Height-resolved wind vectors from GOES Sounder moisture analyses

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Introduction

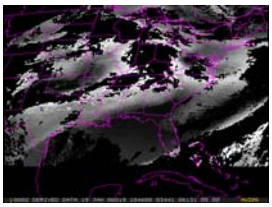
It has long been suspected that the largest errors in atmospheric motion vectors (AMV) inferred from WV feature tracking are introduced by their height assignment. Overcoming this problem is now feasible using the GOES-East and GOES-West sounders hourly real-time retrievals of temperature and moisture profiles. The retrieved clear sky moisture profiles (Ma, X.L., Schmit, T. J., Smith, W. L.,1998) are analyzed on constant pressure surfaces and features are tracked in hourly image sequences to infer height defined atmospheric motions. It is hoped this experimental approach will diminish the effects of the AMV height assignment errors and increase the impact of the observations in data assimilation and numerical weather forecast models.

A scheme was developed at UW-CIMSS to extract the hourly GOES Sounder constant pressure moisture analyses into digital imagery needed as input to the CIMSS/NESDIS automated wind retrieval algorithm. Hourly clear sky single field-of-view (SFOV) retrievals are used to derive the moisture images at a spatial resolution of about 10 km. At this time there are 31 pressure resolved moisture fields to attempt the AMV retrievals. They are between 950 and 100hPa.

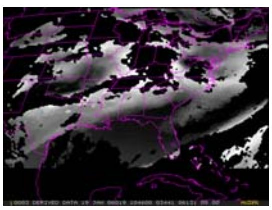
An adapted version of the current CIMSS/NESDIS feature tracking algorithm (Velden at al., 2005) is applied to estimate AMVs from the dew point temperature (*Td*) images. Various algorithm settings (tracking Td vs RH, image enhancement, target and search box sizes) have been tested and the results of the best chosen settings are presented. The new approach is implemented in near-real time and it is producing height resolved wind fields over the continental United States every 3 hours. Initial comparisons with operational winds and radiosondes reveal a slow bias for upper atmospheric winds, however further algorithmic improvements are underway to address the problem.

GOES Sounder constant pressure *Td* images construction

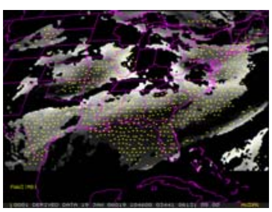
19 January 2006 , 10:46 UTC , 500 hPa



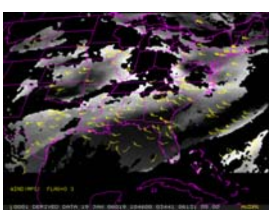
Raw image



Median 3x3 filter



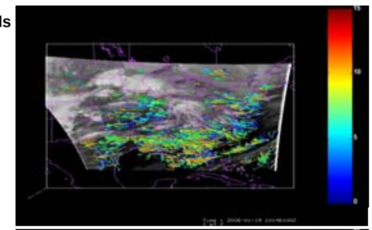
Targets



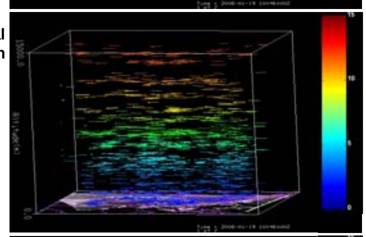
Wind Vectors

GOES Sounder winds, 19 January 2006

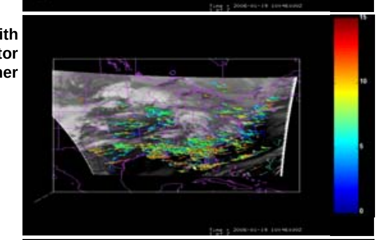
Raw winds



Winds vertical distribution



Winds with quality indicator (QI) 70 and higher



RAOBs vs. Sounder winds

Quality Assessment of GOES Sounder winds with RAOBS

19 January 2006, 12 UTC

Sounder AMVs minus RAOB Winds

A. Search in 11x19 and target in 5x5pix

ALL QI	N	Mean Bias (m/s)	VRMS (m/s)
All winds	336	-2.90	14.72
Low winds	114	-0.19	12.58
Mid winds	143	-0.75	13.43
High winds	79	-10.72	19.17

QI ≥ 70	N	Mean Bias (m/s)	VRMS (m/s)
All winds	87	1.30	12.28
Low winds	9	0.53	10.89
Mid winds	50	5.34	11.82
High winds	28	-5.65	13.46

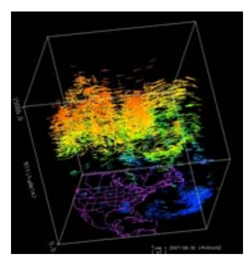
B. Search in 7x11 and target in 5x5pix

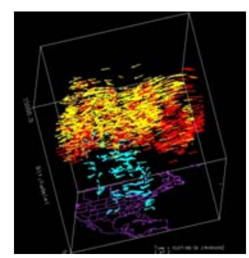
ALL QI	N	Mean Bias (m/s)	VRMS (m/s)
All winds	468	-1.76	8.54

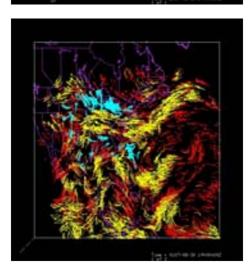
QI ≥ 70	N	Mean Bias (m/s)	VRMS (m/s)
All winds	81	-0.26	8.06

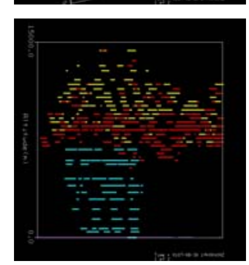
Low: 1000–700 hPa; Mid: 699–400 hPa; High: 399–100 hPa

GOES Sounder vs Imager operational WV AMVs
19 January 2006, 15:00 UTC









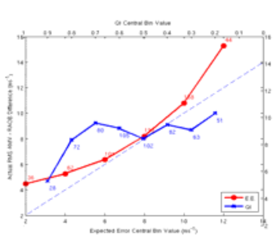
Top left – real time operational Imager AMVs, color represents the vertical distribution of the motion vectors; On average, mean bias is less than 1m/s and vector RMS is around 7m/s

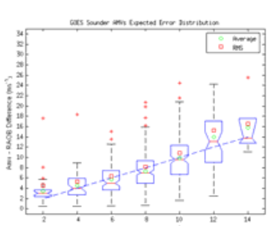
Top right – Imager WV cloud tracked AMVs (yellow), Imager WV clear sky AMVs (red) and clear sky GOES Sounder AMVs (blue)

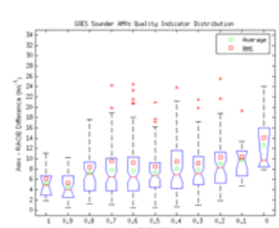
Bottom left – top view of the spatial coverage by Imager WV cloud tracked (yellow), Imager WV clear sky (red) and clear sky GOES Sounder AMVs (blue)

Bottom right – vertical distribution of Imager WV cloud tracked (yellow), Imager WV clear sky (red) & clear sky GOES Sounder AMVs (blue)

Long term product monitoring and statistics (21 June 2007 – 2 July 2007)







The quality of the GOES Sounder winds has been evaluated by monitoring and collecting differences between AMVs and RAOBS and their RMS, and calculating Quality Indicator (QI) and Expected Error (EE).
Left panel – AMV minus RAOB differences RMS as a function of QI and EE binned distributions along with the number of cases into each bin
Center panel – box and whiskers plot of the EE: red square is mean difference, red line is median difference, green circle is difference RMS, blue top and bottom lines are 75th and 25th percentile of the difference distribution
Right panel – box and whiskers plot of the QI (see explanation above)

Future Work

- **Further verification with Wind Profiling Radar data**
- **Monitor long term statistics**
- **Perform model impact studies**
- **Initiate data assimilation collaboration**

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