Environmental Macroscope Observatories

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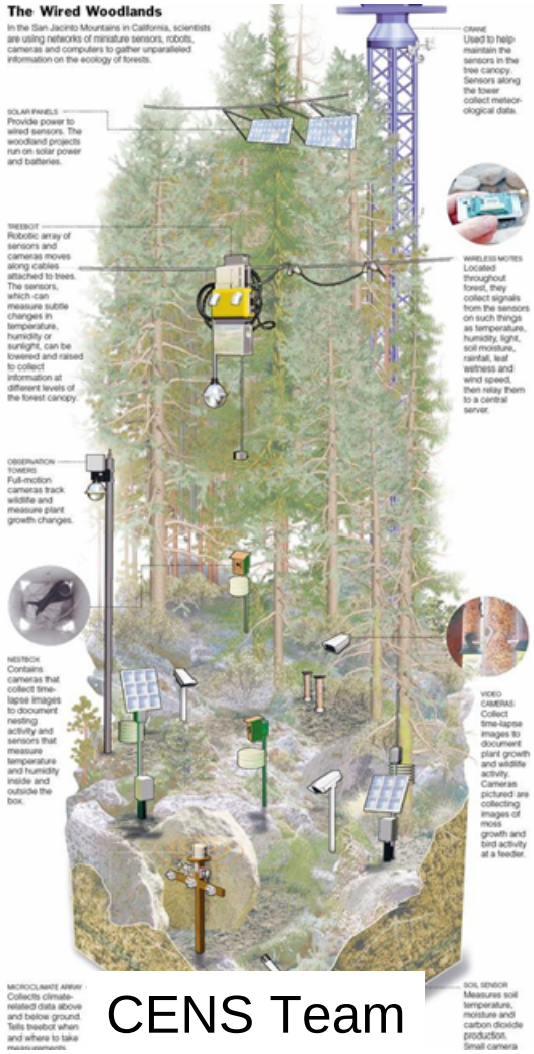
Components of the Macroscope

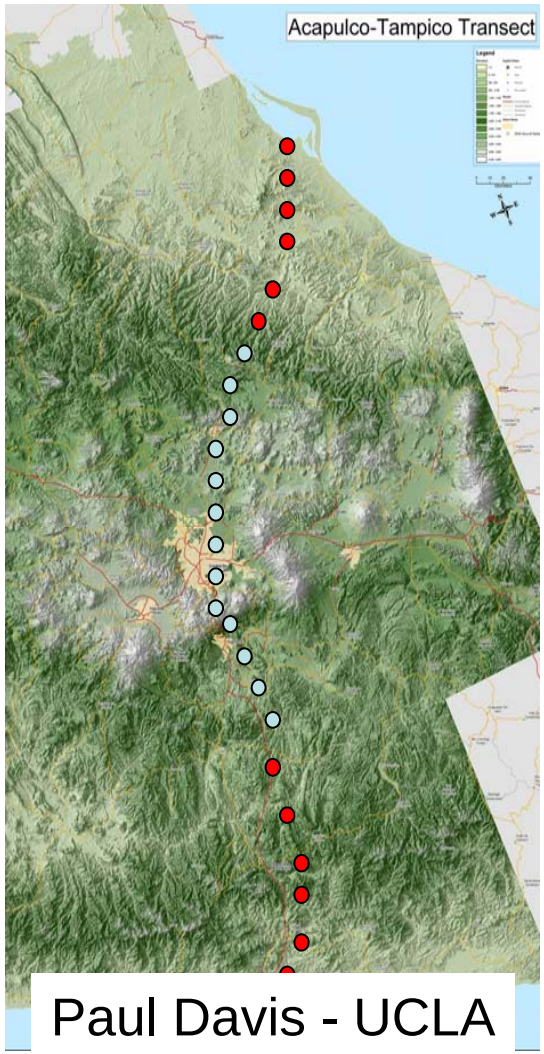
- Application objectives
  - Field variable sampling, event detection, sensing fidelity
- Macroscope sensor systems
  - Static and actuated
- Deployment design
  - Transducers, locations, orientations, sampling protocols
- Adaptation and reconfiguration
  - Autonomous or externally supported
- Verification
  - Audit methods, detailed calibration, physical sampling,
- *Demonstrate with example*
- *Summarize with Macroscope research questions*

Environmental Macroscopes



CENS Team

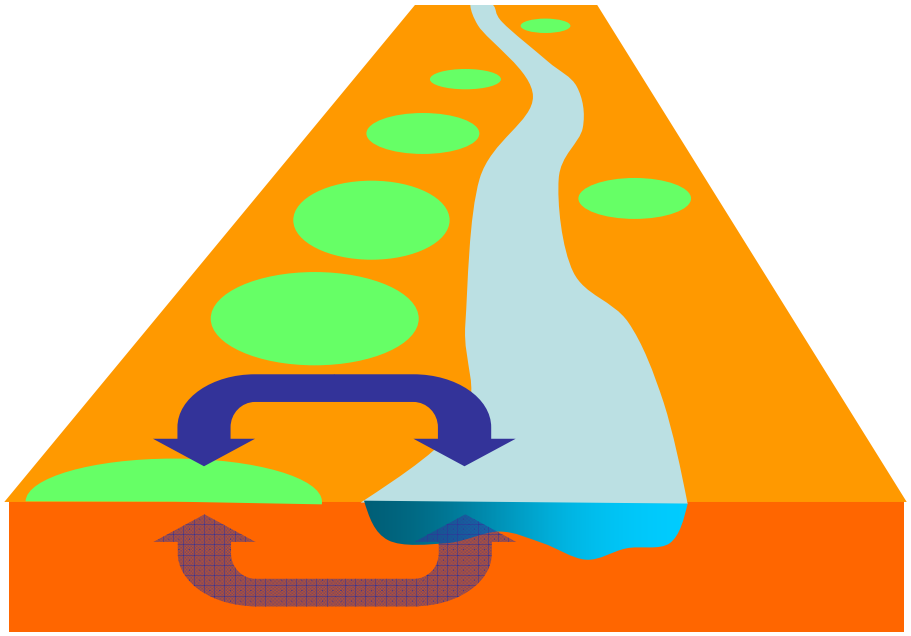
Tom Harmon - UC Merced



Paul Davis - UCLA

Macroscope Objective

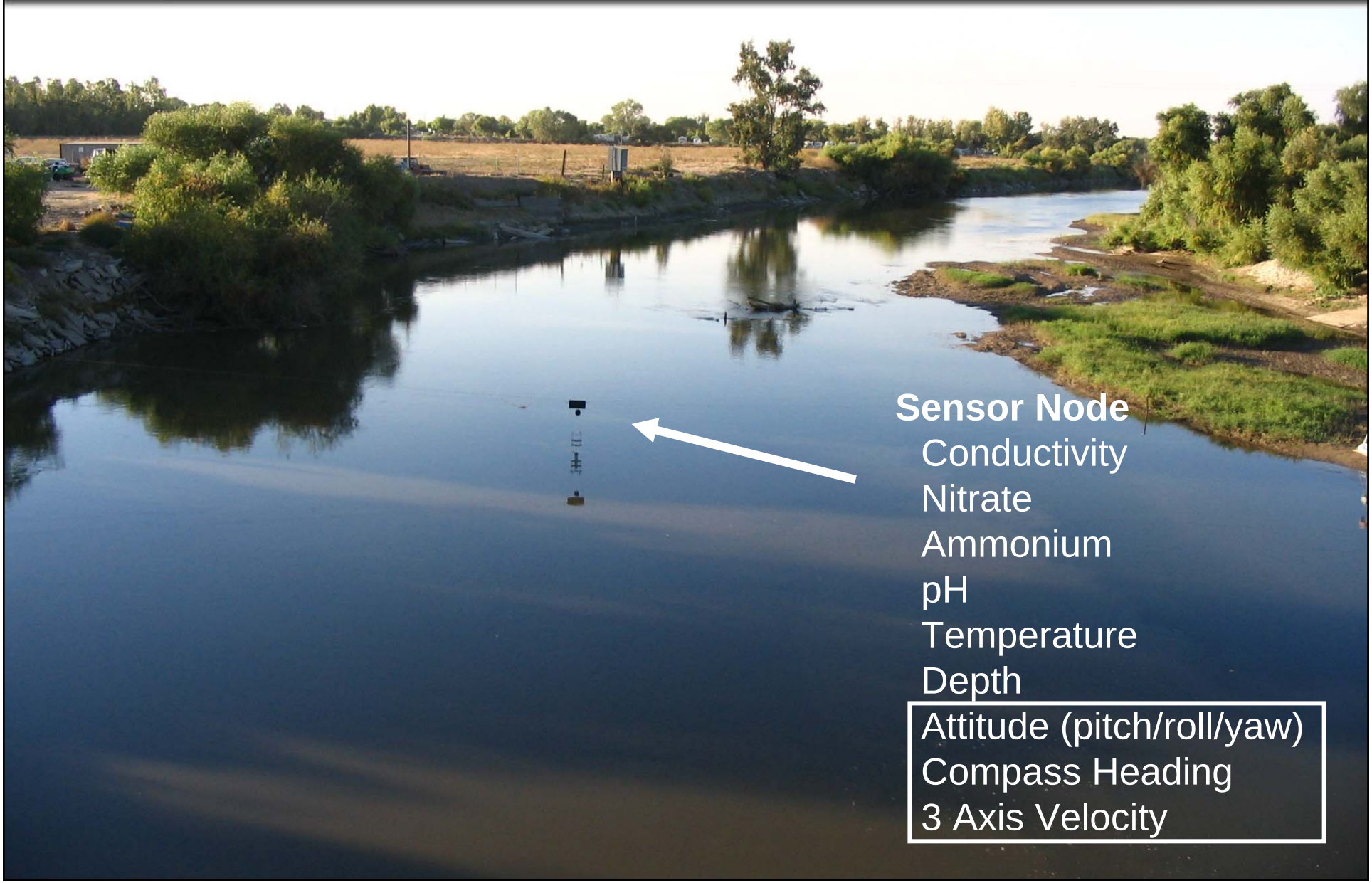
- Example: San Joaquin Valley
  - Irrigation leads to salt contamination
- Fundamental, international problem
  - Must solve salt “circuit” problem
  - Salt contamination nonuniform
- Requires Macroscope solution
  - Properly located
  - Select river “plane”
  - Measure
    - ***Spatially and angular resolved velocity***
    - ***Concentration of salt contaminant***
  - Compute mass flux



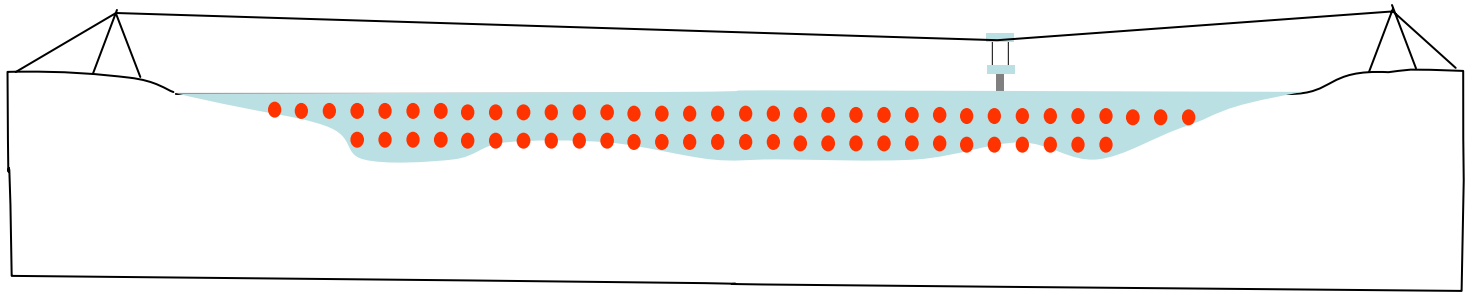
Macroscope Components: Static Sensors

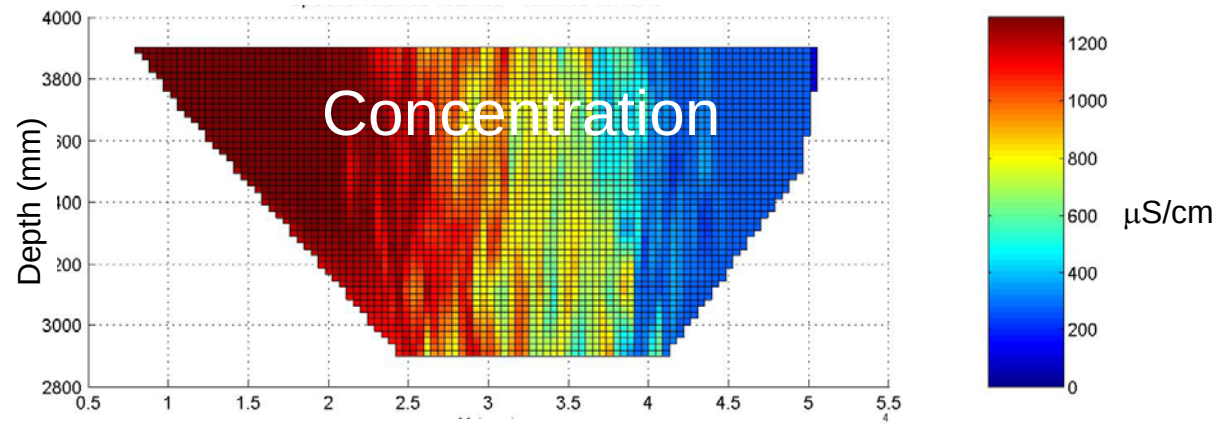
- Javelin
  - Subsurface soil characteristics
  - Groundwater - river interaction
- Sonar depth profiling
  - River subsurface structure
  - Human actuated
- Deployed in advance
  - Guides actuated sensor placement

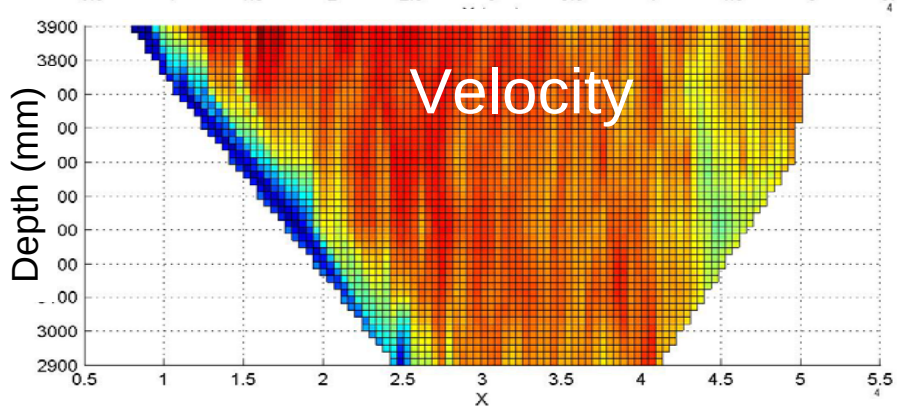
Macroscope Components: Actuated Sensors



Macroscope Image







Width (m/10)

Macroscope Research

- Scaling the Macroscope
  - Near term opportunity (2007)
  - Convergence of science, technology, public policy
  - Entire San Joaquin River map
- Macroscope design problem
  - Given user measurement objectives determine:
    - **Sensor selection, sensor operating protocols**
- Macroscope deployment design
  - Given application-specific phenomena model:
    - **Develop methods for sampling at multiple scales and multiple rates to determine optimal deployment to best benefit objectives**

Macroscope Research

- Macroscope run time systems
  - Adapting to dynamic phenomena:
    - **Develop static and actuated sensor networks that autonomously reconfigure to adapt to time evolution or discrete events**
- Physical sampling problem
  - Recognize limitation of sensor systems
    - **Add ability to Macroscope to sample material water, atmosphere**
- Verification problem
  - For an operating Macroscope system develop:
    - **Audit methods that determine optimal locations for verification of system design selections**
    - **Audit methods that introduce diverse sensors and physical sampling**
    - **Audit methods that use sparse resources to verify over wide regions**

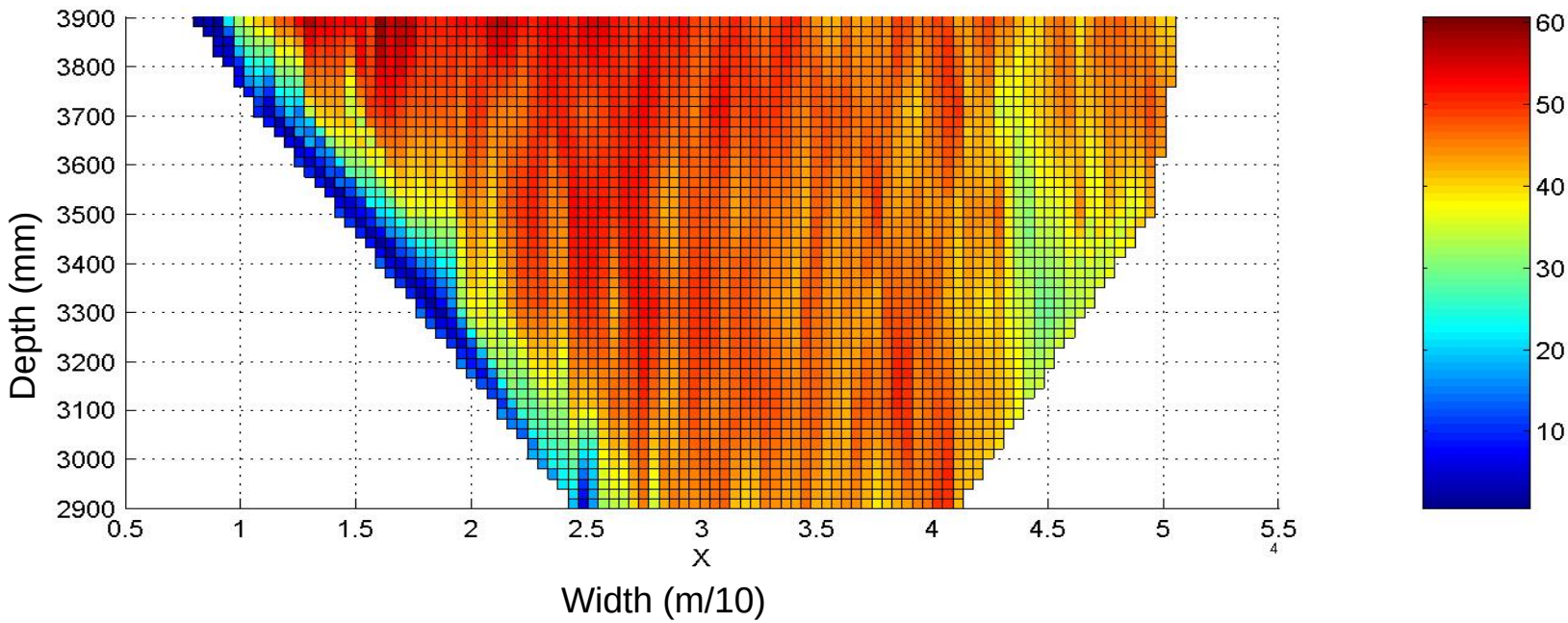
Macroscope Research

- Multitasking Macroscope Observatory
  - Recognize that Macroscope supports many users
    - **Contrast with astronomical observatory**
    - **Macroscope inherently is subject to unexpected events**
  - Recognize that meeting schedules may be mission-critical for multiple users with competing requirements.
    - **Consider example of water resource management where flow, salt, and pesticide detection must occur**
    - **Consider sudden flooding conditions**
- Immediate next steps
  - Public health, economic, and environmental impact questions are in the near future

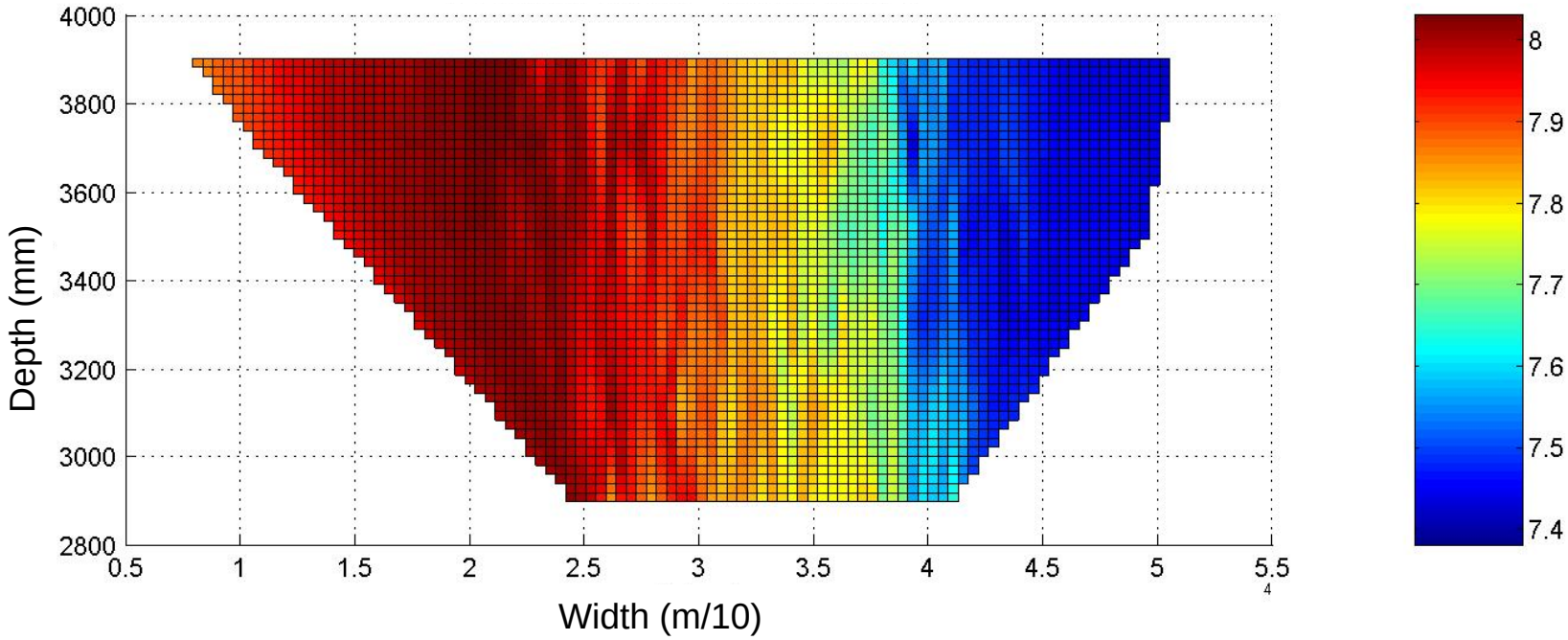
Comparison of Macroscope with Prior Methods

- High resolution profile of flow and contaminants
  - Flow verified to be accurate- two flow conditions
    - **Each agree within less than 1% tolerance of downstream government gauging measurement**
  - Enables *first high resolution direct measurements of mass flow of contaminants*
  - Now possible to *track* input/output of contaminant sources
- Prior methods
  - Manual:
    - **15m stream**
    - **350 sample points and one variable**
    - **Two weeks**
  - Macroscope
    - **50m stream**
    - **6,000 sample points with 8 simultaneous variables**
    - **100 min**
    - **Over 1000x improvement**

Water Velocity Magnitude



pH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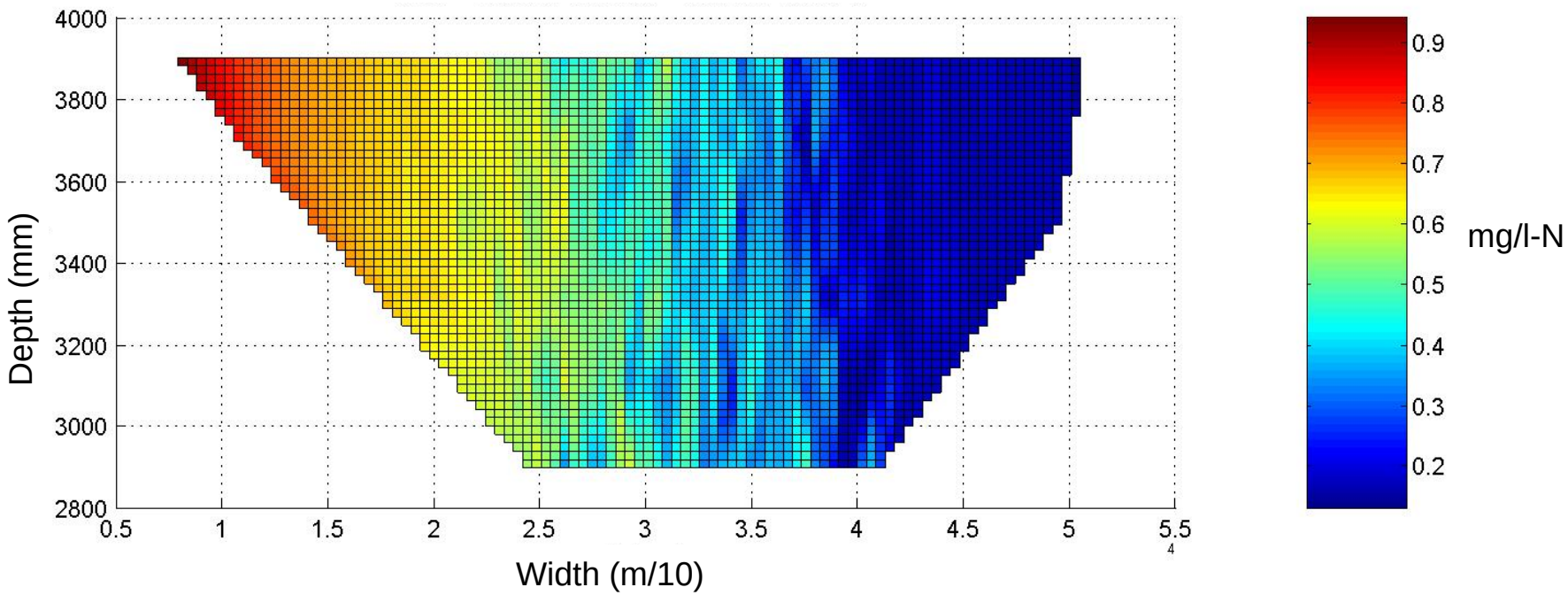
Ammonium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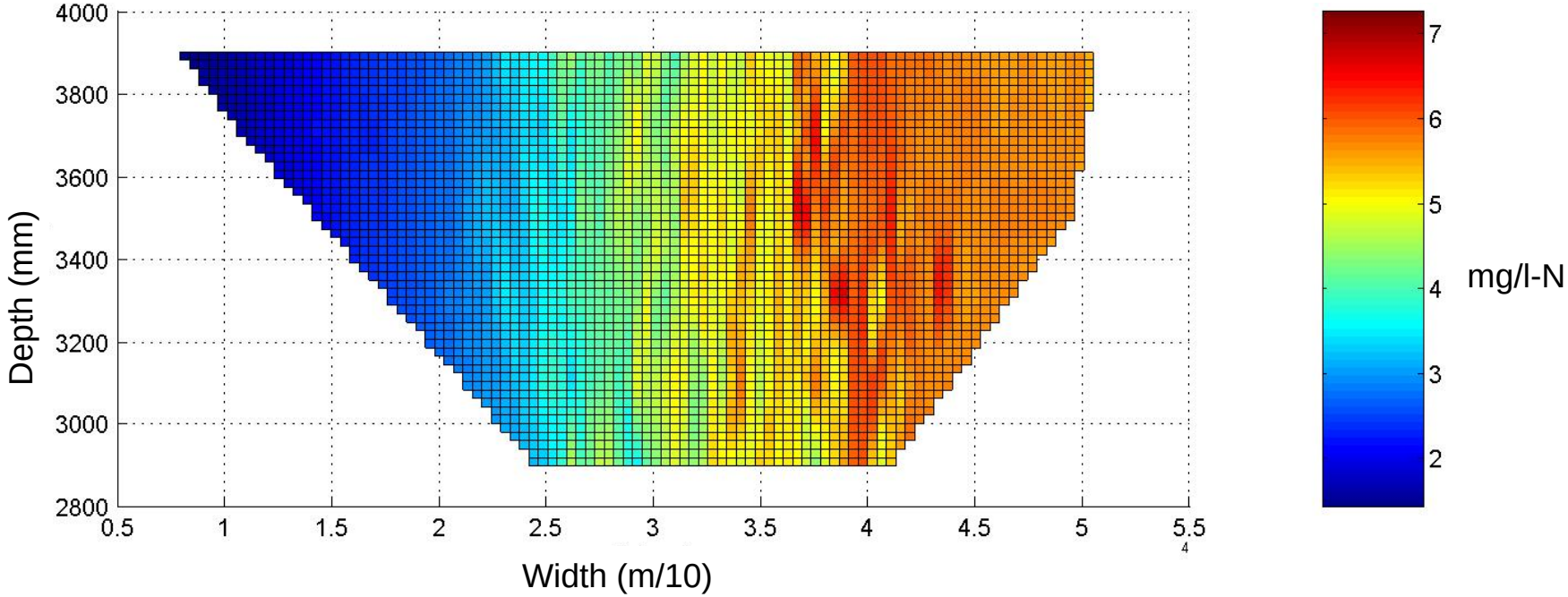
Nitrate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