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# Air pollution measurements in Coyhaique, Patagonia

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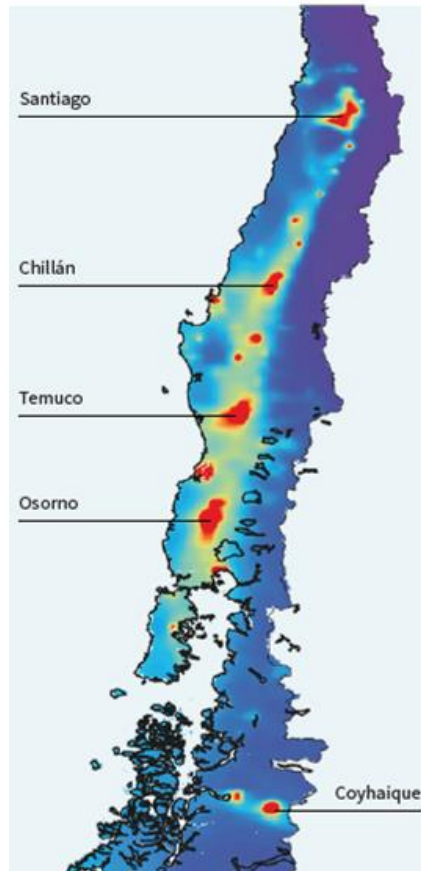
and

Envirohealth Dynamic Systems Group, Universidad del  
Desarrollo (UDD), Santiago de Chile

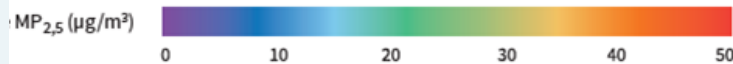
**Luis Gómez, Claudio Herranz, Manuela López ,Andrés Vélez-Pereira, Camilo Rodríguez-Beltrán, Pablo Ortiz-Baeza, Nicolás Fierro Viedma, N., José Miguel Campos, Nicolás Huneeus, Ricardo Muñoz, Marios Panagi**

# Coyhaique, Patagonia

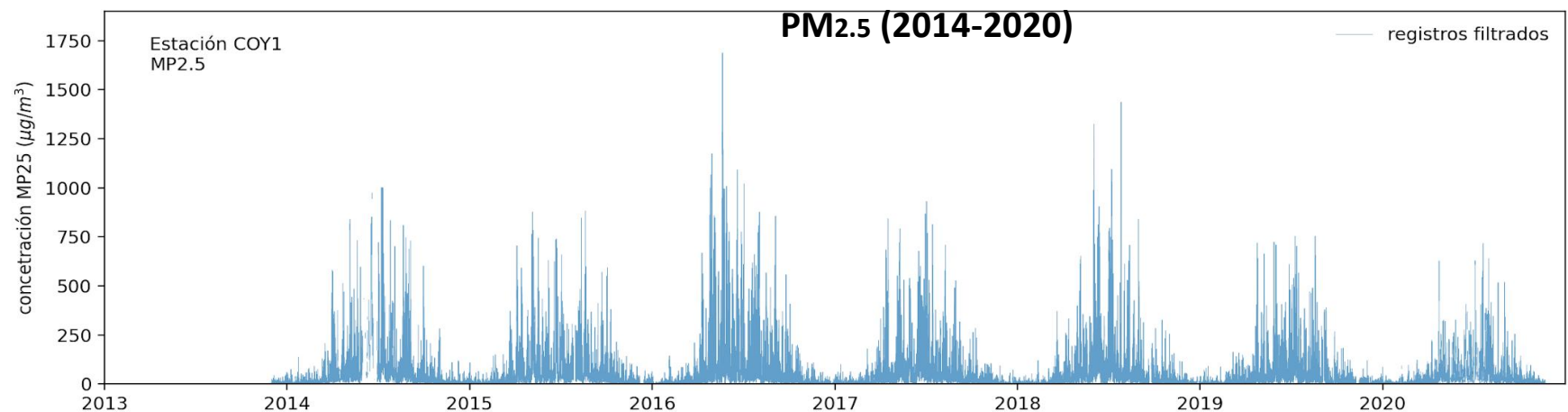
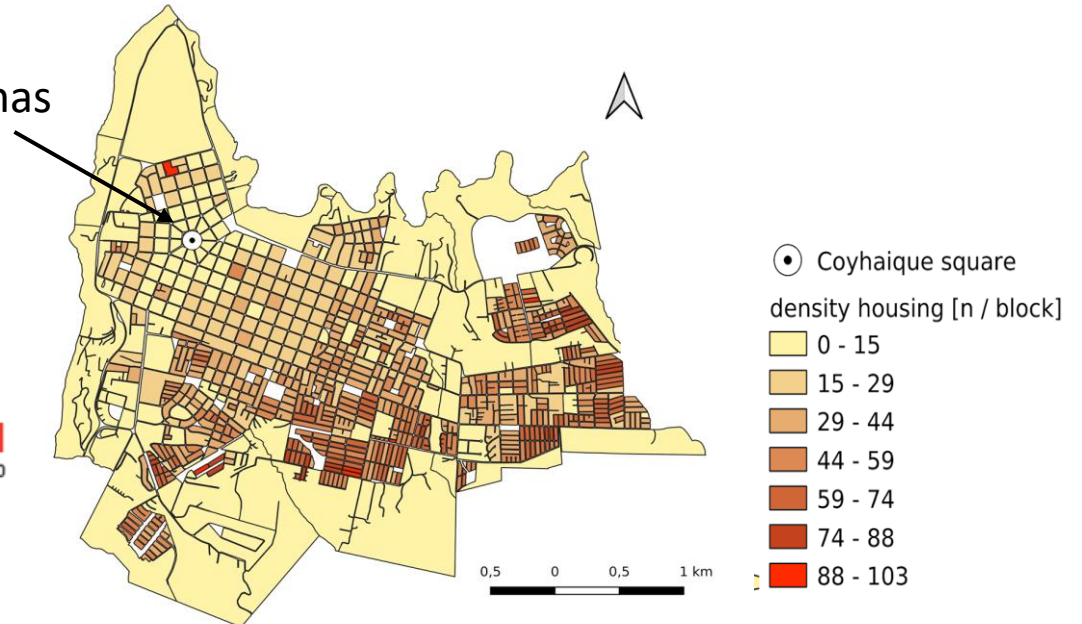
- ❖ Second biggest town (after Punta Arenas) in Chilean Patagonia
- ❖ Population 49,000 (Population of the region of Aysén (107,000 km<sup>2</sup>) is 91,000)



Average of winter 2015-2017 PM<sub>2.5</sub>  
(Informe a las Naciones)

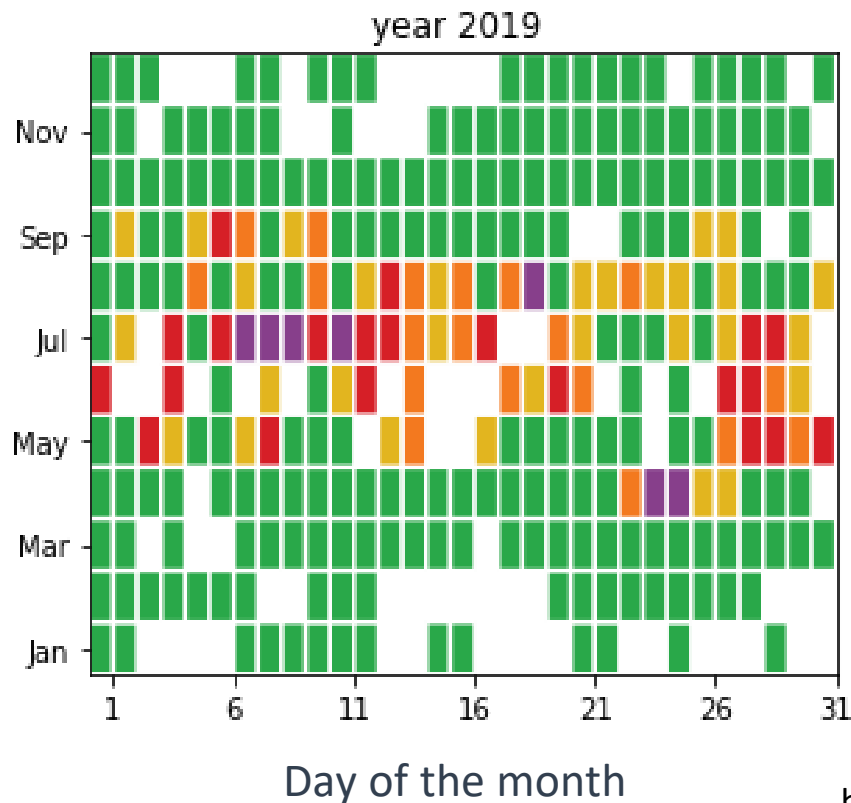


Plaza de Armas



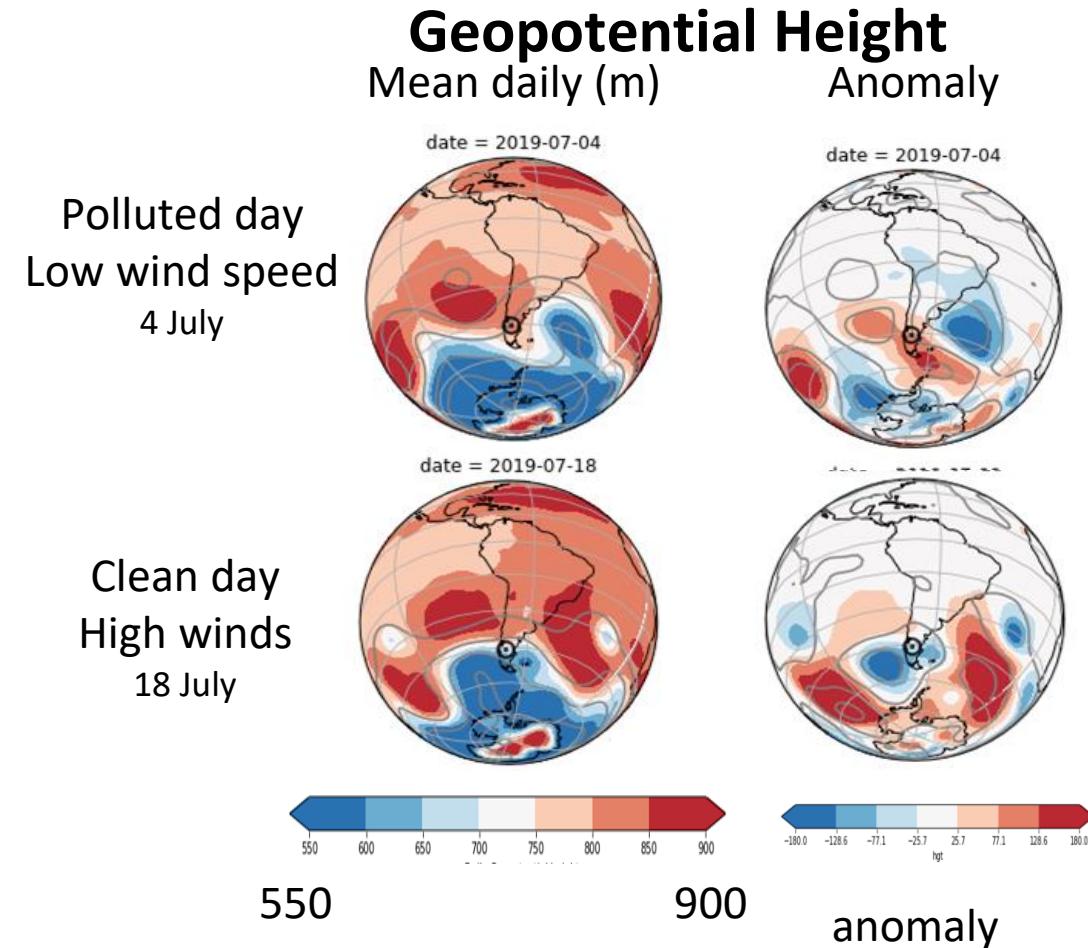
# Winter pollution episodes

- ❖ Winter (April to September) in Coyhaique is when the “Management of Critical episodes “ plan comes into place and a daily air pollution rating is published
- ❖ Restrictions on the use of wood burning stoves (more than one per household are put into place, depending on the level of Particulate Matter



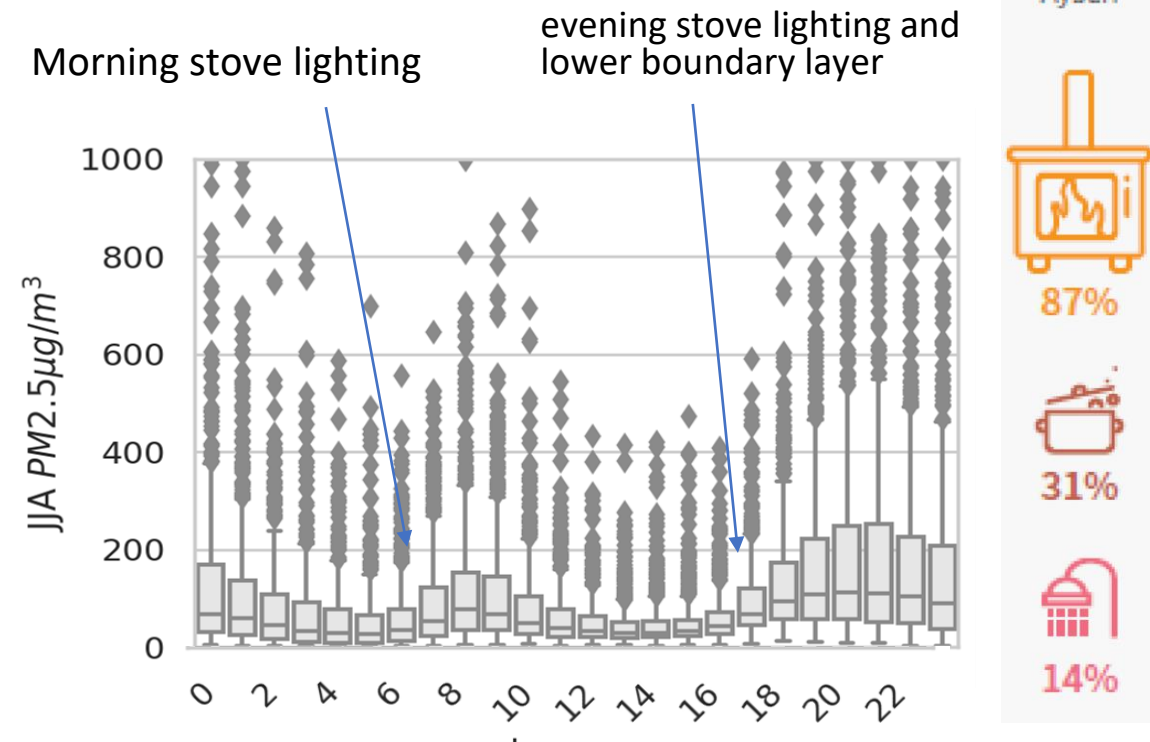
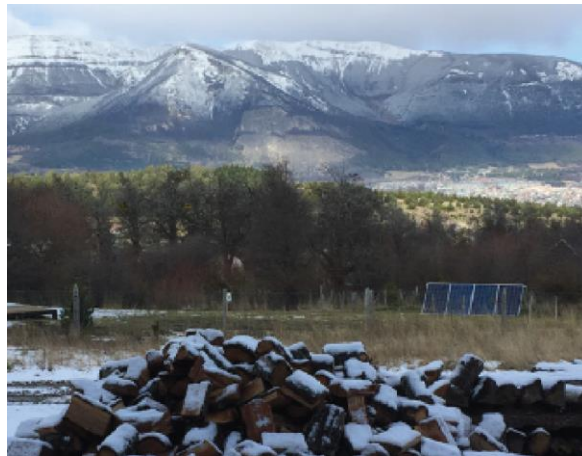
# Meteorology during the pollution episodes

- ❖ The Geopotential height (from NCEP reanalysis) in the upper atmosphere over Patagonia dictates whether a high pressure system will dominate over Coyhaique, leading to stagnant air
- ❖ There was a positive Geopotential height anomaly at the start of July 2019 (when there was high pollution and low wind speeds and a negative ridge on the 18<sup>th</sup> July, a relatively clean day
- ❖ Add to that the temperature inversion that builds up, especially on the cold, clear winter days



# Domestic wood burning in the south of Chile

- ❖ 87 % of households in the region use wood to heat their houses
- ❖ Indoor air pollution is a risk as well (and little studied)
- ❖ Poor housing stock (badly insulated)



Diurnal cycle of PM<sub>2.5</sub> in Coyhaique in Winter (JJA) 2014-2019

## EXCAMP2019 field campaign

- ❖ In July 2019, researchers from Santiago and Coyhaique gathered for an intense field campaign with the Ministry of the Environment, the town council and local volunteers
- ❖ Citizen science mobile measurements as well as boundary height measurements and the running of a variety of models
- ❖ Media coverage and consolidating good links with the local government and the local branch of the Ministry of the Environment

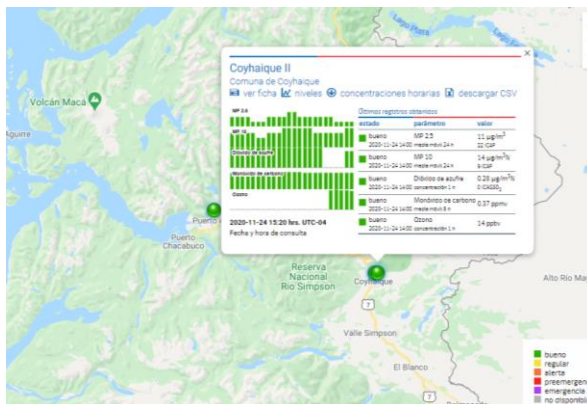


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# Monitoring station data

- ❖ The Environment Ministry (SINCA) has 2 monitoring stations (since 2013) but they are both very close to each other (880 m apart)
- ❖ Measuring hourly PM<sub>2.5</sub>, PM<sub>10</sub>, NO, NO<sub>2</sub>, CO, O<sub>3</sub> and meteorology



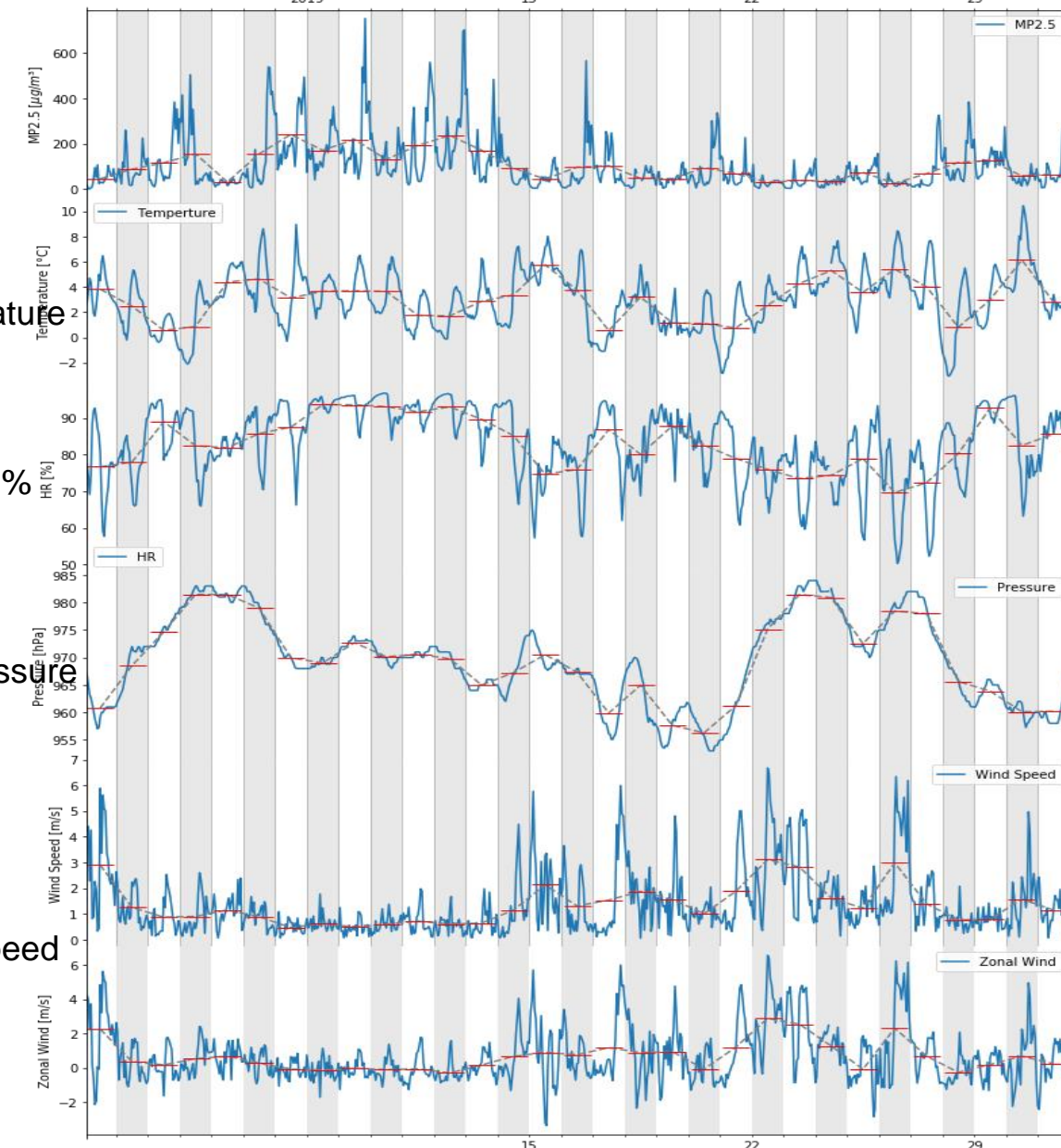
PM<sub>2.5</sub>

Temperature

RH %

Pressure

Wind speed

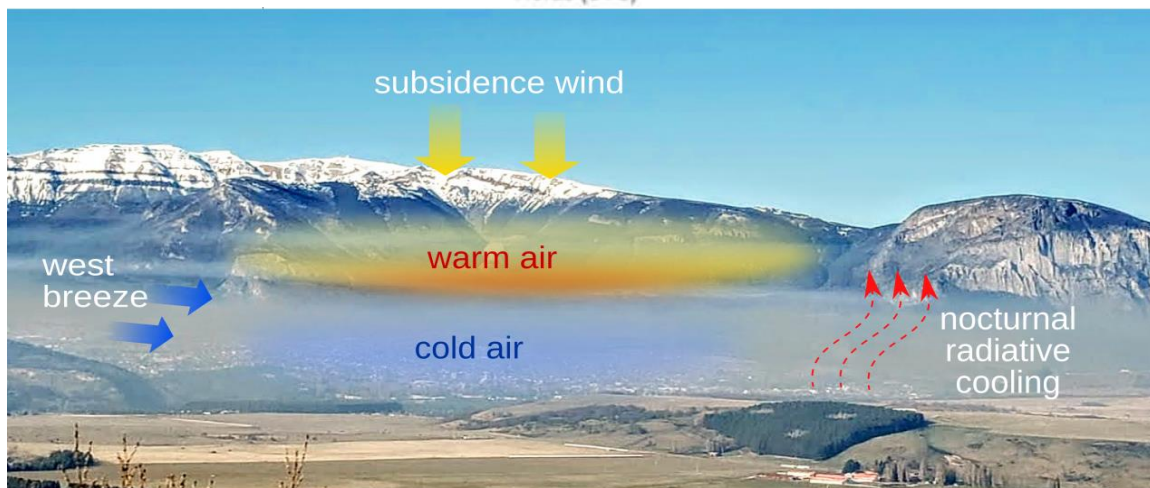
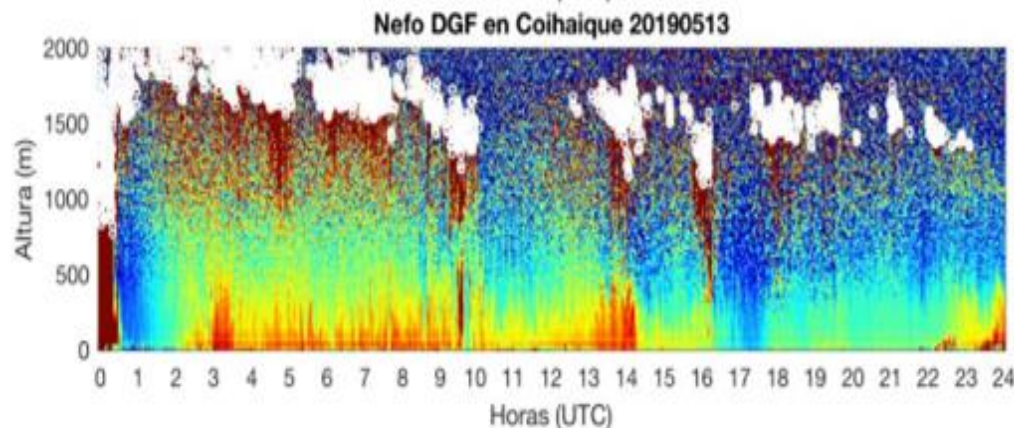


Jul 2019

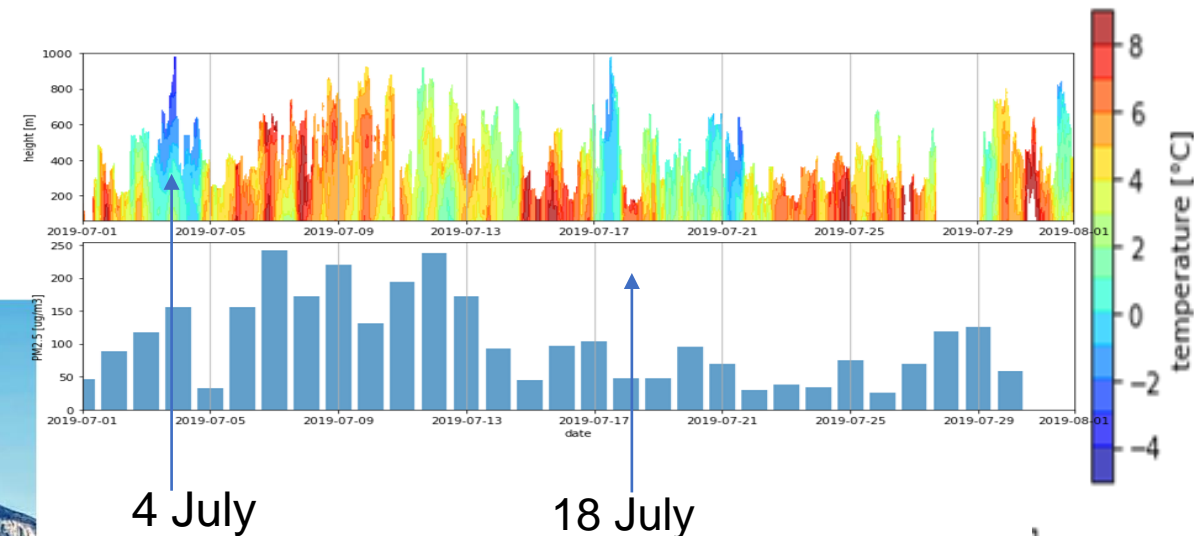
July 2019

# Mixing layer height during the campaign

- ❖ The nefobasimeter can track particles in the atmosphere and the height of the mixing layer, noting when there is a build up of aerosols



- ❖ SODAR-RASS measures the vertical profile of the lower atmosphere: temperature and height of mixing layer

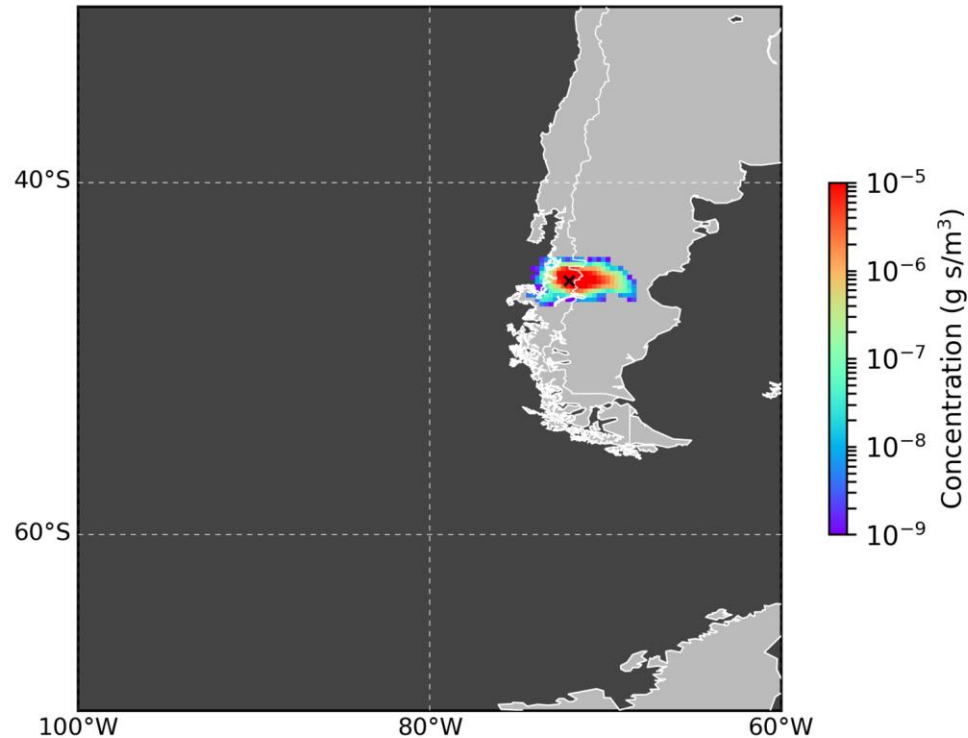


- ❖ The mixing layer can be as low as 10 m at night and extend to 200m in the day in winter

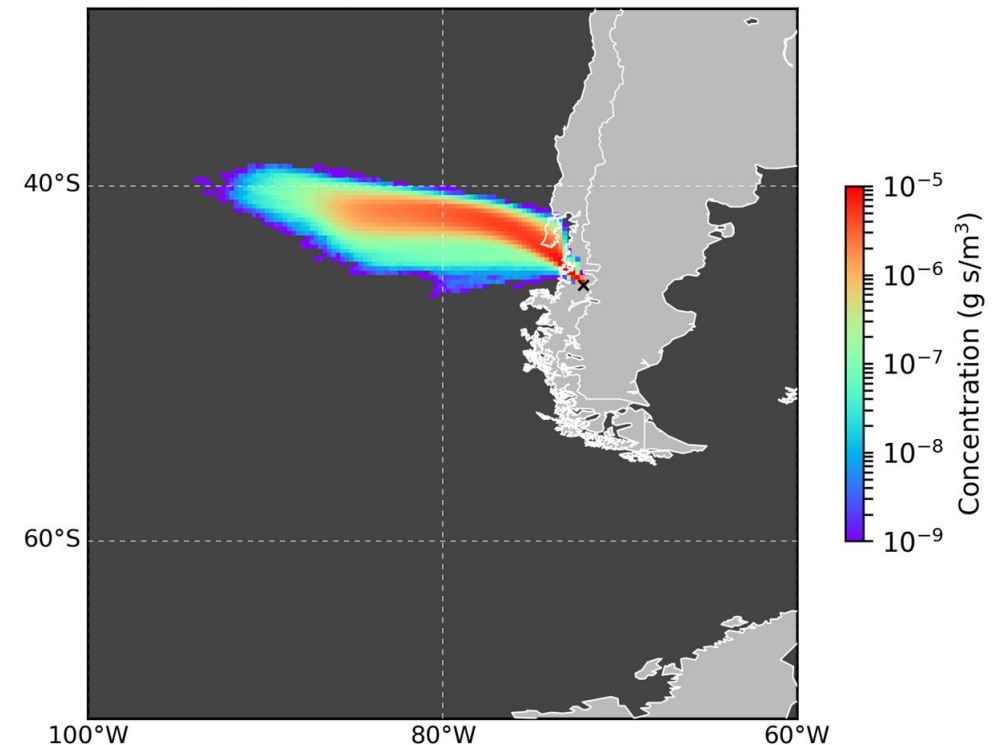
# (CR)<sup>2</sup> Dispersion modelling: origin of the air arriving in Coyhaique

- ❖ NAME dispersion model (UK Met office) using Unified Model (17 km) Met data. 6 hr and 24 hour back runs
- ❖ Comparing the stagnant day with the well-aerated days

COYHAIQUE 1day (0-1000m) Backwards start of release: 04/07/2019 0000

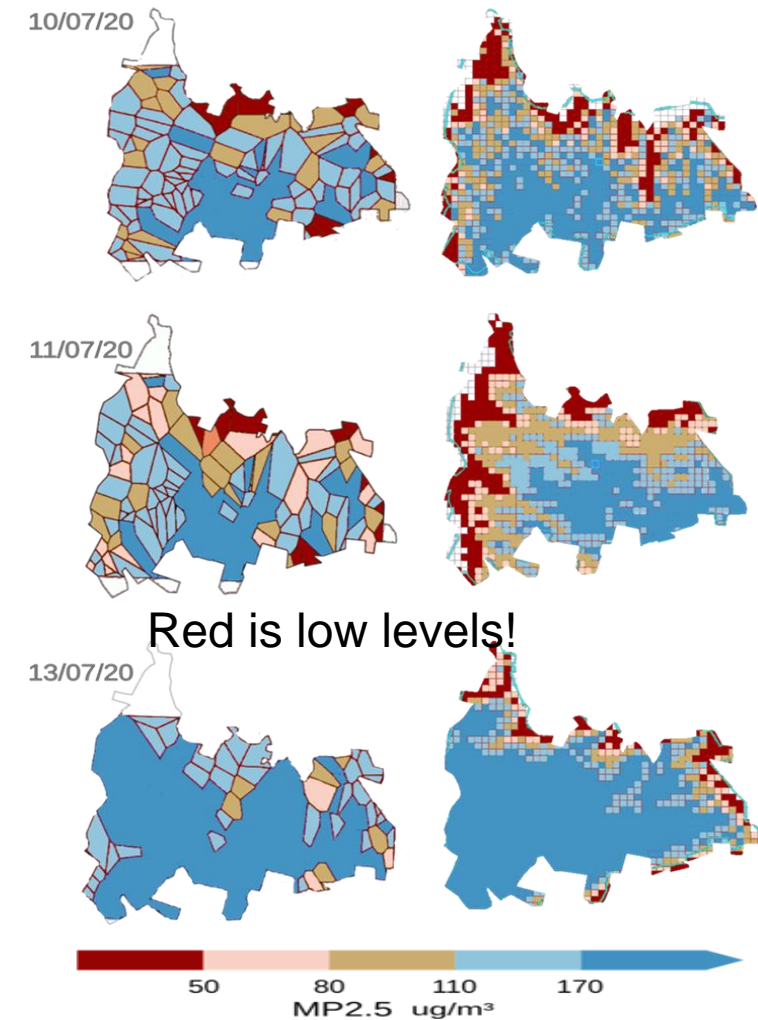
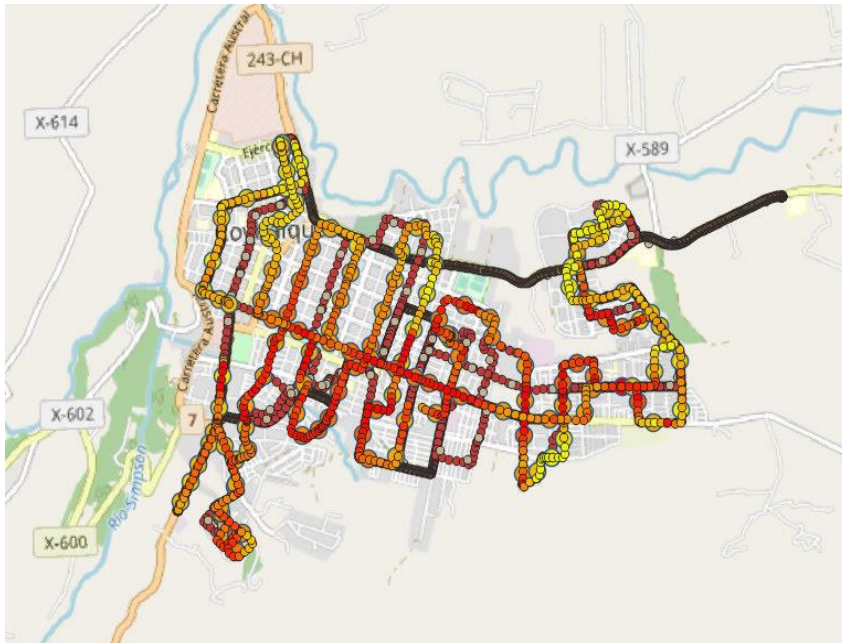


COYHAIQUE 1day (0-1000m) Backwards start of release: 18/07/2019 1200



## Mobile measurements with a vehicle (preliminary)

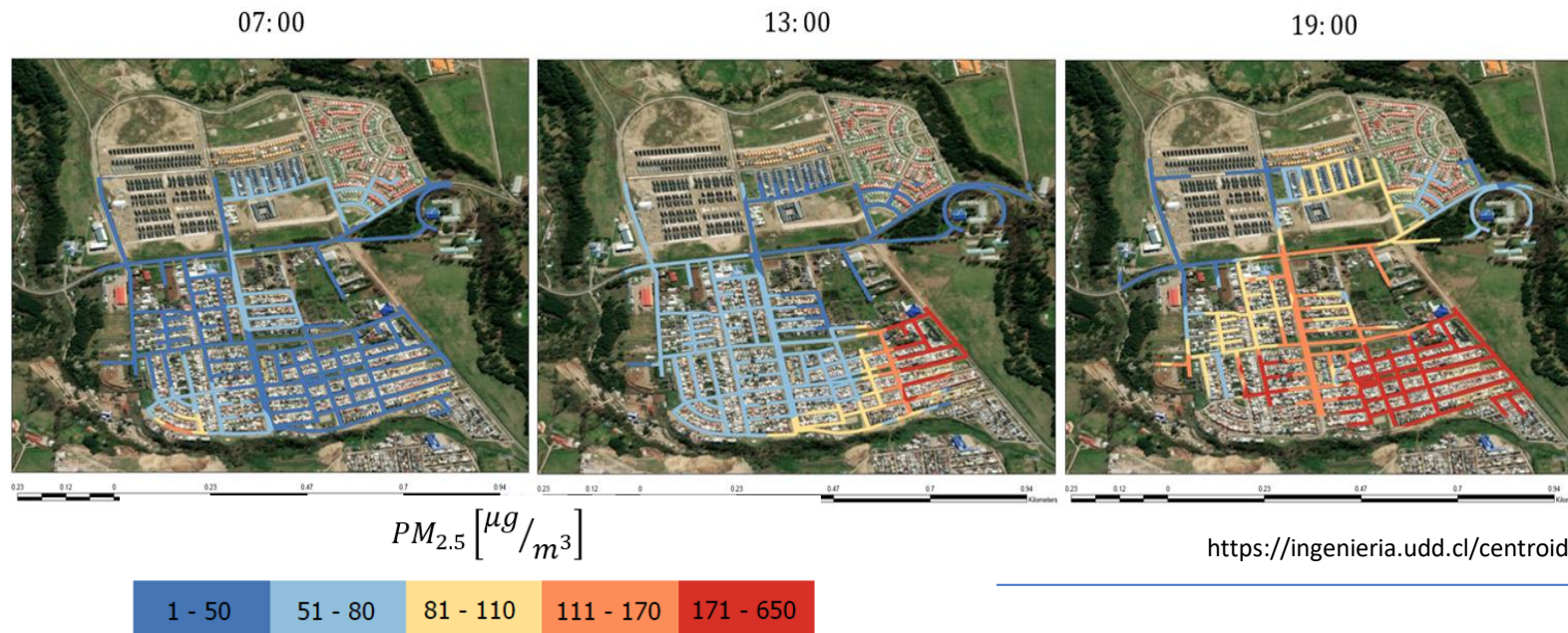
- ❖ 3 hour evening drives around the town
- ❖ 20 km/hour (associated with no more than 1 block for each measurement period)
- ❖ Microaethelometer (BC), Aerocet



- ❖ Left: Direct interpolation of the mobile measurements from the car
- ❖ Right: Gaussian Model of the  $PM_{2.5}$  car measurements on 10, 11 and 13th July

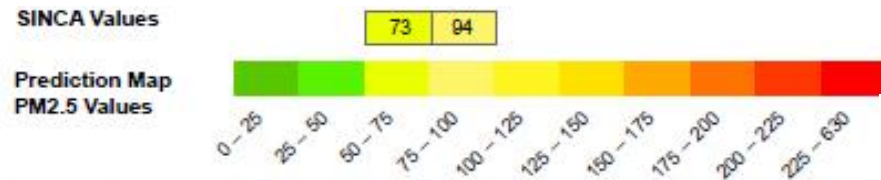
## Walking experiments

- ❖ The Hiri hand held instruments use a Plantower PM sensor which is connected to a smart phone app that captures the georeference of each sample and sends the data to be downloaded later.
- ❖ Used in sets of four 45 minute walks in quadrants
- ❖ Calibration of the instruments for 10 minutes before each walk
- ❖ Spatio-temporal resolution on a street by street scale
- ❖ Monitoring strategy 3 times a day

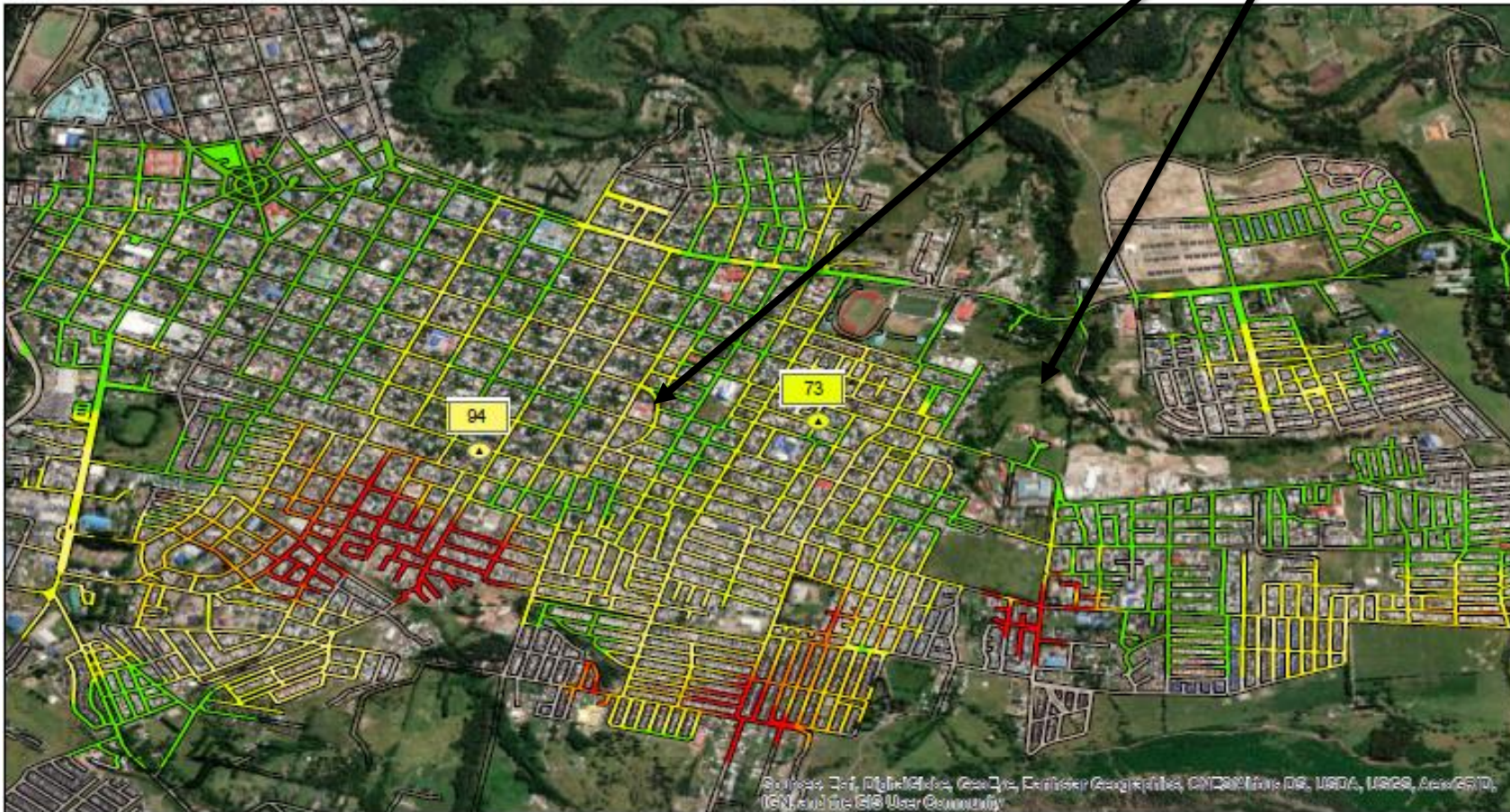


<https://ingenieria.udd.cl/centroid/laboratorios-de-investigacion/envirohealth-dynamic-system-lab/>

# The megawalk on 23 July 2019: 14 people simultaneously walking set routes



The monitoring stations measured similar values



Covering a total of 22km during 45 minutes

## Conclusions

- ❖ The mobile measurements carried out in Coyhaique show an extremely high spatio-temporal variation of the air pollution from the wood smoke
- ❖ These measurements can help with local decision-making such as selecting the areas of town where a stronger focus should be made on stove replacement schemes and better insulation
- ❖ This has provided the impetus for the team to install 20 new low cost stationary instruments (inside and outside of houses)
- ❖ Collaboration between research centers, local government and the citizen's of Coyhaique which has made communication about these issues much more open and productive.
- ❖ A new project between the partners will start in 2021, calibrating and testing low cost sensors

Thank you!

Contacts:

**Centro de Investigaciones de Ecosistemas de Patagonia:** [luiz.gomez@ciep.cl](mailto:luiz.gomez@ciep.cl)

Project starting in 2021: “**Platform for Platform for standardization, characterization and calibration of environmental air and water diagnoses**”: [z.fleming@udd.cl](mailto:z.fleming@udd.cl)

References and Coyhaique data:

<http://www.cr2.cl/contaminacion/> (The air we breathe: Past, present and Future. Report to the Nation.)

[www.aysenmet.cl](http://www.aysenmet.cl)

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Laboratorio Eco-climático de Aysén. Proyecto ANID R17A10002; 2018 -2020

<https://photos.app.goo.gl/vG2vvVv51cd9xzxL8>

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