Influence of El Niño–Southern oscillation on Europe in a changing climate

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Introduction – ENSO

- Most pronounced mode of climate variability in the tropical Pacific, affects weather globally

- Quasiperiodic (2 – 7 years)

- Two components (Bjerknes, 1969.): atmospheric (Southern Oscillation) and oceanic (El Niño)

- Two phases: warm (El Niño) and cold (La Niña)
Climate change

- Natural and anthropogenic
- IPCC
  - Fifth report (2014.)
- Intensive use of fossil fuels, increasing agriculture areas, deforestation, growing cities and areas with asphalt and concrete...
- ENSO and climate change?
  - Response over Europe?

IPCC’s GHG emission scenarios
Data and methods

- **ECHAM5/MPI–OM**: coupled model, CMIP3 dataset

- Simulates well ENSO variability, but with a small overestimation of amplitude (Jungclaus et al., 2005.)

- Ensemble analysis and composite analysis

- Periods and scenarios:
  - 1951 – 2000 (20c3m)
  - 2001 – 2050 (A1B, B1)
  - 2051 – 2100 (A1B, B1)

- $t$– test for statistical significance (are the anomalies significantly different from zero?)
Results
Tropical Pacific

- Stronger amplitude comparing to 20th century
- Will it result with a stronger response?
- Amplitudes of La Niña events stronger than for El Niño

**SSTA [°C], 20th century**

(a) El Niño, SSTA, 20c3m, 1951–2000, Nino3.4=0.23

(b) La Niña, SSTA, 20c3m, 1951–2000, Nino3.4=–2.52

**SSTA [°C], A1B scenario**

(a) El Niño, SSTA, A1B, 2001–2050, Nino3.4=0.65

(b) La Niña, SSTA, A1B, 2001–2050, Nino3.4=–2.62

(c) El Niño, SSTA, A1B, 2051–2100, Nino3.4=2.89

(d) La Niña, SSTA, A1B, 2051–2100, Nino3.4=–2.89
• Stronger amplitude in future climate (especially over the Atlantic)
• Slight space shift
Zonal wind $[m/s]$, $u200$

- Important for weather type of a certain area
- Strengthening of the subtropical jet stream for El Niño events
- Weak response for La Niña events
Precipitation [mm/day]

- Majority of the anomalies over the Atlantic (Herceg Bulić et al., 2012)
- Spreading over mainland in future climate
- Southeastward spatial shift near Iceland
- Maxima over sea?
• Anomalies spreading over south Europe

• Increase in temperature during El Niño
Conclusion

- Prominent mode of climate variability
- Change in amplitude of ENSO in the Pacific
- Change in response over Europe
- 2051. – 2100., A1B, strongest forcing and strongest response
Observed:
- Space shift of geopotential field
- Stronger jet stream over south Europe and weaker over north Europe during El Niño
- Wetter and warmer winters over south Europe, response for northern Europe weaker
Thank you!