

U.S. Carbon Cycle Science Program & Carbon Cycle Interagency Working Group



Celebrating over 20 Years of Interagency Research Partnerships with the Carbon Cycle Science Community

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# From Science to Solutions: The State of the Carbon Cycle Assessment

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Nancy Cavallaro (USDA NIFA), Zhiliang Zhu (USGS)

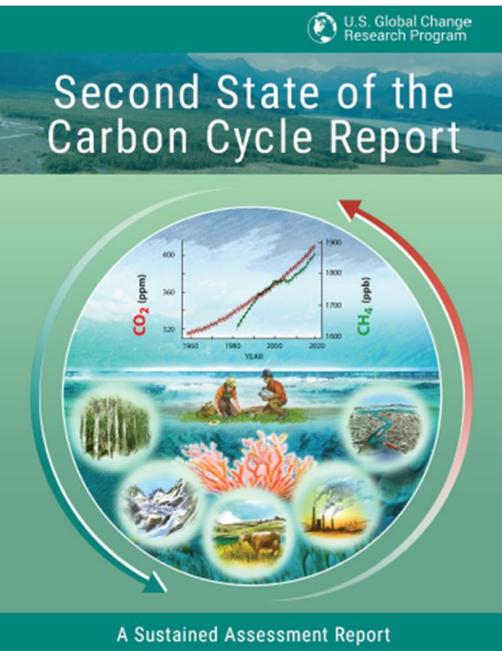
[carbon2018.globalchange.gov](http://carbon2018.globalchange.gov)  
#SOCCR2

26 February 2019

OneNOAA Science Seminars, NOAA HQ, Silver Spring  
Seminar Day #1 of Special NOAA SOCCR2 Tuesday Seminar Series (Feb 26-May 27, 2019)  
'From Science to Solutions: The State of the Carbon Cycle'

# PRODUCTION FACTS

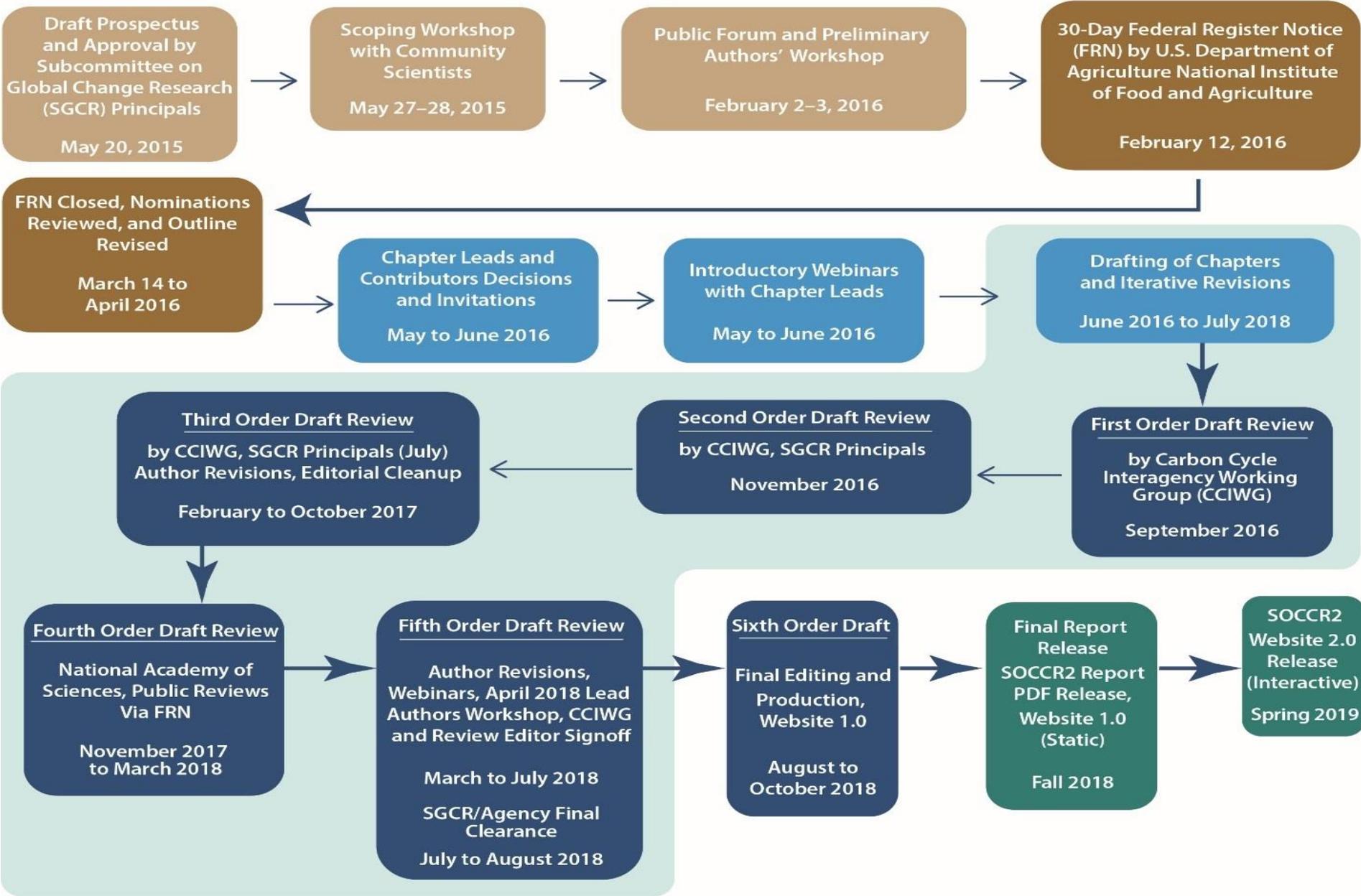
On the Second State of  
the Carbon Cycle  
Report (SOCCR2)



- The full decadal Assessment contains 878 pages
  - Highlights (plain language) & Executive Summary (technical)
  - 4 sections
  - 19 chapters
  - 7 appendices
- Developed by 200+ diverse cross-sectoral experts from U.S., Mexico, Canada, Australia, Cyprus, Hong Kong
- 3764 publications cited
- 33 Chapter Leads
- 200 Contributing Authors
- 5 Science (cross-chapter section) Leads
- 11 Review Editors
- 3 years formulation & production (2015-18)
- Over 6 Drafts reviewed over 6 times incl. by Public (451 comments), U.S. National Academy of Sciences (NAS) publicly nominated committee, expert external reviewers, 21 Federal Steering Committee members.
- Public Responses to Public and NAS Reviews
- Final clearance by 13 U.S. Government Agencies and Departments leading to Friday Nov 23, 2018 Release.

**Recommended Citation:** USGCRP, 2018: *Second State of the Carbon Cycle Report (SOCCR2): A Sustained Assessment Report* [Cavallaro, N., G. Shrestha, R. Birdsey, M. A. Mayes, R. G. Najjar, S. C. Reed, P. Romero-Lankao, and Z. Zhu (eds.)]. U.S. Global Change Research Program, Washington, D.C., USA, 878 pp., <https://doi.org/10.7930/SOCCR2.2018>.

# Major SOCCR2 Process Highlights, Reviews, and Timeline



# SOCCR2 public engagement

- Public feedback on the **draft prospectus** helped shape overall content and direction of SOCCR2 via first Federal Register Notice (FRN 2016)
- A call for **author nominations** helped ensure a range of expertise, and a diversity of viewpoints were included in the writing process via FRN 2016
- **Technical inputs** were solicited through a public call via FRN 2016
- A series of public engagement events with stakeholders, ensuring more relevant, useable chapter content
- A call for **Review Editors** provided an important layer of external, independent validation that authors responded appropriately to external comments from the public, and the NASEM committee
- Nov 2017 –Jan 2018: stakeholders had the opportunity to provide **public comments** on the 4<sup>th</sup> Order Draft (announced via FRN 2017)
- Nov 2017-March 2018: NASEM Committee review of 4<sup>th</sup> Order Draft

# SOCCR2 Team Structure and Interactions

## U.S. Global Change Research Program

USGCRP Includes Principals from the Subcommittee on Global Change Research and USGCRP National Coordination Office Staff (e.g., National Climate Assessment, Global Change Information System, Others)

Carbon Cycle Science Interagency Working Group (CCIWG)  
and SOCCR2 Federal Steering Committee

**Lead Agency:**  
USDA (Legal)

U.S. Carbon Cycle Science Program Office  
with Logistical Support from UCAR CPAESS

Federal Liaisons  
for Each Chapter

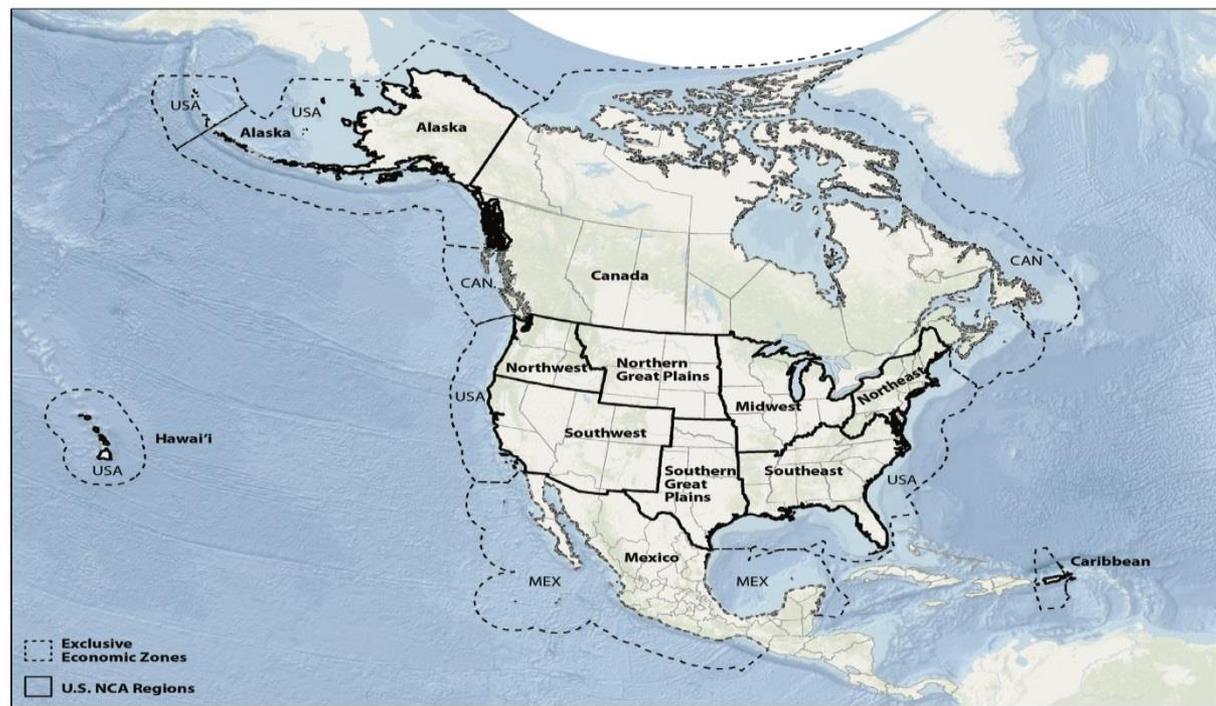
Five SOCCR2 Science Leads  
(Federal and Non-Federal Scientists)

Oak Ridge National Laboratory  
Editorial Team

Chapter Leads, Chapter Contributors  
(Federal and Non-Federal Scientists from  
the United States, Canada, and Mexico)



# What is the Second State of the Carbon Cycle Report or SOCCR2?



- SOCCR2 is an authoritative interagency assessment of the state of the carbon cycle across North America (i.e. U.S., Canada and Mexico), emphasizing advances in the understanding of carbon cycle science and associated human dimensions of the carbon cycle across land, air, and water since 2007.
- Written by a team of North America's top experts in carbon cycle science, SOCCR2 also contributes to Volume Two of the Congressionally-mandated Fourth National Climate Assessment (NCA4).
- The authors include representatives from the government, national laboratories, universities, research institutions and the private sector in the U.S., Canada and Mexico.
- Coordination and development of SOCCR2 was managed through the U.S. Carbon Cycle Science Program Office, led by the Carbon Cycle Interagency Working Group (CCIWG) under the US Global Change Research Program (USGCRP) auspices

# SOCCR2

- Part of USGCRP's Sustained Assessment goal, focusing on U.S. and North America but considers the global context
- Includes relevant carbon management science and information about tools for informing decisions
- Policy relevant, but not policy prescriptive

## The SOCCR2 process:

- Drew on a wide range of scientific and technical inputs
- Provided multiple opportunities for stakeholder engagement
- Operated on clear science communication principles
- Ensured transparency of process and information
- Employed an extensive review process

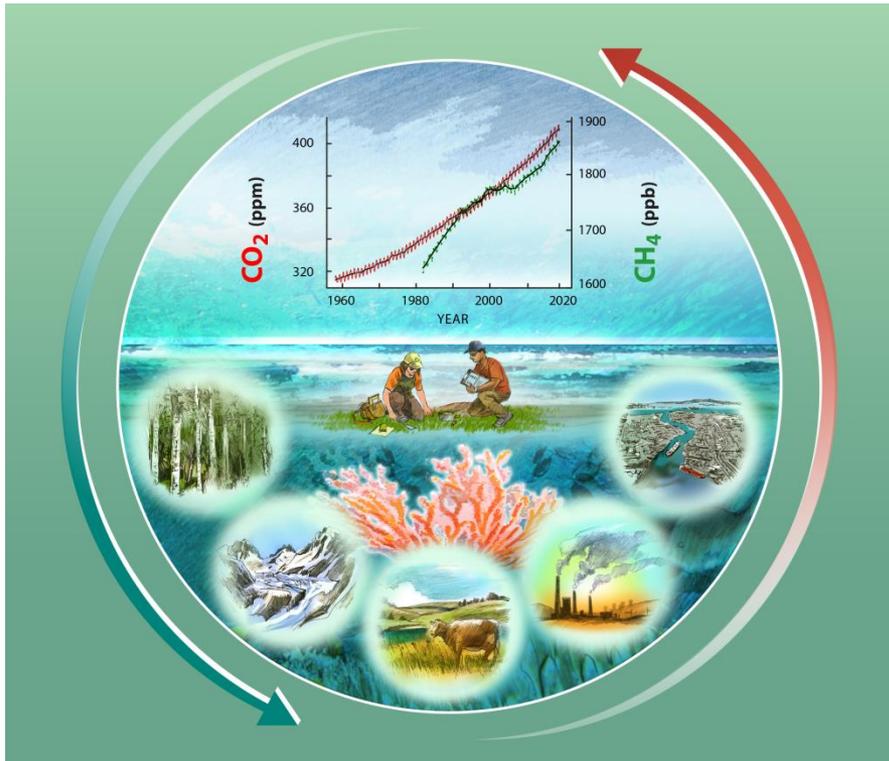
# SOCCR2

- Follow-up to the 1<sup>st</sup> SOCCR (2007)
- Supporting science requirements addressed in/related to A U.S. Carbon Cycle Science Plan (2011), U.S. National Climate Assessment, and USGCRP Strategic Plan (2012-2021)
- Based on a large body of existing, peer-reviewed research, as well as other publicly available sources, including well-established and carefully evaluated observational and modeling datasets.
- Led by Carbon Cycle Interagency Working Group, under USGCRP auspices

## Highlights decadal (2007-2016)

- Carbon dynamics in North America and the United States in a global context
- Fossil fuels and economic impacts
- A changing landscape
- Ocean acidification
- Arctic changes
- Carbon in crops
- Indigenous communities
- Cities and carbon
- Societal relevance

# SOCCR2 Chapter Structure/ Components



Each chapter includes the following components, as appropriate within the chapter's scope:

- Introduction
- Historical Context
- Current Understanding of Carbon Fluxes and Stocks
- Indicators, Trends, and Feedbacks
- Global, North American, and Regional Context [National Climate Assessment regions; United States, Mexico, and Canada]
- Societal Drivers, Impacts, and Carbon Management Decisions
- Synthesis, Knowledge Gaps, and Outlook

# About SOCCR2 Key Findings in each chapter

- Key Findings (2-6 per chapter): Author Team's expert judgment of the major synthesis points of the assessed scientific literature.
- Supporting text provides evidence and discusses implications of each Key Findings.
- **Each Key Finding is accompanied by a “Traceable Account” or Supplementary Evidence at end of each chapter**
  - 1) Provides additional information to readers about the quality of the information used,
  - 2) Allows traceability to resources and data,
  - 3) Documents the process and rationale the authors used in reaching the conclusions in a Key Finding, and
  - 4) Describes the level of likelihood and confidence in the Key Finding, as appropriate



## Section I: Synthesis

Chapter 1: Overview of the Global Carbon Cycle.....

Chapter 2: The North American Carbon Budget .....

## Section II: Human Dimensions of the Carbon Cycle

Chapter 3: Energy Systems.....

Chapter 4: Understanding Urban Carbon Fluxes .....

Chapter 5: Agriculture .....

Chapter 6: Social Science Perspectives on Carbon .....

Chapter 7: Tribal Lands .....

## Section III: State of Air, Land, and Water

Chapter 8: Observations of Atmospheric Carbon Dioxide and Methane .....

Chapter 9: Forests .....

Chapter 10: Grasslands.....

Chapter 11: Arctic and Boreal Carbon .....

Chapter 12: Soils.....

Chapter 13: Terrestrial Wetlands.....

Chapter 14: Inland Waters .....

Chapter 15: Tidal Wetlands and Estuaries.....

Chapter 16: Coastal Ocean and Continental Shelves.....

## Section IV: Consequences and Ways Forward

Chapter 17: Biogeochemical Effects of Rising Atmospheric Carbon Dioxide .....

Chapter 18: Carbon Cycle Science in Support of Decision Making.....

Chapter 19: Future of the North American Carbon Cycle.....

## Appendices

Appendix A: Report Development Process.....

Appendix B: Information Quality in the Assessment.....

Appendix C: Selected Carbon Cycle Research Observations and Measurement Programs .....

Appendix D: Carbon Measurement Approaches and Accounting Frameworks .....

Appendix E: Fossil Fuel Emissions Estimates for North America .....

Appendix F: Acronyms, Abbreviations, and Units.....

Appendix G: Glossary.....

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# carbon2018.globalchange.gov\*

\*Version 1 by USGS, PDFs only

\*Version 2 by NOAA TSU April 2019 (ETA Earth Day)

SOCCR2

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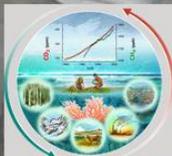
Order Report in Brief ▾



## Second State of the Carbon Cycle Report (SOCCR2)

SOCCR2 is an authoritative decadal assessment of carbon cycle science across North America, developed by over 200 experts from the U.S., Canadian and Mexican governments, national laboratories, universities, private sector, and research institutions. SOCCR2 is a Sustained Assessment Product of the U.S. Global Change Research Program.

Recommended Report Citation



Report in Brief

### Highlights

- English
- Chinese
- Spanish
- French

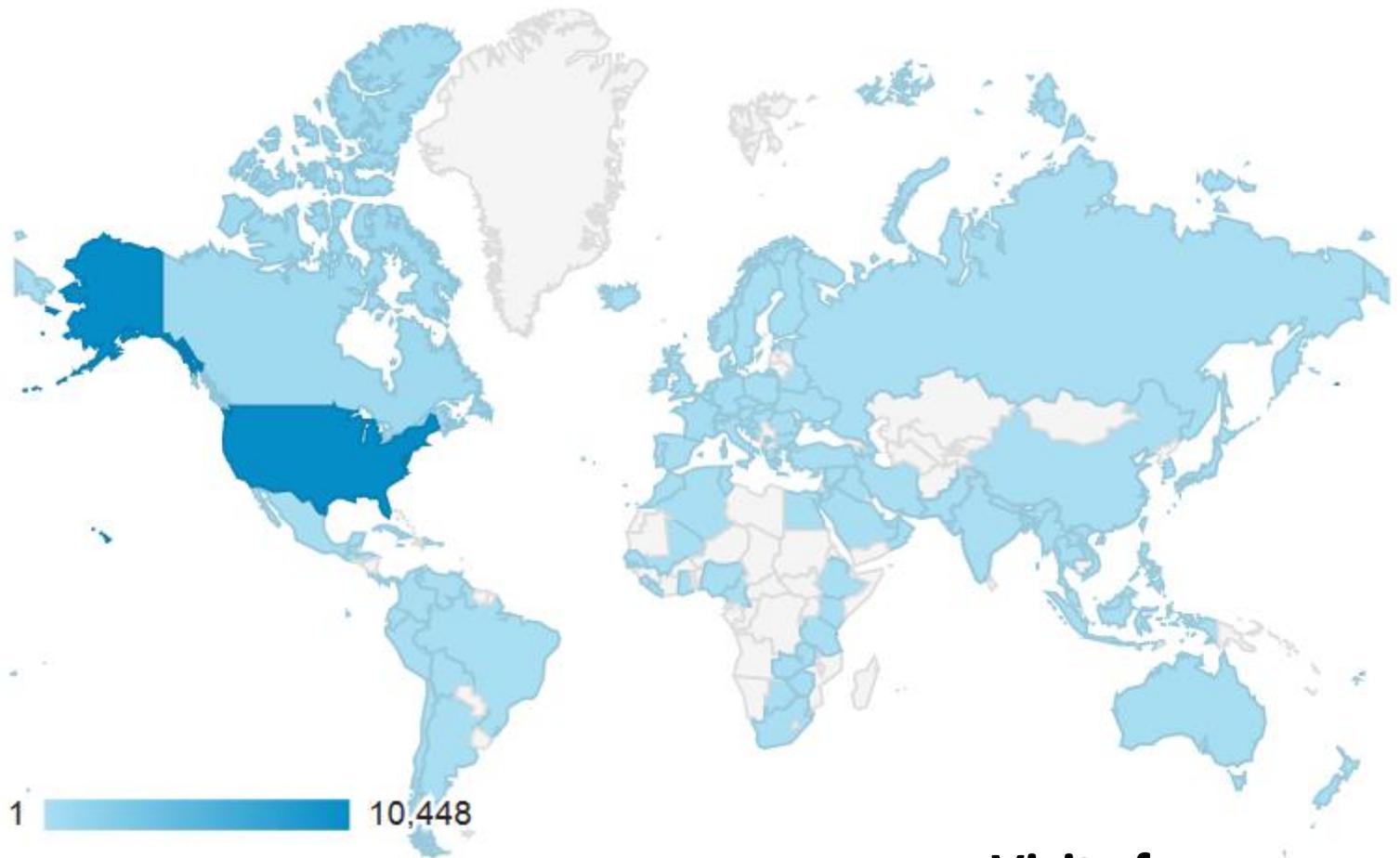
Recommended Citation



### Preface

- About this Report
- Development, Reviews and Approval
- Guide to Report
- Carbon Accounting
- Uncertainty and Confidence
- Interagency Context of U.S. Carbon Cycle Science

Segundo Reporte sobre el Estado del Ciclo del Carbon O Mensajes Clave      北美 第二期碳循环现状 报告 主要重点      Le Deuxième Rapport Sur l'Etat du Cycle du Carbone: Faits saillants



**[carbon2018.globalchange.gov](http://carbon2018.globalchange.gov)**

**Visits from  
116 nations  
2967 cities  
10,500 users**

**16,000 page views as of Feb 25, 2019  
#SOCCR2 news & social media potential reach millions**

## ENVIRONMENT

# The U.S. Could Cut Emissions By 80 Percent For Less Than The 2018 Federal Budget

It cost a projected \$4.1 trillion to run the federal government in fiscal year 2018. Experts say it would take \$1.3-\$5.1 trillion to rein in emissions by mid-century.

EOS Earth & Space Science News

NEWS NEWS FROM AGU JOURNALS TOPICS & DISCIPLINES OPINIONS BLOGS JOBS & RESOURCES

The Washington Post  
Democracy Dies in Darkness

SCIENCE POLICY & FUNDING News

Tracing the Path of Carbon in North America

## Tracing the Path of Carbon in North America

A team of more than 200 scientists released a decade-long look at how carbon weaves through Earth's air, soil, water, and plants. Here are nine key takeaways from their report.

The report is being released at the same time as another major federal climate study that, in contrast, reaches a more positive conclusion — at least with respect to what can be done about climate change.

The Second State of the Carbon Cycle Report, which examines all of North America (not just the United States), finds that over a decade, greenhouse-gas emissions from fossil fuels declined by 1 percent per year. The result is that while North America emitted 24 percent of the world's emissions in 2004, that was down to 17 percent

...urred in part thanks to improvements in vehicle fuel efficiency, the growth of renewable

**SOCCR2:  
The 'Other Report'**

# SIERRA

The national magazine of the Sierra Club

CLIMATE AND ENERGY LANDS AND WATERS ADVENTURE GREEN LIFESTYLE MAGAZINE

Another major U.S. climate report dropped. But you probably missed it.

Share on Facebook Share on Twitter

## Crow Canyon's pueblo farming project cited in carbon cycle report

Facebook Twitter Email

Project about sustainability of Hopi methods is referenced

By The Journal  
Friday, Nov. 30, 2018 11:43 AM



## Can North America Offset Its Greenhouse Gas Emissions?

The Second State of the Carbon Cycle report shows progress being made



# SOCCR2 major themes from Executive Summary

- What Is the Carbon Cycle, and Why Is it Important?
- How Is the Global Carbon Cycle Changing?
- Carbon Sources, Sinks, and Stocks in North America
- Effects of Carbon Cycle Changes on North Americans and Their Environments
- A Systems Approach to Linking the Carbon Cycle and Society
- Projections of the Future Carbon Cycle, Potential Impacts, and Uncertainties
- Carbon Management and Mitigation

Based on assessment of science from the last decade, SOCCR2 finds that:

1. Fossil fuels are still the largest source of carbon in North America.
2. Aquatic systems are both sources and sinks of carbon in North America (depending on type and conditions).
3. Land and coastal waters are sinks of carbon in North America, though some sinks may change in the future.

Plus many scientifically significant and societally relevant key findings across all 19 chapters.

# Boiling down major SOCCR2 highlights for North America

- The energy sector and transportation continue to be the largest source of carbon emissions, but significant reductions in this source are possible with current technologies.
- Emissions due to energy use (fossil fuels) decreased and the increase in these emissions globally has slowed down.

This has occurred as net economic growth has been reported over the same time period.

- 
- Land and coastal waters are sinks of atmospheric carbon, taking up from 1/3 to 1/2 of the total emissions.
  - Soils in croplands, rangelands, grasslands, and forests have strong potential for carbon sequestration.
  - Aquatic systems are both sources and sinks of carbon

Some of the sinks are diminishing in strength and many are at risk due to increasing disturbance in forests (e.g. fire, pests, invasive species) & increasing land use pressure on all ecosystems.

Conversion of peatland soils accounts for the largest emissions from soils.

Accelerated warming in Arctic regions creates vulnerability of large stores of carbon in permafrost soils.

# Carbon management and mitigation

## SOCCR2 Highlights

The United States is currently responsible for 80% to 85% of fossil fuel emissions from North America.

- Afforestation, reduced deforestation,
- Restoration of coastal areas and terrestrial wetlands,
- Improved land-management practices in forests, grasslands, and croplands

Can maintain or increase ecosystem carbon sinks (i.e., carbon storage) while decreasing the sources or emissions of carbon to the atmosphere.

- About 11% to 13% of global ecosystem carbon removal can be attributed to North American ecosystems.
- Changes in climate, human activities, and ecosystem responses may alter future long-term removals of carbon from the atmosphere from current land and ocean system sinks.

- Over last decade, North America reduced its annual fossil fuel CO<sub>2</sub> emissions by 1%. How? Market, technology, and policy drivers.
- Economy recovered with increased energy efficiency and economic structural changes enabling economic growth while continuing the trend of lowering CO<sub>2</sub> emissions.
- Cities largest emitters
- Tribes - sustainable practices

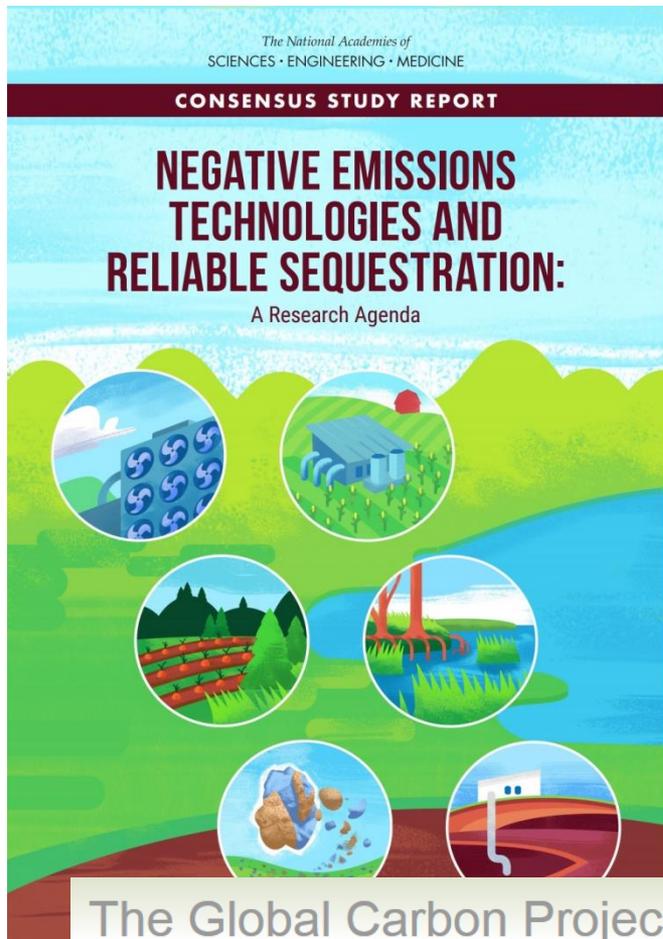
# Since SOCCR1 (2007): *New SOCCR2 Achievements*

SOCCR2 contains separate social science and tribal perspective focused chapters – Enhanced integration of natural sciences and sustainability perspectives, promoting solutions-oriented science

## **Also, thanks to improved carbon observations, SOCCR2 shows**

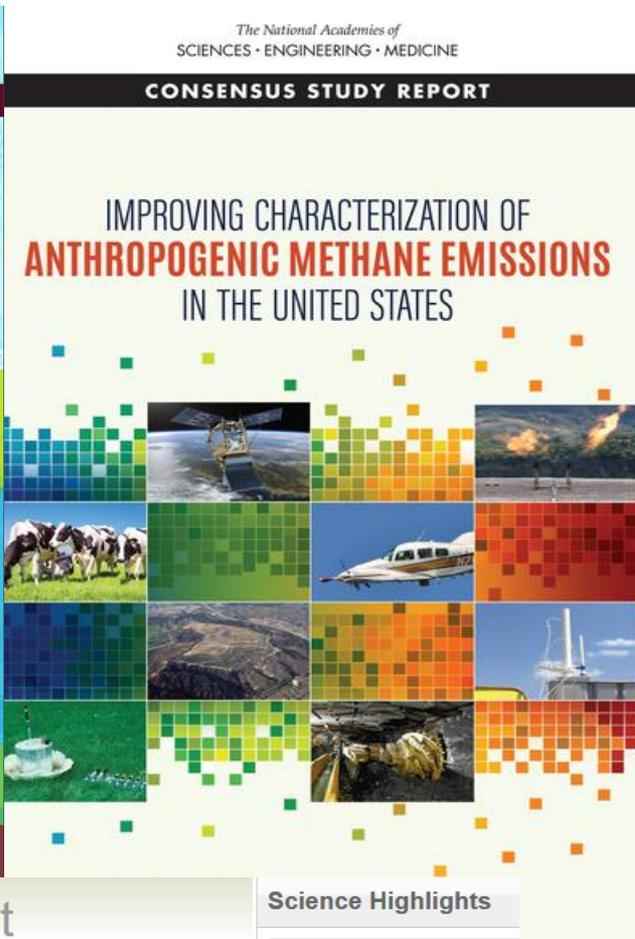
- More complete and better attributed carbon budget in North America
- Convergence between top-down (atmospheric observations) and bottom-up (in-situ and inventories) estimations
- Future projections more robust with enhanced observations and tools for their interpretation
- Coastal wetlands, estuaries and coastal waters included in the budget for the first time
- Lateral transports more consistently determined over space and time
- More high-latitude data collections and synthesis

# Other recent major carbon cycle science focused reports/efforts with science to solutions options echoing SOCCR2 findings informing decisions for carbon management & mitigation



## The Global Carbon Project

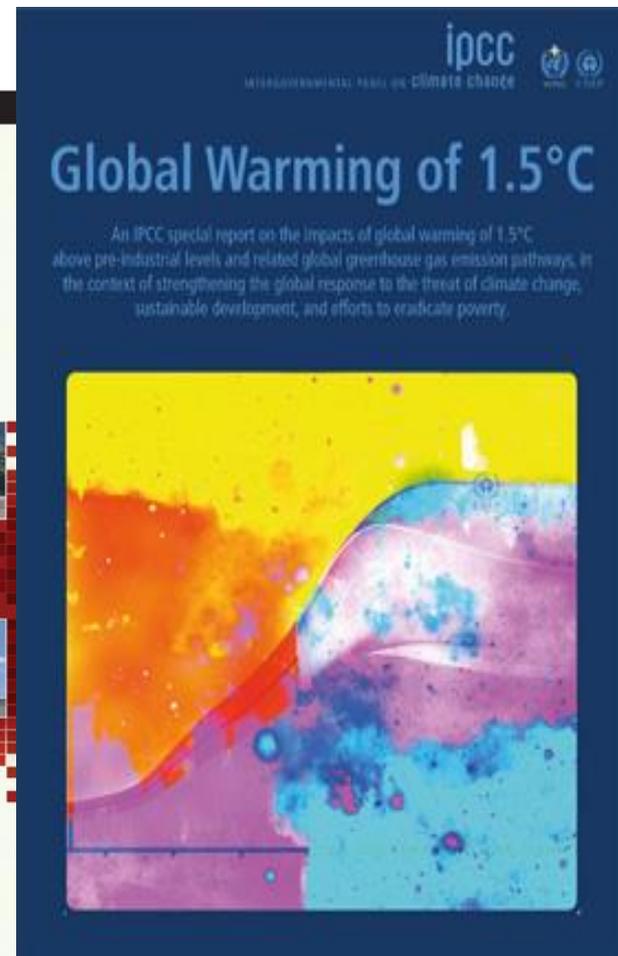
The Global Carbon Project (GCP) integrates knowledge of greenhouse gases for human activities and the Earth system. Our projects include global budgets for three dominant greenhouse gases — carbon dioxide, methane, and nitrous oxide — and complementary efforts in urban, regional, cumulative, and negative emissions.



## Science Highlights



[Carbon Budget 2018](#)



**Also, NCA4 released the same day as SOCCR2, and other reports, studies**

# Closing thoughts from SOCCR2 Highlights

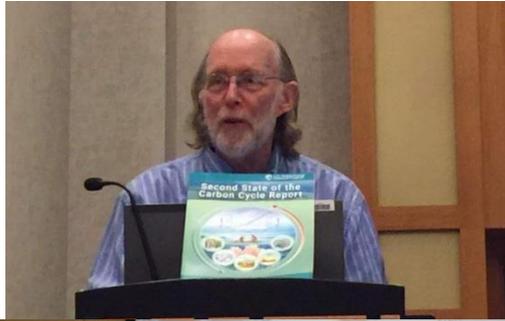
## **Knowledge Gaps and Science Informing Investments in the Future**

Future research will facilitate improvements in knowledge, practices, and technologies for managing carbon emissions, removing carbon from the atmosphere, and accumulating and storing it in Earth systems over the long term. Expansions in monitoring, advanced syntheses of available observations, improvements in assessment tools and models, and extension of existing modeling capabilities can help provide more reliable measurements and future estimates of carbon stocks

and flows at the local, regional, and global level. Co-benefits, such as improvements in air quality, crop productivity, energy efficiency, economic savings to taxpayers, and enhanced quality of life, often result from reduction in carbon emissions. Research identifying and responding to such opportunities—as well as addressing needs for research in carbon management and emissions mitigation across decision-making stakeholders, sectors, and governance at multiple levels—is an investment in the sustainable well-being of Earth, society, and future generations.

Co-benefits, such as improvements in air quality, crop productivity, energy efficiency, economic savings to taxpayers, and enhanced quality of life, often result from reduction in carbon emissions.

# Part of our 200+ team and some of the upcoming Tuesday Speakers 'From Science to Solutions: The State of the Carbon Cycle' SOCCR2 NOAA Seminar Series (Feb 26-May 28, 2019)



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Questions? Contact [gshrestha@usgcrp.gov](mailto:gshrestha@usgcrp.gov)

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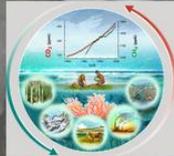
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Extra

# SOCCR2: Some of the major observation platforms supported by interagency science programs advancing carbon science informing decisions

Aquatic-ocean	Aquatic-inland	Terrestrial in-situ	Inventories	Atmospheric
NOAA	USGS, EPA	DOE, USDA, NASA, NSF	USDA, USGS	NASA, NOAA
SOCAT mission, other ship-based measurements	Stream gage network, surface water ECV	AmeriFlux, GRACEnet NEON, LTER	Forest inventory, crop inventory, land cover change mapping	OCO-2, SMAP, Landsat, and various airborne missions

