Diagnosing observation error statistics for Doppler radar radial wind and SEVIRI observations

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Aims

Diagnosing observation error statistics for Doppler radar radial wind and SEVIRI observations

Estimate observation error statistics for SEVIRI and Doppler radar radial winds assimilated into the UKV using the Desroziers Diagnostic,

Background innovation: $d_b^o = y - H(x^b)$

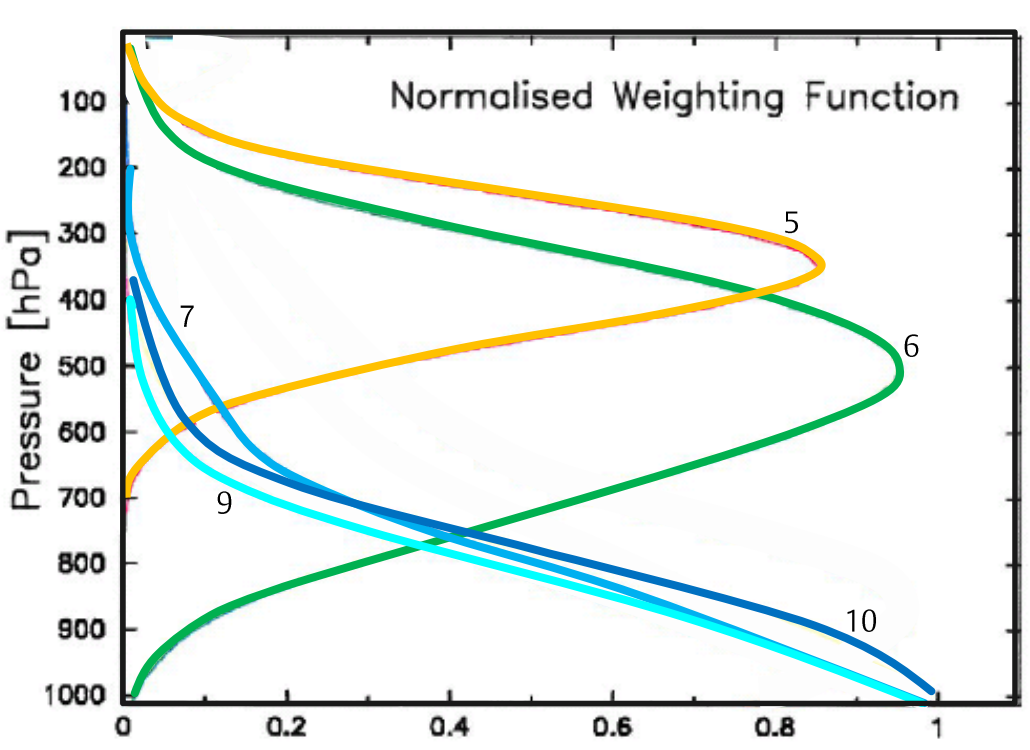
Analysis innovation: $d_a^o = y - H(x^a)$

$$\boldsymbol{R} \approx \mathrm{E}[d_a^o d_b^{oT}]$$

SEVIRI observation error statistics

SEVIRI observations for the UKV

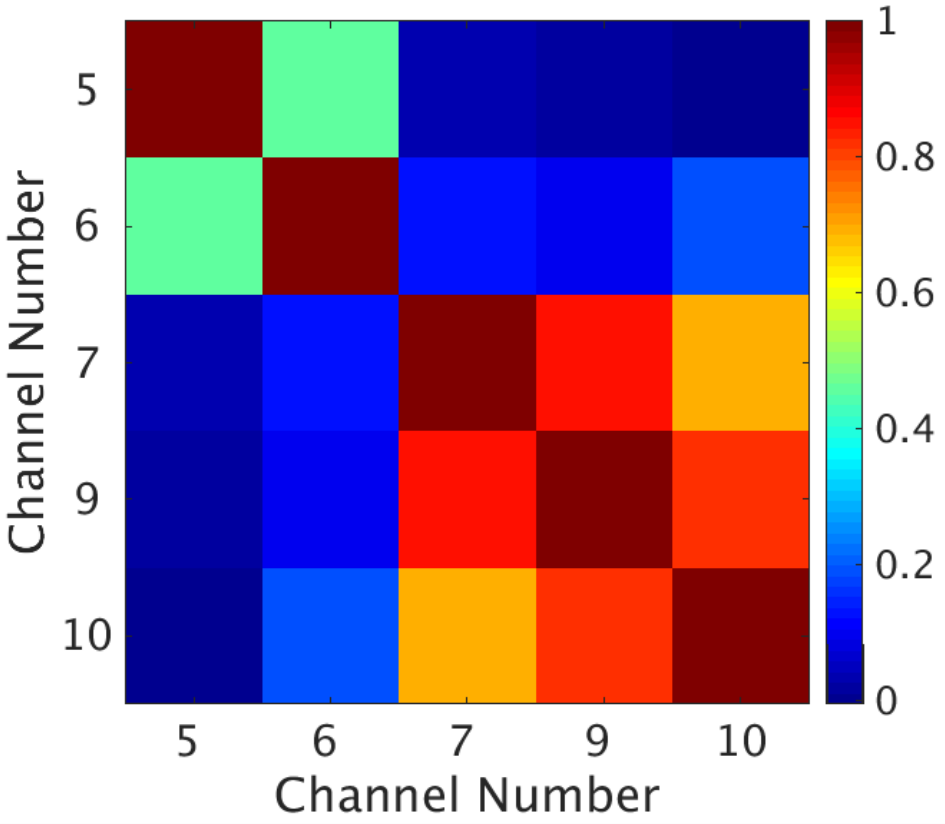
- The SEVIRI instrument on board the Meteosat Second Generation satellite produces observations of top of atmosphere radiances from 12 different spectral channels every 15 min at a 3km spatial resolution.
- Observations thinned to 24
- Simulated brightness temperatures from RTTOV model.
- Humidity channels over clear sky (channel 5 low cloud).
- Surface channels only over clear sky and ocean.



SEVIRI Inter-channel correlations

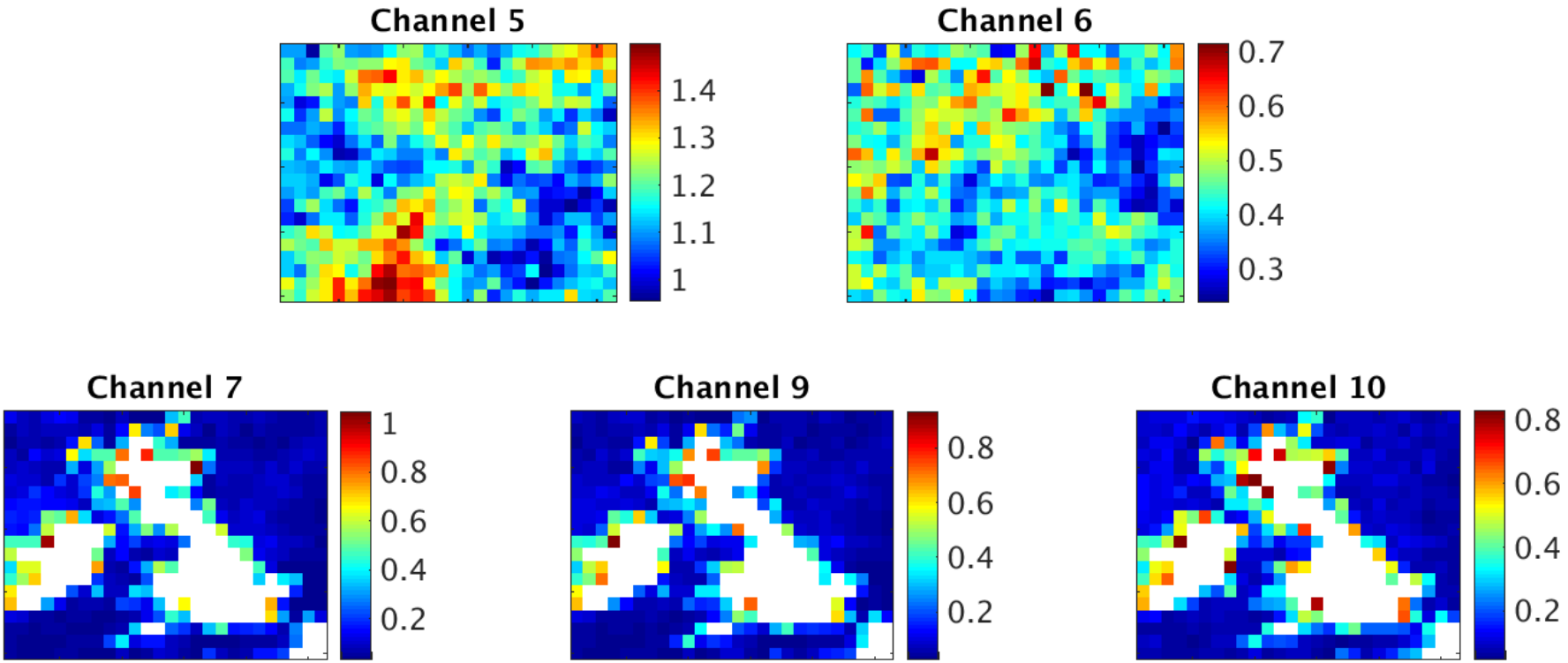
Channel	5	6	7	9	10
Operational variance	4.0	4.0	1.0	1.0	1.0
Estimated variance	1.2	0.4	0.2	0.2	0.2

- Error variances much smaller than those used operationally.
- Significant inter-channel correlation due to overlapping weighting functions.



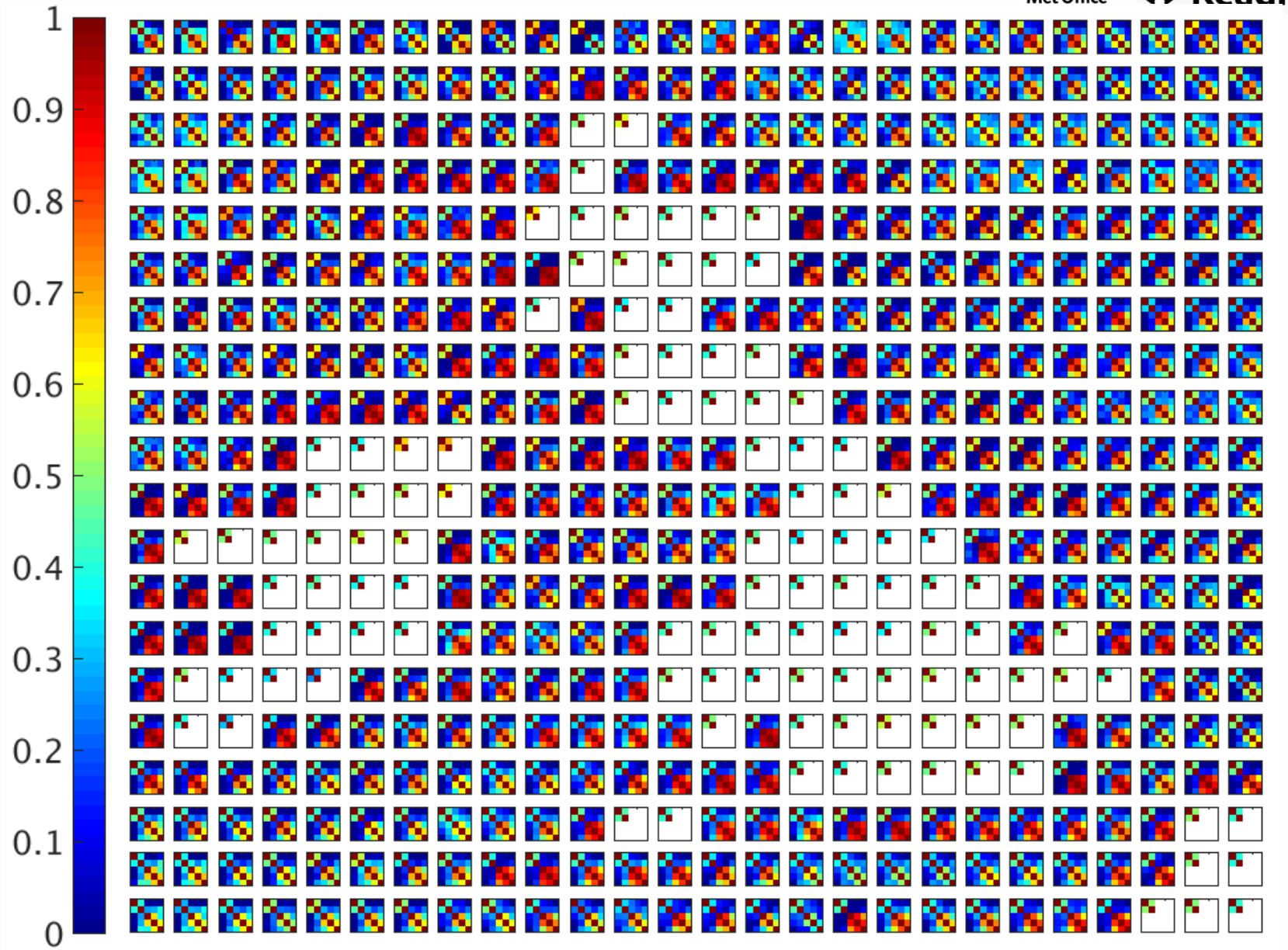
Spatial dependence - variance

- Variance varies across the domain particularly for surface channels.



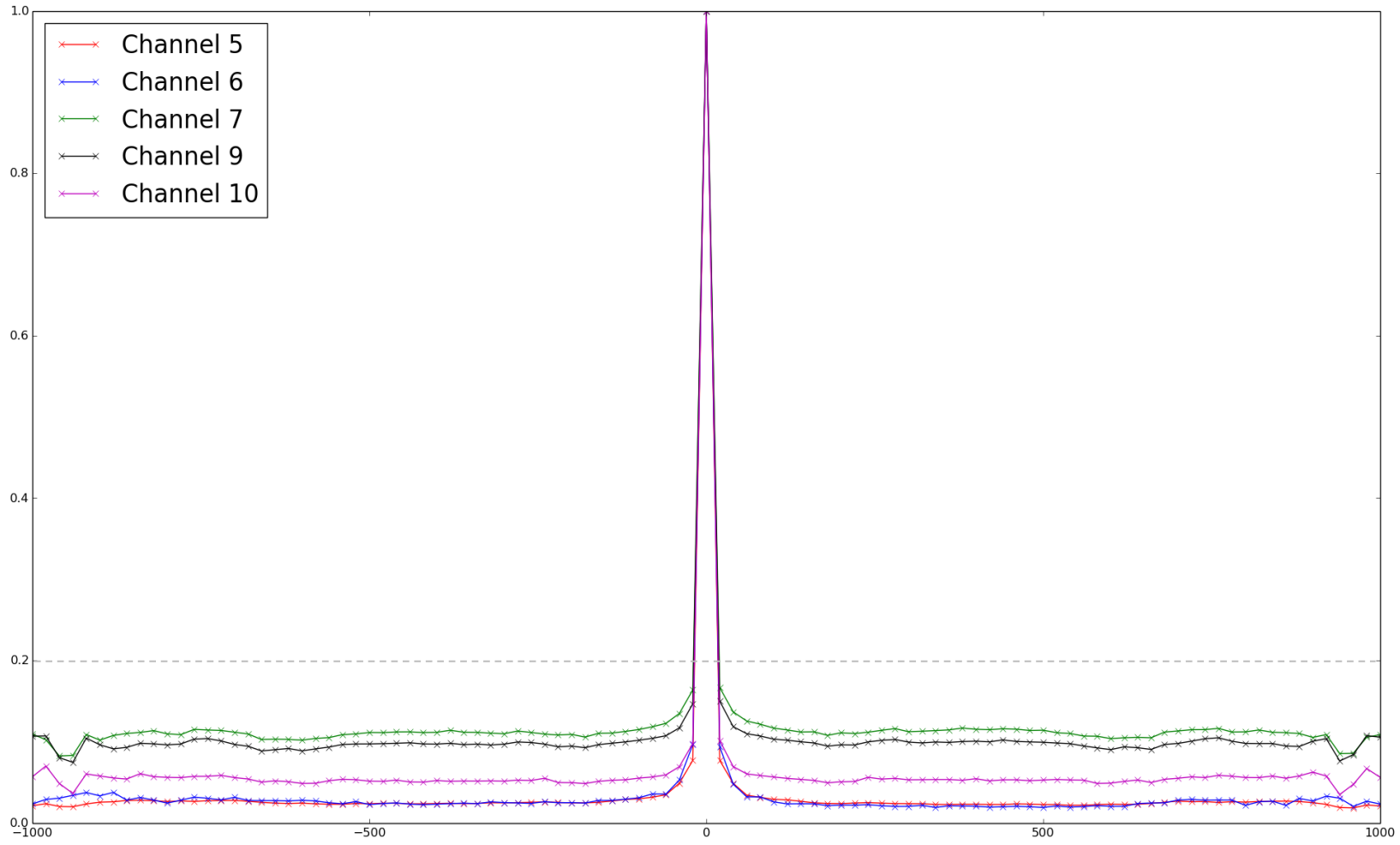
- As does surface channel correlation ….

Spatial dependence - correlation



Horizontal correlations

No significant horizontal correlation due to observation thinning.



SEVIRI Summary

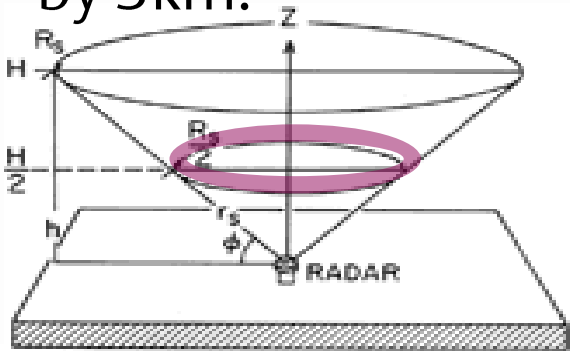
- Estimated variances are much smaller than those used operationally.
- At the operational thinning distance there is no significant horizontal correlation.
- Inter-channel correlations are significant and vary across the domain.

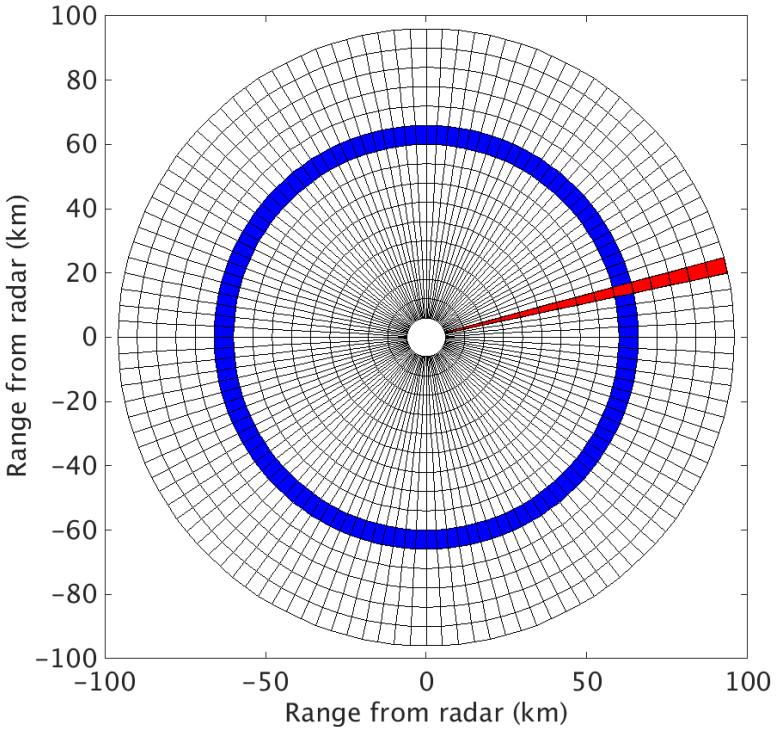
Doppler radar radial wind (DRW) observation error statistics

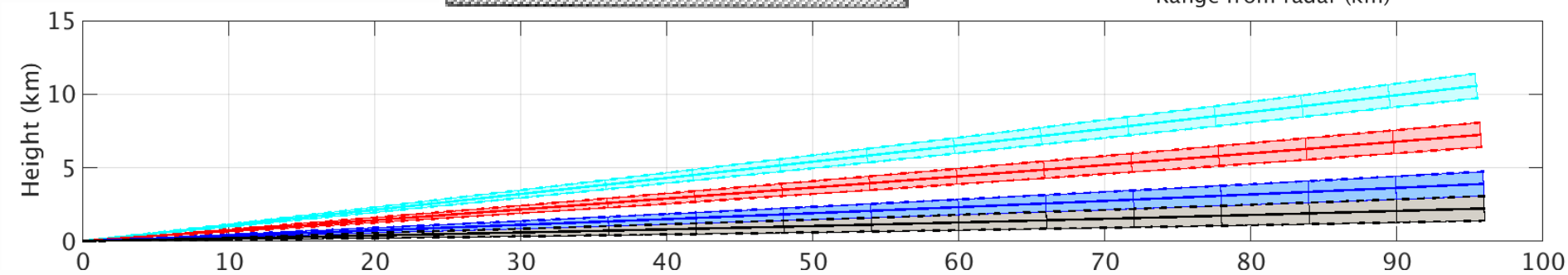
DRW observations for the UKV

Each radar beam produces observations of radial velocity out to a range of 100km with measurements taken:

- Every 75m along the beam.
- Every degree.
- At five different elevation angles.
- Superobbed to 3° by 3km.
- Thinned to 6km.

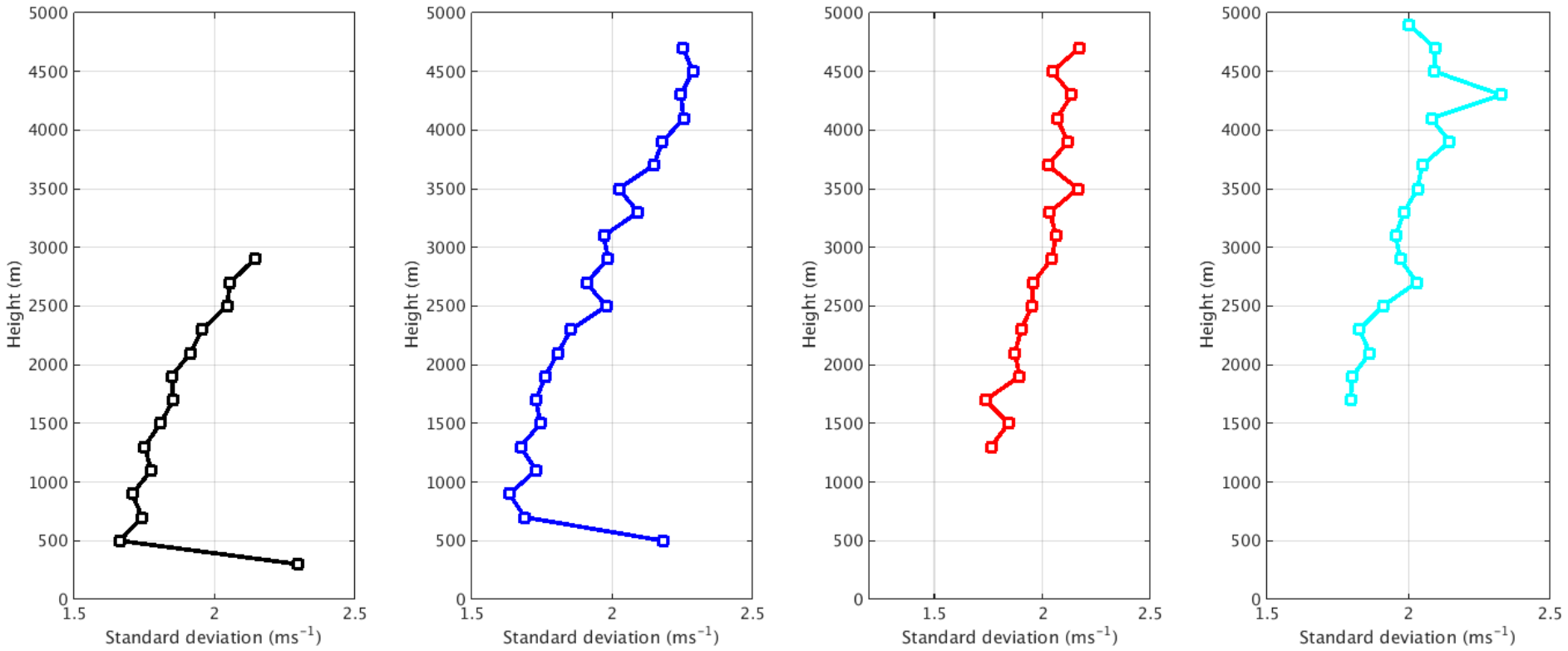




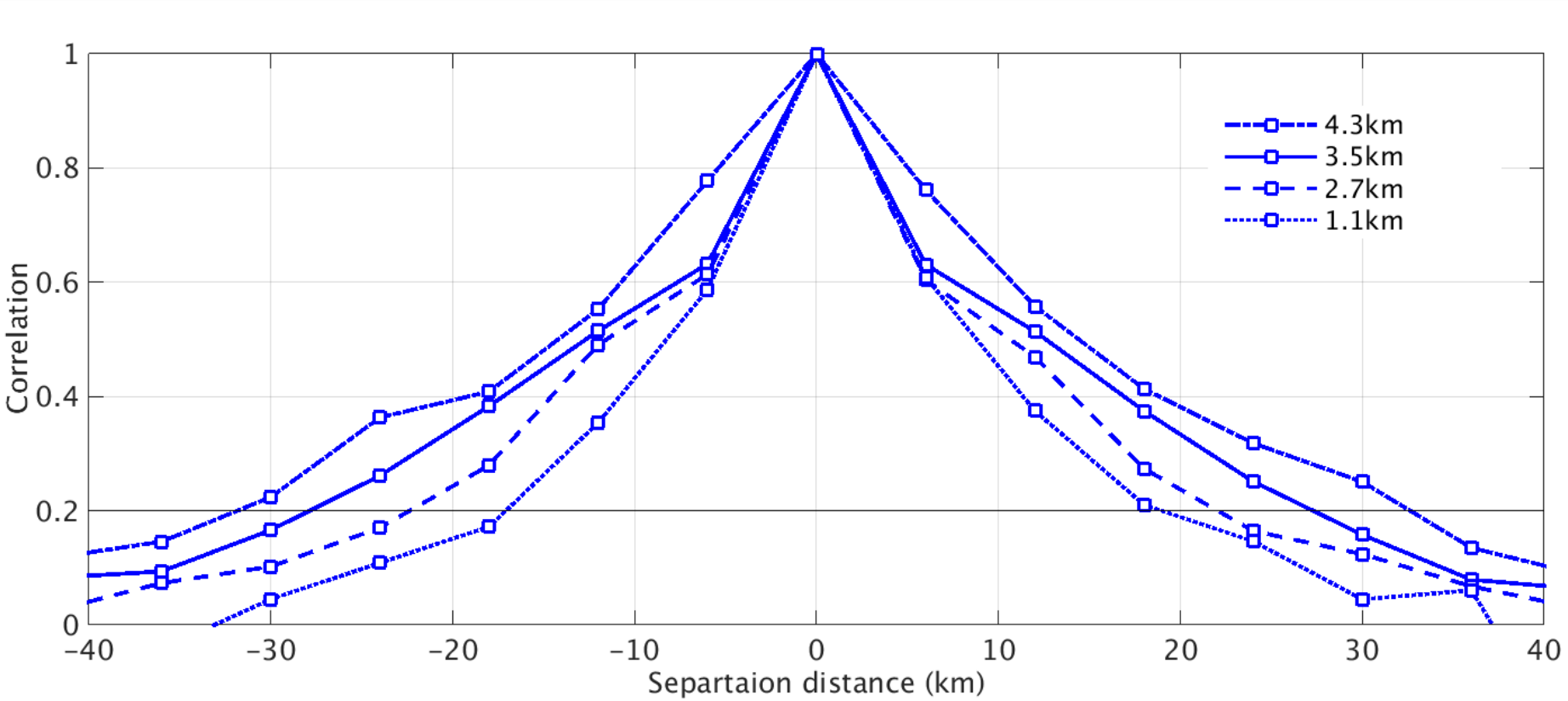


Horizontal DRW error variances

- Standard deviation increases with height due to the increasing measurement volume with height.
- The exception, larger errors at the lowest height, are likely to be a result of representativity errors.

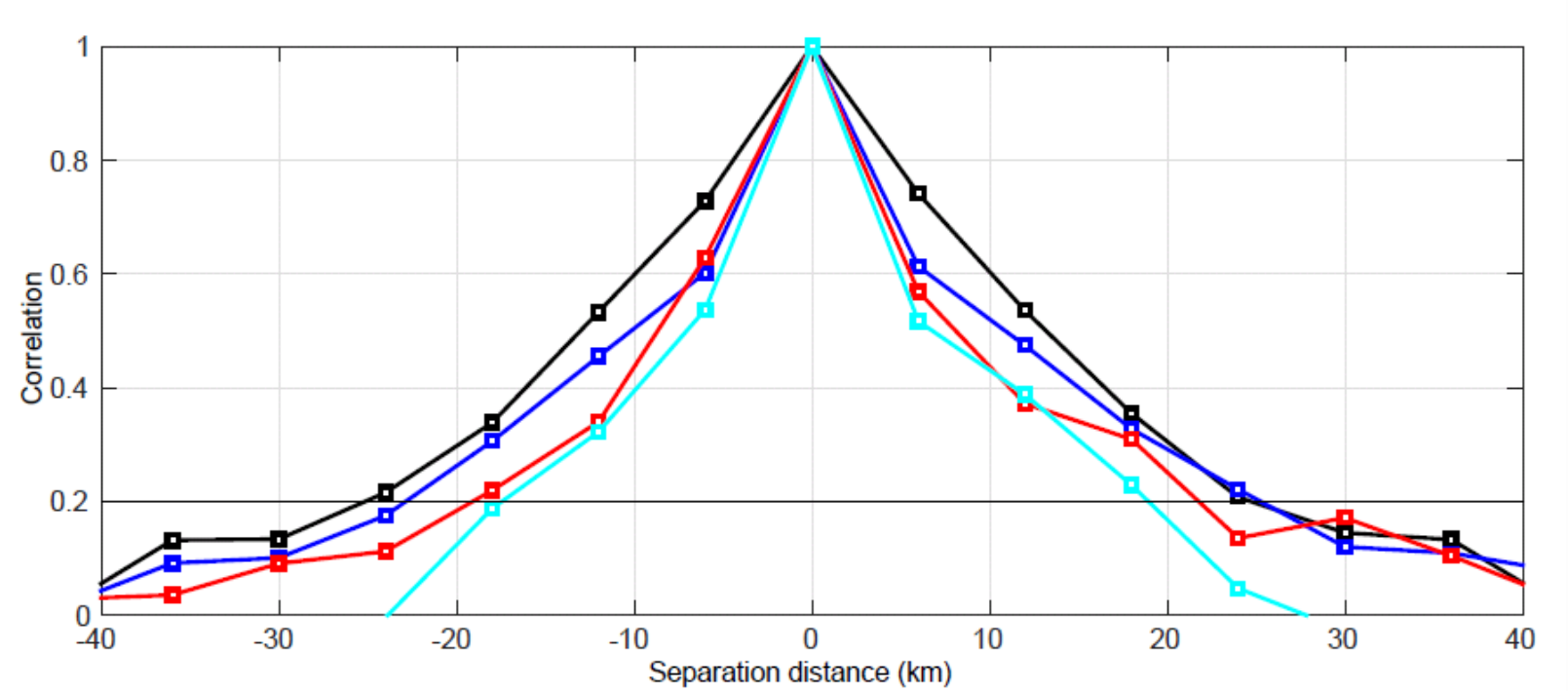


Horizontal DRW error correlation

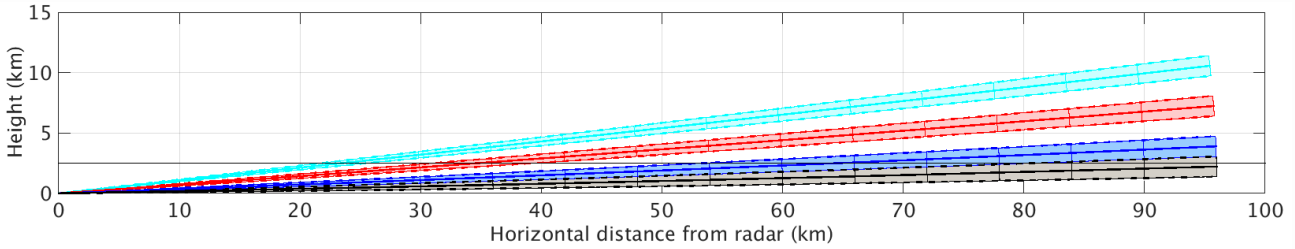


- Correlation length scale increases with height.
- Greater heights have larger errors in the observation operator.

Horizontal DRW error correlation



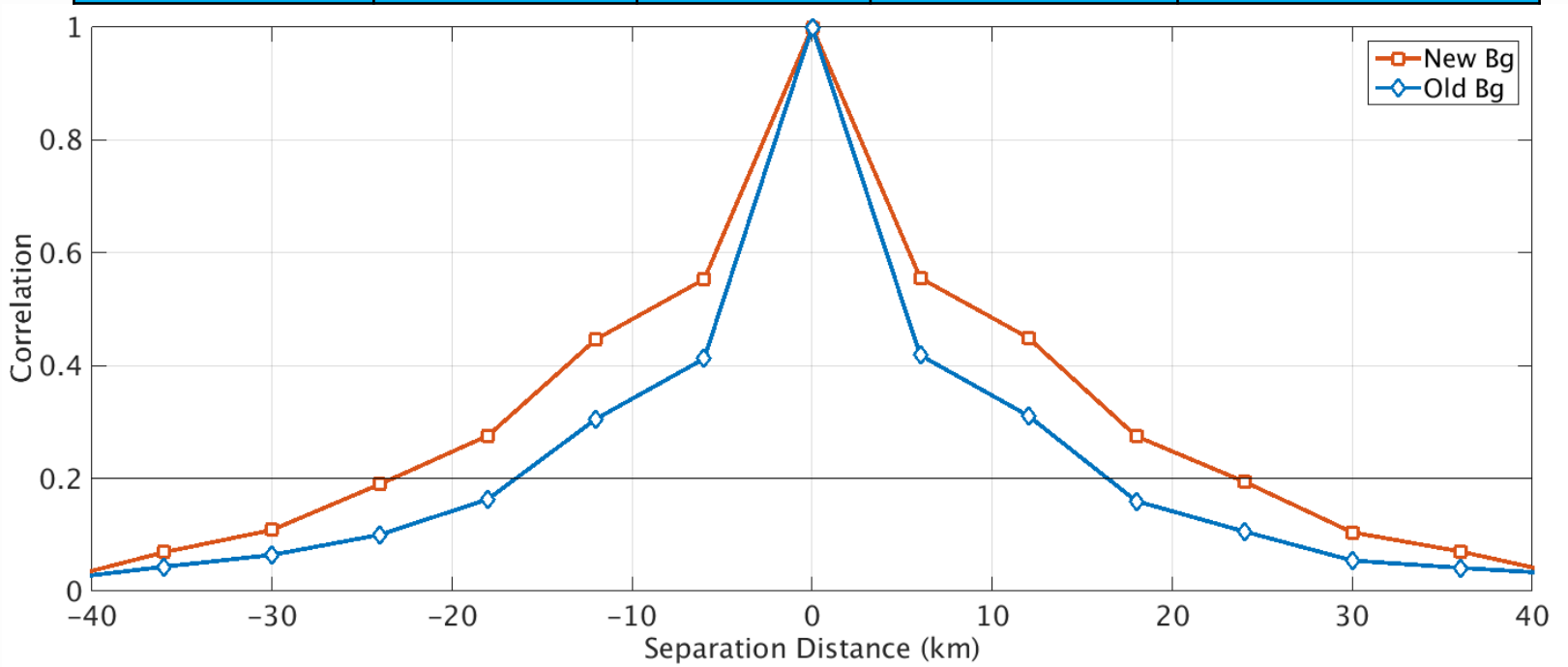
- Correlation length scale at a given height (2.5km) shorter for lower elevations.



- Lower elevations have smaller measurement volumes

Sensitivity of results to background error statistics

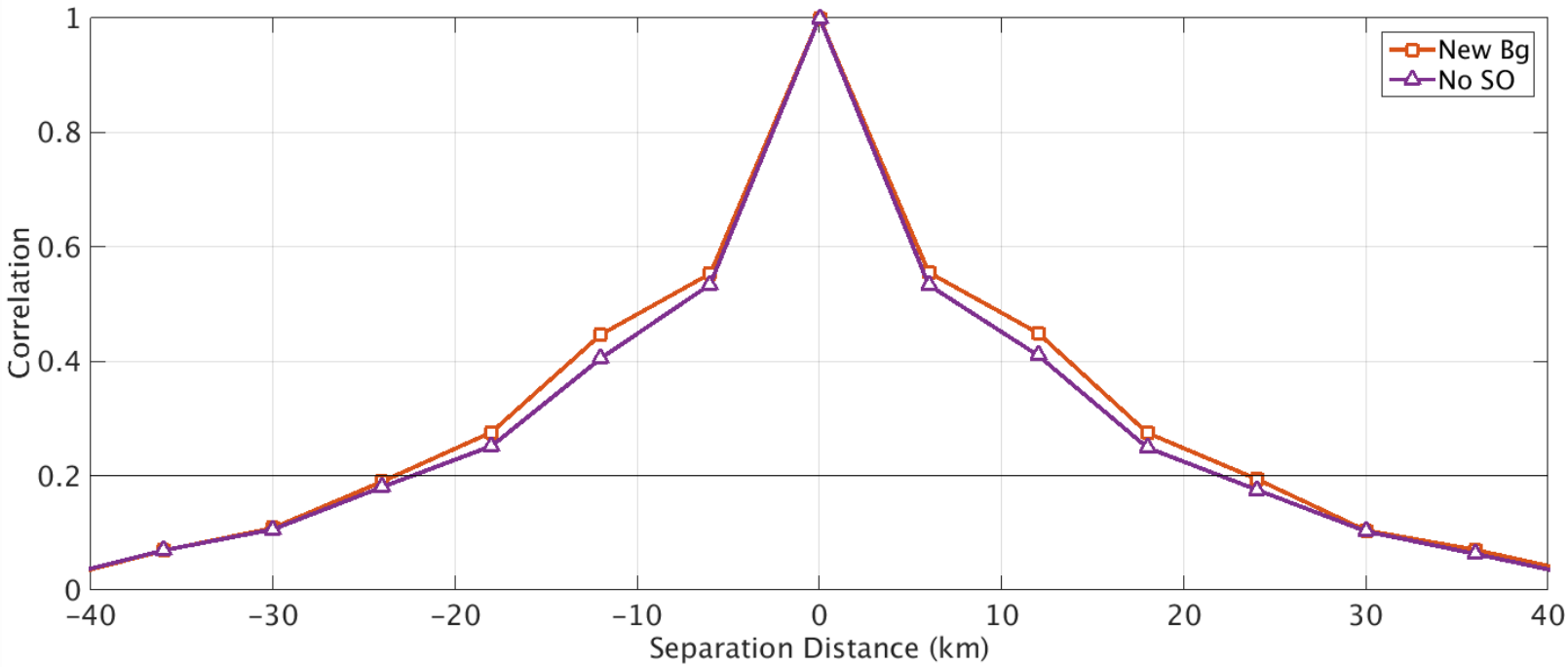
Case	B statistics	Superobs	Observation operator	Standard deviation (m/s)
New Bg	New	Yes	Old	1.97
Old Bg	Old	Yes	Old	1.57



Increasing variance and length scale in **B** reduces variance and length scale in estimated **R**.

Sensitivity of results to superobservations

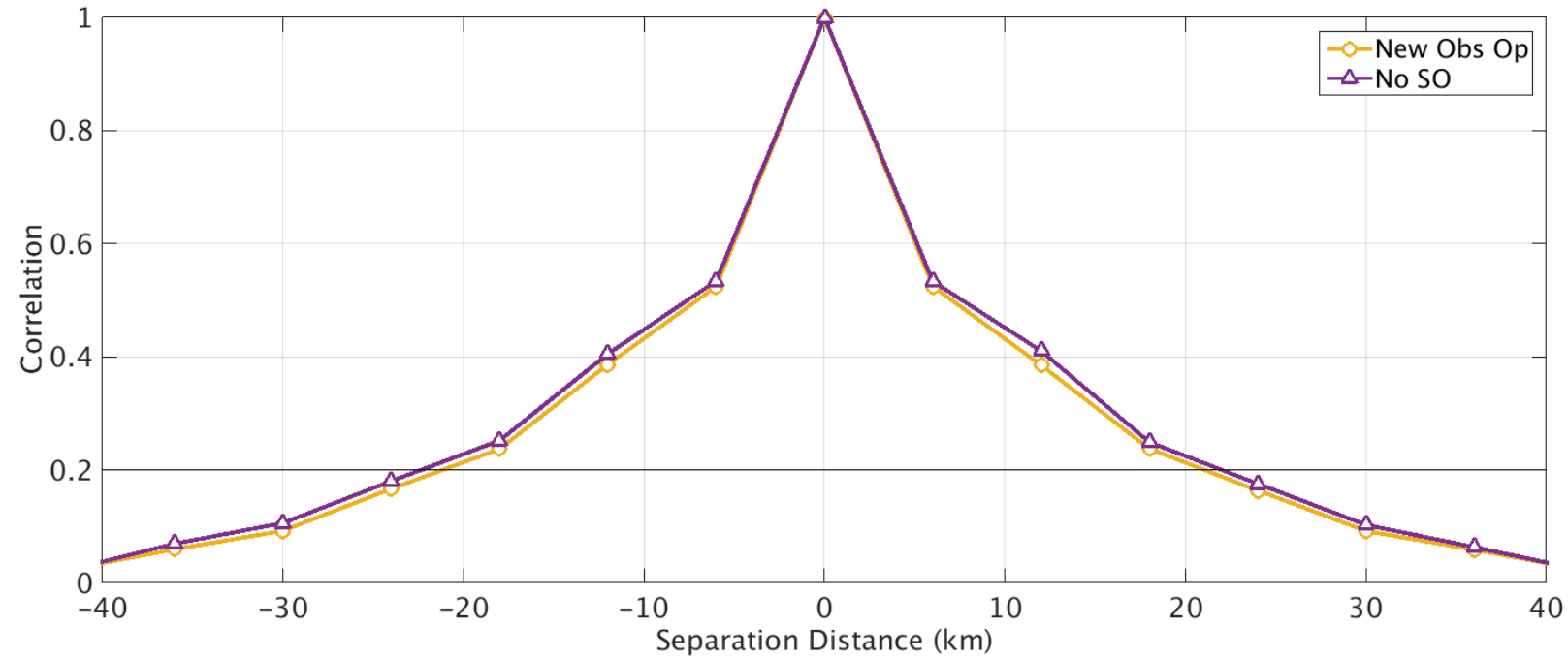
Case	B statistics	Superobs	Observation operator	Standard deviation (m/s)
New Bg	New	Yes	Old	1.97
No SO	New	No	Old	1.96



- Using thinned data slightly reduces correlation length scale.
- Larger reduction at far range where superobservations larger.

Sensitivity of results to the observation operator

Case	B statistics	Superobs	Observation operator	Standard deviation (m/s)
No SO	New	No	Old	1.96
New Obs Op	New	No	New	1.82



- Improving **H** slightly reduces variance and correlation length scale.
- Larger reduction at far range where improved **H** has most impact .

DRW Summary

- Estimated variances for operational case are similar to the operational values.
- Variances increase with height, with the exception of the lowest levels.
- Correlation length scale much lager than thinning distance.
- Correlation length scale increases with height and with elevation angle.
- Some correlation caused by use of superobservations and simplified observation operator.

Conclusions

Observation error statistics

- The diagnostic can provide useful information on observation error statistics.
- Results showing uncorrelated errors may allow thinning distances to be reduced – a simple way to make better use of the data.
- Reducing correlated observation errors may be a possibility if results can provide information on the source of error.
- Some correlated error is being neglected in operational assimilation. Either observations must be thinned further or the correlated errors must be accounted for.