Convection over midlatitudes mountains
Insights from WWLLN

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We often envision (and model) midlatitudes orographic precipitation as a stable, near linear process... yet, tree rings chronologies suggest past fire activity in humid, cool western Patagonia.
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 ±38° 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 µs. 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.

Virts et al. 2013
Spatial Distribution (2008-2012)

Lightning density, 0.1×0.1 lat-lon boxes

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

Garreaud, Nicora et al. 2014
Electric activity in a slightly unstable environment and strong Westerly flow.

Mid level cooling stronger and before than at surface.

Garreaud, Nicora et al. 2014
Compositing analysis for days with more than 50 flashed in WP Box (89 days)

(a) T925 (shaded) & SLP (contours)
(b) aT925 (shaded) & aT500 (contours)
(c) Sfc. LI (shaded) & aPW > 0 (contours)

Postfrontal condition
Stronger cooling aloft
Weakly unstable environment

Garreaud, Nicora et al. 2014
Study regions - Large Scale Context

U700

DEF

JJA

SST

20°C

10°C

1°C

2000 m

1000 m

0 m
Study regions – GPCP mean Precipitation

New Zealand (Southern Alps)

Western North America (coastal range + Rocky mnts)

Scandinavian mountains

Western Patagonia (Austral Andes)

Note the strong orographic precipitation enhancement.
Lightning position (1 every 10), 2013-2014-2015

Winter (October-March)

Summer (April-Sept.)
Lightning position (1 every 10), 2013-2014-2015

Winter (April-Sept.)

Summer (October-March)
Winter Density (0.1 × 0.1 lat-lon) All data 2013-2015

(a) Western North America
49-50°N

(b) Scandinavia
60-61°N

(c) Patagonia
49-50°S

(d) New Zealand
44-43°S
Number of lightning (1×1 lat-lon) during winter months (5). Distribution from 2009-2015.
Preliminary conclusions

- Lightning occurs rather frequently in midlatitudes mountains (1 out of 3-4 storms)
- Consequently, convective precipitation may be a significant component of the total accumulation
- Maximum density located between the coastline and the first topographic rise (except over the Southern Alps)
- Broadly, lightning activity scale with upstream SST (but also water vapor flux and stability)
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