SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2021
Project Title:	Towards operational attribution of predicted signals in sub-seasonal forecasts
Computer Project Account:	spfikarp
Principal Investigator(s):	Dr. Alexey Karpechko
Affiliation:	Finnish Meteorological Institute (FMI)
Name of ECMWF scientist(s) collaborating to the project (if applicable)	Dr. Inna Polichtchouk
Start date of the project:	1.1.2021
Expected end date:	31.12.2021

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	n/a	n/a	10,900,000	635,299
Data storage capacity	(Gbytes)	n/a	n/a	21,715	441

Summary of project objectives (10 lines max)

This project aims to investigate sources of predicted signals in sub-seasonal forecasts for Europe and to test feasibility of detecting such sources in operational forecasting. To this end, we aim to perform a set of relaxation experiments towards selected ensemble members of the control forecasts that exhibit pronounced signals in the stratosphere and/or the Tropics - regions of the atmosphere known for their extended predictability. The experiments will allow quantifying strength of the signal associated with these sources, and, potentially, signal attribution. The rationale behind our approach is the assumption that the knowledge of sources of forecasted signals can help operational forecast users in their applications.…….

Summary of problems encountered (10 lines max)

The largest problem was that I had to learn how to run ECMWF model remotely because, due to COVID-19 pandemic, a planned visit to ECMWF was not possible. However, thanks to commitments of my ECMWF collaborator and very efficient technical support, most technical problems were quickly solved.…...

Summary of plans for the continuation of the project (10 lines max)

So far, only the role of the stratosphere in predictability of two events was studied (see summary of results); therefore the plan for the continuation of the project is to analyse other case studies as well as to analyse the role of the tropics in the predictability……..……

List of publications/reports from the project with complete references

No publications have been written so far.

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Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

So far only two cases were studied: February 2018 (forecast initiated in 1.02.2018) and January 2012 (forecast initiated in 13.1.2012). During both periods, large cold air outbreaks occurred over Eurasia. Both cold air outbreak episodes were preceded by a weakening of the stratospheric polar vortex with respect to its climatological state. In case of February 2018, vortex weakening culminated in a major sudden stratospheric warming. In January 2012 only a minor stratospheric warming took place. For both cases a control ensemble forecast of 2-metre temperature was compared to an ensemble in which relative vorticity and air temperature in the stratosphere above 70 hPa were nudged towards observed values. In both cases the predicted 2-metre Eurasian temperatures were colder by about 2K in the period following vortex weakening in the nudged

ensembles in comparison to the respective control forecasts. While the result for 2018 is not novel (a similar result was published by Kautz et al. (2020), to the best of our knowledge, linking the minor stratospheric warming 2012 to surface cooling has not been reported before.
Two more experiments were done for 2018. In these experiments the stratosphere was nudged towards different ensemble members from the control forecast: one member that predicted a weakening of the stratospheric vortex (albeit with a weaker magnitude than what was observed) and another member that predicted a stronger stratospheric vortex (near-climatological vortex during the first half of February, and a stronger than normal vortex towards the end of February). The ensemble nudged towards the strong polar vortex member predicted a warmer 2-metre temperatures across Eurasia (about 1K warmer than the control forecast), consistent with expectations. On the other hand, the ensemble nudged towards the weak polar vortex member predicted a similar 2-metre surface temperatures evolution over Eurasia as the strong polar vortex ensemble, despite different stratospheric evolution. A possible interpretation of this result is that the stratospheric forcing in this case was insufficient to overcome strong tropospheric variability unrelated to downward stratosphere-troposphere coupling.