

The Community Atmosphere Biosphere Land Exchange (CABLE) model

Annual Report: July 2012 – June 2013

Collated by Rachel Law, 28 June 2013.

1 Introduction

The Community Atmosphere Biosphere Land Exchange (CABLE) model is used for land-surface research. It can be run in 'standalone' mode or coupled to an atmospheric model for single locations, regionally or globally. This annual report summarises the development of CABLE over the last 12 months, documents activities that support CABLE to operate as a community model and lists publications that describe research using CABLE.

2 Science highlights

CABLE has contributed to some significant science achievements in 12/13. CABLE-1.8 provided the land surface component of the Australian Community Climate and Earth System Simulator (ACCESS)1.3 simulations which were submitted to the Coupled Model Intercomparison Project (CMIP5)¹. CABLE, as part of the BIOS2 framework, was an integral part of the Australian region contribution to the REgional Carbon Cycle And Processes (RECCAP) project² (Haverd et al., 2013). CABLE, coupled to a low resolution climate model (Mk3L), was used for simulations out to 2100, focussed on the carbon cycle^{3,4}. The range of science supported by CABLE is evident in the list of publications (Sec 7).

3 Code development and distribution

3.1 CABLE-2.0 release

A major achievement of 12/13 was the release of CABLE-2.0. This was the first formal release of CABLE code since 2008 (v1.4b) and combined standalone and ACCESS versions of CABLE. The release included a major revision of the CABLE user guide, as well as documentation of some standard benchmark simulations. Single-site results were made available through the Protocol for Analysis of Land Surface models (PALS) website (<http://www.pals.unsw.edu.au>). The release included code to simulate biogeochemical cycles (CASA-CNP, carbon, nitrogen and phosphorus) but some elements of this module were not fully implemented (spin-up and ACCESS interface) due to time constraints.

3.2 SVN repository

A new aspect of the CABLE-2.0 release was that code distribution is now handled through a subversion (svn) code repository hosted by the National Computational Infrastructure (NCI) national

¹ Kowalczyk, E.A., Stevens, L., Law, R.M., Dix, M., Wang, Y.P., Harman, I., Haynes, K., Srbinovsky, J. and Pak, B. (2013). The land surface model component of ACCESS: description and impact on the simulated surface climatology. *Australian Meteorol. Oceanog. J.*, 63, 65-82.

² Haverd, V., Raupach, M.R., Briggs, P.R., Canadell, J.G., Davis, S.J., Law, R.M., Meyer, C.P., Peters, G.P., Pickett-Heaps, C. and Sherman, B. (2013). The Australian terrestrial carbon budget. *Biogeosciences* 10, 1-19.

³ Zhang, Q., Pitman, A.J., Wang, Y.P., Dai, Y., and Lawrence P.J., The impact of nitrogen and phosphorous limitation on the estimated terrestrial carbon balance and warming of land use change over the last 156 yr. *Earth Syst. Dynam. Discuss.*, 4, 507–539, 2013.

⁴ Exbrayat, J.-F., Pitman, A. J., Zhang, Q., Abramowitz, G., and Wang, Y.-P.: Examining soil carbon uncertainty in a global model: response of microbial decomposition to temperature, moisture and nutrient limitation, *Biogeosciences Discuss.*, 10, 10229-10269, doi:10.5194/bgd-10-10229-2013, 2013.

facility. While this means that there is some overhead involved in setting up new CABLE users, the code repository provides greatly enhanced capability for managing code updates, sharing code amongst users and controlling versions.

3.3 Trunk updates

Since CABLE-2.0 was 'tagged' in October 2012, the CABLE trunk has been updated with changes approved by the CABLE committee. Changes included bug fixes and minor technical enhancements (from J. Srbinovsky) and implementation of a multi-processor (MPI) version of the standalone code (from B. Pak and M. Golebiewski). These changes are incorporated into the CABLE-2.0.1 tag (April 2013). CABLE version numbers are now incremented in the second digit to represent a scientific code change and in the third digit to represent a technical code change.

3.4 Technical support

An email address for CABLE support has been set up through NCI (cable_help@nf.nci.org.au). While initially combined with more general ACCESS help, the volume of CABLE-specific enquiries necessitated separating the two help lists. Messages to `cable_help` are dealt with by J. Srbinovsky, B. Pak, K. Lu and NCI staff.

3.5 Coupling to the Land Information System (LIS)

The Centre of Excellence in Climate System Science (CoECSS) has coupled a version of CABLE (derived from v1.4b) to the NASA Land Information System (LIS). This allows CABLE to be run in a standalone mode, driven by a range of meteorological forcing provided by LIS. It also allows CABLE to be coupled to the Weather Research Forecasting (WRF) model. This CABLE configuration has mostly been applied to simulations for the Australian region. It is a high priority to upgrade this work to CABLE-2.0 in 13/14.

4 Governance

4.1 CABLE committee

The CABLE committee (comprising R. Law, G. Abramowitz, V. Haverd, E. Kowalczyk and J. Srbinovsky) has met eight times in 12/13 with meeting frequency increasing from every two months to monthly with the release of CABLE-2.0. While the main task of the CABLE committee is to approve CABLE trunk updates, the committee has organized CABLE communication activities, guided development of the CABLE trac (wiki) site and has provided support to the CABLE coordinator (R. Law).

4.2 CABLE licence

With significant input from C. Torres-Villaneuva and CSIRO legal, the CABLE licence was revised for the release of CABLE-2.0. The new licence maintains the underlying principle that CABLE developers own the IP of their developments and sub-licence CSIRO to distribute those developments to the CABLE community. CSIRO's role as custodian of CABLE is defined and the new licence also recognizes the role of NCI in code distribution, and the role of the code repository in capturing Improvements to the CABLE code. There has been good uptake of the new CABLE licence, with 26 (non-CSIRO) users from 14 institutions (and 7 countries) now set up to use CABLE-2.0.

4.3 CABLE business model

As a follow-up to the CABLE Roadmap (published as a CAWCR technical report in 12/13; http://www.cawcr.gov.au/publications/technicalreports/CTR_057.pdf), the CAWCR Supervisory Committee (CSC) requested a CABLE business model be prepared. This was delivered to the CSC April meeting. It addressed the costs and benefits of CABLE operating as a community model and summarized the contributions of the key partners in CABLE development (CSIRO, CoECSS, NCI and

the Australian Bureau of Meteorology). It highlighted where extra investment in CABLE could be targeted and reviewed CABLE governance and licensing arrangements.

5 Communication

5.1 Email list

The CABLE email list is hosted by CSIRO, with individuals able to subscribe/un-subscribe themselves. With the release of CABLE-2.0, we have instigated a policy that anyone registering for CABLE-2.0 will automatically be subscribed to the CABLE email list (with the ability for them to opt themselves out if desired). Traffic to the email list is low, but an approximately monthly 'CABLE news' message is sent out by the CABLE coordinator.

5.2 CABLE workshop

A workshop for CABLE users was held on 25th October, 2012 at the University of New South Wales. Approximately 40 people attended. The program comprised a number of science presentations and an update on the use and performance of CABLE-2.0. The presentations are available at <https://trac.nci.org.au/trac/cable/wiki/CablePresentations>.

5.3 Trac page/wiki

As part of the CABLE code repository installation at NCI, there is a CABLE trac page (<https://trac.nci.org.au/trac/cable/wiki>). This provides a wiki facility, tools to browse the CABLE code and to 'ticket' code issues. The wiki portion of the site is publically available, while registered CABLE-2.0 users are able to view the code, edit the wiki and use the ticketing system. The trac page has been developed significantly over the last 12 months, providing CABLE documentation, recent CABLE news, benchmarking summaries and other information of interest to the CABLE community.

5.4 Video-conferencing

With upgraded video-conferencing available to a number of CABLE community members, we have begun to make use of these facilities. In March 2013, we held a CABLE planning meeting across 3 venues (Vic, ACT, NSW), allowing participants to describe the work they plan to do with CABLE over the next 12 months and to demonstrate the trac page ticketing system. Feedback was positive and another video meeting is planned for August 2013.

6 Participation in international projects

Free Air CO₂ Enrichment (FACE): CABLE has participated in an international model intercomparison project funded by the Department of Energy, USA that analyzed the performance of over 10 different models under elevated CO₂, and nitrogen addition simulation experiments. Simulation results from CABLE have been submitted for the first two intercomparisons. One paper has been published, and three more are being written. CABLE has also been invited to participate in the EUCFACE project for assessing the responses of Australian Eucalyptus trees to elevated CO₂.

PLUMBER: The PALS Land sUrface Model Benchmarking Evaluation pRoject compares land surface models run in standalone mode at single-sites with statistical or simplified model benchmarks. CABLE participated in the intercomparison with two configurations, CABLE-2.0 and CABLE with an alternative soil scheme (Soil-Litter-Iso, SLI). Both performed comparably with other land surface models; CABLE with SLI tended to outperform CABLE-2.0 particularly for latent heat, and, to a lesser degree, net ecosystem exchange (NEE). Preliminary results from the PLUMBER experiment were presented at the 4th WGNE workshop on systematic errors in weather and climate models (Exeter, UK, April 2013) and a paper is expected to be written in 13/14.

7 Publications using CABLE: July 2012-June 2013

- Bai, E., Houlton, B.Z., Wang, Y.P. (2012). Isotopic identification of global nitrogen hotspots across natural terrestrial ecosystems. *Biogeosciences*, 9, 3287-3304, doi:10.5194/bg-9-3287-2012
- De Kauwe, M.G., Medlyn, B.E., Zaehle, S., Dietze, M., Hickler, T., Jain, A., Luo Y.Q., Parton, W., Prentice, C., Thornton, P., Walker, A., Wang, S., Wang, Y.P. et al. (2013). Water use and water use efficiency at elevated CO₂: a model-data intercomparison at two contrasting temperate forest FACE sites. *Global Change Biology*, (in press).
- Exbrayat, J.-F., Pitman, A. J., Abramowitz, G., Wang, Y.-P. (2013) Sensitivity of net ecosystem exchange and heterotrophic respiration to parameterization uncertainty, *J. Geophys. Res., Atmospheres*, 118, 1640–1651, doi:10.1029/2012JD018122.
- Haverd, V., Raupach, M.R., Briggs, P.R., Canadell, J.G., Davis, S.J., Law, R.M., Meyer, C.P., Peters, G.P., Pickett-Heaps, C. and Sherman, B. (2013). The Australian terrestrial carbon budget. *Biogeosciences* 10, 1-19.
- Haverd, V., Raupach, M.R., Briggs, P.R., Canadell, J.G., Isaac, P., Pickett-Heaps, C., Roxburgh, S.H., van Gorsel, E., Viscarra Rossel, R.A. and Wang, Z. (2013). Multiple observation types reduce uncertainty in Australia's terrestrial carbon and water cycles. *Biogeosciences*, 10, 2011-2040.
- Kowalczyk, E.A., Stevens, L., Law, R.M., Dix, M., Wang, Y.P., Harman, I., Haynes, K., Srbnovsky, J. and Pak, B. (2013). The land surface model component of ACCESS: description and impact on the simulated surface climatology. *Australian Meteorol. Oceanog. J.*, 63, 65-82.
- Li, L.H., Wang, Y.P., Yu, Q., Pak, B., Eamus, D. and van Gorsel, E. (2012). Improving the response of the Australian community land surface model to seasonal drought. *J. Geophys. Res. Biogeosciences*, 117, G04002.
- Lu, X.J., Wang, Y.P., Ziehn, T. and Dai Y.J. (2013). An efficient method for global parameter sensitivity analysis and its applications to the Australian community land surface models (CABLE). *Agric. Forest Meteorol.*, (in press).
- Vargas, R., Sonnentag, O., Abramowitz, G., Carrara, A., Chen, J. M., Ciais, P., Correia, A., Keenan, T., Kobayashi, H., Ourcival, J.-M., Papale, D., Pearson, D., Pereira, J. S., Piao, S., Rambal, S., Baldocchi, D. (2013) Drought conditions influence simulated ecosystem fluxes: a model-data meta-analysis for Mediterranean oak woodlands, *Ecosystems*, (in press).
- Wang, Y.P., Lu, X.J., Wright, I.J., Reich, P.B. and Dai, Y.J. (2012). Correlations among three leaf traits provide a significant constraint on the estimate of global gross primary production. *Geophys. Res. Letts.*, 39, L19405, doi:10.1029/2012GL053461.
- Xia, J.Y., Luo, Y.Q., Wang, Y.P., Weng, E.S., and Hararuk, O. (2012). A semi-analytic solution to accelerate spin-up of a coupled carbon and nitrogen land model to steady state. *Geosciences Model Development*, 5, 1259-1271, doi:10.5194/gmd-5-1259-2012.
- Xia, J.Y., Luo, Y.Q., Wang, Y.P. and Hararuk, O. (2013). Traceable components of terrestrial carbon storage capacity in biogeochemical models. *Global Change Biology*, 19, 2104-2116, doi: 10.1111/gcb.12172.
- Zhang, H., Pak, B., Wang, Y.P., Zhou, X., Zhang, Y. and Zhang, L. (2013). Evaluating Surface Water Cycle Simulated by the Australian Community Land Surface Model (CABLE) across Different Spatial and Temporal Domains. *J. Hydrometeorology*, (in press).
- Zhou, X.Y., Zhang, Y.Q., Wang, Y.P., Zhang, H.Q., Zhang, L., Vaze, J., Yang, Y.H. and Zhou Y.C. (2012). Benchmarking global land surface models against the observed mean annual runoff from 150 large basins, *J. Hydrology*, 470(1), 269–279.