Working Area Data Assimilation

Work Plan

Prepared by:	Area Leader Máté Mile
Period:	2017
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1Introduction and background

During the recent years, LACE data assimilation activities focused on the local development of “baseline” data assimilation systems at the LACE centres. It meant usually time demanding and technical challenges for the colleagues to build and later to maintain these local systems beside the their scientific works. The LACE DA Work Plan is trying to support this local efforts with basically short-term portable developments and also to target common achievable goals for long-term researches. For example short-term developments like the use of (new) observations and its pre-processing are recognised as vital and well-shared activities in LACE. On the other hand the limitations of the widely used 3DVAR require long-term developments to alleviate e.g. the representativity error in time by increased assimilation cycle frequency.

The Work Plan of 2017 will deliver actions already started in the previous years and also will give new LACE stays and few new actions. These DA activities can be grouped into algorithmic developments and the use of observations.

2Goals

The main data assimilation goals to be attained in 2017 are the following:

- Progress on algorithmic developments. The work on hourly updated analysis cycle (1h RUC) identified as an important activity in LACE. In 2017 the work on **non-cycled hourly** updated DA systems is being continued, however, it is still very important to study carefully the *initialization procedures, coupling strategies* and *the observation gaps* to be able to benefit later from **hourly cycled** systems. A dedicated “RUC” meeting of this action will be organized again in case of significant progress at the LACE countries. Also in connection with the hourly assimilation systems, the background errors of the DA systems are going to be studied in a separate action. Another important action is to improve surface assimilation system based on **Extended Kalman-Filter** (EKF) method which action was started around 2014-2015 and to be continued in 2017. Both conventional observations and satellite-derived products are going to be tested for operational and special project purposes. Still in 2017 the developments of **OOPS project** is important to follow and to be prepared for the data assimilation refactoring changes in the

upcoming common cycles. Through the local validation of toy models (3DVAR LAM prototype, HOP test harness) the refactoring will be studied in local computers with the resources of LACE.

– More effective use of observations in LACE DA systems. In order to improve local DA systems, the most natural way is to extend the observation set. Step forward is expected in 2017 with the studies and possible operational implementation of **GNSS ZTD**, **Mode-S** (EHS and MRAR) and **AMV** (Geowind, HRW, Multi-Metop) observations in different LACE DA systems. Also the new **radiance observations** from Suomi NPP (CrIS, ATMS) and DMSP (SSMIS) satellites (ATMS is already introduced in OPLACE) are planned to monitor and to use in data assimilation systems. On the other hand there are still open questions concerning the use of **RADAR** reflectivity and radial wind, especially on the field of RADAR data exchange and pre-processing. All these observational activities will be and have to be harmonized with OPLACE maintenance and development for the possibility of (re)distribution and pre-processing of these data sources.

3Main R&D activities

Action/Subject: ***Hourly updated DA systems (RUC, RAP, cycled and non-cycled hourly DA systems)***

Description and objectives: The hourly updated assimilation approach ensures efficient method to employ more observations with reduced representativity error in time. Hourly analyses can be carried out by fully cycled (RUC) and non-cycled data assimilation systems. In 2017 the following studies are going to be carried out:

- Determine appropriate initialization method for hourly forecasts and for hourly assimilation cycling to reduce spurious noises at the beginning of model integration and its accumulation during the first hour. In 2017 the different, available methods (IAU, DFI and IDFI) will be compared and tuned in AROME/Nowcasting (ZAMG) system.

- Continue the evaluation of AROME/Nowcasting (ZAMG) system performance using new objective verification methods from MET tool (MODE-TD, Grid-Stat, etc). Furthermore new case studies and long term impact studies are foreseen this year as well.

- Check the sub-hourly LBC coupling and verify the impact against current hourly coupling.

Proposed contributors, Estimated efforts: M. Mile (Hu), F. Meier (At), B. Strajnar (Sl), M. Pietrisi (Ro), 8 months (4 months LACE stay at ZAMG for Mirela Pietrisi (Ro))

Planned timeframe: whole year

Planned deliverables: report on LACE webpage

Action/Subject: ***Studies of background error statistics in 3DVAR***

Description and objectives: The representation of background error statistics is crucial in mesoscale DA systems. Flow-dependency, more accurate mesoscale structure functions are aimed to derive, however, it is difficult to achieve with the LACE's manpower and computer resources. In 2017 the following actions are foreseen:

- Regular B matrix upgrades at the LACE centres to follow local forecasting system changes and to improve climatological statistics by the use of mesoscale EDA.
- Computation of daily background error statistics from global and/or limited-area EDA is planned. The construction of the data sample, filtering the error noises and doing feasibility studies are included in this action to determine the LACE possibilities. For computer resources either local or ECMWF platform is going to be used and the possibility of ECMWF special project is foreseen. Detailed plan of this action is going to be provided in a separate document.
- To accomplish the action aims and requirements, cooperation with LACE Predictability Area is also considered.

Proposed contributors, Estimated efforts: B. Strajnar (Sl), A. Stanesic (Hr), T. Kovacic(Hr), M. Mile (Hu), 5 months

Planned timeframe: whole year

Planned deliverables: report on LACE webpage

Action/Subject: ***Surface assimilation using Extended Kalman-Filter***

Description and objectives: The Extended Kalman-Filter approach is able to use conventional and non-conventional observations to generate surface analysis. In this LACE action both AROME and ALARO models are

considered to be utilized with EKF, but more experiments have been carried out and currently are planned to execute with AROME model. In 2017 the following actions are foreseen:

- Prepare detailed validation of EKF algorithm with conventional observations (1D experiments, increments, Jacobian matrix and its elements, gridded observations)
- Assess the impact of the EKF analysis at the beginning and at the end of the assimilation window.
- Optimization work in operational framework
- Study the use of ASCAT-Sentinel-1 (soil moisture) and Sentinel-3 (surface temperature) products in EKF for special project purposes

Proposed contributors, Estimated efforts: H. Toth (Hu), V. Tarjani (Sk), S. Schneider (At) 6 months (4 weeks LACE stay at OMSZ for Viktor Tarjani (Sk), 3 weeks LACE stay at ZAMG for Viktor Tarjani)

Planned timeframe: whole year

Planned deliverables: report on LACE webpage

Action/Subject: ***Object Oriented code refactoring (OOPS) and LACE's contributions***

Description and objectives: The OOPS project coordinated by ECMWF is deeply refactoring the DA part of the ARPEGE/IFS common source code. In order to keep track with the source code changes of DA and to preserve the developments of LACE (especially for LAM observations), contributions are necessary. Beside the limited manpower resources the following work is planned:

- Continue the validation of OOVAR and make new local installation based on cy41-cy42.
- Build HOP driver with gmkpack and implement LAM specific observations
- Cooperate with MF, HIRLAM and ECMWF colleagues about the progress of OOPS developments.

Proposed contributors, Estimated efforts: M. Mile (Hu), 2 months

Planned timeframe: whole year

Planned deliverables: report on LACE webpage

Action/Subject: ***Assimilation of radiance observations in DA systems***

Description and objectives: The main goal of this action is to maximise the benefit of the use of satellite radiance data available via OPLACE system. In 2017 there will be new radiance observations from SuomiNPP and DMSP satellites already or soon available for the colleagues through OPLACE. The current list of activities is planned to be investigated:

- Monitoring and first evaluation of the use of radiance observations from SuomiNPP and DMSP
- Improve bias correction scheme for radiance observations (LAM aspects, LAM VARBC predictors, etc)
- Explore all sky radiances (availability, monitoring, error charactheristics)

Proposed contributors, Estimated efforts: P. Benacek (Cz), A. Trojakova (Cz), F. Meier (At), M. Mile (Hu), B. Strajnar (Sl), A. Stanesic (Hr), M. Pietrisi (Ro), 8 months

Planned timeframe: whole year

Planned deliverables: report on LACE webpage

Action/Subject: ***Implementation of RADAR reflectivity and radial wind***

Description and objectives: RADAR reflectivity and radial wind observations are crucial elements of a mesoscale DA system. In many LACE member countries, the RADAR network is currently upgraded. Due to the difficulties of RADAR data exchange and common pre-processing inside LACE the following actions were preliminary proposed as possible continuations:

- Bring closer cooperation with OPERA and utilize OPERA data and pre-processing i.e. prep_opera tool at LACE centers or in OPLACE. Due to OPERA and HIRLAM countries already developed a framework for RADAR volume data and its data assimilation, in 2017 LACE should actively contribute and extend the OPERA pre-processing further to get reasonably good data for LACE countries using directly OPERA data via Odyssey.

- Where the OPERA data exchange is not possible or problematic local studies or LACE internal data exchange can be executed.

Proposed contributors, Estimated efforts: T. Kovacic (Hr), A. Stanesic (Hr), F. Meier (At), M. Nestiak (Sk), 8 months

Planned timeframe: whole year

Planned deliverables: report on LACE webpage

Action/Subject: ***Assimilation of GNSS path delays (ZTD, STD refractivity index, gradient, etc)***

Description and objectives: The meteorological use of GNSS path delays are getting wider and wider by the development of new types of GNSS products. The most commonly tested ZTD is going to be closer to operational implementation in many centres, but other products like slant delay (and its obervation operator) is just under development. In 2017 the following activities are foreseen for this action:

- Study the pre-selection of active GNSS stations, the observation error and its application in an operational system.
- Extend and tune the VARBC settings for the use of ZTD.
- Define new VARBC predictors and predictor selection for ZTD
- Explore new type of products and its availability inside LACE

Proposed contributors, Estimated efforts: B. Strajnar (Sl), A. Stanesic (Cr), M. Mile (Hu), 6 months (2 weeks LACE stay at OMSZ for P. Benacek (Cz))

Planned timeframe: whole year

Planned deliverables: report on LACE webpage

Action/Subject: ***Assimilation of Mode-S (EHS and MRAR) observations***

Description and objectives: The aircraft derived Mode-S EHS and MRAR observations have a growing network inside LACE and in ALADIN/HIRLAM community as well. In 2017 more efforts will be put on the work of this type of observations. The following activities are currently planned:

- Explore the newly available Mode-S EHS and MRAR observations

- Investigate the impact of Mode-S EHS
- Continue the application of Mode-S observations in DA systems with increased assimilation cycle frequency.

Proposed contributors, Estimated efforts: B. Strajnar (Sl), P. Benacek(Cz), A. Bucanek(Cz), J. Kemetmuller(At), A. Stanesic(Cr) 8 months (3 weeks LACE stay for Benedikt Strajnar in Prague)

Planned timeframe: whole year

Planned deliverables: report on LACE webpage

Action/Subject: ***Study the use of AMV products (Geowind, HRW and Multi-Metop)***

Description and objectives: The atmospheric motion vectors provide reliable wind information to NWP data assimilation systems. Beside the long time used Geowind AMV, the new type of AMVs with increased number of wind vectors can serve considerable amount of data in a relatively small NWP domain. In 2017 the following actions are planned:

- The tuning and separation of AMV observation errors with respect to retrieval channels
- Study the distribution and quality of new Multi-Metop AMVs in LAM DA systems

Proposed contributors, Estimated efforts: F. Meier (At), M. Mile (Hu), B. Strajnar (Sl), A. Trojakova (Cz), A. Stanesic(Cr) 5 months

Planned timeframe: whole year

Planned deliverables: report on LACE webpage

4Summary of resources

Subject	Estimated manpower	From LACE	Other(HIRLAM, ALADIN)
Hourly DA system	8	8	
B matrix comp.	3	3	

Surf. Assim EKF	6	6	
OOPS cont.	2	2	
Radiance	8	8	
RADAR	8	8	
GNSS delays	6	6	
Mode-S	8	8	
AMV	5	5	
Total	**54**	**54**	

5Meetings, events and list of LACE stays

1)27th ALADIN Workshop and HIRLAM All Staff Meeting 2017, 3-6/04/2017 Helsinki. Finland (Mate Mile).

2)39th EWGLAM meeting and 24th SRNWP workshop 2017, 2-5/10/2017 Reading, UK (Mate Mile)

3)7 participants at DA Working Days 2017

4)3-4 participants at LACE RUC progress meeting ZAMG Vienna, Austria, 2017 (?)

1)LACE stay: Viktor Tarjani SHMU (EKF Assimilation) – 1 month, in Budapest (OMSZ), 2017

2)LACE stay: Viktor Tarjani SHMU (EKF Assimilation) – 3 weeks, in Vienna (ZAMG), 2017

3)LACE stay: Benedikt Strajnar ARSO (Mode-S assimilation) – 3 weeks, in Prague (CHMI) 2017

4)LACE stay: Mirela Pietrisi MeteoRomania (Hourly DA systems) – 4 months in Vienna (ZAMG) 2017

5)LACE stay: Patrik Benacek CHMI (GNSS ZTD) – 2 weeks, in Budapest (OMSZ), 2017

6Risk and constrain

The main risks for the next years are:

- The OOPS refactoring of DA configurations becomes invisible for LACE and the new source code (despite the aim of the refactoring) might give a bigger “blackbox” effecting more difficult local installation and validation procedure than it is now.
- The cooperation is not effective in many DA actions where it is crucial and should be. Most obviously the RADAR data exchange is a common interest, but for the time being there is no internal solution for that.