Atmospheric Boundary Layer activities in ANDEX

J. Cuxart (UIB), Santiago de Chile, October 22nd, 2018

1) Valley dynamics:

* slope and valley flows,
* thermal inversions,
* air quality

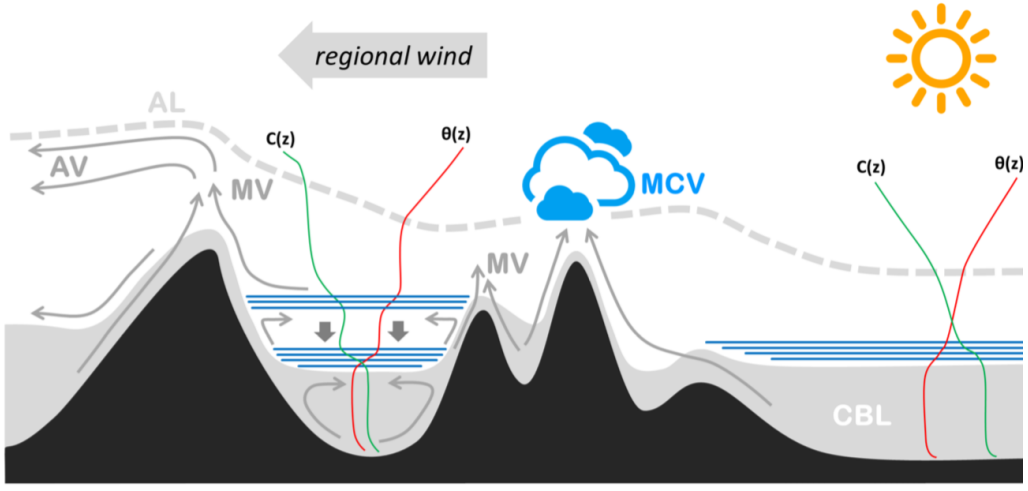


Figure 3. Exchange processes in the daytime boundary layer over mountainous terrain (adapted from [15,99,146–148]). Grey shading indicates the ground-based mixed layer (CBL). MV, AV, and MCV denote, respectively, mountain venting, advective venting, and mountain-cloud venting. Arrows indicate airflow, while $C(z)$ and $\theta(z)$ indicate vertical profiles of pollutant concentration and potential temperature, respectively. Horizontal blue lines represent layers with enhanced static stability, which favour the separation of up-slope flows from the ground. Down-pointing arrows represent valley-core subsidence. The dashed line indicates the top of the regional aerosol layer (AL).

(Serafin et al, 2018)

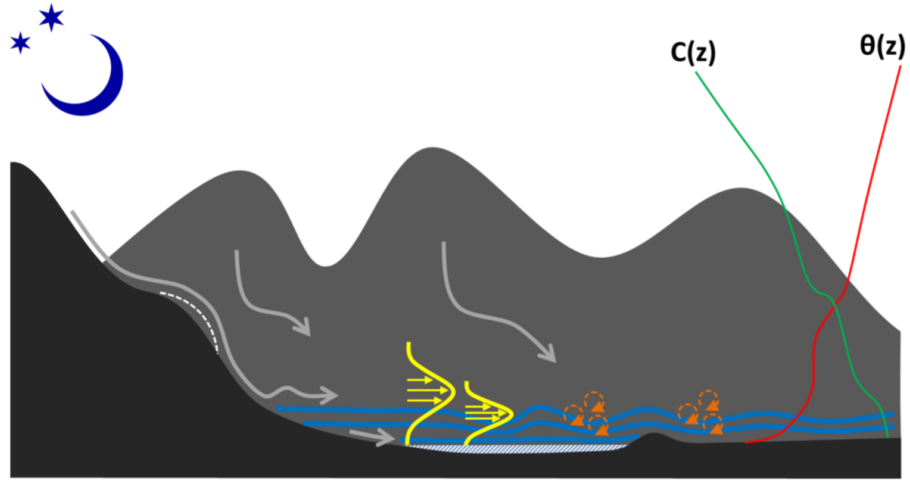


Figure 4. Nocturnal boundary-layer processes over mountainous terrain. Radiative cooling at the valley floor causes the formation of a stable layer near the ground (blue lines). Drainage flow develops along slopes (grey lines). Drainage flow typically has a low-level wind maximum very close to the surface, but it can detach from the ground above stable layers or at convexities in the slope profile (white dashed line). Sheltered areas beneath separated flow are typically less turbulent. If the valley geometry is favourable (for instance, if the cross-section becomes narrower or there are humps on the valley floor), cold air pools and eventually fog may form (white shaded area). If a cold-air pool is present, the down-valley flow typically flows over it (yellow arrows and profiles). Gravity waves may propagate along the top of the surface-based stable layer, forming undulations along the down-valley jet. Increased wind shear at wave troughs enhances turbulence, leading to localized and intermittent mixing episodes (orange whirls). Layering in the profiles of potential temperature and scalar concentration is often observed. After days with strong insolation, a well-mixed near-neutral residual layer may be present in the valley core. The vertical scale of the figure is exaggerated near the valley floor.

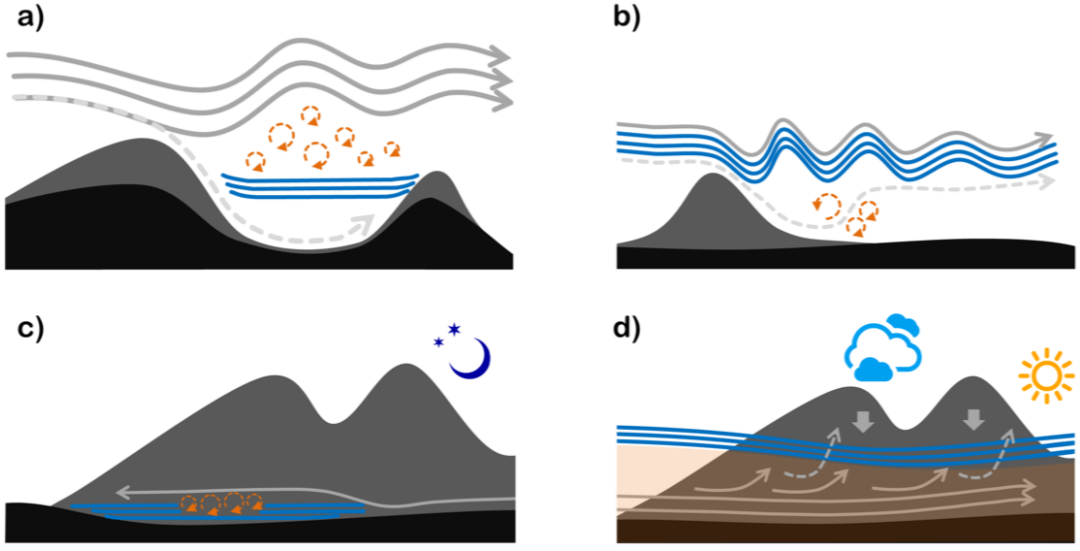
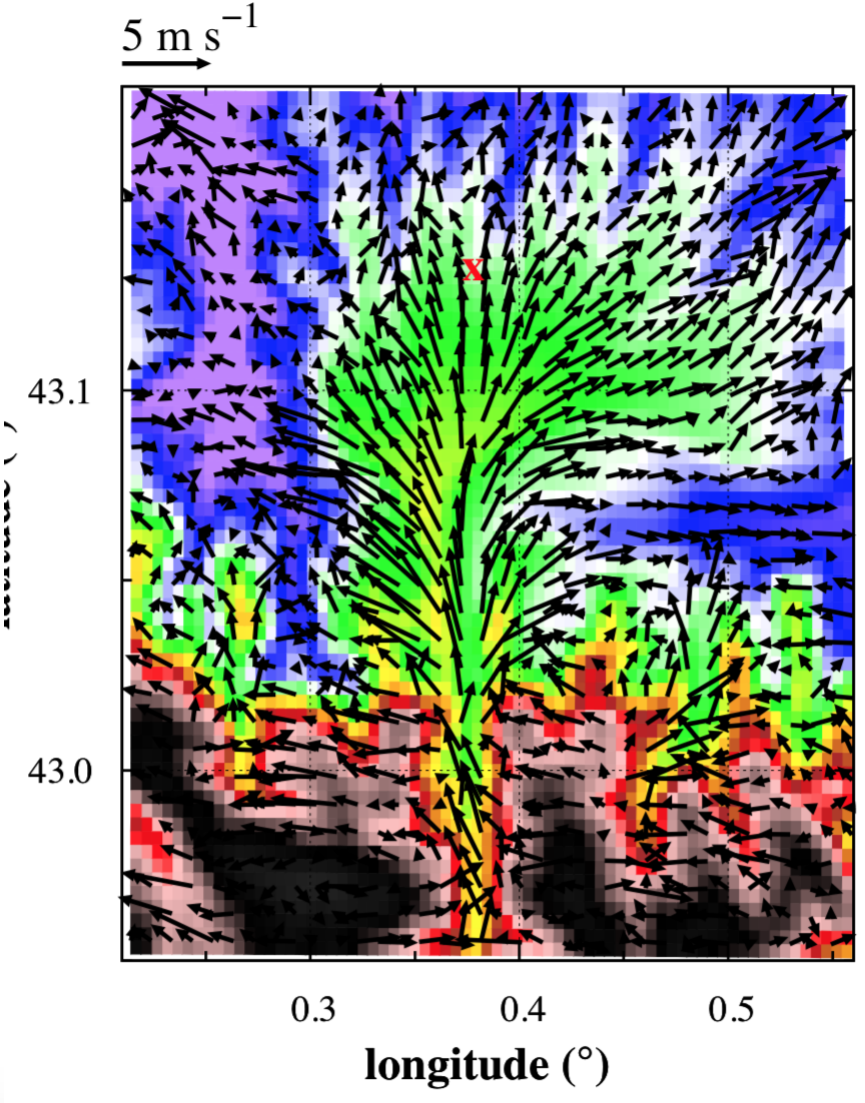


Figure 5. Role of stable layers (blue lines) in controlling multi-scale interactions. (**a**) Airflow over a valley, with (continuous grey lines) or without (dashed grey line) a stable layer below the mountain-top level, results, respectively, in elevated turbulence (orange whirls) and small-amplitude waves or in valley flushing and large-amplitude waves (adapted from [210]). (**b**) Airflow past an isolated mountain with (continous grey line) or without (dashed grey line) a low-level inversion above mountain-top level. In the former case, non-hydrostatic lee waves develop. In the latter, a large-amplitude hydrostatic wave forms, possibly conducive to boundary-layer separation and related turbulence (orange whirls). (**c**) Turbulent erosion of ground-based stable layers underneath a down-valley flow. (**d**) Confinement of moist air (orange shading) beneath a stable layer during daytime, possibly destabilizing the atmosphere. Thermally driven breezes advect air from the plain and upwards along the slopes (grey lines). Part of the upslope flow pierces the stable layer and causes mountain venting (dashed grey lines). Valley-core subsidence (down-pointing arrows) displaces the stable layer downwards.

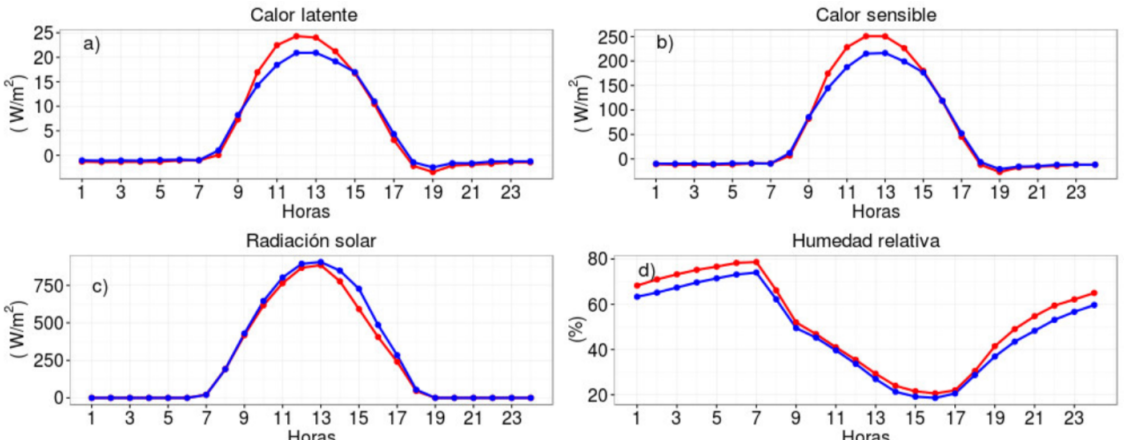
(Serafin et al, 2018)



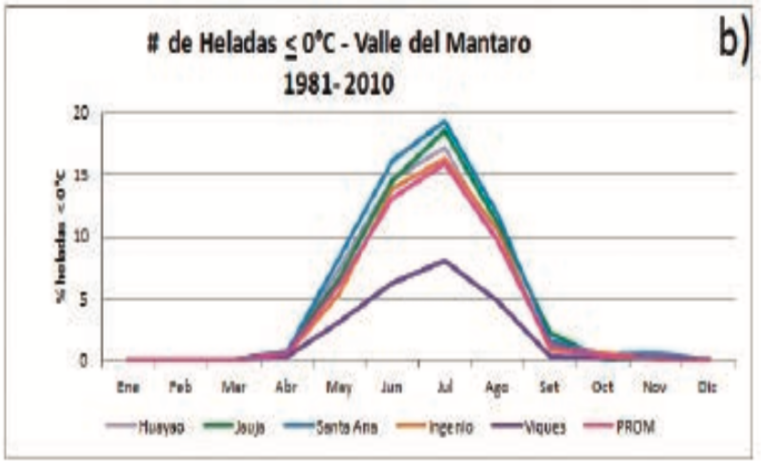
Exit Jet (Jimenez et al, 2018

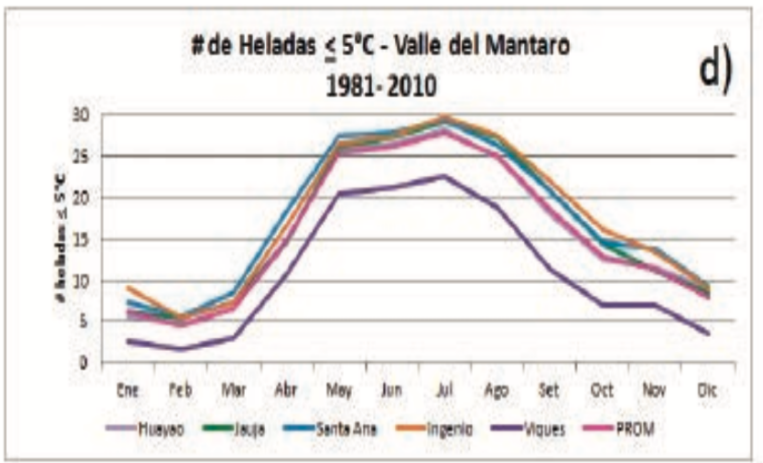
2) Agricultural production in valleys:

* chill hours & frost events
* Water management: evapotranspiration



Average values for july 2015-16 at Huancayo (3300 masl, Mantaro Valley, Perú Callañaupa 2016)

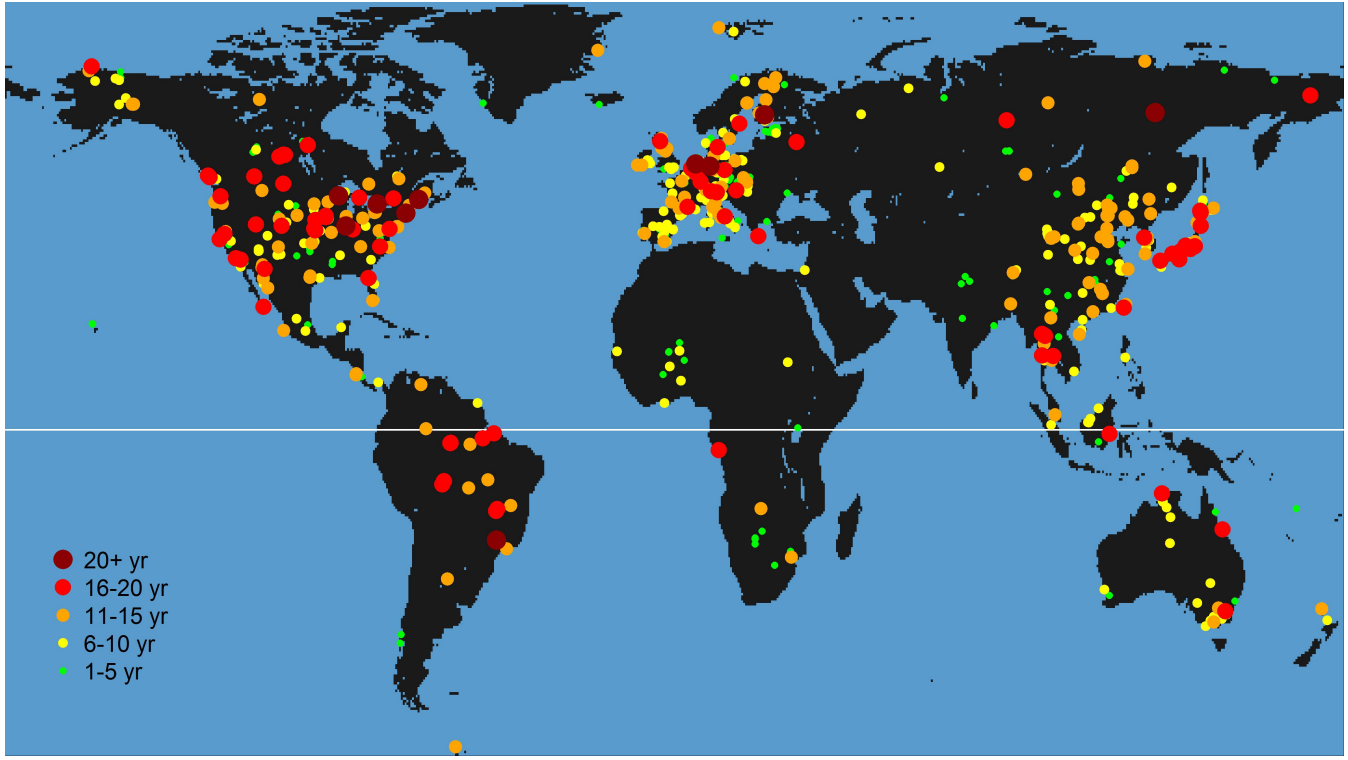




Number of frost days at Huancayo (Trasmonte & Enciso, 2012)

3) Monitoring the surface-atmosphere exchanges

* obtain reliable data in selected locations of the exchange energy and water fluxes
* use them to initialize and validate your numerical models.
* check if theories in use suit the Andean conditions
* display vertical profiling systems to better characterize the low atmosphere
* Improve the air quality network, specially in the main urban areas.



Fluxnet network 2015
(from http://fluxnet.fluxdata.org)