MANCHESTER 1824

The University of Manchester

Modelling Manus ozone using WRF

Richard Newton, Geraint Vaughan, Charles Chemel

Introduction

Ground campaign on Manus Island as part of CAST

Ozonesondes were launched once (occasionally twice) daily

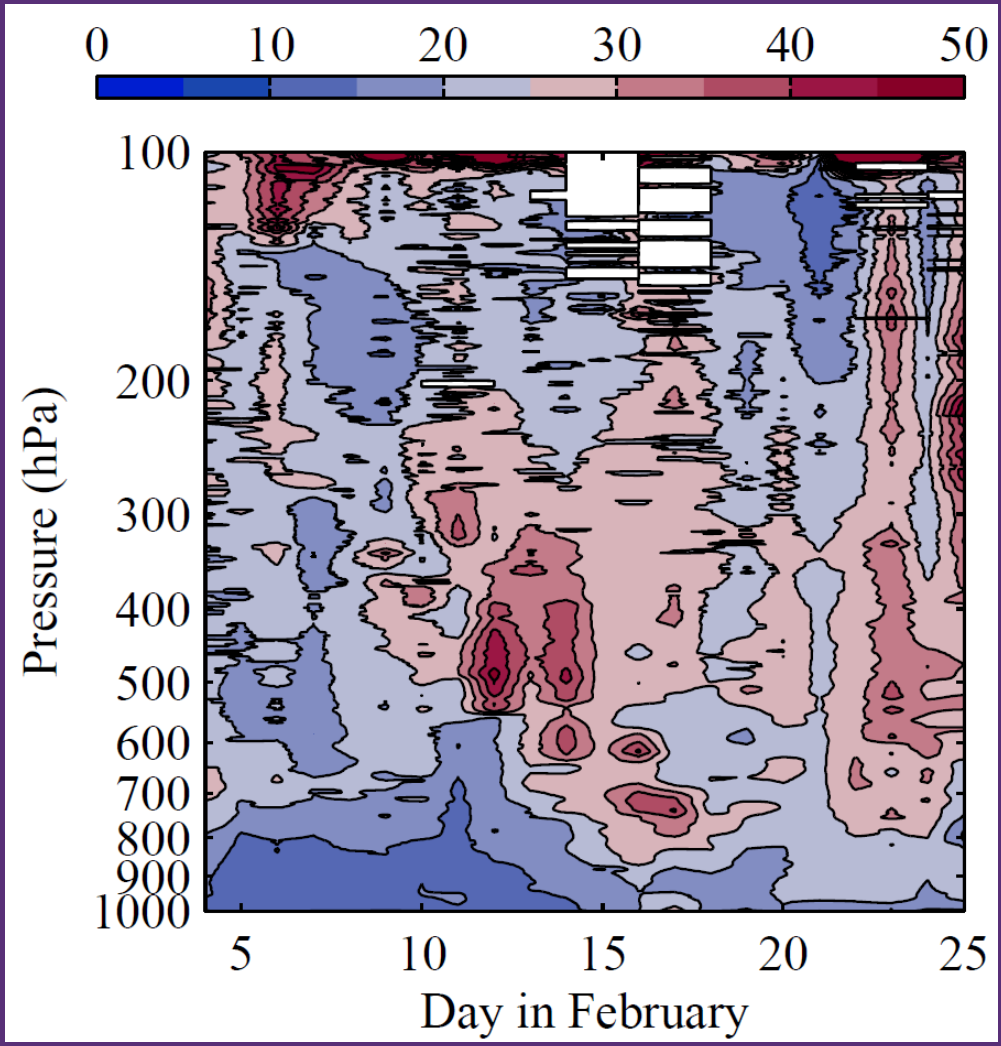
Measurements have now been verified (see poster)

Results published in *Atmos. Chem. Phys. Discuss.* awaiting peer review

Measurements and Results

Ozonesonde data processed into a single contour plot

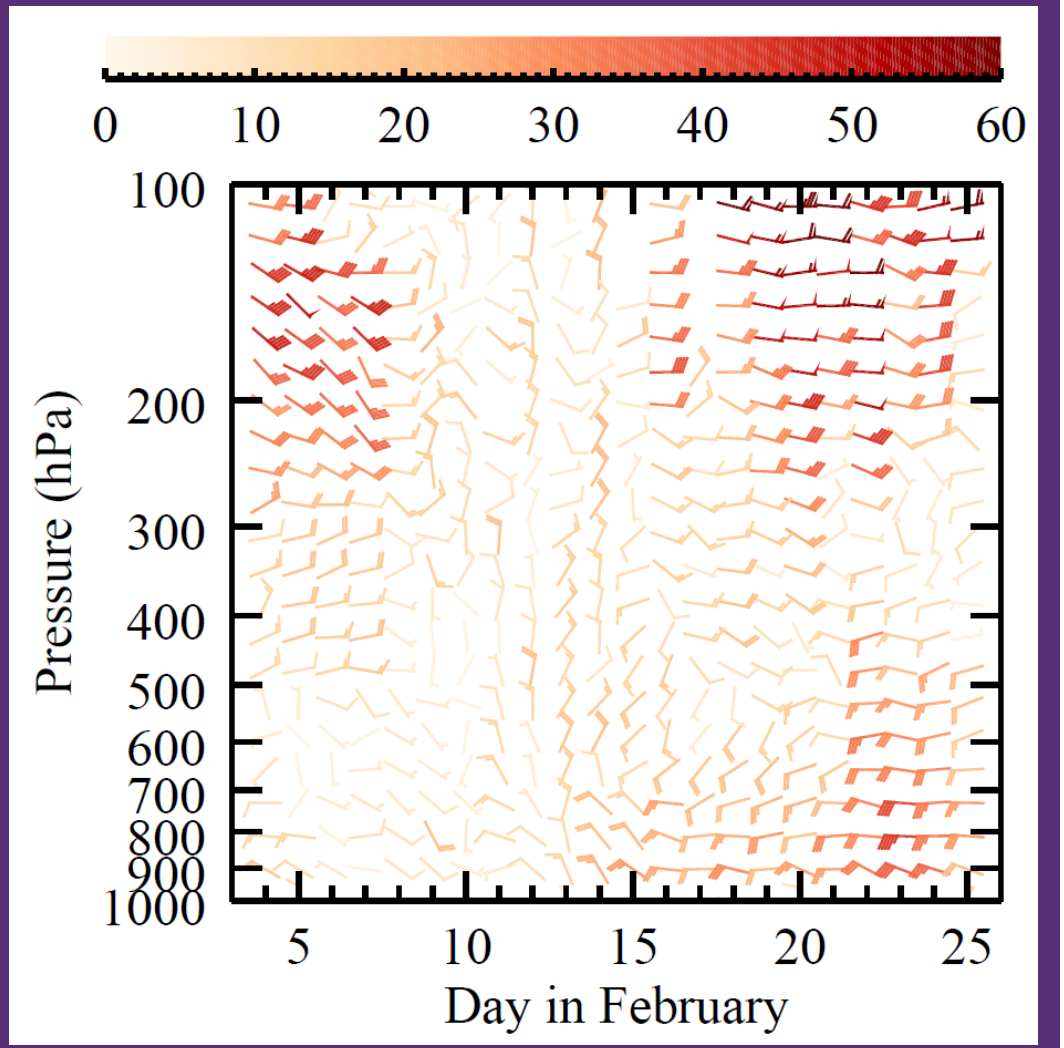
Main point of interest is the low concentrations of ozone found in the TTL on 21–23 February



Measurements and Results

Wind speeds from ozonesondes show high-speed easterly winds during 21–23 February

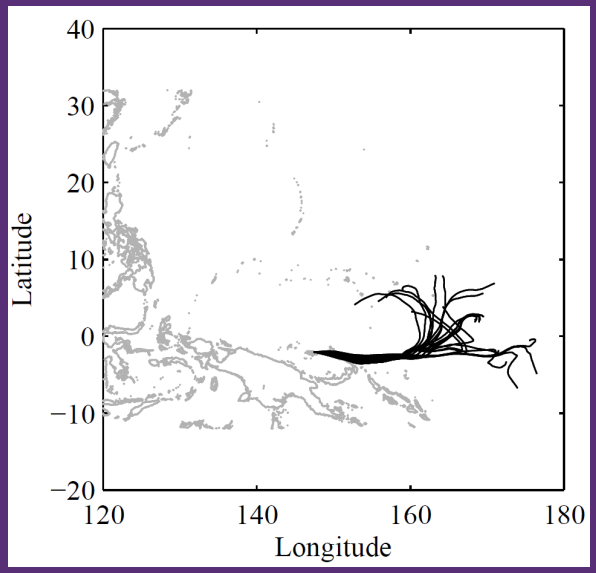
The low ozone has been advected from the east

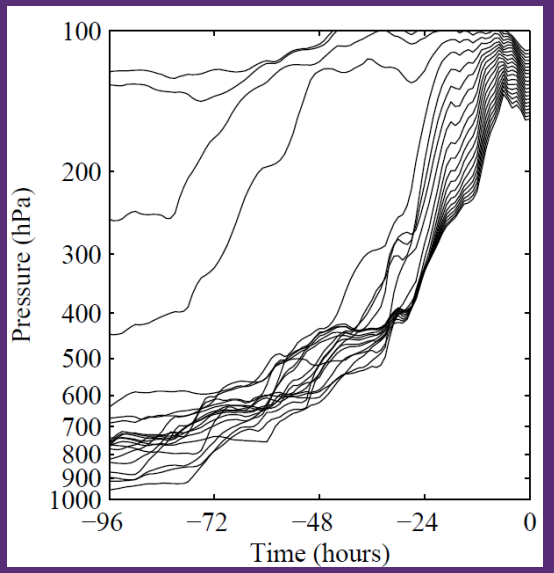


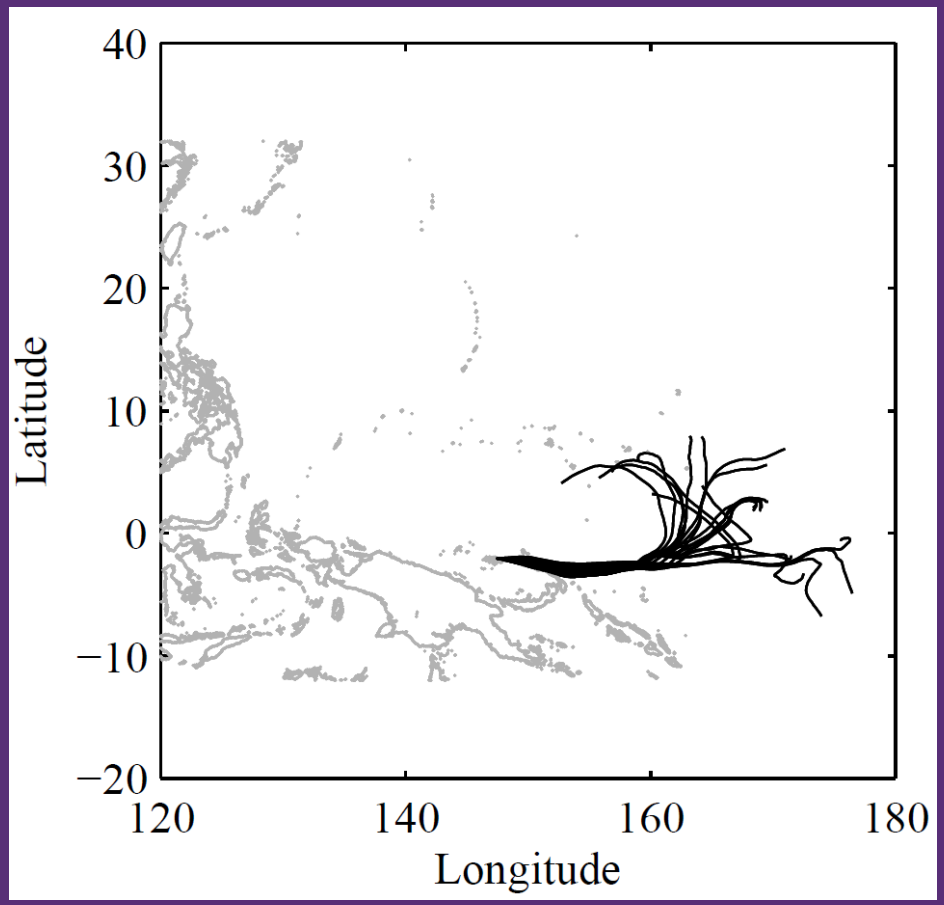
Measurements and Results

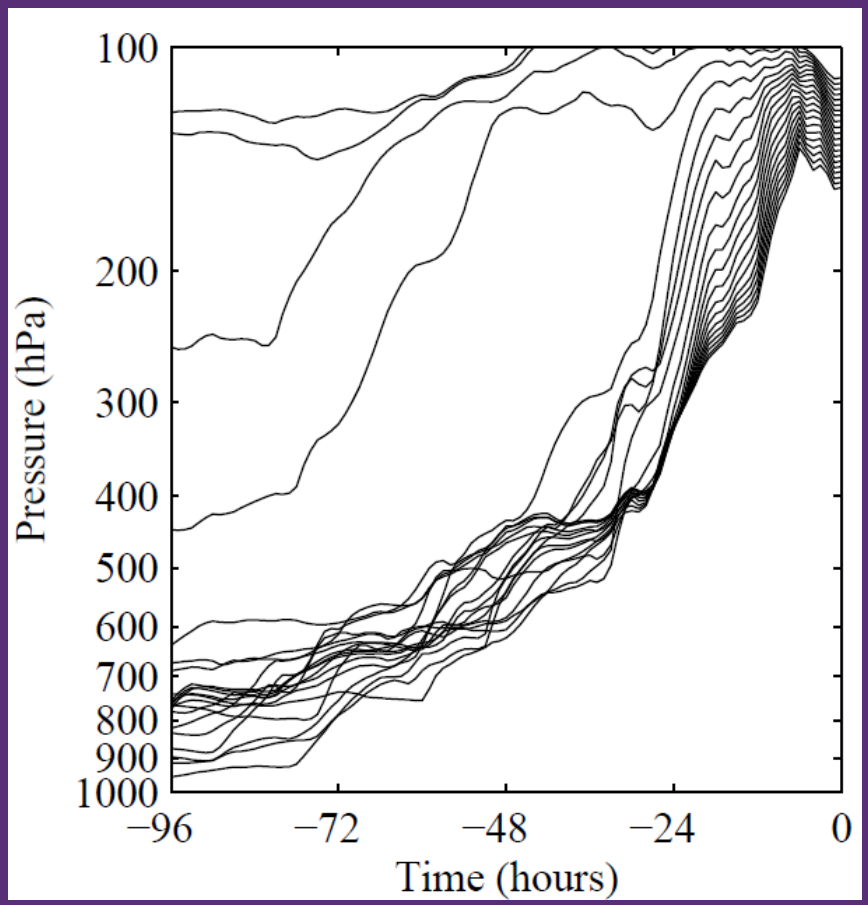
HYSPLIT trajectory analysis confirms the TTL air has come from the east

The air has been lifted from the lower troposphere





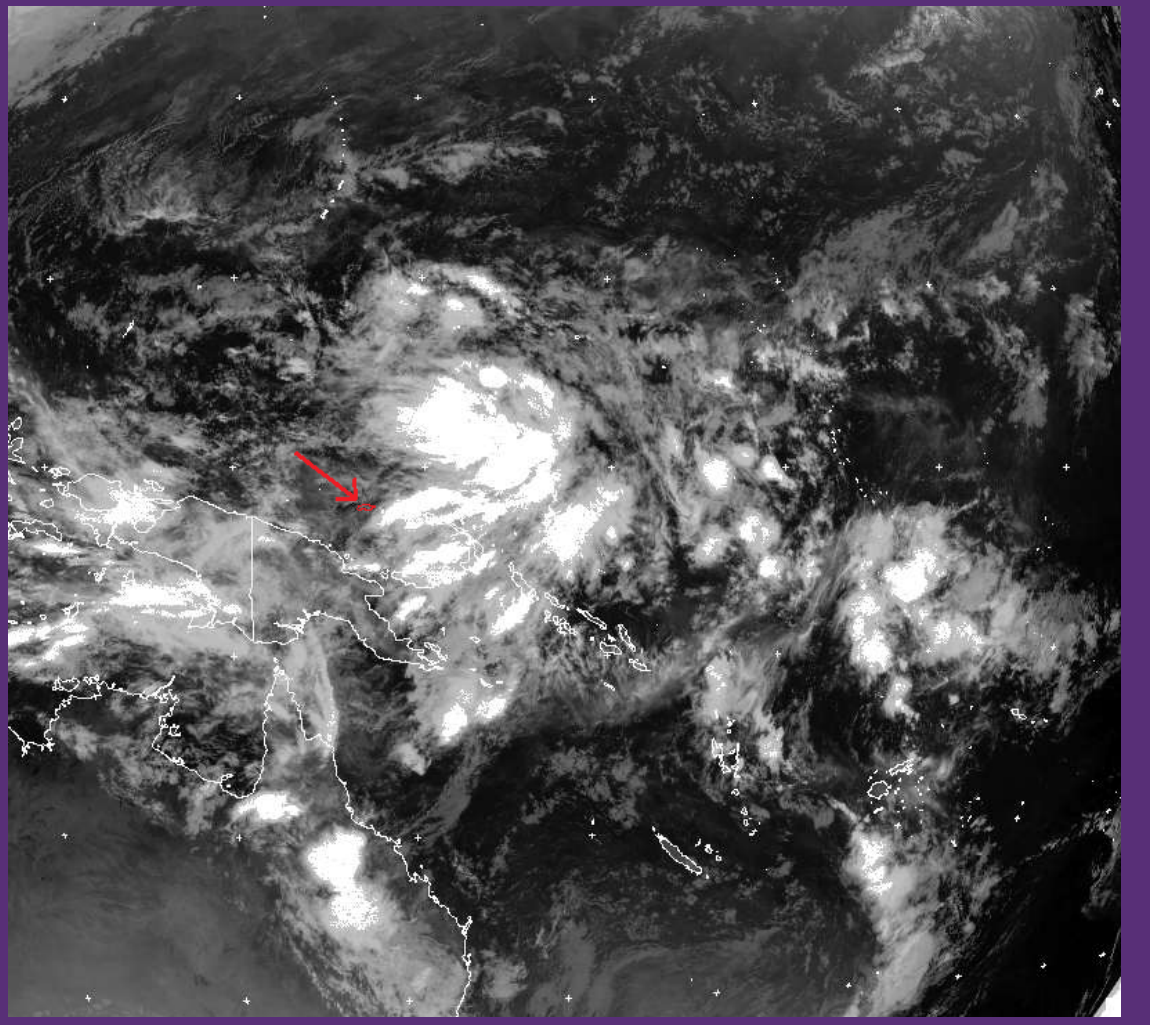

40
30
20
10
0
−10
−20
Latitude
120
140
160
180
Longitude


100
200
300
400
500
600
700
800
900
1000
Pressure (hPa)
−96
−72
−48
−24
0
Time (hours)

Measurements and Results

Satellite imagery from MTSAT at 1800 UTC on 19 February

Organized region of deep convection to east of Manus where air can be lifted from lower troposphere



Measurements: Conclusions

Low ozone found on 21–23 February

Hypothesize that the low ozone originated from the sea surface to the east of Manus, uplifted by convection to the TTL, and then advection in the easterly jet brought it over to Manus where it was measured by the ozonesondes

WRF modelling is being used to examine this further

WRF Modelling

How well can WRF recreate the conditions found on Manus?

Ground measurements include meteorological data (pressure, temperature, wind speed and direction, and rainfall) – are they well represented in WRF?

Can the organized convection, such as that on 19 February, be captured in the WRF simulation?

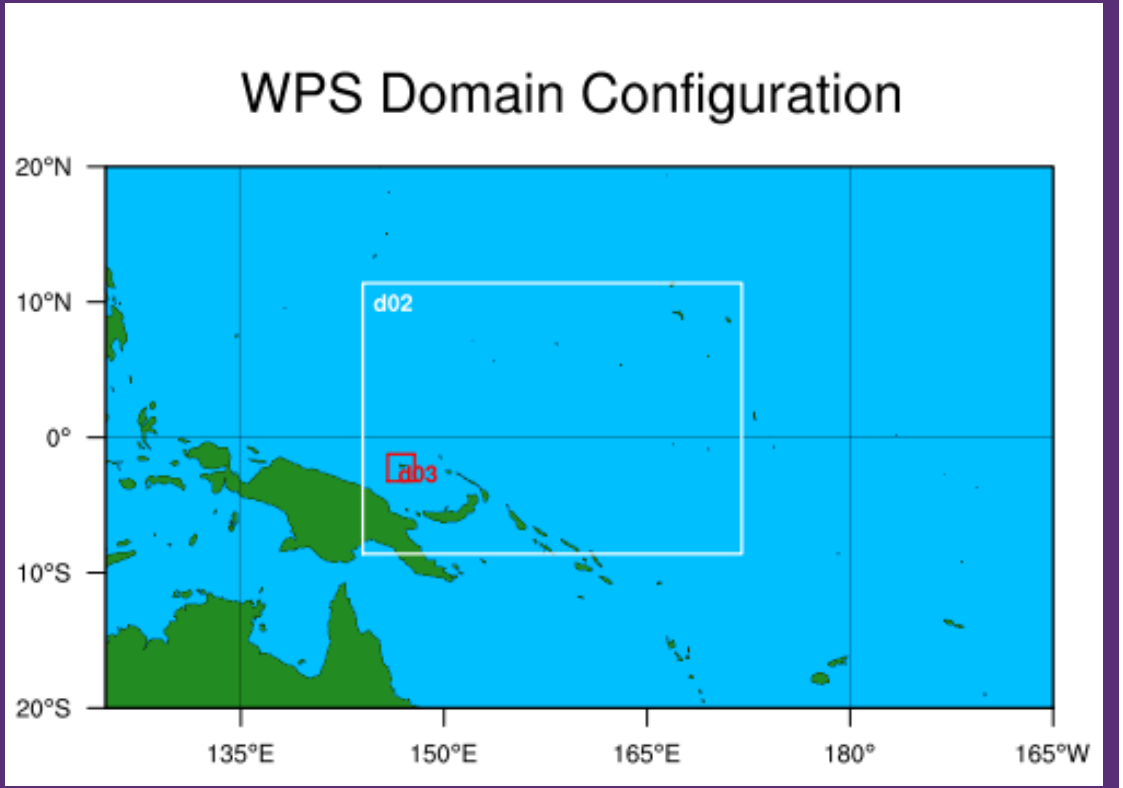
Can we test the hypothesis that the origin of the low ozone of 21–23 February is from the sea surface?

WRF Setup

At the moment, one domain – will be adding two more domains in future

Grid spacing of domain #1 is 22·2 km, which is too coarse for convection to be resolved

Domains #2 and #3 will be able to resolve convection

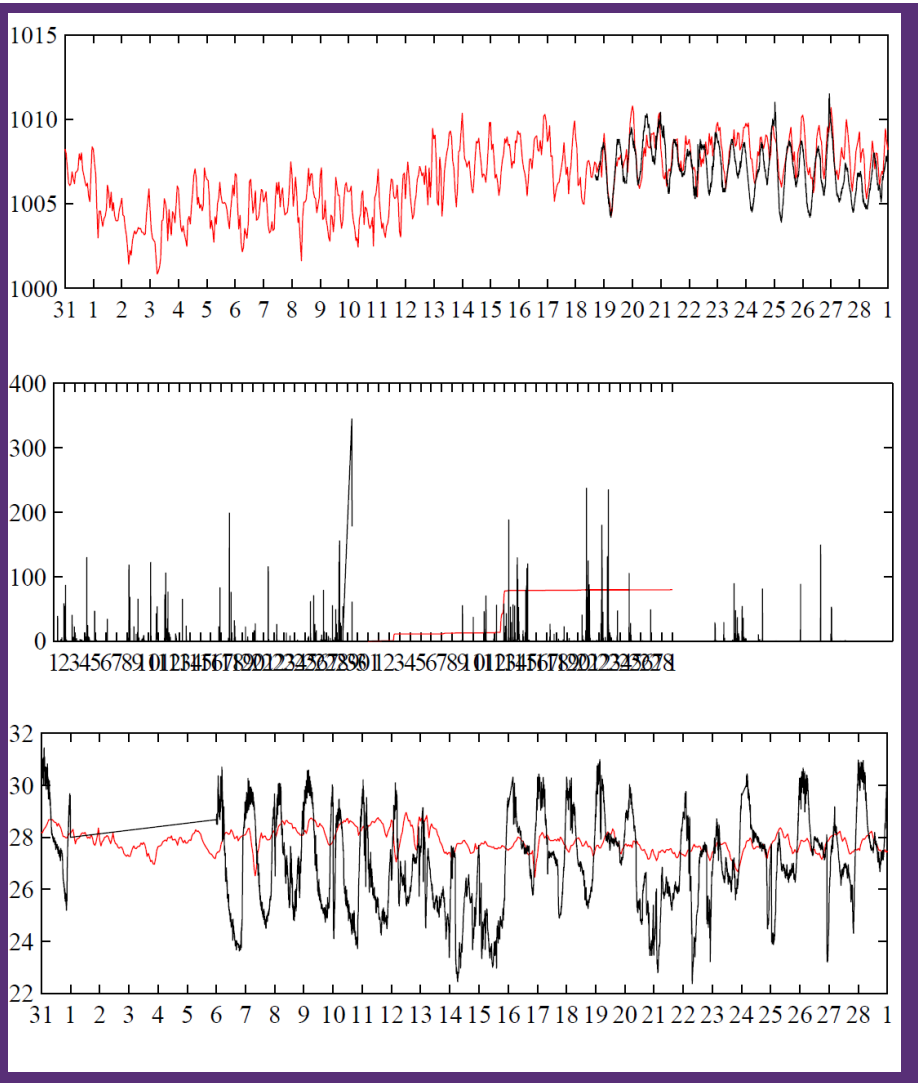


Meteorology: Preliminary Results

Pressure follows the general trend of the measurements

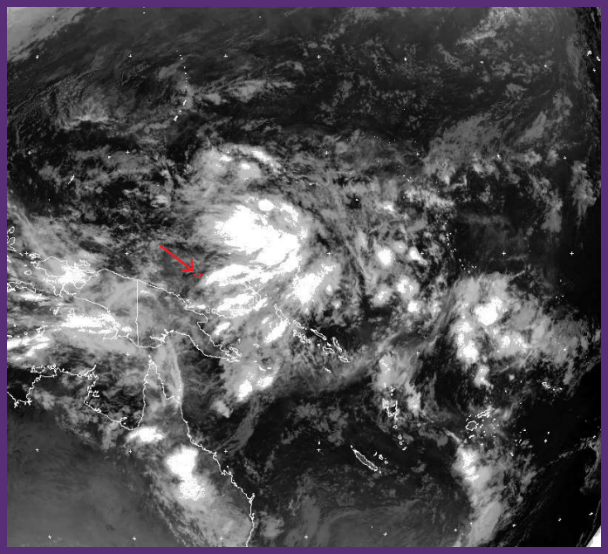
Temperature is not varying as expected: the coarse grid spacing may not see Manus Island

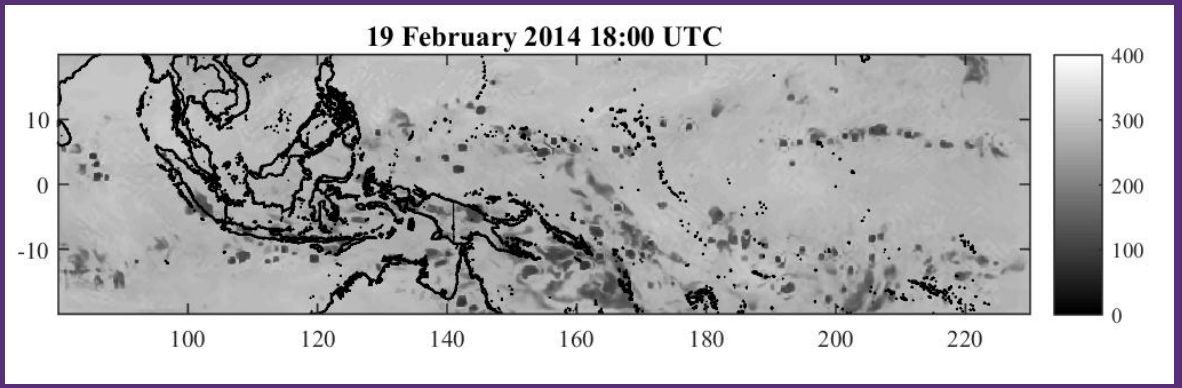
Rainfall is not accurate, because the convection is not captured well



Meteorology: First “Results”

Convection is not well represented in the large domain: the organized convective activity does not exist, and small blobs of convection occur instead





Tracer Setup

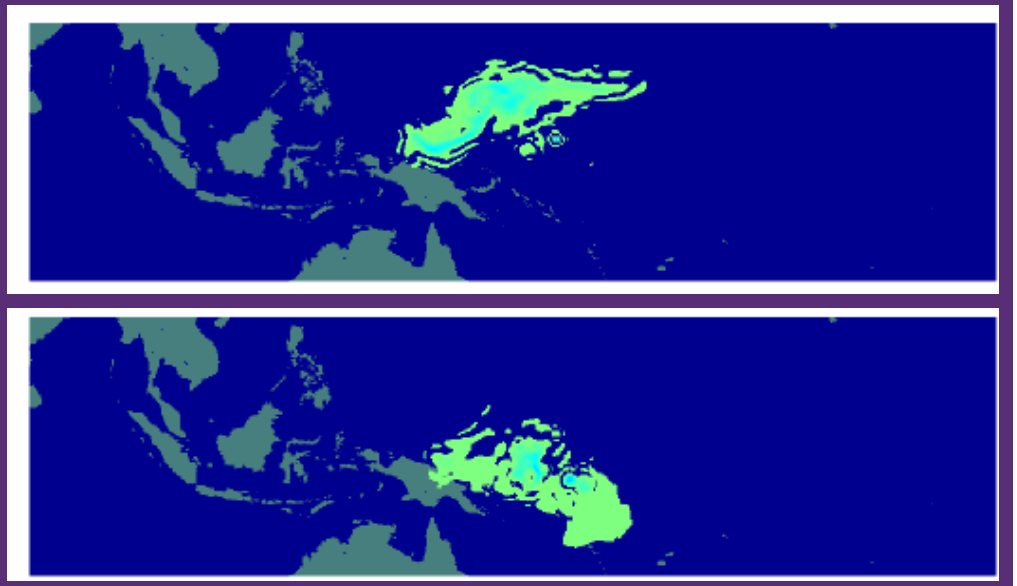
Twenty tracers in a grid, placed in strategic positions in the area where the convection was on 19 February

Aim to see the tracers being visible in the TTL in Manus on 21–23 February

Tracer Experiment: Preliminary Results

Figures show the amount of tracers reaching ‘layer 28’, which is roughly at the tropopause layer

Tracers are reaching the tropopause, even though the convection is not correct



Conclusions

Tropical convection is difficult to reproduce in models – careful choice of parameters is required

Tracers have shown that uplift from the surface to the TTL can take place within a timescale of a few days, even without accurate representation of the convection

Repeating the analysis with better (and more advanced) model choices: e.g. nested domains, nudging, etc. should produce more accurate results.