

RECENT PROGRESS ON UPPER-AIR DATA ASSIMILATION AT METEO-FRANCE

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slides kindly provided by Loïk & Jean-François !

- OOPS developments
- Progress on the use of observations in Arpège and Arôme-France

Aladin-LACE-Hirlam virtual all staff workshop, 30/03 – 02/04/2020

OOPS developments at Météo-France

Use of OOPS in DAVAI to validate DA components :

- observation operator (nl/tl/ad),
- model integration (nl/tl/ad).
- single observation experiments in variational minimization.

=> DAVAI and OOPS have proved to be key tools
to maintain and develop DA components and formulations.

Integration and successful validation of
variational minimization in OOPS (46t1+47t1) :

- ARPEGE : 4D-Var, 4DEnVar.
- AROME : 3D-Var, 3DEnVar, and soon 4DEnVar.

EnVar developments at Météo-France

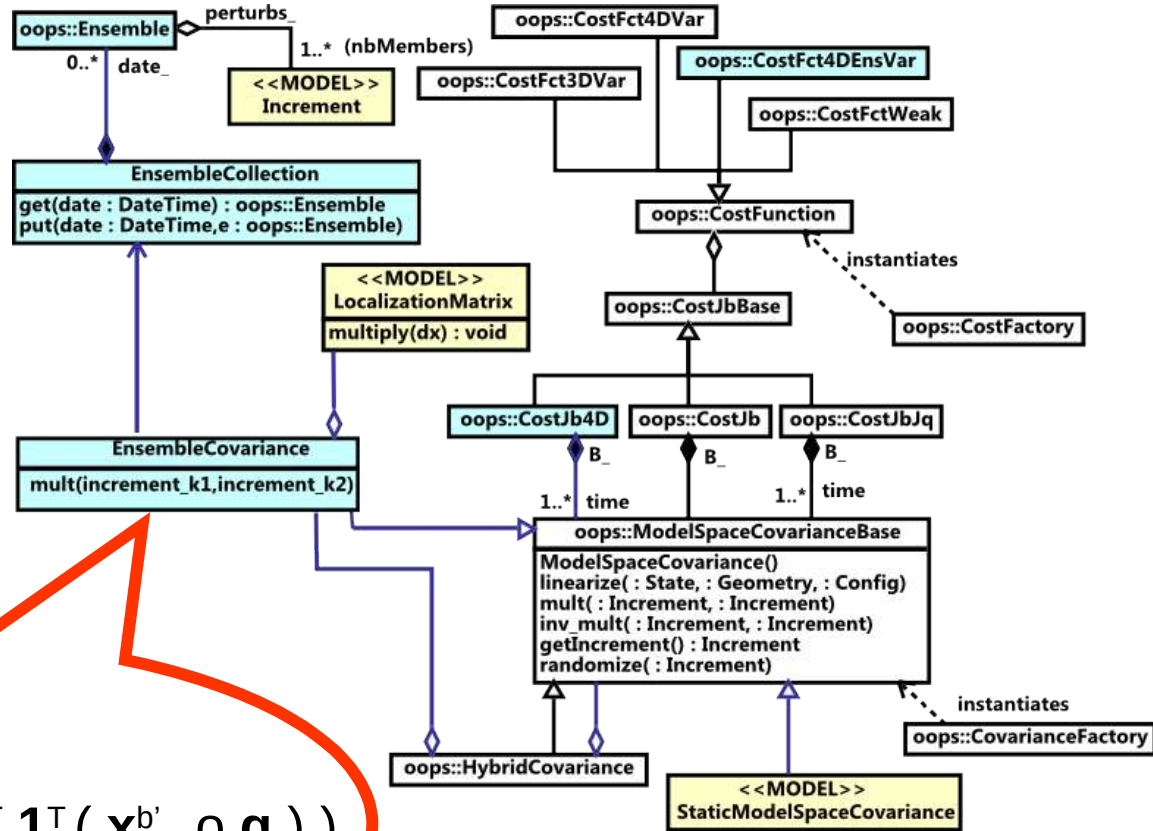
Several building blocks have been developed, in order to construct, experiment and optimize **EnVar formulations** in OOPS :

- I/O of ensemble member fields.
- 3D/4D-ensemble-based and static background error covariance matrices.
- Spatial localization (either spectral, or using recursive filters).
- Advection of spatial localization and of static error covariances.
- Localization diagnostics.

Developments for **corresponding EDA** versions in OOPS :

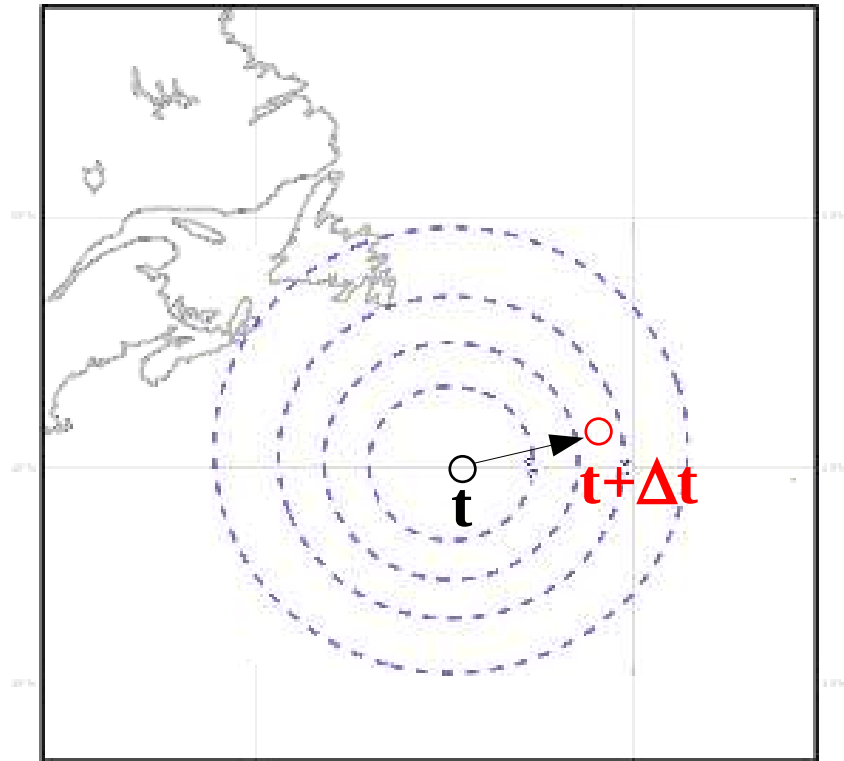
- Ensemble of 4DEnVar (4DEnVar-EDA) in a single EDA job, with optimized storage and MPI communication of ensemble member fields.
- Block-Lanczos version of EDA, in order to accelerate minimization, with optimized MPI communications.

4DEnVar under OOPS

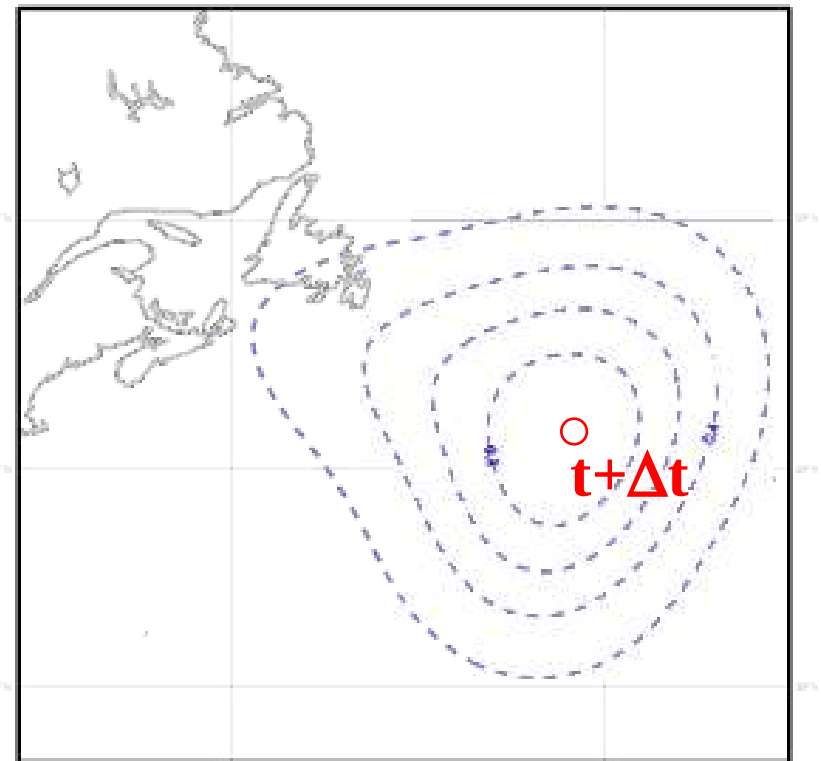


$$\sum_{ne} \mathbf{x}_{ne}^{b'} \mathbf{0} \left(\mathbf{1} \mathbf{S}^{-1} \mathbf{L} \mathbf{S}^{-T} \mathbf{1}^T \left(\mathbf{x}_{ne}^{b'} \mathbf{0} \mathbf{g} \right) \right)$$

Advection of the localisation



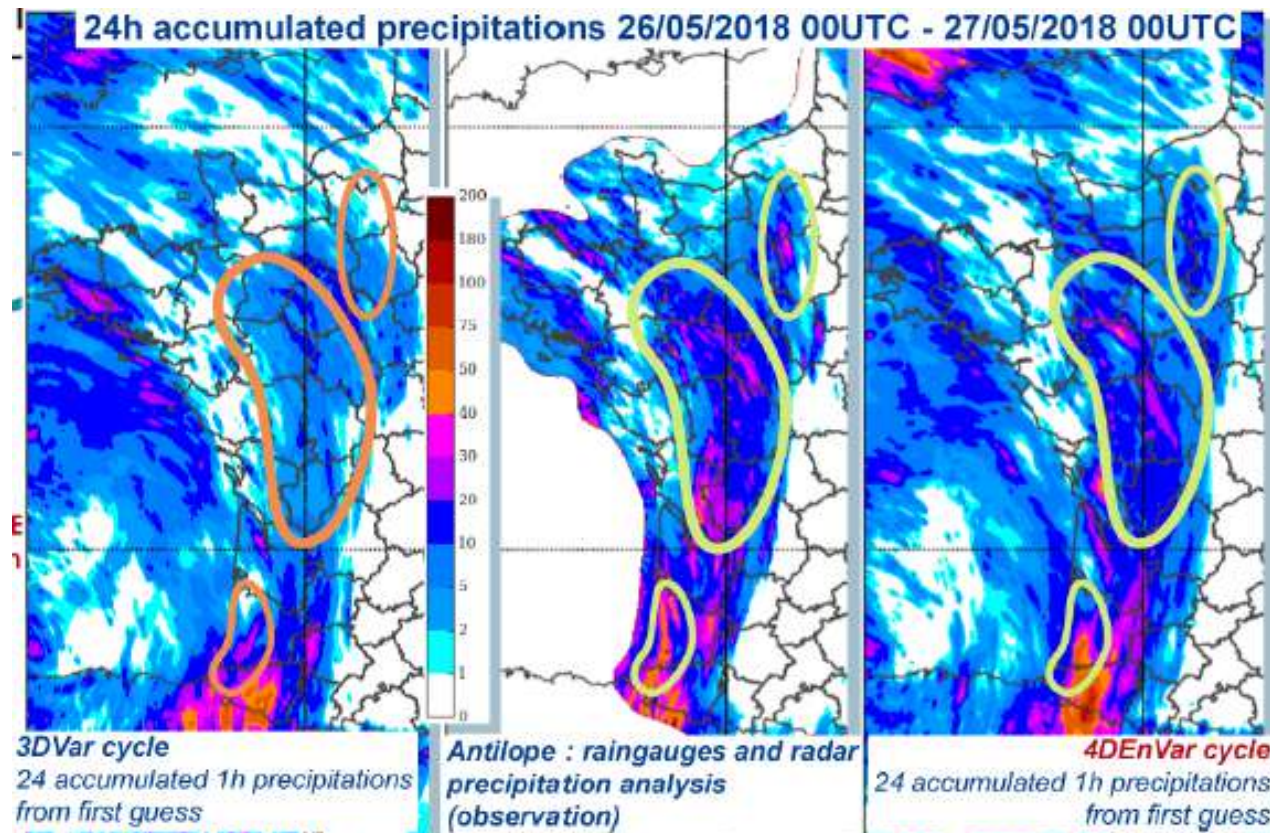
Static localisation



Advected localisation

3DEnVar and 4DEnVar in AROME

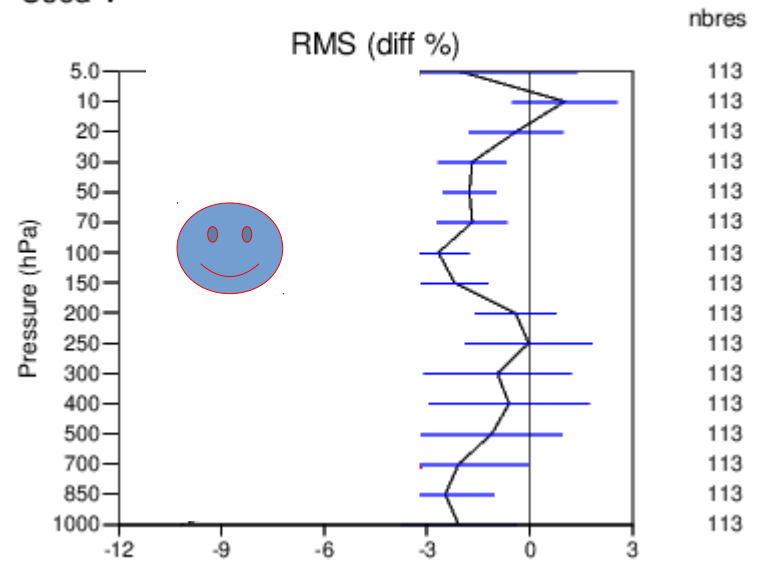
- Positive impacts of **3DEnVar** in AROME, compared to 3D-Var (T. Montmerle, Y. Michel).
- Experimentation of 3DEnVar with **hydrometeors** and specific localisation (PhD M. Destouches).
- Development and tests of **4DEnVar** in AROME, with encouraging results (P. Brousseau) (advection of localisation ; 4D-IAU ; 1h cycle with 15 min timeslots ; full observation set : radar and sevir) every 15 min).



(P. Brousseau)

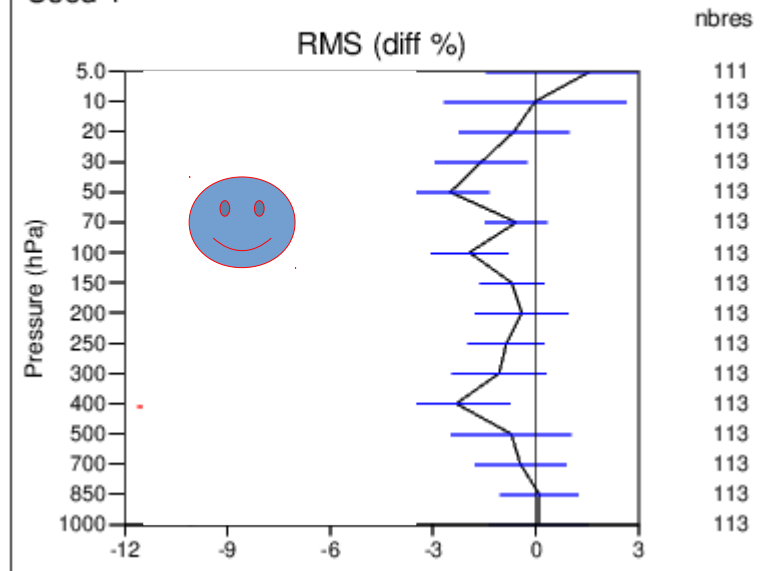
4D-EnVar in ARPEGE : impact on background quality (background fit to radiosondes, over one month)

87NY-87NZ arpA.4dvarfr 2018010300-2018013100
 TEMP-Vwind N.Hemis
 Used V



Wind

87NY-87NZ arpA.4dvarfr 2018010300-2018013100
 TEMP-T N.Hemis
 Used T



Temperature

% of RMSE differences :
 $(\text{RMSE}_{4\text{D-EnVar}} - \text{RMSE}_{4\text{D-Var}}) / \text{RMSE}_{4\text{D-Var}}$

Recent changes in observation usage

New observations in ARPEGE

- Winds from **Scatsat-1** scatterometer and from **GOES-16** (07/2019)
- Microwave instruments from **Metop-C** (**AMSU-A/MHS** + **GNSS-RO** GRAS) and **NOAA-20** (**ATMS**) (07/2019)
- Infra-red instruments from **Metop-C** (**IASI**) and **NOAA-20** (**CrIS**) (10/2019)
- Ocean winds from **ASCAT/Metop-C** scatterometer (01/2020)

More channels from IR instruments + correlated observation errors for IASI and CrIS instruments + VarBC for ground-based GNSS (07/2019)

New observations in AROME

- Instruments from various **polar orbiting satellites** (IASI/Metop-C, ATMS/NOAA-20, Scatsat-1, AMSU-A+MHS/Metop-C) (01/2020)
- European **radars** (26) from **OPERA** (radial winds + reflectivities) (01/2020)

Dedicated snow depth analysis using CANARI and in-situ data (01/2020)



Planned changes in observation usage

New observations in ARPEGE (2021)

- AMVs from GOES-17 (04/2020)
- HLOS winds from AEOLUS Doppler Lidar
- ABI radiances from GOES-16 and 17 (replacement of CSRs)
- GNSS-RO bending angles from various receivers (KOMPSAT-5, COSMIC-2A, SEOSAR/PAZ, GNOS)
- Ocean winds from CFOSAT and HY-2B scatterometers
- CrIS radiances at Full Spectral Resolution (new channel selection)
- « All-sky » microwave radiances using a Bayesian inversion
- Surface observations from METAR reports

Dedicated snow depth analysis with CANARI and in-situ observations

New observations in AROME (2021)

- Aircrafts winds from MODE-S/ADS-B
- Improved radar data from the French network (use of DPOL capabilities)
- Tropospheric gradients from ground-based GNSS (research activity)
- Hyperspectral infra-red radiances from IRS/MTG (OSSE experiments)



hvala za vašo pozornost

Ensemble of 4DEnVar

