出國報告(出國類別：其他)

參加「航空氣象現代化作業系統汰換及更新計畫協調會議」視訊報告

服務機關：交通部民用航空局飛航服務總臺
姓名職稱：余曉鵬 主任、許依萍 技正
派赴國家：臺灣，中華民國
出國期間：民國 **110** 年 **11** 月 **18** 日至 **11** 月 **18** 日
報告時間：民國 **110** 年 **12** 月 **27** 日

列印 匯出

提 要 表

系統識別號：	C11000209
視訊辦理：	是
相關專案：	無
計畫名稱：	航空氣象現代化作業系統汰換及更新計畫協調會議
報告名稱：	參加航空氣象現代化作業系統汰換及更新計畫協調會議視訊報告
計畫主辦機關：	交通部民用航空局

出國人員：

姓名	服務機關	服務單位	職稱	官職等	E-MAIL 信箱
余曉鵬	交通部民用航空局	交通部民用航空局飛航服務總臺臺北航空氣象中心	主任	簡任(派)	
許依萍	交通部民用航空局	交通部民用航空局飛航服務總臺臺北航空氣象中心	技正	薦任(派)	聯絡人 epin@anws.gov.tw

前往地區：	臺灣，中華民國
參訪機關：	NCAR，美國國家大氣科學研究中心
出國類別：	其他

實際使用經費：

年度	經費種類	來源機關	金額
110年度	本機關	交通部民用航空局	0元

出國計畫預算：

年度	經費種類	來源機關	金額
110年度	本機關	交通部民用航空局	217,000元

出國期間：	民國110年11月18日 至 民國110年11月18日
報告日期：	民國110年12月27日
關鍵詞：	AOAWS，AOAWS-RU，亂流，IA#18
報告書頁數：	12頁

報告內容摘要：

飛航服務總臺基於提升飛航安全與服務品質，達成亞太地區飛航服務提供領先者之組織目標，自110年起至113年間推動「航空氣象現代化作業系統汰換及更新計畫(Advanced Operational Aviation Weather System Renewal and Update；AOAWS-RU)」，並與美國簽訂「駐美國臺北經濟文化代表處與美國在臺協會間航空氣象現代化作業系統發展技術合作協議」「第十八號執行辦法」(IA#18)，為順利推動IA#18相關工作，爰透過視訊與美國國家大氣科學研究中心(NCAR)協調雙方合作工作事宜，確認雙方合作發展之年度工作成果及對未來工作規劃，確保計畫執行進度及成效。 本次會議NCAR分享NCAR於110年辦理的亂流工作坊簡報、確認年度工作成果及未來工作規劃。

報告建議事項：

建議事項	狀態	說明
擴展本區亂流觀測資料來源，提升亂流預報準確率。	研議中	
善用視訊軟體，參加國際視訊會議，拓展預報同仁	研議中	

	專業知能。 參與國內氣象會議，累積國內航空氣象科研能量。　研議中
電子全文檔：	C11000209_01.pdf
出國報告審核表：	
限閱與否：	否
專責人員姓名：	
專責人員電話：	

列印 匯出

目錄

壹、　目的

本總臺基於提升飛航安全與服務品質，達成亞太地區飛航服務提供領先者之組織目標，自 110 年起至 113 年間推動「航空氣象現代化作業系統汰換及更新計畫(Advanced Operational Aviation Weather System Renewal and Update；AOAWS-RU)」，並與美國簽訂「駐美國臺北經濟文化代表處與美國在臺協會間航空氣象現代化作業系統發展技術合作協議」「第十八號執行辦法」(IA#18)，主要目的係為引進美國最新航空氣象技術委託美國大氣研究大學聯盟之國家大氣科學研究中心(NCAR)發展航空氣象預報演算法，提升我國之航空氣象預報品質，得以跟上先進國家腳步，持續與國際接軌。

另為打造符合國際民航組織(ICAO)系統廣泛資訊管理（System Wide Information Management；SWIM）要求之航空氣象系統架構，透過本計畫取得國際最新飛航服務規劃，以期有效提升相關作業準備效率。

為順利推動 IA#18 相關工作，爰規劃前往美國國家大氣科學研究中心(NCAR)協調計劃期間雙方合作工作事宜，確認雙方合作發展之年度工作成果及對未來工作規劃，確保計畫執行進度及成效。

貳、　過程

本案原定前往美國執行，為受新冠肺炎(COVID-19)疫情影響，經雙方協調改為以視訊會議方式辦理。會議時間為 110 年 11 月 18 日上午 9 時~12 時，共計 3 小時，會議議程包含：(一) NCAR 亂流工作坊報告分享。(二)110 年工作進度報告。(三)第 19 號執行辦法作業準備。

本次會議美方由本案專案主持人許榮祥博士主持，各工作項目負責人(科學家)參與，我方則由民用航空局飛航管制組官岱煒技正、飛航服務總臺飛航業務室于守良課長及臺北航空氣象中心余曉鵬主任率相關作業同仁參與。

參、　會議內容及重要結論摘要

一、　NCAR 亂流工作坊報告分享

(一) 講題：「Automatic Dependent Surveillance-Broadcast (ADS-B) Derived Turbulence」。

1. 報告人：Larry Cornman， NCAR。
2. 背景：

　　本項研究是 NCAR 與美國 FAA 合作項目，由於亂流在空間和時間上之變化快速，需要同時考慮增加觀測量和改進亂流預測方法(如 GTGN)，而 ADS-B 資料是一種飛機位置/速度自動報告系統，ADS-B 信號提供大量資料，包含飛機的位置、速度、氣壓、高度以及相對於地球的水平和垂直速度。其中垂直速度信息是判斷亂流的關鍵資訊(如圖 1)。

　　目前飛航作業上僅能透過機師空中報告及機載 EDR 偵測器取得亂流觀測資料，惟有關資料常因機師人為判斷及貨航機未配置 EDR 偵測設備而受限，因此如能使用資料量大的 ADS-B 資料進行亂流觀測判斷，對飛航作業將有很大的幫助。

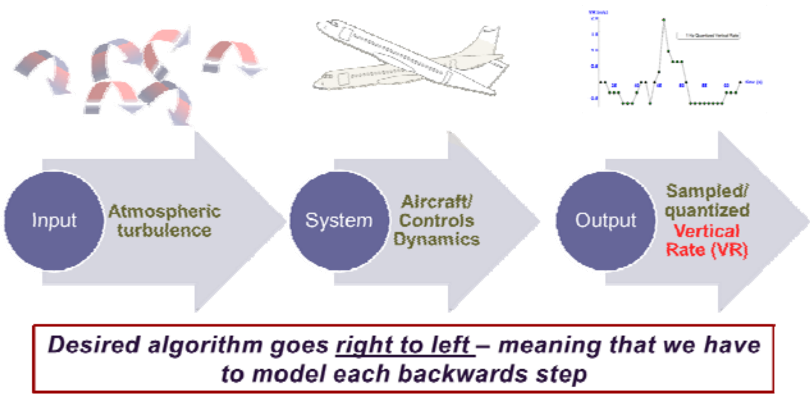

圖 1、使用航機 ADS-B 訊號進行亂流演算概念圖。

3. 研究成果：
   (1) 演算法：發展使用垂直速率(VR)產生 EDR 之演算法，並使用模擬的和實際的航機報告進行驗證。
   (2) 使用 ADS-B 資料計算亂流之初步結果顯示，與渦流消散率（EDR）大致相符，可見 ADS-B 確實可有效增加亂流觀測資料數量。
   (3) 將持續進行各項資料品質管制，並評估 ADS-B 報告之效益。
   (4) 在更遠的未來將可能發展為獨立空中報告、甚至納入亂流圖形化指引即時預報（GTGN）作業中。

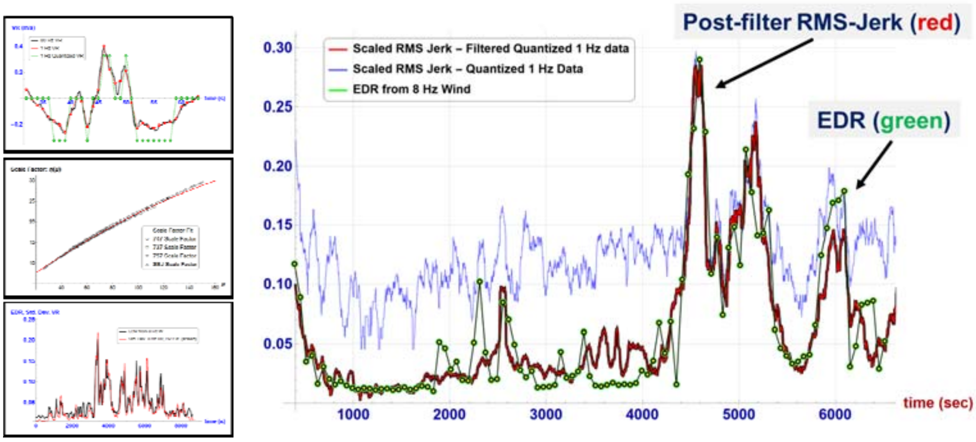

圖 2、垂直速率與 EDR 相關性(左)；經過量化濾波器處理後之 ADS-B 演算亂流資料與 EDR 資料相似。

(二) 講題：「Open Frontiers in Turbulence Forecasting and Detection」。

1. 報告人： Robert Sharman，NCAR。
2. 目標：開發更好、更廣泛的亂流觀測/檢測、亂流預報策略及其驗證方法。另並改進使用觀測和預報來促進避免危險湍流（臨近預報）的操作程序，持續發展亂流氣候學，進行基礎和應用研究，以更了解亂流的起源、生命週期及特性，並應用到亂流預測和觀察策略中。
3. 背景說明(25 年來成果)：
   (1) 改善觀測：取得更好的(定量、穩健、高解析度、常規)觀測資料，如亂流消散係數(EDR)、大氣亂流強度矩陣、國際民航組織(ICAO)亂流標準化及下一代亂流偵測演算法(NTDA)等等。
   (2) 改善數值天氣預報模式：發展更複雜/更高解析度的數值天氣預報(NWP)模式提供更好的亂流預報，且對由波浪和亂流所引起的小尺度特徵有更佳的了解，另外也改進了數字和參數化方法。
   (3) 使用與高解析度和低解析度 NWP 模式相結合的觀測資料，以取得更好的亂流特徵、識別亂流來源及評估診斷效能。
   (4) 確定重力波在產生各種形式的亂流中的重要性（如晴空亂流(CAT)、山岳波亂流(MWT）及雲中亂流(CIT))。
   (5) 確定強對流在產生晴空亂流(CAT)時之重要性
   -在遠離雲邊界的上方和橫向產生的重力波可以“破裂”並導致湍流。
   -對流現象會顯著改變環境（如通過增強中的風切)，這可能會在遠離風暴（> 100 公里）的地方引發亂流。

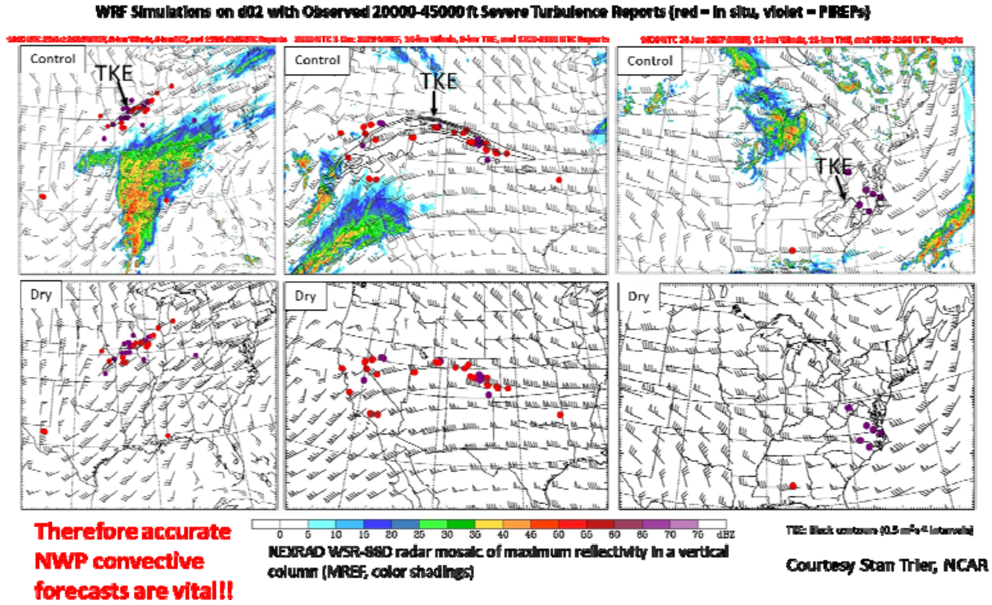

圖 3、遠離雲邊界的上方和橫向產生的重力波可以“破裂”並導致湍流。因此準確的數值天氣預報對亂流預報影響相當重要。

除了一般商務及客運航機外，近年來更小、更輕的飛機已經成為運營中越來越重要的組成，無人機系統(UAS)和城市空中交通(UAM)都越來越多，這些航空器一般都在大氣邊界層內飛行，在這個區越，飛行的穩定性除受天氣系統影響外，更容易受城市效應影響，包含風速、風向、低層穩定度、建築幾何形狀及建築與建築的相互作用等影響。此外，這些情況也會影響在高海拔地區（E 類空域 >FL600）的飛行作業，因此需要持續發展相關亂流預報作業。

4. 結論：

(1) 短期運營和研究需求:

i. 提供複雜地形和城市環境中的低層湍流預報。
ii. 發展更多用於驗證和臨近預報的觀測，可能來自 ADS-B、衛星特徵及高解析度探測。
iii. 提供全球臨近預報。
iv. 使用高解析度模擬資料進行案例研究。
v. 發展用於驗證罕見事件的亂流預報策略。
vi. 發展機率預測。

(2) 長期和更基礎的研究需求

i. 通過高解析度模擬及實驗計畫增強對飛機尺度之亂流的起源和特徵的基本理解
ii. 確立氣候變化之影響情況。

iii. 直接使用 NWP 預測 ε 或 EDR。

(3) 這些研發工作的結果將酌情納入圖形化亂流演算法(GTG)和 GTGN 中。

(三) 講題：「Global Weather Notification」

1. 報告人：Jason Craig，NCAR。
2. 目標：

   本項研究主要目的是嘗試預測特定航機是否會遇到或接近預測或觀察到的不利天氣狀況，根據給定的天氣網格和參數化閾值，預測即時飛機位置(依飛行計劃、速度和航向)，並計算沿著航機路徑的定性亂流強度(例如：輕、中、重)。如果確認會發生，則立即發出“提醒”，以便使用者提早應變(非取代官方天氣諮詢)。
3. 研究成果：

(1) 亂流專案：發展湍流信息頻繁更新系統，且可向駕駛艙顯示頻繁更新的湍流信息的方法，以即時通知駕駛艙實施必要的延遲決定。

(2) 全球天氣專案：評估在海洋區域進行亂流演算法，修改其有效性和準確性，並根據先前的評估調整了雲頂高及大洋對流診斷產品(CTH/CDO)進行估算。

(3) 位置投影和通知的邏輯

i. 收集所有在 3 分鐘內有提供位置報告的飛機，確認期有效地出發地和目的地，並排除飛行高度過低(低於 FL200)及剛出發和即將抵達目的地之航機。

ii. 使用最近的位置和有效航線，將飛機沿著未來 3 分鐘的航線向前投影，建立一個 30 海浬寬（航線兩側各 15 海裡）和 17 分鐘長（使用飛機速度）的框。

iii. 收集框中的亂流信息並建立無、輕度、中度或重度通知訊息。

Determination of the notification

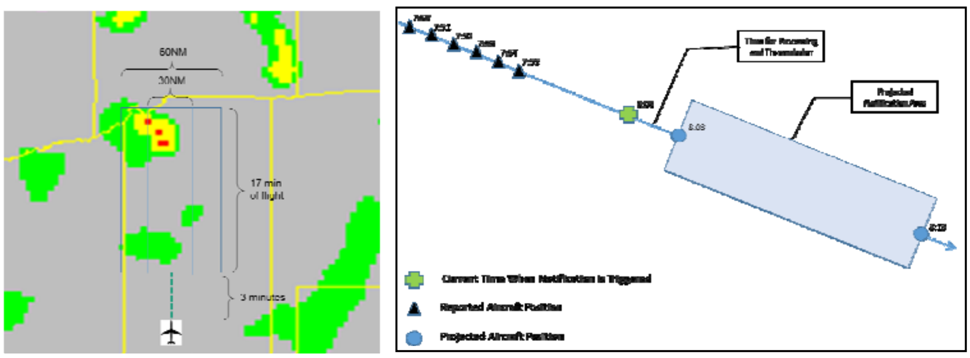

圖 4、航機位置投影和通知的邏輯示意圖

(4) 本項方法經由驗證顯示預報準確率大於 85%。

Turbulence severity from system Vs
turbulence severity from actual flown area

Overall

Projected Notification Classification

Actual Notification Classification	NULL	LIGHT	MOD	SEVERE
NULL	96.2	1.7	1.7	0.4
LIGHT	4.5	89.4	5.3	0.8
MOD	4.2	2.6	87.1	6.1
SEVERE	2.1	0.8	9.4	87.7

False Positives

Missed

圖 5、本案預報方法預報準確率達 85%以上。

二、 110 年工作進度報告

本次會議係依據第 2 次季工作報告(110 年 8 月~10 月)為基礎進行相關工作進度報告，並針對有關工作之後續配合事項進行確認。相關重要工作成果及決議事項說明如下：

(一) 專案管理與資料提供

1. NCAR 測試環境平台之計算環境規劃預計將在 110 年 12 月中旬完成，屆時將請民航局予資拓宏宇國際股份有限公司(IISI，國內資訊系統承商)提供意見。
2. 空軍機場氣象電報線路已經停止服務，改由民航局飛航訊息管理系統(AMHS)線路提供。
3. 空軍氣象雷達資料將由民航局持續與空軍氣象聯隊協調評估提供方案。
4. 亂流圖形化指引(GTG)及亂流圖形化指引臨近預報(GTGN)都需要與 NCAR 亂流偵測演算產品(NTDA)比對，請民航局提供現行 AOAWS 系統 NTDA 資料供比對。
5. 民航局將與中華航空公司協調持續提供實測渦流消散率（EDR）資料，原則期望能至少每季提供一次。有關資料有助於亂流演算法之法展及驗證作業。
6. 為系統發展資料需求，請民航局提供實時 IWXXM 格式電報資料。
7. 考量各種航空氣象預報產品之輸出格式(暫定為 NetCDF 格式)應該相同，因此 NCAR 將深入閱讀 OGC 規範，並訂定符合其規範之統一資料輸出格式。該資料將提供給 IISI 氣象資訊系統之資料來源，並不會直接提供給使用者。

(二) 工作項目 1 - 更新飛行中積冰診斷及預報產品

1. 考量亞洲區的飛機結冰報告很少，因此下一版的飛行中積冰診斷及預報產品將在沒有飛機報告的情況下發展，除非民航局可取得 AMDAR 或液態水報告等資料。

(三) 工作項目 2 - 升級亂流圖形化指引至第 4 版，並建置亂流圖形化指引臨近預報

1. NCAR 同意所有航空氣象預報演算法在作業主機實作前，均應 CAA 的測試環境中測試確認。
2. 系統發展過程中，NCAR 發現台灣地區的亂流報告資料數量相當少，經討論研判，依據最近一個季度的案例來看，可能與季節性天氣系統有關。但也可能跟各區域所能收到的報告數量有關。
3. 為進行本工項之個案研究工作，請民航局提供 2021 年中央氣象局數值天氣預報模式資料，包含 3 公里和 15 公里解析度、資料間隔時間為 6 小時，以及綜觀尺度天氣圖。

(四) 工作項目 3 - 更新 NCAR 亂流偵測演算法

1. 由於空軍雷達資料目前因網路頻寬限制無法提供實時雷達資料，NCAR 建議可以考慮將其存檔之後再設法取出後提供給民航局。民航局將空軍協調可行作法。
2. NCAR 亂流偵測演算法目前規劃使用所有能取得的雷達資料，包含現有的氣象局 4 顆雷達(五分山、七股、花蓮及墾丁雷達)和 6 顆新雷達(包含中央氣象局樹林、林園和中屯雷達及空軍的台中、澎湖和綠島雷達)，惟仍需考慮雷達資料質量再與民航局進行最終決定。
3. NCAR 將持續評估每個參與天氣雷達的雷達數據質量、掃描策略和雙極化數據（如適用）。將進行有關氣象和數據質量的有趣案例研究，並提供調查結果報告。另並繼續根據需要調整當前可用的 Gemtronik2Netcdf 和 NTDA 軟件，以使用 CAA 提供的雷達數據。此新版演算法將包括射頻干擾 (RFI) 緩解方法以及天線掃描速率校正，以減少誤報。

(五) 工作項目 4 -更新雲頂高預測產品

1. 本項產品雛型系統已安裝和配置在 NCAR 作業環境中，該系統使用 AOAWS-RU 未來將使用的資料運作，使用民航局提供的閃電、數值天氣預報模式(WRF)預報資料(Domain 1)和衛星資料進行計算，並以 110 年 7 月 15 日（2000-2359UCT）資料進行預報，並於 110 年 10 月 29 日提供了輸出數據樣本 (GRIB2 格式)。NCAR 將繼續進行系統調整。雛型個案產品範例如圖 6。

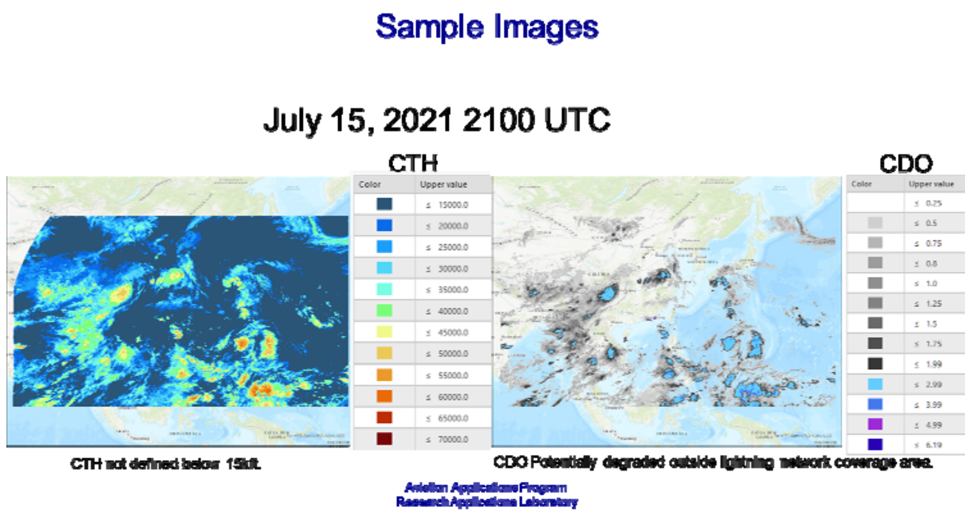

圖 6、左圖為雲頂高度產品，右圖為大洋對流診斷產品。

2. 考量民航局提供之中央氣象局閃電資料範圍僅涵蓋台灣周邊地區，NCAR 提供四個演算法發展方案予民航局參考。民航局將依實際作業需求決定作業方案。

(六) 工作項目 5 -更新機場雲冪與能見度預測產品

1. NCAR 持續進行資料收集、調校預報應用程序。
2. NCAR 使用 UPP(Unified Post Processor)程式處理 WRF 原始資料，以取得若干 WRF 資料裡沒提供，但本工項中所需要的變數，並可以將資料從模式的垂直面內差到等壓面。
3. NCAR 引用阿拉斯加的 C&V 演算法進行本項發展，但因阿拉斯加版本演算法原本使用美國 HRRR 模式的資料，進行演算法訓練，因此 UPP 程序需要進行必要之變數調整，並使用臺北飛航情報(下稱本區)氣象資料盡量進行訓練，由於本區資料尚且不足以作完整的訓練，目前規劃先進行 30 日訓練，並將等進入冬季取得更多資料後，再進行調整。

(一) 工作項目 6 - 發展 0-8 小時的風暴預報能力

1. 初版外延法預報系統雛型已安裝和配置在 NCAR 作業環境中，該系統使用 AOAWS-RU 未來將使用的資料運作，包含中央氣象局高解析度數值模式(RWRF)預報資料(Echo Top)、雷達合成回波資料及降雨機率資料等進行演算。雛型個案產品範例如圖 7。

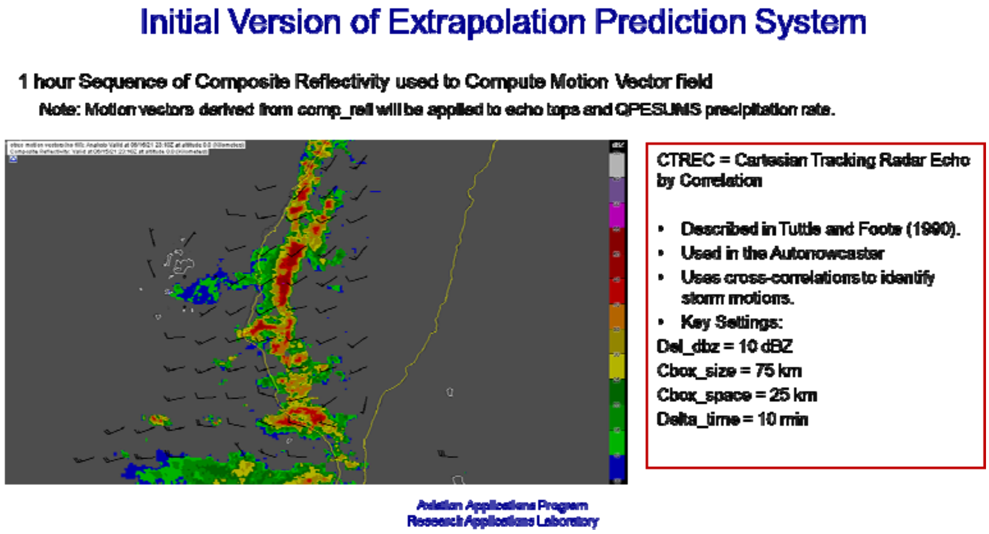

圖 7、航空綜合風暴預報產品樣品。

(七) 工作項目 7 - 發展與實作氣象報告之 XML 格式資料轉換程式

1. NCAR 使用民航局提供之 IWXXM 格式電報樣本進行氣象報文解譯及驗證工作，創建 MetalIwxmm2Spdb 轉換實用程序，將 IWXXM 轉譯為 SPDB 格式資料。
2. NCAR 提供 IWXXM 校驗報告給民航局參考，經檢視，部分錯誤為民航局 IWXXM 轉譯程式規則錯誤造成，其餘則為空軍機場電報報文格式錯誤所致。民航局將調整轉譯程序規則，並提醒氣象電報報文發布單位留意。

(八) 工作項目 8 - 技術諮詢和基礎發展協助

1. 民航局提供一份關於低空風切告警系統升級 NCAR 意見諮詢單，雙方並於 110 年 10 月 26 日進行需求確認會議，目前仍由 NCAR 研議中。
2. 有關 Global Air Navigation Plan（GANP）及 Aviation System Block Upgrade（ASBU）資訊更新部分，NCAR 將請 Matt Strahan 協助整理 GANP 及 ASBU 中與航空氣象相關作業規定及參考文件，部分文件及資料可能需要另行採購，NCAR 將思考由 IA#18 諮詢費用支付的可行方案，另並將與民航局確認需求後再行採購。

(九) 工作項目 9 - 技術轉移及教育訓練

1. NCAR 於 2021 年 9 月 15 日至同年 9 月 30 日辦理「研習航路及機場天氣預報產品演算法原理及發展技術」技術轉移訓練。
2. NCAR 於 2021 年 10 月 19 日至同年 11 月 11 日辦理「航空氣象預報演算法工作坊」。

三、 第 19 號執行辦法作業準備

為使 IA#19 合約(2023~2024)簽署如期完成，經協調訂定相關工作期程如下：

(二) 合約本文部分，以 IA#18 內容進行微調為原則。

(三) 工作聲明書(SOW)部分，以 4 年計畫工作規劃內容為基礎進行調整，UCAR 與 CAA 可依實際工作需求提出討論。

(四) IA#19 經費可依實際工作需求進行估算，調整幅度請先以原預算規劃之 5%內為原則。

(五) 工作時程規劃(以 111 年 4 月 29 日前提送 AIT 審查為目標)

1. NCAR 開始制定文件：111 年 1 月 3 日。
2. NCAR 和美國國家大學聯盟(UCAR)合約部門開啟商討 SOW：111 年 2 月 11 日。
3. UCAR 合約部門同意 NCAR 的 SOW 草案：111 年 2 月 23 日。
4. NCAR 將 SOW 草案提交給民航局：111 年 2 月 25 日。
5. 民航局和 NCAR 開始協議 SOW 內容：111 年 3 月 7 日。
6. 民航局和 NCAR 達成最後協議：111 年 4 月 25 日。
7. UCAR 將 IA#19 提送 AIT 審查：111 年 4 月 29 日。

肆、 心得與建議

本年度航空氣象現代化作業系統汰換及更新計畫(AOAWS-RU)協調會議因受國際新冠肺炎(COVID-19)疫情影響由原計畫前往美國科羅拉多州波德市進行為期七天(含路程)之協調會議行程調整為為期 3 小時之視訊會議(考量兩地時差)。雖然少了實體會議的面對面討論之效率，卻可讓更多參與計畫之人員參與討論(包含今年度之技術轉移教育訓練及工作坊)，對單位整體成長有正向效果。

美方在有限的時間內，除安排 110 年度工作成果報告外，亦分享 NCAR 亂流工作坊(在美國以視訊方式辦理)之部分研究成果，同時亦提供該工作坊之視訊錄影檔供民航局參考，有助於民航局了解國際亂流發展趨勢。

AOAWS-RU 計畫推動包含民航局、氣象局、NCAR 及國內資訊廠商之多方合作，計畫推動需要嚴謹的協調溝通，複雜度高，須由各方投入大量人力及物力資源才能成功。謹就參與本次會議心得提報建議事項如下：。

一、擴展本區亂流觀測資料來源，提升亂流預報準確率。

(一) NCAR 發展即時亂流產品如有即時觀測資料(如飛機報告及渦流消散係數(EDR))導入，可增強產品效能，惟現今空中報告數量少，而我國僅中華航空公司有 3 架貨機配備 EDR 偵測設備，能應用於本區之資料有限。考量 EDR 偵測設備並非航空器之必要裝備，且裝設 EDR 偵測裝備及即時 EDR 資料傳輸均需相當成本，建議於未來與航空公司交流時持續宣導空中報告及 EDR 資料對於航空氣象亂流預報之益處，以擴展亂流觀

測資料之來源，有助於航空氣象預報產品發展及驗證。

(二) 美國發展使用 ADS-B 資訊反演亂流資訊，如若未來相關技術發展成熟，或可引入台灣，使用本總臺 ADS-B 資料，提升亂流預報。

二、善用視訊軟體，參加國際視訊會議，拓展預報同仁專業知能。

受疫情影響，許多國際氣象會議、研討會均改為視訊方式辦理，本總臺透過本專案選派多名同仁參與相關會議，相較於只選派 1~2 名人員出國，可讓更多人參與。建議未來總臺可持續關注此類國際常態性視訊會議(如有)，編列相關預算，並派員參與，預期可有效提升同仁專業知能。

三、參與國內氣象會議，累積國內航空氣象科研能量。

AOAWS-RU 計畫聘請氣象顧問協助針對 NCAR 之航空氣象演算法進行了解，然科研發展應為長遠計畫，需要更多的人來參與，爰建議民航局鼓勵同仁參與國內氣象科研會議甚或編列預算支持相關研究計畫，讓國內學界了解民航局之航空氣象預報發展方向及願景，吸引更多有興趣的學者參與航空氣象議題研究，以達民航局航空氣象在地生根之期望。

伍、 附錄

一、 Open Frontiers in Turbulence Forecasting and Detection, Robert Sharman.

二、 Automatic Dependent Surveillance-Broadcast (ADS-B) Derived Turbulence, Larry Cornman.

三、 Global Weather Notification- A real-time, ground-based, weather notification system for pilots, Jason Craig.

四、 AOAWS-RU IA#18Project Management Review Meeting 簡報

五、 發展 0-8 小時的風暴預報能力成果報告

六、 更新雲頂高預測產品成果報告

七、 AOAWS-RU IA#18 Project Management Review Meeting 紀錄

Open Frontiers in Turbulence Forecasting and Detection

4th Turbulence Mitigation Workshop
10 Nov 2021
Revised for presentation to Taiwan CAA

Robert Sharman
National Center for Atmospheric Research/Research Applications Laboratory
Boulder CO USA
sharman@ucar.edu

NCAR

Turbulence Mitigation Workshop 4 Summary

- Goal is to share latest turbulence research and operational advances to mitigate or at least minimize hazardous turbulence encounters

- Workshop presentations clustered into 5 areas or themes:
  - Develop better and more extensive turbulence observations/detection for routine dissemination, including public-private data sharing
  - Develop better turbulence forecasting strategies and their verification
  - Improve operational procedures that use observations and forecasts to promote avoidance of hazardous turbulence (nowcasts)
  - Develop turbulence climatologies
  - Perform fundamental and applied research to better understand the origin, life cycle, nature of turbulence, and feed back into forecasting and observation strategies

ALL RECORDED PRESENTATIONS WILL BE AVAILABLE ON THE FPAW WEBSITE
https://fpaw.aero/

NCAR | RESEARCH APPLICATIONS LABORATORY
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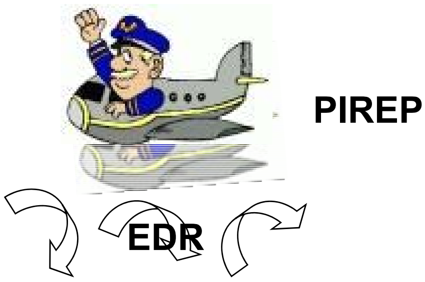
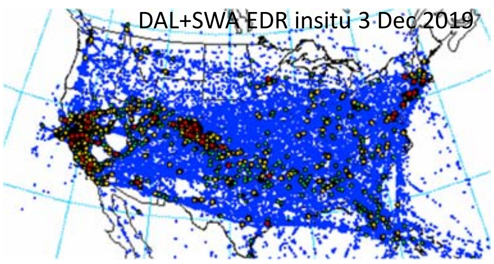
Outline

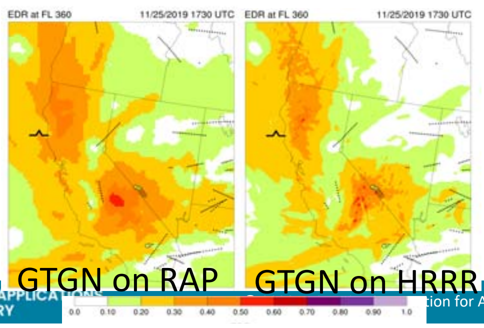
- Progress highlights last 25 years
- Remaining challenges
- Short term operational and research needs
- Longer term and more fundamental research needs
- Summary

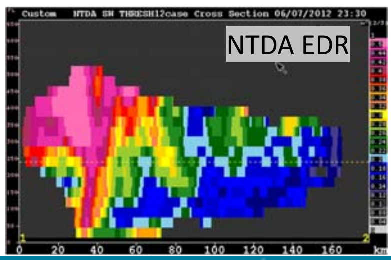
Progress Highlights: Observations and NWP model improvements

1. Better (quantitative, robust, high resolution, routine) observations
   - Moving to standard of energy dissipation rate (EDR) for all observations ($m^{2/3} s^{-1}$)
   - Atmospheric turbulence intensity metric
   - ~ aircraft loads (RMSG~EDR)
   - Preferable to relate to forecasts/nowcasts
   - ICAO standard (for turbulence reporting) since 2001
   - NEXRAD Turbulence Detection Algorithm (NTDA)
2. More sophisticated/higher resolution NWP models provide better turbulence forecasts
   - Better resolves small-scale features due to waves and turbulence
   - Also improved numerics and parameterizations



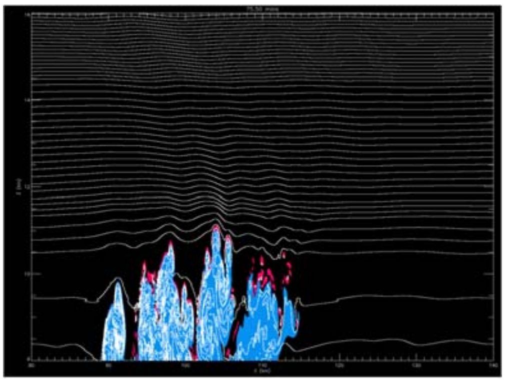






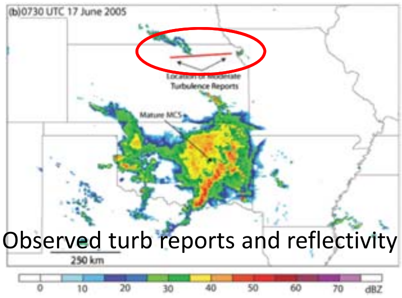
Progress Highlights: Enhanced understanding

3. Use of observations coupled with high-resolution simulations and coarse resolution NWP models to
   - Better characterize turbulence
   - Identify sources of turbulence
   - Evaluate coarse-scale diagnostic performance
4. Identified importance of gravity waves in generating all forms of turbulence (CAT, MWT, CIT)
5. Identified the importance of deep convection in generating "CAT"
   - Gravity waves generated both above and laterally away from the cloud boundaries which can "break" leading to turbulence
   - Convection can significantly modify environment (e.g. by enhancing shear) that may induce turbulence far (>100 km) from the storm

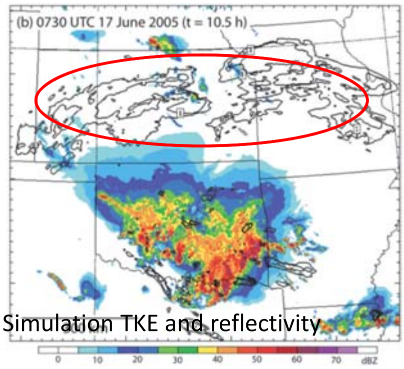


Lane et al. JAS 2003

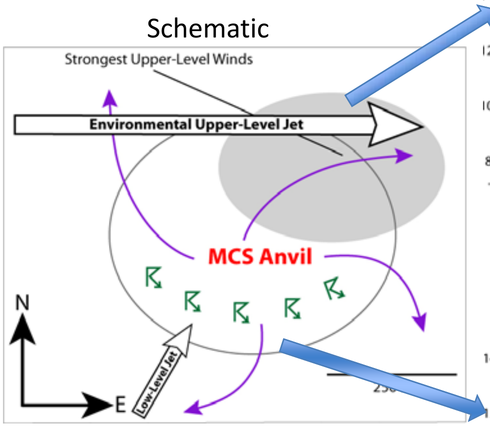
Example: MCS out-of-cloud CIT Mechanism

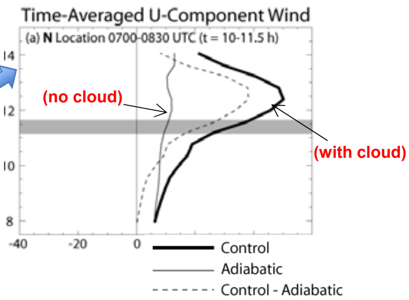


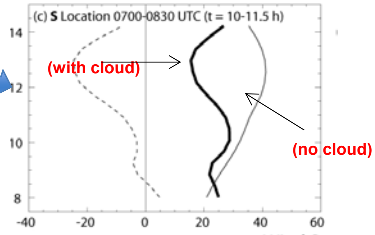
Observed turb reports and reflectivity



Simulation TKE and reflectivity



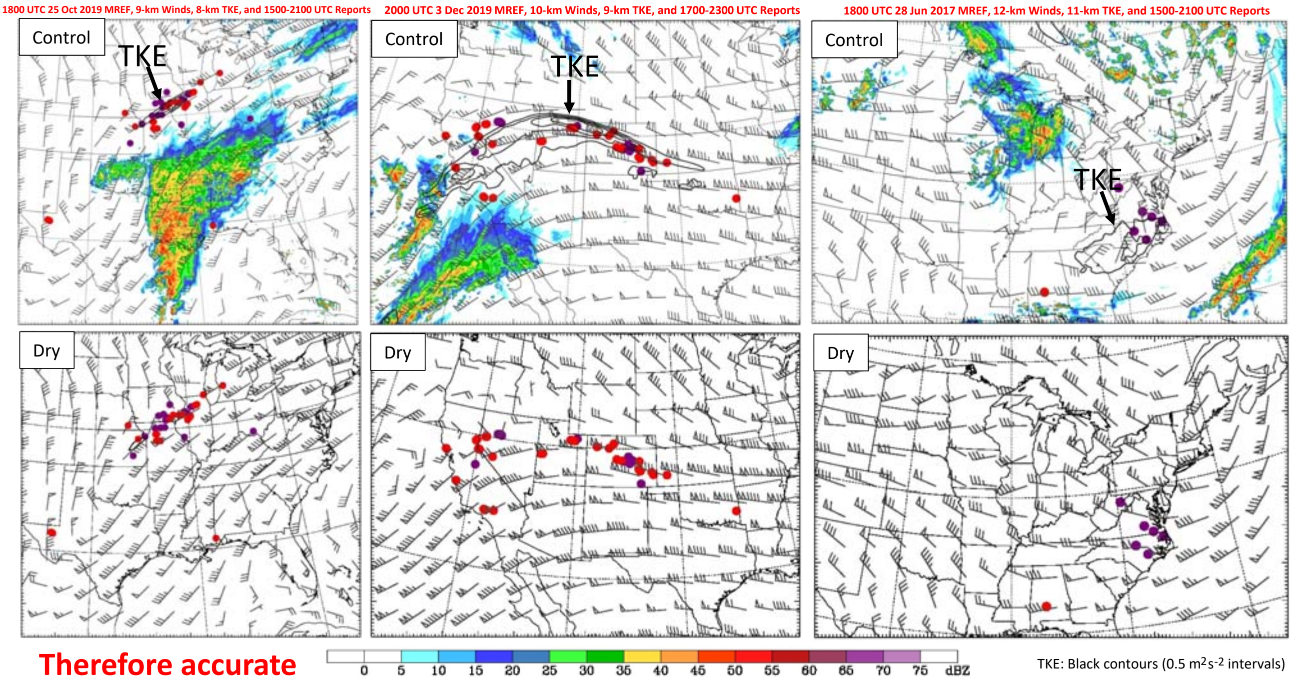




- Strong vertical shear at flight levels due almost entirely to MCS outflow on north side
- Vertical shear at flight levels on south side weaker because easterly outflow winds and shear are opposed by their westerly environmental
- From Trier & Sharman, MWR, 2009

Progress Highlights: Enhanced understanding of “CAT”

WRF Simulations on d02 with Observed 20000-45000 ft Severe Turbulence Reports (red = in situ, violet = PIREPs)



Therefore accurate NWP convective forecasts are vital!!

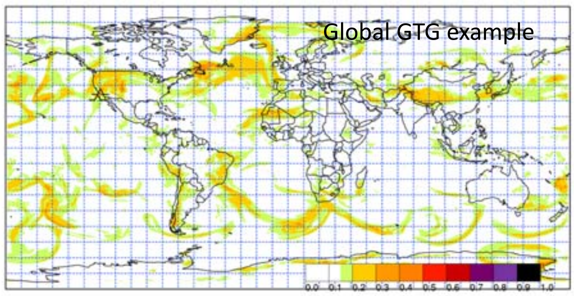
NEXRAD WSR-88D radar mosaic of maximum reflectivity in a vertical column (MREF, color shadings)

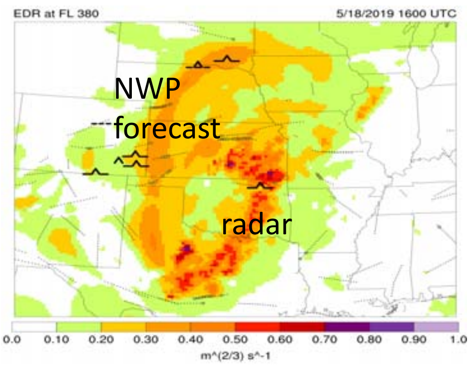
TKE: Black contours (0.5 m^2s^{-2} intervals)

Courtesy Stan Trier, NCAR

Progress highlights: Advances in operational turbulence forecasting

- Forecasts EDR NOT light, moderate, severe
  - Move from AIRMETS, SIGMETS to grid-based graphics
  - Turbulence potential -> severity (EDR)
- Requires inference of turbulence from larger resolved scales ->
- Turbulence diagnostics
  - SGS turbulence parameterizations are deficient at upper levels
  - Can use single or ensemble of diagnostics (**GTG**)
  - Different diagnostics for CAT,MWT,CIT
- Operational implementations of gridded products are now common
  - NOAA/NCEP
  - UK Met Office
  - Meteo France
  - Korean Meteorological Agency
  - Taiwan CAA/CWB
  - DWD
  - ECMWF IFS
  - Private vendors
- Convection difficult to predict so must use a nowcasting approach (e.g., GTGN)

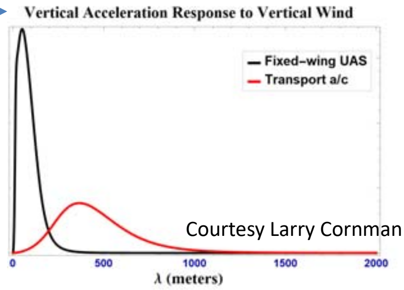




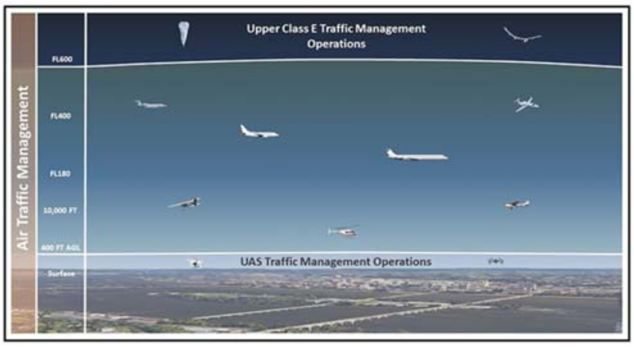
EDR

Frontiers

- Smaller, lighter aircraft are becoming an increasingly important component of operations
  - Unmanned aerial systems (UASs) and urban air mobility (UAM) respond to smaller scales
  - Higher loads for lighter aircraft
  - Response for quadcopters, etc?
  - Most fly in the atmospheric boundary layer
    - Urban effects
      - Extremely complex pattern even in the simplest cases
      - Depends on wind speed, direction, stability, building geometry, building-building interactions, etc.
    - Low-level gusts including rotors
  - Also at high altitudes (Upper Class E airspace >FL600)

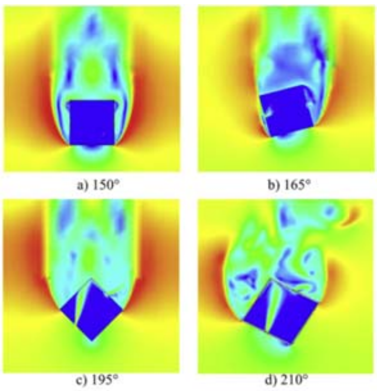


Courtesy Larry Cornman

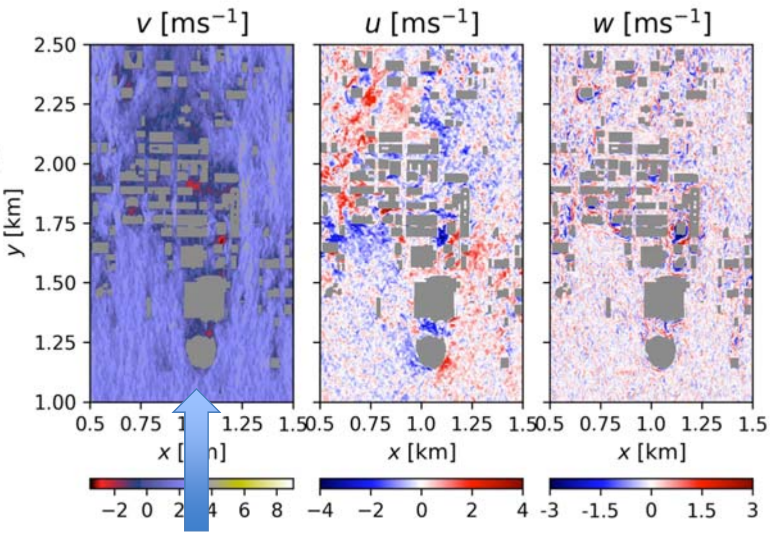


Major challenge: low-level turbulence in urban environments

- Extremely complex pattern even in the simplest case
- Depends on wind speed, direction, stability, building geometry, building-building interactions, etc.



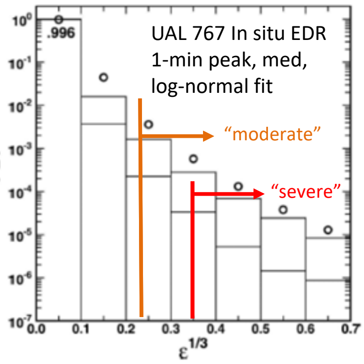
King et al. J Wind Engr&Industrial Aerodynamics 2017



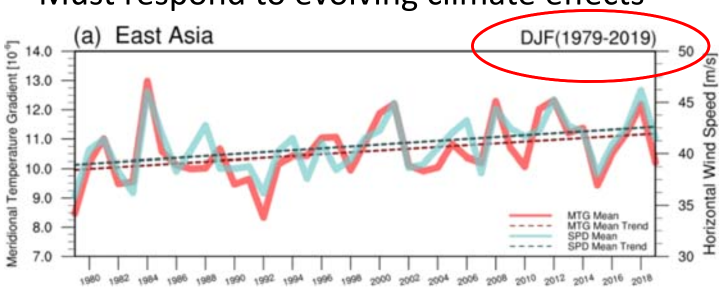
Courtesy Domingo Muñoz-Esparza
OKC Joint Urban 2003 field campaign
$\Delta x = \Delta y = 2$ m, $\Delta z = 2 - 18$ m at z=7.5 m
30 min loop, run time=42 min
Good agreement for wind speed, direction, TKE
Muñoz-Esparza et al. JAMES 2020

Frontiers (cont.)

- Must deal with rare events
  - From insitu EDR data:
    - Frequency of “smooth” >~.99
    - Frequency of “moderate” turbulence (>~0.22 EDR) ~5x10^{-3}
    - Frequency of “severe” turbulence (>~0.35 EDR) ~10^{-4}
  - Need very large sampling of airspace
  - Forced to overforecast
  - Transitioning to probabilistic forecasts
  - Verification of rare events is not trivial!
  - Reliability estimates require robust turbulence climatology
  - How to disseminate rare events to users?



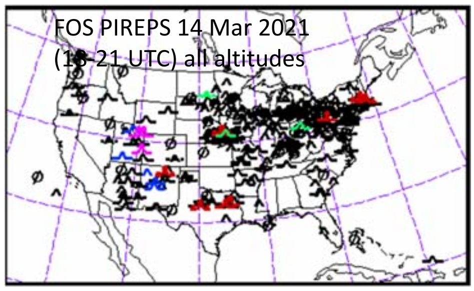
- Must respond to evolving climate effects

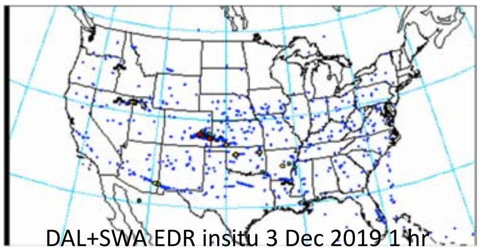


From Kim and Lee:
“Climatology of Clear-Air Turbulence using the ERA5 data”, Turb Workshop 4

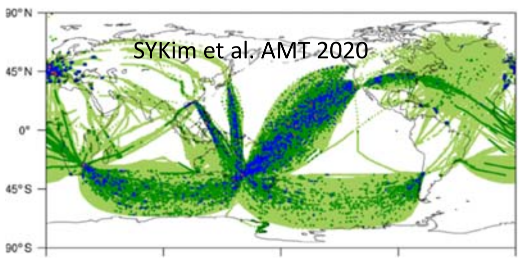
Frontiers: Observations

- Need more data (quantity + quality!)
  - Make PIREPs more precise (~35 km error=10 grid pts)
  - Expand in situ EDR estimates
    - Current on-board (IATA)
    - Include water vapor estimates -> CIT
    - New on-board from Boeing
    - Implement QC’d AMDAR DEVG estimates
- Work towards accessing other observations
  - Implement ADS-B EDR estimates
  - Implement UAS EDR estimates
  - Implement HVRRD EDR estimates
  - Develop automated satellite feature detectors
  - Explore acceleration-based on-board measurements provided by some vendors (convert to EDR?)
  - Others…
- R&D areas
  - Ideally would like other information to better identify turbulence nature (CAT, CIT, waves)
  - How to verify EDR implementations?
  - Develop climatologies
  - Develop *in situ* <u>wave</u> detection algorithms



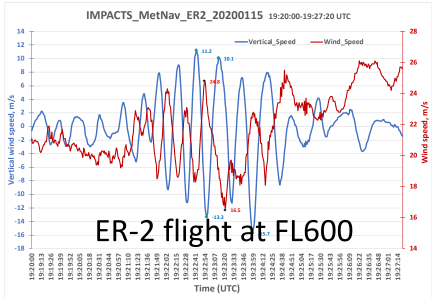


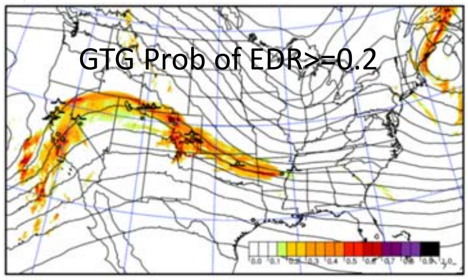
DAL+SWA EDR insitu 3 Dec 2019 1 hr (18-19 UTC) FL360-380

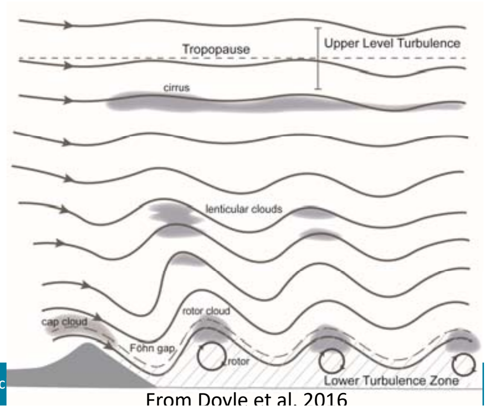


Frontiers: forecasting and nowcasting

- Develop turbulence diagnostics to accommodate:
  - low-level urban environments
  - complex terrain including rotors
  - higher altitudes (Upper Class E airspace >60,000 ft)
  - in-cloud and near-cloud turbulence
  - Results from research
- Develop probabilistic forecasts
  - Must deal with inherent predictability issues
  - NWP spread small for short-term forecasts
  - Explore alternatives, e.g. multi-diagnostic ensemble
- Apply AI/ML forecasting techniques
- Address verification issues
  - What is best metric or metrics for rare events ?
  - NWP errors vs diagnostic errors
  - Poor reliability due to overforecasting
  - What forecast lead times are most important to users?
- Need for rapid updates (nowcasts) globally
- Develop mountain <u>wave</u> forecasts (working group?)







From Doyle et al. 2016

Frontiers: Fundamental research needs

- **Need better understanding of causes and lifecycles of turbulence**
  - What are the sources/damping mechanisms?
  - What is the role of inertia-gravity waves, breaking, Ri reductions?
  - What is the role of the tropopause and tropopause folds?
  - How to handle wave-turbulence interactions?
  - Establish turbulence current climatology (through observations over along period of time and NWP model archives) and assess effects of climate change
  - **Need dedicated multiple aircraft field programs (dropsondes + penetrations)**
- **Modeling**
  - Need better subgrid turbulence parameterizations in free atmosphere -> ε
  - Address convection timing and displacement errors
  - Move to turbulence prediction <u>within</u> NWP framework (has direct access to tendencies)
  - <u>Nested simulations</u> that include large (forcing) scale plus smaller scale have been highly successful
    - Need more cases based on accidents, elevated edr data, field programs
    - Need resolution, parameterization, initialization sensitivity studies

- **Many good PhD topics here!!**
- **For more see Sharman, Lane, Schumann (2017)**

Summary

- Identified short term operational and research needs
  - Provide low-level turbulence forecasts in complex terrain and urban environments
  - Include more observations for verification and nowcasting, perhaps from ADS-B, satellite features, high-resolution soundings
  - Provide global nowcasts that include CIT
  - Case studies using high-resolution simulations
  - Develop strategies for verification of rare events as it applies to turbulence forecasting
  - Develop probabilistic forecasts
  - Develop AI/ML-based systems
  - Develop private vendor – research community collaborations

- Identified some longer term and more fundamental research needs
  - Enhance fundamental understanding of genesis and character of aircraft-scale turbulence through
    - high-resolution simulations
    - Field programs
  - Establish effects of climate change
  - NWP directly predicts ε or EDR

- Results from these R&D efforts will become included in subsequent versions of GTG and GTGN as appropriate

Automatic Dependent Surveillance-Broadcast (ADS-B) Derived Turbulence

Larry Cornman

Kent Goodrich

Greg Meymaris

National Center for Atmospheric Research

Gary Pokodner

Federal Aviation Administration

Sponsored by: FAA Weather Technology in the Cockpit (WTIC) Program

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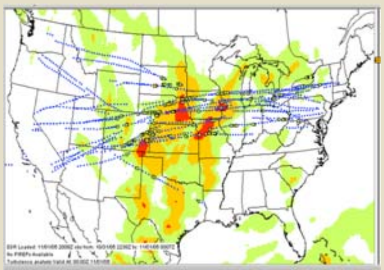
Background

- Given the spatial and temporal variability of turbulence, large numbers of observations are needed.
- Increasing turbulence measurements and improving forecasts (e.g., GTGN) often go hand-in-hand.
- Automatic Dependent Surveillance-Broadcast (ADS-B) is an aircraft position/velocity reporting system that has the potential to augment existing turbulence observations.



In situ EDR reports overlaid on GTG

ADS-B Infrastructure

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Potential Benefit of ADS-B Turbulence Reports is Significant

- **Large numbers of a/c**
  - Most a/c in US controlled airspace are now required to have ADS-B Out.
  - ***As of Oct 1, 2021 there are 158,406 US a/c reporting, including 107,378 GA a/c. (Int'l carriers = 2785 a/c)***
  - Compare to ~1600 a/c reporting *in situ* EDR and ~1200 turbulence PIREPS/day (on average).
- **Good spatial and temporal accuracy**.
- **Aircraft side of implementation is already happening**.
- **Potential use space-based ADS-B reports for oceanic/remote regions.**

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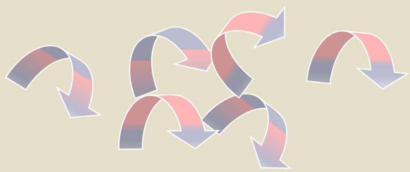
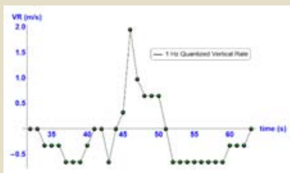
Turbulence from ADS-B Reports: High-Level Concept





Input → Atmospheric turbulence

System → Aircraft/ Controls Dynamics

Output → Sampled/ quantized Vertical Rate (VR)

Desired algorithm goes <u>right to left</u> – meaning that we have to model each backwards step

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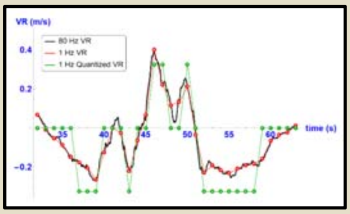
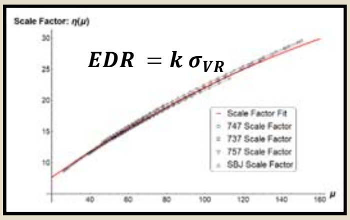
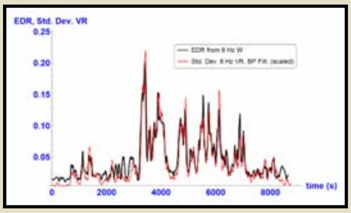
Algorithm Development Approach - Ground-based Reports

- **Developing signal processing methods to address**:
  - Sampling rate (~1 sec) and quantization (64 ft/min) of vertical rate data
  - Maneuver/wave mitigation
- **Developing scaling algorithm to produce EDR from vertical rate**
- **Verification/Development using**:
  - Wind/vehicle simulation (737-800)
  - High-rate, in-service aircraft data (737-800)
  - Real-world ADS-B reports







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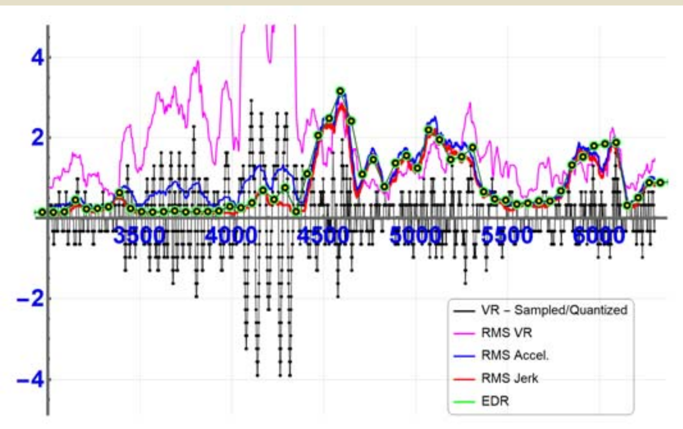
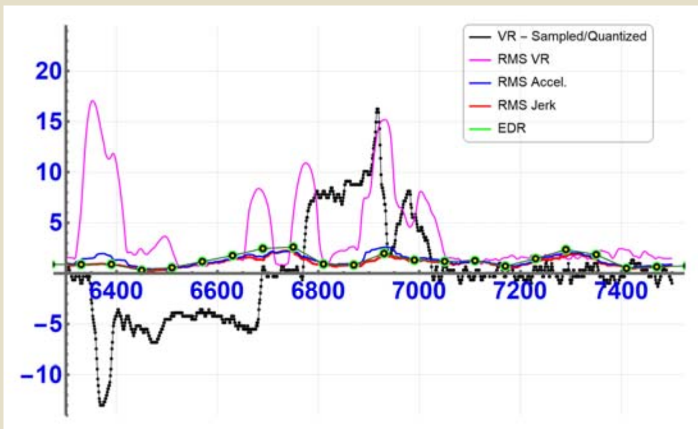
Use of 3rd Derivative of Position,"Jerk"

Wave-Turbulence Region



Maneuver-Turbulence Region



RMS Jerk – <u>for *high-rate* data</u> – has remarkable skill wrt EDR

(Jerk = 2nd derivative of vertical rate)

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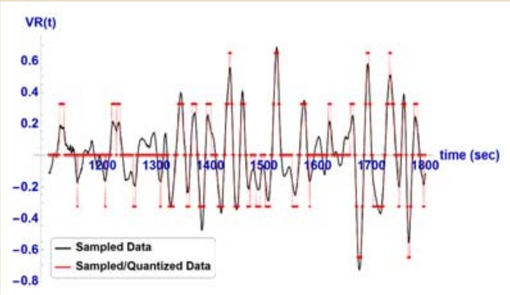
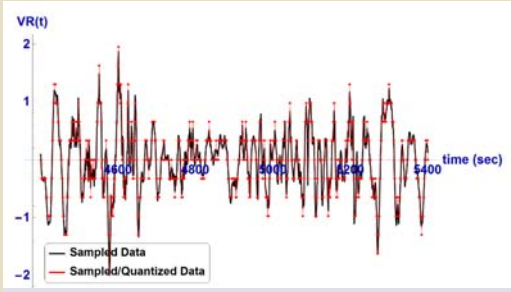
Contamination Due to Quantization

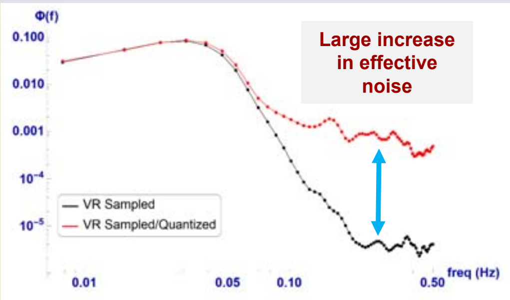


Quiescent Period

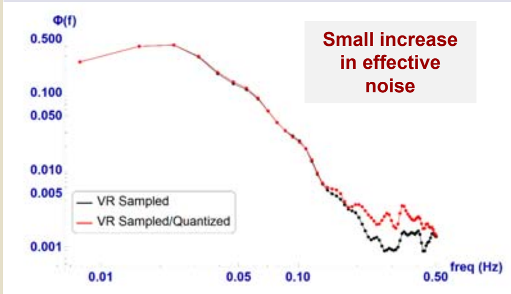
Time Series



Turbulent Period



Power Spectra



Quantization affects quiescent periods more than active ones

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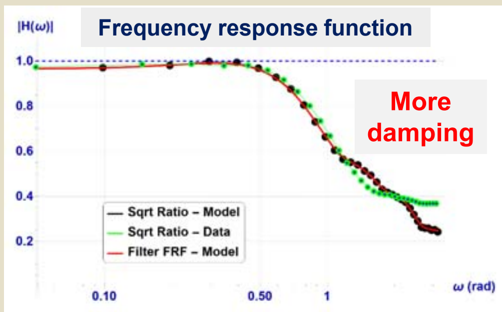
Resolving the "Quantization Problem"

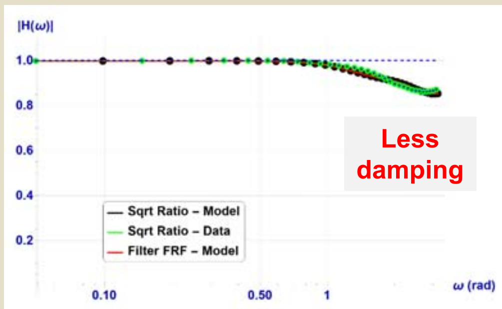
- Solution is an adaptive "inverse filter" that takes into account the amount of quantization contamination, locally.
- The filtered values are then used to calculate jerks (second derivatives of VR) and then RMS-jerks are calculated.

The adaptive-quantization filter is the key…

Quiescent data



Turbulent data



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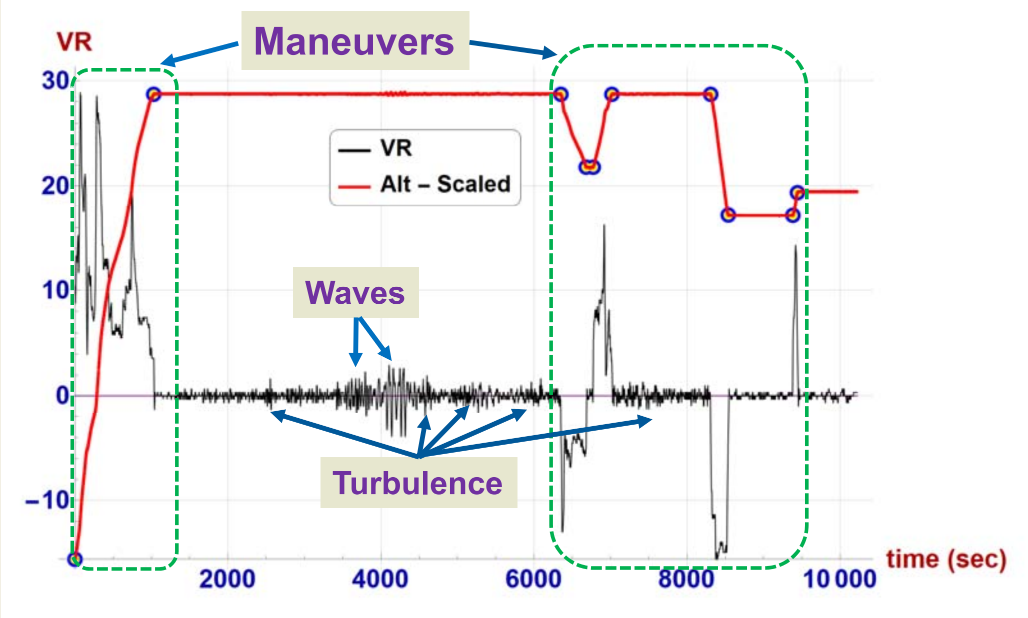
Case Study: Data from Mid-Size Transport



Sampled/Quantized Vertical Rate (black) and Scaled Altitude (red)

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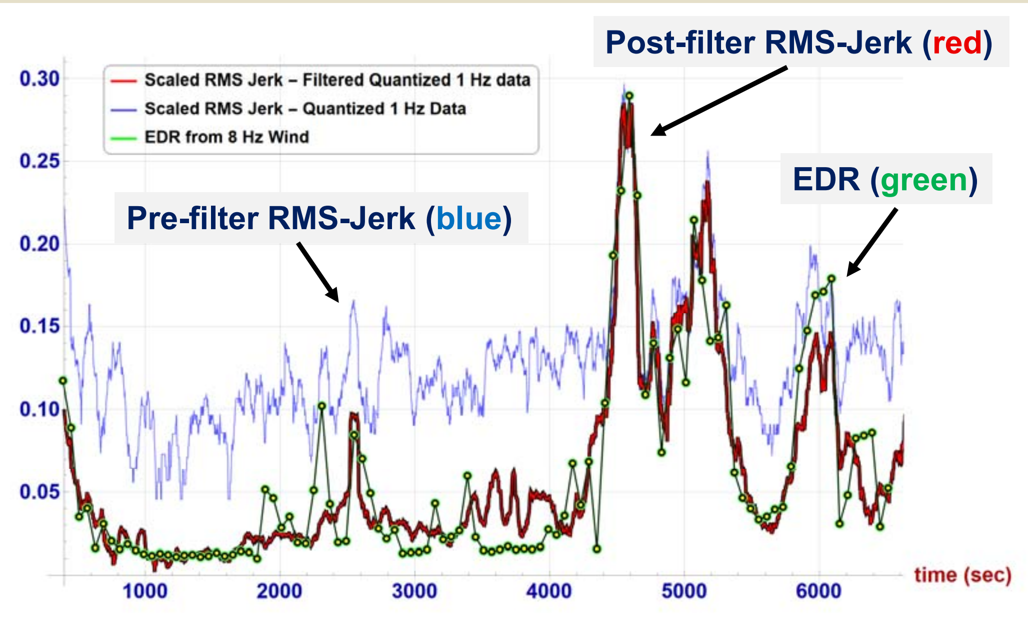
Results for the First Half of Case Study Flight



The quantization-adaptive filter method works well here…

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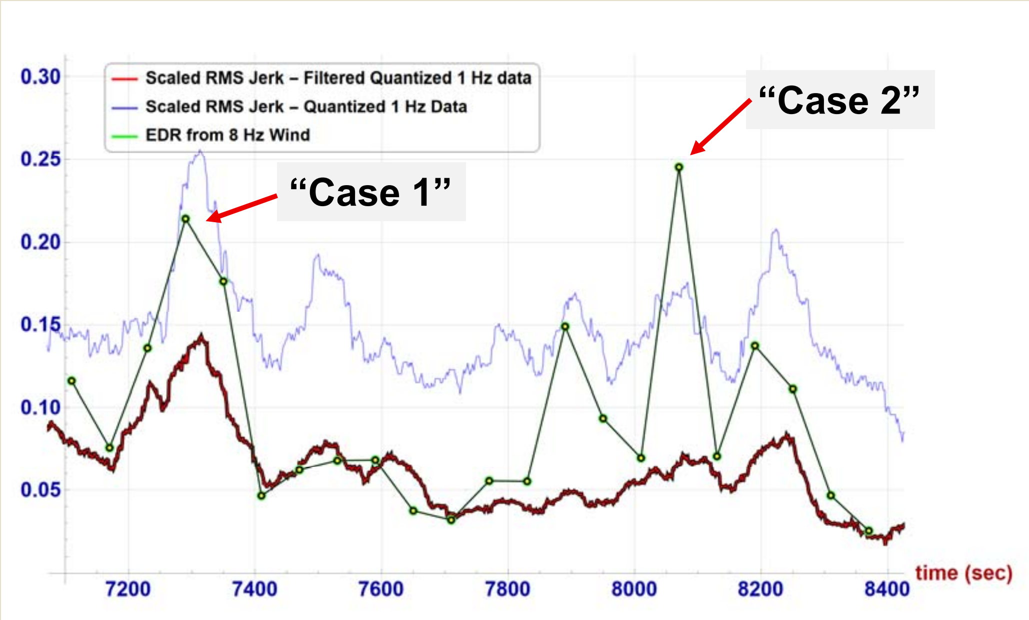
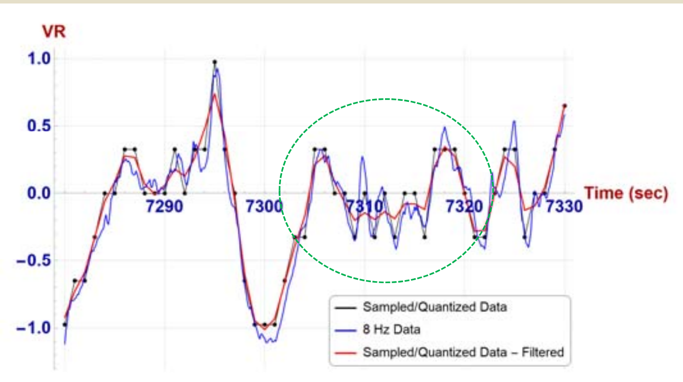
Results for the Second Half of Case Study Flight



Missed Detections

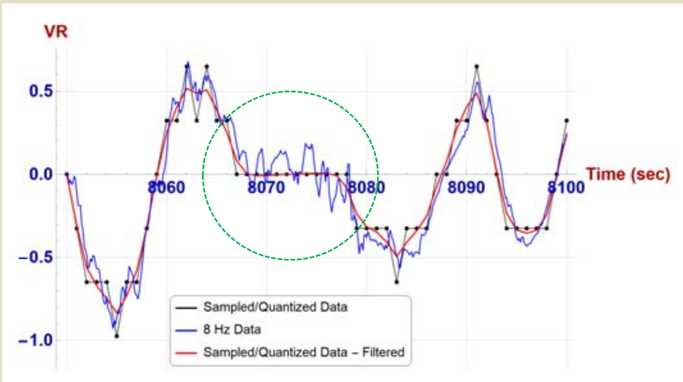
Missed Detections – Closer Look

Case 1



Over-filtering – recoverable (?)

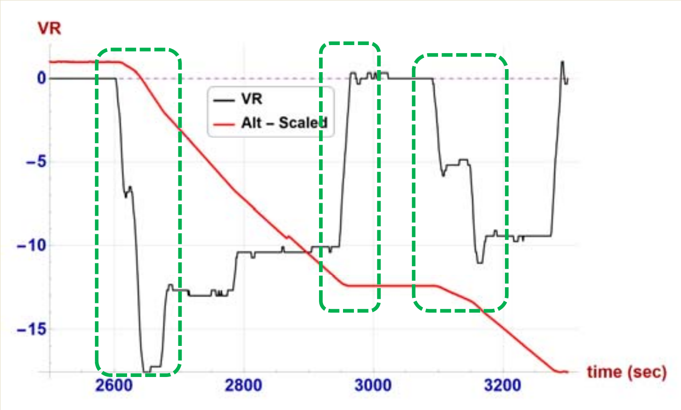
Case 2

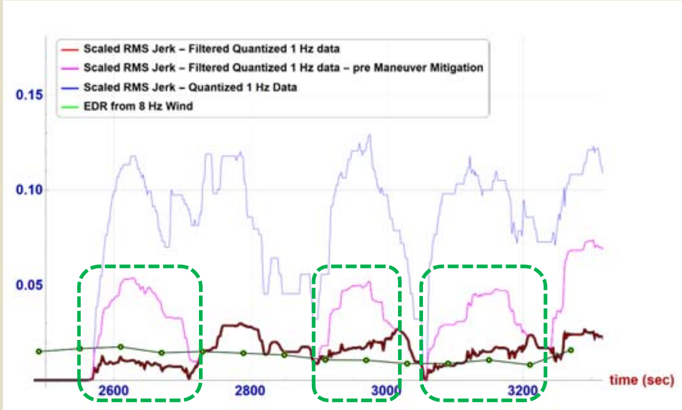


Quantization - unrecoverable

Maneuver Mitigation

Jerk calculation removes "smooth" (linear) part of maneuvers, but not maneuver "transitions"





Maneuver transition regions

Pre-maneuver mitigation (magenta) vs. post-maneuver mitigation (red)

Ongoing Efforts

- **Continue algorithm developments**
  - Adaptive-quantization filtering
  - Maneuver rejection
  - Aircraft-scaling
  - Data quality assessment and QC algorithms
  - Evaluate utility of space-based ADS-B (SBA) reports.
- **Offline verification**
  - Simulation
  - High-rate real-world data
  - ADS-B reports

Near-Term and Future Efforts

- **Operational demonstrations/verification**
- **Operational deployment**
  - Develop phased release plan
    - Standalone "Pireps"
    - Integration into GTGN
- **Provide recommendations on future releases of ADS-B standards**
  - Decrease quantization levels for vertical rate
  - Increase sampling rate (not necessarily reporting rate).

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Global Weather Notification

A real-time, ground-based, weather notification system for pilots

Developed at NCAR as part of the FAA's Weather Technology in the Cockpit (WTIC) Program

Jason Craig
National Center for Atmospheric Research
Fourth Turbulence Mitigation Workshop November 10th 2021

This research is in response to requirements and funding by the Federal Aviation Administration (FAA). The views expressed are those of the authors and do not necessarily represent the official policy or position of the FAA.

Global Weather Notification System

- Attempts to anticipate whether aircraft will encounter or be in close proximity to predicted or observed adverse weather conditions.
- Projects each aircraft's position forward in time (based on the aircraft's flight plan, speed and heading) and calculate a qualitative categorical severity (examples: 'light', 'moderate', 'severe'), based on a given weather grid and parameterized thresholds, along the aircraft's path.
- Runs on the ground ensuring that a large number of aircraft can be processed in a timely manner frequently and large weather grids are not a strain for cockpit bandwidth
- Creates a notification that is designed to give pilots a quick "heads up" message that allows them to seek out additional information, such as an updated weather map or ensuring seat belts are fully fastened for passengers, and is not to replace In-Flight Weather Advisories from official sources.

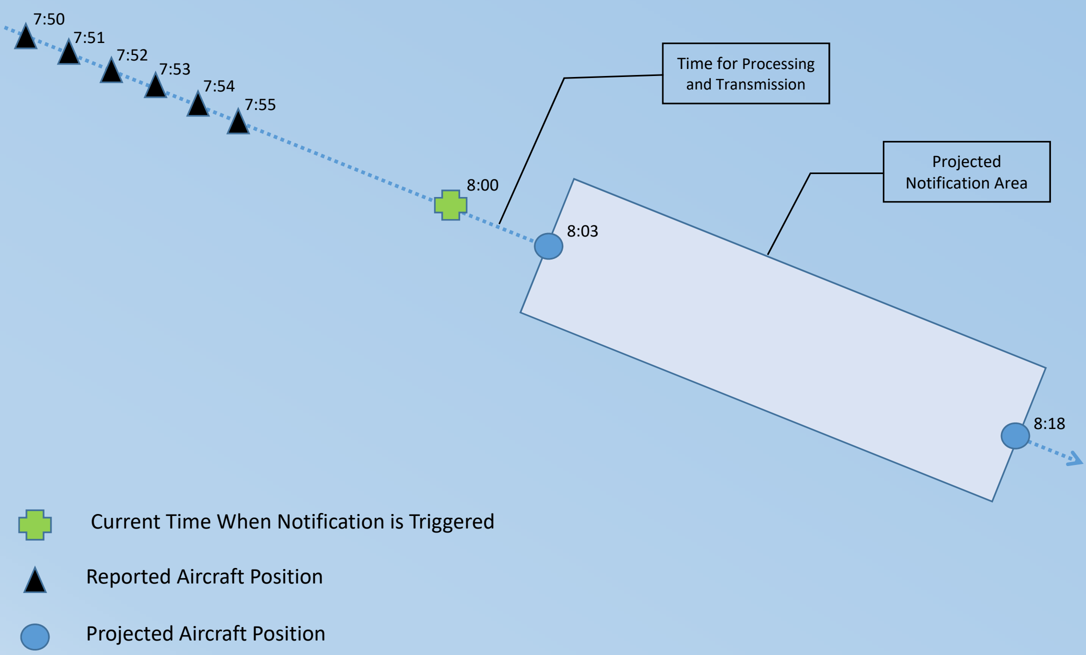
Tactical Turbulence Project

- Developed a method for presenting frequently updated turbulence information to the cockpit
- Developed the system for frequently updating turbulence information
- Demonstrated the feasibility to implement real-time notifications with the necessary latency to the cockpit.

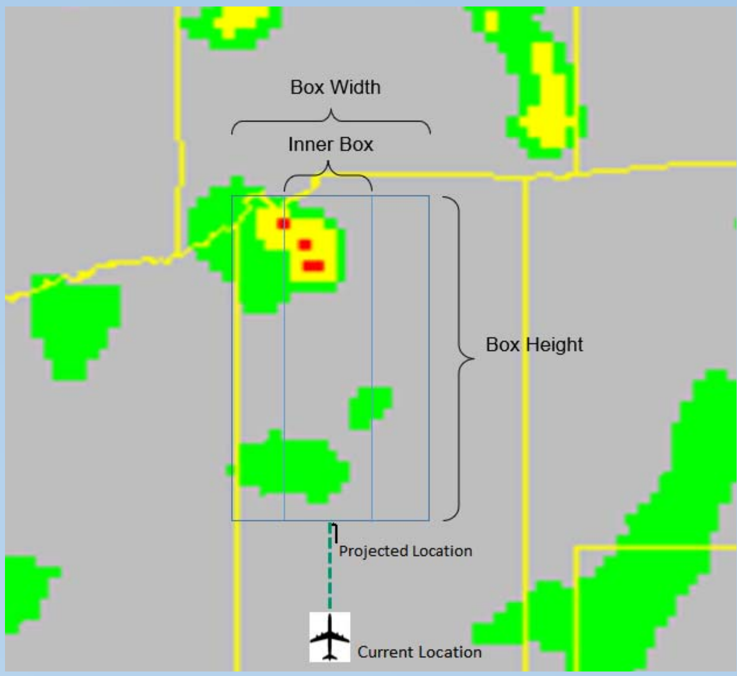
Global Weather Project

- Evaluated running the Tactical Turbulence algorithm in the oceanic region.
- Modified the system for effectiveness and accuracy in oceanic regions and tuned for CTH/CDO based on prior ROMIO evaluations.
- Developed documentation and technology transfer package
- (No longer only for Turbulence, thus new name needed)

Notification Schematic

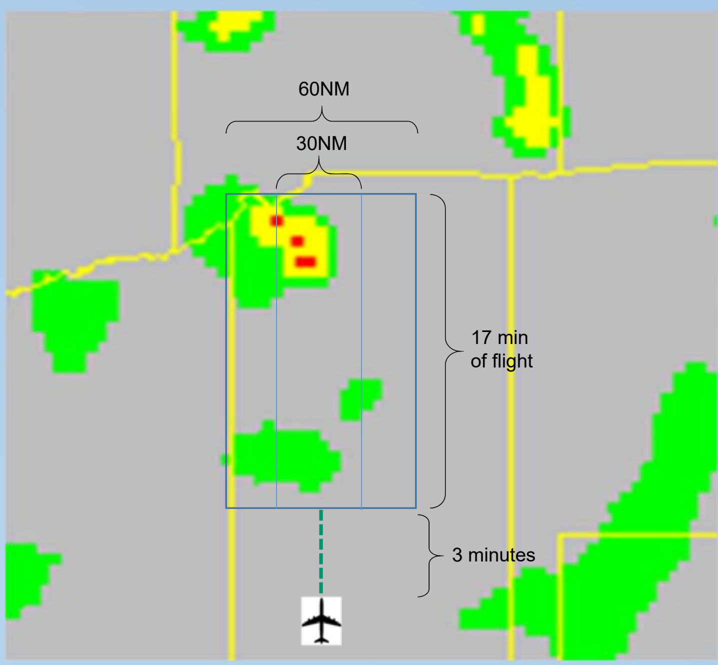


Determination of the notification



Determination of the notification

Calculate number of GTGN pixels in box(s) to determine notification type



Types:
NULL
Light
Moderate
Severe

Logic for Position Projection and Notification

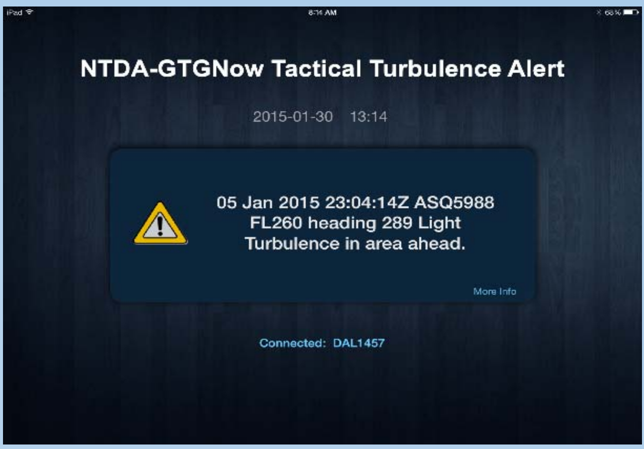
- Gathers all aircraft that have a position report within 3 minutes.
  - Aircraft below minimum altitude (20kft) are skipped.
  - Find a valid departure message to obtain the Departure and Destination airports.
    - No Departure message use simple heading/speed projection.
  - Aircraft within 50nm of departure and 100nm of destination are skipped.
  - Find the most recent route for flight with Departure and Destination airports, eliminates future and past flights with same callsign.
    - No route available use simple heading/speed projection.
  - Aircraft must be within 10nm of route to be considered valid.
    - Aircraft off route use simple heading/speed projection.
  - Using most recent position and valid route, project the aircraft forward along the route 3 minutes into future.
  - Using projected position and valid route create a box 30nm wide (15 to either side of route) and 17 minutes long (using aircraft speed).
  - Gather turbulence information within box and create a NULL, Light, Moderate or Severe notification text.

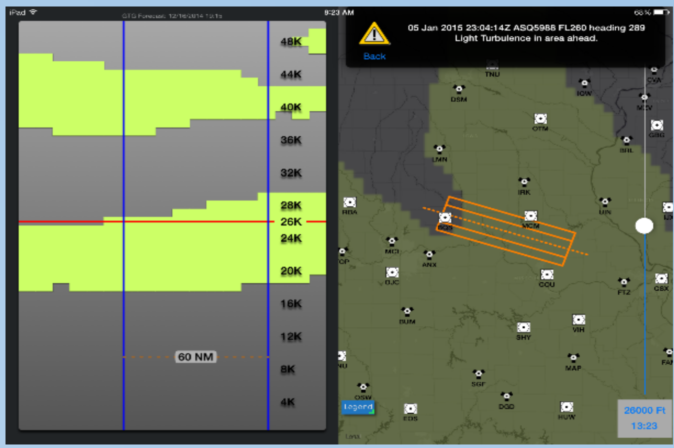
Human Over The Loop Demos (HOTL)

The purposes of the HOTL uplink using the FAA NIEC RCS included:

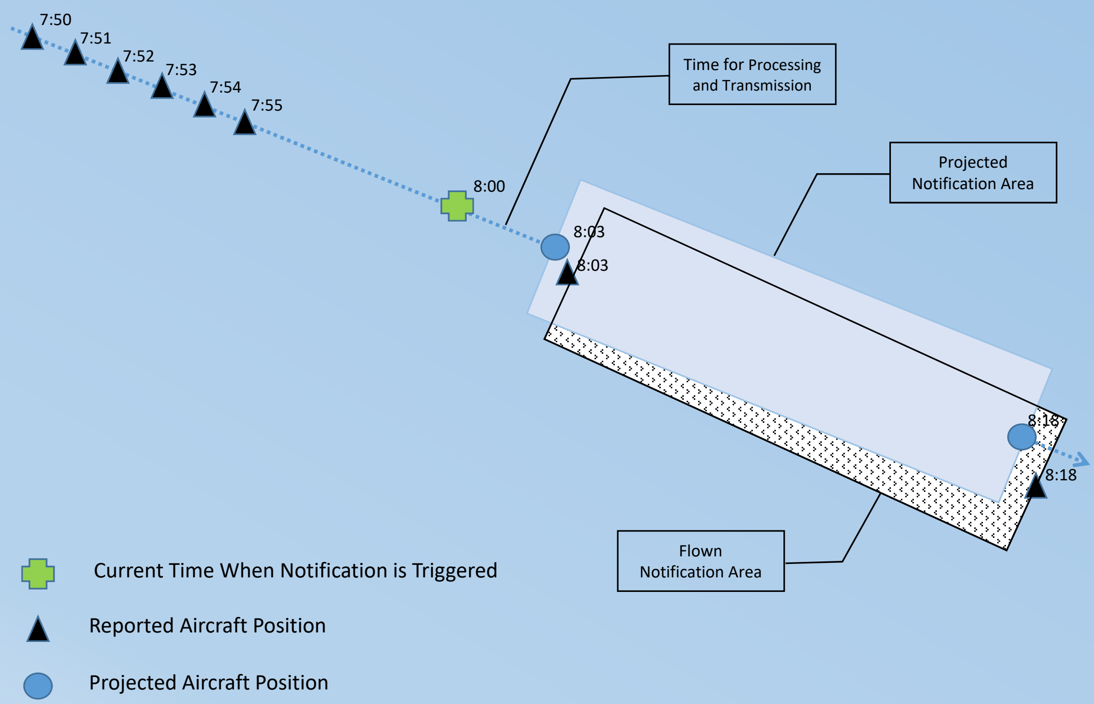
- Identifying flight risks (if any) associated with providing frequently updated turbulence information to the pilots.
- Increasing our understanding of impacts to pilot, dispatch, and air traffic management (ATM) decision making in a collaborative environment when frequently updated turbulence information is provided to the flight deck.
- Identifying demonstration objectives that are best accomplished with an expanded demonstration of frequently uplinked turbulence information to operational airline flights.
- Validating and demonstrating the use of a connection similar to Aircraft Access to System-wide Information Management (SWIM) (AAtS) connection, and data link formats in the turbulence notification role.
- Developing a better understanding of turbulence notification latency requirements, and the ability of AAtS to satisfy them.

HOTL Demonstration Display





Projected vs. Flown Notification Arenas



Turbulence severity from system Vs turbulence severity from actual flown area

Overall

Projected Notification Classification

Actual Notification Classification

	NULL	LIGHT	MOD	SEVERE
NULL	17803	317	309	78
LIGHT	176	3538	210	32
MOD	211	132	4424	312
SEVERE	38	15	171	1590

False Positives

Missed

Turbulence severity from system Vs turbulence severity from actual flown area

Overall

Projected Notification Classification

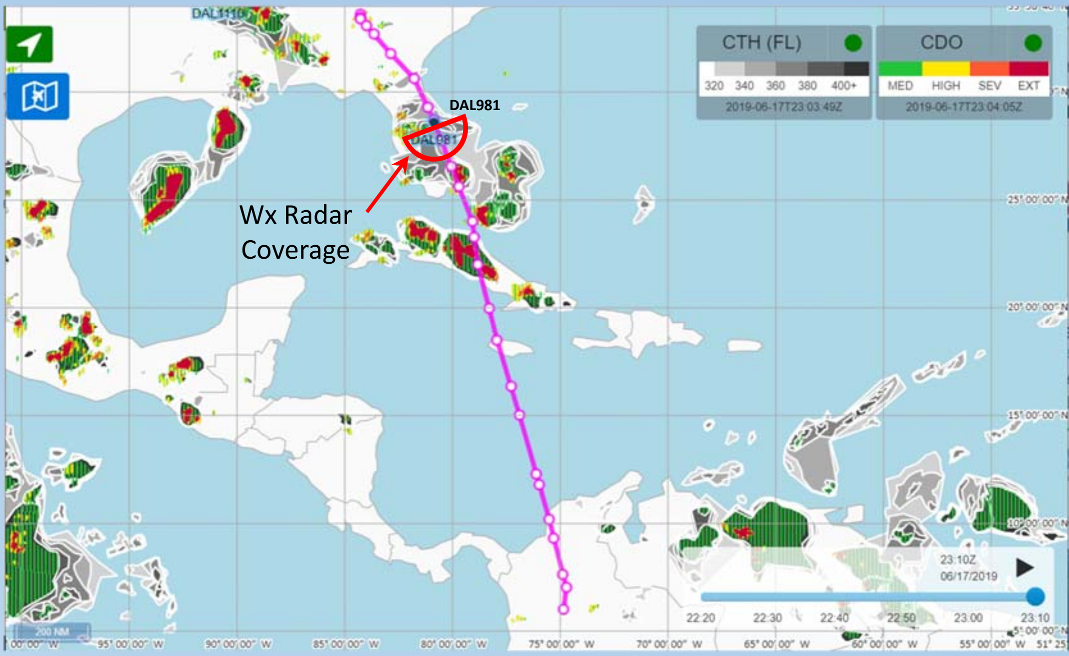
Actual Notification Classification

	NULL	LIGHT	MOD	SEVERE
NULL	96.2	1.7	1.7	0.4
LIGHT	4.5	89.4	5.3	0.8
MOD	4.2	2.6	87.1	6.1
SEVERE	2.1	0.8	9.4	87.7

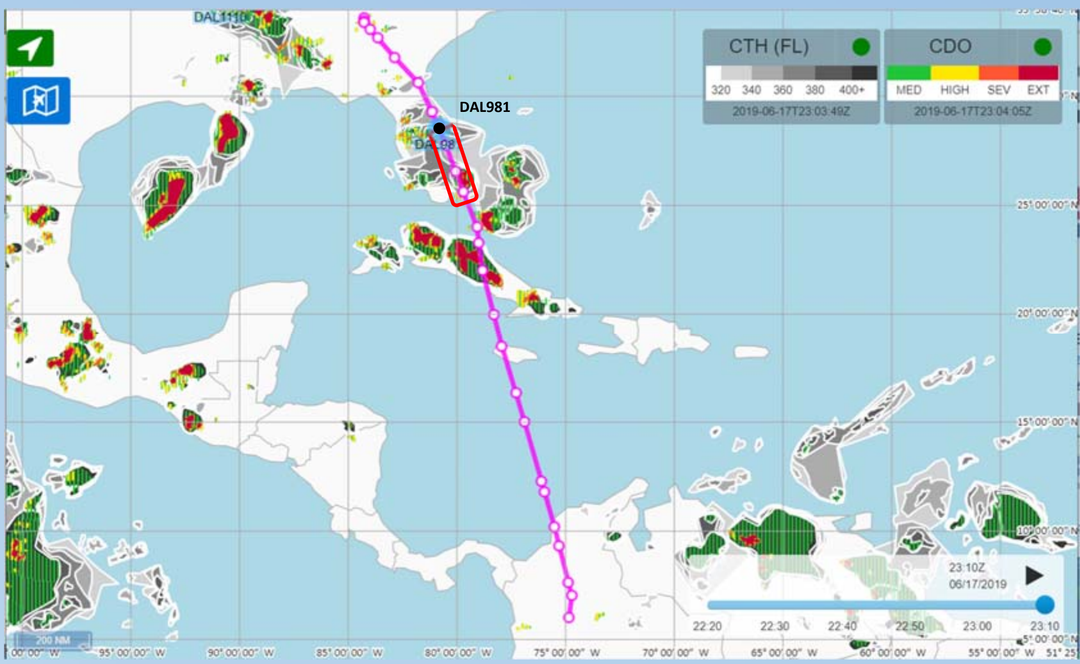
False Positives

Missed

Onboard Radar look-ahead horizon 20min (~160nm)

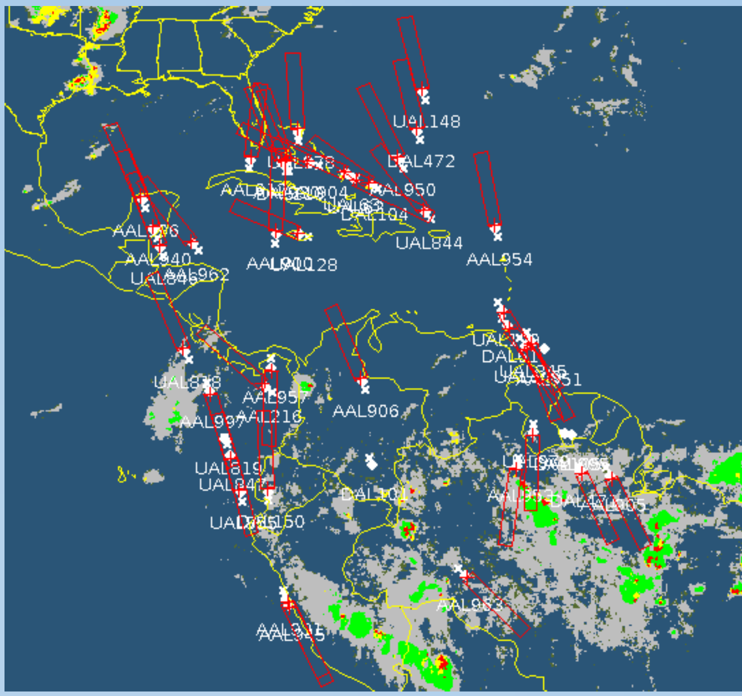


Projection window 32min (~240nm) and 60nm wide



17 Jun 2019 23:02Z DAL981 FL328 heading 159, Moderate Convection ahead at 27.33 -80.82, Cloud Top Height at FL358.

GlobalWeatherNote running with CTH/CDO



Future Plans

- Implementation options?
- Exact method for sending and receiving the notification to target aircraft will be implementation dependent.
- Many different ways for pilots to have their flight “registered”, either manually or automatically.
- Technology Transfer package has been created.
- Planning a spring meeting with industry to discuss implementation options for this and the CTH/CDO product.

Jason Craig - jcraig@ucar.edu

AOAWS-RU IA #18

Task Status Report

Common Tasks

Task	Activities	Status
Define computing environment requirements, including the operating system, software libraries, and storage, for NCAR development and testing servers.	A draft documenting the computing environments of the NCAR development platform has been shared with the NCAR team, seeking input and further recommendation. Will share with CAA and IISI.Q	In progress
Support CAA's development of an interface control document (ICD) that defines the input and output data requirements for this task.	Content to define the input/output requirements for the each task was added to the ICD.	Completed
Collect required sample WRF model and observation data. Examine WRF variables	Sample WRF model data and observations were collected with the help from CAA, IISI, and CWB. Required missing variables in WRF were identified.	Completed
Develop training material and update user documentation.	Training materials for each task were developed.	Completed (for 2021)

Q: When can the computing environments for NCAR testbed be finalized?

Data Requirements and Data Transfer to NCAR

Jason Craig and Rong-Shyang Sheu

Aviation Applications Program
Research Applications Laboratory

Data Transfer Current Real Time

Data Set	Start Date	End Date	Gaps / Issues
WRF_3km	July 1	Near Real Time	Transfer problems, do not receive all forecasts
WRF_15km	July 1	Near Real Time	
RWRF	Aug 10	Near Real Time	
Lightning	June 1	Near Real Time	
Radar vol/ppi	October 1	Near Real Time	Air Force Radars Vol
Mosaic 2d/3d Refl	June 1	Near Real Time	
Cloud Mask	July 1	Near Real Time	August, Sept 5-13
AFTN, CAF, GTS	March 1	Near Real Time	August 6 – August 17 CAF receiving only one file per day - October 17
ACARS txt	June 1	Near Real Time	August 6 – August 28
Mosaic precip	June 1	Near Real Time	

Data Transfer Non Real Time (*cont'd*)

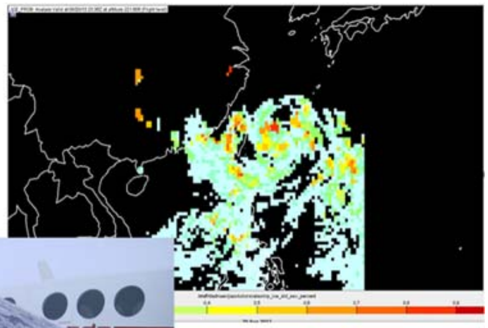
Data Set	Start Date	End Date	Request
InSitu EDR (China Air)	December 2020	August 10 2021	Quarterly Updates
NTDA EDR Mosaic			Near Real Time start mid to late December
IWXXM	August, Sept 16	October 29	Near Real Time or Quarterly Updates

Task 1. Update the In-Flight Icing Diagnosis and Forecast Products

Gary Cunning and Dan Adriaasen

Task 1. Progress Update

- Initial datasets were reviewed for completeness for the TCIP2 and TFIP2 systems. It was confirmed that the Goddard microphysics package is part of the CWB's WRF configuration. TCIP2 and TFIP2 will be adapted to use CWB model results
- Files from 10/9/21 in the archive datasets[Q1] are being used to configure initial versions of TCIP2 and TFIP2. All inputs have been converted to MDV or SPDB formats for the downstream applications to process.
- Documents from the previous phase were reviewed to establish a rough outline for the test and evaluation processes for the icing products. With information gleaned from the previous phase a test and evaluation plan was developed for TCIP2 and TFIP2. A draft of this plan was shared as a deliverable on 10/15/21



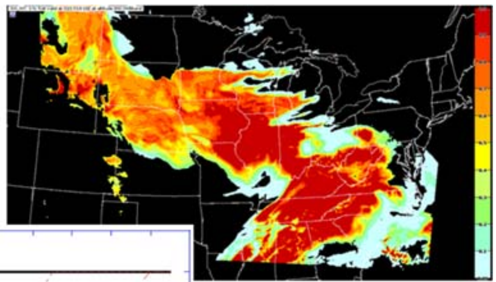
Q1: "more archive data sets will be considered"; what period of time?

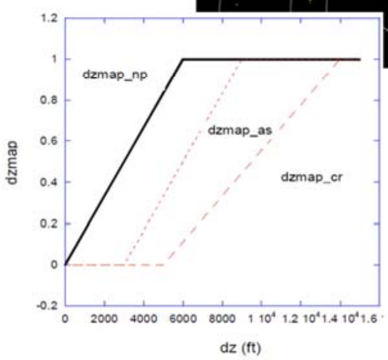
Task 1. Progress Update (*cont'd*)

- Initial investigations into the utility of voice PIREPS and anti-icing indicator data from airlines. The limited number will relegate them to be used in conjunction with any icing case studies that become a part of the testing and verification processes[Q2].
- Underlying libraries that support the MDV file format have been updated to write CF-1.6 compliant NetCDF-formatted files. These libraries are part of TCIP2 and TFIP2 builds. Once the OGC-compliant specifications are known[Q3], an additional process will be added to TCIP2 and TFIP2 to enhance the current CF compliant NetCDF output.

Q2: Aircraft icing reports are indeed sparse in Asia, what are the alternatives?

Q3: Who should verify? NCAR or IISI? When?





Task 2. Update the Graphical Turbulence Guidance to V4 and Implement GTG Nowcasts

Wiebke Deierling, Hailey Shin, Bob Sharman,
Teddie Keller, Julia Pearson, Tom Blitz

Task 2. Progress Update

Coordinate with UCAR AOAWS-RU aviation weather algorithm and product development teams on required data for product development

Put together a list of required WRF output variables that are required to run GTG4. Time-varying roughness length (ZNT), was added by CWB in August & WRF output contains all required GTG4 variables.

Coordinate with UCAR AOAWS-RU PDTs to collect required long-term WRF model and observational data

Decoding and analyzing turbulence reports received from Taiwan as well as an initial batch of in-situ EDR data from China Airlines. Receiving WRF output files for 15-km and 3-km model domains respectively from Jul 1, 2021 on and ran GTG4 prototype on output to gain insights on what needs to be done for adaptation of GTG4 prototype to Taiwan WRF model output. Tested GTG4 on in-house WRF output over larger domain to aid GTG4 adaptation (GTG calibration & case studies). Preliminary results show good agreement between NCAR's in-house WRF outputs with extended domain and those from CWB.

Conduct timing benchmark tests at UCAR for the MPI GTG4

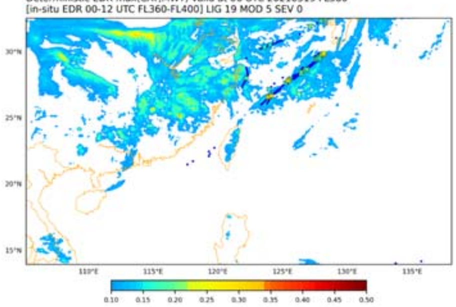
Performed initial runtime tests of GTG4 on NCAR's local machine for WRF_D1 (15 km) and WRF_D2 (3 km) and continue working on these. Final benchmarks and forecast length adjustments will require final project hardware. CAA comment: In the end the timing benchmark should be tested in CAA's testing environments.

Task 2. Progress Update (*cont'd*)

Perform GTG4 case studies based on WRF sample data provided by CAA

Identified turbulence cases based on turbulence observations accessible to NCAR in house. This included case studies identified from all turbulence observation reports from March to September. Note, there is a limited amount of in situ data in the area surrounding Taiwan, and the number of reports per day is highly variable. Additionally, the number of reports decreases in August and September relative to the spring (March-May). (CAA comment: could it be the number of turbulence reports are related to weather systems?)

Uncalibrated GTG results with in-situ EDR



Work with the CAA to support its efforts towards acquiring the in-situ EDR data on airlines that service the southeast Asia area or from other data

NCAR has received an initial batch of in situ data from China Airlines from Dec 2020 to Aug 10, 2021. We continue to need such in situ data over the next year that will help with the adaptation and eventual verification of GTG4.
We also need NTDA data for adaptation and eventual verification of GTG4.
(CAA comment: Needs to negotiate/coordinate with China Airlines.)

Develop Training material and update user documentation

Training materials for GTG4 were developed and presented in 2 virtual training sessions in October 2021.

Task 2. Plans

- Further identify & investigate case studies based on our data
- Initial look at calibration of GTG4 output
- Continue testing operation of GTG4 on NCAR servers
- Support acquisition of turbulence observations (airborne and radar based)

Additional items:

- Additional earlier 2021 WRF data for case studies
  - 30 March 2021, 1 April 2021, 13 May 2021, 19 May 2021, 22 May 2021, 27 May 2021
- Archive weather charts for case study identification

Task 3. Update the NCAR [1] Turbulence Detection Algorithm

Greg Meymaris, Jason Craig, Scott Ellis, Wiebke Deierling, Jeff Hancock, Tom Blitz

投影片 13

1 Slight change to task wording.
Greg Meymaris, 2021/11/17

Task 3. Progress Update

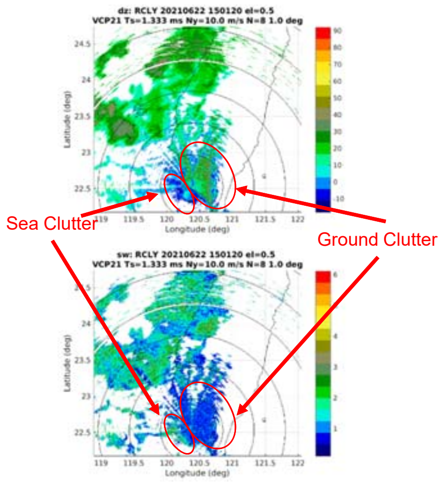
Coordinate with UCAR AOAWS-RU aviation weather algorithm and PDTs, to collect required sample radar data from CAA and examine

Compiled information about the available radars from Taiwan. It was determined that there are potentially six radars that can be added to the NTDA algorithm and are: (RCLY, RCNT, RCSL, RCCK, RCMK, and RCGI(R)). Receiving most of these radars in near real-time. However, 3 radars from the Taiwanese Air Force are not being received in the near real-time feed, but are prepared them for addition to the NTDA Algorithm[Q1] (CAA comment: radar data transfer from Taiwanese Air Force is limited by bandwidth. The issue is being evaluated.)

Add OGC compliant NetCDF output option, or a format that is mutually agreed upon by CAA and UCAR, for the NTDA product

An OGC compliant Netcdf output ability has been added to the final NTDA mosaic. Final look and feel of the Netcdf output is still to be determined and requires coordination between all of the product development teams.[Q2]

Figure: Radar Reflectivity (top) and spectrum width (bottom) from RCLY, one of the new CWB C-band radars from 2021-06-22.



投影片 14

2 Minor fix
Greg Meymaris, 2021/11/17

Task 3. Progress Update (*cont'd*)

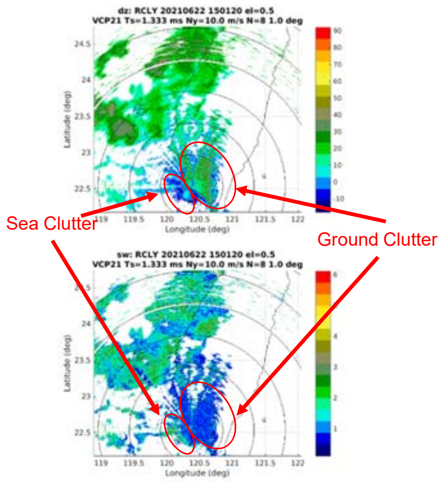
Evaluate the radar data quality, scanning strategies and, where applicable, dual-polarization data for each of the contributing weather radars

NCAR has been looking at data from all the radars. Currently, nothing unexpected has been found. NCAR has identified radar frequency interference, sea clutter, and significant ground clutter, all as expected. Additional work still remains to use the dual-polarization data from the Gematronik dual-pol radars.

Develop training material and update user documentation

Two training sessions on NTDA were developed and presented as part of the fall 2021 virtual training sessions.

Figure: Radar Reflectivity (top) and spectrum width (bottom) from RCLY, one of the new CWB C-band radars from 2021-06-22.



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3 Greg Meymaris, 2021/11/17

Task 3. Plans

- Continue to coordinate with CAA on obtaining radar data.
- Evaluate the radar data quality, scanning strategies and, where applicable, dual-polarization data for each of the contributing weather radars. Specifically, we are mining the meta-information from the radar files to study the scanning strategies
- Identify interesting case studies, both regarding meteorological and data quality. Provide report on findings.
- Continue to adapt as necessary the currently available Gemtronik2Netcdf and NTDA software to work with CAA provided radar data. This updated version is expected to include the Radio Frequency Interference (RFI) mitigation method as well as the antenna scan rate correction to mitigate false alarms.
- Support any further training events.[4]

投影片 16

4 A number of updates on this slide.
Greg Meymaris, 2021/11/17

Task 3. NTDA Questions

- Q1: The 6 radars refer to the newly added radars, right? The new version of NTDA should include the existing 4 radars, right?
- Q2: “Final look and feel of the NetCDF output is still to be determined…” Does this needs IISI’s input, or NCAR will determine it?

Task 4: CTH/CDO*

Task	Activities	Status
Implement the enhanced CTH and the added CDO algorithms that comprise the oceanic convection diagnosis system in a UCAR testing environment	• The prototype system was installed and configured. • The system was used with the anticipated AOAWS-RU data ingest apps to process data from July 15 (2000-2359) using the supplied lightning, WRF D1, and satellite data sets. Samples of output data (GRIB2) were provided 28 October. We anticipate some adjustments to the configuration over the next month or two as we fine-tune the processing	In progress

* See the presentation on the “Initial version of CTH and CDO in UCAR testing environment” deliverable

Q: Will CTH/CDO run on both D1 and D2 domains of WRF_D

Task 5. Update the Airport Ceiling and Visibility Prediction Products

Jim Cowie, Bill Petzke and Dan Megenhardt

Task 5. Progress Update

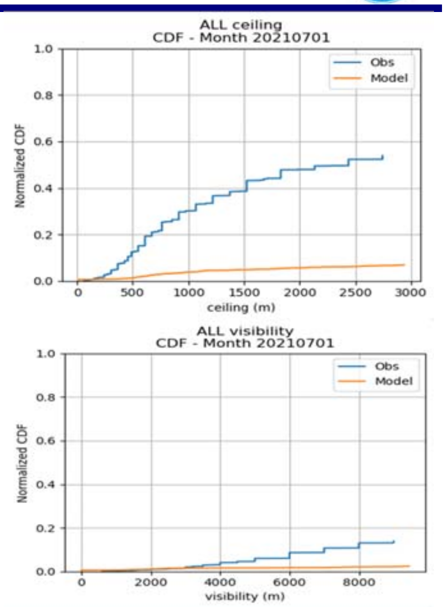
Activities

- Adaptation of the calibration and forecast applications[Q] to use the CWB WRF/UPP output continues
  - Restrict the set of input model files to avoid certain files
  - Use consistent units throughout, adjust initial calibration thresholds
  - Update to use newer netCDF4 C++ API
- Work continues converting the verification script to use output from the UPP and calibration system (*graphs show UPP output only, not calibrated forecasts*)
- Training completed

Issues

- There were many missing model runs and observation (AFTN) files in July and August

Q: We are not adapting from the existing AOAWS C&V system; rather we adapt the Alaska system. Is this why we need to re-train? Or the needs to re-train is based on new model (WRF_D) used? How long of a training period do we need?



Task 6: ASPIRE*

Task	Activities	Status
Develop implementation plan based on meeting with CAA	• Met with the CAA in May 2021 and determined that products should include both precipitation rate and radar reflectivity height (or storm top height). Update rate of the product will be every 10 min and output rate will initially be every hour as this is the output rate of the model. Model data will be obtained from CWBs 2 km RWRF model. • This task has been completed. Details of the system specs are included in the overall AOAWS-RU system ICD which was submitted in July 2021.	Completed
Develop the system requirements document (e.g., uptime, update-rate, forecast variables, system latency)	The forecast variables has been identified, but other information such as the latency of input datasets (2km RWRF in particular), and expected level of system reliability (i.e., uptime) are needed to finalize design of the blending system	In progress
Obtain and process sample datasets	• Obtained, processed and performed preliminary evaluation of 2D and 3D radar mosaics. We have noted that sea-clutter is present in these two datasets and thus, may need to develop an algorithm for removal of sea clutter unless this is already done within QPESUMS. Also, began assessing diurnal climatology of radar reflectivity for the month of March to aid in improving the extrapolation based nowcasts. • Datasets have been processed to generate 0-2 hour extrapolation forecasts of reflectivity. The 3D mosaic has been converted to internal formats and used to compute storm echo top heights	Completed

Task VI: ASPIRE (*cont'd*)

Task	Activities	Status
Develop multiscale extrapolation technique	Work to statistically optimization the extrapolation technique and to incorporate a multi scale approach whereby vectors characterizing multiple scales of motion are obtained and combined into a single motion vector field has begun. A suite of sensitivity studies are underway to evaluate and improve the performance of CTREC.	In progress
Add option to output in OGC-compliant NetCDF	Final products of the extrapolation system are now output as OGC compliant NetCDF. A sample version of extrapolation data has been provided to the CAA using this file format and CAA has been able to properly read and render this data	Completed

* See the presentation on the "Initial version of the new extrapolation prediction system at UCAR" deliverable

Task 7. Develop and Implement XML Converters for Meteorological Reports

Padhrig McCarthy and Arnaud Dumont

Task 7. Progress Update

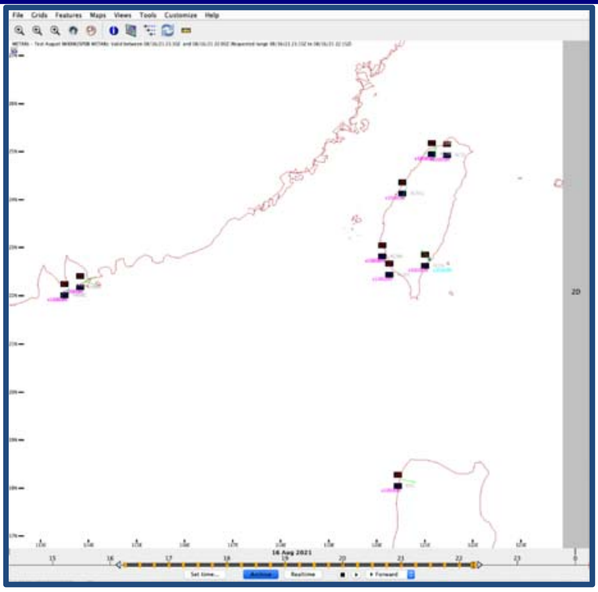
Work Performed:

- ❑ NCAR ran schema validation on sample IWXXM reports issued May 3-4, 2021
  - NCAR Submitted findings to CAA (20 validation failures in 190 reports)
  - CAA revised the IWXXM encoding based on NCAR recommendations
- ❑ NCAR ran schema validation on revised IWXXM reports issued August, 2021
  - NCAR Submitted findings to CAA (46 validation failures from 15,990 reports)
- ❑ NCAR created MetarIwxmm2Spdb conversion utility
  - C++ application patterned after other ingest tools in use within AOAWS-RU
  - Note that subtasks 7.3 and 7.4 were combined into a single converter (CAA comment: since NCAR decides to stick to SPBD, this has very little impact.)
  - NCAR Performed validation on conversion process of the sample August, 2021 data
- ❑ NCAR wrote "Task #7 Validation Report" to complete deliverable (CAA comment: on errors in the Taiwanese Air Force Airport METAR reports, SIGMET report timing (or format?) is inconsistent with ICAO standards. CAA will adjust the translator program to ensure quality assurance.)
- ❑ NCAR work is complete on this task. Awaiting integration into AOAWS-RU

IWXXM METARs in AOAWS Display

METARs and SPECIs converted from IWXXM → SPDB are viewable in AOAWS display

- Display shows August 16, 2021 at 23:00Z (for proof of conversion only, styling incomplete)
- Data source is IWXXM sample from CAA



Task 8: Consultation

Task	Activities	Status
Provide consultation on Low Level Wind-shear Alert System upgrade or its alternatives, e.g., radar or lidar wind-shear detection algorithm	The CAA provided a document describing the needs to upgrade the existing LLWAS system and seeking NCAR's input. NCAR discussed internally and determined a meeting was needed before NCAR can better address CAA's questions. The meeting between NCAR and CAA took place on Tue (Taipei date/time), October 26, 2021.	In progress
Provide consultation on science and technology on various topics, including, but not limited to, model output statistics, upgraded WRF model output processing, data ingest and distribution development, and product visualization system	No requests have been made regarding this item.	Pending
Provide consultation on Global Air Navigation Plan (GANP) and Aviation System Block Upgrades (ASBUs) updates, limited to the scope of aviation weather information system and its integration with the air traffic management system	NCAR has contacted our source of latest ICAO regulations/policy updates, Mr. Matt Strahan.	Pending
Support CAA's development of system integration	Expected in 2022	Pending

Task 9: Training and Tech Transfer

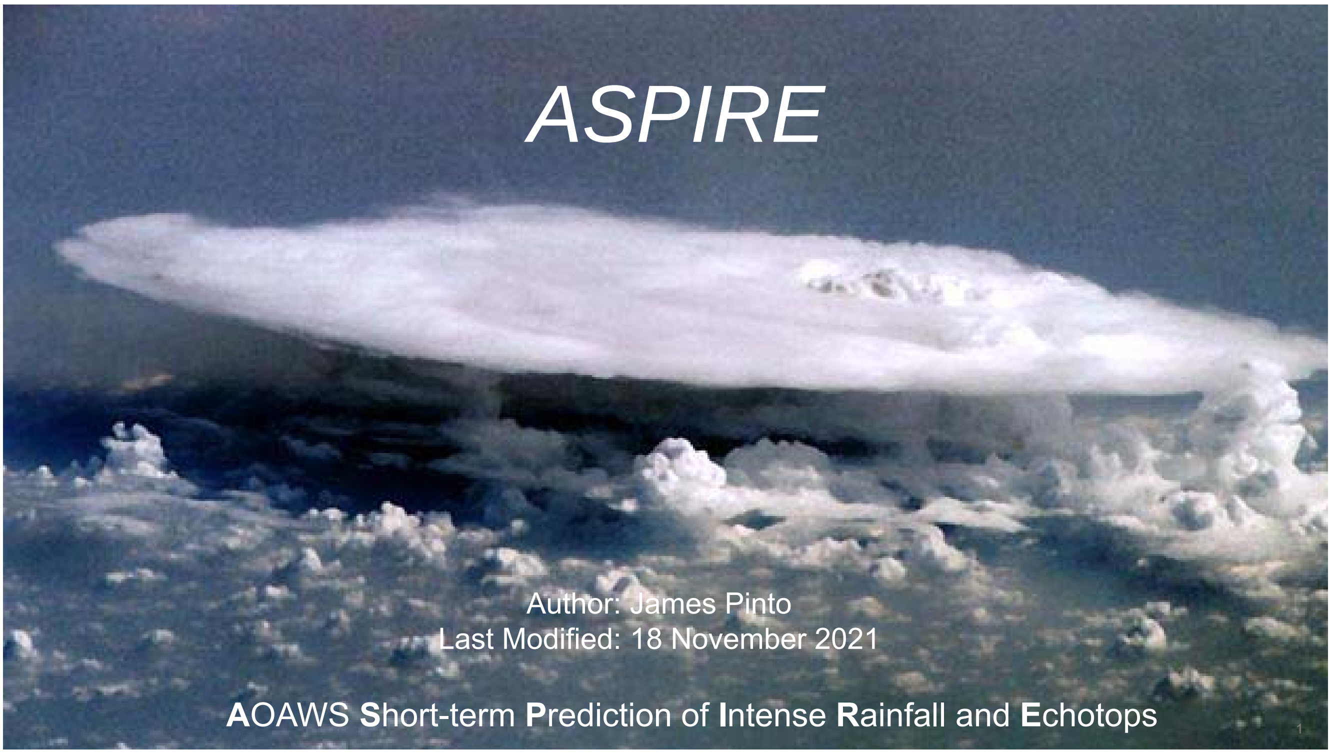
Task	Activities	Status
Prepare a draft Training Program Plan for a two-week training period	• NCAR worked on the scope and schedule for training. It was decided that some topics should be deferred to next year, since they pertain to new research and development which will not be completed in time for this year's training. Fundamental topics regarding core technologies, tools, and system design will be included in this year's training. Previews of the various algorithms and the anticipated research and development will also be presented. • NCAR worked to identify training modules, created a training template, and wrote a training plan which was delivered to CAA.	Completed for 2021
Create training materials designed to educate CAA staff on scientific and technical aspects of the new AOAWS system	NCAR team prepared training materials for 10 sessions of general technical training and followed up by preparing 10 more sessions of workshop presentations on aviation weather algorithm science and technology. The training and workshop presentations were shared with the trainees and workshop attendees before each session. The documents remain accessible on UCAR's shared Google Drive .	Completed for 2021
Conduct the two-week training program designed to educate CAA staff on scientific and technical aspects of the new AOAWS system	NCAR conducted 10 sessions of general technical training from September 15 to 30, 2021. The aviation weather algorithm science and technology workshop was conducted from October 19 and will last through November 11, 2021. The recording of each session will be provided via UCAR's shared Google Drive.	Completed for 2021

Task 10: Management

Task	Activities	Status
Carry out general project management, such as planning, budgeting, technical consultations with team members, and tracking progress	• Worked with NCAR budget administration staff to budget and request pre-spending authorization for the project to get underway. Facilitated discussion between CoSPA task lead and CAA on challenges to CoSPA and tailoring CoSPA designs based on the discussion. Coordinated with NCAR team members and CAA to author a draft ICD specific to NCAR aviation algorithms. Prepared, with input from NCAR team and CAA, a draft training plan. • Coordinated with NCAR team leads and CAA to determine dates for the training and workshop sessions. Facilitated Q&A between NCAR and CAA regarding development data. Facilitated discussion between NCAR low-level windshear alert system experts and CAA. Met regularly with NCAR task leads to understand development issues and track task progress. Prepared and delivered a draft Acceptance Document.	On-going
Prepare monthly and quarterly progress reports	Consolidated input from NCAR team members to finalize and deliver May, June, July, August, September, October 2021 monthly reports, as well as May-Jul, and Aug-Oct quarterly reports.	On-going

Task 10: Management (*cont'd*)

Task	Activities	Status
Respond to routine technical and information requests from the CAA	Coordinated with the CAA to clarify and update information regarding input data requirements and set up data receiving environment.	On-going
Obtain and review user feedback on the new AOAWS system	*No users involved yet.*	Pending, expected in CY2022
Participate in AOAWS-RU related meetings, including annual Acceptance Meeting at CAA	*See quarterly reports for the list of meetings.*	On-going



NCAR

ASPIRE Research and Development Team

Dan Megenhardt

Dave Albo

Tina Kalb

Tom Blitz

Task 6 ASPIRE Deliverables

6	CoSPA	Initial version of the new extrapolation prediction system at UCAR	November 5, 2021
6	CoSPA	As negotiated, exchange examples, either via case studies or a real-time feed, of extrapolated radar reflectivity forecast data with CAA along with performance metrics provided as part of quarterly report	December 3, 2021

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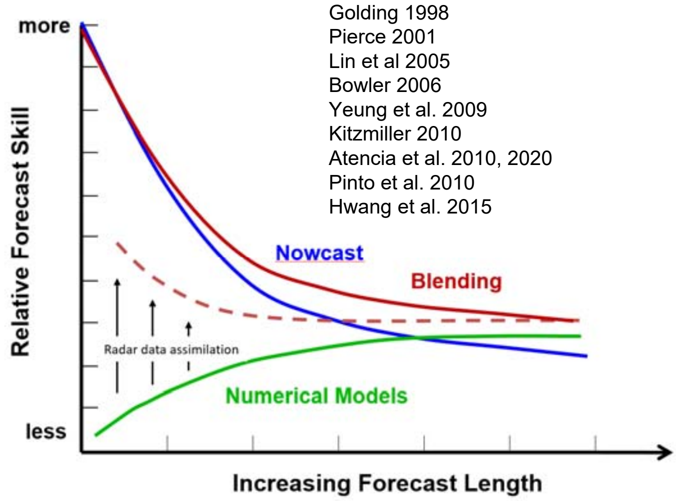
Seamless Transition & Optimized Skill

Goal of ASPIRE Short-term Prediction System

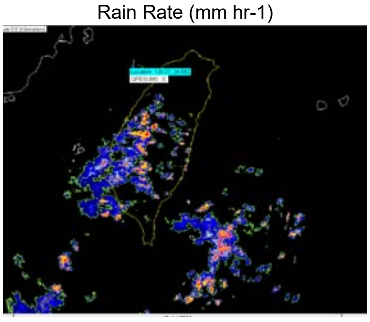
- Generate a rapidly updating forecast system that produced up-to-date guidance products that span tactical (< 2 hr) and strategic planning time scales (4-8 hours).
- Forecasts will have skill greater than or equal to individual inputs (model and extrapolation) by taking advantage of relative strengths of each.
- High resolution products will provide info on future structure / position / intensity / depth of storms and where greatest impacts are expected.



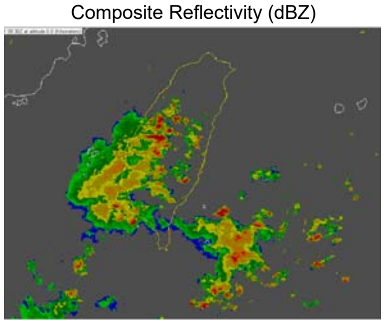
Some Blending REFS
Golding 1998
Pierce 2001
Lin et al 2005
Bowler 2006
Yeung et al. 2009
Kitzmiller 2010
Atencia et al. 2010, 2020
Pinto et al. 2010
Hwang et al. 2015

Planned Features of ASPIRE

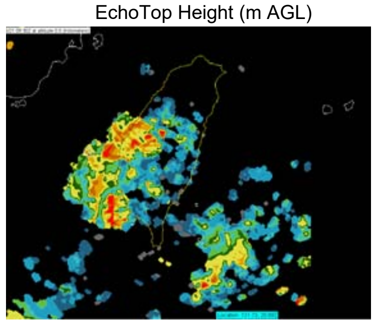
Rain Rate (mm hr-1)



Composite Reflectivity (dBZ)



EchoTop Height (m AGL)



Analyses and 0-12 hour Forecasts

- Composite Reflectivity, Radar EchoTops, Precipitation Rate (using gauge corrected QPESUMS)
- 10 min update rate

Forecast blends extrapolation with high resolution model forecast data

- Extrapolation uses multi-scale NCAR CTREC algorithm
- Model Input will be the CWB R-WRF (2 km) with post-processing using Unified Post-processor.
- 10 min update rate with output out to 10 hours.

Key Features of Blending

- Model bias removal (**calibration**) and position error adjustments (**phase correction**).
- Dynamically updating weights base on Fractions Skill Score
- Heuristic forecast uncertainty-based weighting in storm growth/CI regions
- Uses multi-threading to maximize performance

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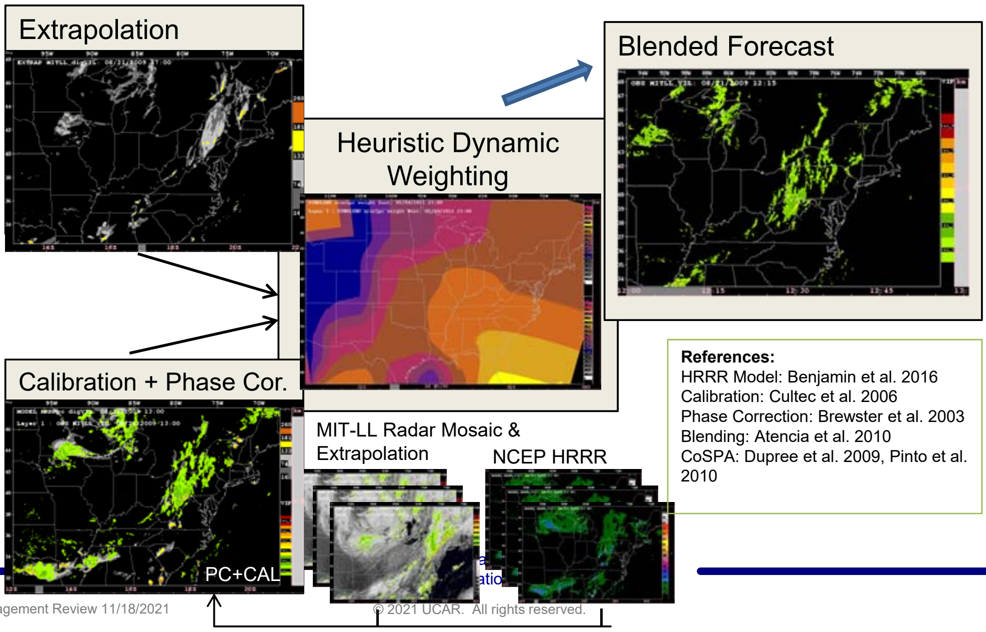
AOAWS-RU Project Management Review 11/18/2021

ASPIRE Blending Algorithm Overview

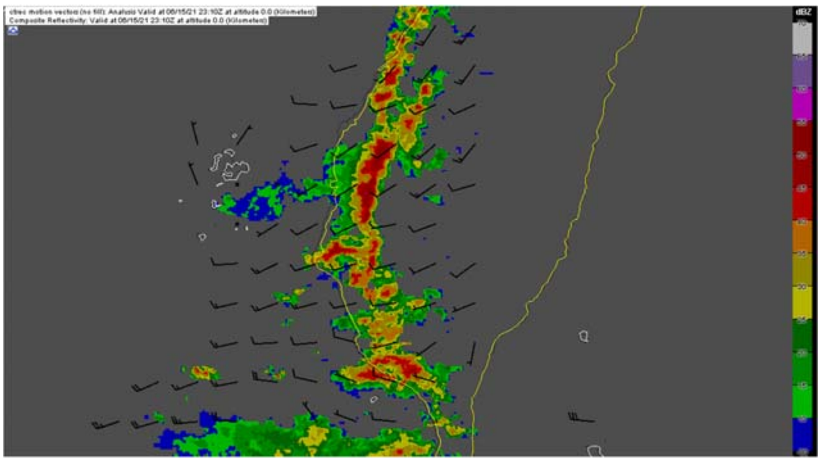


References:
HRRR Model: Benjamin et al. 2016
Calibration: Cultec et al. 2006
Phase Correction: Brewster et al. 2003
Blending: Atencia et al. 2010
CoSPA: Dupree et al. 2009, Pinto et al. 2010

Initial Version of Extrapolation Prediction System

1 hour Sequence of Composite Reflectivity used to Compute Motion Vector field

Note: Motion vectors derived from comp_refl will be applied to echo tops and QPESUMS precipitation rate.



CTREC = Cartesian Tracking Radar Echo by Correlation

- Described in Tuttle and Foote (1990).
- Used in the Autonowcaster
- Uses cross-correlations to identify storm motions.
- Key Settings:

Del_dbz = 10 dBZ
Cbox_size = 75 km
Cbox_space = 25 km
Delta_time = 10 min

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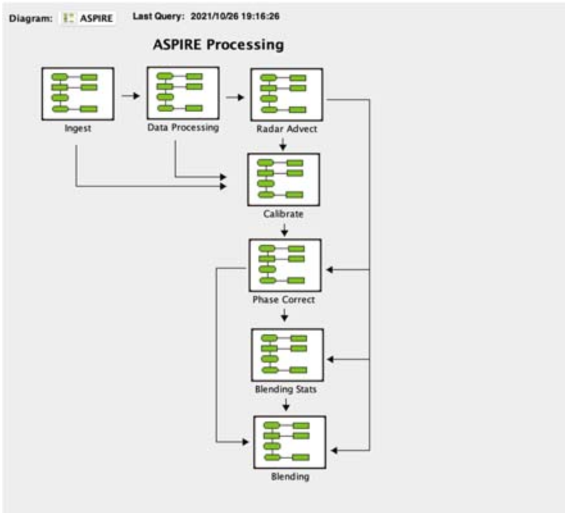
Applications and Processing Flow

ASPIRE top level flow diagram

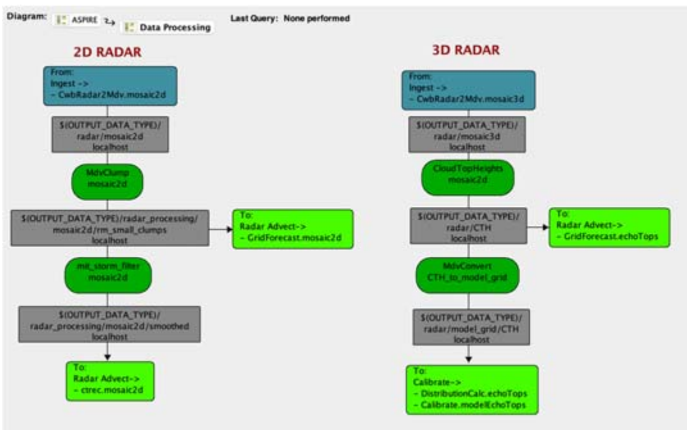
- Multiple processing steps are separated into sub-diagrams.
  - Ingest comes first and blending is the final step.
- Flow lines show data produced in one diagram is used by processes in other diagrams.
  - Ingest data is used in the Data Processing and in the Calibration processing.
  - The advected radar is used in all the down stream processing steps (Calibration, Phase correction, Blending Stats, and Blending).



Applications and Processing Flow

Data Processing diagram

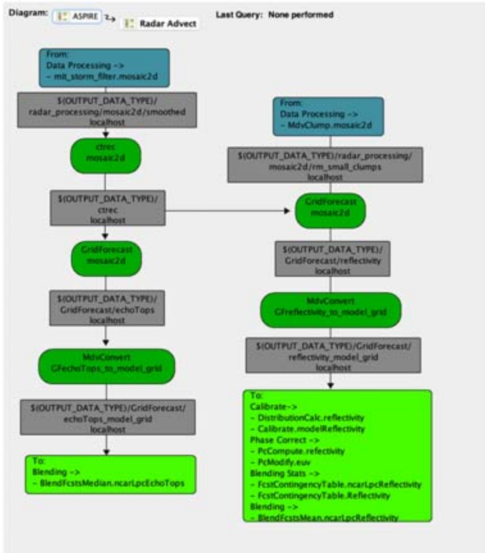
- 2D RADAR
  - Preparing the data for tracking and extrapolation forecasts.
  - **MdvClump** removes small areas of connected grid points.
  - **mit_storm_filter** uses an elliptical filter to smooth the data.
- 3D RADAR
  - **CloudTopHeights** computes the echo tops
  - **MdvConvert** is used to remap the data to match the model grid



Applications and Processing Flow

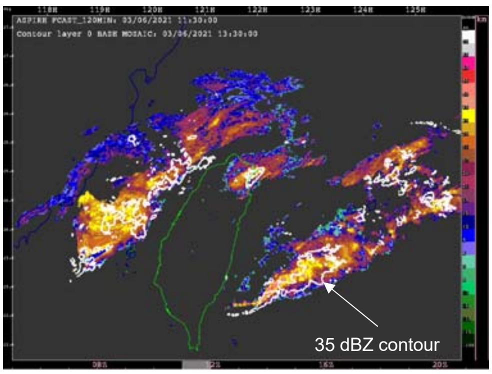
Radar Advect diagram

- **ctrec** – Uses a cross-correlation analysis of echos to calculate motion vectors from radar data.
- **GridForecast** – Uses the ctrec motion vectors to advect gridded data to multiple lead times.

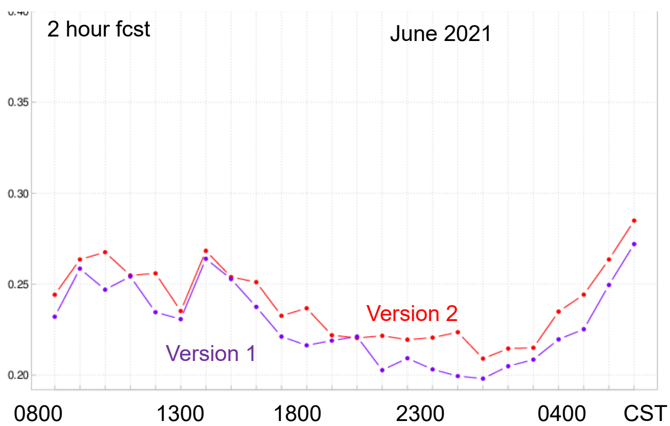


Initial Version of Extrapolation Prediction System

Extrapolated Reflectivity Evaluation



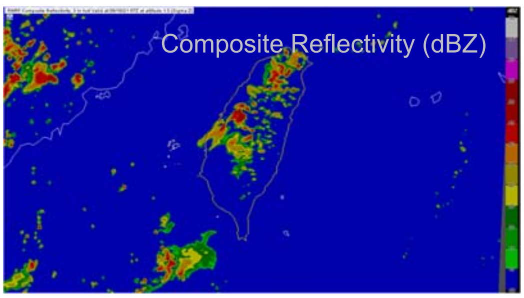
CSI vs time of day

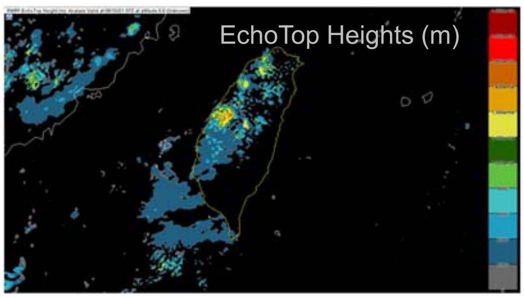


Next Steps

- Working to optimize extrapolation by including multiple scales of motion.
- Extend extrapolation out to 4 hours via combination of multiscale tracking and extrapolated vectors.
- Assess skill as a function of leadtime for two retrospective 30-dayt time periods Jun and Sept.
- Evaluate impact of storm evolution on skill of extrapolations and devise improvements.
- Begin relative assessment of skill with respect to the RWRF reflectivity forecasts.

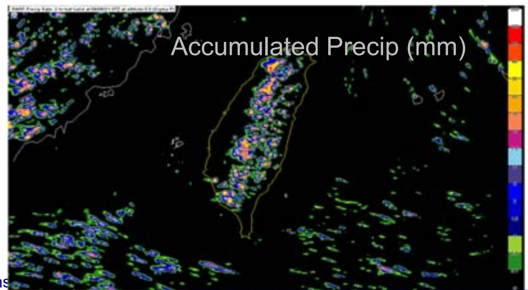
Model Inputs





Model Input: CWB RWRF

- Hourly Update
- 60 min output rate
- DA System including assimilation of 3D radar reflectivity
- 2 km grid spacing
- Derived variable obtained using NCEP Unified Post Processor (UPP)



Task 4. Update the Cloud Top Height (CTH) Prediction Products

Ken Stone, Dan Megenhardt, Thomas Blitz

with significant contributions from Cathy Kessinger

Task 4 – Overview 2021

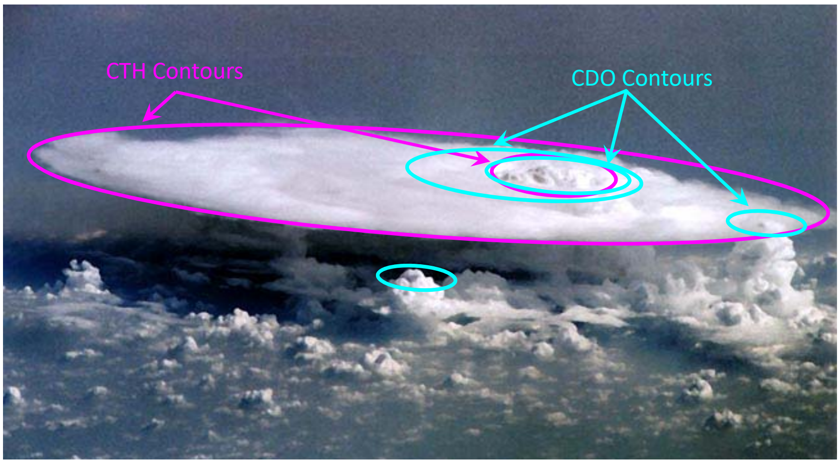
CTH = Cloud Top Heights

- Above 15kft
- For optically thick clouds
- Derived from Himawari and WRF
- Updates every 10 minutes

CDO = Convection Diagnosis Oceanic

- Detection of convective hazards, giving additional information to the CTH.
- Hazard indicator (0 to 6).
- Derived from Lightning, WRF, and Himawari
- Values >= 2 indicate a convective hazard is likely
- Values >= 3 indicate lightning and/or an overshooting top is present.
- Updates every 10 minutes

Two Convective Products: CDO and CTH



- Two products better characterize convective storm
- CTH gives full extent of cloud cover and height
- CDO shows location of updraft/lightning hazards

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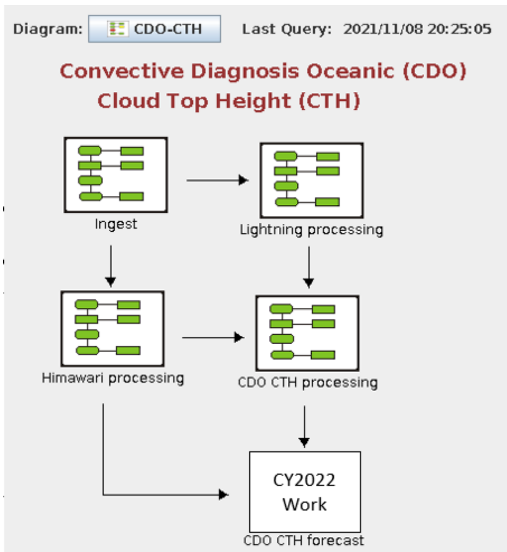
Data Processing Overview

- Prototype Implementation
  - Uses US NCEP GFS model and ENTLN Lightning, along with Himawari Satellite Data
- Prototype can also process sample data as provided
  - Himawari Satellite
  - CWB Lightning
  - WRF Domain D2
- Sample GRIB2 data provided from July 15, 2021.
  - Preliminary configuration, we anticipate updates.



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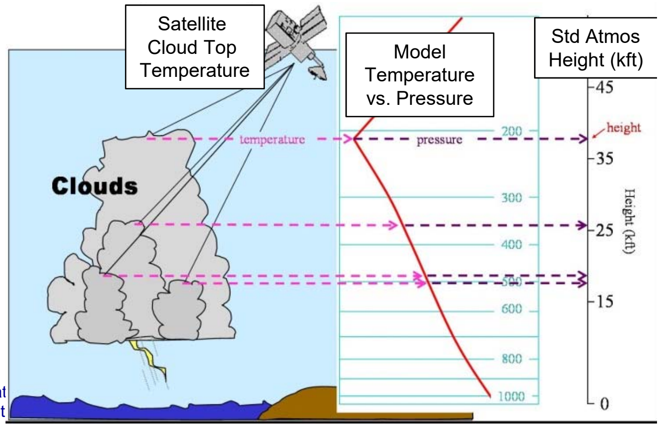
CTH Overview

- Cloud Top Height (CTH) is computed by:
  - Converting the satellite 11.2 micron infrared (IR) brightness temperature to pressure by comparison to the WRF model sounding.
  - Converts the pressure to a flight level through the standard atmosphere equation (Miller 2005).
- Defines storm anvil contours
  - May not show individual convective cells



CDO Overview

- Convection Diagnosis Oceanic is computed using a combination of inputs:
  - 1) Global Convective Diagnosis (GCD) is computed by differencing the brightness temperatures from the longwave IR and water vapor channels (Mosher, 2002).
    - Indicates the location of mature updrafts when the difference is near zero.
    - Optically thick clouds will exhibit similar LIR and WV radiances (assuming water vapor above the cloud is negligible).
  - 2) CTH (as described earlier)
  - 3) Overshooting Tops Algorithm
    - Computed following Bedka et al. (2010) and shows the locations of overshooting tops.
  - 4) Lightning accumulation at 10, 30 and 60 minutes.
    - Weighted more heavily, equivalent importance to satellite contributions.
    - Lightning is critical to determining exact location of hazard.

Defines updraft regions that are most hazardous to aircraft.
Highest CDO values are aligned with convective cells

NCAR

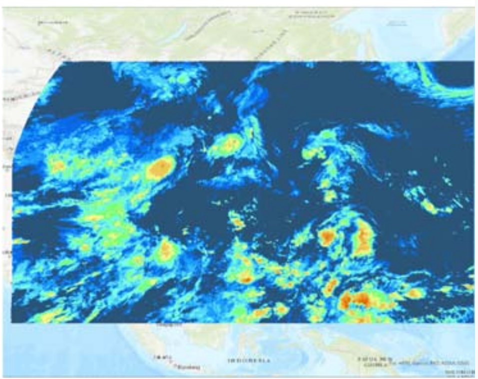
SAMPLE IMAGES FROM JULY 15, 2021

NCAR

Sample Images

July 15, 2021 2000 UTC

CTH



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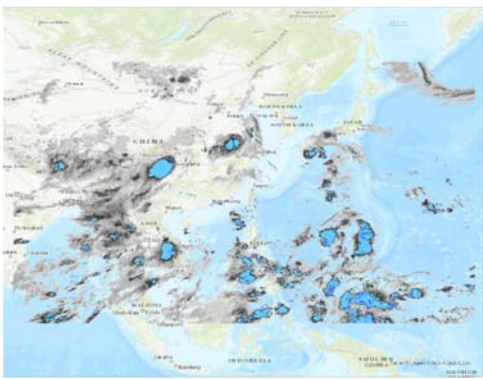
	≤ 65000.0
	≤ 70000.0

CTH not defined below 15kft.

CDO



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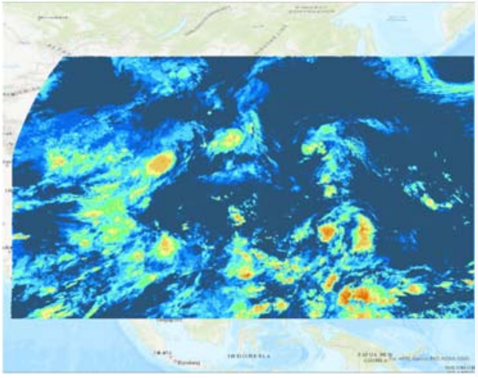
	≤ 1.75
	≤ 1.99
	≤ 2.99
	≤ 3.99
	≤ 4.99
	≤ 6.19

CDO Potentially degraded outside lightning network coverage area.

Sample Images

July 15, 2021 2010 UTC

CTH



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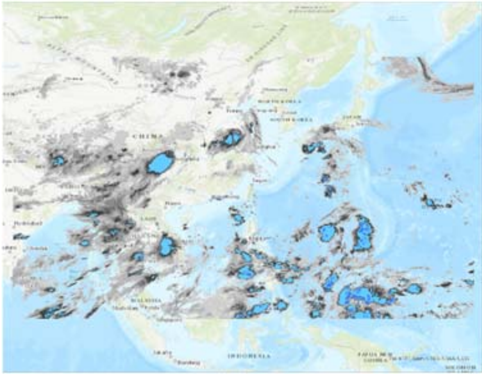
CTH not defined below 15kft.

CDO



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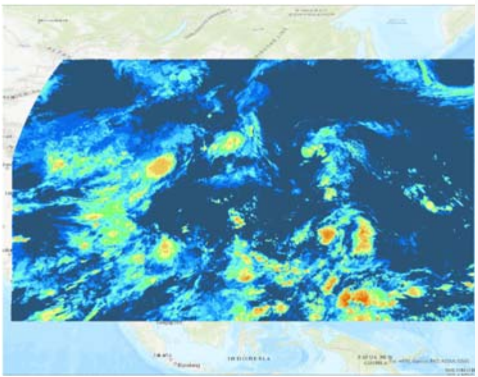
	≤ 3.99
	≤ 4.99
	≤ 6.19

CDO Potentially degraded outside lightning network coverage area.

Sample Images

July 15, 2021 2020 UTC

CTH



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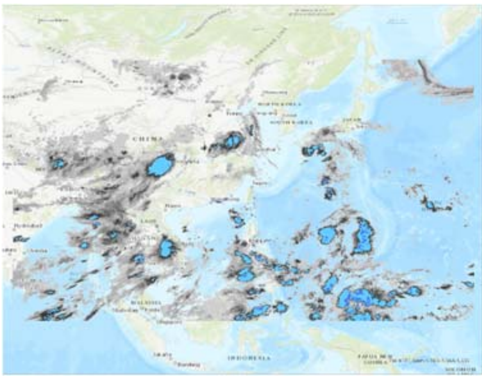
CTH not defined below 15kft.

CDO



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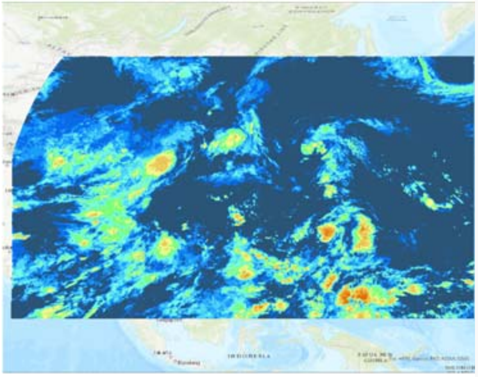
	≤ 1.75
	≤ 1.99
	≤ 2.99
	≤ 3.99
	≤ 4.99
	≤ 6.19

CDO Potentially degraded outside lightning network coverage area.

Sample Images

July 15, 2021 2030 UTC

CTH



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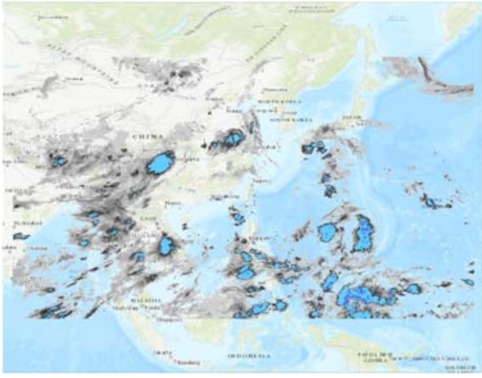
	≤ 70000.0

CTH not defined below 15kft.

CDO



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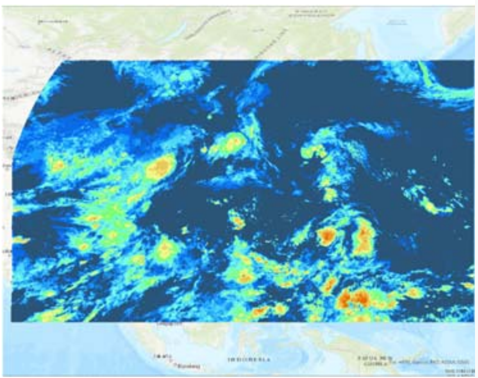
	≤ 2.99
	≤ 3.99
	≤ 4.99
	≤ 6.19

CDO Potentially degraded outside lightning network coverage area.

Sample Images

July 15, 2021 2040 UTC

CTH



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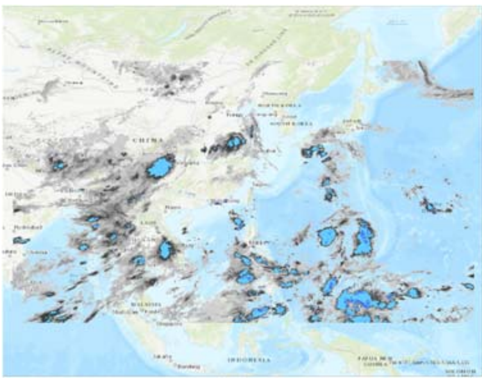
	≤ 65000.0
	≤ 70000.0

CTH not defined below 15kft.

CDO



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	≤ 1.75
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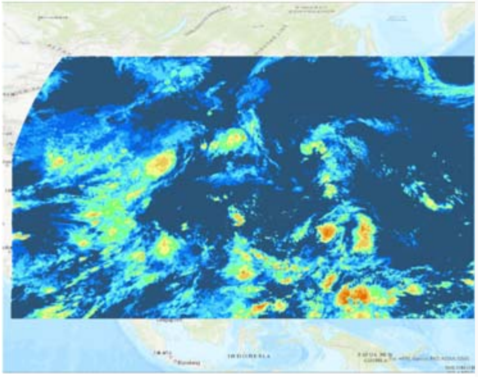
	≤ 2.99
	≤ 3.99
	≤ 4.99
	≤ 6.19

CDO Potentially degraded outside lightning network coverage area.

Sample Images

July 15, 2021 2050 UTC

CTH



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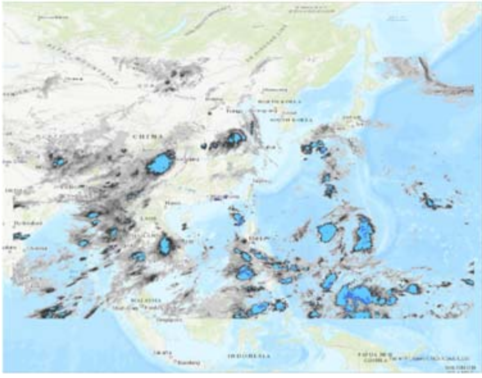
	≤ 65000.0
	≤ 70000.0

CTH not defined below 15kft.

CDO



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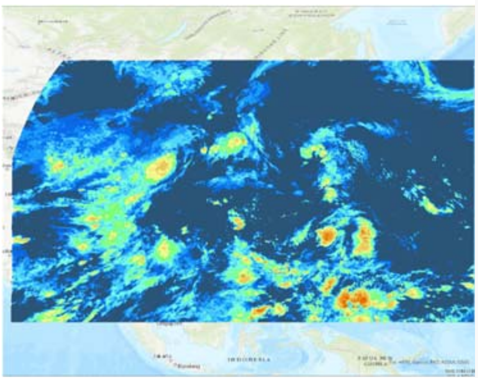
	≤ 1.5
	≤ 1.75
	≤ 1.99
	≤ 2.99
	≤ 3.99
	≤ 4.99
	≤ 6.19

CDO Potentially degraded outside lightning network coverage area.

Sample Images

July 15, 2021 2100 UTC

CTH



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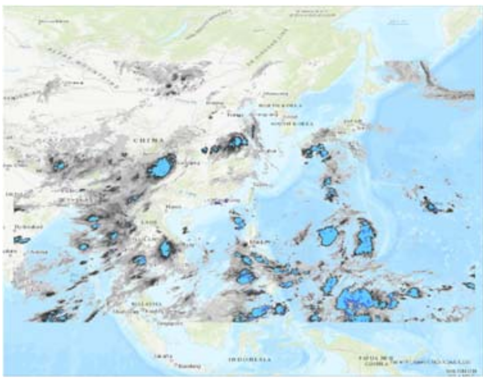
	≤ 65000.0
	≤ 70000.0

CTH not defined below 15kft.

CDO



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	≤ 2.99
	≤ 3.99
	≤ 4.99
	≤ 6.19

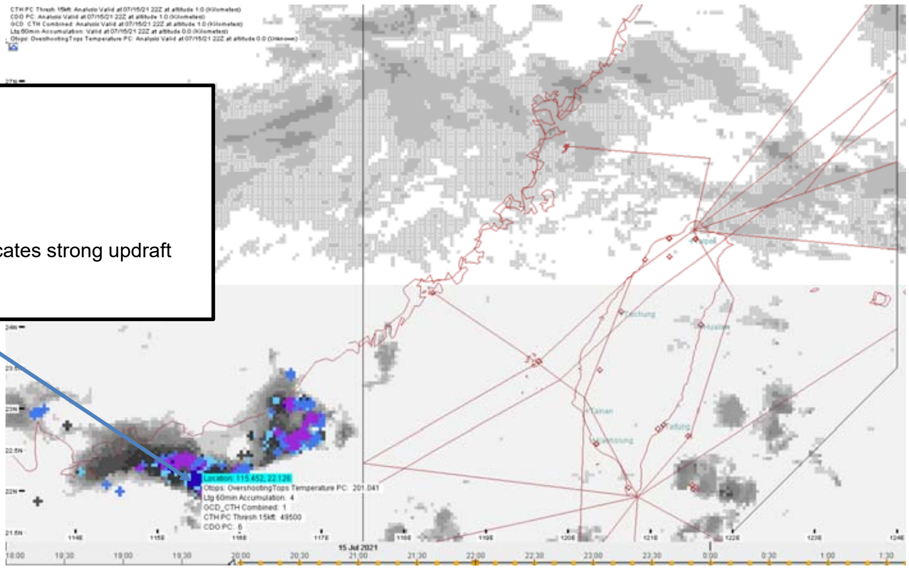
CDO Potentially degraded outside lightning network coverage area.

Sample Showing CDO = 6

July 15, 2021 at 22Z

Example Maximum Case
Lightning has occurred
Overshooting tops are present
Cloud Top Heights > 40 kft
Global Convective Diagnosis indicates strong updraft

CDO = 6



DISCUSSION

Question on Lightning

Handling Lightning in CDO

- Lightning Supplied over ~ RWRF Domain
- CDO is computed over WRF D2 Domain

Options:

1) CDO only over RWRF domain
   – Full functionality; Limited to region that is already covered by radar… might not be too much value-added.

2) CDO over full domain (without lightning)
   – Straightforward to interpret/process; Doesn't provide as much detail on hazard location.
   – Higher latency in hazard identification.

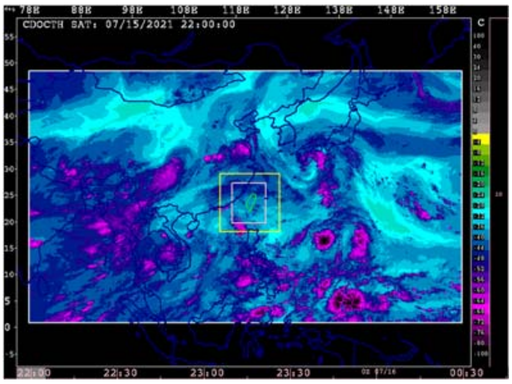
3) CDO hybrid (use lightning over RWRF not outside)
   – Default configuration.
   – Uses all information when/where available.
   – *Might be confusing or difficult to interpret.*

4) Acquire larger Lightning coverage area
   – Ideal

Coverage Area

Pink Box is Lightning

Yellow Box is Radar (roughly)



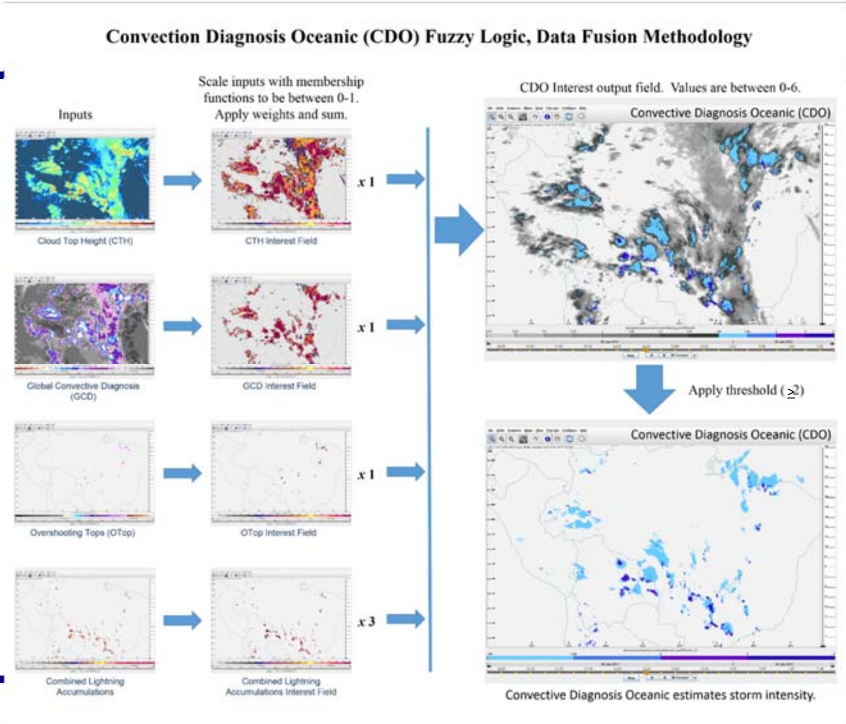
BACK-UP SLIDES

CTH

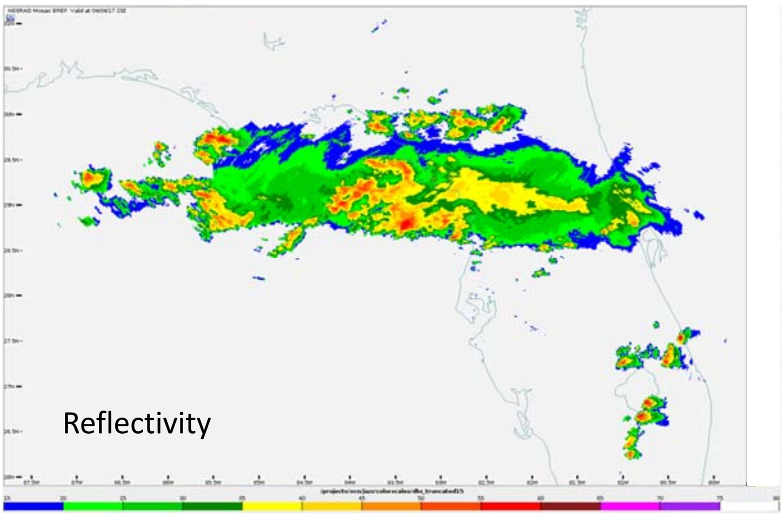
GCD

OTOPS

Lightning



Convection Diagnosis Oceanic



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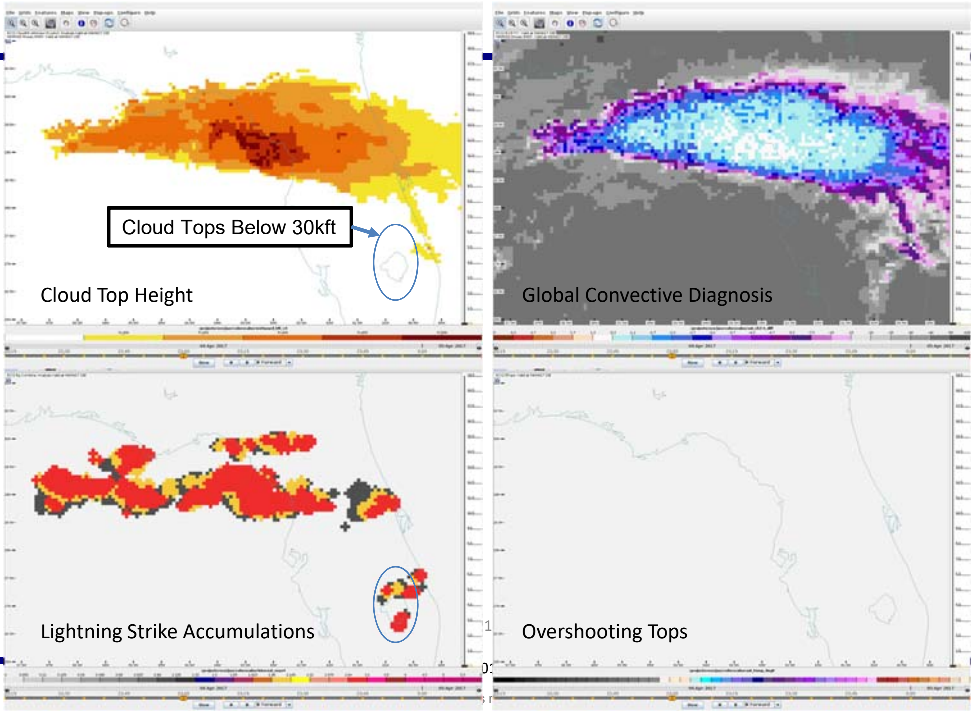
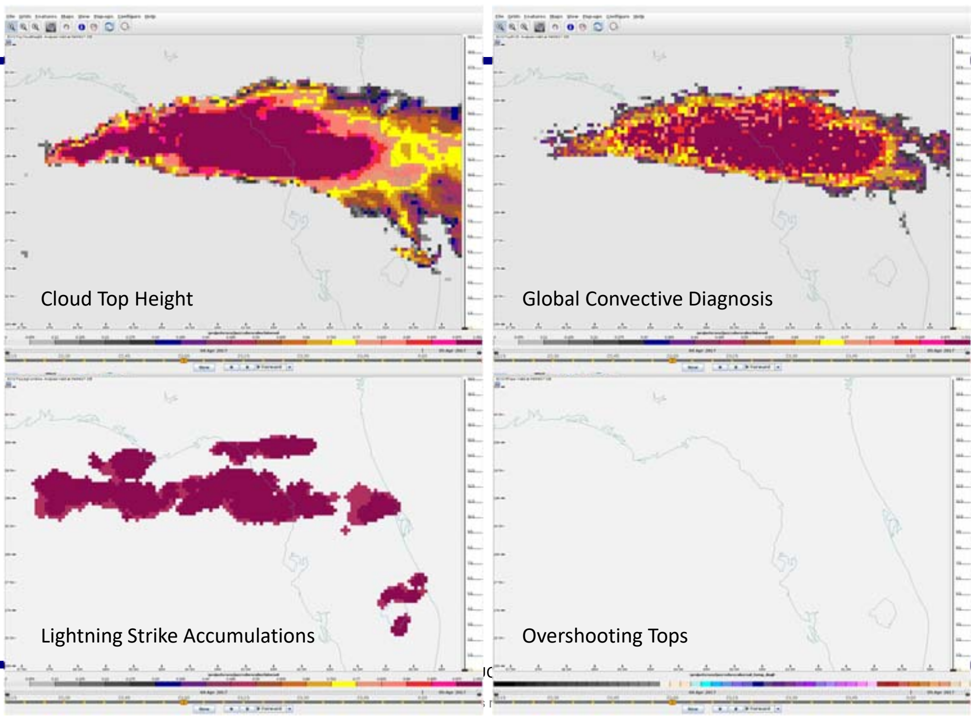
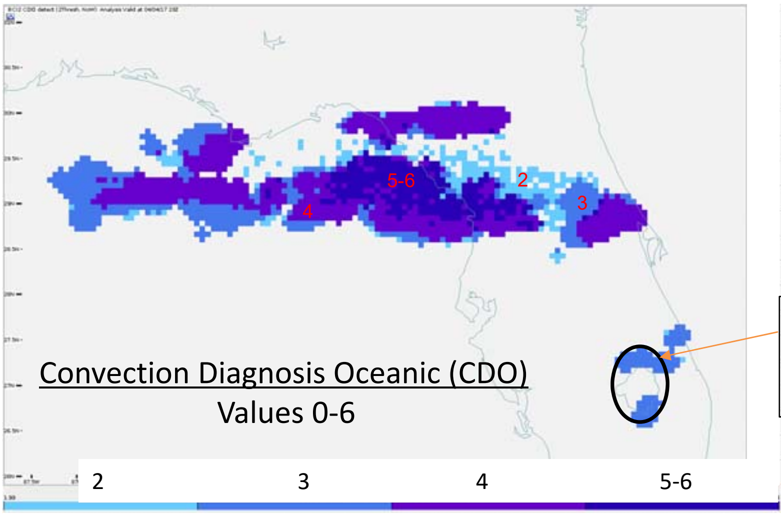
CDO Inputs



CDO Inputs Scaled (0-1)



Convection Diagnosis Oceanic



Lightning important for CDO > 2 in absence of overshooting tops.

IA#18 Project Management Review Meeting

Thursday, November 18, 2021

01:00 UTC

—

Attendees

CAA: Sheau-Perng Yu, Tsh-Hua Yu, Dai-Wei Kuan, Shou-Liang Yu,Chia-Wei Lan,Yi-Ping Hsu, Ching-Yao Chuang, Jyong-En Miao, Tse-Wei Fan, Li-Wei Kuo

NCAR: Rong-Shyang Sheu, Bob Sharman, Wiebke Deierling, Larry Cornman, Tom Blitz, Matthias Steiner, Gary Cunning, Jim Cowie, Jason Craig, Ken Stone, James Pinto, Paddy Mccarthy

Agenda

1. Selected NCAR presentations from the Turbulence Workshop
    a. Larry Cornman, NCAR: "Automatic Dependent Surveillance-Broadcast (ADS-B) Derived Turbulence"
    b. Bob Sharman, NCAR: "Open Frontiers in Turbulence Forecasting and Detection"
    c. Jason Craig, NCAR: "Global Weather Notification"
2. Task progress updates
    a. Task-by-task updates
    b. System deliverables
        i. CTH/CDO: Initial version of CTH and CDO in UCAR testing environment
        ii. ASPIRE: Initial version of the new extrapolation prediction system at UCAR

3. On consultation item: Global Air Navigation Plan (GANP) and Aviation System Block Upgrades (ASBUs) updates, limited to the scope of aviation weather information system and its integration with the air traffic management system
    a. NCAR source Mr. Matt Strahan charge for providing related information
    b. What's our alternatives? What are the expectations？
        i. NCAR will gather and organize relevant information, with a focus on compliance to future international standards of the aviation weather information system and their direct impacts to components/blocks defined in the ASBU. Components/blocks that are indirectly impacted will not be part of the information NCAR provides.
        ii. Any payment/charges NCAR needs to make to gain access to relevant information should be discussed with the CAA first before proceeding with the action.
4. Preparing for IA #19
    a. Are we open to slight departures from the subtasks written in the Four-Year Plan document (AOAWSRU_plan_draft_20191204_opt3.pdf), as long as we stick to the original budget?
        i. This can be accommodated with CAA's approval
    b. Speaking of the original budget, how flexible is it to depart slightly from the budget in the blueprint AOAWSRU_plan_draft_20191204_opt3.pdf?
        i. This is possible if the budget increase is limited to within 5%
    c. Timelines at various stages for IA #19 submission to AIT
        i. UCAR delivers package to AIT -- **4/29/2022; CAA proposed timeline**
        ii. UCAR and CAA reach final agreement -- 4/25/2022
        iii. RAL and CAA begins negotiations -- 3/7/2022
        iv. RAL delivers initial draft of SOW to CAA -- 2/25/2022
        v. RAL and UCAR finalize RAL draft SOW -- 2/23/2022
        vi. RAL and UCAR Contracts begin iterations over SOW 2/11/2022
        vii. RAL begins work on SOW -- 1/3/2022

Notes

- Common tasks / data
    - Computing environment plan for the NCAR testbed is estimated to be finalized in about a month (mid December) for IISI feedback. Final testing of the environment will require the hardware.

- CAF feed discontinued, data is now in the AFTN feed.
- Air force radar data request being evaluated.
- NTDA data requested for both GTGN and current GTG calibration.
- CAA will attempt to provide quarterly updates for the in situ EDR.
- CAA will provide realtime data for IWXXM

- Task 1
  - More archive data sets will be considered - looking at December - March
  - Alternative to aircraft icing reports (sparse in Asia) - Next version of TCIP2 will run without aircraft reports, unless we get something like AMDAR, liquid water reports
  - Who verifies (NCAR or IISI?) and when - Want various product NetCDF to look and feel the same, so NCAR will do a unified approach and a deep readthrough of the OGC specifications to make sure it matches, that information is elusive, and there is no way to verify OGC compliance but we will do our best to follow all OGC specifications. CAA - Provide the data and they will use it, have a system from IISI to provide data to the user in the future, so this data is only in the AOAWS-RU system, not transferred to the user in the future. So there will be IISI converters that bring the data to the user.
- Task 2
  - Final timing benchmark should be CAA's testing environment - we agree with this moving forward
  - Could lack of reports be due to weather systems? We think it is variability in the reports we have received. For looking at cases the most recent quarter it gives less cases
  - CAA will continue to negotiate with China Airlines for EDR data
  - Can we get WRF data for early 2021 cases? CAA is okay with giving us 6hrly output to help do these case studies, do not need RWRF, just 3km and 15km
- Task 3
  - Could take the Air Force radar in archive if we can't get it in realtime due to bandwidth issue.
  - 6 radars refer to the newly added radars, new version includes 4 existing + 6 new, but there are data quality issues

- Task 4
    - Our plan is to run CTH and CDO on D2, not D1. D1 is not an absolute requirement from CAA, so will stick to D2.
- Task 5
    - Why the Alaska system and not existing AOAWS? Retraining? We are adapting the Alaska system, use the most recent history to train on, runs every day and trains for the next day. This is instead of training once and using those values forever. Training period is 30 days for this system, might need to be adjusted depending on if we have a big enough sample, should see more cases as we get into winter.
    - What kind of observation is absent? It's the METAR data, whatever we can find in the AFTN files, have seen some Airforce METARs in there. AFTN seems to be a superset of GTS CAF, so been using AFTN, will use sites in neighboring vicinity as well.
- CTH / CDO Deliverable
    - CAA can evaluate the 4 lightning options and decide which one is best to pursue, needs more thought than can be decided in this meeting