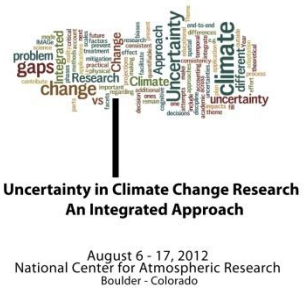


Newcastle University

Uncertainty in Climate Change Research – An integrated approach

Impacts and Adaptation

Prof Hayley Fowler, Newcastle University, UK

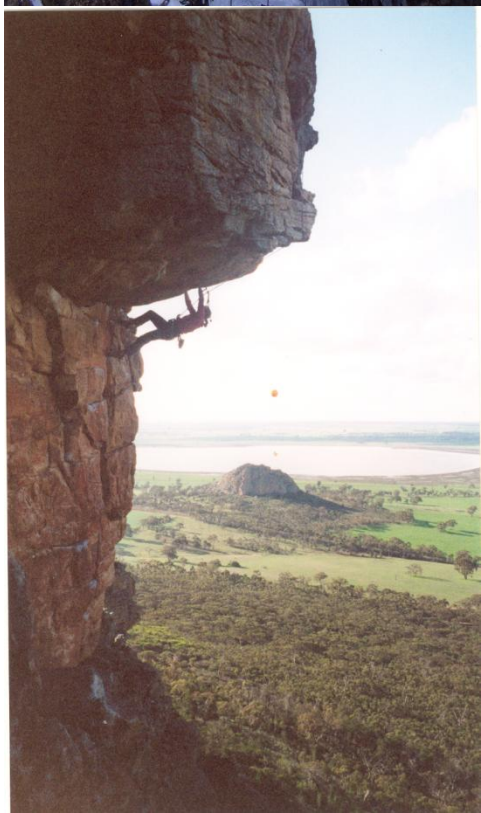
TOY2012, 6-17th August 2012

Uncertainty in Climate Change Research
An Integrated Approach

August 6 - 17, 2012
National Center for Atmospheric Research
Boulder - Colorado

Who am I?

- Geographer – Cambridge University
- Water Resource Systems Engineering and Civil Engineering (MSc/PhD)
- Professor of Climate Change Impacts
- Started with climate change impacts on water resources – but realised that we needed improvements in downscaling, representation of extremes and impacts modelling so branched out (interdisciplinary)
- Interested in practical applications and solutions to societal issues/problems related to climate change and particularly extremes

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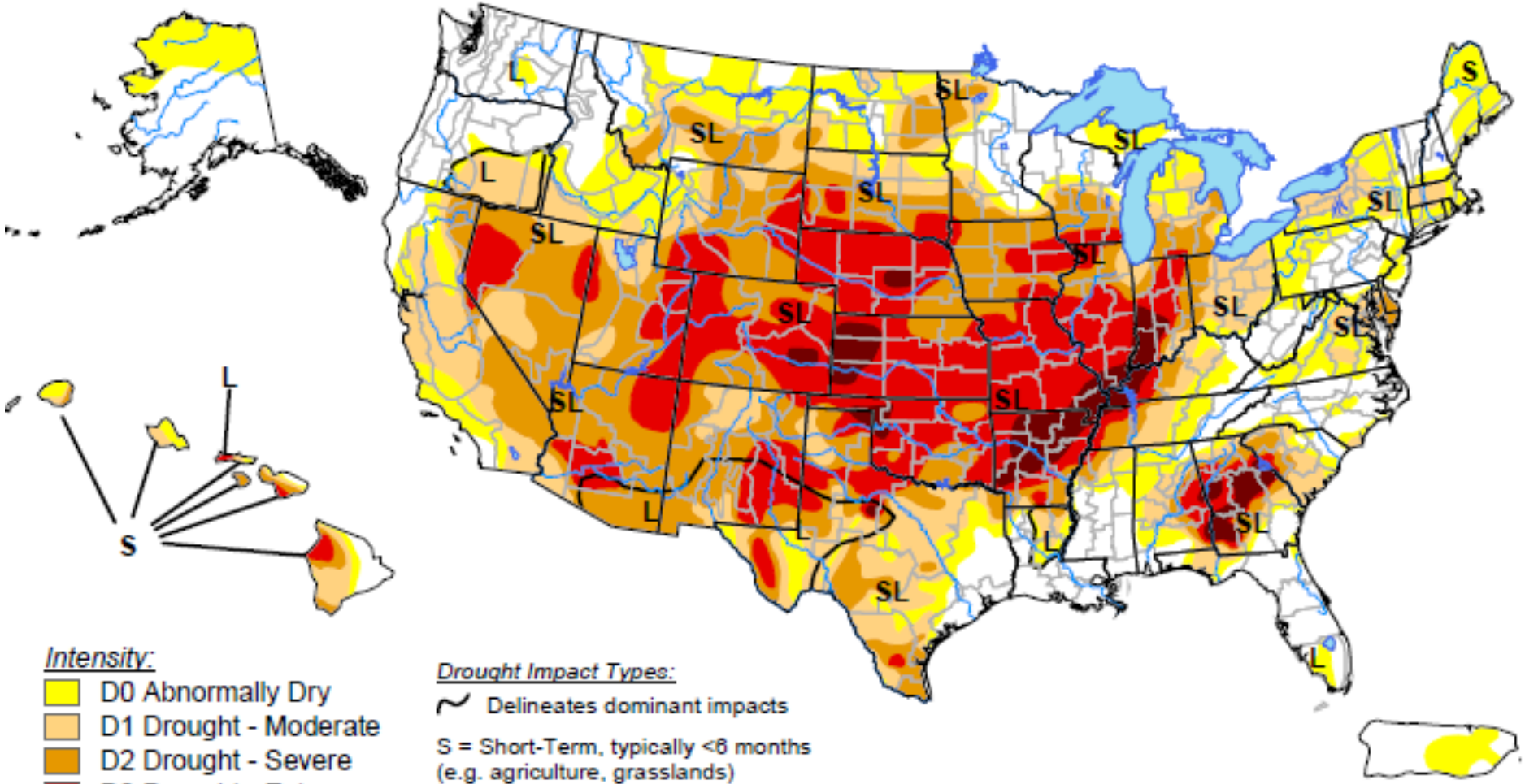
U.S. Drought Monitor

July 31, 2012
Valid 7 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:

~ Delineates dominant impacts

S = Short-Term, typically <6 months (e.g. agriculture, grasslands)

L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

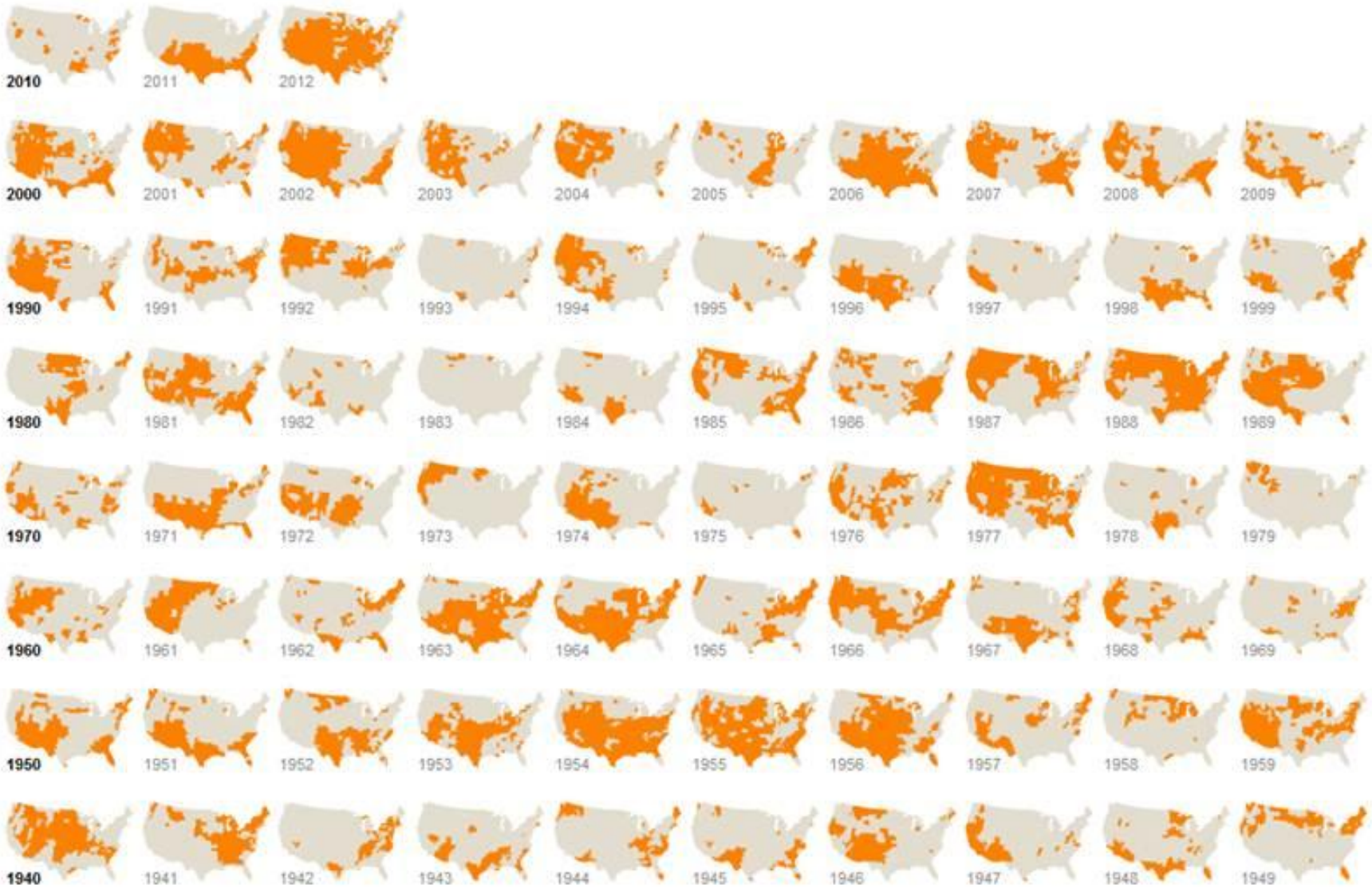
http://droughtmonitor.unl.edu/

Released Thursday, August 2, 2012

Author: Mark Svoboda, National Drought Mitigation Center

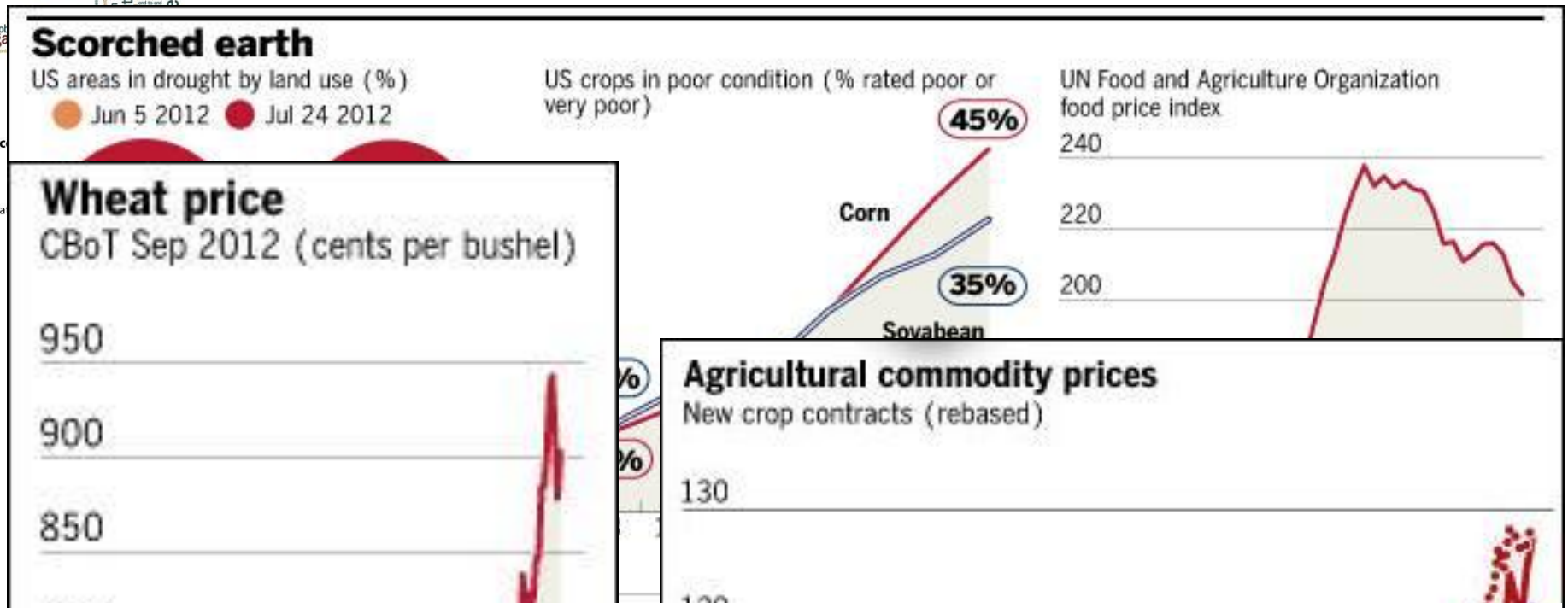
Drought's Footprint

More than half of the country was under moderate to extreme drought in June, the largest area of the contiguous United States affected by such dryness in nearly 60 years. Nearly 1,300 counties across 29 states have been declared federal disaster areas. Areas under moderate to extreme drought in June of each year are shown in orange below.



http://www.nytimes.com/interactive/2012/07/20/us/drought-footprint.html?ref=business

NCDC, NOAA

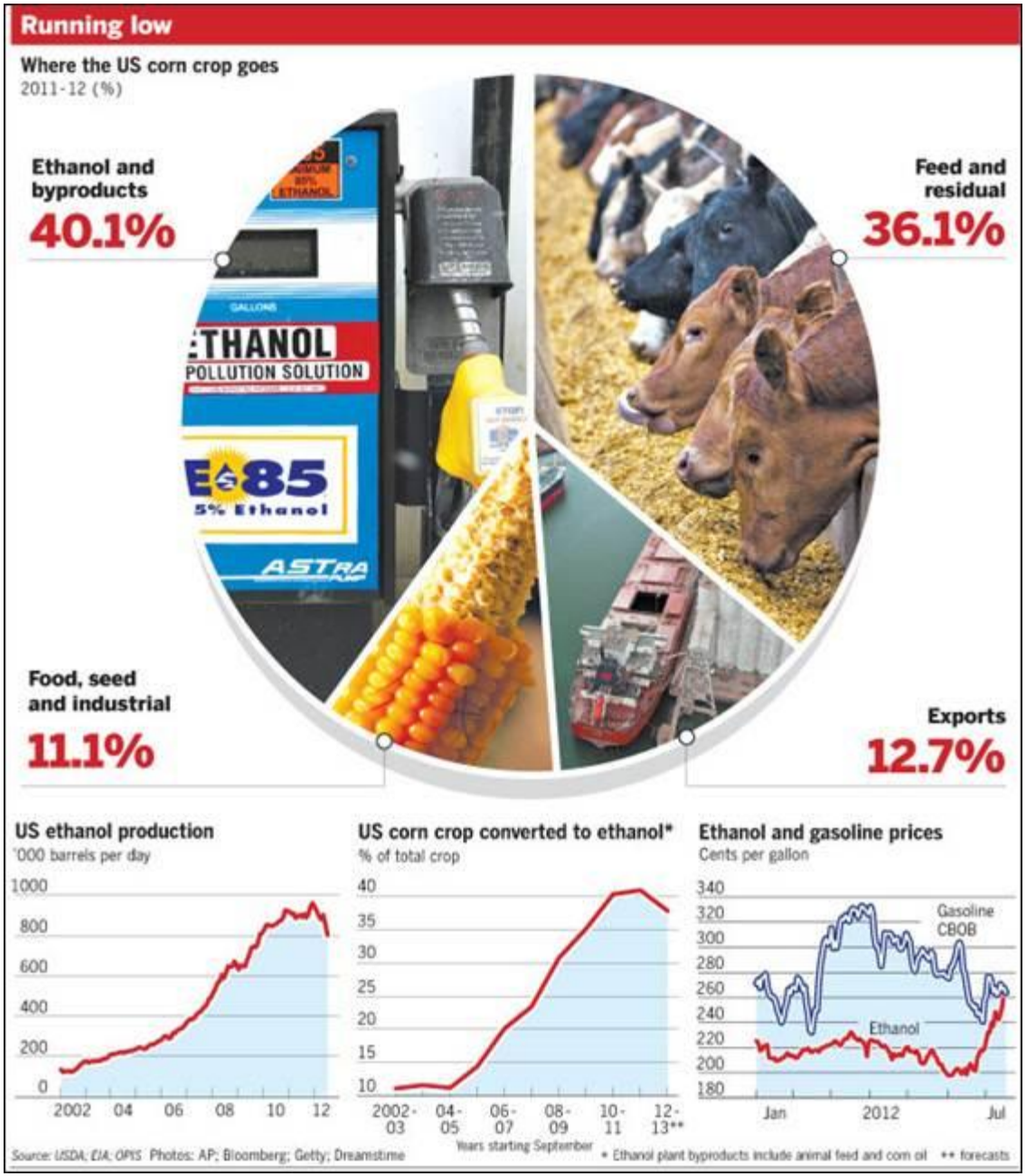


Increase in grain prices already being felt around the world

- **Indonesia** - tofu industry threatened to strike over rising soyabean prices
- **Mexico** - cost of corn tortillas is on the rise
- **Iran** - rare protest over the cost of chicken

Economic effects of sharp rise (30-50%) in agricultural commodities barely begun - most affect countries dependent on agricultural imports and poorer nations

Government policies like the ethanol mandate exacerbate the rise in corn prices



Courtesy: Financial Times

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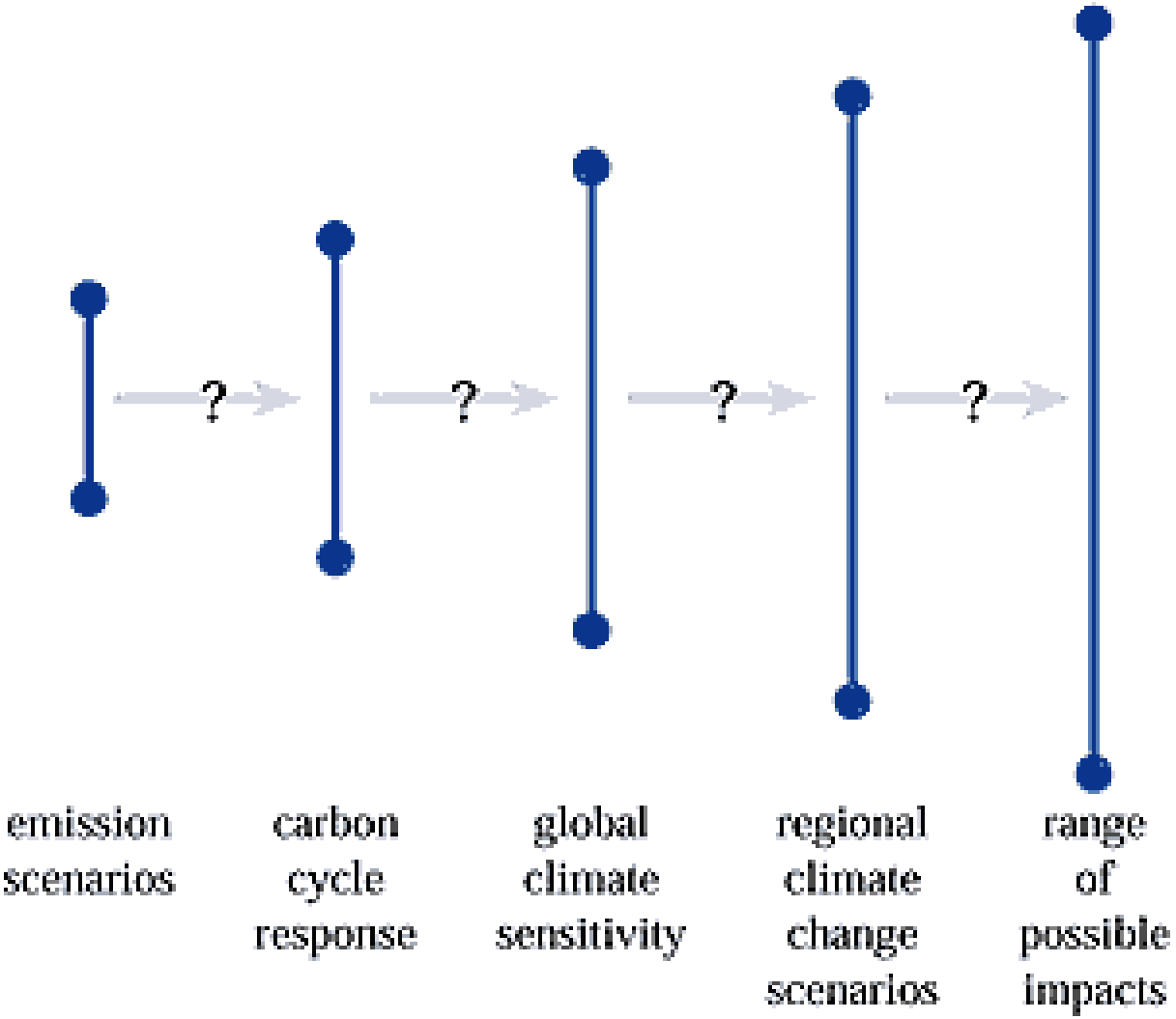
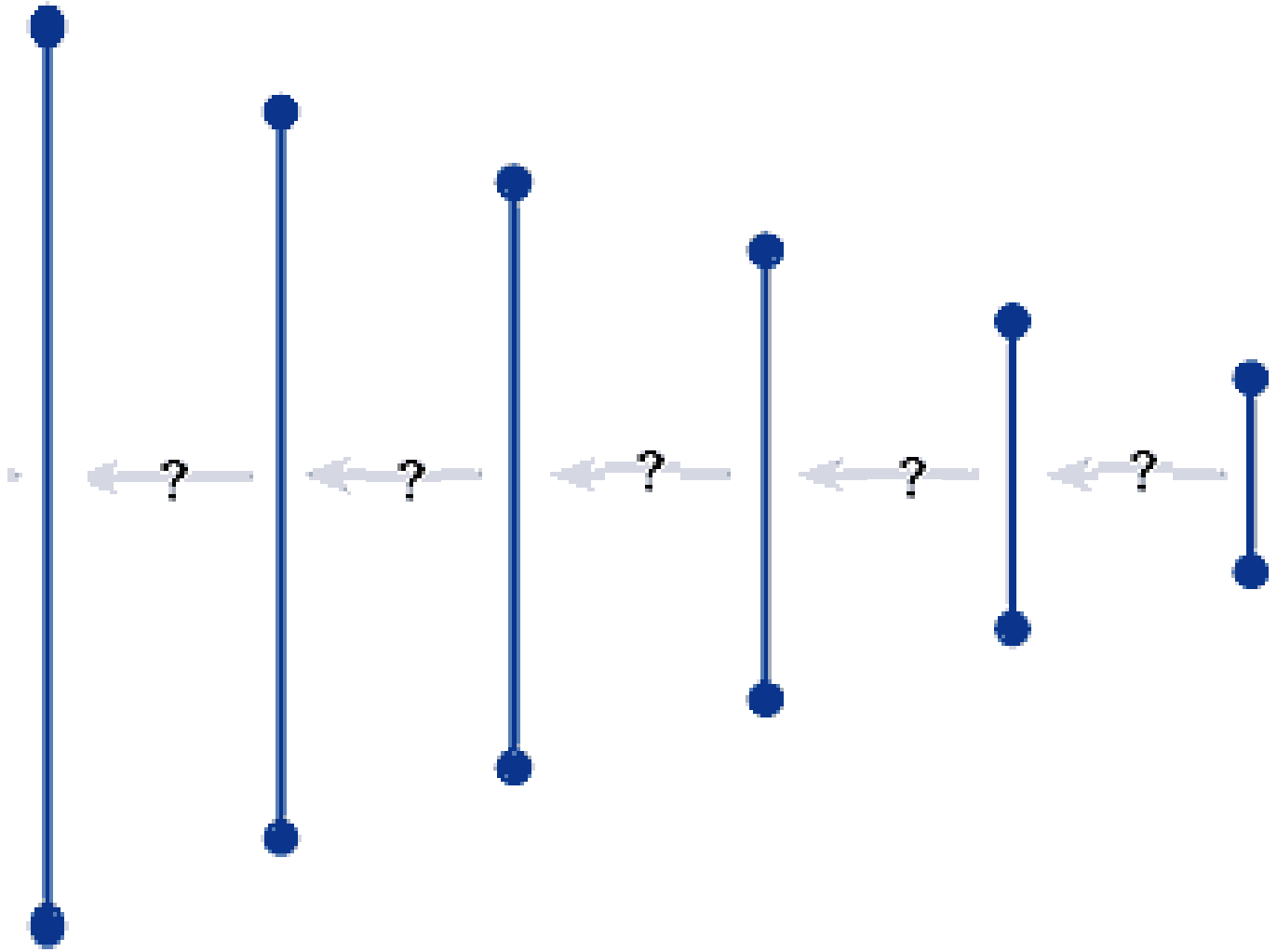
The Uncertainty Cascade



IPCC AR4 WG2 2007 (modified after Jones, 2000, and "cascading pyramid of uncertainties" in Schneider, 1983)

A New Uncertainty Cascade



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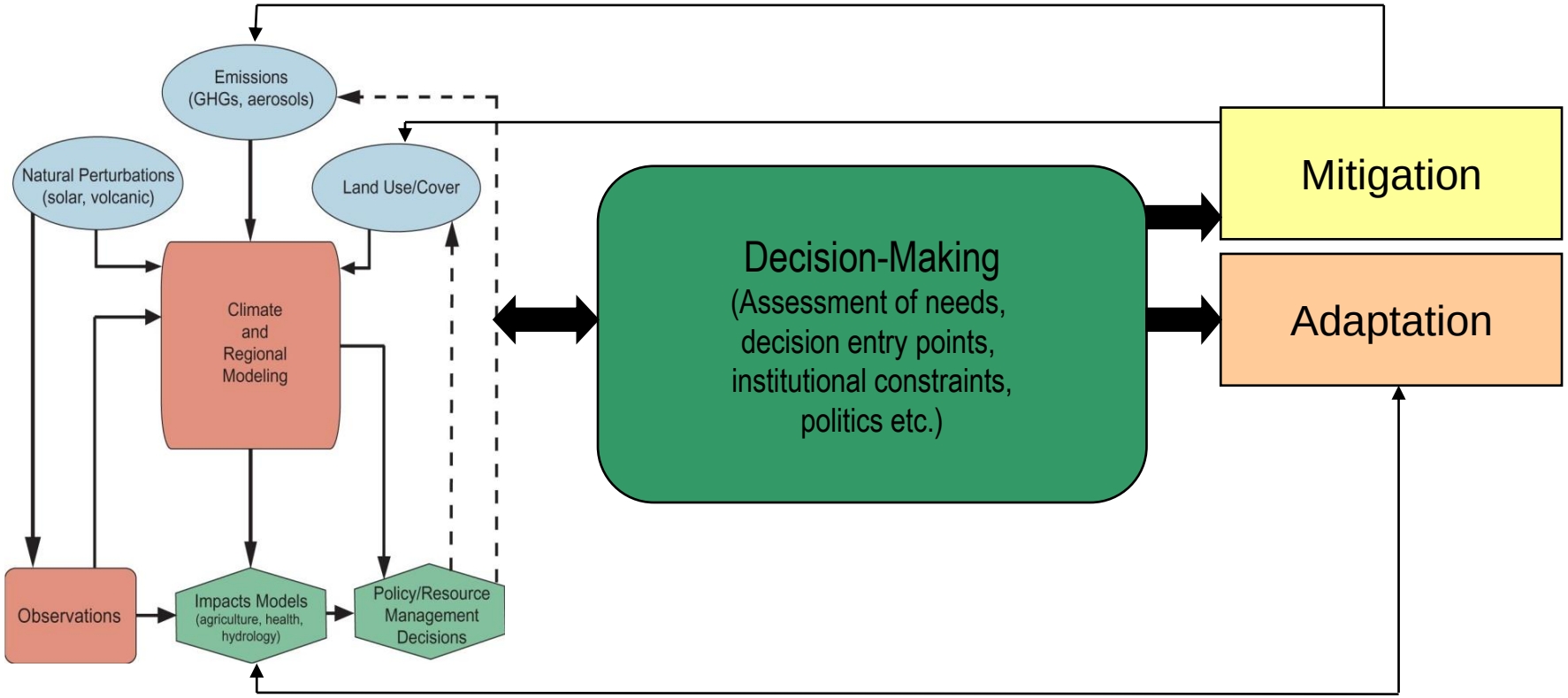
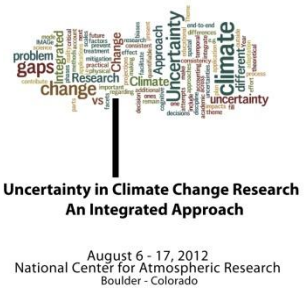
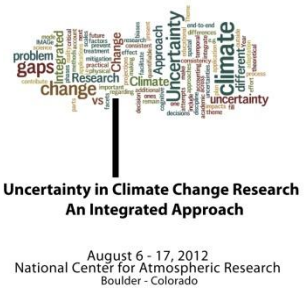
Toward Decision-making as a Central Focus





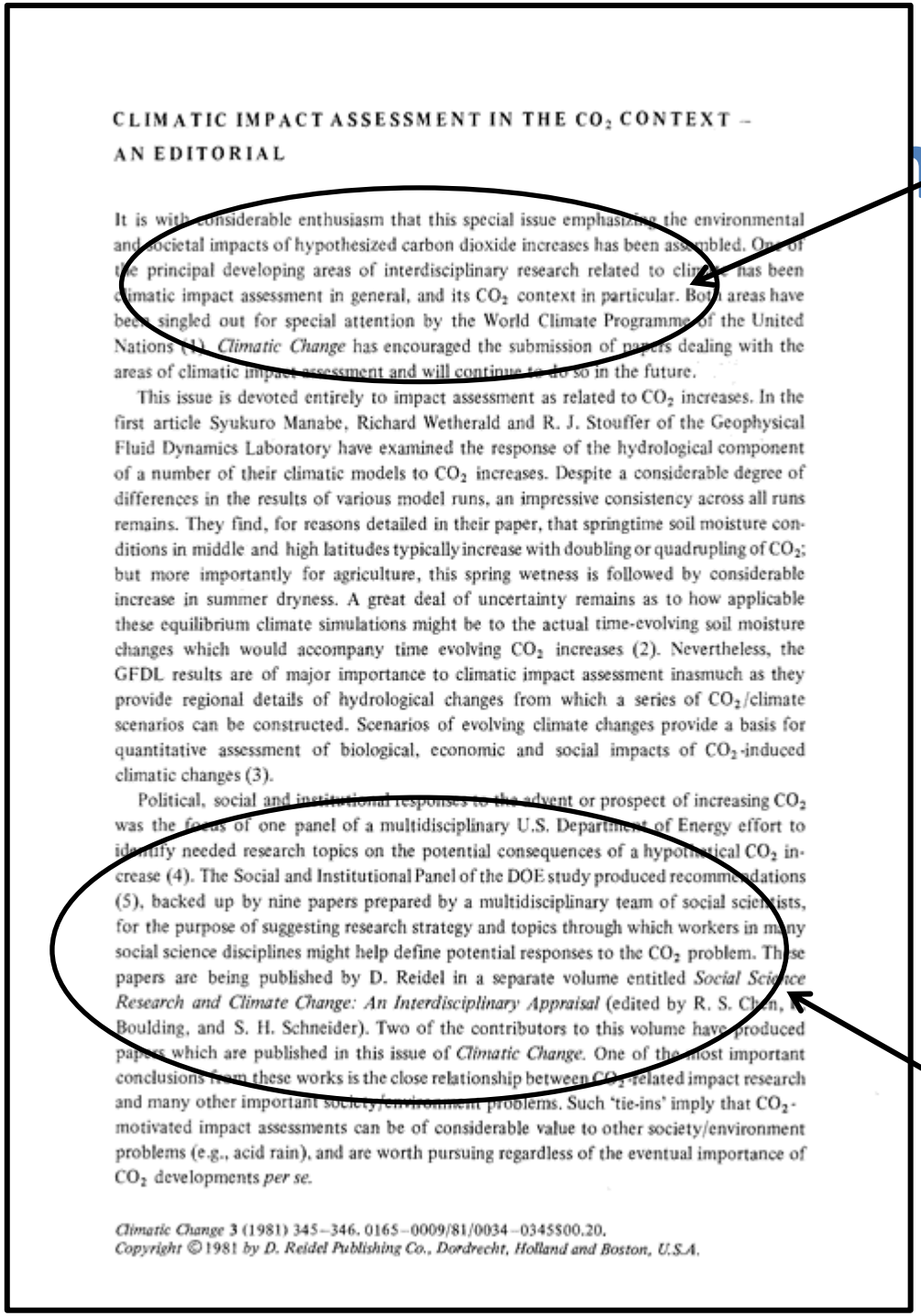
Climate Change Adaptation

- Requires clear understanding of the underlying science and methods of assessing impacts - through entire chain from *climate scientists* to *engineers* to *decision-makers*
- Requires appreciation of both the *physical mechanisms* as well as the *human influence on those strategies* (e.g. population rise, land use changes, economics, etc.) and the decision making process itself



Impact Studies

- Impact studies enable us to produce information for adaptation planning and decision making
- Climate models produce huge amounts data but identifying robust and reliable information is a non-trivial task
- Numerous methodologies for assessing the potential impacts of climate change in various areas have been developed and reported



CLIMATIC IMPACT ASSESSMENT IN THE CO_2 CONTEXT – AN EDITORIAL

It is with considerable enthusiasm that this special issue emphasizing the environmental and societal impacts of hypothesized carbon dioxide increases has been assembled. One of the principal developing areas of interdisciplinary research related to climate has been climatic impact assessment in general, and its CO_2 context in particular. Both areas have been singled out for special attention by the World Climate Programme of the United Nations (1). *Climatic Change* has encouraged the submission of papers dealing with the areas of climatic impact assessment and will continue to do so in the future.

This issue is devoted entirely to impact assessment as related to CO_2 increases. In the first article Syukuro Manabe, Richard Wetherald and R. J. Stouffer of the Geophysical Fluid Dynamics Laboratory have examined the response of the hydrological component of a number of their climatic models to CO_2 increases. Despite a considerable degree of differences in the results of various model runs, an impressive consistency across all runs remains. They find, for reasons detailed in their paper, that springtime soil moisture conditions in middle and high latitudes typically increase with doubling or quadrupling of CO_2; but more importantly for agriculture, this spring wetness is followed by considerable increase in summer dryness. A great deal of uncertainty remains as to how applicable these equilibrium climate simulations might be to the actual time-evolving soil moisture changes which would accompany time evolving CO_2 increases (2). Nevertheless, the GFDL results are of major importance to climatic impact assessment inasmuch as they provide regional details of hydrological changes from which a series of CO_2/climate scenarios can be constructed. Scenarios of evolving climate changes provide a basis for quantitative assessment of biological, economic and social impacts of CO_2-induced climatic changes (3).

Political, social and institutional responses to the advent or prospect of increasing CO_2 was the focus of one panel of a multidisciplinary U.S. Department of Energy effort to identify needed research topics on the potential consequences of a hypothetical CO_2 increase (4). The Social and Institutional Panel of the DOE study produced recommendations (5), backed up by nine papers prepared by a multidisciplinary team of social scientists, for the purpose of suggesting research strategy and topics through which workers in many social science disciplines might help define potential responses to the CO_2 problem. These papers are being published by D. Reidel in a separate volume entitled *Social Science Research and Climate Change: An Interdisciplinary Appraisal* (edited by R. S. Chen, E. Boulding, and S. H. Schneider). Two of the contributors to this volume have produced papers which are published in this issue of *Climatic Change*. One of the most important conclusions from these works is the close relationship between CO_2-related impact research and many other important society/environment problems. Such 'tie-ins' imply that CO_2-motivated impact assessments can be of considerable value to other society/environment problems (e.g., acid rain), and are worth pursuing regardless of the eventual importance of CO_2 developments *per se*.

Climatic Change 3 (1981) 345–346. 0165–0009/81/0034–0345$00.20.

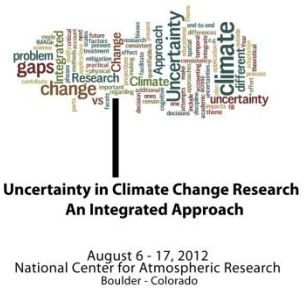
"One of the principal developing areas of interdisciplinary research is climate impact assessment in general and its CO_2 context in particular"

Climatic Change Volume 3, Number 4 (1981), 345-346, DOI: 10.1007/BF00139742

Climatic impact assessment in the CO_2 context — An editorial

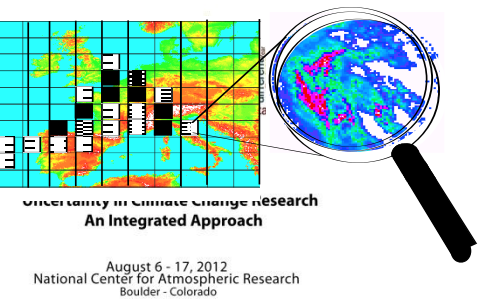
H. Stephen Schneider

Multidisciplinary research is needed: "research strategy and topics through which…social science disciplines might help define potential responses to the CO_2 problem"



History of impact studies

- Started early 1980s
- Concentration on agricultural and hydrological impacts, then ecological
- More recently focus has shifted to include additional impacts: human health, energy, infrastructure systems



How do we get data for impacts studies? Downscaling

- The impacts community need data at much finer temporal and spatial scales than that available from global climate models – number of different downscaling methods available
- However, how reliable are the data at the finer scales relevant to the impacts modeller or decision-maker?

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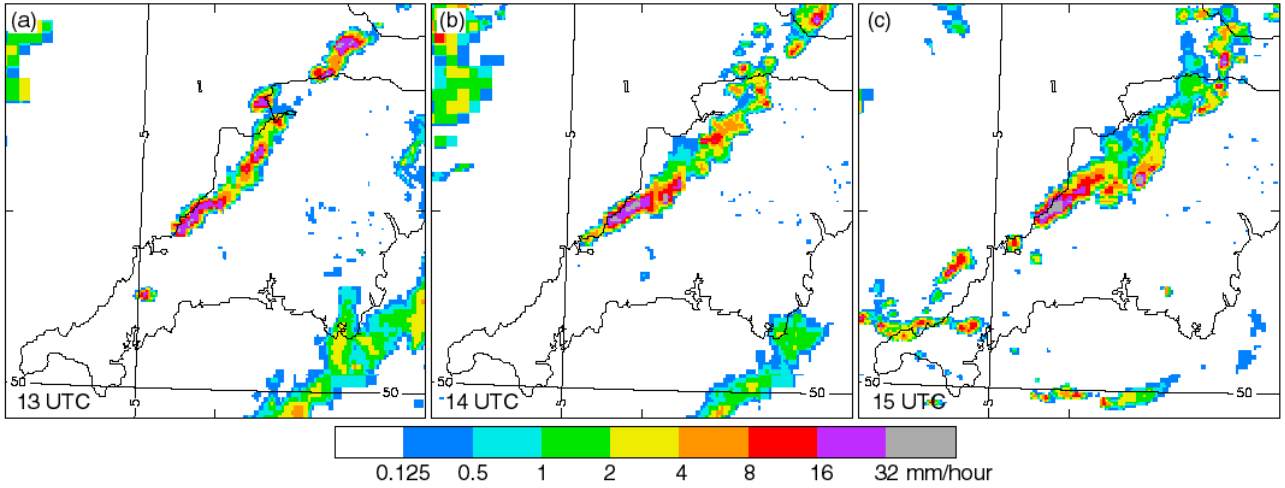
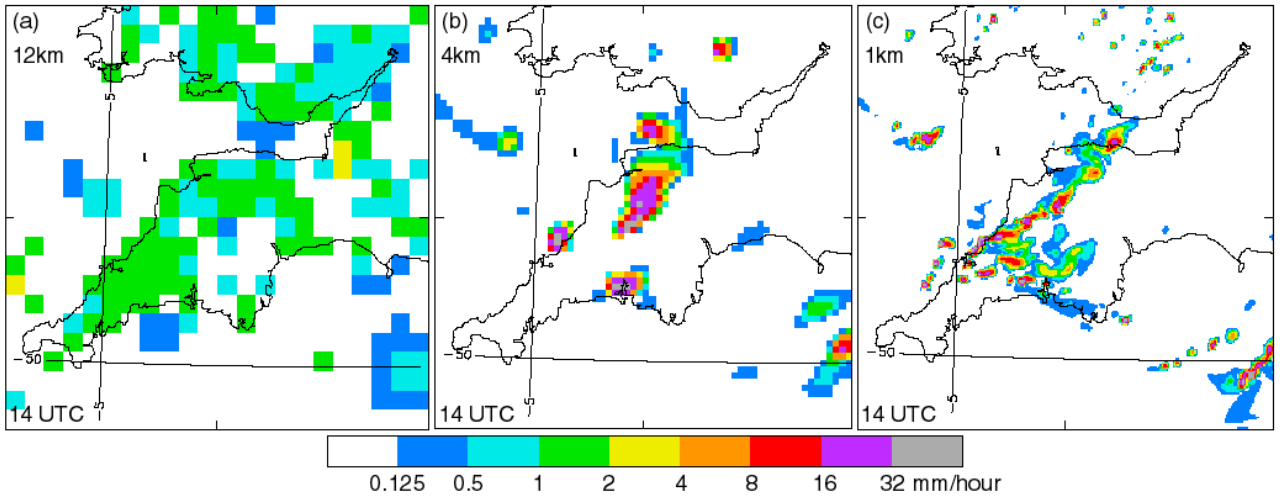
Benefits of very high resolution regional modelling

Hourly rainfall rates from radar

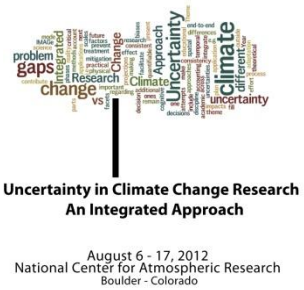


Model forecasts

(a) 12km
(b) 4km
(c) 1km



Case study: Boscastle, 16th Aug 2004; Courtesy: Nigel Roberts



Uncertainties in impact studies

- Multi-model and perturbed-physics ensembles and probabilistic projections (pdfs)
- Lack of assessments of uncertainties in impacts models
  - some assessment of parameter perturbations for individual impact models but few studies performing model comparisons
  - indeed many impacts models not truly physically based (conceptual models)
  - most of the uncertainties addressed in impact studies come from climate modelling

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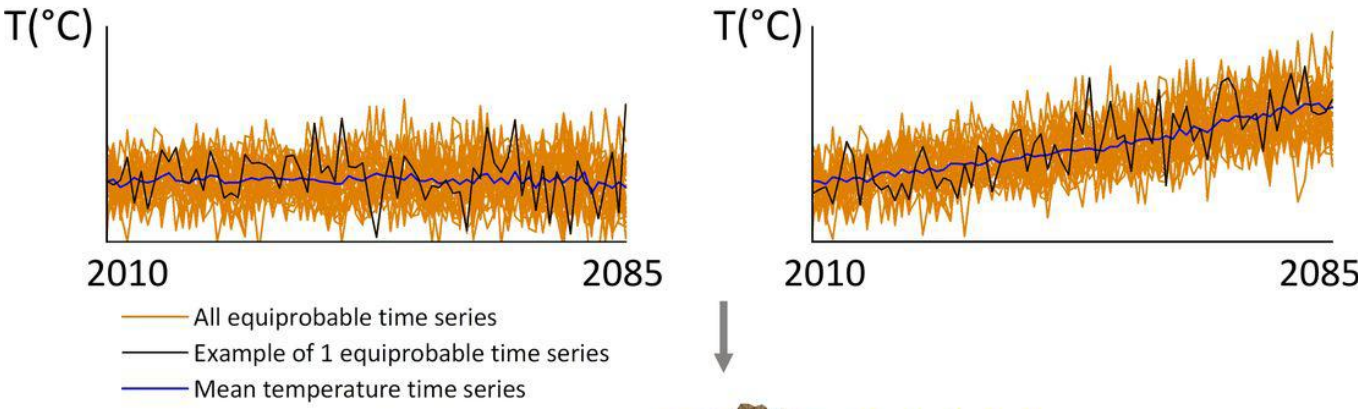
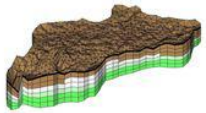
Stochastic Weather Generator

RCM

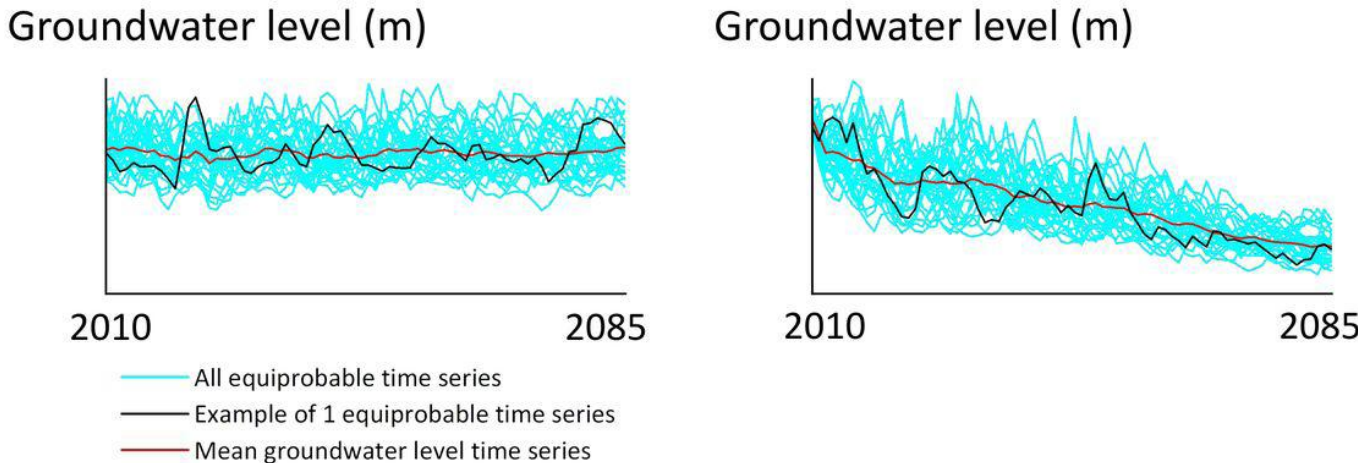
Control scenarios

Climate change scenarios





Hydrological model



Goderniaux et al. 2011. *Water Resources Research,* **47**, W12516,

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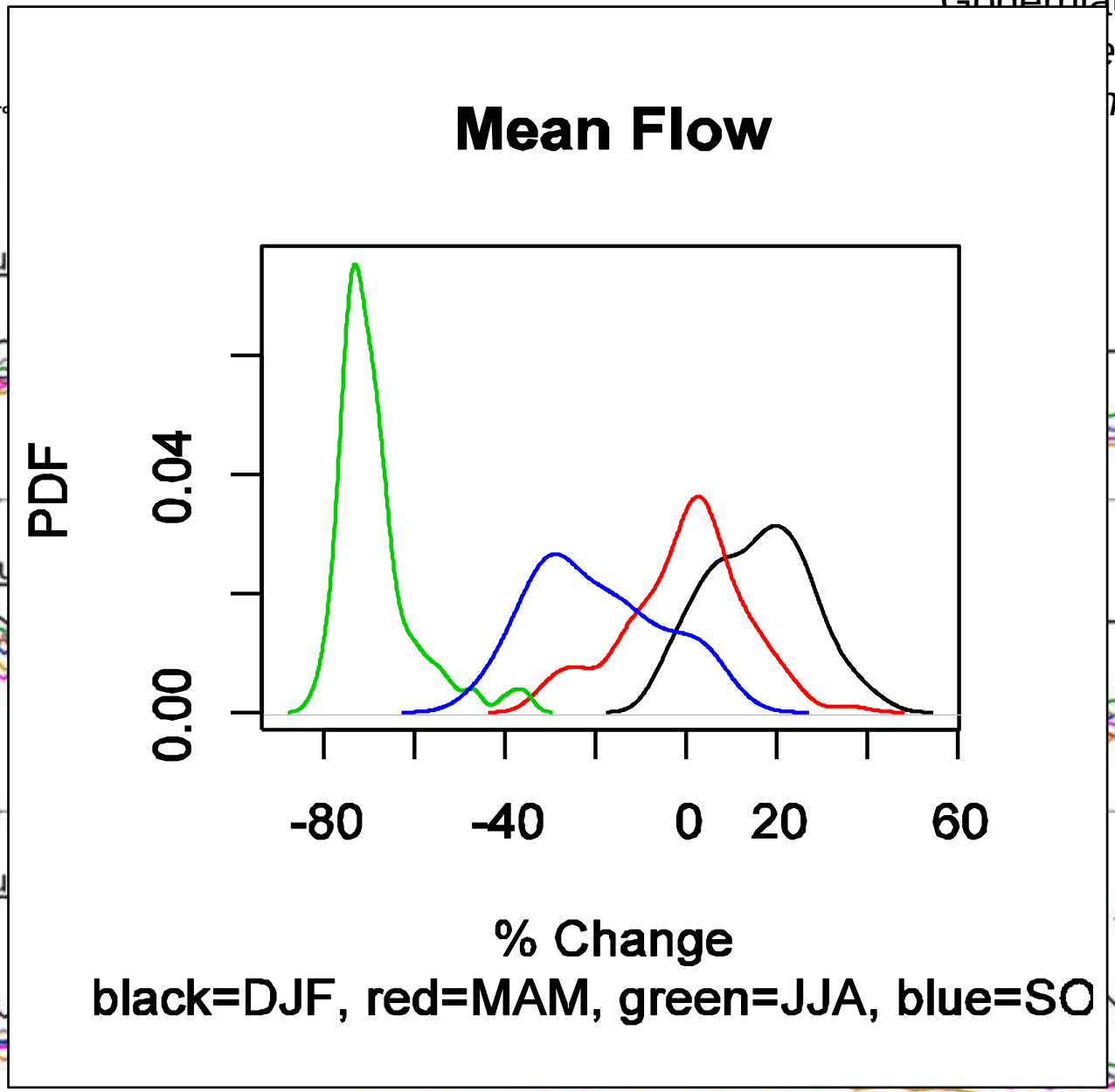

Annu
Febru
Augu
Water flow rates (m³/s)
HAD_P_H
2010
2020
2030
2040
2050
2060
2070
2080
Year

My goals for the workshop

- To interact with as many people as possible with different backgrounds and to learn
- To help to educate a new generation in interdisciplinary thinking and integrated approaches to climate change uncertainty
- To explore some of the big questions in climate change uncertainty together with extremely bright young people and hopefully come up with some interesting new ideas