Aeolian dynamics variability in central Sahel between 1950 and 2000: Are meteorological data about wind representative of the climate change and its environmental impact? Example of the synoptic stations
Mainé-Soroa and Nguigmi (Niger, Lake Chad basin)

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Climatic crises that occurred in Sahel since 1970 were described mainly with rainfall variations. Nevertheless, precipitations are observed only some tens days a year, concentrated in a few months, while dry periods without wind are rare. The aim of this study is to describe climatic variability with original meteorological data of wind characteristics and horizontal visibility from synoptic stations in Niger: Mainé-Soroa (13.23°N-11.98°E, 338 m asl) and Nguigmi (14.25°N-13.12°E, 287 m asl). These stations are located in the western part of the Lake Chad basin. This very flat area is covered by unconsolidated fine sand deposits and the scarce vegetation is not a real obstacle for the wind. These stations are under the influence of NE-SW winds originated in the Boole depression (Northern Chad) which are carried away. We used three daily (6:00, 12:00 and 18:00) measures of wind (direction and speed at 10 meters above the ground), horizontal visibility and corresponding types of weather. Significant winds (> 0.5 m.s⁻¹) are more common in Mainé-Soroa (93.7% of the all measures) than in Nguigmi (71.4%), and wind speeds are faster at 12:00 am in the both stations. In Mainé-Soroa, the main wind direction axis is NE-SW (31.3%) while in Nguigmi the main axis is E-W (21.5%). Major variations described with the rainfall fit with major wind speed variations. Thus, two periods are noticed: 1950-1969 (wet) with higher wind speed variability and 1970-1986 (dry) characterized by increased wind speed, particularly in Nguigmi. Major changing periods (1967-1971 and 1984-1986) are marked by declines of mean speed of winds, mainly from NE, SW, W and S directions. On the contrary, NW and N wind speeds are strengthened. Among the whole data series, speeds present an upward trend in Nguigmi and a slight decline in Mainé-Soroa. In both stations, horizontal visibility decreases after 1969 from an average of 26 km to 16.2 km in Mainé-Soroa (from 24.5 to 16.3 km in Nguigmi). But, dust haze decreased substantially since the 70’s and, on the contrary, sandy haze and blowing sand increased substantially. This increase of sandy haze and blowing sand that move coarser particles than dust hazy testify occurrences of local or regional wind erosion, perhaps as a consequence of less natural vegetation covering the soils near the stations.

Keywords: meteorological measures, wind direction and speed, horizontal visibility, Niger

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In Niger: 150 km southward shift of isohyets (Ozer et Erpicum, 1995)

Global scale: rising trend of temperature averages (IPCC, 2007)

Large variations in climate parameters
**Seasonal cycle**

**July – August**
- 1012 mb
- 1010 mb
- A
- D
- mousson
- FIT
- Equateur
- 1000 Km

**January – February**
- 1020 mb
- A
- harmattan
- FIT
- D

**Dry season:** 8-9 months
- Dry winds *(harmattan)*
- Mobilization and emission of dust into the atmosphere

**Rainy season:** 3-4 months
- Moist winds *(monsoon)*
- Rainfalls
Rainfall is concentrated in three months during some tens days only.

But, windless days are rare and these stations are near one of the most important source of aeolian dust in the world: the Bodélé depression.
In arid areas, is it possible to describe the climate change by wind parameters (wind direction and speed, horizontal visibility)?
Data from two synoptic stations in Niger, Mainé-Soroa (1936) and Nguigmi (1921). Data are collected from original manuscripts archived in DMN. Wind (10 m above the ground) and horizontal visibility at 6:00, 12:00 and 18:00 TU since 1950.
Wind directions: 1950-1992

Results

May to October:
- NE (20.9%), N (12.1%), E (8.5%)
- SW (10.3%), W (8.5%), S (6.9%)

November to April:
- NE (14.8%), N (6.6%), E (13%)
- SW (4.6%), W (8.7%), S (5.7%)
During the rainy season, wind speed maxima occur at the beginning of July in Maïné-Soroa and two weeks later in Nguigmi.
On both stations wind speed increase between the 1970s and the middle 1980s.
Wind speed: daily variability

**Results**

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<th>6h</th>
<th>12h</th>
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<td><strong>MAINE-SOROA</strong></td>
<td><strong>NGUIGMI</strong></td>
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<tr>
<td><strong>SW</strong></td>
<td><strong>NE</strong></td>
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Wind speed in m.s⁻¹ from 1950 to 1990, showing daily variability.
Results

Wind speed: daily variability

*Maine-Soroa*

- **6h**
  - W: Lower variability
  - E: Higher variability

- **12h**
  - W: Lower variability
  - E: Higher variability

*Nguigmii*

- **6h**
  - W: Lower variability
  - E: Higher variability

- **12h**
  - W: Lower variability
  - E: Higher variability
High visibilities occur during the rainy season,
Low visibilities occur during the dry season
Horizontal visibility shows a significant decrease since 1969.
Types of dust haze

Light Dust Haze
5 km < D < 10 km

Dust haze frequency increase strongly, particularly at Maïné-Soroa since late 1960.

Thick Dust Haze
D ≤ 1 km

◊: 6h
+: 12h
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Results

Types of weather

\[ BS = \text{BRUME SECHE (DUST HAZE)} \]
\[ S = \text{BRUME DE SABLE/POUSSIÈRE (SANDY HAZE)} \]
\[ CS = \text{CHASSE SABLE (BLOWING SAND)} \]

◊: 6h
+: 12h
Results

Types of weather

MAINE-SOROA

NGUIGMI

Manga december 1977

Manga december 2002

Durand

Durand

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Winds and horizontal visibility are relevant parameters of climate evolution analysis in arid environment.

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<td>Predominant W and SW wind direction</td>
<td>Lower significant wind observations</td>
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<td>horizontal visibility decreases since 1969</td>
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