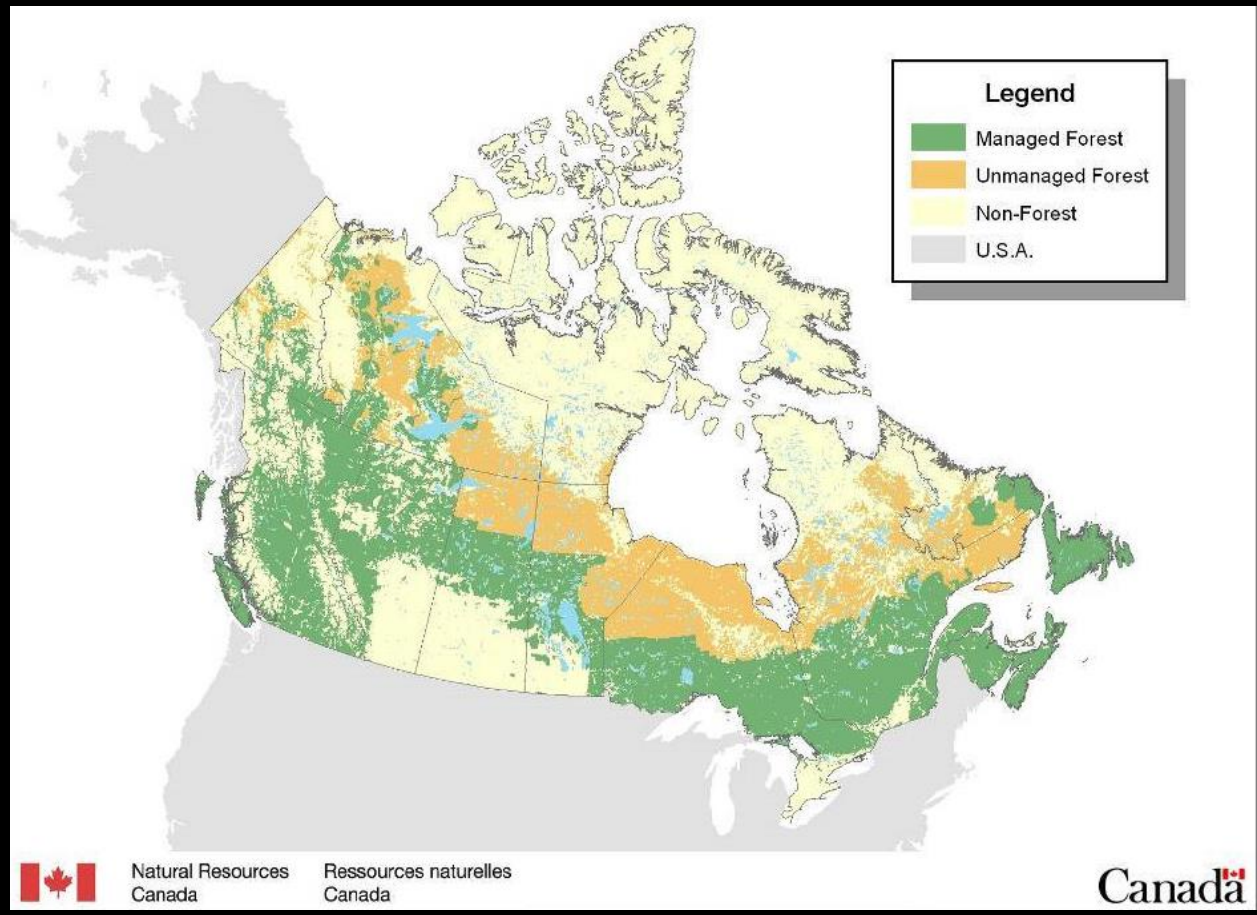
Forest Carbon modelling in the CFS

Céline Boisvenue

Research Scientists,

Pacific Forestry Service, Canadian Forest Service



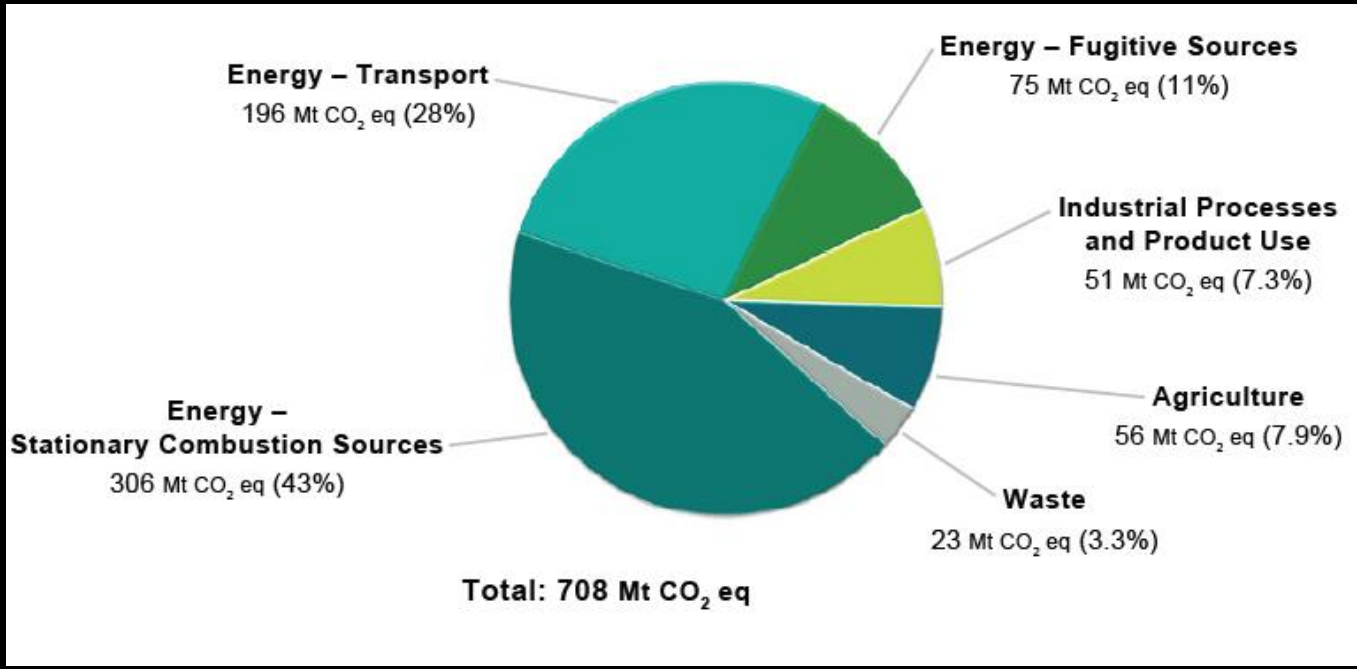
SpaDES workshop

November 19-21, 2024

GHG inventory

United Nations
Framework Convention on
Climate Change

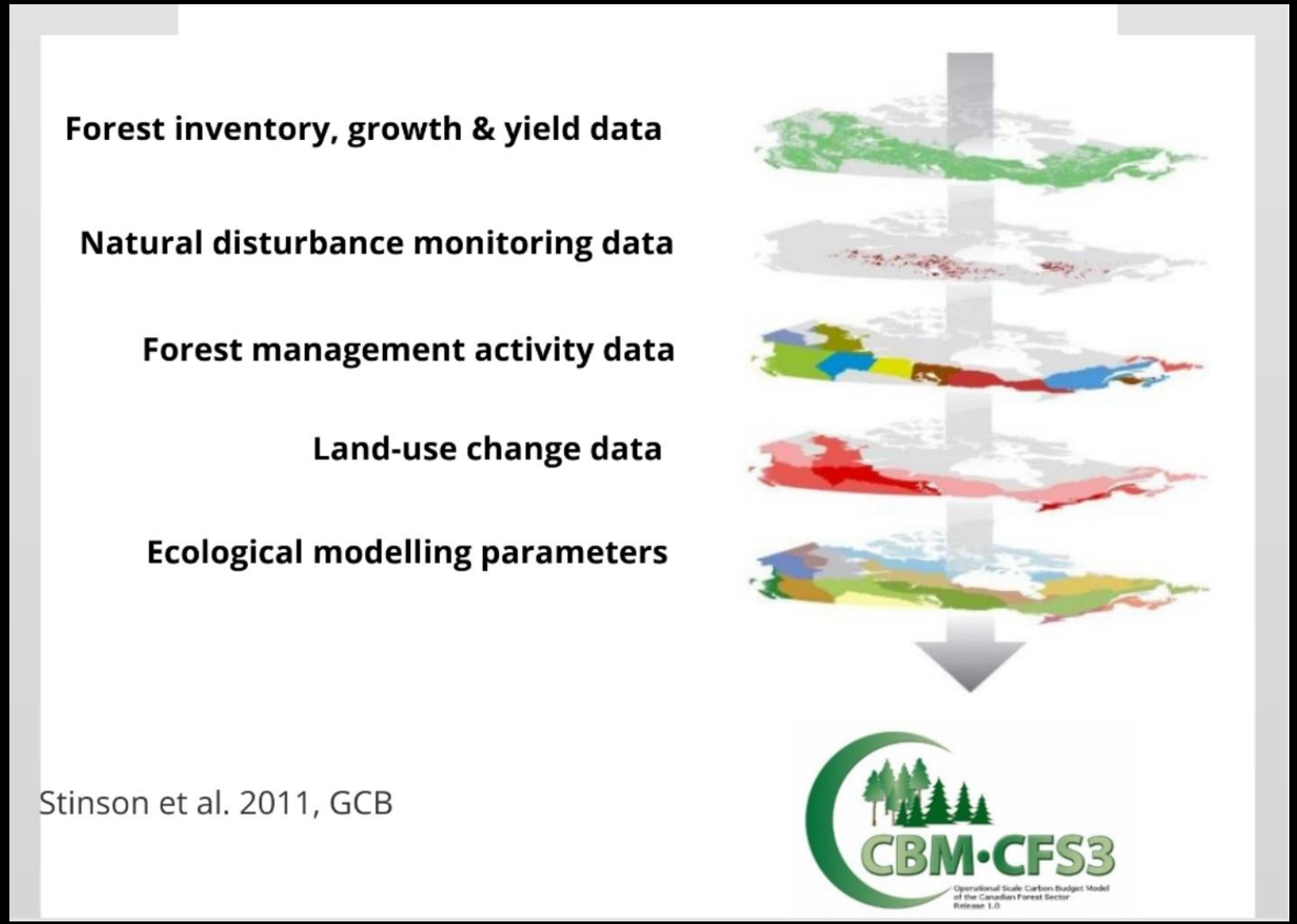
197 members



Environment and Climate Change Canada
Environnement et Changement climatique Canada

Rapport GES 2024 (2022)
https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/inventory.html

NFCMARS
National
Forest
Carbon
Monitoring,
Accounting and
Reporting
System



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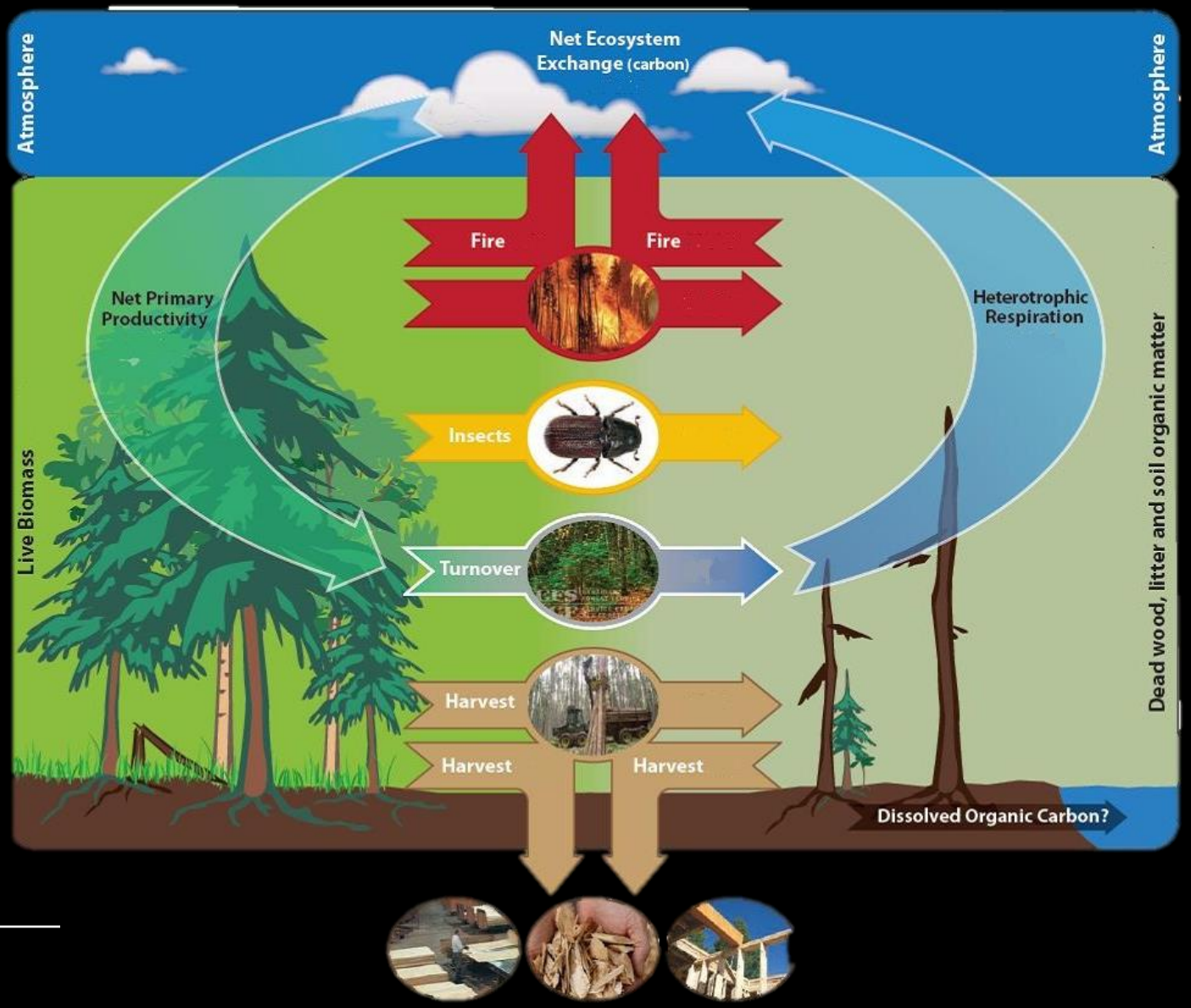
Carbon Budget Model

CBM CFS 3

- Statistical models for AGB estimation
- Process representation via equations
- Carbon pools
- Carbon transactions



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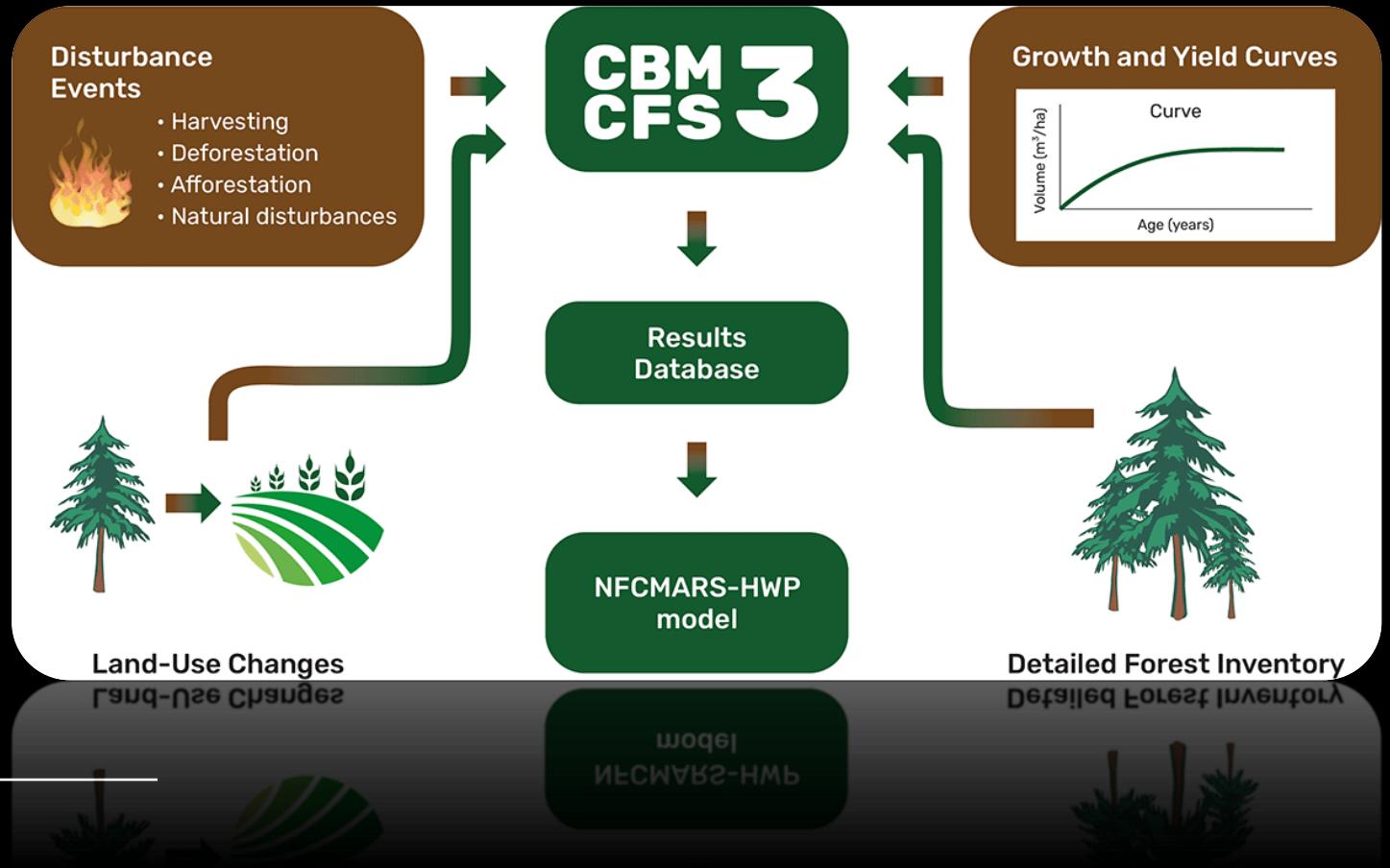
Carbon Accounting in Canada

- *Werner Kurz*
- *Mike Apps*
- *CAT + 30 years of research and collaborations*
- *2006: “Best forest carbon accounting model in the world”*

November 19-21, 2024

NFCMARS

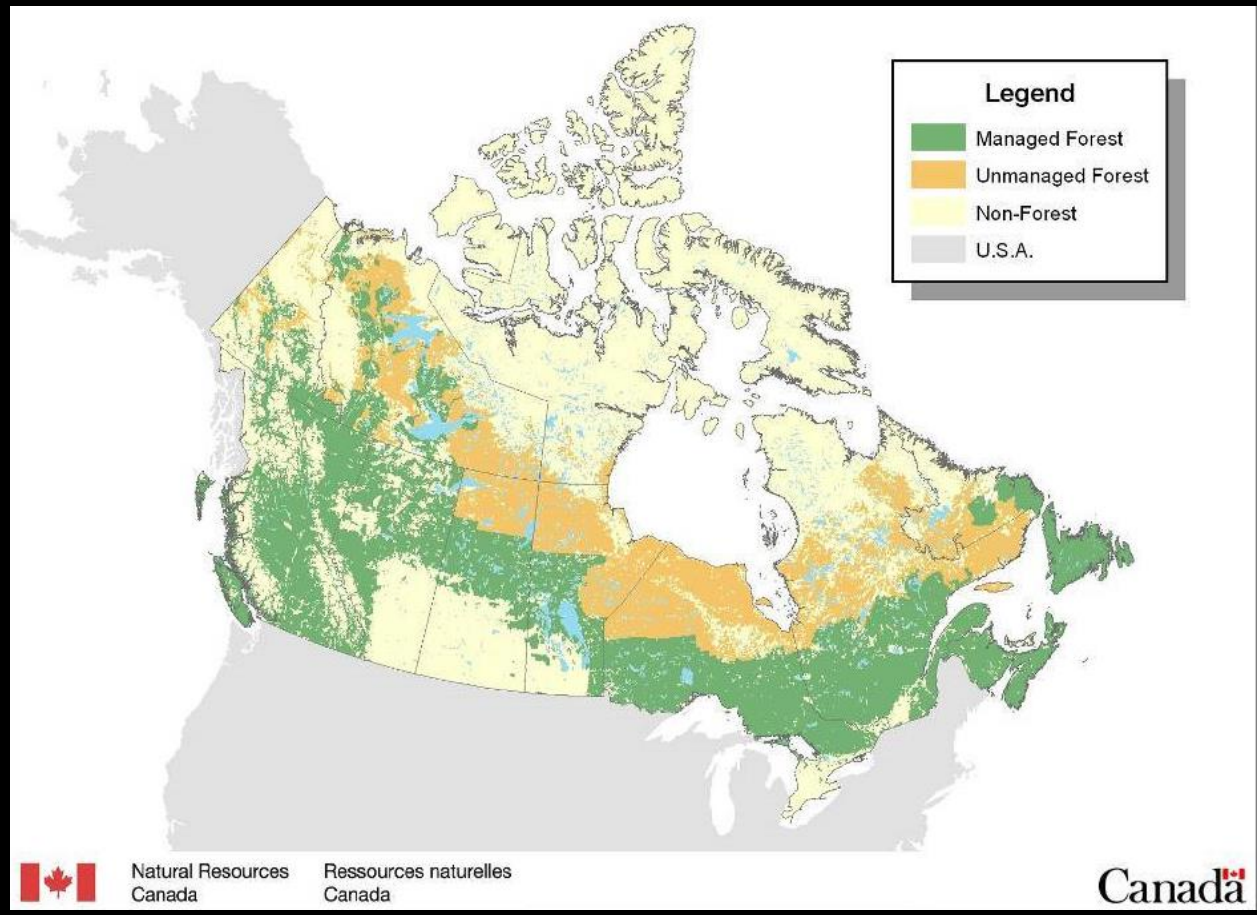
National Forest Carbon Monitoring, Accounting and Reporting System



Forest Carbon

4.4 M km2

3.6 M km2 – all forests
2.3 M km2 – managed forests



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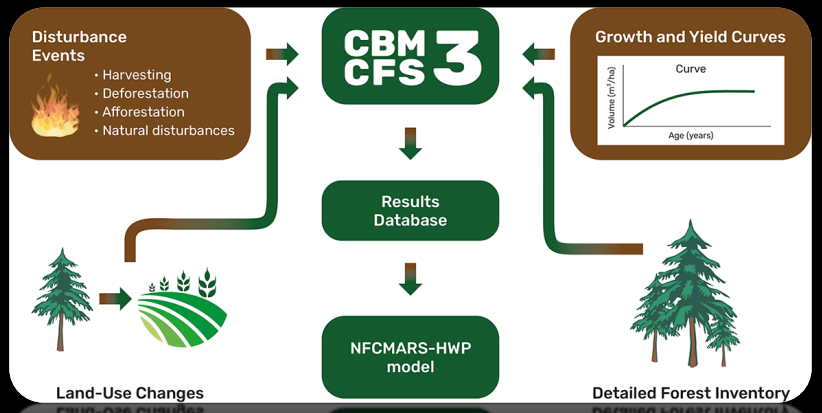
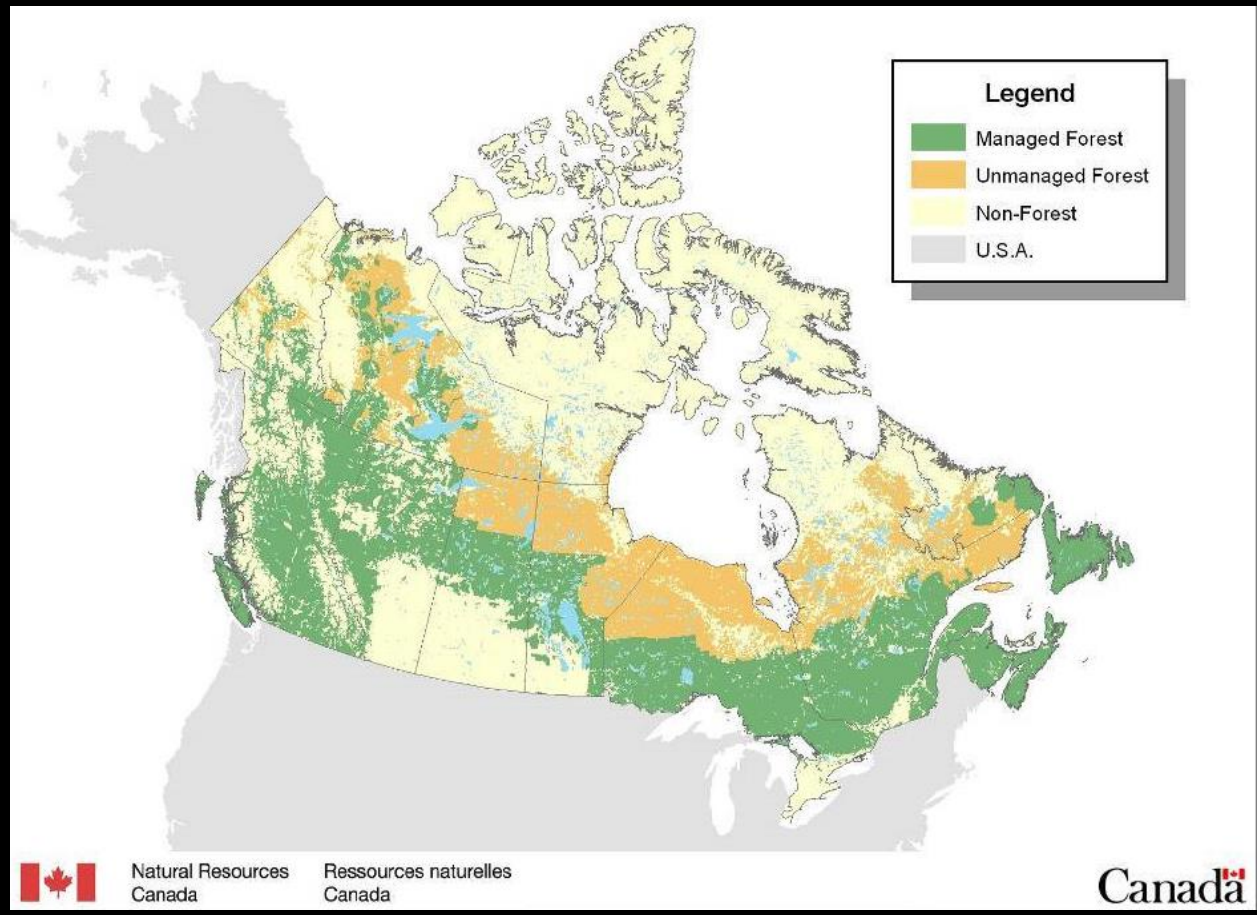




Forest Carbon in SpaDES

Forest Carbon

Forest management decisions - *Challenges*

- Changing the paradigm:
  - **there is no right answer**, we need all the models, all the information/data.
  - Test and validate current models and estimates.
  - Integrating TEK and social sciences.

- Updating/re-structuring models for transparency and linkages
- Testing new data and algorithm – models are not nimble yet!
- Technical support for modelling (CFS was a field organization)

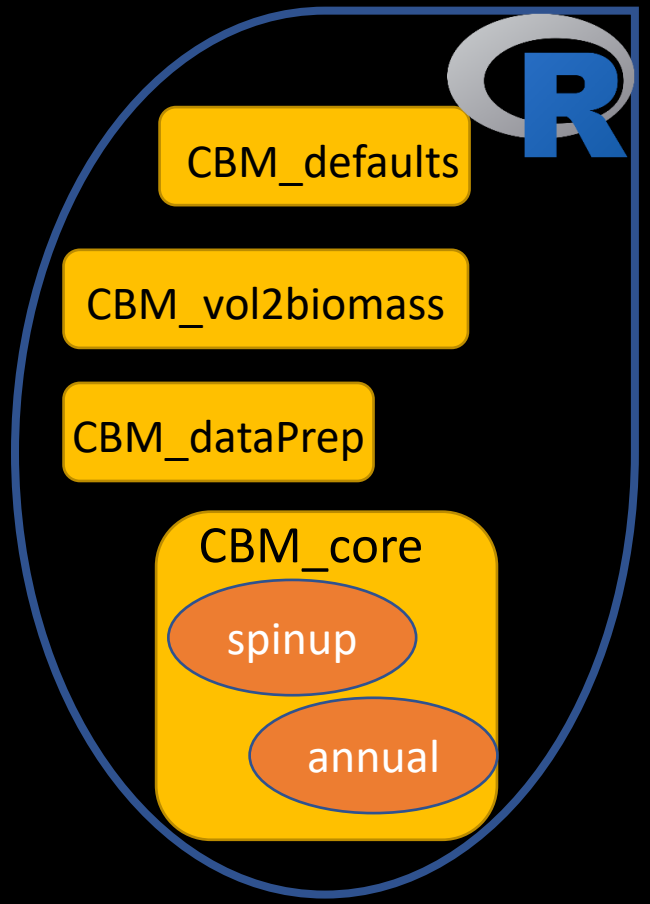
Improving C-modelling: current R&D

- At the core of our international obligations
- Rapidly evolving science (new data, concepts)
- Under intense internal and external scrutiny.

Improving C-modelling: current R&D

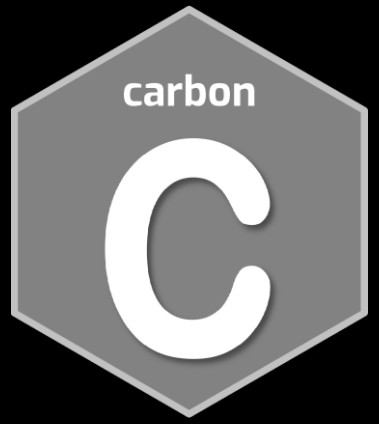
- Common problem in ecological modelling: difficult to get a handle on the model, difficult to update, etc.
- Scientific uncertainty.
- Forest carbon is really an emergent property to forest dynamics.

Improving C-modelling: current R&D



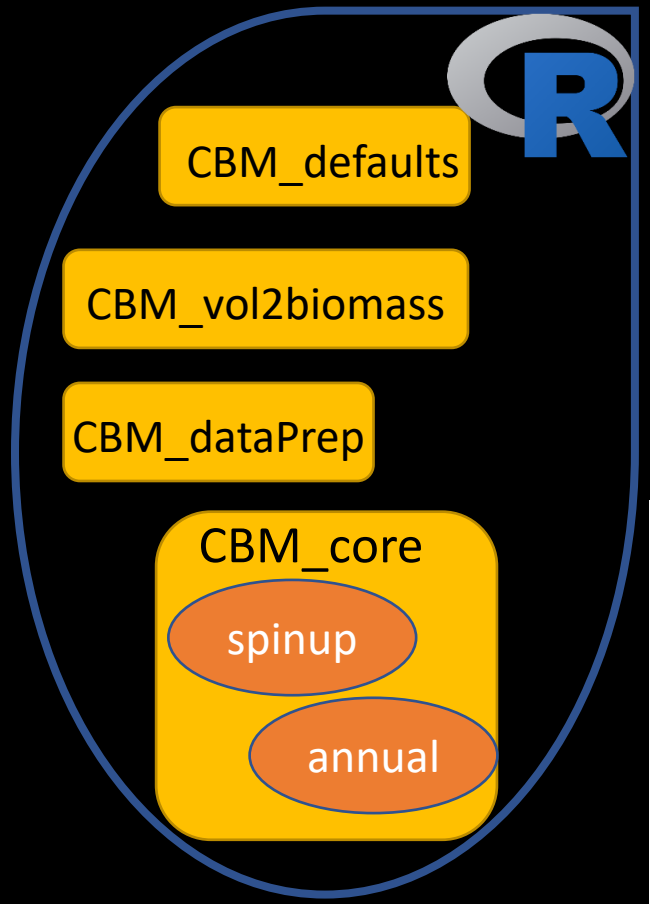
Spatial **D**iscrete **E**vents **S**ystem ***SpaDES***

- Modular
- Transparent

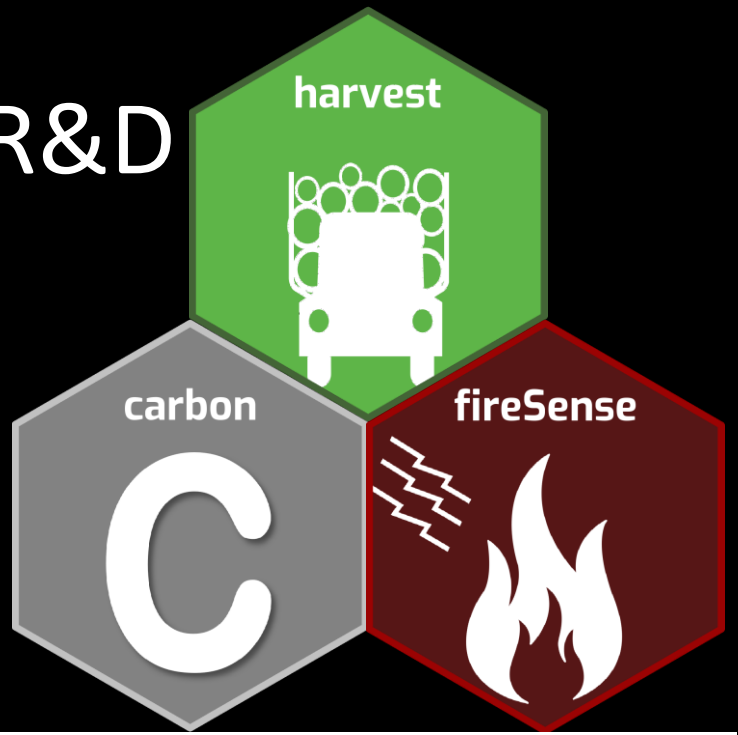


spadesCBM

Improving C-modelling: current R&D



Projections of C under harvest and fire scenarios



IOP Publishing Environ. Res. Lett. 17 (2022) 114013 https://doi.org/10.1088/1748-9326/ac9919

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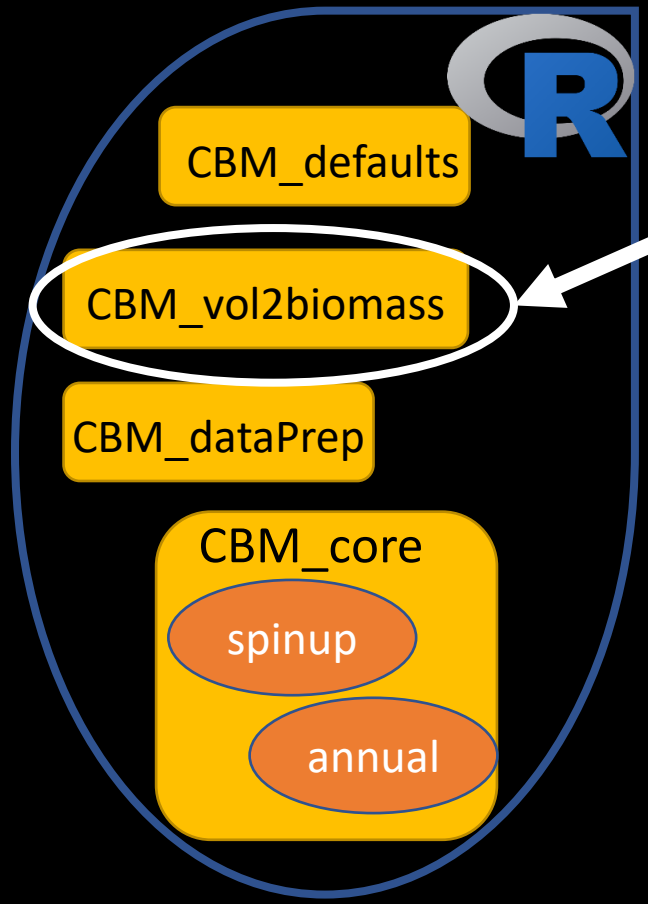
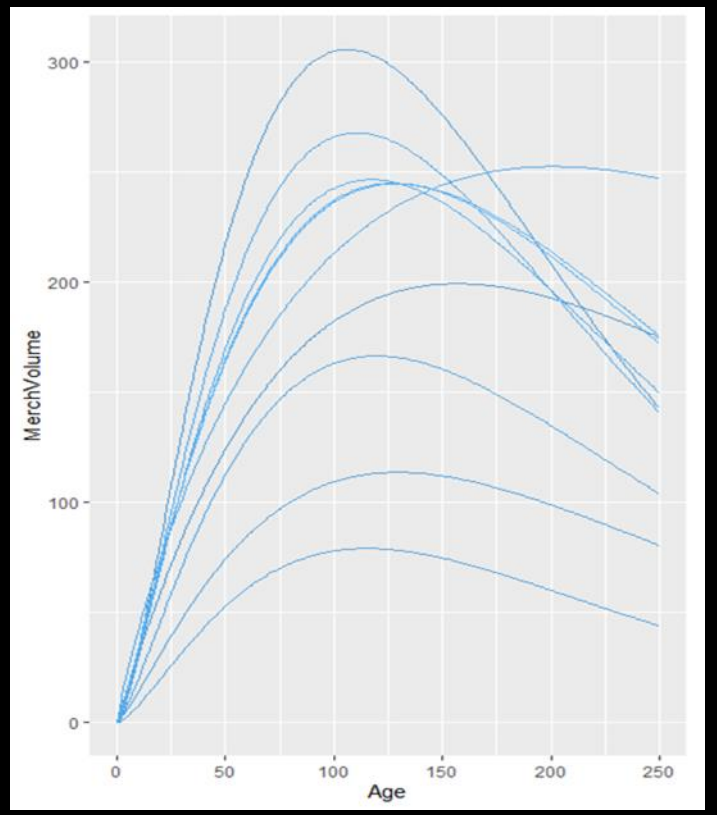
Managing forest carbon and landscape capacities

Céline Boisvenue[1,2,4,*], Gregory Paradis[2], Ian M S Eddy[1], Eliot J B McIntire[1,2,4] and Alex M Chubaty[3,4]

Improving C-modelling: current R&D



Growth curves



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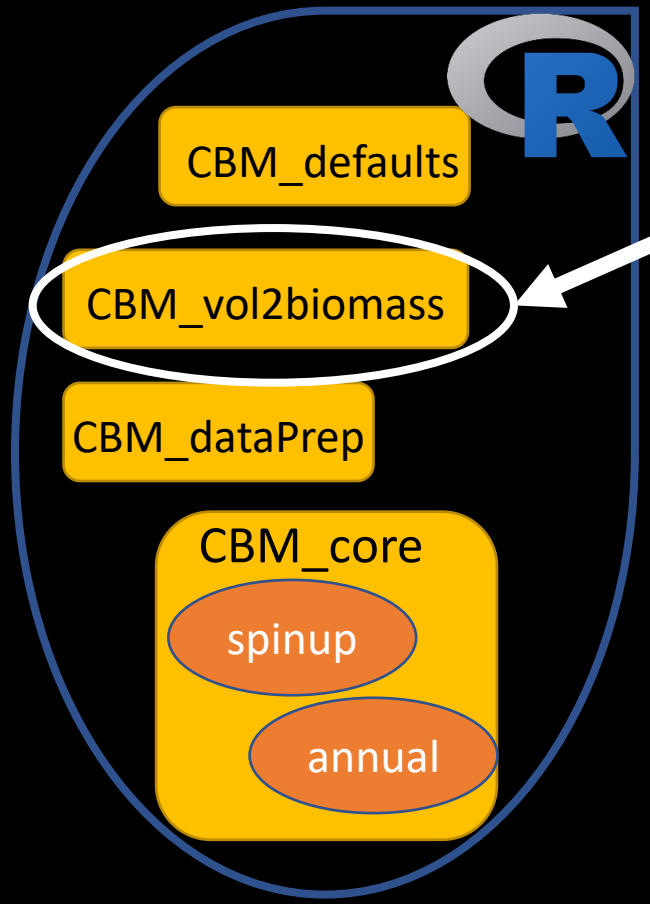
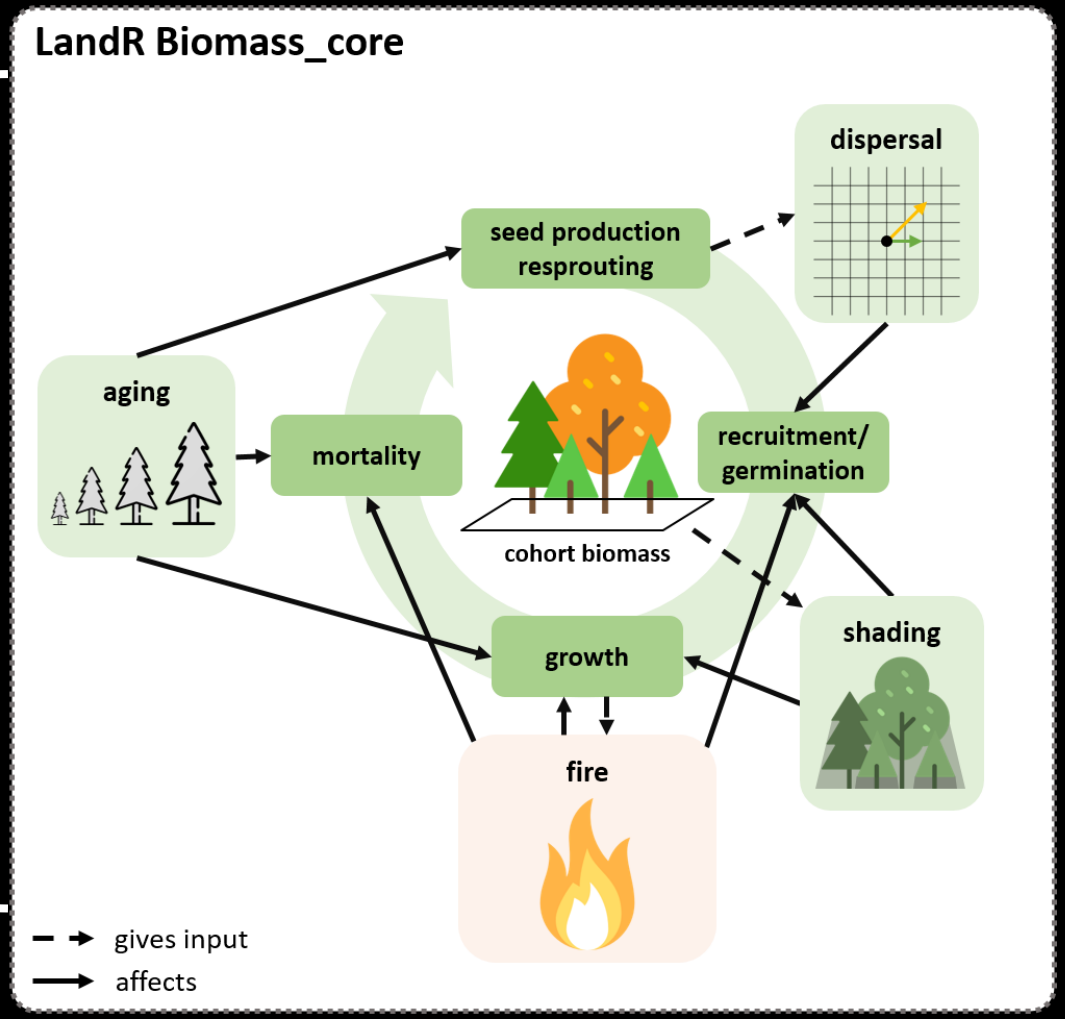
Improving C-modelling: current R&D

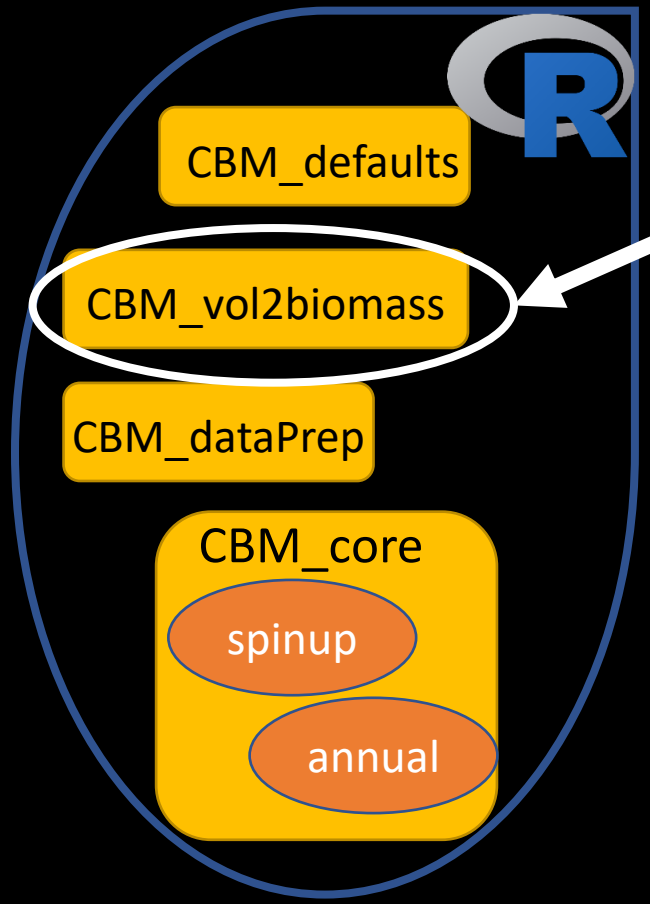


Increments

Biomass increments *emergent phenomenon by cohort*



Improving C-modelling: current R&D



Increments

Biomass increments

Cohort: combination of tree species and age. Multiple cohorts form a stand/pixel.

Data-adjusted trait-based biomass accumulation

LandR Biomass_core

- LandR Biomass_core (vegetation simulator) is based on the LANDIS II Biomass Succession Extension, recoded in R using the SpaDES toolkit
- Parameters are fit to available data (biomass, species distribution, PSP for growth)
- CS growth (Luo et al, 2019)
- Simulations under CC for western boreal region (planned for eastern boreal)
- Unmanaged forest included.

Improving C-modelling: current R&D

LandRCBM

CBM_defaults

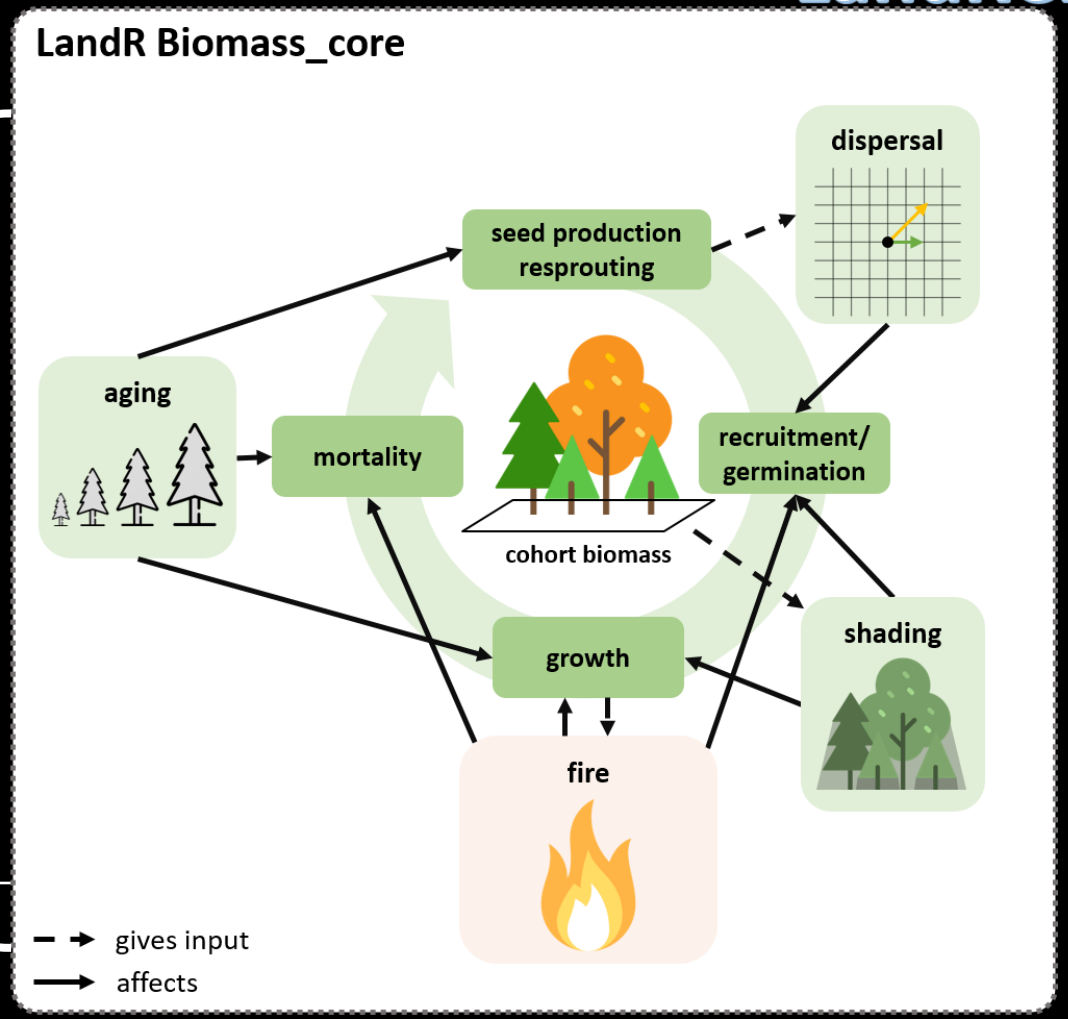
CBM_vol2biomass

CBM_dataPrep

CBM_core

spinup

annual

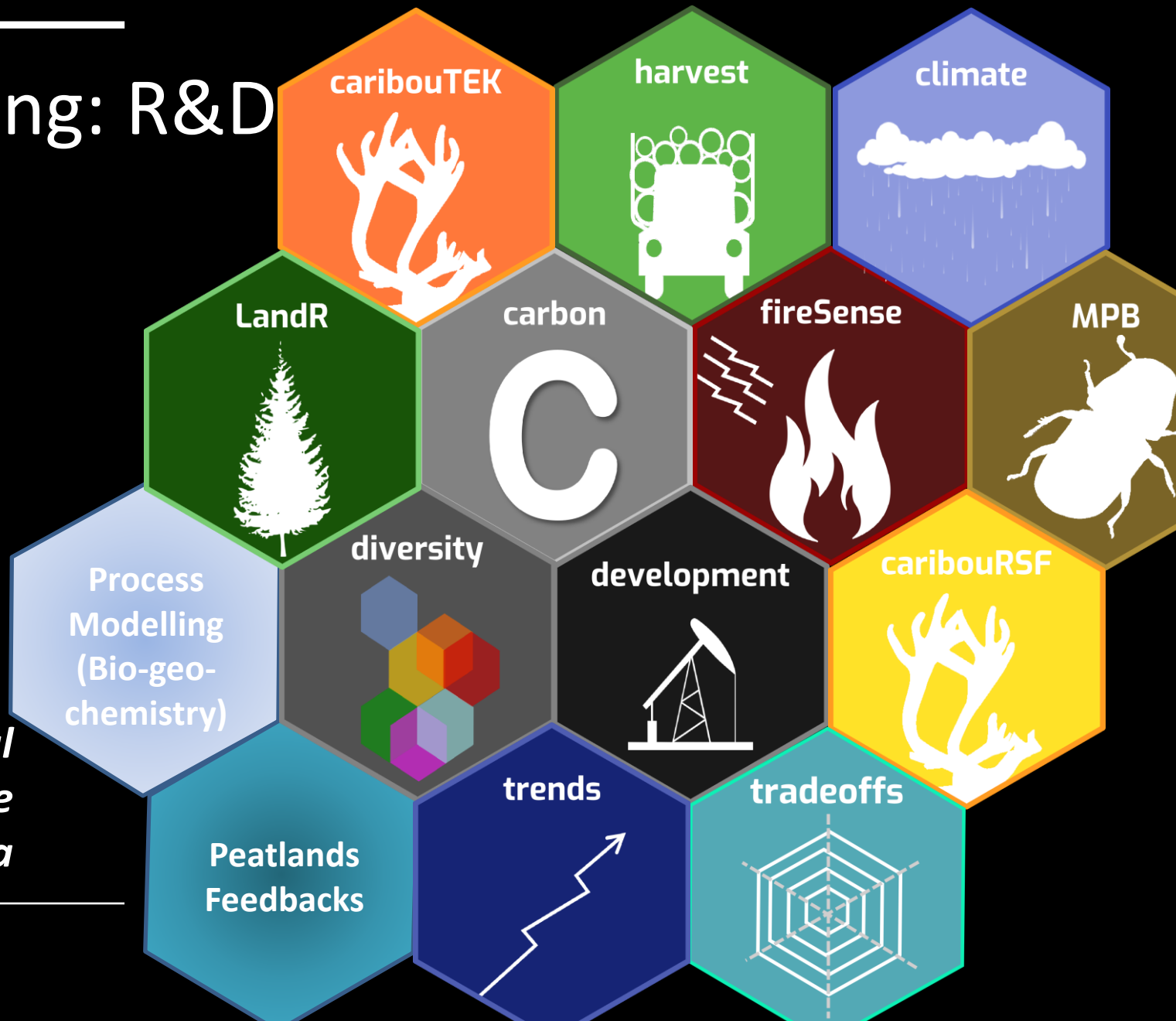


Improving C-modelling: R&D

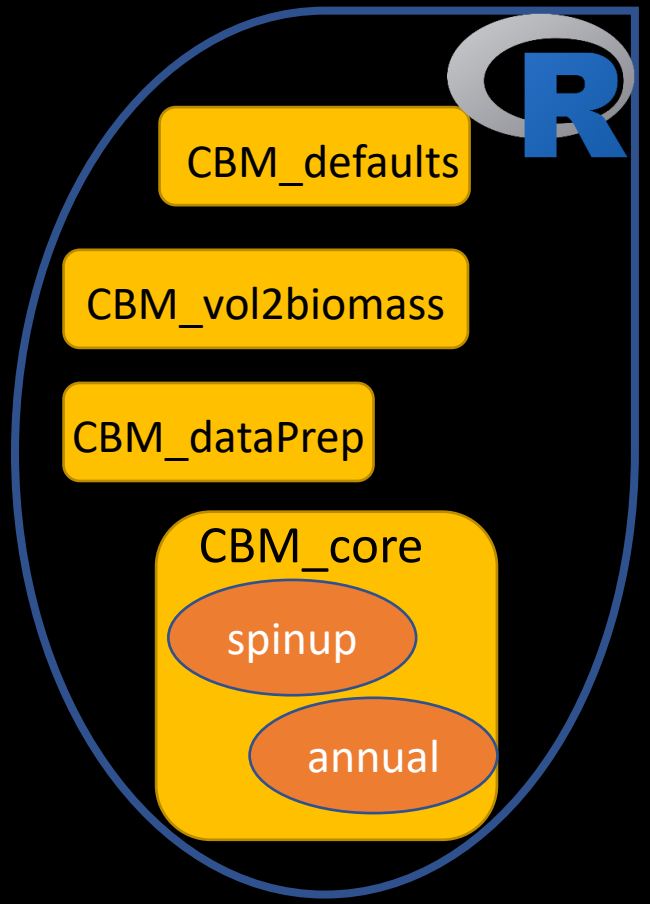
LandRCBM

Soil data

Connection to global circulation and the promise of SIF data



Challenge: improving C-modelling and reporting

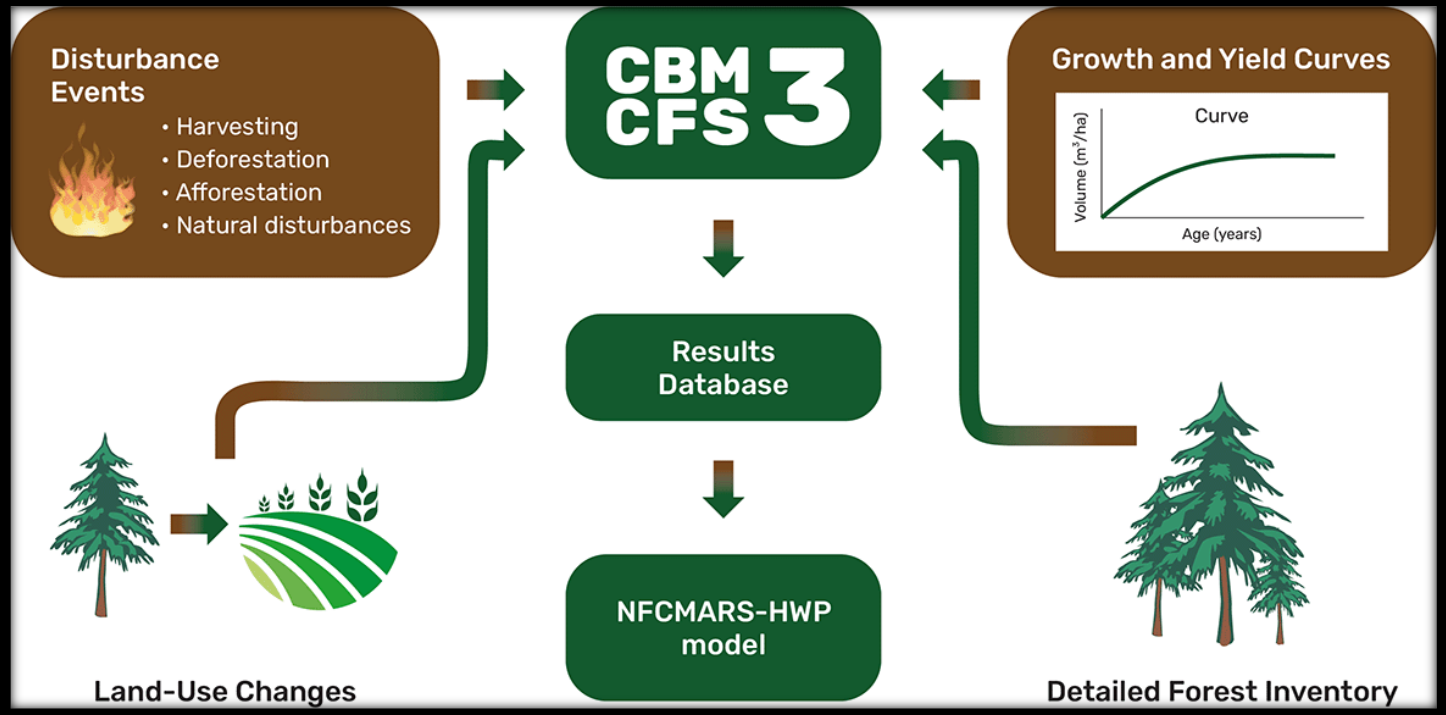


CBM CFS 3

LandRCBM

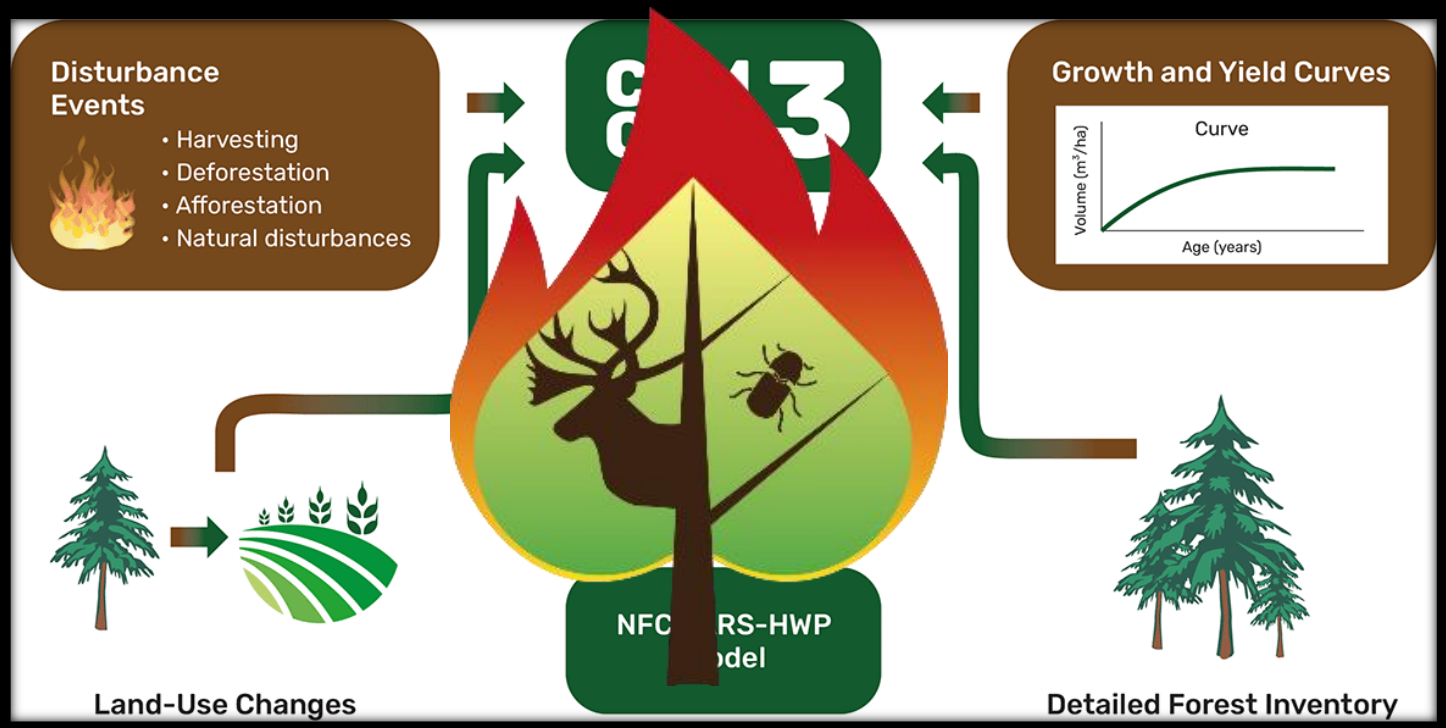
Challenge: improving C-modelling and reporting

NFCMARS



Challenge: improving C-modelling and reporting

NFCMARS



Next Generation Forest Carbon modelling system