Predict and understand heat waves
A case study of summer 2003 and 2010

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SPECS aims to identify the main problems in climate prediction and investigate a battery of solutions from a seamless perspective.
The European heat-wave of 2003 caused the death of 35,000 people and damages of $15 billion.
### Experiment Description

<table>
<thead>
<tr>
<th>Model</th>
<th>Start dates</th>
<th>Land IC</th>
<th>Atm IC</th>
<th>Oce/Ice IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC-Earth 2.3</td>
<td>May, June, July, August</td>
<td>ERA-Land</td>
<td>ERAInt</td>
<td>ORA-S4</td>
</tr>
</tbody>
</table>

- **Start dates**:
  - May, June, July, August
  - 1st May, 1st June, 1st July, 1st August
  - 1st May, 1st June, 1st July, 1st August

- **4-month lead time**: 1981 to 2010

- **10 members**
Are they predictable?

2003

2m-Temperature anomalies

Odds Ratio

2010
Why are they predictable?

Large scale vs local processes

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Percentage of Hot Days (%HD) vs the Standardized Precipitation Index (SPI) in the southeast European domain (1961–2000 period).

Hirschi et al., 2011

Climatology of ERA-Land
Land IC contribution

2m-Temperature anomalies

2003

Odds Ratio

CLIM

INIT

2010

-5 0 5

5 4 3 2 1

1 2 3 4 5
Intra-seasonality of the 2003 heat wave

- May: 56%
- June: 96%
- July: 80%
- August: 96%
Intra-seasonality of the 2003 heat wave

May

June

July

August

INIT

INIT

INIT

INIT

56%

96%

80%

96%
Intra-seasonality of the 2003 heat wave
Intra-seasonality of the 2003 heat wave

May

June

July

August

5

0

-2

CLIM
INIT

96%

56%

80%

96%

CLIM
INIT

CLIM
INIT

CLIM
INIT

CLIM
INIT
Intra-seasonality of the 2010 heat wave

May  

June  

July  

August
Soil moisture

Land – atmosphere coupling
- Both 2003 and 2010 heat waves were predictable.

- 2003 seems to be mainly large scale driven.

- Realistic dry soil initial conditions are necessary to reproduce the 2010 heat wave 2-3 month ahead.

- August 2010 temperature was highly sensitive to soil conditions.

### Impact of resolution

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<tr>
<td>EC-Earth 3.1</td>
<td>May, Nov</td>
<td>ERA-Land</td>
<td>ERAInt</td>
<td>GLORYS</td>
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<tr>
<td>SRes (T255/ORCA1)</td>
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<tr>
<td>HRes (T511/ORCA025)</td>
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Climatology of ERA-Land

- **1993**: 1st May - 1st Nov
- **2009**: 1st May - 1st Nov

4-month lead time

10 members
Effect of land-surface initialization in summer (JJA) 2m-temperature prediction using high-resolution hindcasts (EC-Earth 3.1 T511ORCA025)

Correlation of summer prediction with ERA-Interim

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