Joshua B. Fisher, JPL (PI)

MoDIF: Model–Data Integration Framework for ABoVE

FISHER-01

Daniel Hayes, U. Maine (Co-I)
Deborah Huntzinger, N. Arizona U. (Co-I)
Christopher Schwalm, Woods Hole (Co-I)

Institutional Collaborations

Model	Collaborator(s)
aDVGM2	Simon Scheiter, Senckenberg Gesellschaft für Naturforschung, Germany
Biome-BGC	Weile Wang, NASA Ames, USA
CABLE	Yiqi Luo, Oklahoma University, USA
CLASS-CTEM	Altaf Arain, McMaster University, Canada
CLM4	Charles Koven, LBNL, USA
CLM4-VIC	Maoyi Huang, PNNL, USA
DLEM	Hanqin Tian, Auburn University, USA
DVM-DOS-TEM	Hélène Genet, University of Alaska Fairbanks, USA
ecosys	Robert Grant, University of Alberta, Canada
GTEC	Dan Ricciuto, ORNL, USA
Hyland	Joshua Fisher, NASA JPL, USA
ISAM	Atul Jain, University of Illinois at Urbana-Champaign, USA
JeDI	Ryan Pavlick, NASA JPL, USA
JULES	Anna Harper, University of Exeter, UK
LPJ-GUESS	Ben Smith & Paul Miller, Lund University, Sweden
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Noah-MP	Zong-Liang Yang, University of Texas, USA
ORCHIDEE	Philippe Ciais, LSCE, France
SiB3	Ian Baker & Katherine Haynes, Colorado State University, USA
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SSiB	Yongkang Xue, UCLA, USA
TECO	Yiqi Luo, Oklahoma University, USA
TEM6	Daniel Hayes, University of Maine, USA
TRIPLEX-GHG	Changhui Peng, University of Quebec at Montreal, Canada
VEGAS2.2	Ning Zeng, University of Maryland, USA
VISIT	Akihiko Ito, National Institute for Environmental Studies, Japan

And… but… therefore

- The Arctic-Boreal Region (ABR) is warming and experiencing associated disturbances at a much greater rate and

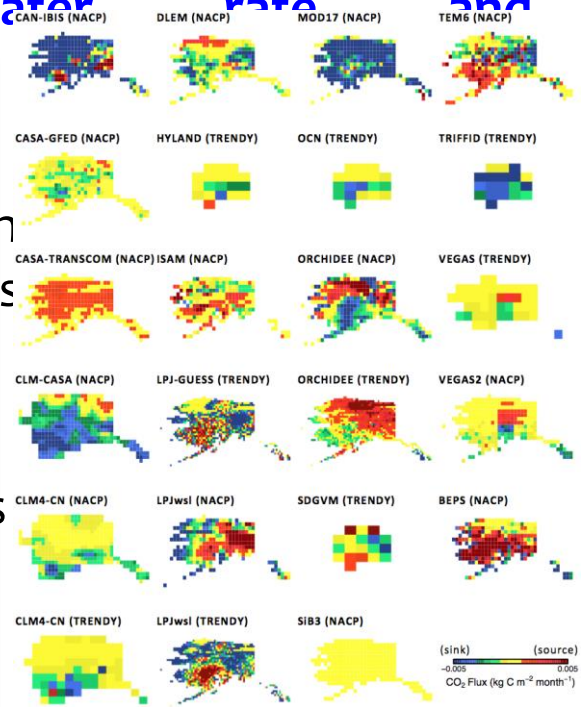
AND

- E… th… v… ss… w…

BUT

- C… s… u… e…

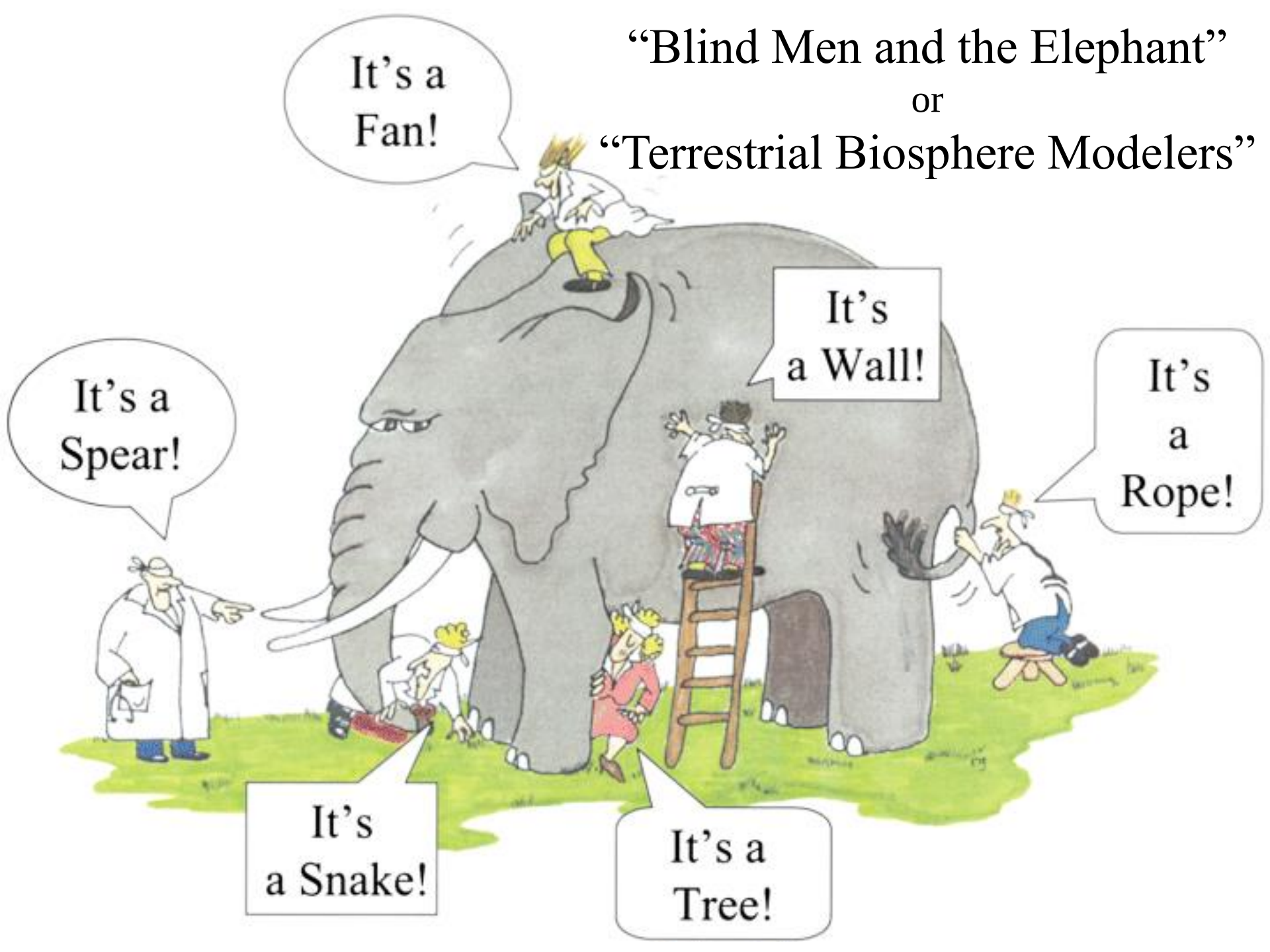
THE



Fisher et al., 2014. Carbon cycle uncertainty in the Alaskan Arctic. *Biogeosciences* 11(15): 4271-4288.

- We propose to **improve ABR model representation and confidence** by providing a framework for driving and evaluating biosphere models with ABoVE data.

“Blind Men and the Elephant”
or
“Terrestrial Biosphere Modelers”



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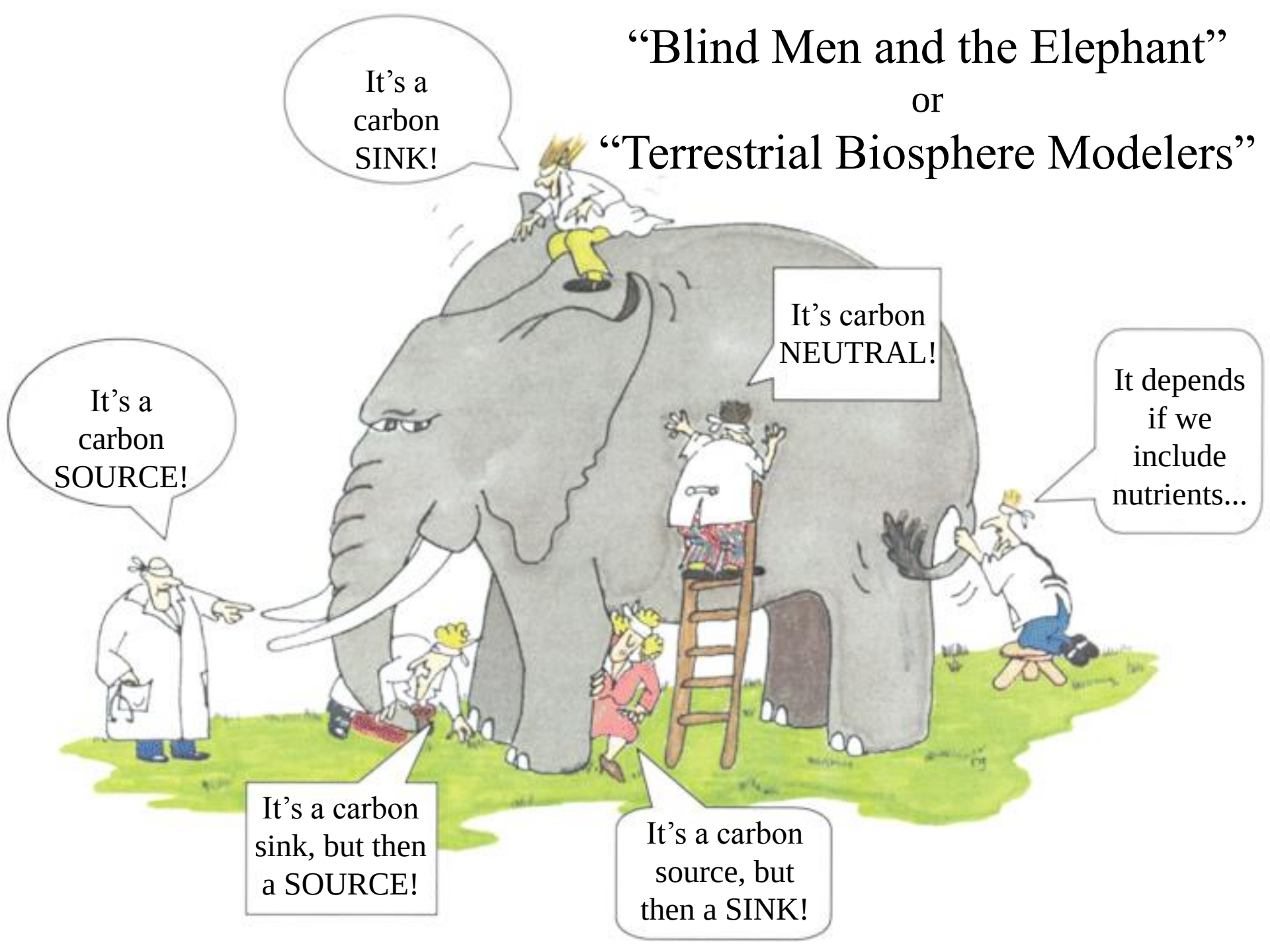
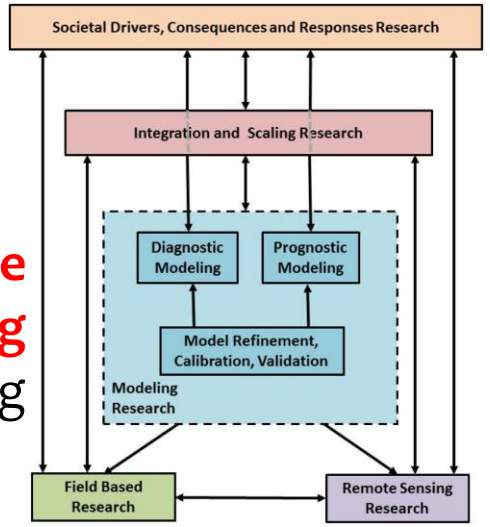


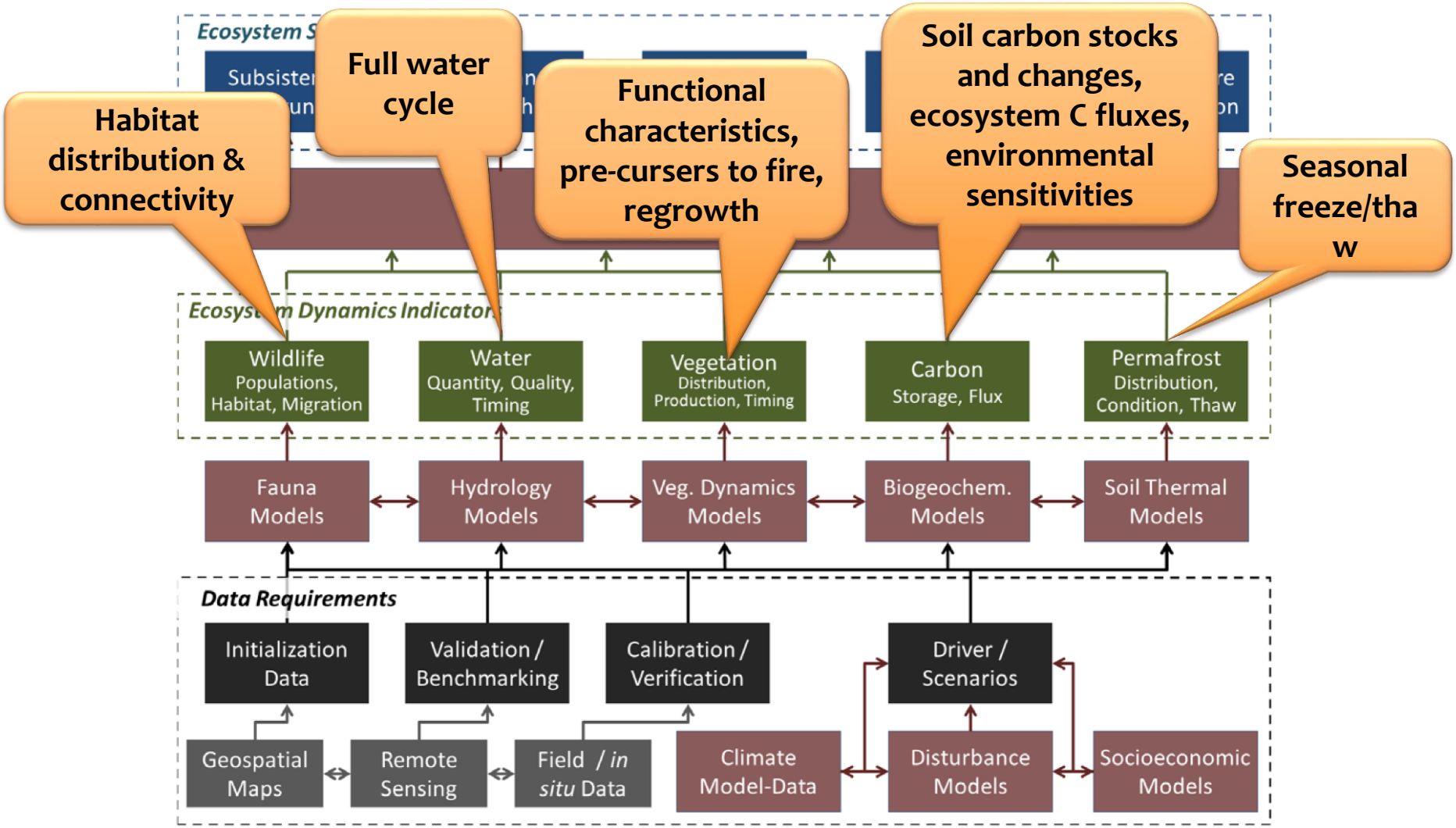
Science Objectives



Our overarching objective is to **evaluate and improve model performance of ABR ecosystem dynamics focusing on critical data gaps** in initializing, driving, and validating process-based simulations for the ABoVE domain.

Foundational [Y1]	Structural [Y2]	Synthesis [Y3]
Initial evaluations	Framework construction: data assembly & org.	Simulation benchmarking
Identify & prioritize process uncertainties	**Model–data integration & refinement**	**Evaluate model progress**
Identify & prioritize data gaps	Model simulation	**Develop ABoVE modeling for Phase II**

Science Questions



Field Studies

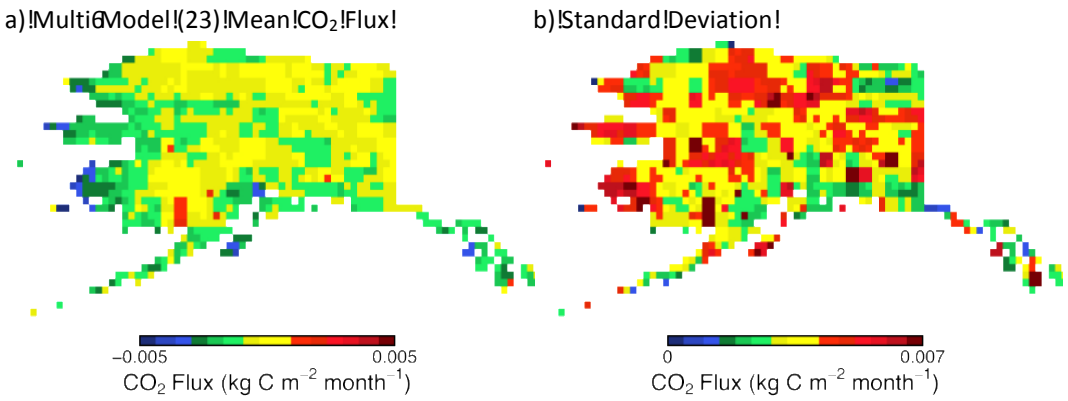


Figure 3. NACP and TRENDY multi-model (n = 23) net CO_2 flux for 2003 **(a)** mean, and **(b)** standard deviation.

The TBM inter-comparison will assess sensitivities to driver data, model structures, and uncertainties in simulating ecosystem dynamics indicators.

These results will contribute to the ABoVE data collection Implementation Plan to ensure data are collected that are designed to reduce model uncertainties.

TASK	YEAR 1												YEAR 2												YEAR 3											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
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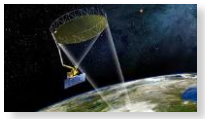
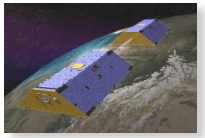
Lessons Learned report and Phase II guidance																																				

Spaceborne Remote Sensing

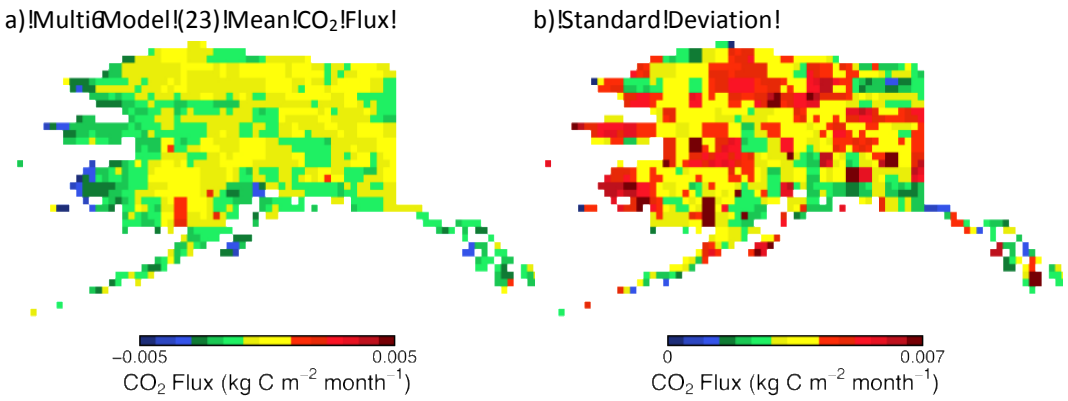
Table 1. Benchmarking data to be used in our project spans the full range of Indicators for ABoVE ecosystem dynamics.

Variable	Dataset	Coverage
Carbon Dynamics		
NDVI, EVI, LAI, fAPAR, NPP	MODIS	Global; weekly; 2002-2013
Soil Carbon Stocks / Depth	Pedons	Regional; static; 100 km
Soil Carbon Residence Time	Incubations	Local; static; 1 m
CO_2 fluxes	AmeriFlux, MPI-BGC	Local/global; hourly; 1 km
CO_2, CH_4 concentration	CARVE, GOSAT, OCO-2/3, SCIAMACHY	Regional/global; weekly; 1-3 km
Biomass	ICESat/GLAS, GEDI, CFS	Regional/global; static; 0.25-1 km
Canopy height	ICESat/GLAS, GEDI	Regional/global; static; 1 km
Water Dynamics		
Soil moisture	SMAP, SMOS, ISMN	Local/regional/global; <weekly; 3-9 km
Evapotranspiration	MODIS, ECOSTRESS	Regional/global; <weekly; 0.05-1 km
Total Water Column	GRACE	Global; monthly; >100 km
Snow characteristics	NASCN, NOAA Snow Cover, MODIS	Regional/local; weekly-annually; 1 km
Energy Dynamics		
Soil, surface temperature	GTN-P, BOREAS, MODIS	Local/regional/global; weekly-static; 1 km
Freeze/thaw	SMAP	Regional/global; <weekly; 3 km
Active layer depth	InSAR, CALM/GTN-P	Regional; static; 1 m
Albedo	MODIS, VIIRS	Global; weekly; 1 km
Fire counts, burnt area	MODIS	Global; weekly; 1 km
Net radiation	MODIS	Global; weekly; 1 km





Airborne Remote Sensing



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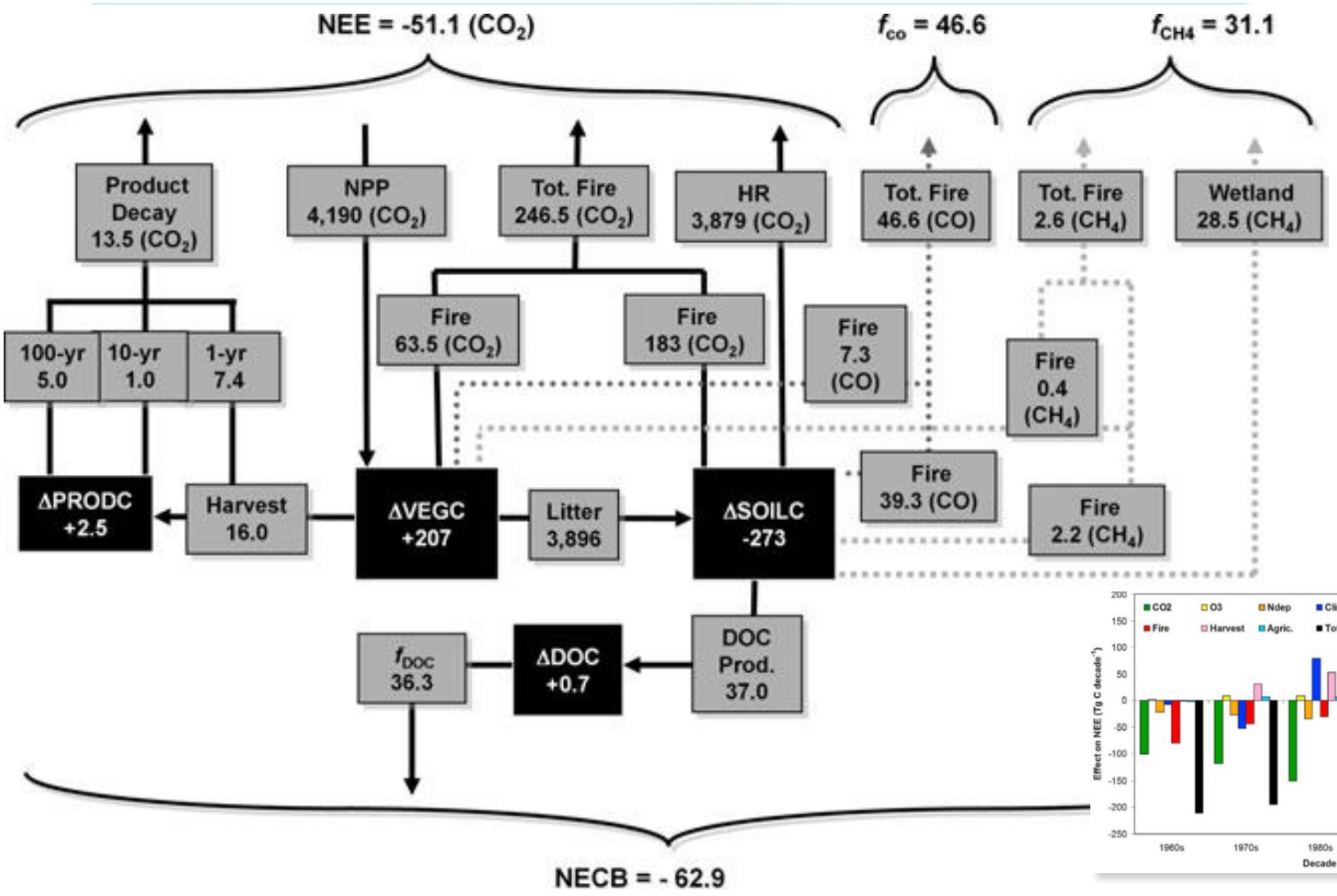
Modeling Approaches: Models



McGuire et al., 2010. An analysis of the carbon balance of the Arctic basin from 1997 to 2006. *Tellus B* 62(5): 455-474.
Hayes et al., 2011. Is the northern high-latitude land-based CO2 sink weakening? *Global Biogeochemical Cycles* 25: GB3018.

The terrestrial biosphere as represented in terrestrial biosphere models.

Modeling Approaches: Models

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aDVGM2	Simon Scheiter, Senckenberg Gesellschaft für Naturforschung, Germany	[*Scheiter and Higgins*, 2009]
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LPJ-wsl	Ben Poulter, Montana State University, USA	[*Sitch et al.*, 2003]
MC2	Dominique Bachelet, Conservation Biology Institute, USA	[*Peterman et al.*, 2014]
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TECO	Yiqi Luo, Oklahoma University, USA	[*Zhou and Luo*, 2008]
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VISIT	Akihiko Ito, National Institute for Environmental Studies, Japan	[*Ito*, 2010]

Modeling Approaches: Driver Data

Environmental driver and initialization datasets that we will organize within the ABoVE Science Cloud and make available for ABoVE modeling research

Driver data sets	Source	Temporal Resolution	Temporal Extent	Spatial Resolution	Spatial Extent
Climate fields (surface air temperature, precipitation, radiation, winds, humidity, etc.)	NARR	hourly	1970s-2000s	0.25°	North America
	DAYMET	daily	1980 - 2014	1 km^2	North America
	SNAP	monthly	1901-2009	2 km^2	ABoVE Domain
Potential vegetation	SYNMAP	-	-	0.25°	Global
	EOSD	-	-	1 km^2	Canada
	CAVM	-	-	1 km^2	Circumarctic tundra
Area burned	Canadian Large Fire Database	annual	1950s-2014	1 km^2	Canada
	AK Interagency Database	annual	1950s-2014	1 km^2	Alaska

Modeling Approaches: Format

- Organized in
  - MODEL
    - SIMULATION
      - VARIABLE (or FILE)
- NetCDF4 with internal compression
- Variable names are mapped to MsTMIP standard
- MsTMIP internal version number removed from file names
- Latitude goes from south (-90°) to north (90°)

- Conventions = "CF-1.4" ;
- history = "Standardized at ORNL (2014-06-20)\n",
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- id = "2f7dc4ab-1ac4-4486-84f8-faa7f17c6ee7" ;
- title = "BIOME-BGC monthly Veg for MsTMIP BG1 global simulation" ;
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- model_version = "v4.1.2" ;
- sim_version = "v1" ;
- contact = "Weile Wang" ;
- institution = "NASA AMES Research Center" ;
- email = "weile.wang@gmail.com" ;
- references = "http://ecocast.arc.nasa.gov\n",
  "Thornton et al. (2002) Modeling and measuring the effects of disturbance history and climate on carbon and water budgets in evergreen needleleaf forests. Agriculture and Forest Meteorology, 113, 185-222." ;
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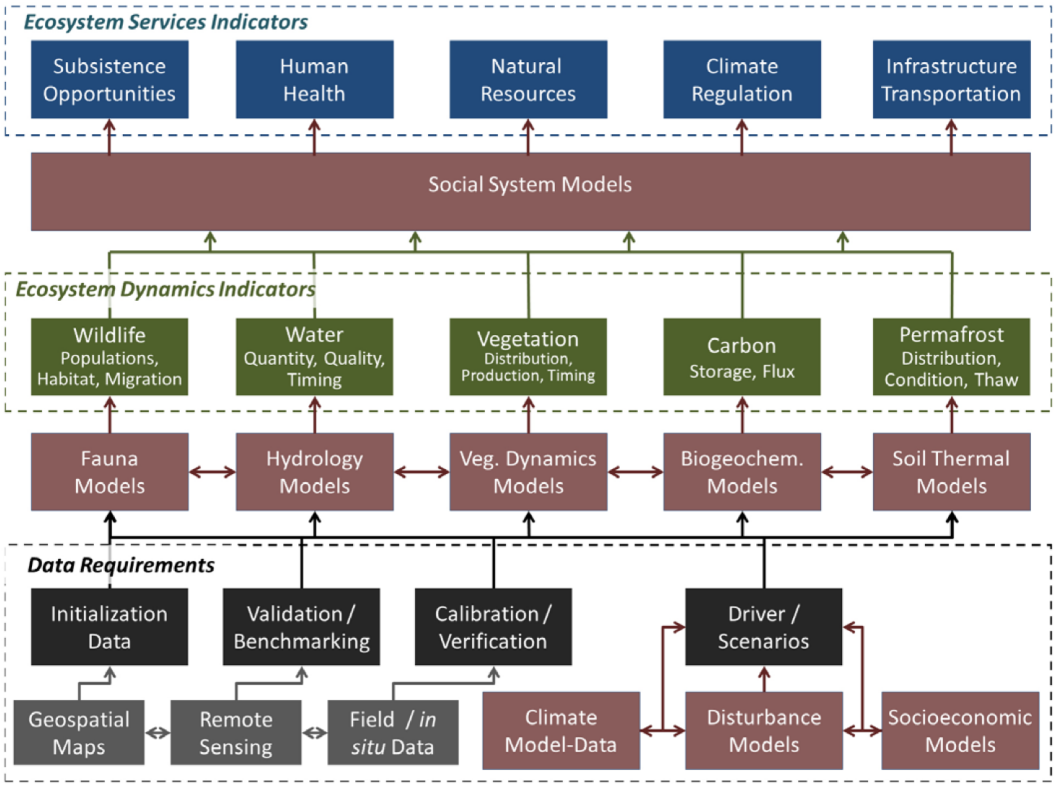
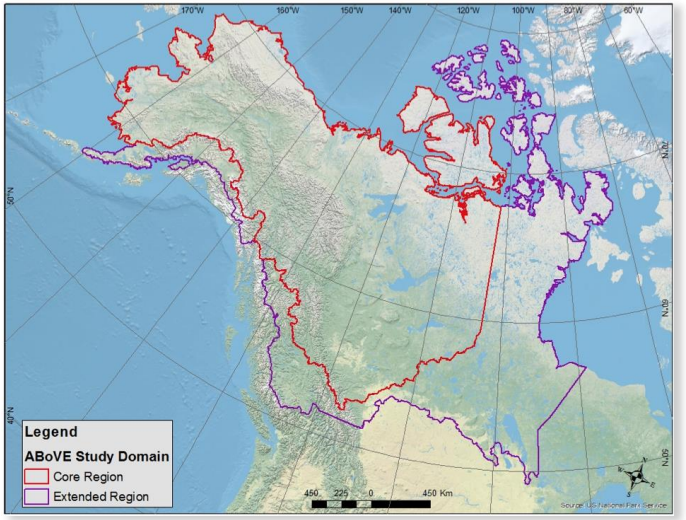
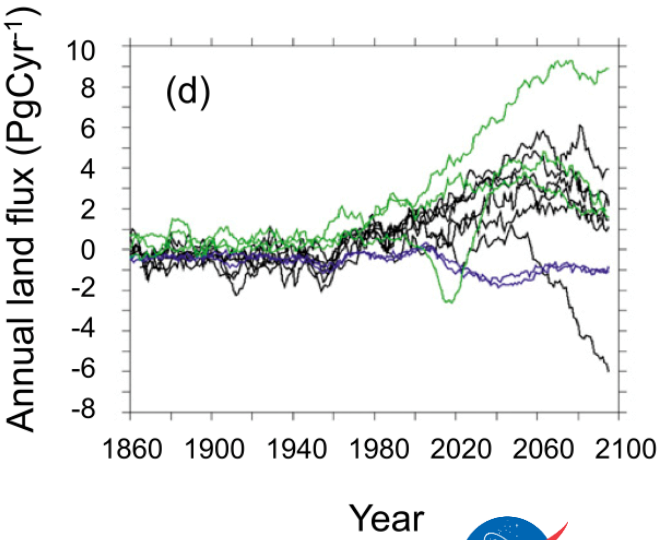
Geospatial Data Products

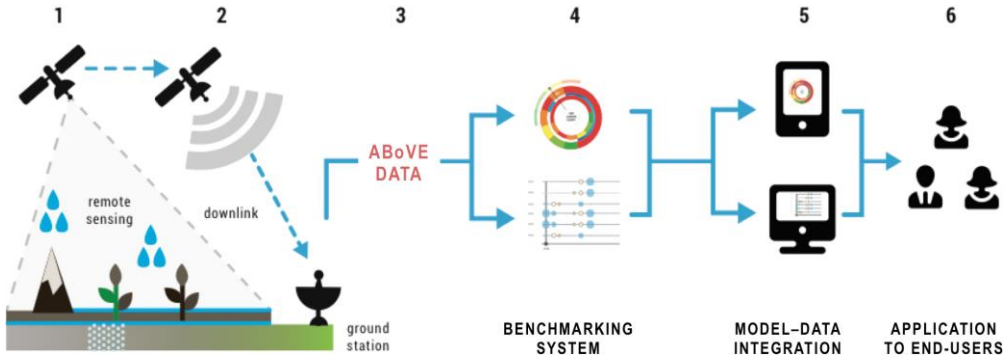






North American Carbon Program
MsTMIP
MULTI-SCALE SYNTHESIS AND TERRESTRIAL MODEL INTERCOMPARISON PROJECT

Other expected products / outcomes



- "**Lessons Learned**" report to guide preparations for ABoVE Phase II modeling research addressing **Ecosystem Services** objectives.
  - Direction and guidance for new and continued field and remote sensing data collections, model refinements and developments, and opportunities for integration across multiple modeling teams and other research activities within ABoVE.
  - In Year 3 we will begin to establish the links to the Ecosystem Services datasets and modeling requirements, following the foundation and setup we will establish throughout Phase I. **For example, this includes using permafrost projections to inform infrastructure decisions (e.g., roads, pipelines built on thawing permafrost).** The focus will be on engagement with interdisciplinary research teams toward a goal of science–data interoperability, including linking TBM frameworks with social systems to develop hypotheses related to ABoVE's Ecosystem Services Objectives.