Weather in the Connected Cockpit

What if the Cockpit is on the Ground?

The Weather Story for UAS

Friends and Partners of Aviation Weather

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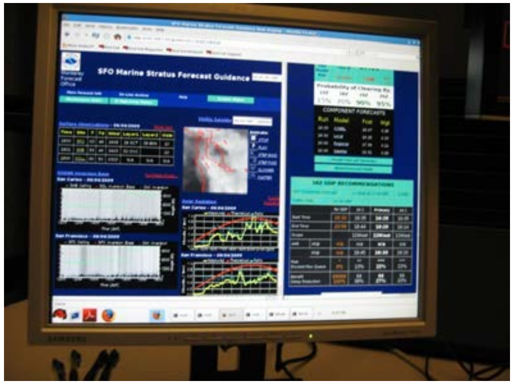
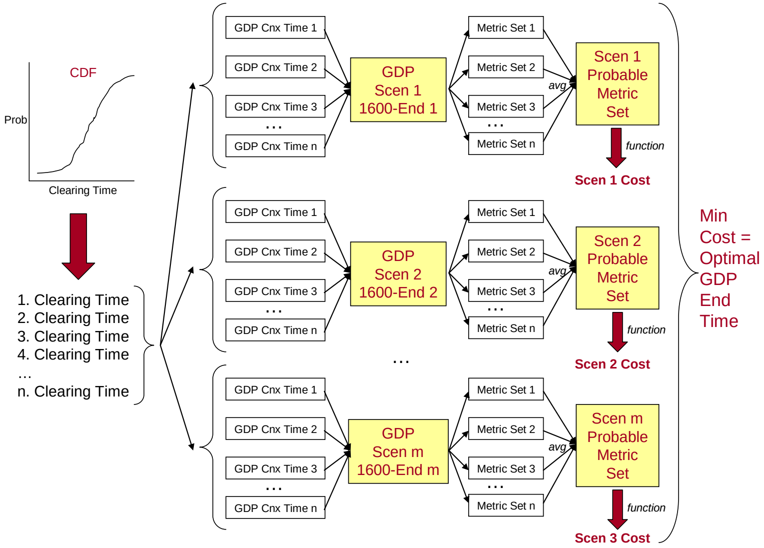
Outline

- Mosaic ATM Role in Aviation Weather
- UAS Research Involvement
- Weather Needs of UAS
- High Bandwidth Air-Ground Connection

Weather Integration: GPSM

- GPSM is a decision support tool designed to provide guidance to decision makers in selecting traffic management programs at SFO when low ceilings are expected to reduce airport capacity.
- Provides recommendations based on probabilistic forecast of the clearing of stratus, bridging the gap between the forecast product and the tool used to issue GDPs.

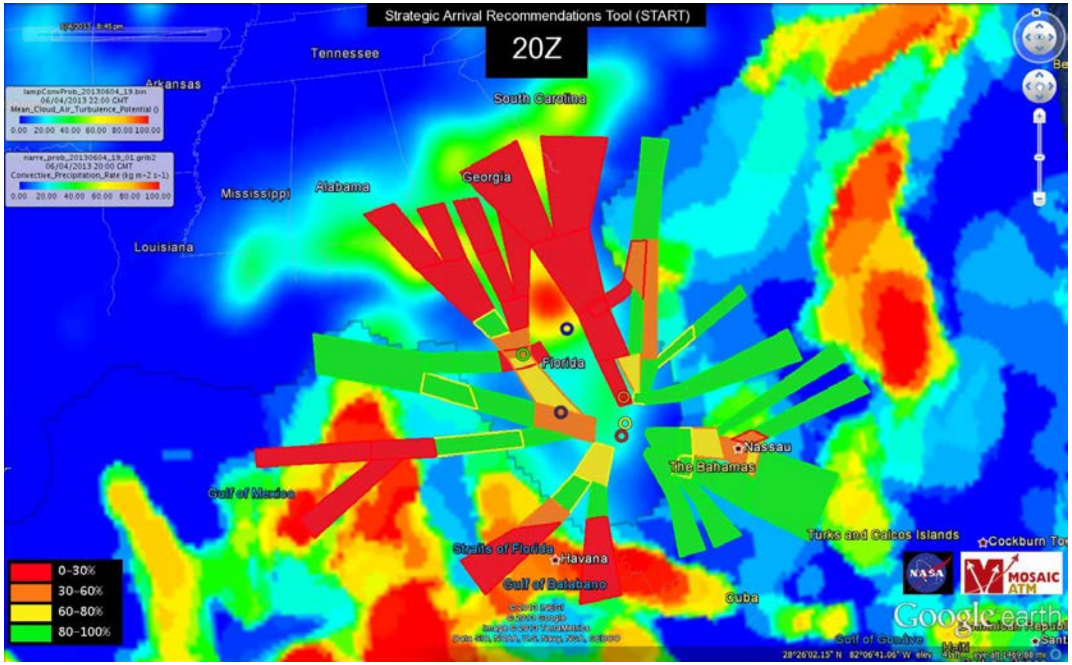




- Provides relative indication of risk and benefit of the recommendations vs. alternative options given the uncertainty in the forecast.
- GPSM is one of the first decision support links between weather forecasts and actual decisions, which can improve the prediction of actions and result in better planning.

Weather Integration: START

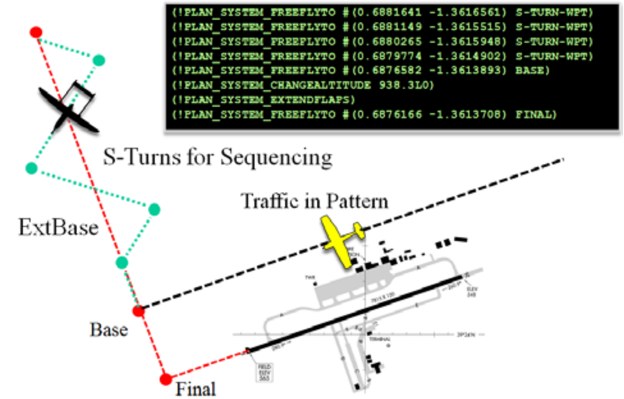
- Purpose:
  - To aid the ZMA TMU in the strategic planning of arriving traffic during convective weather events.
- Motivation:
  - Empower the TMU to proactively manage traffic in anticipation of convective events.
  - Reduce reliance on tactical (reactive) management.
  - Minimize diversions and safety concerns.



- Approach:
  - Utilize probabilistic convective weather forecast products to create probabilistic airspace capacity estimates for key ZMA/ZJX routes.
  - Use the probabilistic capacity estimates to help drive strategic traffic management decision making.

Mosaic's Role in UAS R&D

Advanced Technologies



- **Safety**
  - Flight Risk Analysis - NASA
  - Contingency Planning & Management - NASA
  - File and Fly Visualization Tools - IR&D
  - Non-GPS Navigation in the Terminal Area - Air Force
  - Threat Tracking - Navy, Boeing
  - 4D Trajectory Prediction - Navy
- **Command & Control**
  - Automatic Speech Recognition (ASR) of Air Traffic Control (ATC) - Air Force
  - Adaptive Task Planning Under Uncertainty - Air Force
- **Capability**
  - Optimized Optical Sensing of Complex Terrain - Army
  - Biologically-Inspired Navigation - Army
  - UAV Ground Segment & Mission Planning Functionality - Air Force / Global Hawk

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Innovators for the Next Generation of Aviation

Rapid Automated Mission Planning System (RAMPS) – *Information Integration*

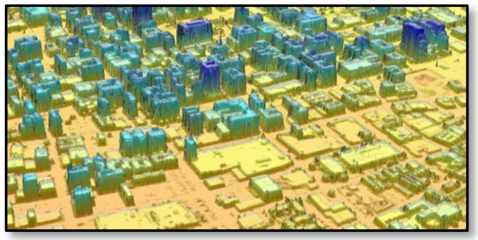
RAMPS Considers a Spectrum of Factors in Its Decision-Making

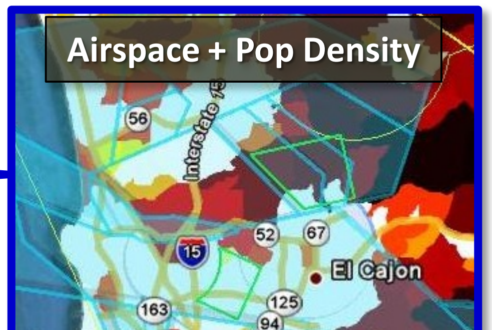
Population Density

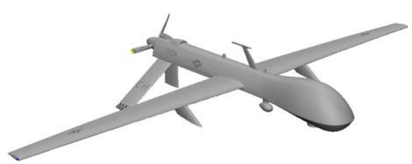
Controlled Airspace

Safety Thresholds

Geospatial / Urban Dev

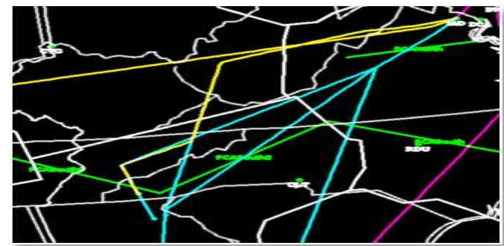


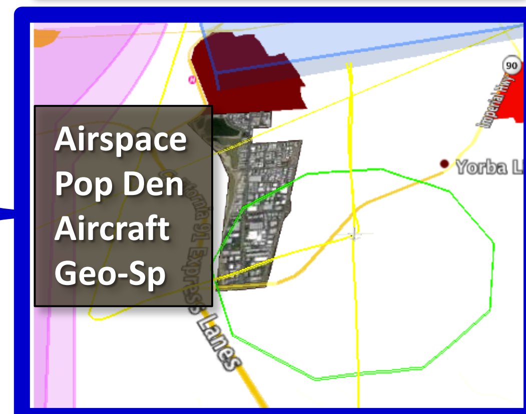


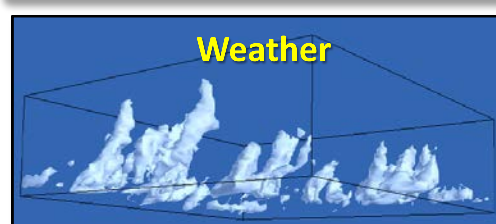


Aircraft Performance Model

Air Traffic Density







Define Risk

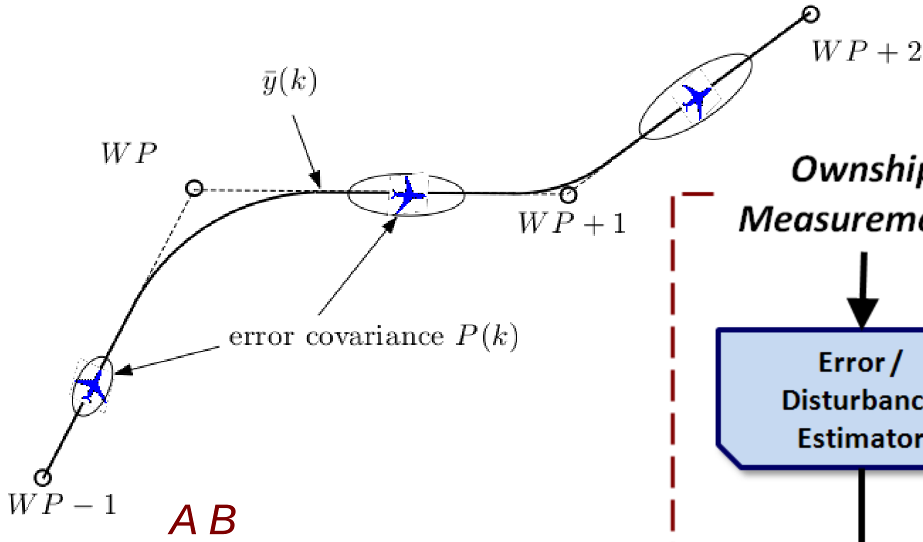
Compute Risk

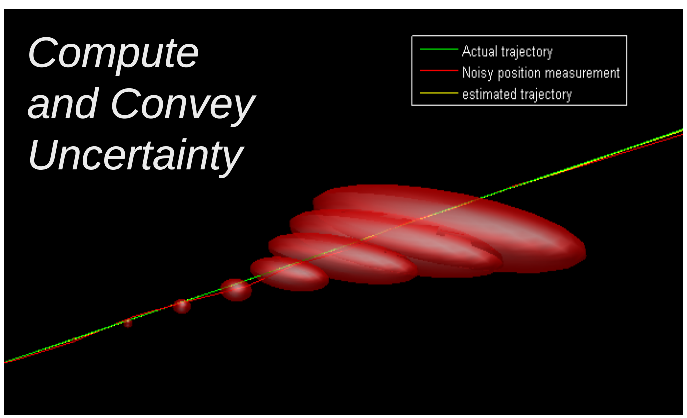
Minimize Risk

SBIR Data Rights apply

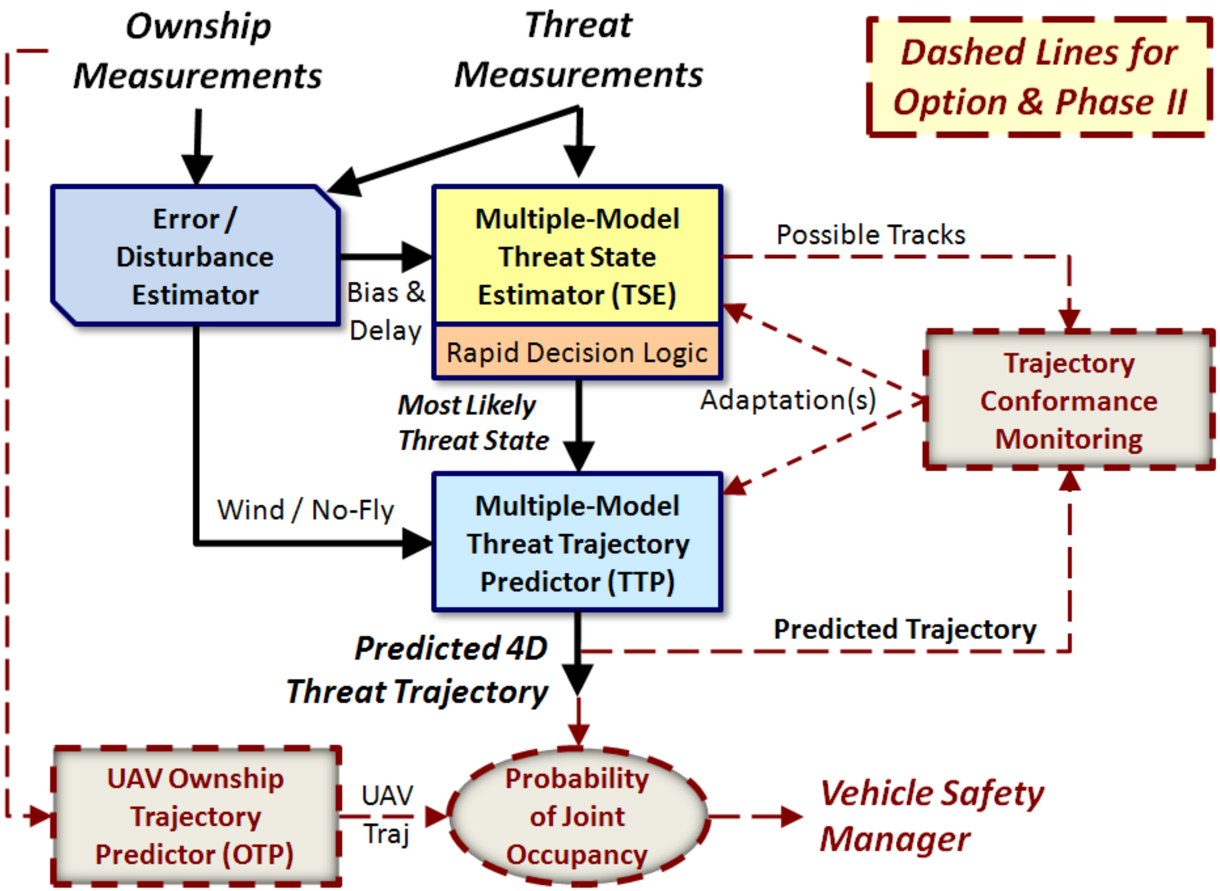
Real-Time Tracking & 4D Trajectory Prediction

NAVAIR





Algorithm Architecture



UAS Weather Needs

Small UAS are More Susceptible to Weather Impact:

- Lower Aircraft Speed and Mass
- High Winds and Turbulence and Greater Impact on Speed, Range, and Severity of Disturbance

Weather Data Required by UAS for Flight Planning and Real-Time Control:

- Surface Wind Dir & Speed
- Winds Aloft
- Convection & Turbulence

Minimize Weight by Offloading Sensors and Systems

- Obtain Weather Data via Uplink, Not Additional Sensors

- High-Bandwidth, Low-Latency Data Pipe Needed!

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UAS Weather Needs

- UAS Operational Requirements and Procedures Specify Flight Must be ***Within Line of Sight*** of Operator
- Visual Contact with the UA Enables Collision Avoidance

via

- Visual Detection of Threat Aircraft, and
- Maneuvering to Avoid the Threat

But is That All?

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UAS Weather Needs

- UAS Operational Requirements and Procedures Specify Flight Must be ***Within Line of Sight*** of Operator
- Visual Contact with the UA Enables Collision Avoidance

via

- **Visual Detection of Clouds, and**
- **Avoidance of Clouds,**
- **So Other Aircraft Can See and Avoid Ownship**

Cloud Detection and Localization

- Downlink UAS Video Feed
- Image Processing to Find Clouds and Geolocate Them
- High-Bandwidth, Low-Latency Data Pipe Needed!

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UAS as Weather Sensors

- Each UA Senses Atmospheric Information
  - Wind via Difference of Motion through Air and Motion over Ground
  - Temperature, Pressure
- UAS Will Predominantly Fly at Low Altitude
  - Low Altitude Weather Will be the Predominant Product
- Most Useful for:
  - Other UAS
  - Surface Wind/Weather Observation and Forecasts

Rapid, Micro-Scale Weather Updates

- High-Bandwidth Air-Ground Datalink to Obtain Frequent Weather Updates from UA
- Fast Weather Model Update Conducted on Ground
- Uplink New Weather Observation and Forecast
- Hypothesis: Dense Airborne Sensor Network Reduces Complexity of Modeling Required

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