Alqueva lake impact on a regional climate: a typical meteorological study

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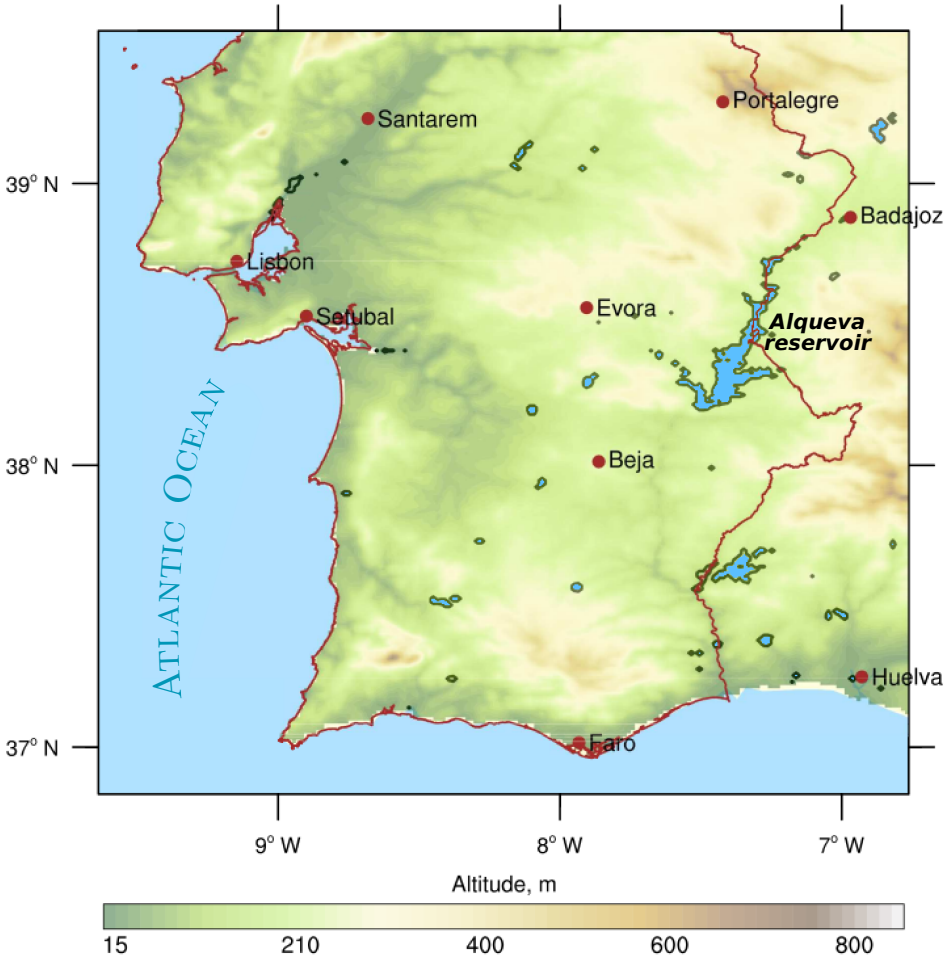
Previsão Numérica em Portugal

Évora — 2021

The Alqueva reservoir?



Basic info:

- the largest artificial lake in Western Europe (250 km^2);
- up to 92 metres depth;
- average depth 16 metres;
- fully filled in 2004;
- affects local weather conditions and environment.

Motivation - aim

UNIVERSIDADE DE ÉVORA · IPBeja · ICT Instituto de Ciências da Terra Institute of Earth Sciences

The project goals are:

- Improve knowledge of the state of the atmosphere and reservoirs in the region with special emphasis on the study about Alqueva – the strategic water reservoir of Alentejo;
- Improve the prediction of the evolution of the atmosphere and its impact on the quantity and quality of water in people life and economic activities;

Aim of this work:

To assess the possible weather/climate impact of the Alqueva on the regional scale using Meso-NH simulations

Modelação numérica da atmosfera: Ano Meteorológico Típico

O Ano Meteorológico Típico é formado pelos 12 meses meteorológicos que melhor reproduzem as estatísticas climáticas do período em estudo (16 anos: 2013-2018).

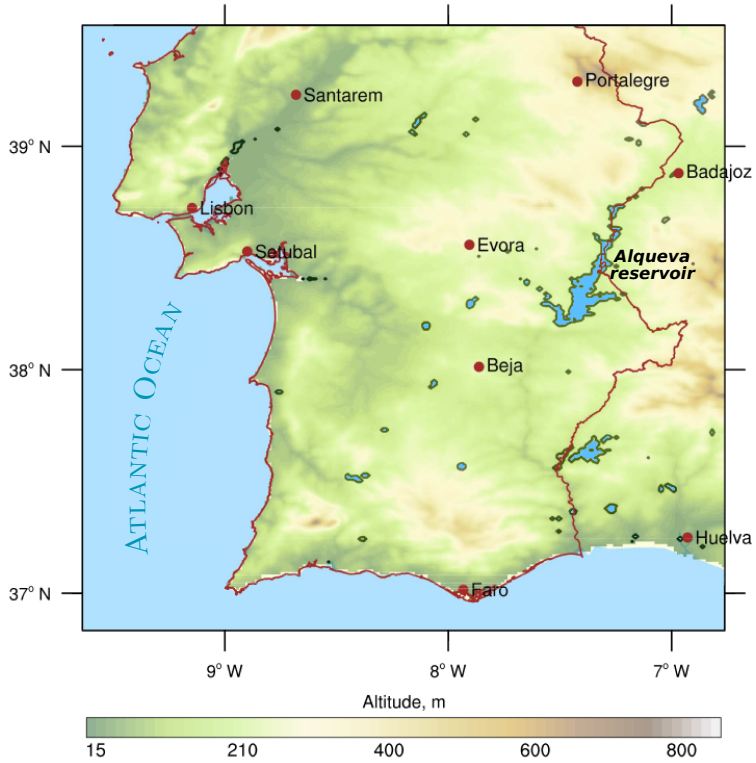
O TMY considerado é comoposto[1] por:

1. January 2018
2. February 2006
3. March 2017
4. April 2008
5. May 2005
6. June 2010
7. July 2014
8. August 2007
9. September 2011
10. October 2008
11. November 2004
12. December 2018

A simulação foi iniciada em 8 nodes (512 processadores) do Supercomputador Khromeleque na Universidade de Évora em **junho** de 2019 e concluído em **novembro** de 2019.

[1] Detailed information about this can be found in E.F.M. Abreu et al. *Renewable Energy*, **127** (2018), 398-411

Numrical simulation: setup



Model - **MesoNH**

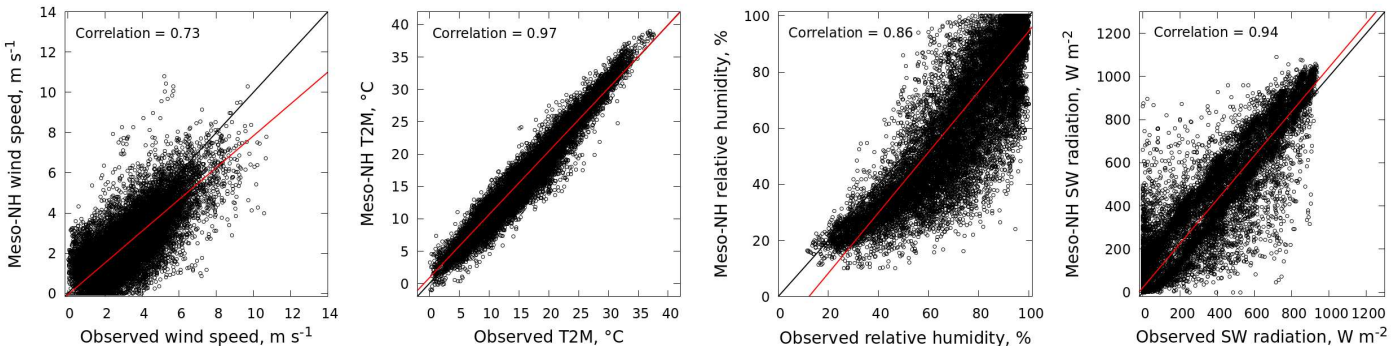
Domain

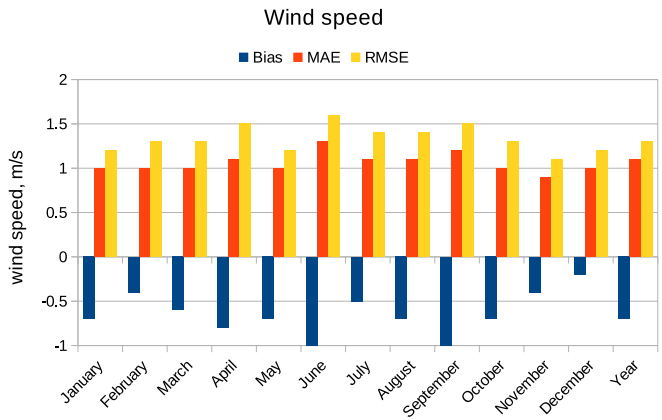
- cobre o Sul de Portugal e parcelas adjacentes de Espanha e do Atlântico;
- 72 níveis verticais até aos 24385 m;
- Resolução horizontal de 1.25km;
- 200x240 grid pixels;
- orografia: srtm (250 m).

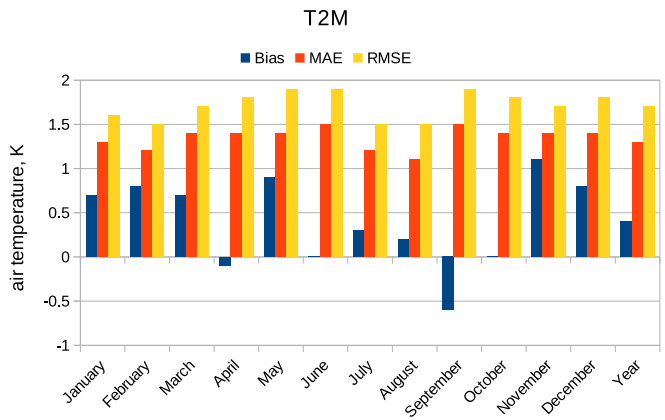
Metodologia:

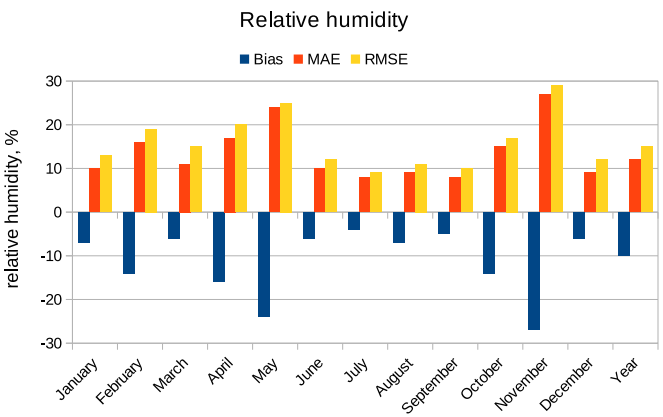
- 2 simulações: uma com Alqueva e outra sem Alqueva;
- O impacto é estimado a partir da diferença entre os resultados da simulação com Alqueva menos o da simulação sem.

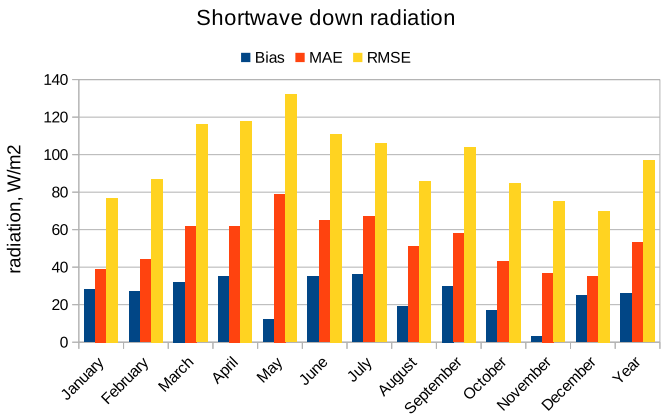
Validation vs. weather stations: Évora, Mitra, and Portel



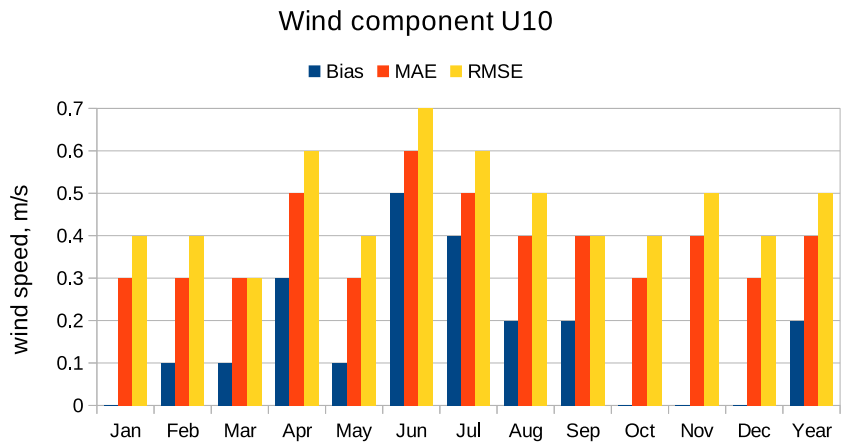


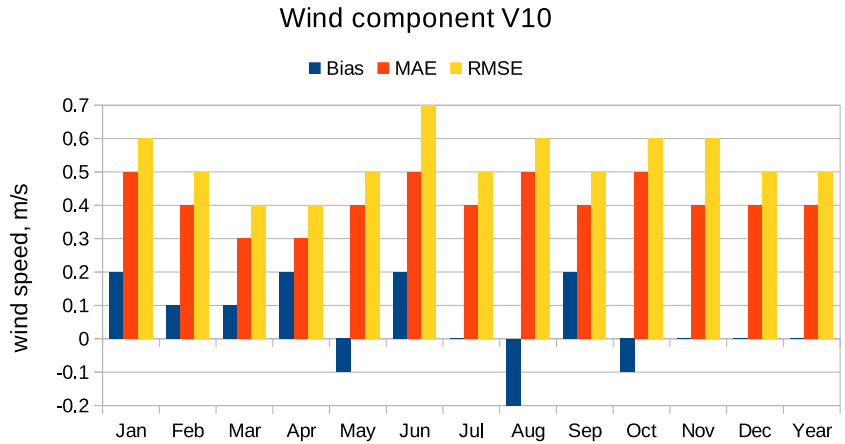


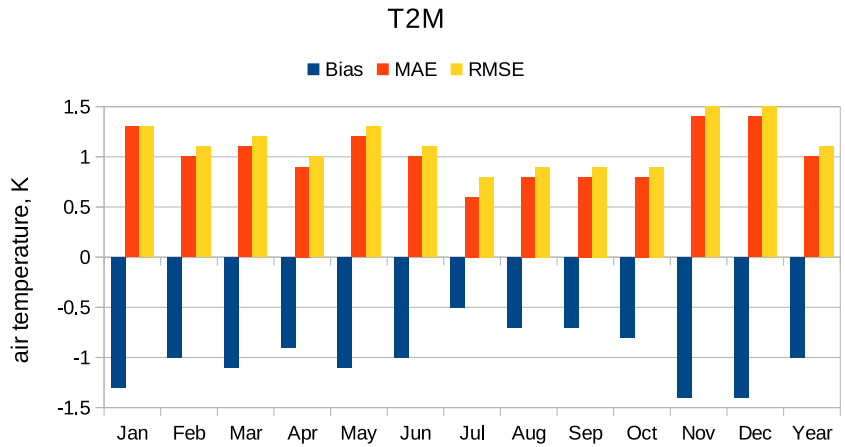


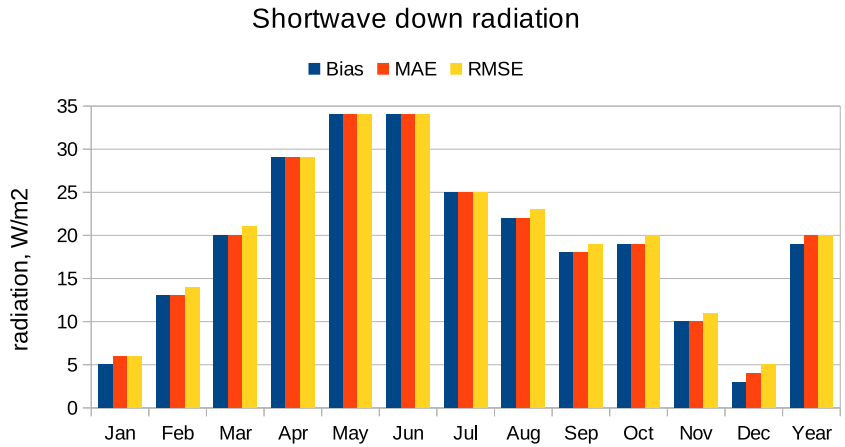


Validation vs. ECMWF ERA5-Land reanalysis

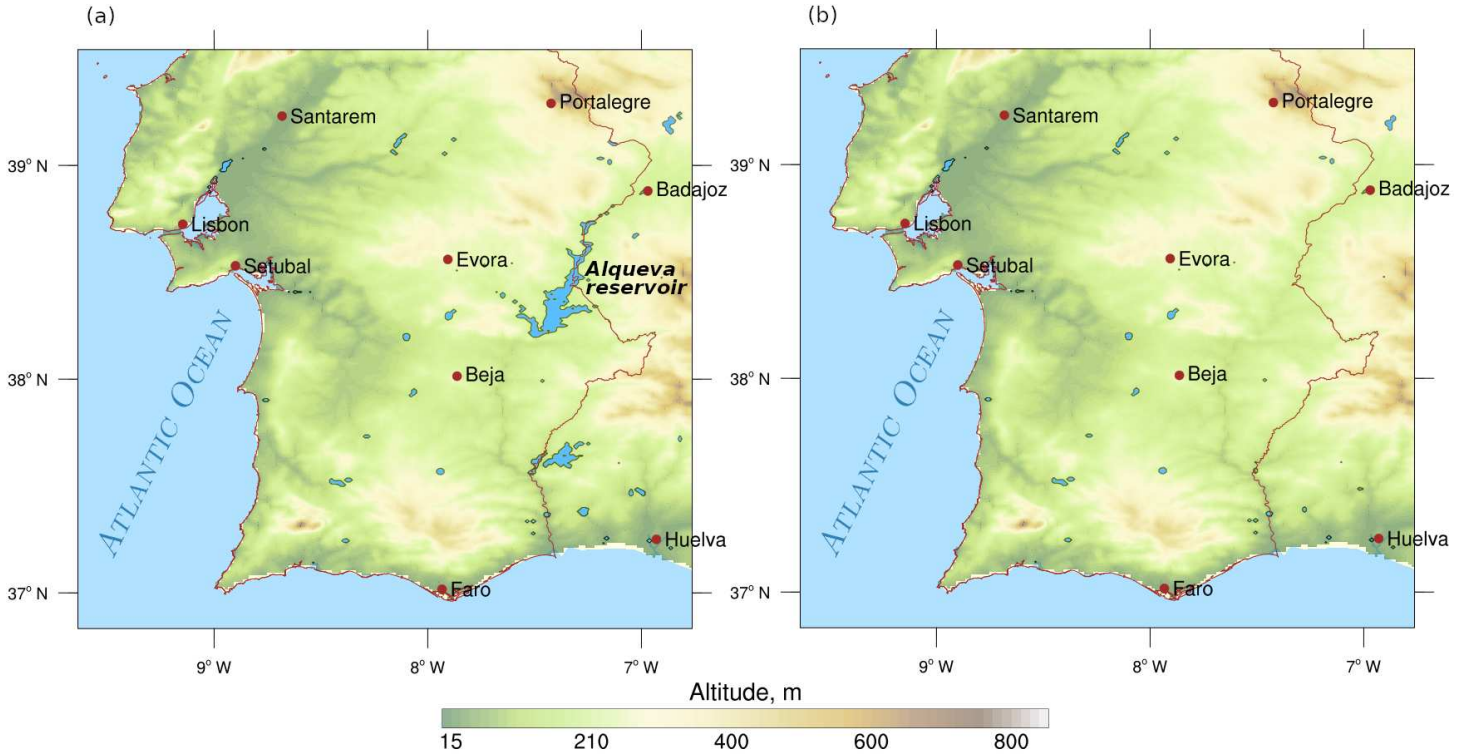








Method

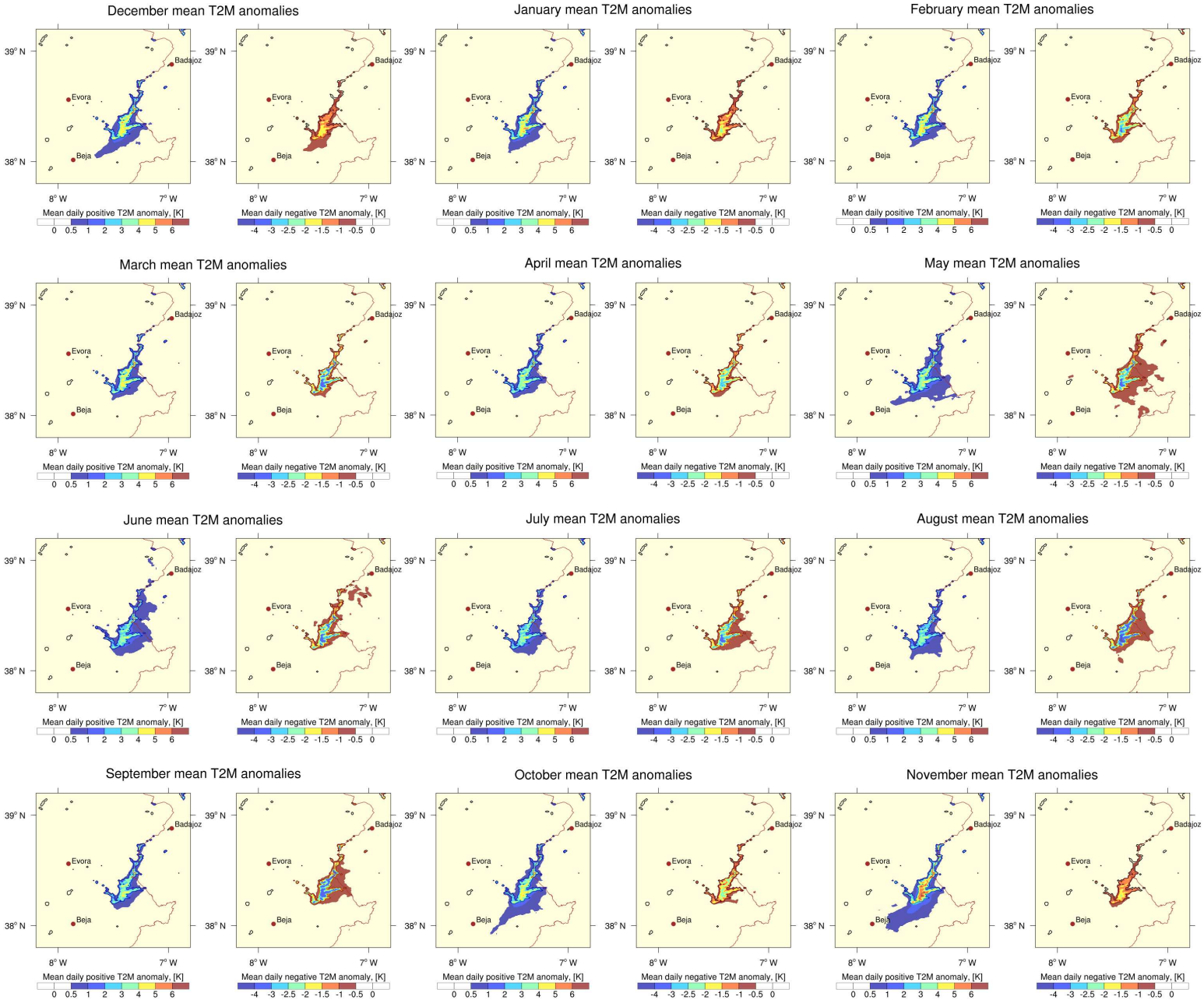


Two sets of simulations were done: **with** and **without** Alqueva.

Comparing those two datasets for a particular variables (subtracting one from another) we could obtain a raw impact of the lake presence on this variable (*anomaly*)

Where anomaly = 0, Alqueva has no impact, and when anomaly is positive or negative — there we can see an added value (a positive or a negative impact).

Resultados: Impacto na temperatura do ar



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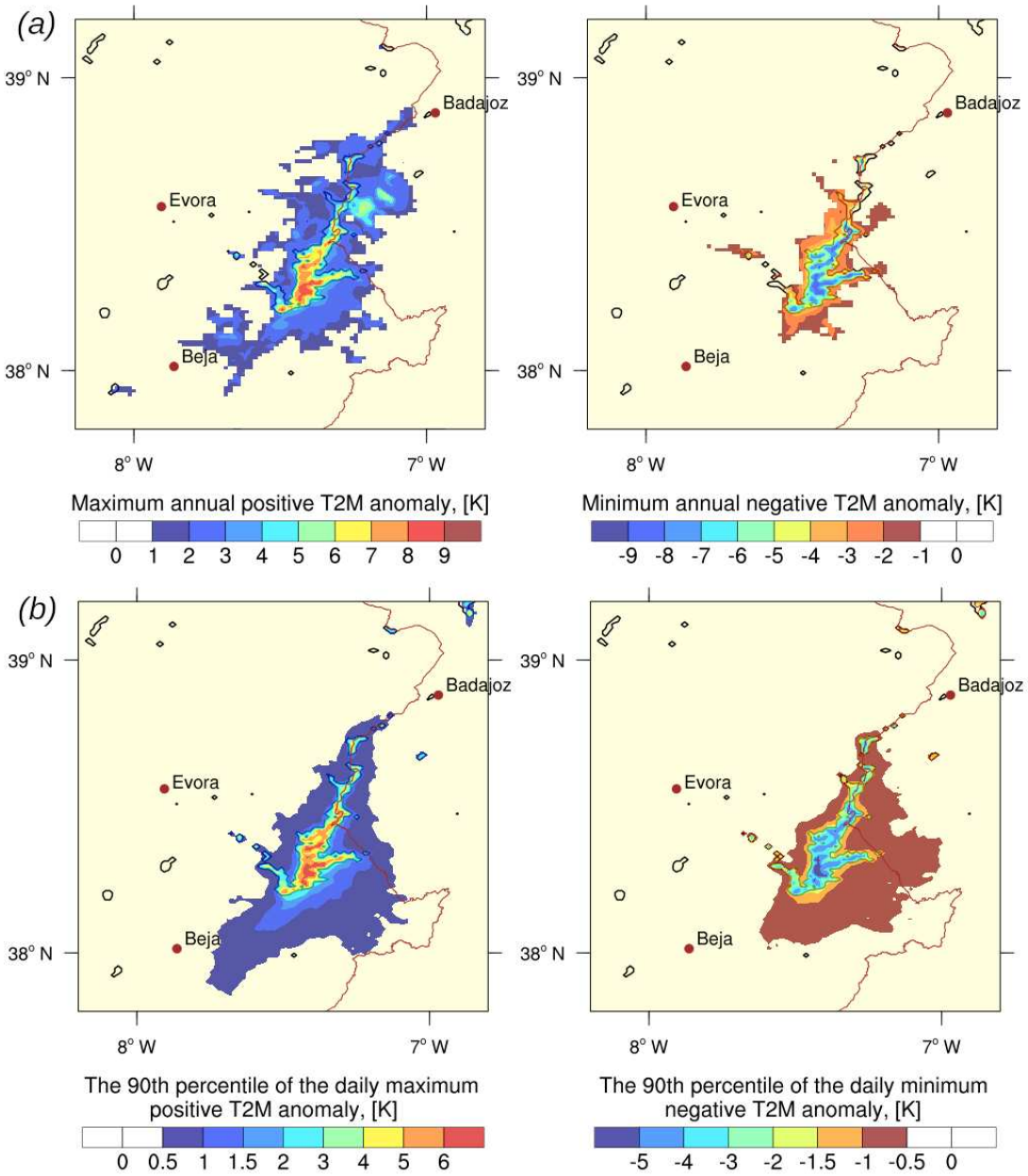
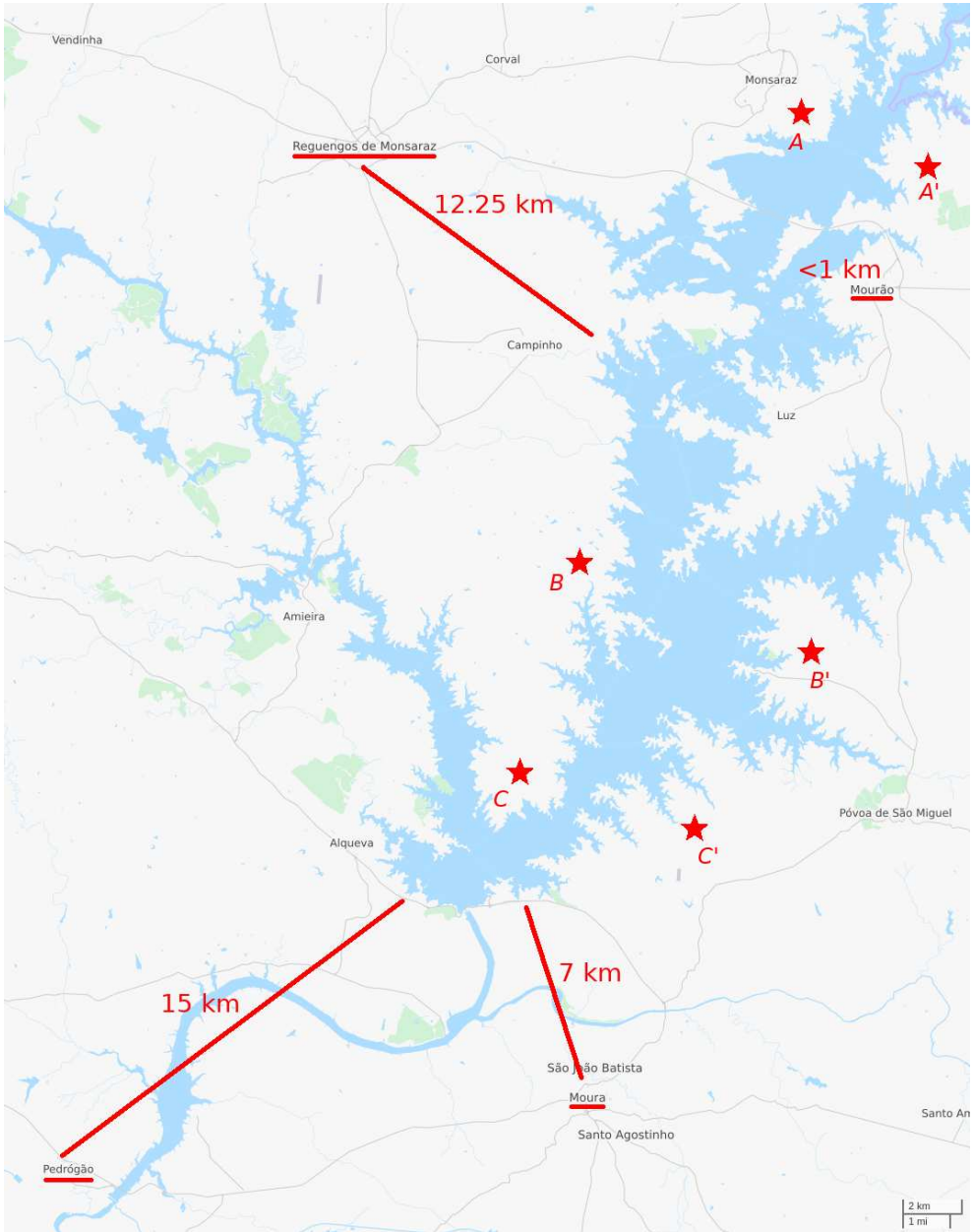


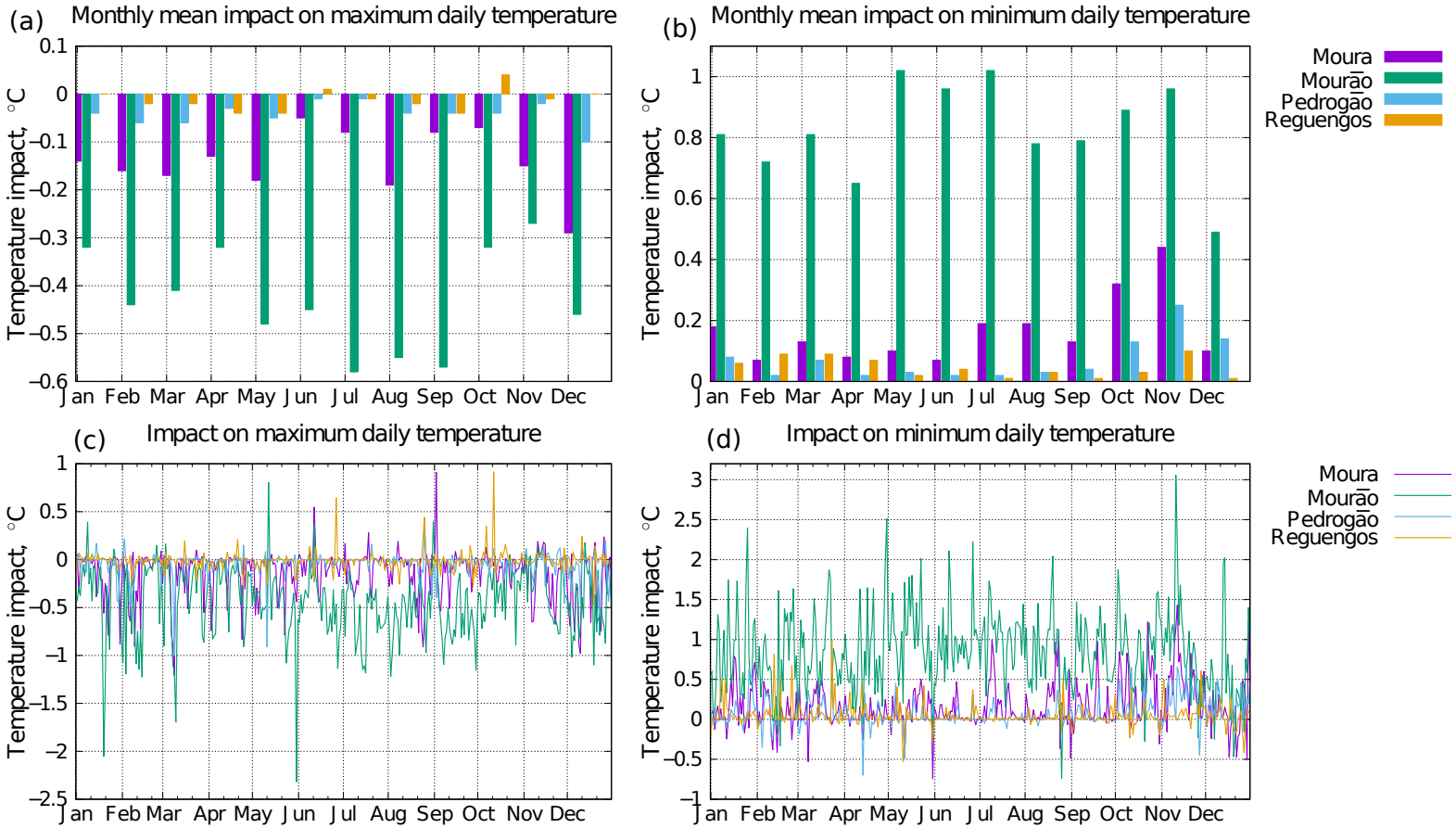
- positive anomalies (up to 1.5 degrees) can be registered in several kilometres away from the lake;
- positive anomalies may reach 9 degrees (over the lake) and 5 degrees over the surrounding land;
- negative anomalies (-1 degree) may spread several kilometres to the East (due to large-scale wind system);
- in extremes, negative anomalies may reach -9 degrees over the lake and -2 over the land.

Localidades próximas ao Alqueva



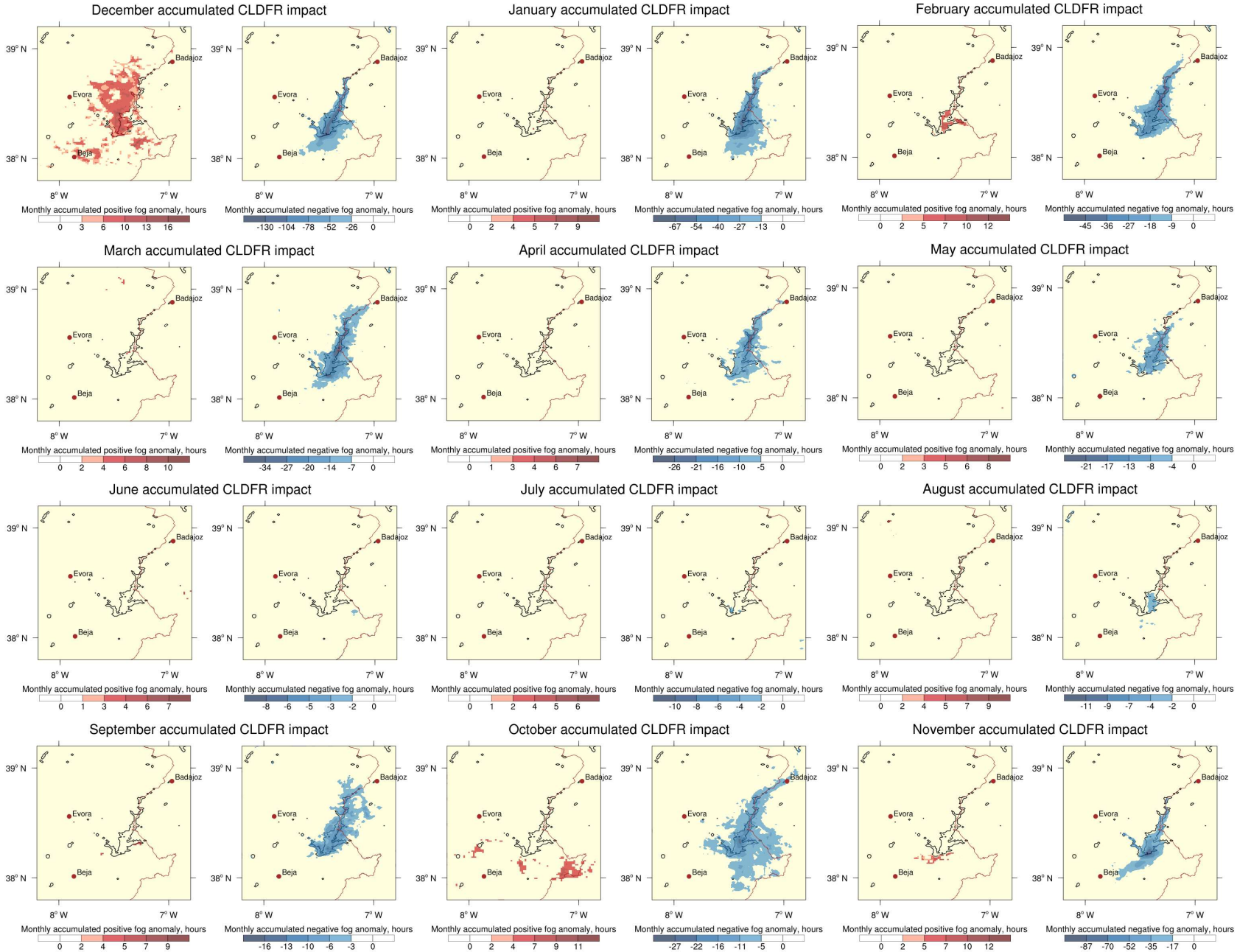
Seleccionámos 4 localidades próximas da albufeira: Moura, Mourão, Pedrogão, and Regengos de Monsaraz — para estimar o efeito de Alqueva nas temperaturas mínimas e máximas.

Resultados: Impacto na temperatura do ar em localidades vizinhas

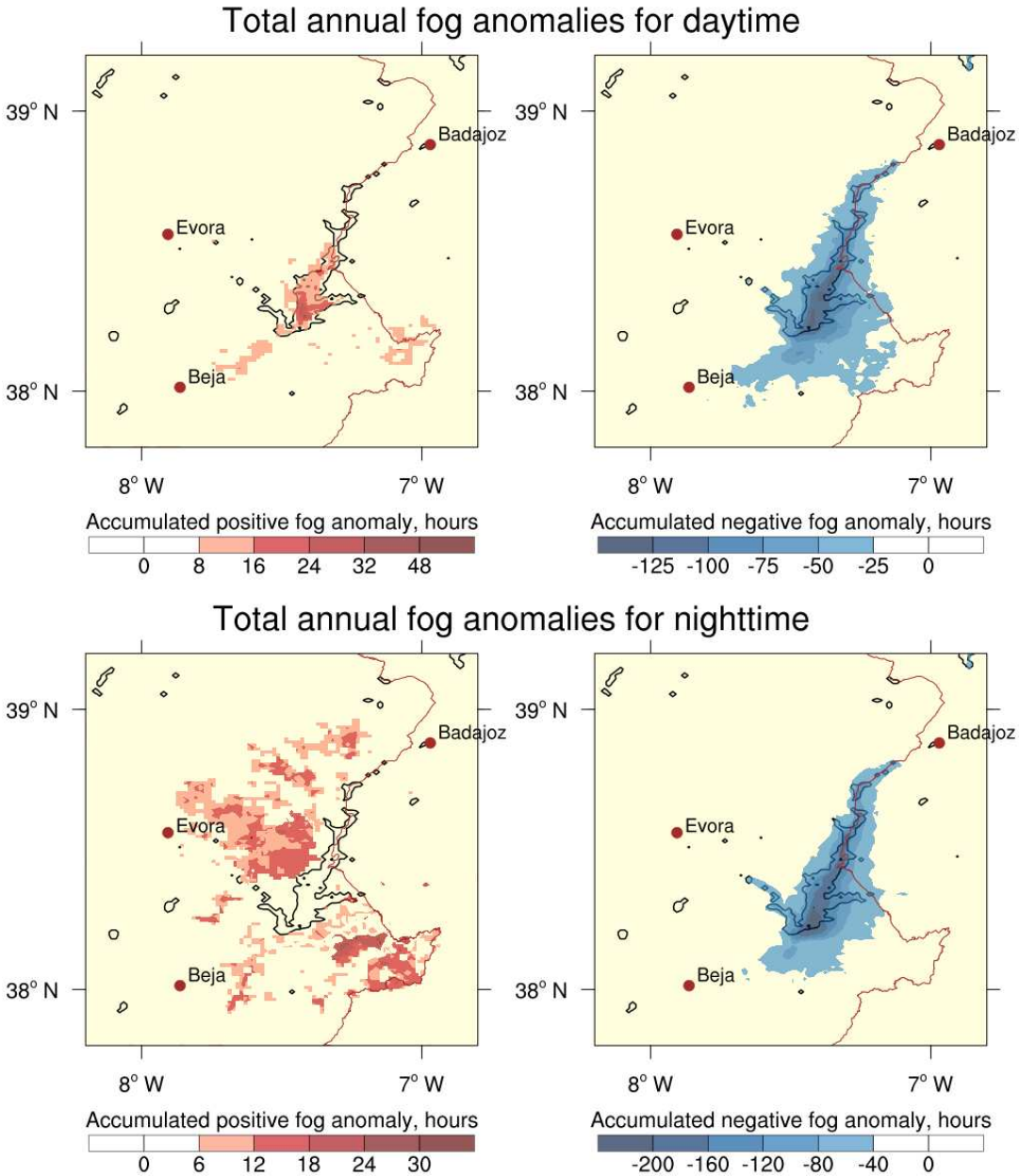


- in Mourão, the town closest to the lake, monthly mean maximum temperature decreased by up to 0.6 degrees, while minimum temperatures increased by up to 1 degree;
- in peaks, daily max are up to 2.5 degrees lower and mins are up to 3 degrees higher;
- the similar situation can be seen in other towns with lower magnitude;
- overall, it can be said that thermal regime in the nearby towns became more mild.

Resultados: impacto no nevoeiro (nuvens baixas)



Resultados: impacto no nevoeiro (nuvens baixas)



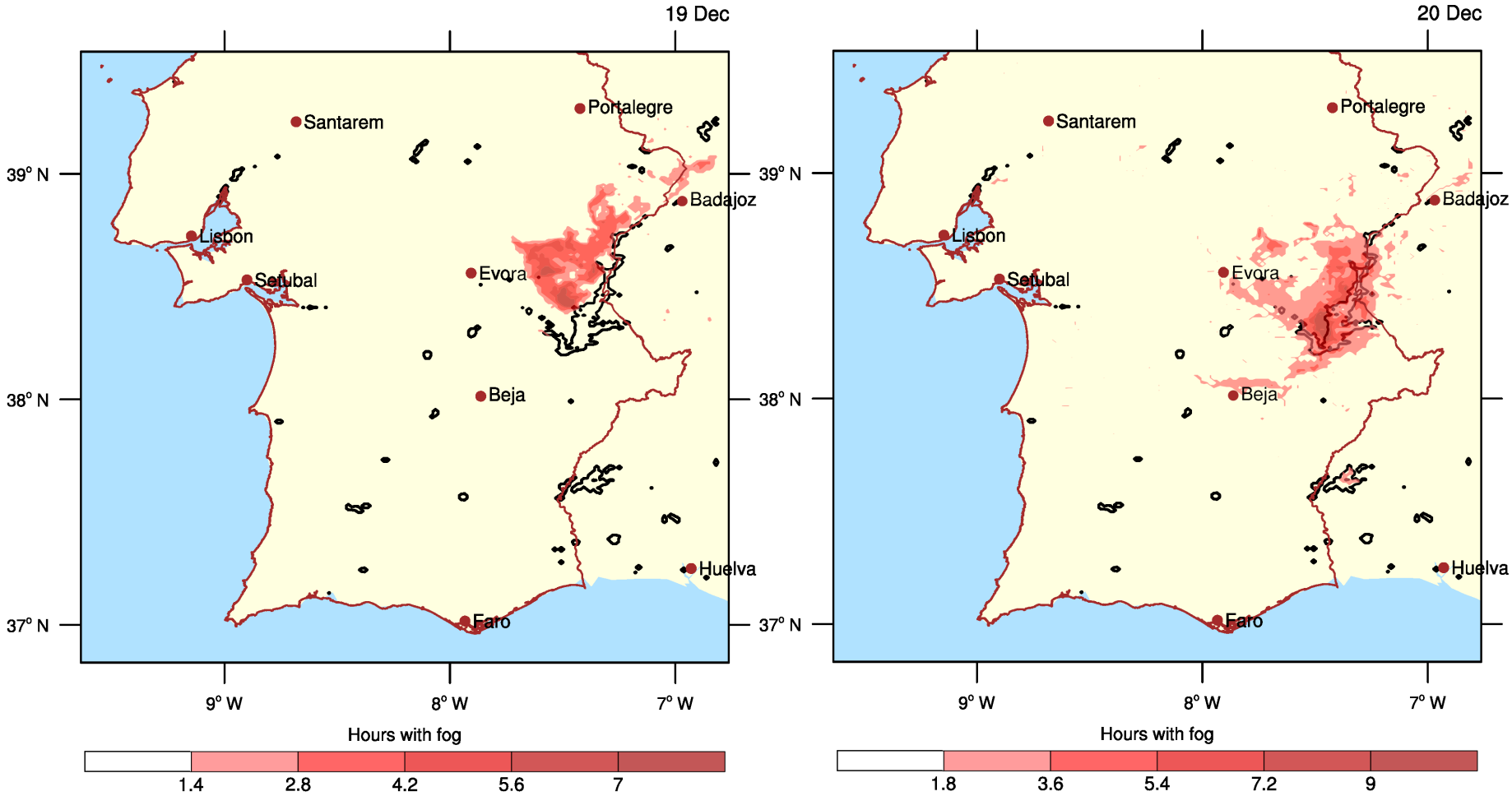
Overall, negative impact on the fog formation is much stronger and results in up to -200 fogless hours during the night time (over the whole TMY) and -125 hours for daytime.

Positive impact, when the reservoir "produces" the fog is quite rare for the TMY.

Resultados: impacto no nevoeiro (nuvens baixas) — um caso.

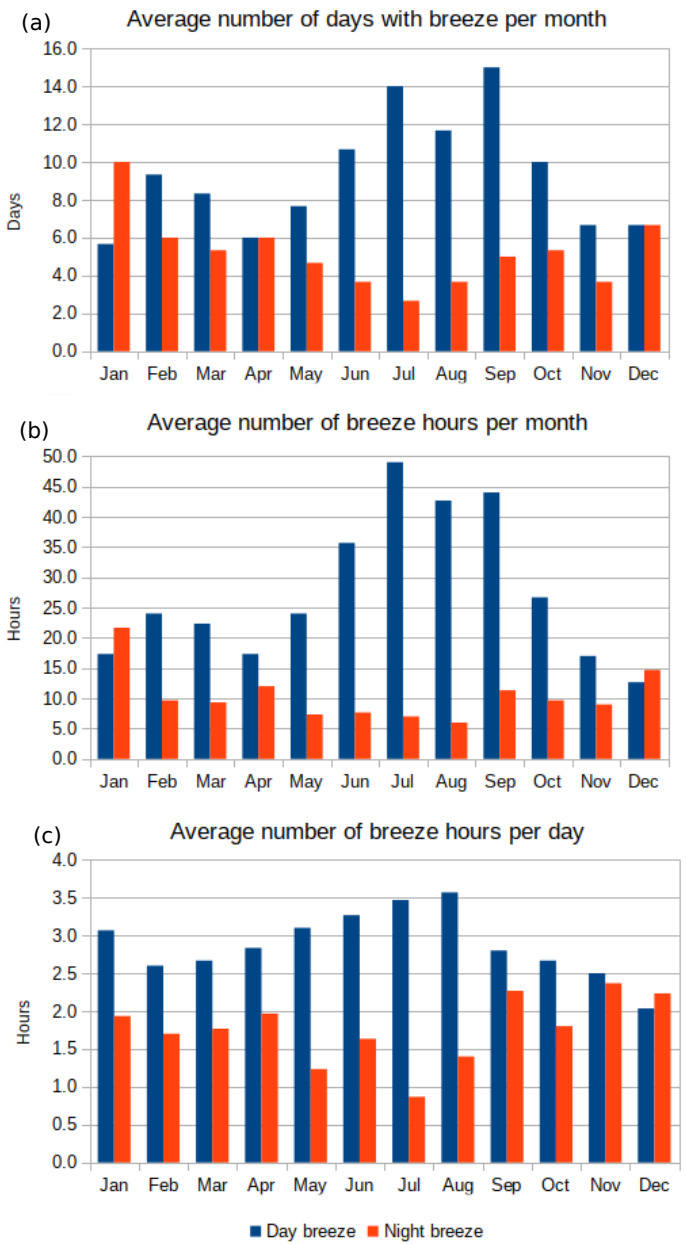
Casos de impacto positivo (mais nevoeiro): 19 e 20 de Dezembro

In both days the fog began to form at the Alqueva and moved in north-west direction



Existem casos de forte impacto, mas não é o mais comum. . .

Resultados: a brisa



Os resultados mostram a existem de uma "estação de brisa" no verão. A formação da brisa depende do contraste entre a temperatura da água e da terra.

As brisas noturnas são raras devido à brisa oceânica em larga escala mais forte da região. Eles ocorrem principalmente durante o inverno.

Publication

All these results were published in the article:

International Journal of Climatology

RMetS

RESEARCH ARTICLE | Open Access

Impact of a large artificial lake on regional climate: A typical meteorological year Meso-NH simulation results

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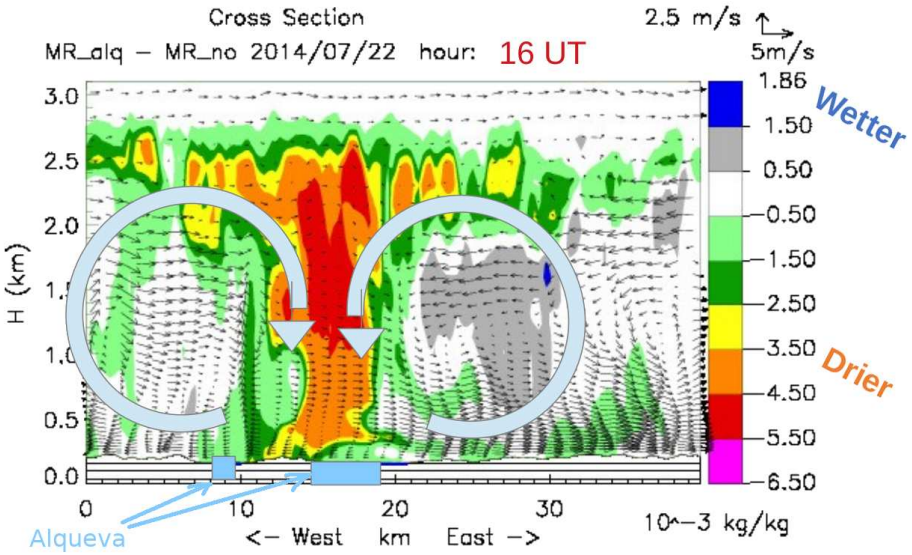
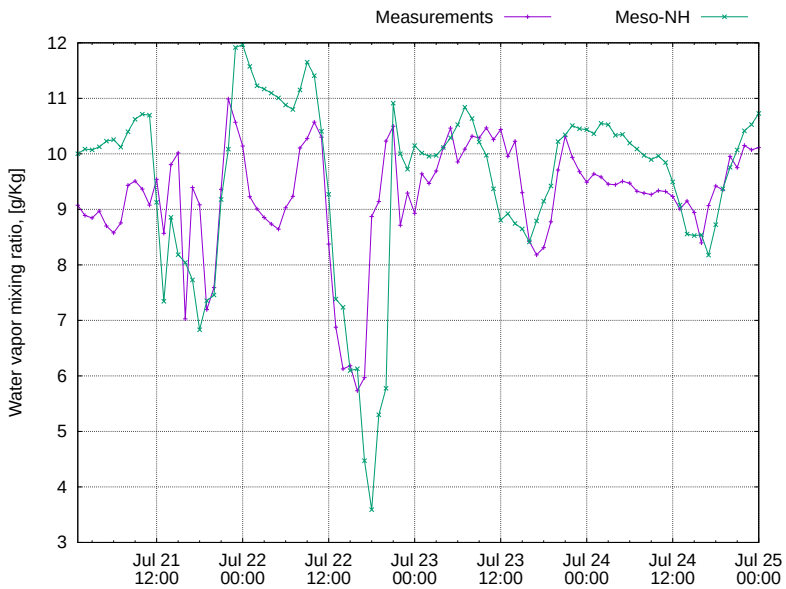
Vertical circulation

Another notable lake effect was found during a separate case study prior to the current research.





Due to the thermal impact which causes day breezes, Alqueva creates a pressure anomaly. Lower pressure above the lake surface forces relatively dry air from the top of the boundary level to move down.

This creates a specific vertical circulation that reaches 2.5 km in altitude and can be seen in the observations at the floating stations resulting in negative peaks of humidity in the late afternoon, when the day breezes are most strong.

Breeze effects at a large artificial lake: summer case study

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Conclusions

- lake impact on air temperature (0.5-1.5 C) can be traced at distances up to 15 km in south and south-east directions;
- thermal regime became slightly more mild in nearby towns, lowering max daily temperatures and increasing min daily temperatures;
- impact on fog formation is "negative" in general and limited by several km around the lake;
- positive fog anomalies are rare but can be more intensive and spread relatively far (up to 30 km);
- lake breeze "season" lasts 4 months, from June to September, however such breezes may also occur in winter;
- night time breezes are rare due to existence of much stronger large-scale ocean breeze in the region; usually they occur in winter;
- there's a vertical circulation exists above the lake that brings dry air from 2-2.5 km altitude to the surface; this effect is clearly seen during hot summer days.

OBRIGADO PELA SUA ATENÇÃO

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