SeasFire

Deep Learning for Global Wildfire Forecasting

Ioannis Prapas (1,2), Akanksha Ahuja (1), Spyros Kondylatos (1,2), Ilektra Karasante (1), Eleanna Panagiotou (3), Lazaro Alonso (4), Charalampos Davalas (3), Dimitrios Michail (3), Nuno Carvalhais (4), and Ioannis Papoutsis (1)

1. Orion Lab, Institute of Astronomy, Astrophysics, Spaces Applications & Remote Sensing, National Observatory of Athens
2. Image Processing Laboratory (IPL), Universitat de València
3. Department of Informatics & Telematics, Harokopio University of Athens
4. Max Planck Institute for Biogeochemistry

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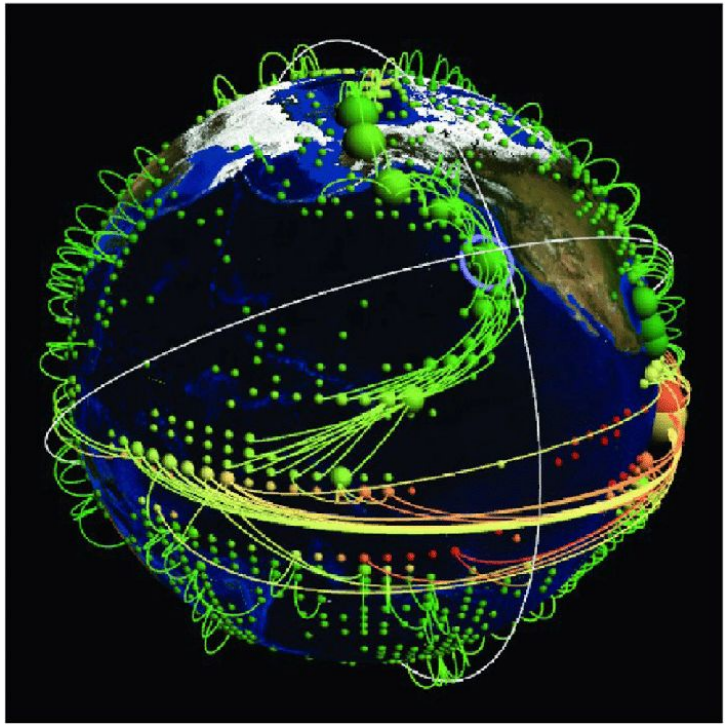
Climate Change Aggravates Fire Weather

Athens wildfires 2021 look from the city.

- Climate change aggravates fire weather
- Wildfire regimes are quickly changing
- Fire to expand to boreal regions and evergreen forests

It is crucial to **improve our understanding** of wildfires in the Earth System and **enhance our ability to anticipate** them.

Seasfire: Earth is a complex interconnected system



Source: Statistical physics approaches to the complex Earth system

Fire Drivers: Any variable contributing to wildfires.
Teleconnections are long-range spatio-temporal connections in the earth system. “Arctic oscillation anomalies linked to extreme wildfires in Siberia” Kim et al. (2020)

Motivation: Use Machine learning to capture the spatio-temporal extent, interaction and influence of Fire Drivers to forecast them in advance for various stakeholders.

Why Machine Learning?
(a) Non-Linear Interactions: Hard to capture relationships on seasonal and sub-seasonal scales.
(b) Large Scale Datasets: More than 100 GB
(c) Limits of the Physical models: fail to understand the combined dynamics of fire drivers and no no physical models exist that capture these teleconnections well.

SeasFire DataCube: Variable types and their sources

Seasfire: Resolution

Temporal Resolution

2001 to 2021

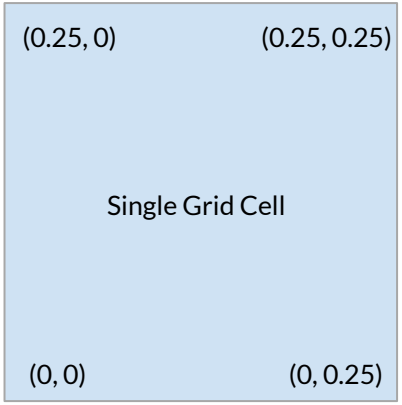
Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8

8-Day Weekly Resolution

W 1	W 2	W 3	W 4	W 5	W 6	…	…	…	W44	W45	W46

Forty Six “8-Day Weeks” in each year

Spatial Resolution



Global, 0.25 x 0.25 Degree

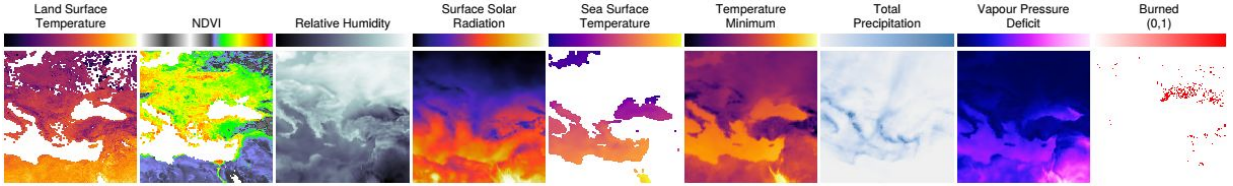
Seasfire: Summary of the Datacube

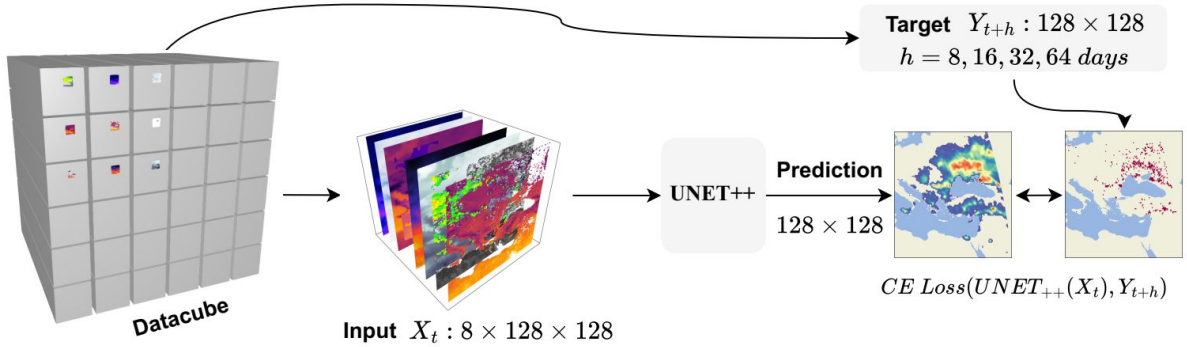
Open-access datacube in a cloud-friendly format

Feature	Value
Spatial Coverage	Global
Temporal Coverage	2001 to 2021
Spatial Resolution	0.25 deg x 0.25 deg
Temporal Resolution	8 day- weekly
Input Variables	**~30**
Target Variables	**5**
Tutorial Link	https://github.com/SeasFire/seasfire-datacube
Zenodo Link	https://zenodo.org/record/7108392

Wildfire Forecasting as a Segmentation Task

- **Input**: 8 fire driver variables at time ***t***.
  Stacked 128x128 patches
- **Target**: Presence of burned area at time ***t+h***
  (h=8, 16, 32, 64 days)
- A separate **UNET++** model is trained for each ***h***
- **Data split temporally:**
  Training (2001 to 2017)
  Validation (2018)
  Testing (2019)





Results - Quantitative (1)

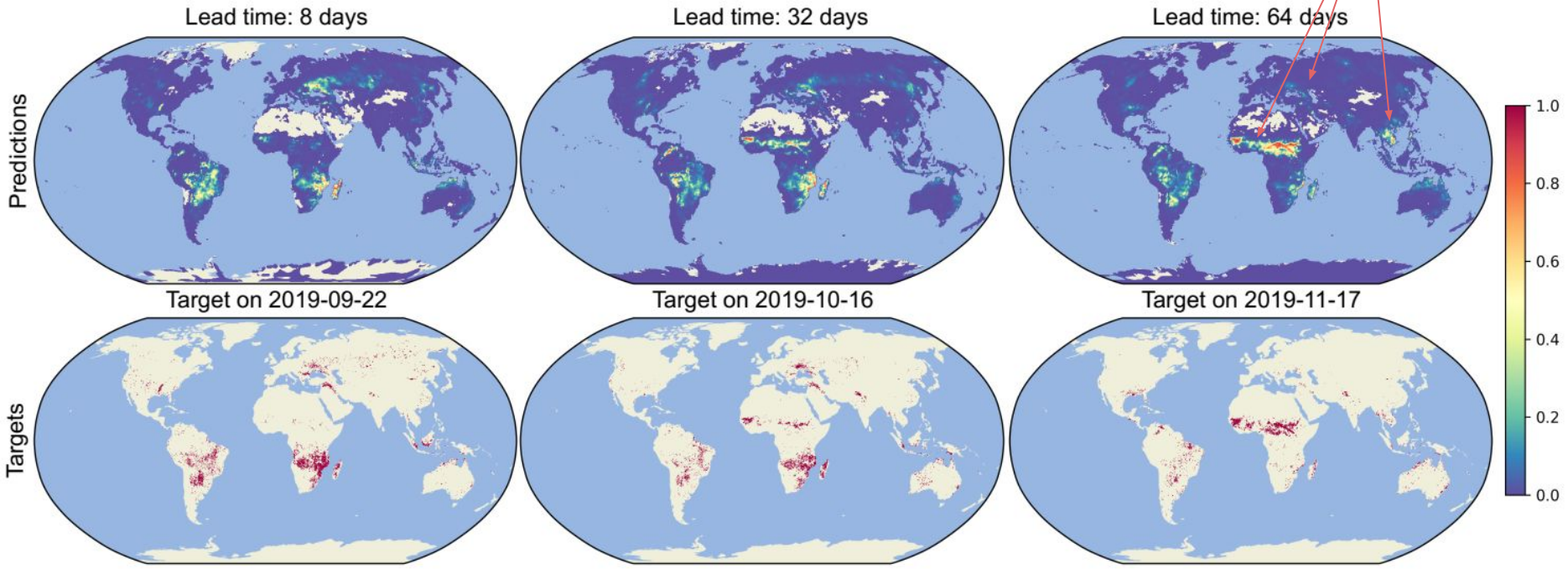
- Area Under the Precision Recall Curve and F1 more fit for imbalanced datasets
- Models' predictive skill is **better than mean seasonal cycle** as
- Burned area patterns can be skillfully predicted **for even 2 months** in advance!

Table 1: AUPRC, F1-score for the UNET++ model forecasting with different lead times on the test dataset (year 2019). Baseline values for the weekly mean seasonal cycle also reported.

	Lead time (days)	AUPRC	F1-score	AUROC
UNET++	8	0.550	0.507	0.976
	16	0.547	0.489	0.975
	32	0.543	0.473	0.973
	64	0.526	0.424	0.971
Weekly Mean Seasonal Cycle	-	0.429	-	0.918

Results - Qualitative (2)

Captured change of fire activity in eastern Europe and south-east Asia, shift from the southern to the northern African savanna.



Summary and Links

- SeasFire Cube contains a complete set of global variables for modeling wildfires.
- Burned area pattern forecasting can be defined as a segmentation task providing skillful forecasting.
- Future work on the SeasFire cube aims to enhance our understanding and ability to anticipate wildfires globally.

Links

SeasFire Project: https://seasfire.hua.gr
Preprint Paper: https://arxiv.org/abs/2211.00534
SeasFire Cube: https://zenodo.org/record/7108392
Tutorials: https://github.com/SeasFire/seasfire-datacube