APDIM – sand and dust storm assessment Australia

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Source: Australian Newspaper 28 Jan 2006
Acknowledgments

• DustWatch project and its community volunteers
• Climate and Atmospheric Science Branch
• NASA - CSIRO
Outline

- Welcome to Southern Oceania - Australia and New Zealand
- Trans boundary issues
- Mitigating impact
Trans boundary issues

- Australia is the largest dust source in the southern hemisphere. Australian dust emissions $10^6$ Tg y$^{-1}$ (Tanaka and Chiba 2006).
  - No incoming dust
  - Dust exporter – New Zealand and Antarctica
Dust Pathways

- Australia to New Zealand
  2200km

- Australia
  ★ Tamworth maximum PM10 of **607 ug/m³** at 13 February 2019 06:00 UTC

- New Zealand
  ★ maximum PM10 of **127 ug/m³** at 14 February 2019 08:00 UTC

HYSPLIT forward trajectory ensemble analysis for 96 h at 10 m height from a source area in Central Australia on 11 February 2019 4 UTC. Source: Nguyen, et al. 2020
Dust Pathways

• Antarctica

NOAA HYSPLIT model matrix forward trajectory analysis from dust source areas in Central Australia with particle release times on 11 February 2019 4:00. Source: Nguyen, et al. 2020
Mitigating impact

• On-site impacts
  • Soil erosion
  • Burying of infrastructure
  • Damage to native vegetation

• Off-site impacts
  • Air quality
  • Dust deposition
Measuring ground cover for Australia

- Satellite – MODIS at 500m resolution, Landsat at 30 m and Sentinel 2 at 10m
- Full validated by Joint Remote Sensing group and Guerschman (CSIRO)

Source: https://www.quora.com/Why-are-there-no-pictures-from-space-of-satellites-or-real-photos-of-the-Earth-that-are-not-simulated

Credit: John Leys
Cover type; green, dead or bare ground for each month
How much cover do we need

Less than 50% soil cover

More than 50% soil cover

Credit: John Leys
Global vegetation cover – RaPP Map [http://map.geo-rapp.org/]
The onsite issue, wind erosion reduces productivity

Photo credits: John Leys
Onsite

- Mitigation though education programs
  - National Landcare program
  - From June 2018 to June 2023 the Australian Government is investing in partnerships with “governments, industry, communities and individuals to protect and conserve Australia’s water, soil, plants, animals and ecosystems, as well as support the productive and sustainable use of these valuable resources”
Offsite impacts – mitigated at on-site

Source: https://erin.maps.arcgis.com/apps/MapSeries/index.html?appid=c2606f315ee74d899c4f7ae478c29ccc
Dust travels long distances

(from Leys et al. 2011)

Red Dawn Sept 2009: Source NASA MODIS

(from O'Loingsigh et al. 2017)
The offsite issue – dust storms reduce air quality

Red Dawn” dust storm September 2009

• 2.54 Tg y\(^{-1}\) (Leys et al 2011).

• $299M for New South Wales economy (Tozer and Leys 2013)

February 2019

• 161 respiratory and 7 cardiovascular disease hospitalisations (Aragnou et al 2021)
NSW DPIE Air Quality Forecasting Framework

NSW DPIE Air Quality Forecasting System

- Observational & Empirical methods
  - Providing guide or bounds for forecasting

- Trajectory & Dispersion modelling
  - HYSPLIT in NSW
  - Predictions of likely path pollutions plumes follow

- Numerical modelling
  - Regional Airshed modelling
  - Predictions of gridded pollutant concentration

- Statistical modelling
  - Multivariate & Artificial neural networks
  - Predictions of site or region-specific pollutant concentration

Multi-model ensemble products for pollutant concentrations & health impact assessment
Dust forecasting – Australian east coast

**Routine data & information**
- Examine trends from DPIE AQMN data
- Identify emission sources (HRBs, bushfires)
- BOM Forecast
- RFS smoke plume model
- DPIE model forecast (HRB, bushfires, dust storm, temperature)

**DPIE Air Quality Forecast Process**
- On duty forecaster(s) assess potential for “poor or worse” air quality
  - Adverse met
  - High temp
  - Significant HRBs/bushfires
  - Dust storm
- DPIE Internal AQF Panel
- Collect further information, DPIE modelling & more detailed analysis
- DPIE Director Climate and Atmospheric Sciences

**Air Quality Forecast**
- “Good” or “Fair” Air Quality Forecast
- Air Quality Forecast Alert

**Disseminate information**
- DPIE Web Air Quality Forecast: for Sydney (now) for Hunter/Illawarra (trial) for NSW (planned)
- Automatic AQ Forecast Alert to Subscribers
- Notify DPIE Policy & DPIE Public Affairs
- Notify Bureau of Meteorology
- Notify NSW Health
Operational Dust Forecast in NSW

1. Monitor regional dust activities by TSP/PM$_{10}$/PM$_{2.5}$ observations from NSW rural air quality network

Source: NSW Air Quality Monitoring Plan 2020–25
2. Dust observations from real-time satellite imagery

NSW DPIE Worldview visualisation platform (AOD + Corrected Reflectance Terra/MODIS)
Example of the HYSPLIT in NSW forecast for a regional dust storm event (19 August 2020)
Operational Dust Forecast in NSW

4. Numerical modelling (in-line dust emission model + regional airshed model)

NSW DPIE Worldview visualisation platform – PM10 prediction (27-28 July 2021)
Conclusions

- Australia is the southern hemisphere’s largest emitter of dust.
- It does not receive dust from other continents.
- The dust travels to New Zealand and Antarctica.
- Due to the threat to the environment and people, Australia has several mitigation plans – e.g. National Landcare.
- Australia’s largest population centre, Sydney, has a dust storm warning system that utilises multiple lines of evidence to warn the population of reduced air quality caused by dust.
Questions

Mildura 1966. Source: Don Turvey, Sunraysia Daily