WG4: Random errors

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Overview

- This meeting was hugely interesting and beneficial!
- We all agree that we need to better understand observation uncertainties.
- We should continue to collaborate and share are progress and ideas on a regular basis.

- Top priorities:
  - Situation dependence
  - Horizontal correlations
  - Understanding our tools.

What tools do we have to estimate observation errors and how well

- We have a variety of methods, but no one covers all our needs.
- Complex methods (e.g. metrological approach) provide great insight into error sources, but are time consuming we may not be able to use full estimates in assimilation.
- Desrozirers is easy to use but very approximate. It is not going to disappear! Therefore better theoretical understanding would be good:
  - Does forward model error end up in R or HBH^T
  - What do we know about sampling error
- We should use more than one method for estimation and compare to give confidence in our estimates.
- We should routinely monitor our uncertainties using Desroziers, but use other methods intermittently to sanity check our routine estimates.
- How do we determine what level of sophistication is needed?

What is the status of accounting for inter-channel observation error correlations?

- Vast majority are using inter channel correlated error for IR (hyperspectral, geo), less so for other observation types.
- Discussion on why does all-sky work well using a diagonal R. **Understanding this is a priority.**
  - Will include testing correlation in all-sky.
  - Is it simply because variances are high?

What is the status of accounting for spatial observation error correlations?

- Only Met Office radar are operationally assimilated with horizontal error correlations.
- In general we would like to use these uncertainties, but we do not have the technology/algorithms in place.
- There is work on possible methodologies, and it likely that we will need to use different methods for different observation types.
- Can we assess the relative importance of for inter-channel and spatial correlations or do we need to account for them simultaneously, if so how?
- Different systems may see different benefit from using spatial correlations.
- Can we learn from the modelling of B.
- There is emerging benefit from accounting for horizontal correlations. It is likely that the benefit will need to be proved in convective scale NWP before global/medium range systems see this as a priority.

Situation-dependence of observation errors

- Considered most important area to develop
- All-sky systems already use situation dependent variances, using cloud predictors and situation dependent correlations have been tested
- Variances also tuned using 1D-Var outputs
- Discussion on flow dependence vs situation dependence (e.g seasonal variation)
- Challenges are very specific to observation types, so its hard to compare experiences

Discussion on use of observation errors in deterministic analysis, 1D-Var, Ensemble initialisation

- Already some differences in use of R in different systems
- Judgement is this isn't an issue
- No strong view from the group

Pre-conditioning aspects, convergence issues

- Conventional wisdom is adding correlations makes convergence worse – but this is not always case
- Discussion on interpretation of small eigenvalues (physical, mathematical)
  - Are they trustworthy if no physical understanding?
- View is both eigenvalue floor and ridge regression methods work well in an operational context
  - interesting to study further, not an operational priority.

Coupled data assimilation/Earth System assimilation: What may become more important for observation error specification?

- R that works for coupled may not be optimal representation in coupled DA framework (resolution requirement may change, making spatial correlation more important to address)
- Recognised as an interesting topic, but not a priority

What role can we see for machine learning approaches and observation error specification?

- For random error no obvious role
- However possible use could be studied for observations with little or no meta data
- General sceptical view of usefulness in this area

Where do we see further scope for improving observation error specifications?

- Independence of background and observation errors – can this assumption be relaxed, or what is the impact of errors in this assumption?
  - Could be studied using simplified models (maybe with OOPS)
  - But a low priority
- Temporal errors?
  - Geo radiances work has shown going down to 20m showed benefit without treating temporal correlation, but down to 10m issues occurred (solved through inflation)
  - Priority in this area seems lower than situation dependent and spatial correlation error modelling
- Are correlated errors more important for very accurate observations? Is this true? Link to all-sky, reconstructed radiances. Worth studying this question.