Don’t breathe the air!
Long-distance atmospheric transport of chemical contaminants with African dust
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Effects on ecosystems

A. Nutrient influx

• African dust
  - Fe triggers red tide blooms in Gulf of Mexico (Lenes et al. 2001, Walsh & Steidinger 2001)
  - soils on carbonate islands (Muhs et al. 2007)
  - nutrients to Amazon Basin (eg., Swap et al. 1992)

• Asian dust
  - nutrients fuel phytoplankton blooms in North Pacific (eg., Young et al. 1991)
  - nutrients to degraded soils of Hawaiian Islands (Chadwick et al. 1995)
Effects on ecosystems

B. Organism introduction/range extension

• microorganisms
  - benign, beneficial and pathogenic (eg., Brown & Hovmoller 2002)
• pollen/plants
• larger organisms - African desert locusts (Rosenberg & Burt 1999)

C. Support fisheries by stimulating increase in prey populations
Human health risks

• PM$_{2.5}$, ultrafine particles and increased incidence of stroke and heart attacks (eg., Dockery et al. 1993)

• role of first row transition metals (Fe) on surface of PM$_{2.5}$ in inflammation

• toxicity of PAHs, dioxins/furans, pesticides, PCBs on fine particle surface –
  - changes in DNA
  - inherited

Bamako, Mali
normal ambient air visibility
15 September 2000, St. John, US Virgin Islands
Visibility during Saharan dust conditions
28 June 2000, St. John, US Virgin Islands
An increasing number of the world’s coral reefs (estimated > 30%) have been lost or seriously degraded in the last 30 years.
Hypothesis: African dust air masses transport nutrients, microbes, and chemical contaminants that adversely affect downwind ecosystems.
- Niger River is repository of all waste
- pesticide use (disease vectors – malaria; crop pests - locust plagues)
- river floods annually
- source of fine particles and particle-active compounds

- increasing industrialization and vehicle emissions

- ubiquitous small fires: low-temperature combustion of garbage (plastics) and other biomass
Identify contaminants in air in the source region and downwind sites

- persistent organic pollutants (POPs)
  - organochlorine pesticides
  - PAHs
  - PCBs
  - dioxins/furans

- trace metals
- microorganisms
- pollen

Test dust and components against organisms, human cell lines and fluid models
persistent organic pollutants

- persist in environment months – decades
- bioaccumulate in organisms

- carcinogenic
- toxic (nervous system)
- suppress immune system
- interfere with reproduction
- mutagenic
- teratogenic

- active at low concentrations
  - 2ppb DDT suppresses photosynthesis
  - 2ppb chlordanes affect nervous system
Preliminary POP findings 2001-2006
active sampling
<table>
<thead>
<tr>
<th>2001-2006 frequency of detects</th>
<th>Bamako Mali</th>
<th>Kati Mali</th>
<th>Sal Island Cape Verde</th>
<th>Galera Point Trinidad</th>
<th>East End USVI</th>
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**OCP**

- Frequency of detects
- 100 analytes
- 21 detects
- 11 families
Total pesticides (sum of mean of detects)

- Bamako, Mali
- ORTM Kati, Mali
- Cape Verde
- Trinidad East End, Virgin Islands

Graph showing comparisons of pesticide levels in different locations.
Total Chlordanes (sum of mean of detects)
Chlorpyrifos (sum of mean of detects)

- Bamako, Mali
- Kati, Mali
- Cape Verde
- Trinidad East End, Virgin Islands

Comparison of chlorpyrifos concentrations between sites.

- **Chlorpyrifos** concentrations are shown in purple bars.
- **TSP** concentrations are shown as black diamonds.

Concentrations are presented on a linear scale and a logarithmic scale for a comprehensive view.
DDT and breakdown compounds (DDD, DDE) (sum of mean of detects)

![Graph showing concentrations of DDT and breakdown compounds in different locations.]

- Total DDD, DDE, DDT
- TSP

Concentrations are shown in ng m$^{-3}$ and mg m$^{-3}$ for various locations:
- Bamako, Mali
- ORTM Kati, Mali
- Cape Verde
- Trinidad East End, Virgin Islands

The graph illustrates the comparison of detected concentrations among these locations, with Bamako showing notably higher values compared to the others.
Endosulfan I, II and sulfate
(sum of mean of detects)

Ng m⁻³

TSP

Endosulfan I
Endosulfan II
Endosulfan sulfate

Bamako, Mali
ORTM Kati, Mali
Cape Verde
Trinidad East End,
Virgin Islands

Endosulfan I, II and sulfate (sum of mean of detects)
Dioxins/furans: potent carcinogens

- detected in Mali samples only
- less toxic compounds
- speculate photo degradation during transport
<table>
<thead>
<tr>
<th>2001-2006</th>
<th>Bamako</th>
<th>Kati</th>
<th>Sal Island</th>
<th>Galera Point</th>
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### PCBs

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<td>Mali</td>
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Possible mechanisms: mineral dust and/or associated contaminants may affect coral reefs - organisms, ecosystems and function

1. disease-related mortality
   - suppress innate immune system (POPs)
   - alter microbial community
     (antibiotic production; POPs, Fe)
   - trigger gene expression (pathogenicity; POPs, Fe)
Possible mechanisms: mineral dust and/or associated contaminants may affect coral reefs - organisms, ecosystems and function

2. suppress recovery
   - interfere with reproduction:
     gamete production, fertilization, settlement (POPs)
   - direct toxicity (single agents or synergistic effects)
Possible mechanisms: mineral dust and/or associated contaminants may affect coral reefs - organisms, ecosystems and function

3. Change in organism abundance, community structure

---thresholds or tipping points

---change in system function
Grazie!
Acknowledgements

US Geological Survey
Friends of Virgin Islands National Park
NASA
NOAA  NURP Program

US Embassy - Bamako
US Embassy – Cape Verde
US Embassy - Trinidad