Combined influence of snow cover and sea ice on North African/Mediterranean precipitation

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Introduction

Anomalously high seasonal temperatures or low precipitation due to interannual climate variability (see Fig. 1) can decimate agricultural yields and increase the burden on surface and subsurface water resources in the Mediterranean region. This variability and its impact on crops and other resources underscore the need for skillful seasonal prediction of temperature and precipitation. Precipitation around the Mediterranean Basin is significantly influenced by snow cover over northern Eurasia, the North Atlantic Oscillation (NAO), Arctic Oscillation (AO), and the El Niño-Southern Oscillation (ENSO) (Rimbu et al., 2001, Efthymiadiis et al. 2007, Zanchettin et al., 2008). We study these teleconnections and try to understand their mechanisms in order to explore their potential for seasonal forecast of temperature and precipitation in the Mediterranean region.

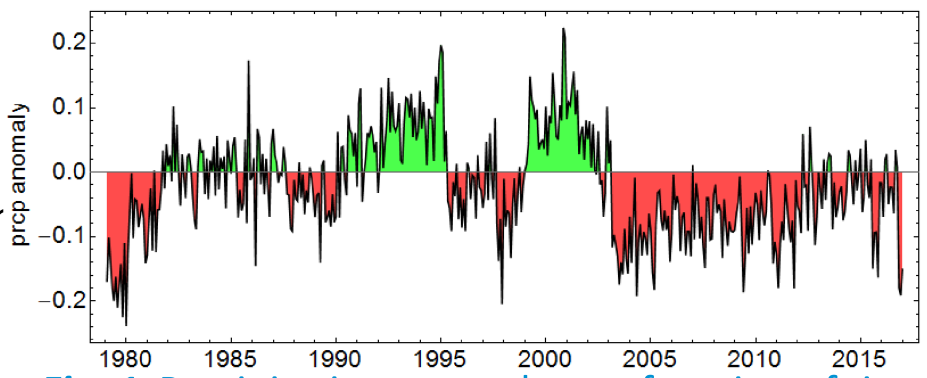
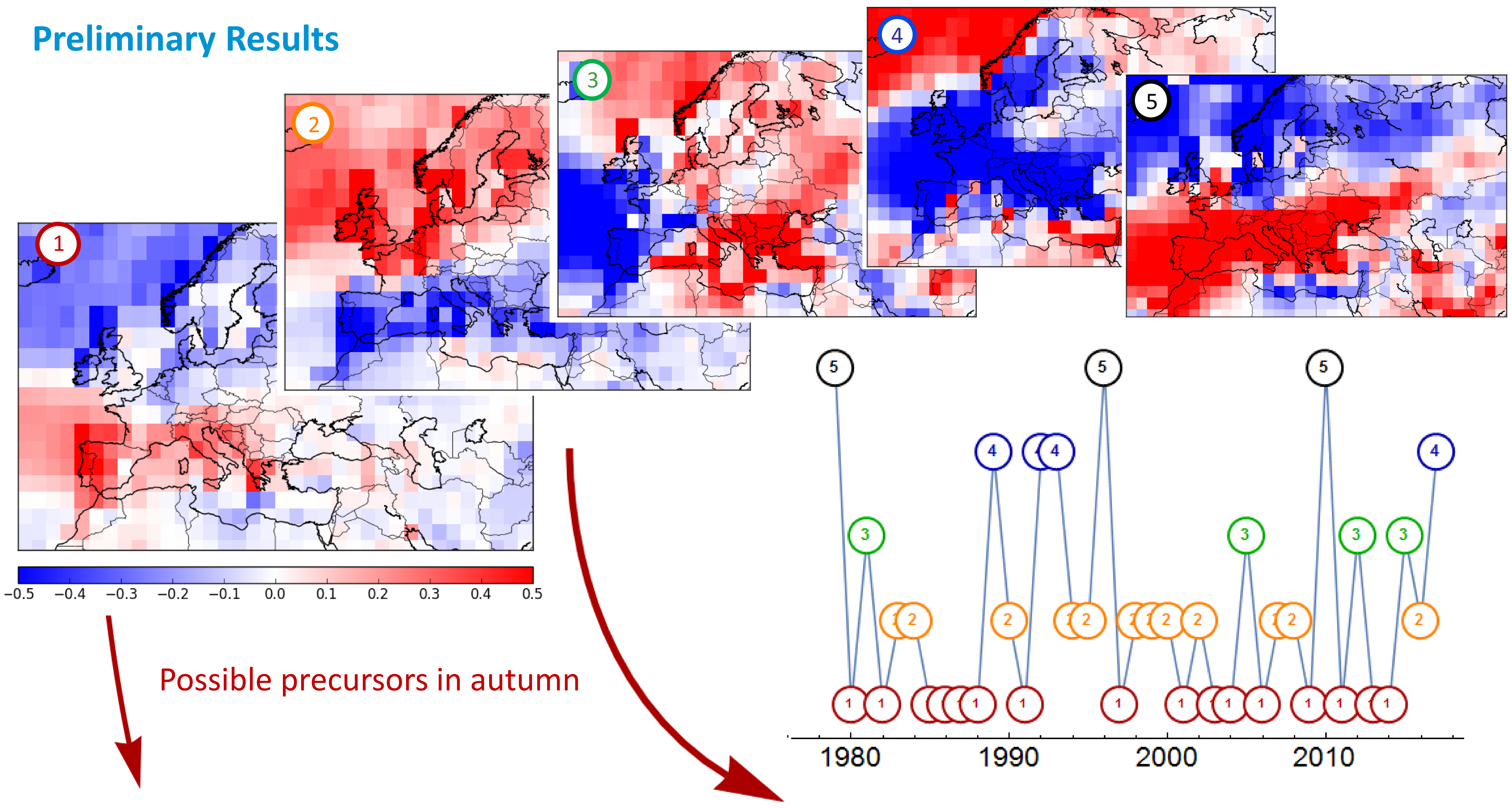


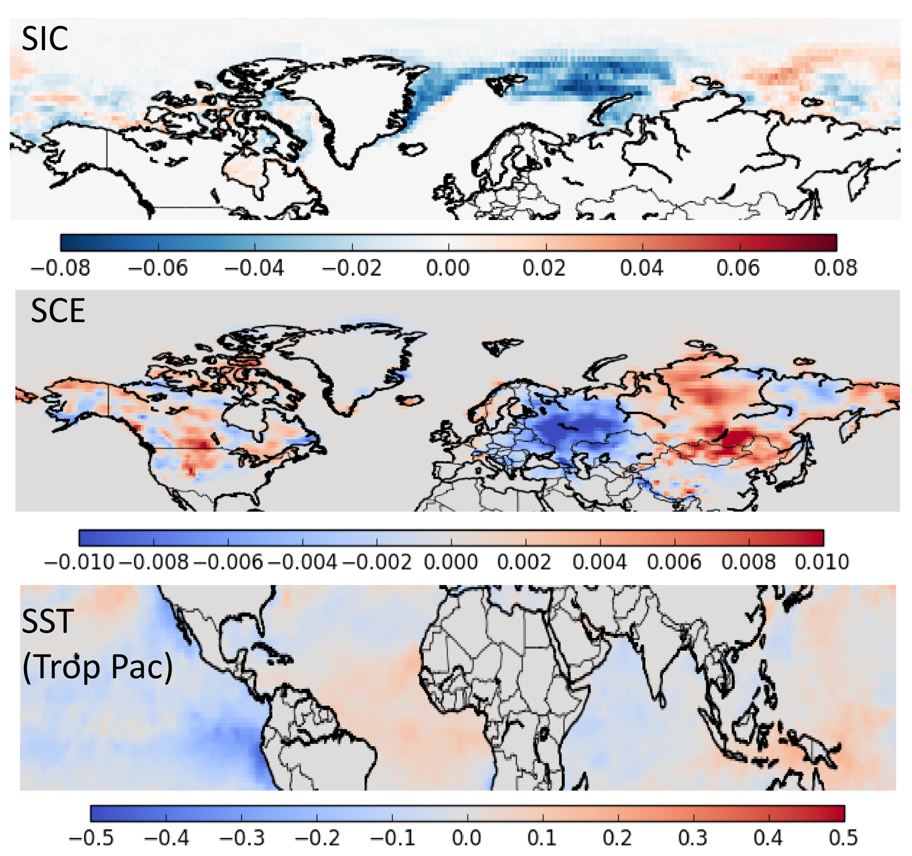
Fig. 1 Precipitation anomaly as a function of time

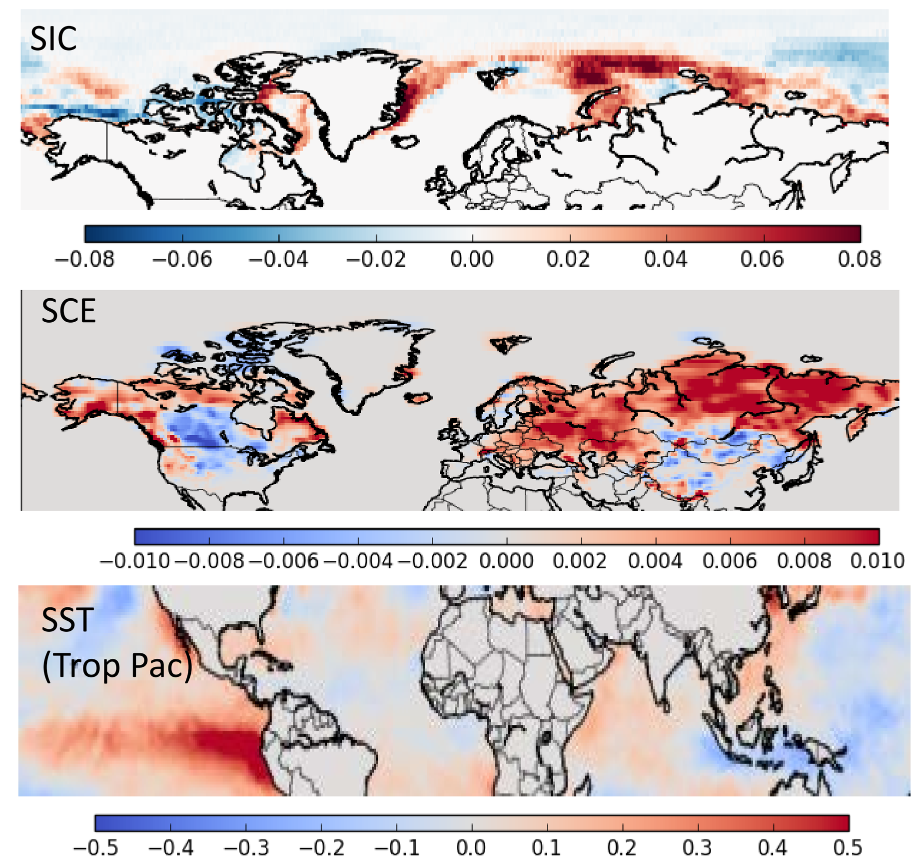
Data & Methods

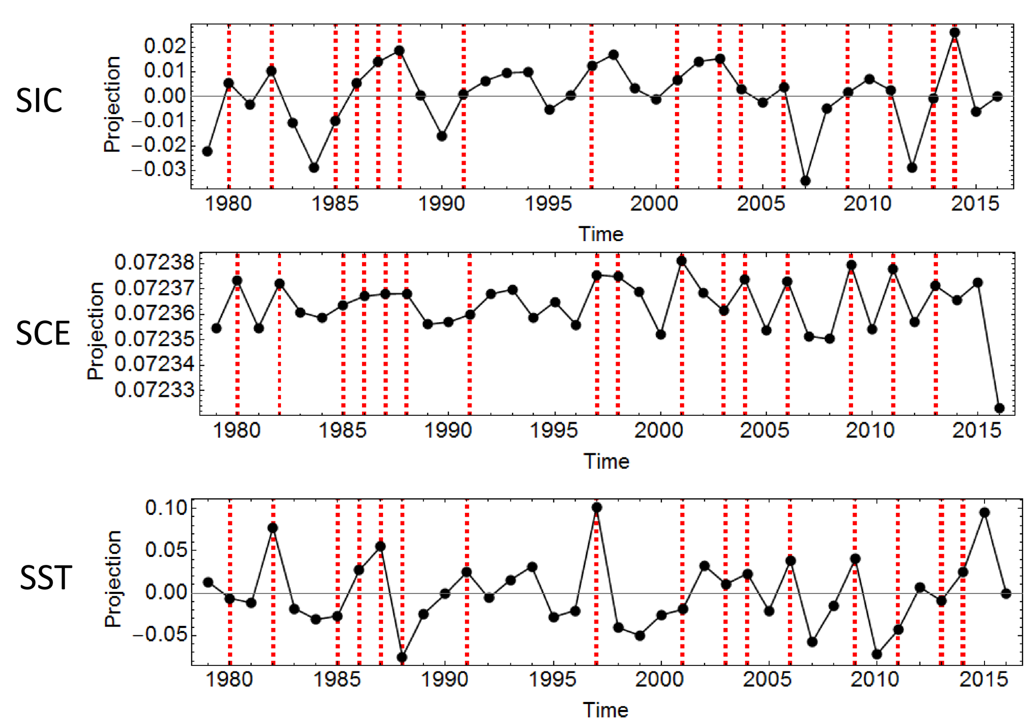
We perform cluster analysis in order to identify dominant patterns of the precipitation in boreal winter using NOAA data. We employ clustering on monthly detrended precipitation anomalies at the Mediterranean region over the period 1979-2016. Using the "elbow"-approach, we derive five relevant clusters. We calculate composites and projections of detrended sea ice concentration anomalies (HadISST), snow cover extent anomalies (NOAA) and sea surface temperature (HadISST) in boreal autumn to find possible precursors of the different clusters.

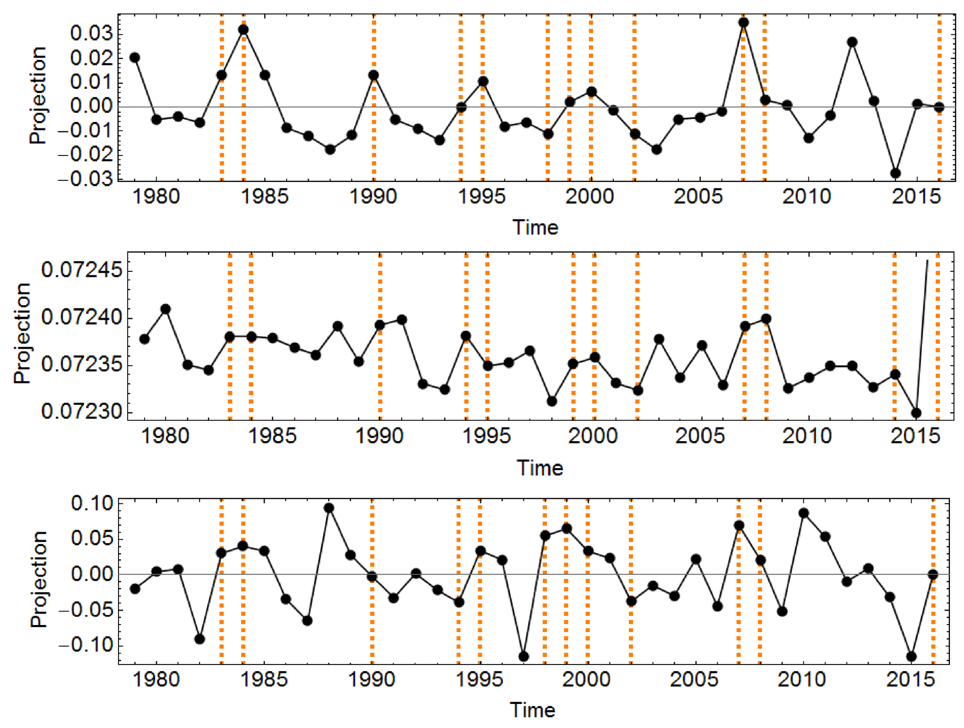
Preliminary Results











Time series and clusters of precipitation

The five clusters of the precipitation can be subdivided into 5 pattern:

(1) Negative NAO pattern
(2) Positive NAO pattern
(3) East-West dipole
(4) North-South pos-neg-pos tripole
(5) North-South neg-pos-neg tripole

The time series reveals that cluster 1 occurs most frequently and that cluster 3 occurs more often in the 21st century than in the last century.

Composites

A positive sea ice content (SIC) anomaly, a positive snow cover extent (SCE) anomaly in mid and south Asia and an El Niño pattern in SST **in autumn** likely lead to a cluster 1 pattern in **winter**. In contrast, a positive SIC, positive SCE in Asia and negative SCE anomaly in South Asia as well as a La Niña pattern in SST in autumn likely lead to a cluster 2 event. For cluster 3 we observe a mixed behavior. For cluster 4 (cluster 5) we notice positive (negative) SIC, negative (positive) SCE anomaly in Eurasia and El Niño (La Niña) pattern in SST (not shown).

Projections

Projections of SIC and SCE onto time series of SIC, SCE anomalies and SST in the tropical Pacific region show that the composites of SIC, SCE and SST could operate as possible precursors. If a cluster event (dashed red lines for composite 1 and dashed orange lines for composite 2) happens, the projection of this composite onto this time event is higher than usually.

Conclusions and Outlook

We have identified five different precipitation pattern using cluster analysis for the time period 1979-2016. Based on composite analysis we show that sea ice content, snow cover extent as well as sea surface temperature in the tropical Pacific region in autumn have the potential to be precursors for cluster 1 and cluster 2. We plan to perform cluster analysis for temperature in the Mediterranean region. Furthermore, we intend to develop and test a statistical empirical prediction scheme for seasonal Mediterranean temperature and precipitation. Moreover, we want to include the influence of the subtropical jet stream into our analysis of precipitation patterns.

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