ASSIMILAZIONE DI PRODOTTI SENTINEL, RIFLETTIVITÀ RADAR E FULMINAZIONI PER LA PREVISIONE DI EVENTI METEOROLOGICI ESTREMI: IL PROGETTO H2020 E-SHAPE

M. Lagasio[1], L. Pulvirenti[1], G. Squicciarino[1], S. Federico[2], R. C. Torcasio[2], S. Puca[3], A. Parodi[1]

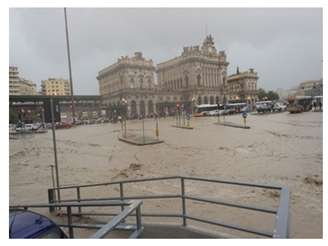
[1]CIMA Research Foundation, Savona, Italy

[2]CNR-ISAC, via del Fosso del Cavaliere 100, 00133 Roma, Italy

[3]Italian Civil Protection Department

I. INTRODUCTION

- A pilot application of the E-SHAPE "**EuroGEOSS Showcase: Applications powered by Europe**" project concerns disasters (e.g. *floods, fires*) in urban environment.
- One of the objectives of the pilot is the design of *innovative services for extreme-scale modelling* that make use of *Copernicus Earth Observation data*.
- An innovative service is a *hydro/fire-meteorological forecasting chain that systematically ingests high-resolution Sentinel-derived remote sensing products*

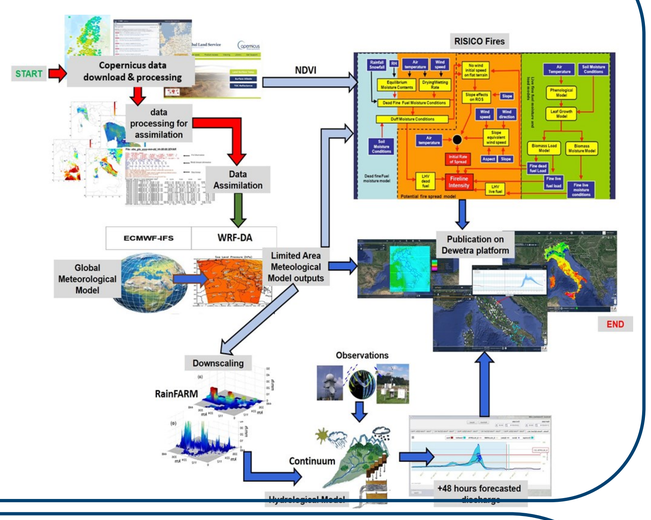


II. MOTIVATION

- Numerical Weather Prediction (NWP) models able to produce forecasts at very high resolution (km scale),but:
  - ✓ Inaccurate representation of the initial and boundary conditions is a major source of uncertainty
  - ✓ Assimilation of conventional observations cannot provide km scale description of the surface and the atmosphere
- The assimilation of Sentinel-derived products in a hydro/fire-meteorological forecasting chain can provide additional information for allowing high-resolution NWP models to reliably forecast high impact weather events such as floods or fires

III. THE FORECASTING CHAIN

- Automatic download & processing of Sentinel data
- Sequential run of
  - ➢ WRF-Data Assimilation
  - ➢ RISICO (Fire forecast)
  - ➢ RainFARM-Continuum (Flood forecast)
- Delivery of the maps to the end user (e.g. MyDewetra platform for the Italian Dept. of Civil Protection)

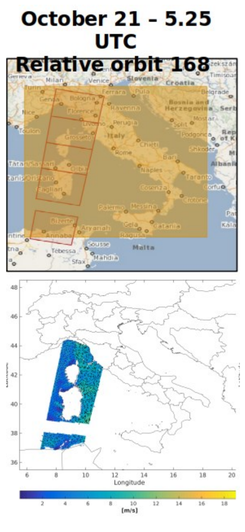


IV. THE EXPERIMENTS

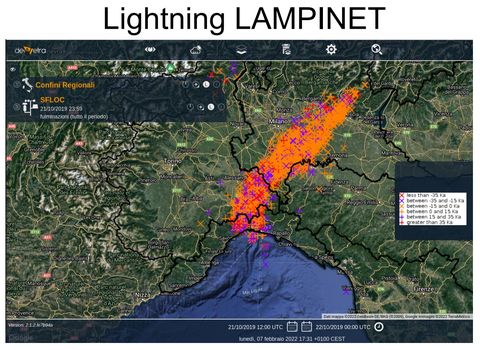
- Investigation on the effect of the assimilation in the WRF model of reflectivity radar data coupled with lighting and Sentinel-1 wind over ocean (OCN) observations.
- Experiments conducted considering a flood that hit the Liguria and Piedmont region on 21-22 October 2019

- Satellite OCN product assimilated at the time closer to their observation with 3DVAR (Lagasio et al., 2019a)
- Lightning data assimilated with nudging (Fierro et. al 2012)
- Reflectivity radar CAPPI assimilated with 3DVAR (Lagasio et al., 2019b).

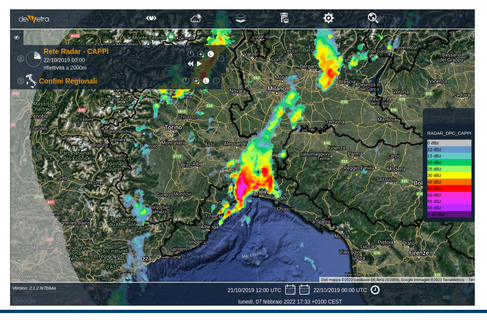
Sentinel-1 OCN



Lightning LAMPINET



Radar reflectivity CAPPI



Experiments:

CASE 1:
Open Loop (OL, GFS 00UTC) without data assimilation

CASE 2:
DA: 00UTC reflectivity, 03UTC reflectivity, 06 UTC reflectivity + Sentinel-1 OCN, lightning 06-15 UTC

CASE 3:
DA: 00UTC reflectivity, 03UTC reflectivity, 06 UTC reflectivity + Sentinel-1 OCN, lightning 06-18 UTC

CASE 4:
DA: 00UTC reflectivity, 03UTC reflectivity, 06 UTC reflectivity + Sentinel-1 OCN, lightning 06-24 UTC

CASE 5:
DA: 06UTC reflectivity+ Sentinel-1 OCN, 09UTC reflectivity, 12 UTC reflectivity , lightning 12-15 UTC

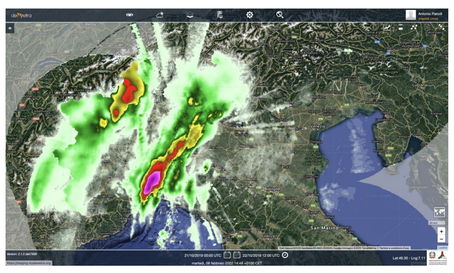
CASE 6:
DA: 06UTC reflectivity+ Sentinel-1 OCN, 09UTC reflectivity, 12 UTC reflectivity , lightning 12-18 UTC

CASE 7:
DA: 06UTC reflectivity+ Sentinel-1 OCN, 09UTC reflectivity, 12 UTC reflectivity , lightning 12-24 UTC

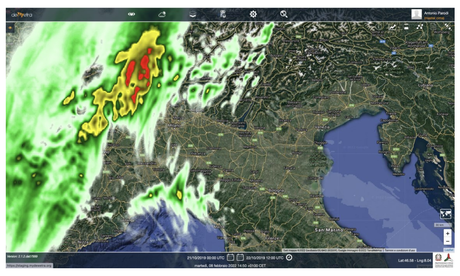
V. RESULTS & DISCUSSION

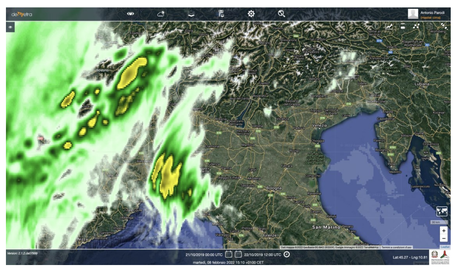
Cumulated rainfall 12-24UTC 21 October 2019

- OBS

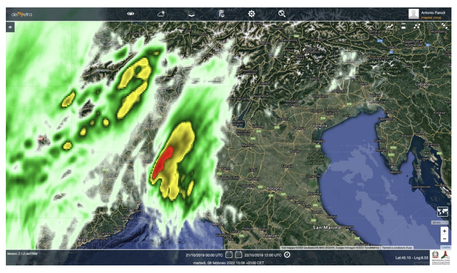


- OL (CASE 1)

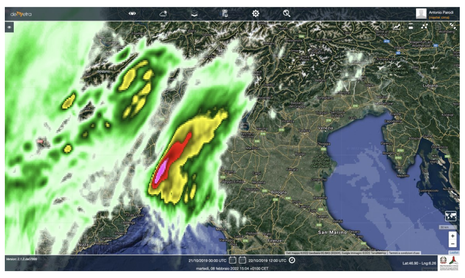




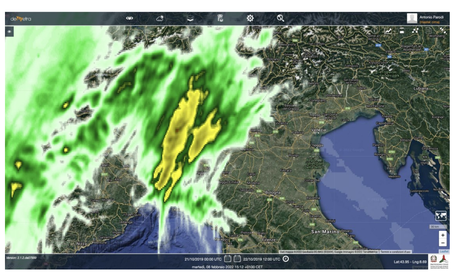
- CASE 2



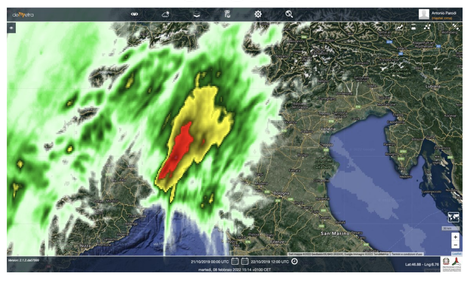
- CASE 3



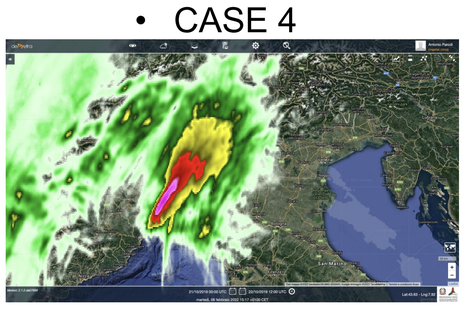
- CASE 4



- CASE 5



- CASE 6



- CASE 7

- The aim of this work was to investigate different variables assimilation effect on a very difficult forecast for the operational models.
- The Sentinel-1 OCN product assimilation allowed the model to correclty capture the typical v-shaped rainfall pattern (not shown).
- The reflectivity assimilation coupled with lightning assimilation is able to intensify the model rainfall.
- The best performances are obtained with simulations starting at 06 UTC with OCN and reflectivity data assimilated at the beginning of the other assimilation steps (CASE 6 and CASE 7).

REFERENCES

Lagasio, M., Parodi, A., Pulvirenti, L., Meroni, A. N., Boni, G., Pierdicca, N., ... & Rommen, B. (2019a). A synergistic use of a high-resolution numerical weather prediction model and high-resolution earth observation products to improve precipitation forecast. Remote Sensing, 11(20), 2387.

Fierro, A.; Mansell, E.R.; Ziegler, C.L.; MacGorman, D.R. Application of a Lightning Data Assimilation Technique in the WRF- ARW Model at Cloud-Resolving Scales for the Tornado Outbreak of 24 May 2011. Mon. Weather Rev. 2012, 140, 2609–2627.

Lagasio, M., Silvestro, F., Campo, L., & Parodi, A. (2019b). Predictive capability of a high-resolution hydrometeorological forecasting framework coupling WRF cycling 3dvar and Continuum. Journal of Hydrometeorology, 20(7), 1307-1337.

PROJECT

This work was carried out in the framework of the H2020 E-SHAPE project (Grant Agreement Number 820852).).