Working Area Data Assimilation

Work Plan

Prepared by:	Area Leader Benedikt Strajnar
Period:	2019
Date:	07/03/2019

Introduction and background

During the recent years, LACE data assimilation activities focused on the local development of "baseline" data assimilation systems at the LACE centers. One of the main issues encountered in this field is that the team members are highly loaded with maintaining and upgrading their local DA systems (as DA improves the complexity a NWP system) and often have to deal with their specific technical issues, which slows down the common development in the area.

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 research. For example short-term developments like the use of (new) observations and its pre-processing are recognized as vital and well-shared activities in RC LACE. On the other hand the limitations of the widely used 3D-Var require long-term developments to alleviate e.g. the representativeness error in time by increased assimilation cycle frequency.

The Work Plan of 2019 delivers ongoing actions started in the previous years and also a few updates to common actions. These DA activities can be grouped into algorithmic developments and the use of observations.

Goal

In algorithmic developments the work will focus on frequently (hourly) updated analysis cycle. In connection with the RUC assimilation systems, feasible improvements to specification of background errors is going to be studied in a separate action. Another important action is to improve surface assimilation system based on Extended Kalman Filter (EKF) method whose development started around 2015 and is to be continued further in 2019.

More effective use of observations stays the top priority of LACE DA systems. The most straight-forward approach to this goal is to extend the observation set and to maintain and monitor the quality of already used observations. Most of the efforts in upper-air data assimilation would be invested to implementation of the radar data assimilation which has been a wish for many years in the RC LACE member countries. Radar reflectivities are now at reasonable developed stage homogeneous while the usability of wind remains limited and also requires further algorithmic developments. Strong cooperation between member countries established in 2018 will continue in 2019. For other data types we foresee a partially shared work on further experiments and possible operationalization of GNSS ZTD, Mode-S (EHS and MRAR) and AMV (Geowind, HRW, Multi-Metop), radiances, scatterometer and microwave link observations in different LACE DA systems. For the well-established observation, the group will tightly follow the developments by Météo France, which is the most pragmatic approach taking into account the group's limited manpower.

Main activities

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

Description and objectives:

The more frequently updated assimilation approach ensures to employ more observations with reduced representativeness error in time. Hourly analyses can be carried out by fully cycled (RUC) and non-cycled data assimilation systems (e.g. RAP). In 2019 the following studies are going to be carried out:

- The experiments of AROME/Nowcasting (ZAMG) test version will continue in 2019. The 1.2 km experiments will include hourly 3D-Var in 2-hourly or hourly cycling, RADAR data assimilation, latent heat nudging and incremental analysis update (IAU). Further work will include finishing the evaluation, tuning of latent heat nudging and wind nudging, work on cloud analysis, inclusion of Mode-S and GNSS ZTD. A revision of 1.2 km B-Matrix is also planned. AROME/Nowcasting is planned to become operational by the end of 2019.
- Construction of an hourly RUC system gets more attention between LACE members next year. In Hungary a newcomer, Aniko Varkony will focus on experimenting with AROME-RUC on new super computer. In the Czech republic the diagnostic ALARO non-cycled system should be extended to a cycled one. In Slovenia, the plan is to develop a prototype of a 1.3 km hourly RUC. A 4-week stay of Anikó Várkonyi in Ljubljana will also be devoted to this subject.

Proposed contributors, Estimated efforts: F. Meier (At), P. Scheffknecht (At), F. Weidle (At), Anikó Várkonyi (Hu), P. Benáček (Cz), B. Strajnar (Si), M. Neštiak(SK), A. Trojáková (Cz), 13 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

Action/Subject/Deliverable: ***Studies of background error statistics in 3D-Var***

Description and objectives:

The representation of background error statistics with actual properties of the meso- and convective-scale systems (flow-dependency) improves the analysis of those systems. Recently the following ideas/tasks are foreseen to be potentially feasible in this subject:

- Recalculation of baseline climatological B-matrix is expected for members which are improving the spatial and temporal resolution of their DA systems.
- Representation of time-dependent background errors in a high resolution LAM EDA providing robust daily statistics. Objective filtering procedure has to be considered to avoid possible spurious sampling noises.
- Representation of spatially varying background errors by the previously tested grid-point background error standard deviation maps. The group will follow improvements and source code developments in the coming cycles.
- Error statistics for the methods allowing to preserve results of host model analysis in a LAM domain (BlendVar, Jk) will be investigated and further optimized.

Proposed contributors, Estimated efforts: K. R. Javorne (Hu), V. Homonnai (Hu), A. Stanešić (Cr), A. Bučánek (Cz), E. Keresturi (Cr), F. Meier (At), B. Strajnar (Sl), 12 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

Action/Subject/Deliverable: ***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 2019 the following actions are foreseen:

- Continue 1D-column validation with conventional observations
- Assess the impact of the EKF analysis at the beginning and at the end of the assimilation window.
- Optimization for operational framework
- Validation of newer model cycles and SURFEX releases
- Test the ISBA diffusion soil scheme

- 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: S. Schneider (At), J. Vural (At), V. Tarjáni (Sk), 8 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

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

Description and objectives:

The main goal of this action is to maximize the benefit of the use of satellite radiance data available via OPLACE system. The list of activities that should 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)
- Investigate use of microwave sensor ATMS that will replace AMSU-B/MHS on polar satellites. The benefit of ATMS data is that their allow its assimilation in cloudy areas. First tests with SUOMI- SSP were successful.
- More effort should be putted to assimilation of infrared sensor IASI, which is now available on polar satellites (Metop) as it will be included on board the next generation geostationary satellites (MTG).
- Effort should be putted to analysis of clouds.

Proposed contributors, Estimated efforts: F. Meier (At), B. Strajnar (Si), 1 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

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

Description and objectives:

RADAR reflectivity and radial wind observations are essential components of a mesoscale DA system especially with increased analysis cycle frequency. In 2017 discussion was started to target the common RADAR data assimilation goals in LACE for the next 3 years and moreover to request additional (manpower) support from LACE Council. In 2018 the cooperation was strengthened and allowed for increased progress in RADAR processing, and this will continue by the assimilation of reflectivity data in 2019. The following actions are foreseen:

- The new OIFS OPERA data homogenization tool will be validated in most of member countries (where it has not already been).
- The local implementation of RADAR assimilation of reflectivity at several LACE Members is planned, this will enable evaluation on test cases and periods.
- Solutions for wind dealiasing and quality control will be searched for in cooperation with OPERA User group.

Proposed contributors, Estimated efforts: B. Strajnar (Sl), P. Smerkol (Sl), M. Neštiak (SK), A. Dumitru (Ro), M. Mester (Hu), A. Stanešić (Cr), A. Trojáková (Cz), 18 PM

Planned time frame: whole year

Planned deliverables: report on LACE web page

Action/Subject/Deliverable: ***Assimilation of GNSS path delays (ZTD, STD, GNSS-RO, 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 at many centers, but other products like slant delay (and its observation operator) is just under development. In 2019 the following activities are foreseen for this action:

- Examination of the impact of GNSS-RO products.
- Sharing the experience with VARBC tuning for ZTD data between LACE members, and local implementation of ZTD assimilation.
- Examination of ZTD data assimilation in case of short cutoff times where degradation is observed.
- Examination of Slant Delays in cooperation with HIRLAM is expected in 2019.

Proposed contributors, Estimated efforts: M. Imrišek (Sk), B. Strajnar (Sl), F. Meier (At), F. Weidle (At), P. Scheffknecht (At), S. Panežić (Cr), 8 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

Action/Subject/Deliverable: ***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 PALADIN/HIRLAM community as well. In 2019, the following activities are currently planned:

- Explore the impact of newly available Mode-S EHS and MRAR observations.
- Continue the application of Mode-S observations in DA systems with increased assimilation cycle frequency.
- Coordinate pre-processing of local Mode-S EHS data with KNMI (Czech Republic, Slovakia, Slovenia, Austria).

Proposed contributors, Estimated efforts: P. Scheffknecht (At), B. Strajnar (Si), K. Čatlošová (Sk) A.Trojáková (Cz), 7 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

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

Description and objectives:

The atmospheric motion vectors provide reliable wind information to NWP. Beside the long time used Geowind AMV, the new type of Am Vs with increased number of wind vectors can serve considerable amount of data in a relatively small NWP domain. In 2019 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.
- Impact studies with HRW AMVs.

Proposed contributors, Estimated efforts: Z. Kocsis (Hu), 2 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

Action/Subject/Deliverable: ***Assimilation of attenuation in telecommunication microwave links***

Description and objectives:

The attenuation of telecommunication inter-antenna links in cellular networks due to rain is an attractive new observation data source (introduced by A. Overeem & H. Leijnse). ARSO gained access to a test data set for Slovenia (600 links), the pre-processing of this data to retrieve rain rate estimates already started. The following actions are planned:

- Refine the preprocessing to efficiently separate dry and wet attenuation.

- Assimilate the estimated rain rates (initially as saturated humidity observation in rainy areas) and study the impact.

Proposed contributors, Estimated efforts: B. Strajnar (Si), P. Smerkol (Si), 3 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

Action/Subject/Deliverable: ***Assimilation of scatterometer data (ASCAT, OSCAT, HSCAT)***

Description and objectives:

The scatterometer data are one of the rare low-level data source over water and thus important for domains with considerable ratios of sea. The ASCAT data from Metop satellites are available from OPLACE and operationally assimilated in Slovenia and Austria. The goal of this item is to investigate potential of other scatterometers which ware recently made available. The following actions are planned:

- Validate HSCAT (HY-2A) and OSCAT (Oceansat-2) data and assist dissemination through OPLACE.

Proposed contributors, Estimated efforts: B. Strajnar (Si), A.Trojáková (Cz), 1 PM

Planned time frame: whole year

Planned deliverables: report on the RC LACE web

Summary of resources

Subject	**Estimated manpower (PM)**	**From LACE**	**Other (HIRLAM, ALADIN)**
Local development	7	7	
Hourly RUC	13	13	
B matrix	12	12	
Surface EKF	8	6	
RADAR obs	20	20	
Radiance obs	1	1	
GNSS obs	8	8	

Mode-S obs	7	6.5	
AMV obs	2	2	
SCAT obs	1	1	
MICROLINK obs	3	3	
Total	**82**	**82**	

Meetings, events and list of RC LACE stays

AL travels:

1) Joint 29th ALADIN Workshop & HIRLAM All Staff Meeting 2019, 1-5 April 2019, Madrid, Spain
2) 41th EWGLAM meeting and 26th SRNWP workshop 2019
3) Spring and autumn LSC meetings and RC LACE management meeting
4) 7 participants at DA Working Days 2019

LACE stays:

1) Martin Imrišek (GNSS assimilation) – 1 month
2) Michal Neštiak (Radar assimilation) – 1 month
3) Alina Dumitru (Radar assimilation) – 1 month
4) Anikó Várkonyi (Hourly RUC) – 1 month
5) Viktor Tarjáni (EKF Assimilation) – 1 month (?)