Urban Air Mobility
Emerging Opportunities for the Weather Community

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Vision of the 60s . . .

https://www.youtube.com/watch?v=tTq6Tofmo7E

Courtesy of Warner Brothers

Today’s vision . . .


Courtesy of Uber Air

Aerial ride sharing
Why such a buzz now?
• Emerging technologies
  - battery energy storage capacity
  - distributed electric propulsion & rotor design
  - vertical takeoff & landing
  - composite materials & manufacturing
  - automation & eventually autonomy
• Market analyses show huge potential

Expected benefits
• Increased mobility & reduced commuting time
• Reduced congestion & pollution
  - low emissions & noise

Use cases
• Scheduled & on-demand aerial ride services
  - fixed shuttle routes & point-to-point
• Air ambulance
• Air cargo & local delivery
• Personal flying vehicles
Lots of challenges . . .

. . . including weather (although not explicitly spelled out)
Manned

Unmanned

Increasing Sensitivity to Weather

Urban air mobility
Weather Sensitivities

Safety, efficiency & reliability
- Inclement weather can affect all of them
- Hazards include wind & turbulence, temperature, ceiling & visibility, precipitation & lighting, icing, etc.

Infrastructure
- Climatic regimes guide infrastructure needs, aircraft design, & fleet mixture to maximize reliability

Operations
- Weather guidance needed for safety & comfort of passengers (both during transfer & aerial ride), performance of aerial vehicle & impact on operations
- Need to understand operationally critical thresholds

Particular challenges
- Added complexity in strong gradient environments like complex terrain, land/sea contrasts, extreme heat, etc.
- Urban environments with localized flow around buildings
- Visual versus instrument meteorological conditions
Planning – Climatologies

• Heat Index (1998 – 2017 KDFW)

95th Percentile

Frequency of heat index exceeding 91 F

Execution – Actual weather

• Vortex shedding off tall buildings in urban setting

Chicago, IL
Weather Guidance

**Observations**
- METAR & others
- Radar (MRMS, CIWS)
- Satellite (VIS, IR, WV)
- Lightning
- Radiosonde
- Aircraft (ACARS, PIREPs, in-situ EDR)

**Analyses**
- RTMA
- Aviation weather hazard diagnosis products

**Forecasts**
- TAF
- HRRR
- Aviation weather hazard forecast products
Wind observations in urban setting

- Many observations available
  - synoptic & mesoscale networks
  - not all approved for flight decisions

... but more & novel observations may be needed to support UAM operations
Opportunities

Observation
• Onboard weather sensing
  - connectivity to share data in real time
• Enhanced urban networks to capture micro scales around vertiports

Prediction
• Building resolving modeling to resolve airflow in cityscape
  - multi-scale modeling, coupling mesoscale with large-eddy simulations (LES)
  - improved urban boundary layer representation & diurnal cycle
  - faster processing using GPU & other methods
• Ensembles to capture prediction uncertainty

Translation
• Understanding weather impacts on operations
  - impacts along flight path & avoidance routing
• Modeling of power consumption, emission & noise pollution

Change
• Ever evolving conditions with climatic changes
Urban boundary layer challenges

- Representation of urban landscape - buildings, surfaces, vegetation, etc.
- Representation of relevant processes - sun angle, cloud coverage, differences in local heating, wind & turbulence, moisture, pollution, etc.
- processes across multiple scales
UAM provides opportunities for weather community
• Collection of additional meteorological data
  - sensors on aerial vehicles can provide real-time weather data aloft
  - benefits from enhanced ground-based urban observing infrastructure
  - validation of prediction capabilities
• More observations yield improved understanding & prediction capabilities
  - advances in meso- & micro-scale toward building-resolving modeling
  - need to understand minimum complexity required for given weather situation
• Creation of tailored, location & time-specific weather guidance
  - translation of weather to operational impacts & constraints
  - weather impacts along flight path & avoidance routing

UAM is sensitive to weather
• Sensitivity increases with decreasing size of aircraft
• Particular weather challenges in urban environments

UAM is happening
• Timeline may be optimistic, but industry is moving fast & progress is visible

Points to Remember