Recommendations for AMV configuration

V3, updated Apr 2022

This document has been produced to address the following CGMS HLPP target and action:

HLPP 4.2.2 Investigate the best configurations to be used by the AMV producers for use in global and regional NWP models respectively, and clearly define the appropriate requirements for each of them.

Action A46.04: NWP community to define the best configuration to be used by the AMV producers, for use in global and regional NWP models.

We include recommendations in the tables below. We don't have all the information to make firm recommendations in all cases but have highlighted some ideas for how we could explore further. With this in mind, we propose to keep this as a living document. We could aim to update based on the latest scientific information at each IWW.

Global NWP

Timeliness	Important as data later in window has most impact.
Target size and image interval	Best to generate AMVs with target size and interval which is optimal for best AMV product. NWP centres can superob data, if necessary, to resolution which is optimal for NWP. Based on recent studies this might be ~ **16x16 pixels** with **~10 min interval** (where available).
Grid size	Should **avoid overlapping targets** (to reduce correlated error). There is an open question as to whether NWP centres might benefit from maximising density after allowing for this constraint as gives flexibility to use data at higher density in regions of interest and potential to reduce random error through superobbing. However, there is a *cost/benefit trade-off: the cost of production/storage/processing of increased volumes versus the currently unknown benefit to NWP*.
Temporal frequency	Many centres assimilate data **hourly** in NWP so this seems like a sensible target, however, increased frequency can help to fill the spatial gaps. *It may be useful to have the data every half hour*, perhaps even more often. However, note caveat re cost/benefit trade-off above. May benefit from enhanced spatial/temporal products for critical events such as storms.
Derivation settings	Are there any other changes that could help to improve the spatial coverage without impacting too much on the quality of the winds? Novel optical flow retrieval is potentially one option.
Derivation information	Access to information from the derivation that might have skill for NWP quality control. This might include information on the correlation surface (for confidence in tracking) as well as information from the cloud analysis and height assignment steps. Request made for standardised cloud type to be made available.

Recommendations

- Discussion with AMV producers to better understand potential of increasing data volume (due to grid size, temporal frequency). How much extra data would we get, is this doable either now or in the future? JMA are moving to every half hour so we could evaluate impact.

- To understand the potential benefits of increased data volumes we might need to generate test data and assimilate using (i) AMV superobbing and (ii) schemes which use data at higher resolution in regions of interest.
- NWP centres (and producers) to evaluate benefit of extra derivation information provided in the BUFR for quality control and/or error setting in NWP.

Regional NWP

Timeliness	**Critical**. Some regional models cannot use data older than 50 min
Target size and image interval	Likely want higher resolution product than for global, but not clear what will be optimal. **Might be worth trying 16x16 and smaller targets** with both **10 min and 5 min intervals** (where available). May need approaches to reduce noise (averaging correlation surfaces, clustering, filtering). Produce AMVs from high resolution channels (0.5 km, 1 km).
Grid size	Ideally set grid size to avoid overlapping targets, but otherwise the more the better. TBC if density is sufficient without overlapping targets – NWC SAF / HRW could be used to explore. May want to relax this criterion.
Temporal frequency	Probably want winds produced every **10/15 min** – should help to improve the spatial coverage even if we thin or superob to one per hour due to correlated error. May benefit from enhanced spatial/temporal products for critical events such as storms. May be useful for NWP and forecasters.
Derivation settings	Are there any other changes that could help to improve the spatial coverage without impacting too much on the quality of the winds?
Derivation information	Access to information from the derivation that might have some skill for NWP quality control. This might include information on the correlation surface (for confidence in tracking) as well as information from the cloud analysis and height assignment steps. Request made for standardised cloud type to be made available. Improving the errors is likely to be particularly important for initialising the smaller scale flow.
NWP usage	A particular challenge is how to benefit from the high resolution information without hitting the system too hard due to correlated errors. We may want to consider back-and-forth nudging as well as variational approaches in NWP.

Recommendations

- Experiments to explore optimal target box size and image interval.
- Work to optimise AMV derivation from high resolution channels.
- Further exploration of approaches to quality control high resolution AMV datasets.
- Explore whether there is a need for overlapping targets to increase AMV density.
- Evaluation of optimal assimilation approaches.
- Assess if the QI is still useful, particularly for regional NWP as the spatial checks mean that it can penalise AMVs in some regions of interest. It may be that we can use other information provided in the BUFR to screen the poorer quality observations. If not, we might want to revisit if the QI should be updated.

Nowcasting and diagnostic studies

- Push boundaries of AMV retrieval, including experimentation of novel optical flow derivation methods enabled by new-generation imagers (e.g., Cross-Correlation, Variational Optical Flow, Motion Retrieval via Machine Learning)
- Evaluate height assignment and quality control options for new AMV retrieval techniques
- Investigate benefit of derived products such as cloud-top flow fields, image temporal interpolation, semi-Lagrangian property changes, and image nowcasting for operational forecasting applications and emerging technologies in objective decision making (i.e., Machine Learning)
- Consider methods for assimilation of novel AMV retrievals and applications into NWP, such as non-variational techniques e.g. field alignment to handle finer scales.