GENERATION, PROPAGATION & PERSISTENCE

WARM BLOB IN 2014/15

by Emanuele Di Lorenzo & Nate Mantua
Winter 2013-2014

SSTa

WARM BLOB
Evolution and persistence
Winter 2013-2014

SSTa

Fall 2014

WARM BLOB

Evolution and persistence
Winter 2013-2014

SSTa

Fall 2014

Winter 2014-2015

WARM BLOB

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Winter 2013-2014

SSTa

Fall 2014

Winter 2014-2015

GOA SSTa Index

CCS SSTa Index

°C

-2 -1.5 -1 -0.5 0 0.5 1 1.5 2

-200 -150 -100 0 20 40 60
Winter 2013-2014

Winter 2014-2015

GOA SSTa Index

Gulf of Alaska

evolution of 2014/15

CCS SSTa Index

California Current
Atmosphere Sea Level Pressure

- Winter 2013-2014

GOA SSTa Index

- Gulf of Alaska

- CCS SSTa Index

- California Current

- Atmosphere Sea Level Pressure

- Winter 2014-2015

- CCS SSTa Index

- California Current
SLPa GOA Index

GOA SSTa Index

Gulf of Alaska

CCS SSTa Index

California Current
\[
\frac{d\text{SST}_a(t)}{dT} = \alpha \cdot \text{SLPI}(t) - \frac{\text{SST}_a(t)}{\tau_{\text{dissipation}}}
\]
\[
\frac{dSSTa(t)}{dt} = \alpha \cdot SLPI(t) - \frac{SSTa(t)}{\tau_{dissipation}}
\]
Strong SSTa Anomalies in winters 2014/2015 driven by atmosphere
Strong SSTa Anomalies in winters 2014/2015 driven by atmosphere.
QUESTION:
Are the 2014 and 2015 anomalies linked?
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Are the 2014 and 2015 anomalies linked?
Winter 2013-2014

SSTa

Fall 2014

Warm Blob

Evolution and persistence

Winter 2014-2015

°C
Winter 2013-2014

NPGO-like

Fall 2014

Warm Blob

Evolution and persistence

Winter 2014-2015
Winter 2013-2014

NPGO-like

Fall 2014

ENSO-like

Winter 2014-2015

PDO-like

Warm Blob

Evolution and persistence
Winter 2013-2014

NPGO-like

Fall 2014

ENSO-like

Winter 2014-2015

PDO-like
North Pacific Gyre Oscillation

Strong in Winter 2013/2014

Winter 2014-2015
PDO-like

North Pacific Oscillation
ATMOSPHERE

Winter 2013-2014

Fall 2014
ENSO-like
Strong in Winter 2013/2014

Aleutian Low

North Pacific Oscillation

ENSO-like

Fall 2014

Winter 2014-2015

Pacific Decadal Oscillation

Winter 2013-2014

North Pacific Gyre Oscillation
Strong in Winter 2013/2014

Aleutian Low
ATMOSPHERE

Winter 2014-2015

Pacific Decadal Oscillation
OCEAN

North Pacific Oscillation
ATMOSPHERE

Winter 2013-2014

North Pacific Gyre Oscillation
OCEAN

ENSO

Fall 2014
**Evolution of the warm blob**

Cross Correlation **GOA SSTA vs. CCS SSTA**

- **CCS SSTA Index Leads**
- **CCS SSTA Index Lags**

- 99%
- 95%

**Cross Correlation GOA SSTA vs. CCS SSTA**

- 12 months

**Sample Cross Correlation**

- -0.2
- -0.1
- 0
- 0.1
- 0.2

**Lags**

- -40
- -30
- -20
- -10
- 0
- 10
- 20
- 30
- 40

**Months Lag**
Evolution of the warm blob

Cross Correlation GOA SSTa vs. CCS SSTa

Gulf of Alaska leads California Current

Correlation

CCS SSTa Index Leads

99%

95%

12 months

-40 -30 -20 -10 0 10 20 30 40

Months Lag

-0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8

-0.2 -0.1 0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8
Evolution of the warm blob

Aleutian Low
ATMOSPHERE

North Pacific Oscillation
ATMOSPHERE

North Pacific Gyre Oscillation
OCEAN

Pacific Decadal Oscillation
OCEAN

ENSO

TROPICS

EXTRA-TROPICS

Winter (JFM) 2014

Fall (OND) 2014

Winter (JFM) 2015

Winter (JFM) 2014

Winter (JFM) 2015
Evolution of the warm blob

**QUESTION**
What was the role of ENSO teleconnection in the persistence?
Evolution of the warm blob

GOAL
Show that ENSO teleconnection contributed to the persistence

Winter SLPa (JFM)

Fall ENSO SLPa (OND)
Evolution of the warm blob

Winter SLPa (JFM)

Tropics

Fall ENSO SLPa (OND)
Evolution of the warm blob

Winter SLPa (JFM)

Fall ENSO SLPa (OND)
Evolution of the warm blob

Winter SLPa (JFM)

Fall ENSO SLPa (OND)

ENSO events
Evolution of the warm blob

- Winter SLPa (JFM)
- Fall ENSO SLPa (OND)

R = 0.64
Evolution of the warm blob

Winter SLPa (JFM)

Fall ENSO SLPa (OND)

TROPICS
QUESTION:
What fraction of variance is accounted by ENSO teleconnection?
**GOAL:**

Decompose SLPa into contributions from **Tropics vs. North Pacific**

**Winter SLPa (JFM)**

**Evolution of the warm blob**

**Winter 2015 North Pacific ~2.2**

UNITS = std
Evolution of the warm blob

- Winter SLPa (JFM)
- Winter NP SLPa (JFM)
- Fall ENSO SLPa (OND)

GOAL:
Decompose SLPa into contributions from Tropics vs. North Pacific

Winter 2015 North Pacific
~2.2

UNITS = std
Evolution of the warm blob

Winter SLPa (JFM)

Winter NP SLPa (JFM)

Fall ENSO SLPa (OND)

Winter 2015 North Pacific
~2.2

UNITIS = std

NP contribution
~1.2
Evolution of the warm blob

Winter SLPa (JFM)

II

Winter NP SLPa (JFM)

+

Fall ENSO SLPa (OND)

Winter 2015 North Pacific
~2.2

UNITS = std

NP contribution
~1.2

Tropical contribution
~1
RESULTS

• Tropical teleconnection accounts ~50%
• North Pacific contribution strong but not unusual

Winter NP SLPa (JFM)

Fall ENSO SLPa (OND)

Winter 2015 North Pacific ~2.2

NP contribution ~1.2

Tropical contribution ~1

UNITS = std
Evolution of the warm blob

Aleutian Low

North Pacific Oscillation

Pacific Decadal Oscillation

North Pacific Gyre Oscillation

Winter (JFM) 2015

Winter (JFM) 2014

Fall (OND) 2014

ENSO
Are these extreme climate events becoming more frequent?
Evolution of the warm blob

- Aleutian Low (Atmosphere)
- Pacific Decadal Oscillation (Ocean)
- North Pacific Oscillation (Atmosphere)
- North Pacific Gyre Oscillation (Ocean)

- Winter (JFM) 2015
- Winter (JFM) 2014
- Fall (OND) 2014
- Fall 2015
- ?

- ENSO
Evolution of the warm blob

**Strength**

of tropical/extra-tropical coupling

OBSERVED

Wang et al. 2014

North Pacific Oscillation
ATMOSPHERE

Winter (JFM) 2014

Extra-Tropics

Aleutian Low

North Pacific Gyre Oscillation
OCEAN

Fall (OND)

2014

2015

Winter (JFM)

2013-2014

2014-2015

Tropics

EXTRA-TROPICS

Evolution of the warm blob

**Strength**

of tropical/extra-tropical coupling

OBSERVED

Wang et al. 2014

North Pacific Oscillation
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OCEAN

Fall (OND)

2014

2015

Winter (JFM)

2013-2014

2014-2015

Tropics

EXTRA-TROPICS
Evolution of the warm blob

**Strength**

of tropical/extra-tropical coupling

**Greenhouse Forcing** (model)

OBSERVED

**Natural** (model)

Wang et al. 2014
Evolution of the warm blob

Strength of tropical/extra-tropical coupling

Greenhouse Forcing

(model)

Natural

(model)

Wang et al. 2014

Winter (JFM) 2014

North Pacific Gyre Oscillation

Ocean

Atmosphere

Extra-tropics

Aleutian Low

North Pacific

Oscillation

ENSO

Pacific Decadal Oscillation

Fall (OND) 2014

Fall (OND) 2015

STRENGTH
QUESTION

Why would this connection become stronger?
QUESTION

Why would this connection become stronger?

Hypothesis:

*Thermodynamic ocean-atmosphere coupling is stronger*
Hypothesis:

Thermodynamic ocean-atmosphere coupling is stronger
Evolution of the warm blob

Aleutian Low
ATMOSPHERE

Winter (JFM) 2015

Pacific Decadal Oscillation
OCEAN

North Pacific Oscillation
ATMOSPHERE

Winter (JFM) 2014

North Pacific Gyre Oscillation
OCEAN

ENSO

Fall (OND) 2014

TROPICS

EXTRA-TROPICS
Evolution of the warm blob

**Working Hypothesis** for generation of persistence, stronger and more frequent of climate event in the North Pacific