

Abnormal winter weather in Japan during 2012 controlled by large-scale atmospheric and small-scale oceanic phenomena

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1. Introduction

- Winter 2012/13: **abnormal cold** over Eurasian continent
- Cold winters continued for last three years and are associated with negative Arctic Oscillation (AO)
- Another important teleconnection associated with cold Eastern Asia is negative Western Pacific (WP) pattern
- Sep. to Dec. 2012: AO and WP were **continuously negative**
- Fall 2012: **Record-breaking high** small-scale ocean temperature around Japan

Research Object

We examined whether **extremely cold 2012/13 winter** was accompanied by **abnormal changes in large-scale atmosphere and small-scale ocean**

2. Data and Methods

- Geopotential height, air temperature, and heat flux: NCEP/NCAR reanalysis data
- Sea Surface Temperature (SST): NOAA 1/4°OISST V2
- Surface Air Temperature (SAT) in Japan: Automated Meteorological Data Acquisition System (AMeDAS)
- The analysis period was 31 years (1982 to 2012)

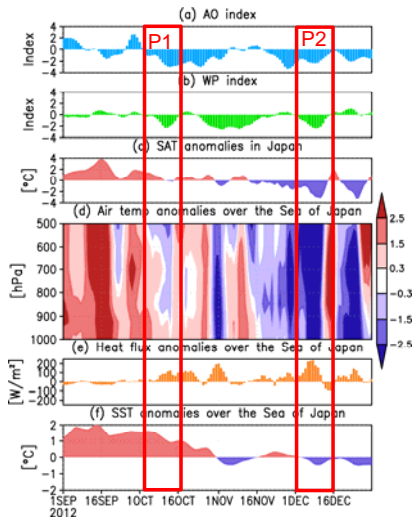
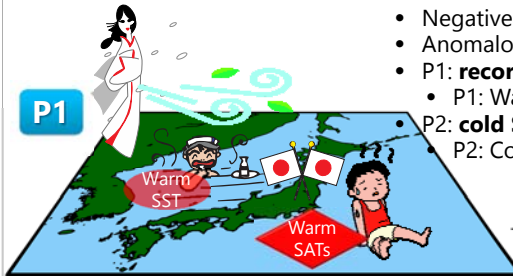


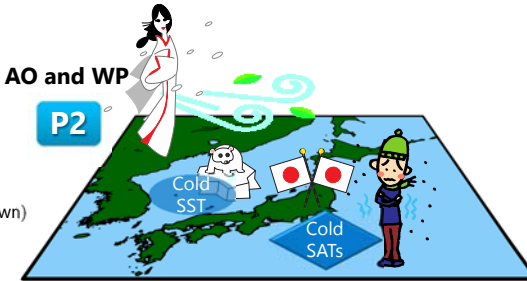
Fig. 1. (a) AO index as defined by Ogi *et al.* [2004], (b) WP index, (c) SAT anomalies in Japan from the AMeDAS station data, (d) air temperature anomalies, (e) heat flux anomalies index, (f) SST anomalies. Panels (d), (e), and (f) are areal averages over the Sea of Japan (the area inside the orange box in Fig. 4).

5. Discussion and Conclusions



- Negative AO and WP make cold surge
- Anomalous upward heat fluxes resulted from negative AO and WP
- P1: **record-breaking warm SST overwhelmed cooling influence of AO and WP**
 - P1: Warm SATs
- P2: **cold SST added to intensity of cold SATs**
 - P2: Cold SATs

- AO and WP were not significantly correlated with SST (Fig. 3a and 3b)
- Another "unknown" large-scale atmosphere did not exist (Figures not shown)
- Support the assumption that SST influenced SATs**



Our conclusion may be relevant to other islands, to peninsulas surrounded by the ocean, and even to coastal continental areas. This study also suggests that an island climate cannot be correctly predicted by a numerical experiment, such as a simulation of global warming, if the surrounding small-scale ocean temperature distribution cannot be correctly predicted as well.



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References

Ando, Y., M. Ogi, and Y. Tachibana, 2014: Abnormal winter weather in Japan during 2012 controlled by large-scale atmospheric and small-scale oceanic phenomena, *Mon. Weather Rev.* (revised)

3. Large-scale Atmosphere Control

- Unusual two-week continuous negative** phases both the AO index (AOI) and WP index (WPI)
 - P1: 3 October to 16 October
 - P2: 1 December to 14 December

P2: Observed T850 were negative
P1: Observed T850 were close to zero

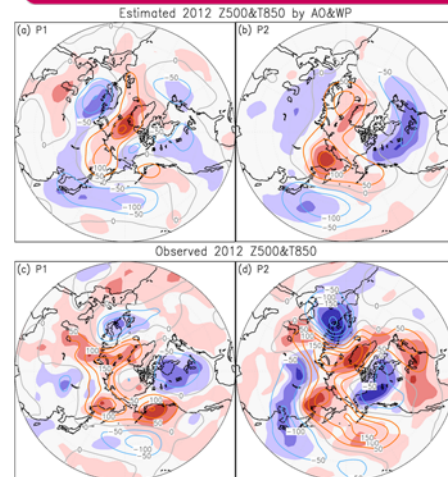


Fig. 2. Anomalies of geopotential height at 500 hPa (Z500; contours) and air temperature at 850 hPa (T850; shaded) in 2012 estimated from a multiple regression equation with AOI and WPI. Panels (c) and (d) are the same as panels (a) and (b), respectively, but for observed anomalies.

P1: Other factors overwhelmed cooling influence of AO and WP
P2: Other factors added to intensity of cold SATs

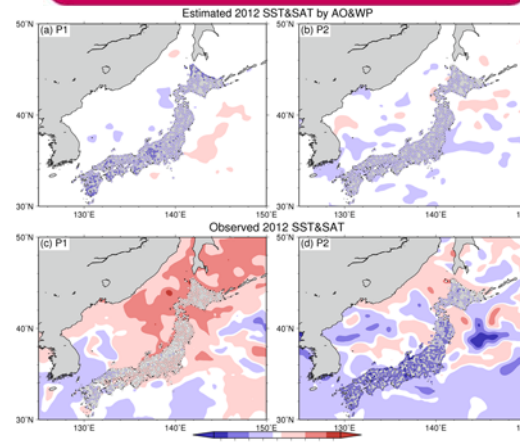


Fig. 3. The same as Fig. 2, but for SAT anomalies over the Japanese Islands and for SST anomalies over the ocean.

4. Small-scale Ocean Control

- SSTs over the Sea of Japan (orange box in Fig. 4) were significantly correlated SATs
- Residual SAT patterns were similar to SAT patterns estimated from SST

SSTs control SATs

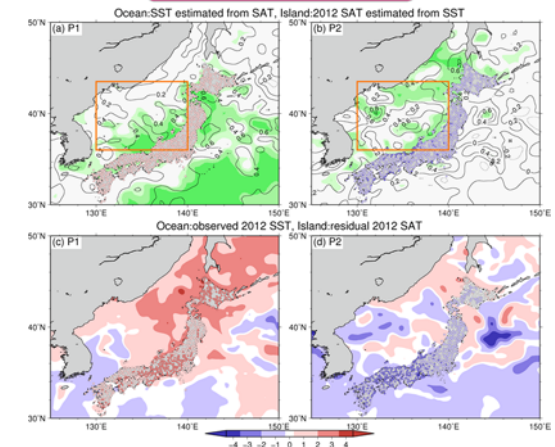


Fig. 4. For the island areas of panels (a) and (b), the SAT anomalies were estimated from a regression equation with the SST index. For the ocean areas of panels (a) and (b), the SST anomalies were estimated from a regression equation with the SAT index. For the island areas of panels (c) and (d), the residual SAT (the observed SAT minus the SAT estimated from the AO and WP shown in Fig. 3a and 3b). For the ocean areas of panel (c) and (d), observed SST anomalies.

We update SV NAM index in the website of our laboratory every day.

Climate and Ecosystems Dynamics Division

(地球環境気候学研究室)

<http://www.bio.mie-u.ac.jp/kankyo/shizen/lab1/AOindex.htm>

