LIAISE WG2: Meteorology

31st May 2022, 16-17 CET

Program:

16:00 Welcome

16:05 Jenn Brooke: Irrigation impacts on the i) morning transition period, and ii) heat and moisture budget.

16:25 Maria Antònia Jiménez Cortés: What have we learned from the 1st mesoscale modelling intercomparison?

16:45 Open discussion and announcements

17:00 Close

Irrigation impacts on the i) morning transition period, and ii) heat and moisture budget.

Jenn Brooke[1], M. Best[1], A. Boone[2], G. Canut-Rocafort[2], J. Cuxart[3], O. Hartogensis[4], F. Gibert[5], A. Lock[1], J. Price[1], A. Roy[2], H. Rumbold[1]

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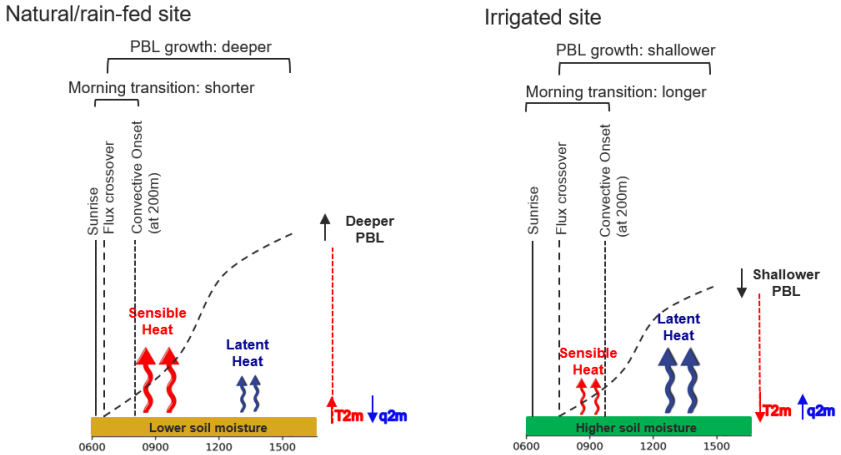

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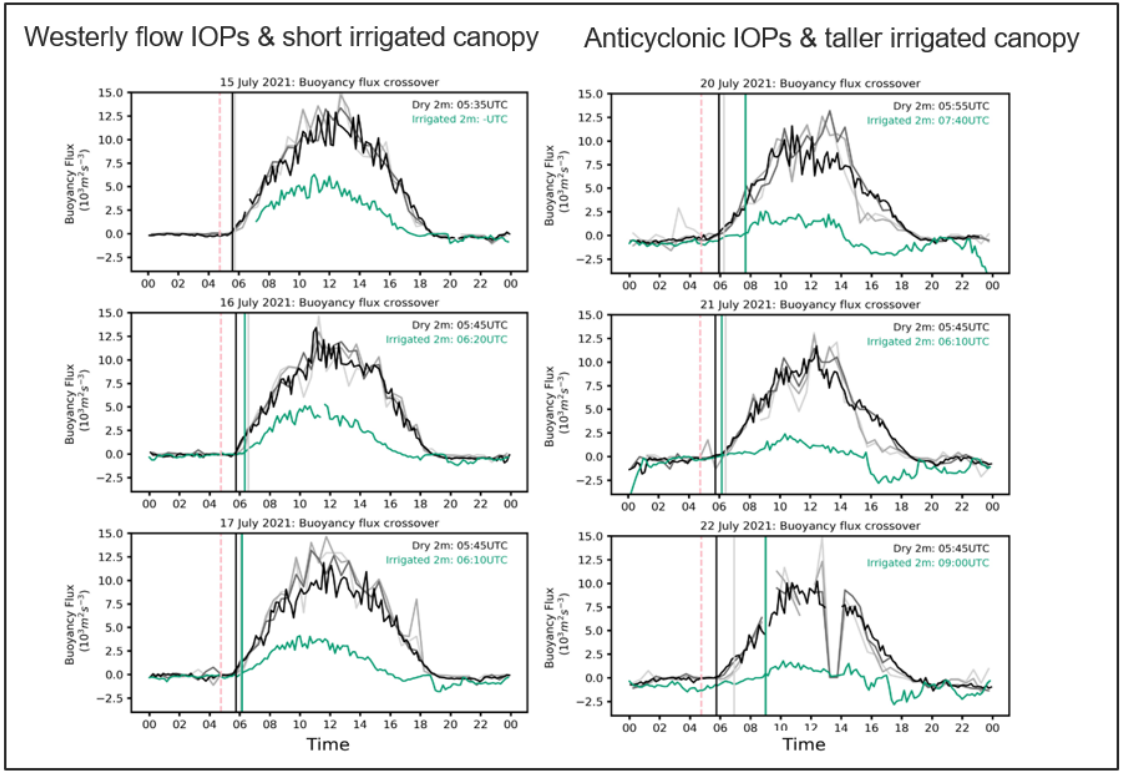
Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment

Buoyancy fluxes: rainfed vs irrigated



- Presence of irrigation suppresses buoyancy flux compared with non-irrigated surfaces.
- Delays the cross-over time (positive flux).
- Moisture flux strongly controlled by irrigated canopy height.

Westerly flow IOPs & short irrigated canopy (IOP1-3):

Buoyancy flux x2 magnitude (4.3 $m^2 s^{-3}$ vs 10.1 $m^2 s^{-3}$)

Rainfed flux cross-over: T+55min (after sunrise)

Irrigated flux cross-over: T+90min (after sunrise) (+35min)

Anticyclonic IOPs & taller irrigated canopy (IOP4-7,IOP11):

Buoyancy flux x5 magnitude (1.6 $m^2 s^{-3}$ vs 8.9 $m^2 s^{-3}$)

Rainfed flux cross-over: T+60min (after sunrise)

Irrigated flux cross-over: T+140min (after sunrise) (+80min)

Rainfed site

Irrigated site

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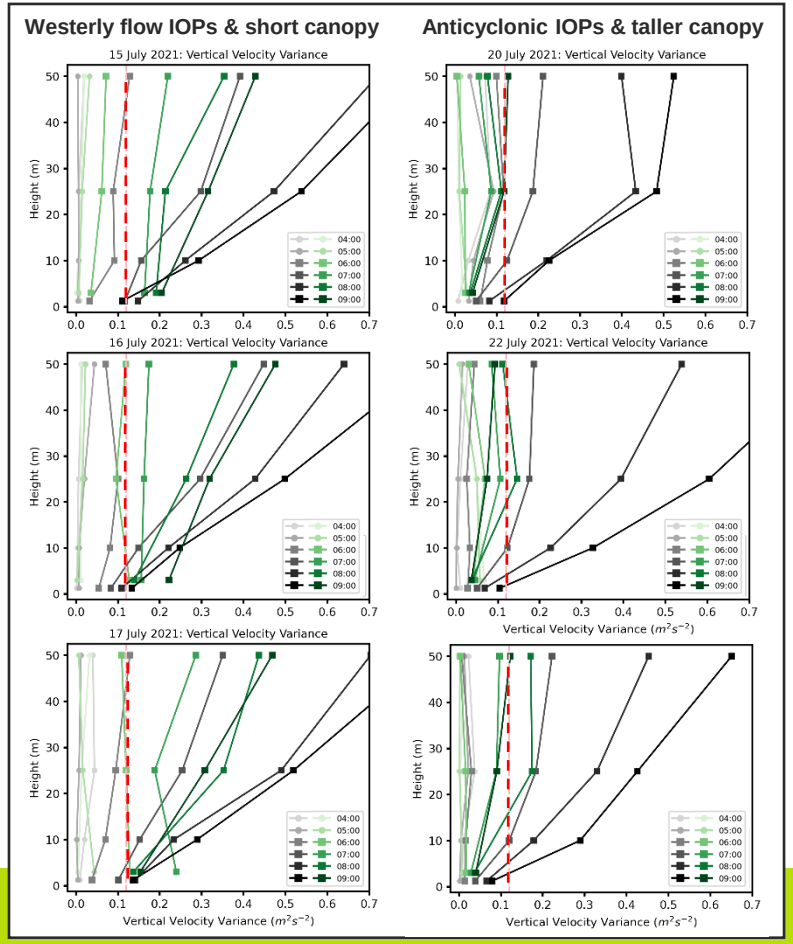
Supersite Flux Towers: rainfed vs irrigated



Establishing convective onset (50m)

Vertical velocity variance (50m) > 0.12 m^2 s^{-2}

Westerly flow IOPs & short irrigated canopy (IOP1-3):

- Rainfed 2m buoyancy-flux cross-over: T+55min (after sunrise) — Delay relative to rainfed site: (+35min)
- Rainfed 50m variance threshold: T+100min (after sunrise)
- Irrigated 2m buoyancy-flux cross-over: T+90min (after sunrise) — Delay relative to rainfed site: (+30min)
- Irrigated 50m variance threshold : T+130min (after sunrise)

Anticyclonic IOPs & taller irrigated canopy (IOP5-7,IOP11):

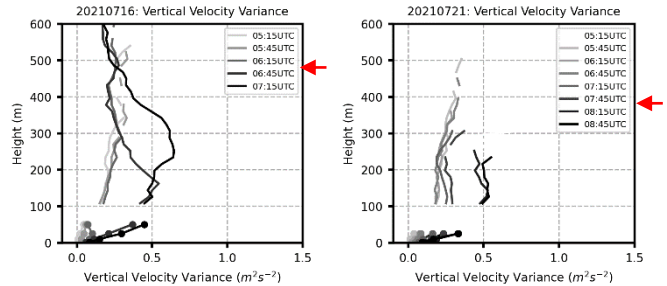
- Rainfed 2m buoyancy-flux cross-over: T+60min (after sunrise) — Delay relative to rainfed site: (+80min)
- Rainfed 50m variance threshold: T+110min (after sunrise)
- Irrigated 2m buoyancy-flux cross-over: T+140min (after sunrise) — Delay relative to rainfed site: (+150min)
- Irrigated 50m variance threshold: T+260min (after sunrise)

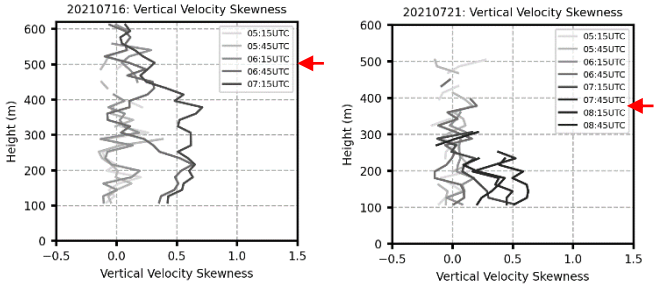
Testing needed around appropriate vertical velocity variance threshold. Taken from Brooke & Osborne (2021) QJRMS.

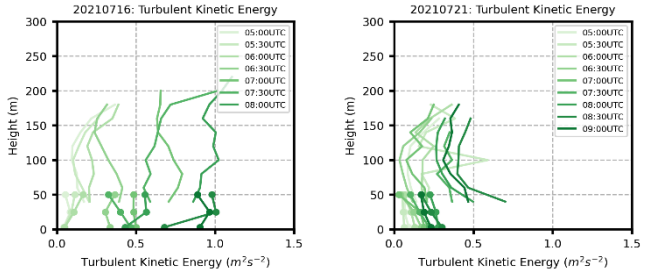
Vertical Profiles: rainfed vs irrigated

Establishing convective onset (200m)

Westerly flow IOPs & short canopy | **Anticyclonic IOPs & taller canopy**







Rainfed site

Flux tower vertical velocity variance at 2m, 10m, 25m, 50m

Doppler lidar profiles 1. Vertical velocity variance (120m, 200m) > 0.2 m^2 s^{-2}
2. Vertical velocity skewness (120m, 200m) > 0.1

Irrigated site

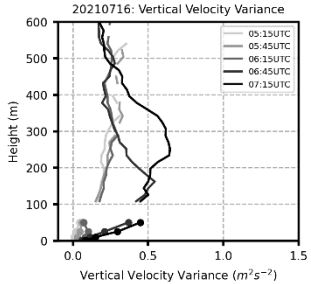
Flux tower TKE at 3m, 25m, 50m

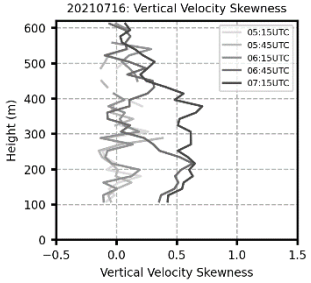
Leosphere Windcube profiles of TKE (to 200m)

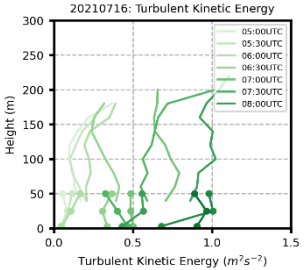
Define & test appropriate thresholds to apply to data from June–September 2021, in addition to IOP days.

Temperature & humidity profiles: rainfed vs irrigated

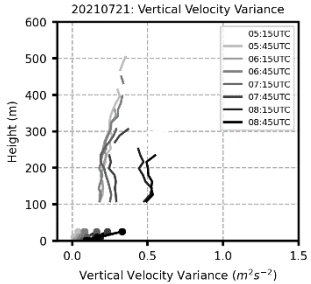
Westerly flow IOPs & short canopy

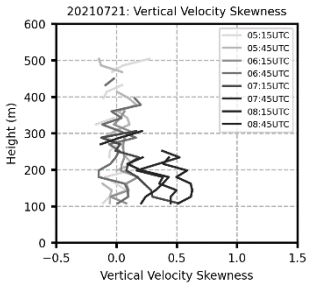


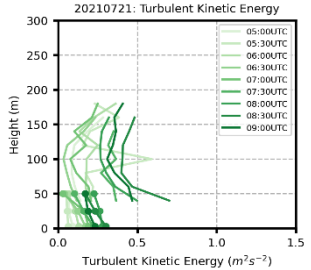




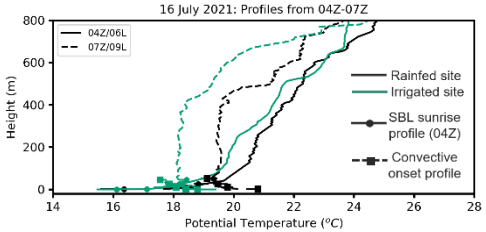
Anticyclonic IOPs & taller canopy

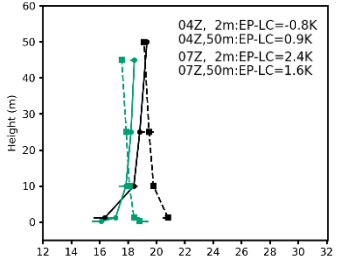


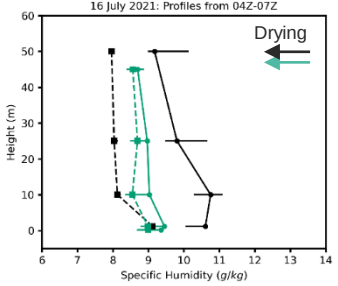


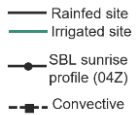


Westerly flow IOPs & short canopy

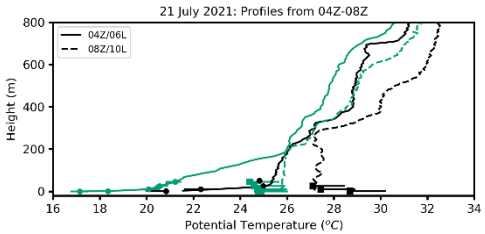


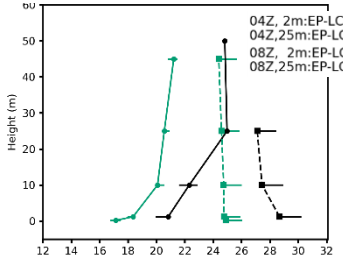


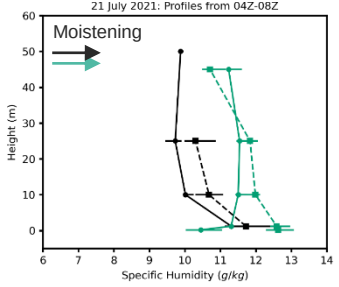




Anticyclonic IOPs & taller canopy







Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment

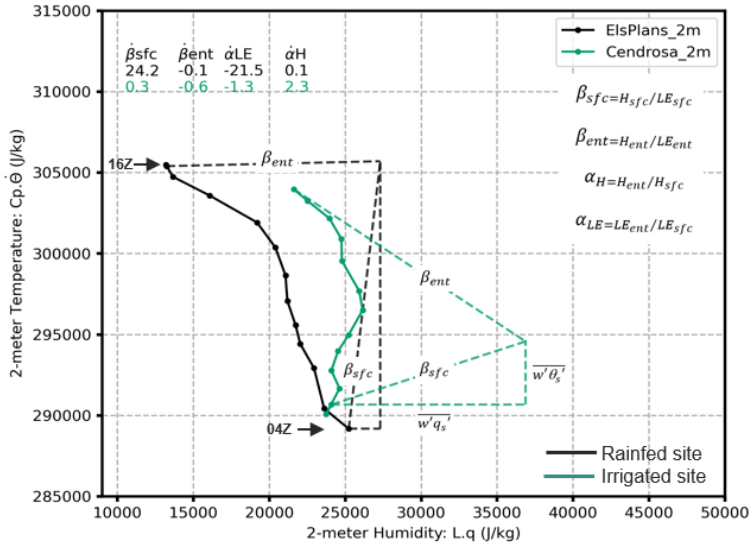
Heat & moisture budget: LoCo approach

GEWEX Local Land-Atmosphere Coupling (LoCo) Project: https://www.gewex.org/loco/

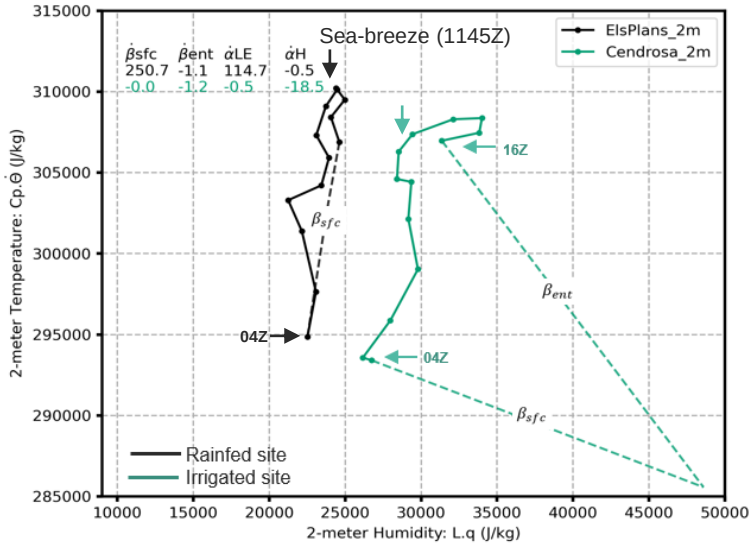
LoCo mixing diagram approach: to understand the relative roles of surface (heat and moisture fluxes) and entrainment (heat and moisture) fluxes on the boundary layer evolution using surface level observations & PBL height.

All surface observations (temperature, humidity and fluxes) are presented as energy variables (J kg^{-1}).

Westerly flow IOPs & short irrigated canopy



Anticyclonic IOPs & taller irrigated canopy



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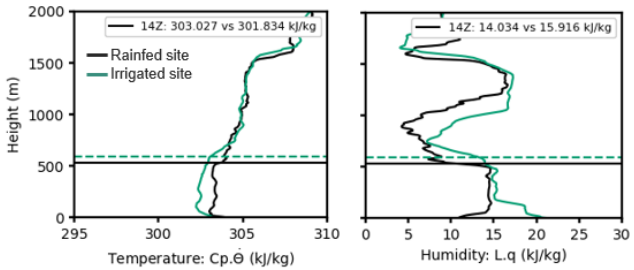
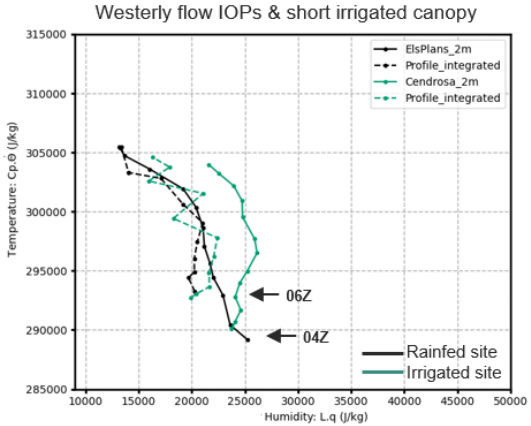
Santanello et al. (2018) Land–Atmosphere Interactions: The LoCo Perspective. *Bulletin of the American Meteorological Society, 99*(6), 1253–1272. https://doi.org/10.1175/BAMS-D-17-0001.1

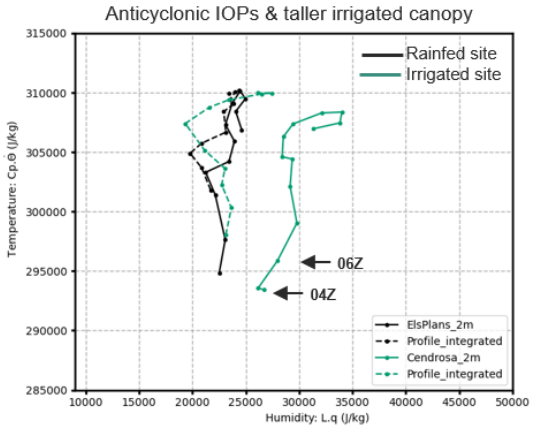
Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment

Heat & moisture budget: Integrating Profiles

- Extend LoCo framework to incorporate integrated energy in PBL > temperature and humidity profiles, presented as energy variables (J kg^{-1}).
- Irrigated profiles: shallower PBL, colder mixed layer, larger humidity gradients (less well-mixed).
- Apply integration to all mixed layer profiles (i.e. not stable BL profiles 04Z-06Z).







- Mixing diagram compares surface evolution vs integrated evolution (from 06Z).
- Temperature evolution similar using both methods, highlighting well-mixed layer assumption is applicable for temperature. Near-surface T are influenced by daytime superadiabatic surface layer.
- Integrated PBL humidity is lower than surface humidity, particularly at the irrigated site. Integrated methodology incorporates vertical gradients in humidity.

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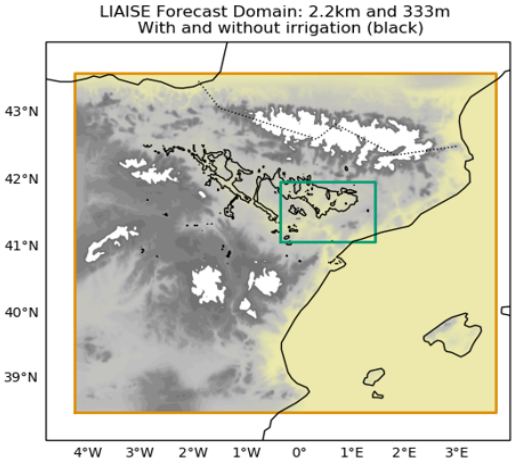
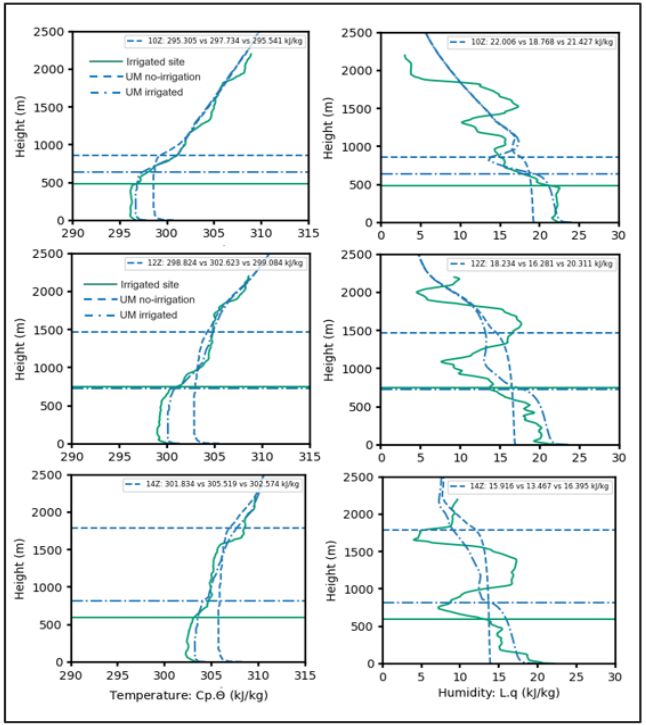
Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment

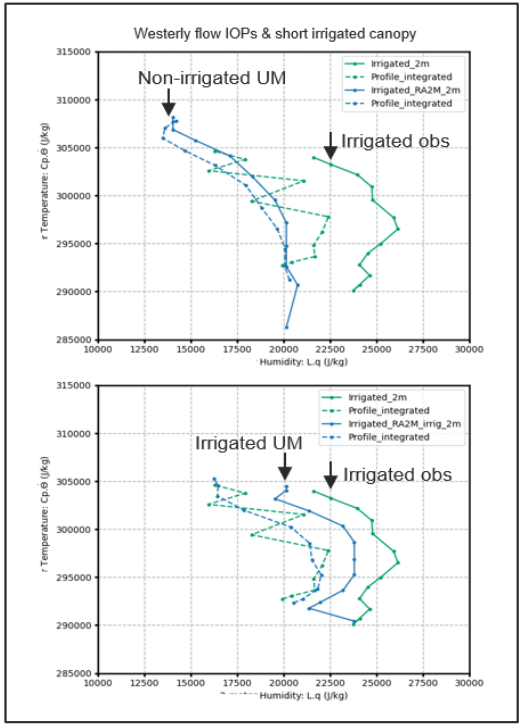
Heat & moisture budget: Unified Model Profiles

Irrigated site profiles vs UM profiles (with & without irrigation)

Running daily 2.2km UM forecasts
Running 333m UM forecasts for July SOP
With & without irrigation







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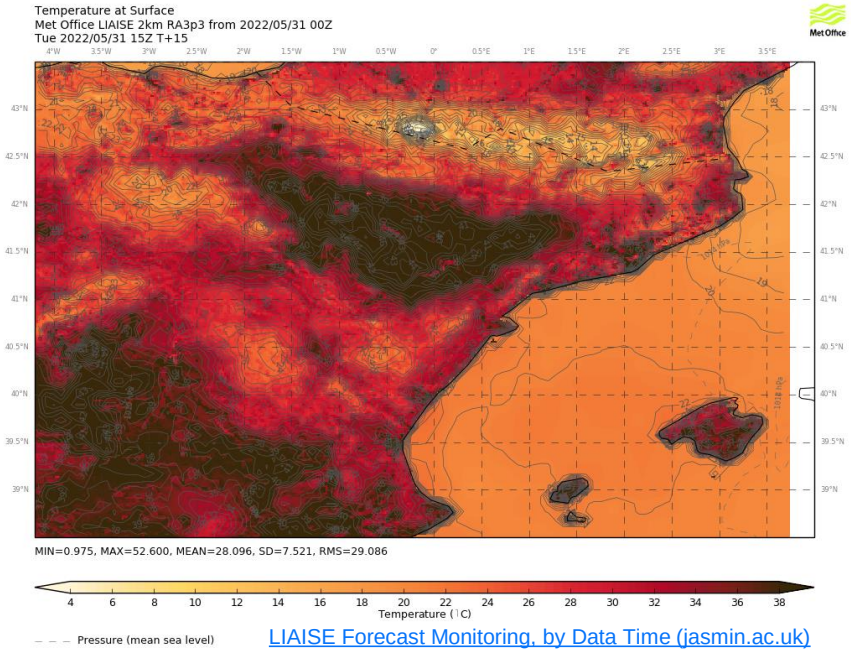
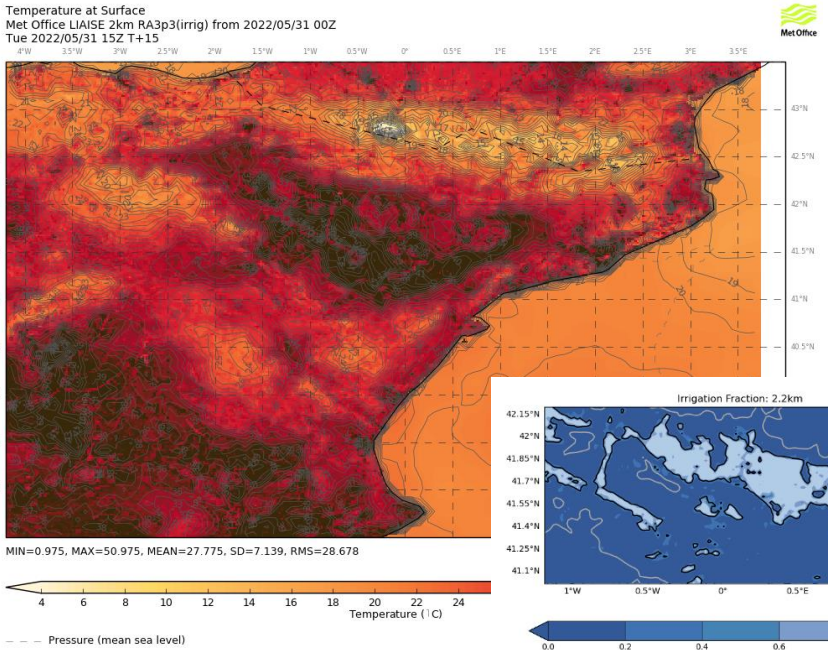
Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment

Unified Model irrigation simulations

Running daily 2.2km UM forecasts: irrigation scheme running daily since mid-March 2022.
Coincides with the soil moisture dry-down experiment.





[LIAISE Forecast Monitoring, by Data Time (jasmin.ac.uk)]

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Land surface Interactions with the Atmosphere over the Iberian Semi-arid Environment

Conclusions

Presence of irrigation suppresses buoyancy flux compared with rainfed surfaces. Moisture flux strongly controlled by irrigated canopy height.

Buoyancy flux (driven by the sensible flux) is larger using CNRM observations than Wageningen observations. Time of buoyancy flux crossover is very similar, but daily maximum fluxes differ.

Developed morning transition methodology and thresholds based on IOP days, and intend to extend to supersite data between mid-June –September 2021. Do conclusions hold true?

Heat and moisture budget > developing methodology to incorporate temperature and humidity PBL profiles into the LoCo mixing diagram approach.