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SUMMARY OF THE SIXTH INTERNATIONAL WINDS WORKSHOP

This paper summarises the Sixth International Winds Workshop (IWW6) hosted by University of Wisconsin Cooperative Institute for Meteorological Satellite Studies (CIMSS) in Madison from 7 – 10 May 2002.

The paper recalls the actions placed by CGMS 29 on IWW6, provides responses to those actions and new recommendations to CGMS 30.

SUMMARY OF THE SIXTH INTERNATIONAL WINDS WORKSHOP

1 Introduction

The Sixth International Winds Workshop (IWW6) was held in Madison, USA from 7 – 10 May 2002. The Workshop was hosted by the University of Wisconsin and organized jointly by the University of Wisconsin Co-operative Institute for Satellite Studies (UW-CIMSS) and EUMETSAT. UW-CIMSS was successful in providing excellent workshop facilities in Madison. The IWW6 was attended by scientists from thirteen countries (Australia, Canada, China, France, Germany, India, Italy, Japan, The Netherlands, Russia, Switzerland, United Kingdom and United States of America) and three international organizations (ECMWF, WMO and EUMETSAT). All satellite operators producing Atmospheric Motion Vectors (AMVs) operationally, and most global NWP centers were present. Scientists from both the research and scientific community working in this field were also well represented.

The IWW6 plenary sessions were devoted to contributed presentations from each of the participants. These are briefly summarized in Section 2. The IWW6 also incorporated the actions given by CGMS 29 in the discussions that were held in three topical working groups. These actions, relevant discussions and recommendations are addressed in detail in Section 3.

2 Summary of Sessions

The 6th International Winds Workshop was opened with welcome addresses by the local host and co-organiser C. Velden and K. Holmlund, respectively. Then P. Menzel (NOAA), D. Hinsman of WMO and Dr. T. Mohr (Director-General of EUMETSAT – address read by J. Schmetz) welcomed all participants. The welcoming address from Dr. Mohr underlined the importance of these meetings to the satellite community and the relevance of the participation of the satellite data users.

Session I, on 'Current systems to derive Atmospheric Motion Vectors (AMVs) chaired by Dr. D. Hinsman included seven presentations describing status and recent advances on AMV processing at the main operational centers producing AMVs. Presentations covered the AMV processing at the Meteorological Satellite Center4 (MSC) of the Japan Meteorological Agency (JMA), the India Meteorological Department (IMA), NOAA/NESDIS and EUMETSAT. The operational use of data was addressed in a paper from the Fleet Numerical Meteorology and Oceanography Center.

Session II, on 'Mesoscale Applications' and chaired by Prof. Xu Jianmin, featured four presentations on mesoscale winds, diurnal cycle of high-level divergence and the evolution of cloud properties.

Session III, on 'Verification/Objective quality analysis', chaired by Dr. M. Tokuno, described development of quality indicators and the use of AMVs at NWP centers.

Session IV, on 'Rapid-scan and high-resolution studies', chaired by Dr. J. LeMarshall, had three papers on the production and use of winds from rapid scans.

Session V, on 'Microwave/Lidar studies', chaired by Dr. R. C. Bhatia, had eight papers on active and passive microwave sensing systems for wind measurements and future lidar wind measurements from space.

Session VI, on ‘New Techniques and Instruments’, co-chaired by C. Velden and N. Bormann, addressed novel wind products, e.g. from MODIS, MISR and the 3.9 µm channel on GOES and impact of MODIS winds. Other paper covered low-level cloud winds, tracer height allocation and a novel image navigation.

3 Working Group Summaries and Recommendations

Following the presentation of papers the workshop continued with three Working Group breakout sessions on ‘Methods’, chaired by J. Daniels, ‘Mesoscale Applications’ chaired by J. Schmetz and ‘Verification’ chaired by K. Holmlund. The following subsections provide summaries of the Working Groups, response to actions from CGMS 29 and recommendations. Relevant actions from CGMS 29 are repeated for convenience.

3.1 IWW6 Working Group I: Methods

CGMS Action 29.36: The 6th International Winds Workshop to discuss the compatibility of spatial resolution and image repeat cycle for winds tracking and to provide pertinent recommendations to CGMS satellite operators.

In response to this action WG I stated and recommended:

- Highest quality winds come from the appropriate match of spatial and temporal resolutions
- A lower limit on wind errors is determined by the spatial resolution sampling interval and image-to-image registration
- The optimal tracking time interval is also dependent on spectral band and on features (cloud, water vapor) being tracked
- Continued improvements in image-to-image registration are needed. It was recalled that IWW4 recommended that image-to-image registration accuracy to be ~ 1/4 pixel size.

Recommendation-IWW6-1:
As a general guideline based upon experience with rapid scan work done to date the following recommendation can be made concerning compatible spatial and temporal resolution for feature tracking in spectral images:

1km VIS ~ 5min
4km IR ~ 10min
4km WV ~ 30+ (for clear sky water vapour winds)

CGMS Action 29.37: The 6th International Winds Workshop to discuss the template size for tracking features in relation to the question of whether the displacement vector represents a local wind vector. A pertinent recommendation should be provided to the CGMS satellite operators.

This refers to the ‘old’ question of whether what is tracked represents a local wind vector. Clearly, when templates get bigger one tracks system displacement. What happens when templates get gradually smaller is not necessarily clear. Is there a specific template size that optimally tracks the local wind?

In response to this action WG I stated and recommended:

- The size of template dictates product density and plays a role in how well features can be tracked. Notably, large errors are expected if template too small. Furthermore, random noise is lower for increased template sizes.

- The appropriate template size is dictated by:
  i. desired feature to be tracked
  ii. resolution of spectral band to be used for tracking
  iii. particular application of product (NWP, nowcasting/field)

Recommendation-IWW6-2:
Experiments should be done by satellite operators to determine optimal template size for winds tracking using rms and speed bias (satwind - raob) as benchmarks.

CGMS Action 29.38: The 6th International Winds Workshop to discuss and encourage the use of geometric (and other) height allocation methods for comparison with and validation of multi-spectral infrared height assignment methods of wind vectors which are used operationally.

Here a qualified statement on the usefulness of stereo for the validation of multi-spectral heights is what is required. Limitations and additional requirements (such as careful manual image referencing) for stereo should be pointed out.

In response to this action WG I stated and recommended :
- Strong consensus existed among the group that, for now, geometric height techniques should be used for verification of heights assigned by temperature methods.
  i. Compare MODIS and MISR heights for same targets
  ii. Compare other GEO and MISR heights for same targets

Recommendation-IWW6-3:
Satellite operators should take advantage of geometric height software tools available to validate heights of their wind products because it seems an effective tool for finding outlier height assignments.

CGMS Action 29.39: The 6th International Winds Workshop to revisit the current concepts of height allocation techniques (e.g. IR-W EBBT, WV intercept, CO_2 slicing and WV EBBT) for assigning atmospheric motion vectors to a single level height and to provide relevant results to CGMS satellite operators.

WG 1 discussed that in theory the multi-spectral height assignments allocate a vector to a specific height. Pertinent questions are: What does it represent (e.g. cloud top)? Is this the optimum choice? What other information might be provided to the NWP community on vector heights?

Recommendation-IWW6-4:
In response to CGMS Action 29.39 on current concepts of height assignment WG I stated and recommended:
- Satellite operators need to do more work in quantifying and characterizing height assignment errors (relative to radiosondes, geometric heights, level of best fit, etc) for the various height assignment methods and passing this information onto NWP users; confidence indicator for height assignment.
- For NWP: Let NWP users find level of best fit; satellite operators should ensure that pertinent tracer information (temperature, unadjusted best estimate of height & speed) is made available.
- For other users applications: Satellite operators should find level of best fit (adjusted best estimate of height & speed) and make best wind product available.

- IWW6 strongly supports the generation, validation, and use of new satellite wind products because there is still a need for much more information on wind, e.g.:
  - Polar cloud-drift and water vapor motion winds from MODIS, MISR, DMSP, AVHRR
  - Wind profiles from Doppler Wind Lidar (DWL)
  - 3.9um cloud-drift winds
  - Future winds from geostationary water vapour tracking (e.g. GIFTS)

It was also reminded that the greatest impact of satellite winds is in data sparse areas even though, by definition, forecast skill scores show degradation in these situations.

Recommendation-IWW6-5:
Satellite operators are encouraged to investigate:
- New feature tracking techniques (i.e., optical flow technique).
- Impact studies involving use of different first guess information in wind processing schemes and use of higher resolution (horizontal and vertical) model data.
- Satellite operators to pursue routine rapid scan capability for generation of rapid scan winds, resources permitting because there are demonstrated benefits to nowcasting and NWP.
- Further R&D to further optimize quality indicators (RFF/QI); satellite operators should also provide derived QI with and without forecast.

Recommendation-IWW6-6:
In view of the enormous and unexpected positive impact on NWP of WV winds from MODIS, IWW6 recommends that the inclusion of water a vapor channel on VIIRS is considered and pursued.

3.2 IWW6 Working Group II: Mesoscale Applications

3.2.1 Introduction

A Working Group on Mesoscale Applications (WG II) was convened for the first time within the framework of an International Winds Workshops (IWW). The growing importance of the topic compelled IWW6 to form this working group.

WG II considered the time and spatial scales of the relevant atmospheric phenomena and concluded that observations at intervals from 5 to 10 minutes with a spatial resolution better than 50 km could be considered mesoscale. It was noted that these requirements are not currently met by satellite observations and a better name for the WG would be 'Satellite wind estimation in support of mesoscale research studies and operational applications'. WG II also noted that broader participation from the mesoscale modelling community is imperative at future IWW. As a way forward, WG II attempted a synopsis of current applications that could help in selecting the relevant topics and lead to focussed discussions at future workshops.

3.2.2 Use of Wind Retrievals in Support of Nowcasting

It was reported that 'Automatic satellite image interpretation' is being developed by the Satellite Application Facility for Nowcasting and Short-term forecasting. Satellite derived displacement vectors are used to forecast the migration of weather phenomena using displacement vectors derived from successive satellite imagery. Along the same lines it was stated that an 'Auto-nowcaster' is being developed in the US, that utilises fuzzy logic and statistics to forecast convection and merges radar and satellite information. These initiatives were welcomed by WG II as it is clear that automatic methods need to be developed to help forecasters to 'digest' the wealth of multi-spectral information with high temporal resolution from current and future (geostationary) satellites. Innovative derived product images that condense the relevant information were considered to be a good means toward this goal.

Progress in deriving high density wind vectors for high resolution models was noted. In concurrence with a recommendation from WG I, WG II requested satellite operators to foster the use of 3.9µm channels during night and solar channels during day-time for the derivation of high-density low-level wind fields. It was suggested that estimations of cloud optical depth could be used as correlative information to cloud top height in order to infer information on the volume displacement of mid- and high-level AMVs; this was understood to be a potential contribution to the recurrent problem that displacement vectors usually represent a volume mean wind.

Two papers presented at IWW6 that analysed mesoscale systems (Rabin, Mecikalski) lead WG II to conclude that VIS and IR channels should be used in addition to the WV channels to resolve features at smaller scales and thus obtain a more complete picture of upper level divergence in mesoscale systems. The missing multi-level analyses could possibly be obtained from future high spectral resolution instruments (e.g. GIFTS) providing wind profiles from water vapor retrievals and lidar measurements (although polar orbiting lidar are compromised by infrequent measurements).

3.2.3 Short-term Forecast Quality Checking and Model Validation

Forecasters often inspect short-term forecasts in order to assess whether a longer range forecast is credible. One approach is to compare the analysis or earlier forecast fields with simultaneous observations. It was reported that high resolution wind products from GOES over the Pacific have been useful for that purpose. WG II encouraged production of such high density wind fields by all satellite operators and combination with other observations can be used as an independent test whether the analysis is ok and the forecast model is starting out well.
As models often do not retain the smaller scale circulation apparent in the satellite derived wind fields, it was suggested that models and analyses with higher resolution are needed before these small scale features can be utilised.

3.2.4 Rapid Scans

Utility of rapid scans has been demonstrated in many research studies and is corroborated by current operational applications. As an early example of an operational application, rapid scan (15 min instead of 30 min) from GMS in support of Typhoon track forecasting was cited. Recent field experiments (NORPEX, THORPEX, PACJET, CAMEX, ALPEX) have also documented the positive impact of rapid scan measurements. As the principal objective of those experiments is to support small scale studies, rapid scan data provide an excellent basis for the derivation of high resolution wind fields. Research experiments have clearly demonstrated that a 15 minute repeat cycle improves wind field derivation when compared to those from a 30 minute repeat cycle. It is expected that models already making good use of high density wind fields from 30 minute imaging cycles will further benefit from wind fields derived from rapid scans. WG II noted the operational rapid scan service established with Meteosat-6, that was initially prompted by a dedicated support ALPEX and then attained operational status after demand from satellite data users. Finally it was recognised that high density wind fields have proven to be very beneficial in supporting forecasts of severe rainfall and severe convective storms over China.

In view of the very successful developments in the area of rapid scans WG II formulated the following recommendations:

Recommendation-IWW6-7: Satellite operators are encouraged to provide rapid scan services operationally as they provide a basis for observing rapidly developing systems in real-time and for high quality wind fields. As it is recognised that rapid scan services are at variance with full disk imaging it is recommended that spare or back-up satellites be utilized for that purpose. It is also recommended that the area covered by rapid scans should be programmable, in particular when research studies request dedicated scan patterns for a certain period of time.

Recommendation-IWW6-8: Satellite operators should establish adequate means to effectively disseminate rapid scan data to all users.

It was noted that the continuous nature of high resolution AMVs allows them to provide important information for mesoscale analysis and initialisation. The efficient use of AMV data at non-synoptic times requires continued emphasis on the development of mesoscale data assimilation techniques. A pertinent recommendation with a view to IWW7 was formulated:

Recommendation-IWW6-9: Co-chairs of IWW7 should invite representatives from the mesoscale data assimilation community to IWW7 in order to focus on the needs for assimilating high resolution winds from rapid scans.

3.2.5 Research on (Tropical) Deep Convective Systems

Rapid scans and associated high-resolution wind fields from satellites can potentially benefit research on deep convective systems. It has been shown that these wind fields have sufficient accuracy to enable estimation of upper level divergence fields. Studies on deep convective systems show promise for better understanding of processes (moistening of the tropical upper tropopsphere, water vapor transport, impact on regional radiation budget, …) and are pertinent to an improved understanding of climate relevant processes. Comprehensive and consistent satellite observations of tropical cloud systems, the cloud parameters, divergence, water vapor outflow and subsequent transport from the tropics into the subtropics would provide compelling tests for climate models and hence benefit climate analysis and prediction.
Therefore WG II encouraged research studies on rapidly changing tropical convective systems with a goal to improve understanding of the moistening of the upper troposphere and the pertinent water vapour transport into the subtropics.
Concerning the upper level divergence fields it was felt that those divergence fields, solely derived from satellite derived winds, provide a useful comparison for numerical models.

As a final issue, WG II discussed user response to the analysis of storm systems in “storm-relative coordinates” (i.e. the mean translation of convective system is subtracted from animated images such that the secondary circulation is discernable). WG II felt that there was considerable merit in storm-relative-motion analysis, noted the existence of this tool in current software packages distributed for training (RAMSDIS), and requested a report on user response to this software package. Therefore WG II recommended.

Recommendation-IWW6-10: CGMS to request all members to report on their use of software for the analysis of storm systems in a ‘storm-relative’ mode.

3.3 IWW6 Working Group III: Verification

3.3.1 Spatial Resolution and Image Repeat Cycle (CGMS Action 29.36 and 29.37)

The CGMS action 29.36 requested: The 6th International Winds Workshop to discuss the compatibility of spatial resolution and image repeat cycle for winds tracking and to provide pertinent recommendations to CGMS satellite operators.

At issue is the fact that the optimum repeat cycle and scale of feature are not mutually independent for the derivation of AMVs.

As the CGMS action 29.37 requested: The International Winds Workshop to discuss the template size for tracking features in relation to the question whether the displacement vector represents a local wind vector. A pertinent recommendation should be provided to CGMS satellite operators.

It was the view of WG III that these two actions are related from the tracking and quality point of view and therefore it was decided two discuss them together.

Recent work by e.g. C. Velden but also by A. de Smet show that even though the issues are indeed important it is not easy to find one general solution for each and every satellite operator. The selection of the most appropriate spatial resolution, image repeat cycle and template size should be done in close co-operation with the users to meet their requirements. Noting that height assignment is currently the major single source of errors (and also horizontally correlated errors as shown by N. Bormann) WG III therefore encourages the data producers and users to closely co-operate on the issues in question. WG III recommends:

Recommendation-IWW6-11: A full characterisation of all AMV related errors should be performed, i.e. for every operationally used combination of image frequency, spatial resolution and template size, the errors should be characterised. Further research on scales of representativeness and correlated errors to be performed including detailed analysis on bias corrections.

3.3.2 Validation and Verification of Height Assignment (CGMS Action 29.38)

The CGMS Action 29.38 requested: The 6th International Winds Workshop to discuss and encourage the use of geometric (and other) height allocation methods for comparison with and validation of multi-spectral infrared height assignment methods of wind vectors which are used operationally.

Several presentations and the 6th IWWS considered the issues in question and showed the great potential of alternative methods for the verification and validation of multi-spectral height assignment methods. The WGIII therefore recommends that:

Recommendation-IWW6-12: Satellite operators/data providers to consider implementation of stereo height methods (semi) operationally for validation.

3.3.3 Height Assignment (CGMS Action 29.39)

The **CGMS Action 29.39** requested: The 6th International Winds Workshop to revisit the current concepts of height allocation techniques (e.g. IR-W EBBT, WV intercept, CO_2 slicing and WV EBBT) for assigning atmospheric motion vectors to a single level height and to provide relevant results to CGMS satellite operators.

The WG III concluded after lengthy discussion that height assignment remains the single largest source of error for the AMVs and in order to solve the problems further research is required. Specific issues to consider are to characterise the vertical representativness of the AMVs, the use of AMVs from cloudy targets as layer means, develop quality indicators for height assignment and to improve verification and validation activities. The use of simulated imagery for these purposes was seen as one promising way forward. Therefore the WGIII re-emphasised the importance of recommendations for CGMS Action 29.38 and further recommended that:

Recommendation-IWW6-13: Further research should be performed to characterise vertical representativeness of the AMVs and how the data is used in NWP. This should also consider layer averaging/representation for validation purposes.

Recommendation-IWW6-14: Data producers to incorporate information on height assignment reliability in BUFR.

3.3.4 Quality Indicators (CGMS Action 29.40)

The CGMS Action 29.40 requested: The 6th International Winds Workshop to analyse the status of the implementation of quality indicators assigned to wind vectors and to report back to CGMS on current benefit to NWP.

This issue was to a large extent covered by the paper presented at this Workshop by Holmlund (2002). The WG III noted that the derivation and use of quality indicators has advanced greatly since the last winds workshop and that this information is now successfully used within NWP. However it as also stressed that the use of quality information is not straight forward and that specific care should be taken when this information is incorporated in NWP assimilation/data screening schemes. Additionally to the information given in the paper the WG III noted that the combined use of the QI/RFF schemes are still not common and that further research and development is required, especially with respect to quality indicators for height assignment. The WG III recommends that:

Recommendation-IWW6-15: Data producers and users to provide updated information on the status of the derivation and use of quality indicators to Eumetsat. Eumetsat will maintain this information on their WEB-site.

Recommendation-IWW6-16: The data providers (satellite operators) to further harmonise their approach to derive quality indicators.

Recommendation-IWW6-17: Data producers (satellite operators) should implement both RFF and QI methods as minimum and distribute these flags to the users.

Recent work performed at Eumetsat has shown that reprocessing of historical data is not only interesting to the users. The use of consistent processing over long periods provides the possibility to better monitor and understand the performance of not only the AMV extraction software, but also the performance of the satellite instruments. The WG III therefore further recommends:

Recommendation-IWW6-18: All data producers to consider reprocessing of winds in support of re-analysis at various centers (ECMWF, NCEP and JMA).

3.3.5 Monitoring

Additionally to the CGMS Actions, WG III discussed the following items raised during the Workshop:

The exchange of information between data providers and users is still not optimal. Cases have been reported where minor modification to the AMV extraction or distribution schemes have caused severe problems to the users. Also, through the highly advanced assimilation schemes, the users can sometimes detect problems earlier that are not obvious to the data producers and should inform the data providers accordingly (when appropriate). The WG III therefore urged data providers to inform users in advance of any changes in the AMV derivation/distribution schemes. WG III further emphasised the importance of established contact points between data providers and users and recommended that

The use of CGMS statistics to monitor the performance is currently limited due to recent developments in the derivation and distribution of wind data. E.g. data is now distributed with quality indicators that are used to filter a certain, currently arbitrarily selected level. WG III therefore recommends:

Recommendation-IWW6-19: Data providers (satellite operators) and users to reconsider the current format of the CGMS statistics in view of recent advances.

4 Conclusions

As a summary recommendations from IWW 6 are repeated below in order to facilitate pertinent discussions at CGMS 30. In view of the large number of recommendations the CGMS rapporteur on ‘Satellite derived winds’ has made an effort to group similar recommendations and assign a preliminary priority, leaving the final judge to the discussions at CGMS 30.

4.1 Recommendations

4.1.1 Recommendations on Operational Matters

Recommendation-IWW6-4:
In response to CGMS Action 29.39 on current concepts of height assignment WG I stated and recommended:

- Satellite operators need to do more work in quantifying and characterizing height assignment errors (relative to radiosondes, geometric heights, level of best fit, etc) for the various height assignment methods and passing this information onto NWP users; confidence indicator for height assignment.
- For NWP: Let NWP users find level of best fit; satellite operators should ensure that pertinent tracer information (temperature, unadjusted best estimate of height & speed) is made available.
- For other users applications: Satellite operators should find level of best fit (adjusted best

estimate of height & speed) and make best wind product available.

- IWW6 strongly supports the generation, validation, and use of new satellite wind products because there is still a need for much more information on wind, e.g.:
  - Polar cloud-drift and water vapor motion winds from MODIS, MISR, DMSP, AVHRR
  - Wind profiles from Doppler Wind Lidar (DWL)
  - 3.9um cloud-drift winds
  - Future winds from geostationary water vapour tracking (e.g. GIFTS)

Recommendation-IWW6-7: Satellite operators are encouraged to provide rapid scan services operationally as they provide a basis for observing rapidly developing systems in real-time and for high quality wind fields. As it is recognised that rapid scan services are at variance with full disk imaging it is recommended that spare or back-up satellites be utilized for that purpose. It is also recommended that the area covered by rapid scans should be programmable, in particular when research studies request dedicated scan patterns for a certain period of time.

Recommendation-IWW6-8: Satellite operators should establish adequate means to effectively disseminate rapid scan data to all users.

Recommendation-IWW6-12: Satellite operators/data providers to consider implementation of stereo height methods (semi) operationally for validation.

Recommendation-IWW6-14: Data producers to incorporate information on height assignment reliability in BUFR.

Recommendation-IWW6-15: Data producers and users to provide updated information on the status of the derivation and use of quality indicators to Eumetsat. Eumetsat will maintain this information on their WEB-site.

Recommendation-IWW6-16: The data providers (satellite operators) to further harmonise their approach to derive quality indicators.

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Recommendation-IWW6-18: All data producers to consider reprocessing of winds in support of re-analysis at various centers (ECMWF, NCEP and JMA).

Recommendation-IWW6-19: Data providers (satellite operators) and users to reconsider the current format of the CGMS statistics in view of recent advances.

4.1.2 Recommendations on Research

Recommendation-IWW6-2:
Experiments should be done by satellite operators to determine optimal template size for winds tracking using rms and speed bias (satwind - raob) as benchmarks.

Recommendation-IWW6-3:
Satellite operators should take advantage of geometric height software tools available to validate heights of their wind products because it seems an effective tool for finding outlier height assignments.

Recommendation-IWW6-5:
Satellite operators are encouraged to investigate:
- New feature tracking techniques (i.e., optical flow technique).
- Impact studies involving use of different first guess information in wind processing schemes and use of higher resolution (horizontal and vertical) model data.
- Satellite operators to pursue routine rapid scan capability for generation of rapid scan winds, resources permitting because there are demonstrated benefits to nowcasting and NWP.
- Further R&D to further optimize quality indicators (RFF/QI); satellite operators should also provide derived QI with and without forecast.

Recommendation-IWW6-10: CGMS to request all members to report on their use of software for the analysis of storm systems in a 'storm-relative' mode.

Recommendation-IWW6-11: A full characterisation of all AMV related errors should be performed, i.e. for every operationally used combination of image frequency, spatial resolution and template size, the errors should be characterised. Further research on scales of representativeness and correlated errors to be performed including detailed analysis on bias corrections.

Recommendation-IWW6-13: Further research should be performed to characterise vertical representativeness of the AMVs and how the data is used in NWP. This should also consider layer averaging/representation for validation purposes.

4.1.3 Recommendations on Future Activities

Recommendation-IWW6-1:
As a general guideline based upon experience with rapid scan work done to date the following recommendation can be made concerning compatible spatial and temporal resolution for feature tracking in spectral images:

1km VIS ~ 5min
4km IR ~ 10min
4km WV ~ 30+ (for clear sky water vapour winds)

Recommendation-IWW6-6:
In view of the enormous and unexpected positive impact on NWP of WV winds from MODIS, IWW6 recommends that the inclusion of water a vapor channel on VIIRS is considered and pursued.

Recommendation-IWW6-9: Co-chairs of IWW7 should invite representatives from the mesoscale data assimilation community to IWW7 in order to focus on the needs for assimilating high resolution winds from rapid scans.