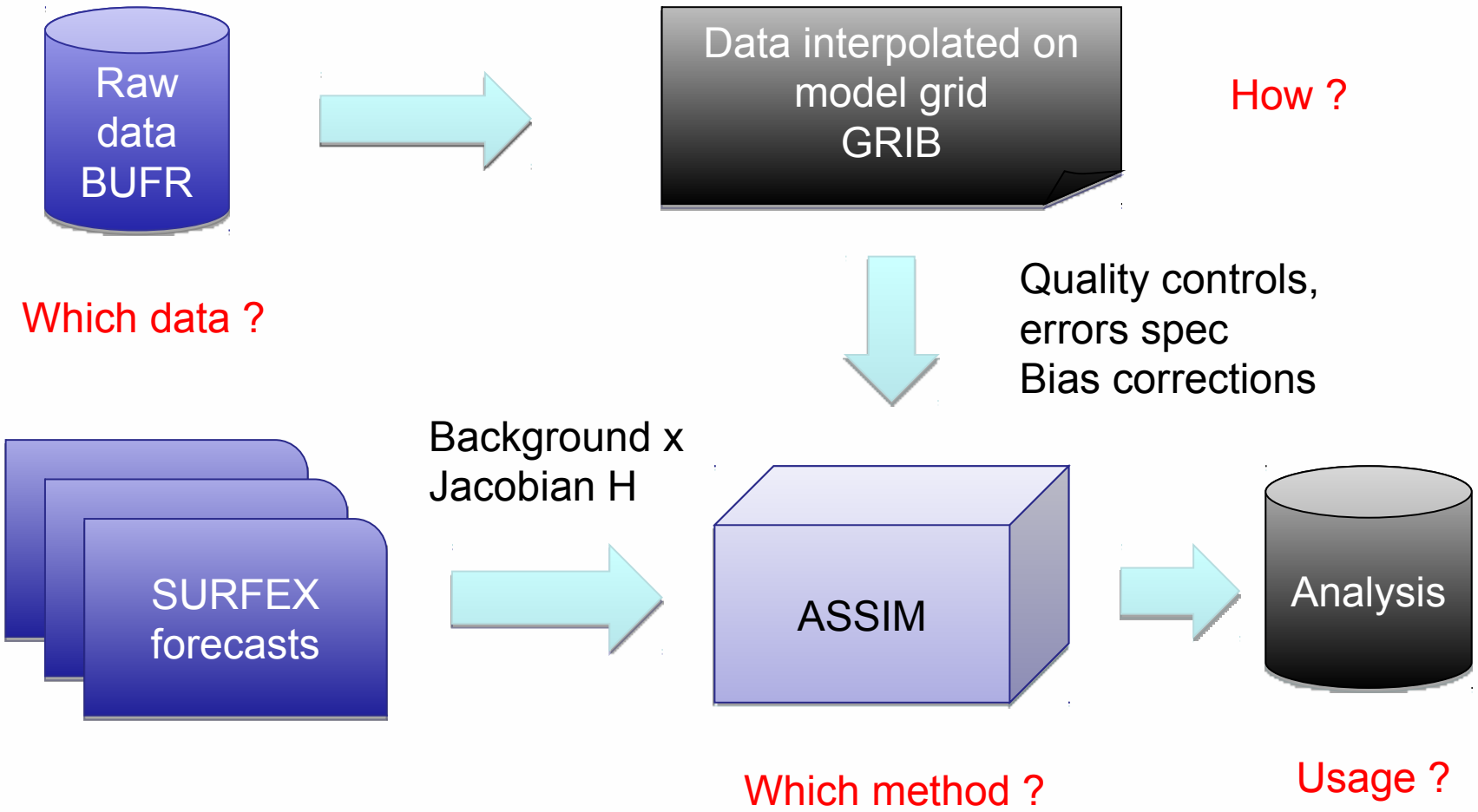
Survey on SURFEX DA

Group	NILU	FMI-RSHU	RMI	MetNo
Model variables	Soil moisture variables	Lake temperature, bottom temperature, ML depth, Shape factor, Ice coverage	Soil moisture and temperature variables	Snow cover and depth, SST, SIC, LST and ice cover, soil water and soil ice
Observations	L2 satellite data (AMSR-E, SMOS) T2m, RH2m (ASCII)	LST, sea-ice cover : in-situ, MODIS	SYNOP T2m and RH2m on model grid using CANARI	In-house SST and SIC, GlobSnow
Assimilation technique	EnKF, EKF, PF (offline)	EKF, KF	OI, EKF, STAEKF (offline + coupled)	OI but EKF soon (offline+coupled)
Domain	Europe, Amazon	Northern Europe	Belgium (4 km)	Northern countries
Planned developments	Compare EKF vs EnKF, PILDAS, assimilation of SMOS	Lake DA in SURFEX – DA for SWE	Use of LSA SAF products and radar derived precipitation in EKF/STAEKF	Merge OI_MAIN and EKF. Improvement to sno analysis. Parallelization of PDG/PREP/OFFLINE
Technical issues	Seamless use of updated SURFEX versions	Unknown	None	Speed increase, use of FA files, interpolation of LFI files, compatibilty between offline and NWP communities
Compatbility with SURFEX evolutions	Need to know SURFEX evolutions	Unknown	Yes	To be known during the workshop

Discussion on scientific aspects



Needs from various applications

- Numerical weather prediction : Initialisation of surface prognostic variables, real-time observations in appropriate format, efficient numerical codes, compatibility with atmospheric data assimilation

- Near-real time monitoring : initialisation of surface prognostic variables (+ optimal parameter tuning), near-real time observations, stand-alone application (independent choices for data format)

- Research applications : Flexibility for examining various scientific choices regarding surface assimilation, no real-time availability of data nor computational constraints (=> interest of PALM)

- Current SURFEX DA is supposed to be compatible with all applications

Assimilation techniques

- Optimum Interpolation
- Extended Kalman Filter (with simplified flavours)
- Ensemble Kalman Filter
- Short Term Augmented Extended Kalman Filter
- Particle Filters
- Adaptive filtering approaches

- The SURFEX Kalman Filters have been designed in a rather generic manner in order to accomodate different **control variables** (from various surface models) and **observation datasets** (but only with ASCII format)
- Improved specifications of model errors : use of ouputs from atmospheric assimilation and/or forecasting ensemble systems

Surface modules and observation operators

- Land surface schemes : **ISBA-2L**, ISBA-3L, **ISBA-A-gs**
- Improved land surface schemes : ISBA-DIF, ISBA-MEB
- Snow schemes : CROCUS / ISBA-ES
- Lake model : FLake

- Microwave radiative transfer model : CMEM

Datasets to be considered

- Snow water equivalent (GlobSnow product, MetNo product)
- Lake surface temperature (MODIS)
- Skin surface temperature over continents (SEVIRI/MSG)
- L-band brightness temperatures (SMOS)
- Surface albedo, LAI FaPar and Fcover (SEVIRI/MSG)
- River discharges and river heights

- LSA SAF downward radiative fluxes (SEVIRI/MSG)
- Surface precipitation analyses (national networks)

- Snow cover (CANARI)
- Screen-level observations (CANARI)
- ASCAT soil wetness index (BUFR)
- BioPar LAI

Discussion on technical aspects

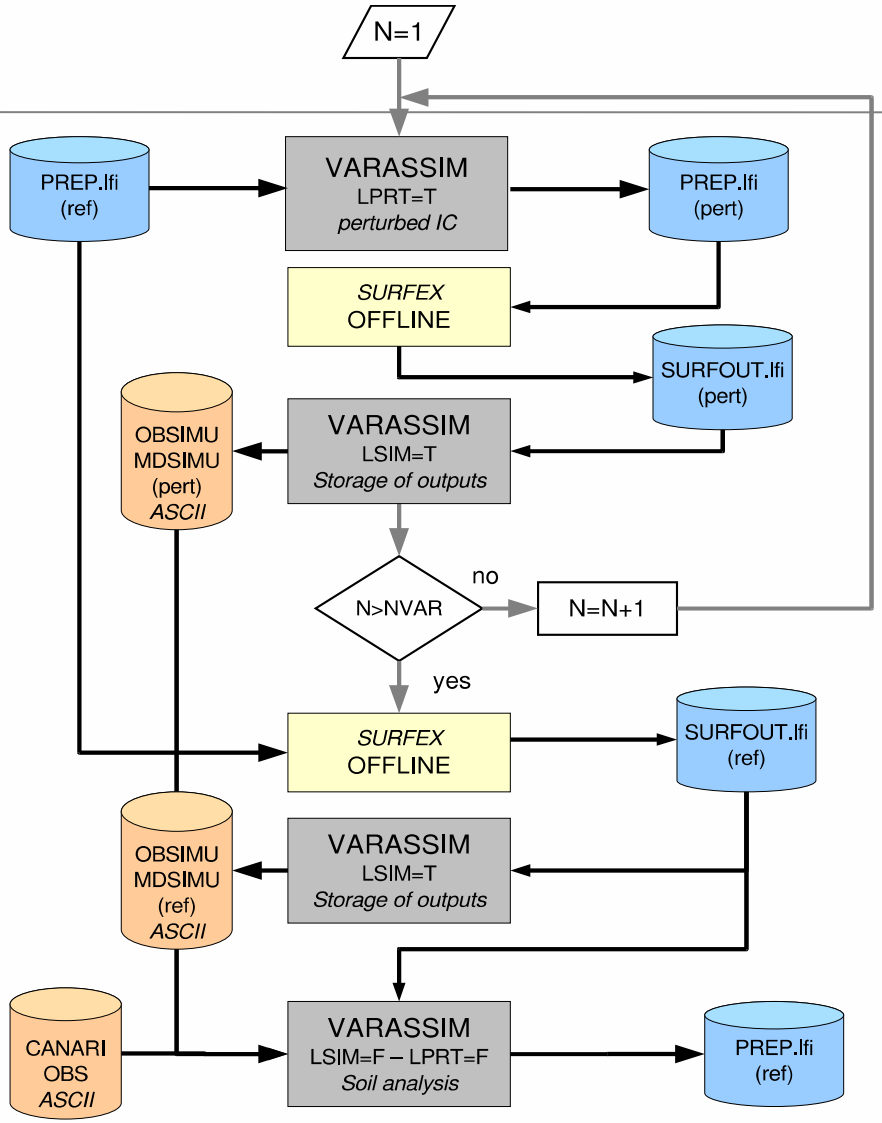


Figure 1: Flowshart of the EKF-SURFEX LDAS (corresponding to the various steps of the script `run_ekf.sh`) - NVAR corresponds to the dimension of the control vector.

Pre-processing of observations

- Data availability and data formats
- Projection on model grid (spatialisation tools, nearest neighbour, bilinear interpolation) – computational efficiency
- Scale issues : coarse resolution observation in fine scale model
- Bias correction schemes : constant, CDF matching, adaptive filtering
- Error specification : a-posteriori diagnostics (Desroziers method)
- Quality controls : measurement flags, consistency flags, background check
- Interest of accessing data through « ODB requests » (should be fine for ASCAT SM – ECMWF choice)
- Interest of projecting GEO satellite data on model grid (FA, GRIB)

Improving the EKF efficiency

- Possible options :
  - Coupling of the EKF within CANARI (suitable for NWP needs) – maintenance and evolution of tools would be compatible with the atmospheric assimilation
  - Parallel driver of SURFEX OFFLINE (OpenMP compatible)
- Interest of having an EKF using PALM ?

Known difficulties with SURFEX EKF

- Runs SURFEX OFFLINE several times to compute Jacobians (very slow, but can be parallelize)
- Data need to be interpolated on model grid first (issue for coarse resolution data) – pre-processing for bias correction
- Data format (ASCII) with one single observation file (no consistency checks on date and location)
- Each application has a different executable file : EKF and ENKF (also OI) => need to merge SURFEX DA options
- Main program VARASSIM is becoming rather big (used for several purposes)

- How to integrate the other analyses (albedo) ?

SURFEX data assimilation for next version

- By the end of 2012 ? SURFEX V7.3 ?
- Optimum Interpolation (maybe not required anymore since called from CANARI)
- Extended Kalman Filter from V6+ suitable for assimilation of :
  - Screen-level parameters
  - LAI
  - Soil Wetness Index
- Compatible with ISBA-2L, ISBA-A-gs (including patches)
- Inclusion of new capabilities (snow, multi-layer soil) : TBD
- Inclusion of improved Q term : TBD