Capacity Building: Data Needs

Statement on Data Accessibility and Information Needs with Respect to Climate Impacts, Adaptation, and Vulnerability[1]

Preface

An important objective of the Intergovernmental Panel on Climate Change (IPCC) Task Group on Data and Scenario Support for Impact and Climate Analysis (TGICA) is to contribute to building capacity in the use of data and scenarios for climate-related research in developing and transition-economy regions and countries. To achieve this objective, it is essential for the TGICA to identify user needs for data and information as they evolve, and to work with other relevant stakeholders to address high priority needs in a coordinated manner. With this in mind, the TGICA has developed this statement on data accessibility and information needs, focusing in particular on climate impacts, adaptation, and vulnerability (IAV) and on the development of capacity in developing and transition-economy regions. This statement is based in part on the results of three workshops held in 2011 and 2012, which brought together a range of users and stakeholders to discuss climate-related data gaps and needs,[2] as well as inputs from TGICA members and the IPCC Working Groups and the IPCC Secretariat.

Importance of Addressing Data Needs for Climate Impacts, Adaptation, and Vulnerability

The scientific community involved in the IPCC assessments and more generally in research on climate change has benefited greatly from the growing availability of data from multiple sources and platforms on a wide range of climate and environmental parameters relevant to climate monitoring, modeling, and prediction. With increased recognition of the urgent need to better understand climate impacts on society and environment, the ability of particular groups, systems, or regions to adapt, and key areas or modes of vulnerability, it is clear that improved IAV data—and better access to such data by the research community—could facilitate new research and improve future assessments. Moreover, it is likely that such data would also be of high interest and utility to a wide range of stakeholders, including local, national, and international decision makers and applied users involved in ameliorating impacts, improving adaptation processes, and reducing vulnerabilities. High quality, consistent, and comparable data on how past and present climate impacts have evolved, on both successful and unsuccessful adaptation strategies, on different types and modalities of vulnerability, and on associated policies and response strategies would be a valuable resource not only for research and assessment, but also for future adaptation planning and decision making.

The scientific and applied user communities in developing and transition-economy regions face particular challenges with regard to IAV data access, as they do in many areas of science. In many instances, mechanisms for collecting, managing, and sharing social science and environmental data are less developed, and the capacity to integrate and analyze these data in conjunction with climate,

[1] Initial draft prepared by R. Chen and A. de Sherbinin, CIESIN, and F. Zermoglio, the World Bank; modified at TGICA-18, St. Petersburg, Russia, 17-20 September 2012; and reviewed and approved at the 2 September 2014 TGICA telecon.

[2] "GEOSS support for IPCC assessments: A workshop on the data needs of the climate impacts, adaptation and vulnerability research community," Geneva, 1-4 February 2011; GEOSS in the Americas Symposium, Santiago, 4-6 October 2011; and "User Workshop on Data Gaps for Research and Action on Climate Change Vulnerability, Impacts and Adaptation," Tuscon, 1 June 2012. See Appendices for participation and other details.

ecological, or other environmental data and models is limited. Fewer institutions exist with the resources to provide data access and user support, or the infrastructure for long-term data preservation and dissemination. Nevertheless, as national institutions and other organizations invest in systems such as the Global Earth Observing System of Systems (GEOSS) and in new international scientific programs such as Future Earth, opportunities may emerge to address key IAV data needs in conjunction with other data needs. It is also incumbent on scientists and scientific institutions in developed countries to take on leadership roles in building capacity and developing linkages and networks in developing countries (ICSU Committee on Freedom and Responsibility in the conduct of Science, 2012).

Summary and Recommendations

Build links to key regional and international initiatives to address priority needs

Although the three workshops summarized in the annex are by no means comprehensive assessments of data needs related to IAV research and decision making, they do suggest that there are a wide variety of needs that, if not addressed, could pose important obstacles to IAV research. These needs likely differ by topic or societal benefit area and by region. Nevertheless, there may be opportunities **to develop consensus around some key data priorities that could have a substantial impact on capacity for both research and decision making.**

There may also be opportunities **to build links with key regional and international initiatives that could help address high priority needs.** For example, the ICSU Integrated Research on Disaster Risk (IRDR) program has initiated a working group on disaster loss data that is working to improve historical hazards and impacts data in ways that should address the need identified by the Hazards breakout group in the May 2012 workshop. PROVIA has identified a priority activity on improving the robustness of IAV assessments through revised technical guidance on tools and research methodologies. Terra Populus, a project led by the University of Minnesota with support from the U.S. National Science Foundation, is developing a unique research resource aimed at integrating microdata from population censuses and surveys with climate, land cover, and other data. A new Joint IAV-IAM Committee on Development and Use of Socioeconomic Scenarios (now known as the International Committee on New Integrated Climate Change Assessment Scenarios, ICONICS) was formed in late 2011 with the objectives to complete fast-track Shared Socioeconomic Pathways (SSPs) including narratives and quantification from models and other sources in time for use in AR5; and to coordinate infrastructure for a long term IAV-IAM agenda for development and application of integrated scenarios beyond the AR5. The TGICA could also link with and/or help users with the growing number of climate data and information portals (see Appendix D for an initial, illustrative list).

Provide Guidance and Coordination

There is a clear opportunity for the TGICA to provide **guidance** on *1)* the use and application of climate model data in impacts assessments; and *2)* on downscaling approaches and the limits to information available in these.

The TGICA is well positioned to **provide leadership and coordination** on these issues and to follow up on specific data needs. For example, building on previous interactions with the Global Climate Observing System (GCOS), the Global Terrestrial Observing System (GTOS), and GEO, the TGICA could promote new initiatives such as the development of a suite of “Essential Human Variables” needed for IAV research. The TGICA could try to **further identify data needs and priorities at the regional scale, e.g., through a possible regional expert meeting on capacity building**. The TGICA could also try **to suggest approaches**

to dealing with specific data problems or gaps in its development of guidelines, and to add resources to the IPCC Data Distribution Center (DDC) that more specifically address IAV data needs, e.g., for finer resolution scenario data.

Appendices

Appendix A: IAV Data Needs: Provider Perspectives

The 2011 workshop, "GEOSS support for IPCC assessments: A workshop on the data needs of the climate impacts, adaptation and vulnerability research community," brought together more than 40 experts (Appendix A) associated with the IPCC and the Group on Earth Observations (GEO).[3] The workshop largely reflected the viewpoints of the scientists and organizations directly involved in developing and disseminating climate-related data, including IAV data, with particular attention to three main application areas, water resources, land cover and land use, and extreme events and disasters. The workshop report includes 18 recommendations on how the IPCC and GEO communities could collaborate to address data needs of mutual interest.

Six of the recommendations identify specific research needs related to IAV and are summarized here:

Recommendation 7: Provide technical advice to GCOS on how to improve the value of the Essential Climate Variables (ECVs). As part of this recommendation, a specific proposal was made to develop Essential Human Variables:

> "Consider the implementation of Human, Environmental and other kinds of Essential Variables. While Essential Climate Variables are perfectly designed to address observations on the time and spatial scales of climate change, human- and environment-related changes may need to be assessed at different scales. Because impacts, adaptation and vulnerability tend to require local and regional scale assessment, Essential Human Variables (EHVs) and Essential Environmental Variables (EEVs) should be designed at these scales. A set of well defined EHVs would also allow the definition of land cover and land use to include "land management".

Recommendation 10: Develop data infrastructures and promote networking for sharing data, information and knowledge on water resources and climate impacts. The recommendation notes:

> "Progress in research depends on improving data availability, enhancing monitoring endeavours worldwide, addressing the challenges posed by projected climate change to freshwater resources, and reversing the shrinkage of observation networks. Broadening access to available observation data is a prerequisite to improving understanding of the ongoing changes. Relatively short hydrometric records can underplay the full extent of natural variability and confound detection studies, while long-term river flow reconstruction can place recent trends and extremes in a broader context. Data on water use, water quality, and sediment transport are even less readily available."

Recommendation 11: Differentiate human and climate impacts on water resources by developing baselines and indicators. This recommendation suggests a strategy for developing and analyzing "data

[3] GEO is a voluntary intergovernmental initiative involving some 92 countries and the European Commission and more than 75 Participating Organizations that are collectively developing GEOSS.

from pristine basins that have experienced minimum human impact in order to develop a baseline and indicators for climate change impacts."

Recommendation 12: Conduct a formal intercomparison and accuracy assessment of the half dozen or so most prominent land-cover datasets and revisit optimum land-cover classification logic. The report notes:

> "In global-scale analysis, disturbance measures are detected by land-cover change using various algorithms and satellite or ground-based inputs. Disturbance generates huge pulses of policy-relevant carbon fluxes and is a core component of REDD+ (Reducing Emissions from Deforestation and forest Degradation – Plus) analysis. Other data sources, such as census data and forestry statistics, can further support assessments of changes in land cover and land use."

Recommendation 14: Strengthen efforts to generate higher resolution and more frequent datasets for urban areas, transitional zones (ecotones) and other complex or rapidly changing areas. The report explains:

> "Urban areas, in particular, with their dense populations, diverse and rapidly changing land uses, and high vulnerability to climate impacts, need to be mapped at higher resolution. However, developing accurate and up-to-date land-cover, land-use and land-use change maps for urban centers, particularly those undergoing rapid expansion, can pose major challenges. Maintaining up-to-date land-use and land-cover information is both costly and time-consuming using traditional field and aerial photography methods; remote sensing technology, however, can increasingly provide an efficient and less-expensive way for mapping cities. Other areas of the globe, such as coastal areas with their complex natural and socioeconomic processes, protected areas with their high level of vulnerability to human action and climate impacts, and degraded areas that may be difficult to interpret at low resolution, may also benefit from higher resolution or more frequent coverage."

Recommendation 16: Strengthen support for human dimensions data. This recommendation focuses on what the GEO community can do to improve access and integration of data central to IAV needs:

> "Given the end-to-end nature of climate issues, from economic and social drivers of climate change to diverse impacts on environmental and human systems, GEO should take the lead in providing integrated access to, and support of, data and information on the human dimensions of climate change through GEOSS. In particular, the GEO community should work to fill in gaps in data on human vulnerability, adaptation, and the socioeconomic aspects of climate change drivers and impacts. For example, data on issues such as water demand, urbanization, agriculture, transportation networks, disaster impacts and vulnerability, protected and degraded areas, and coastal zones are hard to access and integrate. Such improved human dimensions data are essential for all societal benefit areas."

Although these 6 workshop recommendations are not specifically focused on data needs in the developing and transition-economy regions, it is clear they identify needs that are common to scientists and organizations around the world.

Participants in "GEOSS support for IPCC assessments: A workshop on the data needs of the climate impacts, adaptation and vulnerability research community," Geneva, Switzerland, 1-4 February 2011.

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Appendix B: IAV Data Needs: User Perspectives

The GEOSS in the Americas Symposium, held in Santiago, Chile on 4-6 October 2011, explored the role of GEOSS in helping to better understand and address the key data issues of importance to most countries in the Americas region. The Symposium was attended by more than 100 technical experts, researchers, and decision makers from throughout the region (Appendix B) and addressed data needs in various sectors, notably water management, ecosystems and agriculture, coastal management, and urban development.

Several targeted observations emerged on data and interpretation needs of relevance to the IVA community. These include:

- There is a need to provide climate information processed according to variables of relevance to key sectors (climate indices), rather than focusing on the existing suite of variables from the climate science community. Climate indices can help to connect users, and increase the application of climate information for non-specialists. Geo-referenced information (maps) can be especially relevant.
- Tools should be provided to support users to calculate specific indices themselves to allow greater flexibility.
- Guidance on understanding and interpretation of uncertainties, especially with downscaled data, is needed, and would be particularly useful if it were developed in concert with the modeling and impact researchers.
- Issues of accessibility, including data formats and more user-friendly interfaces, hamper data use and sharing among research groups. In many countries, access to climate model data is limited by financial, institutional, and connectivity reasons.

In June 2012, a User Workshop on Data Gaps for Research and Action on Climate Change Vulnerability, Impacts and Adaptation was held in Tuscon, Arizona, immediately after the Adaptation Futures conference hosted by the University of Arizona. Organized by the NASA Socioeconomic Data and Applications Center (SEDAC) with co-sponsorship by the UNEP Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) and the International Human Dimensions Programme on Global Environmental Change (UNU-IHDP), the workshop drew more than 60 participants from universities, research centers, and governmental and nongovernmental organizations from around the world, including more than 20 from developing countries (see Appendix C). Four breakout groups addressed data needs related to: 1) Vulnerable groups; 2) Urban area and critical infrastructure; 3) Natural resource management; and 4) Hazards.

The breakout groups were each given a set of common questions to address, including:

- What are the top research priorities regarding climate VIA?
- What are the top decision-making needs regarding climate VIA?
- What are the primary obstacles to obtaining the relevant data to meet these needs?
- Placing data needs in a two-dimensional space, with need on the X-axis and difficulty on the Y-axis:
  - what are the "low hanging fruit" that are high-priority, low difficulty?
  - what strategies would be most promising for getting the "choice plums" - high-priority, high-difficulty?

The Vulnerable Groups breakout noted the difficulty of combining physical and social indicators, and of assessing causality in complex human-environment interactions. Development of consistent definitions of key factors across borders and over time, e.g., for educational levels, is needed. It is clear that the decision-making community could use process-based decision support tools that could work at multiple scales. High priority data that should be relatively easy to obtain are spatial poverty data, health data from existing surveys, and more detailed climate scenario data that indicates levels of certainty and agreement and trends in extremes. More difficult but important to obtain are data describing livelihoods by urban/rural class.

The Urban/Infrastructure breakout group identified research on the impact of climate change on households at the community and local level and on health and infrastructure as high priorities. Protocols and standards for data collection are needed. Obstacles include the high cost of high resolution remote sensing data and the lack of high resolution health data due to privacy restrictions and limited collection of location information. High priority data that should be relatively easy to obtain are high resolution remote sensing data useful for ecosystem-based adaptation and socioeconomic data at the neighborhood scale. More difficult to access is health data on neighborhood or finer scales, e.g., depersonalized data from surveys, health care providers and insurers.

The Natural Resource Management breakout group identified the need to link and reconcile data across a range of spatial scales and resolutions, so that local adaptation can be assessed in a broader context. This also leads to the need to better define the most appropriate spatial units for integrating social and ecological dynamics. Another need is for research protocols to harmonize local knowledge and to integrate local knowledge with quantitative scientific data. Key problems are spatial and temporal inconsistencies in time series (e.g., boundaries that do not match or that change), data gaps, access to fine scale data, missing metadata, the cost of meteorological and climate data, and the limited availability of data on land tenure and crop and livestock production. In many cases, historical meteorological and climate data in developing countries are hard to access, expensive to obtain, and/or are of uncertain quality, making it especially difficult for developing country scientists to establish baselines and assess impacts.

The Hazards breakout group identified research priorities related to the interrelated issues of coastal flooding, storm surge, and sea level rise; understanding the impact of spatial scale in identifying vulnerable areas; combining socioeconomic data and local knowledge and culture in IAV research; linking of ecological data on vegetation with water use and availability, and downscaling methods. Data needs that may be relatively easy to meet are improved remote sensing data on land cover and land use, historical hazard and impacts data, and better erosion and soils data. More difficult to address is integration of socioeconomic, cultural, and spatial data and knowledge, as well as obtaining more detailed topographic data from LIDAR in key areas, especially in the least developed countries.

Key messages from the general workshop discussions include:

- Data needs at local/national levels depend a lot on local priorities. However, there are some needs that are consistent globally, such as remote sensing-derived land use/land cover and ecosystem data, high resolution elevation data, and livelihood data.
- Some proprietary data such as from reinsurance companies would be valuable for research.
- Some planning will be needed to build consensus on the highest priority data sets needed by the IVA community (similar to earlier initiatives to develop global land cover data sets).
- An overall cyberinfrastructure is needed for sharing data and results of micro-level studies (analogous to online databases of rock samples developed by geochemists).

Participants in the "GEOSS in the Americas Symposium," Santiago, Chile, 4-6 October 2012.

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Appendix C: Participants in the "User Workshop on Data Gaps for Research and Action on Climate Change Vulnerability, Impacts and Adaptation," Tuscon, Arizona, USA, 1 June 2012.

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Avantika SINGH	University of Delhi		India
Keshav Prasad PAUDEL	University of Bergen		Norway
Nancy SELOVER	Arizona State University		USA
Pantaleo MUNISHI	Sokoine University of Agriculture		Tanzania
Halima KILUNGU	Open University of Tanzania	Wageninegni University	Tanzania/ Netherlands
Catherine SIMONET	CERDI		France
Asad SHABBIR	University of the Punjab, Lahore	University of Queensland Australia.	Pakistan
Ian SHIACH	Office of Arid Land Studies	University of Arizona	USA
Samantha JONES	Ohio University		USA
Srinivasan ANCHA	Asian Development Bank		Philippines
Shiv SOMESHWAR	Earth Institute	Columbia University	USA
Adeyinka Adewuyi AYODELE	University of Southern Queensland		Australia

Appendix D: Illustrative List of Climate Information Portals and Available Information on These.

SOURCE	Users	Data Source[i]	Process[ii]	Time Period	Spatial Scale	Temporal Scale	Anom-alies[iii]	Variables	Statistics	Output Format	Ease of Use	Owner Institution and Access
Historical Data												
CRU	+++	Obs	INT	1901-present	0.5° x 0.5° [iv]Temp & 2.5° x 3.75° Prec	Monthly averages	N/A	AvgT, AvgPl	N/A	ASCII & NetCDF	Specialist	University of East Anglia http://www.cru.uea.ac.uk/data/
NCEP	+	Obs * EOS	CALC	1948-present-	2.5° x 2.5° (~500km)	6-hourly, Daily, Monthly, 20 year Average	N/A	AvgP, AvgT, Tmin, Tmax	Many[v]	NetCDF and GRIB	Specialist	National Center for Atmospheric Research http://www.cpc.ncep.noaa.gov/products/wesley/reanalysis.html
World Clim	++	CRU	DS	1950-2000	30 arcs (~1km) (30sec, 2.5min, 5 min, 10min	Monthly	N/A	AvgP, AvgT, Tmin, Tmax	Yes[vi]	ASCII, Grid	Easy	http://www.worldclim.org/
GCMs												
IPCC AR4 climate model outputs	+	GCM 23, CRU	Native GCM output	1961-2100	Varying - native GCM scale	Monthly means, 20 & 30 year means	Yes	MaxT, MinT, AvgT, AvgP	Multi-model ensemble means	GRIB, NetCDF, GeoTIFF,	Moderate	IPCC Data Distribution Center http://www.ipcc-data.org/ar4/gcm_data.html
African Climate Atlas	Decision-makers and analysts	10 models of the CMIP3 Model Archive (IPCC FAR), CRU	Native GCM output, native climatology output	1931-1960 and 1961-1990, 1961-2100?	0.5° x 0.5° (observed temperature), 2.5° x 3.75° for observed rainfall; 0.5° x 0.5° for Temp & Prec anomalies	Monthly (30 year average) Monthly & Decadal time series	Yes	MaxT, MinT, MeanT, Prec, [vii]	Many[viii]	NetCDF, ASCII &PNG	Moderate	CLIVAR VARC, World Climate Research Programme (WCRP) http://www.geog.ox.ac.uk/~clivar/ClimateAtlas/
Downscaled Products												
CSAG	+++	20 GCMs CRU, NCEP*	DSs [ix]	2045-2065 2081-2100	Station (#stations)	Daily and monthly (30 year average)	Yes	AvgT, AvgP, MaxT,MinT	Various[x]	Ascii, Text	Tool available	Climate Systems Analysis Group (CSAG), University of Cape Town http://www.csag.uct.ac.za/unitar-cie/
PRECIS ('Providing REgional Climates for Impacts Studies)	+	UK Climate models	DDg	per user specifications	10-100km	Daily, Monthly and Time seris	Yes	?	Yes[1]	Specialist	Specialist	MetOffice (UK) (at a cost) http://www.metoffice.gov.uk/precis/

SOURCE	Users[xi]	Data Source[xii]	Process[xiii]	Time Period	Spatial Scale	Temporal Scale	Anom-alies[4]	Variables	Statistics	Output Format	Ease of Use	Owner Institution and Access
						Tools and Portals						
Servir Climate Mapper	+++	3 GCMs	Native GCM	2030s 2050s	0.5 deg x	Decadal monthly average	?	Temp, Pre		Charts/ graphics	Extensive	US Agency for International Development, Cathalac http://www.cathalac.org/es/prensa/cathalac-prensa/noticias-de-proyectos/201-servir/1376-the-climate-mapper-tool-for-servir-2
Country Climate Profiles	+++	15 GCM CRU, NCEP	RegGCM	Decadal time-slices[5]	2.5° x 2.5° re-gridded GCMs	Annual and Seasonal	Yes	AvgT, AvgP (monthly)	UNDP	Maps/Data (.txt)/ Descriptions	Varies (Moderate to Expert	UNDP /Oxford University http://country-profiles.geog.ox.ac.uk/
World Bank Climate Change Knowledge Portal	+++	20 GCMs; high resolution model , CRU, *NCEP*	RegGCM *, DSs*	1901-2001 decadal averages, s 2010-2100	standard 2° x 2 gridded GCMs°, 20x20 KM MRI High resolution GCM	Annual, Seasonal *Monthly/decadal*	Yes	Temp, Precip	Various[6]	Ascii	Extensive	World Bank http://sdwebx.worldbank.org/climateportal/index.cfm
Climate Wizard	+++	16 GCMs)	DSg	1950-2000, 2050s and 2090s	0.5° x 0.5° (~50km)	Monthly, Average past 50 years, mid Century (2050s) and late century (2080s)	Yes	Avg T and Precip	Ensemble envelopes (mean, low, high..etc.	ASCII	Extensive	Nature Conservancy http://www.climatewizard.org
World Clim	+++	20 GCMs CRU, NCEP*	DSs	1950-2000, 2020, 30s, 40s, 50s, 60s…2100	30 seconds (~1km), 2.5min, 5 min, 10min	Monthly	No	Prec, Tmin, Tmax, Tmean	Various	ASCII, Grid	Extensive	http://www.worldclim.org/

[i] Data Sources: Global network of observation stations (Obs), Earth Observing Systems and observations (EOS) and GCM models (from IPCC data distribution center) # refers to the number of models available
[ii] Process refers to the transformations conducted before serving the data for public use and include Interpolated grids (INT), Statistical Calculations (CALC), Downscaled grids (DSg) and Downscaled stations (DSs)
[iii] Anomalies calculate the difference between two time periods (and usually are indicative of change.
[iv] (~50km)
[v] 80 different variables: Air Temp, Cloud, Surface winds, Evaporation, Ice extent, Precipitation, Soil Moisture, among others.
[vi] Bioclim*BIO1 = Annual Mean Temperature, BIO2 = Mean Diurnal Range (Mean of monthly (max temp - min temp)), BIO3 = Isothermality (P2/P7) (* 100), BIO4 = Temperature Seasonality (standard deviation *100), BIO5 = Max Temperature of Warmest Month, BIO6 = Min Temperature of Coldest Month, BIO7 = Temperature Annual Range (P5-P6), BIO8 = Mean Temperature of Wettest Quarter, BIO9 = Mean Temperature of Driest Quarter, BIO10 = Mean Temperature of Warmest Quarter, BIO11 = Mean Temperature of Coldest Quarter, BIO12 = Annual Precipitation, BIO13 = Precipitation of Wettest Month, BIO14 = Precipitation of Driest Month, BIO15 = Precipitation Seasonality (Coefficient of Variation), BIO16 = Precipitation of Wettest Quarter, BIO17 = Precipitation of Driest Quarter, BIO18 = Precipitation of Warmest Quarter, BIO19 = Precipitation of Coldest Quarter
[vii] Diurnal temperature range, Water vapour, cloud cover (for future temperature is provided in Kelvin, rainfall in mm/day) Future absolute values, anomalies and percentage with respect to reference climatology)
[viii] mean and standard deviation for observed, ensemble mean, absolute value and percentage change with respect to reference climatology
[ix] (~700 stations in Africa)
[x] Indices of extreme daily temperatures (frequency of 'hot' days, 'cold' days, 'hot' nights, 'cold' nights; indices of extreme daily precipitation (Max 1 day and 5day ranfall, proportion of total rainfall falling in 'heavy' events
[xi] Target Users include the research and modeling community+, decision makers and analysts ++and/or all +++
[xii] Data Sources: Global network of observation stations (Obs), Earth Observing Systems and observations (EOS) and GCM models (from IPCC data distribution center) # refers to the number of models available
[xiii] Process refers to the transformations conducted before serving the data for public use and include Interpolated grids (INT), Statistical Calculations (CALC), Downscaled grids (DSg) and Downscaled stations (DSs)

[4] Anomalies calculate the difference between two time periods (and usually are indicative of change.
[5] 10 year average
[6] Frost days, Heat wave duration, Maximum 5 day precipitation, *for 9 models - number of days with rainfall (ppt) >10mm, number of days with ppt > 2 mm, number of days with ppt > 90th percentile, average number of days between rain events,, mean daily rainfall, total monthly rainfall, mean maxT/minT, number, hot days (90th %), cold days (10th %), cold nights (10% of tmin, warm nights (tmin90th %), frost days (Tmin <zero)