

NOWCASTING SEVERE THUNDERSTORMS OVER LAKE VICTORIA

PhD Talk @ AI4Copernicus

Seppe Lampe – 04/05/2022

Collaborators: Inne Vanderkelen, Dr. Steven Dewitte, Dr. Adrian Munteanu & Dr. Wim Thiery

LAKE VICTORIA

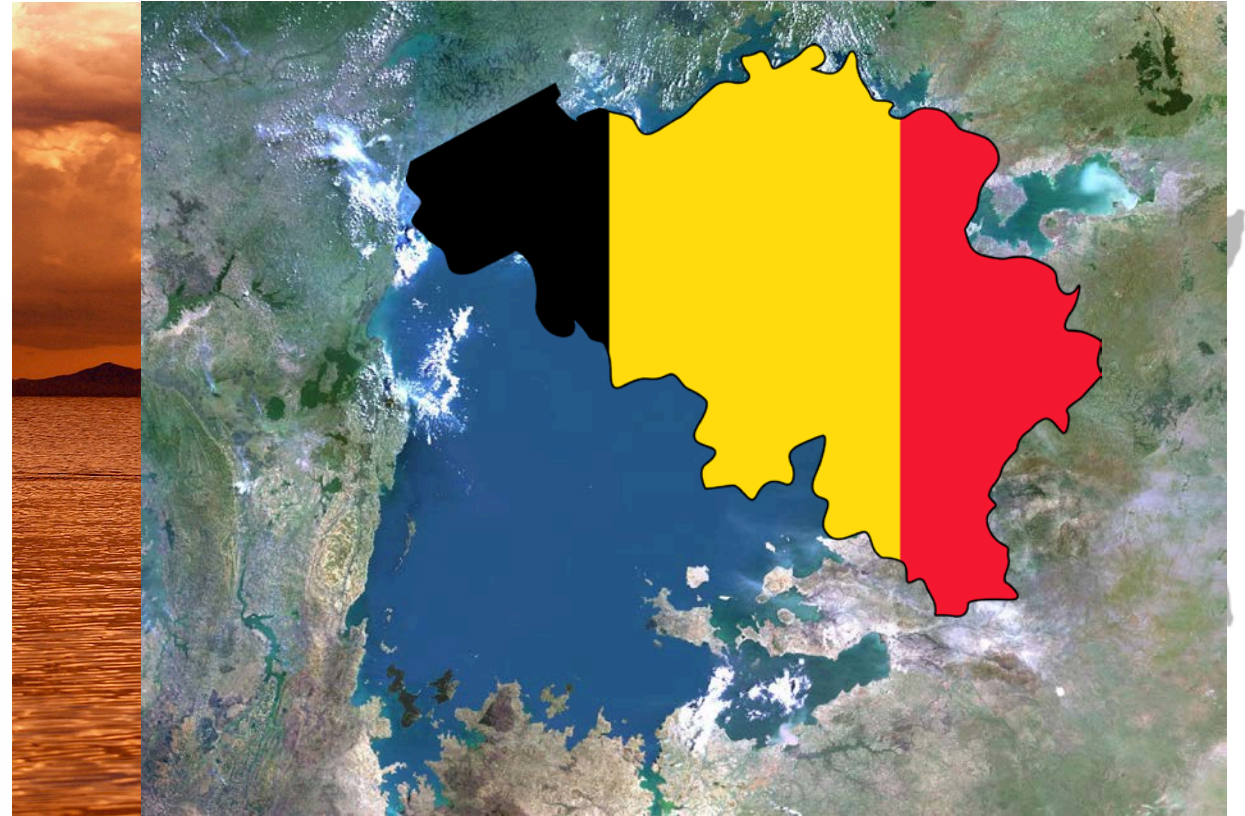
NALUBAALE

Tanzania, Uganda and Kenya

~twice the size of Belgium

Food supply for 30 million people

200.000 fishermen (night)



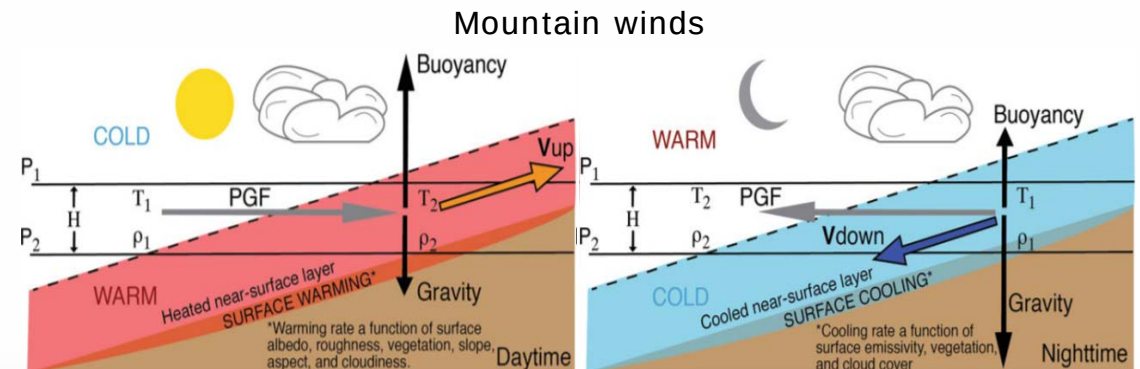
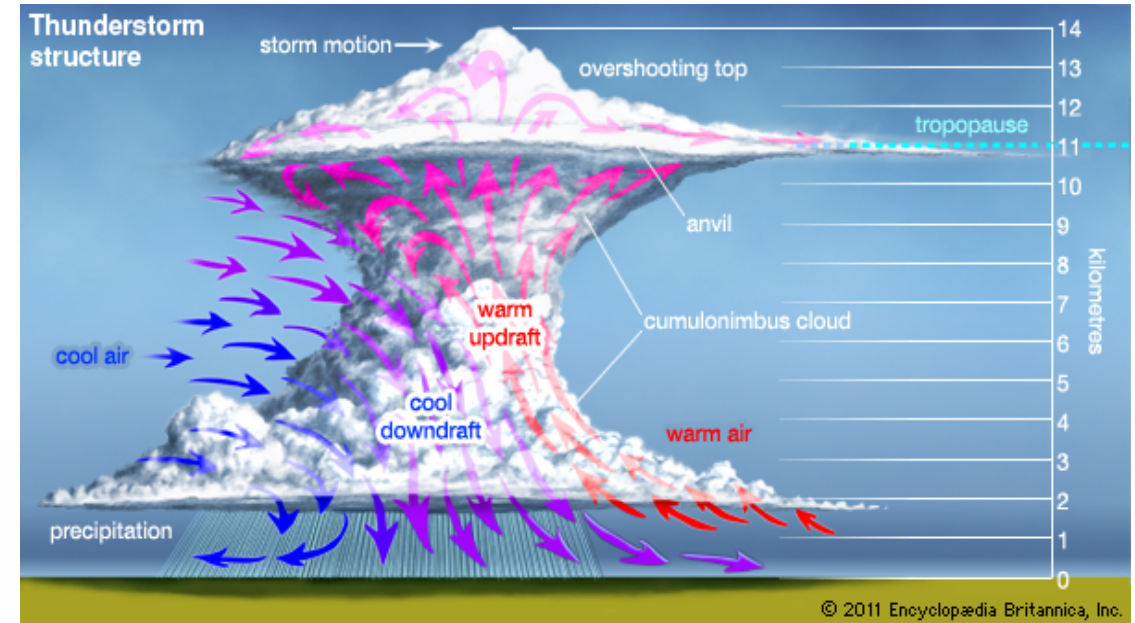
LAKE VICTORIA

WEATHER PATTERN

Afternoon rain over land, night rain over lake

1. Diurnal lake and land breezes
2. Strengthened by mountain winds
3. Intense afternoon rains
⇒ strong land breeze and more moisture
⇒ intense night storm

Lake Victoria is the stormiest place on Earth



Hatchett et al. (2019)

LAKE VICTORIA

DEADLY STORMS

Each year 1000-5000 fishermen die in these thunderstorms

Can we warn these fishermen before they sail out?

Poor weather observation infrastructure prevents good weather forecasting models

= > Use satellite images



DATA

WHAT DO WE HAVE?

Freely available SEVIRI images:

12 bands at 3km resolution, quarter hourly

Overshooting Top (OT) dataset derived from SEVIRI:

18°S-12°N and 22°E-52°E (840 by 840 pixels)

01/01/2005-31/12/2015

MODELLING

SIMPLE APPROACH

1. Use sum of all nighttime OTs over the lake as proxy for total storm intensity
2. Sum all daytime OTs
3. Fit a univariate regression to predict if it will be one of the 1% most storm intense nights

$$H = 0.76, F = 0.24$$

MODELLING

IMPROVE FEATURE SELECTION

Only retain the highly correlated time steps and pixels

⇒ Only sum these and redo the univariate regression

$$H = 0.83, F = 0.18$$

Original correlation

Subset correlation

MODELLING

IMPROVE FEATURE SELECTION

Then, instead of summing the afternoon OTs into 1 value, we sum them into 2, 3, 4, etc. values.

⇒ Best results came from summing into two values

$$H = 0.85, F = 0.15$$

15% False alarms also represent intense events

LAKE VICTORIA

FUTURE WORK

Introduce spatially explicit predictions

Focus on all nights (not solely on 1%)

Expanding the OT dataset in time (2015-2022)

RNNs are likely a good candidate for further analysis



THANK YOU FOR YOUR ATTENTION!

ANY QUESTIONS?

LAKE VICTORIA

REFERENCES

Hatchett B.J., Kaplan M.L., Nauslar N.J., Smith C.M., Nelson K. (2020) Slope Winds. In: Manzello S.L. (eds) Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires. Springer, Cham.
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Khlopenkov, K. V., Bedka, K. M., Cooney, J. W., & Itterly, K. (2021). Recent Advances in Detection of Overshooting Cloud Tops from Longwave Infrared Satellite Imagery. *Journal of Geophysical Research: Atmospheres*, 126(14), e2020JD034359.

TRADITIONAL FORECASTING

PROBLEM STATEMENT

Poor/unreliable weather observation infrastructure

1 East-Africa NWP: Tropical Africa 4.4km model

Predicts ~70% of storms

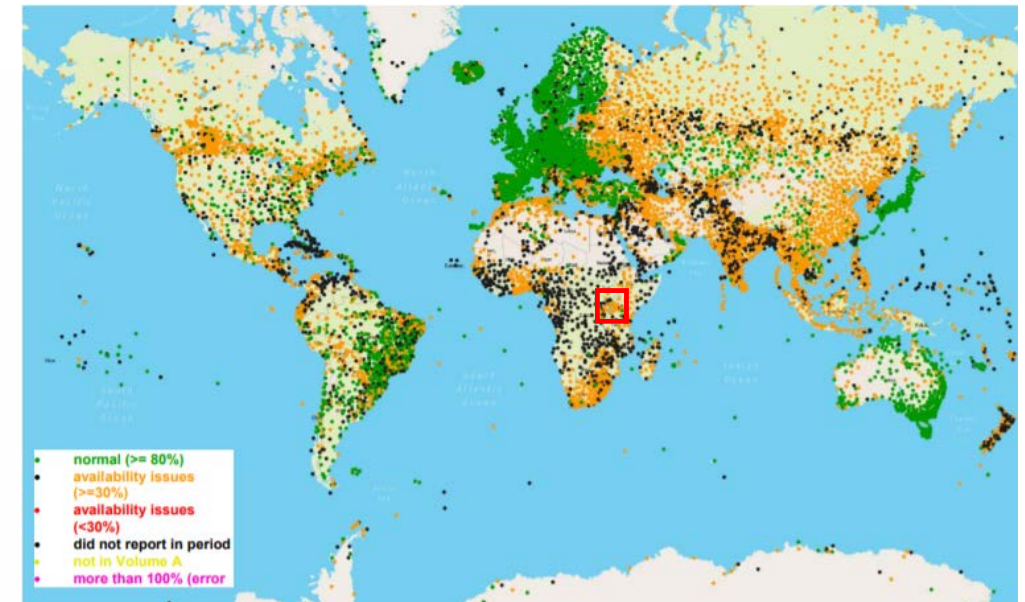
Nightly storms less accurate

Intense events underestimated

Is there an other solution?

Yes, nighttime storm intensity over Lake Victoria is dependent on preceding storm intensity

Reporting frequency of weather observation stations



IOC (2019)

MATERIALS & METHODS

DATASET CHARACTERISTICS

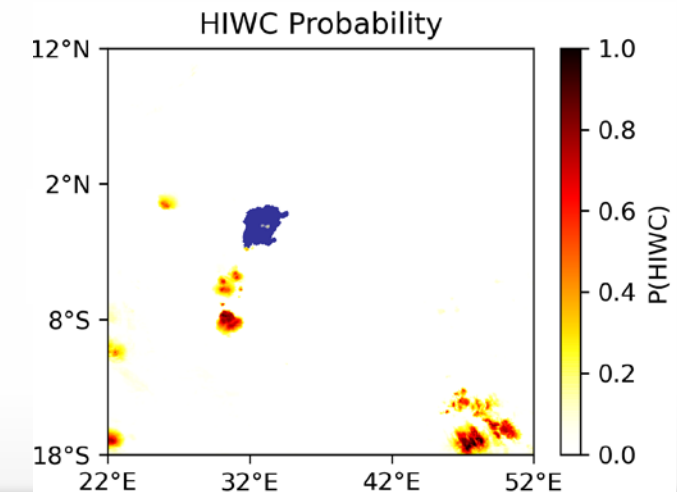
2021 NASA OT detection algorithm

18°S-12°N and 22°E-52°E (840 by 840 pixels)

01/01/2005-31/12/2015

3288 day–night (04:00-18:00 & 21:00-09:00) tuples

22 variables in OT dataset e.g., **OT probability** and HIWC probability



RESULTS & DISCUSSION

MACHINE LEARNING

Performance training set > performance test set
⇒ (slight) overfitting

