Cirrus cloud and temperature variations around the tropical tropopause observed from the lidar measurement on board the research vessel "MIRAI"

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Cirrus clouds in the tropical tropopause layer

(Holton's Web page)
Relation to the temperature field
Boehm & Verlinde [2000]

Micropulse lidar (MPL) and radiosonde (4 times a day) observations at Nauru (0.5S, 166.9E) in 1999
• Lidar observations for 2001 with radiosondes (every 3 hrs)
• Detecting subvisible cirrus clouds (SVC)
• Relation between the temperature and SVC appearance

⇒ SVCs disappear when T anomaly exceeds 1.5K
“MIRAI” observations in 2002

• Observations on board the R/V “MIRAI”
  – November 15- December 13, 2002
  – Anchored at 2N and 138E

• Lidar observation
  – Cirrus clouds: backscattering coefficients \( \beta \) in the range between 3e-7 and 5e-6 (Iwasaki et al. [2004])
  – 100m and 15 min average

• Radiosonde observations
  – November 21- December 13, 2002
  – Every 3 hours (8 times a day)

• A similar set of the data in 2001 was also used (November 9- December 9; analyzed by Iwasaki et al. [2004])

⇒ Focusing on cirrus clouds around the tropopause region (15-18km)
Snow White observations from MIRAI

R/V Mirai (11:16:06 GMT December 1 2002)
(2.02N 138.44E 8 m)

(a) Temperature
(b) RHs (Liquid Water)

Intensity (532nm)

Hour (UTC)
Background T for 2001 and 2002

2001:
Continuously cold

2002:
Warm in the first half
Cold in the second half
T anomaly for 2001 and 2002

2001:
Short time scale anomalies in relation to the gravity waves?

2002:
Warm anomalies moving downward
Relation between U and T

Warm anomalies in the divergent region
Global T variation (100hPa)

2001: almost stationary
2002: eastward moving

NCEP data
Global T variation (70hPa)

2001: between warm and cold anomalies
2002: warm in the first half and cold in the second half
Convective activity (OLR)

2001: stronger activity in the second half
2002: weaker activity in the second half
Cirrus cloud appearance for 2002

(km) 2002 backscatter coefficient and Temperature Anomaly

Height

16.0
15.5
15.0

Nov
Dec

16 18 20 22 24 26 28 30 2 4 6 8 10 12

CONTOUR INTERVAL = 1.000E-01
Cirrus clouds appearance (15-18 km)

High frequency in cold T for 2002, but in warm T for 2001
Cirrus clouds appearance (15-16 km)

Temperature dependence is small
Cirrus clouds appearance (16-17 km)

Slightly high frequency in cold T for 2002
Cirrus clouds appearance (17-18 km)

High frequency in cold T for 2002
Cold region in 15-16.5km

Warm region in 15-16km

Cold region in 17-18km

Case 1

Case 2

Case 3
case 1
(15-16.5km)

Temperature

Cirrus clouds

Frequency

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case 2
(17-18km)

Temperature

Cirrus clouds

Frequency

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case 3
(15-16km)

Temperature

Cirrus clouds

Frequency
Summary

• Appearance of the cirrus clouds in relation to the background temperature has been investigated for the winters 2001 and 2002 in the Western Pacific.
• Temperature structure is quite different: In 2001 it was stable and cold; in 2002 it changed largely in accordance with the intra-seasonal variation.
• In 2002, for 15-16 km height range the appearance does not change with the temperature, but above 17 km it becomes large as the temperature being cold.