

# The Carbon Budget Model of the Canadian Forest Sector: combining inventories, remote sensing and models to estimate emissions and removals

---

Werner A. Kurz

Natural Resources Canada  
Canadian Forest Service  
Victoria, BC, Canada

Expert Meeting on REDD  
25-26 May 2010, Bonn, Germany



Natural Resources  
Canada

Ressources naturelles  
Canada

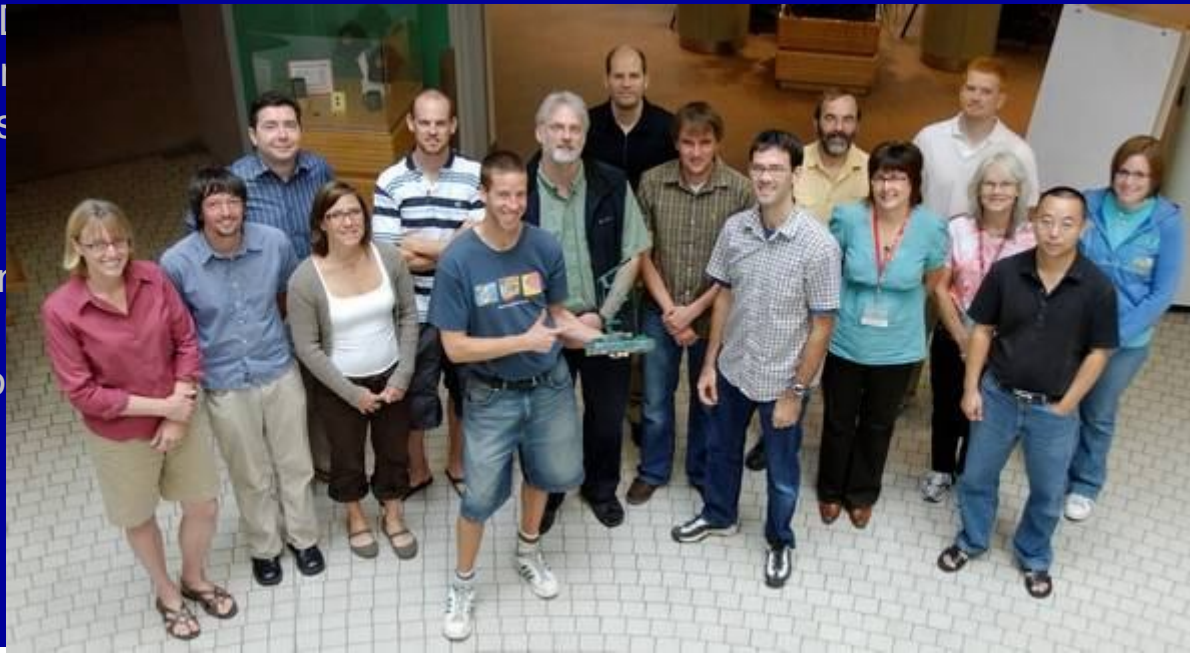
Canada

Greg Rampley Graham Stinson Caren Dymond Eric Neilson Juha Metsaranta Michael Magnan  
Gary Zhang Carolyn Smyth Stephen Kull Cindy Shaw Mike Apps Ed Banfield Tony Trofymow  
Brian Simpson Thomas White Tony Lempriere Peter Graham Darcie Booth Jim Wood Jim Farrell  
Michael Ter-Mikaelian Steve Colombo

## A Team Effort!

David Price Dave  
Paul Gray Ivan I  
Mike Bartlett Jon  
Lois Macklin Jas  
Steve Banducci  
Kevin Belanger  
Marcus Jeon Tim  
Tim Ebata Ling  
Carrier Kim Tho  
Surkova Kersti  
Grabovsky  
Jong Hannes  
Carroll Rich  
Safranyik Terry

MacLean David Gray  
Michel Campagna  
er Bob Wynes  
son Peter Steer  
ey Tom Lakusta  
Zhu Rooz Araghi  
chivatecheva  
Altaf Arain Orion  
ik Johnson Helen  
ott Morken Wasily  
Olguin Ben de  
eve Taylor Allan  
g Ed Berg Les  
uro Thandi



Dominic  
Paul A  
Alfero  
Nealis  
Will Bu  
Song B  
Wang  
DeGro  
Larabie

CFS Carbon Accounting Team in Victoria and Edmonton in close cooperation with CFS policy community in Ottawa  
For national-scale analyses input from Resource Management Agencies in all Provinces and Territories  
Collaboration with scientists in CFS, universities in Canada and abroad, IPCC colleagues, and many others ...

h  
ene  
e  
ells  
x  
u  
ll  
e

# Outline

---

- Overview of CBM-CFS3
- International Applications
- Conclusions



# Approaches to Developing Forest Carbon Budgets

---

- Choice of methods depends on national circumstances and intended use of the system
  - Difference between two inventories (e.g. USA)
  - One inventory plus change information (e.g. Canada)
  - No Inventory – process modelling (e.g. Australia)
  - Mixed approaches (?)
- Convergence of methods can be expected

## Key Elements of Canadian Approach

---

- Science-based conceptual framework is the foundation for the design, and for data synthesis and integration
- Build on forest management knowledge – data driven!
- Initially, combine one inventory with change information.
- Develop models, databases and infrastructure for monitoring and projections using best-available data
- Conduct scenario and sensitivity analyses
- Improve available data for use in monitoring and reporting
- System evolves with better data and new science
- IPCC Tier 3 approach

# Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

- An operational-scale model of stand and landscape-level forest C dynamics.
- Allows forest managers to assess carbon implications of forest management: increase sinks, reduce sources

- Builds on 20 years of CFS Science
- Freely available at:  
[carbon.cfs.nrcan.gc.ca](http://carbon.cfs.nrcan.gc.ca)

Kurz et al. 2009, Ecol. Modelling



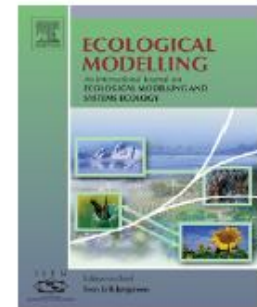
# Several publications on model structure, sensitivity analyses and applications



available at [www.sciencedirect.com](http://www.sciencedirect.com)  
Ecological Modelling (2009) 220: 480-504



journal homepage: [www.elsevier.com/locate/ecolmodel](http://www.elsevier.com/locate/ecolmodel)



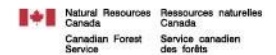
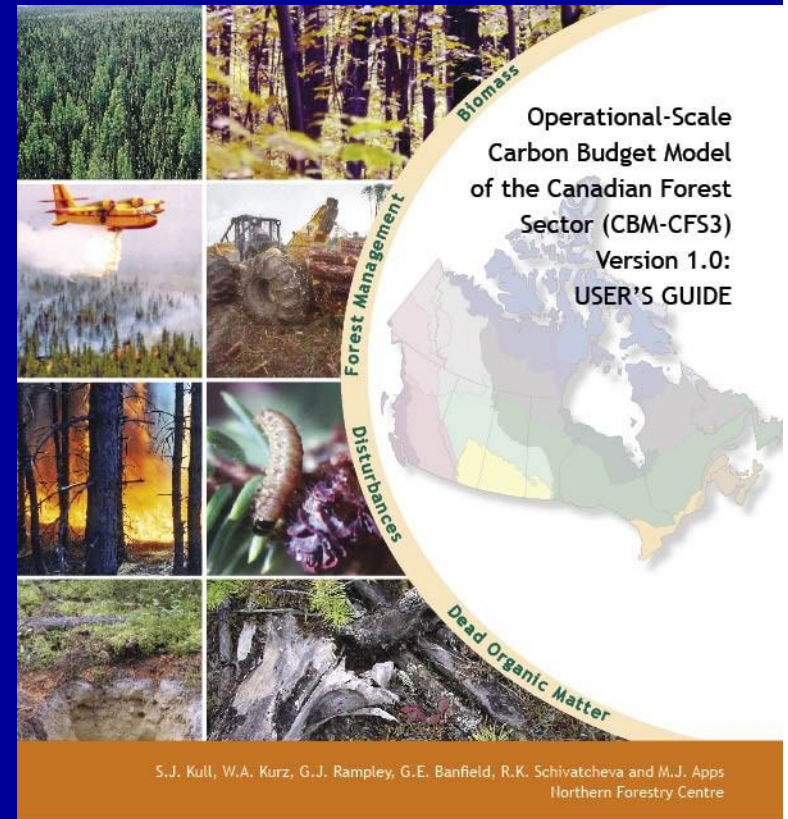
## **GBM-CFS3: A model of carbon-dynamics in forestry and land-use change implementing IPCC standards**

W.A. Kurz<sup>a,\*</sup>, C.C. Dymond<sup>a</sup>, T.M. White<sup>a</sup>, G. Stinson<sup>a</sup>, C.H. Shaw<sup>b</sup>, G.J. Rampley<sup>a</sup>,  
C. Smyth<sup>a</sup>, B.N. Simpson<sup>b</sup>, E.T. Neilson<sup>a</sup>, J.A. Trofymow<sup>a</sup>, J. Metsaranta<sup>a</sup>, M.J. Apps<sup>a</sup>

White, T. N. Luckai, G.R. Larocque, W.A. Kurz, C. Smyth. 2008.  
A practical approach for assessing the sensitivity of the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3),  
Ecological Modelling 219: 373–382

# Carbon Budget Model of the Canadian Forest Sector (CBM-CFS3)

- CBM-CFS3 Toolbox includes
  - Software and databases
  - User's Guide and Tutorials
- Over 600 downloads / 42 countries
- 11 Training Workshops
  - 250+ Trainees
  - from 28 countries
- Liaison Officer for support:  
[Stephen.Kull@nrcan.gc.ca](mailto:Stephen.Kull@nrcan.gc.ca)







# Canada's National Forest Carbon Monitoring, Accounting and Reporting System (NFCMARS)

Reporting of GHG balance to EC for National GHG Inventory Reporting.

Analyses in support of policy development and negotiations.

# CBM-CFS3 General Approach

---

## Stratification of forest into classes

Species, site productivity, management type and other criteria used to divide forest estate into strata

## Relies heavily on existing forest inventory information

Input data from forest inventories (or remote sensing)

Empirical representation of growth dynamics at the stand level.

## Dead Organic Matter (DOM) Dynamics linked to Biomass

Process modelling of litterfall, mortality, disturbance impacts and decomposition to estimate DOM pools

## Simulates natural disturbances, forest management and land-use change

Input data from forest monitoring including remote sensing

# CBM-CFS3 Input Data Requirements

---

## Must Have

Forest inventory – area by growth type and age  
Volume over age curves for all growth types  
Transition rules for growth curves

## Optional Input or User-specified Assumptions

Schedule of harvests and other management activities  
Natural disturbance data (type, area, year)  
Land-use change (Afforestation, Deforestation)

## Provided with CBM-CFS3 (can be changed by user)

Volume to biomass conversion equations  
Ecological parameters

# CBM-CFS3

---

- Compliant with IPCC 2003 GPG and 2006 Guidelines



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

NATIONAL GREENHOUSE GAS INVENTORIES PROGRAMME



## Good Practice Guidance for Land use, Land-use Change and Forestry

# Outline

---

- Overview of CBM-CFS3
- International Applications
- Conclusions



## **CBM-CFS3 International Applications: Russia**

---

- Collaboration with Russian Federal Forest Agency and Russian Academy of Sciences through bilateral agreement between Canada and Russia.
- Application of model to three regional case studies and at national scale.
- Russian language interface in preparation
- Training workshop planned for fall 2010.

### **ОЦЕНКА И ПРОГНОЗ УГЛЕРОДНОГО БЮДЖЕТА ЛЕСОВ ВОЛОГОДСКОЙ ОБЛАСТИ ПО КАНАДСКОЙ МОДЕЛИ CBM-CFS\***

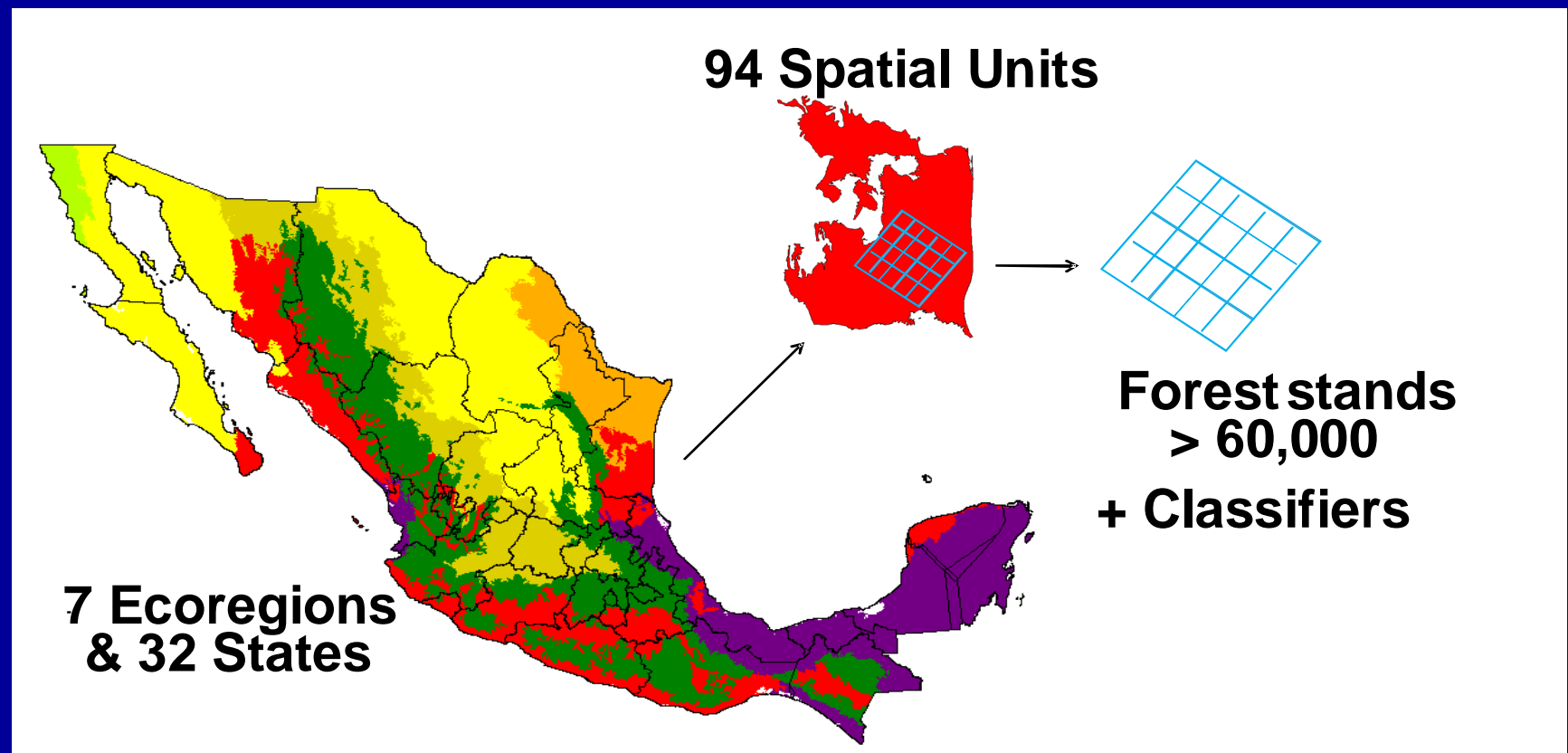
© 2008 г. Д. Г. Замолодчиков<sup>1</sup>, В. И. Грабовский<sup>1</sup>, Г. Н. Коровин<sup>1</sup>, В. А. Курц<sup>2</sup>

### **Assessment and Projection of Carbon Budget in Forests of Vologda Region Using the Canadian Model CBM-CFS**

**D. G. Zamolodchikov, V. I. Grabovsky, G. N. Korovin, W. A. Kurz**

# CBM-CFS3 International Applications: Mexico

- Testing of model in several pilot regions to determine potential suitability of model for UNFCCC reporting and REDD strategy development at national scale.
- 2 workshops and one training session completed in Mexico.



# Examples of CBM-CFS3 International Applications

---

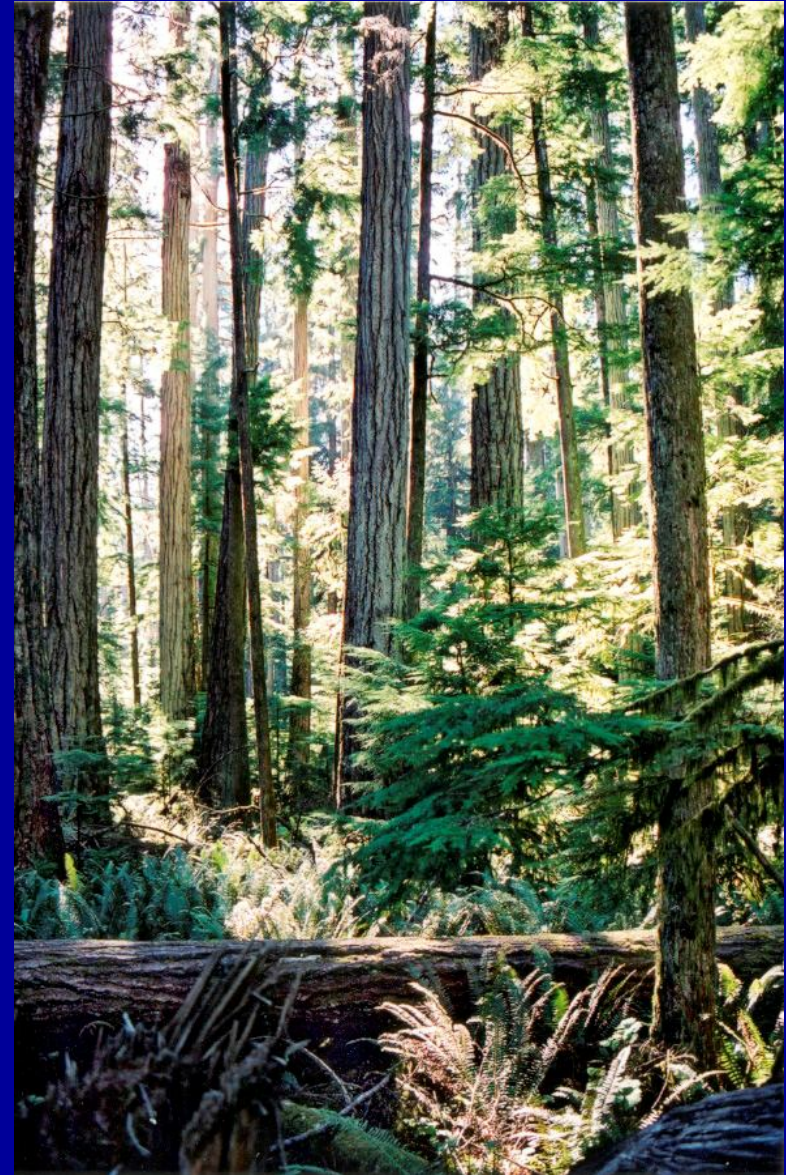
- Russia
- Mexico
- Spain (Castilla y Leon Region)
- Italy (Joint Research Centre of EU)
- China (M.Sc. Student)
- US – Alaska (Ph.D. Student)
- Tasmania (Australia –Forestry Tasmania )
- Korea (two pilot areas for testing)



# Opportunities for International Applications of Model

---

- CBM-CFS3 provides framework for integration of available data.
- Scientific focus can be on data compilation and analysis rather than development of GHG accounting framework.
- Sensitivity analyses to help prioritise data needs.
- IPCC compliant approach.
- Ongoing scientific development and improvements.



# Challenges for International Applications of Model

---

- Long history of land use and land-use change complicates initialization of dead organic matter pools.
- Volume to biomass conversion parameters required.
- Recommend testing in pilot applications and review of results prior to large-scale application.
- Need for ground-plot data with complete carbon estimates for testing and parameter development.



# Conclusions

---

- CBM-CFS3 is an operational-scale model for use from stand level to national scale.
- Core model of Canada's National Forest Carbon Monitoring Accounting and Reporting System (NFCMARS)
- Used for international reporting to UNFCCC and others
- Used nationally and internationally
- Growing number of scientific publications
- Ongoing scientific and technical improvements
- Can be applied to project-level C accounting
- Assessment of forest sector mitigation options in progress.



**Thank you very much!**



Natural Resources Canada  
Ressources naturelles Canada



Forest Carbon Accounting  
Comptabilisation du Carbone Forestier

Canadian Forest Service  
Service canadien des forêts



**<http://carbon.cfs.nrcan.gc.ca>**

**e-mail: [werner.kurz@nrcan.gc.ca](mailto:werner.kurz@nrcan.gc.ca)**

**Publications at: <http://bookstore.cfs.nrcan.gc.ca>**

**Model Support: [stephen.kull@nrcan.gc.ca](mailto:stephen.kull@nrcan.gc.ca)**

**Canada** 

## References

- *Model Description*

Kurz, et al. 2009, *Ecological Modelling* 220: 480-504.

Kurz and Apps. 2006. *Mitigation and Adaptation Strategies for Global Change*, 11: 33–43.

- *Uncertainty Assessment*

White et al. 2008. *Ecological Modelling* 219: 373–382.

- *Example Applications:*

Kurz et al., 2008, *Nature*, 452: 987-990,

Kurz et al., 2008, *PNAS*, 105(5): 1551-1555.

Kurz et al. 2007, *Phil. Trans. R. Soc. B* doi:10.1098/rstb.2007.2198

Trofymow et al. 2008 *Forest Ecology and Management* 256: 1677–1691

Publications available at

<http://bookstore.cfs.nrcan.gc.ca>

Canada 