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agriculture facing extreme climatic events

Extending existing models to capture vegetation response to extreme weather events:
the MODEXTREME project

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7th International Congress on Environmental Modelling and Software (iEMSs)

**June 15-19, 2014
San Diego, CA, USA**

INRA
SCIENCE & IMPACT

Project MODEXTREME

- ❖ **Type of project:**
  - ❖ Collaborative Project (small to medium-size) of the European Commission 7th Framework Programme
- ❖ **Theme:**
  - ❖ Food, Agriculture and Fisheries, and Biotechnologies
- ❖ **Topic addressed:**
  - ❖ KBBE.2013.1.4-09: Improving the capacity of agro-meteorological crop modelling to integrate climatic variability and extreme weather events
- ❖ **Duration:**
  - ❖ Three years (start on 01 November 2013; kick-off meeting on 27-28 January 2014)
- ❖ **Requested budget:**
  - ❖ ≤ 2 million EUR

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JAN. 21, 2014

East Coast Storm Brings Snow and Disruptions to the New York Region
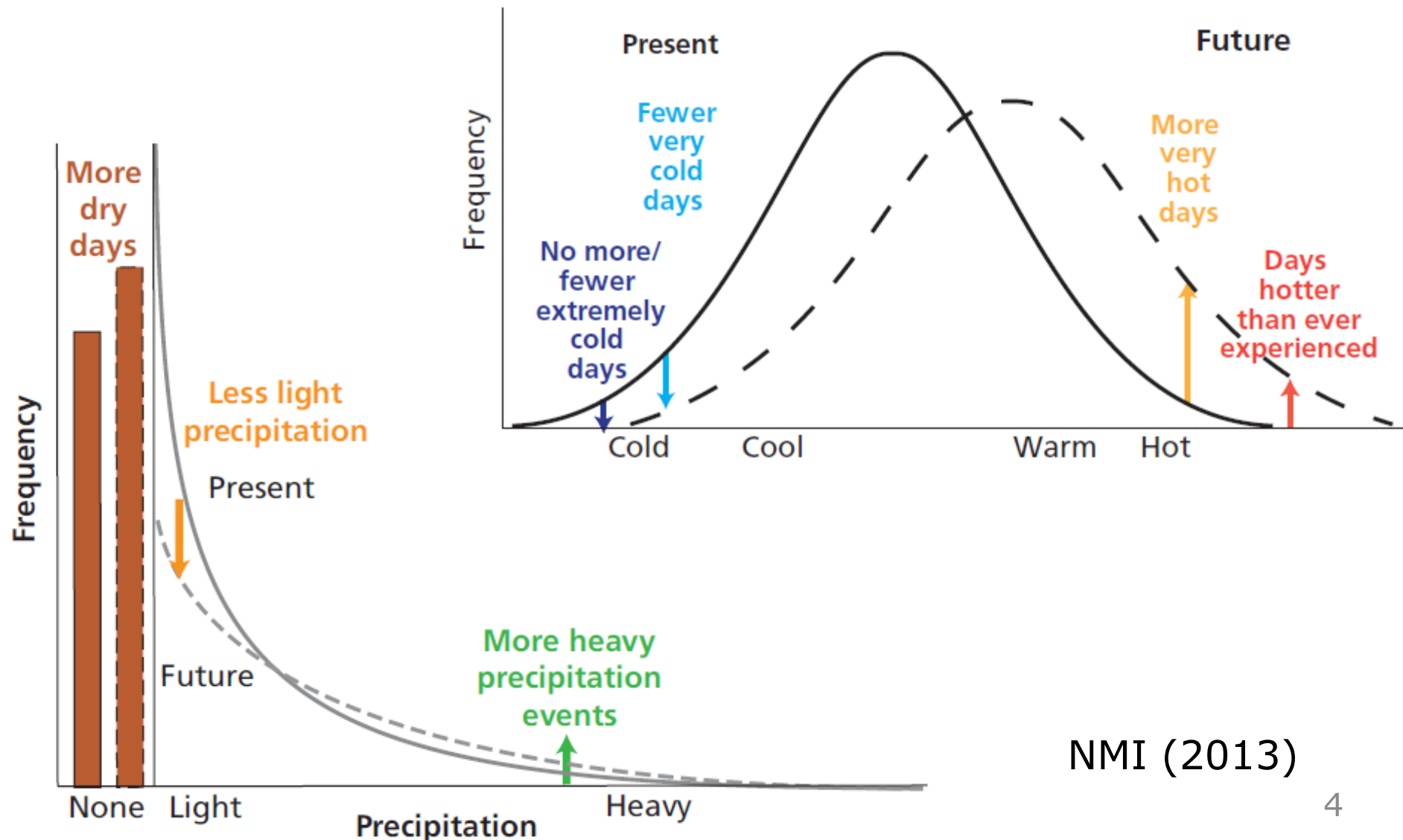
AFP

JAN 21, 2014

California suffering possibly its worst drought in a century

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Reuters

Extreme weather events : statistical definition



NMI (2013)

Extreme weather events : impacts

Year	Region	Event	Impact
2003	Western and Central Europe	Hottest summer in at least 500 years (Luterbarcher et al., 2004)	Crop harvest losses of 20-30% (Ciais et al., 2005)
2004-2005	Iberian Peninsula	Hydrological drought	Grain harvest losses of 40% (EEA, 2010)
2007	Southern Europe	Hottest summer on record in Greece since 1891 (Founda and Giannakopoulos, 2009)	Roughly 575 000 ha burnt area (JRC, 2008)
2007	England and Wales	May-July wettest since records began in 1766	78 farms flooded with about £50 million (Chatterton et al., 2010)
2010	Western Russia	Hottest summer since 1500 (Barriopedro et al., 2011)	Fire damage to forests (Shivdenko et al., 2011). Reduction in crop yields (Coumou and Rahmstort, 2012)
2011	France	Hottest and driest spring since 1880	8% decline in wheat yield (AGRESTE, 2011)

Extreme weather events : agricultural impacts (wheat yield)

Makowski et al. (2013)
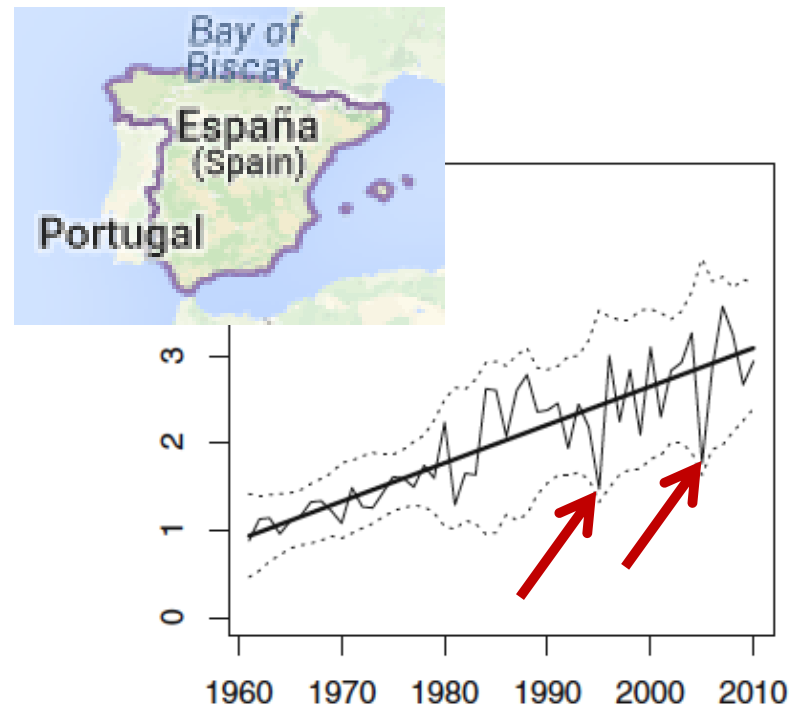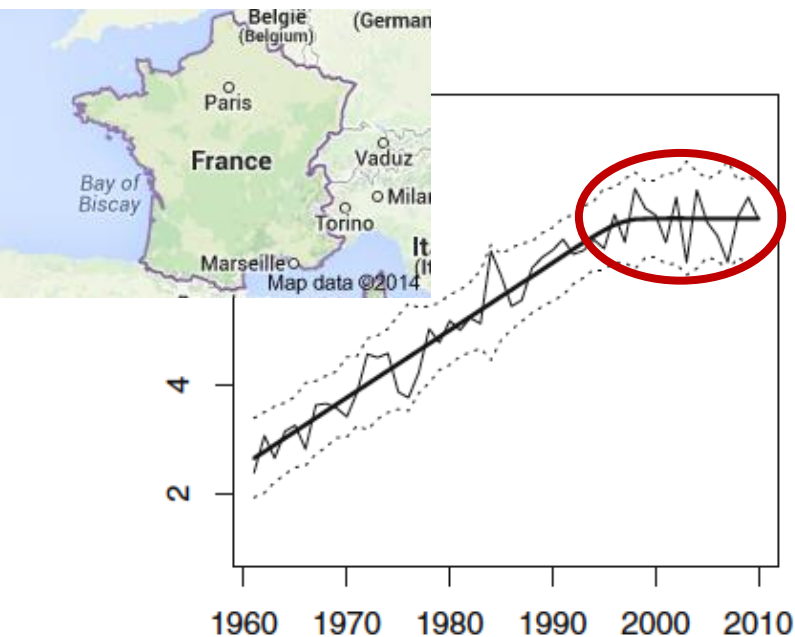
Impacts on agricultural systems

While heat stress and increased water demand are related, the modelling experiment has been able to separate the two factors and shown that **water, not heat, affects crop yields**.

Image: Tony Campbell/Shutterstock

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Project goal

❖ Improve the ability of crop and grassland models to estimate the impact of extreme weather events such as **heat waves**, **cold shocks**, **droughts** and **floods** on agricultural production

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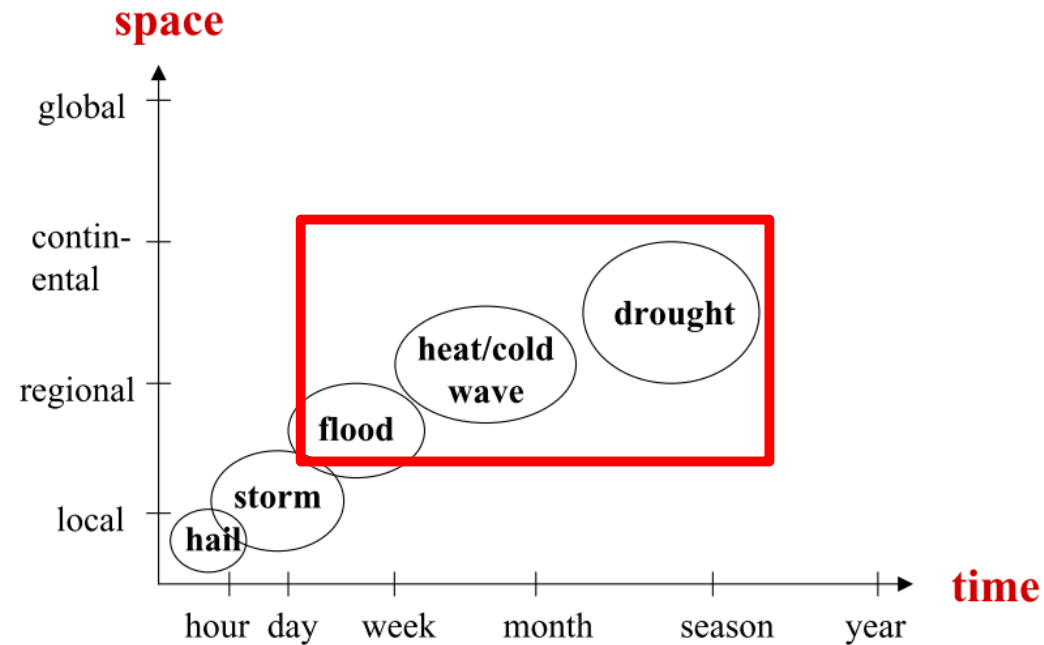
Systemic approach

Agro-ecosystem

Plot scale

Modelling

Inputs
(climate, soil, management)

Initial values

Parameters

PaSim

STICS

flooding

AQUACROP

heat stress on pollination

CropSyst

cold shock on flowering

WOFOST

WARM

Grassland model

generic   **specific (rice)**

Crop models

Outputs
(yield, aboveground biomass, flowering date, …)

implicit account of extreme events

Biophysical processes: example of Harvest Index (HI) / 1

Harvest Index (HI) = yield (Y) / total above ground biomass (B)

$Y = HI \cdot B$

Valid for all crop models
(when linked to biomass at maturity)

Valid for all weather events
(drought – low temperature – high temperature)

$$HI = HI_{max} \cdot f(WS) \cdot f(LT) \cdot f(HT) \cdot f(F)$$

Water stress   High temperature

Low temperature   Frost

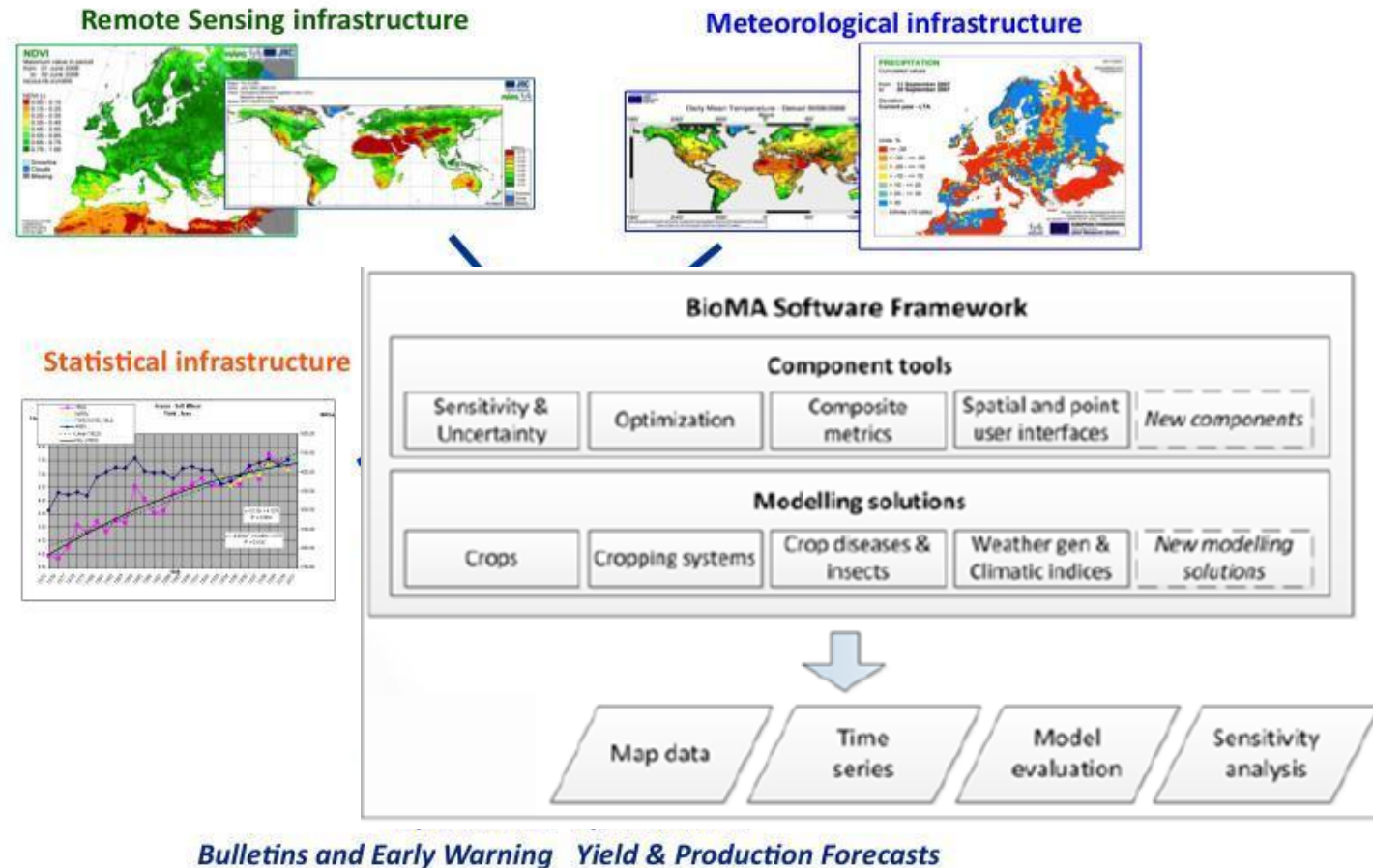modextreme

Biophysical processes: example of Harvest Index (HI) / 2

crop	pre-flowering	flowering	grain filling
winter cereals		F - WS - LT - HT	HT - WS
summer cereals		WS - LT - HT	HT - WS
sunflower	F	WS - HT	HT - WS
others	…	…	…

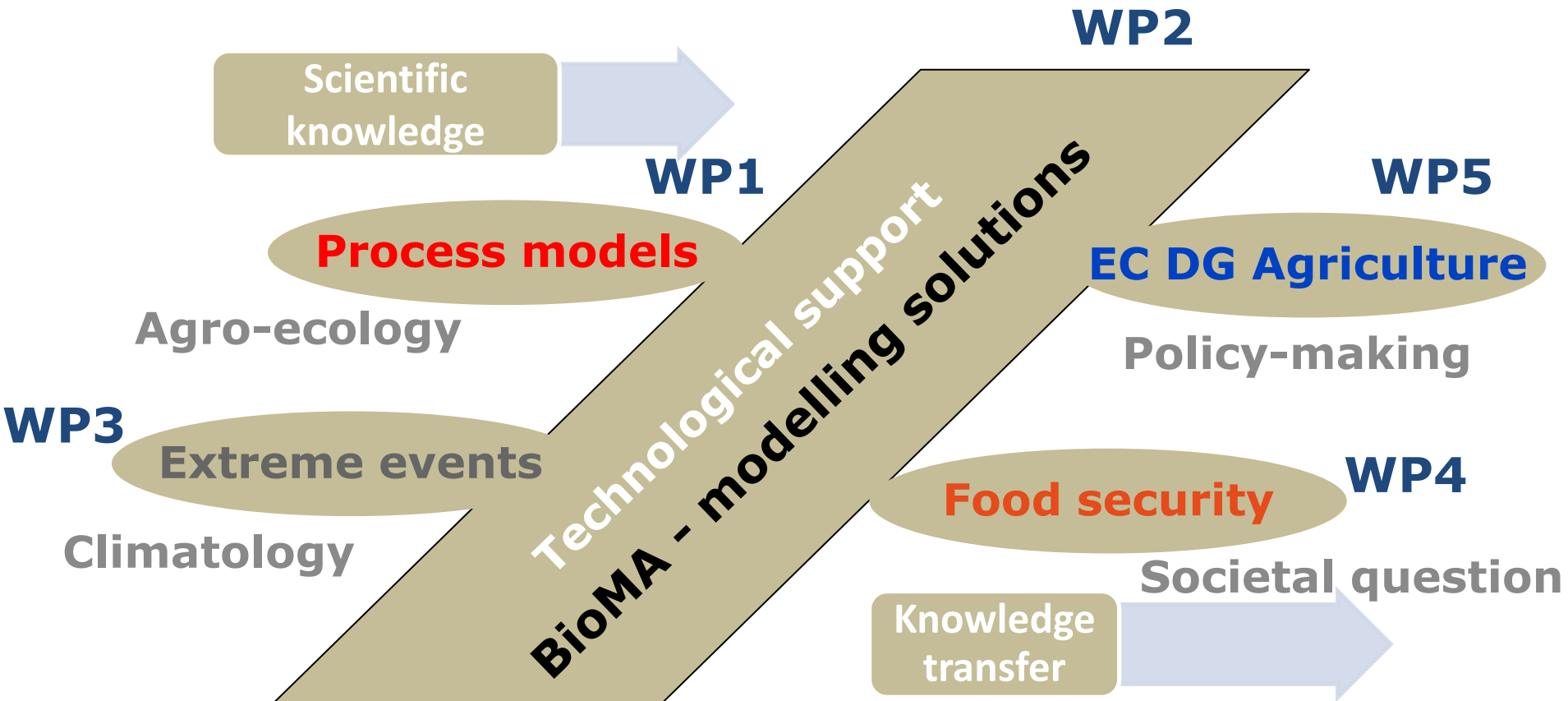modextreme

MODEXTREME in Europe

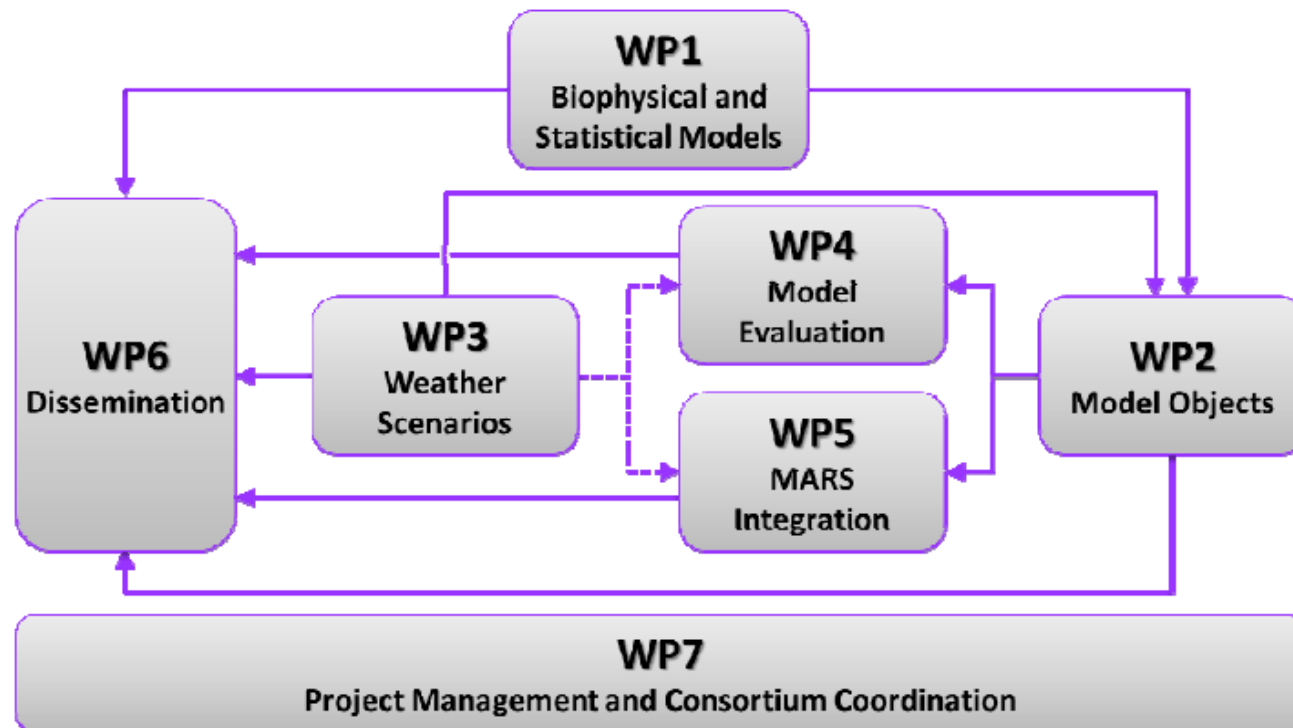# MARS: Monitoring Agricultural Resources

MODEXTREME overseas

Project rationale

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Project structure

- ❖ **Francisco J. Villalobos** University of Cordoba & IAS-CSIC, Spain (WP1)
- ❖ **Marcello Donatelli** Italian Council for Research in Agriculture, Bologna, Italy (WP2)
- ❖ **Ole B. Christensen** Danish Meteorological Institute, Copenhagen, Denmark (WP3)
- ❖ **Oscar Rojas** Food and Agriculture Organization of the United Nations, Rome, Italy (WP4)
- ❖ **Roberto Confalonieri** University of Milan, Italy (WP5)
- ❖ **Ioannis N. Athanasiadis** Democritus University of Trace, Xanthi, Greece (WP6)
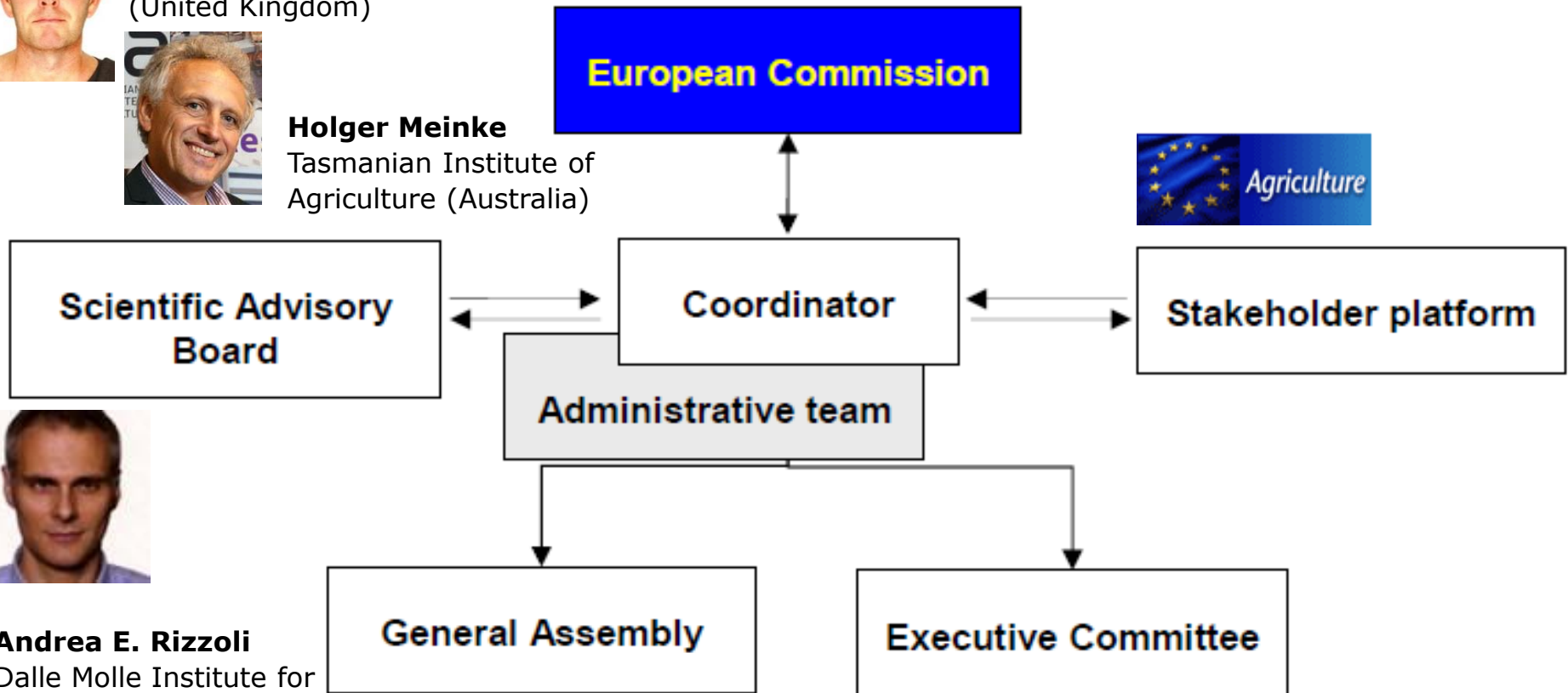- ❖ **Irina Carpusca** INRA-Transfert, Paris, France (WP7)

Project governance

Dominic Moran
Scotland's Rural College
(United Kingdom)

Holger Meinke
Tasmanian Institute of
Agriculture (Australia)

European Commission

Agriculture

Scientific Advisory Board ⟷ **Coordinator** ⟷ **Stakeholder platform**

Administrative team

General Assembly   **Executive Committee**

Andrea E. Rizzoli
Dalle Molle Institute for
Artificial Intelligence (Switzerland)

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Stakeholder platform
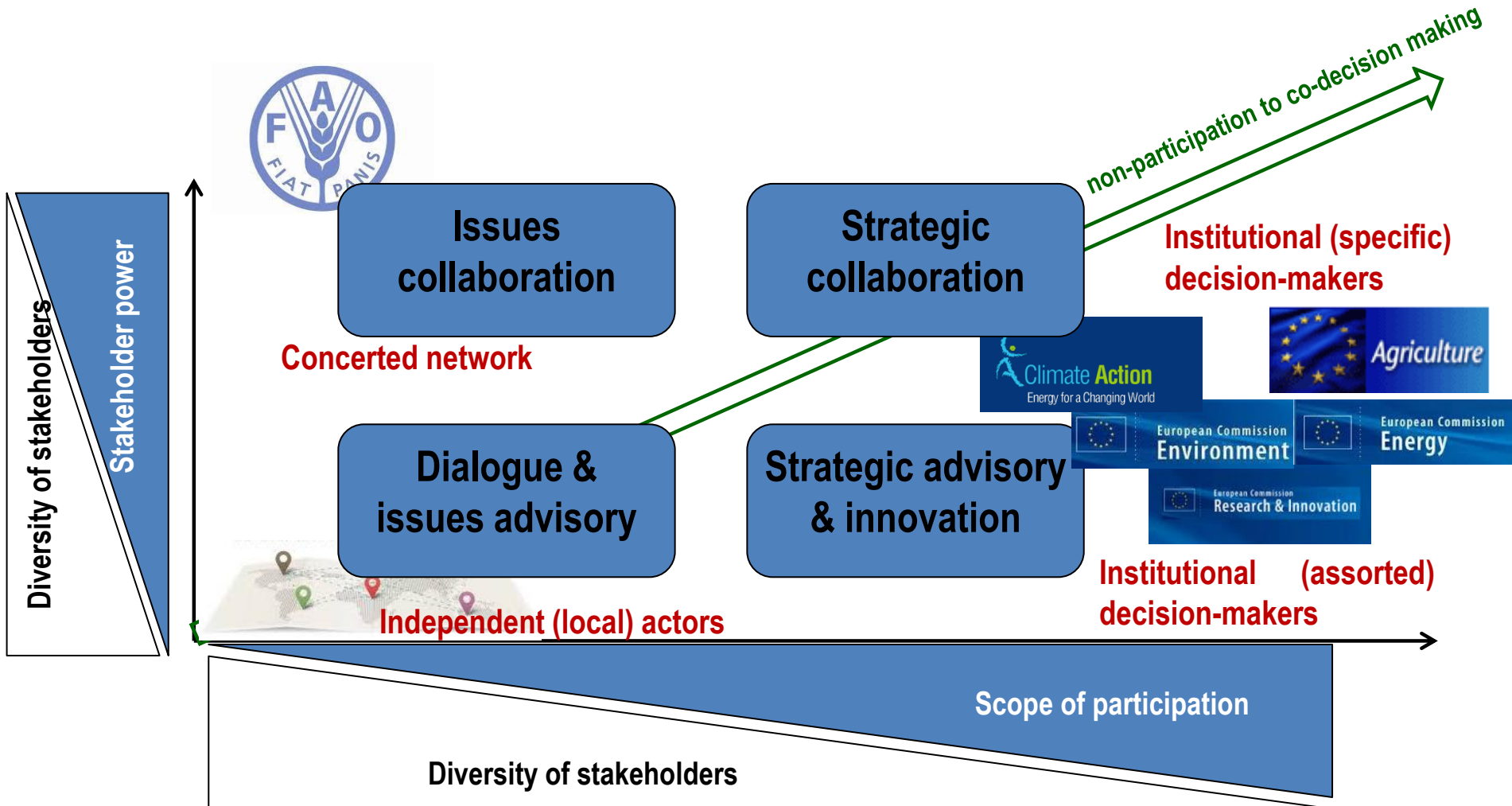
The impact of extreme meteorological events: how can agricultural models deal with?

A project to reconsider and extend biophysical modelling

Speakers:
Gianni BELLOCCHI (INRA- FR)
Marcello DONATELLI (CRA – IT)
Giampiero GENOVESE – AGRI E2

Venue: Auditorium, L102 00/25
Time/date: 12:45 – 13:45 on 10 April 2014
Registration through Syslog Web Training:
Course 453370
Only for Commission staff

EU-FP7 project MODEXTREME – JRC-AGRI4CAST project joint workshop

June 30-July 1, 2014

Ispra (Italy)

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MODEXTREME Workshop on Building model components

July 8 - 10

Workshop on building model components - A technical workshop at University of Milan, Italy

About

The technical workshop on model implementation in MODEXTREME will take place at the University of Milan, on July 8 (13:30) to July 10 (13:00). The workshop will also be run via videoconferencing, but this will surely be less effective than in-site participation. Given that participation to MODEXTREME ranges from the Americas to East Asia, it is also impossible to select a time acceptable for all.

This first workshop is **reserved to MODEXTREME participants** and will primarily deal with the implementation of model components, in which models are implemented at fine granularity. We will start from the definition of the domain (in software terms) to the implementation of models, and to sample applications. This corresponds to the BioMA "ModelLayer".

Target participants are modellers with the knowledge of a programming language, preferably object-oriented. Each participant must have a laptop running Windows 7 or higher, and a version of Visual Studio 2013 for Windows (the Express version is free (click to download); come with the software installed). Other tools specific for the task will be provided.

The last half day will be reserved to illustrate realizations both as components and as modelling solutions.

The workshop is coorganized by WP2 and WP6.
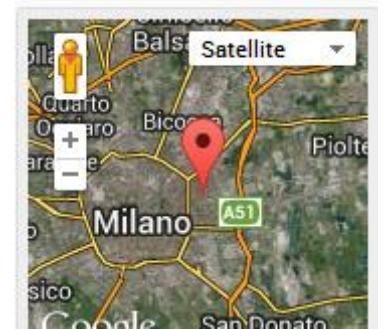
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Acknowledgement

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