

北オーストラリア熱帯域の巨大孤立積乱雲
(ヘクター) の国際共同観測

(課題番号 : 13573005)

平成 13 年度～14 年度

科学研究補助金 (基盤研究 (B) (2))

研究成果報告書

平成 15 年 3 月



研究代表者 津田敏隆

(京都大学宙空電波科学研究センター)

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1. 研究課題名

北オーストラリア熱帯域の巨大孤立積乱雲（ヘクター）の国際共同観測
(課題番号： 13573005)

2. 研究組織

研究代表者： 津田 敏隆（京都大学宙空電波科学研究センター）

研究分担者： 中村 卓司（京都大学宙空電波科学研究センター）

堀之内 武（京都大学宙空電波科学研究センター）

研究協力者： Peter T. May (BMRC)

Robert A. Vincent (Adelaide University)

Andrew McKinnon (Adelaide University)

Michael Reeder (Monash University)

Ross Christmas (BOM, Darwin)

Kevin Hamilton (Hawaii University)

3. 研究経費

平成 13 年度 9,700 千円

平成 14 年度 2,500 千円

合計 12,200 千円

1. 研究成果の概要

1. はじめに

オーストラリア、Northern Territory の中心都市である Darwin の沖に Tiwi Islands と呼ばれる、狭い海峡をはさんだ二つの島(Bathurst, Melville)があり、この上空に孤立型の巨大積乱雲が現れる（現地では Hector と呼ばれている）。2001 年 10-12 月に Darwin 周辺で、積乱雲による大気波動励起に関する国際協同観測キャンペーンが行われ、多くの観測装置が投入された。京大 RASC は豪州気象庁(BOM; Bureau of Meteorology)、Monash 大、Adelaide 大と共同で5日間のラジオゾンデ観測を Darwin 周辺の3点で3回にわたって実施した。初期解析の結果、対流圏界面のすぐ上層(15-20km)で周期が約 84 時間の変動が認められた。また、鉛直スケールが 3km 以下の温度・風速変動の分散値から推定した大気重力波のエネルギーは、高度 20-25km でやや弱く、その上下の層(15-20km、25-30km)で増大しており、背景の東西風の大きさと相関が見られた。これらの波動特性は3期間で共通して認められた。



図1 DAWEX の気球観測点。(A) Pirlangimpi (Garden Point) (緯度 11.4S、経度 130.3E、慣性周期 61 hr)、(B) Darwin 空港気象ステーション (12.4S, 130.9E, 56 hr, A からの距離 130 km)、(C) Katherine 空港 (14.5S, 132.5E, 48 hr, 同 400km)。

2. 観測状況

DAWEX では対流圏から中層大気さらに熱圏下部に至る広い高度領域で波動特性を観測するために、多くの観測装置が導入された。まず、対流圏では Darwin 郊外で定常的に運用されている 50MHz の Windprofiler と 915MHz の境界層レーダーに加えて、新たに Tiwi Island に 50MHz

の小型境界層レーダーが設置された。C帯の2重偏波ドップラーレーダー(C-Pol)については、Darwin 空港での定常観測に加えて、それから約20km北東に離れた Gun Pointで、研究用のC-Polレーダーが11月と12月のキャンペーン期間中に運用された。

成層圏観測のために5日間のラジオゾンデキャンペーンを乾季(Pre-Monsoon)に1回、Hector 季から Monsoon-onset 季に2回実施した(後述)。なお、Darwin では定常観測が行われている(風速は1日に4回、そのうち2回は温湿度等も測定)。さらに、中間圏・下部熱ではMFレーダーおよび各種の CCD イメージャが稼動した。

気球観測は、Hector からの波動伝播を調べるために、Tiwi Island から南東方向にほぼ直線的に並んだ3つの球観測点で行った。つまり、(A)Tiwi Island 上の Pirlangimpi (Garden Point)、(B) Darwin 測候所、および(C)Katherine 空港の3点である。モンスーンオンセット(10月末)以降12月頃までの時期に Hector が現れると期待される。

Hector の有無による大気波動励起の相違を比較することを目指し、乾季である10月中旬(10月13-18日)に観測を行い、次いで Hector 季である11月後半(11月15-20日)と12月中旬(12月11-16日)に、5日間にわたり、3ヶ所から3時間毎に40回、ラジオゾンデを放球した。なお、CCD イメージャ観測を考慮して、観測期間を新月前後にしている。

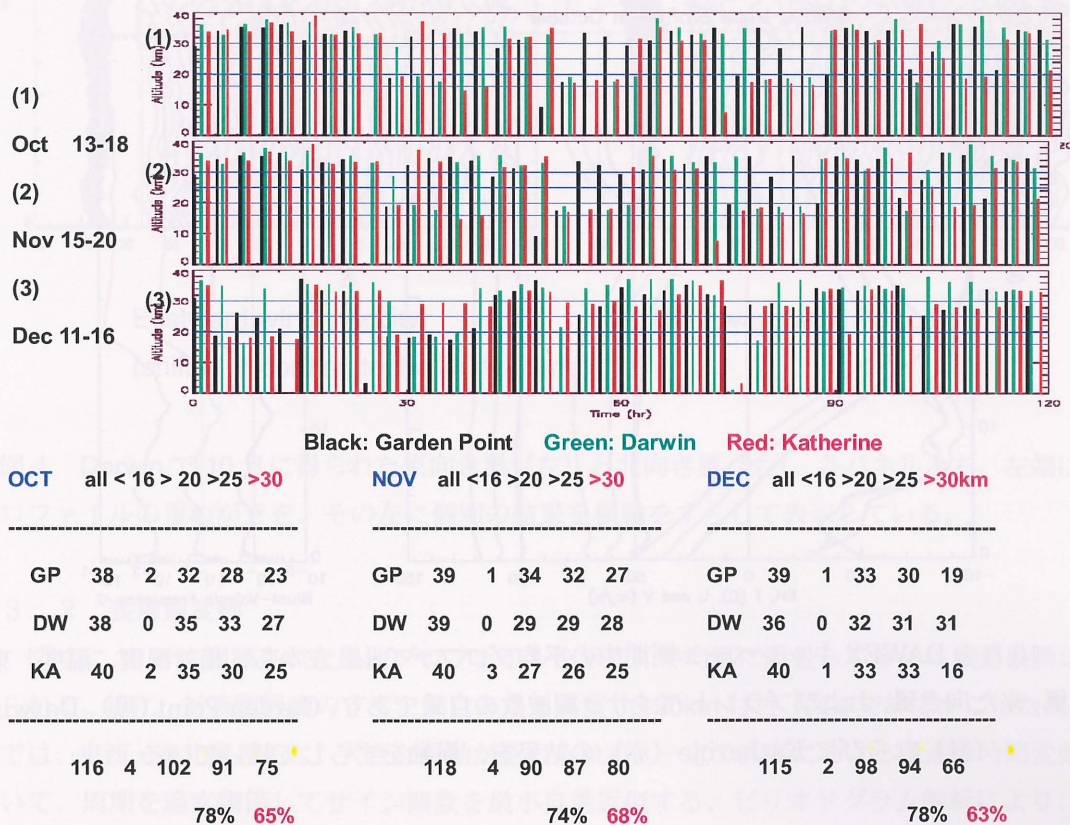


図2 DAWEX キャンペーン期間中の気球到達高度。(1)10月13-18日、(2)11月15-20日、(3)12月11-16日の結果であり、横軸は120時間に対応する。下表の統計は気球破裂高度が16km以下、高度20, 25, 30kmを越えた数を各キャンペーン期間毎に示す。

図2に気球到達高度の統計を示すが、3/4以上が高度25kmに達し、さらに約2/3が30kmを越えたことが分かる。BOMが定常観測に用いている350gの気球では20km程度しか上がらないため、800gの気球を用いた(TX-800)。しかし、11月の観測では一日周期で最高高度が変動している。熱帯域では、対流圏界面付近で大変低温になるため、太陽放射で暖められない夜間に、気球が割れやすくなることによる。10月にその傾向が見られなかったのは、対流圏界面温度がさほど低温でなかったことと、対流圏内が乾燥していたためと考えられる(水分の結露・凍結が重要らしい)。12月では観測開始の2日後から、通称「油漬け」と呼ばれる事前処理をしたために、この問題がある程度解決した。つまり、ケロシンで気球表面を1-2分洗い、その後15分間程度乾燥した後に放球した結果、夜間でも高度30km付近まで到達した。しかし、気球のゴムがふやけたようになり、充填するガス量は2割程度増加した。

3. 解析結果

観測データを整理したばかりであり、詳細なデータ解析を進めている段階であるが、以下に背景の大気状態、長周期の変動および短周期変動(大気重力波)の特性について、クイックルックを紹介する。

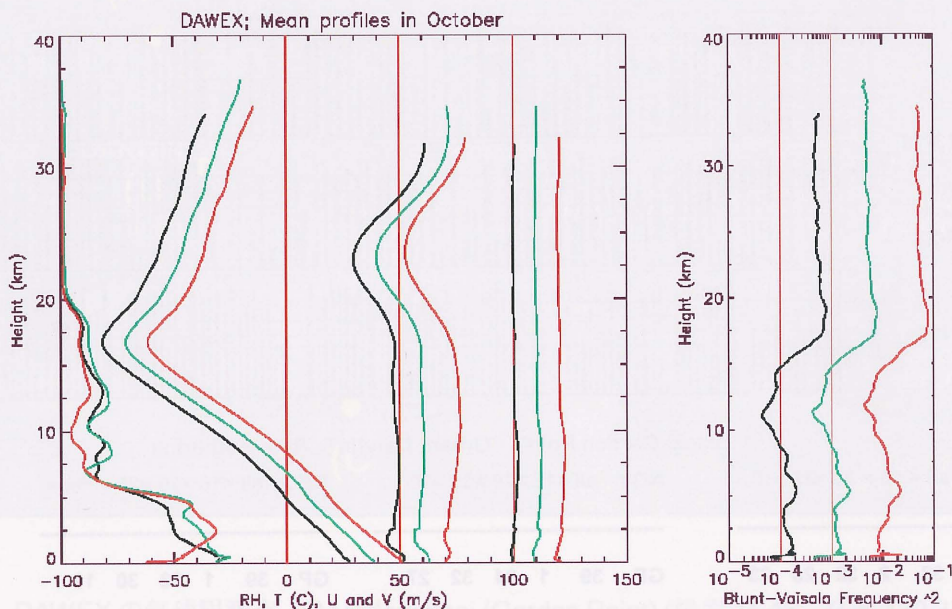


図3 10月のDAWEXキャンペーン期間中の平均プロファイル。左から、相対湿度、温度、東向き風、来た向き風、およびプラントバイサラ周波数の自乗であり、Garden Point(黒)、Darwin(緑)ならびに Katherine(赤)の結果を、横軸をずらして描いている。

3. 1 背景の大気状態

図3に10月のキャンペーン時に観測された5日間平均のプロファイルを示す。モンスーン開始前なので、湿度は比較的低く、対流圏中層・上層は乾燥している。温度構造も熱帯域の特徴的

な高度プロファイルを示し、対流圏界面付近の温度は -80 度C以下になっている。大気安定度は、 $15-17\text{km}$ でほぼ高度に線形に上昇しており、その上下の層でほぼ一定の値を示している。東西風には高度 $20-25\text{km}$ 付近に QBO の影響による東風が見られる。一方、南北風は全高度でほぼ 0 であった。11 月と 12 月の平均プロファイルは、基本的にはでは図 3 と同様であるが、モンスーンの進行に伴い湿度が急増している。また、QBOI による東風の中心高度が若干降下していた。

Wind Velocity Profiles at Darwin during October 13-18, 2001

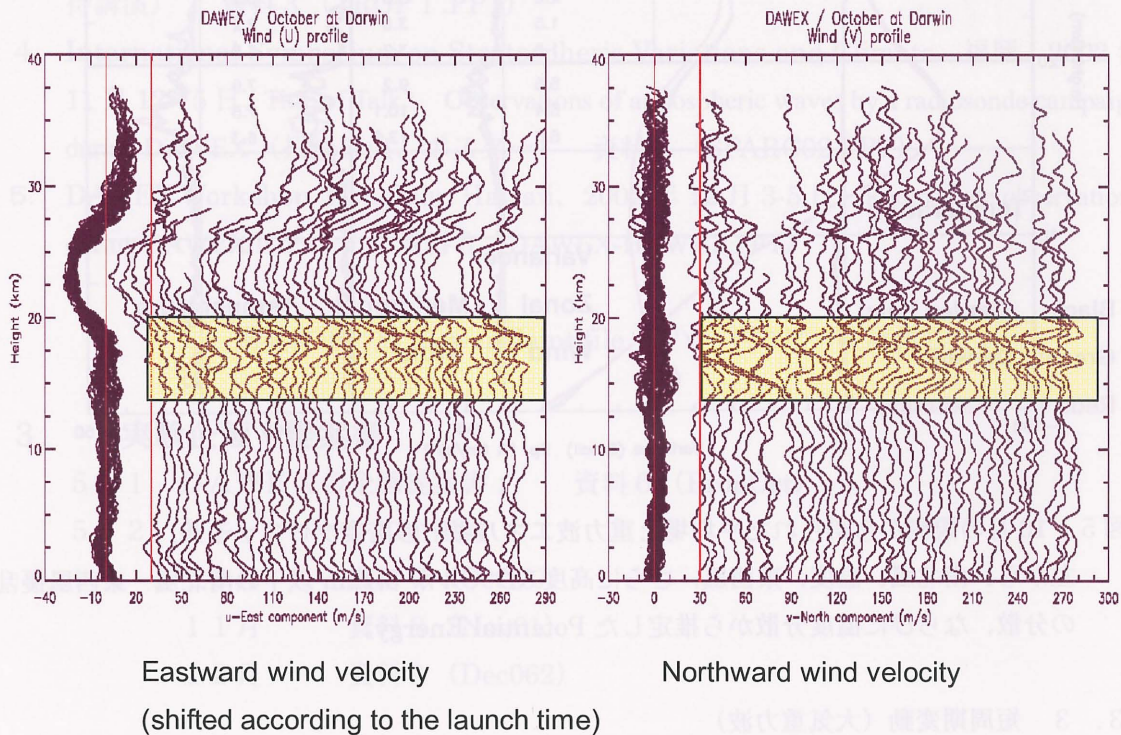


図4 Darwin で 10 月に得られた東向き風 (左) と北向き風 (右)。各パネルとも、左端に全プロファイルの重ねがきを、その左に個別の結果を横軸をずらして表示している。

3. 2 長周期変動

図 4 に 10 月に観測された風速プロファイルを示す。平均風に重畳して多くの風速振動が認められる。特に、対流圏界面のすぐ上部にあたる高度 $15-20\text{km}$ 付近 (図 4 で枠でかこった高度層) では、東西・南北風ともに、大きな振動が認められる。一定の高度における風速の時間変動について、周期を適宜調節してサイン関数を最小自乗近似する、ピリオドグラム解析により、高度 $15-20\text{km}$ の風速振動の卓越周期が 84 時間であることが明らかになった。3 つの観測点の間ではほとんど位相差がないことから、空間スケールが大きな波動であろうと推測される。同様の長周期変動は 11 月および 12 月にも認められた。

Profiles of wind velocity variance and potential energy [(m/s)², J/kg] for waves with vertical scales < 3.1 km in October

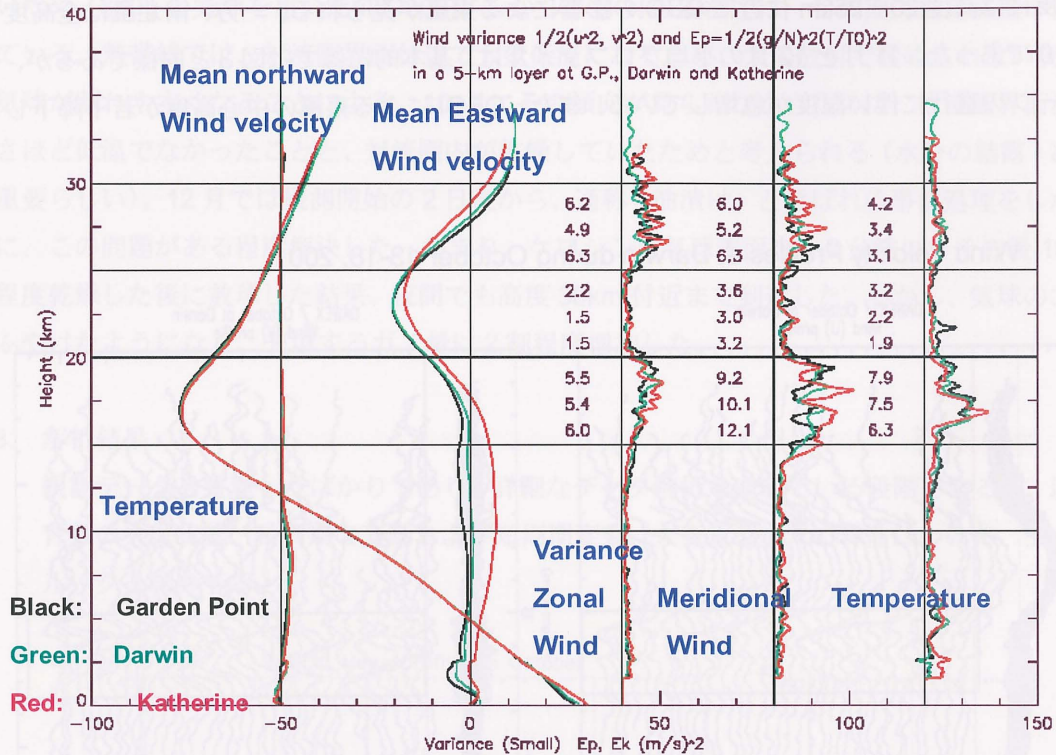


図5 10月の観測から得られた平均場と重力波エネルギーの高度プロファイル。

左から、南北風、温度、東西風、さらに高度スケールが3.1km以下の南北風・東西風擾乱の分散、ならびに温度分散から推定した Potential Energy。

3. 3 短周期変動 (大気重力波)

図4の左端の重ね描きプロファイルでは、線の広がり幅が変動成分の大きさに関係している。高度15-20kmでは上記の長周期変動により幅が大きく広がっている(なお、後述するように、長周期成分を除いても変動分は大きい)。そして、高度20-25km付近で変動幅が一旦減少し、高度25-30kmで増大している。

この特性をより詳しく調べるために、個々の風速・温度プロファイルから背景場を差し引き、さらに高度方向にカットオフが3.1kmのハイパスフィルターを施して、小さな高度スケールの変動成分のみを抽出した。これの自乗値(分散)から求めた波動エネルギーを図5に示す。明らかに、高度20-25kmで重力波エネルギーが減少しており、しかも平均東西風と良く相関していることが分かる。この大気重力波が東西方向に伝播しているならば、Critical levelにおける相互作用、あるいは背景風によるドップラー効果の影響が考えられるが、ホドグラフを調べたところ、多くの波動が南北方向に伝播していた。今後、さらに詳細なデータ解析を継続する必要がある。

2. 学会等での講演

1. 特定領域研究 (B) 「成層圏変動と気候」第3回公開シンポジウム、「DAWEX (Darwin Area Wave Experiment)」、2002年2月18-19日 資料1 (DAWEX.PPT)
2. EPIC 国際シンポジウム、京都、2002年3月、A Preliminary Report of Radiosonde Campaigns during DAWEX (招待講演) 資料2 (EPIC.PPT)
3. 日本気象学会、2002年春季大会、専門分科会「熱帯対流圏界面・遷移層」、大宮、2002年5月、「赤道域におけるラジオゾンデ観測で見られた対流圏界面付近の大気変動」(招待講演) 資料3 (TROP1.PPT)
4. International Symposium on Stratospheric Variations and Climate、福岡、2002年11月12-15日、Title of Talk: Observations of atmospheric waves by a radiosonde campaign during DAWEX (招待講演、ポスター) 資料4 (SPARC02.PPT)
5. DAWEX Workshop, Honolulu, Hawaii, 2002年12月3-5日、Radiosonde observations during DAWEX IOPs 資料5 (DAWEX-HAWAII.PPT)

講演に用いた Power Point file のハードコピーを添付した。

3. 実験企画・提案書

5. 1 DAWEXの企画提案書: 資料6 (PropOct)
5. 2 各キャンペーンの企画書
 - 10月 資料7 (Oct13)
 - 11月 資料8 (Nov01)
 - 12月 資料9 (Dec062)

4. ラジオゾンデ観測関係の写真資料

6. 1 気球: 資料10 (DAWEX_balloon)
6. 2 防風テント: 資料11 (DAWEX_tent)
6. 3 Garden Point 観測サイト: 資料12 (DAWEX_GP)
6. 4 Katherine 観測サイト: 資料13 (DAWEX_Kh)
6. 5 積雲: 資料14 (DAWEX_cloud)

5. 謝辞

DAWEX 実験の遂行にあたり、オーストラリア気象庁、Monash 大学、Adelaide 大学をはじめ多くの方々からの有形無形の支援を得た。ここに厚くお礼を申し上げますとともに、この貴重なデータを十分に活用して、今後、良い研究成果を挙げるべく努力する。

資料 1

特定領域研究 (B) 「成層圏変動と気候」 第 3 回公開
シンポジウム

「DAWEX (Darwin Area Wave Experiment)」
(DAWEX.PPT)



DAWEX (Darwin Area Wave Experiment)

Oct 13 - Oct 18, Nov 15 - 20, Dec 11 - 16, 2001

DAWEX (Darwin Area Wave Experiment)

2001年10-12月に Australia、Northern Territory の Darwin 周辺で、巨大孤立型積乱雲 (Hector) による大気波動励起過程を国際協同観測した。



DAWEX実験

2001年10-12月に Australia, Northern Territory の中心都市である Darwin 周辺で、**巨大孤立型積乱雲 (Hector)** による大気波動励起に関する国際協同観測キャンペーンが行われ、多くの観測装置が投入された。

観測装置

対流圏： 50MHz Windprofiler(Darwin郊外)、915MHz BLR(同)、
2重偏波ドップラーレーダー (同)
50MHZ BLR(Tiwi Island)

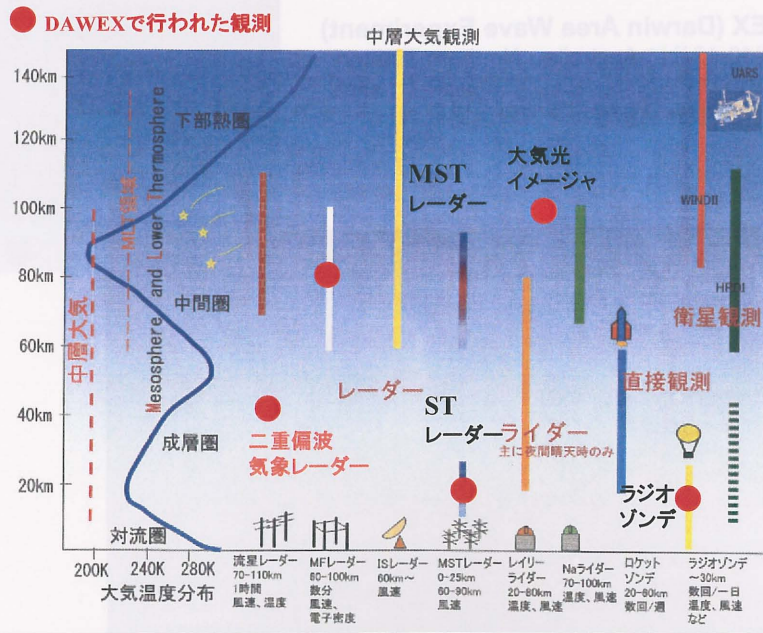
成層圏： 5日間のラジオゾンデキャンペーン
乾季 (10月) に1回、Hector季(11 - 12月)に2回実施
Darwinではルーチン観測も継続されている。

中間圏： MFレーダー、CCDイメージャ各種

京大RASCは気球観測 (ラジオゾンデ) を担当した。

協力機関： 豪州気象庁 (BOM: Bureau of Meteorology)
Adelaide 大学、Monash 大学

中層大気およびMLT領域における力学過程の観測方法



Darwin沖に **Tiwi Islands** と呼ばれる、狭い海峡をはさんだ二つの島 (Bathurst, Melville)があり、この上空に **Hector** が現れる。

気球観測サイト： 3点

Hectorからの波動伝播を調べるために、Tiwi Islandから南東方向に、ほぼ直線的に並んだ3つの観測点を選んだ。

- (A) Tiwi Island上のPirlangimpi (**Garden Point**)
- (B) Darwin 空港のBOM測候所 (Hector から50-100km)
- (C) **Katherine** 空港 (Hector から約300km)



小型気球搭載ラジオゾンデ観測

モンスーンオンセット(10月末)以降12月頃まで、ほぼ定期的に Hectorが現れると期待される。

Hectorの有無による大気波動励起の相違を比較する。

Hector のない乾季(10月中旬)の観測結果を Hector季である11月後半と12月中旬の観測と比較する。

CCDイメージャ観測を考慮して、観測期間を新月前後に行う。

- (1) 10月13-18日 (新月： 10/17 20:59 LT at 135E)
- (2) 11月15-20日 (新月： 11/16 9:43 LT at 135E)
- (3) 12月11-16日 (新月： 12/15 22:27 LT at 135E)

5日間 (120時間) にわたり3時間毎にラジオゾンデを放球し、温度・風速を高度約30kmまで高精度測定する。

期間中の初日 (10/13) の14:45 時から 最終日 (10/18) の11:45 まで40回の放球を行う。

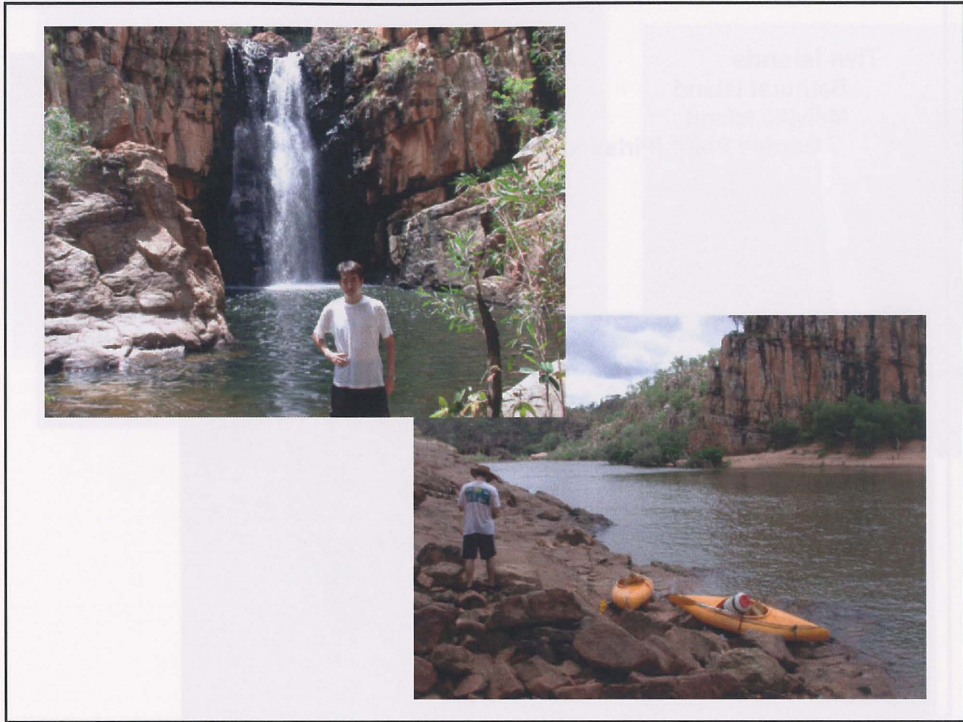
装置： レーダートラッキング (Darwin)
GPSゾンデ (Garden Point and Katherine)

Road to Katherine







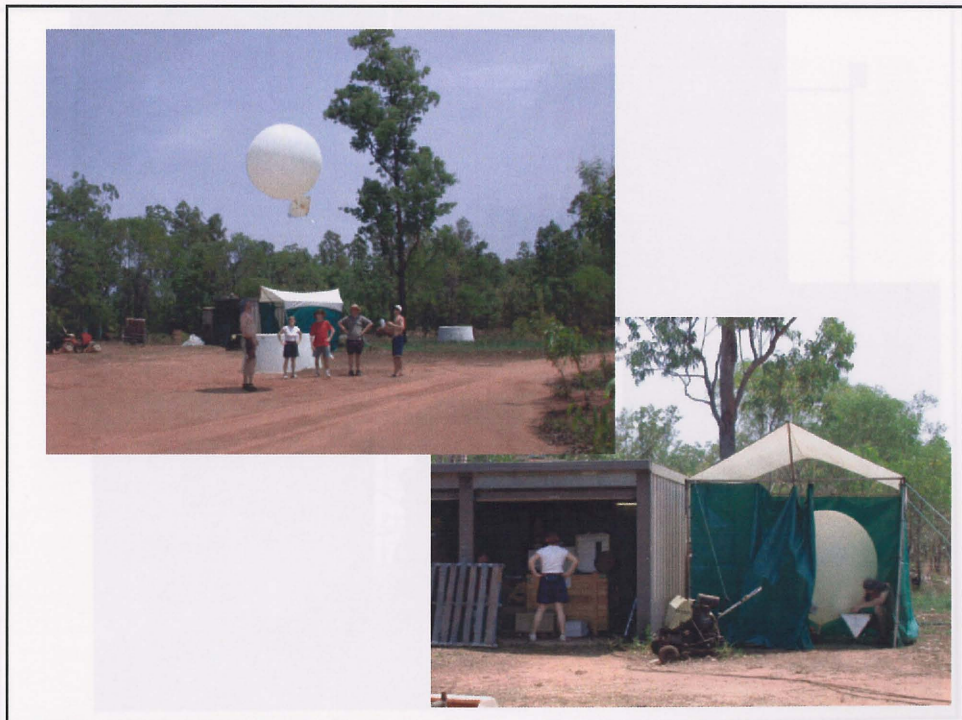


Tiwi Islands
Bathurst Island
Melville Island
Garden Point (Pirlangimpi)

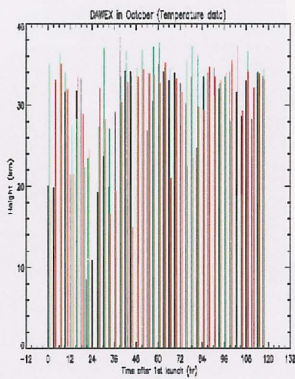


Garden Point



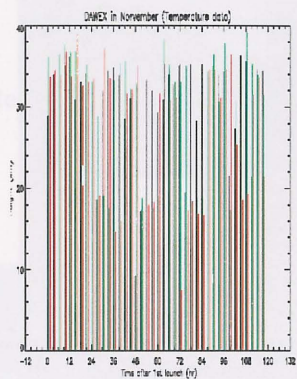


October 13-18



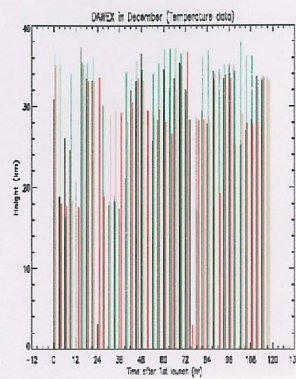
	total	<16 km	>20 km	>25 km	>30 km
GP	38	2	32	28	23
DW	38	0	35	33	27
Ka	40	2	35	30	25
	116	4	102	91	75
			78%	65%	

November 15-20



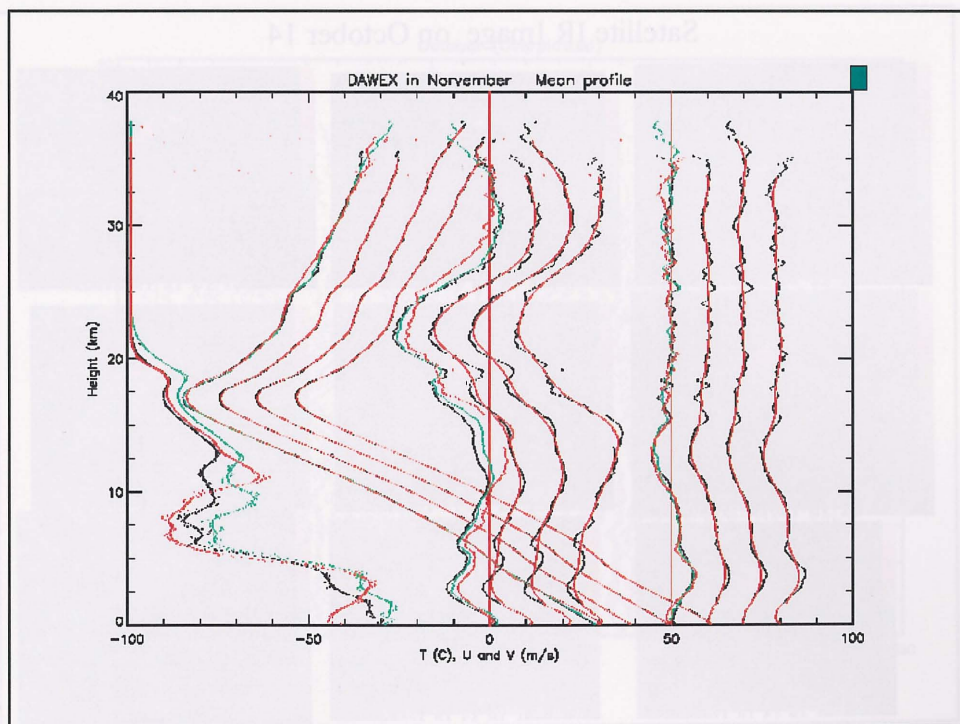
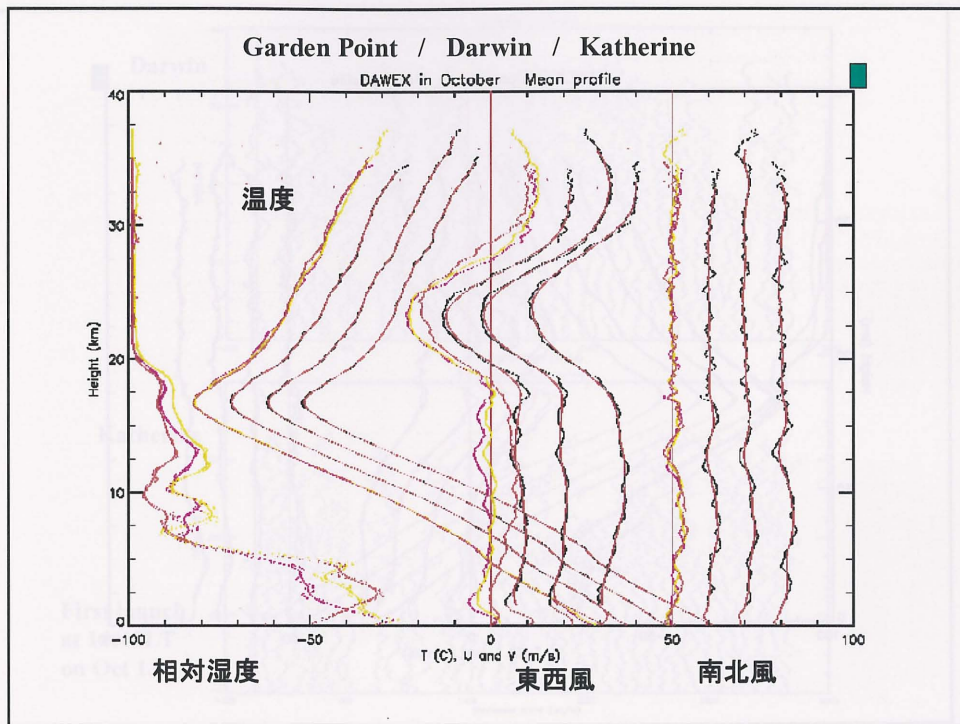
	total	<16 km	>20 km	>25 km	>30 km
GP	39	1	34	32	27
DW	39	0	29	29	28
Ka	40	3	27	26	25
	118	4	90	87	80
			74%	68%	

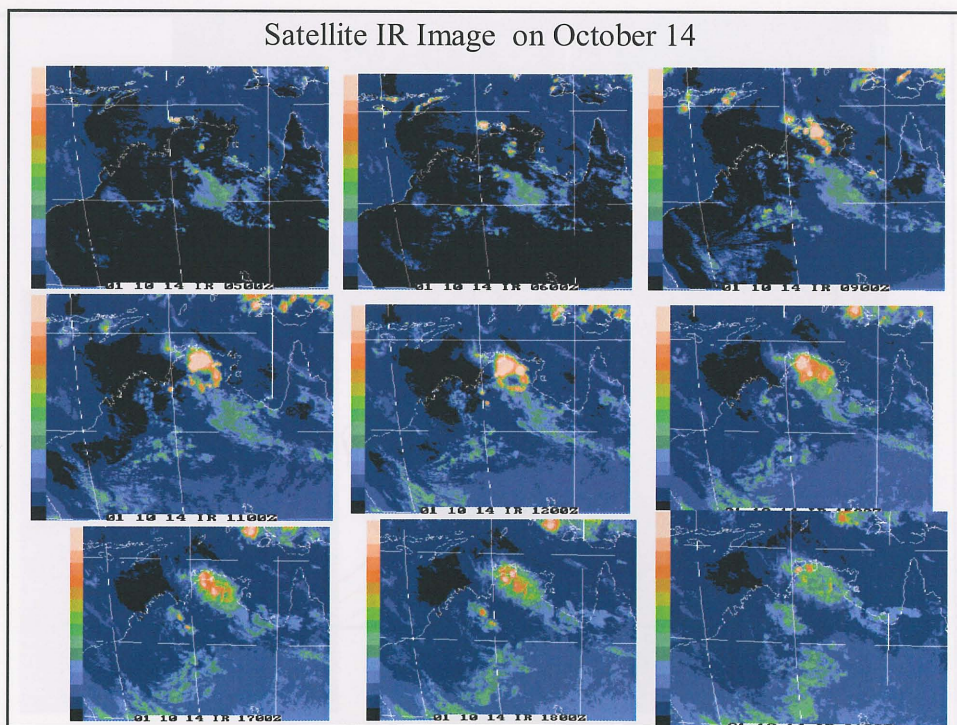
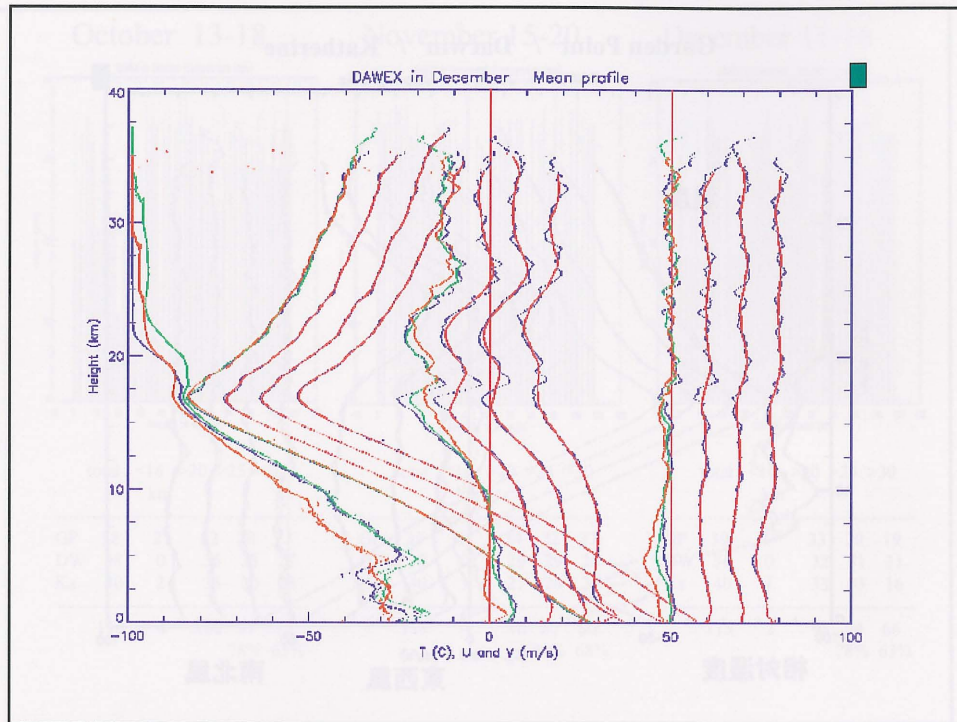
December 11-16

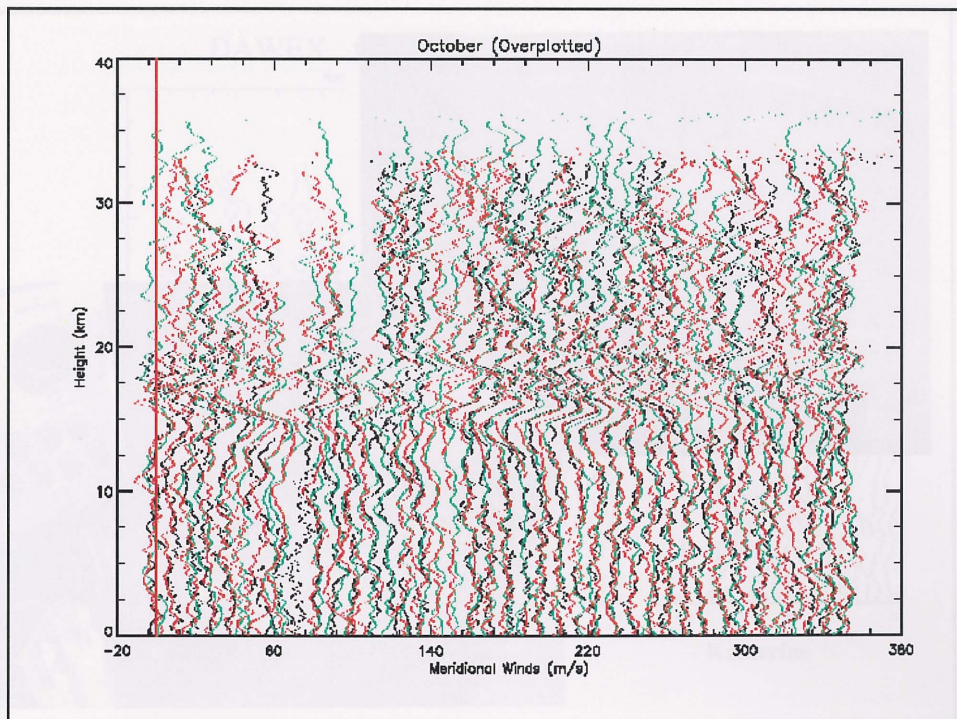
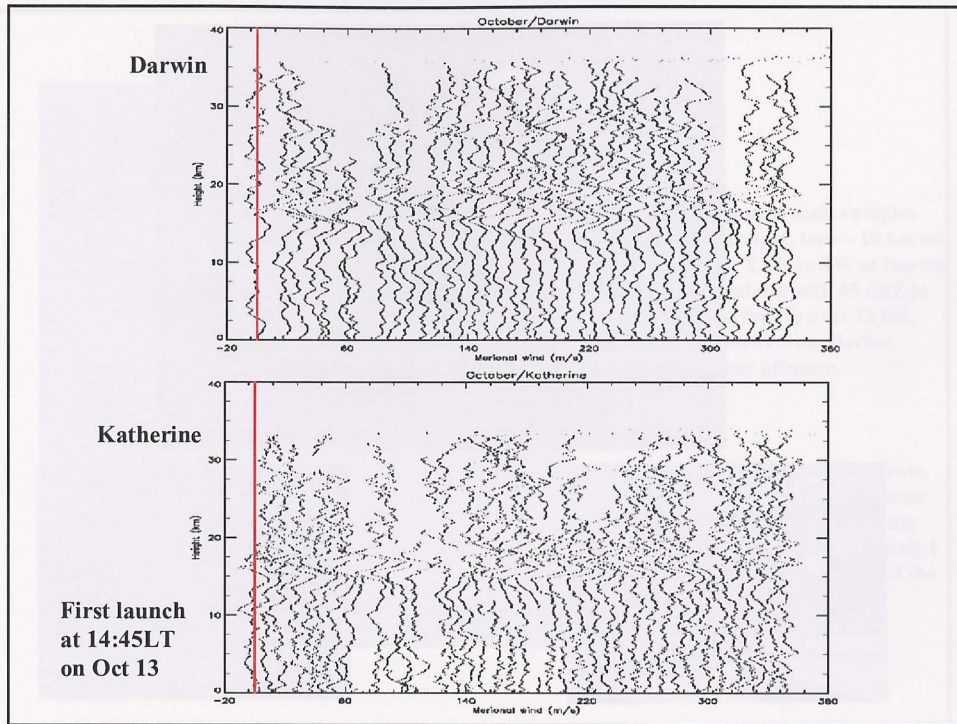


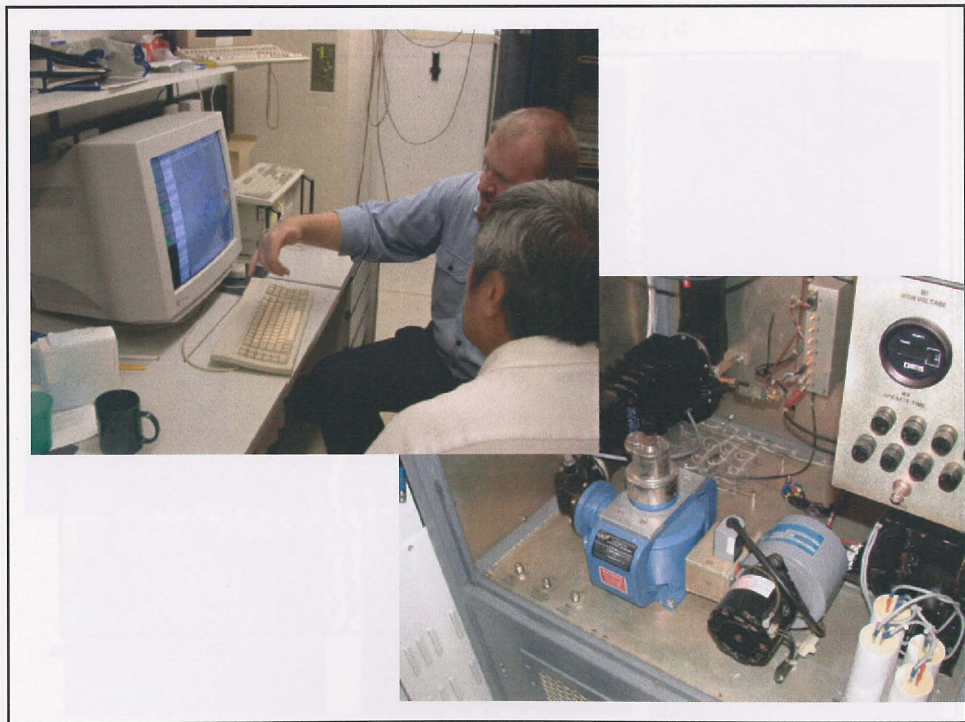
	total	<16 km	>20 km	>25 km	>30 km
GP	39	1	33	30	19
DW	36	0	32	31	31
Ka	40	1	33	33	16
	115	2	98	94	66
			78%	63%	

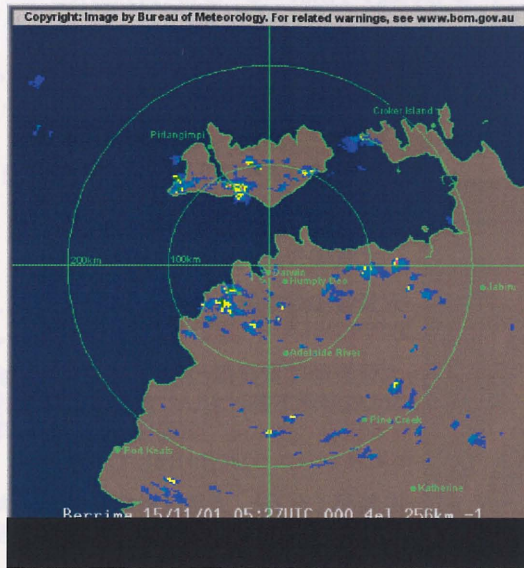












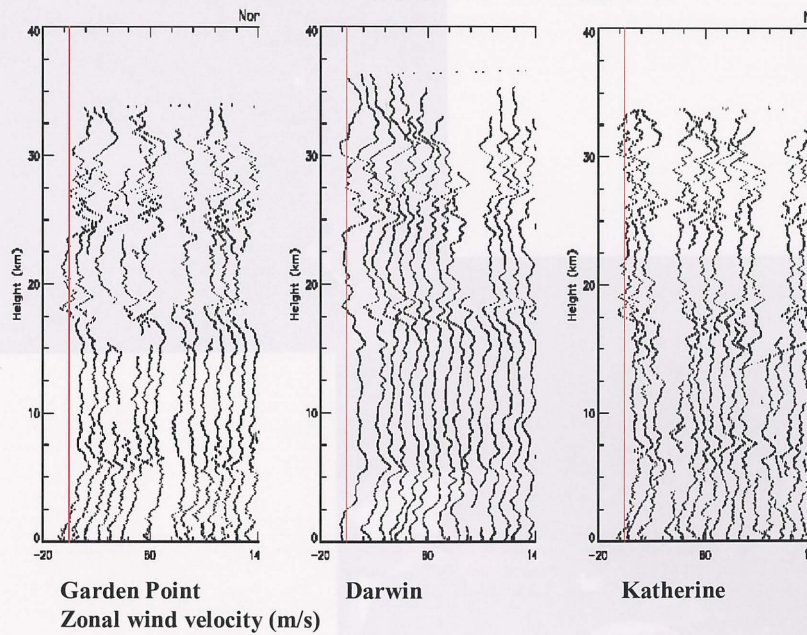
November 15

539 Tops to 20 km in main complex near Apsley Straight, tops ~ 18 km on Cape Fourcroy Cells to SW of Darwin also developing nicely with 45 dBZ to over 10 km and tops to over 18 km. Gust front outflows from Hector visible a long way offshore.

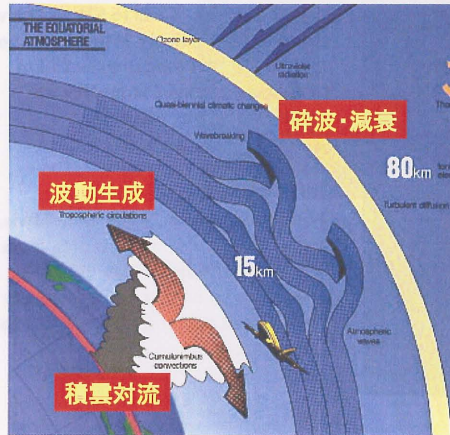
559

Make that tops to 20 km over Tiwis. Also a spectacular anvil visible from Gunn Point as upper flow takes the anvil towards us and unfortunately I don't have a camera, easily one of the best I have seen.

DAWEX from 14:45 LT on November 15



赤道域における積雲対流による波動励起



・赤道域では強い太陽放射エネルギーにより、対流圏で**積雲対流**が活発に励起されている。

・積雲対流により、さらに各種の**大気波動**が生成される。

(赤道波: ケルビン波、混合ロスビー波、大気潮汐波、大気重力波)

・大気波動が中層大気中を伝搬する際に、**力学エネルギー・運動量を上方輸送**する。

・大気波動は背景風と相互作用し、赤道域では成層圏下部において東西風に**準2年周期振動(QBO)**を、成層圏上部では**半年周期振動(SAO)**を作り出している。

・中間圏に至ると、大気波動の振幅が増大し、不安定現象を起こしやすくなり、背景風へ与える影響も顕著になってくる。



資料 2

EPIC シンポジウム

「A Preliminary Report of Radiosonde Campaigns
during DAWEX」

(EPIC.PPT)

A Preliminary Report of Radiosonde Campaigns during DAWEX (Darwin Area Wave Experiment)

Toshitaka Tsuda

Radio Science Center for Space and Atmosphere (RASC), Kyoto University

Peter T. May

Bureau of Meteorology Research Center (BMRC)

Robert A. Vincent and Andrew MacKinnon

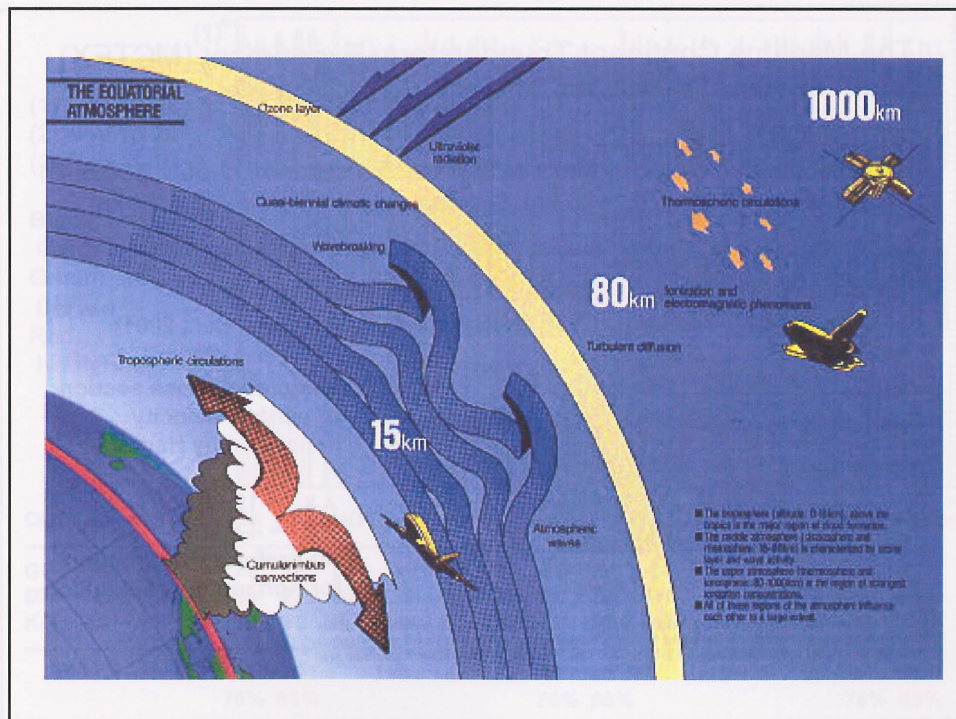
Department of Physics and Mathematical Physics, Adelaide University

Michael Reeder

School of Mathematical Sciences, Monash University

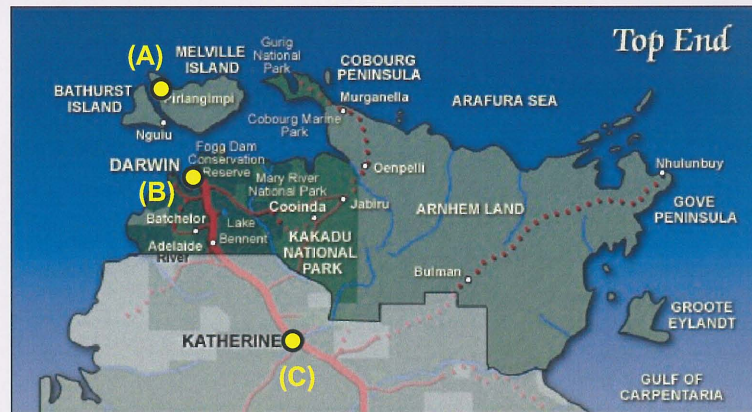
M. Joan Alexander

Colorado Research Associates (CORA)



During the build-up to the monsoon in the Northern Territory, Australia, intense convection known as **Hector** develops over the Tiwi islands (Bathurst, Melville Islands)

DAWEX Radiosonde Sites:	Lat.	Lon.	Distance	1/ f
(A) Pirlangimpi (Garden Point)	11.4S,	130.3E		61 hr
(B) Darwin BOM station	12.4S,	130.9E,	130 km	56 hr
(C) Katherine Airport	14.5S,	132.5E,	400 km	48 hr



The Maritime Continent Thunderstorm Experiment (MCTEX)

[e.g. T. Keenan et al. Bull., Am. Meteorol. Soc., 2000]

MCTEX IOP: Nov 11 to Dec 8, 1995

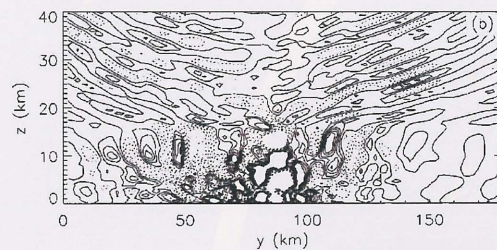
Radiosonde soundings at Maxwell's Creek, Tiwi Island (11.55S, 130.56E)

Total: 99 (>18 km, 78, ~26 km: 9) Mean termination height= 24 km

Characteristics of island-initiated meso-scale convective system

Modeling of gravity wave generation by Hector

T. Lane and M. Reeder (Q. J. R. Meteorol., 2001; J. Atmos. Sci., 2001)



Meridional cross section of vertical velocity generated by Hector

$\lambda_x \sim 15-20$ km

$\lambda_z \sim 4-6$ km

No preferential direction for horizontal propagation

Figure 4. (a) Zonal cross-section of vertical velocity through $y = 100$ km for Domain 1. (b) Meridional cross-section of vertical velocity through $x = 100$ km for Domain 1. Vertical velocity is contoured at 0.1 m s^{-1} intervals, with the negative values dashed. Both plots are valid at 1300 LST. Note that (b) has a different horizontal scale from (a).

Campaign Periods
 (1) October 13-18
 (2) November 15-20
 (3) December 11-16

* 8 launches/day
 x 5 days (120 hr)

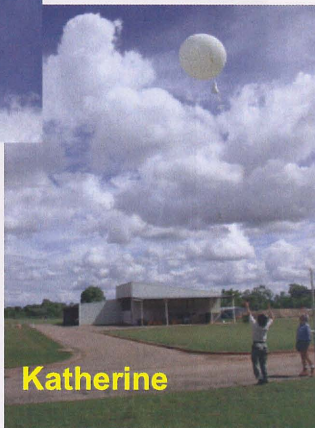
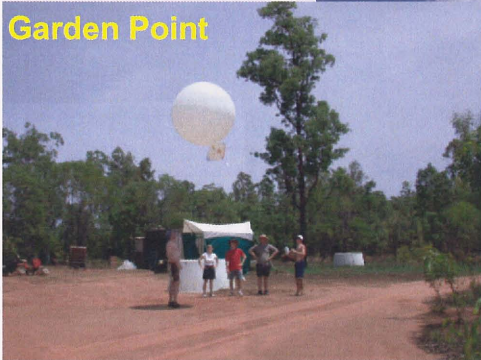
* 40 launches/site
 x 3 sites=120

Total 360 profiles

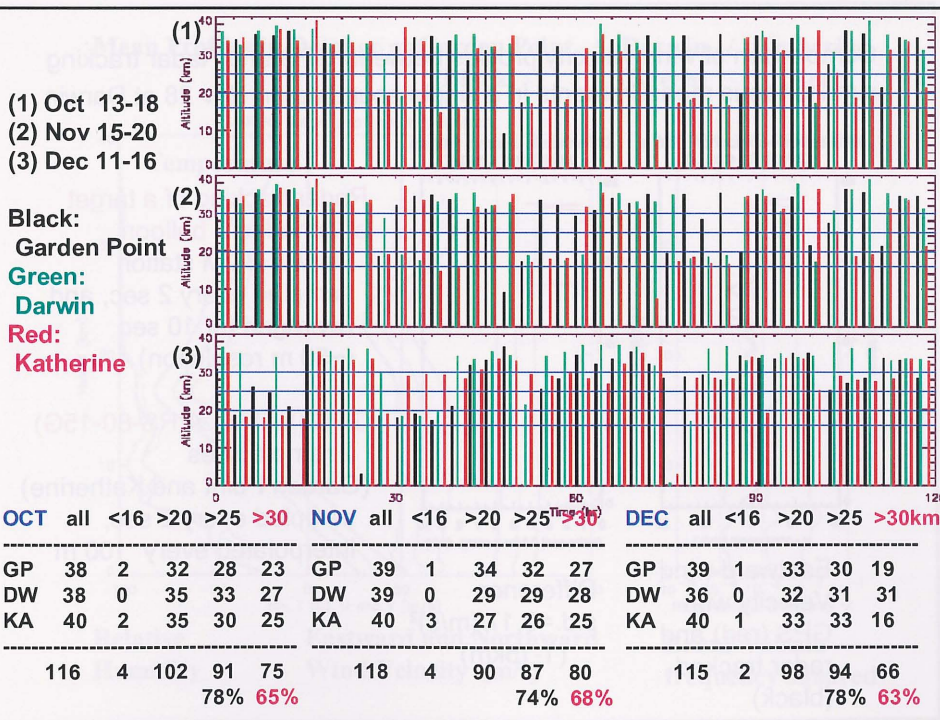


Larger balloon
 (800g ←350g)
 to measure
 the stratosphere
 up to 30 km

Garden Point



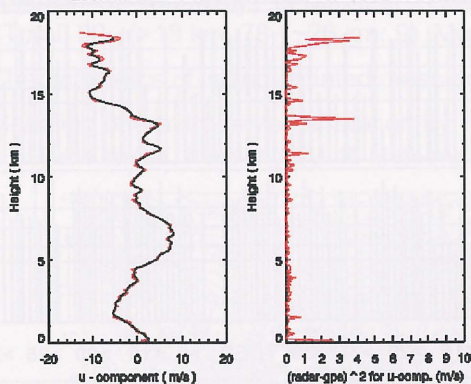
Katherine





Comparison of wind velocity profiles between GPS and Radar tracking simultaneous measurements in a single sounding on Nov 28 at Darwin

Wind speed u-component (100 m) 28 NOV 01 4:56 UT Difference in u-comp. (100 m) 28 NOV 01 4:56 UT



Radar tracking of a target attached to a balloon
 Darwin BOM station sampled every 2 sec, and averaged for 10 sec (~50 m resolution)

GPS (VAISALA RS-80-15G) 2 remote sites (Garden Point and Katherine) sampled every 2 sec, interpolated every 100 m

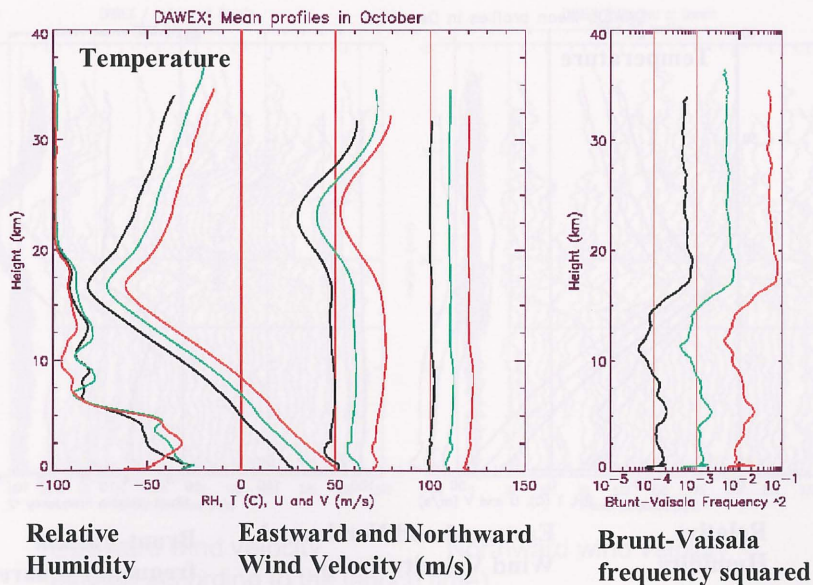
Eastward wind Velocity with GPS (red) and radar tracked (black)

Difference s.d.=0.17 (m/s)² (1-15km)

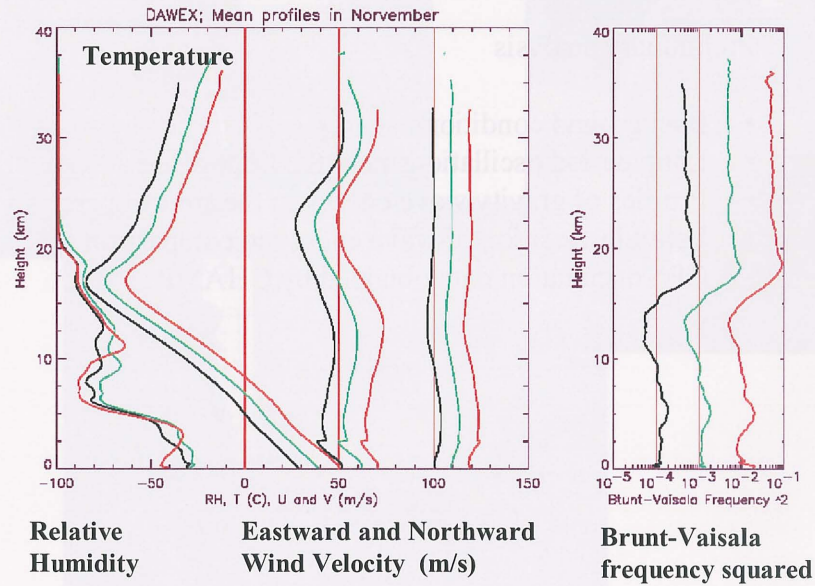
Preliminary analysis

- Background conditions
- Long period oscillations near the tropopause
- Profiles of gravity wave energy in the stratosphere
- Latitude variation of wave energy in comparison to GPS occultation data obtained by CHAMP

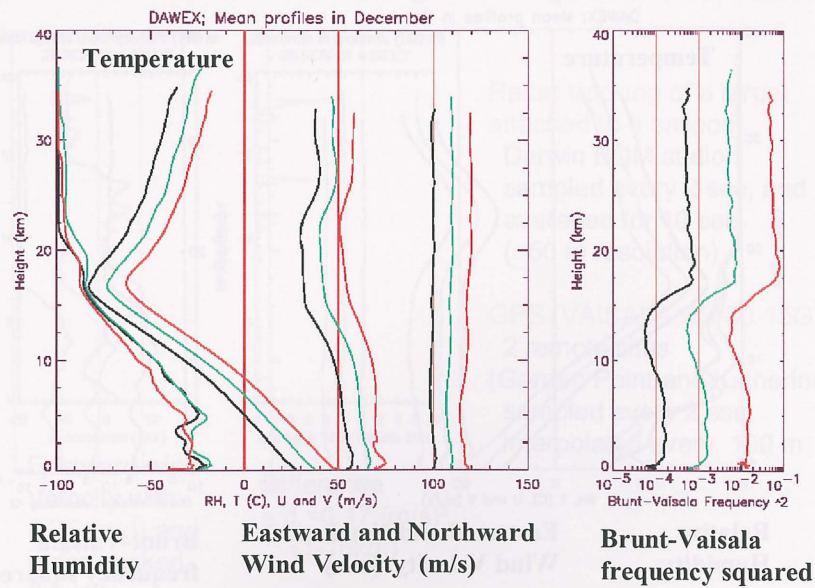
Mean Profiles in **October** at Garden Point / Darwin / Katherine
(Black) **(Green)** **(Red)**



Mean Profiles in November at Garden Point / Darwin / Katherine
 (Black) (Blue) (Red)



Mean Profiles in December at Garden Point / Darwin / Katherine
 (Black) (Blue) (Red)

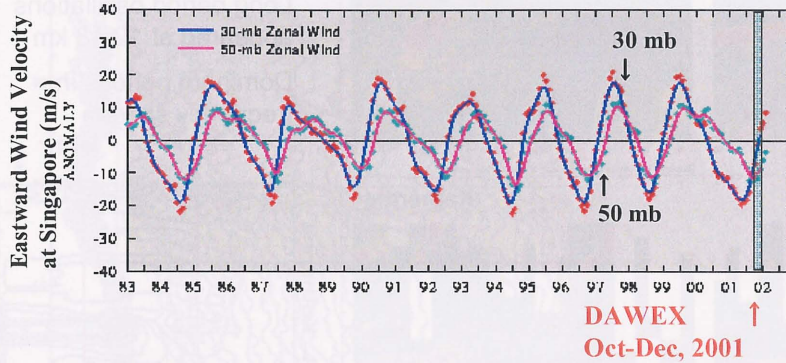


Characteristics of mean zonal winds: Lower stratosphere

QBO at Singapore in late 2001

$u \sim 0$ m/s at 30 mb (~ 24 km)

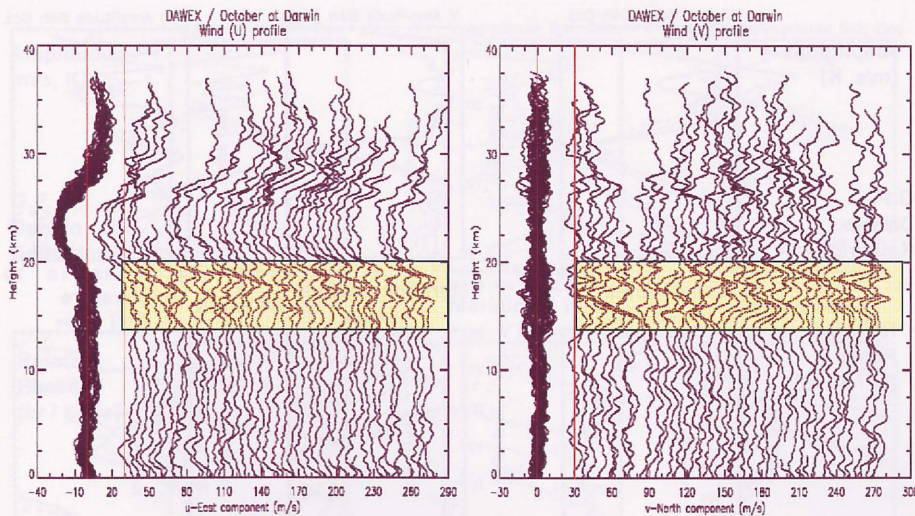
$u \sim -10$ m/s (westward) at 50 mb (~ 20 km)



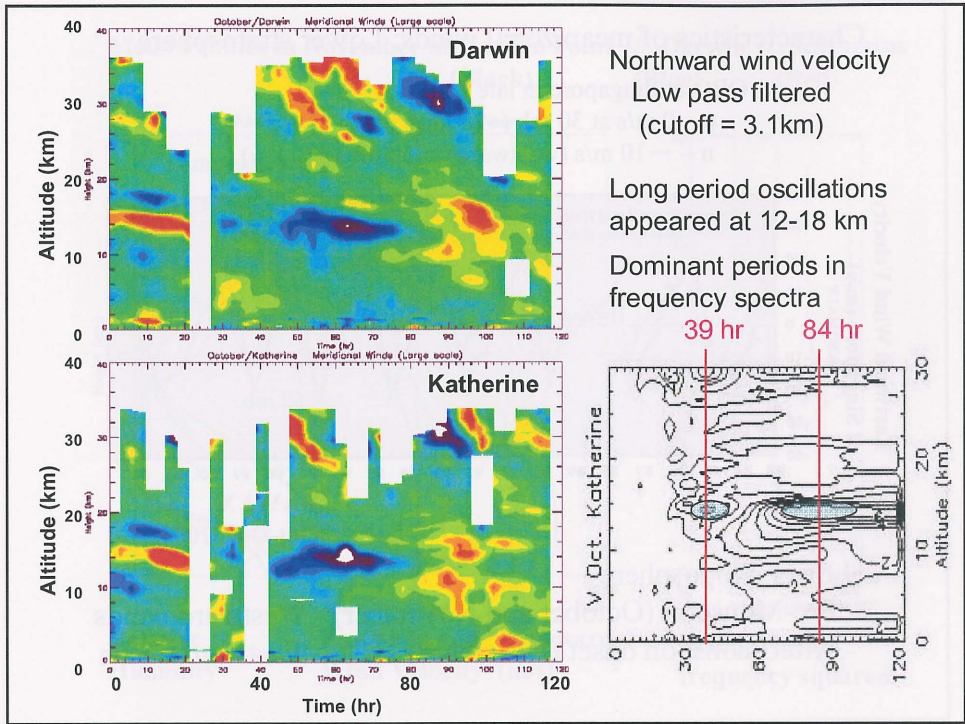
Lower Troposphere

Pre-Monsoon (October and November) Westward winds
 After monsoon onset (December) Eastward winds

Wind Velocity Profiles at Darwin during October 13-18, 2001



Eastward wind velocity Northward wind velocity
 (shifted according to the launch time)

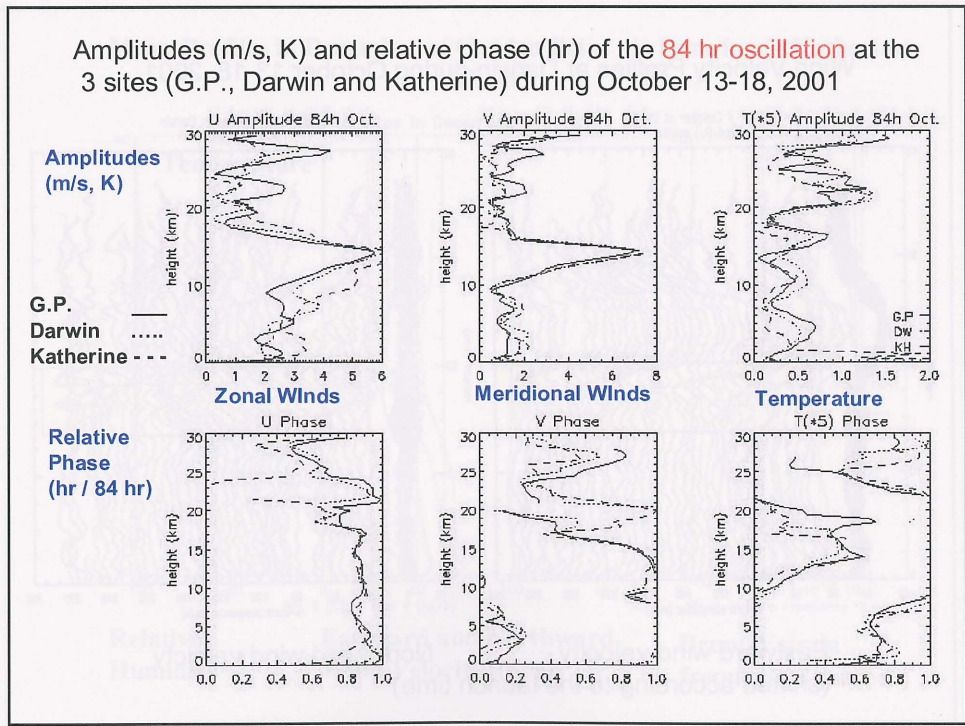


Northward wind velocity
Low pass filtered
(cutoff = 3.1km)

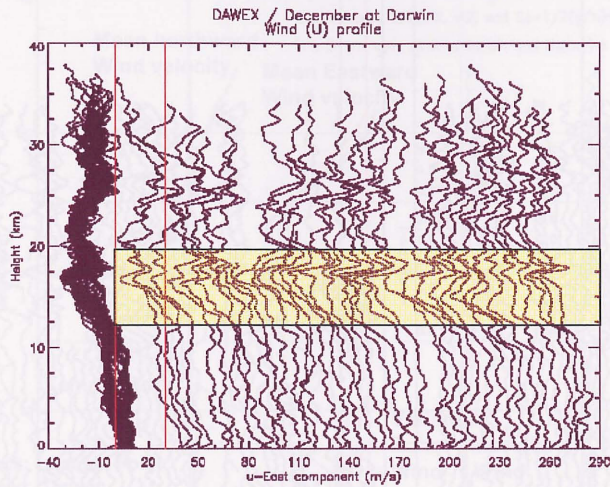
Long period oscillations
appeared at 12-18 km

Dominant periods in
frequency spectra

Amplitudes (m/s, K) and relative phase (hr) of the 84 hr oscillation at the 3 sites (G.P., Darwin and Katherine) during October 13-18, 2001

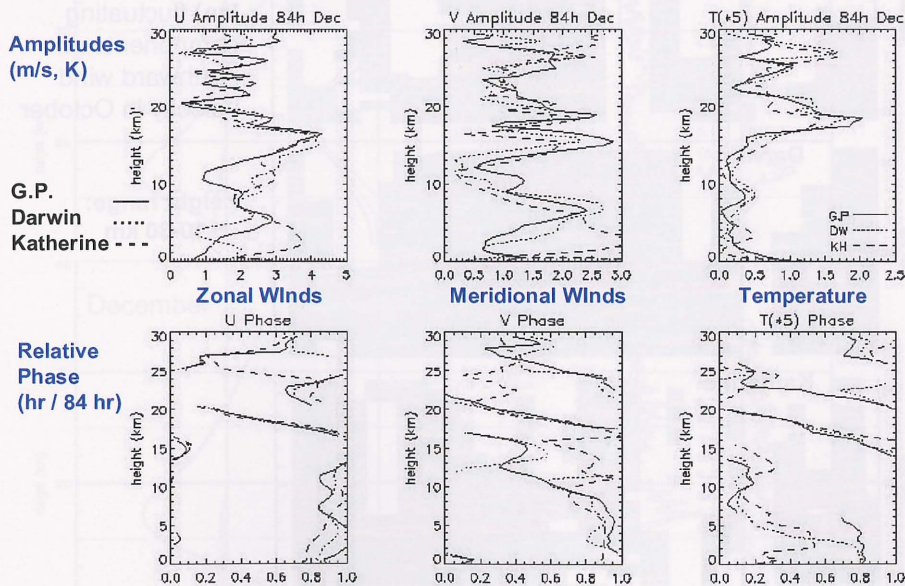


Long-period (84 hr) oscillation near the tropopause

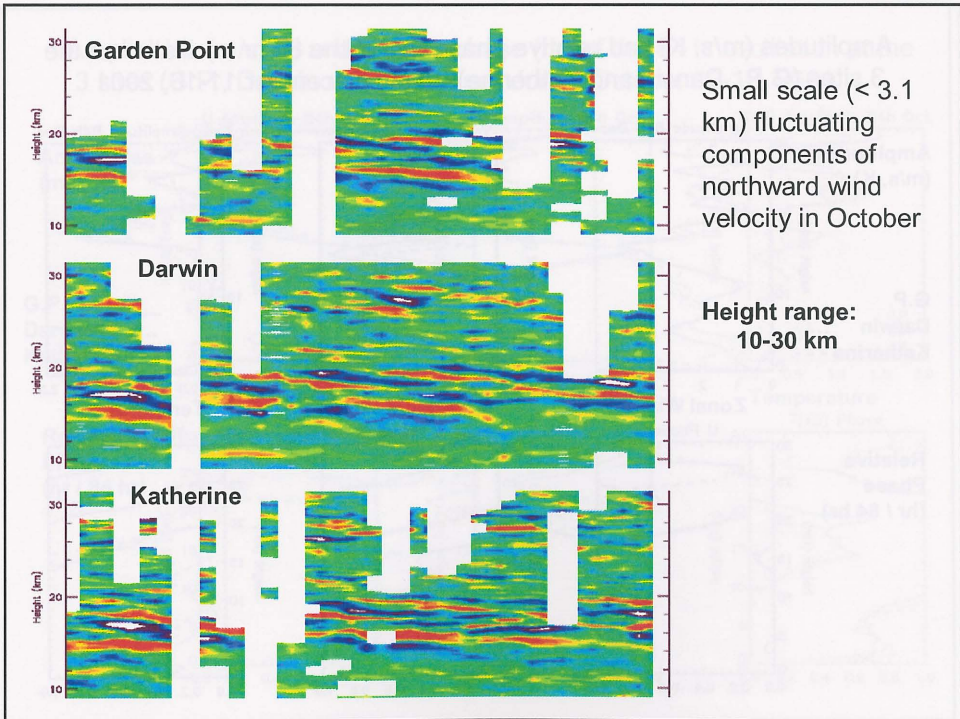
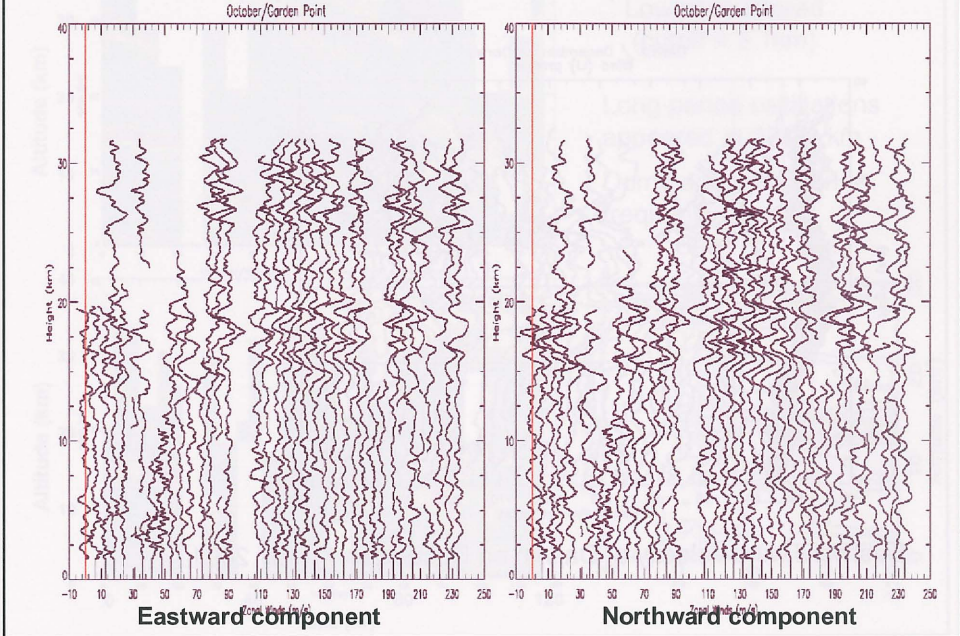


Eastward wind velocity at Darwin on December 11-16, 2001

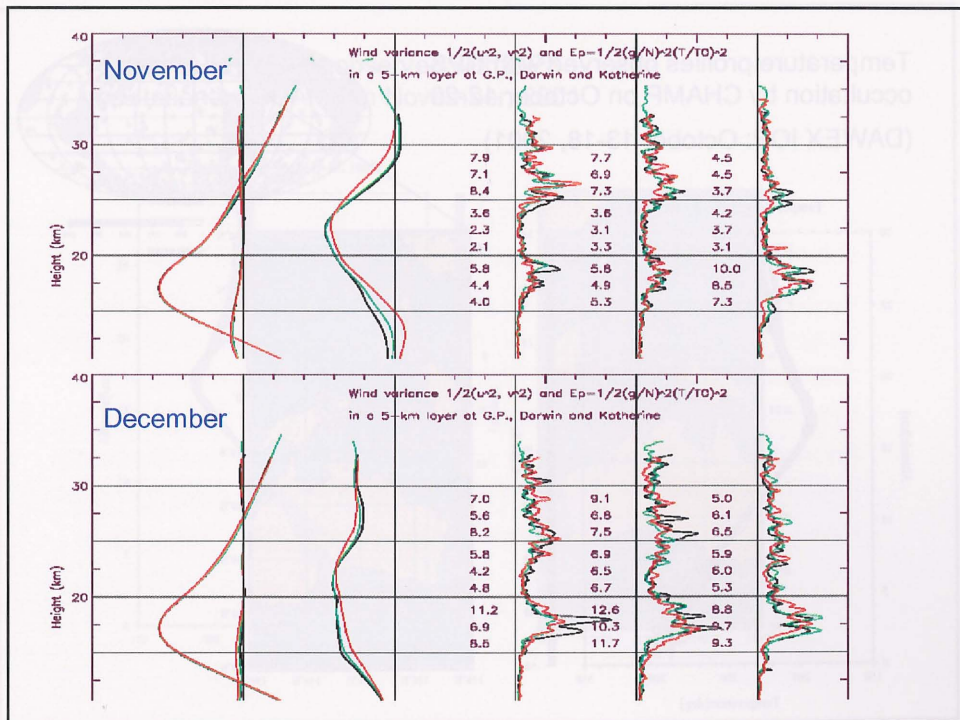
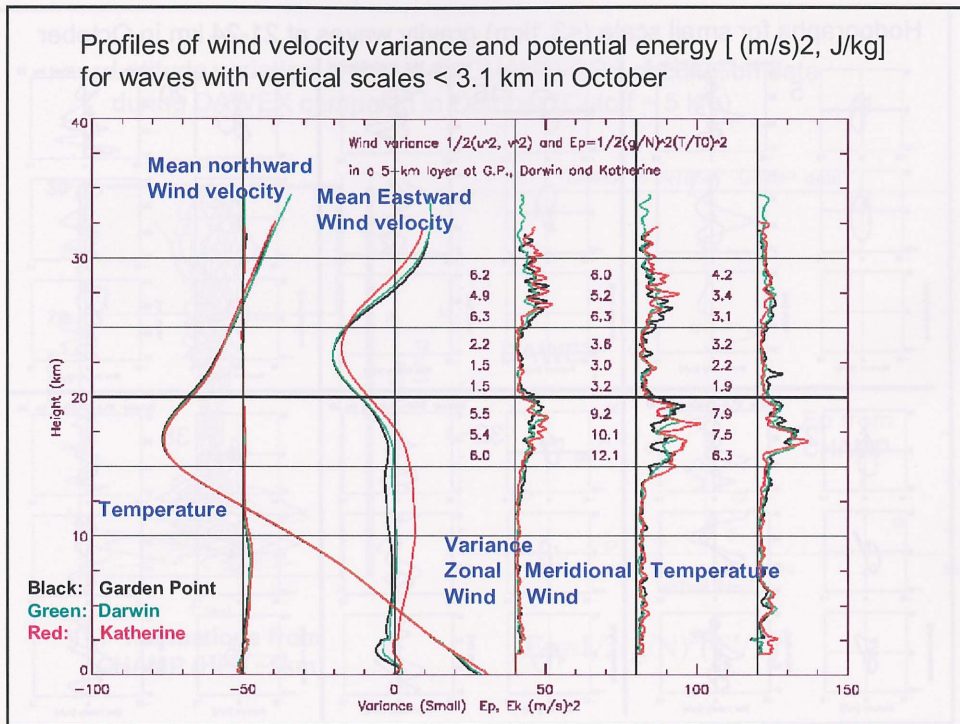
Amplitudes (m/s, K) and relative phase (hr) of the 84 hr oscillation at the 3 sites (G.P., Darwin and Katherine) during December 11-16, 2001



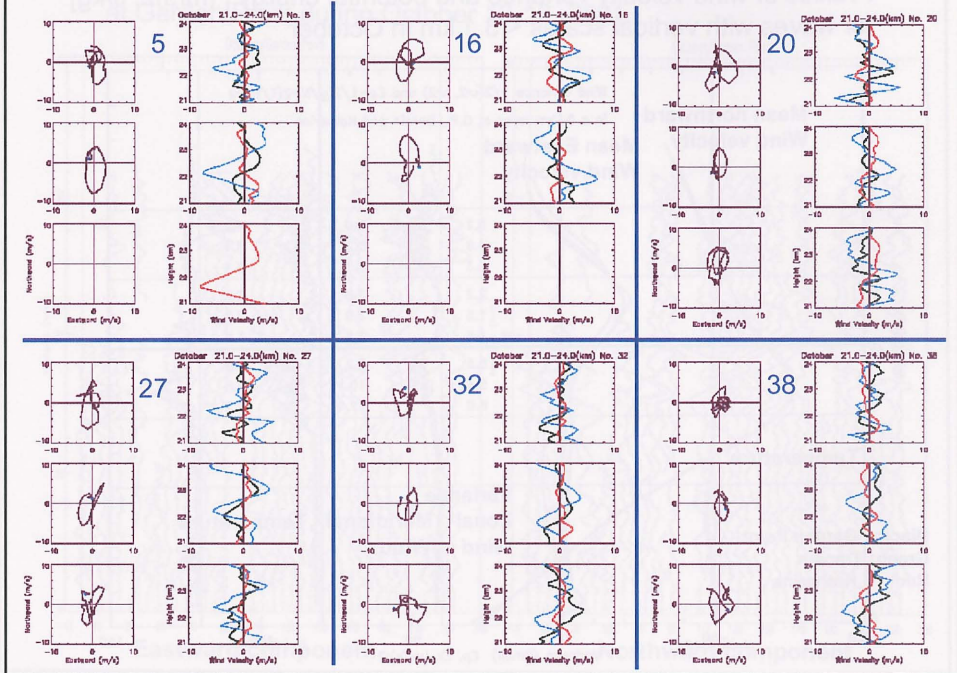
Wind velocity fluctuations with a vertical scale smaller than 3.1 km at Garden Point during October 13-18, 2001



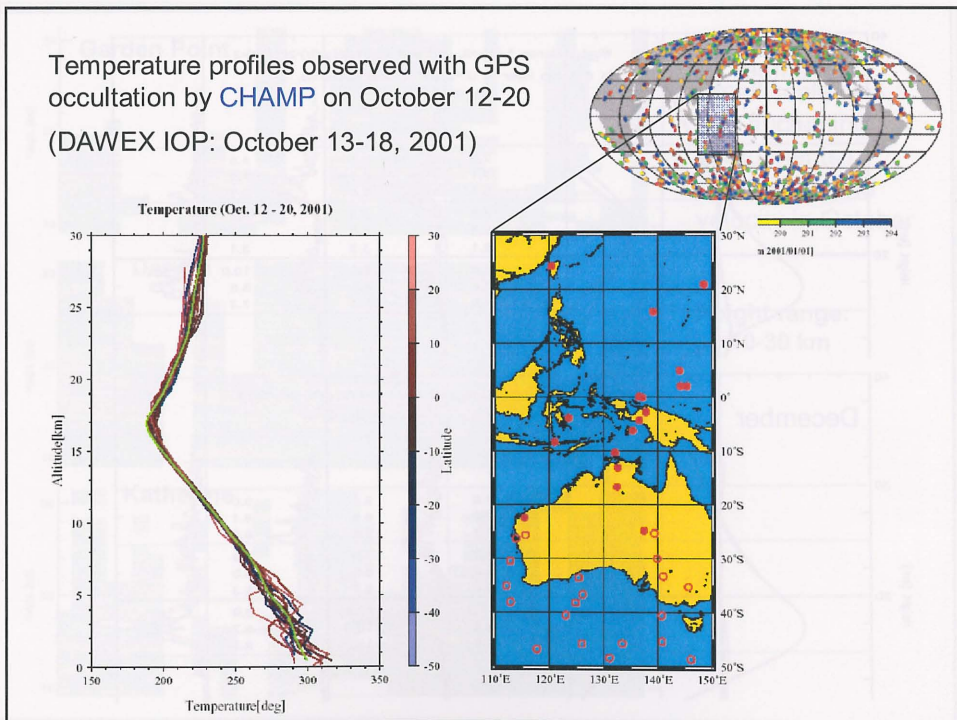
Profiles of wind velocity variance and potential energy [(m/s)², J/kg] for waves with vertical scales < 3.1 km in October



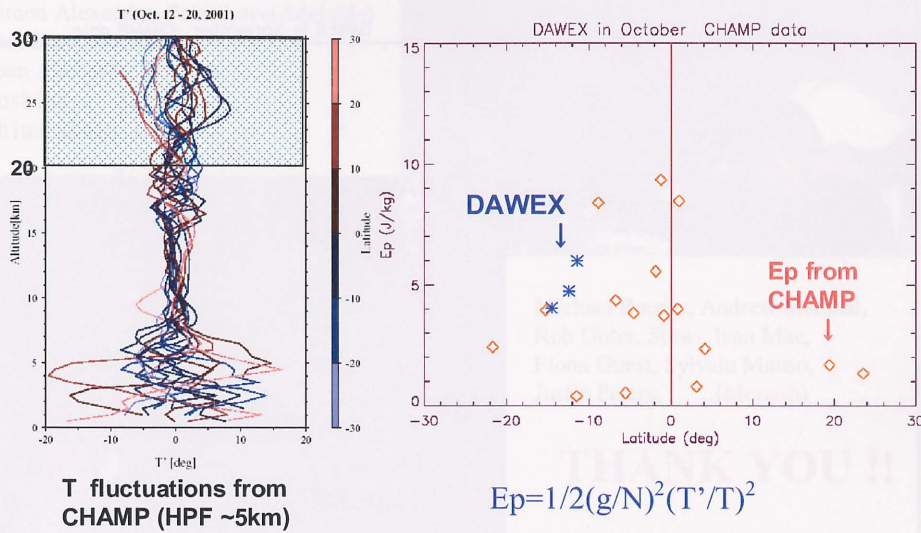
Hodographs for small scale (<3.1km) gravity waves at 21-24 km in October



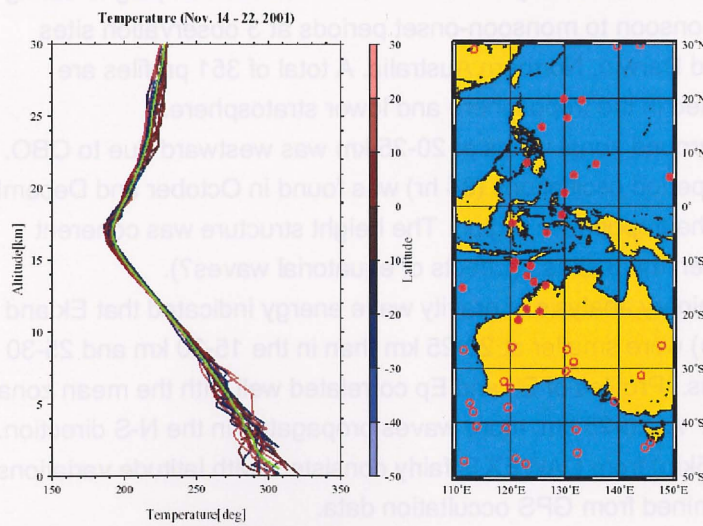
Temperature profiles observed with GPS occultation by CHAMP on October 12-20 (DAWEX IOP: October 13-18, 2001)



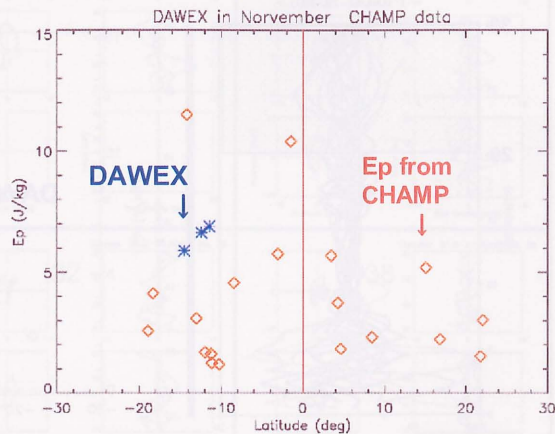
Latitude variation of E_p using CHAMP/GPS occultation data during DAWEX campaign in October (Cutoff ~ 5 km)



Temperature profiles observed with GPS occultation by CHAMP in November, 2001



Latitude variation of E_p using CHAMP/GPS occultation data during DAWEX campaign in November (Cutoff ~ 5 km)



Summary

1. We have successfully conducted 3 radiosonde campaigns during pre-monsoon to monsoon-onset periods at 3 observation sites around Darwin, Northern Australia. A total of 351 profiles are obtained in the troposphere and lower stratosphere.
2. Background zonal winds at 20-25 km was westward due to QBO.
3. Long-period oscillations (84 hr) was found in October and December near the tropopause region. The height structure was coherent between the 3 sites. (Effects of equatorial waves?).
4. Preliminary analysis of gravity wave energy indicated that E_k and E_p (<3km) were smaller at 20-25 km than in the 15-20 km and 25-30 km regions. Profiles of E_k and E_p correlated well with the mean zonal winds. At 20-25 km, more waves propagated in the N-S direction.
5. E_p (<5km) from DAWEX is fairly consistent with latitude variations E_p determined from GPS occultation data.

Peter May, Ross Christmas, Nigel Mules,
Jim Arther, Ken Glasson, Phil Dutton,
Roger Atkinson, (BOM/BMRC)
Bob Vincent, Andrew McKinnon,
Simon Alexander, Peter Love(Adelaide)
Tim Burns (NCAR),
Joan Alexander (CoRA)
Yoshihara, Aoyama,
Shimabukuro (RASC)



Michael Reeder, Andrew Marshal,
Rob Goler, Stew , Ivan Mac,
Fiona Guest, Sylvain Manso,
Justin Peters,(Monash)

THANK YOU !!

(TROP 1.PPT)

資料 3

日本気象学会 2002 年春季大会専門分科会

「熱帯対流圏界面・遷移層」

「赤道域におけるラジオゾンデ観測で見られた

対流圏界面付近の大気変動」

(TROP 1 .PPT)

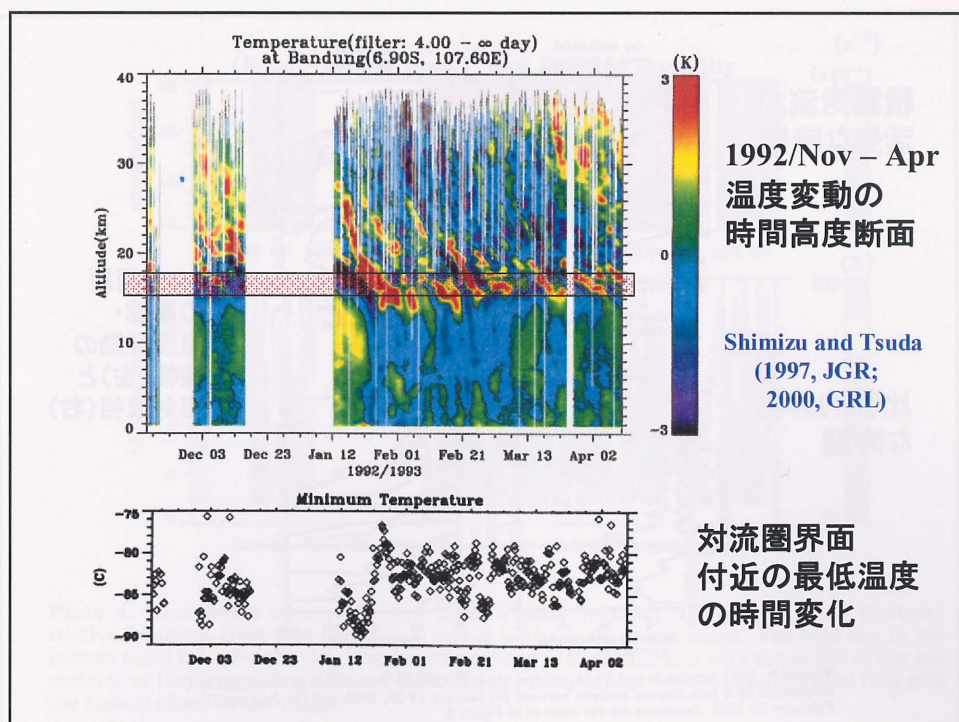
専門分科会「熱帯対流圏界面・遷移層」

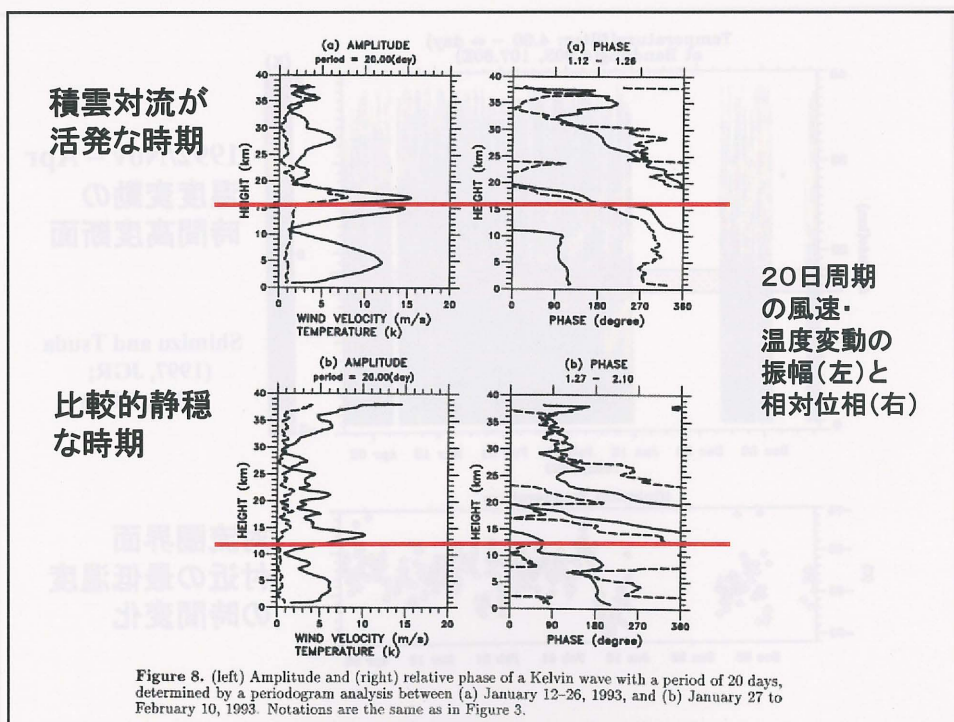
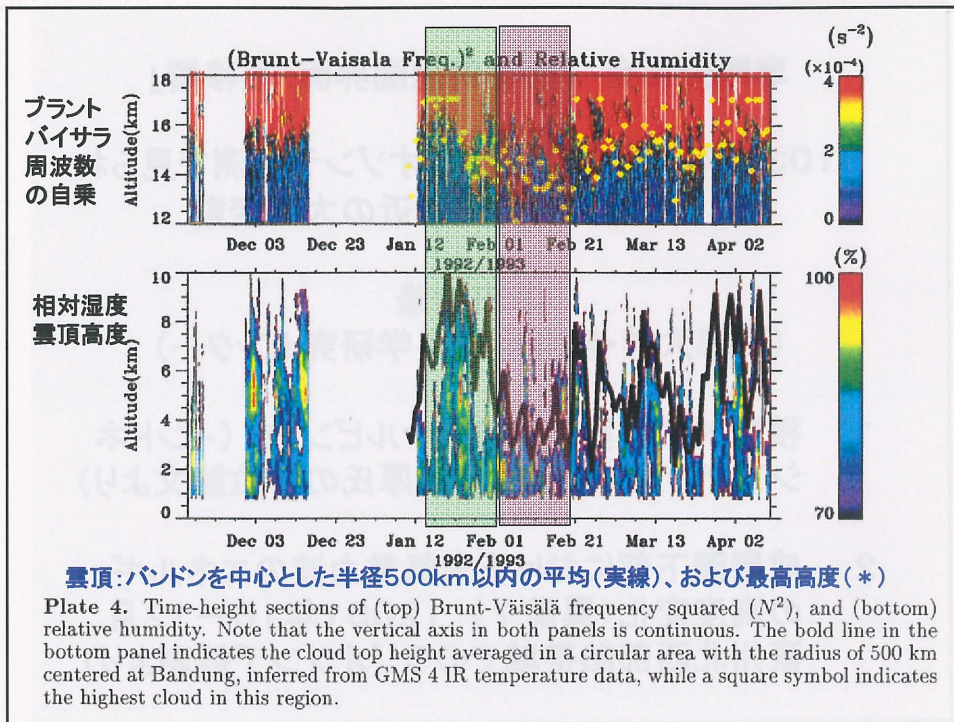
B103 赤道域におけるラジオゾンデ観測で見られた対流圏界面付近の大気変動

津田敏隆

(京都大学・宙空電波科学研究センター)

1. 積雲対流の雲頂高度とケルビン波 (インドネシアでの気球観測、清水厚氏の学位論文より)
2. 成層圏下部における大気重力波のエネルギーの高度変化(異常?) (2001年10-12月、豪州北西部熱帯域でのラジオゾンデ観測より)





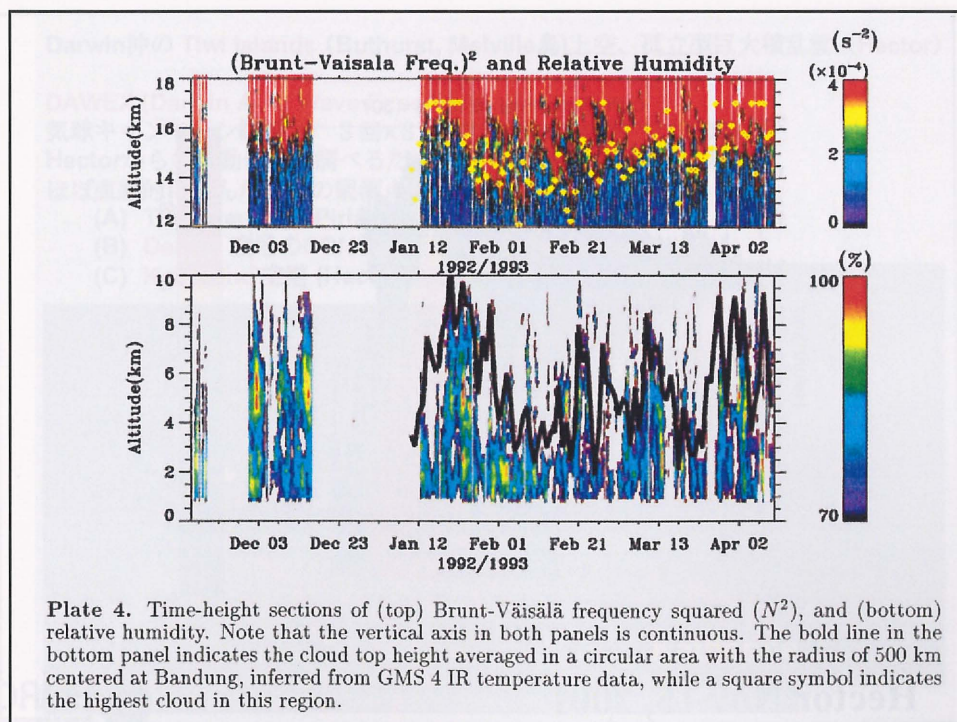
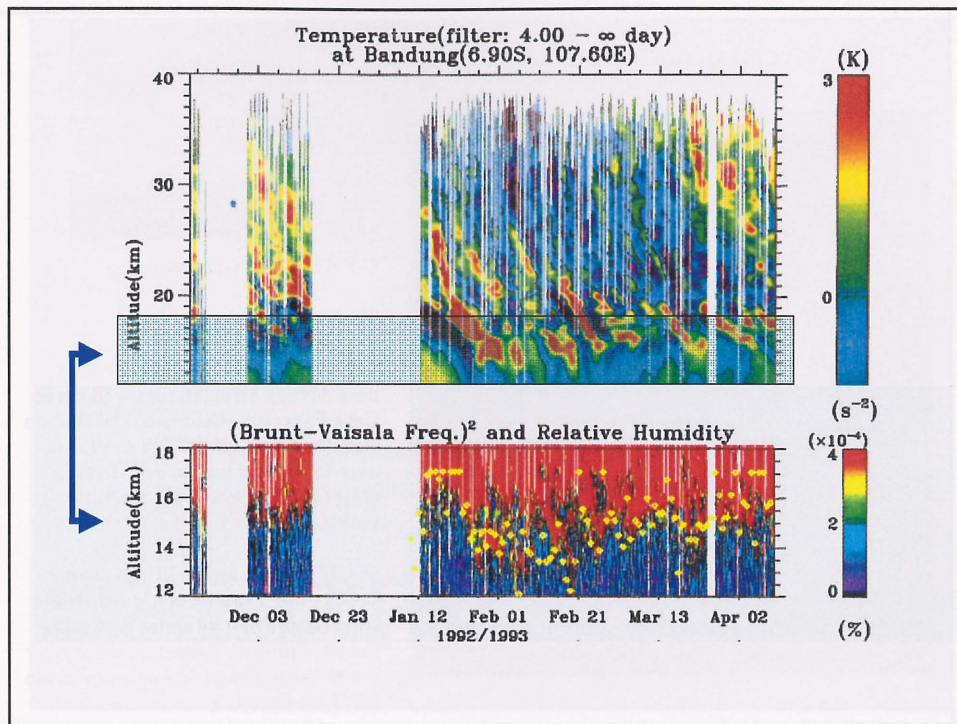
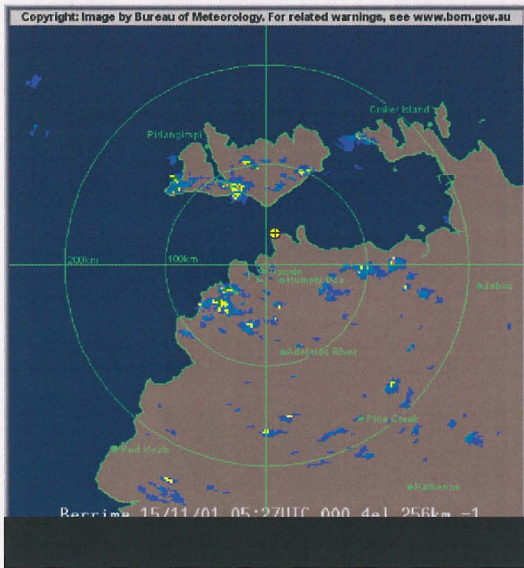


Plate 4. Time-height sections of (top) Brunt-Väisälä frequency squared (N^2), and (bottom) relative humidity. Note that the vertical axis in both panels is continuous. The bold line in the bottom panel indicates the cloud top height averaged in a circular area with the radius of 500 km centered at Bandung, inferred from GMS 4 IR temperature data, while a square symbol indicates the highest cloud in this region.

Hector occurred on Nov 15

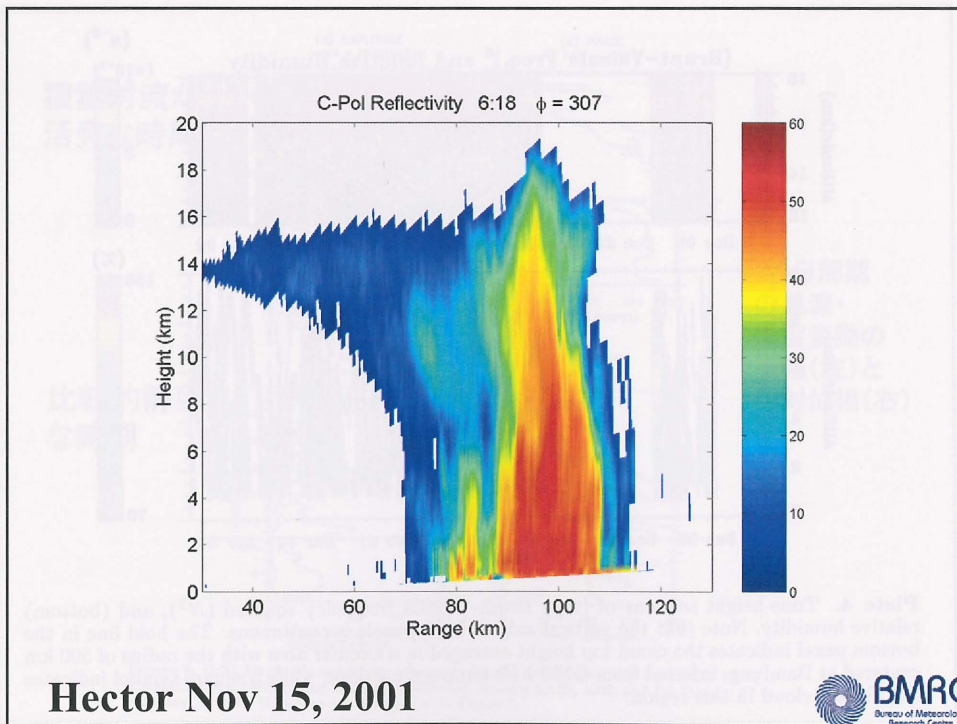


C-Pol radar at Gun Point ☺

Memo by Peter May
November 15

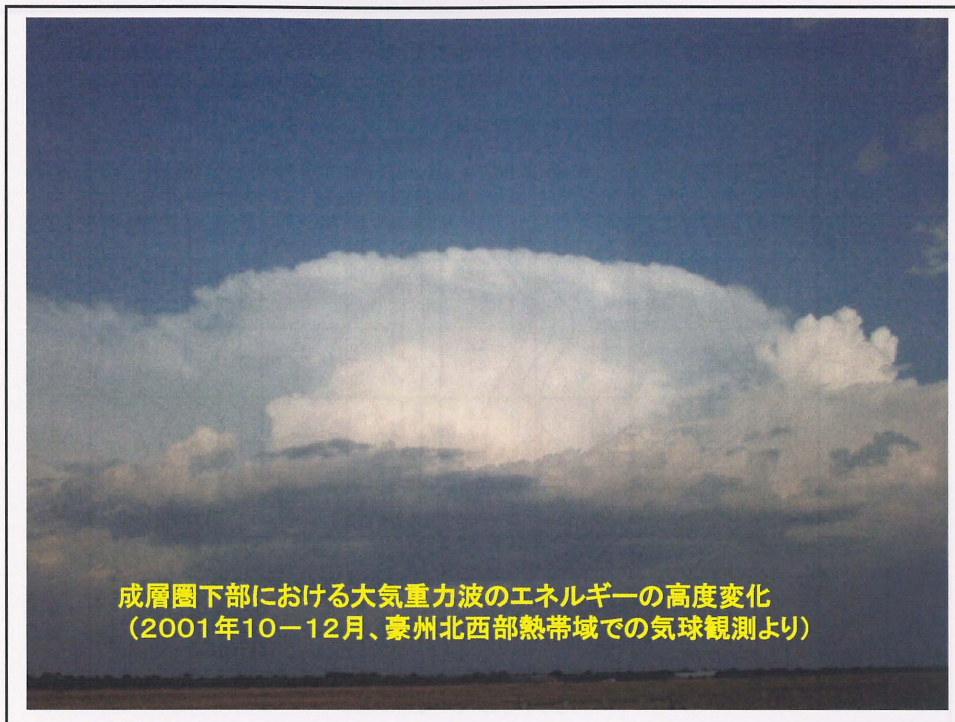
539 Tops to 20 km in main complex near Apsley Straight, tops ~ 18 km on Cape Fourcroy Cells to SW of Darwin also developing nicely with 45 dBZ to over 10 km and tops to over 18 km. Gust front outflows from Hector visible a long way offshore.

559 Make that tops to 20 km over Tiwis. Also a spectacular anvil visible from Gunn Point as upper flow takes the anvil towards us and unfortunately I don't have a camera, easily one of the best I have seen.



Hector Nov 15, 2001





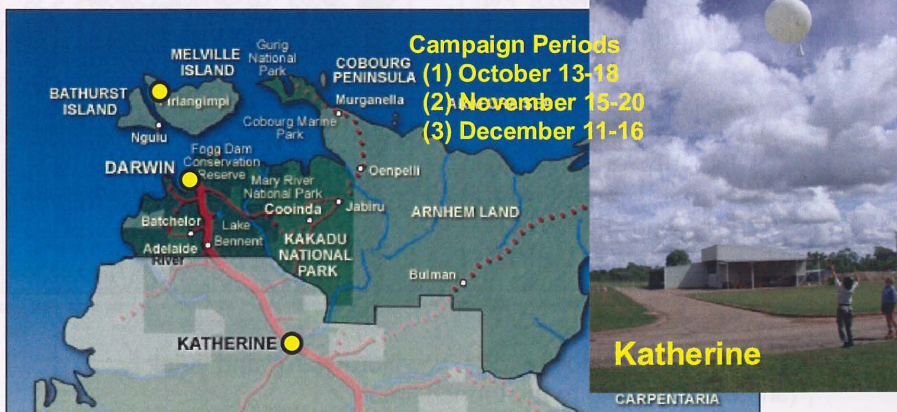
Darwin沖の **Tiwi Islands** (Bathurst, Melville島)上空、孤立型巨大積乱雲 (**Hector**)

DAWEX (Darwin Area Wave Experiment)

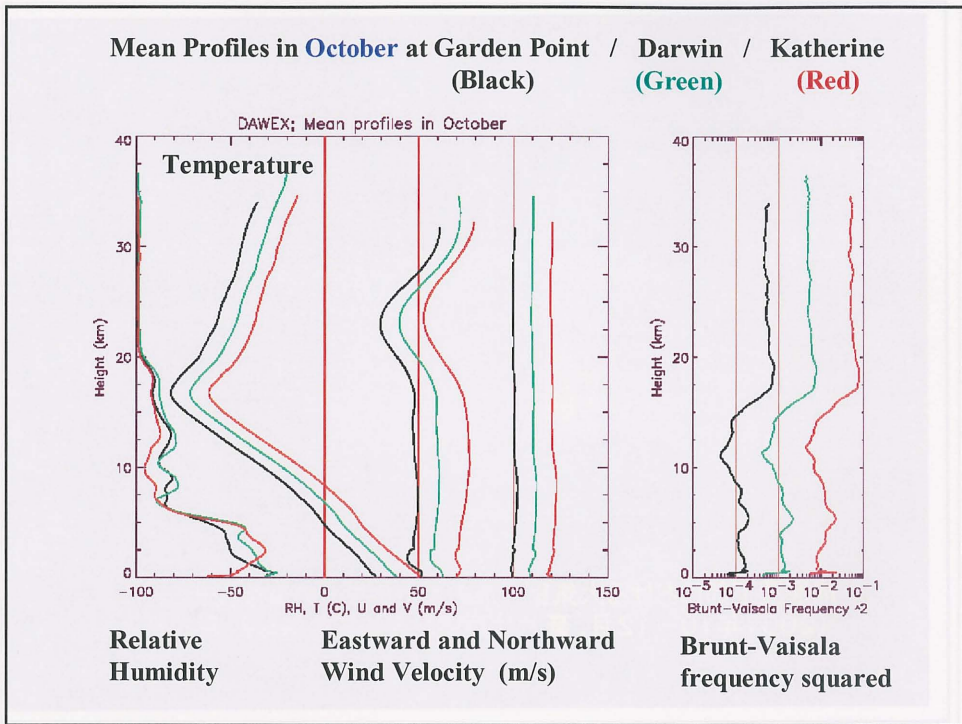
気球キャンペーン観測： 3回x3点x3時間毎に40回 (360回)

Hectorからの波動伝播を調べるために、Tiwi Islandから南東方向に、ほぼ直線的に並んだ3つの観測点を選んだ。

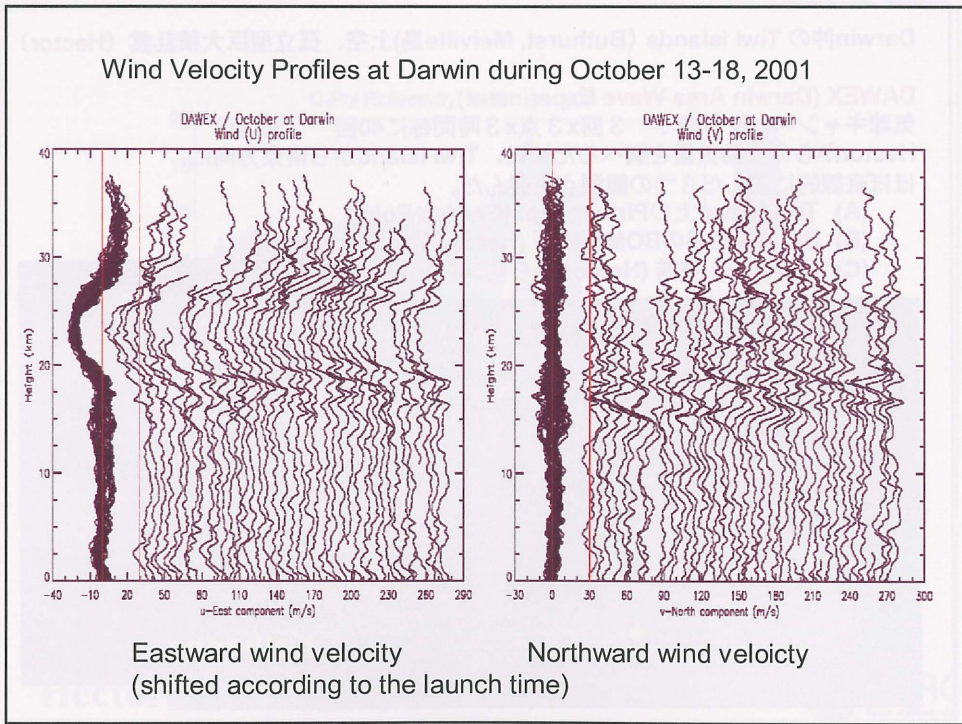
- (A) Tiwi Island上のPirlangimpi (**Garden Point**)
- (B) **Darwin** 空港のBOM測候所 (**Hector** から50-100km)
- (C) **Katherine** 空港 (**Hector** から約300km)



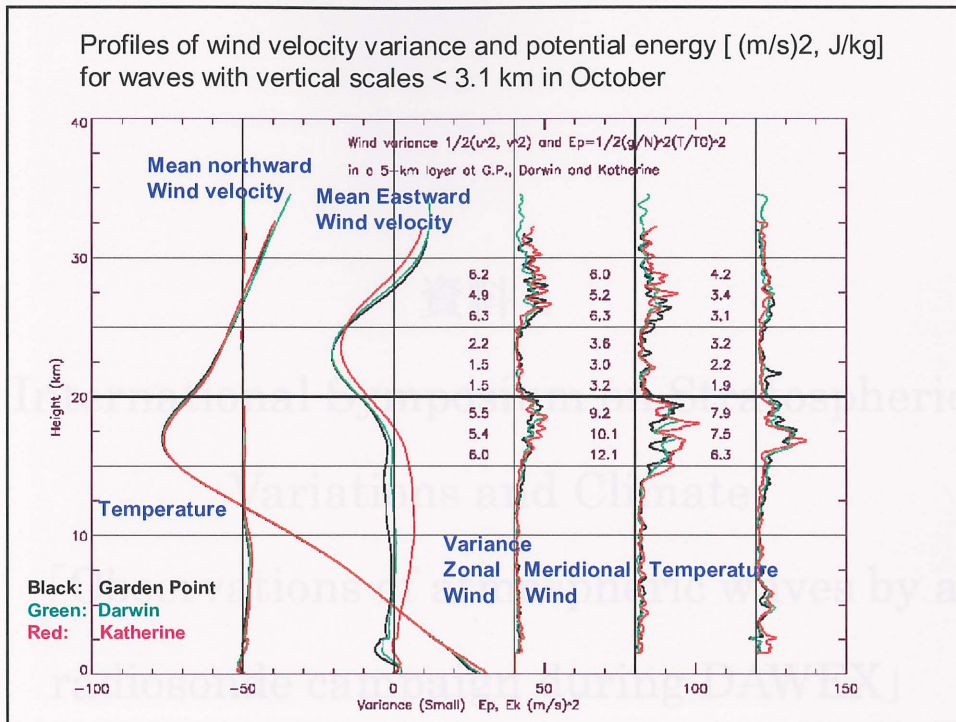
Mean Profiles in October at Garden Point / Darwin / Katherine
 (Black) (Green) (Red)



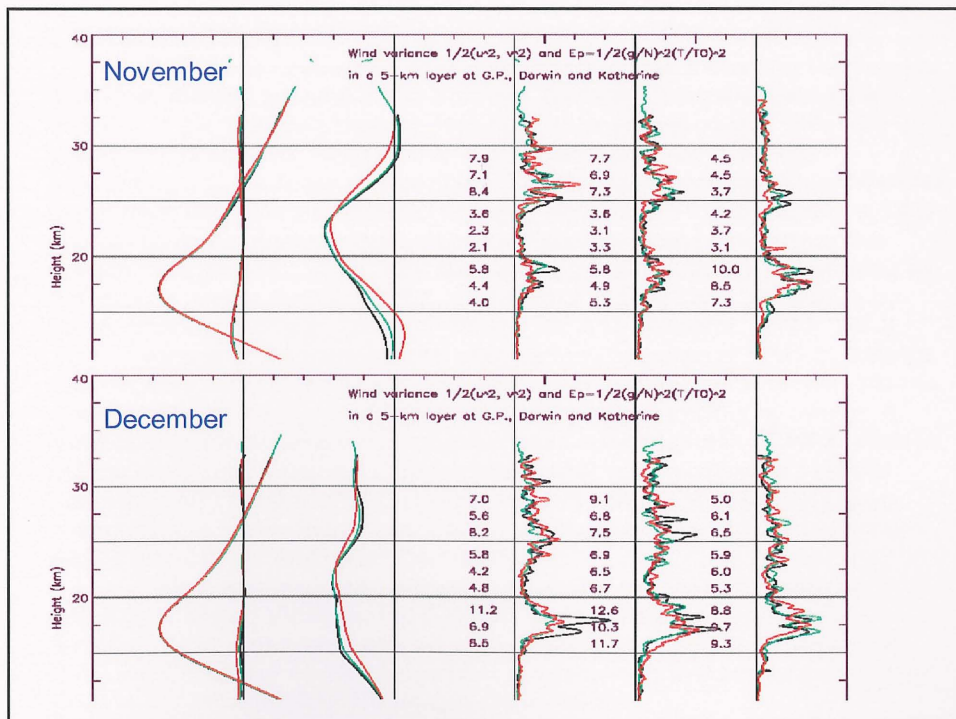
Wind Velocity Profiles at Darwin during October 13-18, 2001



Profiles of wind velocity variance and potential energy [(m/s)², J/kg] for waves with vertical scales < 3.1 km in October



(SPARC02.PPT)



資料 4

International Symposium on Stratospheric
Variations and Climate

「Observations of atmospheric waves by a
radiosonde campaign during DAWEX」

(SPARC02.PPT)

**P-5: Observations of Atmospheric Waves by
a Radiosonde Campaign during
DAWEX (Darwin Area Wave Experiment)**

Toshitaka Tsuda

Radio Science Center for Space and Atmosphere (RASC), Kyoto University

Peter T. May and Colleagues

Bureau of Meteorology Research Center (BMRC)

Robert A. Vincent and Andrew Mackinnon

Department of Physics and Mathematical Physics, Adelaide University

Michael Reeder and Students

School of Mathematical Sciences, Monash University

M. Joan Alexander

Colorado Research Associates (CORA)

1. INTRODUCTION

An intense convection known as Hector appears over the Tiwi islands (Buthurst, Melville Islands) in the Northern Territory, Australia during the build-up to the monsoon periods. Hector is normally associated with very strong thunderstorms, whose cloud-top sometimes reaches 20 km, penetrating into the lower stratosphere. The Maritime Continent Thunderstorm Experiment (MCTEX) was conducted from November 11 to December 8, 1995 in order to study characteristics of island-initiated meso-scale convective system [Keenan et al., , Bull., Am. Meteorol. Soc., 2433-, 2000]. By referring to radiosonde results during MCTEX, modeling of gravity wave generation by Hector was studied [e.g., Lane and Reeder, Q. J. R. Meteorol., 2705-, 2001].

As one of the international observation campaign of SPARC, DAWEX (Darwin Area Wave Experiment) was conducted in October-December, 2001 to observe characteristics of atmospheric gravity waves excited by Hector. A number of ground-based measurements were coordinated in DAWEX, such as radiosondes, dual-polarized C-band radars, VHF wind profilers, a medium frequency (MF) radar and CCD airglow imagers, aiming at describing wave phenomena in a wide height range covering the boundary layer, troposphere, middle atmosphere and lower thermosphere.

This paper is concerned with preliminary results from intensive radiosonde observations during DAWEX. Radiosonde campaigns with a duration of 120 hours were carried out 3 times on October 13-18, November 15-20 and December 11-16, 2001, which were selected just before a new moon so as to collaborate with CCD imager observations.

2. EXPERIMENTAL SET-UP

During IOP of DAWEX, we launched radiosondes every 3 hours from 3 sites. We obtained a total of about 360 profiles of temperature, humidity and wind velocity with a height resolution of 100 m. Almost all balloons (97%) reached the tropopause, and 78% and 63% ascended up to 25 and 30 km, respectively.

DAWEX Radiosonde Sites:	Lat, Lon	Distance	Inertia period
(A) Pirlangimpi (Garden Point)	11.4S, 130.3E	0	61 hr
(B) Darwin BOM weather station	12.4S, 130.9E,	130 km	56 hr
(C) Katherine civilian airport	14.5S, 132.5E,	400 km	48 hr



3 BALLON SOUNDINGS

Campaign periods

- (1) October 13-18
- (2) November 15-20
- (3) December 11-16

* 8 Launches/Day
x 5 days (120 hr)

* 40 Launches / Site
x 3 Sites=120 / IOP

Total about 360 profiles

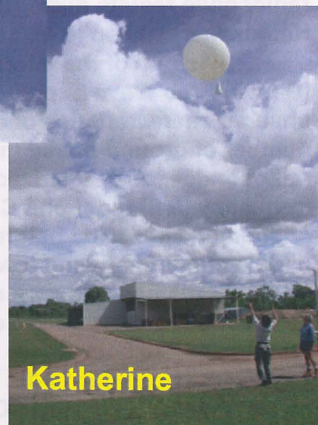
NOTE:

We employed a 800g balloon instead of a 350g balloon used for a routine sounding at BOM, in order to obtain profiles up to about 30 km in the stratosphere.

Garden Point

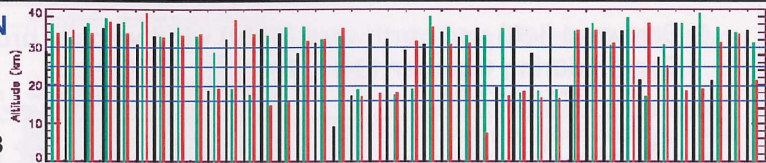


Katherine



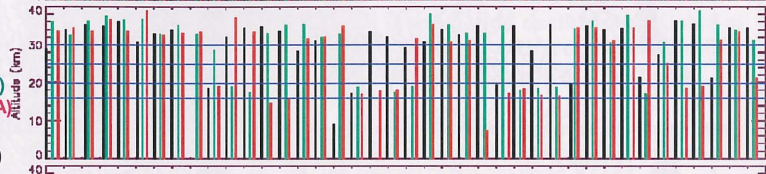
4. BALLOON BURST HEIGHT

(1) Oct 13-18

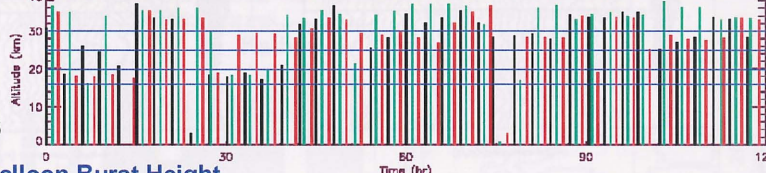


Black: Garden Point (GP)
Green: Darwin DW
Red: Katherine (KA)

(2) Nov 15-20



(3) Dec 11-16



Statistics of Balloon Burst Height

OCT	all	<16	>20	>25	>30
GP	38	2	32	28	23
DW	38	0	35	33	27
KA	40	2	35	30	25
	116	4	102	91	75
				78%	65%

NOV	all	<16	>20	>25	>30
GP	39	1	34	32	27
DW	39	0	29	29	28
KA	40	3	27	26	25
	118	4	90	87	80
				74%	68%

DEC	all	<16	>20	>25	>30km
GP	39	1	33	30	19
DW	36	0	32	31	31
KA	40	1	33	33	16
	115	2	98	94	66
				78%	63%

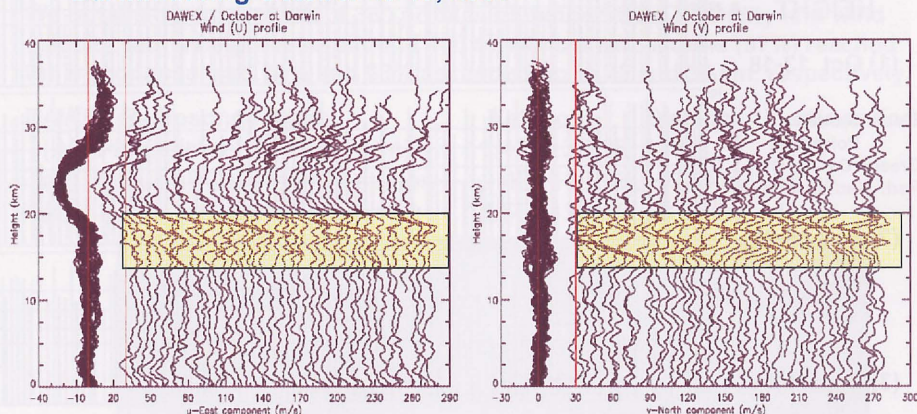
Peter May, Ross Christmas, Nigel Mules,
Jim Arther, Ken Glasson, Phil Dutton,
Roger Atkinson, (BOM/BMRC)
Bob Vincent, Andrew McKinnon,
Simon Alexander, Peter Love(Adelaide)
Tim Burns (NCAR),
Joan Alexander (CoRA)
Yoshihara, Aoyama,
Shimabukuro (RASC)



Michael Reeder, Andrew Marshal,
Rob Goler, Stew, Ivan Mac,
Fiona Guest, Sylvain Manso,
Justin Peters,(Monash)

Thanks for joining the
campaign, Mate !!

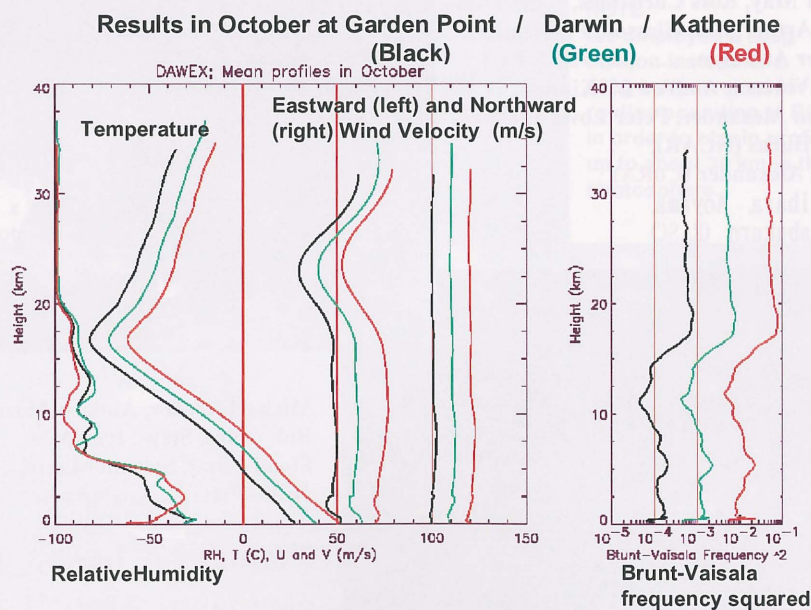
5. Eastward (left) and northward (right) wind velocity profiles at Darwin during October 13-18, 2001



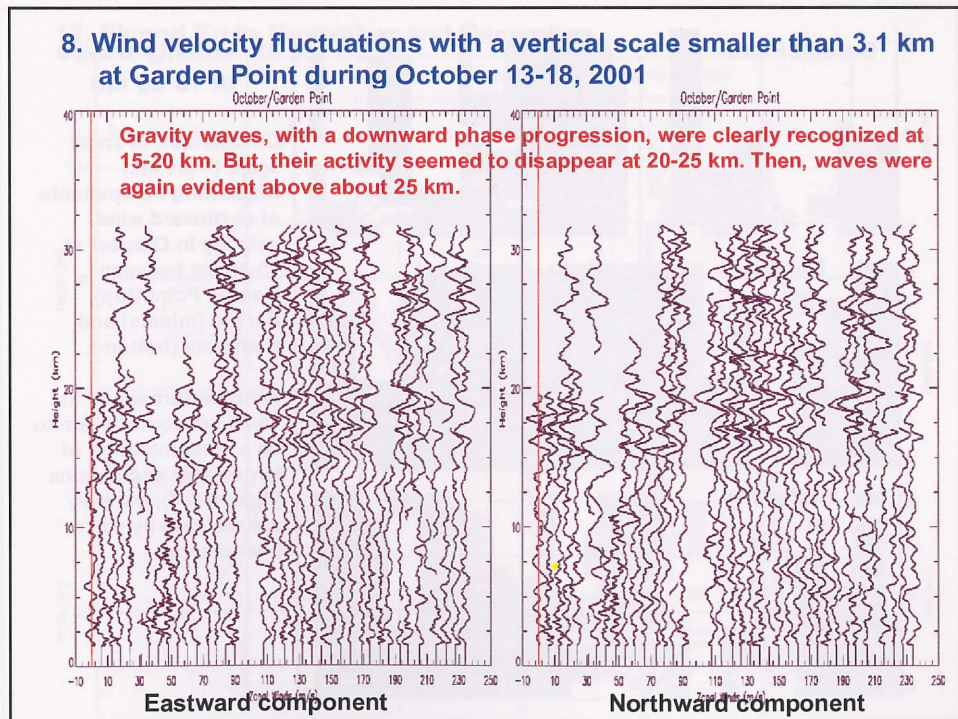
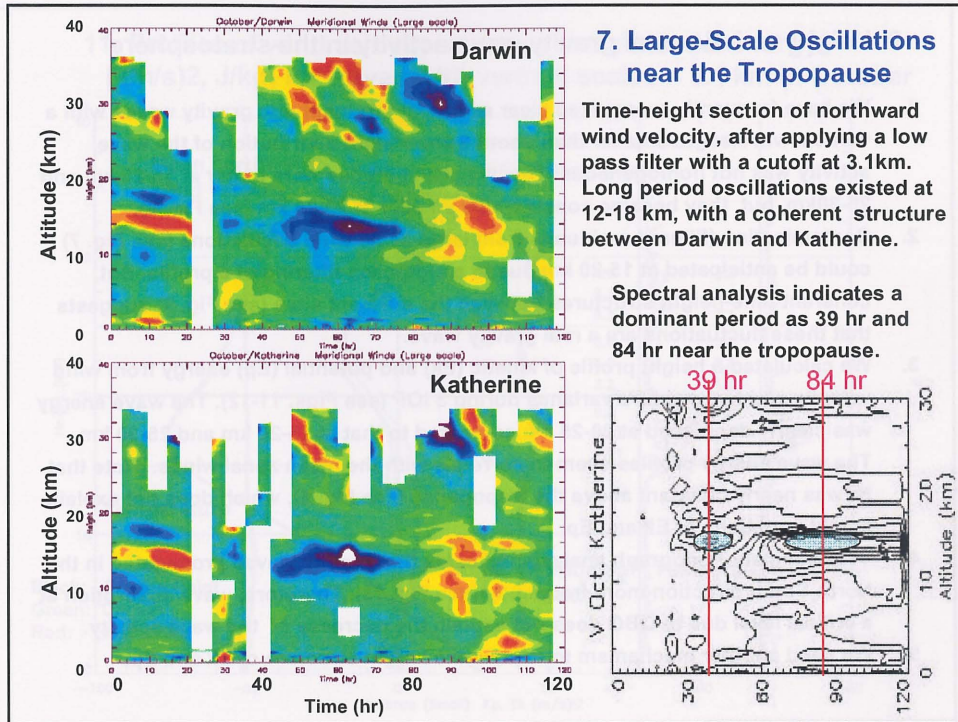
Successive profiles are shifted according to the launch time (interval of nearly 3 hours), while all results are over-plotted on the left in each panel.

- (1) Mean zonal wind was affected by QBO (see Figure 6).
- (2) Long-period waves are dominant at 13-20 km (see Figure 7).
- (3) Small vertical scale perturbations are evident above about 25 km, though they seemed to be suppressed at 20-25 km (see Figures 8-13).

6. BACKGROUND CONDITIONS

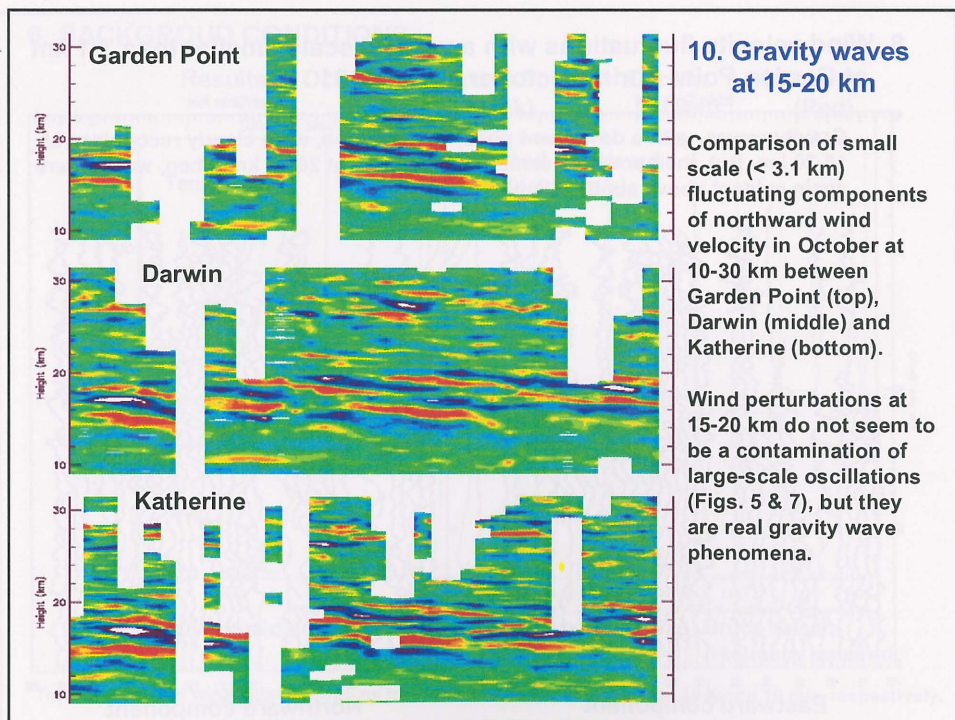


Temperature and wind velocity profiles from the 3 sites are displaced by 10 K and 10 m/s, respectively.

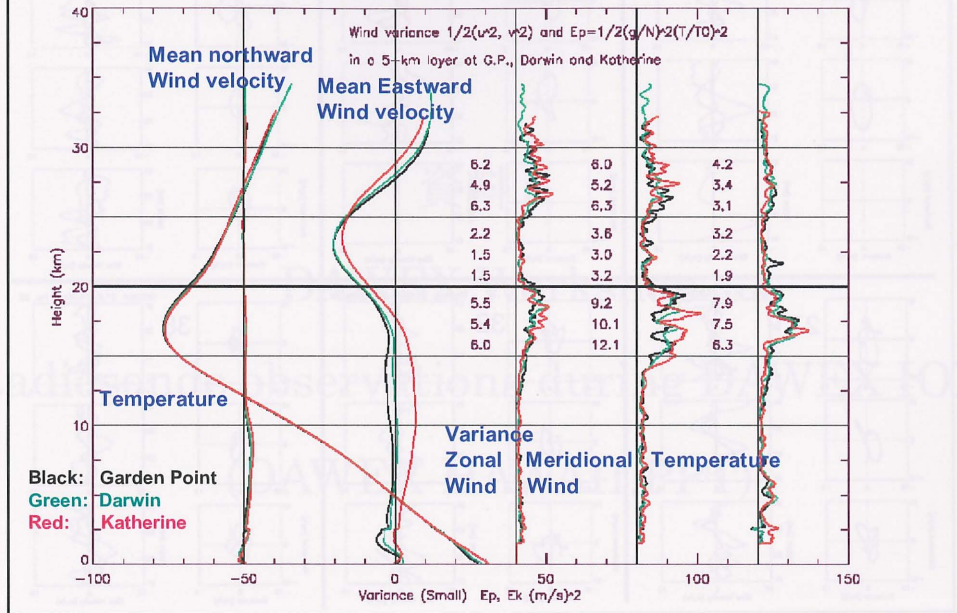


9. Height variations of gravity wave activity in the stratosphere

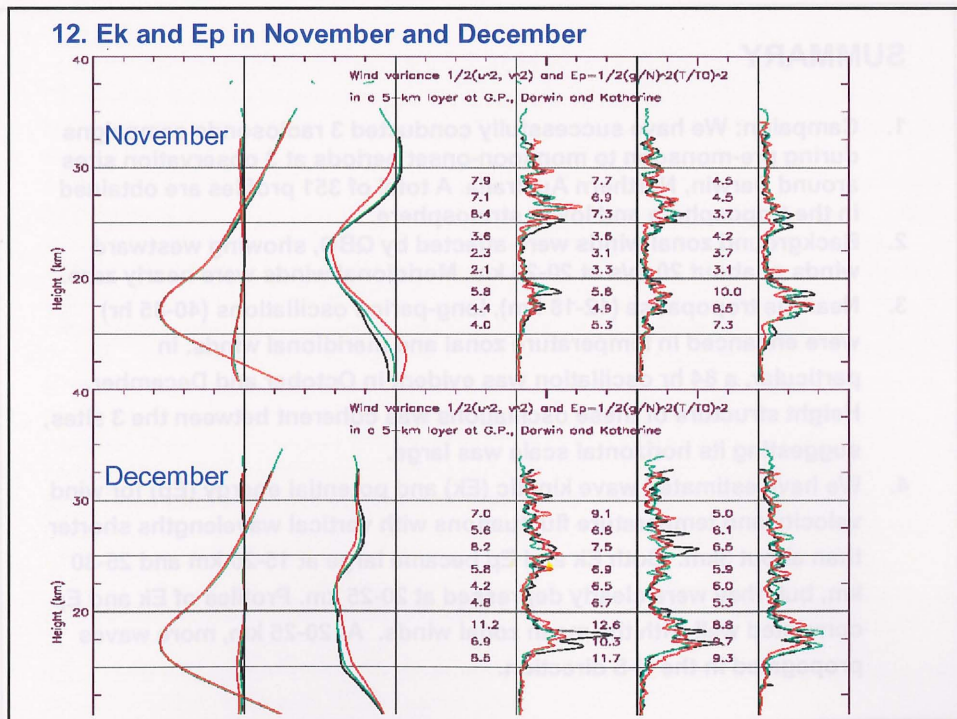
1. We have frequently recognized clear events of stratospheric gravity waves with a vertical wavelength smaller than about 3 km. Height distribution of the wave activity was not homogeneous. The wave amplitudes were larger at 15-20 km and 25-30 km, but, they became considerably smaller at 20-25 km (see Fig. 8).
2. Contamination (filtered residuals) from large-scale wind oscillations (see Fig. 7) could be anticipated at 15-20 km due to a high-pass filtering of a profile. But, coherent time-height structures between the different sites (see Fig. 9) suggests that these fluctuations are a real gravity wave.
3. We calculated a height profile of kinetic (E_k) and potential (E_p) energy from wind velocity and temperature variance during 3 IOP (see Figs. 11-12). The wave energy was clearly depressed at 20-25 km compared to that at 15-20 km and 25-30 km. The wave energy profiles seem to correlate with the mean zonal winds. Note that N^2 was nearly constant above the tropopause (see Fig. 6), which does not explain height variations of E_k and E_p .
4. A preliminary hodograph analysis indicates that gravity waves propagated in the North-South direction more frequently (see Fig. 13). Therefore, wave absorption at a critical level due to QBO does not explain the decrease of the wave activity.
5. We need another mechanism to explain the height structure of E_k and E_p .



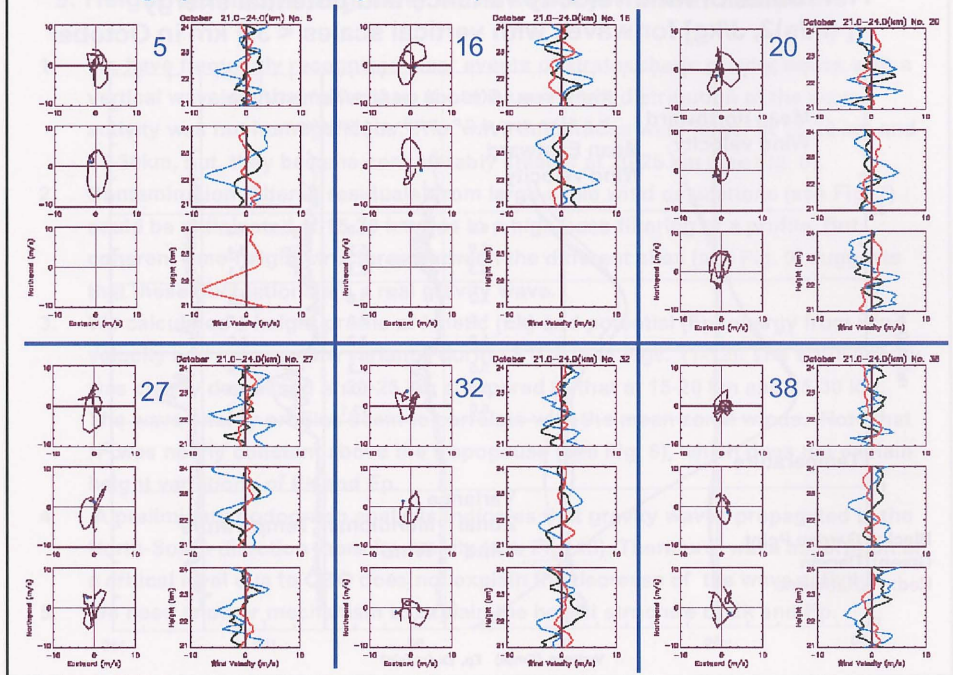
11. Profiles of wind velocity variance and potential energy [(m/s)², J/kg] for waves with vertical scales < 3.1 km in October



12. Ek and Ep in November and December



13. Hodographs for Gravity Waves (<3.1km) at 21-24 km in October



SUMMARY

1. **Campaign:** We have successfully conducted 3 radiosonde campaigns during pre-monsoon to monsoon-onset periods at 3 observation sites around Darwin, Northern Australia. A total of 351 profiles are obtained in the troposphere and lower stratosphere.
2. **Background zonal winds** were affected by QBO, showing westward winds of about 20 m/s at 20-25 km. Meridional winds were nearly zero.
3. **Near the tropopause (12-18 km),** long-period oscillations (40-85 hr) were enhanced in temperature zonal and meridional winds. In particular, a 84 hr oscillation was evident in October and December. Height structure of these oscillations was coherent between the 3 sites, suggesting its horizontal scale was large.
4. **We have estimated wave kinetic (Ek) and potential energy (Ep) for wind velocity and temperature fluctuations** with vertical wavelengths shorter than about 3km. Both Ek and Ep became large at 15-20 km and 25-30 km, but, they were clearly depressed at 20-25 km. Profiles of Ek and Ep correlated well with the mean zonal winds. At 20-25 km, more waves propagated in the N-S direction.

資料 5

DAWEX Workshop

「Radiosonde observations during DAWEX IOPs」

(DAWEX-HAWAII.PPT)



**Observations of Atmospheric Waves by
a Radiosonde Campaign during
DAWEX (Darwin Area Wave Experiment)**

Toshitaka Tsuda

Radio Science Center for Space and Atmosphere (RASC), Kyoto University

Peter T. May and Colleagues

Bureau of Meteorology Research Center (BMRC)

Robert A. Vincent and Andrew MacKinnon

Department of Physics and Mathematical Physics, Adelaide University

Michael Reeder and Students

School of Mathematical Sciences, Monash University

M. Joan Alexander

Colorado Research Associates (CORA)

1. INTRODUCTION

An intense convection known as Hector appears over the Tiwi islands (Buthurst, Melville Islands) in the Northern Territory, Australia during the build-up to the monsoon periods. Hector is normally associated with very strong thunderstorms, whose cloud-top sometimes reaches 20 km, penetrating into the lower stratosphere. The Maritime Continent Thunderstorm Experiment (MCTEX) was conducted from November 11 to December 8, 1995 in order to study characteristics of island-initiated meso-scale convective system [Keenan et al., , Bull., Am. Meteorol. Soc., 2433-, 2000]. By referring to radiosonde results during MCTEX, modeling of gravity wave generation by Hector was studied [e.g., Lane and Reeder, Q. J. R. Meteorol., 2705-, 2001].

As one of the international observation campaign of SPARC, DAWEX (Darwin Area Wave Experiment) was conducted in October-December, 2001 to observe characteristics of atmospheric gravity waves excited by Hector. A number of ground-based measurements were coordinated in DAWEX, such as radiosondes, dual-polarized C-band radars, VHF wind profilers, a medium frequency (MF) radar and CCD airglow imagers, aiming at describing wave phenomena in a wide height range covering the boundary layer, troposphere, middle atmosphere and lower thermosphere.

This paper is concerned with preliminary results from intensive radiosonde observations during DAWEX. Radiosonde campaigns with a duration of 120 hours were carried out 3 times on October 13-18, November 15-20 and December 11-16, 2001, which were selected just before a new moon so as to collaborate with CCD imager observations.

The Maritime Continent Thunderstorm Experiment (MCTEX)
 [e.g. T. Keenan et al. Bull., Am. Meteorol. Soc., 2000]

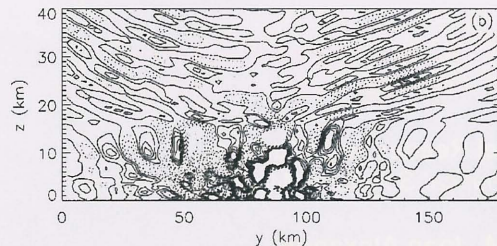
MCTEX IOP: Nov 11 to Dec 8, 1995

Radiosonde soundings at Maxwell's Creek, Tiwi Island (11.55S, 130.56E)
 Total: 99 (>18 km, 78, ~26 km: 9) Mean termination height= 24 km

Characteristics of island-initiated meso-scale convective system

Modeling of gravity wave generation by Hector

T. Lane and M. Reeder (Q. J. R. Meteorol., 2001; J. Atmos. Sci., 2001)



Meridional cross section of vertical velocity generated by Hector

$\lambda_x \sim 15-20 \text{ km}$

$\lambda_z \sim 4-6 \text{ km}$

No preferential direction for horizontal propagation

Figure 4. (a) Zonal cross-section of vertical velocity through $y = 100 \text{ km}$ for Domain 1. (b) Meridional cross-section of vertical velocity through $x = 100 \text{ km}$ for Domain 1. Vertical velocity is contoured at 0.1 m s^{-1} intervals, with the negative values dashed. Both plots are valid at 1300 LST. Note that (b) has a different horizontal scale from (a).

2. EXPERIMENTAL SET-UP

During IOP of DAWEX, we launched radiosondes every 3 hours from 3 sites. We obtained a total of about 360 profiles of temperature, humidity and wind velocity with a height resolution of 100 m. Almost all balloons (97%) reached the tropopause, and 78% and 63% ascended up to 25 and 30 km, respectively.

DAWEX Radiosonde Sites:

	Lat, Lon	Distance	Inertia period
(A) Pirlangimpi (Garden Point)	11.4S, 130.3E	0	61 hr
(B) Darwin BOM weather station	12.4S, 130.9E, 130 km	130 km	56 hr
(C) Katherine civilian airport	14.5S, 132.5E, 400 km	400 km	48 hr



3 BALLON SOUNDINGS

Campaign periods

- (1) October 13-18
- (2) November 15-20
- (3) December 11-16

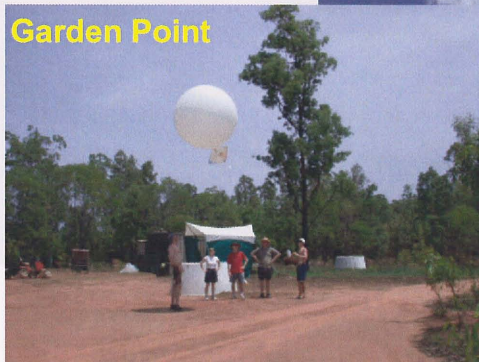
- * 8 Launches/Day
- x 5 days (120 hr)
- * 40 Launches / Site
- x 3 Sites=120 / IOP

Total about 360 profiles

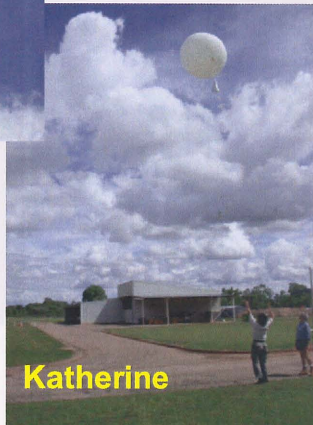
NOTE:

We employed a 800g balloon instead of a 350g balloon used for a routine sounding at BOM, in order to obtain profiles up to about 30 km in the stratosphere.

Garden Point

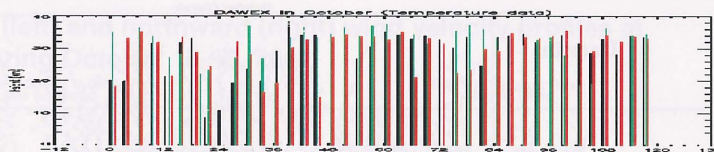


Katherine



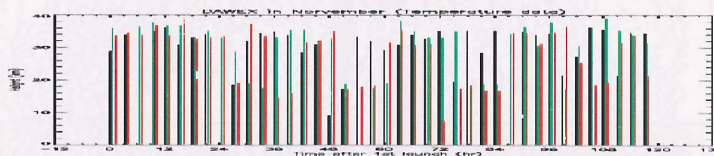
4. BALLOON BURST HEIGHT

(1) Oct 13-18

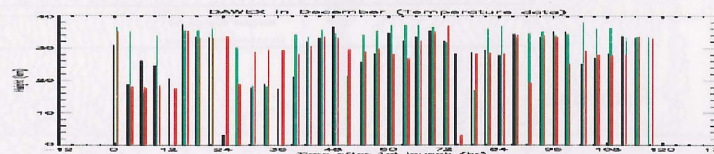


Black: Garden Point (GP)
Green: Darwin DW
Red: Katherine (KA)

(2) Nov 15-20



(3) Dec 11-16

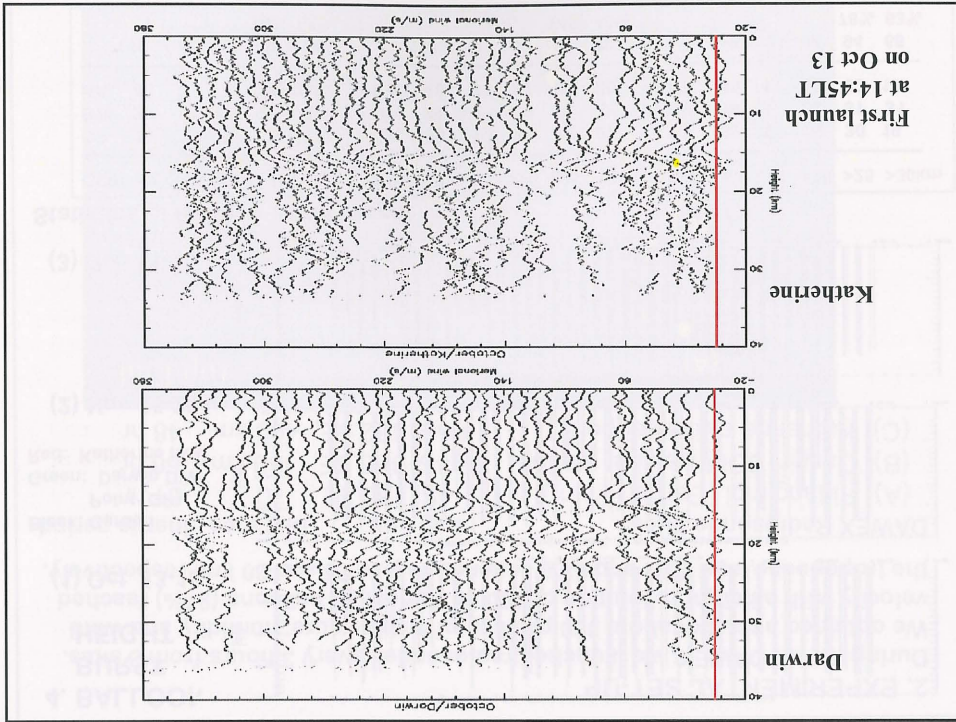


Statistics of Balloon Burst Height

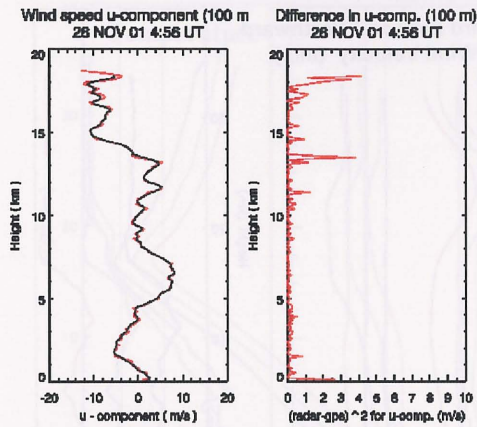
OCT	all	<16	>20	>25	>30
GP	38	2	32	28	23
DW	38	0	35	33	27
KA	40	2	35	30	25
	116	4	102	91	75
			78%	65%	

NOV	all	<16	>20	>25	>30
GP	39	1	34	32	27
DW	39	0	29	29	28
KA	40	3	27	26	25
	118	4	90	87	80
			74%	68%	

DEC	all	<16	>20	>25	>30km
GP	39	1	33	30	19
DW	36	0	32	31	31
KA	40	1	33	33	16
	115	2	98	94	66
			78%	63%	



Comparison of wind velocity profiles between GPS and Radar tracking simultaneous measurements in a single sounding on Nov 28 at Darwin



Eastward wind Velocity with GPS (red) and radar tracked (black)

Difference
s.d.=0.17 (m/s)²
(1-15km)

Radar tracking of a target attached to a balloon

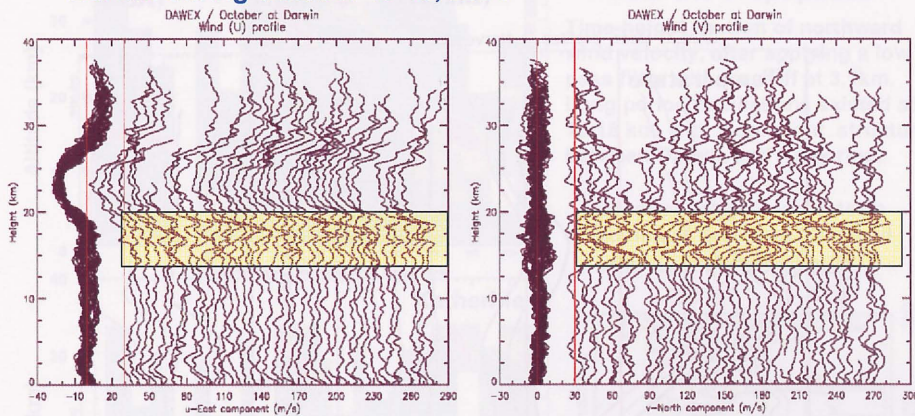
Darwin BOM station sampled every 2 sec, and averaged for 10 sec (~50 m resolution)

GPS (VAISALA RS-80-15G)

2 remote sites

(Garden Point and Katherine) sampled every 2 sec, interpolated every 100 m

5. Eastward (left) and northward (right) wind velocity profiles at Darwin during October 13-18, 2001

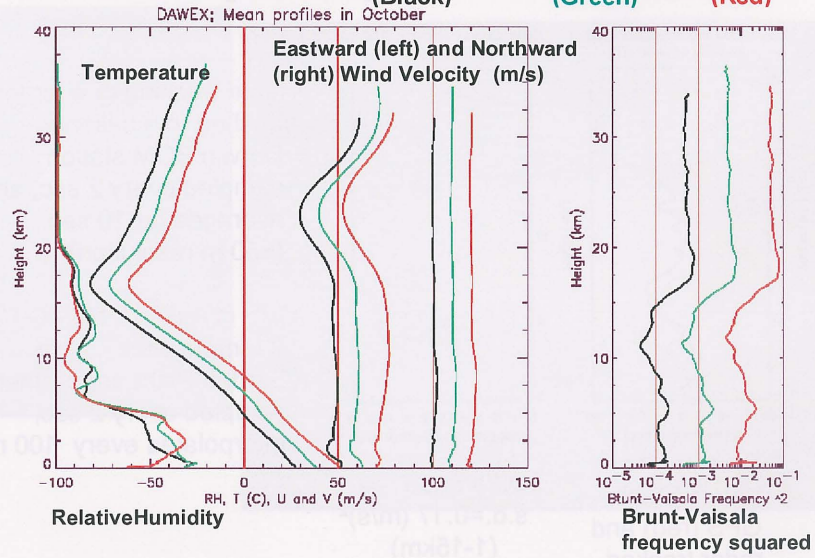


Successive profiles are shifted according to the launch time (interval of nearly 3 hours), while all results are over-plotted on the left in each panel.

- (1) Mean zonal wind was affected by QBO (see Figure 6).
- (2) Long-period waves are dominant at 13-20 km (see Figure 7).
- (3) Small vertical scale perturbations are evident above about 25 km, though they seemed to be suppressed at 20-25 km (see Figures 8-13).

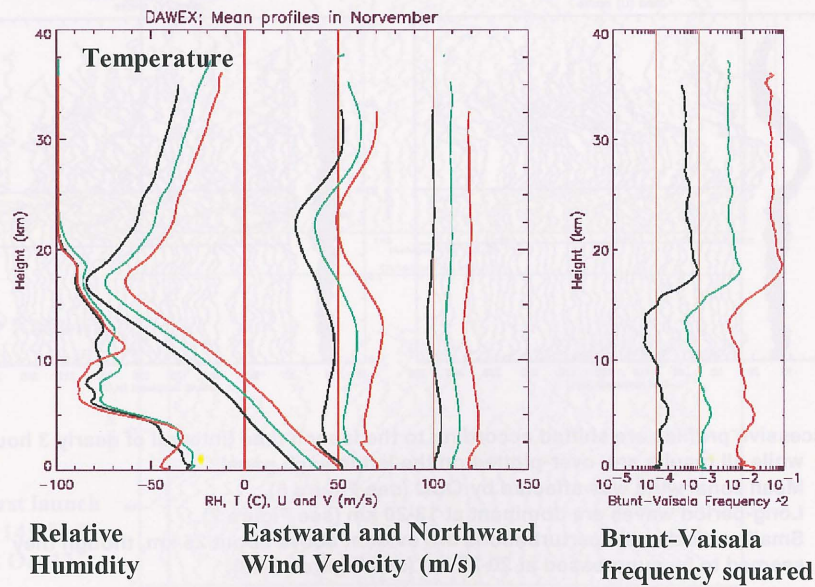
6. BACKGROUND CONDITIONS

Results in October at Garden Point / Darwin / Katherine
 (Black) (Green) (Red)

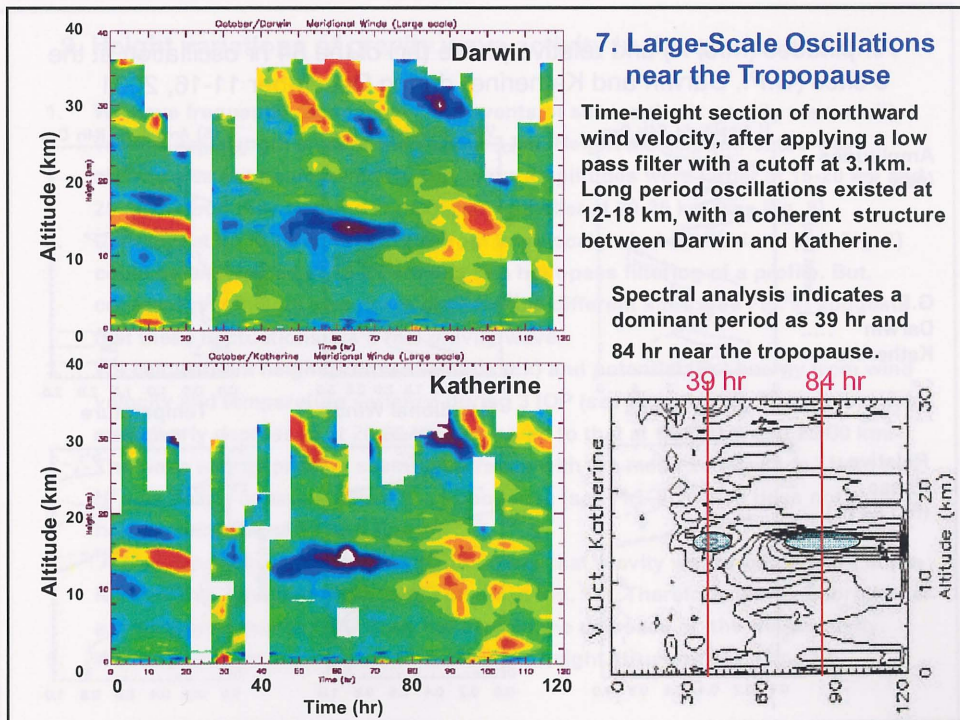
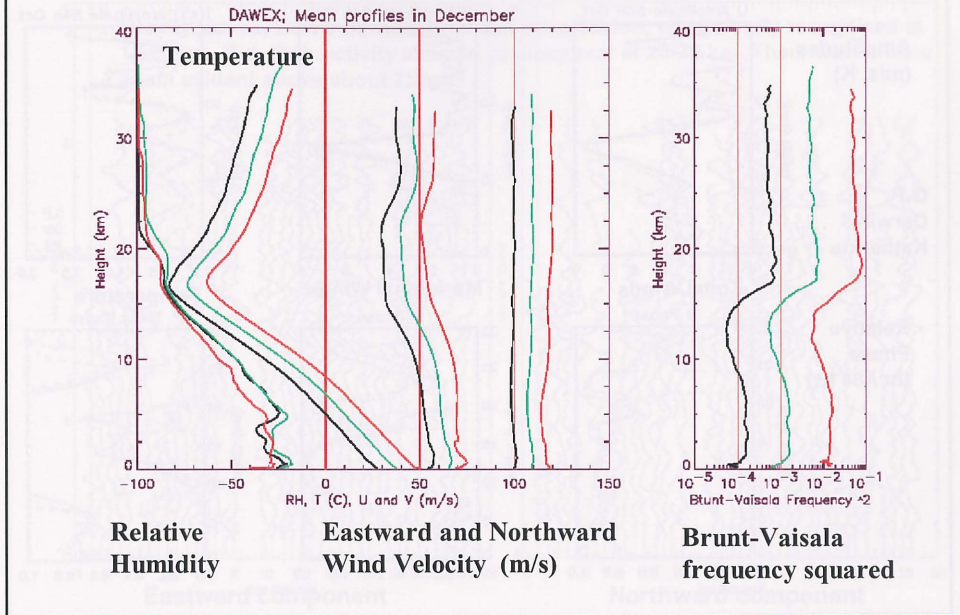


Temperature and wind velocity profiles from the 3 sites are displaced by 10 K and 10 m/s, respectively.

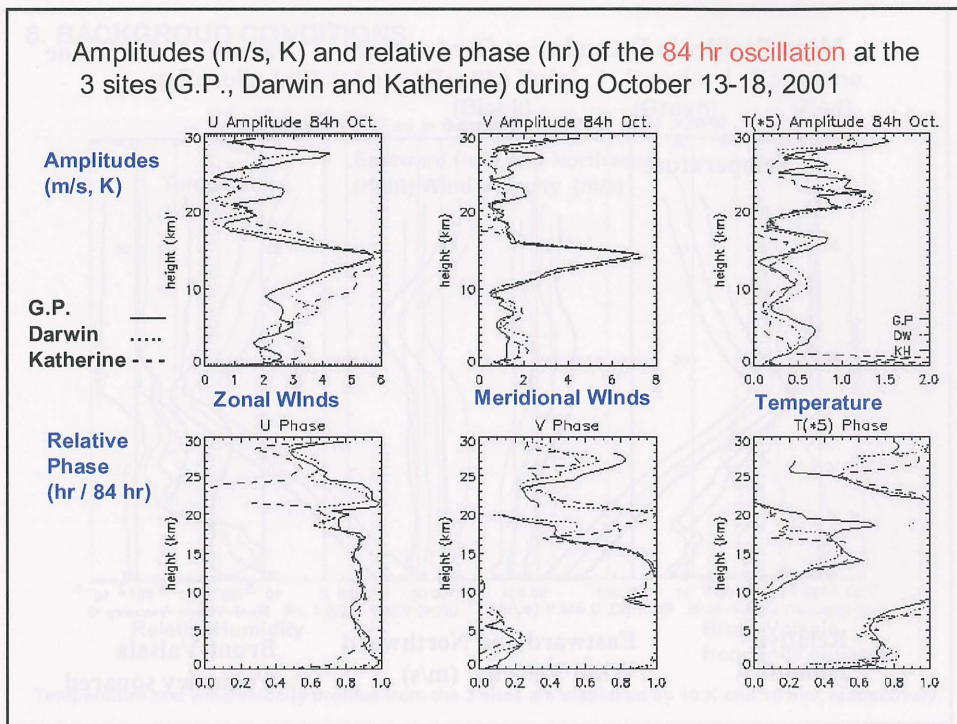
Mean Profiles in November at Garden Point / Darwin / Katherine
 (Black) (Blue) (Red)



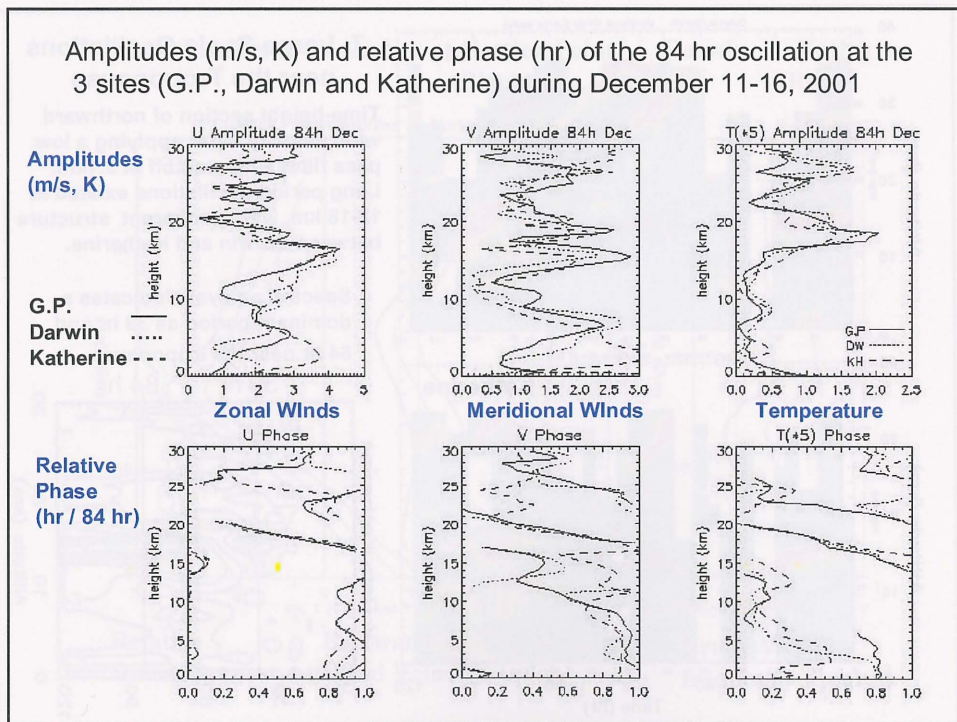
Mean Profiles in December at Garden Point / Darwin / Katherine
 (Black) (Blue) (Red)



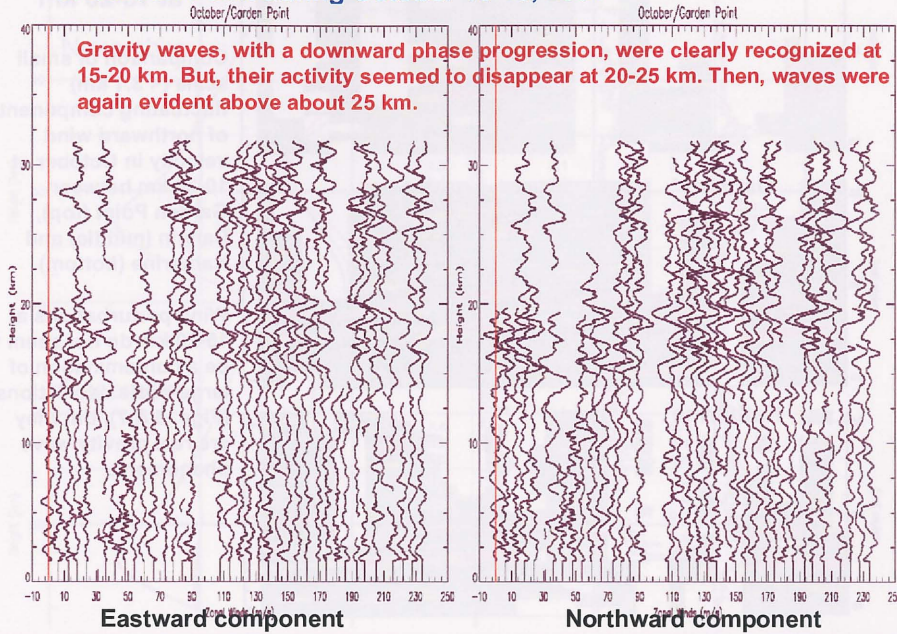
Amplitudes (m/s, K) and relative phase (hr) of the 84 hr oscillation at the 3 sites (G.P., Darwin and Katherine) during October 13-18, 2001



Amplitudes (m/s, K) and relative phase (hr) of the 84 hr oscillation at the 3 sites (G.P., Darwin and Katherine) during December 11-16, 2001

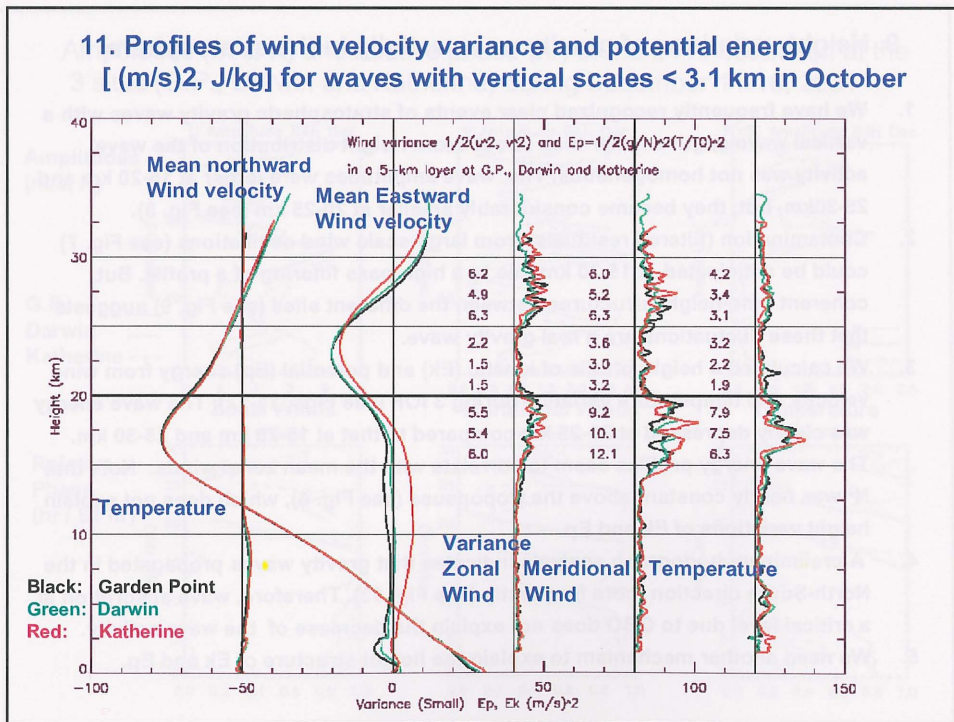
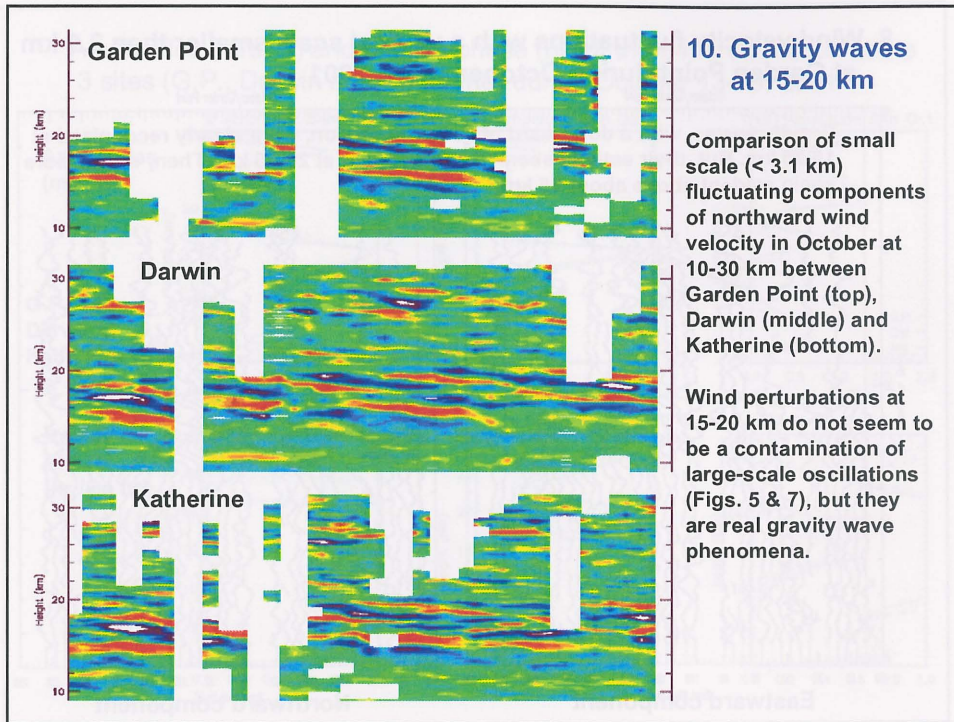


8. Wind velocity fluctuations with a vertical scale smaller than 3.1 km at Garden Point during October 13-18, 2001

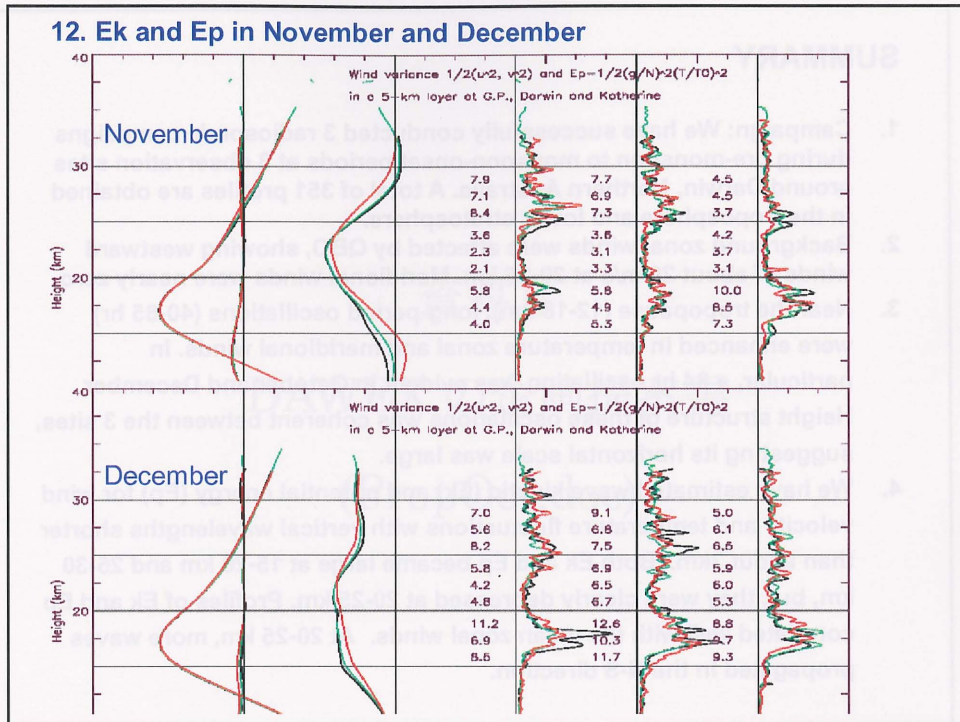


9. Height variations of gravity wave activity in the stratosphere

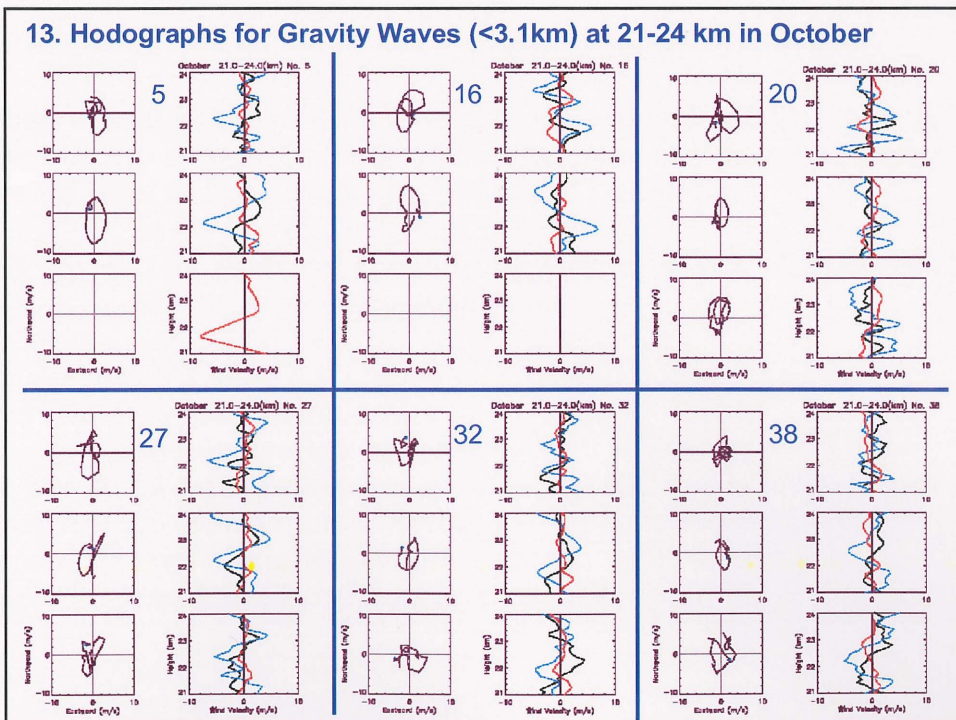
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5. We need another mechanism to explain the height structure of E_k and E_p .



12. Ek and Ep in November and December



13. Hodographs for Gravity Waves (<3.1km) at 21-24 km in October



SUMMARY

1. **Campaign:** We have successfully conducted 3 radiosonde campaigns during pre-monsoon to monsoon-onset periods at 3 observation sites around Darwin, Northern Australia. A total of 351 profiles are obtained in the troposphere and lower stratosphere.
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資料 6

DAWEX の企画提案書

(PropOct.doc)

Radiosonde Sounding for DAWEX experiment

August 15, 2001

Toshitaka Tsuda (RASC, Kyoto Univeristy)

tsuda@kurasc.kyoto-u.ac.jp

Peter T. May (BMRC, Bureau of Meteorology)

p.may@bom.gov.au



Hector over Darwin (Taken from BOM home page)

1. Chief participants

Toshitaka Tsuda (Kyoyo University)

Peter May (BMRC, BOM)

Mike Reeder (Monash University)

Robert A. Vincent, Andrew McKinnon (Adelaide University)

2. Observation periods: **Three core periods** with a duration of **5 days**. One IOP in a **dry season (middle of October)** and two during a **Hector period (end of November and middle of December)**.

See Appendix 1 by Kevin Hamilton

IOP should be selected considering statistics and MLTCX results.

See Appendix 3 by Joan Alexander

3. Launch sites: **3 sites** are proposed, provided budget, man/womam-power and receivers are available.

See Appendix 2 from Kevin

site A: **Darwin** weather station of BOM (50-100 km from Hector)

site B: Civillian airport in **Katherine** (about 300 km from Hector)

site C: **Tiwi island** (0 km from Hector)

See Appendix 8 from Bob Vincent

4. Observation periods

(1) **October 13-18** (New moon at 20:59 LT on Oct 17 at 135E)

(2) **November 15-20** (New moon at 9:43 LT on 11/16 at 135E)

(3) **December 11-16** (New moon at 22:27 LT on 12/15 at 135E)

Observation periods are selected just before a new moon, except (2), so as to coordinate with CCD imager observations. We will start launching at 15LT on the first day, and finishes at 12 LT on the last day. Two and one extra days should be reserved for set-up and clearing, respectively. Therefore, the entire period will be (1) October 11-19, (2) November 13-21, and (3) December 9-17, respectively.

5. Daily launch schedule (tentative)

Routine soundings at Darwin (site A only)

(a) 350 gram balloons with **sondes and radar targets at 8.45am CST (2315 Z) and 8.45pm CST (1115 Z)**

(b) 100 gram balloons with **radar targets (no sonde) at 2.00pm CST (0430 Z) and 2.00am CST (1630 Z).**

Campaign: 3 hourly, i.e. 8 launches per day, for **5 days** from the 3 sites
See Appendix 1 from Kevin

Note: 800 gr balloon will be used at site A (see item 5).

Question by Joan about periods, sites and receivers (see Appendix 7)

6. Radiosondes and Receivers

site A: VAISALA RS80-15(PTU only) + radar reflector

Number: 40 x 2 IOP = 80

PTU and radar tracked winds

See Appendix 3 from Joan, and response by Peter in Appendix 4

site B, C: VAISALA RS80-15G (PTU+GPS wind)

Number: 40 x 2 sites x 2 IOP = 160

PTU and GPS winds by Digicora (MARWIN)

Monash: See Appendix 5 from David Karoly

Bureau: See Appendix 6 from Peter May

For estimates of the costs, see Appendix 10.

7. Balloon and gas

800 g (TOTEX TX-800) balloon is preferable for a sounding up to 30km.

800g balloon at site A for a regular sonde

Hydrogen is generated at site A.

800g balloon at sites B and C for a GPS sonde

Helium gas must be used at remote sites.

8. Operator

site A: **BOM staff.** Overtime wage is necessary.

See Appendix 11 for labor.

site B, C: 2 persons/team x 2-3 teams at each site

8-10 students from Monash and Adelaide
need a **training**

travel expenses and per diem for 8-9 days.

Airfare: ~\$1000 to Darwin, + to Katherine/Pirlangimpi

See Appendix 9 from David

9. Visit by scientists

(1) October: T. Tsuda and 1-2 students from Kyoto

(2) November: Joan Alexander and friends from NCAR

(3) December: T. Tsuda and 1-2 students from Kyoto

10. Logistics:

Need a survey for Katherine and Tiwi island.



11. Contacts

Peter T. May

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GPO Box 1289K, Melbourne, Victoria 3001, AUSTRALIA
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Department of Physics and Mathematical Physics, University of
Adelaide, Adelaide 5005, Australia
Ph: (61 8) 8303-5758 Fax: (61 8) 8303-4384
e-mail: robert.vincent@adelaide.edu.au

Appendix 1

Date: Sat, 26 May 2001 17:07:01 -1000 (HST)
From: Kevin Hamilton <kph@soest.hawaii.edu>
Subject: Re: DAWEX meeting at Innsbruck

From the point-of-view of gravity wave generation, I would encourage the "IOP" for DAWEX to start before the Hector "season" begins. So while the MCTEX IOP was 13 November-10 December, I would advocate something more like **15 October-15 December** for DAWEX, even if that means not taking radiosonde measurements every day. My reasoning is that **the most basic goal for DAWEX is to clearly observe the waves generated by Hector**. For the radiosondes it will be good to have a well-observed "baseline" of **how the observed profiles in the vicinity of Darwin vary through the day in the dry season, and then how they look through the day when Hector is occurring**. Given the regularity of Hector, one would expect to observe some repeatable signal in measured profiles (e.g. a sudden enhancement of variations near 22 km altitude with ~2 km vertical wavelength occurring 3 hours after the peak Hector convection each day).

For the same reasons I would advocate trying to take **measurements as frequently as possible during each 24 hour period, even if that means covering fewer days in total**. I guess the other factor may be a tradeoff between how frequently the balloons are launched and how high each one can be tracked (before switching the receiver to the next balloon). So I would advocate **3-hourly (or even more frequent) if this gives reasonable height coverage in the lower stratosphere**.

Anyways these are just my ideas. There may be other scientific considerations that I have not thought about and also practical limitations that I am not aware of. You should be able to discuss this in person with Bob and Joan next month at CEDAR and then with Bob and myself at IAMAS.

Aloha,

Kevin

Appendix 2

Date: Mon, 28 May 2001 10:53:24 -1000 (HST)
From: Kevin Hamilton <kph@soest.hawaii.edu>

I think some very interesting results could be obtained with ~150 soundings. Again from a DAWEX-science point-of-view I think it would be best to deploy them with the goal of **characterizing the diurnal cycle of wave activity as completely as possible on selected days spaced over the mid-October to mid-December** time frame. If at all possible, it would be great to get **observations from more than one location within ~200 km of Hector on at least some days**. Peter and Bob can let you know how practical that might be.

I have copied this message to David Karoly who had at one point indicated that folks at Monash might be interested in participating in balloon soundings for DAWEX. Perhaps Monash could help out with the manpower/ womanpower issue for your sondes.

If it turns out not to be practical to space out the sondes over two months, then I would advocate **picking a more compressed period near the expected onset of the Hector season** to have the best chance to sample **some dry days and some well-developed Hector days**.

Aloha,

Kevin

Appendix 3

From: Joan Alexander <alexand@colorado-research.com>

Date: Tue, 29 May 2001 09:16:40 -0600 (MDT)

I just wanted to bring up the importance of also **having very regular twice-daily soundings at high z resolution during this campaign**. The reason is that we already know the primary signal in radiosonde observations like these is associated with short vertical wavelength low-frequency inertia-gravity waves. Characterizing these will be crucial to interpreting the shorter-term IOP data. If we can characterize the low frequency waves **from other routine soundings in the area**, perhaps that will do. If not, I think it would be a mistake to eliminate the regular low-frequency sampling in favor of only sporadic IOPs. Some compromise may be needed.

Joan

Appendix 4

Date: Fri, 01 Jun 2001 13:42:43 +1000

From: Peter May <p.may@bom.gov.au>

the Bureau archives the **10 s sounding data routinely**. **The winds at Darwin are radar tracked**, but at high temporal resolution so we have a vertical res of **a few 10's of m** there as well.

The other soundings would be GPS sondes and the raw data could be stored,

peter

Appendix 5

Date: Fri, 01 Jun 2001 13:46:06 +1000

To: r.hibbins@bom.gov.au

From: Peter May <p.may@bom.gov.au>

Ross,

as we discussed, we are interested in using **the GPS capable digicora for 2 periods of about 5 days in Darwin.** (actually either on the **Tiwi's or down at Katherine**). The dates are yet to be confirmed, but we are looking at mid August and late November.

Peter

Appendix 6

Date: Wed, 30 May 2001 11:20:30 +1000

From: David Karoly <David.Karoly@sci.monash.edu.au>

Hi,

Thanks for copying your messages to me. We have some students that are likely to be interested in participating in this field program. I am not sure how many we could provide but I think that it will be 2-4 students. We are interested in being involved in the experiment. However, we do not have funding to support the travel and per diem expenses of the students involved. Hence, we would need funds from somewhere if our students are to participate.

In addition, we have **a portable GPS Marwinsonde system** that could be made available for the sonde launches during the experiment. We would need to know whether this is likely to be needed or not, so that it can be reserved.

Best wishes, David

Appendix 7

From: Joan Alexander <alexand@colorado-research.com>

Date: Fri, 1 Jun 2001 08:20:39 -0600 (MDT)

.....

Can you foresee any **problems mixing the radar tracked with the GPS sonde data**? It sounds like there should be "no worries".

.....

The plan looks good to me. What latitude is Katherine?
I am thinking about the possibility that **the seasonal change in the winds at Katherine from Oct to late Nov might be substantial enough to have a first-order effect on the waves** in the stratosphere over and above the changes in the convection.

The only other possible issue is that the plan gives us **only one shot at each dry and Hector situation**. Do you have confidence in your selected October

and November periods regarding storm statistics, or do we need more research there before setting dates?

Joan

Appendix 8

From: "Robert A. Vincent" <rvince01@ozemail.com.au>
Date: Sat, 2 Jun 2001 13:26:30 +0930

I do not see why not, subject to land council approval. Andrew MacKinnon will be going to the Tiwi Islands in a couple of weeks to do a site survey so maybe he can follow this up. I will talk with Peter soon about contacting the land council.

Cheers,
Bob

> From: Toshitaka Tsuda [mailto:tsuda@kurasc.kyoto-u.ac.jp]
> Sent: 2 June 2001 09:11
>
> Dear Bob,
> As I recall, you are going to put a VHF BLR on Tiwi island. Can we also operate a radiosonde experiment at the same site?
>
> Cheers,
>Toshitaka

Appendix 9

Date: Tue, 12 Jun 2001 16:07:42 +1000
From: David Karoly <David.Karoly@sci.monash.edu.au>

Hi Peter,

Our Marwin system is the same as the Bureau's, with GPS wind finding. It is portable (reasonably) but **we don't have many (any??) trained students** at this time.

I was going to reply to Tsuda today about costs and other arrangements for Darwex. I think that it would be best to get information about the likely costs and arrangements for using the Marwinsonde and **Monash grad students from Michael Reeder**, as he has more recent experience than me with field work in Northern Australia and I am buried under a heap of admin work.

It is likely that Monash could provide a few graduate students to help run Marwin soundings for Darwex and that the Monash Marwinsonde system could be used but we would need funds to support the students and to transport the equipment and students to Darwin. I don't know how much that would cost. Michael may have some information on air fare and other costs.

Sorry that I can't help more, David

Peter May wrote:

>
> David,
> I understand from discussions with Michael Reeder that we need to think
> about **some training for the sonde releases**. Is your marwin the same as
> ours do you know? How do you want to handle training?
>
> regards,
> Peter
>

Appendix 10

Date: Tue, 12 Jun 2001 14:17:41 +1000
From: Peter May <p.may@bom.gov.au>
Cc: r.canterford@bom.gov.au

The required funds for the sondes etc are given below.

.....
Total for 160 RS80GPS and 80 RS80 standard is \$AUD 45,000.00

We have also obtained some **freight quotes, and included the MARWIN:** To Darwin (sondes and MARWIN) :\$AUD 3,218.00 and from Darwin MARWIN): \$AUD 930.00

This price is the total cost for sondes, balloons etc. We are providing in-kind support to the project through the partial supplementation from our operations, in order to reduce costs overall as far as possible.

Do you want me to chase up the cost of He for the remote sites? There will also be some shipping to get equipment, gas, sondes etc from Darwin onto the Tiwis and down to Katherine.

regards,

Peter

Appendix 11

Cost for extra radiosondes from Darwin airport (BOM)

e-mail from: Jim Arthur J.Arthur@Bom.Gov.Au
cc: p.dutton@bom.gov.au, b.kittler@Bom.Gov.Au

Current Programme

Currently, we release (a) 350 gram balloons with sondes and radar targets at 8.45am CST (2315 Z) and 8.45pm CST (1115 Z) (b) 100 gram balloons with radar targets (no sonde) at 2.00pm CST (0430 Z) and 2.00am CST (1630 Z).

Additional Programme (Scenario 1)

If DAWEX only wants (a) a sonde hung off the 2.00am and 2pm flights, upgraded to 350gm balloons (b) an additional 350 gm flight (sonde only, no radar tracking) approximately ½ way between each of these four programmed flights (so, flight times are about 2315Z, 0200Z, 0430Z, 0800Z, 1115Z, 1400Z, 1630Z, 2000Z) rather than exactly every three hours as requested, then the additional labour costs would be as follows:

For each day Monday to Thursday

Total labour cost would be: \$708.40

For each Friday/Saturday

Total labour cost would be: \$790.90

For each Sunday

Total labour cost would be: \$880.10

Additional Programme (Scenario 2)

If you want the sondes at exactly 3 hour intervals, (as would be required if using 800gm balloons) but without wind observations on the additional flights, then an additional 2 hours of rostered time would be required each day bringing the labour costs to:

For each day Monday to Thursday: \$ 911.90

For each Friday and Saturday: \$1010.90

For each Sunday: \$1100.00

Additional Programme (Scenario 3)

Sondes at exactly 3 hourly intervals (using 800gm balloons) with wind observations on all additional flights.

For each day Monday to Thursday: \$1,107.70

For each Friday and Saturday: \$1,450.90

For each Sunday \$1,540.10

Consumable costs/day

(a) For 350gm balloons programme with wind observations

6 X \$13.38 = \$80.28 for balloons

4 X \$ 3.99 = \$15.96 for targets

6 X \$98.38 = \$590.28 for radiosondes

3 X \$ 1.24 = \$ 3.72 for torch/batteries

Total addition consumable costs for programme using 350gm balloons = \$690.24 per day

(b) For 800gm Balloons programme with wind observations

8 X \$39.40 = \$315.20 for balloons

other costs as per 350gm programme

Total additional consumable costs for programme using 800gm balloons = \$925.16 per day

資料 7

キャンペーンの企画書 (10 月)

(Oct13.doc)

Radiosonde Sounding for DAWEX experiment

October Campaign

1. Observation periods: October 13-18

The observation period is selected just before a new moon (new moon at 20:59 LT on Oct 17 at 135E) so as to coordinate with CCD imager observations. We will start launching at 14:45 LT (5:15 Z) on the first day (October 13), and finish the last launch at 11:45 LT (2:15 Z) on the last day (October 18).

2. Launch sites: 3 sites

site A: Darwin weather station of BOM (50-100 km from Hector)

site B: Civillian airport in Katherine (about 300 km from Hector)

site C: Tiwi island (0 km from Hector)

Open field near a fishing lodge at Garden Point

3. Schedule

October 10 Initial inspection and briefing at BOM workshop
(Ross Christmas and Phil Dutton)

October 11 Training of a radiosonde launch at the wind profiler site

October 12 Move to the remote launch sites

To Katherine: vehicle by Ross Christmas and a rent-a-car

To Garden Point; a charter flight or RPT

Set-up radiosonde equipment

October 13 System check at Katherine by Ross Christmas,
at GP by Neil Mules

First launch at 14:45 CST (5:15 Z)

October 14-17 Continue 8 launches/day every 3 hours (see Launch Schedule)

October 18 Last launch at 11:45 LT (2:15 Z)

Clean-up the sites, and return to Darwin

4. Equipment

(1) Receiver: VAISALA digiCola (Marwin) from Monash and BOM

(2) Radiosonde: RS80-15G (PTU + GPS winds) x 40 at GP and Katherine

(3) Balloon: TX-800 (800 gram) x 40 at each site

(4) Helium gas and regulator

(5) Ground-check: VAISLA kit and a barometer

(6) tents (wind shelter)

5. Launch schedule

Considering a routine launch schedule (* in the table) at the Darwin meteorological station, we will launch 8 balloons/day every 3 hours at 2:45 LT , 5:45 LT, 8:45 LT, 11:45 LT, 14:45 LT, 17:45 LT, 20:45 LT and 23:45 LT.

LT	UT	Oct						
		Date	13	14	15	16	17	18
2:45	17:15			5	13	21	29	37
5:45	20:15			6	14	22	30	38
8:45	23:15*			7	15	23	31	39
11:45	2:15			8	16	24	32	40
14:45	5:15		1	9	17	25	33	
17:45	8:15		2	10	18	26	34	
20:45	11:15*		3	11	19	27	35	
23:45	14:15		4	12	20	28	36	

6. Frequency allocation

	1st preference	2nd preference
Darwin	401.5 MHz	400.5MHz
Katherine	403.5 MHz	402.5 MHz
Garden Pt	405.5 MHz	404.5 MHz

7. Barge to Garden Point

Cynthia Sandford, Tiwi Barge Company 08 8947 1118 (Tel), 08 8947 0263 (Fax)

Departure: every Wednesday

Freight should be delivered by the previous Friday

September 28 for the October 3 barge

October 5 for the October 10 barge

Arrival: around lunching time on the Thursday

8. Participants

Name	E-mail	Phone
BOM		
Phil Dutton	P.Dutton@Bom.Gov.Au	(08) 8920 3817
Ross Christmas	R.Christmas@bom.go.au	(08) 8947 0494
		Mobile 0408 644 125
Nigel Mules	n.mules@bom.gov.au	
Kyoto University		
Toshitaka Tsuda	tsuda@kurasc.kyoto-u.ac.jp	(+81) 774 38 3804
Takayuki Yoshihara	yoshihara@kurasc.kyoto-u.ac.jp	
Takayuki Shimabukuro	Simabu@kurasc.kyoto-u.ac.jp	
Adelaide University		
Simon Alexander	salexand@physics.adelaide.edu.au	
Monash University		
Andrew Marshal	Andrew.Marshall@maths.monash.edu.au	
Robert Goler	rag@vortex.shm.monash.edu.au	
Stewart Allen	Stewart.Allen@maths.monash.edu.au	
Ivan Mac	la_nino@hotmail.com	
Fiona Guest	fiona@vortex.shm.monash.edu.au	
Sylvain Manso	sjm@labyrinth.net.au	
Justin Peters	justin.peter@dar.csiro.au	

9. Logistics

Accommodations

Date	Total	BOM	Kyoto	Adelaide	Monash		
Oct 10	10		2	1	7	Value Inn	Darwin
Oct 11	11		3	1	7	Value Inn	Darwin
Oct 12	7	1	3		3	TBD	Katherine
-	6	1		1	4	Fishing Lodge	Garden Point
Oct 13-17	6		3		3	TBD	Katherine
-	5			1	4	Fishing Lodge	Garden Point
Oct 18	11		3	1	7	Vakue Inn	Darwin

Transportation

We have booked a vehicle for a trip to Katherine.

We need to book a flight between Darwin and Garden Point.

10. Contacts

BOM Darwin regional office

Jim Arthur, Director

J.Arthur@bom.gov.au, (08) 8920 3801 Mobile 0417 475 269

BMRC

Peter T. May p.may@bom.gov.au,

phone: +61-3-9669-4490, fax: +61-3-9669-4660

Adelaide University

Robert A. Vincent robert.vincent@adelaide.edu.au

Ph: (61 8) 8303-5758 Fax: (61 8) 8303-4384

Andrew MacKinnon andrew.mackinnon@adelaide.edu.au

Phone +61-(0)8-8303-5313 FAX. +61-(0)8-8303-4384

Monash University

Michael Reeder michael.reeder@sci.monash.edu.au

ph. +61 3 9905 4464 fax. +61 3 9905 3870

Darwin Airport Meteorological Office (TX-800 balloons)

Tim Buckley (08) 8982 2868

Katherine

Roger Atkinson, BoM Tindal RAAF base

Wayne Osburn, Manager of the local airport

Tiwi Government

Lawrence Costa

Manager of the Community Development Program (CDP)

08 8978 3968 (Phone) 08 8978 3803 (Fax)

Garden Point

Mark Nesbitt marksbarrasafaris@octa4.net.au

Owner of a fishing lodge

資料 8

キャンペーンの企画書 (11 月)

(Nov01.doc)

DAWEX (Darwin Wave Experiment)

Radiosonde Sounding in November



40th launch at 11:45 on October 18, 2001, at Garden Point,
by Justin, Fiona, Simon, Stewart and Andrew

1. General Information

Please visit the following Home Pages.

(A) DAWEX http://www.aig.asn.au/gravity_waves.htm

(B) SPARC (Stratospheric processes and their role in climate)

<http://www.aero.jussieu.fr/~sparc/>

Click SPARC initiatives, and look for Gravity waves

(C) Photos from October campaign (by Takayuki Yoshihara)

<http://www.kurasc.kyoto-u.ac.jp/radar-group/members/dawex/index.html>

(D) Photos from October campaign (by Robert Goler)

<http://www.maths.monash.edu.au/~robert/Weather/Dawex/Day1/today.html>

2. Observation periods: November 15-20, 2001

The observation period is selected around a new moon (9:43 LT on November 16 at Darwin) so as to coordinate with CCD imager observations. We will start launching at 14:45 LT (5:15 Z) on the first day (November 15), and finish the last launch at 11:45 LT (2:15 Z) on the last day (November 20).

3. Launch sites

site A: BOM weather station at **Darwin** airport (about 50 km from Hector)

site B: Civillian airport in **Katherine** (about 300 km from Hector)

site C: **Garden Point** (Pirlangimpi) on Tiwi islands (0 km from Hector)

Open field near a fishing lodge



4. Schedule

November 12

To arrive Darwin from Melbourne/Adelaide

Briefing at BOM by Ross Christmas and Nigel Mules

November 13

Training of a radiosonde sounding the BoM Darwin Airport Radar office

Balloon (see Home page (C))

MARWIN and PC

Construction of a tent (see Home page (C))

November 14 Move to the remote launch sites

To Katherine: vehicle by Ross Christmas and a rent-a-car

To Garden Point; a flight by Wimray leaving at 8:00 AM

Set-up radiosonde equipment

NOTE: Joan Alexander will arrive Darwin at 10:40 by QF673 from Adelaide, and will take a Wimray flight leaving at 16:00 for GP.

November 15 **System check** at Katherine and GP by Ross Christmas and Nigel Mules, respectively.

First launch at 14:45 CST (5:15 Z)

November 16-19 Continue 8 launches/day every 3 hours (see Launch Schedule)

November 20 **Last launch at 11:45 LT (2:15 Z)**

Clean-up the sites, and return to Darwin

From Garden Point; a flight leaving at 5:00 PM

NOTE: Please check the followings before leaving the sites.

1. Number of radiosondes, balloons and parachutes
2. Number of Helium gas bottles

Summary Meeting at Tim's on the bay from 7:30 PM

5. Equipment

- (1) Receiver: VAISALA digiCola (**Marwin**) from Monash and BOM
- (2) Radiosonde: **RS80-15G (PTU + GPS winds)** x 40 at GP and Katherine
RS80 (PTU) with a radar winds x 40 at Darwin
- (3) Balloon: **TX-800** (800 gram) x 40 at each site
- (4) **Helium gas** at remote sites
- (5) Parachutes (Radar reflector was used in October.)
- (6) Ground-check: VAISLA kit and a barometer
- (7) tents (wind shelter)
- (8) Mobile Phones: 2 mobile phones are available at Katherine. One should be kept at the launch site. (408)-578-287 (409)-383-485

6. Launch schedule

Considering a routine launch schedule (* in the table) at the Darwin meteorological station, we will launch 8 balloons/day every 3 hours at 2:45 LT , 5:45 LT, 8:45 LT, 11:45 LT, 14:45 LT, 17:45 LT, 20:45 LT and 23:45 LT.

		Nov							
LT	UT	Date	15	16	17	18	19	20	
2:45	17:15			5	13	21	29	37	
5:45	20:15			6	14	22	30	38	
8:45	23:15*			7	15	23	31	39	
11:45	2:15			8	16	24	32	40	
14:45	5:15		1	9	17	25	33		
17:45	8:15		2	10	18	26	34		
20:45	11:15*		3	11	19	27	35		
23:45	14:15		4	12	20	28	36		

We assume that 6 persons at each site will be separated into 3 sub-groups, then, each

group will work on 2-4 successive soundings. Rotating of a shift should be discussed.

Note: Call Tidal airport (8973 6740) before launching a balloon between 9AM and 6 PM.

7. Frequency allocation

Frequency range permitted: 400.15 – 403.00 MHz

	1st preference	2nd preference
Darwin	401.0 MHz	400.5MHz
Katherine	402.0 MHz	401.5 MHz
Garden Pt	403.0 MHz	402.5 MHz

VAISALA radiosonde is tuned at 403 MHz.

8. Participants

Name	E-mail		Phone
BOM			
Ross Christmas	R.Christmas@bom.gov.au	K	8947 0494 Mobile 0408 644 125
Nigel Mules	n.mules@bom.gov.au	GP	8920 3841
Adelaide University			
Andrew McKinnon	andrew.mackinnon@adelaide.edu.au	K	Mobile: 0411 024 713
Simon Alexander	salexand@physics.adelaide.edu.au	GP	
Monash University			
Robert Goler	rag@vortex.shm.monash.edu.au	GP	
Kirsty Fletcher	kirsty.fletcher@maths.monash.edu.au	K	
Briony MacPherson	brimacpherson@hotmail.com	K	
Jin Lee	jinlee@maths.monash.edu.au	GP	
Michael Logan	Michael.logan@maths.monash.edu.au	K	
Andrew Roberts	werdona@hotmail.com	K	
Salah Jimi	Salah.Jimi@maths.monash.edu.au	GP	
Michael Duell	michaelduell@hotmail.com	K	
CORA			
Joan Alexander	alexand@colorado-research.com	GP	
NCAR			
Tim Barnes	tbarnes@ucar.edu	GP	

K: Katherine GP: Garden Point

9. Logistics

(A) Accommodations

Darwin: Mirambeena Tourist Resort <http://www.mirambeena.com.au>

Katherine: Knotts Crossing Resort <http://www.knottscrossing.com.au/>

Garden Point: Munupi fishing lodge <http://www.barrasafaris.com.au>

Date	Total	BOM	Cora/NCAR	Adelaide	Monash	Hotel	Location
Nov 12-13	10		1	1	8	Mirambeena	Darwin
Nov 14	7	1	0	1	5	Knotts Crossing	Katherine
-	7	1	2	1	3	Fishing Lodge	Garden Point
Nov 15-19	6		0	1	5	Knotts Crossing	Katherine
-	6		2	1	3	Fishing Lodge	Garden Point
Nov 20	12		2 (*)	2	8	Mirambeena	Darwin

(*) Joan will leave Darwin by QF829 at 00:15 on November 21.

(B) Transportation

Rent-a-car (Delta): Minibus (7 seats) Reservation # DWBJJ4

(Note that we are on a waiting list for Toyota Tarago with 8 seats.)

Pick up at Darwin airport at 12:00 on Nov 12, and drop at 12:00 on Nov 21.

Booking is guaranteed by Tsuda's VISA card.

NOTE: Take a taxi to downtown Darwin, if necessary, and keep a receipt for reimbursement. Contact Ross for details.

Wimray flights between Darwin and Garden Point.

Booking is made by Ross with Tsuda's VISA card.

Nov 14: Lv. Darwin at 8:00 (6 persons, including Nigel)

Nov 14: Lv. Darwin at 16:00 (Joan Alexander)

Nov 20: Lv. GP at 17:00 (6 persons)

(C) Support and reward

- (1) Room charge for a hotel in Darwin, Katherine and GP for 9 nights during November 12-20 will be charged to Tsuda's credit card.
- (2) As meals are not included at a hotel in Darwin (November 12-13 and 20) and Katherine (November 14-19), \$50/day will be provided. While, at the fishing lodge at GP (November 14-19) three meals will be served.
- (3) We would like to offer \$50/day for 9 days as a reward for assisting experiments during November 12-20.

For example, those who are going to GP and Katherine will receive (2) $\$50 \times 3$ + (3) $\$50 \times 9 = \600 , and (2) $\$50 \times 9$ + (3) $\$50 \times 9 = \900 , respectively.

10. Contacts

BOM (Bureau of Meteorology) Northern Territory regional office

PO Box 40050, Causuarina, NT 0811, Australia

Jim Arthur, Regional Director J.Arthur@bom.gov.au, (08) 8920 3801

Phil Dutton, Regional Observations Manager, P.Dutton@Bom.Gov.Au

(08) 8920 3817 A/Hrs (08) 8927 6806

Tim Buckley, Darwin Airport Meteorological Office,

PO Box 39845 Winnellie NT 0821

T.Buckley@Bom.Gov.Au (08) 892 03868

BOM workshop Lot 1721 Albatross St., Winnellie

BMRC

Peter T. May p.may@bom.gov.au,

phone: +61-(0)3-9669-4490, fax: +61-(0)3-9669-4660

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Monash University

Michael Reeder michael.reeder@sci.monash.edu.au

phone +61 (0)3 9905 4464 fax. +61 (0)3 9905 3870

Mirambeena Resort in Darwin

64 Cavenagh Street, Darwin, Northern Territory, Australia, 0801

Phone: +61 8 89460111 FAX +61 8 8981 5116

Katherine

Roger Atkinson, BoM Tindal RAAF base

Phone 8973 6243 (W) 8371 3245 (H) Mobile: 0418 439970

Tindal Airport 8973 6740

Wayne Osburn, Manager of the local airport

Knotts Crossing Resort in Katherine

Phone: (08) 8972 2511 Fax: (08) 8972 2628

Tiwi Government, the Community Development Program (CDP)

Lawrence Costa, Manager Phone: (08) 8978 3968 Fax (08) 8978 3803

Garden Point

Mark Nesbitt, Owner of a Munupi fishing lodge

Pamela Wanrooy marksbarrasafaris@octa4.net.au

Phone: 8978 3783 8978 3847

Tech-Rentals: Mobile phones (408 578-287, 409 383-485)

Angela Rolfe, Sales Support/Mobile Phones, angela_rolfe@techrentals.com.au

Phone: (08) 8947 2860 Fax: (08) 8947 2901

11. Notes by Nigel Mules

Garden Point is a small aboriginal community with a few facilities which I have found out from the fishing lodge include:

- a bakery for morning tea if you get hungry.
- a Post Office.
- a Commonwealth Bank eftpos facility that costs \$5 per transaction.
- a shop that sells small supplies such as soap, tinned food etc.

Garden point is a 'dry' community but the fishing lodge has a permit for alcohol to be consumed on their premises. So if you enjoy wine or beer with your meals you can bring it with you but it must have the name "Mark's Barra Safaris" written on it so Airnorth know it is to be consumed there. Beer can be purchased at the lodge but is about \$74 a carton (that is not a typo). For those operating at Katherine you will be accommodated at a tourist resort Knotts Crossing which has all facilities, swimming pool, bistro. bar etc. The observation site is located at the civilian airport about 16 km south of Katherine so some travel will be involved. The weather will be hot and humid during the day and cooling down to low 20's at night so a few things to consider packing include:

- Hat, light clothes, long sleeve shirts if you burn easily.
- Sunscreen
- Insect repellent
- Torch
- Personal toiletries
- Water bottle

Suggest for both sites if possible to organize a clock radio, to provide a means of checking the time (important) and to keep in touch with the rest of the world when working.

(contact for use of shed at launching site)

Emergenices: 000

Police: For accident reports and general counter service 8978 3969

Community Health Centre: 8978 3953

資料 9

キャンペーンの企画書

(Dec062.doc)

DAWEX (Darwin Area Wave Experiment) Radiosonde Sounding in December

1. General Information

Please visit the following Home Pages.

(A) DAWEX http://www.aig.asn.au/gravity_waves.htm

(B) SPARC (Stratospheric processes and their role in climate)

<http://www.aero.jussieu.fr/~sparc/>

Click SPARC initiatives, and look for Gravity waves

(C) Photos from October campaign (by Takayuki Yoshihara)

<http://www.kurasc.kyoto-u.ac.jp/radar-group/members/dawex/index.html>

(D) Photos from October campaign (by Robert Goler)

<http://www.maths.monash.edu.au/~robert/Weather/Dawex/Day1/today.html>

2. Observation periods: December 11-16, 2001

The observation period is selected around a new moon (22:27 LT on December 15) so as to coordinate with CCD imager observations. We will start launching at 14:45 LT (5:15 Z) on the first day (December 11), and finish the last launch at 11:45 LT (2:15 Z) on the last day (December 16).

3. Launch sites

site A: BOM weather station at **Darwin** airport (about 50-100 km from Hector)

site B: Civillian airport in **Katherine** (about 300 km from Hector)

site C: **Garden Point** (Pirlangimpi) on Tiwi islands (0 km from Hector)

Open field near a fishing lodge



4. Schedule

December 8

Kyoto team (Toshitaka Tsuda, Yuichi Aoyama and Takayuki Yoshihara) arrives Darwin at 12:35 by QF824

December 9

Adelaide group (Robert Vincent, Andrew MacKinnon, Simon Alexander and Peter Love) also arrive at 10:35.

7 (Tsuda, Aoyama, Yoshihara, m, Simon, Andrew and Stewart), 2 (Bob and Andrew) and Ross go to Katherine.

Tim Barnes arrives at 19:03 on December 9.

December 10

6 (Bob, Andrew, Peter, Tim, Rob and Sylvain) goes to Garden Point; by Wimray leaving at 8:00 AM

Set-up radiosonde equipment

December 11 System check

First launch at 14:45 CST (5:15 Z)

December 12-15 Continue 8 launches/day every 3 hours (see Launch Schedule)

December 16 **Last launch at 11:45 LT (2:15 Z)**

Clean-up the sites, and return to Darwin

From Garden Point; a flight leaving at 5:00 PM

NOTE: Mark will arrange a barge.

Summary Meeting at Tim's on the bay from 7:30 PM

5. Equipment

- (1) Receiver: VAISALA digiCola (**Marwin**) from Monash and BOM
- (2) Radiosonde: **RS80-15G (PTU + GPS winds)** x 40 at GP and Katherine
RS80 (PTU) with a radar winds x 40 at Darwin
- (3) Balloon: **TX-800** (800 gram) x 40 at each site
- (4) **Helium gas** at remote sites
- (5) Parachutes (Radar reflector was used in October.)
- (6) Ground-check: VAISLA kit and a barometer
- (7) tents (wind shelter)
- (8) Mobile Phones: 2 mobile phones are available at Katherine. One should be kept at the launch site. (408)-578-287 (409)-383-485

6. Launch schedule

Considering a routine launch schedule (* in the table) at the Darwin meteorological station, we will launch 8 balloons/day every 3 hours at 2:45 LT , 5:45 LT, 8:45 LT, 11:45 LT, 14:45 LT, 17:45 LT, 20:45 LT and 23:45 LT.

LT	UT	Dec						
		Date	11	12	13	14	15	16
2:45	17:15			5	13	21	29	37
5:45	20:15			6	14	22	30	38
8:45	23:15*			7	15	23	31	39
11:45	2:15			8	16	24	32	40
14:45	5:15		1	9	17	25	33	
17:45	8:15		2	10	18	26	34	
20:45	11:15*		3	11	19	27	35	
23:45	14:15		4	12	20	28	36	

We assume that 6 persons at each site will be separated into 3 sub-groups, then, each group will work on 2-4 successive soundings. Rotating of a shift should be discussed.

Note: Call Tidal airport (8973 6740) before launching a balloon between 9AM and 6 PM.

7. Frequency allocation

Frequency range permitted: 400.15 – 403.00 MHz

	1st preference	2nd preference
Darwin	401.0 MHz	400.5MHz
Katherine	403.0 MHz	402.5 MHz
Garden Pt	402.0 MHz	401.5 MHz

VAISALA radiosonde is tuned at 403 MHz.

8. Participants

Name	E-mail	Phone
BOM		
Ross Christmas	R.Christmas@bom.gov.au	K 8984 3475 Mobile 0408 644 125
Nigel Mules	n.mules@bom.gov.au	8920 3841
Tim Buckley	t.buckley@BoM.GOV.AU	
Roger Atkinson	r.atkinson@bom.gov.au	

Adelaide University			
Robert Vincent	rvincent@physics.adelaide.edu.au	GP	
Andrew McKinnon	andrew.mackinnon@adelaide.edu.au	K	Mobile: 0411 024 713
Simon Alexander	salexand@physics.adelaide.edu.au	GP	
Peter Love		GP	
Monash University			
Robert Goler	rag@vortex.shm.monash.edu.au	GP	
Sylvain Manso	sylvain_4@yahoo.com.au	GP	
Andrew Marshall	andrew.marshall@bom.gov.au	K	
Stewart Allen	Stewart.Allen@maths.monash.edu.au	K	
Kyoto Univeristy			
Toshitaka Tsuda	tsuda@kurasc.kyoto-u.ac.jp	K	
Yuichi Aoyama	aoyama@kurasc.kyoto-u.ac.jp	K	
Takayuki Yoshihara	yosihara@kurasc.kyoto-u.ac.jp	K	
NCAR			
Tim Barnes	tbarnes@ucar.edu	GP	
BMRC			
Peter May	P.May@BoM.GOV.AU		

K: Katherine GP: Garden Point

9. Logistics

(A) Accommodations

Darwin: Mirambeena Tourist Resort <http://www.mirambeena.com.au>

Katherine: Knotts Crossing Resort <http://www.knottscrossing.com.au/>

Garden Point: Munupi fishing lodge <http://www.barrasafaris.com.au>

Dec 8th	2 std rooms	Mirambeena Resort	Kyoto group
Dec 9th	2 std rooms	Mirambeena Resort	4 people for GP
Dec 10th	1 std room	Mirambeena Resort	Bob and Andrew
Dec 10th - 16th		Fishing Lodge	6 people for Garden pt.
Dec 9th - 16th	3 Family rooms	Knotts Xing	6 people for Katherine
Dec 9th	1 Family room	Knotts Xing	Bob and Andrew

(B) Transportation

Vehicle bookings:

Dec 8th - 17th Delta Europcar - Tarago Darwin Airport Booking# DWCNT9

Dec 11th - 16th Delta Europcar - Corolla Katherine Booking # DWCNTG

Air Flight Booking:

Dec 10th 8am Wimray Robert Goler, Sylvain Manso, Tim Barnes, Peter Love

Dec 11th 8am Wimray Bob Vincent, Andrew MacKinnon

Dec 16th 5pm Wimray 6 as above.

(C) Support and reward

- (1) Room charge for a hotel in Darwin, Katherine and GP for 8 nights during December 9-17 will be charged to Tsuda's credit card.
- (2) As meals are not included at a hotel in Darwin and Katherine, \$50/day will be provided. While, at the fishing lodge at GP three meals will be served.
- (3) We would like to offer \$50/day for 8 days as a reward for assisting experiments during December 9-16.

For example, those who are going to GP and Katherine will receive (2) $\$50 \times 2$ + (3) $\$50 \times 8 = \500 , and (2) $\$50 \times 8$ + (3) $\$50 \times 8 = \800 , respectively.

10. Contacts

BOM (Bureau of Meteorology) Northern Territory regional office

PO Box 40050, Causuarina, NT 0811, Australia

Jim Arthur, Regional Director J.Arthur@bom.gov.au, (08) 8920 3801

Phil Dutton, Regional Observations Manager, P.Dutton@Bom.Gov.Au

(08) 8920 3817 A/Hrs (08) 8927 6806

Tim Buckley, Darwin Airport Meteorological Office,

PO Box 39845 Winnellie NT 0821

T.Buckley@Bom.Gov.Au (08) 892 03868

BMRC

Peter T. May p.may@bom.gov.au,

phone: +61-(0)3-9669-4490, fax: +61-(0)3-9669-4660

Kyoto University

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Adelaide University

Robert A. Vincent robert.vincent@adelaide.edu.au

Ph: +61 (0)8 8303-5758 Fax: +61 (0)8 8303-4384

Andrew MacKinnon andrew.mackinnon@adelaide.edu.au

Phone +61-(0)8-8303-5313 FAX. +61-(0)8-8303-4384 Mobile: 0411 024 713

Monash University

Michael Reeder michael.reeder@sci.monash.edu.au

phone +61 (0)3 9905 4464 fax. +61 (0)3 9905 3870

Mirambeena Resort in Darwin

64 Cavenagh Street, Darwin, Northern Territory, Australia, 0801

Phone: +61 8 89460111 FAX +61 8 89815116

Katherine

Roger Atkinson, BoM Tindal RAAF base

Phone 8973 6243 (W) 8371 3245 (H) Mobile: 0418 439970

Tindal Airport 8973 6740

Wayne Osburn, Manager of the local airport

Knotts Crossing Resort in Katherine

Phone: (08) 8972 2511 Fax: (08) 8972 2628

Tiwi Government, the Community Development Program (CDP)

Lawrence Costa, Manager Phone: (08) 8978 3968 Fax (08) 8978 3803

Garden Point

Mark Nesbitt, Owner of a Munupi fishing lodge

Pamela Wanrooy marksbarrasafaris@octa4.net.au

Phone: 8978 3783 8978 3847

Tech-Rentals: Mobile phones (408 578-287, 409 383-485)

Angela Rolfe, Sales Support/Mobile Phones, angela_rolfe@techrentals.com.au

Phone: (08) 8947 2860 Fax: (08) 8947 2901

Emergenices: 000

Police: For accident reports and general counter service 8978 3969

Community Health Centre: 8978 3953

資料 1 0

ラジオゾンデ観測関係の写真資料

気球

(DAWEX_ballon.doc)



写真B-1



写真B-2



写真B-3



写真B-4



写真B-5



写真B-6

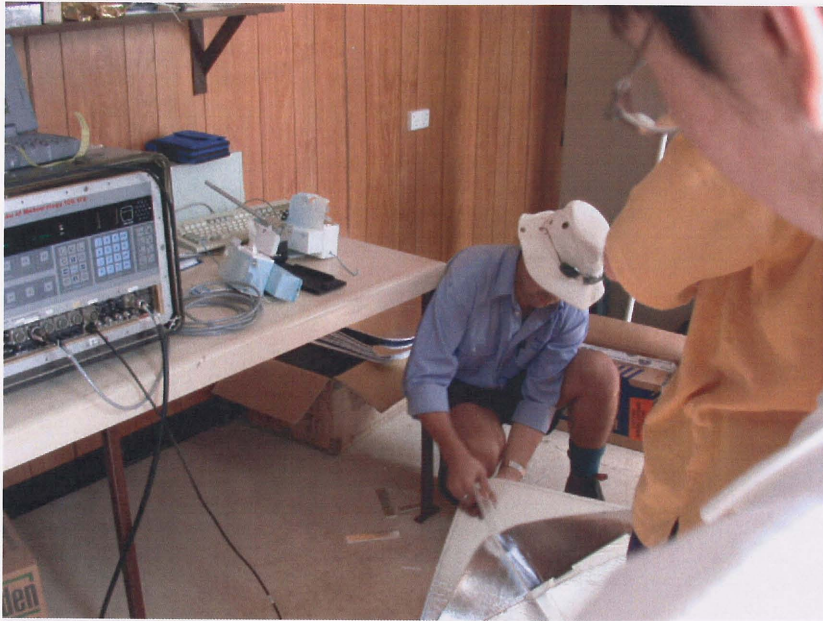


写真B-7



写真B-8

写真B-8



写真B-9



写真B-10



写真B-11



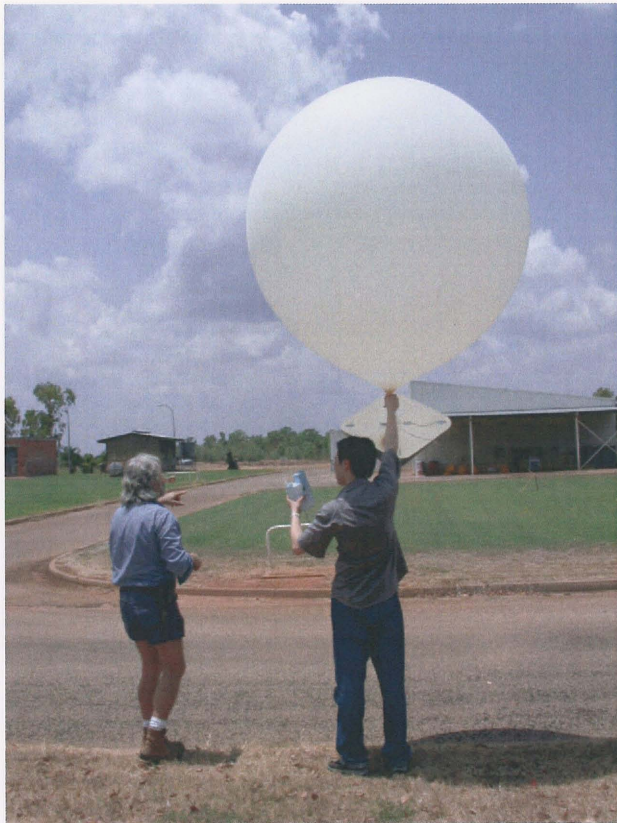
写真B-12



写真B-13



写真B-14



写真B-15



写真B-16

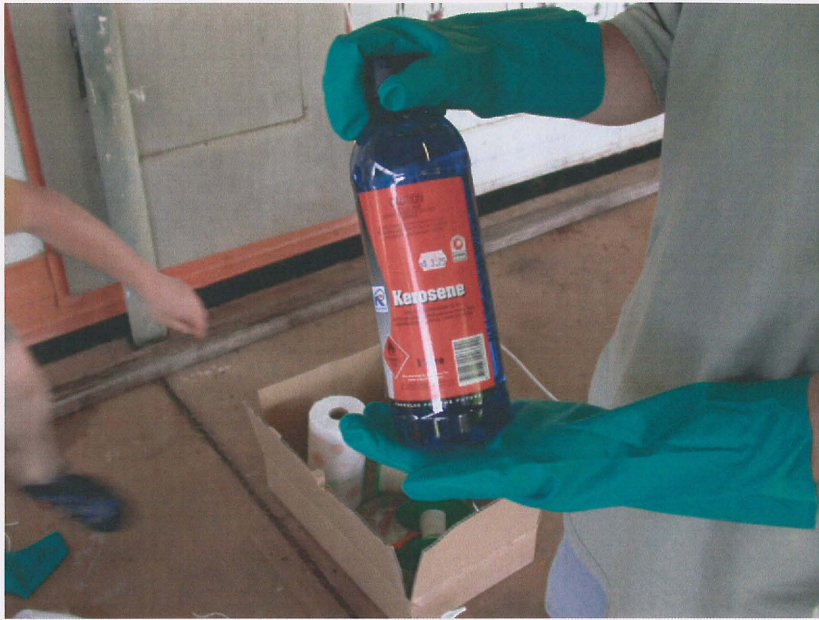
下了一日真平



写真B-17



写真B-18



写真B-19



写真B-20



写真B-2 1



写真B-2 2



写真B-23



写真B-24



写真B-25



写真B-26



写真B-27



写真B-28



写真B-29



写真B-30



写真B-3 1



写真B-3 2

資料 1 1

ラジオゾンデ観測関係の写真資料

防風テント

(DAWEX_tent.doc)



写真 T-1



写真 T-2



写真 T-3



写真 T-4



写真 T-5



写真 T-6



写真 T-7



写真 T-8



写真 T-9



写真 T-10

T-10



写真 T-1 1



写真 T-1 2

資料 1 2

ラジオゾンデ観測関係の写真資料

Garden Point 観測サイト

(DAWEX_GP.doc)



写真 G-1



写真 G-2



写真 G—3



写真 G—4



写真 G—5



写真 G—6



写真 G-7



写真 G-8



写真 G-9



写真 G-10

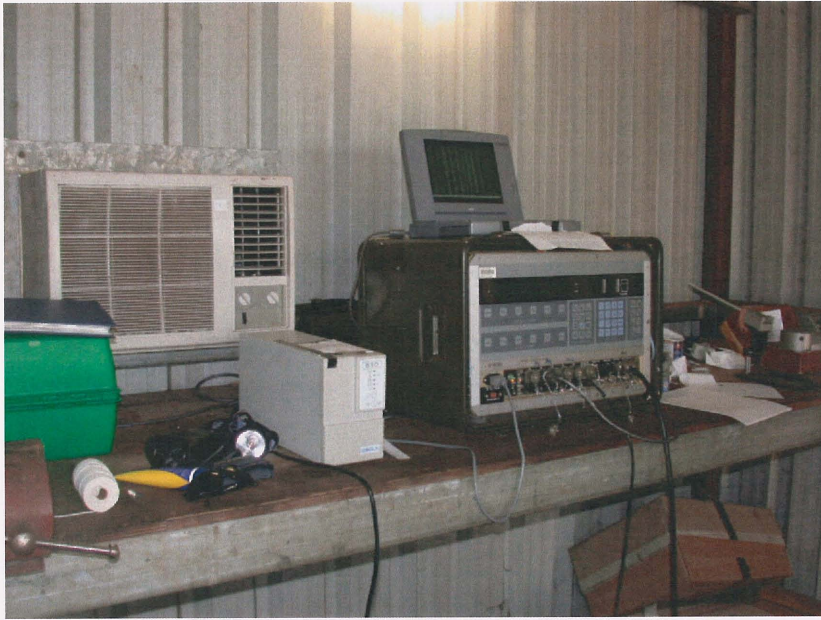


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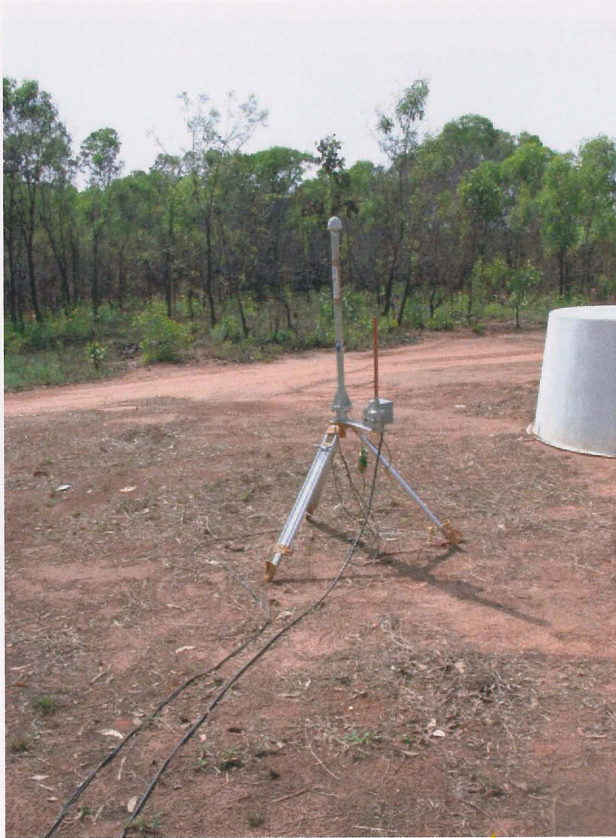


写真 G-1 2



写真 G-13



写真 G-14

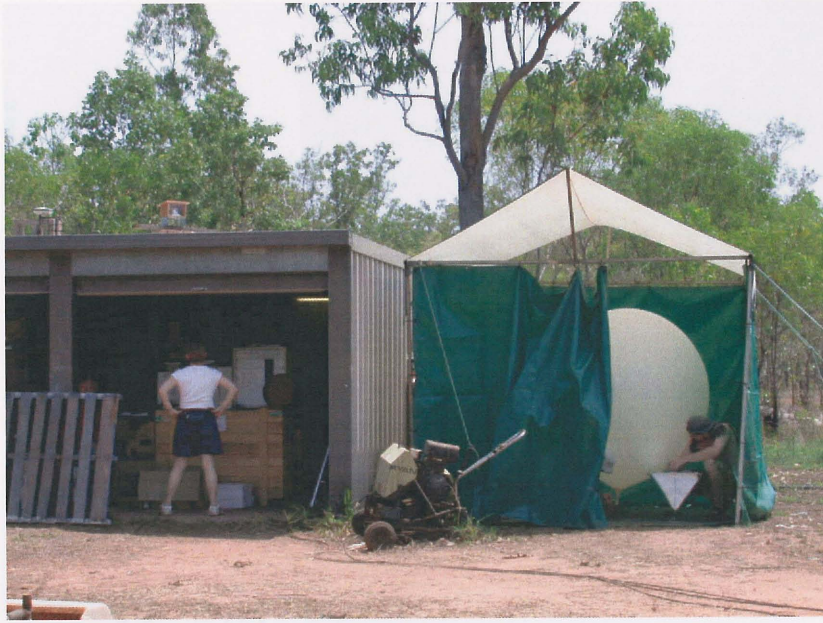


写真 G-15



写真 G-16

FI-DAY



写真 G-17



写真 G-18

写真 G-19



写真 G-19



写真 G-20



写真 G-2 1



写真 G-2 1



写真 G-22



写真 G-20

資料 1 3

ラジオゾンデ観測関係の写真資料

Katherine 観測サイト

(DAWEX_Kh.doc)



写真 K-1



写真 K-2



写真 K-3



写真 K-4



写真 K-5



写真 K-6

8-KAV



写真 K-7



写真 K-8



写真 K-9



写真 K-10

写真 K-10



写真 K-1 1



写真 K-1 2



写真 K-13



写真 K-14

写真 K-10



写真 K-15



写真 K-16

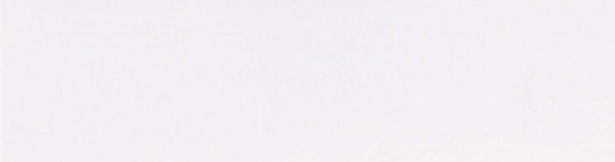


写真 K-17



写真 K-17



写真 K-18

資料 1 4

ラジオゾンデ観測関係の写真資料

積雲

(DAWEX_cloud.doc)

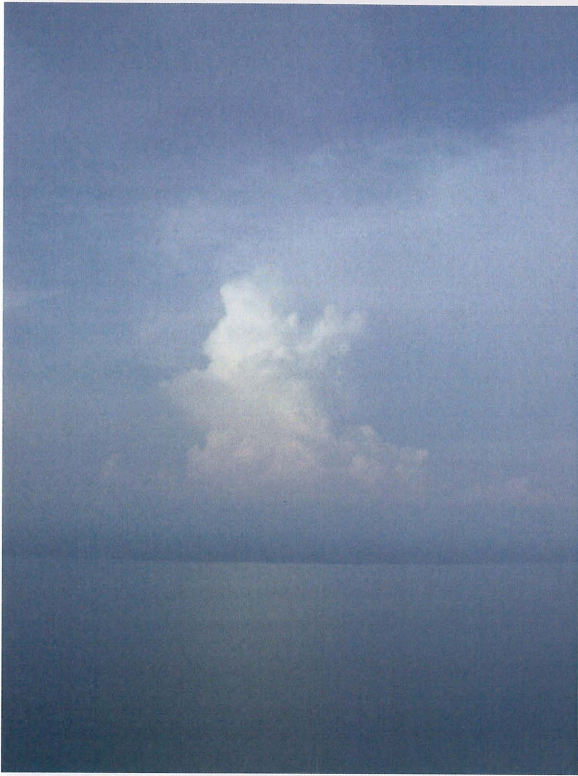
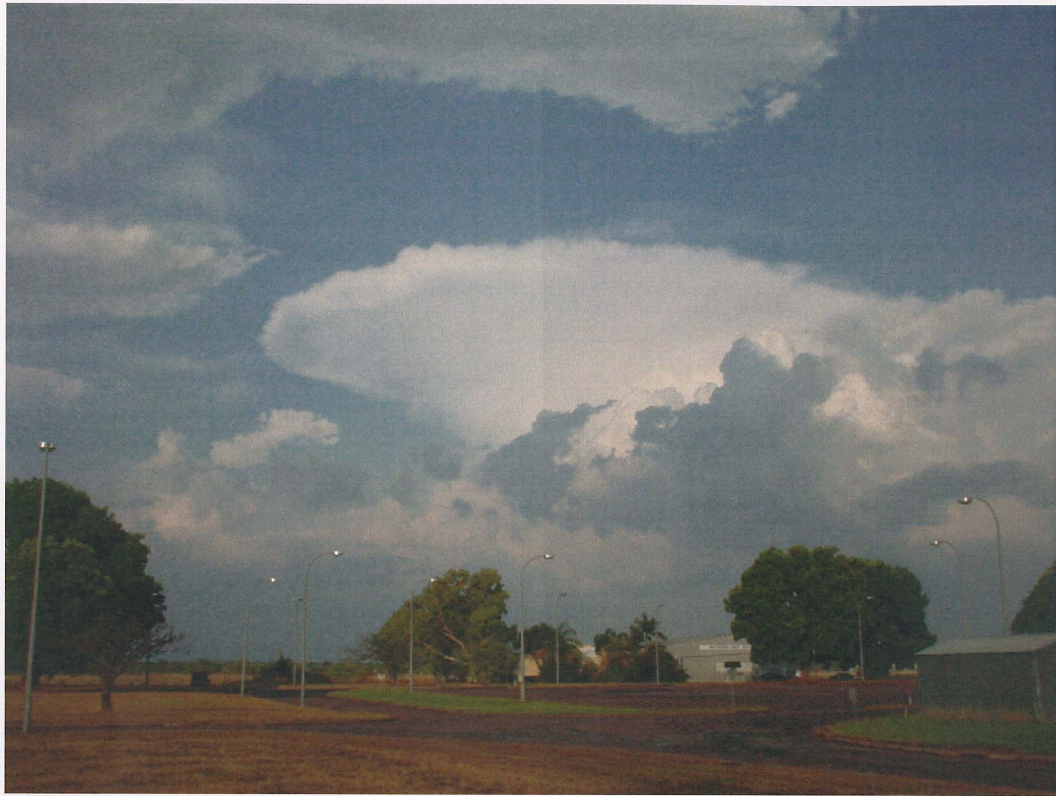


写真 C-1



写真 C-2



1-087

写真 C-3



写真 C-4

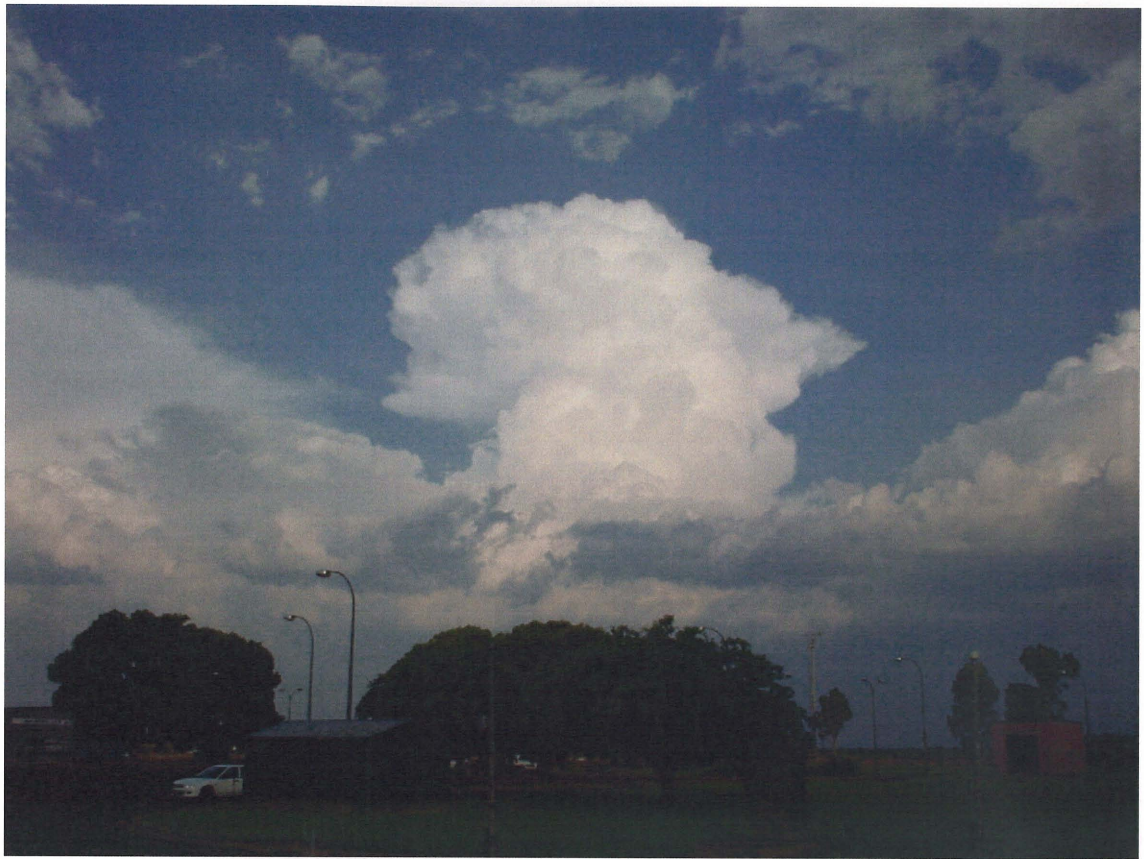


写真 C-5



写真 C-6

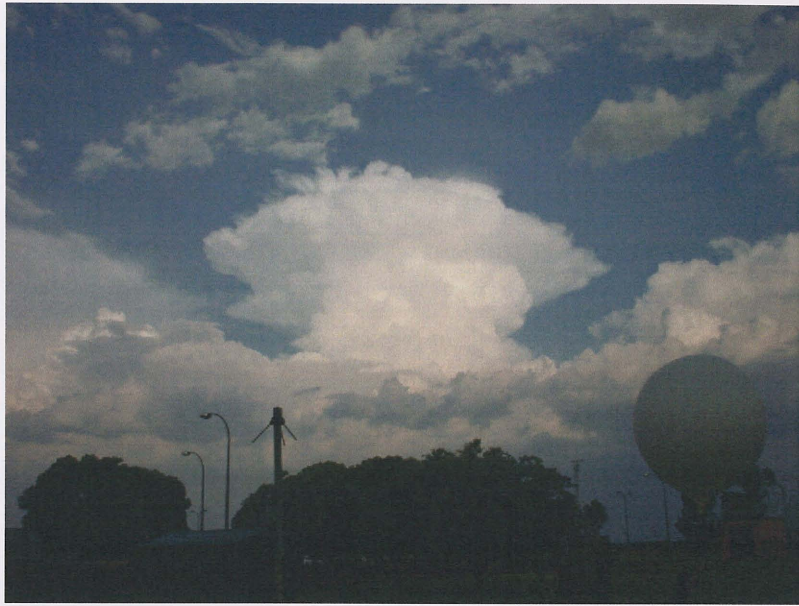


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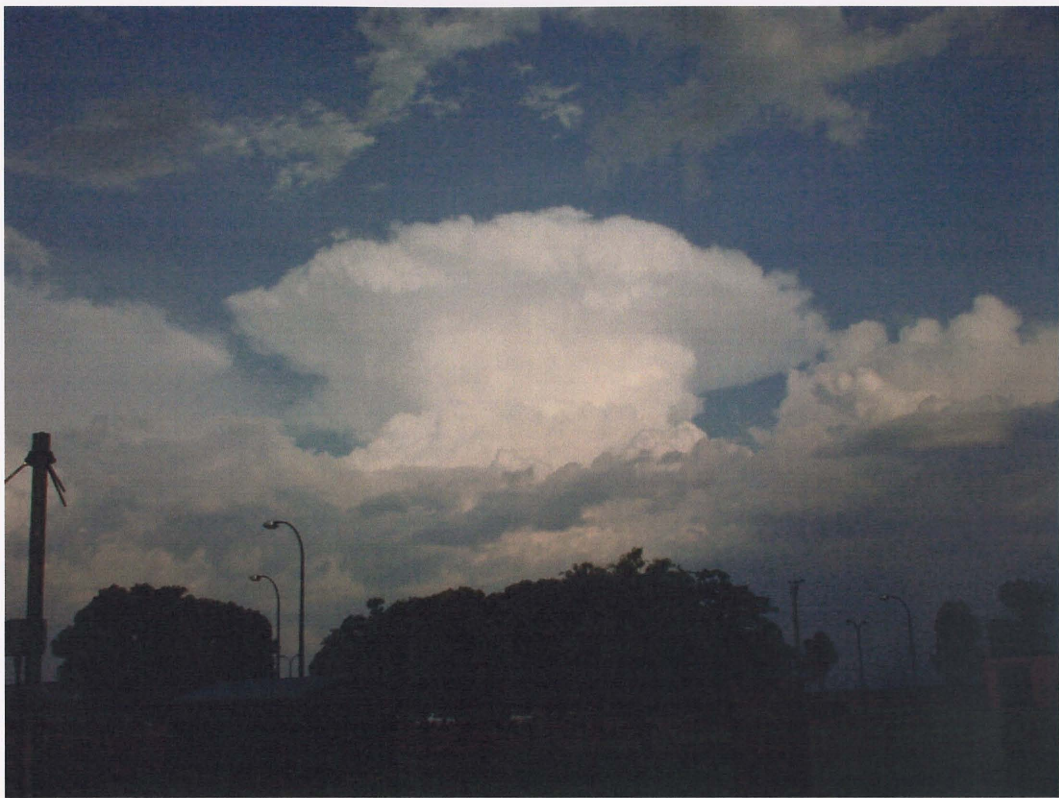


写真 C-8



写真 C-9



写真 C-10



写真 C-11

写真 C-10



写真 C-12



写真 C-13



写真 C-14



写真 C-15

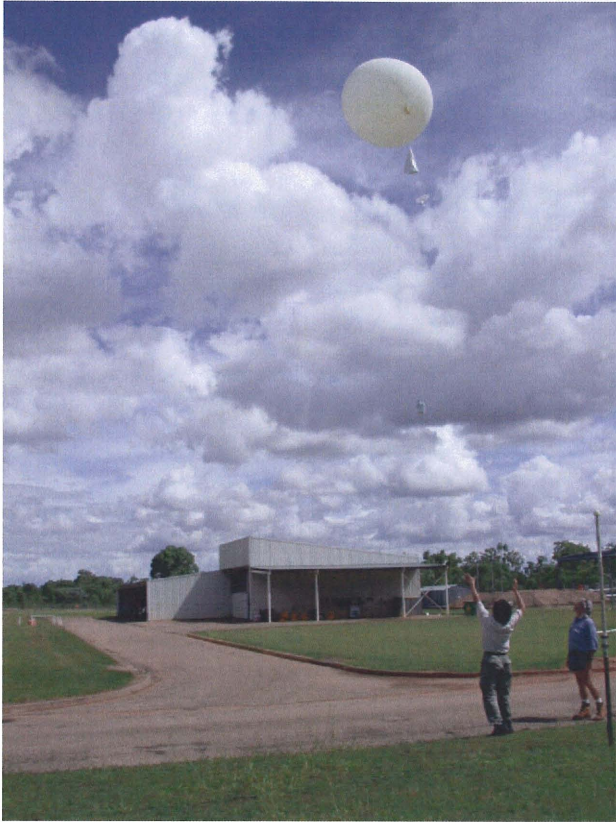


写真 C-16



写真 C-17