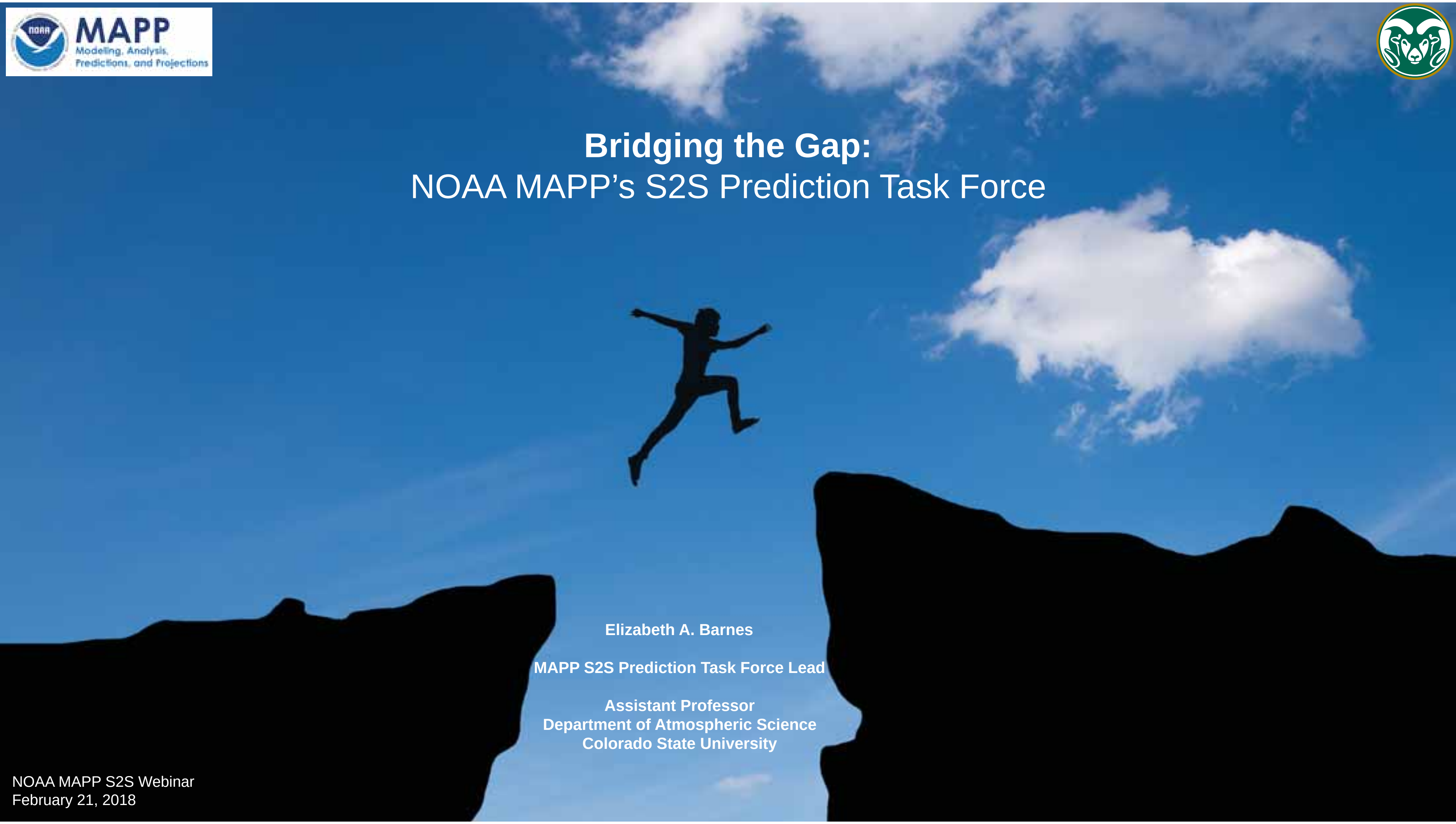


Bridging the Gap:
NOAA MAPP's S2S Prediction Task Force

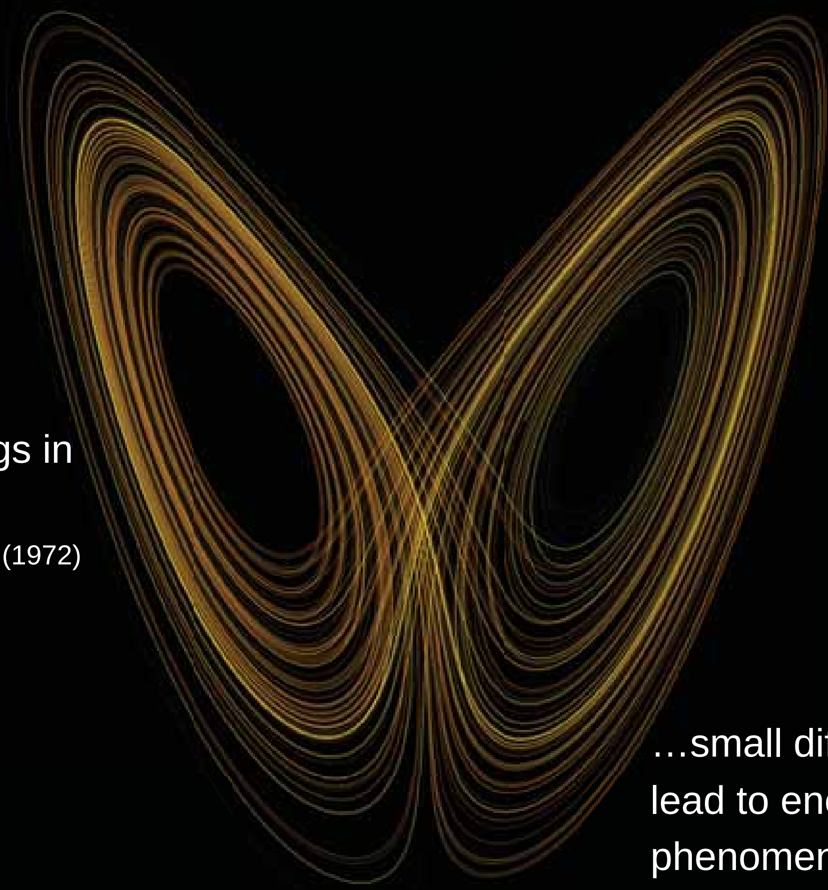
Elizabeth A. Barnes

MAPP S2S Prediction Task Force Lead

Assistant Professor
Department of Atmospheric Science
Colorado State University

NOAA MAPP S2S Webinar
February 21, 2018

BUTTERFLY EFFECT



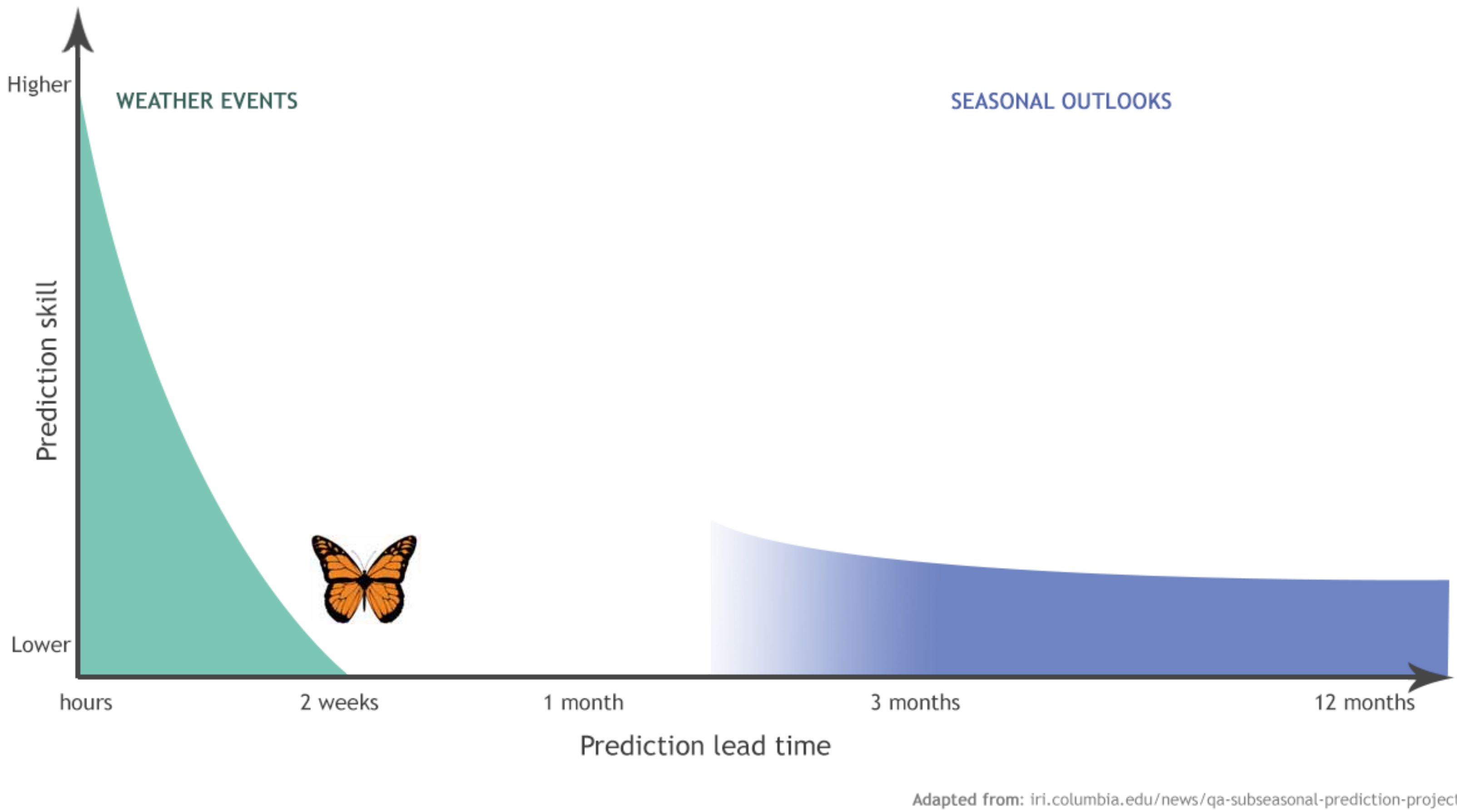
When the flap of a butterfly's wings in Brazil sets off a tornado in Texas.

- Edward Lorenz (1972)

…small differences in the initial positions may lead to enormous differences in the final phenomena. ***Prediction becomes impossible*.**

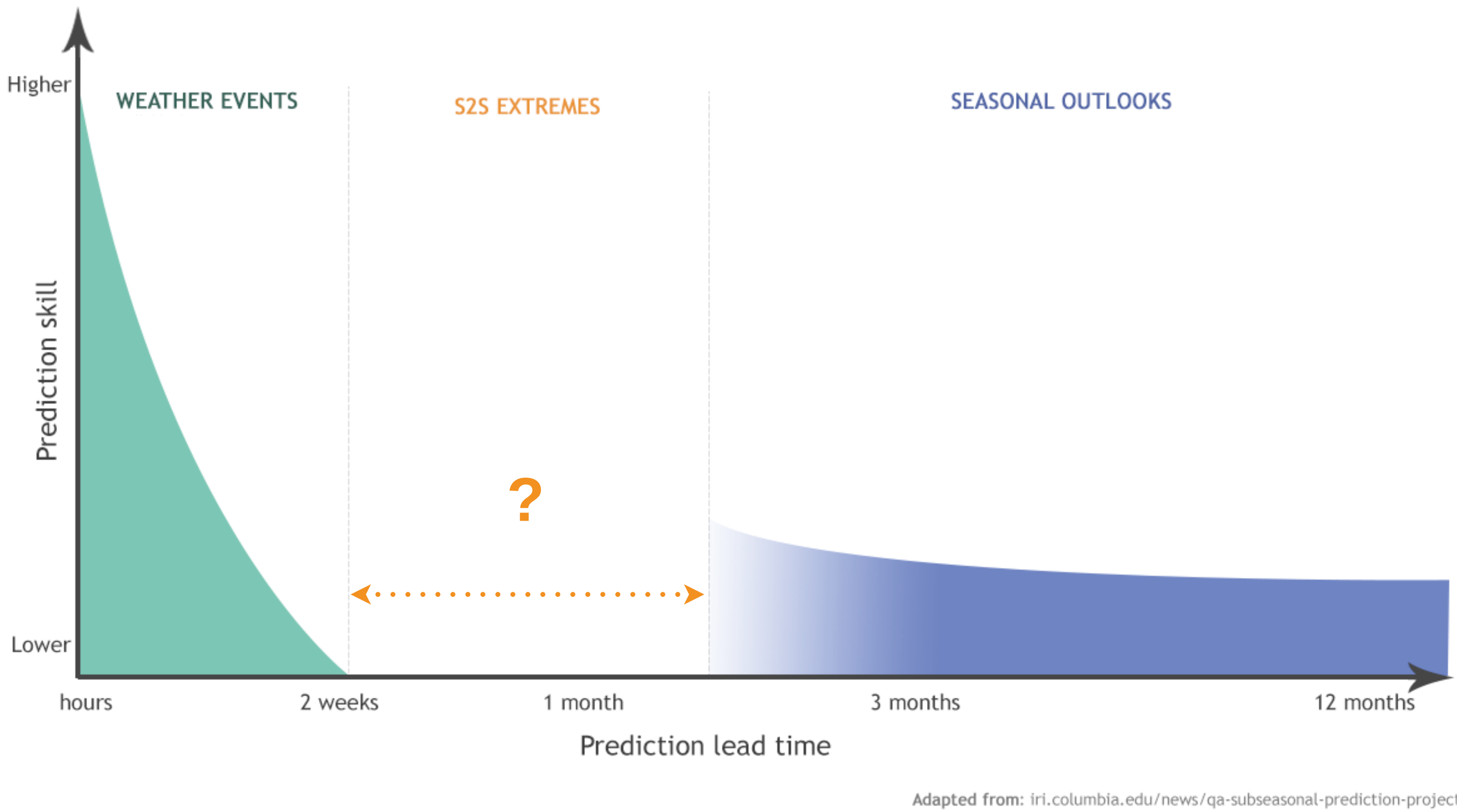
- Henri Poincare (1903)

Forecast Gap at Weeks-to-Months



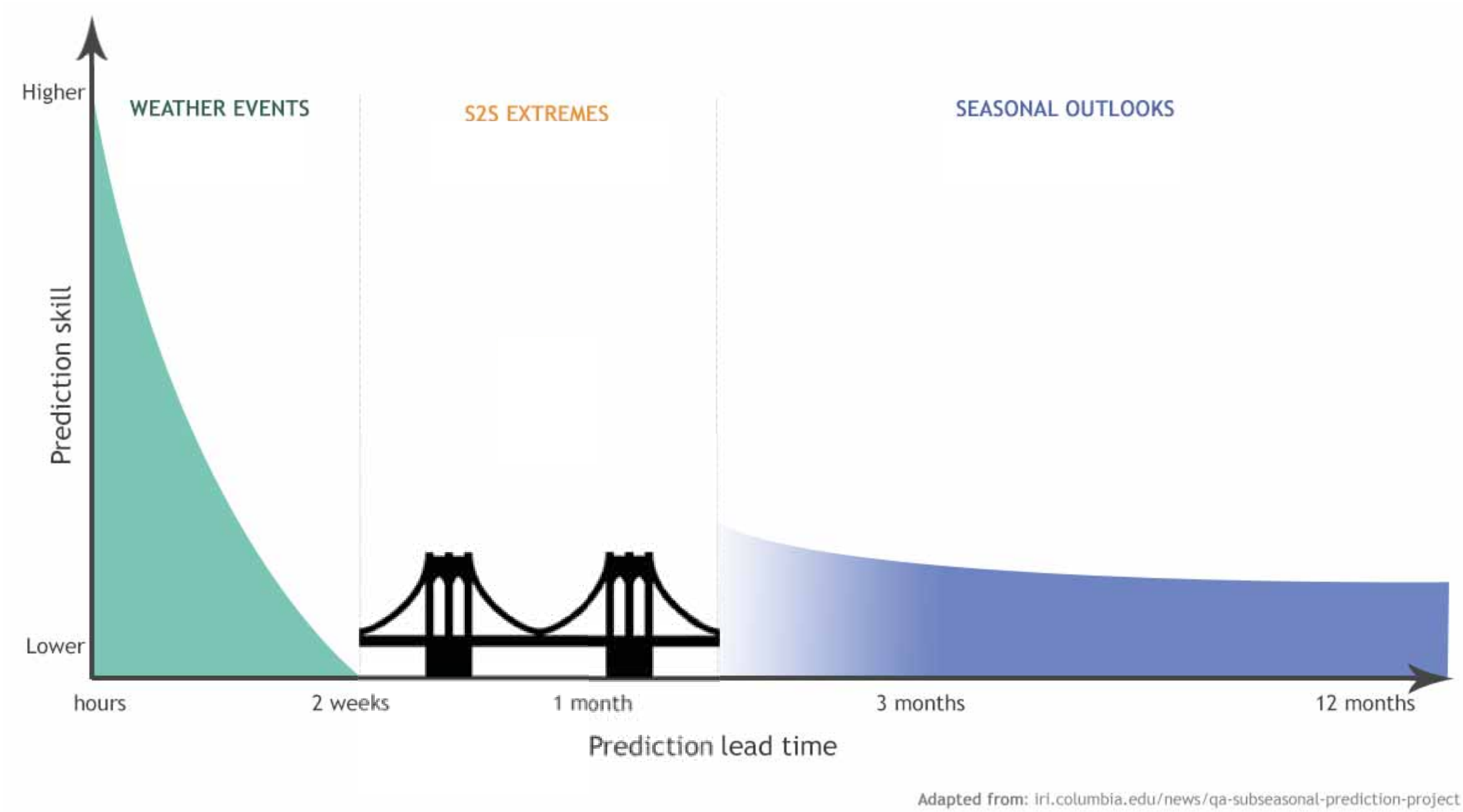
NOAA CPO image

Forecast Gap at Weeks-to-Months



NOAA CPO image

Forecast Gap at Weeks-to-Months



NOAA CPO image

Forecast Gap at Weeks-to-Months

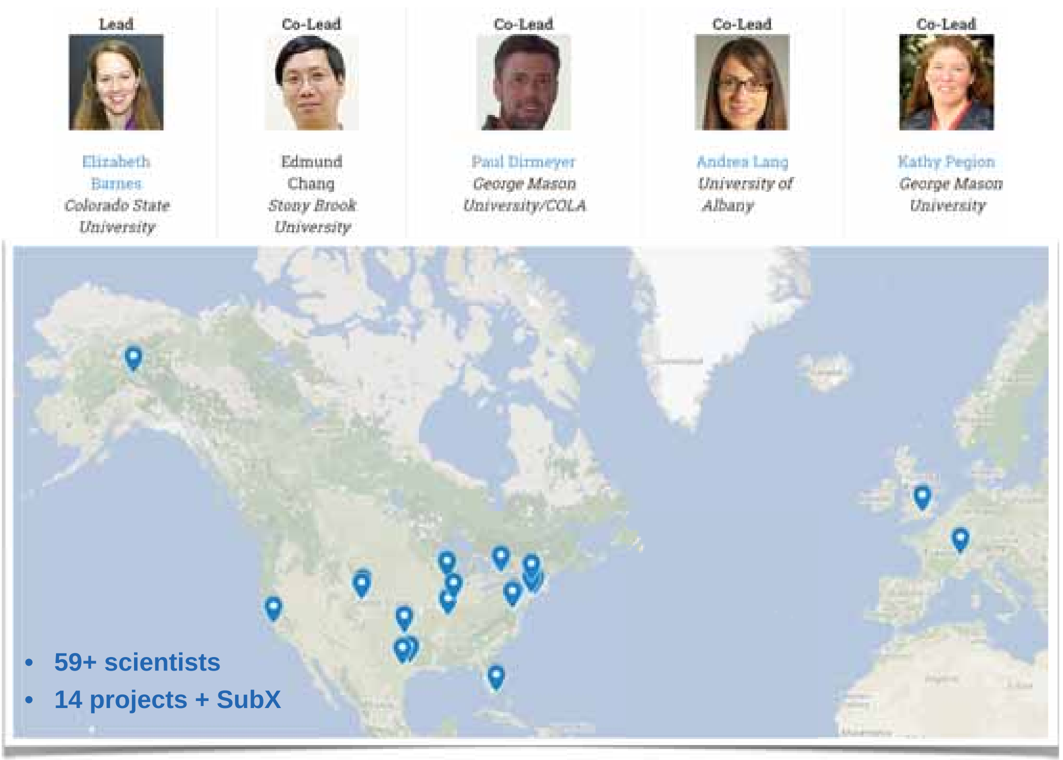
WEATHER EVENTS

S2S EXTREMES

SEASONAL OUTLOOKS

MAPP S2S Prediction Task Force

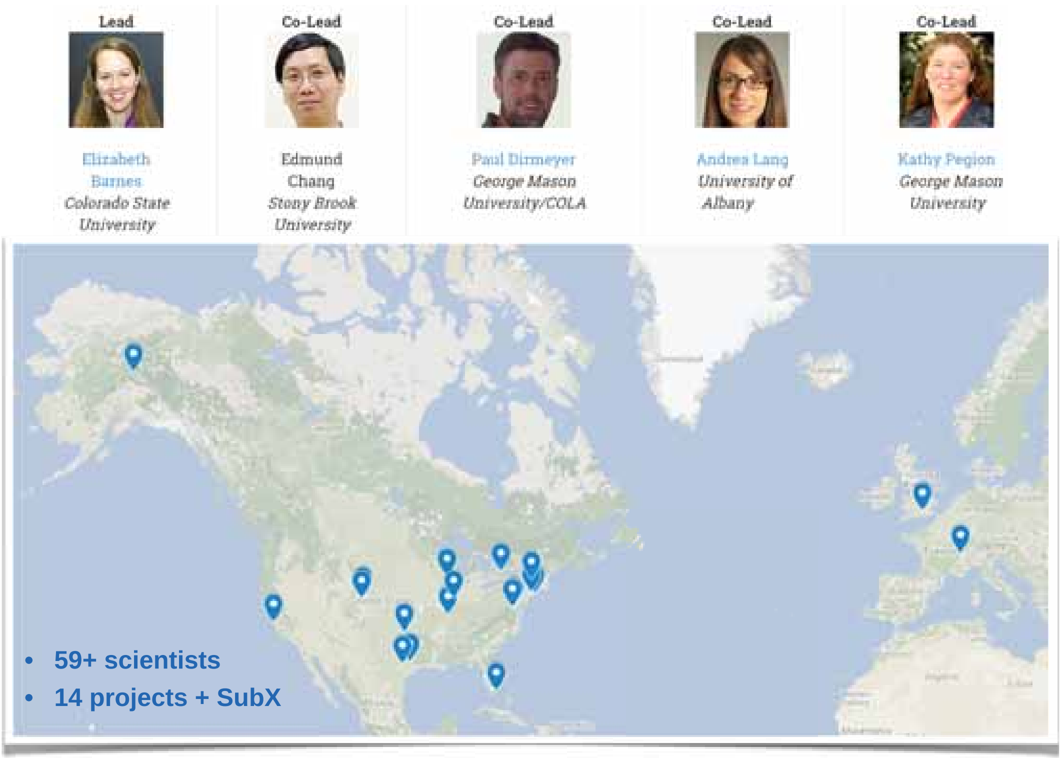
Subseasonal to Seasonal (2016-2019)



Bridge the gap in prediction skill and products between traditional weather and seasonal lead times

MAPP S2S Prediction Task Force

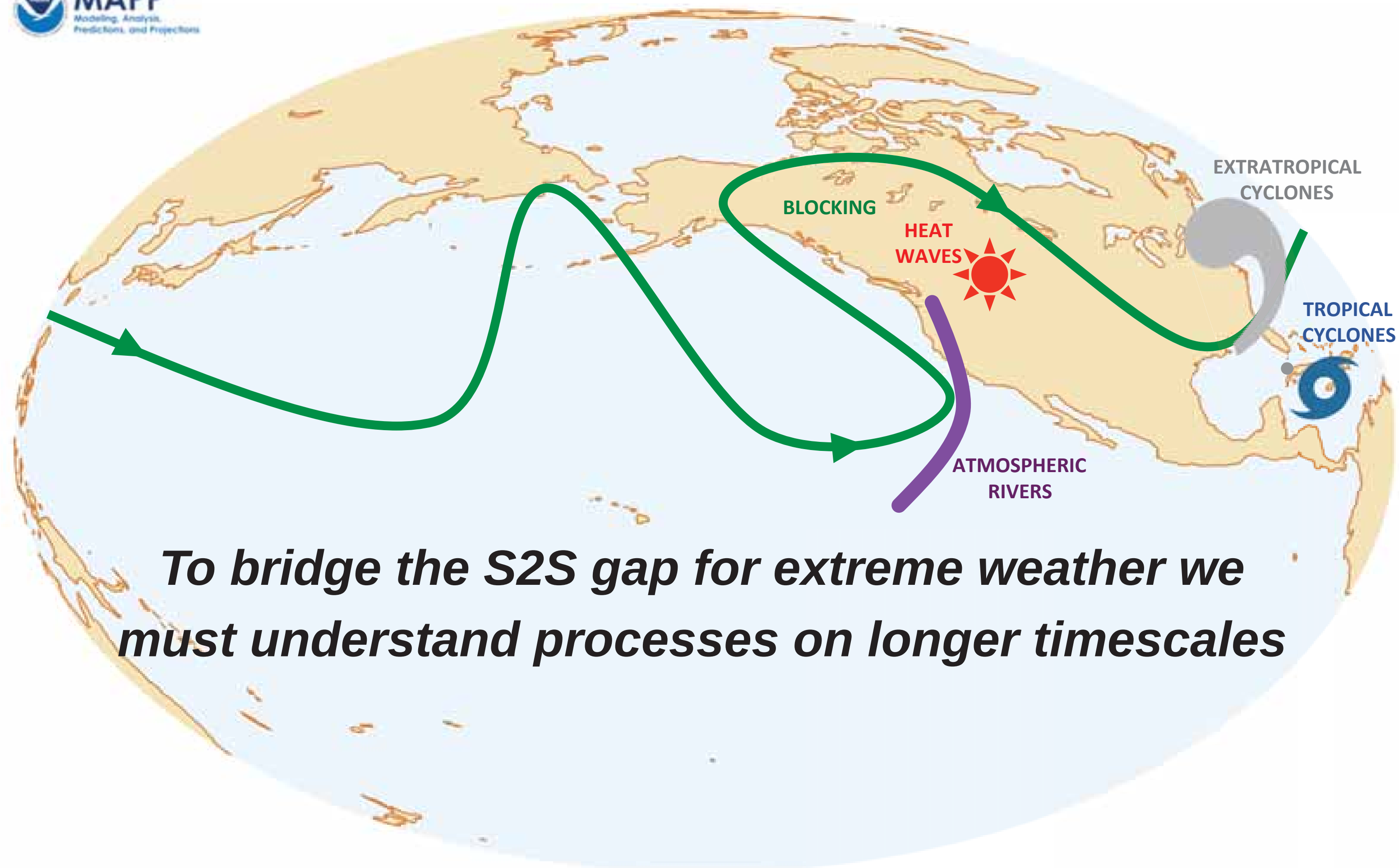
Subseasonal to Seasonal (2016-2019)



- **connecting scientists** by holding monthly teleconferences; most work is conducted remotely
- **facilitating collaboration:** data sets, methodologies, results, strong ties with the International S2S project
- **products:** technical reports, review articles, journal special collections and
- **supported** mainly through the MAPP FY16 S2S research competition
- **MAPP Program management** facilitates Task Force activities with Task Force leads

S2S PREDICTION TASK FORCE

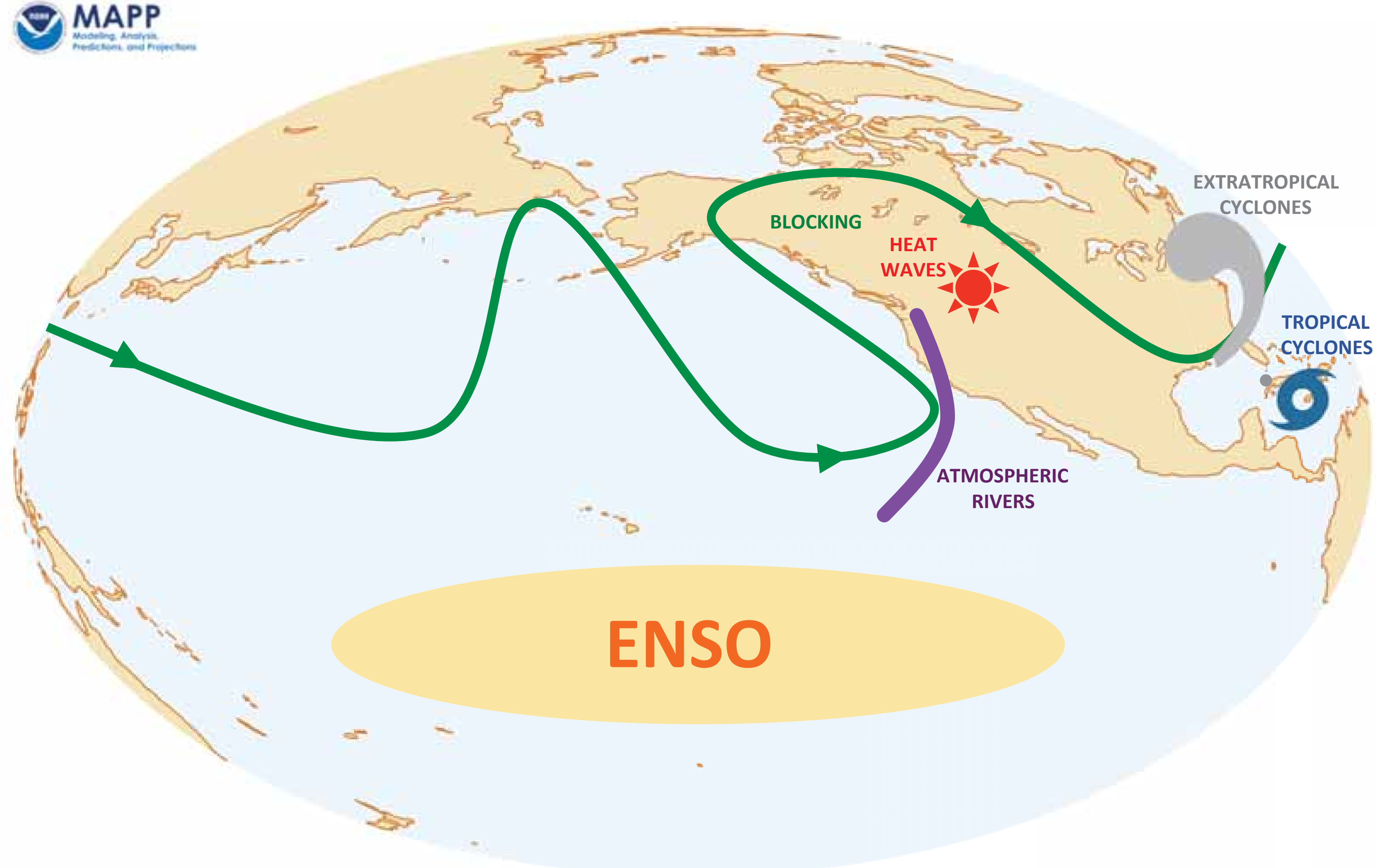
MAPP
Modeling, Analysis, Predictions, and Projections



To bridge the S2S gap for extreme weather we must understand processes on longer timescales

S2S Prediction Task Force

MAPP
Modeling, Analysis, Predictions, and Projections



S2S Prediction Task Force

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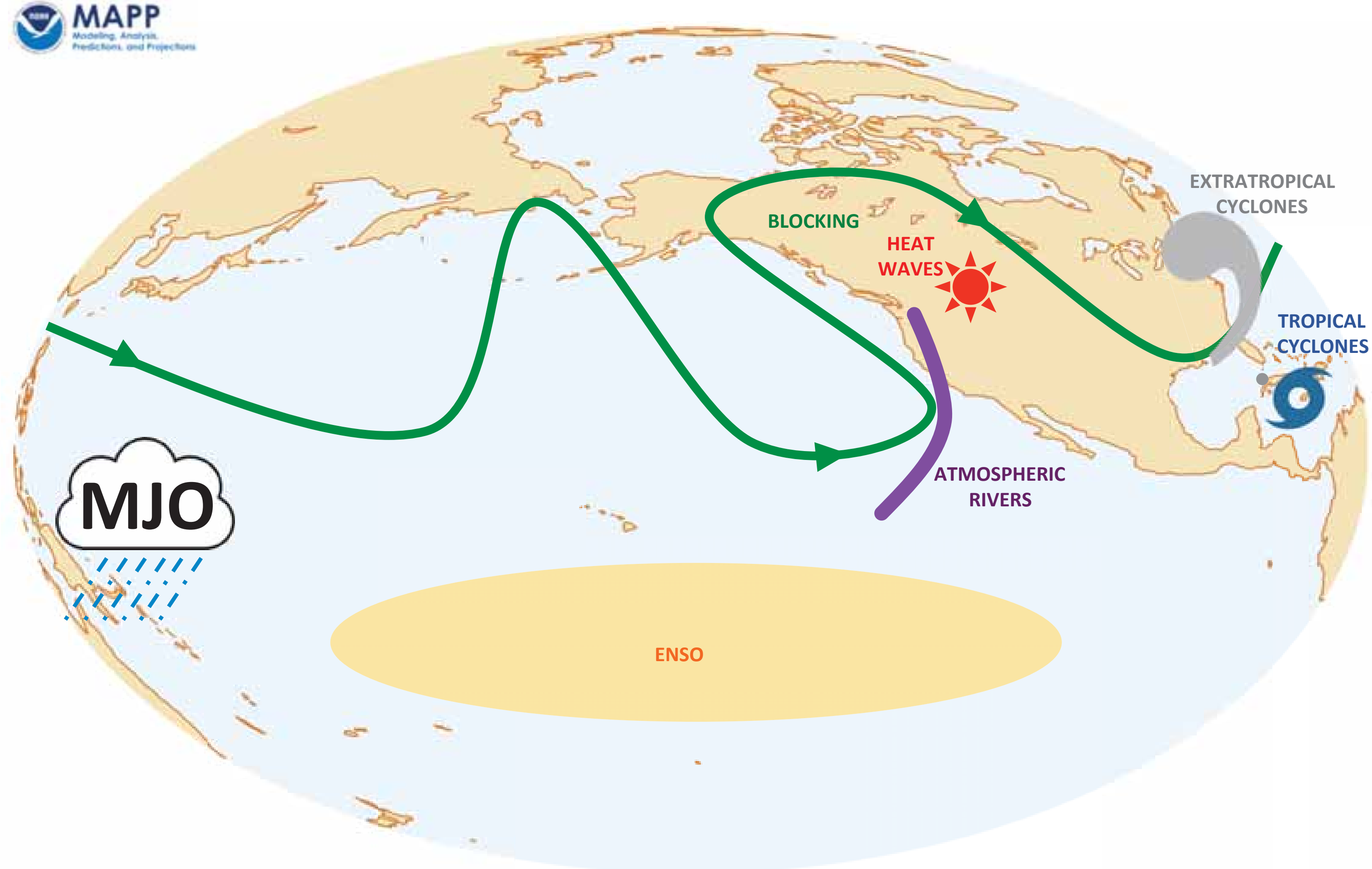
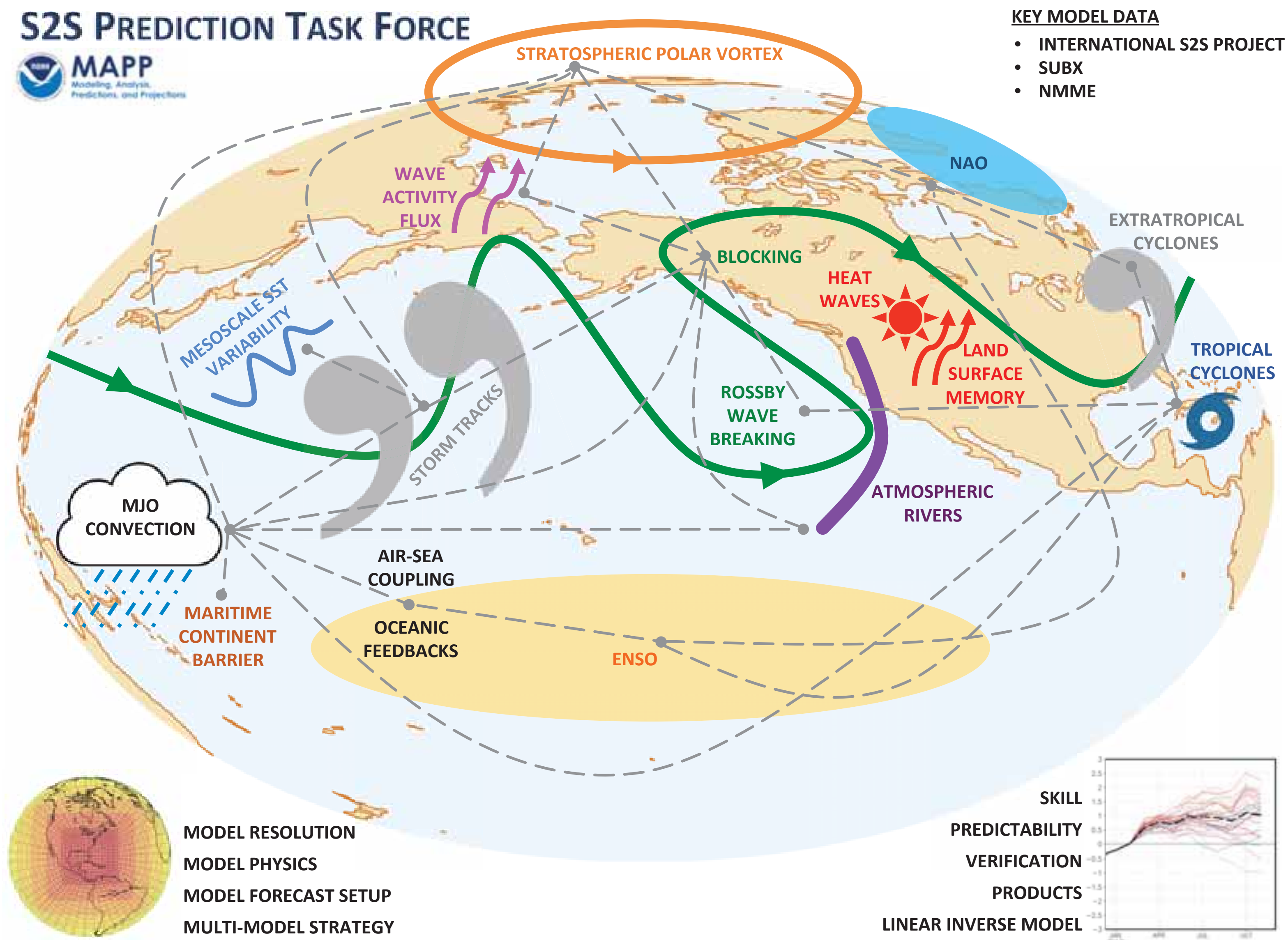
Modeling, Analysis, Predictions, and Projections




S2S PREDICTION TASK FORCE
MAPP
Modeling, Analysis, Predictions, and Projections
KEY MODEL DATA
• INTERNATIONAL S2S PROJECT
• SUBX
• NMME
STRATOSPHERIC POLAR VORTEX
NAO
WAVE ACTIVITY FLUX
EXTRATROPICAL CYCLONES
BLOCKING
HEAT WAVES
MESOSCALE SST VARIABILITY
LAND SURFACE MEMORY
TROPICAL CYCLONES
ROSSBY WAVE BREAKING
STORM TRACKS
ATMOSPHERIC RIVERS
MJO CONVECTION
AIR-SEA COUPLING
MARITIME CONTINENT BARRIER
OCEANIC FEEDBACKS
ENSO
MODEL RESOLUTION
MODEL PHYSICS
MODEL FORECAST SETUP
MULTI-MODEL STRATEGY
SKILL
PREDICTABILITY
VERIFICATION
PRODUCTS
LINEAR INVERSE MODEL

Task Force: Key Questions

Key Questions: Processes and Physics

- What are the dominant physical sources of S2S predictability, and how well are these sources simulated and predicted?
- How do tropical/extra-tropical and stratosphere/troposphere connections influence S2S prediction?

Key Questions: Approaches to S2S Prediction

- What indices/metrics best describe extreme weather phenomena relevant to S2S prediction given the limitations in available model and observed variables?
- How can we seamlessly treat the transition from an atmospheric initial value forecast problem to a boundary value forecast problem across subseasonal (1-4 week) timescales, in terms of forecast products and their validation?
- To what extent can S2S prediction skill be enhanced by statistical post-processing (i.e., model output statistics) for various applications?
- How can single- and multi-model ensembles be best exploited for S2S prediction?

Key Questions: Evaluating and Improving Models for S2S Prediction

- What is the relative importance of model resolution, physics parameterizations and forecast initialization for prediction skill of phenomena on S2S timescales?
- How well do models represent interactions between the tropics and extratropics, troposphere and stratosphere, ocean and atmosphere, land and atmosphere, and between S2S and other timescales?
- What are the main sources of model systematic errors on S2S timescales?

Task Force: Key Questions

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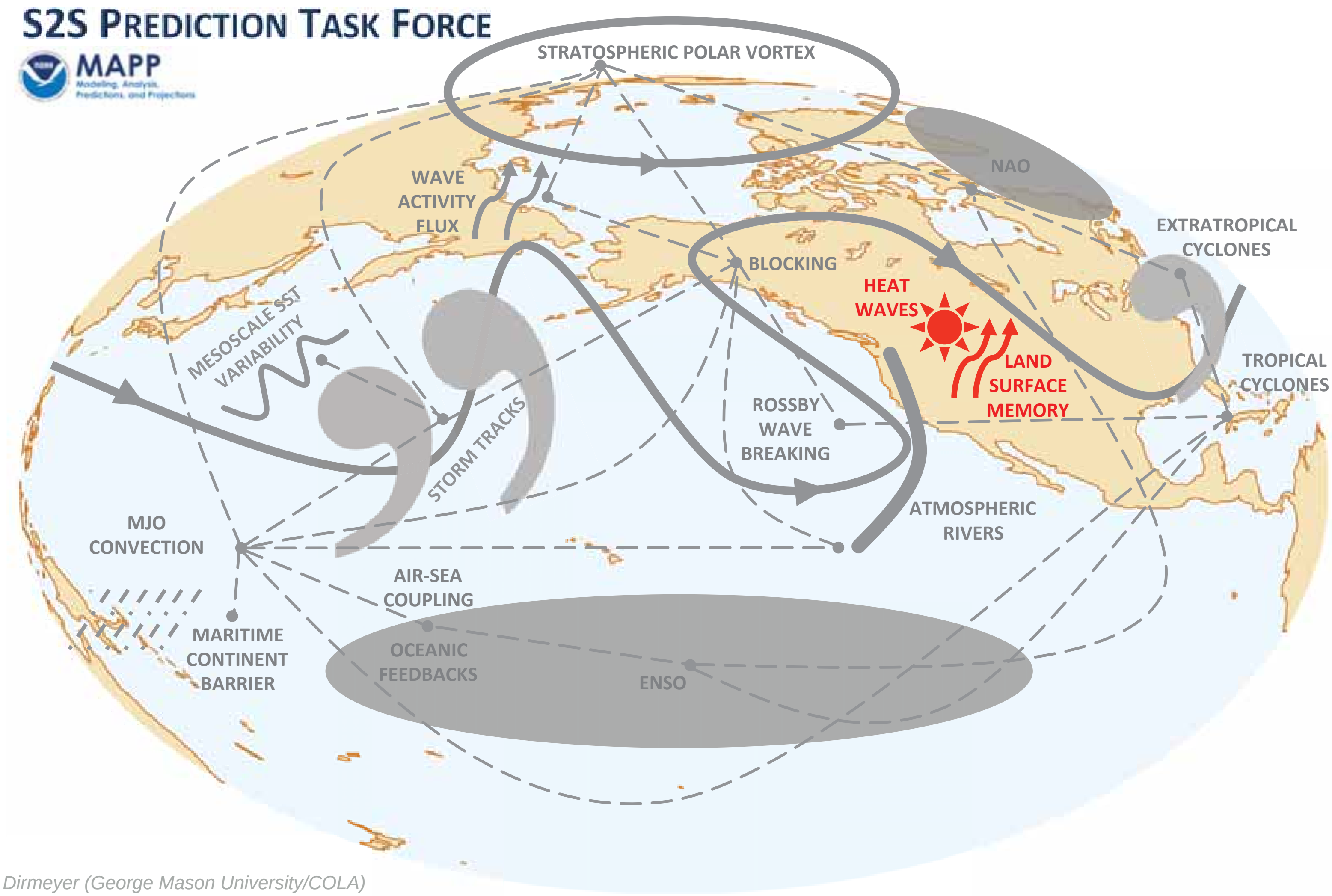
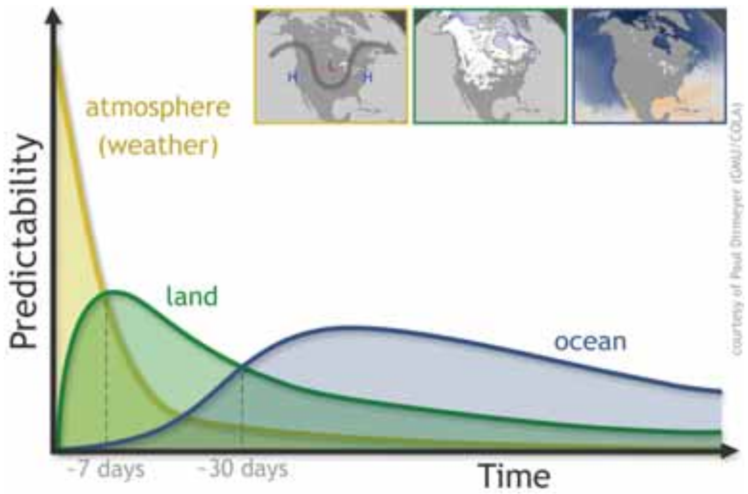
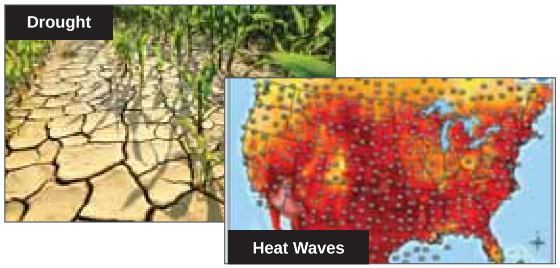


ongoing research by Paul Dirmeyer (George Mason University/COLA)
& Trent Ford (Southern Illinois University)
MAPP Awards: NA16OAR4310066, NA16OAR4310095

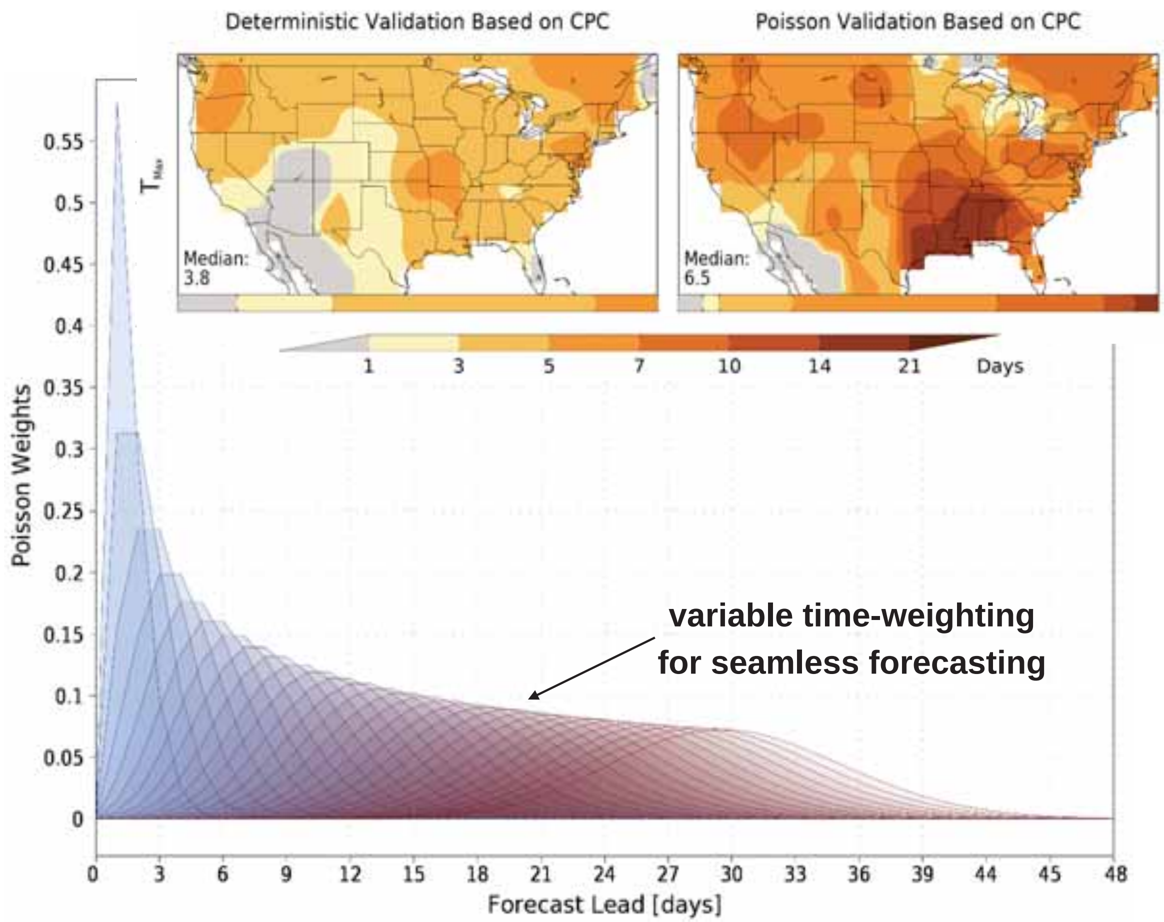
Predicting Heatwaves & Drought

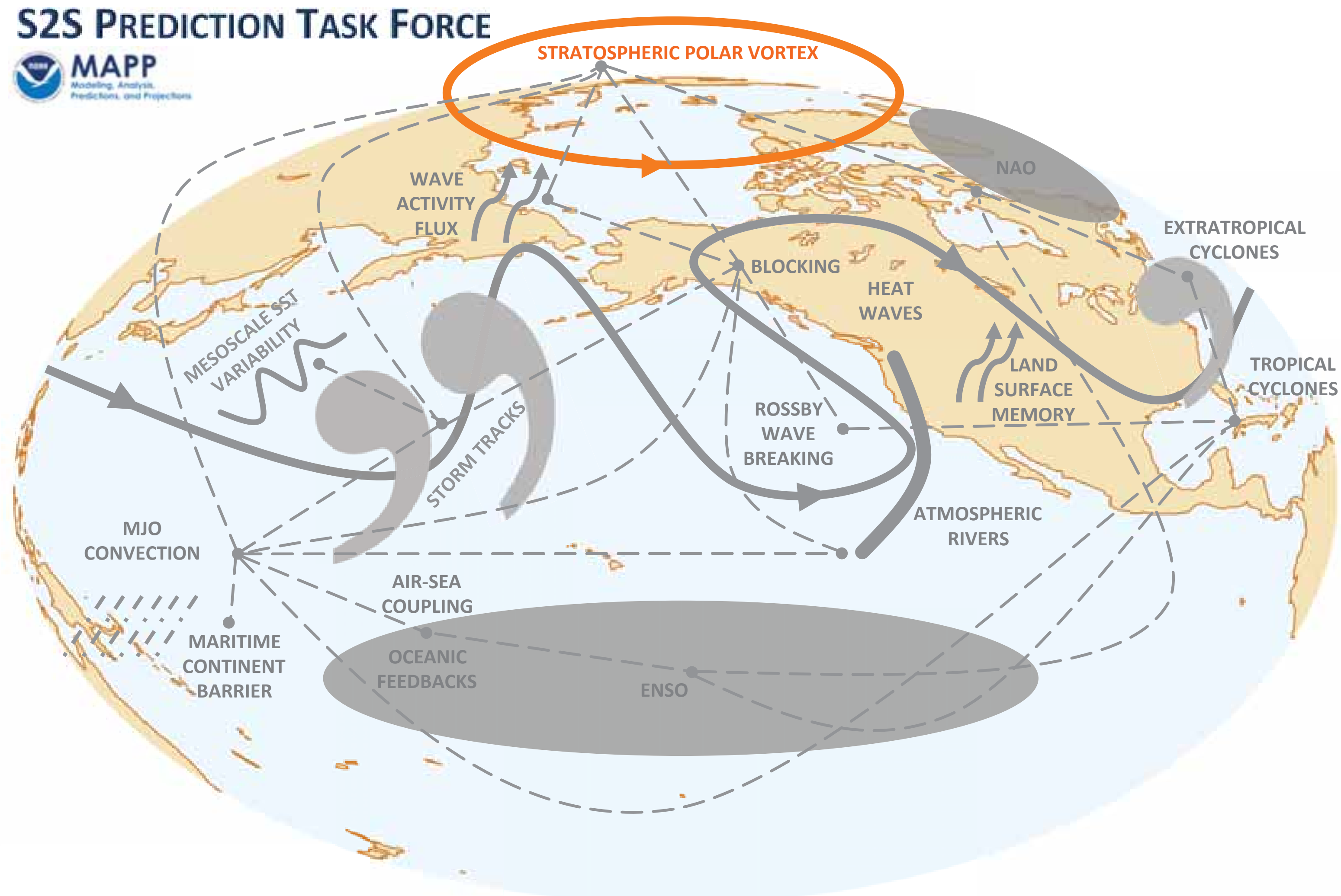




ongoing research by Paul Dirmeyer (George Mason University/COLA)
& Trent Ford (Southern Illinois University)
MAPP Awards: NA16OAR4310066, NA16OAR4310095

Duration of Skill of NCEP CFSv2 Forecasts of Extreme Heat



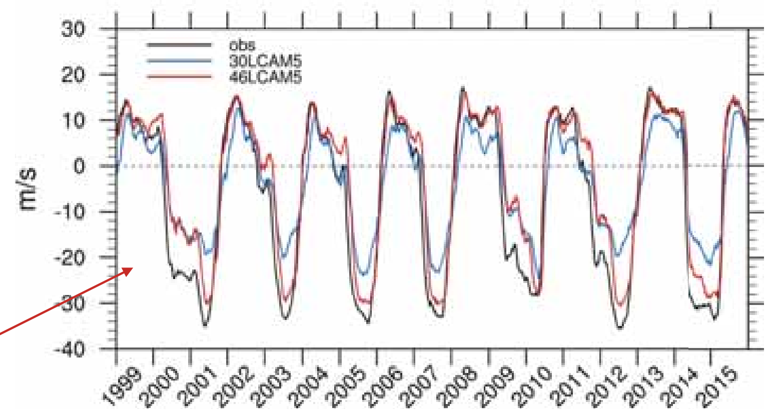


current research by Judith Perlwitz (NOAA/ESRL), Jadwiga Richter (NCAR), Lantao Sun (NOAA/ESRL)

Better Representation of the Stratosphere

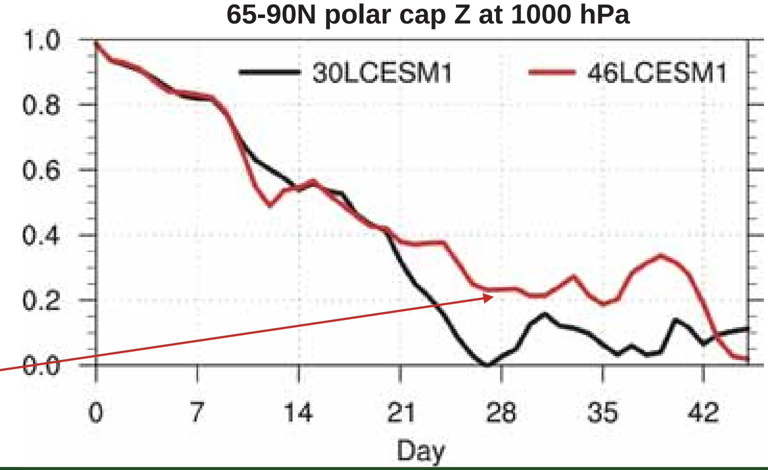
- 30-level (low-top) and 46-level (stratosphere resolving) CESM1
- Ran 1999-2015 hindcast set using SubX protocol, 10 ensemble members
- Data submitted to IRI/SubX

Week 4 QBO forecast (U 2S to 2N, 30 hPa)



Improved predictability of the stratosphere

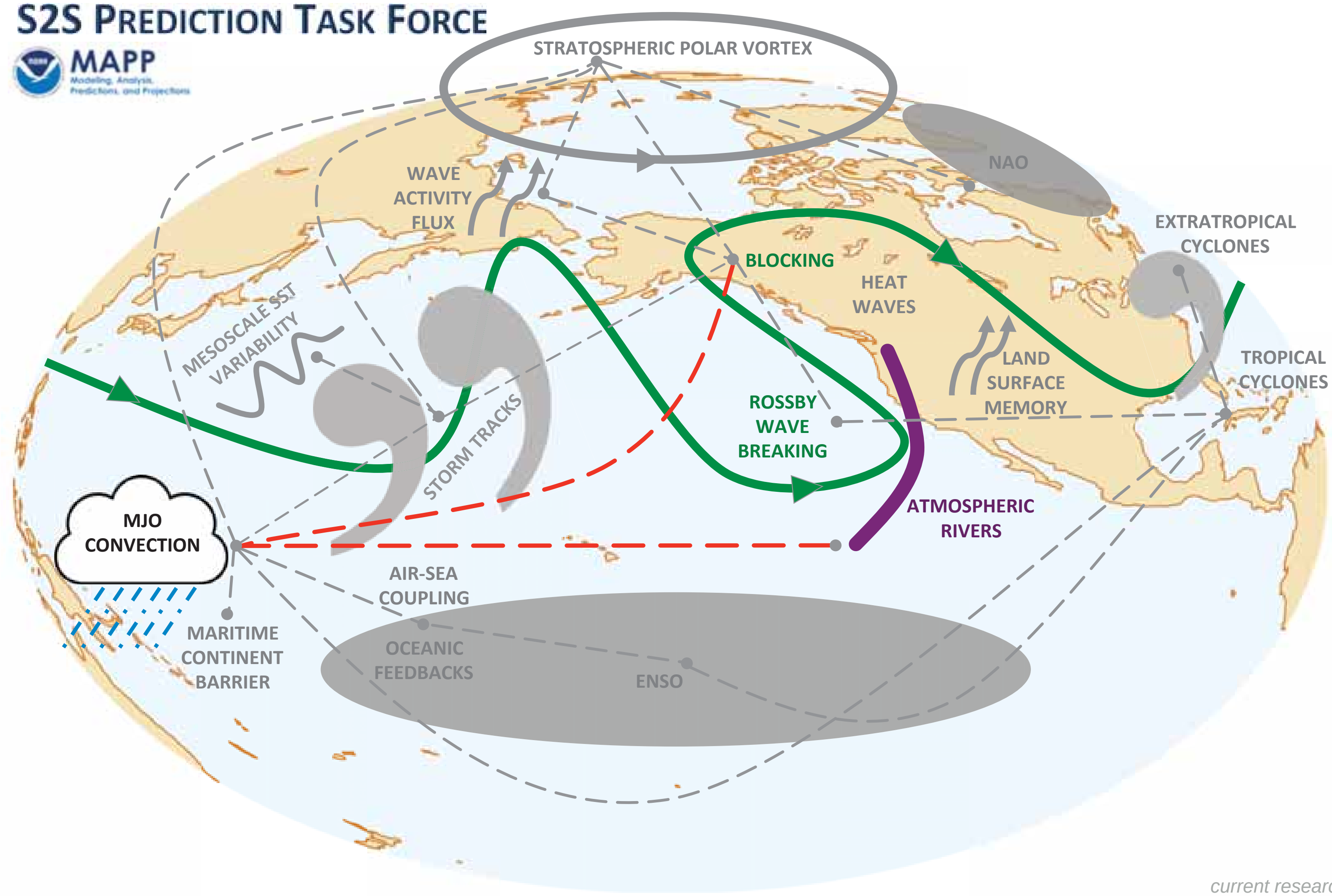
Anomaly Correlation with Reanalysis
65-90N polar cap Z at 1000 hPa



January surface circulation forecast looks more like reanalysis at S2S lead times

current research by Judith Perlwitz (NOAA/ESRL), Jadwiga Richter (NCAR), Lantao Sun (NOAA/ESRL)

S2S Prediction Task Force



current research by Elizabeth Barnes, Eric Maloney, Cory Baggett & Bryan Mundhenk (CSU); MAPP Award: NA16OAR4310064

Can we forecast <u>atmospheric rivers</u> on S2S timescales?

CALIFORNIA

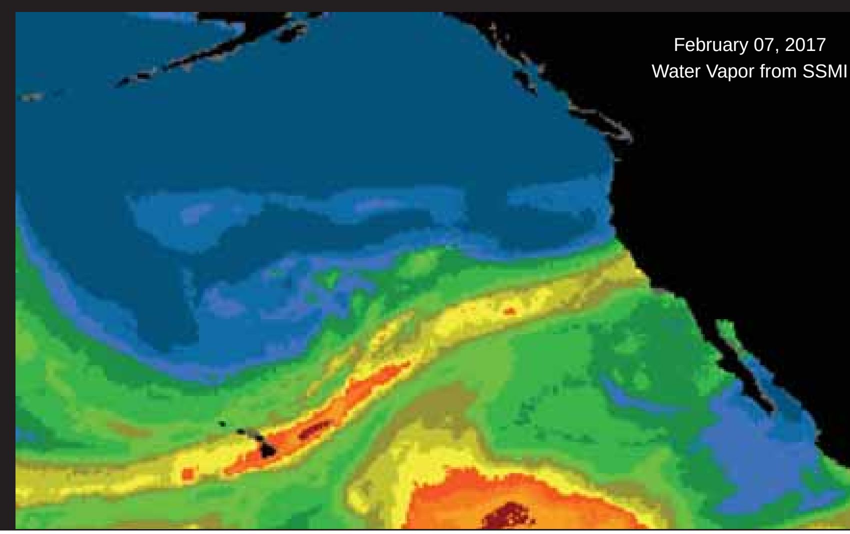
damage to Oroville Dam spillway
Feb. 27, 2017

ALASKA

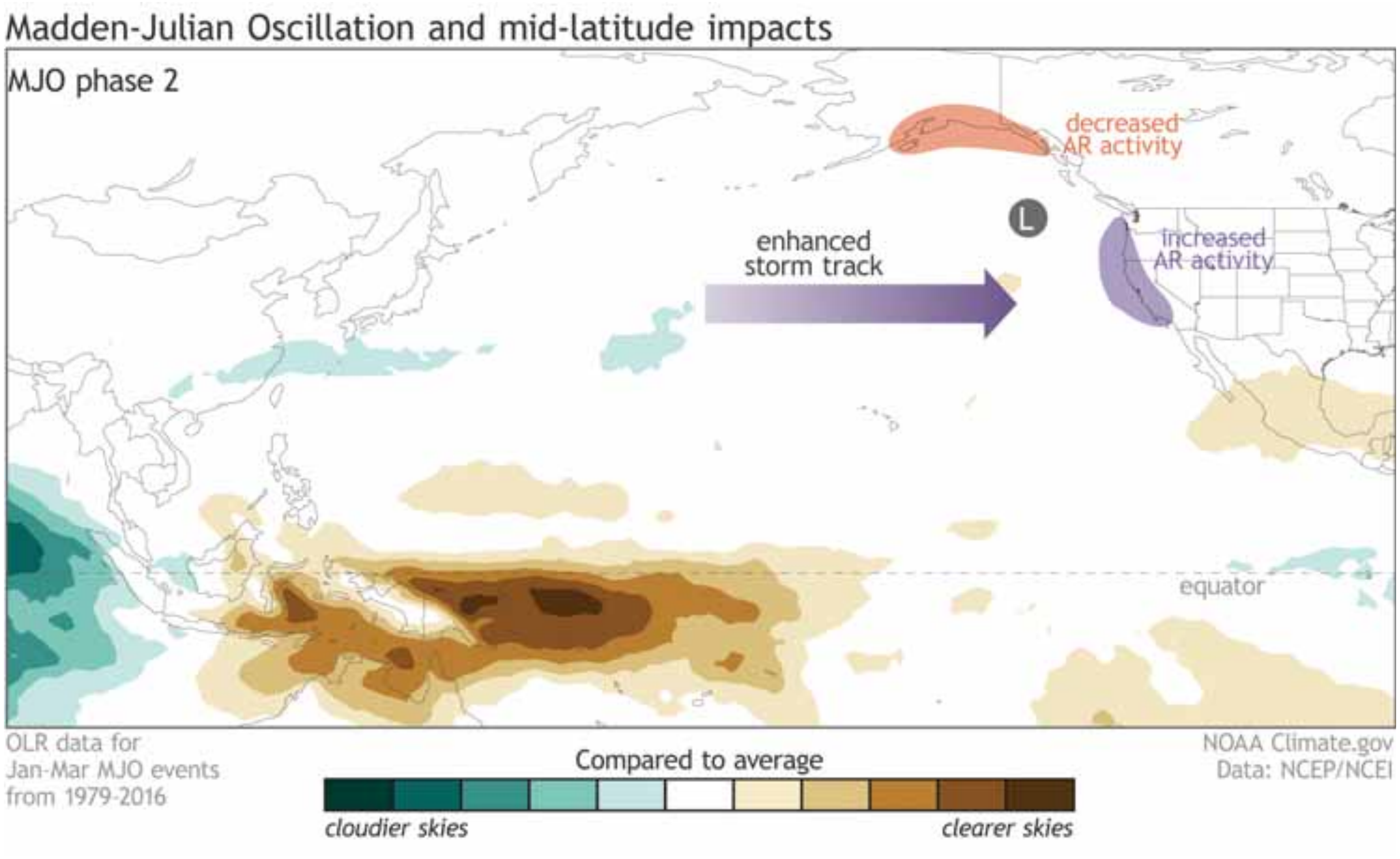
Landslide near Valdez
Jan. 24, 2014

MIDWEST

Summer Flooding = $35.1 billion
summer of 1993



The Madden-Julian Oscillation (MJO) as a source of predictability



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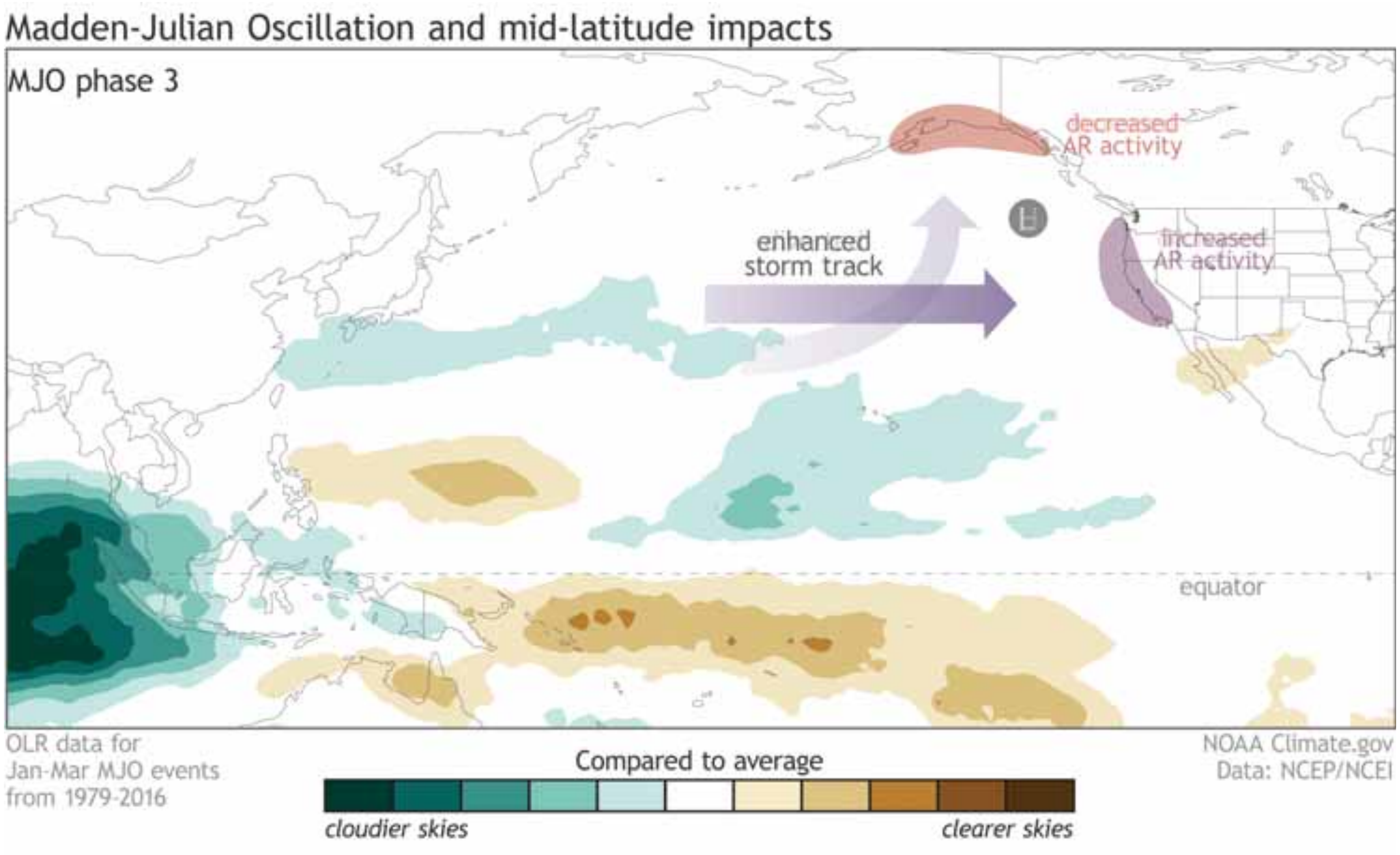

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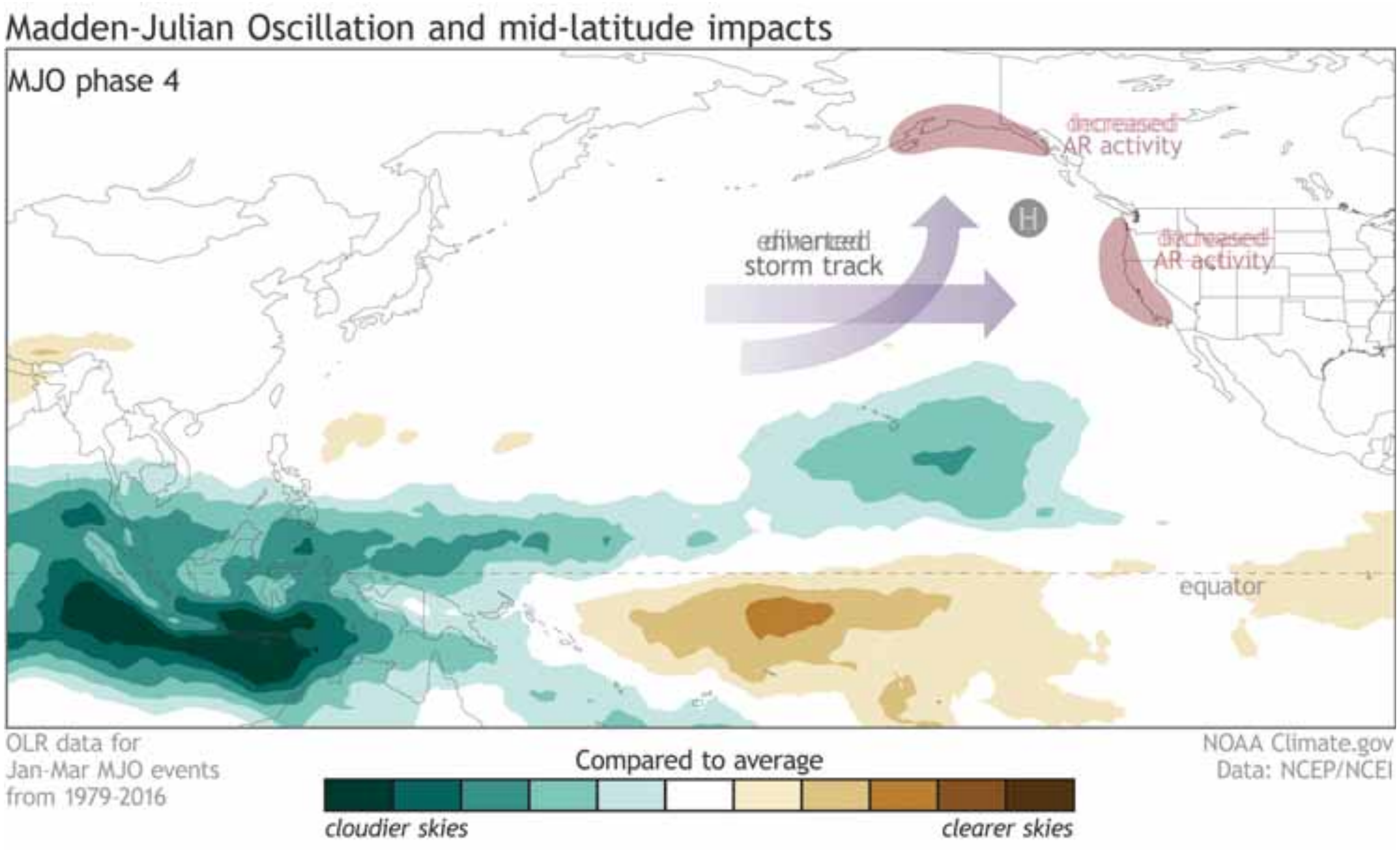

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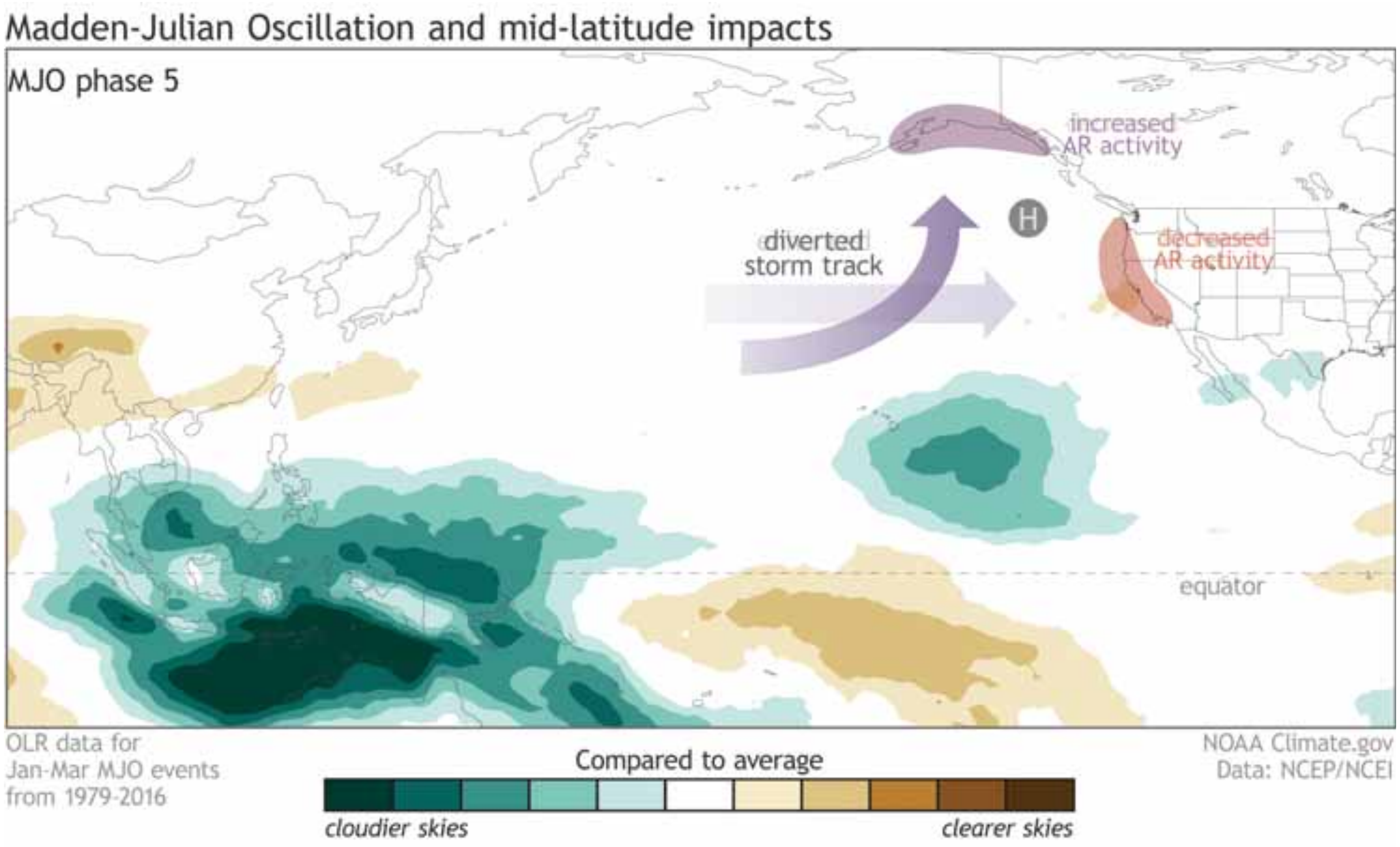

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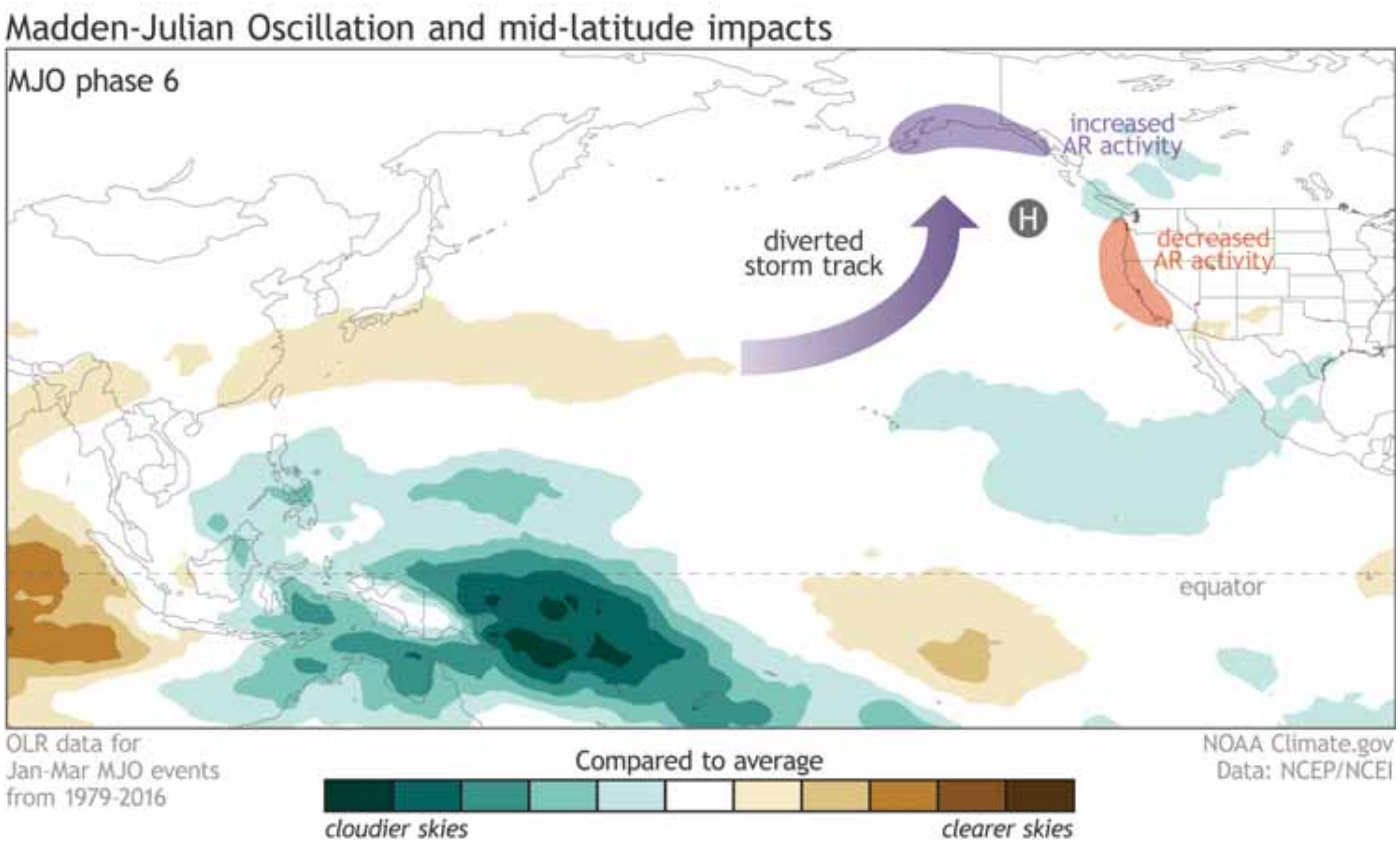

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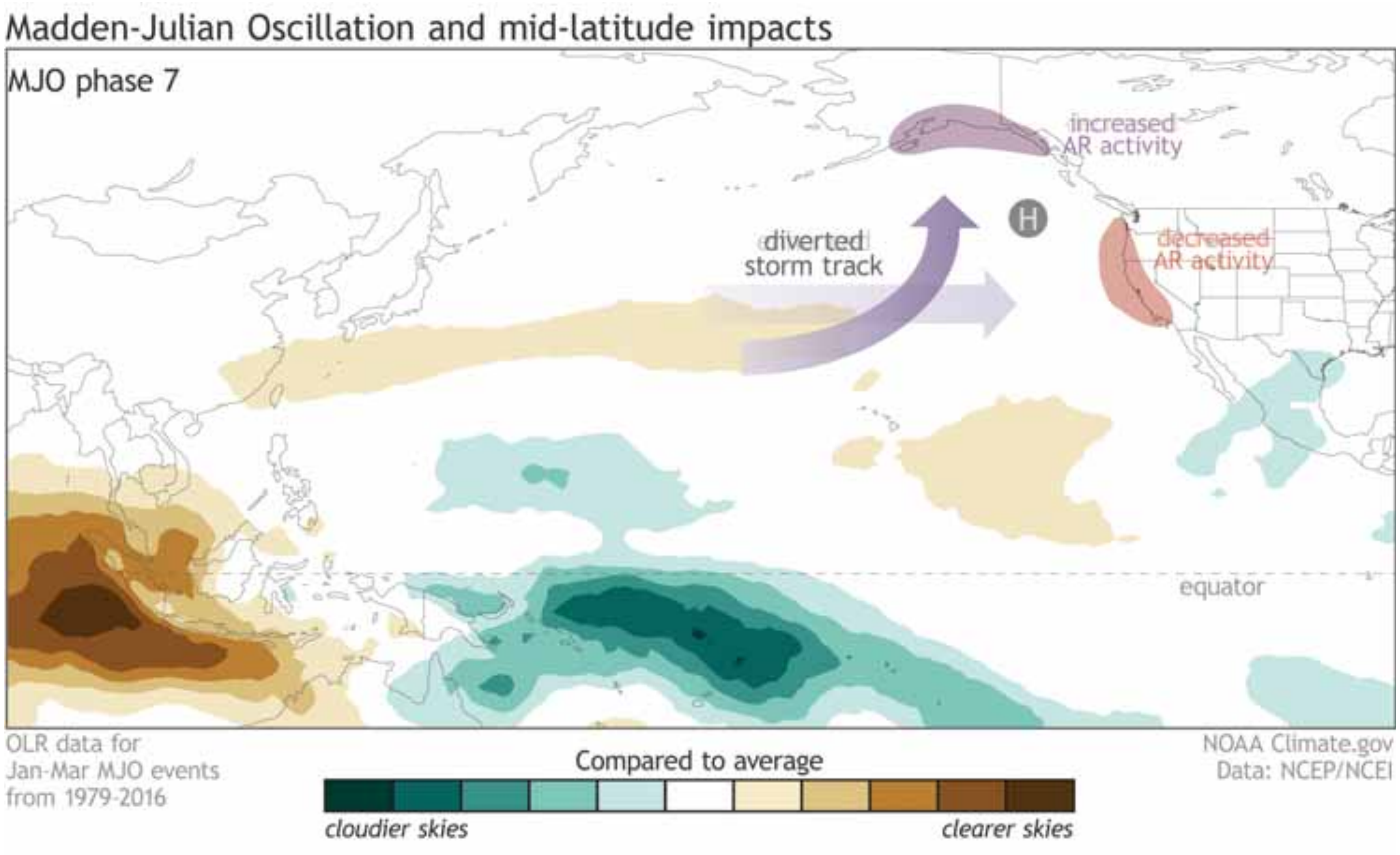

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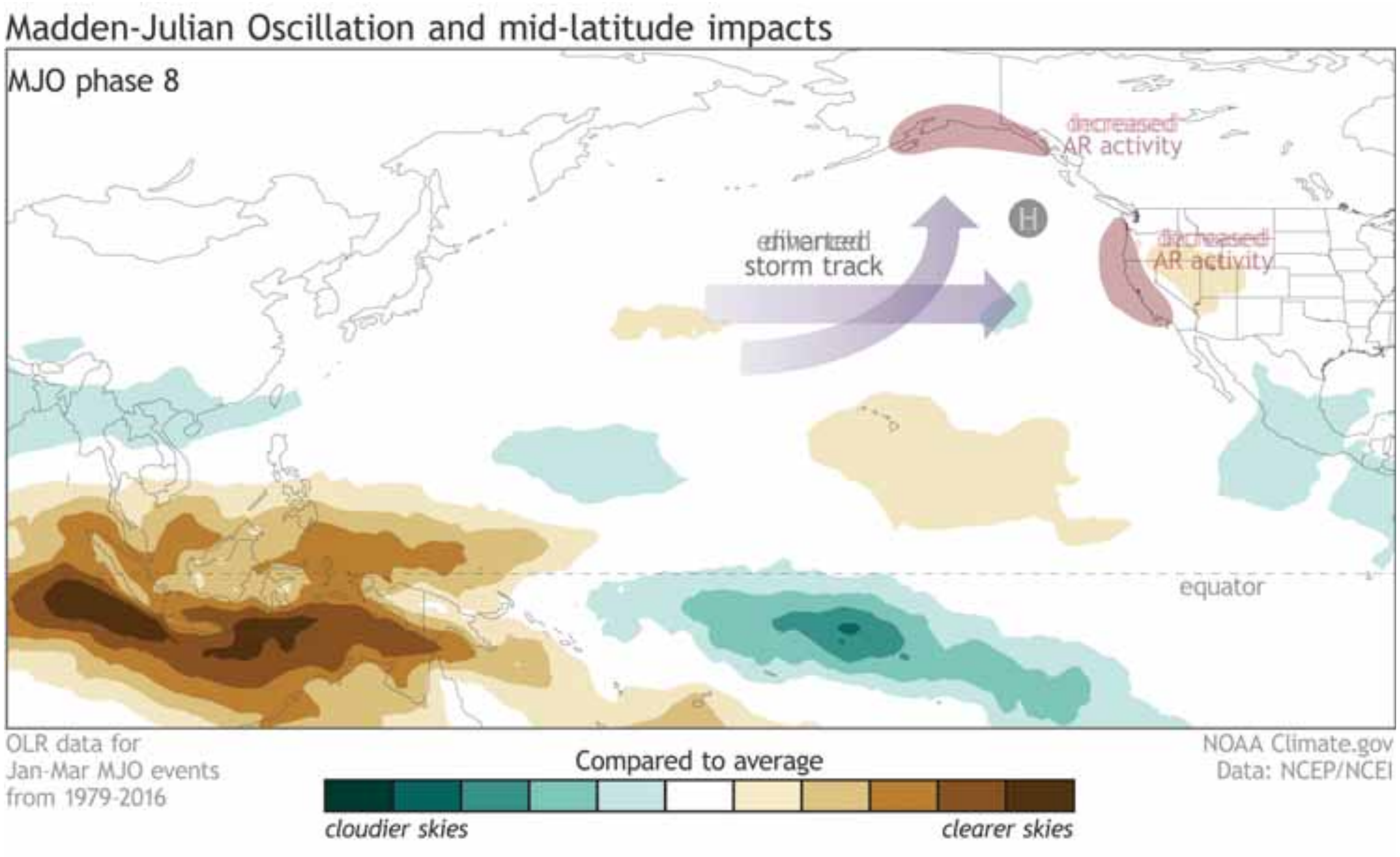

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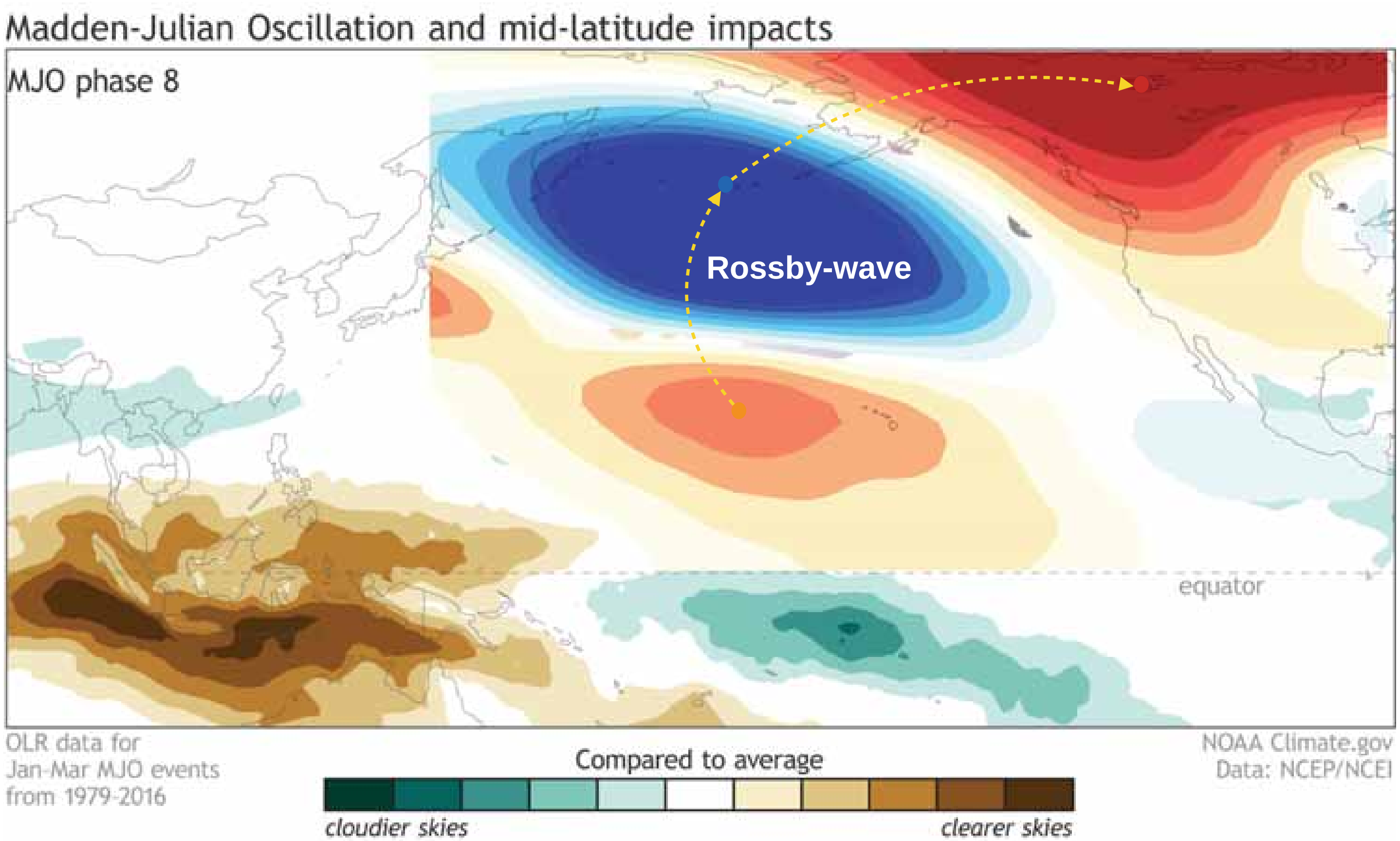
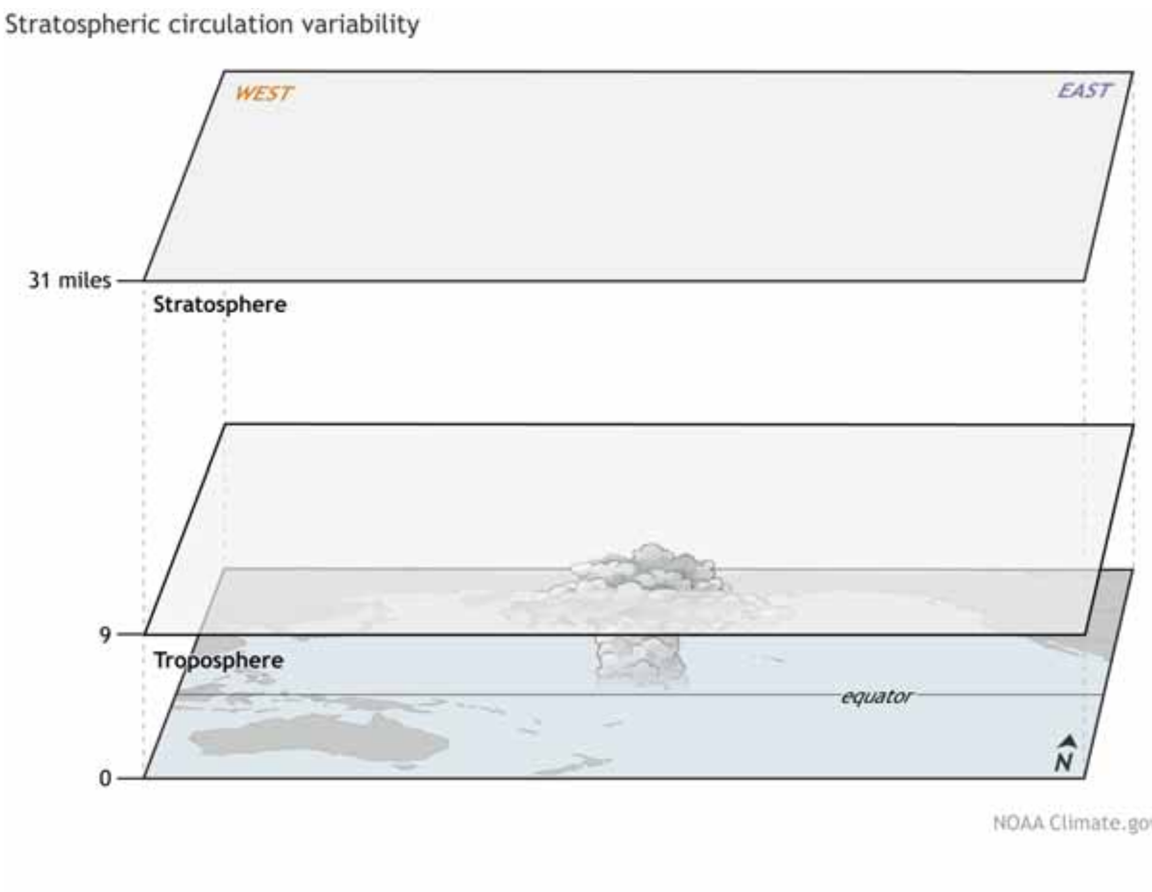


200 hPa geopotential height anomaly
MERRA; made by Kai-Chih Tseng

The Quasi-Biennial Oscillation (QBO) as a source of predictability



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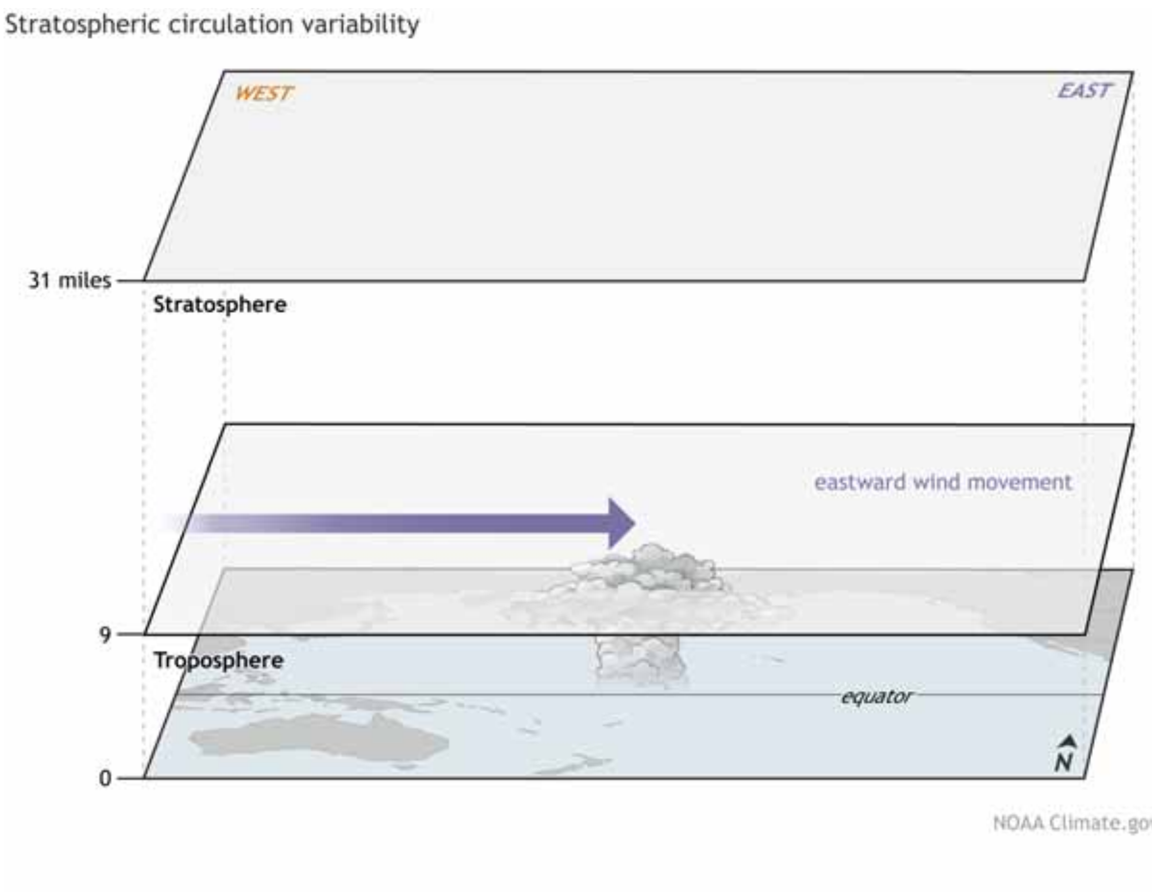

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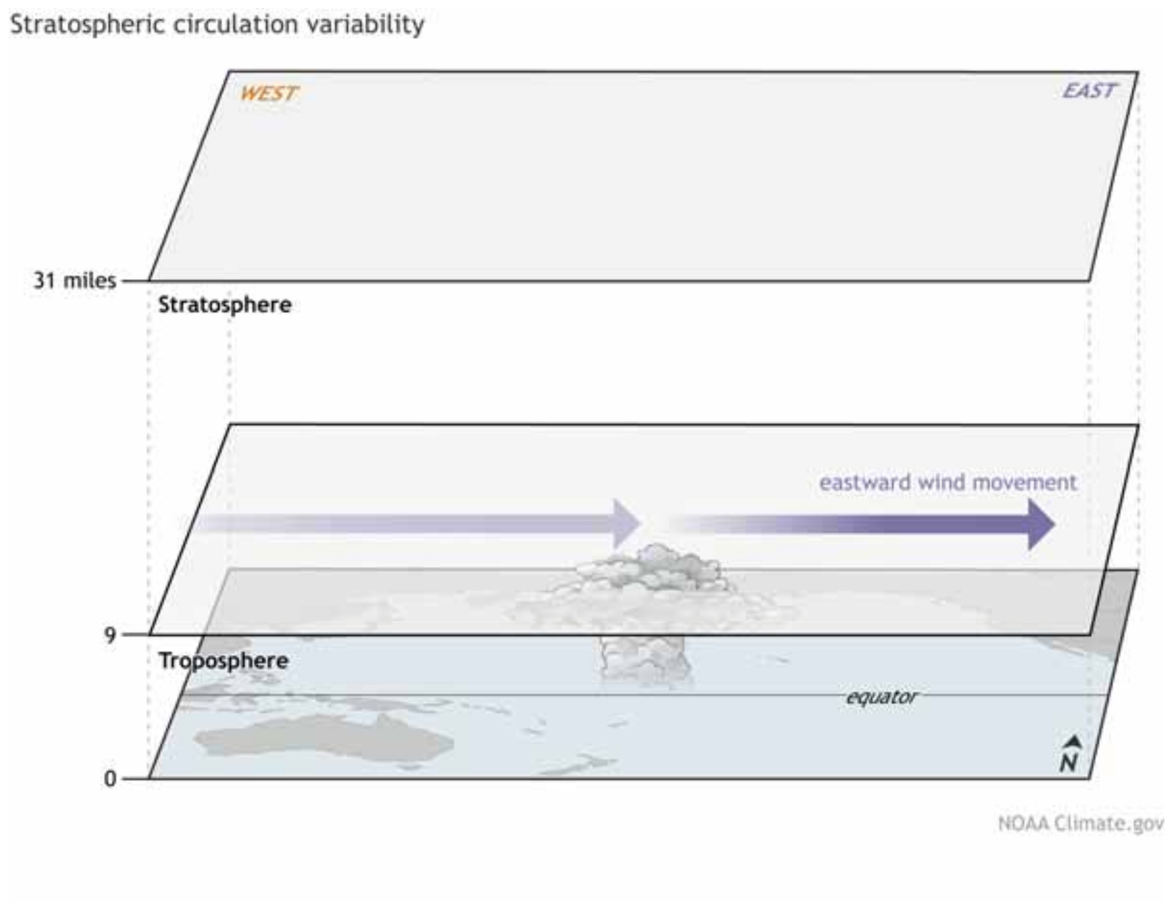

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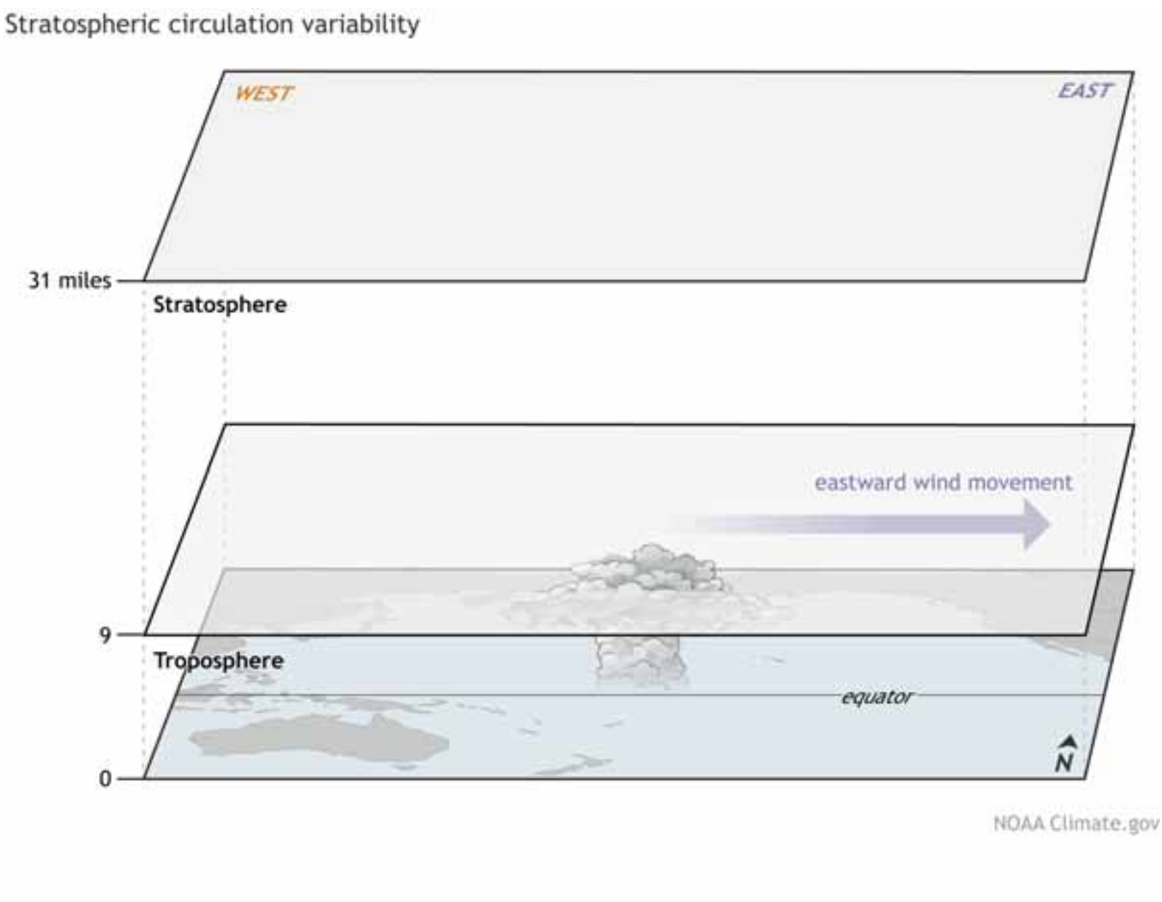

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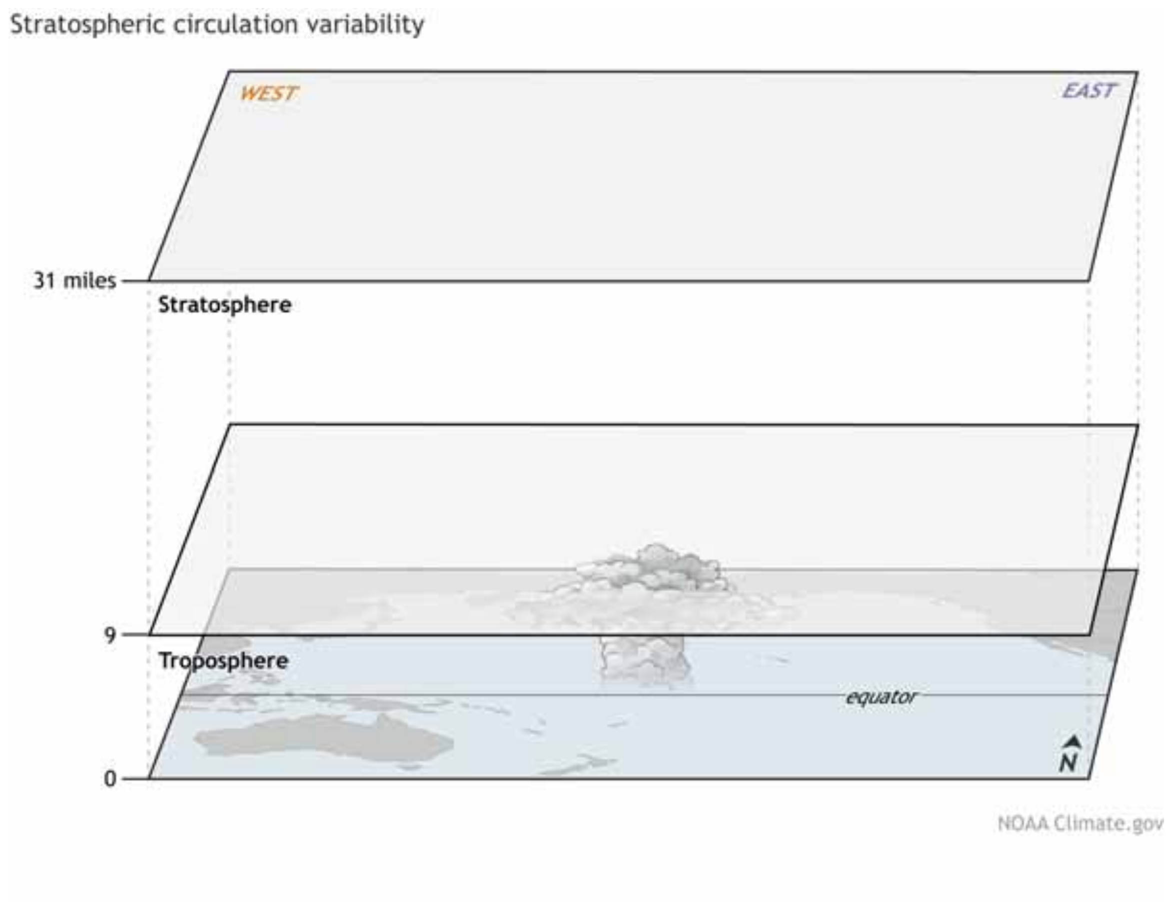

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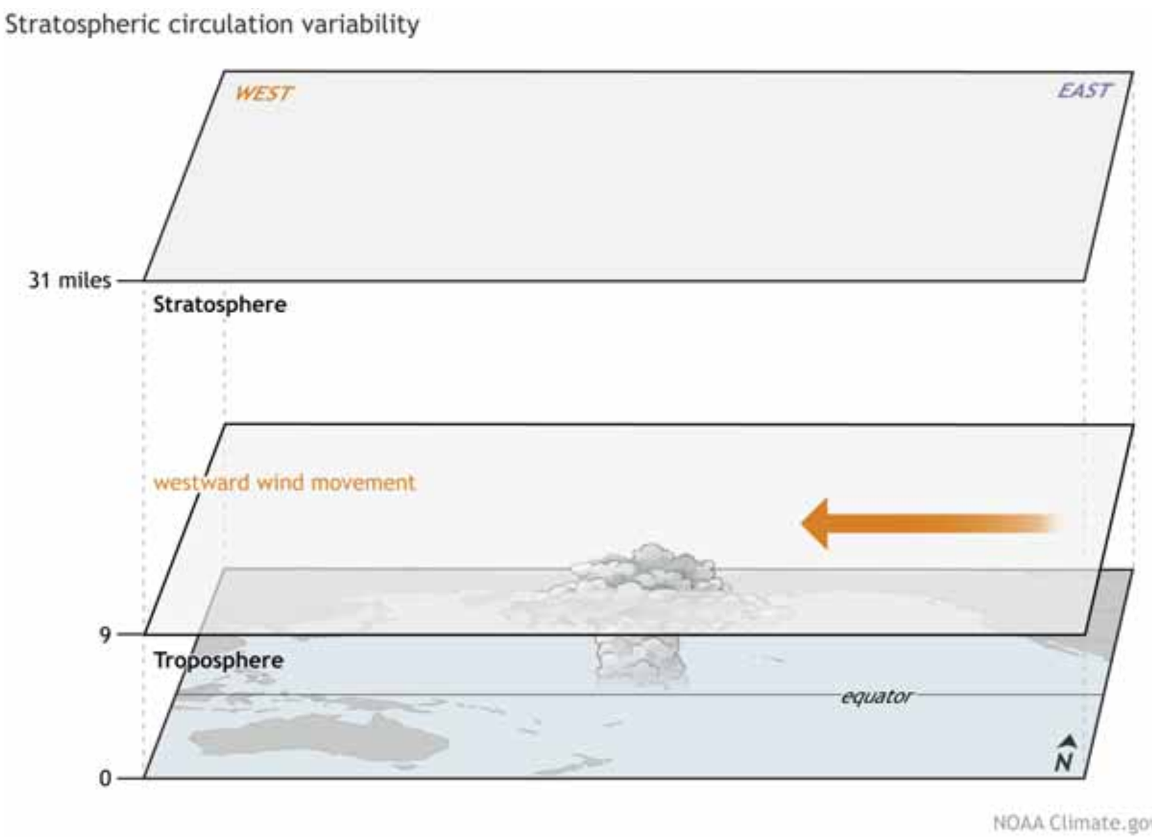

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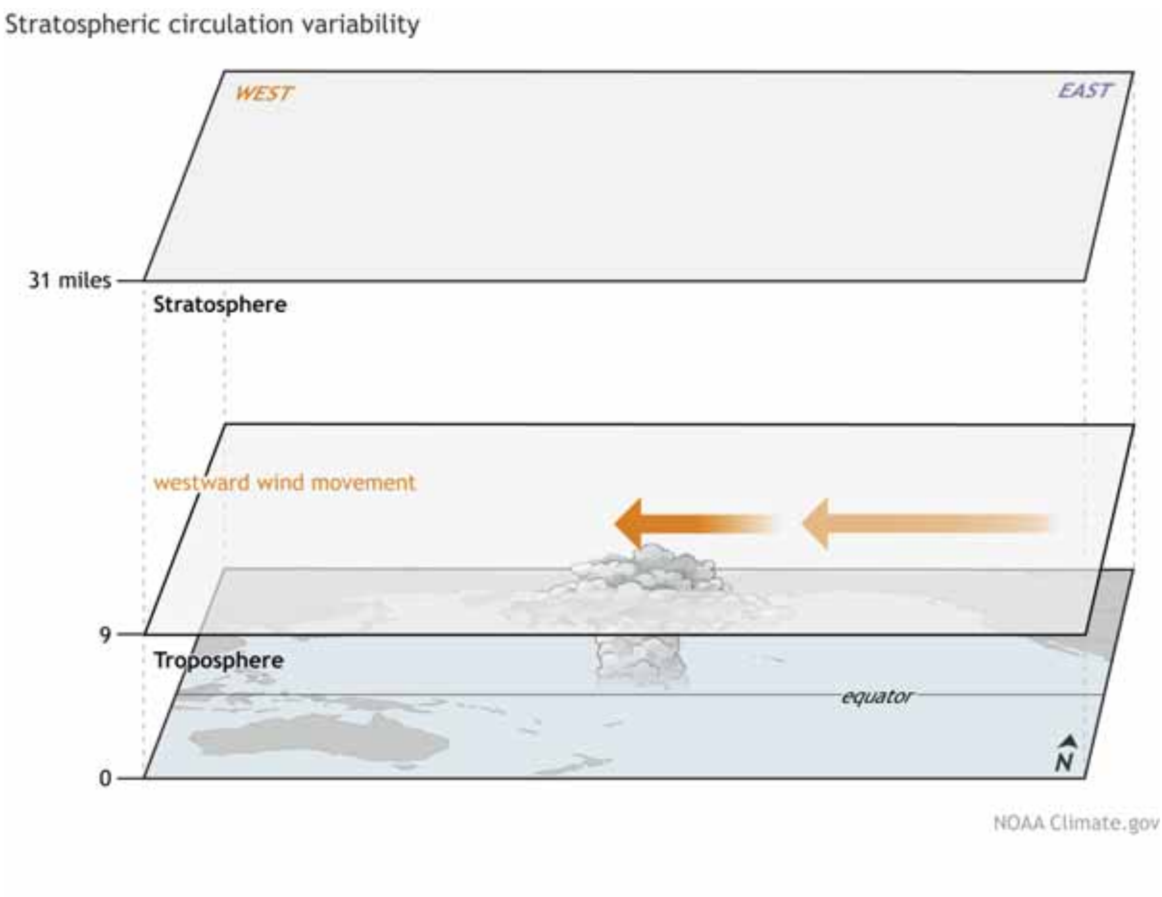

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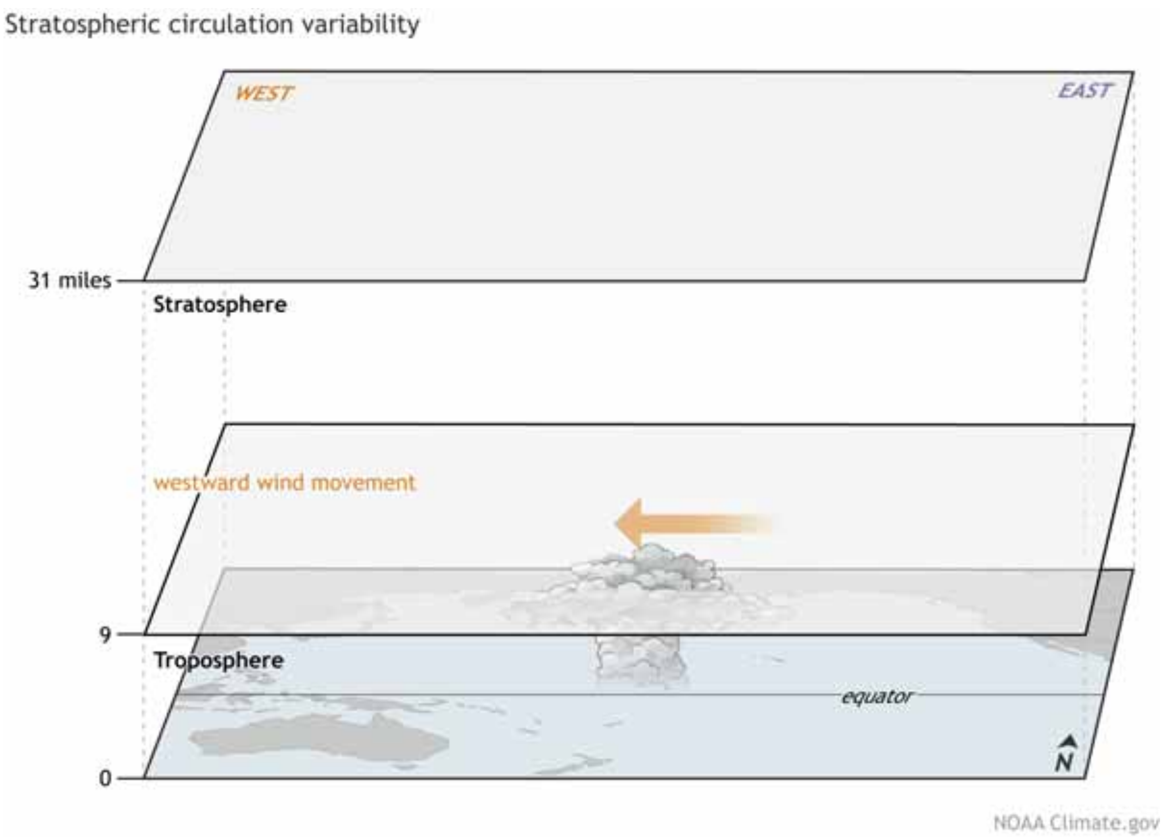
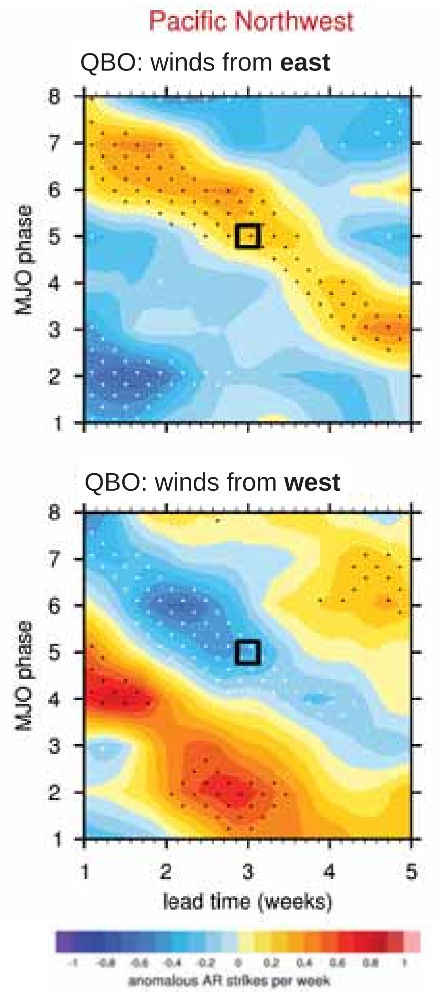
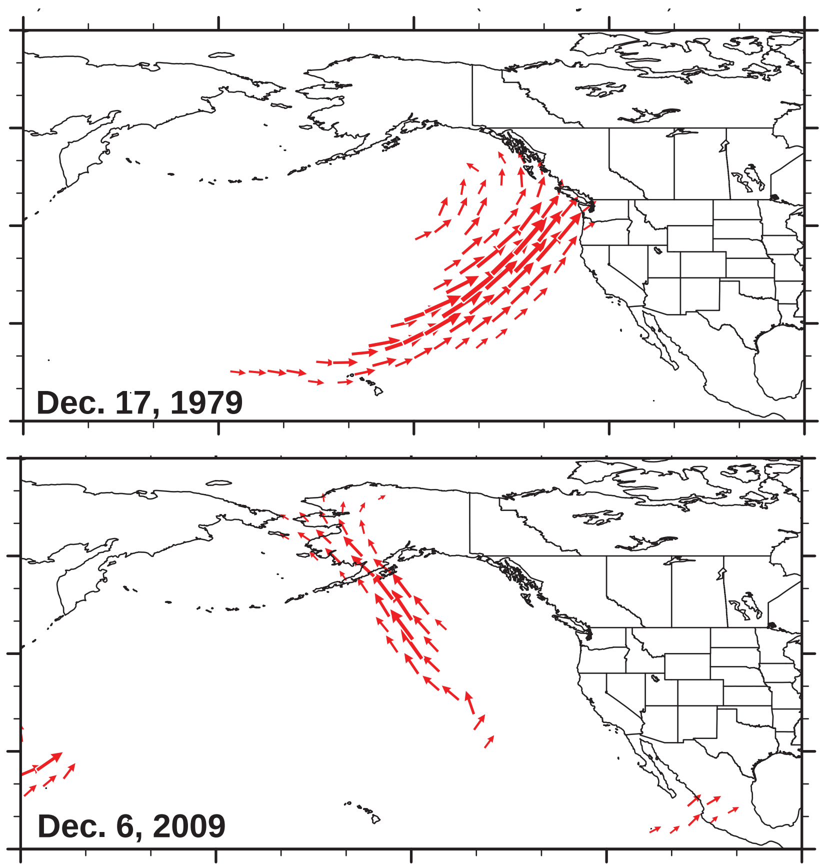


Skill in Atmospheric River Forecasts over the Pacific Northwest





Baggett et al. (GRL, 2017)
Composites of 7-day average activity
ERA-Interim

current research by Elizabeth Barnes, Eric Maloney, Cory Baggett & Bryan Mundhenk (CSU); MAPP Award: NA16OAR4310064

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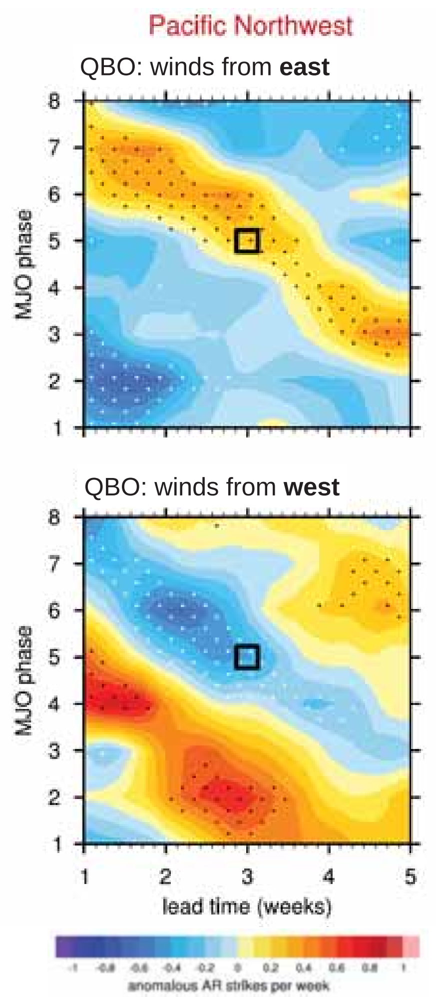

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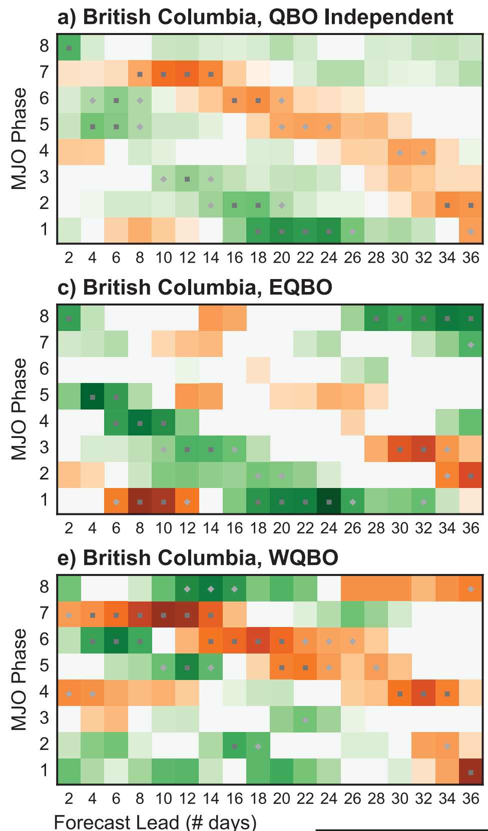

Mundhenk et al. (NPJ Climate, 2018)
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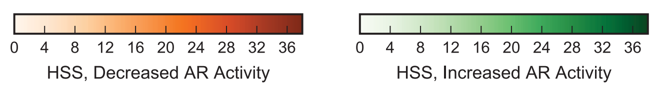
MERRA-2



Heidke Skill Score

prediction skill 30+ days ahead of time using a statistical model based solely on the MJO & QBO

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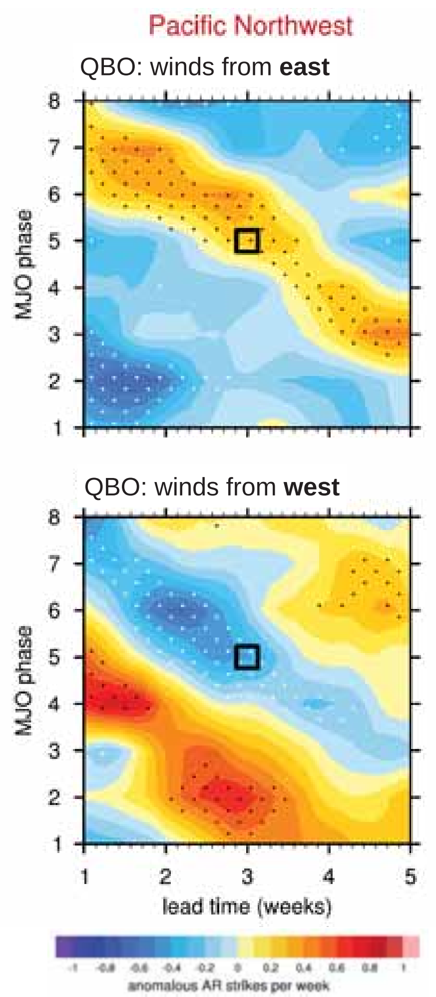

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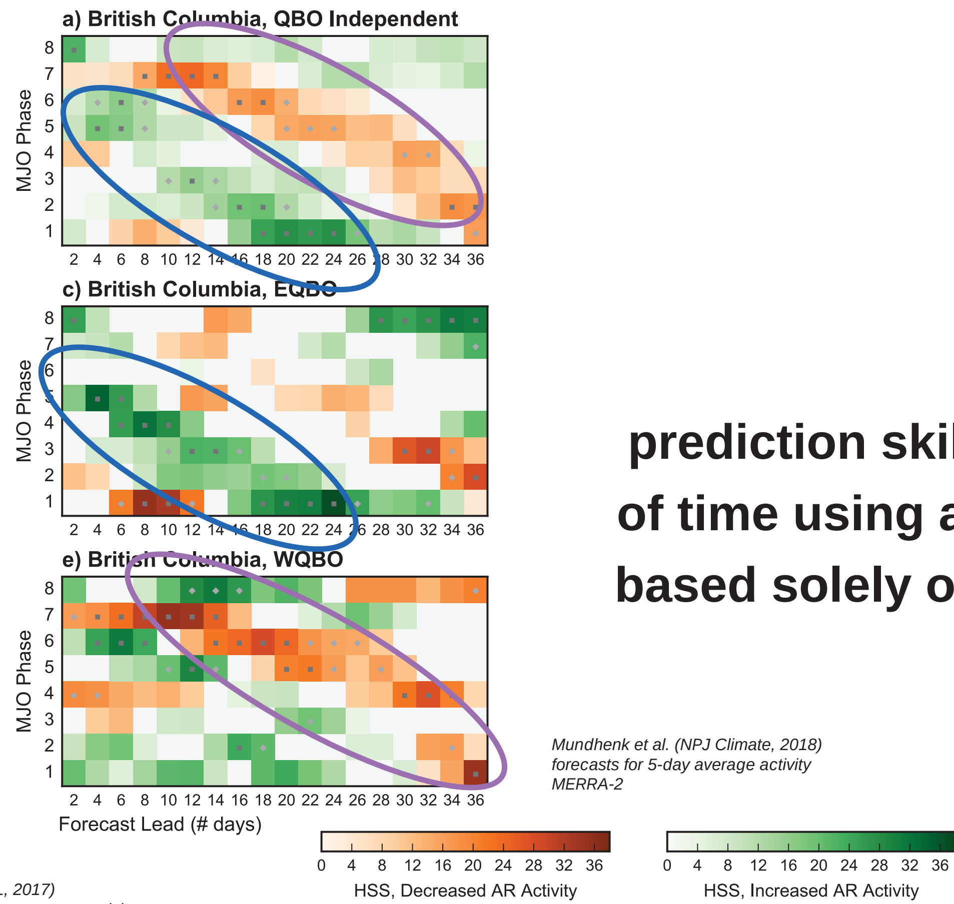

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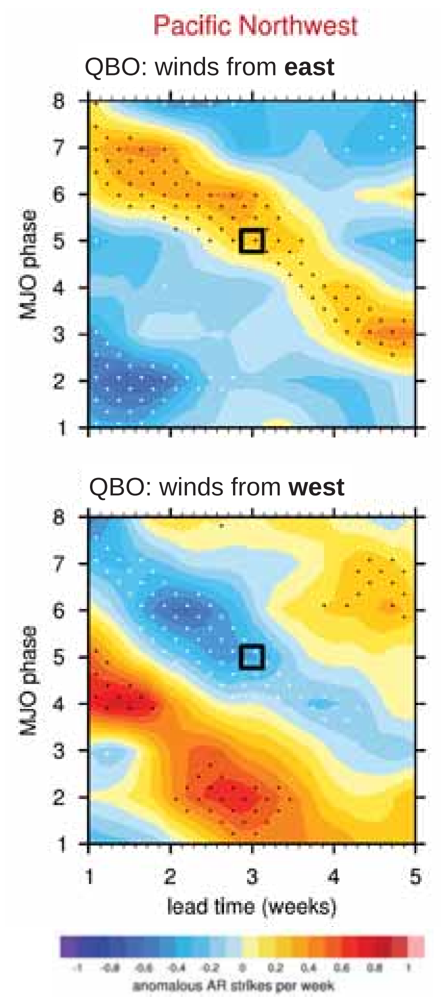

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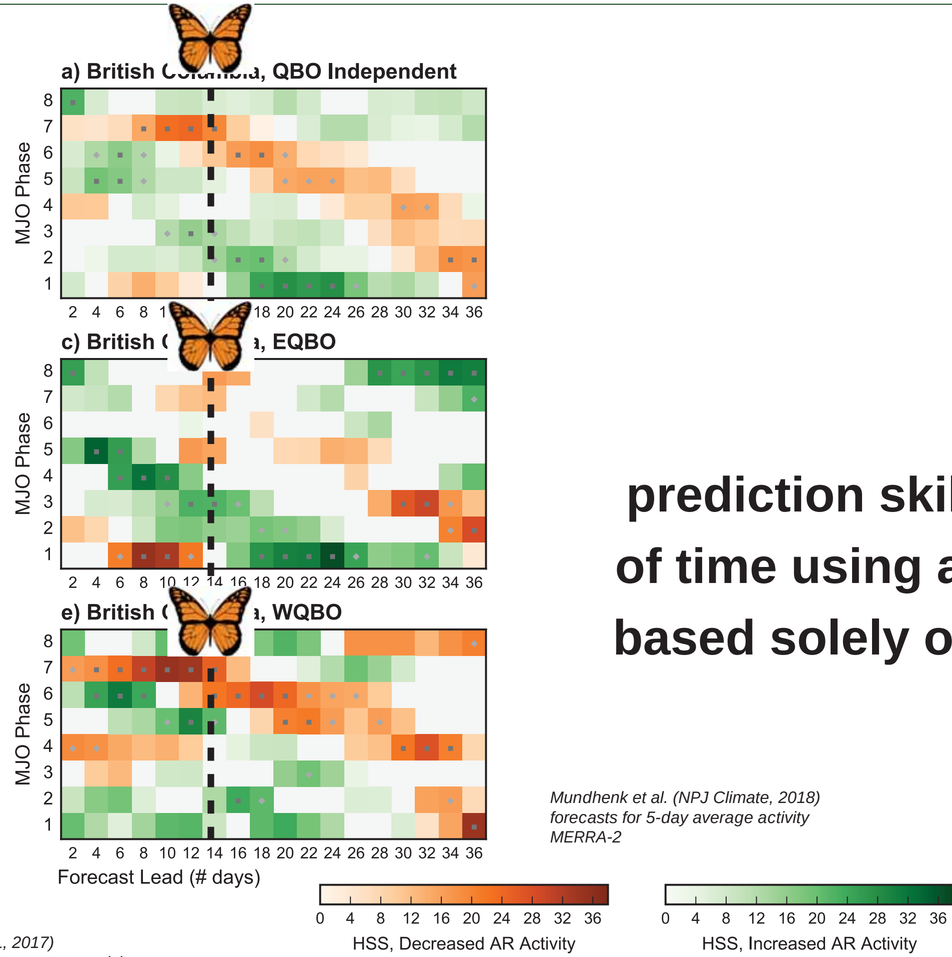

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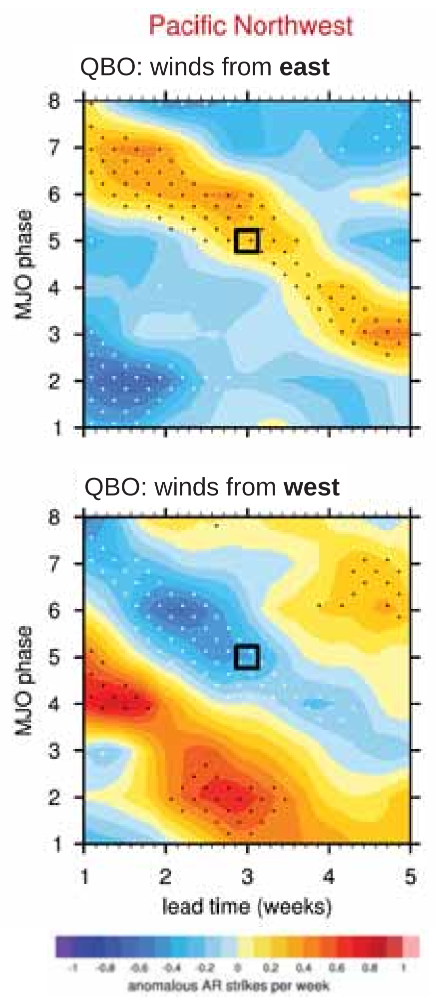

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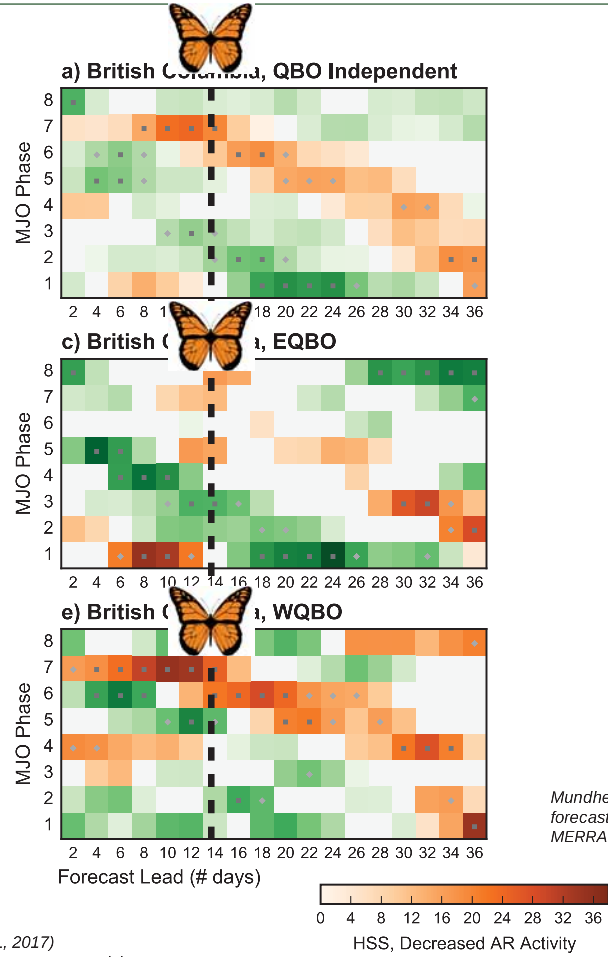

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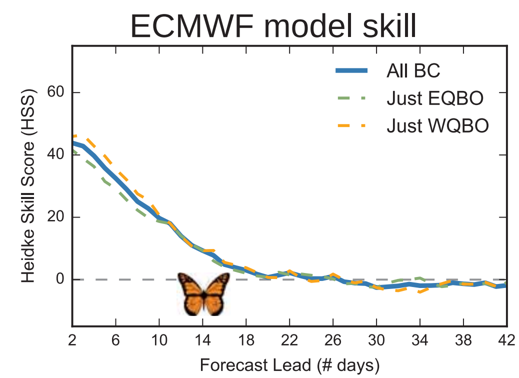

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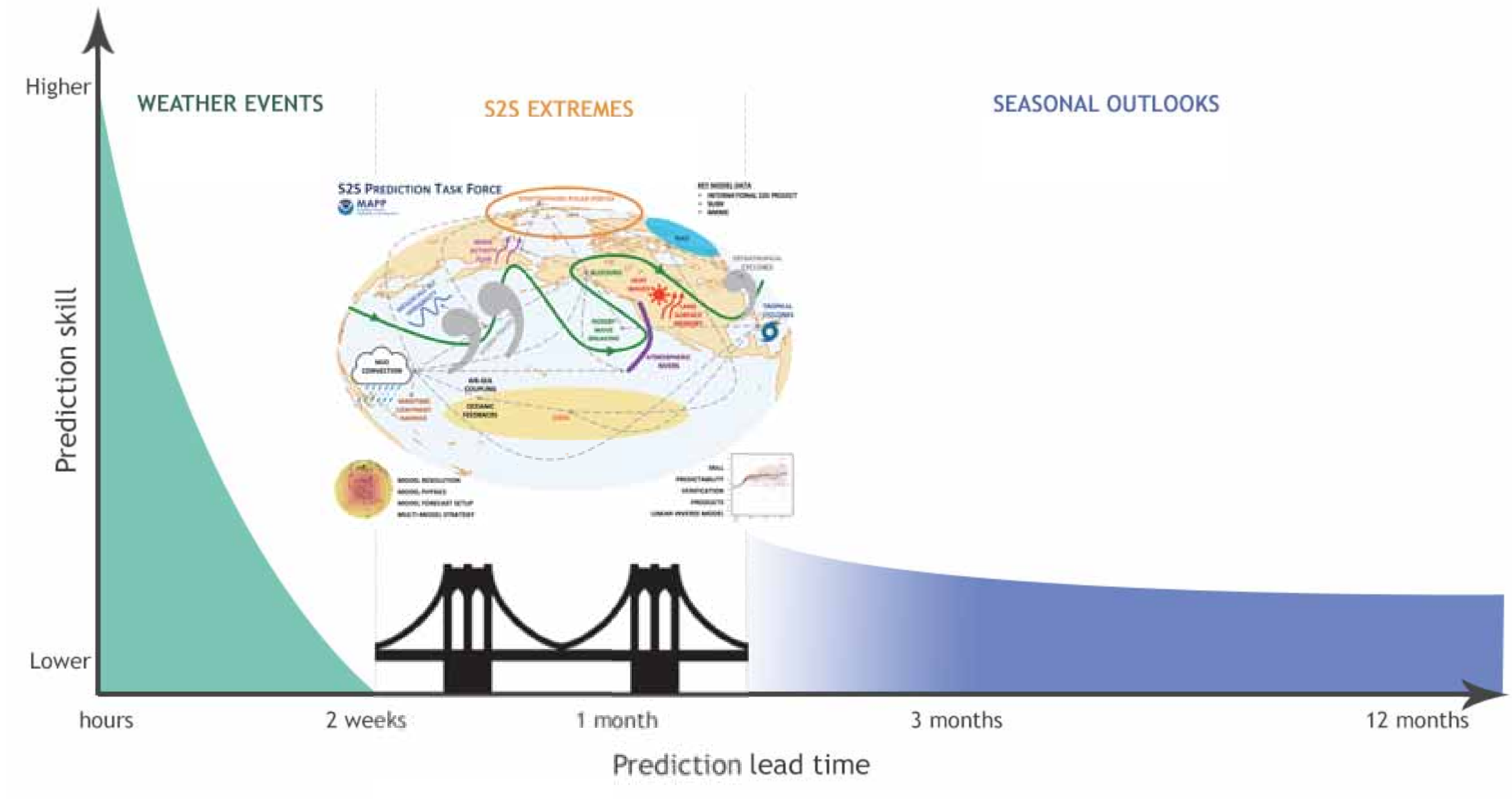
Bridging the Gap: NOAA MAPP's S2S Prediction Task Force



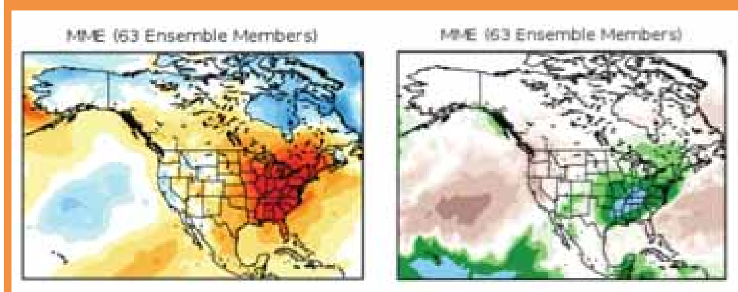
http://cpo.noaa.gov/Meet-the-Divisions/Earth-System-Science-and-Modeling/MAPP/MAPP-Task-Forces/S2S-Prediction-Task-Force

The Subseasonal eXperiment (SubX)

By the Numbers...

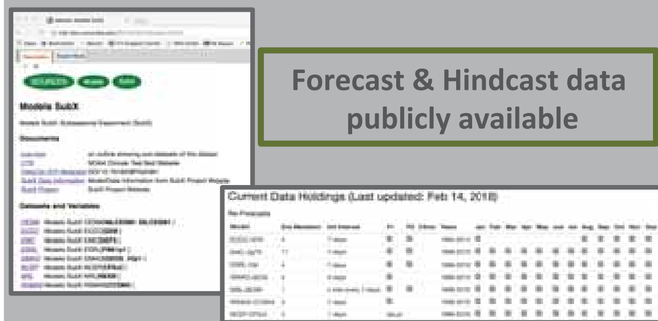
7 **Global Models**
17 **Years of Retrospective Forecasts**
1 **Year of Real-time Forecasts**
3-4 **Week guidance for CPC Outlooks**

Real-time Multi-model Forecasts



SubX Team

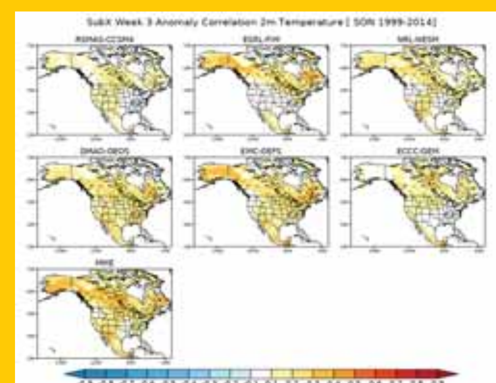
IRI Data Library



Forecast & Hindcast data publicly available

http://iridl.ldeo.columbia.edu/SOURCES/.Models/.SubX/

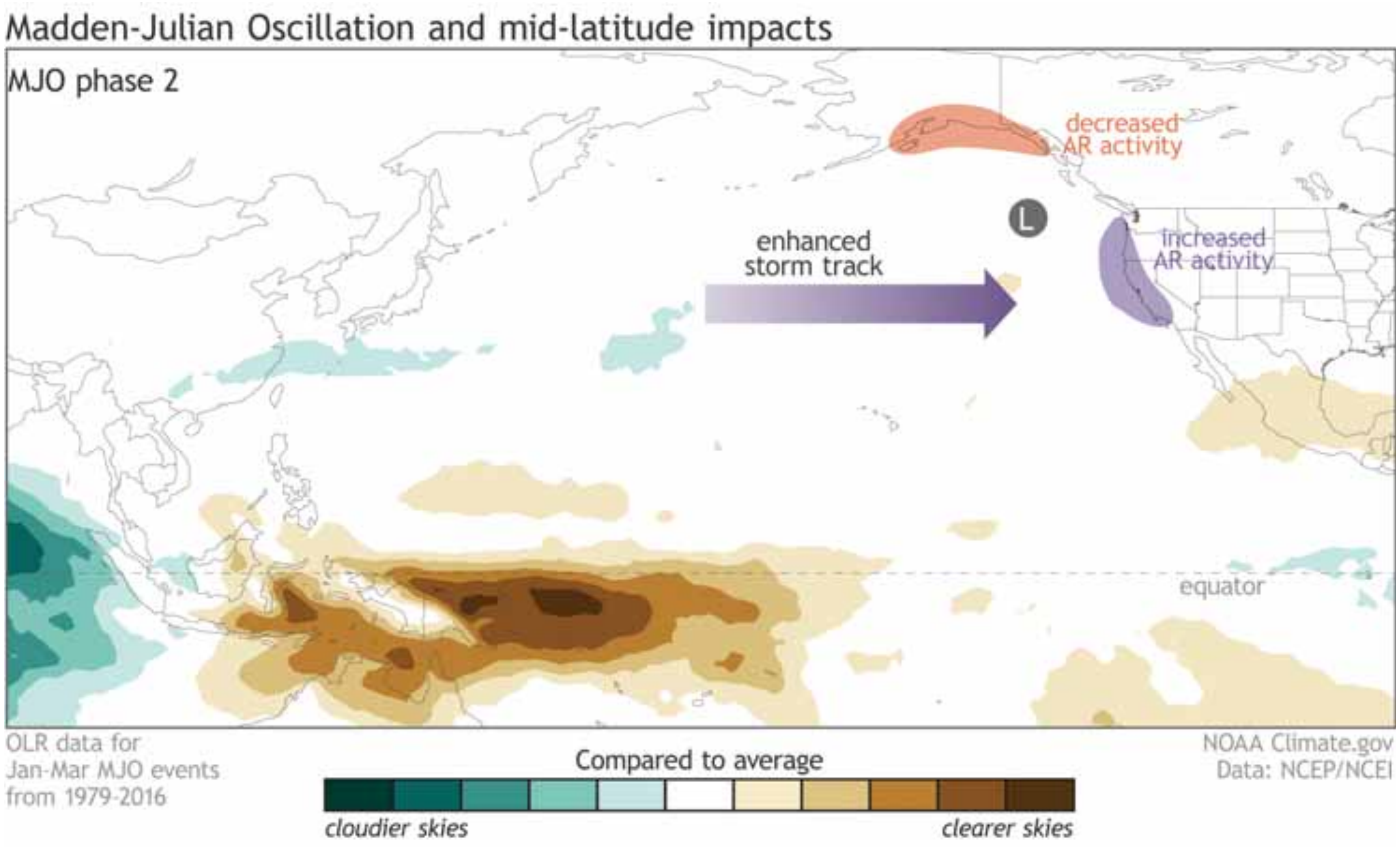
Skill Evaluation



http://cola.gmu.edu/kpegion/subx

slide by Kathy Pegion (GMU)

Looking South: tropical clouds and rain



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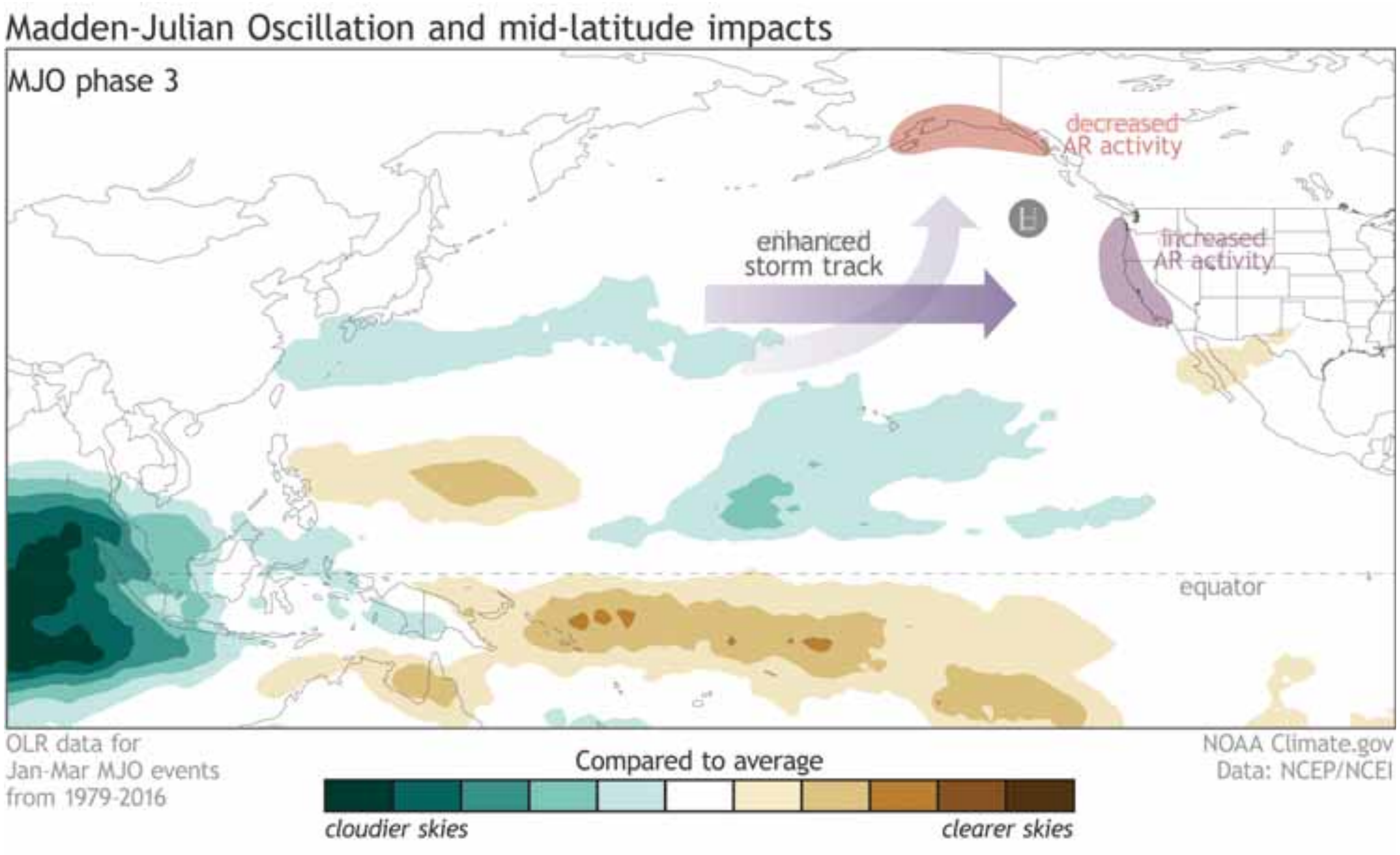

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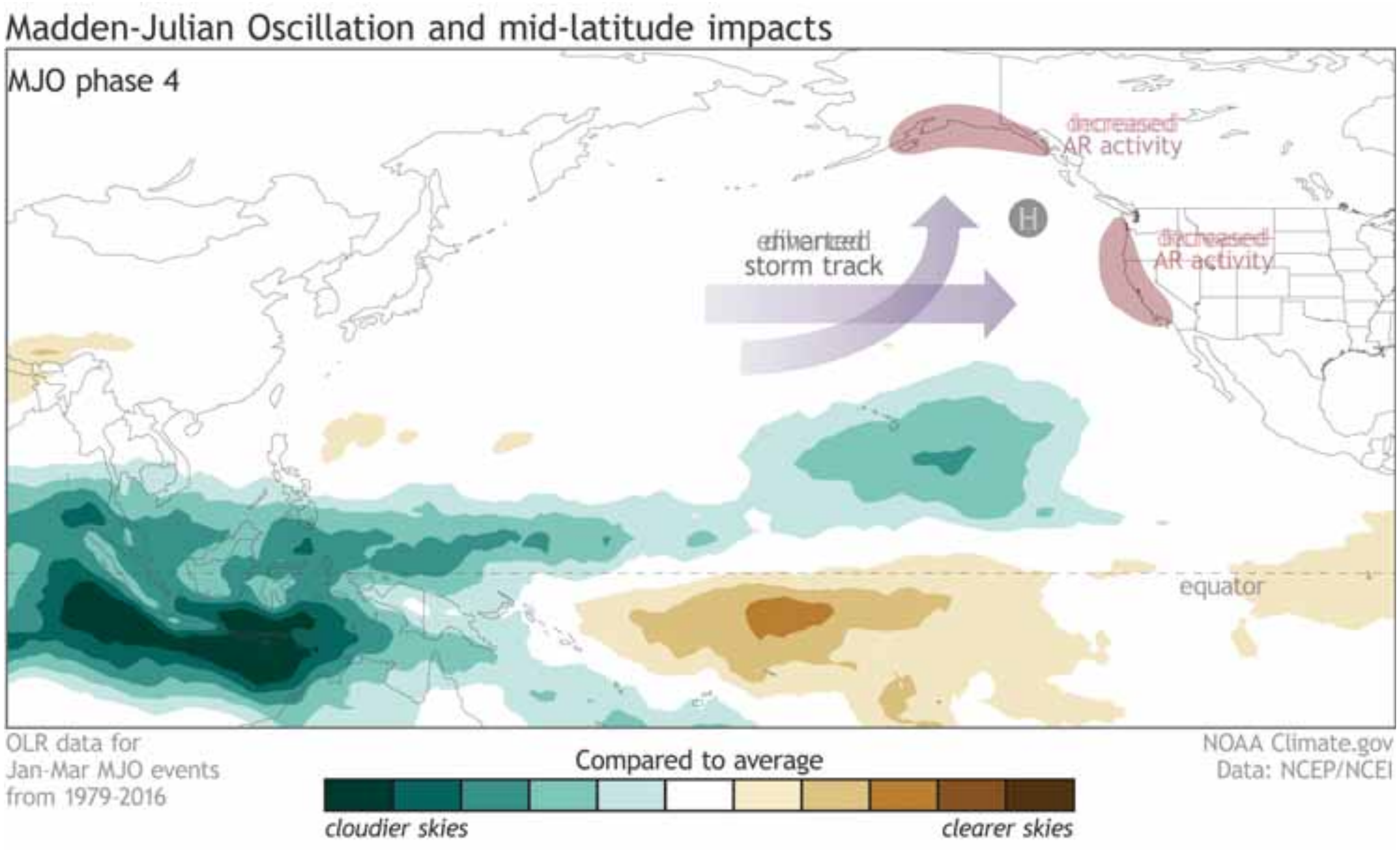

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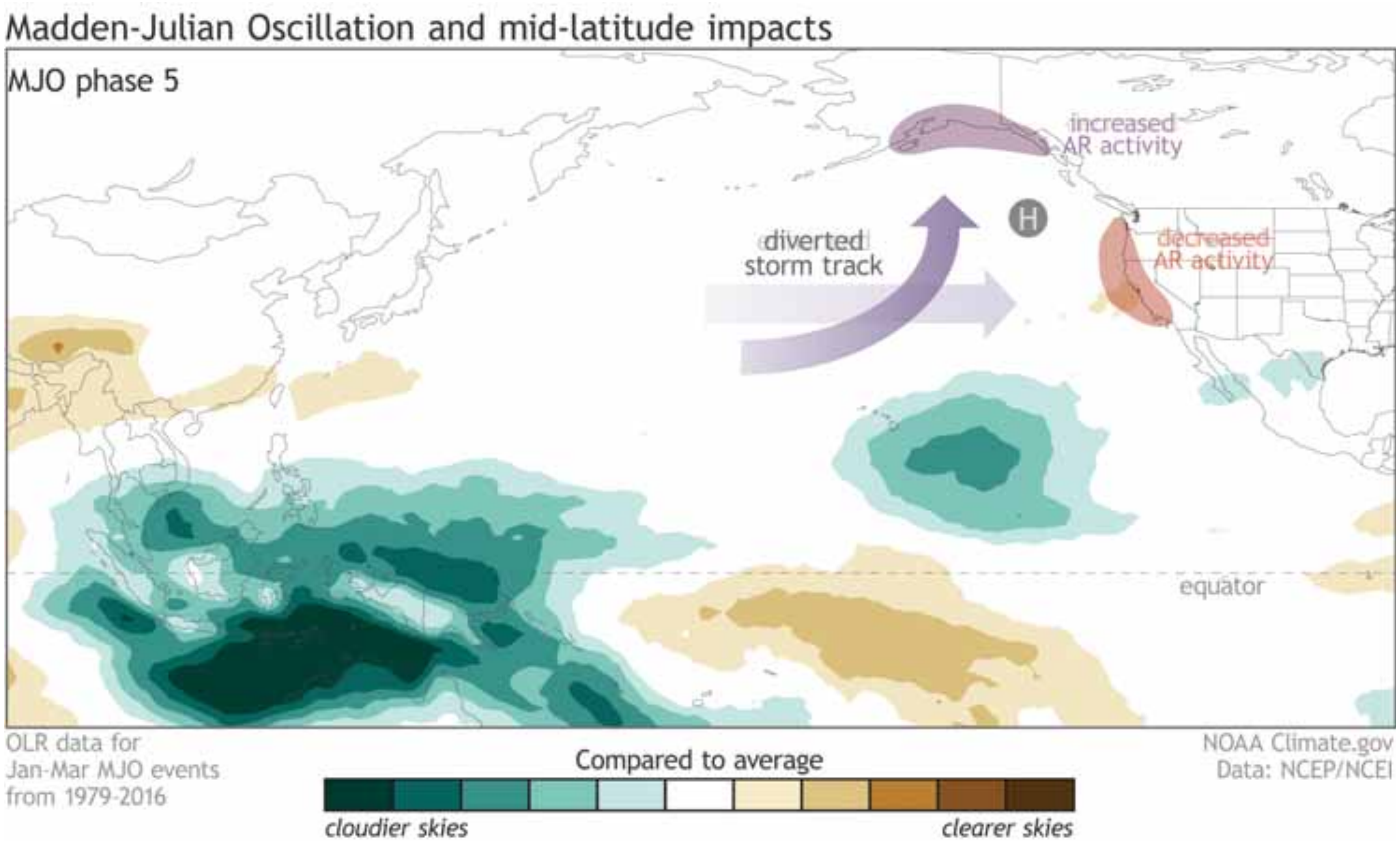

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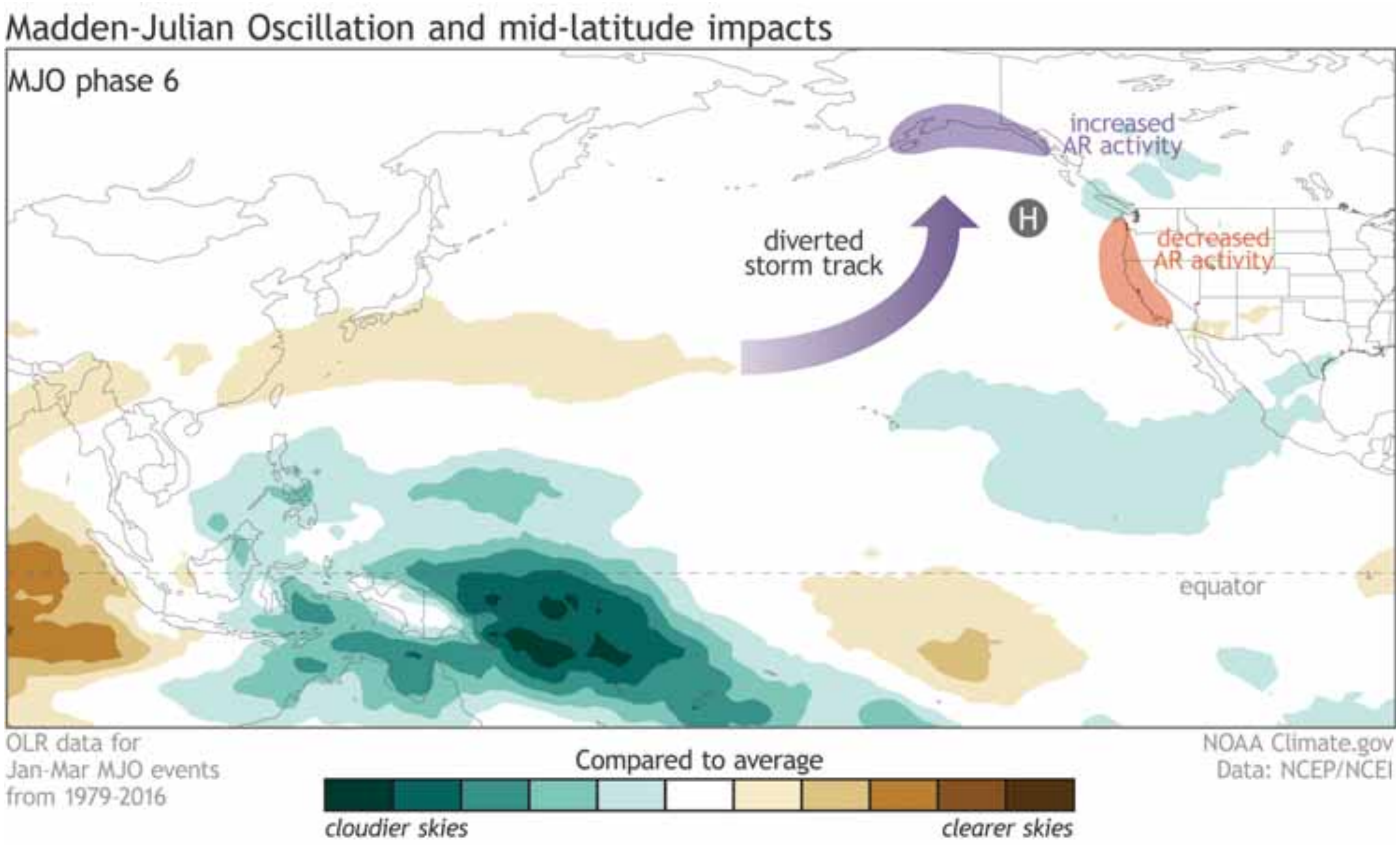

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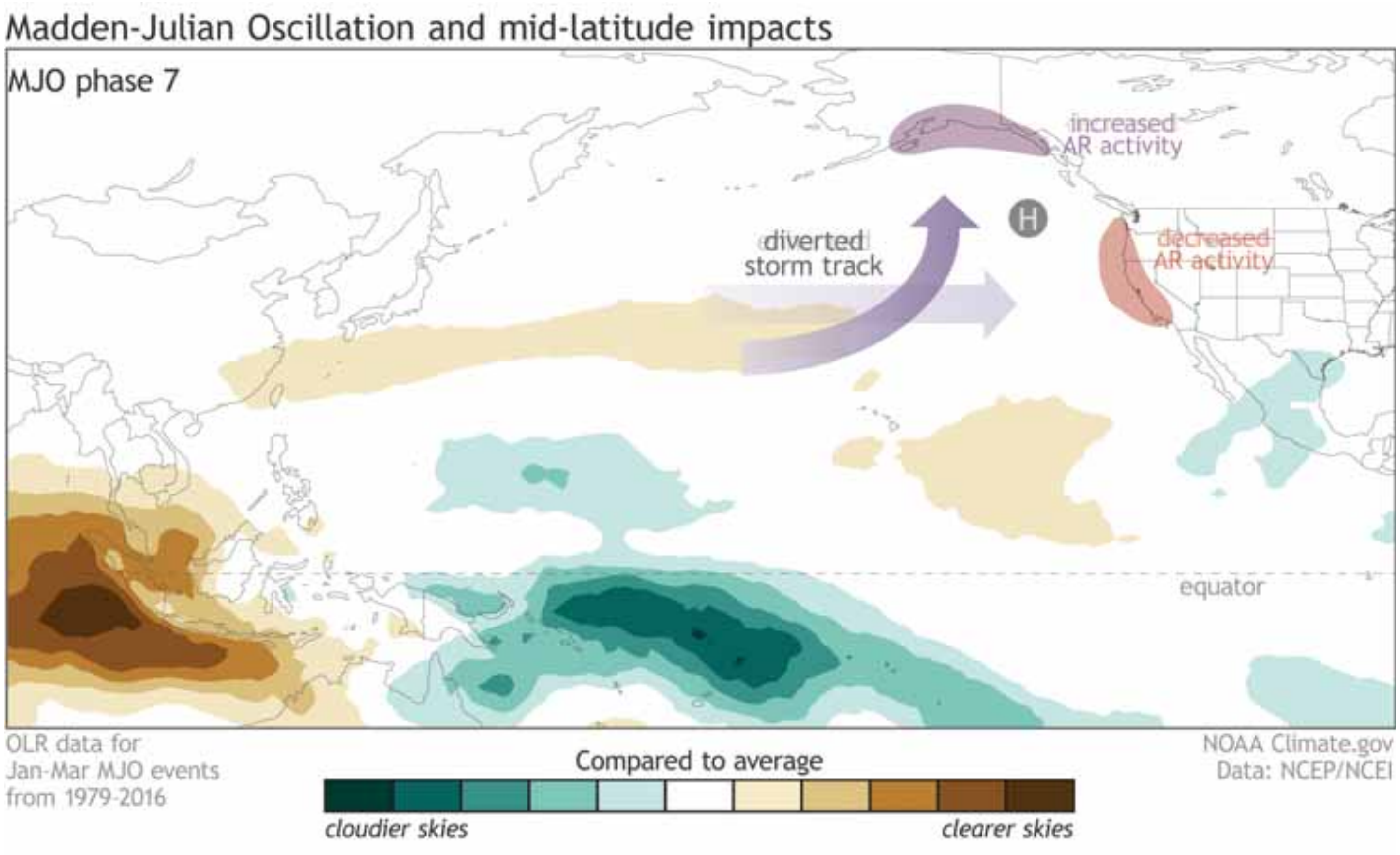

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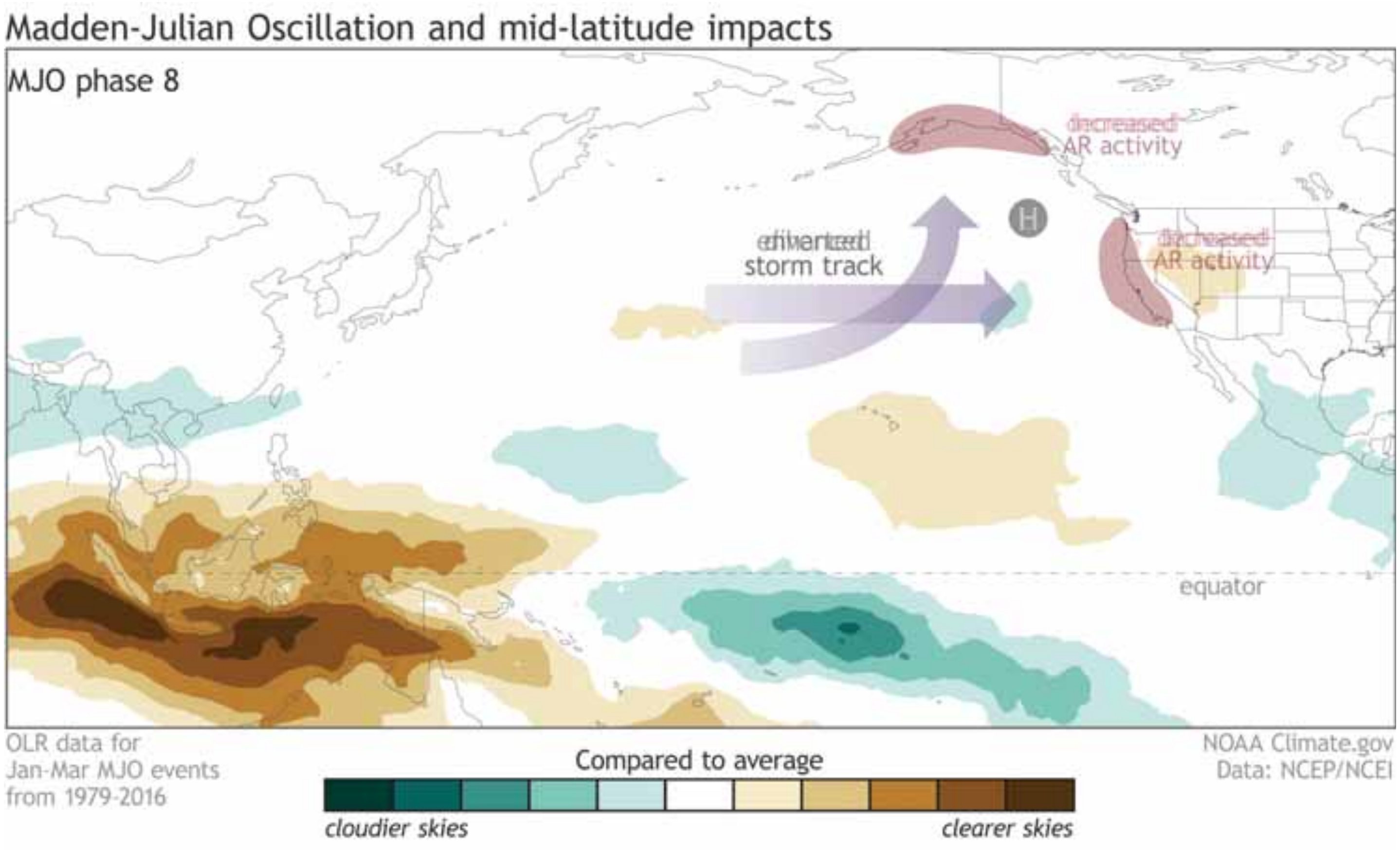

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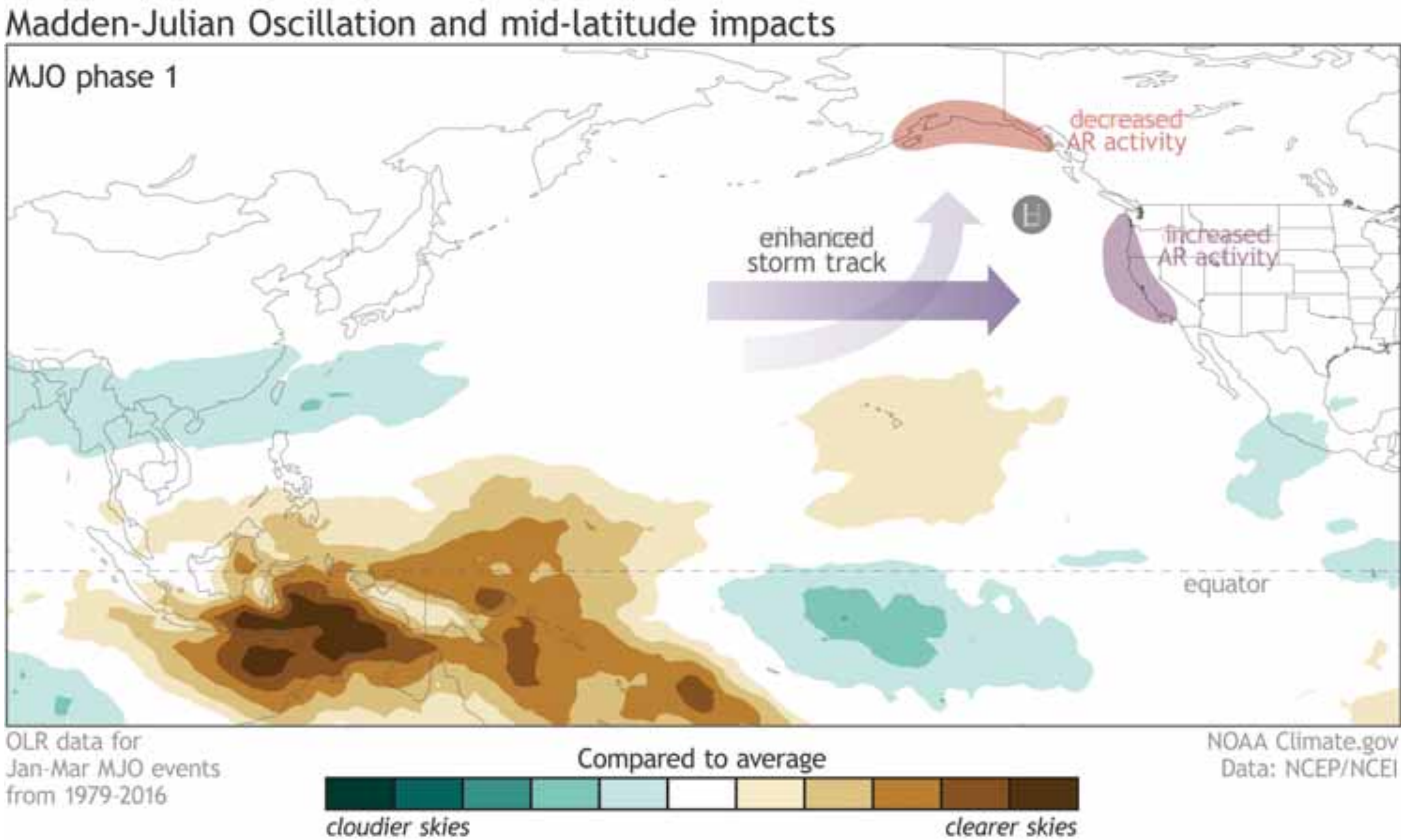

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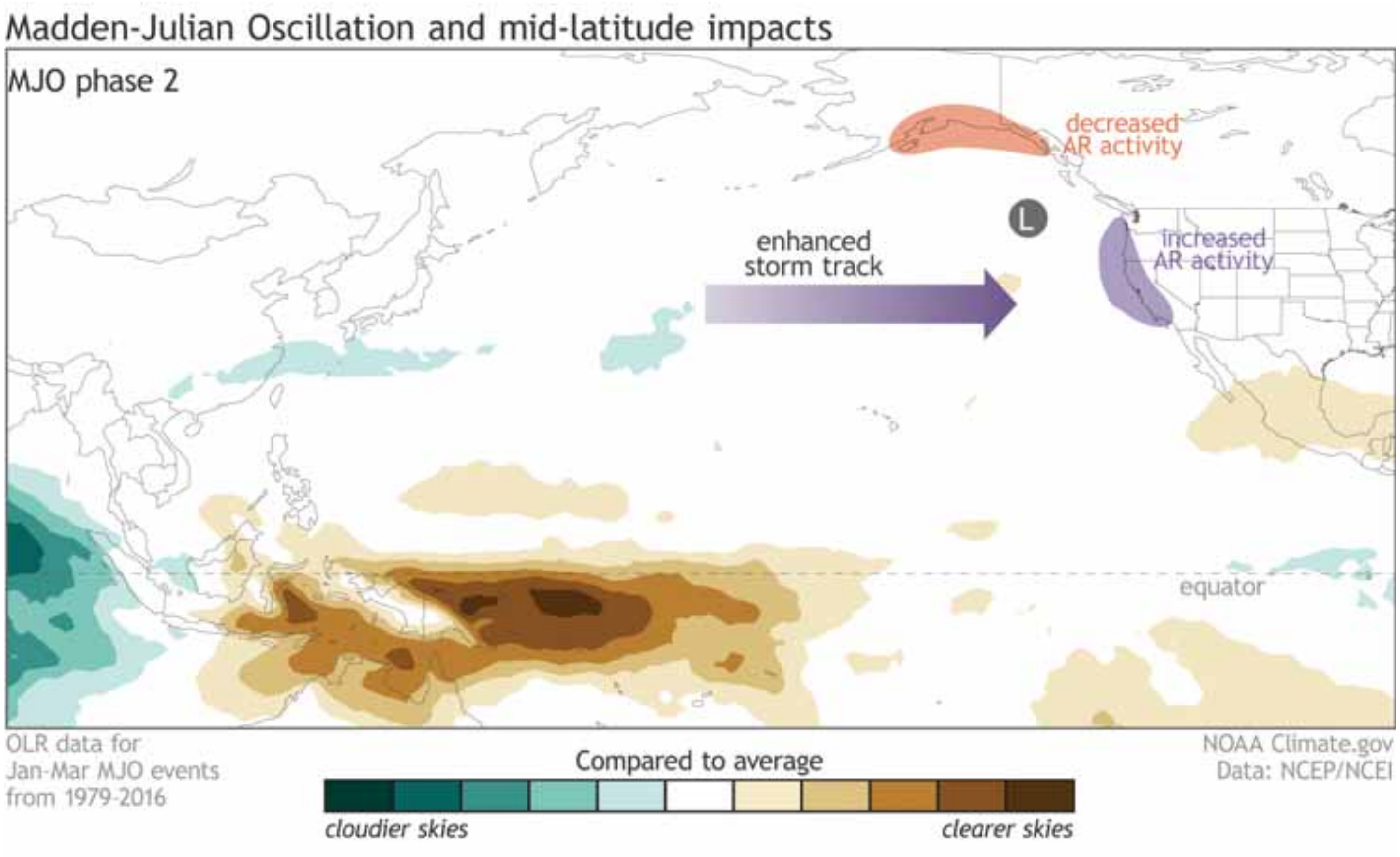
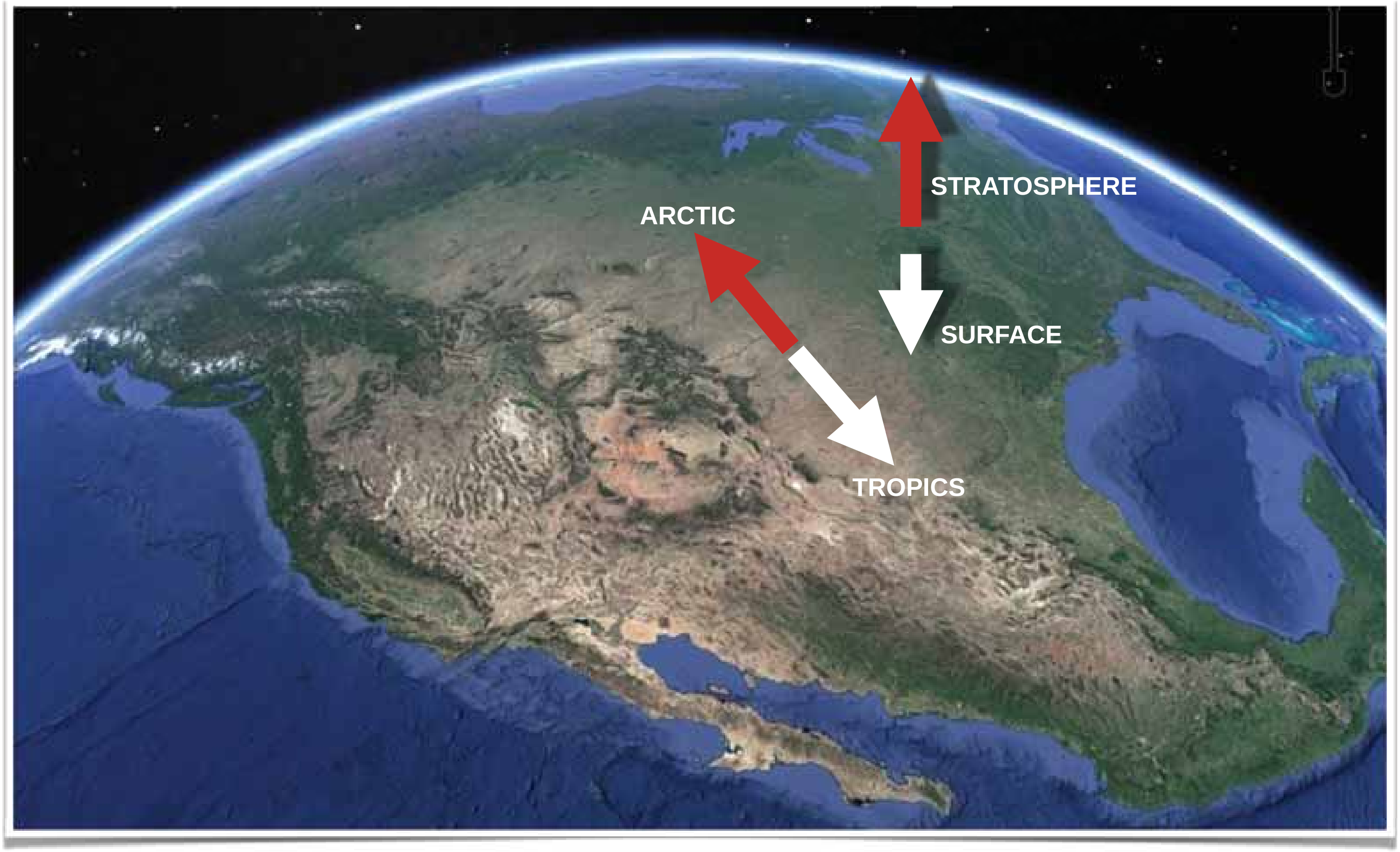
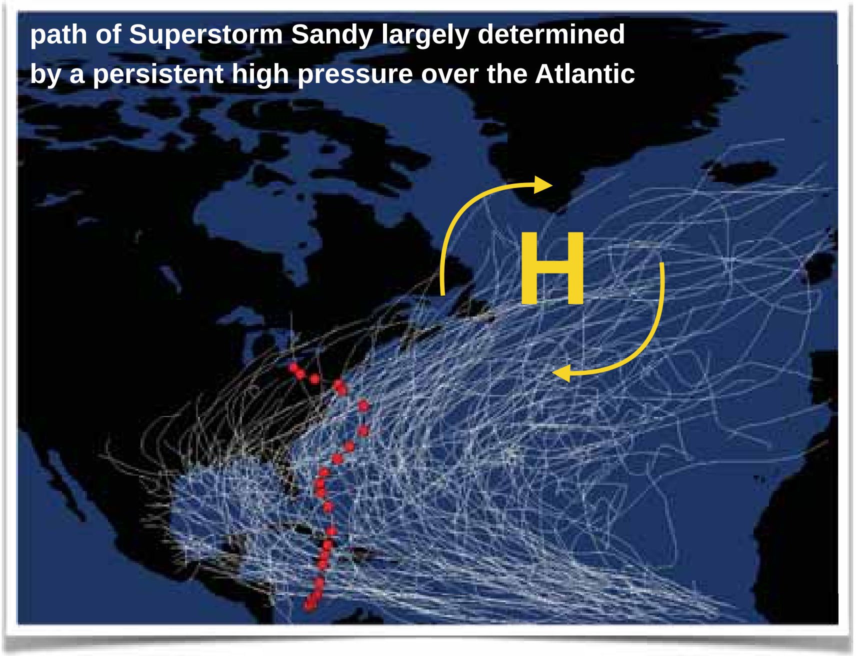
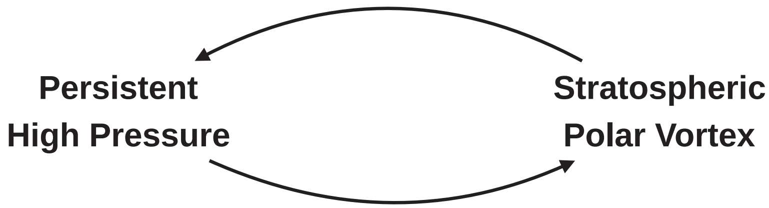


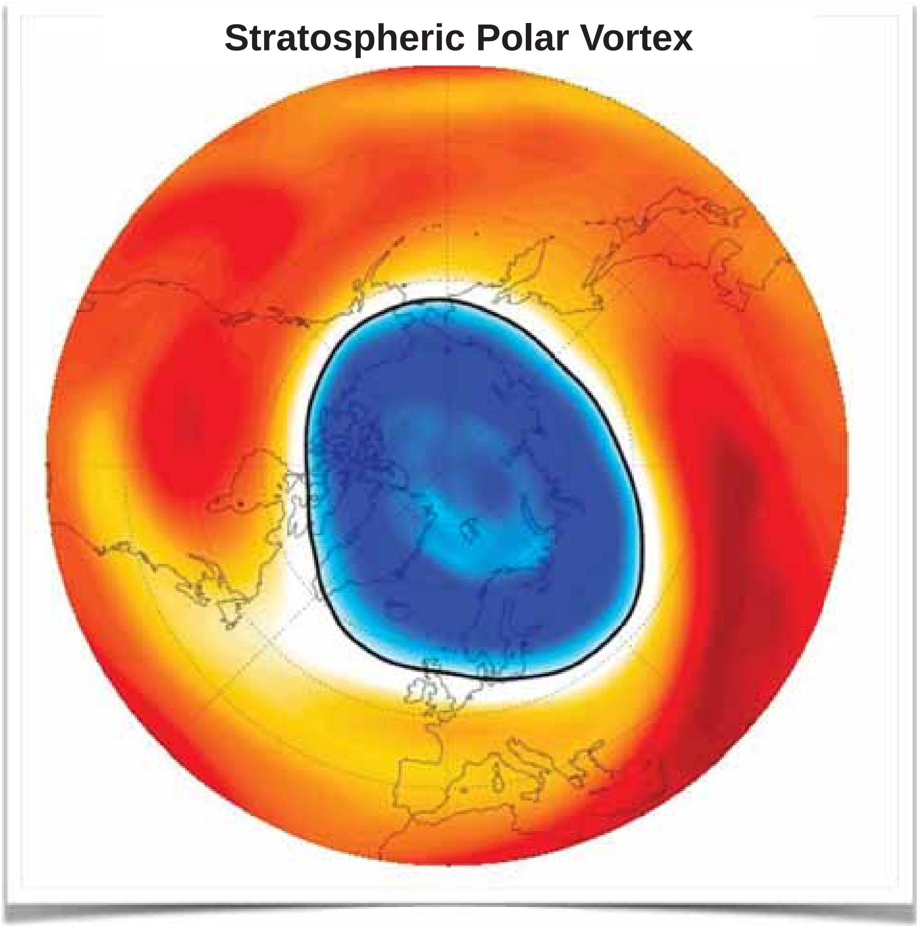
Where should we look to bridge the gap?



Looking North: Arctic polar vortex







ongoing research led by Andrea Lang (University of Albany)
ongoing research led by Jason Furtado (University of Oklahoma)