CLARIFY: Possible science operating from Ascension

Steven Abel with contributions from Jim Haywood, Paquita Zuidema, Yemi Adebiyi, Michael Cotterell, Fanny Peers, Hamish Gordon, Crispian Batstone, the ORACLES team and many others!

7th February 2017, Met Office, Exeter
Outline

What conditions can we expect at Ascension?

- Climatology
- Aerosol and cloud conditions
- Examples from ORACLES/LASIC
- Thoughts from the dry-run (5\textsuperscript{th} – 16\textsuperscript{th} Sept 2016)

Can the models forecast aerosol and cloud conditions?

ORACLES tools available

Flight sorties?
Smoke plumes reaching Ascension are episodic

August to September 2015

Climatology at Ascension
AERONET (2012-2016)
Weekly mean and s.d.

Aug-Sep AOD > 0.5 ~ 5%
Aug-Sep AOD > 0.3 ~ 30%
Aug-Sep AOD > 0.2 ~ 65%

Dry run
- Capture smoke most days but often at the range of aircraft to get into highest AOD
- Want to maximise flying opportunities when high AODs occur
Variable cloud conditions

15 August to 8 September 2016

2002-2012 climatology

MODIS mean 2002–12 cloud fraction (blue to black contours, 0.6–1.0 increments of 0.1), fine-mode aerosol optical depth (yellow-red shading indicates 0.25–0.45 in increments of 0.05 and very light black contour lines indicate 0.5–0.7 in increments of 0.1), fire pixel counts (green–red shading, 10–510 in increments of 50), and ERA-Interim 2002–12 monthly-mean 600-hPa winds. Red squares indicate Ascension Island and St. Helena Island (Adebiyi et al. 2015).

Dry run
- Global NWP was reasonably good at forecasting synoptically driven changes to the main Sc deck in the SE Atlantic but provided little guidance on finer details of the cloud field around Ascension Island.
- Run a regional NWP forecast for the campaign (Field, Gordon). Make use of satellite products will be key.
ORACLES ER2 survey flights (further east than Ascension)

Asi 7.9S 14.4W

ERF04, 2016/09/16

ERF05, 2016/09/18

HSRL lidar team
Aerosol measurements from LASIC

- Aug 2016: Peak AOD events correlate with elevated absorption measurements at the surface – smoke in BL
- Sep 2016: No correlation suggests smoke elevated above BL
- Lidar data shows smoke up to 4 or 5 km but no info when clouds are present

Fig 6. a) The August-September 2016 3-wavelength absorption coefficient derived from the PSAP (red, green, blue) and the total aerosol optical depth derived from AERONET. b) August micropulse lidar normalized relative backscatter.
Aerosol measurements from LASIC

- Number concentration of CCN (S = 0.4%) correlated with PSAP absorption measurements at the surface.
- Biomass burning aerosol likely to impact cloud microphysics.
Opportunities for aerosol-cloud-precipitation interactions and DRE science

August 26th AOD ~ 0.2 minimal smoke at surface

August 31st AOD ~ 0.6 elevated smoke at surface

Aircraft data will provide key measurements above cloud
Examples of the vertical structure
Forecasting aerosol Global NWP with CLASSIC

- Model has reasonable skill at forecasting smoke plumes arriving at Ascension Island
- Model underestimates aerosol absorption at the surface (optical properties/mixing into the BL)

Figure 9. July-Sept ASI observed and modelled a) AOD at 550nm, b) Aerosol absorption coefficient at 550nm, c) model vertical distribution of aerosol and cloud mass mixing ratio at ASI.
Forecasting cloud
Global vs regional NWP (2km CASIM)

Cloud fraction (based on LWP threshold = 0.02 mm)

- Global model has a persistent high bias in cloud fraction
- Regional model more broken cloud field
ORACLES forecast, satellite products, met briefings etc
https://bocachica.arc.nasa.gov/ORACLES/oracles.html

MACC  UM CLASSIC  UIOWA WRF  GEOS5

TERRA RGB  TERRA Above cloud AOD

Do we want to have our own local copied of any of these products?
Flight sorties - discussion

Good time to review flight sorties

• BBA likely to be mixed into BL at times
• BBA plumes can be episodic
• Cloud often at multiple levels in the BL and shallow Cu vs Sc
• Ad-hoc events e.g. POCs
• Co-ordination with LASIC
• Intercomparisons/joint science flights with NASA P3
Co-ordinating with LASIC - AMF1

Scanning Ka and W band radars

Direct over-flights of surface site (5000 ft?)

Radar will perform RHI scans over a 90 degree sector centred on the mean wind direction (blue shading).

5 km range radar sees 500m – 5 km ASL
10 km range radar sees 625 m – 10 km ASL