Short-term climate variability and prediction

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Goals for today:

• Describe modes of climate variability: e.g. El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation, Arctic Oscillation, etc.

• Apply to seasonal climate prediction
Normal conditions in Equatorial Pacific

Walker cell
El Niño (warm state)
La Niña (cool state)
Spreading ENSO effects to higher lat.

- W. Coast of N. America serves as waveguide for warm SST to propagate northward.
- Atmospheric teleconnection: Pac.-N.American (PNA) teleconnection
PNA anomalies

500 mb height anomalies

Surface air temperature anomalies
TYPICAL JANUARY-MARCH WEATHER ANOMALIES AND ATMOSPHERIC CIRCULATION DURING MODERATE TO STRONG EL NIÑO & LA NIÑA

El Niño

La Niña

LOW PRESSURE

PERSISTENT EXTENDED PACIFIC JET STREAM & AMPLIFIED STORMTRACK

VARIABLE PACIFIC JET STREAM

BLOCKING HIGH PRESSURE

VARIABLE
EL NIÑO FOR CANADIAN BIRDS AND BEES:

EL NIÑO, I SEE,
BUT WHAT CAN IT BE?

WARM AND SNOW-FREE—
great time for a bee!

LA NIÑA, I HEAR,
IS THE ONE TO FEAR!

BUT WITH SNOW SO DEEP,
I’LL BE SOUND ASLEEP.
In terms of profit, B.C. Hydro loves

A. El Nino winters as B.C. is warmer
B. La Nina winters as B.C. is colder
C. neither El Nino nor La Nina
D. El Nino winters as there is less snow
E. La Nina winters as there is more snow.
Pacific Decadal Oscillation (PDO)
Arctic Oscillation (AO): positive phase during winter
AO negative phase

With westerlies weak, cold Arctic air reaches more southerly latitudes; the U.S. gets a cold winter.

With lower than normal atmospheric pressure in the central Atlantic and weak westerlies over northern Europe, storms develop over the Mediterranean region.

Weak trade winds prevail.

A pattern of higher than normal atmospheric pressure over the Arctic leads to weaker westerlies in the upper atmosphere.
Positive NAO phase

500 mb height anomalies

Surface air temp. anom.
Atlantic Multidecadal Oscillation (AMO)
The number of hurricanes in the N. Atlantic is expected to be

A. Lower when the AMO is negative
B. Higher when the AMO is negative
AMO index

Accumulated cyclone energy (ACE)
Game plan of our research group

- Machine Learning (neural networks)
- Climate variability
Nonlinear principal component analysis (NLPCA) by neural networks
• Compare 1st mode of tropical Pacific SST anom. from NLPCA and PCA.
Nonlin. CCA (canonical correlation analysis) of sea level pressure (SLP) & SST
Predicting ENSO

• Dynamical coupled atmosphere-ocean models: Expensive.

• Linear regression (LR): \( y = ax + b \)

• Nonlinear regression (NLR): \( y = f(x) \)
  • Use neural networks (NN) for NLR.

• Predictands: tropical Pac. SST anomalies

• Predictors: SLP & SST anomalies.


(a) SSTA NDJ 2009–10

(b) SSTA FMA 2010

(c) SSTA MJJ 2010

(d) SSTA ASO 2010

(27)
Summary

- Modes of climate variability, e.g. ENSO, PNA, PDO, AO (NAO), AMO
- Seasonal climate prediction possible due to signals like ENSO.