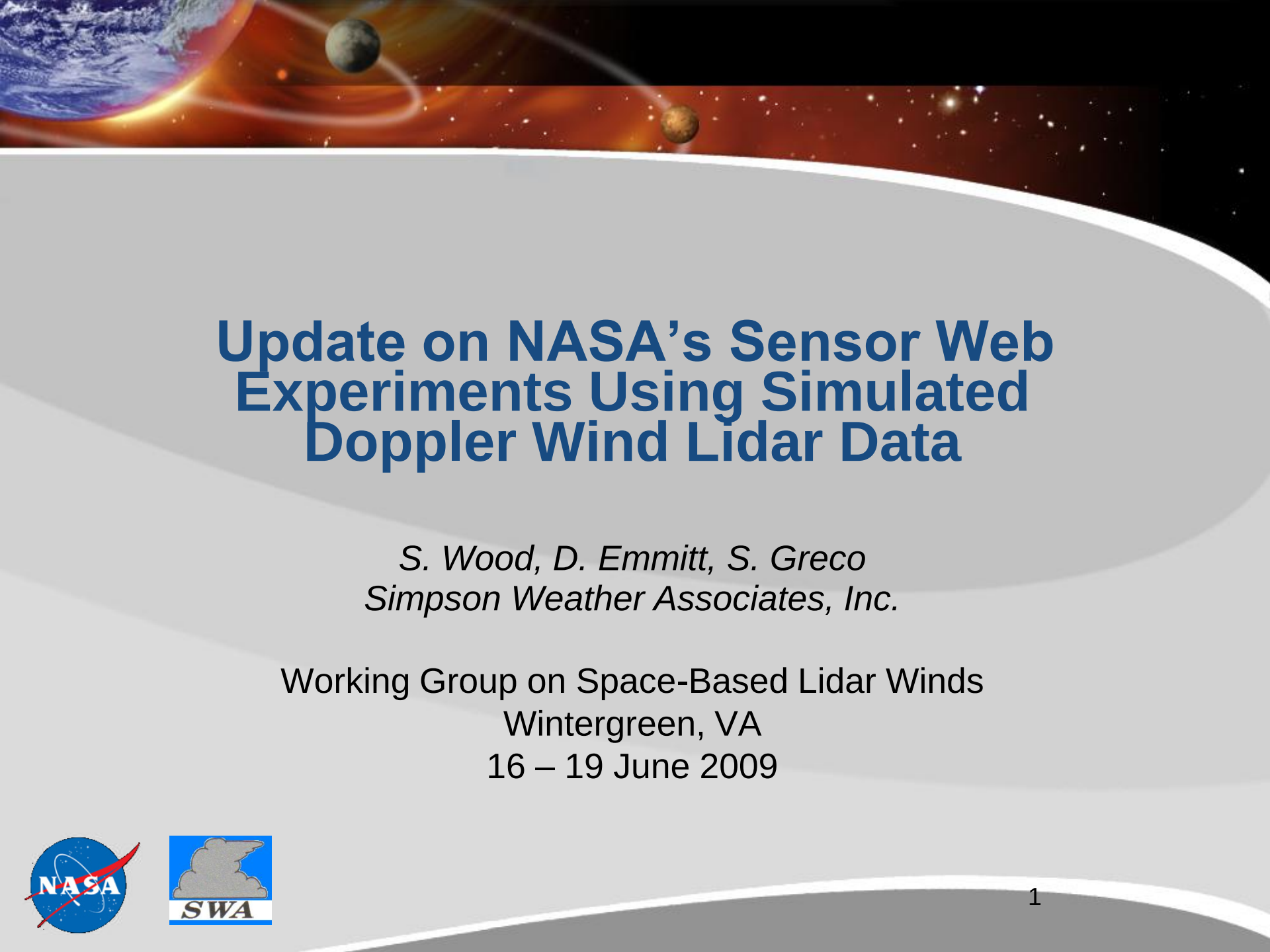




Update on NASA's Sensor Web Experiments Using Simulated Doppler Wind Lidar Data

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SENSOR WEB

A model-driven sensor web is an Earth observing system that uses information derived from data assimilation systems and numerical weather prediction models to drive targeted observations made from earth-orbiting spacecraft as well as from atmospheric- and ground-based observing systems.



Project Goals

Demonstrate the value of implementing sensor web concepts for meteorological use cases

Quantify cost savings to missions

Quantify improvement in achieving science goals

Design and Build an integrated simulator with functional elements that will allow multiple “what if” scenarios in which different configurations of sensors, communication networks, numerical models, data analysis systems, and targeting techniques may be tested

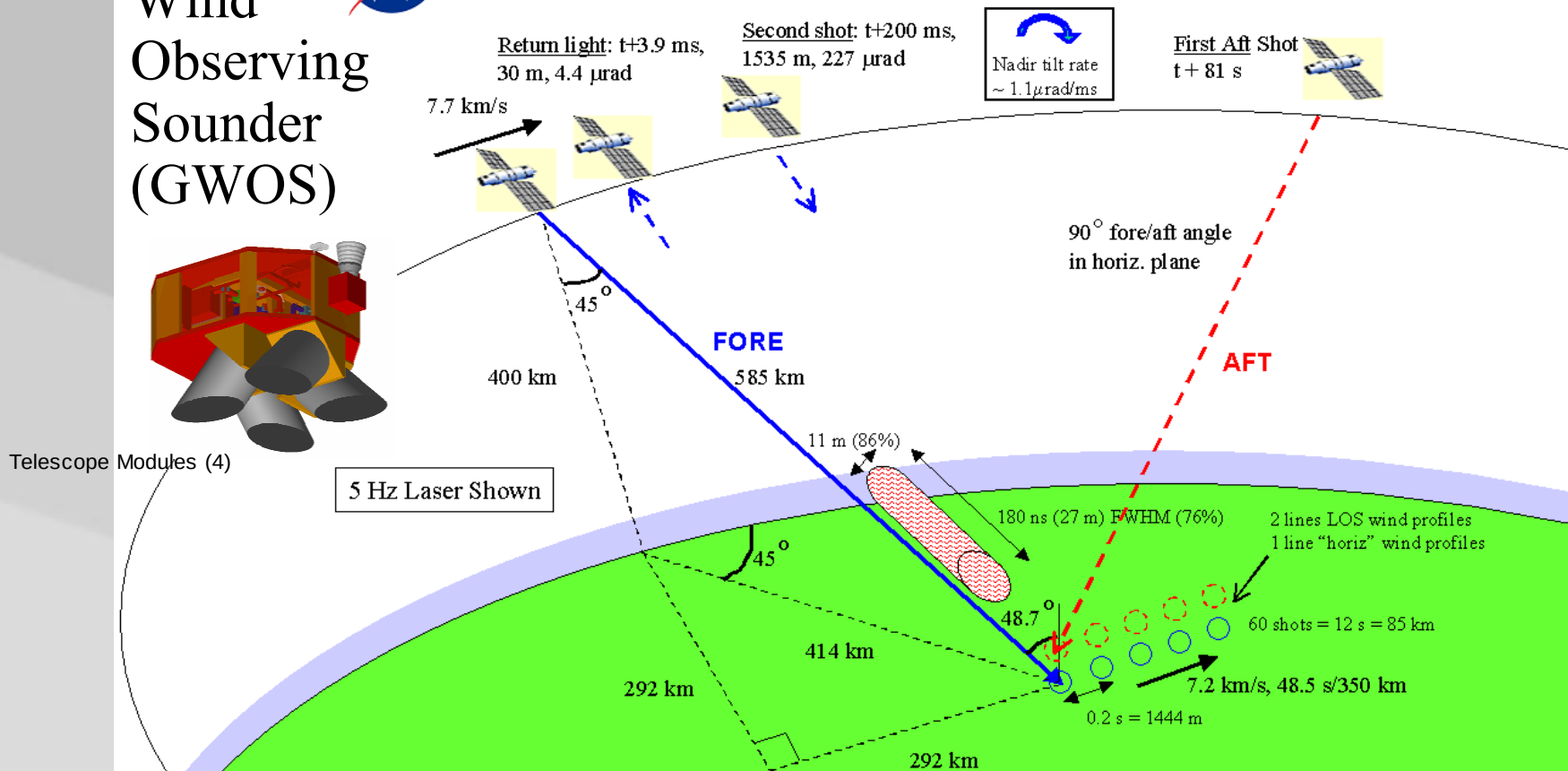


Use Case: Decadal Survey
Mission 3D Wind Lidar

Global
Wind
Observing
Sounder
(GWOS)



Orbiting GWOS at 400 km



Source: Kakar, R., Neeck, S., Shaw, H., Gentry, B., Singh, U., Kavaya, M., Bajpayee, J., 2007: "An Overview of an Advanced Earth Science Mission Concept Study for a Global Wind Observing Sounder".

Application of Sensor Web Concepts

- **Simulation 1: Extend Mission Life via Power Modulation**
- Conserve power / extend instrument life by using aft shots only when there is “significant” disagreement between model first guess line-of-sight winds and winds measured by fore shots
 - Lidar engineers have recently suggested reduced duty cycles may increase laser lifetimes
 - Duty cycles that are on the order of 10 minutes “on” and 80 minutes “off” may be very beneficial to mission lifetime
- Will require model’s first guess fields be made available on board the spacecraft -- requires engineering trades be performed for on-board processing, storage, power, weight, communications



Application of Sensor Web Concepts

- **Simulation 2: Better Science via Targeted Observations**
- Goal is to target two types of features to help improve predictive skill:
 - “Sensitive regions” of the atmosphere: those regions where the forecast is highly responsive to analysis errors
 - Features of interest that may lie outside of the instrument’s nadir view
 - Tropical cyclones
 - Jet streaks
 - Rapidly changing atmospheric conditions
- Would require slewing
- Would require optimization to choose between multiple targets
- Studies have shown that targeted observations can improve predictive skill (difficult to implement operationally)

Source: D. Emmitt and Z. Toth, 2001: Adaptive targeting of wind observations:

The climate research and weather forecasting perspectives. Preprints, 5th Symposium on Integrated Observing Systems, AMS.

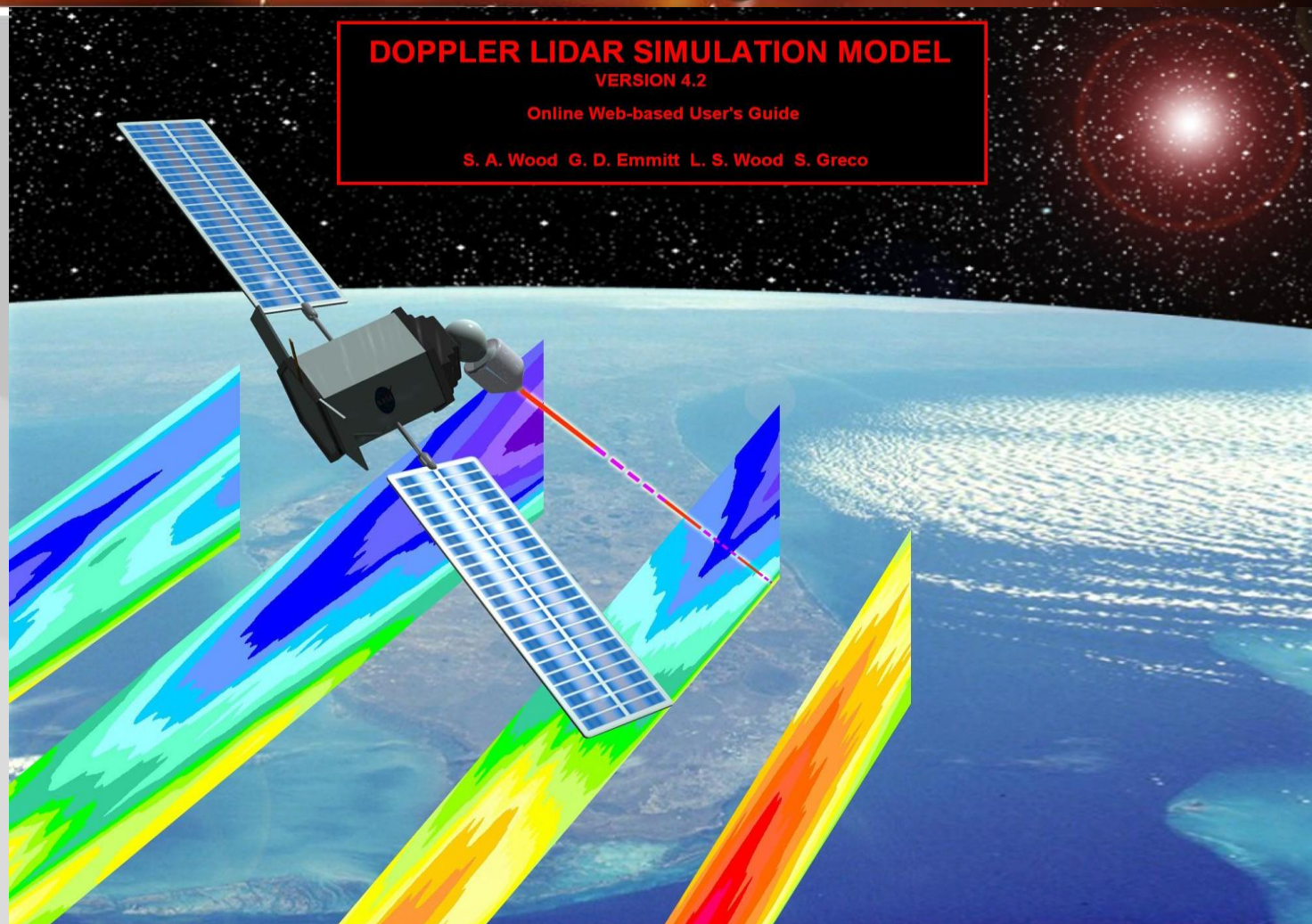


- **Sensor Web Simulator Design**
- 2007 Five separate Observing System Simulation Experiments (OSSEs) were conducted that concluded:
 - Under certain situations¹, the lidar duty cycle may be reduced 30% without impacting forecast skill
 - Under certain situations, having the model task the lidar to perform a roll maneuver improves detection of features of interest 30% (tropical cyclones, jet streaks, rapidly changing atmospheric conditions)
- 2008 **SIVO Workflow Tool (“NASA Experiment Design”)**
- Selected as the “glueware” to sequentially execute components and manage data flow

¹ The OSSEs performed were based upon a 20 day assimilation cycle during September 1999. Although the use cases have been examined by GMAO scientists they have not undergone a rigorous scientific review and the results should not be considered scientifically valid. OSSEs presented here are to validate engineering processes of the simulator.



DLSM

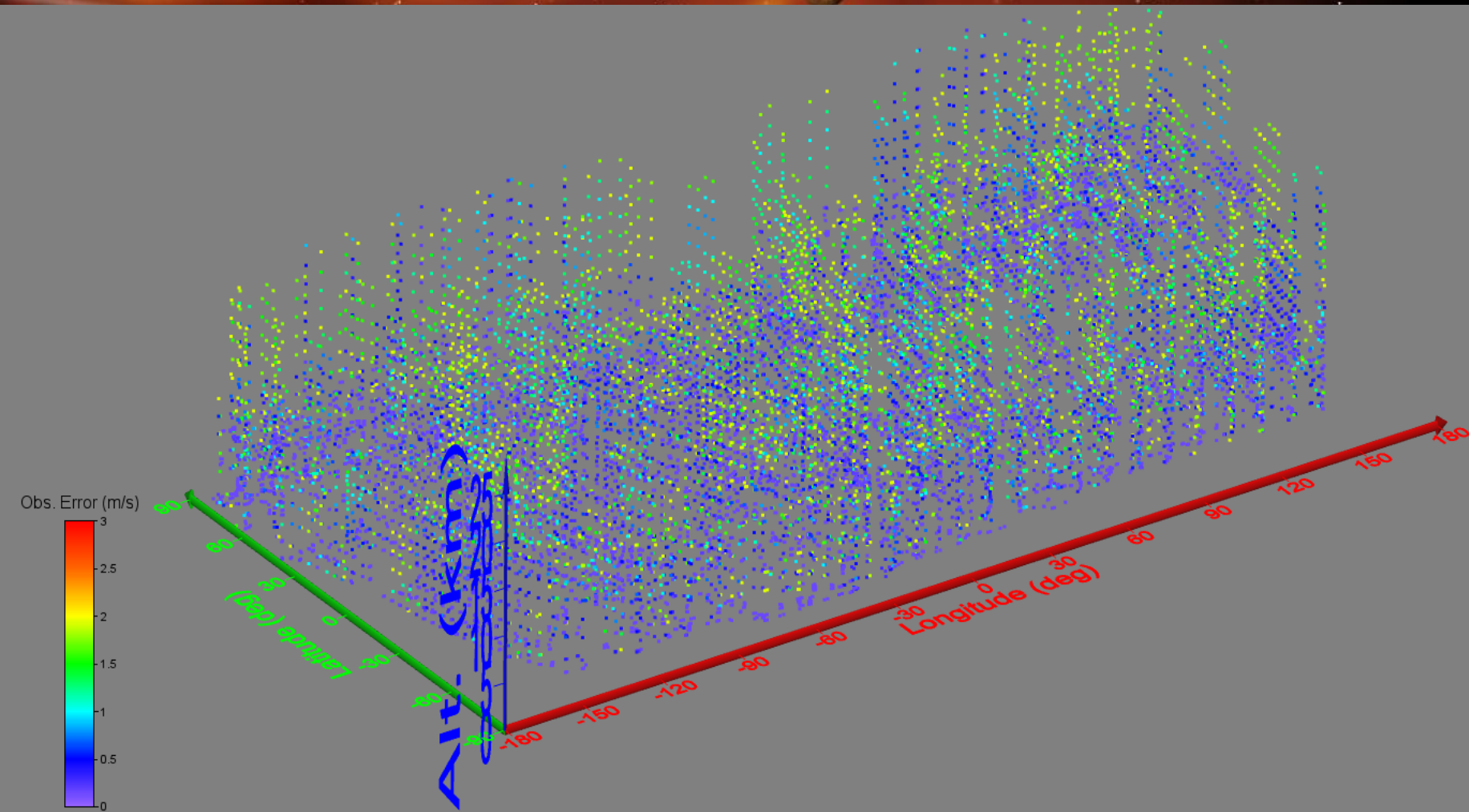


2008 RESULTS

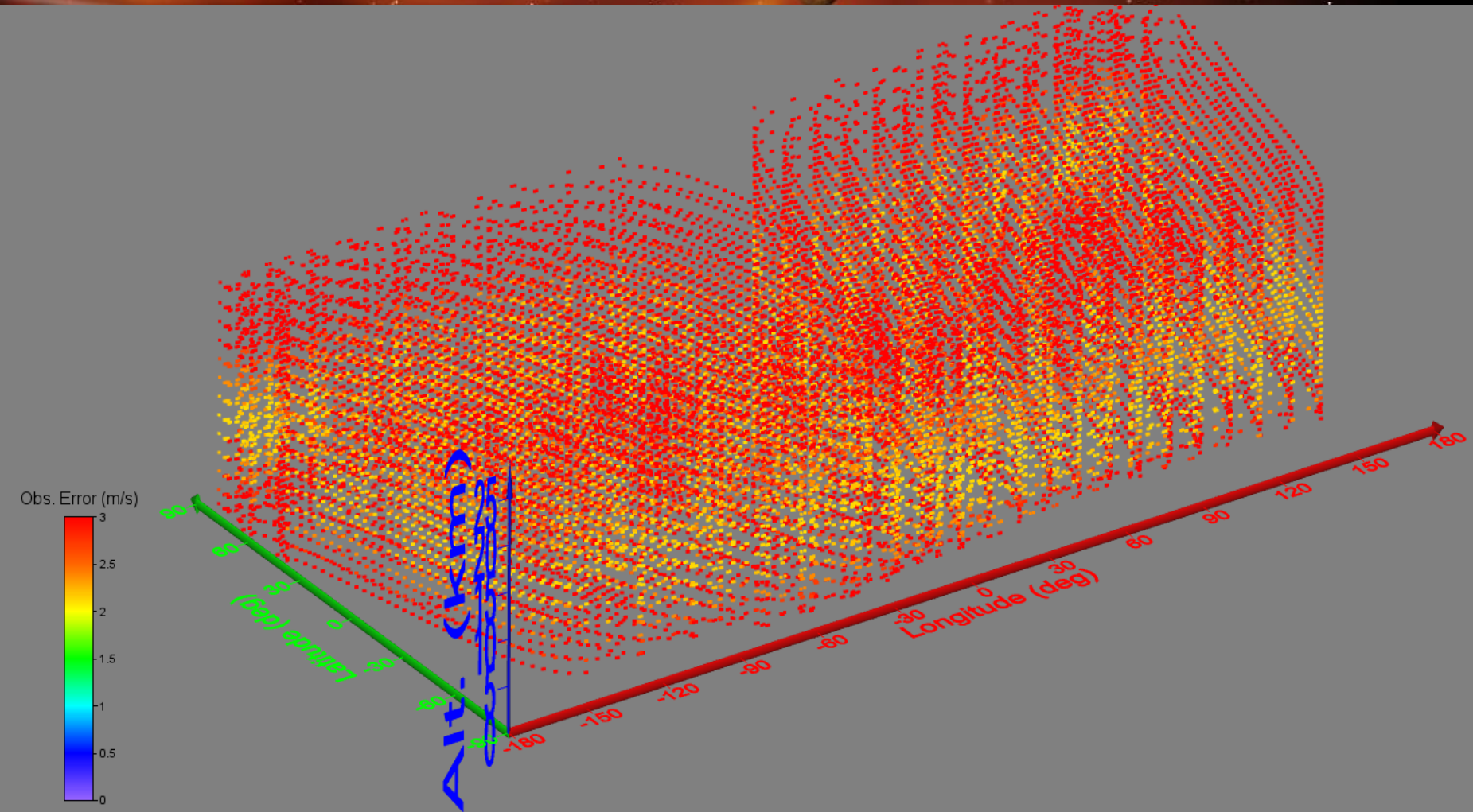
In Spring, 2008 Simpson Weather Associates, Inc. established the Doppler Lidar Simulation Model version 4.2 onto an Apple dual quad processor computer for the SensorWeb project. SSH, the network protocol that allows data to be exchanged over a secure channel between two computers, was installed and tested. SWA and SIVO were able to test the push/pull and communications functionality successfully. SIVO was able to push DLSM inputs to SWA and request model simulations. The DLSM was successfully executed and SIVO was able to retrieve DWL coverage and DWL line-of-sight wind products for a six hour simulation in less than 2 minutes.



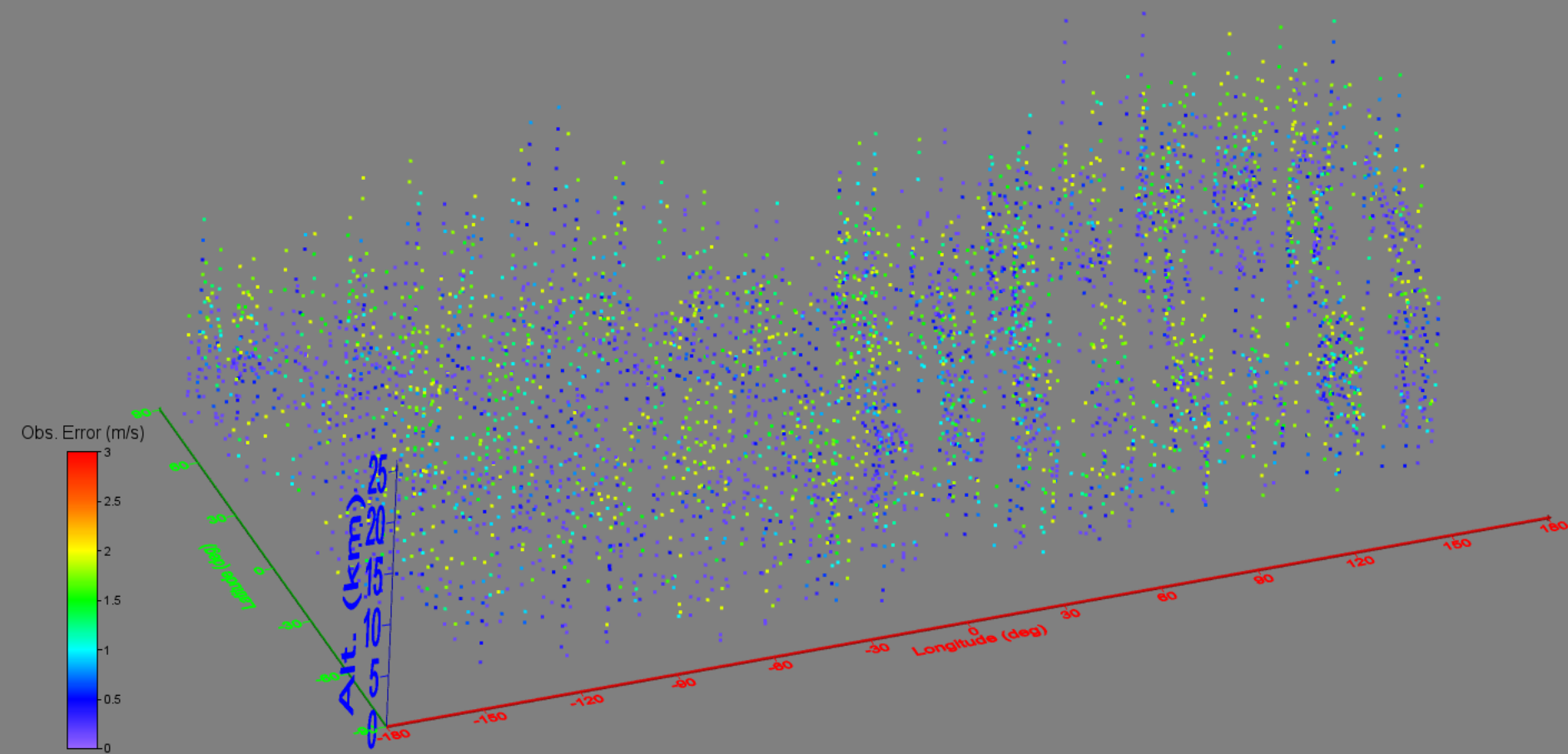
12 Hour Simulation of Coherent DWL LOS Winds



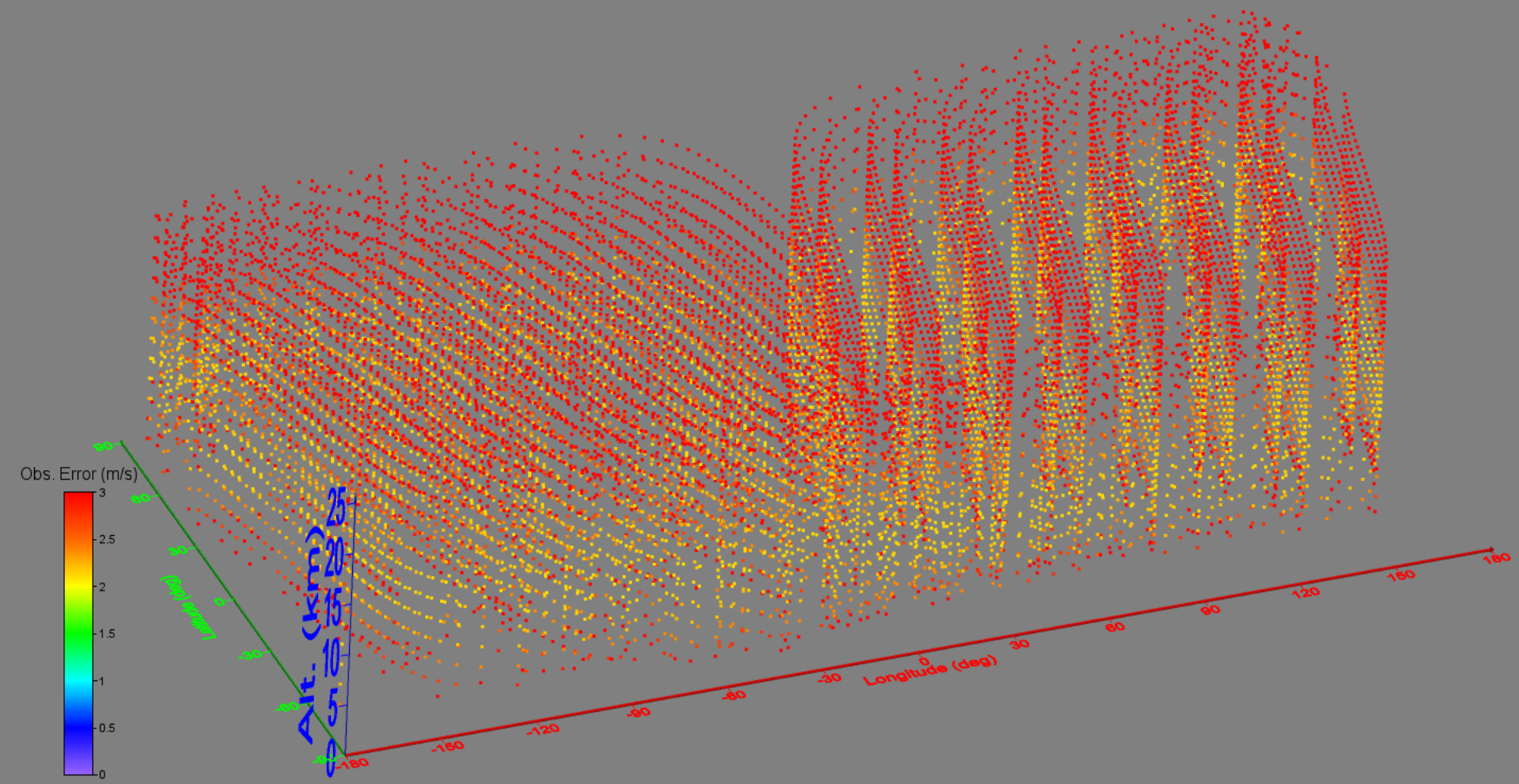
12 Hour Simulation of Direct Detection DWL LOS Winds



12 Hour Simulation of Coherent DWL U/V Winds



12 Hour Simulation of Direct Detection DWL U/V Winds



NEAR FUTURE PLANS

- Line of Sight wind operator for the assimilation models
- Integrate Satellite Toolkit into the workflow tool to provide satellite location and attitude inputs
- Establish the T511 and T799 nature runs into DLSSM database format including generating aerosol, molecular and cloud optical property databases
- Build the slewing capability into the scanner model
- Global / meso-scale (hurricanes) OSSE like experiments
- Adaptive Cloud Avoidance Scheme

