Pacific Warm Pool
Deep Convection

Cirrus Shields

Warm Pool
El Niño Southern Oscillation

Normal Conditions

El Niño Conditions

Source: www.pmel.noaa.gov/toga-tao/el-nino-story.html
TWP Site 1: Manus (ARCS-1)

- Began operations in 1996
- Collaboration with Papua New Guinea National Weather Service (NWS)
Instrument Layout at ARCS-1

Up looking rad sensors

Down looking rad sensors

ARCS Met tower

ISS

Instrument van

Generator van

MWR

Data Van

Office Van

NWS Instrument Field
TWP Site 2: Nauru (ARCS-2)

- Began operations in November 1998
- Collaboration with Nauru Department of Environment and Development (DED)
Nauru Island

Denig Site
TWP Site 3: Darwin (ARCS-3)

- Began operations in April 2002
- Collaboration with Australian Bureau of Meteorology
- Maintenance center for all three ARCS sites
The Nauru Site officially began its operations with the opening ceremony on 20 November 1998. Dr. Wanda Ferrell, DOE/OBER, and His Excellency Derog Gioura, acting president of Nauru, released two connected weather balloons symbolizing the joint effort of ARM and Nauru in establishing and operating the site.
There is a higher level of water vapor and rain over Nauru after the El Nino began in 2002.
There are more easterly winds during El Nino year.
Fig. 2. Island clouds do affect radiation measurements on Manus, Papua New Guinea (though less often than on the island of Nauru).
MTI Visible

GMS 1 km Images

Fig. 1 Comparison of DOE Multispectral Thermal Imaging Satellite and GMS 1km resolution images on 12 Dec. (no island cloud trail) and 13 Dec. (fully developed island cloud trail).
RAMS model calculations using Rawinsonde profiles on 12 Dec. (no cloud trail) and On 13 Dec. 2000 (with fully developed island cloud trail.)
Fig. 3. The MTI derived Surface Water Temperature appears to be about 0.3 °C warmer upwind of the Island.
During Nauru 99 experiment research ship circled island day and night making Sea Surface Temperature Measurements (blue °C). Distance of the ship from ARCs site (pink) shows highest temperatures upwind of island or farthest from ARCs.
Ship Trail Clouds Observed From GOES Satellite in June 1991 With Research Ship Egabrag
Ship Trail Formed in a Very Low CCN Environment

Downward Direct and Diffuse Shortwave Solar Radiation

CCN
# /cm³

Local Daylight Time

Ship Trail

7:02
11:58
The Dichotomy

• Island cloud trails seem to be explained by boundary layer cloud dynamic effects.
• Ship trail clouds are usually explained as a result of ship smoke aerosol (indirect aerosol cloud effect).

Problem: ocean clouds are relatively starved for both aerosol [cloud condensation nuclei] and turbulence.
Conclusions

• 10 years of ship trail cloud studies indicate both aerosol and dynamic effects (more work is needed to separate them)

• Island cloud trails seem to be explained by dynamic effects and more research on these effects may prove useful in understanding how boundary layer clouds respond to climate changes

• Large scale subsidence is required for both ship tracks and island trails to persist. This allows these phenomena to be used to better understand large scale atmospheric processes.