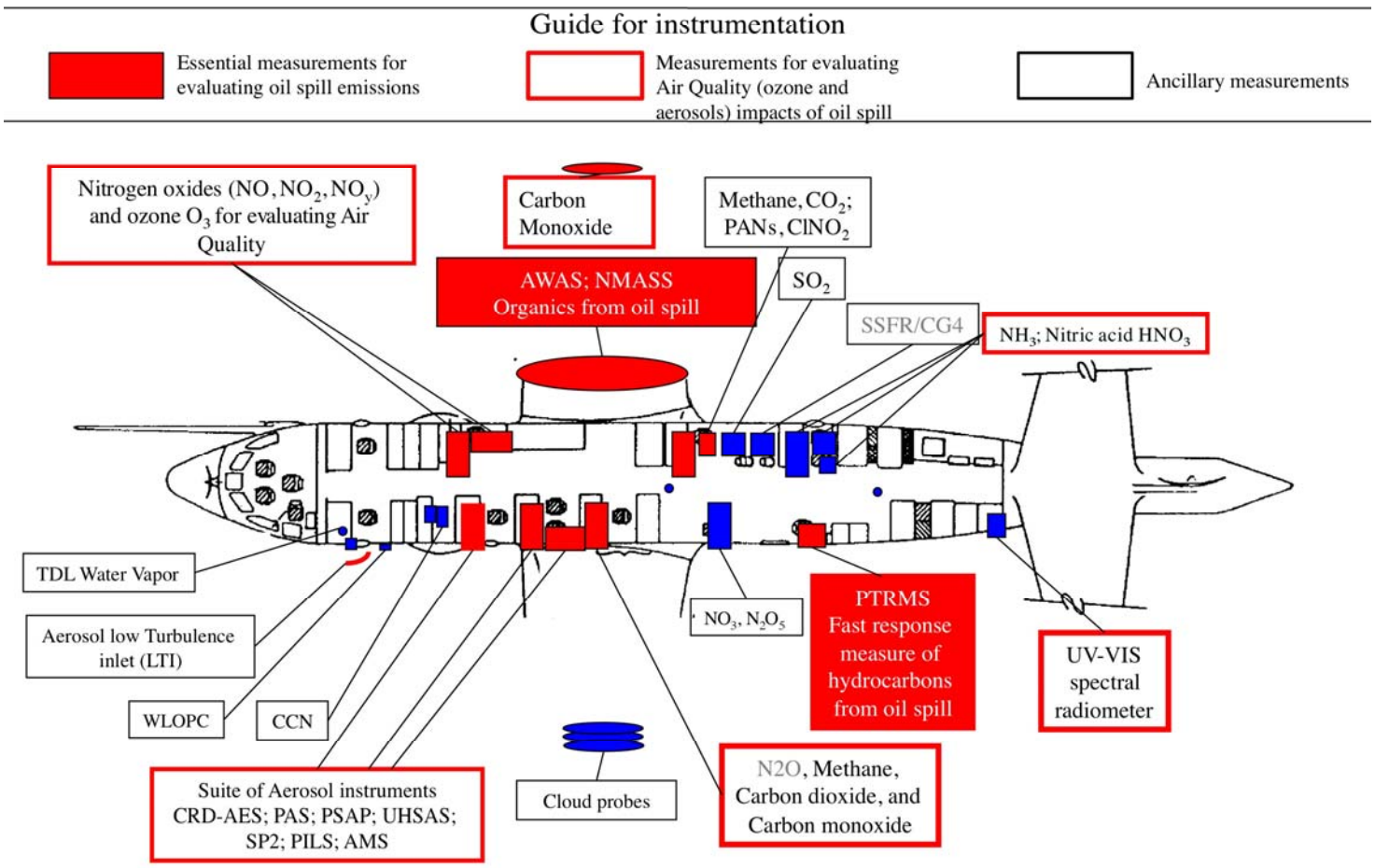

Fig. 2. Instruments on the WP-3D aircraft. Most instruments measure 1 second average concentrations, which correspond to 100 m spatial averages at the aircraft speed.

Definition of instrument acronyms:

AMS – Aerosol Mass Spectrometer
AWAS - Atmospheric Whole Air Sampler
CCN – Cloud Condensation Nuclei counter
CRD-AES – Cavity Ring Down – Aerosol Extinction Spectrometer
NMASS – Nucleation Mode Aerosol Size Spectrometer
PANs – Peroxy Acyl Nitrates
PAS- Photoacoustic Spectrometer
PILS- Particles Into Liquid Sampler
PSAP- Particle Soot Absorption Photometer
PTRMS - Proton Transfer Reaction Mass Spectrometer
SP2- Single Particle Soot Photometer
SSFR/CG4 – Solar Spectral Flux Radiometer
TDL – Tunable Diode Laser
UHSAS – UltraHigh Sensitivity Aerosol Spectrometer
UV-VIS – Ultraviolet-visible
WLPOC – White Light Optical Particle Count

Aircraft Flight Tracks:

The NOAA WP-3D research aircraft flew two missions over the Gulf on June 8 and 10. These flights were designed to provide a more comprehensive picture of air pollution levels throughout the Gulf. The flights tracks covered the area in the vicinity of the Deepwater Horizon spill site and other parts of the Gulf with various levels of contamination from the spill. The flight tracks are shown below.

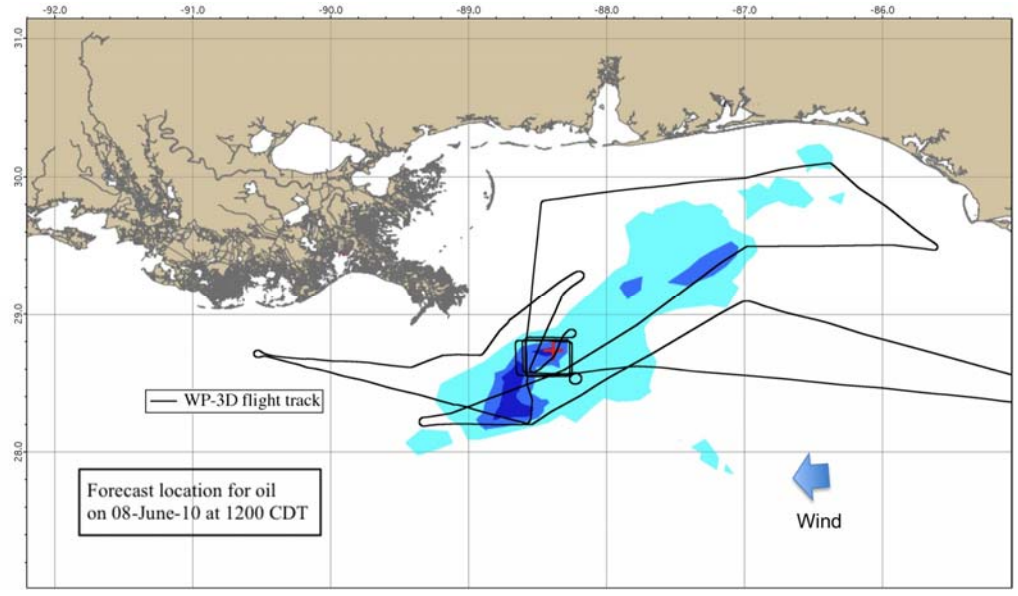

Fig 3. NOAA WP-3D flight track for June 8, 2010. Winds were light (2.4 m/s) and variable out of the ENE.

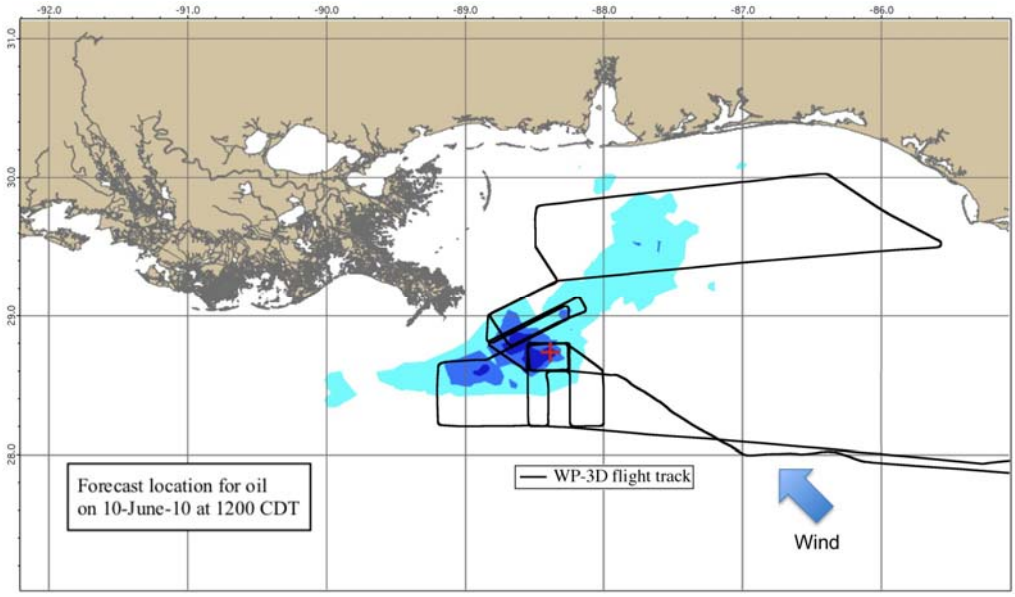

Fig 4. NOAA WP-3D flight track for June 10, 2010. Winds were steady at 5.5 m/s out of the SE.

Level 1 QA/QC Procedures

Air chemistry data collected on the NOAA WP-3D research aircraft

All measurements were made with either custom-built, one-of-a-kind research instruments or highly modified commercially available instruments. These instruments have been designed and/or modified to operate on the NOAA WP-3D research aircraft. For the most part the instrument performance has been documented in the peer-reviewed literature Instrument operating procedures have been developed to ensure that quality data sets are collected from the measurements performed in the unique environment of an airborne platform. Following are some general principles that guide this development..

Detection interferences (if they occur) are documented when the instrument is evaluated prior to deployment on the aircraft. Known interferences are accounted for in Level 1 QA/QC.

Sample inlets on the aircraft are designed to minimize or eliminate sample losses by impaction or absorption. All inlets have been extensively and quantitatively characterized to ensure that no significant sample losses occur under flight conditions.

Calibrations are conducted using absolute reference methods, NIST traceable standard materials (where available), or by standards traceable to the WMO calibration scales for individual compounds. Most instruments are calibrated using standard addition of calibrated gas mixtures at the instrument inlet during flight on the aircraft.

Instrument baselines are obtained using chemical scrubbers that remove the species of interest from the ambient air being sampled. The calibration and baseline determinations are performed repeatedly as needed during all research flights; they have been accounted for in Level 1 QA/QC.

Canister samples collected on the aircraft are analyzed for volatile organic compound (VOC) using standard gas chromatography and gas chromatography-mass spectrometric techniques. All canisters are carefully cleaned prior to use. A subset of the cleaned canisters are retained and analyzed as blanks to insure that no contamination remains from the previous samples.