Air quality forecasting for winter-time PM2.5 episodes occurring on multiple cities in south-central Chile

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NCAR
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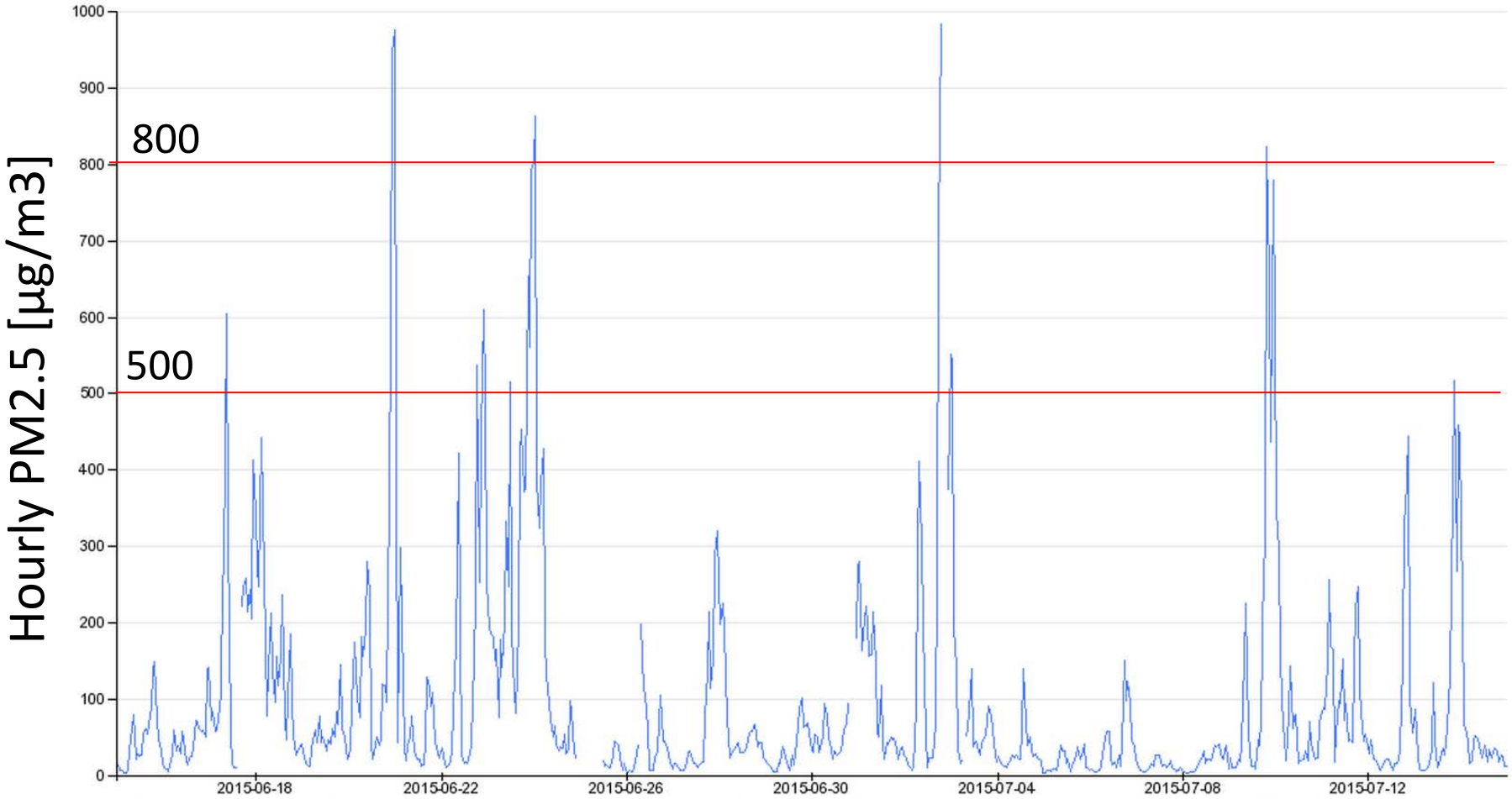
Trivia: What city is this and how big is it?



City: Osorno. Population: ~150k inhabitants

Severe PM2.5 episodes in south-central Chile

- Produced by a combination of:
  - Complex topography
  - Episodic meteorological conditions
  - Emissions due to anthropogenic activities

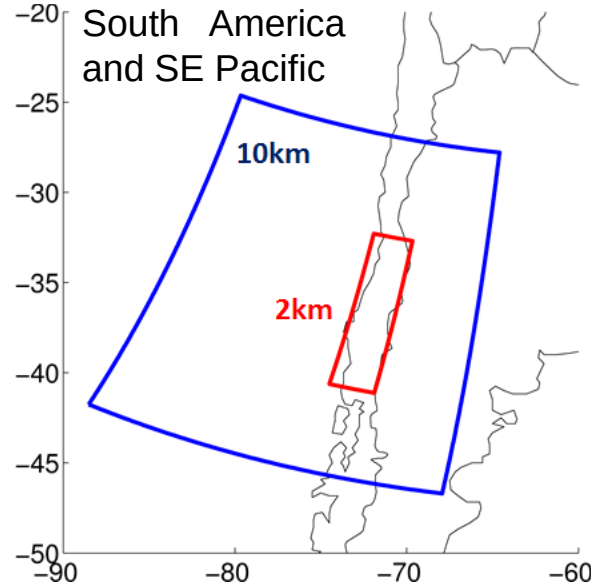
- Episodes are declared to warn the public and to try to reduce the impact by invoking temporary measures

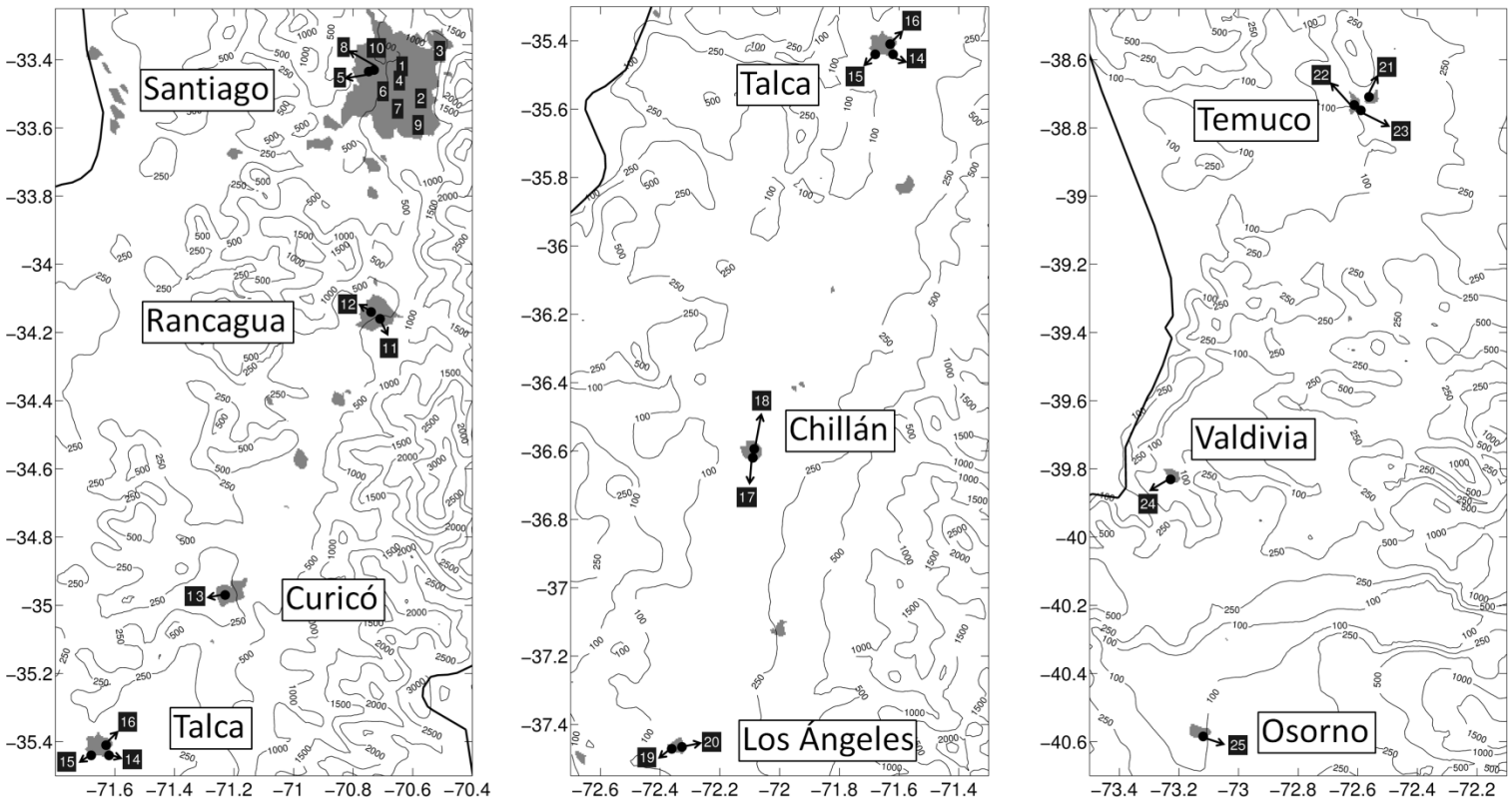
Santiago during en episode

Wood burning stoves in Temuco

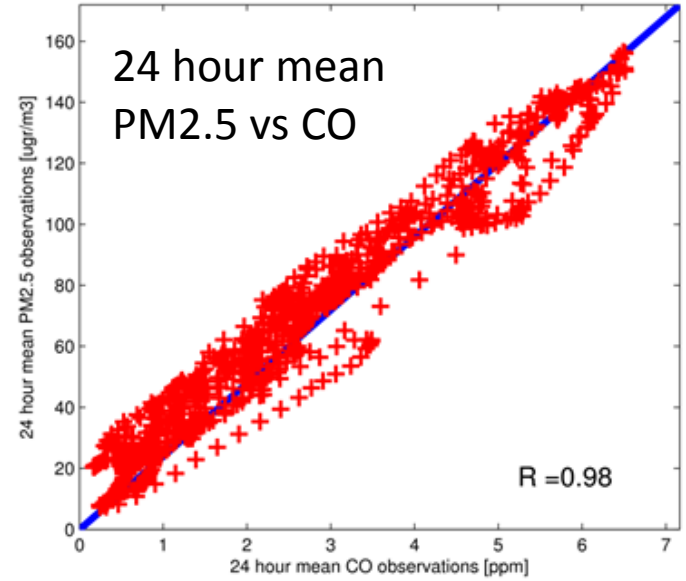
Forecasting system

- WRF-Chem model at high spatial resolution to resolve met conditions, topography and emissions





PM2.5 modeling



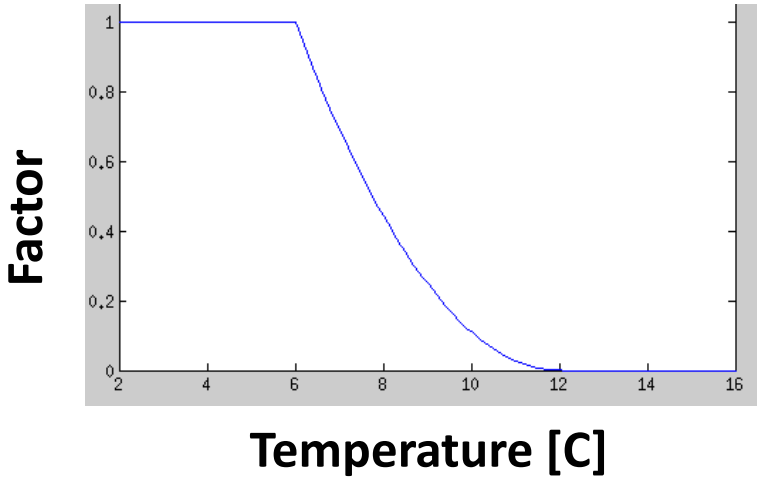
- CO and PM are highly correlated during episodes (Saide et al., Atmos Env 2011)
- Use CO tagged tracers ("traffic" and "wood burning stoves") and an empirically calibration for 2014
- The conversion factors are chosen to match observed episode statistics.
- Factors are introduced to include physical processes

$$PM2.5_{t,s} = Tr_to_PM_s * A_weekend_{t,s} * \ldots$$

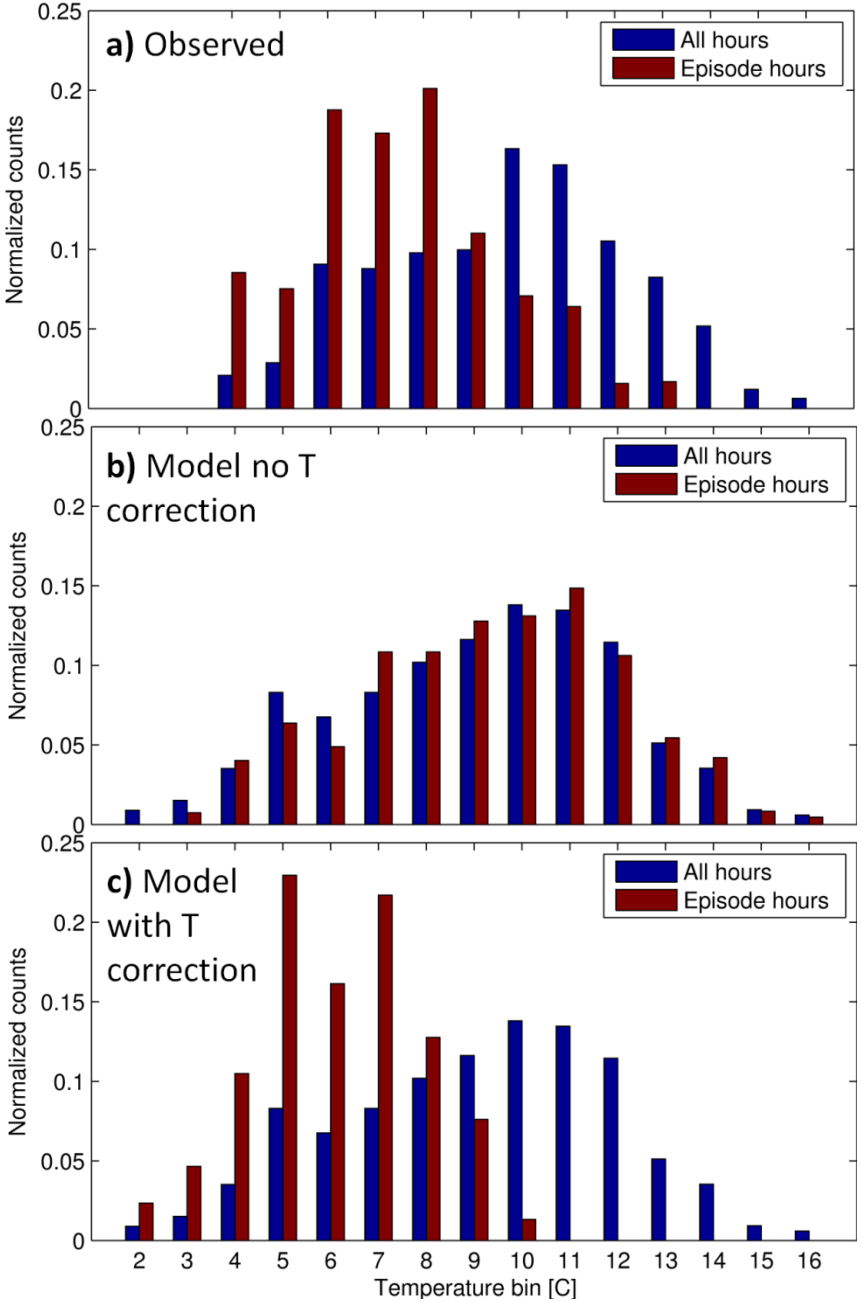
$$\left[F_WB_s * A_WB(T_mean_{t,s}) * \left(\max_{i \in s \cup N_s} Tr_WB_{t,i}\right) + (1 - F_WB_s) * \left(\max_{i \in s \cup N_s} Tr_T_{t,i}\right)\right]$$

Episode's Temperature dependence

- Episodes associated to colder temperatures
- This is due to emissions from wood burning stoves for heating
- Including temperature correction helps reproduce histograms



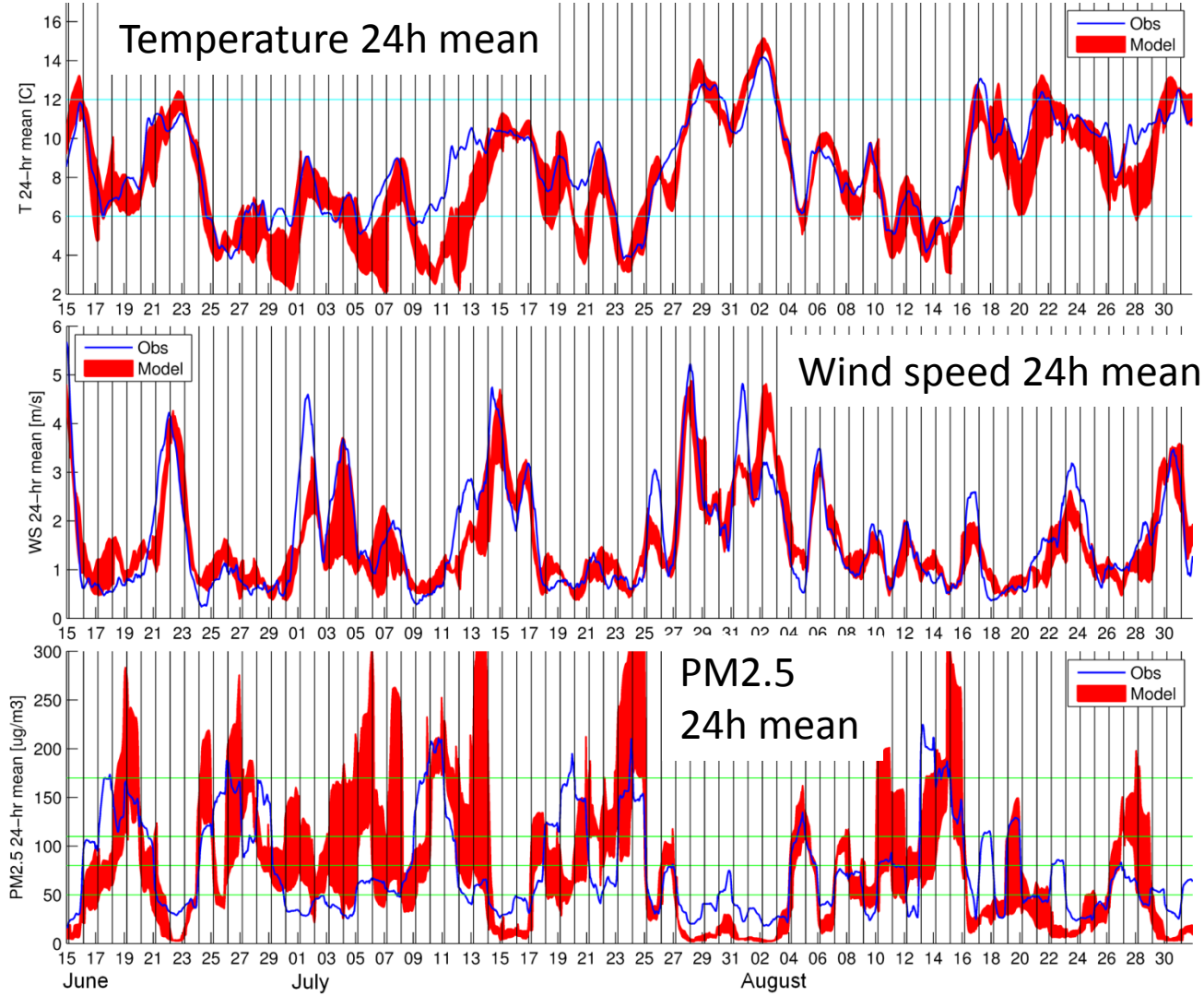
Temperature histograms (Temuco)



Results

Temuco (Padre de las Casas II)

- Large variability within forecasts due to different meteorological initialization
- Variability in PM2.5 much larger than T and wind speed
- Ensemble forecasting should be explored in the future

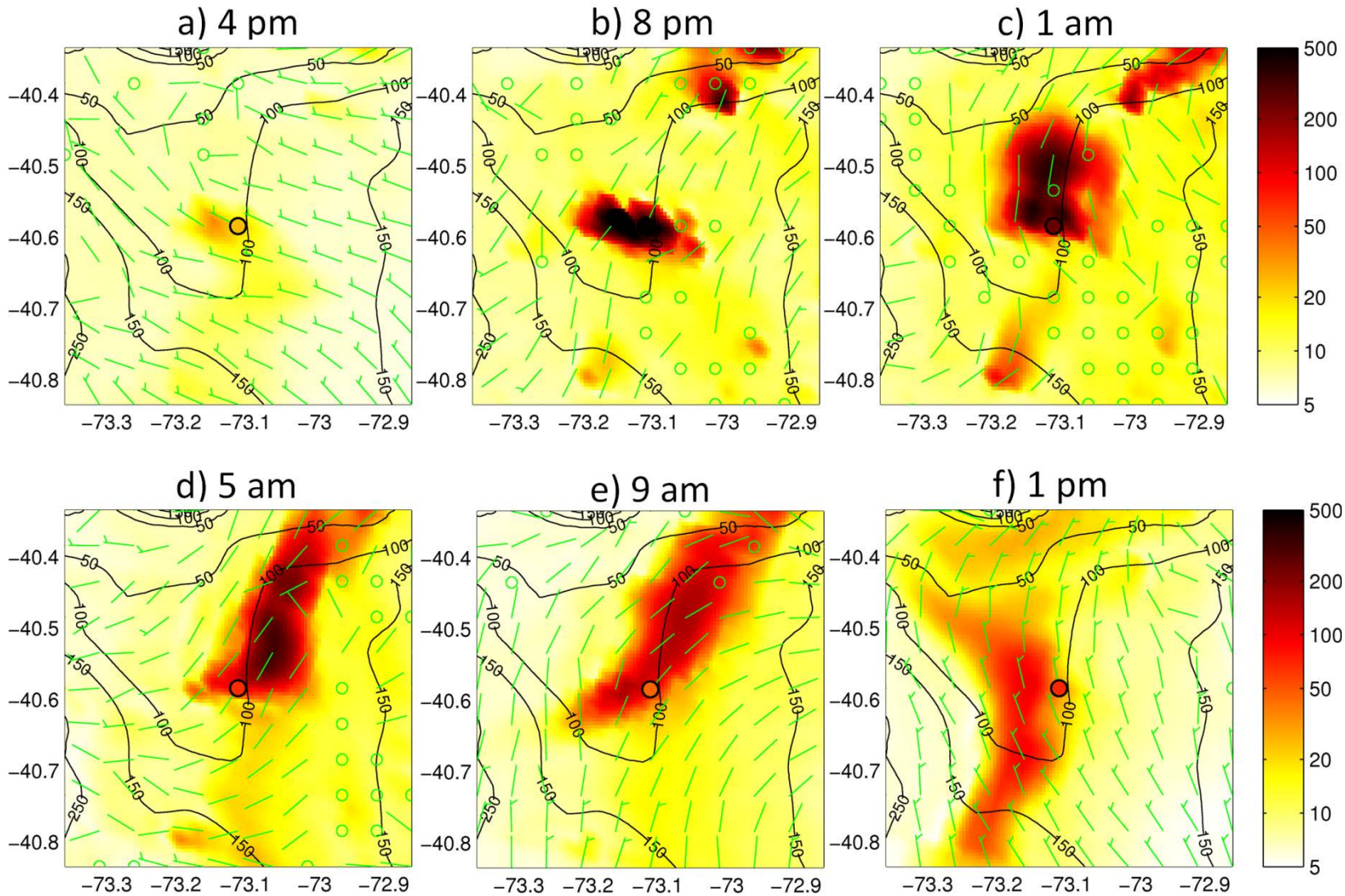


Forecast skill

- Forecasts one, two and three days in advance all have skill in forecasting
- Latest forecast no necessarily the best
- Forecast generally beat persistence

City	Station	Episode days (%)	% correct Episode				
			Day 1	Day 2	Day 3	All	Pers
Santiago	Pudahuel	21%	63%	72%	69%	68%	56%
	Cerro Navia	30%	71%	69%	76%	72%	67%
Rancagua	Rancagua II	35%	68%	72%	68%	69%	64%
Curico	Curico	21%	61%	48%	48%	53%	42%
Talca	La Florida	38%	66%	64%	59%	63%	57%
Chillan	Puren	40%	65%	67%	62%	64%	65%
Los Angeles	21 de Mayo	33%	67%	67%	65%	67%	63%
Temuco	Museo Ferroviario	33%	73%	69%	71%	71%	64%
	Las Encinas	33%	68%	62%	68%	66%	64%
	Padre Las Casas II	38%	73%	71%	68%	71%	73%
Valdivia	Valdivia	31%	59%	61%	61%	60%	52%
Osorno	Osorno	38%	71%	64%	63%	66%	70%

Episode evolution (Osorno)



Forecasting for 2015

- System in place for the 2015 pollution season
- So far providing good guidance, similar skill as the 2014 calibration

EL AUSTRAL

www.australosorno.cl

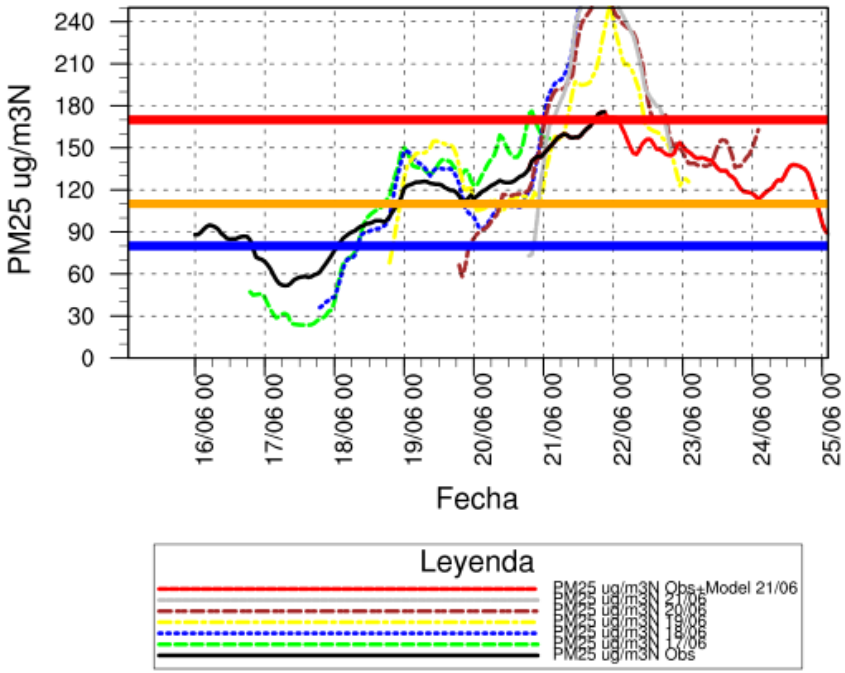
EL DIARIO DE OSORNO

Sistema pronosticará la mala calidad del aire con tres días de anticipación

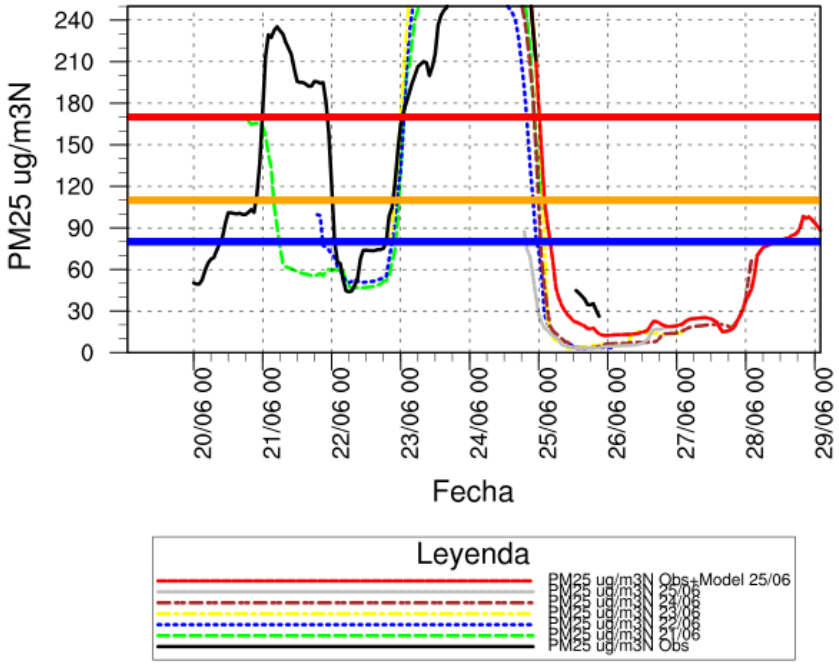
Contaminación. Nueva herramienta fue elaborada en Estados Unidos y busca mejorar procedimiento para avisar los episodios de alertas ambientales.

Subsecretario del Medio Ambiente, Marcelo Mena, explicó que el modelo tiene un 75% para pronosticar días de alta presencia de material particulado. Pág. 4

Emergency in Santiago



Emergency in Osorno



Conclusions

A forecasting system was developed and is in place for predicting severe pollution episodes in 9 Chilean cities with good results

Future work

- Emissions modeling for wood burning stove emissions need to be explored
- Extending forecasts for Austral Chile (Coyhaique)
- Explore capabilities for ensemble prediction

Thanks! Questions or comments?

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