Arctic influence on the predictability of the cold surge occurred in China during January 2016

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1. Introduction

An extreme cold event occurred during 21-25 January 2016, which affected most areas in China, especially eastern China (Fig. 1).

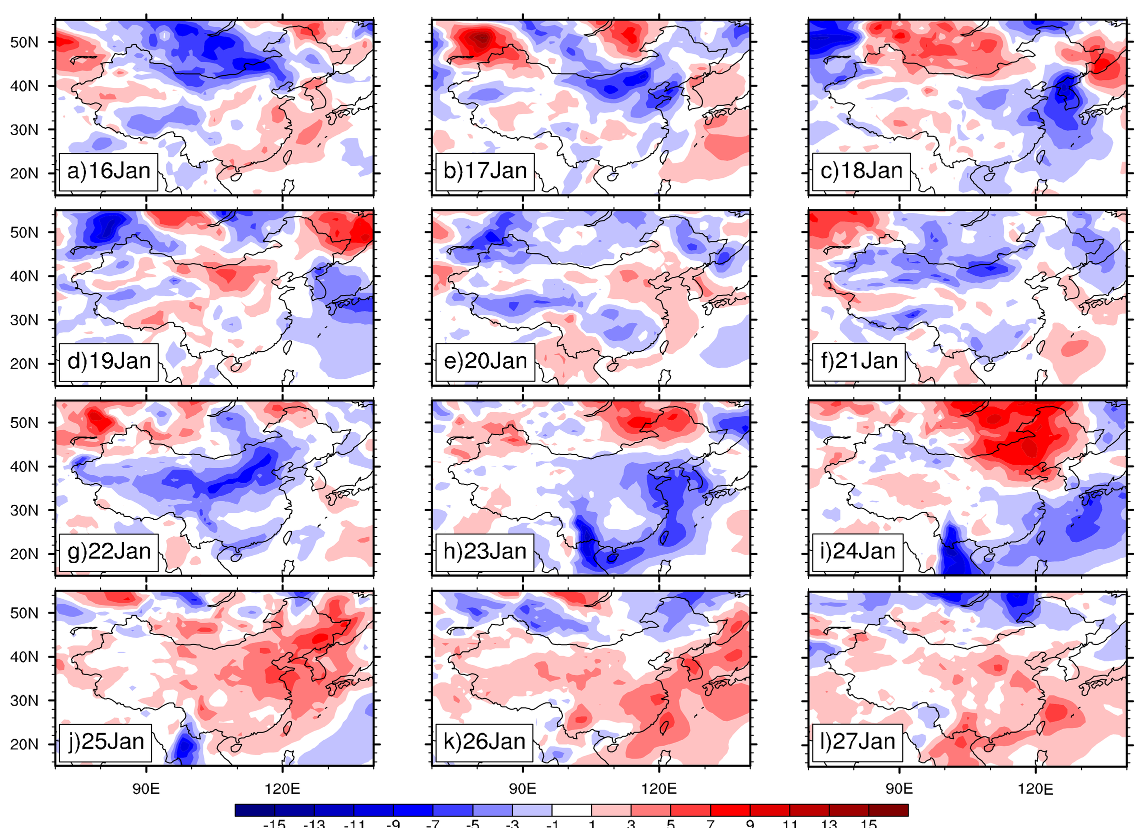

Figure 1 Daily 24-hour surface air temperature change in January 2016. 16 Jan. represents the temperature change from 15 Jan. to 16 Jan. Units: K.

2. Data and model

- ERA-Interim (Dee et al. 2011) and ERA5 (Hersbach and Dee, 2016) reanalysis data from ECMWF are used as both initial conditions and verification
- The numerical model used in this investigation is OpenIFS from ECMWF, which is the same as IFS Cycle 40r1 but without data assimilation module. The model is a global spectral model with a truncation of 511 and 137 model levels in vertical.

3. Results

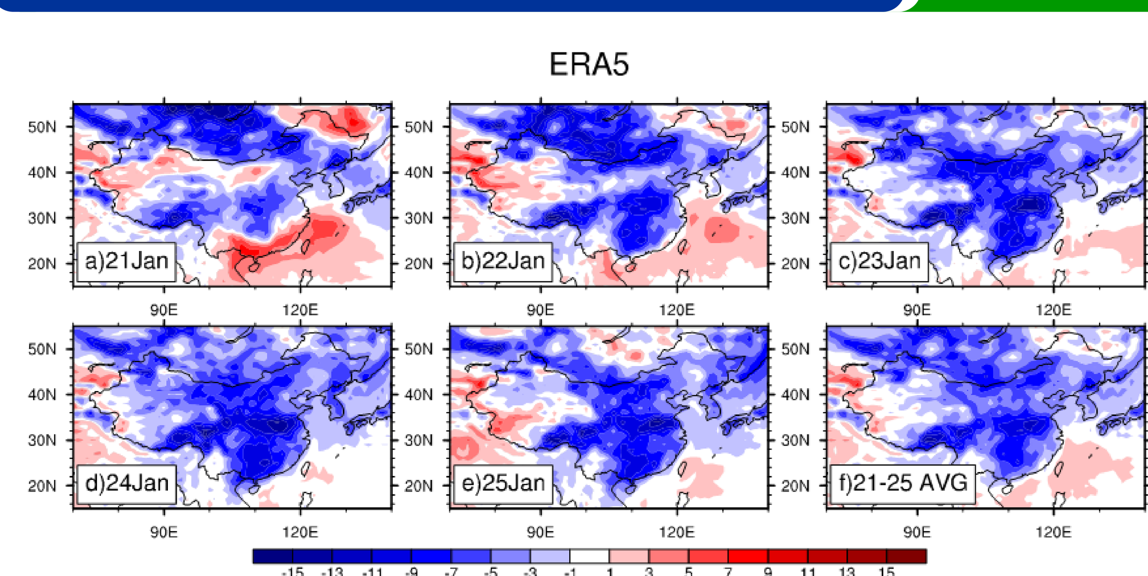

Figure 2 Forecasted daily surface air temperature anomalies during 21-25 January 2016 started from 12 January derived by ERA5 run. Units: K. The climatology is defined as 1979-2015 average from ERA-Interim reanalysis.

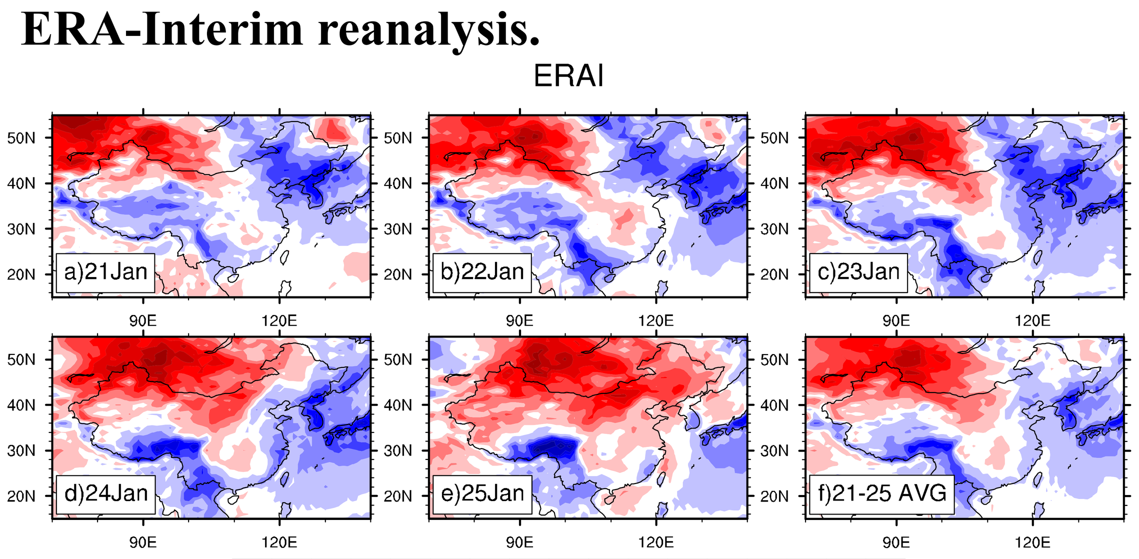

Figure 3 As in Fig. 2, but for ERAI run.

The OIFS can simulate the SAT decline during 21-25 January with ERA5 initial conditions starting on 12 January. But it cannot simulate an obvious cooling with ERAI initial conditions (Fig. 2 and 3).

The main difference between ERA5 and ERAI initial conditions locates in Arctic, especially in troposphere (Fig. 4 and 5).

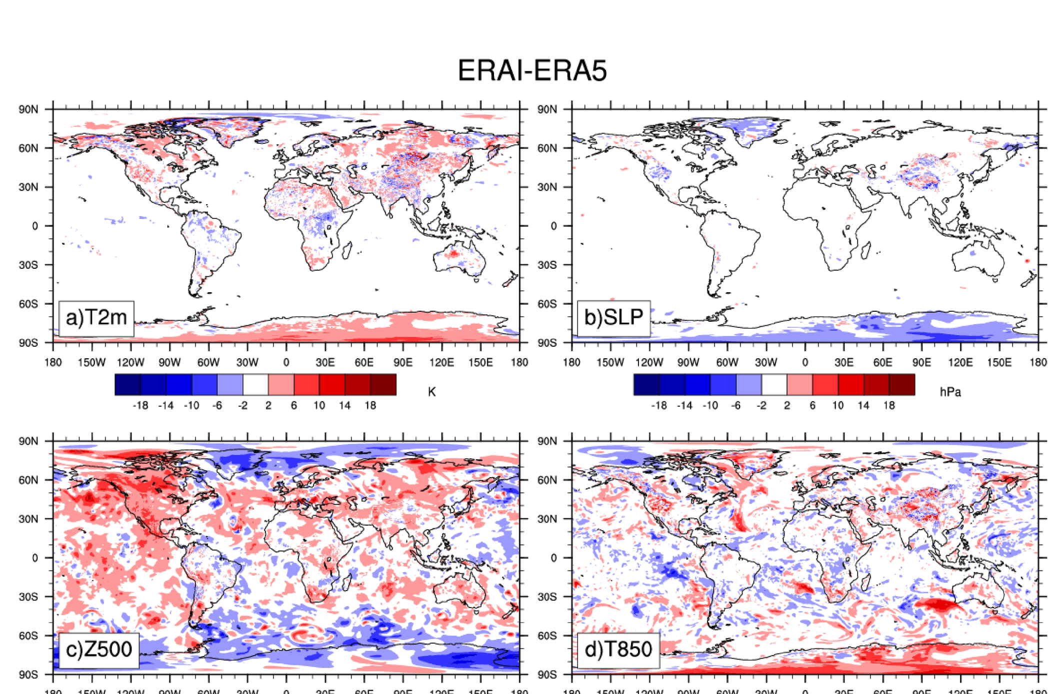

Figure 4 Differences in initial conditions between ERAI and ERA5 (ERAI minus ERA5) on 12 January. (a) for surface air temperature (units: K), (b) for sea level pressure (units: hPa), (c) for geopotential height at 500 hPa and (units: gpm) (d) for temperature at 850 hPa (units: K).

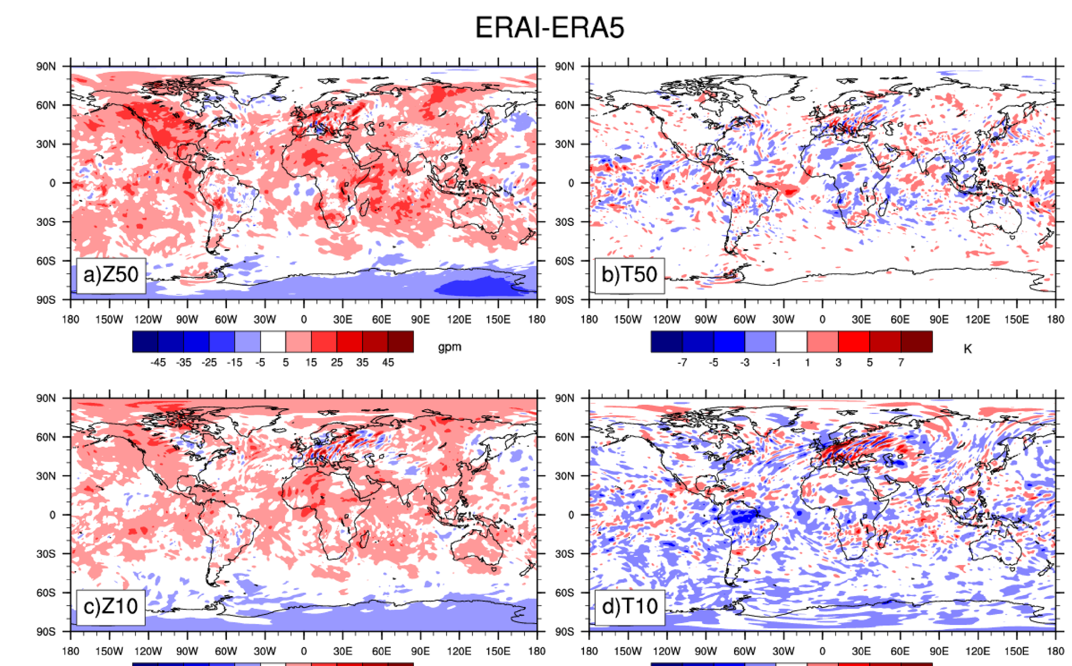

Figure 5 As in Fig. 4, but for (a) geopotential height differences at 50 hPa (units: gpm), (b) temperature difference at 50 hPa (units: K), (c) geopotential height differences at 10 hPa (units: gpm) and (d) temperature difference at 10 hPa (units: K).

Taking the ERA5 initial conditions as the reference state and removing the analysis error from ERAI initial conditions, the OIFS can simulate the cooling in China but with small amplitude (Fig. 6).

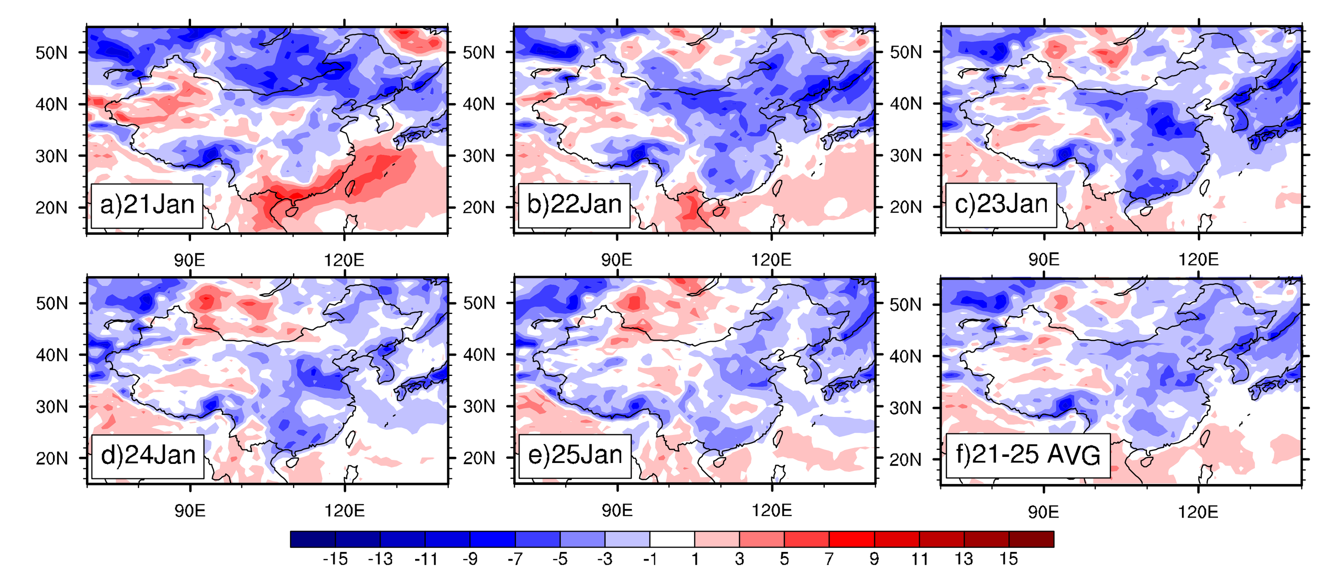

Figure 6 As in Fig. 2, but for hybrid run.

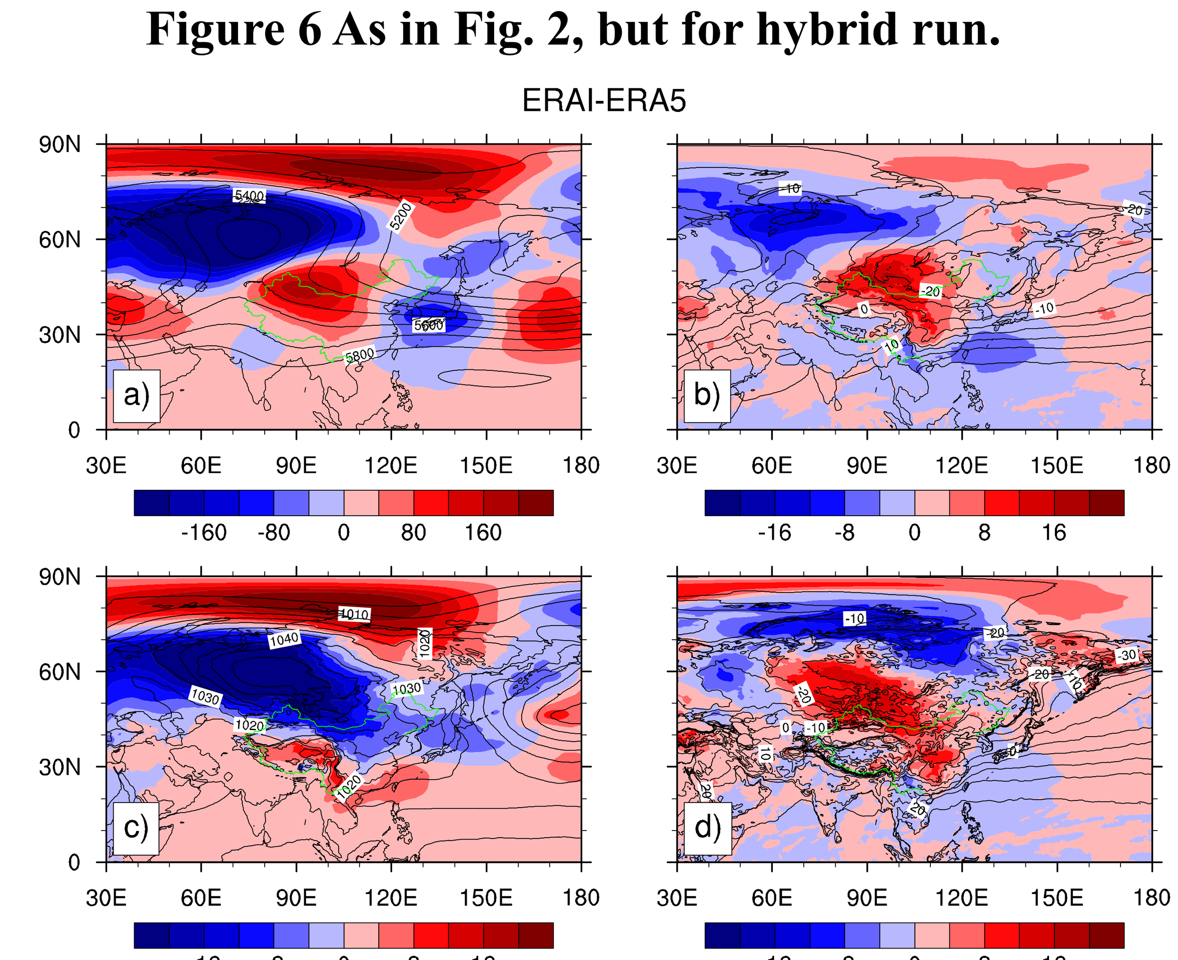

Figure 7 The average atmospheric circulations during 21-25 January derived by ERA5 run (contour) and the forecast differences between ERAI run and ERA5 run (shading, ERAI run minus ERA5 run). (a) for geopotential height at 500 hPa (units: gpm, CI = 100 gpm), (b) for temperature at 850 hPa (units: K, CI = 5 K), (c) for sea level pressure (units: hPa, CI = 5 hPa) and (d) for surface air temperature (units: K, CI = 5 K).

The OIFS could have a better simulation of the Ural blocking at 500 hPa, cold air intensity at 850 hPa and Siberian High at surface which are critical for cold surge prediction with a more accurate description of Arctic initial conditions (Fig. 7 and 8).

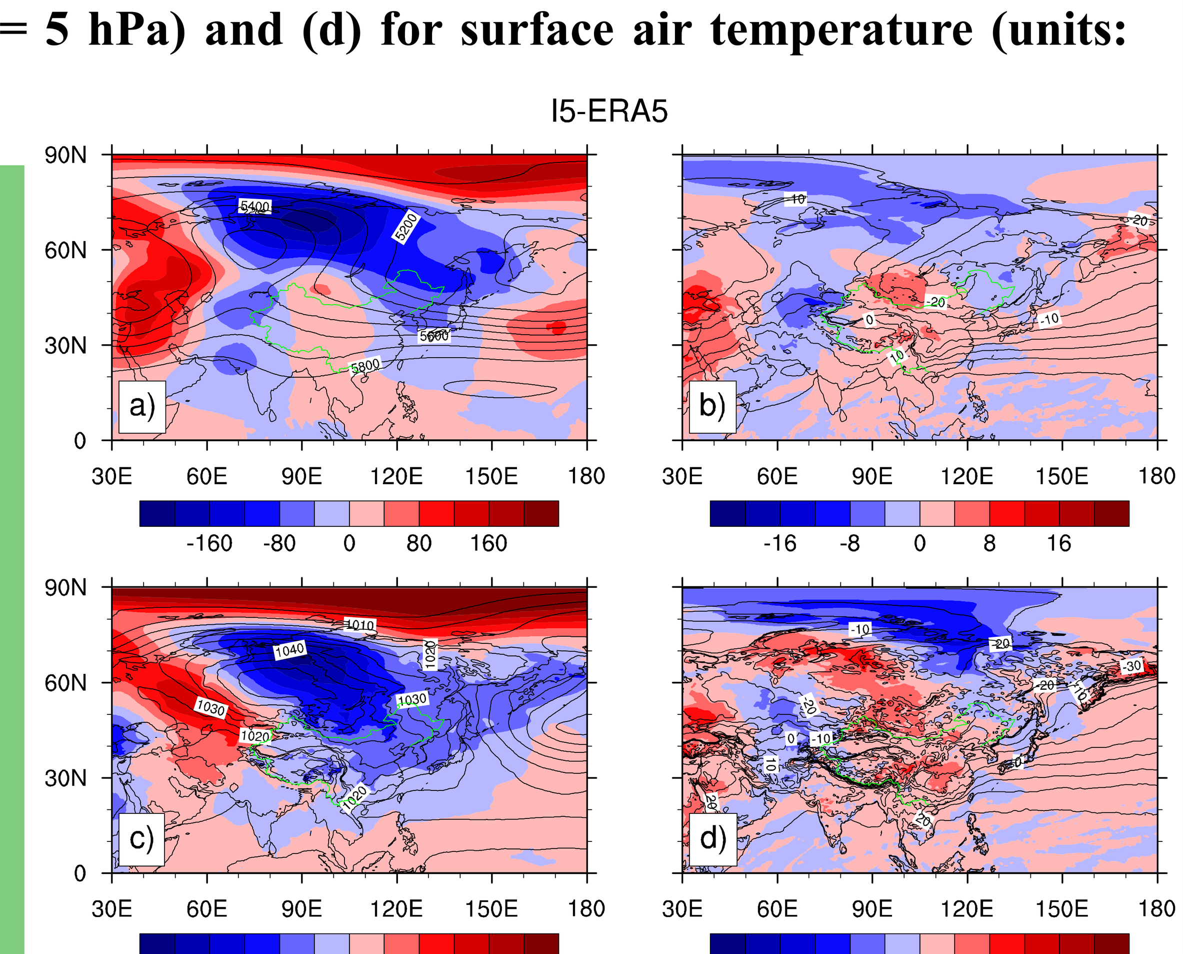

Figure 8 As in Fig. 7, but the shading are the differences between hybrid run and ERA5 run (hybrid run minus ERA5 run).

4. Summary

- OIFS can predict the cold surge occurred in China during January 2016 two weeks in advance.
- Simulation with ERA5 initial conditions can capture the cooling, however simulation with ERAI cannot, which highlights the importance of initial condition in cold surge prediction.
- Differences between ERAI and ERA5 mainly locates in high latitude, especially in troposphere. OIFS can recapture the cooling with a more accurate initial conditions in Arctic.