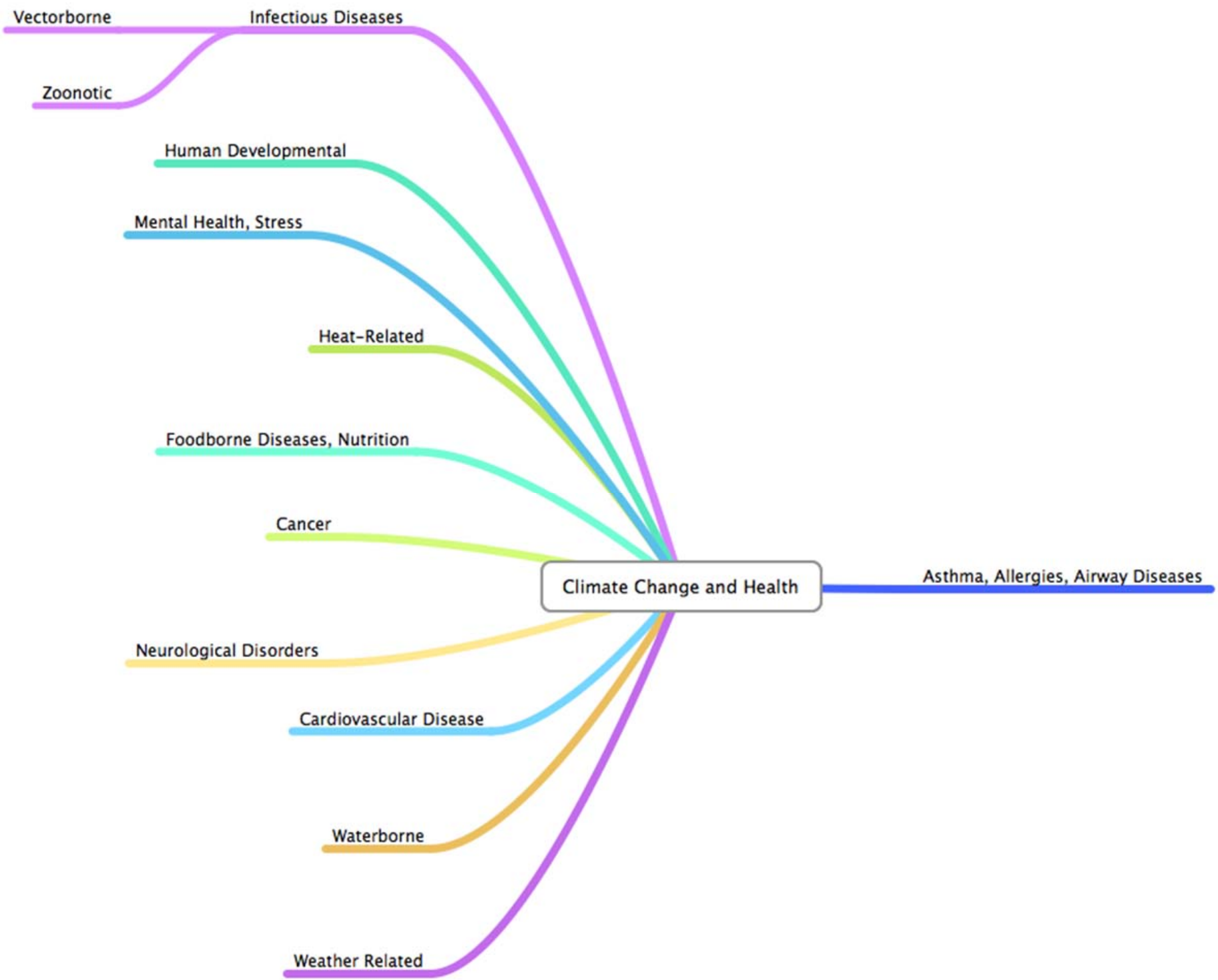
Climate Change and Allergic Airway Disease: Observational, Laboratory, and Modeling Studies of the Impacts of Climate Change on Allergic Airway Disease

PI: Leonard Bielory, M.D.
Rutgers University
EPA Grant Number: R834547



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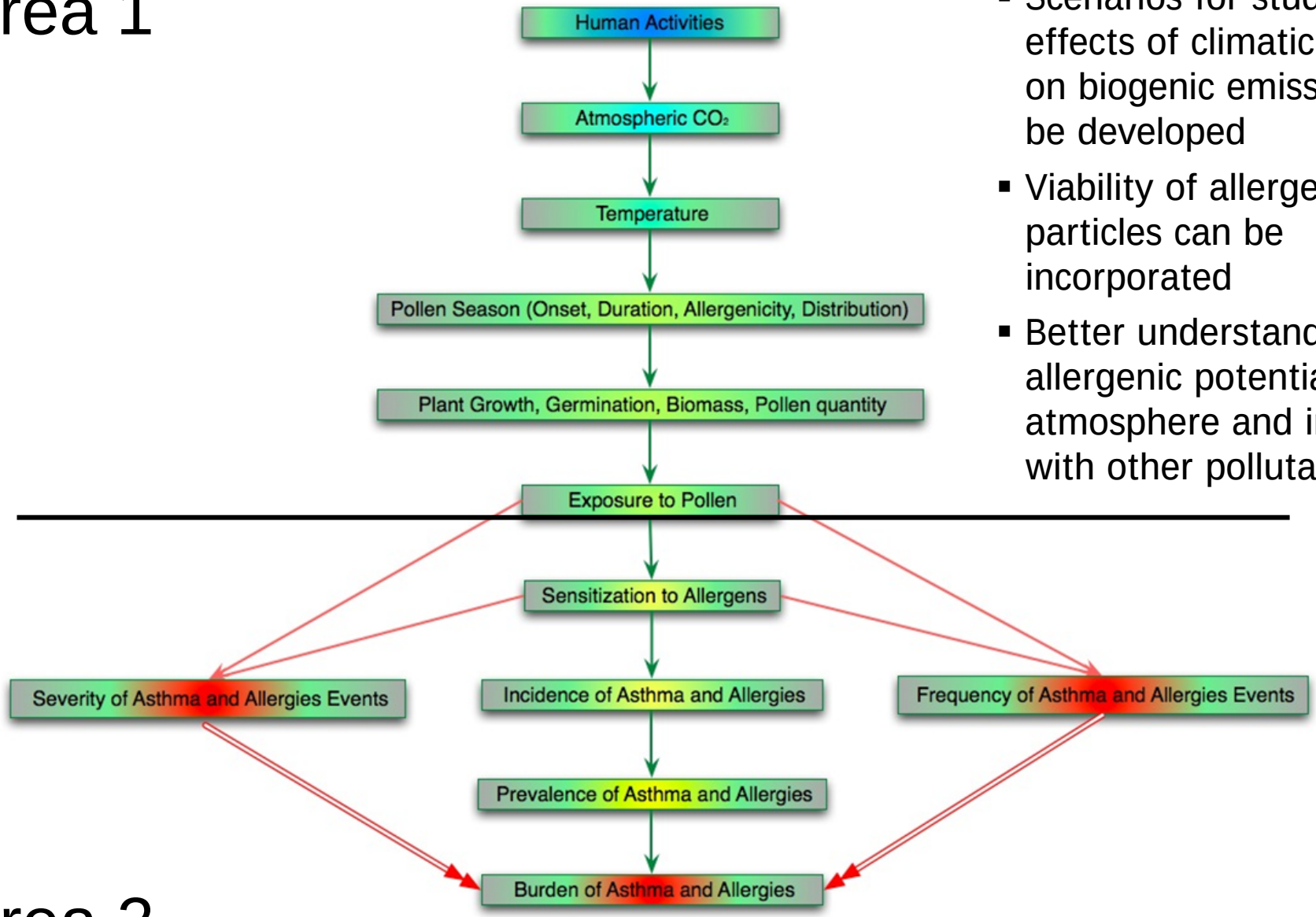
Climate Change and Allergic Airway Disease
STAR Areas of Interest

Area 1



- Scenarios for studying the effects of climatic change on biogenic emissions can be developed
- Viability of allergenic particles can be incorporated
- Better understanding of the allergenic potential of the atmosphere and interaction with other pollutants

Area 2

Climate Change and Allergic Airway Disease Multidisciplinary Team

- Disciplines
  - Botany
  - Meteorology
  - Population
  - Medicine
- Allergy & Immunology

- Techniques
  - Modeling
  - Chamber Studies
  - Molecular genetics
  - Immunoassays
  - Skin testing

Climate Change and Allergic Airway Disease

- Leonard Bielory, M.D. (RU)
  - Director, STARx Allergy and Asthma Center, (Medicine, Pediatrics and Ophthalmology);
  - Chairman, NJDEP Clean Air Council; Visiting Center for Environmental Prediction
- Stacy Bonos, Ph.D. (RU)
  - Assistant Professor of Turfgrass Breeding in Rutgers Dept. of Plant Biology and Pathology
- P. G. Georgopoulos, Ph.D. (UMDNJ - RU)
  - Professor of Environmental and Occupational Medicine UMDNJ-RWJ Medical School;
  - Director, Computational Chemodynamics Laboratory, EOHSI; Co-Director, Center for Exposure and Risk Modeling (CERM) EOHSI
- Henry J. Mayer, Ph.D., (RU)
  - Faculty Fellow, E.J. Bloustein School of Planning & Public Policy of Rutgers
  - Executive Director, National Center for Neighborhood & Brownfields Redevelopment
- Alan Robock, Ph.D. (RU)
  - Distinguished Professor of Atmospheric Science in Rutgers Department of Environmental Sciences
  - Associate Director of the Center for Environmental Prediction
- Lee Simon (RU)

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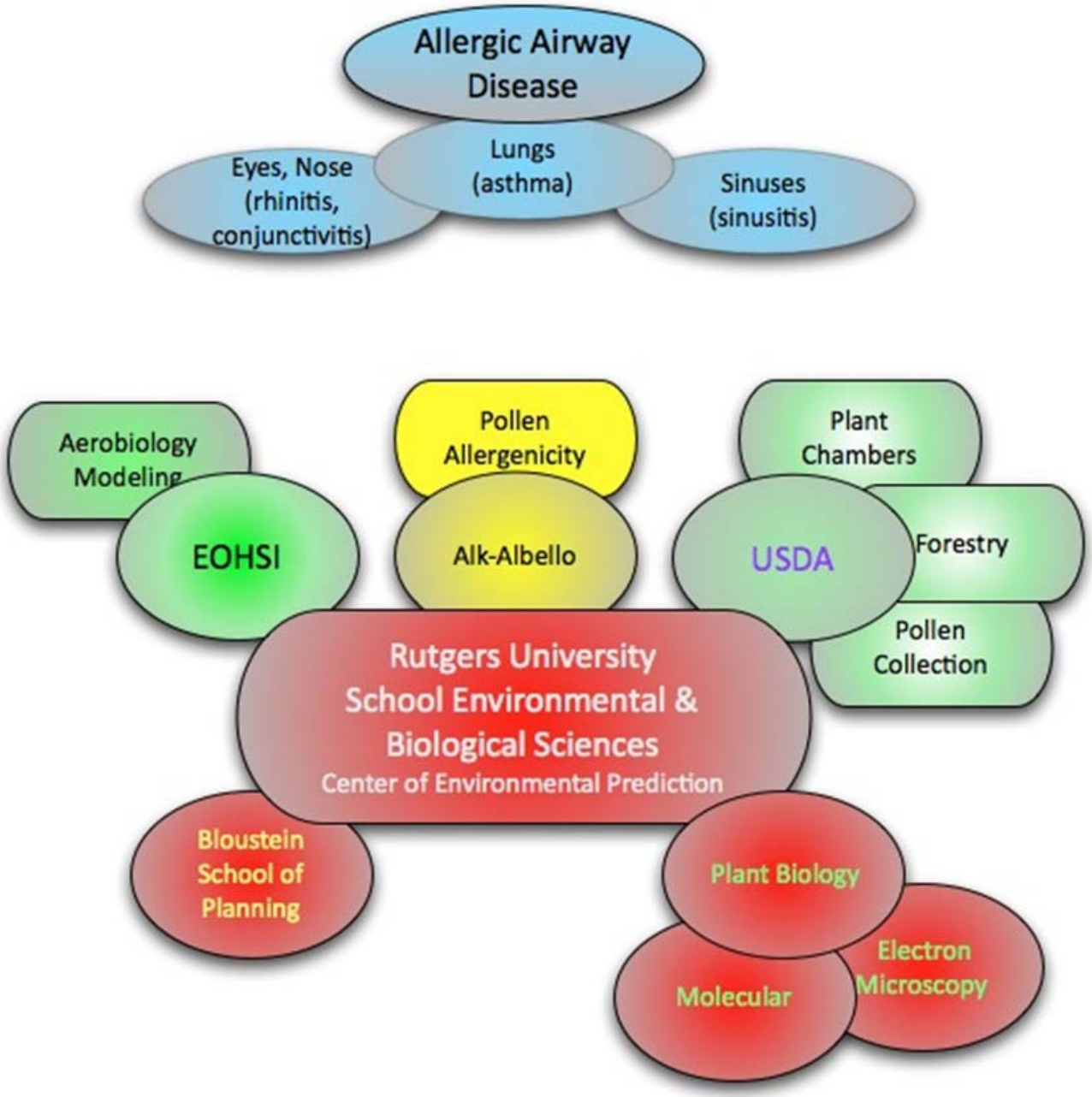

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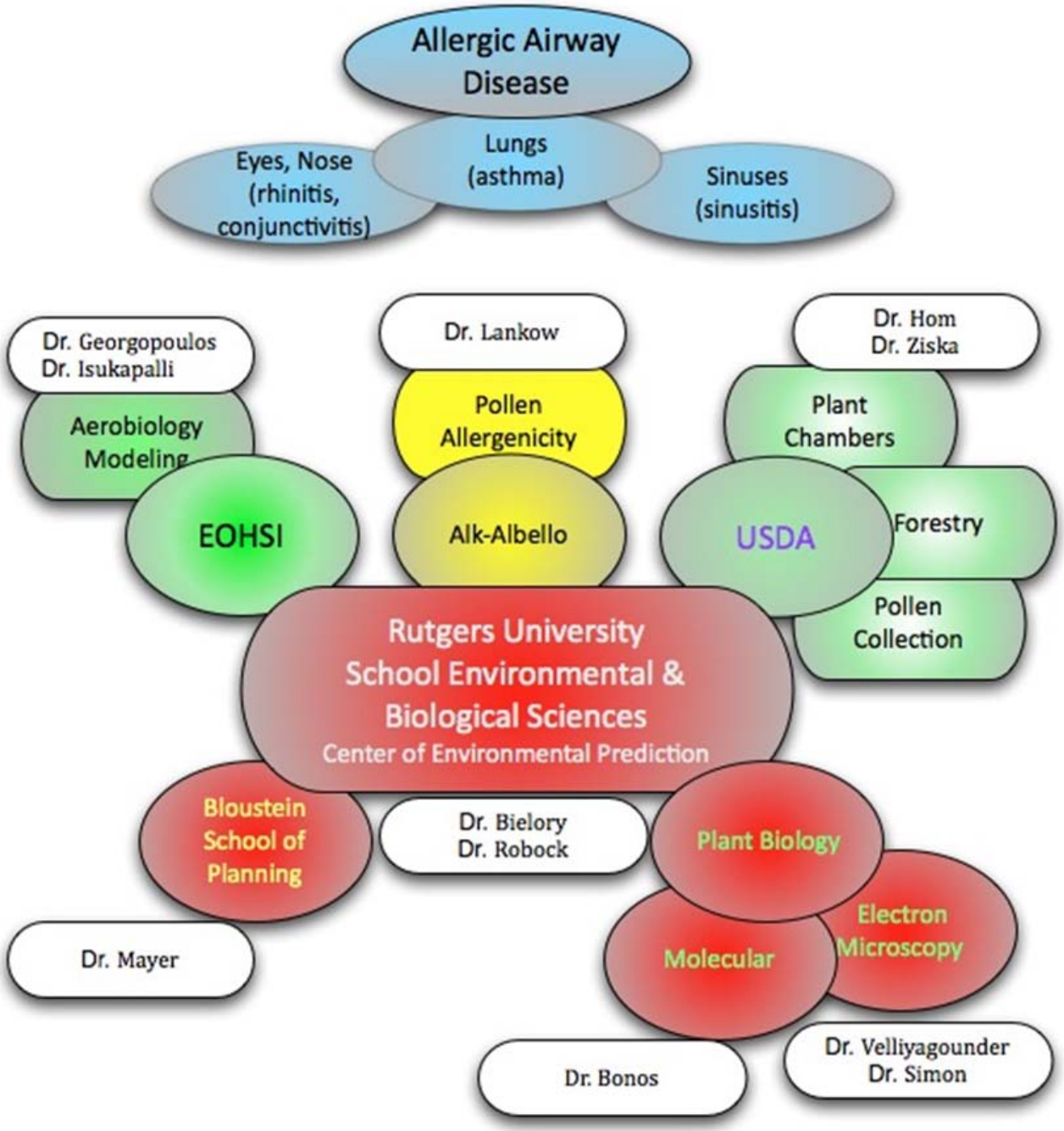
Climate Change and Allergic Airway Disease



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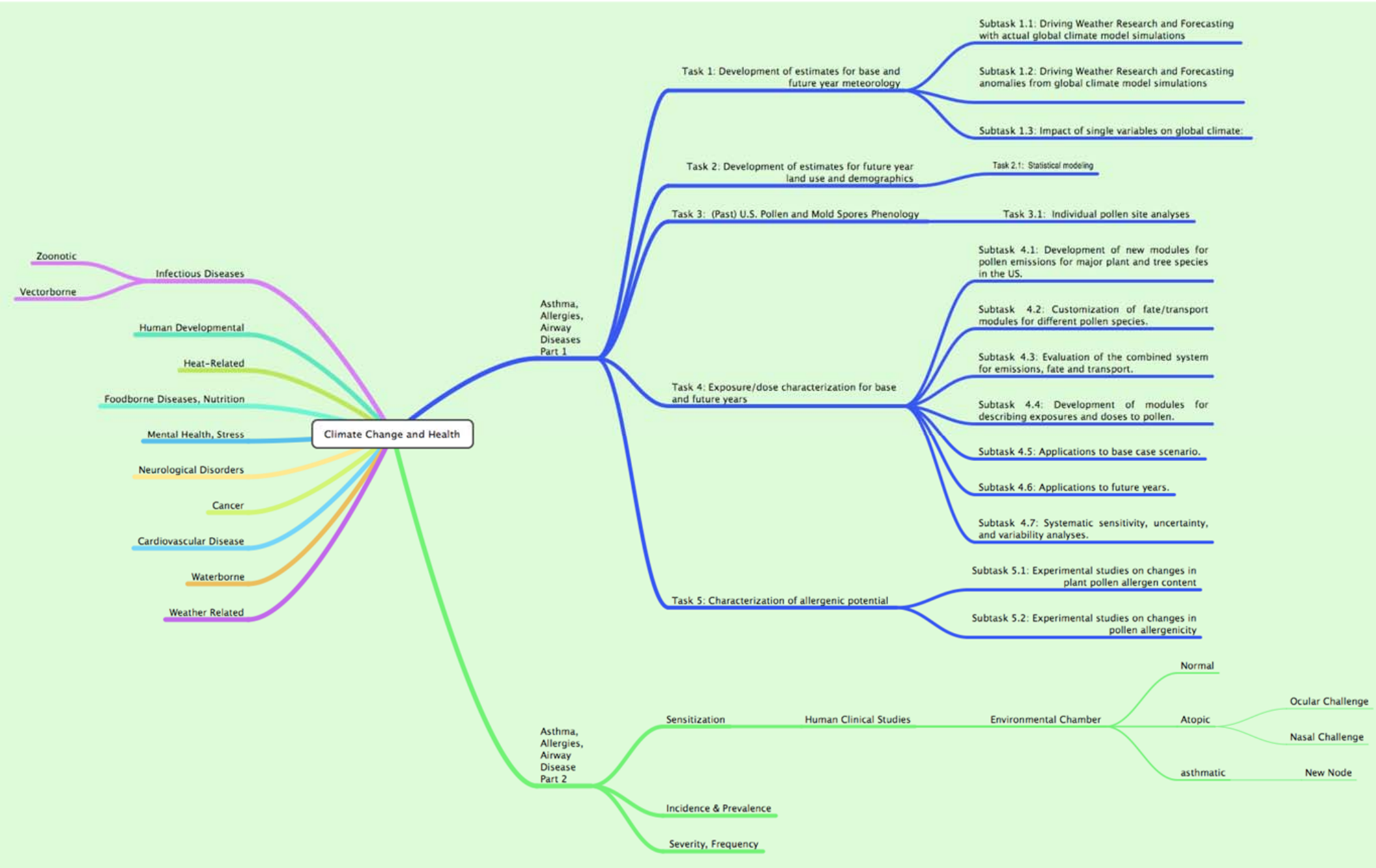
EPA Project Tasks



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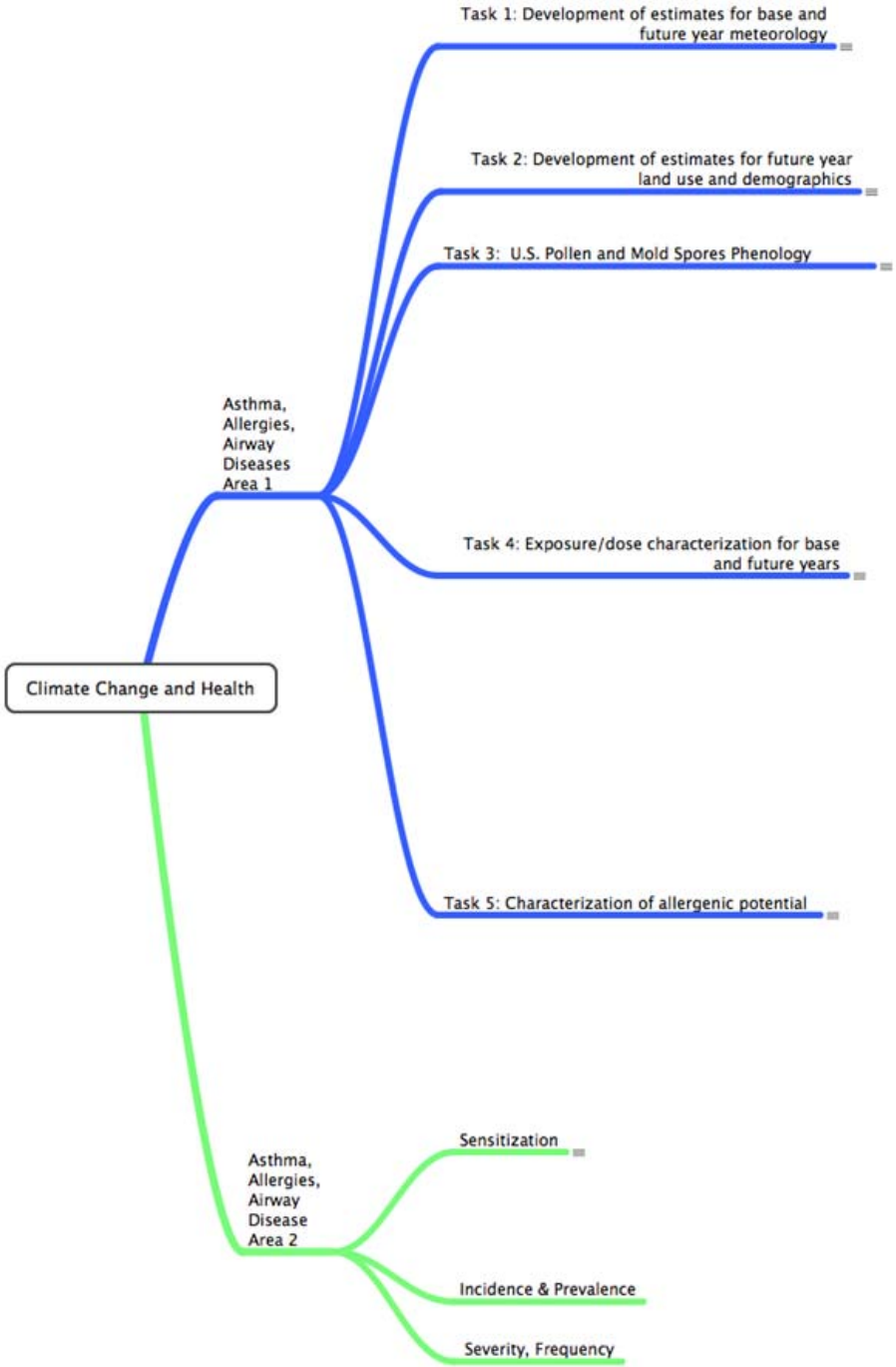
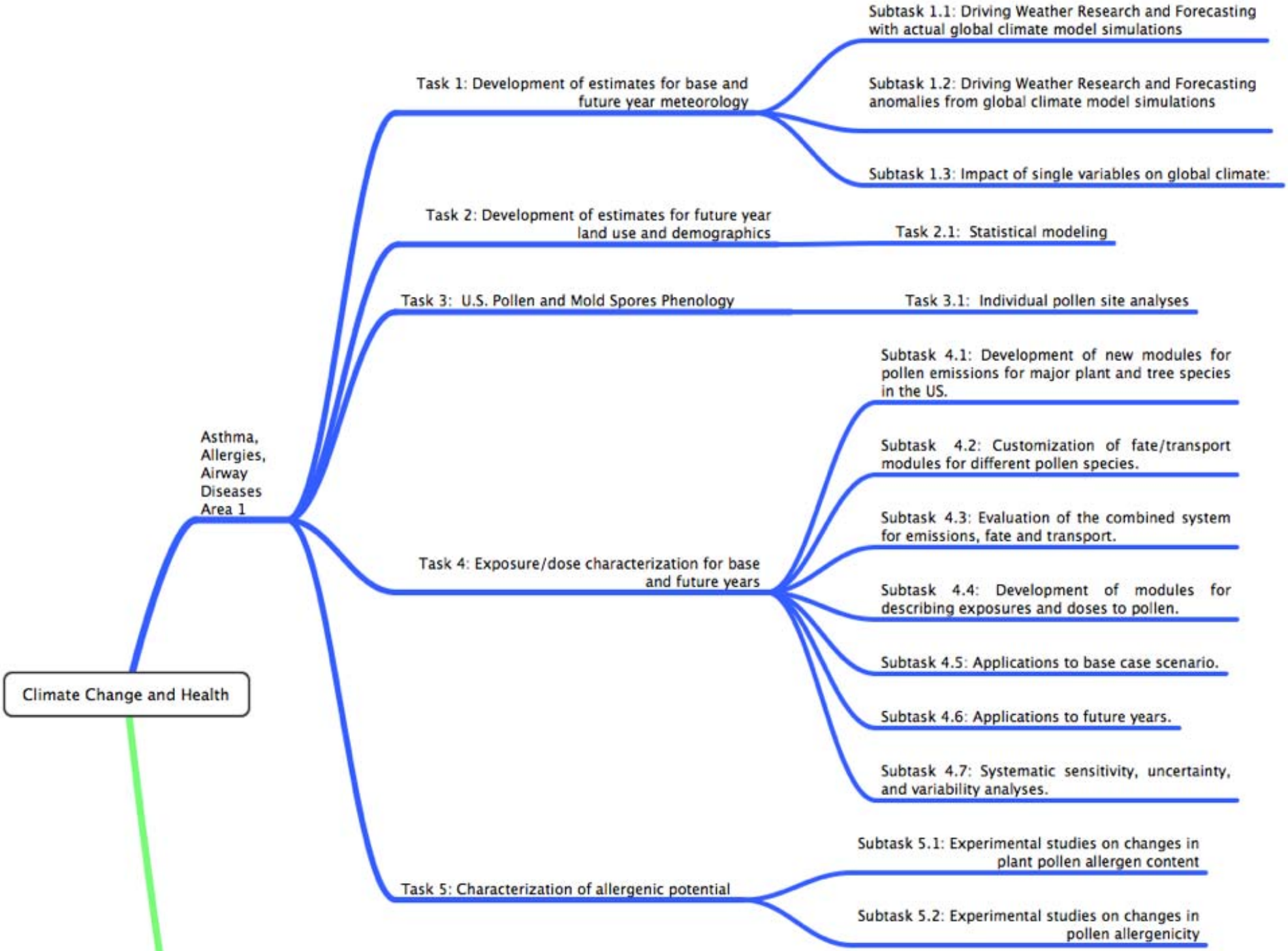
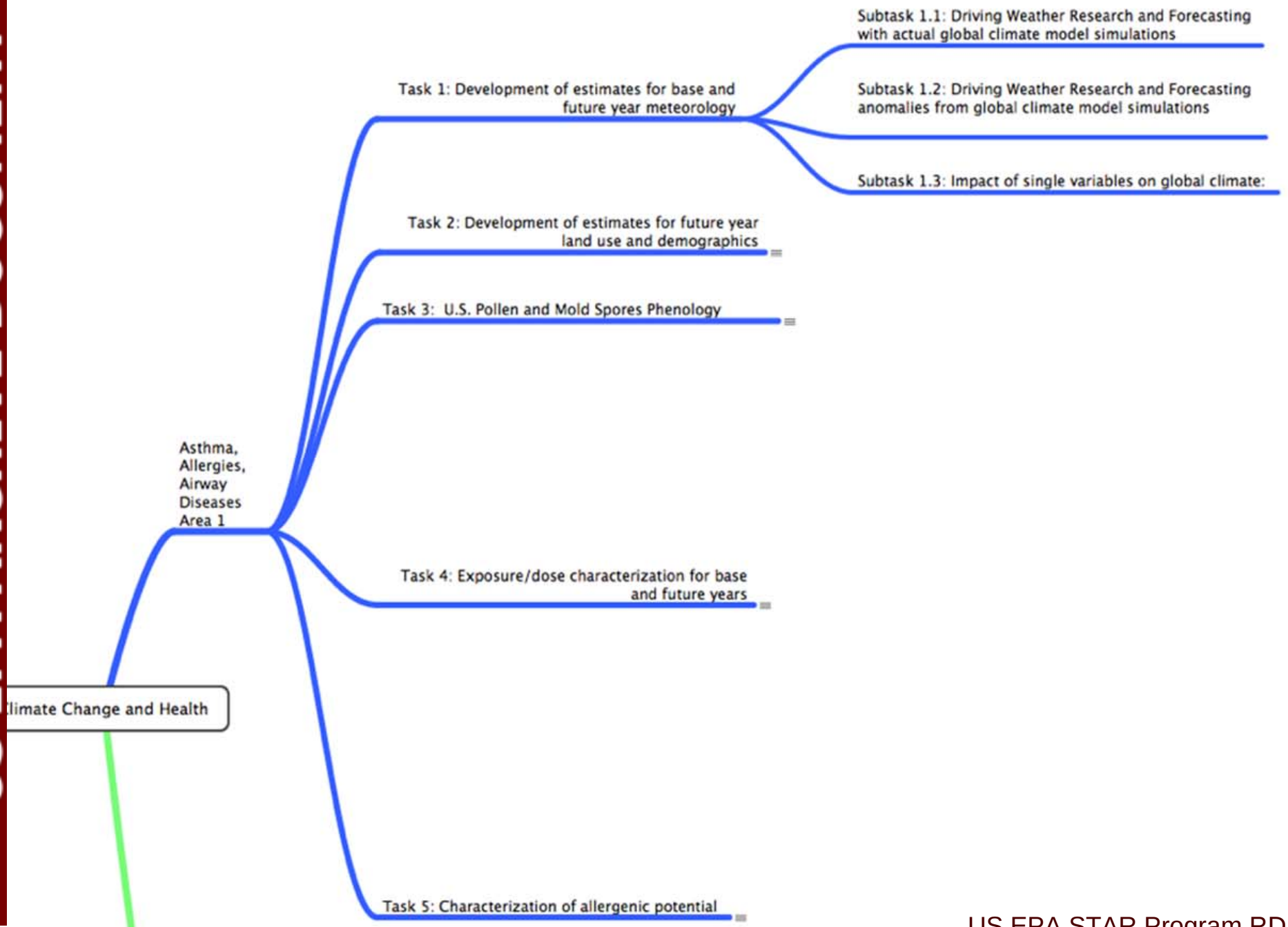
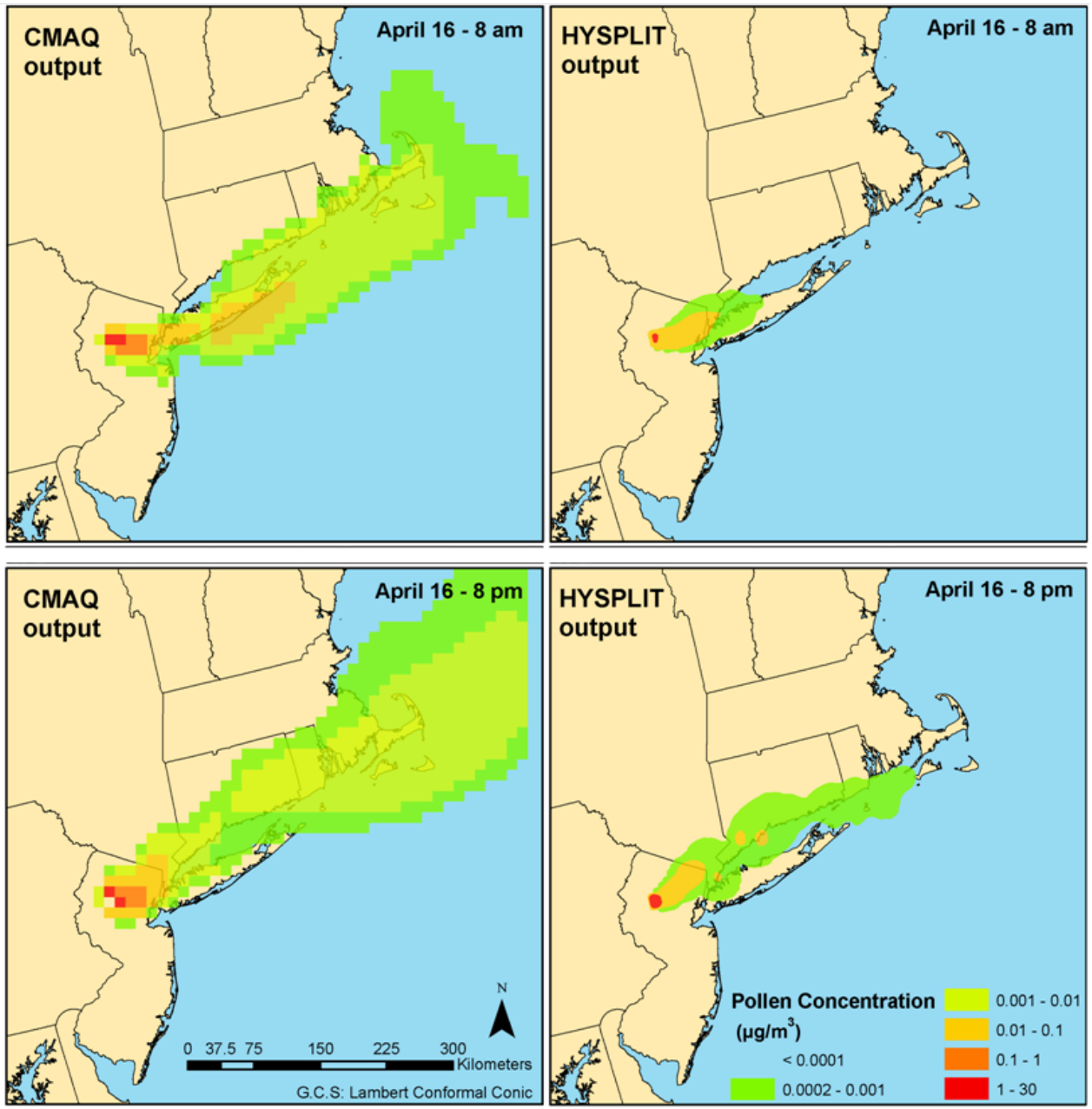


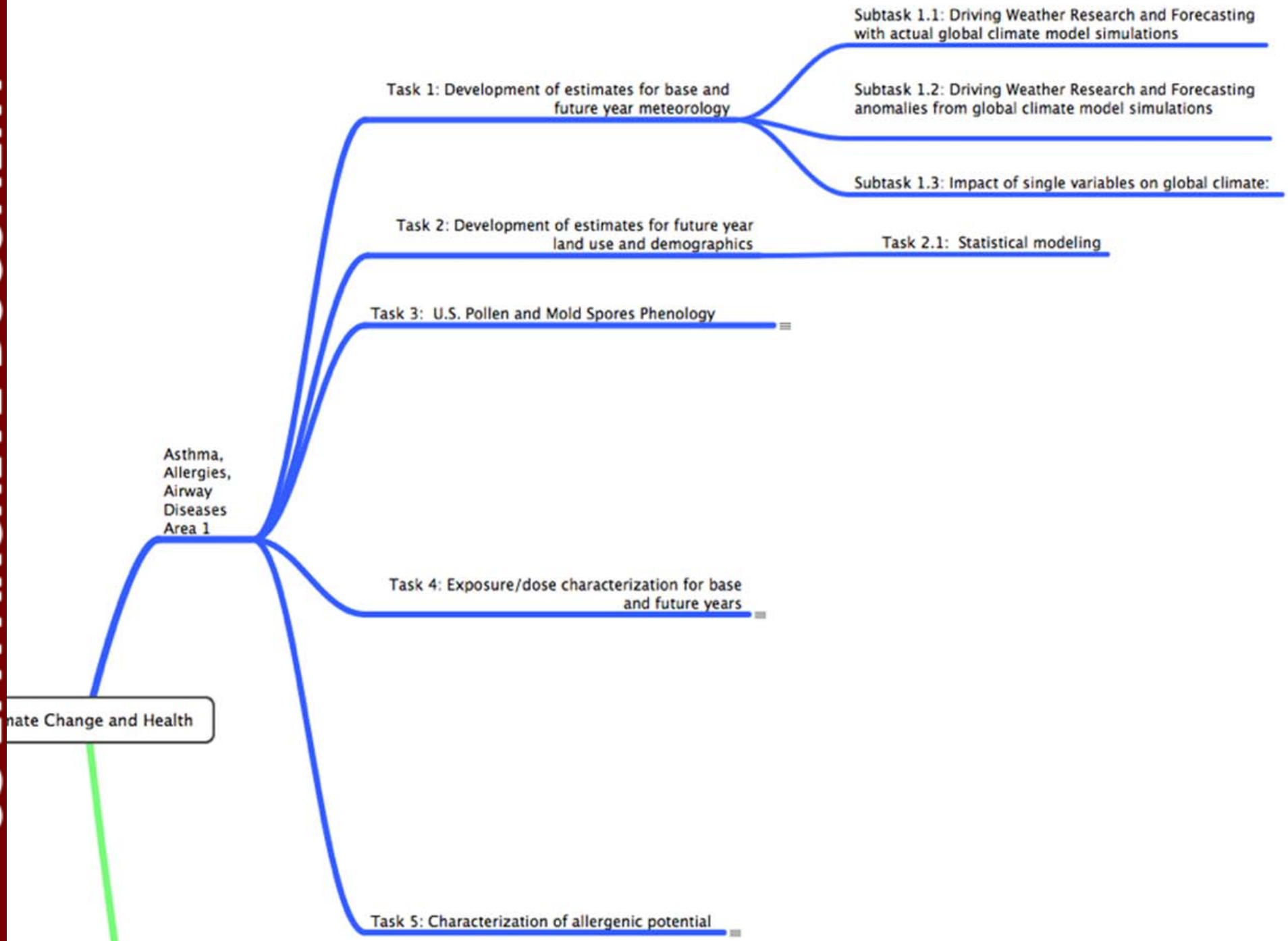




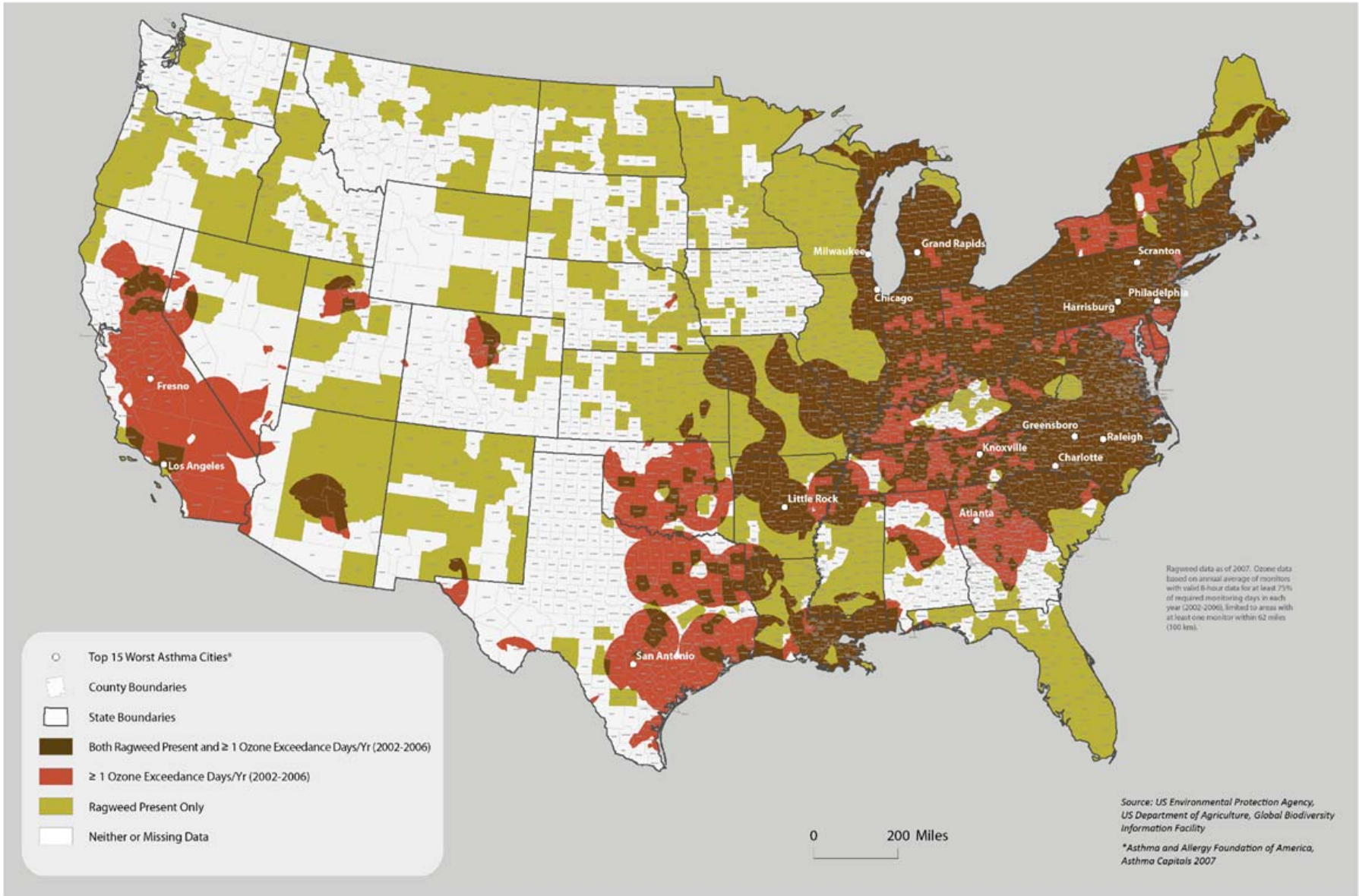
omparative evaluation of pollen dispersion modeling using the new CMAQ-pollen module and HYSPLIT for a hypothetical "single-cell" emissions case



Comparison of results from the CMAQ-pollen modules with the HYSPLIT model. Comparison was done by assuming a "single cell" of emissions of pollen.



Ozone and Ragweed co-exposures in the Continental U.S.



Adapted from Knowlton, et al. 2007. Sneezing and Wheezing: How Global Warming Could Increase Ragweed Allergies, Air Pollution, and Asthma. Natural Resources Defense Council. http://www.nrdc.org/globalwarming/sneezing/contents.asp

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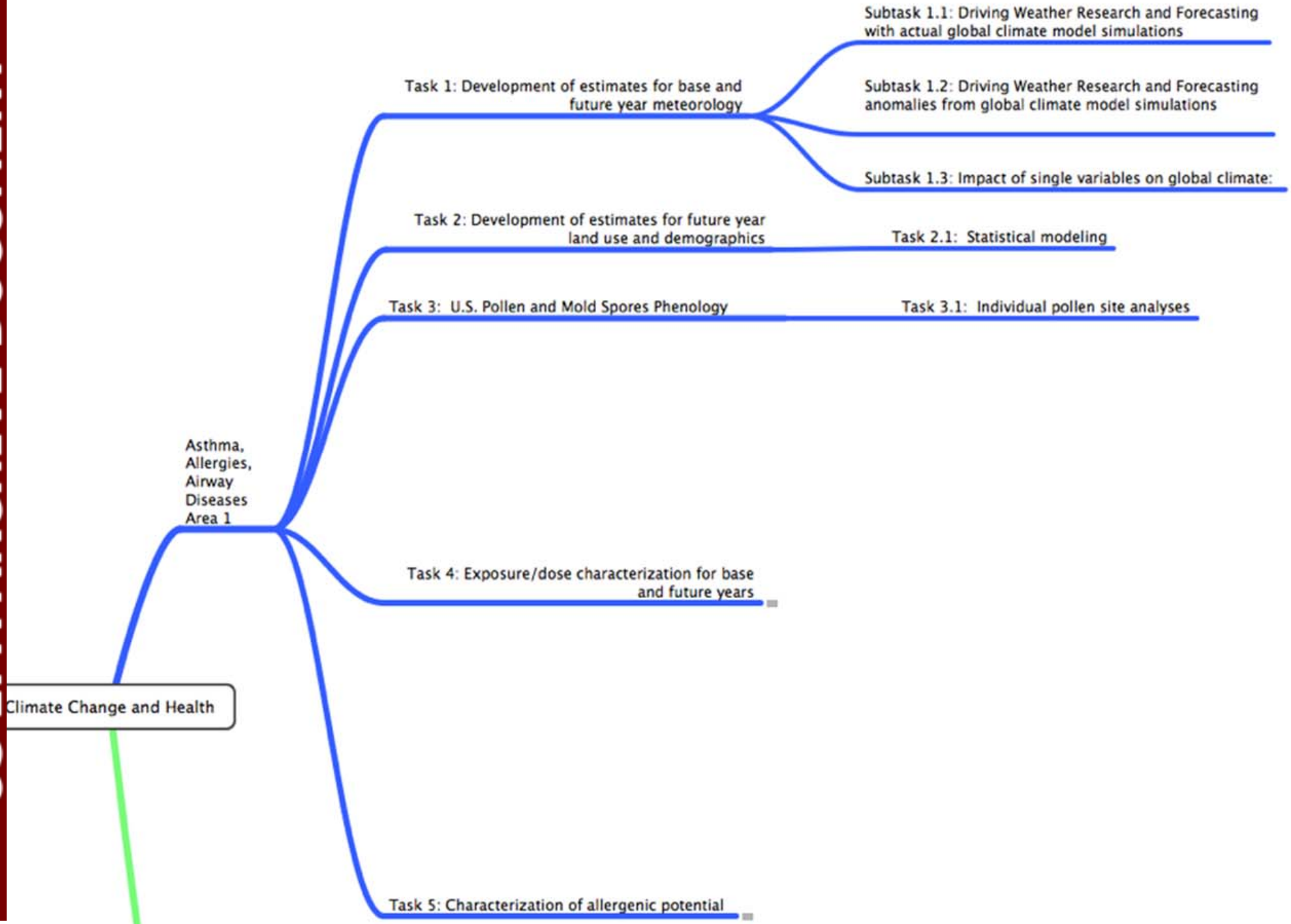
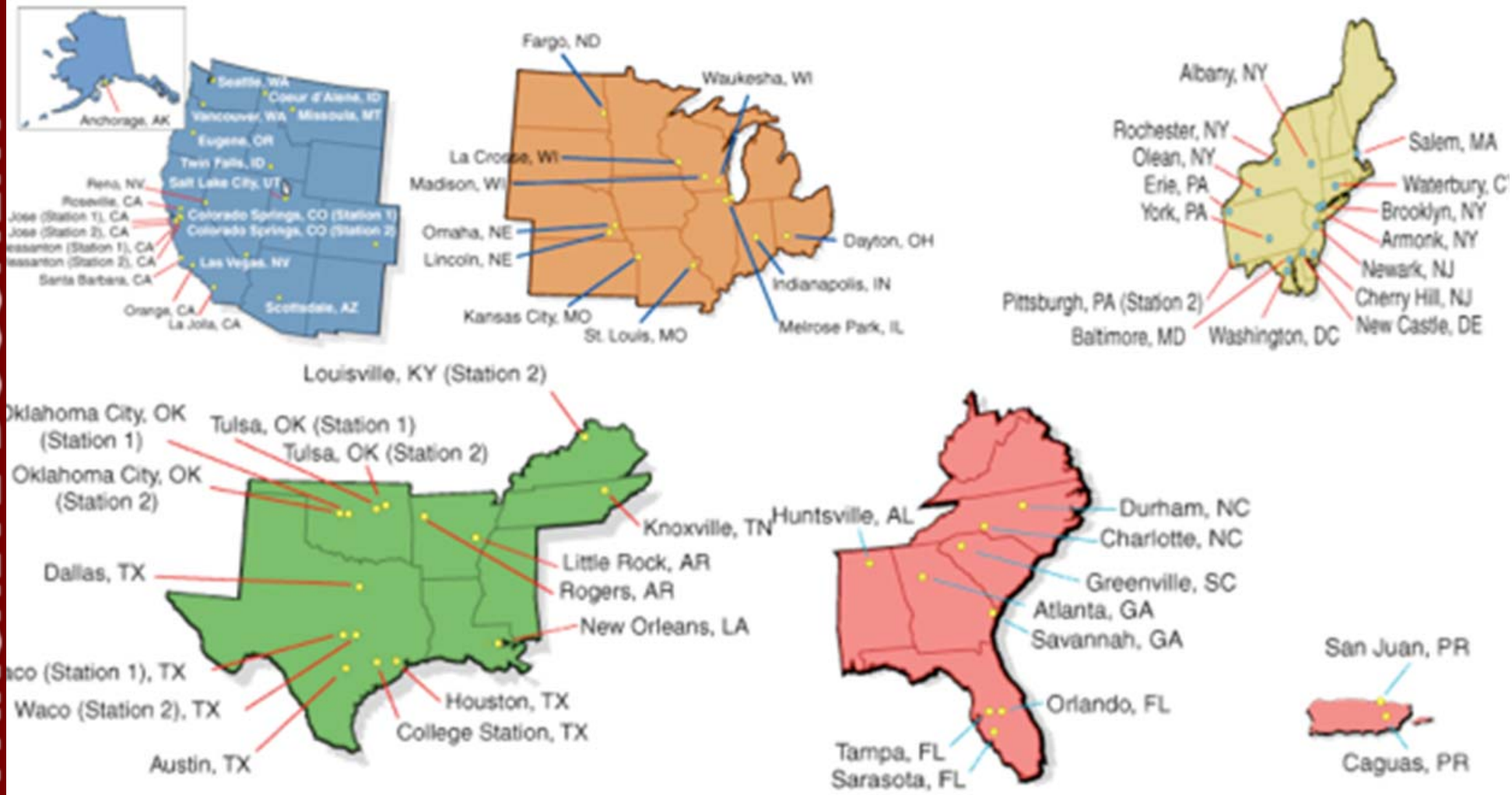
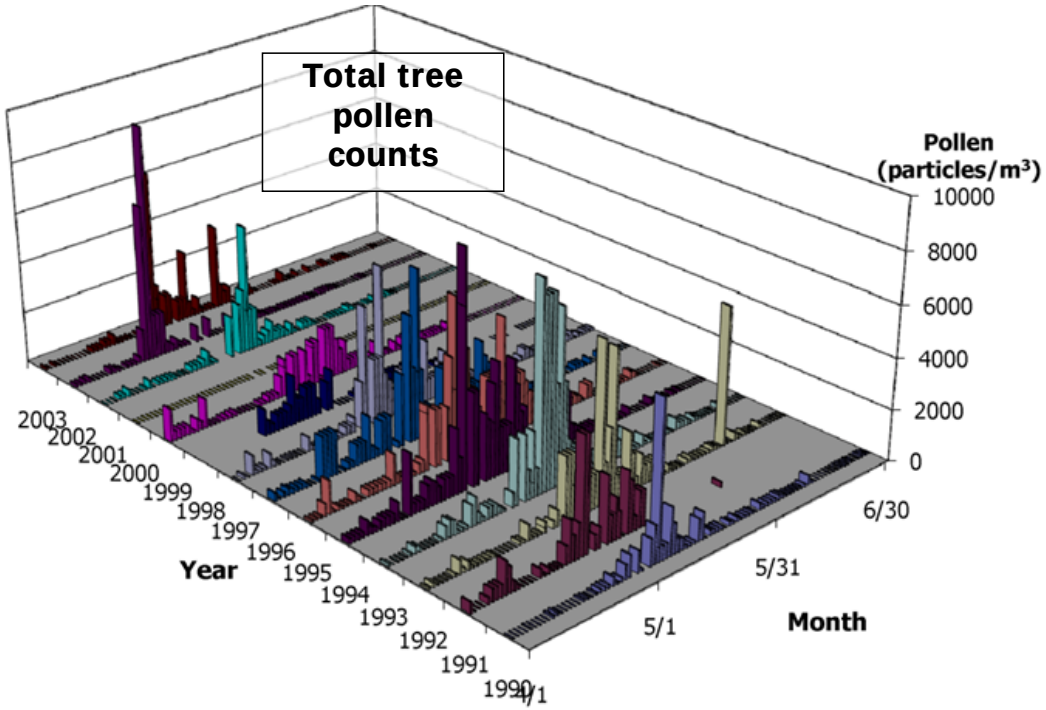


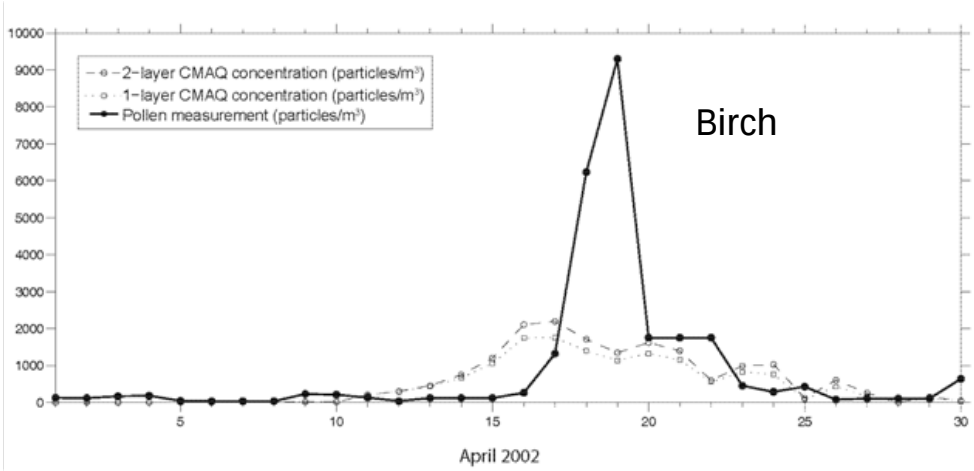


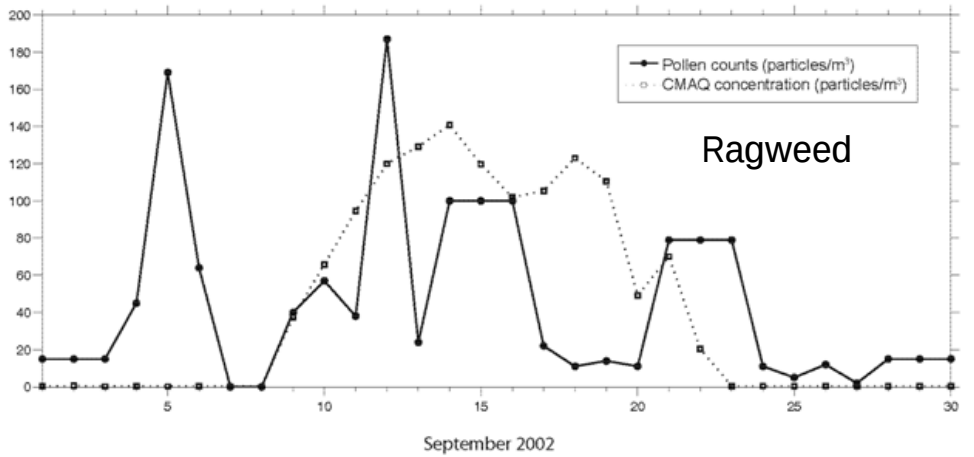
AAAAI National Allergy Bureau

n =74

Local pollen counts at – Newark, NJ: Measurements and model estimates







Pollen counts at Newark, NJ

Rotorod device at the roof sampling every day (except weekends, holidays)

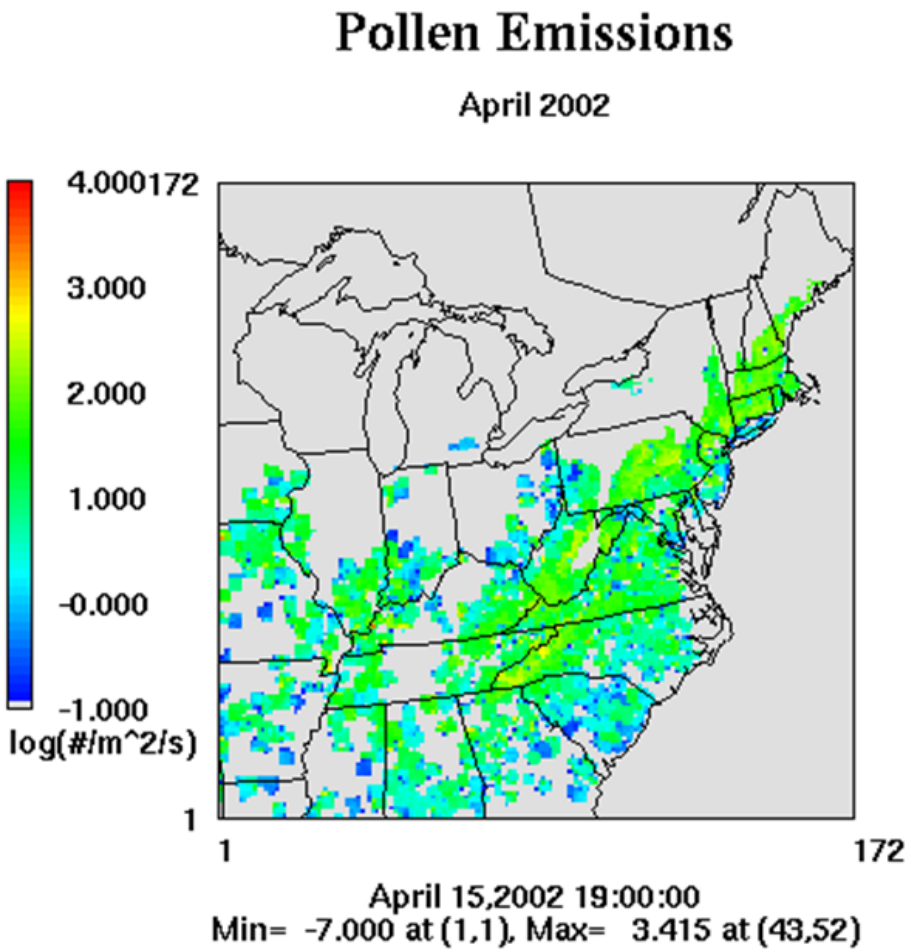
Samples microscopically counted and classified (trees, grasses, weeds, spores)

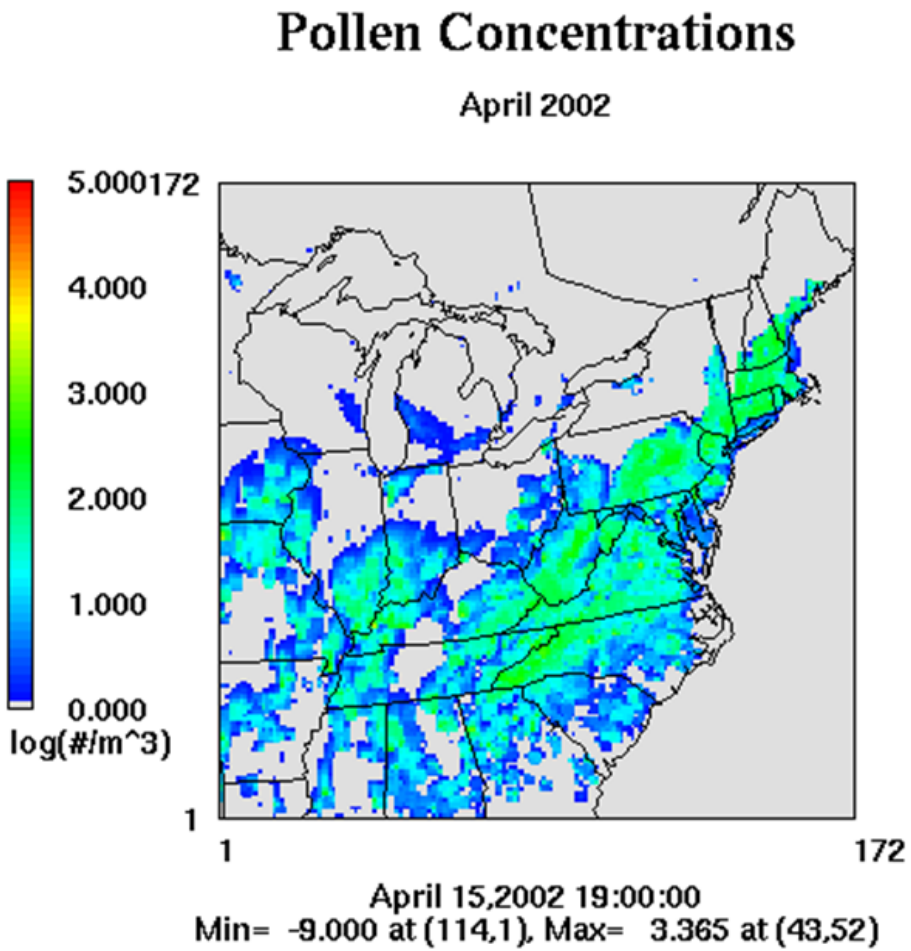
Extrapolated to atmospheric concentration (grains per cubic meter)

(Source: STARx Asthma and Allergy Research Center and Rutgers University Center for Environmental Prediction)

1-layer CMAQ simulation: All birch pollen emissions allocated to first vertical layer (ground - 20 m). 2-layer CMAQ simulation: 80% of emissions allocated to first layer, and 20% to the second layer (20 - 50 m).
Ragweed simulation: all emissions were allocated to the first layer. Data are from AAAAI National Allergy Bureau

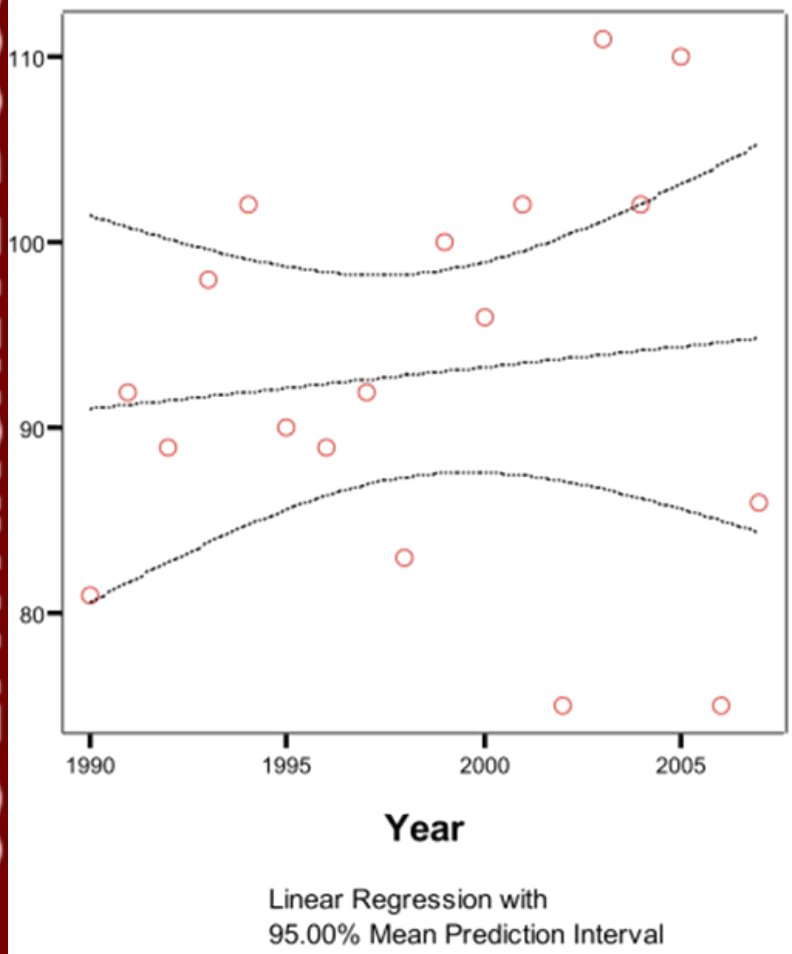
Pollen model results:
Birch emission flux and airborne concentrations

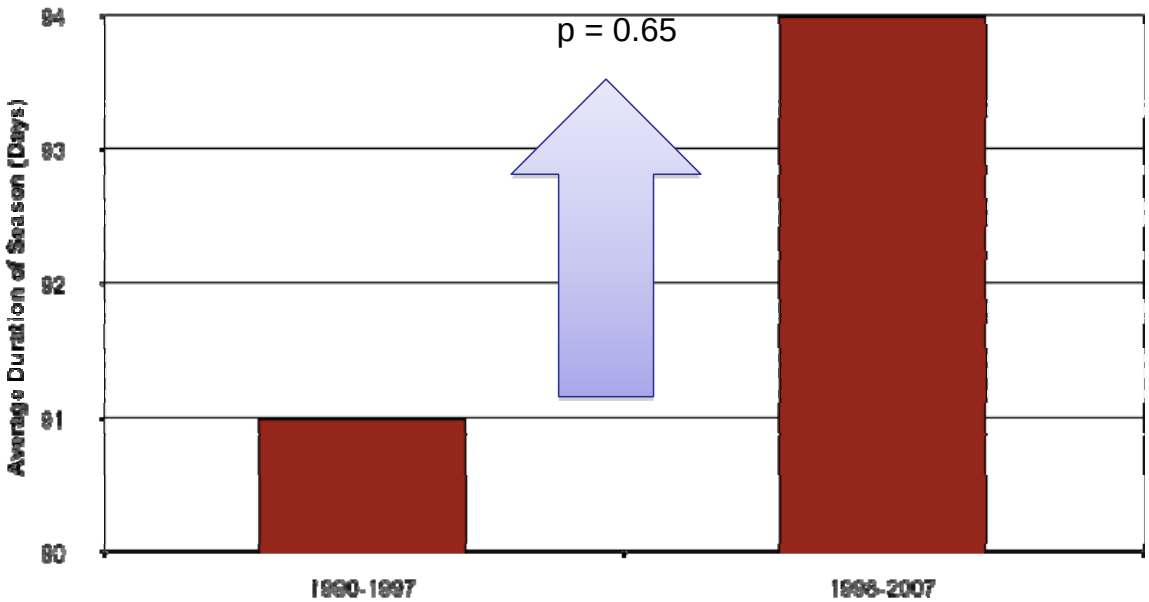




Pollen Trends in New Jersey

AAAAI 2009

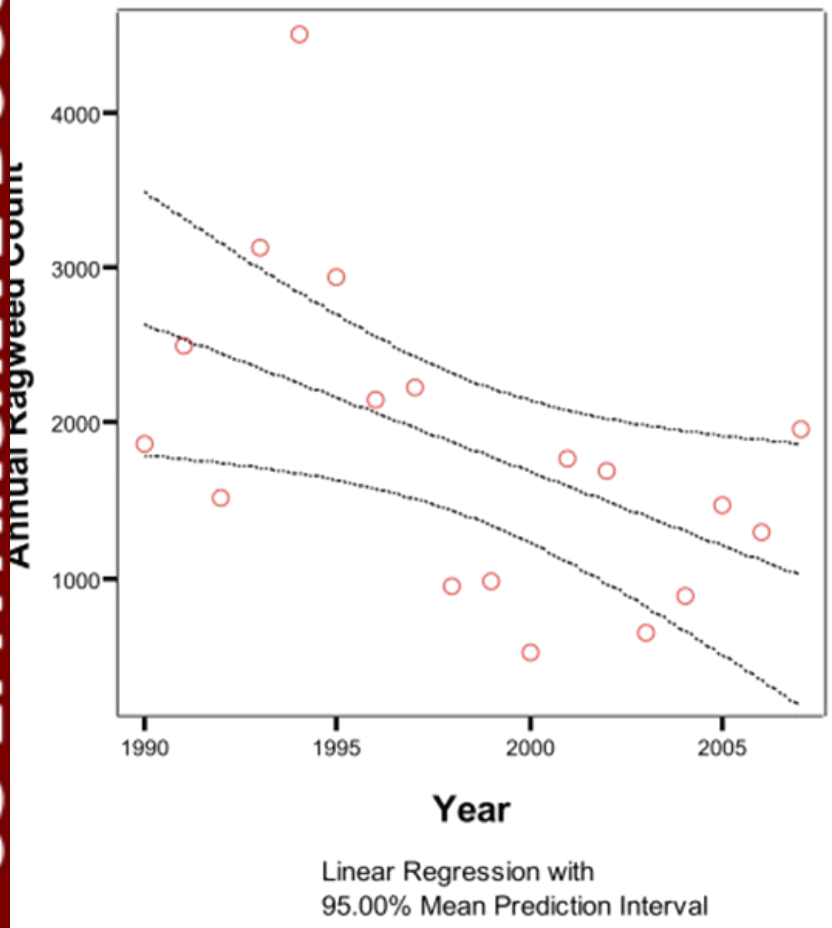


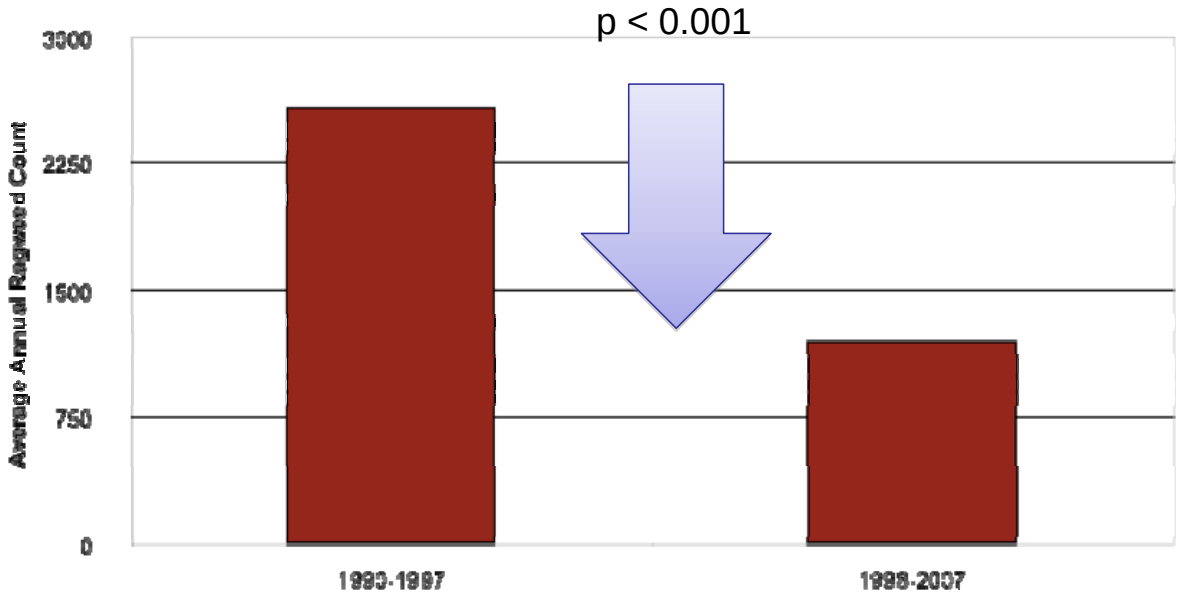


The average duration of Ragweed season has increased from 90 days to 94 days over the last 18 years

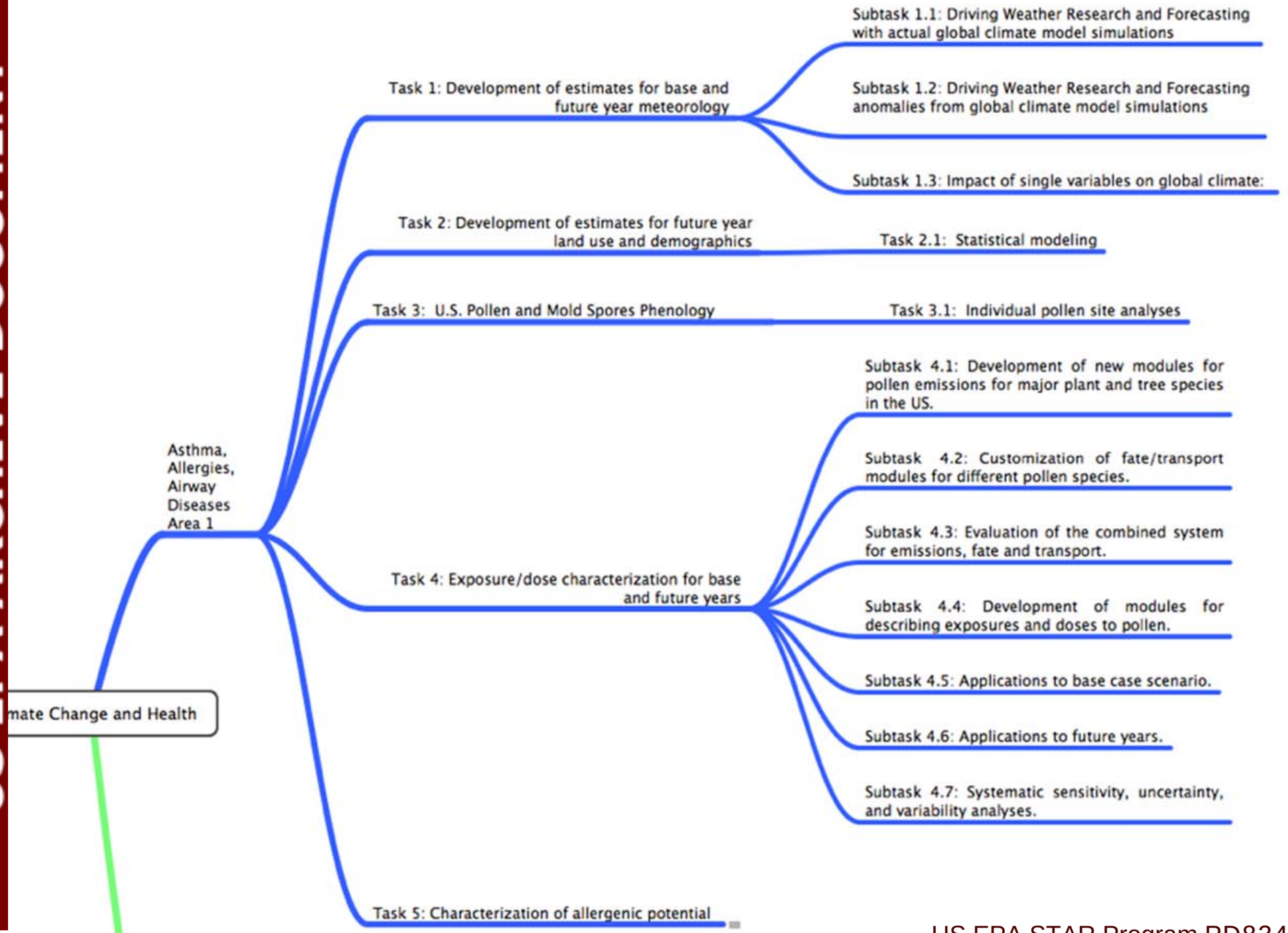
Pollen Trends in New Jersey

AAAAI 2009



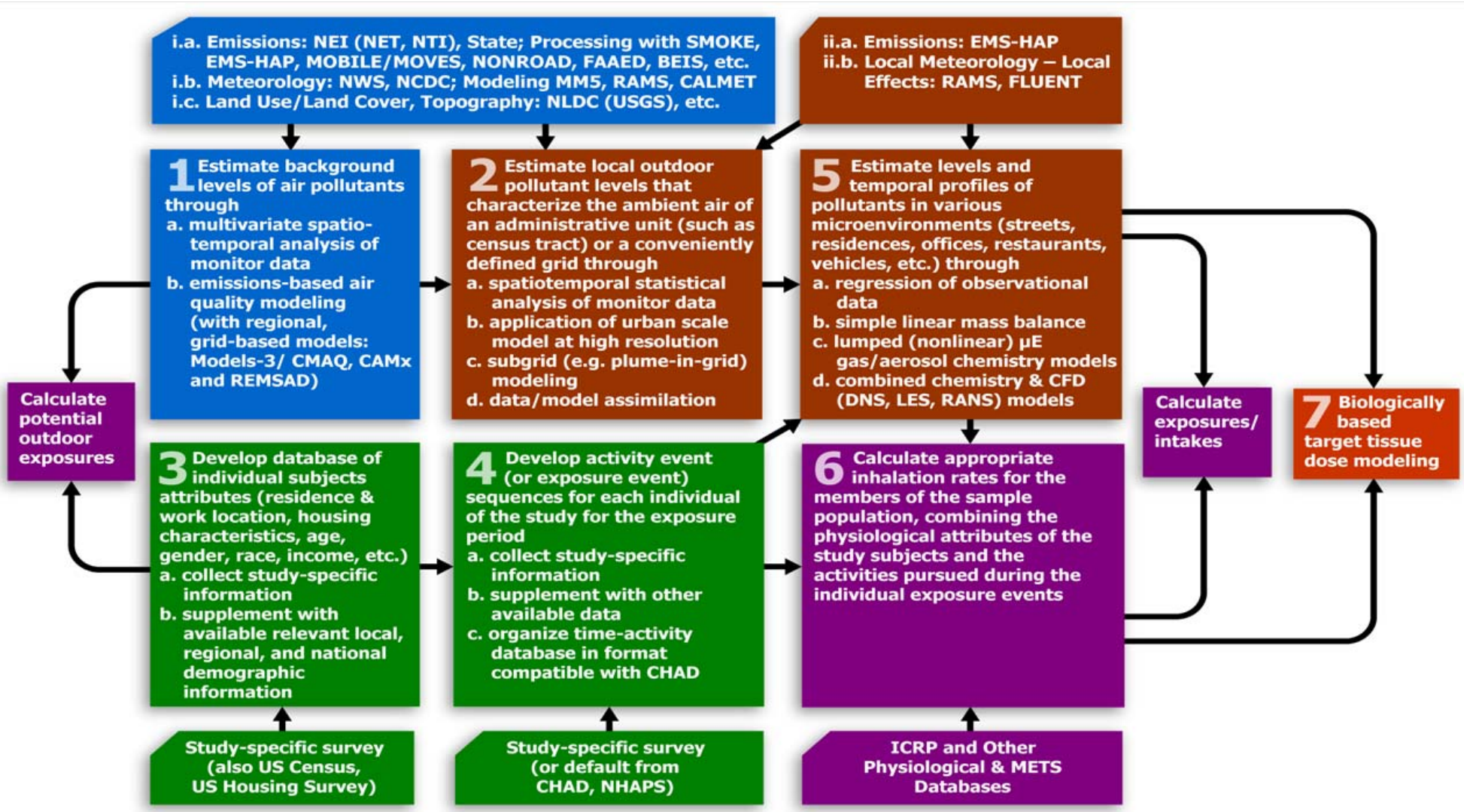


The total number of Ragweed grains counted each season has decreased over the last 18 years

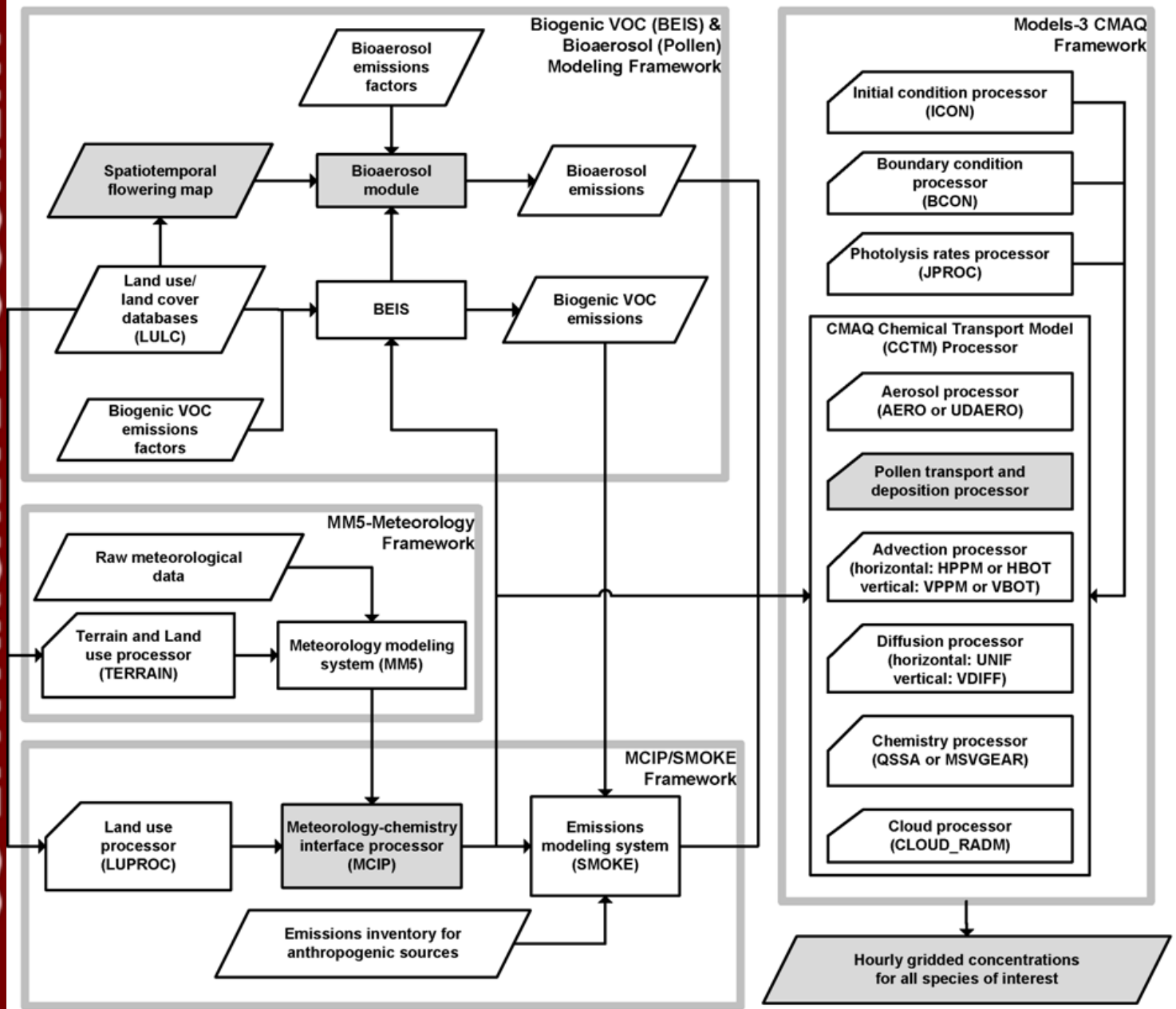


A generalized seven-step population exposure analysis framework for co-occurring air pollutants and pollen

The MENTOR framework has been designed for assessing inhalation exposures and doses for multiple airborne contaminants including bioaerosols and co-occurring air photochemical air pollutants.

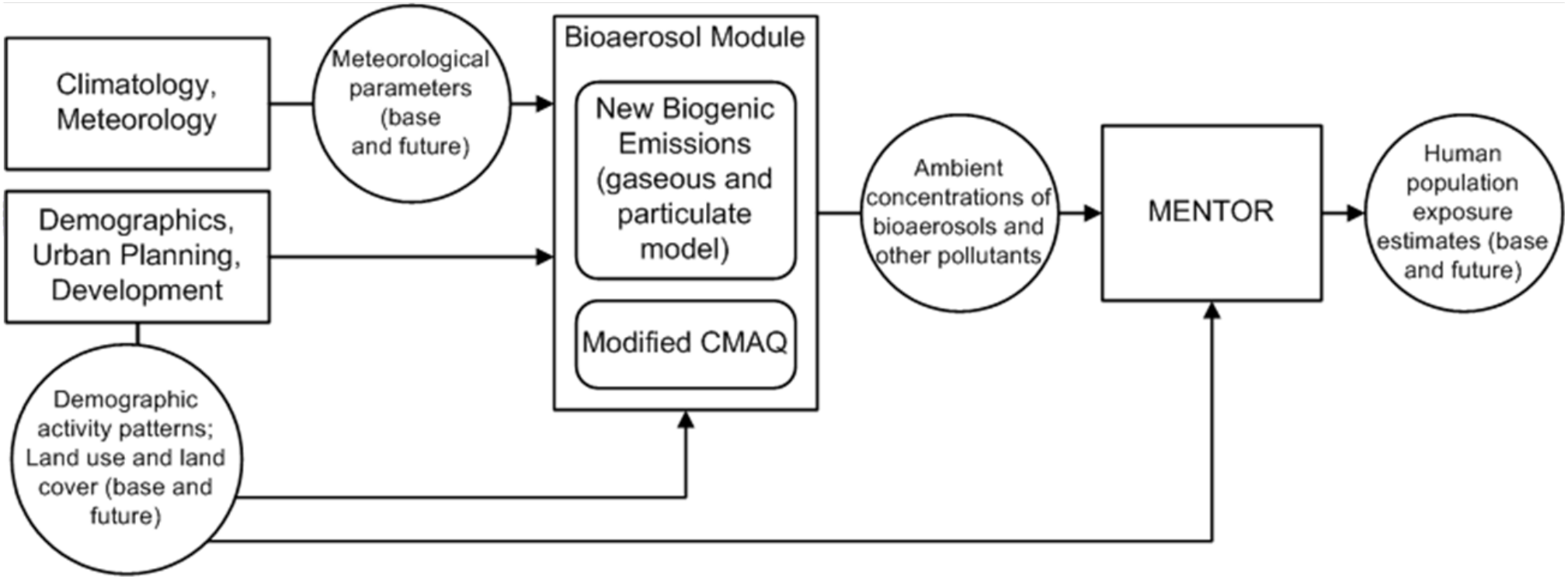


Modules for simulation of pollen emissions and transport

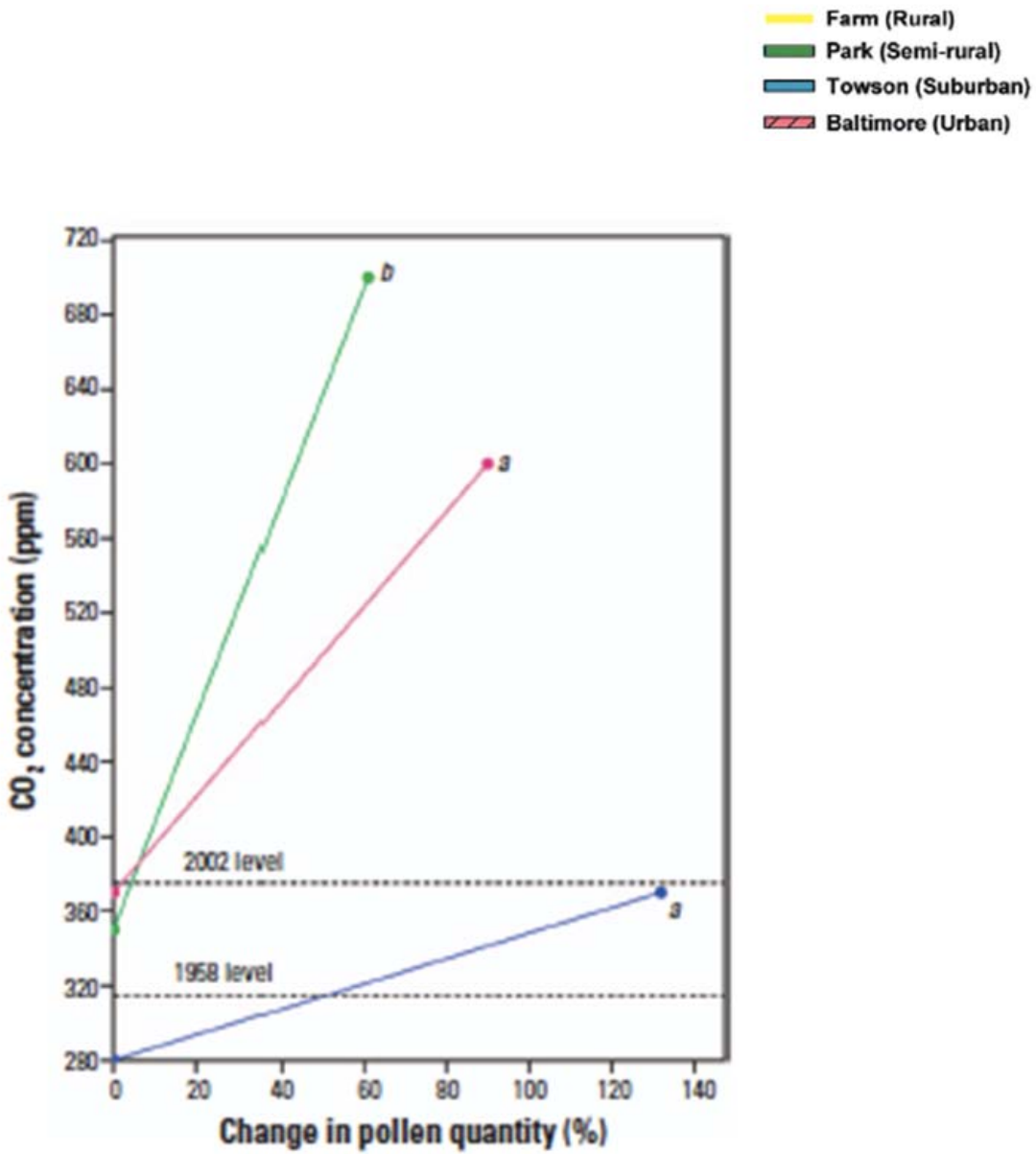


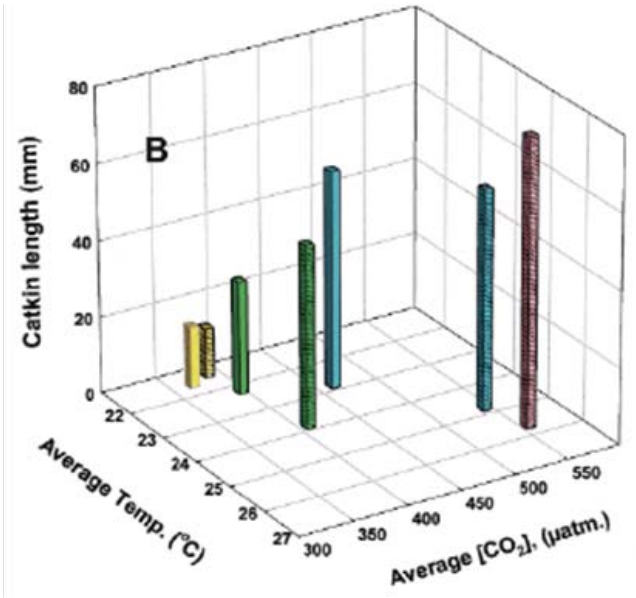
CMAQ has been adapted for simulating the transport of pollen. Schematic of the components of and linkages in CMAQ are shown.

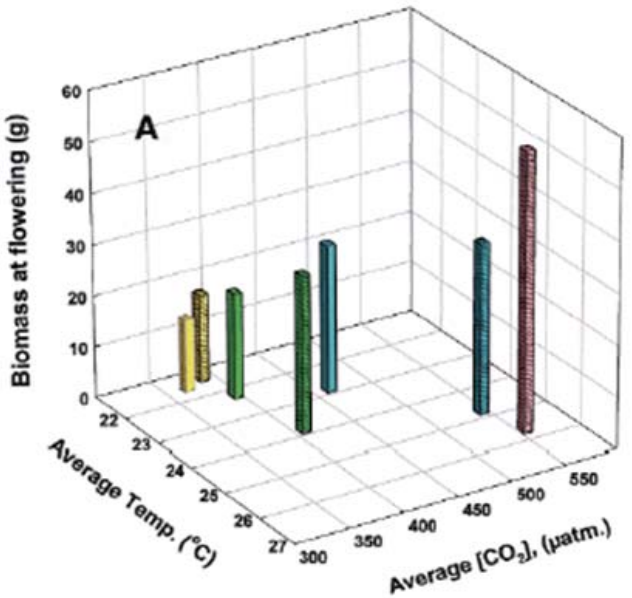
Structure of the overall exposure modeling system for studying co-occurring pollen and gaseous contaminants such as ozone under a changing climate



Pollen Quantity and CO_2



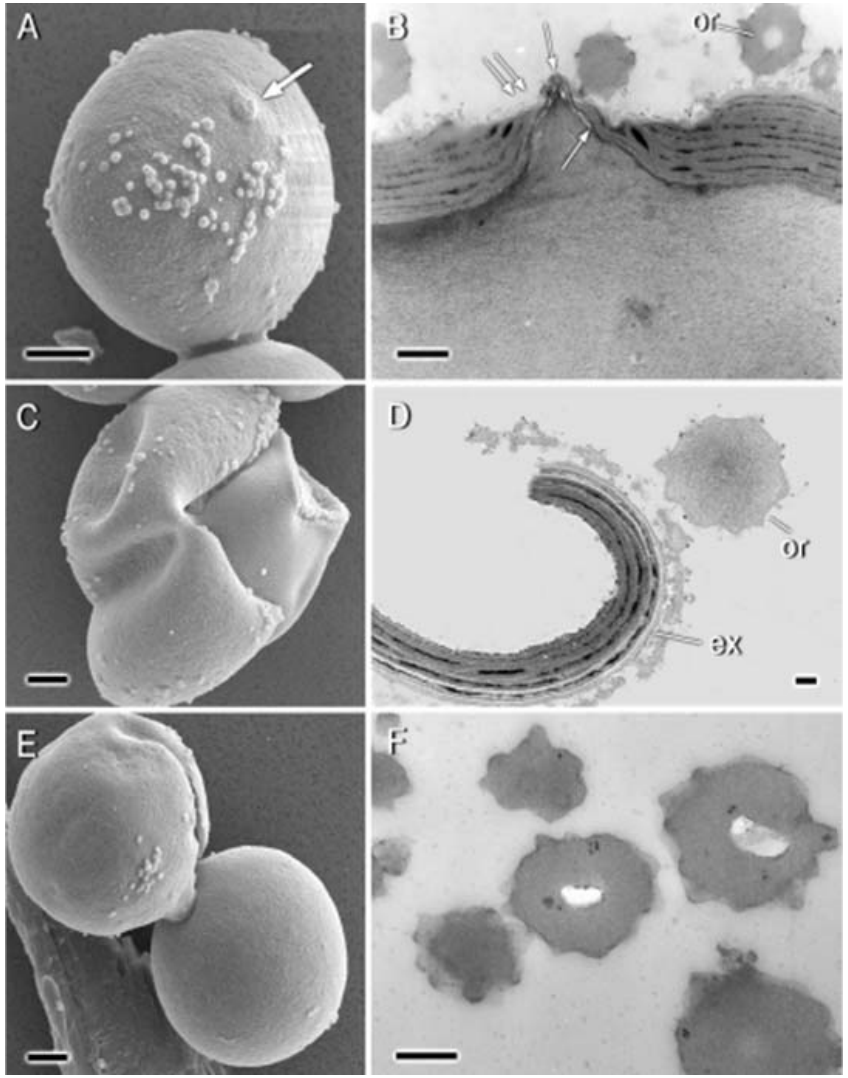


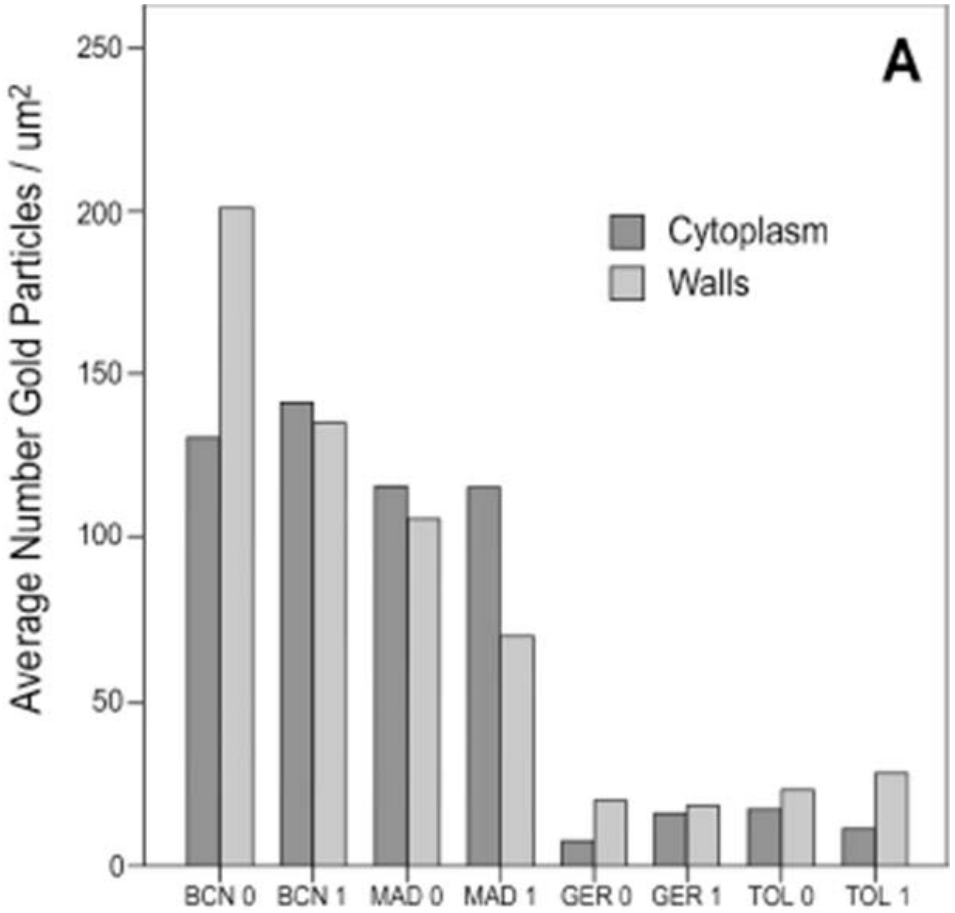


Pollen Phenology

- Pollen increases with increases with CO_2 and/or *T*.
  - Ragweed pollen has increased from pre-industrial to current or future CO_2 levels
  - doubling of greenhouse CO_2 (350 vs 700 microl/L) results in 61% increase
    - Wayne, P., S. Foster, et al. (2002). "Production of allergenic pollen by ragweed (Ambrosia artemisiifolia L.) is increased in CO2-enriched atmospheres." Ann Allergy Asthma Immunol **88**(3): 279-82.
- Examination of ragweed plants in "realistic" urban versus rural areas demonstrated
  - faster growth
  - earlier flowering
  - increased above-ground biomass
  - increased ragweed pollen at the urban locations than at rural locations
    - Ziska, L. H., D. E. Gebhard, et al. (2003). "Cities as harbingers of climate change: common ragweed, urbanization, and public health." JACI **111**(2): 290-5.

Pollen Allergenicity & Pollution





uarez-Cervera, M., T. Castells, et al. (2008). "Effects of air pollution on cup a 3 allergen in Cupressus arizonica pollen grains." Ann Allergy Asthma Immunol **101**(1): 57-66.

Cloned Allergenicity Genes from Grasses and Weeds

Species	Long vs. Short Day	Gene
Perennial ryegrass (Griffiths et al., 1991) (*Lolium perenne*)	Long	Lol p1
Timothy grass (Bufe et al., 1995) (*Phleum pretense*)	Long	Phl p5
Kentucky bluegrass (Olsen et al., 1991) (*Poa pratensis*)	Long	Poa p5
Bermuda grass (Au et al., 2002) (*Cynodon dactylon*)	Short	Cyn D1
Ragweed (Rafner et al., 1991) (*Ambrosia artemissiifolia*)	Short	Amb a1
Mugwort (Arilla, et al., 2007) (*Artemisia annua*)	Short	Art v2

Is this the solution?

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