Coordinating Aircraft During Field Campaigns: Real Time Mission Monitor Tool

Presentation to Dynetics
18 October 2012
## Current Team Members

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Role</th>
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<tbody>
<tr>
<td>Richard Blakeslee</td>
<td>NASA MSFC</td>
<td>Co-Principal Investigator</td>
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<tr>
<td>Michael Goodman</td>
<td>NASA MSFC</td>
<td>Co-Principal Investigator</td>
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<tr>
<td>John Hall</td>
<td>UAHuntsville ESSC</td>
<td>Software Developer RTMM</td>
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<tr>
<td>Matt He</td>
<td>UAHuntsville ESSC</td>
<td>Software Developer Waypoint Tool</td>
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<tr>
<td>Michele Garrett</td>
<td>UAHuntsville ITSC</td>
<td>Systems Administrator</td>
</tr>
<tr>
<td>Paul Meyer</td>
<td>NASA MSFC</td>
<td>Systems Manager</td>
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<tr>
<td>Kathryn Regner</td>
<td>UAHuntsville ITSC</td>
<td>Systems Engineer</td>
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</table>
The Real Time Mission Monitor (RTMM) is an interactive visualization application that provides situational awareness and field asset management to enable adaptive and strategic decision making during airborne field experiments.

- Integrates satellite, airborne, and surface data sets
- Tracks airborne vehicle state information
- Displays model and forecast parameter fields
- Utilizes distributed Web-based architecture

To paraphrase the BASF™ television commercial:
“We don’t make the science, we make the science easier”
RTMM supports all phases of field experiments

• Pre-flight planning
  – Model and forecast fields
  – Satellite overpass predicts
  – Waypoint Planning Tool
• In-flight monitoring and adaptive flight strategies
  – Operations center focal point
  – Current weather conditions
  – Plane-to-plane data transfer
• Post-flight analyses, research, and assessments
  – Encapsulate and replay missions

Matt He works aboard the NASA DC-8 during a flight over the Gulf of Mexico, Tuesday, Aug. 17, 2010. Photo Credit: (NASA/Paul E. Alers)
RTMM User Base
“Making Science Easier”

RTMM available for use by user base that includes:

– Research Scientists
– Program and Project Managers
– Pilots and Flight Engineers
– Educators and Students
– Media and Public Affairs
– Science Attentive Public

RTMM (left) and aircraft observation (e.g., radar image of eye shown in right image) provided key “eyes” and guidance.

RTMM enables:

– Real time interactions and collaborations
– Post-flight mission review and case study development

RTMM used in the cockpit of the DC-8 during GRIP on September 6, 2010.
RTMM Features

“Making RTMM Better”

• Powerful science decision-making tool
  – Built upon a service oriented architecture
  – Seamlessly integrates multiple applications
  – Monitor and manage airborne assets in NASA Earth science ground validation and field campaigns

• Operate RTMM from a web portal
  – Use applications on a common framework for science data visualization and airborne mission management

• Simplify, enhance and expand the user interface and functionality
• Utilizes Google Earth (GE) Plug-in Applications Programming Interface

• Standard access methods for data, tools and services and to enable sharing of resources
  – e.g., Keyhole Markup Language (KML), Sensor Observation Service (SOS)

• Data Base Management System (DBMS)
  – Maintains information on local and remote data resources, tools and projects in a central, web accessible location
RTMM Components

**External Data Sources:** satellite, aircraft, surface data and models

**Server Side RTMM**
- Ingest, Archive & Processing
- Authentication Services
- Local XChat / IRC Services
- Catalog Services
- Data Services

**Local Data Sources**

**Data & Tools Catalog**

**Client Side RTMM 2nd Generation**
- Mission Designer
- 4D Virtual Globe (GE)
- Waypoint Planning Tool
- Web Viewer
- XChat / IRC Client
- Graphs
- Data & Tools Registration
• Multiple windows within the interface to support multi-tasking using different RTMM tools
• Many different layouts possible
• Easy set-up and configuration
• Integrates and displays multiple data sources & types, video and text
- Multiple windows within the interface to support multi-tasking using different RTMM tools
- Many different layouts possible
- Easy set-up and configuration
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Screen shot on 16 Sept as Global Hawk, WB-57, and DC-8 enter the Gulf of Mexico for a rendezvous with Hurricane Karl

18 October 2012
Arctic Research of the Composition of the Troposphere from Aircraft and Satellites
July 6, 2008
NASA DC-8 (red)
B200 (blue)
Global Precipitation Mission (GPM) Cold-season Precipitation Experiment (GCPEX)

January 28, 2012
NASA DC-8 (blue)
UND Citation (white)
CARE Radar underlay

18 October 2012
Spear small UAV flight at Langmuir Lab near Socorro NM August 18, 2012
Genesis and Rapid Intensification Processes
Hurricane Karl on September 16, 2012.
Seven aircraft fly over and through the storm as it approached Mexican coast.

Animation includes colorized IR and lightning flashes

18 October 2012
Dynetics / Stratolaunch
Hurricane and Severe Storm Sentinel
Tropical Storm Nadine in Atlantic on 14-15 September 2012

Global Hawk

Animation includes colorized IR and lightning flashes
## Collaborations & Synergies

**Supported field experiments since 2010**

<table>
<thead>
<tr>
<th><strong>Experiment</strong></th>
<th><strong>Aircraft Resources</strong></th>
<th><strong>Dates</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GloPac</strong> <em>(Global Hawk Pacific Mission)</em> – MSFC used this mission as an internal dry run for RTMM</td>
<td>NASA Global Hawk UAV</td>
<td>Apr 2010</td>
</tr>
</tbody>
</table>
| **Deepwater Horizon** *(Gulf of Mexico Oil Spill)*       | NASA ER-2  
NASA B200                                                                              | Apr – Sep 2010    |
| **GRIP** *(Genesis and Rapid Intensification Processes)* | NASA Global Hawk UAV  
NASA DC-8  
NASA WB-57  
Air Force Reserve C-130  
NOAA P-3  
NOAA Gulfstream IV  
NSF Gulfstream V | Aug – Sep 2010                  |
| **LPVEx** *(Light Precipitation Validation Experiment)*  | University of Wyoming King Air                                                        | Sep – Oct 2010    |
| **WISPAR** *(Winter Storms and Pacific Atmospheric Rivers)* | NASA Global Hawk UAV  
NOAA Gulfstream-IV                                                                        | Feb – Mar 2011    |
| **MACPEX** *(Mid-latitude Airborne Cirrus Properties Experiment)* | NASA WB-57                                                                              | Mar – Apr 2011    |
| **MC3E** *(Mid-latitude Continental Convective Clouds Experiment)* | NASA ER-2  
University of North Dakota Citation  
University of Tennessee Space Institute Piper Navajo                                       | Apr – Jun 2011    |
| **ACE** *(Arctic Collaborative Environment)*             | Coast Guard ships - virtual  
Search and Rescue planes - virtual                                                            | Prototype demo Oct 11 |
## Collaborations & Synergies
### Field Experiments in 2012

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Aircraft Resources</th>
<th>Dates</th>
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<tbody>
<tr>
<td><strong>GCPEX</strong> (Global Precipitation Mission, GPM Cold Season Precipitation Experiment)</td>
<td>NASA DC-8, University of North Dakota Citation</td>
<td>Jan – Feb 2012</td>
</tr>
<tr>
<td><strong>Nimbus</strong> National Science Foundation</td>
<td>Spear UAV</td>
<td>Apr &amp; Aug 2012</td>
</tr>
<tr>
<td><strong>HS3</strong> (Hurricane and Severe Storm Sentinel)</td>
<td>NASA Global Hawk UAVs</td>
<td>Sep – Oct 2012 - 2014</td>
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</table>
• RTMM has evolved into a powerful and easy to use application in support of planning, situational awareness and strategic decision-making during airborne field campaigns.

• NASA is very open to sharing these capabilities with any interested group through interagency collaborations in future field activities.
Thank you.

We welcome questions and discussion.
Backup Charts
The Arctic Collaborative Environment (ACE) is a Technology Demonstration project with DoD in partnership with NASA.

- Goal is to provide near real-time ice and climate information to DoD and all interested partners to support all types of arctic operations.
## Summary of Outreach Activities

<table>
<thead>
<tr>
<th>Date</th>
<th>Venue</th>
<th>Topic</th>
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</thead>
<tbody>
<tr>
<td>December 2009</td>
<td>AGU Winter Meeting session on Virtual Globes – John Bailey session chair</td>
<td>The 2nd Generation Real Time Mission Monitor (RTMM) Development</td>
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<tr>
<td>December 2010</td>
<td>Session IN07 Real Time Data at the Fall American Geophysical Union Meeting</td>
<td>Waypoint Planning Tool poster</td>
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<tr>
<td>March 2011</td>
<td>Interdepartmental Hurricane Conf. Miami</td>
<td>RTMM Presentation</td>
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<tr>
<td>March 2011</td>
<td>Ponca City, OK</td>
<td>RTMM overview and training for MC3E participants</td>
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<tr>
<td>June 2011</td>
<td>Earth Science Technology Forum</td>
<td>The 2nd Generation Real Time Mission Monitor (RTMM)</td>
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<tr>
<td>December 2011</td>
<td>Session IN51B Data Management Strategies for Airborne Science, Fall American Geophysical Union</td>
<td>RTMM Poster Presentation</td>
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<tr>
<td>June 2012</td>
<td>Earth Science Technology Forum</td>
<td>Waypoint Planning Tool</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<td>ACE</td>
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<td>AGU</td>
<td>American Geophysical Union</td>
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<td>AIST</td>
<td>Advanced Information Systems Technology</td>
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<td>American Meteorological Society</td>
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<td>ARCS</td>
<td>Al-Razaq Computing Services</td>
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<td>BASF™</td>
<td>Baden Aniline and Soda Factory</td>
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<tr>
<td>CARE</td>
<td>Centre for Atmospheric Research Experiments</td>
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<tr>
<td>COMPASS</td>
<td>Common Operations and Management Portal for Airborne Science Systems</td>
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<tr>
<td>DBMS</td>
<td>Data Base Management System</td>
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<tr>
<td>DC3</td>
<td>Deep Convection, Clouds, and Chemistry</td>
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<td>DoD</td>
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<td>ESTO</td>
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<tr>
<td>GE</td>
<td>Google Earth</td>
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<td>GOES</td>
<td>Geostationary Observational Environmental Satellite</td>
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<td>GPM</td>
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<td>ITSC</td>
<td>Information Technology and Systems Center</td>
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<td>KML</td>
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<tr>
<td>MSFC</td>
<td>Marshall Space Flight Center</td>
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<tr>
<td>NCE</td>
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<tr>
<td>PHP</td>
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<td>RTMM</td>
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<tr>
<td>SEAC4RS</td>
<td>Southeast Asia Composition, Cloud, Climate Coupling Regional Study</td>
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<td>UAHuntsville</td>
<td>University of Alabama in Huntsville</td>
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<td>U/I</td>
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