Comisión Nacional de Investigación Científica y Tecnológica - CONICYT

TEAM RESEARCH PROJECTS (ANILLOS) IN SCIENCE AND TECHNOLOGY AND IN ANTARCTIC SCIENCE 2009

FINAL REPORT

I. PROJECT PRESENTATION

PROJECT TITLE	CODE
Surface Spectral UV Radiation and UV-Linked Effects on Endemic Species	ACT-98
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MAIN INSTITUTION	
Universidad de Santiago de Chile	
PERIOD INFORMED	
Jun-2010 – Jan-2014	

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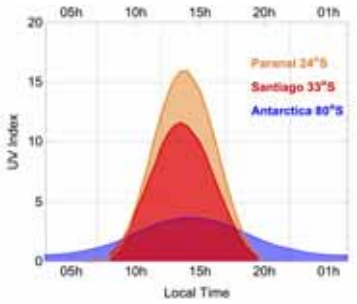
II. EXECUTIVE SUMMARY (3 PAGES)

This project aimed at exploring several aspects of the interrelationship ozone-climate, paying special attention to the surface UV climatology. We monitored ozone and spectral UV irradiances, both from the surface and from satellites, inside and outside the polar vortex. We expect that our efforts will contribute to a better understanding of the UV climate on regional scales.

Since changes in UV radiation caused by global environmental change can have important consequences for terrestrial ecosystems, this project also paid attention to the assessment of some of the UV-linked effects. We focused on changes induced by the UV on the physical properties of cuticles (isolated from both endemic plants and non-Antarctic species). Further tests involved the assessment of UV-linked effects on the DNA molecules. We expect that our work will contribute to a better understanding of the potential effects associated with the enhanced solar UV doses.

Meeting the specific goals of this project required field measurements, remote sensing activities, modeling, growing seedlings, characterization of biological samples, UV irradiation under controlled conditions, and monitoring of UV-induced effects at different scales. Indeed, our research activities ranged from synoptic meteorological scales to molecular nano-scales, and involved physicists, chemists, biologists and engineers. Extensive planning, organizing, and communicating were required in order to successfully carry out this research. Our group adequately responded to unpredictable circumstances, adapted to new situations, stayed focused on our main goals, guided tens of students through their tasks, and effectively produced new science. Indeed, this Antarctic "Anillo" project brought together researches from multiple universities and countries and allowed consolidating in the timespan of only 3 years a well-functioning "Antarctic Research Group".



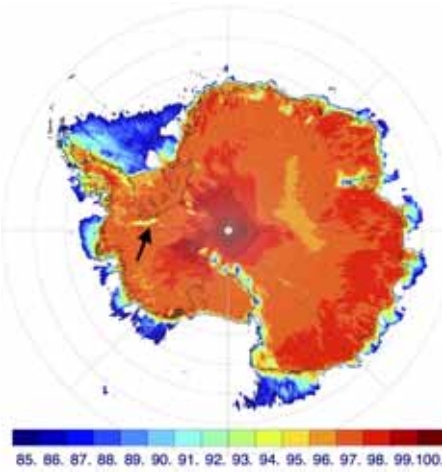
Peak UV levels measured by our team in summer under cloudless conditions at different geographical locations in the Southern Hemisphere.

Significant attention was paid to the development of experimental capabilities. After 3 years of efforts, we may have the best radiometric facilities in the country including a heavy-duty scanner system (for radiance measurements), 3 Bentham® double monochromator-based spectroradiometers (meant to comply the specifications of the WMO), and a whole-sky cloud monitoring system (based on a CCD camera and a fish-eye lens). Moreover, in order to support our research on UV-linked effects, we also developed an irradiation chamber (that allowed subjecting samples to time- or dose-controlled UV irradiation). However, regarding instrumentation, our main achievement was the development of a semi-permanent platform aimed at supporting our Antarctic measurements; specially designed for harsh weather conditions, our first Transportable Antarctic Research Platform (TARP) was successfully deployed on King George Island (Antarctic Peninsula) in March 2013. TARP currently is fitted with a double channel UV radiometer will soon host a Biospherical® multichannel spectroradiometer aimed at long-term measurements.

Our new experimental capabilities allowed us to carry out spectral measurements of UV radiation at locations from 23°S latitude (in the tropics) to 79°S latitude (on the Antarctic Plateau) including areas that are particularly sensitive to climate change (such as the Antarctic Peninsula -one of the fastest warming areas on Earth- and the Ronne Ice Shelf -the second largest ice shelf in Antarctica after the Ross Ice Shelf-). These campaigns allowed us to study the UV climate under the influence of a mix of conditions that included different clouds, surfaces, altitudes (from sea level to 5,100 m asl), and aerosol loads.

Although at each location our measurements were the first quality-controlled spectral measurements in the area, we would like to highlight our campaign at Union Glacier Camp, located in the southern Ellsworth Mountains on the broad expanse of the Ronne Ice Shelf (700 m altitude, 79º 46' S; 82º 52'W; about 1,000 km from the South Pole); as well as our campaign on the Chajnantor Plateau located 50 km to the East of San Pedro de Atacama (5100 m asl, 23°00′S, 67°45′W).

Our campaign at Union Glacier Camp in November-December 2012 enabled us to sample both the downwelling and upwelling radiance distributions. Measurements of the upwelling radiance are particularly important since they allow computing the hemispherical conical reflectance factor (HCRF) that can be in turn used for satellite validations and eventually for estimating realistic radiative forcing due to changes in the snow albedo. Our campaign on the Chajnantor Plateau allowed us to detect what are so far the world's highest levels of surface UV ever measured under controlled conditions. Despite our successful campaigns (see full list of campaigns below), we are aware that satellite validation and trend detection requires longstanding efforts. That is why we are already working on setting up new instrumentation aimed at satellite validation not only in Antarctica but also in northern Chile.

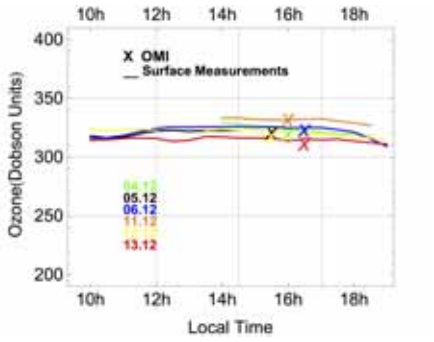


Albedo from OMI surface reflectance data (LER) at 354 nm. Arrow indicates the location of Union Glacier Camp.

In this project, remote sensing activities implied comparing satellite-derived estimates with ground-based measurements. In addition to our own surface measurements, we also compared three years of ground-based ozone measurements carried out in Arctic (Ny-Alesund station, 78.9°N, 11.9° E, Svalbard islands - Norway) with estimates retrieved from the Ozone Monitoring Instrument (OMI), from the Global Ozone Monitoring Experiment (GOME), and from the SCanning Imaging Absorption spectroMeter for Atmospheric CartograpHY (SCIAMACHY). Further remote sensing activities were aimed at investigating the response of the atmosphere (in particular the ozone) to solar activity (such as solar cycles and transient solar activity), as well as at analyzing the satellite-derived estimates of the Lambertian equivalent reflectivity (LER) in the UV-A. In one of our most recent papers (see Damiani et al 2014), we demonstrated that the LER data, retrieved from the Total Ozone Mapping Spectrometer (TOMS) and from OMI, can be used as a proxy for the Cloud Modification Factor (CMF) when dealing with reconstruction models of surface UV radiation.

Our efforts on assessing some of the UV-linked effects focused on the physical properties of cuticles isolated from both endemic plants and non-Antarctic species. The effects of the UV on the cuticles were assessed by comparing permeabilities, as well as mechanical and optical properties, between cuticles exposed to different UV doses under controlled conditions. Since matrix membranes of cuticles are made of the liphophilic polymers, it was not that the exposition to UV led to changes in the tested properties. Our main finding was that, regardless of the tested species, detectable changes in the cuticle properties occur after exposition to relatively low UV-B doses. Although in this project we were able to deal with physical properties only, there are well known effects of UV on changing the chemical composition of cuticles. Therefore, in future endeavors, we plan also to pay attention to the biochemical components.

Further tests were focused on the assessment of UV-linked effects on the DNA molecules. We applied a novel single molecule technique that allowed us to measure force and torque response of single DNA molecules subjected to a tensile test. Since it is known that UV leads to chemical modifications on DNA, we tried to correlate those modifications with the forces and torques measured when testing molecules subjected to different UV doses. Although our results were not conclusive, we were able to further develop our single DNA molecule technique, which can be considered an accomplishment itself.



Ground-based measurements of the Ozone carried out by our team at Union Glacier Camp (79º 46' S; 82º 52' W) in December 2012

Our work in this project had a proven scientific productivity in the form of peer-reviewed publications; the last 3 years the researchers involved in this project published 37 papers (14 only during the last year) showing linked research goals and association. The number of publications steadily increased through the last 3 years but what is even more relevant: the total number of students involved in this proposal also increased and peaked at 20 (1 master, 5 PhD and 14 undergraduate) this summer.

Collaboration with our international partners extended the impact of our activities and strengthened further the last 3 years. Despite the success of our current collaborations (with the German University of Hannover IMUK, the Mexican Centro de Investigaciones en Optica CIO, and the Italian National Research Council IDASC), we took further steps to expand our current network. We are beginning collaborations with the group of Prof. Steve Neshyba (University of Puget Sound, USA) and with the group of Dr. Eija Asmi (from the Finish Meteorological Institute, FMI).

We find it extremely important to disseminate the results of our research and make them broadly accessible for the benefit of the community. Hence, in addition to our research activities, we co-sponsored a weekly Seminar that brought together researchers, visitors, professors, and undergraduate and graduate students interested in a wide range of topics (from surface UV to nanofilms, see details in Annex 1). In addition, we upgraded our website: www.antarctica.cl. This website is meant to expand awareness and understanding of UV-linked phenomena and the ozone depletion, to promote our outcomes, and to encourage undergraduate students to get involved in our research. The website also clusters the activities of a broader multidisciplinary group of Antarctic researchers (physicists, chemists, biologists, and engineers) affiliated with our sponsoring institution (the Universidad de Santiago de Chile, USACH) and their international partners.

In addition to the prolific scientific outputs detailed below, this project allowed us to successfully consolidate our "Antarctic Research Group". We expect our group to become a platform that will support our researchers to effectively achieve ambitious goals through deeper collaboration. In the upcoming years our mission is to support global efforts to assess the crucial role played by Antarctica in global climate, and the impacts of climate change on Antarctica.

III. RESUMEN EJECUTIVO (3 PAGES)

Este proyecto "Anillo" apuntó a explorar varios aspectos de la interrelación ozono-clima, con especial atención en la climatología de la radiación UV. Seguimientos del ozono y la radiación UV fueron realizados, tanto en superficie como mediante lecturas satelitales, dentro y fuera del vórtice polar. Esperamos que nuestros esfuerzos contribuyan a una mejor comprensión del clima UV a escalas regionales.

Dado que los cambios en la radiación UV asociados al cambio climático global pueden tener consecuencias importantes para los ecosistemas terrestres, este proyecto también prestó atención a la evaluación de algunos de los efectos de la UV. Nos centramos en los cambios inducidos por la radiación UV sobre las propiedades físicas de las cutículas (aisladas de plantas endémicas y de especies no antárticas). Otros ensayos incluyeron la evaluación de los efectos vinculados a la UV en moléculas de ADN. Esperamos que nuestro trabajo contribuya a una mejor comprensión de los posibles efectos asociados a la exposición a la radiación UV.

La satisfacción de nuestros objetivos requirió trabajo de campo, uso de mediciones satelitales, aplicación de modelos de transferencia radiativa, cultivo de especies vegetales endémicas, caracterización de muestras biológicas, irradiación bajo condiciones controladas, y la detección de efectos inducidos por la UV a diferentes escalas. De hecho, nuestras actividades de investigación han involucraron físicos, químicos, biólogos e ingenieros trabajando en sistemas con escalas que van desde las meteorológicas hasta las moleculares. Planificación, organización, y comunicación efectiva fueron necesarias para llevar a buen término esta investigación. Nuestro grupo respondió adecuadamente a circunstancias imprevistas, adaptándose a nuevas situaciones, manteniéndose enfocado en sus objetivos principales, guiando a decenas de estudiantes a través de sus tareas y efectivamente produciendo nueva ciencia. Este proyecto "Anillo" reunió a investigadores de varias universidades y países y permitió la consolidación en el intervalo de tiempo de tan sólo 3 años de un nuevo "Grupo de Investigación Antártica" basado en Chile.

Se prestó particular atención al desarrollo de nuestras capacidades experimentales. Después de 3 años de esfuerzos, contamos con las mejores instalaciones radiométricas y fotométricas en el país, incluyendo un sistema de escáner de cielo (para mediciones de radiancia), 3 espectroradiómetros basados en dobles monocromador Bentham® (que cumplen las especificaciones de la OMM), y un sistema de monitoreo de nubes de cielo completo. Por otra parte, con el fin de apoyar a nuestra investigación sobre los efectos de la UV, también desarrollamos una cámara de irradiación (que permite someter muestras a dosis controladas de irradiación UV). Sin embargo, en cuanto a instrumentación, nuestro principal logro fue el desarrollo de una plataforma semi-permanente destinada a apoyar a nuestras mediciones en la Antártica; especialmente diseñado para las duras condiciones climáticas, nuestra primera Plataforma de Investigación Antártica Transportable (TARP, por sus siglas en inglés) fue desplegada con éxito en la isla Rey Jorge (en la Península Antártica) en Marzo del 2013. El TARP está actualmente equipado con un radiómetro UV de doble canal y pronto albergará un espectroradiómetro multicanal Biospherical® destinado al monitoreo permanente.

Nuestras nuevas capacidades experimentales nos permitieron realizar mediciones espectrales de la radiación UV en locaciones entre la latitud 23º S (en el trópico) y la latitud 79º S (en la meseta antártica), incluyendo áreas que son particularmente sensibles al cambio climático (por ejemplo, la Península Antártica -una de las áreas de más rápido calentamiento en la Tierra- y la plataforma de hielo de Ronne -la segunda mayor plataforma de hielo en la Antártida después de la plataforma de Ross-). Estas campañas nos han permitido estudiar el clima UV bajo distintas condiciones incluyendo diferentes nubosidades, superficies, altitudes (desde el nivel del mar, hasta los 5100 m snm) y aerosoles.

Aunque en cada locación, nuestras mediciones fueron las primeras mediciones espectrales de calidad controlada en la zona, nos gustaría destacar nuestra campaña en el Campamento Glaciar

Unión situado al sur de las montañas Ellsworth, en la amplia extensión de la plataforma de hielo de Ronne a unos 1.000 km del Polo Sur (700 m de altitud, 79 º 46 'S; 82 º 52'W), así como nuestra campaña en la meseta de Chajnantor ubicada a unos 50 kilómetros al este de San Pedro en el desierto de Atacama (5.100 m snm, 23 ° 00 'S, 67 ° 45'W).

Nuestra campaña en el Campamento Glaciar Unión en noviembre y diciembre de 2012 nos permitió medir la distribución angular de la radiancia incidente así como también la distribución angular de la radiancia reflejada por la superficie. La radiancia reflejada es particularmente importante ya que permite calcular el factor de reflectancia cónica semiesférica (HCRF por sus siglas en inglés) que puede a su vez ser utilizado para validaciones de lecturas satelitales y eventualmente para estimaciones realistas del forzamiento radiativo debido a los cambios en el albedo de la nieve. Nuestra campaña en la meseta de Chajnantor nos permitió detectar los que son hasta ahora los niveles de radiación UV más altos jamás medidos bajo condiciones controladas en el mundo. A pesar de nuestras exitosas campañas (véase la lista completa de las campañas más abajo), somos conscientes de que la validación de datos satelitales y la detección de tendencias requiere de mediciones permanentes. Esa es la razón por la que ya estamos trabajando en el desarrollo de nueva instrumentación destinada a la validación de datos satelitales no sólo en la Antártida, sino también en el norte de Chile.

En este proyecto, las actividades de detección remota implicaron comparar estimaciones satelitales con mediciones en superficie. Además de nuestras propias mediciones en superficie, también comparamos tres años de mediciones de ozono realizadas en el Ártico (en la estación de Ny-Alesund, 78.9 ° N, 11.9 ° E, islas Svalbard, Noruega) con estimaciones recuperadas del Ozone Monitoring Instrument (OMI), del Global Ozone Monitoring Experiment (GOME), y del SCanning Imaging Absorption spectroMeter for Atmospheric CartograpHY (SCIAMACHY). Otras actividades de detección remota apuntaron a investigar la respuesta de la atmósfera (en particular, el ozono) a la actividad solar (relacionada con los ciclos solares y la actividad solar transitoria), así como al análisis de estimaciones satelitales del Lambertian equivalent reflectivity (LER) en el rango UV-A. En uno de nuestros trabajos más recientes (ver Damiani et al 2014), demostramos que los datos del LER recuperados del Total Ozone Mapping Spectrometer (TOMS), y del OMI, se pueden utilizar como un proxy para el Cloud Modification Factor (CMF) que a su vez se puede utilizar como insumo en modelos de reconstrucción de la radiación UV en superficie.

Nuestros esfuerzos en la evaluación de algunos de los efectos de la UV se centraron en las propiedades físicas de cutículas aisladas de plantas endémicas y especies no antárticas. Los efectos de la radiación UV sobre las cutículas se evaluaron mediante la comparación de las permeabilidades así como de las propiedades mecánicas y ópticas, de cutículas que fueron expuestas a diferentes dosis de radiación UV bajo condiciones controladas. Dado que las membranas de la matriz cuticular están compuestas de polímeros, no fue sorprendente que nuestros tests confirmaran que la exposición a la radiación UV produce cambios en las propiedades ensayadas. Sin embargo, nuestro principal hallazgo fue que, independientemente de la especie estudiada, cambios detectables en las propiedades de las cutículas se producen después de la exposición a dosis de UV-B relativamente bajas. Aunque en este proyecto nos concentramos sólo en las propiedades físicas, hay efectos conocidos de la radiación UV sobre la composición química de las cutículas. Por lo anterior, en nuestros proyectos futuros, prestaremos también atención a los componentes bioquímicos.

Pruebas adicionales se centraron en la evaluación de los efectos de la radiación UV en las moléculas de ADN. Aplicamos una novedosa técnica de manipulación de moléculas individuales que nos permitió medir la fuerza y el torque de moléculas de ADN sometidas a ensayos de tracción. Atendiendo al hecho de que se sabe que la radiación UV produce modificaciones químicas en el ADN, tratamos de correlacionar estas modificaciones con las fuerzas y pares de torsión medidos al testear moléculas sometidas a diferentes dosis de UV. Aunque nuestros resultados no fueron concluyentes, fuimos capaces de perfeccionar nuestra técnica de manipulación de moléculas de ADN, lo que puede ser considerado un logro en sí mismo.

Nuestro trabajo en este proyecto tuvo una gran productividad científica verificable en forma de publicaciones ISI. En los últimos 3 años, los investigadores involucrados en este proyecto publicaron 37 papers ISI (14 sólo el año pasado) demostrando objetivos de investigación comunes y verdadera asociación. El número de publicaciones aumentó de forma constante en los últimos 3 años, pero lo que es aún más relevante, también lo hizo el número total de estudiantes que participan en esta propuesta alcanzando a llegar a 20 este verano (1 master, 5 doctorandos, y 14 estudiantes de pregrado).

La colaboración con nuestros socios internacionales potenció el impacto de nuestras actividades y se fortaleció aún más en los últimos 3 años. A pesar del éxito de nuestras colaboraciones actuales (con la Universidad de Hannover IMUK , el Centro de Investigaciones en Optica de México CIO, y el Consejo Italiano de Investigación Nacional IDASC), dimos pasos para expandir nuestra red actual. Estamos iniciando colaboraciones con el grupo del Prof. Steve Neshyba (Universidad de Puget Sound, EE.UU.) y con el grupo de la Dra. Eija Asmi (del Instituto de Meteorología de Finlandia, FMI).

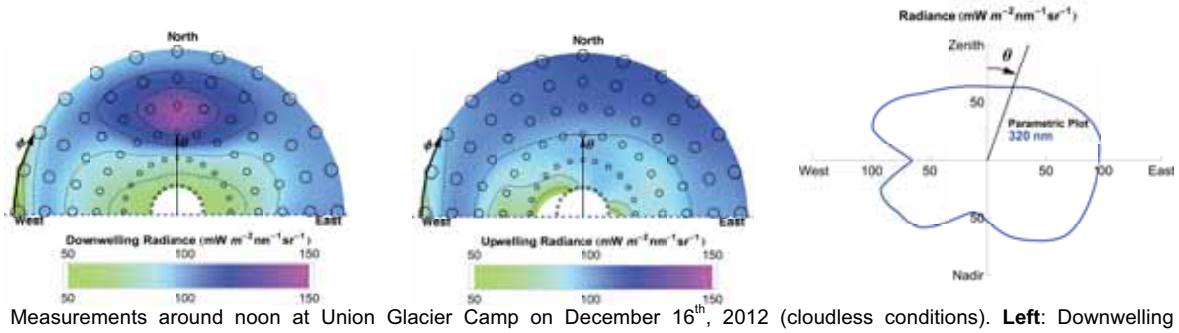
Para nuestro grupo es extremadamente importante difundir los resultados de nuestras investigaciones y hacerlas ampliamente accesibles en beneficio de la comunidad. Por lo tanto, además de nuestras actividades de investigación, durante este proyecto co-auspiciamos un seminario semanal que reunió a investigadores, visitantes, profesores, y estudiantes de pregrado y postgrado, interesados en una amplia gama de temas (desde la radiación UV hasta las nanopelículas, ver detalles en Anexo 1). Además, actualizamos nuestro sitio web: (www.antarctica.cl) destinado a apoyar el conocimiento y la comprensión de los fenómenos ligados a la radiación UV y la depleción del ozono, promover nuestros resultados, y animar a más estudiantes de pregrado a participar en nuestra investigaciones. El sitio web también agrupa las actividades de un grupo multidisciplinario más amplio de investigadores antárticos (físicos, químicos, biólogos e ingenieros) afiliados a nuestra principal institución patrocinadora (la Universidad de Santiago de Chile, USACH) y sus socios internacionales.

Además de los prolíficos resultados científicos que se detallan a continuación, este proyecto nos permitió consolidar con éxito nuestro "Grupo de Investigación Antártica". Esperamos que este grupo se convierta en una plataforma que apoye a nuestros investigadores en el logro de ambiciosos objetivos mediante una colaboración más estrecha. En los próximos años, la misión de este grupo es apoyar los esfuerzos mundiales para evaluar el papel crucial desempeñado por la Antártida en el clima global y los impactos del cambio climático en la Antártida.

IV. HIGHLIGHTS (3 pages)

Ground-Based Measurements

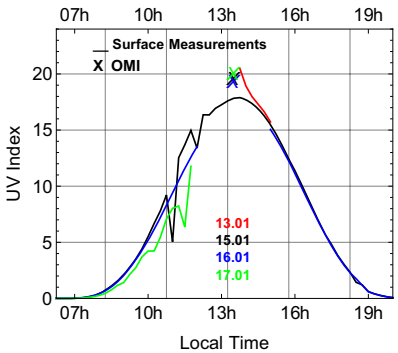
This project allowed us to carry out spectral measurements of UV radiation at locations whose latitude ranged from 23°S to 79°S. These campaigns enabled us to study the UV climate under the influence of a mix of conditions that included different cloud characteristics, different surface characteristics (including open ocean, mountains, glaciers, and dark rock), different altitudes (from sea level to 5100 m asl), and different aerosol load (from the heavy polluted metropolitan area of Santiago to the pure atmosphere on the Antarctic Plateau).



Measurements around noon at Union Glacier Camp on December 16th, 2012 (cloudless conditions). **Left**: Downwelling radiance at 320 nm (over the upper half-hemisphere). **Center**: Upwelling radiance at 320 nm (over the lower half-hemisphere). **Right**: Upwelling and downwelling radiance at 320 nm (on the plane "West-Zenith-East-Nadir"); note that if the radiance would be perfectly isotropic, this plot would show a circle. Quoted from Cordero et al 2013.

Although at each location our measurements were the first quality-controlled spectral measurements in the area, we would like to highlight our campaigns at Union Glacier Camp (700 m altitude, 79º 46' S; 82º 52'W); as well as on the Chajnantor Plateau (5,100 m altitude, 23°00′S, 67°45′W).

Our campaign at Union Glacier Camp campaign allowed us to assess the effects of the high albedo on the radiance distribution by sampling both the downwelling and upwelling radiance distributions. We found that the angular variations observed in both the downwelling and upwelling radiance distributions increase with the wavelength. However, these variations were considerably greater in the case of the downwelling radiance than in the case of the upwelling radiance. Indeed, we found that downwelling radiance tends to be less isotropic than the corresponding upwelling radiance. Regardless of the solar zenith angle and the wavelength, the minima of the downwelling and the upwelling radiance distributions were measured close to the zenith and to the nadir, respectively. The downwelling (upwelling) radiance increased nearly monotonically toward the horizon and peaked at zenith (nadir) angles that ranged from 75° to 90°.



UVI computed from ground-based measurements (see lines) and OMI noontime estimates (see crosses) on the Chajnantor Plateau. Quoted from Cordero et al 2014

Our campaign on the Chajnantor Plateau allowed us to detect what are so far the world's highest levels of surface UV ever measured under controlled conditions. Chile's northern Atacama Desert is characterized by its high altitude, prevalent cloudless conditions and relatively low

total ozone column. We found that on the Chajnantor Plateau the UV index peaked at 20 (see attached plot).

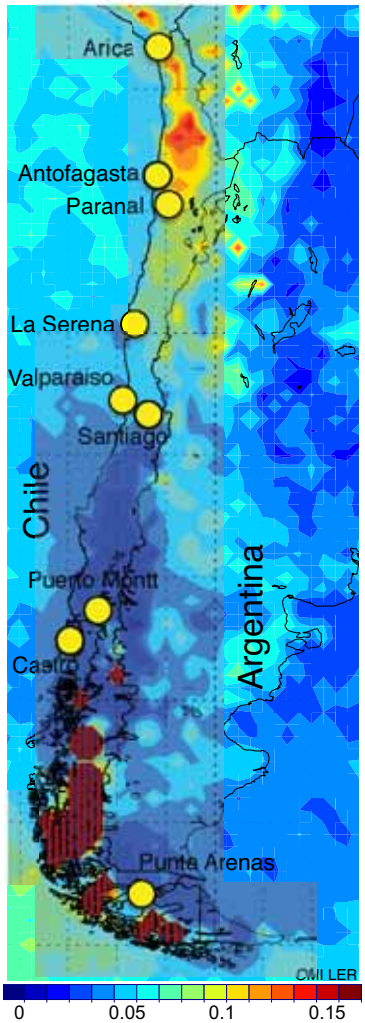
Despite our successful campaigns (see full list of campaigns below), we are aware that validation and trend detection requires longstanding efforts. Therefore, we paid significant attention to the development of our own experimental facilities. The first step was the deployment of the TARP; a semi-permanent platform (aimed at supporting our Antarctic measurements and sheltering our instrumentation on King George Island (Antarctic Peninsula). Future deployments of a twin unit at Union Glacier Camp will allows us to carry out measurements inside and outside the polar vortex. We expect that these measurements will lead to a better understanding of the UV climate on regional scale, and, in the long-term may allow us to detect changes in UV trends linked with climate change.

Remote Sensing

Satellite retrievals were extensively used for comparisons with ground-based measurements. For example, in the frame of our collaboration with the Italian National Research Council (IDASC), we compared *Brewer* ozone measurements in Arctic (Ny-Alesund station, 78.9°N, 11.9° E) with ozone estimates retrieved (over the period 2007-2009) from OMI, GOME and SCIAMACHY. The peculiar characteristics of the surface albedo in Ny- Ålesund were used to test several retrieval algorithms. Despite the extreme conditions in Polar Regions, we found a good agreement between satellite observations and the "ground true".

Our remote sensing activities were also aimed at analyzing the satellite-derived estimates of the Lambertian equivalent reflectivity (LER) in the UV-A. In one of our most recent papers (see Damiani et al 2014), we analyzed the LER data over 8 Chilean locations spanning from about 18°S latitude to 62° S latitude (i.e. including Escudero Station in the Antarctic peninsula), over the period 1978–2011. We found that the LER data retrieved from TOMS and from OMI, can be used as a proxy for the cloudiness when dealing with reconstruction models of surface UV radiation.

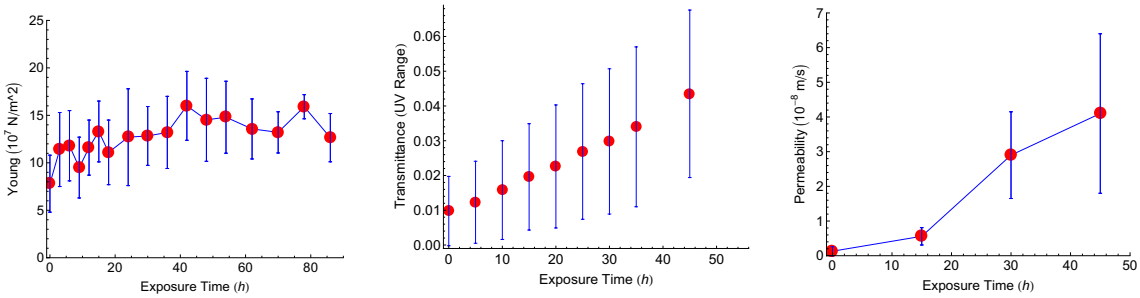
Further remote sensing activities involved studying the response of the atmosphere (in particular the ozone) to solar activity (such as solar cycles and transient solar activity). Although attention has been paid to the forcing related to solar cycles, less attention has been paid to the forcings induced by transient solar activity. Therefore, the last 3 years, we paid particular attention to transient solar events such as the emission of Solar Energetic Particles. Satellite estimates allowed us to track the trace left by solar activity on the atmosphere. For example, by using satellite data retrieved during winters from 2004 to 2011, we detected variations in chlorine components induced by Solar Energetic Particles (see Damiani et al 2012).



OMI-derived Lambertian equivalent reflectivity (LER). Quoted from Damiani, Cordero et al 2014.

UV-linked effects

Our efforts on assessing some of the UV-linked effects focused on the physical properties of cuticles isolated from both endemic plants and non-Antarctic species. The effects of the UV on the cuticles were assessed by comparing permeabilities as well as mechanical and optical properties, between cuticles that were exposed to different UV doses under controlled conditions. Our main finding was that, regardless of the tested species, detectable changes in the cuticle properties occur after exposition to UV-B doses of about 0.1 kWh/m2.



Change in the physical properties of a group of cuticles induced by exposure to UV radiation; blue bars indicate the observed variability. **Left**: Youg Modulus; Tomato (fruit). **Center**: Transmittance in the UV range; Cherry (fruit). **Right**: Permeability; Lemon (leaves). When tested in the irradiation chamber, the cuticles were exposed to UV-B doses of about 40 KJ/m2 per hour.

New Capabilities

Significant efforts were made to develop experimental capabilities. In close cooperation with our international partners (IMUK, Germany), we developed a scanner system (for radiance measurements), 3 Bentham® double monochromator-based spectroradiometers, and a whole-sky cloud monitoring system. Moreover, in order to support our research on UV-linked effects, we also developed an irradiation chamber.

Our Transportable Antarctic Research Platform (TARP) deployed in the Antarctic Peninsula early 2013.

However regarding instrumentation, our main achievement was the development of a semi-permanent platform aimed at supporting our Antarctic measurements; specially designed for harsh weather conditions, our research platform (TARP) was successfully deployed on King George Island in March 2013. TARP was fitted with a double channel UV radiometer and after almost a year, it seems successfully held up under Antarctic conditions. Next year, we plan to deploy another unit fitted with a Biospherical® multichannel spectroradiometer

V. ACTIVITIES (5 pages)

TRAINING & ORGANIZATIONAL ACTIVITIES

01. Networking

Although this proposal allowed us to strengthen our collaboration with the Soft Matter Research and Technology Center (www.smat-c.cl), we took steps to expand our current network and to project our activities in Antarctica.

Sponsored by the Universidad de Santiago de Chile (USACH), we formed an Antarctic Research Group (ARG). The latter is meant to cluster the research activities of a multidisciplinary group of local researchers (physicists, chemists, biologists, and engineers) and their international partners. For details, please visit our website: www.antarctica.cl

Associate National Institutions	
Universidad de Santiago de Chile	USACH
Universidad de Chile	UCH
Universidad Tecnica F. Santa Maria	UTFSM
Universidad de Tarapaca	UTAR
Other involved National Institutions	
Universidad de Concepcion	UCO
Universidad Catolica de Chile	PUC
Universidad Catolica de Valparaiso	PUCV
Universidad Andres Bello	UAB
Direccion Meteorologica de Chile	DMT
Chilean Antarctic Institute	INACH
Chilean Air Force	FACH

ARG is built upon solid ground; the involved associate researchers have considerable Antarctic experience and have been involved in many Antarctic research projects. Moreover, the core of this new group is the same running the "Antarctic Team Research Project (*Anillo* ACT-98).

We expect ARG to become a platform that will support our researchers to effectively achieve ambitious goals through deeper collaboration. Achieving this vision will require: promoting team work and academic exchange; funding new academics and senior researchers; offering new doctoral and postdoctoral fellowships; updating research and logistic facilities; promoting academic curricula aimed at interdisciplinary; and organizing conferences, colloquia, seminars, summer schools and lectures series.

In the long term, ARG aims to support global efforts to assess the crucial role played by Antarctica in global climate, and the impacts of climate change on Antarctica. However, in the upcoming years ARG's mission is the discernment of natural and anthropogenic influences on key Antarctic climate indicators (such as ozone, clouds, UV and albedo). We expect that this new broader group will offer us even more interesting opportunities and challenges.

02. Outreach

The ACT-98 project was part of a broader effort to investigate the UV and its effects on soft materials (such as ultrathin polymer films, nanostructures, lipid vesicles, bio and artificial shells) from a biological, chemical and physical point of view. Attending to this fact, we funded the website www.smat-c.cl, that helped us to organize seminars and others outreach activities such as minicourses, workshops, etc. The last 3 years, we co-sponsored a weekly Seminar Series on Soft Matter related topics. It brought together researchers, visitors, professors, and undergraduate and graduate students interested in a wide range of topics (from surface UV to nanofilms, see details in Annex 1).

We also upgraded our own website that (according to the suggestion of one of our reviewers), adopted a new easy-to-remember URL: www.antarctica.cl. Our website is meant to expand awareness and understanding of UV-linked phenomena and the ozone depletion, to promote the outcomes of this project, and to encourage undergraduate students to get involved in our research. Antarctica offers exciting opportunities and challenges for young scientists. It also offers the chance of working at the world's most beautiful and appealing locations. We believe that by highlighting the

Antarctic magnificence, we will be able to encourage more students to enter scientific and engineering fields.

We have already produced a significant amount of appealing material aimed at high school including 4 downloadable photo-books with amazing pictures of our prior campaigns, a set of "Antarctic posters" (1m x 2m), and more recently 1 e-Book on Ozone and UV (in Spanish). E-versions of this material can be downloaded from our web site.

03. International collaboration

Collaboration with our international partners extended the impact of our activities and strengthened further during the last 3 years. As planned, this project was carried out in close collaboration with leading international groups: the radiation and remote sensing group of the Institut für Meteorologie und Klimatologie (IMUK, Universität Hannover, http://www.muk-uni.hannover.de/~seckmeyer), and the Centro de Investigaciones en Optica (CIO, Leon, Mexico, www.cio.mx). Most of our outputs have been generated in cooperation with these partners.

The collaboration was carried out through the academic exchange and included tens of trips involving researchers, technicians and students. In the case of CIO, the topics of collaboration were mostly focused on the whole-field interferometric measurements meant to assess some of the UV-induced changes in the mechanical and the optical properties of cuticles. In the case of IMUK, the topics of collaboration were mostly focused on the quality control and validation of local ground-based spectral UV measurements, and satellite-derived products, as well as on the derivation of long-term changes in UV radiation.

Two years ago we also initiated a new collaboration with the Italian National Research Council – IDASC that already revealed to be productive and allowed us to test ozone data retrieved from OMI, GOME and SCIAMACHY, by using ground-based ozone measurements in Arctic (Ny-Alesund station).

Our atmospheric team operating at Union Glacier Camp (79º 46' S; 82º 52' W) in December 2012

Despite the success of our current collaborations, we took further steps to expand our current network. Indeed, we plan to study the radiative properties of clouds and aerosols in the Antarctica Peninsula in close collaboration with the group of Prof. Steve Neshyba (University of Puget Sound, USA); we have submitted a joint pre-proposal in order to deploy an ARM mobile facility (see http://www.arm.gov/sites/amf/amf1) in the Antarctic Peninsula. We also plan to study the links between UV-albedo and black carbon (BC) deposition on snow; aimed at BC, we plan to set some instrumentation in the Antarctic Peninsula in close collaboration with the group of Dr. Eija Asmi (from the Finish Meteorological Institute, FMI). Building a relationship with FMI seems to be strategic since it opens the door for further interhemispherical comparisons.

04. Training of students and young researchers

The total number of Chilean students involved in this proposal peaked at 20 the last summer (1 master, 5 PhD and 14 undergraduate, see additional details in the next section). These students helped us to carry out this research and by doing so also benefited from the learning experience of working together with our international partners. Although the 5 PhD students that began the program at the USACH (which requires taking several courses) have not received their degree yet, 4 of our undergraduate students and 1 of our master students successfully finished their theses (see details

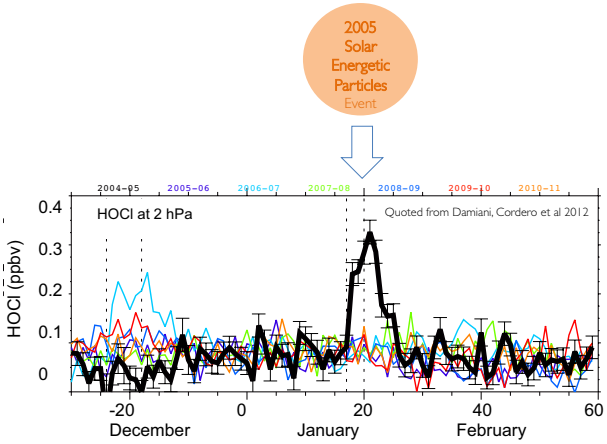
below). 4 others undergraduate students are set to finish their thesis early this year. Most of these students were supported by scholarships through our Undergraduate Research Assistant Program; Conicyt directly supports our 5 PhD students through the well-known Conicyt PhD fellowship program.

Conicyt also supported two Postdocs that were directly involved in this project. Based on his remarkable performance, one of them (Dr. Alessandro Damiani) became an associate researcher of this project and also a leading researcher of our group. Moreover, supported by our sponsoring (University of Chile) two new postdoc will join our group later this year.

R&D ACTIVITIES

01. Remote sensing

Some of our remote sensing activities were aimed at studying the response of the Earth's atmosphere to solar activity changes. In particular, we studied the response of some chemical components of the polar middle/upper atmosphere (e.g., ozone) to solar cycles (11-years and 27-days), and to transient solar activity (e.g., Solar Energetic Particle (SEP) events). Readings at Northern high latitudes by MLS and by MIPAS instruments, on Aura and ENVISAT satellites, respectively, were used to track the trace left by solar activity on the atmosphere and to report on the impact of Solar Energetic Particles on stratospheric chlorine species.



Variability in Chlorine components detected by using Microwave Limb Sounder (MLS), and Michelson Interferometer for Passive Atmospheric Sounder (MIPAS), on Aura and ENVISAT satellites. Quoted from Damiani et al 2012

Satellite-derived estimates (of both ozone and surface UV) were also tested by using ground-based measurements. In the case of UV products, we mainly analyzed data retrieved from OMI. Surface UV retrievals were determined by means of an extension of the TOMS UV algorithm developed by NASA Goddard Space Flight Center. The selection of the algorithm was important since prior efforts have shown that the agreement between ground-based measurements and satellite products depends on the retrieval algorithm and on satellite geometric parameters. In the case of the ozone column, we used data retrieved from OMI, GOME and SCIAMACHY.

Further remote sensing activities involved satellite-derived estimates of the LER in the UV-A range. We analyzed the LER data over eight Chilean locations spanning from about 18°S latitude to 62° S latitude (i.e. including Escudero Station in the Antarctic peninsula).

02. Ground-based Measurements

Aimed at testing the consistency of satellite estimates of ozone and the UV, quality-controlled measurements of the solar spectra were measured (by using our double- monochromator-based espectroradiometeres) at locations ranging from the Atacama Desert in northern Chile to the Antarctic Plateau. In the frame of this project (and in addition to the testing campaigns in Santiago de Chile), we carried out 7 main campaigns (see list below). These campaigns allowed us to study the UV climate under different cloud characteristics, different surface characteristics, different altitudes (from sea level to 5100 m asl), and different aerosol load.

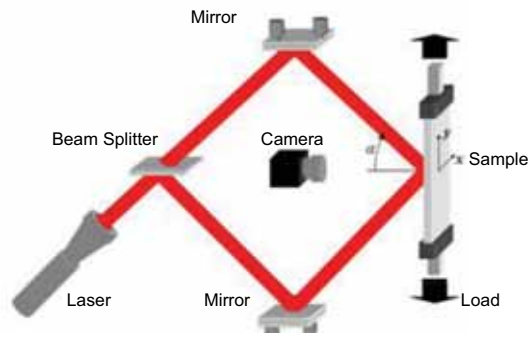
Comisión Nacional de Investigación Científica y Tecnológica - CONICYT

Main Campaigns	Location	Main Goal	Period
1) Escudero, King George Island, Antarctic Peninsula	62º 12' S; 58º 57' W	UV Irradiance	Jan-Feb 2011
2) UTFSM Campus (Valparaiso, Chile)	3.03° S; 71.58°W	UV Radiance	Nov-Dec 2012
3) Union Glacier Camp (700 m altitude, Antarctic Plateau)	79° 460 S, 82°520 W	UV Radiance	Nov-Dec 2012
4) Chajnantor Plateau (5,100 m altitude, Atacama Desert)	23° 00'S, 67°45' W	UV Irradiance	Jan 2013
5) Paranal Observatory (2,635 m altitude, Atacama Desert)	24°37'S, 70°24'W	UV Irradiance	Jan 2013
6) Escudero, King George Island, Antarctic Peninsula	62º 12' S; 58º 57' W	TARP Deployment	March 2013
7) Escudero, King George Island, Antarctic Peninsula	62º 12' S; 58º 57' W	UV Irradiance	Sept 2013

Specially important were our campaigns at Union Glacier Camp and on the Chajnantor Plateau. The former allowed us to assess the effects of the high albedo on the radiance distribution. The latter took us to the Chile's northern Atacama Desert, an area that has been pointed out as one of the places on earth where the world's highest surface ultraviolet (UV) may occur.

03. UV-linked effects on cuticles

Our efforts on assessing some of the effects of UV focused on the physical properties of cuticles isolated from both endemic plants and non-Antarctic species. We characterized the physical properties of the cuticles by using several well-known techniques including confocal imaging (to characterize cell wall and membrane thickness), phase- stepping profilometry (PSP) and electronic speckle pattern interferometry (ESPI) (to study their mechanical behavior). We learned how to measure mechanical properties (such as the Young's modulus), optical properties (such as the transmittance and the attenuation coefficient) as well as the water permeability.

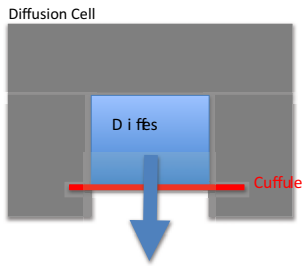


Optical setup for deformation measurements by ESPI.

The mechanical properties of cuticles were measured by subjecting isolated cuticles to tensile tests. The permeability assessment involved measuring the water loss rates of cuticles mounted on transpiration chambers. Studies on the optical properties required measuring the spectrally resolved transmittance and the attenuation coefficient (that depend on the fraction of incident light that passes through isolated cuticles).

We tested cuticles isolated from the abaxial surface of leaves of Antarctic plants (including Colobanthus quinensis and Deschampsia antartica) but also from *leaves* of citrus (*Citrus lemon*) and apples (*Malus domestica*). Cuticles isolated from fruits, including tomato (*Lycopersicon esculentum*), grape (*Vitis vinifera),* and cherry *(Prunus avium),* were also tested. Due to their tiny size we were unable to test the permeability of the cuticles isolated from endemic species.

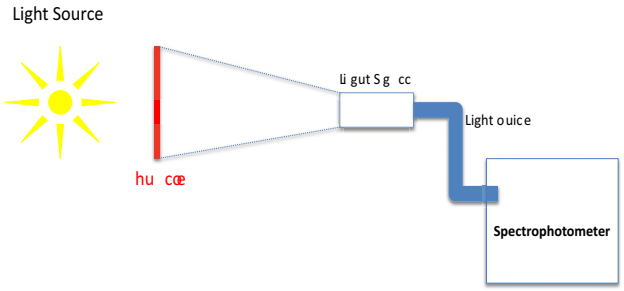
The effects of the UV were assessed by comparing permeabilities as well as the mechanical and optical properties, between cuticles that were exposed to different UV doses in our UV irradiation chamber. The cuticle properties exhibited a considerable natural variability such that a great number of tests were needed to obtain results statistically



Setup for permeability measurements

significant.

Despite the natural variability, we found significant changes induced by the UV in the whole set of tested properties: Young's modulus, transmittance, attenuation coefficient, and water permeability. This was an expected result since matrix membranes of cuticles are made of the liphophilic polymers. Therefore, our attention was mainly focused on the assessment of the UV doses leading to significant changes in the tested properties. A change was considered to be significant when the difference between properties corresponding to two groups of cuticles (subjected to different UV doses) was beyond the variability of the groups. The variability was taken as being equal to the standard deviation of the set of values obtained after testing a group of samples.



Setup for assessment of optical properties

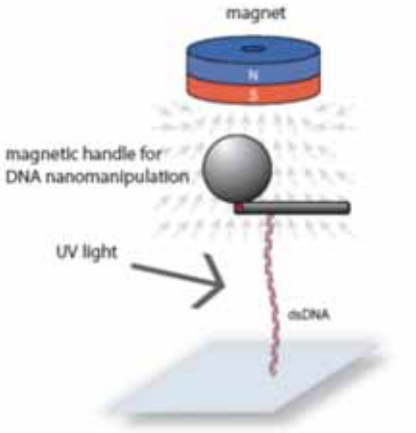
04. UV-linked effects on the DNA molecules

Further tests focused on the assessment of UV-linked effects on the DNA molecules. We applied a novel single molecule technique in order to study how these different DNA conformations are affected by UV radiation. This technique implies attaching one end of a single DNA molecule to a magnetic handle and the other end to a glass substrate. The DNA can be then pulled and twisted by modifying the surrounding magnetic field generated by an external cylindrical magnet. The setup allows measuring force and torque response of single DNA molecules.

Since it is known that UV leads to chemical modifications on DNA, we tried to correlate those modifications with the forces and torques that we measured by using our experimental setup. However, we were unable to measure the torque in the case of *radiated* molecules, and surprisingly no significant force difference was detected between UV-exposed and unexposed molecules.

We also conducted several tests meant to understand the effects of UV radiation on DNA molecular structure and to assess whether DNA conformation makes a difference in the changes undergone by DNA under UV exposure. Although we expected that UV radiation would lead to different effects on different DNA conformations, we found no statistically significant differences between molecules in different conformational stages.

It is known that UV radiation is also capable of generating new chemical bonds. We used experimental results from the interaction of small molecules with DNA as a model to understand some of the possible effects of UV radiation. We found that small molecules that intercalate between DNA base pairs make the molecule softer, reducing the interaction between base pairs.



Single molecule technique experimental setup.

VI. OUTPUTS

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LIST COURSES, SEMINARS, CONFERENCES, WORKSHOP

SEMINARS (last 3 years)

"Atmospheric research in Antarctica" R. Cordero, Seminar, Workshop: The future of Antarctic Research: priorities, collaboration possibilities and funding opportunities,Punta Arenas, Chile (November 28, 2013)

"Mechanical and Optical Properties of Cuticles", R. Cordero, Seminar, Mexican Optics and Photonics Meeting (MOPM), Ensenada, Mexico (September 4, 2013)

"The solar activity influence on the Earth's atmosphere", A. Damiani, 2012 SMAT-C seminars, Santiago de Chile University, Santiago, Chile (17 July 2012).

"Climatology of Solar Radiation", R. Cordero, Seminar, Solar Energy International Conference (SEIC), Valparaiso, Chile (October 9, 2012)

"Cellular response: A mechanical approach", R. Bernal Seminar Series SMAT-C, Departamento de Física, Universidad de Santiago de Chile, Santiago, Chile (August 2, 2011)

"Exploiting Spectral UV Radiation Data by Monte Carlo-based Techniques" R. Cordero, Institut fur Meterologie und Klimatologie, Universitat Hannover, Hannover, Germany (September 19, 2011)

"Solar energetic particle events: a natural laboratory for testing our understanding of the middle atmosphere", A. Damiani, Institute for Space Astrophysics and Planetology, INAF, Rome, Italy (18 May 2011).

"Surface Spectral UV Radiation and UV-Linked Effects on Endemic Species", R. Cordero, Facultad de Fisica y Matematica, Univesidad Autonoma de Nuevo Leon, Monterrey, Mexico (October 3, 2011)

"Mesurements of the Surface Spectral UV Radiation in the Antarctic Peninsula", R. Cordero, Seminar Series SMAT-C, Departamento de Física, Universidad de Santiago de Chile, Santiago, Chile (December 13, 2011)

"DNA mechanical properties and Magnetic Tweezers", A. Celedon, Johns Hopkins University, March 10, 2012.

"Cytoskeleton Dynamics: The Actin-MyosinII Interplay", R. Bernal, Departamento de Física, Universidad de Santiago de Chile, Santiago, Chile (March 26th, 2012)

"Interferometry and Applications", A. Martinez, Seminar Series SMAT-C, Departamento de Física, Universidad de Santiago de Chile, Santiago, Chile (June 12, 2011)

"Whole-field interferometric thecniques", PREFALC Program, R. Cordero, Lyon, Ecole Normale Superiore, Lyon, France, (1-5 November 2010).

"Physical Characterization of Leaf and Fruit Cuticles", R. Cordero, Seminar Series SMAT-C, Departamento de Física, Universidad de Santiago de Chile, (7 September 2010).

"Mechanical characterization by whole-field interferometric techniques: examples of strain monitoring by classical and speckle-based interferometry" R. Cordero, Seminar Series CIMAT, Departamento de Ciencias Físicas, Universidad de Chile, (27 August 2010).

CONFERENCES & WORKSHOPS (last 3 years)

Cordero R.R., Martinez A., Rayas J., Ferrer J., Jorquera J., Tobar M., Laroze D., 2013, "Mechanical and Optical Properties of Cuticles", Mexican Optics and Photonics Meeting (MOPM), September 4-6, Ensenada, Mexico

Laurenza M., Consolini G., Storini M., Damiani A., Acceleration and transport of energetic particles in the heliosphere, Trailing edges Workshop, Ann Arbor, MI (USA), 20-24 May 2013.

Damiani A., Influence of the solar variability on the Earth environment on short and long-term timescales, 2013 Meeting of the Italian Community in Solar and Heliospheric Physics, Catania (Italy), 4-6 September 2013 (INVITED)

Laurenza M., Consolini G., Storini M., Damiani A., A Shannon entropy approach to the temporal evolution of SEP energy spectrum, 2013 Meeting of the Italian Community in Solar and Heliospheric Physics, Catania (Italy), 4-6 September 2013

Rafanelli C., Damiani A., De Simone S., Cordero R.R., Laurenza M., 2012, "Satellite/ground-based total column ozone comparisons in Polar Regions", XXXII SCAR and Open Science Conference, July 13-25, Portland, OR, (USA)

Damiani A., B. Funke, D.R. Marsh, M. López-Puertas, M.L. Santee, L. Froidevaux, S. Wang, C.H. Jackman, T. von Clarmann, R.R. Cordero, A. Gardini, M. Storini, 2012, "Effects of January 2005 SPEs on the chemistry of the polar atmosphere", Japan Geosciences Union Meeting 2012, May 20-25, Tokyo (Japan)

Laurenza M., G. Consolini, M. Storini and A. Damiani, 2012, "A generalized extreme value distribution for the SEP event spectrum: a case study", Thirteenth International Solar Wind Conference, Big Island, June 17-22, Hawaii (USA)

Laurenza M., G. Consolini, M. Storini, A. Damiani, "On the spectral shape of SEP events: an extreme event statistics approach", 5th Isradynamics Conference: Dynamical Processes in Space and. Astrophysical Plasmas, Jerusalem (Israel), 29 April – 7 May, 2012

Garate F, Sanchez C, Quiroz F, Martinez F, Damiani A, Cordero RR, 2011, "Ground-based Spectral Measurements in the Antarctic Peninsula", VIII Chilean Meeting On Antarctic Research, October 20-22, Santiago, Chile.

Correa R, Morales JR, DaSilva L, Donoso S, Godoy S, Mera E, 2012, "Detection of 137Cs in the Andes Mountains near Santiago – Chile", IX Latin American Symposium on Nuclear Physics and Application, July 18-22, Quito, Ecuador

Martinez A, Parra-Michel J., Cordero RR, 2011, "Monte Carlo method for evaluation of uncertainty in topometry by using in-plane electronic speckle pattern interferometry with divergent illumination" ICO-22, August 15-19, Puebla, Mexico.

Toto-Arellano N, Martínez A, Rayas JA, Serrano-García D, Rodríguez G, Montes-Pérez, A, Miranda JM, Resendiz G, Gonzalez A, Garcia L, "Slope measurement of a phase objects" ICO-22, August 15-19, Puebla, Mexico

Toto-Arellano N, Serrano-García D, Martínez A, Rayas JA, Rodríguez G, "Parallel Phase Shifting Interferometry Using a Double Cyclic Shear Interferometer" ICO-22, August 15-19, Puebla, Mexico

Serrano-García D, Toto-Arellano N, Martínez A, Rayas JA, Telles, A, Rodriguez G, "Simultaneous phase-shifting cyclic interferometer for generation of lateral and radial shear" ICO-22, August 15-19, Puebla, Mexico

Martínez A. Rayas J.A. Cordero R. Balieiro D, 2011, "Morphology of leaves cuticle by fringe projection" VIII Simposio La Óptica en la Industria, September 9-10 Toluca, México

Damiani A., B. Funke, M. Lopez-Puertas, L. Froidevaux, M.L. Santee, S. Wang, C.H. Jackman, D.R. Marsh, T. von Clarmann, R.R. Cordero, A. Gardini, M. Storini, "Impact of January 2005 Solar Proton Events on chlorine species", 3nd International Workshop High Energy Particle Precipitation in the Atmosphere, Granada, Spain, (9-11 May 2011).

Damiani A, Solar energetic particle events: a natural laboratory for testing our understanding of the middle atmosphere, seminar at Institute of Interplanetary Space Physics, INAF, Rome, Italy, (18 May, 2011).

Martinez A, Rayas J. A., Cordero RR, D. Balieiro 2011, "Morfologia Cuticular por proyeccion de Franjas" VIII Encuentro de la Ciencia, Centro de Investigaciones en Optcia (CIO), León, México, (May 18-20).

Storini M, A. Damiani, R. Cordero, "Solar energetic particles in the terrestrial polar caps", 22nd European Cosmic Ray Symposium, Turku, Finland, (3 - 6 August 2010).

Storini M, P. Diego, A. Damiani and F. Signoretti, Testing cosmic-ray periodicities during a Forbush decrease, 22nd European Cosmic Ray Symposium, Turku, Finland, (3 - 6 August 2010).

Rafanelli C., E. Benedetti, A. Damiani, S. De Simone, V. Gallo, P. Diego, J. Araujo, H. Ochoa, H. Rodriguez, 1992 ÷ 2010 - eighteen years of stratospheric ozone and carbon dioxide by ground based measurements in polar regions, SCAR Open Science Conference, Buenos Aires, Argentina, (3-6 August 2010).

Rafanelli C., E. Benedetti and A. Damiani, Data cataloguing and archiving of the Italian polar research, SCAR Open Science Conference, Buenos Aires, Argentina, (3-6 August 2010).

Labbé F, "Three-parameter approach for elastic stress field of an embedded elliptic crack".Sixth MIT Conference on Computational Fluid and Solid Mechanics. Focus Advances in Solids and Structures, Massachusetts Institute of Technology, USA, (13-17 June 2011).

Labbé F, "Quantification of the constraint effect along a three-dimensional crack front in a nuclear pressure pipe", International Multiconference on Engineering and Technological Innovation, IMET 2010, Orlando, Florida, USA, (Julio 2010)

Godoy D, S.Donoso, J.R.Morales, R.Correa, L.Da Silva, E.Mera, "Detección de 137Cs en suelos de la Provincia Cordillera, Región Metropolitana, Chile", XVII Simposio Chileno de Física, Pucón, Chile (10-12 November 2010).

Cortes E, L.Da Silva, A.Ossandón, E.Mera, "Influencia del Humo de los Incendios Forestales sobre la Radiación UV en la Región de Valparaíso, Chile", VI Congreso de la Sociedad Iberoamericana de Física y Química Ambiental (SiFyQA), Cancún, México (25-29 April 2011).

Serrano DI, Martínez A, Rayas JA, "Topography measurement of specular and diffuse surfaces", Reflection, Scattering, and Difraction from Surfaces II, Edited by Zu-Han Gu, Leonard M. Hanssen, Proc. Of SPIE Vol. 7792, 77921A, Published 2 September 2010. Presentation type: poster, presentation date: August 2010, SPIE, San Diego CA, USA

Toto Arellano NI, G. Rodríguez Zurita, Martínez A, J. F. Vázquez Castillo, J. A. Rayas Álvarez, "Métodos experimentales para generar patrones interferométricos con simetría en espiral", XXIII Reunión Anual de Óptica (RAO), Puebla, Pue., México, (6-10 September 2010).

López Domínguez YY, Martínez A, Rayas JA, "Topometría y asociación de color real de los objetos", XXIII Reunión Anual de Óptica (RAO), Puebla, Pue., México, (6-10 September 2010).

Flores Muñoz VH, Martínez A, J. A. Rayas, "Asociación de puntos de referencia para el estudio de un objeto a 360º mediante visión estéreo", XXIII Reunión Anual de Óptica (RAO), Puebla, Pue., México, (6-10 September 2010).

Serrano García DI, Martínez A, J. A. Rayas, "Medición de la topografía de superficies especulares y difusas", XXIII Reunión Anual de Óptica (RAO), Puebla, Pue., México, (6-10 September 2010).

Toto Arellano NI, Rodríguez Zurita G, Martínez A, "Interferometría dinámica: avances en interferometría óptica para un mundo en movimiento", Tercer Encuentro Nacional sobre Ciencia, Tecnología e Innovación en México durante la última década y del 6to Congreso Estatal de Ciencia y Tecnología, México, (1-3 September 2010)

Balieiro D, Thelitz D, Baur P, "Potential of commercial antitranspirants to minimise water loss by transpiration", 9th International Symposium on Adjuvants for Agrochemicals (ISAA 2010) in Freising-Weihenstephan , Technical University of Munich in Freising-Weihenstephan 16-20 August 2010 Germany

THESES

THESES - Undergraduate (Finished F, and in process IP)

"UV-induced degradation on fruits cuticles", Victor Duarte, **in process (IP)**, Physical Engineering, Universidad de Santiago de Chile, R. Bernal.

"Estudio de los efectos en la aplicación de la estrategia didáctica Webquest asociadas a la problemática clima-energía, en el subsector física, para NM2 y NM3", Gladys Osorio, Daniela Gaete y Patricia Romante, **in process (IP)**, Bachelor of Education, Universidad de Santiago de Chile, R. Cordero

"Medición de propiedades ópticas en cutículas de frutas y hojas", Mario Tobar, **in process (IP)**, Physical Engineering, Universidad de Santiago de Chile, R. Cordero.

"Estudio de propiedades ópticas de aerosoles de Santiago de Chile (Aerosol optical depth & Single scattering albedo) ", Jose Jorquera, **in process (IP)**, Physical Engineering, Universidad de Santiago de Chile, R. Cordero

"Medición de propiedades mecánicas en cutículas de frutas y hojas", Natalia Salazar, **in process (IP)**, Physical Engineering, Universidad de Santiago de Chile, R. Cordero.

""Estudio del efecto de la radiación UV en la permeabilidad de hojas de limón", Jorge Muñoz, **Finished-2013**, Physical Engineering, Universidad de Santiago de Chile, R. Cordero

Desarrollo de Webquests asociadas a la problemática clima-energía", Gonzalo Guerrero, Ariel Moraga, Bárbara Pizarro, **Finished-2012**, Bachelor of Education, Universidad de Santiago de Chile, R. Cordero

"Mechanical Characterization of Bilayer Vesicles", Desireé Salas, **Finished-2011**, Physical Engineering, Universidad de Santiago de Chile, R. Bernal.

"Desarrollo de un Instrumento de Referencia para Mediciones Absolutas de Radiación de onda corta", Francisca Quiroz, **Finished-2011**, Physical Engineering, Universidad de Santiago de Chile, R. Cordero

THESES - Master (Finished F and in process IP)

Ariel Espinoza J. **Finished-2012** (Universidad Técnica Federico Santa María, Chile), F. Labbé

THESES- PhD´s (ongoing thesis)

Claudia Sánchez, (Universidad de Santiago de Chile, Chile)

Fernanda Gárate, (Universidad de Santiago de Chile, Chile)

Francisco Martinez (Universidad de Santiago de Chile, Chile)

Milenka Van Hemelryck (Universidad de Santiago de Chile, Chile)

Juan Rayas (Universidad de Santiago de Chile, Chile)

PROJECTS RELATED OR WITHIN THIS/ACTIVITIES WITH INTERNATIONAL COLLABORATION

CONICYT (Chile) Consejo Nacional de Ciencia y Tecnología – Institut Fuer Meteorologie und Klimatologie (Universitaet Hannover, Germany) Preis REDES130047" Programa Centro de Energía" 2013-2014 (R Cordero; G Seckmeyer)

CONACYT (México) Consejo Nacional de Ciencia y Tecnología, Preis 180654 "Investigación e Implementación de Técnicas Ópticas en la evaluación de Propiedades Mecánicas de Materiales" 2012-2015 (A. Martínez; R.Cordero)

CONICYT (Chile) Consejo Nacional de Ciencia y Tecnología - BMBF (Germany) Bundesministerium für Bildung und Forschung, Preis 236-2010 "UV-Strahlung in der Antarktis: Solare Strahlung auf der antarktischen Halbinsel: Abschätzung der Auswirkungen von Wolken und Albedo", 2011-2013 (R Cordero; G Seckmeyer)

CONICYT (Chile) Consejo Nacional de Ciencia y Tecnología - DAAD (Germany) Deutscher Akademischer Austausch Dienst, Preis 257-2010 "Solare Strahldichte auf der antarktischen Halbinsel", 2011-2013 (R Cordero; G Seckmeyer)

CONICYT (Chile) Consejo Nacional de Ciencia y Tecnología - CONACYT (Mexico) Consejo Nacional de Ciencia Y Tecnología, Preis 2009–090 "Analisis de los Mecanismos de Deformacion de Cuticulas de Frutas Mediante Tecnicas de Interferometria Laser", 2010-2012 (R Cordero; A Martinez)

CONACYT (Mexico) Consejo Nacional de Ciencia y Tecnología, Preis 180449, "Investigacion e Implementacion de Tecnicas Opticas en la Evaluacion de Propiedades Mecanicas de Materiales y de su Topografia" 2012-2013 (Reserachers: A Martinez, R Cordero, et al)

Model Measurement Intercomparison working group on High Energy Particle Precipitation in the Atmosphere (HEPPA-MMI), 2011-2013 (B. Funke; A Damiani et al.)

PNRA (Italy) Approccio Interdisciplinare per lo studio delle evoluzioni del clima nelle regioni polari - Progetto AIACE (C. Rafanelli; A Damiani et al.)

CONICYT (Chile) Consejo Nacional de Ciencia y Tecnología - BMBF (Germany) Bundesministerium für Bildung und Forschung, Preis 2008–096 "Setting up a high quality portable spectroradiometer system for solar UV radiation", 2009-2011

CONICYT (Chile) Consejo Nacional de Ciencia y Tecnología - DAAD (Germany) Deutscher Akademischer Austausch Dienst, Preis 2008–142 "Messung der spektralen Bestrahlungsstärke im UV Bereich : Abschätzung von hemisphärische Unterschiede" , 2009-2011

PROJECTS RELATED OR WITHIN THIS/ACTIVITIES WITH NATIONAL COLLABORATION

FONDECYT (Chile) Consejo Nacional de Ciencia y Tecnología, Preis 1140239 "Influence of the solar activity on the polar environment" 2014-2017 (A Damiani, R.Cordero)

FONDEF (Chile) Consejo Nacional de Ciencia y Tecnología, Preis IT13I10034 "National Standards for Shortwave radiation and for UV doses", 2013-2015 (R.Cordero; R. Bernal; A Damiani)

FONDEQUIP (Chile) Consejo Nacional de Ciencia y Tecnología, Preis EQM130027 "Multichannel Spectroradiometer for Ozone and UV monitoring in Antarctica", 2013-2014 (R.Cordero)

FONDECYT (Chile) Consejo Nacional de Ciencia y Tecnología, Preis 11080072 "1120639 "Development of a UV Reconstruction Model" 2012-2015 (R.Cordero; F Labbe; L Dasilva; A Damiani)

FONDECYT (Chile) Consejo Nacional de Ciencia y Tecnología, Preis 3110159 "On Climate change-related effects on surface UV radiation in Antarctica: development of a Ground-based UV Reconstruction Model" 2010-2013 (Main researcher: A Damiani; R Cordero)

CONICYT (Chile) Consejo Nacional de Ciencia y Tecnología, National Tender Process for Team Research Projects (Anillos) in Science and Technology, Preis ACT95 "Nano and Micromechanics of Soft Matter systems" 2010-2013 (Associate researchers: R.Cordero, R.Bernal)

FONDECYT (Chile) Consejo Nacional de Ciencia y Tecnología, Preis 11100416 "Modulating biopolymers mechanical properties. the interaction of anticancer drugs with DNA" 2010-2013 (Main researcher: A Celedón)

FONDECYT (Chile) Consejo Nacional de Ciencia y Tecnología, Preis 11080072 "Setting up a portable double monochromator-based spectroradiometer system for ground-based solar UV radiation measurements" 2008-2011 (Main researcher: R.Cordero)

FONDECYT (Chile) Consejo Nacional de Ciencia y Tecnología, Preis 1090471 "Two-Term Integrity Assessment Methodologies: Studying the Out-Of-Plane Constraint Loss and Comparing

Outcomes With Whole-Field Interferometric Measurements" 2009-2012 (Main researcher: F. Labbé)

FONDECYT (Chile) Consejo Nacional de Ciencia y Tecnología, Preis 1090665 "Mimic Of Bone Fracture And Cellular Interaction With A Localized Stress Distribution" 2009-2012 (Main researcher: R Bernal)

PUBLIC OR PRIVATE ENTITIES INVOLVED

Universidad de Santiago de Chile, Chile www.usach.cl
(R Cordero, R Bernal. A Damiani)

Pontificia Universidad Católica de Chile, Chile www.puc.cl
(A Celedon)

Universidad Técnica Federico Santa María, Chile www.utfsm.cl
(F Labbe, L Dasilva)

Universität Hannover, Germany www.uni-hannover.de
(G Seckmeyer)

Centro de Investigaciones en Optica, Mexico www.cio.mx
(A Martinez)

STAYS/VISITS FROM STUDENTS OR RESEARCHERS OF OTHER CENTERS OR INSTITUTIONS (last 3 years)

Miguel Leon (Centro de Investigaciones en Optica, Mexico)
13.1.2014- 20.1.2014

Kevin J. Baker (University of Chicago, USA)
15.6.2013 – 15.9.2013

Holger Schilke (Universidad de Hannover, Germany)
6.1.2013 - 26.1.2013

Hendrik Brast (Universidad de Hannover, Germany)
6.1.2013 - 26.1.2013

Amalia Martinez (Centro de Investigaciones en Optica, Mexico)
1.6.2012- 15.6.2012

Juan Rayas (Centro de Investigaciones en Optica, Mexico)
3.4.2012 - 24.5.2012

Choong Hwa Shin (University of Chicago, USA)
15.6.2012– 15.8.2012

Damien Cuvelier (CNRS/Université Paris 6, France)

9.1.2012-28.1.2012

Holger Schilke (Universidad de Hannover, Germany)
- 13.12.2010

Gunther Seckmeyer (Universidad de Hannover, Germany)
22.02.2011 - 27.02.2011

Stefan Richelmann (Universidad de Hannover, Germany)
01.02.2011 - 27.02.2011

Amalia Martinez (Centro de Investigaciones en Optica, Mexico)
20.4.2011 - 30.4.2011

Juan Rayas (Centro de Investigaciones en Optica, Mexico)
20.4.2011 - 15.5.2011

Trent German (University of Chicago, USA)
15.7.2010 – 15.9.2010

David Blair (University of Chicago, USA)
15.7.2010 – 15.9.2010

STAYS/VISITS TO OTHER CENTERS/INSTITUTIONS BY STUDENTS OR RESEARCHERS OF THIS PROJECT (last 3 years)

R. Cordero, Centro de Investigaciones en Optica, Leon, Mexico,
(August 1-15 2010)

R. Cordero, Ecole Normale Superiore, Lyon, France,
(November 1-5 2010)

R. Cordero, University of Hannover, Hannover, Germany,
(November 8-20 2010)

R. Cordero, University of Hannover, Hannover, Germany,
(May 8-21 2011)

R. Cordero, University of Hannover, Hannover, Germany,
(September 15-30 2011)

R. Cordero, Escuela de Minas de Saint Etienne, Francia,
(August 15-26, 2011)

R. Cordero, Centro de Investigaciones en Optica, Leon, Mexico,
(September 12-23 2011)

Damiani, Consiglio Nazionale delle Ricerche – IDASC, Rome, Italy,
(October 10-16, 2011)

Damiani A, Consejo Superior de Investigaciones Científicas – IAA, Granada, Spain, (October 16-22, 2011)

Damiani A, INAF, Istituto di Fisica dello Spazio Interplanetario, Rome, Italy,
(October 27-November 7, 2011)

R. Cordero, University of Hannover, Hannover, Germany,
(November 7-25, 2011)

M. Van Hemelryck (PhD student), Institut Curie, Paris, France
(September 5, 2011-December 19, 2011)

R. Bernal, Laboratoire Physico-Chimie Curie, CNRS/Université Paris 6,
(December 8-16, 2011)

F. Martinez (PhD student), Centro de Investigaciones en Optica, Leon, Mexico,
(January 15-February 15 2012)

Damiani A, INAF, Istituto di Astrofisica e Planetologia Spaziali, Rome, Italy, (February 27 - March 10, 2012)

A.Celedon, Johns Hopkins University, USA
(March 1-28, 2012).

R. Cordero, University of Hannover, Hannover, Germany,
(April 16-27, 2012)

R. Cordero, University of Hannover, Hannover, Germany,
(May 21-June 1, 2012)

A. Damiani, Consiglio Nazionale delle Ricerche – IDASC, Rome, Italy,
(May 13-June 17, 2012)

R. Cordero, Ecole Nationale Supérieure des Mines, St. Etienne, France,
(July 23-August 8, 2012)

R. Cordero, University of Hannover, Hannover, Germany,
(September 10-September 28, 2012)

N. Salazar (student), Centro de Investigaciones en Optica, Leon, Mexico,
(January 15-February 15 2013)

A. Damiani, Consiglio Nazionale delle Ricerche – IDASC, Rome, Italy,
(April 29-September 27, 2013)

R. Cordero, Centro de Investigaciones en Optica, Leon, Mexico,
(May 6-May 31 2013)

R. Cordero, University of Hannover, Hannover, Germany,
(June 3-10, 2013)

R. Cordero, Centro de Investigaciones en Optica, Leon, Mexico,

(August 19-30 2013)

R. Cordero, University of Hannover, Hannover, Germany,
(October 8-31, 2013)

UNDERGRADUATE RESEARCH ASSISTANT PROGRAM

The following students were involved in the project:

Francisca Quiroz *(Universidad de Santiago de Chile, Chile) 2010-2011

Claudia Sanchez **(Universidad de Santiago de Chile, Chile) 2010-2011

Fernanda Gárate ** (Universidad de Santiago de Chile, Chile) 2010-2011

Francisco Matínez ** (Universidad de Santiago de Chile, Chile) 2010-2011

Milenka Van Hemelryck ** (Universidad de Santiago de Chile, Chile) 2010-2011

Nicolas Reyes (Universidad de Santiago de Chile, Chile) 2011-2012

María José Quiroga (Universidad de Santiago de Chile, Chile) 2011-2014

Jorge Munoz (Universidad de Santiago de Chile, Chile) 2010-2012

Pamela Hernandez (Universidad de Santiago de Chile, Chile) 2011-2014

Mario Tobar (Universidad de Santiago de Chile, Chile) 2011-2014

Natalia Salazar (Universidad de Santiago de Chile, Chile) 2010-2014

Victor Duarte (Universidad de Santiago de Chile, Chile) 2010-2014

Jose Jorquera (Universidad de Santiago de Chile, Chile) 2011-2014

Sergio Manzano (Universidad de Santiago de Chile, Chile) 2011-2011

Marta Montero (Universidad de Santiago de Chile, Chile) 2011-2012

Gabriel Fuentes (Universidad de Santiago de Chile, Chile) 2011-2012

Salvador Atias (Universidad de Santiago de Chile, Chile) 2013

Francisco Cárdenas (Universidad de Santiago de Chile, Chile) 2013-2014

Simón Paiva (Universidad de Santiago de Chile, Chile) 2013-2014

* Became Master Student

** Became PhD Student

Comisión Nacional de Investigación Científica y Tecnológica - CONICYT

PARTICIPATION OF STUDENTS IN NATIONAL WORKSHOPS

Name	Program	Place	Time	Advisor
Claudia Sánchez	Physical Engineering student	XVII Simposio Chileno de Física, Pucón, Temuco	November 9-12, 2010	Raúl Cordero
Fernanda Gárate	Physical Engineering student	XVII Simposio Chileno de Física, Pucón, Temuco	November 9-12, 2010	Raúl Cordero
Francisca Quiroz	Physical Engineering student	XVII Simposio Chileno de Física, Pucón, Temuco	November 9-12, 2010	Raúl Cordero
Natalia Salazar	Physical Engineering student	V Escuela de Nanoestructuras y II Congreso Nacional de Nanotecnología, Valparaíso	October 1-5, 2012	Raúl Cordero
Natalia Salazar	Physical Engineering student	V Escuela de Nanoestructuras y II Congreso Nacional de Nanotecnología, Valparaíso	October 1-5, 2012	Raúl Cordero
Claudia Sánchez	PhD in Physics student	XVIII Simposio Chileno de Física, La Serena	November 21-23, 2012	Francisco Melo
Milenka Van Hemelryck	PhD in Physics student	XVIII Simposio Chileno de Física, La Serena	November 21-23, 2012	Roberto Bernal
Claudia Sánchez	PhD in Physics student	Southern Workshop on Granular Materials, SWGM12, Puerto Varas	December 4-7, 2012	Francisco Melo

OUTREACH (last 3 year)

1. Seminar Series (see Annex 1)

2. New website aimed at outreach (in English):
   www.antarctica.cl

3. Antarctic related "outreach" material (see Annex 2; 4 photo books, 1 Book on Ozone and UV (aimed at school students; in Spanish), set of "Antarctic posters" (1m x 2m).

VII. LESSONS LEARNED

The following section can be used in case of available information related to the possible difficulties, inconveniences or similar issues in the management of the project within the host institution, between CONICYT and the host institution, institution and researchers or any other combination of participants and activities involved. The idea is to resolve these issues on behalf of better practices in the current and future handling of these initiatives.

Information provided in this section must be concise, stating all variables involved and outcomes. Do not extend further than 2 pages.

VIII. INDICATORS

The following section is has no further purpose but to organize some of the previous information. **Indicators have only statistical reasons to be asked for. If you require or would like to define indicators particular to your activities, results or impact please let us know including them at the end of this table**. This program is aware that quantitative indicators do not cover most of the actual impact of your activities and thus they are not evaluated

General	Discipline	Meteorology/ Climatology
	Total project budget	US$150.000 per year
	Percentage of the project costs contributed by non-governmental sources	
	N° of main researchers	4
	N° of associated researchers	4
	Gender (%) of the previous categories	13%
Scientific production	Nº of ISI publications	37
	Nº of non- ISI publications	7
	Percentage of co-authored publications with researchers not participating in the project	100%
	Percentage of co-authored publications between Researchers of this project	33%
	Average impact index of journals with ISI	2
	Publications resulting from this project	37
	Average number of citations per article	7
	N° of presentations in international congresses	29
	N° of presentations in national congresses	3
Commercial results or others	N° of patents applied	
	N° of patents registered	
	N° of licenses and/or material transfer agreements	
	N° of Spin-offs	
	Percentage of the annual funding of the project received from private companies	
	N° of spin-offs	
	N° of applications from results directed to other sectors Than academic (private, public, schools)	
Training of young researchers and students	Nº of undergraduate students	
	Nº of Master's students	1
	Nº of Ph.D. students	5
	Nº of postdocs participating in the project	2
	N° of undergraduate theses finished	4
	N° of graduated theses finished (Master)	1

	N° of graduated theses finished (Ph.D.)	
	Percentage of theses co-tutored by researchers participant in this project.	100%
	Percentage of theses co-tutored with researchers external to this project	50%
	N° of stays/visits to other centers/institutions by students or researchers of this project	27
	N° of stays/visits from students or researchers of other centers or institutions	16
Dissemination and extramural activities	N° of other projects related or within this/activities with national collaboration	10
	N° of other projects related or within this/activities with international collaboration	10
	N° of public or private entities (not enterprises) Involved in this project	5
	Nº of dissemination/extramural events	
	Nº of times the project appears in mass media	
	Total Nº of attendants to extramural events	
	Nº of national academics attending	
	Nº of international academics attending	
	Nº of attending representatives from other sectors than academic	
	N° of documents, reports, proceedings resulting from dissemination/extramural events or activities	5

IX. ANNEXES

ANNEX N°1
SEMINAR SERIES 2010-2013

N°	FECHA	EXPOSITOR	INSTITUCIÓN	TITULO
1	06.04.10	Dr.Paula Zapata Ramírez	Facultad de Química y Biología, Universidad de Santiago de Chile	*"Nanocompositos a base de poliolefinas"*
2	13.04.10	Dr. Laurent Boue	Chemical Physics Department Weizmann Institute of Sciencie, Israel	*The glass transition: Simple Theory for a Complex Problem*
3	20.04.10	Srta.Tiaren García, Sres. Rubén Meza, Franco Tapia, Francisco Javier Martínez	Estudiantes de Ingeniería Física y Programa Doctorado en Ingeniería en Ciencia de los Materiales, Universidad de Santiago de Chile.	*Informe de Estadía de Investigación en la Universidad de Chicago*
4	27.04.10	Dr. Ramiro Godoy-Diana	Laboratoire de Physique et Mécanique des Milieux Hétérogènes CNRS, ESPCI ParisTech, Univ. Paris 6, Univ. Paris 7, Paris, France	*Flapping wings and biomimetic propulsion*
5	04.05.10	Dr.Rodolfo Madrid	Laboratorio de Neurociencias, Depto. De Biología, Fac. de Química y Biología, Universidad de Santiago de Chile	*Bases biofísicas de la termotransducción en neuronas sensoriales primarias*
6	11.05.10	Sr.David Espíndola	Estudiante de Programa Doctorado en Física, Departamento de Física, Universidad de Santiago de Chile	*"Propagación y emisión de sonido en materiales granulares: Inestabilidades bajo perturbaciones sónicas"*
7	18.05.10	Srta.Romina Muñoz	Estudiante de Programa Doctorado en Física, Departamento de Física, Universidad de Santiago de Chile	*"Método de Impulsiones para la determinación del Módulo Elástico"*
8	25.05.10	Srta. Antonella Rescaglio	Estudiante de Programa Doctorado en Física, Departamento de Física, Universidad de Santiago de Chile	*"Propagación de una onda ultrasónica en un medio granular no consolidado seco o húmedo sometido a una fuerza de compresión estática normal"*
9	01.06.10	Sr. Ariel Guerrero	Materials and Surface Science Group,	*"Shell-Isolated Nanoparticle-Enhanced Fluorescence of*

			University of Windsor, Ontario, Canadá	*Dyes"*
10	08.06.10	Dr. M.Ignacio Azócar	Facultad de Química y Biología, Universidad de Santiago de Chile	*"Inorganic films and silver nanoparticles with antibacterial properties"*
11	15.06.10	Dr.Iru Roschzttardtz	Departamento de Física, Universidad de Santiago de Chile	*"Dime cómo fluyes y te diré un secreto…"*
12	22.06.10	Sr. Héctor Alarcón	Departamento de Física, Universidad de Santiago de Chile	*"Inestabilidades inducidas por Strain-Softening en una capa de material granular cohesivo sometida a strain"*
13	29.06.10	Dr.Francisco Santibáñez	Departamento de Física, Universidad de Santiago de Chile	*"Propagación de impulsiones no-lineales en materiales granulares"*
14	06.07.10	Dr.Sergio Ciliberto	Ecole Normale Supérieure de Lyon, Laboratoire de Physique, Francia	*"Life time prediction of heterogeneous material under stress"*
15	20.07.10	Dra. Maritza Páez	Facultad de Química y Biología, Universidad de Santiago de Chile	*"Inhibitors dopped hybrid polymer coating on AA-2024: Corrosion behaviour in chloride solution"*
16	23.07.10	Dr. Fritz Scholz	Chair of Analytical and Environmental Chemistry, Institute of Biochemistry, University of Greifswald (Alemania), Editor del Journal of Solid State of Electrochemistry	*"Electrochemical Studies of the Interaction of Free Oxygen Radicals with Electrode Surfaces and Compounds on Electrode Surfaces"*
17	27.07.10	Dr.Javier Enrione	Departamento de Ciencia y Tecnología de los Alimentos, Universidad de Santiago de Chile	*"Structural Relaxation of Salmon Gelatin Films in the Glassy State"*
18	03.08.10	Mr.John M. Green	Asylum Research, USA	*"Atomic Force Microscopy; Biological and Soft-Matter applications"*
19	10.08.10	Dr.Abel Guarda	Departamento de Ciencia y Tecnología de los Alimentos, Universidad de Santiago de Chile	*"Metalización de materiales plásticos flexibles".*
20	24.08.10	Dr.José Zagal	Facultad de Química y Biología, Universidad de Santiago de Chile	*Tunning the properties of catalyists for maximum activity in electrochemical reactions. Impact in energy conversion and sensors"*
21	31.08.10	Dr. Belfor Galaz	Departamento de Física, Universidad de Santiago	*Elastografía: visualización de propiedades elásticas locales*

			de Chile	*de tejidos blandos*
22	07.09.10	Dr. Raúl Cordero	Departamento de Física, Universidad de Santiago de Chile	*"Physical Characterization of Leaf and Fruit Cuticles"*
23	12.10.10	Sr. Octavio Albarrán	Universidad de Montpellier 2, Francia	*"Growth of holes in Red Blood Cells (RBCs) membranes due to Spontaneous Curvature (Curling Phenomena)"*
24	19.10.10	Dra. Carmen González	Departamento de Ing. Química, Universidad de Barcelona, España	*"Sistemas dispersos: Nuevas formulaciones en alimentos"*
25	26.10.10	Sr.Tom Watt	Departamento de Física, Universidad de Santiago de Chile	*"Zona de movimiento creada por dos puntos de extracción en operación simultánea"*
26	02.11.10	Dr. Enrique Cerda	Departamento de Física, Universidad de Santiago de Chile	*"Metrología en Superficies Ultradelgadas"*
27	09.11.10	Srta. Carolina Adura	Doctorado en Química, Facultad de Química y Biología, USACH Laboratorio de Nanotecnología, Universidad de Chile	*"Obtención de conjugados de Nanoesferas y Nanorods de oro con péptidos para potenciales bioaplicaciones"*
28	16.11.10	Srta. Desireé Salas	Departamento de Física, Universidad de Santiago de Chile	*"Caracterización de vesículas por medio de fluctuaciones térmicas"*
29	30.11.10	Dr. Bernard Tribollet	Laboratoire Interfaces et Systemes Electrochimiques, CNRS, Université Pierre et Marie Curie, Francia	*"Galvanic coupling on aluminum 2024 alloys"*
30	07.12.10	Dr. Singh Dinesh	Departamento de Física, Universidad de Santiago de Chile	*"Nanotribology: High Temperature Lubricating Behavior of Some Solid Lubricants"*
31	14.12.10	Dr. Valerie Vidal	Laboratoire de Physique, Ecole Normale Superieure de Lyon – CNRS, Francia	*"Dynamics of degassing in an inmersed granular medium"*

32	15.03.11	Nelson Sepúlveda	Estudiante del Programa Doctorado en Física, Departamento de Física, Universidad de Santiago de Chile	*"Respuesta de un sistema granular bidimensional frente a perturbaciones locales creadas mediante esfuerzos de corte"*
33	22.03.11	Héctor Alarcón	Estudiante del Programa Doctorado en Física, Departamento de Física, Universidad de Santiago de Chile	*"Respuesta mecánica de una capa de material granular sometida a deformaciones en el plano"*
34	29.03.11	Dr. Yaroslav Ispolatov	Departamento de Física, Universidad de Santiago de Chile	*"Shifting equilibrium in mass-action reaction networks: Example of protein-protein binding?"*
35	05.04.11	Komal Dadlani, Cynthia Eggeling	Estudiantes de Bioquímica, Facultad de Ciencias Químicas y Farmaceúticas, U.Chile, y Universidad Católica de Valparaíso, respectivamente.	*"Interacción entre Bicapas Lipídicas y Nanopartículas; un estudio prometedor"*
36	12.04.11	Dr. Niels Holten-Andersen	University of Chicago, USA.	*"The mussel holdfast thread: A material worth mimicking?"*
37	19.04.11	Dr. Julio Romero	Departamento de Ingeniería Química, Universidad de Santiago de Chile	*"Tecnología de membranas acoplada al uso de solventes alternativos: aplicaciones en hidrometalurgia, alimentos y el tratamiento de residuos"*
38	26.04.11	Carolina Pérez, Sergio Correa, Ignacio Calderón, Roberto Gómez	Estudiantes de Ingeniería Física y Bioquímica , Universidad de Santiago de Chile.	*Informe de Estadía de Investigación en la Universidad de Chicago*
39	03.05.11	Dr. María Paula Junqueira	Departamento de Ciencia y Tecnología de Alimentos, Universidad de Santiago de Chile	*"Uso de películas comestibles activas e irradiación gama como tecnologías combinadas para aumentar la vida útil de berries frescos"*
40	10.05.11	Dr. Silvia Matiacevich	Departamento de Ciencia y Tecnología de Alimentos, Universidad de Santiago de Chile	*"Efecto del estado estructural de peliculas a base de gelatina de bovino y salmón en la propiedad antimicrobiana del quitosano"*
41	17.05.11	Dr. Juan Francisco Silva	Laboratorio Electrocatálisis, Facultad de Química y Biología, Universidad de Santiago de Chile	*"Monocapas autoensambladas, funcionalizadas con catalizadores y sus aplicaciones en el desarrollo de sensores"*

42	31.05.11	Dr. Francisco Santibáñez	Departamento de Física, Universidad de Santiago de Chile	*"Evidencia experimental de interacción de ondas nolineales en cadenas granulares"*
43	14.06.11	Dr. Guillaume Lagubeau	Departamento de Física, Universidad de Santiago de Chile	*"Flower Patterns in Drop Impact on Thin Liquid Films"*
44	28.06.11	Dr. Michel Ignat	On leave at Department of Physics, FCFM, U. Chile - CNRS (R) SIMAP, Grenoble-INP, France	*"Mechanical Stability of thin self standing films, and film on substrate systems"*
45	05.07.11	Sr. Javier Contreras	Estudiante del Programa Doctorado en Física, Departamento de Física, Universidad de Santiago de Chile	*"Rumbo al Éxito: El camino de una gota granular hacia la cima…"*
46	12.07.11	Dr. Jean-Yves Dieulot	Maître de Conférence, Ecole Polytechnique Universitaire de Lille, Food Engineering Department , France	*"Supervised and unsupervised data classification techniques"*
47	19.07.11	Dr. Nicolás Rojas	Université de Nice Sophia-Antipolis. Nice, France	*"Inertial Lubrication Theory "*
48	26.07.11	Dr. Guillaume Lagubeau	Departamento de Física, Universidad de Santiago de Chile	*"Granular interfases"*
49	02.08.11	Dr. Roberto Bernal	Departamento de Física, Universidad de Santiago de Chile	*"Cellular Response: A mechanical approach"*
50	09.08.11	Dr. Etienne Couturier	Departamento de Física, Universidad de Santiago de Chile	*"Fold and leaf shape"*
51	23.08.11	Dr. María Luisa Cordero	Departamento de Física, Fac. Ciencias Físicas y Matemáticas, Universidad de Chile	*"Control óptico de microgotas"*
52	30.08.11	Dr. Ignacio Azócar	Facultad de Química y Biología, Universidad de Santiago de Chile	*"Antibacterial efficiency of silver(I) complexes with Ag-O Bonding"*
53	06.09.11	Srta. Mireya Santander	Estudiante de Doctorado en Química, Facultad de Química y Biología, Universidad de Santiago de Chile	*"Estudio de transferencia de carga y electrocatálisis en sistema electródico molecularmente ensamblado"*

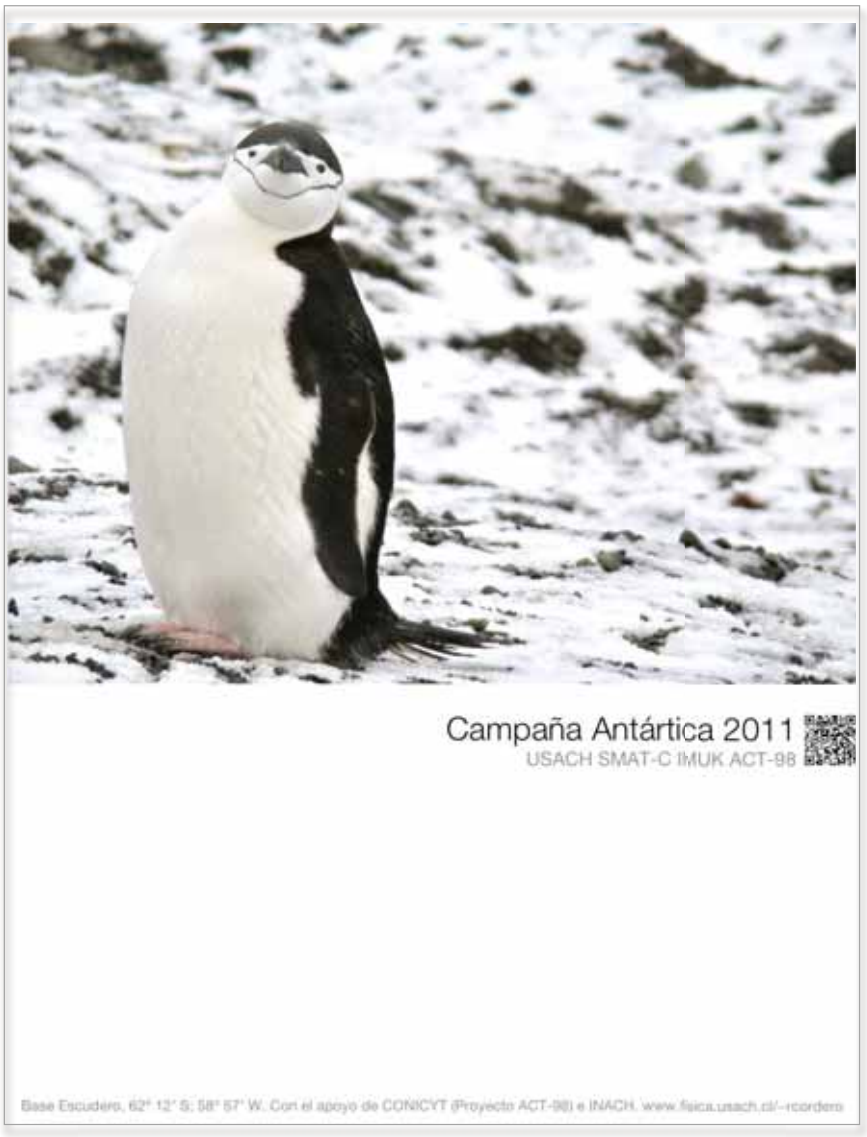
54	27.09.11	Dr. Jerónimo Maze	Departamento de Física, Pontificia Universidad Católica de Chile	*"Exploring the Quantum at the Nanoscale with Diamond"*
55	04.10.11	Dr. Ulrich Volkmann	Departamento de Física, Pontificia Universidad Católica de Chile	*"Organic chain molecules and biological membranes onto solid surfaces for applications in Nanotechnology "*
56	11.10.11	Dr. Patricio Rojas	Lab. de Neurociencias, Facultad de Química y Biología, Universidad de Santiago de Chile	*"Una nueva propiedad de una conductancia iónica de membrana en la fisiología neuronal "*
57	13.12.11	Dr. Raúl Cordero	Departamento de Física, Universidad de Santiago de Chile	*"Radiación espectral UV en la Península Antártica"*
58	20.12.11	Dr. Benoit Roman	PMMH – ESPCI, París, Francia	*"Tearing thin sheets : where does the crack go ?"*
59	27.12.11	Srta. Nathalie Casanova	Département Colloïdes, Verres et Nanomatériaux Université Montpellier II	*"Malaria parasite motion: The merozoites ´Moonwalk´"*
60	10.01.12	Dr. Eugenio Hamm	Departamento de Física, Universidad de Santiago de Chile	*"Colapso de una lámina elástica delgada sometida a presión constante"*
61	17.01.12	Dr. Damien Cuvelier	Laboratoire Physico-Chimie Curie, CNRS/Université Paris 6, Francia	*"Curling Dynamics of thin Sheets"*
62	24.01.12	Dr. Lihua Luu	Depto. de Física, Facultad Ciencias Físicas y Matemáticas, Universidad de Chile	*"Drop impact of yield-stress fluids: rheology, splash and cratering"*
63	31.01.12	Sr. David Espíndola	Estudiante del Programa Doctorado en Física, Departamento de Física, Universidad de Santiago de Chile	*"Ultrasonido de alta amplitud en un test de creep de un sistema granular"*
64	20.03.12	Dr. Nestor Sepúlveda	Departamento de Física, Universidad de Santiago de Chile	*"Movimiento colectivo en células epiteliales: modelo estocástico de partículas interactuantes versus experimento"*
65	03.04.12	Dra. Mina Roussenova	University of Bristol. Bristol, UK	*"Molecular organisation in biopolymer matrices: Opening it up at the nano-level"*

66	10.04.12	Dr. Yaroslav	Departamento de Física,	*"Two traffic models with*

		Ispolatov	Universidad de Santiago de Chile	*passing"*
67	24.04.12	Dra. Claudia Saavedra	Facultad de Ciencias Biológicas, Universidad Andrés Bello	*"De la estructura a la regulación: Rol de las porinas en la supervivencia de Salmonella al estrés oxidativo"*
68	08.05.12	Dr. Rodrigo Soto	Departamento de Física, FCFM, Universidad de Chile	*"Dinámica de medios granulares en geometría confinada: de la micro a la macrofísica"*
69	15.05.12	Dr. Etienne Couturier	Departamento de Física, Universidad de Santiago de Chile	*"Suspension rheology: Measure of normal stresses"*
70	22.05.12	Dr. Andrés Couve	Facultad de Medicina, Universidad de Chile	*"Location matters: protein trafficking and early secretory organelles in dendrites and axons"*
71	29.05.12	Dr. Guillaume Lagubeau	Departamento de Física, Universidad de Santiago de Chile	*"Shapes of liquid marbles"*
72	11.06.12	Dra. Amalia Martínez	Centro de Investigaciones en Óptica, México	*"Visualización tridimensional usando la técnica de proyección de franjas y visión estéreo"*
73	12.06.12	Dr. Julien Armijo	Grupo de Optica No-Lineal, Departamento de Física, Facultad de Ciencias, U.Chile	*"Quantum and thermal density fluctuations in an ultracold 1D Bose gas"*
74	12.06.12	Dra. Amalia Martínez	Centro de Investigaciones en Óptica, México	*"Interferometría y algunas de sus aplicaciones"*
75	19.06.12	Sr. Franco Tapia	Estudiante Programa Doctorado en Ingeniería en Ciencia de los Materiales, Universidad de Santiago de Chile.	*"Dinámica de Bandas de Cizalle en Medios Granulares Densos"*
76	26.06.12	Dr. Nelson Barrera	Departamento de Fisiología, Fac. de Ciencias Biológicas, P.Univ. Católica de Chile	*"Aplicación de Espectrometría de Masas en las Proteínas de Membrana: Desde Proteómica a los Complejos Intactos"*
77	03.07.12	Dr. Eitan Grinspun	Columbia University, USA	*"A Geometric Approach to Computation of Elastica in Contact "*

78	10.07.12	Dr. Ricardo Andrade	Departamento de Ciencias y Tecnología de los Alimentos, Universidad de Santiago de Chile	*"Impacto de gotas sobre diferentes superficies de vegetales"*
79	17.07.12	Dr. Alessandro Damiani	Departamento de Física, Universidad de Santiago de Chile	*"Impact of the solar activity on the Earth's atmosphere"*
80	14.08.12	Dr. Dieter Typke	Lawrence Berkeley National Laboratory, USA	*"Electron Tomography in Structural Biology"*
81	21.08.12	Dr. Yaroslav Ispolatov	Departamento de Física, Universidad de Santiago de Chile	*"A Model of cisternae maturation and vesicle transport in Golgi apparatus"*
82	28.08.12	Dr. Jaime Eugenin	Facultad de Química y Biología, Universidad de Santiago de Chile	*"¿Por qué fumar cigarrillos durante el embarazo se asocia a muerte súbita del lactante?"*
83	04.09.12	Dr. Valeria del Campo	Departamento de Física, Universidad Técnica Federico Santa María	*"Crecimiento de Estructuras Grafíticas por Evaporación Química"*
84	11.09.12	Srta. Claudia Sánchez	Estudiante Programa Doctorado en Física, Universidad de Santiago de Chile.	*"Debilitamiento por cizalle y colapso de burbujas en fluidos visco-elásticos "*
85	09.10.12	Dr. Claudio Acuña	Facultad de Química y Biología, Universidad de Santiago de Chile	*"En búsqueda de una vacuna contra el cáncer "*
86	16.10.12	Srta. Desireé Salas	Estudiante de Doctorado en Física, Centre de Biochimie Structurale (CBS), Montpellier, Francia	*"Caracterización de origamis de ADN mediante microscopía de súper resolución "*
87	16.10.12	Dr. Jérome Hoepffner	Université Pierre et Marie Curie, Francia	*"Recoil of a liquid filament: escape of the pinching through vortex ring inception"*
88	28.10.12	Dra. Silvia Goyanes	Universidad de Buenos Aires, Argentina	*"Nanotecnología aplicada al desarrollo de Nuevos Materiales"*
89	11.12.12	Dr. Christian Wilson	University of California, Berkeley, USA	*"A hybrid TIRF-magnetic tweezers instrument for studying sub-nanometer effects of force on proteins and DNA"*
90	19.03.13	Dr. Franck Quero	University of Manchester	*"Interfacial Micromechanics of Bacterial Cellulose Biocomposites Using Raman Spectroscopy"*

ANNEX N°2
Some of the Antarctic related "outreach" material



One of our "Antarctic posters" (1m x 2m) aimed at outreach.

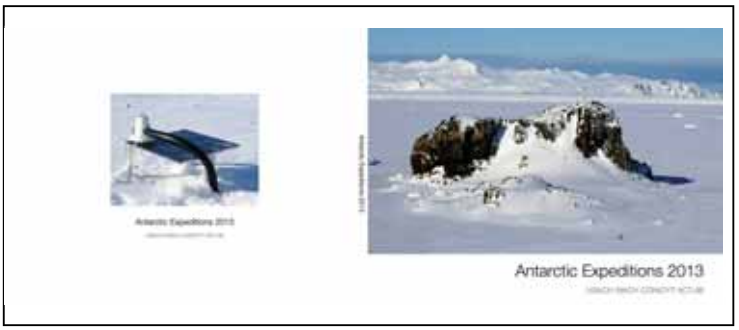
Our 4 Photo books based on our campaigns. The pictures were taken by our students during our Campaigns.

Electronic version are available at our website:
www.antarctica.cl

http://www.antarctica.cl/Atmosphere_files/northern%20chile.pdf

http://www.antarctica.cl/Atmosphere_files/Antarctic%20Campaign%202011.pdf

http://www.antarctica.cl/Cryosphere_files/Union%20Glacier%20Campaing2%20_1.pdf



http://www.antarctica.cl/Cryosphere_files/Antarctic%20Expeditions%202013_1.pdf

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Book on Ozone and UV (aimed at school students; in Spanish)

http://www.antarctica.cl/Outreach/Outreach_files/Ozono%20y%20Radiacion%20UV_1.pdf

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ANNEX N°3 (In Spanish)

Descripción del trabajo de todas las personas beneficiadas con recursos del Anillo ACT-98.

Investigador	Rol / Actividades
Raúl R. Cordero	Como líder del proyecto, se encargó de la gestión del proyecto y la coordinación; participó en campañas antárticas y en el norte de Chile
Fernando Labbe	Investigador a cargo de actividades relativas a la evaluación de las propiedades mecánicas de biomateriales (cutículas)
Luis Da Silva	Investigador a cargo de análisis de mediciones en superficie de Ozono y radiación UV
Roberto Bernal	Investigador a cargo de actividades relativas a la detección de cambios en las propiedades mecánicas de las cutículas sometidas a la radiación UV.
Alfredo Celedón	Investigador a cargo de ensayo de laboratorio que involucraron manipulación de moléculas de ADN.
Alessandro Damiani	Investigador a cargo de actividades relativas a la detección remota y manejo de datos satelitales ; participó en campañas antárticas y en el norte de Chile
Gunther Seckmeyer	Investigador involucrado en el análisis de mediciones en superficie de Ozono y radiación UV
Erika Inoztroza	Apoyo administrativo para gestión del proyecto y la coordinación
Armando Jaque	Encargo de organización de Actividades de Outreach
Holger Schille	Investigador a cargo de mediciones de radiación UV en el norte de Chile; participó en campañas el norte de Chile
Hendrik Brast	Investigador participante en campañas de mediciones de radiación UV en el norte de Chile; participó en campañas en el norte de Chile
Amalia Martínez	Investigadora involucrada en actividades relativas a la evaluación de las propiedades mecánicas de biomateriales (cutículas)
Juan Rayas	Investigador involucrado en actividades relativas a la detección de cambios en las propiedades mecánicas de las cutículas sometidas a la radiación UV; participó en campañas antárticas.
Stefan Richelmann	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas.
Natalia Salazar	Investigadora involucrada en actividades relativas a la evaluación de las propiedades mecánicas de biomateriales (cutículas)
Francisca Quiroz	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas
Claudia Sanchez	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas
Fernanda Gárate	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas
Francisco Martínez	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas
Nicolas Reyes	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas
Maria José Quiroga	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas
Pamela Hernández	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas
Mario Tobar	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas

José Jorquera	Investigador involucrado en mediciones en superficie de Ozono y radiación UV; participó en campañas antárticas
Jorge Muñoz	Investigador involucrado en actividades relativas a la medición de permeabilidad al agua de cutículas
Victor Duarte	Investigador involucrado en actividades relativas a la evaluación de las propiedades mecánicas de biomateriales (cutículas)