

Meteorological support for forest fire protection



Lovro Kalin, Marija Mokorić, Tomislav Kozarić, Tomislava Hojsak
kalin@cirus.dhz.hr



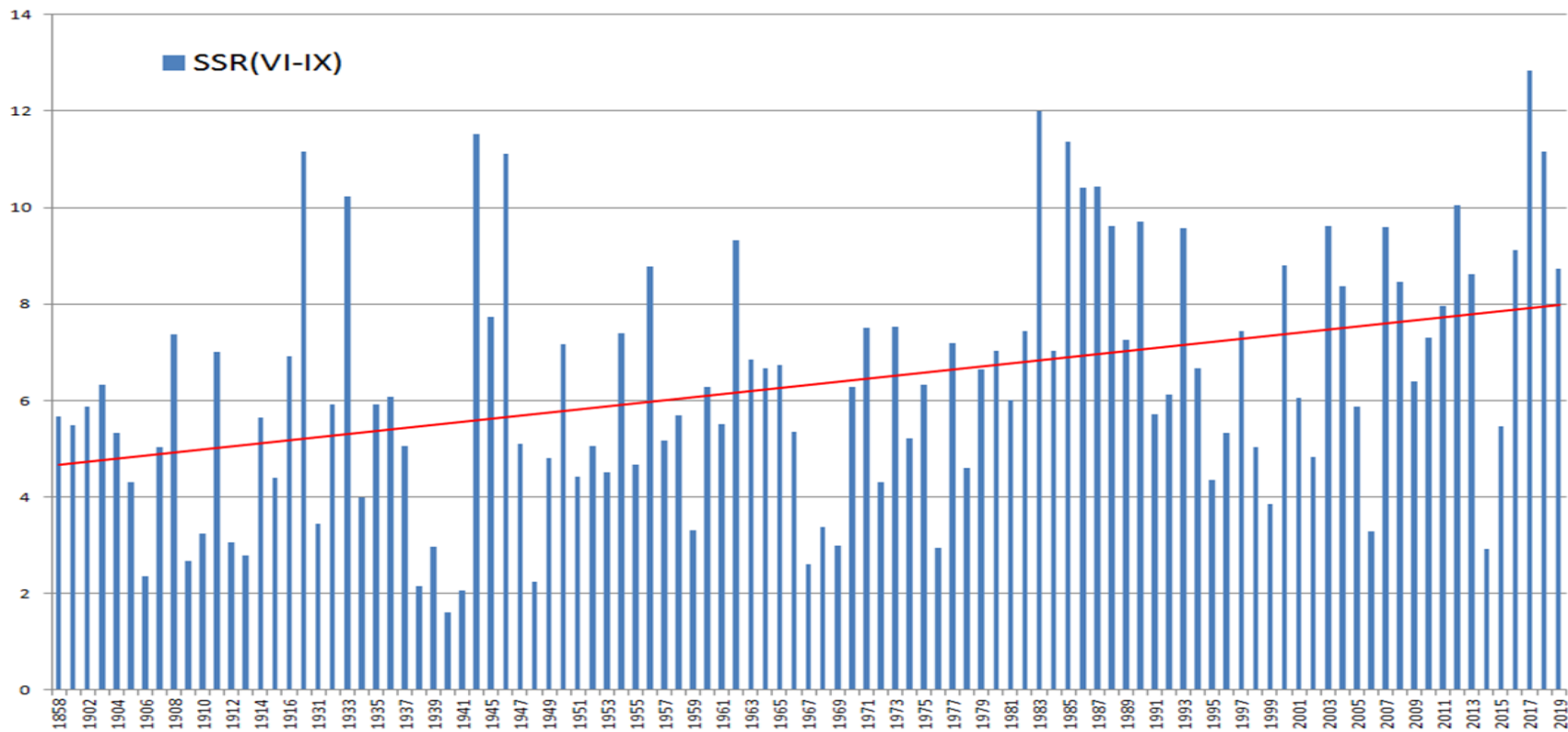
Forest fires in Croatia

- Croatia prone to forest fires, especially in the last two decades
- most frequent and severe in the Adriatic, particularly in summer season
- increasing danger to environment and community
- large fires pose serious crisis events (e.g. Split fire in 2017)
- weather is one of three most important factors for ignition and spread of fires
- weather conditions deteriorate due to climate change

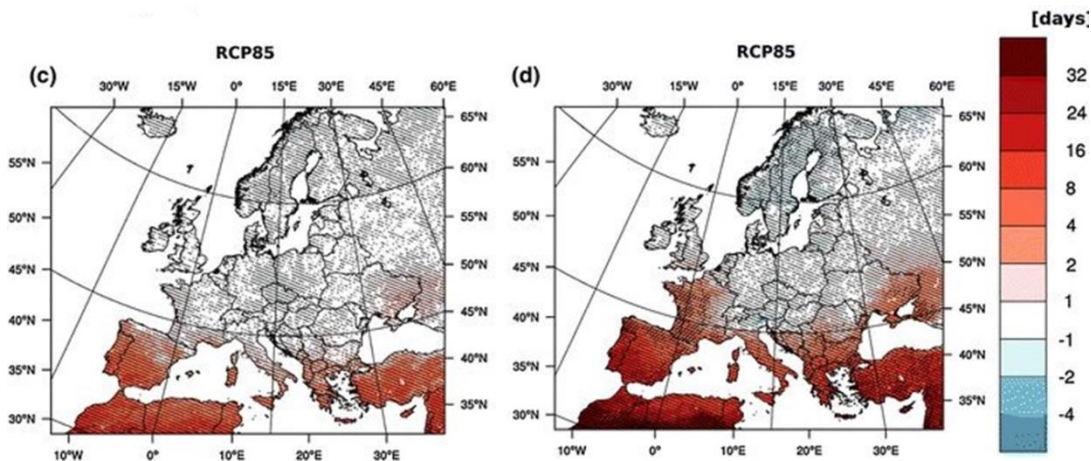


Large fire in Split, July 2017

Climate change – seasonal severity rating (Hvar)



Climate projections: warmer; longer dry spells



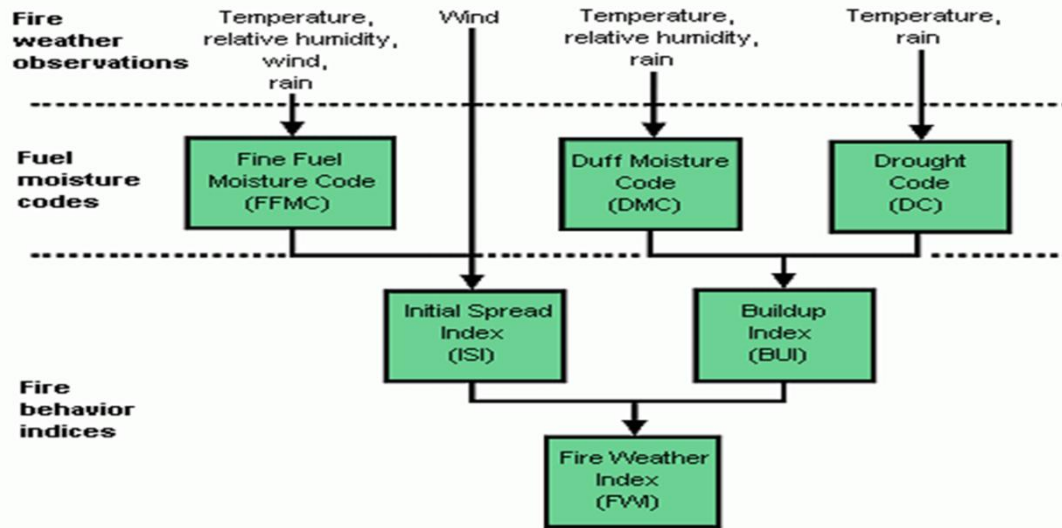
- Jacob et al. (2014)
- temperature rise to the end of 21st century
- trends of warming and drying more stressed at the Mediterranean, also in the summer season
- wind forecast: less reliable, mixed signal

Government Program of fire protection activities

- **Article 25:** role of DHMZ
- mostly oriented to assessment and forecast of meteorological risk of ignition and spread of forest fires
 - long range
 - medium range
 - short range
 - warnings
- most important measure of risk – Fire Weather Index (“Canadian index”)
- information provided to Fire authorities and Ministry of Interior (Civil protection)
- special web-page dedicated to Fire authorities
- analyses, research and development of new methods and products

Fire weather index - FWI

- Van Wagner (1987)
- takes into account: temperature, precipitation, moisture and wind
- strong correlation between FWI and number of fires/burned area



Long range forecasts

- seasonal forecast: mean quarterly anomalies of precipitation, air temperature and sea level pressure expected in the next three months for the whole Adriatic
- monthly forecast: mean weekly anomalies of precipitation and air temperature in the next four weeks for four areas in the Adriatic
- mainly based on the long range ECMWF forecasting
- assessment of the possible onset of the fire season and its probable severity; possible meteorological wildfire risk at the monthly scale
- issued in format of text and charts once/twice a month

Long range forecasts

DHMZ, Odjel za vremenske analize i prognoze

Zagreb, 30. listopada 2020.

VREMENSKA PROGNOZA ZA HRVATSKU ZA RAZDOBLJE OD 2. 11. DO 29. 11. 2020.

TEMPERATURA - ODSTUPANJE OD SREDNJIKA



02.11.2020. - 08.11.2020. 09.11.2020. - 15.11.2020. 16.11.2020. - 22.11.2020. 23.11.2020. - 29.11.2020.



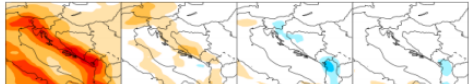
VJEROJATNOST: ODSTUPANJE > 0



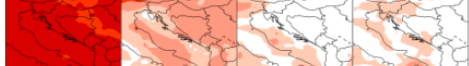
OBORINA - ODSTUPANJE OD SREDNJIKA



02.11.2020. - 08.11.2020. 09.11.2020. - 15.11.2020. 16.11.2020. - 22.11.2020. 23.11.2020. - 29.11.2020.



VJEROJATNOST: ODSTUPANJE > 0mm



Interpretacija prognoze za Hrvatsku

Temperatura: U studenom se očekuje malo viša srednja mjesečna temperatura od prosječne. Toplije nego što je uobičajeno bit će posebno u prvom tjednu kada je izgledno izraženo pozitivno odstupanje srednje tjedne temperature u odnosu na klimatološki srednjak, osobito na Jadranu. U tjednu prema sredini studenog temperatura će vjerojatno biti oko uobičajene ili malo viša od nje. U drugom dijelu mjeseca povećana je vjerojatnost za prosječno toplu ili malo hladniju od prosjeka, poglavito u kontinentalnim područjima.

Oborina: Ukupna mjesečna količina oborine u studenom će biti uglavnom oko prosječne, ponegdje moguće i veća, posebno na Jadranu i u krajevima uz Jadran. U prva 2 tjedna izgledno je u većini područja vrlo malo oborina na koje se može računati sredinom prvog tjedna ponegdje u unutrašnjosti, a u drugom tjednu većinom na Jadranu i uz njega. U drugom dijelu studenog povećana je vjerojatnost za promjenljivije vrijeme uz količinu oborine oko uobičajene pa i veću, posebno u gorju, u unutrašnjosti Istre i Dalmacije te na Jadranu. Pritom u gorju, s padom temperature, može biti i snijega.

e-mail: prognoza@dmz.hr

+385 1 45 65 672, Fax: +385 1 45 65 757

http://meteo.hr

DHMZ, Služba za vremenske analize i prognoze

Zagreb, 1. rujna 2020.

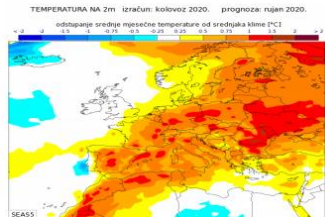
Izgledi potencijalne meteorološke ugroženosti za nastanak i širenje požara raslinja za razdoblje rujna-listopad 2020. godine

Napomena

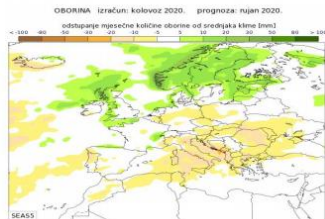
Izgledi potencijalne meteorološke ugroženosti za nastanak i širenje požara raslinja za srpanj, kolovoz i rujna 2020. godine izrađeni su na osnovi sezonske prognoze vremena Službe za vremensku analizu i prognozu DHMZ-a iz produkata European Center for Medium-range Weather Forecast (ECMWF) za područja u Hrvatskoj s posebnim naglaskom na Jadran i područja uz Jadran.

Mjesečna prognoza za rujna 2020.

Srednja mjesečna temperatura predviđa se viša od klimatološkog srednjaka uz veliku vjerojatnost ostvarenja prognoze.



Ukupna mjesečna količina oborine u rujnu se očekuje manja od klimatološkog srednjaka uz umjerenu vjerojatnost ostvarenja prognoze.



DHMZ, Služba za vremenske analize i prognoze

Zagreb, 1. rujna 2020.

Prognoza klase opasnosti za rujna 2020.

Stoga se očekuje da će srednja mjesečna klasa opasnosti za nastanak i širenje požara raslinja u rujnu biti nešto viša od uobičajenog višegodišnjeg srednjaka, osobito za područje Dalmacije.

Izgledi za listopada 2020.

U listopadu će srednja mjesečna temperatura na Jadranu vrlo vjerojatno biti viša od klimatoloških srednjih vrijednosti uz umjerenu vjerojatnost ostvarenja prognoze.

Srednja mjesečna količina oborine će vjerojatno biti oko prosječne, uglavnom na sjevernom Jadranu i veća od prosječne uz umjerenu vjerojatnost ostvarenja prognoze.

Stoga će srednja mjesečna klasa opasnosti za nastanak i širenje požara raslinja u listopadu vjerojatno biti većinom oko prosjeka. To znači da bi se požarna ugroženost u listopadu trebala znatno smanjiti u odnosu na ljetne mjesce i rujna, što je i uobičajeno za naše područje.

	Srednje mjesečne klase opasnosti (za razdoblje od 2003. do 2015. godine)			
	lipanj	srpanj	kolovoz	rujan
Sjeverni Jadran	2,6	3,4	3,0	2,3
	umjerena	umjerena	umjerena	mala
Srednji Jadran	2,9	4,0	3,8	3,1
	umjerena	velika	velika	umjerena
Južni Jadran	2,9	3,9	4,0	3,2
	umjerena	velika	velika	umjerena
Unutrašnjost Dalmacije	2,4	3,3	3,3	2,6
	mala	umjerena	umjerena	umjerena

Klase opasnosti za nastanak i širenje požara raslinja (po kanadskoj metodi):

2,5 > mala

2,5 < umjerena < 3,4


3,5 < velika < 4,4

4,5 < vrlo velika



Medium range forecasts

- 7-days outlook: general weather conditions (dry or wet, windy or not, warmer or cooler)
- special 4-days forecast: quantitative assessment of rain amount and probability, wind speed and direction, maximum temperature range and lightning potential
- assessment for the North Adriatic, Dalmatia and mountainous hinterland (Lika)
- based on ECMWF global weather prediction model and ALARO regional model (run at DHMZ)
- use: fire management planning
- issued in the text and tabular format twice a week

 Državni hidrometeorološki zavod
Sektor za vremenske i pomorske analize i prognoze
Služba za vremenske analize i prognoze
Zagreb, Ravnice 48

Polutjedna prognoza za Dalmaciju do 29. listopada 2020.

	UTORAK	SRJEDA	ČETVRTAK
OBORINE	da	ne	ne
VJETAR	SE (15 do 20) m/s	NW (5 do 10) m/s	Nw (5 do 8) m/s
MAKS. TEMP.	19 do 21	20 do 22	20 do 22
POJAVA MUNJA	da	ne	ne

U Zagrebu, 26.10.2020., izradio dežurni prognostičar.

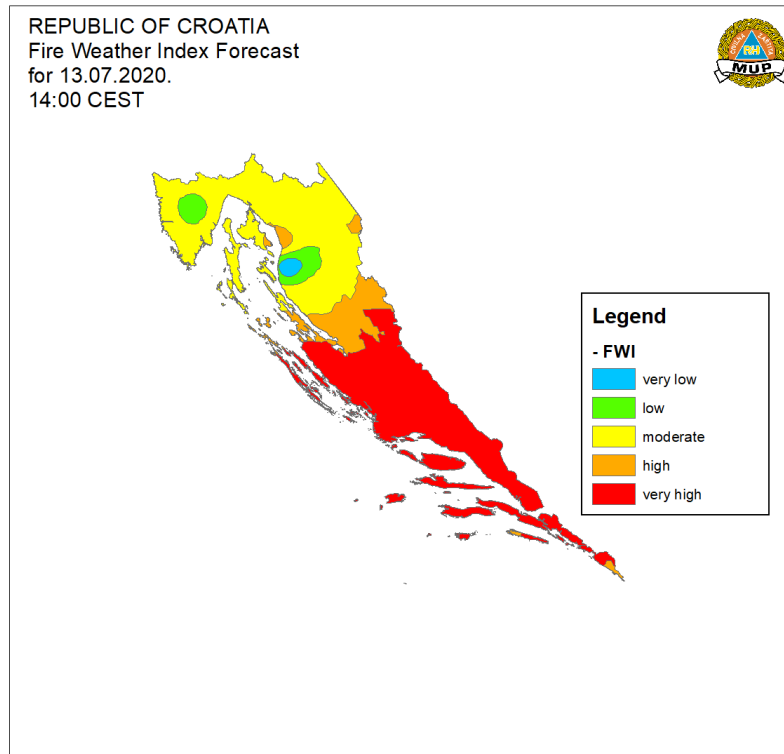
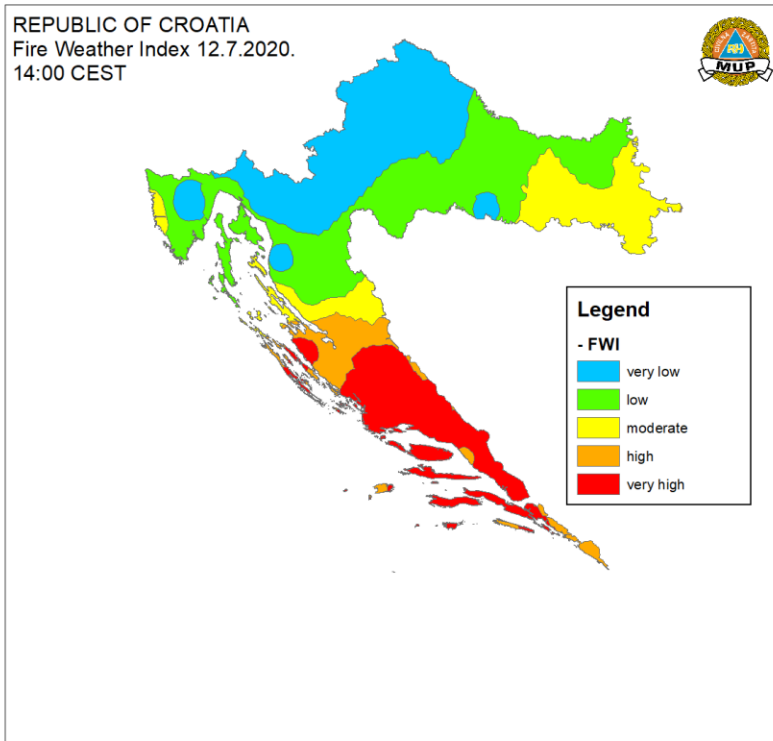
Short range forecasts - FWI

- based on Fire weather index (12 UTC)
- five danger classes - derived by combining FWI and Buildup Index (Dimitrov, 1987)
- delivered daily for 22 stations in the Adriatic region
- prognostic class of fire danger performs well compared to observed data

Tab. 1 - Classes of fire danger for the Adriatic region of Croatia (a color is assigned to each class)

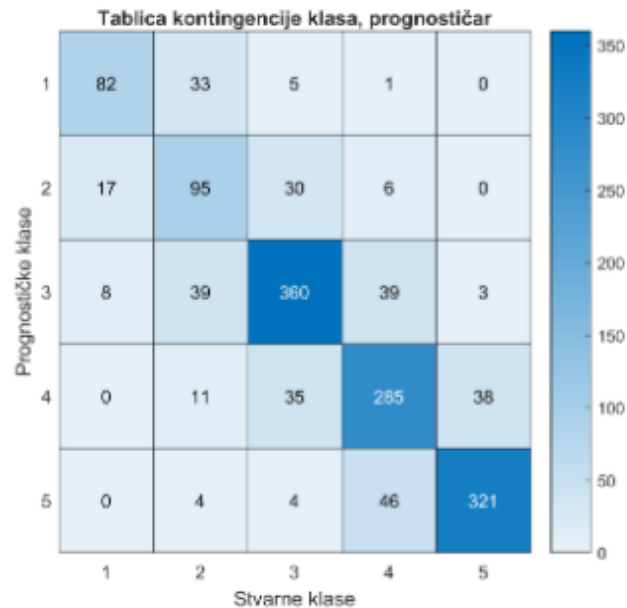
		Fire Weather Index (FWI)				
		0-4	5-8	9-16	17-32	33+
Buildup Index (BUI)	0-48	1	2	2	3	3
	49-85	2	2	3	3	4
	86-118	2	3	3	4	4
	119-158	2	3	4	4	5
	159+	3	3	4	5	5

Analysis and short range forecasts - FWI



Forecast verification

- danger classes, FWI and it's components are verified by contingency tables and related verification scores
- good match with observed data
- DMO (direct model output) from Aladin model is also verified



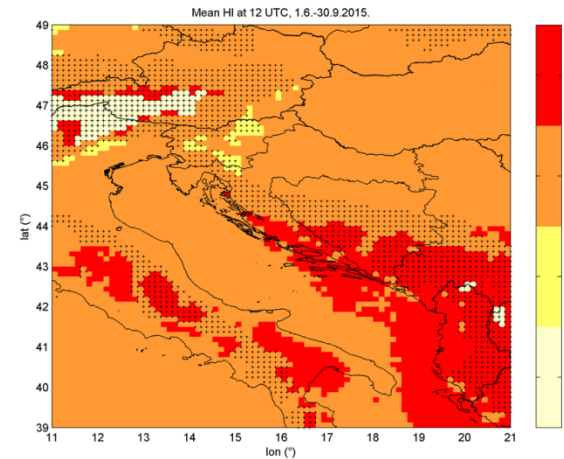
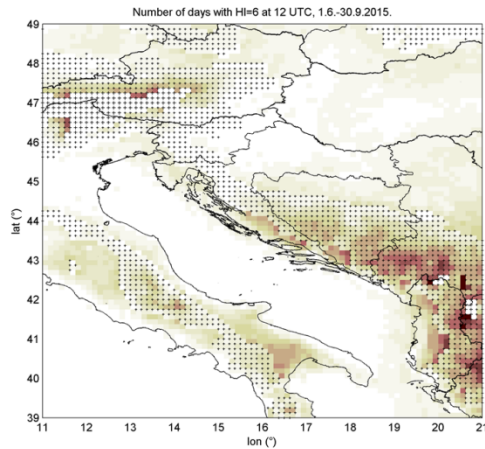
Additional tools – Haines index

- in dry and unstable atmosphere - fires may intensify and behave abnormally ("plume dominated" fires)
- HI - quantitative measure of the instability in the dry atmosphere and potential for large fire growth. Higher value of Haines Index (or the class) means higher potential for fire growth.

Haines Index	Class (potential for large fire growth)
2 or 3	very low
4	low
5	moderate
6	high

Additional tools – Haines index

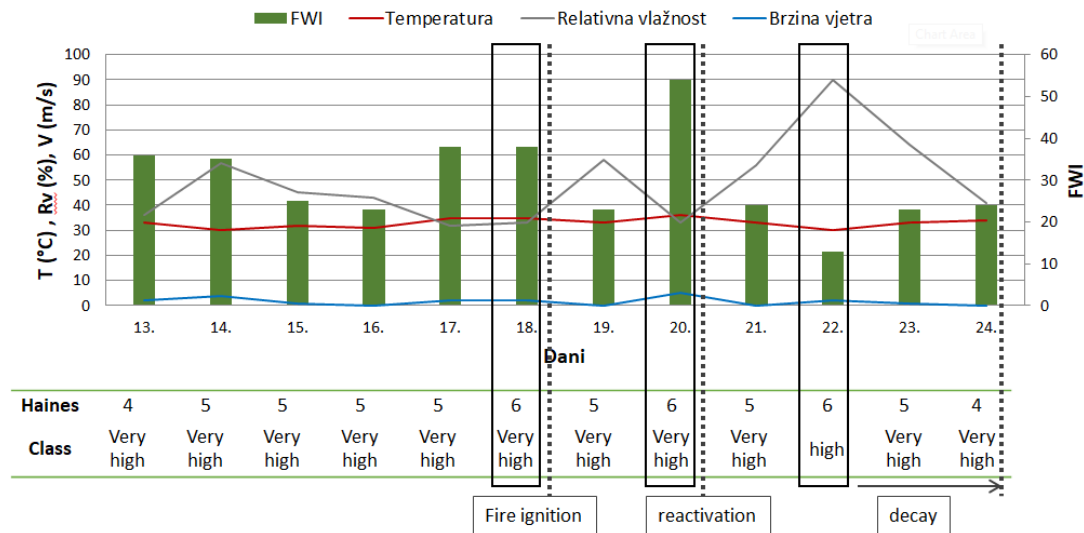
- number of days with the highest values of HI during in the extremely hot and dry 2015 fire season is shown (left panel) and reveal areas with the high potential for large fire growth
- average HI for the same fire season is shown (right panel)



Additional tools – Haines index

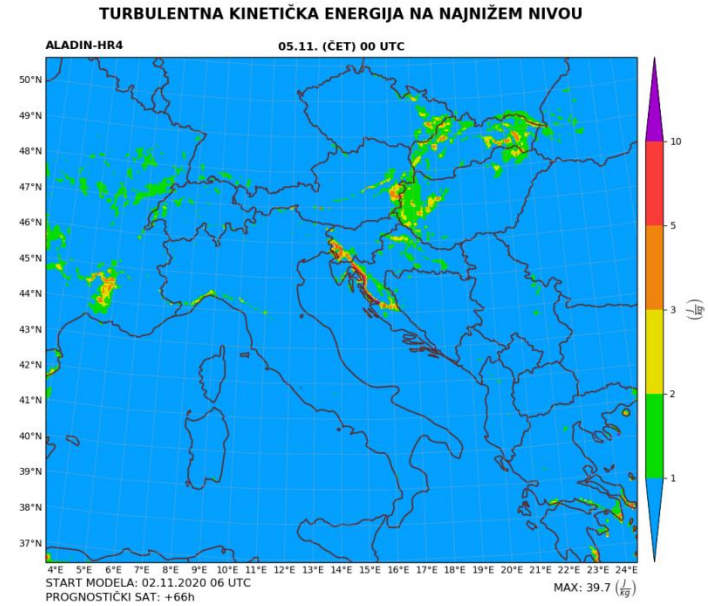
- example: large fire on Korčula island (18 – 24 July 2015)
- points to the importance of atmospheric instability (HI)

Data: Lastovo, 13.-24.7.2015. - 14 h locally



Additional tools – Turbulent Kinetic Energy

- turbulent kinetic energy (TKE) – mean kinetic energy per mass unit (m^2/s^2) associated with turbulent flow
- recent studies suggest that TKE in lower atmosphere may cause extreme fire behavior
- sensitive to wind shear – high values of TKE – particularly in combination with high HI point to dry and unstable atmosphere
- TKE Aladin fields – introduced in 2016.

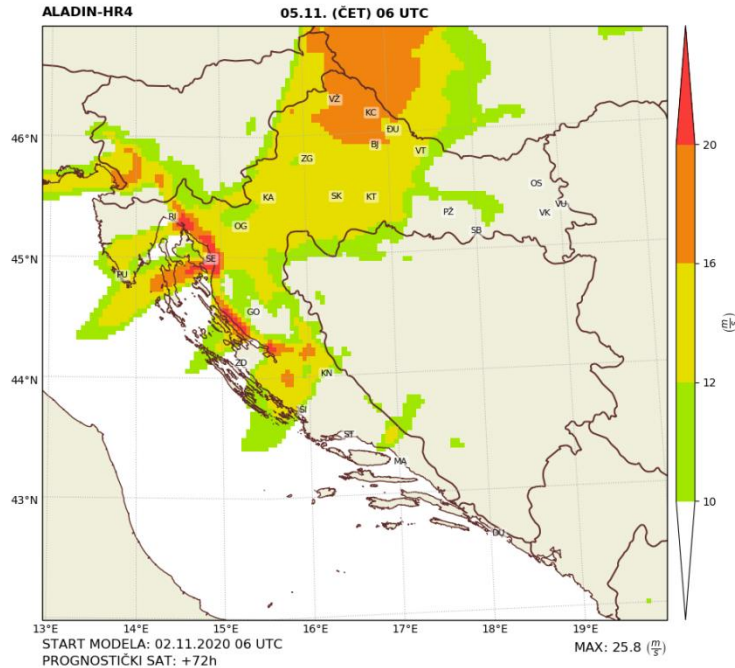


Additional tools – Low level jet

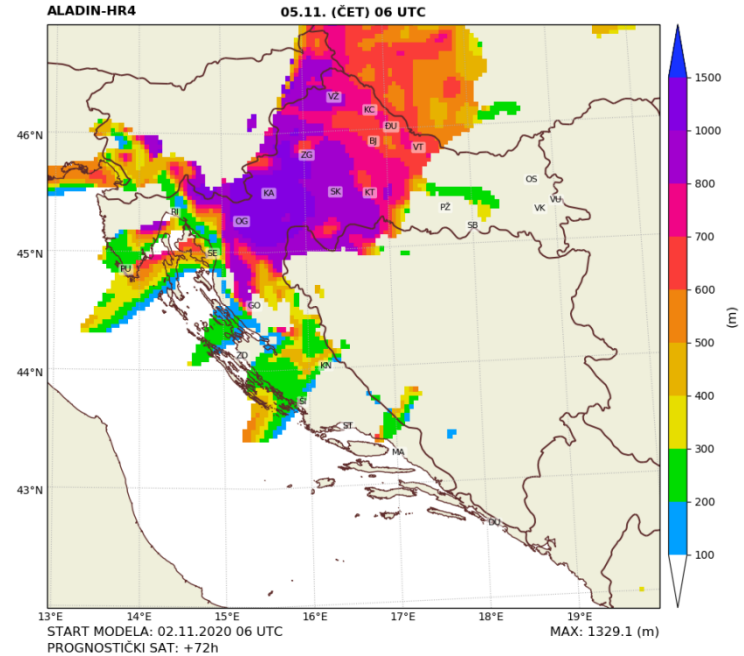
- LLJ - any maximum (12-16 m/s, gusts 30 m/s) of horizontal wind in the lower troposphere
- may occur in typical synoptic situations
- influence on moisture transport
- associated with pronounced vertical and lateral wind shear
- usually 200-300 km wide
- studies revealed presence of LLJ in several large fires

Additional tools – Low level jet

BRZINA NISKE MLAZNE STRUJE



VISINA NISKE MLAZNE STRUJE



Special warnings

- FWI information not sufficient (high values most of the season)
- aim to warn to dangerous situations for potentially large fires
- started in 2012
- criteria defined:

High value of FWI

AND

A) strong wind and/or high TKE (passage of "dry" front)

OR

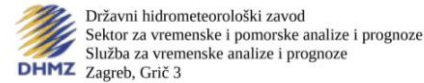
B) vertical instability in the dry air (high Haines index) and/or high TKE

- since 2019. – criteria for three levels (yellow, orange and red)

	warning level			
	yellow	orange	red	red
fire danger	moderate	high and/or very high	high and/or very high	high and/or very high
v (m/s)	>9	5 to 8	> 9	>9 longer than 18 hrs
TKE (m ² /s ²)	3 to 5	3 to 5	≥ 5	>5 longer than 18 hrs
HI		6		

Special warnings

- Delivered exclusively to authorities



Posebno upozorenje za požare raslinja

Upozorenje

Narančasto upozorenje za jaku buru s olujnim, pod Velebitom i orkanskim udarima te izraženu turbulenciju.

Razdoblje za koje se izdaje upozorenje

Sutra kraj dana i u noći na nedjelju.
Napomena: Smirivanje vjetra očekuje se tek u ponedjeljak, pa će se stupanj upozorenja za nedjelju u Dalmaciji vjerojatno biti na najvišoj, crvenoj razini. Bura će biti najjača na području od Zadra do Šibenika te na ostalim poznatim lokacijama.

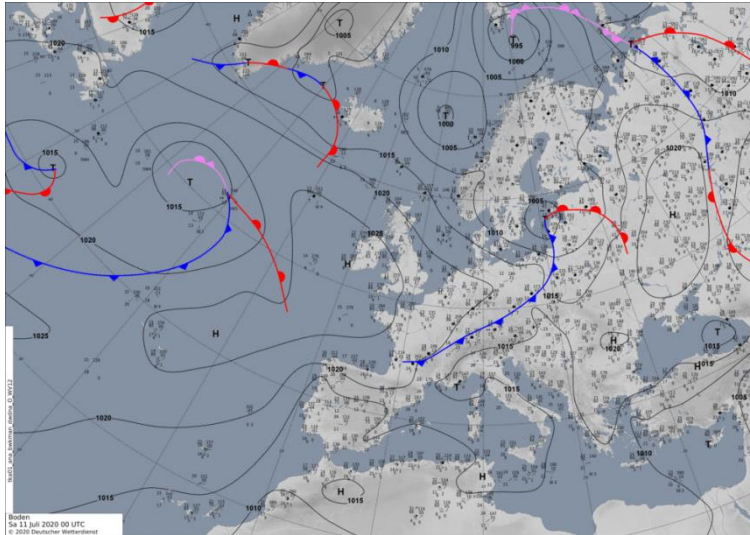
Područje za koje se izdaje upozorenje

Šire riječko područje, kvarnerski otoci i južna strana Velebita. Do kraja dana i u noći sjeverna Dalmacija do Šibenika.

Opis sinoptičke situacije

Prolazak hladne fronte, lokalno uz pljuskove i grmljavinu, zatim jačanje ogranka anticiklone sa sjeverozapada uz jačanje vjetra. Izraženi pljuskovi s grmljavinom mogući su na sjevernom Jadranu navečer i potkraj dana, uslijed čega bi se klase opasnosti lokalno mogle smanjiti. U Dalmaciji oborina se ne očekuje, pa će klase i dalje biti velike i vrlo velike. Navečer na sjevernom Jadranu, u noći i na dijelu Dalmacije zapuhat će bura.

U Zagrebu, 10. srpnja 2020., izradio dežurni prognostičar.



Special warnings – 2020. season

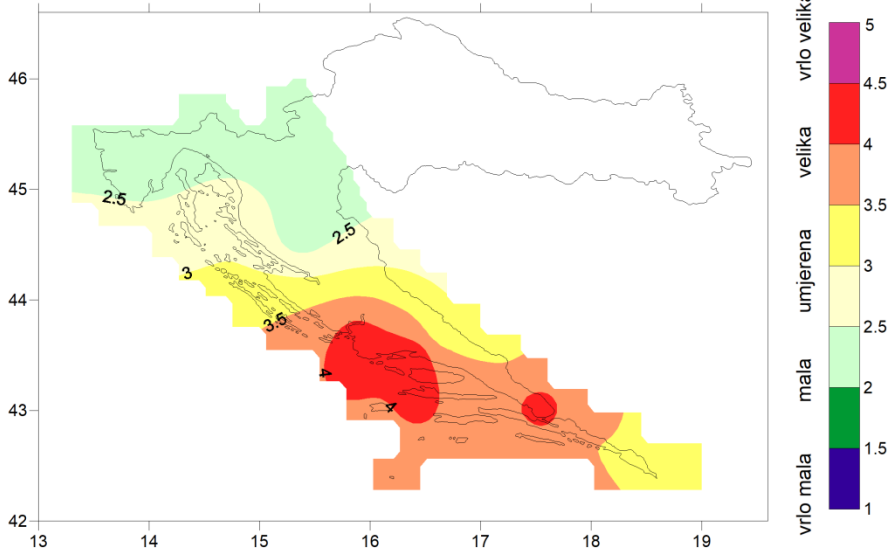
- 42 potentially dangerous situations with strong wind (mostly bora and scirocco)
- 35 potentially dangerous non-gradient situations with instability in dry and hot air
- in this season total of 77 days with special warnings
- 11 orange warnings: 7 for gale force bora, 4 for scirocco (one big fire at Kozjak mountain – Fig.)
- 1 red warning for persistent strong bora (2 days)



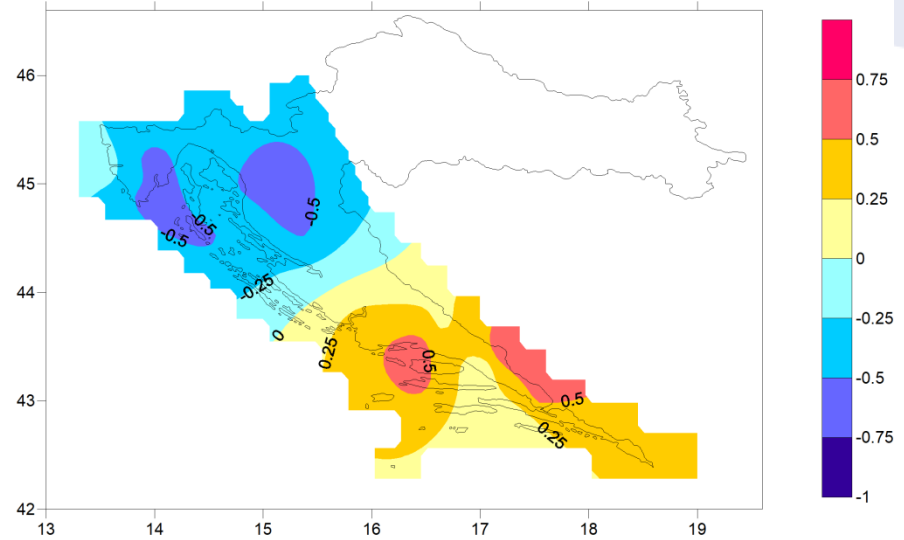
Big fire at Kozjak mountain

Regular monthly and seasonal analyses and statistics

2020 Seasonal FWI class



2020 Seasonal FWI class compared to climatological average (2003-2012)



All products available on special web-page



The screenshot shows the homepage of the Croatian Meteorological and Hydrological Service (DHMZ). At the top, there is a navigation bar with links: Naslovnica, Aktualni podaci, Prognoze vremena, Prognostički materijal, Analize, Kontakti, and Sadržaj. Below the navigation bar, the text reads "DOBRO DOŠLI NA STRANICE DRŽAVNOG HIDROMETEOROLOŠKOG ZAVODA". A large image of a cityscape with a massive, bright, mushroom-shaped cloud over it is displayed. At the bottom, the copyright notice "© Državni hidrometeorološki zavod" is visible.



The screenshot shows the content page of the DHMZ website. It features the same navigation bar as the homepage. Below the navigation bar, the text "Sadržaj stranice" is displayed. The page is organized into three columns of content:

- Aktualni podaci:**
 - Temperatura zraka
 - Oborina
 - Podaci automatskih postaja
 - Radiosondažni podaci
 - Opasnost od šumskog požara
- Prognoze vremena:**
 - Upozorenja
 - Posebno upozorenje za požare
 - Prognoze
 - Prognoze za Jadran (PMC)
 - Opasnost od šumskog požara
 - Polutjedne prognoze
 - Tjedne prognoze - požari
 - Opće tjedne prognoze
 - Mjesečne prognoze
 - Sezonska prognoza
 - Sezonska prognoza - požari
 - Posebne lokalne prognoze
- Prognostički materijal:**
 - Prognostičke karte ALADIN/HR
 - 3-dnevne prognoza ALADIN/HR
 - 10-dnevne prognoze ECMWF

Below these columns, there is a section titled "Arhiva analiza:" with the text "Analize po mjesecima i godinama". At the bottom, the copyright notice "© Državni hidrometeorološki zavod" is visible.

International collaboration - ERCC

- **Emergency Response Coordination Centre**
- weekly meeting via VC, duty forecaster present along with Fire officer
- aim to coordinate resources for mutual help
- Portugal, Spain, France, Italy, Croatia, Greece... ERCC and JRC



ERCC video conference

References

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