

Statistical downscaling: Status and open issues

Rob Wilby, Loughborough University, UK



Oued Ambouli, Djibouti. Photo: Sergio Mora

Raison d'être



Versant digue / 1994

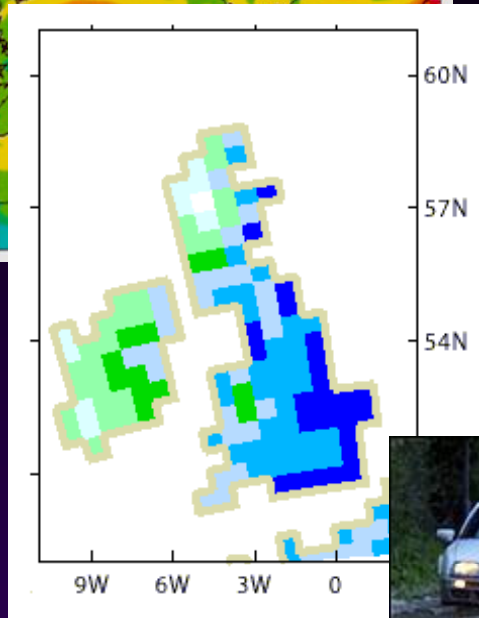
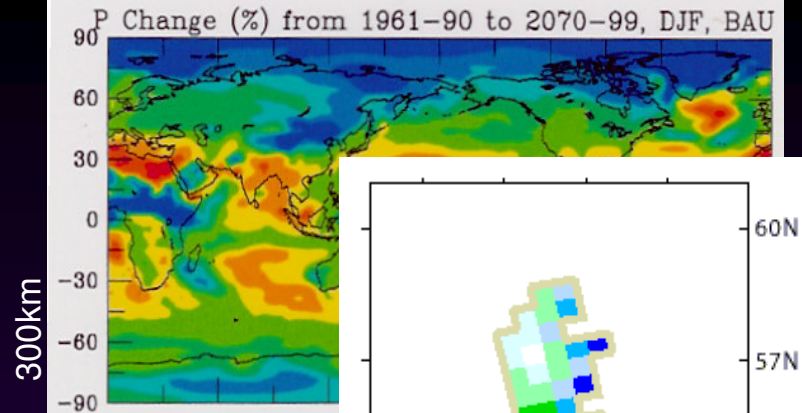


Flooding of Djibouti by the Oued Ambouli in April 1994



The downscaling mantra

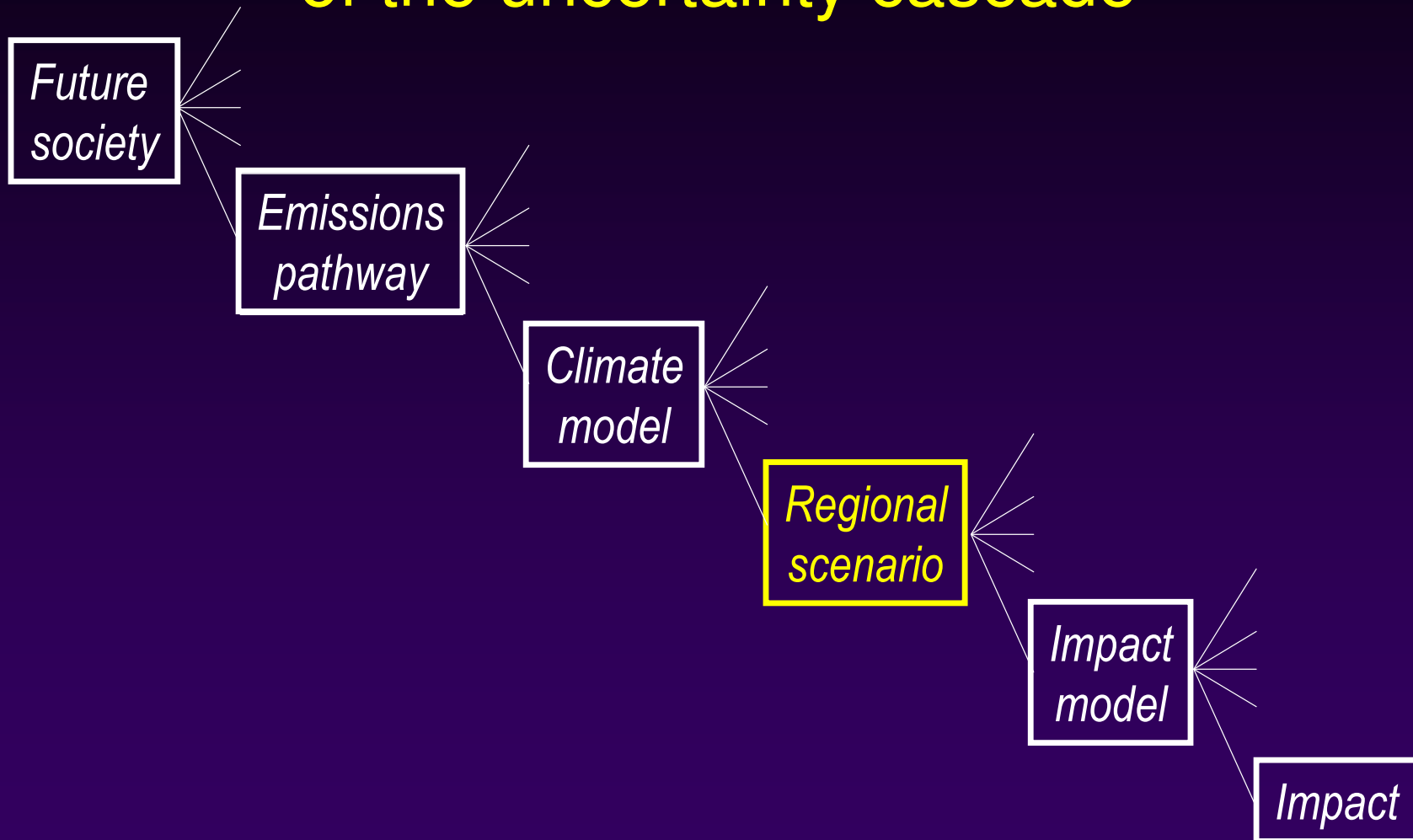
What the climate model centres provide...



downscaling

...what (*we think*) the climate impacts community needs.

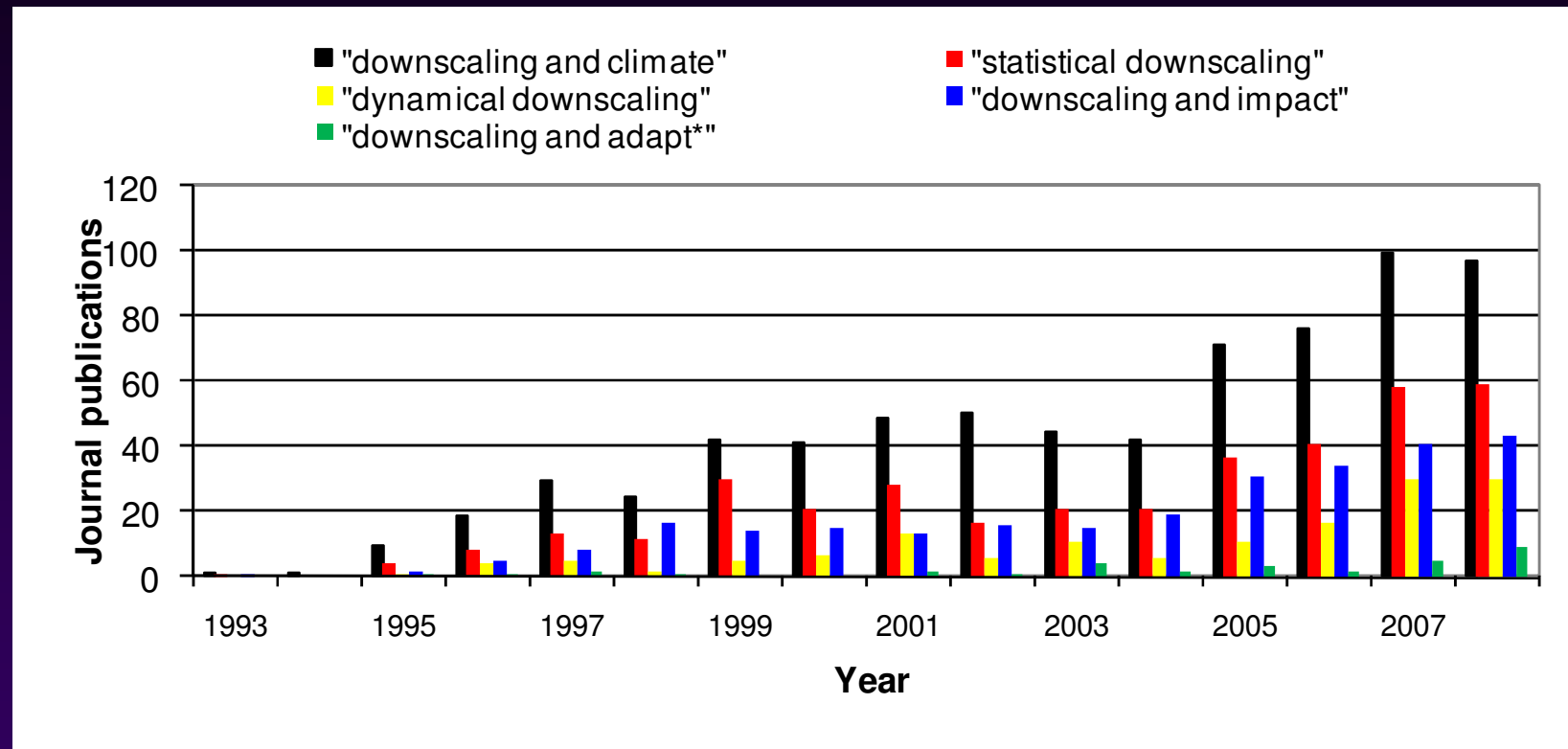
Downscaling is at the heart of the uncertainty cascade



What have we learnt so far?

- GCM boundary conditions are the main source of uncertainty affecting all downscaling methods
- Statistical and dynamical downscaling have similar skill
- Different downscaling methods yield different scenarios
- There are no universally “optimum” predictor(s)/domains
- Downscaling extreme events is highly problematic (for example summer rainfall predictability is very low)
- Traditional skill measures for current climate may not be the best guide to future scenarios of *change*

“Pulse check” for the downscaling industry...



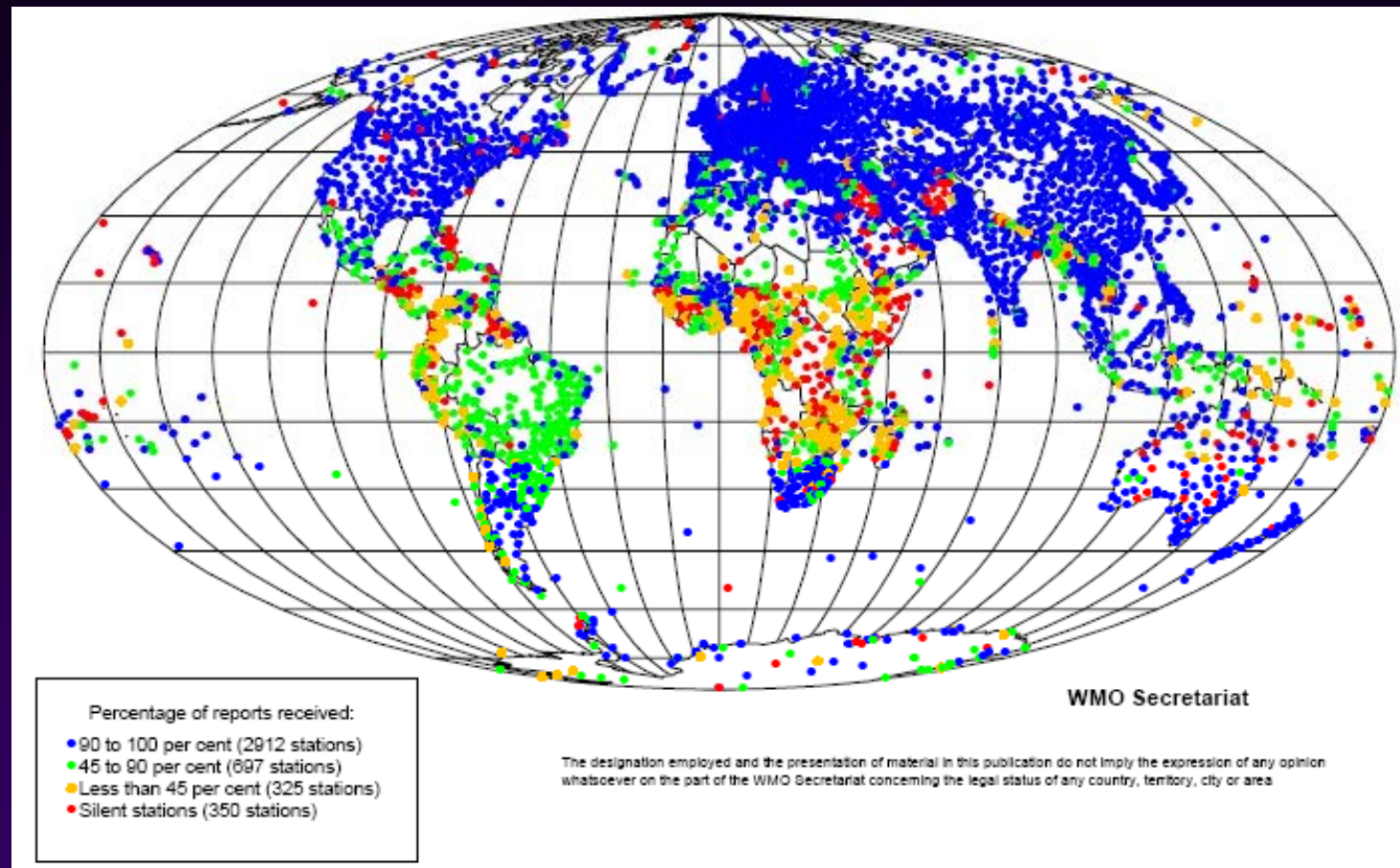
Number of ISBN research publications listed on the Web of Science.
Accessed 10 February 2009

A few practical considerations



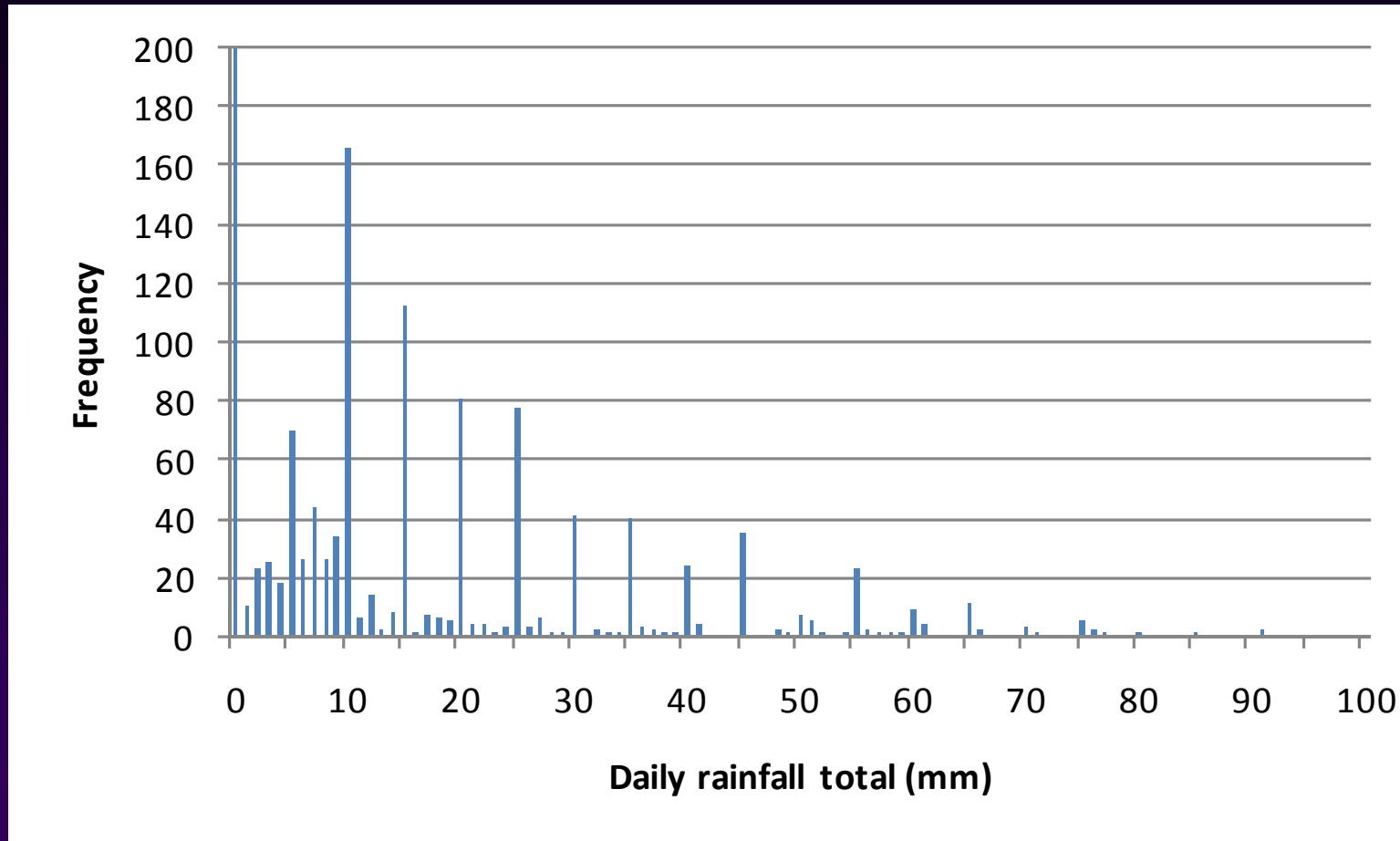
Photo: Bull (1930)

Decaying observing networks



The global network of the World Weather Watch (WWW) stations colour coded to indicate silence (red dot) or reporting rates in 2008. Source: WMO (2009)

Concerns about data quality in vulnerable regions



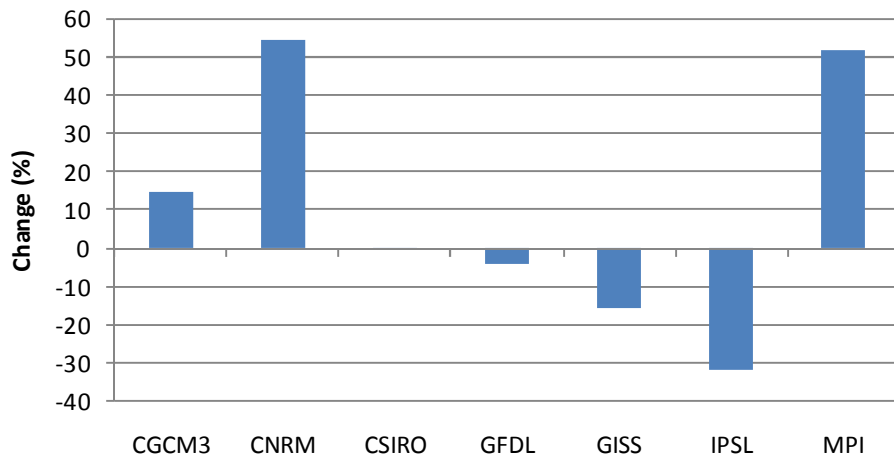
Distribution of daily precipitation amounts recorded at lbb (including 14.6 and 15.8 mm on 30 and 31 February 1995!)

Djibouti's met station

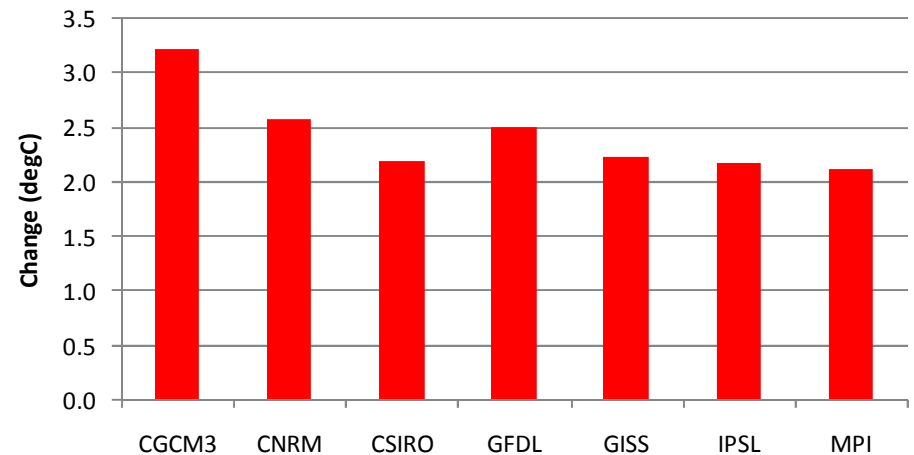


“Shed-loads” of uncertainty

Djibouti annual PRCP2050s



Djibouti annual TMAX 2050s



Data source: Climate Systems Analysis Group, University of Cape Town

Too many tools?

Tool/source	Description
clim.pact	R functions for downscaling monthly and daily mean climate scenarios http://cran.r-project.org/src/contrib/Descriptions/clim.pact.html
CRISTAL	Community-based Risk Screening – Adaptation and Livelihoods http://www.iisd.org/pdf/2008/cristal_manual.pdf
CSAG	Data portal for downscaled African precipitation scenarios for the 2080s http://data.csag.uct.ac.za/
ENSEMBLES	Experimental portal for downscaling tools applied to Europe http://grupos.unican.es/ai/meteo/ensembles/index.html
FINESSI	Multi-sector/ multi-variable climate change scenarios for Finland http://www.finessi.info/finessi/?page=explore
LARS-WG	Tool for producing time series of a suite of climate variables at single sites http://www.rothamsted.bbsrc.ac.uk/mas-models/larswg.php
LCA	Linking Climate Adaptation – community based adaptation http://www.cba-exchange.org/
MAGICC/ SCENGEN	Interactive software for investigations of global/regional climate change http://www.cgd.ucar.edu/cas/wigley/magicc/
PRECIS	UK Met Office portable regional climate model http://precis.metoffice.com/
RClimex	Graphical interface to compute 27 core indices of climate extremes http://cccma.seos.uvic.ca/ETCCDMI/software.shtml
SDSM	Downscaling tool for scenario production at single sites http://www-staff.lboro.ac.uk/~cocwd/SDSM/
SERVIR	The Climate Mapper and SERVIR Viz http://www.servir.net/index.php?option=com_content&task=view&id=101&Itemid=57&lang=en
Tearfund	Mainstreaming disaster risk reduction: a tool for development organisations http://www.tearfund.org/webdocs/Website/Campaigning/Policy%20and%20research/Mainstreaming%20disaster%20risk%20reduction.pdf
UKCIP	Online adaptation data base (UK) http://www.ukcip.org.uk/resources/tools/database.asp
UNFCCC	Database on local coping strategies http://maindb.unfccc.int/public/adaptation/
World Bank	Indigenous Knowledge Practices Database http://www4.worldbank.org/afr/ikdb/search.cfm
WRI	Climate Analysis Indicators Tool (CAIT) http://cait.wri.org/
WWF	Climate Witness Community Toolkit http://www.wwfpacific.org.fj/publications/climate_change/cw_toolkit.pdf

Source:
Wilby & Miller
(2008)

More worked examples needed

GENERAL GUIDELINES ON THE USE OF SCENARIO DATA FOR CLIMATE IMPACT AND ADAPTATION ASSESSMENT

Version 2

June 2007

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Task Group on Data and Scenario Support for
Impact and Climate Assessment (TGICA)

Intergovernmental Panel on Climate Change

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IPCC (2007)

December 2006

Guidance on the Development of

REGIONAL CLIMATE SCENARIOS

for Vulnerability and
Adaptation Assessments



NATIONAL COMMUNICATIONS SUPPORT PROGRAMME
GUIDANCE DOCUMENT

UNDP (2006)

Loughborough
University

Water crises NOW!...not 2080s...or even 2020s

	Djibouti	Morocco	Yemen	Spain
Population (1000)	793	31,478	20,975	43,064
Growth rate (%)	2.1	1.5	3.1	1.1
Water per capita (m ³ /yr)	378	921	195	2578
GDP agriculture (%)	4	16	13	3
Rural water access (%)	59	56	65	100

Source: United Nations Statistics Division (2005)

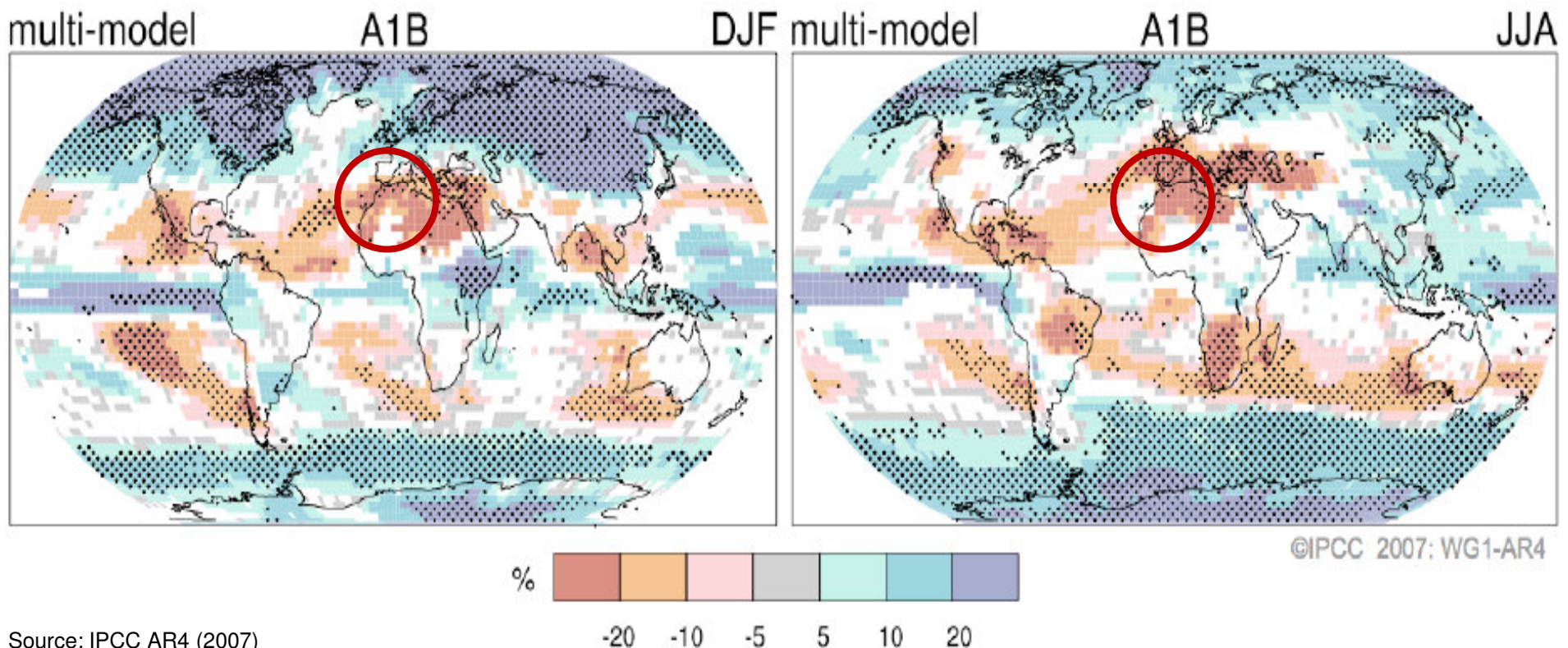


Now the good news



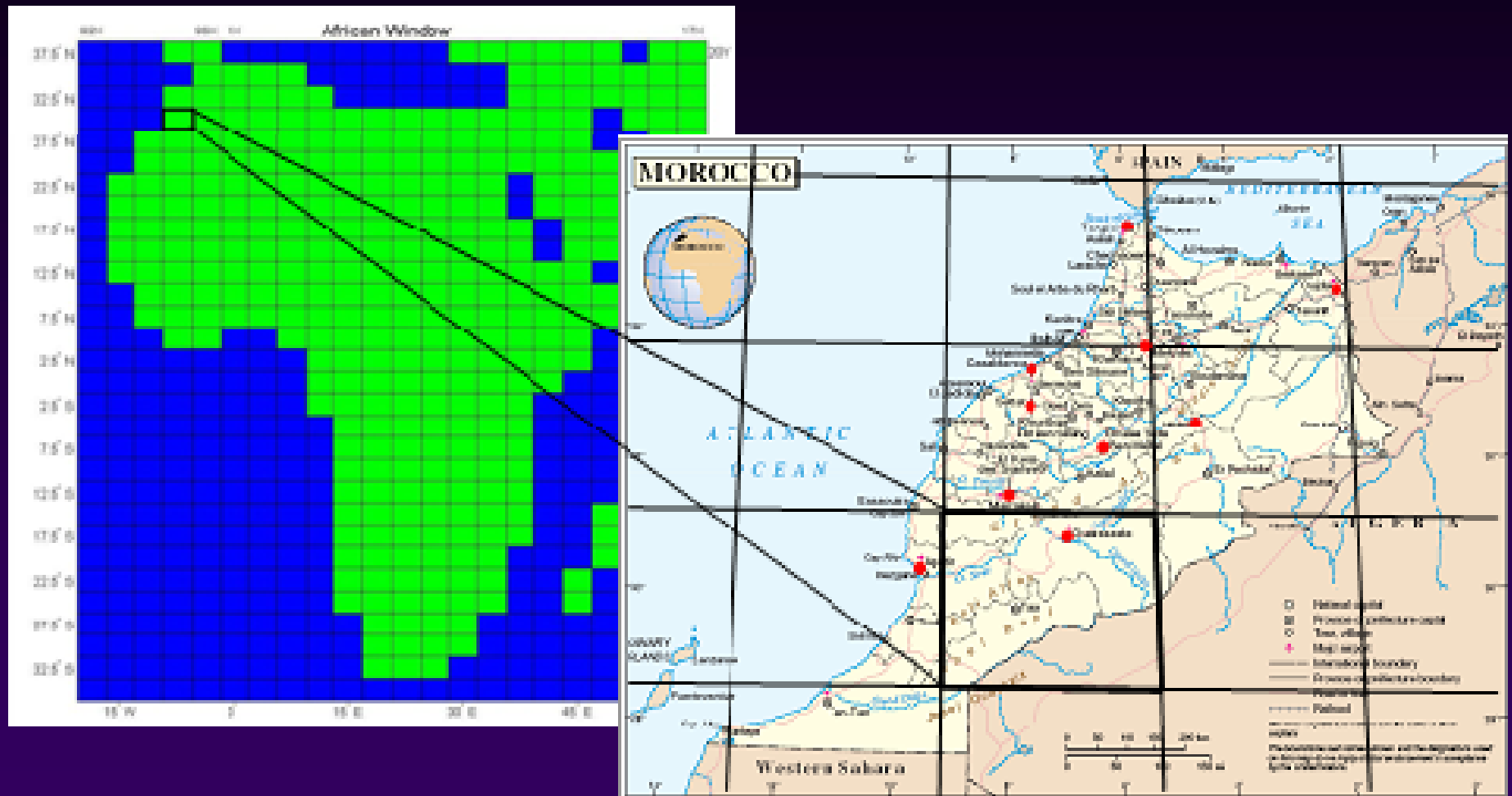
There are regions where “top down” /
scenario-led approaches make sense

Projected Patterns of Precipitation Changes



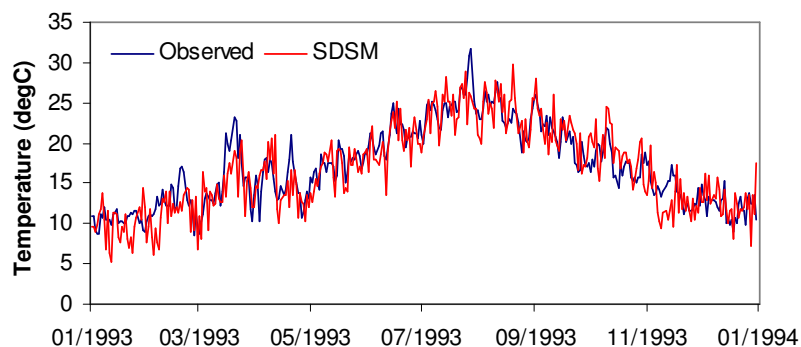
Source: IPCC AR4 (2007)

Downscaling to stations across Morocco

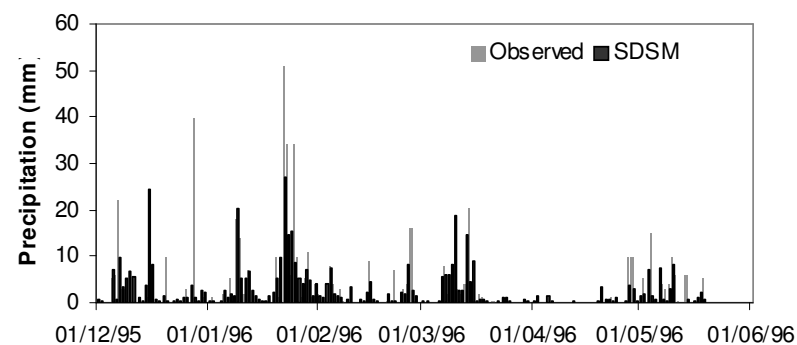


Downscaling daily weather in Morocco

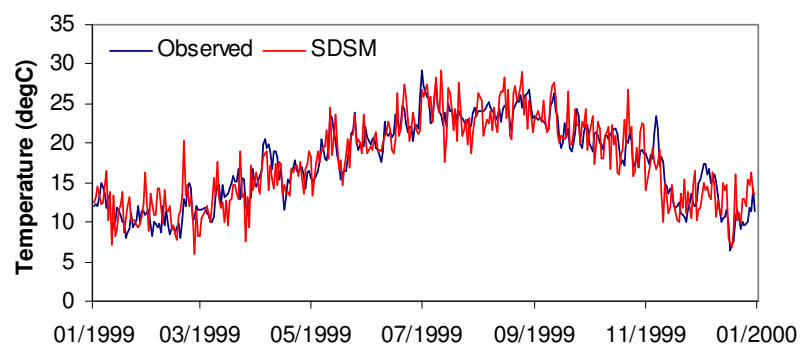
Casablanca TAVG 1993 ($r=0.88$)



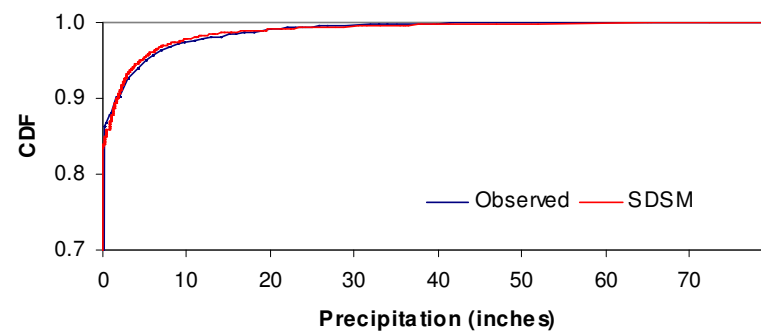
Casablanca PRCP Dec 1995 to May 1996



Casablanca TAVG 1999 ($r=0.89$)

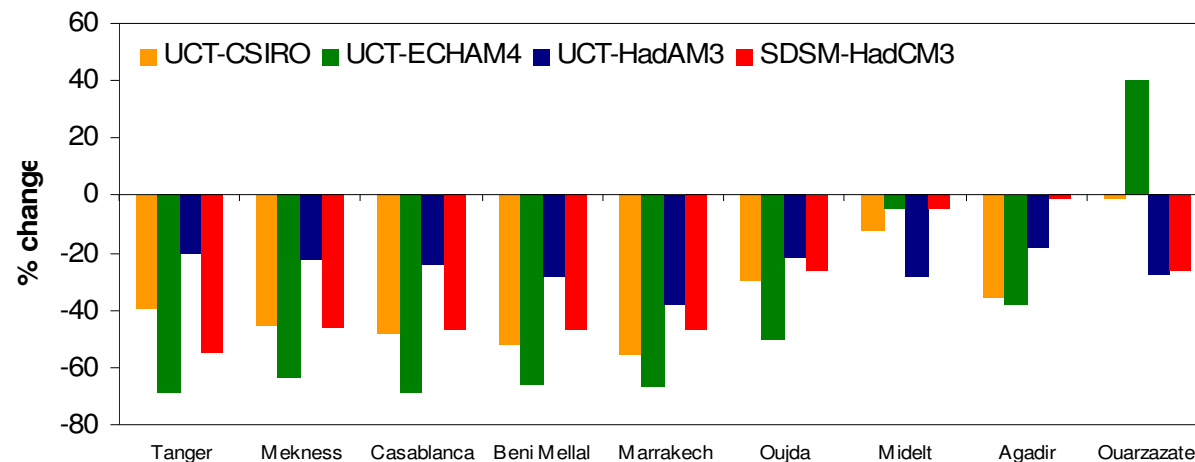


Casablanca PRCP 1991-2000



Decisions must still be robust to uncertainty

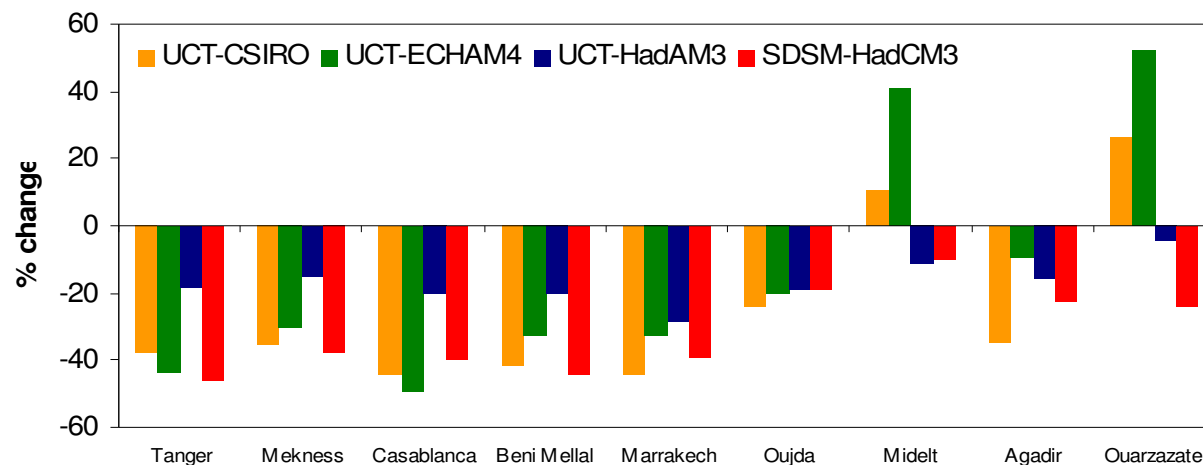
Spring precipitation scenarios



Projected changes in spring and annual precipitation totals for the 2080s for two downscaling methods (UCT, SDSM) and three climate models (CSIRO, ECHAM4, HadCM3) under A2 emissions

Source: Wilby & DMN (2007)

Annual precipitation scenarios



Where do we go from here?



- 1) Number of participating models and partners. Of course the more the better, however it should be realized that at the moment there is no funding specifically available for this, so that the participation needs to be necessarily on a voluntary basis. On the other hand, we feel that a well conceived and designed plan might elicit opportunities for funding.
- 2) Experiments to be completed. In the next round of IPCC there is a wide range of experiments planned, from decadal prediction to standard scenario runs (using specified GHG Reference Concentration Pathways), stabilization runs and a number of sensitivity experiments to isolate the effects of different forcings and processes. We cannot obviously do them all, so we need to prioritize the key ones to be carried out.
- 3) Choice of domains, resolution and time slices. WCRP is keen that as many regions of the globe as possible be treated. This may increase the number of domains by quite a lot. The model resolution should be state-of-the-art, and a value that has been floating around is 25 km grid point spacing. Should we do full 150 year simulations or time slices? We need to find an optimal compromise among these issues.
- 4) Choice of GCMs for providing lateral boundary conditions or, more generally, forcing fields. This is a key issue. In order to produce RCD runs, we need to have GCM data to downscale, and we need them in a timely fashion. At the last WGCM meeting, GCM groups generally expressed their support for this notion, as long as it does not add to much work for them. So we need to design an approach workable for them as well as for us.
- 5) Databanks and data accessibility. Another key issue. There will be a lot of data, both the GCM data to drive the RCDs and the output produced by the RCDs. CMIP3 has been incredibly successful because of the role of the PCMDI databank. How should we approach this? The idea has been floating around of regional databanks, since nobody might afford a comprehensive central one. And then, how to produce comprehensive but workable sets of model fields?
- 6) We need to involve the end-user community, represented in Toulouse by a number of impact experts, from the very beginning of the discussion, because they are the recipient of the RCD-information. How to optimize this process?
- 7) A final issue that WCRP is very keen on is to increase the involvement of scientists from developing countries, so we do need to discuss this issue as well.

These are some of the basic issues we will discuss in Toulouse. Hopefully, if we all come prepared we will have a straw-man plan that can be presented at the following JSC/WCRP meeting at the beginning of April in Maryland. The plan is then to eventually finalize the framework at the RCM workshop of May 4-8 in Lund, so that participating groups can gear up to start their simulations not too far thereafter. It is expected that the GCM groups will start their simulations sometimes in the second half of 2009, and we should plan to start ours not much later than that. We may even decide to use AR4 global simulations if it turns out that using the new AR5 ones is not feasible, in other words have a plan B. All this needs to be discussed in Toulouse.

We stress that if this enterprise is successful it will represent one of the newest aspects of the AR5 and will likely have an extremely high visibility, so that we hope you appreciate the importance of our task. Hoping that this letter is of some help for your participation in the Toulouse workshop, looking forward to see you there and to work with you in the next year,

With our best regards,

Filippo Giorgi



Changed priorities

A science agenda driven by adaptation needs



Verssant digue / 1994

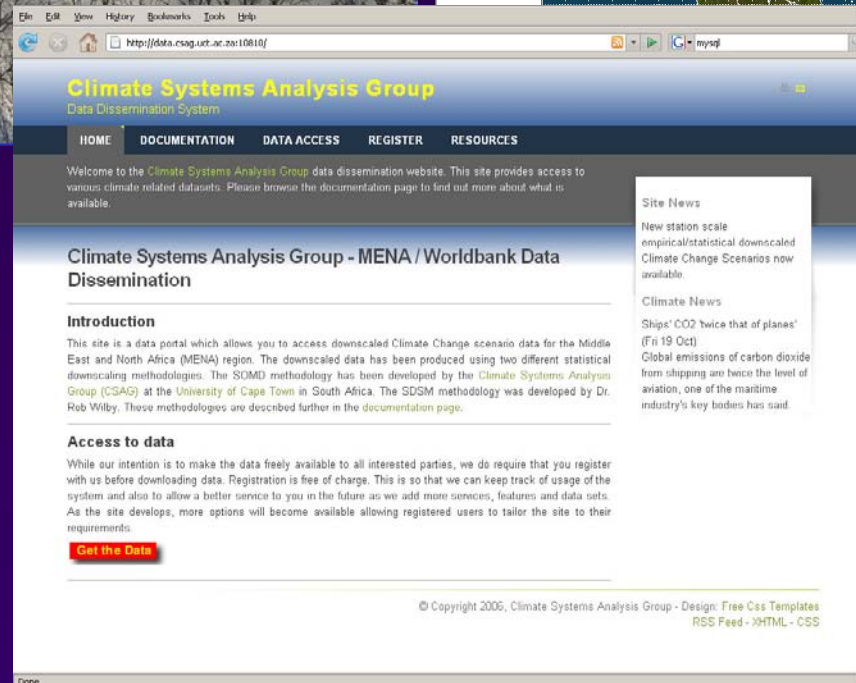
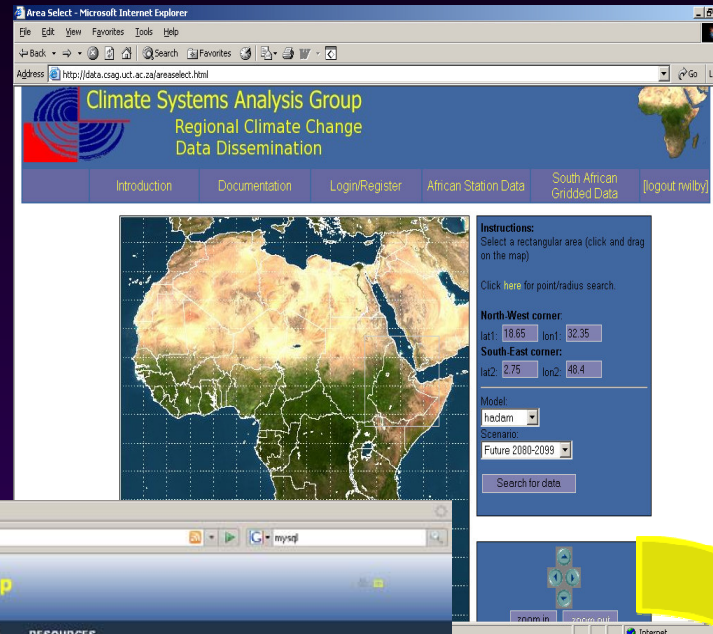
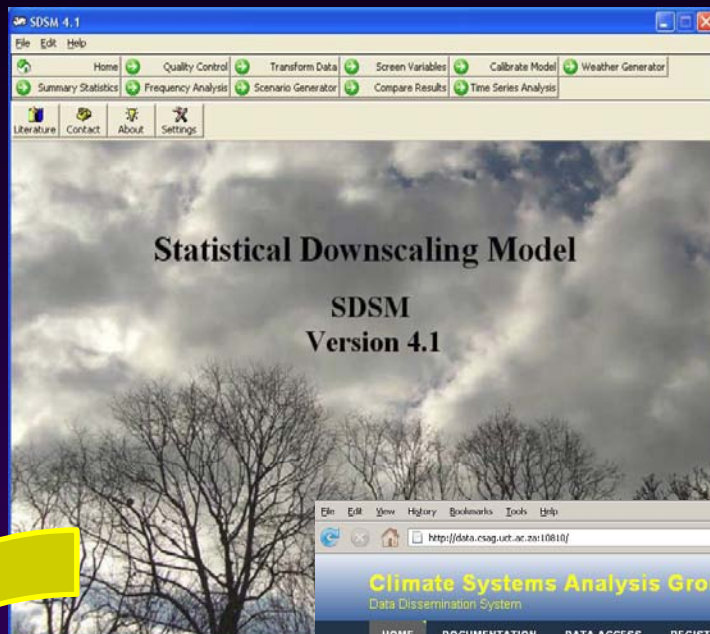


Flooding of Djibouti by the Oued Ambouli in April 1994



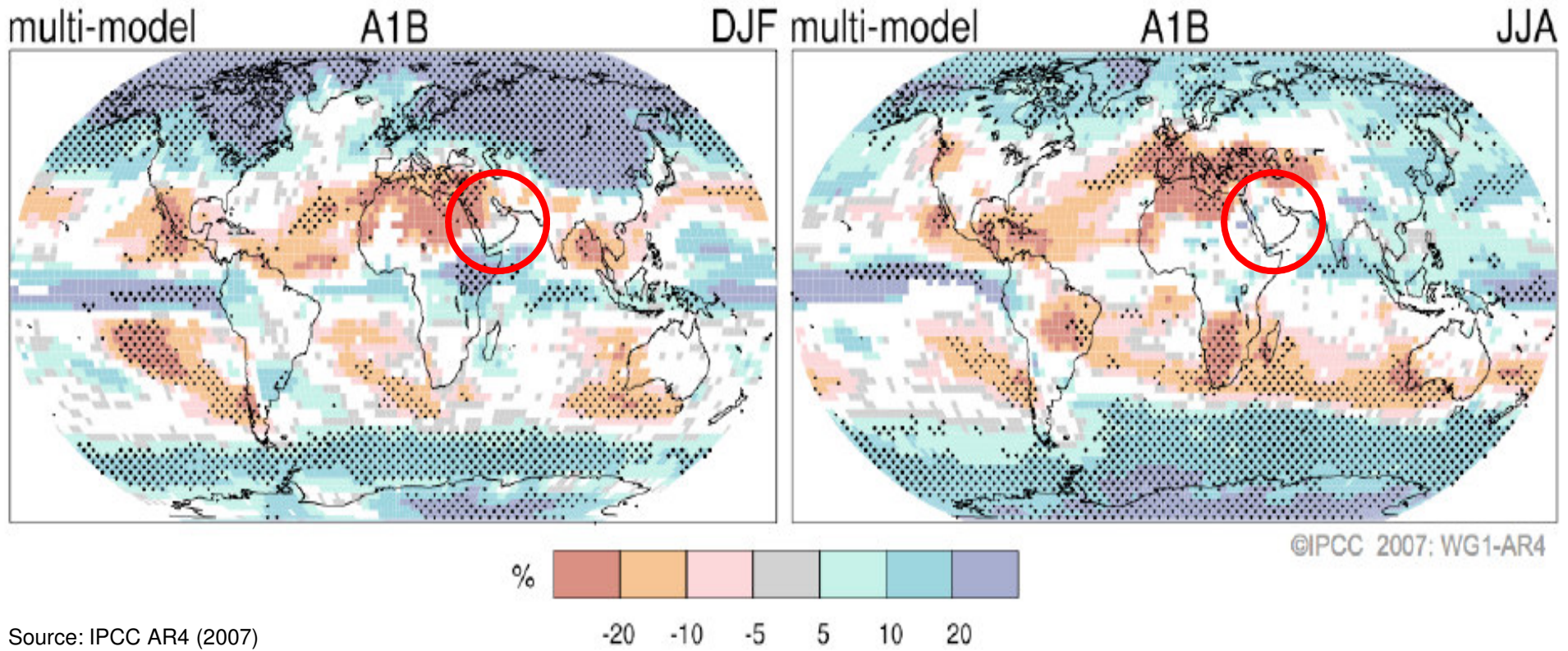
“Second generation downscaling”:

Improved access and support



Admitting that “Bottom up” approaches make more sense where the map is blank

Projected Patterns of Precipitation Changes



Source: IPCC AR4 (2007)

Know your end user!



Source: Times Tues 3 February 2009