Classification of surface currents distribution maps

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EOF analysis *Cluster analysis* SOM analysis

Summary

Hisaki Y.: Classification of surface current maps, .Deep-Sea Res. (accepted).

Background

- Ocean data such as currents, temperatures and salinities are functions of time and space.
- One of the important analyses for ocean data is the classification of physical features according to contour or vector patterns in maps.

Ocean data classification







Methods of classification

- EOF (Empirical Orthogonal Functional) Analysis
- Cluster Analysis

hierarchical :Ward method non-hierarchical : K-means method

• SOM (Self Organization Map) Analysis

Non-hierarchical : K-means method



Non-hierarchical : K-means method



hierarchical :Ward method



dendrogram

Data length must be short to draw.

Cluster Analysis

- Not so often used in physical oceanography as metrology.
- Map classification:

data dimension:2 × No. of observation points (2-D current field) is high.

So called "Curse of dimensionality" 次元の呪い

Curse of dimensionality



S1:sphere with radius r S2:sphere with radius ar 0 < a < 1V1:volume of S1 V2:volume of S2 $\Delta V = V1 - V2$ N: dimension

Curse of dimensionality



Even though a (0<a<1) is close to 1, the difference between the distances OA and OB is large for large N.



Reduction of the dimension: EOF analysis

$$V_{(m)}(\mathbf{x},t) = \sum_{k=1}^{N_E} b_k(t) \Psi_{(m)}, \qquad m = 1,2$$

$$(V_{(1)},V_{(2)})$$
 reconstructed current $\Psi_{(m)}=\Psi_{(m)}(\mathbf{x})$ eigenfunction

 $b_{k}(t)$ time coef. for EOF mode k N_{E} $_{\mathrm{No}}^{\mathrm{cut-off}\,\mathrm{EOF}\,\mathrm{mode}\,\mathrm{k}}$

Objectives

- Apply the classification methods (EOF, Cluster, SOM) to radar-derived currents, and compare the methods.
- Reduction of dimension by EOF and investigate the cut-off EOF mode number dependency.

Method (SOM)

 Example: Consider to divide 3×4=12 groups (3×4SOM arrays).























EOF



EOF mode 1 -2



EOF mode 1 -2



hierarchical cluster analysis: Ward method



hierarchical cluster analysis: Ward method



Mean currents for each groups by the Ward method



Mean currents for each groups by the Ward method



clockwise eddy-like pattern in the HF radar observation area.

mixtures of the two typical patterns.

strong southward currents flow east of the HF radar observation area.

SOM pattern& BMU





SOM pattern(I)& Cluster(r)

























SOM pattern (I)& Cluster (r)



SOM pattern(I)& Cluster(r)

























SOM pattern(I)& Cluster(r)



In all of the SOM arrays, the currents near the coast are northeastward, while, currents by the cluster method are not.







Time series of group number



Group No: Numbered by the order of number of daily surface current maps in the group.

Time series of group number (SOM)

Cut-off EOF mode No dependency



Cut-off EOF mode No dependency

(a) SOM



Summary

- The classification by SOM reveals the current patterns.
- 1. strong southward currents flow east of the HF radar observation area.
- 2. clockwise eddy-like pattern in the HF radar observation area.
- 3. mixtures of the two typical patterns.

Summary

- Ward method is similar to SOM.
- The K-means method cannot be applied to grouping without compressing the dimensions.
- The SOM is the most insensitive to the cut-off EOF mode number, while the K-means method is the most sensitive.

The end

