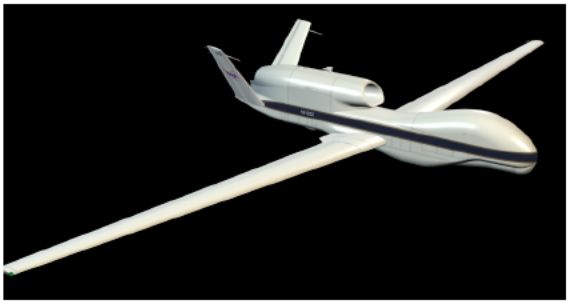
Mission Overview

NASA DFRC 2009 GloPac Mission

UAS COA Application Attachment

National Aeronautics and Space Administration

Dryden Flight Research Center
Edwards, CA 93523-0273



Global Hawk

GloPac 2009 Mission Overview

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Revision Sheet

Revision	Author	Date	List of Changes
Initial	Philip Hall	November 17, 2008	

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1 INTRODUCTION

This document provides an overview of the concept of operations (CONOPS) for NASA Global Hawk 872 (formerly USAF AV-6) flights for the Global Hawk Pacific Mission (GloPac) in support of the Aura Validation Experiment (AVE). Aura is one of the A-train satellites supported by NASA Earth Observation System. GloPac will take place out of Dryden Flight Research Center (DFRC) and is expected to encompass the entire offshore Pacific region and the US controlled Arctic region with a total of four to five flights, from 12 to 30 hours in duration.

2 SCHEDULE

GloPac flights are being planned for Spring 2009 and Winter 2010. Significant preparations are currently underway to prepare for the Spring GloPac campaign. Prior to flight, all aircraft modifications, mission profiles, and payloads will be approved by the NASA DFRC Aircraft Flight Safety Review Board (AFSRB). Mission flights are scheduled to begin on April 1, 2009. An initial flight into the NAS to check out command-and-control systems is planned for on or about 15 March. A build-up approach for flight duration will be used to minimize programmatic risks. Aircraft and payload checkout flights (2 – 8 hrs) will initially be conducted in Edwards AFB, R-2508 restricted airspace. The initial flight into the National Airspace System (NAS) will be a 12-hour mission. Longer duration flights (up to 30 hours) in the NAS will then be flown. A total of 5 flights in the NAS are planned for the Spring GloPac campaign.

3 PAYLOAD

The flights are designed to address various science objectives:

1. Validation and scientific collaboration with NASA earth-monitoring satellite missions, principally the Aura satellite,
2. Observations of stratospheric trace gases in the upper troposphere and lower stratosphere from the mid-latitudes into the tropics,
3. Sampling of polar stratospheric air and the break-up fragments of the air that move into the mid-latitudes,
4. Measurements of dust, smoke, and pollution that cross the Pacific from Asia and Siberia,
5. Measurements of streamers of moist air from the central tropical Pacific that move onto the West Coast of the United States (atmospheric rivers).

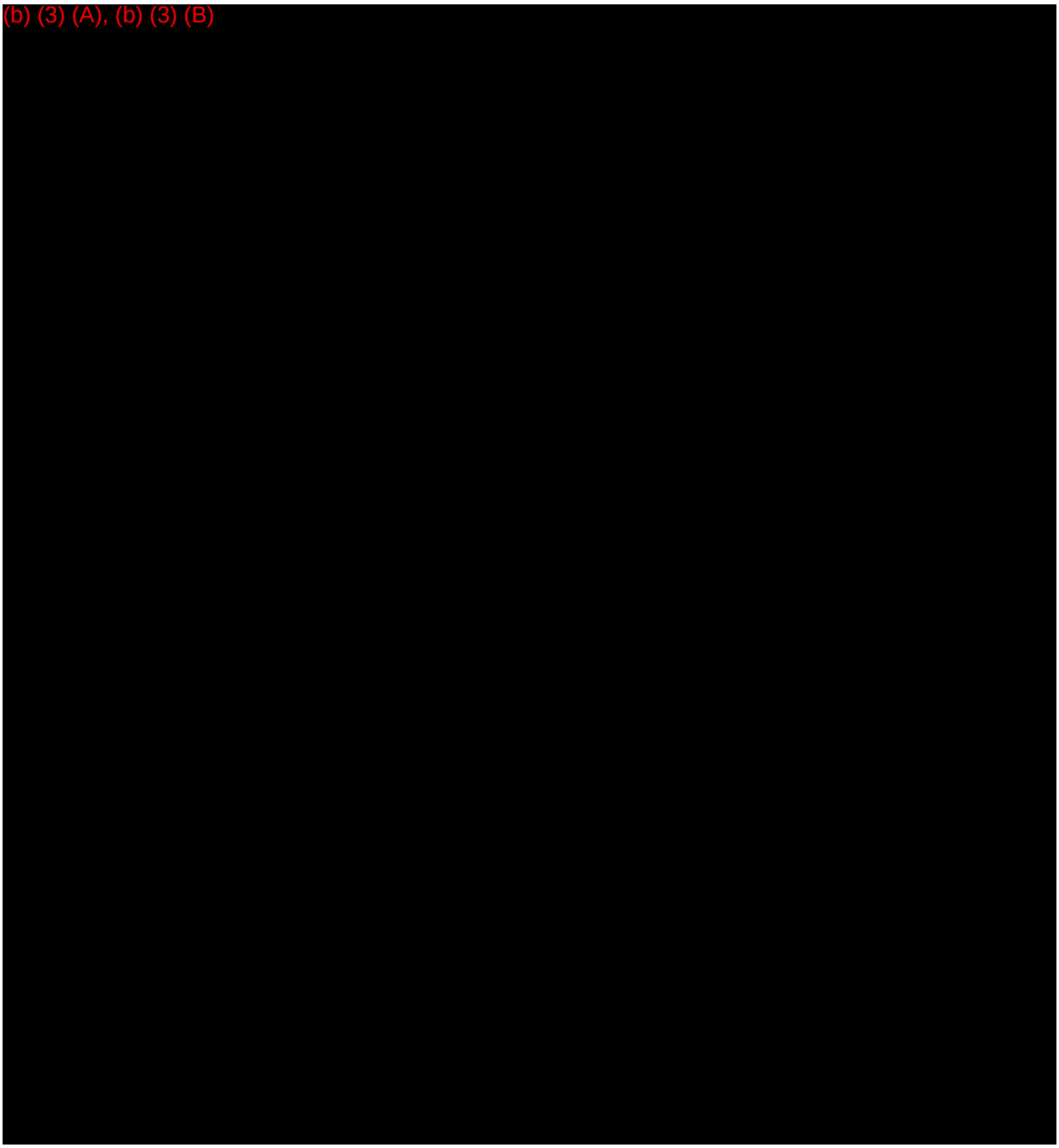
The scientific payload suite for GloPac consists of a combination of *in situ* and remote sensing instruments. These instruments will complete thorough environmental testing and the NASA flight approval processes before flight. The majority of these instruments have flown on other airborne platforms and notably the NASA ER-2 research aircraft.

4 FLIGHT TRACKS

All GloPac flights will originate from and return to Edwards AFB, CA. The GloPac science objectives will be met with two categories of flights: Pacific Zone flights and Arctic Zone flights.

4.1 Edwards AFB Departure & Approach Routes

The departure and approach routes between Edwards AFB, CA to the Pacific Ocean for the NASA Global Hawk will be same routes approved for the USAF Global Hawk operations. The departure / approach routing is depicted in Figure 1.



After takeoff from Edwards AFB, the Global Hawk will orbit and climb in R-2515. During this time, aircraft and payload system checks will be conducted. The Global Hawk will exit R-2515 at or above FL450, fly the box pattern shown in Figure 1, and proceed at or above FL540 via a route that follows the cruise missile corridor offshore to W-537 at DINTY intersection. At the DINTY intersection the aircraft is expected to be at or above FL560. The approximate time from departing R-2515 to DINTY intersection is 1 hour.

Due to the turn radius of the aircraft, the actual waypoints and flight tracks will differ slightly from the flight track depicted. The aircraft will lead the turn before reaching the waypoint.

4.2 Pacific Zone Flight Tracks

The Pacific Zone flight tracks will be bounded within the Oakland Oceanic Flight Information Region (FIR) and include Honolulu Center. Flights beyond U.S. controlled airspace are not requested at this time. A primary objective for GloPac flights is to validate Aura satellite measurements by having the Global Hawk travel along or near the satellite ground track. Flights in the vicinity of the Hawaiian Islands will be requested.

Five example Pacific Zone flight tracks are shown in Figure 2. For each track, the north-south segment is aligned over the nominal ground track of a typical ascending orbit of the Aura satellite. The Aura crossing time is close to 13:30 local time. Specific flight routes in the Pacific Zone are dependent primarily on satellite orbit geometry. In the case of the Aura satellite, which is in a sun synchronous orbit, these orbits longitudinally precess a significant amount each day. The orbit precession repeats each 16 days. Each track in Figure 2 has been generated for an actual satellite orbit for a specific day in Spring 2008. For GloPac flights in April 2009, the actual flight tracks will differ slightly from the example flight tracks shown because details of the Aura orbital geometry slowly vary over a year.

The example flights shown in Figure 2 well represent the characteristics of the flight tracks being proposed for the GloPac campaign. Nominally, the east-west segments will not vary greatly. Due to daily orbital precession, the north-south segment locations will vary depending on the day of flight. An example of this can be seen in the differences between flight #1, where the orbital path is farther west, and flight #2, where the two orbital paths that are over-flown are closer to the east (see Figure 3).

Figure 3 shows the details of two example flight tracks options on a particular day (in this case April 8) in this region. On this day there are two very different flight tracks that over-fly the satellite orbital path. The blue dots represent the satellite orbital path and the shaded areas represent the region where the aircraft would actually fly. Note that for flight track #2 a course deviation to the north is shown on the southern segment of the flight track. The scientific objectives for the flight and meteorological conditions will determine the geometry of the flight track requested for a particular day.

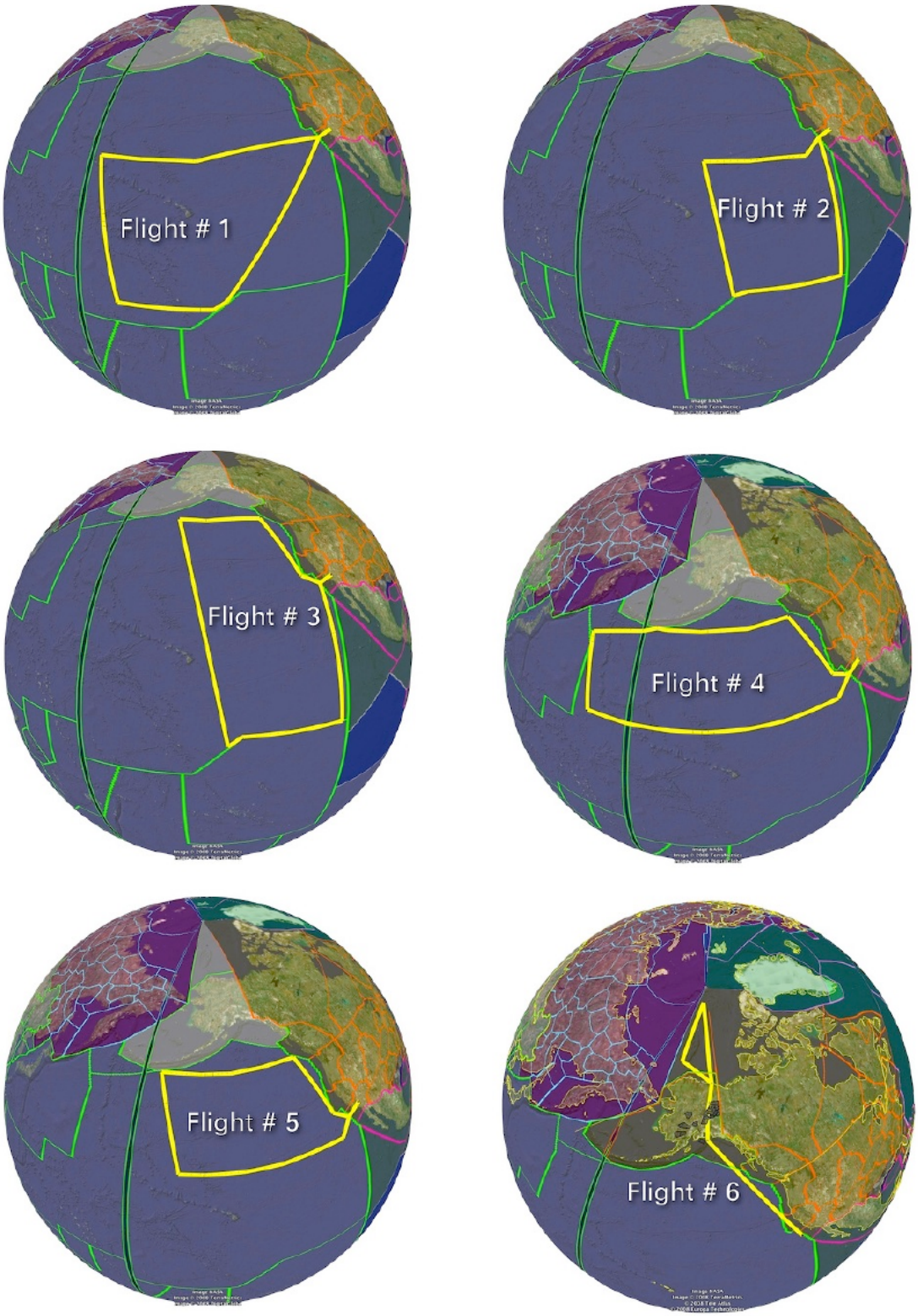


Figure 2. Example Flights in the Pacific Zone and Alaska Zones

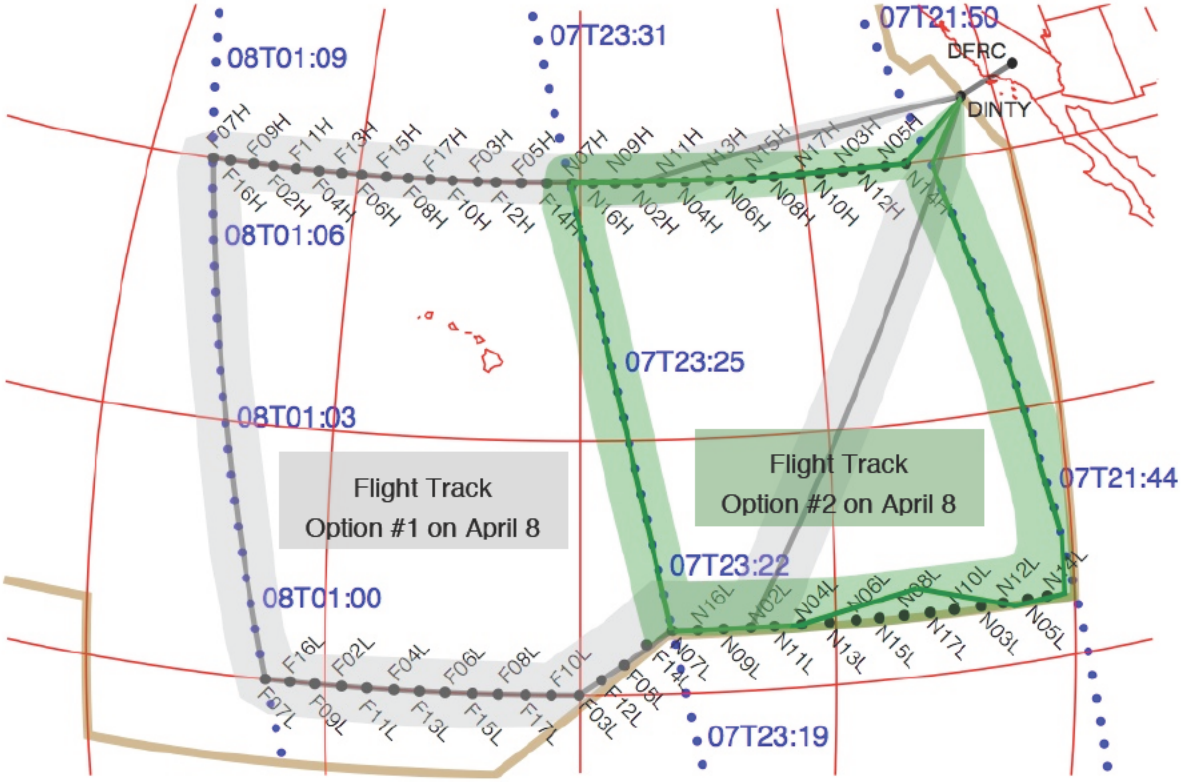


Figure 3. Details of Two Example Flight Track Options for a Particular Day

The flight track for a specific GloPac flight will not be chosen until several days prior to flight. Nominally, flight tracks will be determined 48 hours prior to flight and coordinated with the appropriate FAA organization. It is expected that the project will fly one flight per week during the campaign for a total of 4 or 5 flights.

Additionally, there will be other meteorological, volcanic and climactic phenomena that will be of interest to investigate during GloPac flights. Sampling of these phenomena will be requested real time as deviations from the filed flight plan or modifications to the 48-hr coordinated flight track. The modifications will be determined 6 – 12 hrs prior to flight using short term meteorological forecasts. Longer-range meteorological forecasts (greater than 12 hrs) are too inaccurate to adequately specify the location of these phenomena.

4.3 Arctic Zone

The Arctic Zone flight will be bounded within the Anchorage Oceanic, Continental, and Arctic FIRs. The primary objective of the flight will be to sample air above 80°N latitude. Flight #6 on Figure 2 shows the proposed flight route for the Global Hawk to ingress / egress the Arctic Zone. Generally, the Global Hawk will transit over the Pacific Ocean and the state of Alaska. Once in the Arctic Zone, transects will be flown that will be contained within the US controlled FIR.

Detailed mission and contingency planning along with a substantial hazard and risk analysis will be conducted for the over-flight of Alaska that utilizes Global Hawk mission plans that have already been conducted in this airspace. Unlike other Global Hawk aircraft, the NASA AV-6 Global Hawk utilizes a multi-channel iridium command and control system that provides global coverage including polar regions.. A notional flight route across Alaska is shown in Figure 4. This route is optimized to avoid population areas and keep the aircraft within glide distance of either special use airspace or the ocean.

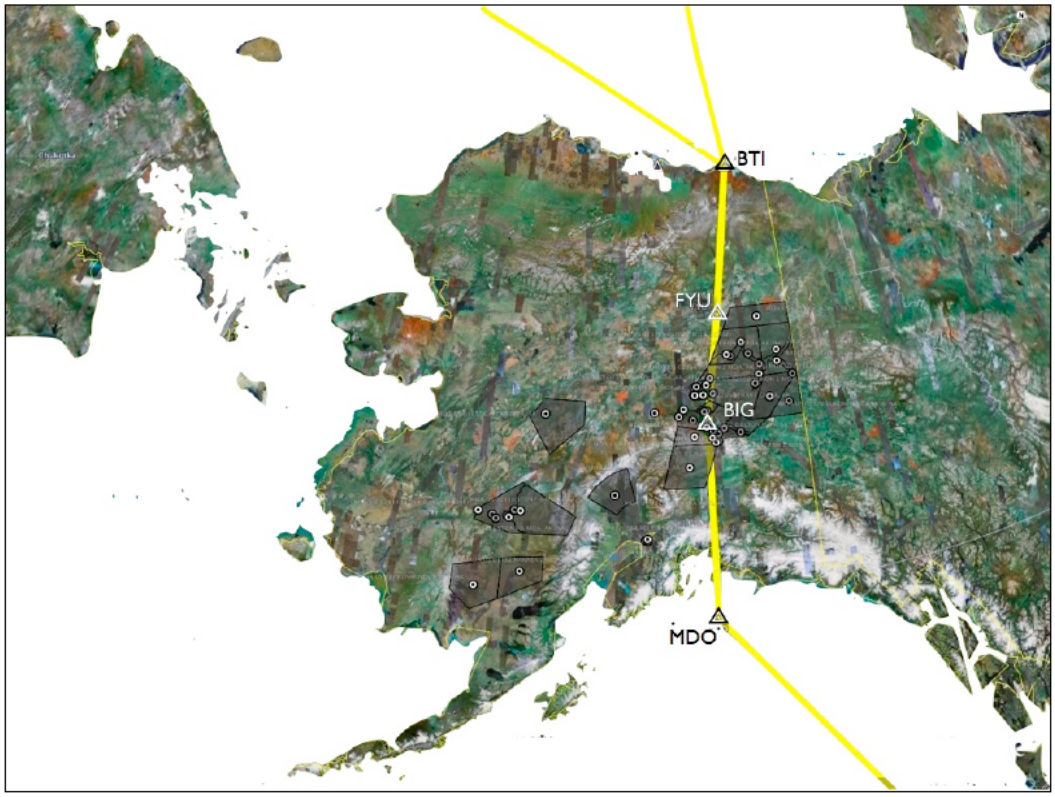


Figure 4. Notional Alaska Routing to the Arctic Zone

(b) (3) (A), (b) (3) (B)

[redacted]

(b) (3) (A), (b) (3) (B)

[redacted]

4.5 Flight Track Deviations

During GloPac Missions, flight track deviations will be requested to study real time meteorological phenomena. It is expected that 3-5 deviations will be required per

flight. Deviations will be coordinated with the appropriate FAA facility during the mission. Deviations will be characterized by the following:

a. Course deviations that move the aircraft up to 200 nm from the submitted fight track

b. Vertical profiles from cruise altitude to FL430

(b)(3)(A), (b)(3)(B)

[redacted]

(b) (3) (A), (b) (3) (B)

[redacted]

(b)(3)(A), (b)(3)(B)

[redacted]

7 Summary

The purpose of the document has been to explain how NASA DFRC proposes to conduct flights of the Global Hawk during the GloPac Mission and why flexibility in specifying and approving flight tracks is needed in order for the GloPac science objectives to accomplished.

Ideally, flight coordination for the Pacific Zone will take place 48 hours prior to flight, the IFR flight plan will be filed 2-4 hours before flight, and flights will be able to take place anywhere within Oakland Oceanic FIR. A few (3-5) Vertical Profiles down to FL430 would take place on each flight. Real-time deviations during the flight would also be requested. For the Arctic Zone, flight coordination would take place one week prior to the flight.