The heritage of the Fire Paradox project: the growing family of the Tiger model

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EU Fire Paradox project
Tiger Simulator Model

Tiger family models: MEG – 2D

Tiger family models: FFAS – 3D
EU Fire Paradox project

REGULATING THE WILDFIRE PROBLEM BY THE WISE USE OF FIRE

"Fire is a bad master but a good servant" - Finnish proverb

An Innovative Approach of Integrated Wildland Fire Management - A Joint European initiative

Members of the FIRE PARADOX Consortium

FINLAND: VTT Technical Research Centre of Finland, Helsinki
FRANCE: Algeria, MDC Editions, Alain Perrromant, Nantes, France, University of Nancy, Nancy, France, University of Reims, Reims, France, University of Lorraine, Nancy, France, University of Strasbourg, Strasbourg, France, University of Paris 13, Paris, France, IRM, Grenoble, France, Université Grenoble Alpes

GERMANY: DLR, Institute for Ecological Research, Darmstadt

Netherlands: Faculty of Forest Sciences, Wageningen University, Wageningen

SWITZERLAND: UNIL, University of Lausanne, Lausanne

UNITED KINGDOM: University of Brighton, Brighton

INTERNATIONAL: US, European Forest Institute

EUROPEAN FOCUS: Federal Ministry of Agriculture, Berlin

FIRE PARADOX: Instituto Superior da Agronomia, Técnica e Orquida, Portugal

SHARING EXPERIENCES FROM DIFFERENT GEOGRAPHICAL REGIONS OF EUROPE

The FIRE PARADOX consortium includes 31 partners from 15 different countries affected by wildfires.

FURTHER INFORMATION

Project acronym: FIRE PARADOX
Project full title: An Innovative Approach of Integrated Wildland Fire Management Regulating the Wildfire Problem by the Wise Use of Fire
Solving the Fire Paradox
Contract no: FP6-018505
Start date: March 2006
Duration: 48 months
EU contribution: about 12 M
Total cost: about 15 M
http://www.fireparadox.org

COORDINATION

Coordinator: R. Regn, fireparadox@ist.utwente.nl
Coordination Team: E. Eklund, erik.eklund@aalbo.org, P. Balsdon, p.balsdon@nef.co.uk, D. Alekseev, alekseev@ya.ru, G. Ronga, fireparadox@ist.utwente.nl

Participating countries
Tiger model

Tiger
2-D F.P. Simulator Model
The Tyger
William Blake (1757-1827)

The Tyger something at once beautiful and terrifying, something sublime or tragic

Duality (paradox) between beauty and primordial ferocity
Tiger Model: Preliminary knowledge and modularity
(pixel-raster models)

2D model

- Wind model
- Convection
- Diffusion
- Irradiation
- Insolation
- Spotting

1D model

- Water Relation
- Temperature Balance
- Combustion
- Ignition
- Tiger F.P. Simulator Model
The model

\[ \frac{\partial T}{\partial t} = -\nabla \cdot (v(P,t)T) + \nabla \cdot (\chi(P)\nabla T) - h(T)(T - T_\infty) + f(t,T) \]

where the quantities are:
- \( T(P,t) \) is the temperature scalar field
- \( v(P,t) \) is the wind vector field, function of space and time.

\[ \chi(P) = \frac{kV}{m(P)c} \]

\( k \) is the air conductivity, \( V \) is the volume of the cell, \( m(P) \) is the air mass in the cell, \( c \) is the specific heat of the air.

\[ h(T) = \frac{\eta \cdot V}{m(P)c} (T - T_\infty)^{1/3} \]

is the vertical convection heat transfer coefficient, being the \( T_\infty \) ambient temperature

- \( f(t,T) \) is the heat source due to combustion in the cell.

The in-plane convective term is responsible for the motion of the air temperature field along the lines of the wind vector field.

\[ v(P,t) = v_x(P,t) + \Delta v_x(P,t) + \Delta v_z(P,t) \]

The in-plane convective term is responsible for the motion of the air temperature field along the lines of the wind vector field.
Tiger Model - WASP technology integration

www.worldinabox.eu
Tiger Model – Wind and Slope
Tiger Model: the final implementation

- Ignition area
- Fuel Parameters
- Fuel map
- DEM map
- Wind map
- WAsP model
- Wind
- Fire fighting operations
- Rate of Spread
- Combustion (Heat release and convection)
- Fire Line Algorithm
- 2D Pixel-Raster model approach
The spatial spread sequence is reversible -> Backwards simulation (reverse engineering algorithm)
Tiger Model: 3D model structure
Tiger & CFS: MEG e FFAS

TIGER

MEG

Forest Fire Area Simulator (FFAS - Virtual Lab)
Tiger & CFS: MEG tool

Aims:
- Education
- training and brainstorming (pre-fire and post-fire analysis)

- Optimized, Simple GUI
- Simulation types run forward and backward / reverse engineering
- Wasp wind model integrated
- Fire line representation
- Available geobase as input data and map
- Cloud versions: Windows and Android clients
MEG client interface: fuel map tool

Input data
- Set scenario coordinate
- DEM (preload for 3 Italian region)
- Combustion Map (Map editor tool)
- Ignition / burned area

Simulation
- Simulation Control
- Forwards/backwards run

Output
- fire line
- word and excel report
- Google Earth
**MEG client**

**Input data**
- Set scenario coordinate
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Roma (Italy), 29/07/2015 - wildfire inside Focene pine woodland on the outskirts of Leonardo da Vinci International Airport
National Park of Vesuvio Campania Region (Italy)
20/07/2016
Burned area: 1.5 kmsq
TIGER

- MEG
- Forest Fire Area Simulator (FFAS - Virtual Lab)
FFAS - 3D Virtual Lab

Aim: tool for training firefighting teams and teaching fire behaviour

- 2 vegetation layers
  - Surface <2m
  - Crown >2m
- High spatial resolution (1 m)
- Smoke submodel
- Fire Fighting operations
  - Water drop
  - Fuel removal
<table>
<thead>
<tr>
<th>Crown</th>
<th>Trees</th>
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<tbody>
<tr>
<td></td>
<td>olive grove</td>
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<tr>
<td></td>
<td>Deciduous oak</td>
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<tr>
<td></td>
<td>Pinus</td>
</tr>
<tr>
<td></td>
<td>chestnut</td>
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<tr>
<td></td>
<td>Quercus ilex</td>
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<table>
<thead>
<tr>
<th>Surface</th>
<th>Shrubs</th>
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<tbody>
<tr>
<td></td>
<td>Cistus</td>
</tr>
<tr>
<td></td>
<td>Erica</td>
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<tr>
<td></td>
<td>Pistacia</td>
</tr>
<tr>
<td></td>
<td>Myrtus</td>
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<tr>
<td></td>
<td>Spartium</td>
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<table>
<thead>
<tr>
<th>Vegetation</th>
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<tbody>
<tr>
<td></td>
<td>short grass</td>
</tr>
<tr>
<td></td>
<td>tall grass</td>
</tr>
<tr>
<td></td>
<td>high maquis</td>
</tr>
<tr>
<td></td>
<td>short maquis</td>
</tr>
<tr>
<td></td>
<td>shrub undergrowth</td>
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<tr>
<td></td>
<td>litter</td>
</tr>
<tr>
<td></td>
<td>conifer litter</td>
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</tbody>
</table>

**TIGER – FFAS 3D Virtual Lab: graphical rendering**
**Vegetation types**

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<tbody>
<tr>
<td>short grass</td>
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</tr>
<tr>
<td>chestnut</td>
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<tr>
<td>holly oak</td>
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TIGER 3D virtual lab: graphical rendering
TIGER 3D virtual lab: 3D model simulations
The heritage of the Fire Paradox project: the growing family of the Tiger model


The **videoclip** on FFAS 3D Virtual Lab

Thank you for your attention

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