Background Paper on "Impacts, Vulnerability and Adaptation to Climate Change in Latin America"

Part I: Impacts

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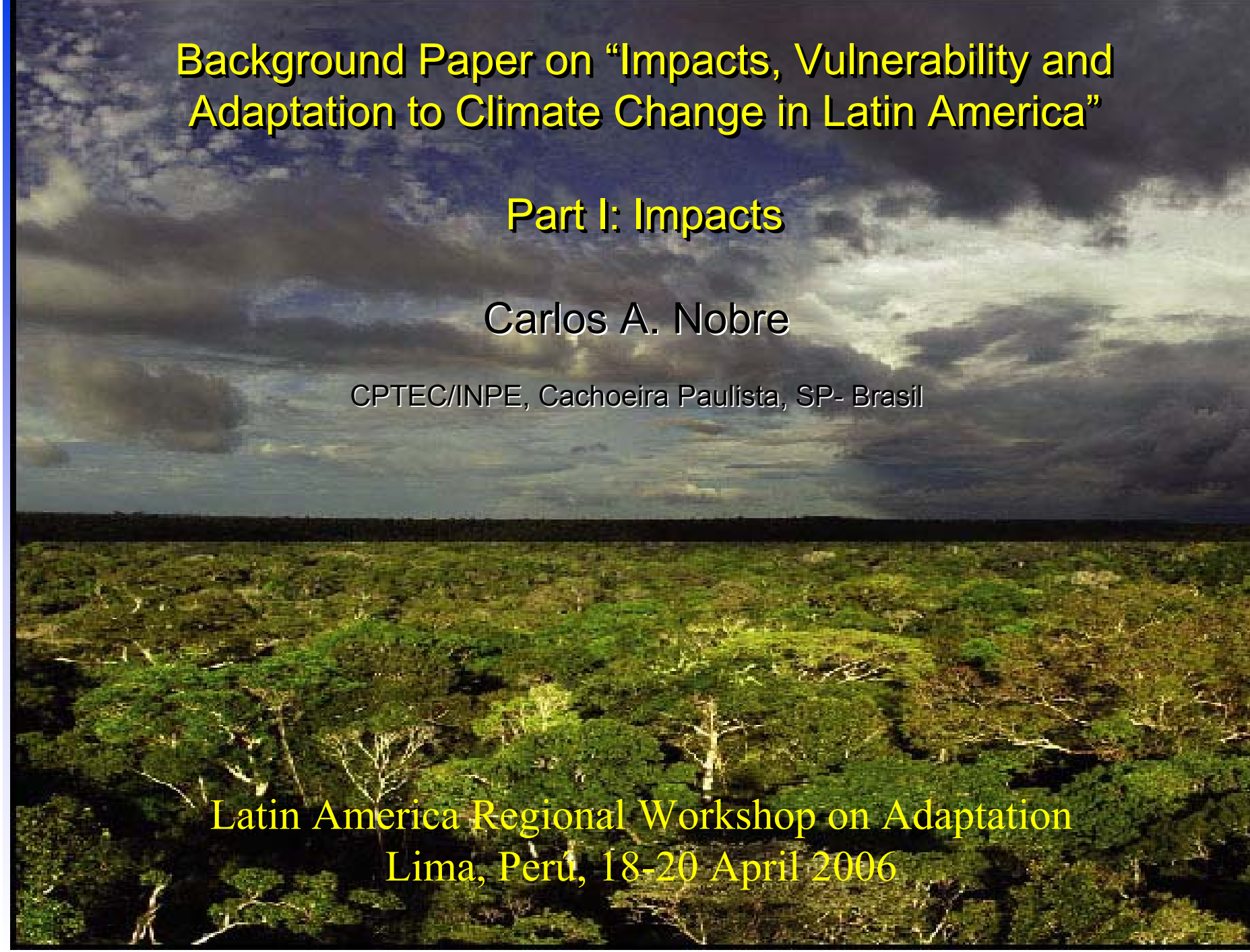
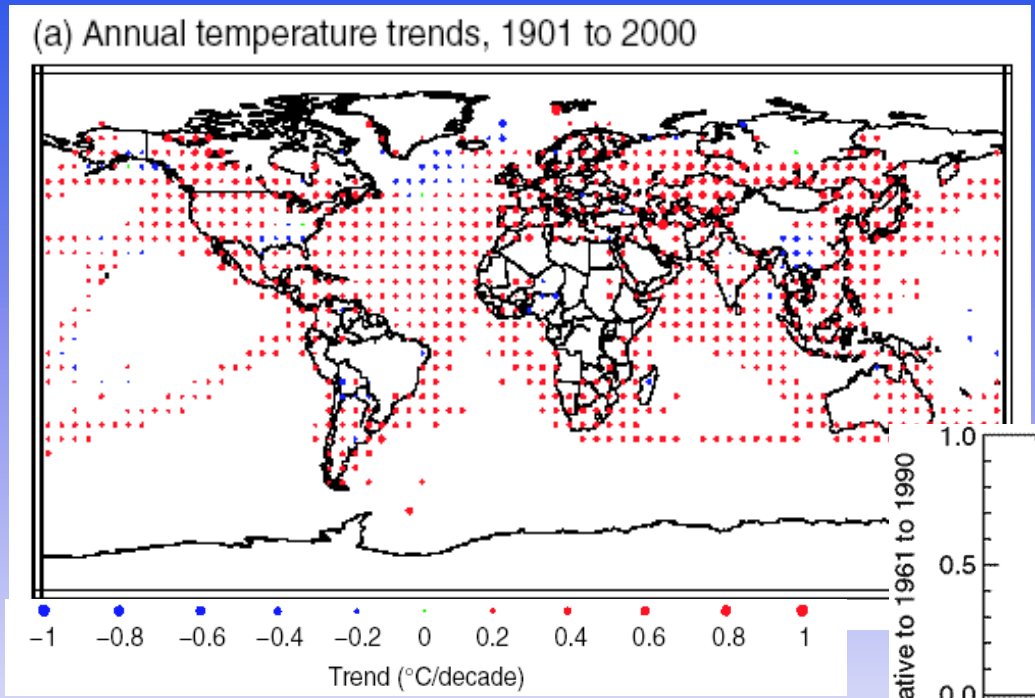
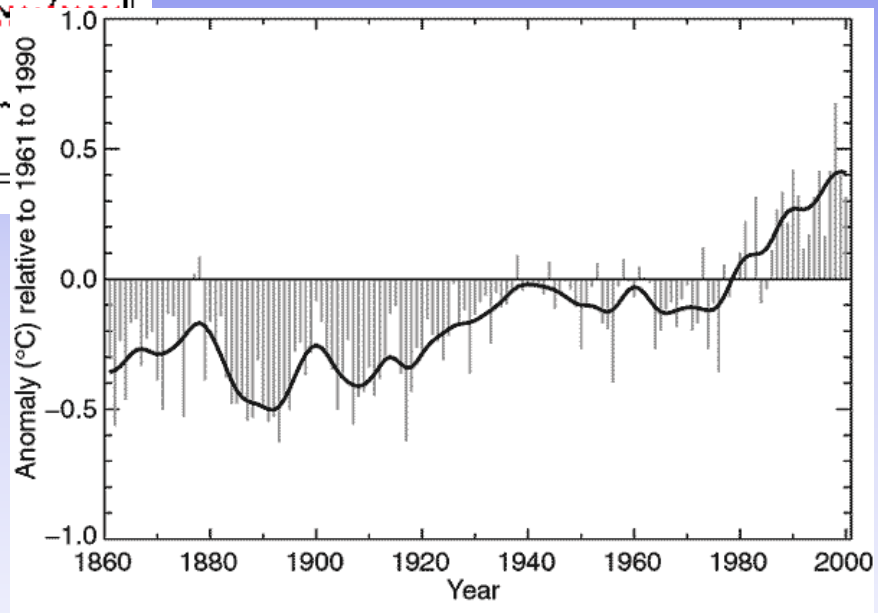


Latin America Regional Workshop on Adaptation
Lima, Perú, 18-20 April 2006

It's warmer on average than it was a century ago.



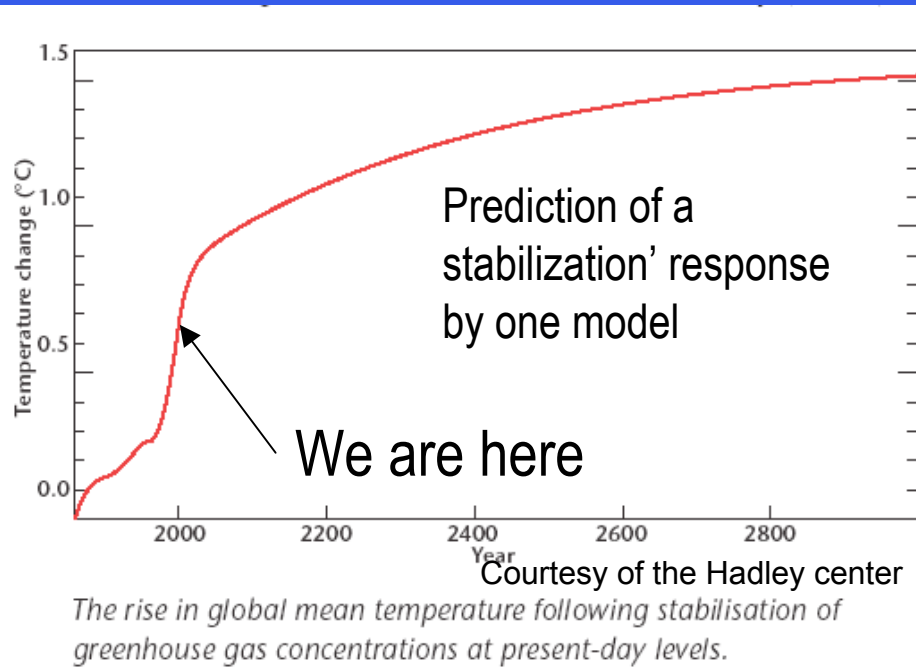


IPCC (2001): "new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."

FSTRR

If we were to stabilize the concentrations (not emissions) of all GHG and aerosols at present levels tomorrow, here's the kind of thing that would occur.

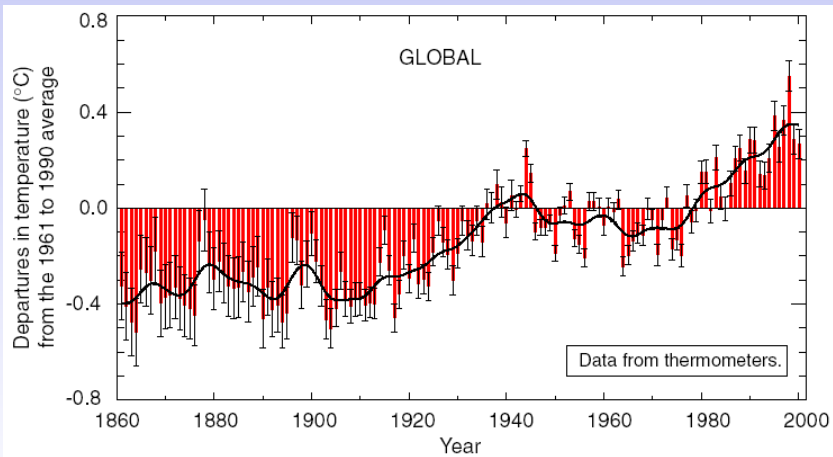
Future ? …air warms in the next few decades as the ocean mixed layer responds



Courtesy of the Hadley center

The rise in global mean temperature following stabilisation of greenhouse gas concentrations at present-day levels.

Past



A 'commitment' to future climate change (due to long lived warming agents in today's atmosphere) is alrea in place: "a coiled spring"

Courtesy: S. Solomon

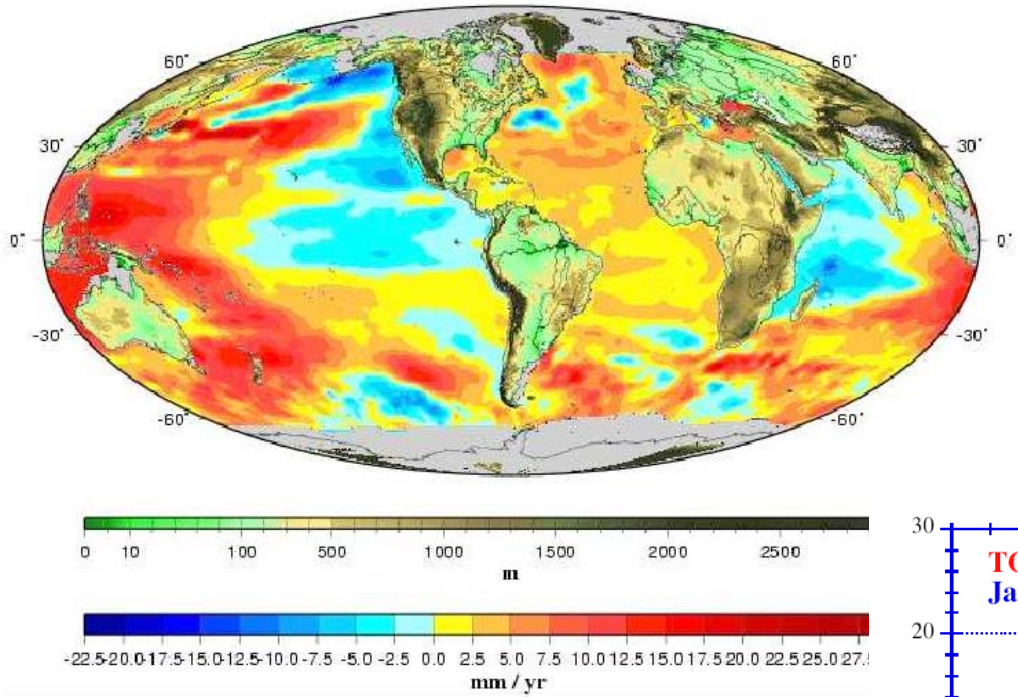


Figure 7. Sea level trends over 1993-2003 from the T/P mis

New satellite observations are quantifying the sea level rise of the past decade

[Figures from Cazenave and Nerem, 2003]

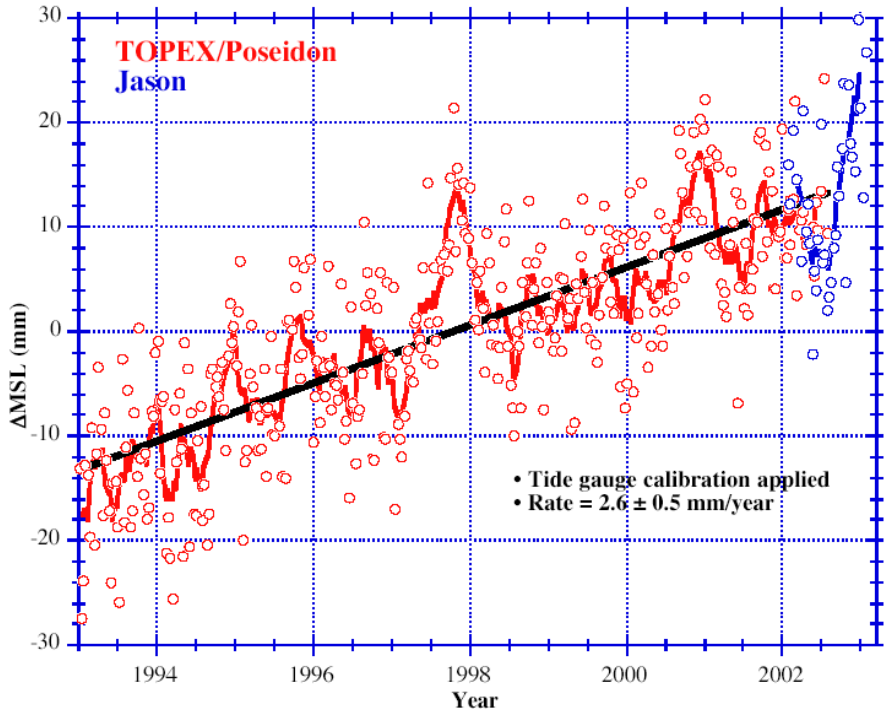
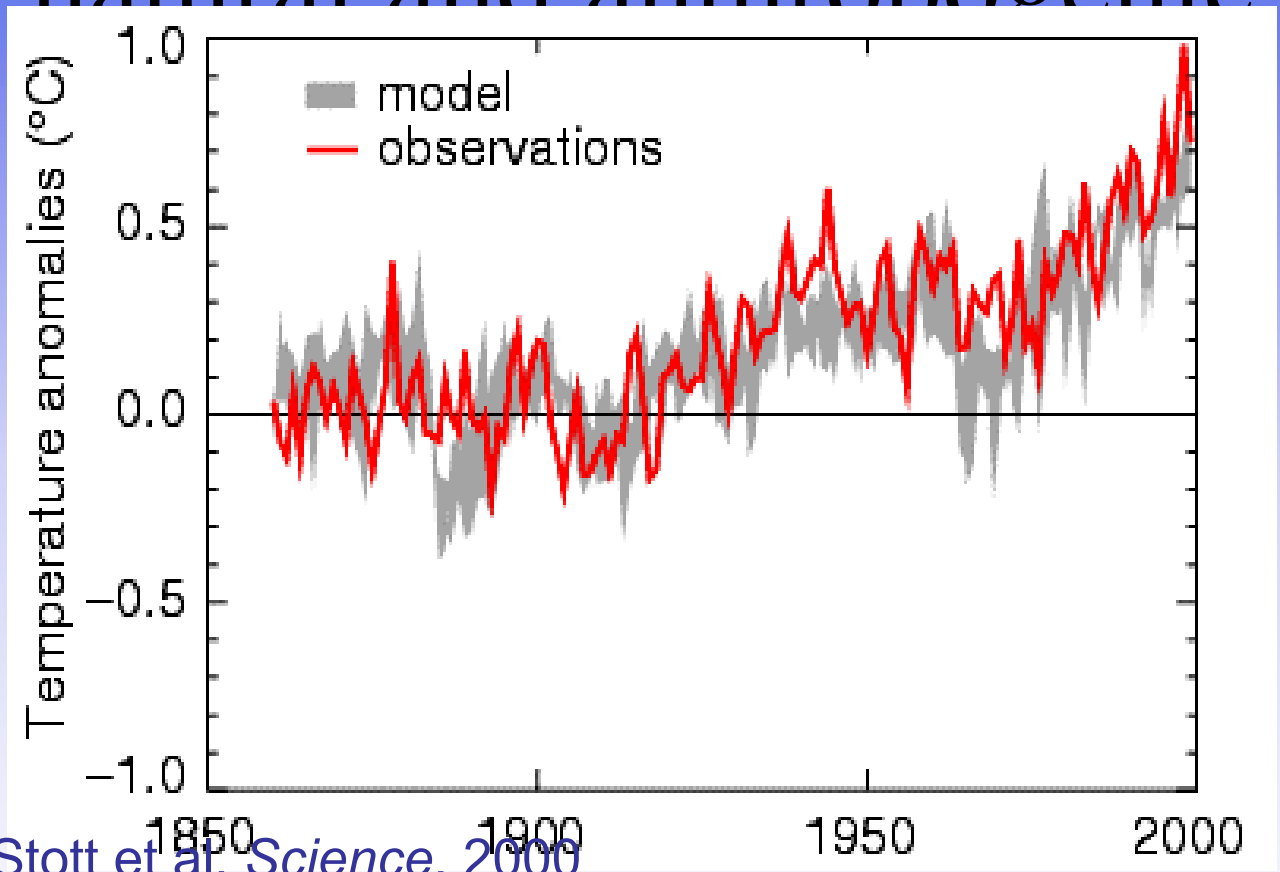


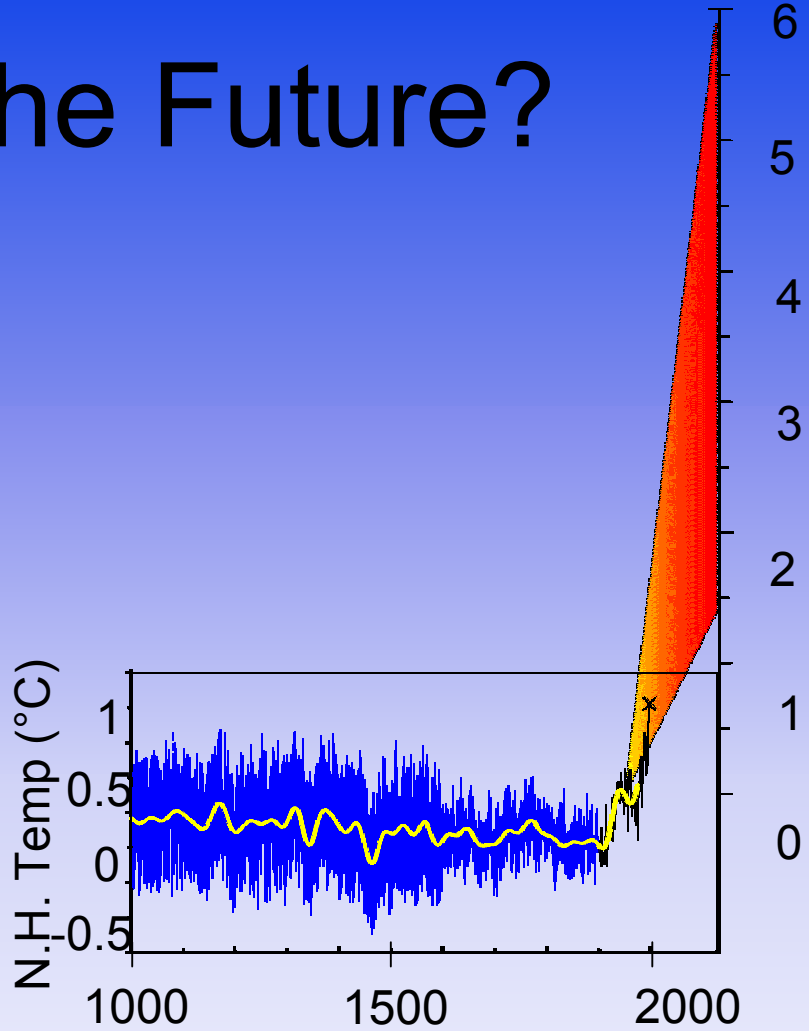
Figure 5. Global mean sea level variations from T/P and Jason.

Large-scale temperatures respond predictably to external driving, natural and anthropogenic

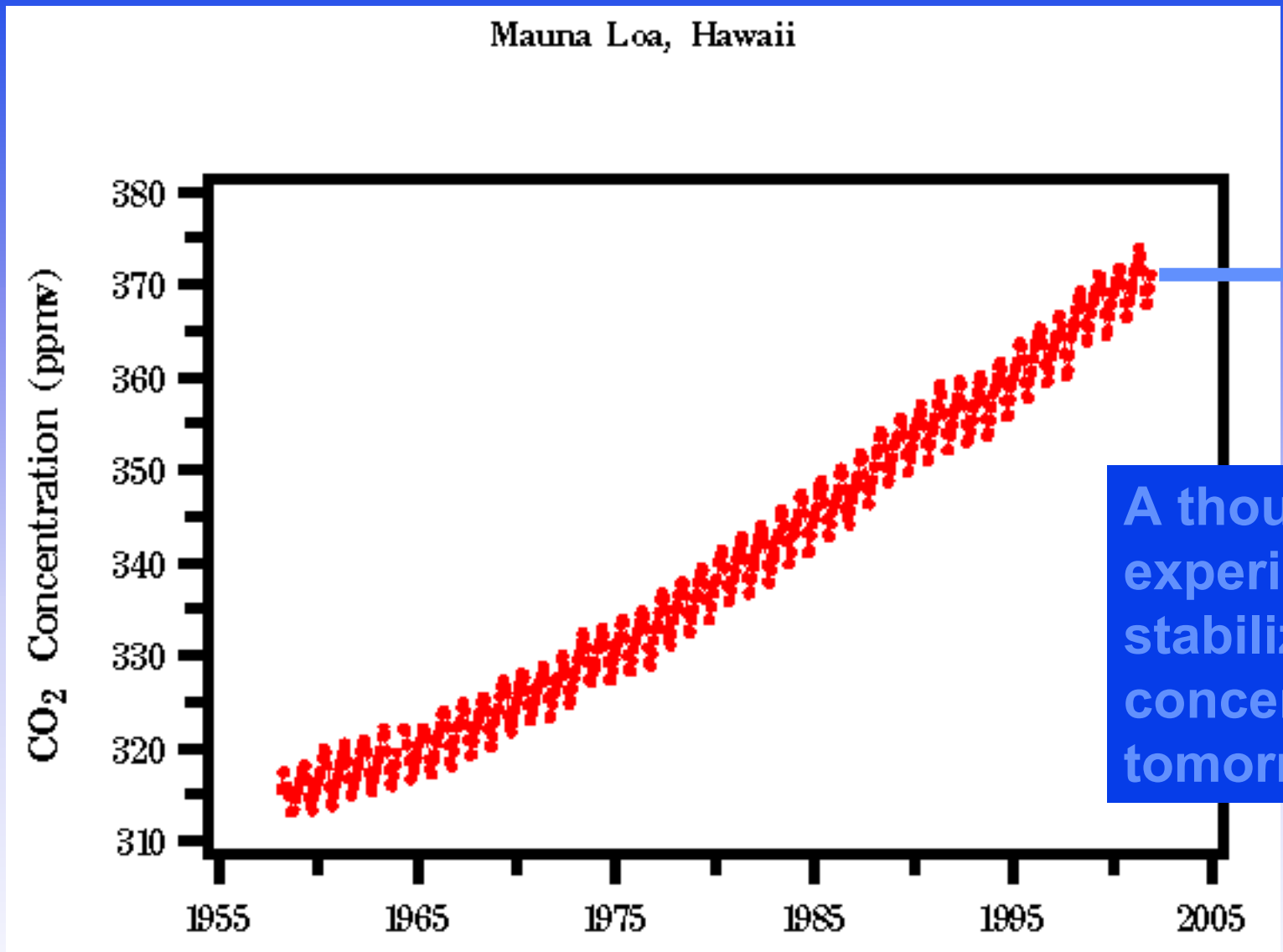


Stott et al, *Science*, 2000

The Future?

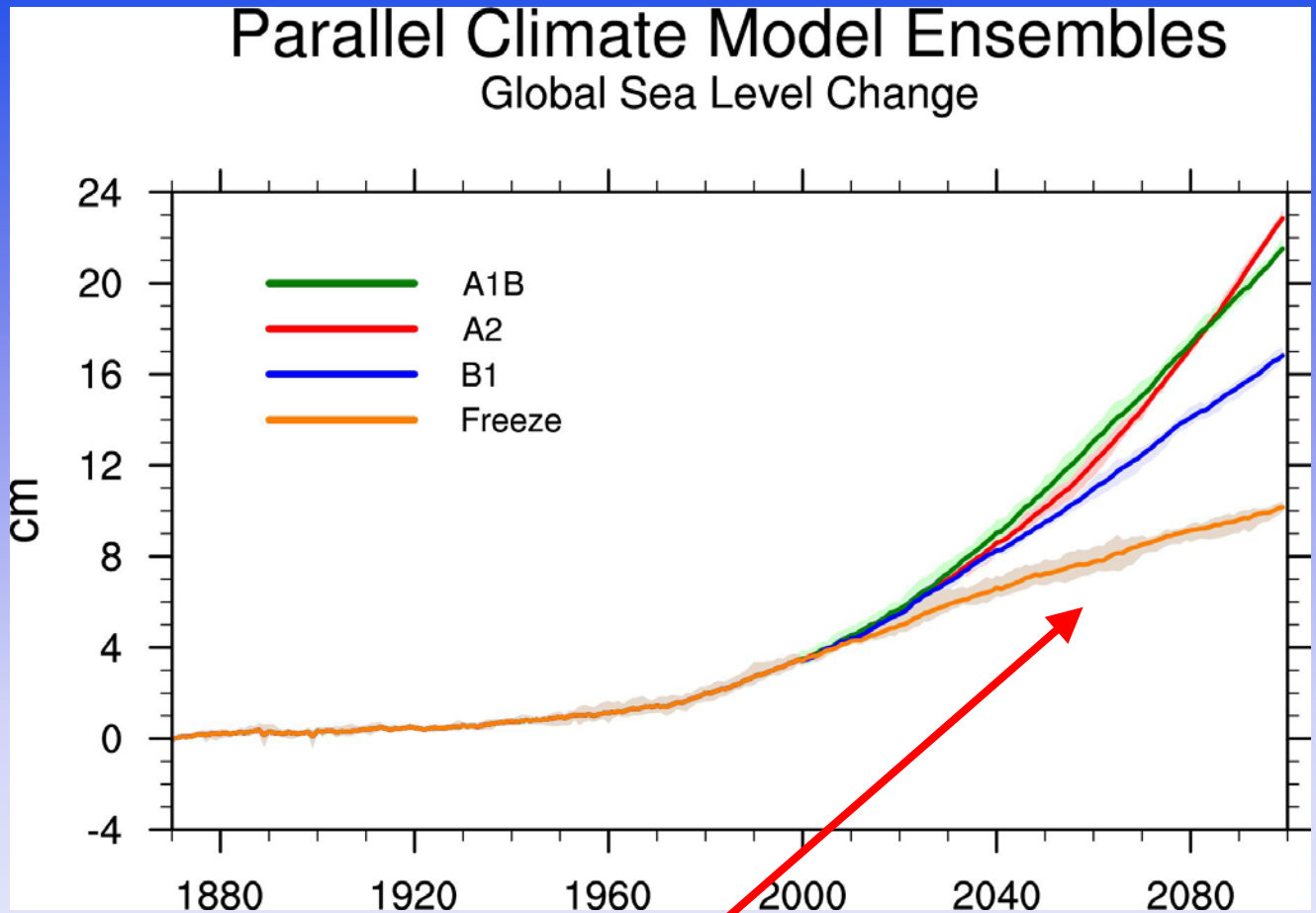


Mann et al (1999) and IPCC 2000



A thought experiment: stabilize all concentrations tomorrow

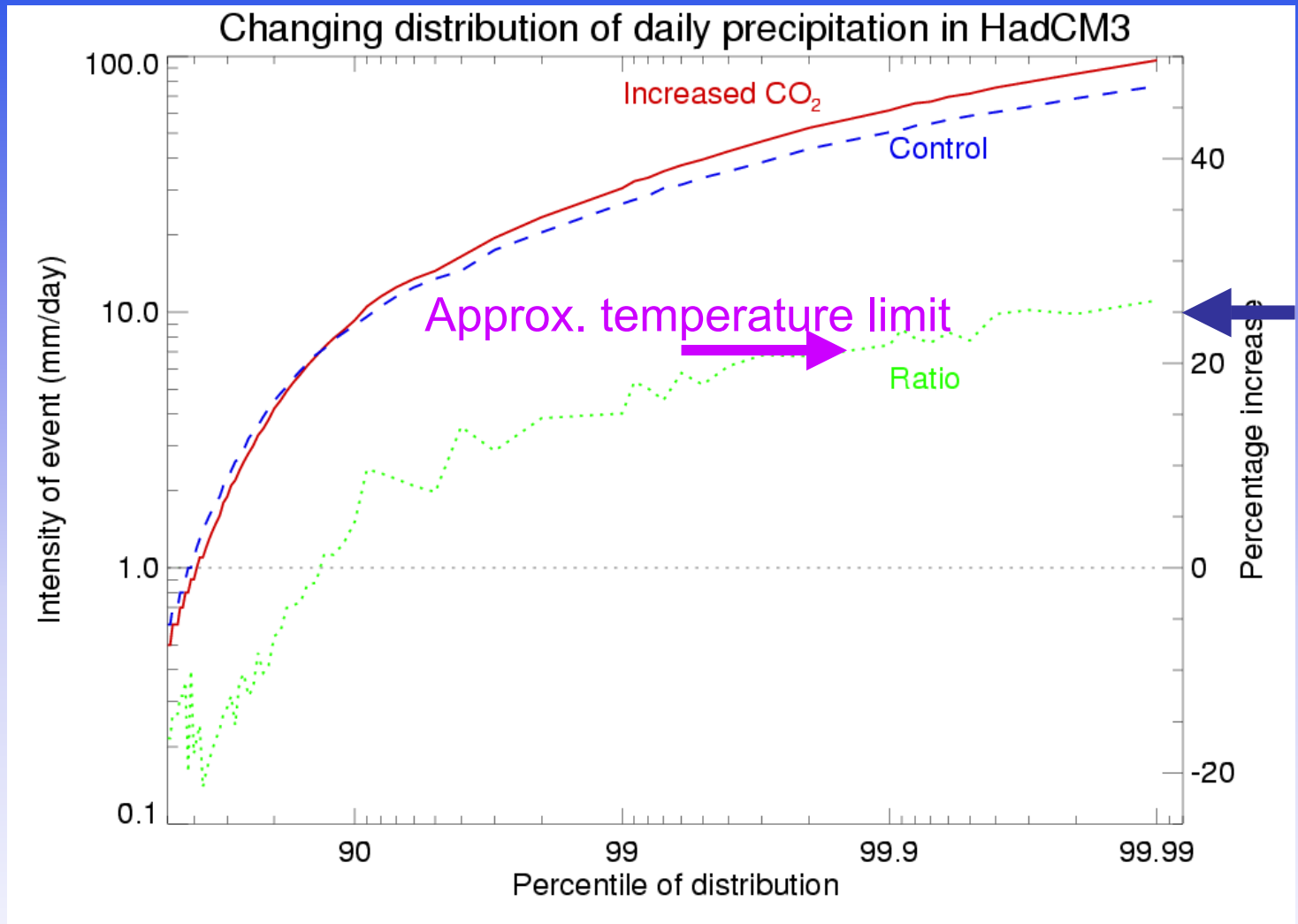
Courtesy: S. Solon



•There is <u>already</u> a substantial commitment to future sea level rise as well

••••Much of the future is physics-dependent, not very scenario dependent

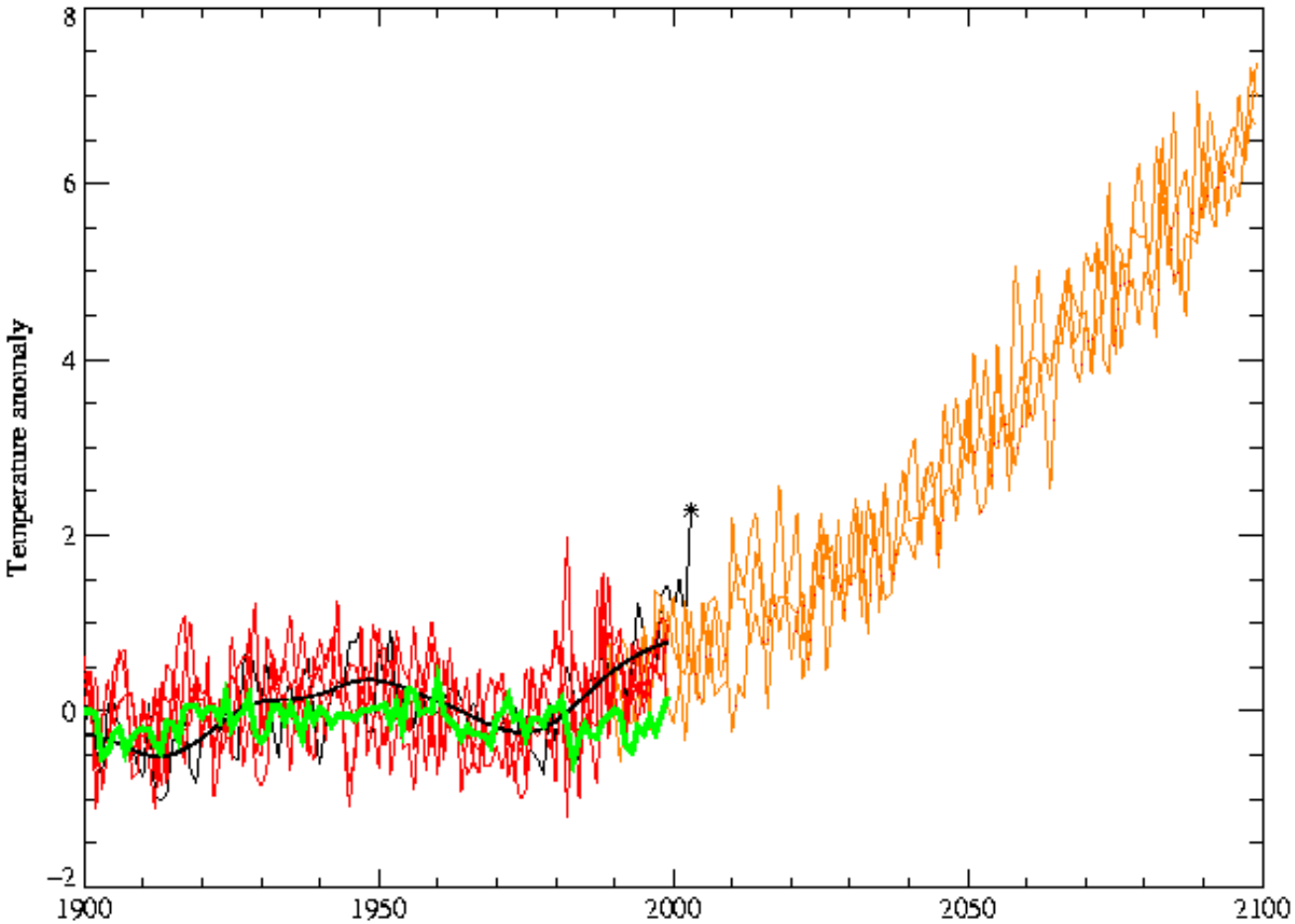
Relationship between temperature and magnitude of extreme precipitation events



GFDL hurricane model (Knutson et al, 2001

Allen and Ingram, *Nature*, 2002

A sobering thought: by mid-century, 2003 will be an average summer



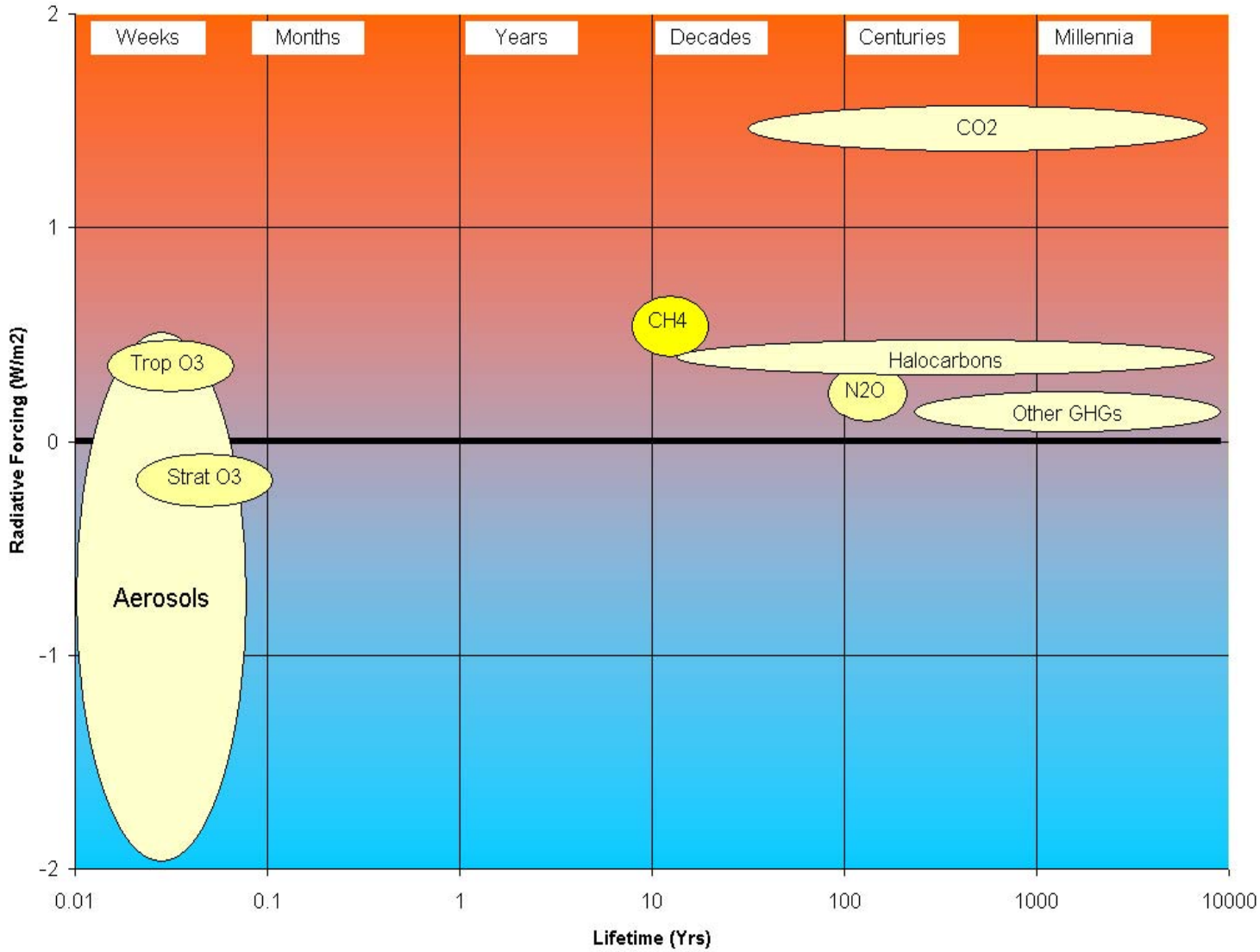
Observations
Model including anthropogenic and natural forcings
Model prediction under SRES A2 scenario
Model without anthropogenic forcings.

What are the magnitudes and time scales of the human forcings on this temperature record?

Many key warming agents live for decades or more

All known cooling agents are relatively short-lived

-> implications for short and long-term effects and options

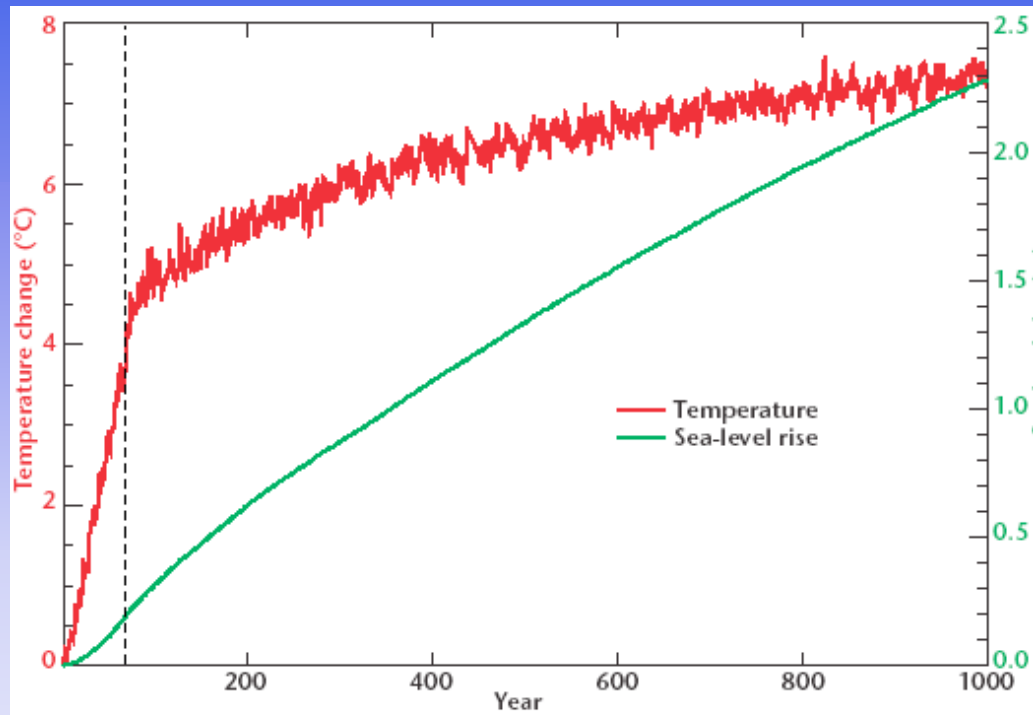


How about longer response time scales?

Hot water expands…which is the main cause of current global sea level rise.

Air temperature stabilizes in a few decades after stabilization of concentrations as the ocean's mixed layer warms.

Sea level will continue to rise for centuries as the deep sea slowly absorbs energy from a warmer atmosphere.



Simulated temperature change and the thermal-expansion component of sea-level rise for the four times pre-industrial CO_2 concentration ($4xCO_2$) experiment. Global temperatures stabilise quicker than sea level, which is still rising after 1,000 years. We estimate that it would take more than 2,500 years before the sea level reaches 90% of its final value. The dashed line shows the year when CO_2 concentrations were stabilised.

(Hadley center)

Impacts of Climate Change in Latin America

- Observational records show that Latin America, with a few variations, has been warming throughout the 20th Century, as the rest of the world.

- Impacts of natural climate variability, including extremes, are very common throughout Latin America and affect all sectors and systems.

- Vulnerability and risk of the population and economic sectors to climate variability and extreme events seem to be increasing in Latina America as population increases and land use patterns change.

Extreme weather and climate events commonly associated to significant impacts in Latin America I

- Heat waves affect agricultural production in some regions, but their impact is more significant on mortality of elderly population in many countries of the region.
- Cold fronts and snow storms cause many deaths and losses of animals in the higher elevations of the Andes.
- Torrential rains and resulting floods, including those associated to tropical cyclones, area among the main natural hazards in Latin America, resulting in tens of thousand of deaths and severe economic losses and social disruption.

Extreme weather and climate events commonly associated to significant impacts in Latin America II

- El Niño and La Niña are the main climate phenomena associated to droughts in many parts of Latin America, but there other large scale climate factors inducing dry spells and droughts. The cumulative effect of severe droughts affect tens of million of people and impact natural ecosystems and agro-systems.

- Receding glaciers in many Andean areas present a threat to the tourism industry and to water availability for settlements and agriculture dependent on snowmelt water.

Table 2. Projected changes in temperature and precipitation for broad sub-regions of Central and South America

Changes in temperature (°C)

Region	Season	2020	2050	2080
Central America	Dry	+0.4 to +1.1	+1.0 to +3.0	+1.0 to +5.0
	Wet	+0.5 to +1.7	+1.0 to +4.0	+1.3 to +6.6
Amazon Basin	Dry	+0.7 to +1.8	+1.0 to +4.0	+1.8 to +7.5
	Wet	+0.5 to +1.5	+1.0 to +4.0	+1.6 to +6.0
Southern South America	Winter (JJA)	+0.6 to +1.1	+1.0 to +2.9	+1.8 to +4.5
	Summer (DJF)	+0.8 to +1.2	+1.0 to +3.0	+1.8 to +4.5

Changes in precipitation (%)

Region	Season	2020	2050	2080
Central America	Dry	-7 to +7	-12 to +5	-20 to +8
	Wet	-10 to +4	-15 to +3	-30 to +5
Amazon Basin	Dry	-10 to +4	-20 to +10	-40 to +10
	Wet	-3 to +6	-5 to +10	-10 to +10
Southern South America	Winter (JJA)	-5 to +3	-12 to +10	-12 to +12
	Summer (DJF)	-3 to +5	-5 to +10	-10 to +10

Source: Based on Ruosteenoja et al. (2003)

Future scenarios of climate change for Central and South America based on global climate models for a range of greenhouse gases emissions scenarios

- A temperature range of warming from 0.4 C to 1.8 C in 2020, and from 1.0 C to 7.5 C. in 2080.
- The highest values of warming are projected to occur over Tropical South America.
- Higher degree of uncertainty for precipitation, with a tendency of drier climate for Central and Tropical South America in 2080.
- Uncertainly is even larger for southern South America precipitation changes for both winter and summer seasons.

Key expected impacts of climate change in Latin America:
Natural Ecosystems

Likelyhood of large impacts on natural ecosystems, increasing species extinctions in low-land and altitude tropical forests to catastrophic levels for some animal and plant species.

Key expected impacts of climate change in Latin America: Agriculture

Except for mid-latitude areas, where CO_2 fertilization effects balance out negative effects of climate change, agriculture yields are expected to decrease throughout Latin America at the end of the Century.

Key expected impacts of climate change in Latin America:
Water Resources

Notwithstanding the uncertainty of precipitation and runoff scenarios, semi-arid and arid regions of South America are expected to be the most affected by a decrease of water availability. Many glaciers will disappear before the end of the Century.

Key expected impacts of climate change in Latin America:

Sea Level Rise

Sea level rise is expected to affect most coastal zones in Latin America. It presents a serious threat to low-lying mangroves, it will increase salt intrusion in freshwater resources, and increase the frequency and intensities of storm surges, coupled to atmospheric circulation changes.

Key expected impacts of climate change in Latin America:
Human Health

Increased temperatures are likely to increase transmission rates of vector-borne diseases such as malaria and dengue fever, but drier future climate in parts of Amazonia and Central America could decrease malaria risk.

Mitigate emissions or adapt to Climate Change?

Approved GEF Projects related to Climate Change for the period 1991-2006 for Latina America countries (except Caribbean countries) stratified by type of project: enabling activity, national communication, mitigation (energy sector, and other sectors), and adaptation

- **Removing barriers to energy conservation and efficiency: 12**
- **Promoting adoption of renewable energy by removing barriers and reducing costs: 23**
- **Reducing Long-term costs of low greenhouse gas-emitting energy technologies: 06**
- **Promoting environmentally sustainable transport: 06**
- **Climate Change Enabling Activities: 38**
- **Climate Change short-term measures: 04**
- **Adaptation Plans: 03 (one regional, one global)**

Few studies and success stories about adaptation to climate change exist for Latin America. It is needed to understand what the socio-cultural, political, economic, environmental, technological and institutional constraints to adaptation are.

- In Latin America, funding for adaptation studies and projects comes predominantly, and in some cases almost exclusively, from international sources, in particular the Global Environmental Facility (GEF), the World Bank, and the International Development Bank.

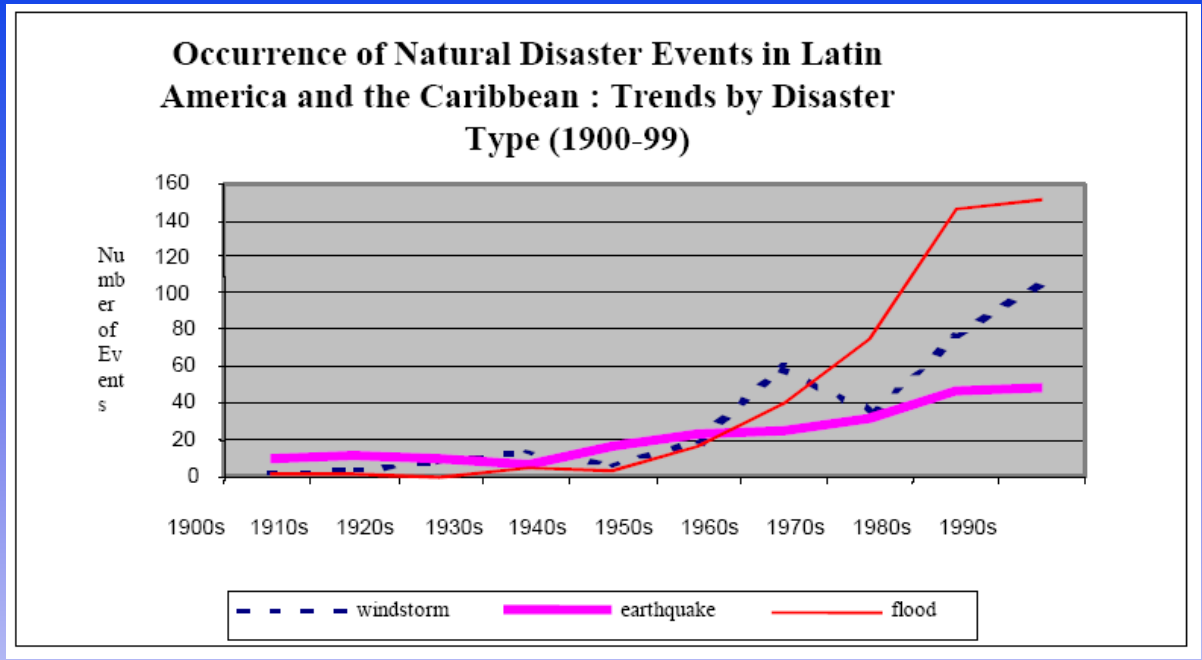
- As a relatively less developed region, Latin American countries have to balance concern about climate change and adaptation against competing social and environmental priorities. As a whole, Latin American countries consider poverty the basic social issue, and to many populations in the region, the most important environmental problem is the lack of basic sanitation in urban areas.

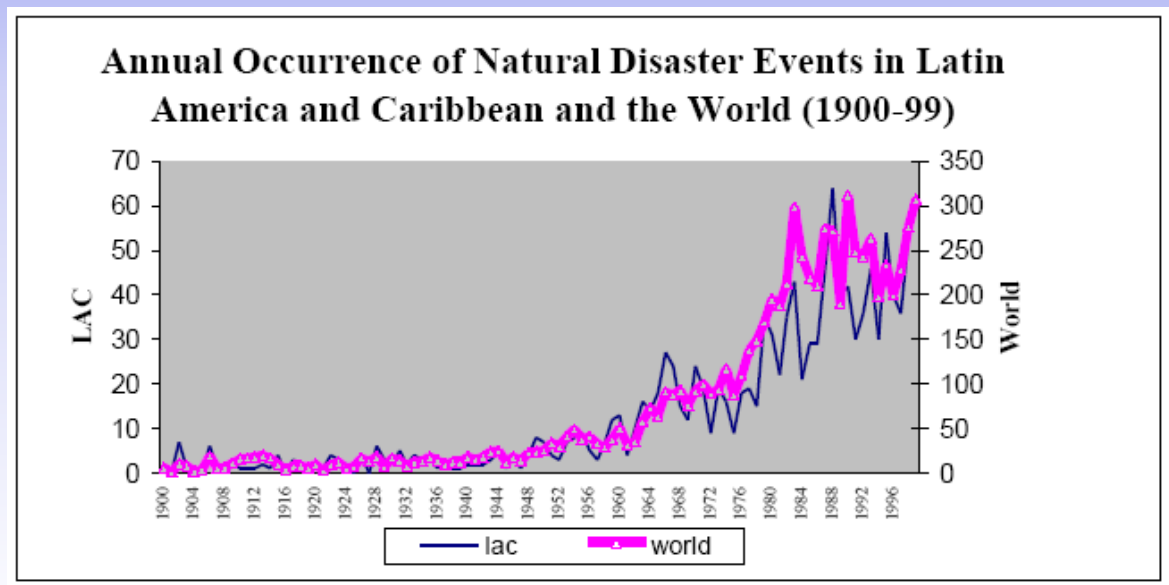
- The dynamics of the science-policy interface in less developed countries is different from those of developed countries because of resource disparities. That reduces the effectiveness of international efforts to assess and combat human-induced climate change.


Muchas Gracias!

Panel Discussion on Climate Methods and Tools: availability, applicability, accessability and training opportunies

A summary of recommendations of the Background Paper on “Impacts, Vulnerability and Adaptation to Climate Change in Latin America”





Charvériat, Céline. Natural disasters in Latin America and the Caribbean : an overview of risk.2000

Climate Data Availability in Latin America

- Climate data availability is severely limited in Latina America. The Global Climate Observing System (GCOS) receives, on average, only 119 surface stations and 23 altitude stations from all of Latin America. There is a significant gap in observational coverage and the problem is more acute for some regions, mainly the higher elevations along the Andes Cordillera.

- National Meteorological services Websites, in general, do not make available datasets to allow studies of detection and attribution of climate change. There are just a few countries in Latin America which have active climate change programs.

- It is extremely urgent to implement a plan for investments in meteorological information and to improve Latin American countries' capabilities and knowledge to undertake and maintain systematic, long-term, climate observational programs, along with the capacity to undertake analyzes of climatic information.

Capacity Development

There is a need for training and capacity building, as well as technology transfer from countries that have and are working on climate change modeling to others in the region.

Suggested Training Activities and Internet Resources

- **Training for installation and operation of meteorological networks**
- **Training on freeware visualization packages (GrADS/GEMPACK), statistical analyses of climate and/or regional climate change scenarios and developing analytical and useful products**
- **Training workshops** (model: CIMMS' (Cooperative Institute for Mesoscale Meteorological Studies)
- **Developing a multimedia CD ROM with topics about environment and climate change**
- **Internet use for simple and easy results on climate and/or statistical applications**

Internet resources for simple and user-friendly analyses and climate and/or statistical applications

- KNMI Climate Explorer (http://climexp.knmi.nl/) - This site allows external users to produce spatial averages of climate variables such as rainfall from global, gridded data sets, and relate these to global data sets such as SSTs and NCEP reanalysis;
- Climate Diagnostic Center (http://www.cdc.noaa.gov/ncep_reanalysis/) - Plots maps, cross-sections and time series based on the NCEP reanalysis dataset. There are options to plot anomalies and compare the data with the GFDL model results dataset and plot the GFDL dataset;
- Virtual Centre for Decadal Climate Variability (http://www.decvar.org/) *(Vikram Mehta - Univ. of Maryland)*. Provides access to long-term data sets integrated with analysis and visualization software, and allows community-wide planning of experiments and analyses;
- Interactive statistics pages (http://members.aol.com/johnp71/javastat.html) *(StatPages)*. Lists pages with programs for calculating confidence intervals, Bayesian methods, interactive tutorials, etc.;
- WebStat (http://www.stat.sc.edu/webstat/**)** On-line statistics, including multiple regression;
- Hyperstat Online *(David Lane).(http://davidmlane.com/hyperstat/)* Statistics "textbook";
- Regression explained *(Vijay Gupta) (http://www.spss.org/wwwroot/TIPS_ADVISE/regression_explained.doc)*. MS Word document explaining output of multiple regression;;
- Wavelets *(Torrence & Compo (http://paos.colorado.edu/research/wavelets/);*
- A complete interactive course in introductory statistics from Massey University (*Douglas Stirling*);
- Climate Change Outreach to Youth (http://edugreen.teri.res.in/) -
- Resources: PCs or laptops with good internet connection.

Climate Modeling Capabilities in Latin America

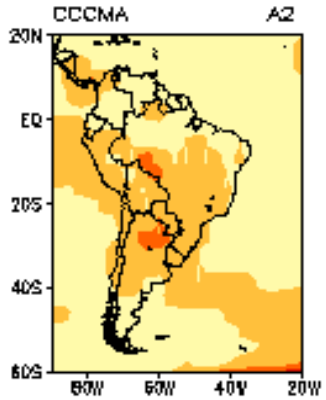
- The development of climate modeling capability for climate change studies confronts a knowledge gap in Latin America, and is particularly important with regard to detailed regional climate scenarios in developing areas of the world.

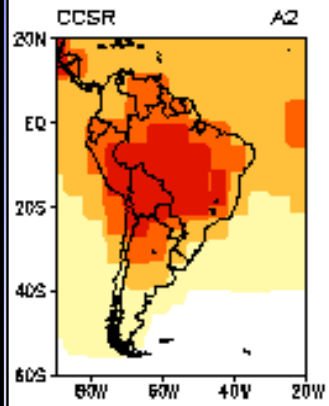
- The availability of future climate change scenarios from both global and regional models provides crucial information for the definition of policies for adaptation to climate change, especially coming from regional or statistical models.

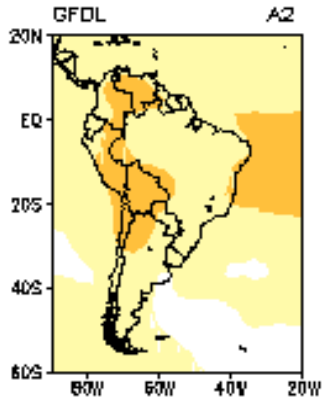
- In Latin America, some groups have developed the capacity to use dynamic and statistical downscaling techniques using Global Climate Model-generated climate scenarios over a region.

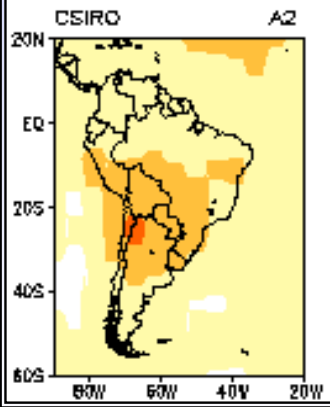
Temperature Anomalies (°C) for 2091-2100

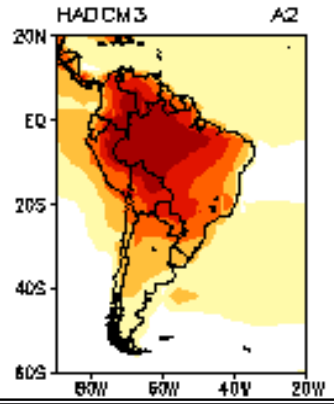
A2 High GHG Emissions Scenario



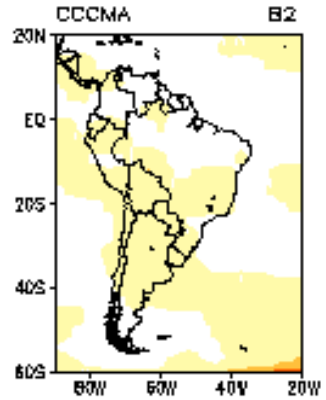


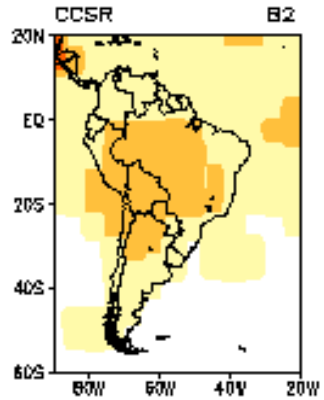


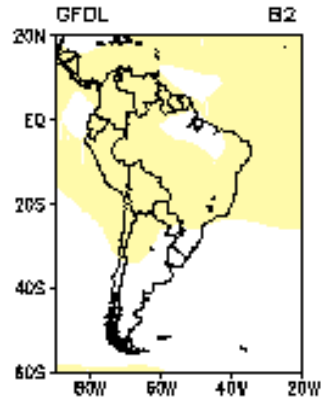


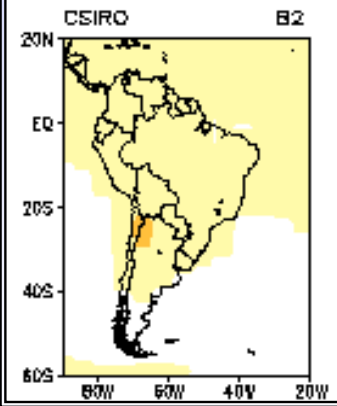


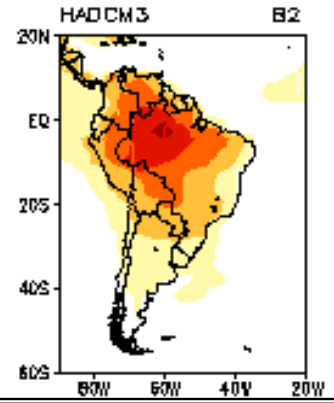
B2 Low GHG Emissions Scenario







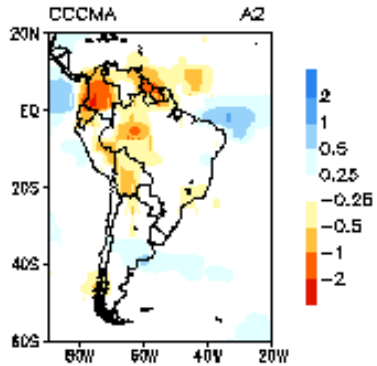


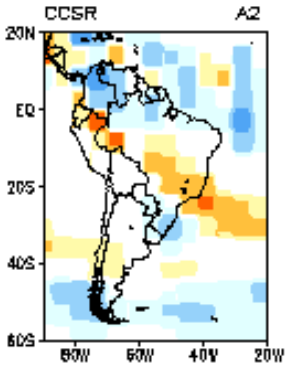


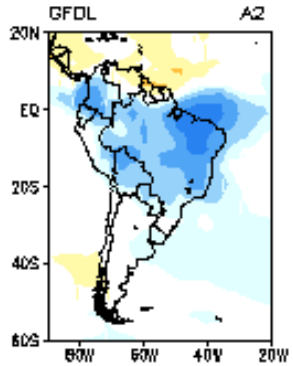
Nobre et al., 20

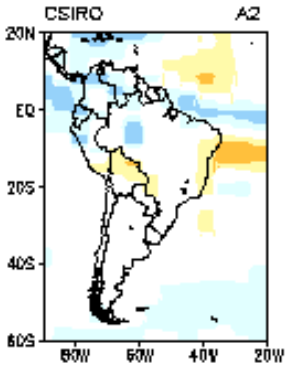
Precipitation Anomalies (mm.day^{-1}) for 2091-2100

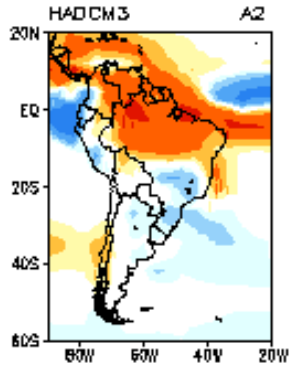
A2 High GHG Emissions Scenario











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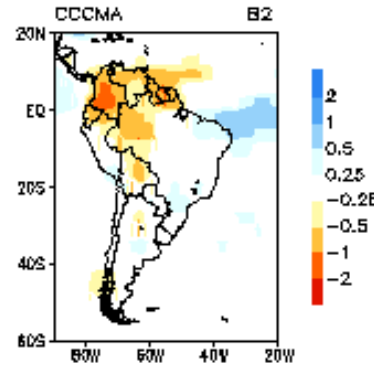
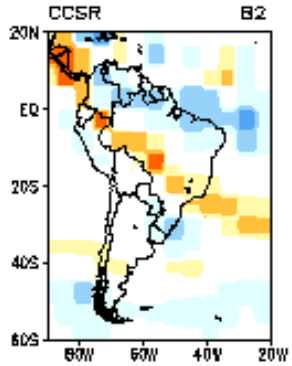
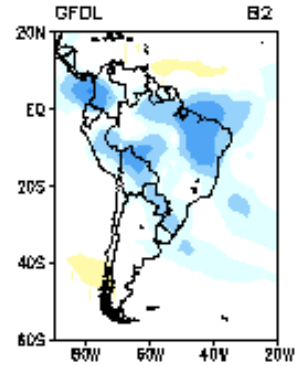
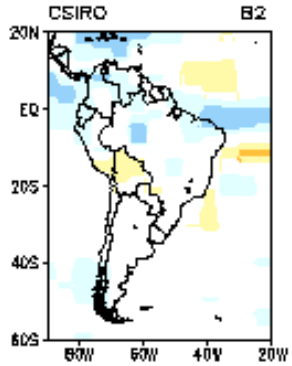
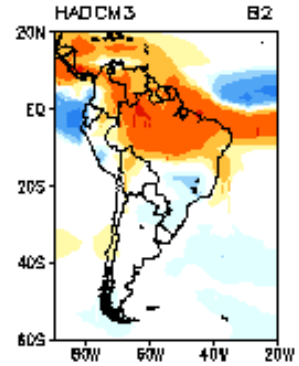






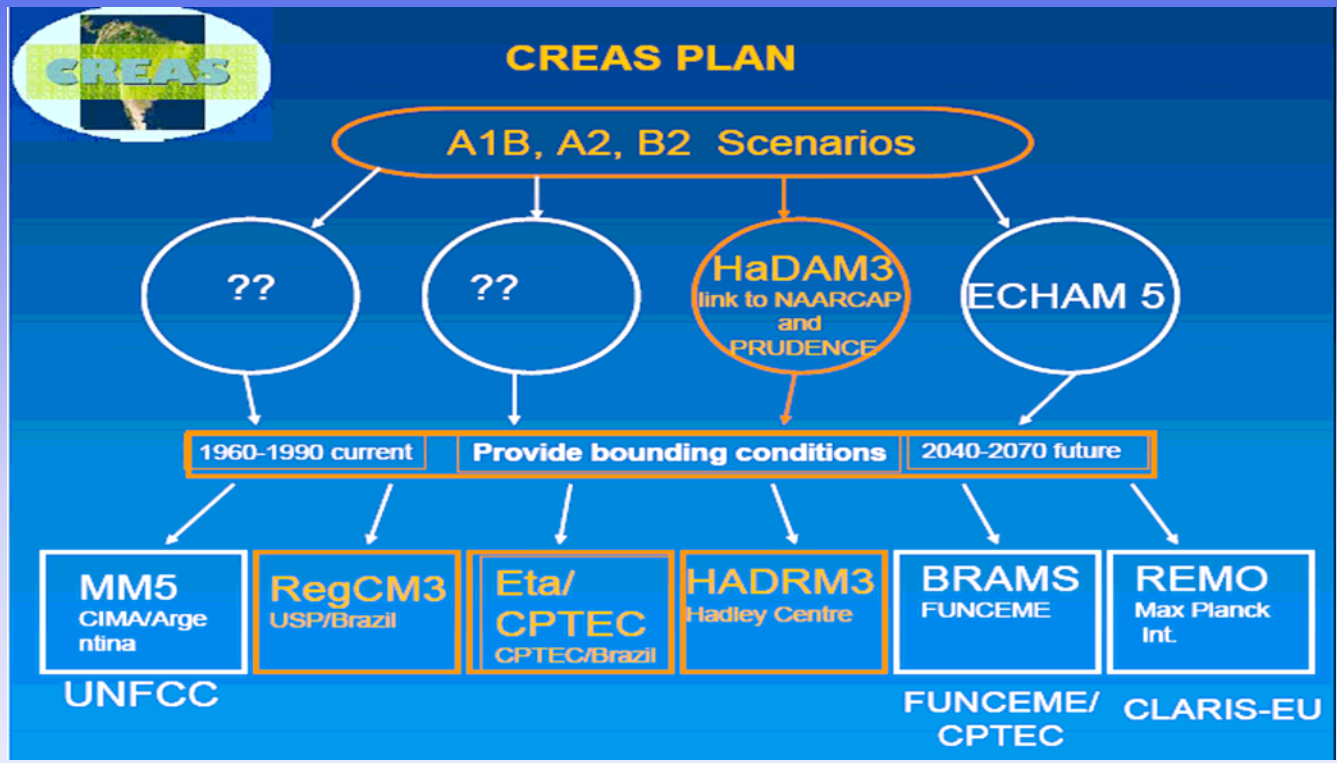




Nobre et al., 2

Dynamic Dowscaling of GCM in Argentina and Brazil

Regional Climate Change Scenarios for South America (CREAS)



Similar efforts in Chile, Colombia, Costa Rica, Mexico, Perú, etc.

Suggested Training Opportunities and Internet Resources

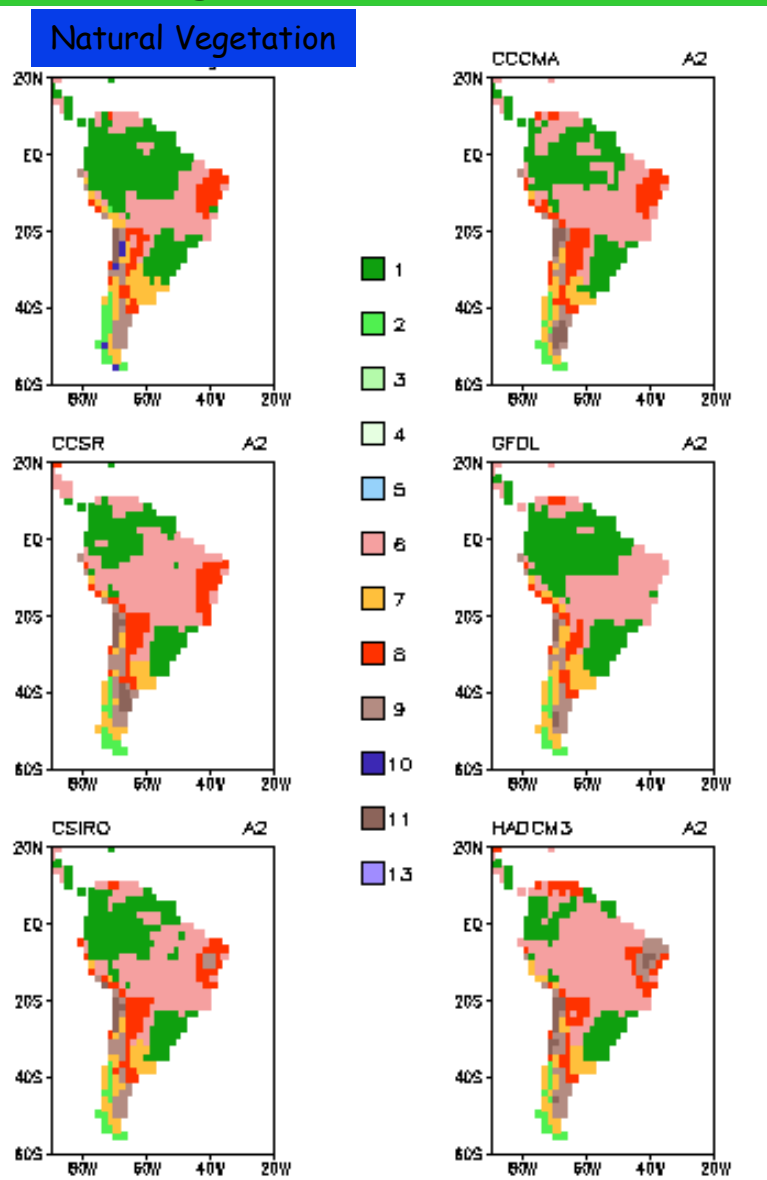
- **Training activities in the use of regional climate model output for future climate in studies of impacts and assessments: From PRECIS to new training initiatives**
- **A proposal for training activities and capacity development on climate change modeling and downscaling in Latin America ("Downscaling of Climate Change Scenarios Working Package")**
- **Internet resources for access to model climate projections**

Internet resources for access to model climate projections

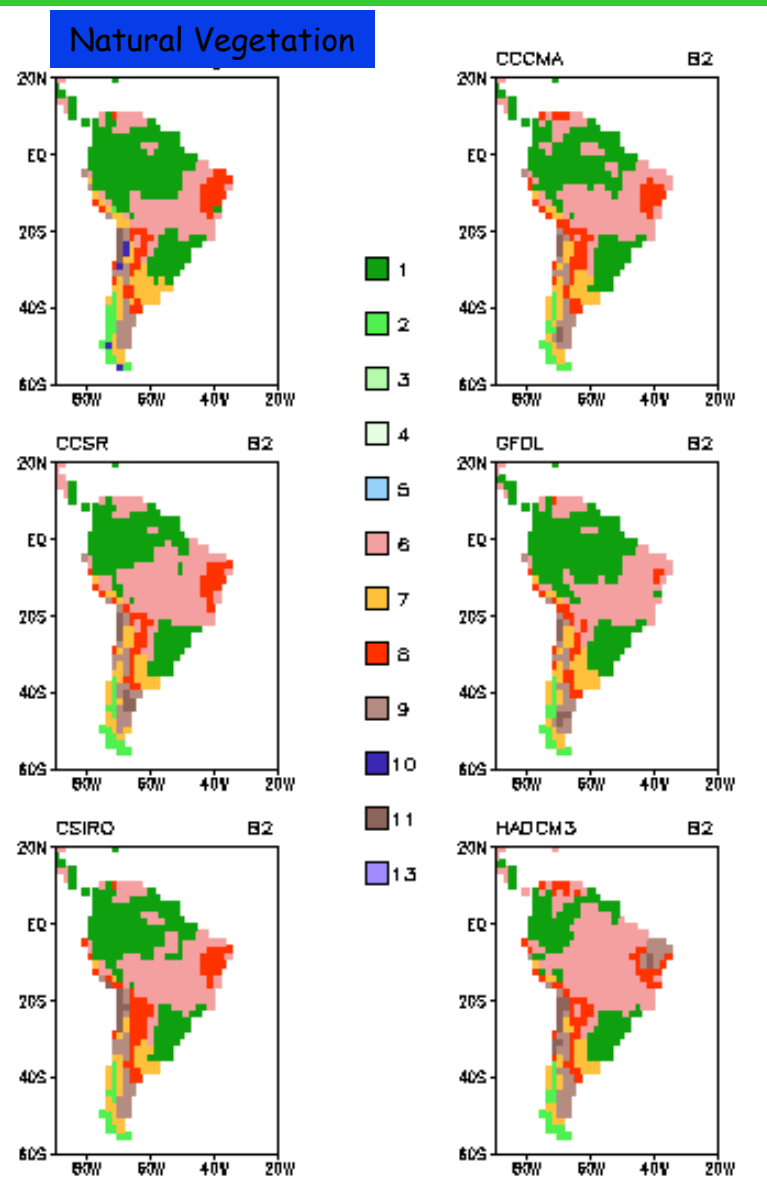
- -IPCC DDC for TAR models (in the UK, with links to the Max Planck Institute for Meteorology and the Columbia University Socio Economic data): http://ipcc-ddc.cru.uea.ac.uk.
- -PCMDI access to IPCC AR4 data (there is a need for registration and data can be downloaded for free): http://www-pcmdi.llnl.gov/ipcc/about_ipcc.php
- -PRUDENCE web site (regional projections Europe): http://prudence.dmi.dk/
- -NAARCAP web site (regional projections for North America): http://www.narccap.ucar.edu/index.html.
- -CREAS web site (regional projections for South America), available in July 2006: www.cptec.inpe.br/mudancadeclima/CREAS
- -AIACC web site (for projects on climate change in Latin America): http://sedac.ciesin.columbia.edu/aiacc/.
- -UNFCCC web site (for access to the National Communications): www.unfccc.int

Projected Biome Distributions for South America for 2091-2100

A2 High GHG Emissions Scenario



B2 Low GHG Emissions Scenario



Nobre et al., 20