(CR)² Center for Climate and Resilience Research
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Center for Climate and Resilience Research
The first 5 years and continuity plan

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Directora del Centro de Ciencia del Clima y la Resiliencia

First 5 years: achievements

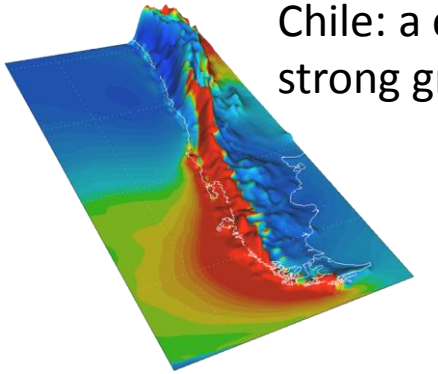
New endeavors and approaches

Fundamental Objectives

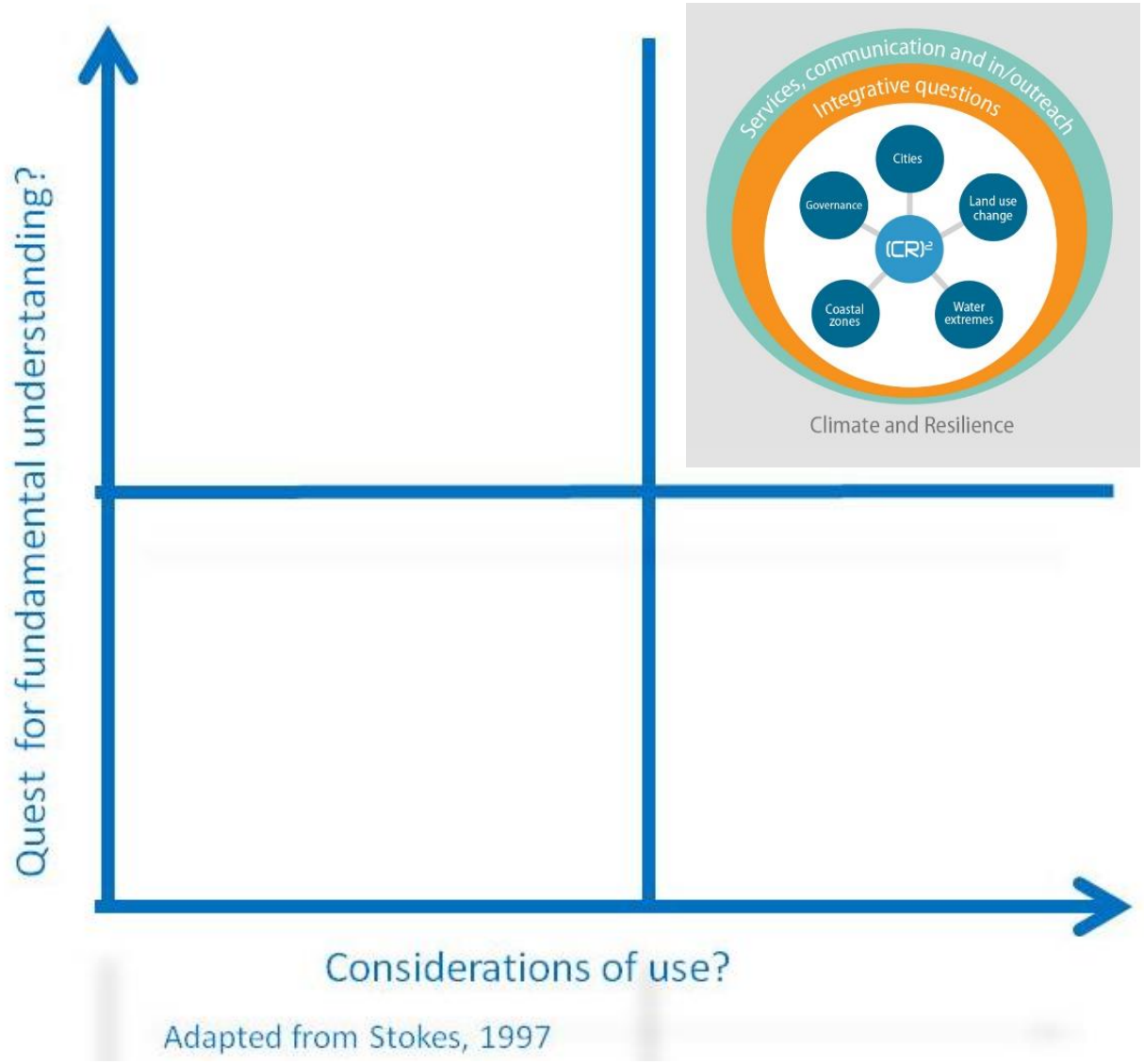
To deepen our understanding of the climate system, processes, and impacts throughout Chile, in a holistic manner that confronts the complexities of socio-ecological systems

To strengthen the emerging community of natural and social scientists in Earth System Science in Chile

In collaboration with stakeholders, to contribute to the definition of climate change adaptation and mitigation measures for building societal resilience.



Chile: a country of strong gradients



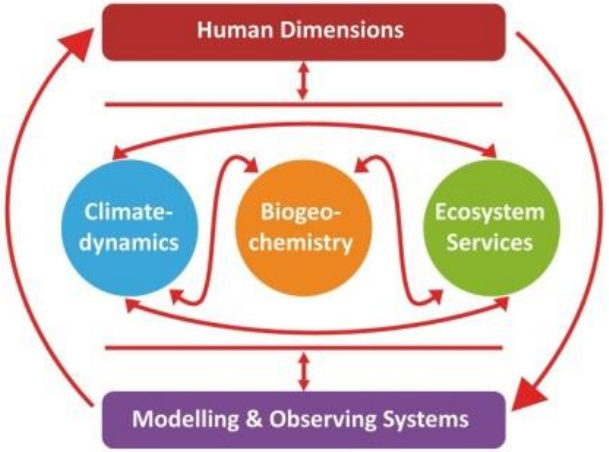
Achievements of the first 5 years

1. Deepening of understanding
    1. *Questions by research line*
    2. *Integrative questions*
        1. Mega drought study
        2. Regional manifestations of the Anthropocene: the case of Chile
2. Enabling science
3. Team building for interdisciplinary research
4. Networking and outreach

Scientific highlights per research line

- **…**areas of coastal upwelling along northern and central Chile constitute significant sources of greenhouse gases to the atmosphere…. oxygen-poor subsurface waters favor the accumulation and recycling of nitrous oxide (N_2O) and methane (CH_4), and identified **a new biological pathway of N_2O consumption**
- **an attribution to anthropogenic forcing of ca. 25% (MD)** …drying trend of ca. 10% since 1980 in central and southern Chile, Altiplano … contextualized in paleo-records and climate projections…consequences on water resources and vegetation …identifying centennial to millennial modes of natural variability …a monotonic warming since 1960 at elevations above 1000 m a.s.l. and a cooling along the costal stations since 1980 in contrast with a coastal warming in the previous decades
- ..rapid loss of native forests from 1975 to 2010, and the consequences of this loss in terms of biodiversity …**Native forests' role in storing carbon, providing water and reducing vulnerability to forest fires** gives them advantages when compared to exotic pine and eucalyptus plantations ….An estimate of the amount and seasonality of the recovery of water provision from the restoration of native forests has been provided….
- identification of local drought adaptation strategies…theoretical and practical aspects of resilience …**novel legal conceptualization of climate change damage**…Legal framework for climate change
- documented climate variability and change …Tropospheric ozone climatologies and trends for the remote atmosphere …analysis of simulations for the last millennium …. evaluation of fluctuations in the South American Monsoon …long-term climate variations associated with insolation changes and the more recent effects of anthropogenic forcing in southern South America **…impacts of air pollution on the Andean cryosphere …long-term evolution of air quality in urban areas…**

~200 ISI publications



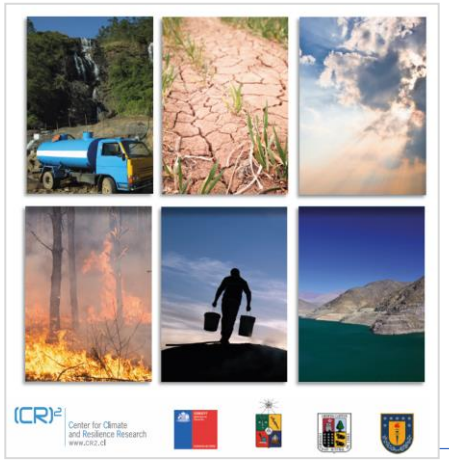
Integrative questions

Central Chile's Mega drought (2010-2017?)

A series of dry years has afflicted central Chile since 2010. The on-going mega drought is the largest and longest dry spell on record with few analogues in the last 1000 years. One third of the mega drought has been attributed to anthropogenic climate change.

The central Chile MD became the first integrative research topic for CR2, and we now better understand its origin, impacts, responses and projections. These results are included in:

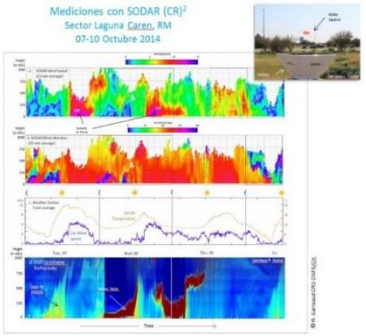
- *Our first **Report to the Nation** (2015)*
- *10 Peer review papers (6 published)*
- *12 Scientific presentations*
- *11 Presentations for general public*
- *17 Coverage in national media*

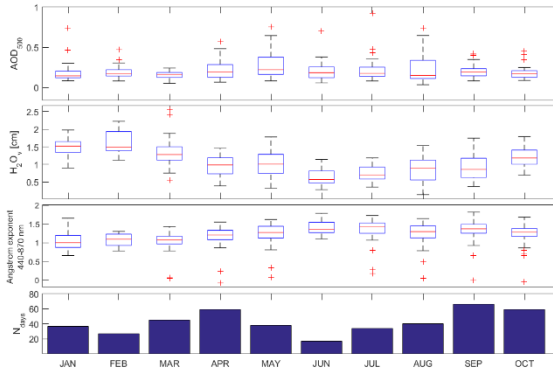


Regional Manifestations of the Anthropocene: the case of Chile

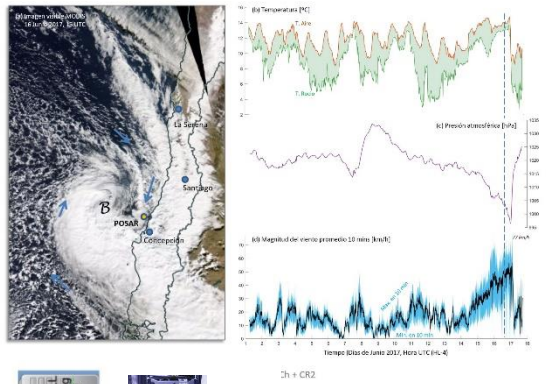
1. **Aguirre et al, Some insights about anthropogenic forcing on coastal upwelling off central and -southern Chile**
2. **Arriagada et al, Governing climate change in the Anthropocene: modes of governance and steps towards polycentrism in Chile**
3. Barría et al, Anthropocene and streamflow: long-term perspective of streamflow variability and water rights
4. Boisier et al, Long-term precipitation and streamflow variability in Chile over the last 50 years
5. **Gallardo et al, Evolution of Santiago's air quality: the role of mobility and lessons from the science-policy interface**
6. Gayó et al, Geo-historical records of the Anthropocene in Chile
7. **Lara et al, The impacts of land use change on biodiversity and forest ecosystem services during the Anthropocene in Chile**

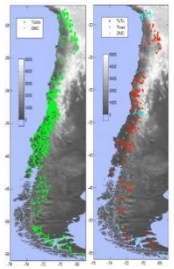
Enabling Science

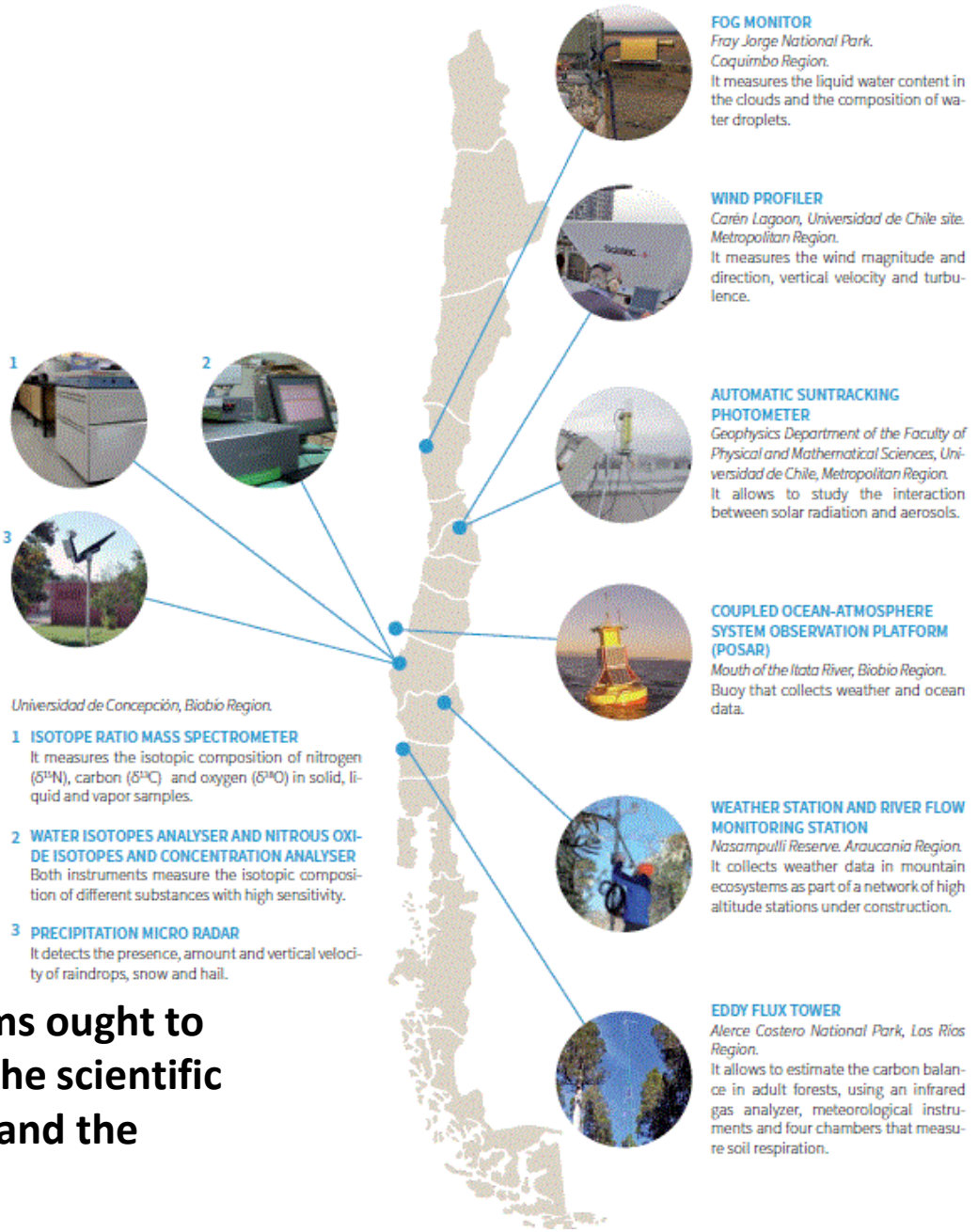




POSAR enfrentando la tormenta del 16 Junio 2017
http://www.cr2.cl/posar/







Universidad de Concepción, Biobío Region.

1 ISOTOPE RATIO MASS SPECTROMETER
It measures the isotopic composition of nitrogen ($\delta^{15}N$), carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) in solid, liquid and vapor samples.

2 WATER ISOTOPES ANALYSER AND NITROUS OXIDE ISOTOPES AND CONCENTRATION ANALYSER
Both instruments measure the isotopic composition of different substances with high sensitivity.

3 PRECIPITATION MICRO RADAR
It detects the presence, amount and vertical velocity of raindrops, snow and hail.

FOG MONITOR
Fray Jorge National Park. Coquimbo Region.
It measures the liquid water content in the clouds and the composition of water droplets.

WIND PROFILER
Carén Lagoon, Universidad de Chile site. Metropolitan Region.
It measures the wind magnitude and direction, vertical velocity and turbulence.

AUTOMATIC SUNTRACKING PHOTOMETER
Geophysics Department of the Faculty of Physical and Mathematical Sciences, Universidad de Chile, Metropolitan Region.
It allows to study the interaction between solar radiation and aerosols.

COUPLED OCEAN-ATMOSPHERE SYSTEM OBSERVATION PLATFORM (POSAR)
Mouth of the Itata River, Biobío Region.
Buoy that collects weather and ocean data.

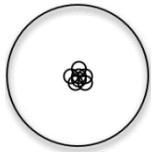
WEATHER STATION AND RIVER FLOW MONITORING STATION
Nasampulli Reserve. Araucanía Region.
It collects weather data in mountain ecosystems as part of a network of high altitude stations under construction.

EDDY FLUX TOWER
Alerce Costero National Park, Los Ríos Region.
It allows to estimate the carbon balance in adult forests, using an infrared gas analyzer, meteorological instruments and four chambers that measure soil respiration.

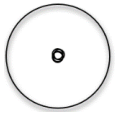
CR2 platforms ought to be open to the scientific community and the public

Team building for interdisciplinary research

…an Earth System functioning in no-analogue mode, requires action not only to mitigate the drivers of dangerous climate change and enh societal resilience, but also to shift scientific paradigm from the traditional disciplinary model towards an integrative approach…



Co-production of knowledge



Multi/inter discipline

Disciplines

El Añil 2013

Villa Alegre 2014

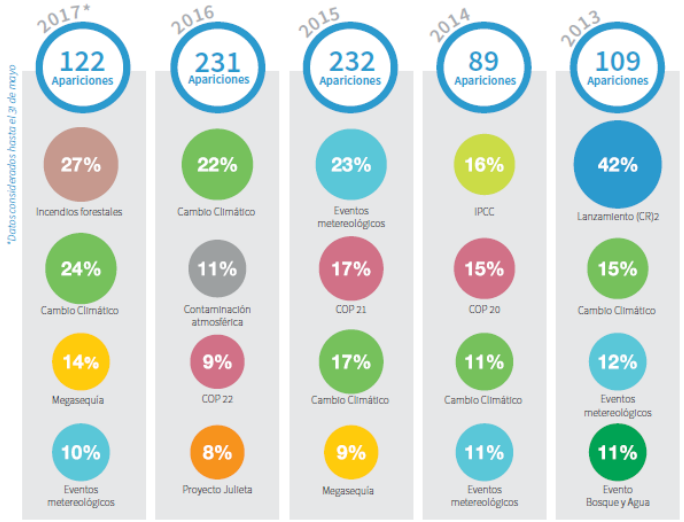
Casablanca 2016

Roca Negra 2015

Malalcahuello 2017

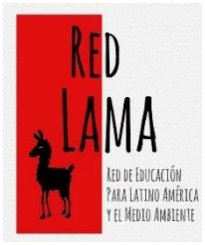
Lago Grey 2017

Networking and outreach



Media presence

Science Communication



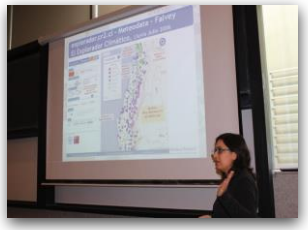
Continuous education

Diploma on Low Carbon Development and Climate Change

Policy relevant information

PROPUESTA DE MARCO LEGAL E INSTITUCIONAL PARA ABORDAR EL CAMBIO CLIMÁTICO EN CHILE

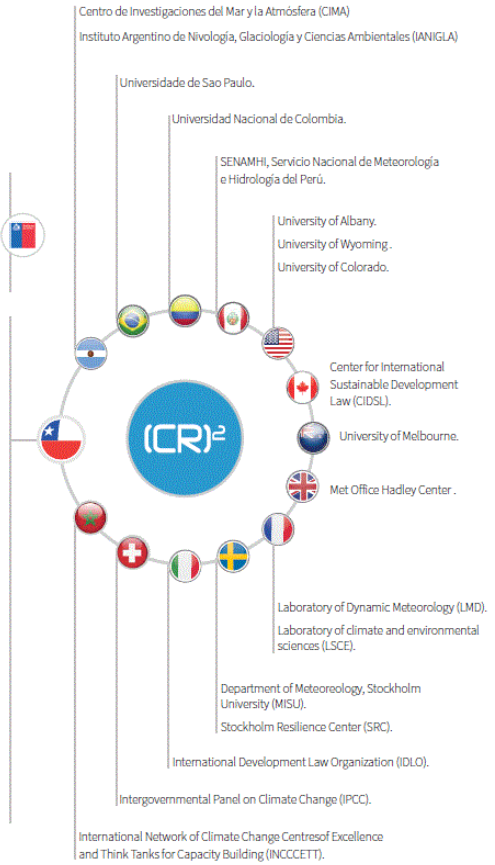
Explorador Climático (CR)2



Multiple collaborations with ministries, research centers in Chile and abroad

Ministerio del Medio Ambiente
Ministerio de Relaciones Exteriores
Ministerio de Obras Públicas
Oficina Nacional de Emergencia del Ministerio del Interior y Seguridad Pública
Comisión sobre marea roja del Ministerio de Economía

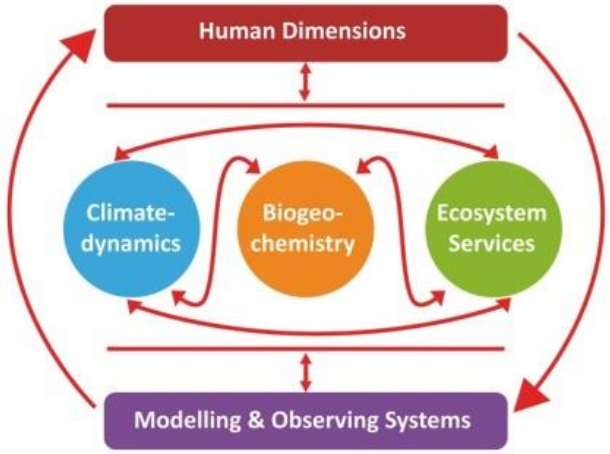
Centro de Excelencia en Geotermia de Los Andes (CEGA)
Center for Mathematical Modeling (CMM)
National Lab for High Performance Computing (NLHPC)
Núcleo Milenio Paleoclima del Hemisferio Sur
Centro Cambio Global de la Pontificia Universidad Católica de Chile
Centro de Desarrollo Urbano Sustentable (CEDEUS)
Centro de Optica y Fotónica (CEFOP)
Instituto Milenio de Oceanografía (IMO)
Dirección Meteorológica de Chile (DMC)
Consejo Nacional de Innovación y Desarrollo (CNID)
Solar Energy Research Center (SERC)
Adapt Chile
Instituto de Ecología y Biodiversidad (IEB)
Centro Nacional de Investigación para la Gestión Integrada de Desastres Naturales (CIGIDEN)
Centro de Investigación Dinámica de Ecosistemas Marinos de Altas Latitudes (IDEAL)
Programa de Reducción de Riesgos y Desastres de la Universidad de Chile (CITRID)
Centro de Energía (CE) de la Universidad de Chile
Instituto de Sistemas Complejos de Ingeniería (ISCI)
Centro de Recursos Hídricos para la Agricultura y la Minería (CRHIAM)
Centro de Derecho Ambiental de la Universidad de Chile (CDA)
Advanced Mining Technology Center (AMTC)



Centro de Investigaciones del Mar y la Atmósfera (CIMA)
Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA)
Universidade de Sao Paulo.
Universidad Nacional de Colombia.
SENAMHI, Servicio Nacional de Meteorología e Hidrología del Perú.
University of Albany.
University of Wyoming.
University of Colorado.
Center for International Sustainable Development Law (CIDSL).
University of Melbourne.
Met Office Hadley Center.
Laboratory of Dynamic Meteorology (LMD).
Laboratory of climate and environmental sciences (LSCE).
Department of Meteorology, Stockholm University (MISU).
Stockholm Resilience Center (SRC).
International Development Law Organization (IDLO).
Intergovernmental Panel on Climate Change (IPCC).
International Network of Climate Change Centresof Excellence and Think Tanks for Capacity Building (INCCCETT).

New endeavors and approaches: re-structuring science making

From a 5 year Project to a long lasting institution (complementary and closely related to our host institutions)**:** From too many, some narrow, some broad objectives to fill a key space between curiosity-driven and problem-oriented research.



neither disciplinary- nor problem- oriented

Research lines around complex problems, covering broad, short- to long- term objectives …combining researchers of diverse disciplinary backgrounds …in the context of climate and resilience research

….integrative questions to allow for cross-pollination and interdisciplinary exchange between research lines, and to provide a platform for delivering high-quality, societally-relevant science and usable knowledge, and hopefully opening the door for trans disciplinary exploration

Research objectives

Provide scientific assessments that support policy-making and resilience to **fire regimes, air pollution, hydro meteorological extremes, and algae blooms** in the context of climate variability and change.

Water availability and extremes: Disentangle the role of natural variability and anthropogenic factors (either local or remote) as drivers of change in the distribution of extreme hydro meteorological events (frequency, extent, intensity) and their impact, and translate these results into actionable science that enhances Chile's resilience.

Coastal zones: Identify the mechanisms by which climate variability and change affect coastal processes relevant to the functioning of Chilean ecosystems and society.

Land use change: Design resilient landscapes for the sustained provision of ecosystem goods and services to cope with climate variability and change.

Cities in a changing climate: Assess the resilience capacities of Chilean cities to climate disturbances at present and under future conditions supposing different emission scenarios and governance conditions.

Governance and policy-science interface: Assess governance modes compatible with a low-carbon economy and coherent with the Paris Agreement, SDG priorities, and Chile's socio-economic conditions, emphasizing a sound and strengthened science-policy interaction.

(Medium-to-long term goals)

(Short-term objectives with societal interface)

More tomorrow!

In sum

*…becoming and remaining a major player in **developing climate and resilience science** and contributing to our country's goals of achieving low-carbon, sustainable development consistent with the Paris Agreement and the Sustainable Development Goals (SDGs)…*

¡Gracias!

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Centro de Ciencia del Clima y la Resiliencia
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Sponsoring institution

Associated Institution

Funding Agency