1. Introduction and Goals

- Convection and chemistry control the composition of the tropical troposphere as well as the air that enters lower stratosphere.
- Understanding these processes involves modelling interactions between ocean biology, atmospheric composition and climate change.
- UK Met Office Numerical Atmospheric-dispersion Modelling Environment (NAME) model is used to assess spatial and temporal variability in transport of very short-lived halogenated organic substances (VSLs): methyl iodide, CH\textsubscript{3}I.
- The convective influence on the CH\textsubscript{3}I in the TTL is investigated quantitatively using NAME.

2. CAST-CONTRAST-ATTREX

- CAST aimed to characterise distribution and emission sources of VSLs in the tropical lower troposphere. CONTRAST and ATTREX aircraft flew at higher altitudes to sample the mid-upper troposphere and lower stratosphere to study convective outflow and its impact on UTLS composition.
- NAME: (i) tool for flight planning and flight coordination (pre- and in-campaign); and (ii) post-campaign analysis of tracer data.

3. NAME modelling approach for ATTREX

- NAME is a Lagrangian Particle Dispersion model developed by the UK Met Office.
- We use the Unified Model global wind fields at 5km resolution (*ukm from 2016*).
- 12-day back trajectories with new convection scheme.
- 15,000 particles released from each AWAS sampling location along all ATTREX Global Hawk flight tracks.
- Calculate fractions of trajectories that crossed below 1 km (and 5 km, not shown) in previous 12 days, as a 0.25 quantitative measure of the boundary layer air mass contribution to those samples (Fig. 1).
- Assign initial CH\textsubscript{3}I concentrations (from the CAST observations) to trajectories < 1 km and calculate the CH\textsubscript{3}I contribution from the boundary layer, allowing for the decay of CH\textsubscript{3}I in each trajectory since it was last < 1 km.

4. NAME modelling activities for ATTREX – RESULTS

- ATTREX III 2014, Research Flight 03, 16-17/02/2014
  - The Global Hawk made 20 TTL profiles at the single point location (east off Guam, the US).
  - Unique sampling of TTL over 18 hours.
  - CH\textsubscript{3}I observations: high degree of variability in the TTL.
  - Highest at 14–15 km, decreasing with altitude.

5. NAME modelling activities for ATTREX – RESULTS

- All ATTREX III 2014 Research Flights
  - Comparison of ATTREX II (2013) and ATTREX III (2014)
    - Large flight-to-flight variability (Fig. 4a). As in RF03, the 1 km fractions drop off with altitude (Fig. 4b).
    - Boundary layer CH\textsubscript{3}I contribution can explain most of the observations for the 14–15 and 15–16 km, but there are bigger differences above 16 km.
    - The sum of the NAME boundary layer and the background CH\textsubscript{3}I estimates (Fig. 4d) show reasonable agreement with AWAS observations.
  - Large fraction of trajectories that are transported through the TTL (Fig. 4c). As in RF03, the 1 km fractions drop off with altitude (Fig. 4b).
  - Boundary layer CH\textsubscript{3}I contribution can explain most of the observations for the 14–15 and 15–16 km, but there are bigger differences above 16 km.
  - The sum of the NAME boundary layer and the background CH\textsubscript{3}I estimates (Fig. 4d) show reasonable agreement with AWAS observations.

References


6. Results and on-going work

- Approach developed to estimate relative contributions of air with different origins for comparison with observations, and used to study the influence of convective transport on the TTL.
- Higher CH\textsubscript{3}I concentrations observed in ATTREX III are explained by much more recent convective uplift from the boundary layer than in ATTREX II. In ATTREX III, the longer transport times resulting from the horizontal transport in the TTL led to more photolysis destruction and lower CH\textsubscript{3}I concentrations.
- Good quantitative agreement between modelled estimates and AWAS observations in 2014 using the NAME new convection scheme.
- This approach is now being applied to study the budget of the longer-lived substances CH\textsubscript{3}Br and CH\textsubscript{3}Br\textsubscript{2}, where an accurate assessment of both the background and boundary layer contribution is important.