Deep learning based forecasting and classification of aerosol
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Motivation
- Different concentration distribution for different aerosols.
- Different morphologies and sizes for different aerosols.
- Aerosol effects vary depending on type and distribution.

Fig 1. Distribution and morphology of different types of aerosols

Fig 2. Deep learning classification framework

Fig 3. Diagram of experimental system

Fig 4. Scattering pattern of ice crystals

Fig 5. AE-CNN framework (left) and input and output images (right)

Fig 6. Latent spaces

Fig 7. Supersites in Manchester (left and middle) and example of AOD (right)

Fig 8. Aerosol concentration analysis framework

Methodology

1. Type Classification
   - Classifier Framework
     1. Reconstruct images and group aerosol to different clusters and types or directly predict the aerosol types.
   - Current Results
     1. Use PPD to capture ice crystal formed in MICC (-30 to -10 °C).

2. Concentration Prediction
   - Concentration Distribution Data Source
     1. Sites in different regions record concentration information and global or regional AOD data.
     2. Supersites in Manchester supply data of the wider Manchester region with concentration of different particle types and other information.
   - Concentration Analysis
     1. Deep learning analyzes concentration changes relatively accurately, but input parameters are fixed (nearly 16 meteorology factors), and ignore physical and chemical processes, so it is less adaptable in different region.
     2. Other methods like Chemical transport model (CTM) can describe complex physical and chemical processes, but not accurate enough to analyze concentration changes. However, it can help to find the main factors.
     3. Add the analysis end and combine the CTM/Statistics and Deep learning can better analyze the changes in aerosols.

Fig. 1. Distribution and morphology of different types of aerosols.

Tab 1. CH index scores

<table>
<thead>
<tr>
<th>Cluster numbers</th>
<th>CH index score</th>
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<tbody>
<tr>
<td>2</td>
<td>1876.7</td>
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<tr>
<td>3</td>
<td>1908.5</td>
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<td>4</td>
<td>1647.8</td>
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Calinski-Harabasz index (CH index)

How to distinguish different types of aerosols?

How to predict concentration distribution?

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