


Benefits of More Accurate Wind Information to UAS and AAM Operations



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The MITRE Corporation

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FOR A SAFER WORLD®

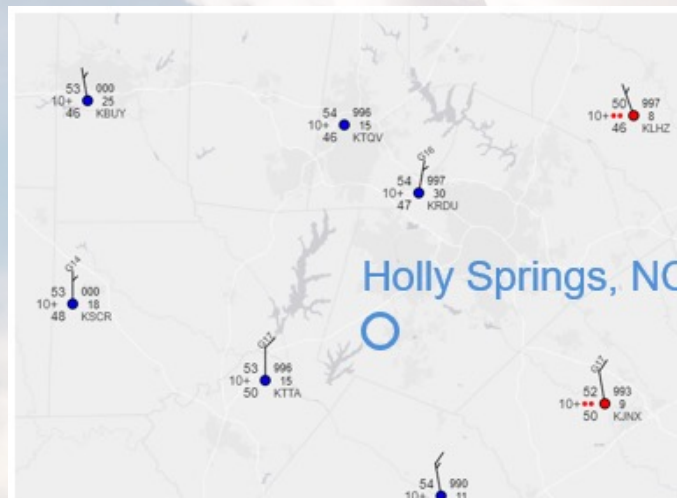
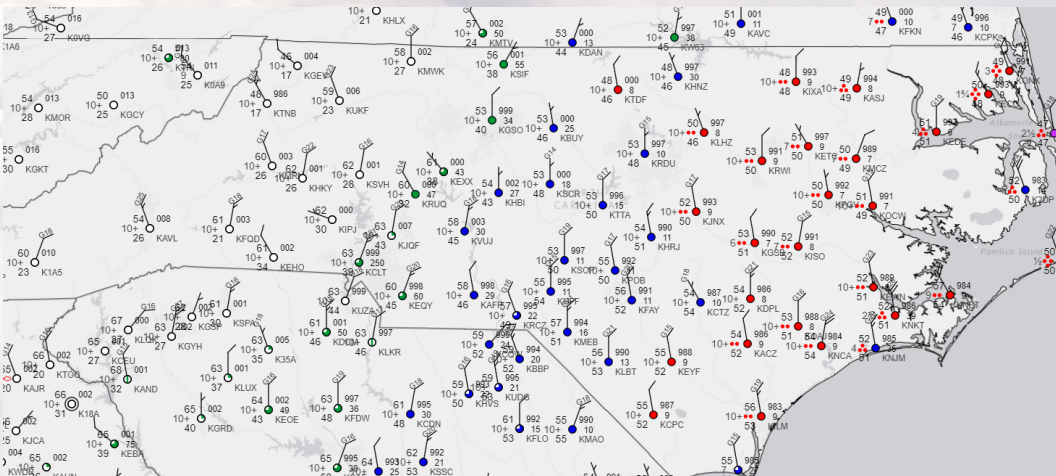
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Outline

- Key Wind Information for UAS / AAM Operations
 - Wind Inaccuracies – and How Operations Cope
 - What does Improved Accuracy Mean and How Will Operations Benefit?
 - Societal and Economic Wins – Key Contribution from Improved Winds
- 

Our Challenge – Racing Away from Conventional Operations and Associated “Approved Common Weather Picture”

NOAA GFA Observations



Wing seeks FAA nod for up to 10,000 drone delivery flights in Dallas per day

Ishveena Singh | Sep 12 2023 - 5:24 am PT | 0 Comments



https://www.linkedin.com/posts/flytrex_drone-dronedelivery-flytrex-activity-7130933462101864449-gidT



Important Wind Information for UAS, AAM Aviation Missions

Wind Elements (Direct, Derived)

Wind Characteristics

Current, Future


- **Speed**
- **Direction**
- **Gust**
- **Gust Spread**
- **Gradient, Shear**
- **Headwind, Tailwind**
- **Crosswinds**
- **Vertical Winds**
- *Turbulence*

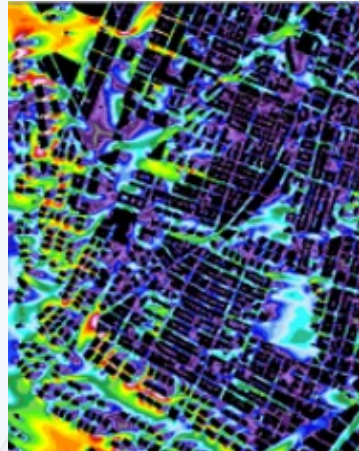
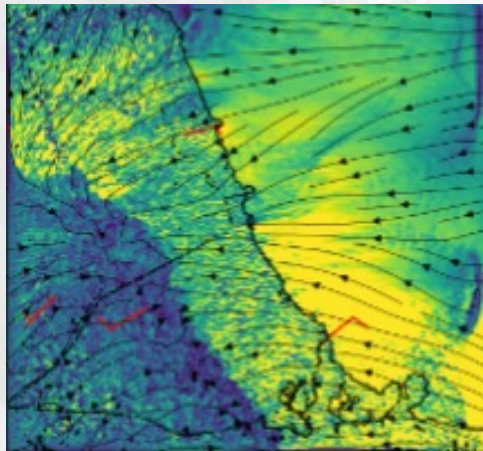
- **Intensity**
- **Evolution, Trends**
- **Location / Proximity**
(“Surface”, Elevated Surface, Aloft, En Route)
- **Representativeness (Space and Time)**
(e.g., Siting, Updates, Latency)
- **Uncertainty**

OBSERVATION

FORECAST

Winds Inaccuracies That May Most Affect UAS and AAM Operations?

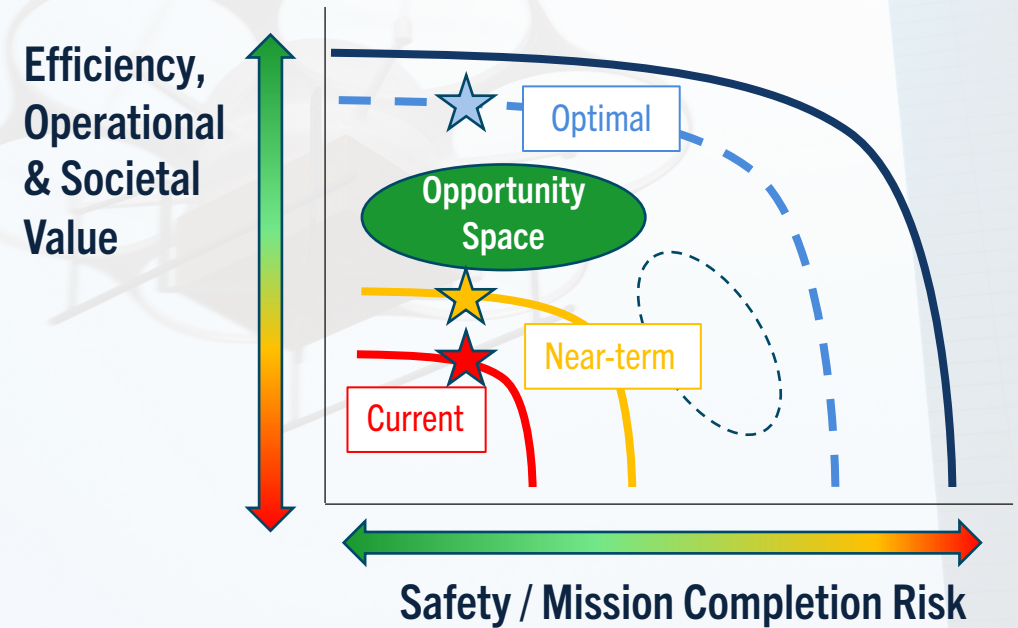
- Scalar measurements – horizontal, vertical; surface, aloft (speed, gusts, direction, shear...)
- Fidelity (resolution and timeliness) 
- Evolution, state change (e.g., outflow, PBL 'mix-out')
- Uncertainty accountability



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How do Operators Manage Weather / Wind Challenges Today?



- Given uncertainties, incompleteness, missing wind information, “outsized” safety risk buffers required and severe limitations in:
 - Where operating, type of mission, types of vehicles, aid of automation, ops duration, efficiency of trajectories / power, etc.

What Does it Mean to Have Improved Wind Accuracy?

- Improved accuracy in wind speed, wind gust, wind direction observations / forecasts
 - Improved, derived operational limitations / hazards (e.g., crosswinds, wind shear, turbulence)
- Access to actionable, trustworthy wind condition / hazard intelligence needed for UAS, AAM operations envisioned by targeted business cases and equitable “needs and wants” of society:
 - ▶ ■ **Increased “GO” operations:** Improved understanding for when operations viable, weather-wise, while demonstrating safety will be maintained
 - **Understood, more stable “No-GO” operations:** Clearer, more transparent disruptions / stoppages in service due to weather
 - **Increased “GO” / More Trustworthy “No-GO”** for more of society and its needs and opportunities:



Locations / Markets



More Urban Areas / More People

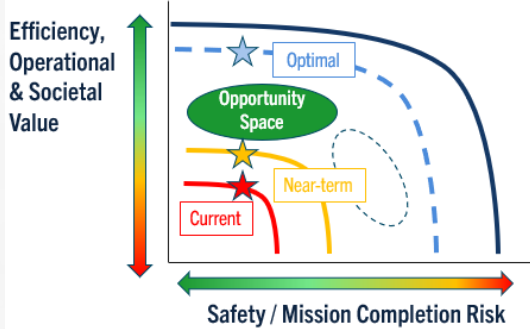


More Services



More Value, More Innovations, More Momentum

How will UAS and AAM Operations Benefit?



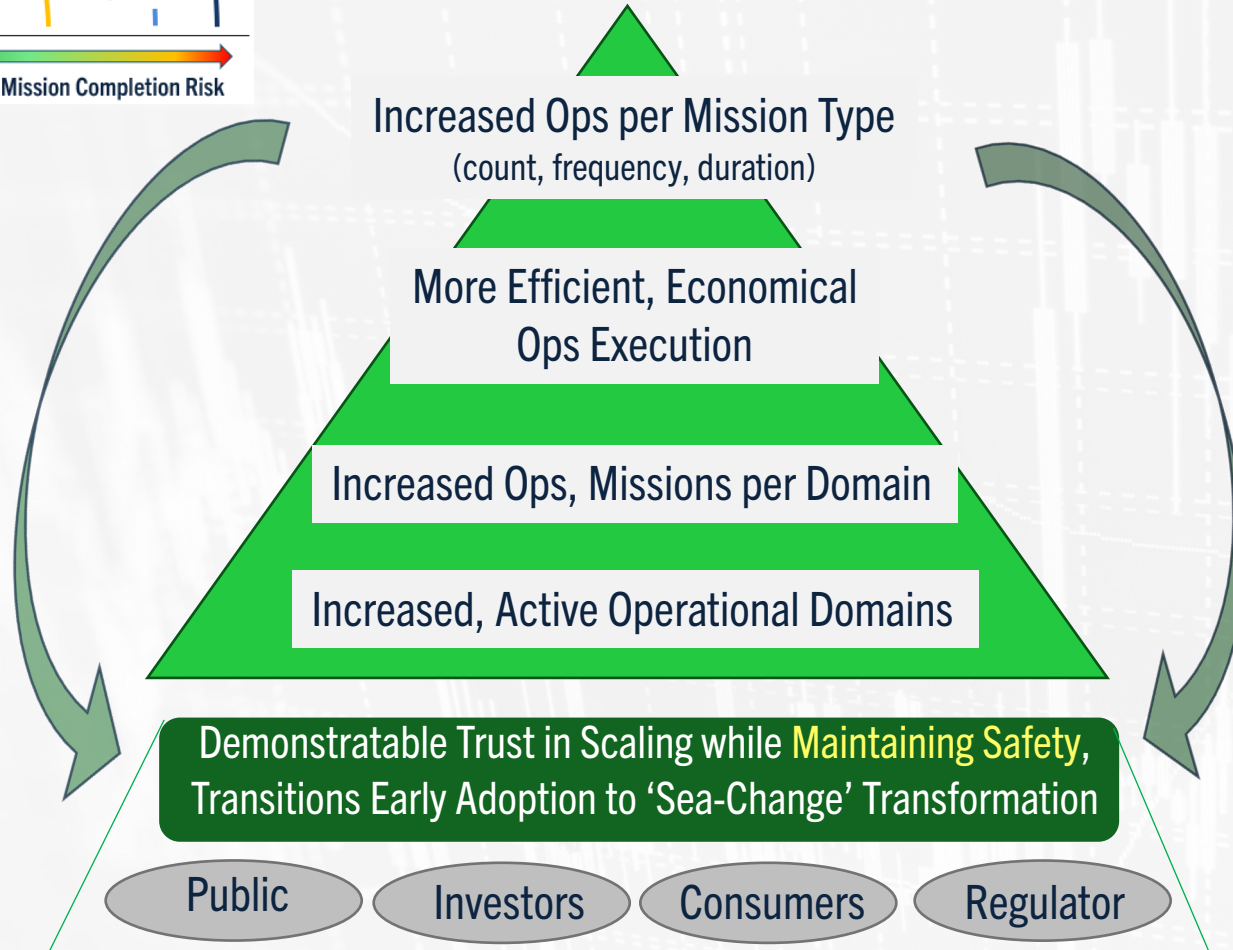
Aren't there MANY operational improvement areas that will generate these benefits? (e.g., CNS, UTM, Automation)

YES – But weather (winds) typically drives most significant aviation disruptions;

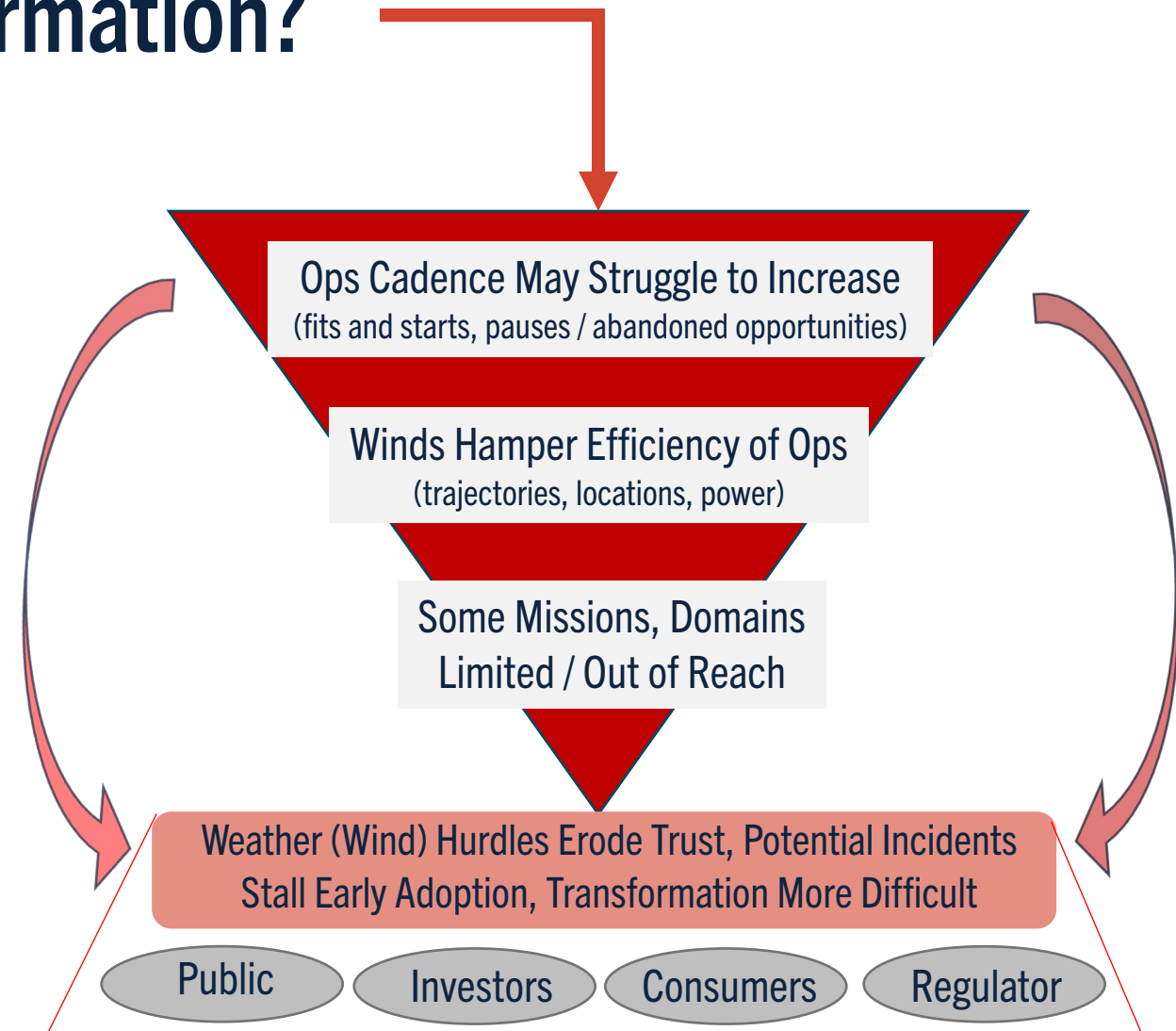
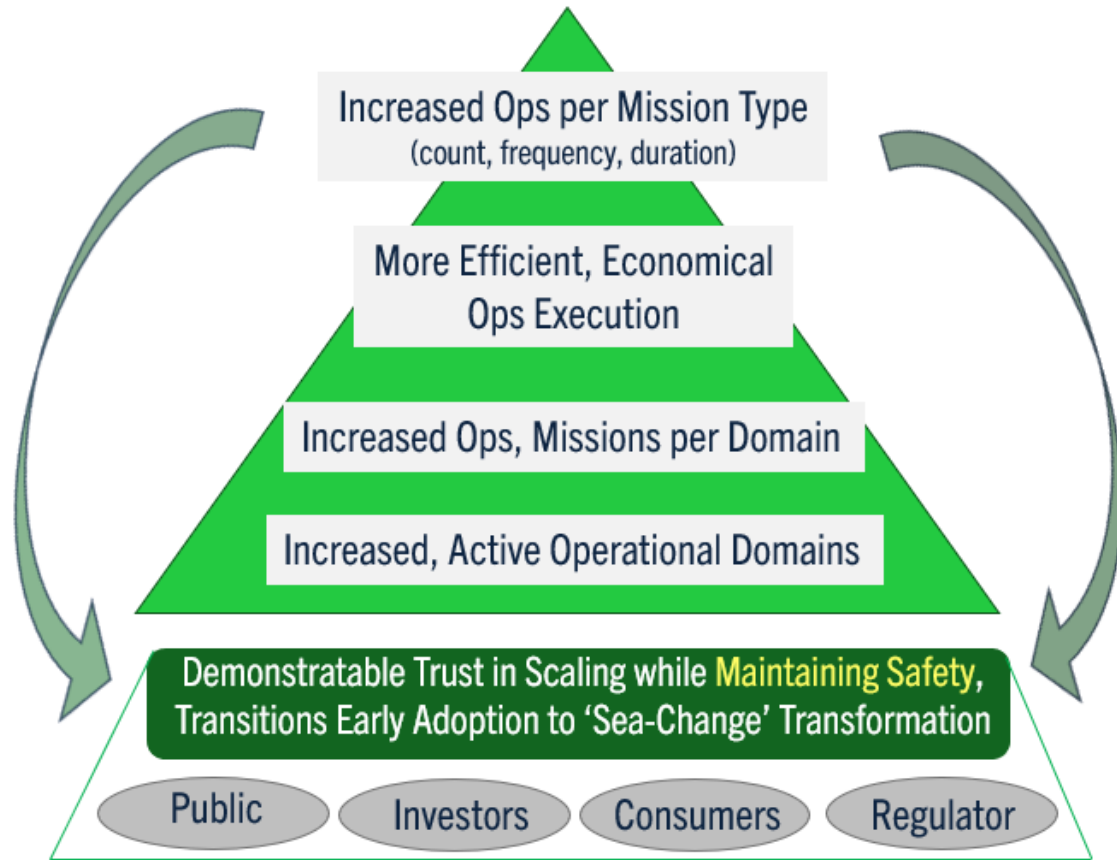
Mitigating disruptions / departures from optimality most challenging given steep uncertainties accompanying weather-induced irregular ops

Challenges present opportunities for significant improvements to operational efficiency that must be achieved, then maintained, for envisioned ops

Benefits of improved weather/ winds have opportunity to exponentially increase services, value of UAS / AAM operations compared to optimality in “very benign” weather

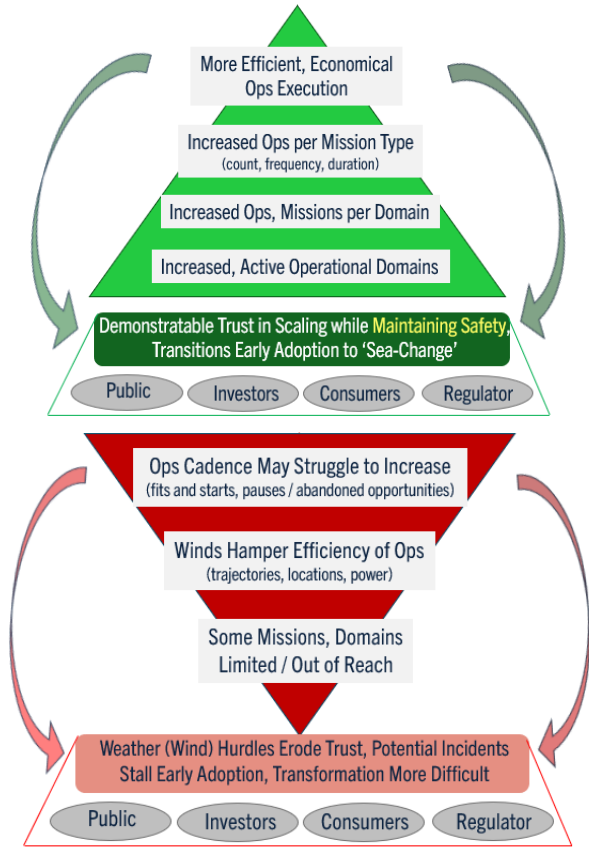


What if UAS / AAM Operations Struggle to Advanced Accuracy / Access of Wind Information?



What Will be Economic and Societal Wins of More Viable, Wind-Managed UAS /AAM Operations?

Direct Operations and Supply Chain Benefits	Direct Ops Industry Components	Indirect Impacts	Catalytic Impacts
UAS, AAM operators	Pilots, Maintenance, Delivery Services / Integration, Remote Monitoring, Photography, Civil Services, Medical & Ambulance; Automation Development, Implementation	<ul style="list-style-type: none"> Energy Production & Transmission, Construction Telecommunications Financial Investment 	<ul style="list-style-type: none"> Increased STEM education
Vehicle Manufacturing	Manufacturing, Engineering, Scientific / Technical Services	<ul style="list-style-type: none"> Reduced gaps in equitable access to critical services 	<ul style="list-style-type: none"> Increased labor markets through improved access
Ground Infrastructure	Vertiports, Launch/landing, Delivery, Power, Battery Tech and Services, Security, Amenities	<ul style="list-style-type: none"> Spending, direct & indirect employee wages (housing, personal consumption, restaurants, recreation) 	<ul style="list-style-type: none"> Improved healthcare access, outcomes
UTM Infrastructure	CNS, Detect & Avoid, Cloud & Distributed Services, USS, 3PSP, Weather Sensors / Forecasts, 3PWP	<ul style="list-style-type: none"> Real estate Tax Revenues (Fed, State, Local, Sales) 	<p><i>** Sources: States' economic benefits assessments for AAM (e.g., VA, by Virginia Innovation Partnership Commission)</i></p>



All these benefits are expected, but how many benefit, by how much, and how quickly depends notably on demonstrable ability to consistently manage / mitigate weather (wind) risks

BENEFITS

Revenue Jobs Health Taxes, Reinvestment Access, Equity Environment Mobility

Summary

- Wind (and weather) is a significant challenge that will limit ability of UAS and AAM operations to scale as envisioned to potentially transform our society
- Inaccurate winds make weather hazard management and avoidance extremely uncertain; managed in near-term with outsized, extra-cautious safety buffers in UAS (and coming AAM) operations
- More accurate wind observations and forecasts, as needed for ‘scaled’ operations of inter / intra-community aviation operations, will allow UAS / AAM operations to increase in number, duration, efficiency, mission type, and domain(s) / market(s)
 - Achieved partly as more accurate weather would support “demonstrable trust” in scaled operations that do not change very high safety targets
- Societal and economic benefits of more accurate winds (weather) lies not in the type of applications and ROI, but how MANY people, domains, service / industry sectors benefit...by how much more...and how quickly
- Wind (Weather) solutions and operational empowerment **MUST NOT** be a ‘bolted-on’ advancement after other hurdles have been advanced – this will stall innovation, struggle with stability and trust, and miss high-value circumstances when / where ability to operate will be exponentially more beneficial