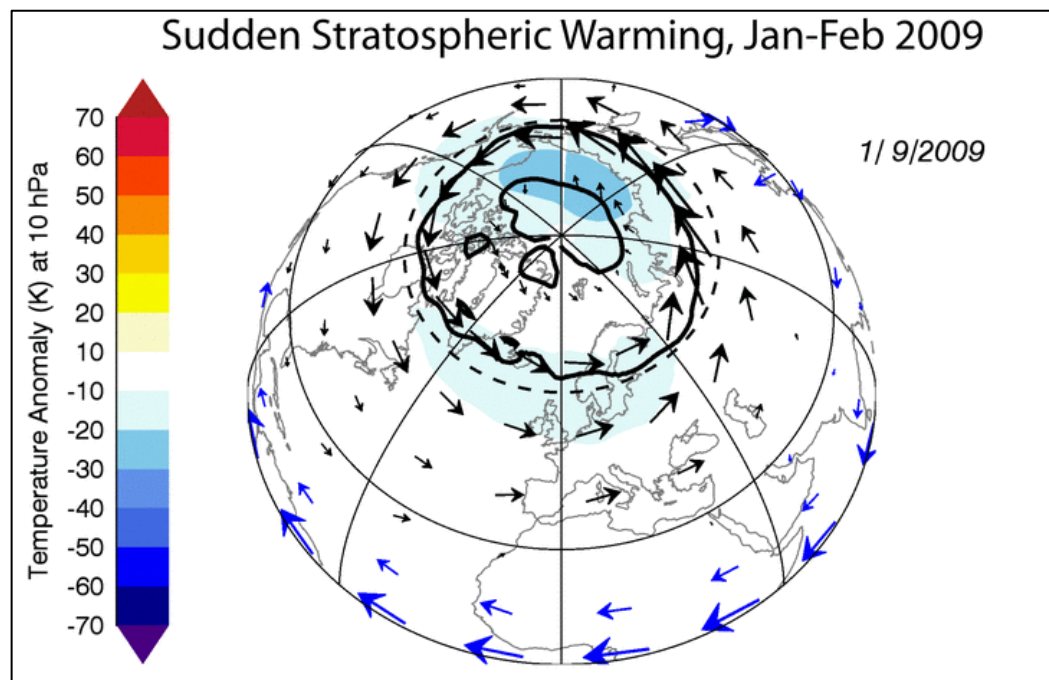


What is a Sudden Stratospheric Warming (SSW)?



- Rapid warming (>30-40 K) of stratosphere in only a few days
- For major events, a complete reversal of polar vortex winds
- Occur approximately every other winter in Northern Hemisphere, but occasionally in Southern Hemisphere

Butler et al. 2015, BAMS

CSD will lead efforts to: (a) create a historical SSW atlas; (b) update the standard SSW definition based on international community feedback

Why do we care?

SSWs

Winter Weather

Improved Seasonal Prediction

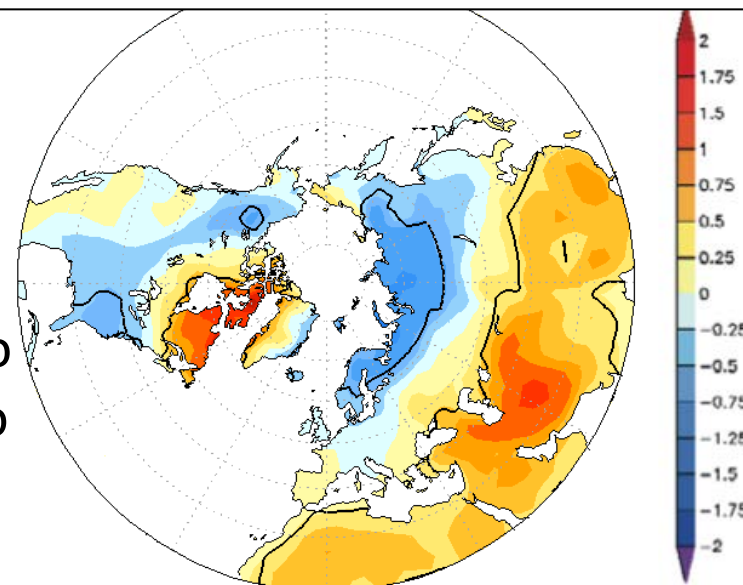
Ozone/
Stratospheric Transport

Much more...



- Anomalies descend from stratosphere into troposphere in days to weeks
- Associated with extreme cold outbreaks over Eurasia and eastern USA

Temperature anomalies averaged 60 days after SSWs



Butler, Polvani, Deser 2014, ERL

Why do we care?

SSWs

Winter Weather

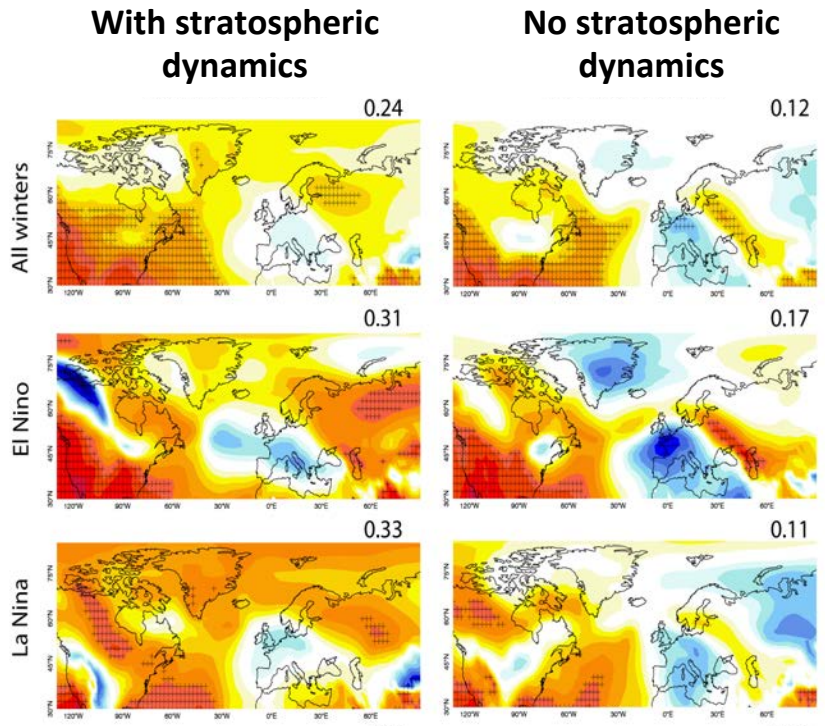
Improved Seasonal Prediction

Ozone/Stratospheric Transport

Much more...

Stratosphere-troposphere coupling is one of the most promising sources of remaining predictability
(NAS, 2010)

But many models do not accurately simulate SSWs and their coupling to the surface



Skill of mean sea level pressure anomalies in international suite of operational forecasting models *(Butler et al., in prep)*

Why do we care?

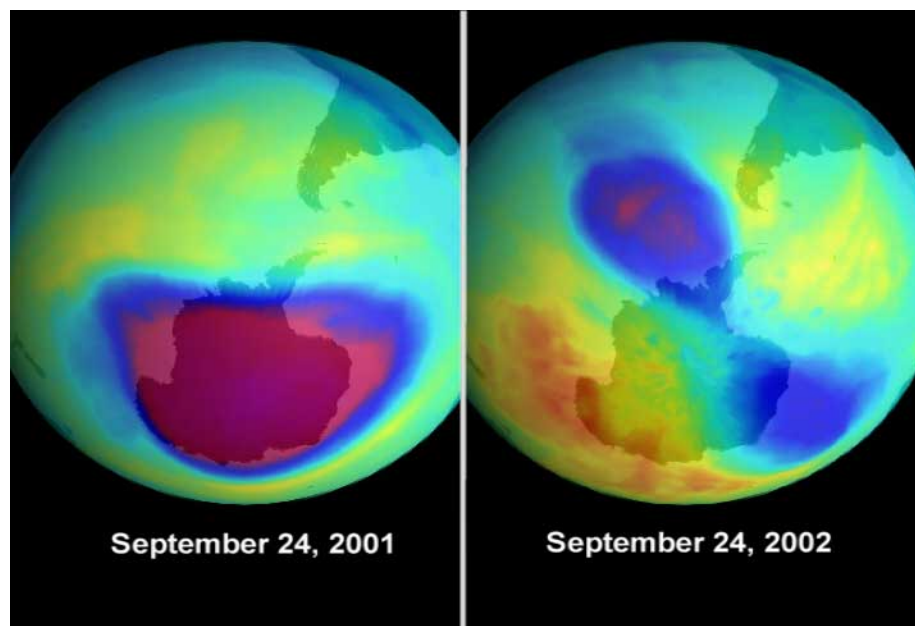
SSWs

Winter
Weather

Improved
Seasonal
Prediction

Ozone/
Stratospheric
Transport

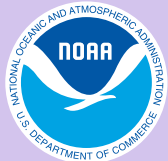
Much more...



NASA

A rare SSW in the Southern Hemisphere nearly eliminated the ozone hole in 2002

SSWs also impact Northern Hemisphere ozone and UV radiation



Climatology of stratospheric warmings



Why do we care?

SSWs

Winter
Weather

Improved
Seasonal
Prediction

Ozone/
Stratospheric
Transport

Much more...

Tropospheric
transport of CO₂
and pollutants

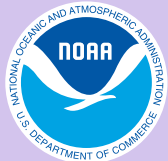
Polar clouds

Tropical
convection and
water vapor

El Niño- Southern
Oscillation
teleconnections

Breakdown and
reformation of
stratopause

Decadal variability in the
North Atlantic Ocean
circulation

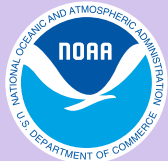


The SSW Atlas: a new database

Funded by NOAA CPO (Climate Observations and Monitoring)

Collaborative effort with NOAA Air Resources Laboratory (Dian Seidel)

- **Goal #1:** Evaluate and update current “standard” definition for SSWs as defined by the World Meteorological Organization in the 1970s
 - ❖ *Partnerships: New York University, University of Oxford, Met Office Hadley Centre, Colorado State University, Cornell University, SPARC, WMO*
 - ❖ *Butler et al. 2015, BAMS*
- **Goal #2:** Develop a stratosphere-troposphere coupling index and consider how extreme events in the stratosphere are related to extremes at the surface
- **Goal #3:** Create a comprehensive multi-decadal dataset of sudden warmings in the historical record, available publicly, using multiple reanalysis and satellite products

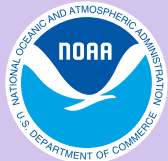


Climatology of stratospheric warmings



The SSW Atlas: a new database

METRICS		
Level of maximum warming	Downward descent of anomalies	Strength of coupling to troposphere
Level of wind reversal	Location of downward descent	# of extreme cold/warm days after event
Amplitude of max warming	Time series of wavenumbers 1 and 2	# of extreme precipitation days after event
Amplitude of minimum zonal wind	Type of event (split vs displacement)	# of days with extreme NAO values after events
Lag between maximum warming and minimum zonal wind	Heat and momentum flux changes before and after event	QBO/ENSO phase during event
Rate of temperature increase	Location of warming as a function of altitude	Maps of impacts 60 days following event
Rate of wind deceleration	Time series of warming	



Expected Achievements

- Provide product which allows user access to metrics, plots, and surface impacts of individual historic SSW events
 - ❖ *Database archived by National Climatic Data Center*
 - ❖ *Available publicly at ESRL/CSD website*
- Database can be used for model evaluation and improvement
- Improved understanding of stratosphere-troposphere coupling and relation to surface extremes
- International community effort underway through SPARC/WMO to re-evaluate and update standard SSW definition, for improved consistency in research and operations