Evaluations – Ying Ping Wang

- Comparing with independent estimates: mean annual GPP, LE, plant biomass, and monthly canopy LAI
- Comparing with functional relationships: GPP/LE correlation, Thermal adaptation? Budyko curve and rainfall use efficieicny
- Analyze modelled plant biomass: attributing the differences of different models
- Simulations
  - Spin the model to steady state (1980), and then integrate forward from 1980to 2010.
  - Sensitivity analysis
    - Using the Morris method to identify the three most sensitive parameters to GPP, NPP and LE for each PFT
    - Varying those three parameters per PFT to simulate the ranges of GPP, NPP and LE from 1980 to 2010 (including spinning the model to steady state).

- Possible participating models: CABLE, CLM4.0, CLM4.5, CoLM, JULES

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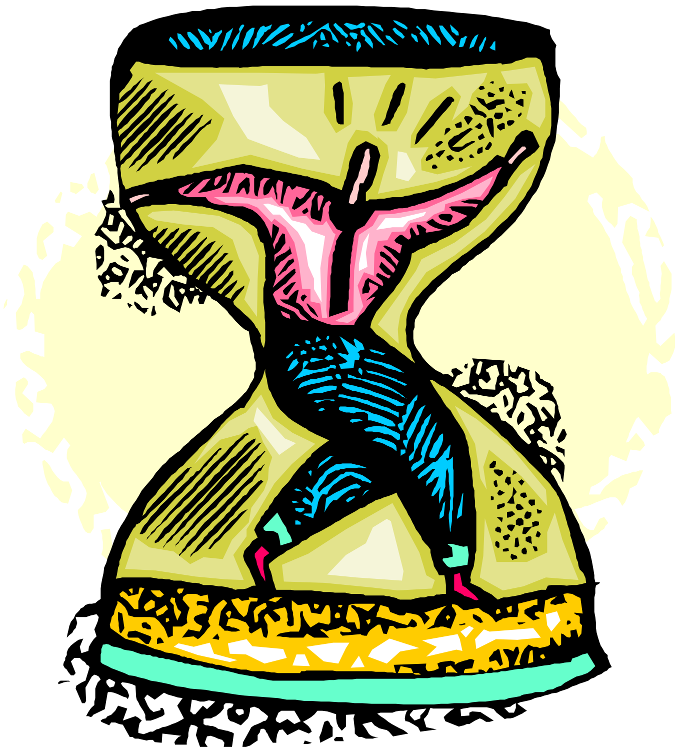
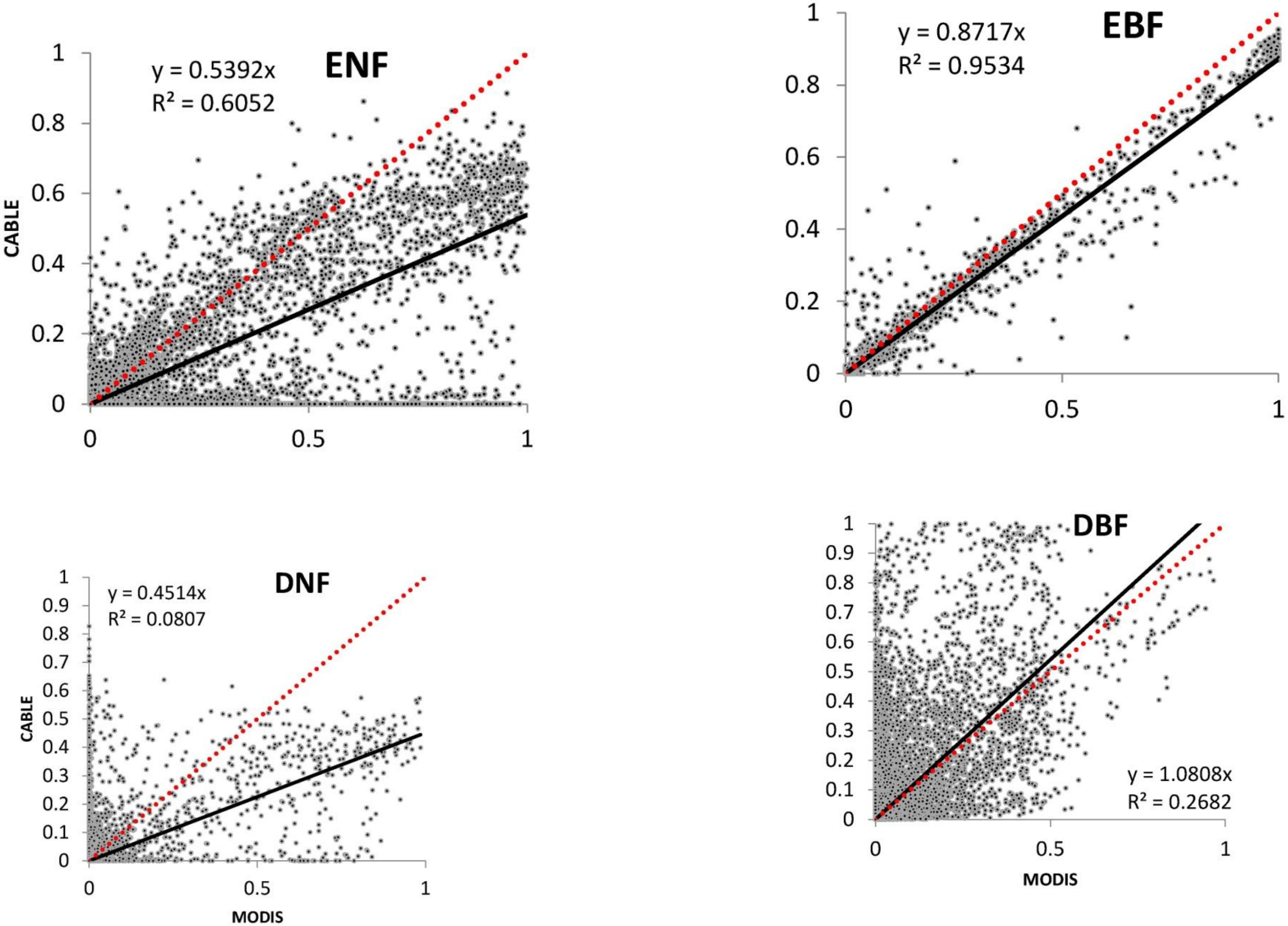
Parameter estimation

- Using PEST – a framework for parameter estimation and uncertainty analysis
- To constrain some model parameters using observations by minimizing λ;
- Cost function: $$\lambda = \sum_{PFT} \sum_{N} \frac{\left(P_{PFT,N} - O_{PFT,N}\right)^2}{w^2_{PFT,N}}$$



- The CPU time required for optimizing 3 parameters per vegetation type, or 30 parameters using first derivatives calculated by finite differencing:
- 30*29*(10 years)* 2489s /year=6015 hours
- 50 iterations to converge = 50*6015=~34 years

How much can plant trait variations explain the geographic distributions of different forest types?



Spatial abundance of PFTs: unpublished work by Lu et al.

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Bernard Pak (Bernard.Pak@csiro.au)

1) Make available various met forcing for offline global runs
    a) GSWP2 forcing at 1x1 degree, 3-hourly time steps
    b) Princeton forcing at 1x1 degree, 1-hourly time steps
    c) Princeton forcing at N96 resolution, 1-hourly time steps
    d) ACCESS forcing at N96 resolution, 1-hourly time steps
2) Benchmark the new spinup codes for CASA-CNP (codes developed by YP Wang) and get that through to the SVN repository trunk
3) Benchmark results committed to the PALS website
4) Write a paper on the benchmarking of CABLE with the full capability of CASA-CNP
5) Revisit all CABLE input files to check and document the origin of data

Lakes – Marcus Thatcher

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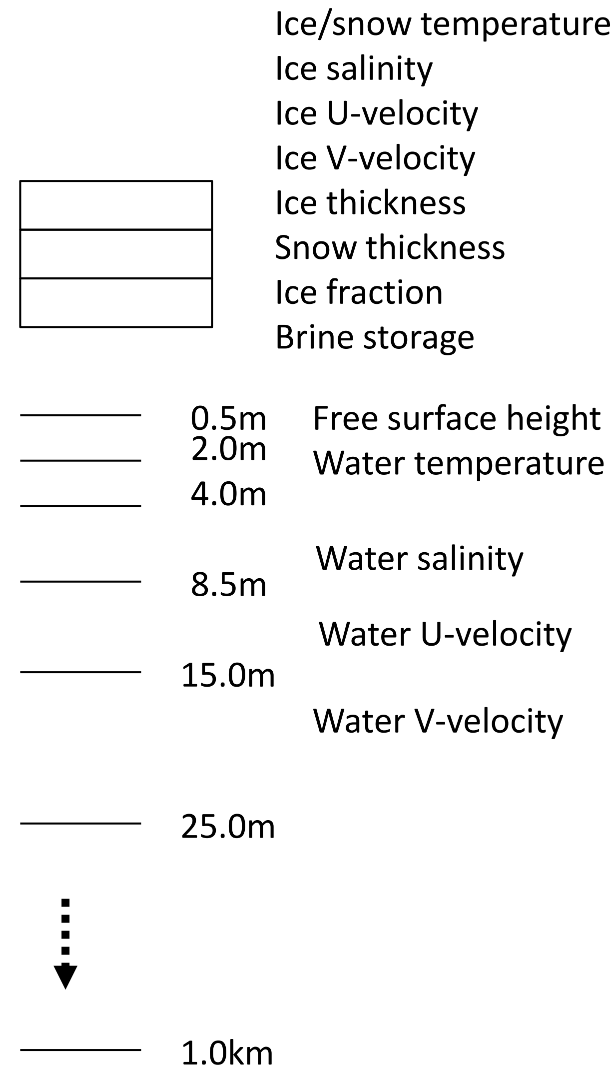
- Lake code currently based on KPP mixing (Large et al 1993), combined with ice model derived from O'Farrell – e.g., Mk3.6)
- Currently a fixed depth is used in ACCESS, but bathymetry data exists in CCAM
- Considering including a sediment layer and then allow lake to dry up. Also considering prognostic TKE
- Considering extension to wetlands



Urban – Marcus Thatcher

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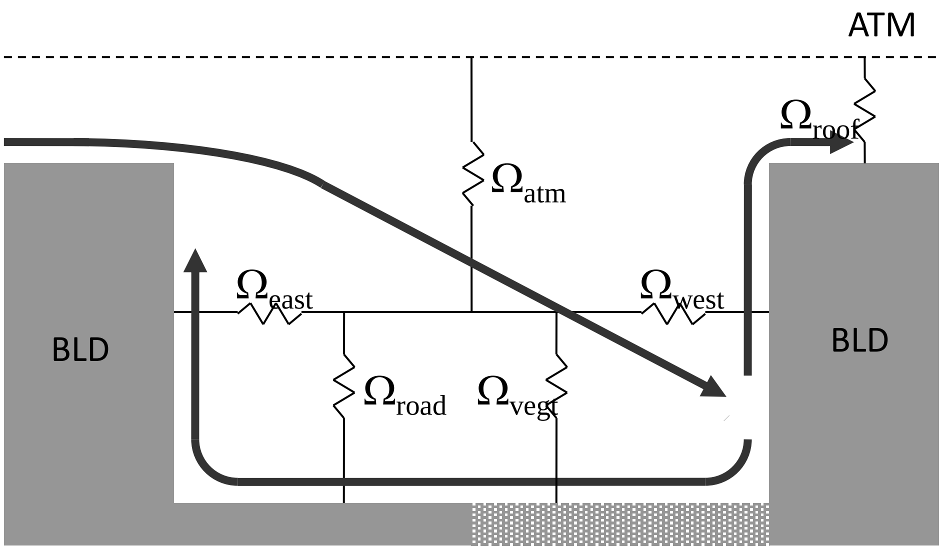
- Performing model intercomparisons (mainly with UKMet Office scheme)
- Currently implementing into global ACCESS model. Later plan for limited area ACCESS RCM.
- Developing constraints for urban vegetation based Loridan and Grimmond (2011)
- Considering extensions to multi-level canyon for dispersion transport



Schematic of air recirculating and venting within the canyon, based on Harman et al (2004) but modified for vegetation

Soil moisture modelling in CABLE: Monash University (Jeff Walker, Gift Dumedah)

1. calibrating CABLE using in-situ soil moisture data from the Yanco area in New South Wales
2. assimilating AMSRE soil moisture into CABLE using the evolutionary data assimilation.
3. develop a framework for identification of model weaknesses in CABLE through evaluation (with clustering analysis) of the changes in model parameter values, states and input forcing errors across assimilation time steps.
4. derive robustness/sensitivity of model parameters and forcing errors in relation to changes in observation data. Will be used to
   i. make linkages between model parameters/states and model (CABLE) structure; and
   ii. make inference about model (CABLE) physics.

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Modeling permafrost thaw and carbon cycle under climate warming at a Tundra site in Alaska

Jianwei Li[1], Yiqi Luo[1], Susan Natali[2], Ted Schuur[2], Jianyang Xia[1], Bernard Pak[3], Eva Kowalczyk[3], and Yingping Wang[3]

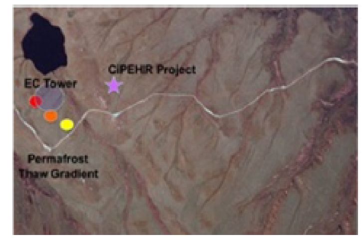
1. Department of Botany and Microbiology, The University of Oklahoma, Norman, OK, United States.
2. Department of Biology, University of Florida, Gainesville, FL, United States.
3. CSIRO Marine and Atmospheric Research, Centre for Australian Weather and Climate Research, Aspendale, Victoria, Australia

Research questions and hypotheses

Q1: How intensively will permafrost thawing be affected by global climate warming?
H1: Permafrost thaw depth and active layer depth (maximum thaw depth) will deepen under climate warming.

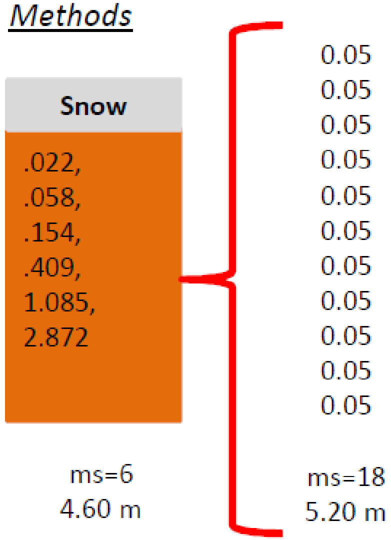
Q2: What is the consequence on ecosystem carbon budget under permafrost thawing with warming?
H2: Warming-induced thawing will increase respiratory C release to atmosphere and warming-stimulated plant growth, two in combination leading to net ecosystem C losses.

Site Characteristics



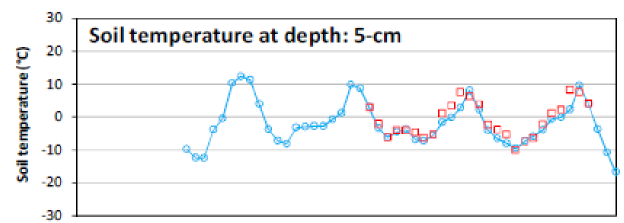
Left and middle: Location of the Carbon in Permafrost Experimental Heating Research (CiPEHR); Right: snow fences were used to warm soil temperatures in winter (by S Natali)

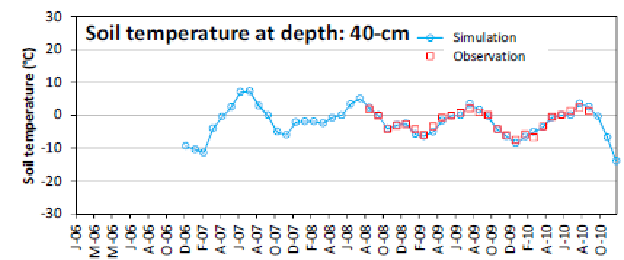
Methods



1. To improve the simulation of soil temperature at finer spatial resolution, about ten layers (each thickness ~5.00 cm) is added to the model;
2. To identify the thaw depth, simulated soil temperature (~0.0 ± 0.05°C) was first identified and its corresponding depth were used to derive the warming effect on thaw depth change under different warming scenarios (i.e. cm/°C);
3. Warming treatments include ambient and ambient plus 2, 4, 6, 8 and 10°C.

Model calibration





Preliminary results

1. On average, warming increases active layer thickness at a rate of ~4.5 cm/°C in 2009 and 2010;
2. The percentage increase in thaw depth is generally larger than that of GPP and NEE under the same warming treatment;

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Land Carbon Cycle in ACCESS

Rachel Law (Rachel.Law@csiro.au) and Tilo Ziehn (Tilo.Ziehn@csiro.au)

- Main focus on ACCESS application (CABLE coupled to the **A**ustralian **C**ommunity **C**limate and **E**arth **S**ystem **S**imulator) at the global scale
- ACCESS can now be run with land carbon cycle and prognostic LAI, first results are promising but more work is required:
- Calibration of model parameters (i.e. pool turnover rates, Q_{10} respiration parameter, etc.) in CABLE and CASA-CNP (Biogeochemistry)
- Switch on carbon-nutrient interactions (Carbon, Nitrogen and Phosphorus Cycles) and perform atmosphere only simulations with ACCESS
- Switch on atmospheric tracer capabilities (in order to compare with CO_2 concentration measurements) and perform atmosphere only simulations with ACCESS
- Implement land use change component
- Implement prognostic phenology scheme?
- Run ACCESS coupled model with land and ocean carbon and prescribed atmospheric CO_2 (pre-industrial, historical and 2 RCP cases)
- Short test of emissions-driven simulation i.e. carbon fluxes change atmospheric CO_2 and consequently climate

CABLE-related Studies (2013-2014)

H. Zhang (CAWCR: h.zhang@bom.gov.au)

1: Investigating land-surface processes in modulating the Australian monsoon climate, its variability and potential changes in warmed climate (as part of the activities under an ACCSP monsoon project submitted)

Monsoon is traditionally viewed as the product of land-sea thermal contrast, but the influence of land-surface conditions on Australian summer monsoon is yet to be thoroughly investigated. We plan to analyse the AR5 model experiments, complimented by some ACCESS sensitivity experiments to explore this issue.

2: Continuing assessing the application of using land-surface models (including CABLE) in drought monitoring and their simulations of surface processes in arid and semi-arid climate (collaboration with Institute of Arid Meteorology (IAM) in China)

IAM scientists have conducted experiments comparing land-surface model outputs (including CABLE) with traditional drought monitoring products such as rainfall based indices, PDI, stream flow etc. They also evaluate models against field campaigns in semi-arid climate in northwest China.

Proposed work Eva Kowalczyk & Lauren Stevens

- Improving modelling of permafrost dynamics in UM/Cable
  - Extension of soil depth from 4.7 to 30m+ and an increase in a number of soil layers from 6 to 12+.
  - Update to the soils routines to allow for up to 4 soil horizons.
  - Inclusion of high latitude organic soils and soil carbon.

- Further modularisation of CABLE code, in particular; extraction of code and updates for calculations of screen level variables.

- Inclusion and testing of Ian Harman improvements to RSL representation in CABLE

  - In the light of the recent development in the theoretical understanding of the flow within and above canopies from I. Harman research, there is a number of improvements to representation of canopy turbulence in CABLE. These improvements are most likely of no great consequence to simulation of climate but could be important for NWP simulation.

- Implement Soil-Litter-Iso (SLI) in ACCESS
  - Take Vanessa Haverd's SLI code and implement in ACCESS.
  - Run for the full AMIP period and Benchmark against standard CABLEv2.0 AMIP run.

CABLE-JULES - Jhan Srbinovsky

- Why bother?
- Technical brief
  - CABLE called in 4 places UM(7.3)
  - ¾ now in JULES(3.2). ¼ can be moved.
  - JULES standalone(offline) I/O is completely different to UM.
  - Need to
    - assert “17” tiles, 6 soil layers, 3 snow.
    - Add new vars for CABLE (39)
    - Add code to read these vars
    - Create/modify the raw I/O
    - Get them to CABLE (and others)

CABLE-JULES – Jhan Srbinovsky

- Update
  - All of the above is basically done
  - Debugging/testing ???
- Next
  - Change call(s) for UM(8.2)
  - Verify consistency with operational requirements
  - Tidy it up

Changes to JULES

- 2 new files. ~10 modified files.
- specific CABLE build

Changes to CABLE

- JULES branch for drivers.

Introducing demographics and landscape heterogeneity to CABLE/CASA — the POP model

Vanessa Haverd & Lars Nieradzik

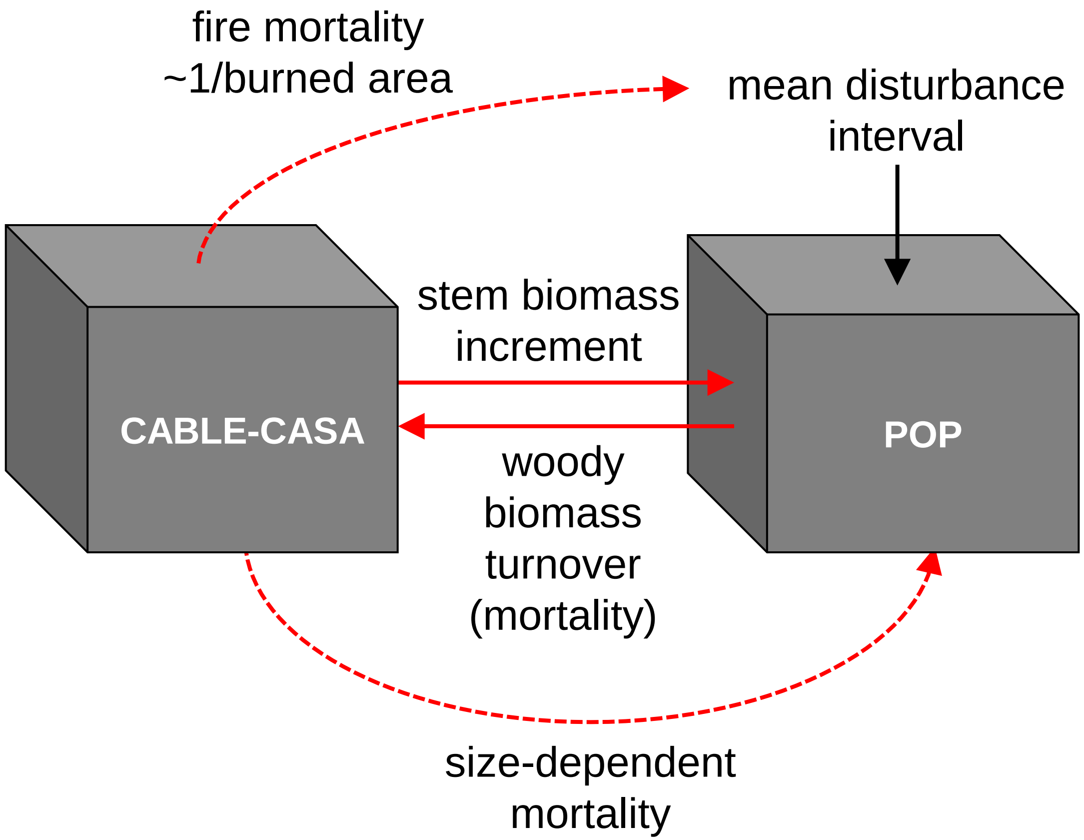
Criteria:

- Account for age-size-density development of stands after disturbance
- Account for distribution of stand ages across landscape
- Minimise increase in CPU and memory use
- Keep it deterministic (avoid stochastic representation of e.g. LPJ-GUESS)
- Stand alone model that can be coupled to not integrated within CABLE/CASA

Elements:

- Forcing by whole-ecosystem stem biomass increment from CABLE/CASA
- Simulate recruitment, allometric growth and mortality of age-size cohorts of trees in stands
- Partition total stem biomass increment among stands and cohorts as a declining proportion of current size
- Mortality influenced by declining growth efficiency under crowding and with increased size
- Upscaling to landscape by interpolation among stands of different age-since-disturbance

Envisaged coupling scheme



SIMPLEFIRE

calibration parameters

$$A(y) = a(L)\ F^{b}\ N_{\max}(y)^{c}\ \exp(dP)$$

burnt area for year y

land cover (vegetation) class

1. needleleaved forest
2. broadleaved forest
3. mixed forest
4. shrubland
5. savannah or grassland
6. tundra
7. barren or sparsely vegetated

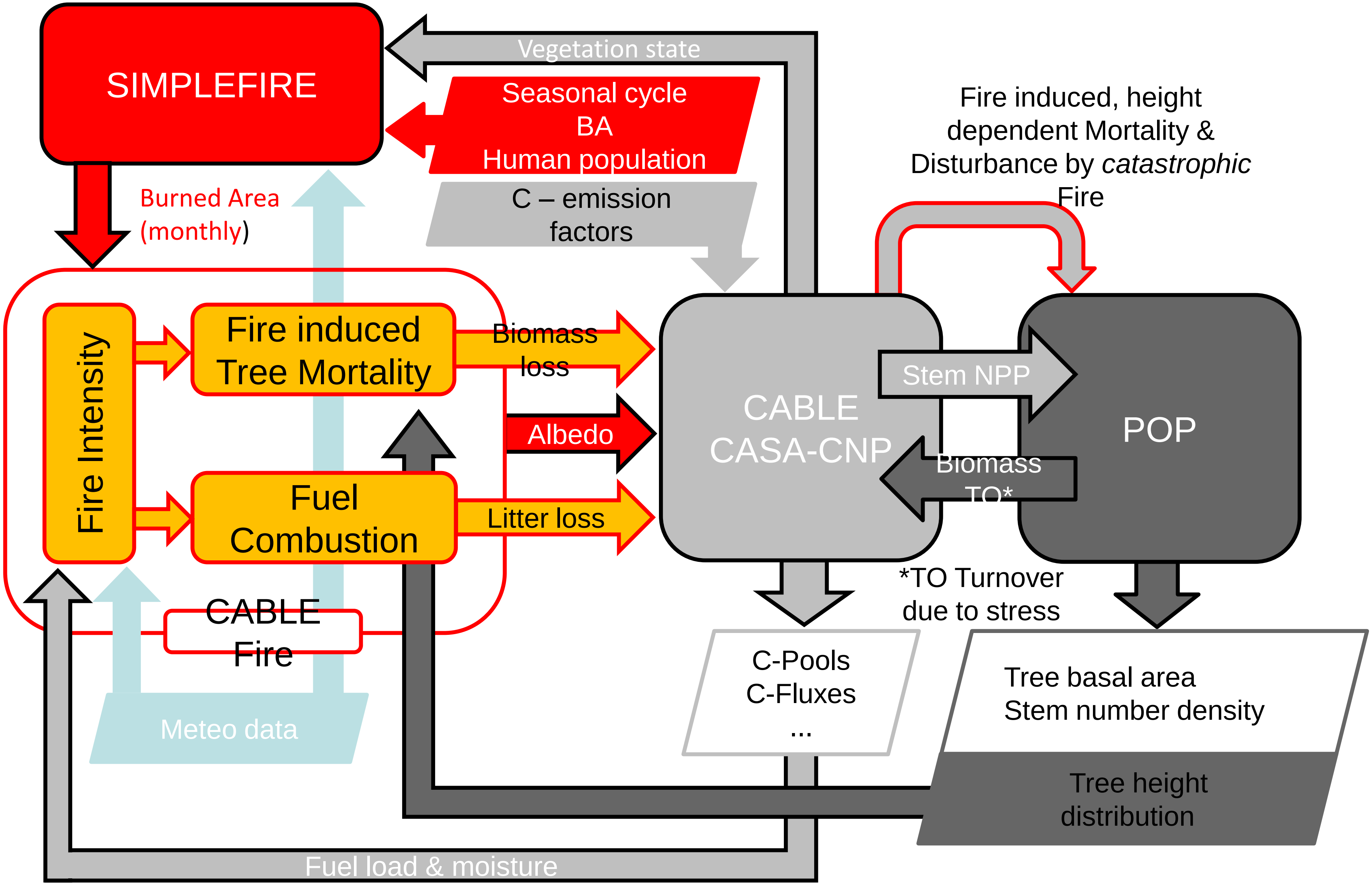
annual max fAPAR running mean

proxy for vegetation productivity and fuel load

fuel dryness index (Nesterov)

$f\,(T, P)$

human population density


SIMPLEFIRE
Vegetation state
Seasonal cycle
BA
Human population
C – emission factors
Burned Area (monthly)
Fire induced, height dependent Mortality & Disturbance by *catastrophic* Fire
Fire Intensity
Fire induced Tree Mortality
Biomass loss
Albedo
Fuel Combustion
Litter loss
CABLE CASA-CNP
Stem NPP
Biomass TO*
POP
*TO Turnover due to stress
CABLE Fire
Meteo data
C-Pools
C-Fluxes
...
Tree basal area
Stem number density
Tree height distribution
Fuel load & moisture