Fire in JULES- first steps

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Introduction

(and confessions of a metrologist)

Wildfire: The motivation slide

Atmosphere:

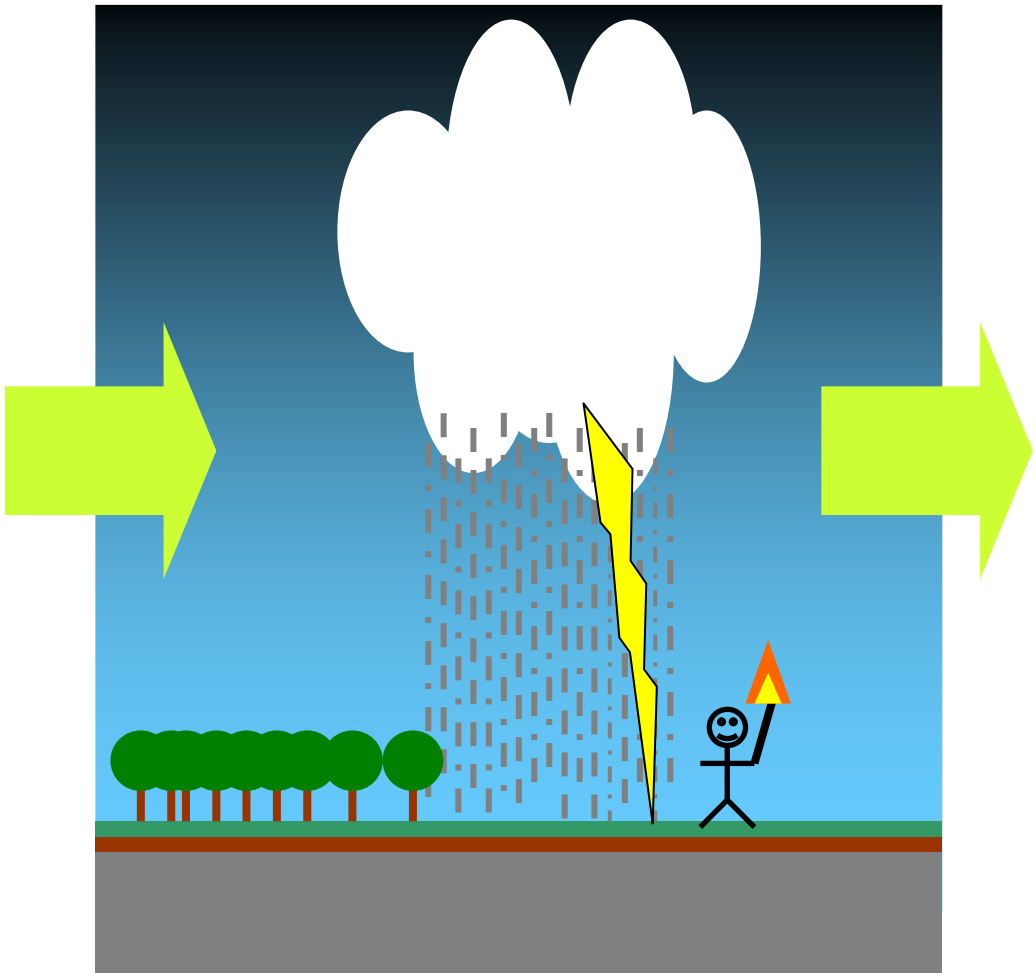
- Temperature
- Humidity
- Wind
- Precipitation
- Lightning

Humans:

- Ignitions

Land Surface:

- Veg cover
- Veg moisture



Atmosphere:

- Gas & aerosol
- Energy

Humans:

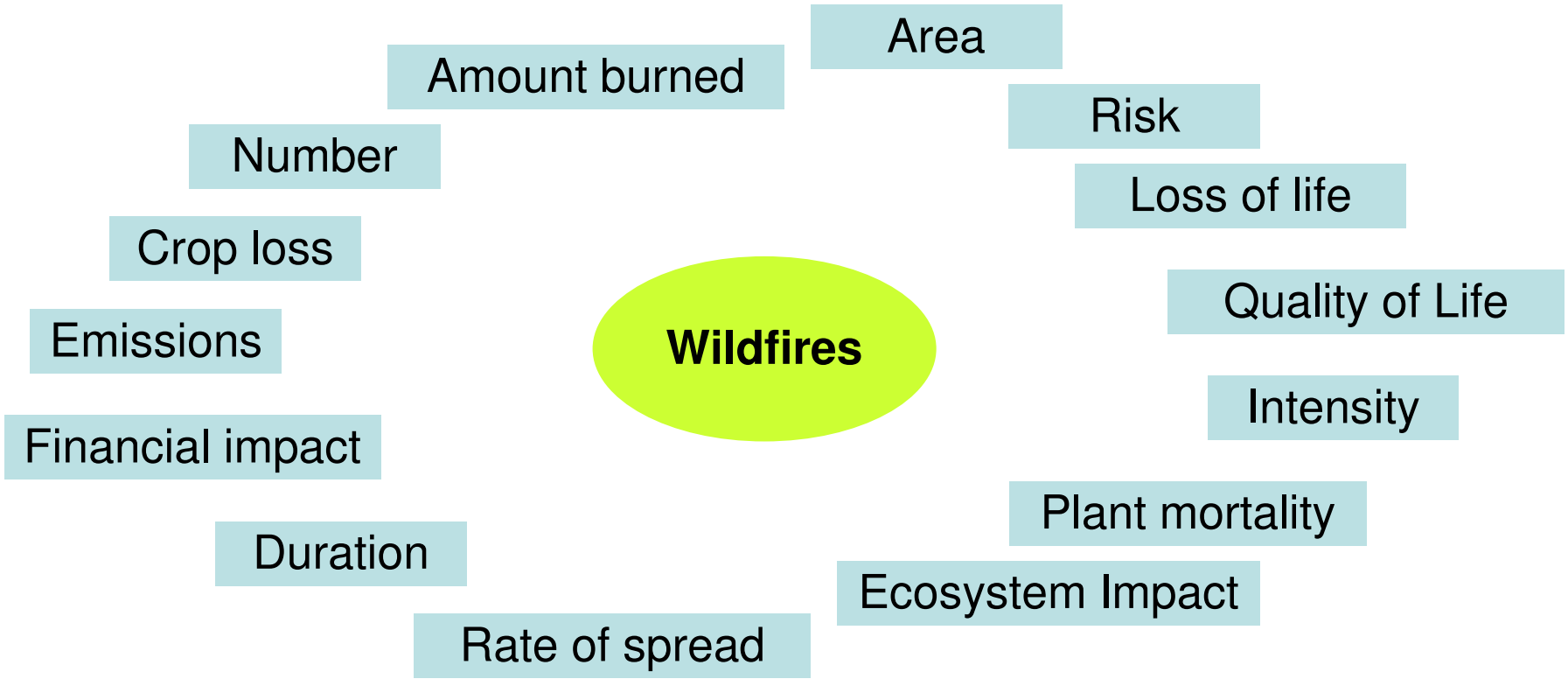
- Food
- Air Quality
- Financial
- Quality of Life
- Other impacts

Land Surface:

- Veg cover

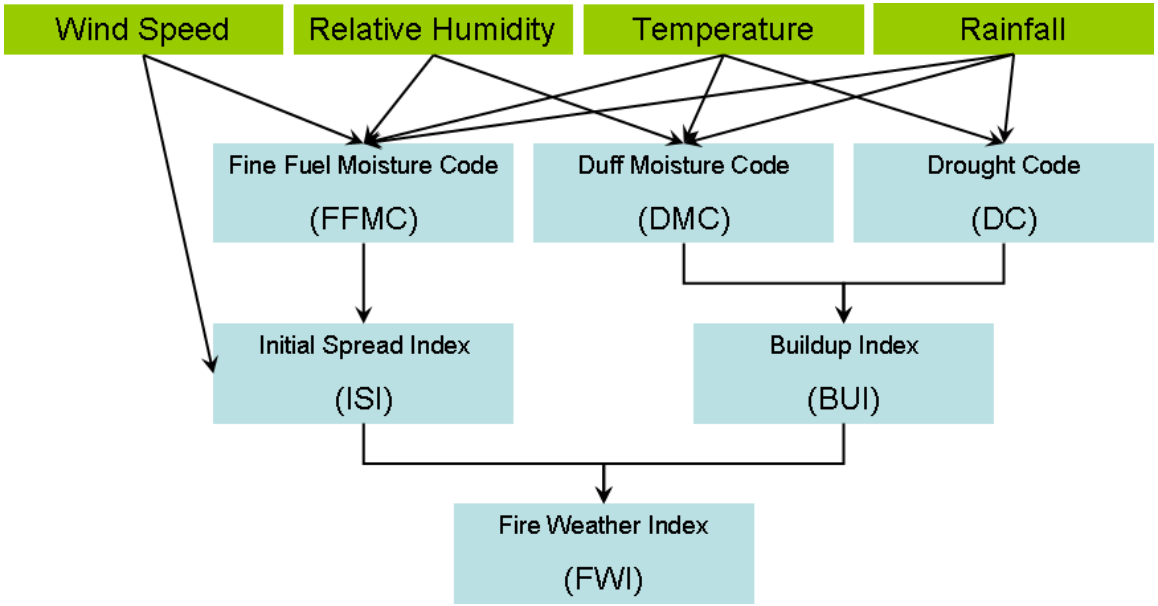
I often say that ***when you can measure what you are speaking about, and express it in numbers, you know something about it****; but when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be.*

Lord Kelvin, 1883



Anatomy of some fire models

Canadian Fire Weather Index



- 6-component index
- 3 moisture elements representing different fuel types
  - Daily wetting & drying phases
- 2 fuel consumption elements
- Final intensity-related index
- Optimised for pine forests

	Timelag (days)	Water cap. (mm)	Nom. fuel depth (cm)	Nom. fuel load (kg/m^2)
FFMC	2/3	0.6	1.2	0.25
DMC	12	15	7	5
DC	52	100	18	25

McArthur Forest Fire Danger Index

$$FFDI = 1.275 D^{0.987} e^{\frac{T_{\max}}{29.5858} - \frac{H_{\min}}{28.9855} + \frac{W_{ave}}{42.735}}$$

$$D = \frac{0.191(I + 104)(N + 1)^{1.5}}{3.52(N + 1)^{1.5} + R - 1}$$

- Drought factor modified by $T_{(max)}$, $\%RH_{(min)}$ and average wind speed
- Accumulation of drought considers *N* days since *R* amount of rain with a soil moisture deficit *I* (in top ~80 cm)

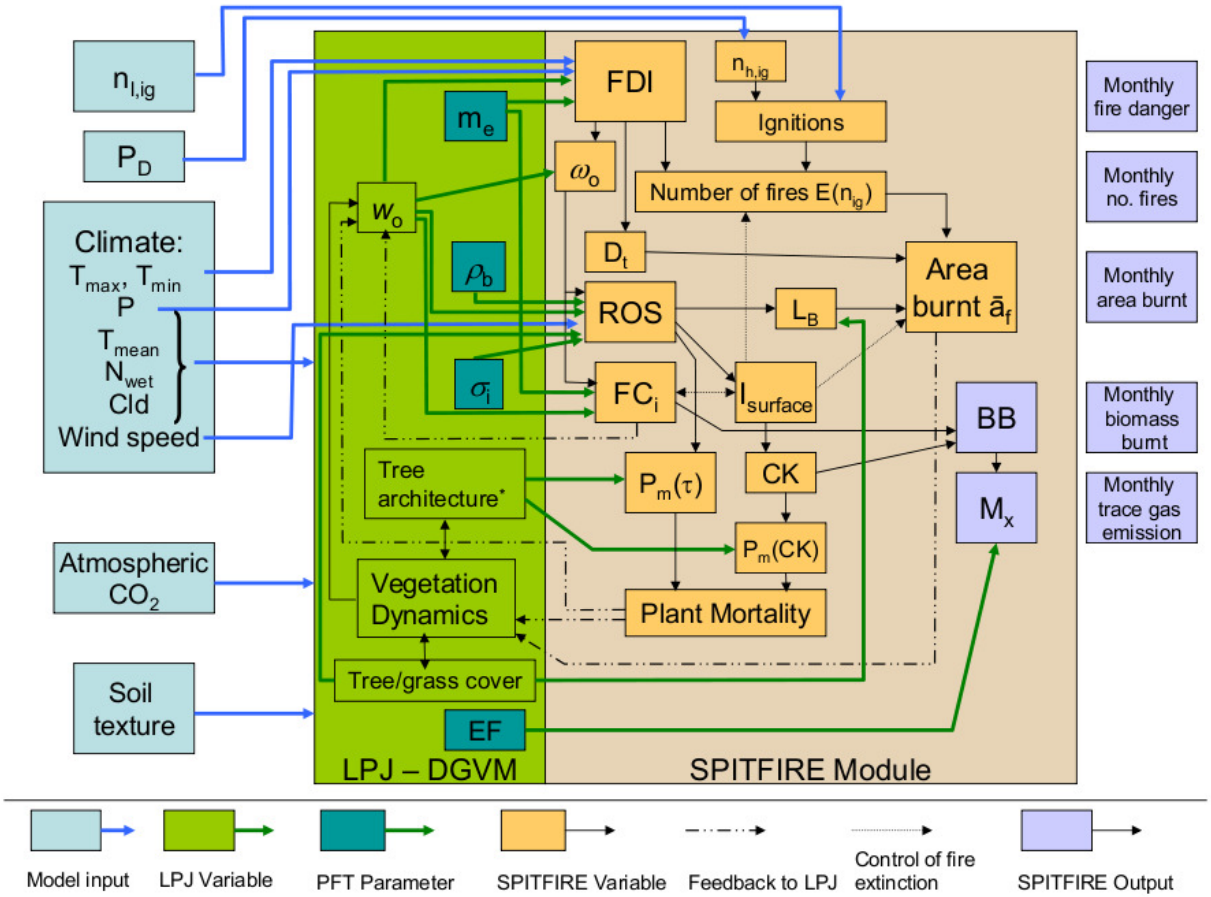
Nesterov Index

$$N = \begin{cases} N_0 + ((T - D) \times T), & P < P_t \\ 0, & P \geq P_t \end{cases}$$

- Accumulates until daily precip > 3 mm, then resets to zero
- Daily increment depends on daily mean dewpoint and temperature

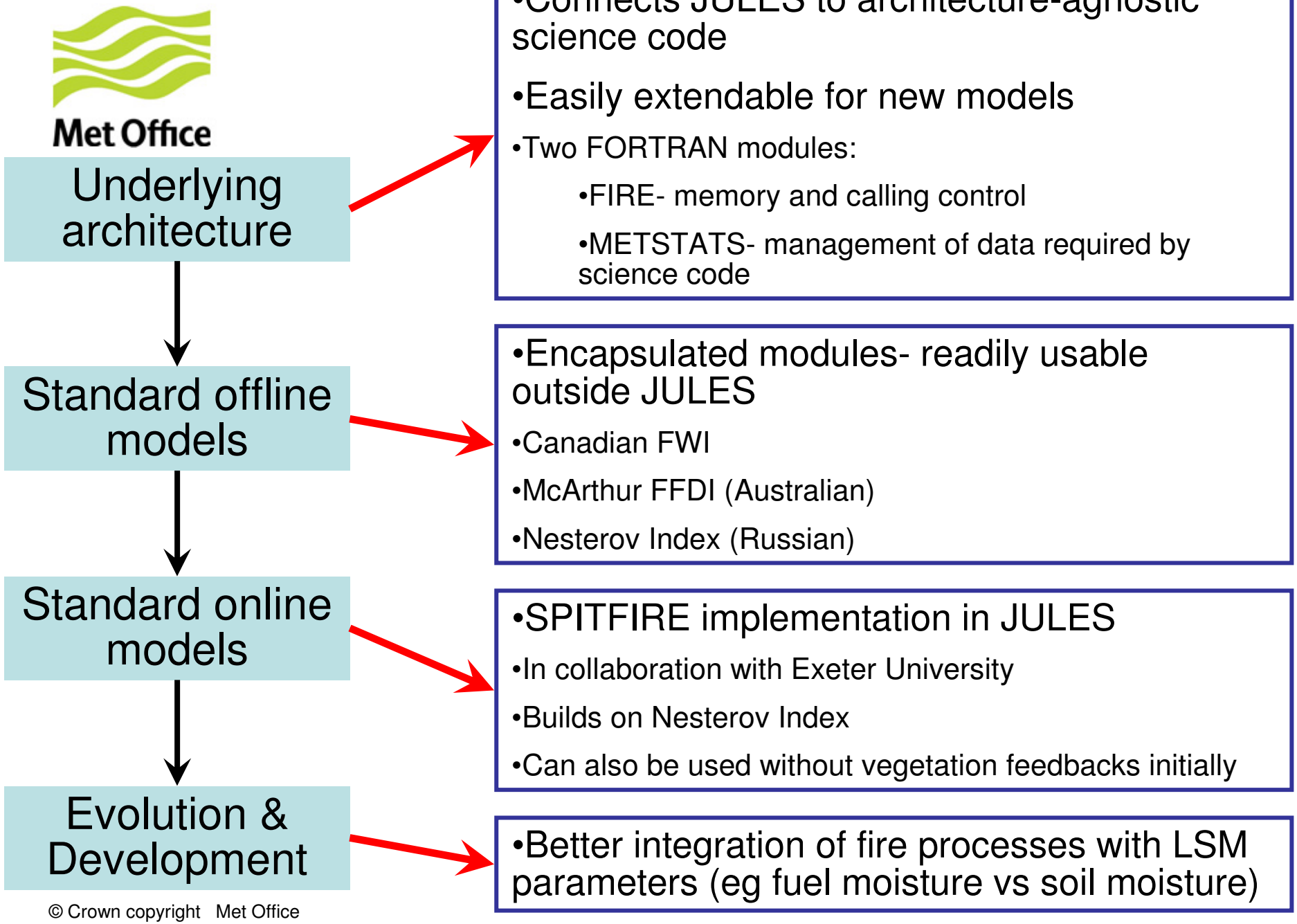
SPITFIRE

- Builds on Nesterov index
- Process-based model
- Close links to vegetation scheme in LSM



From Thonicke et. al. (2010) Biogeosciences, **7**, 1991-2011
doi:10.5194/bg-7-1991-2010

JULES Implementation



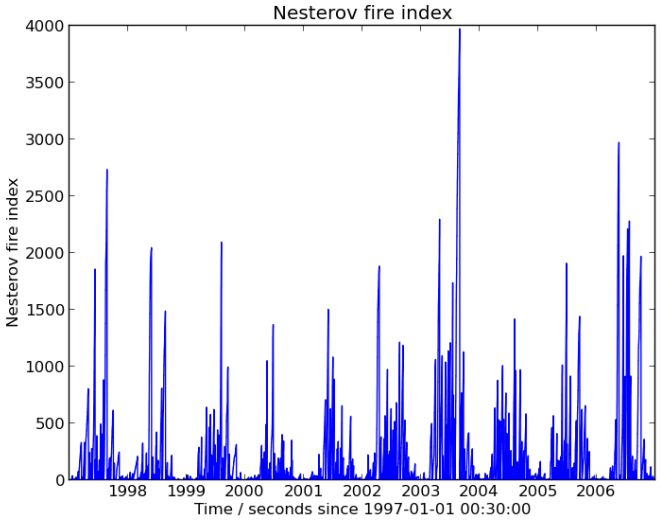
Initial Results

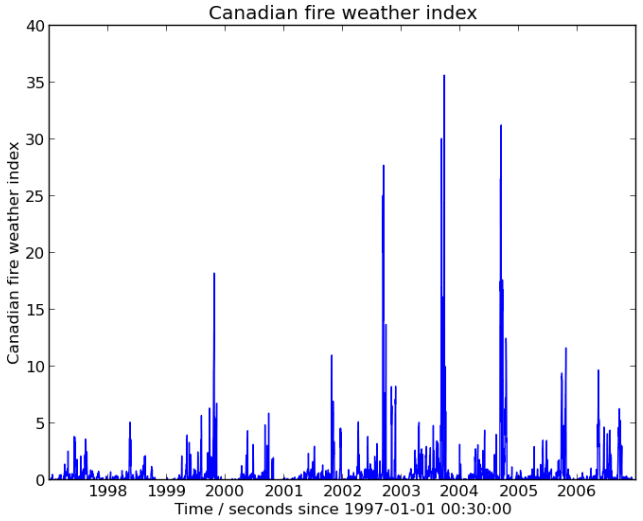
Single Site Runs

- 42 fluxnet sites (PALS sites)
  - 2 examples for now
- JULES at version UM8.4 (ie v3.2 & a bit)

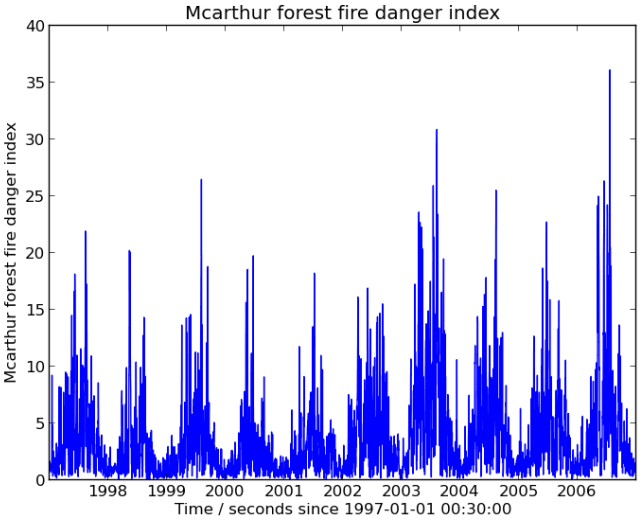
- Plot raw index and risk phrase categories (eg Low, Moderate, High etc)

Loobos





- Seasonal cycle OK
- 2003- interesting details
  - Spring peak
  - Max values



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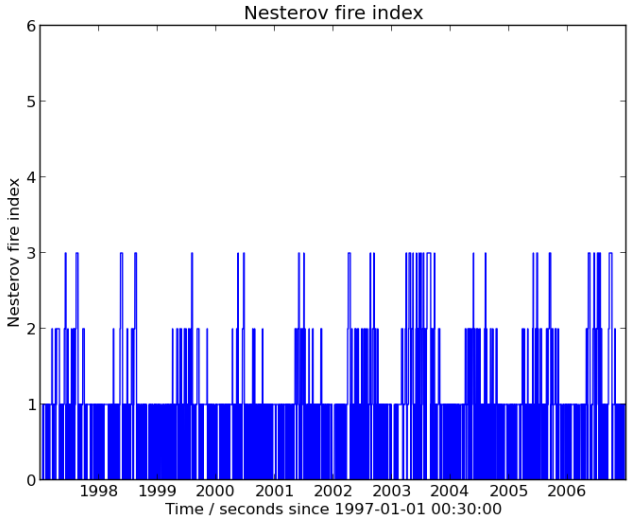

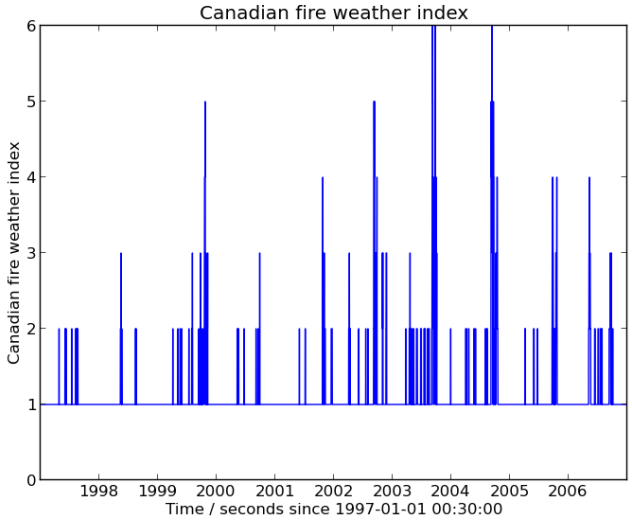

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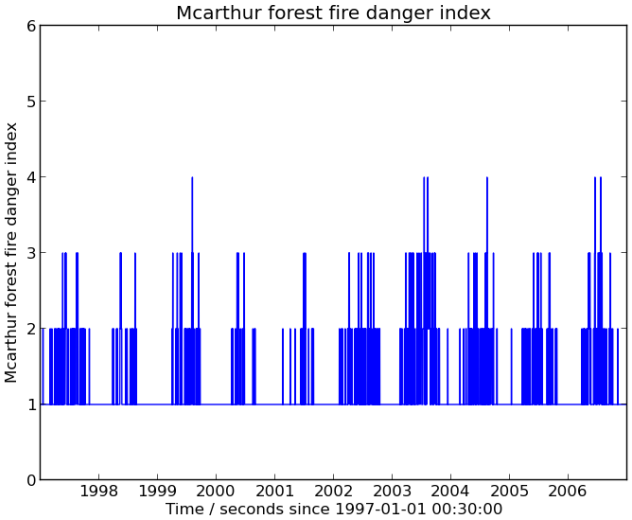
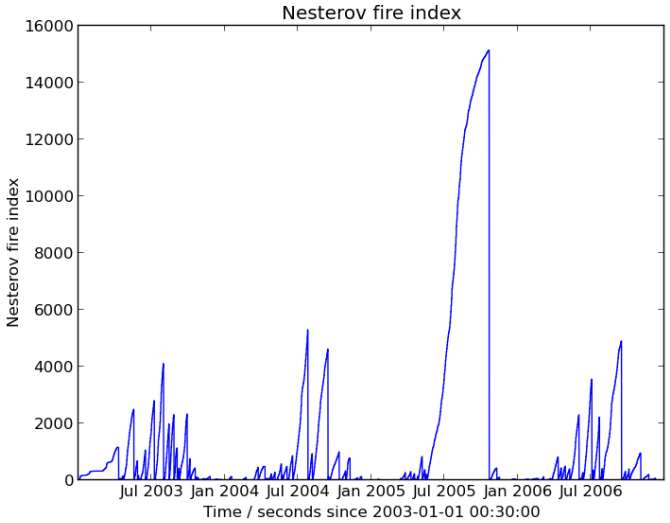
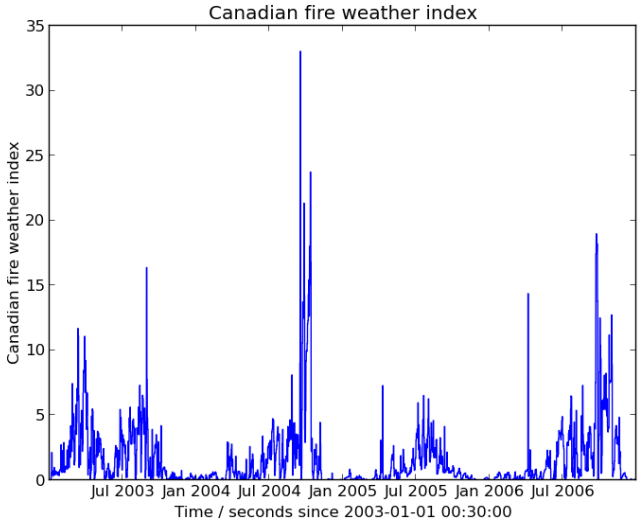
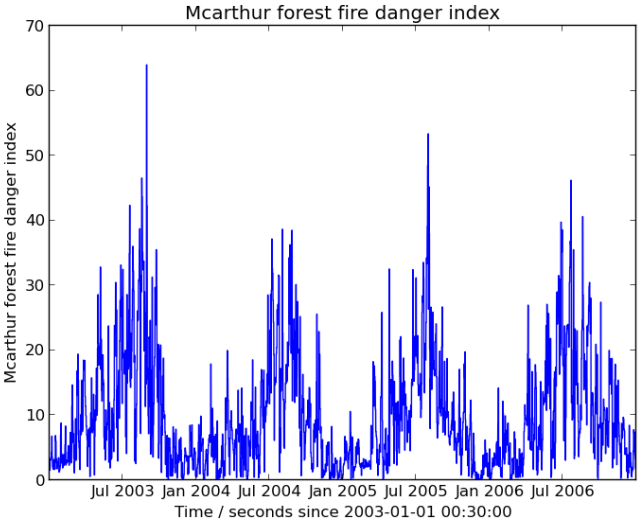


Amplero





- Seasonal cycle OK
- 2005- divergence between all 3 indices



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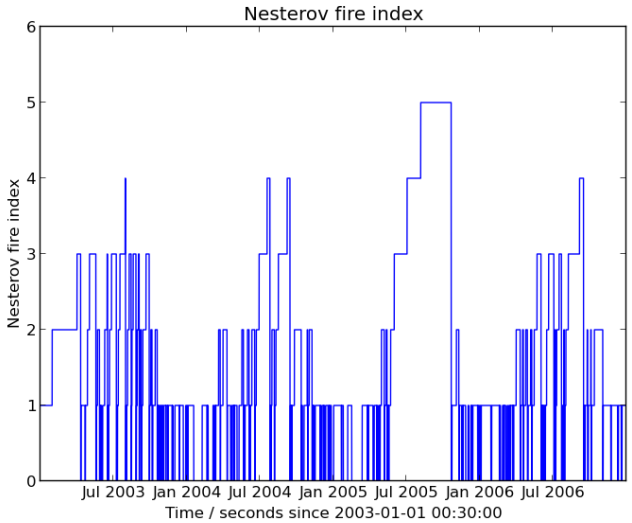

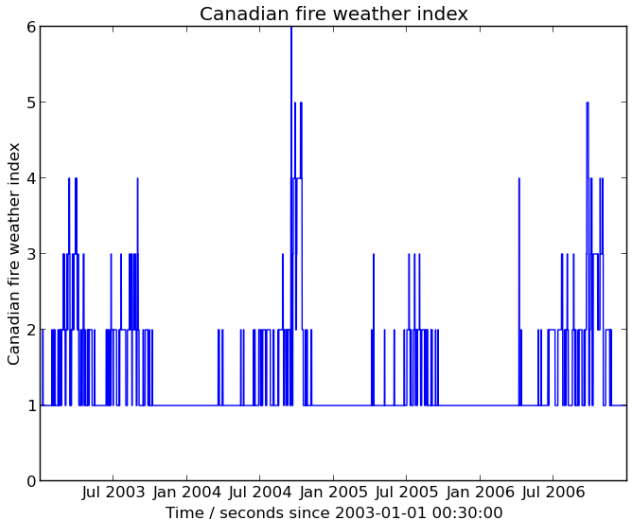

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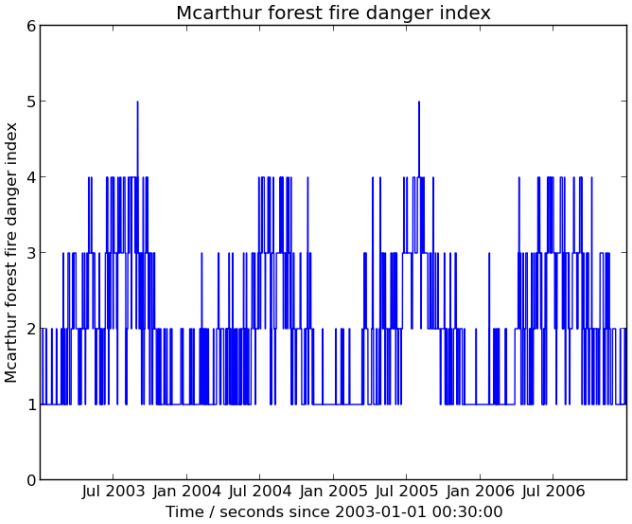


Point Runs

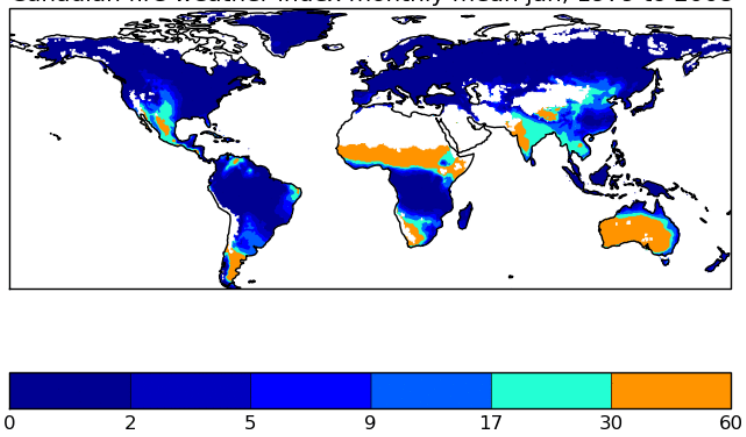
- Grossly similar behaviour between indices
- Many differences in the detail
  - Sensitivity to specific conditions?
  - Case studies needed
- Point runs too short to build climatologies

WFDEI Global Runs

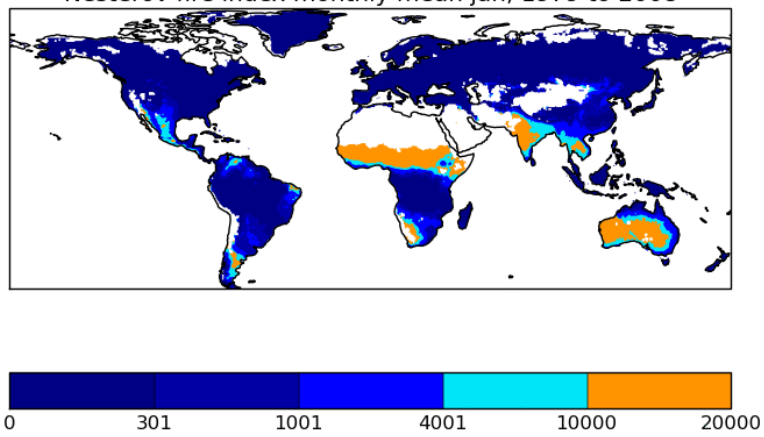
- 0.5deg, 30 year dataset
- JULES v3.2 fire branch
- No TRIFFID

- Mask out all gridboxes > 50% soil
- Shade according to risk phrases
  - Colouration similar, but not identical

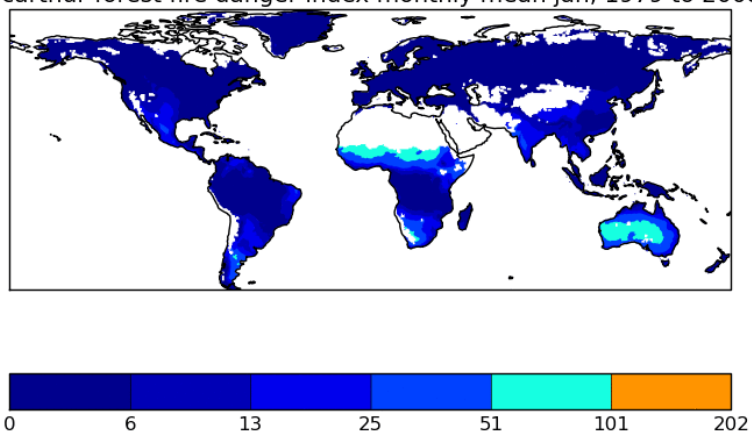
Canadian fire weather index monthly mean jan, 1979 to 2008



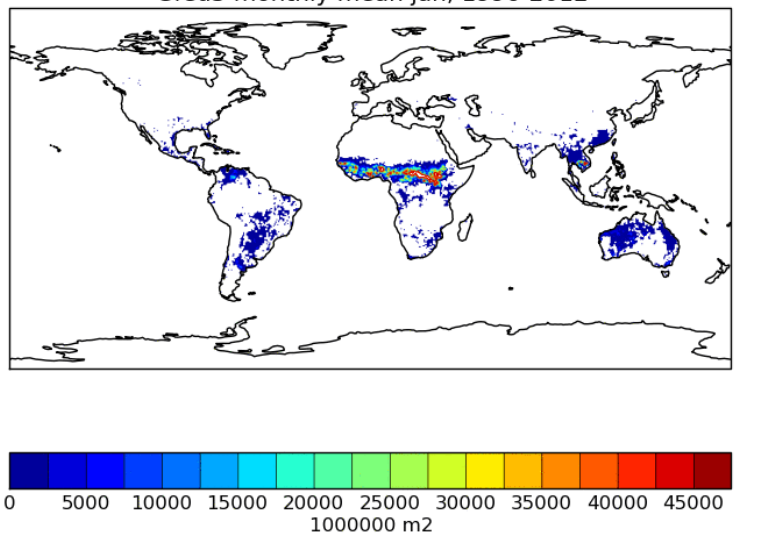
Nesterov fire index monthly mean jan, 1979 to 2008



Mcarthur forest fire danger index monthly mean jan, 1979 to 2008



Gfed3 monthly mean jan, 1996-2012



WFDEI Fire Risk Climatologies

- All 3 models show similar gross patterns
  - Any show-stopping differences for climate studies?
- Several interesting high-risk areas
  - Sahel, Australia, Amazon, sub-Saharan Africa, USA, Mediterranean Europe & Africa

Conclusions

- Difficult to compare different arbitrary scales
  - Linear? Co-linear?!
- Indices generally agree on climate timescales
  - Exact model choice not critical for CR?
- Indices differ in day-to-day site-specific details
  - Care needed for NWP
- Structure in place for more models & development

Future Work

- Get risk models operational in UM
- Comparison/validation
  - Operationally
  - Climate research
- SPITFIRE

Questions and answers

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