Development a prototype fire model for Hadley GCMs

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Three parallel fire modelling activities

- Implementation of prototype fire model HADLEY-FIRE into HadCM3LC (SV,TK,RB,CJ) in fully coupled mode – started
- Implementation off-line version of HADLEY-FIRE in JULES using IMOGEN/Climate emulator for fine tuning (SV,TK,CH) – start in summer 2007
- Validation of temporal dynamics of HADLEY-FIRE against ATSR/MODIS (YLP,SV) -started
- Number of ignitions is constant in time and space. It is calculated from averaged estimate of SEVER-FIRE - 12 fires a year for 0.5 ° x 0.5 ° grid cell
- Fires are not affecting vegetation
- Fire stops only due to weather conditions – no fire suppression
- Fuel threshold is determined by total fraction of vegetation in a cell
HADLEY-FIRE model structure

- INCORPORATED into HadCM3LC GCM
- STEP = 30 minutes
- SPATIAL RESOLUTION = 2.5° x 3.75°

OUTPUT
- Fire weather risk (0;1)
- Area burnt (m²)

INPUT:
- from the atmosphere module (HadAM): $t_{\text{max}}$, $t_{\text{dew}}$, Precip
- from the hydrology module (MOSES): Unfrozen soil moisture in the upper layer: USM
- from the vegetation module (TRIFFIDS): fractional distribution of five PFTs $F_i$
Equations of HADLEY-FIRE

- FIRE RISK - directly taken from Reg-FIRM model (Venevsky, et.al., 2002). Same as in SEVER-FIRE and SPIT-FIRE

\[
FR (t) = H(t_{\text{max}}, t_{\text{dew}}, \text{USM})
\]

- AREAS BURNT – simplified Rothermel equation scaled to total vegetated fraction of the cell

\[
AB (t) = \sum F_i \times FR(t) \times N_{\text{ign}} \times \frac{\pi}{8} \times U^2 (F_i , \text{USM}) \times (30 \text{ min})^2
\]

where U is the rate of frontal spread
Comparison against GBA-2000

HADLEY-FIRE

GBA-200

Averaged correlation 0.16
Simulated seasonal distribution of areas burnt: current climate

Area burnt (% of grid cell)

- 0 - 2.5
- 2.5 - 5
- 5 - 7.5
- 7.5 - 10
- 10 - 12.5
- 12.5 - 15
- 15 - 17.5
- 17.5 - 20
- 20 - 22.5
Change of burnt areas: $2\text{CO}_2$ climate

Increase in area burnt (% of grid cell):
- < 0
- 0 – 2.5
- 2.5 – 5
- 5 – 7.5
- 7.5 – 10
- 10 – 12.5
- 12.5 – 15
- 15 – 17.5
- 17.5 – 20

DJF

MAM

JJA

SON
Inter-annual variability

Area burnt (million ha)

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Comparison of key fire regions for different models

ATSR

SEVER-FIRE

HADLEY-FIRE

MC 1
Implementation of HADLEY-FIRE into HadCM3LC

- Implementation of fire risk and areas burnt into HadCM3LC in uncoupled mode with vegetation and constant ignitions – started. Delivery – summer 2007
- Implementation of carbon and aerosol emissions in uncoupled mode with vegetation – Delivery end of 2007
- Coupling of HADLEY-FIRE with TRIFFIDS vegetation model Delivery - spring 2008
- Implementation of lightning ignitions in coupled mode – end of 2008
- Implementation of human ignitions in coupled mode – summer of 2009
Implementation of HADLEY-FIRE in IMOGEN

This activities will take part in parallel with implementation of HADLEY-FIRE in HADCM3LC and will take the same steps (see previous slide) with an approximate time lag 4 months.

Thus this will be the first prototype JULES fire model fully tested within LSS and GCM. It can be further changed to more sophisticated fire model