Preliminary Summary of Observational Needs Recommendations from the 2017 AMS Annual Meeting

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“Observations Lead the Way”

- Theme of the 2017 Annual AMS Meeting in Seattle
- NSF provided partial support for 100 students to attend 426 sessions in 31 scientific conferences to “harvest” observational needs from both oral and poster sessions
- Stacey Hitchcock (CSU) was the “shepherd” of the harvesters:
  - Made all the session assignments
  - Collected all of the 1729 student reports of oral talks
  - Poster information still being collected
  - Created an enormous Google spread sheet that organizes all the information

Information/Questions Requested

- Date, Conference, Session
- Author, Title, Paper Number
- Does this talk contribute to or use observations?
- What measurements are discussed?
- What problem is being addressed?
- What is the greatest unmet observation need for this topic?
- Recommendations for improving instruments or designing new ones?
- Additional points related to observations

Goals of the Observation Harvesting

- Goal is to produce a **community consensus** on the greatest observational needs in most disciplines within atmospheric science and related fields (hydrology, space weather, etc.)
- **Dissemination**:
  1. Two articles in *BAMS*:
     a. Summary of the observational recommendations
     b. Going Forward (update of "NoN" NRC and other reports)
  2. Summary for agencies that develop and/or support observations
  3. Summary for policy makers (OMB; Congress)
- Hope to create strong enough value proposition to develop support for increasing our nation's observing capacity (Infrastructure!)

Conferences/Symposia at 2017 Annual AMS Meeting (43)

- 17th Presidential Forum: Earth System Observations in Service to Society
- Special Symposium on Individual, Social, and Cultural Observations in Weather and Climate Contexts
- Observation Symposium: Progress, Problems, and Prospects
- Lance Bosart Symposium
- Robert A. Houze, Jr. Symposium
- 33rd Environmental Information Processing Technologies
- 31st Conference on Hydrology
- 29th Conference on Climate Variability and Change
- 28th Conference on Weather Analysis and Forecasting
- 24th Conference on Numerical Weather Prediction
- 26th Symposium on Education
- 21st Conference on Integrated Observing and Assimilation Systems for Atmosphere, Oceans, and Land Surface
- 20th Atmospheric Science Librarians International Conference
- 19th Conference on Atmospheric Chemistry
- 18th Conference on Aviation, Range, and Aerospace Meteorology
- 16th Annual AMS Student Conference
- 15th Conference on Artificial and Computational Intelligence and its Applications to the Environmental Sciences
- 15th History Symposium
- 15th Symposium on the Coastal Environment
- 14th Conference on Polar Meteorology and Oceanography
- 14th Conference on Space Weather
- 13th Symposium on New Generation Operational Environmental Satellite Systems
- 13th Symposium on the Urban Environment
- 12th Symposium on Societal Applications: Policy, Research and Practice

Conferences/Symposia at 2017 Annual AMS Meeting (cont.)

- Ninth Symposium on Aerosol–Cloud–Climate Interactions
- Eighth Conference on Environment and Health
- Eighth Conference on Weather, Climate, Water and the New Energy Economy
- Eighth Conference on the Meteorological Applications of Lightning Data
- Eighth Symposium on Lidar Atmospheric Applications
- Seventh Conference on Transition of Research to Operations
- Seventh Symposium on Advances in Modeling and Analysis Using Python
- Fifth Annual AMS Conference for Early Career Professionals
- Fifth Symposium on Building a Weather-Ready Nation: Enhancing Our Nation's Readiness, Responsiveness, and Resilience to High Impact Weather Events
- Fifth Symposium on Prediction of the Madden–Julian Oscillation: Processes, Prediction, and Impact
- Fifth Symposium on the Joint Center for Satellite Data Assimilation
- Third Symposium on High Performance Computing for Weather, Water, and Climate
- Fifth Symposium on the Weather, Water, and Climate Enterprise
- Second Symposium on Multi-scale Atmospheric Predictability
- Second Symposium on Special Sessions on US-International Partnerships
- Symposium on Greening the Built Environment
- **Special Symposium on Meteorological Observations and Instrumentation**
- Major Weather Impacts of 2016
- **Special Symposium on Severe Local Storms: Observation Needs to Advance Research, Prediction, and Communication**

How to Organize?

- By **Variable**? (**V**, radiance, fluxes, moisture, etc., etc.)
- By **Instrument**? (radars, satellite sensors, profilers, mesonet, etc., etc.)
- By **Phenomena**? (convection, turbulence, jet streams, bores, etc., etc.)
- By **Scientific problem**? (grand challenges; process studies; etc., etc.)
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- By **Application need**? (better warnings and forecasts; verification; etc.)
- By **Location**? (surface, PBL, soil, troposphere, cryosphere, etc., etc.)
- **Suggestions welcome!**

Sample Summary:

Special Symposium on Severe Local Storms: Observation Needs to Advance Research, Prediction, and Communication

- Most requested: **Low level moisture f(z)** (surprise!)
- Also needed:
  - Low level temperature and wind
  - *Dense* radar obs of Vr, Z, hydrometeors
  - Better storm-report data base
  - *Dense* surface variables; land surface parameters; topography
  - Hydrometeors; Precipitable water; rainfall; snowfall; lightning
- Could state in terms of what models need for initial conditions
- Increased resolution in **z**, x, y, t, but requests vary depending on purpose

Sample Summary (cont.)

Instruments:

- Dense mesonets (stationary and mobile)
- Dense, multi-wavelength, polarimetric radars
- Other wind (lidars, sodars, rawinsonde, UAS)
- Thermodynamic profilers (MWR, AERI, DIAL, Raman lidar, GPS, UAS, raobs)
  - Strengths and weaknesses in each system
  - Data assimilation can help here
- Satellite sensors (remote estimation of many of the requested obs and derived parameters such as CAPE) but important to incorporate ground-based and in-situ obs to improve products, especially in cloudy regions)
- Disdrometers; ceilometers; photogrammetry
- Space-based radar

Sample Summary (cont.)

Phenomena:

- Tornadoes
- Boundaries (dry lines, gust fronts, outflow boundaries, cold/warm fronts)
- Bores, gravity waves, squall lines, QLCS, MCC, derechos, cold pool, RIJ
- Supercell (mesocyclone, RFD, FFD, updraft, vault, right- & left-movers)
- Microphysical processes (for cloud water & ice, hail, other hydrometeors)
- PBL (thermals, HCRs, neutral vs stable/ nocturnal, entrainment)
- Surface processes (SH and LH flux; soil temp and moisture as f(z)
- Flooding; hydrologic processes

Observational requirements different for all these (and other) phenomena

Sample Summary (cont.)

Scientific problem

- Tornadogenesis
- Convective initiation
- Convective and stable boundary layers; Turbulence
- Precipitation forecasting (start, end, location, duration, intensity)
- Microphysical processes
- Improved data assimilation and NWP for convective phenomena
- Surface and hydrologic processes

Sample Summary (cont.)

Application need

- Improved watches and warnings
- Improved societal response to warnings (human obs required)
- Better ability to verify microphysical processes in clouds
- Better verification of all parameters on all time and space scales
- Improved forecasts of all convective and mesoscale phenomena

Sample Summary #2

Special Symposium on Meteorological Observations and Instrumentation

Variables:

- Surface observations (esp. in poor counties or sparsely-populated areas)
- Aerosols (in and outside clouds)
- Air quality (PM, chemistry)
- Heat, moisture, momentum fluxes
- Hail
- Moisture profiles
- Soil temp. (and moisture)
- Aircraft radar data
- Refractivity gradients
- Cloud droplet number size/concentration
- PBL height

Sample Summary #2 (cont.)

Phenomena:

- Aerosol-cloud interactions
- Entrainment
- Bores
- Hurricanes
- Turbulence
- Surface-PBL interactions
- Stable BL

Sample Summary #2 (cont.)

Instruments:

- Surface instrument components made from 3-D printers (for poor regions)
- UAS/RPV/quadcopters/drones
- Ceilometers
- DIAL
- Entire ARM SGP site suite (Raman lidars, etc. etc.)
- Dropwindsondes
- S-Pol Ka radar; dual wavelength
- Wind lidars (surface and airborne)
- Hail sensors
- Airborne phased array radar (in development)
- RASS; sodars
- Sonic anemometers

Sample Summary (cont.)

Scientific problem

- Surface data in inaccessible locations
- Cloud-aerosol interactions
- PBL evolution – diurnal change transitions
- Waves in stable flows
- Pollution transport in and above PBL
- Vertical profiles of everything
- Convective initiation
- LES model verification

Other Issues w.r.t. Obs Rec. Harvesting Summary

- Should we consider:
  - Cost
  - Technical feasibility
  - QC; coverage/resolution; accuracy; metadata
  - Research needs vs operational NWP needs (converging?)
  - Weather vs climate observing standards/variables
  - Field programs necessary to make progress; long-term testbeds
  - Information from sources outside AMS AM (answer is “Yes”; doing this today!)
  - Great comments. E.g. *“Even though substantial is wind data collected, there are simply not enough thermodynamic data sampled on the storm-scale, especially close to the surface. This type of data could contribute valuable knowledge to our understanding of cold pool dynamics and the role of buoyancy in and around the supercell and its associated mesocyclone, as well as aloft. Additionally, there is a need for in situ microphysics data to validate model physics, as well as novel ways to assess velocity in the tornado corner flow regions”*

Final Comments

- Hope to finish summary by end of summer - BAMS in 2018
- PBL/turbulence conference not at Annual Meeting - welcome feedback from people attending this meeting. Send papers that summarize observational needs.

- Challenge for instrument developers in making use of the electromagnetic spectrum: GoPro has captured the visible band, now has lightweight, low-cost “sensors” on UAS, etc. Can we do this in the microwave, infrared, etc. bands and create lightweight, portable, low-cost profiling sensors? CubeSats seem to have done it.