Main WP4 tasks

• T4.1 - Quality control, bias adjustment and homogenisation of input observations
  • UNIVIE, ECMWF, UBERN, FFCUL
  • Assess and improve the quality of input observations used for reanalysis. This includes quality control, bias adjustment and homogenization of observations.

• T4.2 - Diagnostics and uncertainty assessments of reanalysis output
  • UNIVIE, ECMWF, RIHMI, DWD, UVSQ
  • Quality assessment of reanalysis products. Deliverables consist of Reanalysis Quality Assessment reports.
  • Integration and expansion of diagnostic tools for estimating the uncertainty of new assimilation products. Assessment of the “climate quality” of the reanalysis products.
Main WP4 tasks

- ECMWF, ocean, carbon communities already have excellent monitoring tools - so where can we contribute?
  - Ensure that essential metadata are right - this is assumed in ECMWF QC
  - Assess and adjust observation biases
  - Check fulfilment of budget constraints
  - Physical relationships as seen in different data sets
  - Help with intercomparisons of (reanalysis) data sets

- Do existing diagnostics meet users’ need?
Time varying biases as seen in background departures and budget evaluations

Leopold Haimberger, Marco Milan, Michael Mayer, Michael Blaschek, Lorenzo Ramella-Pralungo,

ERA-CLIM2 General Assembly, Nov 20\textsuperscript{th}, 2014
# Diagnostic tools

<table>
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<th>Diagnostic</th>
<th>State X</th>
<th>Observations Y</th>
<th>Predicted fluxes Fx</th>
<th>Observed fluxes Fy</th>
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<tr>
<td>Background departures</td>
<td>Y-H(X)</td>
<td>Y-H(X)</td>
<td>F_y-H[F_x(X)]</td>
<td>F_y-H[F_x(X)]</td>
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<tr>
<td>Comparison of (input) obs.</td>
<td>Y_a-H(y_b)</td>
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<td>F_yc-H[F_yd]</td>
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<tr>
<td>State perturb.</td>
<td>AnInc(X)</td>
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<td>Spinup(F_x)</td>
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<tr>
<td>Tend+Fluxdiv+Conversion=0?</td>
<td>X_{fc}, F_x(X_{fc}), X_{an}, F_x(X_{an})</td>
<td>Tend(y), Fluxdiv(y)</td>
<td>F_x(X_{fc})</td>
<td>F_y</td>
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<tr>
<td>Diagnostic relationships</td>
<td>X_c vs. X_d</td>
<td>Y_c vs. Y_d</td>
<td>F_{xa}(X_{fc}) vs. F_{xa}(X_{fc})</td>
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<td>fs[Y,H(X_{fc})], fs(X_{fc},X_{an})</td>
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<td>fs(F_y,H[F(X_{fc})])</td>
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<tr>
<td>OS(S)Es</td>
<td>X(y) vs X(Y_b)</td>
<td></td>
<td>X(F_y) vs X(F_{Yb})</td>
<td></td>
</tr>
</tbody>
</table>

... other, more specialized diagnostics for data assimilation
Departure time series of early radiosonde data

- Background \((y-Hx_b)\) and analysis \((y-Hx_b)\) departure statistics from pilot assimilations and reanalyses
- These series can be considered third level of QC after basic QC, internal consistency QC
- Credo: Departure statistics have high potential for QC/BC
- ERA-PreSAT **background** departures 1939-1967
- ERA-40/ERA-Interim **background** 1968-1978, 1979-2013
- Use also **analysis** departure statistics from
  - ERA-20C ensemble member 0 (rerun)
  - 20th Century Reanalyses v2 ensemble mean
Moscow obs-ERA-presat

These data are easily retrieved from ECMWF odb2

ERA-PRESAT  ERA-40  ERA-Interim

300hPa

STD: 1.02

STD: 0.92

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Moscow obs - ERA20C, NOAA-20CR

ERA-20C

NOAA-20CR
US composite

Background departures, 072202-072913, 00h

50hPa

200hPa
T-Trends, 300hPa, 1949-1967

Unadjusted temperature

ERA-PreSAT bg

These data are easily retrieved from ECMWF odb2
Very strong cooling in obs over most of FSU, less so in bg
Good agreement over Europe, US
T-Trends, 300hPa, 1949-1967

ERA-20C analysis

NOAA-20CR analysis

No sign of cooling over FSU at all in surface data only reanalyses!
RAOBCORE adjusted temperatures

Method does not detect trend-like bias changes
ERA-presat bg also has cooling;
Departures from surface data only reanalyses have large variance
Status of offline homogenization

- RAOBCORE/RICH adjustments available back to 1958
- RAOBCORE/RICH adjustments back to 1939
  - RAOBCORE results there depend on reference used, much better break detection with ERA-presat
  - RICH needs to avoid neighbours from same country more strictly
- Wind data adjustments: available back to 1920s, Ramella-Pralungo et al. 2014a,b,c
- Humidity: just started
  - Calculate SSM radiances from RS profiles (using RTTOVs)
  - Analyse Humidity background departures
SSM-T2 brightness temperatures at single station

- RTTOVS 10 used for calculating BTs
- Potential for intercomparison back to early 1990s
- Comparison with GPS-RO?
- Background departures will be examined and interpreted with healthy scepticism
Flux diagnostics

- Relationships between fluxes, state variables
- Mean Analysis increments indicate flux imbalances in early forecast steps
- Variability of fluxes as interesting as variability of state
- Fluxes should fulfil budget constraints, e.g. for vertically integrated total energy
ERA-Presat Sea Ice and SST

![Graphs showing sea ice and sea surface temperature (SST) fraction and SST values over time.]
Surface Flux and RadTOA, ERA-PreSAT
Analysis increment anomalies

ERA-PRESAT
TETEND ANA-FC 3-month-ave

ERA-20C
TETEND ANA-FC 3-month-ave

ERA-Interim
TETEND ANA-FC 3-month-ave

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Surface flux and sea ice extent

- Robust relationship between summer surface energy flux and September ice extent anomalies
- Indirect $F_S$ estimate from satellite data and atmospheric budgets yields even clearer results

**Area averages 70N-90N**

- F$_S$ from ERA-I in JJA (Wm$^{-2}$)
- Indirect F$_S$ estimate in JJA (Wm$^{-2}$)
Radiation at TOA and sea ice extent

- Summer (JJA) $\text{Rad}_{\text{TOA}}$ clearly has strong impact on September sea ice extent
- Reanalysis has difficulties to show this, probably due to cloud biases

Area averages 70N-90N

- $\text{Sea ice anomaly in Sep}$ vs $\text{Rad}_{\text{TOA}}$ from ERA-I in JJA (Wm$^{-2}$)
- $\text{Sea ice anomaly in Sep}$ vs $\text{Rad}_{\text{TOA}}$ from CERES in JJA (Wm$^{-2}$)
Do these results improve anything?

- (Radiosonde) observation bias estimation
  - Offline:
    - Ready for wind (Ramella-Pralungo et al. 2014),
    - backward extension for Temperature to pre-1958 ongoing
  - Online: Bias model for VarBC of Radiosonde-T ->Marco Milan
  - Implemented by end of year but not sufficiently tested

- Budget diagnostics:
  - Need to be communicated early to have a chance of improvement within project
  - Valuable tool to discover physical relationships

- Need „canonical“ set of diagnostics for comprehensive intercomparison of reanalysis, flux data
Conclusions

• Radiosonde T/wind bias estimation offline/online:
  - Deliverable due at end of year
  - Implemented but testing delayed

• Budget diagnostics:
  - Reveal problems but not necessarily a solution. 
    Communication with „modelers“ important
  - Emphasis on polar regions planned

• So far most work in WP4 in parallel, without much interaction except with ECMWF.
1960-1979 minus 1915-1935

TEDIV

Rad TOA

ENERGY TENDENCY FORECAST 24h

Wm²
ERA-CLIM2 General Assembly 20 Nov 2014
Japanese Radiosonde Composite

Background departures, 047401-047963, 00h

Analysis increments, 047401-047963, 00h

bgpresat-e20c, 047401-047963, 00h

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US


NOAA-20CR
No obvious sign of break
Tropical trends 1958-2010
Temperature and wind 1950-1970