

## OPERATIONAL SETUP

The operational model version used is AL38T1 with ALARO0 physics for 8, 4 and 2 km resolution forecasts.

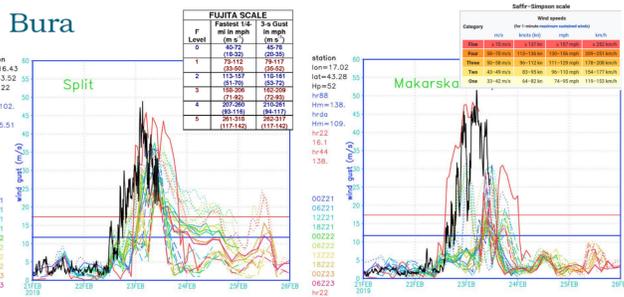
Operational forecasts run for:

- ALADIN-HR8: 8km horizontal grid spacing, 37 levels; CA-NARI+3DVar with 6h cycle (no DFI); 72h fcs., (with DFI) ECMWF LBC (lagged mode), 4 runs per day (00, 06, 12 and 18 UTC); hydrostatic
- ALADIN-HR4: 4km horizontal grid spacing, 73 levels; CA-NARI+3DVar with 3h cycle (no DFI); 72h fcs. (with DFI), ECMWF LBC (lagged mode), 4 runs per day (00, 06, 12 and 18 UTC); hydrostatic
- ALADIN-HR2: 2km horizontal grid spacing, 37 levels, SSDFI, 24h fcs. hours, ALADIN-HR8 LBC, 1 run per day (06 UTC); non-hydrostatic
- ALADIN-HRDA: 2km horizontal grid spacing dynamical adaptation of wind; hydrostatic

## EXTREME WEATHER EVENTS

In the (very) early morning hours of 2nd October 2018, Dubrovnik experienced a torrential rain that brought more than 260 mm in 3 hours. It was a localized storm above the area, while most of the surroundings remained dry. Operational HR2 forecast (NH ALARO 2km run) forecasted very intensive precipitation in the same 3 hours over and near Dubrovnik (picture not shown).

In February 2019, severe bura conditions over Croatian Adriatic coast were fairly well forecasted by the HR2 suite. The event was record breaking, but strong and severe bura events are not rare, and happen regularly between November and March. Just for reference, please observe that such wind strength fits hurricane category 3 on a Saphir Simpson scale or tornado F2 on Fujita scale.

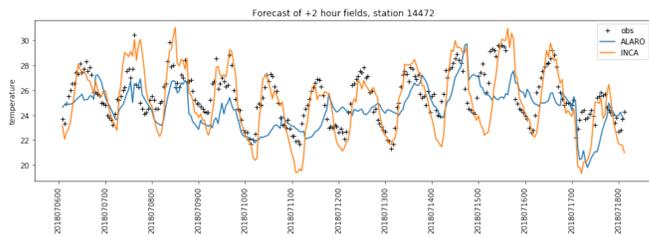


Wind gusts (m/s) in Split and Makarska with Fujita and Saphir Simpson scale for comparison

## NOWCASTING

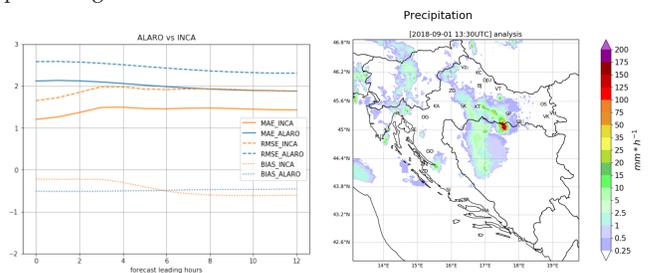
INCA system was implemented and verified against ALADIN-HR4 forecast. Seven stations (4 of them not used for analysis calculation) were used for the INCA forecast field verification and its comparison to the ALADIN-HR4 forecast fields (also used as INCA background).

Comparison showed overall improvement over ALADIN during first six hours of INCA run initiation. Two significant ALADIN forecast runs (00 and 12 UTC) were also isolated and compared to the INCA forecast fields. It was shown that ALADIN's cold temperature bias during the day and warm temperature bias during the night were significantly corrected by the INCA nowcasting system (picture not shown).



2m temperature +2h forecast from INCA (orange), ALADIN-HR4 (blue) and observations (black cross) for 10 days in July 2018 for station 14472

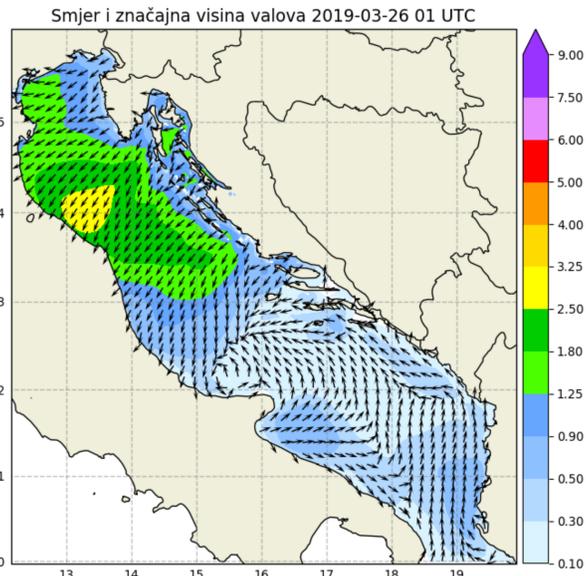
INCA precipitation module was set up, using the 15 min OPERA (Operational Programme for the Exchange of weather Radar information) radar composites as background and automatic rain gauge network for corrections. Despite the lack of radar measurements along the Croatian coast, first results look promising.



Left: Mean absolute error, bias and root mean square error for INCA (orange) and ALADIN-HR4 (blue) plotted against INCA forecast hour and calculated over 7 stations and time period 2018/06/20-2018/08/20. Right: example of one precipitation analysis field

## WIND WAVE MODEL

Wind Wave Model III is coupled (one way) to the dynamical adaptation (HRDA) wind fields (operational since 2019/01/14). It runs once per day (00 UTC) and produces 72 hour forecast of significant wave height and direction with temporal resolution of 1 hour.



Significant wave height and direction forecast for bura case

For more information check the article Dutour Sikirić, M. et al (2018): Operational Wave Modelling in the Adriatic Sea with the Wind Wave Model. *Pure and applied geophysics*, 175, 3801-3815.

## ECOCLIMAP EVALUATION

In preparation for the use of SURFEX, ECOCLIMAP v2.2 cover types over Croatia were assessed. For the Croatian domain, 600x760 matrix was extracted and analysed.

Analysis showed there were some islands along the coast, smaller towns, bays and lakes missing. Apart from missing lakes, some extra appeared as well. Here is an example where a bay at the island of Pag (left picture) became a relatively smaller lake in the ECOCLIMAP database (highlighted in dark blue on the right picture).



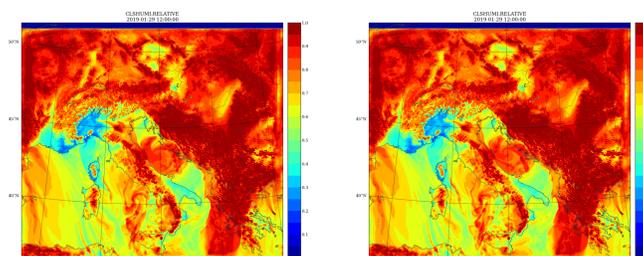
False representation of sea and ocean as inland waters cover type

Other features worth mentioning are complete lack of rocks in the entire domain and too large percentage of C4 crops along the coast where shrubs are prevalent. Due to many errors, corrections will be made using the Croatian Agency for Environment and Nature natural habitats database and the new CORINE 2018 database.

## CY43 CLIMATOLOGICAL FILES

During the LACE stay, in collaboration with Claude Fischer, Alexandre Mary and Florian Suzat from Météo France, e923 procedure was updated to cy43 and tested on the Croatian HR4 domain. Croatian operational ALADIN-HR4 suite was run with the new climatological files for further verification and compared with the operational suite forecast that uses cy40 climatological files.

Comparison showed that new climatological files produce the same meteorological shapes in the forecast, but due to slight differences in orography some differences are introduced to the forecast. These differences slowly accumulate over time and become visible by the end of the forecast time (+72 hours).



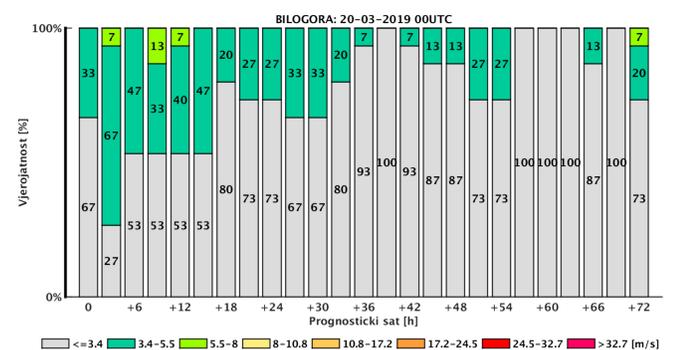
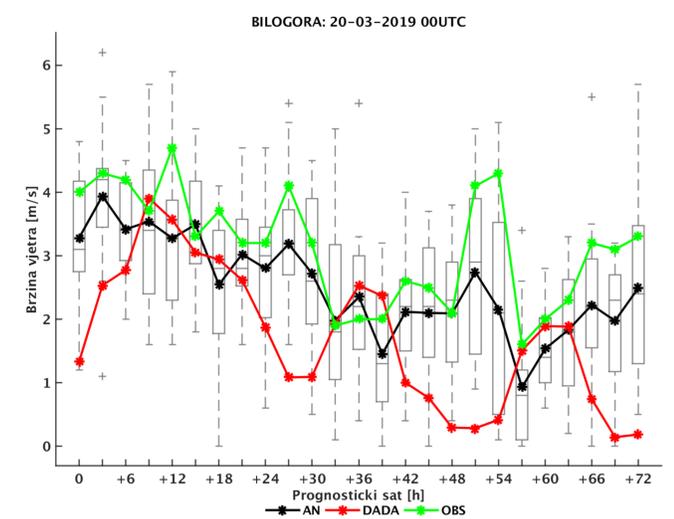
+72 forecast 2m humidity fields with cy40 (left) and cy43 (right) climatological files

## ANALOG-BASED METHOD

The analog-based method is operationally generating predictions for 16 locations in a test mode since 2016/11/24 to further improve HRDA wind speed predictions and assess prediction uncertainty.

Comparing 5 different predictors (wind speed and direction, temperature, relative humidity and pressure) within a 3-lead-time-steps wide time window, it seeks for the most similar numerical predictions for the same lead time in the past. Then, by using the corresponding measurements, it forms 15-member ensemble.

In addition to predicting the mean of this analog ensemble (AN) with ensemble spread (shown via boxplots), probabilistic prediction is also generated for 8 wind speed categories. The lead time step of these forecasts is 3 h, up to 72 h ahead.



Deterministic (up) and probabilistic (down) forecast with analog-based method for station Bilogora

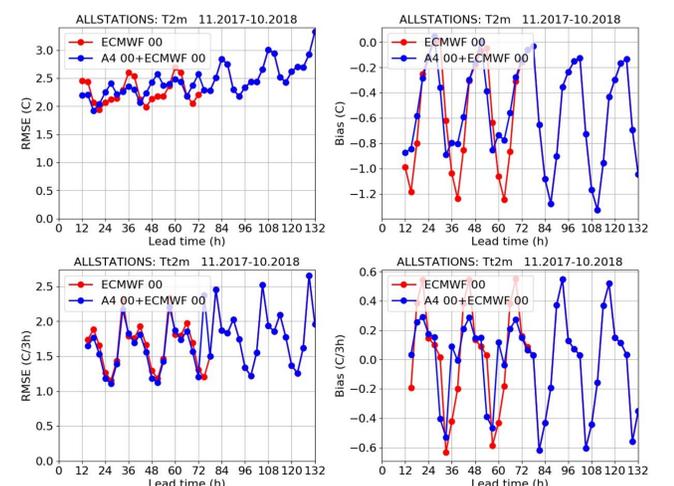
## TEMPERATURE FORECAST

Comparison of ALADIN and ECMWF temperature forecast was done using ALADIN-HR4 model and ECMWF (operational, 9 km) on 30 stations in Croatia during 1 year period (11.2017-10.2018). Verification was done for temperature (T2m) and temperature tendency (Tt2m).

Goal: verify both models and assess potential issues when joining ALADIN 0-72 hr forecast range and ECMWF 75-132 hr forecast ranges into point forecasts

Conclusions:

- ALADIN has lower T2m and Tt2m bias than ECMWF and comparable rmse
- discontinuity at the model discontinuity forecast range (75 hr) is not seen in T2m, but is evident in Tt2m
- Tt2m error at the model discontinuity forecast range is comparable with maximal T2m errors found for other forecast ranges



Bias/rmse (up) and bias/rmse tendencies (down) in A4 and ECMWF T2m forecast