Predicting Sudden Stratospheric Warming 2018 and its climate impacts with S2S models

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Many SSWs are followed by anomalies in surface weather lasting for up to two months:

- Negative phase of the North Atlantic Oscillation
- Cold spells across northern Eurasia and eastern US
- Precipitation anomalies over Atlantic and western Europe

SSWs provide source of enhanced subseasonal predictability
Sudden Stratospheric Warming 2018

60°N Zonal Mean Zonal Wind
10 hPa MERRA2

1979-2018 mean

2017/2018
Europe Was Colder Than the North Pole This Week. How Could That Be?

By Kendra Pierre-Louis

March 1, 2018

A gondolier cleared snow this week in Venice. Manuel Silvestri/Reuters

Subfreezing temperatures have spread across the past week, stretching from Poland to Spain.

The main airport in Geneva was closed for several hours on Thursday. Hundreds of flights were canceled across Europe. Martial Trezzini/Keystone, via Associated Press

Europe's weather usually approaches from the Atlantic, to the west,
SSW predictions of SSW 2018

- SSW occurred on 12 February 2018
- Earliest ensemble mean forecasts by some models from 30-31 January (lead time 12-13 days)
- Forecasts from 1 February (lead time 11 days): predicted SSW probability by S2S models (151 members in total) is ~0.3
- Forecasts from 8 February (lead time 4 days): predicted SSW probability by S2S models (151 members in total) is 1.0
SSWs predictability in ECMWF system

SSW predictability averaged across 6 past SSWs with strong tropospheric impacts

SSW probability

 días 7-0: Deterministic limit
días 13-7: Fast increase in predictability
días 32-13: Slow increase in predictability

Karpechko, 2018, MWR
Wind forecasts from 1 February strongly correlate with eddy heat flux forecasts across ensemble members ($r=0.94$) which is underestimated by most members (see also Taguchi 2016).

Forecasts from 8 February correctly predicted the magnitude of the heat flux. Consequently, SSW was also well predicted.
Tropospheric forcing of SSW 2018

- SLP anomaly field averaged over 1-11 February in reanalysis and forecast from 1 February shows several anomalous anticyclones
- Anticyclones, in particular over northern Europe, are often associated with SSW forcing (e.g., Martius et al. 2009; Woollings et al. 2010)
- For the SSW 2018, errors in the forecasted location of the high over Ural strongly correlate with the errors in stratospheric winds

The subgroup of forecast ensemble members from 1 February with best forecasts of the Ural high predicts stronger eddy heat flux to the stratosphere; it also predicts an SSW.
Downward propagation

- Strat.-trop. coupling of Northern Annular Mode (NAM) anomalies was not forecast from 1.02 but was forecast from 8.02
- In both 1.02 and 8.02 forecasts, ensemble means predicted a negative NAM in the troposphere continuing into early March, as observed, with ~70% members forecasting NAM signal into week 3.
Predicting cold spell 2018

Forecast 8.02  Forecast 1.02  Reanalysis 15.02-15.03

- Long duration of the cold signal is captured well but the magnitude of the signal is underestimated
The 2018 SSW was predicted by some models at lead times 12-13 days

- not unusual when compared to previous events

The predictability of the 2018 SSW was limited by errors in the forecasted location of weather system (Ural high) and underestimated magnitude of the stratospheric wave forcing

Cold period was captured at lead times 3-4 weeks qualitatively, but not its magnitude

Stratosphere has likely played a role in extended predictability in Feb-Mar 2018