

# Climate Change & Entrepreneurship in the Developing World



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**APRIL 9, 2009**

**GUEST LECTURE  
UGBA196-1 ENTREPRENEURSHIP TO  
ADDRESS GLOBAL POVERTY**

# Goals

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- Provide enough background about climate change to:
  - Stimulate entrepreneurial brainstorming
  - Pique your interest in both mitigation and adaptation
- Introduce sources for further reading



# Agenda

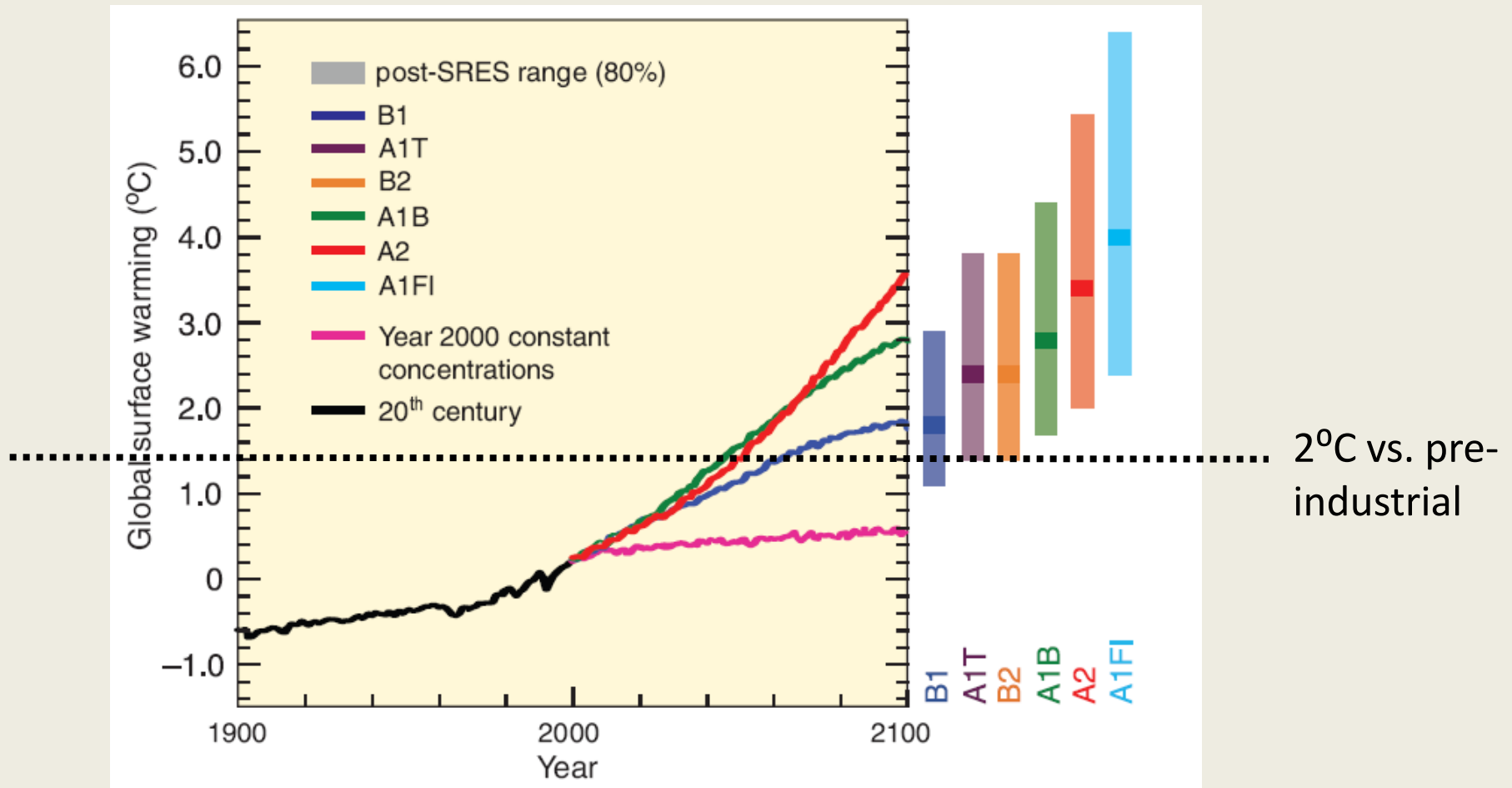
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- Climate projections
- Impacts and adaptation in BOP countries
- Pollutants
- Emissions from BOP countries
- Mitigation in BOP countries
- Conclusion and Q&A

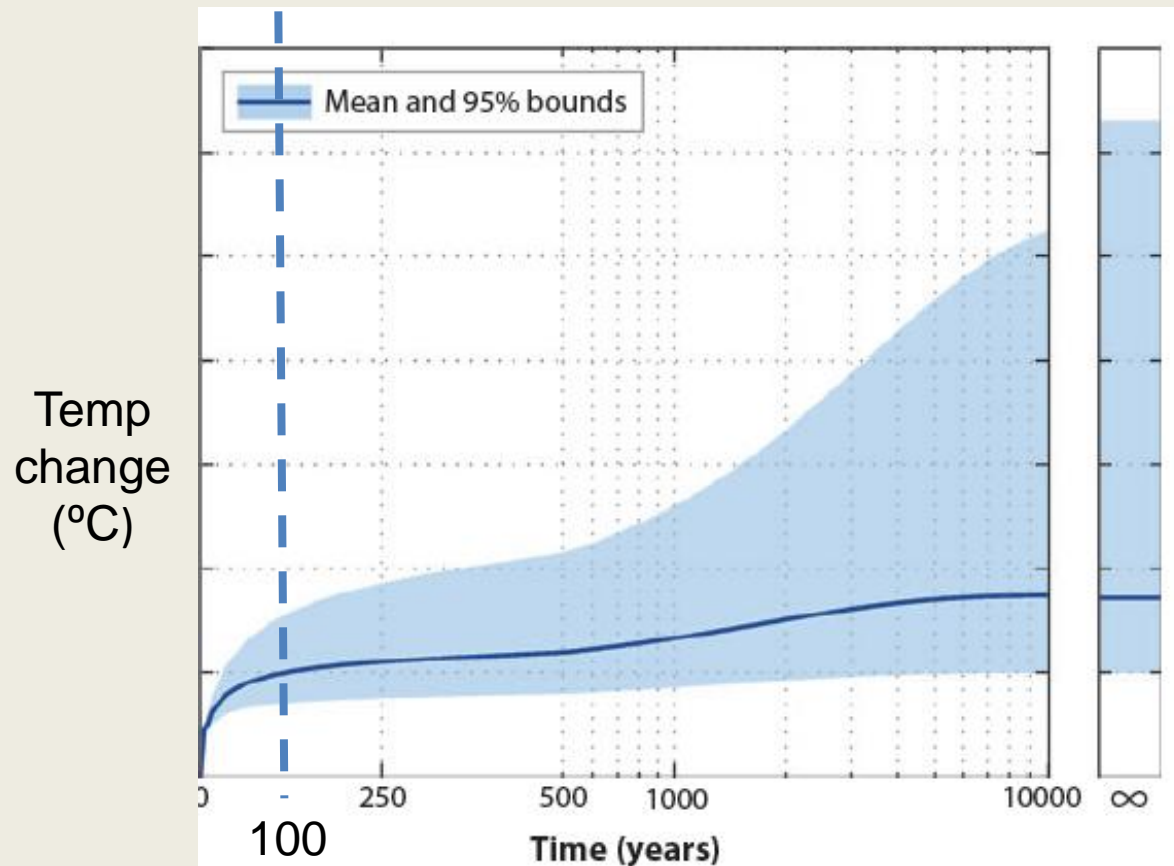
## **CLIMATE PROJECTIONS**

- **IMPACTS AND ADAPTATION IN BOP COUNTRIES**
- **POLLUTANTS**
- **EMISSIONS FROM BOP COUNTRIES**
- **MITIGATION IN BOP COUNTRIES**
- **CONCLUSION AND Q&A**

# Climate Projections (for standard IPCC scenarios)



# Time Lag in Climate Response



# Climate beyond Average Temperature

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- Temperature variations:
  - Bigger change at the poles
  - More heatwaves
- Precipitation:
  - Different locations
  - Changing amounts
  - Changing intensity
  - More extreme events
- Sea level rise
- Glacier melt
- Wildfires
- Habitat range changes
- Predator/prey mismatches
- Atmosphere & ocean circulation

# Tipping Points

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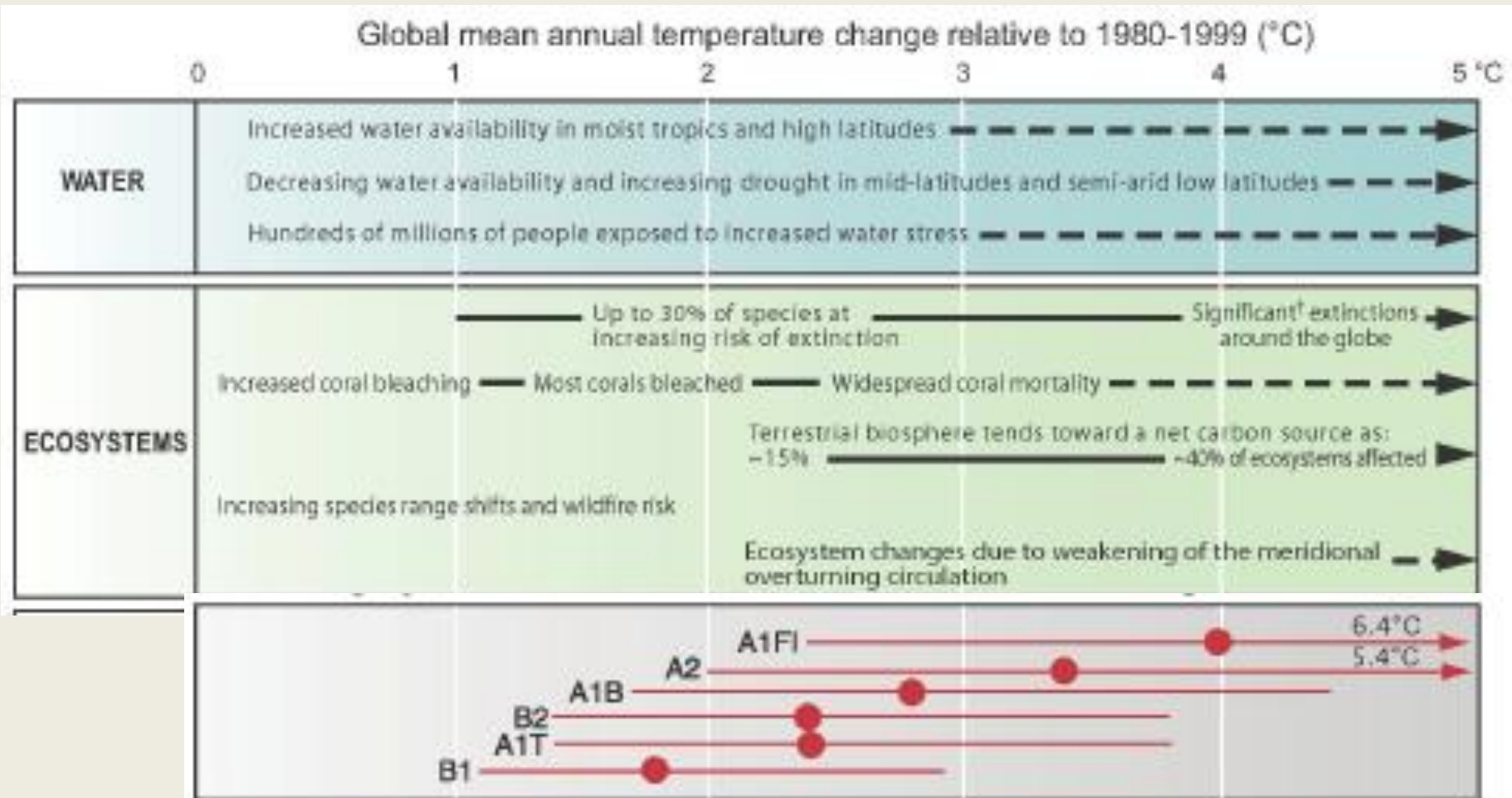
- *Definition of tipping point:*  
the critical point at which an earth subsystem is switched to a qualitatively different state by a small perturbation
- *Examples (temp. trigger, transition time):*
  - Arctic summer sea ice (0.5-2C, 10 yr)
  - Indian summer monsoon (?, 1 yr) (drought)
  - Amazon rainforest (3-4C, 50 yr) (dieback, drought)
  - El Nino-S. Oscillation (3-6C, 100 yr) (SE Asia drought)

- **CLIMATE PROJECTIONS**

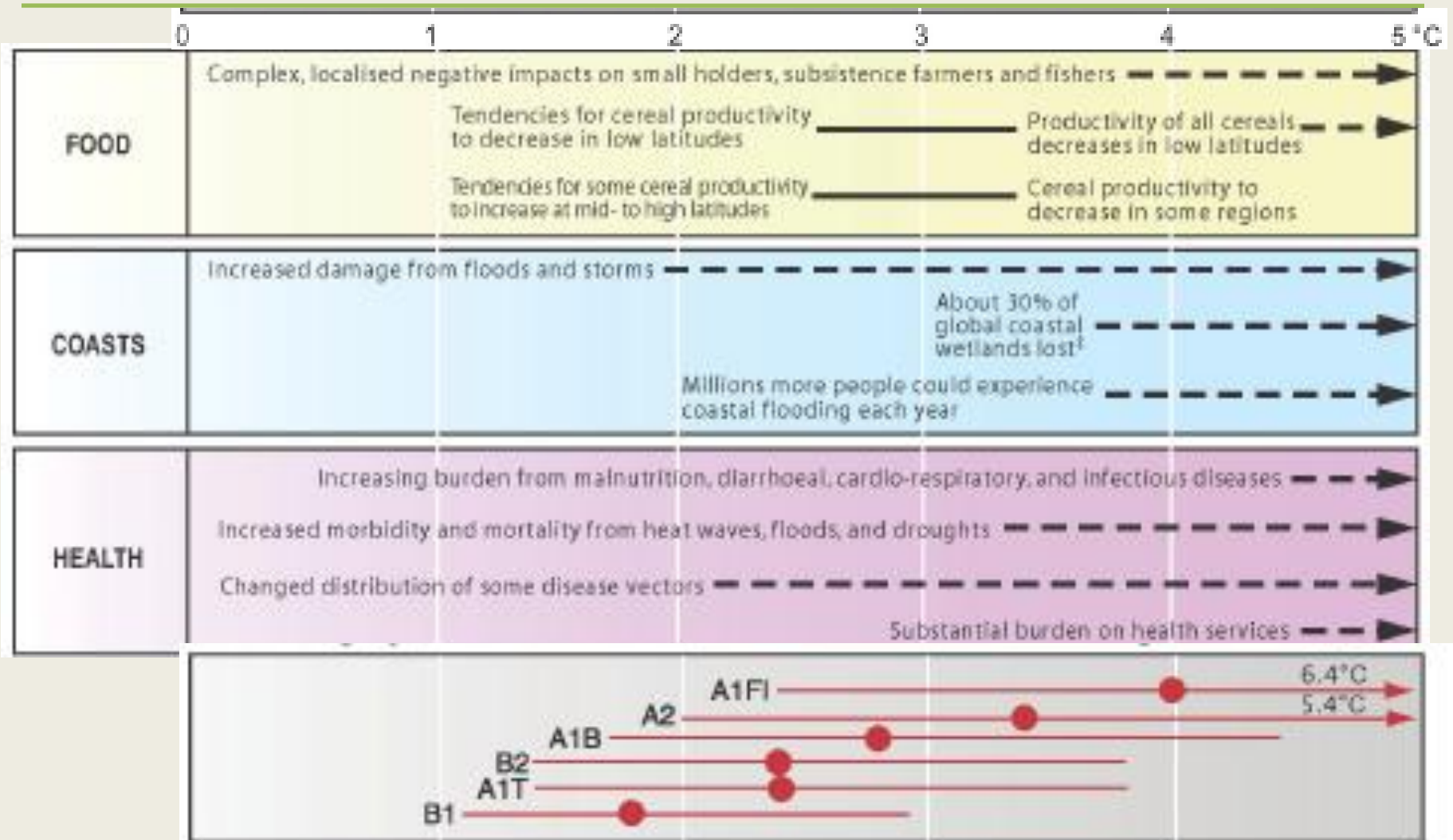
**IMPACTS AND ADAPTATION IN BOP COUNTRIES**

- **POLLUTANTS**
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- **CONCLUSION AND Q&A**

# Global Impacts, by temperature change I



# Global Impacts, by temperature change II



# Regional Impacts: Asia

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- Flooding of megadeltas – e.g., Vietnam:
  - A 1 meter sea level rise could affect 4 million in the Red River delta and 3.5-5 million in the Mekong River delta
  - 100,000 hectares of cultivated area -> salt marsh
  - Loss of half mangrove habitat in Mekong River delta
- Additional loss in area of Himalayan glaciers
- Increased water stress:
  - 120M-1.2B people in 2020's; 186-921million by 2050's
  - Nearly 50% reduction in per capita freshwater in India by 2025
- Mixed effect on crop yields: up to 20% increase in E. & SE, up to 30% decrease in C. & S. Asia by 2050

# Regional Impacts: Africa

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- Increase of 5-8% in arid & semi-arid land by 2080's
- Increased water stress
- Declining agricultural yields due to drought & land degradation + changes in the length of growing season
- Reduction of primary production & possible fish yields of Lake Tanganyika by ~30% (provides 25-40% animal protein for surrounding countries)
- Major shifts & changes in species ranges & possible extinctions
- Greatest impacts co-occur with other stresses (unequal access to resources, food insecurity, poor health management system)

# Regional Impacts: Latin America

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- Disappearance of high-altitude tropical glaciers (Bolivia, Peru, Colombia, Ecuador)
- Lack of adequate water:
  - 7-77M people by 2020's; 60-150M in 2<sup>nd</sup> half of century
  - Pacific coast of Costa Rica & Ecuador
- Replacement of tropical forest by savannas in E. Amazonia & tropical forests of C. & S. Mexico -> biodiversity impacts
- Declining rice yields after 2020
- General impacts on low-lying areas, mangrove habitat, buildings & tourism

# Climate Shocks & the Global Poor

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## “Climate Shocks”:

- Extreme events
- Disease
- Water stress
- Hunger



## Vulnerability



- Diminished health
- Reduced income
- Elimination of assets
- Reduced time/money for education



**“Lifelong  
cycles of  
disadvantage”**

- **CLIMATE PROJECTIONS**
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# Five Key Pollutants

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- **Warming:**

- Carbon dioxide ( $\text{CO}_2$ )
- Methane ( $\text{CH}_4$ )
- Tropospheric ozone ( $\text{O}_3$ )
- Black carbon (BC)



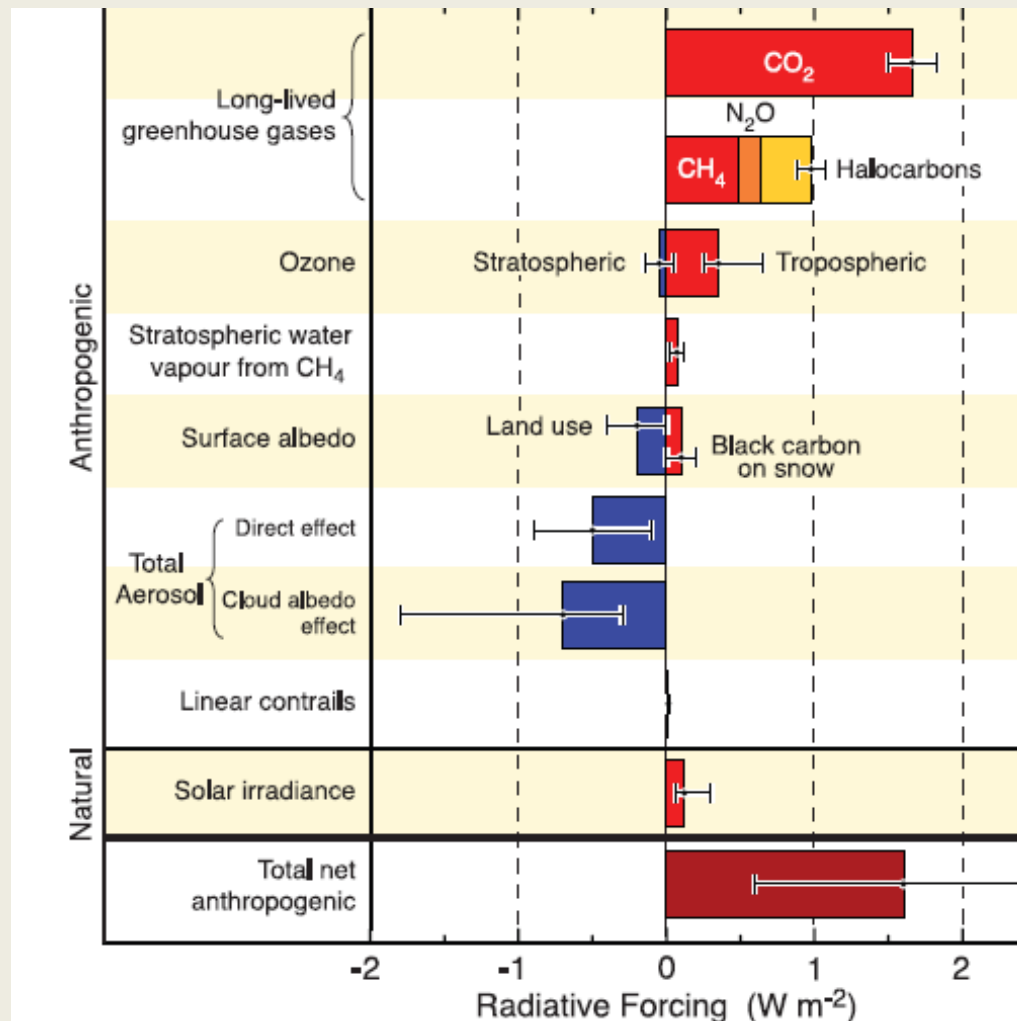
- **Cooling:**

- Sulfur dioxide ( $\text{SO}_2$ )



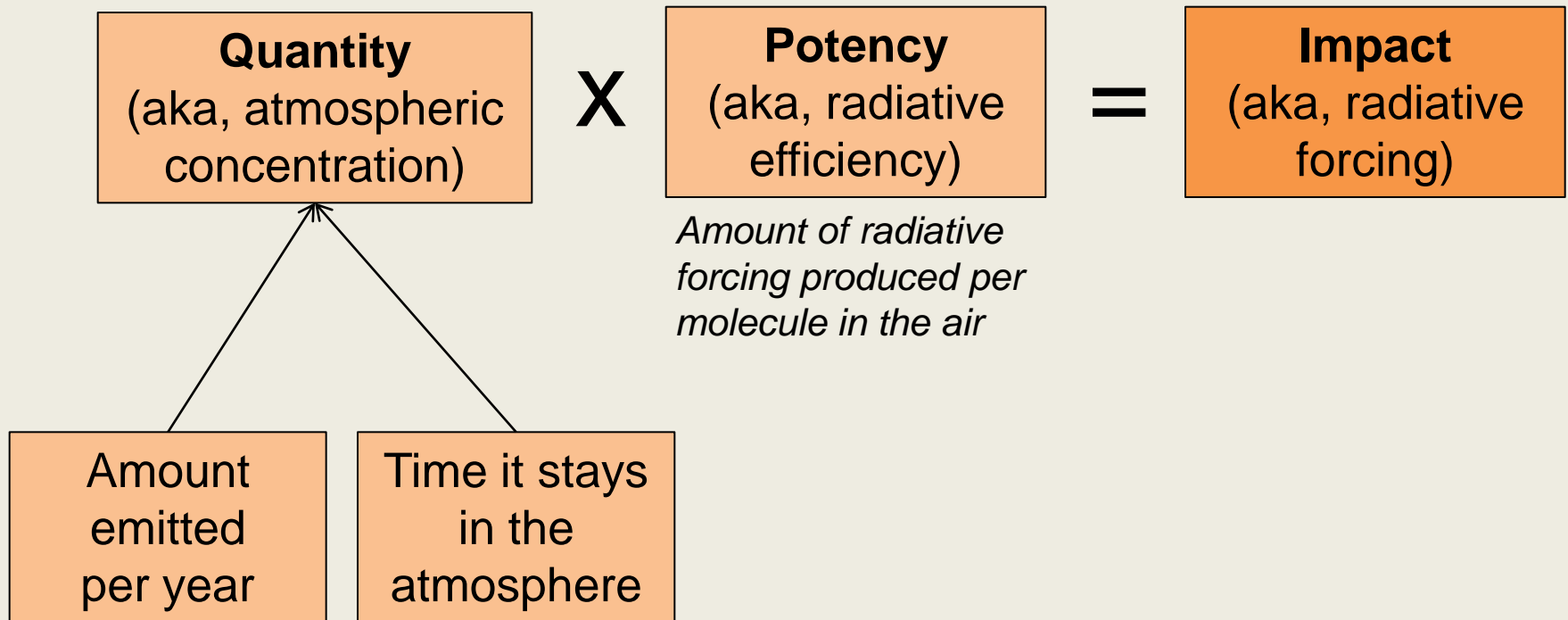
# Anthropogenic Sources of Climate Change (global, historical)

**Today's Radiative Forcing**  
(resulting from emissions between 1750-2005)

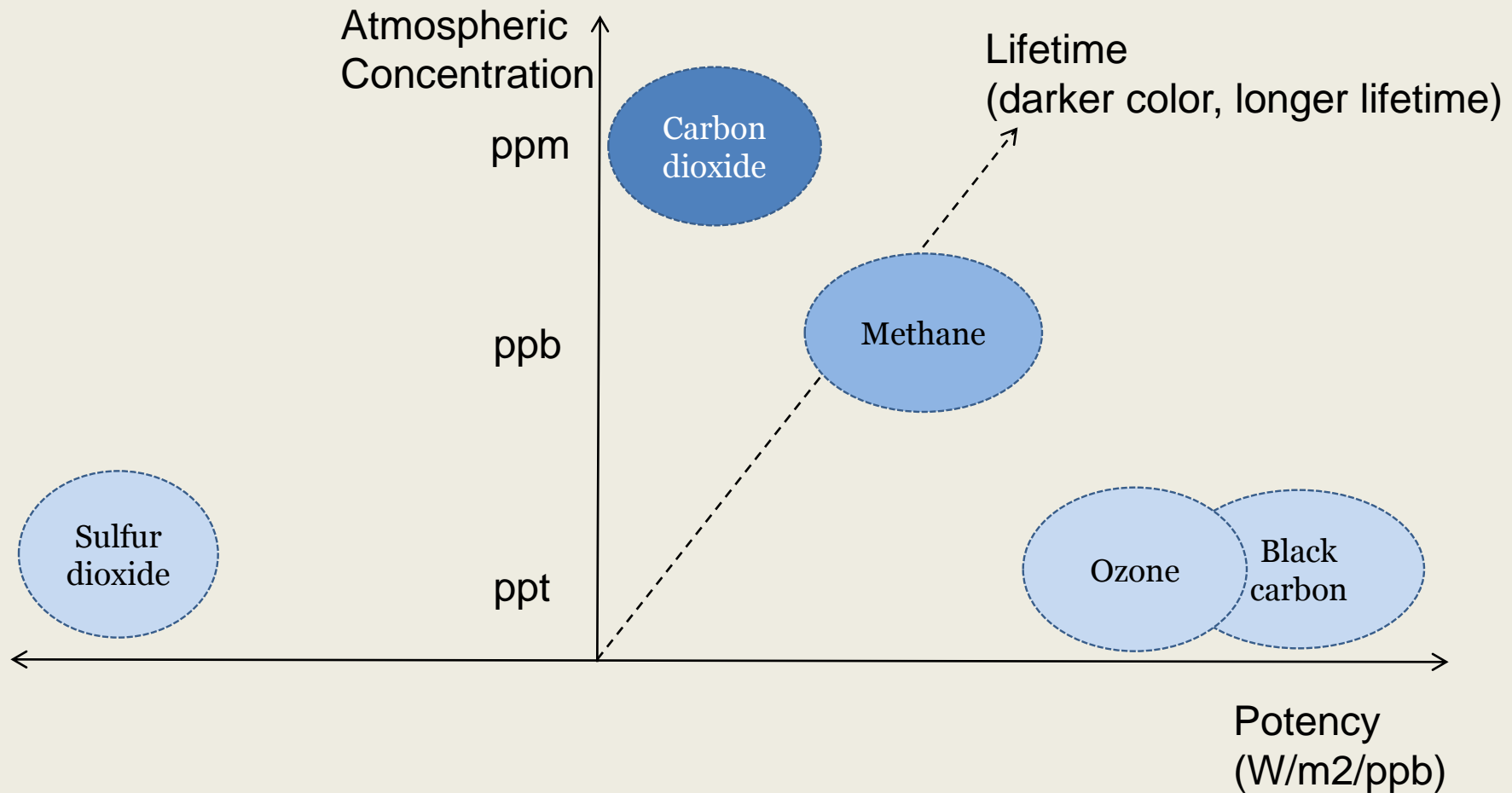


# Impact of a Pollutant is a Function of its Quantity and Potency

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# Characteristics of Key Pollutants

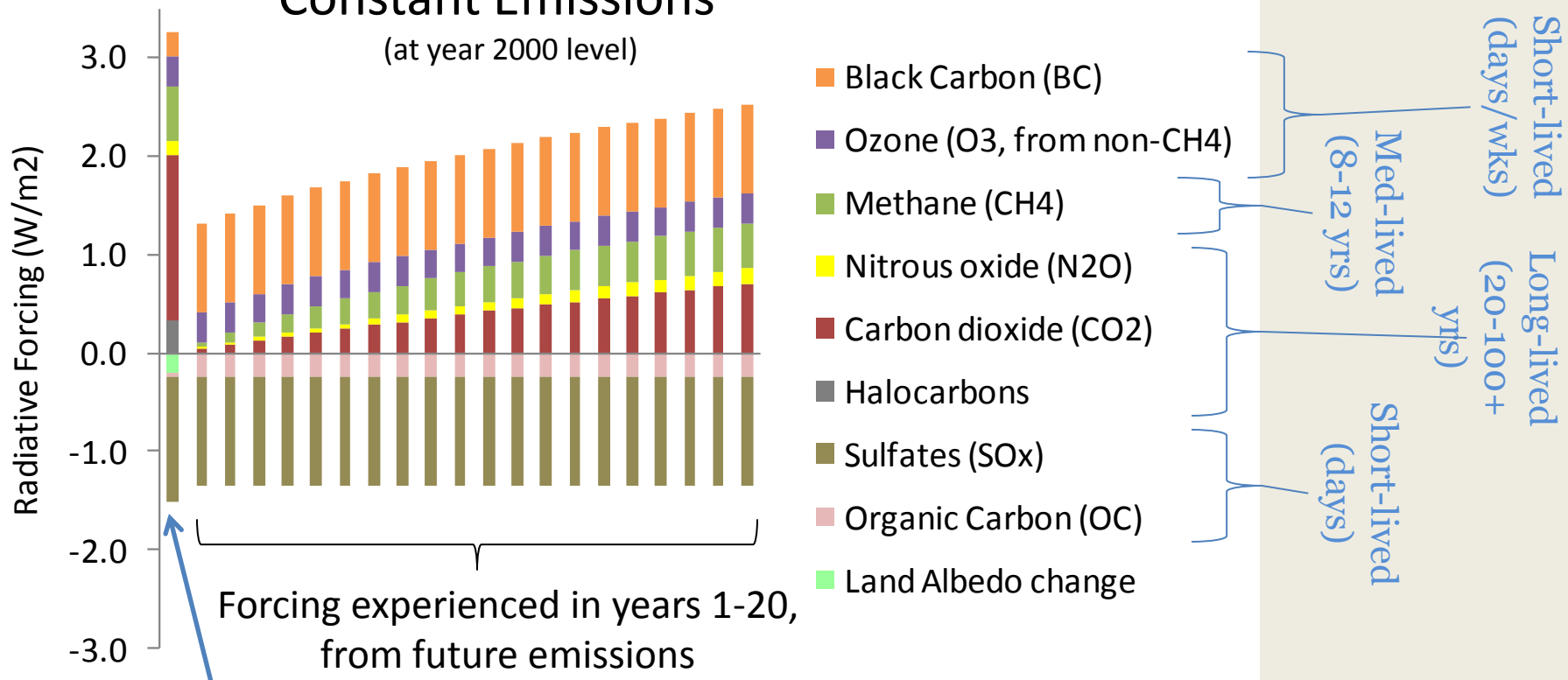


# Climate Impact of Near-Term Emissions

## Forcing Produced by Next 20 Years of Emissions

### Constant Emissions\*

(at year 2000 level)



Historical anthro. forcing  
(emissions, 1750-2005)

# Complexities of Greenhouse Pollutants

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- Short vs. long lifetimes
- High vs. low forcing (potency)
- Local vs. regional vs. global effects
- Co-pollutants
- Cooling aerosols
- Public health effects (in addition to climate)

# Key Take-Away: Five Key Pollutants

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- Warming:

- Carbon dioxide ( $\text{CO}_2$ )
- Methane ( $\text{CH}_4$ )
- Tropospheric ozone ( $\text{O}_3$ )
- Black carbon (BC)



- Cooling:

- Sulfur dioxide ( $\text{SO}_2$ )

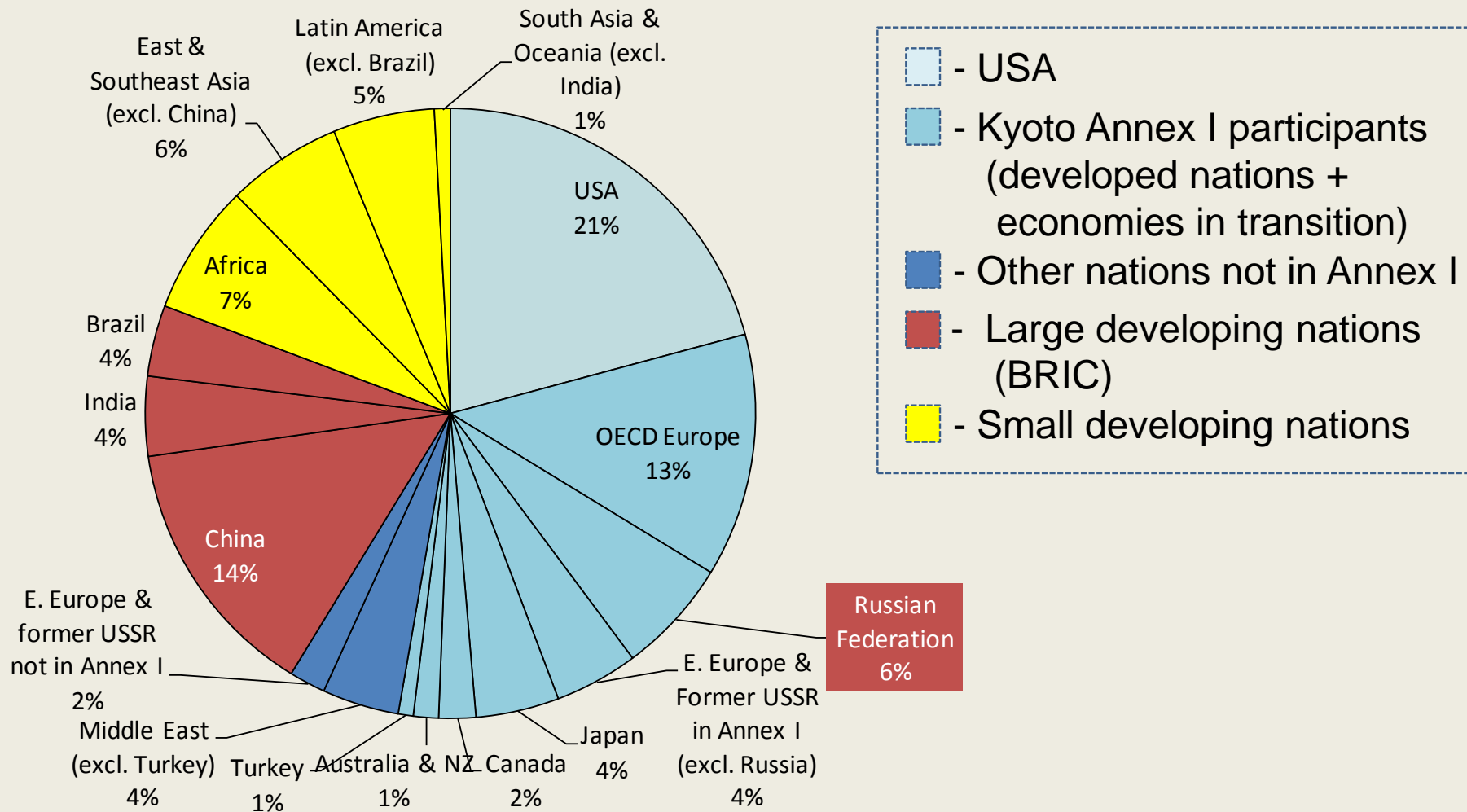


- **CLIMATE PROJECTIONS**
- **IMPACTS AND ADAPTATION IN BOP COUNTRIES**
- **POLLUTANTS**

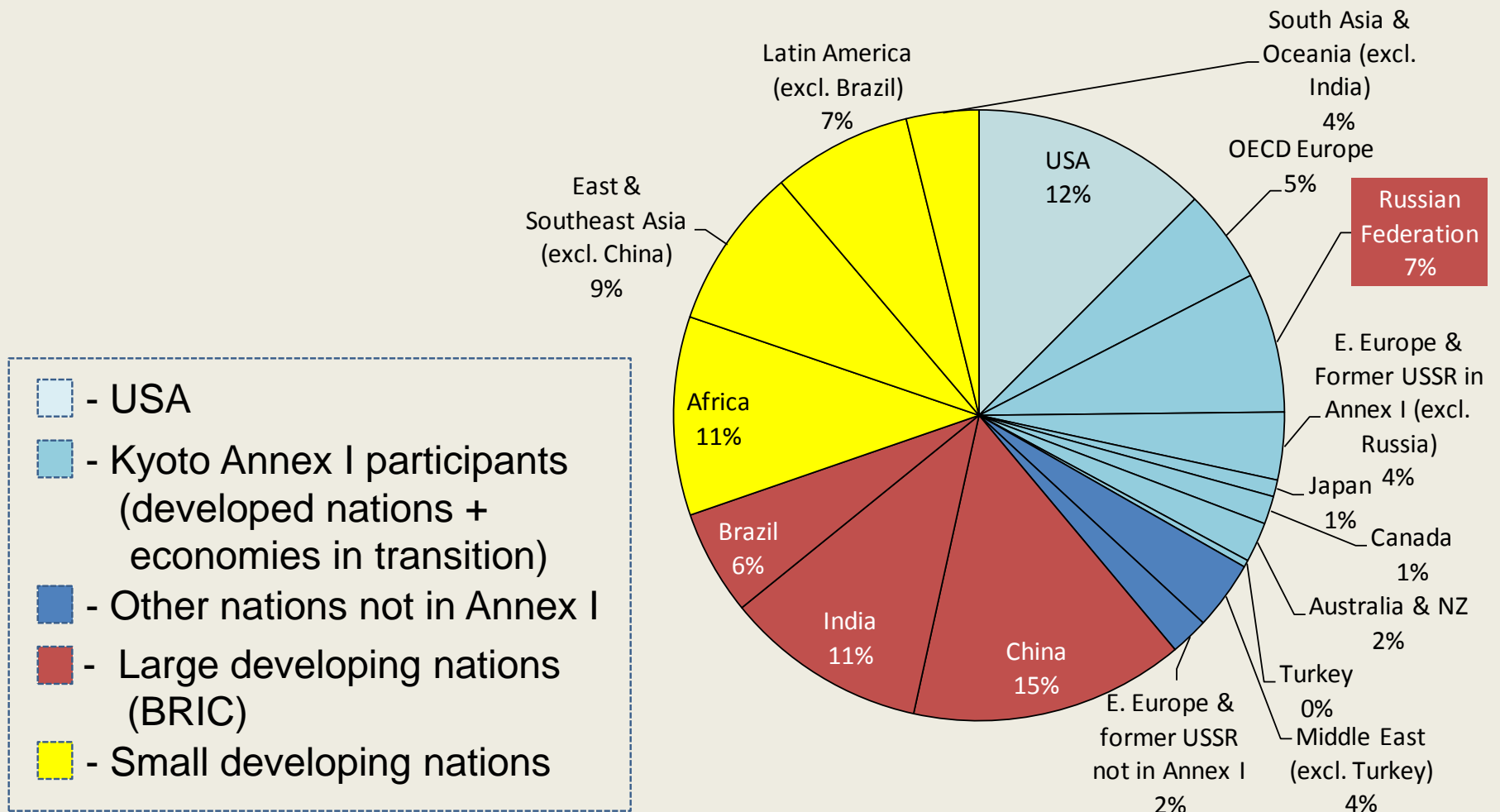
## **EMISSIONS FROM BOP COUNTRIES**

- **MITIGATION IN BOP COUNTRIES**
- **CONCLUSION AND Q&A**

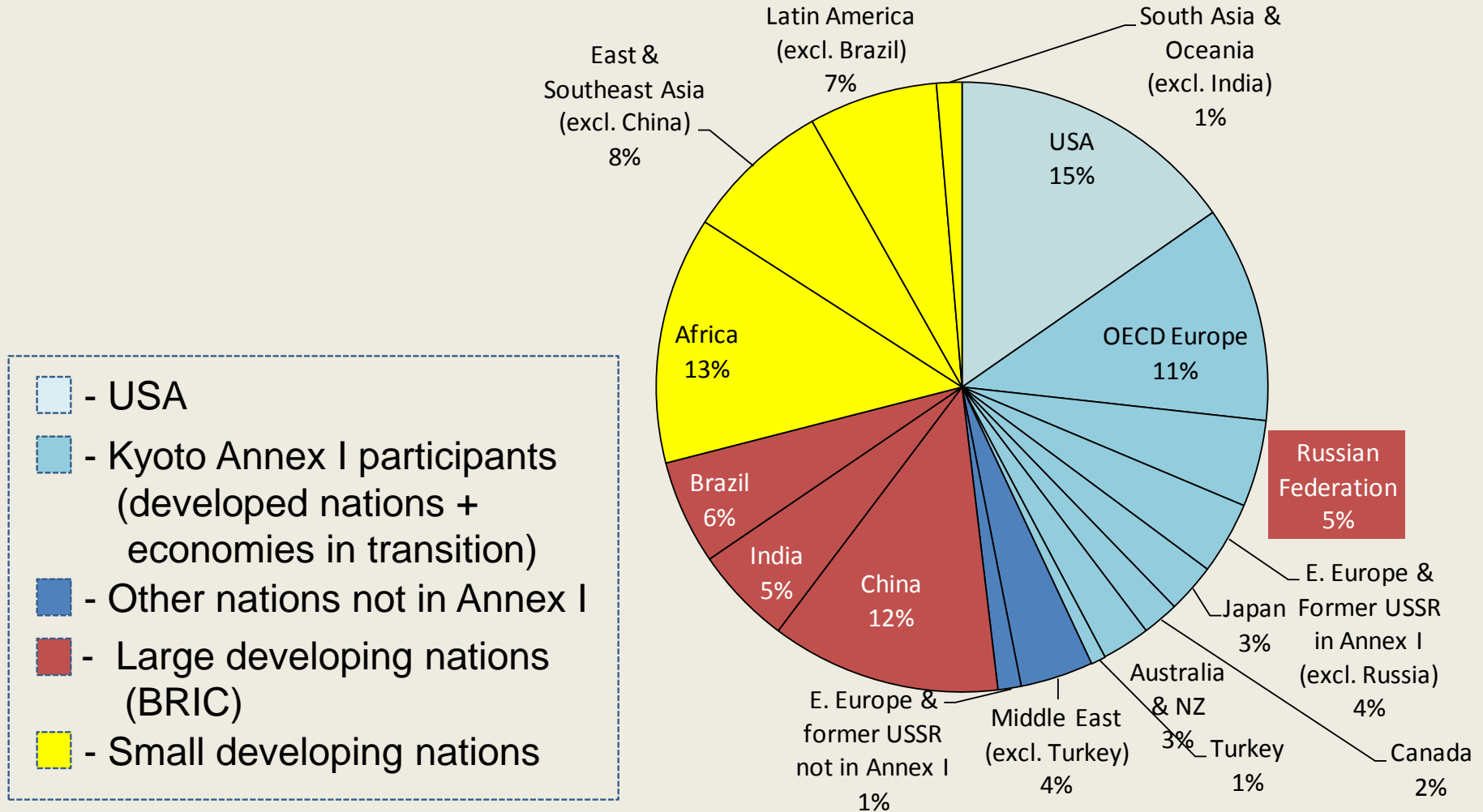
# Carbon Dioxide Emissions, year 2000: 47% from BRIC & BOP nations



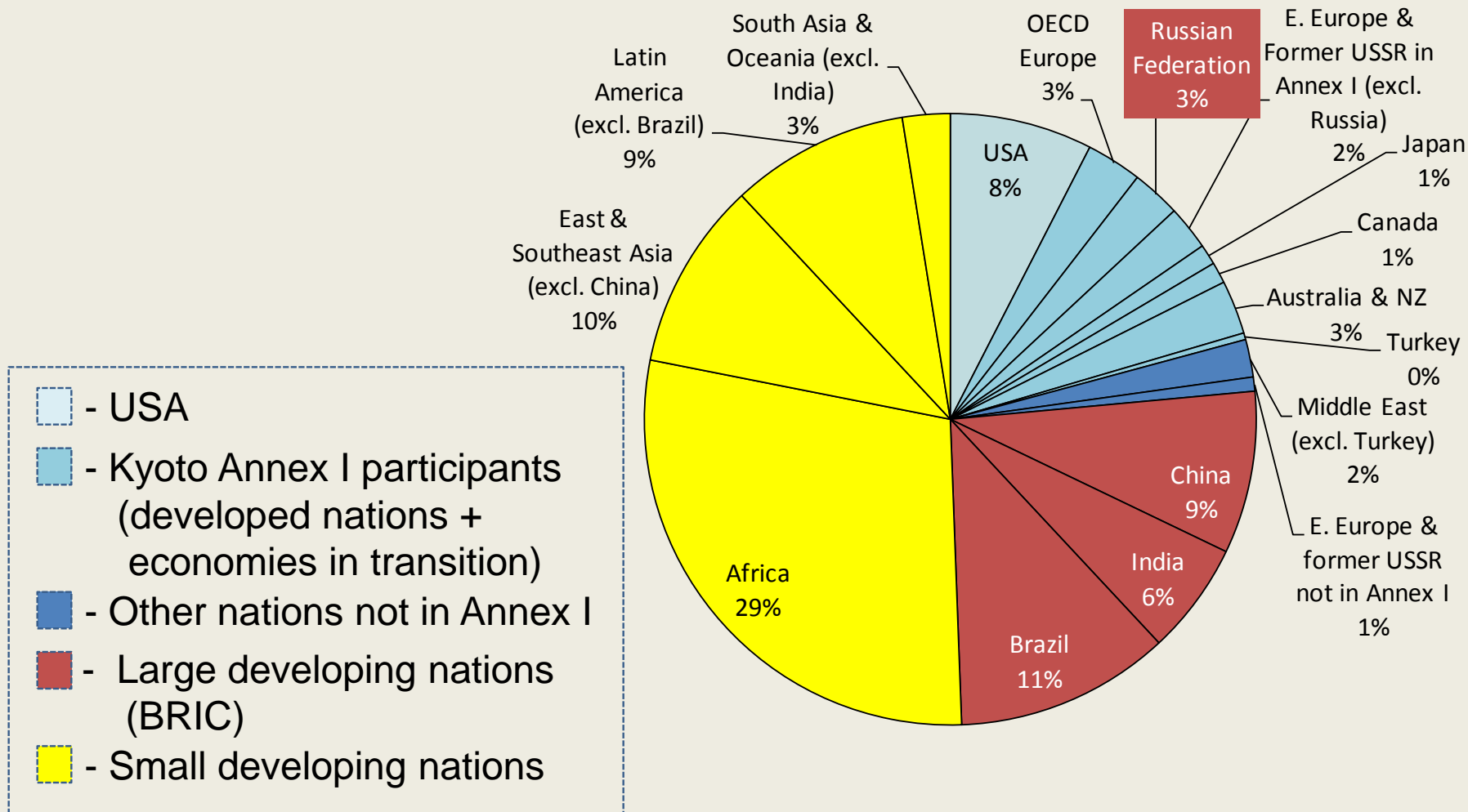
# Methane Emissions, year 2000: 68% from BRIC & BOP nations



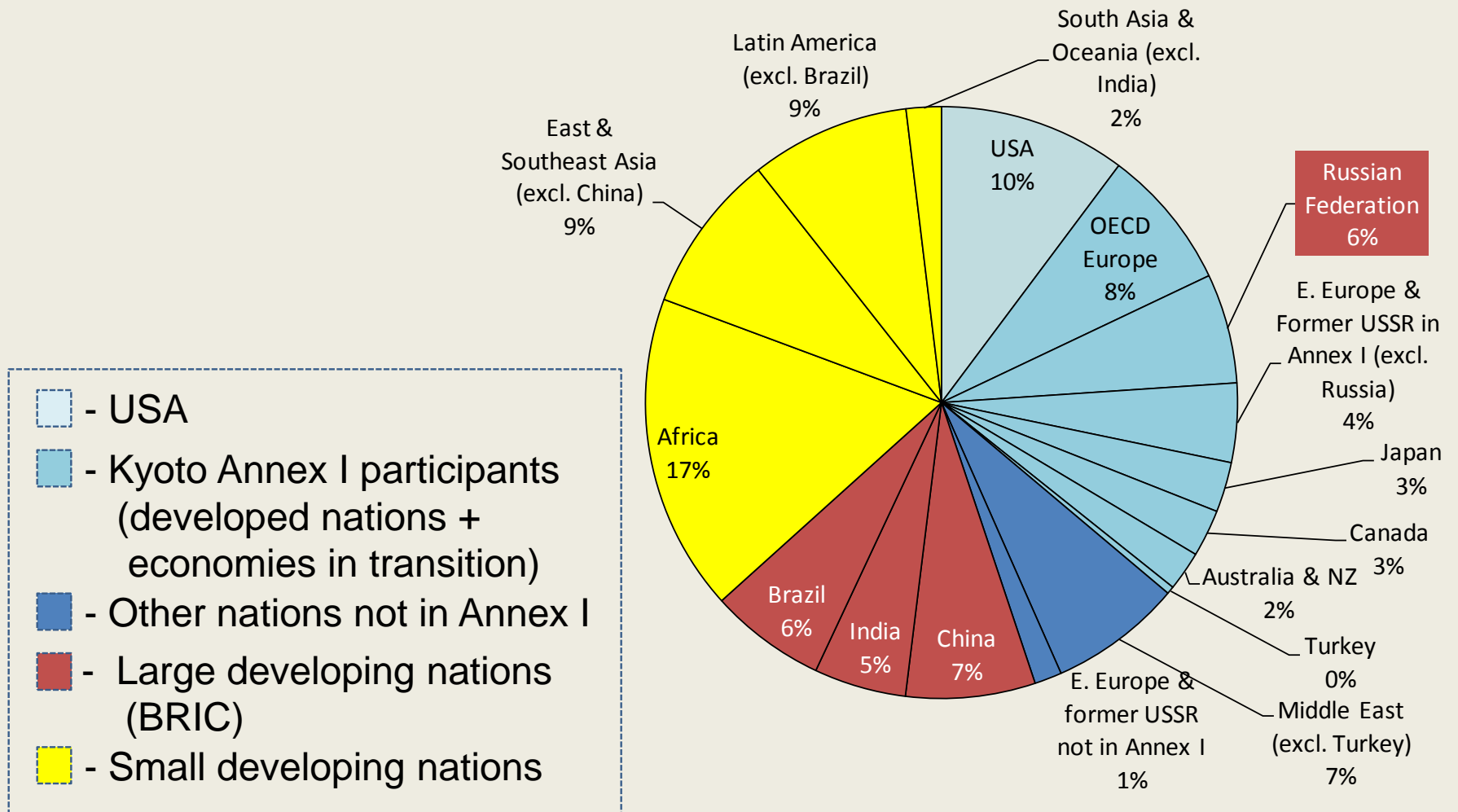
# Ozone Precursor 1 (NO<sub>x</sub>) Emissions, yr2000: 56% from BRIC & BOP nations



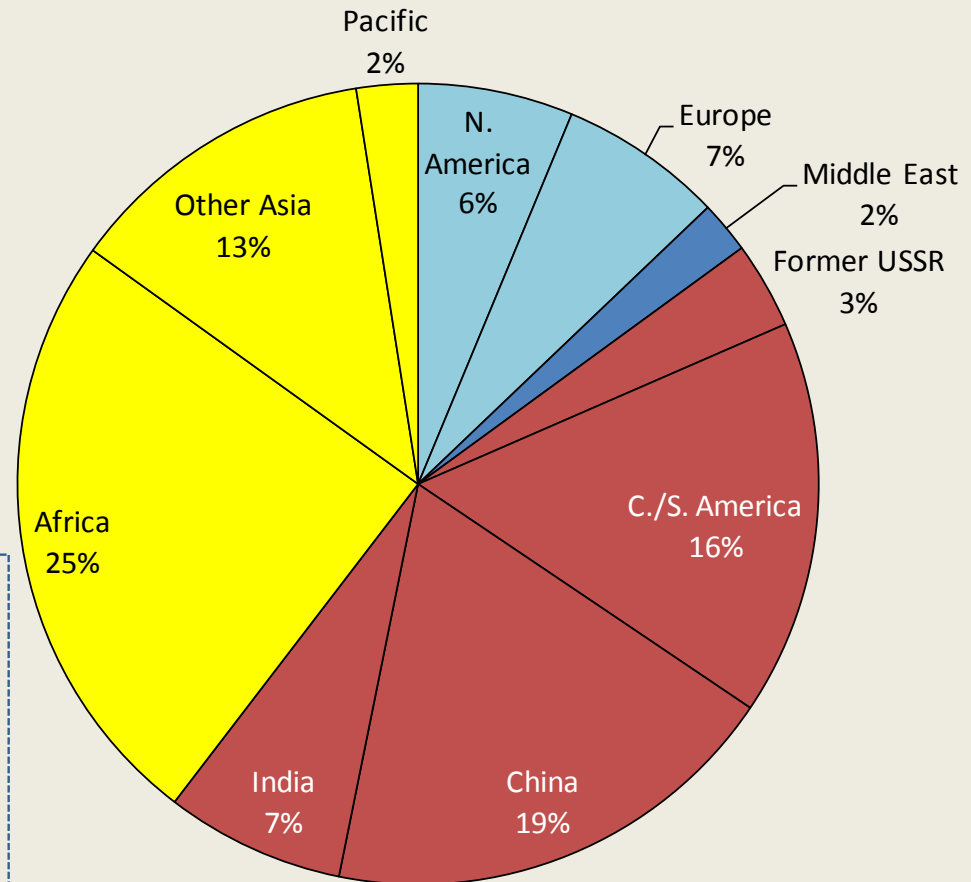
# Ozone Precursor 2 (CO) Emissions, yr 2000: 79% from BRIC & BOP nations



# Ozone Precursor 3 (NMVOC) Emissions: 61% from BRIC & BOP nations (year 2000)

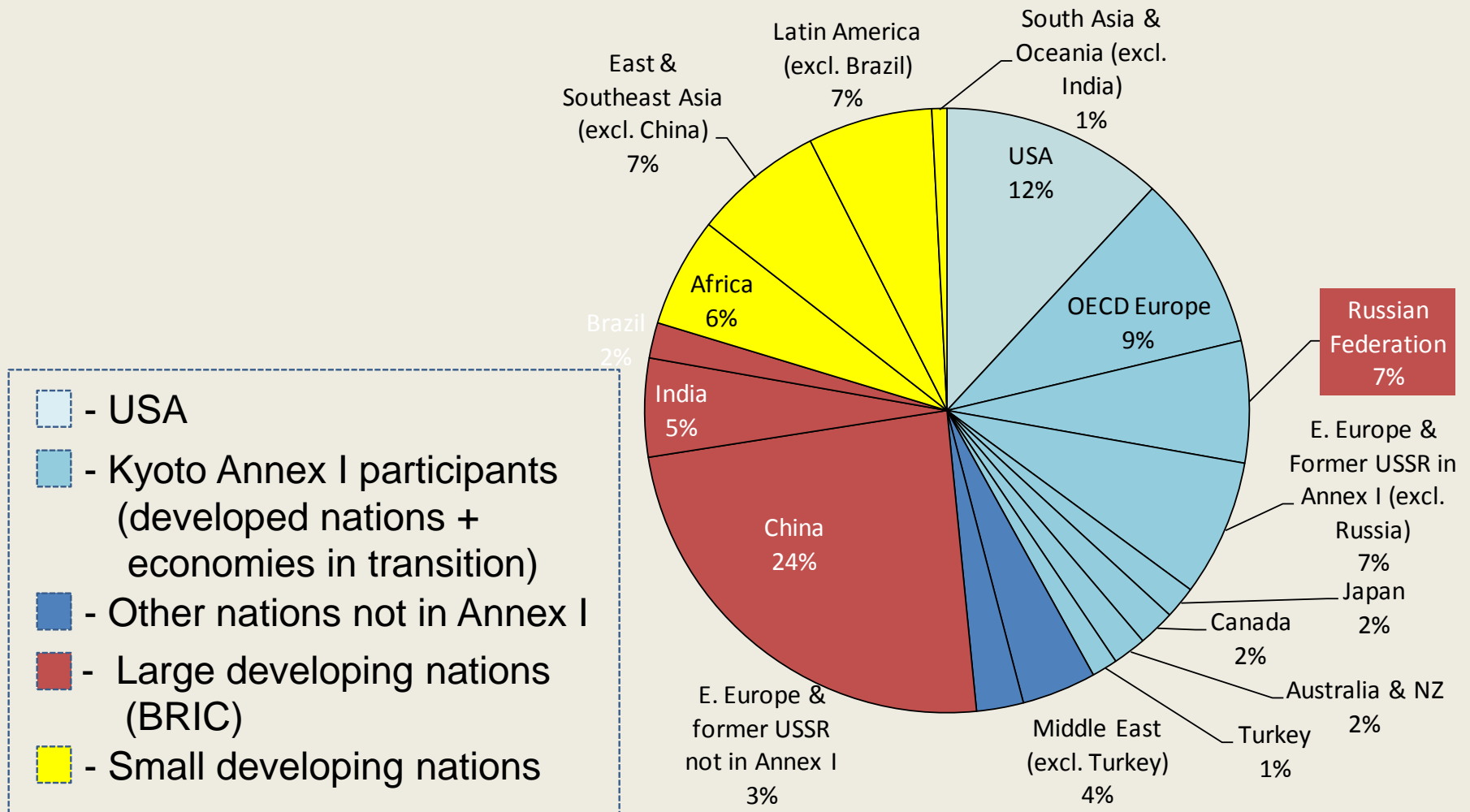


# Black Carbon Emissions, year 1996: ~80% from BRIC & BOP nations



- - Kyoto Annex I (roughly) (developed nations + economies in transition)
- - Other nations not in Annex I
- - Large developing nations (roughly BRIC)
- - Small developing nations

# Sulfur Dioxide (cooling) Emissions: 58% from BRIC & BOP nations (year 2000)



# Key Take-Aways re. National Emissions

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- Business angle vs. policy angle on developing nation emissions is different:
  - Policy angle: Low per capita emissions & high development needs in BRIC & BOP -> focus attention on large developed nations first
  - Business angle: Large total emissions & even larger future emissions in BRIC & BOP -> mitigation opportunities abound (& are largely ignored by those in developed world)

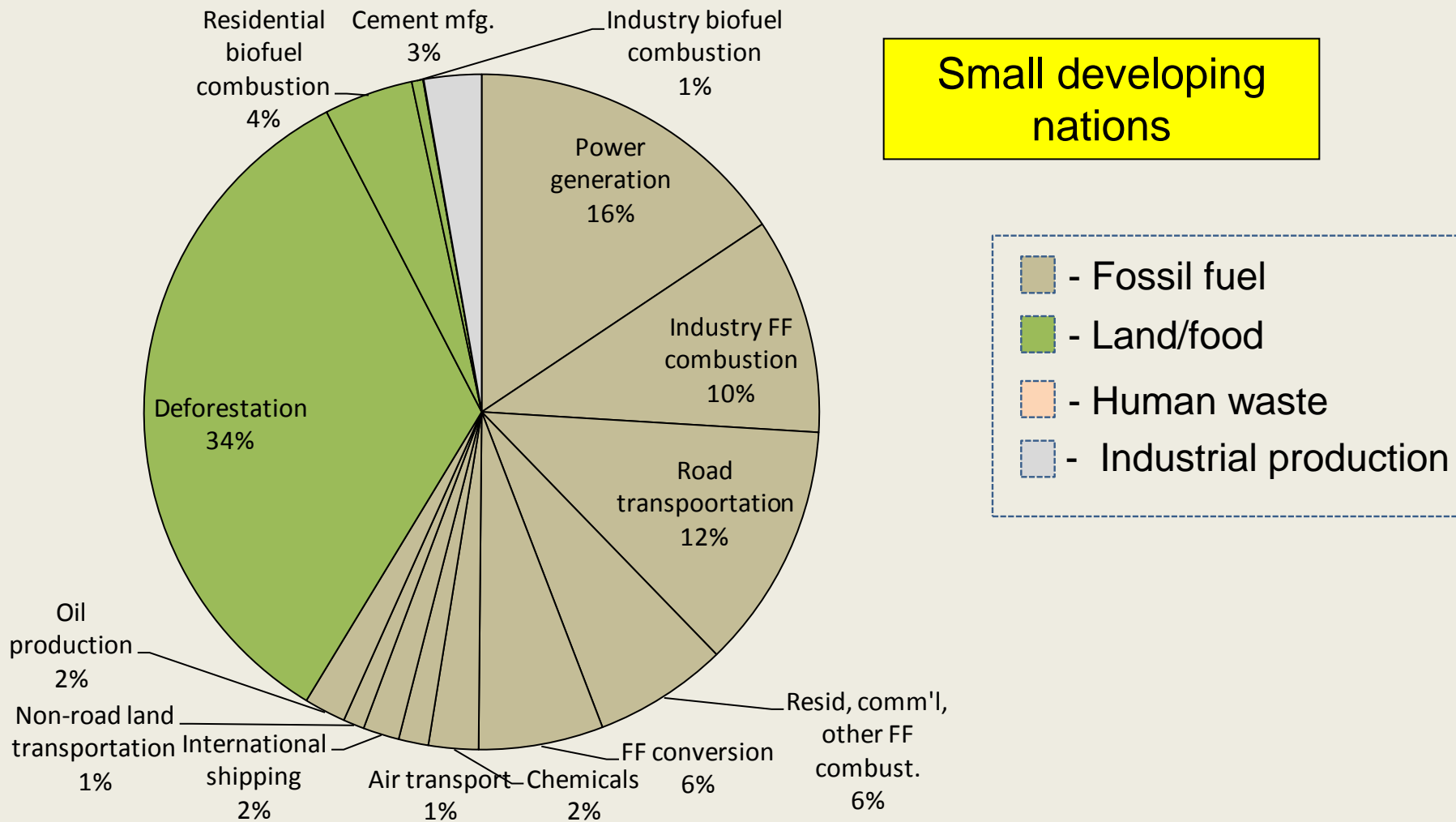
- **CLIMATE PROJECTIONS**
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- **EMISSIONS FROM BOP COUNTRIES**

## **MITIGATION IN BOP COUNTRIES**

- **CONCLUSION AND Q&A**

# Carbon Dioxide Sources, year 2000

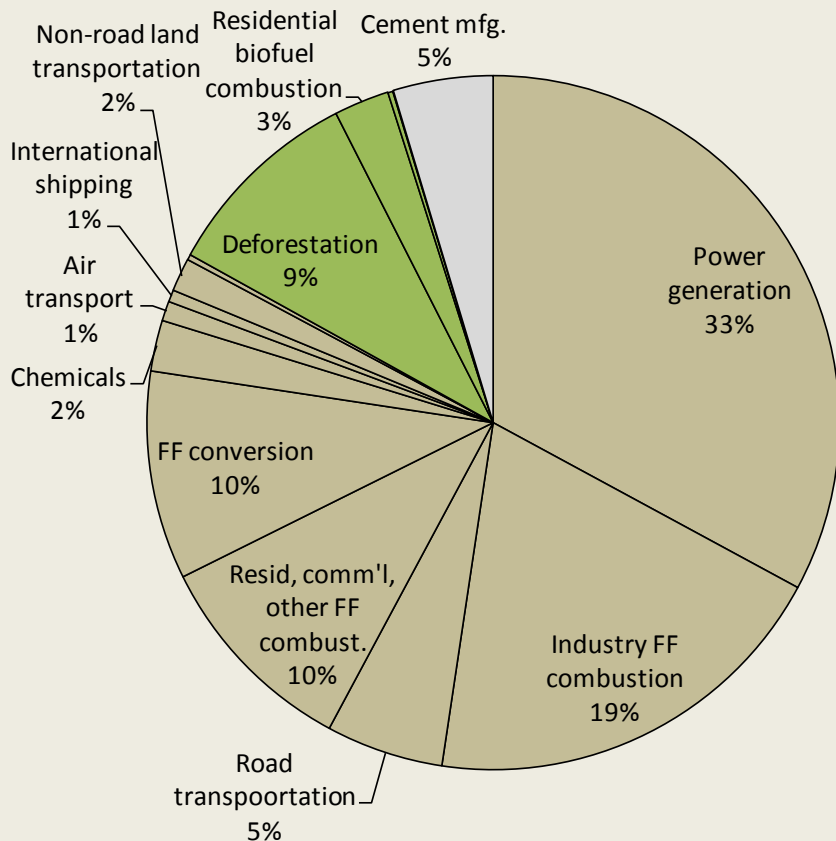
## Small (yellow) developing nations



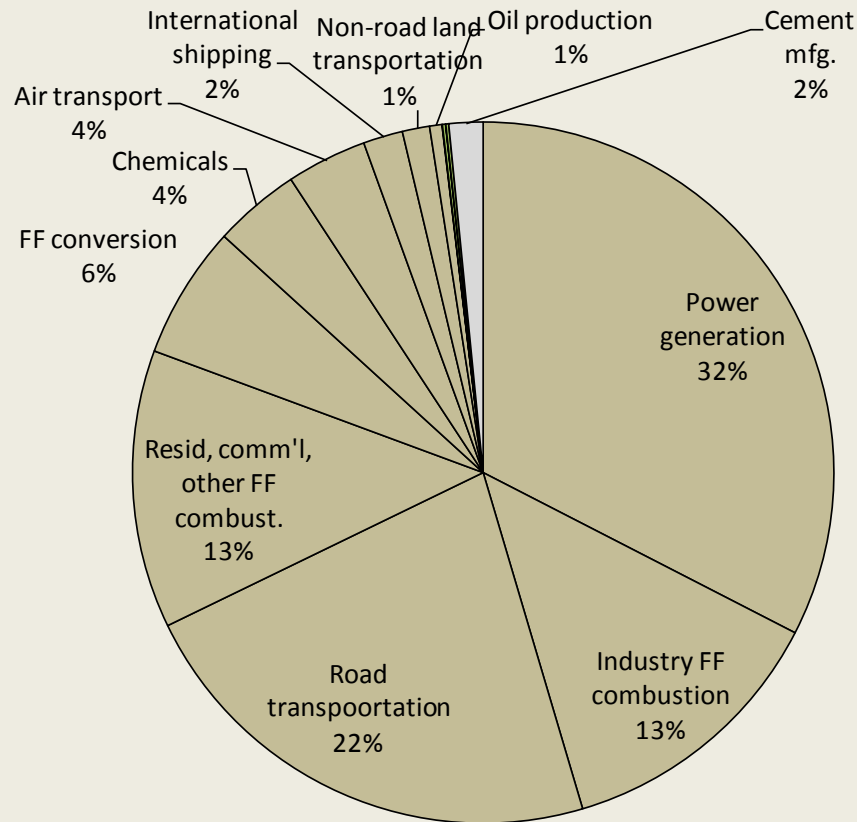
# Carbon Dioxide Sources, year 2000

## BRIC & Large developed nations

BRIC Nations

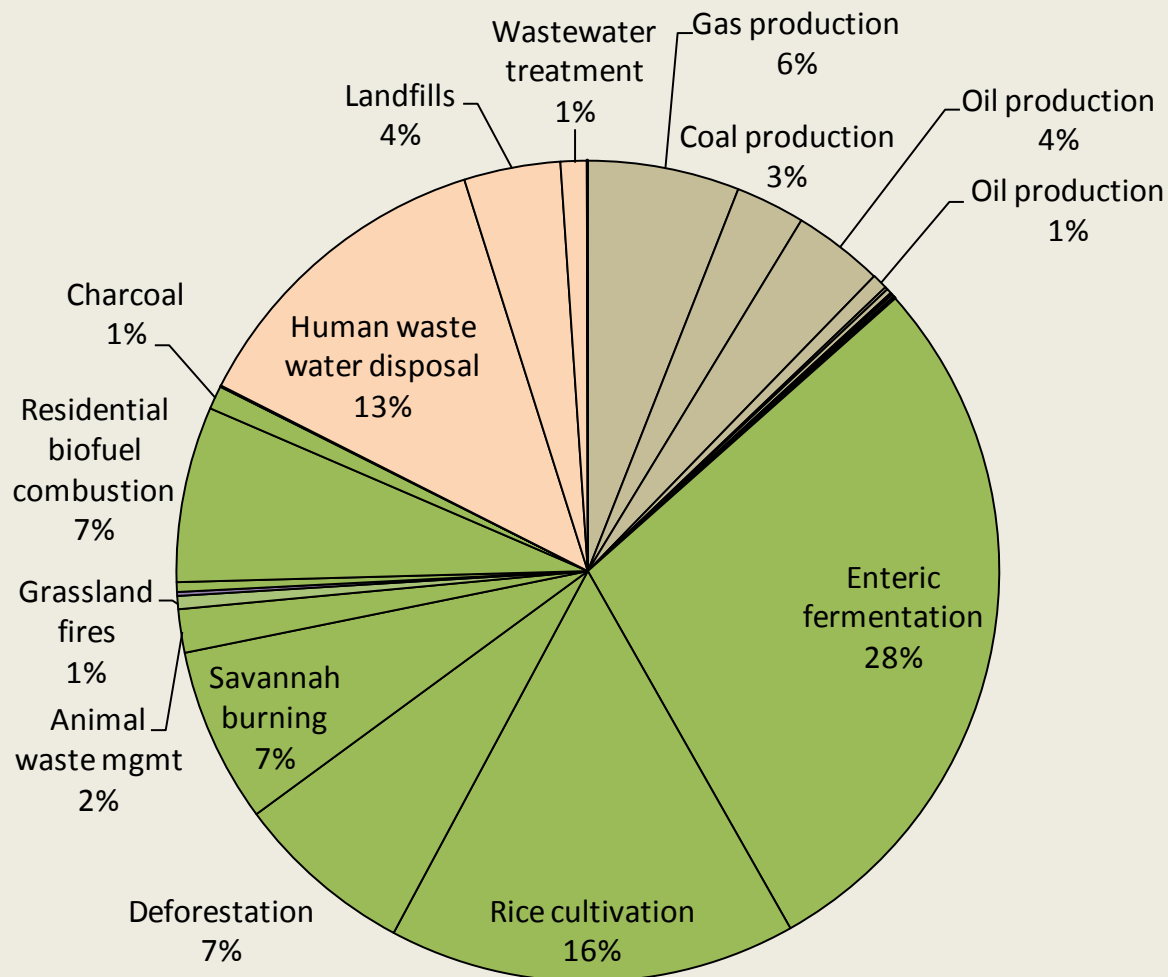


Large Developed Nations



# Methane Sources, year 2000

## Small developing nations



Small developing nations

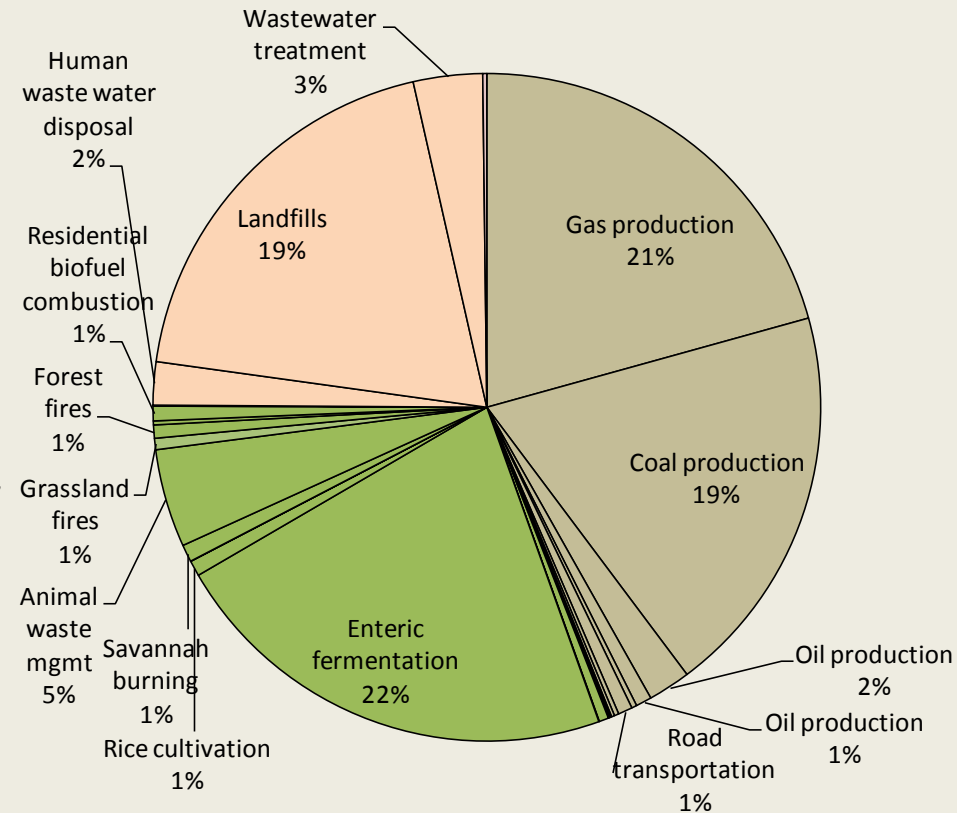
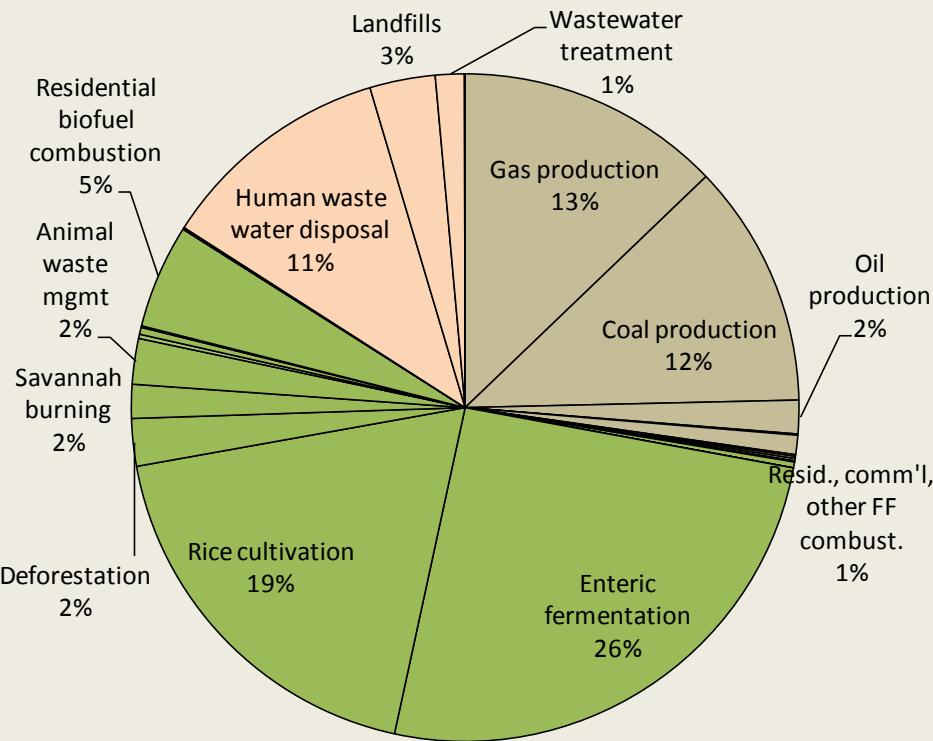
- Fossil fuel
- Land/food
- Human waste
- Industrial production

# Methane Sources, year 2000

## BRIC & Large developed nations

BRIC Nations

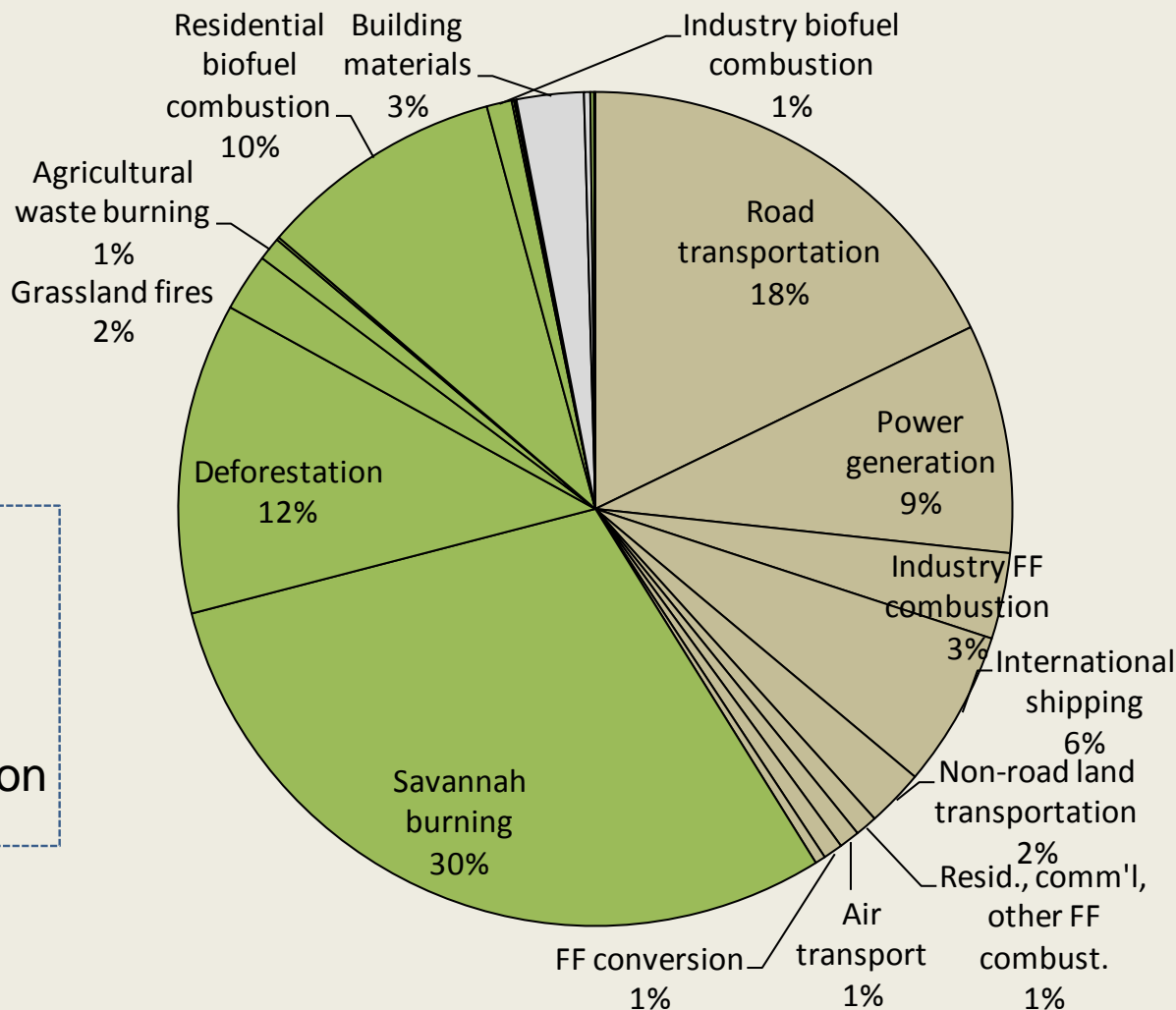
Large Developed Nations



# Sources of Ozone Precursor 1 (NO<sub>x</sub>), yr 2000

## Small developing nations

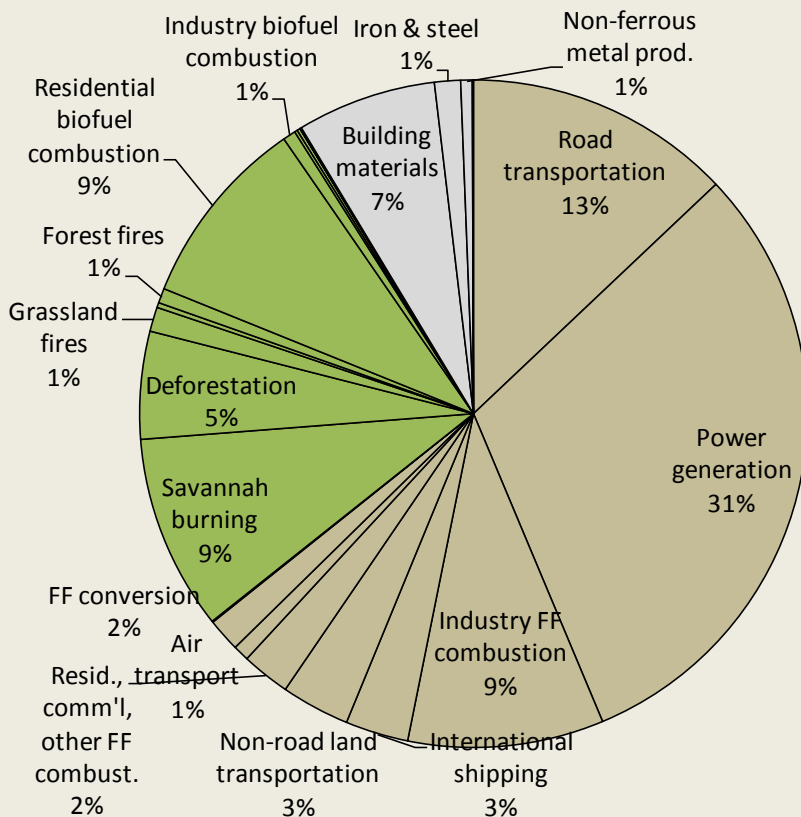
Small developing nations



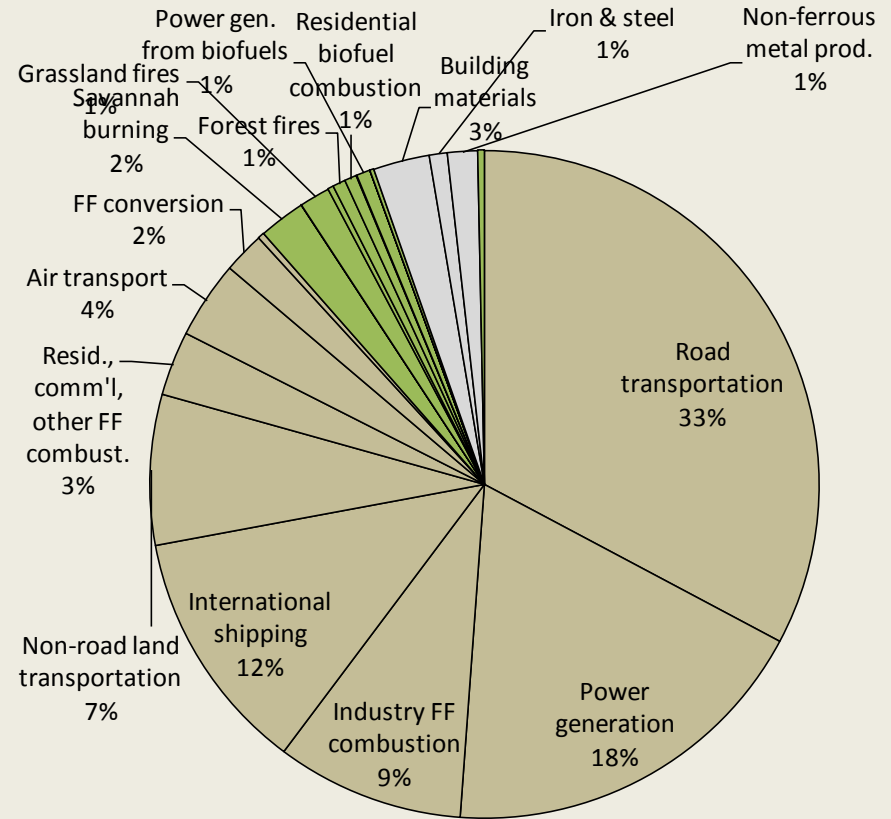
- Fossil fuel
- Land/food
- Human waste
- Industrial production

# Sources of Ozone Precursor 1 (NO<sub>x</sub>), yr 2000 BRIC & Large developed nations

BRIC Nations



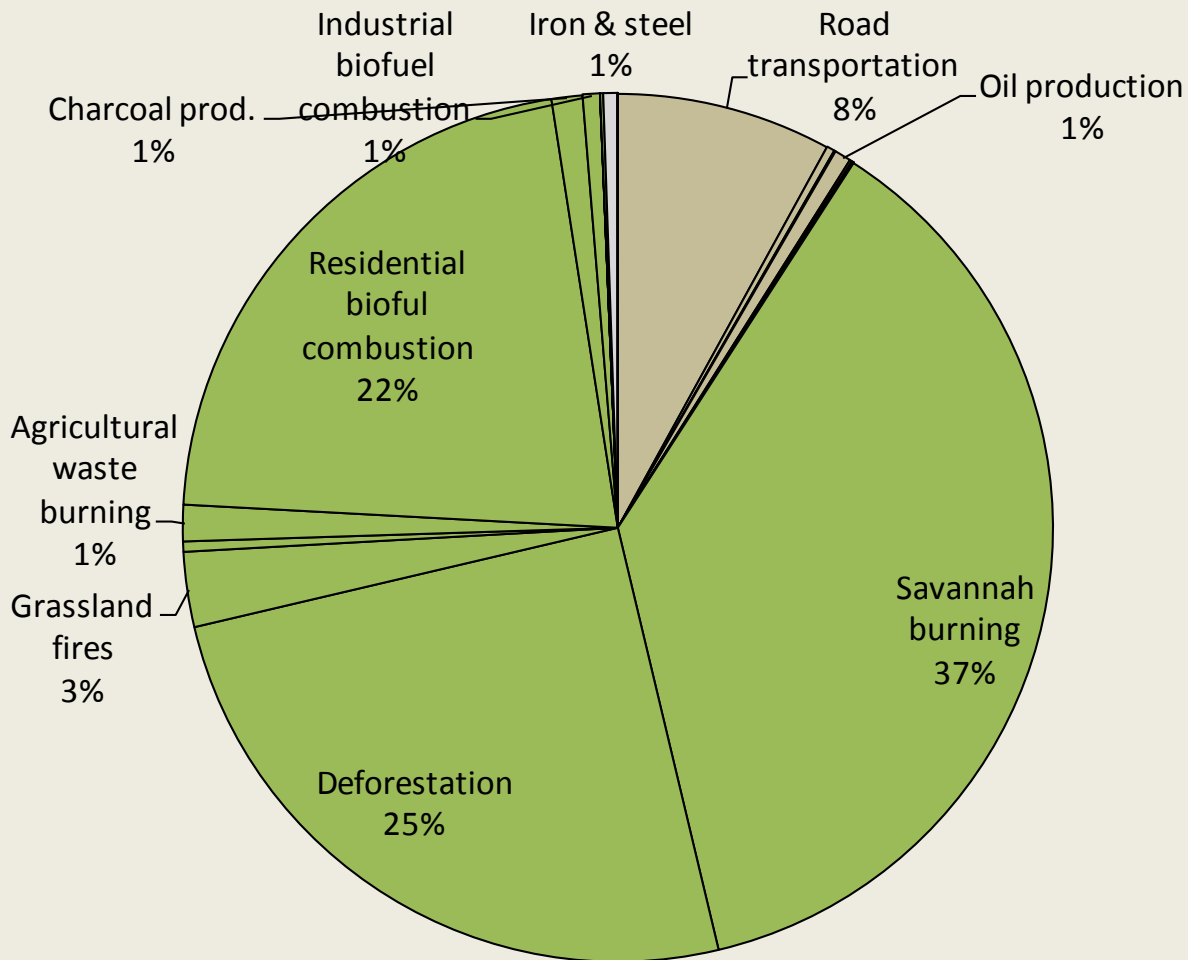
Large Developed Nations



# Sources of Ozone Precursor 2 (CO), yr 2000

## Small developing nations

Small developing nations

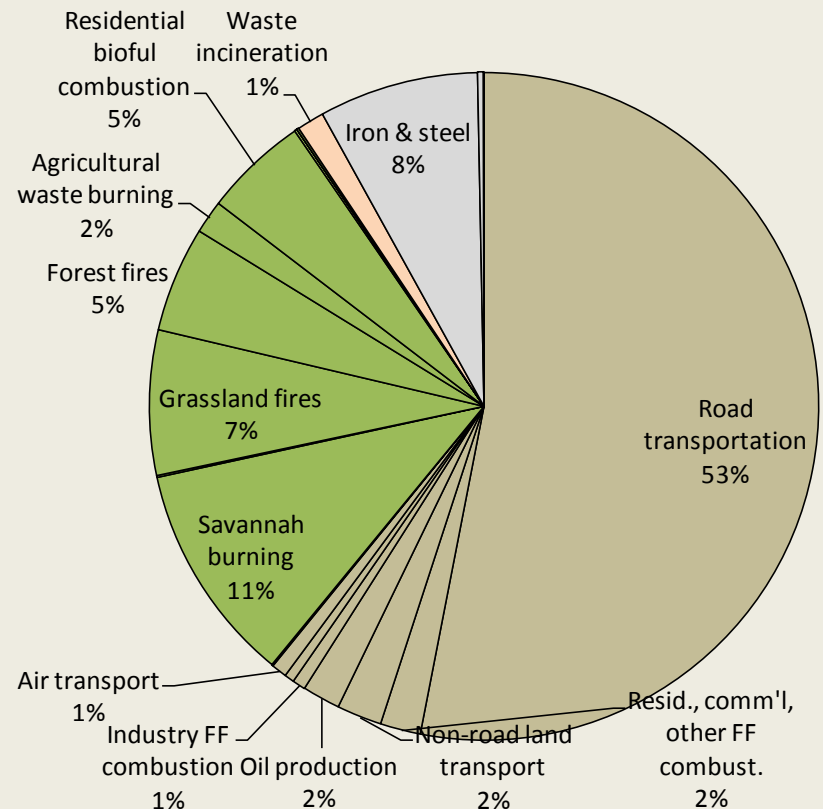
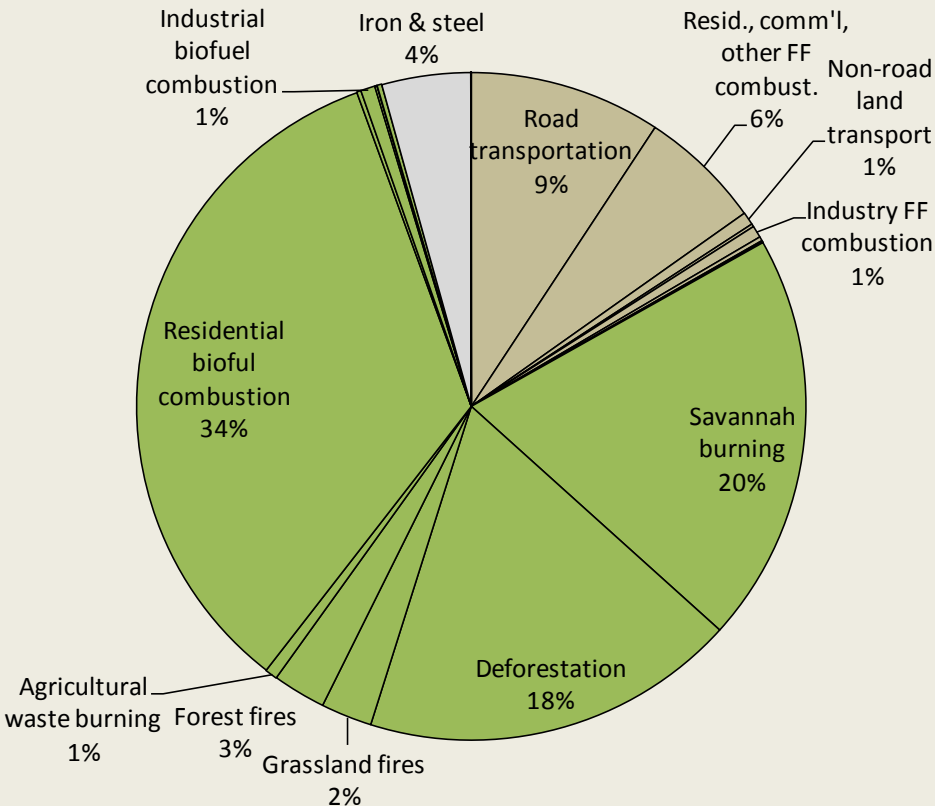


- Fossil fuel
- Land/food
- Human waste
- Industrial production

# Sources of Ozone Precursor 2 (CO), yr 2000 BRIC & Large developed nations

## BRIC Nations

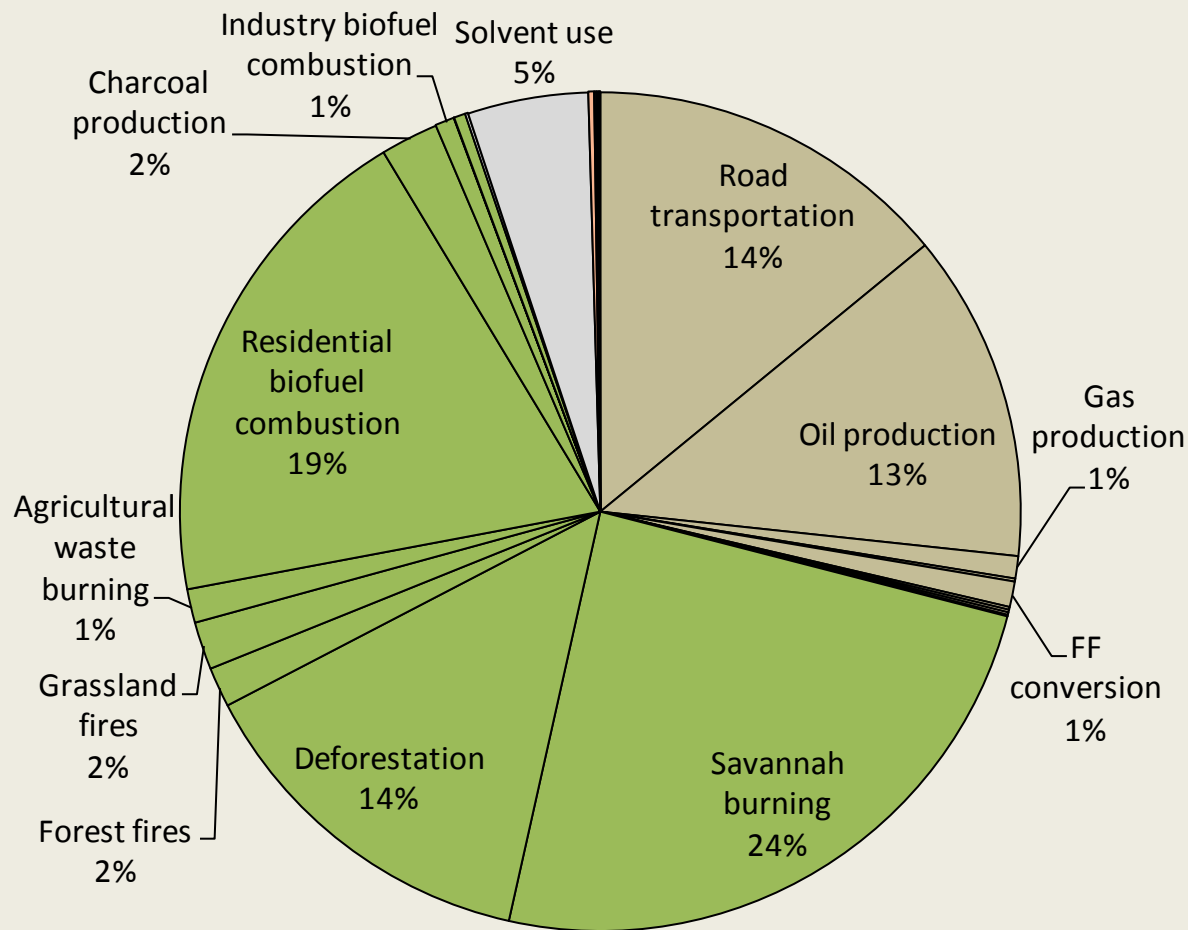
## Large Developed Nations



# Sources of Ozone Precursor 3 (NMVOCs)

## Small developing nations, year 2000

Small developing nations

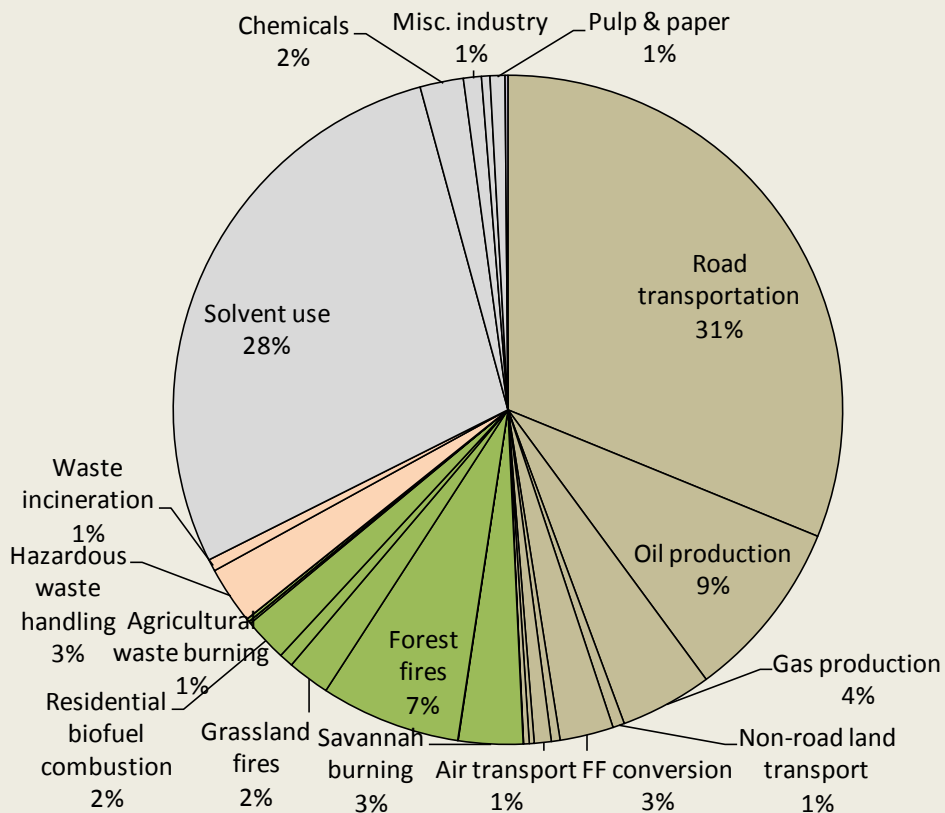
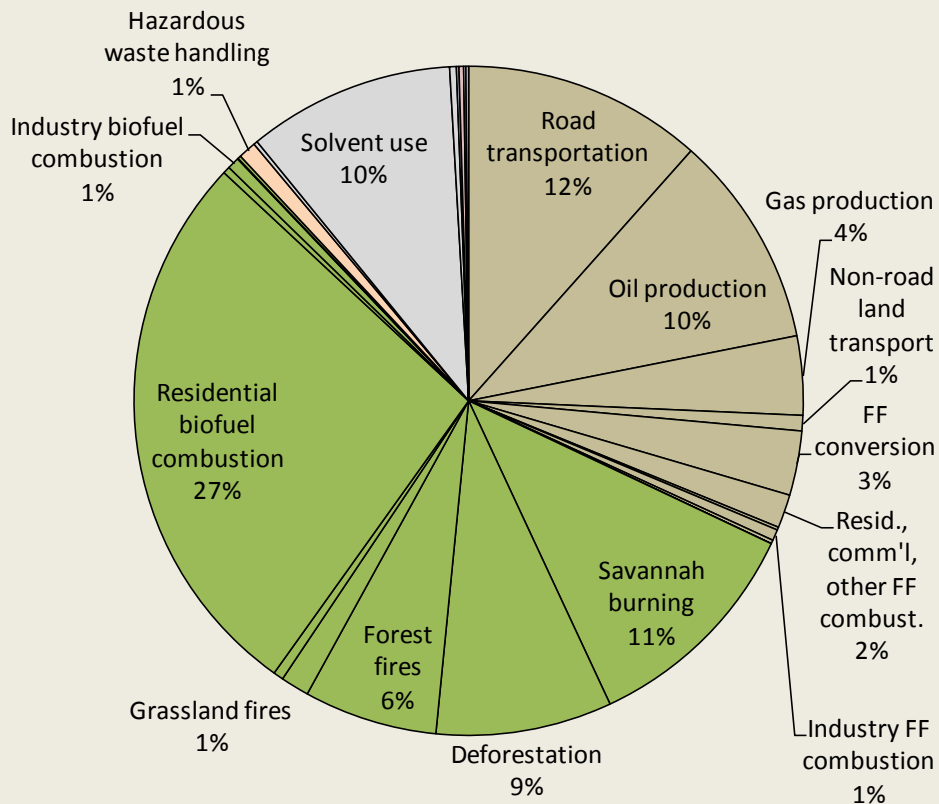


- Fossil fuel
- Land/food
- Human waste
- Industrial production

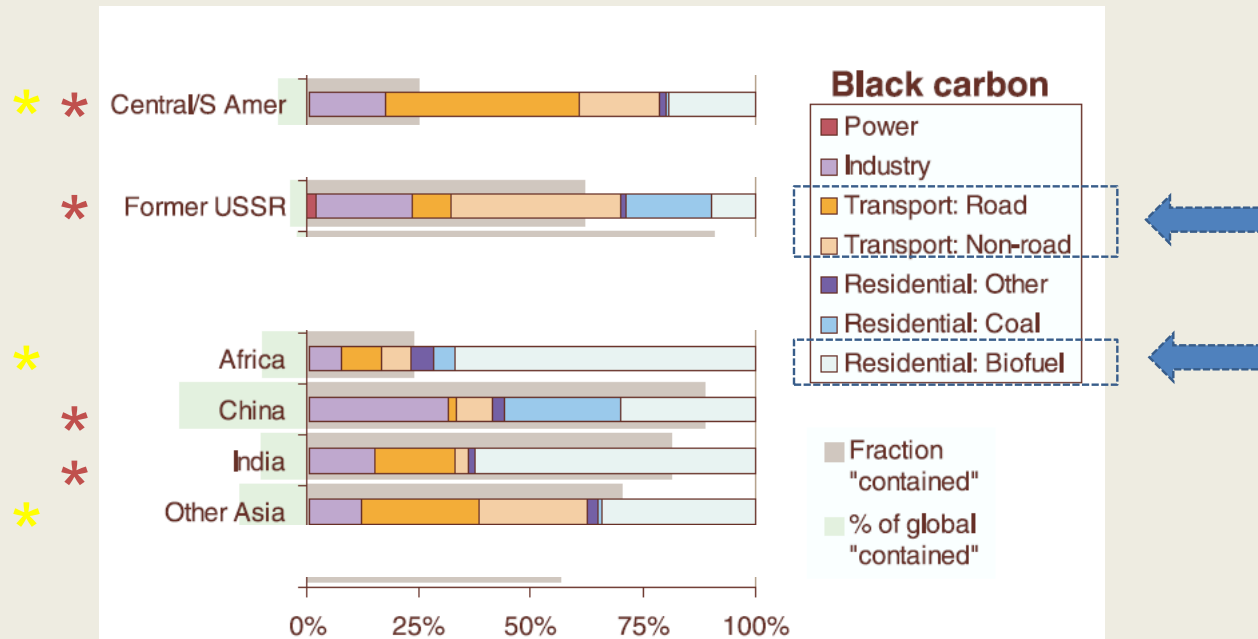
# Sources of Ozone Precursor 3 (NMVOCs) BRIC & Large developed nations, yr 2000

BRIC Nations

Large Developed Nations



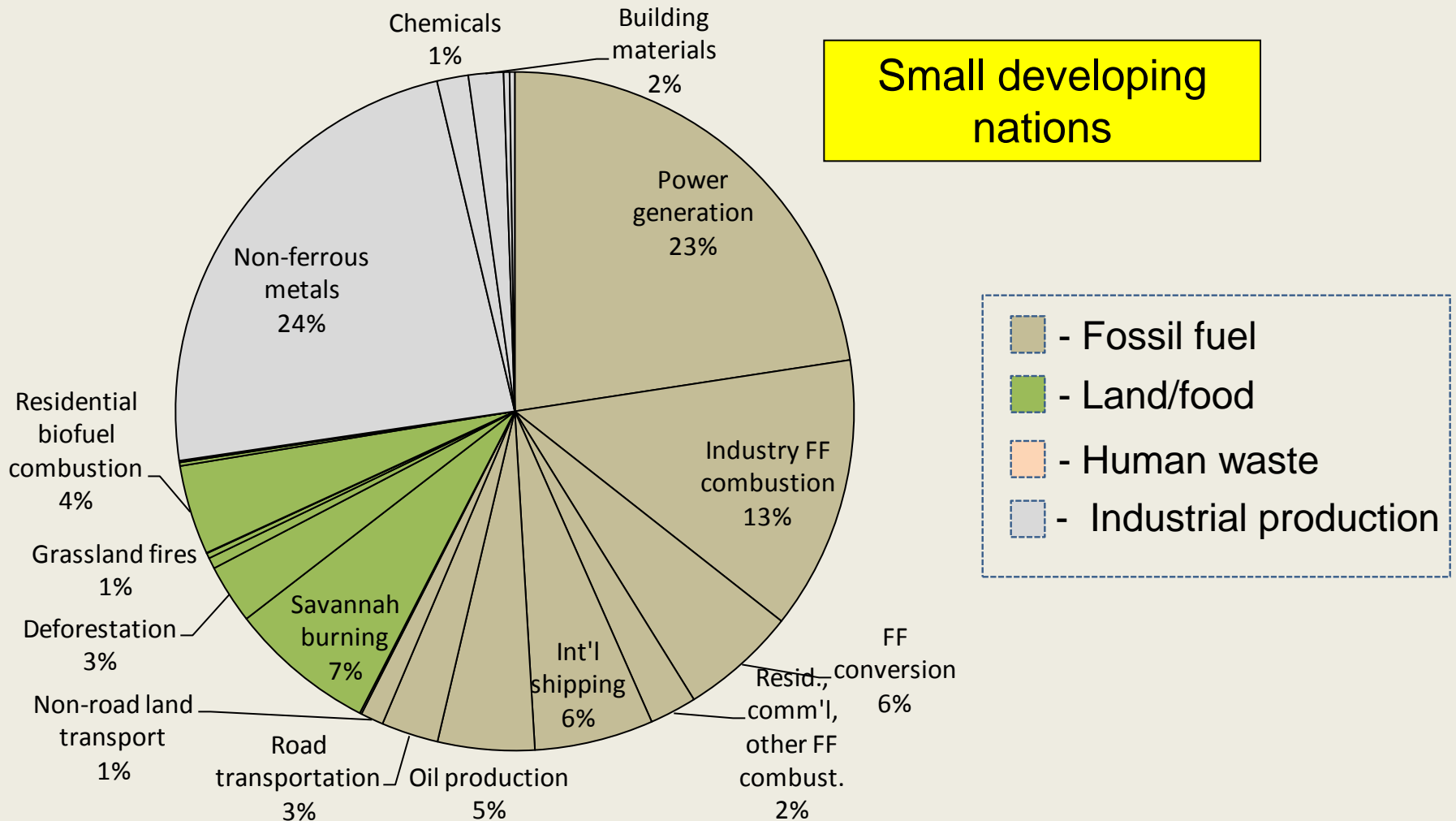
# Sources of Black Carbon, year 1996



**Figure 4.** Sectoral contributions to emissions of black and organic carbon emissions. The gray bars behind the colored bars represent the fraction of emissions from “contained” combustion (that undertaken for energy use, excluding open burning) in each region. The green bars to the left indicate the relative contribution of each region to the total. The contributions are based on our central values and carry all the caveats outlined in the text.

# Sources of Sulfur Dioxide (cooling)

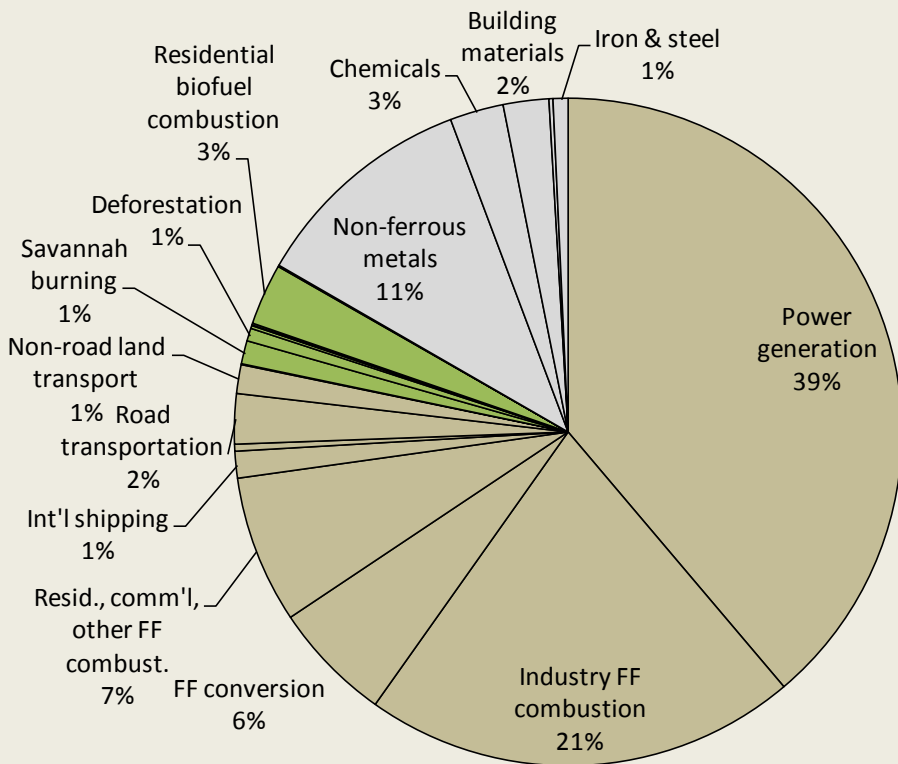
## Small developing nations, year 2000



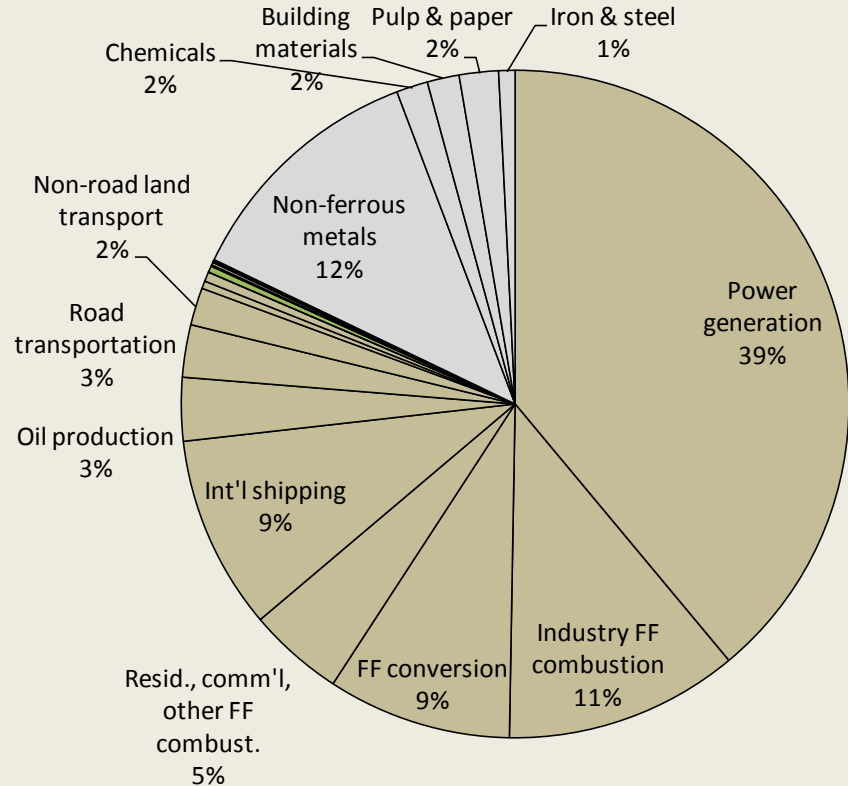
# Sources of Sulfur Dioxide (cooling)

## BRIC & Large developed nations, yr 2000

BRIC Nations



Large Developed Nations



# Key Take-Aways re. Source Activities

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- The emissions “industry” is fragmented & has a high degree of substitution:
  - There are many, many source activities
  - For each source activity, there are many, many emitters
  - Entrepreneurial opportunities abound!
- The nature of the emissions sources changes as nations develop:
  - Entrepreneurs in BOP countries can either mitigate current emissions sources or provide ways to avoid future emissions
- Don’t ignore the small slices of the pie – they represent very large business opportunities

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**CONCLUSION AND Q&A**

# Conclusions

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- Climate change will hit BOP nations first and will create climate shocks for the global poor
- Adaptation needs of BOP nations are large and widely recognized
- Mitigation opportunities in BOP nations are also large and are less widely recognized
- Entrepreneurial opportunities abound!

# Sources of Further Information

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- Impacts:

- Intergovernmental Panel on Climate Change (IPCC)'s 4<sup>th</sup> Assessment Report (AR4), 2007:
  - ✦ Summary for Policymakers (high-level summary on p.10)
  - ✦ Working Group II (Impacts, Adaptation, & Vulnerability)
    - Technical summary (summary of regional impacts on p.59-63)
    - Chapters 9, 10, 13: Africa, Asia, Latin America
    - Chapter 17: Adaptation options
    - Chapter 19: Key vulnerabilities (summary tables on p.787-789)

- Mitigation:

- IPCC AR4, Working Group III (Mitigation)



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