Can recently observed precipitation trends over the Mediterranean area be explained by climate change projections?

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Objective

We investigate whether recently observed precipitation trends can be explained with what models projected as response of climate to anthropogenic forcing (Greenhouse gases and sulfate aerosols)

Key question: **"Is the trend of recent years a harbinger of the future?"**

Data

Observed trends

Precipitation

- CRU TS 3.1
- GPCC4
- GPCP- V2.1

Model simulations

- 16 AOGCMs (CMIP3 multi-model dataset archive of PCMDI)
- INGV regional model (CIRCE)

Future projections

- A2 emission scenario (IPCC 2000)

Method

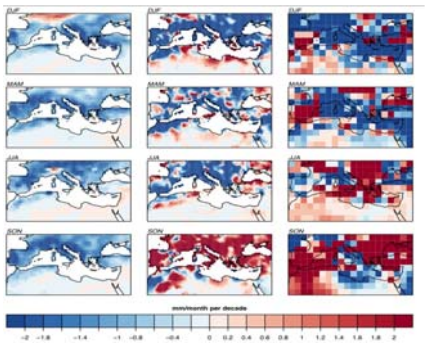
We define the anthropogenic climate change signal as the difference between the last decades of the 21st century (2071-2100) and the reference climatology (1961-1990).

The comparison of observed and anthropogenic climate change signal patterns are carried out using three pattern similarity statistics:

- **Amplitude**: Includes information about the mean change field.
- **Regression**:Focuses on the magnitude of anomalies about the mean.
- **Pattern Correlation**:Combines two aspects of consistency analysis, spatial mean and spatial pattern of change.

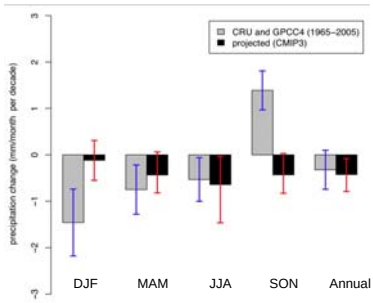
Bootstrap test with observed fields:

- moving block bootstrapping, to account for autocorrelation
- Bootstrap replication is 1000
- Size of moving block is 5

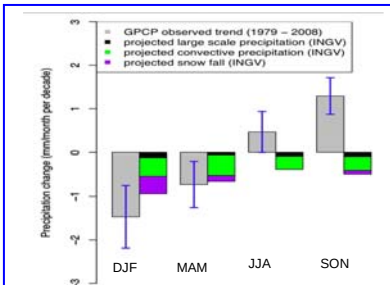


The right column: Observed pattern GPCP (1979-2008)
The middle column: Observed pattern CRU (1965-2005)
The left column:Anthropogenic signal pattern, multi-model ensemble mean (CMIP3), consist of 119 simulations.

Observed seasonal and annual are mean changes of precipitation over the period from 1965 to 2005 in comparison wit anthropogenic signals (GS) derived from the CMIP3 multi-model ensemble mean.



-The red whiskers: spread of trends of 16 climate change projections.
-The blue whiskers: bootstrap 90% confidence interval of observed trends



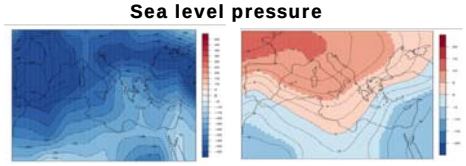
-The blue whiskers: bootstrap 90% confidence interval of observed trends

Seasonal pattern similarity statistics for 30-year trends (1979 – 2008) of Precipitation (GPCP), compared to the trend of anthropogenic change signals derived from the INGV regional model.

	Correlation	Regression	Amplitude
DJF	0.56	1.4	2.5
MAM	0.29	0.52	0.73
JJA	-0.2	-0.31	-0.64
SON	-0.17	-0.13	-0.71

Focus on autumn (SON)

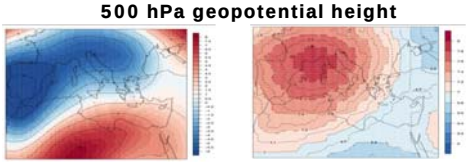
Sea level pressure



Observed pattern (1965-2005)

Anthropogenic signal pattern, multi-model ensemble (CMIP3)

500 hPa geopotential height



NCEP reanalysis pattern (1965-2005)

Anthropogenic signal pattern, multi-model ensemble (CMIP3)

-The projected changes in large-scale circulations are not consistent with the observed changes in recent decades.

-NCEP reanalysis 500 hPa geopotantial height pattern confirms the observed upward trend in precipitation.

Summary

•Externally forced changes are detected in the observed precipitation trends in all seasons with probability of error of less than 5%.

•In winter projections strongly underestimate the observed trends. The 8 scenarios projected upward trend in precipitation, which is in contrast with observations.

•No pattern correlation has been found in spring. The amplitude indices are 0.73 with regional model and in the range of [0.71, 1.1] with 16 global scale scenarios.

•Small consistency has been found in summer with CRU and GPCC4 datasets, in spatial mean and spatial pattern of change.

•GPCP dataset suggests that the Mediterranean region has become wetter by about +0.5 mm/month increase in amount of precipitation, which contradicts the regional and global scenarios.

•In autumn we find an important difference, observations contradict the projections.

Most likely candidates to explain the large discrepancy between observed precipitation trends with projections

- **Natural variability are too strong**
- **The hypothesized anthropogenic forcing is not dominant**
- **Significant drivers are not taken into account**
- **Models are wrong**