

SWA Environment Laser Division: In-flight Lidar Integrated Mission Management System (I-LIMMS)

Beginning in 2005, Simpson Weather Associated began working with the [Navy's Office of Naval Research \(ONR\)](#) to develop an In-flight Lidar Integrated Mission Management System (I-LIMMS) that provides real-time 4-D visualization of airborne Doppler Wind Lidar (DWL) data aboard an aircraft as well as a real-time system to manage both the mission flight strategy and the lidar scanning strategy. A SBIR Phase I feasibility study was completed in December 2006 and a SBIR Phase II was completed in December 2011.

I-LIMMS Phase I SBIR results include:

- Evaluation of Commercial Off The Shelf (COTS) data display software for real-time and visualization and analysis of DWL data---The choice was made to go with Google Earth as the display environment.
- Identified all hardware and software requirements and defined a testbed for prototyping I-LIMMS and data benchmarking.
- Through this feasibility study, SWA concluded that the I-LIMMS, while representing unique and original ideas in the use of DWL data in flight, was both doable technically and cost wise during a Phase II effort.

Preliminary results and products of the I-LIMMS Phase II development:

Using Google Earth as a display, SWA together with [WxAnalyst](#) developed software to provide real-time 4-d real-time visualization of DWL data with interactive mission management options/scenarios as well as on-screen guidance for in-flight mission operations and decisions such as the positioning of aircraft and instrumentation to meet stated mission objectives

(i.e., selecting the level to fly to intercept wind shear, aerosol and cloud features).

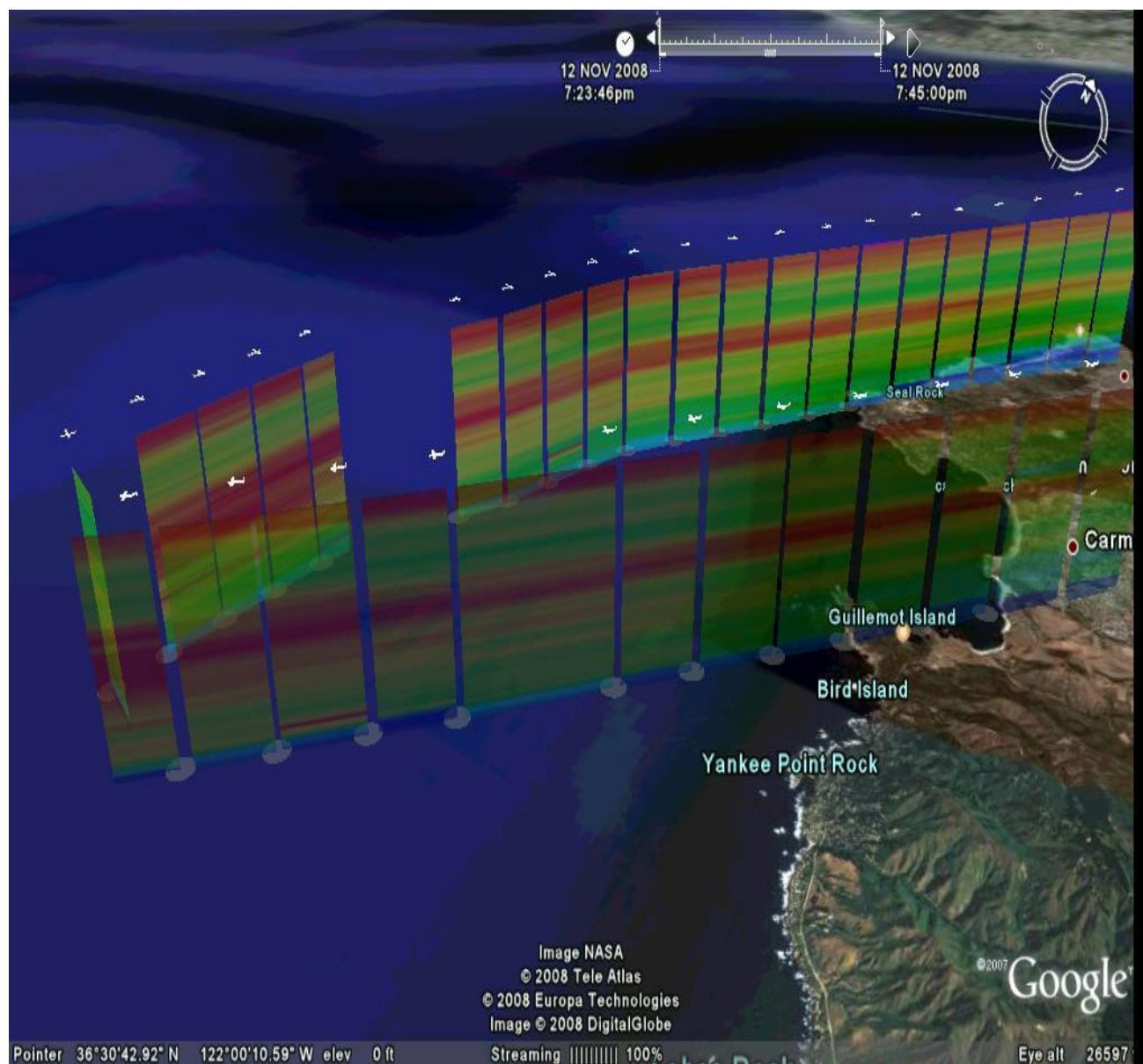
Over the past ten years, the Integrated Program Office (IPO) of NPOESS (National Polar-orbiting Operational Environmental Satellite System) has funded the use of an airborne coherent DWL initially mounted in a Navy Twin Otter aircraft to conduct a variety of investigations. Since 2002, under the direction of SWA and operated by the Navy's Center for Interdisciplinary Remotely Piloted Research Studies (CIRPAS), this Twin Otter Doppler Wind Lidar or TODWL has flown more than 125 hours of atmospheric missions with most of that over the Pacific Ocean and within 50 km of the shore near Monterey, CA.

SWA has used this wealth of airborne lidar data to develop various and adaptive strategies of visualizing lidar data within Google Earth. The TODWL can measure both wind and aerosol (in the form of SNR) and data processing algorithms have been developed by SWA to create vertical profiles along the flight path (time resolutions as small as every minute) as well as instantaneous line of sight (LOS) wind velocities and SNR along the path of each lidar shot, which can be in any direction from the aircraft.

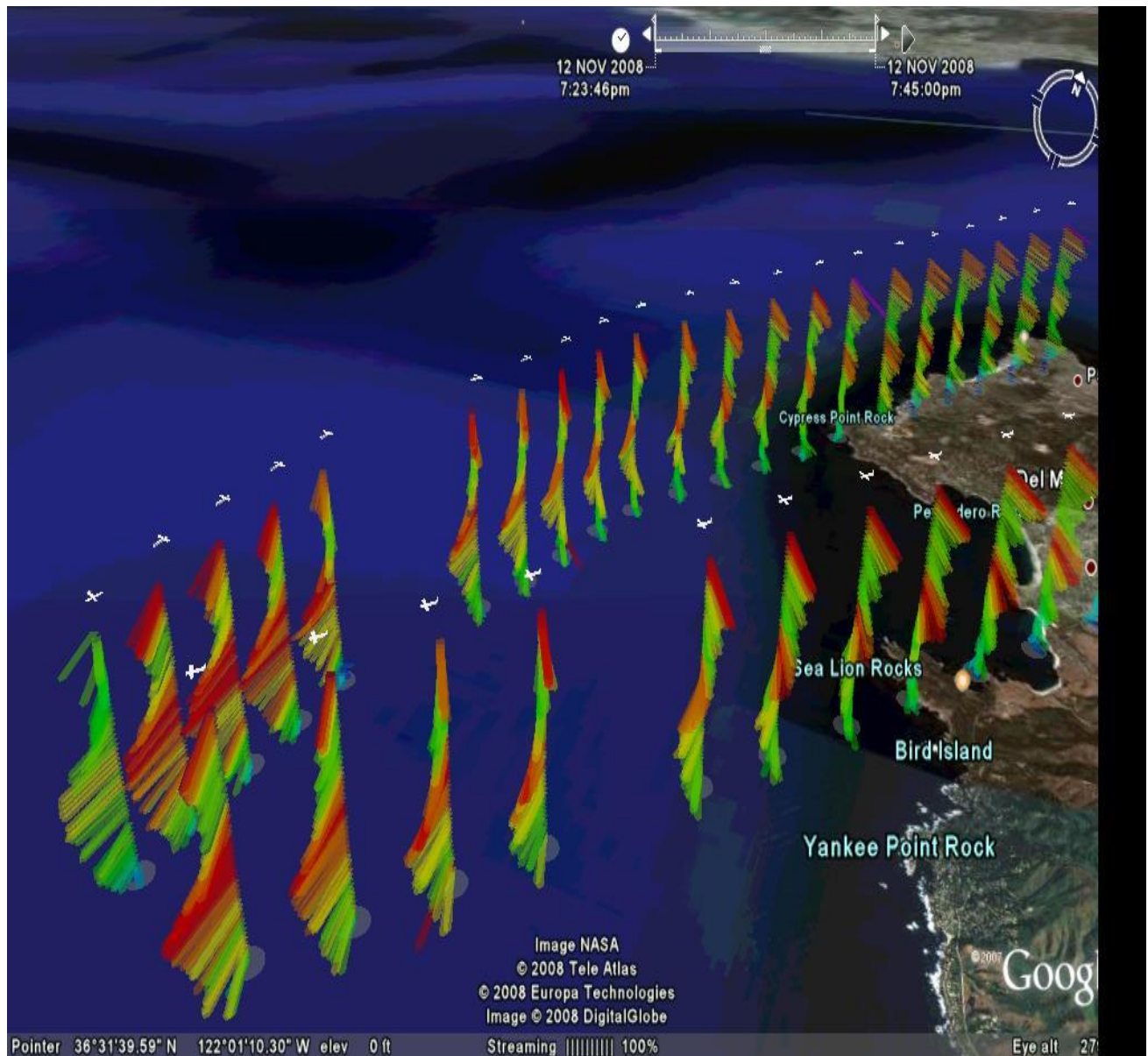
Visualization examples of vertical profiles

Examples of the visualization of wind profiles data taken on November 12th, 2007 near Monterey, CA are provided below. Both wind speed and wind direction (flags) are presented. Also included in these visualizations are the location of the aircraft and the ground coverage.

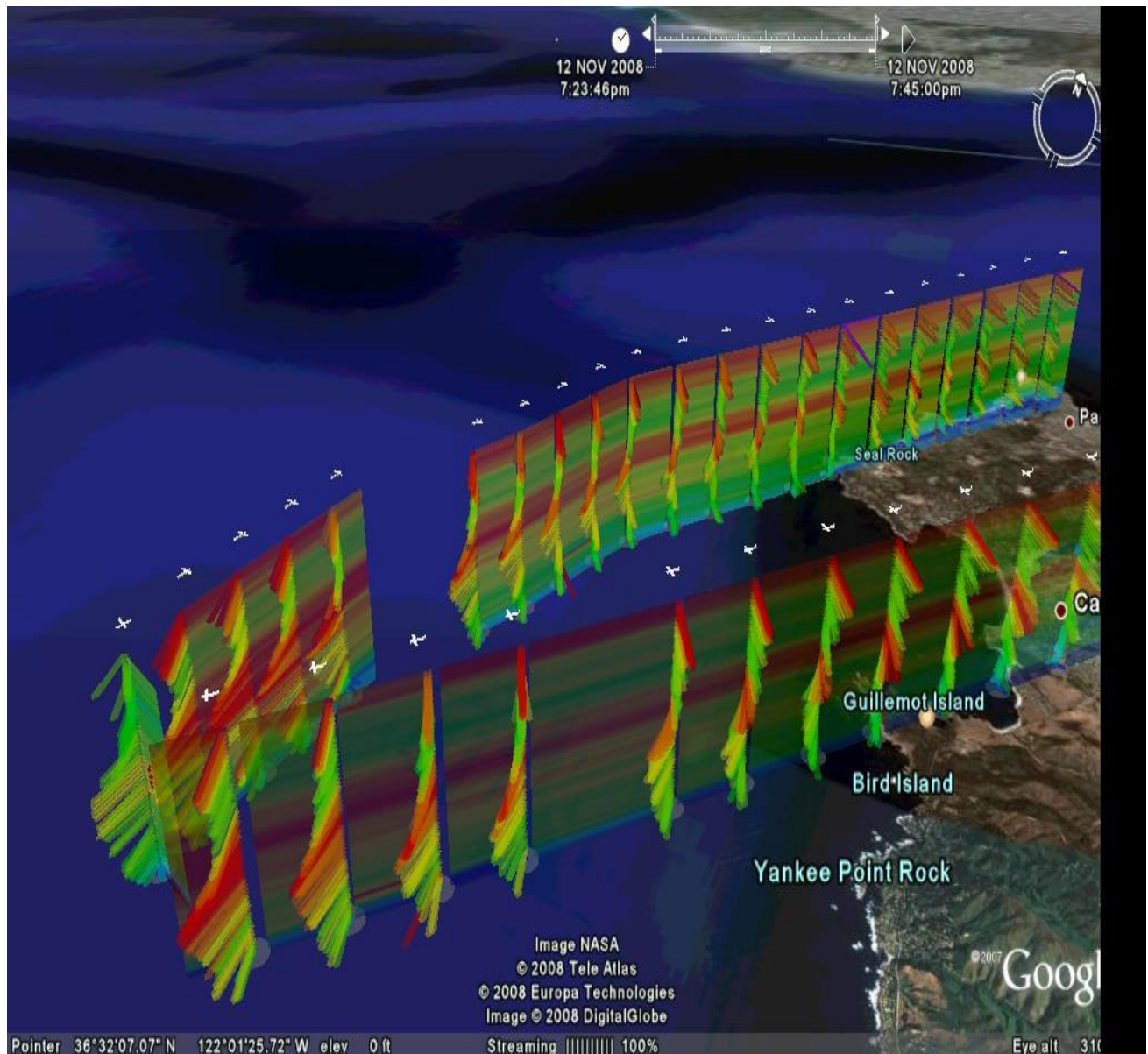
Wind Speed



Wind Flags (wind speed and direction)



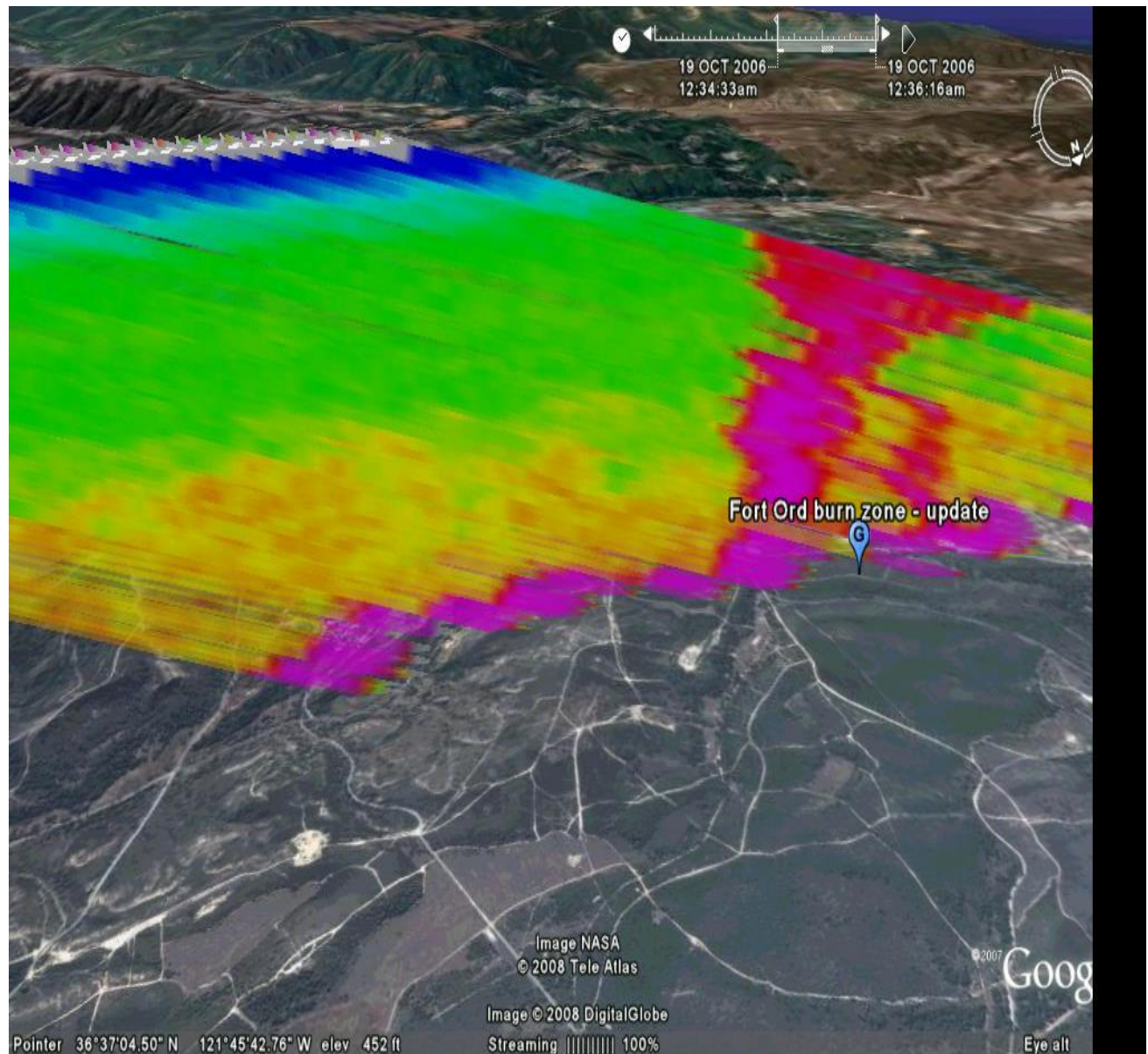
Wind Speed and Wind Flags



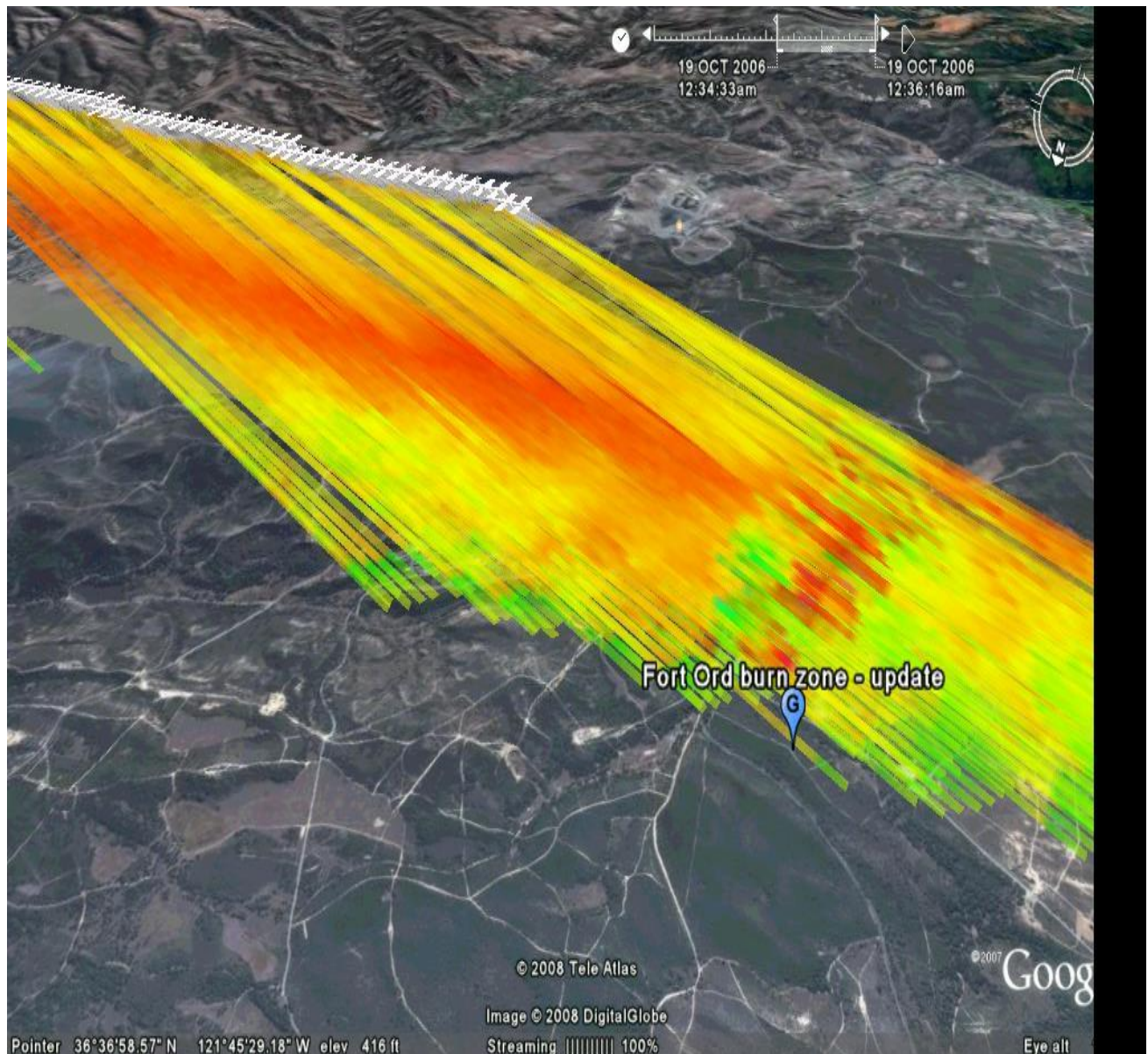
Visualization examples of raster or shot data

Examples of the visualization of LOS wind and aerosol (SNR) "raster" data taken on October 26, 2007 near Monterey, CA are provided below. It should be noted that on this afternoon, the aircraft flew over a prescription burn near Fort Ord, CA. This feature is clearly evident in presentations below.

Aerosol (SNR)



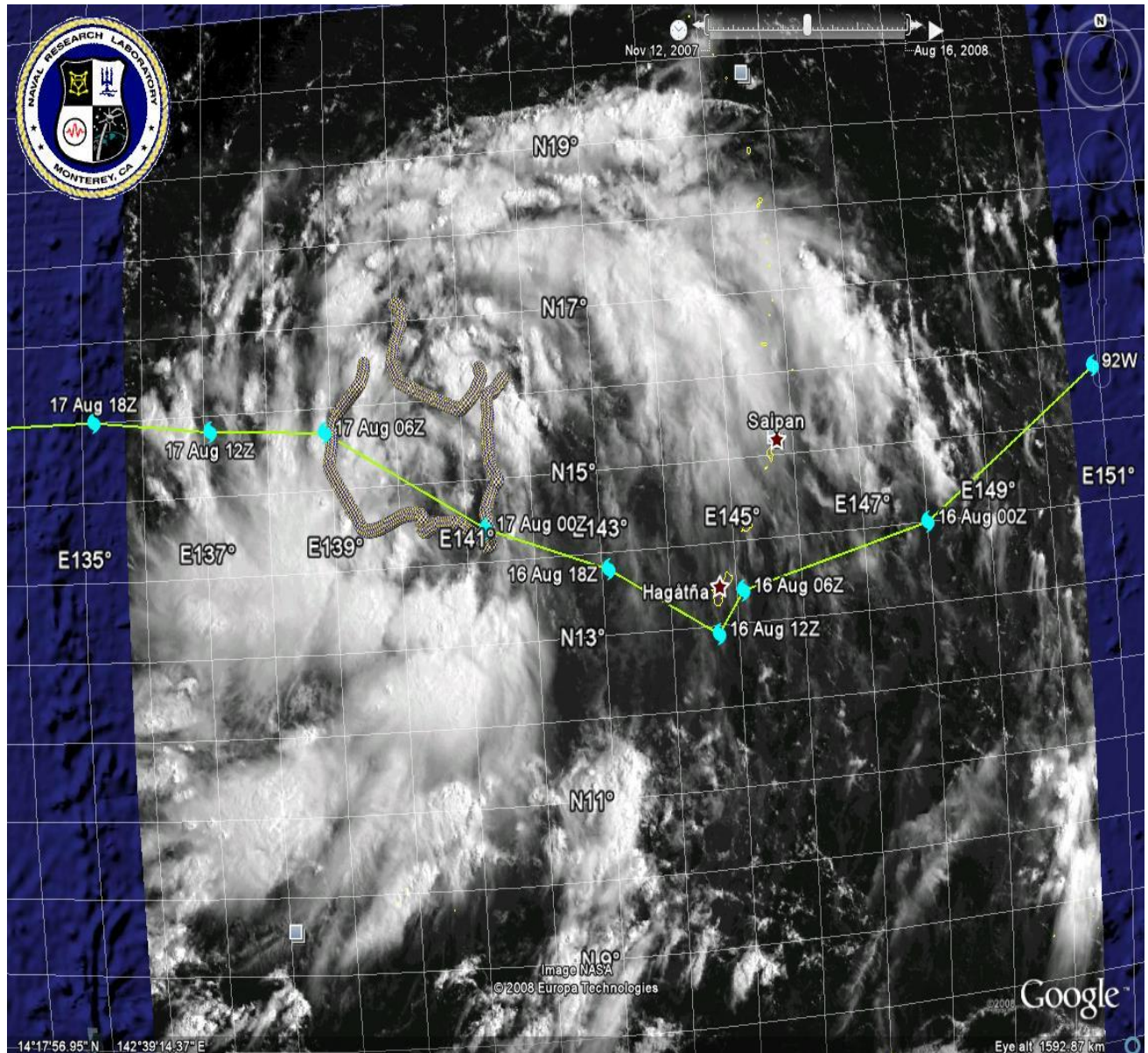
Wind Speed (LOS)

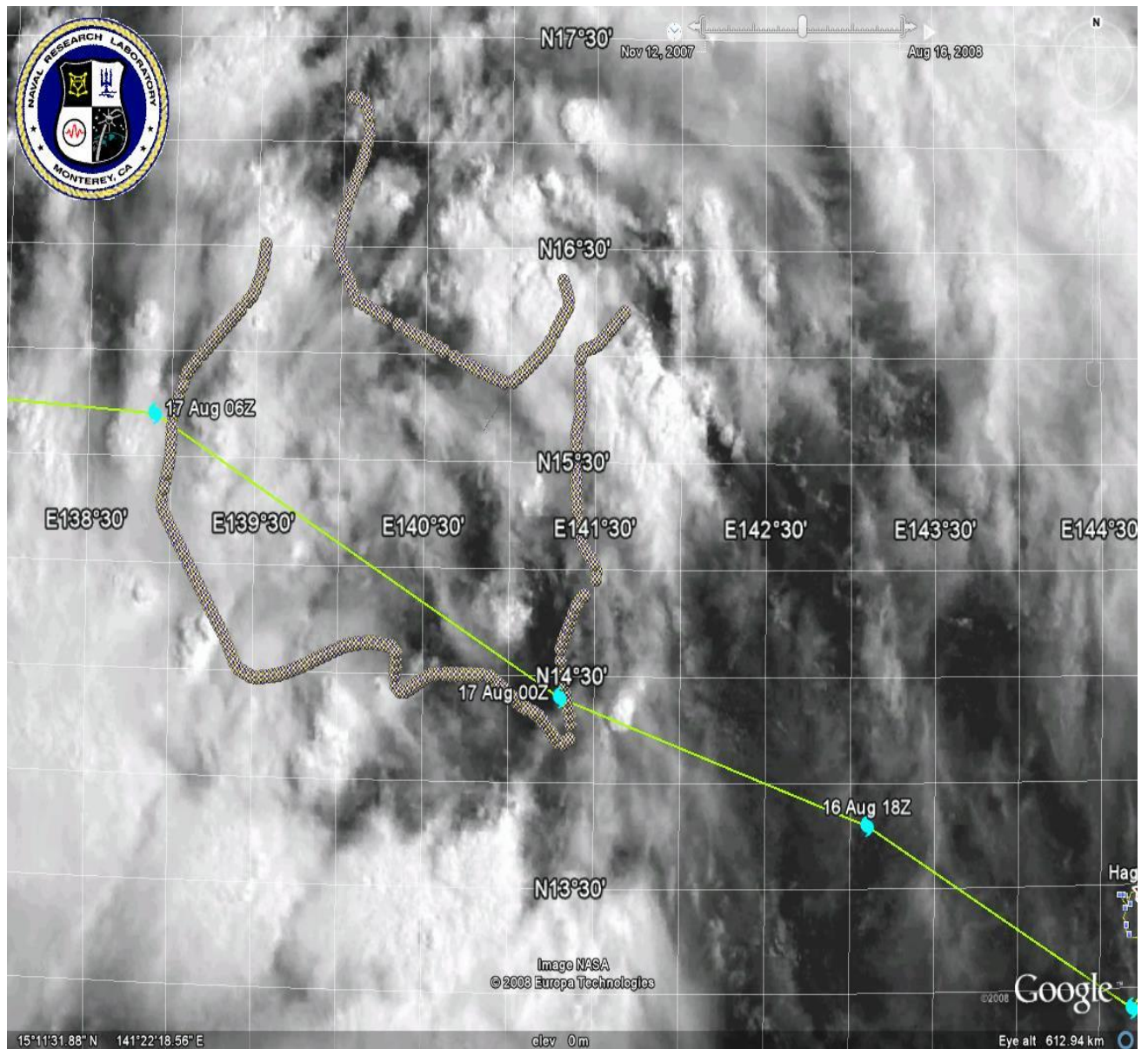


I-LIMMS and Google Earth visualization of airborne DWL data taken during the 2008 TPARC Experiment

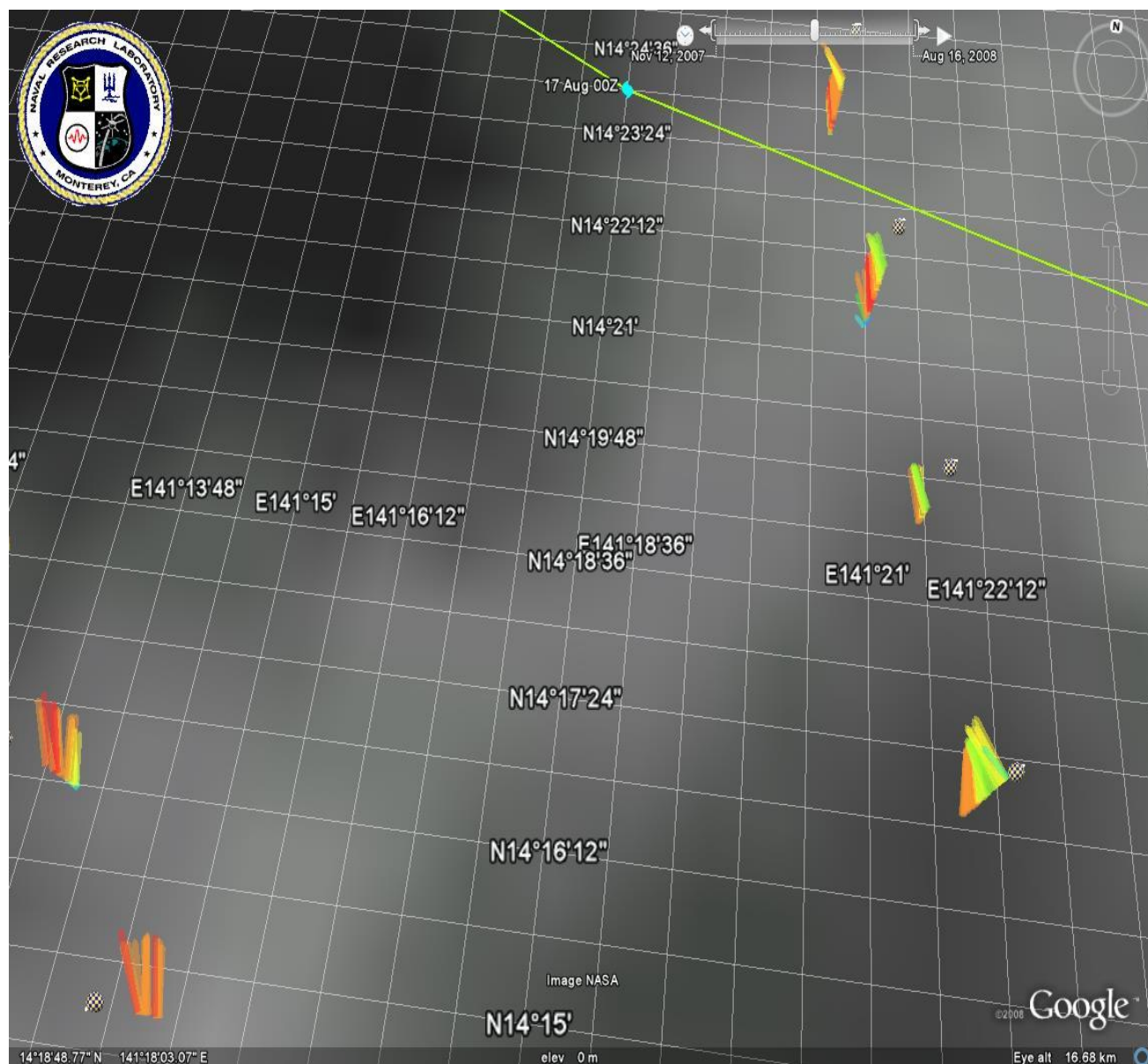
The DWL was flown aboard a P3 aircraft in the western Pacific Ocean as part of the 2008 TPARC field experiment. One of the

initial missions occurred on August 16th-17th, 2008 around Tropical Cyclone Nuri. The two image below show different perspectives of the METOP-A 2352Z large scale cloud field, the track of Nuri and the P3 aircraft track between August 16th 23Z and August 17th 03Z visualized on Google Earth.





Below are a few examples of the wind profiles taken during the mission and visualized by the Google Earth and I-LIMMS software:





Nov 12, 2007

Aug 16, 2008

N14°25'48"

E141°23'24"

N14°24'36"

E141°22'12"

E141°21'

N14°23'24"

E141°19'48"

17 Aug 00Z

N14°22'12"

E141°18'36"

N14°21'

E141°17'24"

Image NASA

Google

14°23'04.53" N 141°19'53.77" E

elev 0 m

Eye alt 8.63 km