Algorithm for Prediction of HIWC Areas (ALPHA): Performance Assessment using Darwin Cases

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ALPHA 3-Input Algorithm

Satellite

Model

3D Radar Mosaic

Identify highest, coldest, thickest clouds from Total Water Path, Cloud Top Height and Cloud Top Temperature – 2D field
Total Satellite Interest

Find deep cloud layer, heavy precipitation, high condensate, updrafts, temperature below -15°C – 3D field
Total Model Interest

Find active updrafts, high reflectivity in column with heights of 10 dBz and 30 dBz echo tops – 2D field
Total Radar Interest

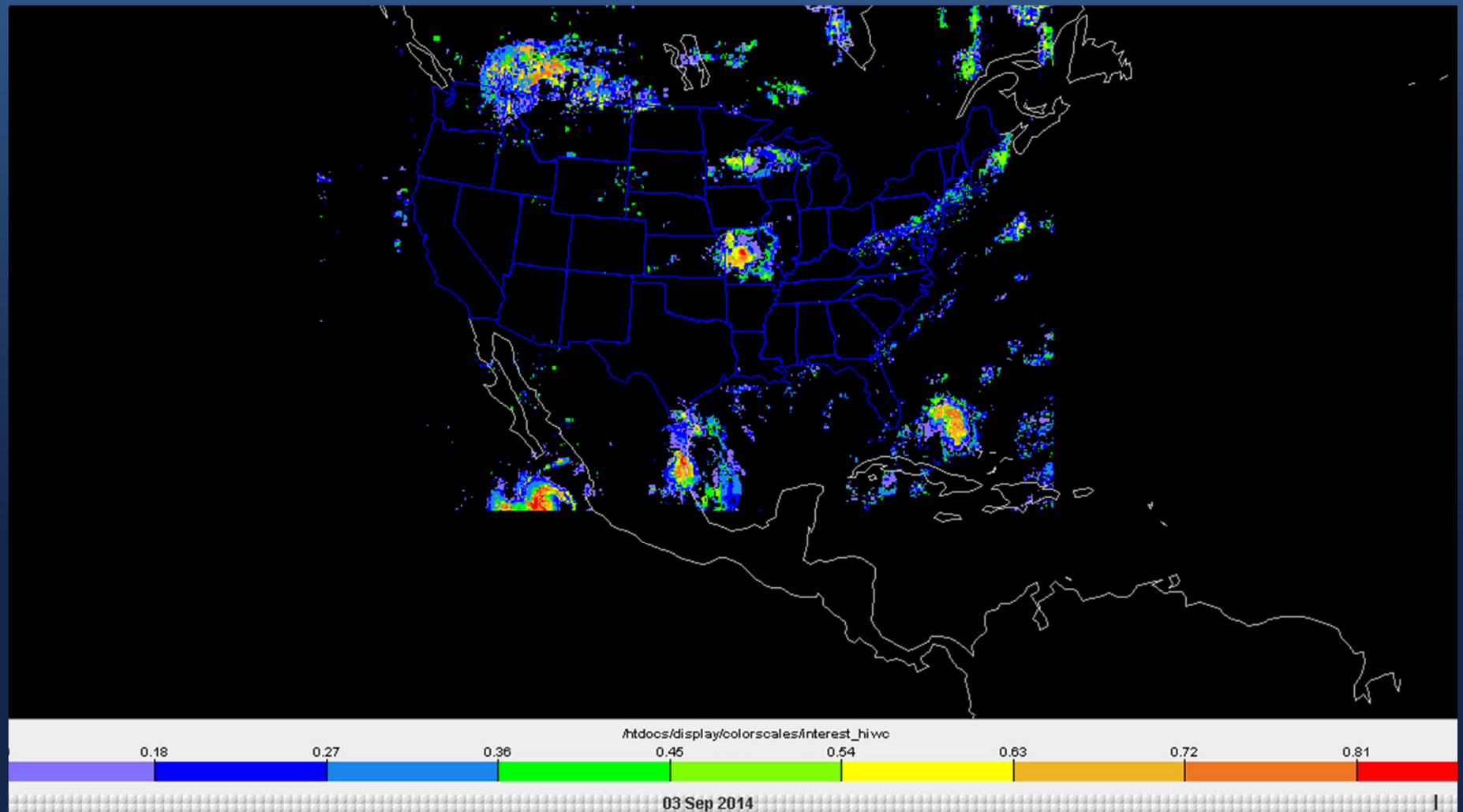**Calculate Total HIWC Interest**
If Total Satellite Interest is > 0
Model 3D Temperature Interest * [45% Total Satellite Interest + 10% Total Model Interest + 45% Total Radar Interest]
= Total HIWC Interest

ALPHA-CONUS HIWC Product
3 September 2014
FL350

Upgrades to ALPHA

- Better data quality control
- Fine tuning and integration of Enhanced Cirrus Anvil interest scheme
- Consistency between 2 and 3 input ALPHA versions
- Air mass temperature interest map
- Development of ALPHA Playback system

Analysis Procedures

- Reran ALPHA for all research flights with most up to date data set
- Focused on level flight segments
- Averaged IKP TWC values over 25 second intervals to approximate ALPHA time and space scales
- Histograms of IKP TWC values
- Used a newly developed flight track tool to extract ALPHA values along each flight segment
- Categorized flight segments by Night, Terminator and Day time
- Time series plots of TWC, ALPHA HIWC Interest, and intermediate interest fields
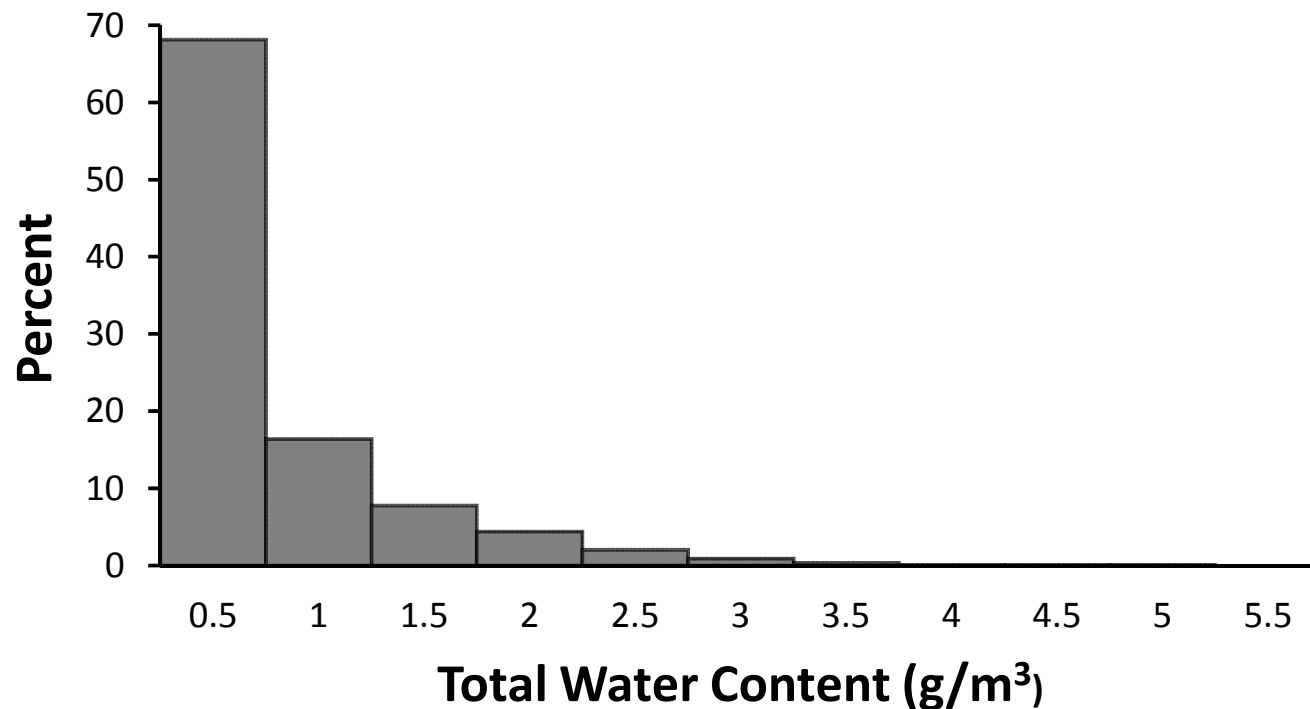- Generated contingency tables and comparison statistics for each flight segment

Flight Segments

- 24 usable flight segments
  - Some level segments defined by team were combined if at the same altitude
  - Varying in time length from 10 mins to just over 2 hrs
  - 12 flight segments in day conditions
  - 12 flight segments mostly night/terminator
    - Can pull some day data points out of these flight segments
- ALPHA relies heavily on NASA LaRC satellite products, and hence is affected by quality issues in the terminator (many Darwin flights occurred near sunrise)

Distribution of TWC
over all level transects during Darwin Research Flights

Total Water Content
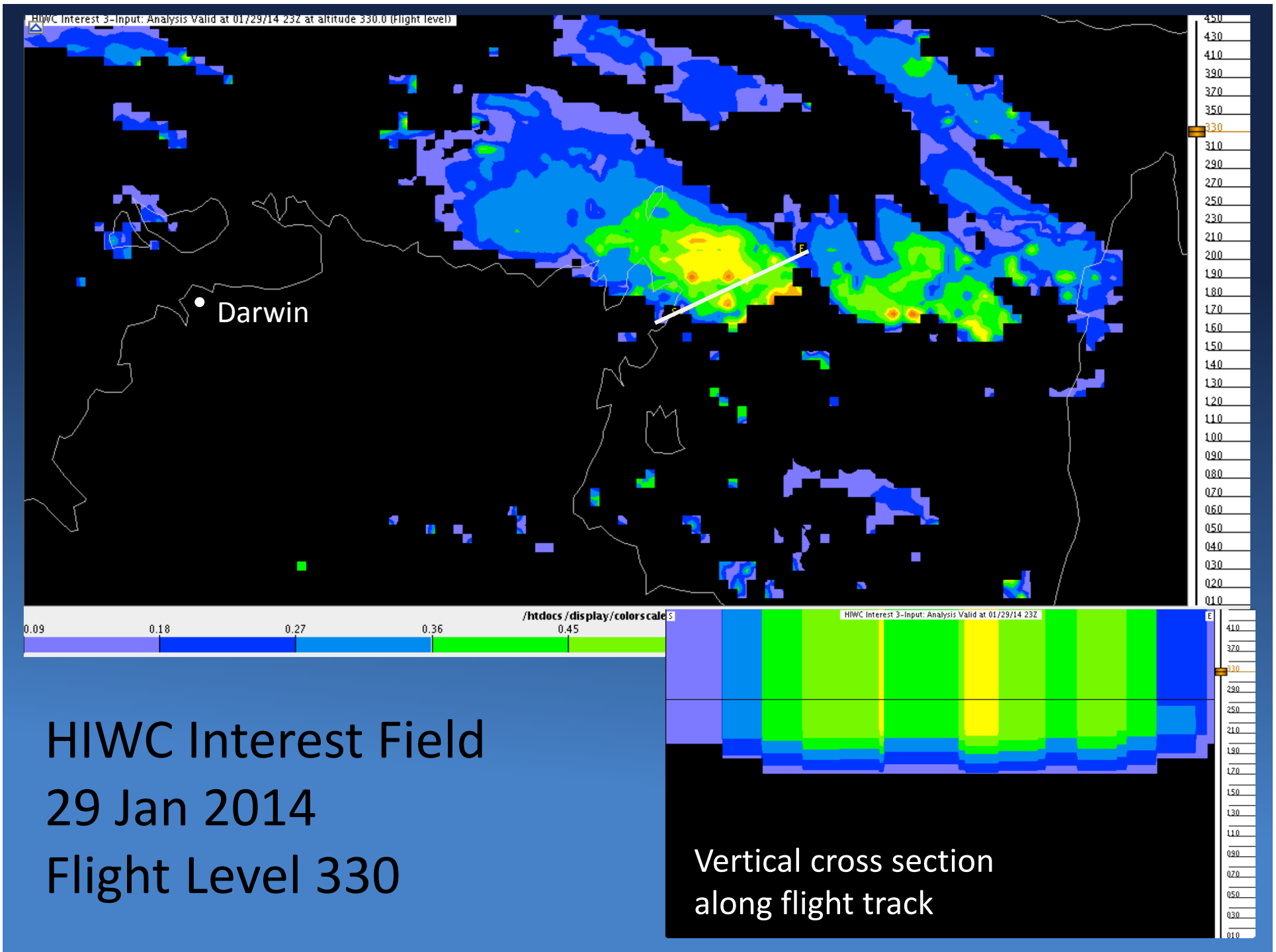Frequency of Occurence
All Flights

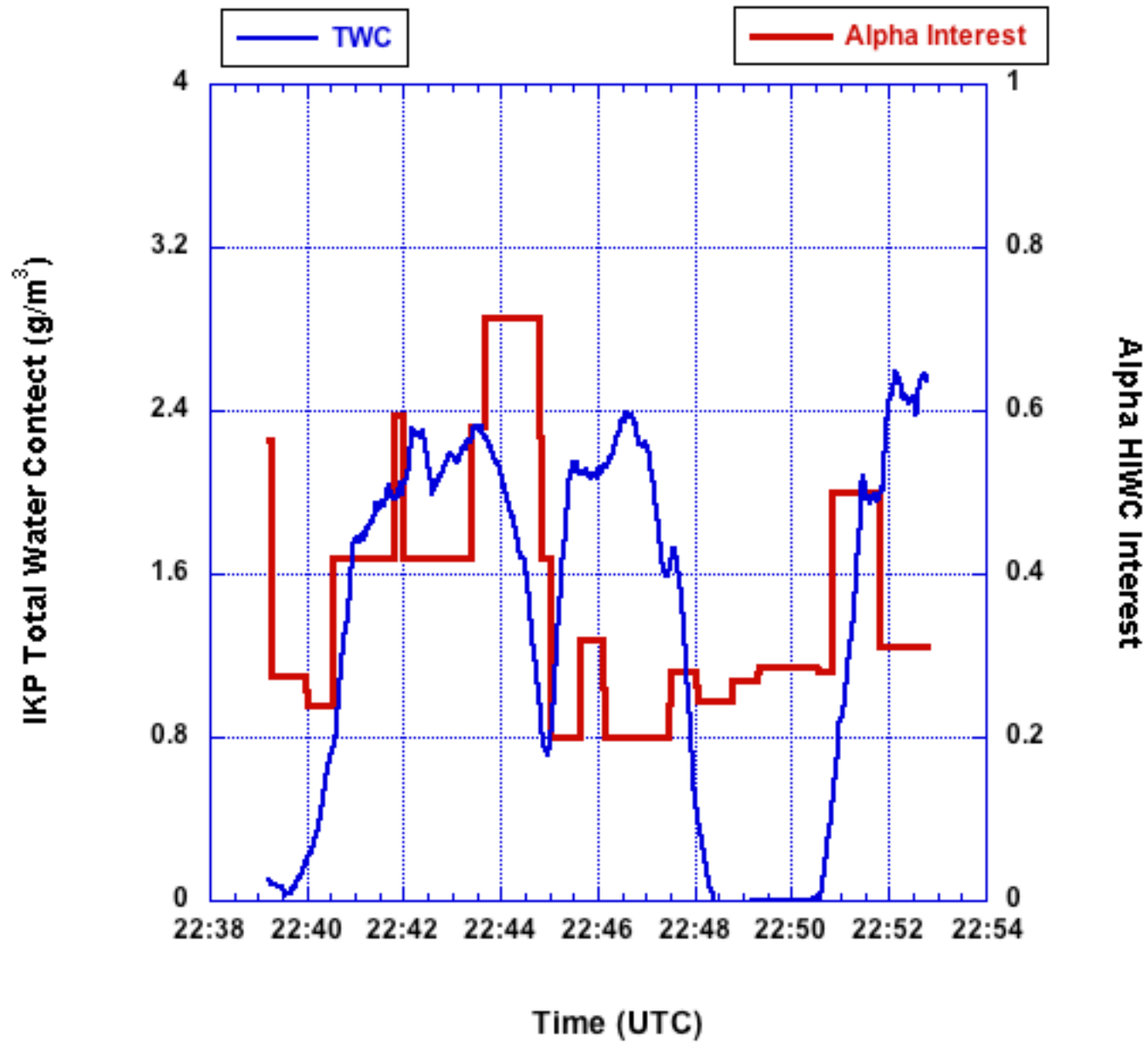# Categories Used to Compare ALPHA Interest with TWC Measurements

TWC
- Low: $0 - 1.0$ g/m^3
- Moderate: $1.0 - 2.0$ g/m^3
- High: > 2.0 g/m^3

ALPHA Interest (0 - 1)
- Low: $0 - 0.3$
- Moderate: $0.3 - 0.6$
- High: > 0.6

HIWC Interest 3-Input: Analysis Valid at 01/29/14 23Z at altitude 330.0 (Flight level)

Darwin

/htdocs /display/colorscale

0.09   0.18   0.27   0.36   0.45

HIWC Interest 3-Input: Analysis Valid at 01/29/14 23Z

HIWC Interest Field
29 Jan 2014
Flight Level 330

Vertical cross section
along flight track

29 Jan 2014
Darwin Research Flight 10
Flight Level 330kft, Temperature -29C

Contingency Table
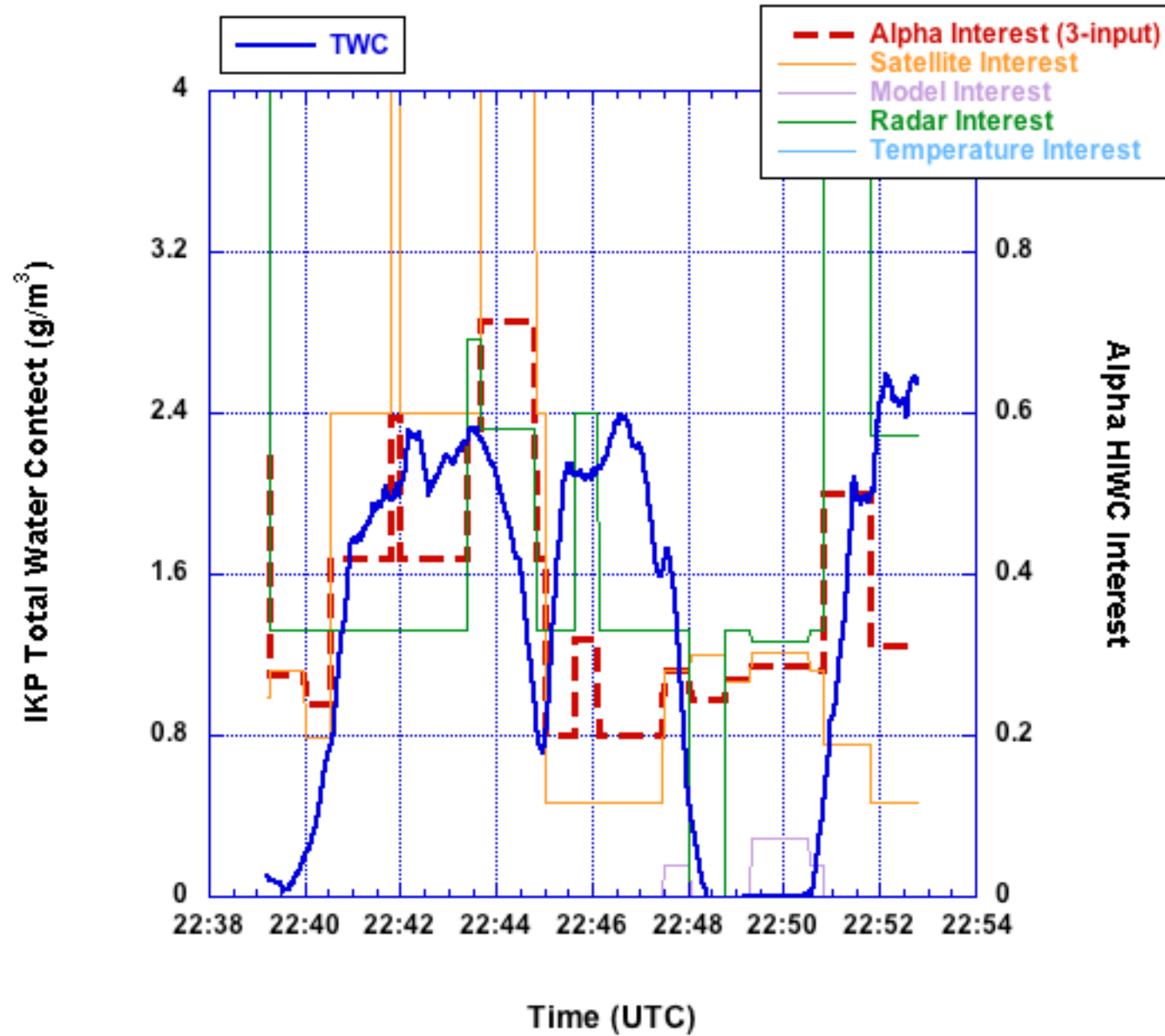## 29 Jan 2014 Flight Segment

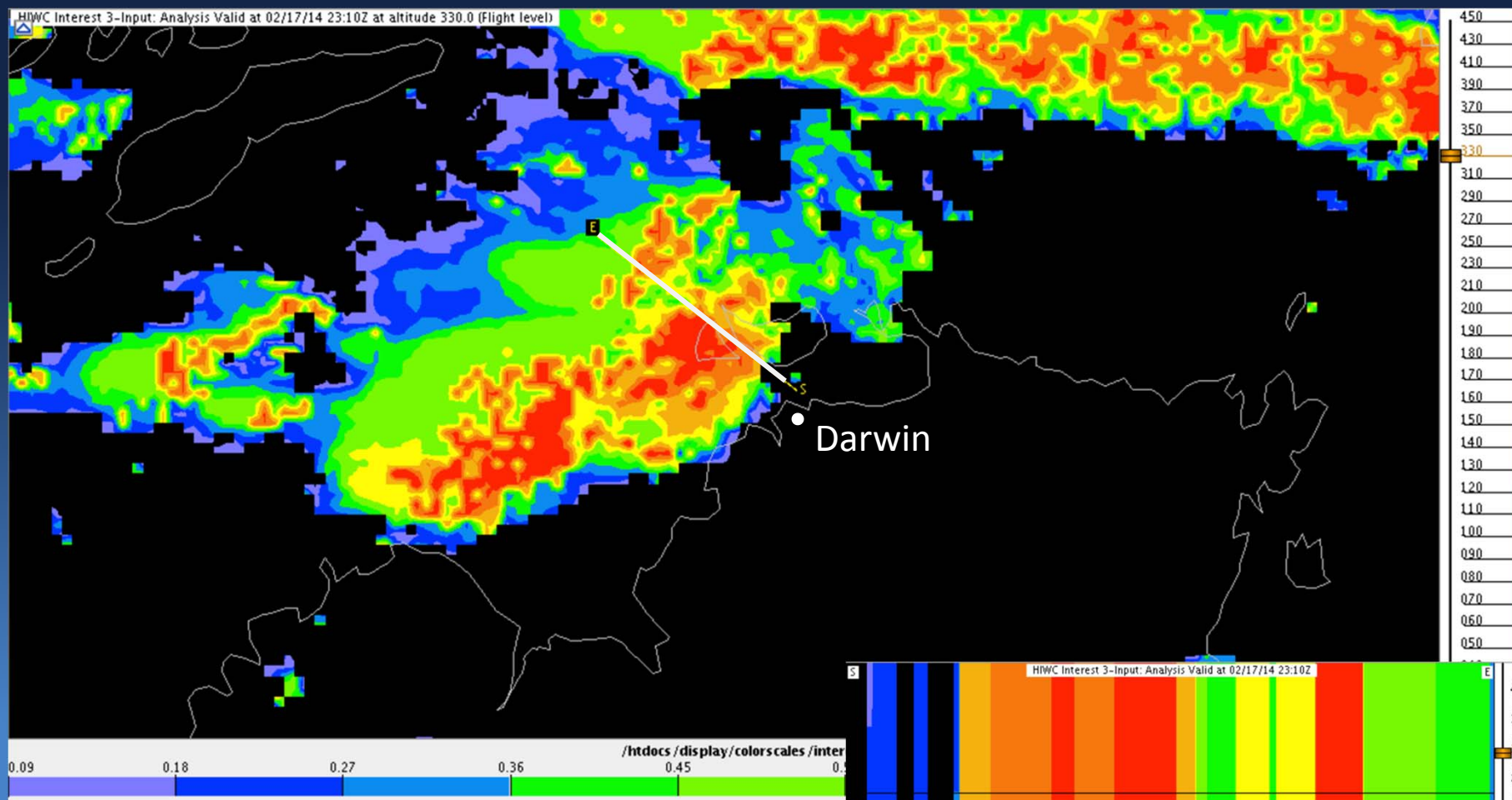**Moderate or Greater TWC   > 1.0 g/m³   = YES**
Moderate or Greater ALPHA > 0.3 Interest = YES
Total Data Points   = 815

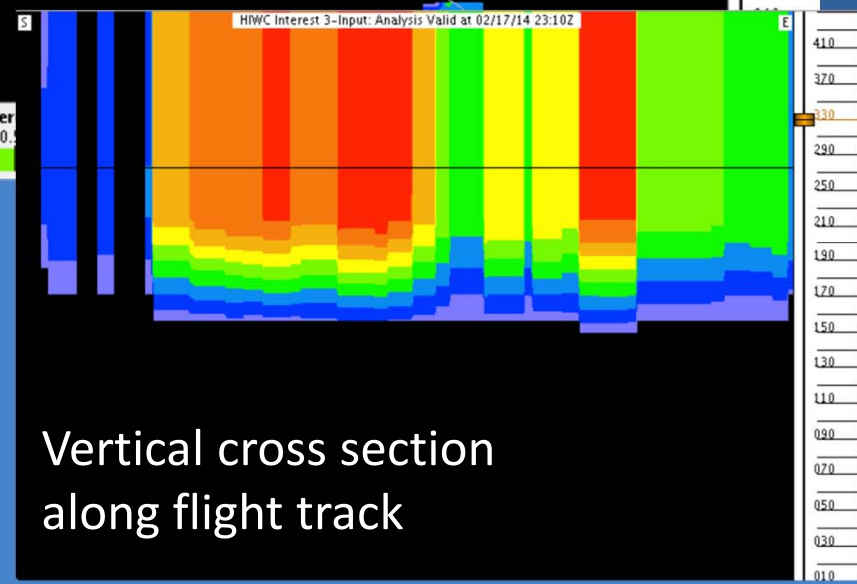|		TWC	
		YES	NO
ALPHA	YES	379	42
	NO	136	258

Percent Correct = 78.16 %

Hit Rate = 0.74

False Alarm Ratio = 0.10

Critical Score Index = 0.68

Bias = 0.82

29 Jan 2014
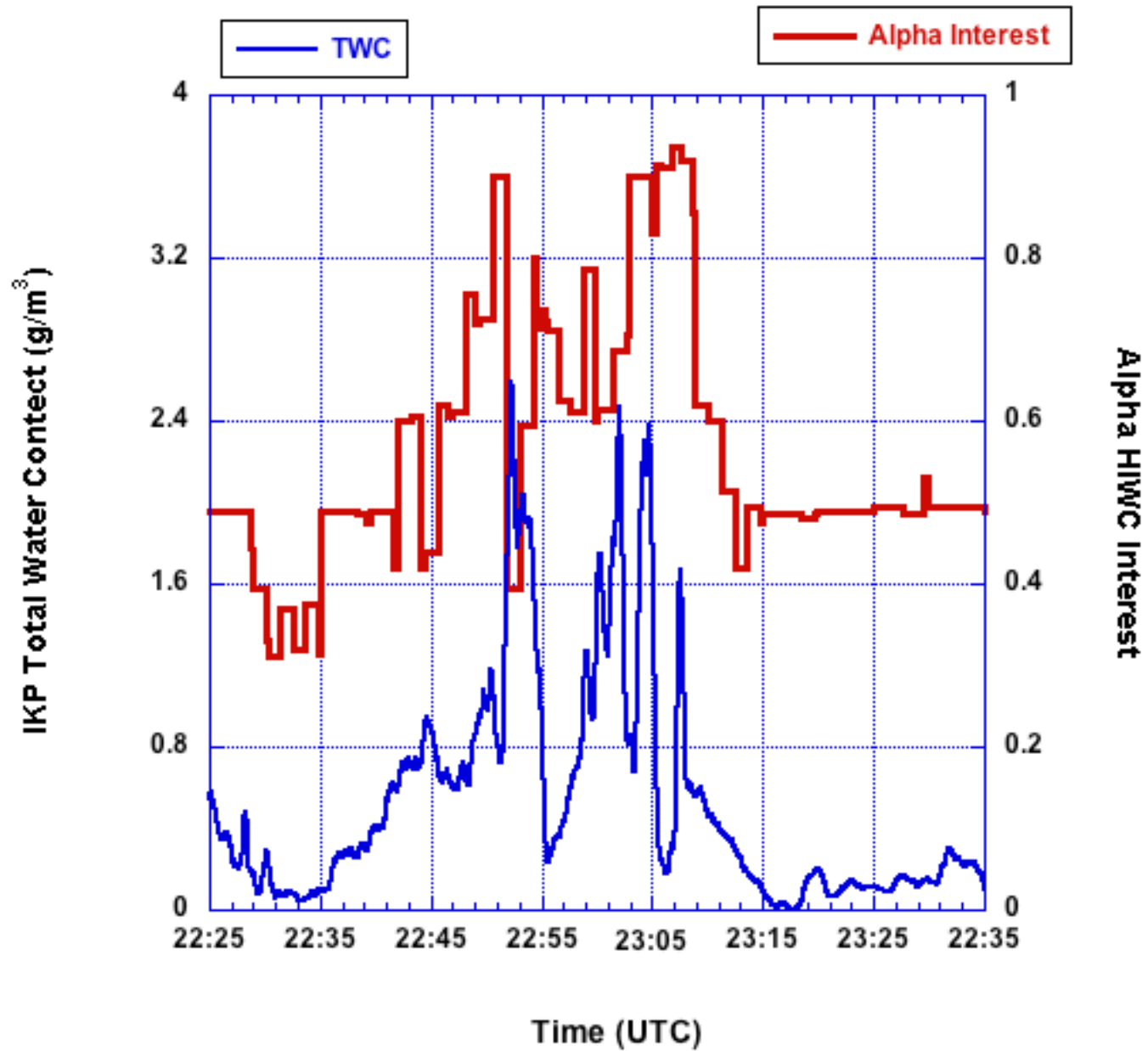Darwin Research Flight 10
Flight Level 330kft, Temperature -29C

HIWC Interest 3-Input: Analysis Valid at 02/17/14 23:10Z at altitude 330.0 (Flight level)

Darwin

/htdocs /display/colorscales /inter

0.09   0.18   0.27   0.36   0.45   0.5

HIWC Interest Field
17 Feb 2014
Flight Level 330

HIWC Interest 3-Input: Analysis Valid at 02/17/14 23:10Z

Vertical cross section
along flight track

17 Feb 2014
Darwin Research Flight 22
Flight Level 330kft, Temperature -31C

Contingency Table
17 Feb 2014 Flight Segment

Moderate or Greater TWC   > 1.0 g/m³   = YES
Moderate or Greater ALPHA > 0.3 Interest = YES
Total Data Points   = 4369

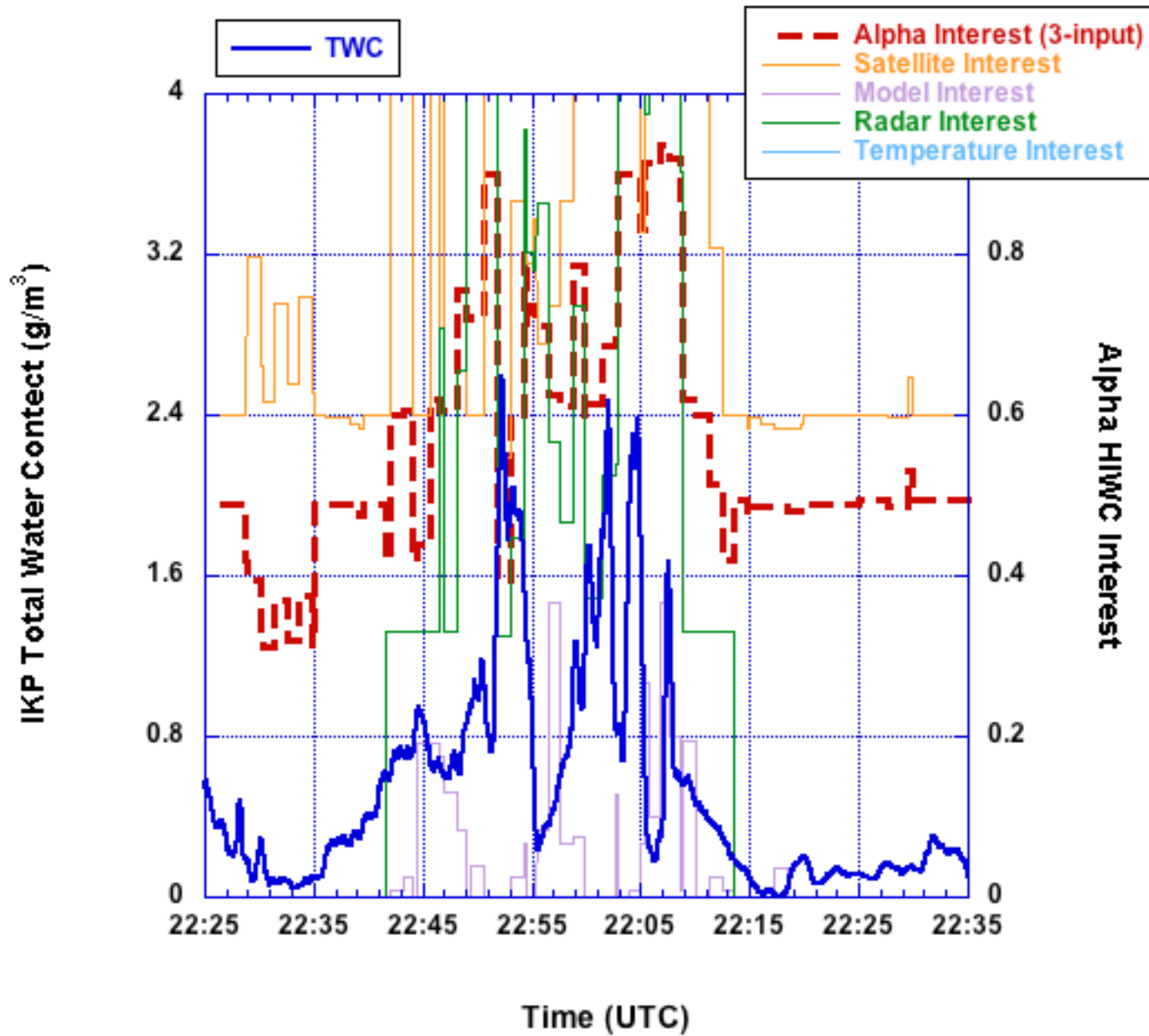|		TWC	
		YES	NO
ALPHA	YES	605	3764
	NO	0	0

Percent Correct = 13.85 %

Hit Rate = 1.00

False Alarm Ratio = 0.86

Critical Score Index = 0.14

Bias = 7.22
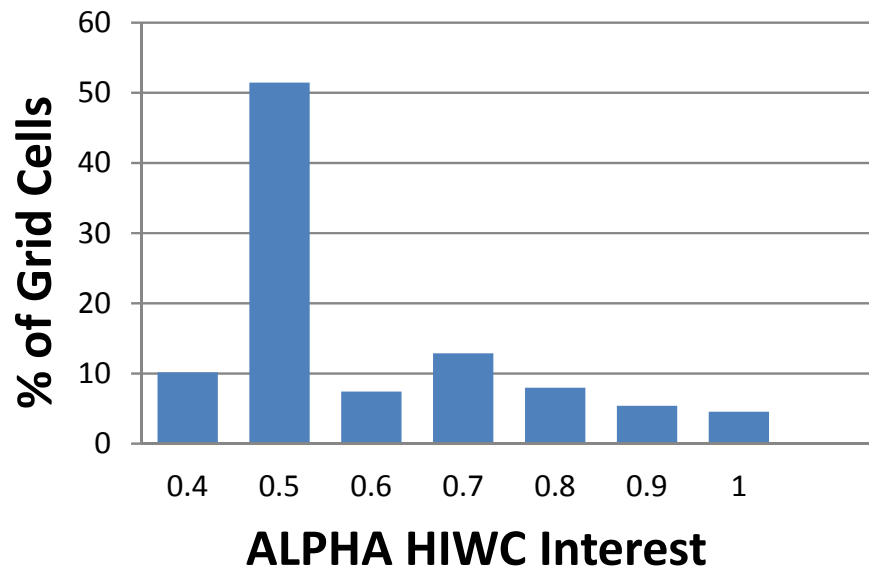
17 Feb 2014
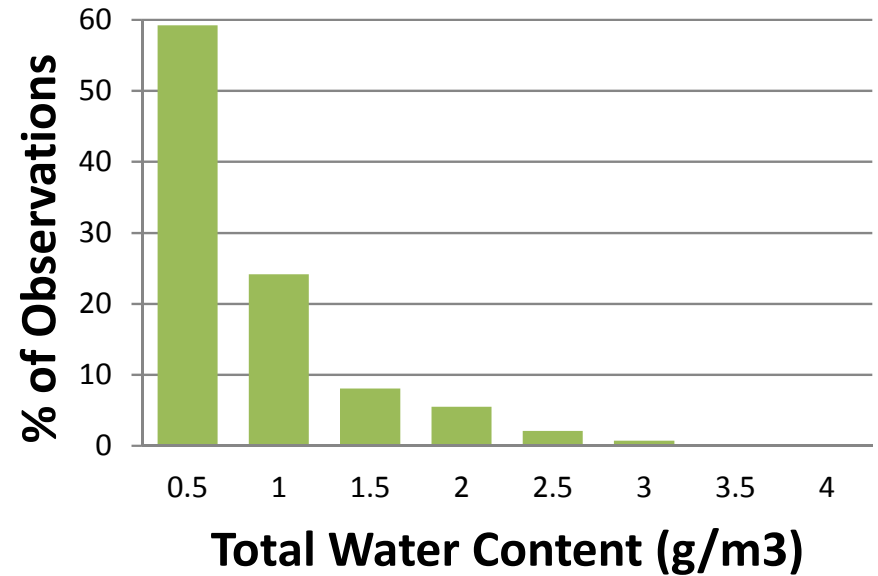Darwin Research Flight 22
Flight Level 330kft, Temperature -31C

Distribution of ALPHA HIWC Interest vs. Measured Total Water Content
Research Flight 22

Further Analysis

- Apply analysis procedures to remaining flight segments
- Stratify flight segments by altitude, temperature and storm type
- Prepare contingency table statistics for all flight segments
- Calibrate HIWC total interest and/or intermediate field as indicated by statistics
- Add other interest maps that show skill in detecting elevated TWC values (e.g., model data not currently used – CAPE, vertical reflectivity profiles, etc.)

Thank you

Questions

Publications and Presentations

- Detection of High Ice Water Content (HIWC) Conditions: Assessment of a Nowcasting Tool Using Data from the HAIC-HIWC International Field Campaign
  - AMS Conference, Jan 2015 in Phoenix, Arizona
- Detection of Ice Crystal Engine Icing Conditions with the Algorithm for Prediction of High Ice Water Content (ALPHA): Overview and Validation with Research Aircraft Data
  - SAE Conference, June 2015 in Prague, Czech Republic