Estimation and assessment of uncertainties in climate reanalyses produced by ERA-CLIM2

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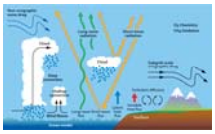
ERA CLIM 2

ERA-CLIM2 aims to reconstruct the past weather/climate

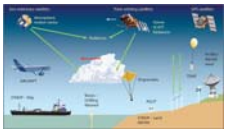
Reanalysis method based on the key elements developed for NWP at ECMWF

Model



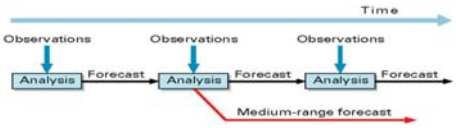
Earth system model

Observations



International databanks (data rescue activities)

Data assimilation scheme



observations are ingested in the model to reconstruct the climate

CERA-20C: a coupled reanalysis of the 20th century

Atmosphere

Land

Wave

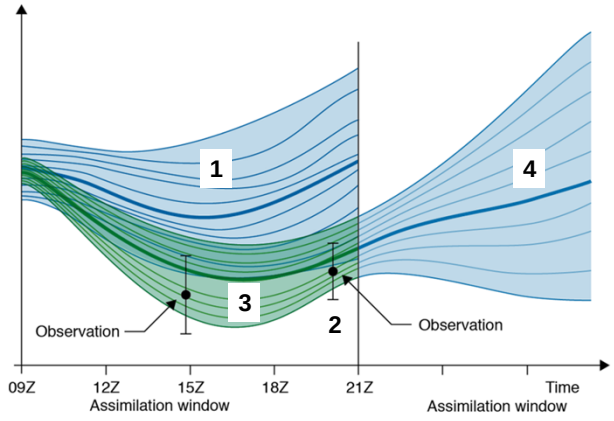
Ocean

Sea ice

CERA-20C is based on an Ensemble of Data Assimilation (EDA)

The climate reconstruction is done by chunk of 24 hours using a 10-member ensemble

1. Compute an ensemble of first-guesses (perturbations in the physics/forcings)
2. Perturb observations (measurements and/or positions)
3. The assimilation scheme is producing an ensemble of analysis
4. The analyses are used to compute the next ensemble of first-guesses



Two types of diagnostics to evaluate uncertainties in CERA-20C

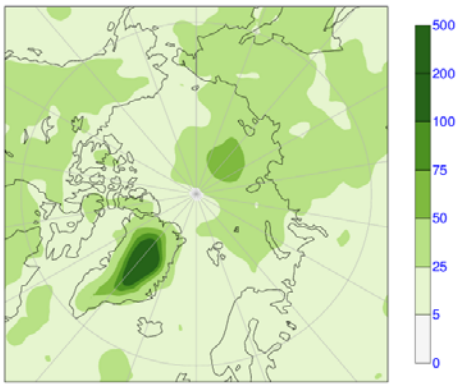
Model space

Observation space

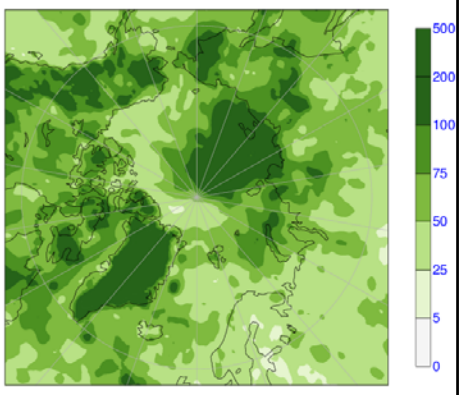
Diagnostic in the model space

Case study for mean sea level pressure in Arctic for Aug. 2009

Standard deviation of the 10-member analysis ensemble



RMSE (CERA-20C – truth) with the oper analysis as a proxy of the truth



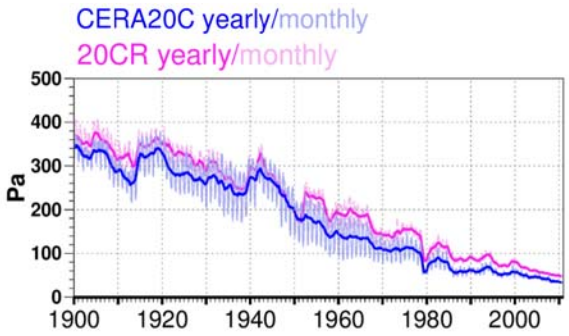
Ideally, ensemble standard deviation should be equal to the analysis root mean square error

→ ensemble standard deviation is too small (correct patterns with wrong amplitude)

Diagnostic in the model space

Evolution of the ensemble standard deviation over the 20th century

Timeseries of the ensemble standard deviation for global mean sea level pressure



→ more observations, less uncertainties (from 350 Pa to 50 Pa)
→ uncertainties are expected to be under-estimated (from case study)
→ 10 members in CERA-20C and 56 members in 20-CR

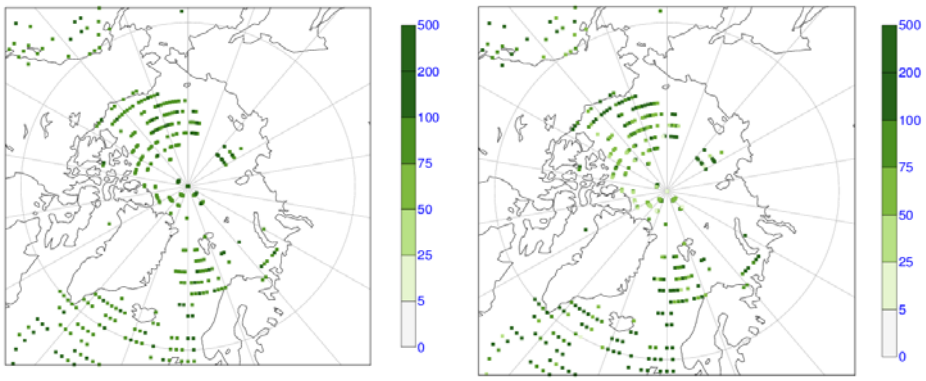
Courtesy of Per Dahlgren, ECMWF

Diagnostic in the observation space

Case study for mean sea level pressure in Arctic for Aug. 2009 (buoys only)

Assimilation scheme requires specification of observation and first-guess errors

$\sqrt{\sigma_o^2 + \sigma_b^2}$ $\mathrm{RMS}(o-b)$

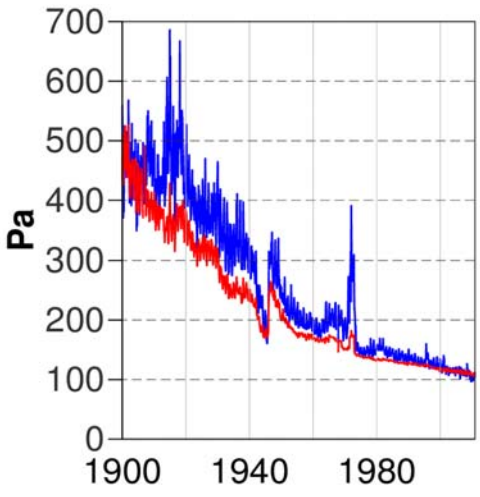


Ideally, the sum of observation and first-guess errors used in assimilation should be equal to the root mean square difference between the observations and the first-guess

→ Better (but not perfect) match with the observation space diagnostic

Diagnostic in the observation space

Evolution over the 20th century using mean sea level pressure observations



$\sqrt{\sigma_o^2 + \sigma_b^2}$ $\mathrm{RMS}(o-b)$

→ Observation and first-guess errors are correctly specified for assimilation (good match)

Courtesy of Per Dahlgren, ECMWF

Final comments

Different diagnostics, different conclusions

- Uncertainties largely under-estimated (model space diagnostic)
- Observation/first-guess errors are correctly specified (observation space diagnostic)

Very preliminary results, further investigations are ongoing

Model fields and observation feedbacks will be disseminated

- CERA-20C (research activity)
- ERA5 (C3S operational activity)

WEB API to access data store in MARS