Climate Change Education -Background and Activities from the State Climatologist perspective

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NSF Geoscience Education

NSF DR K-12

NOAA Education

NSF CAREER

NSF Informal Science Education

NSF CyberInfrastructure (CEOP)

(Undergraduate and graduate courses on weather and climate)

PURDUE UNIVERSITY

Collaborators: Dan Shepardson, Anita Roy Choudhury, Andrew Hirsch, Natalie Caroll, Catherine Halverson (LHS), and teachers/ graduate students (Soyoung Choi, Umarporn Charusambot).

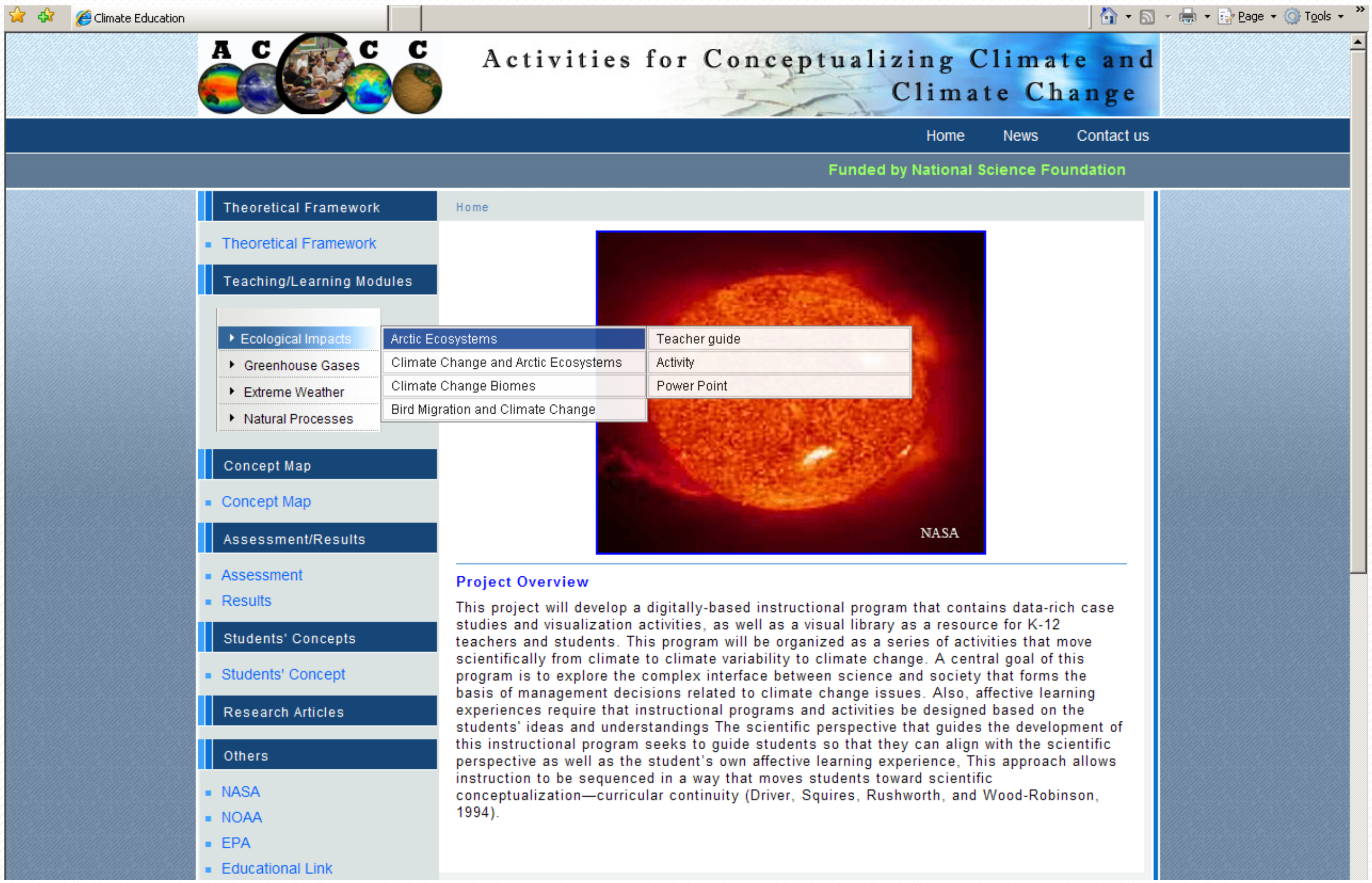

Papers got a bunch of Climate Change mumbo-jumbo in it today.
I love climate change. Spring, summer, fall, winter. Tell them to leave it alone.


EarthFirst.Com
I MAY WEAR A SIZE 7 SHOE, BUT I LEAVE A SIZE 14 CARBON FOOTPRINT.
SHOES

Educational Themes/Modules
- local scale but still thinking of the big questions

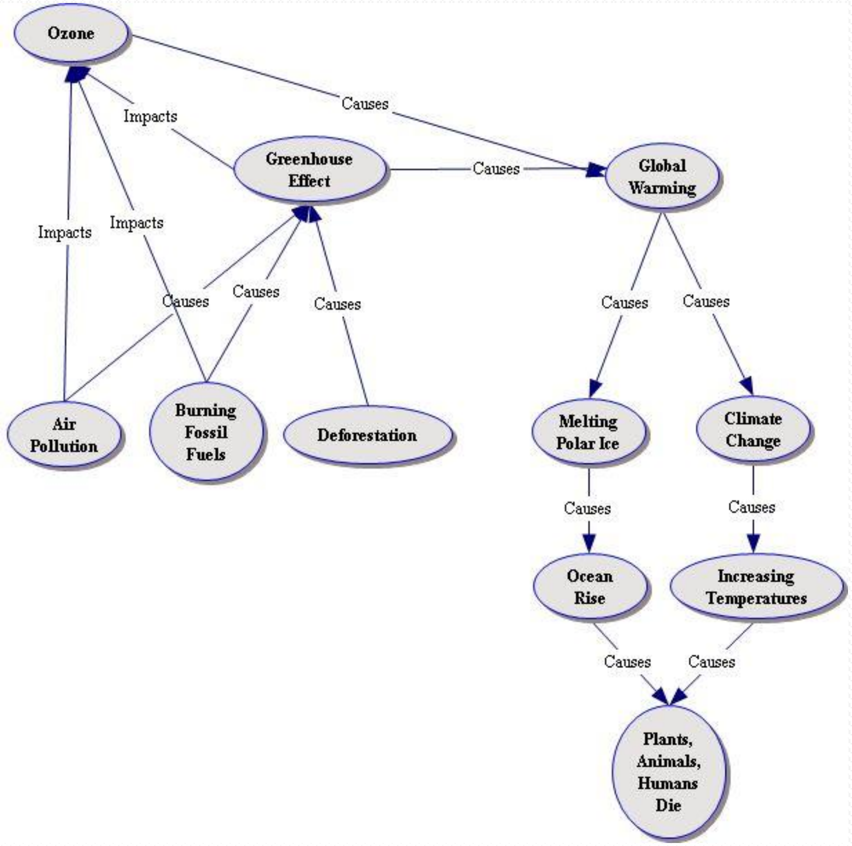
- Weather and Climate, Climate System
- Earth Energy Budget, GHE and Greenhouse Gases, Carbon Cycle
- Global Warming, Climate Change, and Climate Variability
- Climate Change Impacts
- Tools, Monitoring, Models, and Data Sets
- Personal and Community Action
- (primary audience – elementary and middle school / citizens – Policy Makers)

Project Website



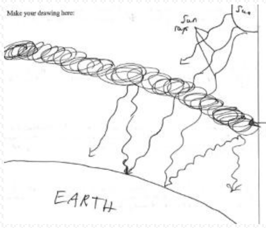
http//ICLIMATE.ORG/CCC

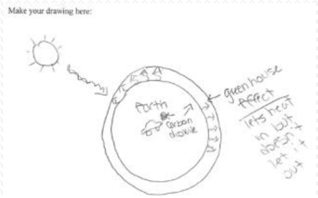
Challenges: Student Conceptions



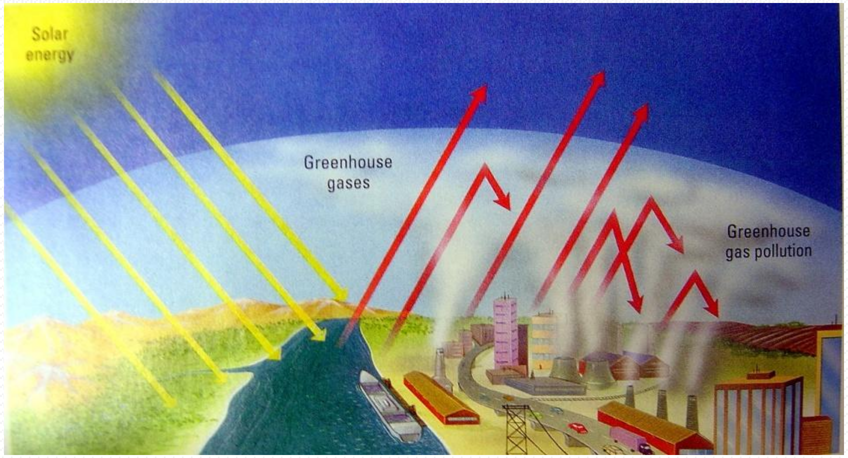
Challenges: Student Conceptions

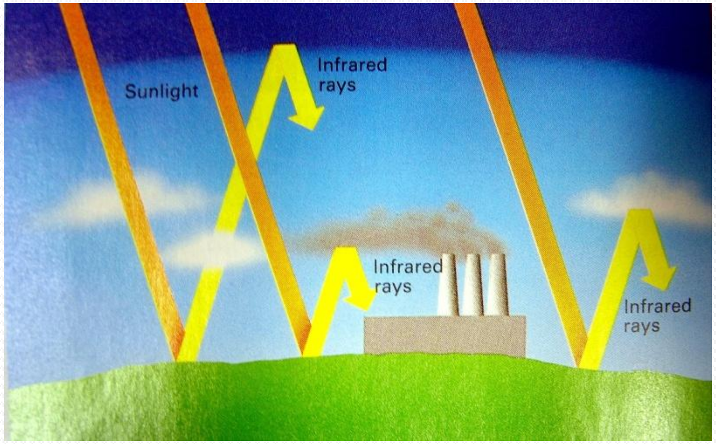
Mental Model of the Greenhouse Effect	Totals (n=225)
Model 5. Sun's rays are "bounced" or reflected back and forth between the Earth's surface and greenhouse gases, heating the Earth (may or may not identify specific greenhouse gases)	30 (13%)
Model 4. Greenhouse gases "trap" the sun's rays, heating the Earth (may or may not identify specific greenhouse gases)	78 (35%)
Model 3. Greenhouse gases, but no heating mechanism, simply gases in the atmosphere	38 (17%)
Model 2. Greenhouse gases cause ozone depletion or formation causing the Earth to warm	14 (6%)
Model 1. "Greenhouse" for growing plants	65 (29%)






Challenges: Textbook Diagrams





Challenges: Experiencing Climate and Analyzing Data

- Ability to observe climate change
  - Collect local weather data, but cannot monitor climate change due to time and scale issues
  - We experience weather and often link it to climate change

- Data handling difficulties
  - Distinguishing between description and interpretation
  - Calculating and comparing means
  - Making and Interpreting graphs

Challenges: Students' Ways of Reasoning about Climate Data

- Students paid selective attention to new information/data:
  a) they attended to information/data that was congruent to or obviously opposing their existing conceptions
  b) they went straight to the graphs/data and made their own interpretations, ignoring the textual information about the graphs/data.

- Students manipulated data/new information to support their existing conceptions

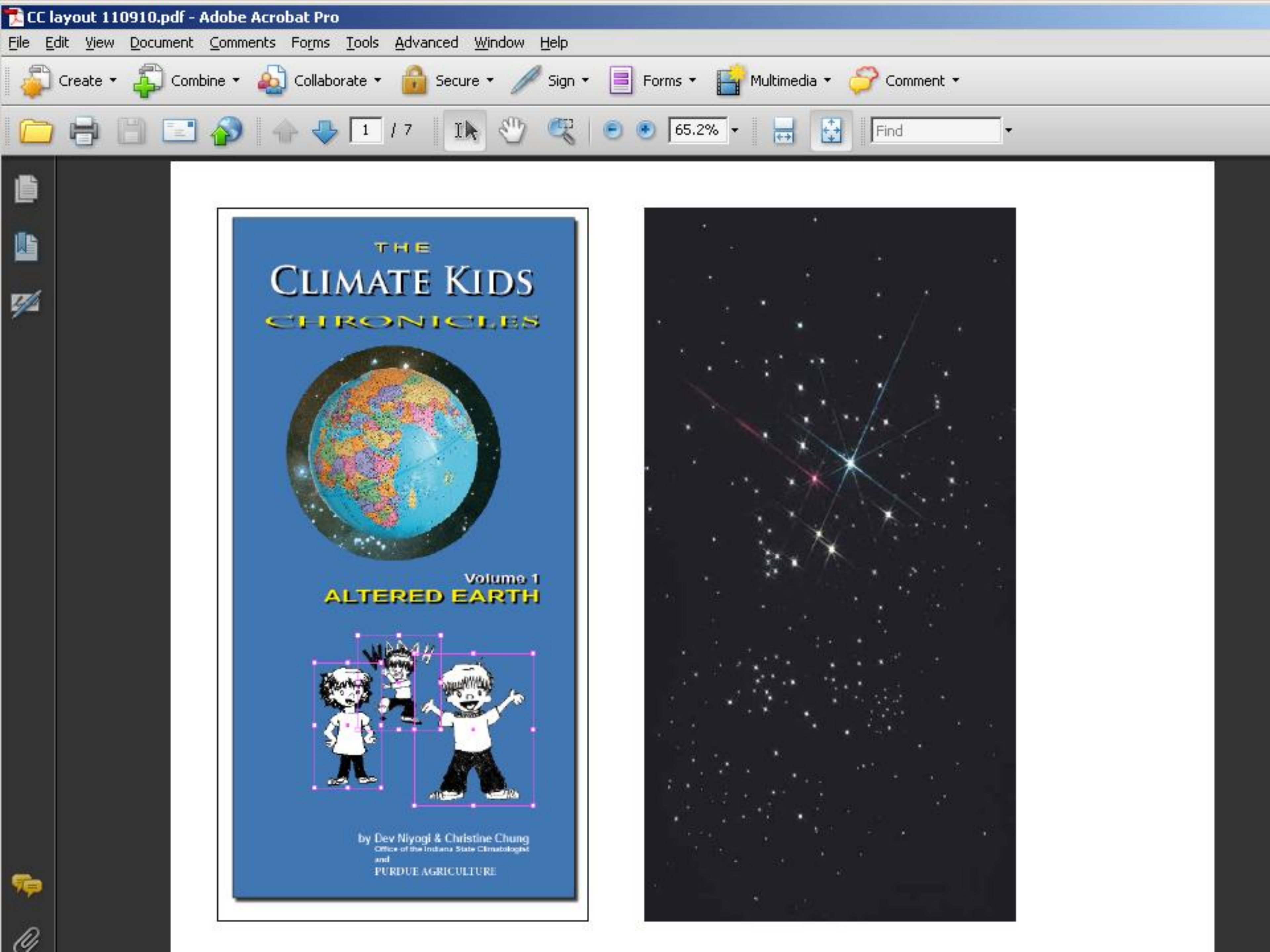
- Students did not understand variation in data:
  a) they interpreted individual fluctuations in a graph, instead of looking at the whole data set or trend
  b) they interpreted a graph based only on how the graph ends (i.e., the very recent data);

Example publications

- Shepardson D., S. Choi, D. Niyogi, and U. Charusombat, 2010: Seventh Grade Students Mental Models of the Greenhouse Effect, Environmental Education Research, accepted

- Choi*, S., Shepardson, D., Niyogi, D. & Charusombat*, U., 2010, Do Earth and Environmental Science Textbooks Promote Middle and High School Students' Conceptual Development about Climate Change? : Textbooks' Consideration of Students' Conceptions. Bull. Amer. Meteorol. Soc., 91, 889-898.

- Shepardson, D., D. Niyogi, S. Choi*, U. Charusombat*, 2010, Student conceptions about greenhouse effect, global warming and climate change, Climatic Change, DOI: 10.1007/s10584-009-9786-9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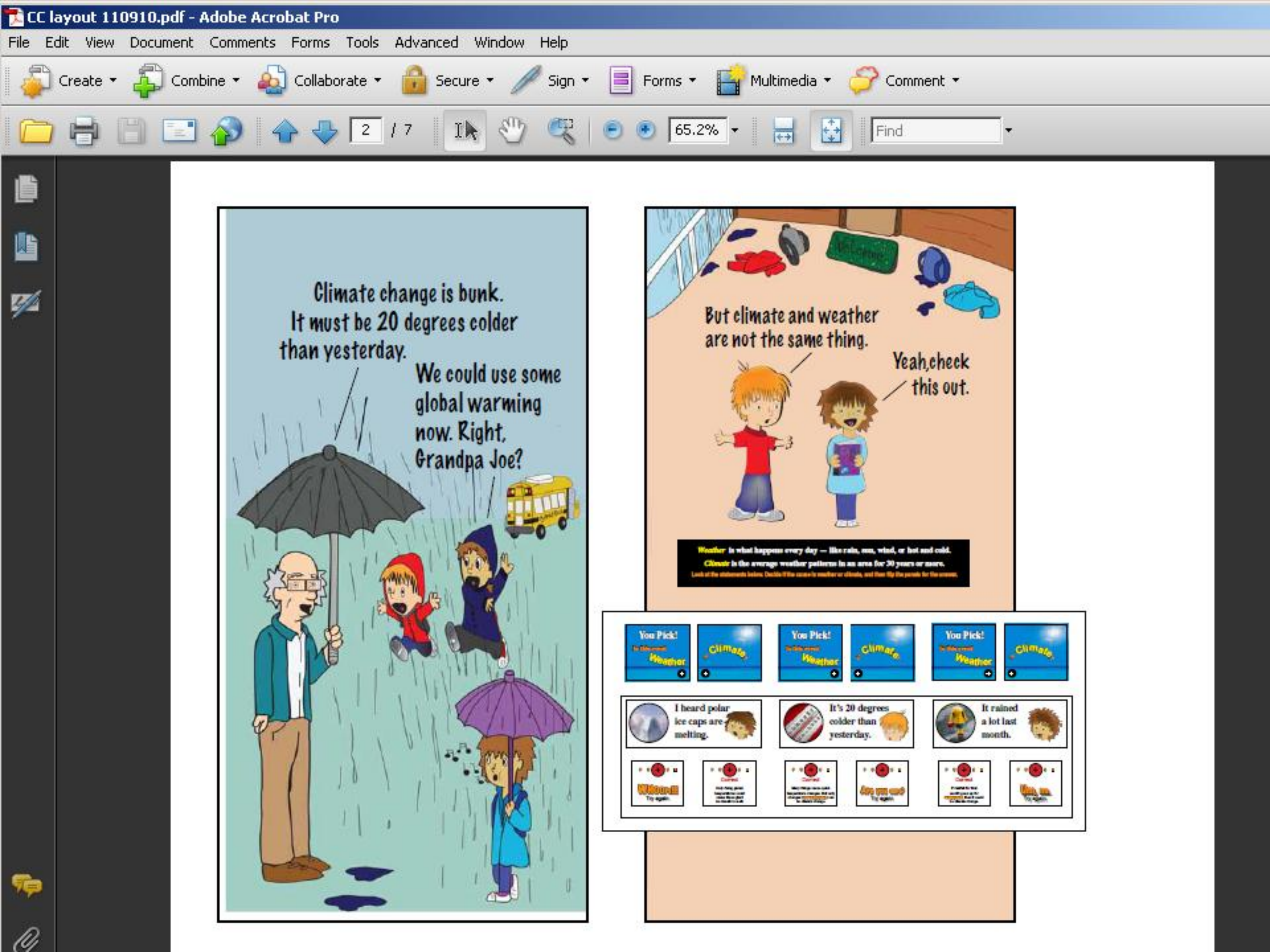
THE
CLIMATE KIDS
CHRONICLES
Volume 1
ALTERED EARTH
by Dev Niyogi & Christine Chung
Office of the Indiana State Climatologist
and
PURDUE AGRICULTURE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File Edit View Document Comments Forms Tools Advanced Window Help
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Find
Climate change is bunk. It must be 20 degrees colder than yesterday.
We could use some global warming now. Right, Grandpa Joe?
But climate and weather are not the same thing.
Yeah, check this out.
Weather is what happens every day — like rain, sun, wind, or hot and cold.
Climate is the average weather patterns in an area for 30 years or more.
You Pick!
Weather
Climate
You Pick!
Weather
Climate
You Pick!
Weather
Climate
I heard polar ice caps are melting.
It's 20 degrees colder than yesterday.
It rained a lot last month.
Try again.
Try again.
Try again.


OK, we're doomed. There's nothing we can do.
Sure there is. Don't forget that we can make less greenhouse gases by burning less fossil fuels.
Look, it stopped raining. Can you drive us to the park?
Drive? No way. Grab your bikes and let's stop making so many greenhouse
Don't forget what we've learned today

- Misconceptions continue their way to undergraduate levels (informal tests) – and may also be valid in different geographical regions (informal testing)
- Assessments critical in designing effective climate related activities / modules.

Some project ideas…

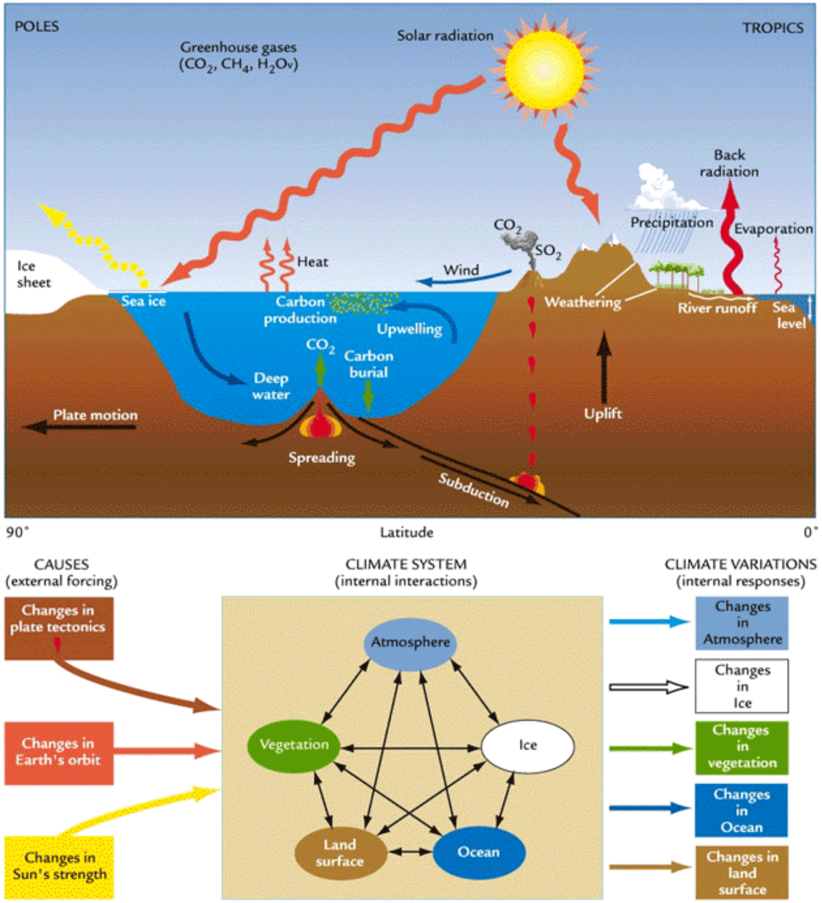
- Measurements
- Data Analysis
- Concept Maps
- Scales (local to regional to global as well as temporal)

Measurements

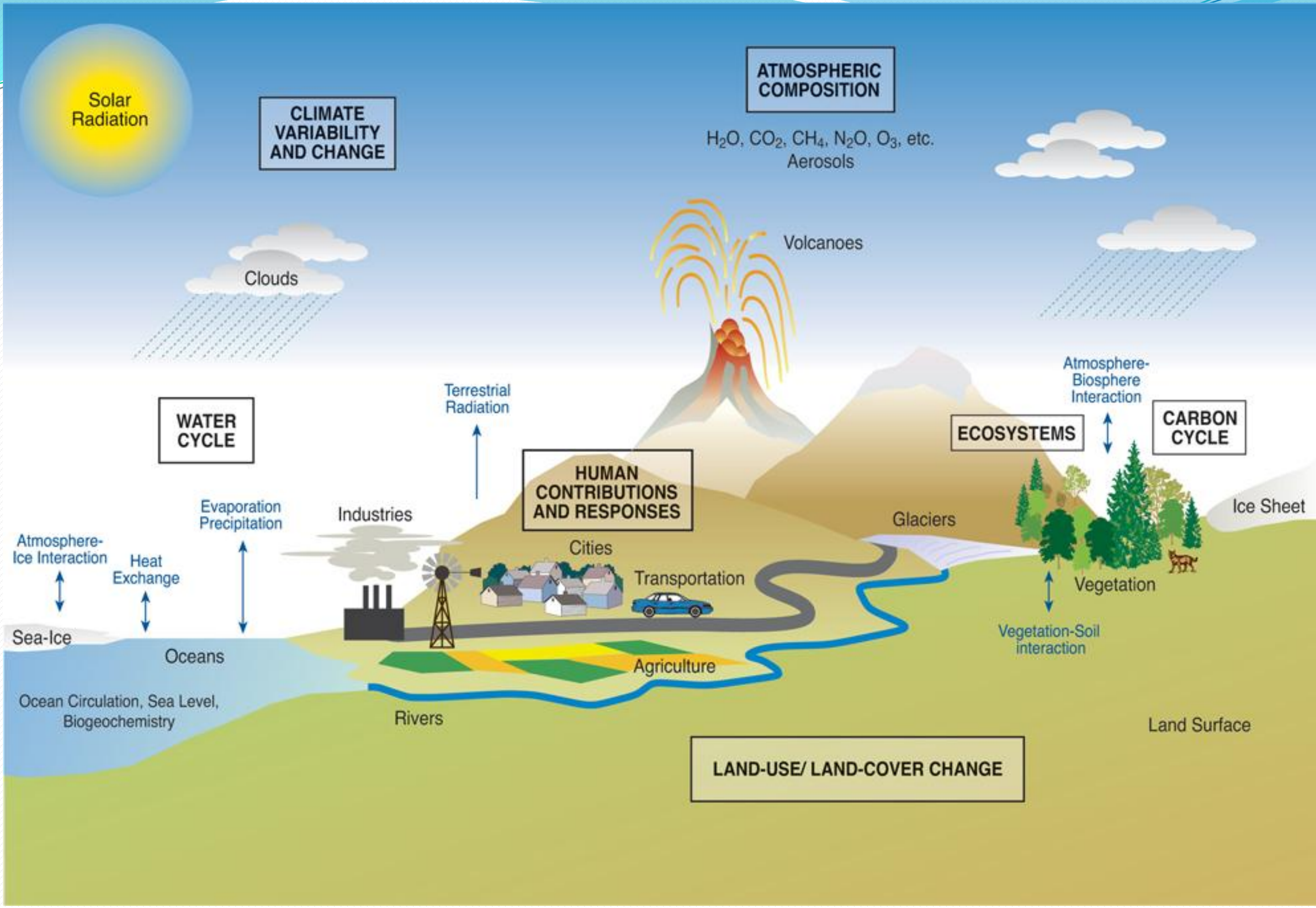
- (measurements to help models rather than monitoring may be feasible)
- Would be interested in albedo, temperature, Urban Heat Island, building morphology, green space map developments
- Green roof/ agriculture impacts for local climate mitigation
- Urban Rainfall Changes (leading the Indiana collaborative rainfall network- CoCoRaHS)
- Data archival, integration within larger systems (monitoring, modeling) protocols

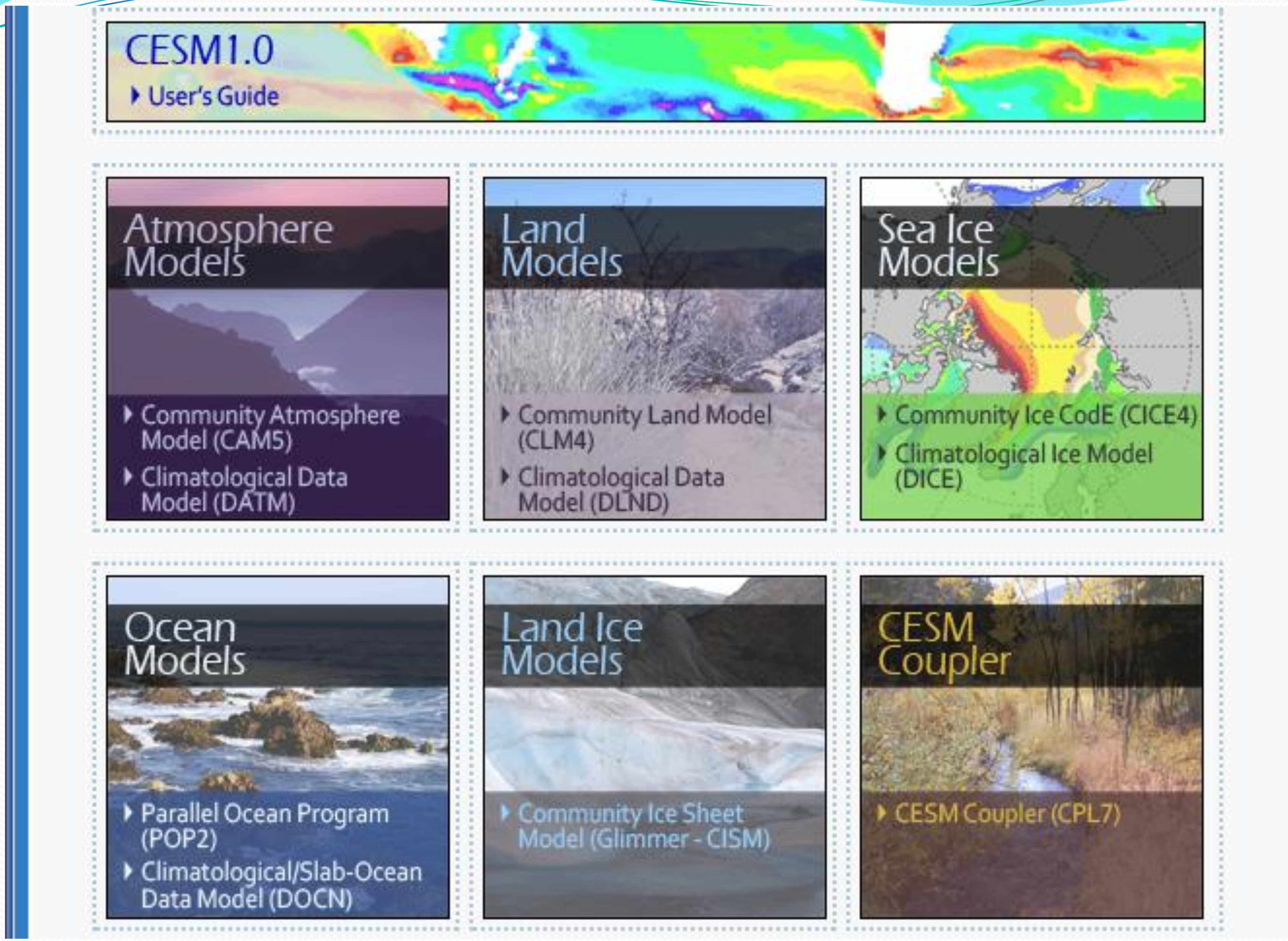
Climate System

- What makes up the Earth's climate system?

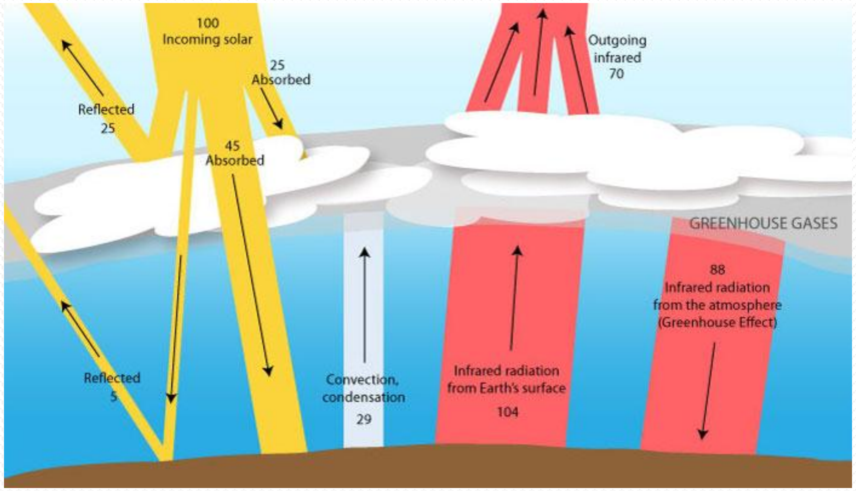


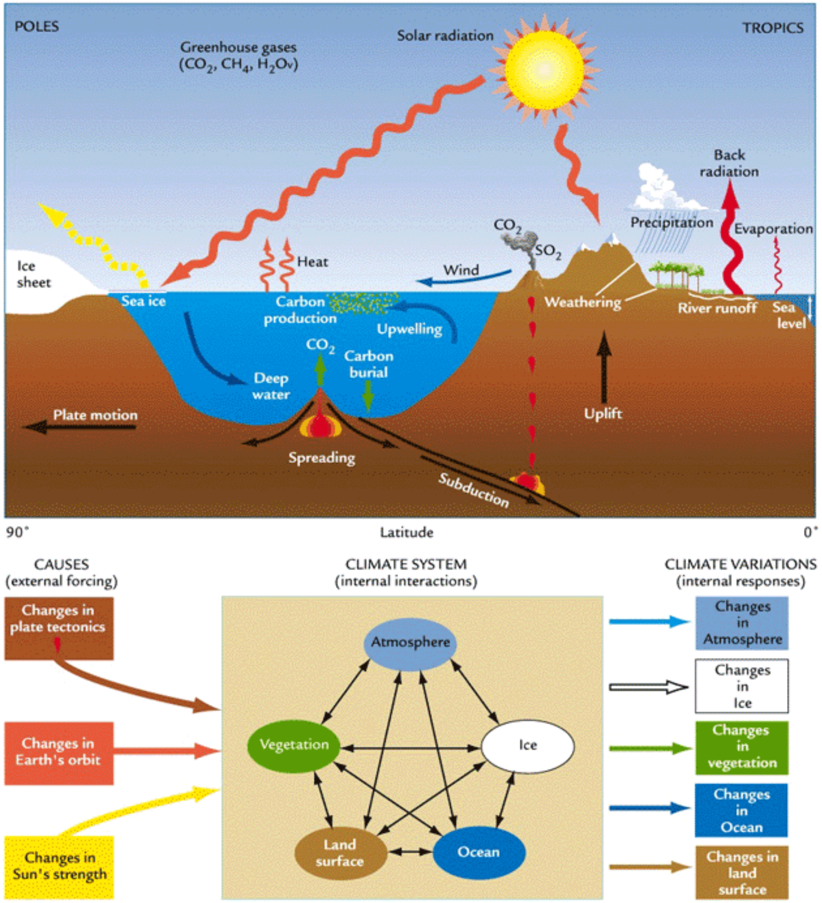

"Putrid Smoke"


Solar Radiation
CLIMATE VARIABILITY AND CHANGE
ATMOSPHERIC COMPOSITION
H_2O, CO_2, CH_4, N_2O, O_3, etc.
Aerosols
Volcanoes
Clouds
WATER CYCLE
Terrestrial Radiation
Atmosphere-Biosphere Interaction
ECOSYSTEMS
CARBON CYCLE
HUMAN CONTRIBUTIONS AND RESPONSES
Evaporation Precipitation
Industries
Glaciers
Ice Sheet
Atmosphere-Ice Interaction
Heat Exchange
Cities
Transportation
Vegetation
Sea-Ice
Oceans
Agriculture
Vegetation-Soil interaction
Ocean Circulation, Sea Level, Biogeochemistry
Rivers
Land Surface
LAND-USE/ LAND-COVER CHANGE


CESM1.0
User's Guide
Atmosphere Models
Community Atmosphere Model (CAM5)
Climatological Data Model (DATM)
Land Models
Community Land Model (CLM4)
Climatological Data Model (DLND)
Sea Ice Models
Community Ice CodE (CICE4)
Climatological Ice Model (DICE)
Ocean Models
Parallel Ocean Program (POP2)
Climatological/Slab-Ocean Data Model (DOCN)
Land Ice Models
Community Ice Sheet Model (Glimmer - CISM)
CESM Coupler
CESM Coupler (CPL7)

Earth's Energy Budget (Albedo)





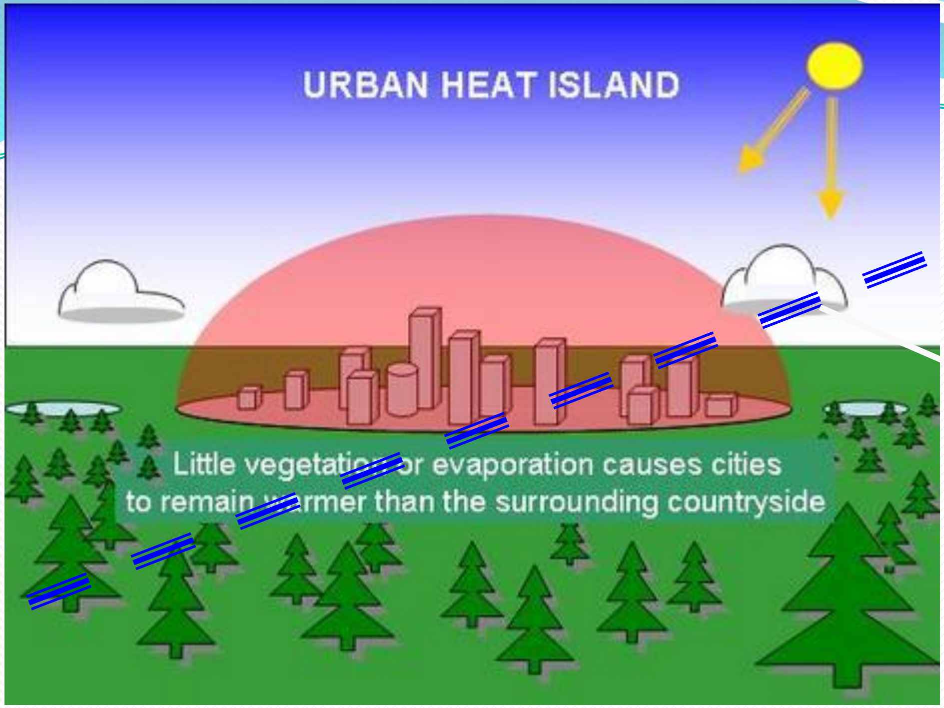
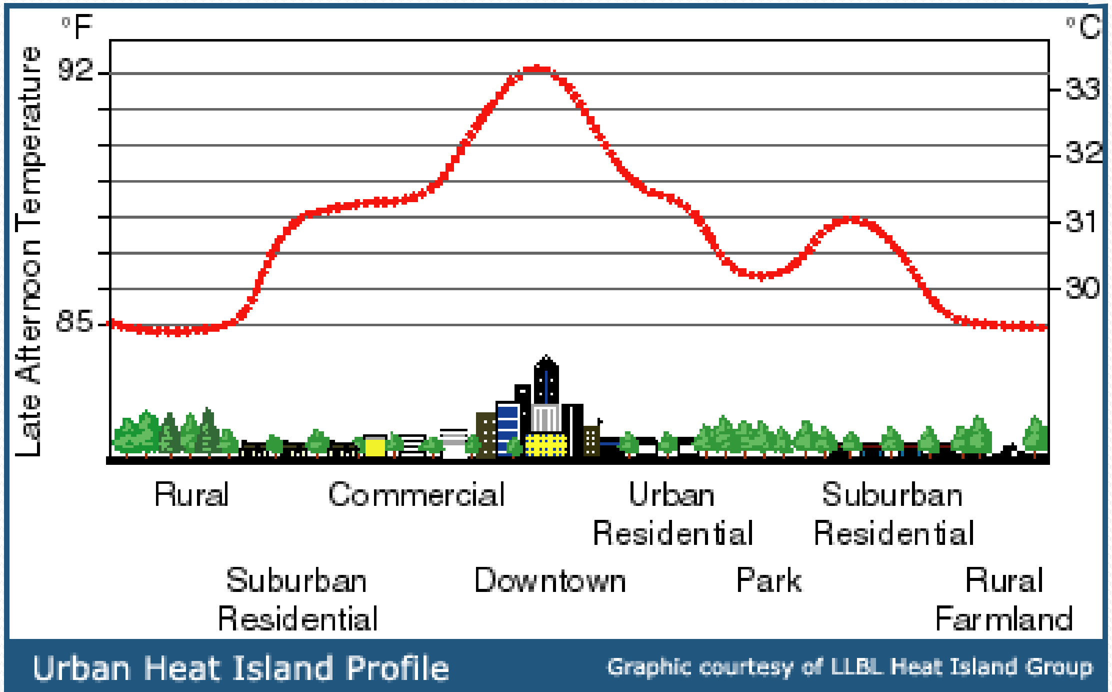
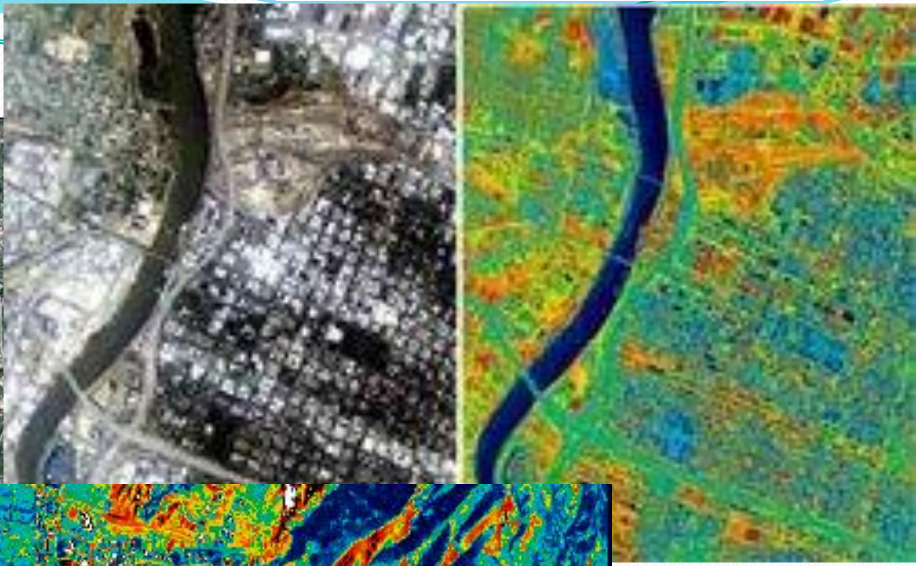


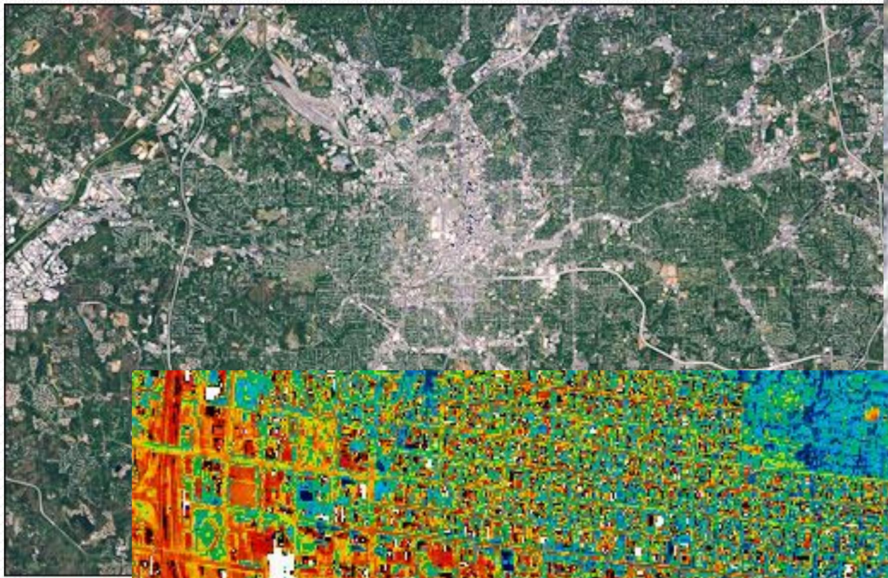
Image from treehugger.com

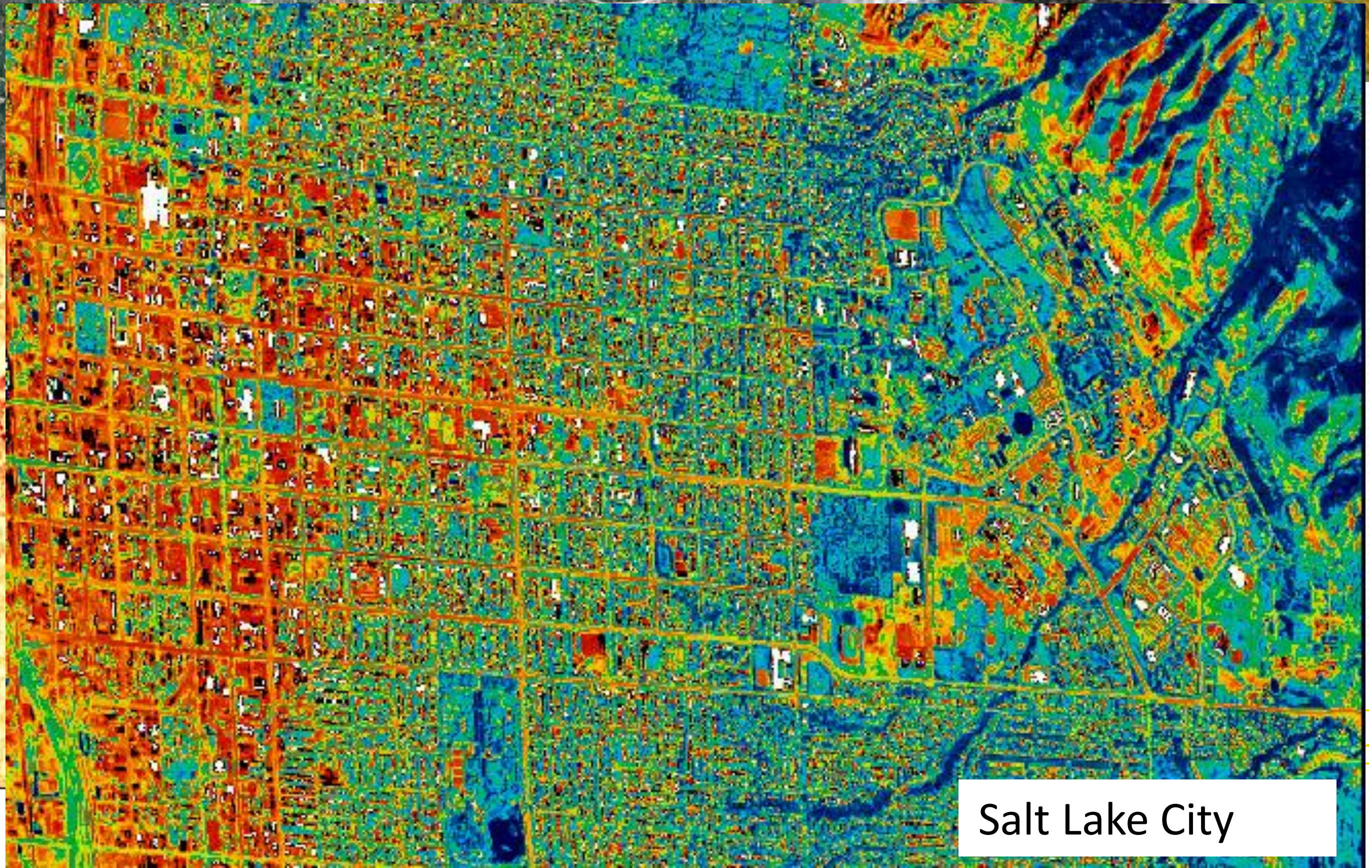


Sacramento, CA UHI



ATLANTA UHI





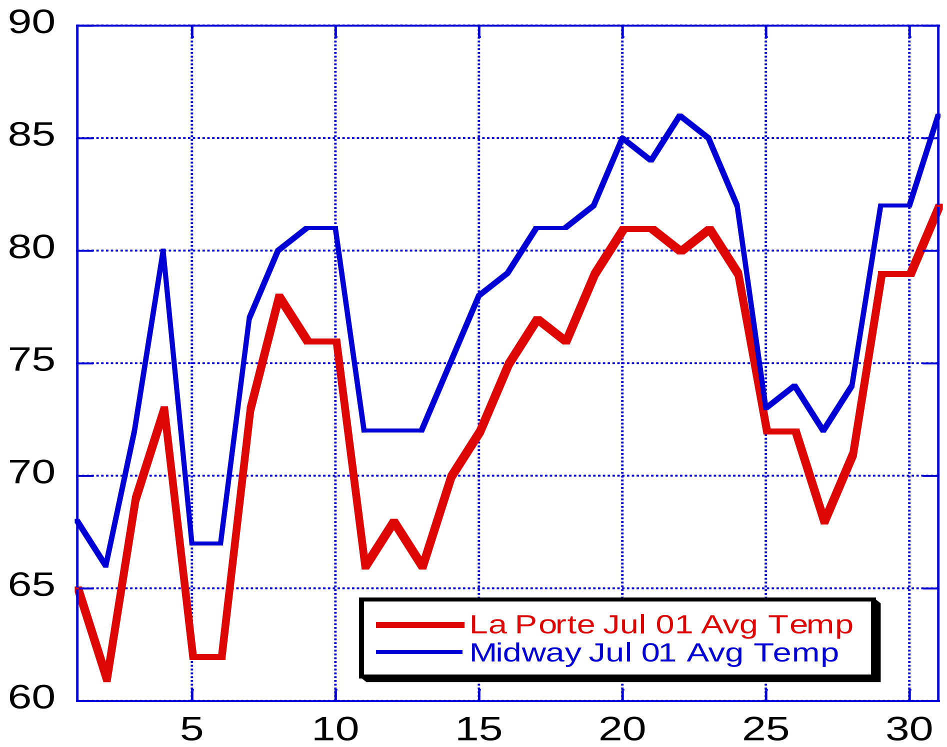
Salt Lake City

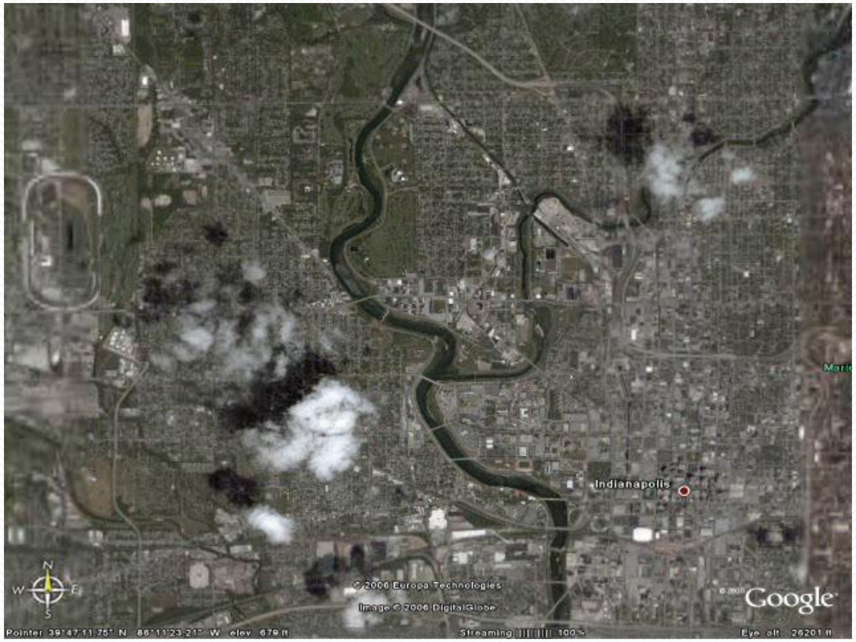
asa.gov/Newsroom/Ne

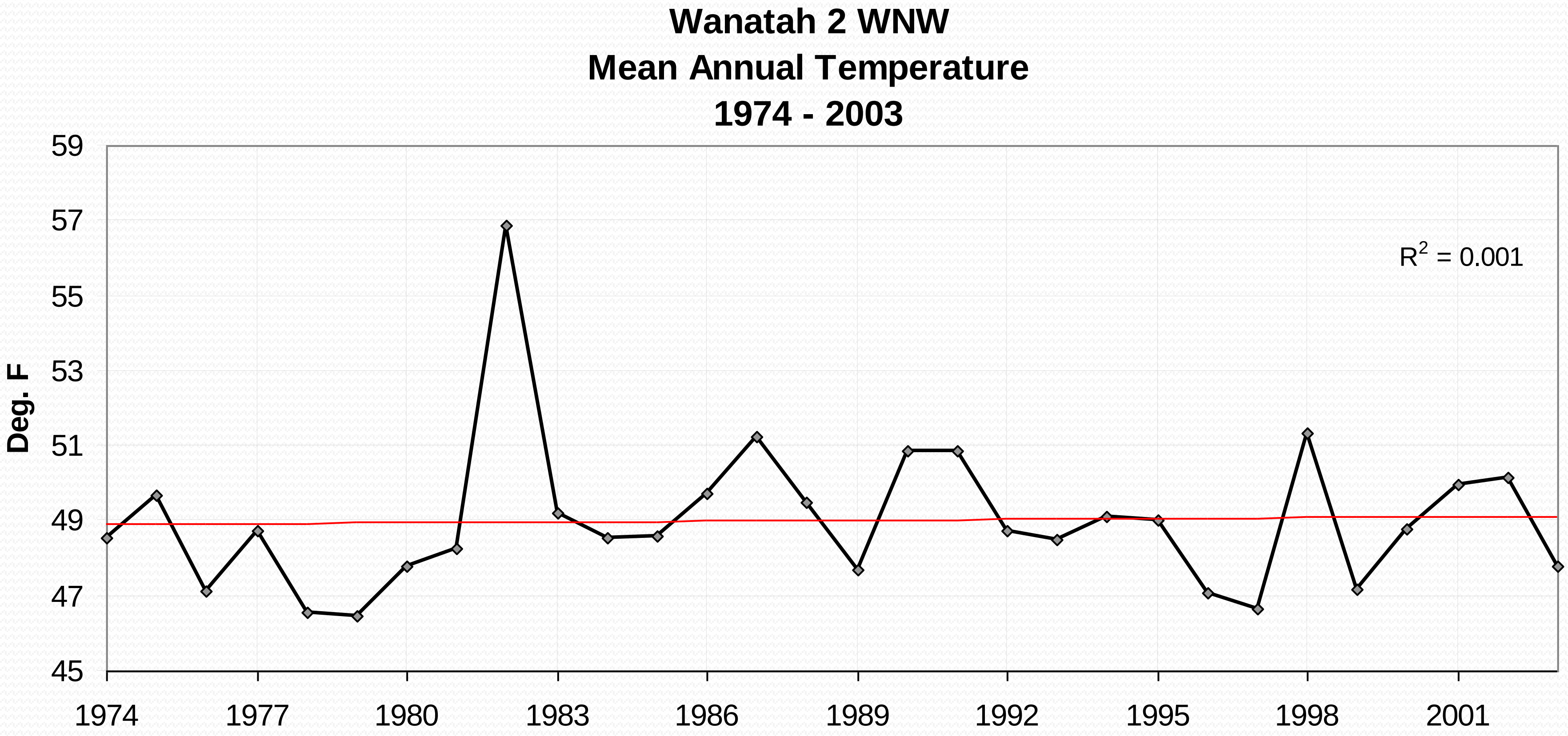
ng_id=17489

Urban Heating

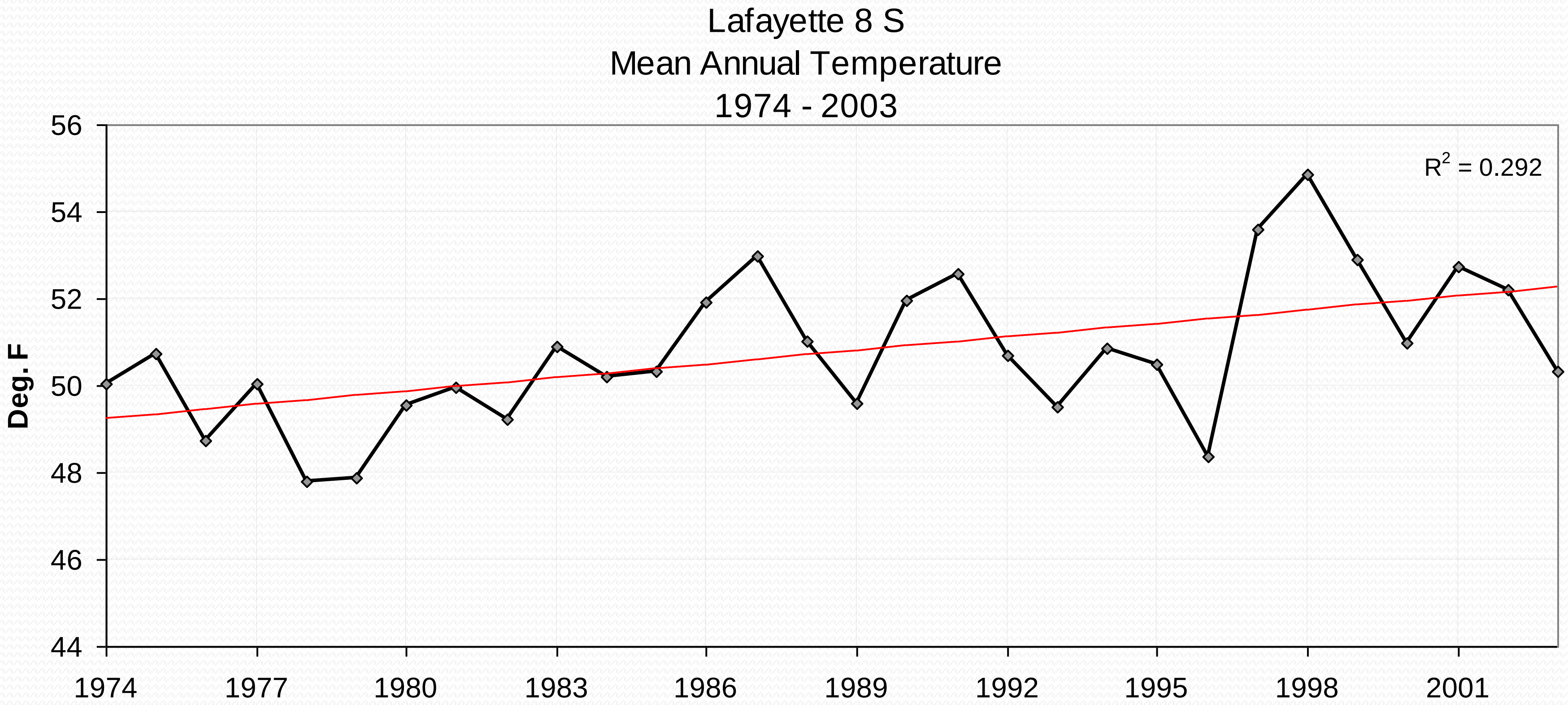
Average Temperatures in
July for Urban & Rural Areas



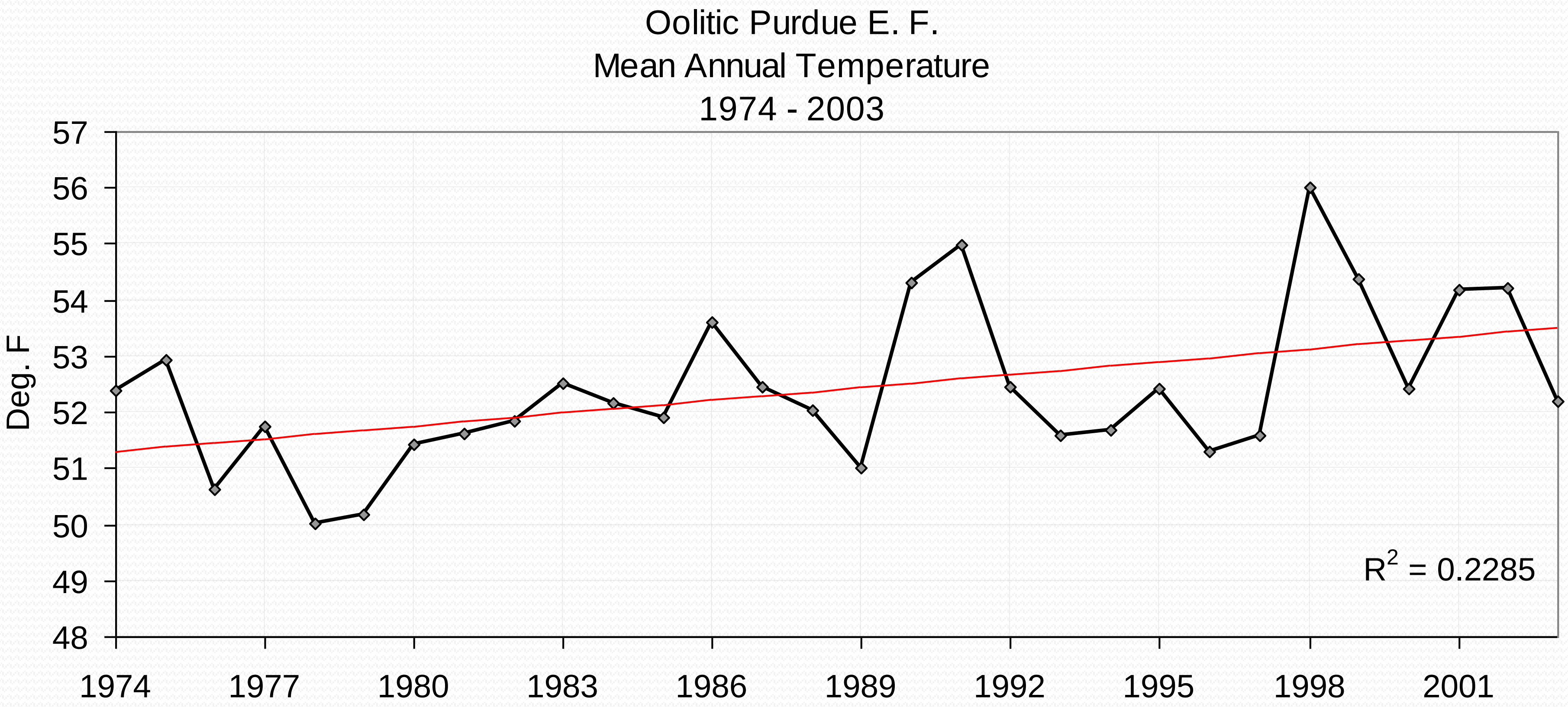




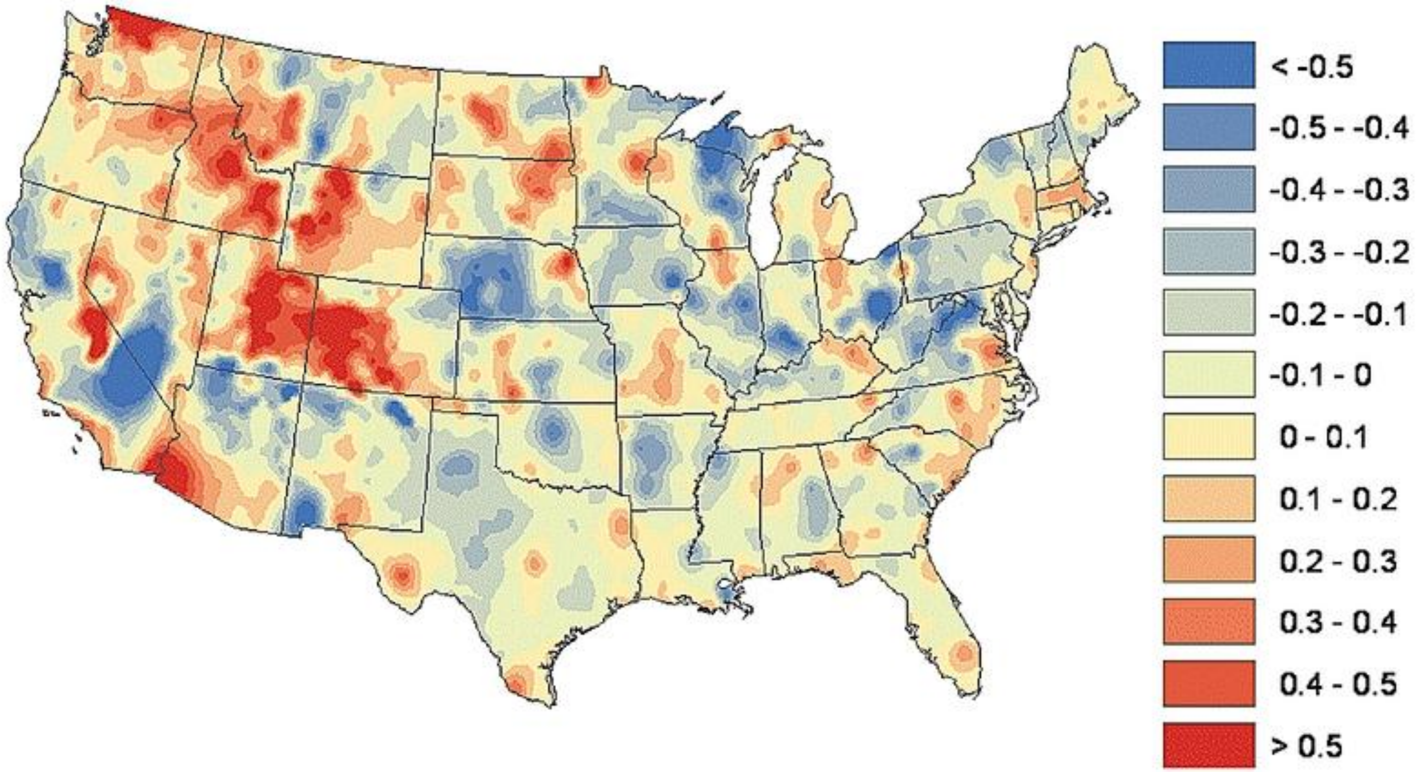
Wanatah 2 WNW
Mean Annual Temperature
1974 - 2003
Deg. F
59
57
55
53
51
49
47
45
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
R2 = 0.001



Lafayette 8 S
Mean Annual Temperature
1974 - 2003
Deg. F
56
54
52
50
48
46
44
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
R2 = 0.292


Oolitic Purdue E. F.
Mean Annual Temperature
1974 - 2003
Deg. F
57
56
55
54
53
52
51
50
49
48
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
R2 = 0.2285

Green is cool but US landscape is not -The impacts of land use on temperature trends over the US



- Landuse based temperature changes over the last 3 decades highlight the significance of agriculture and urban planning in climate change mitigation

Linking measurements to climate system components (Albedo change)

paper-submitted-IEEE-Vis-March2010.pdf - Adobe Acrobat Pro

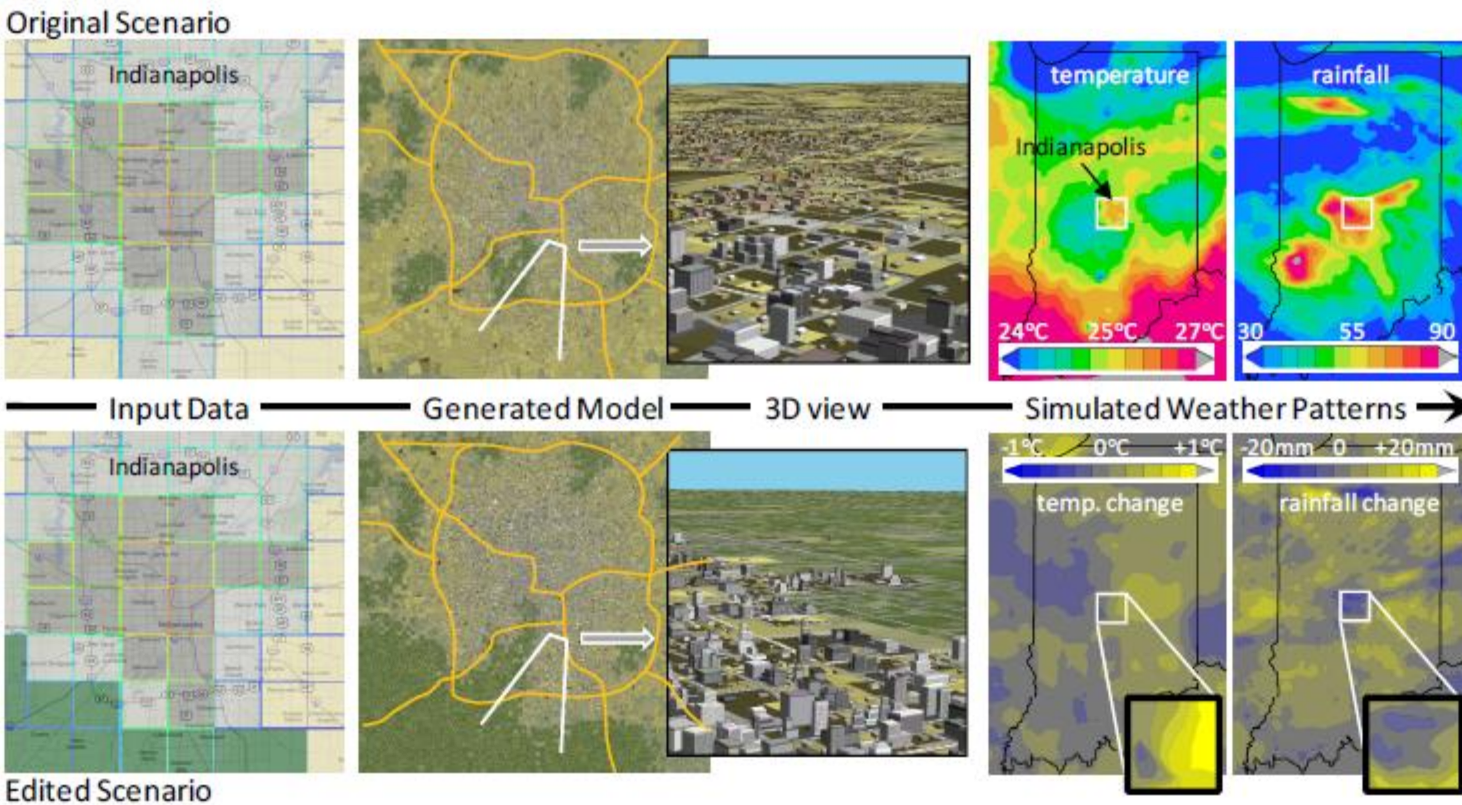
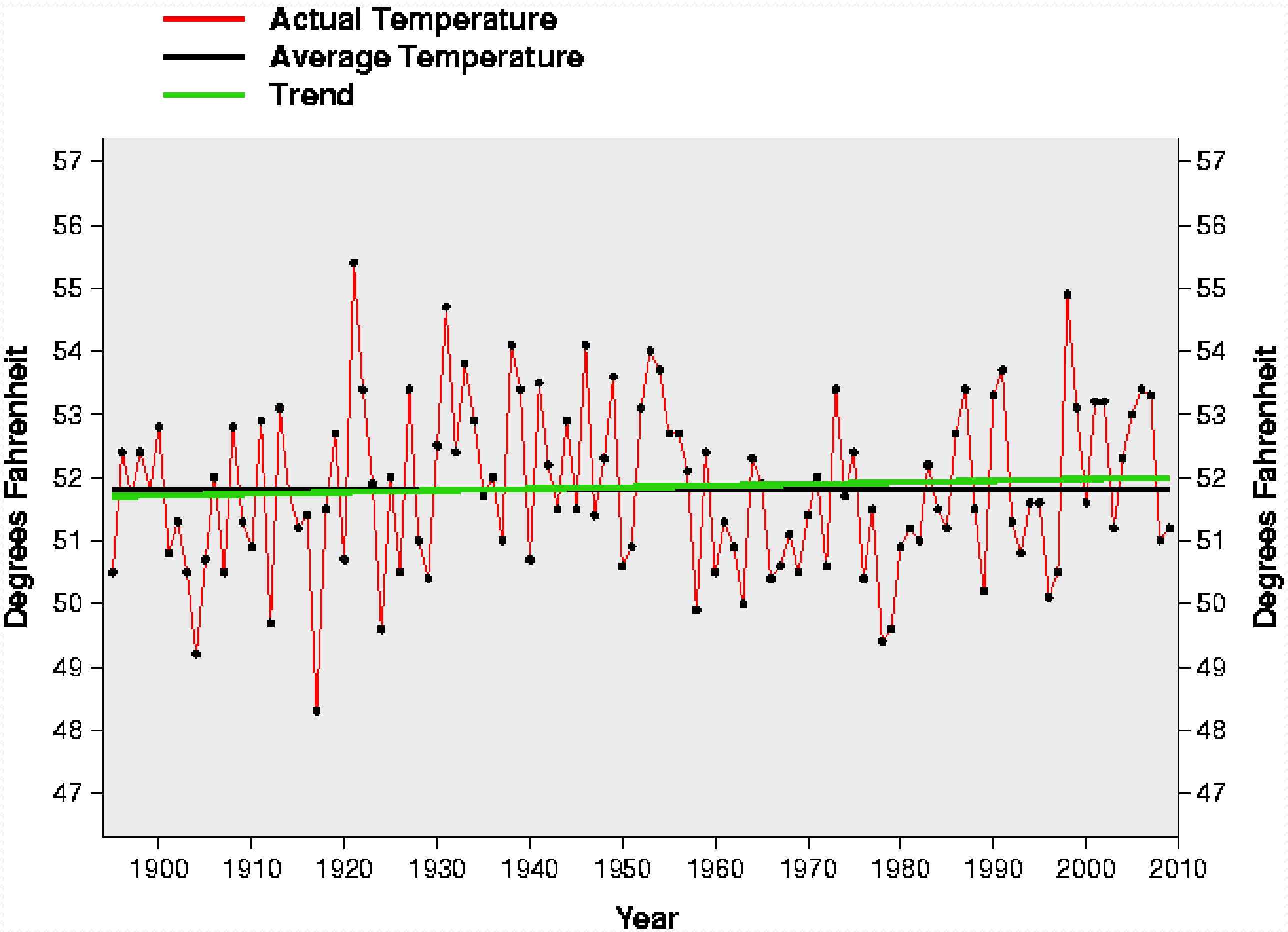
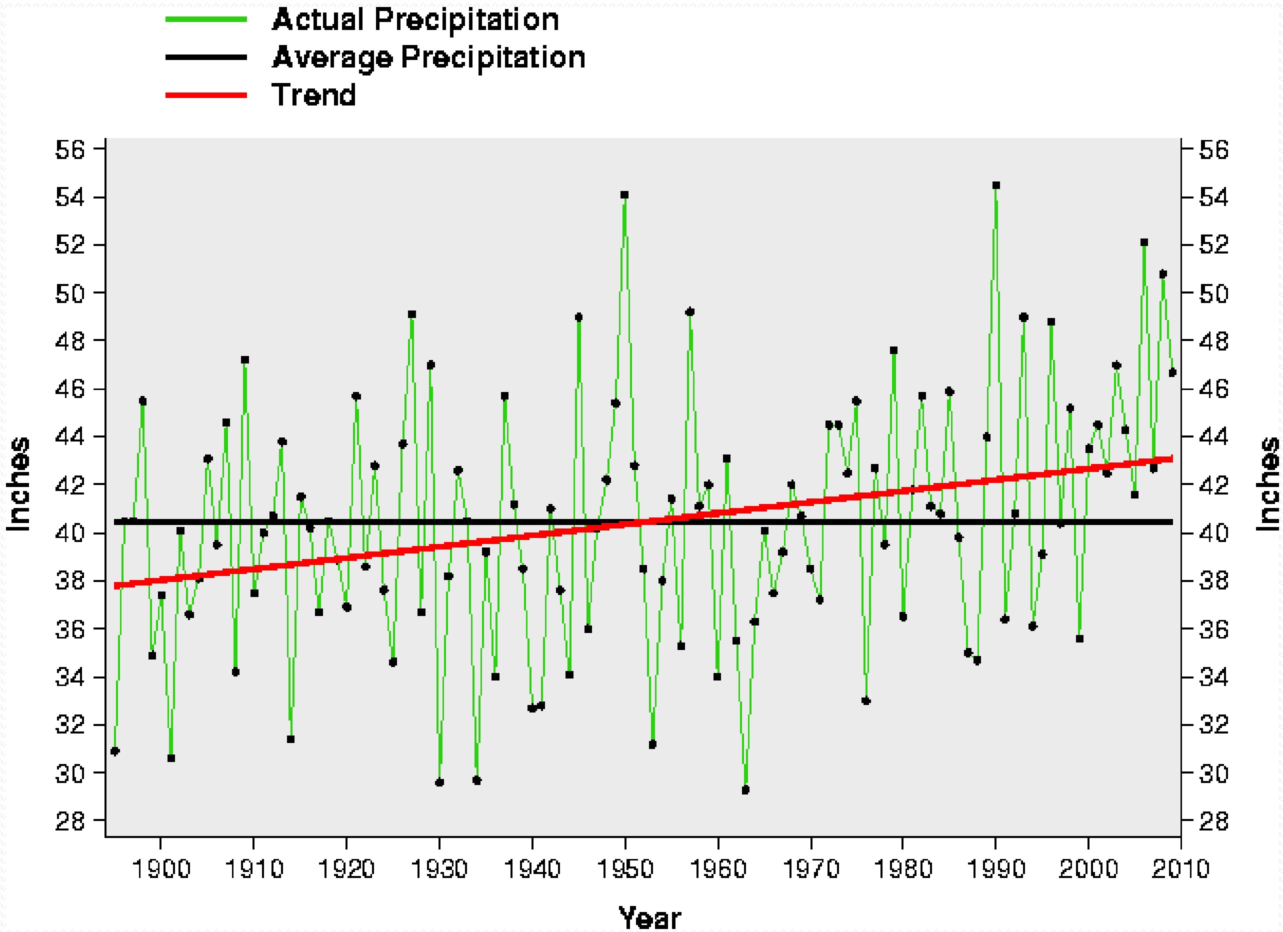


Figure 1. Visualization-based Decision Support System. *Top*: original urban scenario for Indianapolis, IN. *Bottom*: hypothetical (edited) urban scenario where the southwest corner became parks. Using LULC data (*left column*), complemented by population and terrain data, our DSS automatically produces a plausible 3D city model (*second and third columns*) from which urban morphology parameters are ex-

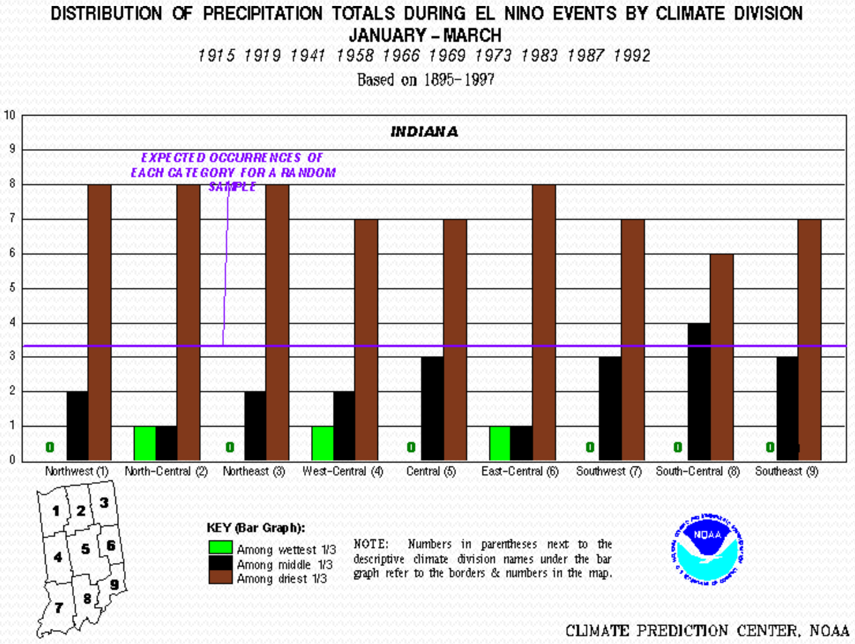
IN Climate Data Analysis
Indian Annual Temperature

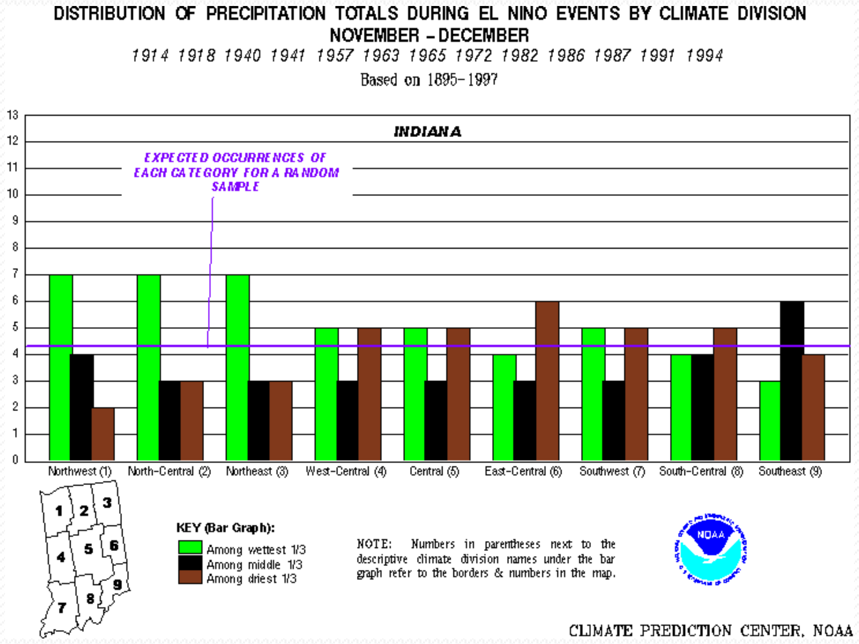


IN Climate Data Analysis
Indiana Annual Precipitation

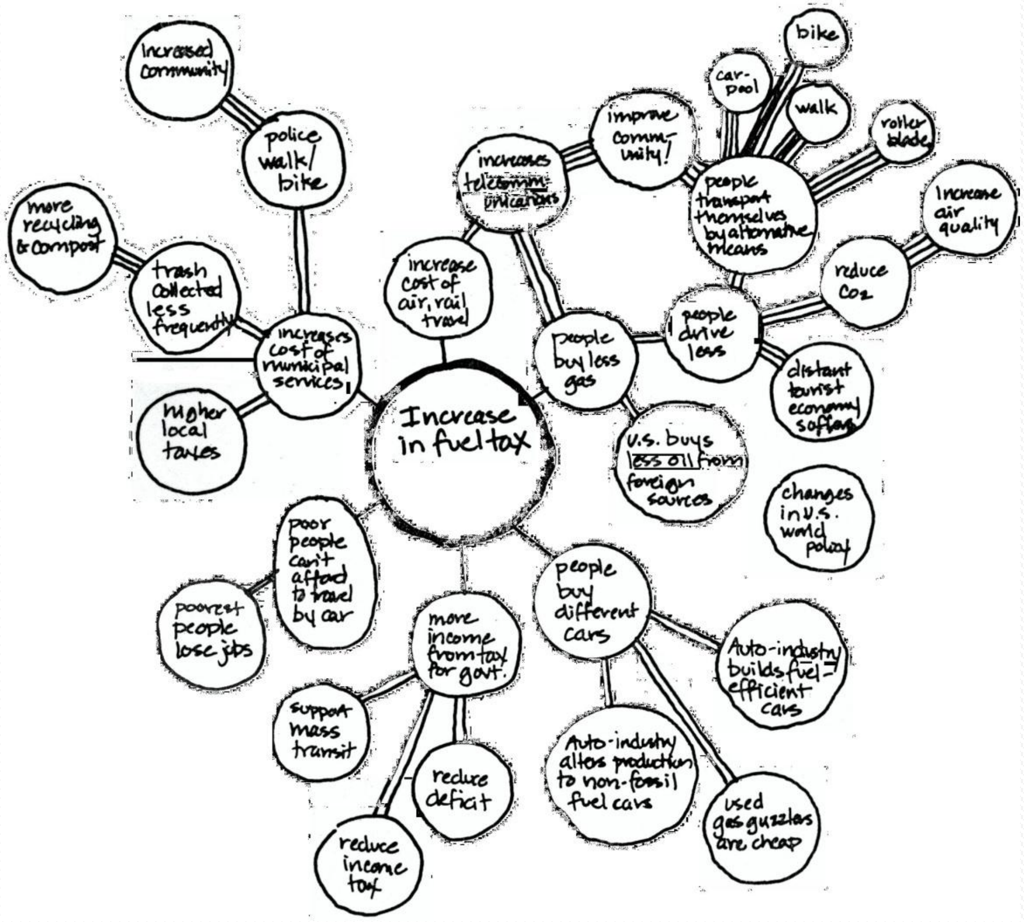


IN Climate Data Analysis
El Nino and Precipitation
(Climate Variability)

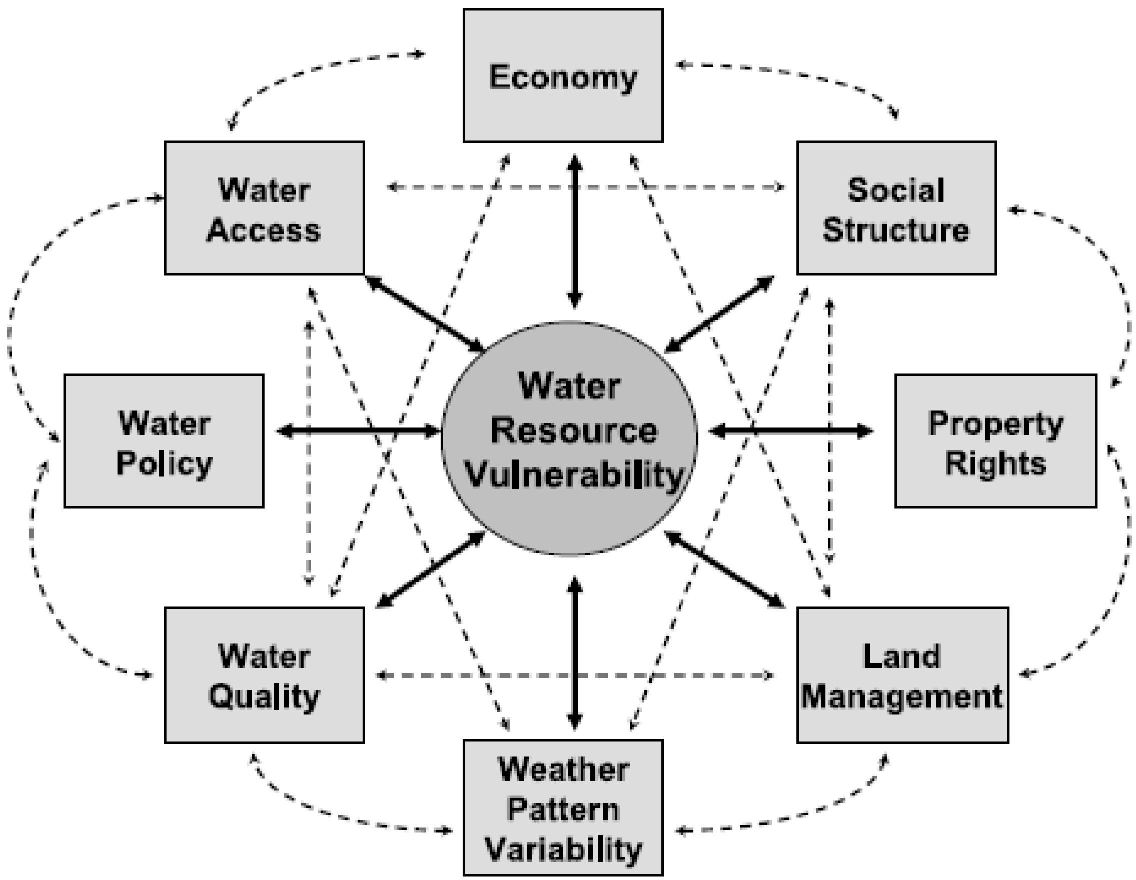




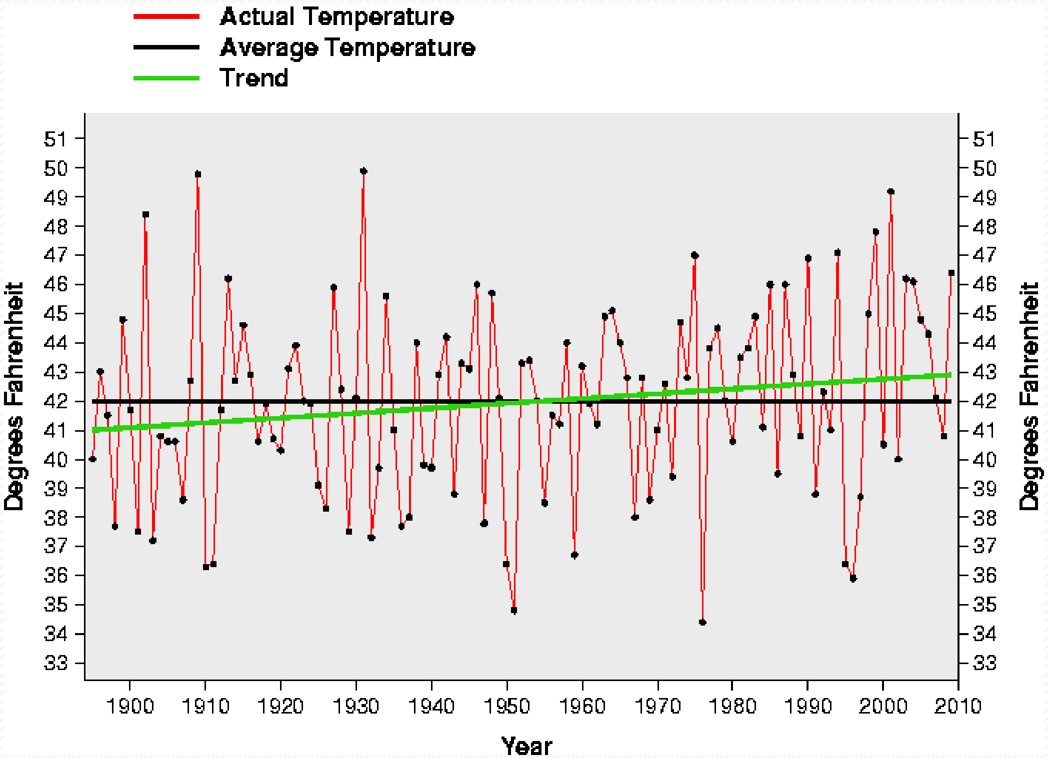
Vulnerability Mapping/Futures Wheel



Example of a Vulnerability Map



Weather and Data
Indiana November Temperature

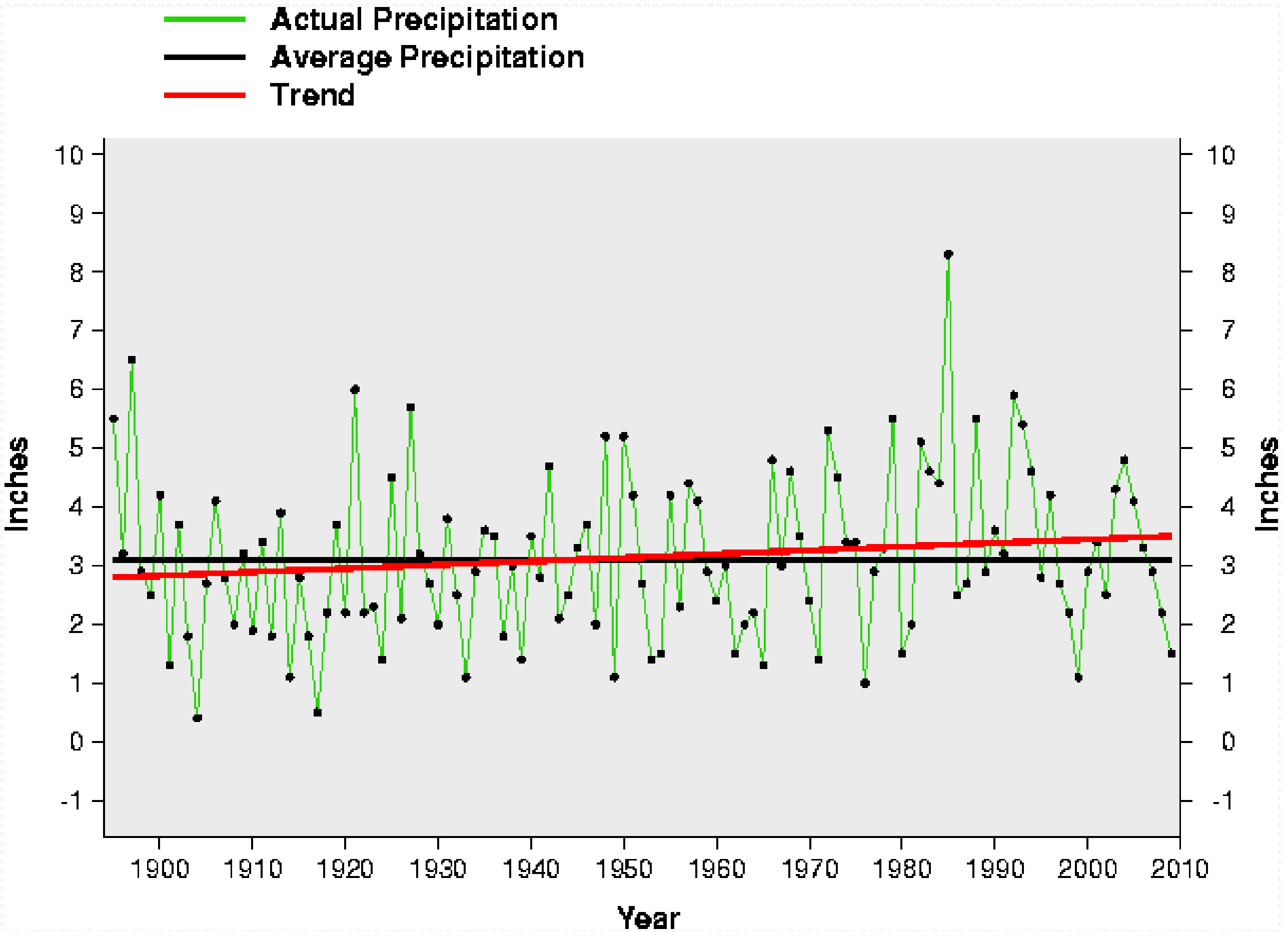


http://www.ncdc.noaa.gov/oa/climate/research/cag3/in.html

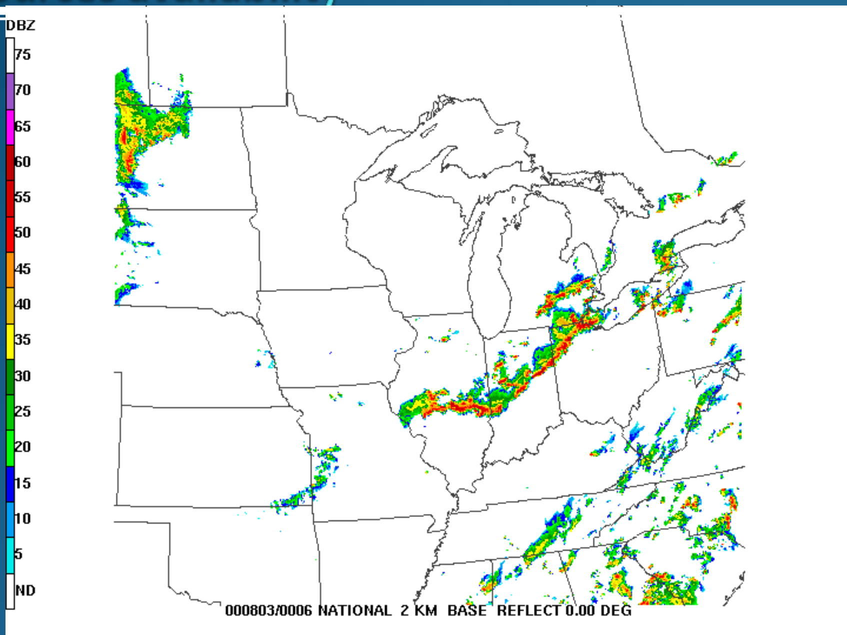
National Climatic Data Center http://www.ncdc.noaa.gov/oa/ncdc.html

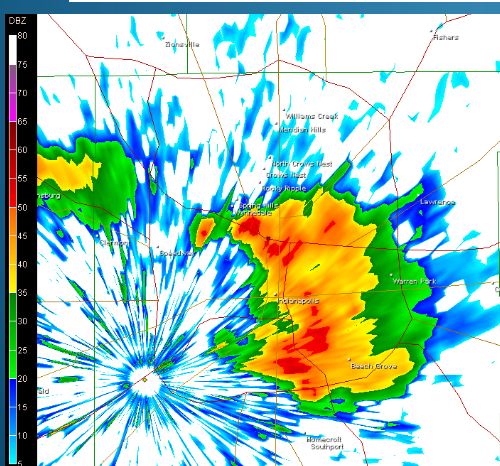
http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp

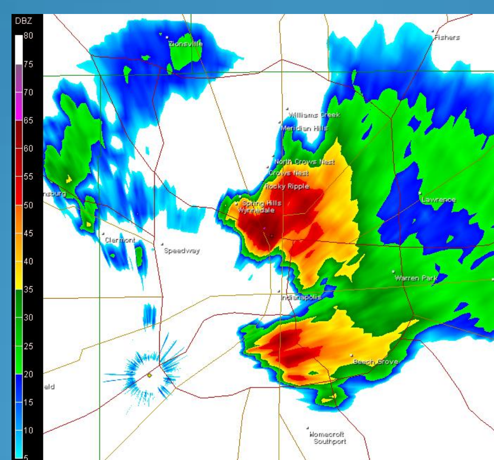
Weather and Data
Indiana November Precipitation



Thunderstorms can be dangerous but they are also a major source of rainfall! Changes in storminess as Indiana becomes urbanized. Implications for future growth and water resources availability

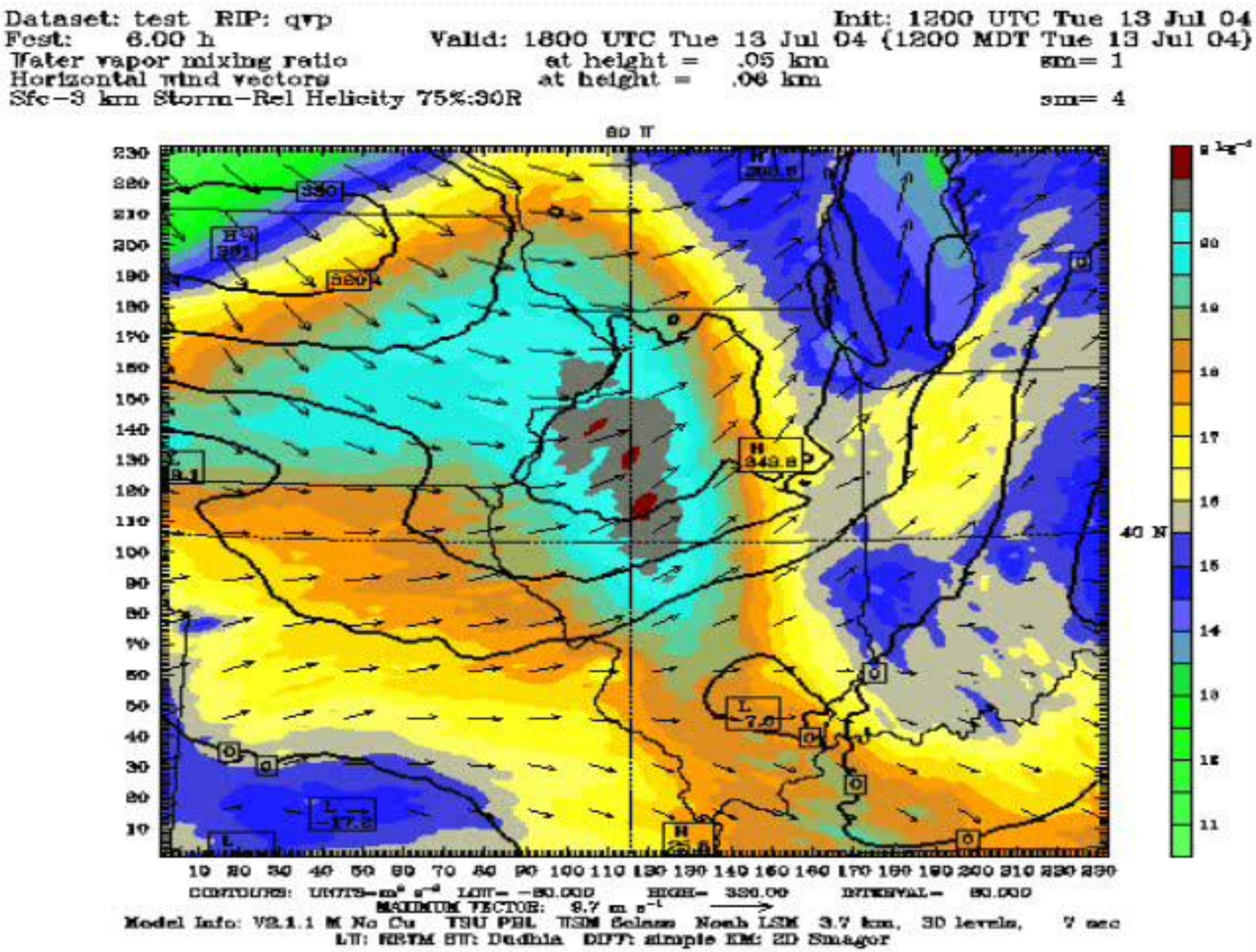






IL-IN F4 Tornado simulation (13 July 2004)

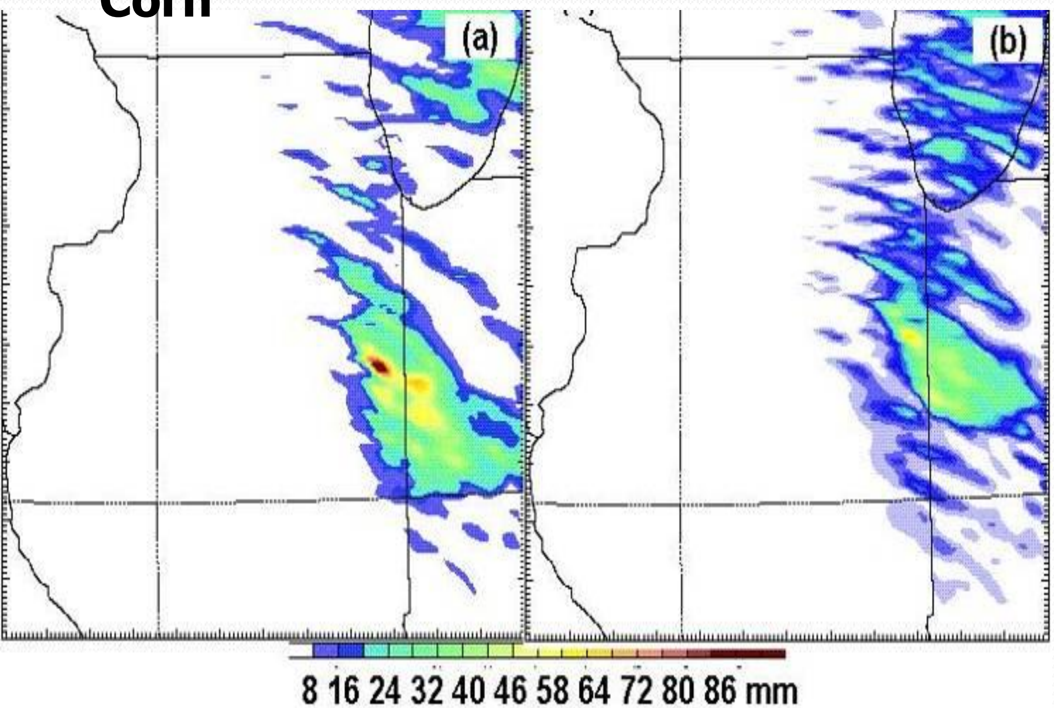
Effect of agriculture intensification on thunderstorms



More agricultural landscape → More transpiration → more water vapor in the atmosphere → more potential for thunderstorms?

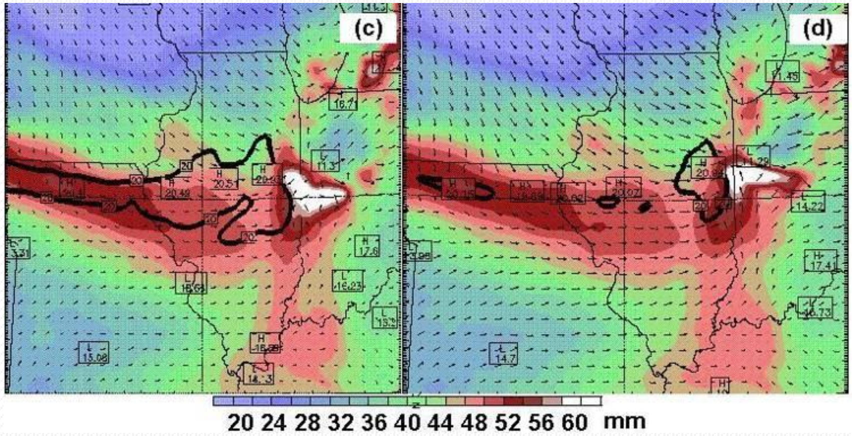
Explicit consideration for Soybean and Corn

Default

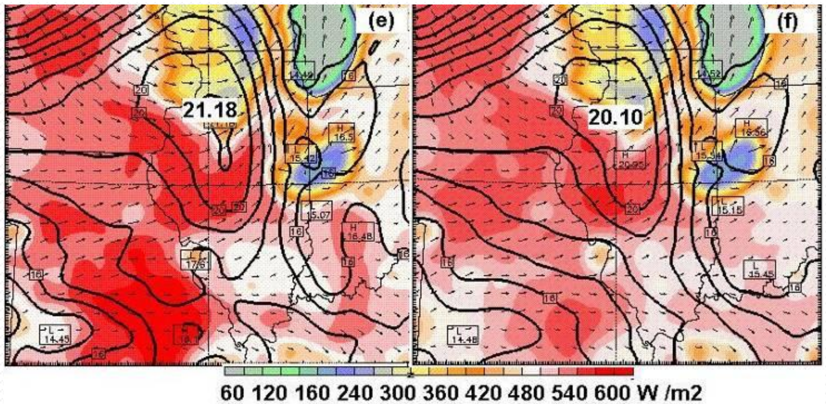


Considering Agriculture

Default



Precipitable water (color shade), high vapor mixing ratio (dark line)



Latent heat W/m2 (color shade), high vapor region (contour)

Measurements

- Would be interested in albedo, temperature, Urban Heat Island, building morphology, green space map developments
- Rainfall (leading the Indiana collaborative rainfall network- CoCoRaHS)
- Data archival, integration within larger systems (monitoring, modeling) protocols