WGs on the treatment of biases (WG2)

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- How well can we separate biases arising from (1) biases in the observations and/or forward models and (2) biases in the NWP model?
  - Are present anchor observations sufficient?

Noted that there is a system (model) dependency.

Requirements for anchor observations: uncertainty characterisation, stability, sensitivity to geophysical parameter in question.

Recommend exploring use of hyperspectral IR instruments as anchor measurements; use of realistic CO2 profile, recent developments in RT mean that biases can be greatly reduced (small compared with assumed observation errors).

Can intercalibrate geostationary radiances with IASI and CrIS, need to know targets for uncertainty and stability (application dependent)

Feed uncertainty estimates (e.g. Fiduceo) into constrained VarBC?

Recommend investigating biases in forward models (line-by-line) separately from forecast model. Use of good in situ data e.g. GRUAN in comparison with well calibrated observations.

- What is the role of further constraints, such as bias models in VarBC, model error covariance statistics, implicit constraints from parameter estimation? What can we do to specify these better?

We make assumption about the form of observation bias/form of model bias.

Recommend investigating correlations between observation biases and model error term in observation space.

Note that bias correction framework dates back many years and it may be timely to revise form of bias predictors. Airmass predictors were devised at a time when forward model and instrument errors were larger.
Recommendation: Reassess role of airmass/other predictors in modern systems.

- Further challenges in coupled Earth System Assimilation systems?

How do we bias correct observations that are dependent on both atmosphere and ocean in coupled models?

- Estimation of model bias (either during the assimilation or through increment analyses etc):
  - What techniques look most promising? E.g., model parameter estimation or model tendency correction? Are they mutually exclusive?

We need a strong interaction with modellers to make sure model developments are collaborative. Contact developers to find out which biases should be investigated as a priority.

  - What can we learn from the corrections for model development?

Some parameters could be improved or constrained using DA techniques.

- Should we apply the model bias corrections derived in the assimilation during the subsequent forecast?

Recommendation: test weak constraint and parameter estimation in forecast mode.

- What are the tools available to diagnose model biases over different timescales (e.g. assimilation window, medium-range, seasonal)? How can we estimate higher-order statistics of the model error (e.g. covariance)?

Use of high quality monthly means and higher order statistics from e.g. GPSRO.

- Estimation of observation/observation operator bias:
  - What can we learn from bias corrections about addressing biases at source?

Analysis of bias statistics from NWP or GSICS in support of root cause analysis allowing biases to be corrected at source.

Aeolus is a good example of addressing bias root cause.

Forward model biases caused by spectroscopy, keep up to date with latest state-of-the-art radiative transfer in order to minimise biases.

- What independent estimates of observation bias do we have? Are we making full use of them?

Error budgets prelaunch, intercalibration during mission lifetime (GSICS). Fiduceo.

- Changes in observation system coverage in climate reanalyses affect trend estimates. How can we mitigate this?

Reanalysis performance with different observing systems – benchmark period? Withhold subset of very high quality observations for validation.

- Do we need different bias constraints for reanalysis?

Depends whether we are aiming for best analysis or aiming for best forecast. More aggressive use of anchor measurements in reanalysis? Constrained VarBC with error budget may be higher priority for reanalysis.

- Is there anything more that could be done to accelerate progress (towards a bias free-world!) - through ways of exchanging information, coordination, prioritisation ... ?

Recommend GSICS-NWP dialogue, systematic data exchange mechanism (biases and alerts).

SRFs uncertainties in spectral space, need to map into observation error budget, e.g. though use of RTMs.

Alerts (outages, drifts, when data is blacklisted) information can flow both ways.

- Are there future challenges (e.g. the evolving satellite observing system, the move to Earth System Models and DA, …) that present particular challenges?

Small sats with short lifetime, need for quick feedback.

Shortwave-only polar satellites, many issues with bias correction (non-LTE, solar radiation).