Atmospheric Motion Vector Impact Study Using the NCEP Global Forecast System

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Background

• May 2011 version of the NCEP GDAS/GFS
• T574L64 (operational resolution)
• Operational configuration except:
  – Conventional data QC from the operational run, not the experiment
  – No restricted data used (aircraft, ships, etc.)
• Two Seasons:
  – 1 Dec 2010 – 15 Jan 2011
• Two experiments
  – Deny all AMVs (NAMV) (both seasons)
  – Deny Polar AMVs (NMOD) (Dec – Jan only)
Denied AMVs for No AMV Experiment

• MTSAT, infrared and visible below 850 hPa
• Meteosat, infrared and visible below 850 hPa
• GOES, infrared
• GOES, water vapor cloud top
• MTSAT, infrared and visible above 850 hPa
• Meteosat, infrared and visible above 850 hPa
• MODIS, infrared
• MODIS, water vapor cloud top
• MODIS, water vapor deep layer
Denied AMVs for No Polar AMV Experiment

• MODIS, infrared
• MODIS, water vapor cloud top
• MODIS, water vapor deep layer
No AMV Experiment
15 Aug 2010 – 30 Sep 2010
GOES infrared

Black = Control (O-B)  Red = Control (O-A)
Green = Experiment (O-B)  Blue = Experiment (O-A)

No AMV Experiment 15 Aug 2010 – 30 Sept 2010
GOES Water Vapor Cloud Top

Black = Control (O-B)
Green = Experiment (O-B)
Red = Control (O-A)
Blue = Experiment (O-A)

No AMV Experiment 15 Aug 2010 – 30 Sept 2010
MTSAT infrared above 850 hPa

Black = Control (O-B)
Green = Experiment (O-B)
Red = Control (O-A)
Blue = Experiment (O-A)

No AMV Experiment 15 Aug 2010 – 30 Sept 2010
Meteosat-9 infrared above 850 hPa

Black = Control (O-B)  
Green = Experiment (O-B)  
Red = Control (O-A)  
Blue = Experiment (O-A)

No AMV Experiment 15 Aug 2010 – 30 Sept 2010
MODIS infrared

Black = Control (O-B)
Green = Experiment (O-B)
Red = Control (O-A)
Blue = Experiment (O-A)

No AMV Experiment 15 Aug 2010 – 30 Sept 2010
MODIS Water Vapor Cloud Top

Black = Control (O-B)  
Red = Control (O-A)  
Green = Experiment (O-B)  
Blue = Experiment (O-A)

No AMV Experiment 15 Aug 2010 – 30 Sept 2010
Geopotential heights - day 3
Bias time series at 500 hPa for Northern and Southern Hemispheres.

Positive = WCTL closer to zero
Geopotential heights, day 3, RMSE time series at 500 hPa for Northern and Southern Hemispheres.

Positive = WCTL < NAMV
Geopotential heights anomaly correlation time series at 500 hPa for Northern and Southern Hemispheres.
No AMV Experiment 15 Aug 2010 – 30 Sept 2010
Wind Speed RMSE Day 1 time series at 200 hPa for the Northern and Southern Hemisphere and Tropical region.

Positive = WCTL < NAMV
Wind Speed RMSE, Day 1, time series at 850 hPa for the Northern and Southern Hemisphere and Tropical region.

Positive = WCTL < NAMV
No AMV Experiment 15 Aug 2010 – 30 Sept 2010
No AMV Experiment 15 Aug 2010 – 30 Sept 2010
WIND: RMSE
P860 G2/TRO GOZ, 20100615–20100930 Mean

- NAMV 47
- WCTL 47

Difference w.r.t. NAMV

rms differences outside of outline bars are significant at the 95% confidence level

Forecast Hour

No AMV Experiment 15 Aug 2010 – 30 Sept 2010
Vertical profile vs forecast time of wind speed RMSE for the Northern and Southern Hemispheres and Tropical Region.

Left panel is average wind speed from the control. Right panel is difference of experiment - control.

Red = Improvement
Green = Degredation
24 and 48 hour time series of Vector Wind RMS fit to Rawinsondes at 200 hPa for the Northern and Southern Hemispheres and Tropical Region.

Solid lines are the control
Dashed lines are the experiment

Red = 48 hr. statistics
Black = 24 hr. statistics
24 and 48 hour time series of Vector Wind RMS fit to Rawinsondes at 850 hPa for the Northern and Southern Hemispheres and Tropical Region.

Solid lines are the control
Dashed lines are the experiment

Red = 48 hr. statistics
Black = 24 hr. statistics
Summary
15 Aug 2010 – 30 Sep 2010

• Slow bias for U prominent for Geostationary AMVs
• AC scores are generally neutral (not shown)
• 500 hPa height bias/RMS generally positive
• 200 hPa vector wind RMSE wrt own analysis:
  – Mostly positive and significant
• 850 hPa vector wind RMSE wrt own analysis:
  – Positive at mid-latitudes but negative in the tropics
• 200 hPa 24 & 48 hr. fit to rawinsondes:
  – Positive for NH, SH, TR.
• 850 hPa 24 & 48 hr. fit to rawinsondes:
  – Mostly neutral
No AMV Experiment
1 Dec 2010 – 15 Jan 2010
GOES infrared

No AMV Experiment 1 Dec 2010 – 31 Jan 2011
GOES Water Vapor Cloud Top

Black = Control (O-B)  
Red = Control (O-A)  
Green = Experiment (O-B)  
Blue = Experiment (O-A)  

No AMV Experiment 1 Dec 2010 – 31 Jan 2011
MTSAT infrared above 850 hPa

U component

V component

Black = Control (O-B)
Green = Experiment (O-B)

Red = Control (O-A)
Blue = Experiment (O-A)

No AMV Experiment 1 Dec 2010 – 31 Jan 2011
Meteosat-9 infrared above 850 hPa

U component

V component

Black = Control (O-B)
Green = Experiment (O-B)
Red = Control (O-A)
Blue = Experiment (O-A)

No AMV Experiment 1 Dec 2010 – 31 Jan 2011
MODIS infrared

Black = Control (O-B)  Red = Control (O-A)
Green = Experiment (O-B)  Blue = Experiment (O-A)

No AMV Experiment 1 Dec 2010 – 31 Jan 2011
MODIS Water Vapor Cloud Top

Black = Control (O-B)  
Red = Control (O-A)  
Green = Experiment (O-B)  
Blue = Experiment (O-A)

No AMV Experiment 1 Dec 2010 – 31 Jan 2011
MODIS Water Vapor Deep Layer

U component

V component

Black = Control (O-B)
Green = Experiment (O-B)
Red = Control (O-A)
Blue = Experiment (O-A)

No AMV Experiment 1 Dec 2010 – 31 Jan 2011
Geopotential heights, day 3, Bias time series at 500 hPa for Northern and Southern Hemispheres.

Positive = WCTL
Geopotential heights, day 3, RMSE time series at 500 hPa for Northern and Southern Hemispheres.
Geopotential heights anomaly correlation time series at 500 hPa for Northern and Southern Hemispheres.

Positive = WCTL closer to zero
Wind Speed Root Mean Square Error, Day 1, time series at 200 hPa for the Northern and Southern Hemisphere and Tropical region.

Positive = WCTL < NAMV

No AMV Experiment 1 Dec 2010 – 31 Jan 2011
Wind Speed Root Mean Square Error, Day 1, time series at 850 hPa for the Northern and Southern Hemisphere and Tropical region.

Positive = WCTL < NAMV

No AMV Experiment 1 Dec 2010 – 31 Jan 2011
No AMV Experiment 1 Dec 2010 – 31 Jan 2011
No AMV Experiment 1 Dec 2010 – 31 Jan 2011
WIND: RMSE
P850 G2/NHX 00Z, 20101201–20110116 Mean

- NAMV 46
- WCTL 45

Forecast Hour

rms differences outside of outline bars are significant at the 95% confidence level.
Vertical profile vs forecast time of wind speed RMSE for the Northern and Southern Hemispheres and Tropical Region.

Left panel is average wind speed from the control. Right panel is difference of experiment - control.

Red = Improvement
Green = Degredation
24 and 48 hour time series of Vector Wind RMS fit to Rawinsondes at 200 hPa for the Northern and Southern Hemispheres and Tropical Region.

Solid lines are the control
Dashed lines are the experiment

Red = 48 hr. statistics
Black = 24 hr. statistics
24 and 48 hour time series of Vector Wind RMS fit to Rawinsondes at 850 hPa for the Northern and Southern Hemispheres and Tropical Region.

Solid lines are the control
Dashed lines are the experiment

Red = 48 hr. statistics
Black = 24 hr. statistics
Summary
1 Dec 2010 – 15 Jan 2011

• Slow bias for U for GOES AMVs, others are closer to zero
• AC scores: (not shown)
  – NH positive but not significant
  – SH short term positive, long term negative
• 500 hPa height bias/RMS generally positive
• 200 hPa vector wind RMSE wrt own analysis:
  – Mostly positive and significant at mid-latitudes
  – Negative and significant in tropics
• 850 hPa vector wind RMSE wrt own analysis:
  – Positive to neutral at mid-latitudes
  – Negative in the tropics
• 200 hPa 24 & 48 hr. fit to rawinsondes:
  – Neutral for NH
  – Positive for SH, TR
• 850 hPa 24 & 48 hr. fit to rawinsondes:
  – Neutral for NH
  – Positive for SH, TR
No Polar AMV Experiment
1 Dec 2010 – 15 Jan 2011
MODIS infrared

U component

V component

Black = Control (O-B)
Green = Experiment (O-B)
Red = Control (O-A)
Blue = Experiment (O-A)

No Polar AMV Experiment 1 Dec 2010 – 31 Jan 2011
MODIS Water Vapor Cloud Top

U component

V component

Black = Control (O-B)
Green = Experiment (O-B)
Red = Control (O-A)
Blue = Experiment (O-A)

No Polar AMV Experiment 1 Dec 2010 – 31 Jan 2011

11th International Winds Workshop
MODIS Water Vapor Deep Layer

U component

V component

Black = Control (O-B)
Green = Experiment (O-B)
Red = Control (O-A)
Blue = Experiment (O-A)

No Polar AMV Experiment 1 Dec 2010 – 31 Jan 2011
Geopotential heights - day 3 Bias time series at 500 hPa for Northern and Southern Hemispheres.

Positive = WCTL closer to zero
Geopotential heights, day 3, RMSE time series at 500 hPa for Northern and Southern Hemispheres.

Positive = WCTL < NAMV
No Polar AMV Experiment 1 Dec 2010 – 31 Jan 2011

Geopotential heights anomaly correlation time series at 500 hPa for Northern and Southern Hemispheres.
AC: HGT P500 G2/NHX 00Z, 20101201-20110115

Difference w.r.t. NMOD

AC differences outside of outline bars are significant at the 95% confidence level.

Forecast Hour
Wind Speed Root Mean Square Error, Day 1, time series at 200 hPa for the Northern and Southern Hemisphere and Tropical region.

Positive = WCTL < NAMV
Wind Speed Root Mean Square Error, Day 1, time series at 850 hPa for the Northern and Southern Hemisphere and Tropical region.

Positive = WCTL < NAMV
No Polar AMV Experiment 1 Dec 2010 – 31 Jan 2011
No Polar AMV Experiment 1 Dec 2010 – 31 Jan 2011
Vertical profile vs forecast time of wind speed RMSE for the Northern and Southern Hemispheres and Tropical Region.

Left panel is average wind speed from the control. Right panel is difference of experiment - control.

Red = Improvement
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24 and 48 hour time series of Vector Wind RMS fit to Rawinsondes at 200 hPa for the Northern and Southern Hemispheres and Tropical Region.

Solid lines are the control
Dashed lines are the experiment

Red = 48 hr. statistics
Black = 24 hr. statistics
24 and 48 hour time series of Vector Wind RMS fit to Rawinsondes at 850 hPa for the Northern and Southern Hemispheres and Tropical Region.

Solid lines are the control
Dashed lines are the experiment

Red = 48 hr. statistics
Black = 24 hr. statistics
Summary
1 Dec 2010 – 15 Jan 2011

• 500 hPa AC Scores: (not shown)
  – NH Positive (not significant)
  – SH Negative (not significant)
• 500 hPa Bias is positive
• 500 hPa RMS
  – NH Positive
  – SH Negative
• 200 hPa vector wind RMSE wrt own analysis:
  – Mostly positive (not significant) at mid latitudes and tropics
• 850 hPa vector wind RMSE wrt own analysis:
  – Positive NH (not significant)
  – Negative SH and tropics (not significant)
• 200 hPa 24 & 48 hr. fit to rawinsondes:
  – Neutral to positive for NH + SH
  – Negative for TR
• 850 hPa 24 & 48 hr. fit to rawinsondes:
  – Neutral for NH, SH, TR