Effects of **soil desiccation** on the escalation of temperatures in **heatwaves**

Diego Miralles *Ryan Teuling* *Jordi V.-G. de Arellano* *Chiel van Heerwaarden*

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Using **mechanistic models** to interpret **observations** and yield **process-understanding** of extremes

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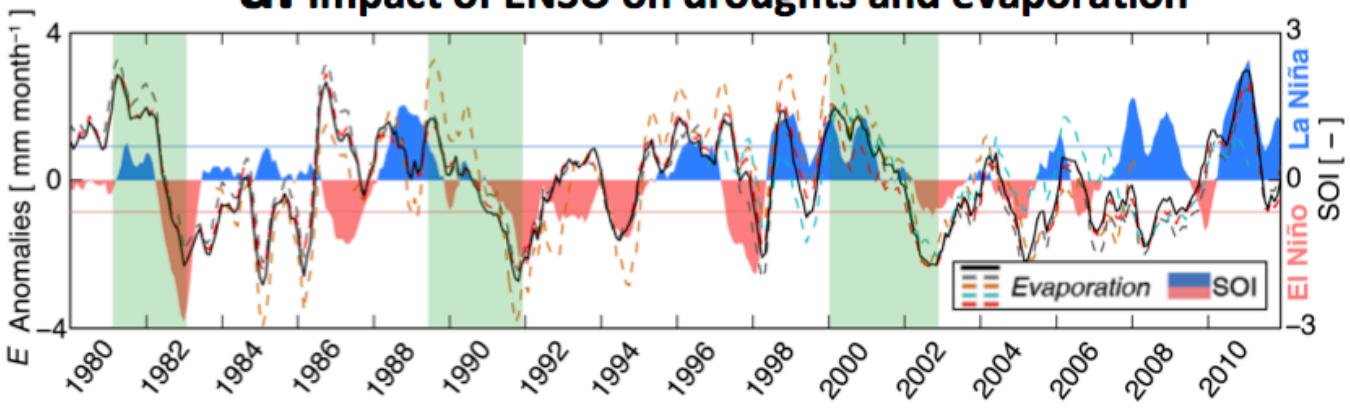
Current activities in two directions:

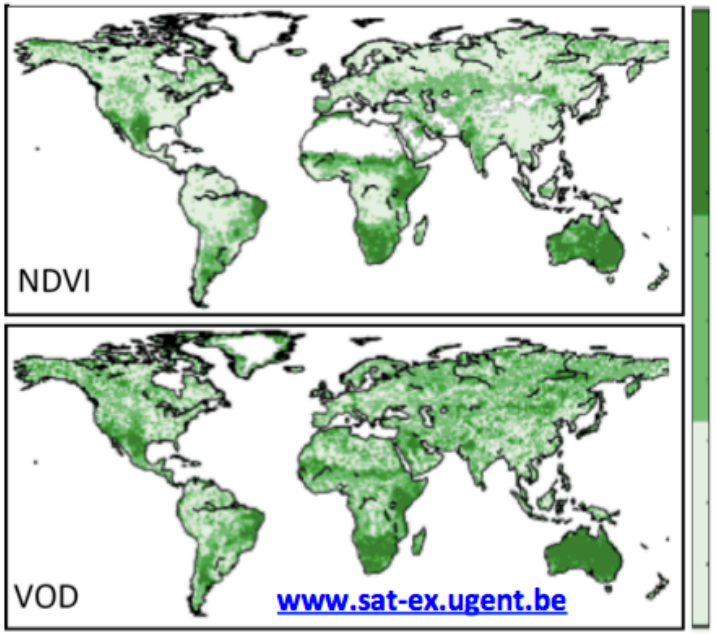
① Statistical detection, trends and variability

a. Impact of ENSO on droughts and evaporation



Miralles et al. (2014) – *Nature Cl. Change* doi: 10.1038/NCLIMATE2068

b. Water extremes on vegetation



Papagianopoulo et al. – *in prep.*

SAT–EX

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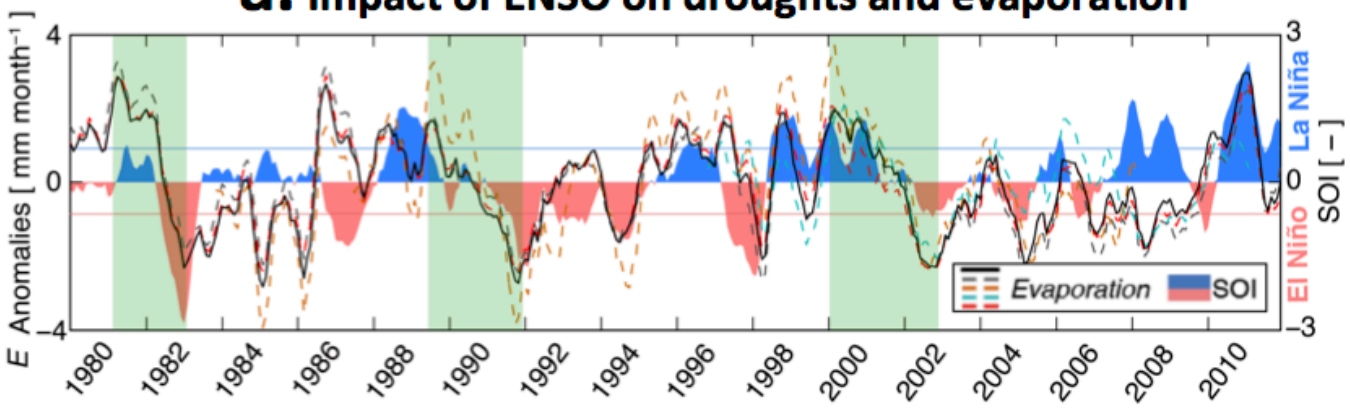

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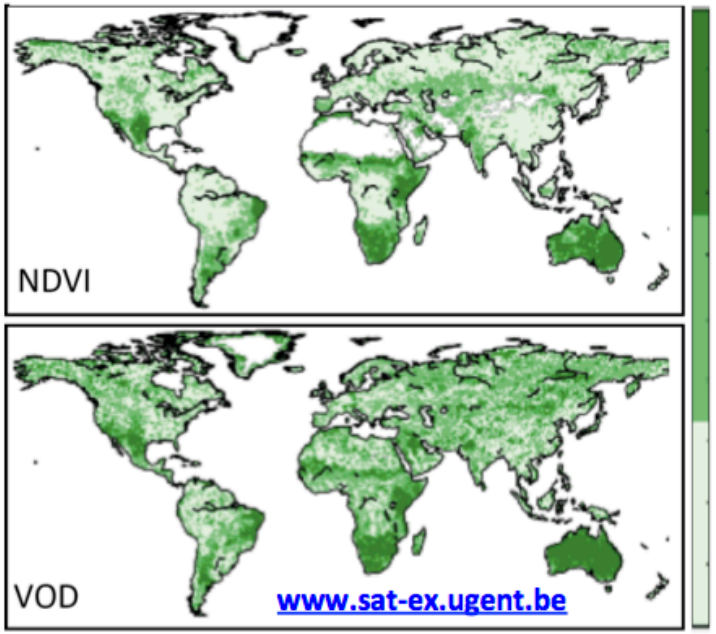

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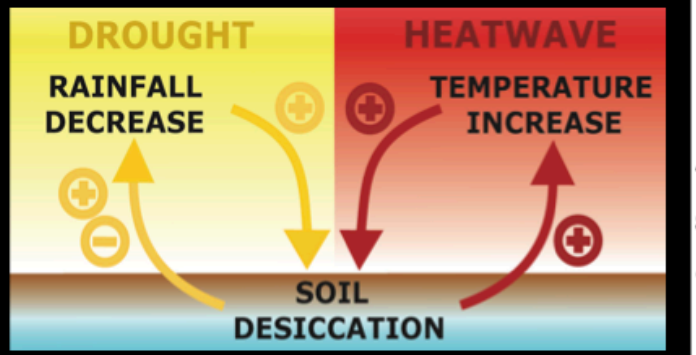
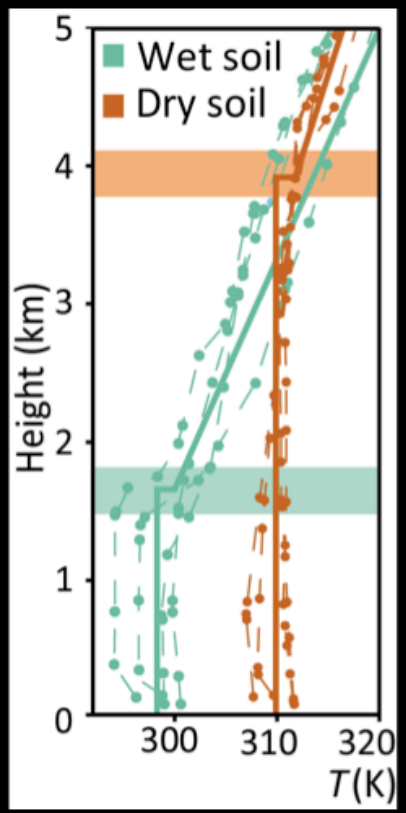
SAT–EX

② Process understanding



a. Heatwaves, using ABL models



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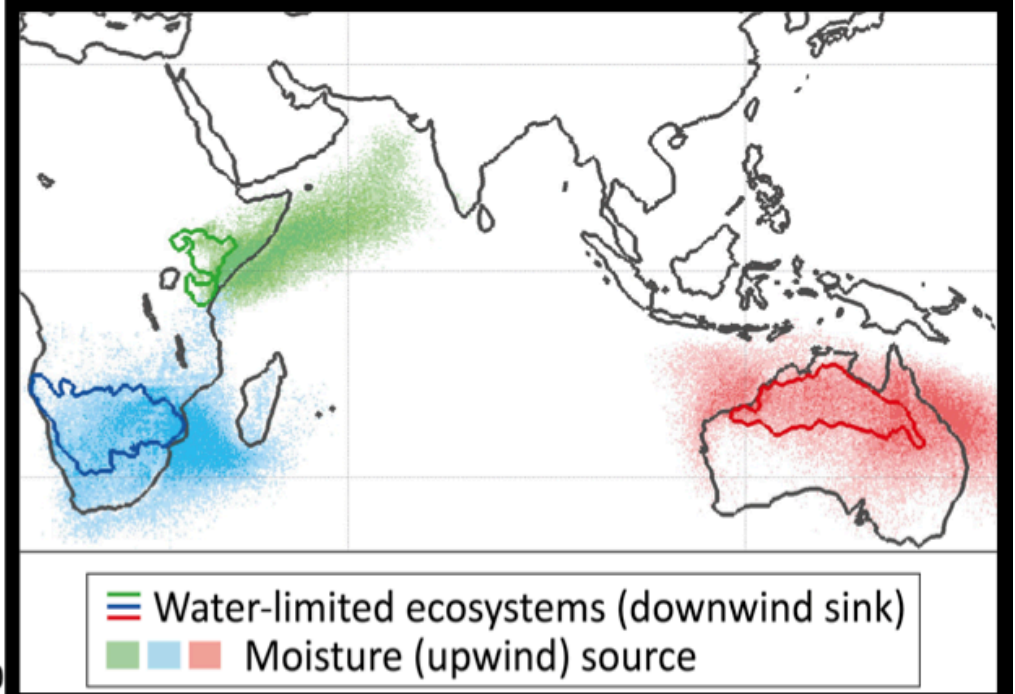
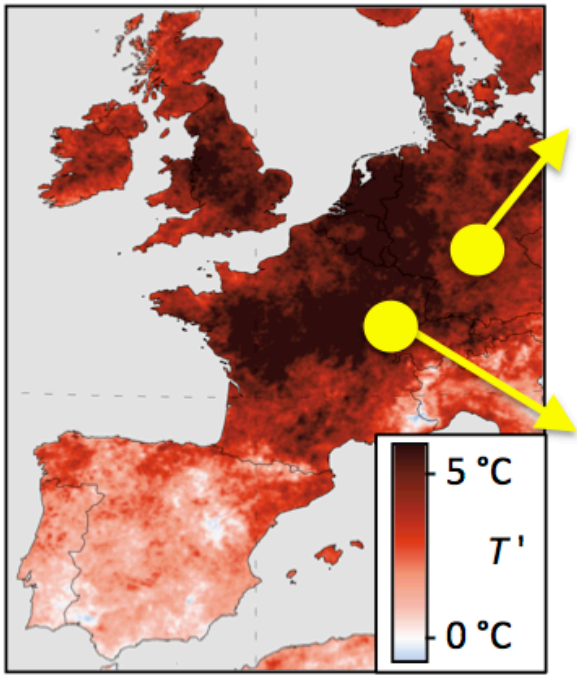
b. Droughts, with vapor trajectory models



Miralles et al. (2015?) – *in prep.*

Extremes – process-understanding

Western Europe 2003



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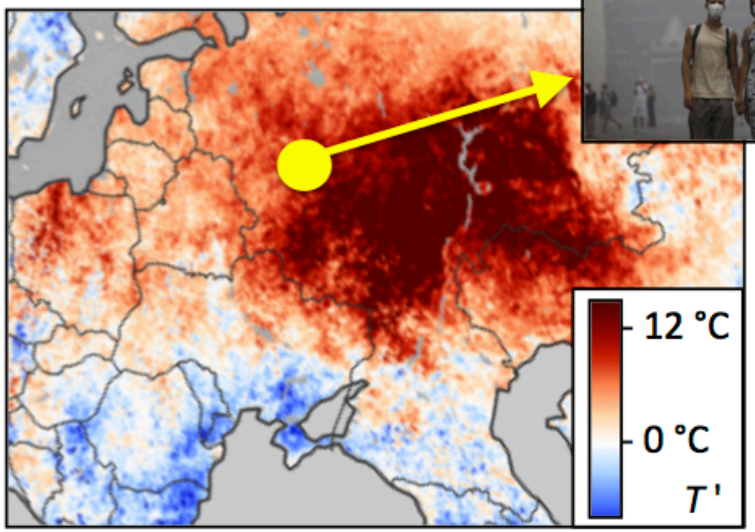
Russia 2010



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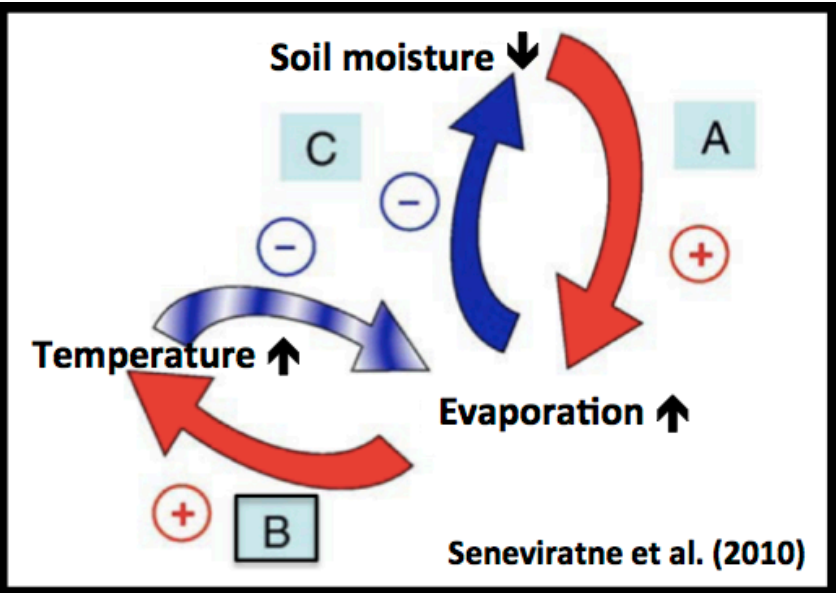

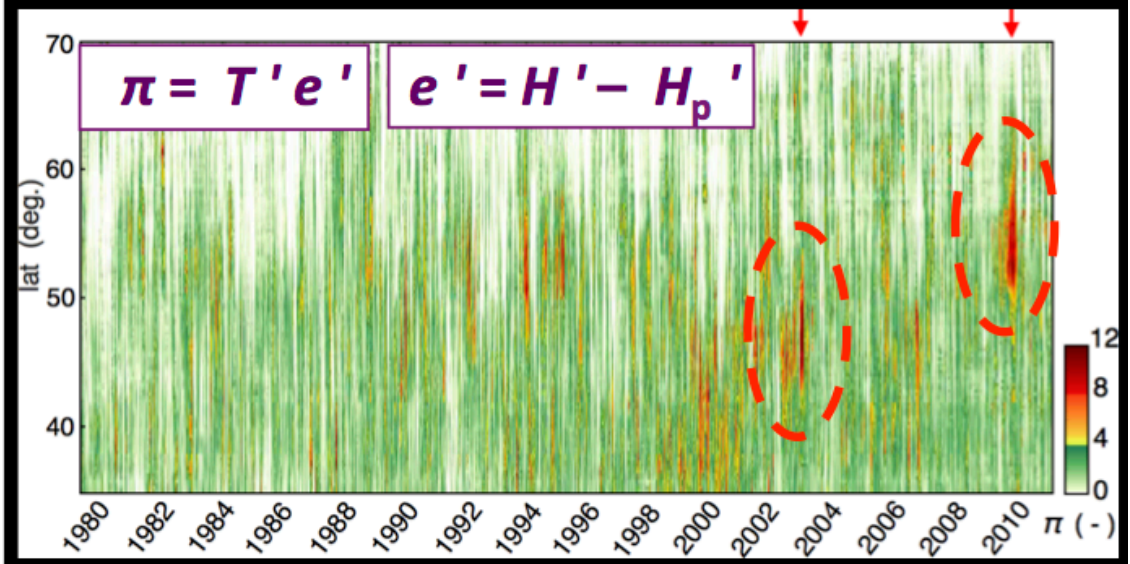

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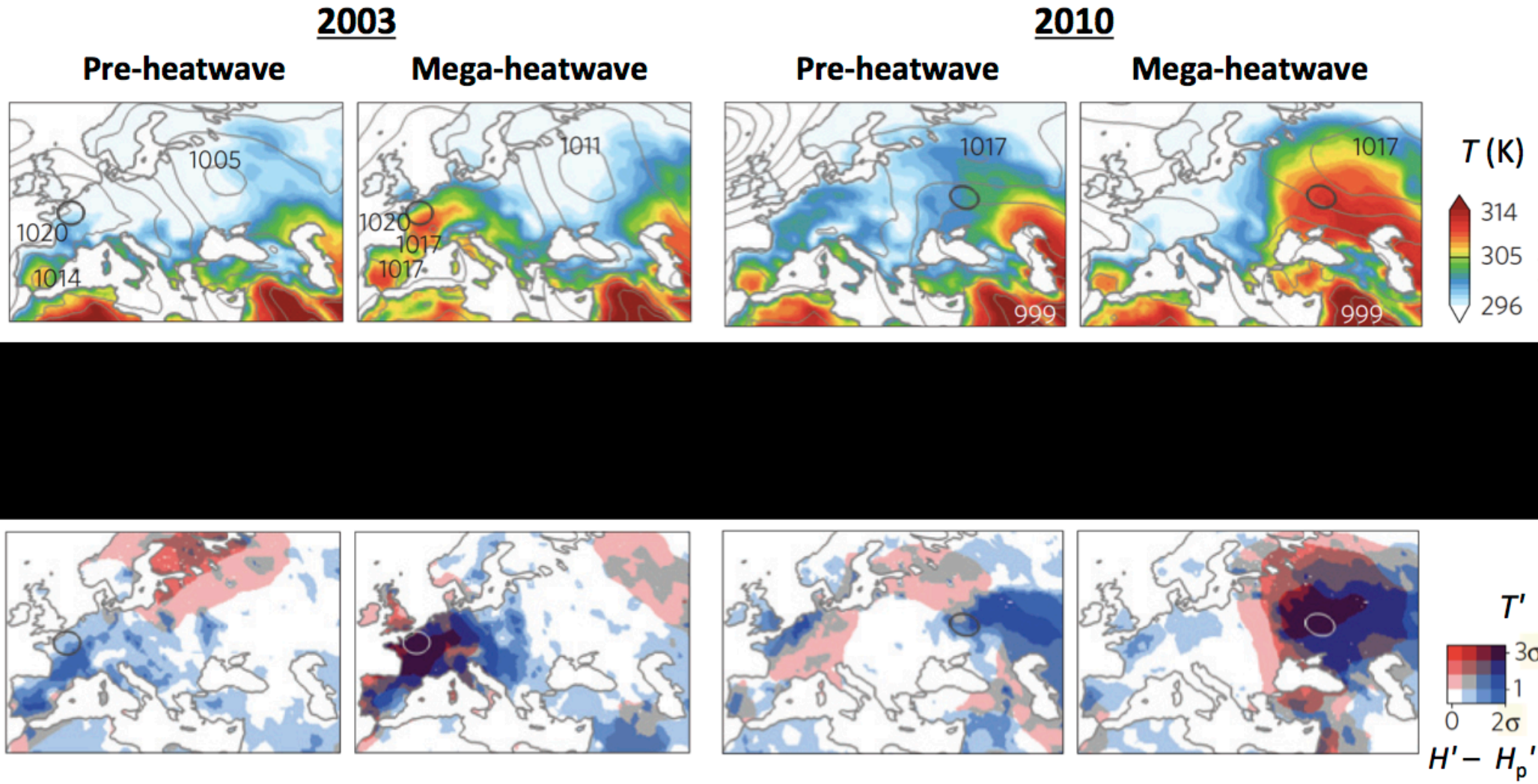
Mega-heatwave temperatures due to combined soil desiccation and atmospheric heat accumulation

Diego G. Miralles[1,2*], Adriaan J. Teuling[3], Chiel C. van Heerwaarden[4] and Jordi Vilà-Guerau de Arellano[5]



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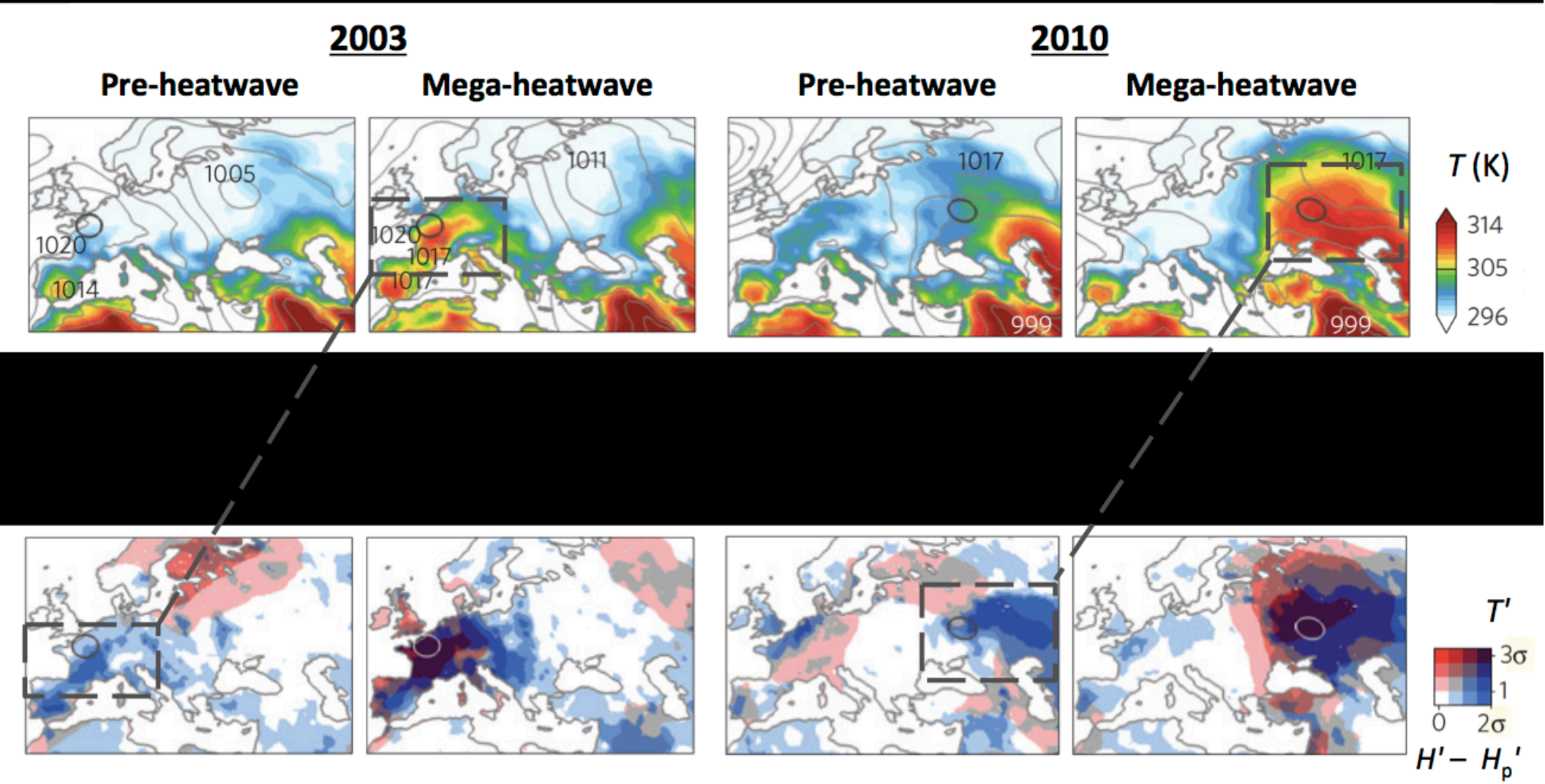

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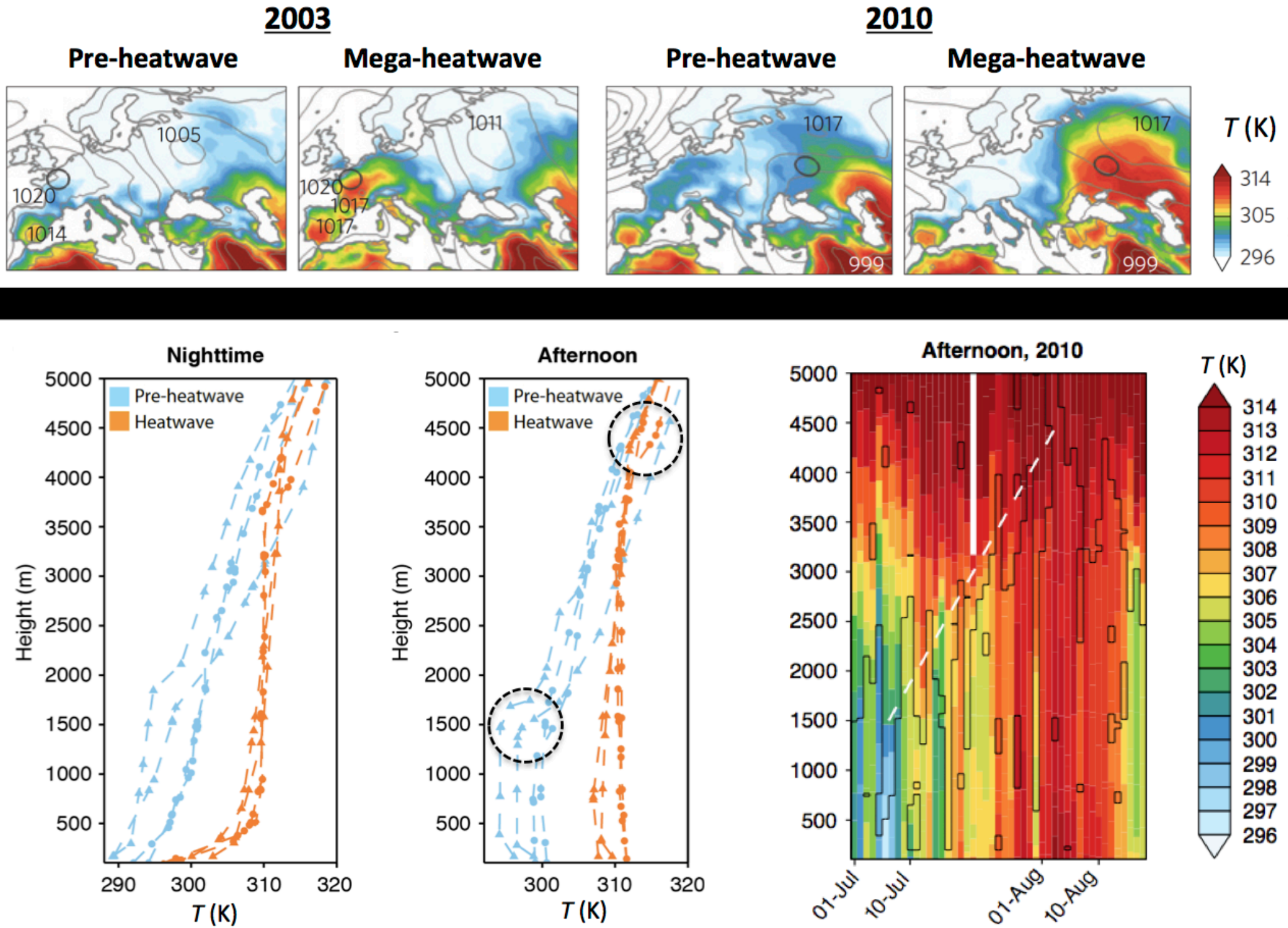
2003
2010
Pre-heatwave
Mega-heatwave
Pre-heatwave
Mega-heatwave
1005
1020
1014
1011
1020
1017
1017
1017
999
1017
999
T (K)
314
305
296
Nighttime
Afternoon
Afternoon, 2010
Pre-heatwave
Heatwave
Height (m)
T (K)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
290
300
310
320
01-Jul
10-Jul
01-Aug
10-Aug
314
313
312
311
310
309
308
307
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305
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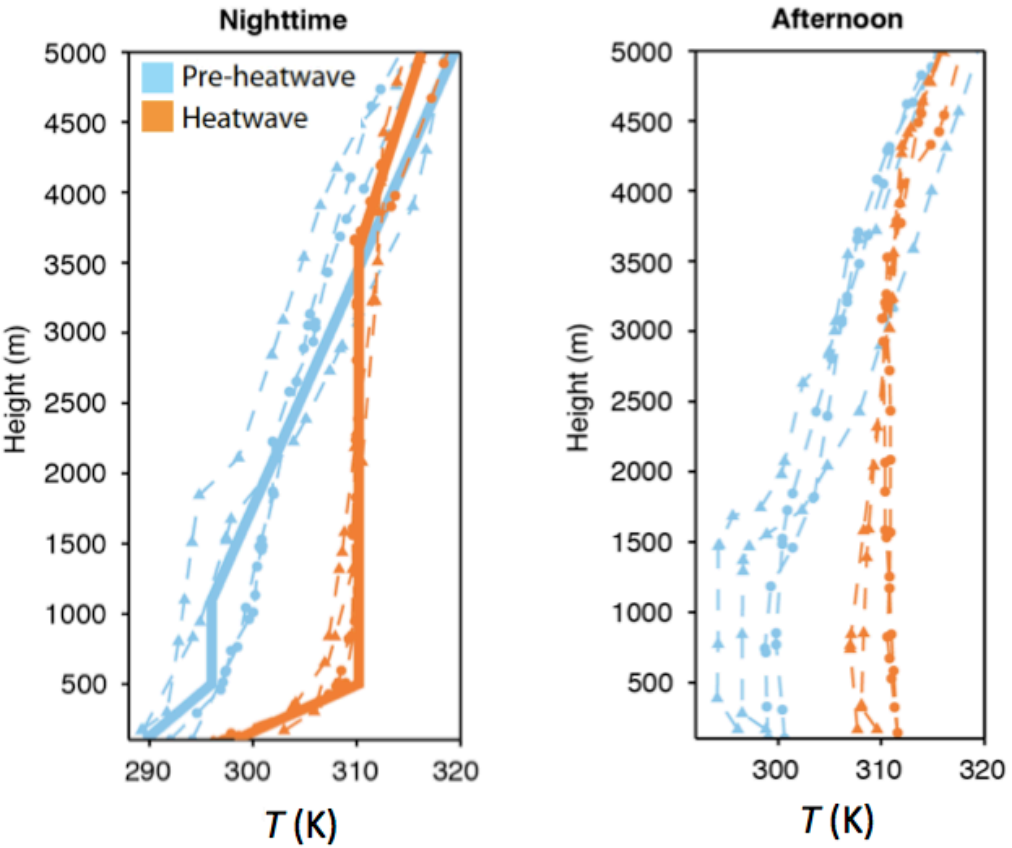
296

To physically interpret observations:
<u>mechanistic model</u>

① Initialized by night soundings

② Constrained by satellite data



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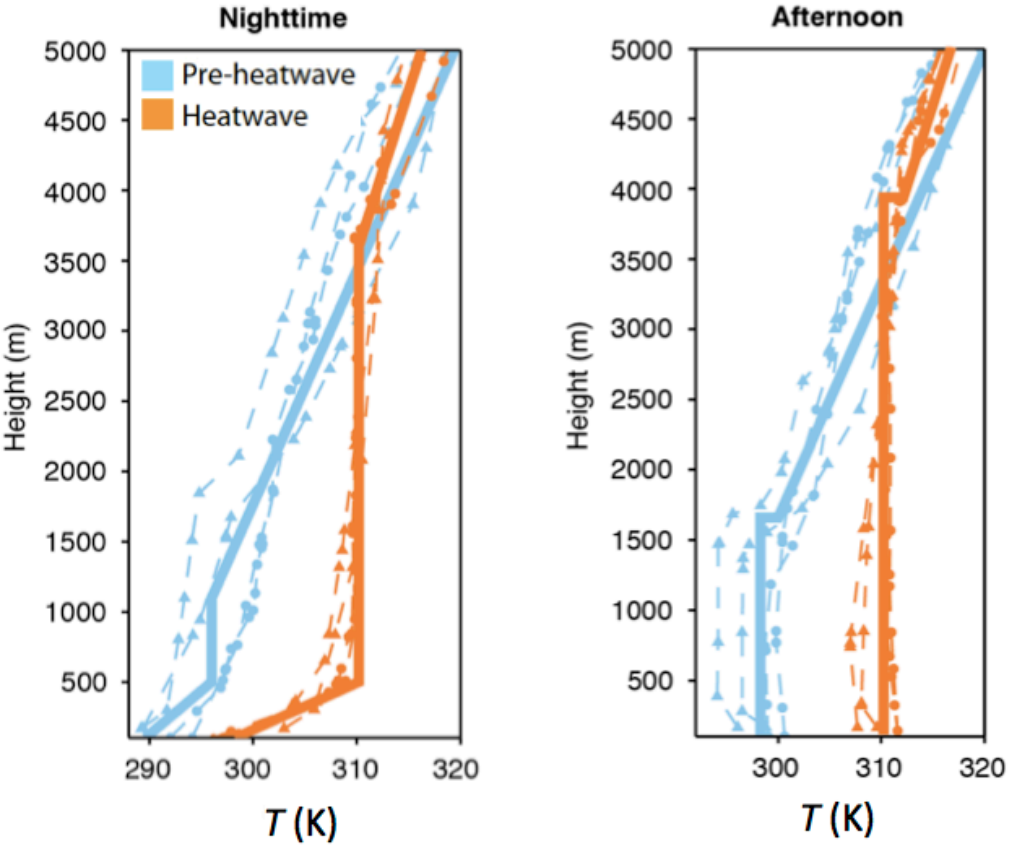

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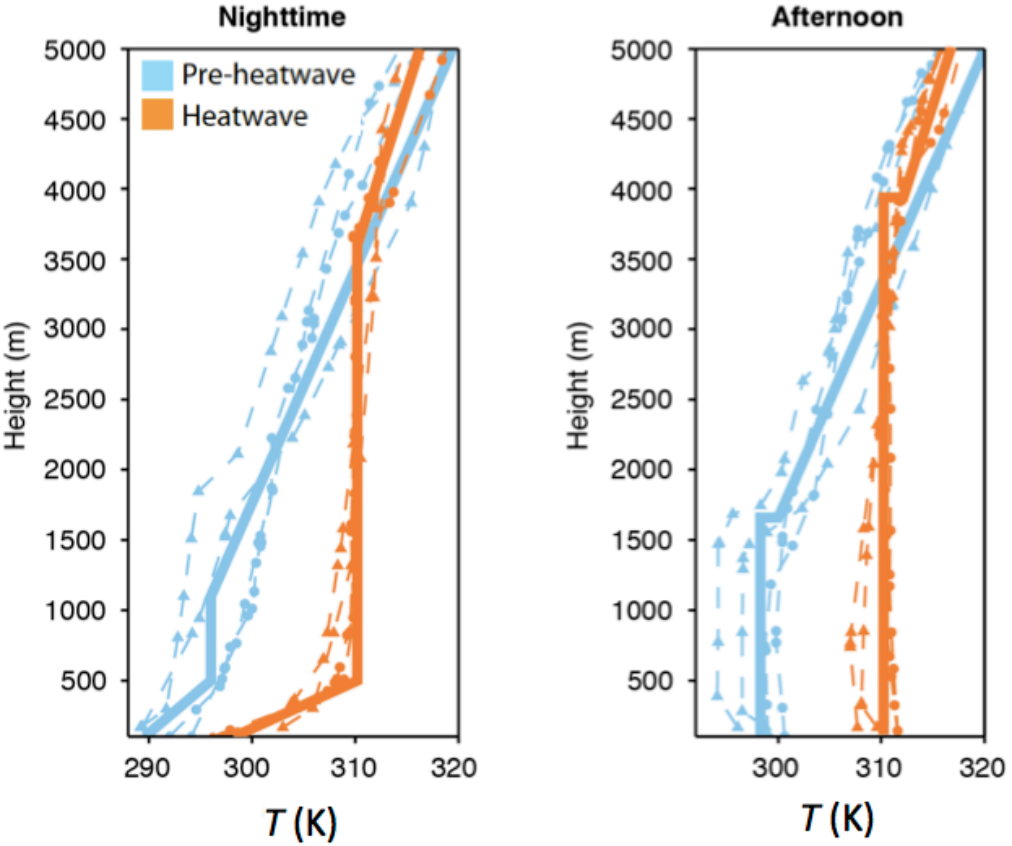
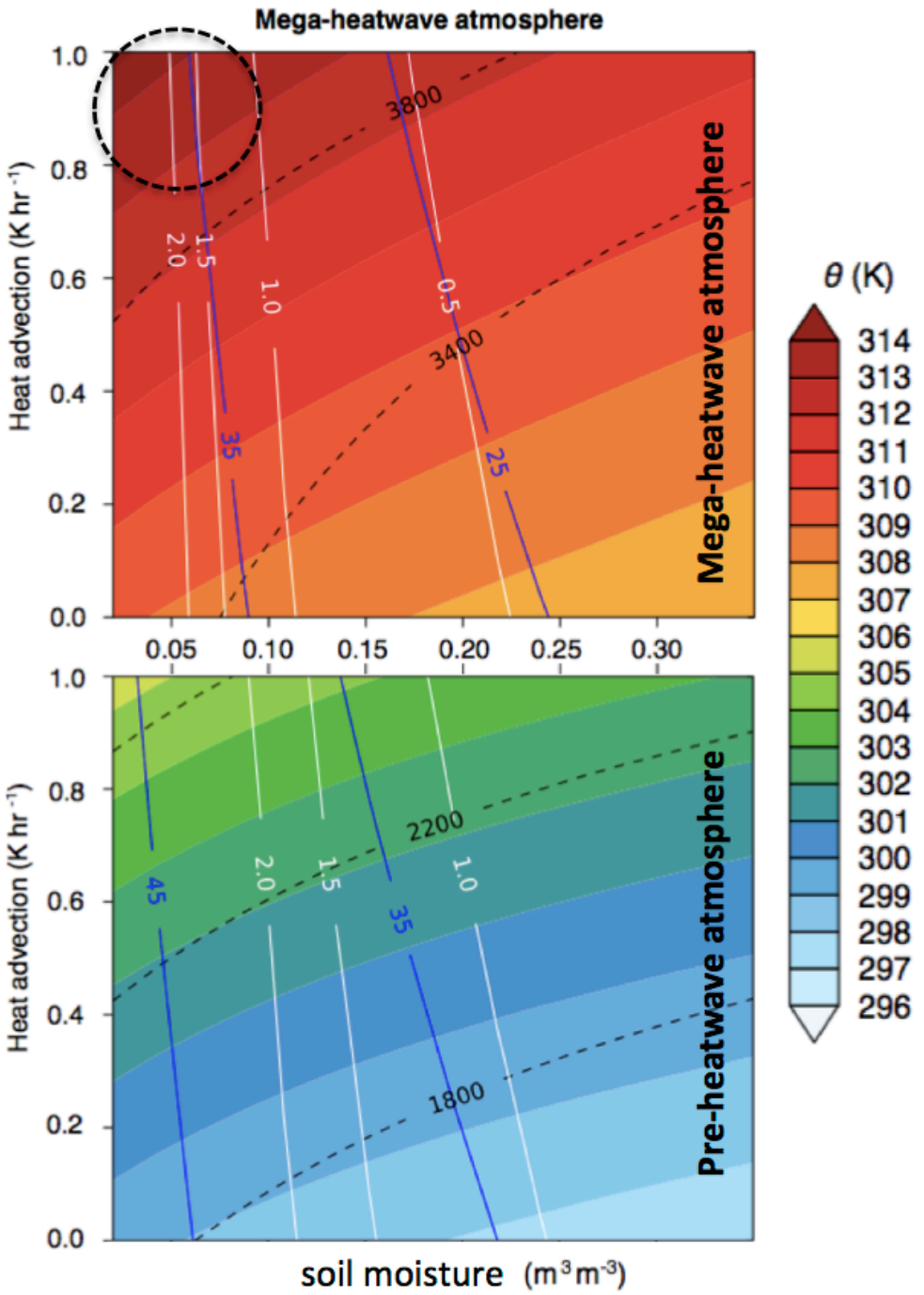
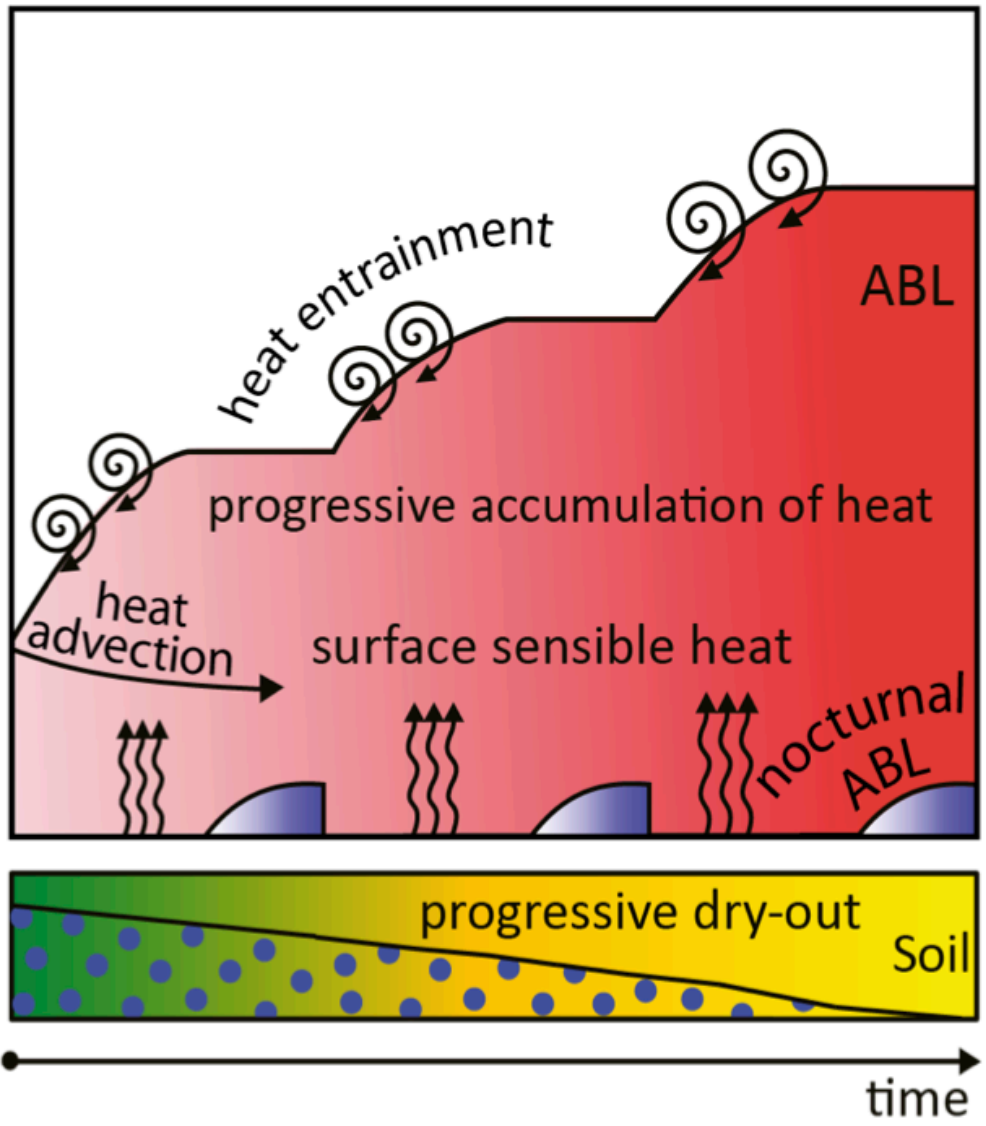




- Only **combined conditions of <u>dry soils</u> + high heat <u>advection</u>** yield observed *T*
- **And multi-day accumulation in <u>residual layer</u> essential**
- ~50% from sensible heat, ~40% advection, ~10% entrainment

Conclusions and perspectives



- **New satellite records** allow:
  1. **Statistical** analysis of detection, trends, etc.
  2. But also **process-understanding**
- Simple **mechanistic models to interpret** them:
  1. To yield **understanding of extremes**
  2. To **benchmark** more complex models

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