Air Quality and Climate Change in the Mediterranean

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Outline

- Observed climate change (annual precipitation)
- Model projections for the 21st century
- Regional climate change “hotspots”
- Link between climate change and air quality
- Ozone air pollution
- Particulate air pollution and climate
Black: 1901-1950
Blue: 1951-1978
Red: 1979-2003
Annual Precipitation, 1901 to 2005

Eastern North America (1163 mm)
Northern Europe (748 mm)
Mediterranean Basin (559 mm)
North Asia (455 mm)
East Asia (1075 mm)
December–January–February (DJF)

Based on regional studies assessed in chapter 11:

- Precipitation increase in ≥90% of simulations
- Precipitation increase in ≥66% of simulations
- Precipitation decrease in ≥66% of simulations
- Precipitation decrease in ≥90% of simulations

- Precipitation decrease – very likely
- Precipitation decrease – likely
- Precipitation increase – very likely
- Precipitation increase – likely
- Increased drought – likely
- Less snow – very likely
- Precipitation extreme increase – likely
Giorgi (2006): Regional Climate Change Index

\[ RCCI = (n\Delta P + n\Delta\sigma_P + n\text{RWAF} + n\Delta\sigma_T)_{WS} + (n\Delta P + n\Delta\sigma_P + n\text{RWAF} + n\Delta\sigma_T)_{DS} \]

- \( n \): factor between 0 and 4
- \( P \): precipitation (\( \sigma_P \) is precipitation variability)
- \( T \): temperature (\( \sigma_T \) is temperature variability)
- \( \text{RWAF} \): regional warming amplification factor
- \( \text{WS} \): wet season
- \( \text{DS} \): dry season
RCM climate change scenario

Schär et al. (2004)
Number of days with dangerous or extremely dangerous heat index

Diffenbaugh et al. (2007)
Summary

- Wet regions are getting wetter and dry regions dryer
- Mediterranean region is a climate change hot spot
- Mediterranean seems already subject to drying
- Mediterranean drying will likely increase in future
- Number of very/extremely hot days will likely increase
Number of hours of ozone exceeding 80 ppbv
Near-surface ozone air pollution (CTM)

Summer 1995

Summer 2025
Ozone trends (ppbv/yr) over Atlantic 1977-2002
Ozone air quality standard exceedance in July-August 2006
Poor $O_3$ air quality in Mediterranean and Middle East
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Seasonal vertical O$_3$ distribution over the Gulf
Global \(O_3\) from the stratosphere along 25-30\(^\circ\)N during summer
Summary

○ Ozone air quality standards in the Mediterranean and Middle East exceeded, especially in Persian Gulf region

○ In Gulf region the natural background ozone is relatively high (STE and natural $\text{NO}_x$ sources)

○ Gulf region subject to long-distance transport of air pollution from Europe and Middle East

○ Future: Increasing pollution emissions and climate change will exacerbate poor air quality conditions
Finokalia station, University of Crete
Near surface trajectories
precipitation change: low-high SST (%)
Summary

○ Aerosol pollution especially strong in summer (lack of precipitation and transport from Europe)

○ Aerosol has exerted cooling tendency which is reversing since 1990s

○ SST cooling has likely influenced evaporation-precipitation: Future?

○ Aerosol-cloud interactions?

○ Feedbacks between drying, forest fires, desert dust?