

Rayos y centellas sobre la Patagonia



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RESEARCH ARTICLE

10.1002/2013JD021160

Key Points:

- Significant lightning activity occurs in Western Patagonia
- Lightning storms develop under a cold, weakly unstable postfrontal condition
- Topography and ocean conditions favor lightning activity in Western Patagonia

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Lightning in Western Patagonia

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Abstract On the basis of 8 years (2005–2012) of stroke data from the World Wide Lightning Location Network we describe the spatial distribution and temporal variability of lightning activity over Western Patagonia. This region extends from ~40°S to 55°S along the west coast of South America, is limited to the east by the austral Andes, and features a hyper-humid, maritime climate. Stroke density exhibits a sharp maximum along the coast of southern Chile. Although precipitation there is largely produced by cold nimbostratus, days with more than one stroke occur up to a third of the time somewhere along the coastal strip. Disperse strokes are also observed off southern Chile. In contrast, strokes are virtually nonexistent over the austral Andes—where precipitation is maximum—and farther east over the dry lowlands of Argentina. Atmospheric reanalysis and satellite imagery are used to characterize the synoptic environment of lightning-producing storms, exemplified by a case study and generalized by a compositing analysis. Lightning activity tends to occur when Western Patagonia is immersed in a pool of cold air behind a front that has reached the coast at ~40°S. Under these circumstances, midlevel cooling occurs before and is more prominent than near-surface cooling, leading to a weakly unstable postfrontal condition. Forced uplift of the strong westerlies impinging on the coastal mountains can trigger convection and produces significant lightning activity in this zone. Farther offshore, large-scale ascent near the cyclone's center may lift near-surface air parcels, fostering shallow convection and dispersing lightning activity.

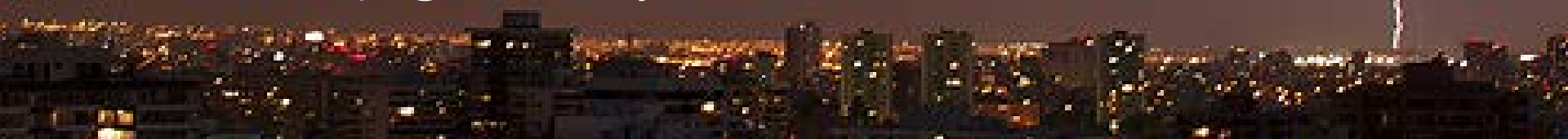
Rayos en la Patagonia

- Motivación
- Distribución espacio-temporal
- Un caso de estudio
- Análisis Climatológico
- Conclusiones
- Otras aplicaciones



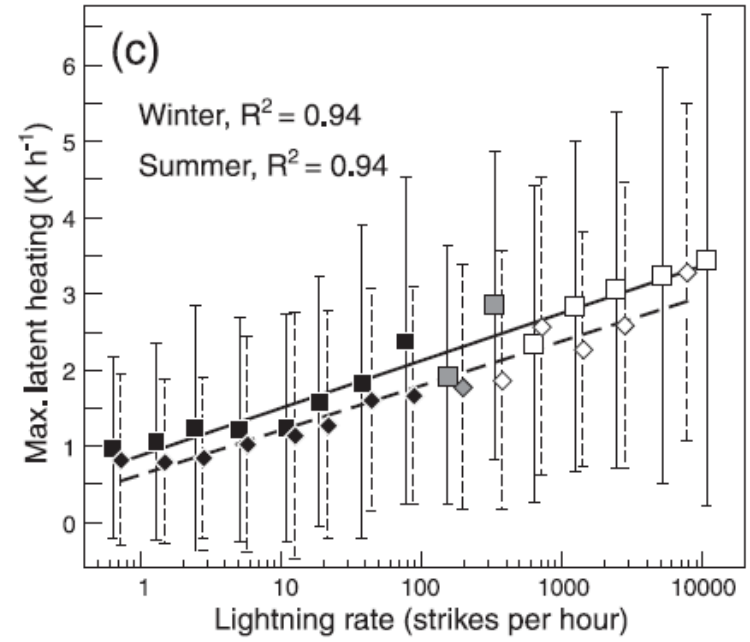
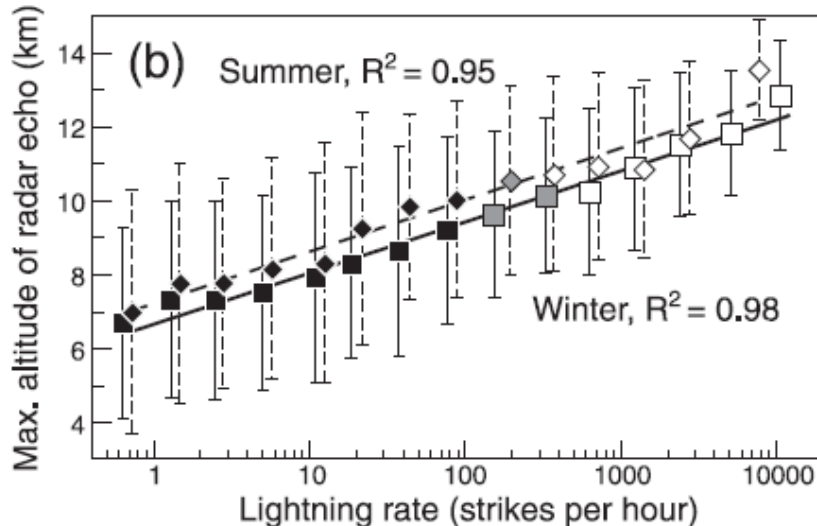
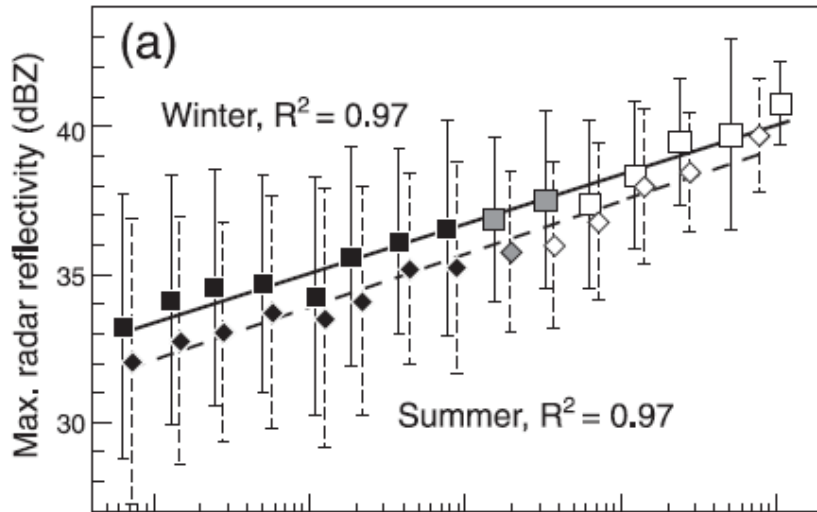
Electrificación de nubes 101

- Cerca de 50 rayos por segundo a nivel planetario. Distribución muy poco uniforme.
- Tormentas eléctricas, y en particular rayos nube-tierra, constituyen un riesgo natural importante para el público en general, aviación, transmisión eléctrica e incendios forestales.
- Generalmente ocurren junto a otros elementos de tiempo severo: lluvia intensa (aunque localizada), granizo y viento fuerte.



Relación entre cantidad de descargas y precipitación en el Pacífico NE (sector de Hawaii)

Pessi and Bussinger 2009, JAMC



Eventual asimilación en PNM

Electrificación de nubes 102

Actividad eléctrica en nubes convectivas es producto de inducción electrostática y depende de **factores microfísicos** ($q_{\text{droplet}}, q_{\text{ice}} > 0$ en una capa profunda entre 0 y -40°C) y **factores dinámicos** (corriente ascendente intensa ($w \geq 5 \text{ ms}^{-1}$) y sostenida en capa mixta).

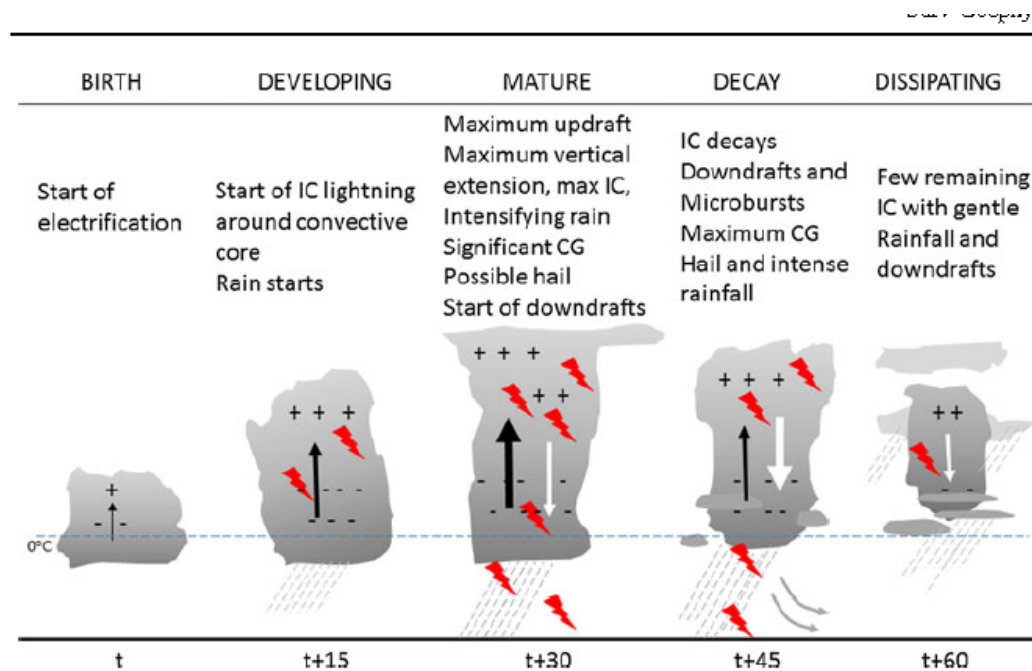
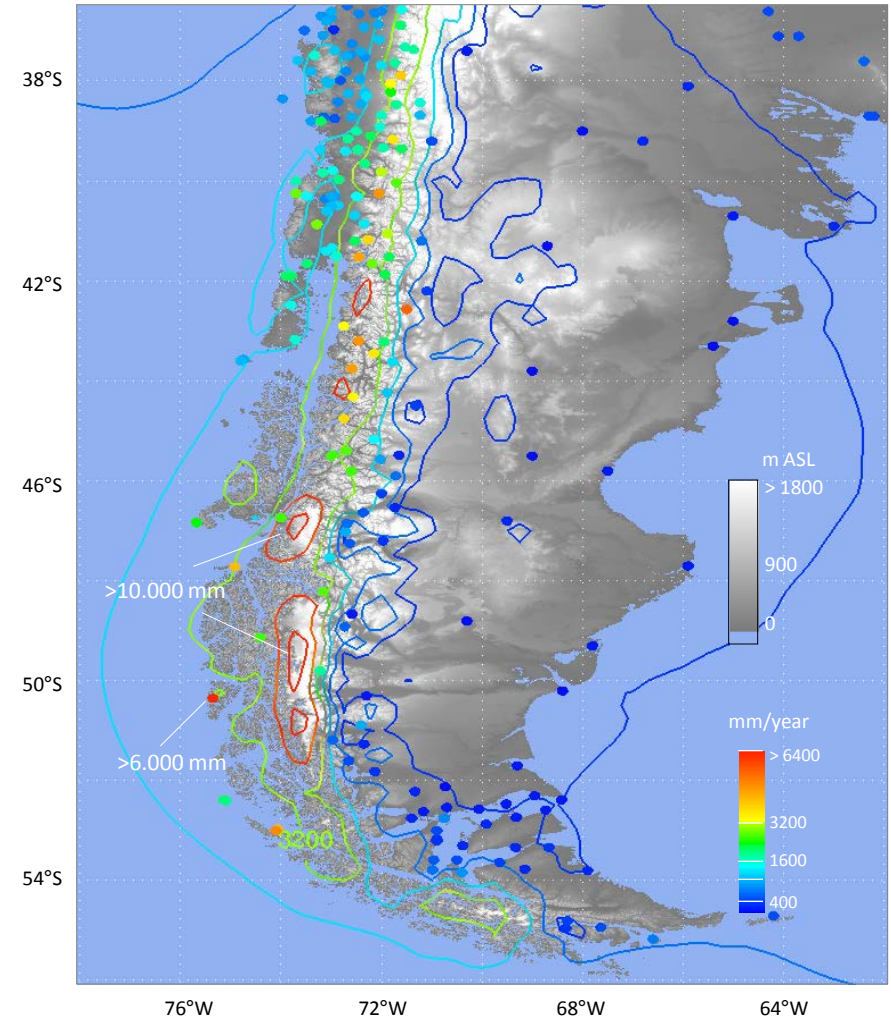


Fig. 1 The various stages of development and decay of a thunderstorm cell and the associated lightning and possible severe weather associated with each stage. Updrafts (*black arrows*) and downdrafts (*white arrows*) are shown relative to their intensity. IC and CG lightning are shown in *red* either in cloud or below cloud base. The approximate time (*minutes*) between each stage is shown below

Patagonia Oeste 101

- Clima templado híper-lluvioso con baja estacionalidad.
- Notable incremento orográfico de la precipitación.
- Precipitación causada por sistemas de latitudes medias de naturaleza estable y fría (nimbo-estratos)... CAPE~0, FZL ~ 1 km

→ **Actividad eléctrica parece improbable en esta región...tal vez al Este....sin embargo...**



Evidencia de paleo-incendios en Patagonia Oeste sugiere ocurrencia de rayos en esta región

L14710

HOLZ AND VEBLÉN: SAM AND WILDFIRE IN PATAGONIA

L14710

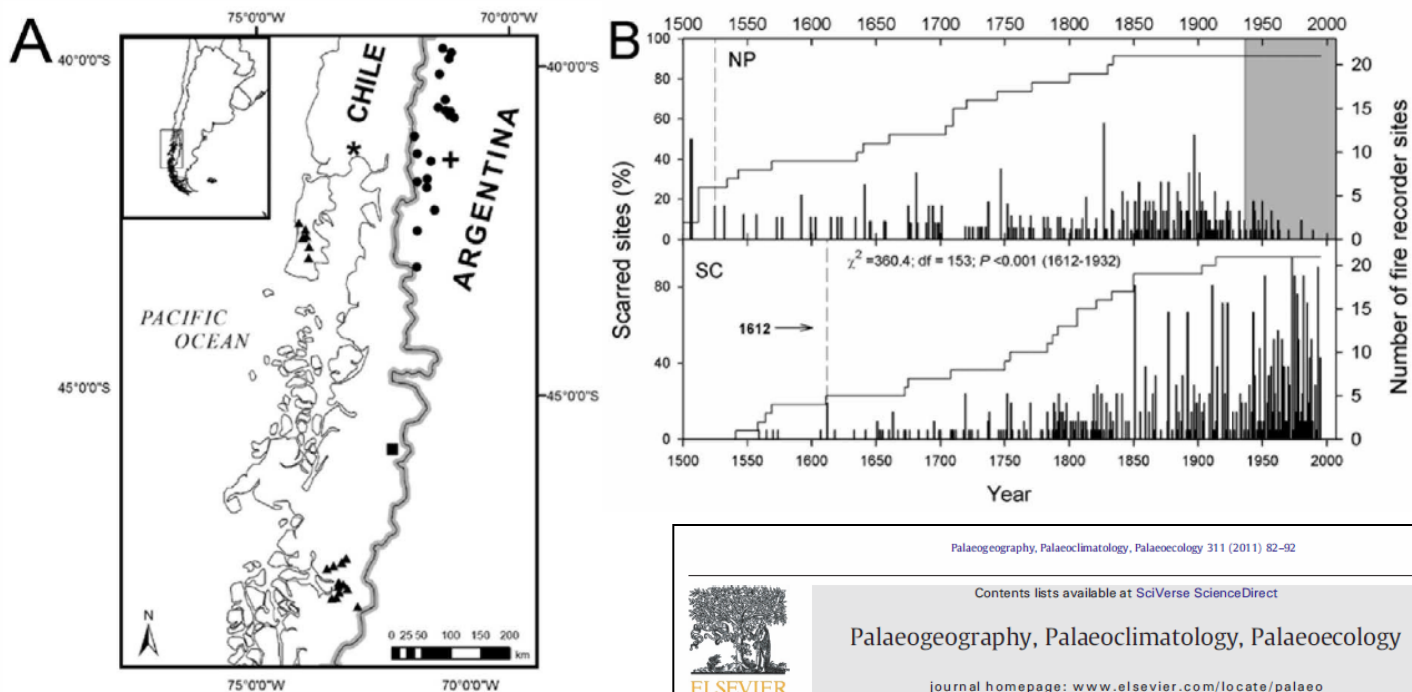


Figure 2. (a) Locations of the regional fire-chronology sites (triangles), and of the Puerto Montt (asterisk), Bariloche (plus) (1500–2004) of all fire events and sample depth of each period (post-1932) in the NP area). Chi-square and p-value ($\geq 10\%$ of all sites in each area, with a minimum of two sites). Vertical dashed-lines and “1612→” indicate the start year of the fire chronology and of analysis.

Palaeogeography, Palaeoclimatology, Palaeoecology 311 (2011) 82–92

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PALAEO 3

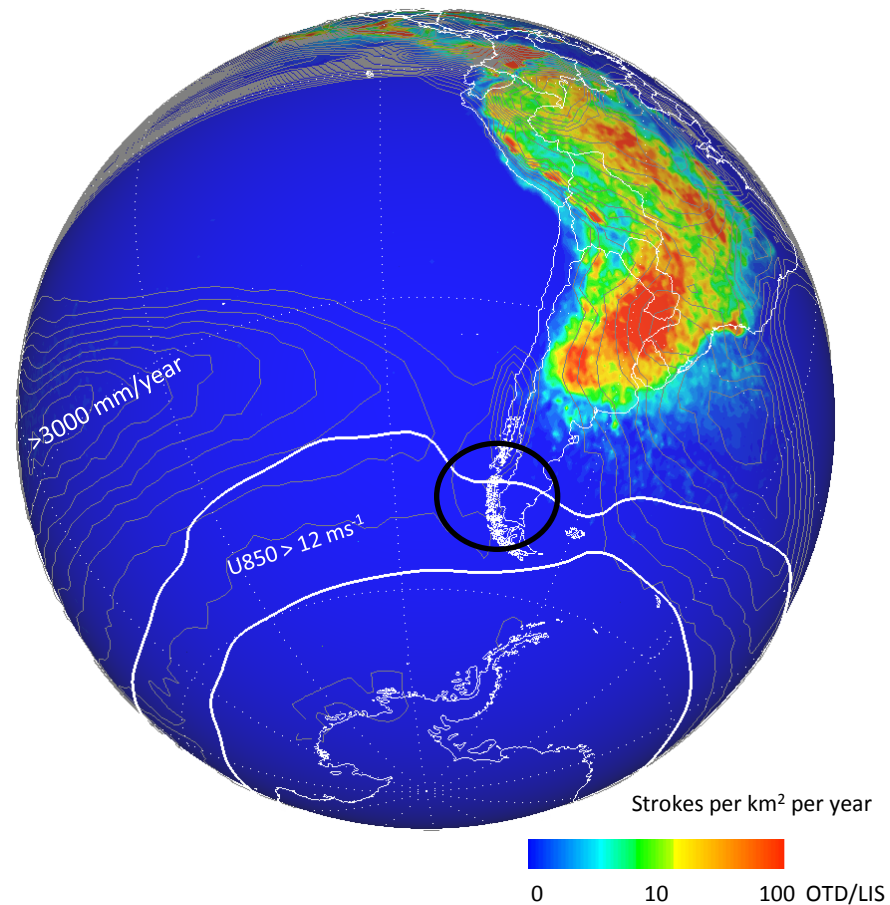
The amplifying effects of humans on fire regimes in temperate rainforests in western Patagonia

Andrés Holz*, Thomas T. Veblén

Department of Geography, University of Colorado, Boulder, CO 80309 USA

The Lightning Imaging Sensor (LIS)

LIS is on board of the Tropical Rainfall Measuring Mission (TRMM) detecting the discrete optical pulses associated with changes in cloud brightness at each pixel. Its sampling is restricted to the $\pm 38^\circ$ latitude band.



World Wide Lightning Location Network (WWLLN)

It monitors the VLF radio waves (sferics) emitted by lightning and uses a time of group arrival technique to locate lightning strokes within ~ 5 km and $< 10 \mu\text{s}$. Online data available at:

<http://wwlln.net/>

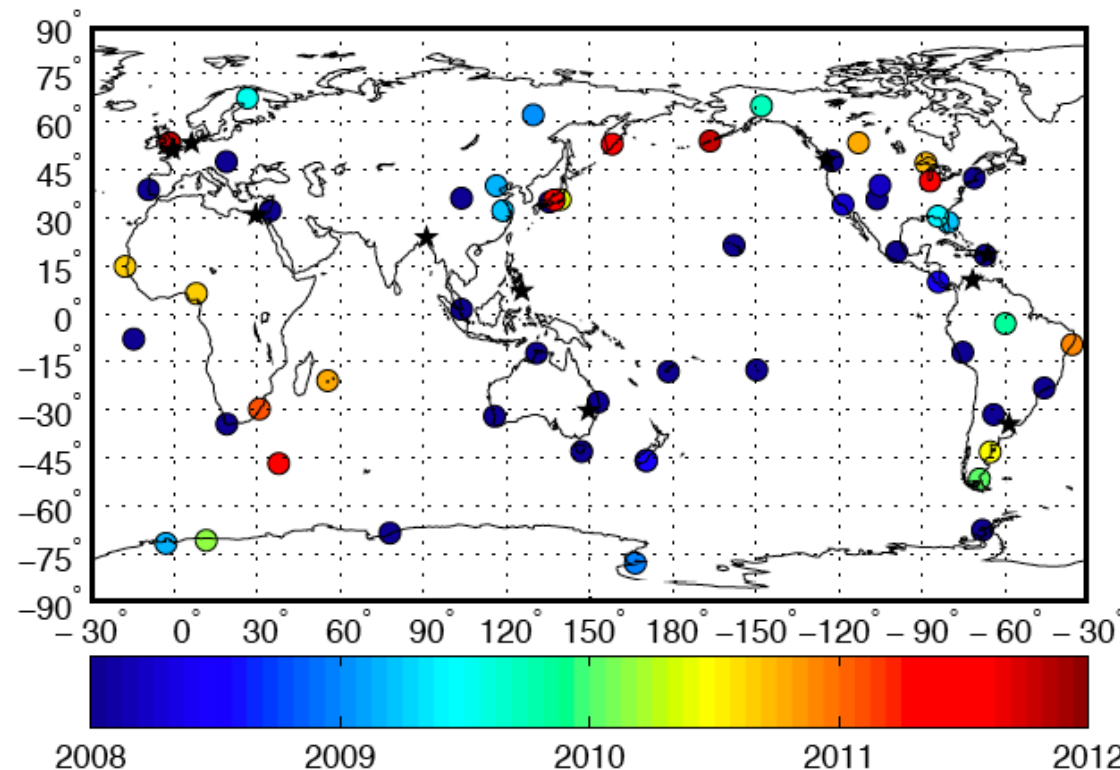


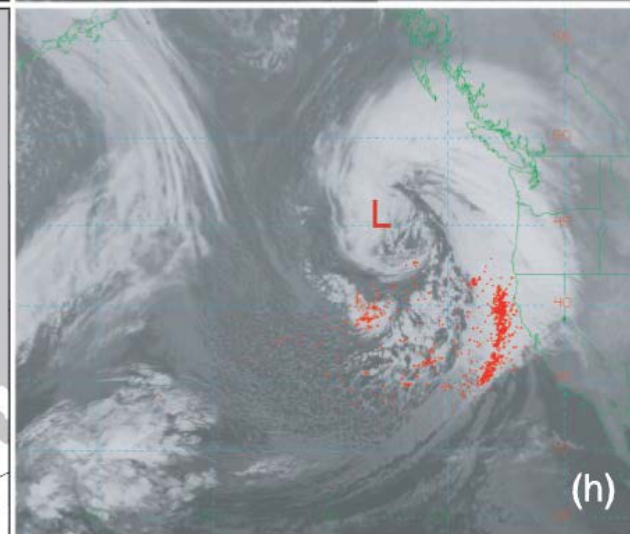
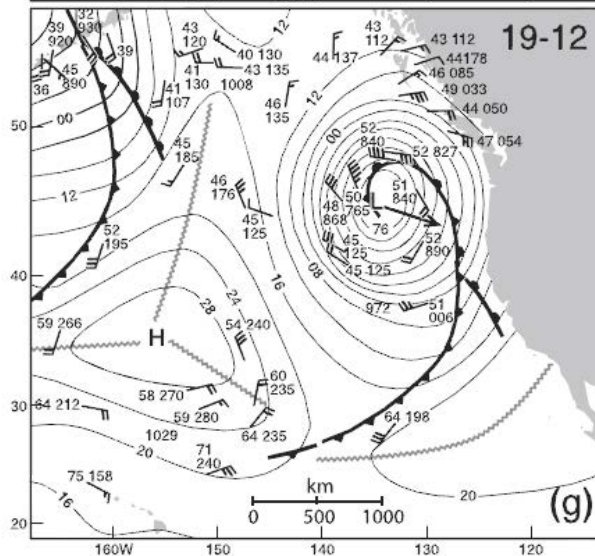
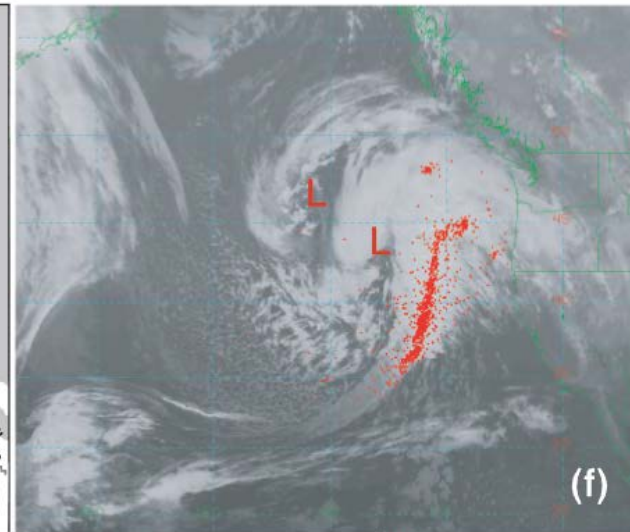
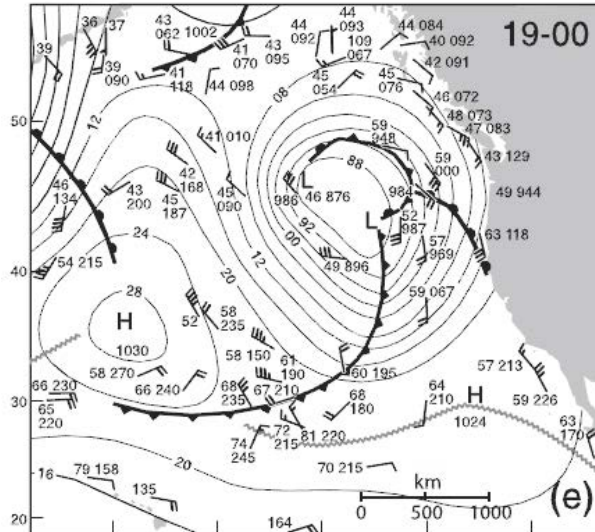
Figure 1. Location of WWLLN sensors, color-coded according to the date each was established. Stations established prior to 2008 are shown in dark blue; black stars indicate stations established 2012-present.

WWLLN permite “sentir” rayos en latitudes medias....

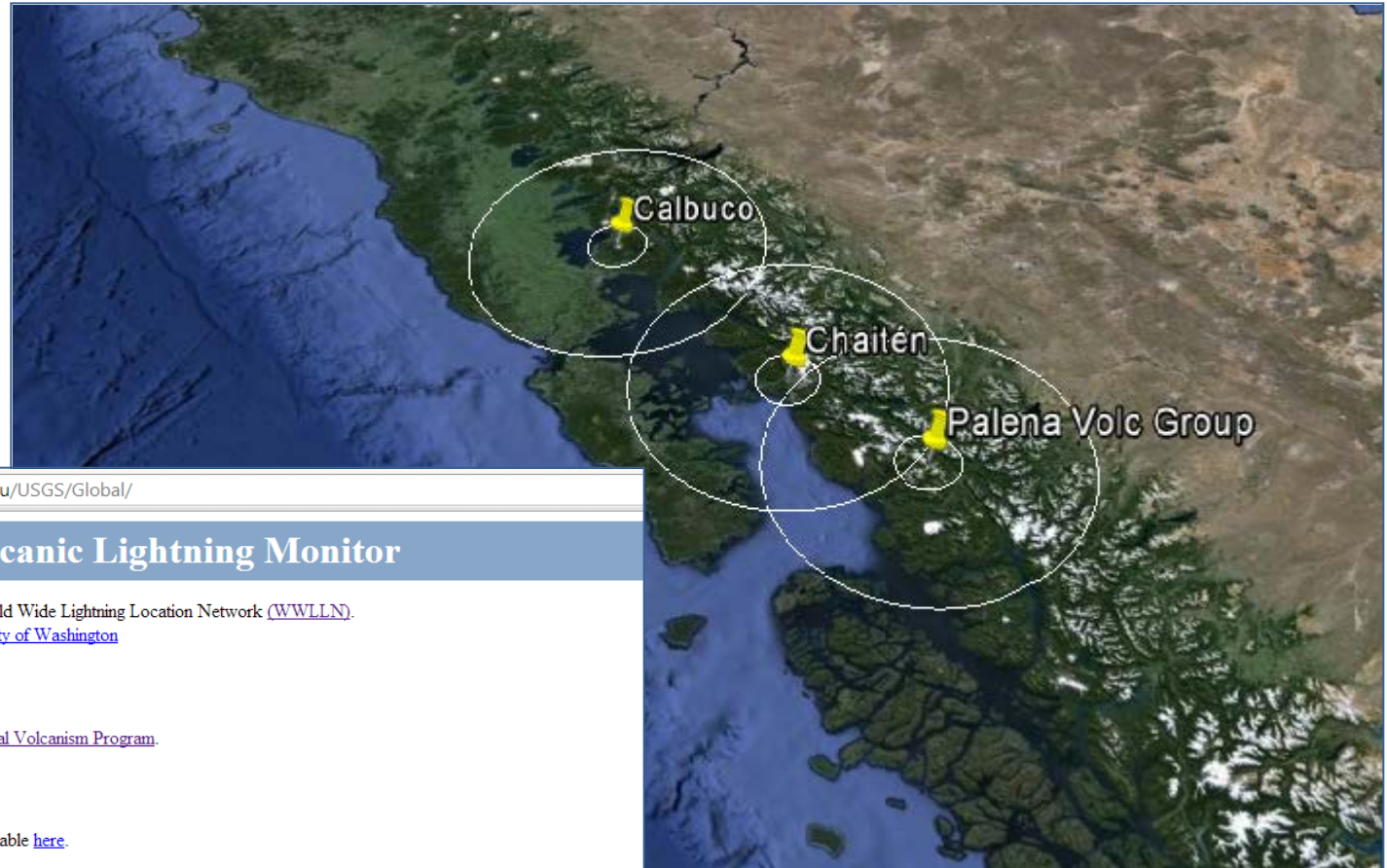
OCTOBER 2009

PESSI AND BUSINGER

3181



Alerta de volcanes en fase eruptiva muy frecuente en los Andes australes (3-5 casos/mes)



← → ↻ 🏠 flash3.ess.washington.edu/USGS/Global/

WWLLN: Global Volcanic Lightning Monitor

Detecting explosive volcanic eruptions with the World Wide Lightning Location Network ([WWLLN](#)).
All data and images are copyrighted by the [University of Washington](#)

Monitored Region

The complete global list of volcanoes from the [Global Volcanism Program](#).

Archive Data

A listing of archived data from previous days is available [here](#).

Latest Data

The table below lists all monitored volcanoes. The distance is calculated from each volcano to each lightning flash detected by [WWLLN](#) over t
both an inner 20 km radius and outer 100km radius are determined and shown in the table. To view the detected lightning flashes, use [Google J](#)

Start: 2014-04-07 23:43:00 UTC
Stop: 2014-04-08 00:43:00 UTC
Processed at: 2014-04-08 00:44:20 UTC

Rayos en la Patagonia

o el derecho a estar en desacuerdo conmigo mismo

Malargue, Agosto 2006

PM: Nuestros análisis de sedimentos lacustres indican abundancia de carbón en el pasado, producto de paleo-incendios forestales en WP iniciados por rayos..

RG: Me “estai” %\$&//==/? Como %\$/&%&% se te ocurre que van haber rayos en esa zona...

Mendoza, Mayo 2012

GN: Che, mi red de raYos indica una actividad eléctrica barbará sobre los volcanes del sur de Chile, pero que cosa mas activa....

RG: Pero querida colega, volcanes hay pero no son tan activos. Tu red debe estar triangulando mal, pero veamos esto mas de cerca...

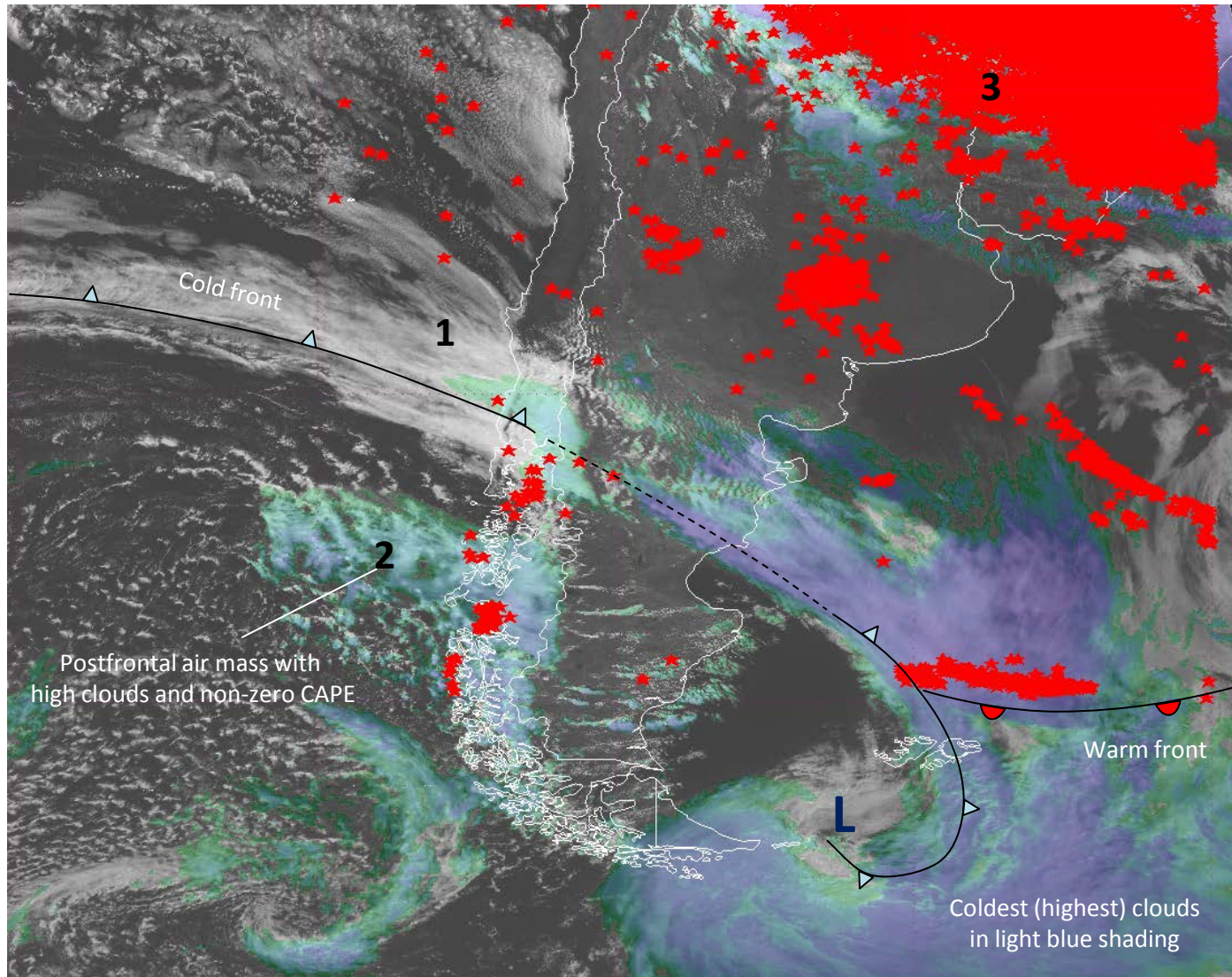
Concepción, Enero 2013

RS: Cuídese, que hay un frente muy activo cruzando por el sur....

RG: Pero hasta cuando me dice que me cuide...además, como que un frente activo en Enero? Quien es el Doctor?

January 6, 2013 – 1800 UTC

GOES-13 Visible (BW) and IR4 (light shading) + WWLLN Lighting (stars)



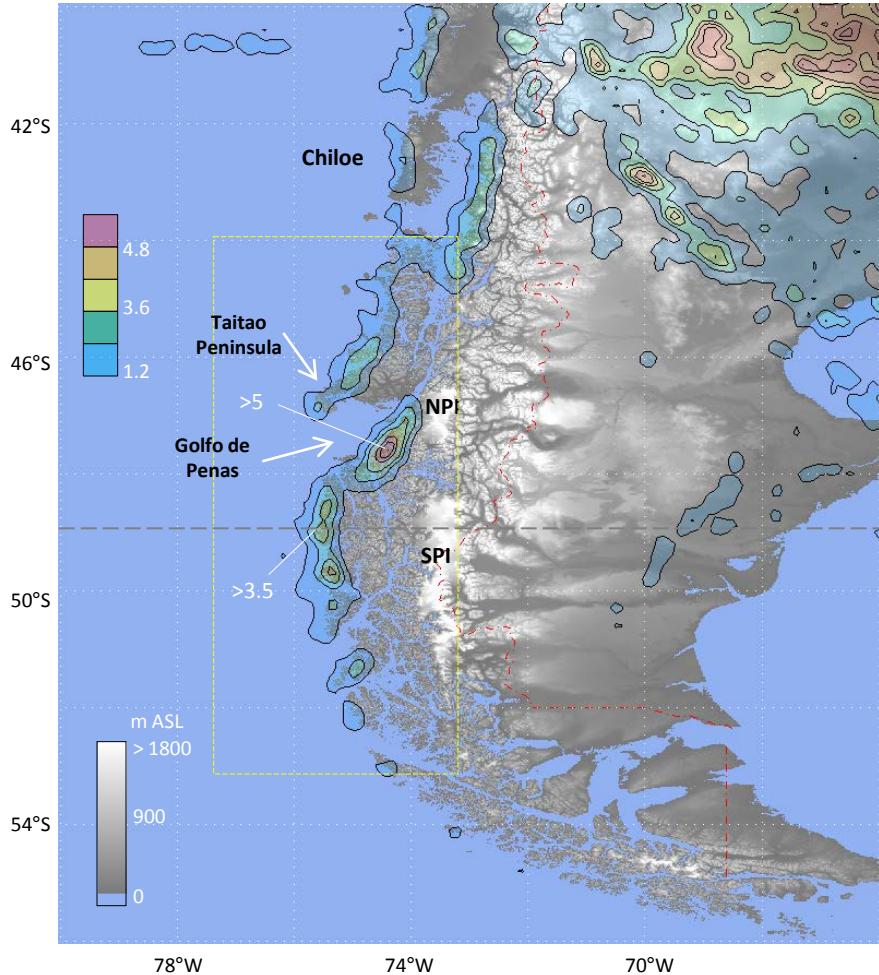
Lightning distribution

- Spatial distribution of lightning density and number of days with lightning: clustering at the coastline but some flashed offshore as well. No flashes inland!
- Small annual/diurnal cycle. Little interannual variability (may be affected by network efficiency)
- Lightning days cluster in 1-4 day events. Many storms (rainfall events) without lightning.

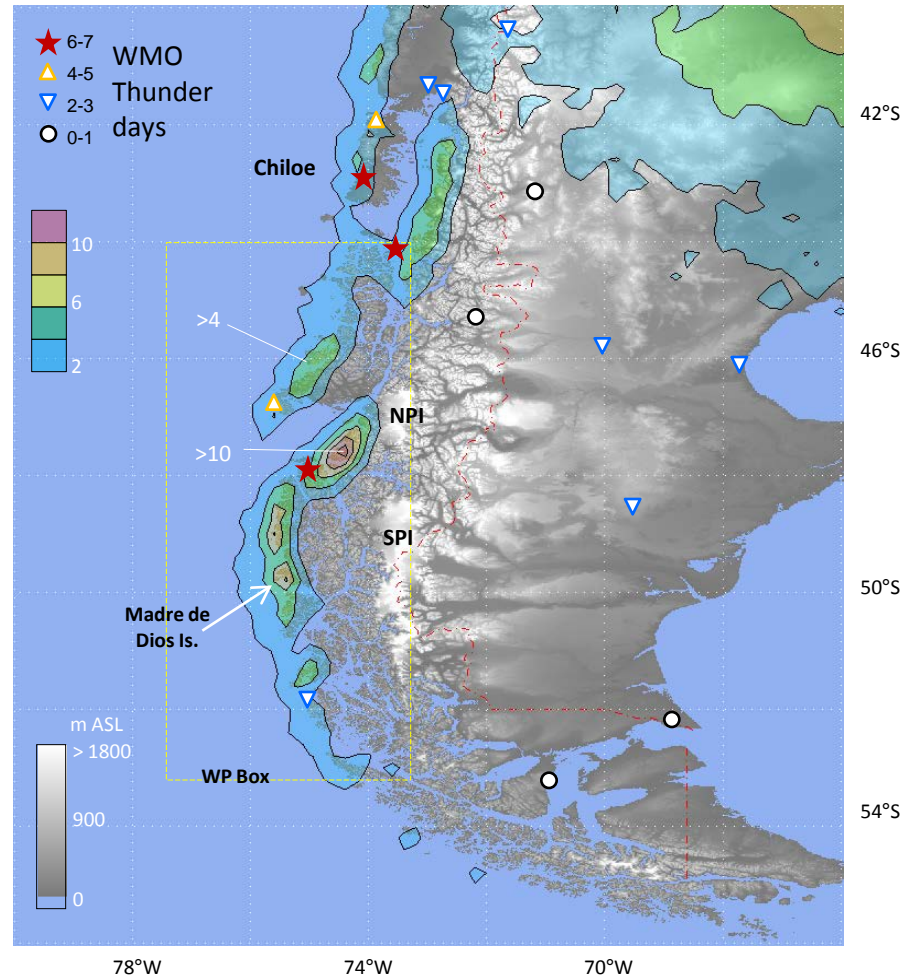
Distribución Espacial

Patrón de densidad similar entre años (pese a cambio de ED)

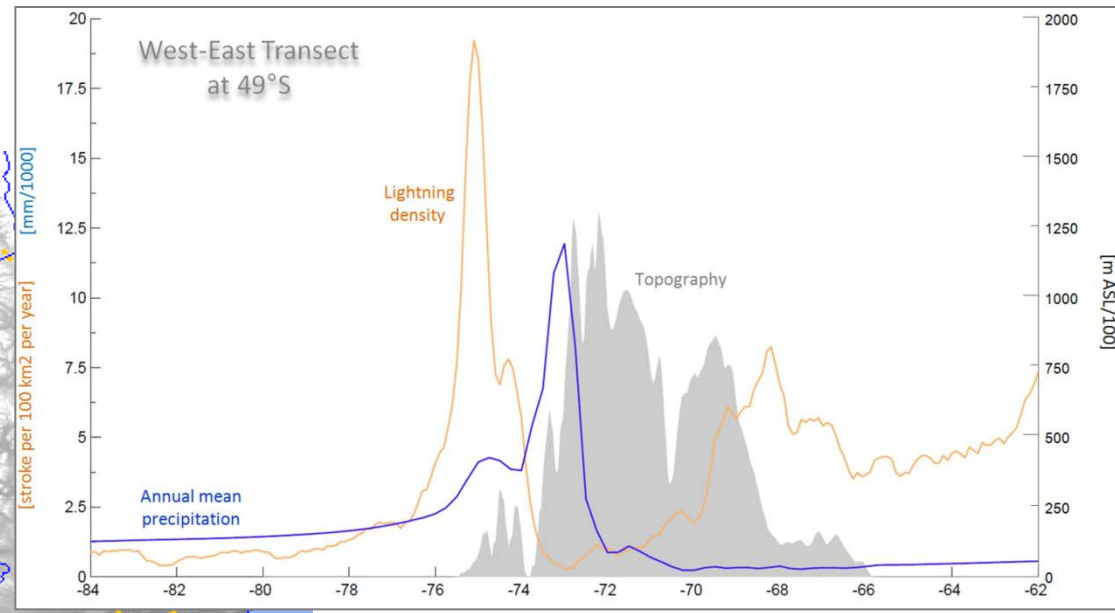
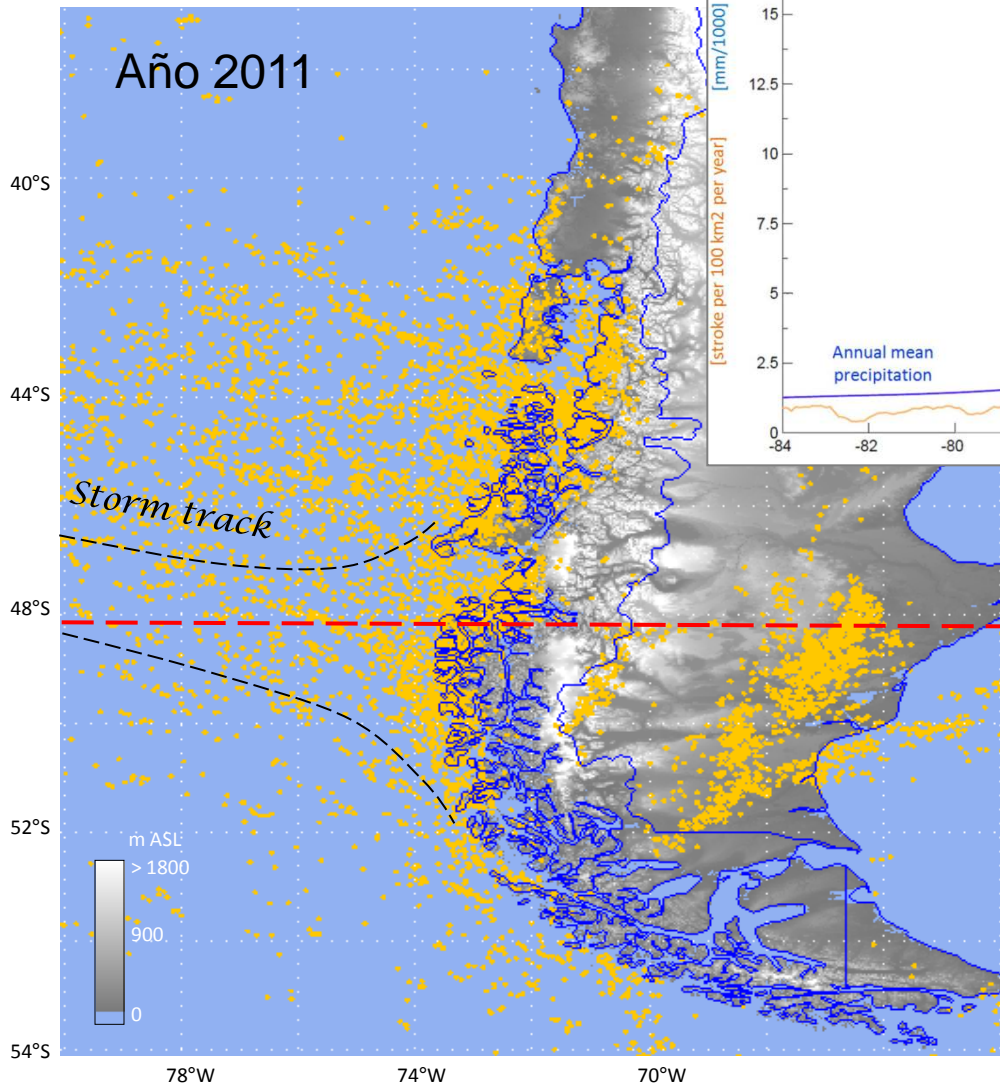
Lightning density, 0.1×0.1 lat-lon boxes



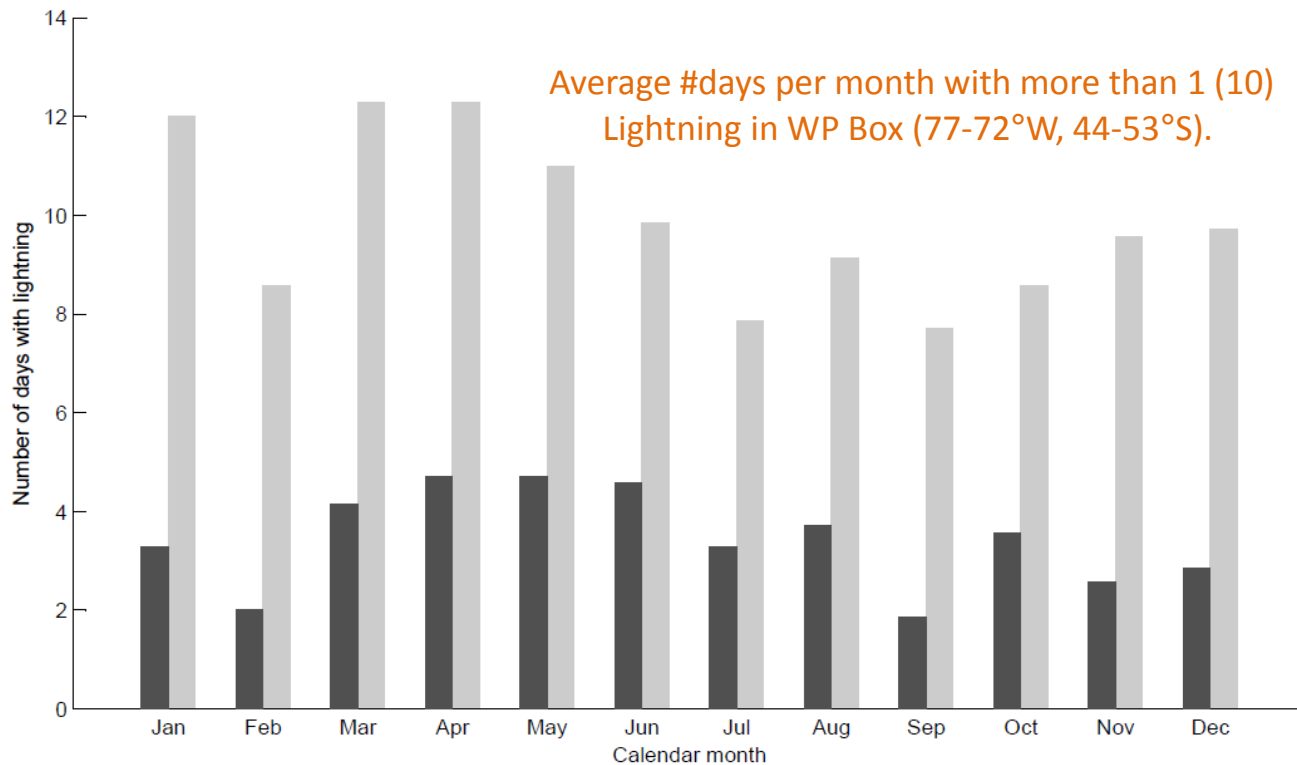
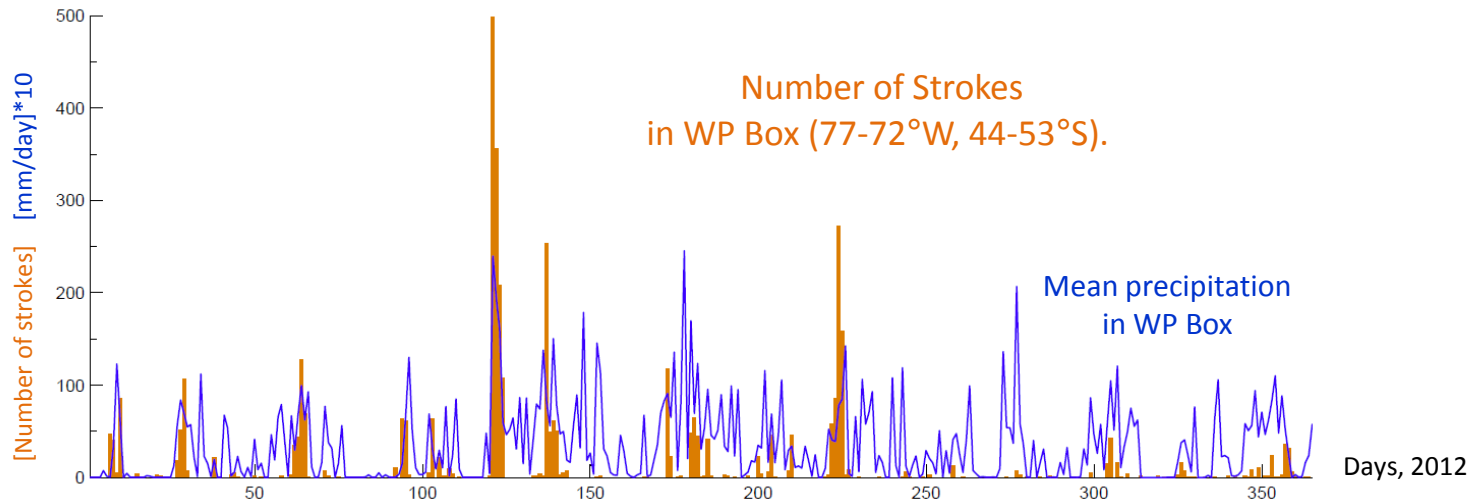
Number of lightning-days, 0.2×0.2 lat-lon boxes



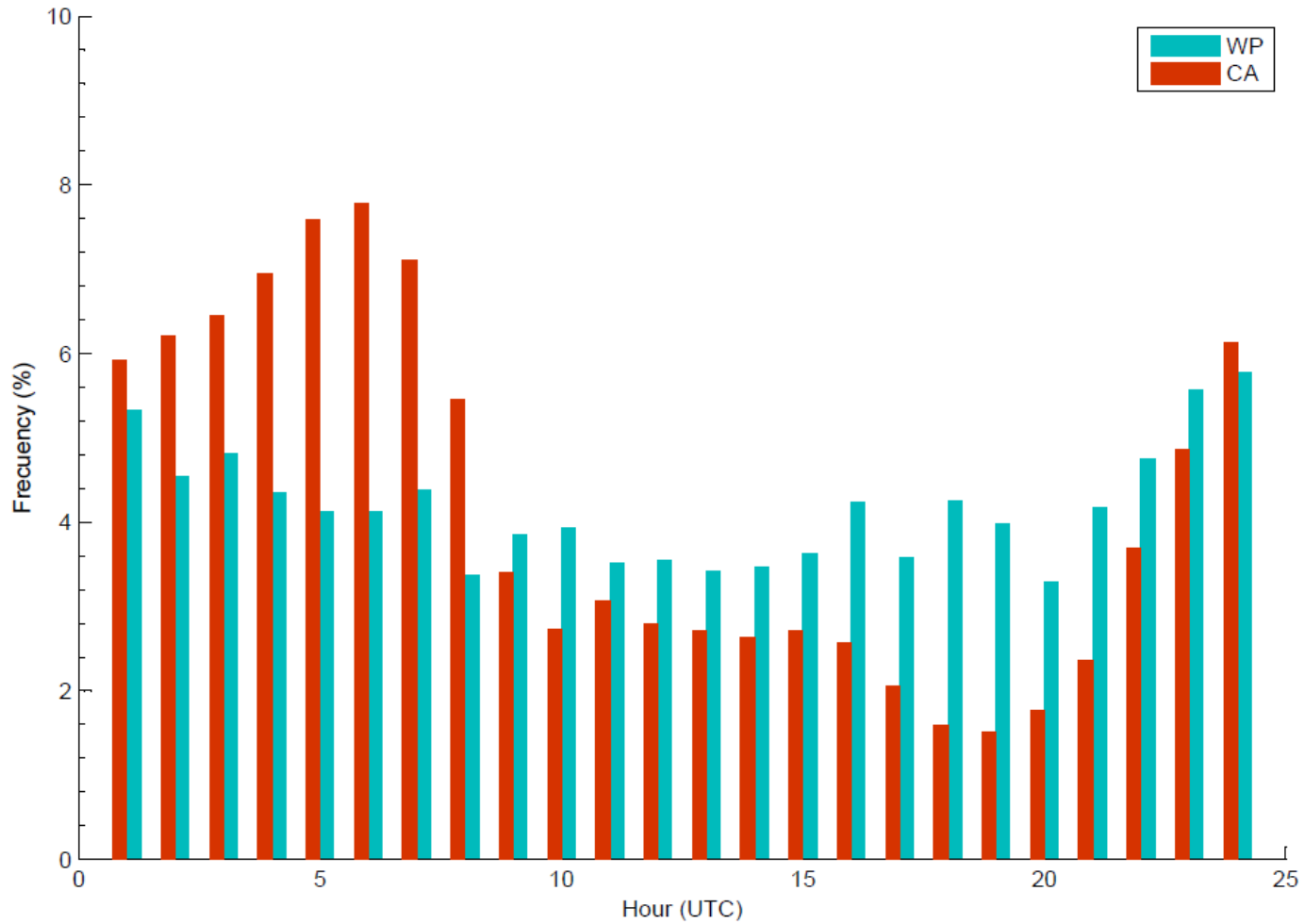
Distribución Espacial



Ciclo anual



Hourly (monthly) distribution of flashes in WP and Central Argentina Boxes

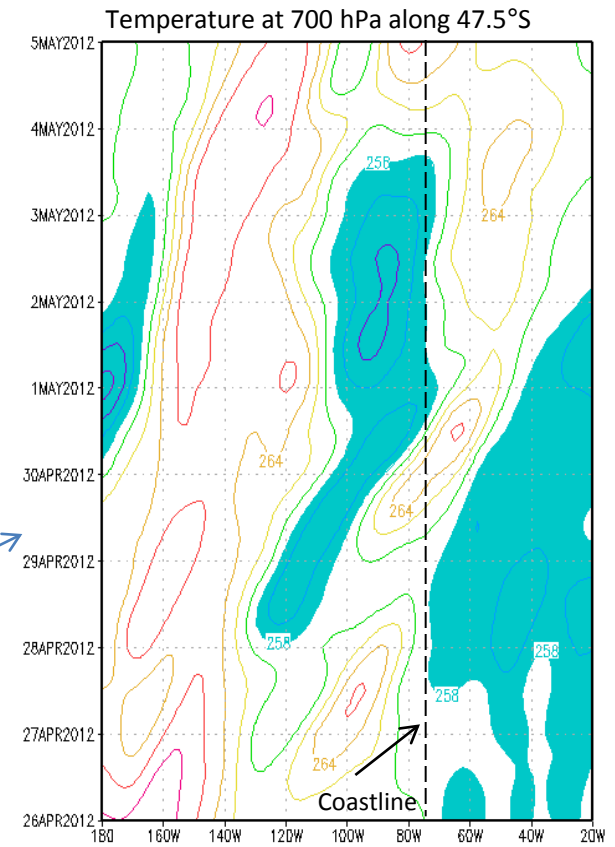
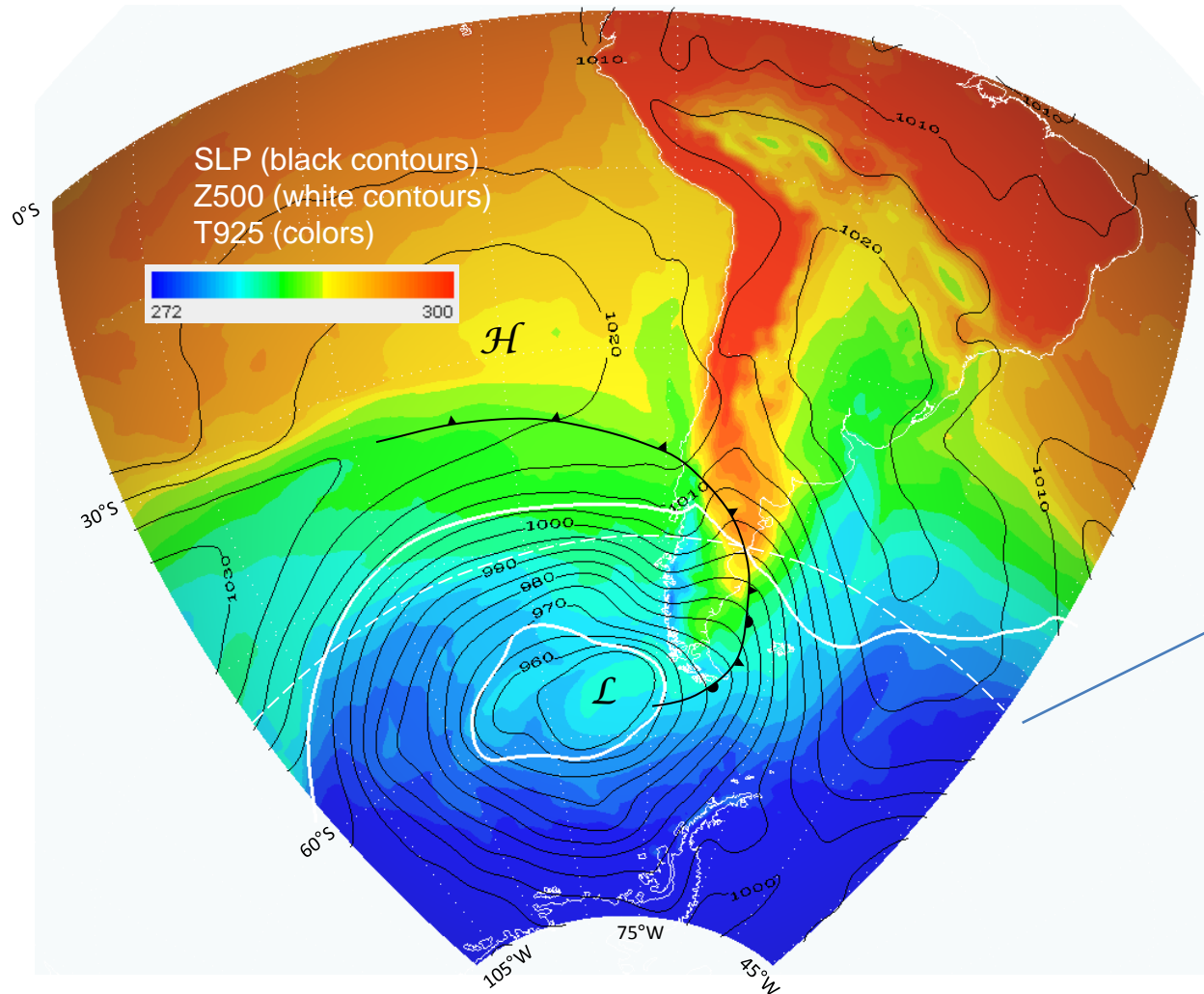


A case of study (30-04-2012)

- Let's consider the event 30-Apr 03-May 2012. The first day has the highest number of flashes over WP on record.
- A slow moving, mature midlatitude cyclone over the south Pacific. Cold front intersect the Chilean coast at about 40°S. Highest precip. over the Andes.
- Cold advection at low and mid levels over relatively warm waters create weakly unstable environment off WP (CAPE>50).
- Shallow convective clouds evident in GOES-VIS and CloudSAT collocated with area with flashes.

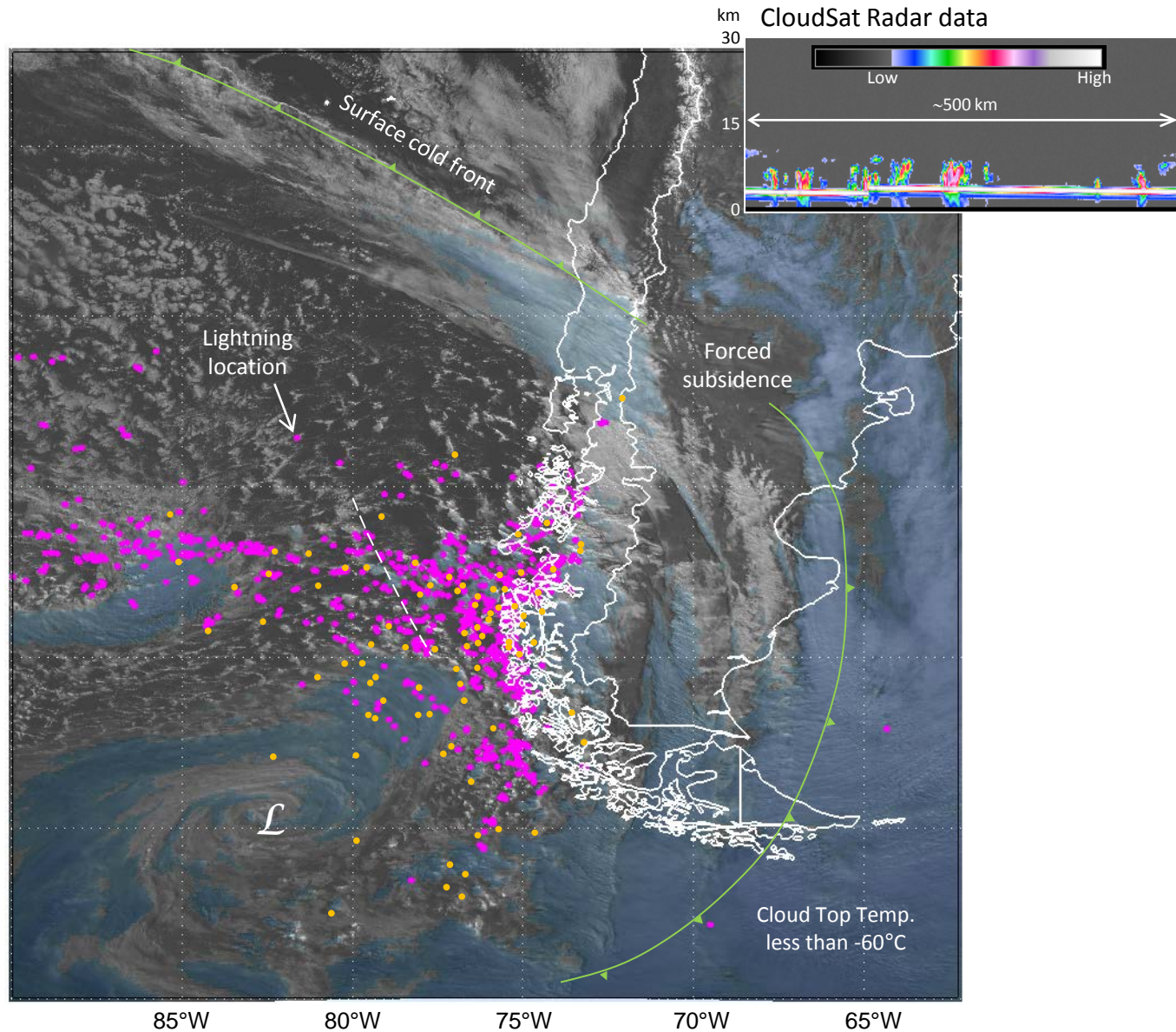
April 30, 2012 – 1800 UTC

Análisis sinóptico (CFSR)

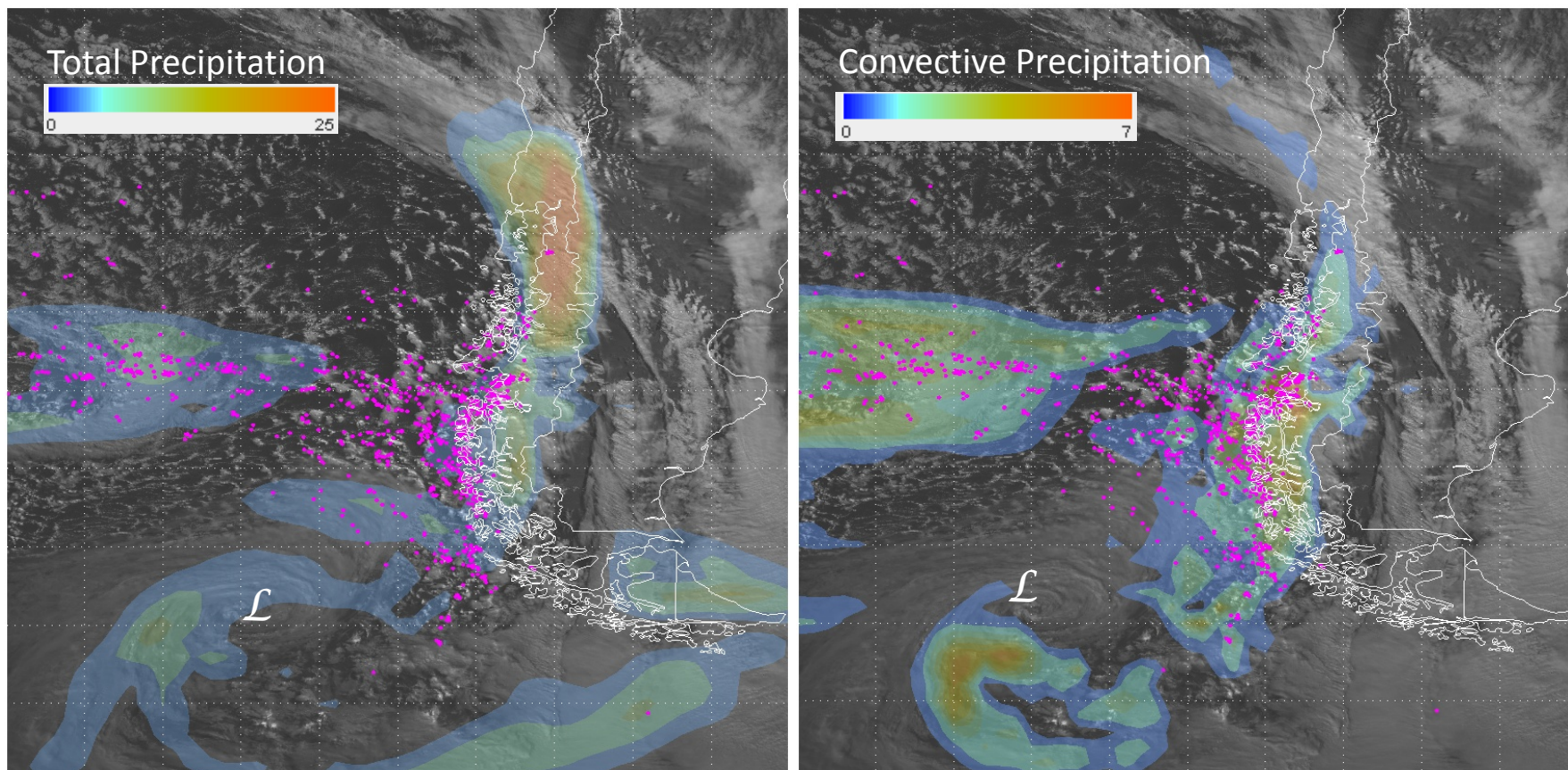


April 30, 2012 – 1800 UTC

GOES-13 Visible (BW) and IR4 (light shading) + WWLLN Lighting (dots) + Starnet

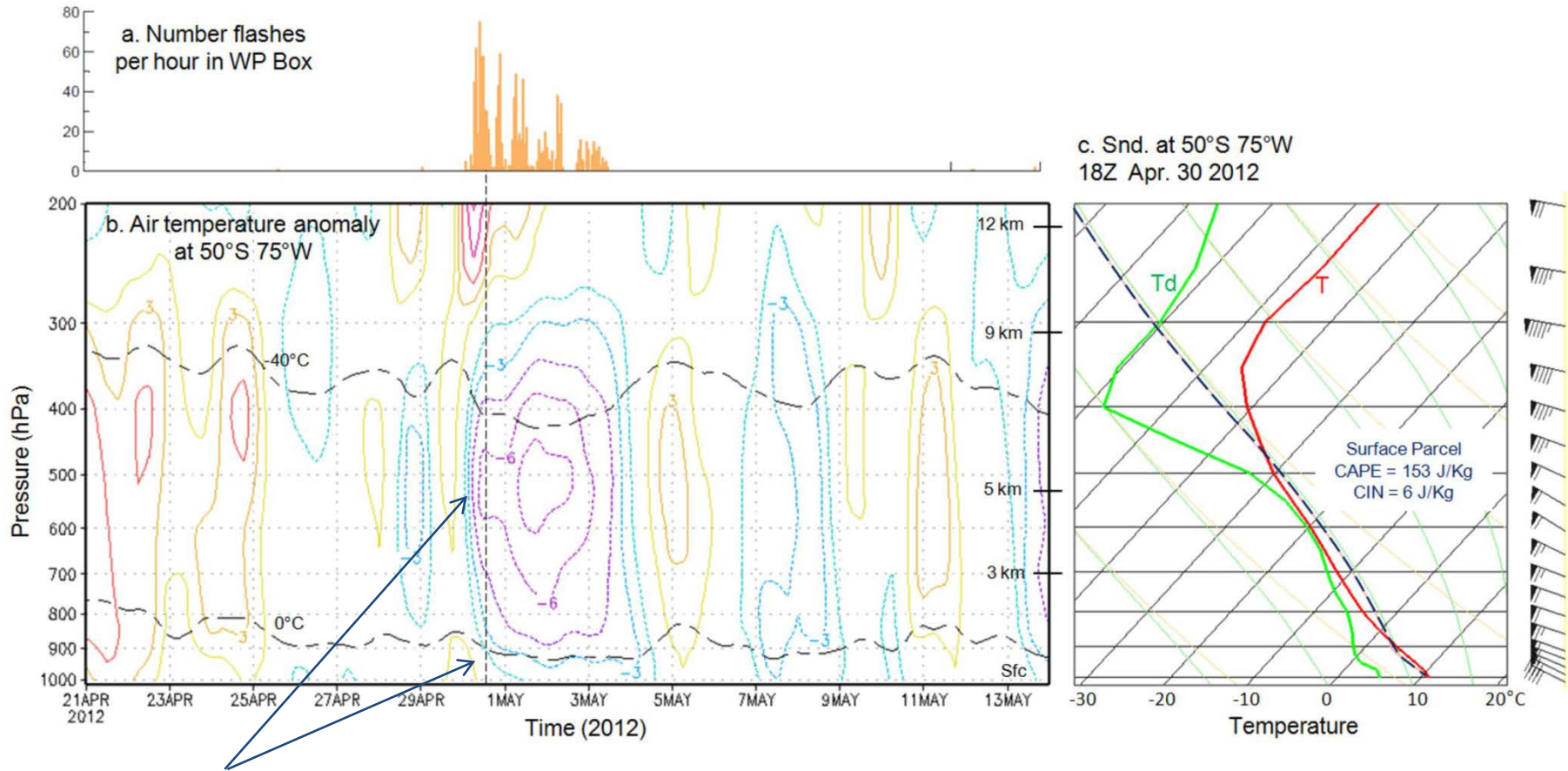


CFSR (0.5°) valid at 18 UTC April 30, 2012
GOES-13 Vis Image at 1745 UTC April 30, 2012
WWLLN detected flashes during April 30, 2012



*Actividad eléctrica en sector postfrontal.
Buen indicador de la Precipitación Convectiva pero no de la Precip. Total*

Actividad eléctrica en ambiente ligeramente inestable y vientos intensos del W

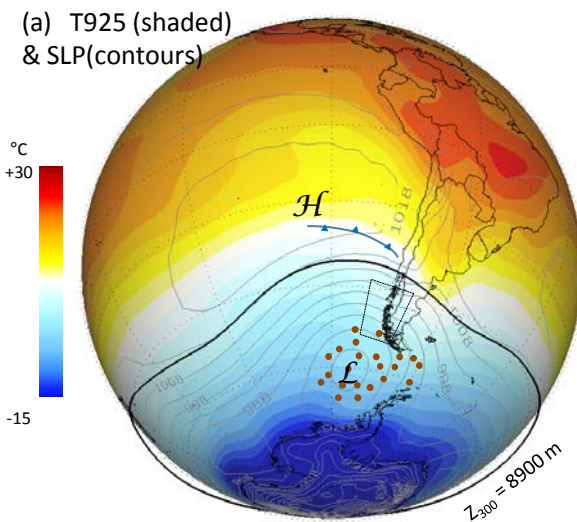


Enfriamiento en tropósfera media comienza antes y es mas marcado que en superficie

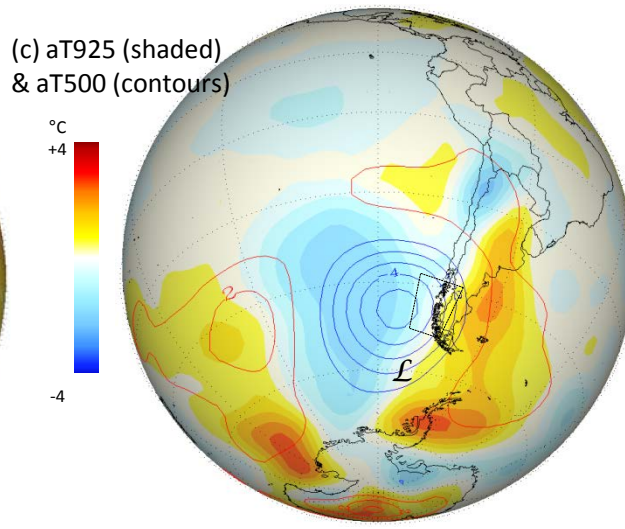
Climatology

- We inspected several episodes and found synoptic conditions similar to the case study. This is synthesized using a compositing analysis of the days with more than 50 flashes...
- Strong winds and weakly unstable conditions are *necessary conditions* for lightning events.
- Weak temporal relationship between CAPE and number of flashes...
- Area of high frequency of non-zero CAPE off WP (collocated with maximum of flash density) linked to warm SST anomaly there. Coastal topography provides the strong updrafts...

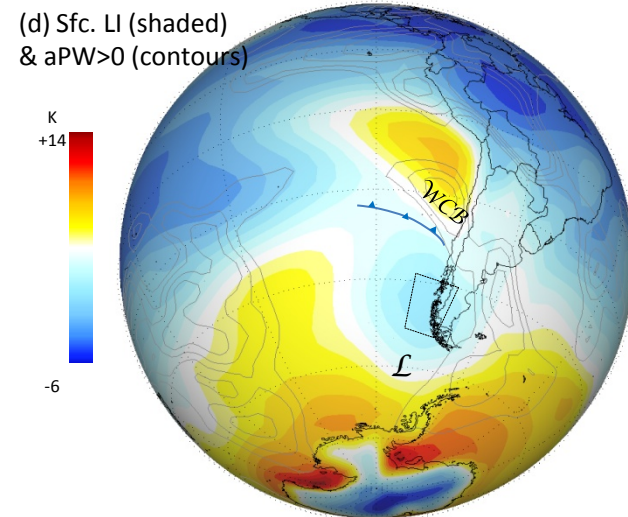
Compositing analysis for days with more than 50 flashed in WP Box (89 days)



1. Depresión
Extratropical en
etapa madura. PO
en masa postfrontal

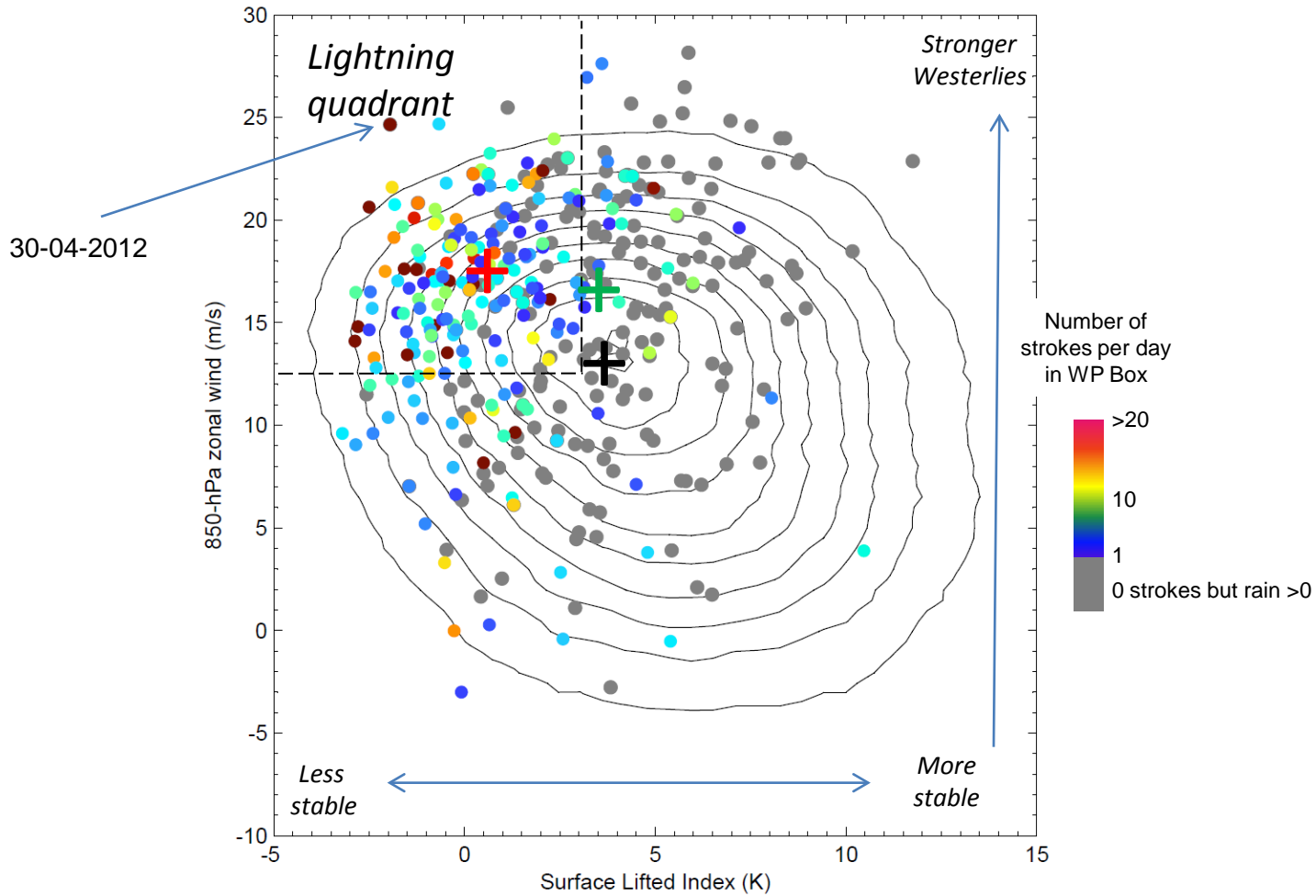


2. Enfriamiento más
pronunciado en
troposfera media



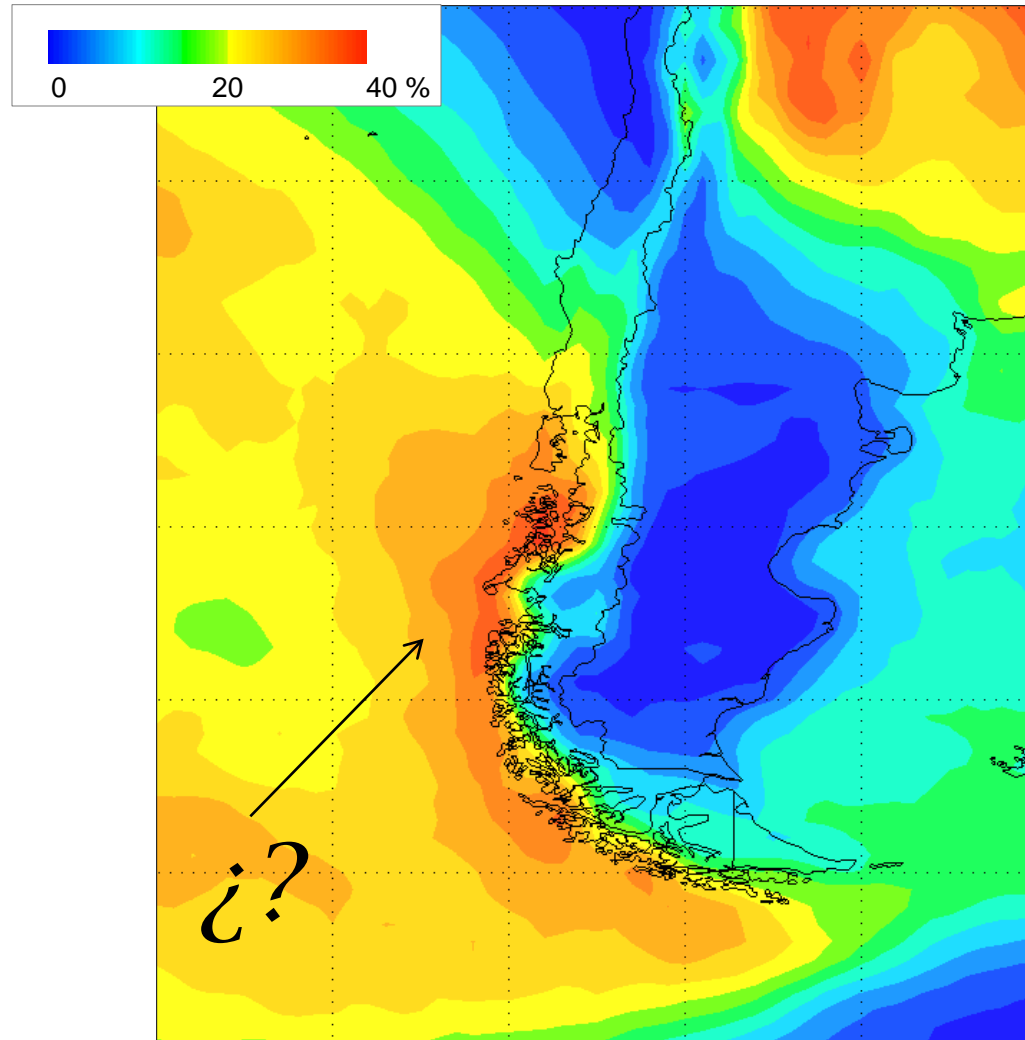
3. Ambiente
ligeramente
inestable sobre WP

Joint distribution of LI-U850 over WP for all days (contours), rainy days (gray dots) and lightning days (colors dots)

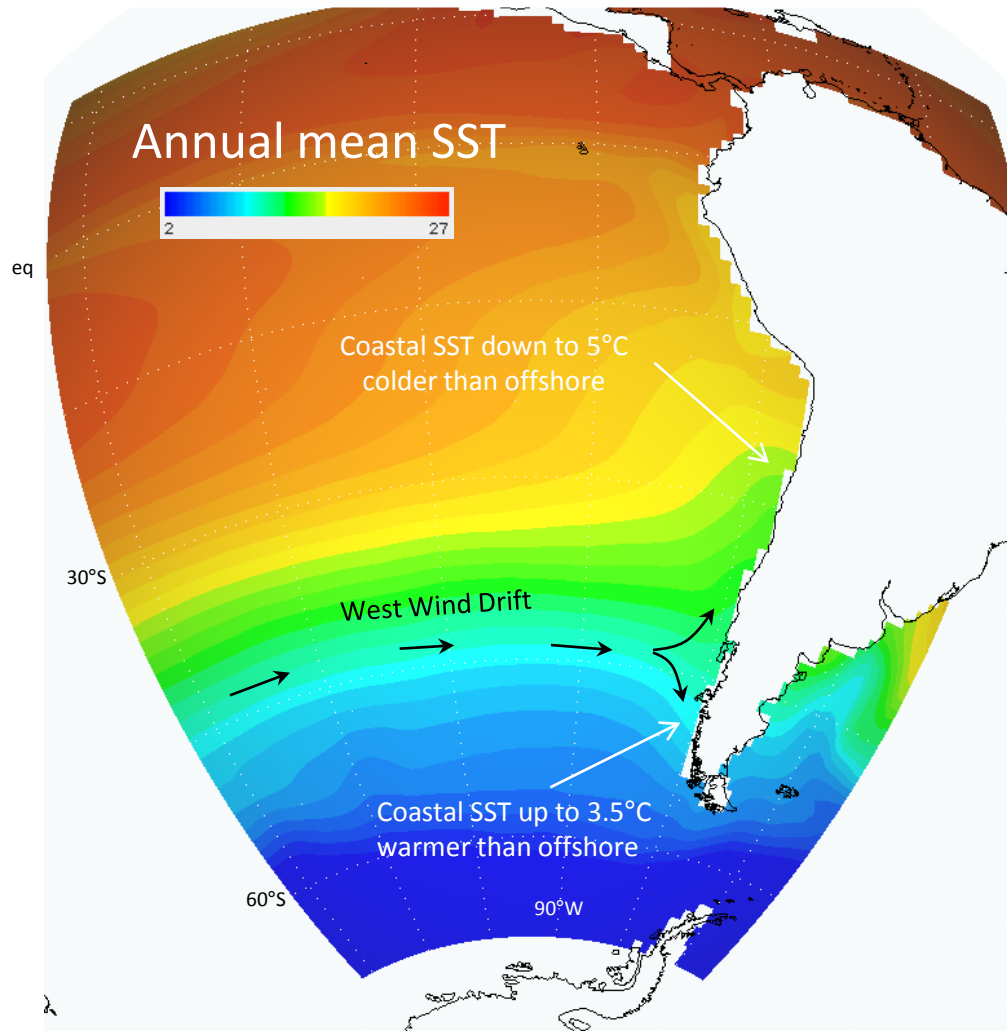


Frecuencia de días con $LI \leq 0.5$...similar a $CAPE > 0$

Datos CFSR. Notar máximo de cond. Inestables sobre Patagonia Oeste...



El máximo de ocurrencia de cond. Inestables sobre Patagonia podría estar asociado a mayor TSM en esta región



Conclusiones

- Ocho años de datos WWLLN indican un máximo relativo de actividad eléctrica sobre la costa de Patagonia Oeste, donde rayos son detectados al menos 1/3 de los días.
- Las tormentas eléctricas se asocian al paso de una depresión extratropical profunda y madura al sur del continente.
- La máxima actividad ocurre cuando PO se encuentra inmersa en masa postfrontal bajo condiciones levemente inestables (enfriamiento más marcado sobre 700 hPa) y viento fuerte del W
- El área de mayor frecuencia de CAPE>0 (colocalizada con max. de rayos) costa afuera de PO asociado a anomalía cálida de TSM.
- Vientos intensos del Oeste forzados a subir sobre la abrupta topografía costera proveen el ingrediente dinámico para gatillar convección somera y actividad eléctrica.

Helicóptero de Onemi sobrevuela la comuna de Lonquimay por incendios forestales

18/12/2013 | [Chil: Araucanía, Destacador](#) | [Por: El Periodico](#)

[Me gusta](#) [Compartir](#) A 2 personas les gusta esto. Regístrate para ver qué les gusta a tus amigos.



Brigadas del Ejército, bomberos de las distintas comunas, están alertas y preparados para actuar ante la ocurrencia de incendios que puedan afectar a viviendas o localidades cercanas a vegetación.

Actualmente, son más de 410 hectáreas las consumidas por las llamas en toda La Araucanía, según el último reporte de Conaf.

El intendente (s) Erick Baumann, junto con el director regional de la Onemi, José Bugmann y técnicos de Conaf, se dirigieron a la comuna de Lonquimay, con el fin de efectuar una evaluación en terreno de la emergencia y realizar las coordinaciones para la extinción de los incendios.

Brigadas del Ejército, bomberos de las distintas comunas, están alertas y preparados para actuar ante la ocurrencia de incendios que puedan afectar a viviendas o localidades cercanas a vegetación.

Rayos (circulos) + Topografía

-37.5
-38

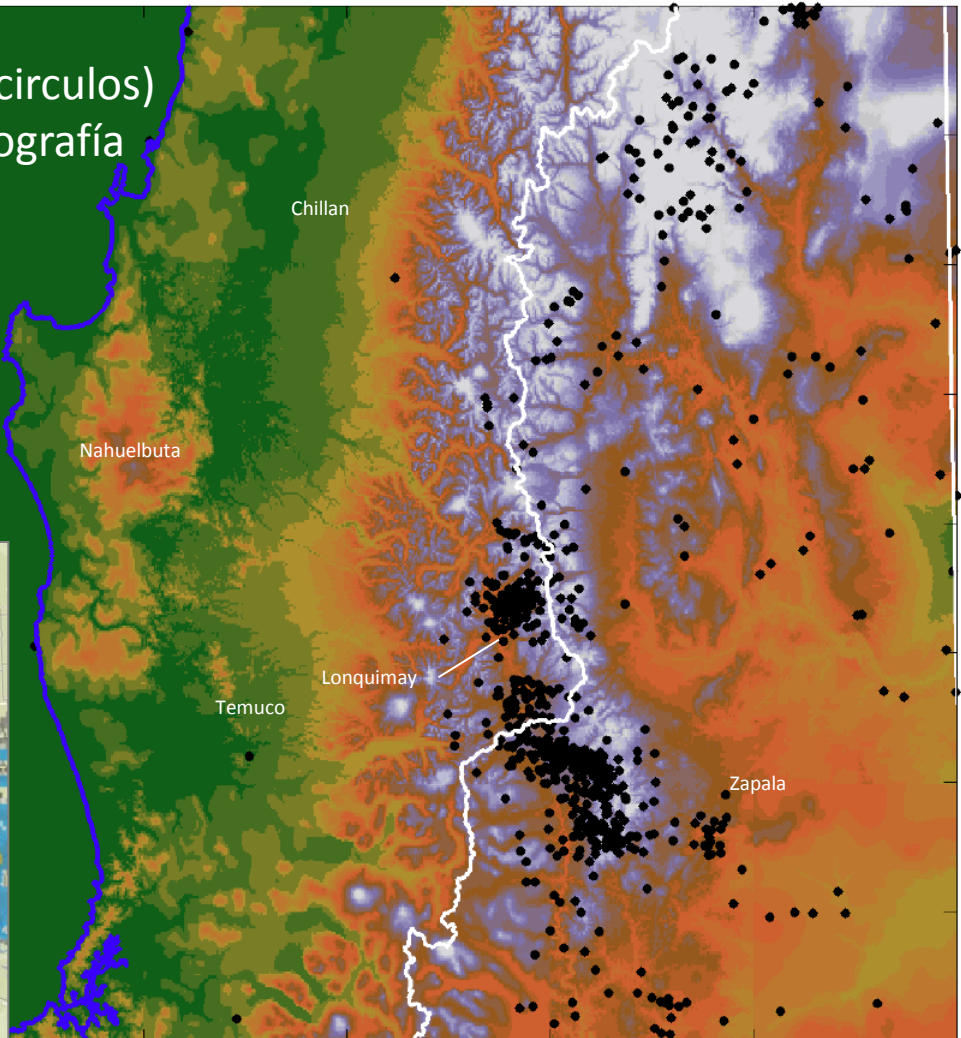
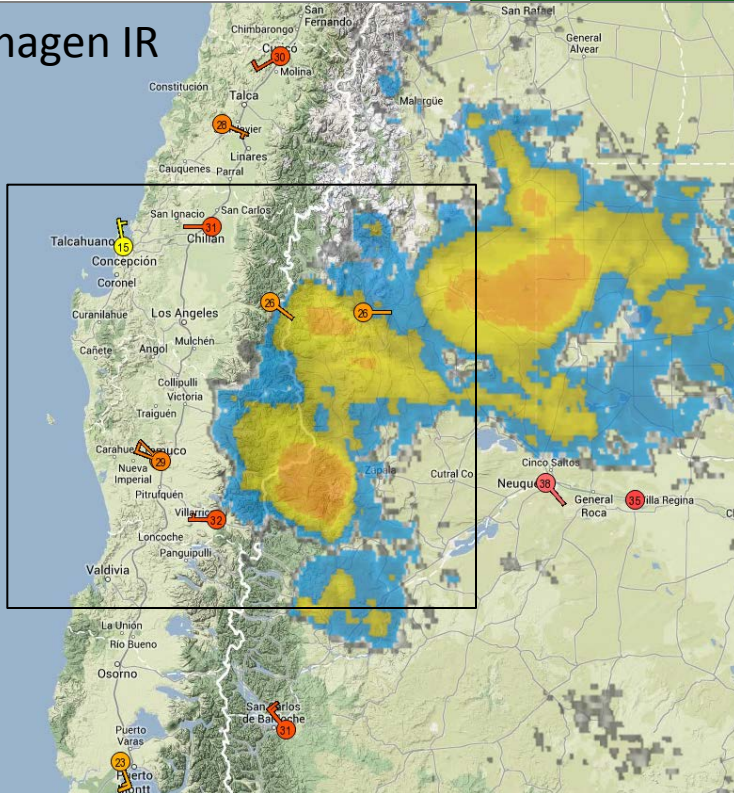


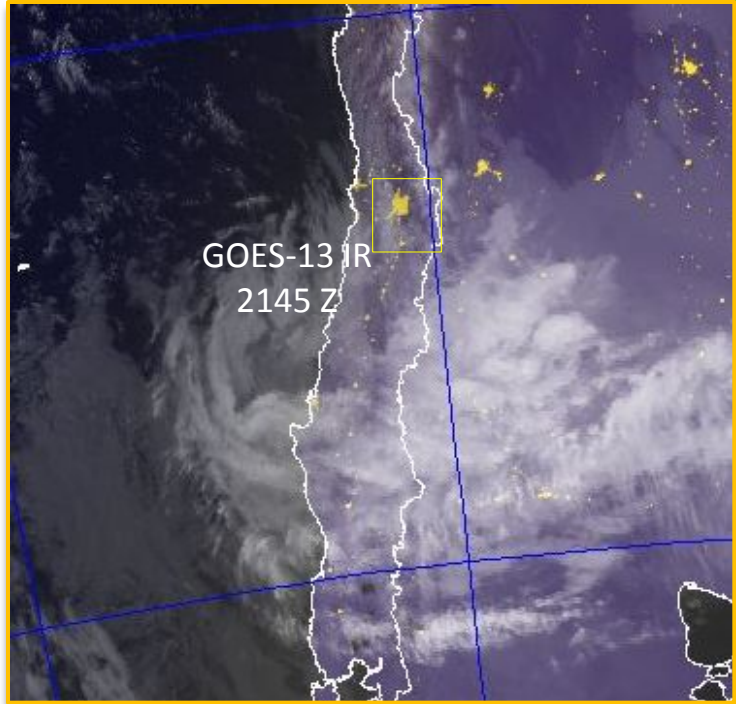
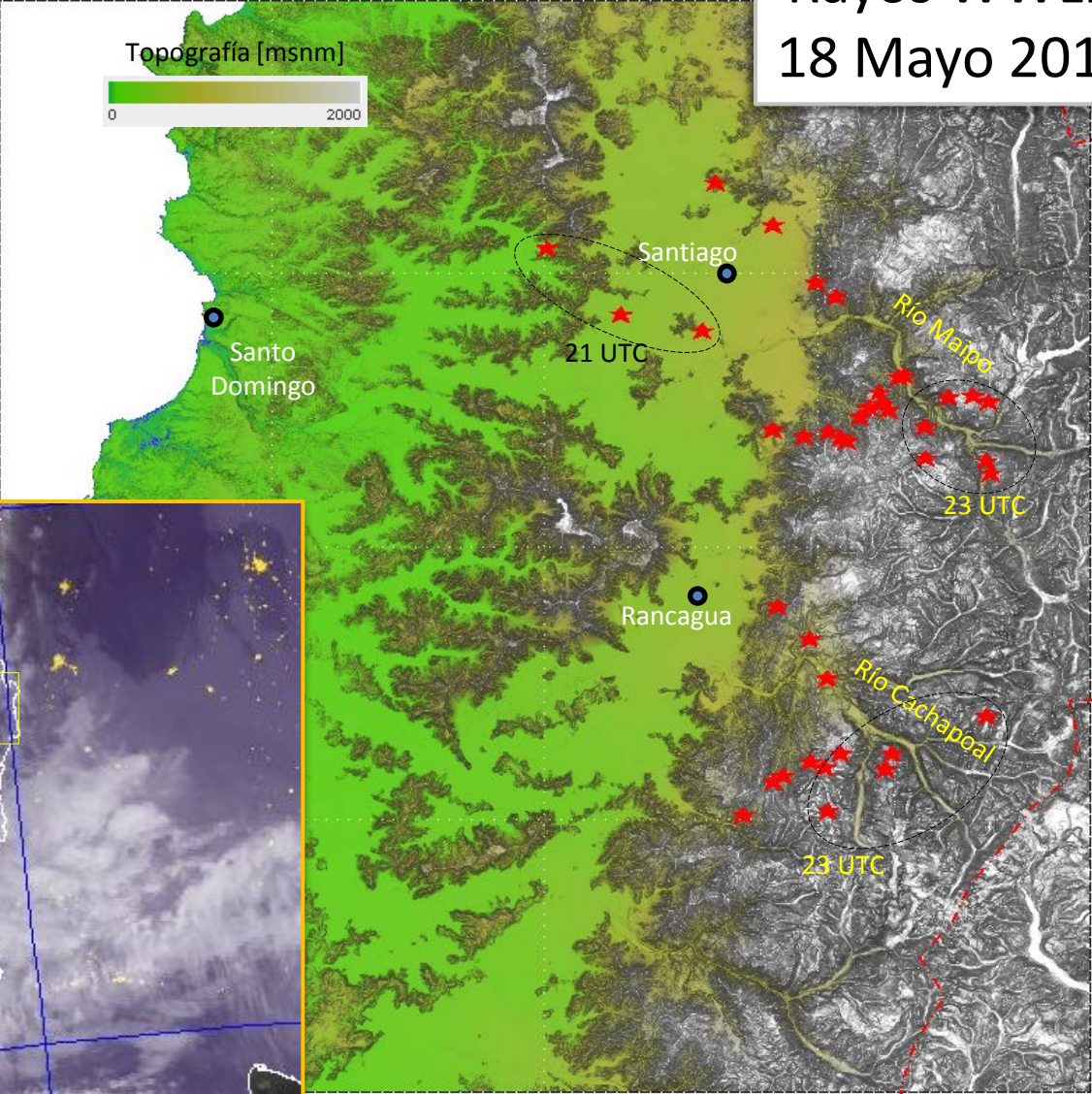
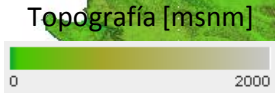
Imagen IR



Tormenta eléctrica en zona de Lonquimay, Chile 16-Dic-2013

Rayos WWLN 18 Mayo 2013

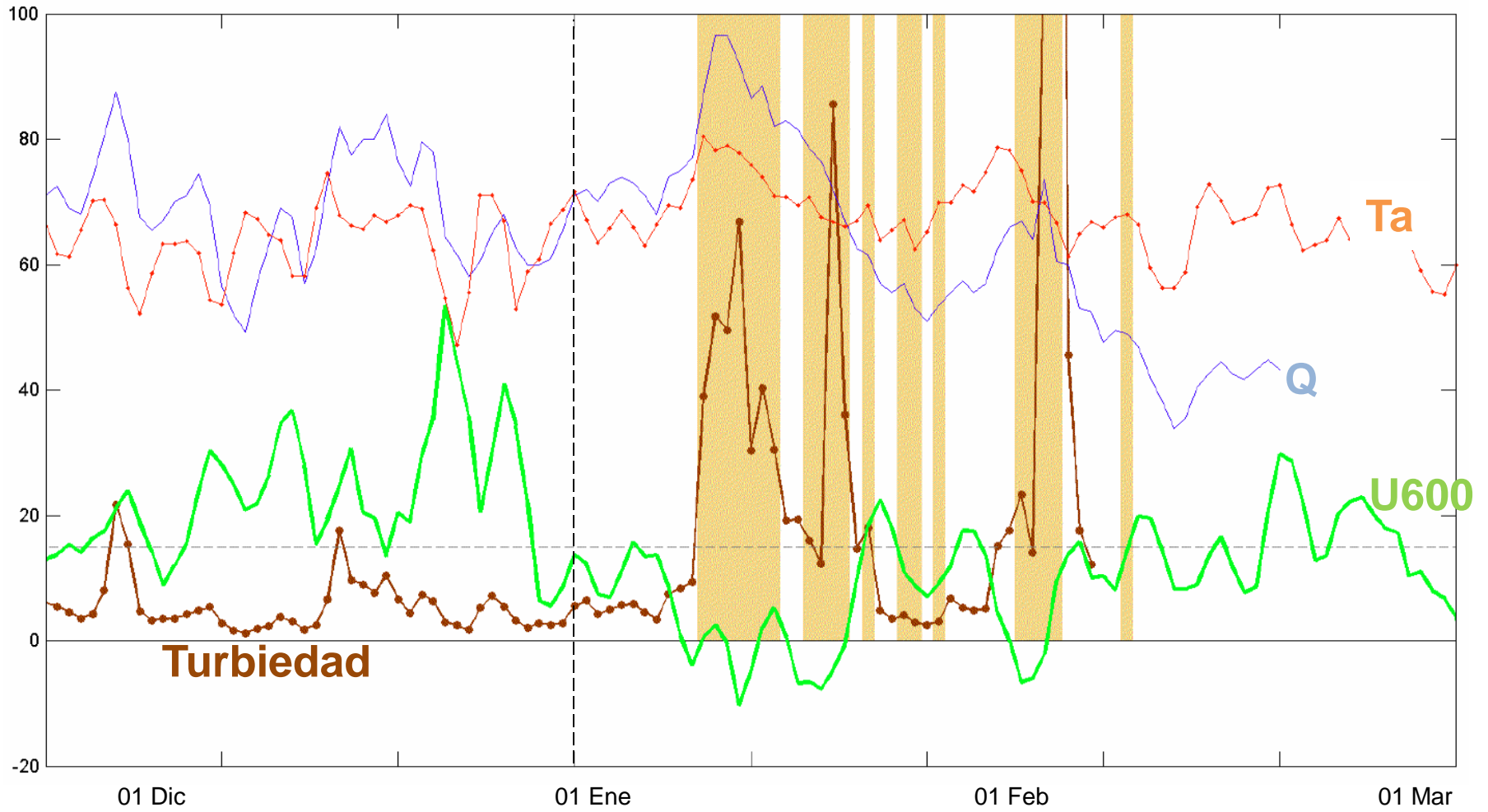
33°S



71°W

70°W

Río Maipo en el Manzano (o cerca de allí...)



2012-2013

