Scientific Community Engagement for Carbon Cycle Researchers

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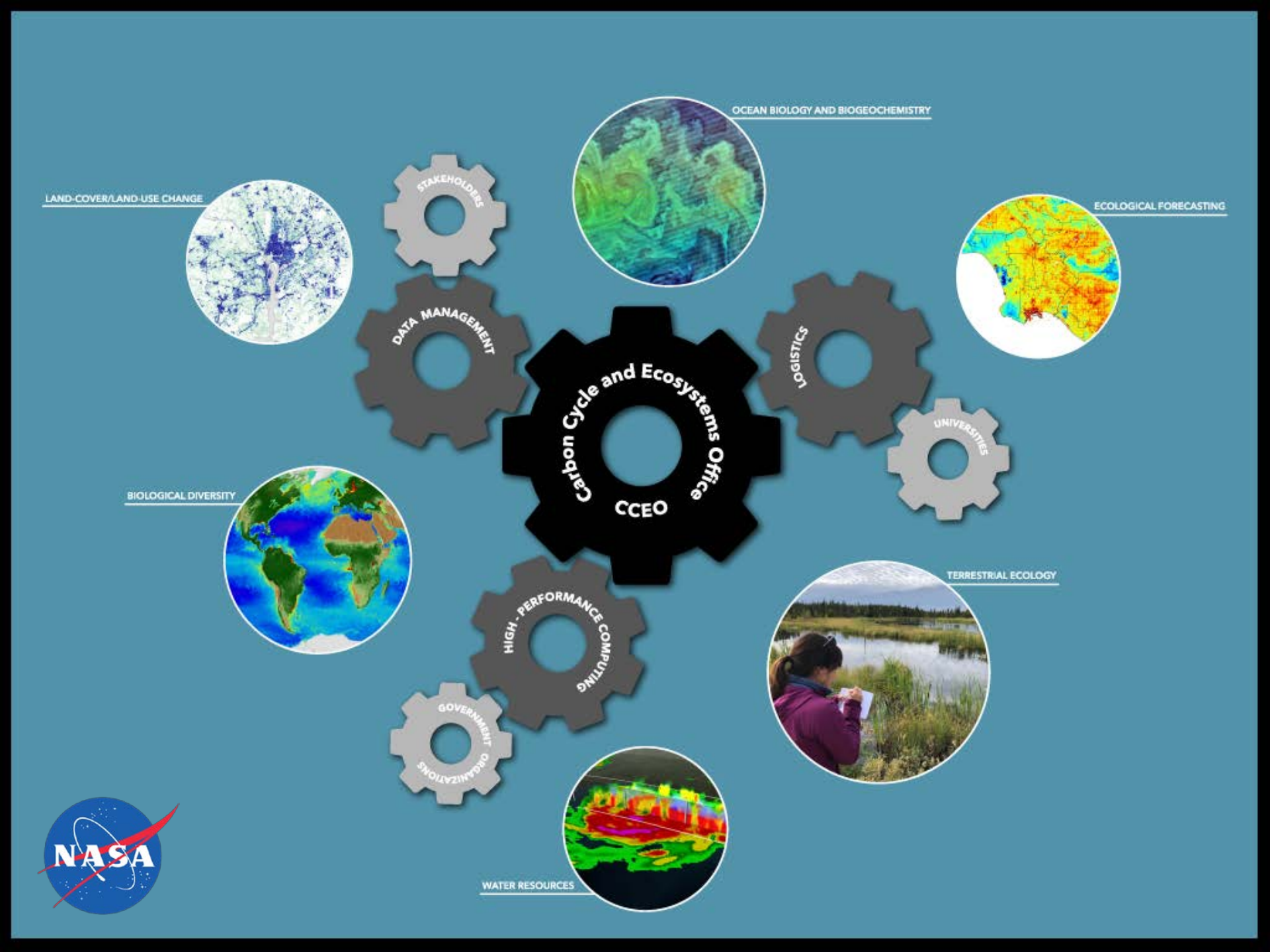
What is scientific community engagement?

"engagement with the members of an organization, association, community of practice, or research group within the STEM community, rather than *public* engagement."

Benefits of managing scientific community engagement include:

- A shared sense of belonging and self-identification as a member of the community
- The exchange of scientific information and/or connection to other community members
- The accomplishment of specific project goals

New AAAS Center for Scientific Collaboration and Community Engagement: https://www.aaas.org/programs/center-scientific-collaboration-and-community-engagement


OCEAN BIOLOGY AND BIOGEOCHEMISTRY
LAND-COVER/LAND-USE CHANGE
ECOLOGICAL FORECASTING
STAKEHOLDERS
DATA MANAGEMENT
Carbon Cycle and Ecosystems Office
CCEO
LOGISTICS
UNIVERSITIES
BIOLOGICAL DIVERSITY
HIGH - PERFORMANCE COMPUTING
TERRESTRIAL ECOLOGY
GOVERNMENT ORGANIZATIONS
WATER RESOURCES
NASA

NASA Carbon Cycle & Ecosystems Office

https://cce.nasa.gov/cce/index.htm

Logistics – Field Campaign Support

Arctic-Boreal Vulnerability Experiment (ABoVE):

- Field offices with equipment and staff in Fairbanks, Yellowknife
- Hazards and safety training
- Trip planning, including information on insurance, workers compensation, emergency planning, packing
- Assistance with permits

ABoVE
ARCTIC – BOREAL VULNERABILITY EXPERIMENT

https://above.nasa.gov/

High Performance Computing

ABoVE Science Cloud:

- Partner with NASA Center for Climate Simulation
- Provides a shared set of computational and data resources to the ABoVE science team.
- Enables access to large, common data sets (both observation and model) that are relevant to the ABoVE research goals.
- Provides a system and collaboration environment by which results may be quickly and readily shared to the ABoVE research community and ultimately to decision makers.

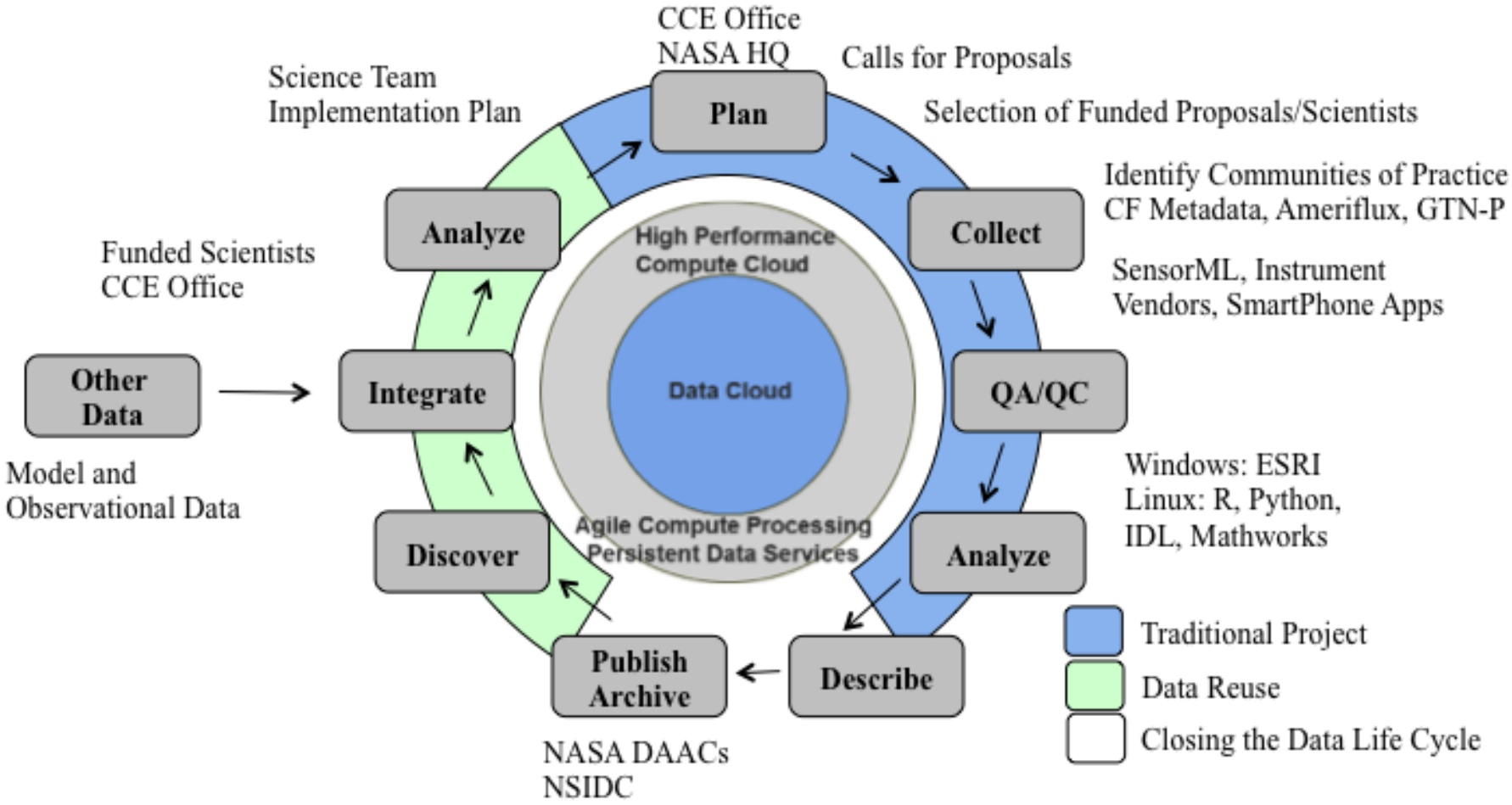
https://above.nasa.gov/

High Performance Computing

ABoVE Science Cloud:

- Enables researchers to propose larger problems, analytics, and more science than they could address using the capabilities of typical computer workstations.
- Provides tailored computational, analysis, and data management environments to meet the needs of the individual science projects.
- Supports researchers with comprehensive services to facilitate the use of advanced information technology, creation of metadata and documentation, and archival of finalized products.

Data Management



Augmented from Rüegg et al 2014 in *Front Ecol Environ*

Rüegg et al. 2014. Completing the data life cycle: using information management in macrosystems ecology research. Front Ecol Environ 12 (1): 24-30. doi:10.1890/120375

ABoVE and SOCCR2

French, N. H. F., Jenkins, L. K., Loboda, T. V., Flannigan, M., Jandt, R., Bourgeau-Chavez, L. L., Whitley, M. **2015**. Fire in arctic tundra of Alaska: past fire activity, future fire potential, and significance for land management and ecology. International Journal of Wildland Fire. 24(8), 1045. doi: 10.1071/WF14167

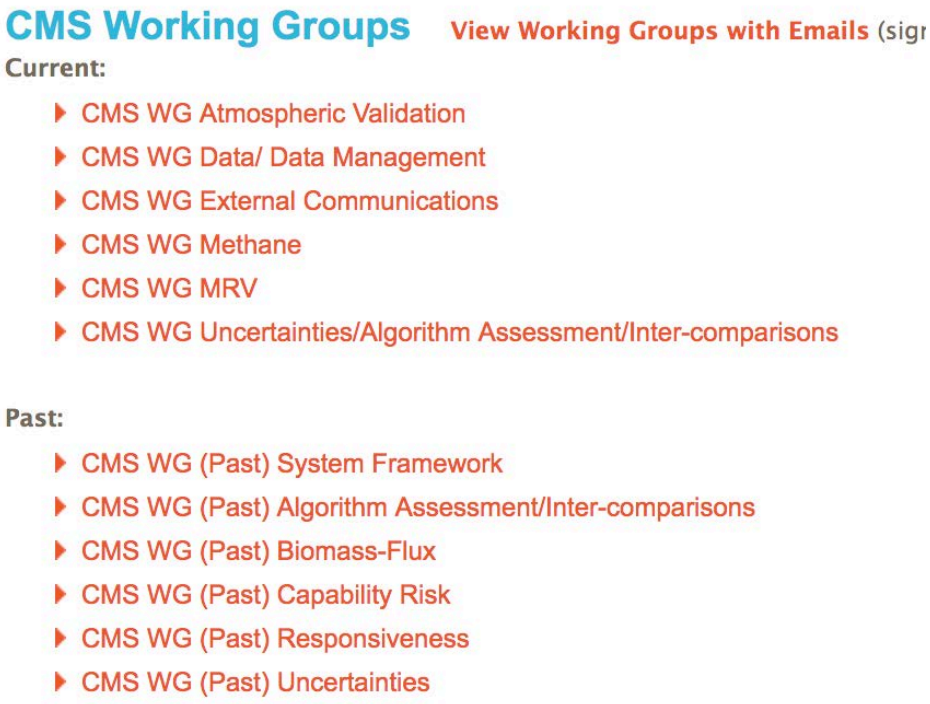
Liljedahl, A. K., Boike, J., Daanen, R. P., Fedorov, A. N., Frost, G. V., Grosse, G., Hinzman, L. D., Iijma, Y., Jorgenson, J. C., Matveyeva, N., Necsoiu, M., Raynolds, M. K., Romanovsky, V. E., Schulla, J., Tape, K. D., Walker, D. A., Wilson, C. J., Yabuki, H., Zona, D. **2016**. Pan-Arctic ice-wedge degradation in warming permafrost and its influence on tundra hydrology. Nature Geoscience. 9(4), 312-318. doi: 10.1038/ngeo2674

Commane, R., Lindaas, J., Benmergui, J., Luus, K. A., Chang, R. Y., Daube, B. C., Euskirchen, E. S., Henderson, J. M., Karion, A., Miller, J. B., Miller, S. M., Parazoo, N. C., Randerson, J. T., Sweeney, C., Tans, P., Thoning, K., Veraverbeke, S., Miller, C. E., Wofsy, S. C. **2017**. Carbon dioxide sources from Alaska driven by increasing early winter respiration from Arctic tundra. Proceedings of the National Academy of Sciences. 201618567. doi: 10.1073/pnas.1618567114

Carbon Monitoring System (CMS)

https://carbon.nasa.gov/

- Science team meeting support
- Data management support
- Working Groups
- Applications



CMS and SOCCR2

Pan, Y., R. A. Birdsey, J. Fang, R. Houghton, P. E. Kauppi, W. A. Kurz, O. L. Phillips, A. Shvidenko, S. L. Lewis, J. G. Canadell, P. Ciais, R. B. Jackson, S. W. Pacala, A. D. McGuire, S. Piao, A. Rautiainen, S. Sitch, and D. Hayes, 2011: A large and persistent carbon sink in the world's forests. *Science*, **333**(6045), 988-993, doi: 10.1126/science.1201609

Cai, W.-J., X. Hu, W.-J. Huang, M. C. Murrell, J. C. Lehrter, S. E. Lohrenz, W.-C. Chou, W. Zhai, J. T. Hollibaugh, Y. Wang, P. Zhao, X. Guo, K. Gundersen, M. Dai, and G.-C. Gong, 2011: Acidification of subsurface coastal waters enhanced by eutrophication. *Nature Geoscience*, **4**(11), 766-770, doi: 10.1038/ngeo1297

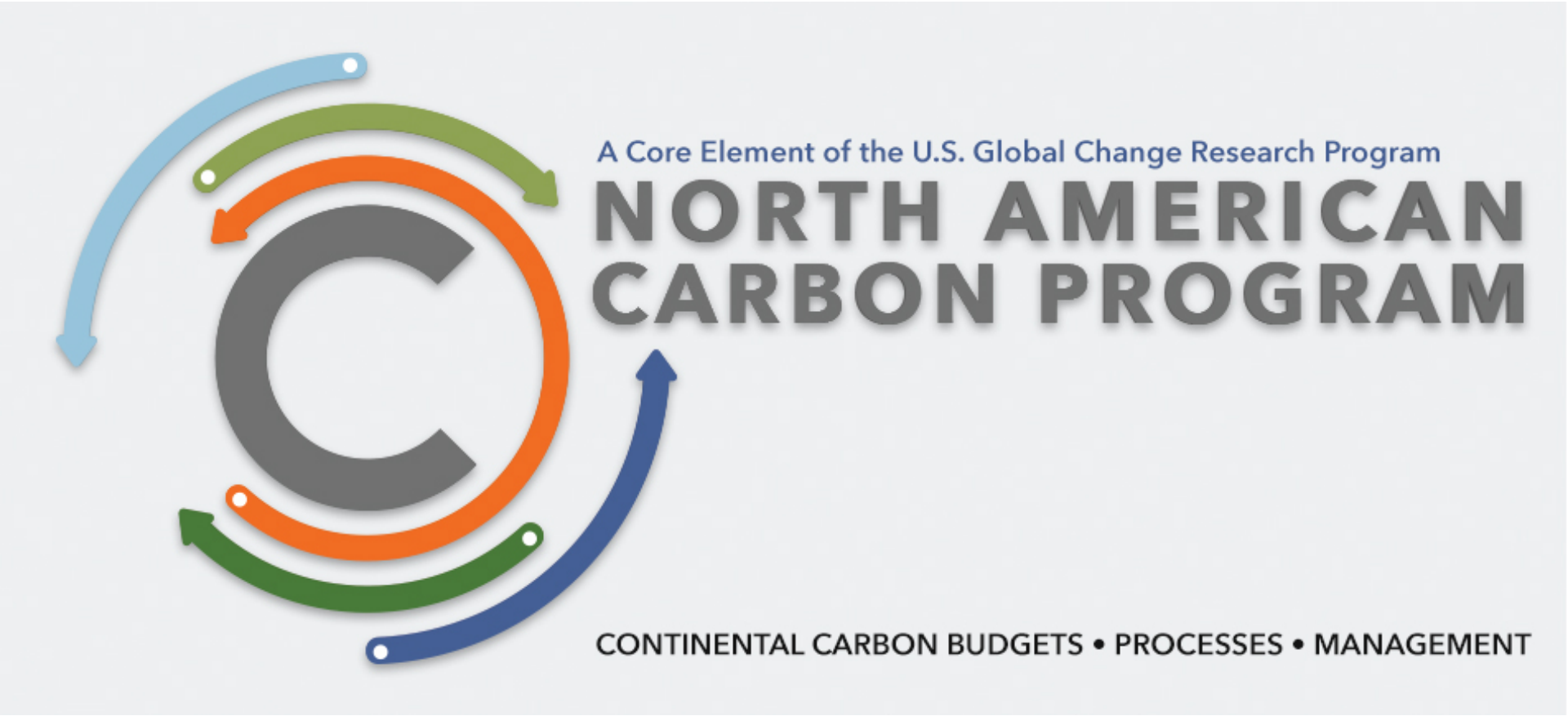
Holmquist, J. R., L. Windham-Myers, N. Bliss, S. Crooks, J. T. Morris, J. P. Megonigal, T. Troxler, D. Weller, J. Callaway, J. Drexler, M. C. Ferner, M. E. Gonneea, K. D. Kroeger, L. Schile-Beers, I. Woo, K. Buffington, J. Breithaupt, B. M. Boyd, L. N. Brown, N. Dix, L. Hice, B. P. Horton, G. M. MacDonald, R. P. Moyer, W. Reay, T. Shaw, E. Smith, J. M. Smoak, C. Sommerfield, K. Thorne, D. Velinsky, E. Watson, K. W. Grimes, and M. Woodrey, 2018a: Accuracy and precision of tidal wetland soil carbon mapping in the conterminous United States. *Scientific Reports*, **8**(1), 9478, doi: 10.1038/s41598-018-26948-7

Luo, Y., Ahlstrom, A., Allison, S. D., Batjes, N. H., Brovkin, V., Carvalhais, N., Chappell, A., Ciais, P., Davidson, E. A., Finzi, A., Georgiou, K., Guenet, B., Hararuk, O., Harden, J. W., He, Y., Hopkins, F., Jiang, L., Koven, C., Jackson, R. B., Jones, C. D., Lara, M. J., Liang, J., McGuire, A. D., Parton, W., Peng, C., Randerson, J. T., Salazar, A., Sierra, C. A., Smith, M. J., Tian, H., Todd-Brown, K. E. O., Torn, M., van Groenigen, K. J., Wang, Y. P., West, T. O., Wei, Y., Wieder, W. R., Xia, J., Xu, X., Xu, X., Zhou, T. **2016**. Toward more realistic projections of soil carbon dynamics by Earth system models. Global Biogeochemical Cycles. 30(1), 40-56. doi: 10.1002/2015GB005239

Tian, H., Lu, C., Ciais, P., Michalak, A. M., Canadell, J. G., Saikawa, E., Huntzinger, D. N., Gurney, K. R., Sitch, S., Zhang, B., Yang, J., Bousquet, P., Bruhwiler, L., Chen, G., Dlugokencky, E., Friedlingstein, P., Melillo, J., Pan, S., Poulter, B., Prinn, R., Saunois, M., Schwalm, C. R., Wofsy, S. C. **2016**. The terrestrial biosphere as a net source of greenhouse gases to the atmosphere. Nature. 531(7593), 225-228. doi: 10.1038/nature16946

North American Carbon Program (NACP)

https://www.nacarbon.org/nacp/index.html?

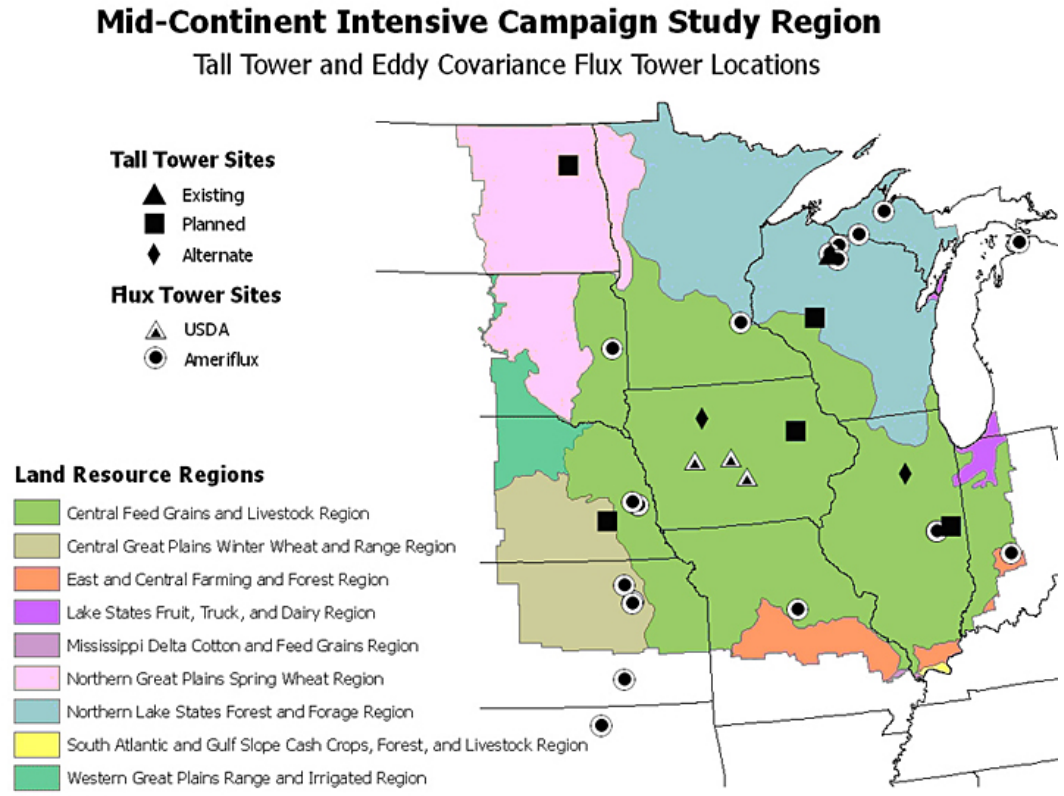


North American Carbon Program (NACP)

- Multi-agency, multidisciplinary research program focused on C sources and sinks in North America and adjacent oceans
- Community-led activities:
  - Intensive campaigns
  - Synthesis activities
  - Workshops w/CCIWG
- Since inception (2002) **227 publications with 100+ citations**
- 150+ active projects

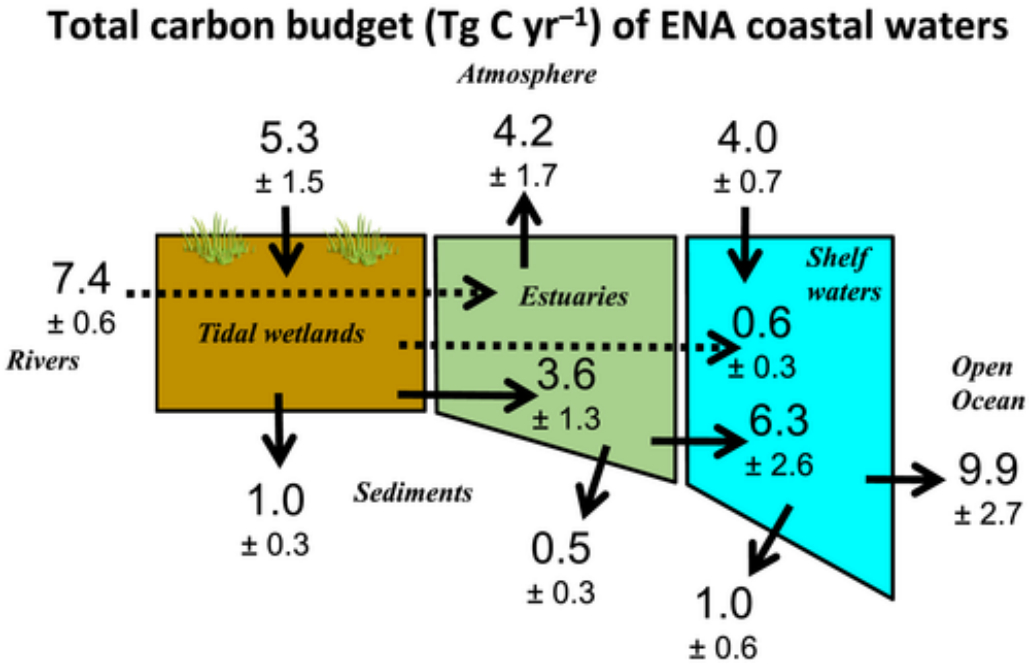
NACP Intensives
Mid-Continent Intensive (MCI)

- 2003 – 2007
- Test-bed
  for methodologies to determine carbon flux between land and atmosphere
- Essential for understanding and reconciling top-down vs. bottom up estimates
- Multi-agency funding: DOE, NASA, NOAA, NSF, USDA ARS, USDA FS, USGS



NACP Syntheses

- Coastal Carbon Synthesis (CCARS) 2012 – 2015 **in collaboration with OCB**
- Multi-scale Synthesis and Terrestrial Model Intercomparison Project (MsTMIP) 2014 – 2017
- Regional-Continental 2012 – 2015
- Site-level 2008 – 2013
- Disturbance 2009 – 2013



Global Biogeochemical Cycles, Volume: 32, Issue: 3, Pages: 389-416, First published: 20 February 2018, DOI: (10.1002/2017GB005790)

(Some) NACP and SOCCR2

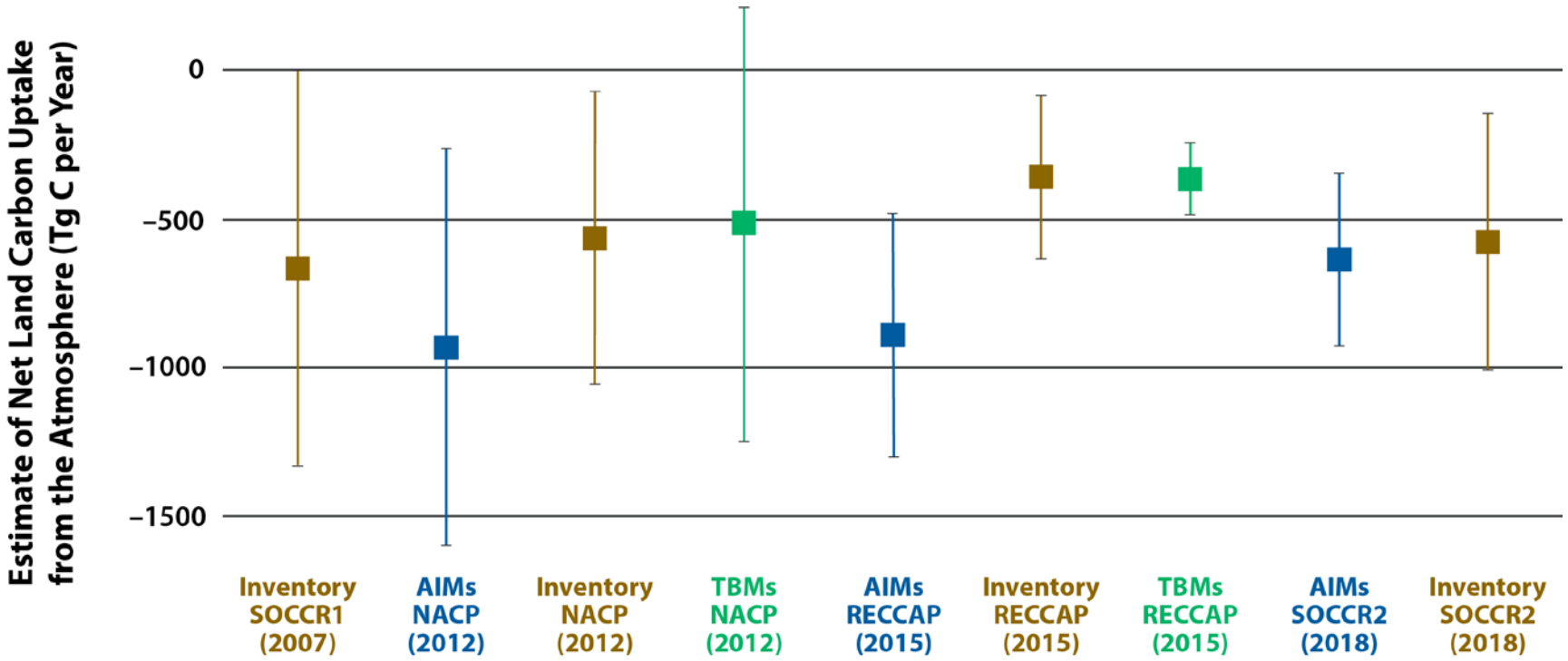


Figure 2.5: These estimates, in teragrams of carbon (Tg C) per year, are derived from inventory analysis, atmospheric inversion models (AIMs), and terrestrial biosphere models (TBMs). [Data sources: *First State of the Carbon Cycle Report* (SOCCR1; CCSP 2007), North American Carbon Program (NACP; Hayes et al., 2012), REgional Carbon Cycle Assessment and Processes (RECCAP) initative (King et al., 2015), and this report (SOCCR2). Publication year of each estimate is given in parenthesis.]

(Some) NACP and SOCCR2

Hayes, D. J., D. P. Turner, G. Stinson, A. D. McGuire, Y. X. Wei, T. O. West, L. S. Heath, B. Dejong, B. G. McConkey, R. A. Birdsey, W. A. Kurz, A. R. Jacobson, D. N. Huntzinger, Y. D. Pan, W. Mac Post, and R. B. Cook, 2012: Reconciling estimates of the contemporary North American carbon balance among terrestrial biosphere models, atmospheric inversions, and a new approach for estimating net ecosystem exchange from inventory-based data. *Global Change Biology*, **18**(4), 1282-1299, doi: 10.1111/j.1365-2486.2011.02627.x

Huntzinger, D. N., W. M. Post, Y. Wei, A. M. Michalak, T. O. West, A. R. Jacobson, I. T. Baker, J. M. Chen, K. J. Davis, D. J. Hayes, F. M. Hoffman, A. K. Jain, S. Liu, A. D. McGuire, R. P. Neilson, C. Potter, B. Poulter, D. Price, B. M. Raczka, H. Q. Tian, P. Thornton, E. Tomelleri, N. Viovy, J. Xiao, W. Yuan, N. Zeng, M. Zhao, and R. Cook, 2012: North American Carbon Program (NACP) regional interim synthesis: Terrestrial biospheric model intercomparison. *Ecological Modelling*, **232**, 144-157, doi: 10.1016/j.ecolmodel.2012.02.004

Ogle, S. M., K. Davis, T. Lauvaux, A. Schuh, D. Cooley, T. O. West, L. S. Heath, N. L. Miles, S. Richardson, F. J. Breidt, J. E. Smith, J. L. McCarty, K. R. Gurney, P. Tans, and A. S. Denning, 2015: An approach for verifying biogenic greenhouse gas emissions inventories with atmospheric CO_2concentration data. *Environmental Research Letters*, **10**(3), 034012, doi: 10.1088/1748-9326/10/3/034012

Schuh, A. E., T. Lauvaux, T. O. West, A. S. Denning, K. J. Davis, N. Miles, S. Richardson, M. Uliasz, E. Lokupitiya, D. Cooley, A. Andrews, and S. Ogle, 2013: Evaluating atmospheric CO_2 inversions at multiple scales over a highly inventoried agricultural landscape. *Global Change Biology*, **19**(5), 1424-1439, doi: 10.1111/gcb.12141.

(Some) NACP and SOCCR2

"The North American Carbon Program (NACP) is an example of a boundary program that supports scientists' efforts to engage in social, economic, and policy-relevant research to improve how carbon cycle science is conducted and ensure - policy-relevant findings…the NACP community ***expanded its research on human and social impacts on the carbon cycle, contributing to a better understanding of how human and physical processes interact with one another***."

Chapter 18: Carbon cycle science in support of decision making

NACP Science Leadership Group

- Andrew Fox (Co-Chair), Univ. of AZ
- Chris Williams (Co-Chair), Clark Univ.
- Simone Alin, NOAA
- Iris Anderson, VIMS
- Alison Boyer, ORNL
- Roisin Commane, Columbia Univ.
- Sarah Cooley, Ocean Conservancy
- Grant Domke, USFS
- Christian Frankenberg, Caltech
- Deborah Huntzinger, NAU
- Lucy Hutyra, Boston Univ.
- Robert Kennedy, Oregon State
- John Lin, Univ. of Utah
- Yiqi Luo, NAU
- Ray Najjar, Penn State Univ.
- Erika Podest, JPL
- Ben Poulter, NASA GSFC
- Ben Ruddell, NAU
- Kevin Schaefer, NSIDC
- Rob Striegl, retired
- Maria Tzortziou, CCNY
- Rodrigo Vargas, Univ. of Delaware

Next meeting: June 5 – 6 (1.5 days) – open to all!

The Future of NACP

New Science Implementation Plan in the works:

- Based on US Carbon Cycle Science Plan (Michalak et al. 2011)
- Writing team leads:
  - Chris Williams, Clark University
  - Eric Sundquist, USGS
  - Arlyn Andrews, NOAA
  - Ken Davis, Penn State Univ.
  - Molly Brown, Univ. of Maryland
  - Ben Poulter, NASA GSFC
  - Forrest Hoffman, Climate Modeling/ORNL

The Future of NACP

New Science Implementation Plan in the works:

- Sustained and Expanded Observation (Andrews)
- Assessment and Integration (Sundquist)
- Processes and Attribution (Williams)
- Prediction (Davis)
- Communication and Decision Support (Brown)

The Future of NACP

7th NACP Open Science Meeting

- March 16 – 19, 2020
- George Mason University, Fairfax, VA
- Planning Committee meeting monthly

Overarching theme:

The future is here: North American carbon cycle science for a changed climate

How can scientific community engagement support future carbon cycle research?

What will the next SOCCR look like?

How can we meet stakeholder needs?

Thank you!