ASSIMILATION OF SENTINEL-DERIVED AND GNSS-DERIVED PRODUCTS IN HIGH IMPACT WEATHER EVENTS NUMERICAL SIMULATIONS: THE ESA-STEAM PROJECT RESULTS

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MOTIVATION

- There is a strong interest in forecasting heavy rainfall events because of their high impact on the society
- Numerical weather prediction models suffer from coarse resolution initial and boundary conditions

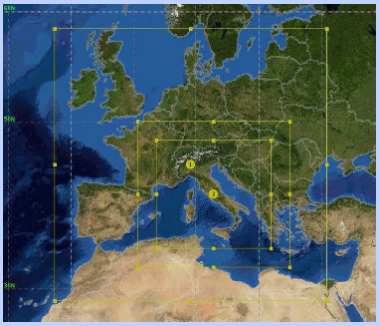
RESEARCH QUESTION
Does the assimilation of high resolution Earth Observation (EO) variables improve the forecast of heavy rain events?

Various data assimilation experiments are performed for two case studies:

- the Livorno 9-10 September 2017 case (brief and localized)
- the Silvi Marina 14-15 November 2017 case (extended and long lasting)

[Molini et al, 2011]

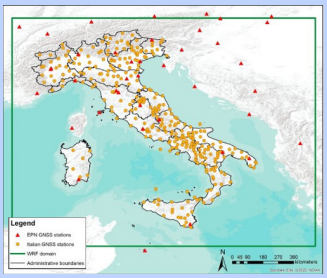
EARTH OBSERVATION PRODUCTS AND MODEL SETUP



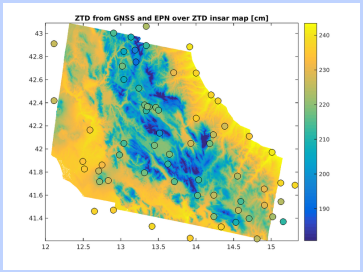
Products to be assimilated:

- Soil Moisture, SM (nudging-like)
- Surface wind, WIND (3DVAR)
- Sea Surface Temperature, SST (direct insertion)
- Land Surface Temperature, LST (direct insertion)
- Zenith Total Delay, ZTD, from GNSS (3DVAR)
- Zenith Total Delay from InSAR (3DVAR)

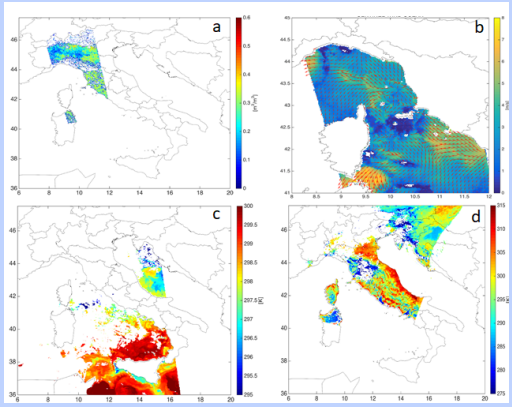
< WRF domains V3.8.1 at 13.5, 4.5 and 1.5 km. Initial and boundary conditions come from both NCEP-GFS and ECMWF-IFS.



^ Map of the GNSS receivers assimilated in the experiments.



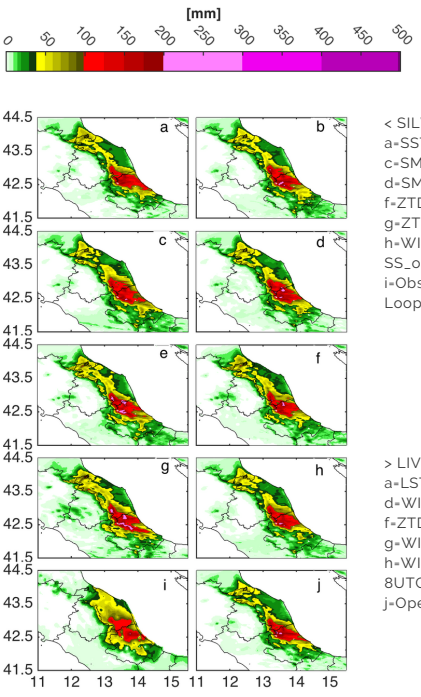
^ ZTD [cm] from InSAR at 05 UTC 14/11/2017, overlaid with the GNSS-derived ZTD.



> (a) Soil moisture [m^3/m^3] 18 UTC 08/10/2017 (b) Surface wind field [m/s] 18 UTC 08/10/2017 (c) Sea surface temperature [K] 21 UTC 09/10/2017 (d) Land surface temperature [K] 10 UTC 09/10/2017.

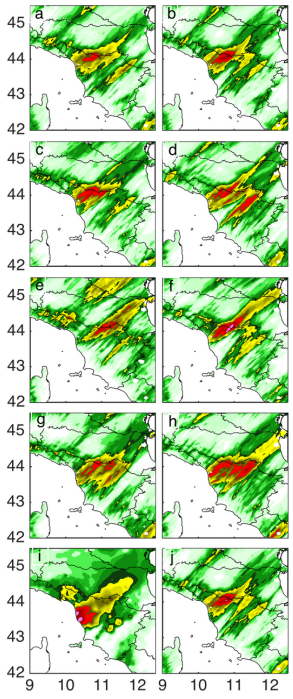
The satellite products are assimilated at the time of the passage. The ZTD from GNSS is assimilated every three hours (except when explicitly written).

3DVAR is performed with WRFDA [Barker, et al, 2012] V3.9.1. The background error covariance matrix is estimated with the National Meteorological Center method.



< SILVI MARINA
a=SST, b=SM-Sentinel 1, c=SM-SMAP/Sentinel 1, d=SM-SMAP, e=WIND, f=ZTD-INSAR, g=ZTD3h_1ist, h=WIND+SM+INSAR+GNSS_only5UTC, i=Observations, j=Open Loop

> LIVORNO
a=LST, b=SST, c=SM, d=WIND, e=ZTD3h, f=ZTD3h_1ist, g=WIND+SM+ZTD, h=WIND+SM+ZTD_only18UTC, i=Observations, j=Open Loop



RESULTS

Validation is performed with the MODE technique [Davis et al, 2006a,b] that calculates some spatial indices to compare the forecasted field and the observed one.

The timing and spatial coverage of the satellites are constrained by the satellite swat and, thus, are not always the most suitable: more experiments on that are planned.

TAKE HOME MESSAGE
Assimilating satellite-derived wind and/or water vapor content appears to have the largest positive impact on the forecast of heavy rain events.

REFERENCES
Barker et al (2012), Bull. Amer. Meteor. Soc., 93, 831–843.
Molini et al (2011), Q. J. Royal Meteorol. Soc., 137(654), 148-154.
Davis et al (2006a), Mon. Weather Rev., 134, 1772–1784.
Davis et al (2006b), Mon. Weather Rev., 134, 1785–1795.