Improving the use of historical surface and upper-air observations in reanalysis

Pre-satellite era <1979
1950-1979

Per Dahlgren

Overview

From ERA-CLIM, ERA-CLIM2 projects
Archived in MARS
Format: ODB2
Covers whole 20th century

ISPD
ICOADS
} Surface observations

NCAR_UA
NCAR_CHUAN
CHUAN2.1
} TEMP/PILOT

From ERA40 project
Archived in MARS
Format: BUFR
1958-2002

Surface observations
TEMP/PILOT
AIRCRAFT

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Surface observations
TEMP/PILOT
AIRCRAFT

- Several data sets with historical observations available at ECMWF:
  Data from ERA-CLIM and ERA-CLIM2 projects
  Data from ERA-40 project
- Subsets of available data sets used in reanalysis
  ERA-Interim: ERA40 observations
  CERA-20C: ISPD, ICOADS
- Aim: Use data from all data sources

Technical challenges

- IFS undergoes technical restructuring of the code (OOPS, **COPE**)
- Changes to how observations are retrieved and prepared before assimilation
- What worked in previous reanalyses (ERA20C, CERA20C) does not work in the ERA5 system
- Status: ERA5 can retrieve all available data and get it ready for assimilation through **COPE**
- ...Restructuring of the IFS code is ongoing

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Works in ERA5
Possible to trace an observation's source in IFS

Changes to IFS quality control

- Data assimilation for a specific date:
  Retrieve observations from all available sources
- Put them together
- Read into the IFS DA

- Observations will appear several times (duplicated)
- Duplicates can appear to be different observations as the duplicate can have:
  - Different station id
  - Slightly different time
  - Slightly different position
  - Different data(!)

Changes to IFS quality control

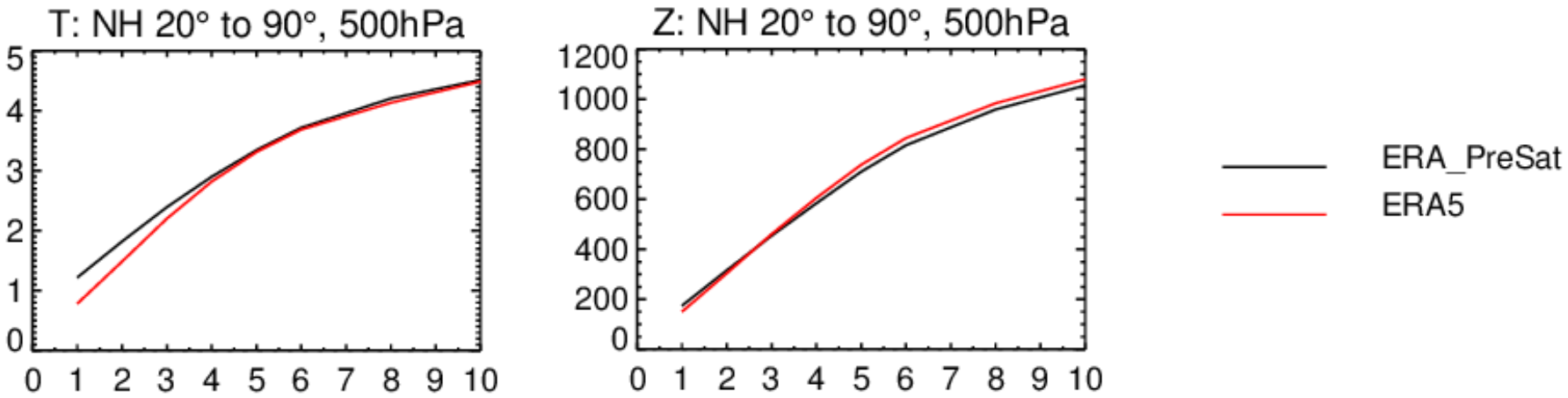
- Observations inside the IFS DA undergoes rigorous quality checks
- … but, can not handle these types of duplications
- 2 new, specially designed routines needed for reanalysis
- For TEMP/PILOT some data sources are considered better than other:
  1: CHUAN2.1
  2: ERA40 bufrdata
  3: NCAR_CHUAN

Assimilation experiments

- Goal: find a model configuration to run ERA5 1950-1979
- Bias corrections from Leo Haimberger, RISE160, used
- Do test runs in the early periods and compare with ERA-PreSAT

Assimilation experiments

1–Jan–1950 to 30–Aug–1950 from 233 to 242 samples. Verified against own–analysis.



Roughly similar performance as era_PreSAT in terms of forecast scores

Assimilation experiments

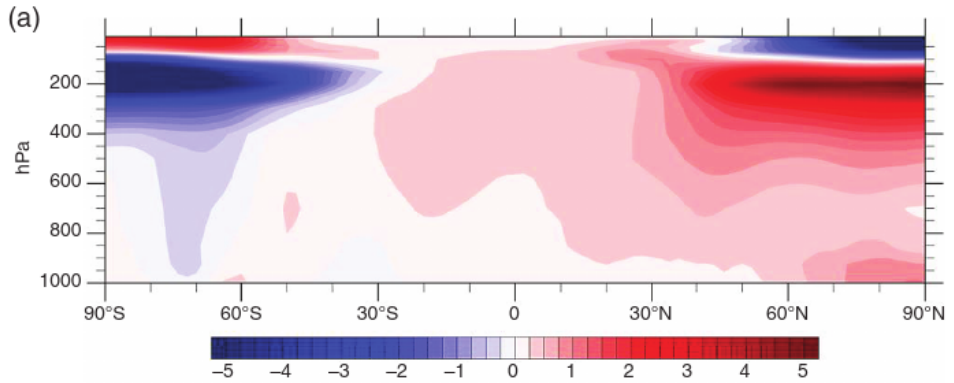
Hemispheric imbalance in ERA_PreSAT

Model used to produce ERA_PreSAT biased cold in upper stratosphere

Assimilating TEMP observations (NH only) warms the model

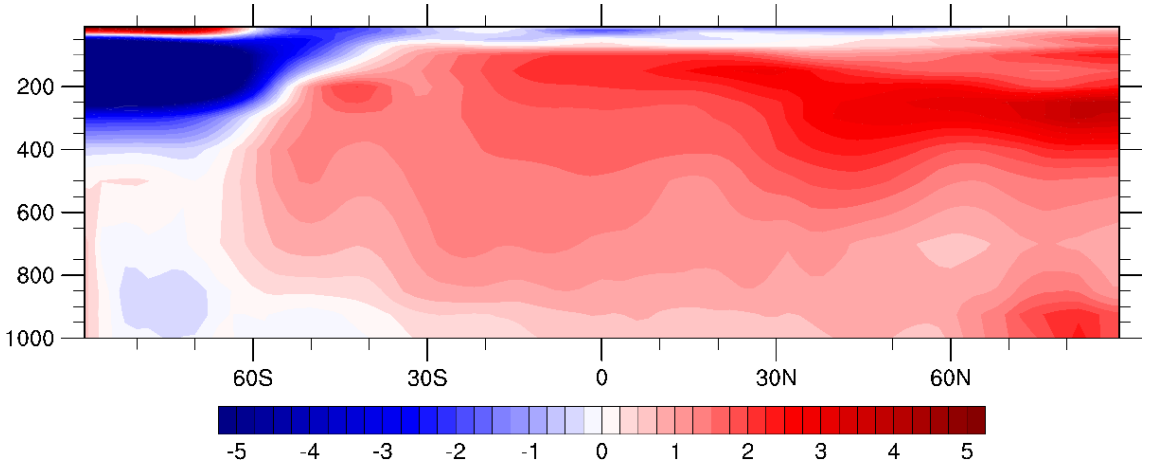
ERA_PreSAT-ERA20C
1939-1944

Hersbach et al. 2017



Assimilation experiments

Hemispheric imbalance in ERA_PreSAT vs ERA5

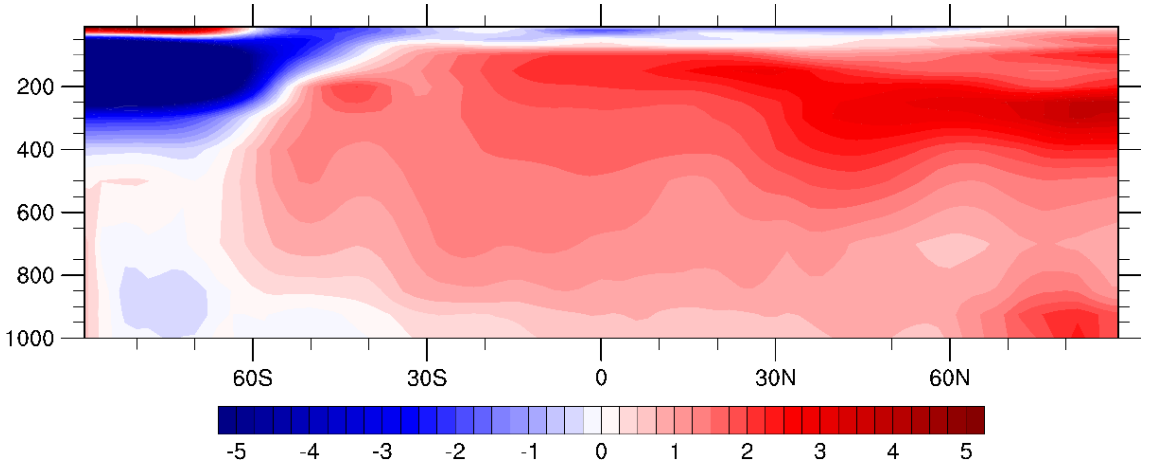


ERA_PreSAT-ERA20C
1950

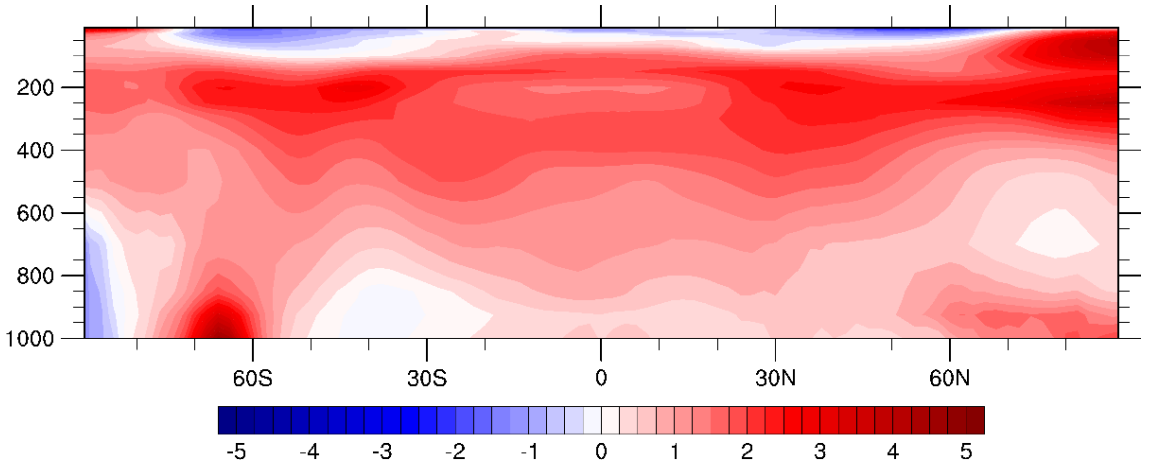
Courtesy of Michael Mayer

Assimilation experiments

Hemispheric imbalance in ERA_PreSAT vs ERA5



ERA_PreSAT-ERA20C
1950



ERA5-ERA20C
1950

Courtesy of Michael Mayer

Summary

- Data recovered in ERA_CLIM2 already used in reanalysis

  CHUAN2.1 into ERA5
  Radiosonde bias corrections (RISE160) into ERA5

- ERA5 system updated so that all available (at ECMWF) observation data sets can be effectively used
  - Data retrieval
  - Updated quality control, duplicate removal

- Current status: ERA5 in 1950, 1960 performs on similar level to ERA_PreSAT
  Model bias present in ERA_PreSAT seems to have been resolved in ERA5

- Copernicus plans to start producing ERA5 1950-1979 next year 2018