On the effects of reservoirs on local climate

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A kind of introduction

ALEX2014 – ALqueva hydro-meteorological EXperiment → ALOP – Alentejo Observation and Prediction systems

- An ongoing project 2016 – 2019
- Observation, prediction and alert systems in atmosphere and in water reservoirs of Alentejo
- Includes an 1 Year (at least) field experiment in Alqueva
  - Continuous water thermal profiles; Radiative, Heat and CO_2 fluxes; Dissolved CO2; air meteorological parameters at 3 stations
  - water reflectivity pH, Dissolved O_2, Conductivity, Redox, Turbidity, Nitrates, Nitrogen, Phosphates, Phosphorus, Phytoplankton, Diatoms
- Data will be available, namely to inter comparison experiments

Summary

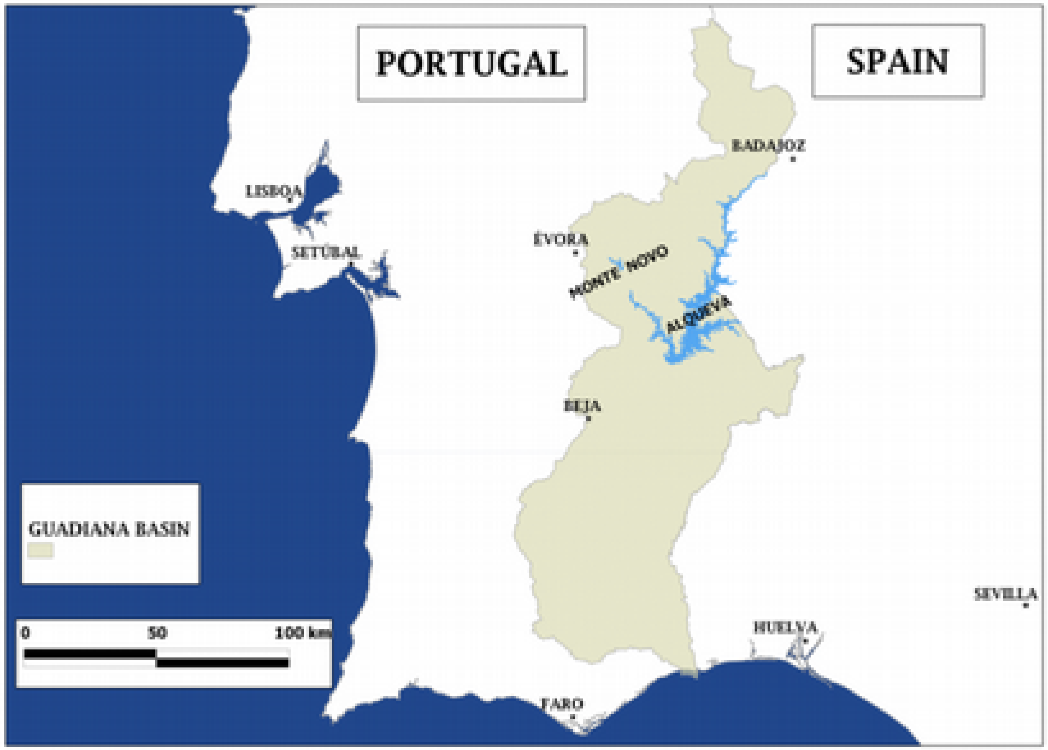
Among the various effects of lakes and reservoirs on the local climate, this presentation is about two features, on which we have advanced since LAKE 2015:

- The impact on fog
- The lake breeze and effects on air temperature, moisture and electrical field

Our natural laboratory is the Alqueva reservoir. The methodology is based on:

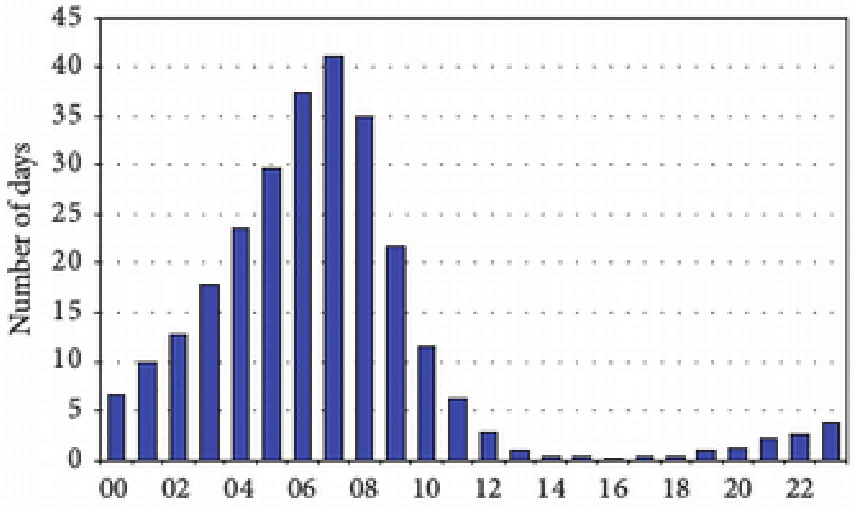
- Measurements ALEX / ALOP and others
- Simulations with the Meso-NH model

Region in study



Policarpo, C., Salgado, R. and Costa, M. J. (2017): Numerical Simulations of Fog Events in Southern Portugal. Advances in Meteorology, vol. 2017, Article ID 1276784, 16 pages, 2017. doi:10.1155/2017/1276784

Fog Climatology



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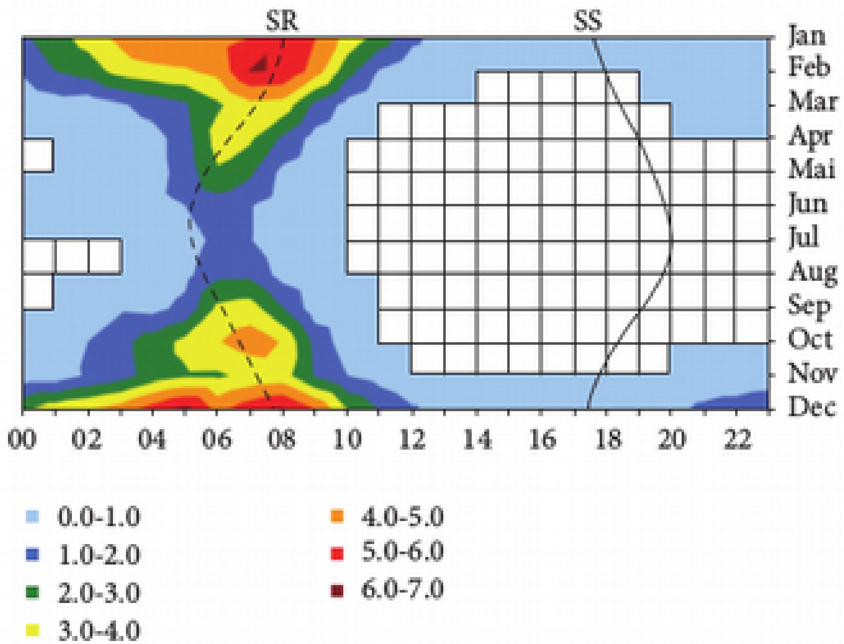
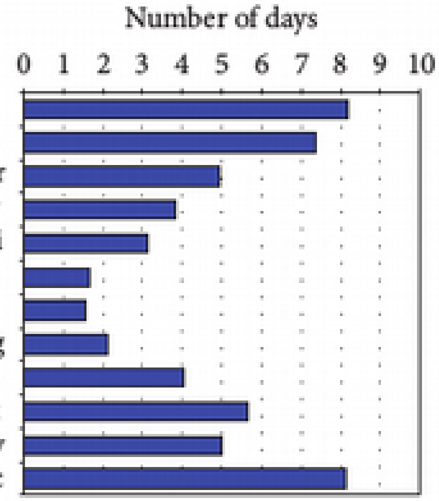


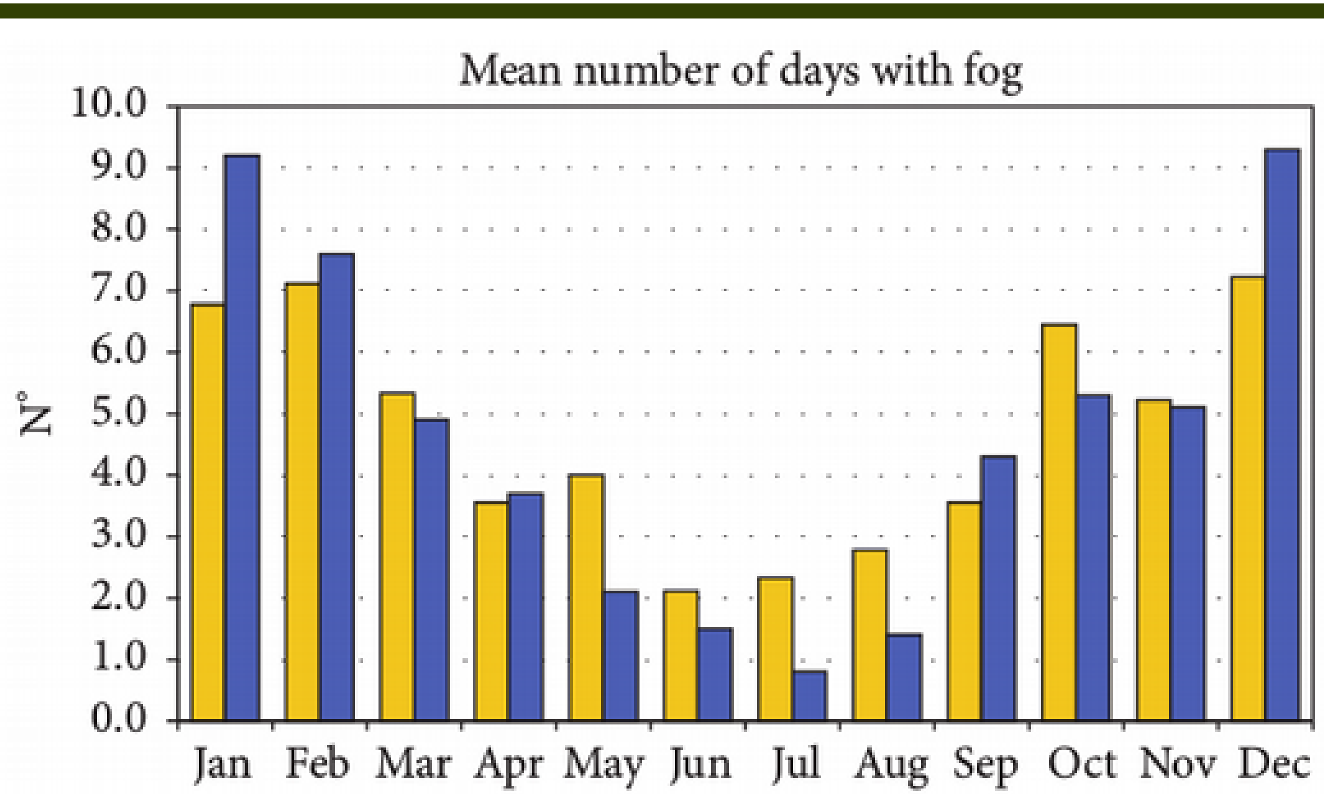


Mean number of days with fog over the entire year in Beja Air Base (2006–2012) by hour, hour and month, and month. Hours in UTC. SR: sunrise; SS: sunset.

- More frequent in winter
- mostly between 04 and 10 UTC
- more than 40 days with fog at 07 UTC
- In Winter, the majority are radiation fog
- advection fogs occur in the remaining seasons.

Fog: What says the observations?

- it seems that there is an increase in the number of days with fog in the winter
- and a decrease in May - August
- Suggest the existence of a slight impact caused by Alqueva in the increasing of the number of foggy days during winter.
- On the contrary, the decrease in the average number of foggy days in May-August is difficulty attributed to a specific regional effect, being mainly due to synoptic conditions

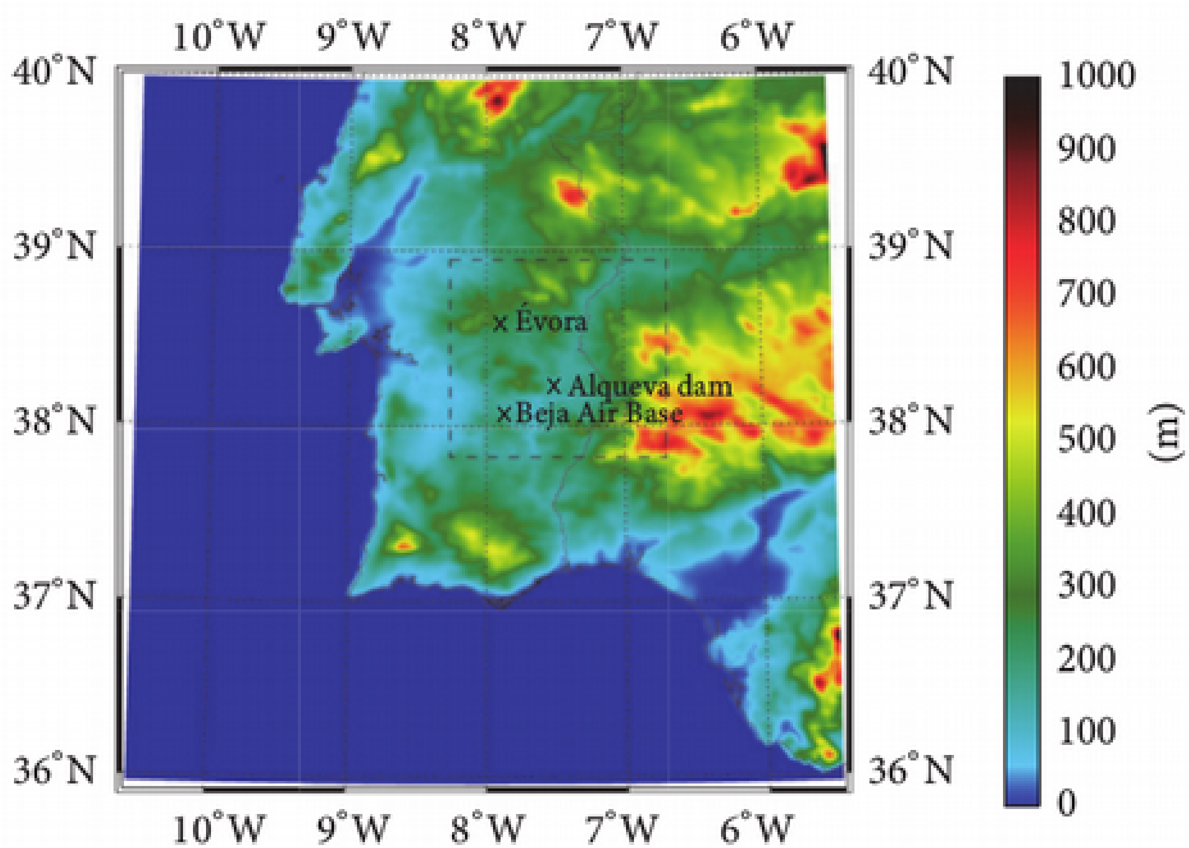


Monthly mean days of Fog in Beja Air Base in the 9 years periods:

Fog: Model Setup

- Physics schemes:
  - Radiation: ECMWF
  - Turbulence: Quasi-1D
  - microphysics: ICE3
  - No convection
  - SURFEX with FLake
- Initialization and forcing: ECMWF analysis
- vertical grid with 55 levels, with the lowest level at 5 m
- ECOCLIMAP v2.0 database, improved to include Alqueva reservoir
- Temperature of the Alqueva water surface was initialized from MODIS satellite data

Two domains:
Largest: 150 × 150 points, spatial resolution of 3 km
Smallest: 120 × 120 points, spatial resolution of 1km, includes Alqueva reservoir and Beja Air Base.
Two-way grid nesting technique



Case studies

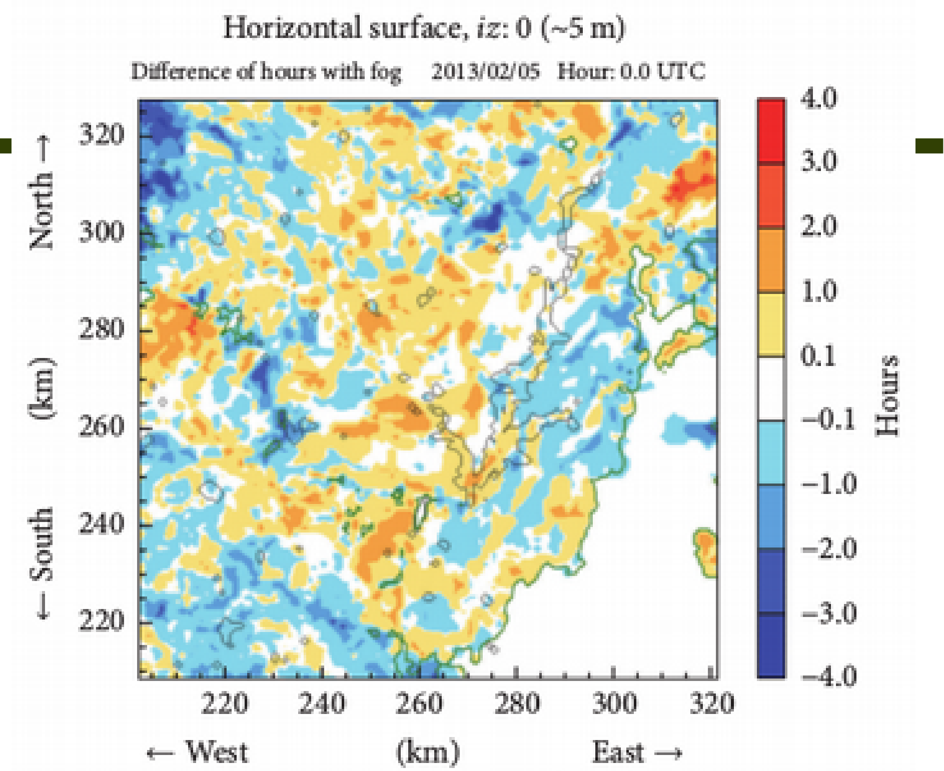
- The period considered: December 2012 and Ju:ly 2013. In Beja Air Base, 47 fog events were registered. Among these, five events were selected
- Two simulations, one with Alqueva and the other without were performed

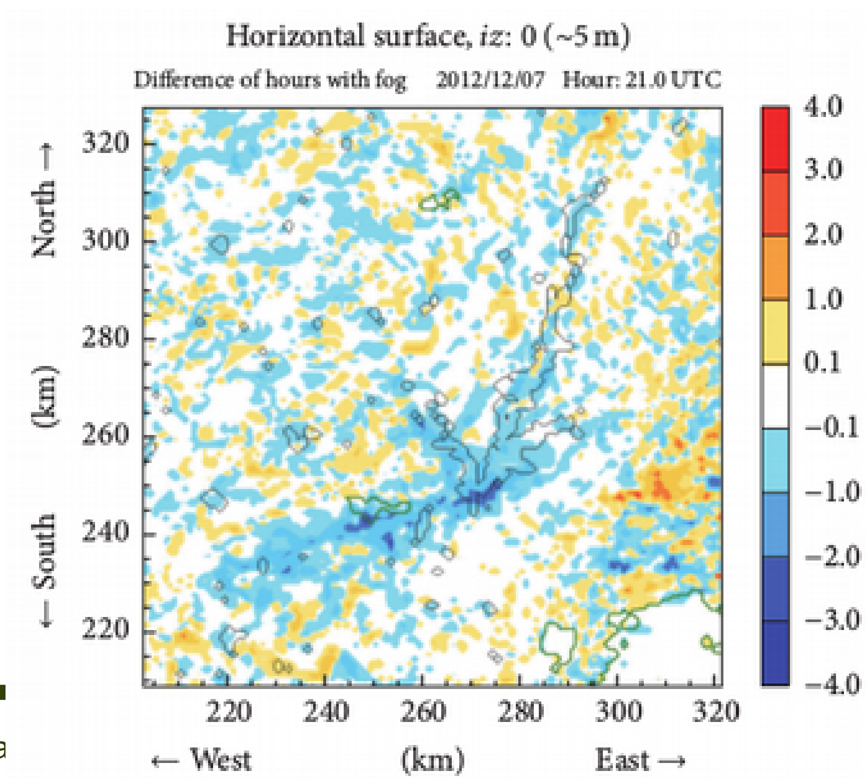
Table 3: Simulation periods for the selected case studies.

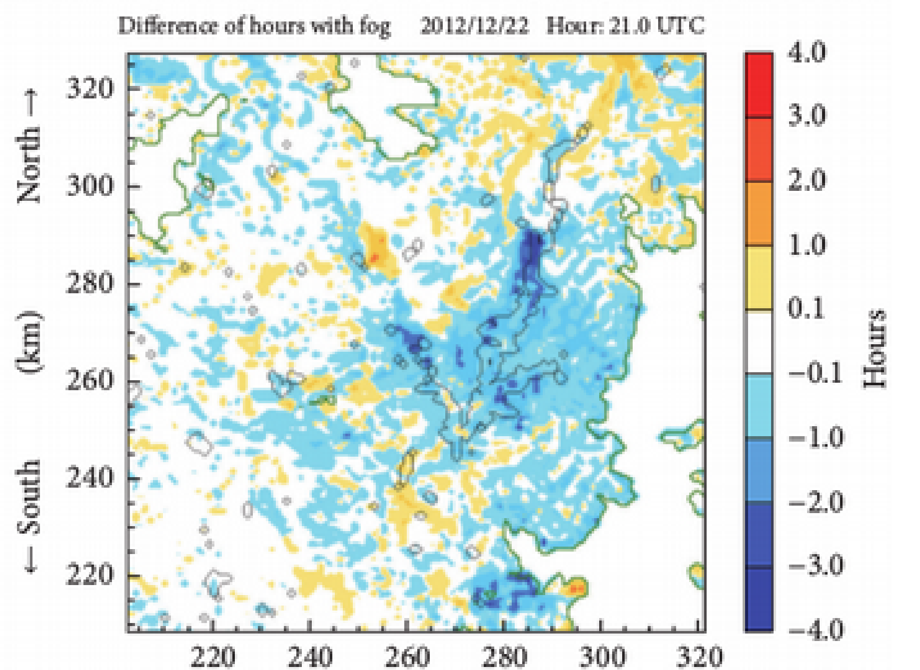
Date	Simulations	Study periods
2012-12-08	07 18:00–08 18:00 UTC	07 21:00–08 15:00 UTC
2012-12-23	22 18:00–23 18:00 UTC	22 21:00–23 15:00 UTC
2013-02-05	04 12:00–05 18:00 UTC	05 00:00–05 15:00 UTC
2013-07-16	15 18:00–16 12:00 UTC	15 21:00–16 12:00 UTC
2013-07-18	17 18:00–18 12:00 UTC	17 21:00–18 12:00 UTC

Winter case studies

- Difference between the “number of hours with fog”, with and without Alqueva from 21:00 to 15:00 UTC in son domain. Fog occupation boundaries with Alqueva (green line), color scale: 2012/12/08, 2012/12/23, and 2013/02/05

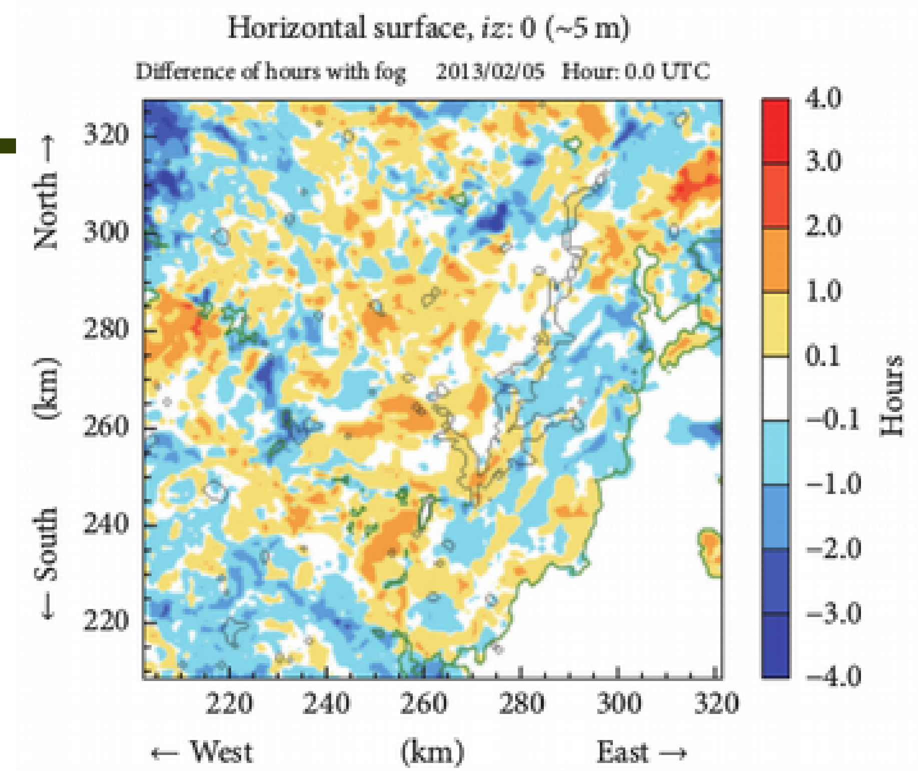


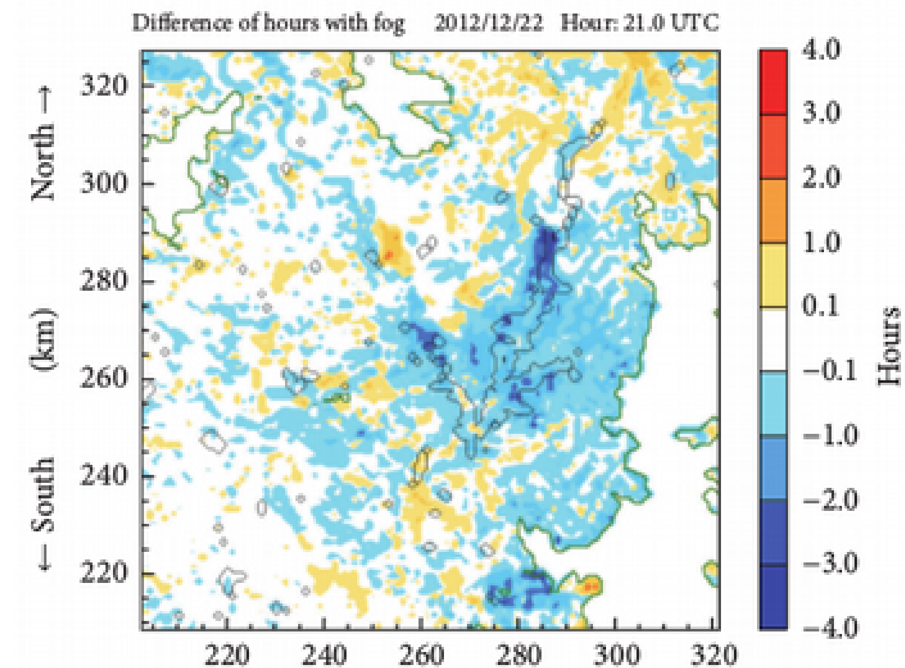


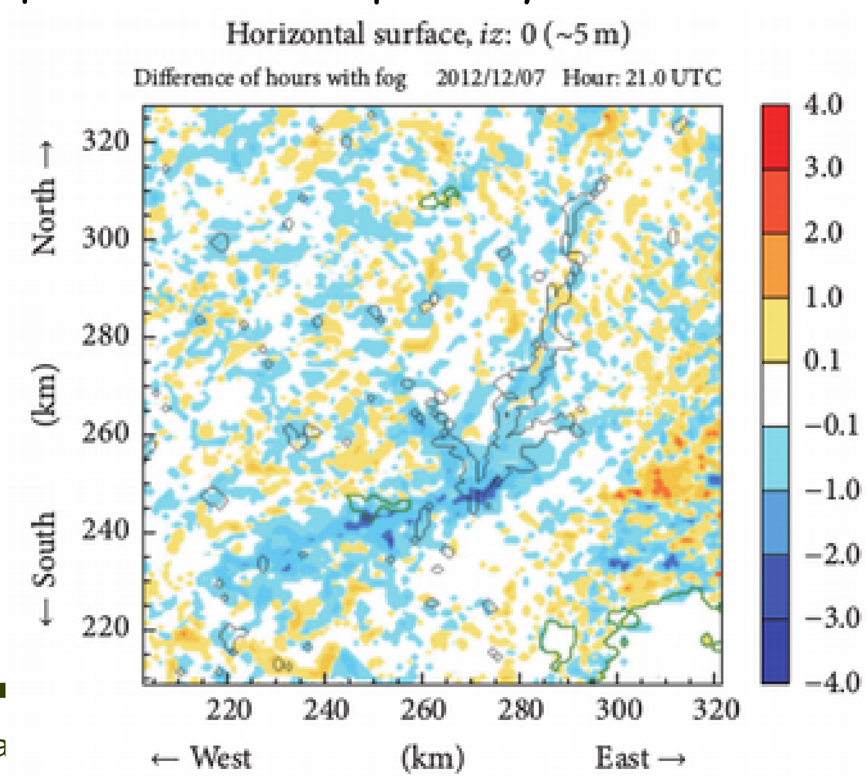


Winter case studies

- In winter cases the impact was visible
- depending the direction and wind speed, different effects may become dominant
- The fog duration over the reservoir had a shorter duration in the simulations with Alqueva during December, suggesting that its existence inhibited the fog formation and evolution.
- In the situation of February there has been a slight increase in the fog duration over the Alqueva reservoir, possibly due to the weak flow

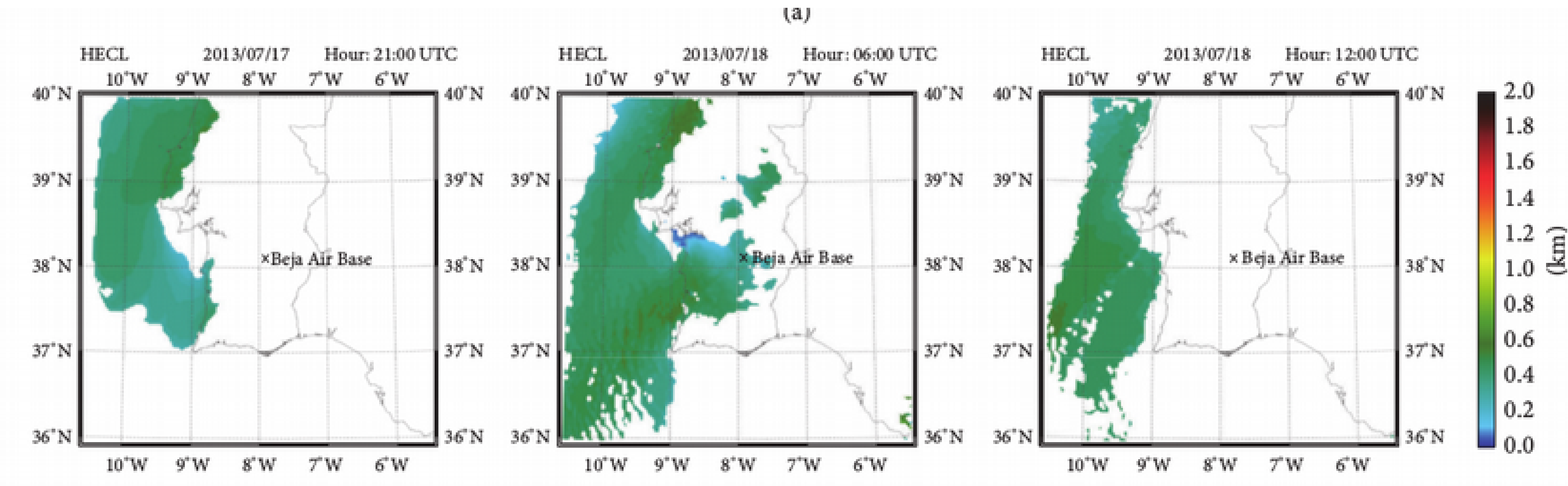




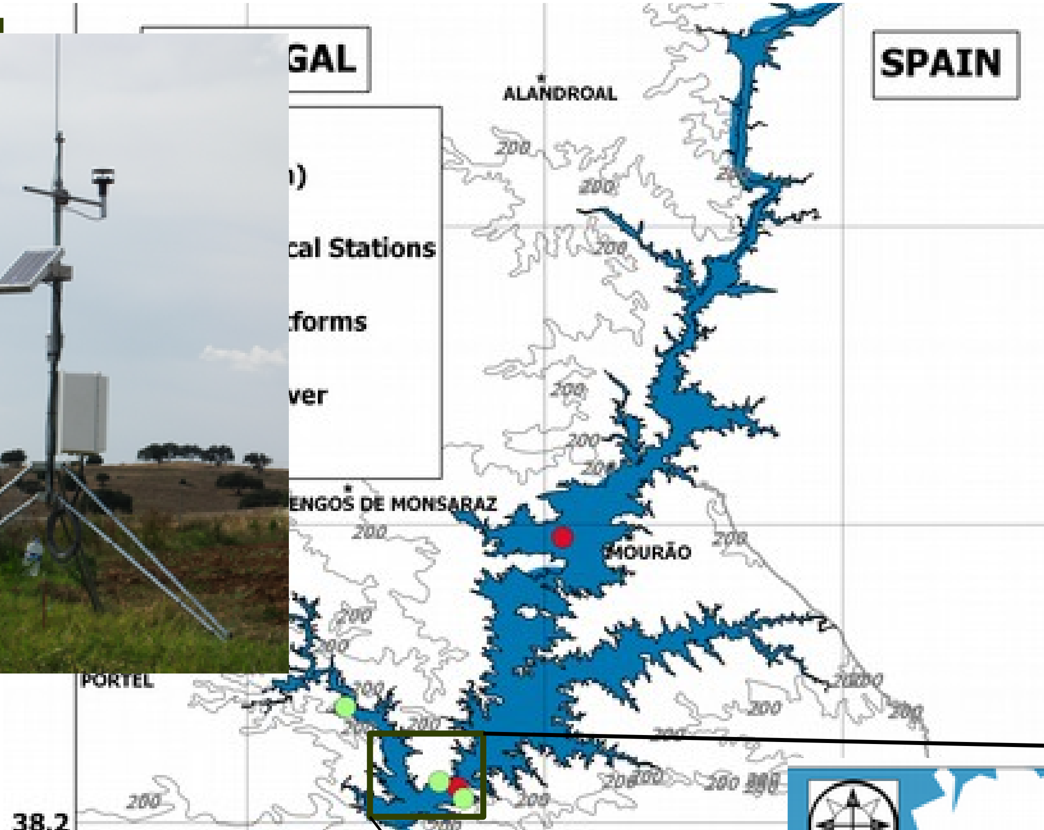


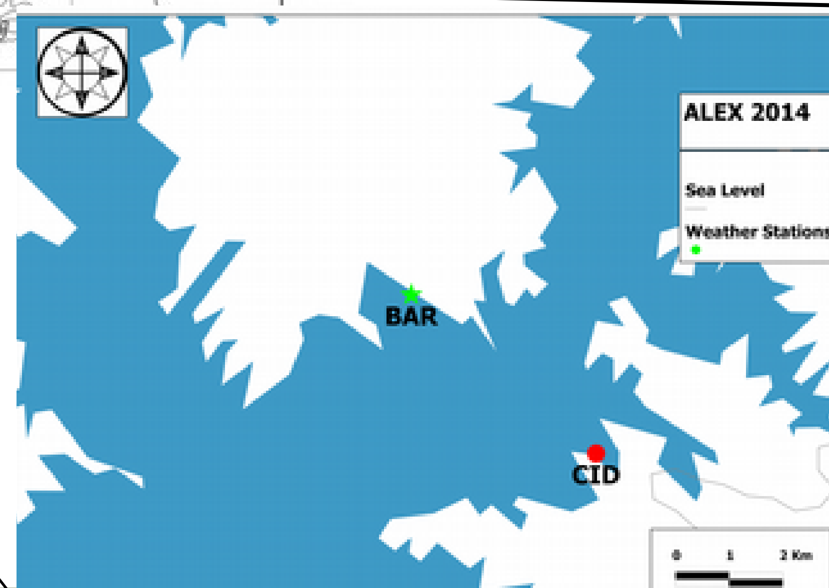
Summer cases

- For summer cases, there were no significant differences between simulations with and without Alqueva, due to the fact that they correspond to events of advection fog, originated in the Atlantic Coast, and that they have not reached Alqueva reservoir.



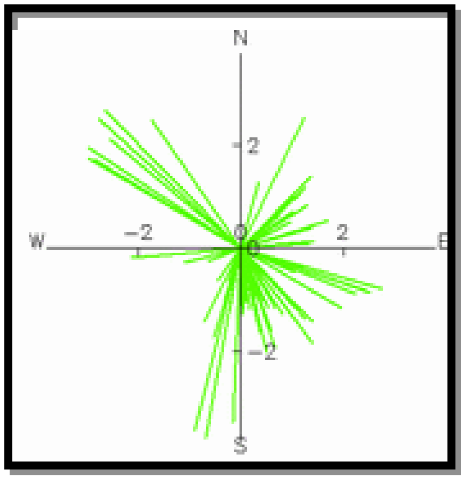
Sea Breeze: Observations



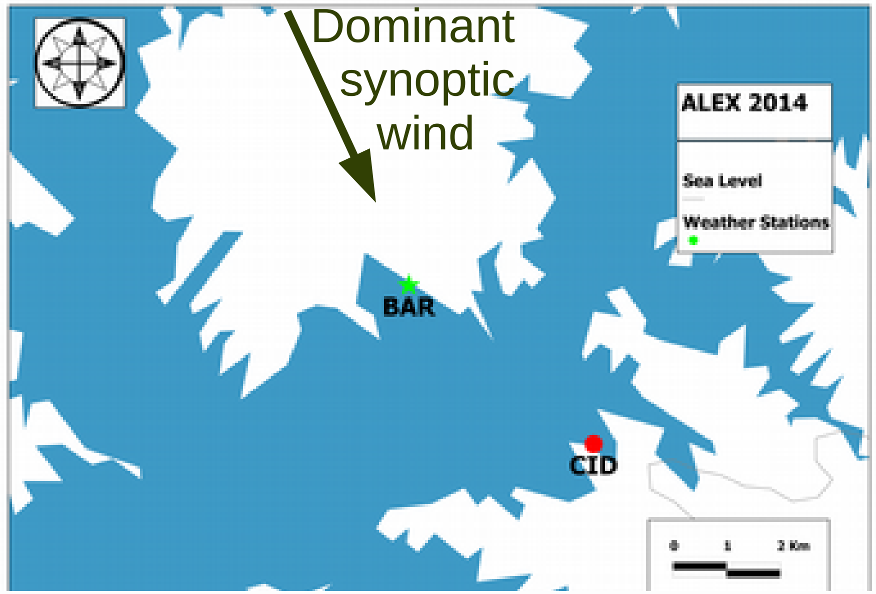


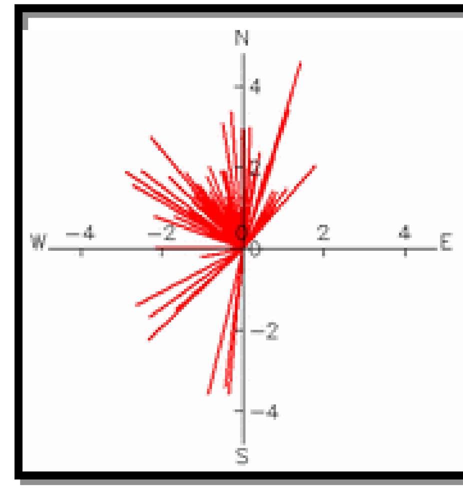
Potes, M. Salgado, R., Costa M.J., Morais, M., Bortoli, D., Kostadinov, I. and Mammarella, I. (2016). Lake–atmosphere interactions at alqueva reservoir: a case study in the summer of 2014. Tellus A 2016, 00, 1272787, http://dx.doi.org/10.1080/16000870.2016.1272787

Sea Breeze: What says observations

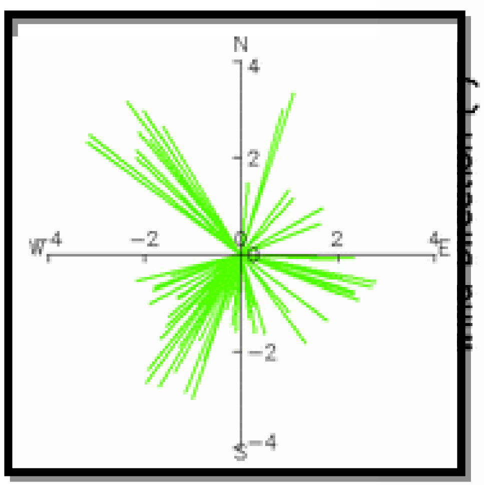


BAR:10-12 UTC

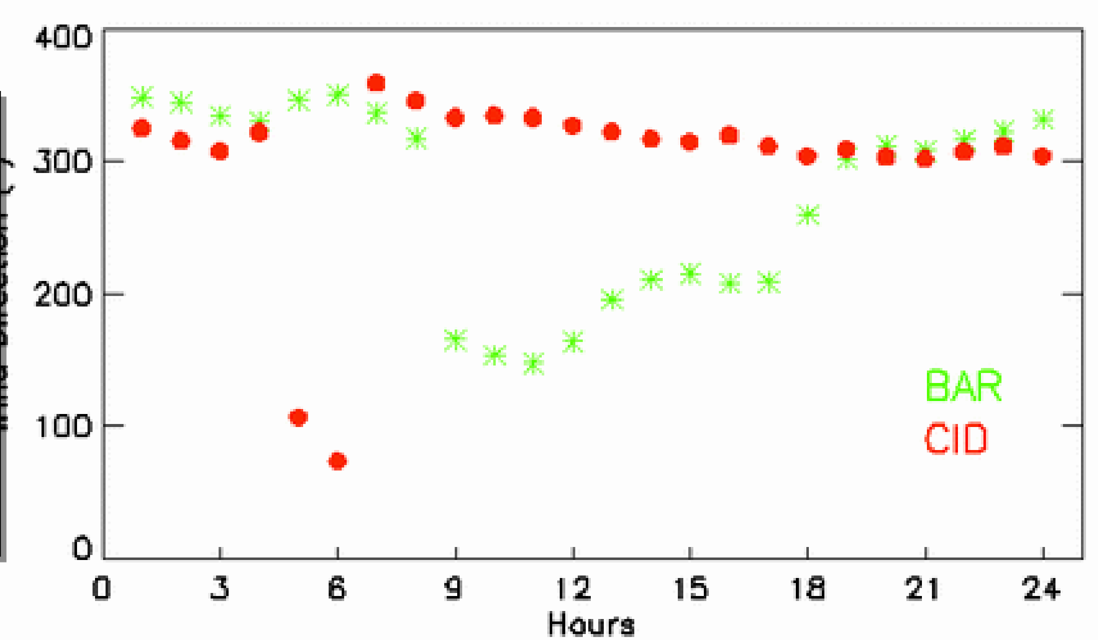


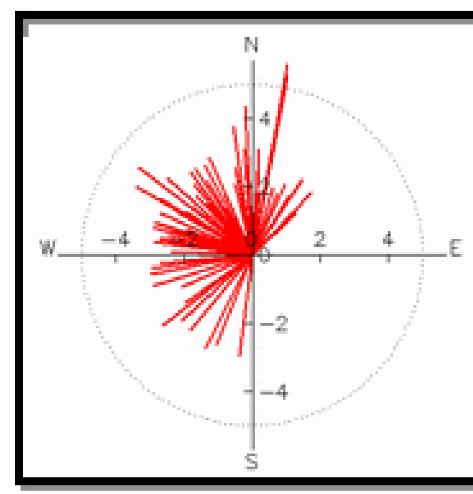


CID: 10-12 UTC



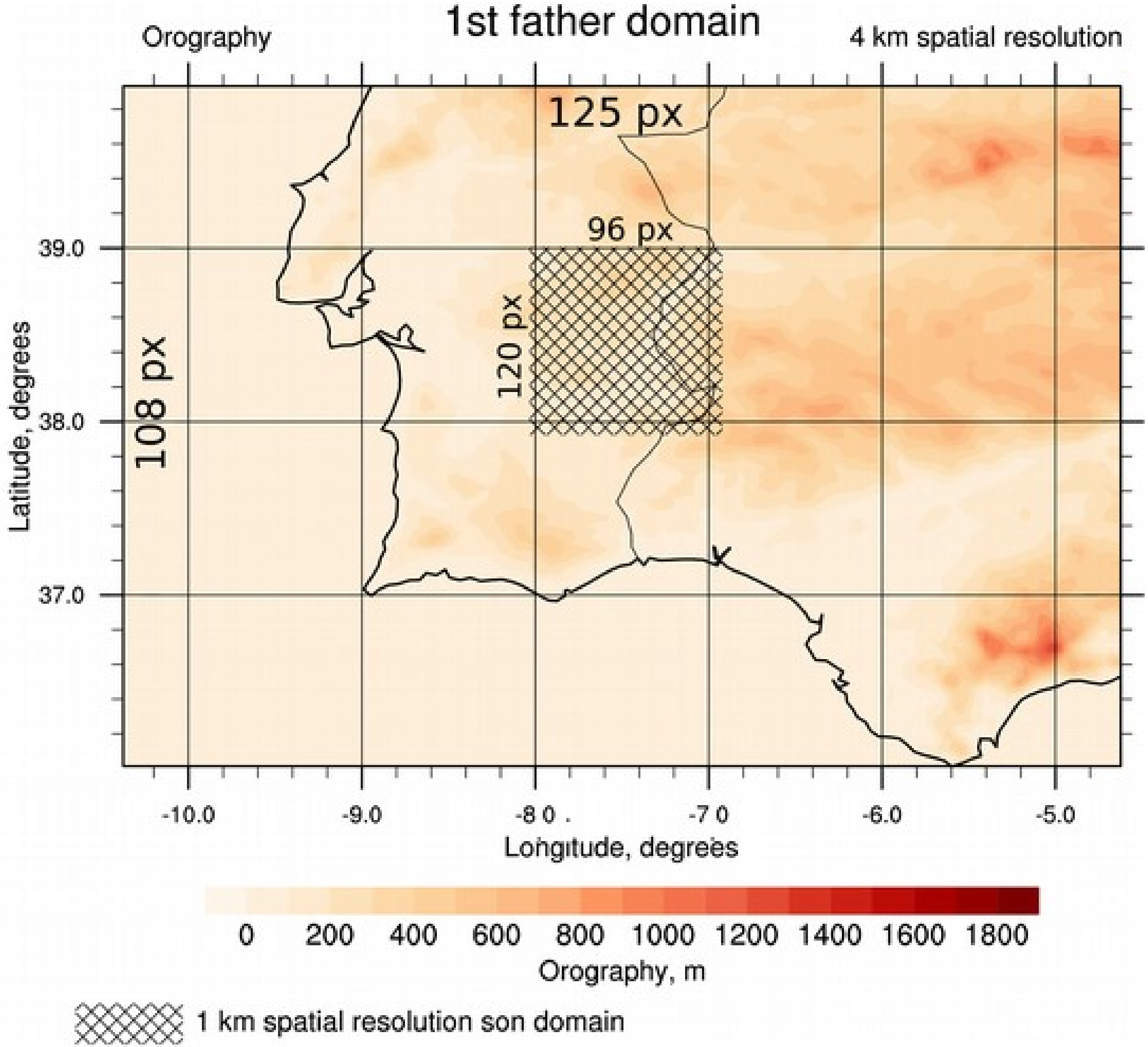
BAR:13-15 UTC



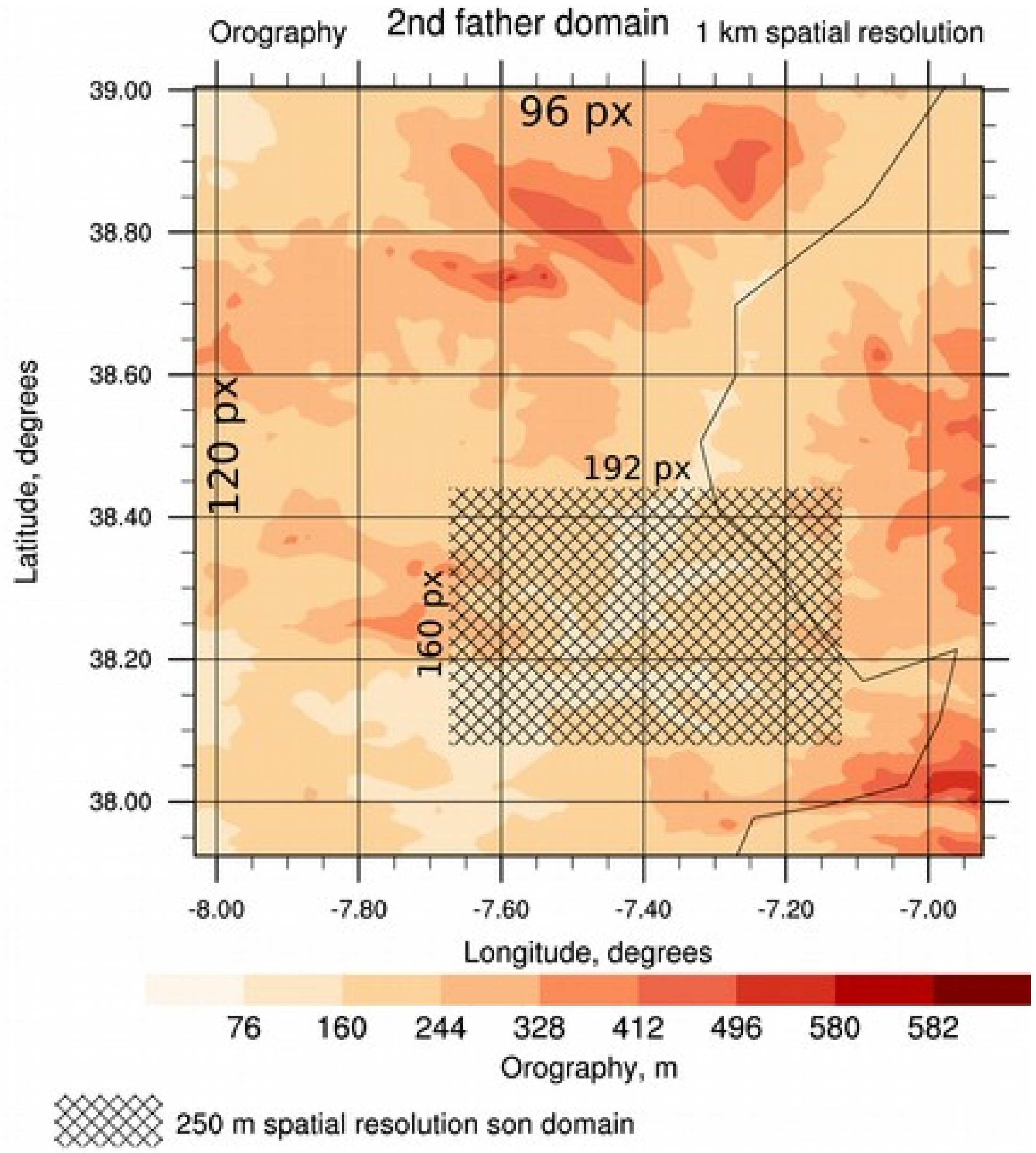


CID: 13-15 UTC

Lake Breeze simulation: Domains 1 & 2



Lake Breeze simulation: Domains 2 & 3

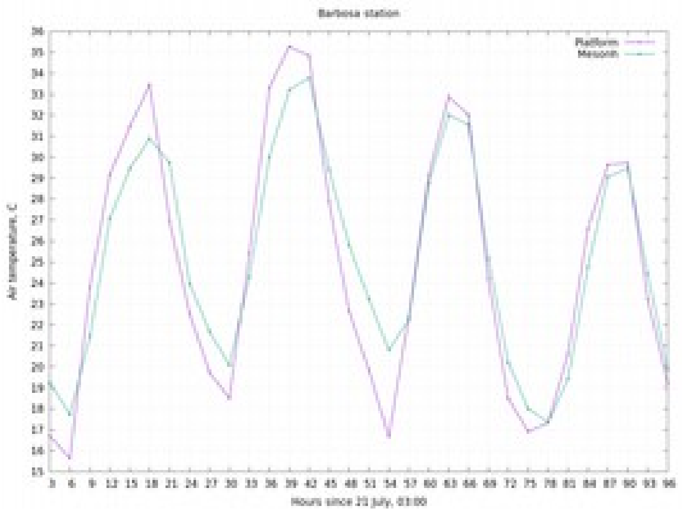


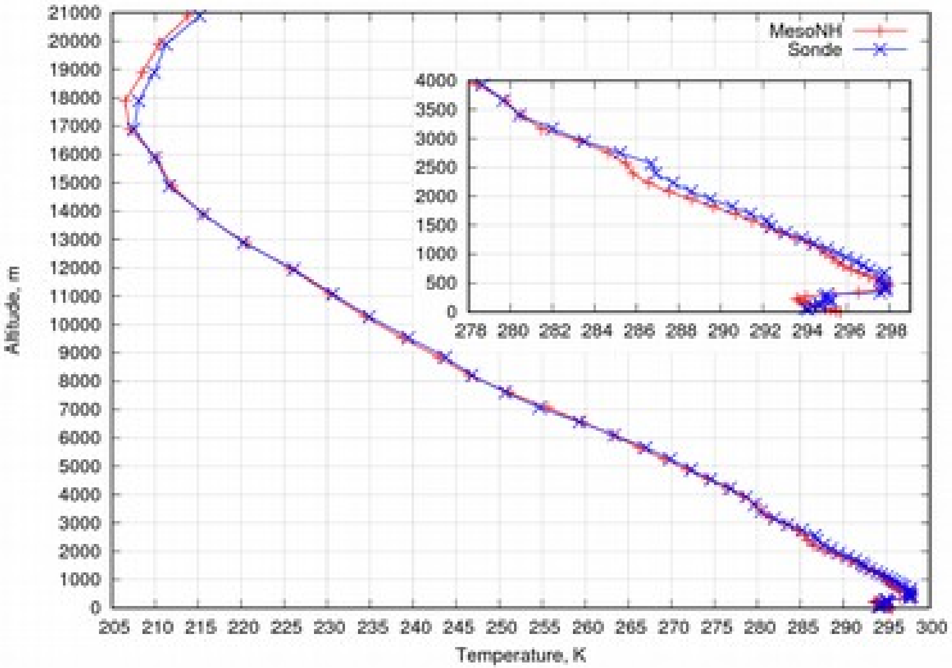
Lake Breeze simulation: Setup

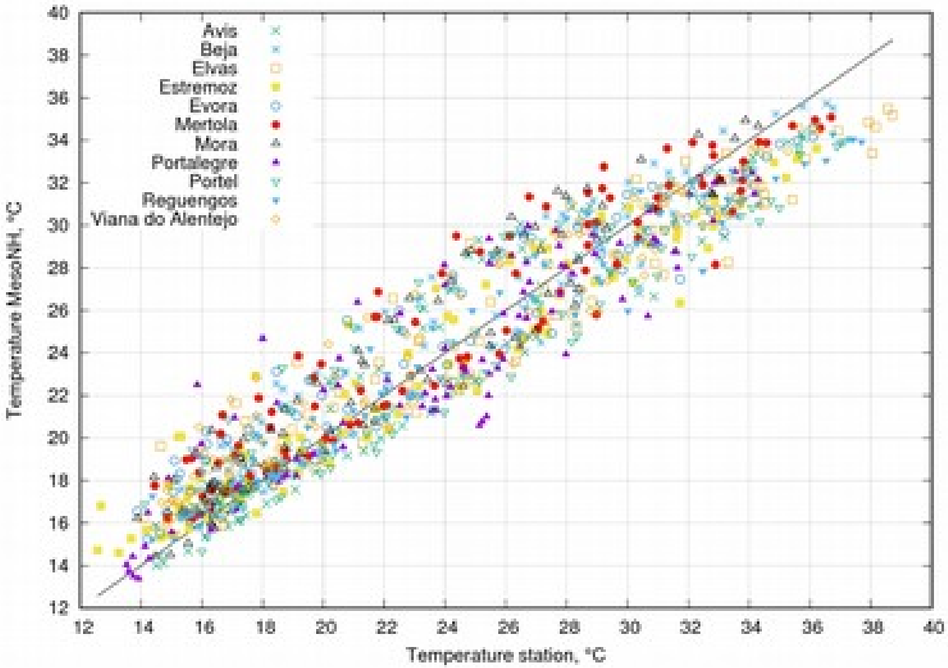
- MesoNH v5.3.0 + FLake scheme;
- 3 nesting levels: 4 km – 1 km – 250 m;
- Inicialized and forced by ECMWF analysis;
- Ecoclimap (updated to include Alqueva);
- Two simulations: with and without lake;
- Turbulence: TKEL (1D);
- No deep convection, but shallow convection: EDKF;
- XTSTEP: 20. for 4 km, 10. for 1 km, 1. for 250 m;
- 68 vertical levels, 36 for boundary layer;
- 21-25 July 2014 simulation;

Lake Breeze simulation: Validation

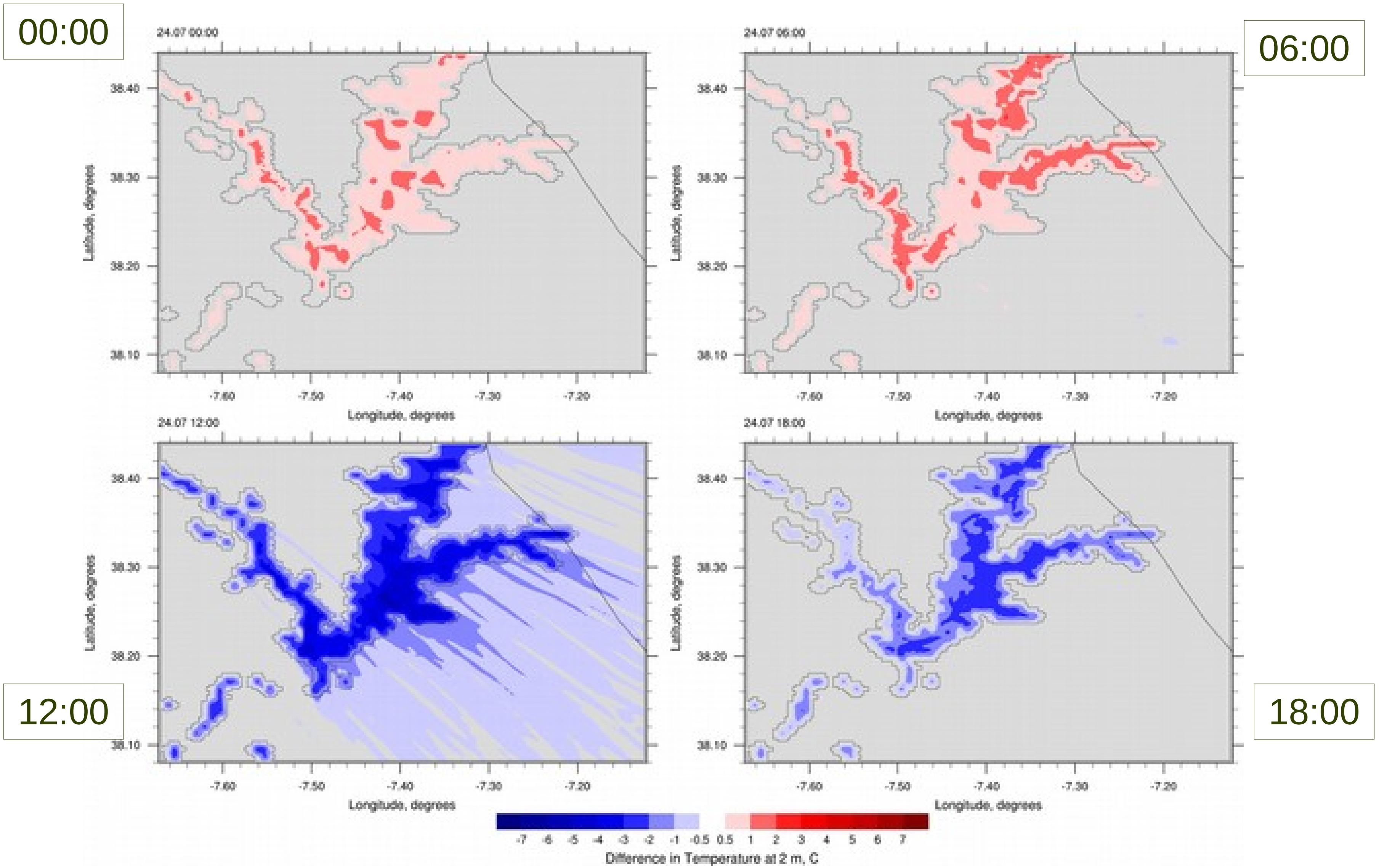
- Simulation data were compared with
  - National meteorological network
  - ALEX meteorological stations
  - radiosonds







Impact of the Lake: Air Temperature



12:00

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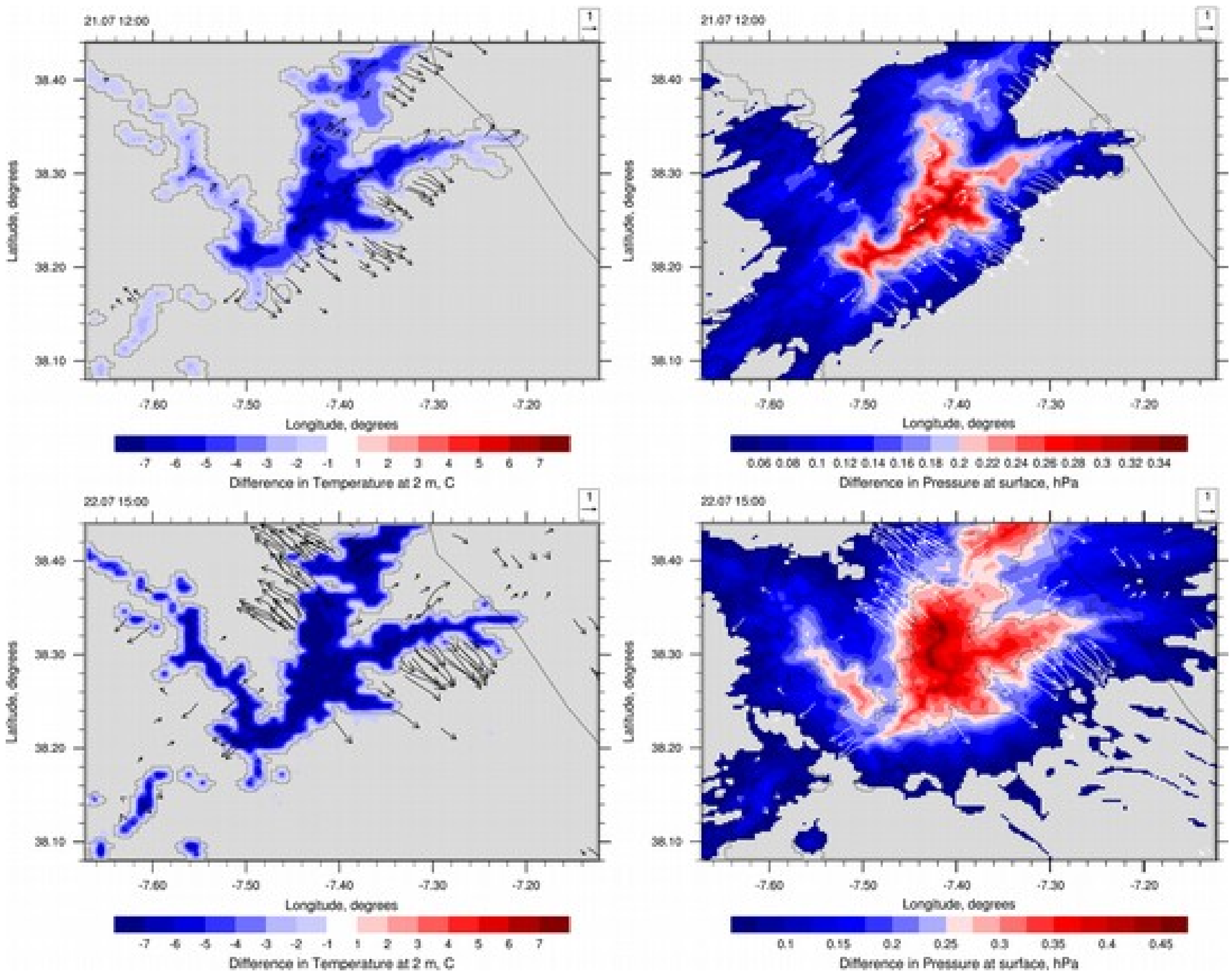


18:00

18:00

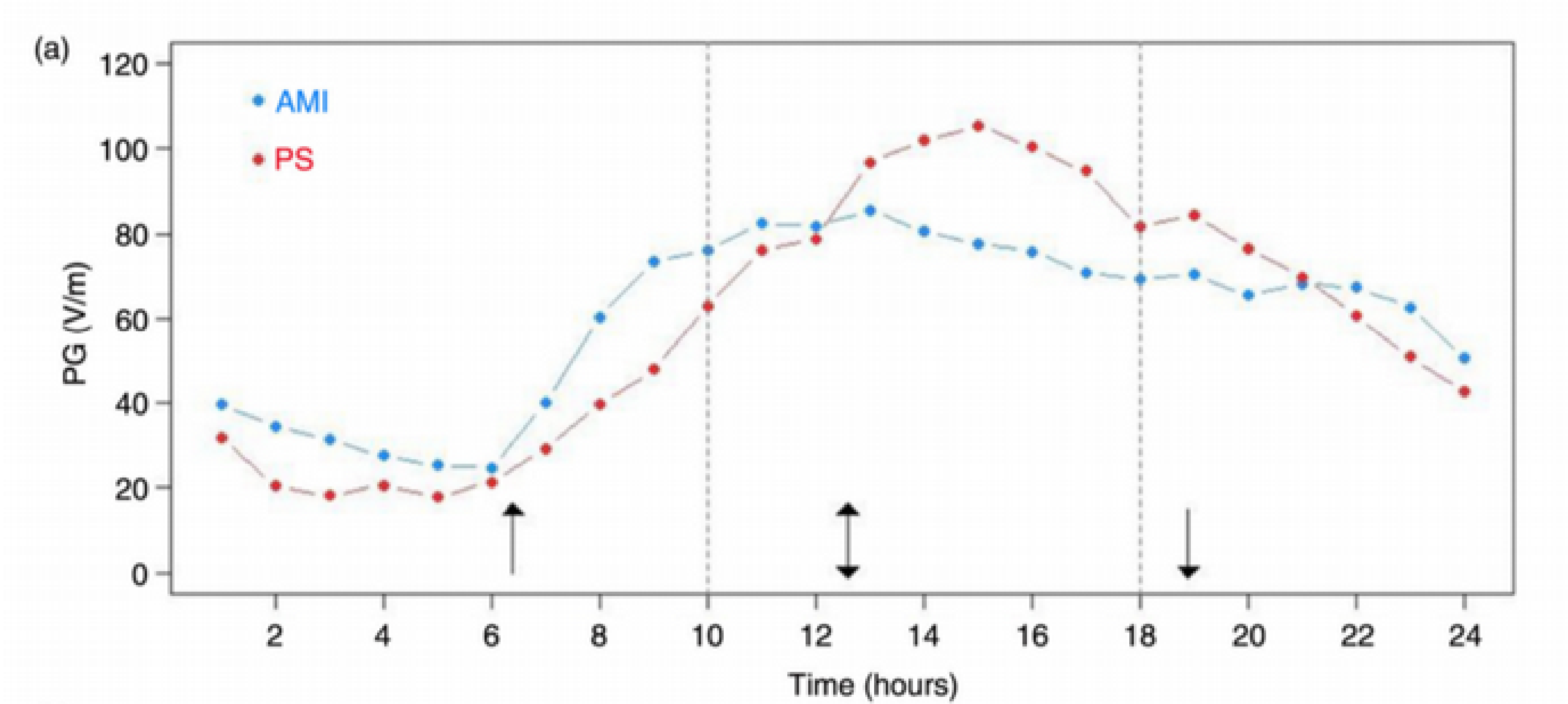
Atmospheric electrical field measurements

- Two ALEX2014 stations 10 km apart were used
  - located up and down-wind of the lake (Amieira and Parque Solar, respectively), in reference to the dominant northwestern wind direction.
  - measurements of atmospheric electrical field in terms of potencial gradiente: *PG = dV / dz (V is the electrical potential)*
  - using two identical electrostatic field mills, JCI 131F
- Seventeen days of Fair Weather were chosen, based on local undisturbed daily solar radiation curves, cloud-free days and the availability of PG data in both stations.

Lopes, F., Silva, H., **Salgado, R.**, Potes, M., Nicoll, K., & Harrison, R. (2016). Atmospheric electrical field measurements near a fresh water reservoir and the formation of the lake breeze. *Tellus A, 68*. doi: http://dx.doi.org/10.3402/tellusa.v68.31592

Effects of the lake in the atmospheric electrical field

- Measurements in both stations indicates that the presence of the lake has a local signature on the atmospheric electricPG
- The up-wind station shows lower atmospheric electric potential gradient values than the ones observed in the down-wind station between 12 and 20 UTC, when the breeze is fully developed



Hourly mean diurnal variation of potential gradient (V/m) at the two measuring locations, AMI and PS

Acknowledgements

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THANK YOU VERY MUCH

References

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