Emerging Scientific Findings and Activities Relevant to UNFCCC

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Tony Busalacchi, Ghassem Asrar, Jim Hurrell (WCRP)
and **all project leaders and researchers contributing to these international programmes**

UNFCC-SBSTA 30, Informal Meeting with the Parties
Bonn, Germany, 3 June 2009

ESSP is a joint initiative of

Presentation Outline

Part 1: Introduction: GEC Programmes and ESSP

Part 2: Capacity Building

Part 3: Communications

Part 4: Research Planning Activities

Part 5: **New emerging scientific insights**

Part 6: Conclusions and future directions

The Global Change Research Programmes Promote, Facilitate and Coordinate Climate and Global Change Research for Society

ESSP is a joint initiative of

GEC Research Programmes

Earth System Science Partnership

DIVERSITAS promotes an **integrative biodiversity science** that links biological, ecological and social disciplines, to provide the **scientific basis for the conservation and sustainable use of biodiversity and ecosystem services**.

The International Geosphere-Biosphere Programme studies the **interactions between biological, chemical and physical processes and with human systems and improve the sustainability of the living Earth**

The International Human Dimensions Programme on Global Environmental Change **promotes, catalyzes and coordinates research on the human dimensions.**IHDP works at the interface between science and practice.

The World Climate Research Programme ***determines the extent of human influence on climate and projects changes in climate and to determine***

Earth System Science Partnership




- Develops inter- and transdisciplinary research
- Facilitates an integrated study of the Earth System
- Describes and analyses the ways that the Earth is changing
- Determines implications for global and regional sustainability
- Imparts the understanding necessary to respond




Global Change System for Analysis, Research and Training (START)

Earth System Science Partnership

START {global change SysTem for Analysis, Research, and Training}

The objective of START's research-driven capacity building activities is to engage the scientific communities of developing regions in international collaborative scientific research and policy discussions related to global change.

Through a framework of regional research centers, research nodes, science committees and secretariats, START

- facilitates research on regional aspects of global change
- provides fellowship and education opportunities
- shares knowledge, expertise and data
- bridges between science and society to support decision making
- mobilizes financial, institutional and human resources.

Part 2: Capacity building

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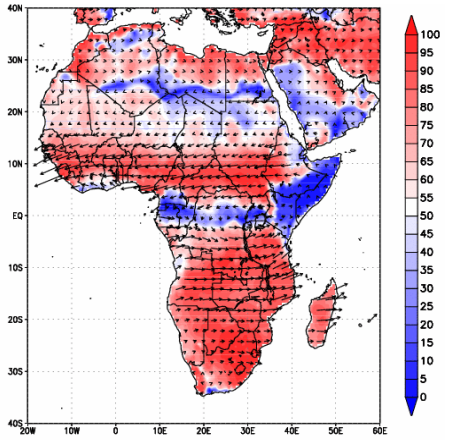
WCRP World Climate Research Programme

All programmes support specific capacity-building activities

- IHDP's summer courses, Bonn dialogues and Energy dialogues
- IGBP's Science Series
- IGBP-AIMES's Young Scholars Netwerk
- Diversitas' Science-Policy Workshops
- Diversitas' partnership with greenfacts.org and Global Water for Sustainability Programme (GWSP)
- Joint WCRP-ICTP workshops on *Interpreting Climate change Simulations* and *Theory and Use of Regional Climate Models*
- WRCP & IPCC's African Climate Atlas
- ESSP contribution to Social Science Forum and Tallberg Forum



All programmes communicate their research results

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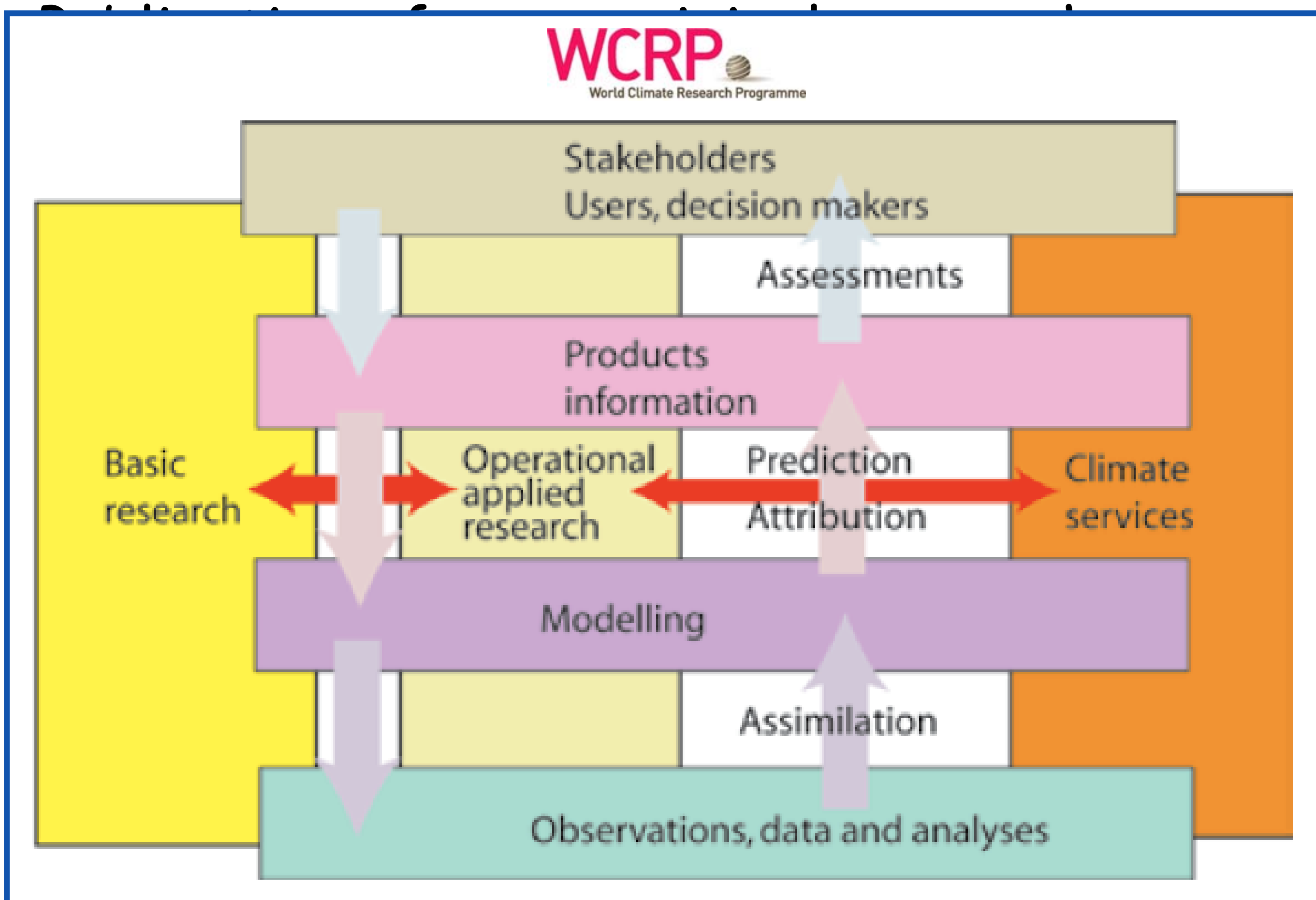
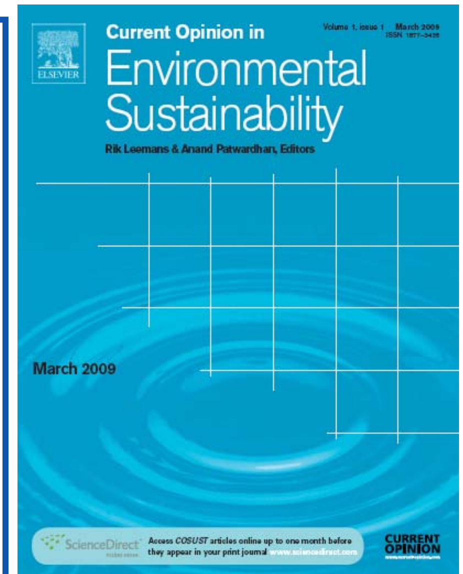
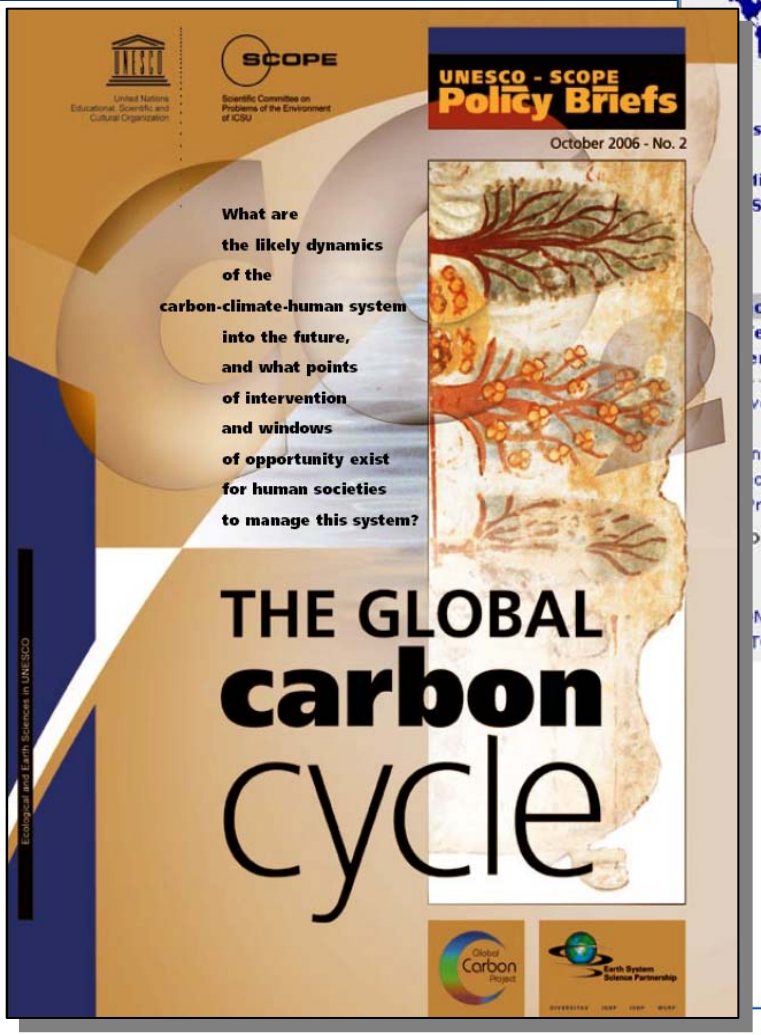




Part 3: Communications

Earth System Science Partnership



Part 3: Communications

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ESSP Contribution to policy relevant scientific assessments

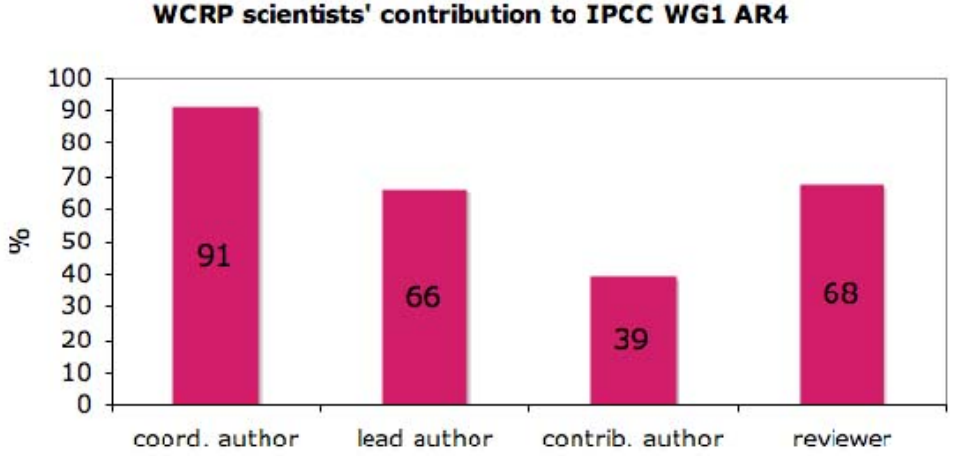
Almost half of the contributors to IPCC AR4 are WCRP/IGBP/IHDP/DIVERSITAS associated scientists

- Contributors include climatologists, meteorologists, atmospheric chemists, paleoecologists, ecologists, hydrologists, geographers, epidemiologists, economist and political scientists

Also a strong contributions to the Ozone Assessment, the Millennium Ecosystem Assessment and the Agricultural Assessment

"WCRP serves an irreplaceable role for coordination within the science community, which in turn is invaluable to the IPCC"

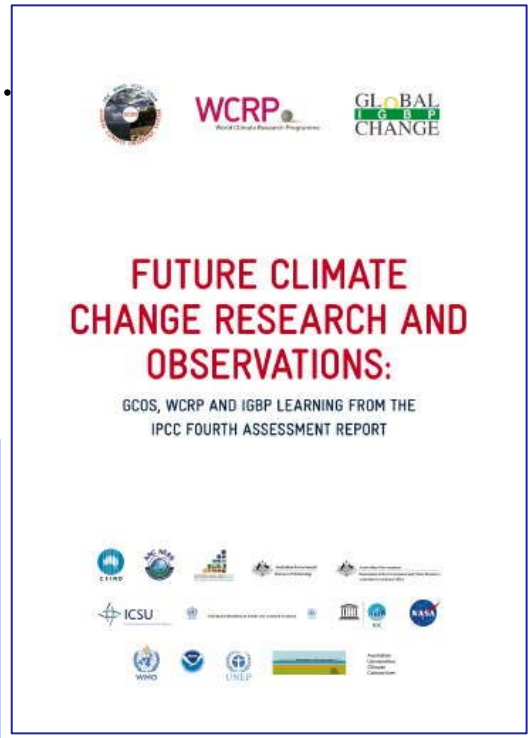
Dr. Susan Solomon,
IPCC Working Group I Co-Chair

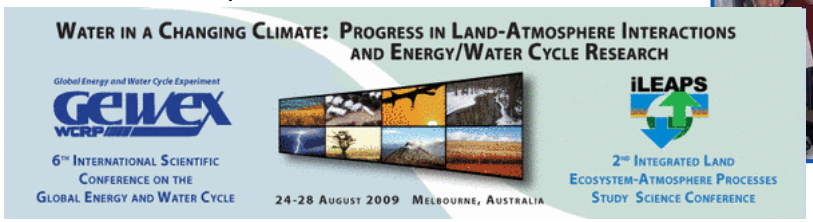


Part 3: Communications

Agenda-setting workshops with IPCC and many other partners

- GCOS, WCRP and IGBP "Learning from the IPCC Fourth Assessment Report" workshop in Sydney, Australia, October 2007.
- Workshop on "Climate Change Impacts, Adaptation, and Vulnerability Community Coordination," National Center for Atmospheric Center in Boulder, USA, January 2009.
- ESSP-IPCC Workshop on Workshop on 'Future Climate Change Response Research: Learning from IPCC's AR4'. Amsterdam, NL, January 2009
- IGBP-ESSP Workshop on Impacts, Adaption and Vulnerability in Developing Countries in Brazil, November 2009

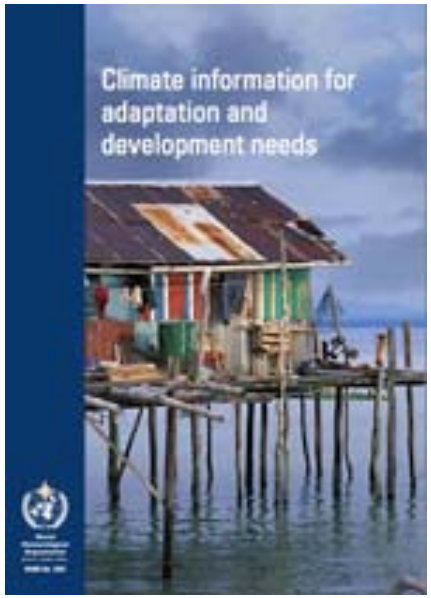




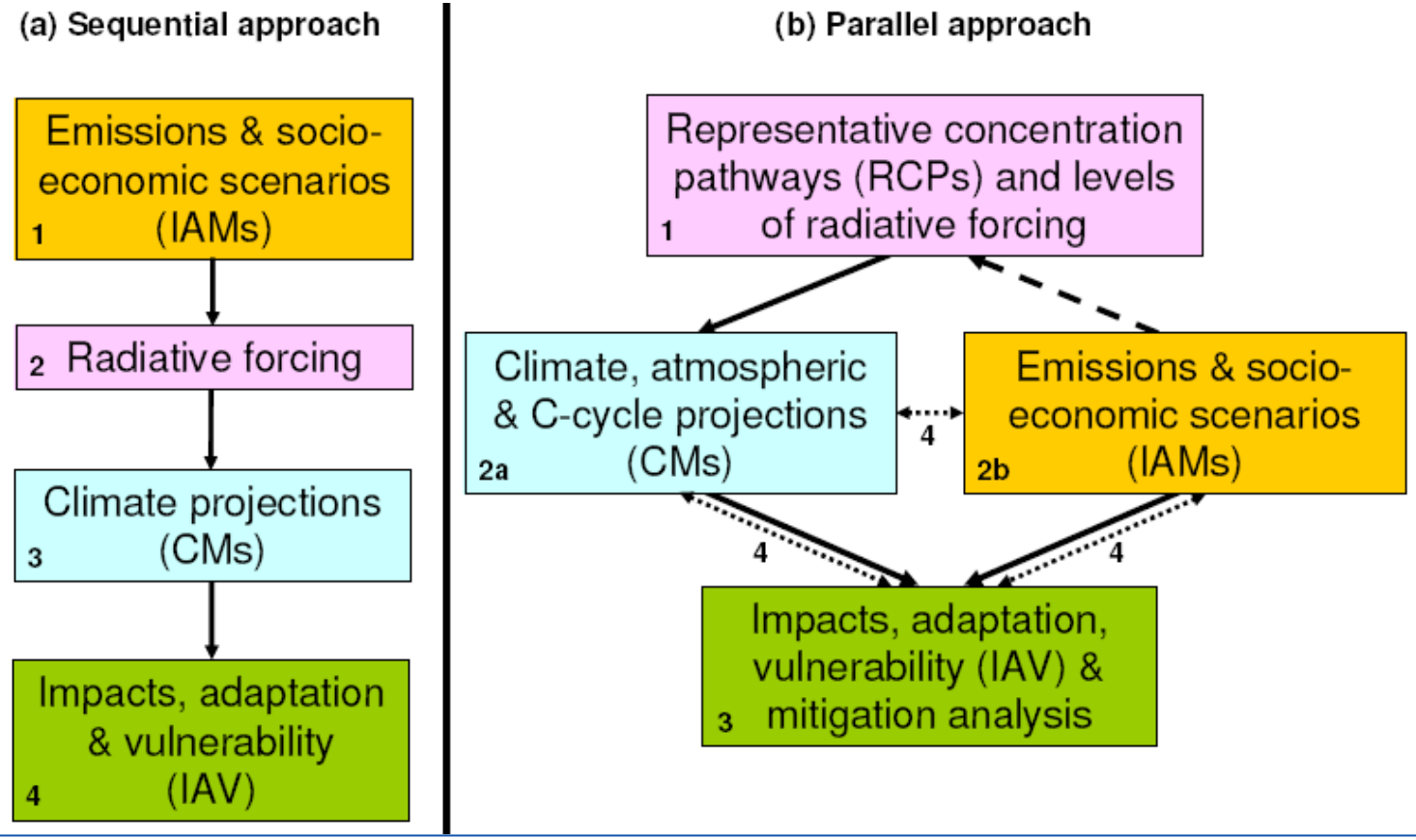
Part 4: Research Planning

Nairobi Work Programme

- Promote climate research in the context of climate information for decision-making
- Engage in with policy and decision makers
- Improve climate models and projections
- Decadal climate predictions
- Provide regional climate downscaling and modeling

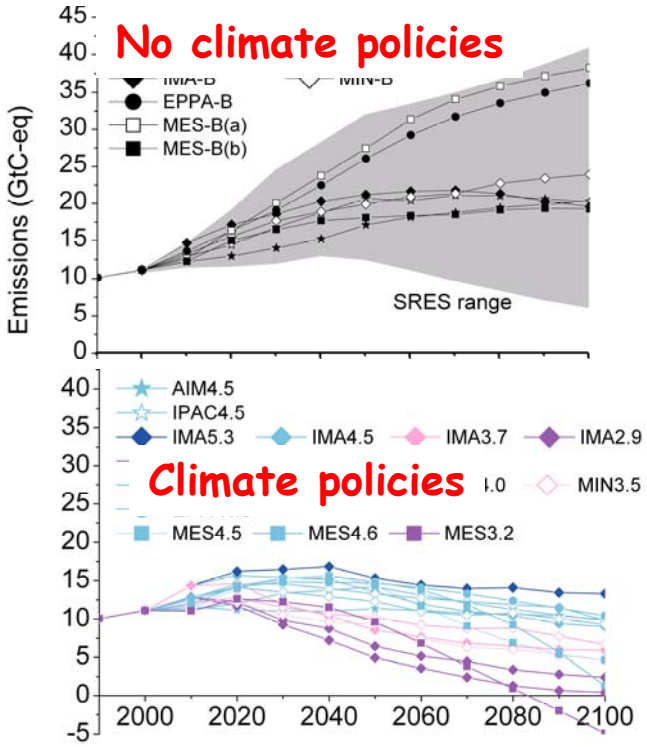


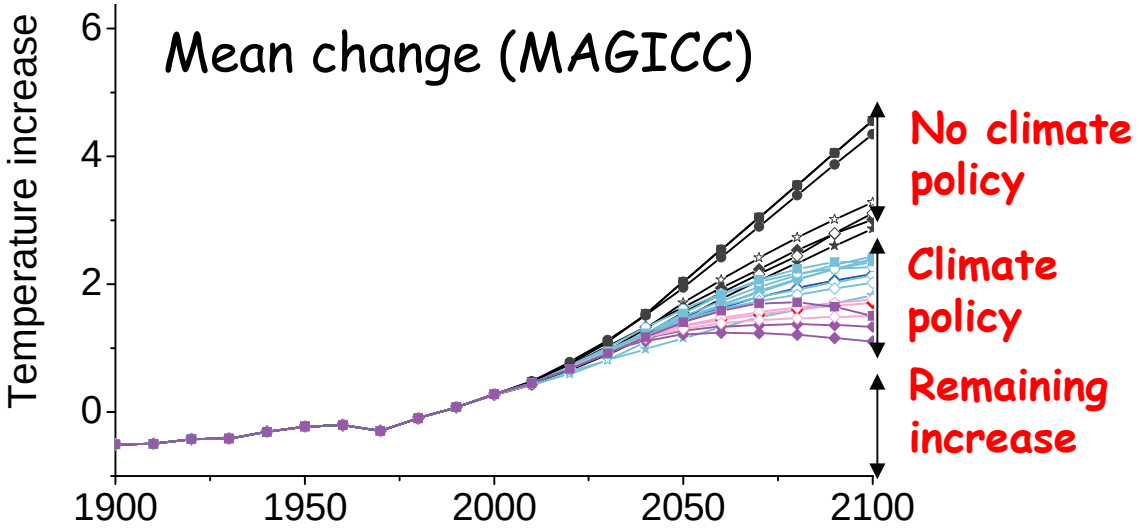
New scenarios for IPCC
(including energy and land-use emissions)



Review and update all selected scenarios from the literature to span a wide range of different possible futures and trajectory shapes.

Runs of integrated assessment models to explore possible mitigation scenarios



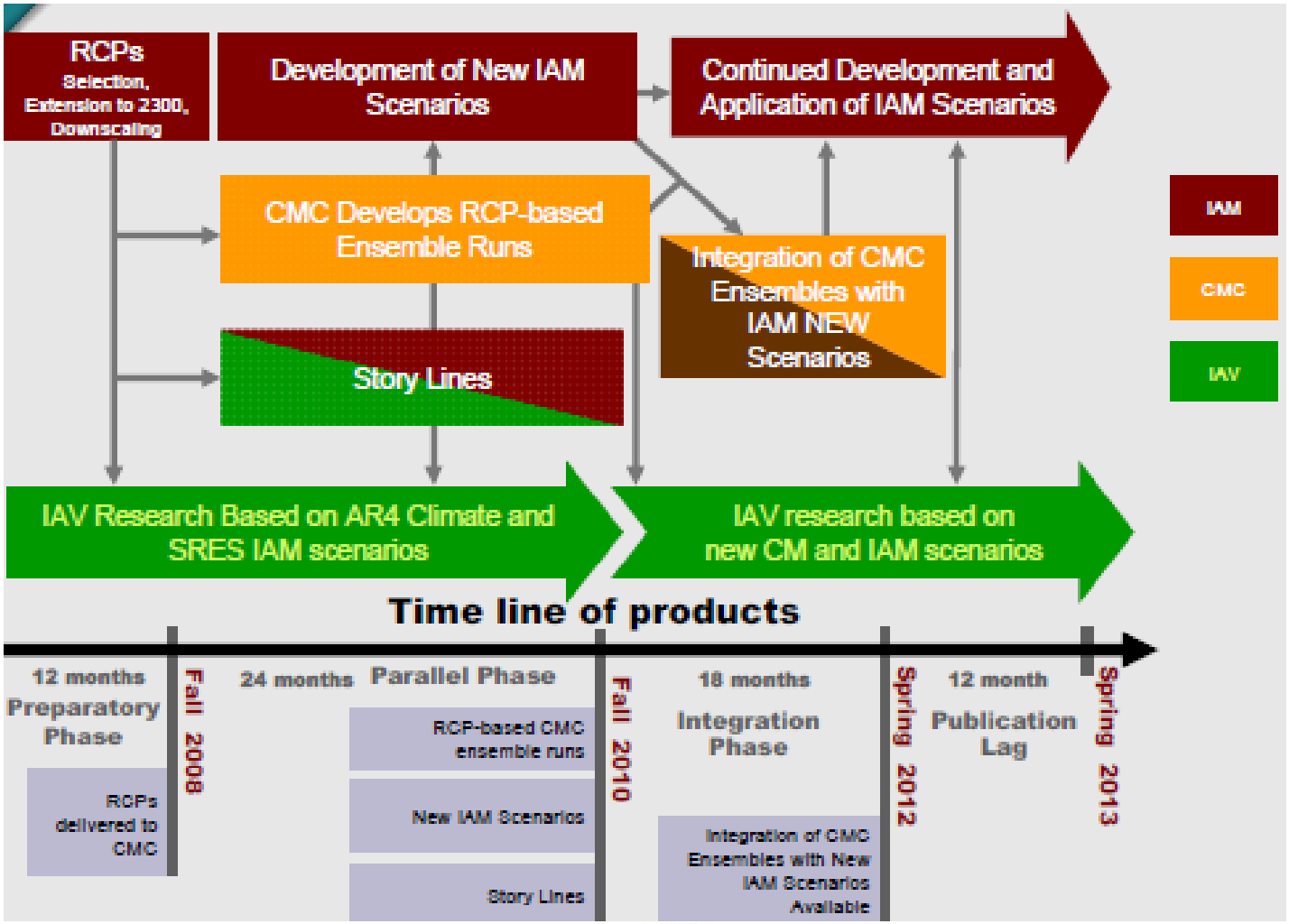


Mitigation can effectively reduce the 21st century temperature range but adaptation is still needed.
Van Vuuren et al. (2008) PNAS 105 15258–15262

This research developed a set of **Representative Concentration Pathways** (RCPs) that span a range of plausible climate forcing between now and 2300, including policy and no-policy scenarios.

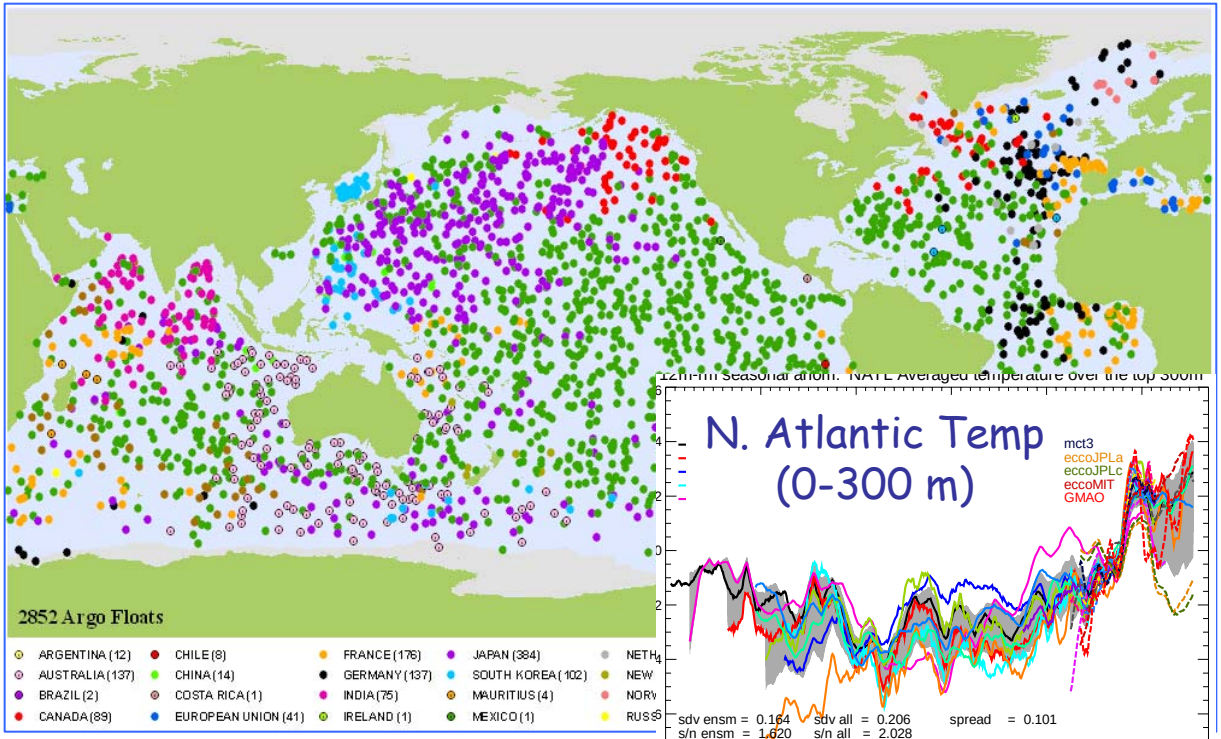
Part 4: Research Planning

Timeline for the new RCPs, involving all different kind of modeling groups



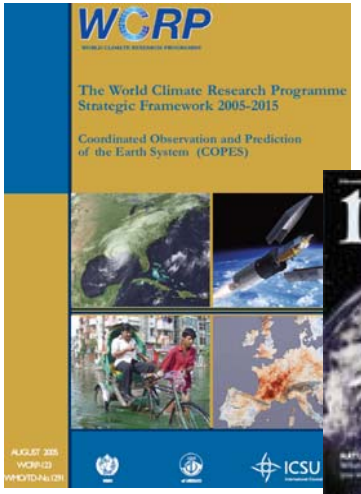
Part 4: Research Planning

We try to sustain observation activities of the Earth system



GROUP ON EARTH OBSERVATIONS

GTOS GLOBAL TERRESTRIAL OBSERVING SYSTEM



Observations are critical and urgent – atmosphere, terrestrial, ocean, cryosphere, biosphere. We can not take today's observation tomorrow!

Part 4: Research Planning

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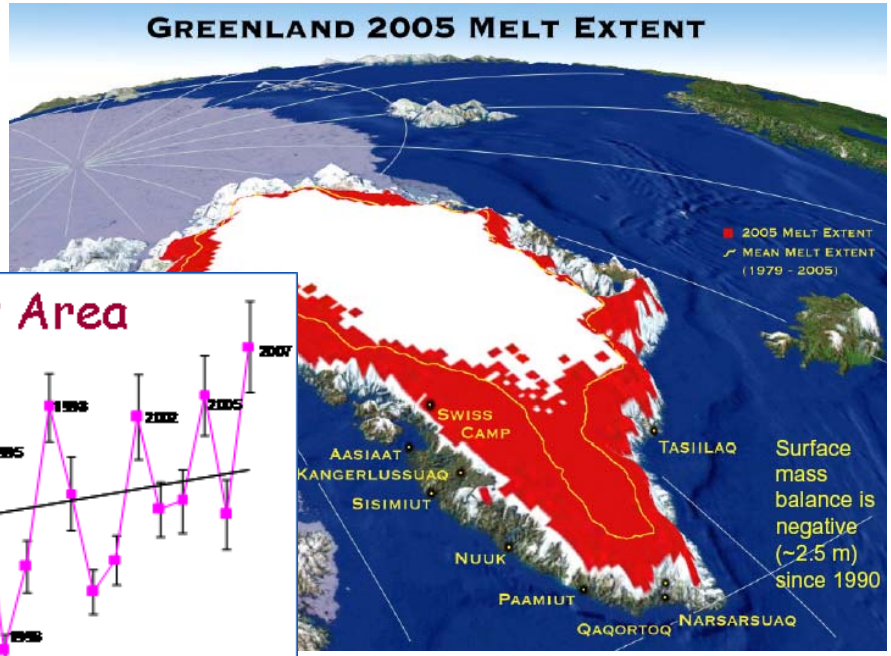
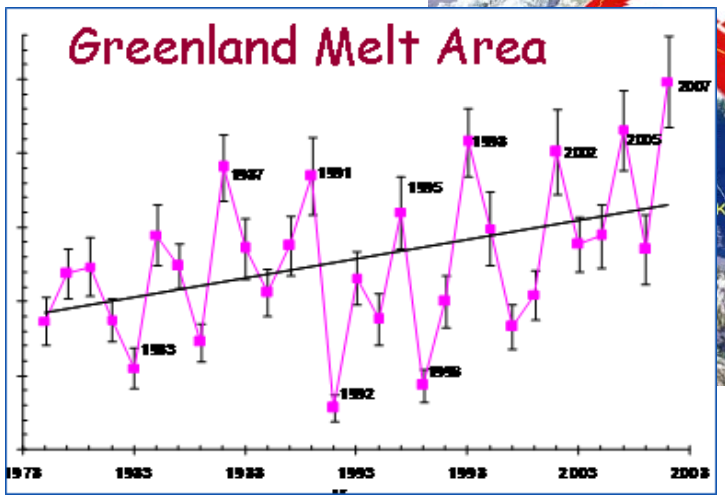
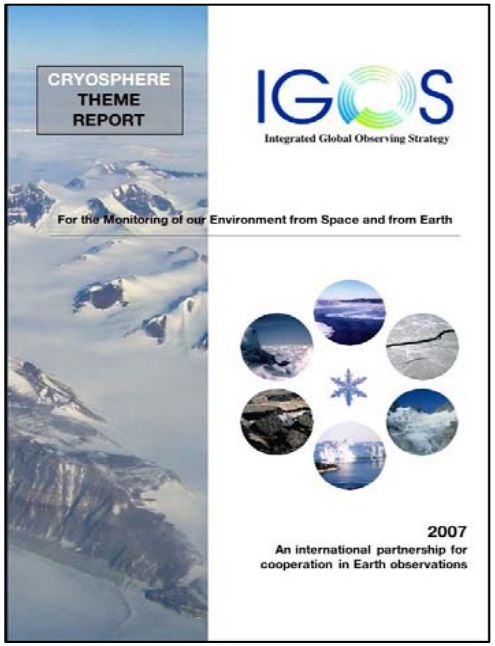
We address scientific uncertainties

Earth System Science Partnership

For example: Uncertainties in ice-sheets' stability and their impact on sea level a major concern for tens to hundreds of millions of people!







AIM: initiate a process to create a more comprehensive, coordinated and integrated cryospheric observing system

Part 4: Research Planning

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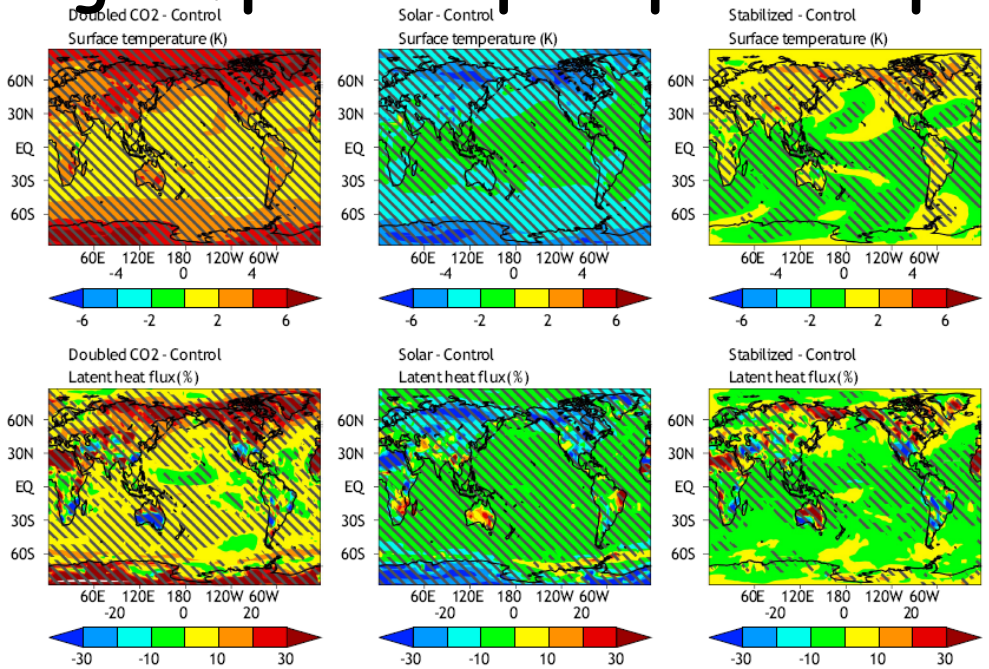
We address scientific uncertainties

Earth System Science Partnership

For example: Assess impact of geo-engineering on hydrology.
preliminary conclusion: **a changed radiative balance has large impact on precipitation patters**

Bala, G., et al. 2008.. PNAS 105, 7664-7669.



The hydrological cycle is more sensitive to temperature adjustment by changes in insolation than by changes in greenhouse gases. This implies that an alteration in solar forcing might offset temperature changes or hydrological changes from greenhouse warming, but could not cancel both at once.

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NEW: Food system research in collaboration with CGIAR

Earth System Science Partnership

We also effectively connect with researchers from other organizations, such as the International Agricultural Research Institutes (CGIAR) Together we will implement a 10-years, M$250 challenge programme on **Climate Change, Agriculture and Food Security (CCAFS)** to develop the necessary knowledge to assess food systems and food security in relation to climate-change adaptation and mitigation.

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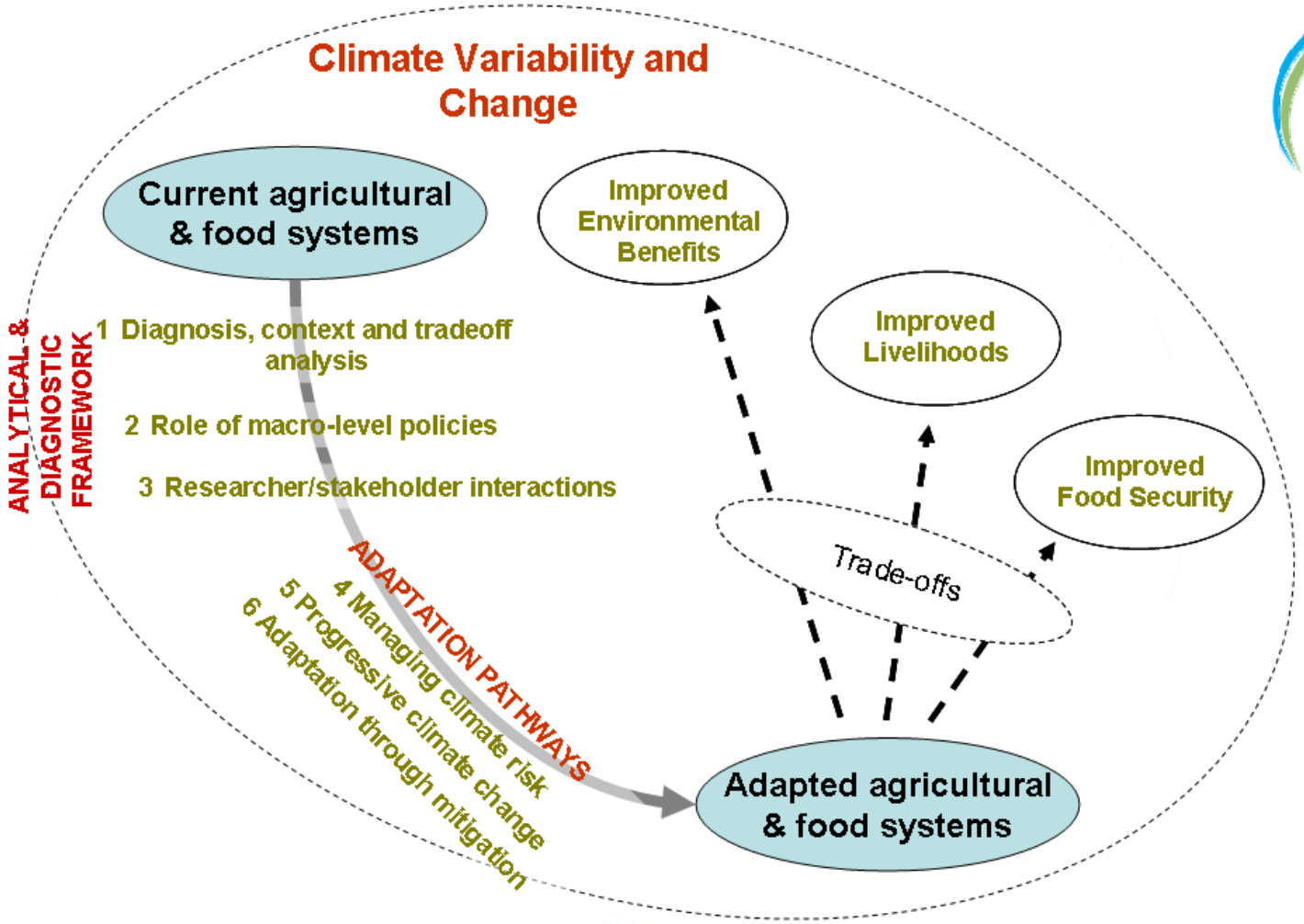
Research Framework and Science Themes of the Challenge Program on Climate Change, Agriculture and Food Security (CCAFS)



Part 4: Research Planning

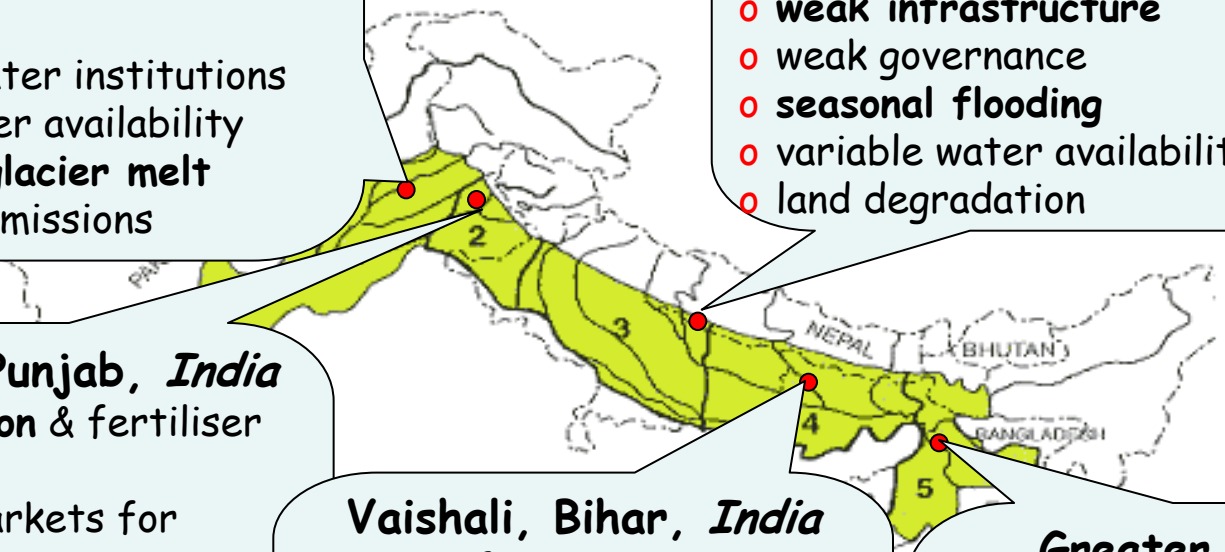
GECAFS Indo-Gangetic Plain Food System research context

Gujarat, Punjab *Pakistan*

- effective institutions
- **high irrigation** & fertiliser inputs
- effective water institutions
- variable water availability
- **changes in glacier melt**
- rising GHG emissions

Ruhani Basin, Terai *Nepal*

- out-migration of labour
- **weak infrastructure**
- weak governance
- **seasonal flooding**
- variable water availability
- land degradation



Ludhiana, Punjab, *India*

- **high irrigation** & fertiliser inputs
- effective markets for staples
- in-migration of labour
- **groundwater depletion**
- changes in monsoon
- changes in GHG emissions

Vaishali, Bihar, *India*

- weak infrastructure
- out-migration of labour
- **little policy support**
- seasonal flooding
- **variable water availability**
- siltation of dams

Greater Faridpur *Bangladesh*

- low household incomes
- **institutions failing**
- out-migration of labour
- drought
- seasonal flooding
- **SLR & salt water intrusion**

Part 5: New research f

GECAFS Global Environmental Change and Food Systems

CGIAR Challenge Program on WATER & FOOD

NATURAL ENVIRONMENT RESEARCH COUNCIL

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

DFID Department for International Development

APN

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Key concerns on GEC-induced vulnerability of case study food systems

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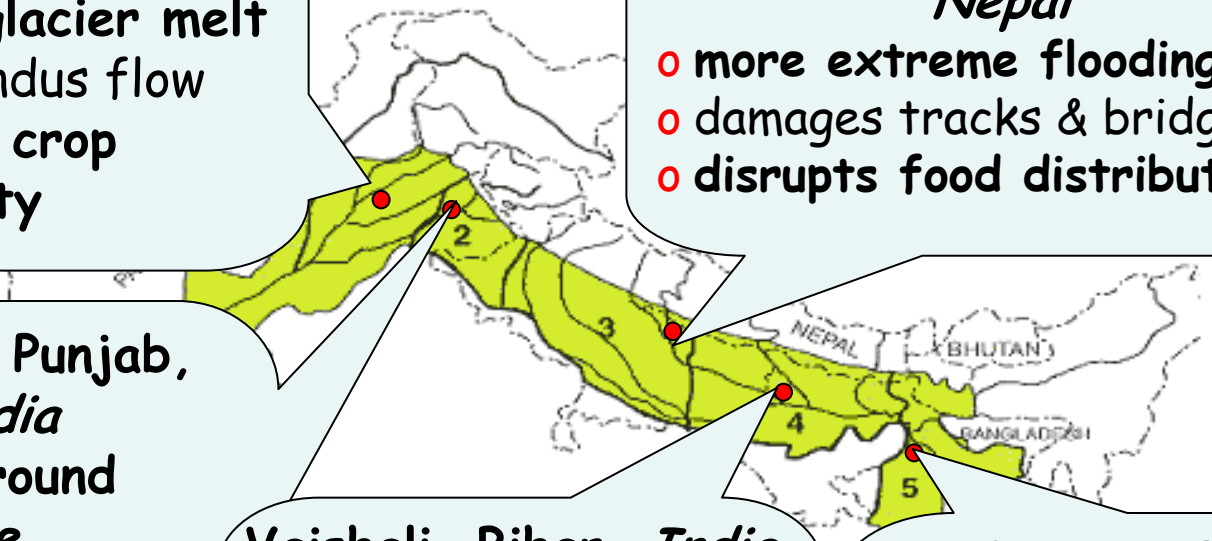
Gujarat, Punjab *Pakistan*
- o **reducing glacier melt**
- o reduces Indus flow
- o **threatens crop productivity**

Ruhani Basin & Terai *Nepal*
- o **more extreme flooding**
- o damages tracks & bridges
- o **disrupts food distribution**

Ludhiana, Punjab, *India*
- o **lowering ground water table**
- o reduces irrigation supply
- o **threatens crop productivity**



Vaishali, Bihar, *India*
- o **increasing weather extremes**
- o Increases food costs
- o **reduces food affordability**

Greater Faridpur Bangladesh
- o **sea-level rise and salt water intrusion at coast**
- o decreases arable land
- o **reduces food production**

GECAFS Global Environmental Change and Food Systems

CGIAR Challenge Program on WATER & FOOD

NATURAL ENVIRONMENT RESEARCH COUNCIL

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

DFID Department for International Development

APN

Part 5: New research

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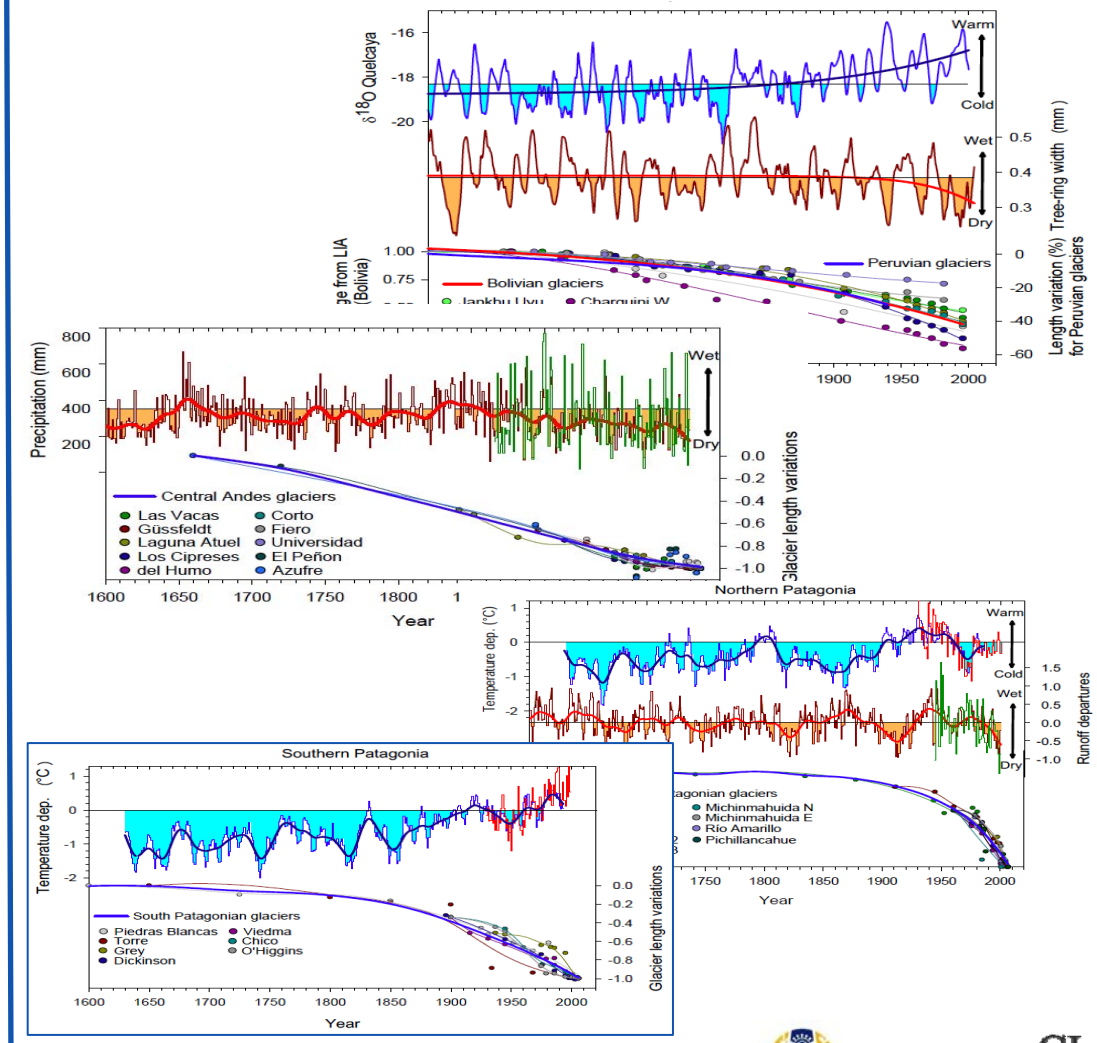
South America: Analyzing the retreating glaciers

Earth System Science Partnership



Part 5: New research

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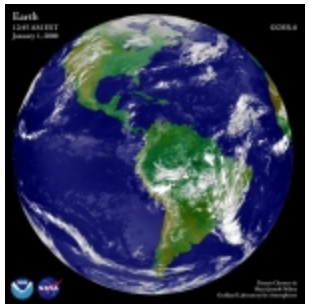
Annual Carbon Budget 2008



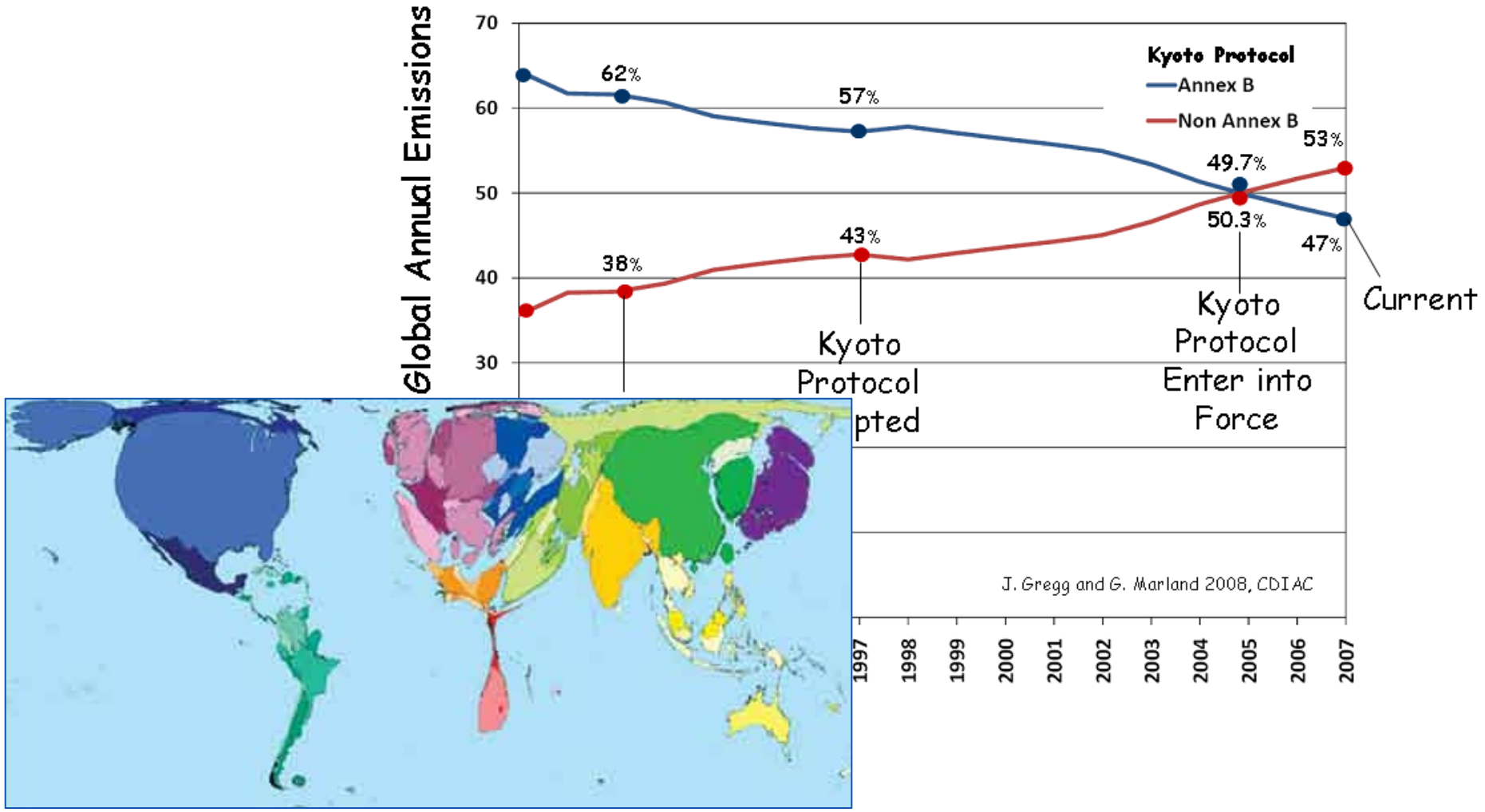
- Anthropogenic CO_2 emissions have been growing four times faster since 2000 than during the nineties - despite efforts to curb emissions of the Kyoto Protocol.
- Natural CO_2 sinks are growing, but more slowly than atmospheric CO_2, which has been growing at 2 ppm per year since 2000. This is 33% faster than during the previous 20 years.
- All of these changes characterize a carbon cycle that is generating stronger climate forcing and sooner than expected.

- **CAN WE HELP TO DEVELOP A CARBON ASSESSMENT OFFICE?**

For details: www.globalcarbonproject.org

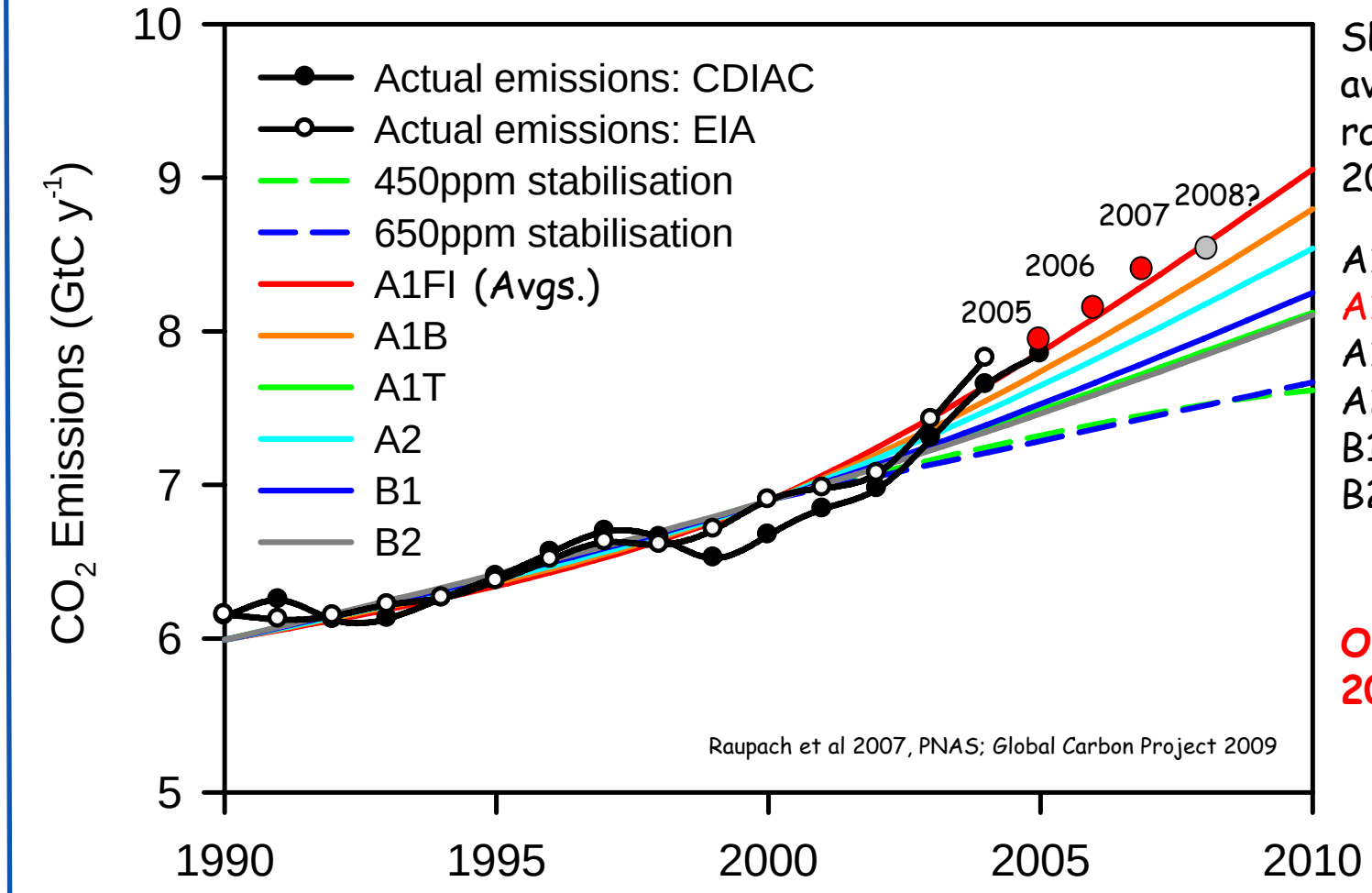
Part 5: New research

Regional Shift in Emissions Share



Part 5: New research

Fossil Fuel Emissions: Actual vs. IPCC Scenarios



SRES (2000) aver. growth rates in % y^{-1} for 2000-2010:

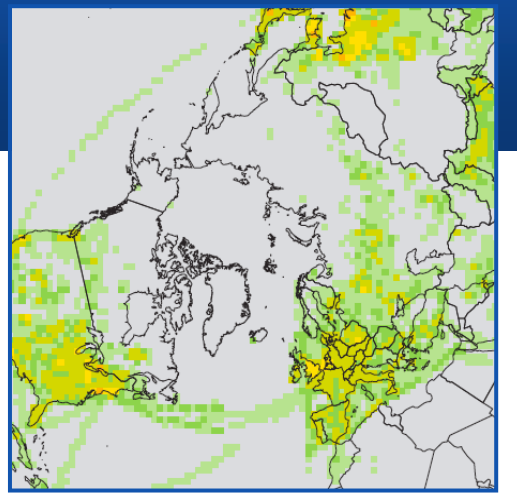
A1B: 2.42
A1FI: 2.71
A1T: 1.63
A2: 2.13
B1: 1.79
B2: 1.61

Observed 2000-2007 3.5%

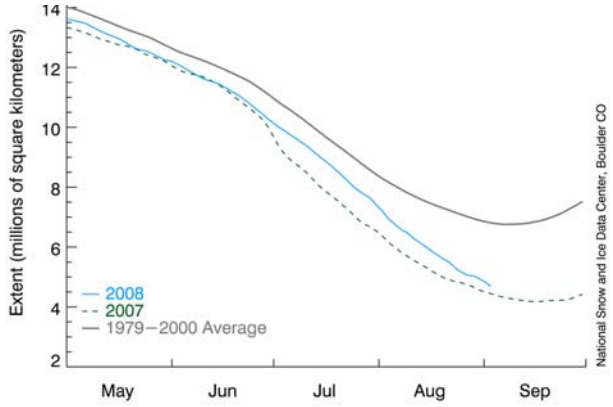
Part 5: New research

Black carbon (soot) snow & ice albedo feedback

Earth System Science Partnership



Observed Arctic Sea-ice Extent



Soot deposition darkens surface ⇨ more solar energy absorbed ⇨ increases surface temperature ⇨ snow melts ⇨ more solar energy absorbed ⇨ increases surface temperature (same effect with GHGs)

Part 5: New research of

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Species responses to climate change

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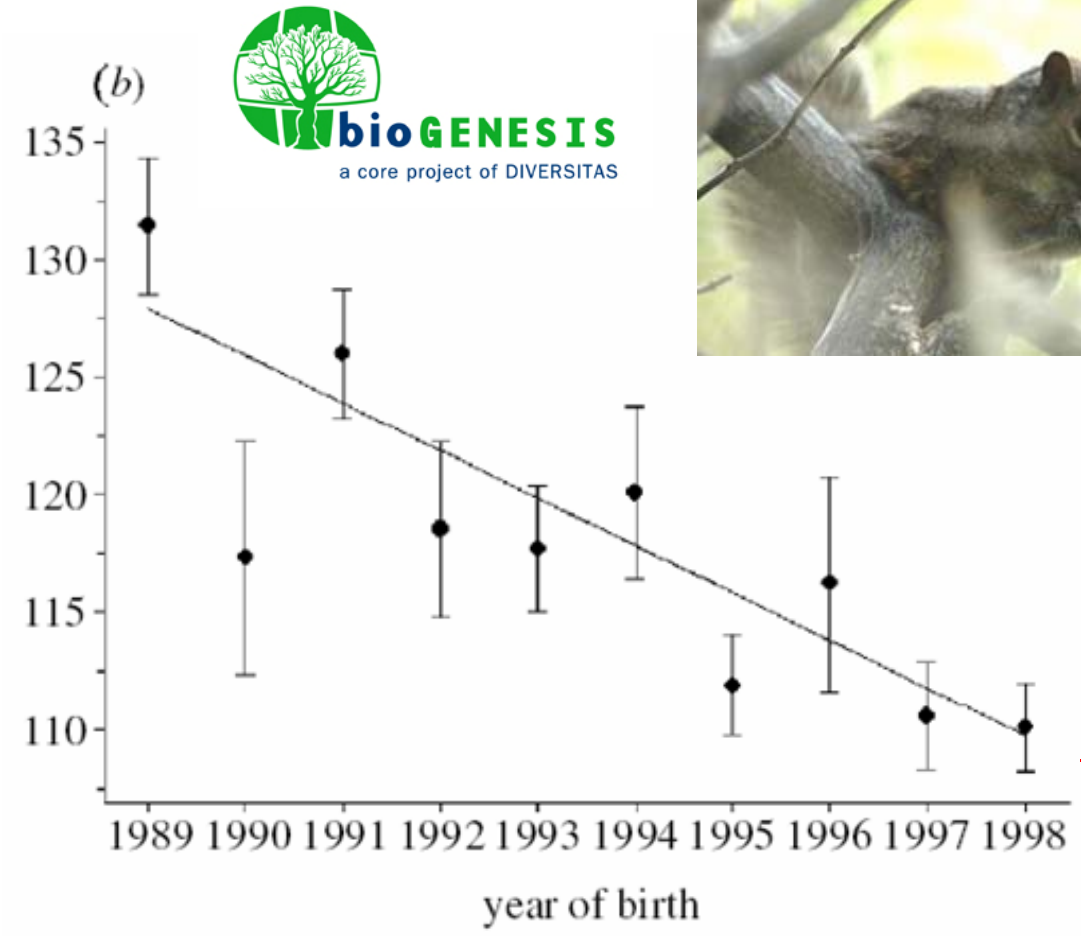
Bradshaw and Holzapfel 2007, PNAS



bioGENESIS
a core project of DIVERSITAS

Yukon squirrel

Red squirrels have responded to a 2C mean Apr-June temperature change by advancing the date at which they give birth by almost 26 days in 26 years (matching the peak spruce cone production)

Part 5: New research

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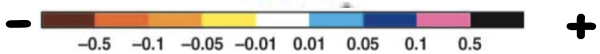
Impacts on biodiversity in the Amazon

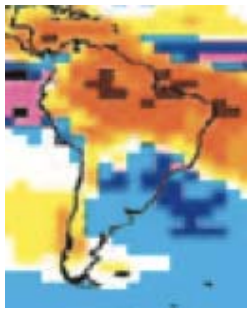
Earth System Science Partnership

A potential tipping-point of global importance caused by changes in fire, deforestation and climate

2080 compared to 2000



Change in humid tropical forest (fraction of current)



Betts et al. Nature, 2004

Change in precipitation (mm / day)

Moorecroft et al. Science, 2003

Change in C storage (kg C / m^2)

+ Species extinctions of unparalleled magnitude

Amazon Forest represented by Only one plant type in most DVGM models

Part 5: New research

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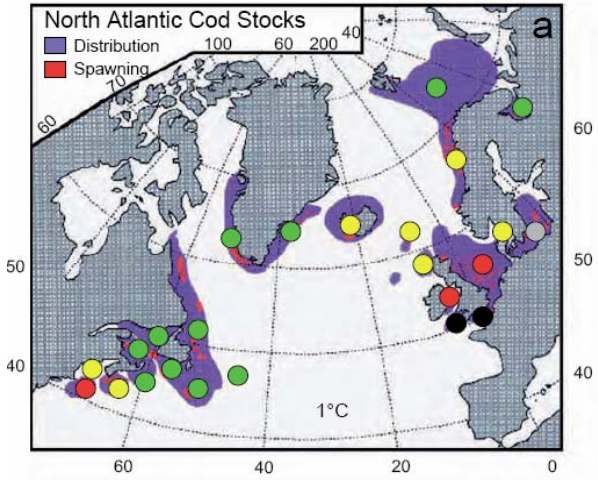
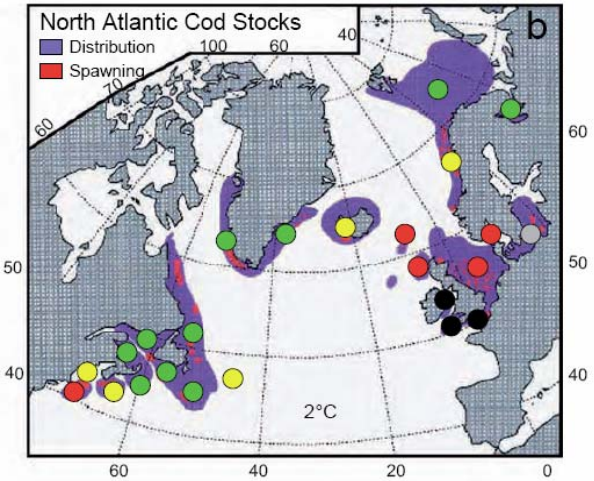
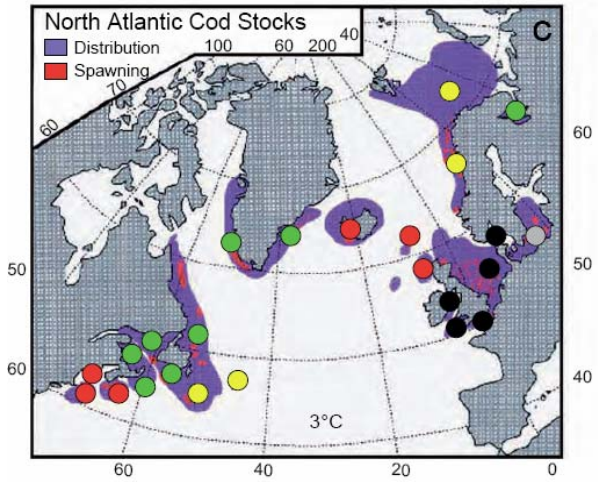
Expected changes in the abundance of cod stocks with a temperature increase of (a) 1°C, (b) 2°C, (c) 3°C, and (d) 4°C

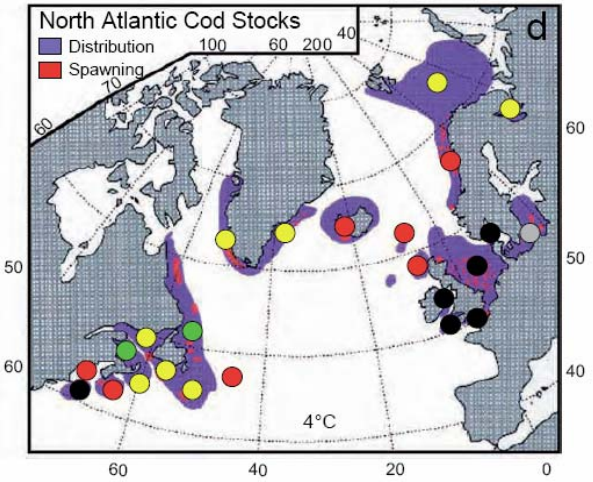
Earth System Science Partnership

Drinkwater 2005. *ICES Journal of Marine Science*









- Increase
- No change
- Decrease
- Collapse
- ?

Note: the changes are relative to the previous change, i.e. 4°C represents the changes from those at 3°C.

Part 5: New research

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GLOBAL IGBP CHANGE

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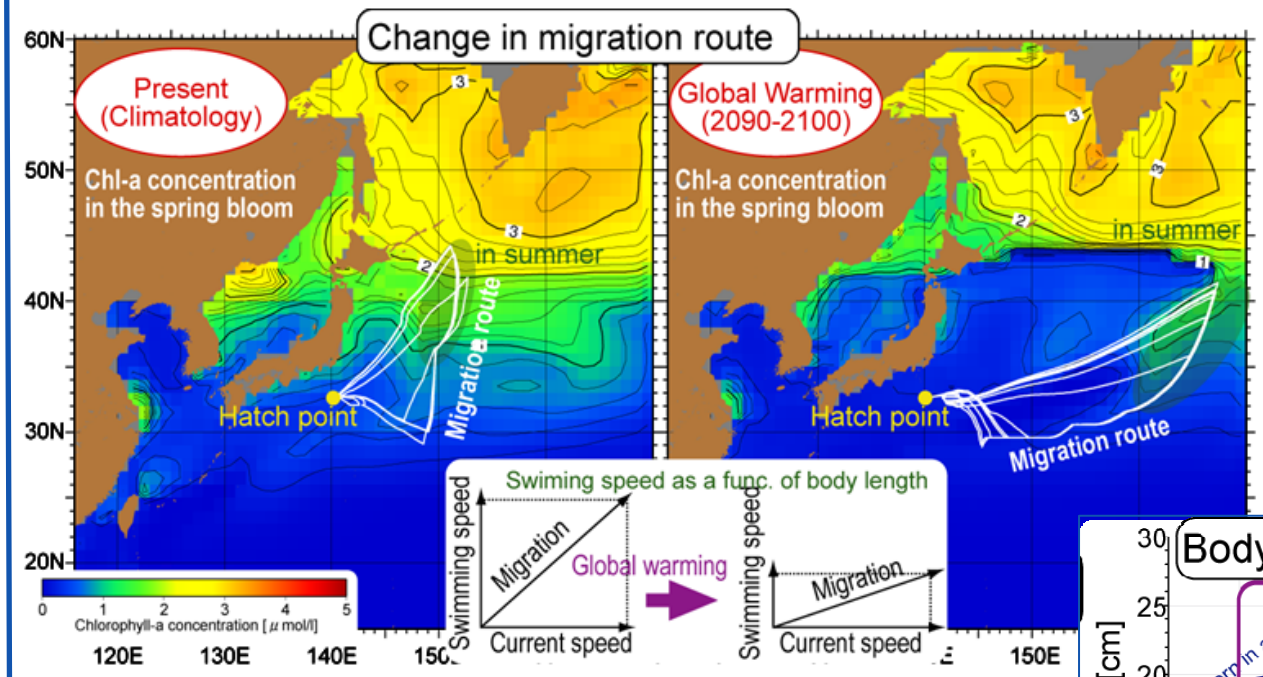
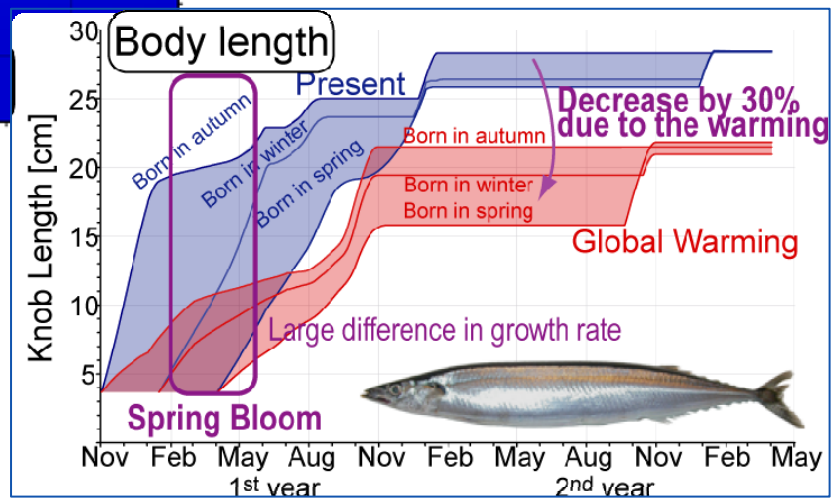
Shift in extent and productivity of the fish Pacific saury





The spring bloom of plankton (i.e. the major food) could occur much further north than at present, away from the usual habitat and distribution of this fish. The consequences are reduced food and 30% reduced growth of the fish, making the population less productive.

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Hashioka et al, 2007

Rising CO_2 and climate change impacts on coral reefs

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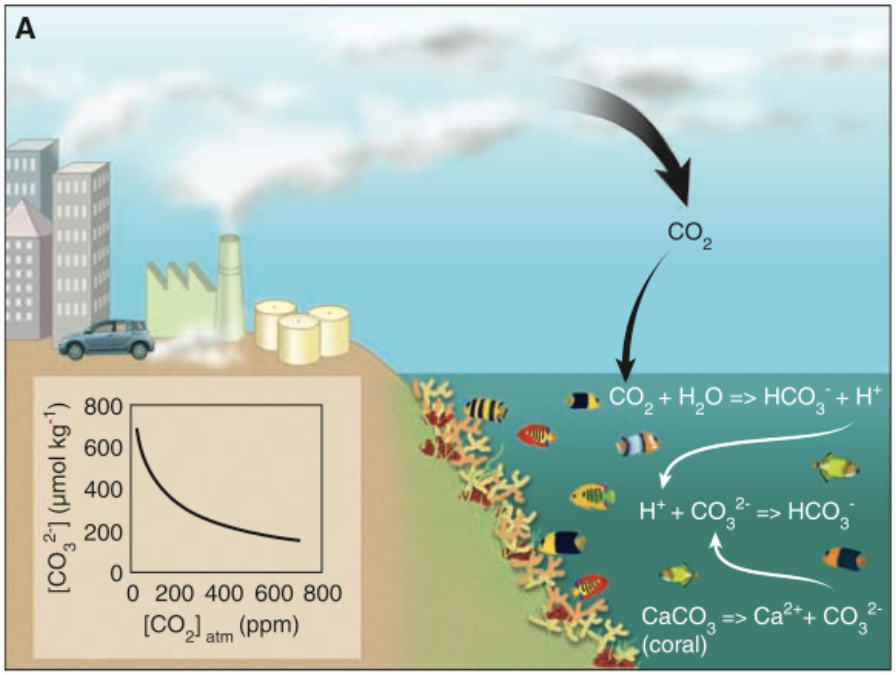
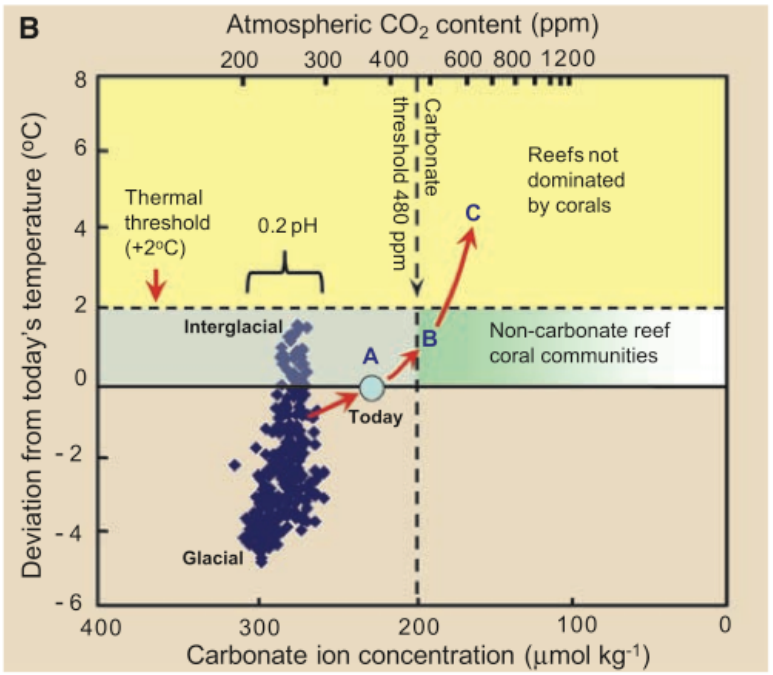
1) Rising CO_2 concentrations increase ocean acidity. This reduces the capacity of hard corals to build reefs

2) High temperatures cause reef polyps to loose their symbiotic algae ("bleaching").





Hoegh-Guldberg et al. 2007 Science

1) + 2) = very bad news for coral reefs

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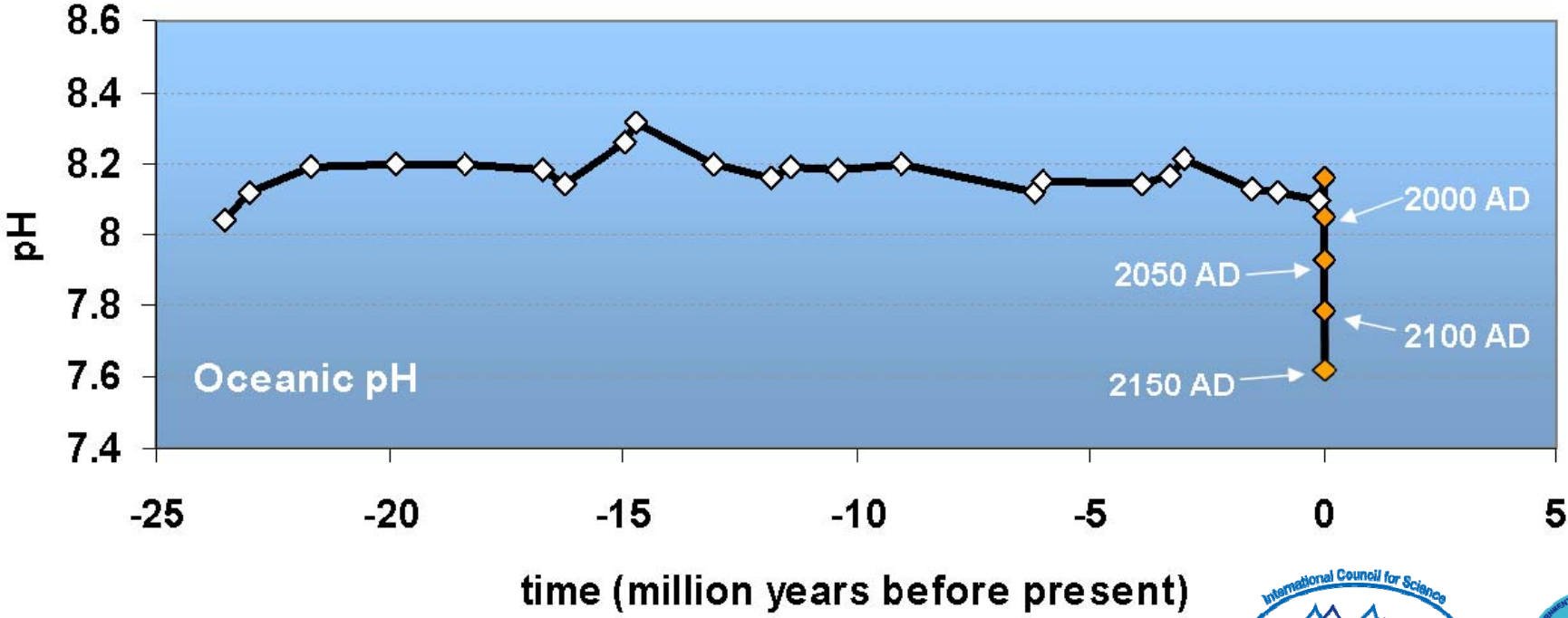
The Oceans are acidifying fast

at a rate and to a level not experienced by marine organisms for at least 20 million year



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Effect of rising atmospheric CO_2 on coral reefs

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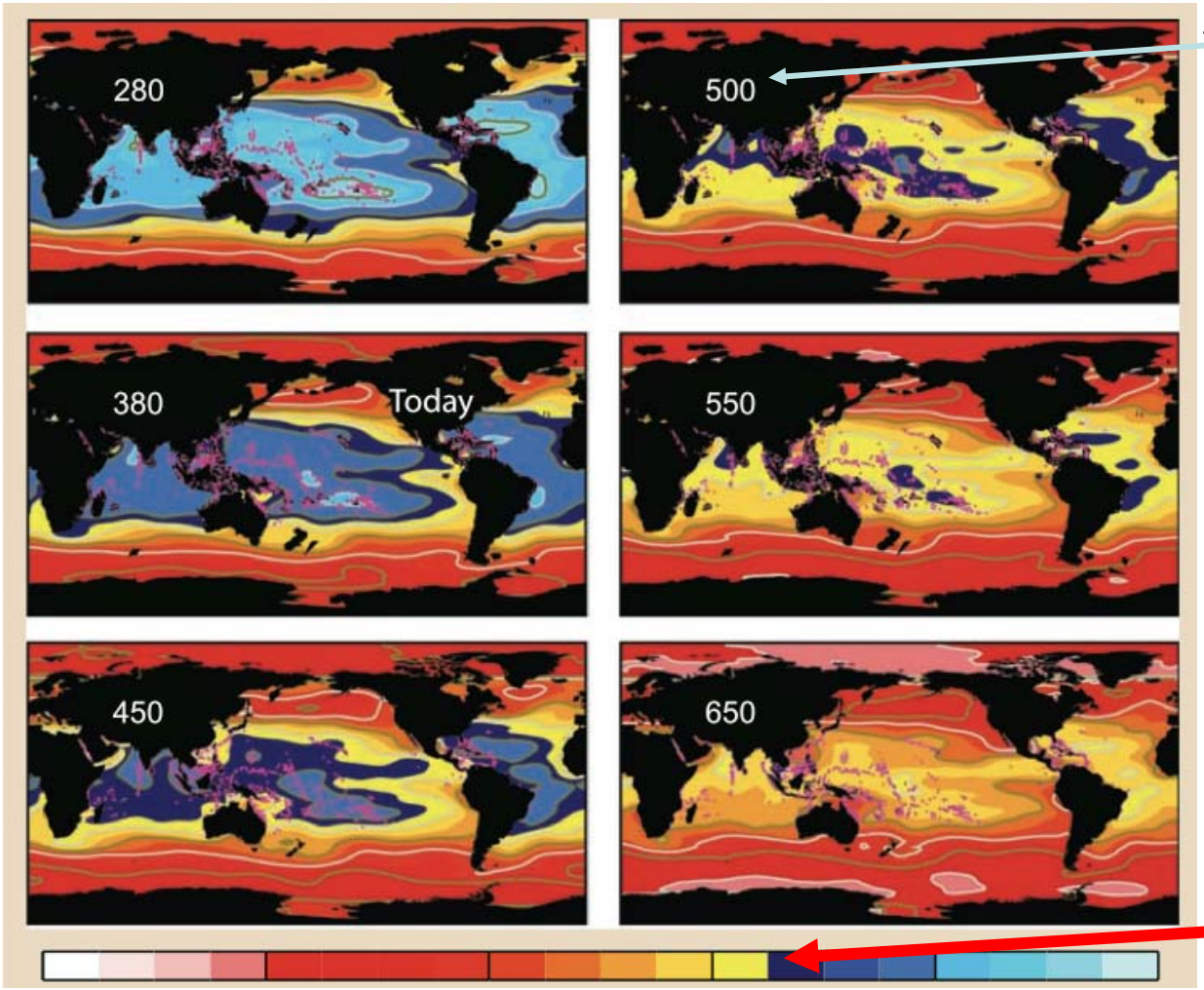

Hoegh-Guldberg et al. 2007 Science

Atmospheric CO_2 concentration

Models of ocean chemistry suggest that hard corals will be unable to build reefs (aragonite) or that coral reefs may even begin to dissolve due to ocean acidification by the middle of the 21st Century

Level below which hard corals cannot build reefs

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Climate change and rising CO_2 impacts on coral reefs

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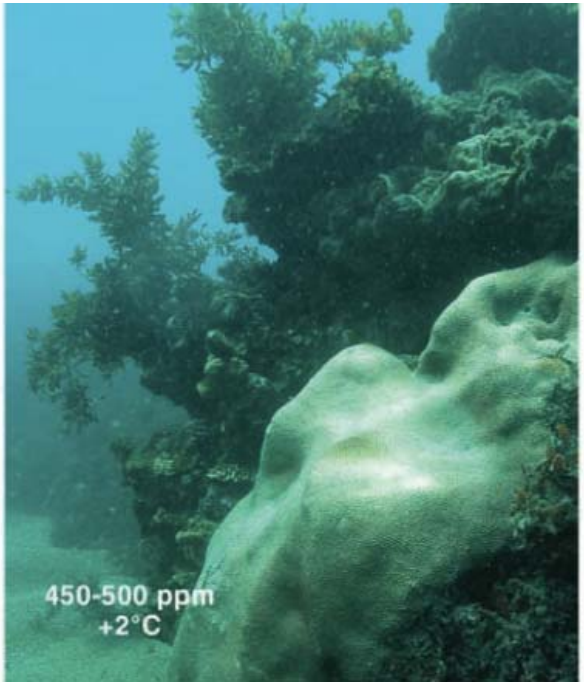
Examples of what the future might look like

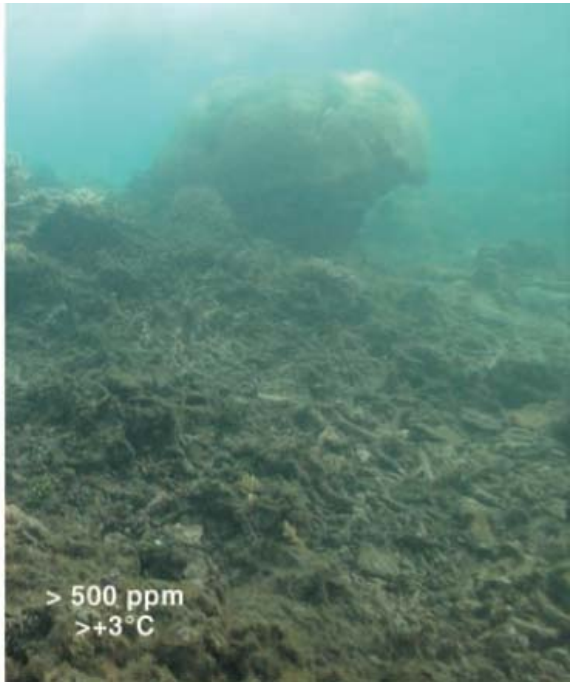
(photos from the Great Barrier Reef)

"Healthy" Coral reef

"Bleached" coral reef large areas already, most coral reefs in the next few decades



"Dead" reef middle to end of the 21st century



Hoegh-Guldberg et al. 2007 Science

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Deltas Under Threat

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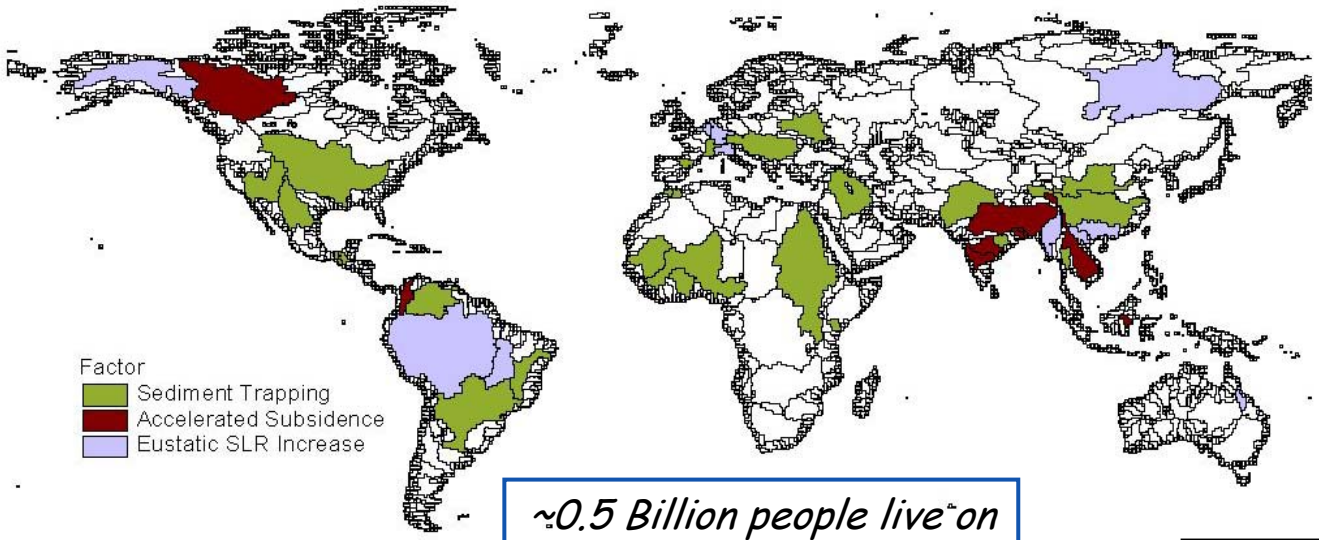
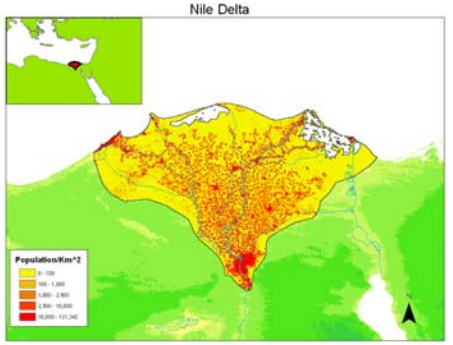
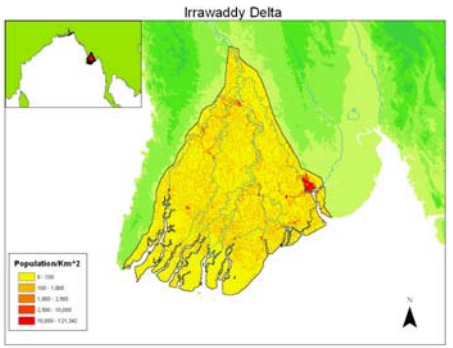
LOICZ

Basin Water Management Reverberates to Coastlines:
Eustatic/Steric Sea Level Rise Only Part of the Story



Ericson et al., 2006, Global and Planetary Change
Vörösmarty et al., 2009, Bull. Atomic Scientists





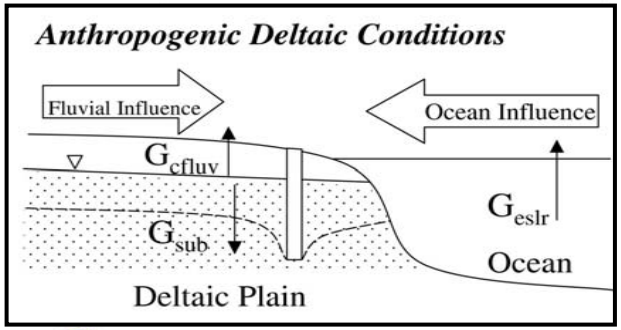
~0.5 Billion people live on deltas worldwide

Sources of Change for 40 deltas:

-- 5 Global Sea Level Rise

-- 8 Groundwater/petroleum extraction

-- 27 Upstream sediment trapping & diversion



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Research on urban-induced changes in climate

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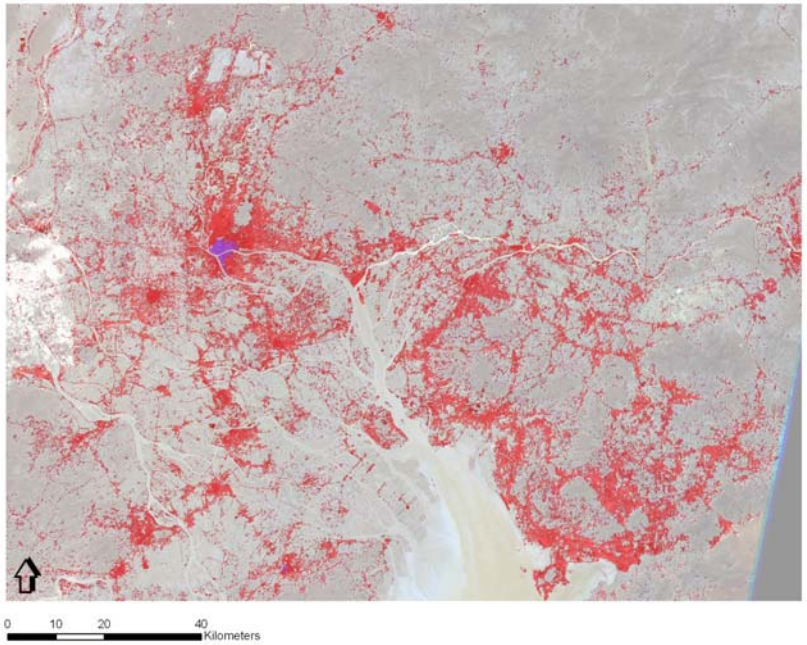
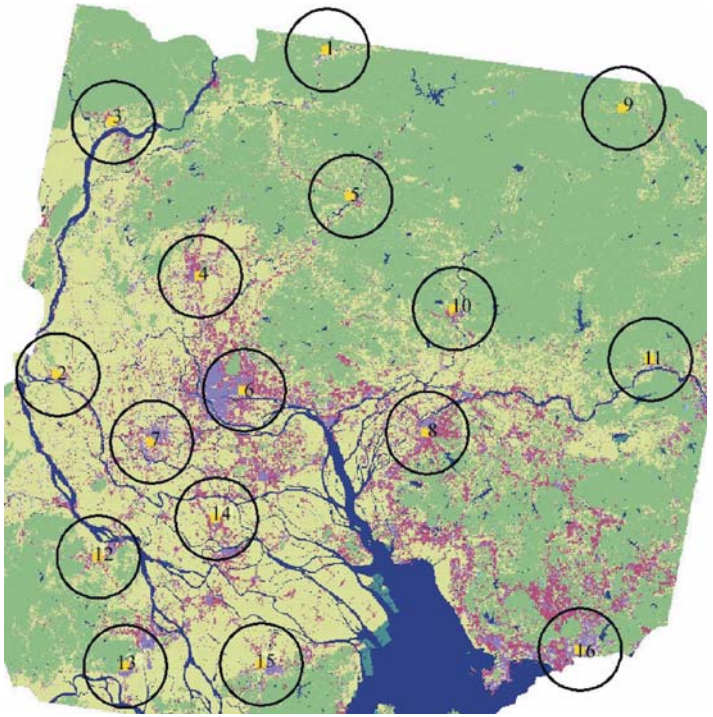
Urban Growth in Pearl River Delta, China - 1999



Climate Response to Rapid Urban Growth: Evidence of a Human-Induced Precipitation Deficit

ROBERT K. KAUFMANN,* KAREN C. SETO,+ ANNEMARIE SCHNEIDER,# ZOUTING LIU,@ LIMING ZHOU,& AND WEILE WANG**



- Changes surface properties
- Slows water transfer from soil to atmosphere
- Reduced winter rainfall caused by urban land-use change

Part 5: New research t al., 2007. *Journal of Climate*

Urbanization and Global Environmental Change

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Upstream-Downstream Asymmetries: potential source of conflict

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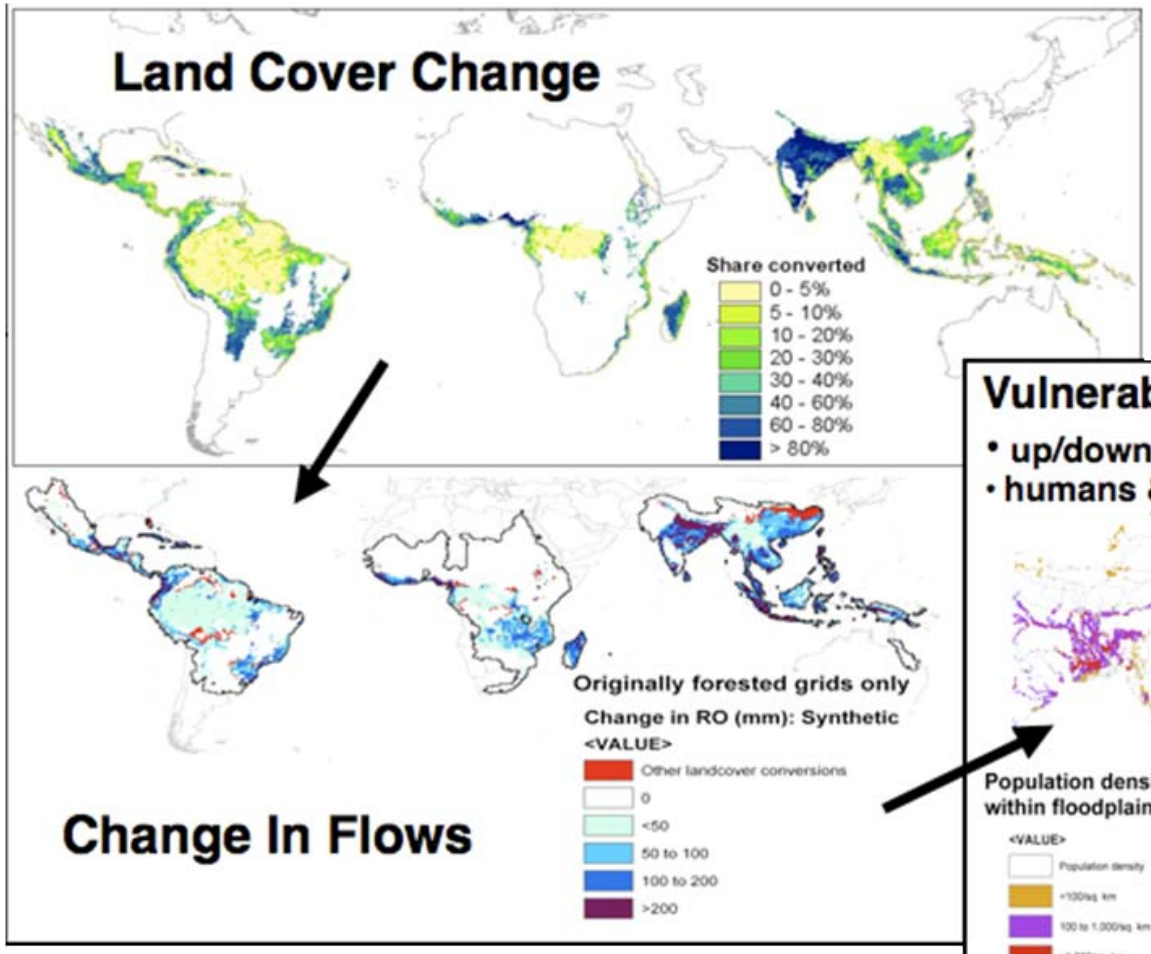
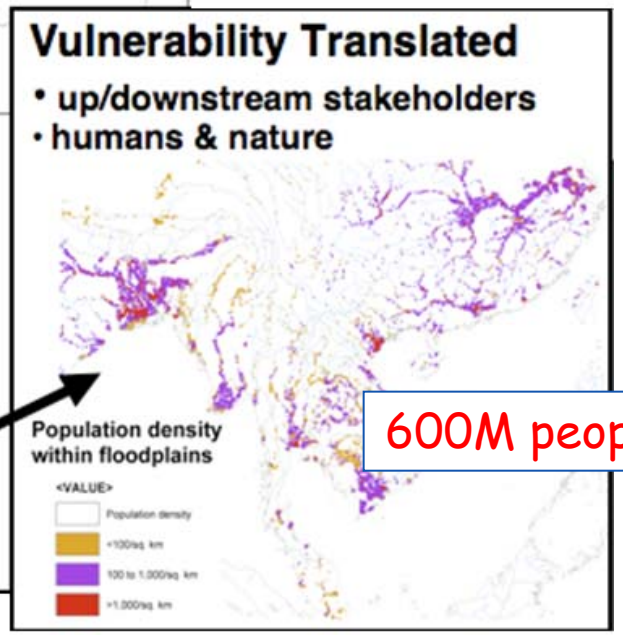


Wet Tropical Biome



600M people at risk

Douglas et al. 2007, WRM

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Climate Change as an Human Security Issue

- Climate change threatens the security of millions of individuals and their communities
- Vulnerability is not evenly distributed across society
- Patterns of vulnerability are dynamic and influenced by multiple stressors.

Enhancing human security in the 21st century is about responding to climate change in ways that not only reduce vulnerability, but also create a more equitable, resilient and sustainable future

Climate Change and Migration

- The magnitude of expected climate change may contribute to an increased number of regional and international migrants
- With well-designed policies in host and sending areas, migration can be harnessed to increase the capacity of vulnerable populations to adapt (*but migration should be a choice, not impelled*).
- Climate change also presents new arenas for cooperation, including a renewed focus on resilience and vulnerability reduction.

Comparative analysis and synthesis of urban experiences with adaptation to climate change

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Table 3: Response Capacity (Action)

Criterion	Bogotá	Cape Town	Delhi	Pearl River Delta	Pune	Santiago	Sao Paulo	Singapore
What motivated Action	External funding for the National Adaptation Project	Existing threats; Experiences with disasters	Perceived role as leader and a global city; Urgent need to address problems related to basic services provision and opportunity to capitalize on CDM and other financial mechanisms	Scientific findings + consensus on CC risks; International collaboration (UN-FCCC (common but differentiated respon-sibilities), IPCC, UK's DFID); Participation in international environmental agreements; Establishment of a National Leading Committee on CC; National plan is first climate plan from a developing country	No climate change motivators; Poverty alleviation, Disaster management	On National level: response to interna-tional commitments (OECD, UN)	Mayor brought back the idea from a C40 meeting	Adaptation as the continuation of a well established long-term/coordinated planning approach
Policy Fields where dedicated Climate Action has been introduced	No information	Water resources conservation and consumption; Disaster management/ preparedness	"Air Ambience Fund" to promote clean air policies.;Transporta-tion (CNG buses), Energy sector (greater reliance on solar, shutting down some coal powered plants), Water (rain-water harvesting, solar heaters), Waste management (inter-ceptor sewer canals)	No urban policy but China's National Climate Change Program (national policy established by central government)	No dedicated CC action; Sectoral interventions in flooding, water supply and transport (mitiga-tion: Bus Rapid Transit)	No dedicated plan of action	Disaster management; Vulnerability analyses Plan 'Parque Lineares'; Transportation, Energy, Waste Management, Health, Building standards, Land use/ Resettlement	Infrastructure Planning: Drainage, recent tidal barrier and reservoir; Trans-portation coordinated land use (short dis-tances); Energy effi-ciency (techno-logy, audits, standards, behaviour change); Water supply (desalination, recyc-ling); Urban Greening
Type of Action	No dedicated action; Pre-existing sectoral initiatives	Adaptation linked to goal and ongoing initiatives of reducing vulnerability and sustainability; Pro-active and protecting; Knowledge driven	Action plans primarily focused on mitiga-tion, strongly driven by need to tap opportunities offered by CDM. Adaptation linked to existing development concerns and largely follows a sectoral approach.	Ecosystem protect-tion, disaster preven-tion + reduction, and other key infrastruc-ture construction (anti-flood safety of large rivers, key cities + regions, guarantee safe drinking water + sound social + eco-nomic development,); Technological ad-vancement	No dedicated action; Pre-existing sectoral initiatives. Shifting of slums along flood prone river bed; Bus Rapid Transport System	No dedicated action; Pre-existing sectoral initiatives	Adaptation linked to prominent concerns (transportation); Mix of retreating, accom-modating, and pro-	Protecting; Linking with Science and Technology

Urbanization and Global Environmental Change

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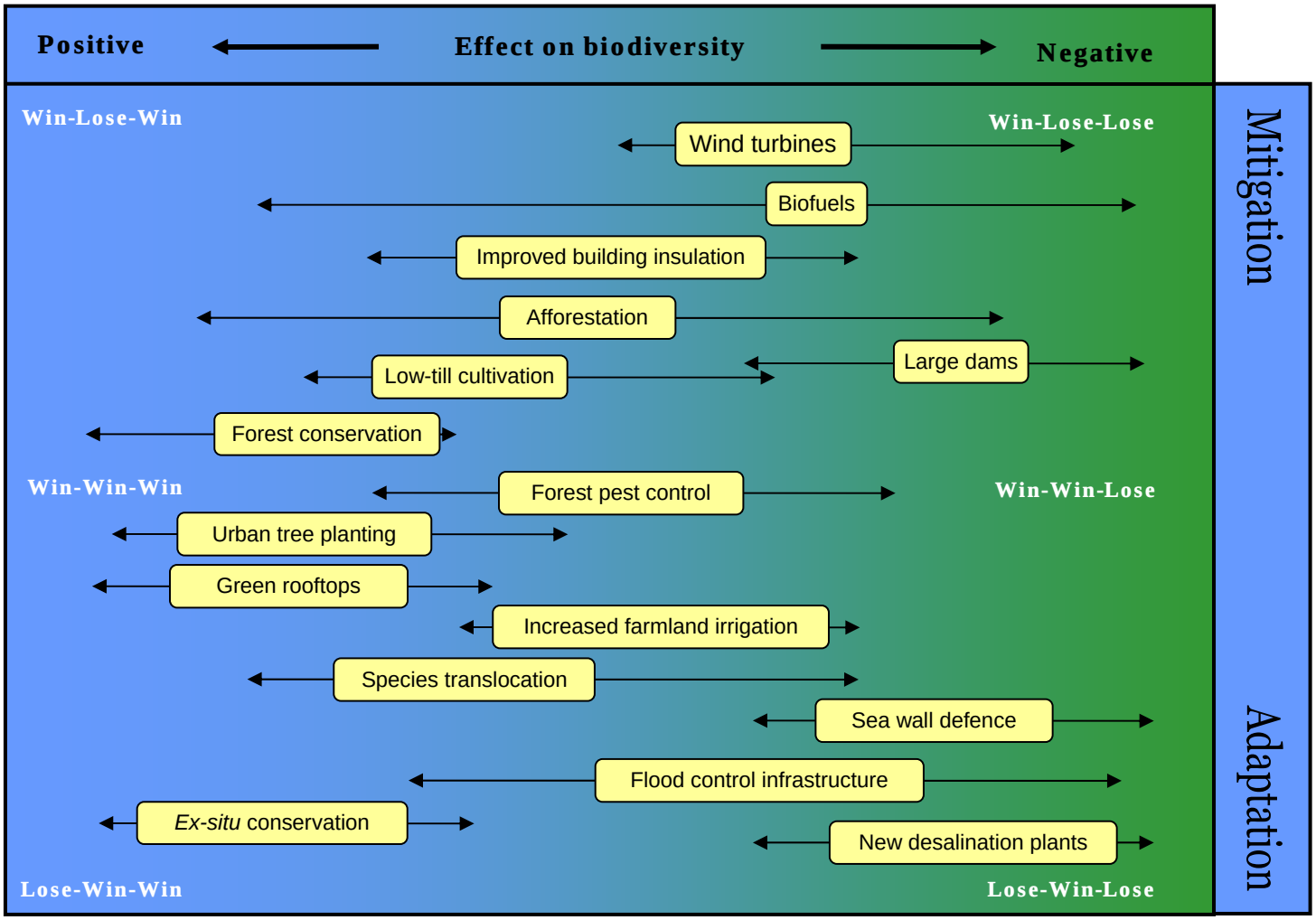
Source: Heinrichs et al., 2009. Urban Research Symposium (in prep.)

Sustainable Adaptation

- Adaptation to climate change is a social process;
- Not every adaptation is positive—some may exacerbate the vulnerability of others (in the present or future);
- Climate change adaptation must be closely linked to development and address local needs;
- Climate change affects the things people value, both individually and collectively;
- There are both objective and subjective limits to adaptation as a response to climate change.

The relationship between climate mitigation and adaptation measures and their impacts on biodiversity



Berry et al. 2008, Conservation Biology
Paterson et al., 2008 Conservation Biology

Part 5: New research

Conclusions

- Emissions continue to rise, but greater part now comes from lesser developed countries.
- Impacts of climate change are now irrefutable, even if they are difficult to measure and attribute precisely. The world's poorest in arid and coastal regions are the most vulnerable to climate change.
- Without large reductions in CO_2 emissions, acidification and increasing temperature of oceans, and species extinctions will become major threats.
- There are ample ways to mitigate and adapt but adaptation has (besides costs) also its limits.
- Low emission scenarios without dangerous climate change have been developed by several research groups and these scenario pathways will be central in new vulnarability assessments

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Integrative science to support decision making

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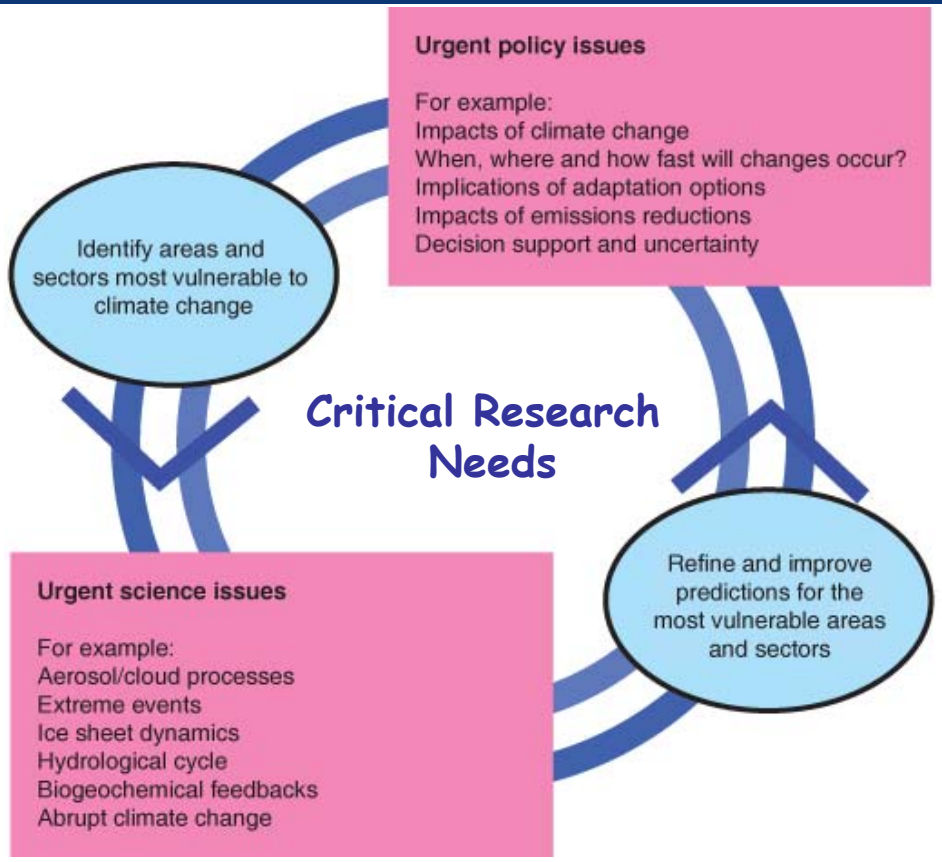

Image courtesy of IGBP

To achieve all this we have to work together!

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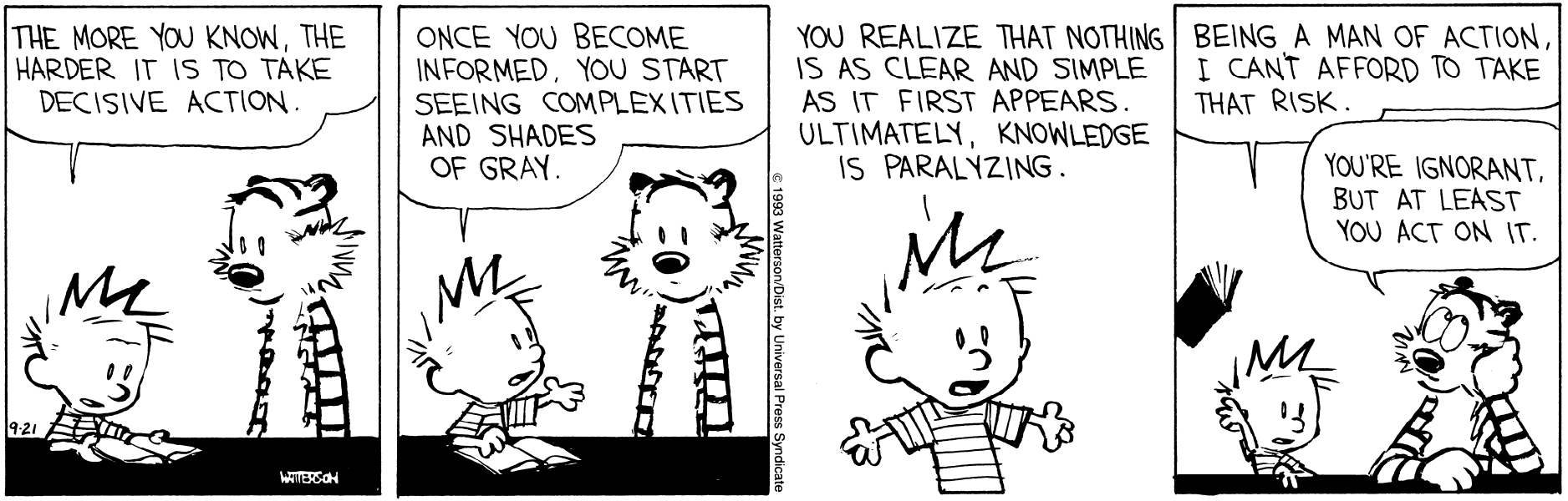
Thanks for your attention!



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