Overview of Hazard Prediction Modeling Program

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Joint Science and Technology Office
Defense Threat Reduction Agency

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Environmental Hazard Prediction

- Why we're here: Warfighter support through technical improvement of JEM, JWARN, JOEF
  - Primarily supporting JEM

- Program structure focused on known limitations in dispersion modeling capabilities
  - Need for continued progress in dispersion modeling and related work *in particular areas*
  - Anticipate CBDP budget cuts in FY07
  - We need to continue making good progress to enable defense of our budget and projects

Environmental Hazard Prediction Thrust Area Evolution

- Past: DoD environmental hazard S&T performed mostly independently by DTRA, Navy, Army
  - Lack of coordination within DoD
    - Duplication in some areas
    - No capability or programs in other areas
- Last year: Began to coordinate efforts
  - Developed S&T plan, addressing joint program needs
  - Began developing, managing projects to address key areas
- Current: Integrated programs leveraging capabilities across DoD, collaboration with US govt, universities, companies, foreign countries
  - Meeting CBDP needs, reducing duplication of effort

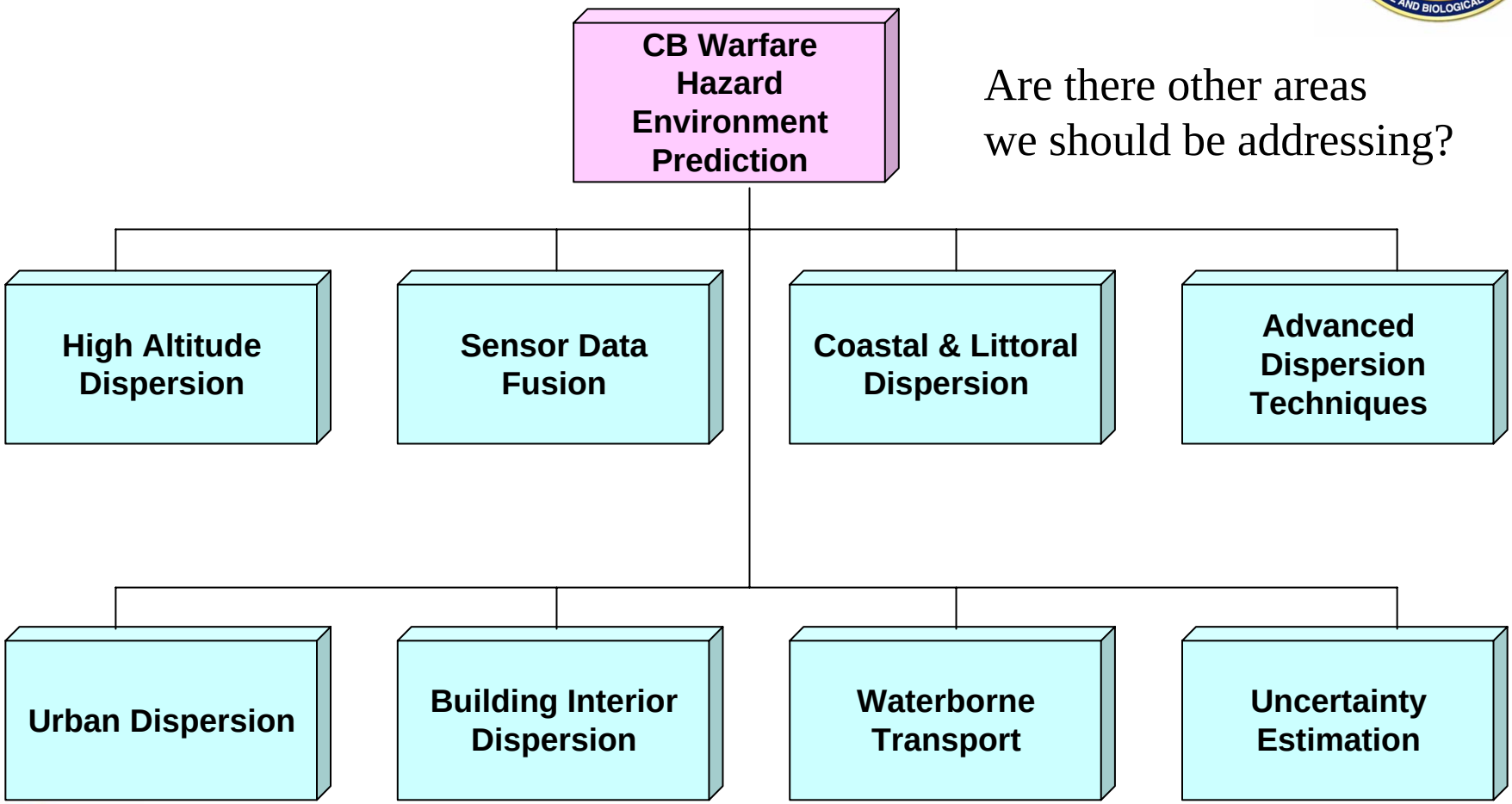
Environmental Hazard Prediction Thrust Area Objectives

- Objective: Provide technological capabilities to meet stated requirements in CB defense programs
- Provide *core system* capabilities, *enabling* capabilities
- *Core system*: components of JEM, JWARN, JOEF
- *Enabling*: provide data needed by JEM, JWARN, JOEF to function
- Requirement: Ensure technological capabilities are in place to enable JEM, JWARN, and JOEF to work, when called for by development schedules

Environmental Hazard Prediction Program Components

- Program management
- Technical guidance and support
- **Model development and acquisition**
- Enabling capability coordination
- **Experimental data**
- System integration
- Technology transition

CB Warfare Hazard Environment Prediction Thrust Area Focus Areas



Are there other areas we should be addressing?

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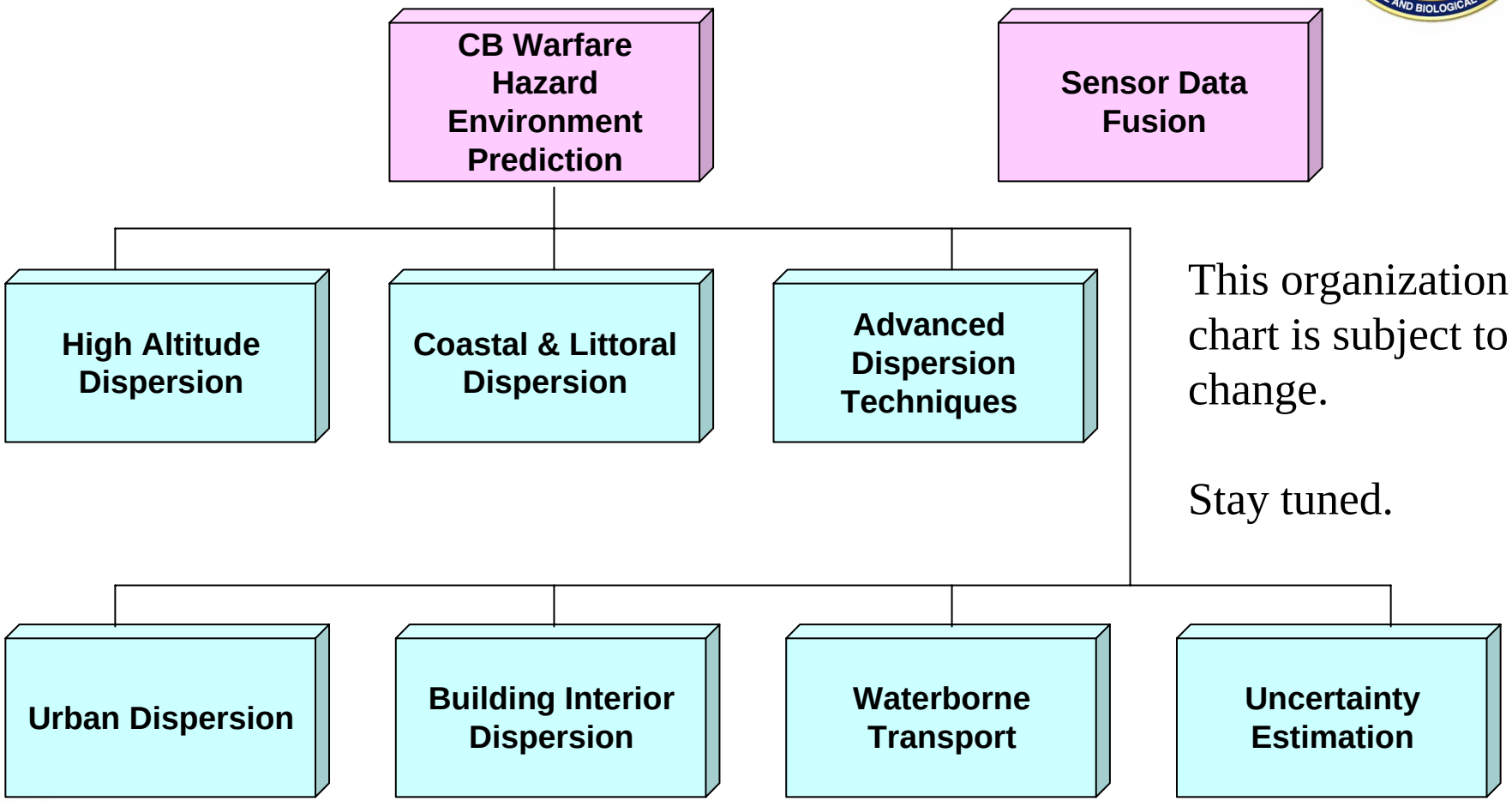
Future Structure – Split Thrust Area



This organization chart is subject to change.

Stay tuned.

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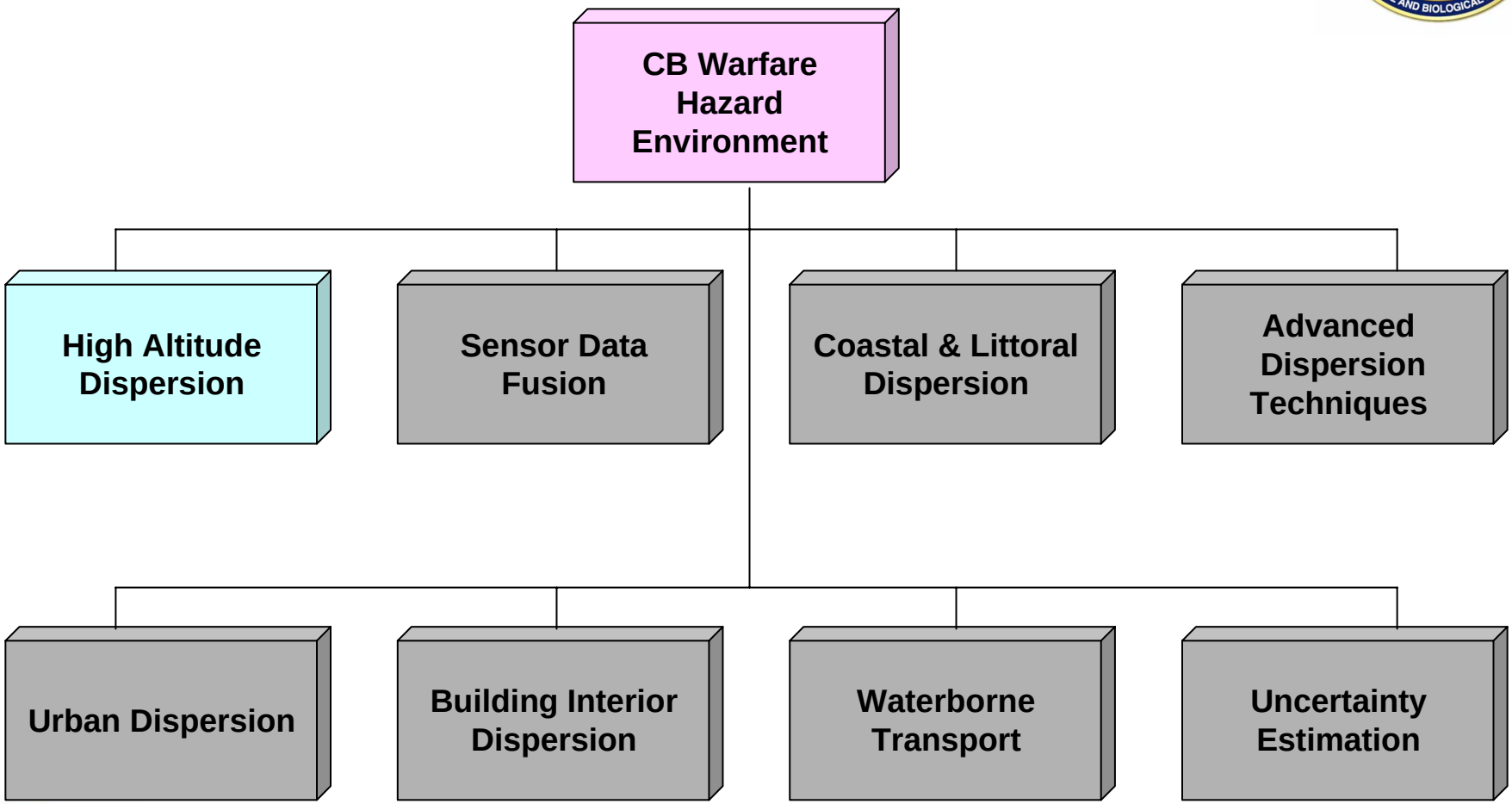
CB Warfare Hazard Environment Prediction Thrust Area Focus Areas



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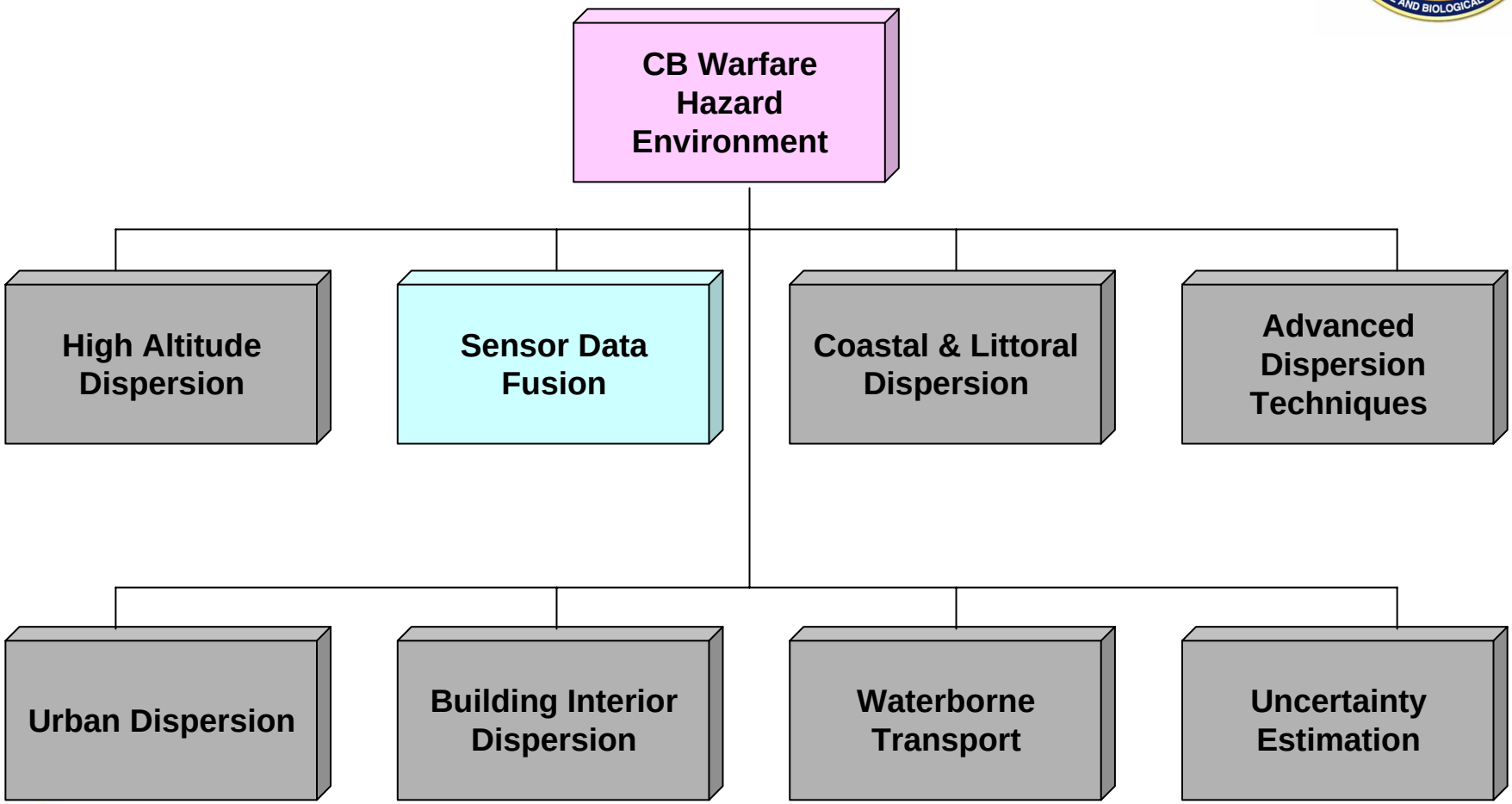
Missile Intercept Modeling

- JEM Block II requirement
- Very different from modeling in lower atmosphere
  - Thin atmosphere, different turbulence characteristics, uncertainty about behavior and characteristics of released CB materials
  - Lack real-time weather predictions

- Missile intercept source term characterization
  - JSTO is funding program at LLNL/UCSB to address source term specification: *Release and Atmospheric Dispersal of Liquid Agents* (Thursday 1330)

- High-altitude weather
  - JSTO funded project at LLNL to evaluate impact of real-time weather data
    - results show significantly different ground deposition patterns
  - JSTO expects to fund 6.1 project beginning in FY06 to study connection between terrestrial and space weather

CB Warfare Hazard Environment Prediction Thrust Area Focus Areas



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Sensor Data Fusion

- Large program to improve dispersion modeling
  - Large increase in work projected for FY06
  - Supports both JEM and JWARN
- JSTO program coordinated with TP9/TP10 program
  - Coordinates several related projects, leverages UK programs
- Principle objectives:
  - Blend CB sensor data with dispersion model
  - More accurate depiction of CB hazard area
  - Ability to “backtrack” to source location
  - Provide guidance about sensor performance
  - Support tool to place sensors for facility protection
  - Future: Extend to fusion of meteorological data

Sensor Data Fusion Presentations

- *Source Term Estimation* (Dstl)
  - Presentation, demo Wednesday 1055-1200
- *Fusion of CB Data and Model Output* (Dstl)
  - Wednesday 1300-1330
- *Chemical/Biological Source Characterization* (DTRA)
  - Wednesday 1330-1400
- *Optimizing Sensor Placement for CB Defense* (NGIT)
  - Wednesday 1400-1430
- *Sensor Location Optimization Tool Set* (ITT)
  - Wednesday 1430-1500
- *Overview of Mesoscale Modeling for Dispersion Applications* (NRL Monterey) – Wednesday 1500-1530

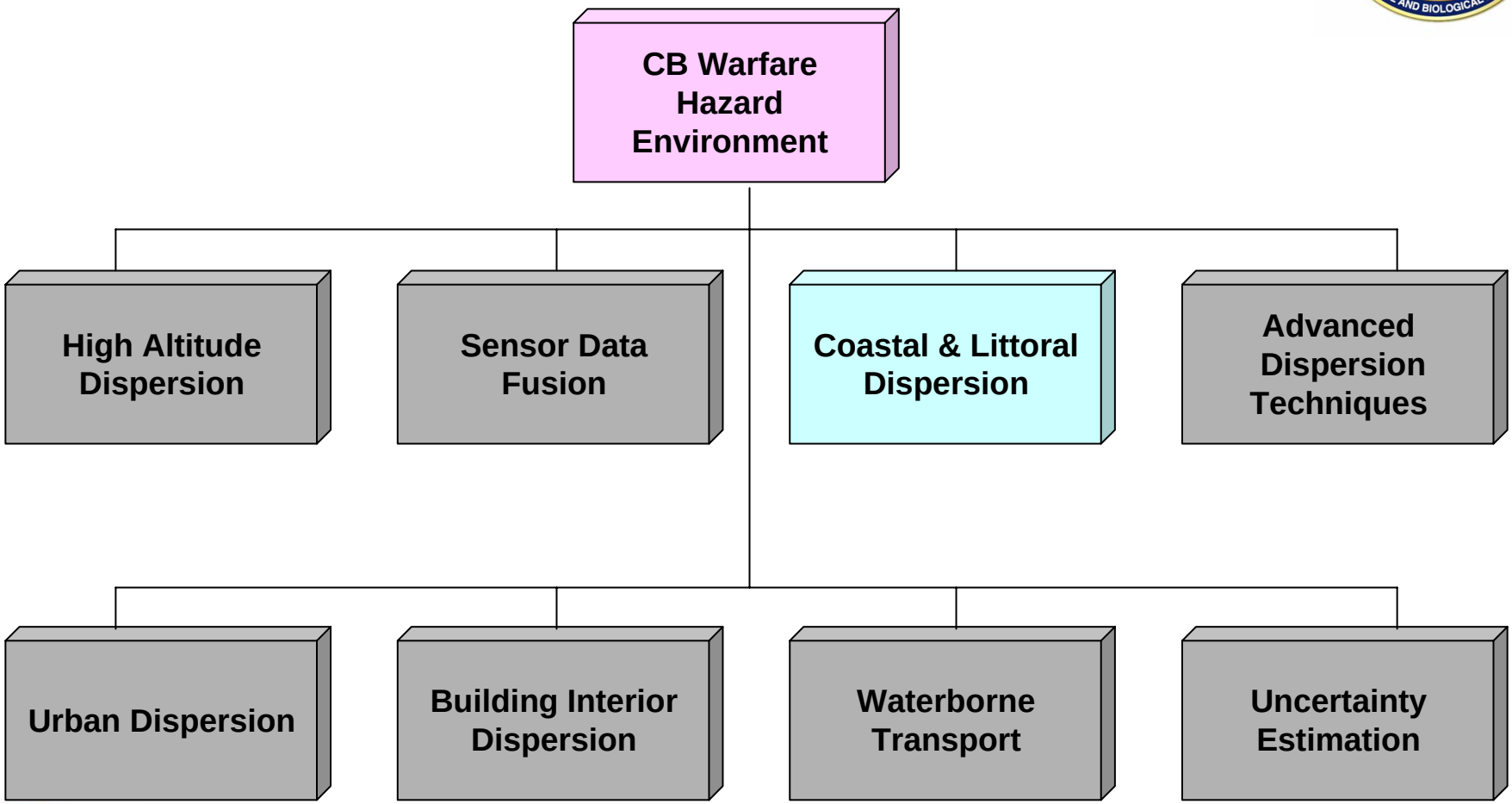
Additional JSTO Sensor Data Fusion Projects

- Sensor Network Methodologies (NSWC Crane)
- Support to JSTO Sensor Data Fusion Program (NOAA)
- Beginning: Sensor Software Placement Suite (NSWC Dahlgren)
- Beginning: SCIPUFF Adjoint Model for Release Source Location from Observational Data (Aerodyne)
- Beginning: Data Assimilation for Chem-Bio Dispersion in the SCIPUFF/HPAC Computing Environment (UB/PSU) (6.1 project)

Sensor Data Fusion Program Concerns

- Need to work toward better integration, coordination between S&T projects
- Not good enough only to work independently
- Collaboration will increase productivity and improve overall capability
- Some duplication is intended in order to explore different approaches to same problem

CB Warfare Hazard Environment Prediction Thrust Area Focus Areas



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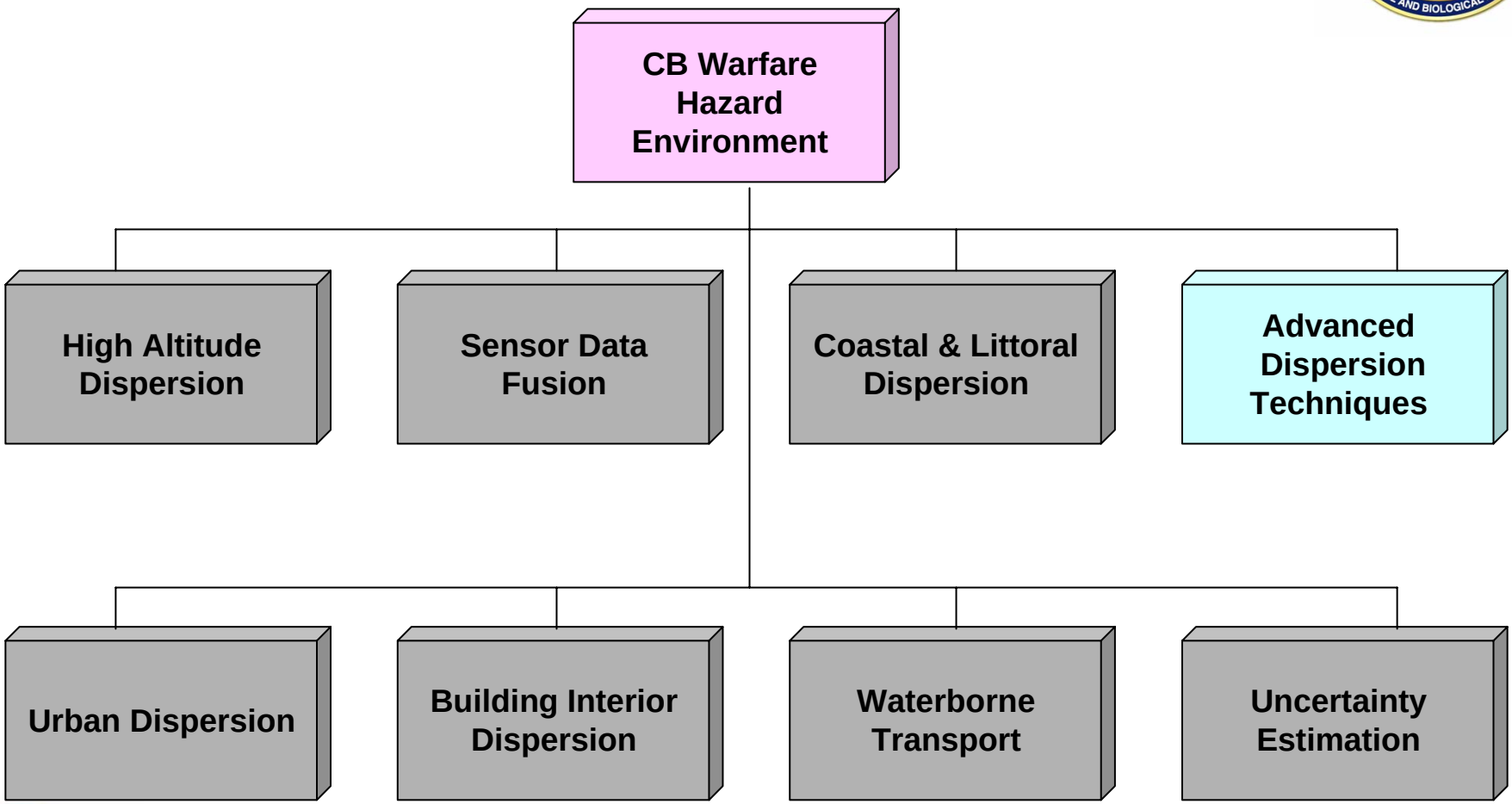
Coastal and Littoral Improvement

- JEM Block II requirement – also a key problem area
- Identified at least three ways to address this requirement
  - Use high-resolution weather data
  - Develop improved weather modeling and data assimilation systems to use more observations, including radar and other remote sensing, and develop coupled air-sea models
  - Improve boundary layer parameterizations
- JSTO program currently pursuing four C&L initiatives
  - Nowcasting DTO (NRL Monterey) directly relates to this requirement
  - Beginning: *Coupled Air-Sea Modeling for Improved Coastal Urban Dispersion Predictions* (NRL Monterey) (Thursday 1030-1100)
  - Link to radar propagation work, field tests at NSWC, NRL, NPGS. Beginning: *Measurement of Coastal & Littoral Toxic Material Tracer Dispersion* (NSWC Dahlgren) (Thursday 1100-1130)
  - NOAA/Kamada study using AF data from Cape Canaveral to identify sensing systems required for operational improvement, and to evaluate new boundary layer parameterization scheme

CB Warfare Hazard Environment Prediction Thrust Area Focus Areas



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Improvements in T&D Methodologies

- JEM has Block II requirement to improve T&D methodologies when significant benefits will result
  - Many options: Add new models, improve source term models, improve parameterizations, make better use of weather or land-surface data, etc.
- Current Projects:
  - Developing MESO/RUSTIC as possible future component of JEM: *Chemical and Biological Hazard Environmental Prediction* (NSWC Dahlgren) (Thursday 0900-0930)
  - Supporting R&D in weather data assimilation (NRL Monterey)
- New Projects:
  - 6.1 project with Army Research Lab: Turbulence in the Stable Boundary Layer
  - 6.1 project with NCAR/PSU: Relationship of Boundary Layer Winds to Soil Moisture & Cloud Properties
  - Cellular Automata Exterior Hazard Assessment Tool (NSWC Dahlgren)
  - Modeling the Atmospheric Chemistry of TICs (DTRA)
  - Coastal and Littoral program (discussed earlier)

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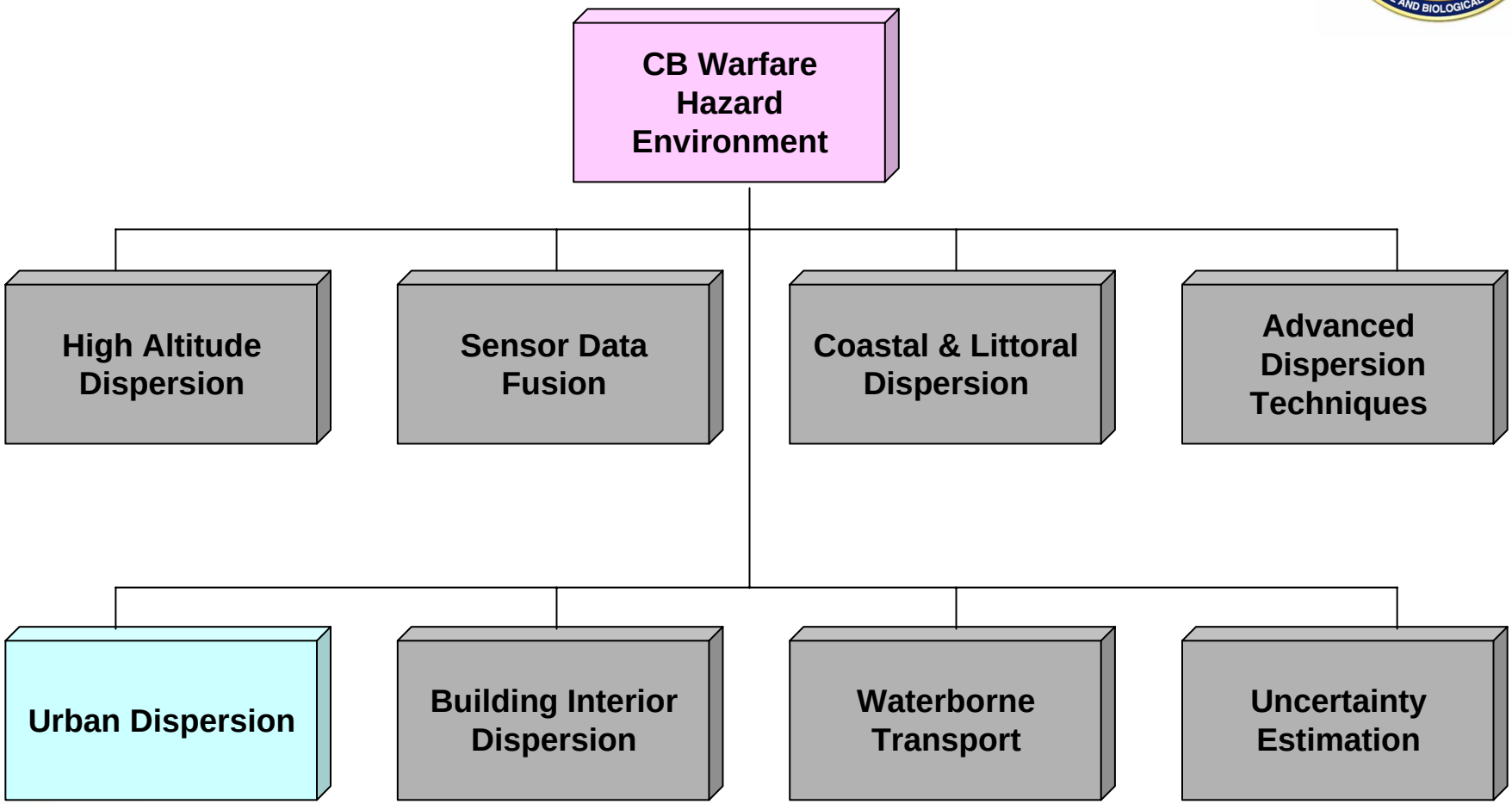

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Urban Dispersion Modeling

- JEM Block II requirement – already many investments elsewhere – relatively little needed by JSTO
- Variety of urban wind and dispersion models available
  - One choice is to link models of difference scales: *Contaminant Transport and Dispersion Modeling in Urban Areas Using Coupled Mesoscale (WRF) and Urban Scale Models (CFD-Urban)* (CFDRC) (Thursday 0930-1000)
  - UWM, UDM integrated into HPAC
  - JSTO is supporting development of MESO/RUSTIC
  - Initial JEM urban models will be selected by JPM-IS
  - Will need ability to predict CB agent concentration and atmospheric pressure on sides of buildings for link to building interior modeling

Urban Dispersion Modeling (cont)

- Program Plans
  - Complete DTO developing MESO/RUSTIC
  - Proposed IPT to evaluate use of CFD models by JEM
- New Projects
  - Benchmark for Computational Modeling of Urban Flows (NRL)
  - Rapid Wind & Pressure Calculations Around Buildings (LANL)
- Field Studies
  - Urban 2000, MUST, Joint Urban 2003 datasets in widespread use
  - Considering future field studies
    - May conduct study to collect and use data from Pripyat, Ukraine (near Chernobyl) (Texas Tech)
    - May participate in field study near Helsinki Finland

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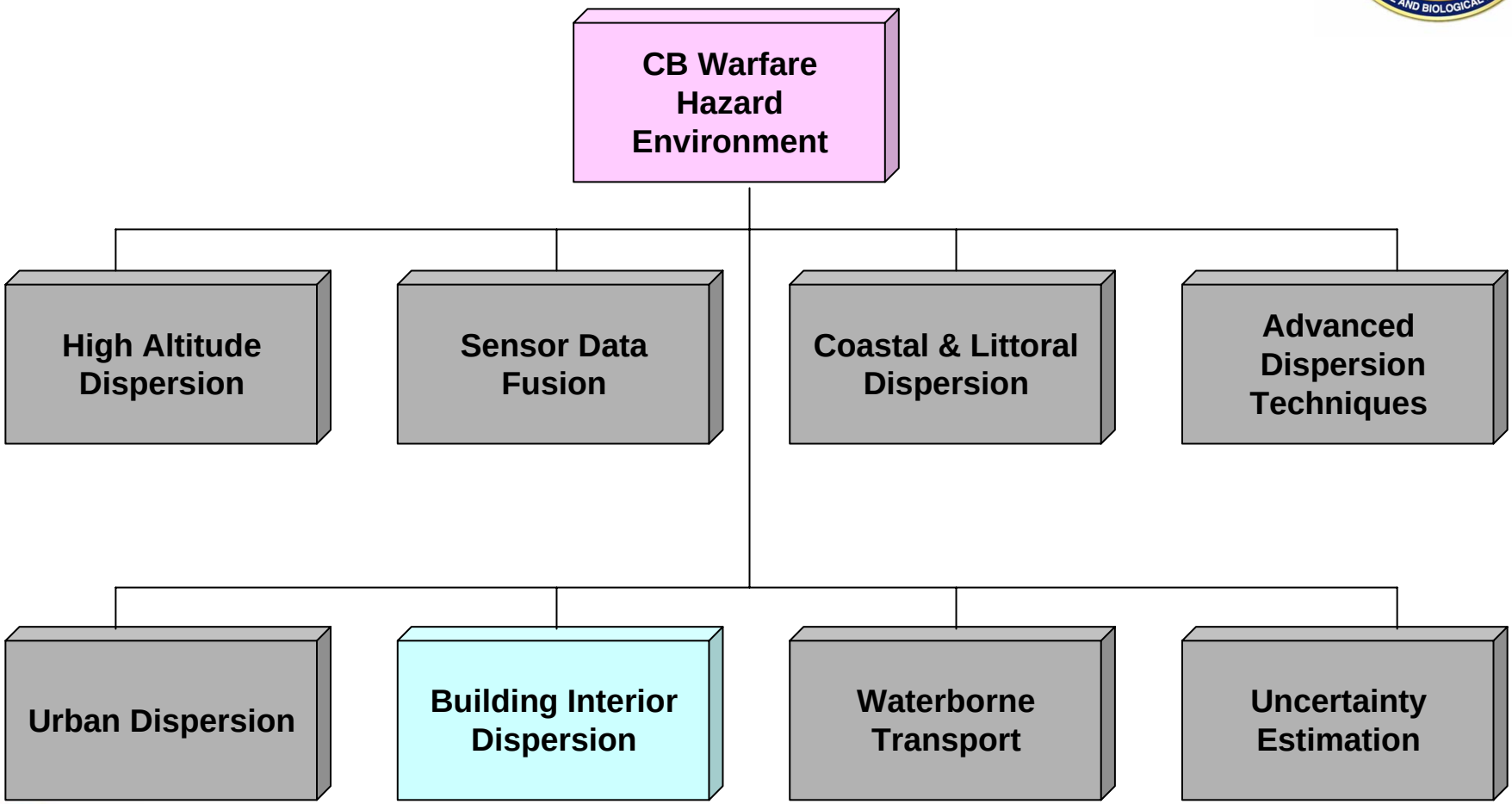

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Building Interior Dispersion Modeling

- JEM Block III requirement
- Some models already exist
  - Multi-zonal models (COMIS, CONTAM, MBLM) at LBNL, NIST, DTRA, DARPA, NSWC, SAIC
  - Coarse-grid CFD models for large rooms
- Newer types of models may become available
- Proposal to fund coordination of COMIS and CONTAM into next-generation multi-zonal model
  - Leverage DARPA's Immune Building Program, DTRA's BINEX capability, NSWC and DOE/DHS R&D programs
- Hope to coordinate with DHS
  - DHS making large investment in this area

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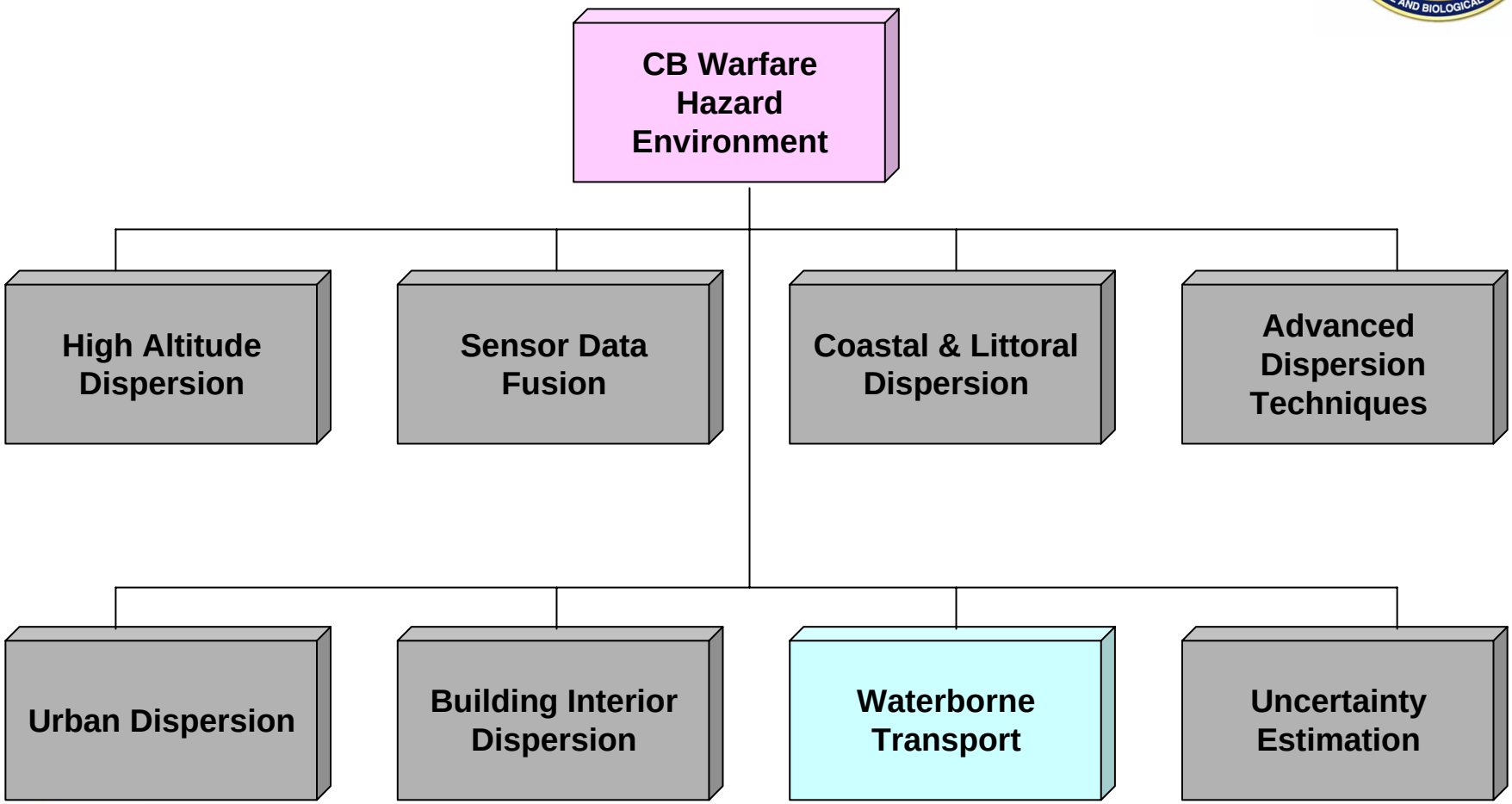

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Waterborne Transport Modeling

- JEM Block III requirement
- No active JSTO program in this area now
- Several programs underway elsewhere
  - Navy, ORNL, DTRA, DHS
- JSTO will watch other work and develop programs as needed

- Should we be doing something?

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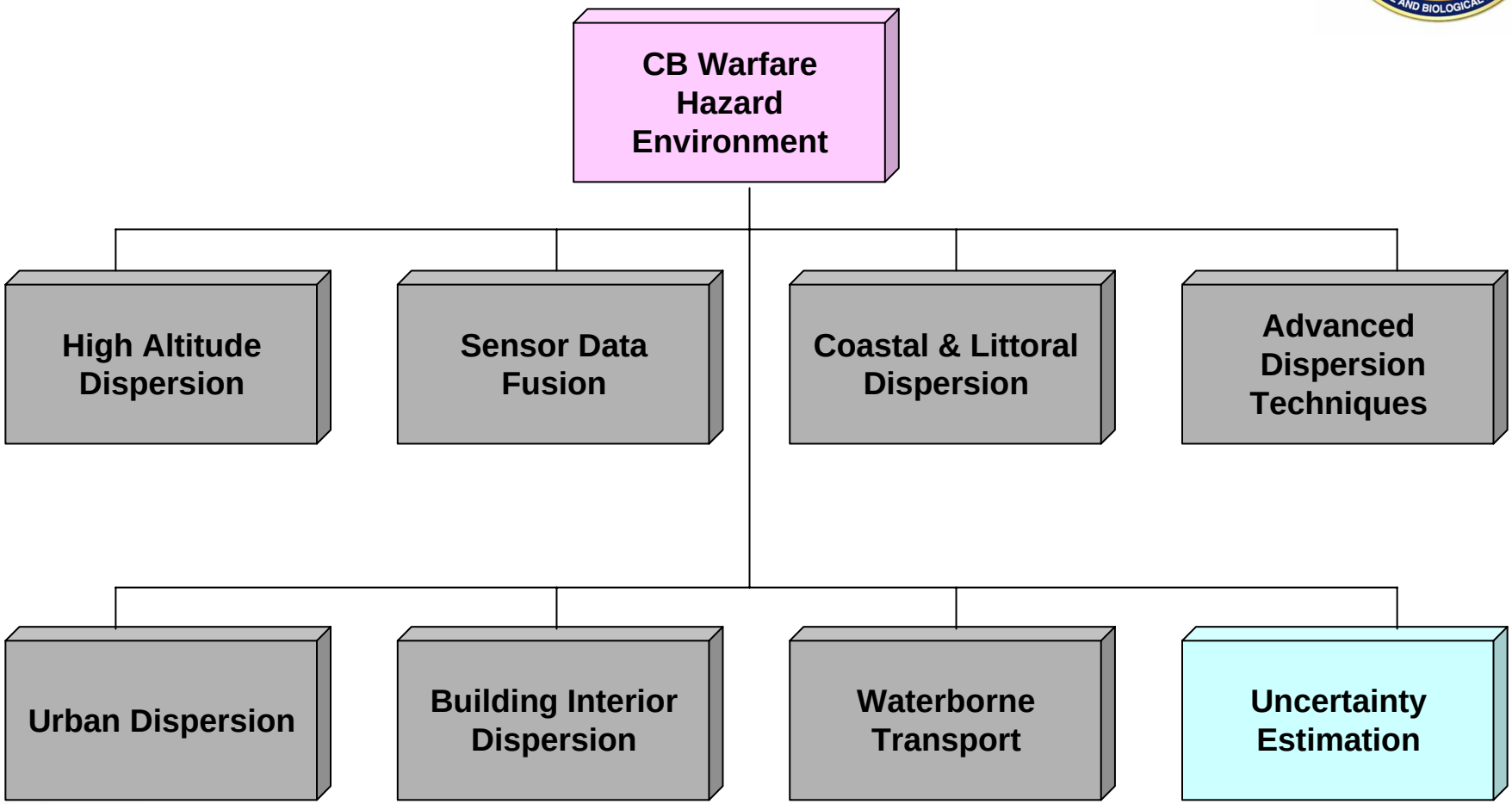

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Uncertainty Estimation

- No active JSTO program in this area now

- Should we be doing something?

Performing Organizations

- Previous: NSWC Dahlgren, NRL Monterey, ITT
- Current: NSWC Dahlgren, NRL Monterey, ITT, DTRA, LLNL, UCSB, Dstl, NOAA, NSWC Crane
- Imminent (planned): NSWC Dahlgren, NRL Monterey, ITT, DTRA, LLNL, UCSB, Dstl, NOAA, NSWC Crane, NRL DC, NGIT, NASA, ARL, UB, PSU, NCAR, Aerodyne
- Possible Future: NSWC Dahlgren, NRL Monterey, ITT, DTRA, LLNL, UCSB, Dstl, NOAA, NSWC Crane, NRL DC, NGIT, NASA, ARL, UB, PSU, NCAR, Aerodyne, CFDRC, Titan, ARIA, LBNL, NPS, DPG, DRDC, NIST, DARPA, NASA, AFWA, Titan, ORNL, SAIC, DSTO, TTU, Vaisala…?

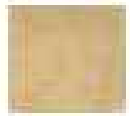
Summary

- Established comprehensive program to meet requirements, address weak areas, coordinate activities
- Brings S&T program into line with coordinated, unified model development programs
- Expect to see areas of particular expertise developed at DoD labs, R&D activities
- EPP budget increase provided opportunity to develop comprehensive, coordinated program
  - But – can we keep the money?

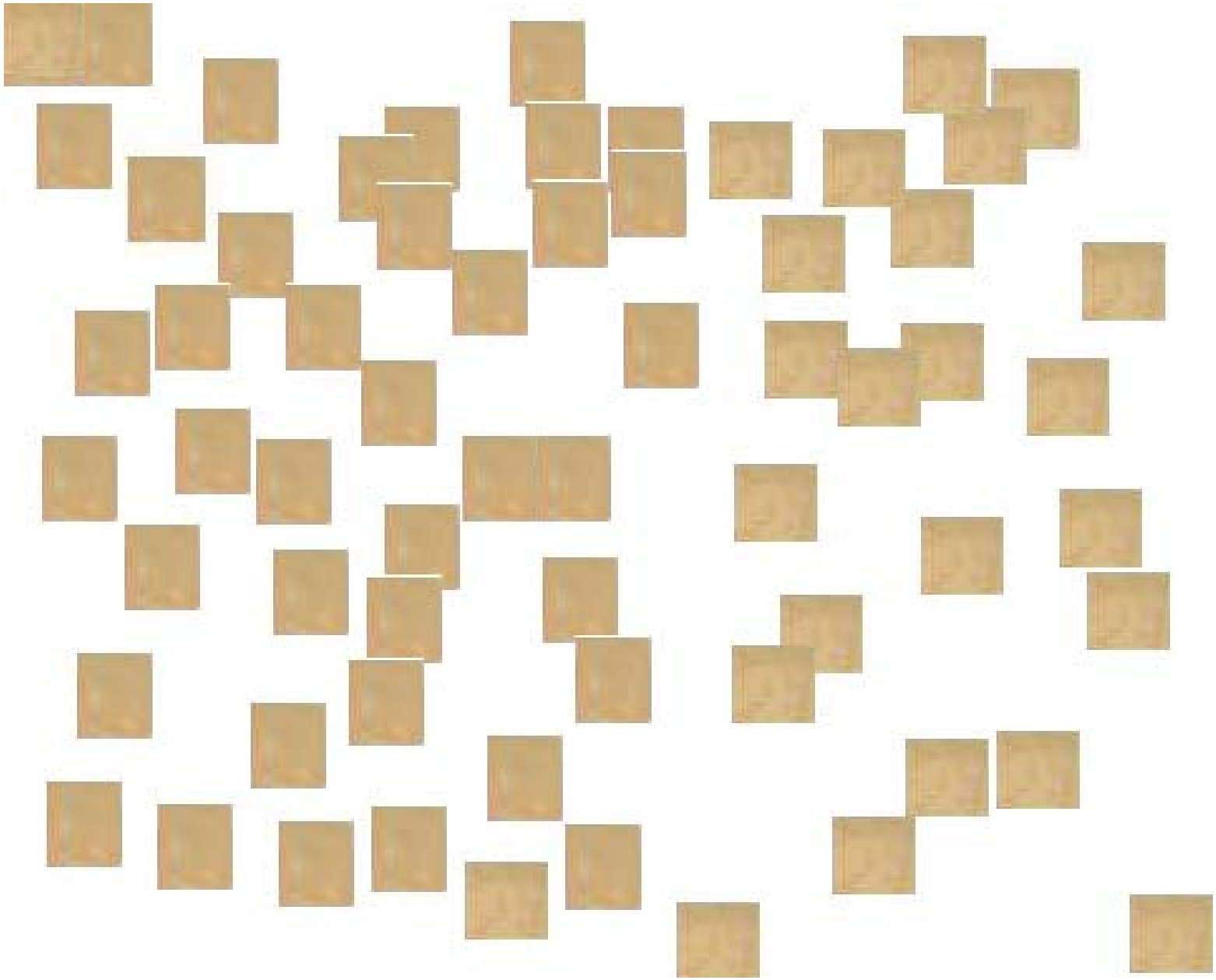
Backup Slides

"Model" Results – not perfectly accurate

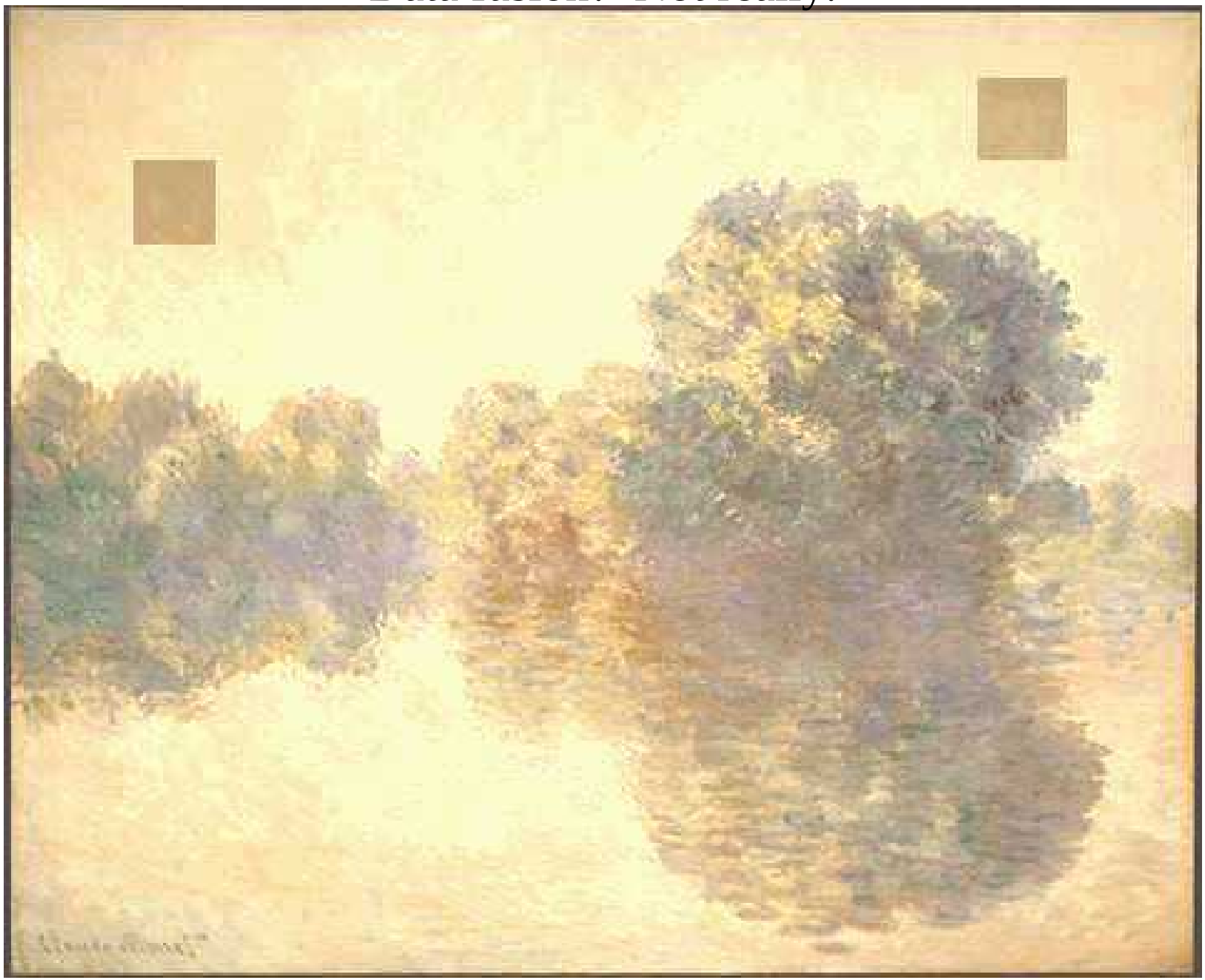
Sensor Data – provide only snapshots of hazard



Hazard depiction based on interpolation of sensor data



Data fusion? Not really.



Claude Monet ***The Seine at Giverny*, 1897**

Jackson Pollock ***Number 1, 1950 (Lavender Mist)*, 1950**

(The urban problem will be even more complex)

Weather Model Resolution Effects

Coarse-resolution models unable to resolve the sea breeze circulation

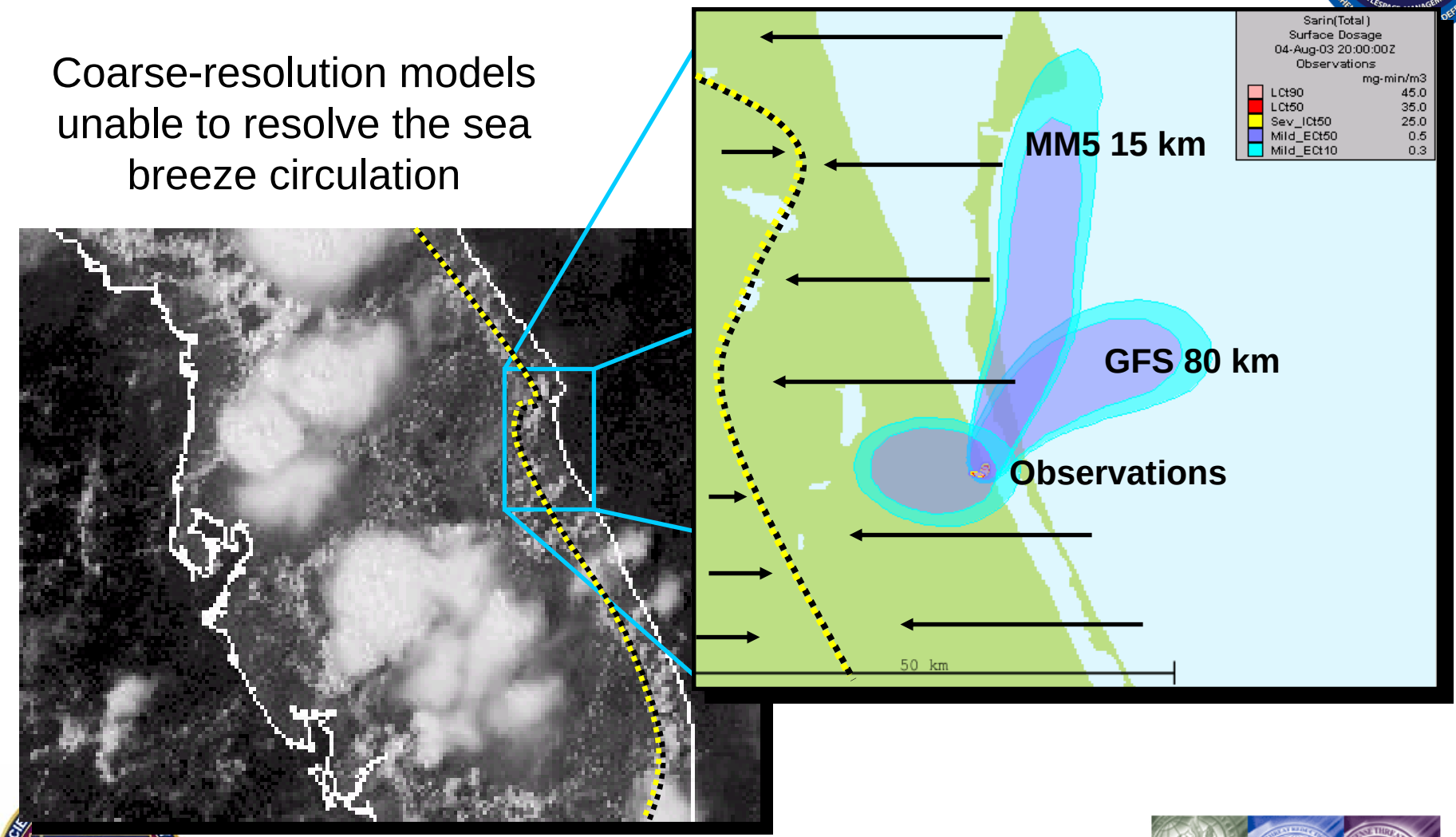


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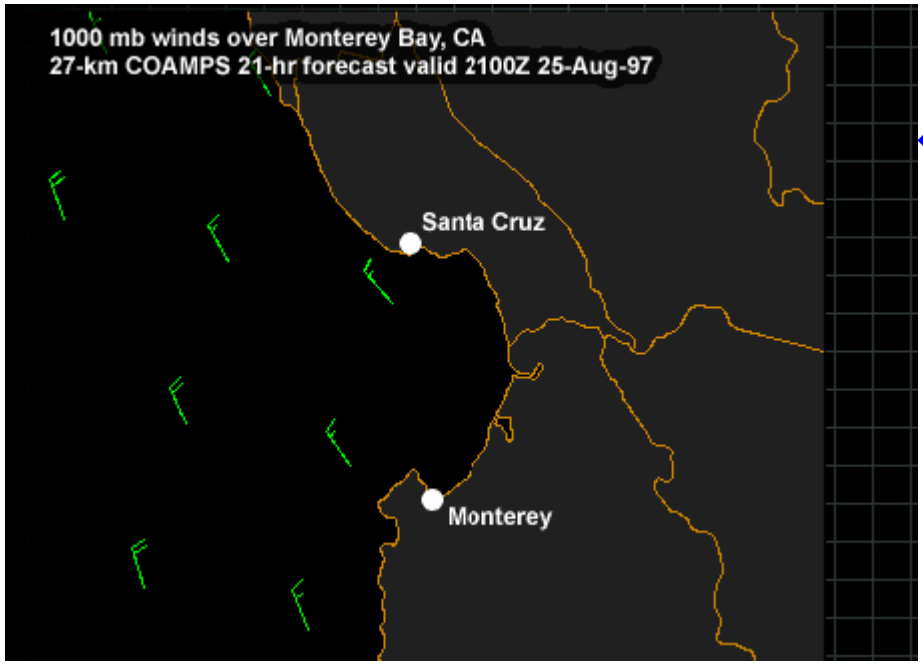
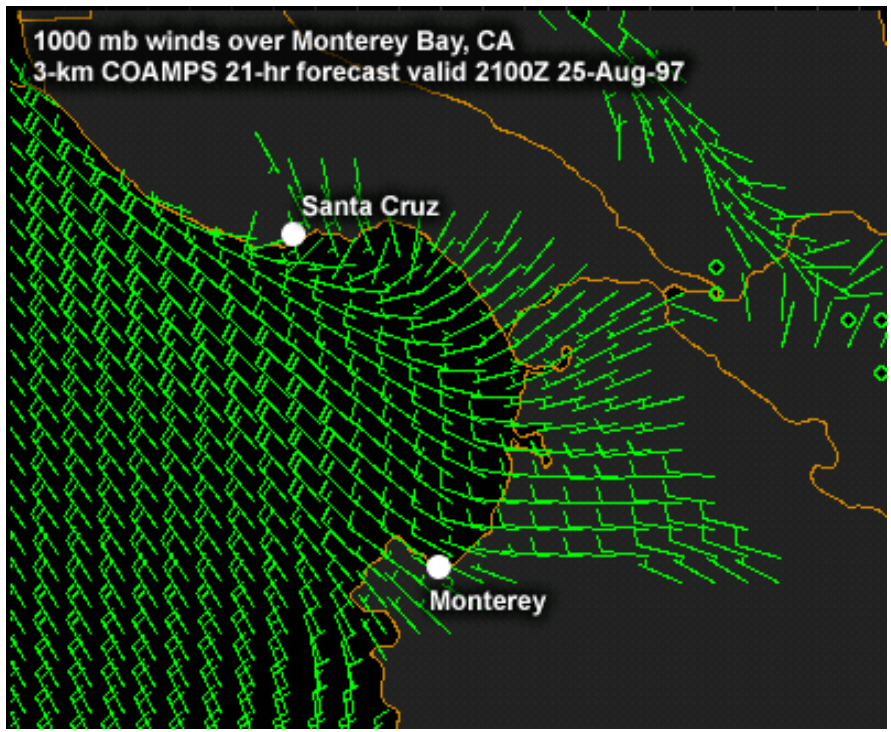
Illustration of Model Resolution Impact



Coarser resolution (27 km) reveals very little detail in the wind field

Higher resolution (3 km) reveals onshore flow of the sea breeze



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