We appreciate the referee's comments to this manuscript. Below are our general responses, followed by more detailed responses to specific questions raised by the referee.

General Reponses

We fear that the referee has somewhat misunderstood our focus. We'd like to make it clear that we are not trying to evaluate the hypothesis that "the summer climate is modulated by **only** NAO-related precipitation". What we address in this manuscript is rather the existence of a specific climate regime that is modulated by NAO-related precipitation via soil moisture. We estimate that this regime accounts significantly for 5-15% of the total variance of T_{max} and T_{mean} respectively (Fig 1). If the NAO-related precipitation is the only driver for summer climate, precipitation should account for 100% of the total variance of climate fields. This is obviously not the case.

We addressed the relation as the expression of a regime of land-atmosphere coupling. We stated in the paper that "we also note that we are not addressing the full picture of land-atmosphere feedback processes but only that part that is related to Jan.-Mar. precipitation". There are many other modulators, for example, aerosol, radiation, vegetation, etc. These, however, are not included in this paper.

To avoid this misunderstanding, we suggest to change the title to "A summer climate regime modulated by NAO-related precipitation over Europe".

Detailed Reponses

Comment #1

Aren't the descriptions/letters for Fig. 1 in the wrong order or position? If so, it took quite a while to realize about it. It made all the reading more difficult. Actually, the description of Fig. 1 does not seem to match the irrespective references in the text. E.g. Section 3, Subsection 3.1, lines 19 and 20, page 5084: What is referred as Fig. 1d in the text seems to be actually Fig. 1b in the Fig.1 description. Furthermore, apparently Fig. 1 description itself does not match also with the titles ot each respective letter, i.e. Fig. 1b would mean Fig. 1c. Of course, the descriptions are not correct, all the parts Interactive Discussion of the text that refers to this figure are not correct as well. Sorry if the order/positioning is correct and I misunderstood.

Response:

We thank the reviewer for the comment. The referee's comments are correct. We apologize for the erroneous uploading of the figure when submitting this paper. The caption of the figure is correct and consistent with the text. The order should be a, b and c for the left panel, and d, e, f for the right panel. We will replace it with the correct figure in the revised version. We appreciate the referee's careful reading.

Comment #2

Often in the text, latitudes are referred (e.g. "50N", line 2, page 5085; "50N", line 27, same page and other parts of the text). All the reviewers might know where it is, but it would be more clear just to put a latitude scale at the right corner of each figure in each line and a

longitude scale at the bottom of each figure in each column in Figs. 1 and 2;

Response:

Thanks for suggestions. We will put the latitude and longitude scales in the figures.

Comment #3

From line 21, section 3.2 page 5087: "Therefore the responses of scPSDI & Tmin/Tmax to precJFM variability appear to be driven by the same climate dynamics, and precJFM is very likely to influence Tmean and Tmax via soil moisture." As I understood, this statement does not exclude the possibility of another mechanism influence both, JJA Tmax/Tmean and soil moisture index in southern Europe, right? From this, although it's stated in line1, page 5084 that" the CMT technique detects causality" how can exactly, if possible, such a technique shows there is causality?

Response:

From statistics analysis alone, it is impossible to completely exclude exogenous variables. If we analyze the direct relations between temperature and soil moisture, pronounced signals of external forcings of solar energy and remote SSTs exist. It is thus not surprising to find that these external forcings explain most of co-variability of summer temperature and soil moisture.

However, in our analysis the summer temperature and soil moisture are not directly linked to each other but indirectly via precipitation in previous winter. This has largely reduced the influence of other mechanisms. Precipitation is nearly a white noise process with very limited memory; and winter precipitation can not persist into summer solely through its atmospheric memory. When a linkage between winter precipitation and summer climate is observed, the underlying mechanism goes more in the direction of the low frequency-varying land surface processes (Koster et al., *Science*, 2004; Vautard et al., *GRL*, 2007). We have reviewed the literature on this in our paper to provide in that way some circumstantial evidence for our conjectures. Although worries are often raised about the exogenous variables, in reality there doesn't exist over Europe a possible circulation mechanism that can sustain winter precipitation into summer; otherwise atmospheric precipitation would necessarily have to show a long range memory.

Furthermore, in our responses to comments from referee 1, we have further provided statistical evidence to justify: 1) our analysis has excluded the possibility of external mechanisms influencing both winter precipitation and summer temperature; 2) what we have presented are indeed directional influences from winter precipitation to summer climate fields. This statistical evidence will be included in the revised version of our paper.

Disentangling the directions and quantifying the strengths of interactions from statistics is an increasingly active topic from a broader view of science. In our responses to the first referee's comments, we have mentioned some well-established statistical techniques for this purpose. In this literature, the "causality", "directional influences" as well as "feedbacks" are only valid in the statistical sense, and can't be directly interpreted as physical causal chains. We should have avoided this ambiguity in our paper where we deal with application of CMT in

climate space. In the revised version we will address it more cautiously and strictly to avoid the ambiguity.

Comment #4

Qian et al. (2003) is cited in Section 3, subsection 3.3, line 10 page 5088, and Fig4. from this paper showed significant correlations mostly for the UK and rather weak correlations for the "Mediterranean" Europe, which is not consistent with the results presented in this manuscript. Is it related to the applied technique?

Response:

Yes, we think the difference between ours and Qian's results is mainly due to the applied technique. And it is possibly also related to the data length and data preprocessing. Qian et al (*J. Clim*., 2003) performed a correlation analysis for the period 1972-2001, and observed significant values only in the UK. These were suggested to link to atmospheric circulation. Referee 1 to our paper also made correlation analysis for the period 1901-2005, but no correlation was observed in the UK and throughout the Europe.

In our paper, we use an approach fundamentally different from the above correlations, which does not directly link summer temperature to the NAO index. Instead, we are linking the NAO to a persistent climate regime initialized by winter precipitation, and we show that the correlation between this regime and NAO is r=0.65. We address the underlying mechanism of this linkage to be the interaction of soil moisture with temperature, different from Qian's. The spatial pattern we have obtained are consistent with numerical studies of land-atmosphere coupling over Europe, as we cite in our paper (Seniveradne et al., Nature, 2006; Vauturd et al., GRL, 2007; etc).

Comment #5

Does the signal persist throughout the semester, i.e. moving from JFM towards JJA? How can we know that land-atmosphere feedbacks are responsible for persisting the signal until the summer season?

Response:

We cannot infer from these statistics alone whether or not the derived signal can persist into summer via the land-atmosphere feedbacks. Our statistics can only suggest plausible functional relations which also should not be interpreted directly as physics. We stated this as: "there is always a risk to infer physics from statistics". The statistical results must be combined with existing knowledge to obtain an interpretation of the underlying physical reality.

Fortunately, there exists a large body of primary evidence that substantiate our results to land-atmosphere feedbacks. See our response to comment #3. The dynamical linkage between winter/spring precipitation (subsequent soil moisture) and summer temperature/heat waves has actually been well established in numerous publications (e.g., Vautard et al., 2007; Seneviratne et al., 2010; and others we have cited). The specific contribution of our paper is

to address this from an observational perspective and generalize it from published individual years to inter-annual variability.

"Does the signal persist throughout the semester, i.e. moving from JFM towards JJA?"

This is a good question. From both observations and experimental simulations, we can see the final responses to initial states, but the processes in between, for example, when soil moisture becomes effective and what time scale it follows, are still beyond determination. The feedback between soil moisture and atmosphere is generally thought to be nonstationary (time-varying) and only to occur in the warm season, but to date no observational or numerical evidence is reported for Europe. We are actively working on this, and our primary result appears to support this hypothesis. Significant linkage between winter precipitation and summer temperature is found here; however, soil moisture is pretty much inactive in the early stage of this linkage. This might indicate a triggering mechanism of soil moisture, whereby precipitation "prepares" moisture states in the early stage until there is sufficient energy for evaporation for soil moisture to become active in partitioning available energy into sensible and latent parts. So, while we do not explicitly know how the signal moves from JFM towards JJA, we expect it to include a quiet stage and an active stage. This subject is however the subject of another paper in preparation.