Figure S1. Monthly dust emission fluxes together with the soil moisture over each region averaged from 2013 to 2017. Seasonal fluxes of dust emissions are shown as black lines. The correlation coefficients ($r$) between the dust emission fluxes and soil moisture are also shown as inset.

Figure S2. Time series of Atlantic Multidecadal Oscillation (AMO) during 2010-2015 together with the linear trends over the periods 2000 – 2015 and 2010 – 2015. The black triangles and red circles represent monthly and annual mean, respectively.
Figure S3. Annual dust emission fluxes together with the 95th percentile wind speeds (red lines), the 75th percentile wind speeds (red dotted lines), precipitation (yellow lines) and soil moisture (blue line) over each region from 2013 to 2017. The correlation coefficients ($r$) between the dust emission fluxes and different meteorological variables are also shown as inset.
Figure S4. Simulated dust column burden averaged from 2013 to 2017 over the region between 80° W – 40° E and 25° S – 40° N. The location of ATTO site is marked as black asterisk and the transport paths of dust in four seasons are marked by black arrows.

Table S1. Annual dust emission fluxes (g month^{-1} m^{-2}) over different source regions in northern Africa^a.

<table>
<thead>
<tr>
<th>Year</th>
<th>Region A</th>
<th>Region B</th>
<th>Region C</th>
<th>Region D</th>
<th>Region E</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>7.4</td>
<td>7.6</td>
<td>3.6</td>
<td>9.1</td>
<td>4.9</td>
</tr>
<tr>
<td>2014</td>
<td>6.7</td>
<td>5.3</td>
<td>2.8</td>
<td>9.6</td>
<td>5.3</td>
</tr>
<tr>
<td>2015</td>
<td>5.0</td>
<td>4.0</td>
<td>3.2</td>
<td>14</td>
<td>4.6</td>
</tr>
<tr>
<td>2016</td>
<td>5.3</td>
<td>4.0</td>
<td>2.2</td>
<td>10</td>
<td>3.6</td>
</tr>
<tr>
<td>2017</td>
<td>4.4</td>
<td>3.1</td>
<td>2.0</td>
<td>9.5</td>
<td>3.7</td>
</tr>
</tbody>
</table>

Mean±std$^b$ | 5.8±1.3 | 4.8±1.8 | 2.8±0.64 | 11±2.1 | 4.4±0.74 |


$^b$ standard deviation
### Table S2. Seasonal dust deposition (Pg a⁻¹) as well as the ratio of deposition to total emission over northern Africa, AOaTPa and the Amazon Basin during 2013 – 2017.

<table>
<thead>
<tr>
<th>Region</th>
<th>Spring Dep</th>
<th>Spring Ratio (%)</th>
<th>Summer Dep</th>
<th>Summer Ratio (%)</th>
<th>Fall Dep</th>
<th>Fall Ratio (%)</th>
<th>Winter Dep</th>
<th>Winter Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>northern Africa</td>
<td>0.51±0.090</td>
<td>54%</td>
<td>0.38±0.10</td>
<td>64%</td>
<td>0.26±0.055</td>
<td>60%</td>
<td>0.44±0.085</td>
<td>48%</td>
</tr>
<tr>
<td>AOaTP</td>
<td>0.073±0.031</td>
<td>7.7%</td>
<td>0.079±0.034</td>
<td>13%</td>
<td>0.063±0.019</td>
<td>15%</td>
<td>0.18±0.034</td>
<td>20%</td>
</tr>
<tr>
<td>Amazon Basin</td>
<td>0.015±0.0064</td>
<td>1.6%</td>
<td>0.0089±0.045</td>
<td>1.5%</td>
<td>0.0022±0.0010</td>
<td>0.51%</td>
<td>0.015±0.0033</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

*a Atlantic Ocean along the transport path, over the region between 20° – 50° W and 5° S – 25° N.

### Table S3. Dust emission (Pg a⁻¹) from northern Africa and its lifetime (d) along the trans-Atlantic transport during January – April of 2014 – 2016.

<table>
<thead>
<tr>
<th>Year</th>
<th>January Emission</th>
<th>January Lifetime</th>
<th>February Emission</th>
<th>February Lifetime</th>
<th>March Emission</th>
<th>March Lifetime</th>
<th>April Emission</th>
<th>April Lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>0.68</td>
<td>1.4</td>
<td>1.2</td>
<td>1.5</td>
<td>0.97</td>
<td>1.8</td>
<td>0.75</td>
<td>1.8</td>
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<tr>
<td>2015</td>
<td>1.5</td>
<td>1.5</td>
<td>0.92</td>
<td>1.4</td>
<td>1.5</td>
<td>1.6</td>
<td>1.2</td>
<td>1.9</td>
</tr>
<tr>
<td>2016</td>
<td>0.78</td>
<td>1.4</td>
<td>0.95</td>
<td>1.7</td>
<td>1.0</td>
<td>1.7</td>
<td>0.68</td>
<td>1.8</td>
</tr>
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