

# Global Environmental MEMS Sensors (GEMS): A Revolutionary Observing System for the 21st Century

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**Engineering • Science • Technology**

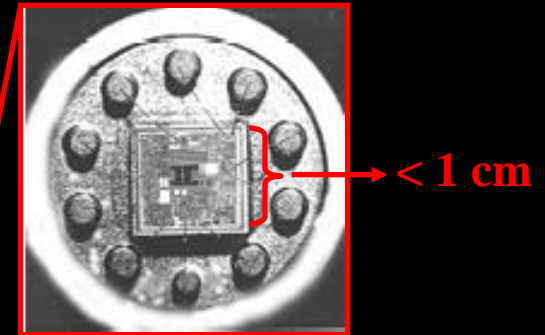
# Outline

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- Introduction/definitions
- Concept description
- Major feasibility issues
- Simulations
- Summary

# What are MEMS?

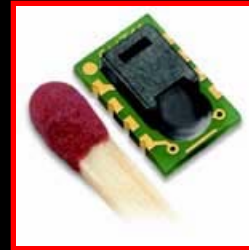
- Micro Electro Mechanical Systems (MEMS)
- Micron-sized machines + IC
- Sample applications



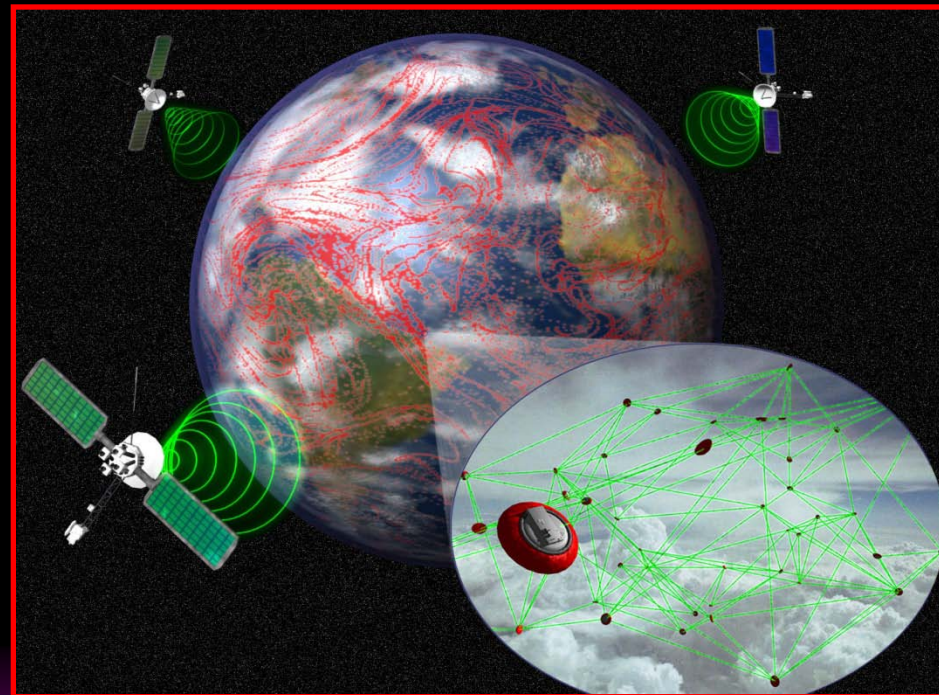
# GEMS "Concept"

- Integrated system of airborne probes
  - Mass produced at very low per unit cost
  - Disposable
  - Suspended in the atmosphere
  - Carried by wind currents
  - MEMS sensors to measure T, RH, P
  - Determine u,v based on position changes
- Self-contained with power source for
  - Sensing
  - Navigation
  - Communication
  - Computation
- Mobile, 3D wireless network with communication among
  - Probes
  - Intermediate nodes
  - Data collectors
  - Remote receiving platforms

T, RH

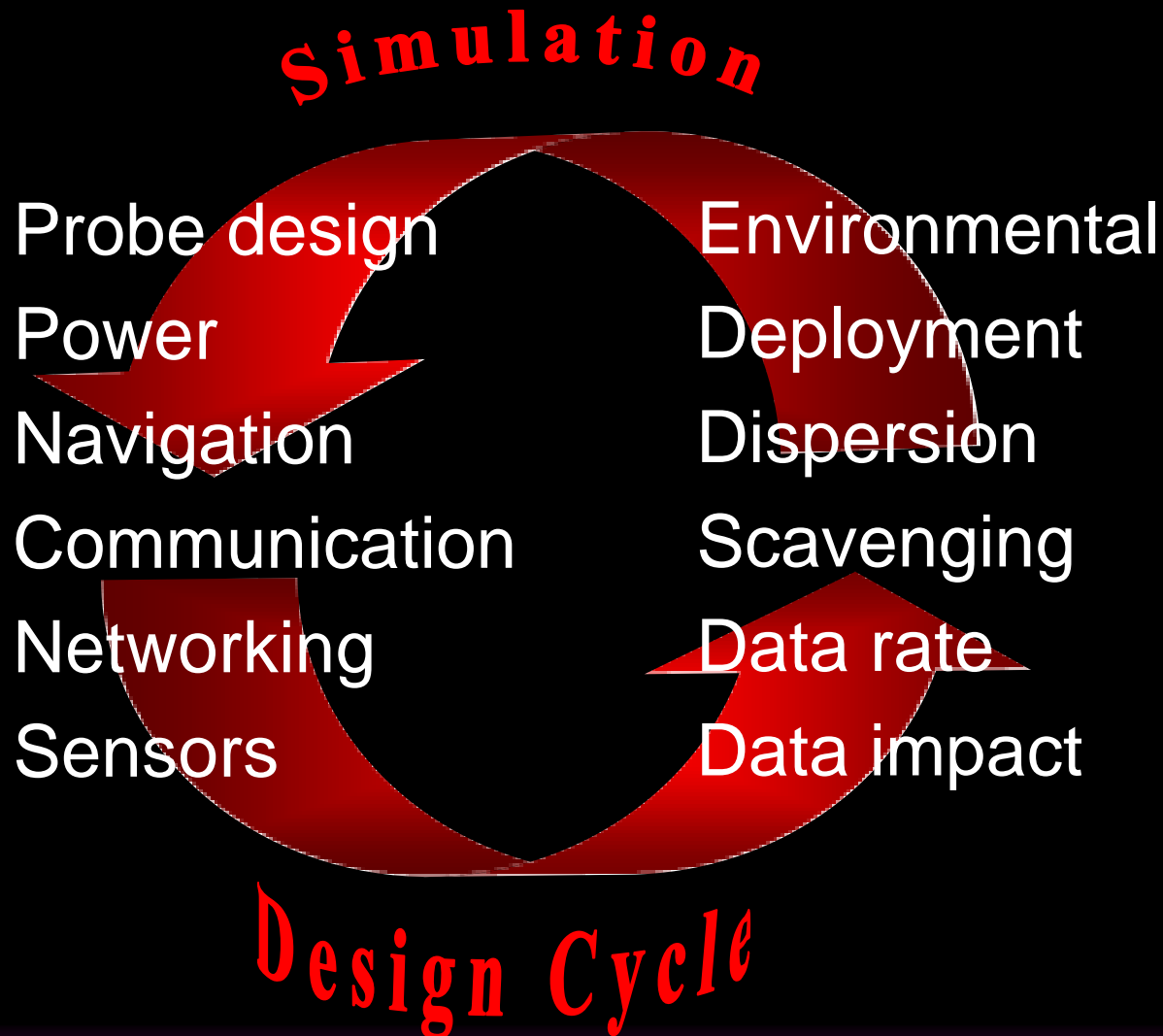


Pressure



# Major Feasibility Issues

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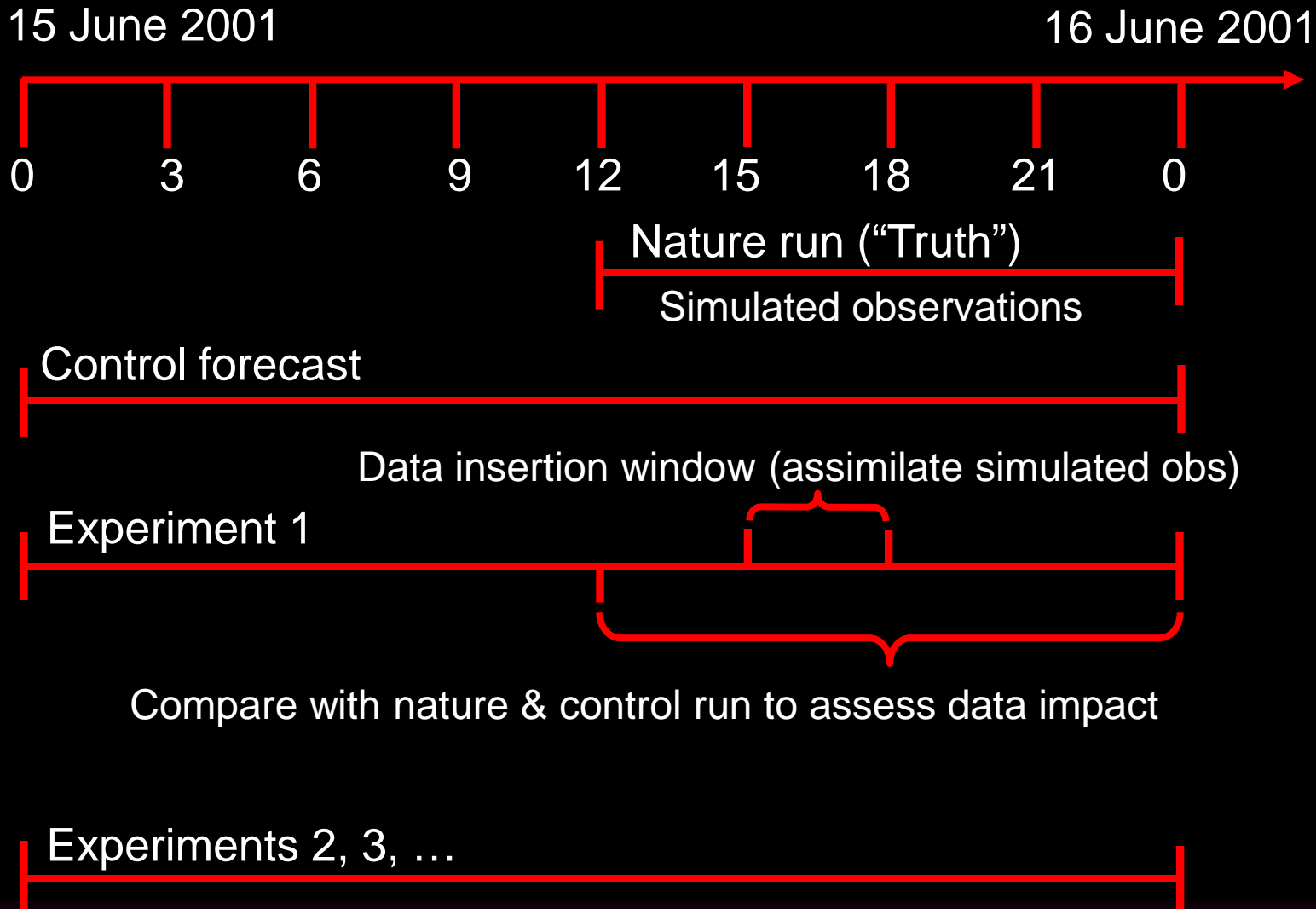


# Simulation Tools

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- Numerical weather prediction model
  - Advanced Regional Prediction System (ARPS)
  - Virtual weather scenarios
  - Variable spatial & temporal resolution
- Lagrangian particle model
  - Probe deployment and dispersion
  - Simulate turbulence, terminal velocity, etc.
  - Scavenging (washout)

# Observing System Simulation Experiments (OSSE)



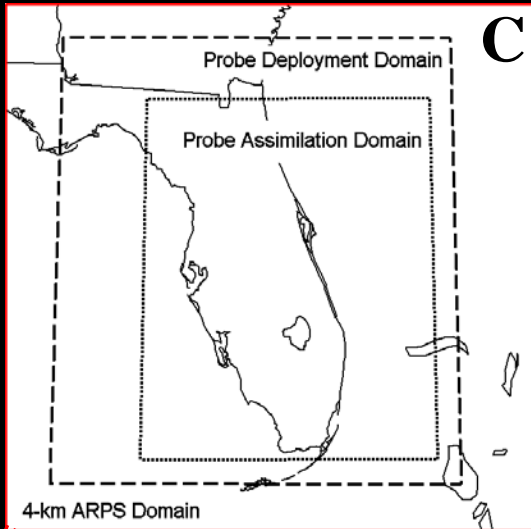
# Experiment Design

“Identical  
Twin”  
  
Intermittent  
DA  
30-minute  
Intervals  
  
No  
Conventional  
OBS

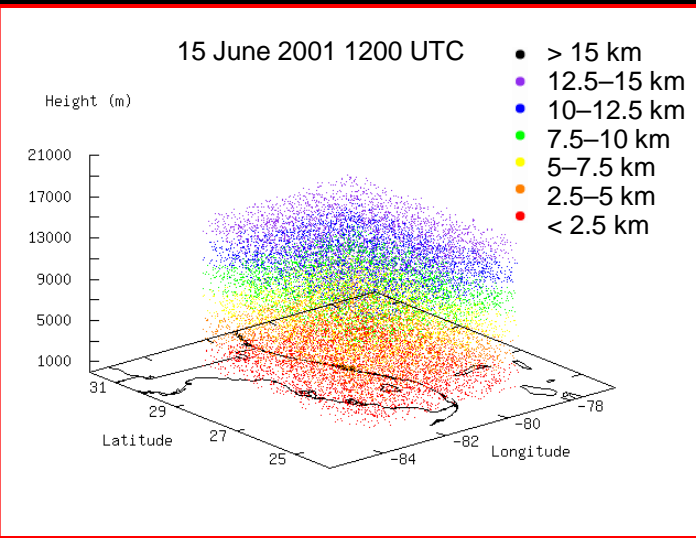
Simulation	Description
Nature	RUC Analysis IC
Control	NOGAPS Forecast IC
OSSE 1	Assimilate T, RH, P, Wind
OSSE 2	Exclude RH
OSSE 3	Exclude Wind
OSSE 4	Exclude T
OSSE 5	Include errors
OSSE 6	Exclude 50% of OBS
OSSE 7	Exclude 75% of OBS



# Simulation Domains

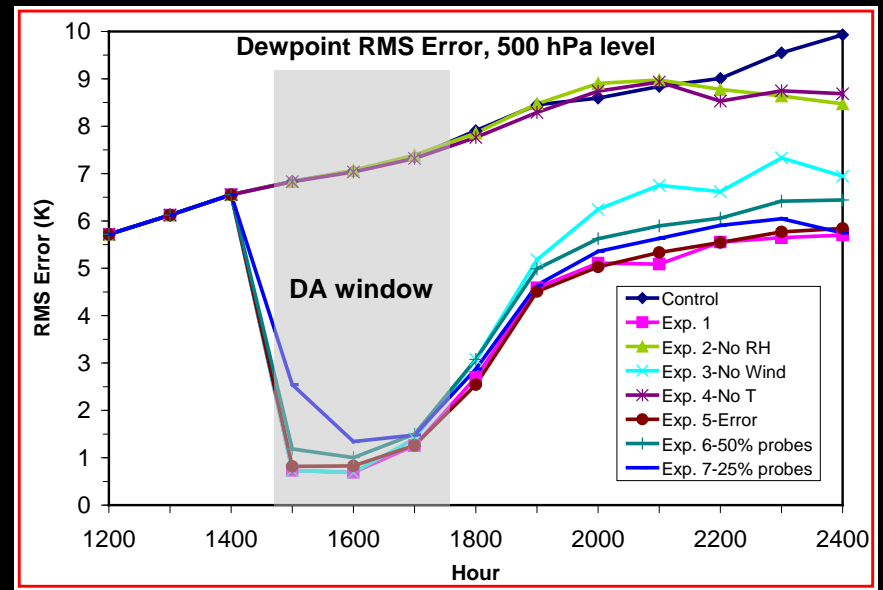
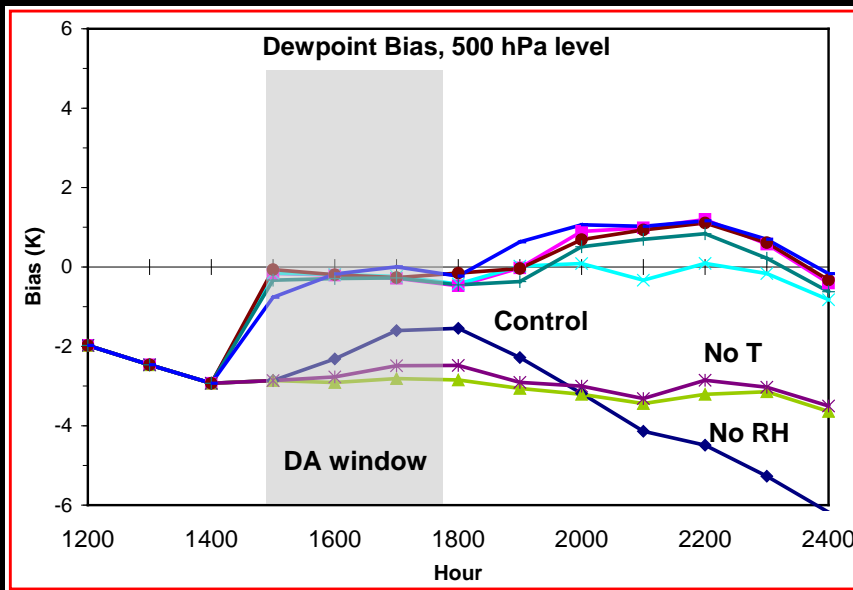


Random 3D deployment  
Initial separation distance  
16 km horizontal  
1 km vertical  
Terminal vel.:  $0.08 \text{ m s}^{-1}$



# Simulation Results

## Grid-Averaged Dew Point Statistics



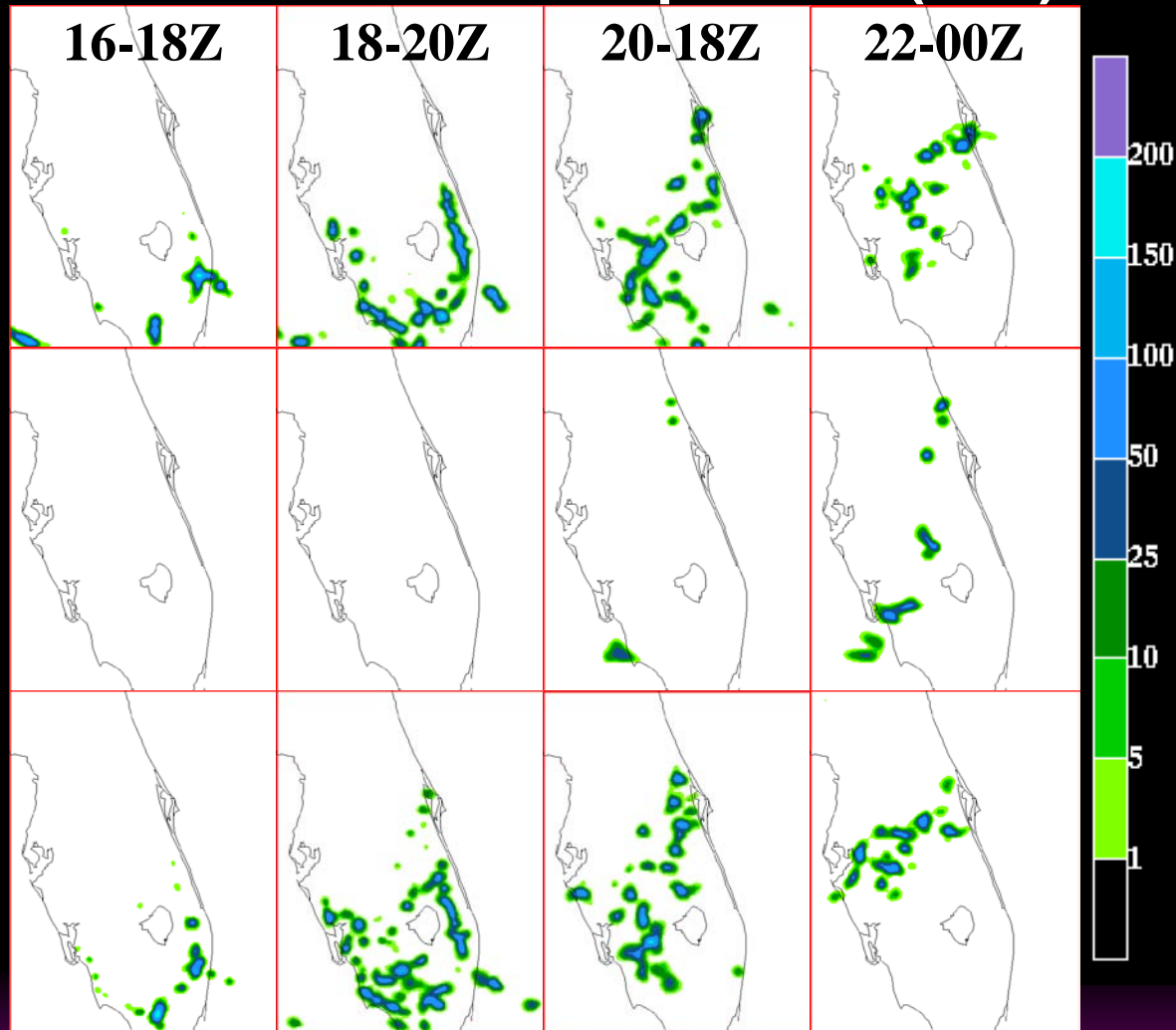
# Simulation Results (con't)

## 2-h Cumulative Precipitation (mm)

Nature

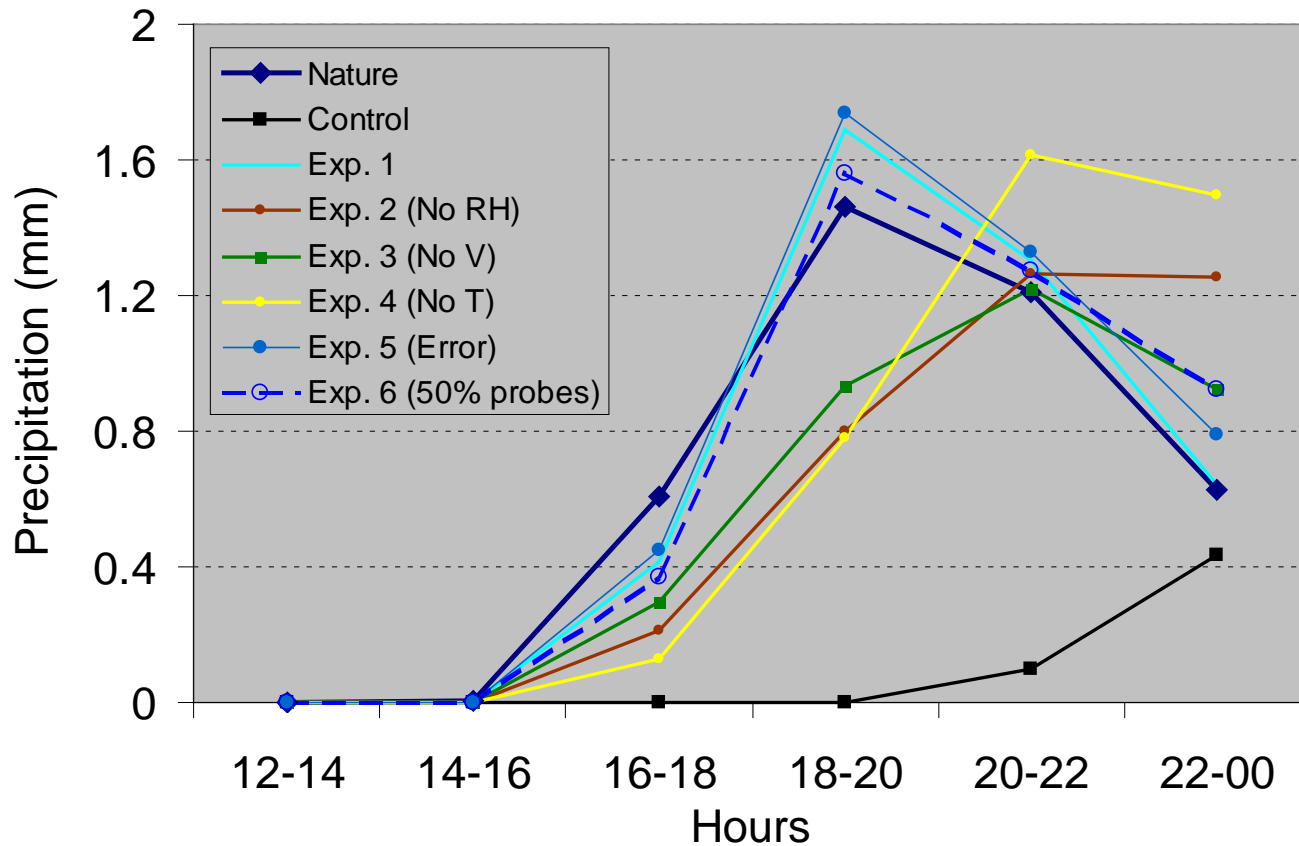
Control

Exp. 1



# Simulation Results (con't)

## Grid-Averaged 2-hour Precipitation



# Summary

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- Advanced concept description
  - New observing system based on mobile network of wireless, airborne probes w/ MEMS sensors
- Key issues
- OSSE results

Phase I final report: <http://www.niac.usra.edu/studies/>

Phase II award pending

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