ASSESSING THE 'EXPECTED ERROR' AS A POTENTIAL NEW QUALITY INDICATOR FOR ATMOSPHERIC MOTION VECTORS

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Outline

- CIMSS/NESDIS QC Summary
- Expected Error's impact on AMV quality.
- Conclusions and Future Work

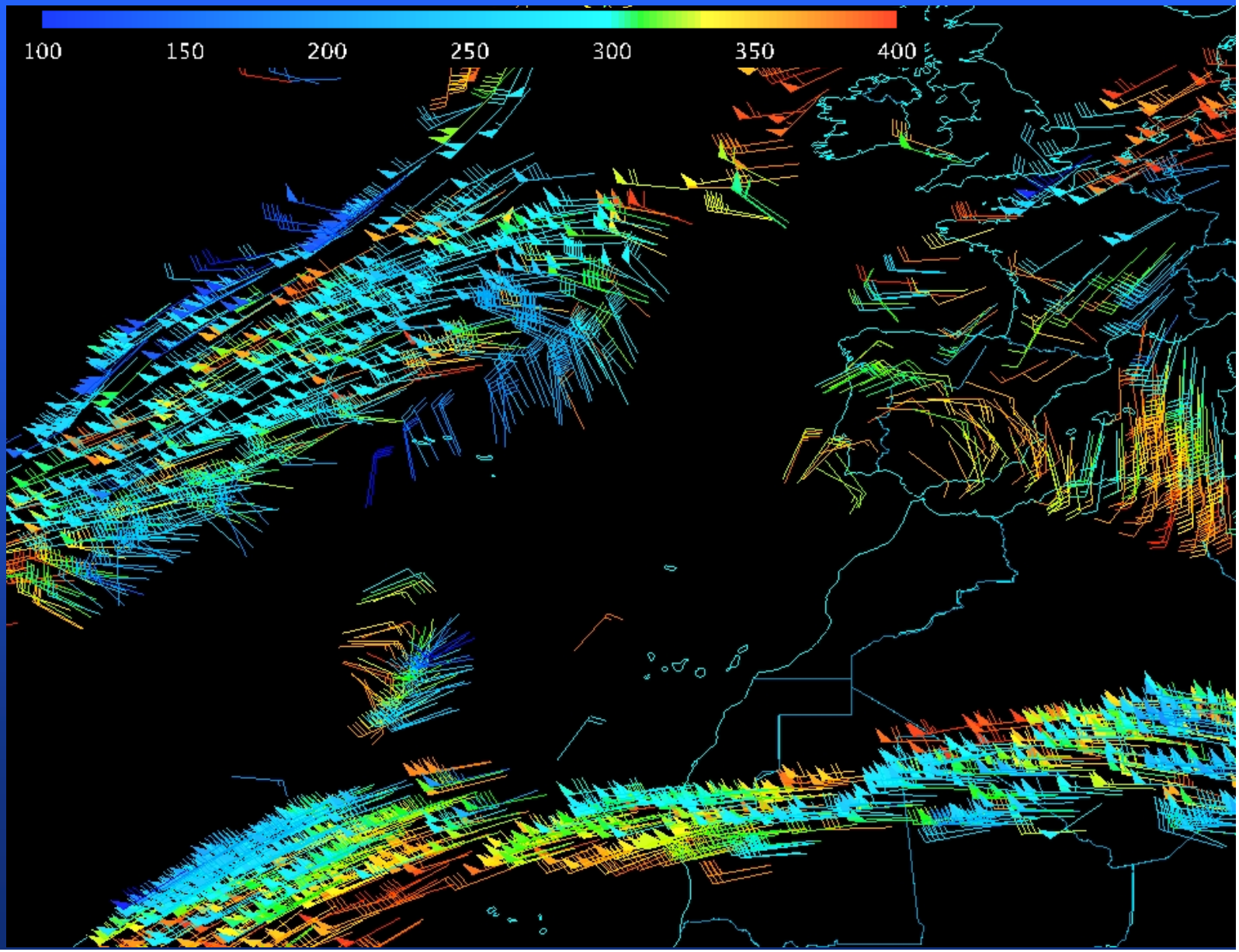
CIMSS/NESDIS AMV QC Process

- Pre-RF checks, mostly gross error checks.
- QI less than 0.5 removed.
- Some upper-level AMVs are given a 10% increase in AMV speed.
- Generate 3-D Recursive Filter (RF) objective analysis (Hayden and Purser, 1995) using AMVs and NWP model winds.
- Some AMV heights are adjusted by minimizing penalty function of fit to objective analysis (Hayden and Velden, 1991).
- Each AMV is assigned a flag (RFF) based on fit to analysis. RFF > 0.5 AMVs are retained.
- Some high speed AMVs in jet regions are re-inserted after failing RFF test.

CIMSS/NESDIS QC Rejection

00z 25 Feb. 2008 (my birthday)

Pre-RF AMV Dataset



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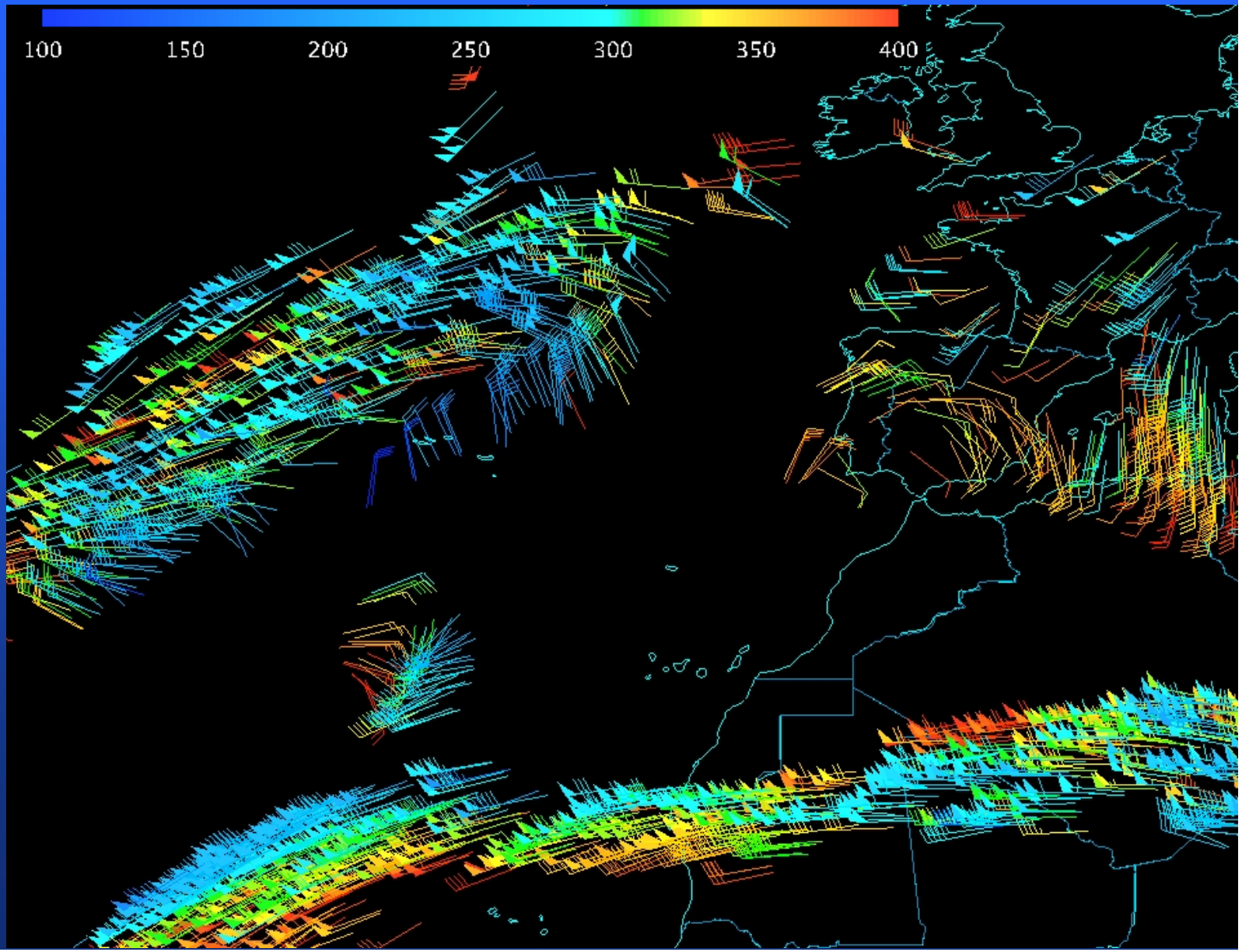
Post-RF AMV Dataset



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Example Performance on GOES AMVs

- GOES-12 Data from 03, Aug. 2007 - 01 Oct. 2007
- This presentation will focus on IR AMVs.
- AMVs with QI < 0.5, and AMV - RAOB Vector Difference > 30 ms^{-1} are eliminated for this study.
- AMVs compared with collocated RAOBS: 150 km horizontal, 25 hPa vertical AMV - RAOB separation.
- Statistics calculated for Pre-RF and Post-RF data.

Impact of QC on bulk GOES-12 IR AMV statistics

Dataset	Height (hpa)	Pre-RF	Post-RF
Number	100-400	41430	35361
	400-700	7989	5390
	700-1000	3419	2221
Spd Bias	100-400	-2.02	-0.64
	400-700	-1.30	-1.25
	700-1000	-0.23	-0.13
RMS Vector Difference	100-400	8.89	7.24
	400-700	7.46	5.86
	700-1000	4.89	4.71
AVG RAOB Speed	100–400	19.18	19.80
	400-700	14.88	14.66
	700-1000	8.68	9.35

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The 'Expected Error' (EE) QC Index (Le Marshall *et. al*, 2004)

Multiple Linear Regression of AMV - RAOB Differences Based on:

1. QI Speed Test
2. QI Direction Test
3. QI Vector Difference Test
4. QI Local Consistency Test
5. QI Forecast Test
6. AMV Speed
7. Assigned Pressure Level
8. Model Wind Shear (200 hPa below and above)
9. Model Temperature Gradient (200 hPa below and above)

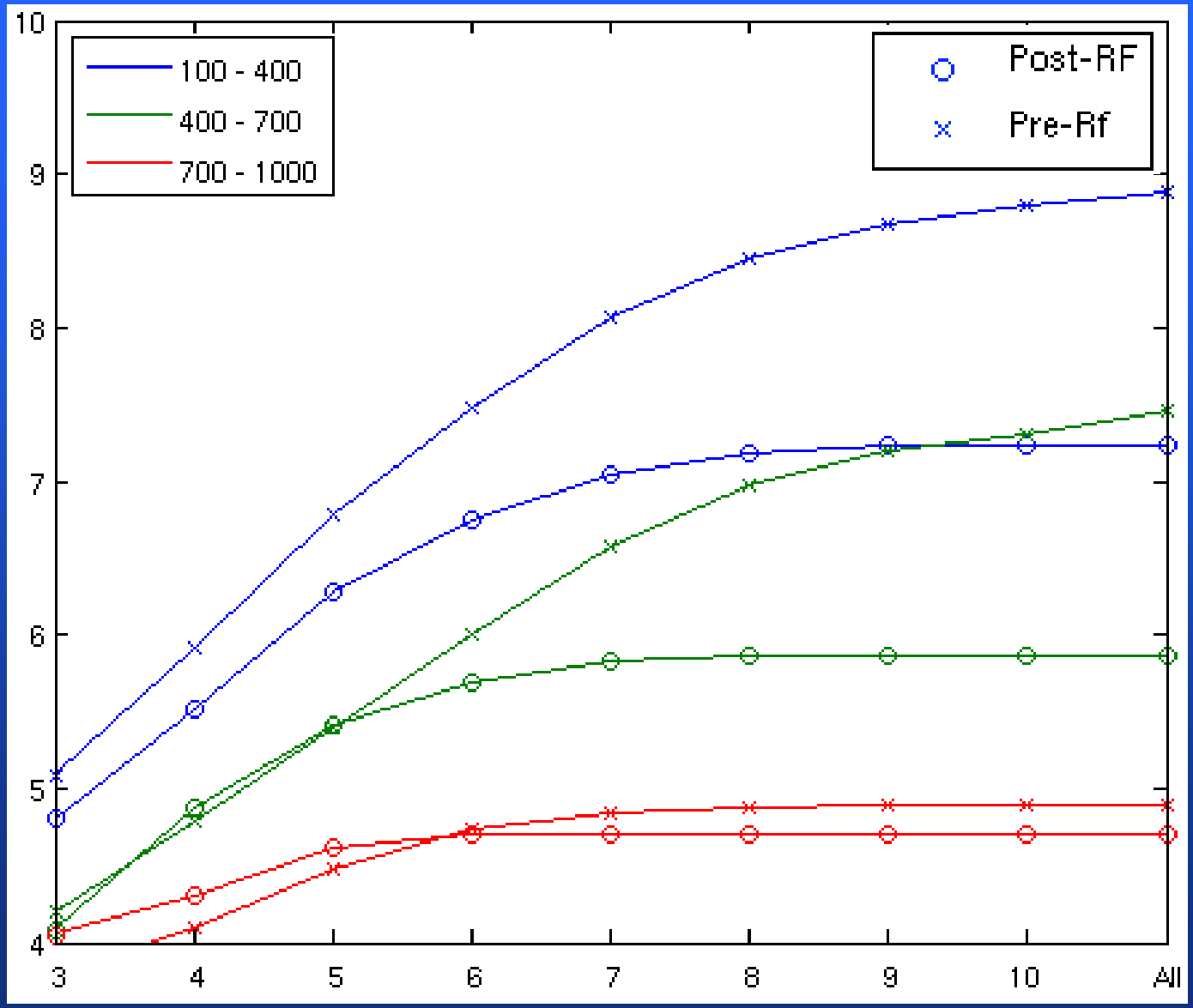
Experimentation with the EE at CIMSS

- Can the EE be used to remove the need for the RF in CIMSS/NESDIS real-time processing??? ☺
- Goal is to achieve RF performance level QC using the EE (or blend of EE with QI)

Expected Error study details

- Separate coefficients were generated for each channel and quality control level (e.g. pre-RF, post-RF).
- Performance results based on collocated RAOB comparisons

Impact of EE on GOES Post- and Pre-RF AMV - RAOB: RMS Vector Difference



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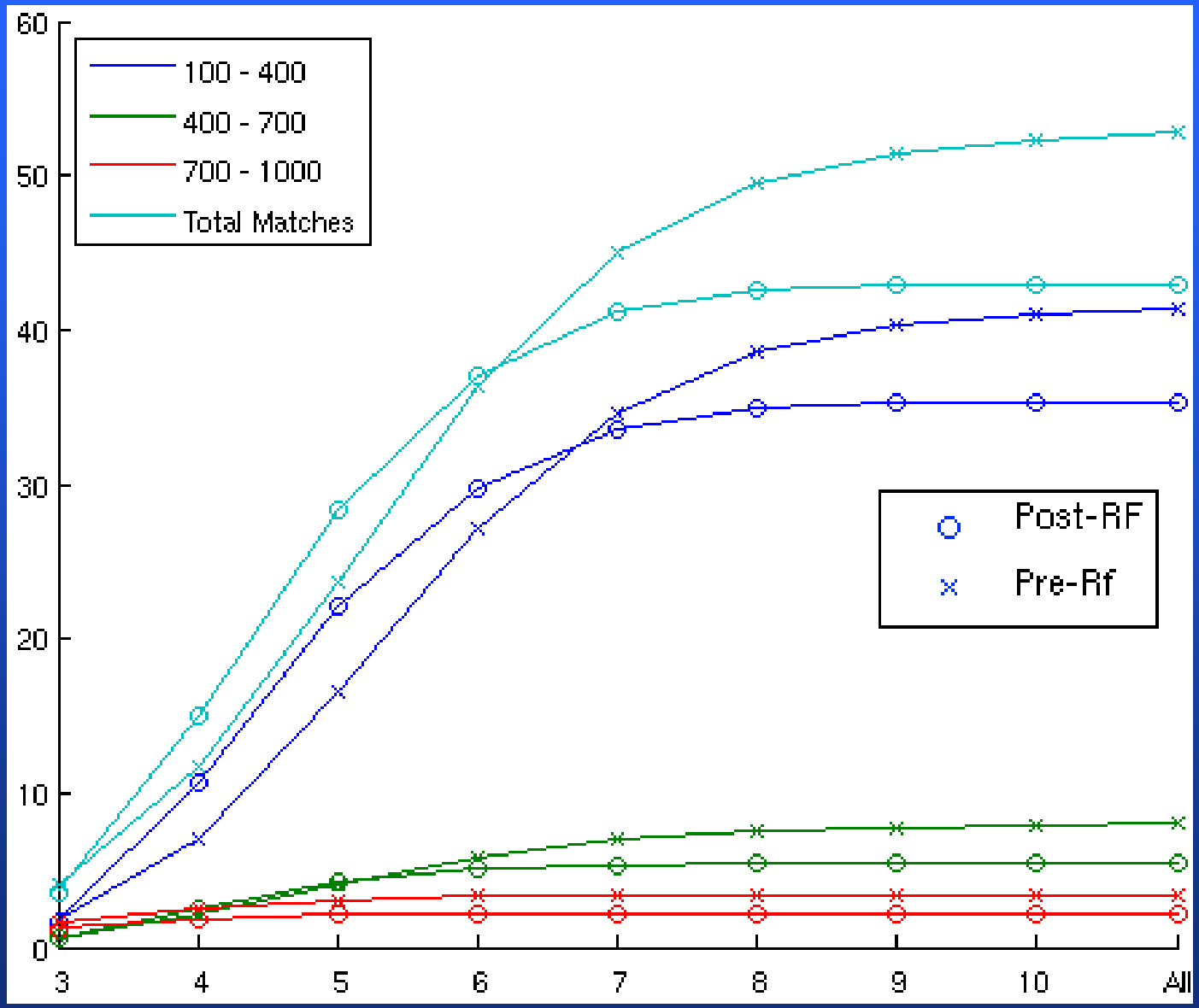
Impact of EE on GOES Post- and Pre-RF AMV-RAOB: Number of Matches



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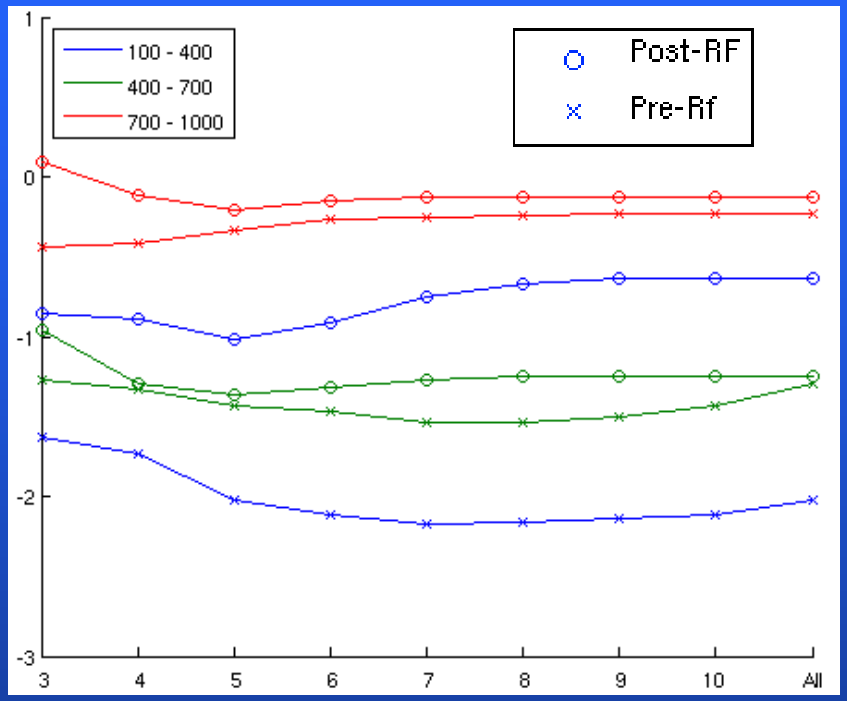
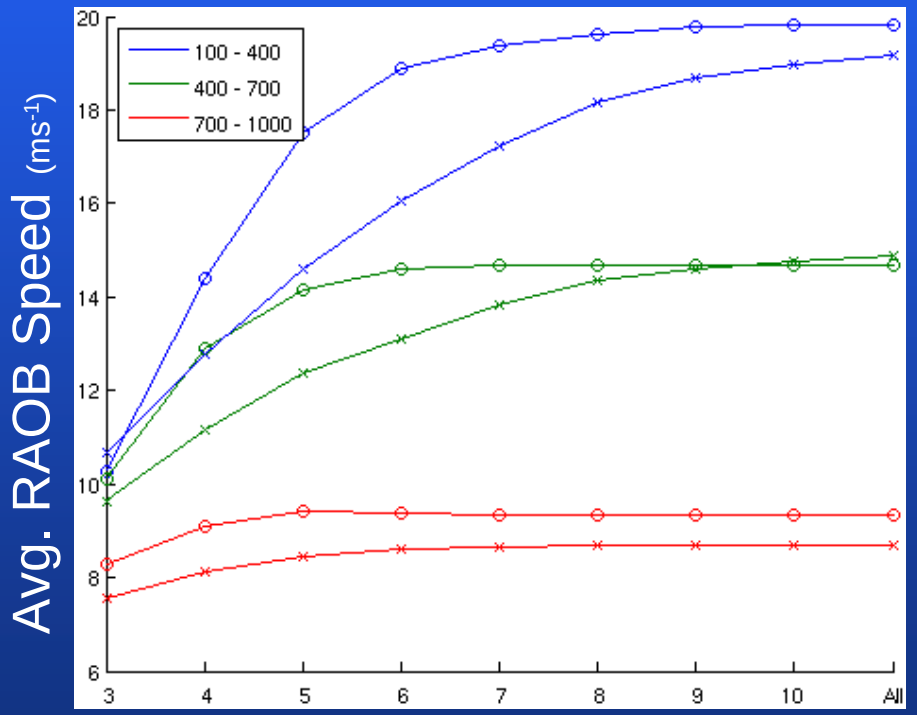
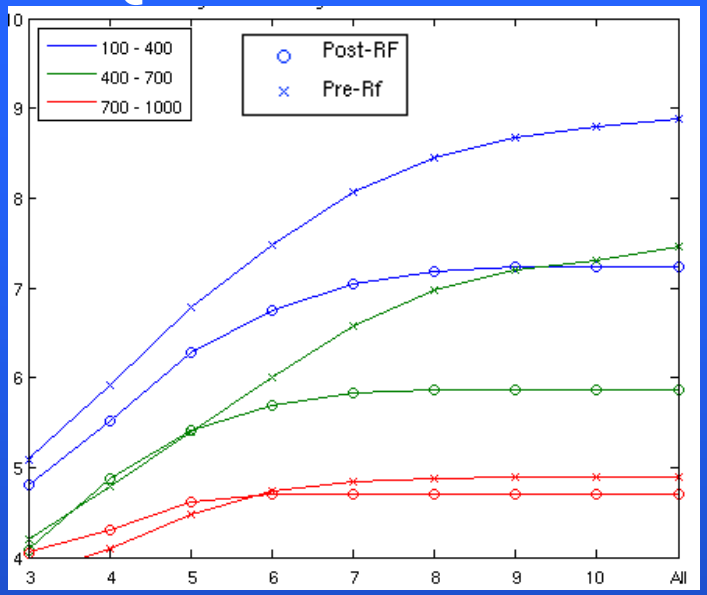
Impact of EE on GOES Post- and Pre-RF



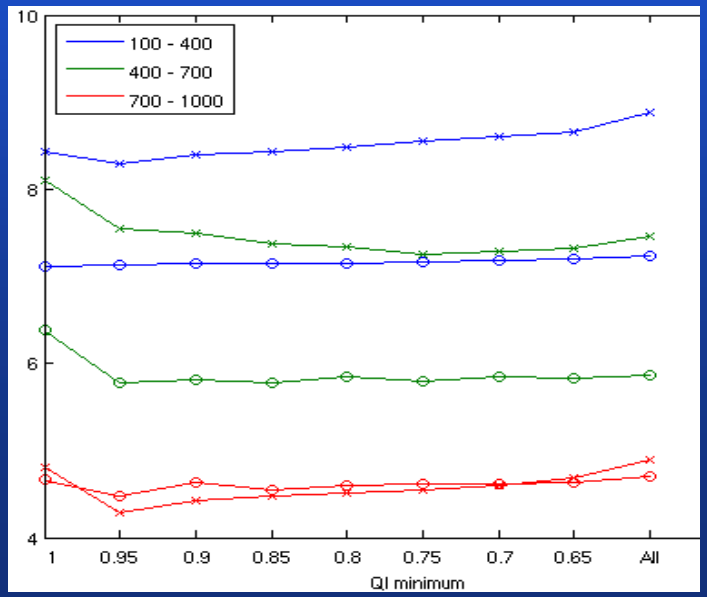


Impact of EE and QI on GOES Post- and Pre-RF

RMS Vector Error (ms^{-1})

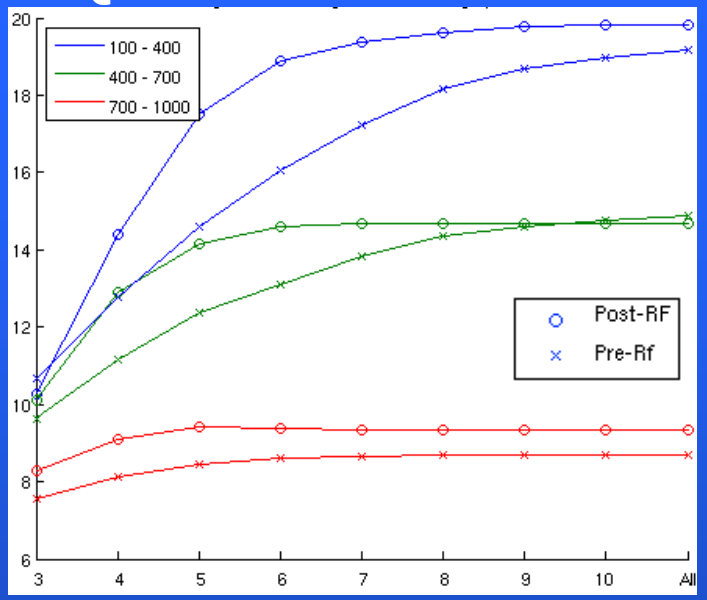


Expected Error Maximum (ms^{-1})



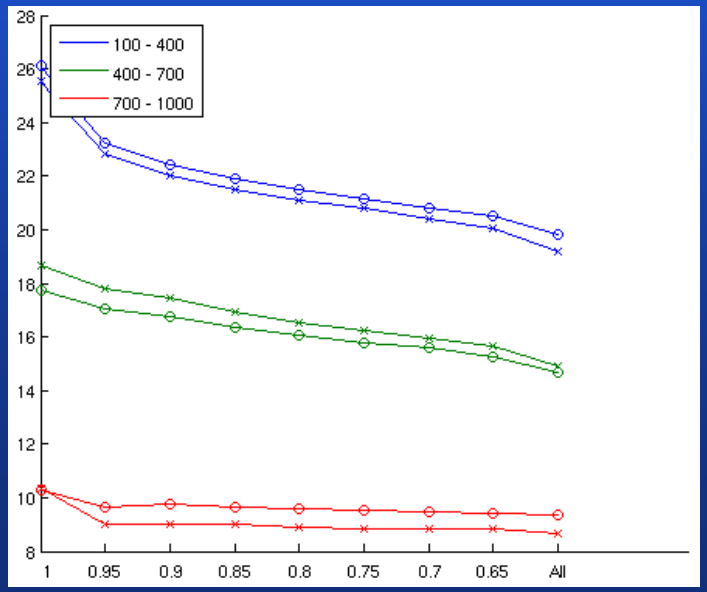
QI Minimum

Impact of EE and QI on GOES Post- and Pre-RF



Average RAOB Speed (ms^{-1})

Expected Error Maximum (ms^{-1})



QI Minimum

EE Impact

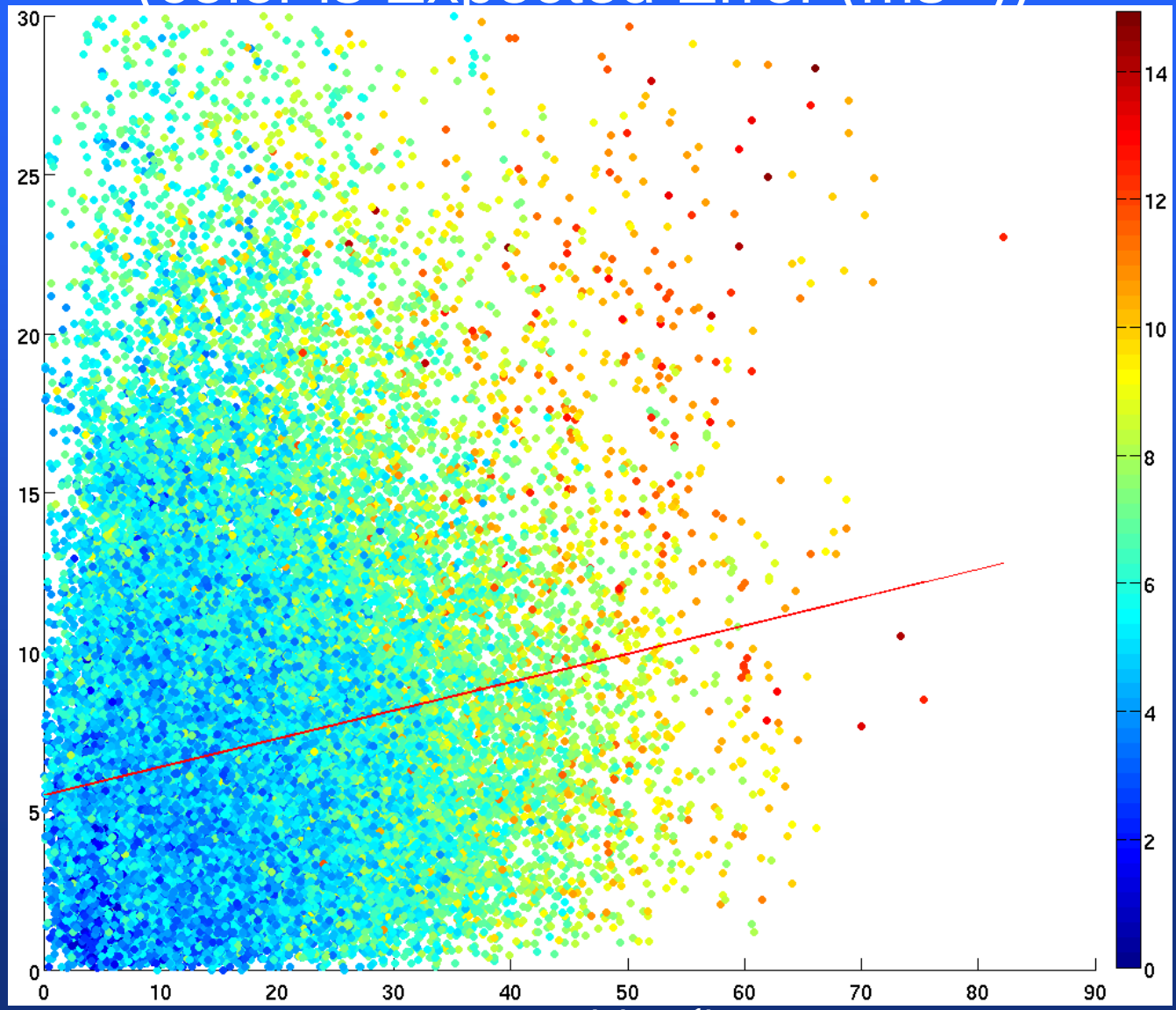
- Decreasing EE threshold decreases RMS vector difference compared to RAOBS.
- This RMS decrease is at the cost of AMV numbers and reduction in average speed.
- Challenge: Can we efficiently reduce AMV errors to near Post-RF levels while maintaining similar numbers and average speed statistics?

Two strategies:

- Apply a speed threshold for EE
- Use a combination of the QI and the EE, utilizing the QI's preference for maintaining faster AMVs

Vector Difference vs. AMV Speed

(color is Expected Error (ms^{-1}))



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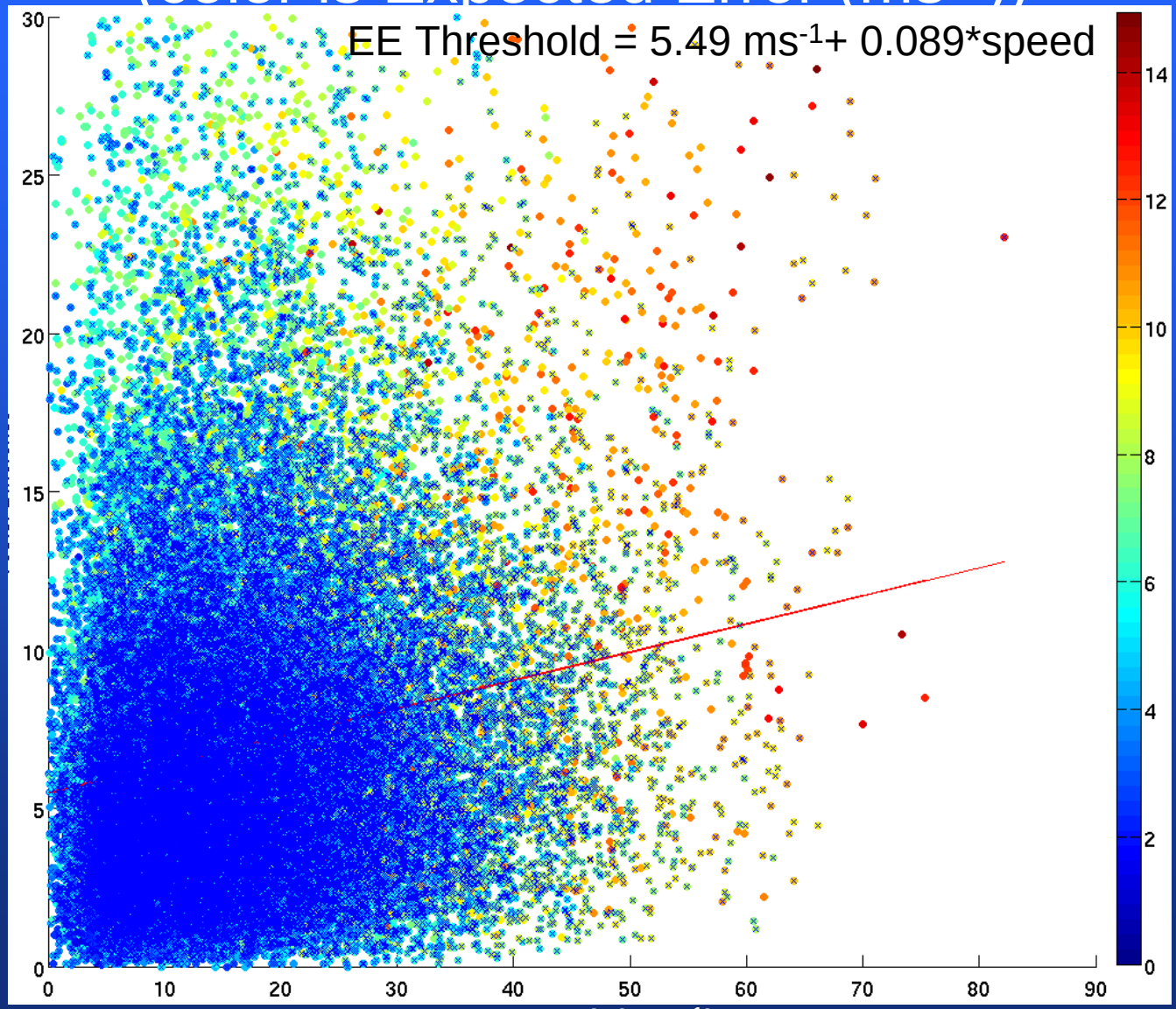
Vector Difference vs. AMV Speed

(color is Expected Error (ms^{-1}))



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Match Statistics Comparison

Data Set		Pre-RF Linear Threshold	Pre-RF EE Max 6 ms^{-1}	Post-RF All
Number of matches	100 - 400	35593	27184	35361
	400 - 700	6852	5796	5390
	700-1000	3363	3310	2221
Spd Bias (AMV Š RAOB)	100 - 400	-1.93	-2.12	-0.64
	400 - 700	-1.21	-1.47	-1.25
	700-1000	-0.21	-0.27	-0.13
RMS Vector Diff. (vs RAOB)	100 - 400	8.20	7.48	7.24
	400 - 700	6.46	6.01	5.86
	700-1000	4.81	4.74	4.71
Avg RAOB Speed	100 - 400	19.23	16.04	19.80
	400 - 700	14.41	13.11	14.66
	700-1000	8.65	8.60	9.35

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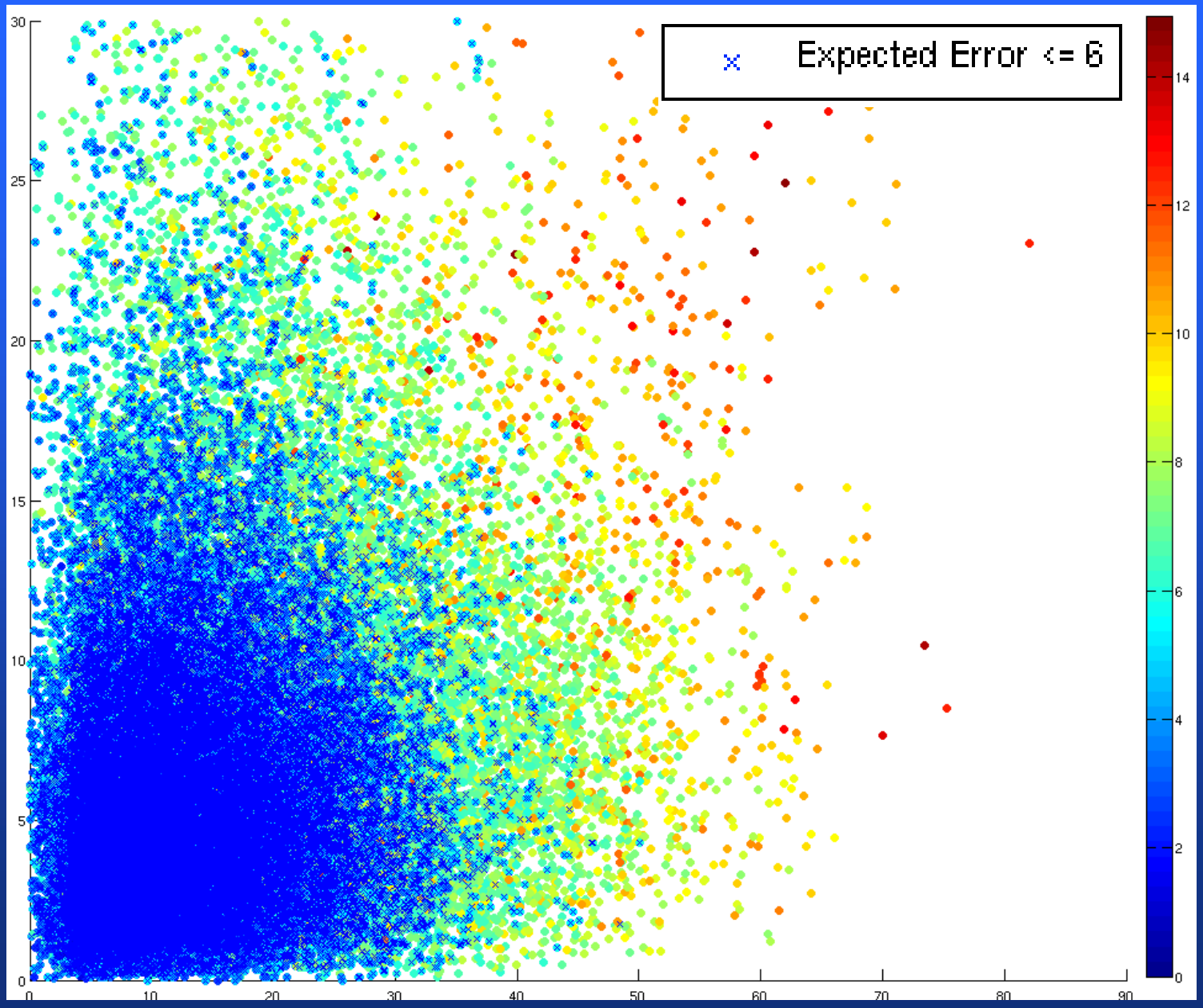
Two strategies:

- Apply a speed threshold for EE
- Use a combination of the QI and the EE, utilizing the QI's preference for maintaining faster AMVs

QI/EE Strategy:

- For slow AMVs, use EE only
- For faster AMVs, keep AMVs with high QI values.
- The trick is optimally setting the (QI/EE/Speed) thresholds.

Straight EE Threshold



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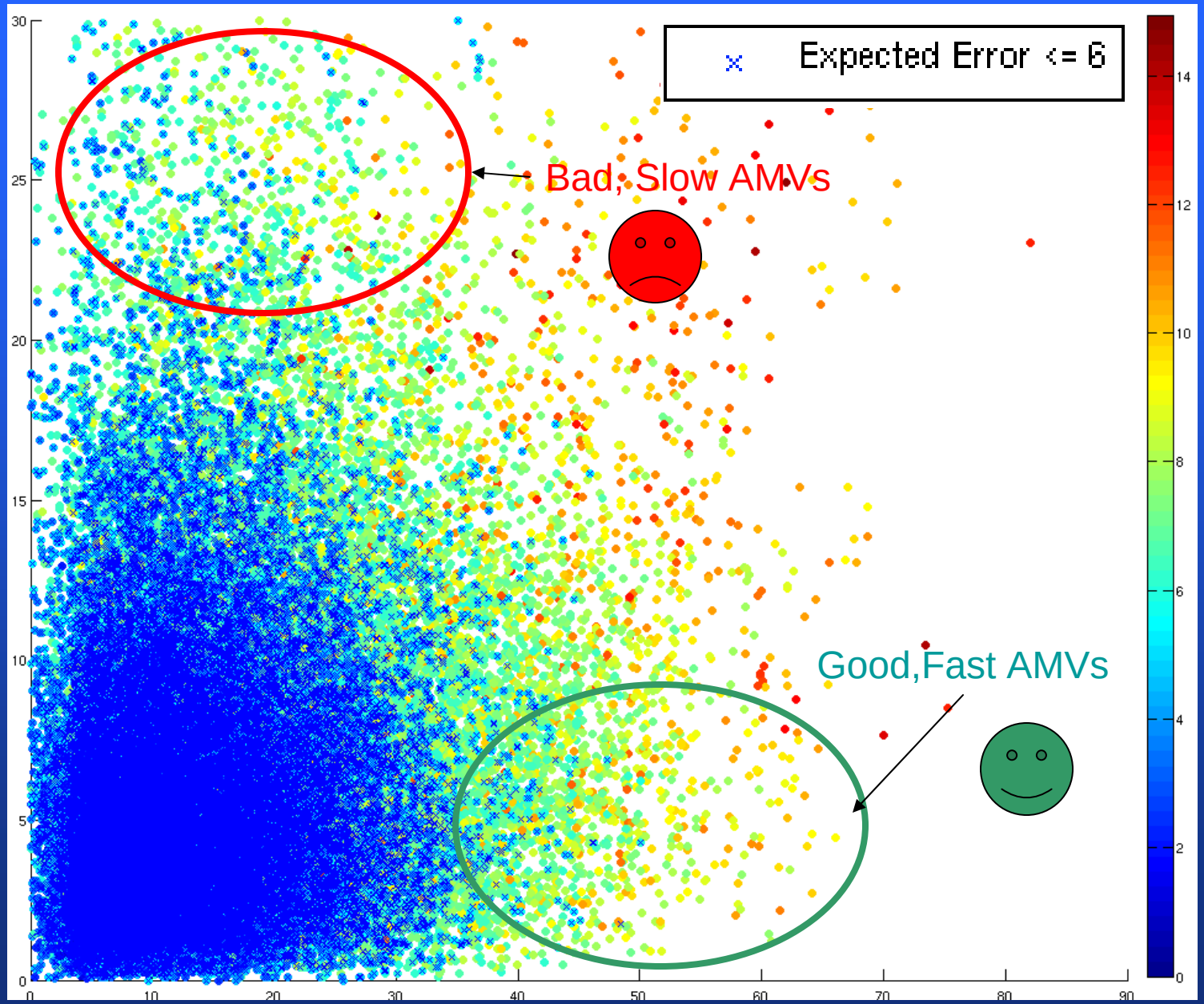
Straight EE Threshold



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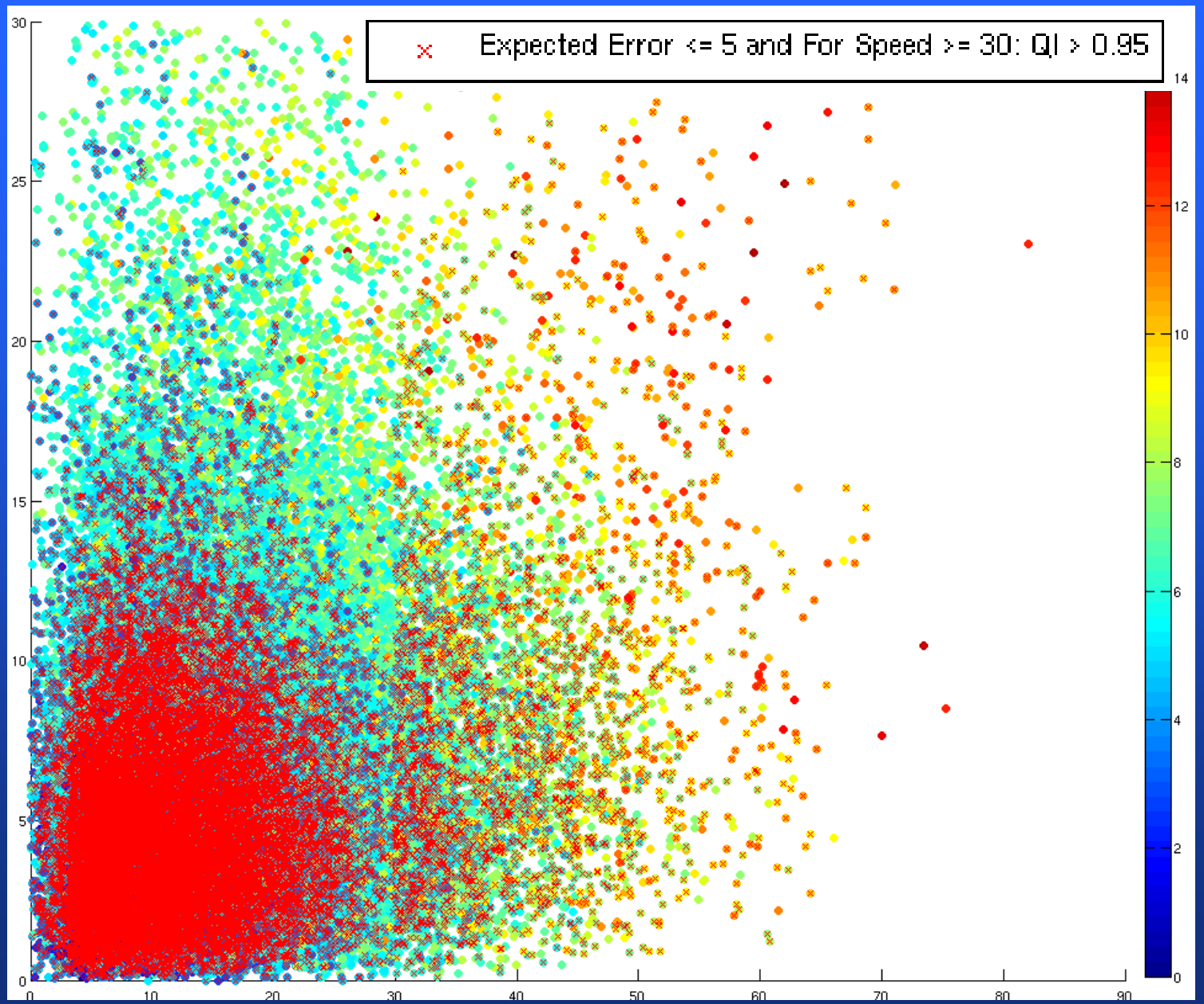
EE and QI threshold for fast AMVs



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Match Statistics Comparison

Data Set		Spd >= 30 ms^{-1} EE > 5 ms^{-1} QI >=0.95	Pre-RF EE Max 6 ms^{-1}	Post-RF All
Number of matches	100 - 400	18707	27184	35361
	400 - 700	4155	5796	5390
	700-1000	3075	3310	2221
Spd Bias (AMV Š RAOB)	100 - 400	-1.69	-2.12	-0.64
	400 - 700	-1.23	-1.47	-1.25
	700-1000	-0.33	-0.27	-0.13
RMS Vector Diff. (vs RAOB)	100 - 400	7.20	7.48	7.24
	400 - 700	5.63	6.01	5.86
	700-1000	4.48	4.74	4.71
Avg RAOB Speed	100 - 400	17.36	16.04	19.80
	400 - 700	12.83	13.11	14.66
	700-1000	8.43	8.60	9.35

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Match Statistics Comparison

Data Set		Spd >=20ms^{-1} EE > 5 ms^{1} QI >=0.95	Spd >= 30 ms^{1} EE > 5 ms^{-1} QI >=0.95	Pre-RF EE Max 6 ms^{-1}	Post-RF All
Number of matches	100 - 400	20,565	18707	27184	35361
	400 - 700	4346	4155	5796	5390
	700-1000	3077	3075	3310	2221
Spd Bias (AMV Š RAOB)	100 - 400	-1.62	-1.69	-2.12	-0.64
	400 - 700	-1.13	-1.23	-1.47	-1.25
	700-1000	-0.33	-0.33	-0.27	-0.13
RMS Vector Diff. (vs RAOB)	100 - 400	7.41	7.20	7.48	7.24
	400 - 700	5.77	5.63	6.01	5.86
	700-1000	4.49	4.48	4.74	4.71
Avg RAOB Speed	100 - 400	18.13	17.36	16.04	19.80
	400 - 700	13.28	12.83	13.11	14.66
	700-1000	8.43	8.43	8.60	9.35

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Conclusions

- The EE can reduce AMV - RAOB RMS errors to a level similar to the RF processing.
- This RMS reduction, however, reduces the AMV quantity and dataset mean speed.
- Research is underway to examine ways to optimize the use of the EE, either by itself or in combination with the QI.

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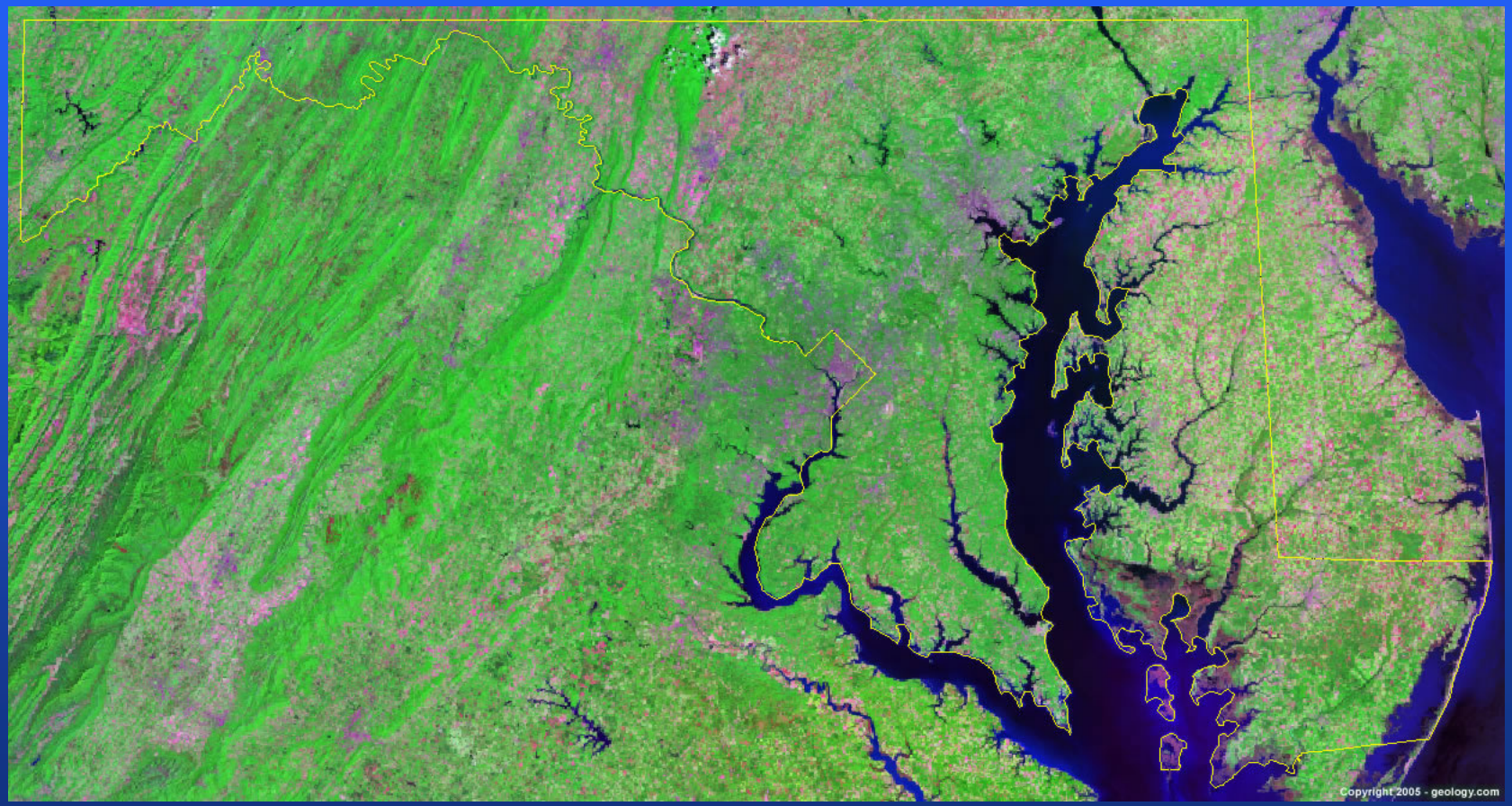
Future Work

- Expand study to other channels/satellites.
- Investigate a ‘Weighted’ EE
  - Weight QI more for higher speed AMVs or weight by predictor variance
- Examine/Implement new predictors
  - Remove forecast QI test
  - New AMV height assignment information
- Perform regression on log(AMV - RAOB) vector difference
  - Predictand becomes more normally distributed

Thanks for your attention!



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