CANARI

- Code Description -
Algorithms and Data Flow

Code
d'Analyse
Necessaire à
ARPEGE pour ses
Rejets et son
Initialisation

Code for the
Analysis
Necessary for
ARPEGE for its
Rejects and its
Initialisation

The GOAL of an Objective Analysis

To obtain an informatic representation of the most probable state of the atmosphere taking into account the ensemble of the available information.

Problems to be taken into account into an Objective Analysis

- The *nature* and the *quality* of the different observations => representativity errors
- QC => the quality control
- To take into account the information coming from the past => background/ first guess
- The gravity wave control

Variational formulation of the OI

- $J(x) = (x - x^b)^T B^{-1} (x - x^b) + (Hx - y)^T R^{-1} (Hx - y)$

- $\nabla J = B^{-1} (x - x^b) + H^T R^{-1} (Hx - y) =$
  $= (H^T R^{-1} H + B^{-1}) (x - x^b) + H^T R^{-1} (Hx^b - y)$

$\nabla J = 0$ ■□ $x = x^b + (H^T R^{-1} H + B^{-1}) H^T R^{-1} (y$ ◆ $Hx^b)$

O.I. : $x = x^b + B_{xy} (B_{yy} + R)^{-1} (y - x^{b,o})$

⬇

Matrix with HUGE dimension

⬇

To invert it ◆ number of OBS artificially reduced

⬇

In *CANARI* performed by GRID-POINT selection

CANARI- Specifications

- To analyse 1 point one has to solve the linear system:

$$\left[\mathrm{cov}(x_i^o - x_i^b, x_j^o - x_j^b)\right]\begin{bmatrix} W_1 \\ \ldots \\ W_N \end{bmatrix} = \left[\mathrm{cov}(x_i^o - x_i^b, x_A^t - x_A^b)\right]$$

According to the number of obs in x_i^o , the OI can be:

- 3D multivariate in : U, V, T, Ps
- 3D univariate in: RH
- 2D univariate for 2m fields.

The analysis is performed :

- for the variables of the forecast model;
- in the grid-point;
- on the model levels

CANARI - Basic hypothesis

- Homogeneity and isotropy (made on correlation)

$$cov\ (x_i^b, x_j^b) = \sigma_i^b \sigma_j^b\ cor\ (x_i^b, x_j^b)$$

- Separability (horizontal and vertical)

$$cor\ (x_i^b, x_j^b) = corh\ (x_i^b, x_j^b)\ corv\ (x_i^b, x_j^b)$$

where:

$$corh\ (x_i^b, x_j^b) = f_d(r) \sim \exp(-h^2/2r^2)$$

$$corv\ (x_i^b, x_j^b) = f_v(z) \sim 1/(1 + k\ z^2) \quad ,\ \text{where } z = \ln(p_1/p_2)$$

OBSERVATIONS in CANARI

- *OBSERVATION* - ensemble of measured parameters with a given type of instrument at a moment of time (ex: SYNOP, TEMP)
- *DATA* - a measured parameter at a given level and certain moment of time (ex: T at 850hPa)

- 10 types of observations classified in ARPEGE/IFS
  - SYNOP - Ps, 2m T and Rh, 10m Wind, Prec, Snow depth, (SST - if possible)
  - AIREP - P (or Z), Wind, T
  - SATOB - P, Wind, T - from geostationary satellite imagery
  - DRIBU - Ps, 2m T, 10m Wind, SST
  - TEMP - P, Wind, T, Q
  - PILOT - Wind with the corresponding Z, (sometimes 10m Wind)
  - SATEM - Q, T (14 layers) retrieved from radiances
  - PAOB - forced observations of pressure
  - SCATT - surface wind (not yet used)

Selection of the Observations (I)

STEP 1 - Geographic selection

- searching the Obs in a circle around the point to analyse;
- computing the distance from obs to the point of the analysis and selection of the nearest N obs according with their type;
- selection of the M nearest Obs for each type and for every quadrant of the circle.

Selection of the Observations (II)

STEP 2 - Statistical selection

Phase 1

- Selection of the parameteres kept after STEP 1
- Eliminating the redundant parameters on the vertical
- Selecting of the parameters situated beneath the lowest level which is analysed

Phase 2

- For every vertical point
  - Selection of the parameters located within a ΔP region
- For every vertical level and predictand
  - Selection of the best correlated predictors
  - Selection of the best correlated predictors with every predictands

QC of the Observations

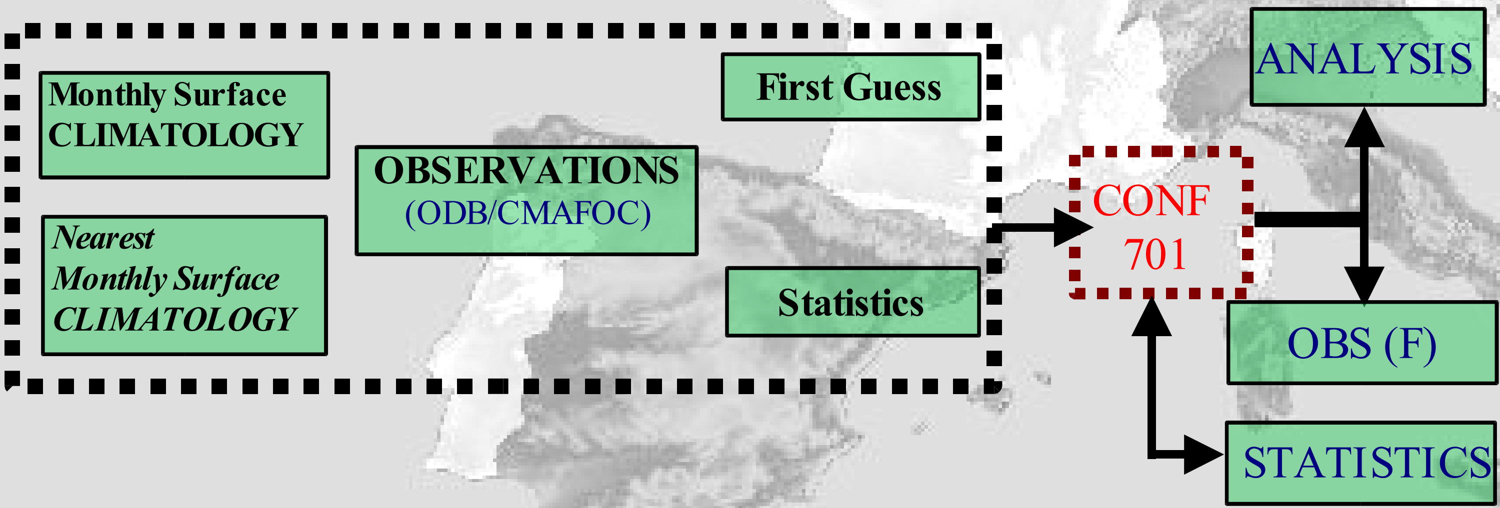
- ***STEP 1***
  - diff OBS - GUESS compared with standard deviation error $(\sigma_o^2+\sigma_b^2)^{1/2}$
  - ***MARKS:***
    5 - good
    3- doubtful
    2- bad
    1 - eliminated

- **STEP 2 - SPATIAL COHERENCE**
  - Diff OBS - ANALYSIS compared with standard deviation error $(\sigma_o^2+\sigma_a^2)^{1/2}$
  - MARKS:
    5 - good
    3 - doubtful
    2 - bad

- **STEP 3 - Synthesis of the QC**
  - the result from STEP 2 is prevalent when there is no doubt; otherwise the result from STEP 1 become crucial.

DATA FLOW

Climatological constraints are applied on surface fields only (T and water content)



Level 0 - Initialisation

CNT0
- SU0YOMA
  - SUDIM — SUDIMO
  - SUEDIM
  - SUALLO — SUALLOBS
  - SUELLO
- SU0YOMB
  - SUALGES
  - SUELGES
  - SUALCAN
- **CAN1** — First control level of CANARI

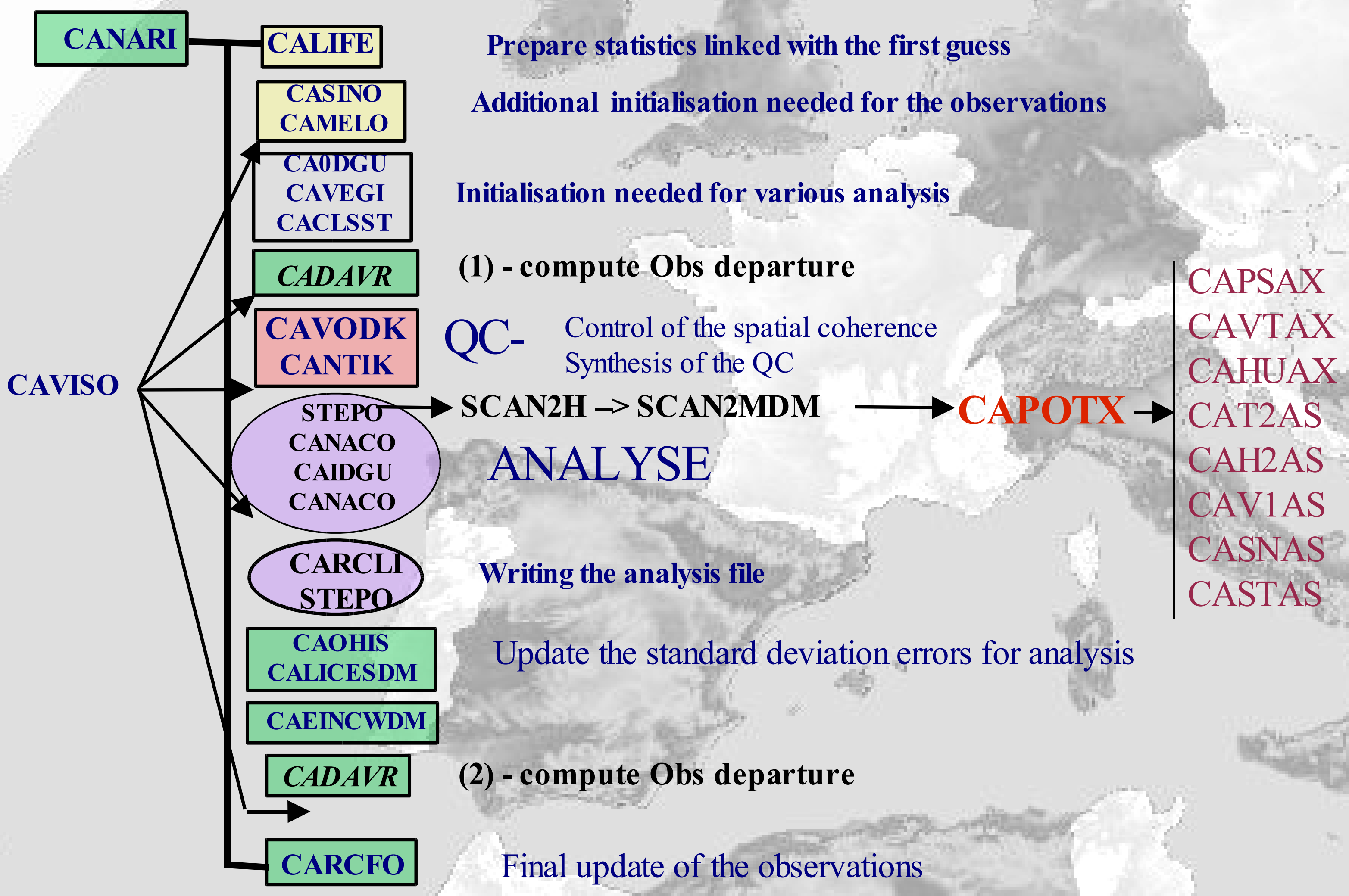
Level 1 - Initialisation and control

CAN1

- SU[1..3]YOM
- SUOBS — DEFRUN ↔ NAMOBS, NAMJO, NAMSCC
- CANAMI ↔ NAMPRE
- CANALI ↔ NALORI, NACTEX, NAIMPO, NAMCOK, NADOCK, NACOBS, NACTAN

  Setup of the predictors/predictands list for OI
- ELSAC
- CAEXCO
- CASINO
- CANARI

Code description ♦ algorithms and data flow: CANARI



The QC of the OBS

CAVODK | CARATK

CARNAK → CANEVA → CANADA

CANADA

- CASGVA **For each horizontal point - Geographical selection for a vertical**
- CAINSU **Initialization of statistical coefficients**

Statistical selection on vertical

- CASSVA **Statistical selection of predictors on vertical**
- CATRMA **Build the matrix of the linear system**
- CALINA **Solving of the linear system of OI**
- CAIMMA **Prints the matrix of the linear system**
- MXMAOP **Performs Legendre transformation**

Statistical selection point by point

- CASSVA
- CAMERA
- CATRMA
- CALINA
- CAIMMA
- MXMAOP

Analysis

STEPO → CAPOTX →

		PREDICTORS (what is used)
CAPSAX	- Surface pressure	- 10m Wind, Wind, Z, T
CAVTAX	- Wind and Temperature	- Z, T, Wind, layer thickness
CAHUAX	- Relative Humidity	- Rh on the level and layer
CAT2AS	- 2m T	- 2m T, T
CAH2AS	- 2m Rh	- 2m Rh, Rh
CAV1AS	- 10m Wind	- 10m Wind, Wind
CASNAS	- Snow cover	- Prec flux, Snow quantity
CASTAS	- SST	- SST