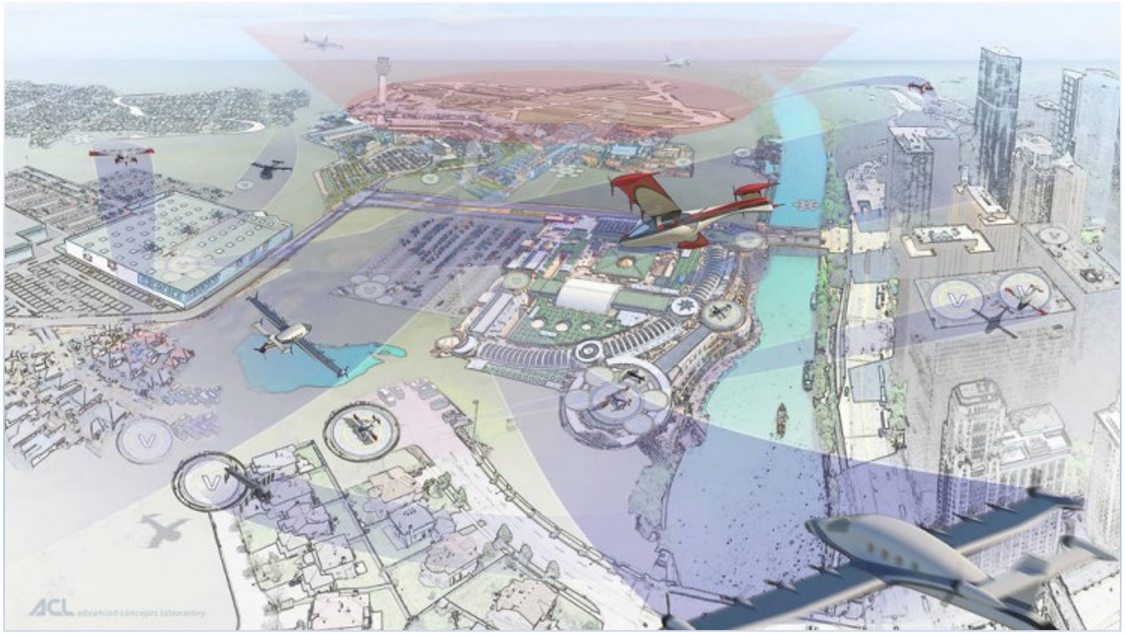
Collaborative Weather Research and Development for Urban Air Mobility

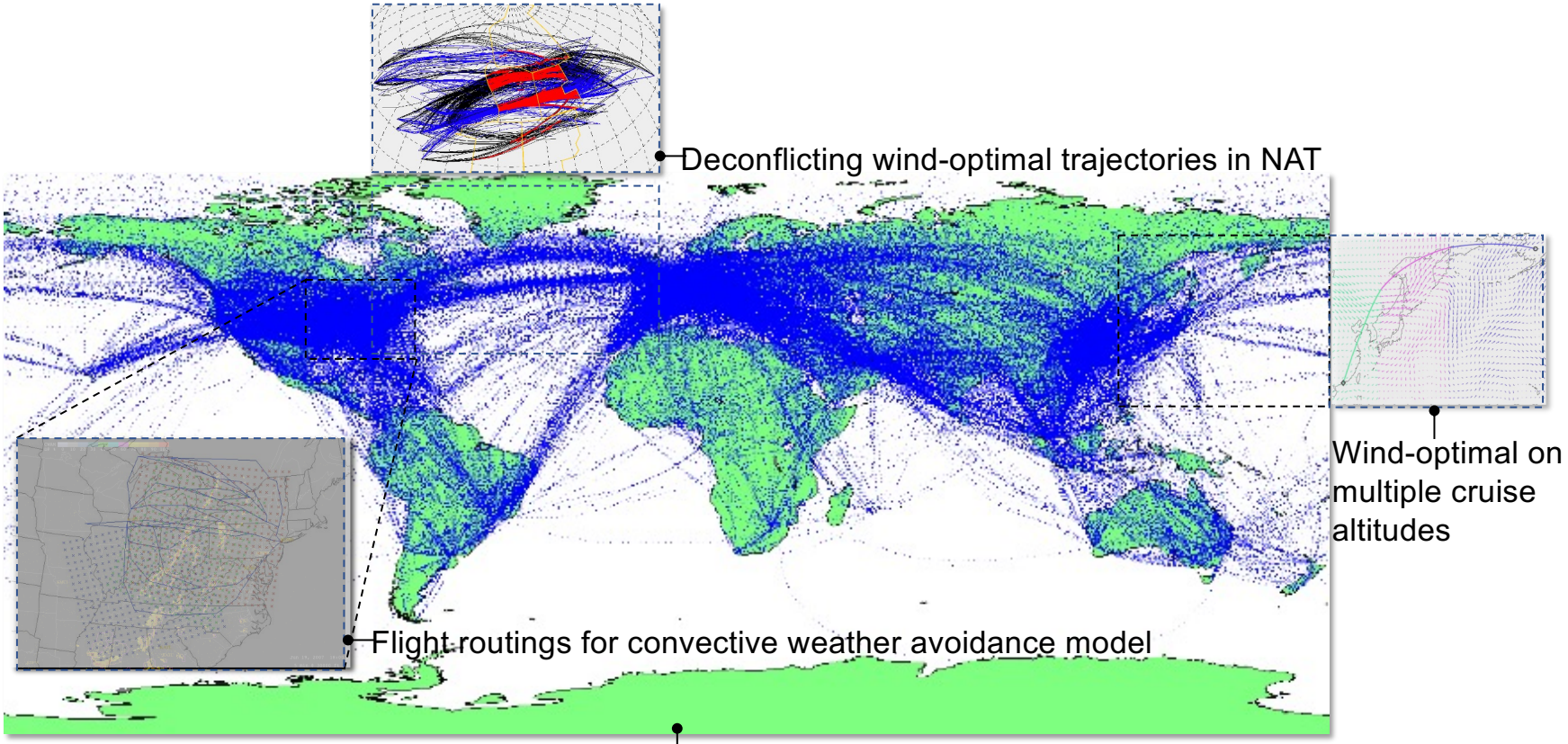


Dr. Hok K. Ng
Flight Trajectory Dynamics and Controls
Aviation Systems Division
NASA Ames Research Center
hokkwan.ng@nasa.gov

Outline

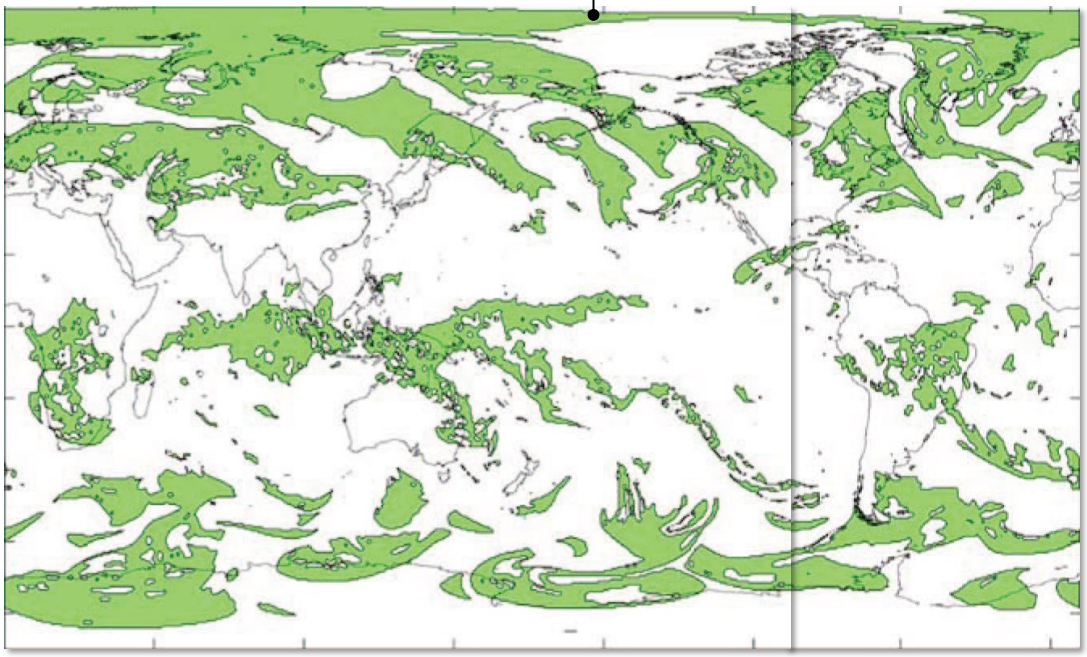
- Introduction
  - Wind optimal and weather avoidance operations
  - Climate impact and aircraft emissions tradeoff
- Background: Urban Air Mobility (UAM)
- Overview: Collaborative Weather Research and Development
- Impact Analysis for Dallas-Fort Worth Metroplex
  - Input Data
  - Preliminary Results
- Work in Progress
  - Weather Impact Data Analysis
  - Airspace Capacity Analysis

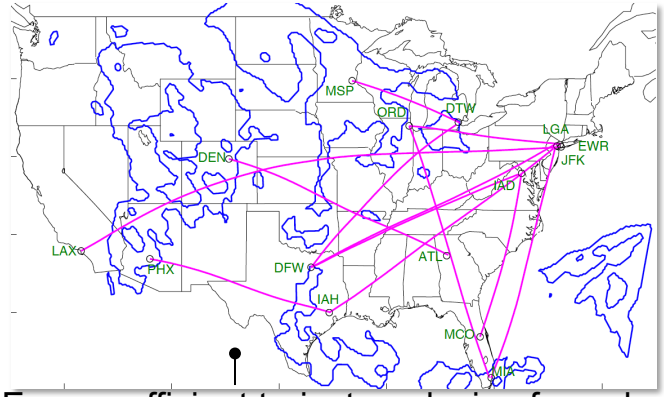
Introduction: Wind Optimal and Weather Avoidance Operations



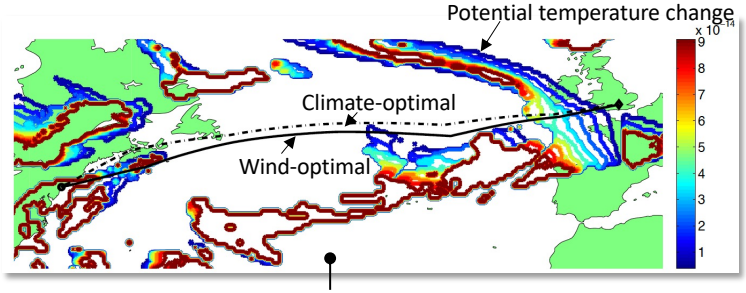
Introduction: Climate Impact and Aircraft Emissions Tradeoff

Persistent contrails favorable regions worldwide for December 31, 2009





Energy-efficient trajectory design for reducing climate-impact on various timescales



Trajectory design for reducing climate-impact of trans-Atlantic flights

Background: Urban Air Mobility

National Aeronautics and Space Administration

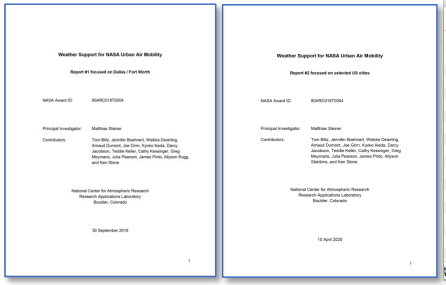
2

- **Policy and Regulations**
  - Weather Policy at UML-4 evolved from requiring the vehicle operator or pilot to be responsible for the quality of the weather information to the weather data provider.
- **Weather Data Collection**
  - UML-4 weather data collection will require balancing the need for greater granularity of weather observations, at a micro-climate scale, with the cost of taking those observations.
- **Weather Data**
  - Weather data meeting performance standards, collected from sensors described above, will be accessible from government, private sector and non-profit entities following a standard set of data performance standards.
- **Modeling and Forecasting**
  - At UML-4, higher resolution, coupled forecast models are required to capture urban wind and weather effects for safe and cost-effective high-density urban flight operations.
- **Weather Supplemental Data Service Providers (SDSPs)**
  - Weather Supplemental Data Service Providers are expected to drive innovation and leverage government and commercial weather data sets to produce granular micro weather products and services customized to support UTM and UAM operator operations.

1. National Aeronautics and Space Administration (NASA) UAM Vision Concept of Operations (ConOps) UAM Maturity Level (UML) 4
2. Advanced Air Mobility (AAM) Ecosystem Community Integration Working Group: UAM Weather

Overview: Collaborative Weather Research and Development

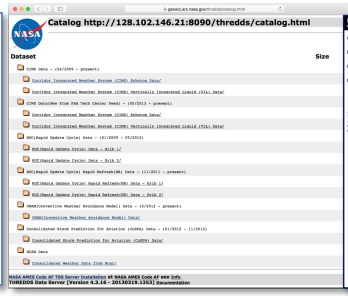
- Data support
  - NCAR project (FY19-20)
  - Initial analysis (FY20-22)
- Impact translation model
  - AvMet SBIR Phase III (FY20)
- Impact analysis
  - DLR collaboration (FY21-22+)

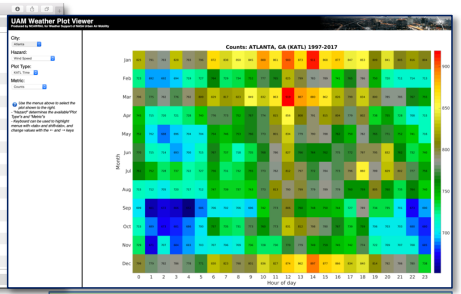

Weather Support for NASA Urban Air Mobility

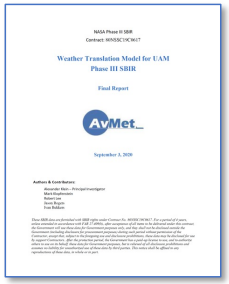
Report #1 focused on Dallas / Fort Worth

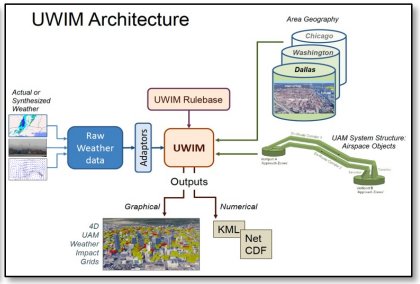
Weather Support for NASA Urban Air Mobility

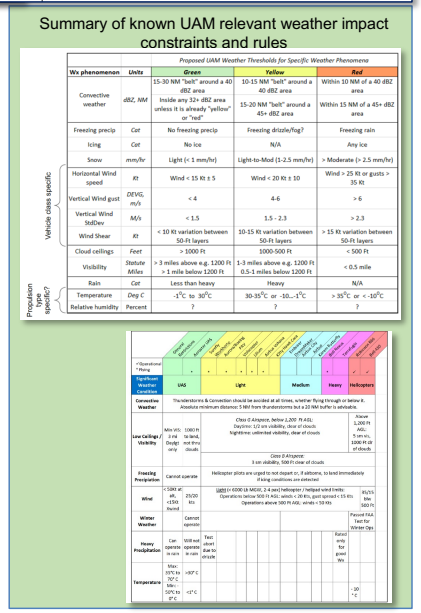
Report #2 focused on selected US cities

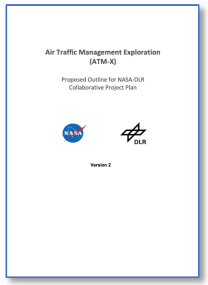





Weather Translation Model for UAM
Phase III SBIR
Final Report
AvMet
September 3, 2020



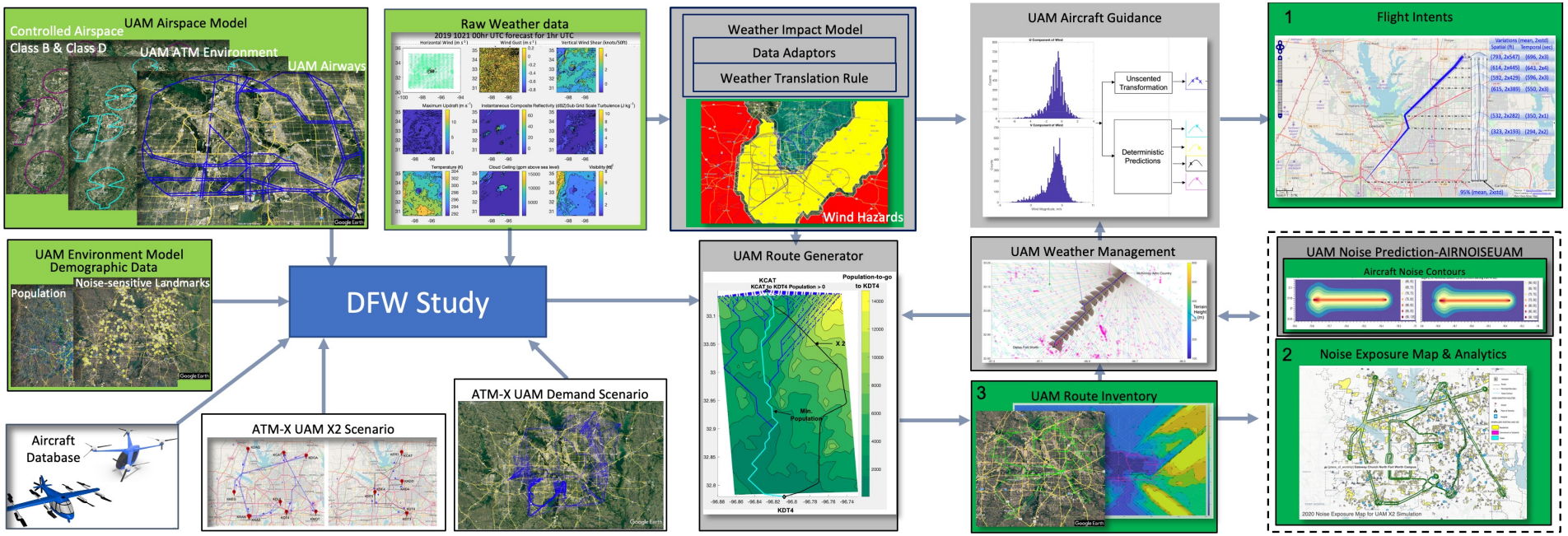



Air Traffic Management Exploration (ATM-X)

Proposed Outline for NASA-DLR Collaborative Project Plan

Version 2

UAM Impact Analysis for Dallas-Fort Worth Metroplex



1. Ng, H., “Strategic Planning with Unscented Optimal Guidance for Urban Air Mobility”, 2020 AIAA Aviation Forum
2. Li, Jinhua, Ng, H., Zheng, Y., Gutierrez, S., “Noise Exposure Maps for Urban Air Mobility,” 2021 AIAA Aviation Forum
3. Ng, H., Li, Jinhua, Zheng, Y., “Noise Impact Analysis for Urban Air Mobility in Dallas-Fort Worth Metroplex”, 2022 AIAA Aviation Forum (to be published)

Inputs to UAM Impact Analysis

UAM Airspace Model

Controlled Airspace

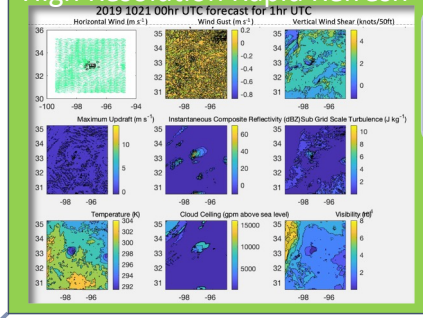
Class B & Class D

UAM ATM Environment

UAM Airways

Raw Weather data

High Resolution Rapid Refresh



Weather Scenarios

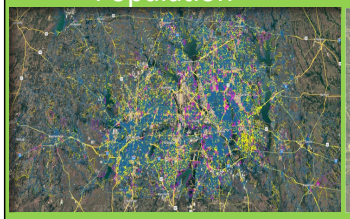
Typical Winter	Precipitation & Low Temperature	Typical Summer	Typical Fall
1/9/2019-1/10/2019	2/9/2019-2/10/2019	7/5/2019-7/6/2019	10/20/2019-10/21/2019
			VFR, marginal VFR, IFR, Low ceilings, turbulence, lightning

DFW Study

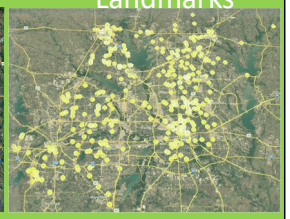
UAM Environment Model

Demographic Data

Population



Noise-sensitive Landmarks

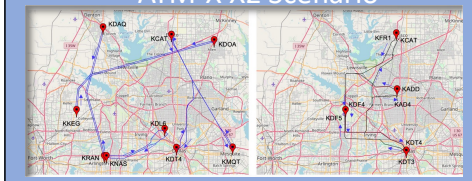


Aircraft Database

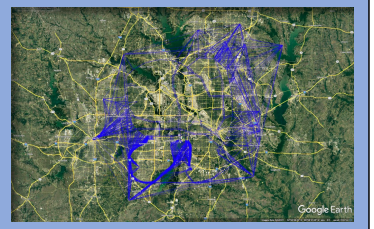
NASA RVLT Concept UAM Aircraft

UAM Demand Model

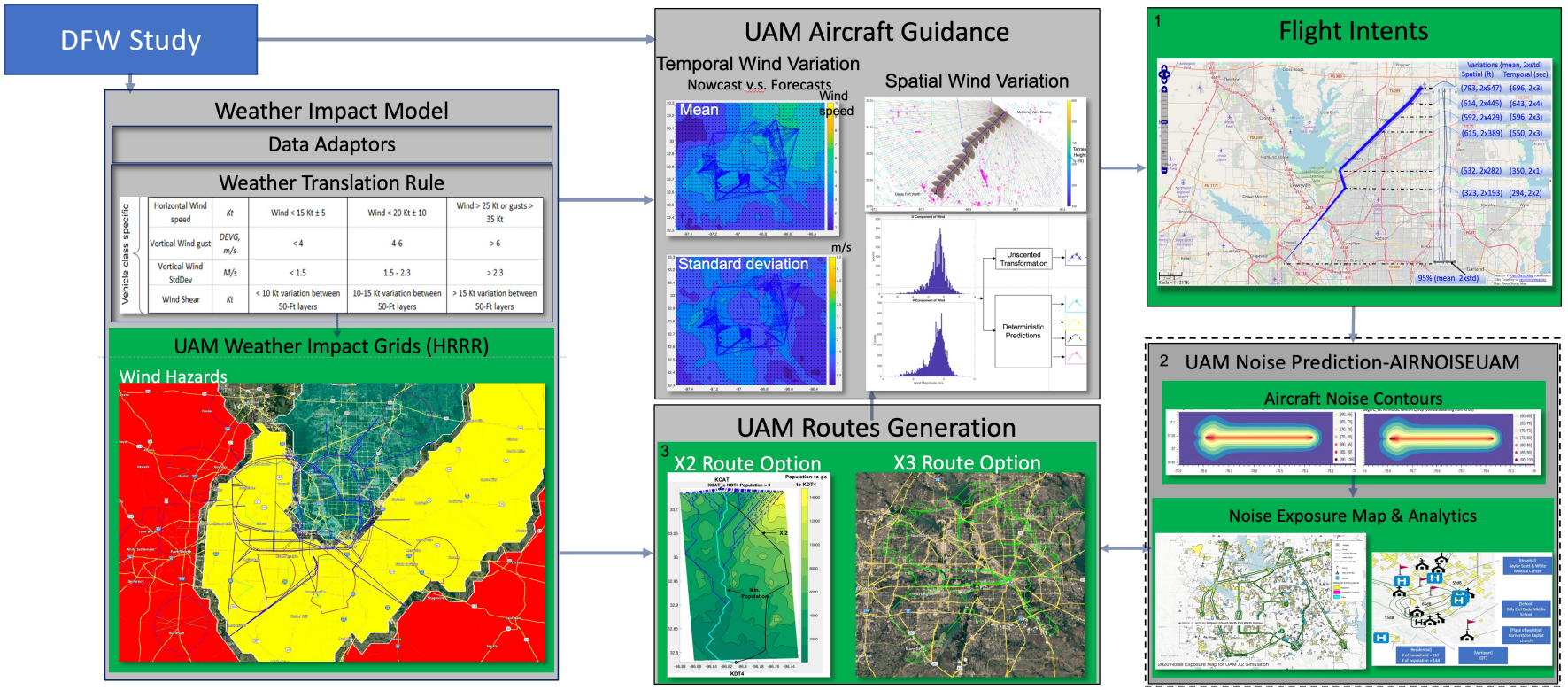
ATM-X X2 Scenario



ATM-X X3 Scenario

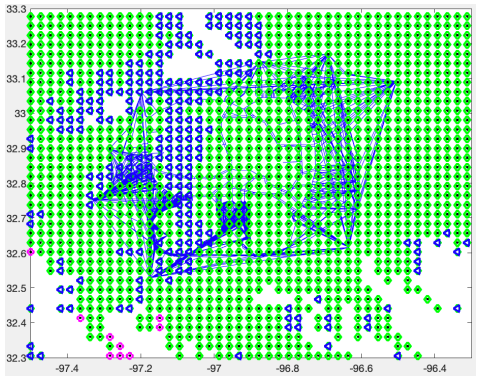


UAM Weather and Noise Impacts-Preliminary Results



Work in Progress & Discussion

- Weather Impact Data Analysis

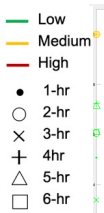


Wind-impacted DFW Airspace (Black Dot)

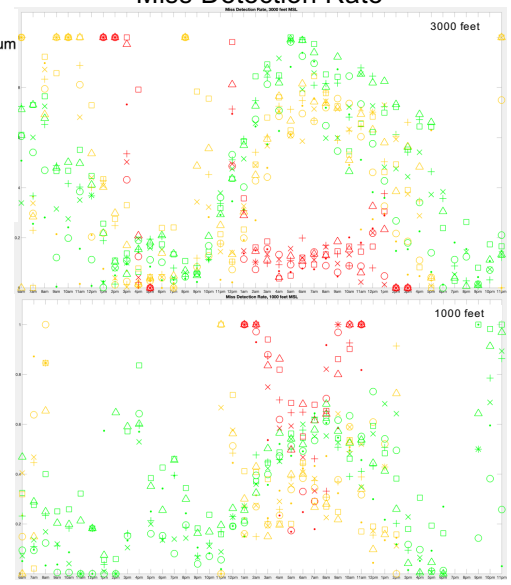
Detection (Green Diamond)

Miss Detection (Magenta Circle)

False Alarm (Blue Cross)

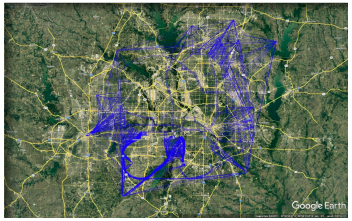


Miss Detection Rate

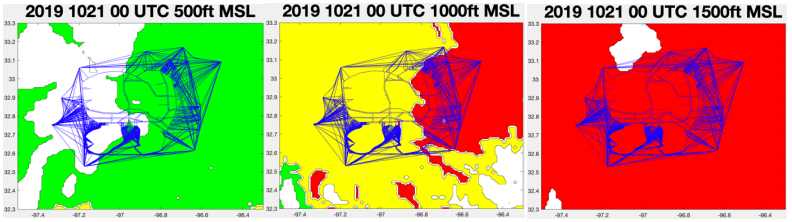


False Alarm Rate

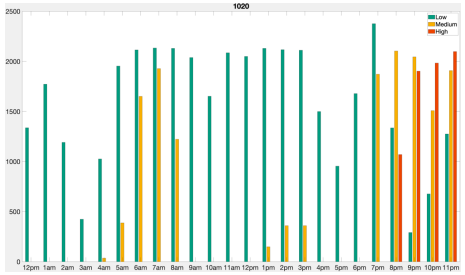
- Airspace Capacity Analysis



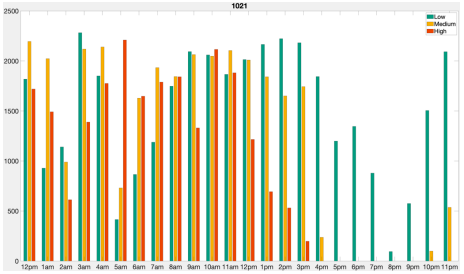
2,450 Routes, 35,576 waypoints



Typical Fall, October 20, 2019



Typical Fall, October 21, 2019



Thank You!

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hokkwan.ng@nasa.gov