Simulazioni Multi-Modello ad Alta Risoluzione della Tempesta Vaia sull'Italia Nord-Orientale

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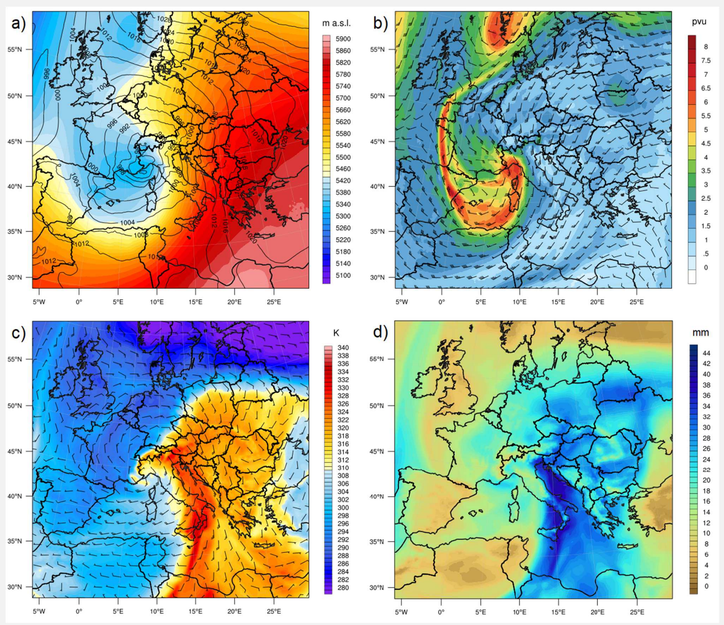
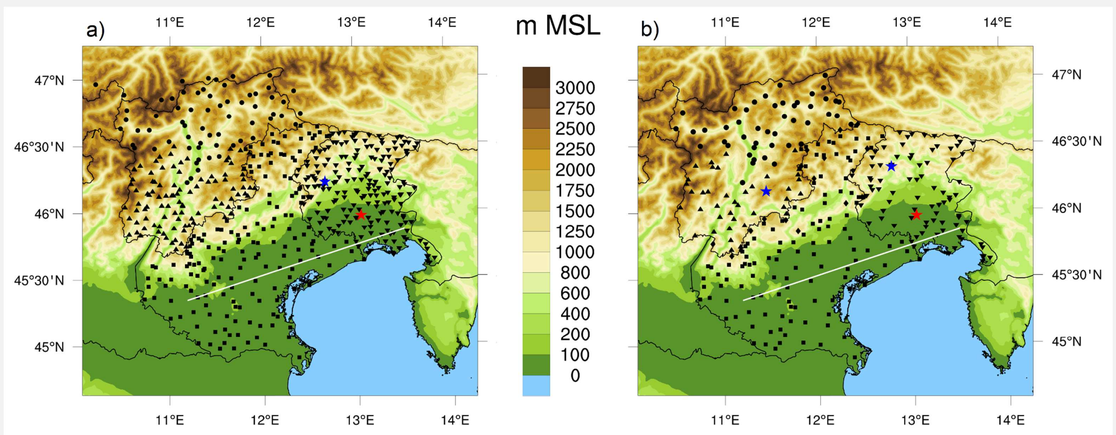
Synoptic Situation



Synoptic situation over Europe from GFS analysis at 18 UTC, 29 October: a) 500-hPa geopotential height (color shading) and sea-level pressure (isolines), b) mean potential vorticity in the 500–150 hPa layer and wind barbs at 300 hPa, c) equivalent potential temperature at 925 hPa and wind barbs at 925 hPa, d) precipitable water.

The synoptic situation over Europe was characterized by a trough, which deepened over the eastern Atlantic, extending to France and Spain, driving a strong moist flow towards the Alpine region. At the surface, a wide cyclonic area developed over the western Mediterranean. On 29 October at lower levels the Mistral generated an outbreak of cold air over the Gulf of Lion, which caused a sharp contrast with the warm and humid air advected by the strong southerly winds preceding the cold front. This represented a strongly baroclinic environment, favorable for the rapid deepening of the surface cyclone, which underwent an explosive intensification and attained the lowest value of 977 hPa, while moving northward towards northwestern Italy.

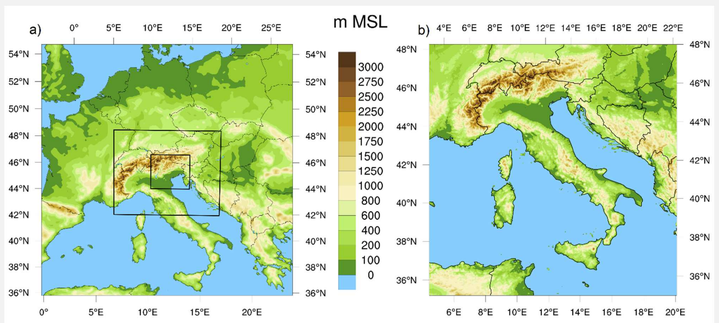
Observations



Weather stations used in the present work for a) precipitation, and b) wind speed. The blue stars in b) represent the stations used in the bottom-right figure of the poster. The red star in a) and b) represents the location of the sounding data. The white line in both a) and b) shows the section represented in the bottom-left figure of the poster.

- 531 hourly time series of precipitation
- 192 hourly time series of wind gust
- Maximum daily wind gust from additional 122 stations
- Sounding data from Udine Rivolto

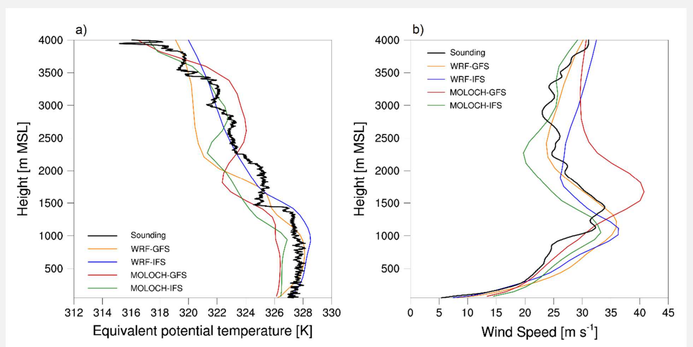
Modeling Set Up



Domains used for the simulations with a) WRF b) MOLOCH.

Simulations with WRF (1-km resolution) and MOLOCH (1.25-km resolution) using initial and boundary conditions from GFS and IFS global models, for a total of 4 simulations (WRF-GFS, WRF-IFS, MOLOCH-GFS, MOLOCH-IFS).

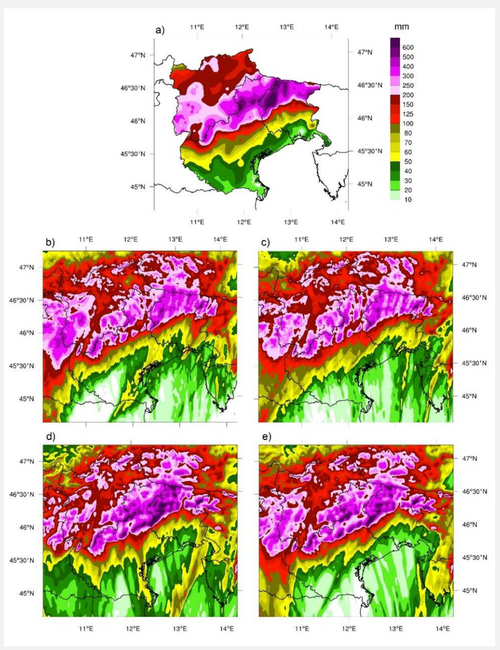
Modeling Results: Soundings



Profiles of a) equivalent potential temperature and b) wind speed at 18 UTC, 29 Oct from soundings and simulations.

The vertical profiles of equivalent potential temperature and wind speed from soundings indicate the presence of a low-level jet at 18 UTC, 29 October, reaching its maximum intensity at the top of the mixed-layer displaying a uniform vertical profile of equivalent potential temperature. All simulations capture this wind maximum, even though with some differences with respect to observations.

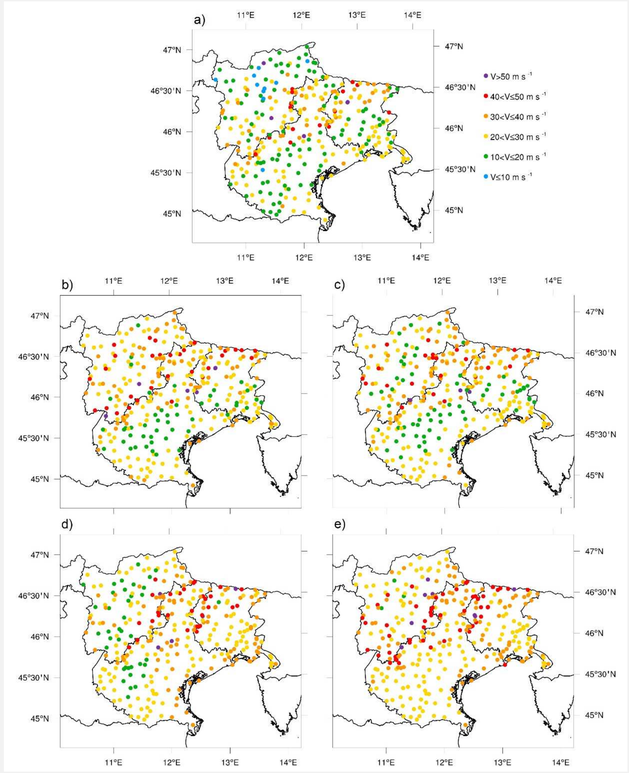
Modeling Results: Precipitation



72-h accumulated precipitation from a) observations b) WRF-GFS, c) WRF-IFS, d) MOLOCH-GFS, e) MOLOCH-IFS.

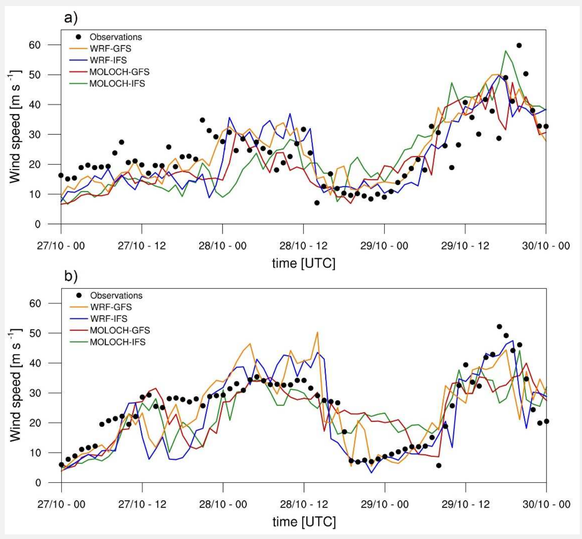
All simulations capture the spatial distribution of precipitation, with maximum values in the prealpine region and a sharp gradient from the plain to the mountain. However, the maximum values of accumulated precipitation are underestimated by both WRF simulations, while MOLOCH better reproduces extreme values in the Alpine area, even if rainfall tends to be overestimated over the southernmost prealpine reliefs.

Modeling Results: Wind

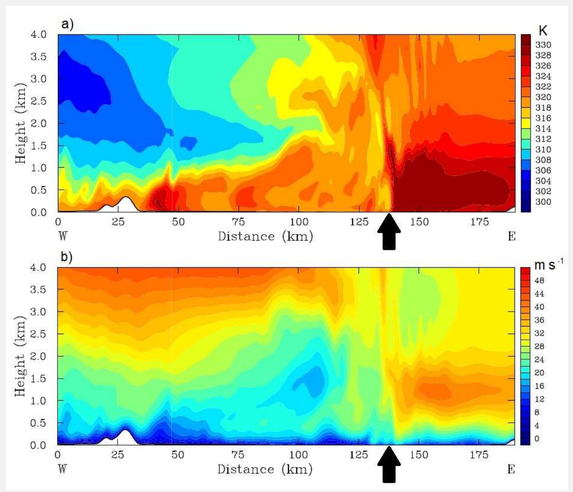


All simulations tend to overestimate the maximum wind speed, especially in the northwestern part of the region of interest. Wind speed is overestimated especially in narrow Alpine valleys, which are not well reproduced by the models orography even at the rather high resolution adopted.

Left: Maximum wind gust at 10 m AGL over the entire event at the available weather stations from a) observations, b) WRF-GFS, c) WRF-IFS, d) MOLOCH-GFS, e) MOLOCH-IFS. Bottom: Hourly time series of the maximum wind gust at 10 m AGL from observations and modeling results at a) Passo Manghen and b) Malga Rest.



Modeling Results: Low-Level Jet



Cross section of a) equivalent potential temperature and b) mean wind speed from WRF-GFS at 18 UTC, 29 October. The black arrows indicate the approximate position of the cold front at the surface.

A low-level jet is located immediately east of the cold front. Considerably lower wind speeds are found in the low levels behind the cold front, as opposed to stronger wind speeds at higher levels, connected with the passage of the main upper tropospheric jet.

All simulations well capture the temporal evolution of the wind speed during the three days at two representative weather stations, and in particular the two periods characterized by strong wind intensities, strictly related to precipitation. It is worth noting that, even after more than 3 days of simulation, the models are able to simulate extremely high values of wind gusts, very close to the observations.

More information: Giovannini et al., 2021, Multi-model convection-resolving simulations of the October 2018 Vaia storm over Northeastern Italy, *Atmos. Res.*, 253, 105455, https://doi.org/10.1016/j.atmosres.2021.105455.