SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year 2014

Project Title: Limited Area Ensemble Kalman Filter

Computer Project Account: SPITLEKF

Principal Investigator(s): Lucio TORRISI, Francesca MARCUCCI

Affiliation: CNMCA - Italian Met. Service

Name of ECMWF scientist(s) collaborating to the project
(if applicable)

Start date of the project: 2007

Expected end date: 2014

Computer resources allocated/used for the current year and the previous one
(if applicable)
Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	3000000	~~10~~100 %	4500000~~3000000~~	0
Data storage capacity	(Gbytes)			2000	0

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Summary of project objectives

(10 lines max)

The SPITLEKF main goal is to investigate methodologies to improve analysis and forecast skill of operational limited area NWP models through the use of an ensemble data assimilation algorithm based on a variation of the Ensemble Kalman Filter approach (LETKF). This is an important current research topic in meteorology and many competing approaches are currently under study and experimentation.

Summary of problems encountered (if any)

(20 lines max)

No real problem was encountered, neither technical nor conceptual.

Summary of results of the current year (from July of previous year to June of current year)

The Italian National Meteorological Center runs routinely an ensemble data assimilation algorithm based on the LETKF approach [1]. The CNMCA-LETKF data assimilation system [2,3] is used operationally to initialize the deterministic COSMO-ME model since 1 June 2011. LETKF is running with 40+1 members having a 10 km grid spacing. The observational dataset operationally ingested comprises radiosonde ascents (RAOB), surface pressure observations from land and sea stations (SYNOP, SHIP, BUOY), manual and automatic aircraft observations, atmospheric motion vectors from Meteosat, European wind profilers, scatterometer winds from METOP/OceanSat2 and AMSU-A/MHS radiances.

During last year a number of activities has been done to tune and improve the LETKF system. Major developments comprise:

- the assimilation of MHS radiances
- the implementation of a dynamical land emissivity retrieval algorithm [4]
- the implementation of a forecast sensitivity to observations diagnostic tool (FSO [5])

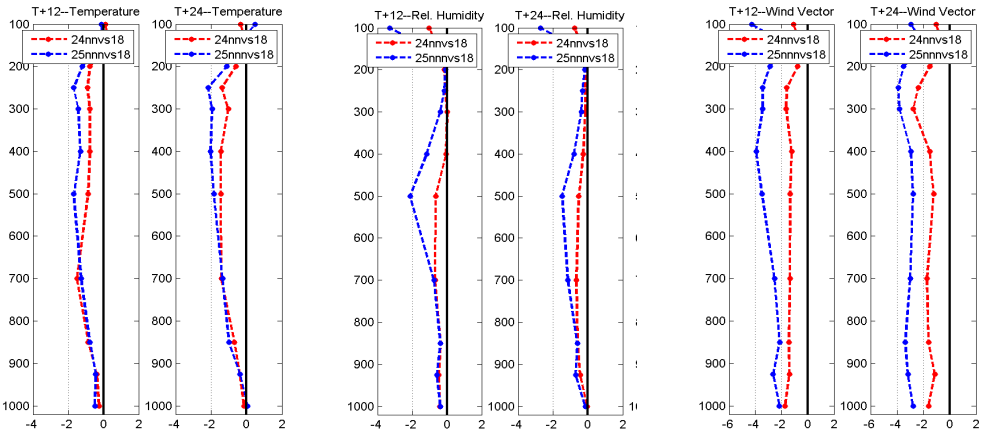

Fig.1: Relative difference (%) in RMSE computed against IFS analysis for 00 UTC COSMO runs from 16-09-2012 to 05-10-2012 with respect NO-RADIANCES assimilation, for temperature, rel. humidity and wind vector for T +12h and T+24h forecast. In blue impact of assimilation of both MHS and AMSU-A, in red assimilation of AMSU-A only. Negative values mean positive impact.

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The assimilation of MHS radiances have been recently introduced in the operational system because their clear positive impact on forecasts for all variables. As example the relative difference in root mean square error (rmse) computed against IFS analysis for temperature, relative humidity and wind vector for T+12h and T+24h forecasts is shown in Fig.1.

The "dynamical land emissivity retrieval" method proposed in Karbou et al. (2005) has been also implemented in our system in order to improve the specification of land surface emissivity. The method is applied to AMSU-A and MHS data: AMSU-A channel 3 and MHS channel 1 are used to estimate the emissivity for the other sounding channels. A clear positive impact is observed looking at the observation increment statistics, especially for AMSU-A observations (Fig.2), and at the relative difference in rmse computed against IFS analysis for different variables and forecast lead times (Fig.3) for the assimilation of both AMSU-A and MHS radiances.

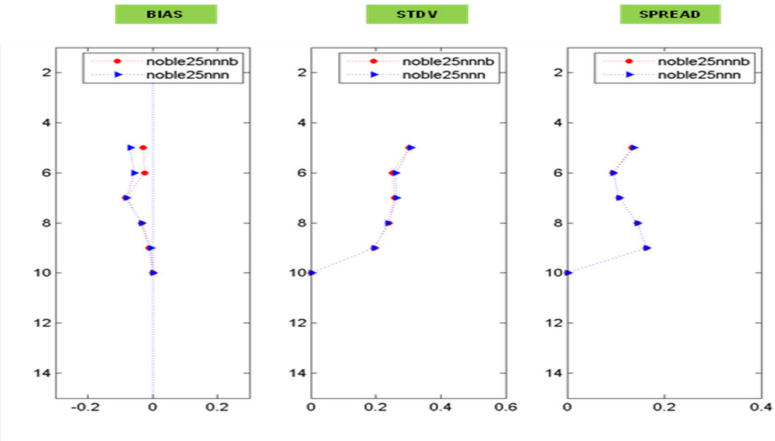

Fig.2: AMSU-A observation increment statistics (bias, stdv and spread) for the period 16-09-2012 to 05-10-2012.

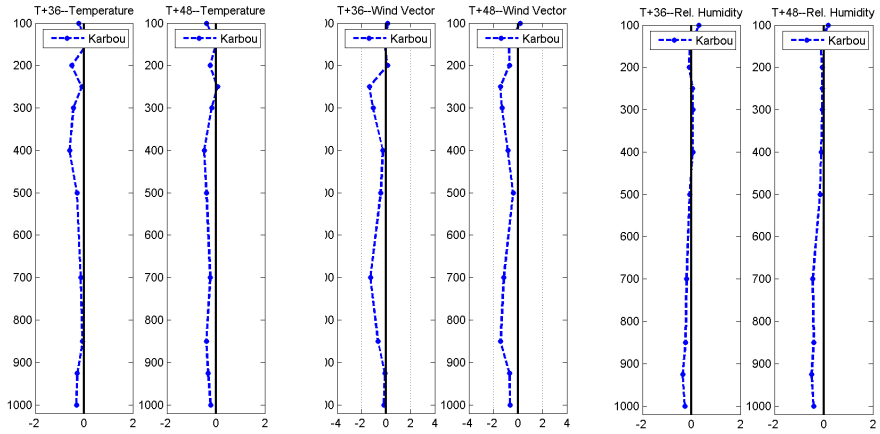

Fig.3: Relative difference (%) in RMSE computed against IFS analysis with respect to the configuration without dynamical emissivity retrival (MHS+AMSU-A assimilation) for 00 UTC COSMO runs from 16-09-2012 to 05-10-2012.

The estimation of the impact of assimilated observation has been investigated following the approach proposed in Kalnay et al. (2012). The impact of each class of observations on each variable that describes the system state (temperature, u and v components of wind, specific humidity) is calculated. Figure 4 illustrates the impact of observations on temperature, u and v

components of wind and specific humidity 6 hour-forecast in term of the moist total energy reduction. Looking at the total general impact picture, the larger contributions are from aircrafts and radiosounds observations, as expected, because their large amount, but, as enhanced in the singular impact figure (impact normalized by the number of observations), the bigger value is obtained for AMV observations.

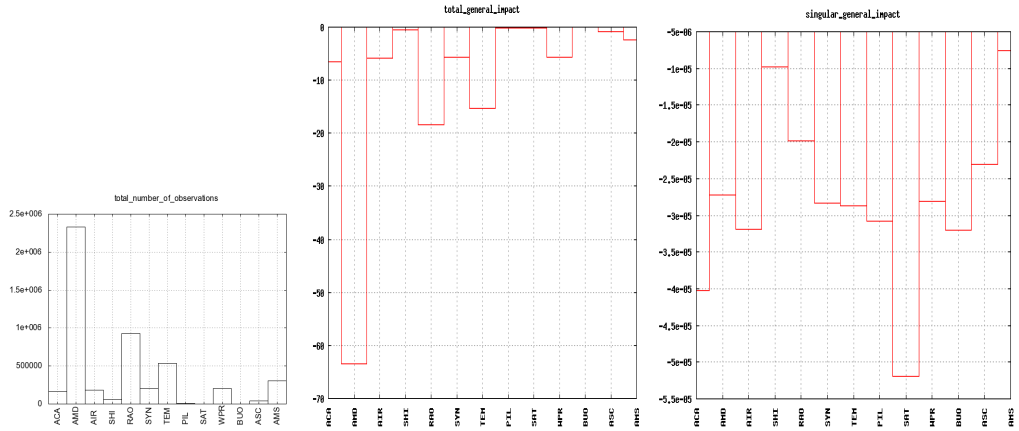

Fig.4: Observation statistics in the period 17 july -17 aug 2013 (left panel). Singular (right panel) and total observation impacts (central panel) on T,u,v,qv forecast; in the x-axis there are the classes of observations while numbers in y-axis represent the forecast error reduction due to each class of observations (moist total energy, J /Kg) in the period 17 july - 17 aug 2013 computed with FSO technique.

List of publications/reports from the project with complete references

[1] Hunt, B. R., E. Kostelich, I. Szunyogh. "Efficient data assimilation for spatiotemporal chaos: a local ensemble transform Kalman filter", *Physica D*, 230, 112-126, 2007

[2] Bonavita M, Torrisi L, Marcucci F. 2008. The ensemble Kalman filter in an operational regional NWP system: Preliminary results with real observations. *Q. J. R. Meteorol. Soc.* 134: 1733-1744.

[3] Bonavita M, Torrisi L, Marcucci F. 2010. Ensemble data assimilation with the CNMCA regional forecasting system. *Q. J. R. Meteorol. Soc.* 136: 132-145.

[4] Karbout F., Prigent C., Chevalier F., Bauer P. and Kelly G. (2005): AMSU-A lan surface emissivity estimation for nmerical weather prediction assimilation schemes. Journal of applied Meteorology, 44:416-426

[5] Kalnay E., Ota Y., Miyoshi T. and Liu J. "A simpler formulation of forecast sensitivity to observations: application to ensemble Kalman filters", *Tellus,* 64A, 18462, 2012

Summary of plans for the continuation of the project

(10 lines max)

Plans for the continuation of the project envisage the LETKF trial with a more complete subset of the operational observational dataset comprising nonlocal observations (I.e. radiances from ATMS and GPS total zenith delays).

Further investigation of model error representation is planned, particularly the implementation of a self-evolving additive noise and the use of stochastic physics perturbed tendencies approach.