交通部中央氣象局委託研究計畫期末報告

探空及遙測資料校正技術在中尺度天氣系統分析與預報技術之應用

計畫類別：■國內　　□國外

計畫編號：MOTC-CWB-98-2M-06

執行期間：98 年 1 月 21 日至 98 年 12 月 31 日

計畫主持人：　劉清煌

執行單位：中國文化大學

中華民國　98 年　12　月

98 年度政府部門科技計畫期末摘要報告

計畫名稱： 探空及遙測資料校正技術在中尺度天氣系統分析與預報技術之應用

審議編號：	x	部會署原計畫編號：	MOTC-CWB-98-2M-06
主管機關：	交通部中央氣象局	執行單位：	中國文化大學
計畫主持人：	劉清煌	聯絡人：	劉清煌
電話號碼：	0919-094520	傳真號碼：	(02)28615274
期程：	98 年 1 月 21 日至 98 年 12 月 31 日		
經費：（全程）	888 仟元	經費(年度)	888 仟元

執行情形：

1.執行進度：

	預定（%）	實際（%）	比較（%）
當年	100	100	0
全程	100	100	0

2.經費支用：

	預定	實際	支用率（%）
當年	355200	355200	100.0
全程	888000	608090	68.5

3.計畫執行概況：

下圖為預定進度甘梯圖（Gantt Chart），至目前為止，皆按原計畫進行中無落後。

年月 / 工作項目	第一月	第二月	第三月	第四月	第五月	第六月	第七月	第八月	第九月	第十月	第十一月	第十二月	備　註
1.探空資料蒐集與整理	■	■											
2.資料格式整合並使用 ASPEN QC		■	■	■									
3.人工檢視及列表			■	■	■	■							
4.撰寫期中報中					■	■							
5.利 GPS PW 確認探空資料之潛在問題						■	■	■					
6.分析校驗比對資料，確認各探空資料校正需要								■	■	■			
7.探空資料校正方法研究與分析								■	■	■	■		
8.撰寫期末報告											■	■	
工作進度估計百分比（累積數）	5	10	30	40	50	60	70	80	90	100			
預 定 查 核 點	第一季:探空資料整合並使用 ASPEN QC 第二季:建立自動化探空資料 QC 流程 第三季:探空資料校正 第四季:期末報告												

期中報告於 6 月 25 日假中央氣象局衛星中心會議室完成，期中預計完成的項目有：

（1）探空資料蒐集與整理。

（2）資料格式整合並使用 ASPEN QC。

（3）人工檢視及列表。

這些工作均已如期完成，審查委員亦根據期中報告內容給予建議如下，Part A 為修正後之期中報告：

（1）加入 Version1 探空品質控管程序之流程圖。

（2）詳細說明流程圖中的每一步驟，並列表統計 Questionable 與 Bad 的比例。

（3）加入 ASPEN 軟體濾除之可疑資料點以及主觀認定為 Questionable 及 Bad 之例圖。

回覆：V1 品質控管程序詳述於 Part A 中的第六部分（第 11 頁~第 14 頁）。圖 2 為 V1 品質控管流程圖，首先藉由探空直接測量之各變數的垂直剖線圖來檢視探空資料的品質（圖 3），以主觀目視法對所有的探空資料進行檢驗，人工判斷資料是否有所缺失、所繪出的垂直剖線曲線是否合理，以及資料曲線變動

(fluctuation)是否太大等，藉此來檢查資料的系統性誤差以及個別探空資料的問題，表 2 即為利用主觀識別法所統計出 Questionable 與 Bad 的資料筆數。接著，先將資料內差至 5-hPa，再利用客觀統計的方法來評估資料的品質，表 3 即為經過客觀統計法對探空資料做品質評估得到的結果。最後，根據斜溫圖進一步檢視每一筆探空資料的狀況，斜溫圖可以協助我們找出受到其他污染的探空資料，如圖 5 所示。

（4）將 NCAR ASPEN 使用者手冊置於期末報告之附錄中。

回覆：Part C 即為 NCAR ASPEN 使用者手冊。

期末報告於 12 月 7 日假中央氣象局衛星中心會議室完成，期末預計完成的項目有：

（1）利用 GPS 或衛星反演出的可降水量（PW）來檢驗探空資料的溼度偏差。

（2）分析校驗比對資料，確認不同類型探空儀是否需要校正。

（3）探空資料校正方法研究與分析。

這些工作亦如期完成，審查委員給予之建議如下：

（1）圖表解說需配合，部分圖表的 scale 不一致需改善。

回覆：已修正原第 10 頁圖 4 左右兩張圖的 Scale 不同之問題，修改後的圖置於本報告第 13 頁圖 4。

（2）詳細說明 CDF 配對法。

回覆：CDF 配對法之詳細說明以添加於 Part Ｂ的第四部分（第 43 頁）。

（3）在計算累積頻率分布時，加入在不同溫度與溼度區間下的總資料筆數。

回覆：表 4 即為在不同溫度與溼度區間下可用來執行 CDF 配對法的資料筆數（第 41 頁）。

（4）比較 NCAR ASPEN 與 CWB 現行作業上使用之 QC 程序。

回覆：NCAR ASPEN QC 程序位於 Part A 的第三部分（第 7 頁～第 8 頁），而目前中央氣象局作業上的 QC 程序詳列於 Part A 的第四部份（第 9 頁）中。

（5）比較不同種類探空儀的特性。

回覆：於實驗開始前，計畫辦公室曾於板橋進行為期 2 天的 intercomparison 比對實驗，Graw、Vaisala RS-92 與 Meisei 一起升空，所以我們可以清楚的看到三種不同探空儀的特性，圖 17 即為其中兩顆探空的不同參數的垂直剖面圖（第 50 頁～第 51 頁）。

4.期末主要執行成果如 Part B（第 33 頁～第 47 頁）所示。

Part A

期中報告

探空資料庫概述與品質控管（QC）程序

前言：

期中報告前的工作主要是針對 SoWMEX 實驗期間（2008 年 5, 6 月）所收集到的探空資料進行資料品質的分析，並起著手準備探空資料的校正工作。

一、資料庫綜述：

SoWMEX 實驗期間（2008 年 5, 6 月）的加強探空網是由 13 個地面探空站以及在洋面上進行 15 次飛行任務的投落送所組成（圖 1），主要的觀測發生在 5/15~6/26 間。表 1 總結了各個測站的位置以及其他相關資訊。這些探空站皆為高時間解析度（0.5-10s）的探空資料，分為六種不同格式，這些不同格式的原始資料會先轉換成一種共用的格式—NCAR ASPEN D-glass，這些 D-glass 檔經過 ASPEN 軟體對資料進行 QC 後會輸出成 EOL 格式的檔案， EOL 格式將於第二節中介紹。

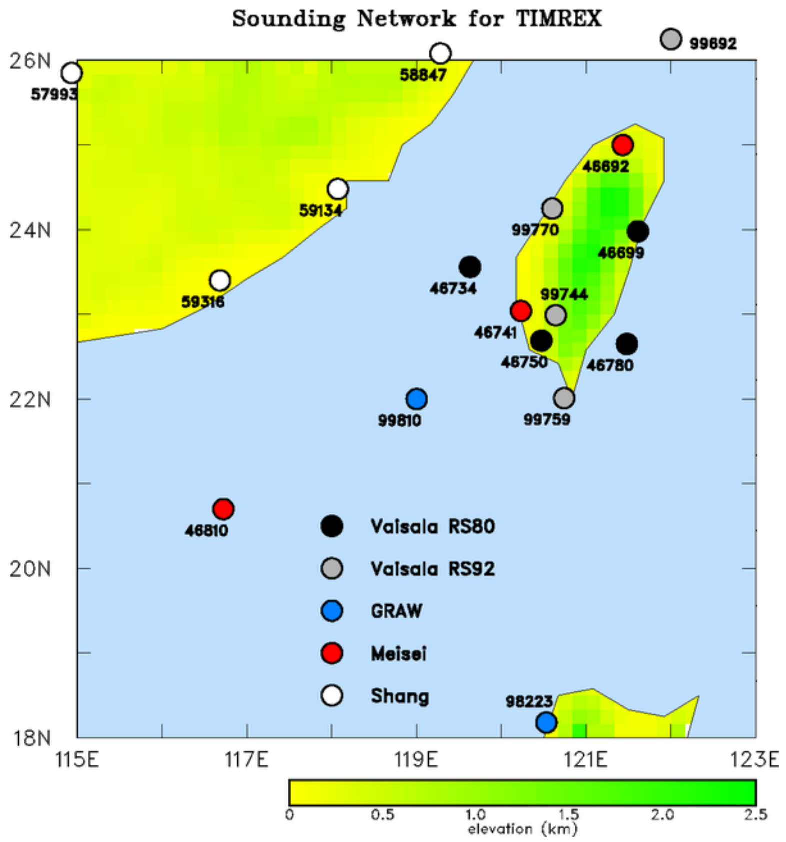

圖 1 SoWMEX 實驗期間之探空網，圓圈內填色則代表不同的探空儀系統，此外，中國的探空站不包含在 SoWMEX 的加強探空網中。

表 1 SoWMEX/TiMREX 實驗期間各探空站之相關資訊。*代表研究船在名義上的位置。MS80 表示 Meisei RS80 系統，VS 為 Vaisala 系統；風場的測量則是自動追蹤無線電經緯儀(Automatic Tracking Radiotheodolite，ATR)或全球定位系統(Global Positioning System，GPS)。

測站站碼	測站名稱	系統類型	緯度	經度	高度 (m)	解析度 (s)	探空筆數	日期
46692	Banchiao	MS 80-ATR	25.00	121.43	11	5	184	5/16-6/25
46699	Hualien	VS 80-ATR	23.98	121.61	19	2	185	5/15-6/25
46734	Makung	VS 80-ATR	23.56	119.63	34	2	232	5/15-6/26
46741	Tainan	MS 80-ATR	23.04	120.23	8	5	76	5/27-6/06
“	“	VS 92-GPS	23.04	120.24	15	1	53	6/12-6/23
46750	Pingdong	VS 80-ATR	22.69	120.47	27	2	248	5/15-6/26
“	“	VS 92-ATR	“	“	“	“	18	6/3-610
46780	Lu-Tao	VS 80-ATR	22.65	121.48	252	2	201	5/16-6/21
“	“	VS 92-GPS	“	“	“	“	18	6/22-6/26
46810	Dongsha Is.	MS 80-ATR	20.70	116.72	4	5	156	5/07-6/25
“	“	VS-92-ATR	“	“	“	2	1	6/10
98223	Laoag, Phil.	Graw-GPS	18.18	120.53	5	10	67	5/15-6/30
99692	N. Ship	VS 92-GPS	26.3*	122.0*	6	2	46	5/30-6/10
99744	Liou-Guei	VS 92-GPS	22.99	120.64	266	1	218	5/14-6/26
99759	Henchun	VS 92-GPS	22.01	120.74	24	1	140	5/14-6/26
99770	Taichung	VS 92-GPS	24.25	120.60	202	2	163	5/15-6/17
99810	SW Ship	Graw-GPS	22.0*	119.0*	3	1	134	5/14-6/21
	dropsondes	Vaisala-GPS				0.5	190	5/02-6/25
total							2330	

二、資料格式說明：

所有 D-glass 檔案格式的探空資料經過 ASPEN QC 後將會被輸出成 UCAR/JOSS (University Corporation for Atmospheric Research/Joint Office for Science Support) EOL (Earth Observing Lab) 格式，這些檔案的命名規則為 "D yyyymmddhh_stnid.QC.eol"，D 代表此檔案為 D-glass 轉換而來，年、月、日分別以 yyyy、mm、dd 表示，hh 為世界標準時，(UTC)，stnid 是測站站碼(如表 1 所示)，eol 則代表檔案格式類型。EOL 格式為 ASCII 格式的一種，包含檔頭以及 17 欄高解析度的探空資料。前 14 行為檔頭，包含資料類型、計畫名稱、探空站位置、氣球釋放時間和其他詳細的資訊。第 5 行表示釋放地點，其格式為：經度 (deg min)、經度 (dec. deg)、緯度 (deg min)、緯度 (dec. deg)、高度 (meters)。以 dec min 表示經度的格式為：ddd mm.mm'W，ddd

為度、mm.mm 為分、W 和 E 代表西經及東經。緯度和經度有相同的格式，除了 S 和 N 表示南、北緯。8~10 行包含機載資料、輔助資訊和注釋；第 12 行為參數名稱、第 13 行為單位、第 14 行用虛線來表示檔頭的結束。檔頭後即為詳細的探空資料，17 個欄位所代表的參數場如下表所示：

Field No.	Parameter	Units	Measured/Calculated
1	Time	Seconds	-------------
2	UTC Hour	Hours	-------------
3	UTC Minute	Minutes	-------------
4	UTC Second	Seconds	-------------
5	Pressure	Millibars	Measured
6	Dry-bulb Temp	Degrees C	Measured
7	Dewpoint Temp	Degrees C	Calculated
8	Relative Humidity	Percent	Measured
9	U Wind Component	Meters/Second	Calculated
10	V Wind Component	Meters/Second	Calculated
11	Wind Speed	Meters/Second	Measured
12	Wind Direction	Degrees	Measured
13	Ascension Rate	Meters/Second	Calculated
14	Geopotential Altitude	Meters	Calculated
15	Longitude	Degrees	Measured
16	Latitude	Degrees	Measured
17	GPS Altitude	Meters	Measured

這邊要注意的是 upsondes 沒有 GPS 高度，所以此欄位設定為-999。

三、UCAR/JOSS 品質控管程序 (Quality Control Processing)：

此資料庫經過一自動化的 QC 程序，要注意的是熱力場(溫度與露點)與風場將分開進行，此程序主要包含兩種內部一致性的檢驗：對所有參數進行概括性檢驗(gross limit check)和對溫度、氣壓和上升速度進行垂直遞減率檢驗。更進一步地 QC 程序資訊能在 Loehrer et al. (1996)和 Loehrer et al. (1998)的文章中找到。

1. Gross Limit Checks：

此檢驗將會把每一筆標註為 Bad 的探空資料設成遺失值，檢驗標準如下表所示，P 為氣壓、T 為溫度、RH 為相對溼度、U 是東西風分量、V 是南北風分量，B 代表 Bad、Q 代表 Questionable。

Parameter	Parameters(s) Gross Limit Check	Flag Flagged	Applied
Pressure	< 0 mb or > 1050 mb	P	B
Altitude	< 0 m or > 40000 m	P, T, RH	Q
Temperature	< -90C or > 45C	T	Q
Dew Point	< -99.9C or > 33C > Temperature	RH T,RH	Q Q
Relative Humidity	< 0% or > 100%	RH	B
Wind Speed	< 0 m/s or > 100 m/s > 150 m/s	U,V U,V	Q B
U Wind Component	< 0 m/s or > 100 m/s > 150 m/s	U U	Q B
V Wind Component	< 0 m/s or > 100 m/s > 150 m/s	V V	Q B
Wind Direction	< 0 deg or > 360 deg	U,V	B
Ascent Rate	< -10 m/s or > 10 m/s	P,T,RH	Q

2. 垂直一致性檢驗（Vertical Consistency Checks）：

此檢驗從最低層開始，並且比較鄰近的資料點 (但是當氣壓小於 100mb 時，則使用 30 秒的平均值)，在檢查時必需要確保資料數值的增加或減少合乎預期，否則需標註成 -999。

Parameter	Vertical Consistency Check	Parameter(s) Flagged	Flag Applied
Time	decreasing/equal	None	None
Altitude	decreasing/equal	P,T,RH	Q
Pressure	increasing/equal > 1 mb/s or < -1 mb/s > 2 mb/s or < -2 mb/s	P,T,RH P,T,RH P,T,RH	Q Q B
Temperature	< -15 C/km < -30 C/km (not applied at p < 250 mb) > 50 C/km (not applied at p < 250 mb) > 100 C/km (not applied at p < 250 mb)	P,T,RH P,T,RH P,T,RH P,T,RH	Q B Q B
Ascent Rate	Change of > 3 m/s or < -3 m/s Change of > 5 m/s or < -5 m/s	P P	Q B

四、CWB 現行作業上的 QC 程序：

CWB 的 QC 程序由氣象局資訊中心張庭槐先生提供，主要可分為兩類，：

（一）解碼檢驗條件：檢定方法的各個項目：

(1) 尾差參數的計算和標準化：

用來計算觀測資料的各項尾差值並加以標準化：包括增量值尾差、垂直統計尾差、靜力平衡尾差、基線尾差、降溫率檢驗、水平統計尾差、尾差值標準化。

(2) 資料型態的設定 (Surface Layer Type)：

利用探空資料高度場與溫度場是否齊全和各標準層間彼此之相對位置，分類出 13 種資料型態。

(3) 資料誤差型態的設定：

探空資料的誤差型態可分成通訊誤差、計算誤差及觀測誤差。針對不同的資料層型態歸納出七種不同的資料誤差型態。

(4) 資料層型態產生誤差型態的判斷：

依據不同資料型態之誤差型態，進行誤差判斷。

(5) 誤差型態之錯誤修正程序

1. 根據不同誤差型態計算其錯誤修正值。
2. 利用各種尾差和這些尾差標準差統計資料做權重平均，可得一最佳修正值。
3. 如果錯誤修正值和最佳修正值十分接近時，則用錯誤修正值做簡單修正，簡單修正的方法為利用正負號交換、更改一個數字、兩個數字調換或是上述方法的組合。
4. 若錯誤修正值和最佳修正值差距很大時，則用此最佳修正值做簡單修正。
5. 檢驗是否所有的尾差值都變小，若尾差值沒有變小，則標示此資料是有錯誤的。

（二）模式輸入檢驗條件：

Parameter	Error Value	
Pressure	100 Pa	
Wind Speed	1.1~3.3~2.7 (m/s)	隨高度遞增直到 200 hPa 達最大後就開始遞減
Wind Direction	5°	
Height	7~59.3 (m)	隨高度遞增
Temperature	1℃	
Dew Point	1℃	
Relative Humidity	10%	
模式頂為 30 hPa		
在 WRFVAR 中，O － B > 5 * (Error Value)為主要的 QC 門檻值		
其中，B 為背景值（First Guess），O 為觀測值。		

五、資料檔案詳述以及重要注記：

探空資料的時間解析度為 0.5-10 秒，氣壓、溫度和相對溼度為直接量測量；露點溫度是由相對溼度計算而來；高度則將氣壓、溫度和露點溫度代入靜力方程中得出；上升速度是由連續兩個時間的高度差異來取得；位置／地點則是用水平風與初始釋放位置來計算。由於氣球下方之探空儀呈鐘擺運動，所以原始風場已經使用一濾波器來移除低頻震盪。另外，每個探空第一筆資料的時間為-1.0 秒，表示資料是由獨立的地面氣象站而來，在 QC 程序中，此資料被當成參考值來決定探空儀氣壓、溫度和相對溼度測量的準確度。

六、品質控管與探空品質的初步評估：

圖 2 為探空資料品質控管（QC）流程圖，此品質控管流程主要分成三大部份：

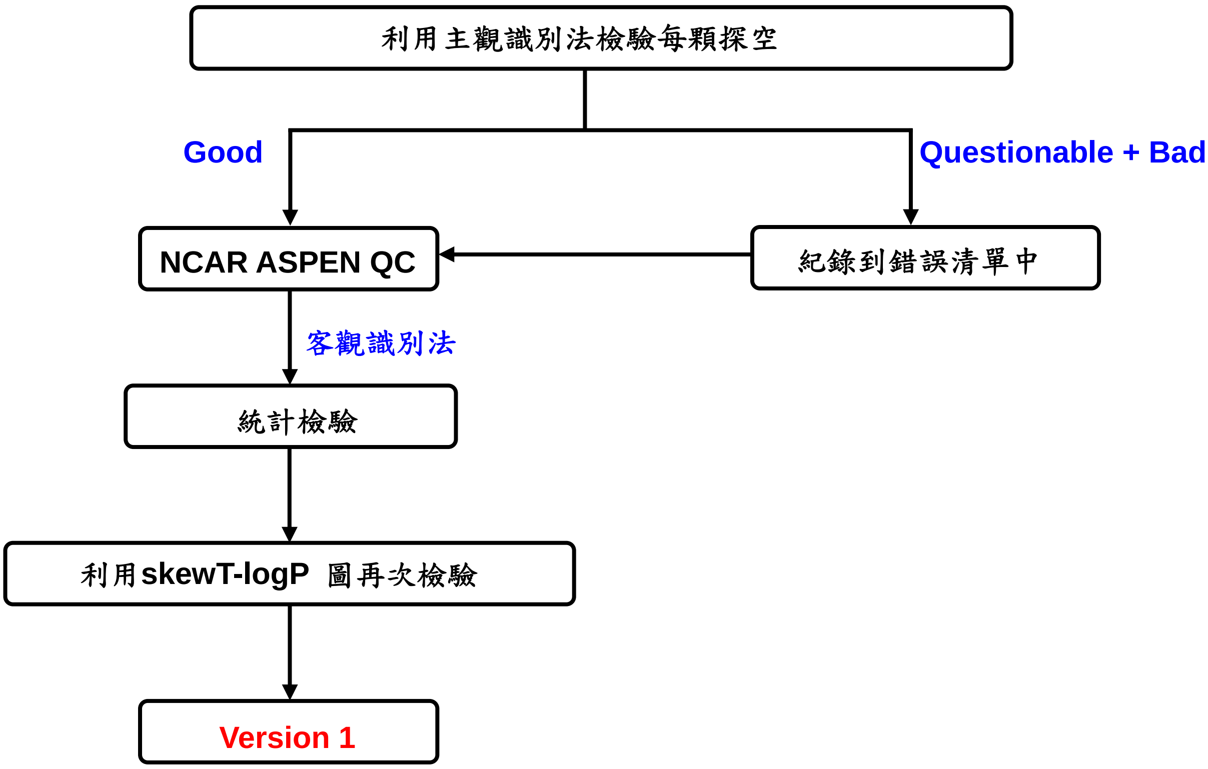

圖 2 探空資料品質控管（QC）流程圖

首先藉由探空直接測量之各變數的垂直剖線圖(variable line plot diagram)來檢視探空資料的品質（圖 3），對所有的探空資料進行檢驗，在此主要是主觀的由人工檢查資料是否有所缺失、所繪出的垂直剖線曲線是否合理，以及資料曲線變動(fluctuation)是否太大等，藉此來檢查資料的系統性誤差以及個別探空資料的問題，表 2 即為利用主觀識別法所統計出 Questionable 與 Bad 的資料筆數。若該筆探空資料被判斷成有問題，找出並記錄該筆探空之探空儀序號(Serial Numbers)及當時之工作日誌，列表儲存。

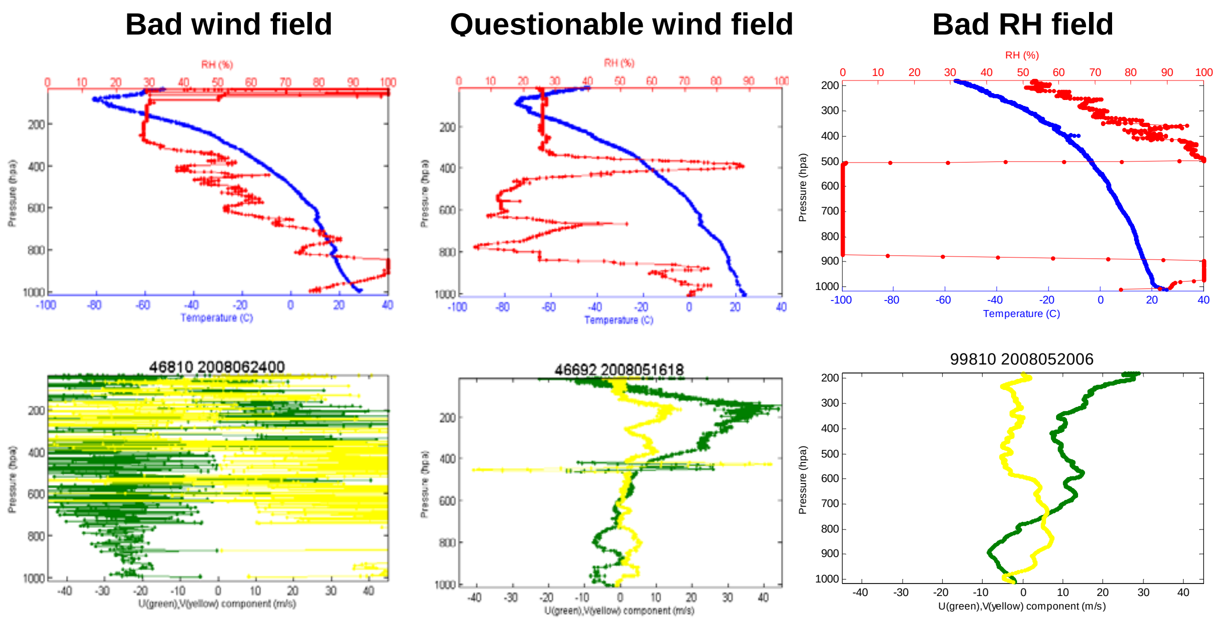

圖 3 利用主觀識別法來檢視探空資料的品質。

表 2 主觀判斷各探空站探空資料有問題之筆數統計。

測站名稱與站碼	系統類型與探空儀型號	探空個數	有問題的探空 (筆 / %)
花蓮 (46699)	Vaisala RS-80	185	16 / 8.7
馬公 (46734)	Vaisala RS-80	232	18 / 7.8
屏東 (46750)	Vaisala RS-80	248	21 / 8.5
綠島 (46780)	Vaisala RS-80	219	21 / 9.6
板橋 (46692)	Meisei	184	9 / 4.9
東沙 (46810)	Meisei	156	56 / 35.9
台南 (46741)	Meisei &Vaisala RS-92	129	9 / 7.0
六龜 (99744)	Vaisala RS-92	218	10 / 4.6
恆春 (99759)	Vaisala RS-92	140	4 / 2.9
台中 (99770)	Vaisala RS-92	163	18 / 11.0
佬沃, 菲律賓 (98223)	Graw	67	2 / 3.0
南船 (99810)	Graw	134	25 / 18.7
北船 (99692)	Vaisala RS-92	46	3 / 6.5
投落送	Vaisala RSS903	190	30 / 6.4

經過此步驟後，我們已經對於探空資料品質有大致上的輪廓，而後我們將探空資料利用 NCAR ASPEN 進行品質控管的程序，為了盡可能保留所有探空資訊，不論該筆資料是否被判定為有問題，所有的探空資料都會進到 NCAR ASPEN 做品質控管的動作。原始

D-glass 資料經過 ASPEN (Atmospheric Sounding Processing ENvironment)　QC 後不僅能讓資料更平滑，更能移除可疑的資料點（圖 4）。

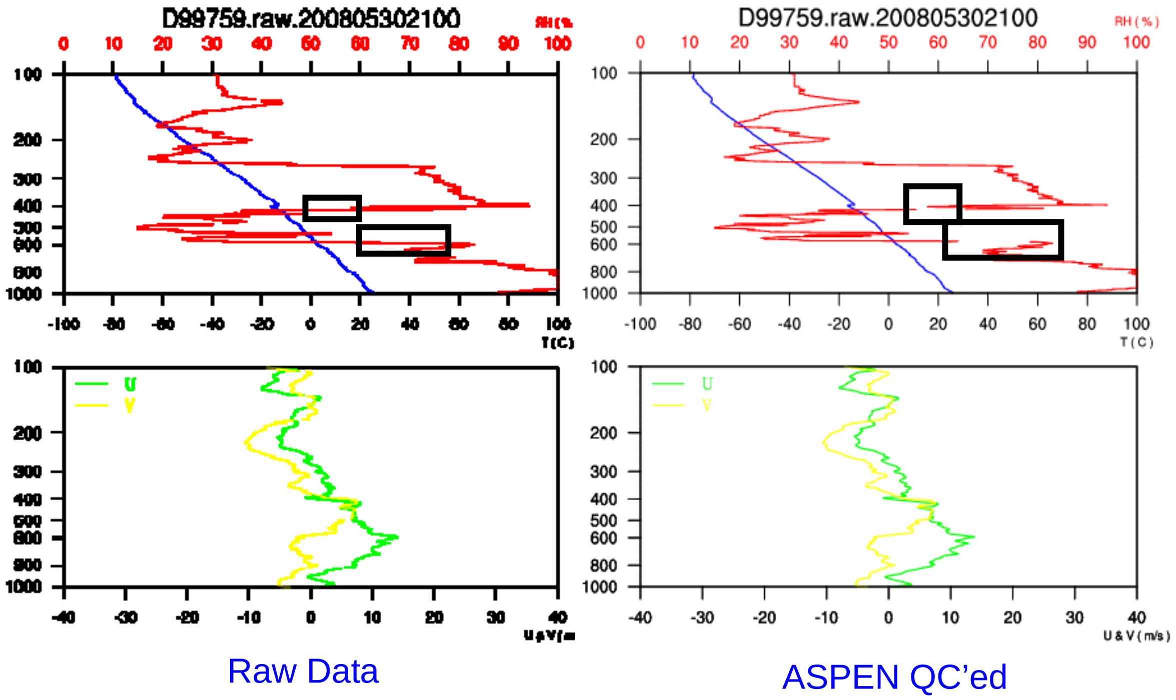

圖 4 NCAR ASPEN 品質控管程序，左圖為探空之原始資料，右圖為經過 ASPEN 品質控管後，已濾除可疑的資料點（黑色方框）。

接著，我們將利用客觀統計的方法來評估資料的品質，先將資料內差至 5-hPa，再計算每一層、不同參數的時間平均，然後將實際觀測值與此平均值相比，若是介於 3-6 個標準差歸類成 Q，大於 6 個標準差則為 B，表 3 即為經過客觀統計法對探空資料做品質評估得到的結果。

表 3　客觀統計法之探空資料品質評估。

Site ID	System type	Sondes (#)	Quality T Q, B (%)	Quality T_d Q, B (%)	Quality Winds Q, B (%)
花蓮 (46699)	Vaisala RS-80	185	11.4, 0	24.3, 1.1	13.5, 2.2
馬公 (46734)	Vaisala RS-80	232	11.6, 0	27.6, 0.9	9.5, 3.0
屏東 (46750)	Vaisala RS-80	248	13.7, 0	21.4, 1.2	12.5, 1.6
綠島 (46780)	Vaisala RS-80	219	15.5, 0	24.2, 1.4	12.8, 2.3
板橋 (46692)	Meisei	184	14.7, 1.6	22.8, 2.7	36.4, 4.9
東沙 (46810)	Meisei	156	9.6, 1.3	15.4, 2.6	22.4, 10.3
台南 (46741)	Meisei &Vaisala RS-92	129	5.4, 1.6	15.5, 2.3	16.3, 2.3

北船 (99692)	Vaisala RS-92	46	13.0, 0	26.1, 0	2.2, 0
六龜 (99744)	Vaisala RS-92	218	17.9, 0	19.7, 3.2	11.5, 0
恆春 (99759)	Vaisala RS-92	140	20.7, 0	15.7, 2.1	10.0, 0
台中 (99770)	Vaisala RS-92	163	11.0, 0.6	25.6, 4.3	17.7, 1.2
南船 (99810)	Graw	134	17.2, 0.7	12.7, 3.7	6.7, 0
佬沃，菲律賓 (98223)	Graw	67	6.0, 1.5	16.4, 1.5	13.4, 1.5
Total		2121	13.4, 0.5	21.1, 2.1	14.9, 2.4

最後，根據斜溫圖進一步檢視每一筆探空資料的狀況，斜溫圖可以協助我們找出受到其他污染的探空資料，如圖 5 所示，在 500~600 hPa 處受到對流污染，使得溫度與露點溫度同時不正常下降與上升。所有的 V1 品質控管過程到此就告一段落，圖 6 為 V1 最後的初步評估結果，VS92 的在熱力及動力場的表現皆相當不錯，除了台中站有較雜亂的風場分布，這需更多的分析資料來分析。

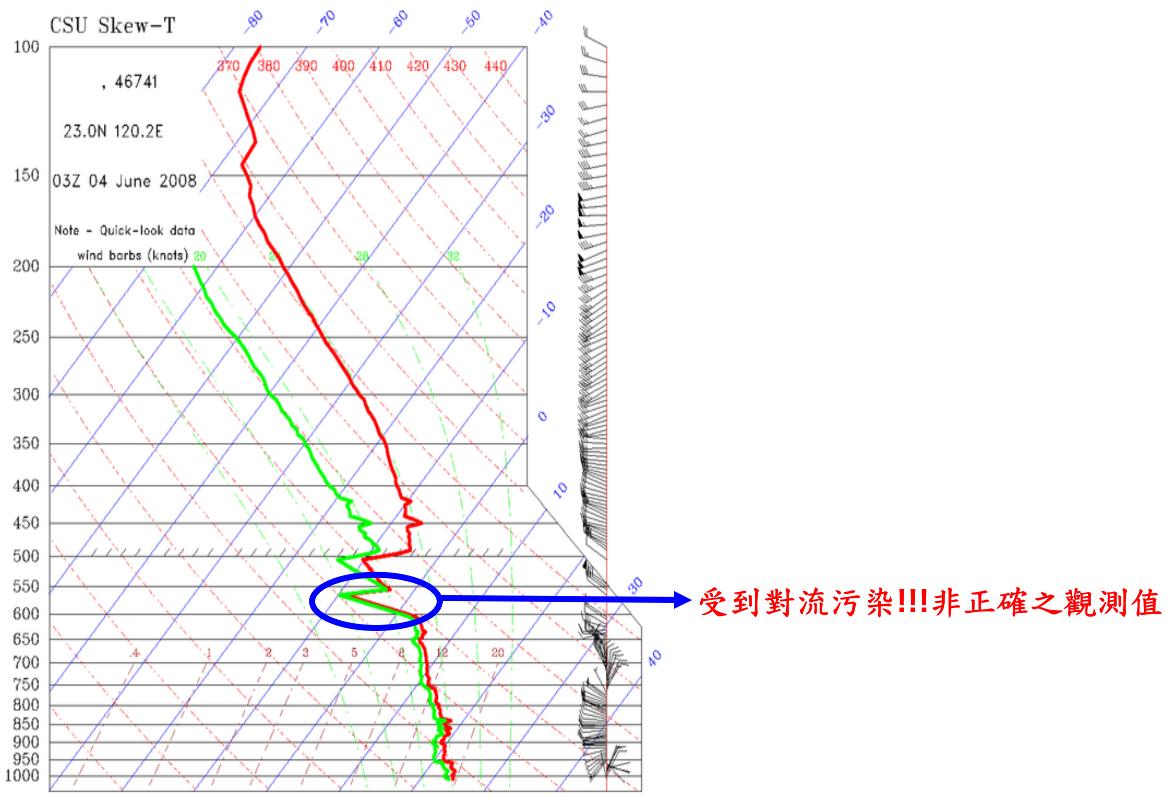

圖 5 台南站 2008 年 6 月 4 日 0300UTC 之斜溫圖，為 Meisei 探空儀。

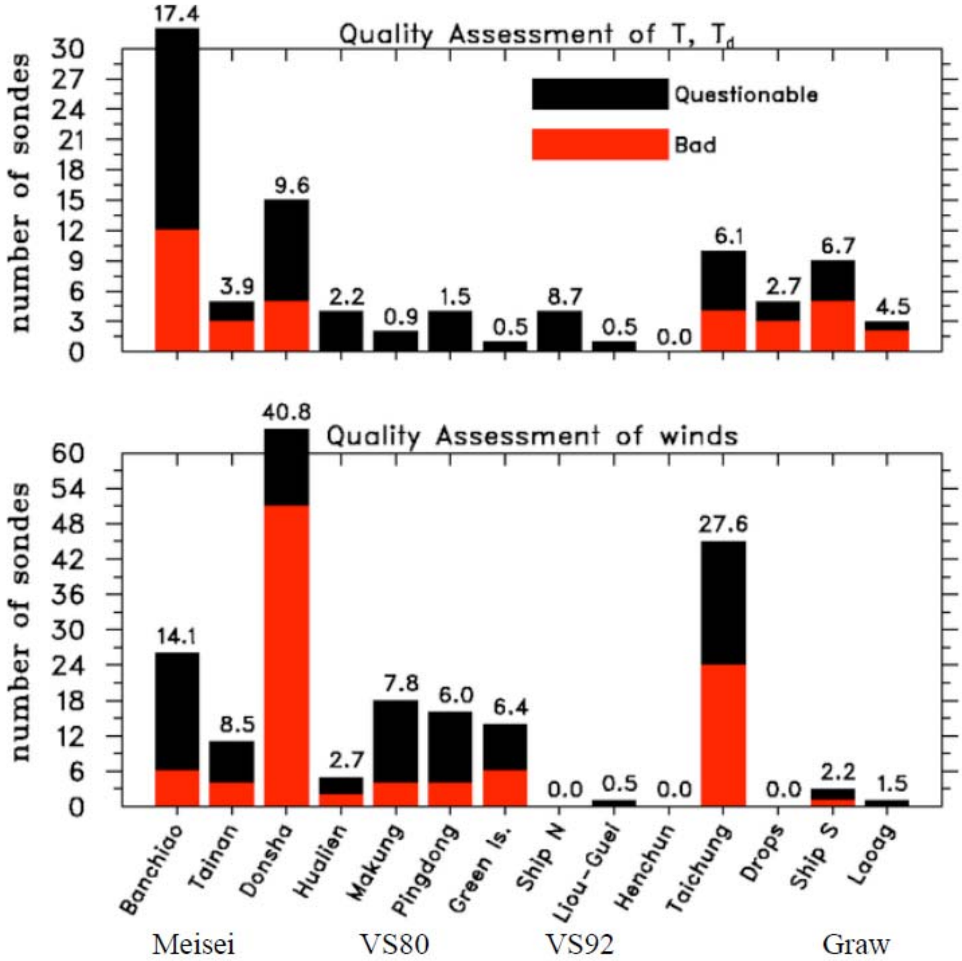

圖 6 V1 探空資料的初步評估。長條狀上方的數字代表有問題與錯誤資料所佔的百分比。

Version 1 探空資料的初步評估總結於下表，此表僅代表資料可能有問題(questionable)或是錯誤的 (bad)，我們無法保證這個清單已經很完美了，但是，較嚴重的問題也幾乎都已經確定，每個使用者可自行決定要如何看待這些可能有問題的數據。表中，若是該筆探空資料在任何層有出現 Questionable (那也就是說資料看起來是可疑地)，那麼 Q 將計數乙次；若是出現 Bad (也就是稍微懷疑資料是錯誤地)，將計為 B 而不是 Q；q dif 表示地面的比溼減去探空第一筆量測到的比溼之平均差異。

測站站碼	測站名稱	系統類型	資料品質 T,T_d *Q, B*	資料品質 Winds *Q, B*	*q*_dif	探空數目
46692	Banchiao	MS 80-ATR	20, 12	20, 6	0.23	184
46699	Hualien	VS 80-ATR	4, 0	3, 2	2.58	185
46734	Makung	VS 80-ATR	2, 0	14, 4	3.08	232
46741	Tainan	MS 80-ATR	2, 3	7, 4	0.54	76
“	“	VS 92-GPS	0, 0	0, 0	0.54	53

46750	Pingdong	VS 80-ATR	4, 0	12, 4	2.51	248
“	“	VS92-GPS	0,0	0,0	1.53	18
46780	Lu-Tao	VS 80-ATR	1, 0	8, 6	2.57	201
“	“	VS92-GPS	0,0	0,0	-0.09	18
46810	Dongsha Is.	MS 80-ATR	10, 5	13, 51	0.82	156
“	“	VS92	0,0	0,0	2.31	1
98223	Laoag, Phil.	Graw-GPS	1, 2	1, 0	1.47	67
99692	N. Ship	VS 92-GPS	4, 0	0, 0	0.50	46
99744	Liou-Guei	VS 92-GPS	1, 0	1, 0	-0.45	218
99759	Henchun	VS 92-GPS	0, 0	0, 0	0.51	140
99770	Taichung	VS 92-GPS	6,4	21, 24	0.10	163
99810	SW Ship	Graw-GPS	2, 3	0, 0	0.51	134
	dropsondes	Vaisala-GPS	4,6	2, 1	-0.02	190
total			59, 35	103, 102		2330

Version 1 的初步結論如下：

(1) 首先，品質評估是利用目視法檢查斜溫圖、時間序列及散佈圖來主觀決定。有問題或錯誤的測定建議有一個確定性的判斷，一般來說，從時間平均來看，介於 3-6 個標準差歸類成 Q，大於 6 個標準差則為 B。

(2) 在大多數個案中，錯誤或有問題的資料通常發生在有限的垂直層，其餘的探空資料仍然是有用的。

(3) 板橋及東沙為 Meisei 系統，結果顯示有較差的成績，特別是在 300 hPa 以上，RH 隨高度時常為接近一常數，因此，需小心使用。

(4) Vaisala RS80（VS80）系統存在較大的 q_dif，這表示 dry bias 存在且需要更進一步進行溼度校正，此校正將在 version 2 中完成。

(5) 當溫度資料在某些層為錯誤或有問題時，在一定程度上也會影響到重力位高度。

(6) 許多有問題或是錯誤的探空可能是因為強對流在探空儀附近，這將使環境有較大的擾動存在，在這種情況下，探空並無法代表中尺度或大尺度環境場，應謹慎小心使用。

更詳細的分析則紀錄於下。

46692（板橋）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面，SA 表示超絕熱層。

Wind QC (46692)

Date	Time GMT	Level (hPa)
05/19	06	200-300
05/19	18	< 250
05/24	06	~900
05/29	12	~950
05/30	03	~950
05/29	09	~900
06/01	15	150-200
06/01	21	250-275
06/03	06	100-150
06/03	12	~150
06/03	18	125-200
06/04	09	~150
06/04	12	~150
06/05	15	~100
06/05	18	~250
06/11	**00**	**200-950**
06/11	**06**	**200-900**
06/11	12	TO
06/12	**00**	**TO**
06/12	12	~150
06/13	18	~550
06/14	**00**	**150-600**
06/14	06	150-350
06/14	**12**	**< 600**
06/17	06	~250
06/22	**00**	**750-850**

T,Td QC (46692)

Date Time Level

	GMT	(hPa)
05/18	00	~990 SA
05/21	06	~525 SA
05/23	06	500-600 SA
05/23	12	~725 SA
05/26	**06**	**near sfc SA**
05/26	**18**	**~950 SA**
05/27	**00**	**~950 SA**
05/29	12	~940 SA
05/30	00	~990 SA
05/30	**12**	**450-600**
06/02	03	~950 SA
06/02	09	~400 SA
06/02	18	~460
06/02	**21**	**> 500**
06/04	06	~1000 SA
06/06	**00**	**~530 SA**
06/10	**06**	**~670 SA**
06/11	00	~900
06/12	**00**	**~1000, too cold TO**
06/12	12	~400
06/13	**00**	**>950**
06/14	**00**	**>950**
06/14	18	~975
06/15	**12**	**~850 SA**
06/17	06	> 950
06/18	00	~975
06/19	03	near sfc SA
06/19	12	~925 SA
06/20	00	> 950
06/20	03	850-sfc SA
06/21	12	near sfc SA
06/25	06	near sfc, **850 SA**, < 150 too warm

Notes：此探空系統易於發生超絕熱（Super Adiabatic，SA）層（也就是遞減率>乾絕熱）。而超絕熱層常發生在日間之陸地上近地面處，這邊提到的超絕熱稍高於地面或在雲層上方。當探空儀位於雲內，附著在溫度感應器上的水蒸發造成感應器過度冷卻（6/10 06Z 為一個相當好的例子）。

46699（花蓮）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面。

Wind QC (46699)

Date	Time GMT	Level (hPa)
05/17	18	<220
06/03	15	<440
06/06	15	600-800
06/15	**12**	**~850, ~250**
06/17	**12**	**~500**

T,Td QC (46699)

Date	Time GMT	Level (hPa)
05/21	18	near sfc
05/22	06	sfc
05/31	00	> 750
06/01	00	sfc T, heights too low

Notes：本站使用 VS80 探空儀，Version 1 的資料有顯著的 dry bias，此 bias 將在 Version 2 中被校正。

46734（馬公）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面。

Wind QC (46734)

Date	Time GMT	Level (hPa)
05/16	00	< 250
05/19	09	< 250
05/19	12	> 850
05/30	21	TO
05/31	18	< 250
06/01	15	< 900
06/01	**18**	**< 350**
06/03	**12**	**TO**
06/03	15	< 450
06/05	**09**	**< 400**
06/06	09	500-900
06/06	18	750-950
06/14	15	~950
06/15	06	~950
06/16	12	< 150
06/17	09	150-250
06/18	18	< 200
06/23	**06**	**TO**

T,Td QC (46734)

Date	Time GMT	Level (hPa)
05/19	00	too cool at low levels
06/17	03	~600

Notes：本站使用 VS80 探空儀，Version 1 的資料有顯著的 dry bias，此 bias 將在 Version 2 中被校正。

46741（台南）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面。

Wind QC (46741)

Date	Time GMT	Level (hPa)
05/27	06	~950
05/30	06	~780
05/30	21	900-1000
06/02	**00**	**< 400**
06/03	00	~550
06/03	03	> 900
06/04	03	~550
06/04	**06**	**>800**
06/05	**03**	**~300**
06/05	**06**	**~250**
06/06	12	>900

T,Td QC (46741)

Date	Time GMT	Level (hPa)
06/02	00	500-600
06/02	03	400-750
06/03	**00**	**400-600**
06/04	**03**	**500-600**
06/06	**00**	**TO**

Notes：5/27-6/6 使用 Meisei 系統，6/12-6/23 則使用 Vaisala RS92，RS92 的探空將可能需要需要日間 dry bias 的校正。多數有問題和錯誤的資料可能是由於在對流附近施放。

46750（屏東）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面，SA 表示超絕熱層。

Wind QC (46750)

Date	Time GMT	Level (hPa)
05/16	**18**	**200-800**
05/18	**18**	**125-700**
05/31	18	800-1000
06/02	00	~ 800
06/02	09	800-1000
06/03	21	800-900
06/04	00	800-900
06/04	18	~350, < 200
06/05	12	< 650
06/05	**15**	**< 500**
06/07	06	< 500
06/08	**00**	**< 700**
06/13	18	< 200
06/14	03	> 900
06/14	09	~ 400
06/16	09	~ 500

T,Td QC (46750)

Date	Time GMT	Level (hPa)
05/29	00	~ 550
05/30	21	450-500 SA
06/05	00	sfc － 980
06/14	18	550-850

Notes：本站使用 VS80 探空儀，Version 1 的資料有顯著的 dry bias，此 bias 將在 Version 2 中被校正。

46780（綠島）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面。

Wind QC (46780)

Date	Time GMT	Level (hPa)
05/17	**06**	**200-600**
05/18	**06**	**< 650**
05/20	**12**	**200-750**
05/23	12	~ 450
05/25	00	550-850
05/28	18	550-1000
05/28	18	~ 1000
05/30	21	TO
06/01	03	~ 800
06/04	**00**	**300-1000**
06/10	**18**	**TO**
06/11	00	~ 1000
06/15	03	TO
06/19	**00**	**TO**

T,Td QC (46780)

Date	Time GMT	Level (hPa)
06/23	12	sfc Td too low

Notes：5/16-6/21 使用 Meisei 系統，6/22-6/26 則使用 Vaisala RS92，RS92 的探空將可能需要需要日間 dry bias 的校正。多數有問題和錯誤的資料可能是由於在對流附近施放。

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46810（東沙）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面。

Wind QC (46810)

Date	Time GMT	Level (hPa)
05/14	12	750-sfc
05/15	**06**	**880-1000**
05/16	**06**	**~950**
05/16	12	100-125
05/17	**18**	**~900**
05/18	**12**	**TO**
05/19	**00**	**830-950**
05/19	**06**	**~850**
05/19	**12**	**< 650**
05/19	**18**	**TO**
05/20	**06**	**< 200**
05/20	**12**	**TO**
05/20	**18**	**< 160**
05/21	**06**	**> 800, < 250**
05/21	**18**	**< 650**
05/22	**00**	**200-500**
05/22	**06**	**TO**
05/22	12	TO
05/22	**18**	**> 750, < 130**
05/23	**12**	**300-850**
05/23	**18**	**300-650**
05/24	**18**	**TO**
05/25	06	> 950

Wind QC (46810) continued

Date	Time GMT	Level (hPa)
06/04	06	> 700
06/04	18	TO
06/05	**12**	**> 300**
06/06	**06**	**TO**
06/06	**18**	**250-550**
06/07	00	> 850, < 150
06/07	18	> 500
06/11	**06**	**> 900**
06/11	**12**	**< 150**
06/13	**06**	**300-700**
06/13	**12**	**> 400**
06/13	**18**	**TO**
06/14	**00**	**> 170**
06/14	**06**	**TO**
06/14	**12**	**200-800**
06/15	**00**	**TO**
06/15	06	~1000
06/15	**12**	**~1000**
06/16	00	700-900
06/16	**06**	**> 500**
06/16	**12**	**> 700**
06/17	**00**	**> 500**
06/17	**12**	**180-700**

05/25	**12**	**200-650**
05/26	18	TO
05/27	**18**	**150-500**
05/28	00	> 700
05/30	**00**	**300-400**
05/31	00	~950
05/31	**06**	**> 700**
05/31	**12**	**> 700**
05/31	**18**	**> 700, 150**
06/02	**12**	**> 700**
06/03	**12**	**250-600**
06/18	**00**	**300-900**
06/20	**00**	**> 900**
06/23	**00**	**< 400**
06/24	**00**	**TO**
06/24	**12**	**TO**
06/25	**00**	**TO**
06/25	**12**	**TO**

T, Td QC (46810)

Date	Time GMT	Level (hPa)
05/16	18	~800 SA
05/17	**18**	**400-800 Td**
05/24	06	sfc, SA
05/24	**12**	**< 350**
05/26	06	sfc, SA
05/28	**18**	**TO, Td**
05/30	18	260-280
06/02	00	~500
06/02	**12**	**< 850, Td**
06/03	06	< 450, too warm
06/03	**12**	**550-650**
06/04	18	< 600, Td
06/05	12	~900 SA
06/21	00	~930 SA
06/23	00	~780 SA

Notes：超絕熱層普遍存在於 06Z 的近地面層，這些超絕熱層在某些個案（5/24 與 5/26）中被標記成有問題的資料，這是因為有較大的強度。

98223（佬沃，菲律賓）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面。

Wind QC (98223)

Date	Time GMT	Level (hPa)
05/15	00	sfc

T, Td QC (98223)

Date	Time GMT	Level (hPa)
05/17	**00**	**TO**
06/21	**00**	**< 250**
06/27	12	500-700, Td too dry

Notes：本站使用 GRAW 系統。當新探空儀送達此站時，工作人員才發現不能相容於地面站的接收軟體，所以，此軟體於 2008 年 5 月底更新，6/1 開始使用。原始資料中釋放高度為 0m，經過與佬沃探空站的工作人員討論後，真實的高度應為 5m，所以將每一層的高度加上 5m。

99692（北船）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面。

Wind QC (99692) : 沒發現問題。

T, Td QC (99692)

Date	Time GMT	Level (hPa)
05/30	00	Td sfc
05/31	06	T, Td, sfc
06/01	00	Td sfc
06/01	06	Td sfc

Notes：處理此站時是將作業人員額外紀錄之獨立的地面觀測值當成探空的第一筆，但不幸地，在 6/2 之前並沒有紀錄地面觀測值。另外，此站使用的 Vaisala RS92 探空儀可能需要日間 dry bias 的校正。

99744（六龜）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面。

Wind QC：

Date	Time GMT	Level (hPa)
06/26	06	~500

T, Td QC：

Date	Time GMT	Level (hPa)
06/20	03	Td near surface

Notes: 此站使用的 Vaisala RS92 探空儀可能需要日間 dry bias 的校正。

99759（恆春）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料。

Wind QC：沒發現問題。

T, Td QC：沒發現問題。

Notes：此站使用的 Vaisala RS92 探空儀可能需要日間 dry bias 的校正。

99770（台中）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料，TO 表示該筆探空的錯誤或有問題資料存在於整個探空剖面。

Wind QC

Date	Time GMT	Level (hPa)
05/15	**06**	**near sfc**
05/16	00	~220
05/19	06	~160
05/19	**18**	**~625**
05/20	06	~550
05/21	06	~390
05/21	12	~750
05/23	12	~975
05/26	00	~650
05/26	**18**	**~600**
05/28	06	850-950
05/29	**06**	**600-900**
05/30	03	~750
05/30	**15**	**350-500**
05/31	**03**	**~850**
05/31	06	> 850
05/31	**09**	**550-650**
05/31	**12**	**> 900**
06/02	18	~ 650
06/03	**00**	**350-sfc**
06/03	**12**	**~440**
06/03	**18**	**~ 430**
06/05	09	120-250
06/05	**15**	**> 500**
06/05	21	~975
06/06	09	~950

Wind QC (continued)

Date	Time GMT	Level (hPa)
06/13	18	~600
06/14	**03**	**~800**
06/14	12	~650
06/14	**15**	**> 700**
06/15	**00**	**~925**
06/15	**03**	**~900**
06/15	**06**	**~975**
06/15	09	~975
06/16	**03**	**> 550**
06/16	**06**	**~700**
06/16	**09**	**sfc-750**
06/17	**03**	**~650**

06/06	15	~700
06/07	00	~950
06/08	**00**	**~700**
06/08	12	~200
06/11	06	850-900
06/12	**00**	**> 550**
06/12	**06**	**> 450**

T, Td QC：

Date	Time GMT	Level (hPa)
06/01	**03**	**sfc Td too low**
06/01	09	~960 Td
06/05	00	~960 Td
06/05	06	~960 Td
06/05	15	~950 SA
06/06	**03**	**sfc Td too low**
06/06	06	~960 Td
06/08	12	~960 Td
06/13	**00**	**sfc Td too low**
06/17	**03**	**TO, T too warm**

Notes：此站使用的 Vaisala RS92 探空儀可能需要日間 dry bias 的校正。有許多筆雜亂的風場剖面是因為探空在對流附近施放所導致。

99810（南船）之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料。

Wind QC：沒發現問題。

T, Td QC：

Date	Time GMT	Level (hPa)
05/15	**06**	**sfc**
05/19	**12**	**500-600 Td**
05/20	**06**	**500-850 Td**
06/04	18	~800 Td
06/13	06	sfc

Notes：許多 06 和 12Z 施放的探空在近地面有較大的超絕熱溫度遞減率，這可能是由於船體結構的加熱。原始資料中顯示探空釋放高度為 0m，經過進一步的討論後，甲板的高度應為 3m，因此每層的高度皆直接加上 3m。

Dropsondes 之初步品質控管評估

當使用下列時間的資料時須特別小心，氣壓層標是有問題資料大約出現的位置。**粗體字表示為錯誤的資料**，其他則代表有問題的資料。

Wind QC：

Date	Time GMT	Level (hPa)
06/05	0607	< 300
06/17	0455	~580
06/17	**0529**	**~400, ~200**

T, Td QC：

Date	Time GMT	Level (hPa)
05/02	**0304**	**~625, ~925**
05/02	0337	600-650
05/20	**2251**	**~775**
06/03	**2330**	**550-750**
06/04	**0528**	**~650**
06/04	0611	~625, SA
06/04	2328	~750
06/04	**2332**	**450-650**
06/04	**2347**	**750-950**
06/25	1043	~450

Note：05/20 2327Z、05/29 2159Z 及 2211Z、06/04 0603Z 沒有經緯度資訊。在第四次任務（5/30）之前有明顯的資料遺失問題，在這之後，較新的探空儀大大地改進資料遺失問題。

七、尚在進行之工作：

q_dif 之結果顯示 Vaisala RS80 探空儀會有顯著的 dry bias，而透過比較探空儀與 GPS 的總可降水量(PW)更可幫助我們更進一步估計 dry bias 的大小。如果探空站周圍 25 公里內沒有 GPS 資料，可使用客觀分析法把資料內差到探空站的地點；海島站（東沙、馬公和綠島）沒有 GPS-PW，可利用 AMSR-E 衛星所估計出的 PW，衛星一天通過台灣地區兩次（06 及 18Z），AMSR-E 的資料可到下列網址下載：http://www.remss.com/。

在 SoWMEX 期間，Vaisala RS80 的 dry bias 早就被發現了，因此，計劃辦公室於 2008 年 6 月在屏東站（46750）針對 Vaisala RS80 與 RS92 進行一系列的探空比對試驗計劃（Intercomparison Launches），此資料庫包含 18 個比對探空，而我們可以利用累積分布函數法（Cumulative Distribution Function matching method，CDF method）來校正屏東站 RS80 探空儀的 dry bias (Nuret et al. 2008, Ciesielski et al. 2009)，並且應用到其他 RS80 的站。此外，林博雄教授也請 Vaisala 公司提供新的探空溼度係數來重新處理 RS80 的資料。這兩種方法應該同時進行，才能觀察哪種方式可以提供更接近 GPS-PW 或 AMSRE-PW 值。另外，在屏東站進行的比對也建議 RS80 也有輕微的 temperature bias 需要校正。在 Meisei 和 GRAW 系統上也應該藉由比較 sonde-PW 與 GPS-PW 來觀察 bias 是否存在，我們也曾在板橋針對 Meisei、GRAW 與 RS92 進行 12 次探空比對，不幸地，僅在 4 月(4 次)和 10 月(8 次)執行此任務，而沒有在季風條件下進行，若顯著的 bias 存在於 Meisei 和 GRAW 中，那麼，我們就需要在季風條件下進行額外的比對實驗，以建立一套適合的校正法。

有了比對的資料庫後，CDF 法將可讓品質較差之 Vaisala RS80 達到 RS92 的標準，而 GPS 和衛星之 PW 可用來檢驗此校正法的強弱，如果經過此校正法後仍存在 dry bias，那麼就需要額外的校正法，例如：許多研究皆指出 Vaisala RS92 需要日間太陽輻射的校正（Yoneyama et al., 2008 與 Cady-Pereira et al., 2008）。使用這些校正法後，即可建立一套經過溼度校正後的 Version 2 資料庫。最後，我們計畫建立以 CSU 格式（Colorado State University Format）儲存之 5-hPa 探空資料庫並標上 QC 標籤，這就是 Version 3，此資料庫將更能節省儲存空間且更便於研究用途上的使用。為了建立品質標籤，各種參數將會經過一系列自動化品質控管檢驗（gross limit, vertical consistency 等），最後將會以目視法檢查每 5-hPa 來鑑定任何仍然有問題或是錯誤的資料（可使用 CSU 以 TCL 語法寫成的 xsnd 軟體）。在 Version 3 中，我們並不會更改任何的資料，僅加入品質控管標籤，如此一來，使用者將可輕易自己決定要使用哪些資料。

期中報告預計完成的項目有：

(1)探空資料蒐集與整理

(2)資料格式整合並使用 ASPEN QC

(3)人工檢視及列表

這些工作均已完成。

八、參考文獻：

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Part B

探空資料庫之溼度偏差校正法

前言、

期中報告後的工作主要是將 QC 後的探空資料進行分析，找出各種不同類型探空儀的可能偏差（溼度或溫度），並加以校正，期望得到一組更接近真實大氣環境條件的探空資料庫。

一、探空資料的溼度校正：

圖 7（上）為在 SOP 期間探空儀的地面觀測值（q_s）與其量測到的第一筆資料（q_{s+1}）之平均比溼差異（δq），這邊要注意的是所有探空資料的地面觀測值皆應來自於獨立的測量儀器。Stull (1988)指出在所有天氣條件下，地面層（10-100m AGL）內的 δq 都不應該超過 1 g kg^{-1}，而在西南氣流實驗期間，**Meisei**、Vaisala RS92（**VS92**）跟 **GRAW** 探空儀都能符合此條件，但 Vaisala RS80（**VS80**）的 δq 卻相當大（> 2 g kg^{-1}）。另外，台南站（46741）於實驗期間曾使用 VS92 跟 Meisei 兩種不同的探空儀，結果顯示 VS92 有較小的 δq（0.33 V.S. 0.67），然而，我們分析探空站鄰近的 GPS 站來反演總可降水量（Total Precipitable Water，**TPW**）後發現 Meisei（TPW=58.4 mm）比 VS92（TPW=52.1 mm）來得溼，所以，此結果也表明台南站的 Meisei 探空儀可能存在輕微的 dry bias。圖 7（下）則為在每 5-hPa 下，出現飽和的頻率，結果顯示在 VS92 的探空站，飽和層發生的頻率約為 5-10%，這與北美季風實驗（North American Monsoon Experiment）觀測到的結果相似（Ciesielski et al., 2009），對照之下，VS80 在對流活躍的季風環境中，其飽和層發生頻率卻不到 1%，這也再次證實 VS80 有顯著的 dry bias，此外，Meisei 探空儀之飽和層出現頻率也偏低。在台南站，兩種不同探空儀的表現也大不相同，VS92 的發生頻率是 Meisei 的兩倍，此結果表明 Meisei 仍有輕微的 dry bias。

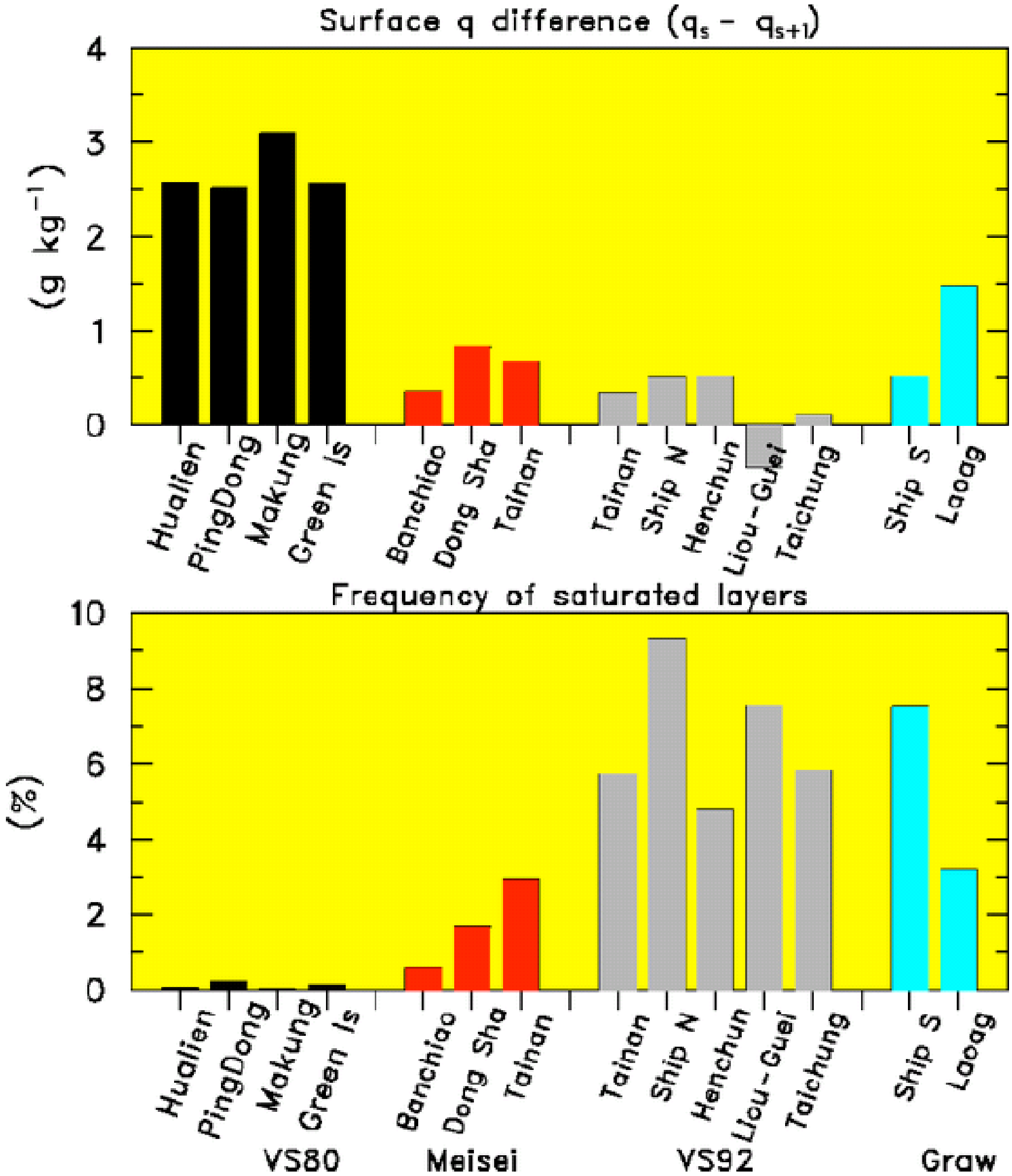

圖 7 地面與探空第一筆量測之平均比溼差異（上圖）以及在每 5-hPa 下，出現飽和的頻率（下圖）。

圖 7 的分析結果指出 VS80 探空儀有非常顯著的 dry bias，為了能確定 dry bias 的範圍及大小，我們先計算每個探空儀的 TPW，再與 GPS 或衛星反演得到的 TPW 做比較。過去研究指出 GPS 與衛星 TPW 反演的準確率為 1-2 mm（Wentz, 1997, Bock et al., 2007），顯示遙測反演出的可降水量資料適合用於評估 dry bias。圖 8 是台灣探空站及 GPS 站的位置，為了降低誤差，我們僅選擇距離探空站 50 公里內的 GPS 站。在缺乏 GPS 站的海島（東沙、馬公及綠島）則使用 AMSR-E 衛星反演之 TPW（資料可由以下網址取得：http://www.remss.com/），AMSR-E 通過台灣附近的時間大約在 06Z 和 18Z，由於微波反演在陸地上會有困難，所以此產品只適用於海洋上。

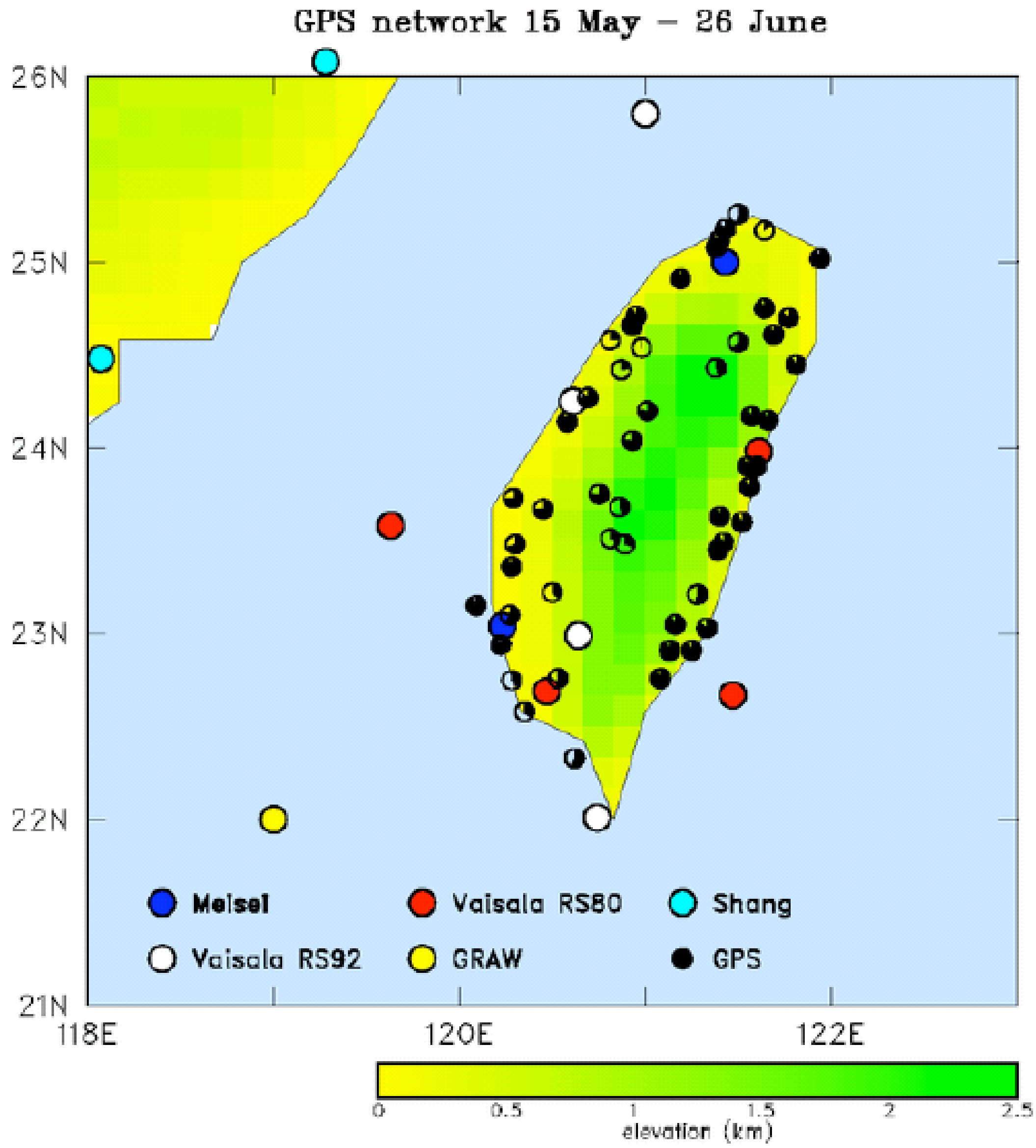

圖 8 台灣探空站及 GPS 站的位置。不同顏色的圓圈代表不同類型的探空儀，而 GPS 站圓圈內的充填程度則代表該站在 SOP 期間可以被使用的資料百分比。

圖 9 為 SOP 期間，利用 multiquadric 客觀內差法(Nuss and Titley, 1994)將 AMSR-E 和 GPS 合併而得到之平均 TPW 分布情形，在中台灣北部山區的山區有一 TPW 最小值，如果 GPS TPW 在南部山區也有資料的話，那麼此最小值將很有可能同樣會延伸到南部山區；最大值則出現在中國的南部海岸外，另外，在台灣南部與東北部外海有一相對較大之 TPW 區存在。

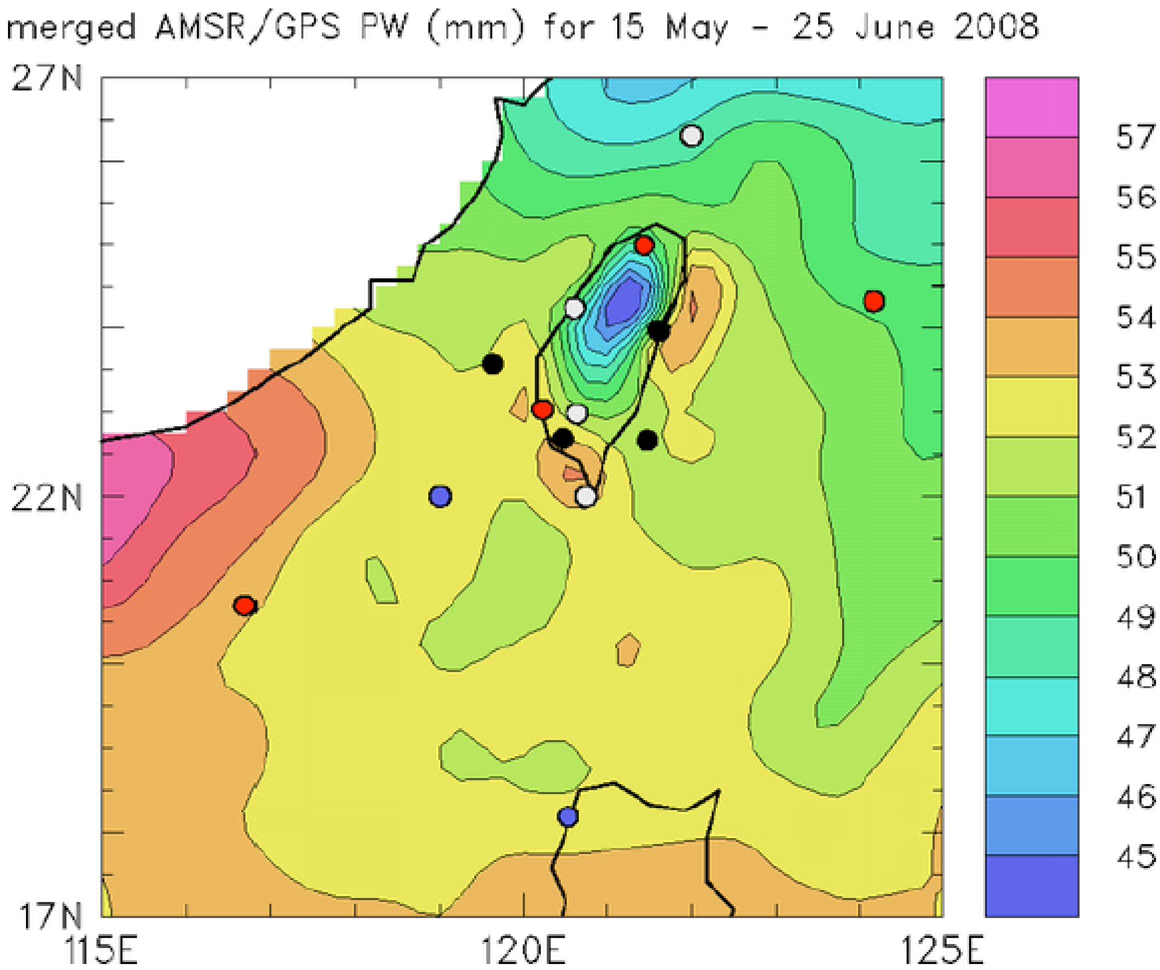

圖 9 SoWMEX/TiMREX SOP 期間，將 AMSR-E 和 GPS 合併而得到之平均 TPW 分布情形。填滿的圓圈代表探空站的位置，不同顏色則代表不同類型的探空儀(如同 3 所示)。

我們可以藉由圖 9 之分析來得到實驗期間任何位置的平均 TPW，接著我們將各站不同來源的 TPW(探空資料直接計算、圖 9 的 AMSR-E 與 GPS 之合併分析與最接近的 GPS 站）進行比對（圖 10）。因為有許多的觀測發生在 IOP 期間，此期間為較潮溼的時期，所以若是使用實際探空資料來直接計算 SOP 的平均 TPW 將會引入 moist bias，為了解決潮溼期間的過多取樣，所以在使用探空資料計算 TPW 時會採用日平均且每一天都給予相同的權重。從圖 10 的比較可發現 VS80 的 dry bias 很明顯，其範圍從屏東的 6 mm 到綠島的 11 mm，綠島有較大的 dry bias 有一部分是因為探空站位於較高的高度（252 m），此高度差異將會對 TPW 引入約 4 mm 的差異。Meisei 站看起來似乎也有微小的 dry bias（1-3 mm），這與圖 7 的分析結果一致。圖 10 也建議 VS92 的探空站有輕微的 dry bias，我們懷疑是日間輻射加熱所導致，為了證實此猜測，更進一步的分析是必須的。六龜的 dry bias 是過大的，這是因為最靠近的 GPS 站所在高度都小於 50 m，而六龜的高度是 266 m，如同前面提到的，此高度的差異將會使 TPW 約有 4 mm 的差異。最後，Graw 站看起來似乎沒有溼度的偏差。

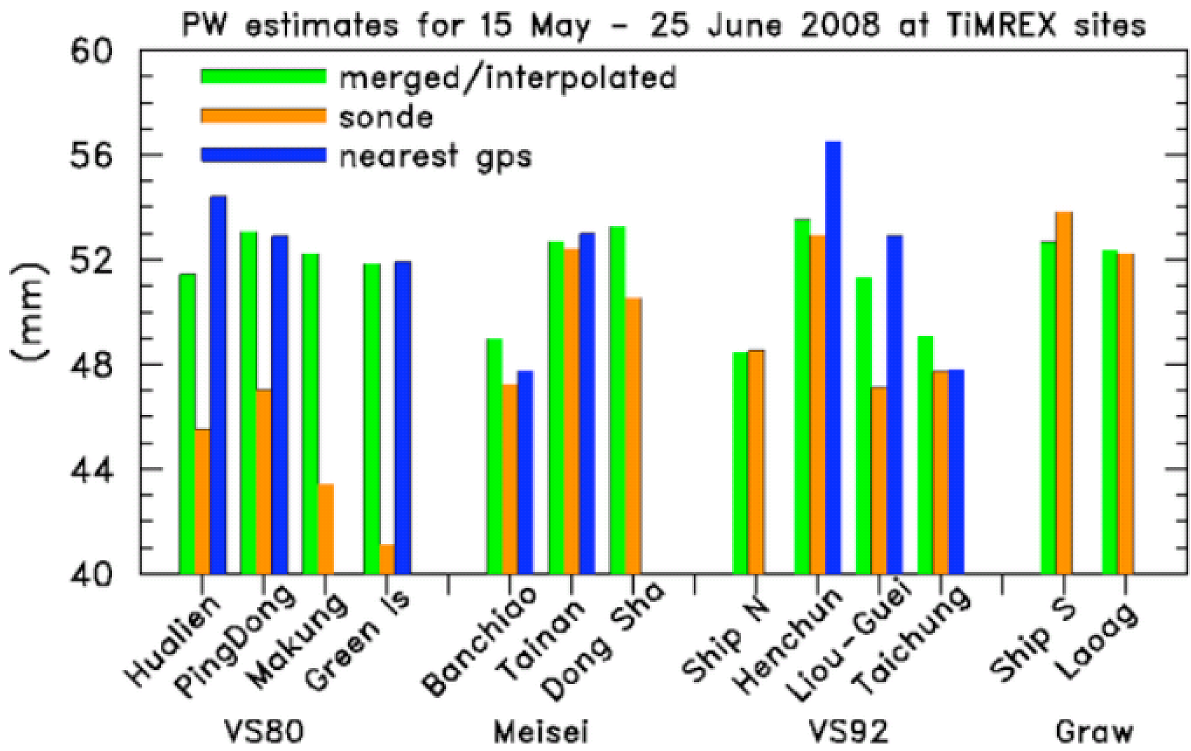

圖 10 不同方法之 TPW 比較結果（探空資料直接計算、圖 4 的 AMSR-E 與 GPS 之合併分析與最接近的 GPS 站）。

三、探空比對研究：

在 SoWMEX 期間，Vaisala RS80 的 dry bias 早就被發現了，因此，計劃辦公室於 2008 年 6 月在屏東站（46750）針對 Vaisala VS80 與 VS92 進行一系列的探空比對試驗計劃（Intercomparison Launches），VS92 探空儀在夜間的溼度偏差很小（甚至沒有），而日間的 dry bias 則很容易被移除（Yoneyama et al., 2008, Cady-Pereira et al., 2008），所以適合用來校正其他探空儀的溼度場資料。此資料庫包含 18 個比對探空（10 個日間、8 個夜間；6 個雨天，3 個陰天及 9 個晴天），表 4 即為在不同溫度與溼度區間下可用來執行 CDF 配對法的資料筆數，雖然我們只有 18 顆比對探空，但在每個溫度區間皆至少有 1000 筆資料，顯示此方法相當具代表性。接著，我們可以利用累積頻率分布函數法（Cumulative Distribution Function matching method，CDF method）來校正屏東站 RS80 探空儀的 dry bias（Nuret et al., 2008, Ciesielski et al., 2009），並且應用到其他 RS80 的站。

另外，我們在板橋站（Ban-Ciao，46692）也有 12 筆探空比對資料（Meisei、Graw 與 VS92），不幸的是，這些並不是在季風條件下所取得，而是在 4 月（4 筆）與 10 月（8 筆）。一些初步的分析顯示只有 VS92 在雲中能達到飽和；在較暖且潮溼的環境下，Meisei 有較小的 dry bias（5%），然而，Meisei 的相度溼度在 300 hPa 以上幾乎是不變

的，這也會導致高層有 moist bias。與 VS92 相比，Graw 探空儀在溫度較低時有輕微的 moist bias，而在潮溼環境中有輕微的 dry bias。

表 4 SoWMEX/TiMREX 期間，於屏東站進行之 18 顆比對探空資料在不同溫度與溼度區間下的總資料筆數。

日間																				
	0~5%	5~10%	10~15%	15~20%	20~25%	25~30%	30~35%	35~40%	40~45%	45~50%	50~55%	55~60%	60~65%	65~70%	70~75%	75~80%	80~85%	85~90%	90~95%	95~100%	Total
20~40℃	0	7	0	17	16	227	68	58	66	67	76	72	55	44	44	56	36	39	29	28	1005
0~20℃	0	103	0	39	111	432	53	59	66	67	76	72	55	44	44	56	35	39	31	27	1409
-20~0℃	0	55	42	136	26	510	52	59	67	67	77	72	55	44	44	56	35	39	34	27	1497
-40~-20℃	0	24	63	246	167	786	52	59	67	67	78	71	55	44	46	55	36	40	37	27	2020
-60~-40℃	0	49	92	142	386	473	52	60	67	67	78	70	55	44	49	54	36	41	39	27	1881
-80~-60℃	0	90	99	157	225	210	52	60	67	68	78	69	55	44	52	53	36	42	39	28	1524
夜間																				
	0~5%	5~10%	10~15%	15~20%	20~25%	25~30%	30~35%	35~40%	40~45%	45~50%	50~55%	55~60%	60~65%	65~70%	70~75%	75~80%	80~85%	85~90%	90~95%	95~100%	Total
20~40℃	0	0	0	8	0	0	98	80	70	61	68	81	67	60	56	56	49	30	46	45	875
0~20℃	0	0	17	103	0	59	85	81	68	63	68	80	67	60	58	54	48	32	48	44	1035
-20~0℃	0	9	63	138	22	393	84	81	67	65	68	80	67	60	59	54	48	33	48	44	1483
-40~-20℃	0	13	42	47	14	386	83	82	66	65	68	80	67	60	59	53	47	34	48	46	1360
-60~-40℃	0	9	47	144	47	427	82	83	65	66	68	80	67	61	59	53	45	36	48	48	1535
-80~-60℃	0	15	49	120	106	477	81	83	64	66	68	80	66	61	59	52	42	36	48	48	1621

四、屏東站與其他 VS80 站的溼度校正：

1.一般的處理方法：

如圖 7 和圖 10 所示，屏東站的 VS80 探空儀有顯著的 dry bias，所以要用下列幾種方法來校正這些資料。首先，所有類型的 Vaisala 探空儀需進行日間太陽加熱的校正（Yoneyama et al., 2008, Cady-Pereira et al., 2008），接著使用在屏東站進行的 18 個比對個案（VS80 與 VS92），利用 CDF 配對法可建立一組校正表，根據此校正表即可使 VS80 的資料達達 VS92 的水準。

2.累積分布函數配對法（Cumulative Distribution Function matching method，CDF）：

CDF 配對法可將不同溼度與溫度下的 VS80 溼度場作修正，CDF 配對法乃是假設兩種不同探空儀施放地點具有相似的環境，這代表兩者具有接近均勻的大氣條件存在，因此，才會有類似的統計條件，而此方法的應用將可校正 VS80 的溼度場，使資料品質達到 VS92 的水準。由於先前的研究也顯示溼度的偏差也存在於垂直方向，所以在進行 CDF 配對法時，不同的溫度區間會有不同的溼度校正，本研究選取溫度範圍為+40 ℃至-80 ℃，每 20 ℃為一區間，例如：我們以 30℃來代表 20~40℃、10℃代表 0~20℃，若想得到溫度為 20℃下的校正量，則利用 30℃與 10℃的校正量經過線性內差而得出。另外，溼度是從 0 %至 100 %，每 5%為一區間。以白天時的 20℃-40℃區間為例（圖 11），首先，我們可以計算出兩個不同種類的探空儀在不同的溫度區間內、相同累積頻率下，VS92 與 VS80 的相對溼度差值（圖 11a），而後，可將此差異轉換成在相同相對溼度下，兩者的相對溼度差異（圖 11b），由圖 11a 可以清楚地看到當 CDF 為 40%時，VS80 的相對溼度為 72%，而 VS92 則為 82%，VS80 與 VS92 的差異偏差為 10%，這代表 VS80 有 10%的 dry bias，而經過轉換後，圖 11b 則是 VS80 與 VS92 在不同相對溼度下的差異偏差量，顯示在此溫度區間下，相對溼度為 70%會達到最大，VS80 的相對溼度需有 10%的校正。每個不同的溫度區間都會產生一張類似 11b 的圖，將這些圖合併後便可得到一張 CDF 校正表（圖 12），此校正表的橫座標為相對溼度，縱座標為溫度，因此，我們可以得到不同溫度與溼度下的校正量。除此之外，另一件需要特別注意的事是 CDF 校正表必須將日間與夜間區分開，如圖 12 所示，這是因為白天與夜晚的大氣環境條件非常不同。對於溫度大於 0℃而言，夜間最大校正值（10%）出現在相對溼度約為 70%處，而日間最大校正值為 8%，發生在相對溼度為 65%處；對於溫度小於 0℃來說，夜間 bias 校正量大幅增加，峰值位於溫度為-60℃~-80℃、相對溼度為 40%處，校正量可達到 25%。

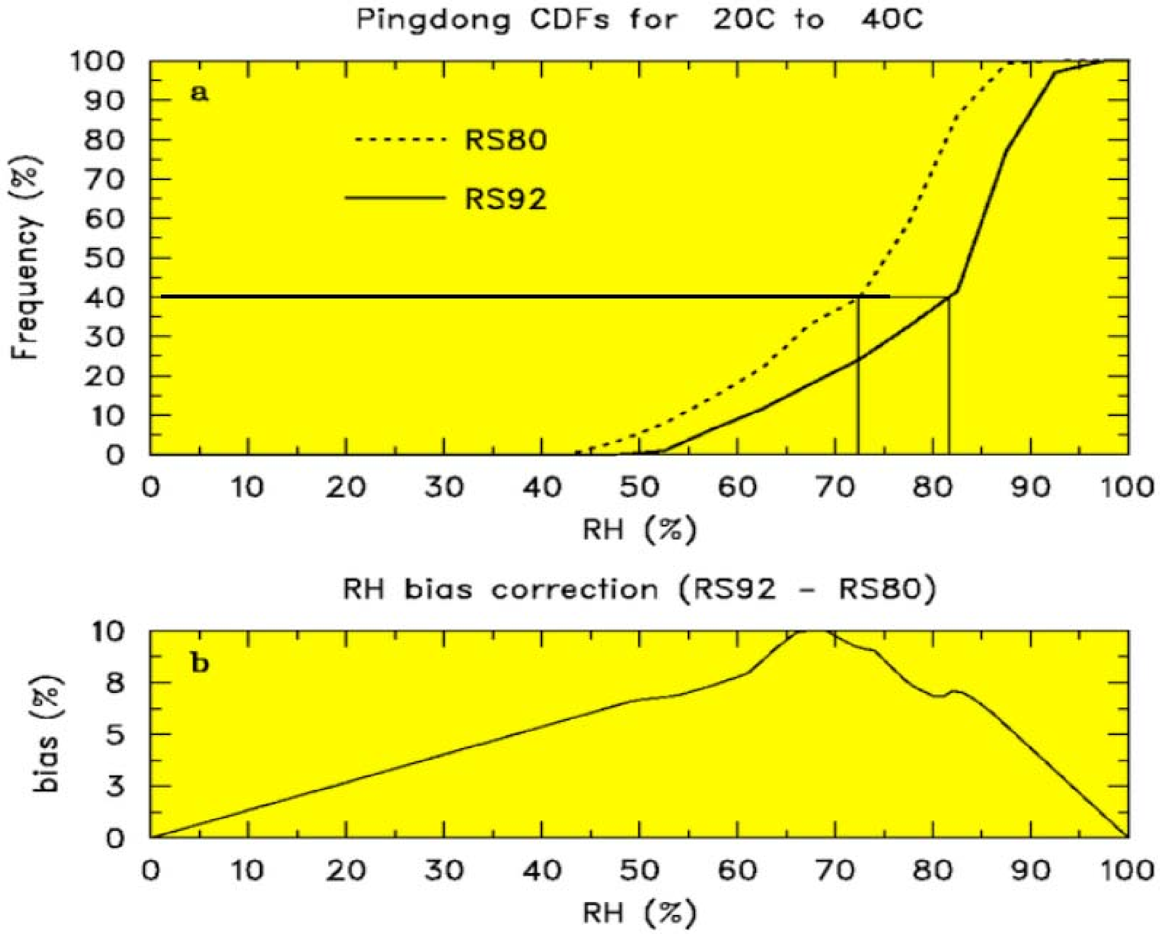

圖 11 上圖為 VS80 與 VS92 在溫度區間 20~40℃下，相對溼度的累積分布函數。下圖為經過 CDF 配對法後的相對溼度 bias 校正量。

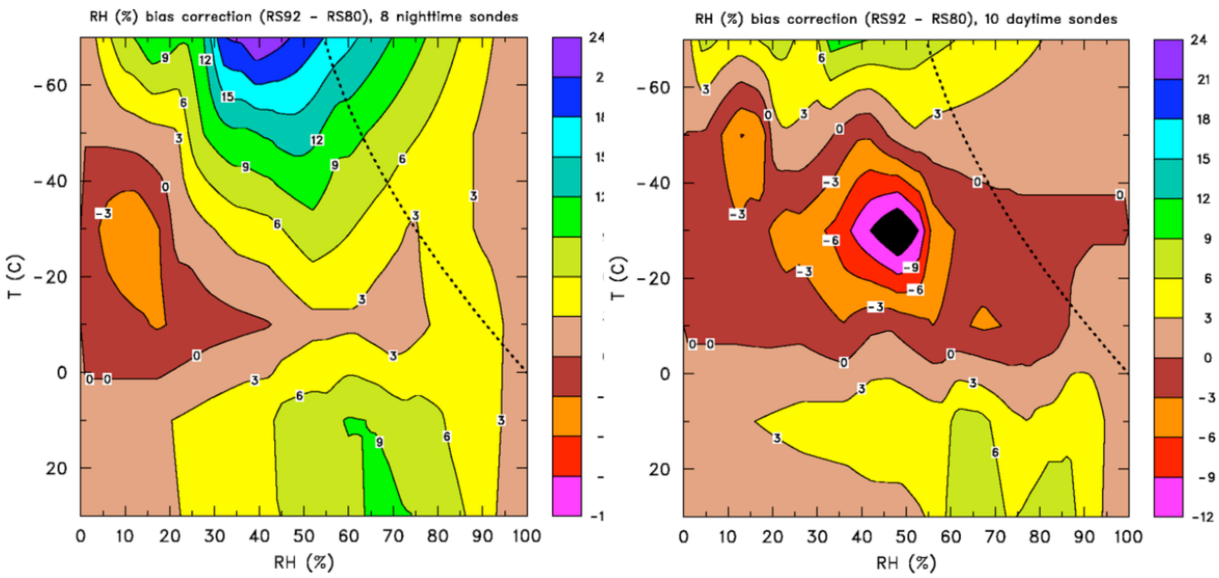

圖 12 利用 CDF 配對法（VS80 與 VS92）在所有溫度區間下的 bias 校正表。左圖為夜間，右圖為日間，點線代表冰的飽和點。

3.日間太陽加熱校正：

Cady-Pereira et al. (2008) 透過比較探空的 TPW 與衛星微波反演的 TPW，針對不同類型的 Vaisala 探空儀發展出一套日間溼度校正法。Vaisala 的 dry bias 主要來自於溼度感應器受到太陽加熱地影響，Vaisala RS80-H 的溼度感應器上有保護蓋以降低日間降雨和輻射的影響，然而，較新的探空儀（VS90 與 VS92）已移除此保護蓋，所以日間 dry bias 會比 VS80 系列來的大。由圖 12 中也可得到 VS80 在白天時，在-20~-40℃範圍內都比 VS92 來得潮溼（圖 12 右在-20~-40℃的負校正量），這就代表 VS92 有很大的日間輻射加熱偏差，這與 Cady-Pereira et al. (2008)得到的結果一致，所以，我們將繼續進行此校正法。

對 VS92 探空儀而言，日間輻射加熱校正係數為：

$$SF = 1.0 + 0.093 \times \exp\left[\frac{-0.2}{\cos(SZA)}\right]$$

SF 為一比例係數（Scale Factor）； SZA 則代表太陽天頂角，為測站經緯度、時間及年份的函數。圖 13 為屏東站在 2008 年 6 月 1 日的 SF 在不同時間的分布情形，我們可以清楚看到只有在 0530 LST 到 1830LST 之間施放的探空才會受到太陽加熱的影響，且在 1130 至 1300LST 之間施放的探空需經過 8%的修正。實際上，日間校正是將露點溫度（T_d）轉換成混合比（r），而後把每一層的混合比（r）乘上此係數以得到新的混合比，最後，再用新的混合比計算出新的露點溫度。另外，Vomel et al. (2007)與 Yoneyama et al. (2008)在最近的研究中，比較 VS92 和 Chill Mirror 溼度計之高精度溼度探空後發現 VS92 的 dry bias 會隨高度增加，這也是需要考慮的問題。

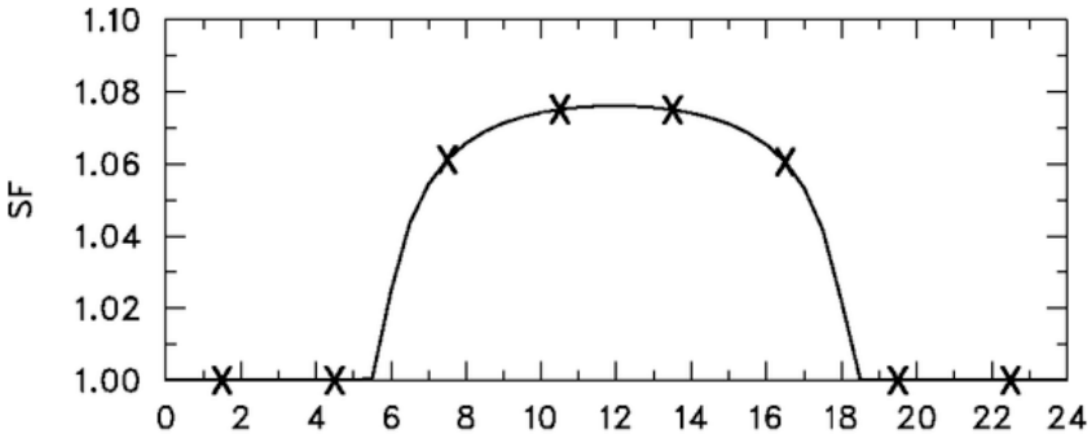

圖 13 2008 年 6 月 1 日於屏東站之比例係數（Scale Factor）對混合比的校正程度，為測站經緯度、當地時間及年份的函數。X 代表一天 8 次的探空施放時間。

4.校正法的應用：

所有屏東站所蒐集到的 VS80 探空資料先經過 CDF 校正表，使 VS80 的溼度場達到 VS92 的標準，然後，對所有白天的探空進行日間輻射校正，但在進行這些校正時，也要

遵循以下的限制，那就是新的露點溫度不能超過溫度，這也使得當溫度大於 0℃，相對溼度不能超過 100%、當溫度小於 0℃，相對溼度可達到 130%。

5.屏東站校正的驗證：

屏東站的探空資料經過 CDF 與日間太陽輻射加熱校正後，在 SOP 期間，平均 TPW 從 48.2 mm 提升至 53.9 mm（約增加 11%）。最靠近的 GPS 站（ZEND）位於屏東站東方 37 公里處且非常靠近海岸，在 SOP 期間也蒐集到非常完整的紀錄，平均 TPW 為 54.8 mm，這比校正過的探空值還高 0.9 mm，而 GPS 站有較高的 TPW 可能是因為較接近海岸。3 小時 GPS 和校正後探空資料之 TPW 的相關係數則為 0.88。

接著，我們挑出同時有 GPS 及探空資料的時間點，來分析 TPW 的日夜循環（圖 14 上），在非加強觀測期時，屏東站的釋放時間為 2，8，11，14，20 LST。結果顯示未經修正的探空資料與 GPS 的差異在每個不同的施放時間介於 5 mm 至 10 mm 之間，而校正後的探空資料在每個時間點非常接近 GPS 的估計值，兩者的差異在 2 mm 以下。較高的平均 TPW 出現在 5，17 和 23 LST，這是因為這些時間只有在加強觀測期（IOP）才有施放探空，這段時間內的對流較旺盛且較潮溼（圖 15）。

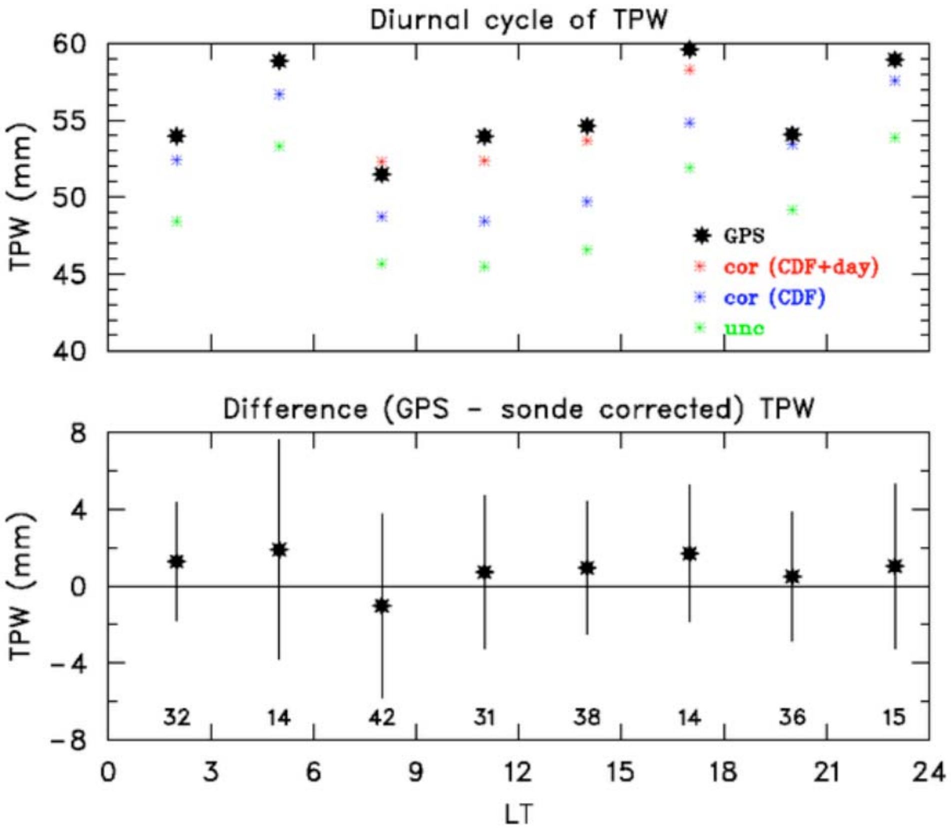

圖 14 上圖為總可降水量的日夜循環，GPS-PW 以黑色星號表示，未經校正的探空則是綠色星號，經過校正後的探空以藍色星號代表僅做過 CDF 校正、紅色星號則為 CDF 與日間太陽輻射校正。下圖為總可降水量差異（GPS-PW － 校正後探空 PW）的日夜循環，星號表示平均值，垂直線為標準差，底層的數字表示用來計算平均的資料筆數。

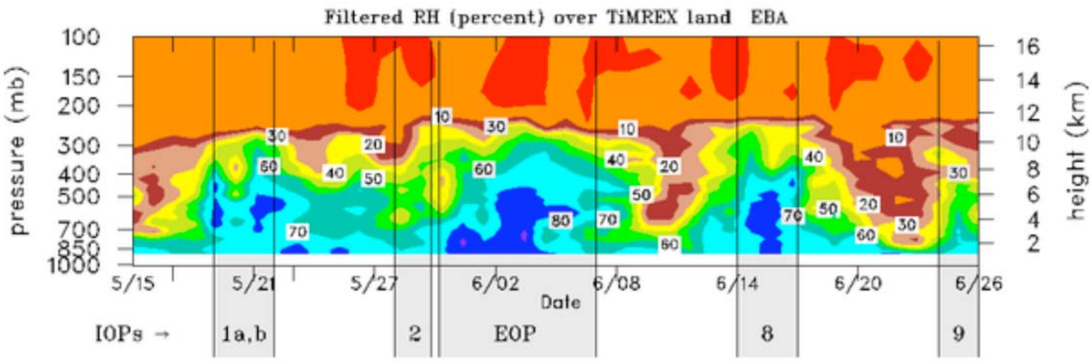

圖 15 平均相對溼度之時間序列，垂直線與陰影區代表加強觀測期（IOPs），一天有 8 次探空的施放。

下表為屏東站的溼度校正對不同對流參數的影響，經溼度校正後的資料看起來能有效地移除 dry bias，在未校正前，較低的對流可用位能（CAPE）和較高的對流抑制能（CIN）表示對流不容易被激發，而在校正後，各種對流參數看起來更合理，

參　數	未校正	校正後
可降水量（PW）	48.2 mm	53.9 mm
對流可用位能(CAPE)	169 J Kg^{-1}	782 J Kg^{-1}
對流抑制能（CIN）	-165 J Kg^{-1}	-84 J Kg^{-1}
舉升凝結面（LCL）	900 hPa	924 hPa
平衡面（EL）	215 hPa	164 hPa

6.將校正法應用在其他 VS80 站：

從屏東站得到的 CDF 校正表(圖 12)與日間太陽輻射加熱校正將被應用在其他 VS80 站，結果如圖 16 所示，初步的分析結果顯示僅有在花蓮站可得到不錯的結果。

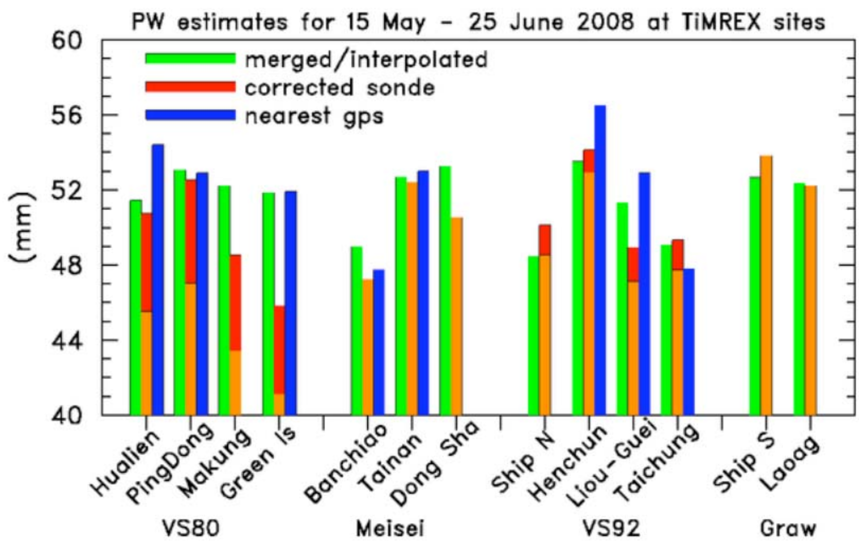

圖 16 不同方法之 TPW 比較結果（探空資料直接計算、圖 4 的 AMSR-E 與 GPS 之合併分析與最接近的 GPS 站）。紅色長條為 VS80 與 VS92 的溼度校正作用。

除了上述兩種方式外，我們亦提供所有 VS80 原始探空資料給 Vaisala，所以，我們又得到另外一組經 Vaisala 原廠新係數校正後的資料，此資料庫的品質已相當不錯，僅需進行 RS-80 的日間太陽輻射加熱校正。可惜的是，Vaisala 沒有辦法重新建造花蓮站之探空，然而，圖 16 已清楚地告訴我們若將前述兩種校正法應用在花蓮站便能得到相當不錯的結果。

五、VS92 探空儀的溼度校正：

所有日間 VS92 探空儀將進行日間太陽加熱校正。

六、Meisei 探空儀之探空站的溼度校正：

某些校正看起來似乎是需要的，但是必須有更多的分析來證實校正的範圍及大小。

七、Graw 探空儀的溼度校正：

目前看起來似乎不用對溼度進行校正，若仍有輕微的 bias 存在，那麼，我們就需要額外的比對實驗，以建立一套適合的校正法。

八、目前正持續進行之工作：

截至目前為止，我們已成功建立一套經過溼度校正後的 Version 2 資料庫，接下去仍會建立另一組 5-hPa 探空資料庫，此 5-hPa 探空資料庫將會標記上 QC 標籤，這就是 Version 3，我們預期此資料庫將更能節省儲存空間且更便於研究用途上的使用。為了建立品質控管（QC）標籤，各種參數將會經過一系列自動化品質控管檢驗（gross limit, vertical consistency 等），最後還會以目視法檢查每 5-hPa 的資料，以鑑定任何仍然有問題或是錯誤的資料（可使用 CSU 以 TCL 語法寫成的 xsnd 軟體）。在 Version 3 中，我們並不會更改任何的資料，僅加入品質控管標籤，如此一來，使用者將可輕易自己決定要使用哪些資料。

期末報告預計完成的項目有：

(1)利用 GPS 或衛星反演出的可降水量（PW）來檢驗探空資料的溼度偏差。

(2)分析校驗比對資料，確認不同類型探空儀是否需要校正。

(3)探空資料校正方法研究與分析

這些工作均已完成。

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5.計畫變更說明：

按原計畫進行中無變更。

6.落後原因：

按原計畫進行中無落後。

不同種類探空儀的特性：

在 SoWMEX/TiMREX 實驗開始前（4 月 15~16 日，共 4 顆）於板橋站進行一系列的比對研究，參與的探空儀類型有 Meisei、Vaisala RS-92 以及 Graw，三種不同類型的探空儀綁在同一顆氣球上一起升空。圖 zzz 即為初步分析結果，從相對溼度來看，當探空儀經過雲時，只有 RS-92 可以達到飽和，Graw 與 Meisei 從 800 到 950 hPa 約比 RS-92 乾 3~5%，而 RS-92 在 300 hPa 以上明顯偏乾，Vaisala RS-92 在高層偏乾乃是受到太陽輻射加熱所導致之 dry bias。此外，與 RS-92 相比，Graw 與 Meisei 較暖，特別是 Meisei，雖然我們從此結果可以得知不同探空儀的溫度亦不相同，但卻無足夠證據證明哪一種探空儀的溫度才是真值，因此，現階段我們僅針對溼度的 bias 來作校正。

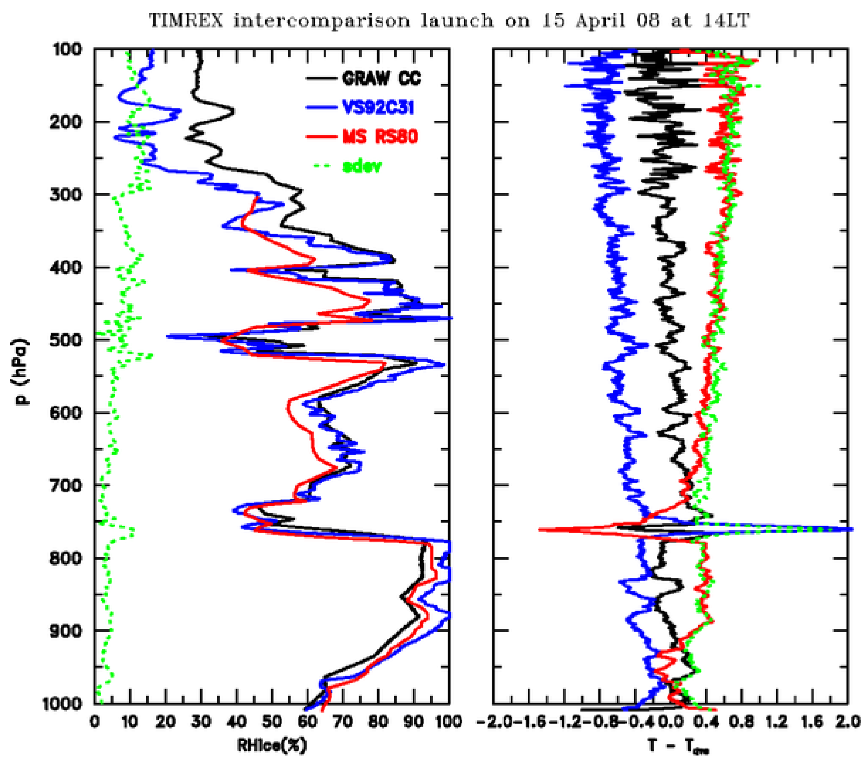


圖 17a 2008 年 4 月 15 日 00Z 於板橋實施之比對研究（VS92、Graw 與 Meisei）。左側為相對溼度、右側為溫度差（T - T_{mean}）；紅色實線為 Meisei，藍色實線為 Vaisala RS92，黑色實線為 Graw，綠色點虛線則為標準差。

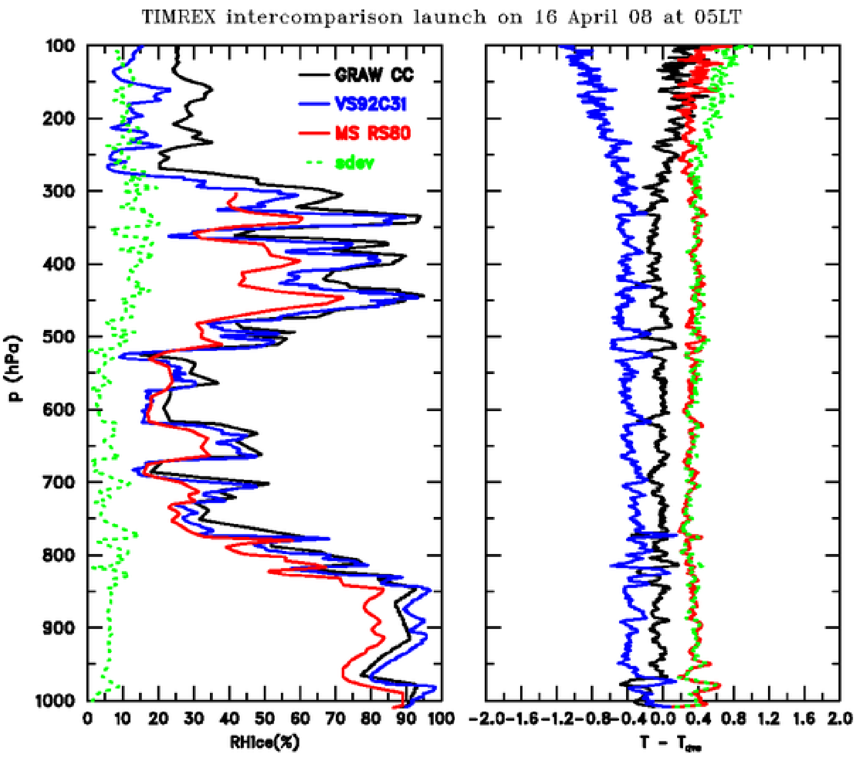


圖 17b 2008 年 4 月 16 日 00Z 於板橋實施之比對研究（VS92、Graw 與 Meisei）。左側為相對溼度、右側為溫度差（T - T_{mean}）；紅色實線為 Meisei，藍色實線為 Vaisala RS92，黑色實線為 Graw，綠色點虛線則為標準差。

Appendix

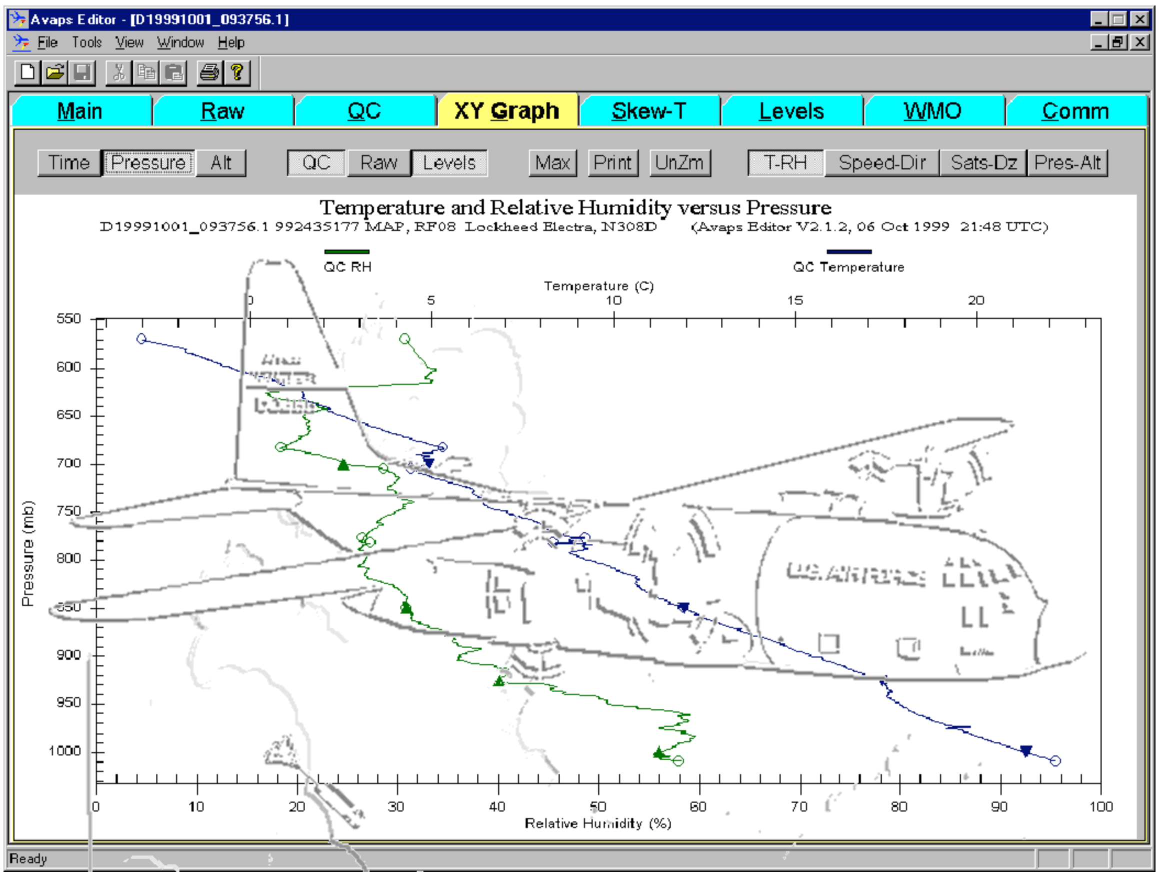
NCAR-ASPEN

使用者手冊

ASPEN

(ATMOSPHERIC SOUNDING PROCESSING ENVIRONMENT)

USER MANUAL



Charles Martin

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February 2007

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Table of Contents

List of Tables

Introduction

Aspen (Atmospheric Sounding Processing Environment) is used for analysis and quality control (QC) of sounding data. It has the following capabilities:

- Automatically apply quality control procedures to the sounding data
- Present data in tabular and graphical forms
- Automatically determine levels and code them in WMO message formats
- Transmit the WMO messages to other systems
- Save the raw and derived data products in various formats

Since Aspen can process data provided in the AVAPS "D" file, NCAR GLASS, NCAR MCASS and NCAR CLASS formats, it is able to analyze both dropsonde and upsonde soundings.

Aspen is designed to operate as automatically as possible, while allowing the user to have some control over the QC methods. For instance, as soon as the user selects a sounding file for processing, the data is brought into Aspen and automatically analyzed. In most cases this first pass will be the only one required. If the processing needs to be modified, the user can change the QC parameters and reprocess the data as many times as necessary.

An extensive series of QC algorithms are applied to the data. These algorithms typically have one or two parameters that may be adjusted by the user if the default values are not suitable for a particular sounding. The user can save the modified options, so that when a new sounding is opened, the initial analysis will use the customized QC parameters.

Aspen can have up to six sounding files open at the same time. This makes it convenient to compare soundings.

Aspen is designed so that its operation requires minimal user intervention. However, there are a few concepts that are very helpful in understanding the behavior of the program.

The QC process mainly removes suspect data points

Aspen maintains two separate data sets: the raw data and the QC data. At the start of processing, the QC data is an exact copy of the raw data. The algorithms are then successively applied to the QC data. As the processing proceeds, data points that fail each test are removed from QC data set. At the end of this process, a final smoothing is applied to the remaining QC data. It is important to understand that ***nearly all of the QC steps simply remove unreliable points from the raw data set***. The dynamic adjustments and the final smoothing are the only steps where the observed data values are actually modified.

Time is the independent variable

A sounding is simply a time series of observations, and so almost all of the QC operations are based on the time of each data point. The QC parameters are specified in relation to time, and the tabular data listings are ordered by time.

The processing follows a fixed sequence

The complete processing routine is applied as soon as a sounding is selected for analysis, and whenever the user chooses to recompute the analysis. The sequence is as follows:

1) Apply the QC algorithms, discarding bad points and applying corrections
2) Compute the levels, by analyzing the QC results.
3) Code the WMO message, using the levels as input.

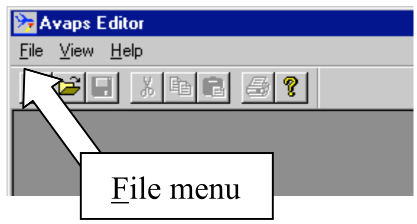
Throughout this manual, notes in *italics* provide additional information and suggestions which, while not essential to operation, will help you use Aspen more effectively.

Overview of Operation

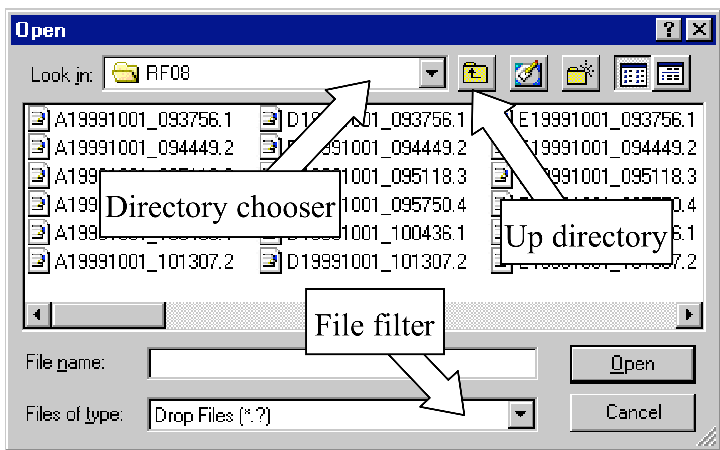
1 Run

To run Aspen, double click on the Aspen icon 

, or choose Aspen from the start menu. An initial start screen will appear. If the file selector does not appear immediately, choose Open under the File menu:



You will now see the file selector:



The file selector is used to choose the sounding file to be processed. You can move to other directories using the up directory button or the directory chooser. The file filter controls the file types that are displayed in the chooser.

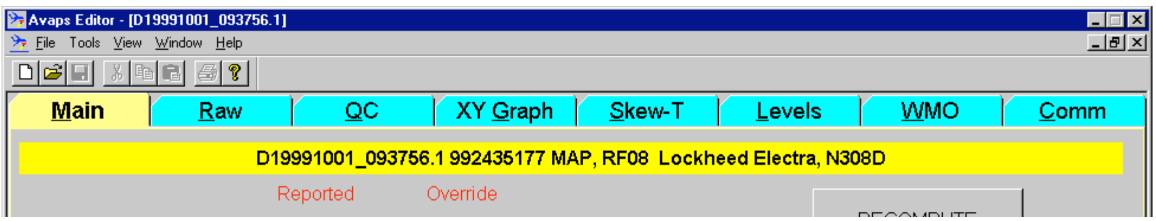
If you do not see your data files in the directory where they are supposed to be, it is probably because the file filter is set incorrectly. Change the file filter to "All files (.*)" in order to display all files in the directory.*

2 Open Select the file containing the sounding that you want to analyze. Click once on the file and then press "Open", or double-click the file name.

Aspen will show a warning message if you select a file that is in a format which it can't process.

Processing of the sounding begins as soon as the file is opened. The progress of the analysis is displayed in the status box in the lower left hand corner of the main screen, but until the processing is complete, the screen will remain blank.

When the sounding analysis has completed, the initial screen will be filled with a tab-based display, in which each tab represents a different view of the data. The tabs are arranged from left to right (see figure below) in the general order of the data processing, i.e. from raw data, through the QC and levels computation, to the coded message. Read the **Tab Displays** section for further description.



3 Verify Verify the sounding by examining all of the tab selections. Read the **Post-Processing Adjustment** section for important guidelines on doing this. After examining the sounding, the user may decide that one or more of the processing parameters should be adjusted.

4 Recompute (if necessary) The most commonly altered processing parameters can be changed on the Main tab. When they have been set to the desired values, press the Recompute button on the Main Tab to reanalyze the sounding using the new parameters. The processing status will again be displayed in the lower left status box. When completed, the displays in each tab will be updated with the new results.

Be sure to press the Recompute button after changing the processing parameters; otherwise, the new parameters will not be applied to the sounding.

5 Next Sounding To analyze another sounding, open another data file using the File➞Open menu. Many soundings can be open at one time. Use the Window menu to choose which sounding is displayed.

Post-Processing Adjustment

Once a sounding has been processed by Aspen, the results must be examined carefully. Frequently some parameters will need to be adjusted to compensate for characteristics of the data.

End of data

In a well-behaved sounding, the end of the raw data set will occur at the end of the sounding. For a dropsonde landing in water, this is the usual case. For a dropsonde hitting the earth, or with upsondes, the raw data can contain observations that should not be included in the processed sounding. The user must then manually specify the end of the drop by setting the end of drop time on the Main tab. It is **critical** that the end of drop be correctly set for dropsonde soundings

The Raw data table and the XY graph are useful for determining the end time. Scroll to the bottom of the raw data to view the values of individual data points. On the XY graph, enable the raw data trace, and use the mouse to zoom in the area of the sounding end. Data point markers and grids can be enabled with buttons above the graph.

> *The QC tabular display will only show data points that are within the end of data time period.*

Dropsonde heights and the surface

For dropsonde soundings, the height calculations are the trickiest part of the Aspen analysis. If the drop terminated cleanly at a known altitude, upward integration of the heights is straightforward. Upward integration is *impossible*, however, if the dropsonde termination altitude is unknown. This can occur if the drop did not make it all of the way to the surface, or if it the termination point on land had an unknown altitude (which is almost always the case).

In the latter situations, the sounding heights can be computed by downward integration from the launch altitude. Note that this suitable only if the launch altitude is known with accuracy. Usually the launch altitude is provided by the aircraft data system, and it is critical to determine the accuracy of this altitude. If altitude is provided by a radar altimeter over the ocean, it is probably acceptable. If it is provided by a pressure-based altimeter, at some time or distance since the altimeter setting was applied, the aircraft-provided altitude is probably not acceptable.

The Main tab has several items that relate to the height calculations. In the box labeled “Height Overrides” there are check buttons that have the following effects:

- Hit Surface – Check this check box if the dropsonde hit the surface. The heights will be integrated up from the surface altitude.

- Unknown Surface Altitude – Check this box if the surface altitude is unknown, such as when a dropsonde has terminated on land. The heights will be integrated down from the launch altitude.
- Set Heights Unknown – Check this box if you feel the heights are not sufficiently accurate, no matter which way they are calculated. The heights will not be calculated or used in latter processing.

At the lower right of the Main tab is a box displaying the results of the upward and downward height integrations. This is shown for diagnostic purposes. If downward integration leads to a launch altitude close to the surface altitude and, likewise, the upward integration is close to the launch altitude, then there is confidence in the launch altitude. If there are significant discrepancies, the launch altitude is probably incorrect. Additionally, differences in the diagnostics can signify a large systematic error in the variables used in the height integration, i.e. pressure, temperature or humidity.

If the surface altitude can be determined for a launch which terminated on land, this value can be entered into the surface altitude box, so that the upward integration can be computed.

The final item affecting the height calculation is the Launch Altitude entry in the Launch Parameters box in the upper left corner of the Main tab. If another source of the launch altitude is available, it may be entered here in order to override the aircraft supplied value. The Clear button can be used to remove the override.

It should be pointed out that the heights are mainly relevant to the coding of the WMO messages, where they are used to report the altitudes of standard pressure surfaces. Even if the heights are unusable, the WMO message will still contain a very accurate report of the sounding based on pressure. The upshot is to set heights to missing when in doubt, rather than report erroneous values.

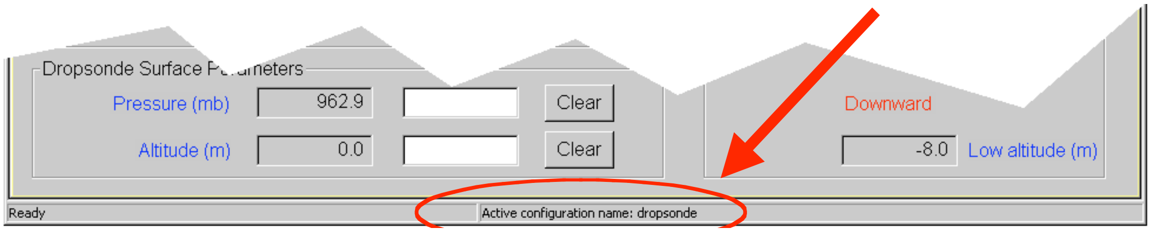
Launch parameters

The launch parameters are the surface or aircraft flight level observation made at the time of launch. They become either the bottom or top point in the sounding, depending on the sounding direction. The QC procedures assume that these launch observations are accurate, so they will not be changed. If the launch observations do need to be modified, the Launch Parameters box in the upper left corner of the Main Tab has entries that allow the user to override them. Enter the new values into the boxes. Use the Clear button to revert to the original values. Be sure to hit “Recompute”.

Setting the QC parameters

The QC parameters, which control the operation of the various QC algorithms, can be modified by the user. However, only experienced users who understand the effects of the parameters should do this. See the Quality Control Procedures section for a complete description.

The QC parameters are organized in named sets, with one of them designated as the currently ***active set***. The parameters in the active set are the ones used for succeeding analyses by Aspen. The active set name is displayed on the right side of the status bar at the bottom of the Aspen application window. It is visible for every Aspen tab:



The initial installation of Aspen provides a configuration set named "dropsonde", and designates it as active. These parameters are generally useful for dropsonde soundings in a tropical environment. If analyzing dropsonde soundings in different environments, as well as upsonde soundings, you will almost always need to create a new configuration set and adjust its QC parameters appropriately.

See the Configuration section for directions on setting the active set, maintaining configuration sets.

The user should be in the habit of always checking the status bar to verify that the correct configuration set is designated as active.

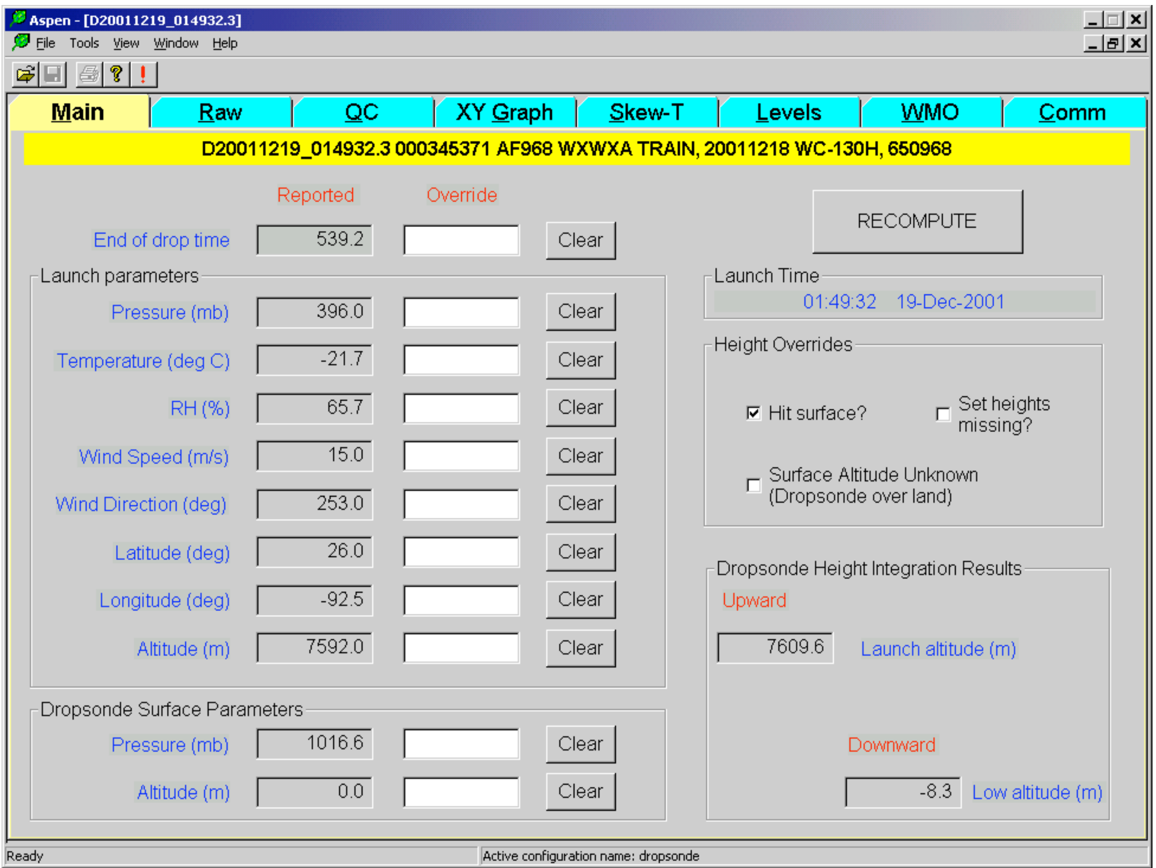
To change the choice of active configuration set, close all sounding files within Aspen. The file menu will now have a "Configuration…" entry that allows access to the configuration editor.

Tab Displays

Sounding Identifier

Each tab displays an identifier that describes the sounding. The details are extracted from various fields within the raw data file. For graphical displays, this information is printed as text on the graph. For other tabs, a yellow bar at the top of the tab contains the identification (see figure below).

Main Tab

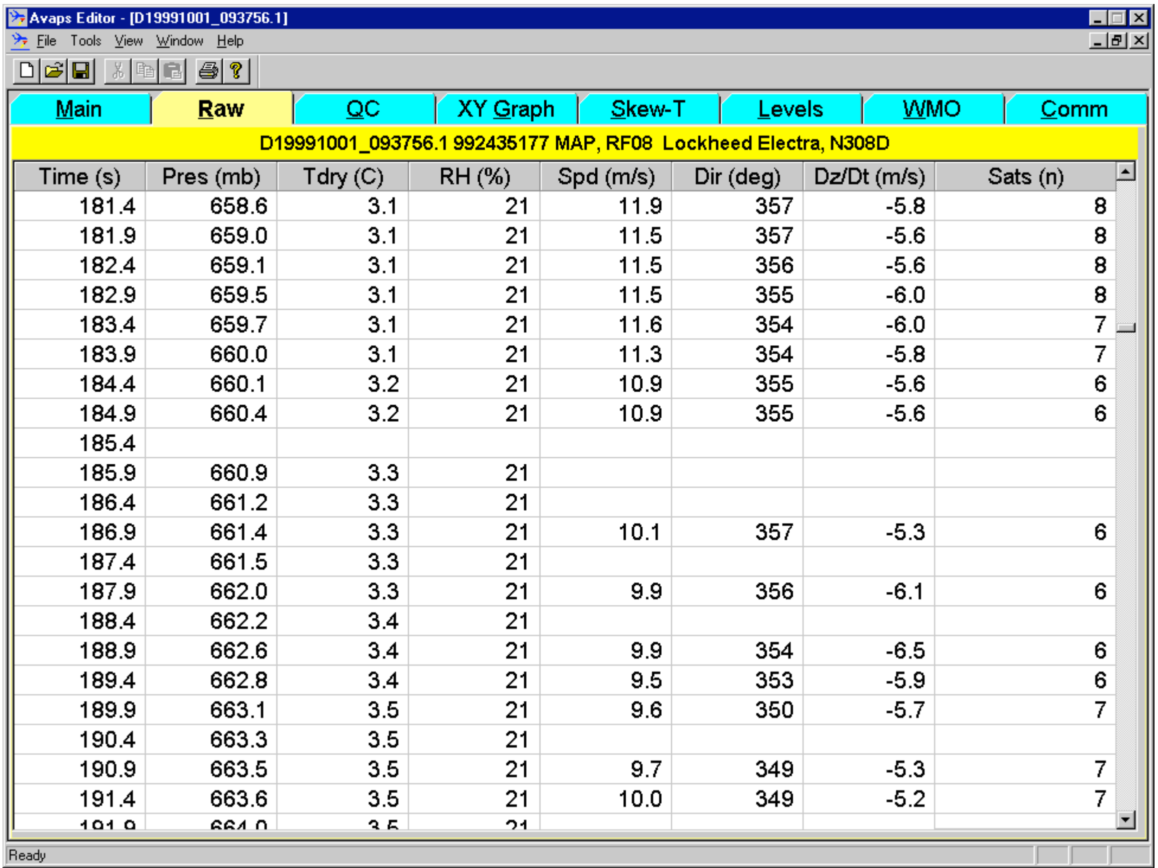


The Main tab is used to specify certain characteristics of the sounding, and to override the launch point observations. Entering a value into the appropriate box specifies the override. To remove the override, press the associated Clear button.

Directions for using the height-related controls is discussed in the **Post-Processing Adjustments** section.

Be sure to press “RECOMPUTE” after changing items on the Main tab.

Raw and QC Tabs



Time (s)	Pres (mb)	Tdry (C)	RH (%)	Spd (m/s)	Dir (deg)	Dz/Dt (m/s)	Sats (n)
181.4	658.6	3.1	21	11.9	357	-5.8	8
181.9	659.0	3.1	21	11.5	357	-5.6	8
182.4	659.1	3.1	21	11.5	356	-5.6	8
182.9	659.5	3.1	21	11.5	355	-6.0	8
183.4	659.7	3.1	21	11.6	354	-6.0	7
183.9	660.0	3.1	21	11.3	354	-5.8	7
184.4	660.1	3.2	21	10.9	355	-5.6	6
184.9	660.4	3.2	21	10.9	355	-5.6	6
185.4							
185.9	660.9	3.3	21				
186.4	661.2	3.3	21				
186.9	661.4	3.3	21	10.1	357	-5.3	6
187.4	661.5	3.3	21				
187.9	662.0	3.3	21	9.9	356	-6.1	6
188.4	662.2	3.4	21				
188.9	662.6	3.4	21	9.9	354	-6.5	6
189.4	662.8	3.4	21	9.5	353	-5.9	6
189.9	663.1	3.5	21	9.6	350	-5.7	7
190.4	663.3	3.5	21				
190.9	663.5	3.5	21	9.7	349	-5.3	7
191.4	663.6	3.5	21	10.0	349	-5.2	7
191.9	664.0	3.5	21				

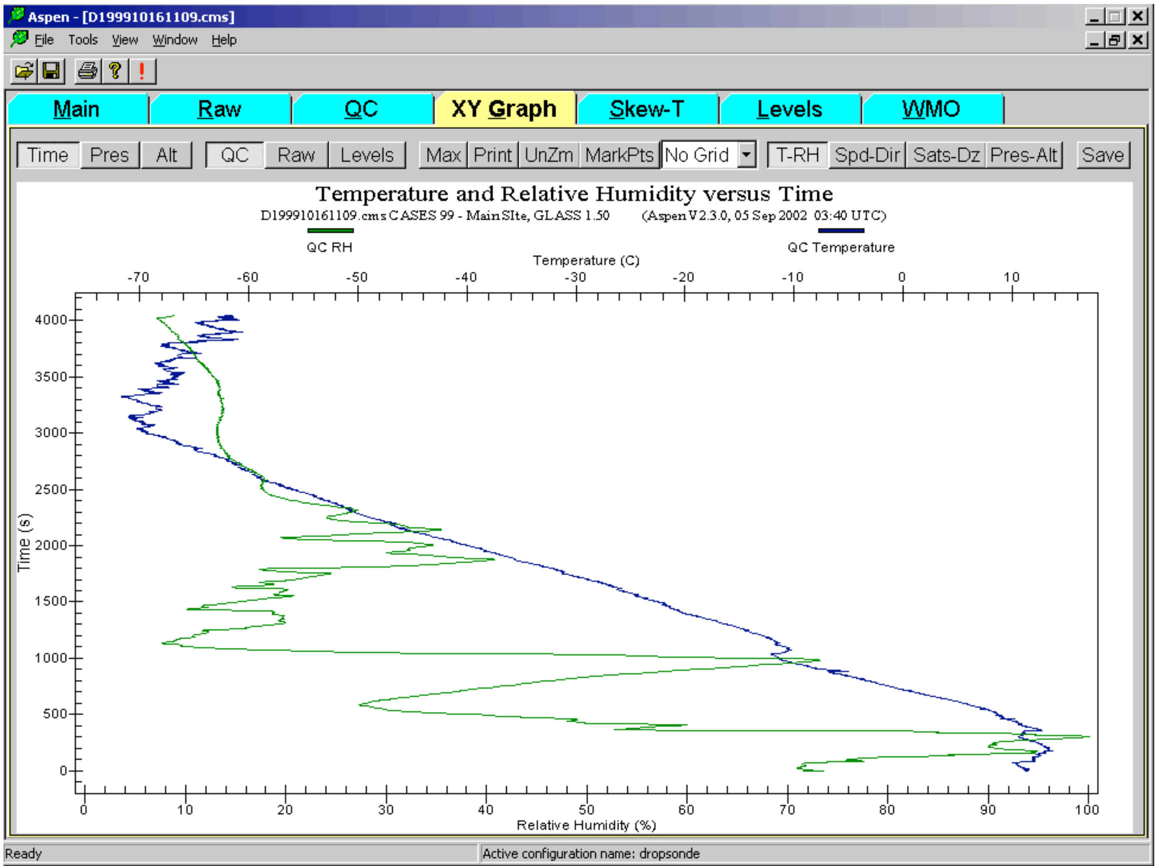
These two tabs each provide a table of data values. The data is listed in time order. The scrollbar on the right side is used to scroll up and down within the table. Notice that the pressure of the current scroll position is displayed as the scrollbar is moved.

The Print and Print Preview commands on the File menu are available for the Raw and QC tabs. The preview can be used to determine on which pages a particular range of data points falls. The Print command is used to print either the whole table or selected pages. The complete table for a sounding will range from 8 pages (drops from 700 mb) to upwards of 50 pages (upsondes to <100 mb).

The Save command allows the data to be saved in the NCAR CLASS or netCDF formats. The CLASS format produces an ASCII text file that can easily be imported into spreadsheets.

> *The launch observations are shown as the first line in the Raw and QC data displays. They will not be modified by the QC processing, but override values can be specified by the user.*

XY Graph Tab



This tab provides numerous options for graphical display of the data. The buttons above the graph select which data products and parameters are displayed. The buttons also select the choice of vertical axis. The main options on the XY Graph tab are as follows:

Time – Pres – Alt. These buttons select the parameter displayed along the vertical axis. When the tab is first selected, time is chosen as the vertical axis, with only the QC data plotted. This leads to the "cleanest" display, since time uniformly increases in both the raw and QC data. When the raw data is displayed using the pressure or altitude axis, the display may be confusing due to noise in the raw pressure reading.

Zoom - UnZm. To magnify (zoom) an area of the plot, left-click and drag to draw a rectangle around the area of interest. Release the left mouse button to zoom into the defined area. The UnZm button restores the graph to the full area display.

If the plot is zoomed into a particular area, and then the plot data type is changed, or a different vertical axis is selected, the plot area may go blank. This is because the zoom area is now in the wrong region for the new plot type. Hit the UnZm button to restore the plot to its full region.

Max. The Max button can be pressed in order to expand the plot to the full screen of the monitor. Press the Esc key to bring the monitor back to the normal configuration.

QC – Raw. The QC and Raw buttons select the dataset(s) to be displayed in the graph. The two datasets can be displayed simultaneously. Conversely, if neither button is selected, no data will be displayed.

Levels. Pressing the Levels buttons causes the computed levels to be overlaid on the graph. Moving the mouse pointer over a level symbol will cause the level type to be displayed. Standard levels are displayed as triangles, and other levels are displayed as circles.

Different levels types contain different sets of parameters. For instance, the standard levels report temperature, moisture, winds and altitude. On the T-RH plot, the standard levels will appear for any vertical axis choice. If the axis is set to altitude, however, the significant levels will not be shown here, since they are not reporting altitude. Also, if a particular field is missing from a level, it will not be overlaid on a trace. For instance, if a standard level does not have a temperature data value, it will not appear on the temperature trace.

Grids – MarkPts. Grid overlays may be selected from the drop-down list above the graph. Marking of the data points can be toggled on and off using the MarkPts push button.

The four buttons on the far right select the parameters to be plotted along the horizontal axis:

T – RH. Selects temperature and relative humidity.

Speed - Dir. Selects wind speed and direction**.**

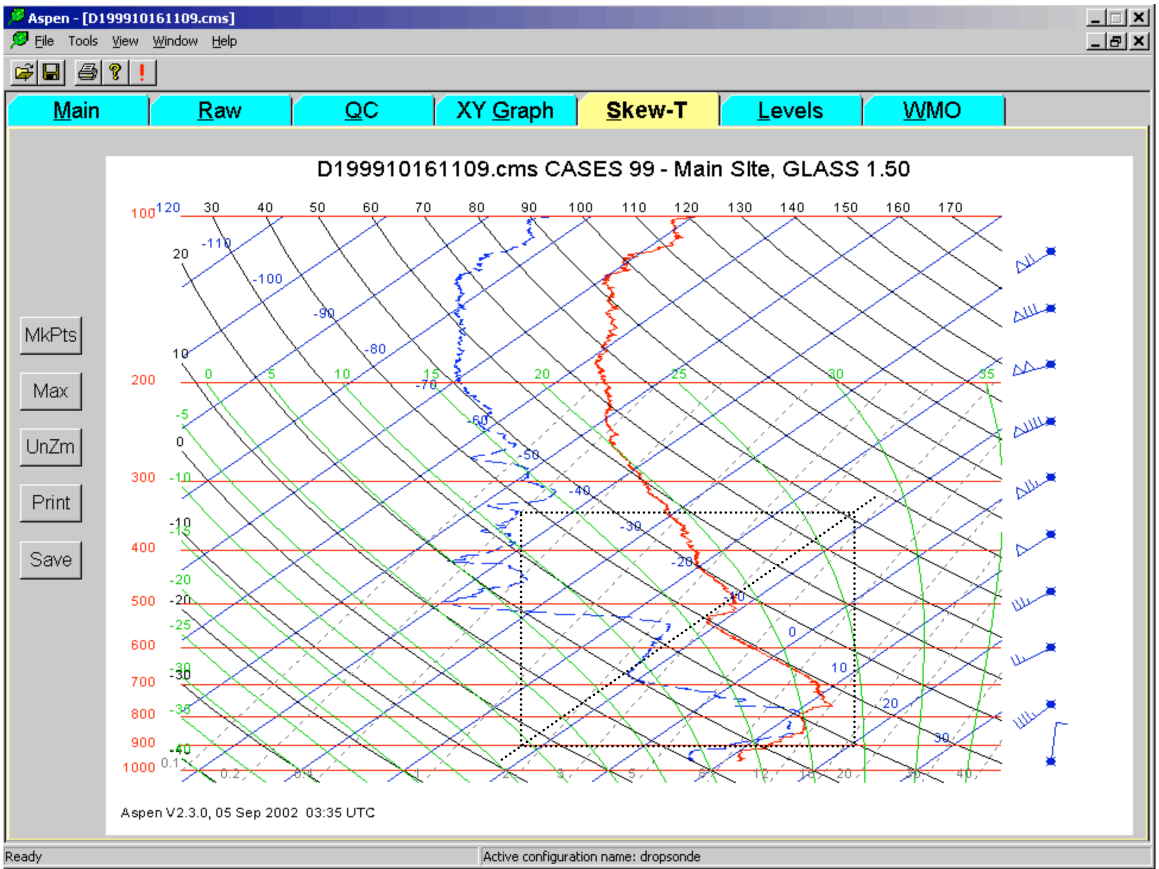
Sats – Dz. Selects number of satellites and ascent speed.

Pres - Alt. Selects pressure and altitude.

The Save button on the far right is used to save the graphic image as a PNG or JPEG file. PNG provides better compression and much higher quality graphics presentation for the line drawings of Aspen, and is the preferred file format. The pixel dimensions of the saved graphic file can be specified in the configuration options.

Other plotting options are available by holding down the right mouse button over the plot.

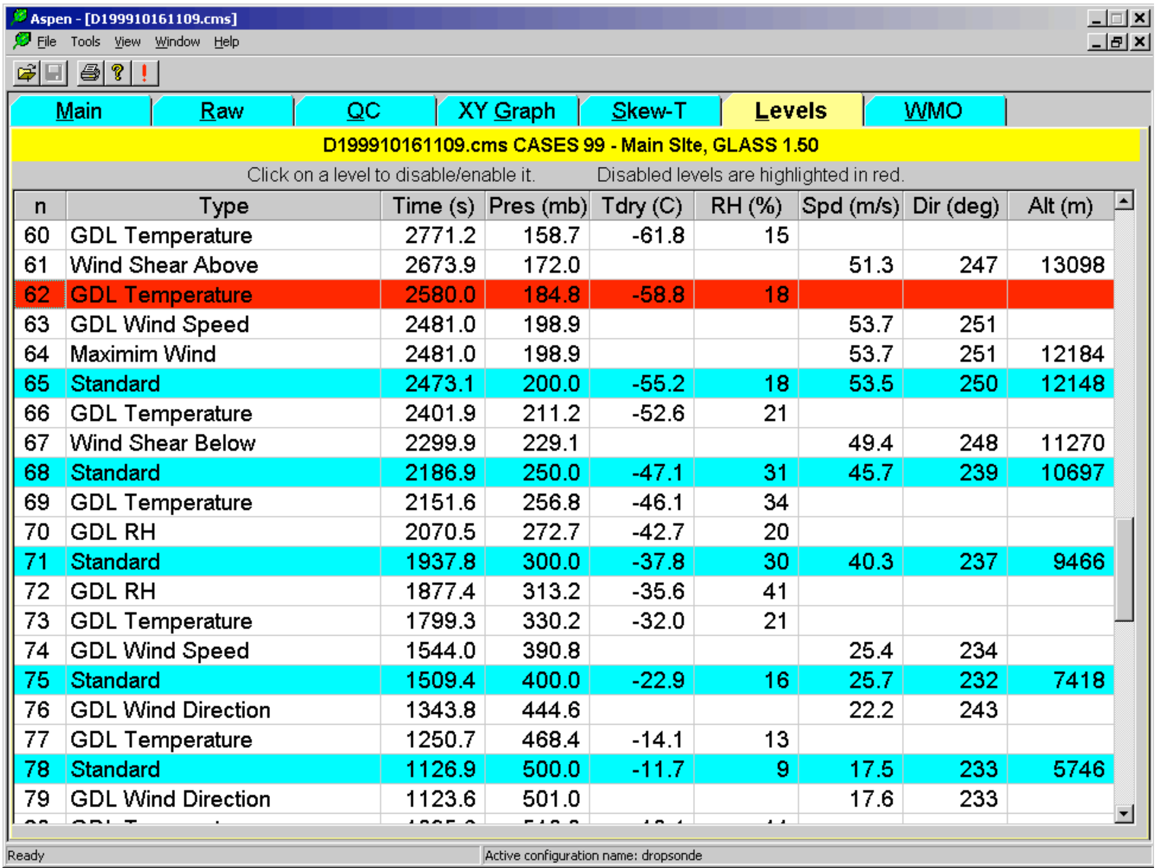
Skew-T Tab



A standard skew-T log-P plot is accessed in the Skew-T tab. Zooming, maximizing, printing and saving of the plot are available in the same manner as for the XY Graph. The right mouse button brings up the same menu of plot options as well.

Meteorologists are accustomed to seeing a particular aspect ratio on skew-T plots and thus a consistent shape of the various isopleths. To maintain the correct aspect ratio when zooming, choose a zoom box whose lower left and upper right corners share a common temperature, i.e. they share a common diagonal. An example of a correct zooming rectangle is superimposed on the figure above.

Levels Tab



n	Type	Time (s)	Pres (mb)	Tdry (C)	RH (%)	Spd (m/s)	Dir (deg)	Alt (m)
60	GDL Temperature	2771.2	158.7	-61.8	15			
61	Wind Shear Above	2673.9	172.0			51.3	247	13098
62	GDL Temperature	2580.0	184.8	-58.8	18			
63	GDL Wind Speed	2481.0	198.9			53.7	251	
64	Maximim Wind	2481.0	198.9			53.7	251	12184
65	Standard	2473.1	200.0	-55.2	18	53.5	250	12148
66	GDL Temperature	2401.9	211.2	-52.6	21			
67	Wind Shear Below	2299.9	229.1			49.4	248	11270
68	Standard	2186.9	250.0	-47.1	31	45.7	239	10697
69	GDL Temperature	2151.6	256.8	-46.1	34			
70	GDL RH	2070.5	272.7	-42.7	20			
71	Standard	1937.8	300.0	-37.8	30	40.3	237	9466
72	GDL RH	1877.4	313.2	-35.6	41			
73	GDL Temperature	1799.3	330.2	-32.0	21			
74	GDL Wind Speed	1544.0	390.8			25.4	234	
75	Standard	1509.4	400.0	-22.9	16	25.7	232	7418
76	GDL Wind Direction	1343.8	444.6			22.2	243	
77	GDL Temperature	1250.7	468.4	-14.1	13			
78	Standard	1126.9	500.0	-11.7	9	17.5	233	5746
79	GDL Wind Direction	1123.6	501.0			17.6	233	

The Levels tab displays the computed levels, which have been derived from the QC data set. The surface and standard levels are highlighted in blue. These are the levels that are coded in parts A and C of the WMO message. The levels data can be previewed and printed from the File menu.

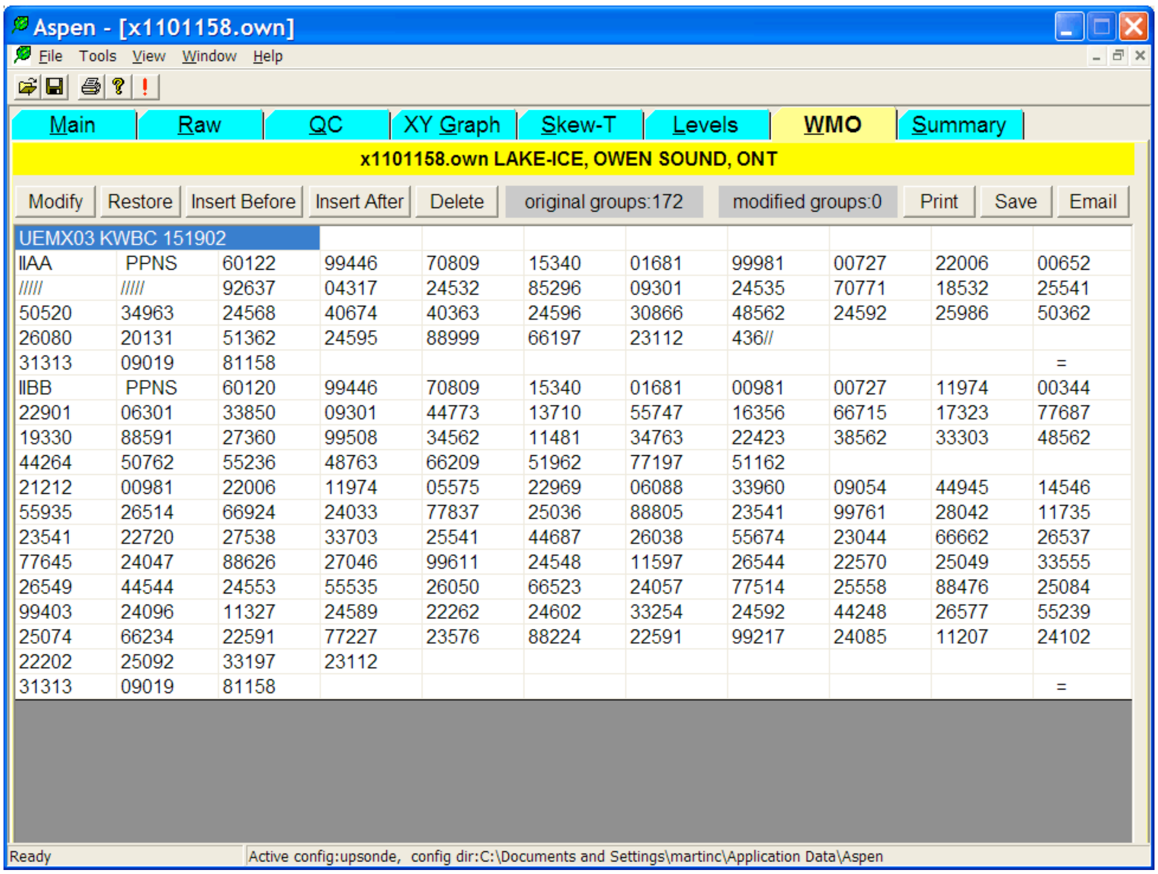
The levels listing may be sorted by any of the variables by clicking on the desired column heading. Clicking a second time in the same heading reverses the order of the sorting. It is typical to sort either by time or pressure, both of which will give similar results.

In certain cases the Aspen operator may wish to prevent particular levels from being coded in the WMO message. Clicking on a level in the Levels Tab will mark a level so that it is not coded. Excluded levels are marked with a red background. Click again on the level to toggle its status back for normal coding. Clicking on the temperature, RH, speed, direction or altitude fields will select that individual field and prevent it from being coded in the WMO message. Clicking on any other field (the columns to the left of these) will disable the whole level.

> *Not all variables are recorded for each level. This is because each level type is used to report only specific variable in the coded message. If a*

variable is not reported for a given level type, it is not calculated for that level.

WMO Tab



The WMO tab displays the WMO message, which has been coded from the levels information. It can be previewed and printed from the File menu, and also saved as a text file using the *Save* and *Print* buttons.

The WMO message can be emailed from within Aspen by pressing the *Email* button on this tab. The email recipient is specified by the "TempEmailAddress" configuration parameter. When the *Email* button is pressed, the default Windows mail client (e.g. Outlook or Outlook Express) is started, and the user is presented with an email editing window. If the message is being mailed to an automatic processing system, such as the NWS email GTS ingest gateway, then the mail client should be configured to send in plain text format, and to no wrap the text lines. Group or alias entries can also be made in the client address book (e.g. "GTS") to serve as the message recipient address.

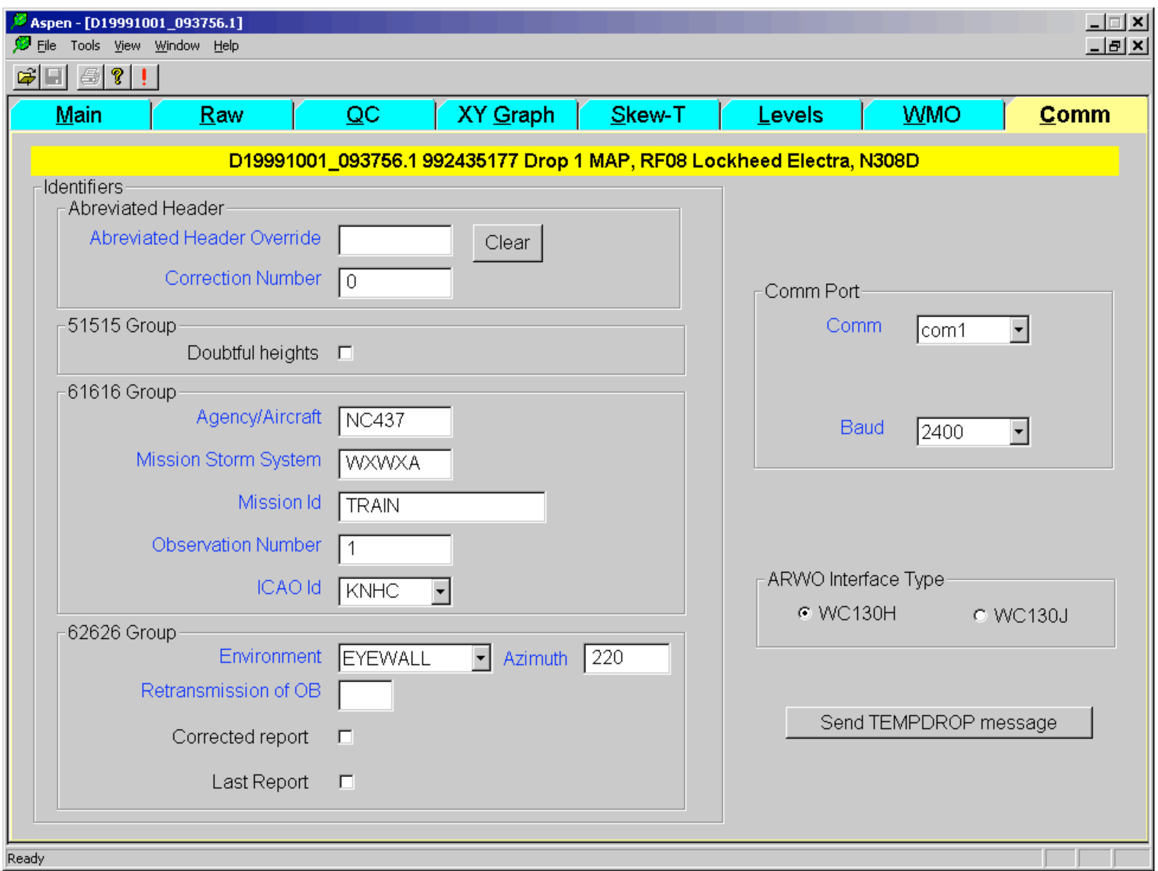
The format for the WMO message is very exacting, and there may be times when Aspen does not get the coding quite right. The buttons at the top left of the WMO tab allow the user to modify the WMO message if necessary. Use the mouse to select the code group to be edited, and press the appropriate editing button.

Some code groups, such as the abbreviated header, the 61616 group, and the 62626 group contain more than the nominal 5 characters. To select these groups for editing, you must click on the left end of the code group.

There are a number of administrative entries in the WMO message that are not derived from the levels data. These are items such as the abbreviated header, and information in the 61616 and 62626 groups. This information is managed on the Comm tab. When a field is changed on the Comm tab, the WMO message is adjusted accordingly.

If the sounding analysis is recomputed (from the Main tab), a new WMO message will be coded, and any edits made previously will be lost.

Comm Tab



The Comm tab is used to enter the administrative information that is coded in the WMO message. It also has controls for transmitting the WMO message via an attached interface on the USAFR WC130 aircraft. The field names should be self-explanatory.

Press the "Send TEMPDROP message" button to transmit the WMO message. A message box will pop up to indicate that the transmission is in progress.

Most of the data entry fields on the Comm tab are saved as soon as they are entered, and used as the defaults for the next sounding that is processed. Be sure to verify that the fields are correct before saving or transmitting the message.

Menu Commands

The menu commands will be familiar to anyone who has previously used Windows-based programs. Only the Tools Menu contains commands unique to Aspen.

File Menu

The File menu contains command choices that are generally applicable to all tabs within Aspen. There are cases when a command cannot be used with a particular tab. For instance, when the Main tab is selected, the File Save command is not enabled, since there is no data product associated with this tab. The following commands are found under the File menu:

Open…	Open a sounding file and begin the processing.
Close	Close the sounding.
Configuration.	Open the configuration editor (available only when no soundings are open.
Save…	Save data products associated with the tab.
Print…	Print the tab. The output print format will depend on the tab type.
Print Preview	Preview the print output.
Print Setup…	Configure the printer.

At the bottom of the File menu is a list of the most recently analyzed files. Sometimes it is convenient to go here to reopen a sounding that you have recently examined.

See the "Configuration" section for an explanation of the configuration management procedures.

Tools Menu

The Tools menu provides access to commands associated with the QC parameters, when a sounding is open. See the "Configuration" section for their description.

View Menu

The display of toolbar and status lines is controlled in the View menu.

Window Menu

The Window menu contains a listing of all of the soundings currently being analyzed by Aspen. Clicking on the file name will bring that sounding to the front of the display.

Toolbar

The Toolbar provides buttons that can be clicked instead of selecting some of the entries found on the drop-down menus. As with the File menu, the buttons that are enabled depend upon which tab is currently selected.

Quality Control Procedures

One of the main purposes of Aspen is to apply quality control algorithms to a sounding. These algorithms attempt to systematically detect data points that are likely to be incorrect, and remove them from the QC data set.

The processing begins with a copy of the original (raw) observations. In most cases, all parameters are considered separately. The main exception to this is the handling of the wind observations. In this case, the wind speed and direction are separated into *u* and *v* components, and the QC tests are individually applied. However, if one of the two components fails a test, then both components as well as the speed and direction are removed from the QC data.

There are other QC tests that depend upon the relationship between two variables; in some algorithms, the processing of a given parameter requires input from another parameter. For instance, the GPS-measured velocity is used as a discriminator for the horizontal wind observations. In another case, the dynamic adjustment procedure requires the time constant of the sensor making the measurement. This time constant is a function of density and ventilation rate, which are obtained from the pressure and vertical velocity.

The Algorithms

The following table lists the QC processing steps, in the order that Aspen applies them. Also listed are the sounding direction and variables to which each step is applied. Following the table is a more detailed description of each step.

Table 1. QC Processing Steps

Procedure		Sounding Direction		Variable				Note
		Dn	Up	P	T	RH	Wind	
1.	Launch parameter overrides	✓	✓	✓	✓	✓		a
2.	Copy raw data set to QC data set	✓	✓	✓	✓	✓	✓	
3.	End of drop override	✓	✓	✓	✓	✓	✓	
4.	Ambient equilibration	✓		✓	✓	✓		
5.	Apply fixed offsets	✓	✓	✓	✓	✓		

Procedure		Sounding Direction		Variable				Note
		Dn	Up	P	T	RH	Wind	
6.	Limit Check	✓	✓	✓	✓	✓	✓	
7.	Satellite Check	✓	✓				✓	b
8.	Buddy Check	✓	✓	✓	✓	✓	✓	
9.	Outlier Check	✓	✓	✓	✓	✓	✓	
10.	Filter Check	✓	✓	✓	✓	✓	✓	
11.	Pressure Smoothing	✓	✓	✓				
12.	Monotonic Pressure Check	✓	✓	✓				
13.	Temperature Dynamic Adjustment	✓	✓		✓			
14.	RH Lower Limiting	✓	✓			✓		
15.	Final Smoothing	✓	✓		✓	✓	✓	
16.	RH Lower Limiting	✓	✓			✓		
17.	Pressure Adjustment	✓		✓				
18.	Compute Vertical Velocity	✓	✓					
19.	Vertical Velocity Check	✓	✓				✓	b
20.	Create Surface Observation	✓		✓	✓	✓		
21.	Winds Dynamic Adjustment	✓	✓				✓	
22.	Compute Altitude	✓	✓					
23.	Compute Position	✓	✓					

Procedure	Sounding Direction		Variable				Note
	Dn	Up	P	T	RH	Wind	
Notes: a: Launch parameter override for the winds will be available in a future version b: GPS based winds only c: Dependent upon sonde type							

A description of each processing step follows. If the step can be adjusted via a configuration parameter, the title for the configuration item is listed, as it appears on the Aspen configuration-editing dialog. See the Configuration section for details on managing Aspen configurations.

1. ***Launch parameter overrides*** *Dn Up P T RH*

The user-specified launch parameter overrides, if any, are substituted for the ones given in the data file.

2. Copy raw data set to QC data set *Dn Up P T RH Wind*

The QC data set is initialized with a copy of the original observation. If the option is chosen to discard frames with CRC errors, these frames are not copied to the QC data set, except for the very last frame in the original observation (applies only to AVAPS dropsonde soundings).

3. End of drop override *Dn Up P T RH Wind*

If the user has specified an end of drop time, all data beyond this time is ignored.

4. Ambient equilibration *Dn P T RH Wind*

A dropsonde undergoes an extreme change in environment when exiting the aircraft. The pressure, temperature and RH sensors require a significant time period to get close to the ambient conditions. This equilibration time is calculated to be 7 times the time constant of the sensor, and data within this period is discarded.

The temperature time constant is dependent on the ventilation rate (which is the fall rate), and the air density. Right at the dropsonde launch, the pressure sensor is undergoing extreme changes, and cannot be used to determine the dropsonde fall rate. For this reason, a theoretical fall rate is calculated, which is based on the force balance between the parachute drag and the mass of the sonde. This fall rate has been shown to be reasonably accurate. The aircraft measured temperature and pressure, or the first observed values in the sounding, are used to calculate the density, and the temperature time constant at launch is computed using these parameters.

The ambient equilibration region for pressure is set equal to the temperature region, so that pressure and temperature have the same data coverage at the top of the sounding.

An empirically determined formulation for the RH time constant is used.

5. *Apply fixed offsets* *Dn Up P T RH*

Fixed offsets can be added to the measurement. *Configuration Item: Offset to Add*

6. *Limit Check* *Dn Up P T RH Wind*

Absolute bounds checks are used to discard measurements falling outside of hard limits. The limits are set at:

Table 2. Limit Check Bounds

Parameter	Minimum	Maximum
P	1 mb	1200 mb
T	-100 °C	50 °C
RH	0 %	100 %
Wind Speed	0 m/s	150 m/s
Wind Direction	0	360

7. ***Satellite Check*** *Dn Up Wind*

GPS-derived winds are not reliable if an insufficient number of satellites are used in their computation. If the number of satellites falls below a minimum, the associated wind observations are discarded. *Configuration item: Number of Satellites*

8. *Buddy Check* *Dn Up P T RH Wind*

This test uses the data points on either side of an observation to check for consistency, and is useful for detecting and removing wild points. Since the neighboring points may be separated from the observation by varying time deltas, the buddy check thresholds are specified in terms of change per unit time. A point is discarded if it shows a change greater than the limit for one neighbor, and a change greater than the limit, but of the opposite sign, for the other neighbor. *Configuration Item: Buddy Check Slope*

9. *Outlier Check* *Dn Up P T RH Wind*

A least-squares linear fit to the data series is calculated. Data points that are greater than a specified multiple of the standard deviation from the linear fit are removed from the data set. *Configuration Item: Outlier Check*

10. *Filter Check* *Dn Up P T RH Wind*

A copy of the data series is low pass filtered at a given wavelength. Data points are removed if they differ from the filtered series by greater than a specified deviation. *Configuration Items: QC Filter Wavelength, QC Filter Deviation*

11. Pressure Smoothing *Dn Up P*

The smoothing is applied to the pressure data. The pressure needs to be smoothed before the pressure monotonic check. If the final smoothing wavelength is set to 0, this is not applied. A small amount of final smoothing should almost always be applied to pressure, so that reverse trends in pressure caused by noise will not cause a data point to be discarded. *Configuration Item: Final Smoothing*

12. Monotonic Pressure Check *Dn Up P*

The pressure trace must change monotonically in order for pressure-based searching to be performed. The pressure time series is scanned; when a point is found which follows an incorrect trend (i.e. decreasing for a dropsonde, increasing otherwise), it is removed from the series.

13. Temperature Dynamic Adjustment *Dn T*

The temperature is adjusted for the time lag related to the sensor time constant. The time constant is a function of the sonde ascent rate and the density. An empirically determined relation for the sensor time constant, as a function of pressure and ascent rate, is used.

The series is first smoothed using the temperature dynamic correction smoothing wavelength. This smoothed series is used to compute a time tendency for each data point. Each observation is then adjusted by adding to it the product of the time constant and tendency. *Configuration items: Dynamic Correction On-Off and Dynamic Correction Wavelength*

14. RH Lower Limiting *Dn Up RH*

RH values less than 0.2% are set to 0.2%.

15. Final Smoothing *Dn Up T RH Wind*

The series are smoothed using the final smoothing wavelength. If the final smoothing wavelength is set to 0, this is not applied. *Configuration Item: Final Smoothing*

16. RH Lower Limiting *Dn Up RH*

RH values less than 0.2% are set to 0.2%.

17. Pressure Adjustment *Dn P*

If a surface pressure is specified on the main tab, it is proportionally applied to the pressure profile as a function of time. Thus the bottom pressure value becomes the specified pressure, and the launch pressure is unchanged, with a proportional adjustment applied between these points.

18. Compute Vertical Velocity *Dn Up P*

The pressure series is first smoothed using the final pressure-smoothing wavelength. The time tendency of the pressure is then computed at each data point. The time-differentiated hydrostatic equation is then used to compute the vertical velocity.

19. Vertical Velocity Check *Dn Up Wind*

The GPS-measured fall velocity is a good discriminator for the quality of the GPS-derived horizontal wind. If the difference between the hydrostatically determined fall velocity and the GPS-measured velocity is greater than the specified limit, the horizontal wind point is discarded. *Configuration item: Vertical Velocity Threshold*

20. Create Surface Observation *Dn P T RH*

In order to achieve as accurate a surface pressure reading as possible, a procedure is applied which attempts to account for the distance the dropsonde fell to the surface after the last data point was reported. Empirical estimates of this distance are used to extrapolate the last surface pressure measurement to the surface. The last temperature and RH are simply duplicated for the surface measurement, since the distance is generally on the order of 5 meters. These fabricated measurements of pressure, temperature and RH are appended to the data series.

21. Winds Dynamic Adjustment *Dn Up Wind*

Each wind component is adjusted with the formula: $u_{new} = u_{obs} - (du/dt)*(dz/dt)/g$. The wind component series is first smoothed, using the winds dynamic correction smoothing wavelength for the component. This smoothed series is used to compute a time tendency for each data point. The observation is then adjusted according to the formula, using the previously calculated vertical velocity for dz/dt. *Configuration items: Dynamic Adjustment On-Off and Dynamic Correction Wavelength*

22. Compute Altitude *Dn Up*

The hydrostatic equation is integrated from the surface upwards. For dropsondes, the same computation may be made from the launch altitude downward. See the **Post-Processing Adjustment** section for a description of dropsonde height computations.

The downward height integration requires both a starting altitude and a starting pressure. If the pressure at launch time for a dropsonde is not available (a common situation on many aircraft), the first raw pressure point from the dropsonde is used as the launch pressure, but only for the purpose of height computation. This unwarranted assumption can lead to significant height errors if the raw sonde pressure data is late or inaccurate.

23. Compute Position *Dn Up*

The horizontal winds are used to integrate the sonde location from the initial launch position. If a time gap of greater than maximum position integration interval (a configuration parameter) occurs in the wind measurements, the integration terminates.

The position integration requires an initial position to start the integration. Similarly, an initial wind speed and direction at the launch point are used in the integration. If these are not available, Aspen will use the first Q/C wind speed and direction as the launch point value. This unjustified assumption thus assumes a constant wind profile at launch, in the absence of a wind measurement at the launch point. *Configuration Item: Position Interpolation*

Guidelines for Adjusting QC Parameters

The supplied default values for the Aspen Q/C parameters in general produce excellent results. However, there may be times when a group of soundings have peculiar error characteristics, and the Q/C paramaters need to be modified in order to produce better discrimnation against outliers. Some tips for adjusting the configuration parameters are given here. The user should carefully read and understand the descriptions of the Q/C algorithms given in the preceeding section; this will provide the best guidance on modifying the Q/C parameters to match the error characteristics of the sounding data.

- Toggle the display of raw data off and on in order to see which data points are being rejected by the algorithms. Toggle the “mark points” option, and use the zoom and pan capabilities freely to investigate the effectiveness of the procedures. Stay zoomed in on a region when modifying configuration parameters, and use the “!” (recompute) button to reprocess the sounding, so that the new results are displayed immediately in the zoomed region.
- If the sounding system does not report the number of GPS satelittes used in the winds calculation, set the GPS satellite threshold to 0, so that winds are not discarded due to a lack of satellites.
- The most frequently adjusted parameters are the the *QC Filter Wavelength* and the *QC Filter Deviation,* which are used in the filter check and are applied together. In this algorithm, a smoothed curve is calculated from the data series. If the filter wavelength is small, the curve will closely follow the data; if large the curve will be a very smooth representation of the data. The deviation is the amount that a data point is allowed to deviate from the smoothed curve. If the difference between the curve and the raw data point is larger than the deviation, the data point is discarded. The interplay between the amount of smoothing and the allowed deviation allow for wide latitiude in tuning the filter check algorithm.
- The dynamic adjustments for temperature and wind speed can significantly increase the variance of the data series. If the Q/C results appear noiser than the raw data, it will be due to the dynamic adjustments. Use of the dynamic adjustments is the perogative of the user, and can be deactivated in the configuration. Note that the tendency of the series, used in the adjustment, is calculated from a smoothed version of the data. The dynamic correction smoothing wavelength is used for the smoothing value during the dynamic adjustment procedure. If a very small smoothing wavelength is specified, the variance increase in the Q/C data can become significant.

Configuration

Aspen is very flexible and can produce a large variety of output products. It will analyze data from a number of different sounding systems. In order to tailor it for differing applications, Aspen provides a configuration system. This same system is used to configure Aspen, BatchAspen and AspenQC, and the configuration information is shared between each of these programs.

Configuration Items: At the heart of the configuration system is the *configuration item*, which matches a keyword with a current value, and a default value. The keyword identifies a particular characteristic to be used during the next Aspen analysis; e.g. the smoothing wavelength to be applied the pressure field, or the mass of the dropsonde.

Configuration sets: A family of configuration items is collected in a *configuration set*. Configuration sets are assigned names, and a named set is chosen as the currently active one, to be used the next time that Aspen is run. In this way, users can create configuration sets that are tailored to a particular instrument, environment, or field program, and switch between them as needed.

The Active Set: At any time, one of the named configuration sets is designated as the active set. This means that any further processing with Aspen or BatchAspen will use the configuration items from the active set. **It is critical that the user verify that the correct set has been designated as active when processing soundings.**

A user interface is provided within Aspen and BatchAspen for manipulating the Aspen configuration. This is divided into two activities. The first is the management of the configuration sets: creating, deleting and activating a set. The second is modification of the configuration items within a selected set.

Note that within Aspen, the management of the configuration sets can only be initiated from the File menu, when no soundings are currently open. Configuration items for any named set may be modified at this time also. However, configuration items for the currently active set may also be modified when soundings are open within Aspen.

aspen.xml: The configuration information is stored in XML[1] format, in a file named *aspen.xml*. A "Document Type Definition file", *aspen.dtd*, accompanies aspen.xml, and must be located in the same directory. See the Appendix A: Configuration Parameters, for a description of aspen.xml.

The location of these files depends upon the version of Windows, as well as the *ASPENCONFIG* environment variable. When Aspen first runs, it checks to see if *ASPENCONFIG* is set. If it is, Aspen then checks for the existence of the configuration

[1] XML: Extensible Markup Language; this is a widely used standard for defining structured data, and is used extensively in Web applications.

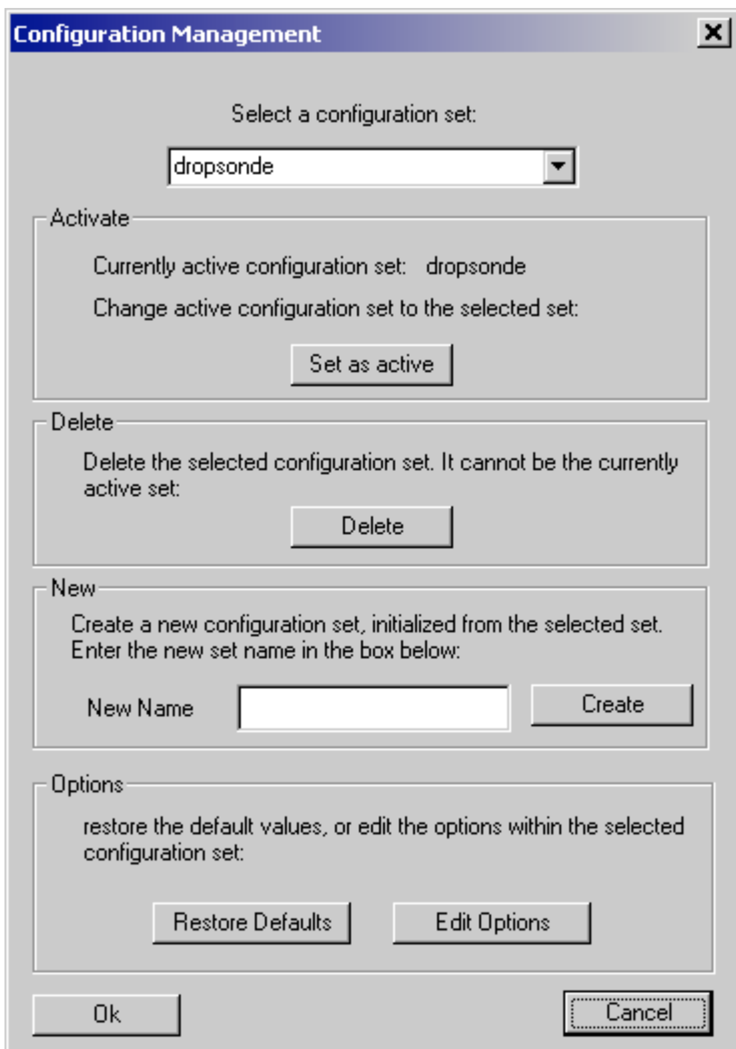
files in that directory. If the files are not found, Aspen offers to copy default configuration files to that directory.

If *ASPENCONFIG* is not set, Aspen will assume directories for the configuration files, according to the following:

- For Windows 98 systems: The directory where Aspen is installed
- For Windows NT/2000/XP systems: C:\Documents and Settings\<user name>\Application Data\Aspen\. This scheme allows individual users to maintain private versions of the configuration files.

Configuration Set Management

Management of the configuration sets is available through the File->Configure… menu within Aspen and BatchAspen. Choosing this item will cause a configuration set management dialog to open, from which configuration sets may be activated, deleted, created and edited:



The selection drop down box at the top of the dialog is used to select the named configuration set that all other operations will reference. The selected set can be activated, deleted, or edited using other buttons in the dialog. To create a new configuration set, select an existing set to be used a source set, enter a name in the box, and hit the Create button.

When all configuration editing actions are finished, hit the Ok button to save them, or the Cancel button to discard the changes.

The actual configuration items for the selected configuration set can be edited by hitting the Edit button. This will bring up a dialog from which the quality control parameters and other options can be modified. See the "Changing the QC Parameters" section (below) for details on modifying the configuration items from this dialog.

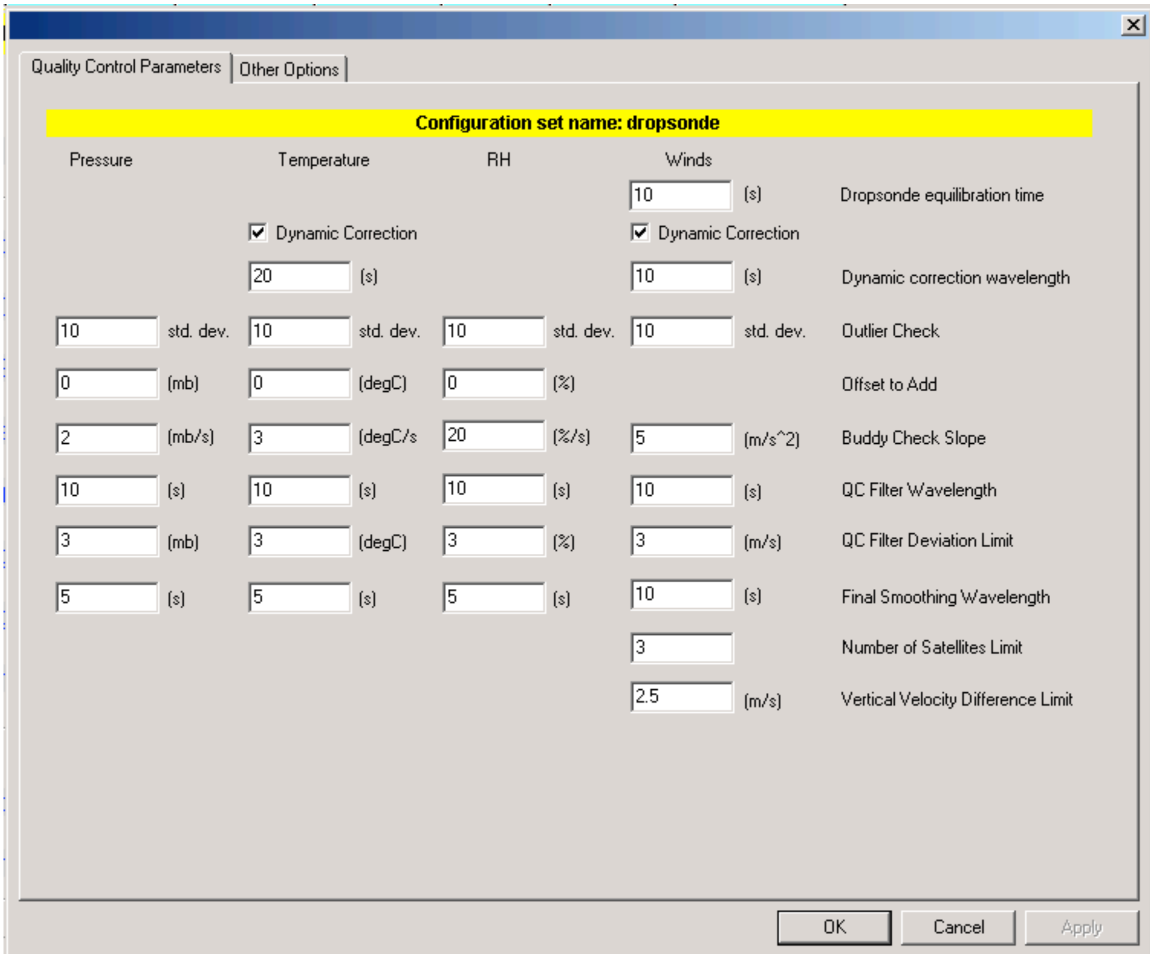
Hitting the Restore Defaults button will restore the entire set of configuration items for the selected set, restoring them to their default values.

The Sample Configuration Set: There is a special configuration set, named *sample*, provided with Aspen. This set cannot be activated, deleted or edited. It is available as a default set that can be used as the source when creating a new configuration set.

> *Remember that within Aspen, the configuration editor is only available (from the File->Cofigure… menu) when no soundings are open. When soundings are open in Aspen, the options for the currently active configuration set can be edited from the Tools->Options menu.*

Changing the QC Parameters

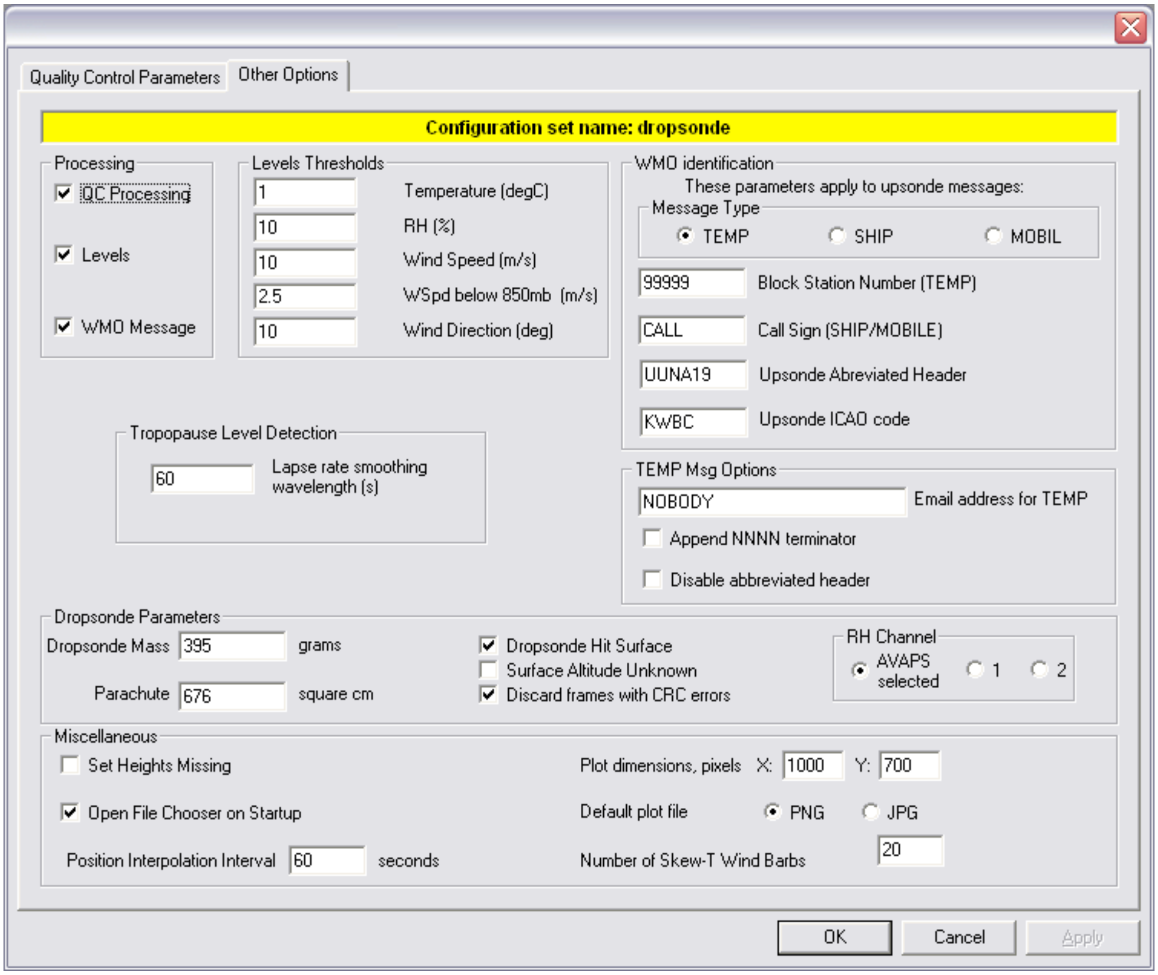
In order to configure Aspen to match your particular requirements, the configuration items (i.e. parameters) within a configuration set must be properly specified. This can be initiated from either the configuration management menu (File->Configure…->Edit Options) when no files are open, or from the options menu (Tools->Options…). A tabbed property sheet will open, containing two tabs. The "Quality Control Parameters" tab is used to configure quality control parameters:



The quality control parameters are used to adjust the various quality control algorithms, and are described in the “Quality Control Procedures” section.

Other Options

The “Other Options” tab provides further options for the processing of sounding data:



QC Processing. In normal usage, this feature should always be enabled. If it is turned off, Aspen will only display the raw sounding data. This may be useful if you want a quick look at a large data set without waiting for processing.

Levels – WMO message. These two features should always be enabled if WMO messages are the ultimate data product (e.g. weather reconnaissance). For all other soundings, these features may be turned off.

Levels Thresholds. These five parameters set the thresholds used in the determination of the GDL levels for the designated measurement. They should be modified with caution, since this would result in a deviation from the specifications of the FMH-3.

Tropopause Level Detection: Lapse Rate Smoothing Wavelength. This is the wavelength of the smoother that will be applied to the temperature data before the automatic determination of tropopause levels is made. A tropopause is identified by the derivative of the temperature lapse rate, and so a high variance in temperature can lead to the creation of unrealistic tropopause levels.

WMO Message Type. Choose the type of TEMP message to be generated for an **upsonde** sounding.

Block Station Number and Call Sign. These are identifiers that are required either for the TEMP, TEMPSHIP, or TEMPMOBILE messages.

Upsonde Abbreviated Header. The WMO abbreviated header for upsonde WMO messages. (Note that dropsonde abbreviated headers are specified on the Comm tab).

Upsonde ICAO Code. ICAO code for upsonde abbreviated headers. (Note that dropsonde ICAO codes are specified on the Comm tab).

Email address for TEMP. Address to receive an emailed WMO message.

Append NNNN Terminator. If checked, append NNNN to the WMO message when it is saved or emailed. Some communications systems, such as the GTS, require this terminator.

Disable Abbreviated Header. If checked, the abbreviated header will not be generated for the WMO message. This is useful in the common situation where another system generates the abbreviated header.

Dropsonde Mass and Parachute Area. The dropsonde mass and parachute area are required in order to estimate the initial fall speed of the dropsonde, after launch from the aircraft. The values differ only from the defaults in special cases where a custom parachute or modified sonde are deployed.

Dropsonde Hit Surface. This box is checked if the dropsonde was believed to have hit the surface. This causes the sounding altitudes to be integrated from the surface altitude upwards; otherwise they will be integrated from the flight level altitude (if available) downward. If checked it also allows the computation of an extrapolated surface data point.

Surface Altitude Unknown. Check this box if the dropsonde was believed to have hit the surface, but the surface altitude is unknown, as in a dropsonde landing on the earth. It causes the height integration to be performed from flight level down.

Discard frames with CRC errors. If this box is checked, data frames that are marked as having a CRC error are discarded. This only applies to AVAPS dropsonde soundings.

RH Channel. The AVAPS/Dropsonde based systems use a radiosonde that carries dual relative humidity sensors. The firmware in the sonde chooses the humidity value from one of them, and the selected channel is reported in the main RH field of the “D” file. The original values for both sensors are reported in additional columns in the file. The user can elect to use the sonde chosen value (AVAPS selected), or either of the original sensor values (RH1 or RH2).

Set Heights Missing. Check this box to cause the height computations to be skipped, in cases where the operator does not trust the data to provide for accurate height integration.

Open File Chooser on Startup. If this box is checked, a File Chooser dialog will open as soon as aspen is started. Otherwise, the File menu can be accessed in order to select a file to process.

Position Interpolation Interval. Set the maximum time interval over which the winds can be interpolated for the position integration calculation. If the gap in winds is greater than this interval, the winds will not be interpolated and the position integration will stop.

Plot dimensions, pixels. Specify the X and Y dimensions, in pixels, for graphics output files.

Default plot file. Choose either PNG or JPG as the default choice for the output graphics file format. The user can also choose the file type at save time. PNG is the recommended format.

Generate Q/C diagnostics file. Select this to cause a file with Q/C diagnostic information to be created. The file name will begin with '*AspenDebug*' and have a *.txt* extension. It will be created either in the directory where the Aspen program is installed, or the directory where the first data file is located. Be sure to disable this option when finished, otherwise diagnostic files will be created every time Aspen is run.

Saving Changes and Restoring Defaults

When the user closes a sounding in which the QC parameters have been changed, a dialog box asks if these parameters should be saved as the processing defaults. All soundings opened after this time will be processed using these options. The Tools menu provides a command, Tools➞Restore Defaults, which can be used to restore the options to initial system defaults. Thus the customized parameters will revert to the initial installation defaults.

The user may also revert the QC parameters to the initial installation defaults before opening any soundings. This is done via the File Configure…Restore Defaults button (available only when no soundings have been opened).

When in doubt about the proper values of the QC parameters, restore the defaults.

Corrupted Configurations

As mentioned above, the configuration information is stored in the *aspen.xml* file. If the configuration file becomes corrupted, Aspen will not be able to run, and the file will need to be repaired or restored.

The file "*AspenOriginal.xml*" is provided as a copy of the orginally distributed configuration file, and is located in the Aspen installation directory (typically "C:/Program Files/ NCAR/Aspen". In the worst case, this file can simply be copied over *aspen.xml* (note that the file name case is significant). This will restore Aspen to the default configuration parameters, but all changes or additions that have been made to the configuration will be lost.

If the *aspen.xml* file is only slightly corrupted, it may be possible to correct the error with a text editor. A simple way to locate a syntax error is to open *aspen.xml* in Internet Explorer, which provides structured viewing of XML files. Internet Explorer will indicate lines that do not parse correctly, and then a standard text editor may be used to fix minor problems.

BatchAspen

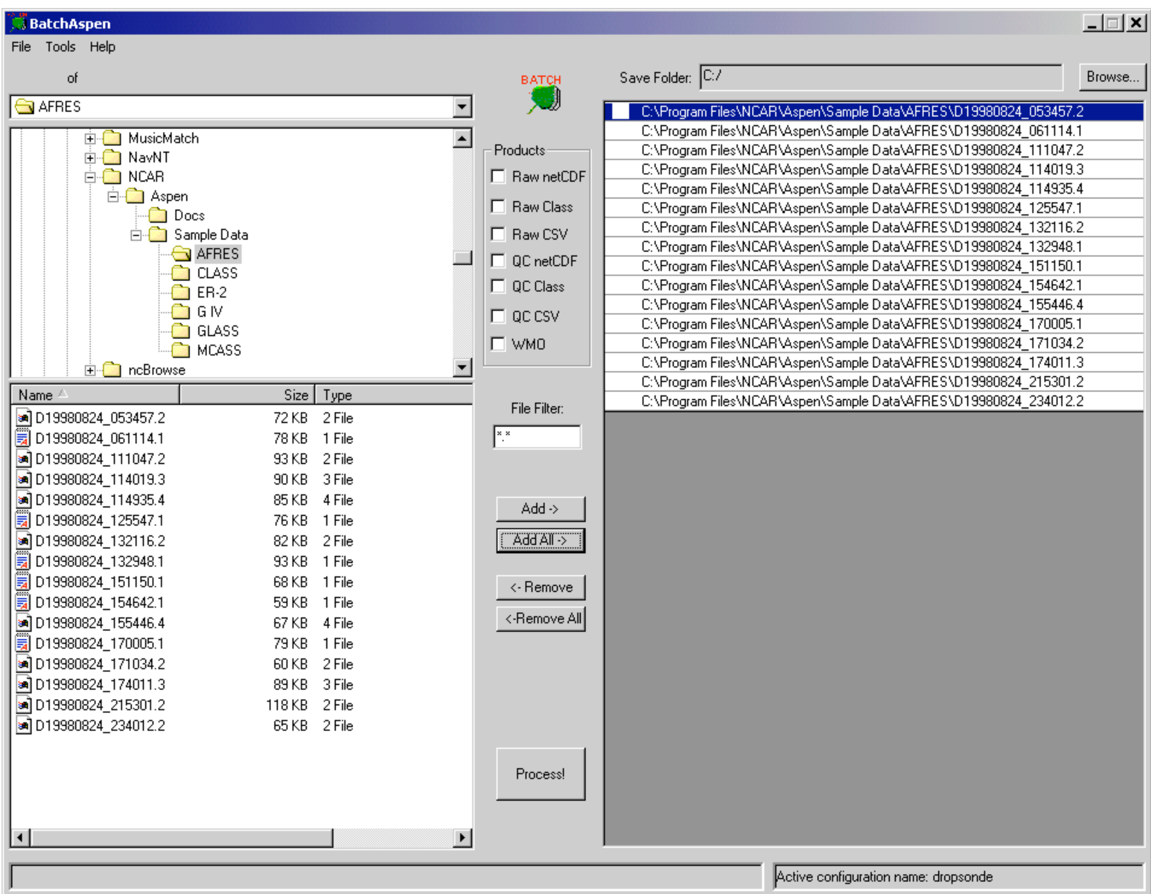
BatchAspen is a separate application that is used to apply the Aspen Q/C procedures to a collection of sounding files. The user selects the data products to be created. The program then iterates over the list of files, placing the results in a specified destination directory.

BatchAspen shares an exact copy of the Q/C processing algorithms that are used by Aspen, so that identical results for both programs can be guaranteed.

Starting BatchAspen and Selecting Files

Start the application by clicking on the BatchAspen icon 

. A single screen will be presented. The screen is roughly divided into left and right sections, with control buttons in between. The left side is used to select the files to be processed. The right side specifies the output file destination and the processing list:



On the left side, there are two independent directory browsers, either of which can be used to navigate into directories containing input files. The files in the selected directory are shown in the file selector in the lower left. The display of file types can be restricted using the "File Filter" in the center edit box.

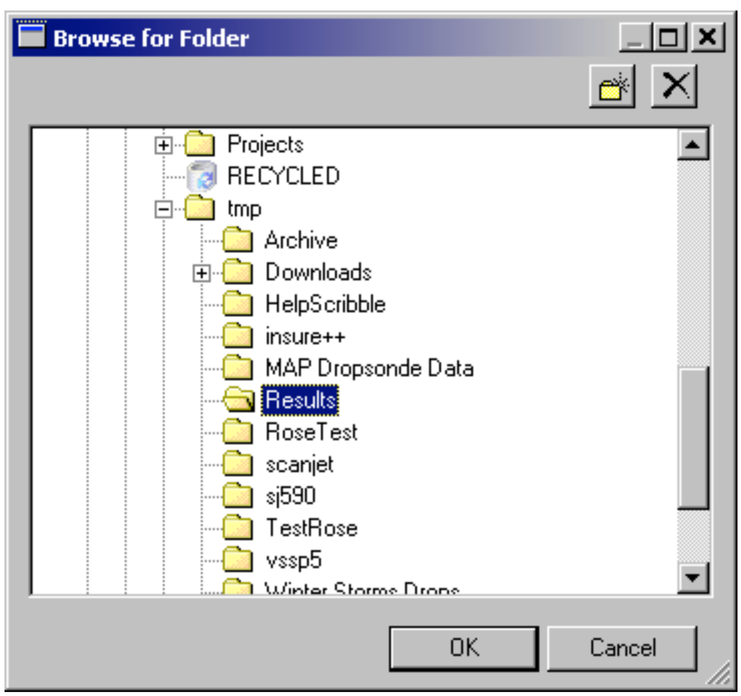
Individual files can be selected, using the standard Explorer left-click, shift-left-click, and ctrl-left-click mouse selection commands. Once the desired files are chosen, press the "Add->" button to add them to the processing list on the right side of the screen. Pressing "Add All->" will cause all of the displayed files to be added to the processing list.

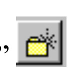
Selected files can also be dragged from the file selector and dropped into the processing list.

Files from multiple directories can be collected in a single processing list. However, all output files will be created in a single directory.

Files may be removed from the processing list by selecting them in the processing list, and pressing the "<-Remove" button, or press "<-Remove All" in order to empty the list completely.

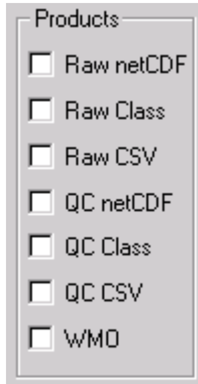
To select the output directory, hit the "Browse" button above the processing list. A folder browser will pop up; use it to select the folder for the output files.



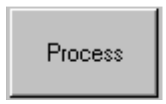
Create a new folder by pressing the "new folder"  button.

Q/C Processing

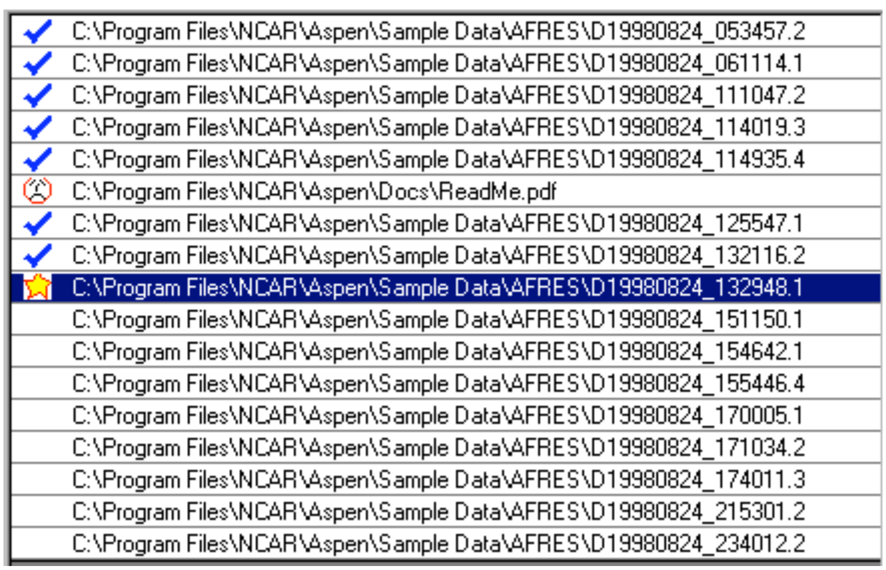
The desired output products are chosen using the toggles:



An output file of each selected type will be created for each input file.

To begin the processing, hit the 

button. BatchAspen will start processing each file, starting at the beginning of the list. A status indicator will appear next to each file, with a yellow star denoting the file currently being processed. A check mark indicates that the file was successfully processed; an unhappy face denotes a file that could not be processed.



During the processing of each file, the status box at the top of BatchAspen provides a running display of the Q/C processing steps.

When processing is underway, the "Process" button changes to 

. To stop the processing before the end of the list has been reached, press Abort. BatchAspen will stop when the processing of the current file has completed[2].

Q/C Parameters

BatchAspen uses the same configuration scheme as Aspen, which is documented fully in the "Configuration" section. As with Aspen, activating the File->Configure… menu item will display the configuration management interface.

> *The configuration set that is designated as active is used by both Aspen and BatchAspen.*

[2] This may take up to several minutes on a slow machine.

AspenQC

AspenQC is a version of Aspen that performs the Q/C and message coding functions, but does not provide a graphical user interface. Therefore, it can be run from shell scripts or the command line, to process a sounding data file in a standalone mode. The same Q/C and coding algorithms used in Aspen are incorporated into AspenQC.

A Windows executable file, *AspenQC.exe,* is provided in the Aspen Windows distribution. AspenQC can be compiled and run under Linux. Contact NCAR in order to obtain the source code for Linux.

AspenQC uses the same XML configuration file as Aspen, located in the ASPENHOME directory.

Switches

Command line switches control the processing and output products from AspenQC:

```
usage: AspenQC [-i|--input <sounding file>]
               [-e|--csv [<output csv file>]]
               [-c|--class [<output class file>]]
               [-w|--wmo [<output wmo file>]]
               [-n|--netcdf <output netcdf file>]
               [-v|--verbose]
               [-s|config <config set name>]
               [-a|--csvattributes] [-h|--help]
```

- *i* – the name of the input data file. AspenQC will automatically determine the file type, and as with Aspen, will make assumptions about the type of souding, dependent on the file format. AVAPS, CLASS, GLASS, MCASS and CSV format files can be processed. If this parameter is missing, the data are read from standard input.
- *e* – Generate a CSV format output file (“-e” is meant to indicate *E*xcel, since CSV files are the best method for transferring data between AspenQC and Excel).
- *c* – Generate a CLASS format output file.
- *n* – Generate a netCDF format output file.
- *w* – Generate a WMO message.
- *v* – Print (verbose) status messages as the processing proceeds.

- *s* – Specify a config set name to override the one selected by the <active> tag in the XML configuration file.
- *e* – If a CSV file is being created, print the configuration attributes at the beginning of the file.
  Note that these will not be interpreted or used when a CSV file is used as input to AspenQC.
- *h* – Print out the usage statement.

The output format specifiers (*-e, -c, -w and –n)* can take an optional file name, to which the data will be written. If not provided, the data will be written to the standard output.

An example of an AspenQC usage would be:

```
AspenQC –i classData.dat –a –e classData.csv
```

Input File Types

Aspen can process sounding data that is provided in the following file formats:

- NCAR AVAPS GPS Dropsonde “D” files
- NCAR GLASS Upsonde files
- NCAR GAUS Upsonde files
- NCAR CLASS Upsonde files
- NCAR MCASS Upsonde files
- “Comma Separated Values” (CSV) (MS Excel compatible)[3]

  Warning: Aspen automatically detects the format of the file that it opens, and assumes that the sounding contained is from the associated instrument. This can lead to ambiguities, if Aspen is used to process a file that it has written. For instance, if dropsonde data are saved by Aspen in “CLASS” format, and then this file is used as input to Aspen, the program will assume that the data are from an upsonde sounding, rather than a dropsonde. This can lead to erroneous results within Aspen, since the characteristics of the sounding system affect the processing procedures.

Output files can be produced for data products in the following formats:

Table 3. Output File Types

Data Product	File Output Formats
Raw data	NetCDF CSV NCAR CLASS format ASCII text NCAR EOL format ASCII text
QC data	NetCDF CSV NCAR CLASS format ASCII text NCAR EOL format ASCII text
Graphics	JPG PNG

[3] See Comma Separated Values (CSV) on page 50 for a more general description of Aspen compatible CSV files.

Data Product	File Output Formats
	(or use Alt-PrtSc for clipboard capture)
Levels	None
WMO message	ASCII text

Appendix A: Configuration Parameters

The Aspen configuration is stored in XML format. There are two files: *aspen.xml* and *aspen.dtd*. *aspen.xml* contains the actual configuration values, while *aspen.dtd* defines the syntax of the *aspen.xml* file.

Explanation of the structure of XML files is beyond the scope of this manual. However, given an existing XML file, it is not difficult to discern the layout of the information[4]. XML elements are delineated by start and end tags, and are nested to create a hierarchical data structure. *aspen.xml* observes the following structure:

```
<aspenConfig>
      <active>dropsonde</active>
      <set name="sample">
            <option name="SetHtsMissing" type="bool">
                  <current>false</current>
                  <default>false</default>
            </option>
            .
            .
            .
            <option name="WindSmoothWL" type="numeric">
                  <current>10.000000</current>
                  <default>10.0</default>
            </option>
            <option immediate="true" name="IcaoIndex" type="numeric">

                  <current>1.000000</current>

                  <default>1</default>

            </option>
      </set>
      <set name="dropsonde">
      .
      .
      .
      </set>
</aspenConfig>
```

Thus, the Aspen configuration contains one entry (*<active>*), designating which named configuration set is active, followed by one or more named configuration sets (*<set>*).

[4] This is particularly easy if the the file is examined with an XML capable browser, such as Internet Explorer.

Each configuration set contains a list of configuration options (<*option*>), with the current and default values for each option. Each option has a designated type:

- *bool* – boolean, with a value of either true or false.
- *numeric* – A floating point numeric value.
- *string* – A text string.

An option may also be marked with "*immediate=true*" to effect an immediate save of the option when it is changed. It is useful for some options to be saved immediately after they are changed, before closing the sounding in Aspen, so that when the next sounding is analyzed, it will immediately use the new version of the option. For instance, if the dropsonde operator on the Hurricane Hunter aircraft opens a sounding, and then changes the ICAO value for the TEMP message, it is likely that all soundings opened during the same run of Aspen should use this value for the ICAO string. An immediate save allows the configuration to be updated, without having to close that sounding.

The following table gives a description of the configuration options.

The case of the configuration item name is critical. It must be matched exactly as shown.

Element name	Type	Description
SetHtsMissing	bool	Corresponds to the "Set heights missing" checkbox on the main tab, which causes height computations to be skipped.
DropsondeHitSfc	bool	Corresponds to the "Dropsonde Hit Surface" checkbox on the main tab, indicationg that the dropsonde sounding terminated with hitting the surface.
SfcAltUnknown	bool	Corresponds to the "Surface Altitude Unknown" checkbox on the main tab, which when set causes the upward height computation to be skipped.
DiscardBadCrcData	bool	Set true if frames with CRC errors are to be discarded. (AVAPS dropsondes only).
ReportObservedPos	bool	If true, the sonde position reported in the input file will be used in place of the winds integrated position. Lat and Lon from the input file will go directly into output products and the tabular displays. This can be utilized to take advantage of sondes which report GPS positions directly. The default is

Element name	Type	Description
		false.
WindSmoothWL	numeric	Final smoothing wavelength. Set this to 0 to disable final smoothing.
WindQCWL	numeric	Filter check smoothing wavelength.
WindDynCor	bool	Enable dynamic correction.
WindDynCorWL	numeric	The wavelength used when smoothing the wind data prior to calculating the derivative used in the dynamic correction.
WindBuddySlope	numeric	Buddy check slope limit.
WindQCDev	numeric	Filter check deviation limit.
WindsDisableQCFilter	bool	Do not perform the QC filter for the winds.
WindOutlier	numeric	Outlier check number of standard dev. limit.
WindsDisableOutlierCheck	bool	Do not perform the outlier check for winds.
WindSats	numeric	Minimum number of GPS satellites required in wind solution.
WindVVdelta	numeric	Vertical velocity check limit.
WindEquilTime	Numeric	For dropsondes, winds falling within this time period from the launch will be discarded.
PresSmoothWL	numeric	Final smoothing wavelength. Set this to 0 to disable final smoothing.
PresQCWL	numeric	Filter check smoothing wavelength.
PresBuddySlope	numeric	Buddy check slope limit.
PresQCDev	numeric	Filter check deviation limit.
PresOutlier	numeric	Outlier check number of standard dev. limit.
PresOffset	numeric	Offset correction.
TdryQCWL	numeric	Filter check smoothing wavelength.

Element name	Type	Description
TdryDynCor	bool	Enable dynamic correction.
TdryDynCorWL	numeric	The wavelength used when smoothing the temperature data prior to calculating the derivative used in the dynamic correction.
TdryQCDev	numeric	Filter check deviation limit.
TdryOutlier	numeric	Outlier check number of standard dev. limit.
TdryOffset	numeric	Offset correction.
TdryBuddySlope	numeric	Buddy check slope limit.
TdrySmoothWL	numeric	Final smoothing wavelength. Set this to 0 to disable final smoothing.
RHSmoothWL	numeric	Final smoothing wavelength. Set this to 0 to disable final smoothing.
RHQCWL	numeric	Filter check smoothing wavelength.
RHBuddySlope	numeric	Buddy check slope limit.
RHQCDev	numeric	Filter check deviation limit.
RHOutlier	numeric	Outlier check number of standard dev. limit.
RHOffset	numeric	Offset correction.
TdryLevelDelta	numeric	Threshold value for GDL determination on temperature.
RHLevelDelta	numeric	Threshold value for GDL determination on RH.
WspdLevelDelta	numeric	Threshold value for GDL determination on wind speed.
Wspd850LevelDelta	numeric	Threshold value for GDL determination on windspeed, below 850 mb. Applies only to dropsondes.
WdirLevelDelta	numeric	Threshold value for GDL determination on wind direction.
TropSmoothWL	numeric	The wavelength used for smoothing of the temperature time series before

Element name	Type	Description
		calculation of tropopause levels.
DoQC	bool	True to perform quality control processing.
DoLevels	bool	True to calculate levels.
DoWMO	bool	True to create the coded message.
AutoFile	bool	True to enable of file chooser when aspen starts.
ChuteArea	numeric	Dropsonde parachute cross section area , cm^2.
DropSondeMass	numeric	Dropsonde mass, grams.
PosInterpSpan	numeric	Maximum time span, in seconds, over which the position integration will be interpolated.
CallSign	string	Immediate, call sign for TEMPSHIP and TEMPMOBIL messages.
BSN	string	Immediate, Block Station Number for TEMP messages.
TempMsgType	numeric	Temp message type (0=TEMP, 1=TEMPSHIP, 2=TEMPMOBIL)
TempApendNNNN	Bool	Set true if an NNNN should be appended to the TEMP message when it is saved in a file. This terminator is required by some telecommunication gateways.
RHchoice	numeric	AVAPS RH channel selection(0=AVAPS selected, 1=RH1, 2=RH2)
ExcludeAbrHdr	bool	True if the abreviated header should be excluded from the TEMPDROP message.
PlotPixelsX	numeric	Default plot X dimension in pixels.
PlotPixelsY	numeric	Default plot Y dimension in pixels.
PlotFileFormat	numeric	Default graphics file output format (0=PNG, 1=JPG)

Element name	Type	Description
ACtype	numeric	Immediate, Dropsonde aircraft type (0=C130H, 1=C130J). Use only for the automated file transfer method for Huricane Hunters.
BaudRateIndex	numeric	Immediate, serial port baud rate selector for Hurricane Hunter C130H aircraft. (0=300, 1=1200, 2=2400, 3=4800, 4=9600, 5=19200, 6=38400)
CommPortIndex	numeric	Immediate, serial com port selector for Hurricane Hunter C130H aircraft. (0=com1, 1=com2, … 7=com8)
ACagency	string	Immediate, agency designator in the TEMPDROP 61616 group.
MissionStorm	string	Immediate, storm designator in the TEMPDROP 61616 group.
MissionId	string	Immediate, mission id designator in the TEMPDROP 61616 group.
IcaoIndex	numeric	Immediate, index of ICAO designator (0=user defined, 1=KNHC, 2=KBIX, 3=KISX, 4=KHIK, 5=KTRR. For TEMPDROP messages.
AbrHdrOvr	string	Immediate, User defined overide for the abreviated header. For TEMPDROP messages.
AtcfId	String	Immediate, the ATCF cyclone or storm system identifier.
OptIcao	numeric	Immediate, user defined optional ICAO identifier. For TEMPDROP messages.
UpsondeAbrHdr	string	Immediate, abbreviated header code (e.g. UUNA15) for upsonde messages.
UpsondeICAO	string	Immediate, ICAO code (e.g. KWBC) for upsonde messages.
TempEmailAddress	String	Immediate, email address that TEMP messages should be sent to.
DataDir	string	Directory where input data files are located.
WmoSaveDir	string	Directory to save WMO messages in.

Element name	Type	Description
QCSaveDir	string	Directory to save QC data in.
RawSaveDir	string	Directory to save raw data in.
XYPlotSaveDir	string	Directory to save XY plot graphics in.
SkewTPlotSaveDir	string	Directory to save Skew-t plot graphics in.
BatchSaveDir	string	For BatchAspen use, defines the diretory that output files will be written to.
BatchSaveRawCLS	bool	For BatchAspen use, set true to save the raw data in a CLASS format file.
BatchSaveQCCLS	bool	For BatchAspen use, set true to save the Q/C data in a CLASS format file.
BatchSaveRawCDF	bool	For BatchAspen use, set true to save the raw data in a netCDF format file.
BatchSaveQCCDF	bool	For BatchAspen use, set true to save the Q/C data in a netCDF format file.
BatchSaveRawCSV	bool	For BatchAspen use, set true to save the raw data in a CSV format file.
BatchSaveQCCSV	bool	For BatchAspen use, set true to save the Q/C data in a CSV format file.
BatchSaveWMO	bool	For BatchAspen use, set true to save the WMO message in a text file.
FixedSrcEnabled	bool	If true, the source data and save destination directories will specified by *FixedSrcDir*
FixedSrcDir	string	The directory to use as a data source and a save destination, if *FixedSrcEnabled* is set to true.
QcDiagFile	Bool	If true, create a text file containing diagnostic information from the Q/C process. Usually not of much use to the typical user. The file will be written to either the directory where Aspen is installed, or the directory that the first data file read is located. The file name begins with AspenDebug-, is followed

Element name	Type	Description
		by a time stamp and then a .txt extension.

Table 4. Configuration Parameters

Appendix B: File formats

An overview of the output file formats is given here. The file structures are sraightforward, and examination of the files will provide most of the documentation on their formats.

Note that the file formats are not complete; i.e one format will contain information that another format does not support. Thus, the CSV and netCDF formats can document the configuration parameters used in the processing, whereas the CLASS format does not support inclusion of this information.

CLASS Format

The CLASS file starts with a 15 line header section, followed by a variable number of data lines. The data lines are arranged in fixed width columns. A mandatory set of 21 data parameters is reported, even though a number of these (specifically the "quality" values) are always marked with a missing value indicator.

The data is reported in the sequence of decreasing pressure, i.e. from the surface upward, regardless of the direction of the sounding.

EOL Format

The EOL file starts with a 15 line header section, followed by a variable number of data lines. The data lines are arranged in fixed width columns. A fixed set of 17 data parameters is reported

The data is reported in the sequence of decreasing pressure, i.e. from the surface upward, regardless of the direction of the sounding.

NetCDF

Section "Appendix D: netCDF Attributes" contains the attributes listing from an ncdump of an Aspen generated netCDF file. Note that for legacy compatibilty reasons, a number of unecessary variables are included in the netCDF file. The global attributes contain a record of the Q/C processing options.

Comma Separated Values (CSV)

The "Comma Separated Value" file format is used for data interchange between Aspen and other software. It is a free form structure, with one data record per line, and the fields in a record separated by commas. A CSV file can be read directly into Microsoft Excel, and the data will be correctly organized in the spreadsheet.

For input to Aspen, certain conventions must be followed within the CSV file.

Each line begins with an identifier, followed by one or more fields. The order of the lines is generally not important, within the following guidelines:

- The first line must be:

```
FileFormat,CSV
```

- After the first line, the launch time **must** be provided on lines as follows:

```
Year,2001
Month,08
Day,01
Hour,17
Minute,58
Second,34
```

- The launch observation data may be provided in lines labeled with the parameter name.
- To designate a dropsonde sounding, include a line:

```
Ascending,"false"
```

- A “Fields” line defines the data fields and their order, for the succeeding “Data” lines. Aspen output CSV files will contain a fairly large number of fields, e.g.:

```
Fields,Time,Pressure,Temperature,RH,Speed,Direction,Latitude,    \
Longitude,Altitude,Dewpoint,Uwnd,Vwnd,Ascent
```

- For an input CVS file to be read properly by Aspen, the following data field conventions must be followed:

Fields	Aspen utilization
time pressure	These are required input data fields.
rh rh1 rh2 speed direction latitude longitude altitude ascent sats gpsalt	These data fields will be utilized, if provided.
others	Other data fields will be ignored on input.

- The “Units” lines documents the units of each data field. Note that the units shown here must be adhered to; Aspen will not make units conversions. At least the time and pressure fields must be provided:

```
Units,sec,mb,deg C,%,m/s,deg,deg,deg,m,deg C,m/s,m/s,m/s
```

- The “Data” lines follow after all of the preceeding records.

Some other rules apply:

- Long strings should be enclosed in quotes.
- Don’t include commas in strings
- Capitalization is not important.
- The data series must be ordered in time
- Time tags less than zero will be ignored
- Don’t use reserved strings in the first field of a line.
- “Fields” must come before “Data”
- Missing data are simply represented by empty fields, i.e. two commas in succession, or a trailing comma on the end of a line, indicating that the last field is missing.

The following demonstrates a small CSV file (note that the line breaks are not found in the actual file):

```
FileFormat,CSV
Year,2001
Month,08
Day,01
Hour,17
Minute,58
Second,34
Pressure,57.6,"units=mb"
Temperature,-59.9,"units=deg                                        C"
RH,,"units=%"
Speed,7.9,"units=m/s"
Direction,92.0,"units=deg"
Latitude,30.9909,"units=deg"
Longitude,-119.5005,"units=deg"
Altitude,19610.0,"units=m"
Ascending,"false"
Fields,Time,Pressure,Temperature,RH,Speed,Direction,Latitude,Longitude,
Altitude,Dewpoint,Uwnd,Vwnd,Ascent
Units,sec,mb,deg        C,%,m/s,deg,deg,deg,m,deg        C,m/s,m/s,m/s
Data,0.3,,,,,,,,,,,,
Data,0.8,,,,,,,,,,,,
Data,11.8,,,,11.52,69.53,,,,,-10.79,-4.03,
Data,38.8,71.06,-60.33,,8.23,104.25,30.99129,-119.50375,18295.7,,-
7.98,2.03,-39.94
Data,51.8,77.01,-63.75,,8.67,160.11,30.99174,-119.50441,17799.7,,-
2.95,8.15,-36.35
Data,66.3,83.86,-62.29,,,,30.99267,-119.50520,17276.1,,,,-35.06
Data,75.8,88.52,-64.99,,8.95,119.15,30.99295,-119.50592,16944.3,,-
7.82,4.36,-34.01
```

Appendix C: System Requirements

Screen resolution: 1024x768 pixels or greater

Windows display: configured for small fonts

Free disk space: at least 20 MB

Processor speed: 500 MHz or better recommended

System memory: 256 MB RAM or greater

Operating system: Windows XP

Appendix D: netCDF Attributes

The following shows the output of an ncdump command applied to an Aspen generated netCDF file.

```
netcdf D20010801_175834QC {
dimensions:
      time = 2122 ;
variables:
      int base_time ;
            base_time:long_name = "sounding launch time" ;
            base_time:units = "seconds since 1970-01-01 00:00:00 UTC" ;
            base_time:string = "Wed Aug 01 17:58:34 2001" ;
      float time_offset(time) ;
            time_offset:long_name = "seconds since base_time" ;
            time_offset:units = "seconds" ;
            time_offset:missing_value = -999.f ;
            time_offset:_FillValue = -999.f ;
      double time(time) ;
            time:long_name = "time" ;
            time:units = "seconds since 1970-01-01 00:00:00 UTC" ;
            time:missing_value = -999.f ;
            time:_FillValue = -999. ;
      float pres(time) ;
            pres:long_name = "pres" ;
            pres:units = "hPa" ;
            pres:missing_value = -999.f ;
            pres:field_type = "P" ;
            pres:_FillValue = -999.f ;
      float tdry(time) ;
            tdry:long_name = "tdry" ;
            tdry:units = "degC" ;
            tdry:missing_value = -999.f ;
            tdry:field_type = "T" ;
            tdry:_FillValue = -999.f ;
      float dp(time) ;
            dp:long_name = "dp" ;
            dp:units = "degC" ;
            dp:missing_value = -999.f ;
            dp:field_type = "T_d" ;
            dp:_FillValue = -999.f ;
      float rh(time) ;
            rh:long_name = "rh" ;
            rh:units = "percent" ;
            rh:missing_value = -999.f ;
            rh:field_type = "rh" ;
            rh:_FillValue = -999.f ;
      float u_wind(time) ;
            u_wind:long_name = "u_wind" ;
            u_wind:units = "m/s" ;
            u_wind:missing_value = -999.f ;
            u_wind:field_type = "uwind" ;
            u_wind:_FillValue = -999.f ;
```

```
      float v_wind(time) ;
            v_wind:long_name = "v_wind" ;
            v_wind:units = "m/s" ;
            v_wind:missing_value = -999.f ;
            v_wind:field_type = "vwind" ;
            v_wind:_FillValue = -999.f ;
      float wspd(time) ;
            wspd:long_name = "wspd" ;
            wspd:units = "m/s" ;
            wspd:missing_value = -999.f ;
            wspd:field_type = "wspd" ;
            wspd:_FillValue = -999.f ;
      float wdir(time) ;
            wdir:long_name = "wdir" ;
            wdir:units = "degree" ;
            wdir:missing_value = -999.f ;
            wdir:field_type = "wdir" ;
            wdir:_FillValue = -999.f ;
      float dz(time) ;
            dz:long_name = "dz" ;
            dz:units = "m/s" ;
            dz:missing_value = -999.f ;
            dz:_FillValue = -999.f ;
      float range(time) ;
            range:long_name = "range" ;
            range:units = "km" ;
            range:missing_value = -999.f ;
            range:_FillValue = -999.f ;
      float qp(time) ;
            qp:long_name = "qp" ;
            qp:units = "hPa" ;
            qp:missing_value = -999.f ;
            qp:_FillValue = -999.f ;
      float qt(time) ;
            qt:long_name = "qt" ;
            qt:units = "degC" ;
            qt:missing_value = -999.f ;
            qt:_FillValue = -999.f ;
      float qrh(time) ;
            qrh:long_name = "qrh" ;
            qrh:units = "percent" ;
            qrh:missing_value = -999.f ;
            qrh:_FillValue = -999.f ;
      float qu(time) ;
            qu:long_name = "qu" ;
            qu:units = "m/s" ;
            qu:missing_value = -999.f ;
            qu:_FillValue = -999.f ;
      float qv(time) ;
            qv:long_name = "qv" ;
            qv:units = "m/s" ;
            qv:missing_value = -999.f ;
            qv:_FillValue = -999.f ;
      float qwind(time) ;
            qwind:long_name = "qwind" ;
            qwind:units = "m/s" ;
```

```
            qwind:missing_value = -999.f ;
            qwind:_FillValue = -999.f ;
      float mr(time) ;
            mr:long_name = "mr" ;
            mr:units = "gram/kg" ;
            mr:missing_value = -999.f ;
            mr:_FillValue = -999.f ;
      float vt(time) ;
            vt:long_name = "vt" ;
            vt:units = "degC" ;
            vt:missing_value = -999.f ;
            vt:_FillValue = -999.f ;
      float theta(time) ;
            theta:long_name = "theta" ;
            theta:units = "K" ;
            theta:missing_value = -999.f ;
            theta:_FillValue = -999.f ;
      float theta_e(time) ;
            theta_e:long_name = "theta_e" ;
            theta_e:units = "K" ;
            theta_e:missing_value = -999.f ;
            theta_e:_FillValue = -999.f ;
      float theta_v(time) ;
            theta_v:long_name = "theta_v" ;
            theta_v:units = "K" ;
            theta_v:missing_value = -999.f ;
            theta_v:_FillValue = -999.f ;
      float lat(time) ;
            lat:long_name = "north latitude" ;
            lat:units = "degrees" ;
            lat:missing_value = -999.f ;
            lat:_FillValue = -999.f ;
            lat:valid_range = -90.f, 90.f ;
      float lon(time) ;
            lon:long_name = "east longitude" ;
            lon:units = "degrees" ;
            lon:missing_value = -999.f ;
            lon:_FillValue = -999.f ;
            lon:valid_range = -180.f, 180.f ;
      float alt(time) ;
            alt:long_name = "altitude above MSL" ;
            alt:units = "meters" ;
            alt:missing_value = -999.f ;
            alt:_FillValue = -999.f ;

// global attributes:
            :bad_value_flag = -999.f ;
            :zebra_platform = "class" ;
            :history = "ClassNcFile" ;
            :AvapsEditorVersion = "2.3.1" ;
            :SoundingDescription = "D20010801_175834.3 011118097 AAVAPS
Flight Test, EAFB Flight Test 3 Lockheed ER-2, NASA 809" ;
            :ACagency = "AF001" ;
            :ACtype = "0" ;
            :AbrHdrOvr = "0" ;
            :AutoFile = "1" ;
```

```
:BSN = "99999" ;
:BaudRateIndex = "2" ;
:CallSign = "CALL" ;
:ChuteArea = "676" ;
:CommPortIndex = "0" ;
:DoLevels = "1" ;
:DoQC = "1" ;
:DoWMO = "1" ;
:DropSondeMass = "395" ;
:DropsondeHitSfc = "1" ;
:ExcludeAbrHdr = "0" ;
:IcaoIndex = "1" ;
:MissionId = "TRAIN" ;
:MissionStorm = "WXWXA" ;
:OptIcao = "W" ;
:PlotFileFormat = "0" ;
:PlotPixelsX = "1000" ;
:PlotPixelsY = "700" ;
:PosInterpSpan = "60" ;
:PresBuddySlope = "2" ;
:PresOffset = "0" ;
:PresOutlier = "10" ;
:PresQCDev = "3" ;
:PresQCWL = "10" ;
:PresSmoothWL = "5" ;
:QCSaveDir = "C:\\tmp\\ER-2" ;
:RHBuddySlope = "20" ;
:RHOffset = "0" ;
:RHOutlier = "10" ;
:RHQCDev = "3" ;
:RHQCWL = "10" ;
:RHSmoothWL = "5" ;
:RHchoice = "0" ;
:RawSaveDir = "C:/" ;
:SetHtsMissing = "0" ;
:SfcAltUnknown = "1" ;
:SfcAltitude = "0" ;
:SkewTPlotSaveDir = "C:/" ;
:TdryBuddySlope = "3" ;
:TdryDynCor = "0" ;
:TdryOffset = "0" ;
:TdryOutlier = "10" ;
:TdryQCDev = "3" ;
:TdryQCWL = "10" ;
:TdrySmoothWL = "5" ;
:TempMsgType = "0" ;
:WindBuddySlope = "5" ;
:WindDynCor = "0" ;
:WindOutlier = "10" ;
:WindQCDev = "3" ;
:WindQCWL = "10" ;
:WindSats = "3" ;
:WindSmoothWL = "10" ;
:WindVVdelta = "2.5" ;
:WmoSaveDir = "C:/" ;
:XYPlotSaveDir = "C:\\tmp" ;
```