The role of large-scale atmospheric structure for end-of-century local precipitation changes in CMIP5 models

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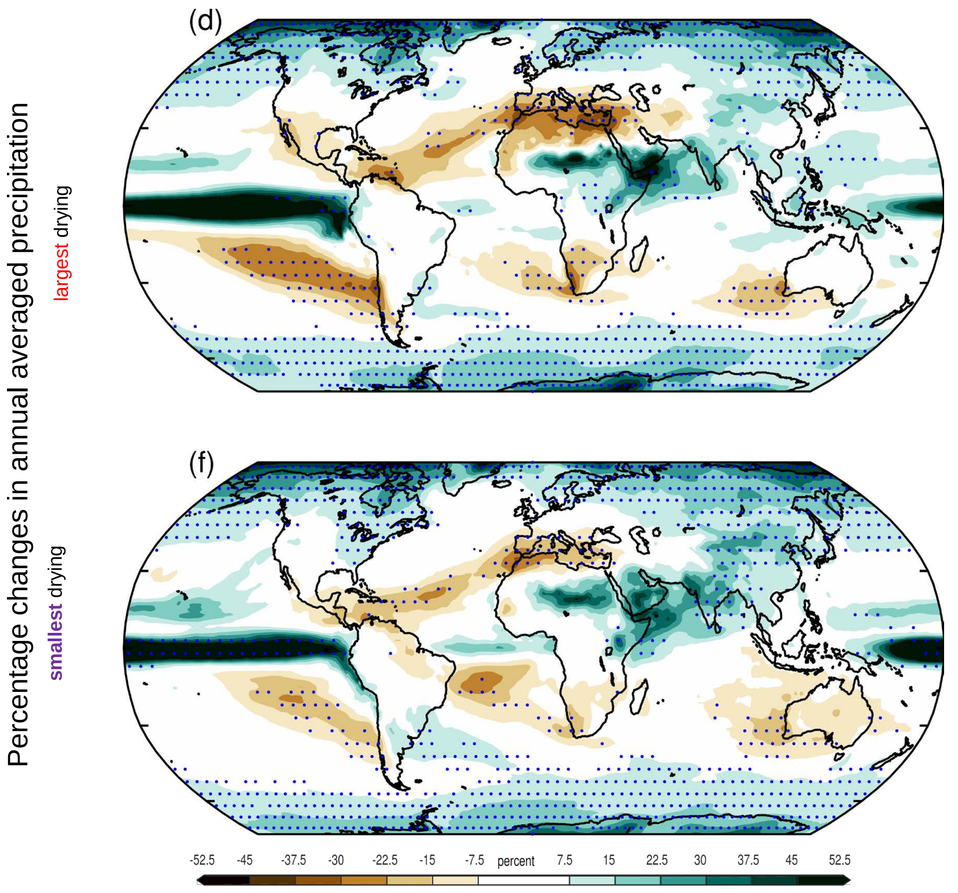
משרד המדע והטכנולוגיה

1. Introduction and Conclusions

●Observational trends and climate change projections indicate significant drying of the subtropics, and specifically of the Eastern Mediterranean region, associated with global warming.

●The magnitude of drying varies across climate models, with some models indicating more than a 50% reduction in e.g. the Eastern Mediterranean and other models indicating less than a 10% reduction by the end of the century for RCP8.5 in CMIP5. Our goal is to understand the spread in model projections across 42 CMIP5 models.



Percentage changes in annual averaged precipitation from 2080-2099 as compared to 2009-2029 in (top) 15 RCP8.5 experiments with largest drying change in Eastern Mediterranean; (bottom) 15 RCP8.5 experiments with **smallest** drying change in Eastern Mediterranean;

●What drives the diversity in model projections?

●Is model diversity due to ***global*** mechanisms that may lead to more pronounced subtropical drying in some models as compared to others?

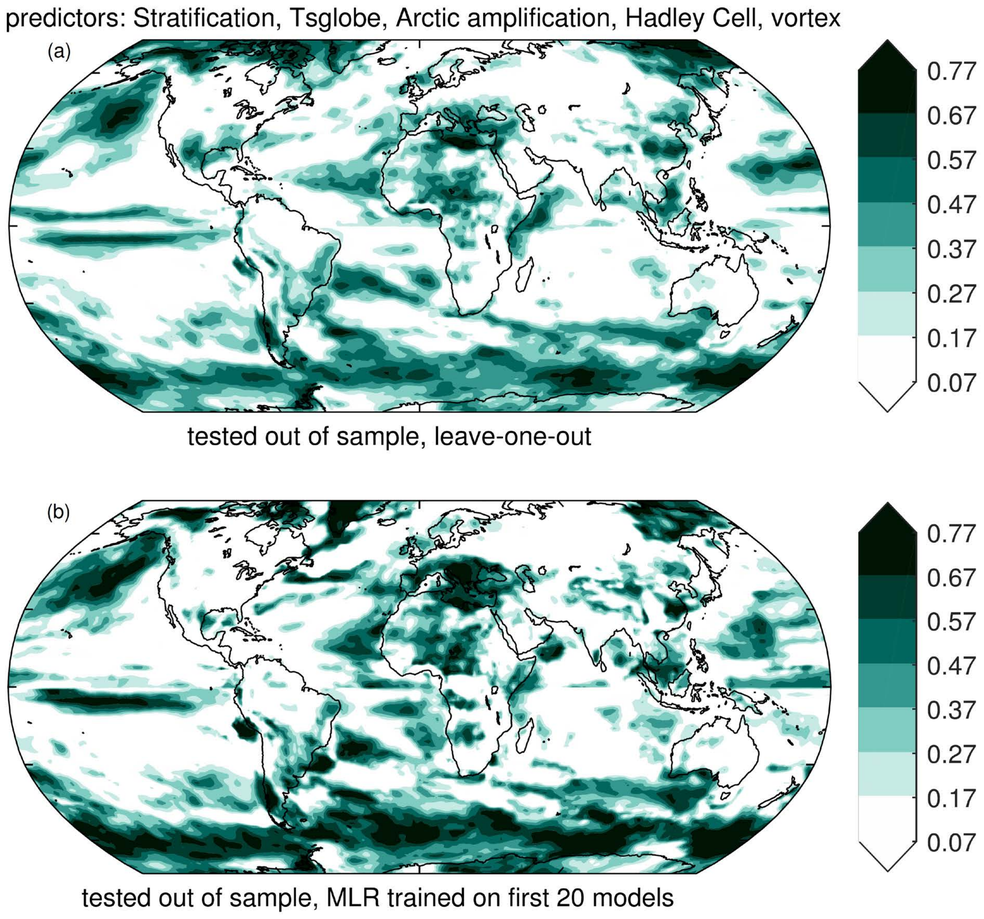
●Are there ***local*** factors that lead to more pronounced Eastern Mediterranean drying as compared to other subtropical regions?

●Approach: Formulate a multiple linear regression model using the global scale mechanisms that have been proposed to explain changes in subtropical precipitation (i.e. Hadley Cell widening, changes in polar stratosphere, Arctic amplification, increased stability in Tropics; #2 and #3).

●We then add on local factors (not shown, but can lead to R^2 exceeding 0.9)

●Key conclusion: Global and local factors are roughly equally important for the model spread in Eastern Mediterranean drying. In contrast, e.g. over Europe and most of USA, global factors relatively unimportant for model spread (#4).

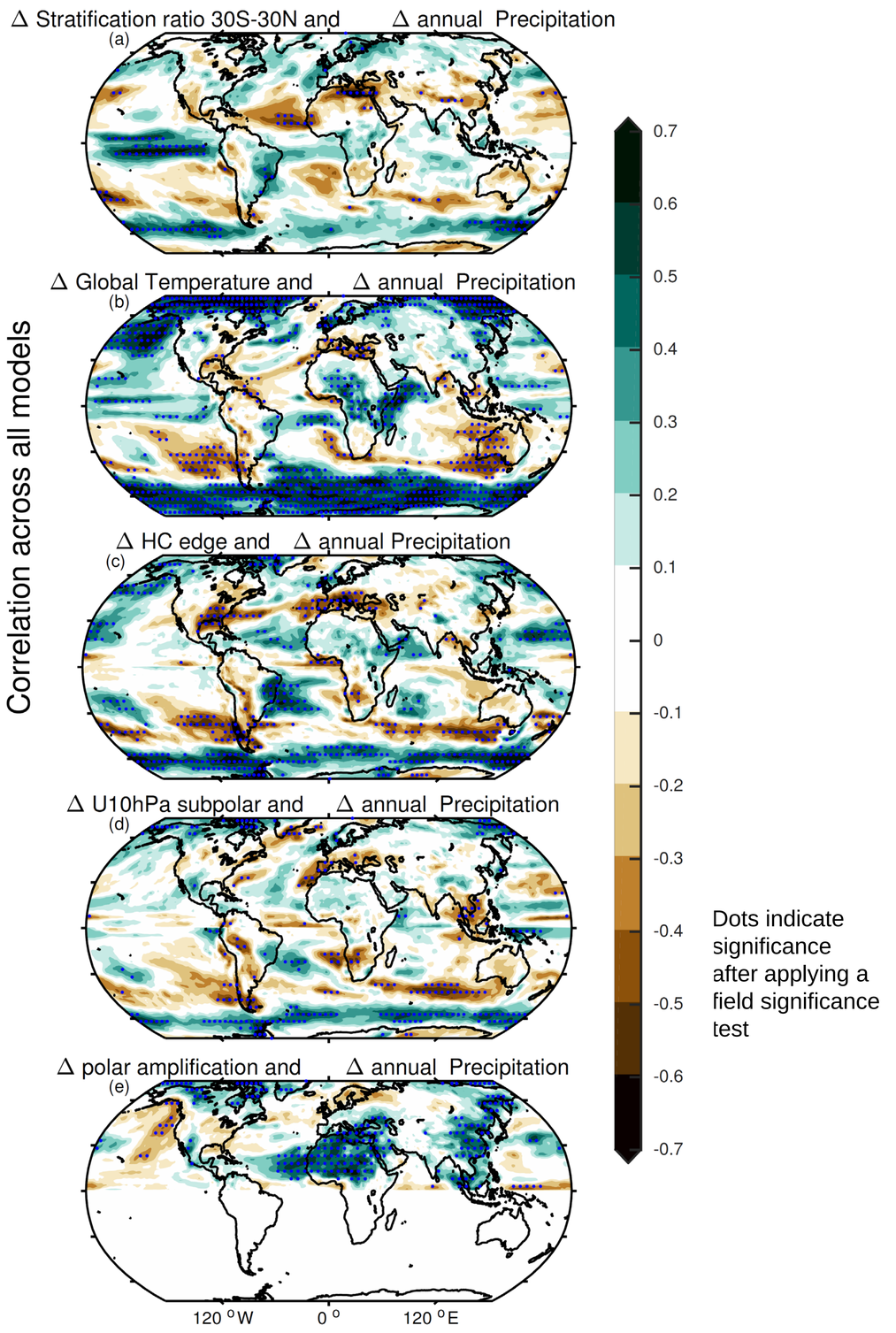
3. Correlation of predicted change in precip. from MLR model with the actual change in precip. across all 42 models.



In out of sample test, R^2 exceeding 0.5 over Eastern Mediterranean, East Asia, Mexico/Southern US, and coastal southern Australia and Africa.
In contrast, global factors unimportant over most of Europe and most of USA.

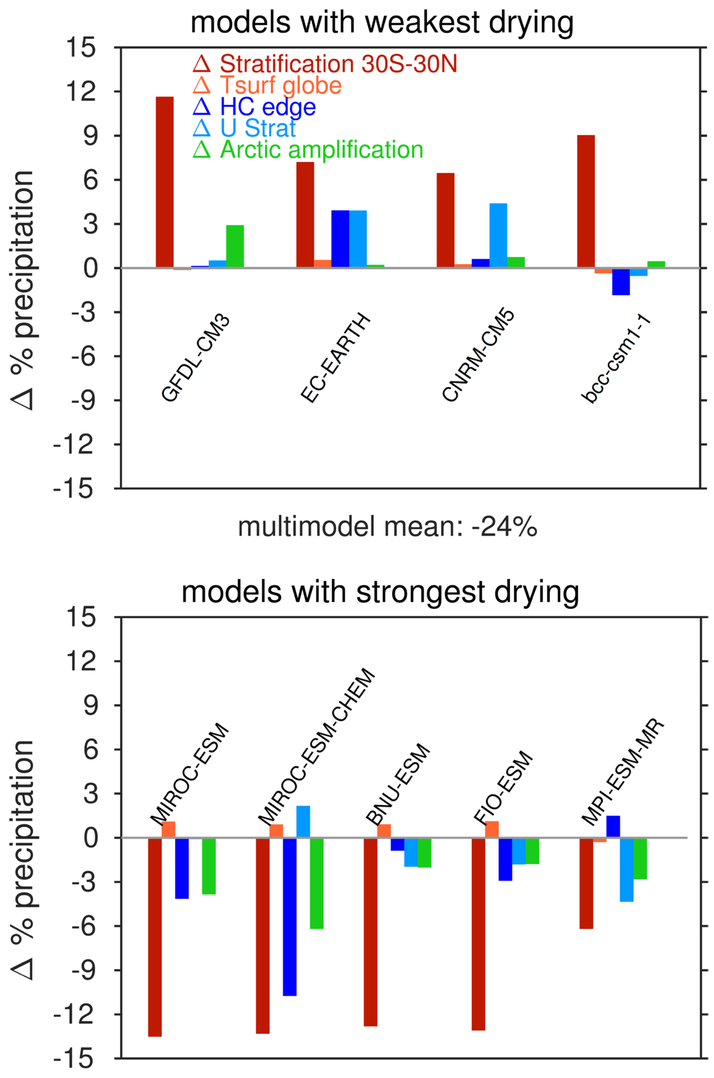
2. Individual correlation of spread in global factors with spread in precip changes

At least 5 different global scale processes have been linked to subtropical drying trends, and here we correlate the change in each of these between 2080-2099 and 2009-2029 in 42 RCP8.5 integrations with the change in precipitation over the same period.



Dots indicate significance after applying a field significance test

4. Over Southern Levant (32N, 35E), changes in vertical stratification are most important for distinguishing models with weak vs. strong drying



●***Vertical stratification*** changes account for 20% change in precipitation as compared to present day values, when comparing models with large projected drying as compared to models with weak projected drying.