

The Waypoint Planning Tool: Real Time Flight Planning for Airborne Science

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ABSTRACT

Airborne real time observations are a major component of NASA's Earth Science research and satellite ground validation studies. For mission scientists, planning a research aircraft mission within the context of meeting the science objectives is a complex task because it requires real time situational awareness of the weather conditions that affect the aircraft track. Multiple aircraft are often involved in the NASA field campaigns. The coordination of the aircraft with satellite overpasses, other airplanes, and the constantly evolving dynamic weather conditions often determine the success of the campaign. A flight planning tool is needed to provide situational awareness information to the mission scientists and help them plan and modify the flight tracks successfully.

Scientists at the University of Alabama-Huntsville and the NASA Marshall Space Flight Center developed the Waypoint Planning Tool (WPT), an interactive software tool that enables scientists to develop their own flight plans (also known as waypoints) with point-and-click mouse capabilities on a digital map filled with real time raster and vector data. The development of this Waypoint Planning Tool demonstrates the significance of mission support in responding to the challenges presented during NASA field campaigns. Analyses during and after each campaign helped identify both issues and new requirements, initiating the next wave of development. Currently the Waypoint Planning Tool has gone through three rounds of development and analysis processes.

The development of this waypoint tool is directly affected by the technology advances on GIS/Mapping technologies. From the standalone Google Earth application and simple KML functionalities to the Google Earth Plugin and Java Web Start/Applet on web platform, as well as to the rising open source GIS tools with new JavaScript frameworks, the Waypoint Planning Tool has entered its third phase of technology advancement. The newly innovated, cross-platform, modular designed JavaScript-controlled Way Point Tool is planned to be integrated with the NASA Airborne Science Mission Tool Suite. Adapting new technologies for the Waypoint Planning Tool ensures its success in helping scientists reach their mission objectives.

This presentation will discuss the development processes of the Waypoint Planning Tool in responding to field campaign challenges, identifying new information technologies, and describing the capabilities and features of the Waypoint Planning Tool with the real time aspect, interactive nature, and the resultant benefits to the airborne science community.

MOTIVATION

- Airborne and spaceborne flights require well-developed flight plans
 - Includes waypoint location and time, flight pattern over target area, flight duration, etc.
 - Emphasizes coordination between aircraft during planning
 - Can be quickly changed if conditions are changed
 - Uses real time data to assist flight planning
 - Emphasis on Web-based application is increasing
 - JavaScript-based Map Application is desirable
- No easy tools available for Mission Scientists
 - Aircraft navigation tool (FalconView) not suitable for mission planning
 - Other planning tools relied on Excel-type functions rather than point-and-click to create flight plans

CAPABILITIES

- Easily creates, updates, and publishes flight waypoints
- Provides situation awareness data, such as real time satellite imagery, satellite tracking, storm tracking, etc.
- Helps flight coordination between multiple aircraft and multiple users
- Delivers new plan to user via NASA's Real Time Mission Monitor (companion situational awareness tool)
- Modular design that can be easily extended for adding components
- New JavaScript-based Web Application is developed
- Allows creating, updating multiple flight plans at the same time within one application

SUMMARY

- Waypoint Planning Tool provides a convenient way to create and update flight plans using a point-and-click mouse interface
- Assists in the coordination among multiple aircraft during pre-flight planning
 - Real time data are used to help mission planners to make immediate decisions
 - Fits the need of various users, including Mission Scientists, Mission Managers, Pilots, and others
 - Permits multiple waypoint input formats and can create multi-formatted output, as requested. Output formats include KML for visualization and Falcon View, a navigation tool widely used by Pilots
 - Used in several multi-agency field campaigns for flight planning
 - Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS): March-July 2008, NASA
 - Marshall Airborne Polarimetric Imaging Radiometer (MAPIR): September-October 2008, NASA
 - Genesis and Rapid Intensification Processes (GRIP): July - September 2010, NASA, NOAA, NSF/NCAR, AF Reserve
 - Mid-latitude Airborne Cirrus Properties Experiment (WSPAR), Feb-Mar, 2011
 - MIZOPEX Dry Run 2012, NASA



During 1990s and early 2000s, mission scientists could use an Excel spreadsheet to calculate the Way Point parameters for aircraft flights. After Google Earth appeared, mission scientists would select their way points in Google Earth and then put their coordinates in Excel to calculate time, distance, etc. Each time a point was changed, the new values would have to be re-entered into the Excel spreadsheet.

| # | Lat | Lon | Speed | Alt | Alt | Delay | UTC | Local | Leg | Cum Leg | Dist | Cum Dist | Dist | Cum Dist |
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| 3 | 27.128 | -92.420 | 51 | No | 7619 | 20000 | 7 | 14.00 | 06.00 | 00.00 | 00.00 | 0 | 0 | 0 |
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| 5 | 29.867 | -91.640 | 51 | No | 7619 | 20000 | 7 | 14.00 | 06.00 | 00.00 | 00.00 | 0 | 0 | 0 |
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| 43 | 29.867 | -91.640 | 51 | No | 7619 | 20000 | 7 | 14.00 | 06.00 | 00.00 | 00.00 | 0 | 0 | 0 |
| 44 | 29.867 | -91.640 | 51 | No | 7619 | 20000 | 7 | 14.00 | 06.00 | 00.00 | 00.00 | 0 | 0 | 0 |
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As the web technologies advance, the client-side JavaScript-based map applications that work in a wide variety of web browsers are gaining momentum. This new Way Point Tool is developed on top of DoJo JavaScript framework and OpenLayers Map APIs. With built-in layer management and map projection capabilities, this Way Point Tool can be tightly integrated with RTMM and other web applications, as well as with web-based Content Management Systems.

| # | Altitude | Speed | Dist | Leg Distance | Leg Time | Dist/Altitude | Time/Alt | LineColor | Comment |
|---|----------|-------|------|--------------|----------|---------------|----------|-----------|---------|
| 1 | 20000 | 400 | 10 | 0 | 00:00:00 | 0 | 00:00:00 | Red | |
| 2 | 20000 | 400 | 10 | 200.000 | 00:07:30 | 200.000 | 00:07:30 | Red | |
| 3 | 20000 | 400 | 10 | 210.418 | 00:08:27 | 210.418 | 01:28:58 | Green | |
| 4 | 20000 | 400 | 10 | 246.548 | 00:43:08 | 446.548 | 02:08:14 | Green | |
| 5 | 20000 | 400 | 10 | 170.747 | 00:13:20 | 446.548 | 02:40:38 | Green | |



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