RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

METEO FRANCE

Forecast impact of ROMEX observations in the Météo-France system

Dominique Raspaud MÉTÉO-FRANCE/DESR/CNRM

COSMIC/JCSDA Workshop and IROWG-10 Meeting
UCAR, Boulder, 12-18 September 2024

CNRM

cnrs

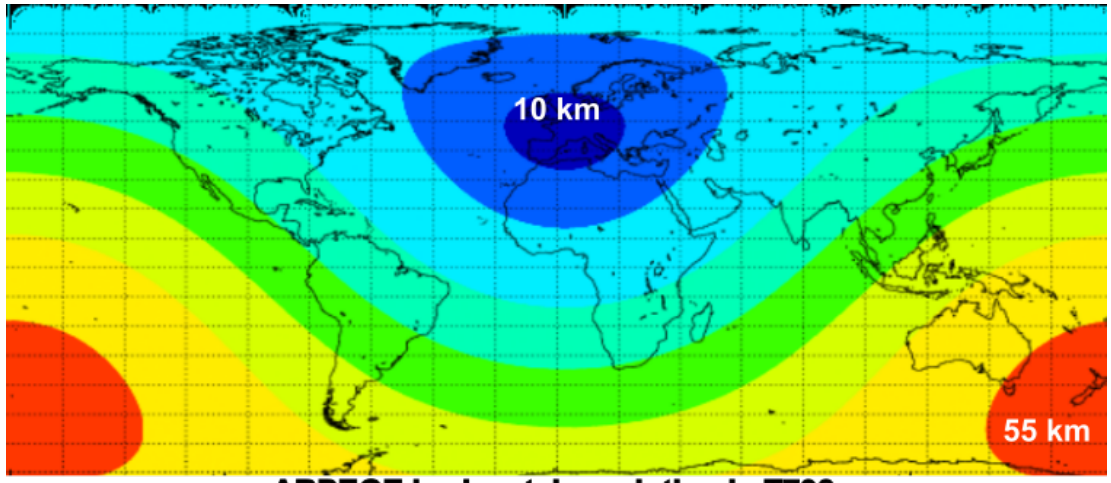
Outline

Outline

Global data assimilation for ROMEX

Configuration of the Météo-France 4D-Var system ARPEGE for ROMEX

- ARPEGE model cycle CY48T1 (soon in operations)
- Model resolution T798 (horizontal resolution : 10km over Western Europe, 55km over New-Zealand), lower than operations
- 105 vertical levels up to 65km
- Maximal forecast term extended from 102 hours to 240 hours



ARPEGE horizontal resolution in T798

ROMEX Experiment Setup

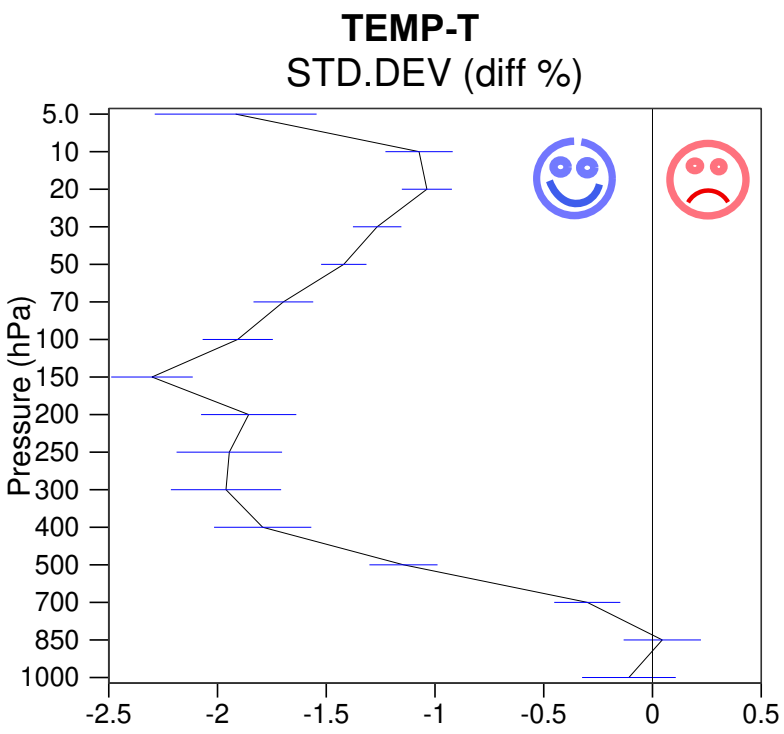
Details of the experiments setup (Study period : 2022-09-01 to 2022-11-30)

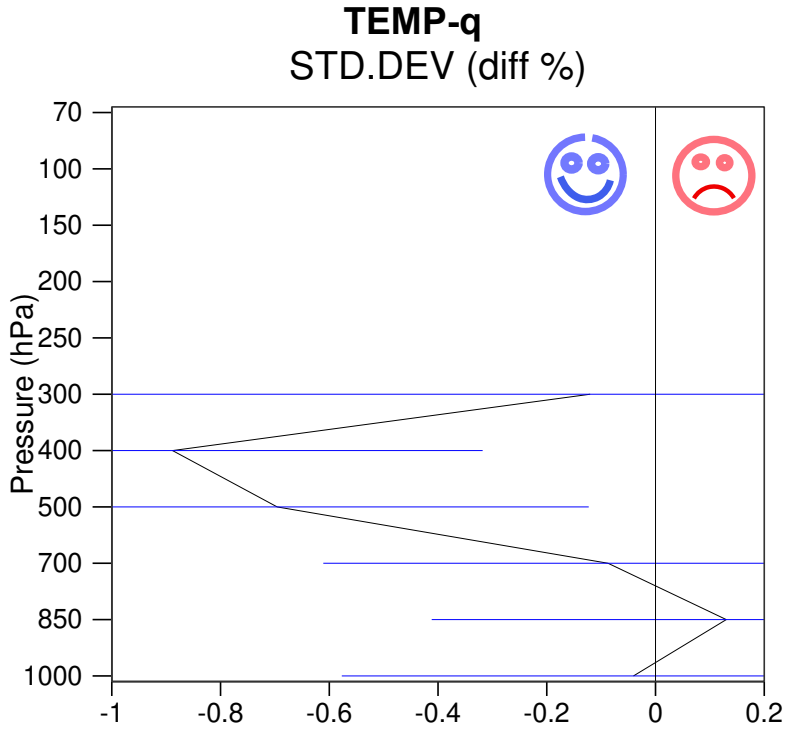
- CONTROL experiment (7.300 profiles/day) :
  - Metop, Sentinel-6
  - COSMIC-2, Kompsat-5, PAZ, TerraSAR-X, TanDEM-X
- ROMEX experiment (35.000 profiles/day) as CONTROL plus :
  - SPIRE, PlanetIq
  - GeoOptics
  - FY3x, Yunyao, Tianmu used above 5km
- Denial experiment : no GNSS-RO
- Use of GNSS-RO data for CONTROL and ROMEX experiments :
  - similar observation errors for all missions (the same as in operation)
  - QC check based on first guess departure
- All non-RO observation types as in operation
- Background error covariances from the operational EDA system (50 members)

Outline

Fit to radiosondes

Normalised change (ROMEX - CONTROL) in std.dev of O-B for radiosonde Temperature (left) and Rel. humidity (right) - Globe, 3-month period

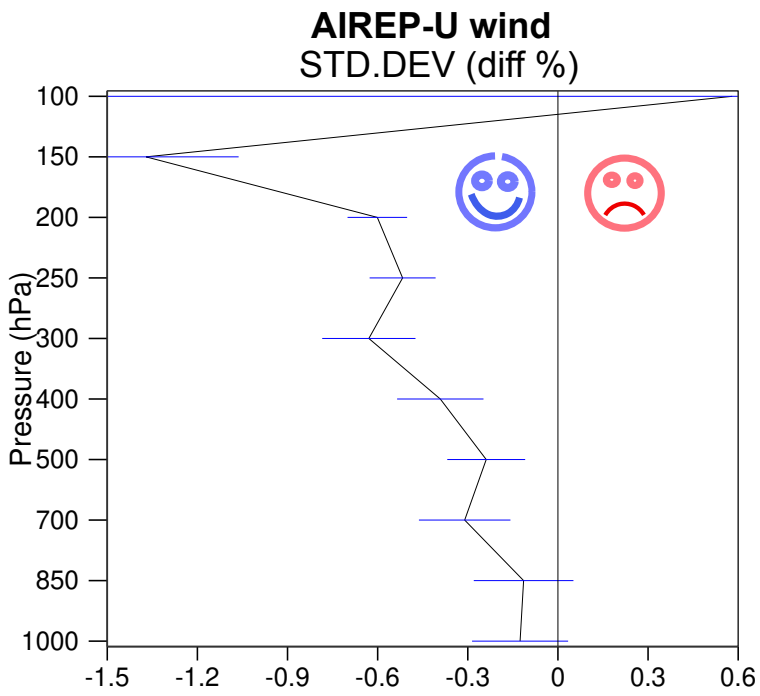


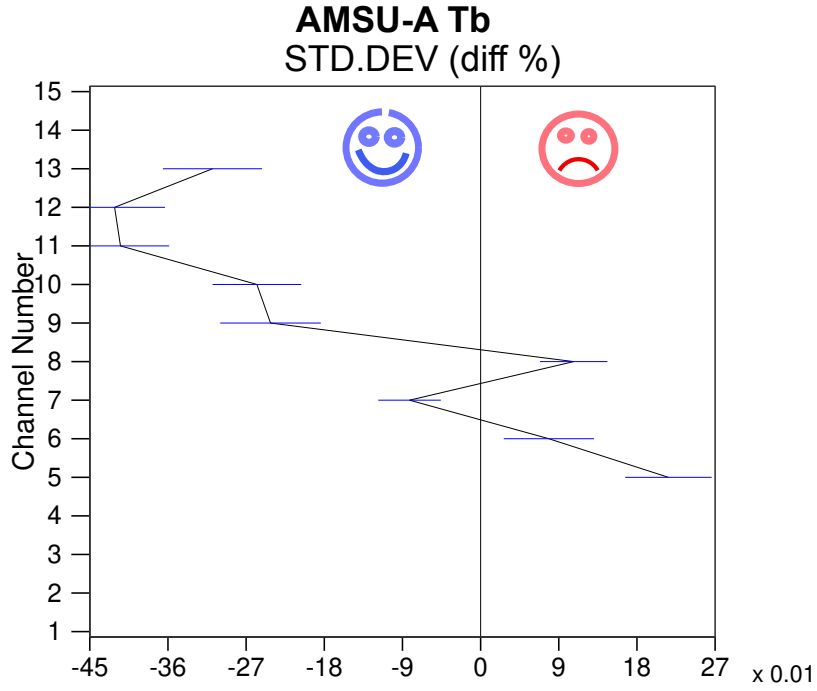


- Better stdv of the fit to TEMP-T (up to 2.25 % at 150 hPa), neutral in lower troposphere
- Stdv of the fit to TEMP-q slightly better in middle troposphere, neutral in lower troposphere

Fit to aircraft (wind) and AMSU-A (Tb)

Normalised change in std.dev of FG departures (ROMEX - CONTROL) - Globe, 3 months





- Better fit to AIREP for U-wind (up to 1.3 % in altitude)
- Improvement of the fit to AMSU-A for channels 9 to 13 (stratospheric temperature), deterioration for channels 5, 6, 8 (tropospheric temperature)

Impact of ROMEX data on the analysis

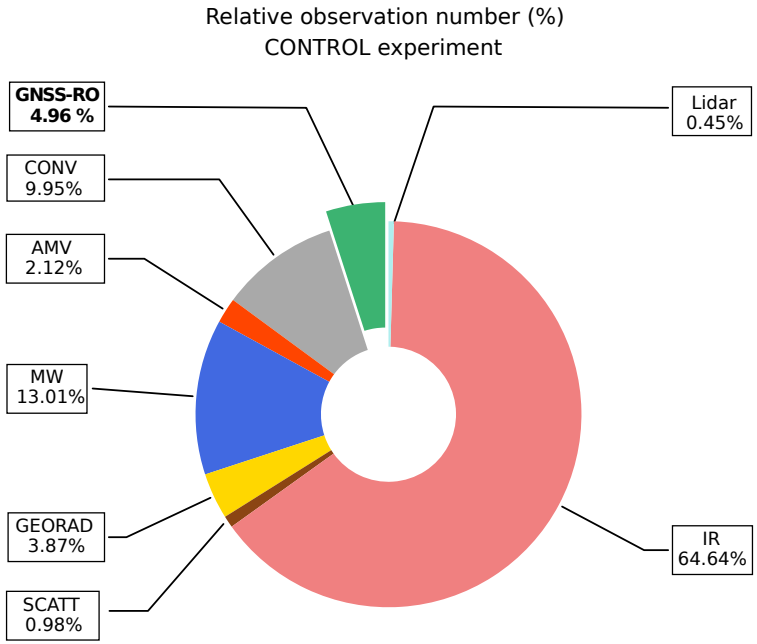
Information content : DFS diagnosis

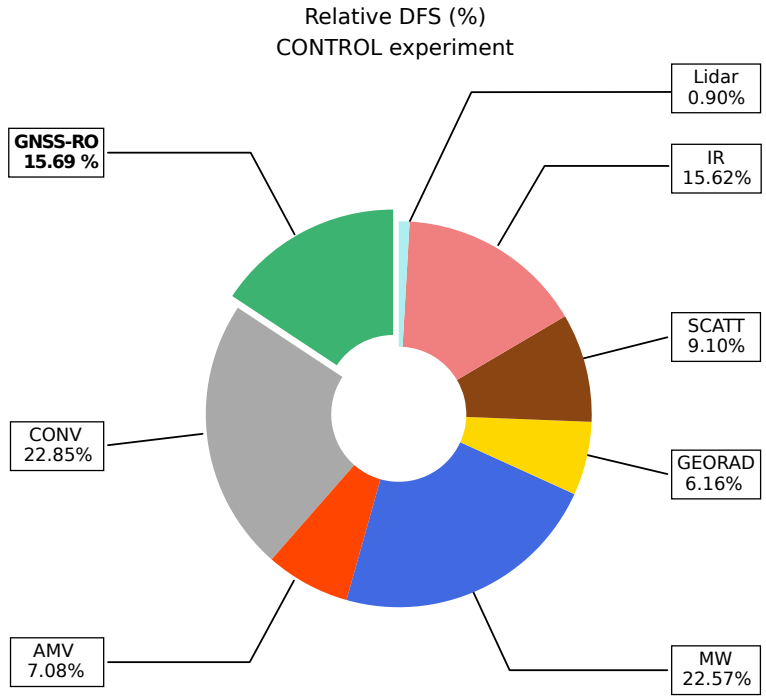
- Degree of Freedom for Signal estimates the analysis sensitivity to observations (Fisher 2003)
- Methodology : 1-day (4 networks) with 6 different 4D-Var assimilations with perturbed observations for each run

Impact of ROMEX data on the analysis

DFS diagnosis for the CONTROL experiment

- Relative observation number (left) and relative DFS (right) for CONTROL (2022/09/01)

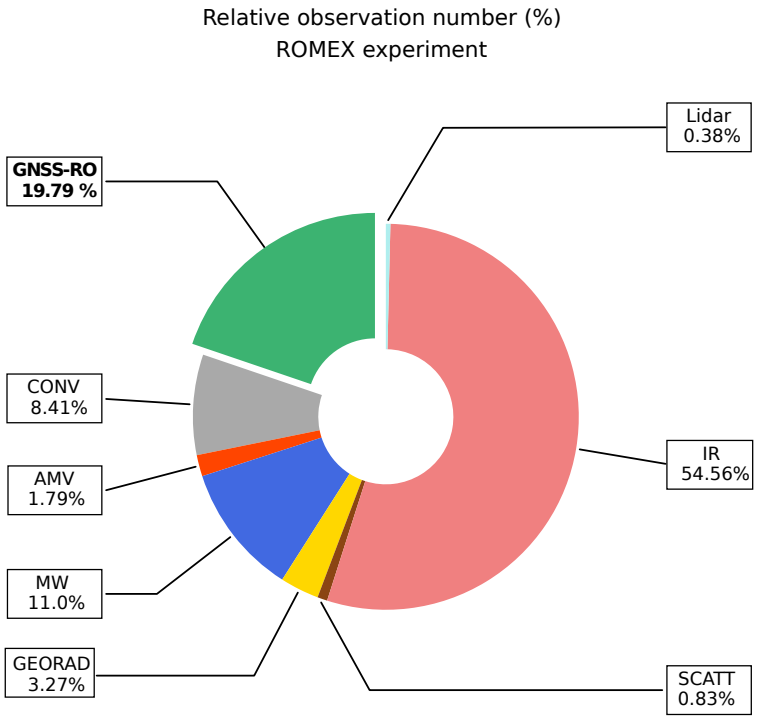


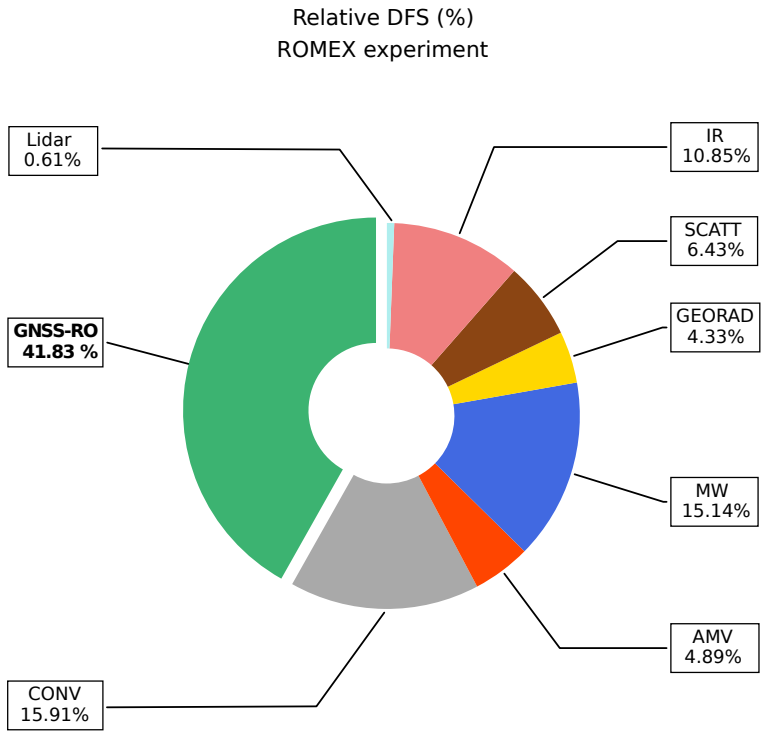


Impact of ROMEX data on the analysis

DFS diagnosis for ROMEX experiment

- Relative observation number (left) and relative DFS (right) for ROMEX experiment (2022/09/01)



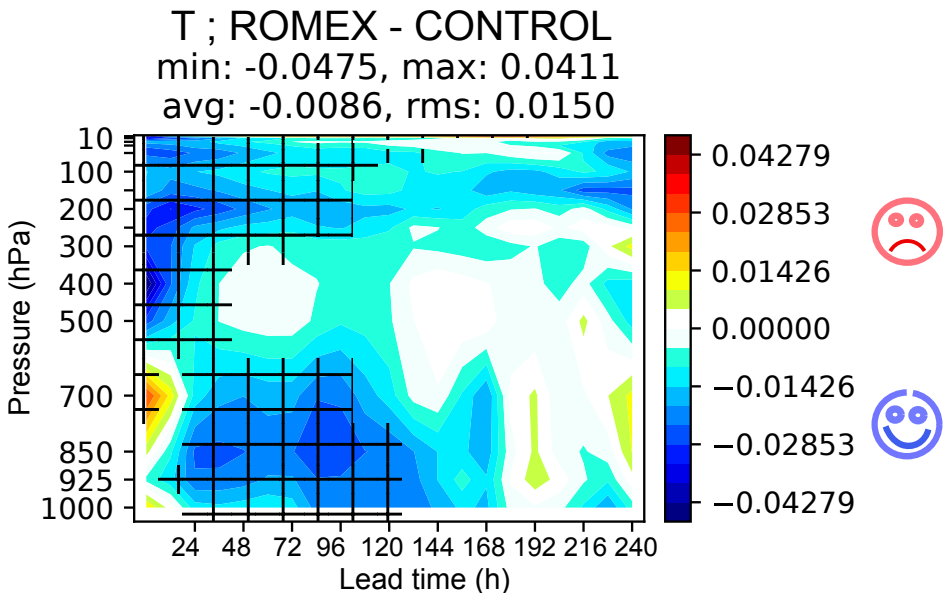


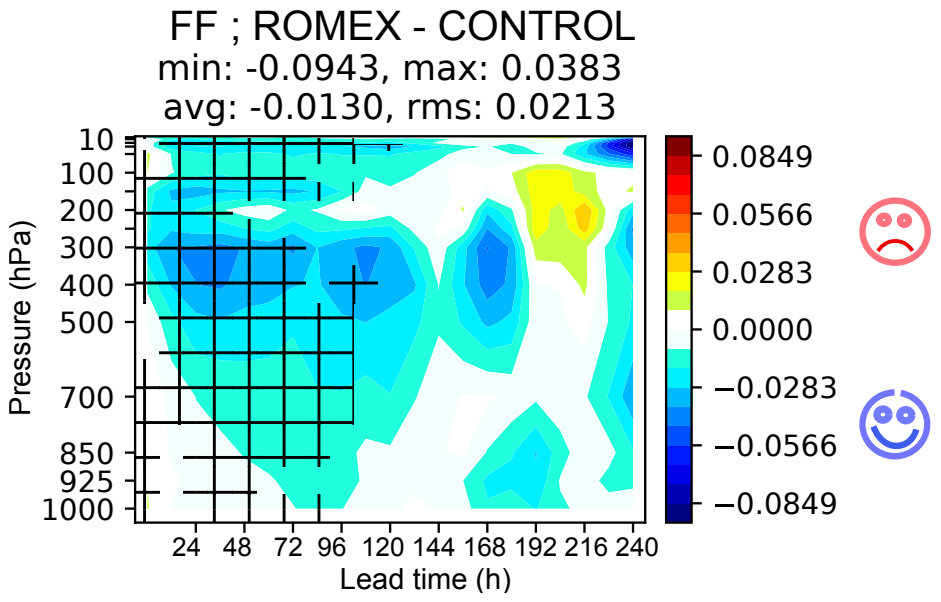
- Strong increase of the DFS for GNSS-RO $\Rightarrow$ 1st rank with more than 41% of the total DFS !

Outline

Forecast impact (1)

Change in the std.dev of the forecast error against IFS analysis for Temperature (left) and Wind speed (right) - Globe, 3-month period

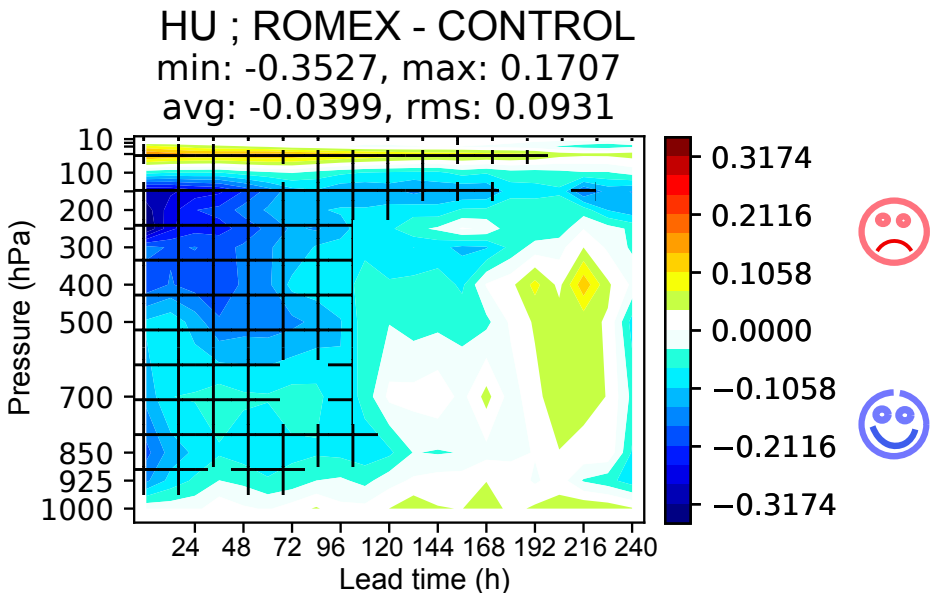


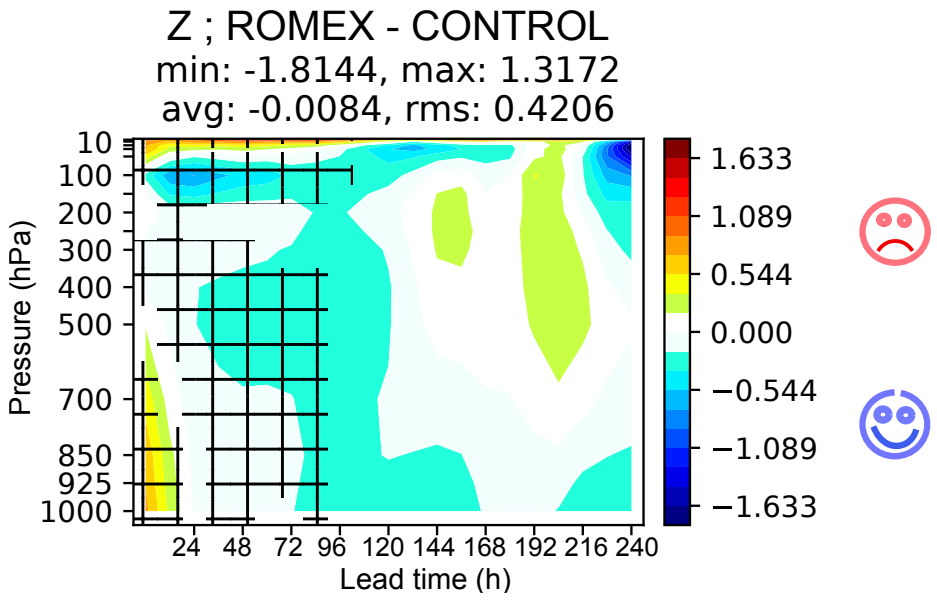


- Clear improvement for temperature until 96h (except in lower troposphere at very short range)
- Significant improvement for wind speed in upper troposphere until 96h
- Statistically non-significant impact after 96h

Forecast impact (2)

Change in the std.dev of the forecast error against IFS analysis for Relative humidity (left) and Geopotential (right) - Globe, 3-month period

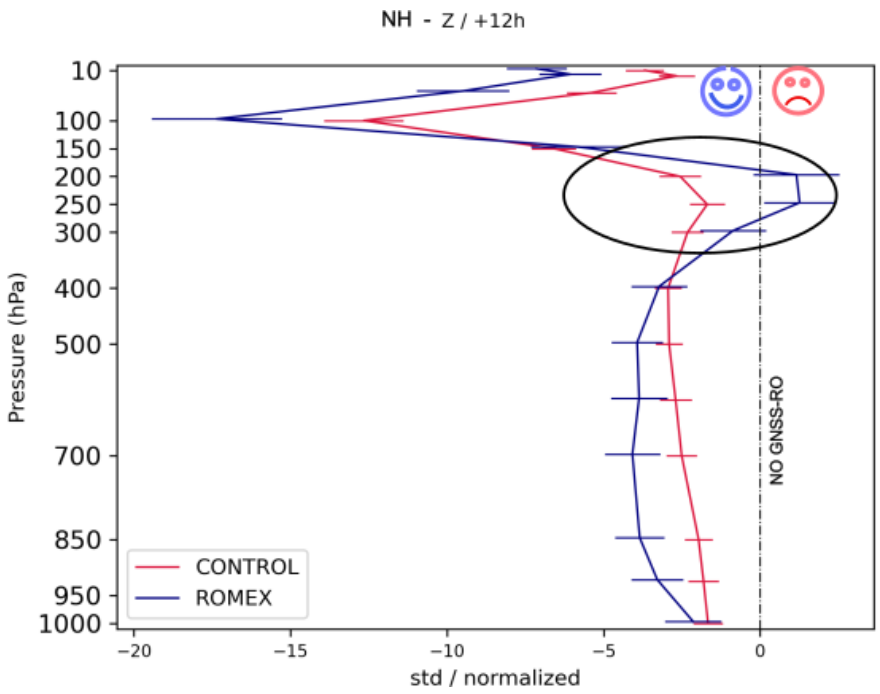


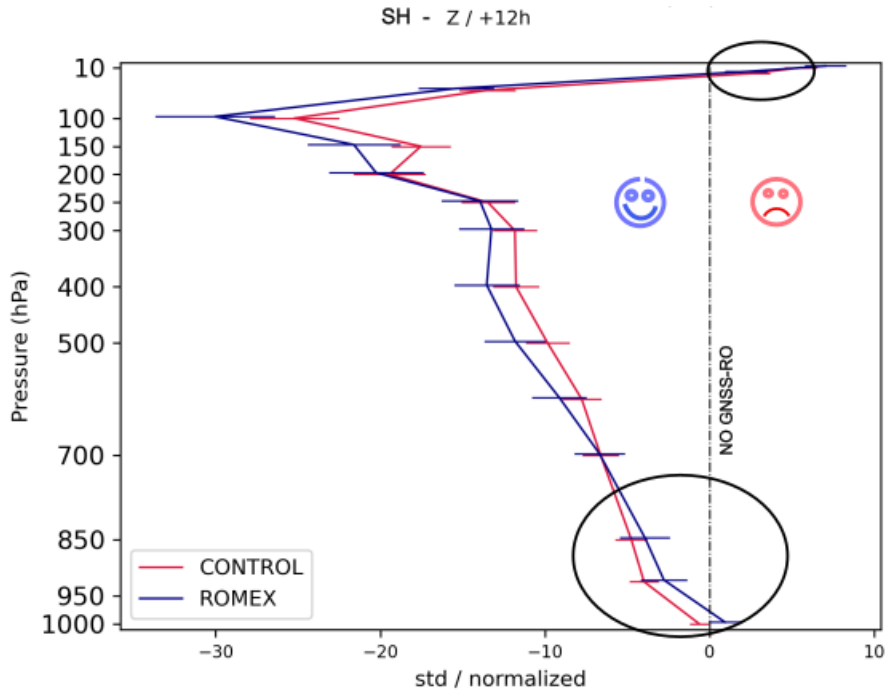


- Significant improvement for humidity in the troposphere until 96h
- Mainly positive impact on geopotential between 24h and 96h in middle and upper troposphere but clear negative impact in the troposphere at very short range and above 50 hPa

Forecast impact on Z wrt DENIAL experiment

Normalised change in std.dev for Z forecast error againt IFS analysis wrt DENIAL experiment at lead-time 12h





- Improvement when adding GNSS-RO data (up to 17% compared to no GNSS-RO)
- but local negative impact with ROMEX data at 250-200 hPa in NH and above 20 hPa in SH

Outline

Summary and additional plans for ROMEX-1

Main impact results

The addition of ROMEX observations shows clear benefits on the Météo-France system :

- mainly positive impact on background and analysis
- forecast scores mostly improved for temperature, wind speed and rel. humidity until 96h
- but negative impact on geopotential $>$ 100 hPa and in lower troposphere at very short range
- no significant impact at medium range (after 96h)

Planned work

- when refractivity available in the BUFR files for FY-3 + Tianmu, run the ROMEX experiment with the super-refraction check based on the observed refractivity
- run an experiment with an intermediate amount of data (20.000 profiles/day)
- run Ensemble Data Assimilation experiment
- estimate FSOi to quantify the impact of ROMEX data on the reduction of the forecast error

Thanks to all involved contributing to the ROMEX-1 dataset !