Discussion #21: Implementation

Ross Salawitch & Walt Tribett

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Class Web Site: http://www.atmos.umd.edu/~rjs/class/honr229L
ELMS Page: https://myelms.umd.edu/courses/1229919

Source of renewable energy

- Bio
- Hydro
- Solar
- Wind


15 November 2017
Class Logistics

- We will meet on Monday, 20 Nov
  - Review last two ATs
  - Organization of class project

- Paper due on Monday, 20 Nov, 5 pm
  - Will except without penalty until Tuesday, 21 Nov, 11:59 pm
  - Campus is officially closed on Wednesday, 22 Nov

- Papers received after Tues, 21 Nov, 11:59 pm will incur the following late penalty:
  - Half a letter grade until Sat, 25 Nov, 11:59 pm
  - Full letter grade until Mon, 27 Nov, 5 pm
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  Writing tips:

  Avoid use of “This means”, “one other thing”, and “as we have seen, it is the single most important development holding back our progress”
  Be kind to your reader: economy of words is the mark of a great writer
Implementation

Maggie Ryan

15 November 2017
What was the pre-industrial value of CO$_2$?

What is today’s value of CO$_2$?

According to RCP 4.5, what is the threshold for future CO$_2$ emissions?
What was the pre-industrial value of CO$_2$?
~280 ppm
What is today’s value of CO$_2$?

According to RCP 4.5, what is the threshold for future CO$_2$ emissions?
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~280 ppm

What is today’s value of $\text{CO}_2$?

Just over 400 ppm

According to RCP 4.5, what is the threshold for future $\text{CO}_2$ emissions?
What was the pre-industrial value of CO$_2$?
~280 ppm
What is today’s value of CO$_2$?
Just over 400 ppm
According to RCP 4.5, what is the threshold for future CO$_2$ emissions?
540 ppm
What was the pre-industrial value of CO$_2$?
~280 ppm

What is today’s value of CO$_2$?
Just over 400 ppm

According to RCP 4.5, what is the threshold for future CO$_2$ emissions?
540 ppm

Figure 2.1 GHG abundance, 1950–2100
If the EIA projections of energy demand prove true, then how much of the world’s energy needs must be met by renewables in year 2060, in order for emissions of atmospheric CO$_2$ to achieve RCP 4.5?
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50% by year 2060
Figure 4.2 World energy consumption and CO₂ emissions
Figure 4.3 World energy consumption and CO$_2$ emissions, modified to meet RCP 4.5 in 2030
Figure 4.5 World energy consumption and CO$_2$ emissions, modified to meet RCP 2.6
What is:

a) one important similarity
b) one important difference

between the projections in Chap. 4 & those in the RCP 4.5 paper of Thomson et al. (2011).

Note: there is no need to consult the Thomson et al. paper; this information is stated in the chapter
What is:

a) one important similarity
b) one important difference

between the projections in Chap. 4 & those in the RCP 4.5 paper of Thomson et al. (2011).

Note: there is no need to consult the Thomson et al. paper; this information is stated in the chapter

a) Assumption for future energy demand in RCP 4.5 paper is nearly identical to the energy demanded presented in Chapter 4
What is:

a) one important similarity
b) one important difference

between the projections in Chap. 4 & those in the RCP 4.5 paper of Thomson et al. (2011).

Note: there is no need to consult the Thomson et al. paper; this information is stated in the chapter

a) Assumption for future energy demand in RCP 4.5 paper is nearly identical to the energy demanded presented in Chapter 4

b) The role of nuclear energy
What is the importance of Fig 4.4 (i.e., why did the authors include this figure in the chapter)?

Figure 4.4 World energy consumption, renewables
What is the importance of Fig 4.4 (i.e., why did the authors include this figure in the chapter)?

Quantify the rapid growth of renewables that will be required in order to reach RCP 4.5
Highlight the proportion of renewable energy that is biomass versus truly friendly renewables
What is the importance of Fig 4.4 (i.e., why did the authors include this figure in the chapter)?

Quantify the rapid growth that will be required in order to reach RCP 4.5
Highlight the proportion of renewable energy that is biomass versus truly friendly renewables

Why is biomass not allowed to increase?
What is the importance of Fig 4.4 (i.e., why did the authors include this figure in the chapter)?

Quantify the rapid growth that will be required in order to reach RCP 4.5
Highlight the proportion of renewable energy that is biomass versus truly friendly renewables

Why is biomass not allowed to increase?
- Health concerns
- Women, Children
- “1.5 million females die prematurely every year by inhaling poisonous fumes as they cook or heat their homes”
Summarize how NASA measurements of night lights are used in the reading.
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Used to show economic disparities between geographic areas
Compares population concentrations with light visible from space
Figure 4.6 Population and night lights, global
Figure 4.7 Population and night lights, North America and Africa
Figure 4.8 Population and night lights, Europe and India
Summarize how NASA measurements of night lights are used in the reading.

Used to show economic disparities between geographic areas
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How can we bring light to India and Africa without using fossil fuels?
Summarize how NASA measurements of night lights are used in the reading.

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How can we bring light to India and Africa without using fossil fuels?
• Green Climate Fund

Our research group made Fig 4.6, 4.7, 4.8, and 4.9. The first three of these are self explanatory.
Fig 4.9 is our attempt to show the various regions of the world on the same coordinate system.

Would be great if you could included at least Fig 4.6, 4.7, and 4.8 into your discussion, then lead a significant discussion about the Green Climate Fund of the Paris Climate Agreement, whether folks thought this would be sufficient, etc.

Feel free to either use or omit Fig 4.9
Summarize how NASA measurements of night lights are used in the reading.

Used to show economic disparities between geographic areas
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How can we bring light to India and Africa without using fossil fuels?
• Green Climate Fund
  • Collect and disburse $100 billion USD per year by 2020
Summarize how NASA measurements of night lights are used in the reading.

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How can we bring light to India and Africa without using fossil fuels?
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  • $25 per person per year
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• Private Investment
  • Solar Reserve in South Africa
  • Gigawatt Global in Rwanda

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Feel free to either use or omit Fig 4.9
Is the future trajectory of atmospheric methane important for achieving the goal of the Paris Climate Agreement?

Yes, for under 1.5º C goal

Not as important for 2º upper limit

For RCP 4.5, CH4 is supposed to level off and decline by end of century

Great if you are prepared to describe Fig 4.12 and lead a discussion about whether it is realistic to assume CH4 will truly level off. Can do your best to goad students memory of what we wrote on pages 169 to 171 about CPP, about diet, about the RCPs, etc.
Is the future trajectory of atmospheric methane important for achieving the goal of the Paris Climate Agreement?

Yes, for under 1.5º C goal
Not as important for 2º upper limit
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- Diet
- Clean Power Plan
  - Fracking
- RCP 4.5 vs 8.5
Figure 4.12 Impact of CH$_4$ on EM-GC projections using RCP 4.5
World Energy Supply, 2014: units of Energy

In 2014, world obtained ~80% of its energy from combustion of fossil fuels

## Global Emission of GHGs

<table>
<thead>
<tr>
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<th>CO\textsubscript{2} eq (Giga tons)</th>
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\[ \text{CO}_2\text{-equivalent emissions} = \text{CO}_2^{\text{Fossil}} + \text{CO}_2^{\text{Land Use Change}} + 28 \times \text{CH}_4 + 265 \times \text{N}_2\text{O} \]

where 28 & 265 are the global warming potentials of CH\textsubscript{4} & N\textsubscript{2}O on a 100 year time horizon, respectively.

Giga is a scientific word for Billion, or \(10^9\)

Humans collectively pump 52.5 billion tons of greenhouse gases into the atmosphere every year.
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Humans collectively pump 52.5 billion tons of greenhouse gases into the atmosphere every year.
Per-capita (left) and cumulative (right) emissions of CO$_2$ (fossil fuels & cement) from the U.S. far exceed those of China, India the rest of the world (cumulative) and most of the rest of the world (per-capita).
Global GHG Projections

BAU: Business as Usual

CO₂-eq: Considers emissions of CO₂, CH₄, & N₂O

Fig. 3.8 & 3.13
**Fig. 3.9 & 3.13**

**CO₂-eq**: Considers emissions of CO₂, CH₄, & N₂O
Fig. 3.10 & 3.13

Global GHG Projections

CO\textsubscript{2}-eq: Considers emissions of CO\textsubscript{2}, CH\textsubscript{4}, & N\textsubscript{2}O
Global GHG Projections

Attain & Improve, all Unconditional & Conditional INDCs

CO$_2$-eq: Considers emissions of CO$_2$, CH$_4$, & N$_2$O

Fig. 3.11 & 3.13
Global GHG Projections

Attain & Improve, all Unconditional & Conditional INDCs

Except US BAU

CO₂-eq: Considers emissions of CO₂, CH₄, & N₂O
Global GHG Projections

Attain & Improve, all Unconditional & Conditional INDCs

Except US 8 year delay

2060 Unc. & Cond.

$\text{CO}_2$-eq: Considers emissions of $\text{CO}_2$, $\text{CH}_4$, & $\text{N}_2\text{O}$
Attain & Improve, all Unconditional & Conditional INDCs

Except US 4 year delay

Global GHG Projections

CO$_2$-eq: Considers emissions of CO$_2$, CH$_4$, & N$_2$O

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2017 Will Be A Record Year for Global GHG emissions


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Another Look at the Top Three Emitters, Relative to RCP Projection for Each Country
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Global and US Emissions Relative to RCP 4.5 & 8.5 and Our Attain & Improve^{UNC+CON} Paris Scenario

Global GHG emissions from CDIAC, Global Carbon Budget, EDGAR, & FAO STAT

GHG emissions for the US from EPA
Global and US Emissions Relative to RCP 4.5 & 8.5 and Our Attain & Improve \textsuperscript{UNC+CON} Paris Scenario

![Graph showing global and US GHG emissions relative to RCP 4.5 & 8.5 and our UNC+CON Paris Scenario.](image)

- **Global GHG Emissions**
  - Global GHG emissions from CDIAC, Global Carbon Budget, EDGAR, & FAO STAT

- **U.S. GHG Emissions**
  - GHG emissions for the US from EPA

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Factors Leading to the Decline in U.S. GHG Emissions

GHG emissions from the EPA 2017 GHG Inventory

U.S. GHG Emission Mitigation

- Actual Emissions
- Projected Emissions

Cumul. Contrib. (%)

- Economic Growth: 56.5
- Renewable Energy: 17.5
- Coal to Gas: 15.4
- Carbon Efficiency: 6.9
- Vehicle Efficiency: 3.7

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