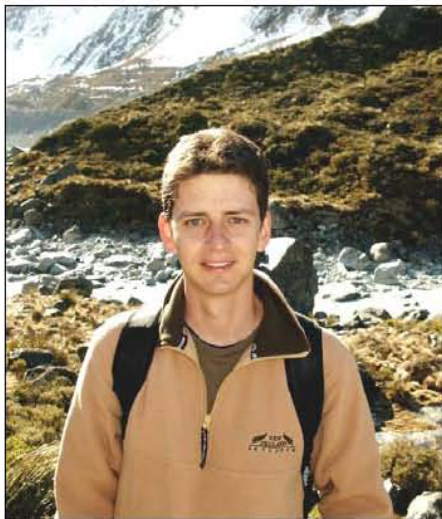


Annual Migrations of North American Centroids of Carbon Emissions from Fossil Fuels – What do they Reveal about Causes and Future Trends?

Jay Gregg



Bob Andres



T. J. Blasing



Earth System Research Laboratory
Global Monitoring Annual Conference
May 17, 2010



CLIMATE SUMMIT

WHAT IF IT'S
A BIG HOAX AND
WE CREATE A BETTER
WORLD FOR NOTHING?

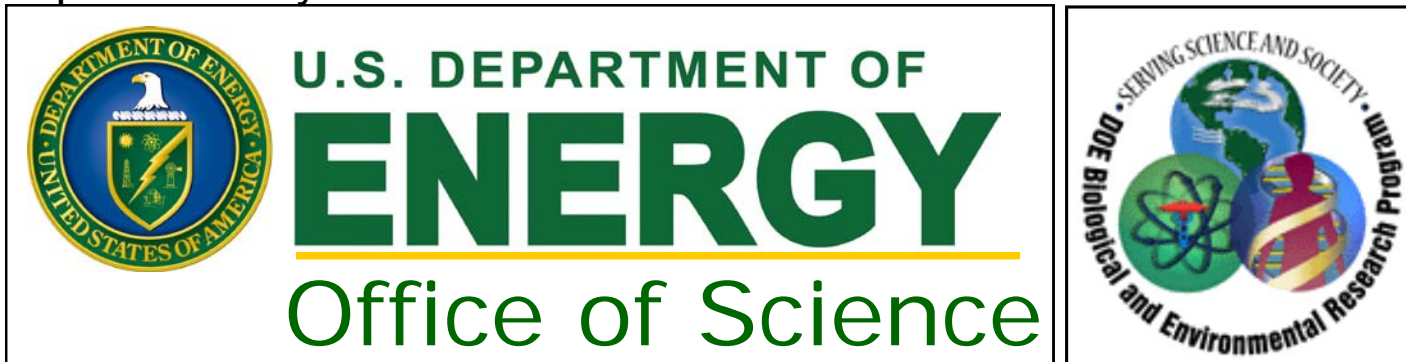
- ENERGY INDEPENDENCE
- PRESERVE RAINFORESTS
- SUSTAINABILITY
- GREEN JOBS
- LIVABLE CITIES
- RENEWABLES
- CLEAN WATER, AIR
- HEALTHY CHILDREN
- etc. etc.



We are:



Sponsored by:



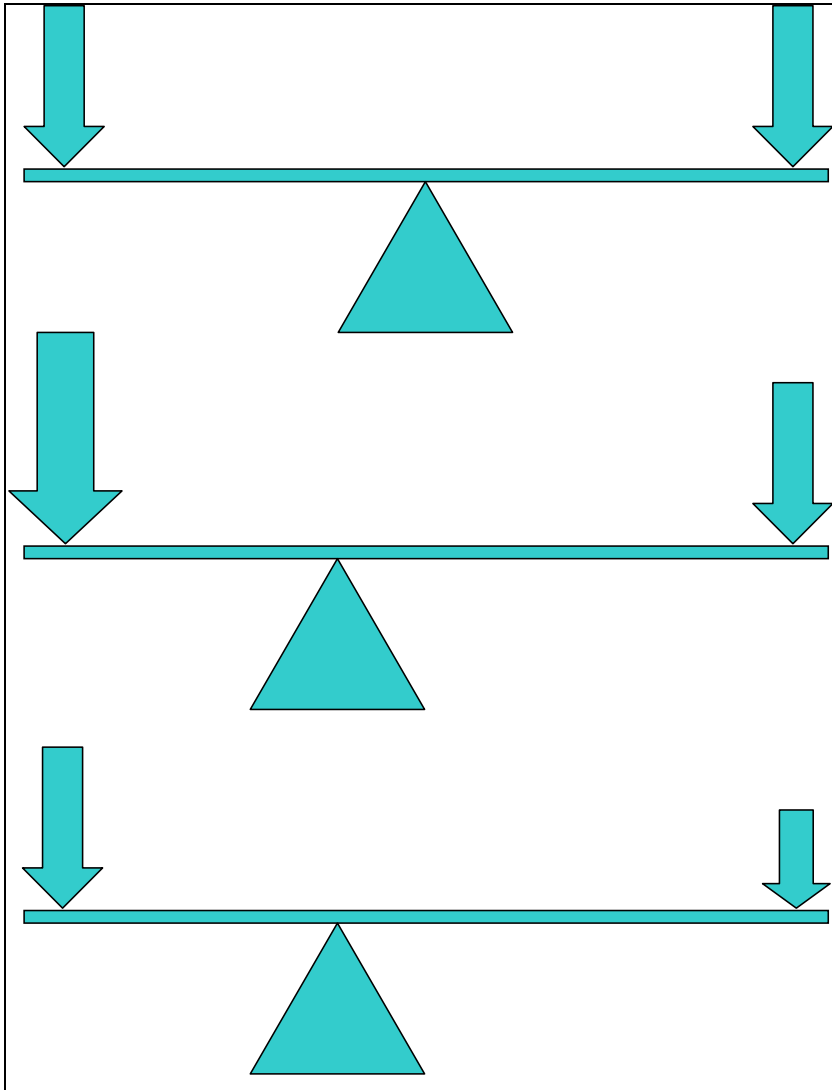
Housed at:



We are here.



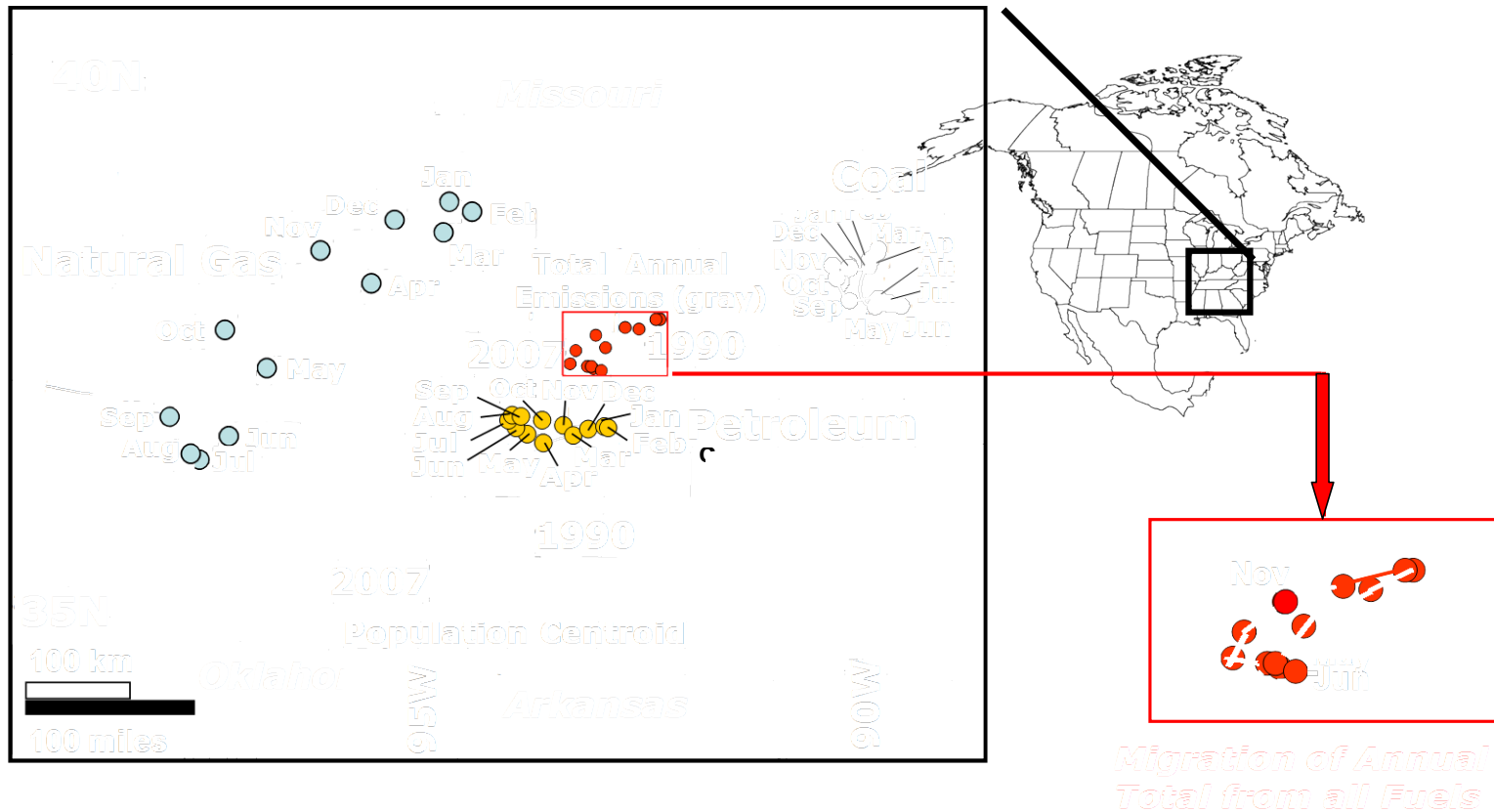
Centroids are based on leverage; they are relatively less influenced by movements near the centroids; to study such movements you have to shrink your area.



$$d_{x,y} = \frac{\sum_{i=1}^n d_i e_i}{\sum_{i=1}^n e_i}$$

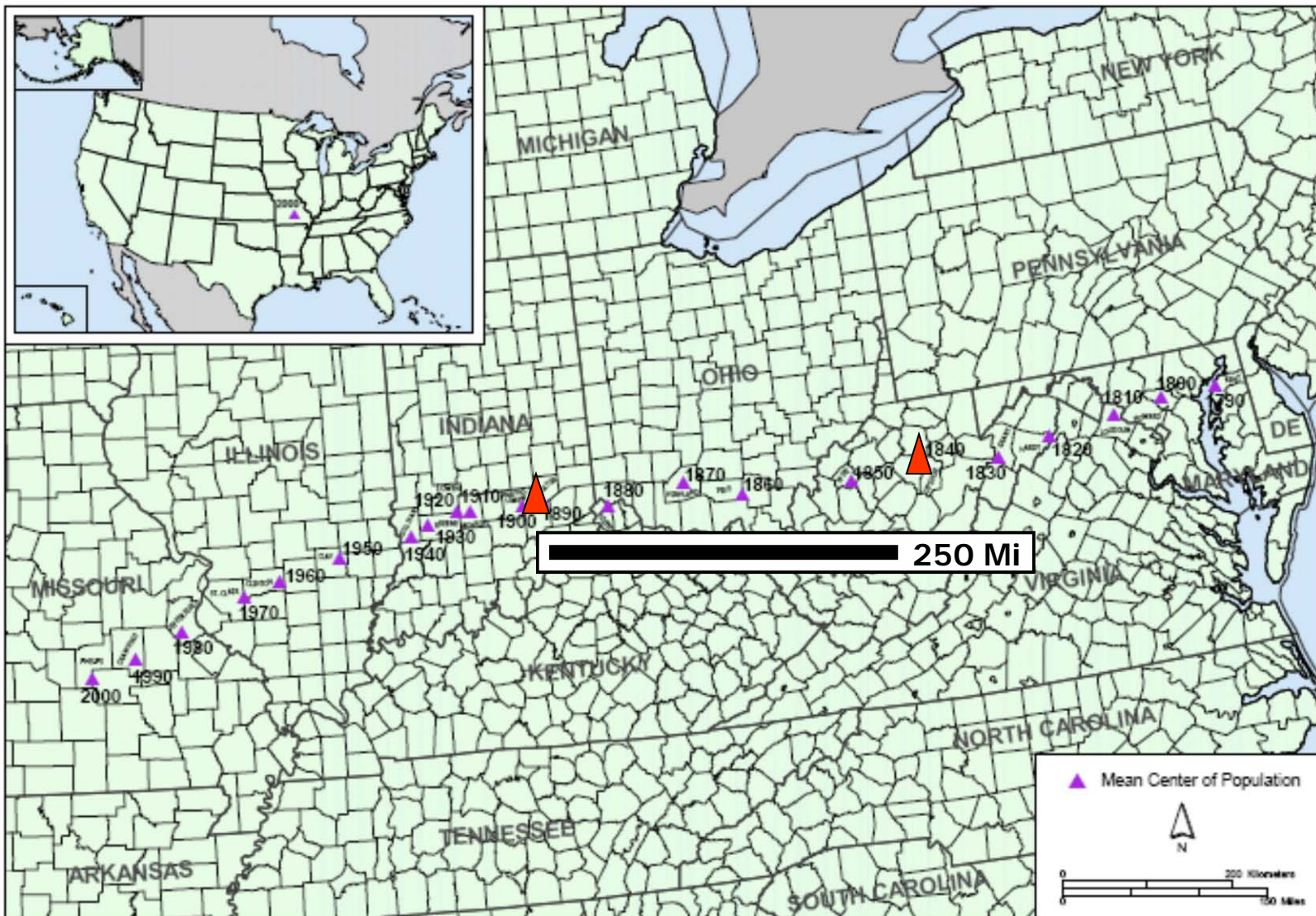


All you ever wanted to know (and more besides) about centroids

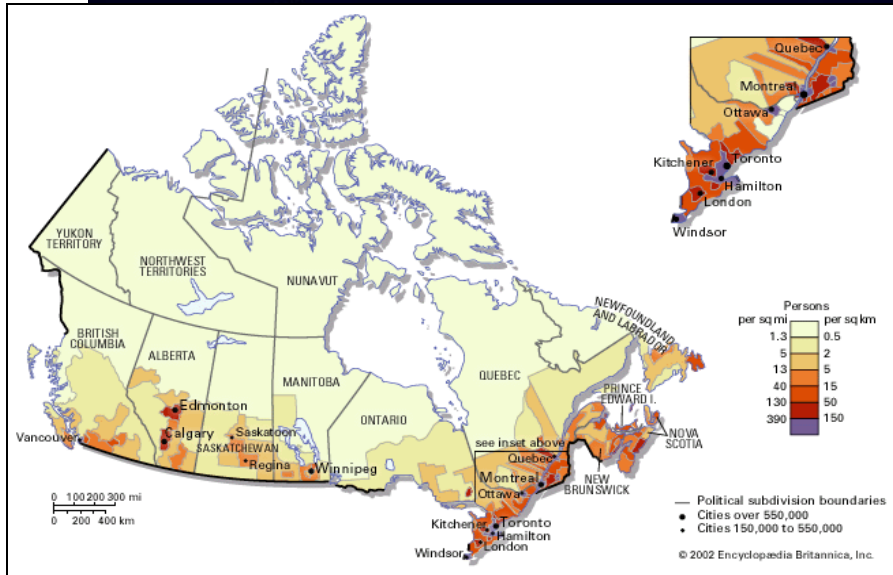
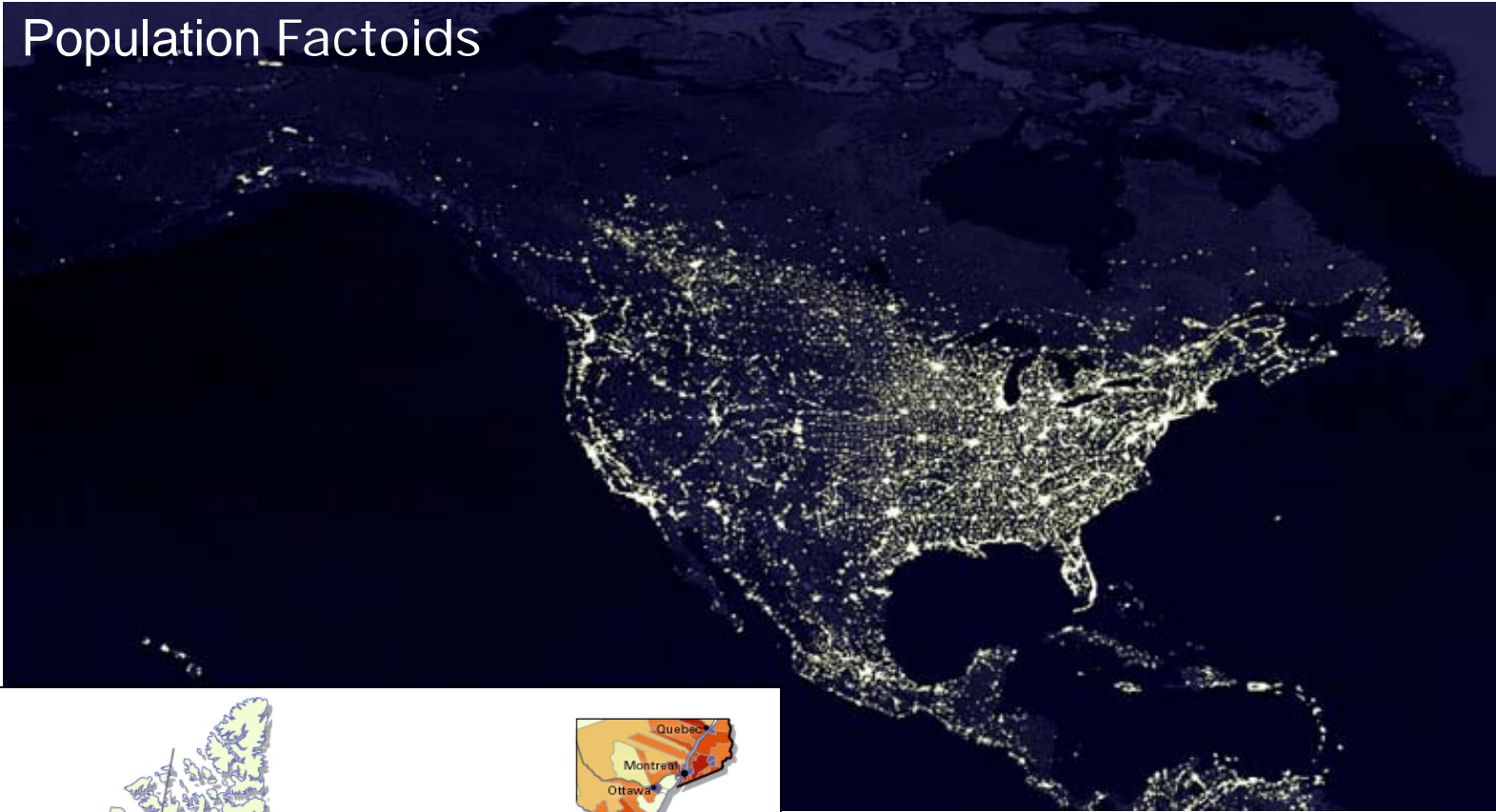


Adapted from: J. S. Gregg, L. M. Losey, R. J. Andres, T. J. Blasing and G. Marland, The Temporal and Spatial Distribution of Carbon Dioxide Emissions from Fossil-Fuel Use in North America *J. Appl. Meteorol. and Climatol.* 48 2528 (2009).

Mean Center of Population for the United States: 1790 to 2000



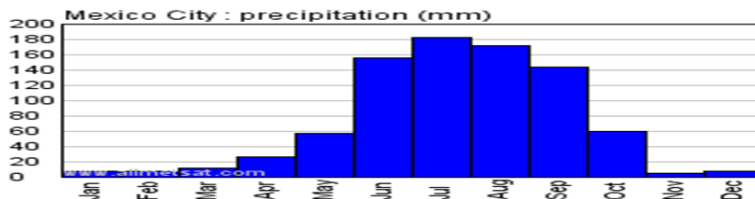
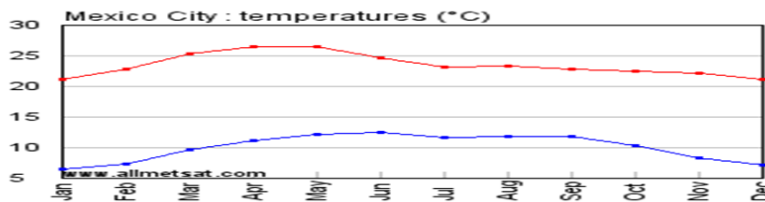
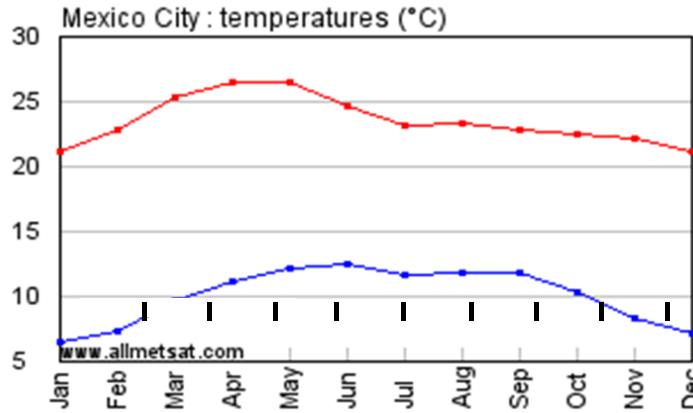
Population Factoids



2010 U.N. Population estimates to nearest million persons:	
Canada	34,000,000
United States	318,000,000
Mexico	110,000,000

<http://www.un.org/esa/population/unpop.htm>

Climate of Mexico City

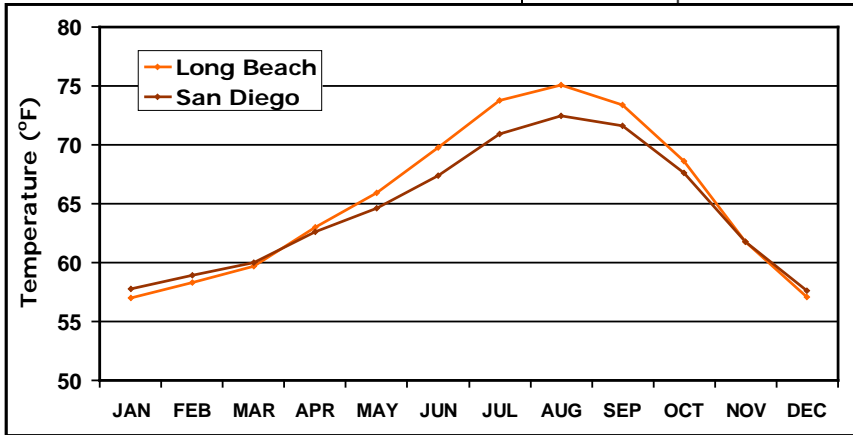


°F
86
77
68
59
50
41

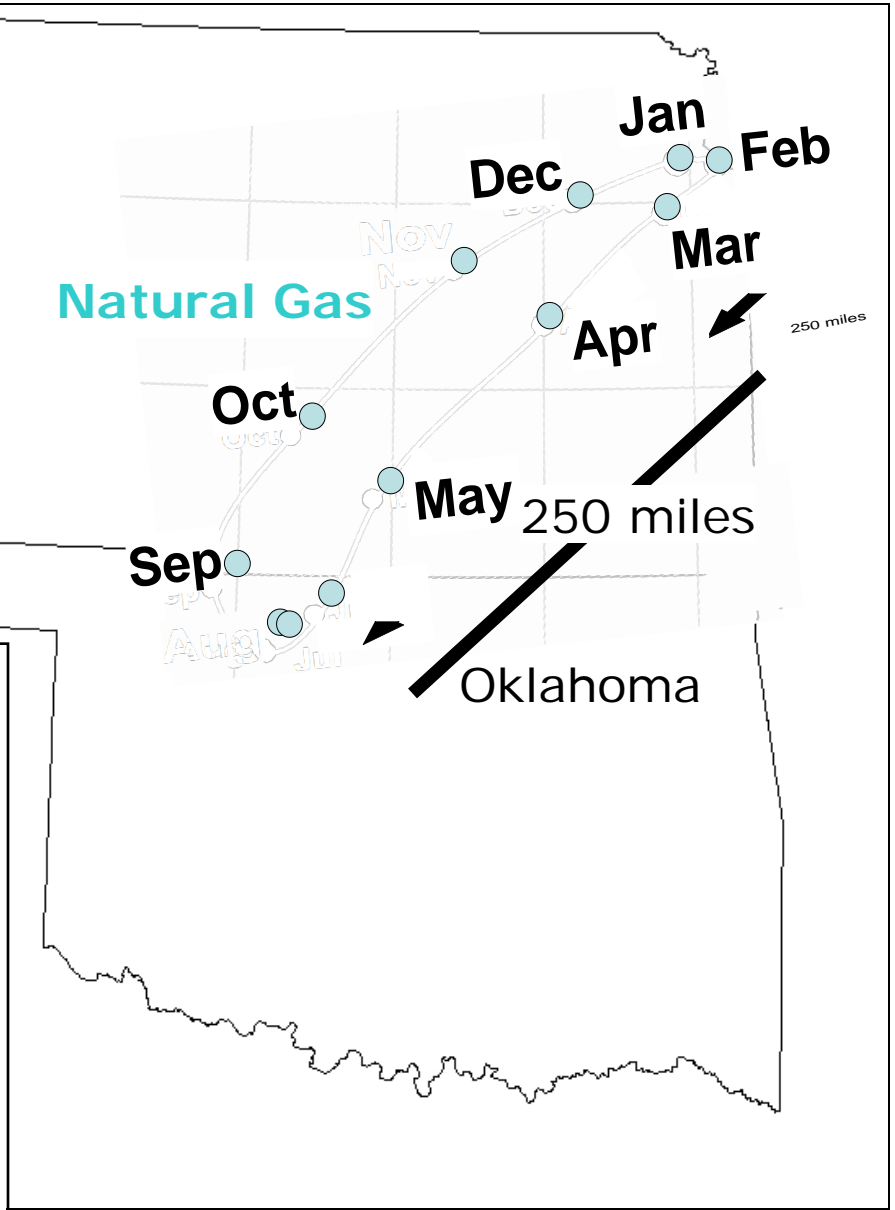
8
6
4
2
0

Migration of Natural Gas Centroid

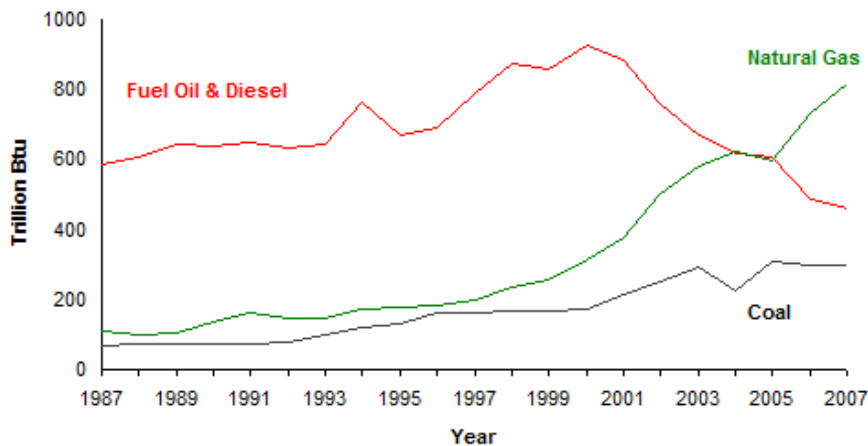
Kansas



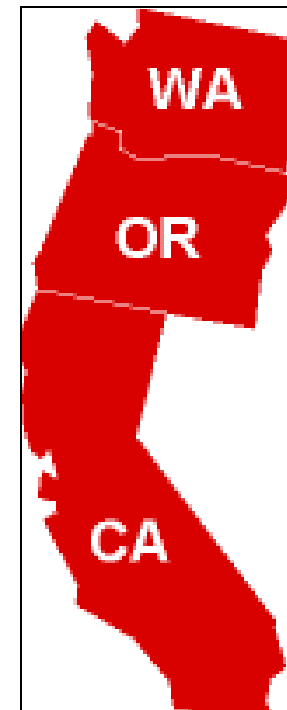
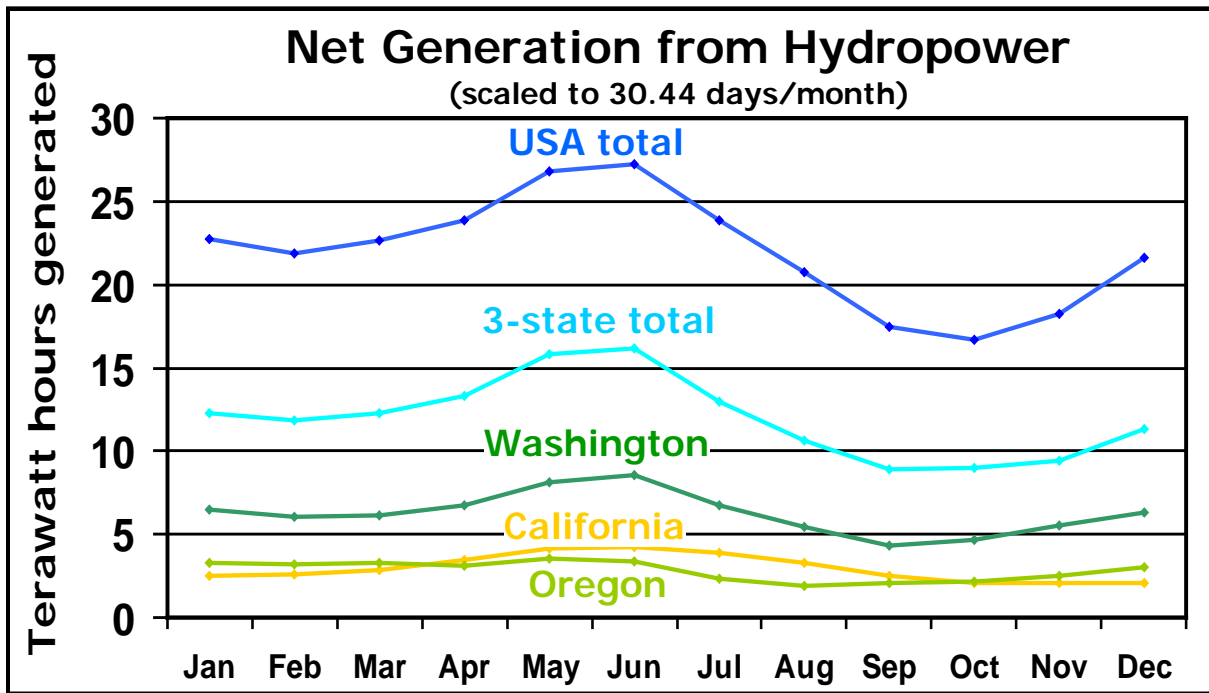
Natural Gas



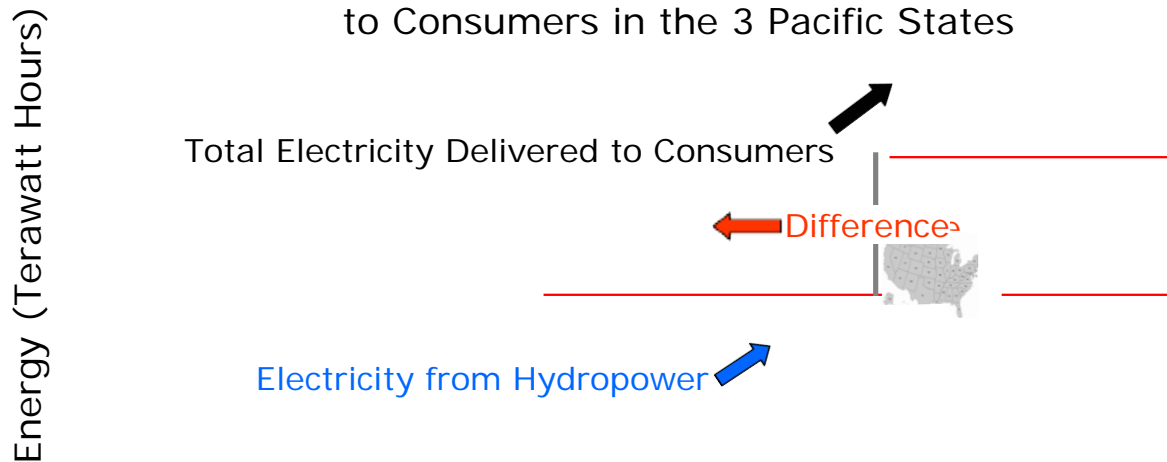
Consumption of Hydrocarbons For Electricity Generation in Mexico



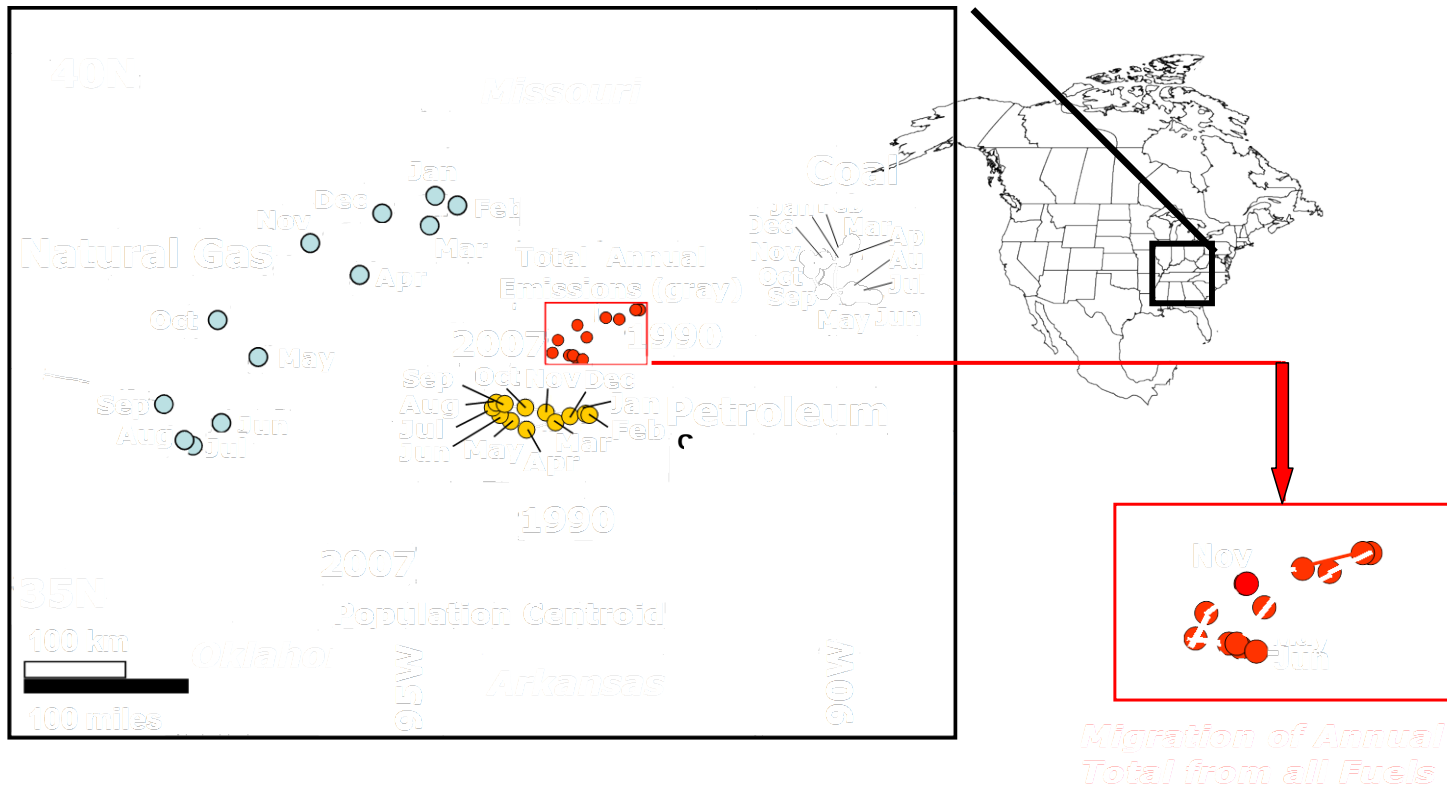
Source: Sener Balance Nacional de Energia



Electricity from Hydropower and Electricity Delivered to Consumers in the 3 Pacific States

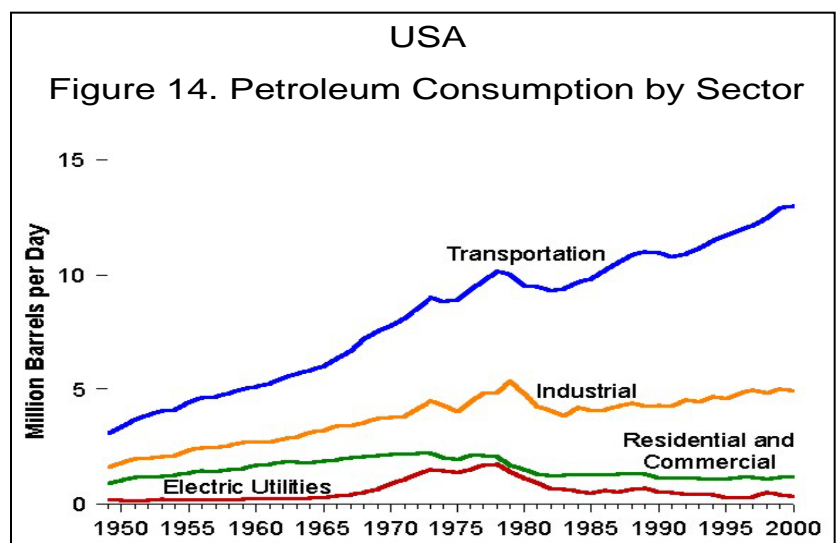
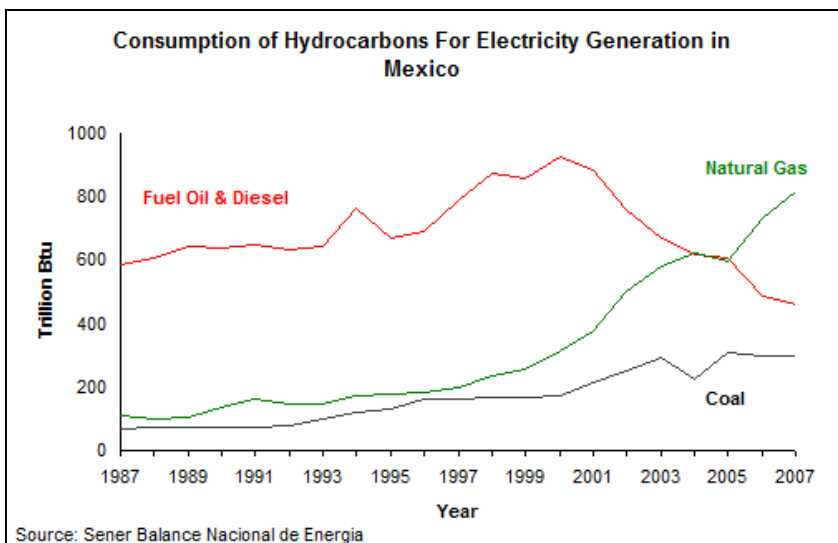


Migration of Petroleum Centroid



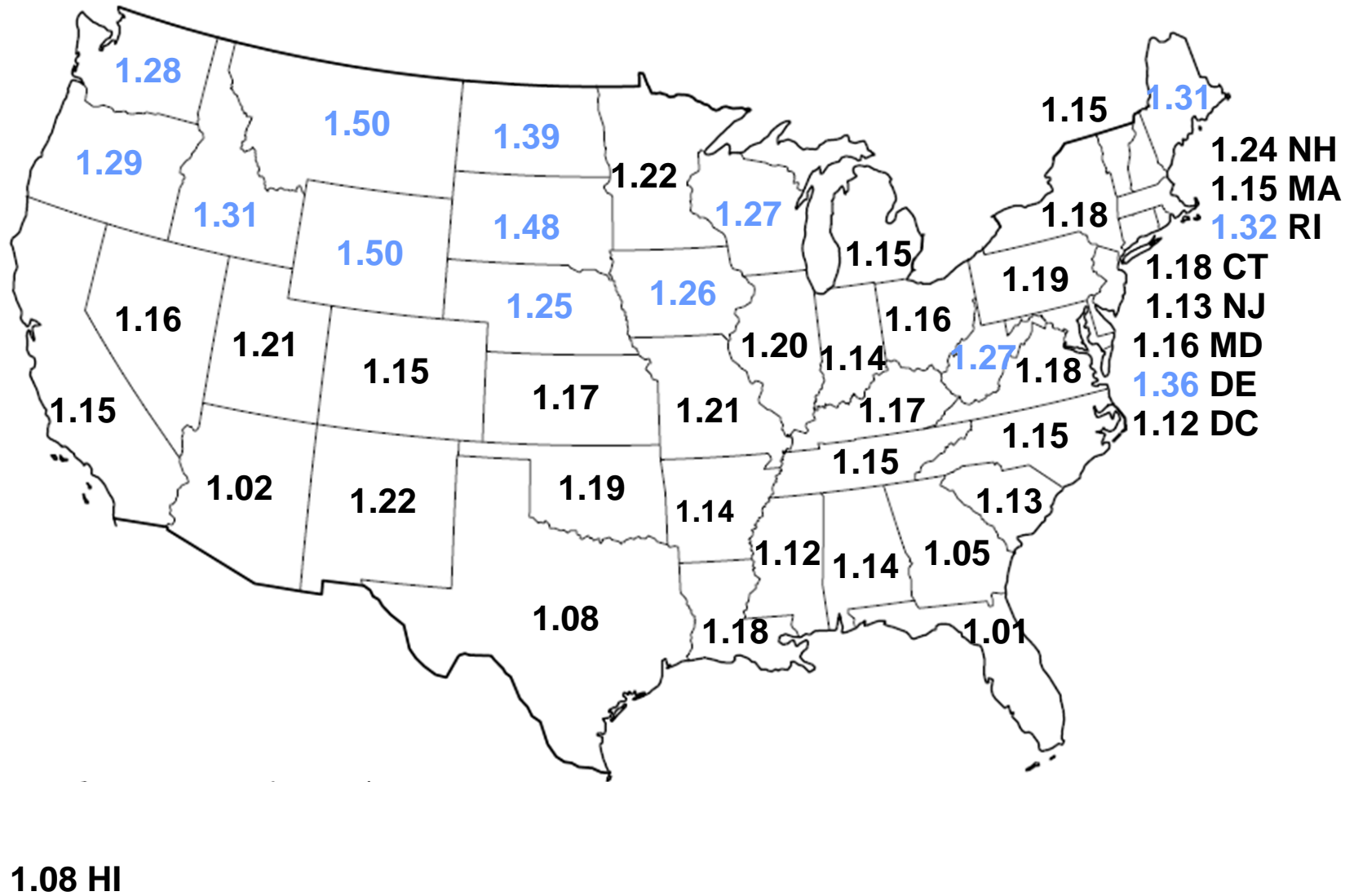


80% of the petroleum for home heating in the USA is used in these states

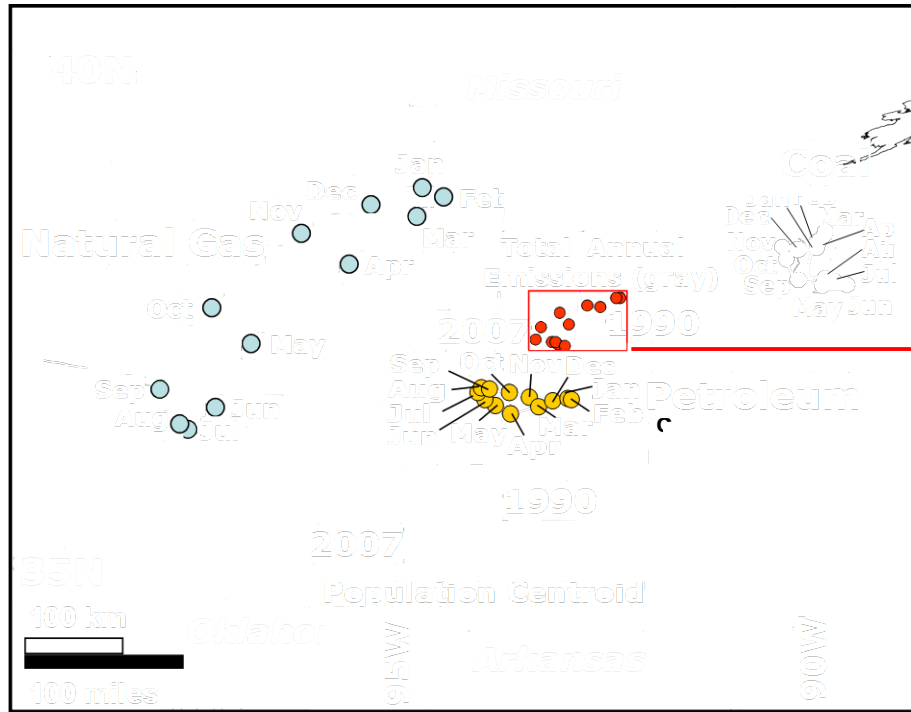


1.40 AK

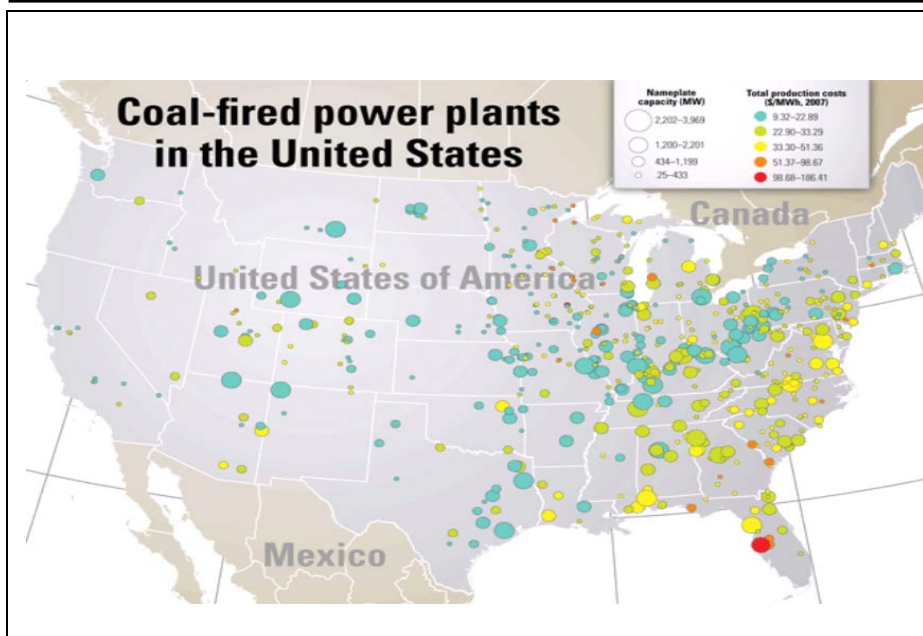
Ratio of Driving Miles: (June-August)/(December-February)



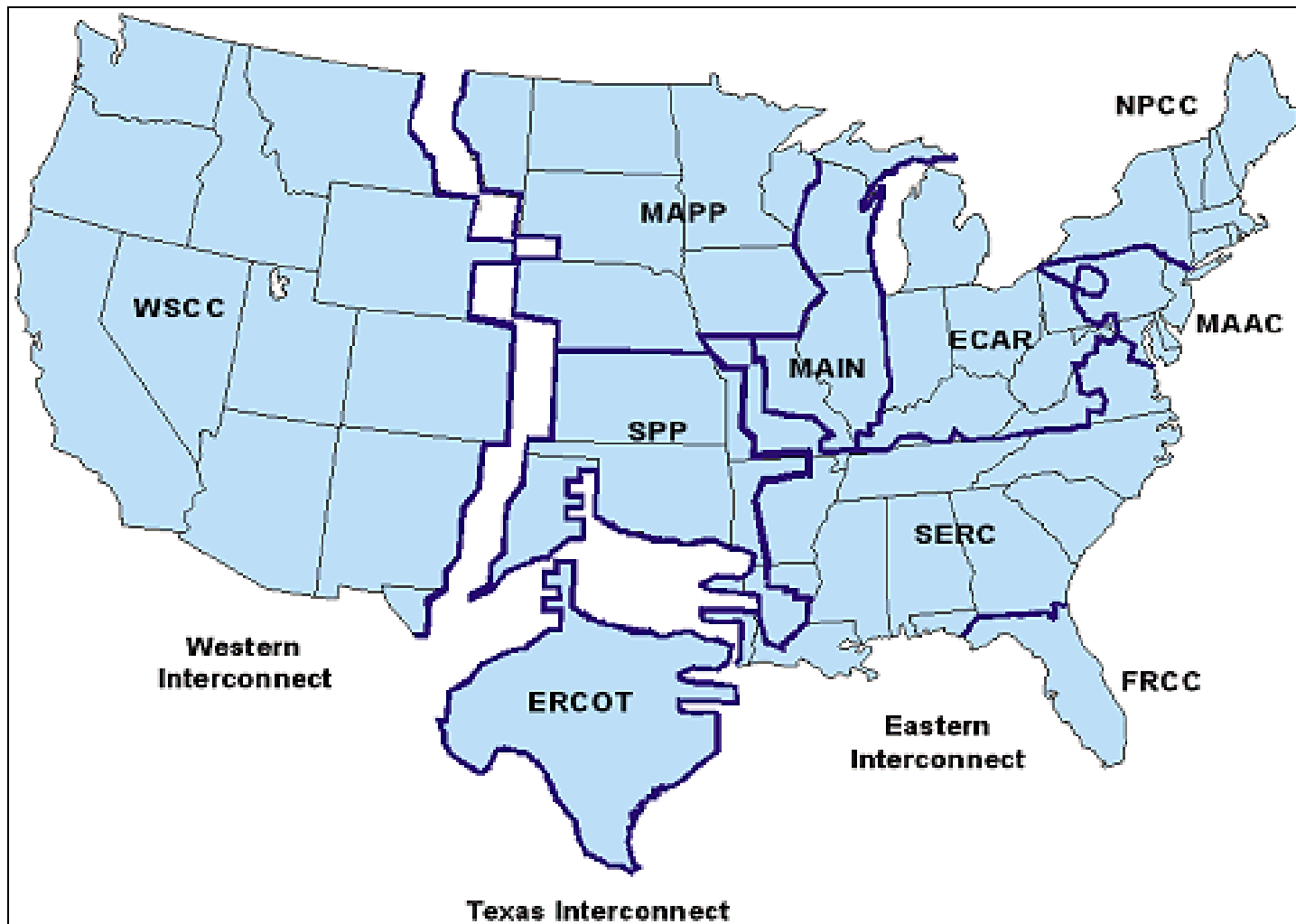
Migration of Coal Centroid



Migration of Annual Total from all Fuels



North American Electric Reliability Council (NERC) Regions



ECAR: East Central Area Reliability Coordination Agreement

ERCOT: Electric Reliability Council of Texas

FRCC: Florida Reliability Coordinating Council

MAAC: Mid-Atlantic Area Council

MAIN: Mid-America Interconnected Network

MAPP: Mid-Continent Area Power Pool

NPCC: Northeast Power Coordinating Council

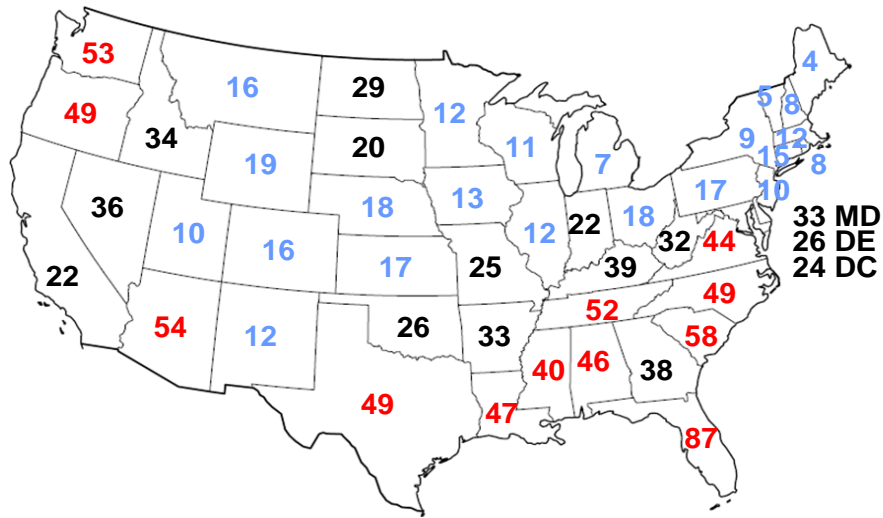
SERC: Southeastern Electric Reliability Council

SPP: Southwest Power Pool

WSCC: Western Systems Coordinating Council

10 AK

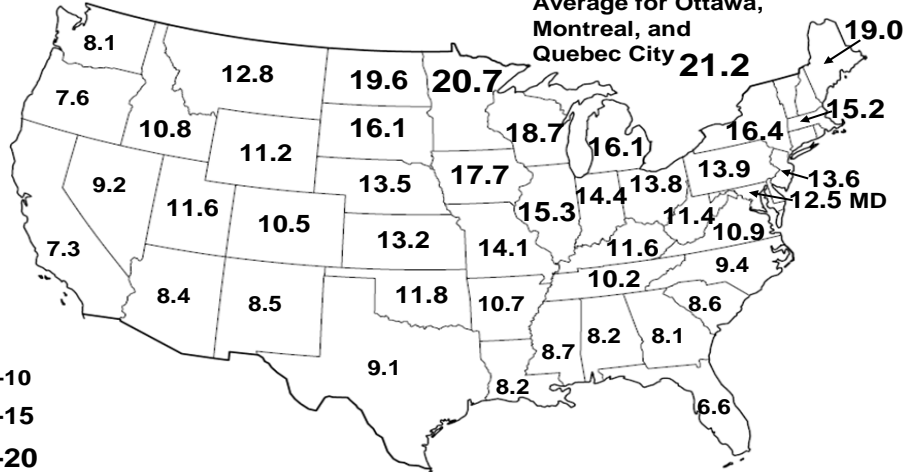
% of households using electricity for heating



49 HI

4.9 for Vancouver

Average for Ottawa, Montreal, and Quebec City 21.2



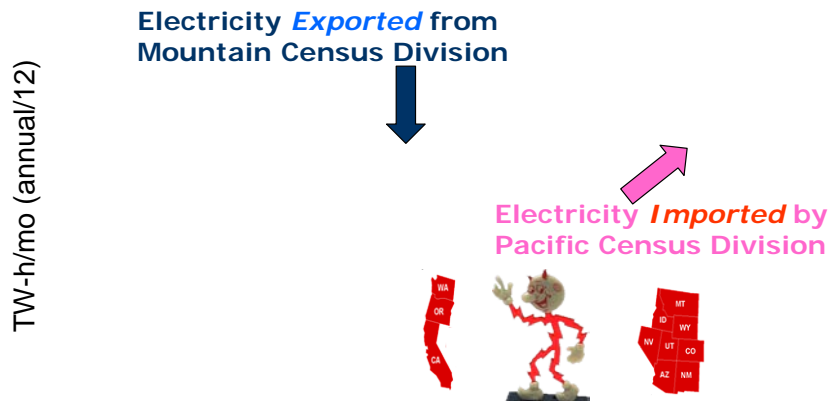
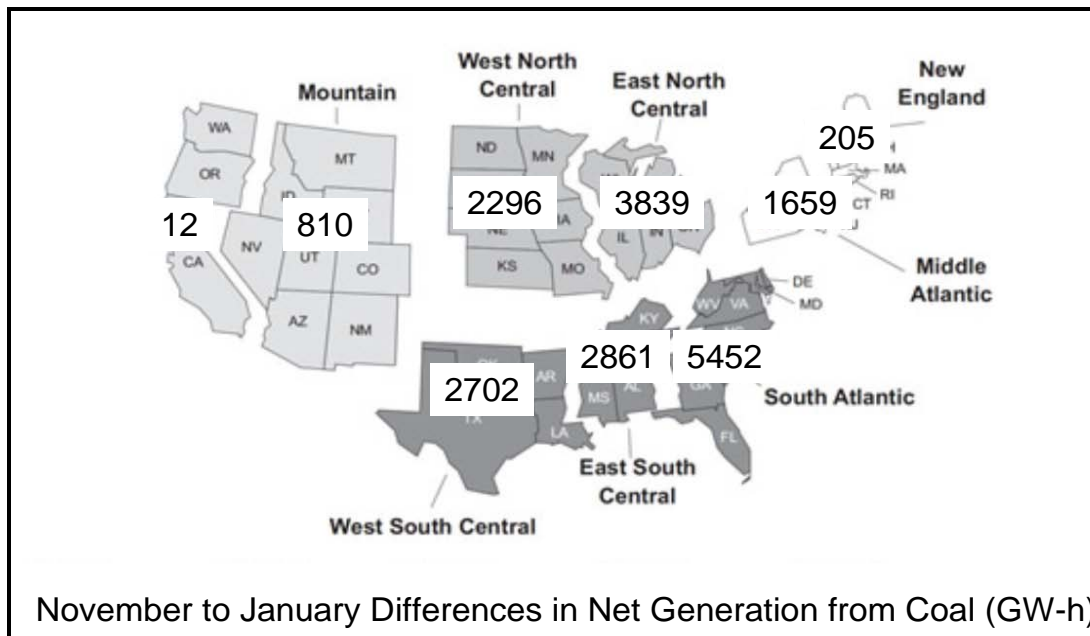
- 5-10
- 10-15
- 15-20
- > 20

November – January Temperature Differences

Canadian data from: http://www.climate.weatheroffice.ec.gc.ca/climate_normals/stnselect_e.html



Migration of Coal Centroid (2)





Conclusions:

Seasonal and Regional variations in centroid movements provide clues to:

- a. Seasonal/regional variations in CO₂ emissions, their causes and future developments, in quantifiable form for modeling studies;**
- b. Changes in energy demand/production in response to climate/economy,**
- c. How to reduce carbon emissions by energy-source switching.**