



Seasonal Prediction Skill of Northern Extra-tropical Surface Temperature Driven by the Stratosphere

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Correlation skill of seasonal mean temperature, DJF



Correlation skill of DJF 2m temperature from GFDL FLOR hindcasts (1981-2014).

• Large skill over tropics; limited skill over extra-tropics

Correlation skill of seasonal mean temperature, MAM



Correlation skill of MAM 2m temperature from FLOR hindcasts.

• Large skill over tropics; limited skill over extra-tropics

Source of seasonal predictability



Cold Episode Relationships December - February Impacts related to El Niño and La Niña in DJF. <u>images</u> <u>courtesy NWS/NCEP Climate</u> <u>Prediction Center</u>

Source of extra-tropical seasonal predictability



Persistence timescales of geopotential height anomalies over extra-tropics(20-90N). *Kidston et al, 2015*

Motivation

- Can the extra-tropical stratosphere influence seasonal prediction of surface climate?
- How does the stratosphere influence surface climate?

Model and experiments

- **GFDL FLOR** (forecast-oriented low ocean resolution)
 - Coupled AOGCM
 - ~50km atmos/land; ~100km ocean/ice
 - > 32 vertical levels in the atmosphere (top level: 1hPa)
 - contributing to NMME real-time seasonal predictions
- FLOR constrained simulations (5 members)
 - SSTonly: SSTs are relaxed to HadISST.
 - SST+Strat: SSTs are relaxed to HadISST; temperature, horizontal winds (100hPa above) are relaxed to MERRA.
 - from 1980s to present.

Bias of zonal wind averaged over 60-90N



SSTonly

SST+Strat

Climatological bias of zonal mean U averaged over 60-90N.

Predictability from the stratosphere



Correlation of MAM 2m T in FLOR simulations

FLOR retrospective forecasts

- atmospheric/land initial conditions
 - **SST-forcedAIC**: AM2.5 forced by observed SST.
 - ObsSIC: stratospheric (100hPa above) U,V,T relaxed to MERRA.
 - ObsAIC: atmospheric (entire column) U, V, T and surface pressure relaxed to MERRA.
- oceanic initial conditions from data assimilation (ECDA)
- Prescribed time-varying radiative forcing

ObsSIC - SST-forcedAIC = influence from Strat. ObsAIC - SST-forcedAIC = influence from Atmos.

Skillful prediction due to the stratosphere



Corr. of MAM (IC=Mar.) 2m T in FLOR hindcasts

Skillful prediction due to the entire atmos.



Corr. of MAM (IC=Mar.) 2m T in FLOR hindcasts

Stratosphere influence via AO-like pattern



Predictable pattern of SLP & regression of T

Connection between stratospheric PV and SLP



Scatter plot between PVI in MERRA and SLP of the AO pattern PVI: 50-hPa zonal mean U averaged over 60-90N)

Connection between PV and SLP



Composite of zonal mean U difference between 5 strongest/weakest PV years.

Summary

- Skillful seasonal prediction of MAM 2m temperature over northern Eurasia driven by the stratosphere.
- The stratosphere influence surface climate through its influence on circulation (i.e., AO).
- Connections between PVI and SLP.

Extra slides

• Reference:

Liwei Jia and co-authors, 2017, <u>Seasonal Prediction Skill of</u> <u>Northern Extratropical Surface Temperature Driven by the</u> <u>Stratosphere</u>, *Journal of Climate*, <u>https://doi.org/10.1175/JCLI-D-</u> <u>16-0475.1</u>





Influence of the stratosphere on troposphere



Composite of zonal mean U difference between 5 strongest/weakest PVI years in March (PVI: 50-hPa zonal mean U averaged over 60-90N).

1st predictable pattern of SLP, and regression of T



Polar vortex in MERRA vs.ObsSIC



Composite of T in strong vs.weak PVI years in JFM

