The NCAR Climate Risk Management Engine (CRMe)

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Overview

1. **Growing challenges for decision-makers today**
   - threats from weather and climate variability: events
   - evolving questions about climate change

2. **The need for going beyond data and information**
   - data and information portals & the lack of addressing specific needs
   - tailoring and translation to put information into proper context

3. **Examples of approaches and tools to build relevant knowledge and to enable the development of solutions**
   - *top-down* data and information (portals)
   - *bottom-up* requirements and challenges (requests)
   - Co-development concept: embedded capacity building
   - Screening tools and dashboards: Informing decision processes
Events in the news: climate variability or change?

Coffee And Climate Change: In Brazil, A Disaster Is Brewing

October 12, 2016 · 4:00 PM ET
Heard on All Things Considered

Food for Thought

Flood / Landslides

Droughts / Crop Failure

Pests / Diseases
Climate Impact Studies — Current Climate Data Libraries

IPCC AR4 (2007)
IPCC AR5 (2013)
IPCC AR6 (2019?)

Total: 35 TB
Total: 2,200 TB (Petabyte)
Expected: 0.2–1 Exabyte
... not just data and information ...

a picture is more than pixels
Water: Precipitation $\neq$ Precipitation

Application-specific understanding and evaluation needed

Itaipu: Hydropower

Mexico: Drought

Panama: Flash Flood

Haiti: Hurricane
New Tools to Evaluate Models and Data: MET/MODE

**Field:** pr(DJF)

Mean (mm)

**Observations**
CRU TS3.21

Object frequency >500mm

Object frequency >900mm

**Models**
CESM-LE
Example: Climate Change Screening

CLIMATE BUSINESS

ACCOUNT FOR CLIMATE RISK
**Input:** Climate variables
- tas
- tasmin
- tasmax
- pr
- uas
- vas
- rhs
- psl
- huss
- ...

**Output:** Climate indices
- climatological fields
- sectoral indices
  - health indices
  - agricultural indices
  - water sector indices
  - insurance indices
  - transportation / ports
  - energy
  - ...
- diverse climate statistics
- ensemble information
- comparison options

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**CRMe:** “Climate Risk Management engine”

*efficiency, flexibility, extensibility, …*

**Broad input data:**
- raw models (GCM, RCM),
- compilations (CMIP5, CORDEX)
- observational datasets
Diversity of Climate Indicators
for analysis platforms, screening tools and dashboards

- Median number of days of daily rainfall larger than 50mm
- Median rainfall during very heavy precipitation days
- Number of Tropical Nights (tasmin > 20°C)
- Number of Days without Wind (windspeedlow (days_below_threshold))
Change in annual likelihood for drought by 2035
Extreme Rainfall: 5-day cumulative rainfall – 20-yr return levels

Return Level of \( rx_{5\text{day}} \) for 20 Year Return Period

Parameters of GEV

20-year Return Level of 5-day Cumulative Rainfall

5-day cumulative rainfall maximum

\[ \text{Data Min} = 3.45085, \text{Max} = 1878.4856 \]
Suitability of Pinus Taeda

(example CCSM4)
Changes in Suitability of Plantation Tree Species
(CMIP5 ensemble)

- Little change
  - Projected range changes for Paper / Pulp
  - Potentially new regions

- Significant shifts
  - Loss of paper industry
Challenges
need for expanded capabilities

- wave and sea level
- integrate human components
HEALTH SECTOR: HEAT HAZARD

Rising temperatures will pose elevated risk for people around the world. However, taking into account moisture is important to link to human health. High temperatures combined with high atmospheric moisture can prevent the human body to balance its temperature through transpiration. The simple heat index is one of many measures of this risk to human health.
Data archives

accessible, standardized, ...

Information Portals

quality control, use-oriented, ...

Interactive Platforms

translated, put in context, ...

Communities of Practice

robust, embedded, ...

data

Information

knowledge:

Wisdom:
CRMe Summary

- Develops indices/indicators from “bottom-up” needs of practitioners, implemented through discrete, structured, “top-down” workflows for rapid delivery

- Web-based data services to deliver usable climate info

- Dashboards for quick, user/application-specific summaries of climate info

- 200+ application/sector-oriented climate indices/indicators
  - 27 core Climate Extremes (ETCCDI) indices
  - Human health, heat, ecological indices
  - Return period-based indices (flood, drought, fire, TCs, ...)
  - “Nice”/“miserable” weather indices

- We welcome partnerships with climate data users, social scientists, policy and decision-makers, risk practitioners, and commercial interests to expand CRMe capabilities!
Thanks! Any Questions?

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Climate Risk Management for Adaptation — Main Objectives

*Deliver, evaluate and translate sound, past-present-future climate science to decision makers to identify and address adaptation needs, to promote sustainability, and to reduce human system vulnerability to regional climate variability/change.*

*Climate Data Evaluation:* Implement a capability to compute transparent, standardized metrics that offer application-oriented information about quality of data and their uncertainties.

*Usable Climate Science:* Develop the scientific basis for co-developing sound climate data and information services in critical end-use domains (e.g., agriculture, urban, and natural resource planning).

*Scenario Environment for Integrated IVA Studies:* Define a protocol for interdisciplinary engagement through quantitative scenario development and testing of the effectiveness of climate-adaptive interventions.

*Climate Change Capacity Building:* Define and develop modular science content and tools to assist in the translation of climate science information to support multi-directional capacity building and decision-making in context of extreme societal vulnerability.
Example “top-down” Data & Information Portals

Building on standardized data: offering broad information
Common Challenges

Important foundations, but limitations in usability and usefulness

- **Top-down**: generalizes information, might not be applicable for many needs, ...

- **Bottom-up**: describes local needs, ignores larger context, unaware of realistic projection information, ...
WMO - GFCS
Global Framework for Climate Services

- **User Interface Platform**
  - A means for users, user representatives, climate researchers and climate service providers to interact

- **Climate Services Information System**
  - To collect, process and distribute climate data and information according to the needs of users and according to the procedures agreed upon

- **Observations and Monitoring**
  - To ensure that the climate observations necessary to meet the needs of climate services are generated

- **Research, Modeling and Prediction**
  - To assess and promote the needs of climate services within research agendas

- **Capacity Building**
  - To support systematic development of the necessary institutions, infrastructure and human resources to provide effective climate services.
New Focus on Regional Climate and Impacts

Integration of data and knowledge across scales. 
Global - to - Local

e.g.: Agriculture
Validation: Skill of Models

IPCC Model “Spatial Skill”: Pattern Correlations
Modular Dashboards
Rapid tailoring to different specific needs

**Module #1**
Map of Heat Index

**Module #2**
Seasonal Cycle of Heat

**Module #3**
time series of #days of per year

**Module #4**
relentless heat period

**Summary**

99

**Narrative:**
Rising temperatures will pose elevated risk for people around the world. However, taking into account moisture is important to link to human health. High temperatures combined with high atmospheric moisture can prevent the human body to balance its temperature through transpiration. The simple heat index is one of many measures of this risk to human health.

**x-ray**: data quality evaluation
Levels of Integrated Approaches

with the common property of iterative co-development

CO-DESIGN
- Issues of Concern
- Knowledge & Data Gaps
- Conceptual Frameworks
- Context & Scale Processes & Feedbacks

CO-IMPLEMENTATION
- Solutions, Evaluations
- Future Needs
- Decision Processes
- Science-Policy Interface
- Decision Support Toolkits

CO-PRODUCTION
- New Knowledge & Tools
- Theories & Methods
- Observations & Modeling Analyses

STAKEHOLDERS
- SOCIAL & PHYSICAL SCIENTISTS

Interdisciplinary Research Approach
Policy Learning Interventions

Data Services

Collaborative Work and Scientific Exploration
- Platform

Data and Information Services embedded in Screening Tools

Application-oriented communication tools and Dashboards

1

2

3
NCAR CRMe
Climate Data Processing Steps
of CMIP5 data from raw archives to screening tool products

1. Ingest raw CMIP5 archived data files for all models
2. Standardization for CRMe: regridding to common 1 x 1 degree single files
3. Base series calculations: climate and basic indicator time series
4. Restructuring of data for rapid percentile and extremes calculations
5. Computation of different indices defined in delivery tables
6. Visual inspection and basic validation of results
7. Migration of results to exposed host and spreadsheets for delivery