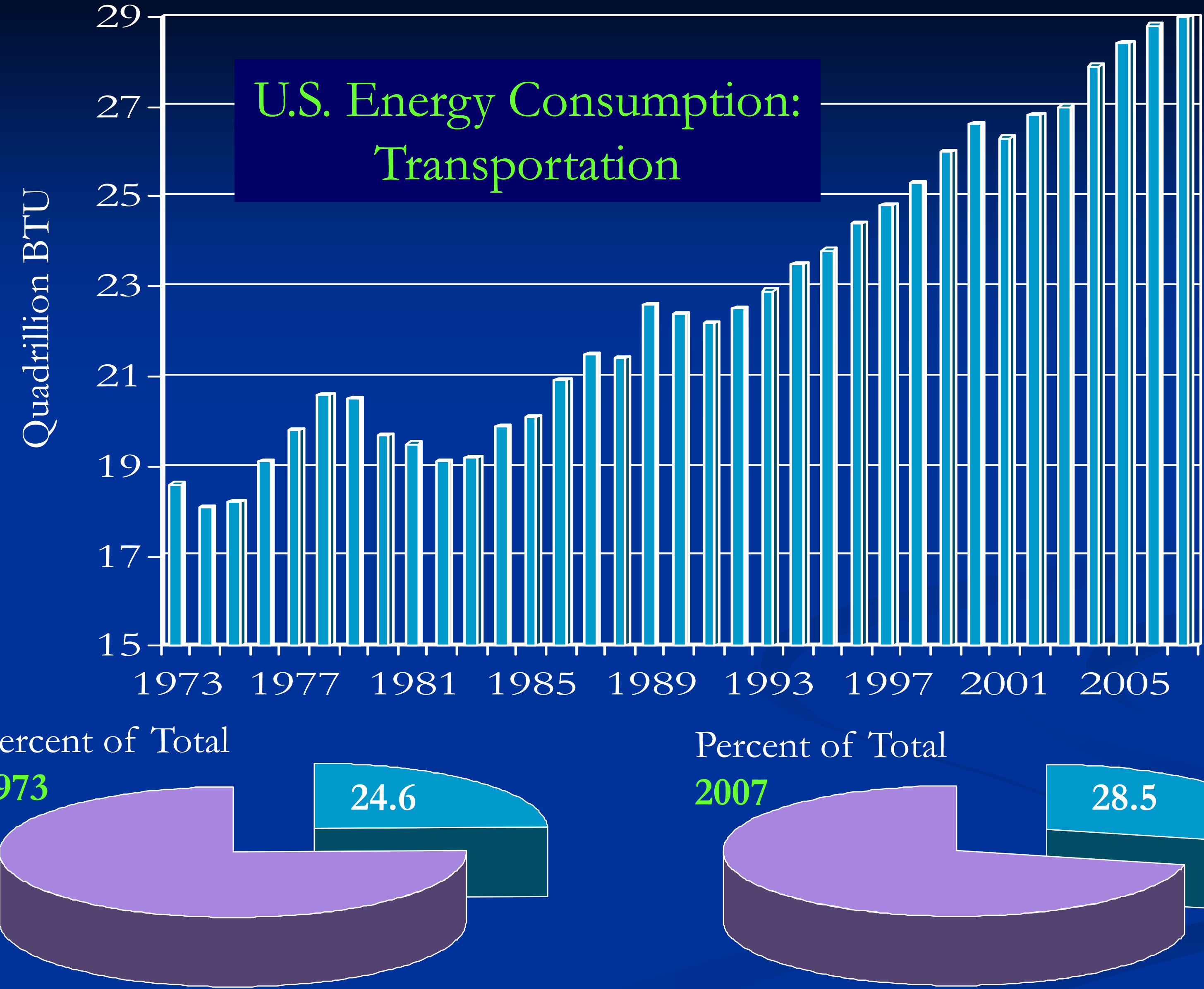
Climate, Weather and Tourism in North Carolina: Issues and Opportunities

<u>Faculty Perspectives: Transportation</u>

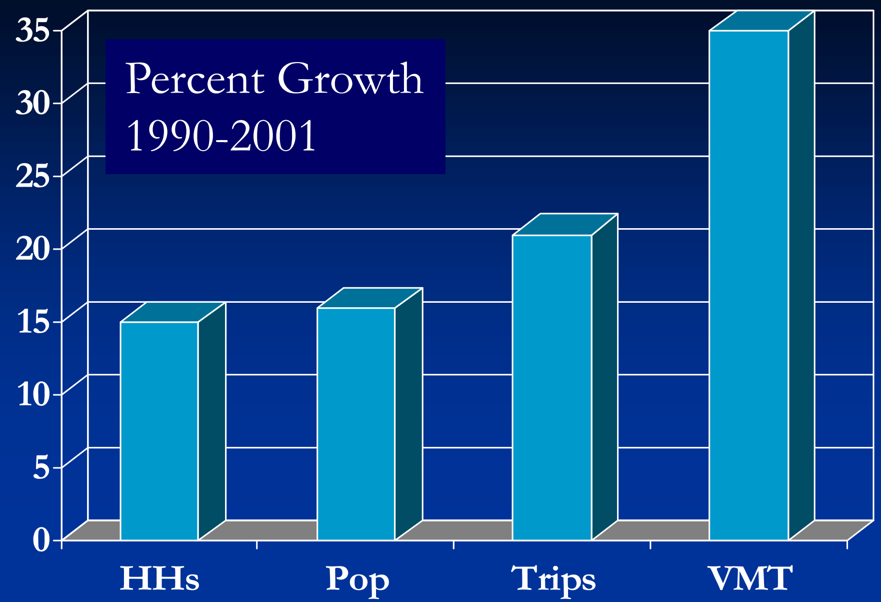
"Almost all about energy"

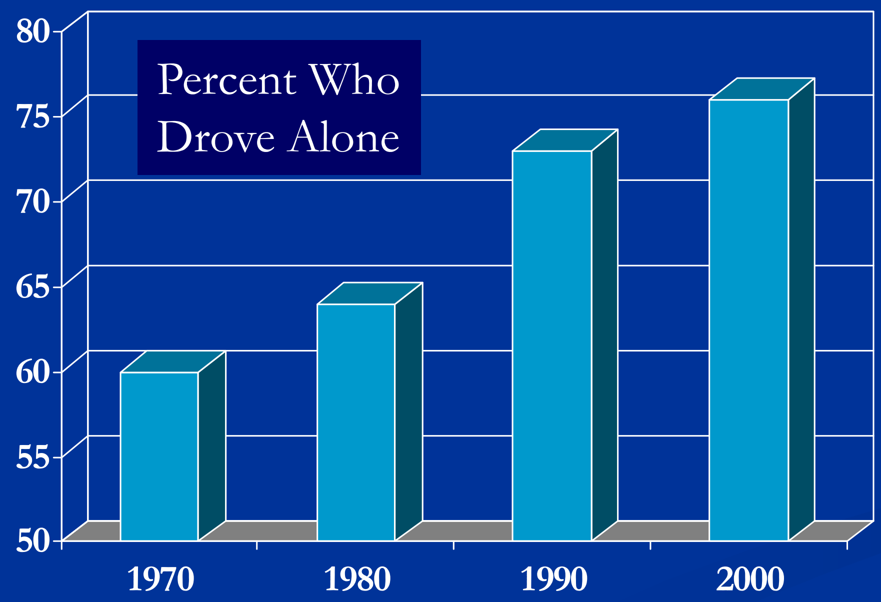
Dr. Ron Mitchelson
Department of Geography
East Carolina University

Saturday, November 15 2008, 1:00 PM



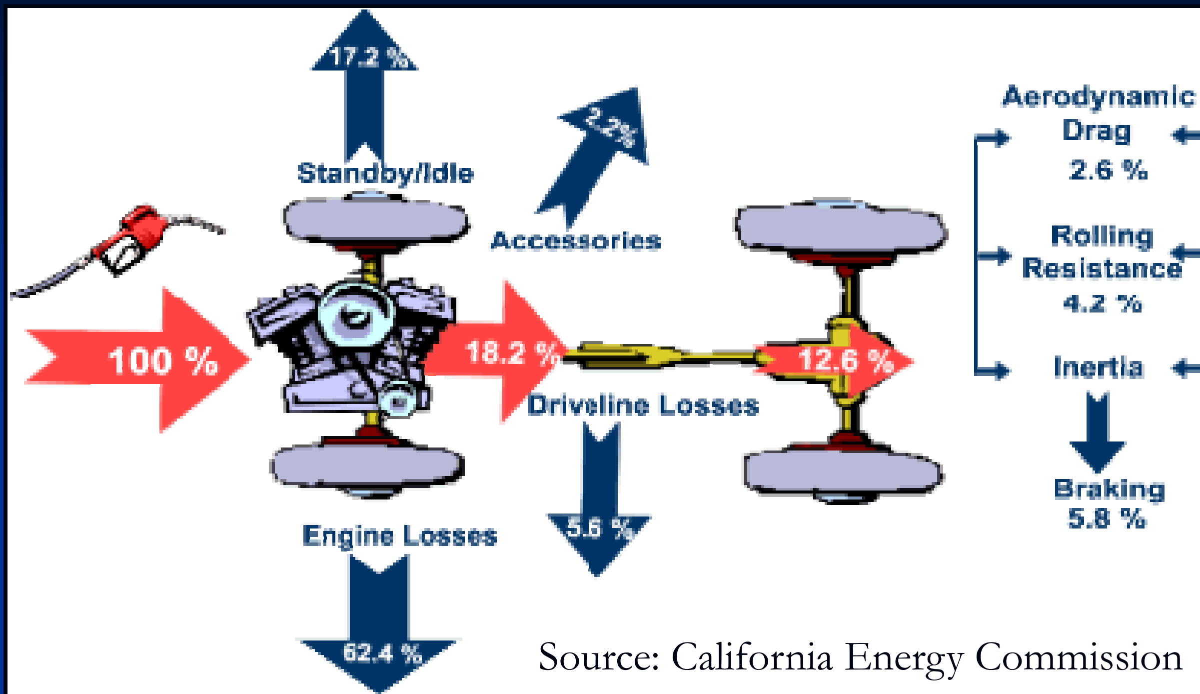
Source: US DOE. March 2008. Energy Information Administration, *Monthly Energy Review*





Source: USEPA. 2006. Greenhouse Gas Emissions from the U.S. Transportation Sector, 1990-2003

Note: a recent survey places the drive alone percentage at 82%.

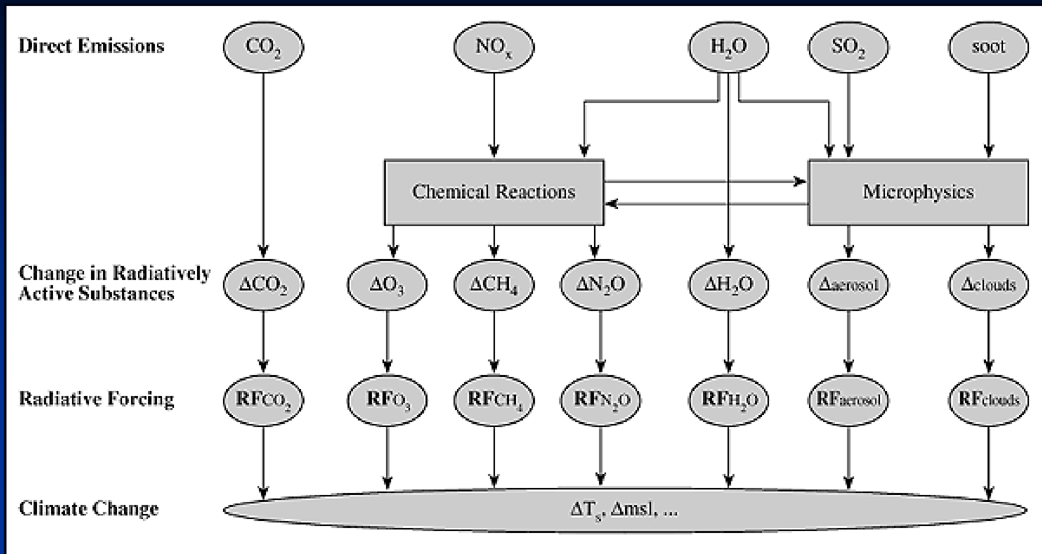


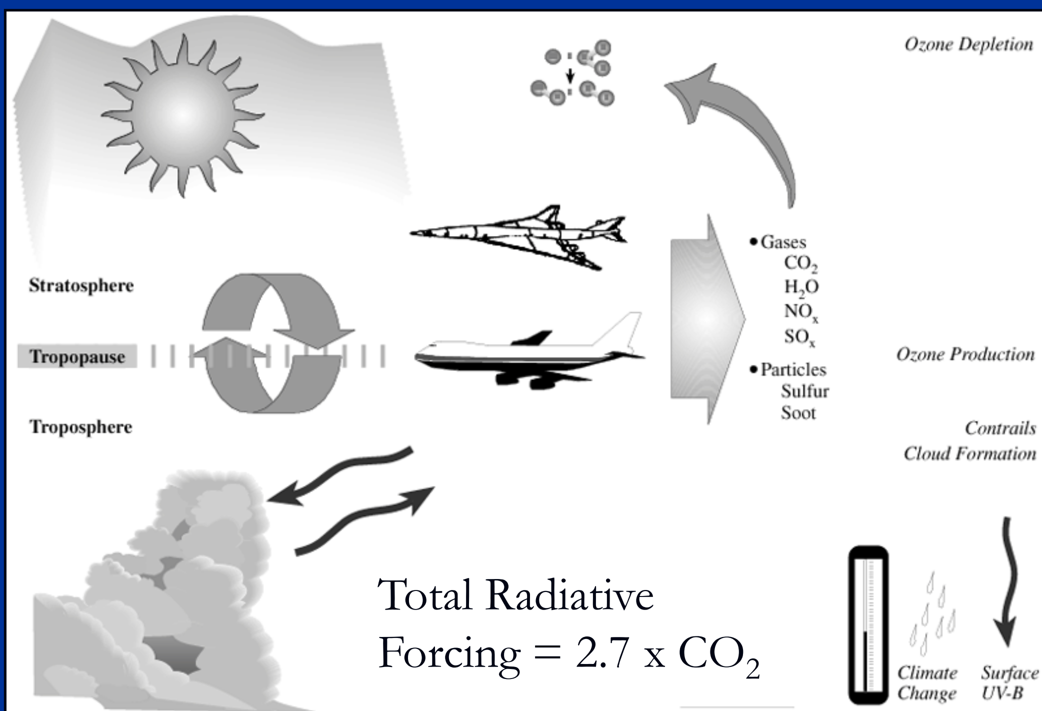
Source: California Energy Commission

The Average Auto: Callous Inefficiency

The purpose of transportation is to provide mobility and accessibility.

About 2% (yellow slice) of the energy contained in a gallon of gasoline is used to move the occupant.

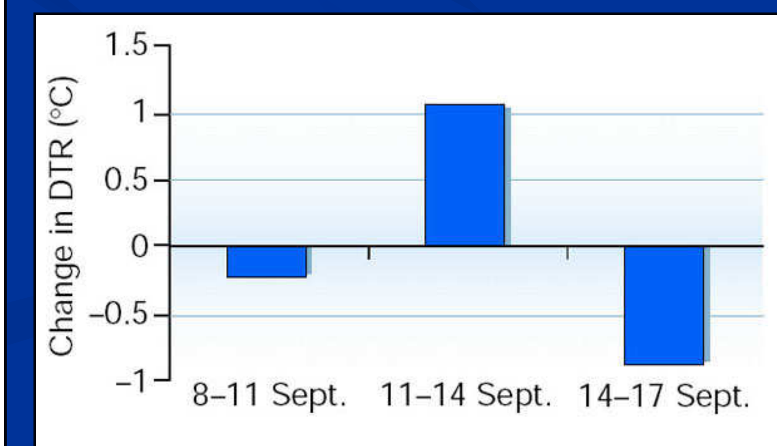




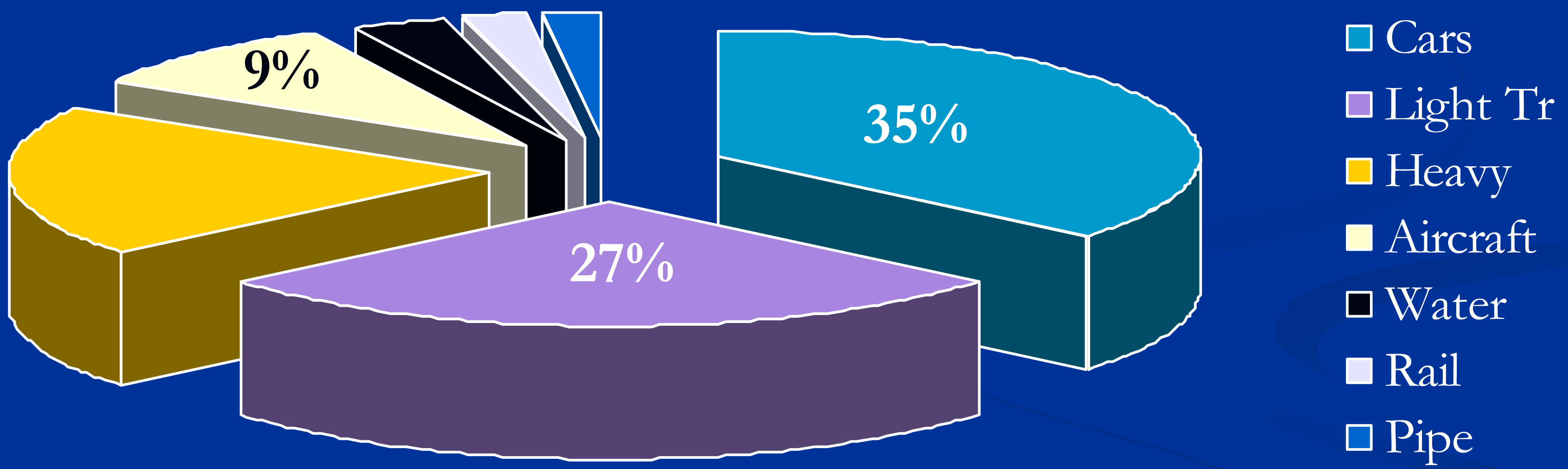
Aviation: Disproportionate Impacts

Sources: David J. Travis et al. 2002 "Contrails Reduce Temperature Range," Nature, Vol. 418, 601.

Penner, J. et al. 1999. Aviation and the Global Atmosphere. Cambridge: Cambridge University press.

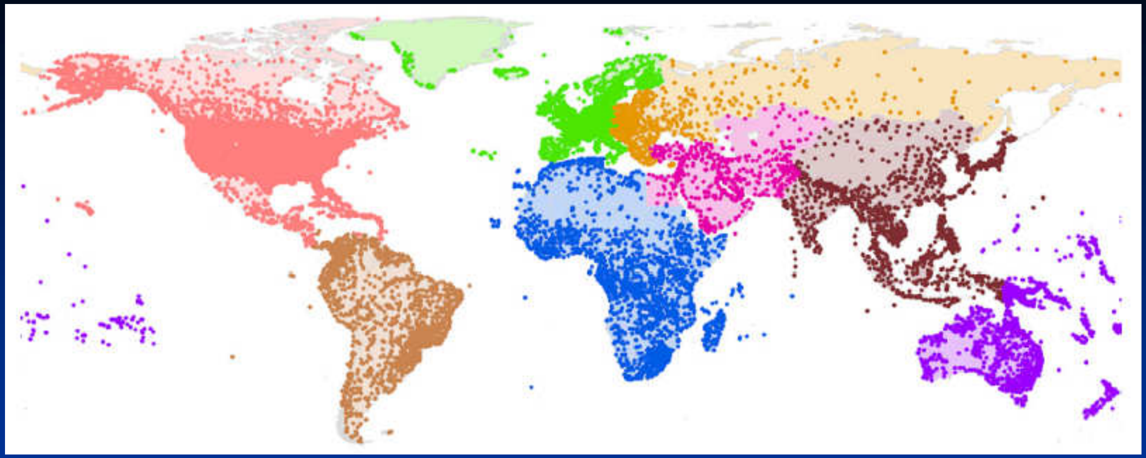


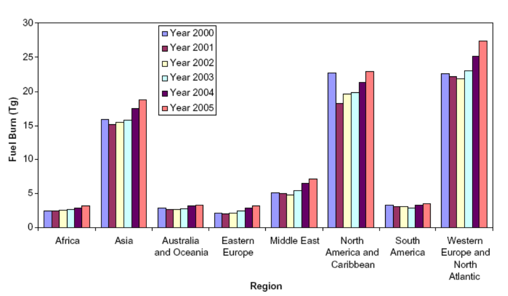
U.S. Greenhouse Gas Emissions, By Transport Source (2003)

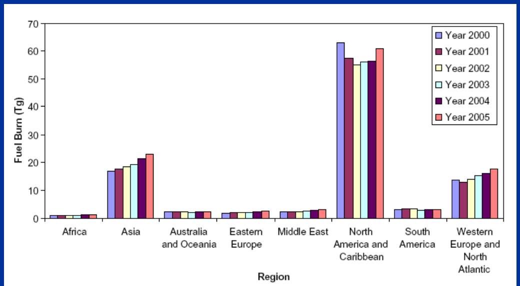


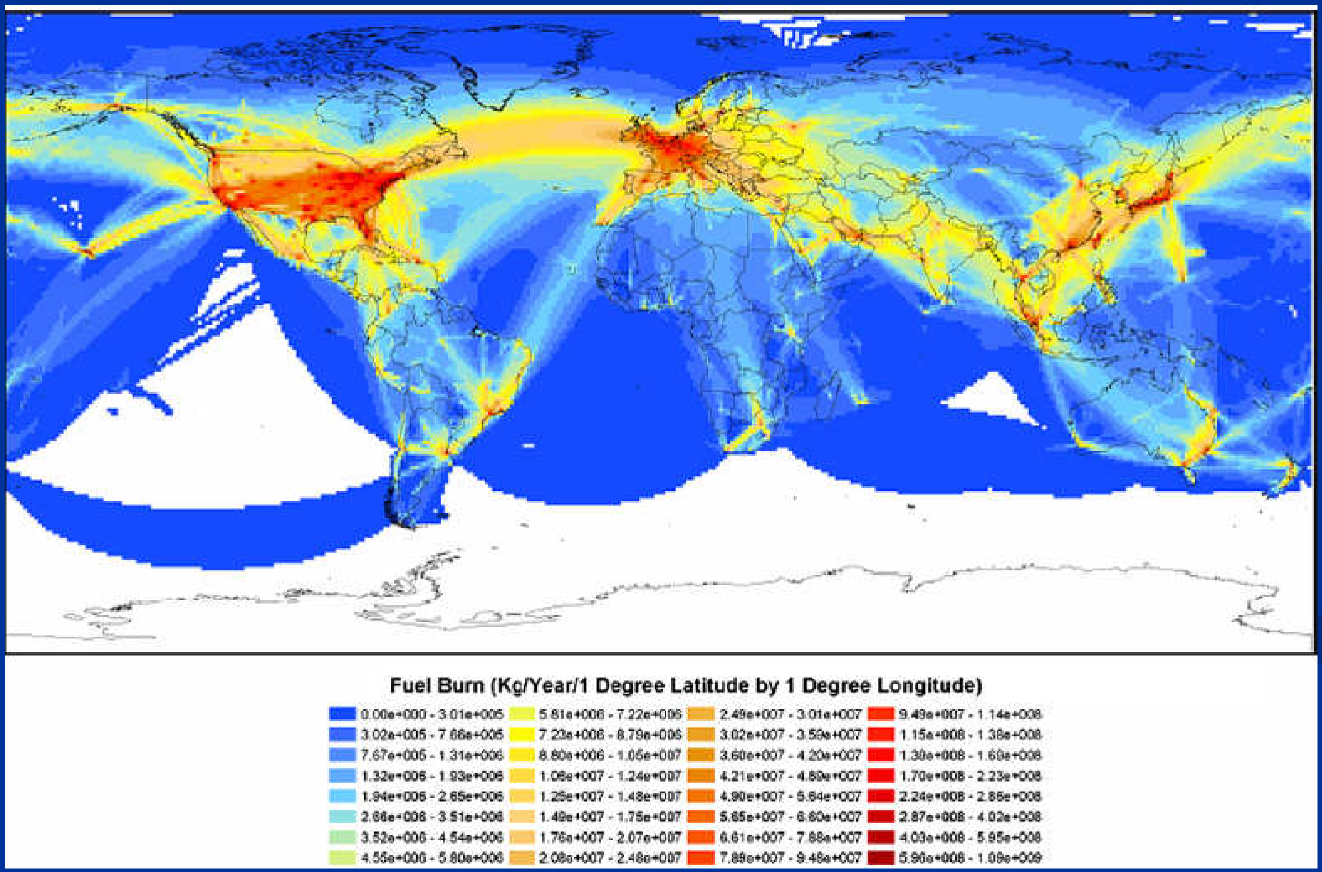
SAGE: System for Assessing Aviation's Global Emissions

(U.S. FAA)







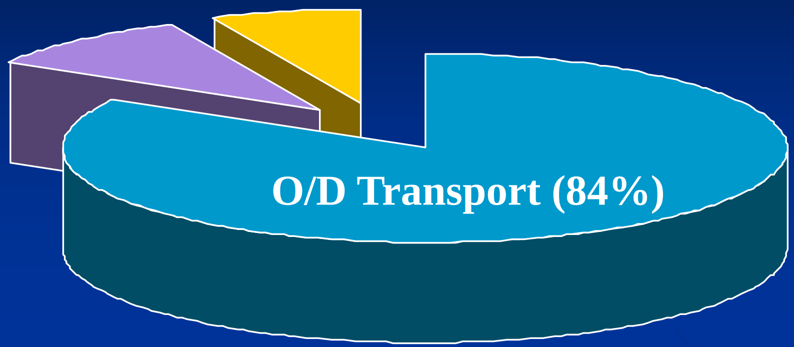


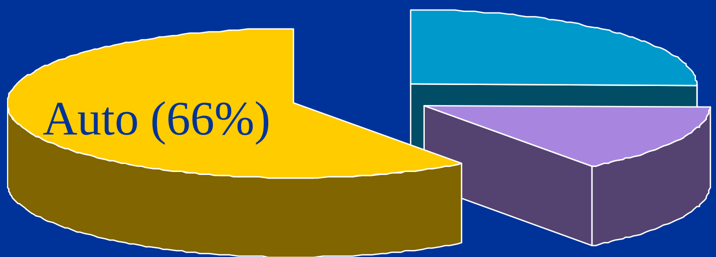
Source: Brian Kim et al. 2007. System for Assessing Aviations Global Emissions. Transportation Research D, Vol. 12, 325-346.

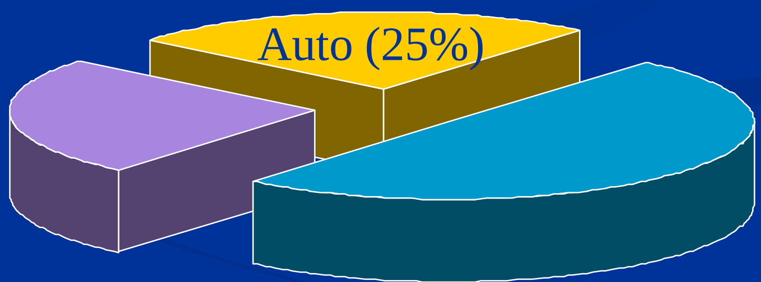
Rocky Mountain National Park

(967 Surveys, 70% response, Summer 2001, extrapolate to 3 million visitors)

Total Emissions	**(CO_2-eq) (kg)**
Transport	950,111,267
Accommodation	108,354,551
Activities	76,179,000
total	*1,134,644,818*







Transport Emissions	**Volume (km)**	**CO_2-eq (kg)**
Air (<2000)	1,258,347,175	475,655,232
Air (>2000)	735,110,208	238,175,707
Auto	3,000,385,110	236,280,327
total		*950,111,267*

Source: Stefan Gossling et al., 2005. "The Eco-Efficiency of Tourism." Ecological Economics, Vol. 54, 417-434.

Ecological Footprint (EF)

EF is an aggregate measure of demands made upon biophyisical productivity and waste assimilation imposed by human activity in terms of an equivalent land/sea area (gha = global hectares).

In 2000, the EF ranged from 0.50 gha (Bangladesh) to 9.57 gha (United States). The 'fair earthshare' (mean) is estimated to be 2 gha/year.

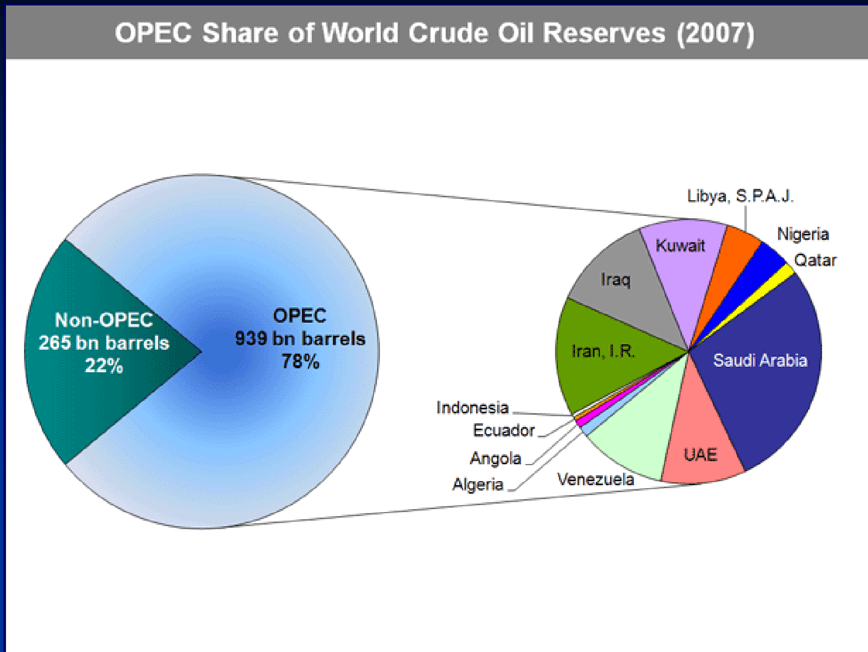
The gross EF of a two week holiday from UK to Cyprus is 0.93 gha. Fifty percent of gha is air travel.

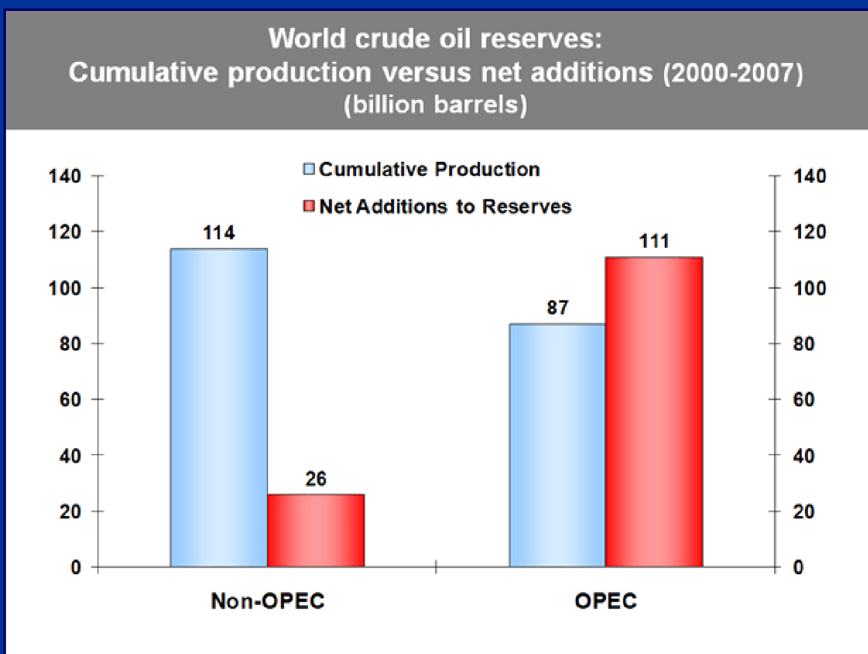
Net EF = Gross EF - generation at home
e.g.) 0.93 - 0.21 = 0.72 (UK to Cyprus)

US Tourist (3 weeks) from Miami to Costa Rica:

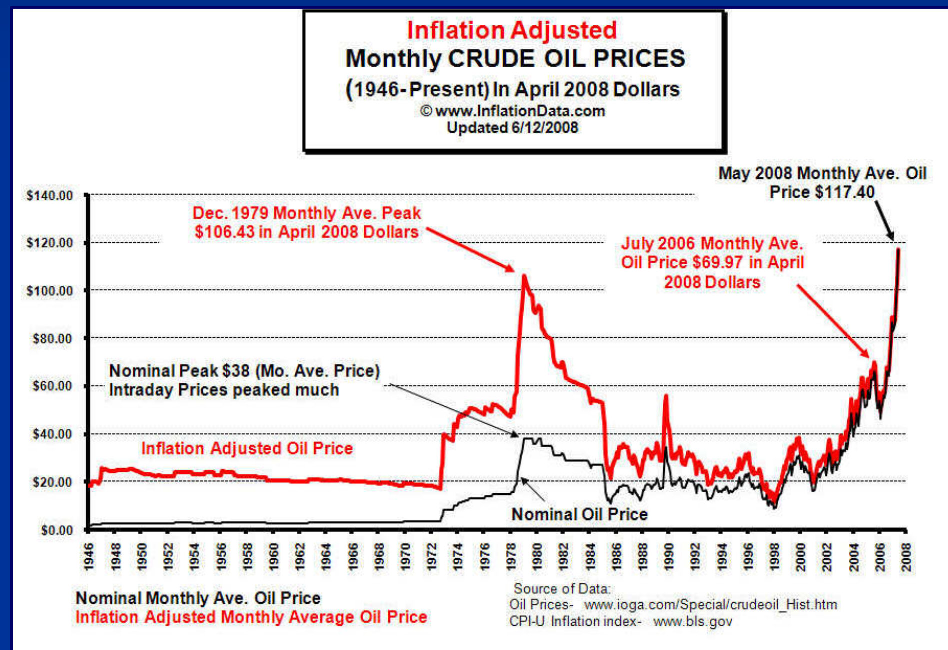
Transit = 0.37 gha
Destination= 0.12 gha
Net = 0.49-0.54 = -0.06 gha

Source: Colin Hunter and Jon Shaw. 2007. "The Ecological Footprint as a Key Indicator of Sustainable Tourism," Tourism Management, Vol. 28, 46-57.





Tourism = Travel
Travel = Oil
Tourism = Oil



"Oil Price Rallies as Saudi Arabia Announces Production Cuts"

Boston Globe (11/5/2008)

Oil Depletion:
What Could it Mean for Scottish Tourism ?

Scenario 1: Energy Inflation (2005-2015)
low priced oil ends and no intervention
(500% oil, 300% gas, 200% electricity)
Scenario 2: Pay for Climate Change (2005-2015)
carbon taxes (VAT), train subsidy, renewable technologies initiated
(200% oil, 100% gas, 100% electricity)

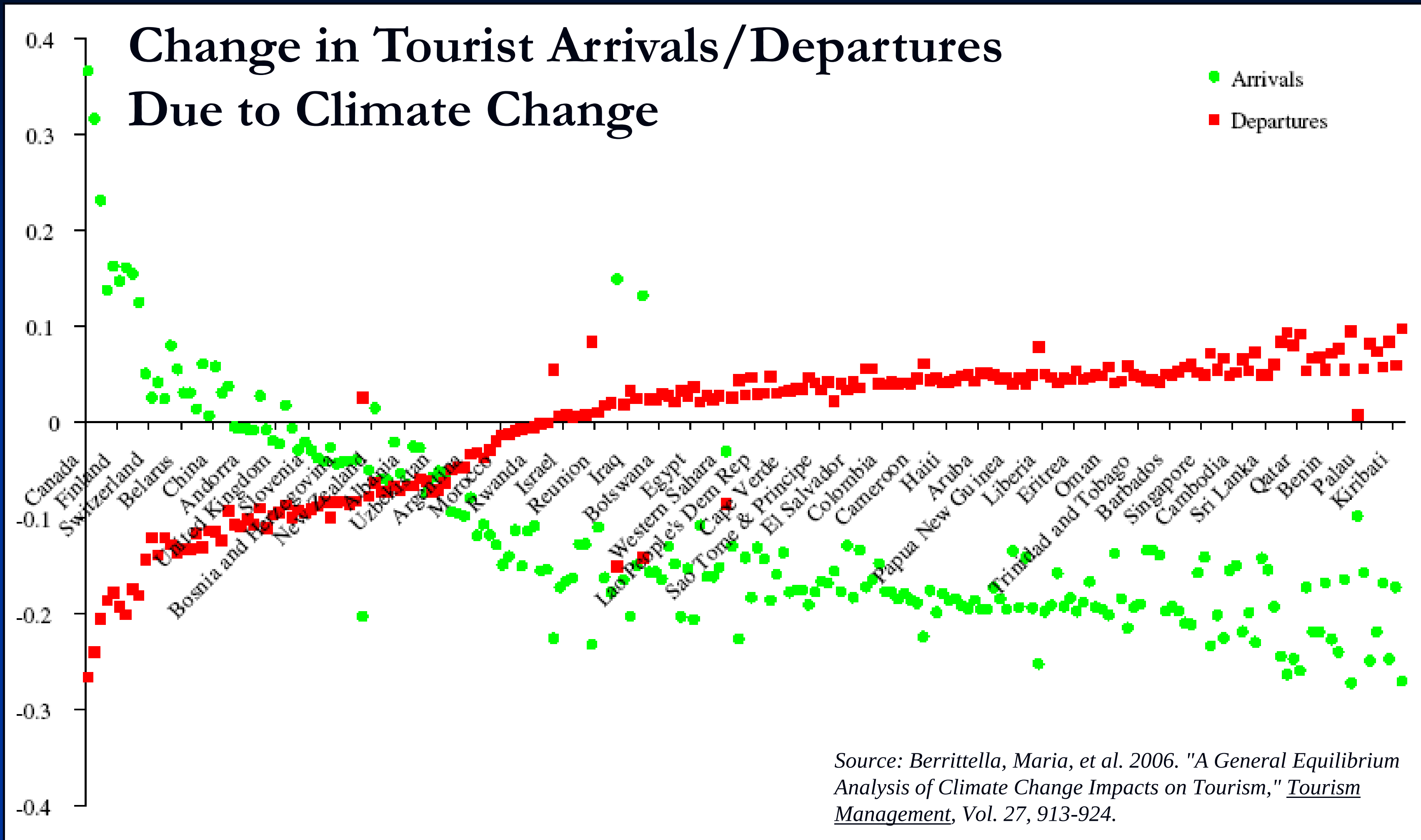
	2015 Baseline	Scene1	Scene2
GDP	84,548	+1	-4
Employment (fte)	2,163,269	-2	-3
Govt Rev	27,018	-10	0
Daytrip Expend	3,468	-1	-1
Domestic Tour Expend	2,095	+1	+1
UK Expend	3,514	-19	-16
International Expend	1,842	-37	-27
Overnight Expend	7,452	-18	-14
Tourism+Day Expend	10,920	-13	-10

In addition, tourism markets are segmented and the income elasticity (in the origin area) for short-haul tourist trips is much smaller than the income elasticity for long-haul tourist trips.

Years
1980-2003

Origin	Destination	Income Elasticity
Japan	New Zealand	**2.60**
Japan	Taiwan	**1.20**

Source: Lim, Christine, et al. 2008. "Modeling Income Effects on Long and Short Haul International Travel from Japan," Tourism Management. Vol. 29, 1099-1109.



The Change in arrivals and departures due to climate change as a percentage of arrivals and departures without climate change. Countries shown in rank order of mean annual temperature, 1961 - 1990.

Canadian Rockies

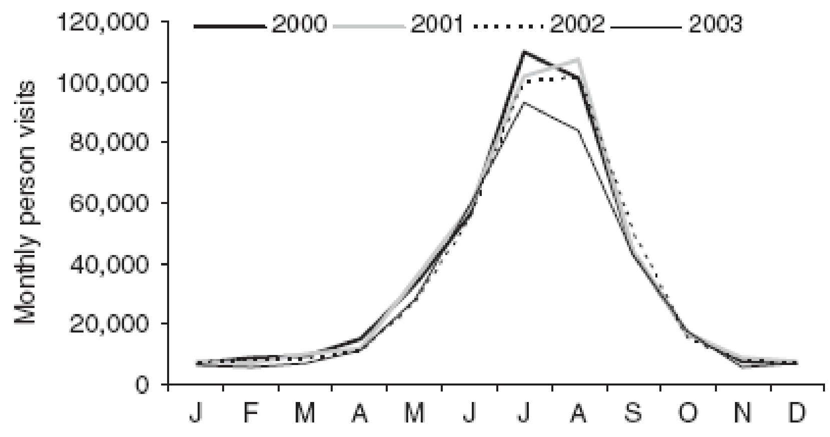
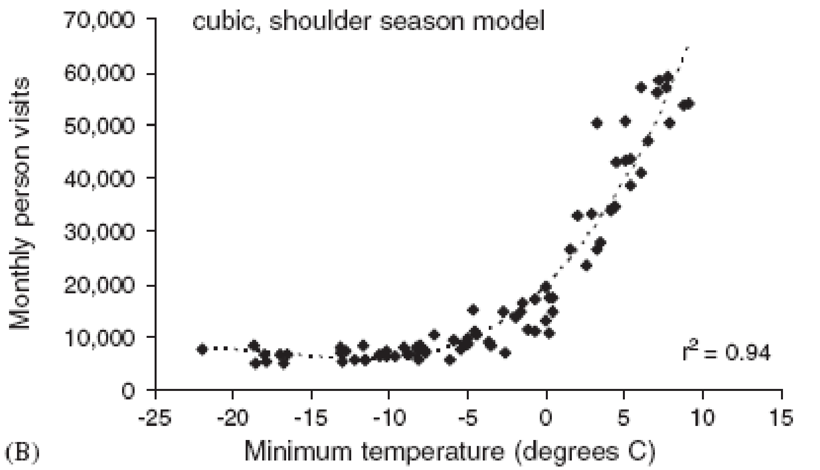


Fig. 2. WLNP visitation, 2000–2003.



(B)

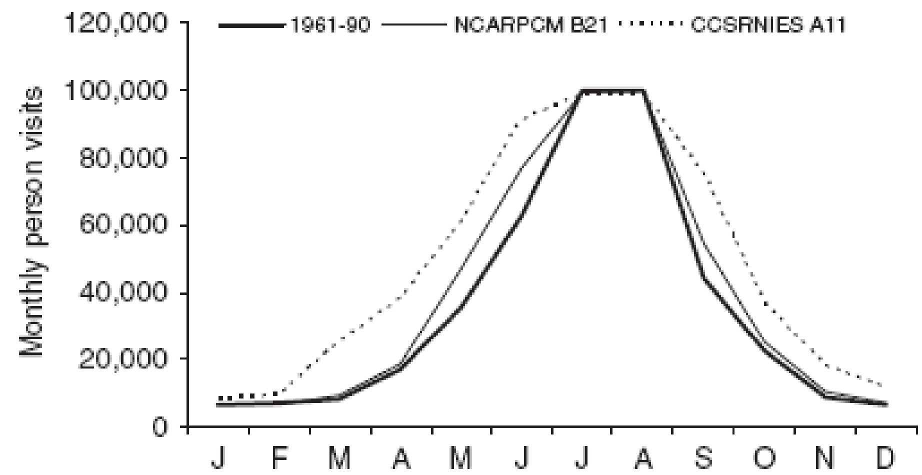


Fig. 4. Projected changes in seasonality in WLNP under climate change (2050s).

So, the effect of warmer temperatures would yield an increase in visitorship of 10 - 36%.

Source: Daniel Scott et al. 2007. "Implications of Climate Change for Nature-Based Tourism in the Canadian Rocky Mountains," Tourism Management, Vol. 28, 570-579.

Climate Impacts on Transportation Operations and Infrastructure

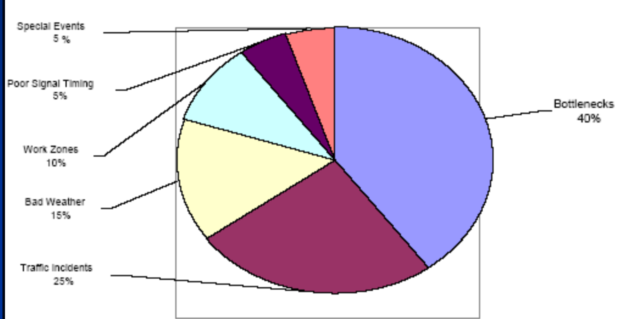


EXHIBIT 1 Sources of Delay and Unreliability
Source: *Traffic Congestion and Reliability*, FHWA, 2005

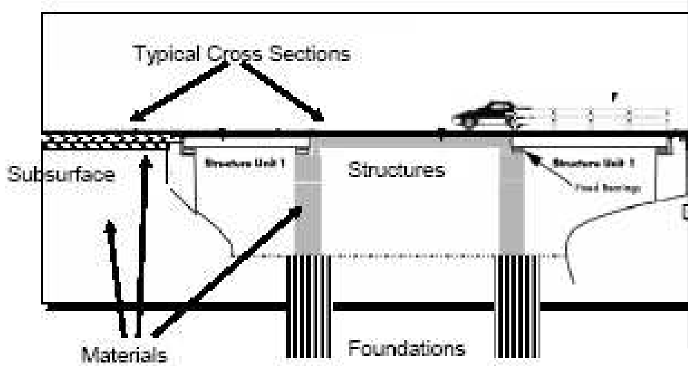


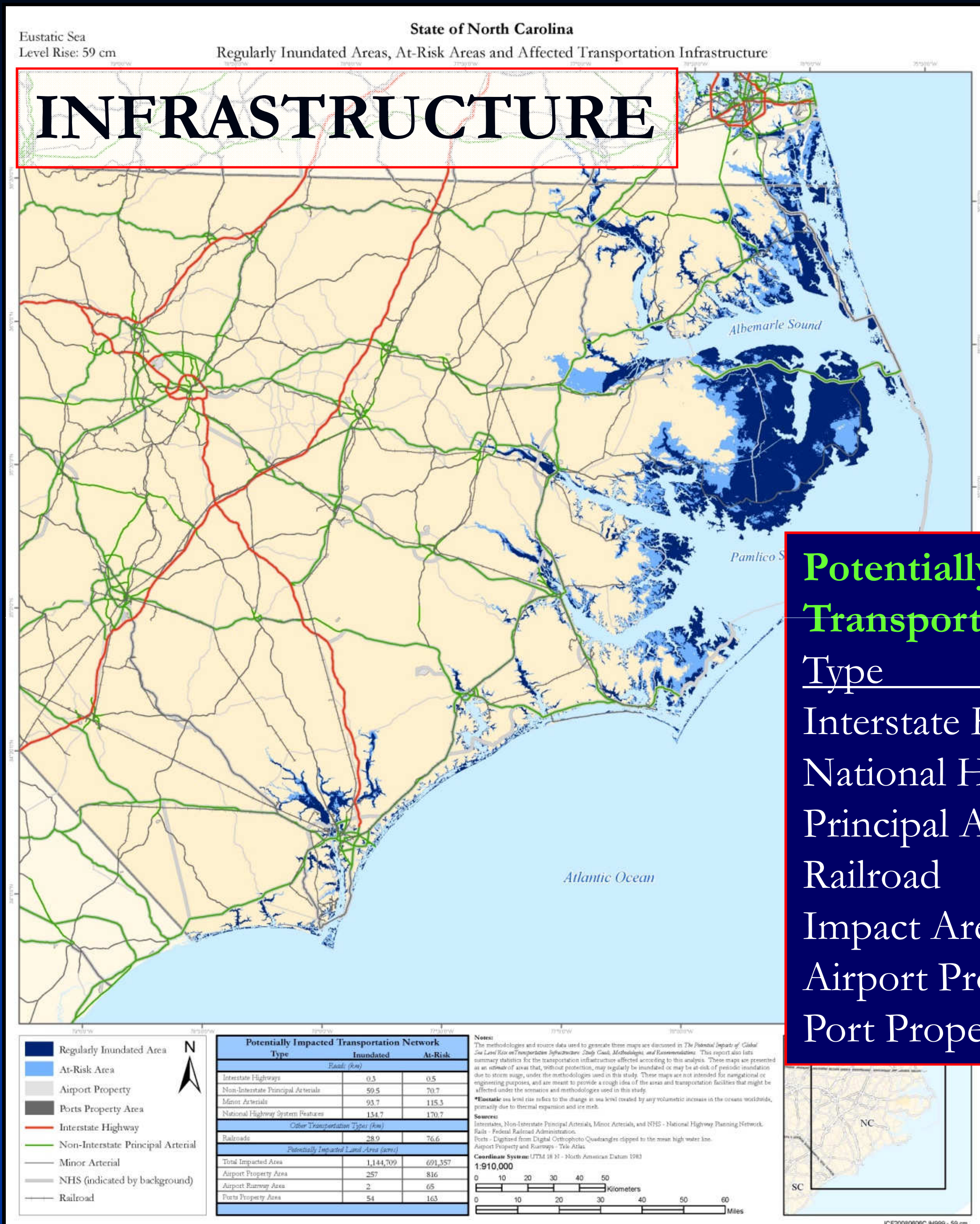
FIGURE 1 Critical components of infrastructure design.

Exhibit A: Principal Climate Impacts on Operations

Climate-Related Road Weather Variables	Roadway Impacts	Operational Impacts
Air temperature and humidity	• Contribution to snow and icing • Freeze/thaw cycle impacts on pavement smoothness	• Traffic speed
Wind speed	• Visibility • Lane obstruction • Major storm disruption • Appurtenance damage • Structural damage	• Travel speed and delay • Accident risk • Road closure
Rainfall	• Visibility distance • Pavement friction • Lane obstruction and submersion • Landslides and scour • Structural damage	• Roadway capacity • Travel speed and delay • Accident risk • Road closure
Sleet/Snow	• Visibility distance • Pavement friction • Lane obstruction • Avalanche risk • Appurtenance damage	
Fog	• Visibility distance	• Speed variance • Travel time delay • Accident risk
Sea level	• Lane submersion • Structural damage	• Traffic speed • Travel time delay • Accident risk • Road closure

Source: U.S. DOT. Center for Climate Change and Environmental Forecasting. 2008.

INFRASTRUCTURE

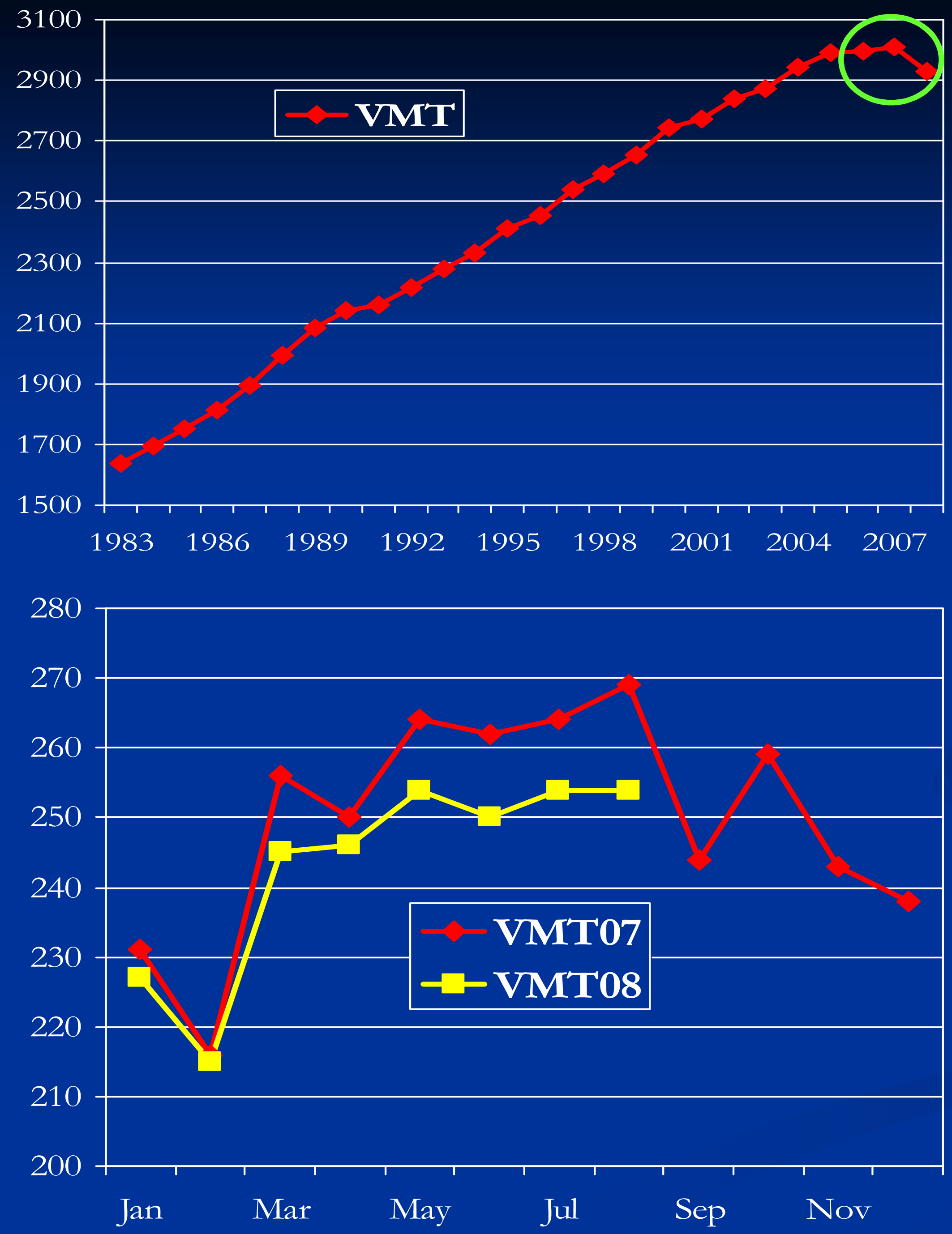


Source: U.S. DOT. Center for Climate Change and Environmental Forecasting. 2008. "The Potential Impacts of Global Sea Level Rise on Transportation Infrastructure."

Potentially Impacted Transportation Network

Type	Inundated	At Risk
Interstate Highway (km)	0.3	0.5
National Hwy System	134.7	170.7
Principal Arterials	59.5	70.7
Railroad	28.9	76.6
Impact Area (acres)	1,144,709	691,357
Airport Property	257	816
Port Property	54	163

Note:
Assuming Eustatic Sea Level Rise of 59 cm.

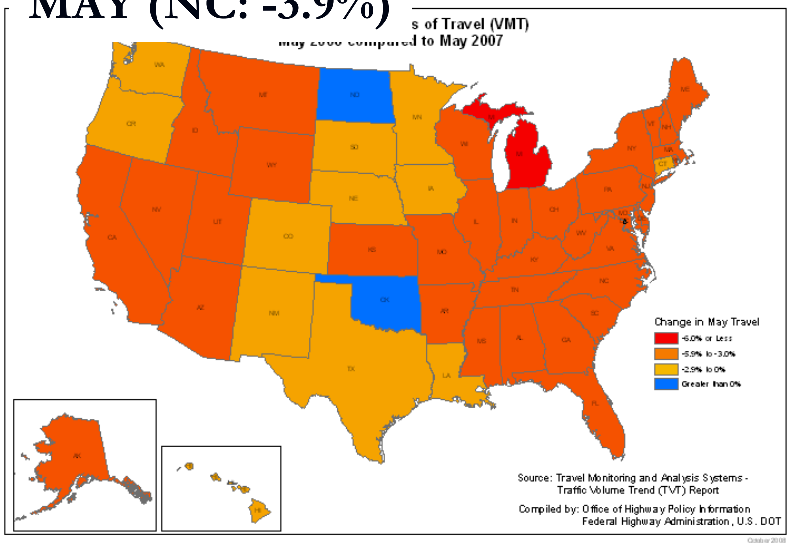


Cumulative Travel

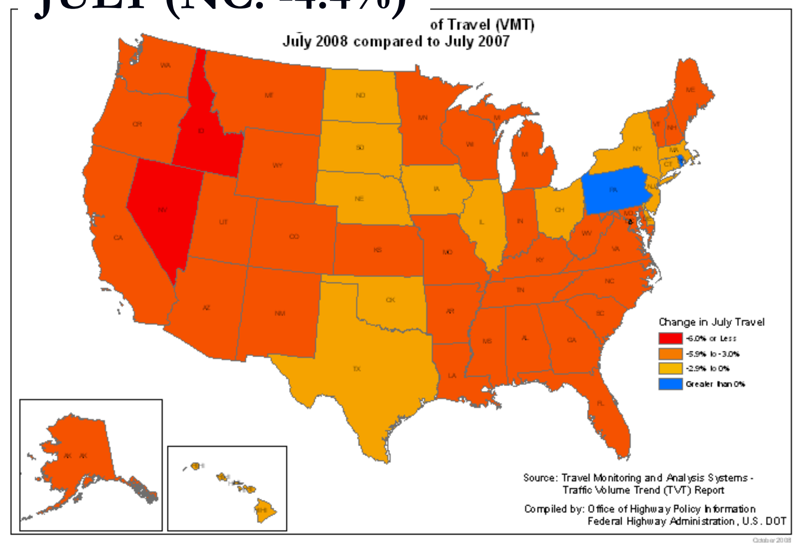
Is down 67.2 billion miles (-3.3%) over 2007 in the U.S.

Source: U.S. Department of Transportation, Federal Highway Administration. Traffic Volume Trends August 2008.

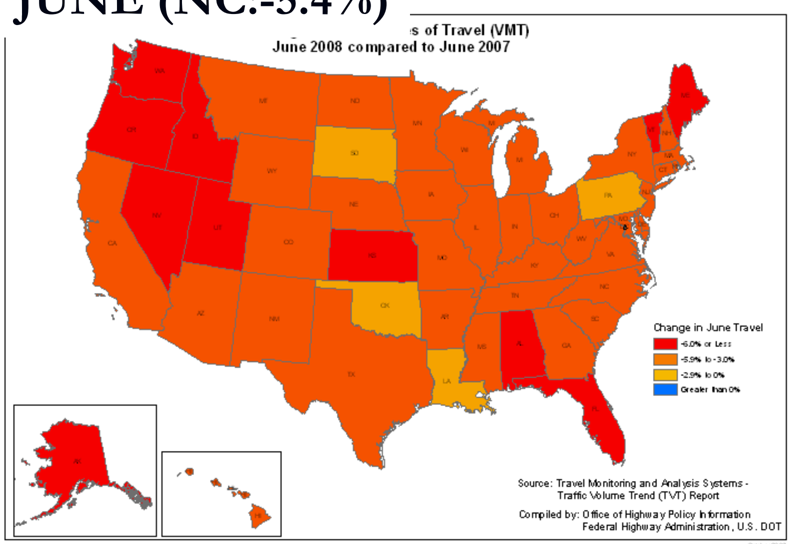
MAY (NC: -3.9%)



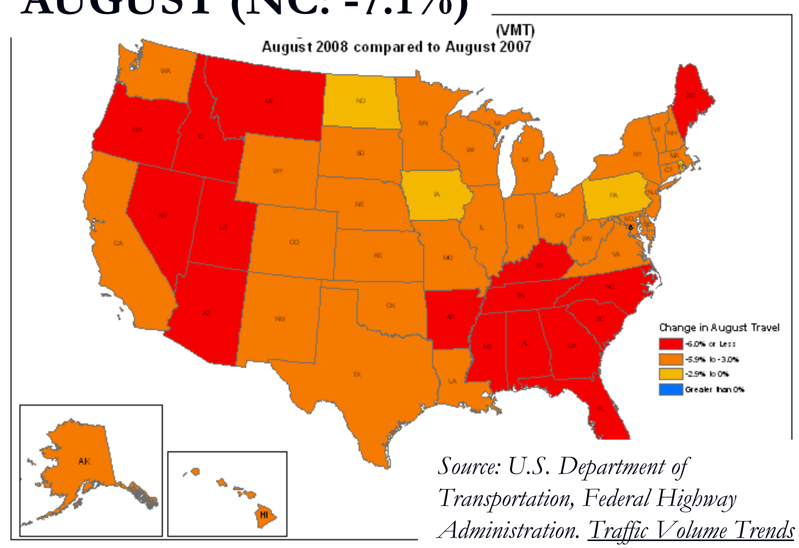
JULY (NC: -4.4%)



JUNE (NC:-5.4%)



AUGUST (NC: -7.1%)



Source: U.S. Department of Transportation, Federal Highway Administration. Traffic Volume Trends August 2008.

Don't Forget to Evacuate !!

Clearance time is the interval required to clear the roadway of all vehicles evacuating in response to a hurricane. The interval begins when the first evacuating vehicle enters the road network and ends when the last vehicle reaches assumed point of safety. (Does not include time needed for officials to assemble and declare.)

Clearance (hrs) = Mobilization Time + Travel Time + Queuing Time

	Low Occ		**High Occ**	
North Coast	**#**	**Clear**	**#**	**Clear**
Dare	80,327		166,727	
Currituck	27,340		42,640	
	107,667	**17.00**	**209,367**	**32.00**
Pamlico South				
Pamlico	13,032		16,585	
Craven	54,212		57,144	
Carteret	75,576		108,224	
Jones	4,515		4,570	
	147,335	**12.25**	**186,523**	**17.50**

(Scenario assumed: Category 4-5 storm and "medium" response)

Note: FEMA identifies no fewer than 25 critical roadway segments and intersections in NC. (e.g., 64W-east of Plymouth, 264 W- west of Washington, 70- through Havelock, I-40N at I-95)

Source: http://chps.sam.usace.army.mil/USHESDATA/NC/Data/framemain_preface.html

Some Recent Evacuation Lessons Learned

Texas (Katrina, Rita):
Evacuation of people with special needs: RUCS, statewide data base, community colleges
Fuel availability and distribution: TX DOT and Texas Oil and Gas Assoc
Traffic control: TX Dept of Safety and Border Patrol
Public awareness: Utilities and monthly billing statements

Alabama (Contraflow Plan on I-65 based on Ivan, 2004 and Dennis, 2005)
Public perception = 2.5 hours (commute time), actual = 7.5 hours
Pre-position dedicated equipment at 30 traffic control points
State troopers (at least vehicles) needed to actually clear existing traffic
Northern terminus (Montgomery) required substantial modification
Lane reversal (during Dennis) specified for 7/9 from 8:00 am to 5:00 pm
Annual exercise program

Source: US DOT, FHA. Appendix E: Best Practices, "Catastrophic Hurricane Evacuation Plan Evaluation: A Report to Congress."
Accessed (11/2008) at www.fhwa.dot.gov/reports/hurricaneevacuation/appendixe.htm