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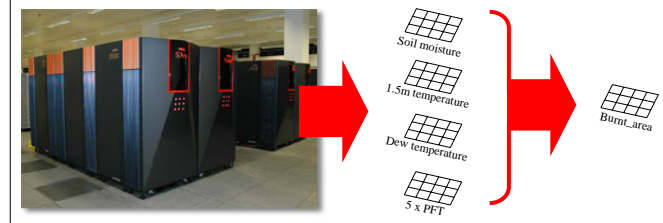
## ABSTRACT

The objective of this work was to improve the existing fire-module coupled with Hadley Centre General Circulation Model (GCM). Equations different than those applied in the original model have been proposed and tested.

During the study an off-line fire model (not coupled with GCM) has been developed (performing much faster than GCM). Results from this off-line model and from the same model integrated within a GCM are in good agreement, and the off-line approach was successfully employed in the process of fire-module optimisation.

The process of optimisation was based on maximising the correlation coefficient between computed and observed burnt fraction: GFED database<sup>[1]</sup>. Results showed that the correlation between modelled and observed burnt fraction increased from **R=0.133** (original model) to **R=0.329** (modified one).

## INTRODUCTION



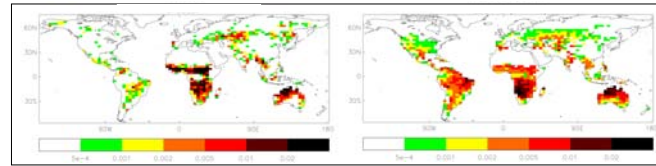
Schematic structure of fire model feeding with GCM data

A fire module was already integrated as part of the Met Office Hadley Centre General Circulation Model (GCM). Within this model burnt area is calculated using modelled climate data at each GCM timestep. Even using supercomputers running this integrated GCM-fire model is very time-consuming.

In order to speed-up the development and optimisation of the fire model, the driving climate data were computed once using the GCM for a 10 year period. Such obtained data were averaged yearly. Next, this data was used to drive the fire model off-line.

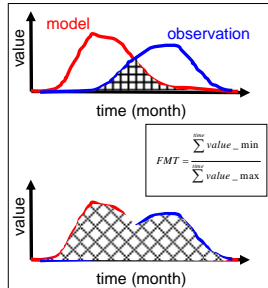
## OPTIMISATION

The off-line model consists, except for climate fields, of 16 parameters. The process of optimisation relies on searching for the optimal set of these parameters. The maximisation of correlation between modelled and observed dataset was chosen as the optimisation criteria.



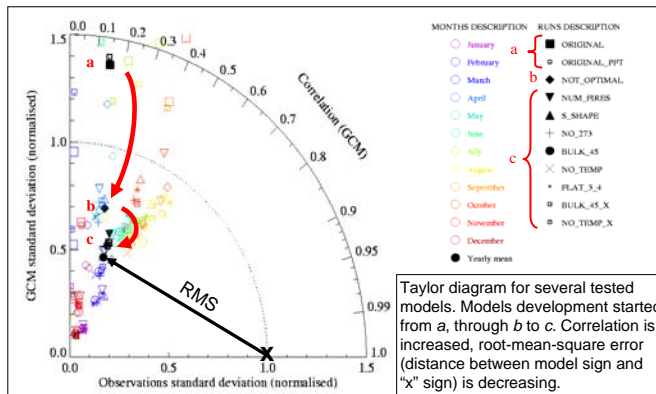
Observed (left) and modelled (right) burnt fraction (annual mean)

## SKILL SCORES APPLIED



Figures of merit in time (FMT) is a scoring procedure that reflects both the intensity and timing of fire. This method is independent from the correlation coefficient.

The progress of optimisation is easy to observe on a Taylor diagram<sup>[2]</sup>, where correlation, standard deviation and root-mean-square error are displayed simultaneously.



Taylor diagram for several tested models. Models development started from a, through b to c. Correlation is increased, root-mean-square error (distance between model sign and "x" sign) is decreasing.

## REFERENCES

- [1] Randerson JT., van der Werf G., Giglio L., Collatz GJ., Kasibhatla PS. Global Fire Emissions Database version 2 (GFEDv2). Released 21 December 2005 (available at: <http://www.geo.vu.nl/users/gwerf/GFEDv2/readme.pdf>)  
 [2] Taylor KE. Summarizing multiple aspects of model performance in a single diagram. J. Geophys. Res. 106(7) 7183-7192, 2001

## RESULTS

Results of the off-line fire model optimisation are presented in the table below. The best results in each column are highlighted.

Model	Correl	RMS	FMT	Correlation in months											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
NOT_OPTIMAL	0.2328	1.0106	0.1307	0.3399	0.2681	0.1753	0.1646	0.1774	0.1329	0.1749	0.1930	0.3798	<b>0.4667</b>	<b>0.3141</b>	0.2302
NUM_FIRES	0.3507	0.9442	0.1471	0.5404	0.4720	0.3237	0.2002	0.3252	0.3805	0.5083	0.6051	0.5642	0.4242	0.1964	0.2736
S_SHAPE	0.3733	0.9291	<b>0.1679</b>	0.5694	0.5016	0.3755	0.2458	0.3600	0.4126	0.5246	0.5980	0.5214	0.3904	0.2273	0.3132
NO_273	0.3991	0.9172	0.1611	0.5849	0.5074	0.3674	0.2516	0.3914	0.4657	0.5677	0.6469	0.5430	0.3969	0.2282	0.3577
BULK_45	0.4057	0.9159	0.1681	0.5901	0.5110	0.3740	0.2596	0.3695	0.4496	0.5540	0.6243	0.5380	0.4139	0.2798	0.3872
NO_TEMP	0.4074	0.9156	0.1569	0.5907	0.5109	0.3728	0.2599	0.3720	0.4539	0.5567	0.6281	0.5397	0.4140	0.2780	<b>0.3906</b>
FLAT_3_4	0.3889	0.9213	0.1585	0.5667	0.4883	0.3445	0.2254	0.3808	0.4597	0.5602	0.6409	<b>0.5673</b>	0.4305	0.1937	0.3437
BULK_45_X	0.4085	0.9129	0.1447	<b>0.5938</b>	<b>0.5131</b>	<b>0.3798</b>	0.2629	0.3977	0.4671	0.5672	0.6454	0.5405	0.3936	0.2610	0.3826
NO_TEMP_X	<b>0.4103</b>	<b>0.9122</b>	0.1437	<b>0.5945</b>	<b>0.5131</b>	0.3788	<b>0.2633</b>	<b>0.3997</b>	<b>0.4704</b>	<b>0.5691</b>	<b>0.6487</b>	0.5421	0.3940	0.2607	0.3861

As the model development relied on maximising the correlation coefficient, the greatest value is observed for the last model (NO\_TEMP\_X). The smallest error is also observed for this model.

The model performance has been checked by coupling it to the GCM. Results of the on-line optimisation are presented in the table below. In most cases the ranking of models is the same as in the off-line runs.

Model	Correl	RMS	FMT	Correlation in months											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ORIGINAL	0.1327	1.1994	0.1007	0.0325	0.0326	0.0235	0.0967	0.1649	0.1237	0.2125	0.2972	0.3889	0.3686	0.0922	0.0256
ORIGINAL_PFT	0.1264	1.1974	0.1019	0.0235	0.0171	0.0182	0.1053	0.1809	0.1106	0.1785	0.2651	0.3917	0.3899	0.0958	0.0282
NOT_OPTIMAL	0.2229	1.0023	0.1451	0.1812	0.1842	0.1445	0.1589	0.1968	0.2276	0.1968	0.2045	0.2710	0.5005	<b>0.5300</b>	<b>0.2271</b>
NUM_FIRES	0.3113	0.9585	0.1570	0.4082	0.4663	0.3329	0.1883	0.3506	0.4173	0.4664	0.5428	<b>0.5359</b>	0.4507	0.1844	0.2336
S_SHAPE	0.3080	0.9556	0.1708	0.4459	<b>0.5193</b>	<b>0.4189</b>	<b>0.2325</b>	0.3857	0.4233	0.4490	0.4983	0.5055	0.3970	0.1637	0.2163
NO_273	0.3134	0.9521	<b>0.1722</b>	0.4600	0.4739	0.3765	0.2240	0.4197	0.4575	0.4850	0.5176	0.5212	0.4067	0.1511	0.2478
BULK_45	0.3225	0.9467	0.1678	0.4355	0.4320	0.3448	0.2171	0.3929	0.4366	0.4840	0.5645	0.5091	0.4385	0.2128	0.2553
NO_TEMP	0.3226	0.9468	0.1685	0.4589	0.4651	0.3198	0.1985	0.4058	0.4400	0.4826	0.5471	0.5160	0.4452	0.1910	0.2657
FLAT_3_4	0.3102	0.9547	0.1698	0.4704	0.4382	0.3651	0.1948	0.4023	0.4617	<b>0.5097</b>	<b>0.5741</b>	0.5211	0.4009	0.1412	0.2617
BULK_45_X	<b>0.3294</b>	0.9463	0.1564	<b>0.4716</b>	0.4978	0.3701	0.2269	<b>0.4451</b>	<b>0.4661</b>	0.4990	0.5739	0.5131	0.4273	0.1832	0.2349
NO_TEMP_X	0.3280	<b>0.9461</b>	0.1548	0.4698	0.4866	0.3686	0.2166	0.4124	0.4459	0.4700	0.5418	0.4969	0.4317	0.1929	<b>0.3294</b>

Monthly values of correlation coefficient and root-mean-square error are presented on the two graphs below.

