

CLIMATE (COMMUNICATION) EMERGENCY

*A map of climate
change representations
across the online
weather forecast
landscape*

Introduction

1. NATURE

Which kind of relationship between humanity and nature is implied in the representations? Are humans more detached or in communion with nature? Is humanity represented in control of nature? Or is nature instead represented as out of control? Is it represented as exploited by humanity? Is it represented as endangered by human activities? Is humanity represented as part of endangered nature? Are there representations of utopias based on community with nature?

2. PEOPLE

Are humans included in the representations? How many of them? Can they be identified as individuals? Where do they come from? How are they represented? Which roles do they have (politicians, citizens, officers, protesters, ...)? Are they more victims or saviours?

3. CAUSES, IMPACTS, AND SOLUTIONS

Which is predominant in the representations, causes, impacts or solutions? Are there representations of connections between the three of them? Are causes, impacts and solutions represented relevant? Which kind of causes, impacts and solutions are represented? Which are the most recurring between them? Which are their temporal and spatial scales? Are they more abstract or concrete? Do the representations of solutions focus more on adaptation or mitigation?

4. STEREOTYPE

How varied are the representations? Are the representations original? Are they recognisable? Are they striking? Are they relevant? Do the representations add something new to the climate change discourse?

5. SPACE

Which is the spatial scale of the representations? Are they local or global? Are the subjects close by or far away for the audience? How serious or relevant are they? Are there connections between localities in the representations? Are there connections between different scales? How are they structured?

6. TIME:

Which is the temporal scale of the representations? Are they based in the present or in the future? Are they more short-term or long-term? Are there connections between different temporal moments and scales in the representations? Do the representations leave space for change?

7. UNCERTAINTY:

Is uncertainty addressed in the representations? Is it framed more as ignorance or as part of the scientific discourse? Which space is given in the representations to uncertainty, compared to certainty and confidence?

8. LOSS AND GAIN:

Do the representations try to engage more through hope of advantages or fear in consequences? Do they stress more on gain affirmation or loss negation? Which kind of loss are represented? And which kind of gains? How much stress is given to action in the representations? Is the action in the representations more individual or collective?

9. SCIENTIFIC AND SOCIAL:

Are representations more based on data or on stories? Which kind of data is the most recurring? And which kind of stories? Do the representations provide more scientific or social framings? Do representations require more rational or emotional responses and interpretations? Are representations easy to understand? Are they more abstract or concrete? Are scientific representations more trustworthy or deceiving? Are connections between physical processes and personal stories addressed in the representations?

“Climate (communication) emergency” is the result of a process of collection, organisation and analysis of climate change representations in the online environment of weather forecasts. It was conceived and designed as a device for autonomous exploration of the visual and textual landscapes inspected.

BACKGROUND

Despite humanity is starting to experience on its own skin the dangerous impacts of the **climate changes** produced by greenhouse gases emissions, there haven't yet been policies and agreements capable of properly addressing the crisis. In a context in which governments and international organisations prove to be reluctant to seriously confront the global threats we face, citizens and individuals could play a fundamental role, influencing the political agenda through demands of **relevant responses**. For this to happen, however, there needs to be a shared understanding of the climate emergency stressing both urgency and agency, the need for action as well as the concrete possibilities in that sense.

The **online weather forecast landscape** can play a critical role in spreading knowledge on the issue through meaningful, engaging and empowering communications. Weather websites are globally spread, and at the same time they cover the most concrete expression of climate change: the extremisation of weather patterns. They have the opportunity to **connect localities to the wider picture**, engaging communities through concrete accounts of extreme weather events and finally empowering them in the demand of systemic change.

This report is meant to map the representations of the climate crisis produced and shared by weather forecast platforms and websites in order to highlight trends, patterns, recurring features and imaginaries – and, in the end, provide a structure for the evaluation of their efficacy.

CASE STUDIES

The online weather forecast landscape is analysed through various case studies organised in **three research protocols**. Each protocol answers a single question, connected to a specific communicative context:

- 1. How do weather forecast agencies represent climate change when they are explicitly asked to?*
- 2. How do weather forecast platforms represent climate change in their everyday practice?*
- 3. How do weather forecast platforms represent climate change in connection to extreme weather events?*

The three protocols share a similar structure, meant to encourage cross-protocol comparisons. They open with a data collection phase, followed by the analysis structured according to the data types: **texts, images and (for protocol 2 only) urls**.

EVALUATION CRITERIA

The process of analysis keeps into consideration 9 criteria based on existing literature on climate change communication's engagement and empowerment. The full list is available on the left.

PROTOCOL 1

*How do weather
forecast agencies
represent climate
change when they
are explicitly
asked to?*

Data collection

Protocol 1 analyses the series of imaginary future weather forecasts produced by well-known media companies all over the world at the request of the WMO (World Meteorological Organization).

The 63 total reports were first retrieved through the WMO YouTube Channel, then mapped and downloaded for further analysis.

SOURCES

Between 2014 and 2018 The [WMO](#) asked media companies all over the world to produce imaginary weather reports from the future, with the purpose to sensitise people about the local impacts of climate change and support important conferences and summits regarding climate policies. There are [62 videos organised in 5 series, plus one extra](#) (for a total of 63 reports).

Each of the [series 1–4](#) is connected to a specific international summit on political responses to the climate crisis. The videos are designed as imaginary – but realistic – 2050 weather reports from well-known television presenters illustrating the likely consequences of a business-as-usual approach to emissions.

[Series 5](#) is the result of a collaboration between the WMO and the NGO *Climate Central*, and the videos explore how climate change may affect summer heat in major cities worldwide by the end of the 21st century. While Climate Central came up with the general concept, the reports were still produced by weather forecast companies all over the world.

The [extra report](#) was the last one to be released, produced by the Hungarian National Meteorological Service and designed with the 2050 weather format.

SERIES	RELEASE	VIDEOS	FORMAT	CONTEXT
1	09/2014	14	Weather Report 2050	Climate Summit 2014
2	12/2014	6	Weather Report 2050	Lima COP20
3	03/2015	7	Weather Report 2050	UNWC Disaster Risk Reduction
4	11/2015	22	Weather Report 2050	Paris COP21
5	07/2017	13	Summer 2017–2100	Climate Central collaboration
extra	06/2018	1	Weather Report 2050	none

SELECTION

The reports are all available in different languages on the WMO YouTube channel, gathered in a playlist named “Weather Reports for the future / Climate Change”. A [single version of each report](#) was selected (English spoken one if it exists, otherwise with English subtitles) and a playlist with the 63 videos was created. Then all of them were downloaded with set quality (720p) and format (mp4). A spreadsheet, mapping key metrics for each report, was also manually compiled ([Dataset P1_reports](#)).

DATASETS



YouTube Playlist

Including the selected 63 reports (English spoken version if it exists, otherwise with English subtitles).



Dataset P1_reports

Spreadsheet with detailed information for each selected report, manually extracted from YouTube.

Texts

The speech from all the reports was first extracted from the videos and converted into written text, then translated to English (when in a different language) in order to allow comparison.

TRANSCRIPTION

A custom Python script based on *SpeechRecognition* was used to extract the dialogues from each report and convert them into written text. In order to get an accurate transcription, for each video the language to extract was set before running the code. A few videos included more than one language: in those cases, the text was extracted once for each language, then the transcriptions were manually merged.

Almost all videos end with a final speech from representatives of the promoters (either WMO officials or the mayor of Mexico City, depending on the series), discussing the general purpose of the reports. Because of the differences in both the producers and the purpose, the transcriptions of these final speeches were separated from the transcriptions of the actual future weather reports.

All the transcriptions were organised in a spreadsheet, indicating for each text:

- the video from which it was extracted;
- the language in which it's written;
- whether it belongs to a report or to a final speech.

TRANSLATION

A custom Python script based on *GoogleTrans* was used to translate all the extracted texts into a single language: English. The code ran through the spreadsheet mentioned above and saved the translations into a new csv file.

Each row of the csv file (**Dataset P1_translations**) includes both:

- the original transcription;
- its translation to English.

And for each translation it indicates:

- the video from which it was extracted;
- the language from which it was translated;
- whether it belongs to a report or to a final speech.

DATASET



Dataset P1_translations

Spreadsheet resulting from the transcription and then translation of the reports' speech.

Tag clouds - categories

Merged texts' tag clouds were further investigated: the words they contain were grouped on the basis of their meaning and in accordance with the evaluation criteria previously set.

Meaningful comparisons between reports and final speeches were provided through categorisation and colour coding.

CATEGORISATION

Each word from the two merged tag clouds was categorised into 1 exclusive category of 15, according to its meaning. Categories are the same as in protocol 2 and 3, and kept into consideration both the specific words in the tag clouds of all protocols and the evaluation criteria set prior to starting the analysis.

Each category can be made of 1, 2 or 3 specific subcategories. Categories and subcategories are listed and defined on the opposite page. However, the analysis initially focused on first-level categories (highlighted in blue in the list).

COLOUR CODING

A colour for each category was established, then the words in the merged texts' tag clouds were coloured according to their category of belonging. Working directly with colour on the clouds allows to see:

- variety → how many words for each category;
- frequency → position and size of words for each category.

REPORT ↔ FINAL SPEECH

Comparing the distribution of each colour for the two tag clouds (*final-speeches-excluded* and *final-speeches-only*) allows to go deeper into analysing how the intentions of the WMO initiative have been translated into the actual reports.

◆ P1 → TEXTS → TAG CLOUDS → VIZ 03

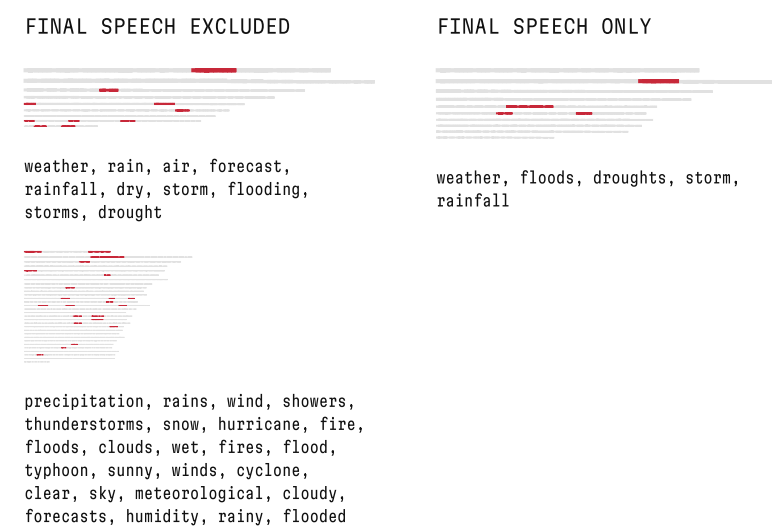
The visualisation on the right shows for each category the pair of tag clouds placed side by side, with the words falling in colour.

In order to give more importance to the colours, words were replaced with rectangles through Dan Ross' *Flow Block* font. The terms included in the category were made readable in an ordered list (most frequent to least frequent) that follows each tag cloud.

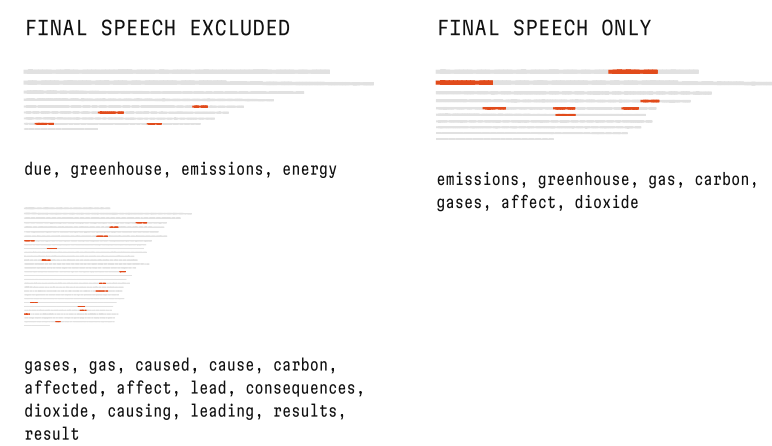


In order for the comparison to be as immediate as possible, the division of the *final speeches-excluded* tag cloud into two pieces introduced in the previous visualisation (P1 → texts → tag clouds → viz 02) was kept.

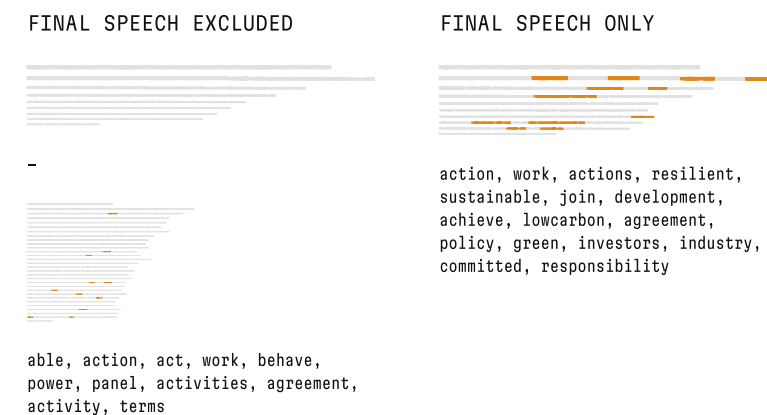
Weather



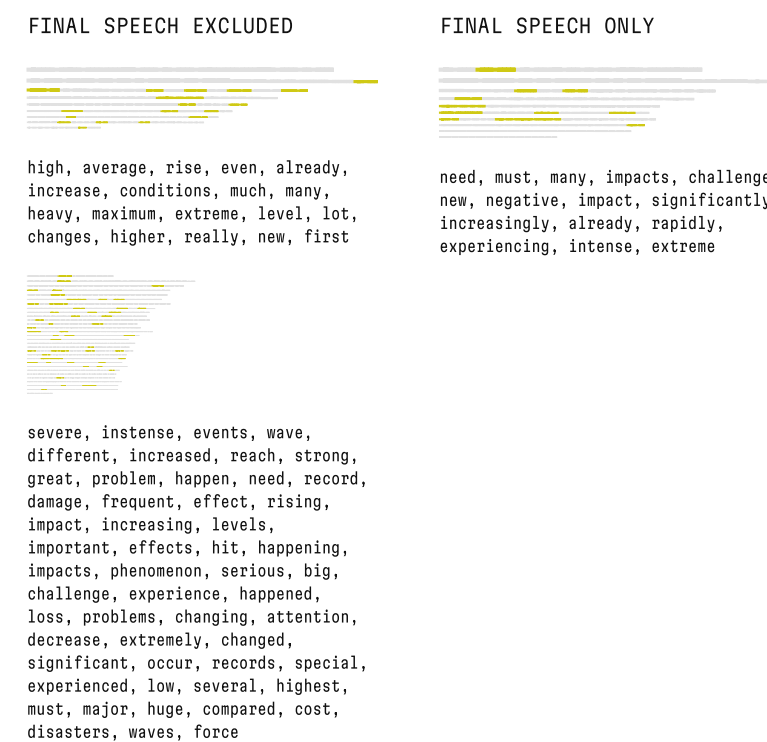
Causes



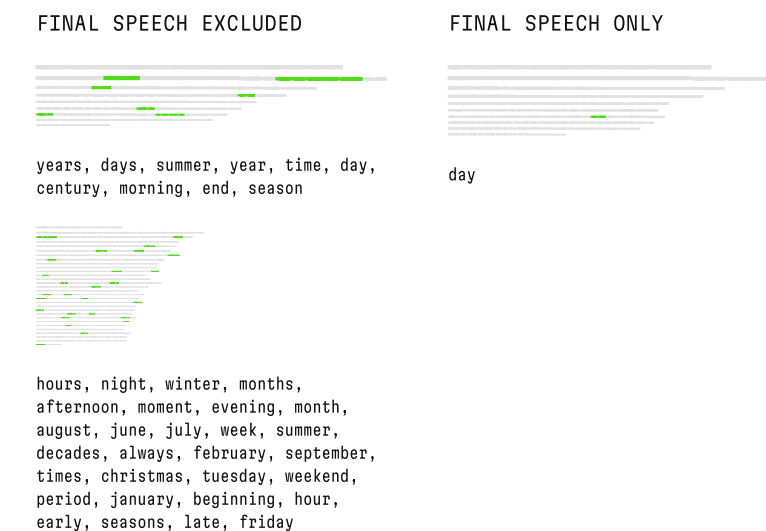
Solutions



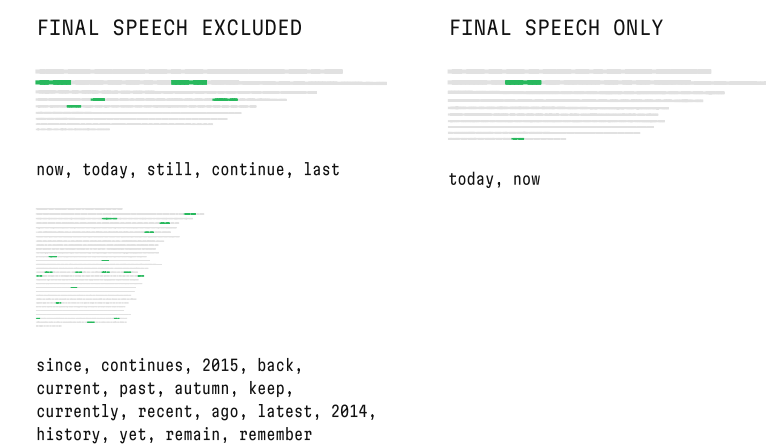
Impacts



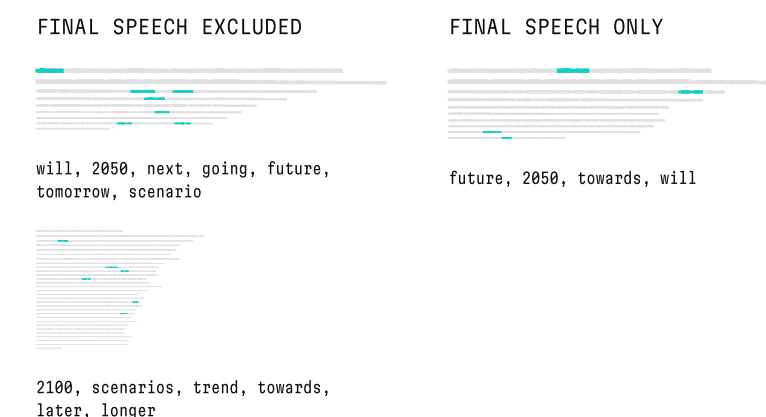
Time



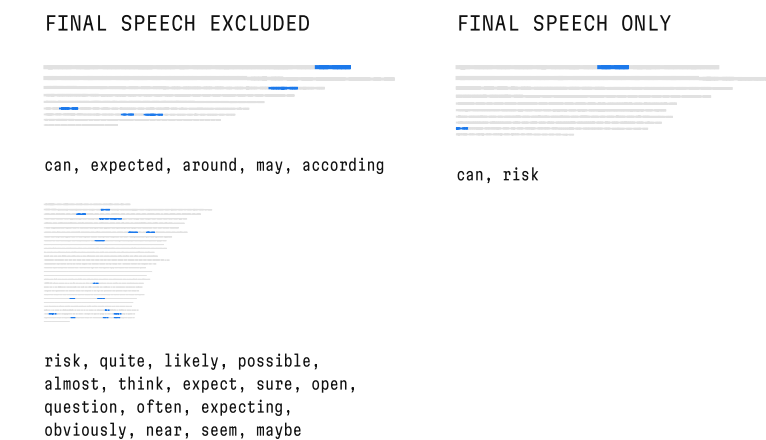
Past & present



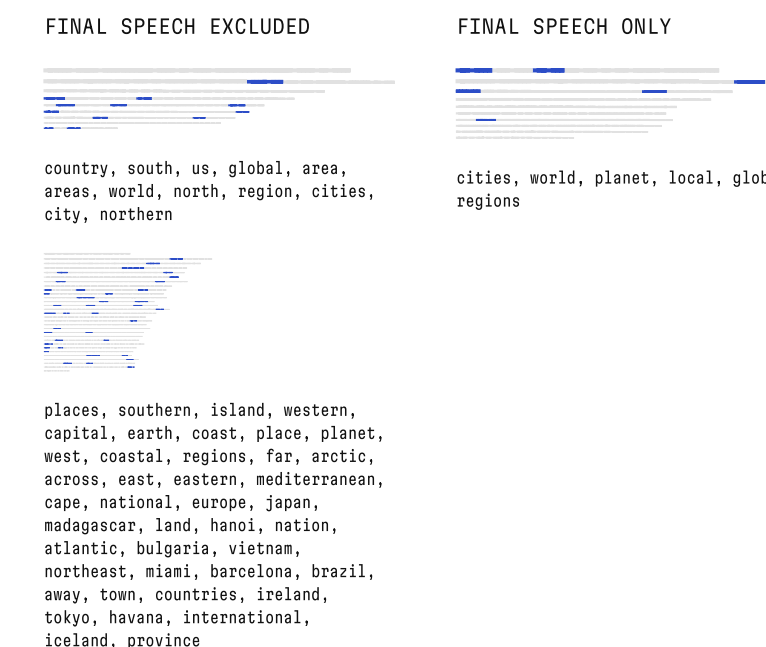
Future



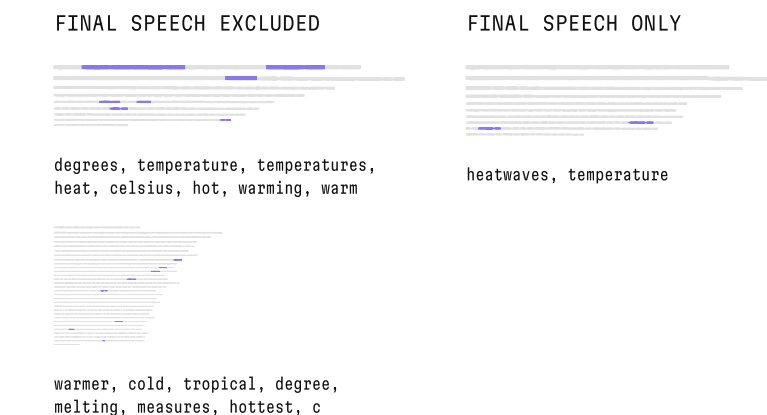
Anticipation



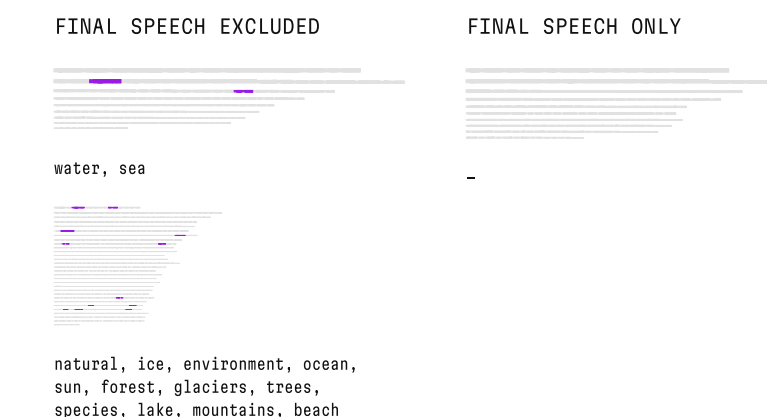
Locations



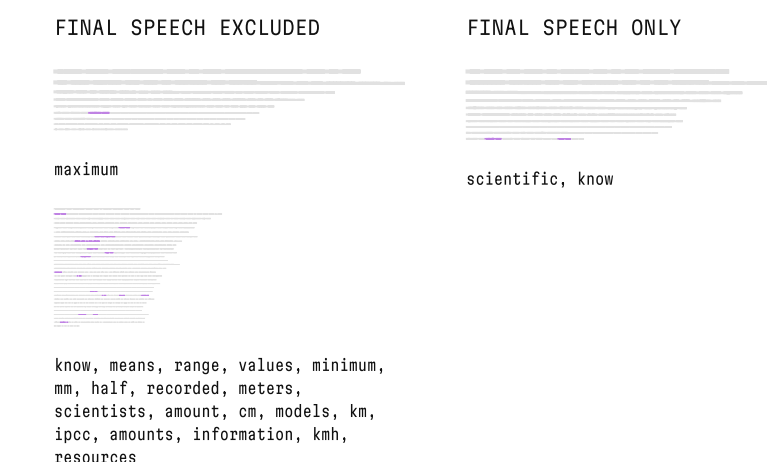
Temperature



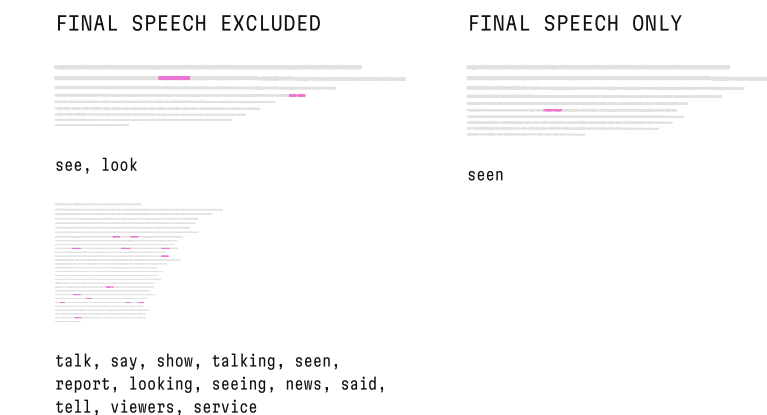
Natural environment



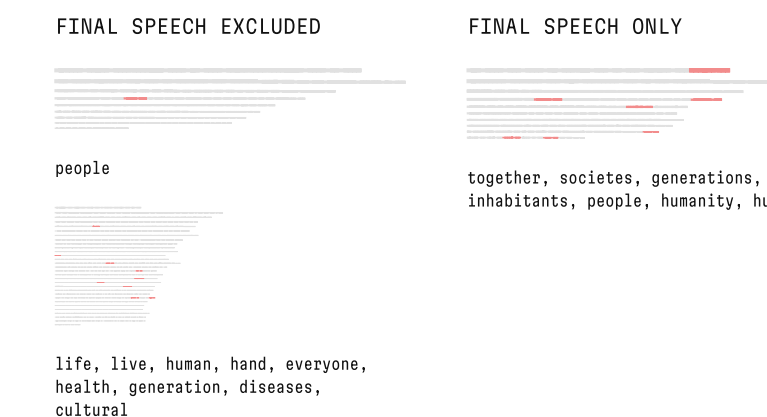
Science



Media



People



Others



CATEGORIES AND SUBCATEGORIES WITH THEIR EXPLANATIONS

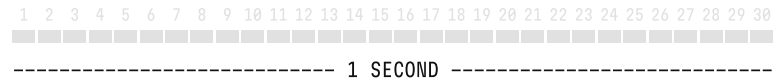
- WEATHER**
 - Forecasts → words referring to weather and weather forecasting (*e.g. meteorological*);
 - Phenomena → words referring to weather phenomena and events (*e.g. rain*);
- CAUSES**
 - General → words generally related to causation (*e.g. due*);
 - Climate change → words referring to specific causes of climate change (*e.g. greenhouse*);
- SOLUTIONS**
 - Action → words conveying the general idea of action/reaction (*e.g. fight*);
 - Institutions → words related to institutions or governments, supposed to act against climate change (*e.g. intergovernmental*);
 - Climate change → words related to specific behaviours connected with climate change saviness (*e.g. sustainability*);
- IMPACTS**
 - Extreme → words conveying a sense of out of the ordinary (*e.g. extreme*);
 - Effects → words generally related to effects (*e.g. impacts*);
 - Threats → words related to clearly negative effects (*e.g. disasters*);
- TIME**
 - Time → words expressing general time periods and intervals (*e.g. winter*);
- PAST AND PRESENT**
 - Past → words expressing specific moments in the past, specifically before the moment when the data was collected (*e.g. 2019*);
 - Present → words generally addressing the present moment (*e.g. now*);
- FUTURE**
 - General → words generally related to future (*e.g. projections*);
 - Specific moment → words expressing specific moments in future time (*e.g. 2050*);
- ANTICIPATION**
 - Uncertainty → words expressing uncertainty or doubt (*e.g. might*);
 - Certainty → words expressing certainty or confident expectancy (*e.g. sure*);
- LOCATIONS**
 - General → general geographical terms (*e.g. longitude*);
 - Global → words related to earth as a whole (*e.g. global*);
 - Local → words referring to specific locations (*e.g. greenland*);
- TEMPERATURE**
 - Temperature → words related to temperature (*e.g. heat*);
- NATURAL ENVIRONMENT**
 - Natural environment → words related to natural environments, ecosystems and/or their elements (*e.g. mountain*);
- SCIENCE**
 - Institutions → words related to scientists and scientific institutions (*e.g. ipcc*);
 - Studies → words related to scientific studies and measurements (*e.g. data*);
 - Information → words related to scientific communications (*e.g. report*);
- MEDIA**
 - Media → words generally related to formats and channels (*e.g. photo*);
- PEOPLE**
 - People → words connected with humanity as a group (*e.g. human*);
- OTHERS**
 - Others → everything else;

Images

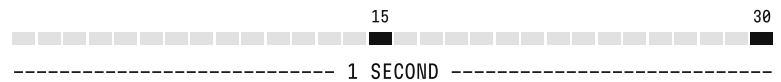
Each report was reduced to a sampling of its frames (one frame every half a second of video). In order to analyse both quantitatively and qualitatively the images, sampled frames were considered in their totality as well as through a selection of unique images.

FRAME SAMPLING

The frame rate for all videos was set to 30 fps through *Adobe Premiere Pro*.



VLC Media Player was used to extract every 15th frame: it means 2 sampled frames every second of video.



The frame sampling resulted in 42,077 total images.

UNIQUE IMAGES SELECTION

From the totality of the frames, unique images were manually selected. The criteria used for the definition of a unique image were the following:

- Each shot (“single sequence of a motion picture or a television program shot by one camera without interruption”, *Merriam-Webster*) corresponds to at least one unique image.
- Inside the same shot there can be more than one unique image only if there is a significant change in the meaning and/or content of the frame.
 - e.g. 1 → When a map turns from showing temperatures to showing wind directions, it's two unique images.*
 - e.g. 2 → When the same visualisation is used first for the weather forecast of today and then for the weather forecast of tomorrow, it's just one unique image (the meaning doesn't change).*
 - e.g. 3 → When the same visualisation is used first for the weather forecast of today and then for the weather forecast of 2050, it's two unique images.*

Out of 42,077 total frames, 2,413 unique images were selected.

Network

Unique images were arranged into a network based on AI image captioning. The network provided the base for mapping the visual representations of climate change in the reports.

VISUAL SIMILARITY

The 2,413 unique images were fed to Yale DHI's PixPlot in order to get an interactive image network based on similarity: each frame is captioned from a previously trained neural network model, then all frames are arranged in the space according to their content similarity.

The network can be explored through panning and zooming in the space or jumping to hotspots (image clusters). PixPlot automatically identifies some default hotspots, but they can also be created and curated by the user.

TAGGING

A static screenshot of the network was taken and manually tagged according to groups and clusters visually identified while exploring the interactive model and with the help of automatically identified hotspots.

PI -> IMAGES -> NETWORK -> VIZ 00

The visualisation on the right shows the 2,413 unique images (selected from the sampled frames as previously described) displayed in the space on the basis of similarity (according to PixPlot's process of image captioning and positioning through a pre-trained convolutional neural network model).

Areas characterised by the predominance of a specific subject are outlined and tagged, even if subject clusters are often more spread around and less localised than they appear.

A straight diagonal line separates the upper-left portion of the map (majority of images including people) from the lower-right portion (majority of images without people).

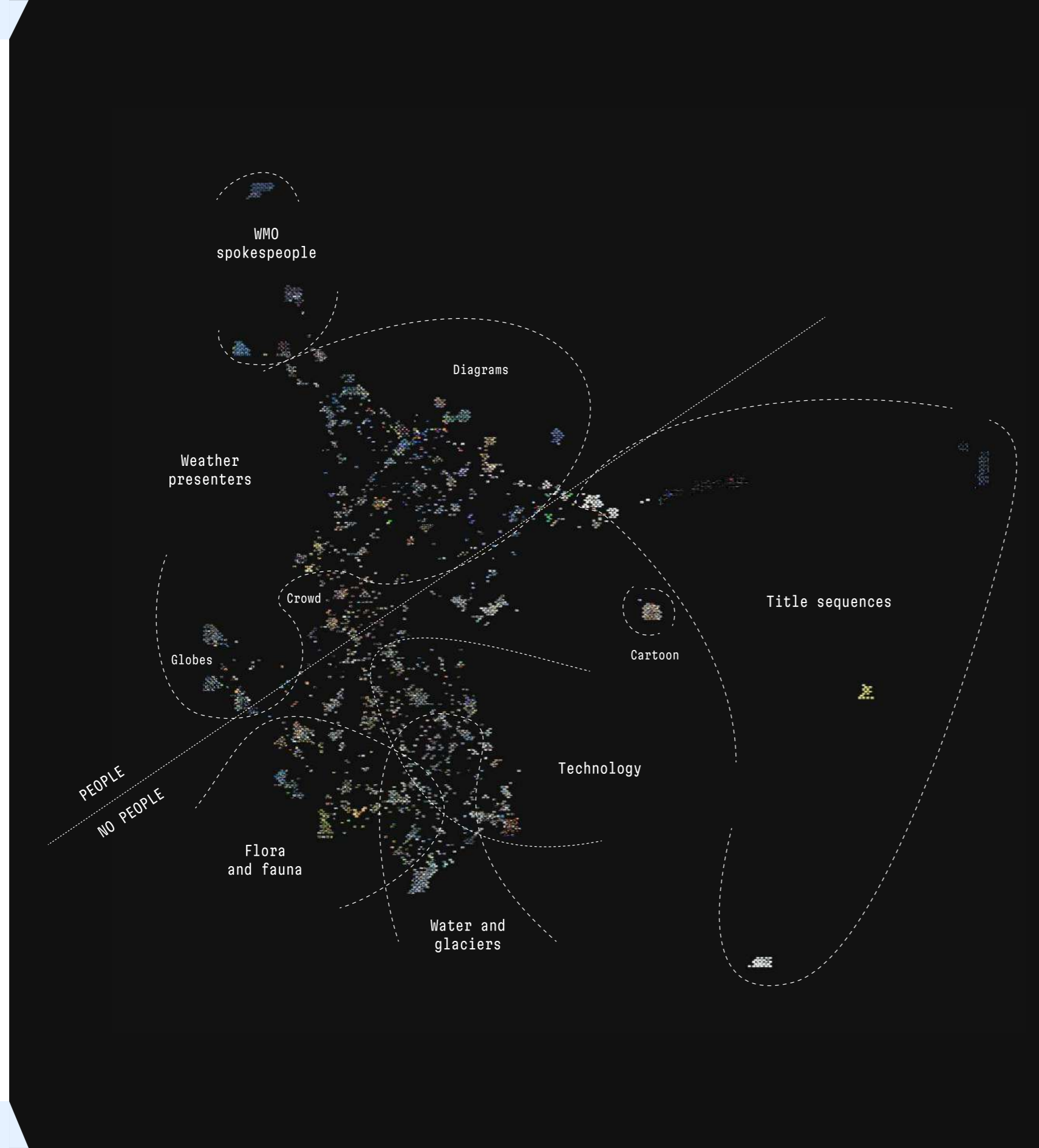
CLUSTERING

The network mapping was expanded into a detailed clustering of the images through the creation of a hierarchy of manually curated hotspots. The categorisation process kept into consideration the actual images' features and subjects as well as the evaluation criteria previously set. The hierarchy of (not exclusive) image clusters is visible on the opposite page.

INTERACTIVE NETWORK



PixPlot P1
Interactive network including all the 2,413 unique frames, displayed according to image similarity and with hotspots based on images' subjects.

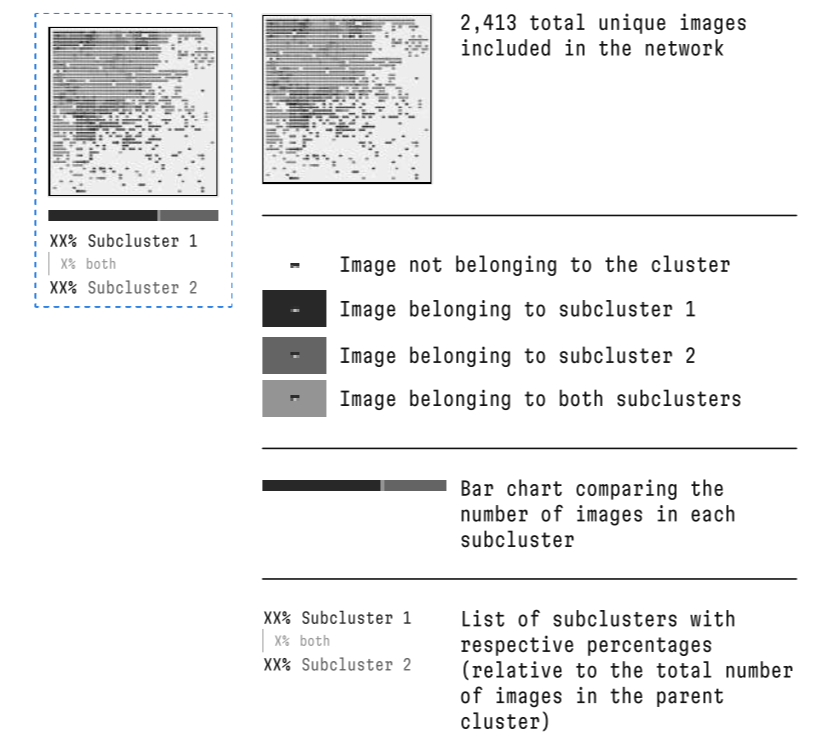


PI -> IMAGES -> NETWORK -> VIZ 01

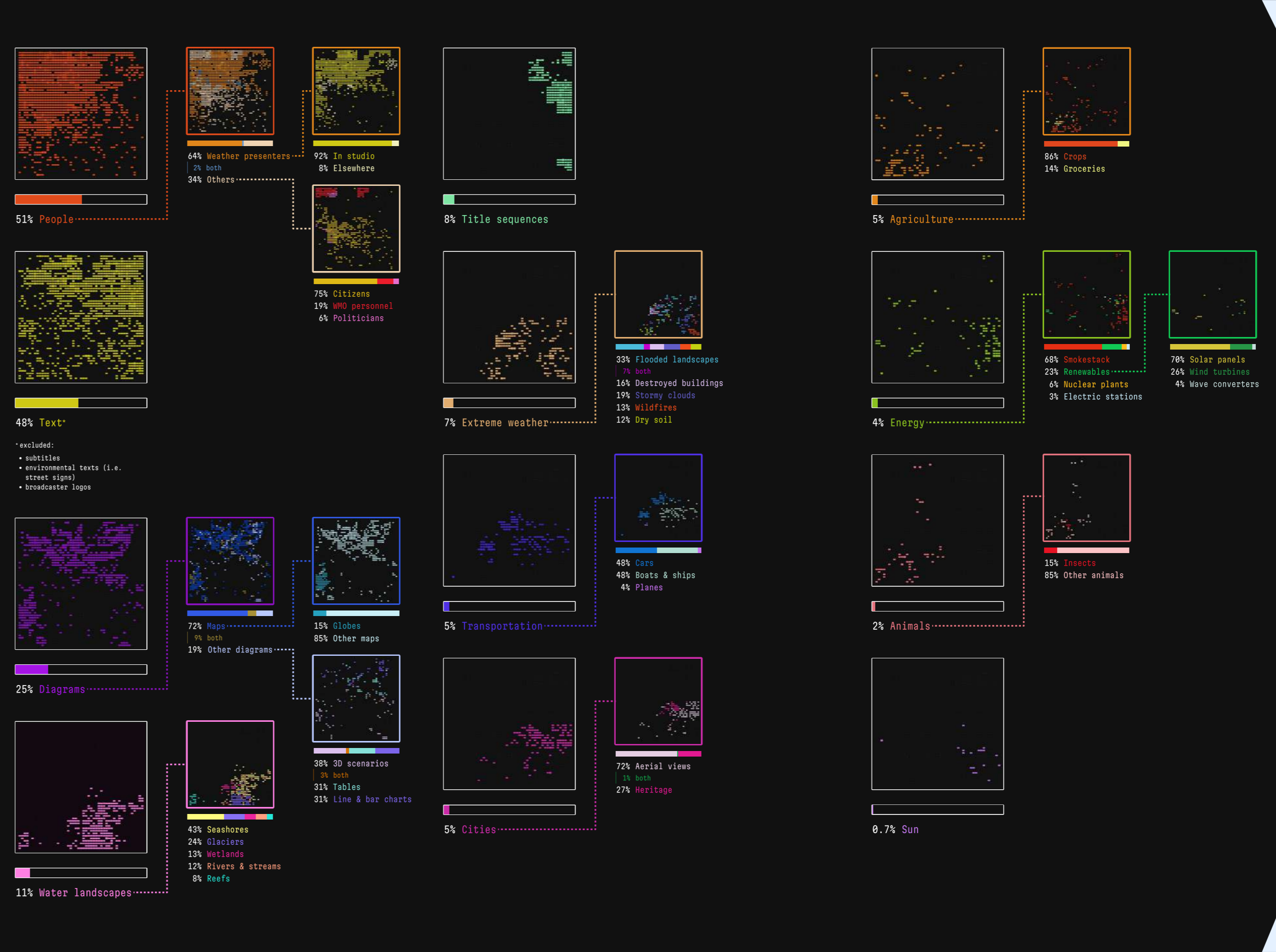
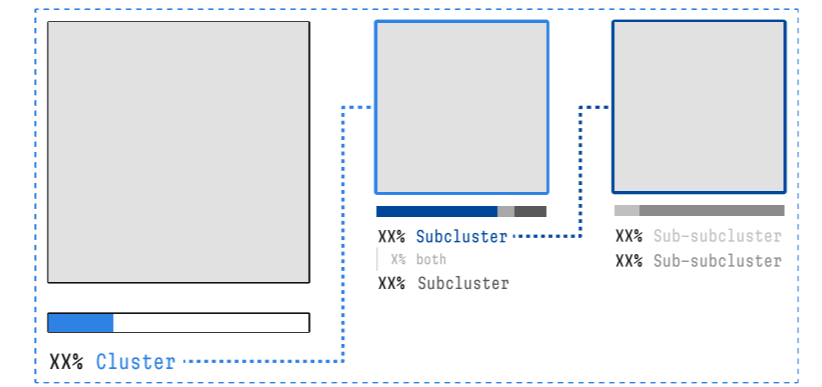
The visualisation on the right displays the cluster hierarchy and the quantity of images for each cluster and subcluster. It builds on the grid display provided by PixPlot and uses colour to distinguish one category from the others as well as for highlighting the links in the hierarchy.

Clusters are ordered from the most populated to the least populated. Quantities are always expressed as percentages, since the most interesting comparison in that sense is that between child clusters belonging to the same parent cluster (or that of parent clusters between each other).

A single cluster is visualised as follows:



A family of clusters is visualised as a series of cluster visualisations connected through dashed lines and colour coding according to their hierarchy.



HIERARCHY OF IMAGE CLUSTERS

PEOPLE-----> Weather presenters-----> In studio
• Others-----> Elsewhere
• Citizens
• WMO personnel
• Politicians

TEXT

DIAGRAMS-----> Maps-----> Globes
• Other maps
• Other diagrams-----> 3D scenarios
• Tables
• Line & bar charts

WATER

LANDSCAPES-----> Seashores
• Glaciers
• Wetlands
• Rivers & streams
• Reefs

TITLE SEQUENCES

EXTREME-----> Flooded landscapes
WEATHER-----> Destroyed buildings
• Stormy clouds
• Wildfires
• Dry soil

TRANSPORTATION

-----> Cars
• Boats & ships
• Planes

CITIES

-----> Aerial views
• Heritage

AGRICULTURE

-----> Crops
• Groceries

ENERGY

-----> Smokestack
• Renewables-----> Solar panels
• Wind turbines
• Wave converters

ANIMALS

-----> Insects
• Other animals

SUN

-----> 0.7% Sun

Network - images

Clustered images were reconnected with their visual appearance through cluster-specific wall of images based on the grouping hierarchy.

CHILD CLUSTER

All images in each low-level-cluster (clusters which don't contain other clusters) were downloaded and arranged together in creating cluster-specific image walls. The purpose of this operation was to connect the abstraction of the network with the qualitative appearance of the frames, providing samples of the distinctive visual qualities in each image group.

The complete hierarchy of clusters with the low-level-clusters highlighted in blue is available on the right.

PI -> IMAGES -> NETWORK -> VIZ 02

The visualisation on the right covers all low-level-clusters in the previously defined hierarchy. For each cluster are shown:

- the hierarchy of its parent clusters (if any);
- the number of images in the cluster;
- the position of the images in the network;
- a sample of images from the cluster (image wall).

Colours are maintained from the previous visualisation (P1 -> images -> network -> viz 01). A single cluster is visualised as follows:

↓ CLUSTER HIERARCHY NUMBER OF IMAGES ↓

Cluster ↓ Subcluster ↓ Sub-subcluster	XX IMAGES
---------------------------------------	-----------

↑ IMAGES IN THE NETWORK WALL OF IMAGES ↑

The sequence of low-level-clusters' displays is followed by a miniature of the tagged network (P1 -> images -> network -> viz 00), in order to provide an easy-to-consult map of the network areas.

HIERARCHY OF IMAGE CLUSTERS (CHILD CLUSTERS HIGHLIGHTED)

- PEOPLE-----> Weather presenters-----> **In studio**
- Others-----> **Elsewhere**
 - Citizens
 - WMO personnel
 - Politicians

- TEXT-----> Maps-----> **Globes**
- Other diagrams-----> **Other maps**
 - 3D scenarios
 - Tables
 - Line & bar charts

- WATER LANDSCAPES-----> Seashores
- Glaciers
 - Wetlands
 - Rivers & streams
 - Reefs

- TITLE SEQUENCES-----> Flooded landscapes
- Destroyed buildings
 - Stormy clouds
 - Wildfires
 - Dry soil

- TRANSPORTATION-----> Cars
- Boats & ships
 - Planes

- CITIES-----> Aerial views
- Heritage

- AGRICULTURE-----> Crops
- Groceries

- ENERGY-----> Smokestack
- Renewables-----> **Solar panels**
 - Wind turbines
 - Wave converters

- ANIMALS-----> Nuclear plants
- Electric stations

- SUN-----> Insects
- Other animals

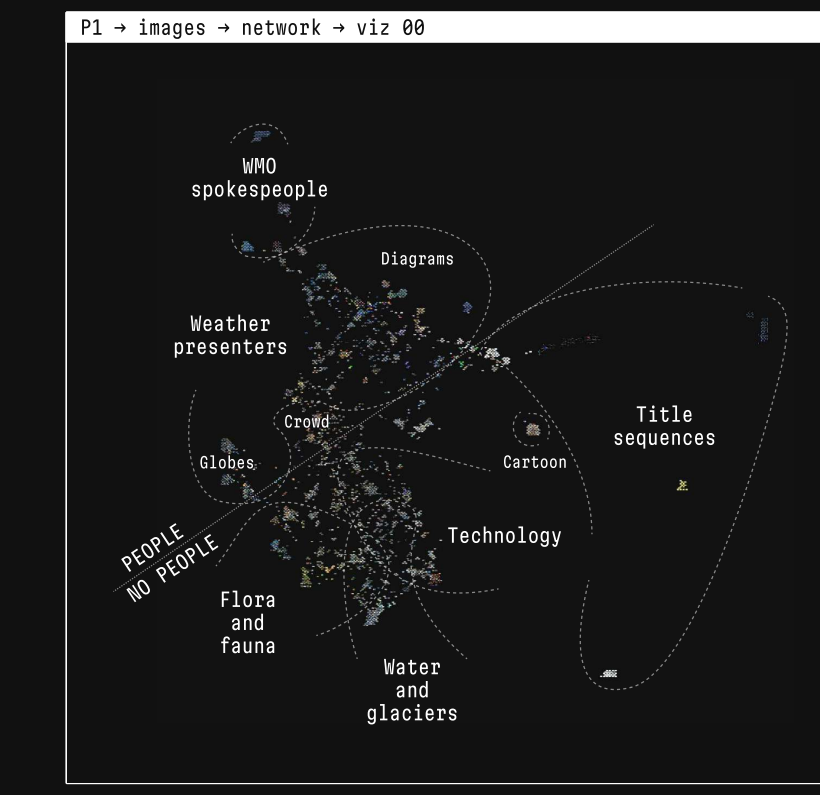
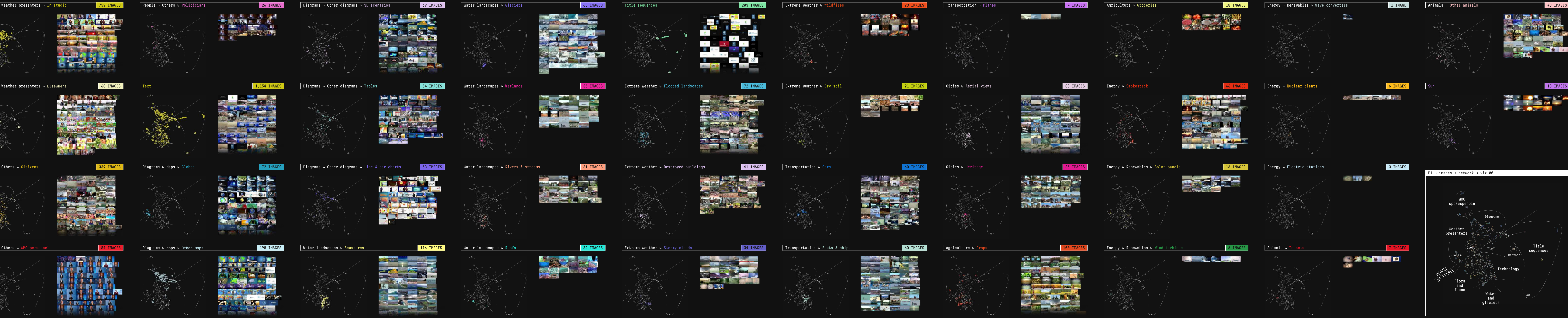


Image plot

The visual space of the reports was also examined in regard to hue and brightness values in the pictures, to detect trends and tendencies in the use of colours of climate crisis' representations.

IMAGE MEASURING

Colour values in each of the 2'413 unique images were measured through *ImageMeasure* for ImageJ. In particular, the process returned for each picture:

- median of brightness values;
- standard deviation of brightness values;
- median of saturation values;
- standard deviation of saturation values;
- median of hue values;
- standard deviation of hue values.

PLOT DIMENSIONS

The measures of brightness and hue were used to build a plot of images through *ImagePlot* for ImageJ. The axis of the plot were mapped as below:

- X axis → median of hue values (*hue_median*);
- Y axis → standard deviation of brightness values (*brightness_stdev*).

Each image was positioned in the plot according to its measured values.

PLOT EVALUATION

The distribution in the plot was analysed mainly in regard to the hue values, considering image density as well as recurring subjects across the x axis.

◆ P1 → IMAGES → IMAGE PLOT → VIZ 01

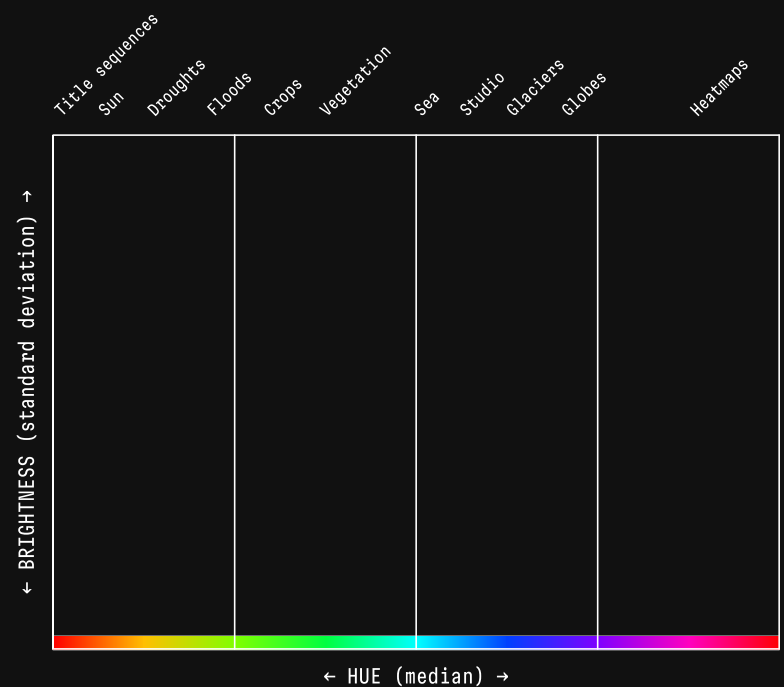
The visualisation on the right shows the 2,413 unique images distributed in the space according to their hue values (median mapped on X axis) and brightness values (standard deviation mapped on Y axis), as previously explained.

The plot is split vertically into 4 portions of equal width, according to hue values:

1. red to green (X1);
2. green to light blue (X2);
3. light blue to purple (X3);
4. purple to red (X4).

The purpose of those portions is to facilitate the evaluation of image density in relation to hue values.

Recurring subjects for specific hue areas are noted above the plot.



Frame grids

The total sampled frames were rearranged in grids, providing static reductions of the reports. The grids were mapped according to the series to which the report belonged, its continent of production and duration.

FRAME UNIFORMATION

All 42,077 frames were uniformed in their ratio, so that they could be more easily aggregated and compared. The uniformation process had the following settings:

- ratio → 16:9;
- image → fill ratio;
- squashing and stretching → allowed.

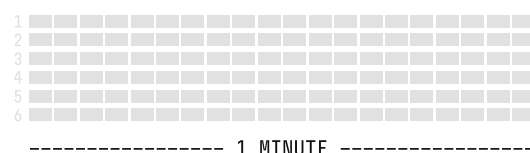
Frames from videos which had an original ratio different from the output ratio (16:9) were deformed, but their content remained in all cases recognisable.

GRID CONSTRUCTION

Frames were rearranged to build an image grid for each report. Every row of the grid displays 20 frames, which correspond to 10 seconds of the original report: as previously explained, the sampling extracted 2 frames each second of screen time.



Consequently, 6 rows correspond to 1 minute of screen time.



◆ PI → IMAGES → FRAME GRIDS → VIZ 00

The visualisation on the right shows the 63 image grids resulting, one for every report. They are grouped according to:

- series to which they belong (horizontal grouping);
- continent where they were set and produced (vertical grouping);

Inside each series/continent unit, the reports are ordered according to their duration, from the shortest to the longest (final speech included).

CONTINENT



SERIES

Frame grids - subjects and people

Images in the grids were categorised on the basis of subjects and people represented, using respectively colours and patterns in order to implement cross classification. Pictures in each category were then counted to provide quantitative comparisons of the identified typologies.

CATEGORISATION

The frames in the grid were mapped on the basis of both the main subject represented (8 exclusive categories) and the role of the people framed (5 non-exclusive categories). In either cases the categories resulted from the previous analysis of unique images and the evaluation criteria set prior to the analysis.

Main subjects:

1. **Map** → synthesised images of earth from above (satellite views included);
2. **Chart** → charts including bar and line charts, tables, 3D scenarios;
3. **Extreme weather** → all images of environments or people experiencing extreme weather (floods, droughts, wildfires, storms, heatwaves).
4. **Technology** → images centered on some piece of technology.
5. **Natural landscape** → images of natural environments that don't show clear modifications due to human activity (such as buildings, infrastructures, crops); pictures of extreme weather are excluded;
6. **Artificial landscape** → all images of environments that show clear modifications due to human activity; pictures of extreme weather are excluded;
7. **Title sequence** → all frames of title sequences (recurring as openings and endings in most videos);
8. **Speech** → pictures centered on people talking (giving a speech, interviewing, ...) where the context is not visible or not relevant.

People framed:

1. **No people** → nobody is visible (only exclusive category of the 5);
2. **Presenters** → weather presenters, meteorologists and scientists or internal personnel of the media company;
3. **WMO personnel** → as in most final speeches;
4. **Politicians** → on all levels, from local to national;
5. **Citizens** → basically anyone else.

Categories are associated to colours and textures as in the table below:

	No people	Presenters	Citizens	WMO personnel	Politicians	+ Combinations
Title sequence	[Green box]	[Blue box]	[Pink box]	[Orange box]	[Purple box]	Presenters & citizens:
Map	[Light blue box]	[Dark blue box]	[Light pink box]	[Light orange box]	[Light purple box]	[Dark blue box] + [Light pink box] = [Pattern]
Chart	[Light blue box]	[Dark blue box]	[Light pink box]	[Light orange box]	[Light purple box]	[Dark blue box] + [Light pink box] = [Pattern]
Extreme weather	[Light blue box]	[Dark blue box]	[Light pink box]	[Light orange box]	[Light purple box]	WMO spokespeople & Politicians:
Natural landscape	[Light blue box]	[Dark blue box]	[Light pink box]	[Light orange box]	[Light purple box]	[Dark blue box] + [Light pink box] = [Pattern]
Artificial landscape	[Light blue box]	[Dark blue box]	[Light pink box]	[Light orange box]	[Light purple box]	[Dark blue box] + [Light pink box] = [Pattern]
Technology	[Light blue box]	[Dark blue box]	[Light pink box]	[Light orange box]	[Light purple box]	[Dark blue box] + [Light pink box] = [Pattern]
Speech	[Light blue box]	[Dark blue box]	[Light pink box]	[Light orange box]	[Light purple box]	[Dark blue box] + [Light pink box] = [Pattern]

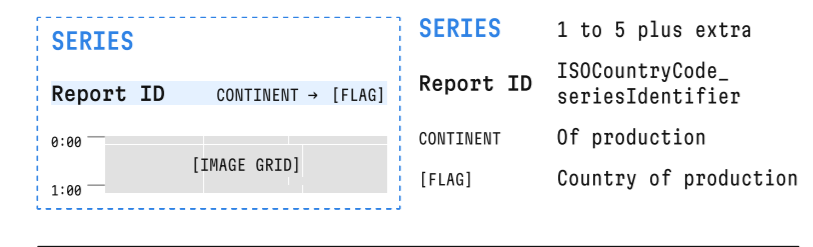
PI → IMAGES → FRAME GRIDS → VIZ 01

In the following visualisation the images in the grids are replaced with rectangles characterised by:

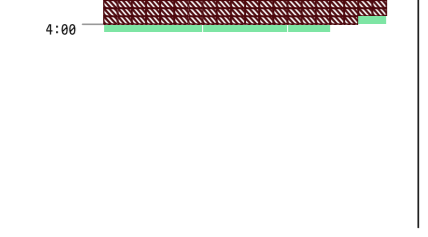
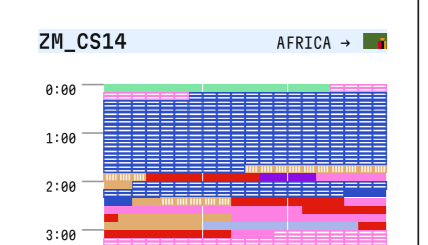
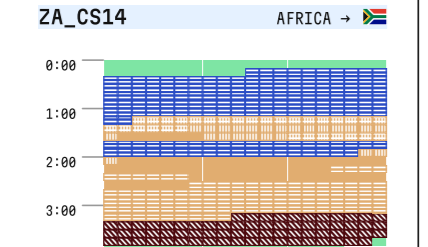
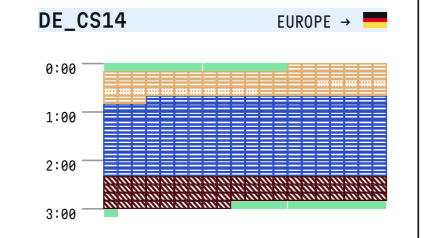
- a colour → according to the main subject represented (8 colours);
- a texture → according to the people framed (5 textures + their combinations).

As mapped in the table on the left.

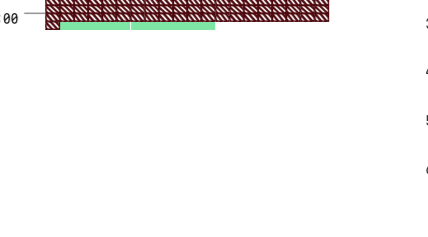
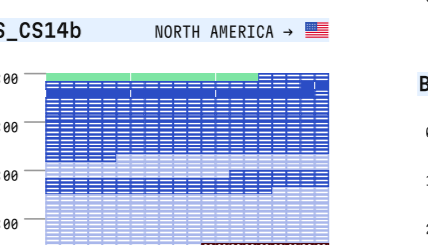
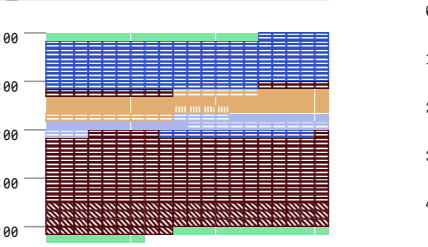
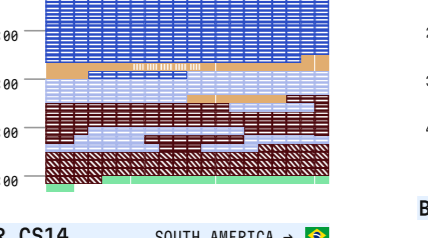
The grids are grouped according to the report series. Inside each series the reports are ordered on the basis of their duration (from the shortest to the longest - final speech included). The visualisation is designed as follows:



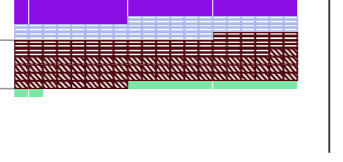
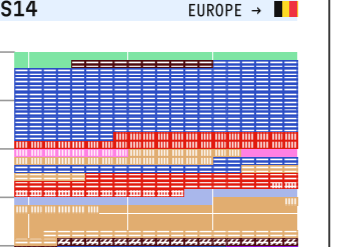
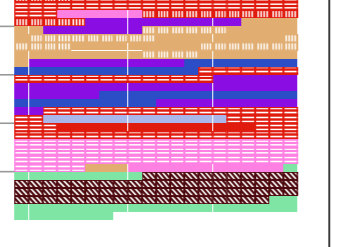
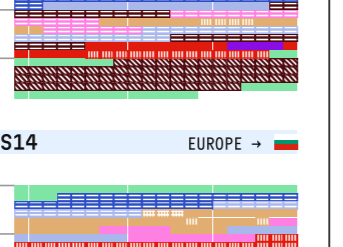
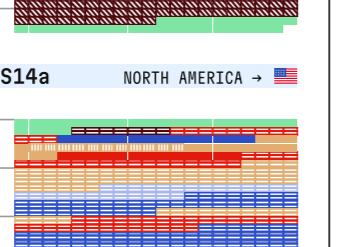
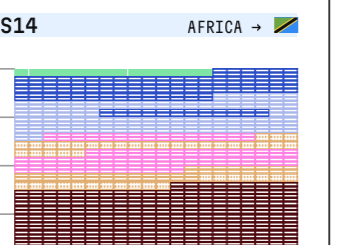
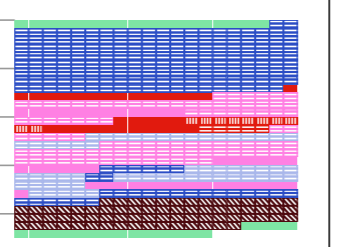
SERIES 1 - Climate Summit 2014



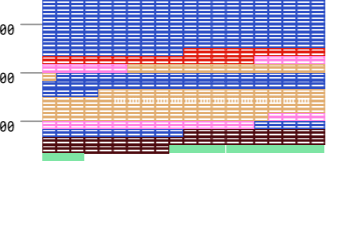
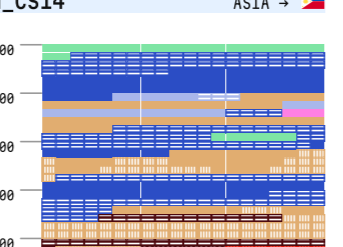
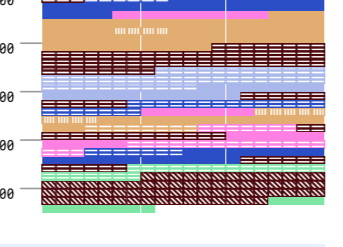
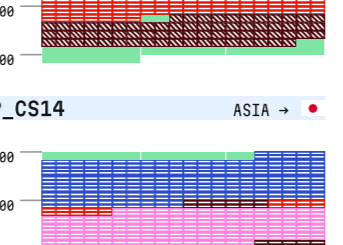
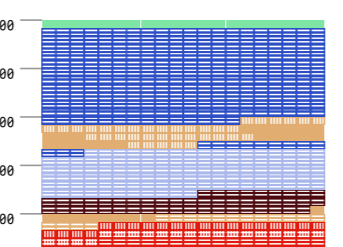
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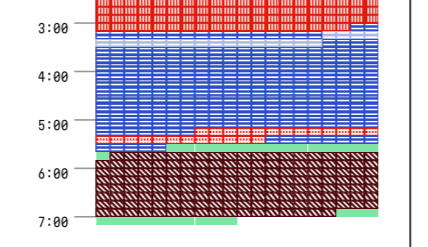
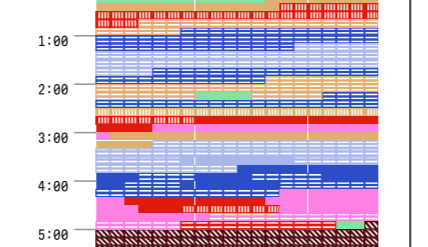
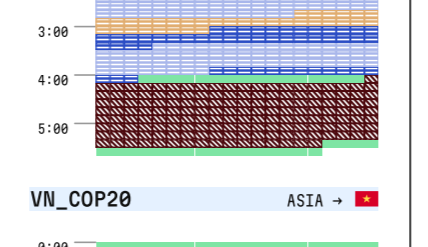
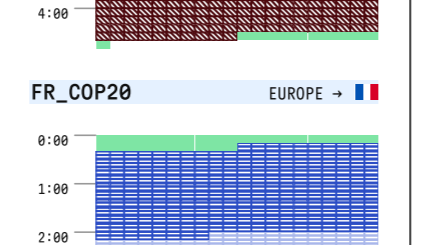
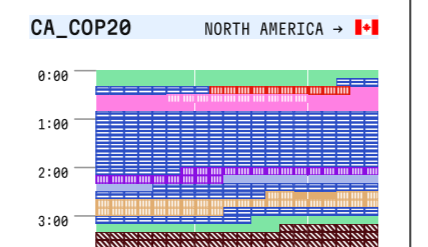
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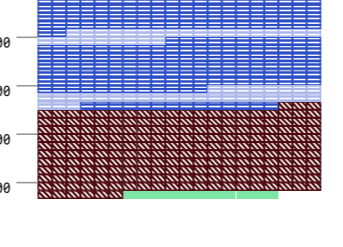
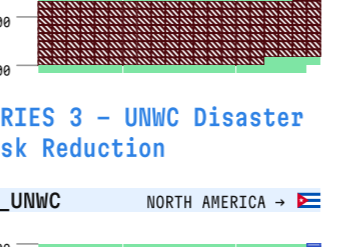
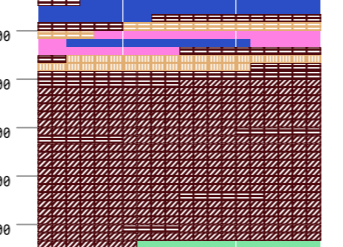
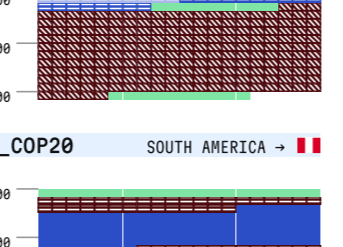
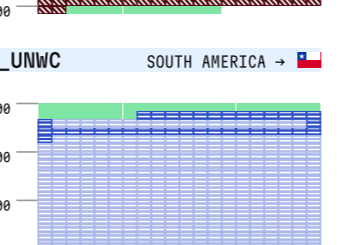
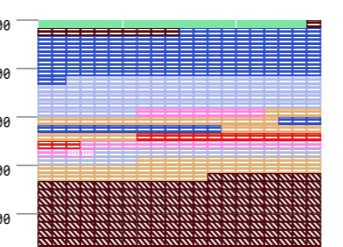
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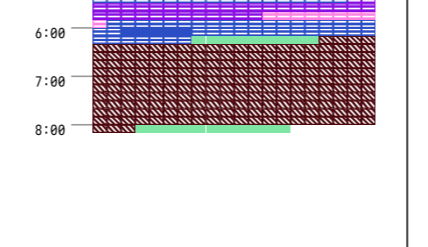
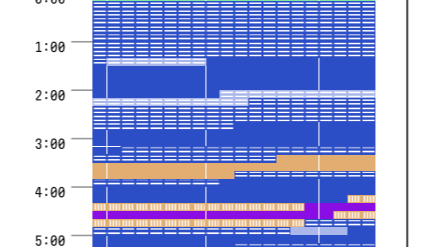
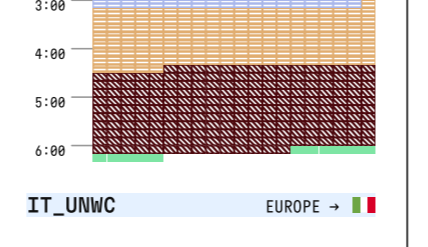
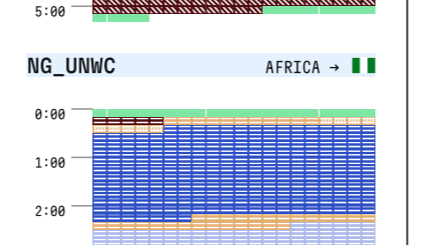
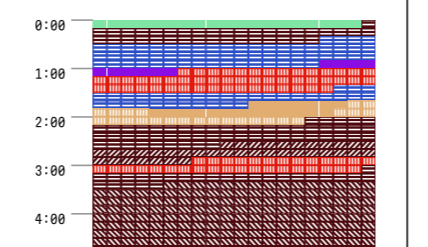
SERIES 2 - Lima COP20



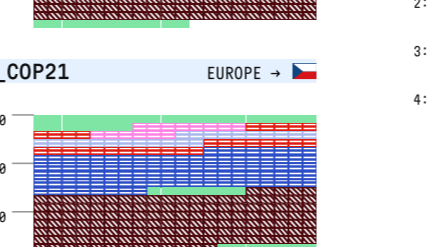
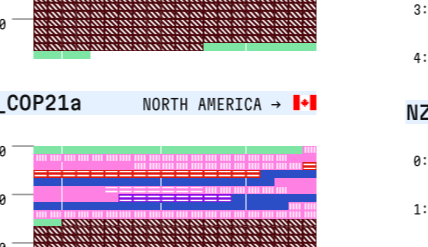
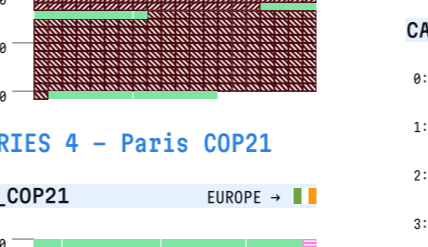
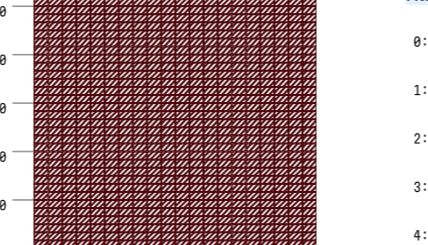
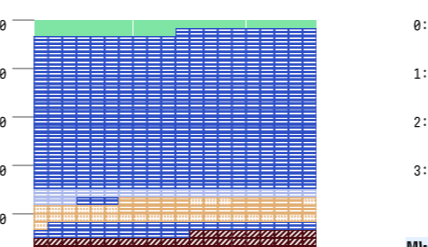
SC_UNWC



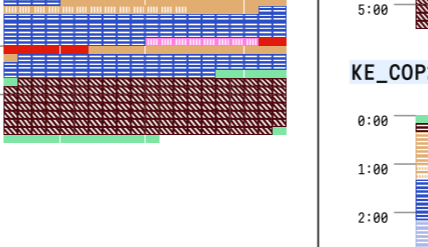
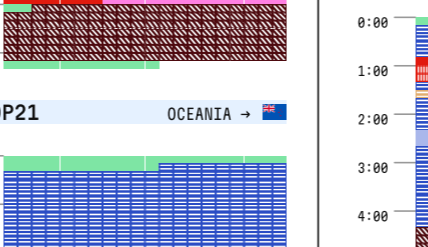
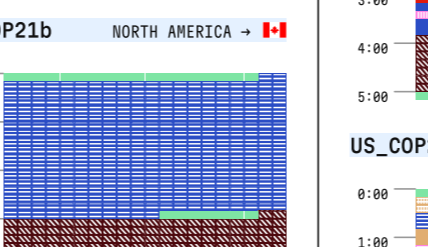
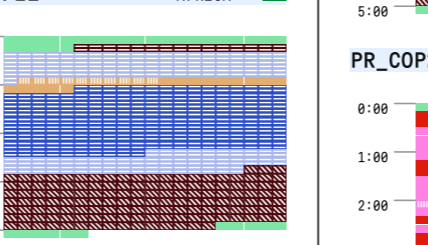
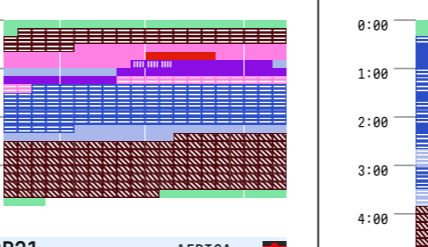
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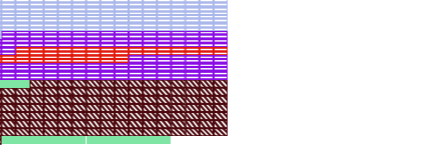
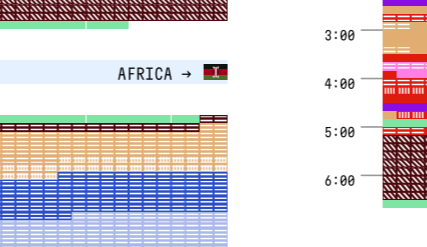
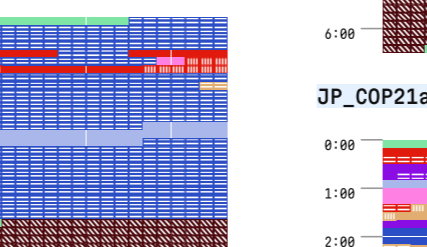
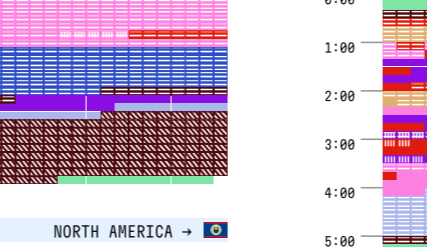
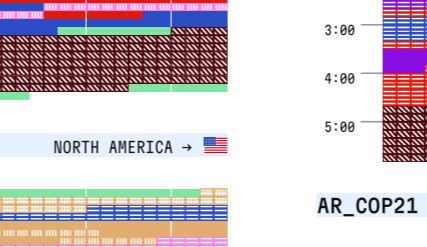
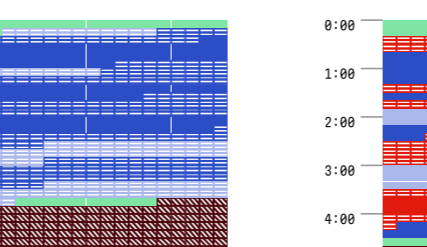
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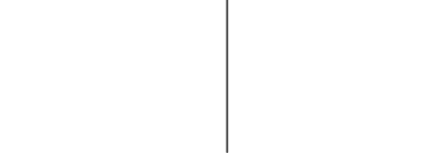
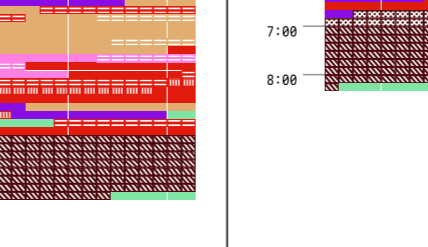
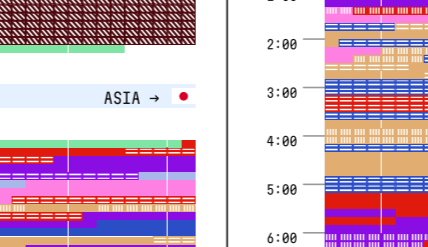
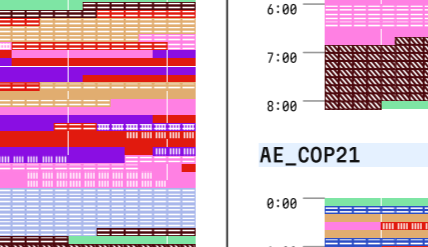
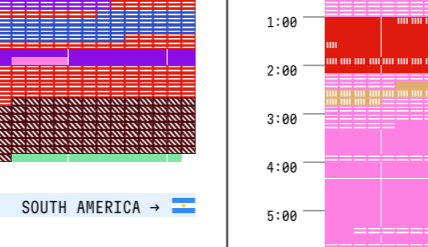
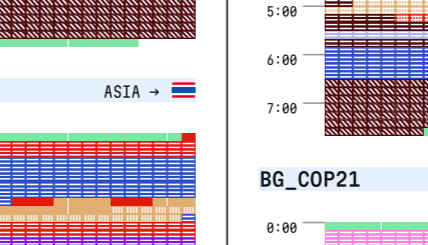
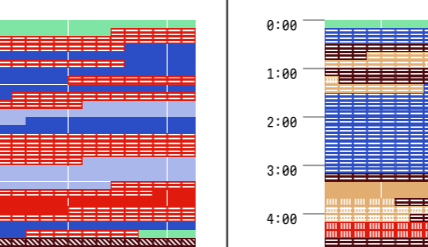
US_COP21a



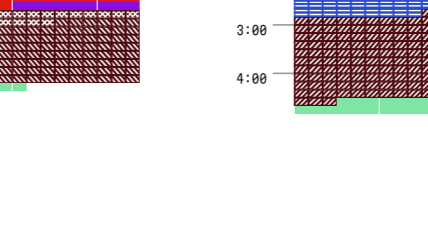
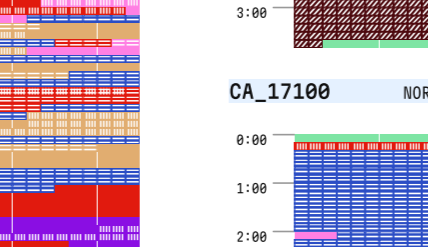
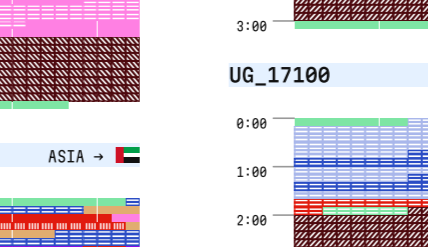
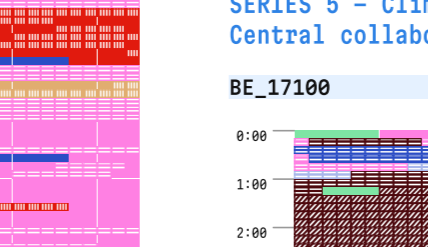
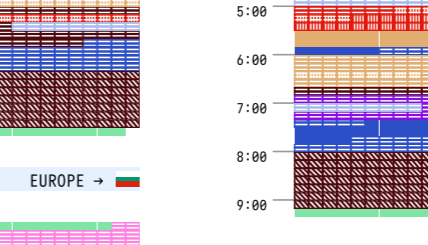
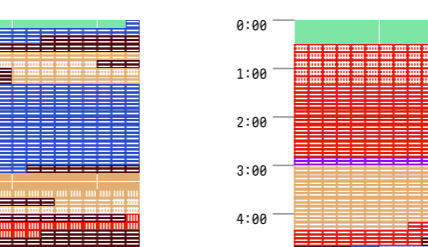
MW_COP21



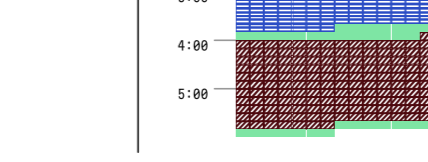
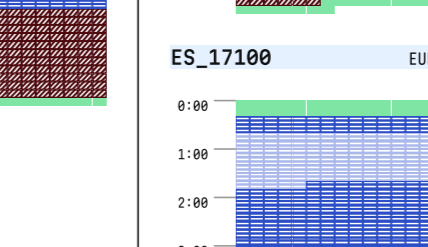
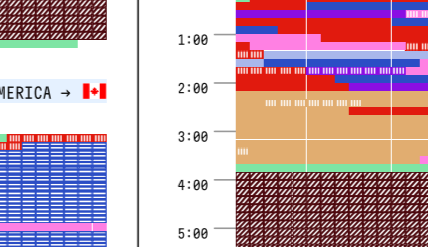
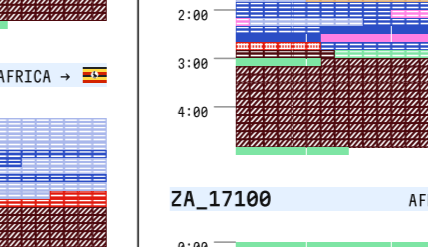
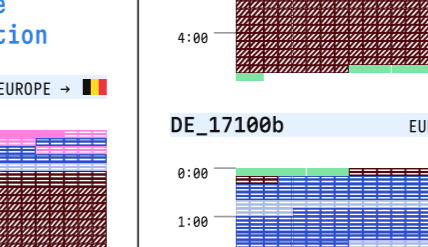
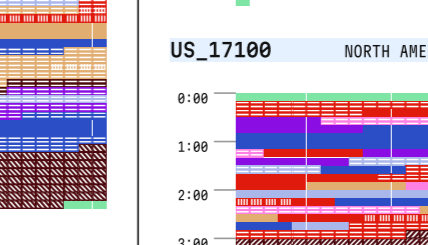
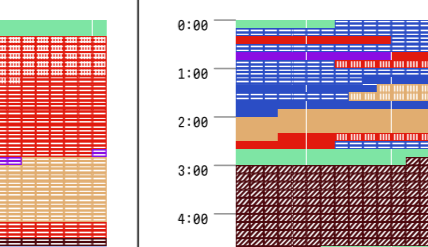
RU_COP21



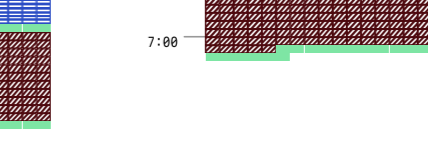
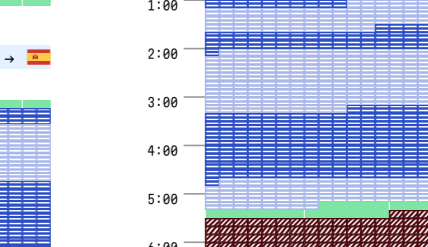
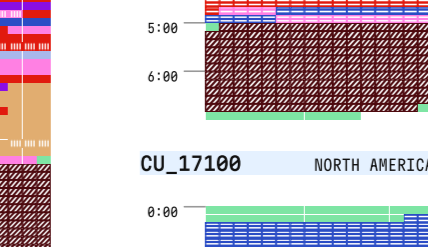
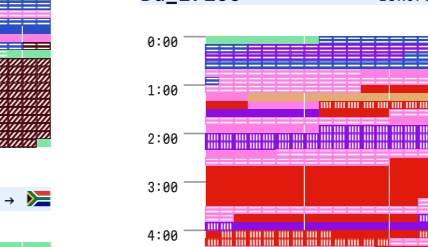
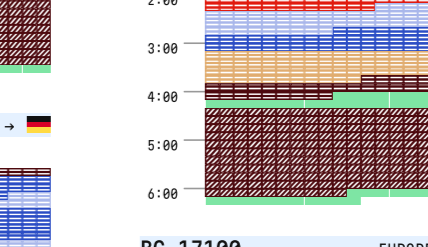
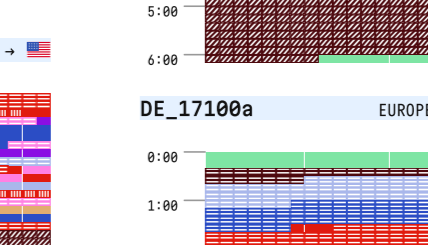
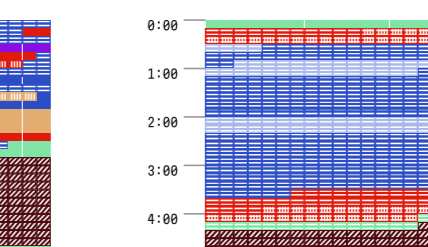
CH_COP21



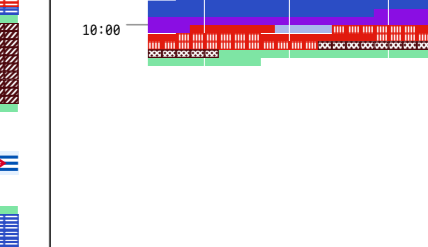
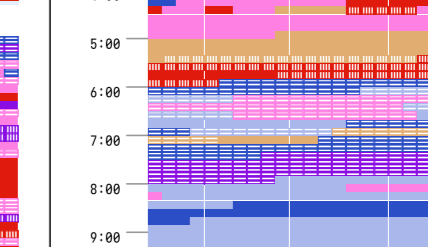
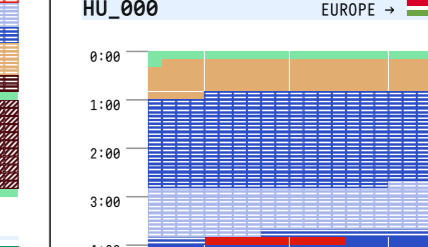
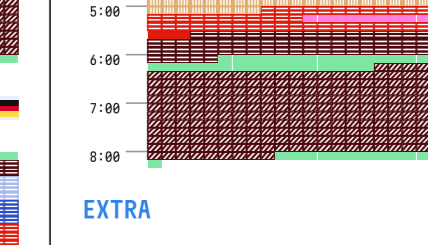
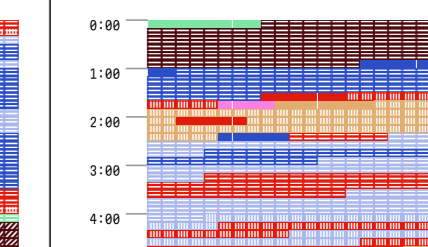
JP_COP21b



AR_17100



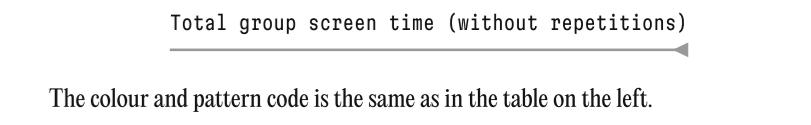
FR_17100



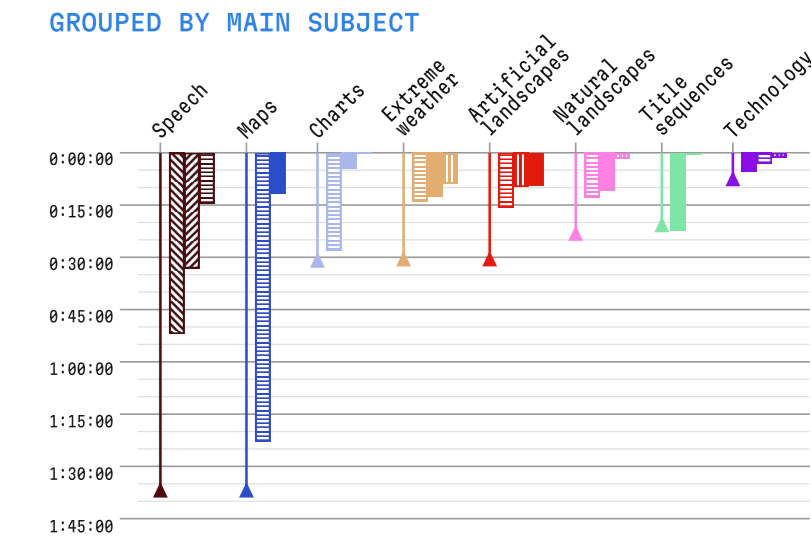
PI → IMAGES → FRAME GRIDS → VIZ 02

The visualisation below uses bars to show the quantity of screen time dedicated in total by the reports to each subject/people unit (e.g. maps including weather presenters). The time is calculated from the number of frames in the considered unit, knowing that every 2 frames correspond to a second.

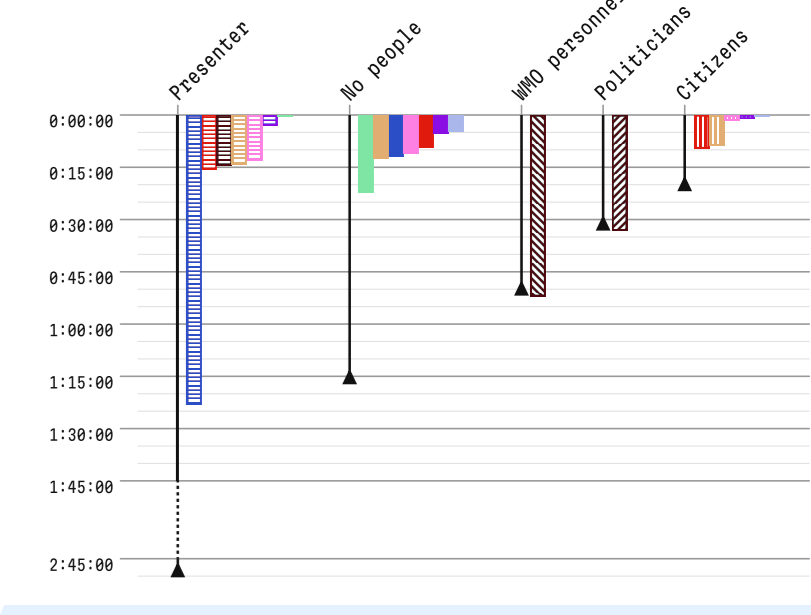
Bars are both grouped according to the main subject represented (above), and according to the people framed (below). Inside each group they are ordered from the longest to the shortest. The total screentime of each group is also visualised.



GROUPED BY MAIN SUBJECT



GROUPED BY PEOPLE FRAMED



PROTOCOL 2

*How do weather
forecast platforms
represent climate
change in their
everyday
practice?*

Data collection

Protocol 2 analyses the communication and interfaces of the 50 most visited weather websites worldwide according to Similarweb.

Pages, articles and general contents concerning climate change on each website were retrieved through web scraping and search operators on both Google Search and Google Images.

SOURCES

Similarweb is a software and data company specialising in web analytics, web traffic and performance. They gather traffic data from public sources, partnerships, analytics services and contributors and use them to provide websites' rankings. The rankings include a list of the "most visited weather websites worldwide" from 1 to 50.

SELECTION

A spreadsheet (Dataset P2_websites) was manually compiled, mapping key metrics for the 50 weather websites in the list (accessed on Feb 11, 2023). The saved information includes:

- rank → 1 to 50;
- website → e.g. bom.gov.au;
- country → where the website is based;
- continent → in which the country is located.

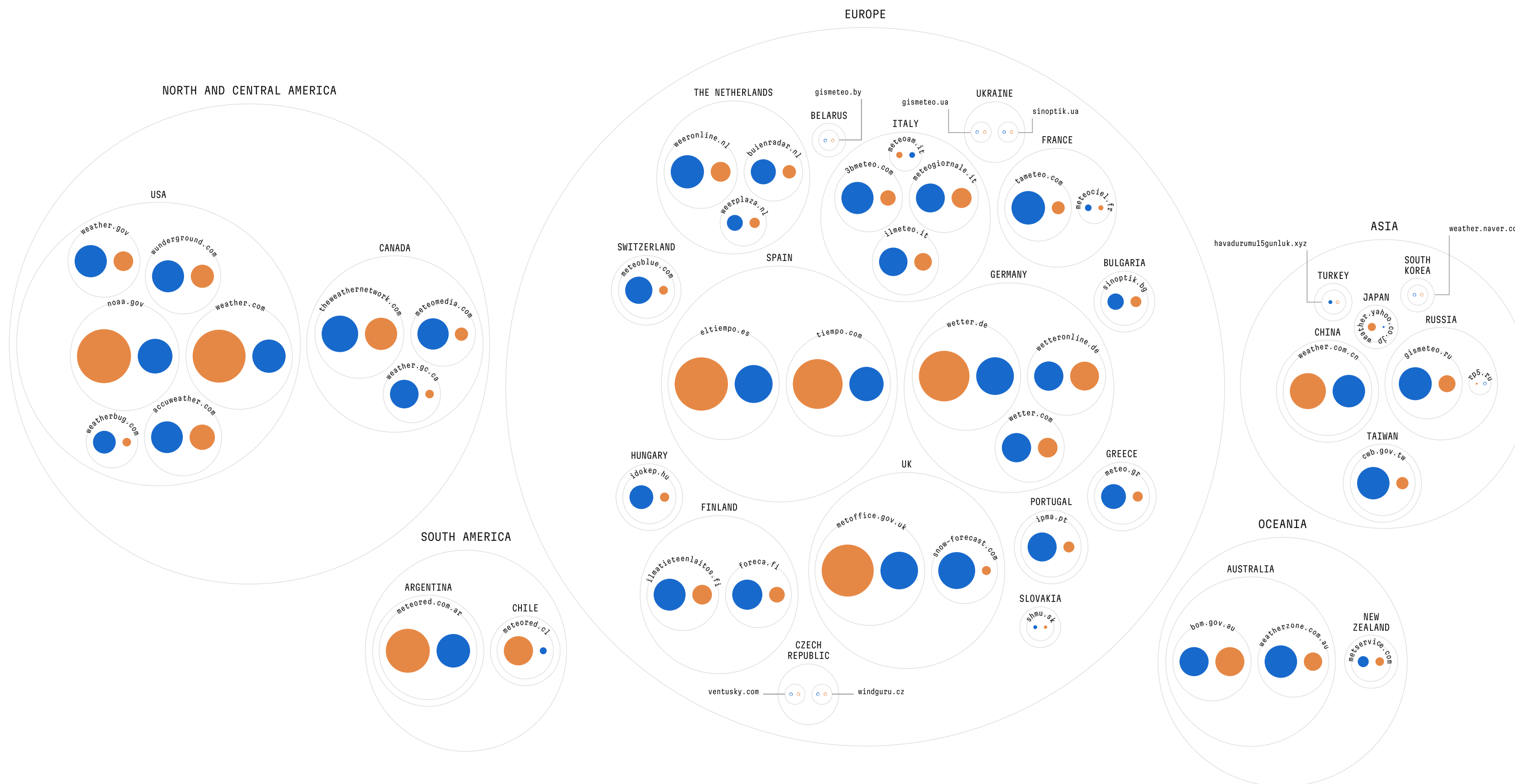
SCRAPING

A custom python script based on Selenium was used to scrape Google Search and Google Images through advanced queries. Every query is designed to return results which include "climate change" (or its translation) only from a specific website. A single query has the following structure:

site:website.domain "climate change (or translation)"

Scraping was performed for each of the 50 websites, using a VPN as well as Windows and Chrome settings to simulate as much as possible being in the country where the website is based, in order to influence the results accordingly.

Google results were loaded until reaching the end (or until Google displayed a message such as "the rest of the results might not be what you're looking for" or "in order to show you the most relevant results, we have omitted some entries very similar to the one already displayed"), and information for all of them was saved in one of two distinct spreadsheets: the first for Google Search (Dataset P2_GoogleSrc), the second for Google Images (Dataset P2_GoogleImg).



DATASETS



Dataset P2_websites

Including the 50 most visited weather websites worldwide at the moment of the analysis (according to similarweb).



Dataset P2_GoogleSrc

Spreadsheet with detailed information on Google Search results including "climate change" for each website.



Dataset P2_GoogleImg

Spreadsheet with detailed information on Google Images results including "climate change" for each website.

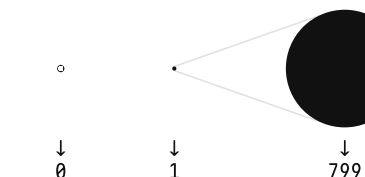
◆ P2 → DATA COLLECTION → CIRCLE PACKING → VIZ 01

The visualisation to the left shows the number of results for each website from each scraping (Google Search and Google Images). Websites are grouped according to country and continent where they are based, the number of results is mapped to size and the type of scraping is connected to colour.

SCRAPING FROM ↓

- Google Search (blue square)
- Google Images (orange square)

SCRAPED RESULTS ↓



Texts

The text entries resulting from both Google Search and Google Images scrapings were gathered and translated to English (when in a different language) in order to allow comparison.

SELECTION

The textual entries resulting from the Google Search scraping are:

- titles;
- meta descriptions.

While the textual entries resulting from Google Images scraping are only:

- alt texts.
-

TRANSLATION

A custom Python script based on *GoogleTrans* was used to translate all the extracted texts into a single language: English. The code ran through all the entries mentioned above and saved the translations into a new csv file.

Each row of the csv file (**Dataset P2_translations**) includes both:

- the original text;
- its translation to English.

And for each translation it indicates:

- the website from which it was extracted;
 - the type of text (e.g. title).
-

DATASET



Dataset P2_translations

Spreadsheet resulting from the translation of the textual entries from Google Search and Google Images scrapings.

Tag clouds

The analysis of translated texts started with detecting the predominant words in the websites, and later visualising them with sizes proportional to their frequencies.

WORD COUNT

A Python-based tool was used to process a word count on the translated texts of each website. The the following conditions were set:

- Language → English;
- Custom stopwords → *Climate, Change* + the website's name;
- Saved words → most frequent 100.

The tool was also run on merged translations from all websites, three times:

- Only on texts from Google Search scraping.
- Only on texts from Google Images scraping.
- On all texts, from both Google Search and Google Images scrapings.

All three times with the following conditions:

- Language → English;
- Custom stopwords → *Climate, Change* + all websites' names;
- Saved words → most frequent 500.

For each word count process the tool produced a csv file with the list of most frequent words, their rank and their frequency.

TAG CLOUDS

The tag cloud generator tool from *Digital Methods Initiative* was used to create tag cloud visualisations out of all the word counts. From each word count list the generator produced an svg file in which the text sizes are associated to absolute frequency ranges (e.g. 61–65 times → 18px).

INDIVIDUAL ↔ GLOBAL

The purpose of individual websites' tag clouds is to give an horizontal mapping of the words used in each website. On the other hand, the merged texts' tag clouds provide insights on general trends and patterns.

GOOGLE SEARCH ↔ GOOGLE IMAGES

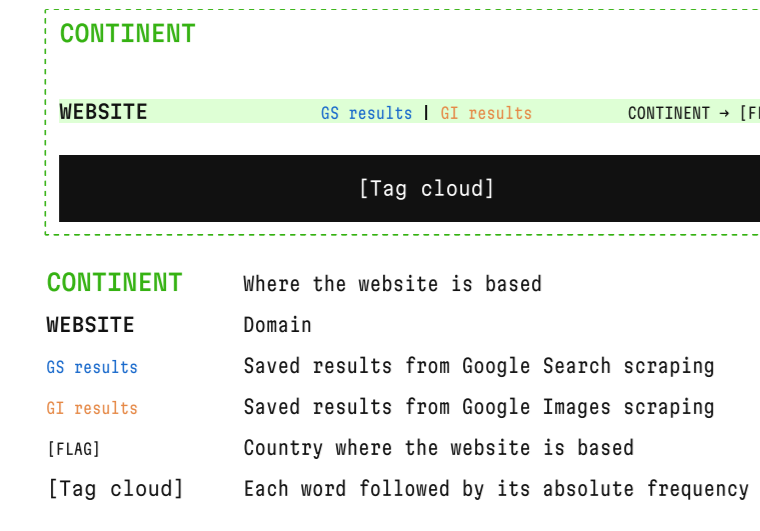
Differentiating between Google Search and Google Images is functional to detect relevant differences between texts clearly visible – titles and meta descriptions – and texts generally hidden – alt texts. The tag cloud centered on all texts from both scrapings, instead, provides the most comprehensive picture.

◆ P2 → TEXTS → TAG CLOUDS → VIZ 01

The following visualisation shows all tag clouds from individual websites, grouped according to the continent where they are based. Inside each continent the reports are ordered on the basis of the number of their total results.

The proportion between word frequency and text size is consistent for all tag clouds inside the following visualisation, but it is different from the proportion in corresponding visualisations of protocol 1 and 3 (P1 → texts → tag clouds → viz 01 and P3 → texts → tag clouds → viz 01).

The visualisation is designed as follows:



CONTINENT	Where the website is based
WEBSITE	Domain
GS results	Saved results from Google Search scraping
GI results	Saved results from Google Images scraping
[FLAG]	Country where the website is based
[Tag cloud]	Each word followed by its absolute frequency

EUROPE	
GSMTEO-UA	000 000 EUROPE → 🇺🇦
SNNOPTIK-UA	000 000 EUROPE → 🇺🇦
WINDGURU-CZ	000 000 EUROPE → 🇨🇪
VENTUSKY-COM	000 000 EUROPE → 🇵🇸
GSMTEO-BY	000 000 EUROPE → 🇷🇺
SHMU-SK	004 003 EUROPE → 🇸🇰
METEOR-IT	009 011 EUROPE → 🇮🇹
WEERPLAZA-NL	069 029 EUROPE → 🇳🇱
SNNOPTIK-BG	073 032 EUROPE → 🇧🇬
IDEKPE-HU	155 023 EUROPE → 🇭🇺
METEOR-GR	169 028 EUROPE → 🇬🇷
new (239) data (79) year (79) month (75) metopedia (75) variations (74) cloud (74) atlas (74) dictionary (74) meteoraphics (67) ...	
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) changing (20) summer (19) ...	
forecast (112) radar (93) current (65) precipitation (59) will (56) snow (56) due (52) satellite (49) images (49) rain (47) become (44) winters (44) common (40) trend (40) milder (38) line (38) ice (32) also (30) heat (28) water (28) sea (28) years (28) ...	
forests (18) météociel (15) archives (9) modélisation (8) ...	
forams (18) météociel (15) archives (9) modélisation (8) ...	
METEOR-IT	089 011 EUROPE → 🇮🇹
METEOR-PT	231 033 EUROPE → 🇵🇹
TAMETE.O.COM	308 046 EUROPE → 🇮🇹
day (93) 14 (90) region (86) rick (85) heat (132) update (117) forecast (85) weathered (82) yourweathercouk (81) impacts (78) analysis (70) company (68) specializing (68) australian (67) global (67) warming (67) will (51) us (51) news (50) ...	
ILMTEO.IT	222 085 EUROPE → 🇮🇹
will (57) also (56) increasingly (55) italy (55) even (30) effects (27) video (27) global (24) heat (24) summer (24) years (23) us (23) due (23) environment (22) hot (21) news (20) alarm (20) go (20) risk (19) 2022 (19) problem (19) planet (19) august (19) new (18) can (17) program (17) warning (17) something (17) ...	
SNNOPTIK-BG	073 032 EUROPE → 🇧🇬
earth (23) world (13) day (13) heat (11) will (10) ...	
FORECA-FI	249 067 EUROPE → 🇫🇮
blog (336) finland (232) bring (190) published (180) can (178) recordbreaking (178) 1953 (178) news (154) yesterday (132) heat (117) forecast (116) waves (109) driving (85) map (83) cameras (81) show (81) location (81) forecasts (77) thicket (72) may (65) behind (64) ...	
time (91) picture (82) can (53) year (42) labels (40) may (39) login (38) articles (34) older (24) half (24) observers (33) timeline (32) read (31) register (31) ice (30) due (29) water (23) caused (27) bodies (23) also (23) ...	
METEOR-IT	229 110 EUROPE → 🇮🇹
newspaper (156) archives (71) page (54) Italy (40) global (35) will (35) winter (35) heat (32) extreme (30) climate (28) earth (27) ...	
WEERONLINE-NL	303 108 EUROPE → 🇳🇱
due (225) warm (91) winter (90) 2022 (89) getting (81) winters (73) november (72) 13 (70) degrees (67) now (65) read (63) know (61) 716 (67) heat (65) forecast (53) ...	
WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
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WETTER.COM	220 186 EUROPE → 🇩🇪
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WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
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WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
forecast (112) radar (93) current (65) precipitation (59) will (56) snow (56) due (52) satellite (49) images (49) rain (47) become (44) winters (44) common (40) trend (40) milder (38) line (38) ice (32) also (30) heat (28) water (28) sea (28) years (28) ...	
WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
forecast (112) radar (93) current (65) precipitation (59) will (56) snow (56) due (52) satellite (49) images (49) rain (47) become (44) winters (44) common (40) trend (40) milder (38) line (38) ice (32) also (30) heat (28) water (28) sea (28) years (28) ...	
WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
forecast (112) radar (93) current (65) precipitation (59) will (56) snow (56) due (52) satellite (49) images (49) rain (47) become (44) winters (44) common (40) trend (40) milder (38) line (38) ice (32) also (30) heat (28) water (28) sea (28) years (28) ...	
WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
forecast (112) radar (93) current (65) precipitation (59) will (56) snow (56) due (52) satellite (49) images (49) rain (47) become (44) winters (44) common (40) trend (40) milder (38) line (38) ice (32) also (30) heat (28) water (28) sea (28) years (28) ...	
WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
forecast (112) radar (93) current (65) precipitation (59) will (56) snow (56) due (52) satellite (49) images (49) rain (47) become (44) winters (44) common (40) trend (40) milder (38) line (38) ice (32) also (30) heat (28) water (28) sea (28) years (28) ...	
WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
forecast (112) radar (93) current (65) precipitation (59) will (56) snow (56) due (52) satellite (49) images (49) rain (47) become (44) winters (44) common (40) trend (40) milder (38) line (38) ice (32) also (30) heat (28) water (28) sea (28) years (28) ...	
WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
forecast (112) radar (93) current (65) precipitation (59) will (56) snow (56) due (52) satellite (49) images (49) rain (47) become (44) winters (44) common (40) trend (40) milder (38) line (38) ice (32) also (30) heat (28) water (28) sea (28) years (28) ...	
WETTER.COM	220 186 EUROPE → 🇩🇪
germany (58) consequences (48) heat (41) due (32) new (31) will (29) also (27) extreme (24) sea (24) global (23) already (22) world (22) year (22) water (22) arctic (21) winter (21) can (21) ...	
forecast (112) radar (93) current (65) precipitation (59) will (56) snow (56) due (52) satellite (49) images (49) rain (47) become (44) winters (44) common (40) trend (40) milder (38) line (38) ice (32) also (30) heat (28) water (28) sea (28) years (28) ...	
WETTER.COM	220 186 EUROPE → 🇩

Tag clouds - categories

The merged texts' tag cloud including both Google Search and Google Images entries was further investigated: the words it contains were grouped on the basis of their meaning and in accordance with the evaluation criteria previously set.

CATEGORISATION

Each word from the merged tag cloud was categorised into 1 exclusive category of 15, according to its meaning. Categories are the same as in protocol 1 and 3, and keep into consideration both the specific words in the tag clouds of all protocols and the evaluation criteria set prior to starting the analysis.

Each category can be made of 1, 2 or 3 specific subcategories. Categories and subcategories are listed and defined on the opposite page. However, the analysis initially focused on first-level categories (highlighted in green in the list).

COLOUR CODING

A colour for each category was established, then the words in the merged texts' tag cloud were coloured according to their category of belonging. Working directly with colour on the clouds allows to see:

- variety → how many words for each category;
- frequency → position and size of words for each category.

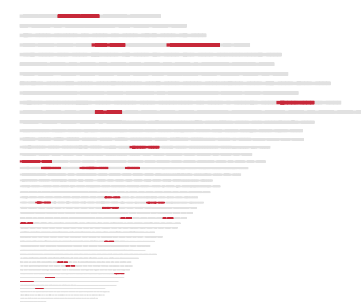
◆ P2 → TEXTS → TAG CLOUDS → VIZ 03

The visualisation on the right shows for each category the tag cloud, with the words falling in the category highlighted in colour.

In order to give more importance to the colours, words were replaced with rectangles through Dan Ross' *Flow Block* font. The terms included in the category were made readable in an ordered list (most frequent to least frequent) that follows each tag cloud.

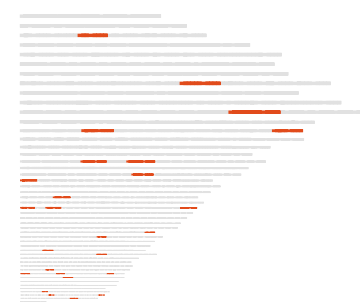


Weather



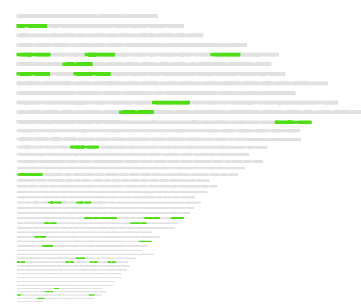
forecast, snow, meteorological, drought, rain, almanac, meteorology, rainfall, precipitation, air, floods, storms, forecasts, flooding, storm, fires, cloud, wind, droughts, clouds, hurricane, tsunami, nino, weathered

Causes



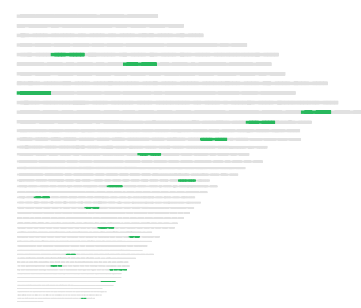
due, causes, greenhouse, affected, carbon, caused, emissions, affecting, affect, cause, affects, energy, influence, co2, gas, related, gases, fueling, causing, dioxide, result, contributing, blame, pollution, methane

Time



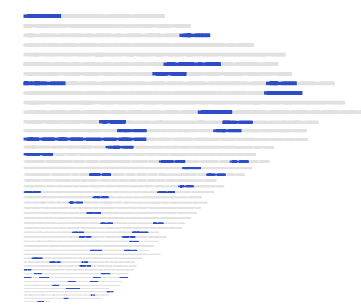
time, years, winter, year, day, days, autumn, summer, winters, timeseries, february, november, daily, month, january, december, season, hourly, spring, weekend, 7day, biannual, annual, week, times, period, june, march, july, decades, april, october, seasons

Past & present



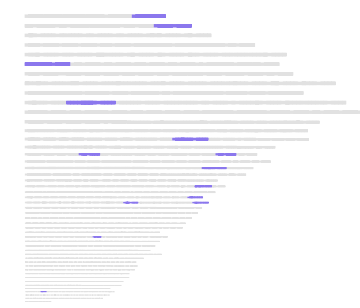
2022, 2023, current, now, 2021, today, 2020, recent, past, 1953, since, yesterday, 2019, 2018, continues, history, century, earlier, 2016, 2015

Locations



global, world, earth, us, china, trambileno, arctic, national, planet, uk, finland, region, costa, europe, united, canada, volpino, australia, australian, germany, north, state, regions, taiwan, cities, states, country, spain, british, latitude, areas, italy, south, international, finnish, countries, area, regional, longitude, locations, city, european, india, land, northern, paris, southern, chad, coastal, location, ontario, french, pacific, local, greenland, worldwide, alps, east, california

Temperature



heat, warming, temperature, temperatures, averages, warm, cold, degrees, tropical, warmer, melting, warmest, hot, hottest

Media



news, photo, channel, blog, videos, video, picture, read, image, story, stories, details, update, page, site, media, newspaper, online, topics, topic, menu, editorial, images, archives

People



human, people, health

Solutions



bureau, fight, protect, un, government, action, project, adaptation, nations, help, administration, intergovernmental, green, agreement, sustainability, response

Impacts



new, extreme, impacts, effects, record, exceptional, events, increase, impact, extremes, changes, rise, top, waves, severe, already, much, consequences, level, average, many, effect, changing, recordbreaking, crisis, wave, increasing, increasingly, increased, rising, records, urge, threat, intense, threatens, disasters, frequent, phenomena, faster, end, heavy, increases, conflict, need, ever, must, alerts, major, problem, threatened

Future



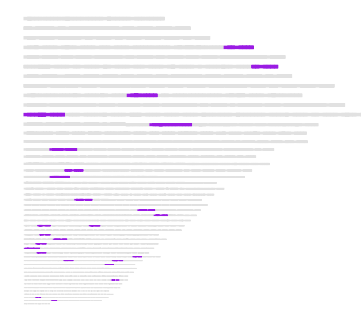
will, trend, future, projections, longterm, longer, next, 2050, trends

Anticipation



can, may, risk, question, likely, around, questions, risks, possible, variability

Natural environment



sea, ice, water, mountain, environment, ocean, lake, natural, glaciers, species, marine, alpine, polar, trees, oceans, nature, environmental, forest, basin, glacier, antarctica, stream, animals, lakes, forests

Science



report, data, study, science, research, scientists, maps, institute, published, ipcc, according, information, analysis, official, experts, conference, panel, statistics, scientific, charts, map, researchers, reports, assessment, student, whiteroom, ozone, observations, dictionary, nasa, studies, atlas

Others



CATEGORIES AND SUBCATEGORIES WITH THEIR EXPLANATIONS

- WEATHER**
 - Forecasts → words referring to weather and weather forecasting (*e.g. meteorological*);
 - Phenomena → words referring to weather phenomena and events (*e.g. rain*);
- CAUSES**
 - General → words generally related to causation (*e.g. due*);
 - Climate change → words referring to specific causes of climate change (*e.g. greenhouse*);
- SOLUTIONS**
 - Action → words conveying the general idea of action/reaction (*e.g. fight*);
 - Institutions → words related to institutions or governments, supposed to act against climate change (*e.g. intergovernmental*);
 - Climate change → words related to specific behaviours connected with climate change savviness (*e.g. sustainability*);
- IMPACTS**
 - Extreme → words conveying a sense of out of the ordinary (*e.g. extreme*);
 - Effects → words generally related to effects (*e.g. impacts*);
 - Threats → words related to clearly negative effects (*e.g. disasters*);
- TIME**
 - Time → words expressing general time periods and intervals (*e.g. winter*);
- PAST AND PRESENT**
 - Past → words expressing specific moments in the past, specifically before the moment when the data was collected (*e.g. 2019*);
 - Present → words generally addressing the present moment (*e.g. now*);
- FUTURE**
 - General → words generally related to future (*e.g. projections*);
 - Specific moment → words expressing specific moments in future time (*e.g. 2050*);
- ANTICIPATION**
 - Uncertainty → words expressing uncertainty or doubt (*e.g. might*);
 - Certainty → words expressing certainty or confident expectancy (*e.g. sure*);
- LOCATIONS**
 - General → general geographical terms (*e.g. longitude*);
 - Global → words related to earth as a whole (*e.g. global*);
 - Local → words referring to specific locations (*e.g. greenland*);
- TEMPERATURE**
 - Temperature → words related to temperature (*e.g. heat*);
- NATURAL ENVIRONMENT**
 - Natural environment → words related to natural environments, ecosystems and/or their elements (*e.g. mountain*);
- SCIENCE**
 - Institutions → words related to scientists and scientific institutions (*e.g. ipcc*);
 - Studies → words related to scientific studies and measurements (*e.g. data*);
 - Information → words related to scientific communications (*e.g. report*);
- MEDIA**
 - Media → words generally related to formats and channels (*e.g. photo*);
- PEOPLE**
 - People → words connected with humanity as a group (*e.g. human*);
- OTHERS**
 - Others → everything else;

Images

All images extracted with the Goole Images scraping were considered.

IMAGE COUNT

Google Images scraping provided urls for 8,043 total images, all of which were downloaded in order to be analysed.

Network

Images were arranged into a network based on AI image captioning. The network provided the base for mapping the visual representations of climate change in the websites.

VISUAL SIMILARITY

The 8,043 images were fed to Yale DHLab's PixPlot in order to get an interactive image network based on similarity: each picture is captioned from a previously trained neural network model, then all pictures are arranged in the space according to their content similarity.

The network can be explored through panning and zooming in the space or jumping to hotspots (image clusters). PixPlot automatically identifies some default hotspots, but they can also be created and curated by the user.

TAGGING

A static screenshot of the network was taken and manually tagged according to groups and clusters visually identified while exploring the interactive model and with the help of automatically identified hotspots.

P2 → IMAGES → NETWORK → VIZ 00

The visualisation on the right shows the 8,043 images (resulting from Google Images scraping as previously described) displayed in the space on the basis of similarity (according to PixPlot's process of image captioning and positioning through a pre-trained convolutional neural network model).


Areas characterised by the predominance of a specific subject are outlined and tagged, even if subject clusters are often more spread around and less localised than they appear.

A straight line separates the left portion of the map (where the majority of images are diagrams) from the right portion (where the majority of images are photos).

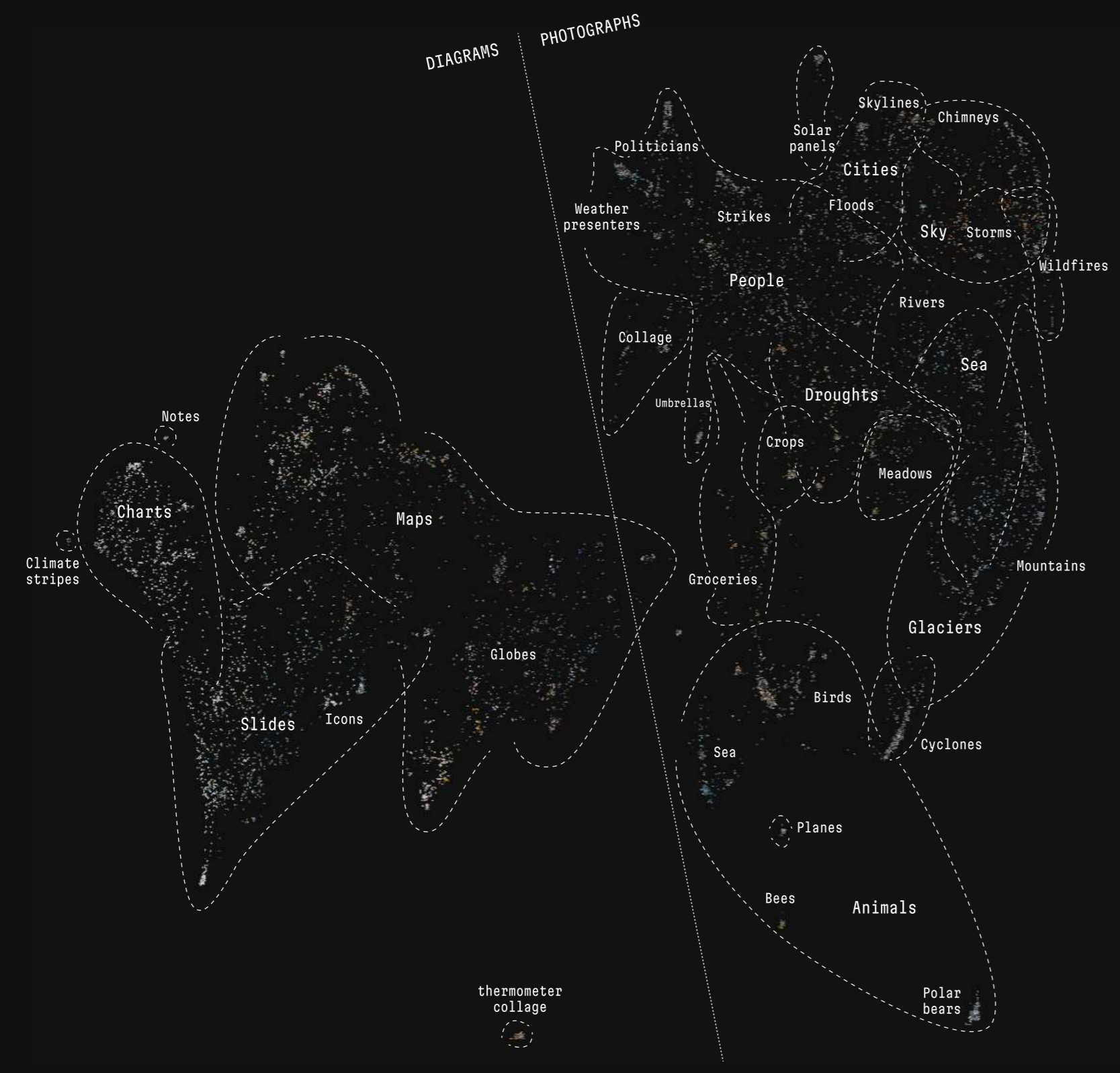
CLUSTERING

The network mapping was expanded into a detailed clustering of the images through the creation of a hierarchy of manually curated hotspots. The categorisation process kept into consideration the actual images' features and subjects as well as the evaluation criteria previously set. The hierarchy of (not exclusive) image clusters is visible on the opposite page.

INTERACTIVE NETWORK

 PixPlot P2

Interactive network including all the 8,043 images, displayed according to image similarity and with hotspots based on images' subjects.



P2 → IMAGES → NETWORK → VIZ 01

The visualisation on the right displays the cluster hierarchy and the quantity of images for each cluster and subcluster. It builds on the grid display provided by PixPlot and uses colour to distinguish one category from the others as well as for highlighting the links in the hierarchy.

Clusters are ordered from the most populated to the least populated. Quantities are always expressed as percentages, since the most interesting comparison in that sense is that between child clusters belonging to the same parent cluster (or that of parent clusters between each other).

A single cluster is visualised as follows:

8,043 total images included in the network

XX% Subcluster 1
X% both
XX% Subcluster 2

- Image not belonging to the cluster
- Image belonging to subcluster 1
- Image belonging to subcluster 2
- Image belonging to both subclusters

Bar chart comparing the number of images in each subcluster

XX% Subcluster 1
X% both
XX% Subcluster 2

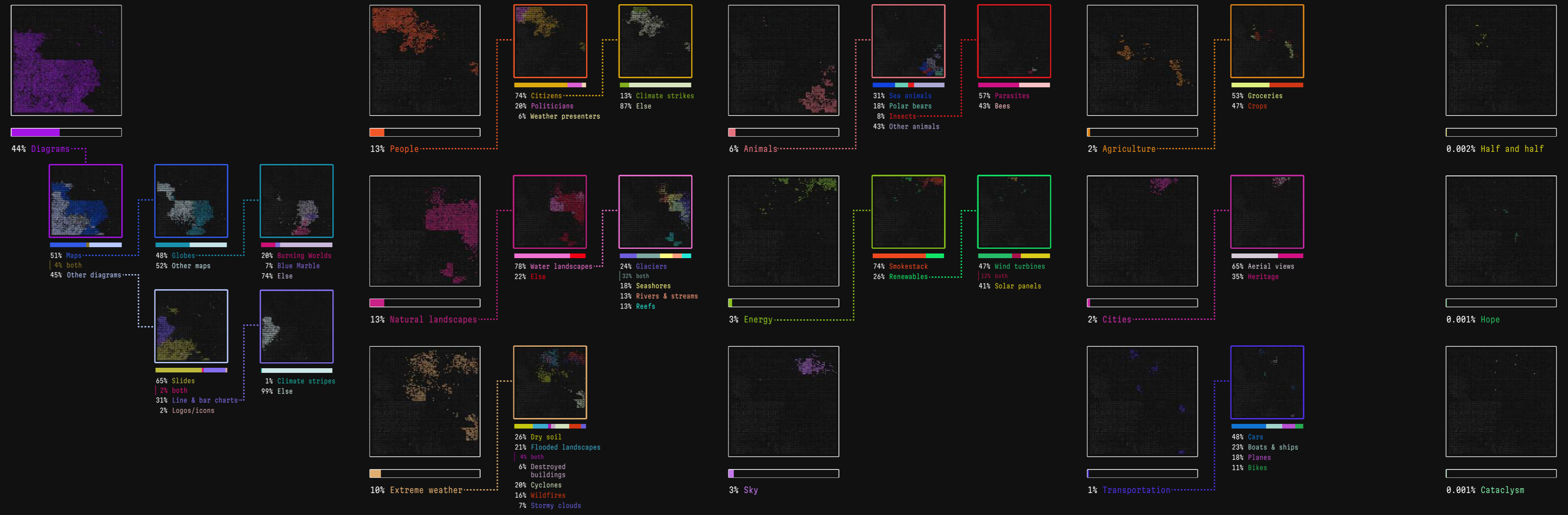
List of subclusters with respective percentages (relative to the total number of images in the parent cluster)

A family of clusters is visualised as a series of cluster visualisations connected through dashed lines and colour coding according to their hierarchy.

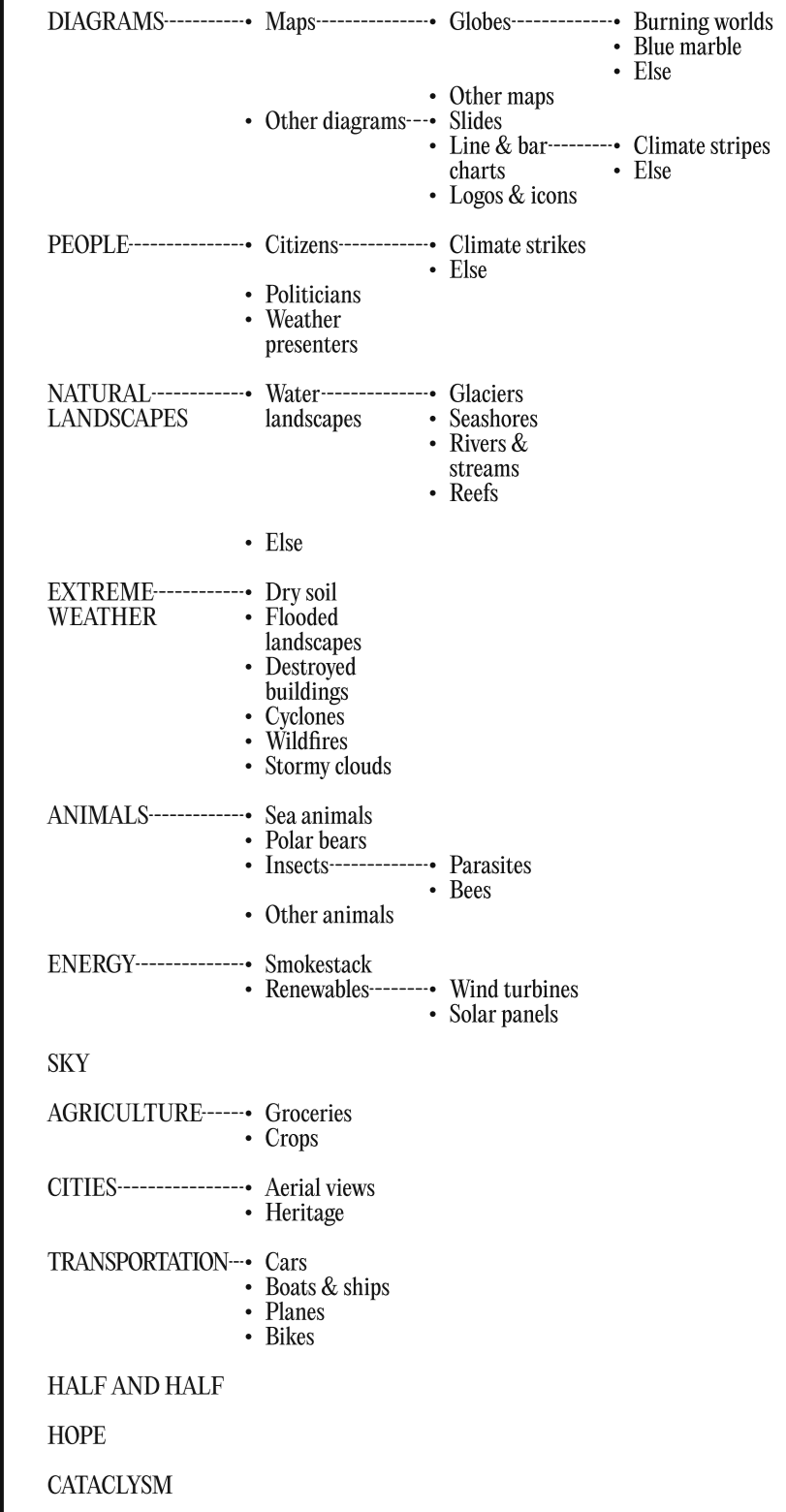
XX% Cluster

XX% Subcluster
X% both
XX% Subcluster

XX% Sub-subcluster
XX% Sub-subcluster



HIERARCHY OF IMAGE CLUSTERS



Network - images

Clustered images were reconnected with their visual appearance through cluster-specific wall of images based on the grouping hierarchy.

CHILD CLUSTER

All images in each low-level-cluster (clusters which don't contain other clusters) were downloaded and arranged together in creating cluster-specific image walls. The purpose of this operation was to connect the abstraction of the network with the qualitative appearance of the images, providing samples of the distinctive visual qualities in each image group.

The complete hierarchy of clusters with all low-level-clusters highlighted in green is available on the right.

P2 - IMAGES -> NETWORK -> VIZ 02

The visualisation on the right covers all low-level-clusters in the previously defined hierarchy. For each cluster are shown:

- the hierarchy of its parent clusters (if any);
- the number of images in the cluster;
- the position of the images in the network;
- a sample of images from the cluster (image wall).

Colours are maintained from the previous visualisation (P1 -> images -> network -> viz 01). A single cluster is visualised as follows:

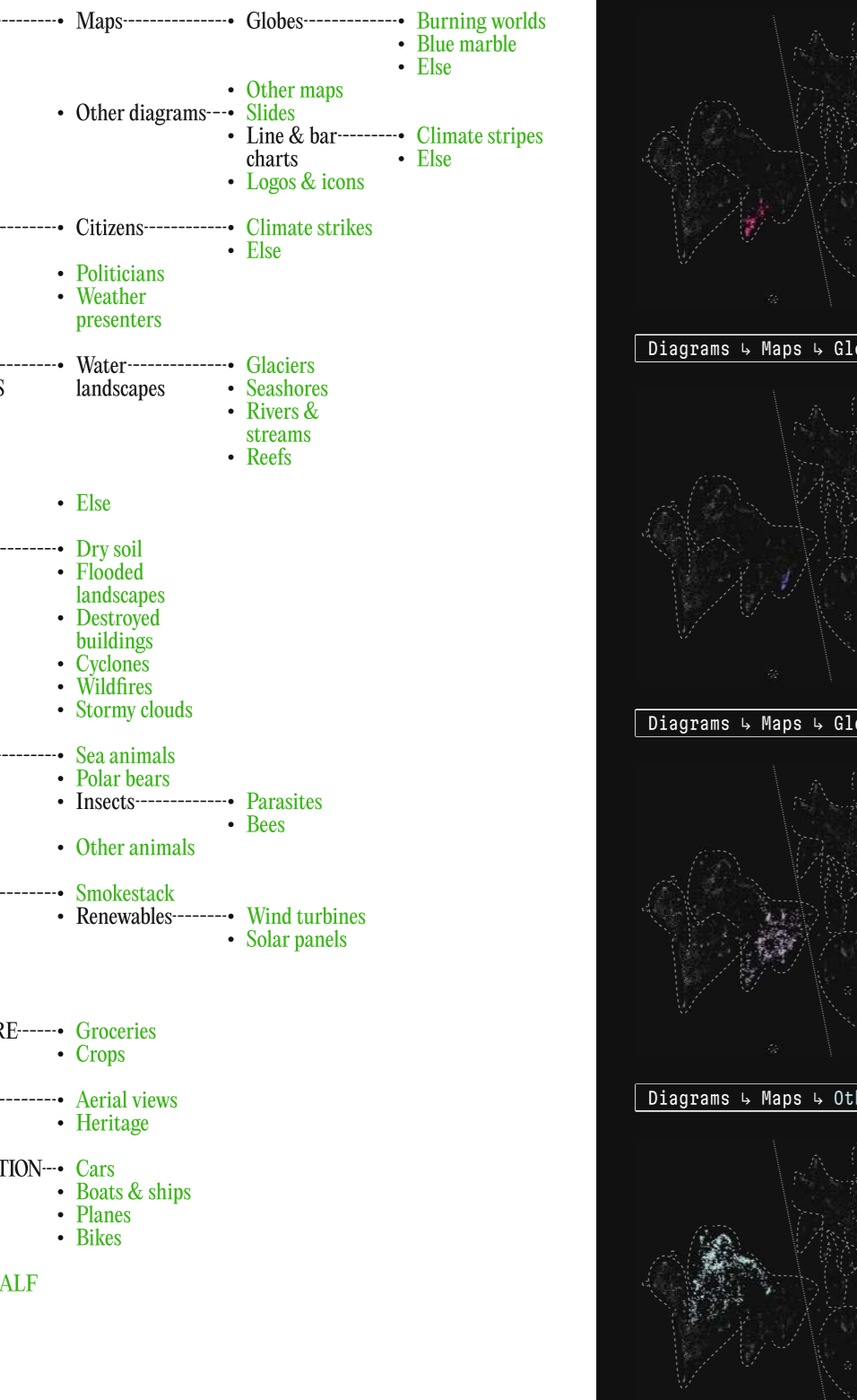
↓ CLUSTER HIERARCHY NUMBER OF IMAGES ↓

Cluster ↳ Subcluster ↳ Sub-subcluster XX IMAGES

1 IMAGES IN THE NETWORK WALL OF IMAGES ↑

The sequence of low-level-clusters' displays is followed by a miniature of the tagged network (P2 -> images -> network -> viz 00), in order to provide an easy-to-consult map of the network areas.

HIERARCHY OF IMAGE CLUSTERS (CHILD CLUSTERS HIGHLIGHTED)



P2 -> images -> network -> viz 00

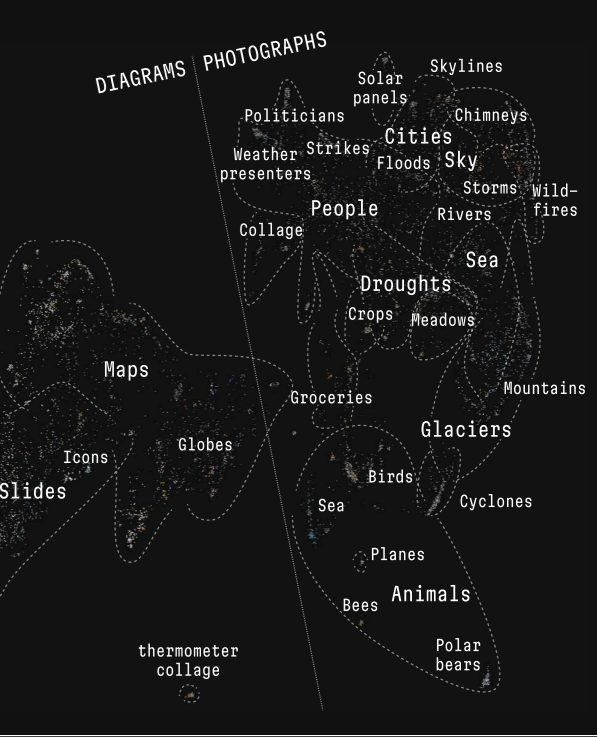


Image plot

The visual space of the websites was also examined in regard to hue and brightness values in the pictures, to detect trends and tendencies in the use of colours of climate crisis' representations.

IMAGE MEASURING

Colour values in each of the 8'043 images were measured through *ImageMeasure* for ImageJ. In particular, the process returned for each picture:

- median of brightness values;
- standard deviation of brightness values;
- median of saturation values;
- standard deviation of saturation values;
- median of hue values;
- standard deviation of hue values.

PLOT DIMENSIONS

The measures of brightness and hue were used to build a plot of images through *ImagePlot* for ImageJ. The axis of the plot were mapped as below:

- X axis → median of hue values (*hue_median*);
- Y axis → standard deviation of brightness values (*brightness_stddev*).

Each image was positioned in the plot according to its measured values.

PLOT EVALUATION

The distribution in the plot was analysed mainly in regard to the hue values, considering image density as well as recurring subjects across the x axis.

◆ P2 → IMAGES → IMAGE PLOT → VIZ 01

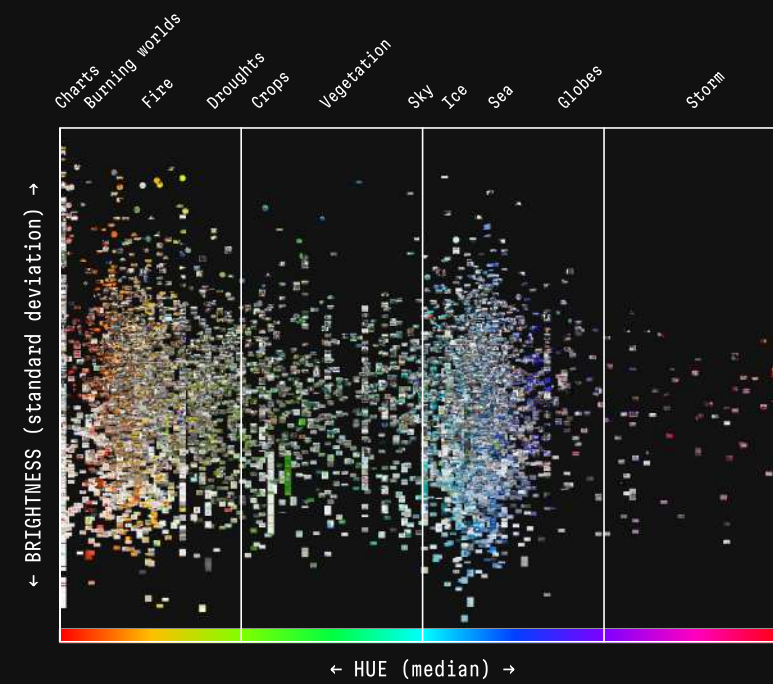
The visualisation on the right shows the 8,043 scraped images distributed in the space according to their hue values (median mapped on X axis) and brightness values (standard deviation mapped on Y axis), as previously explained.

The plot is split vertically into 4 portions of equal width, according to hue values:

1. red to green (X1);
2. green to light blue (X2);
3. light blue to purple (X3);
4. purple to red (X4).

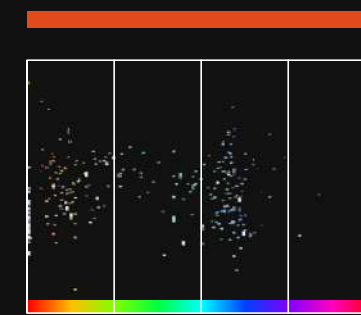
The purpose of those portions is to facilitate the evaluation of image density in relation to hue values.

Recurring subjects for specific hue areas are noted above the plot.

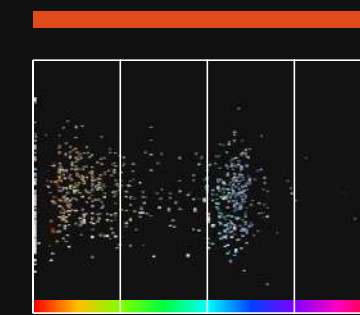


Causes

GENERAL

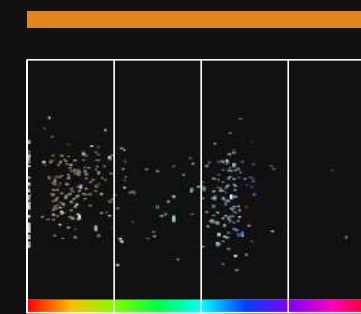


CLIMATE CHANGE

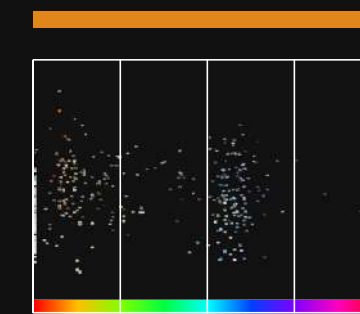


Solutions

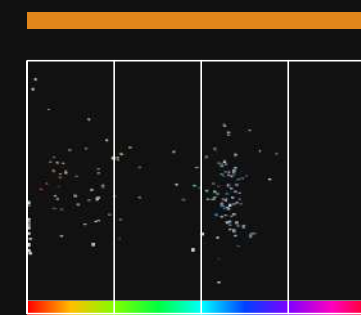
ACTIONS



INSTITUTIONS

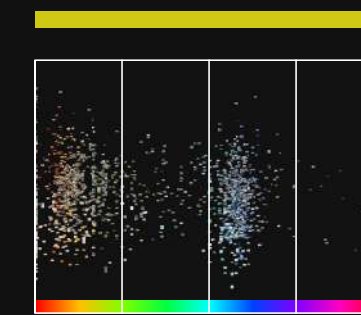


CLIMATE CHANGE

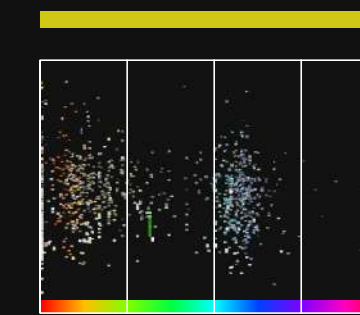


Impacts

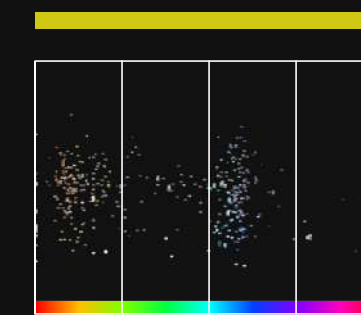
EXTREME



EFFECTS

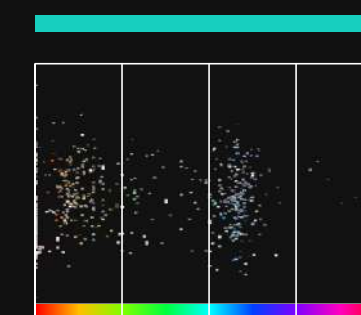


THREATS

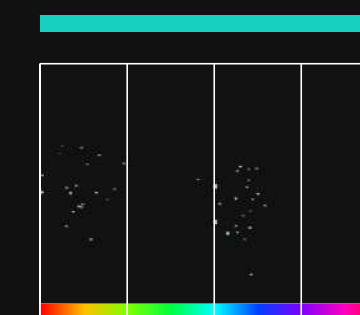


Future

GENERAL

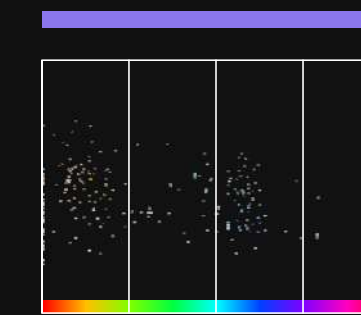


SPECIFIC MOMENT



Temperature

TEMPERATURE



People

PEOPLE

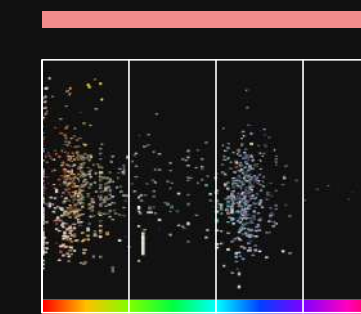


IMAGE FILTERING

Each scraped image is connected to its respective alt text. Words from the merged texts' tag cloud were used as filter queries in order to extract all images whose alt texts include terms connected to a specific category and subcategory. For example, images with the word "exceptional" in their alt text are connected with the *extreme* subcategory of the *impacts* category as defined in the text analysis.

Terms from 6 specific categories (and respective subcategories) were used to classify images. The categories were chosen on the basis of their relevance according to the evaluative criteria set prior to the analysis, and they are:

- causes (general, climate change);
- solutions (actions, institutions, climate change);
- impacts (extreme, effects, threats);
- future (general, specific moment);
- temperature (temperature);
- people (people).

ImageMeasure and *ImagePlot* for ImageJ were used to build hue/brightness plots for each subcategory. The axis of the plots were mapped as below:

- X axis → median of hue values (*hue_median*);
- Y axis → standard deviation of brightness values (*brightness_stddev*).

Each image was positioned in the respective plot according to its measured values.

CATEGORY-BASED ↔ GLOBAL

The axis of every individual plot include the same range of values, in order to make them comparable. The evaluation of subcategory-based plots in relations to the global plot is also encouraged, in order to detect cross-category tendencies as well as category-specific features in the use of colours.

◆ P2 → IMAGES → IMAGE PLOT → VIZ 02

The visualisation on the left shows the subcategory-specific image plots for the 6 categories selected. As in previous visualisation (P2 → images → image plot → viz 01), images are distributed in the space according to their hue values (median mapped on X axis) and brightness values (standard deviation on Y axis).

Each plot is split vertically into 4 portions of equal width, according to hue values:

1. red to green (X1);
2. green to light blue (X2);
3. light blue to purple (X3);
4. purple to red (X4).

The purpose of those portions is to facilitate the evaluation of image density in relation to hue values for visual spaces connected to specific concepts.

Urls

Through the urls of the scraped results regarding the 50 websites, pages and sections centered on the climate crisis were identified and listed.

CLIMATE CHANGE PAGES

The last piece of analysis of protocol 2 was centered on specific sections and pages of the 50 weather websites, explicitly designed and produced to address climate change. The focus was on containers rather than contents: not single articles connected to a climate change particular expression (e.g. a single weather event), but portions of the site dedicated to climate change in general.

SELECTION

Through a process of dataset exploration and url parsing, 77 climate change pages from 27 of the total 50 websites were selected (23 websites didn't have any section expressly related to the issue).

CATEGORISATION

The 77 web pages were classified according to 9 exclusive categories:

1. **Section** → ramified portion of the website fully centred on climate change, often covering various aspects and perspectives.
2. **News tag** → collection of news tagged climate change or similar.
3. **Blog tag** → collection of blog articles tagged climate change or similar.
4. **Glossary** → information in the form of terminology explanations.
5. **Educational** → section with lectures, presentations, tests and similar content (mainly intended for schools).
6. **Research** → portal that leads to technical studies on climate change aspects.
7. **Data** → dashboard showing updated data on aspects of climate change.
8. **Feature** → collaboration of the website with some other organisation/entity in order to make a systemic communication focused on climate change.
9. **Business** → page which promotes services connected to climate change.

All climate change pages were listed in a csv file (**Dataset P2_urls**), with indication of respective category and website of origin.

DATASET



Dataset P2_urls

Spreadsheet listing the 77 climate change pages identified through the weather websites, with respective categories.

Climate change pages

Analysis of climate change pages started with mapping the pages according to their height in pixels, website of origin and page category.

MEASURING LENGTH

The height in pixels of each climate change page was measured through full page screenshots' sizes. The purpose of the measure was to provide an easily assessable (although partial) metric on the quantity of content inside each page.

PAGE MAPPING

Each climate page was classified according to the 9 categories previously defined. Also, climate change pages were listed according to their website of origin. Websites, in turn, were grouped according to the country and continent where they were based.

◆ P2 → URLS → CLIMATE CHANGE PAGES → VIZ 01

The visualisation on the right is a matrix plot showing climate change pages at the intersection between page categories and websites:

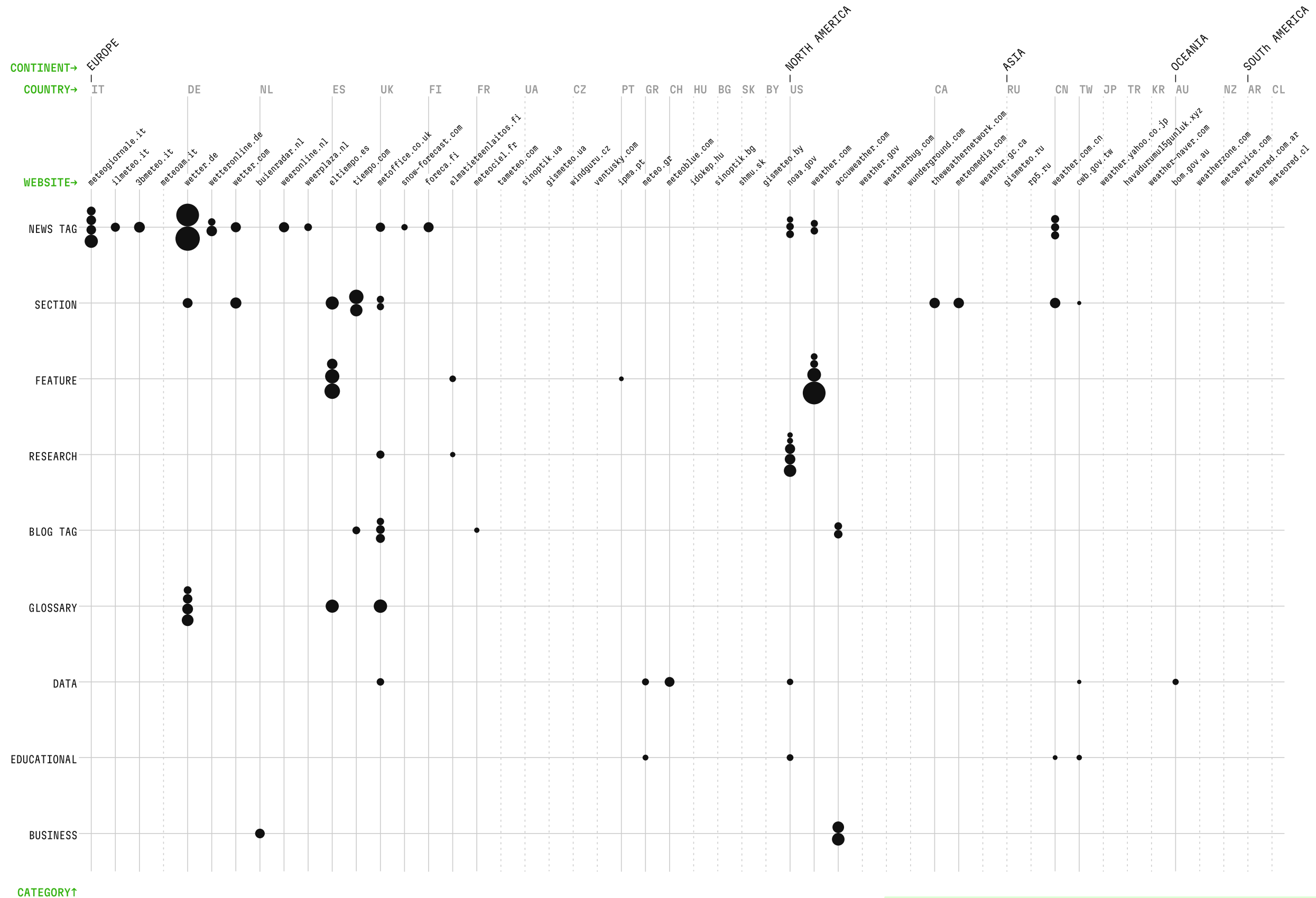
- X axis → websites < countries < continents
- Y axis → page categories

Page categories are ordered according to the number of pages they include (from the one with the most pages, at the top, to the one with the least, at the bottom).

Websites, instead, are grouped according to country and continent. Continents, countries inside each continent and websites inside each country are ordered according to the respective number of climate change pages they include.

Climate change pages are represented as circles at the intersection between a category and a website. The circle size is proportional to the corresponding page's height (in pixels). If there's more than one page for a single category/website intersection, corresponding circles are placed one above each other, from the smallest (on top) to the biggest (at the bottom).

PAGE HEIGHT ↓



Paths – page types

Climate change pages were examined in relation to their ease of access from the main page of the corresponding website, as a metric of the visibility and importance attributed to them.

PATH DETECTION

The path detection from the home page to the climate change page considered was mostly done manually, following the phases below:

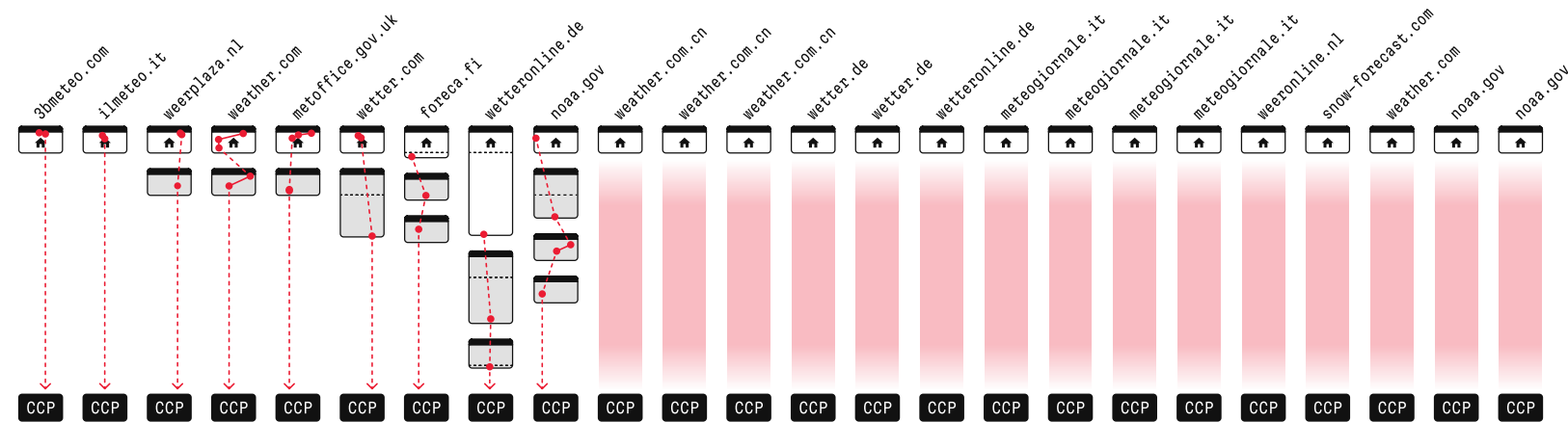
1. open the home page;
2. try the following:
 - a. inspect mode and search box to look for the climate change page's url (or at least a portion of it);
 - b. English translation of the page and search box to look for keywords connected to the climate change page's title or content;
 - c. English translation of the menu to look for a rationale path in the direction of the considered climate change page;
3. two cases:
 - a. if one of the procedures in point 2 seems to lead to a promising new page (closer to the considered climate change page), open the new page; then start again from point 2;
 - b. if none of the procedures in point 2 leads anywhere, move back to the previous page and try other paths;
4. repeat until reaching the climate change page or until all reasonable paths from the home page prove to be dead ends; in the latter case, the analysis proves that no clear direct path from the home page to the considered climate change page exists.

Out of 77 total climate change pages, 38 didn't have any clear direct path from the home page.

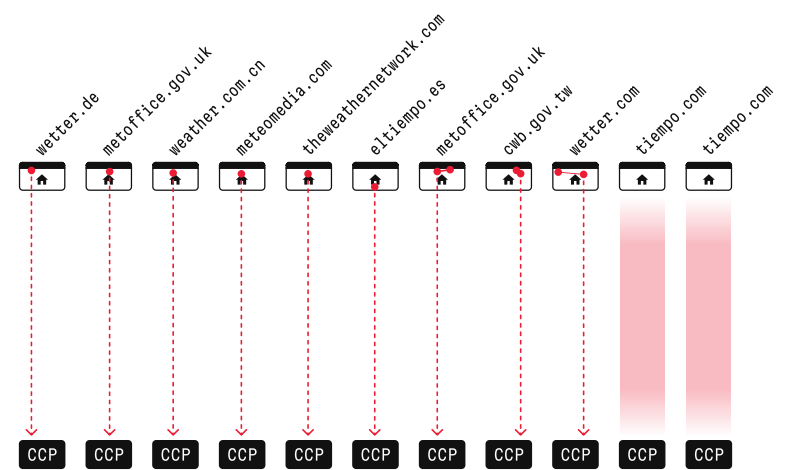
GROUPING – PAGE CATEGORIES

Paths were examined in groups in order to detect relevant tendencies. The first grouping was on the basis of page categories.

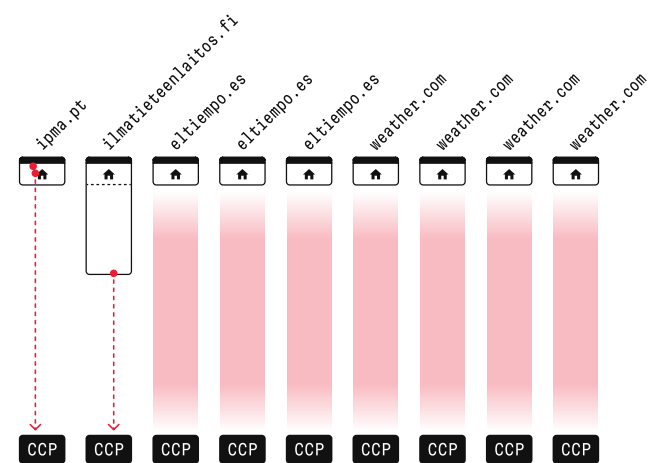
NEWS TAG: collection of news tagged "climate change" or similar



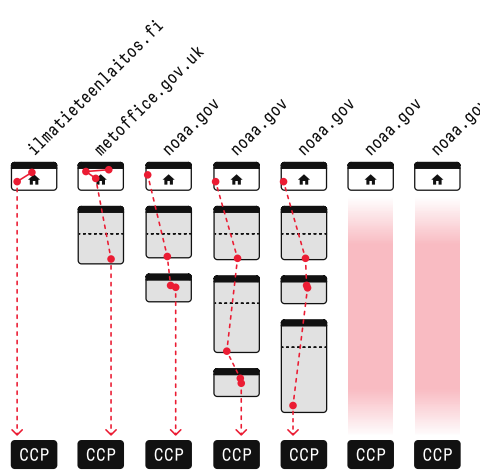
SECTION: ramified portion of the website fully centred on climate change, often covering various aspects and perspectives



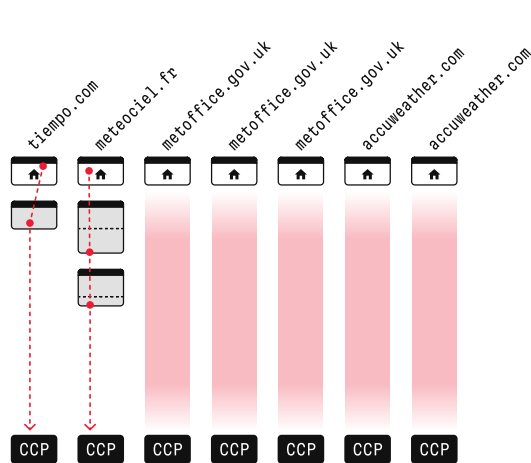
FEATURE: collaboration of the website with some other organisation/entity in order to make a systemic communication focused on climate change



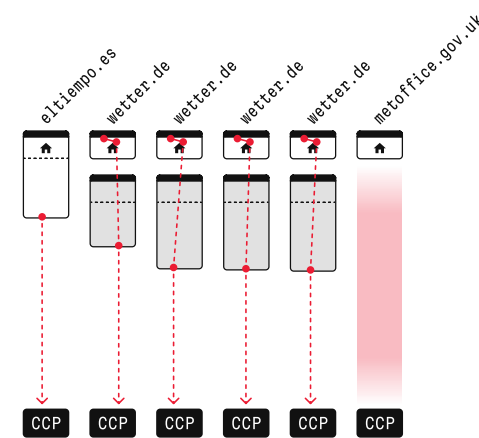
RESEARCH: portal that leads to technical studies on climate change aspects



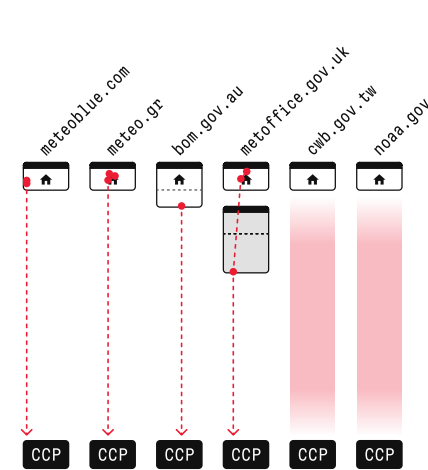
BLOG TAG: collection of blog articles tagged "climate change" or similar



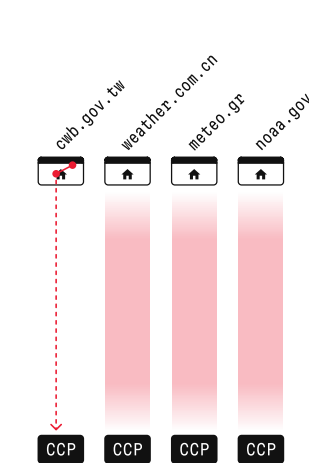
GLOSSARY: information in the form of terminology explanations



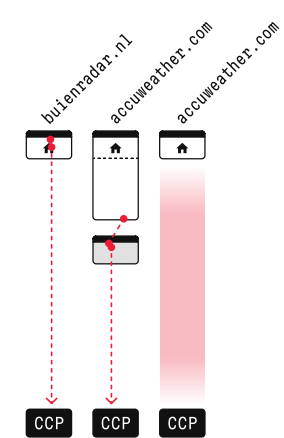
DATA: dashboard showing updated data on aspects of climate change



EDUCATIONAL: section with lectures, presentations, tests and similar content (mainly intended for schools)



BUSINESS: page which offers and promotes services connected to climate change

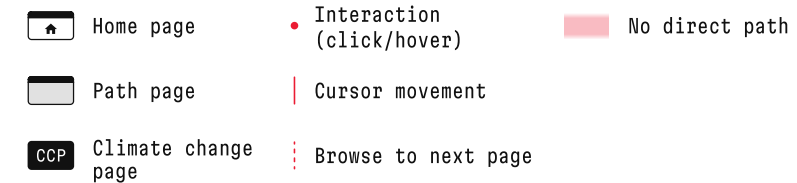


◇ P2 → URLS → PATHS → VIZ 01

The visualisation on the left shows the paths from home pages to climate change pages, grouped by page categories. Paths are represented as series of interactions (clicks or hovers) across one or more pages. The position of interactions in each page is accurate, and interactions which needed some scrolling impact on the length of their respective page in the path.

Inside a group, paths are ordered according first to the number of steps (pages in-between the home page and the climate change page) and then to the total height scrolled, and finally to the total number of interactions.

Each path has indicated above the website it comes from.



Paths - individual pages

Paths were synthesised and grouped on the basis of websites, in order to provide a wide mapping of each platform's effort in covering the topic. For the examination to be more detailed, screenshots of the climate change pages were paired with respective paths.

PATH SYNTHESIZING

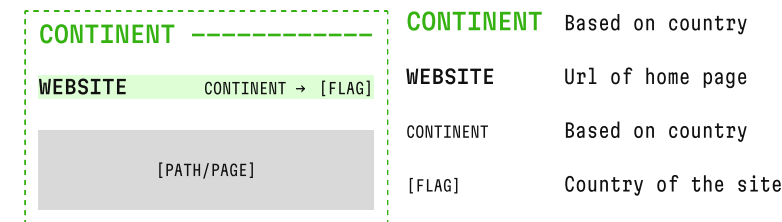
Paths were regrouped, this time according first to their website of origin. The information on the interactions was left behind, and the tracking focused more on number of pages in-between and lengths to scroll.

CLIMATE CHANGE PAGES SCREENSHOTS

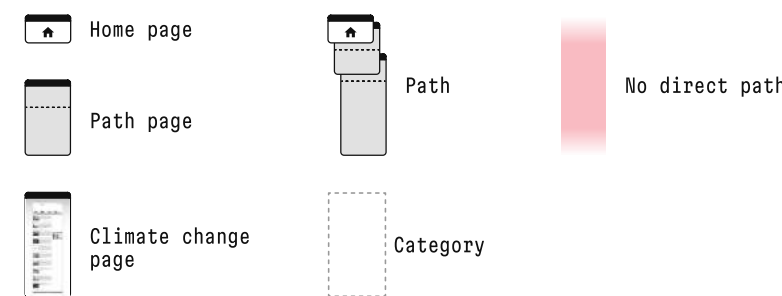
Full length screenshots of climate change pages, produced with *GoFullPage*, are taken into consideration in order to provide information about both the length of the page and its visual appearance.

◇ P2 → URLS → PATHS → VIZ 02

The visualisation on the right shows the paths from home pages to climate change pages and the appearance of the considered pages, grouped by website. Inside each website, the path/page pairs are grouped according to their category. Inside each category they are ordered according to the number of pages in the path, then to the total height scrolled in the path, then to the height of the page. Websites are also grouped on the basis of continents and countries. The visualisation for a single website is designed as below:



Paths are shown as sequences of pages, which height depends on the height scrolled in the actual paths. Interactions are not represented.



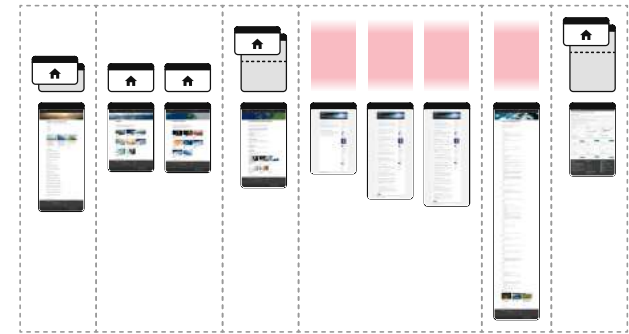
WEBSITE/PAGES TABLE

Below, a table that synthesises the visualisation on the left (P2 → urls → paths → viz 02) by showing the number of climate change pages, with and without a path from the home page, for each website (ordered according to the number of climate change pages with a path, from the highest to the lowest).

WEBSITE	PAGES WITH DIRECT ACCESS	PAGES WITHOUT DIRECT ACCESS
METOFFICE.GOV.UK	5	4
WETTER.DE	5	2
NOAA.GOV	4	5
ELTIEMPO.ES	2	3
WETTER.COM	2	0
ILMATIETEENLAITOS.FI	2	0
WEATHER.COM	1	5
WEATHER.COM.CN	1	4
ACCUWEATHER.COM	1	3
TIEMPO.COM	1	2
VNB.GOV.TW	1	2
WETTERONLINE.DE	1	1
METEO.GR	1	1
ILMETEO.IT	1	0
3BMETEO.IT	1	0
METEOBLUE.COM	1	0
METEOCIEL.FR	1	0
BUIENRADAR.NL	1	0
WEERONLINE.NL	1	0
WEERPLAZA.NL	1	0
IPMA.PT	1	0
FORECA.FI	1	0
BOM.GOV.AU	1	0
METEOMEDIA.COM	1	0
THEWEATHERNETWORK.COM	1	0
MTEOGIORNALE.IT	0	4
SNOW-FORECAST.COM	0	1
WEERONLINE.NL	0	1

EUROPE

METOFFICE.GOV.UK EUROPE →



NEWS TAG SECTION RESEARCH BLOG TAG GLOSSARY DATA

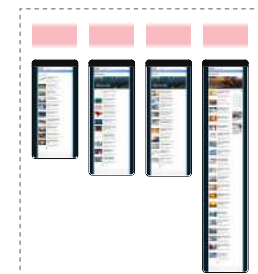
SNOW-FORECAST.COM EUROPE →



TIEMPO.COM EUROPE →



MTEOGIORNALE.IT EUROPE →



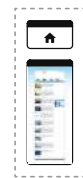
NEWS TAG

ELTIEMPO.ES EUROPE →



SECTION FEATURE GLOSSARY

ILMETEO.IT EUROPE →



NEWS TAG

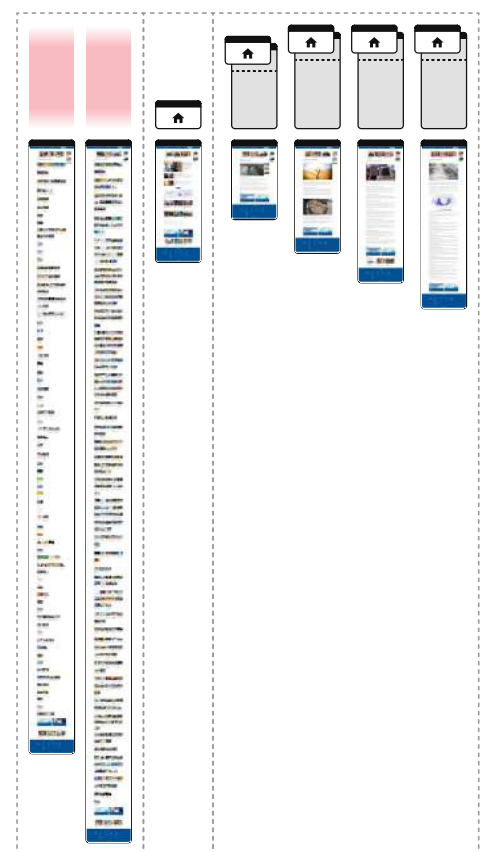
3BMETEO.IT EUROPE →



NEWS TAG

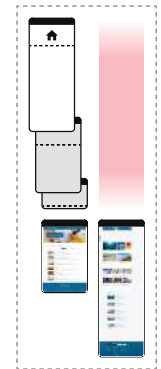
WETTER.DE

EUROPE →



NEWS TAG SECTION GLOSSARY

WETTERONLINE.DE EUROPE →



NEWS TAG

METEOBLUE.COM EUROPE →



DATA

WETTER.COM EUROPE →



NEWS TAG SECTION

METEOCIEL.FR EUROPE →



BLOG TAG SECTION

BUIENRADAR.NL EUROPE →



BUSTINESS

WEERPLAZA.NL EUROPE →



NEWS TAG

METEO.GR EUROPE →



DATA EDUCATIONAL

IPMA.PT EUROPE →



FEATURE

ASIA

WEATHER.COM.CN ASIA →



NEWS TAG SECTION EDUCATIONAL

CWB.GOV.TW ASIA →



SECTION DATA EDUCATIONAL

OCEANIA

BOM.GOV.AU OCEANIA →



DATA

WEERONLINE.NL EUROPE →



NEWS TAG

ILMATIETEENLAITOS.FI EUROPE →



FEATURE RESEARCH

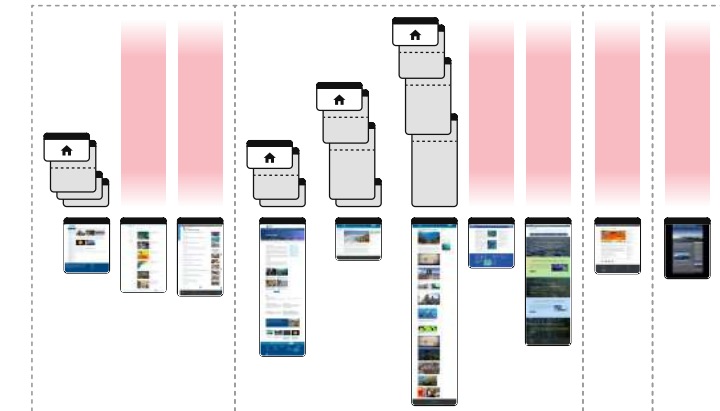
FORECA.FI EUROPE →



NEWS TAG

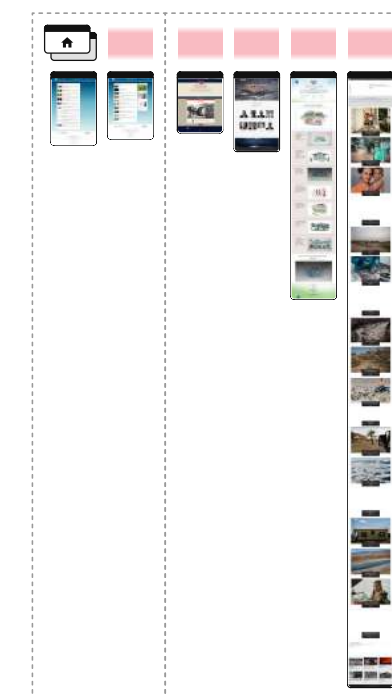
NORTH AMERICA

NOAA.GOV NORTH AMERICA →



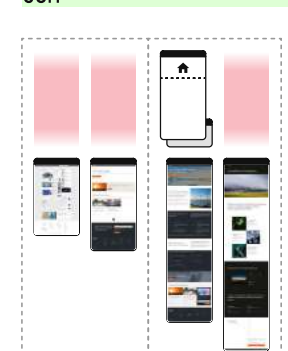
NEWS TAG RESEARCH DATA EDUCATIONAL

WEATHER.COM NORTH AMERICA →



NEWS TAG FEATURE SECTION

ACCUWEATHER.COM NORTH AMERICA →



BLOG TAG BUSINESS

METEOMEDIA.COM NORTH AMERICA →



SECTION

THEWEATHERNETWORK.COM NORTH AMERICA →



SECTION

PROTOCOL 3

*How do weather
forecast platforms
represent climate
change in
connection to
extreme weather
events?*

Data collection

Protocol 3 analyses the coverage of 15 extreme weather events worldwide made by a selection of five weather websites from the ones investigated in protocol 2. The events selected are all correlated to climate change according to studies from the WWA (World Weather Attribution).

Reports and articles on the specific weather phenomena are retrieved by scraping the selected websites.

SOURCES

The World Weather Attribution (WWA) is a team of researchers from several institutions worldwide born to study actual extreme weather phenomena and assess their correlation to climate change in terms of frequency and/or intensity.

SELECTION - EVENTS

Out of all the events they investigated, 15 were selected: they are all significantly correlated with climate change and varied in terms of both event type (e.g. storm) and location. A spreadsheet (Dataset P3_events) was manually compiled, mapping key metrics for each event. The saved information includes temporal and geographical coordinates as well as details on the type of event and its relation to the climate crisis.

SELECTION - WEBSITES

Out of the 50 websites analysed in protocol 2, five were selected. They comply with the following conditions:

1. they must significantly address climate change (according to protocol 2);
2. they must have an archive of weather news going back to (at least) Jan 2017.

SCRAPING - WEBSITES

A custom python script based on Selenium was used to scrape the news archive of each website. Textual information was saved from the previews of articles published in set time frames, each related to one extreme weather event.

SELECTION - ARTICLES

The scraped texts were analysed - partly manually and partly with automated filters - in order to detect all individual articles covering the selected extreme weather events. In total, 275 relevant articles were identified.

SCRAPING - ARTICLES

The articles were subjected to a second round of scraping, this time more detailed and focused not on the previews but on the article pages. Scraped information was saved into a spreadsheet (Dataset P3_Articles).

DATASETS



Datates P3_events
Including the selected 15 extreme weather events assessed by the World Weather Attribution.



Datates P3_articles
Spreadsheet with detailed information from the 275 articles by 5 websites covering the selected extreme weather events.

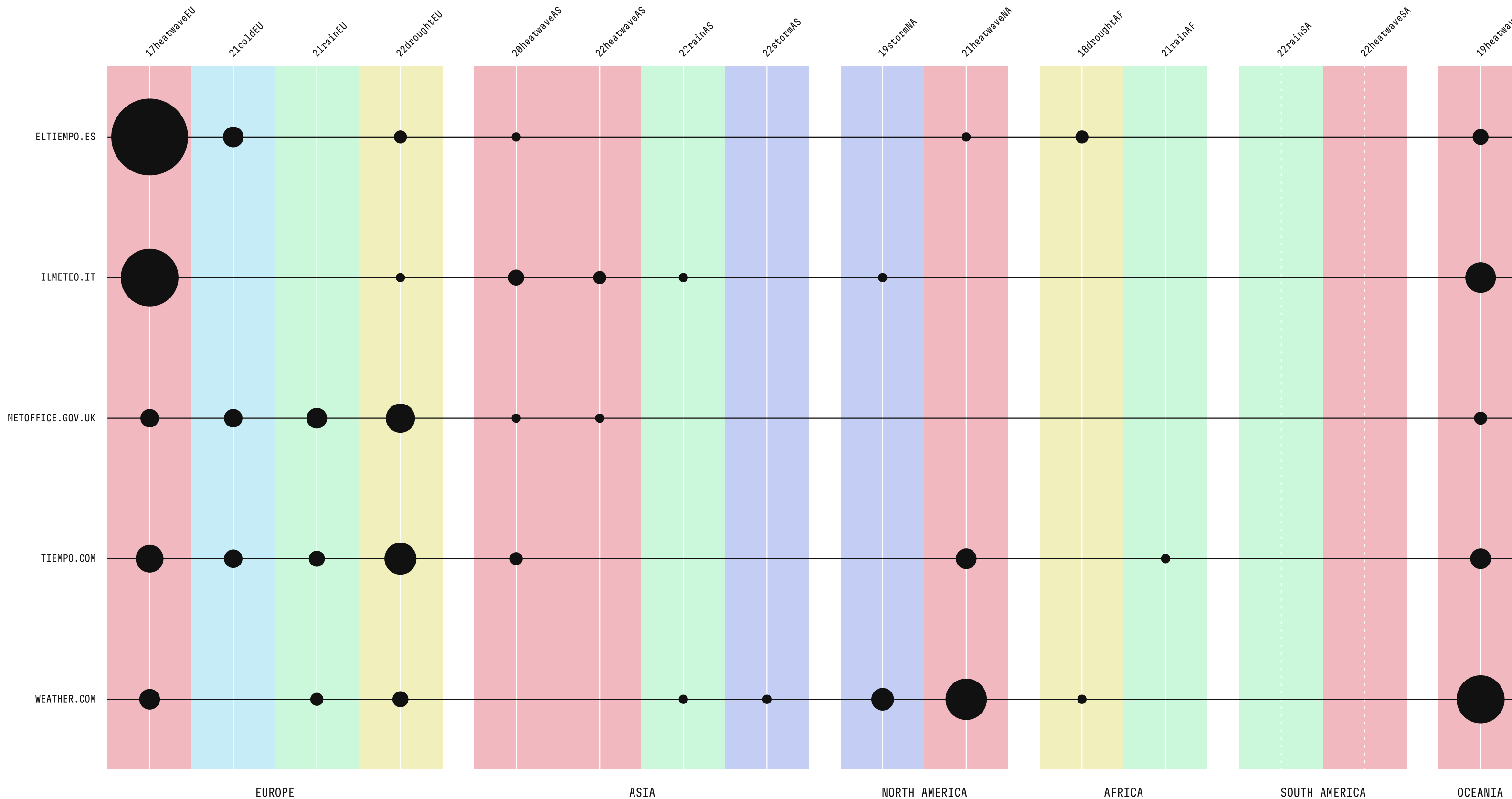
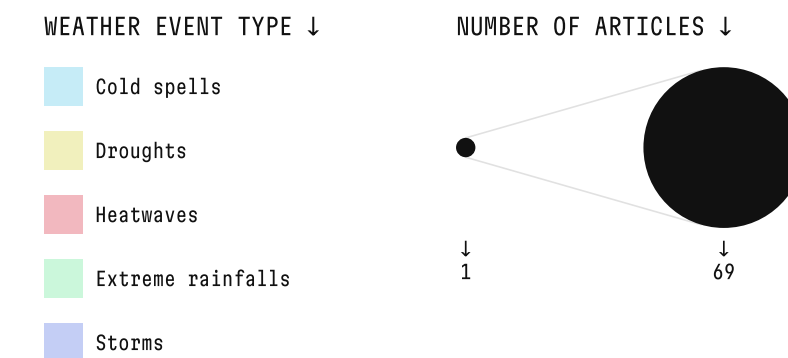
📍 P3 → DATA COLLECTION → MATRIX PLOT → VIZ 01

The visualisation on the left is a matrix plot showing the selected articles at the intersection between extreme weather events and websites:

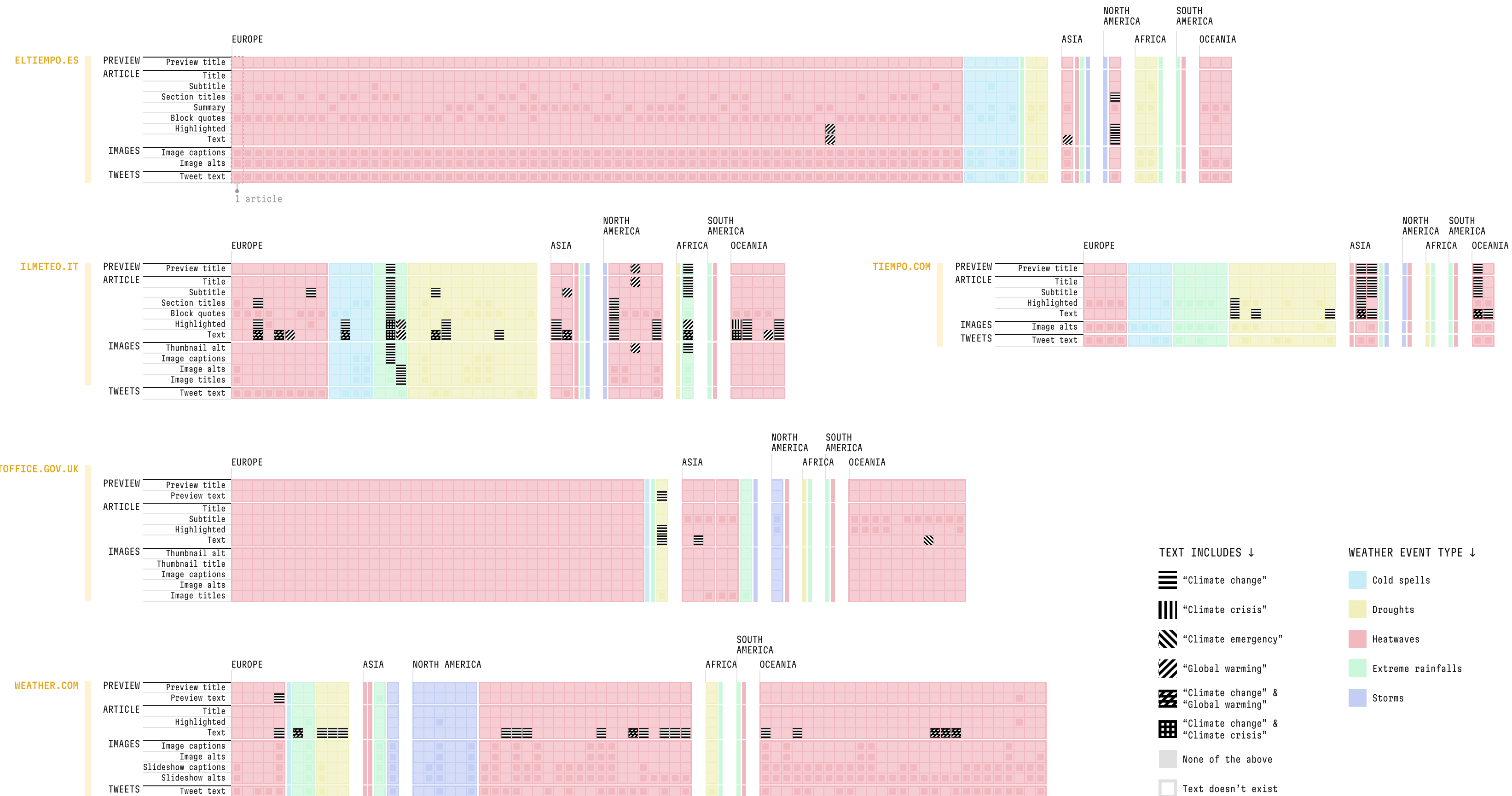
- X axis → extreme weather events - continents
- Y axis → websites

Websites are ordered alphabetically, while weather events are grouped on the basis of the continent where they took place and ordered chronologically inside each group. Event types (e.g. storm) are identified by colour.

The number of articles is represented through the size of a circle at the intersection between event and website. The absence of the circle means the absence of articles for that event in that website.



Texts



The text entries resulting from the articles' scraping were filtered in order to detect explicit references to the climate crisis and divide articles in climate-change-citing and climate-change-avoiding ones.

All texts were then translated to English (when in a different language) in order to allow comparison.

SELECTION

Both texts in the preview of the articles and texts inside the article pages were included in the analysis.

FILTERING

The detection of articles that explicitly cite climate change was handled with Google Sheets' conditional formatting options. Four key terms were considered: *climate change*, *climate crisis*, *climate emergency*, *global warming* (plus their translations in the language corresponding to the considered website). Out of 275 articles, only 52 include at least one of the terms listed above.

TRANSLATION

A custom Python script based on *GoogleTrans* was used to translate all the extracted texts into a single language: English. The code ran through all the entries and saved the translations into a new csv file.

Each row of the csv file (**Dataset P3_translations**) includes both:

- the translated text;
- information on website and article from which the original text was extracted.

DATASET



Dataset P3_translations

Spreadsheet resulting from the translation of the textual entries from the articles scraping.

◆ P3 → TEXTS → MATRIX PLOT → VIZ 01

The visualisation on the left is a series of matrix plots (one for each website) showing text entries at the intersection between articles and text types:

- X axis → articles < extreme weather events < continents
- Y axis → text types

Each individual text is represented as a square which is covered by a black and white texture when it includes a climate change reference - with the texture depending on the actual term used. The purpose of this matrix plot is to map climate change references across websites and in relation to the text types (which are connected to visibility and importance).

Tag clouds - categories

Merged texts' tag clouds were further investigated: the words they contain were grouped on the basis of their meaning and in accordance with the evaluation criteria previously set.

Meaningful comparisons between all articles and climate-change-citing articles were provided through categorisation and colour coding.

CATEGORISATION

Each word from the two merged tag clouds was categorised into 1 exclusive category of 15, according to its meaning. Categories are the same as in protocol 1 and 2, and kept into consideration both the specific words in the tag clouds of all protocols and the evaluation criteria set prior to starting the analysis.

Each category can be made of 1, 2 or 3 specific subcategories. Categories and subcategories are listed and defined on the opposite page. However, the analysis initially focus on first-level categories (highlighted in orange in the list).

COLOUR CODING

A colour for each category was established, then the words in the merged texts' tag clouds were coloured according to their category of belonging. Working directly with colour on the clouds allows to see:

- variety → how many words for each category;
- frequency → position and size of words for each category.

ALL ARTICLES ↔ CLIMATE-CHANGE-CITING ARTICLES

Comparing the distribution of each colour for the two tag clouds (*all articles* and *climate-change-citing articles*) allows to go deeper into analysing whether and how communications addressing the climate crisis differ from the regular flow of news in the websites.

◆ P3 → TEXTS → TAG CLOUDS → VIZ 03

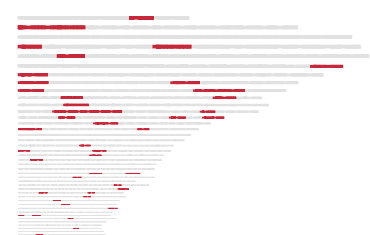
The visualisation on the right shows for each category the pair of tag clouds placed side by side, with the words falling in the category highlighted in colour.

In order to give more importance to the colours, words were replaced with rectangles through Dan Ross' *Flow Block* font. The terms falling in the category were made readable in an ordered list (most frequent to least frequent) that follows each tag cloud. Words in the *all articles* list that don't appear in the *climate-change-citing* list are faded.



Weather

ALL ARTICLES



fire, fires, weather, air, drought, rain, clouds, climate, burning, burned, wildfires, wind, change, rainfall, storms, forecast, showers, winds, smoke, dry, rains, wildfire, pressure, anticyclone, thunderstorms, sun, storm, flames, bushfires, charon, flooding, precipitation, meteorological, snow, blaze, meteorologist, lightning, skies, sunny, blazes, radiation, sunshine, gusts, heatwave, driest, inelids, typhoon

CLIMATE-CHANGE-CITING



fire, fires, climate, change, weather, drought, air, burning, burned, wildfires, dry, wildfire, winds, rain, rainfall, meteorological, smoke, flames, forecast, blaze, storms, bushfires, flooding, floods, driest, lightning, pressure, blazes, wind, droughts, humidity, anticyclone, atmospheric, meteorologist, heatwave, clouds

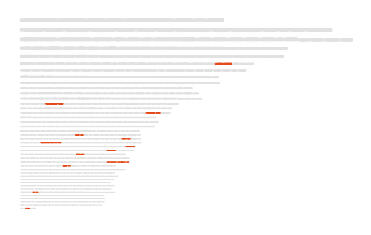
Causes

ALL ARTICLES



due, associated, caused, issued, affect, cause, affected, department

CLIMATE-CHANGE-CITING



due, associated, emissions, fueled, cause, greenhouse, gas, caused, affected, linked, consequences, influence, attribution, lead, result

Solutions

ALL ARTICLES



firefighters, officials, authorities, chief, agency, firefighting, sheriff, police

CLIMATE-CHANGE-CITING



firefighters, officials, agency, firefighting, brigade, department, police, noaa, nifc, authorities, management, control, minister, spokesperson, ready, beat, environmental

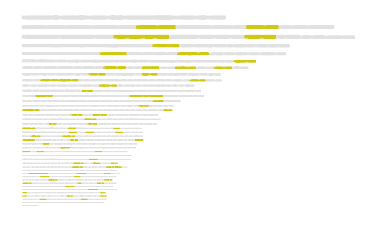
Impacts

ALL ARTICLES



high, many, extreme, record, wave, conditions, new, much, large, average, situation, even, several, rise, least, records, already, strong, first, reach, reached, risk, destroyed, warnings, intense, low, emergency, level, end, highest, help, warning, higher, important, heavy, increase, evacuation, exceed, waves, died, worst, hit, manage, deaths, need, evacuations, evacuate, great, levels, largest, lower, exceeded, events, forced, severe, killed, increasing, reaching, experiencing, dangerous, evacuated, suffered, warned, significant, lot, ever, frequent, dead, numerous, devastating, death, increasingly, unprecedented, effects, problem, impacts, rising

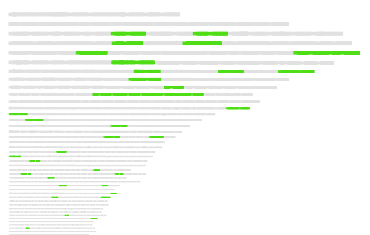
CLIMATE-CHANGE-CITING



extreme, record, high, new, wave, many, several, conditions, already, situation, least, records, much, even, large, deaths, destroyed, waves, increase, risk, reached, emergency, highest, end, help, evacuation, worst, events, first, hit, intense, rise, need, increasing, great, low, higher, reach, died, suffered, evacuations, exceptional, worse, largest, major, extremely, effects, death, level, frequent, extraordinary, historic, really, experienced, anomaly, greater, devastating, evacuated, dangerous, strong, increased, event, catastrophic, evacuate, exceeded, lot, impacts, frequency, unprecedented, ever, alltime, top, forced, exceed, disaster, important

Time

ALL ARTICLES



days, week, may, summer, year, month, day, thursday, friday, june, weekend, sunday, time, july, saturday, wednesday, tuesday, monday, years, hours, morning, afternoon, august, night, months, weeks, april, season, period, early, spring, later, winter, times, september, pm, january, fall

CLIMATE-CHANGE-CITING



year, summer, tuesday, days, june, time, years, july, may, week, wednesday, day, monday, season, hours, month, friday, weekend, months, august, weeks, winter, times, morning, thursday, period, right, prolonged, saturday, earlier, early, later, afternoon, spring, century, sunday, yesterday

Past & present

ALL ARTICLES



continue, since, last, now, recent, today, 2017, current, 2020, 2019, history, continues, 2021, 2022, latest, historic, currently, previous, past, continued, ago

CLIMATE-CHANGE-CITING



since, last, continue, now, recent, 2020, today, 2022, current, latest, 2019, previous, 2021, ago, past, 2017, 2018, continued, continues, currently

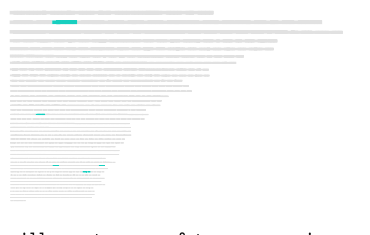
Future

ALL ARTICLES



will, next

CLIMATE-CHANGE-CITING



will, next, soon, future, scenario

Anticipation

ALL ARTICLES



can, expected, around, likely, possible, expect

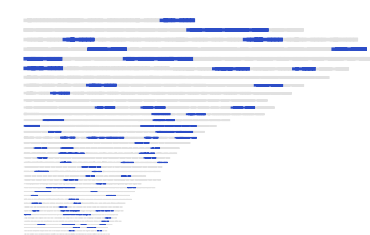
CLIMATE-CHANGE-CITING



can, around, expected, likely, estimated, seems, think, possible

Locations

ALL ARTICLES



areas, south, peninsula, north, australia, islands, spain, europe, area, country, northern, southern, us, across, western, uk, state, canary, eastern, east, wales, national, england, west, cantabrian, county, galicia, town, northwest, continent, region, australian, southeast, states, mediterranean, regions, atlantic, coast, city, balearic, iberian, andalusia, world, california, castilla, northeast, place, arizona, italy, southwest, united, madrid, london, valley, la, houston, sydney, pyrenees, local, france, portugal, texas, ebro, arctic, catalonia, provinces, washington, places, cordoba, victoria, scotland, guadalquivir, germany, european, african, global, canada, inland, territory, capital, mancha, canberra, africa, oregon, locally, coasts, kingdom, southeastern, idaho, jaen, granada, strait, cities, land, coastal, british

CLIMATE-CHANGE-CITING



us, area, australia, areas, uk, south, across, london, country, europe, state, spain, north, global, world, arctic, california, region, county, washington, east, western, west, wales, southern, england, states, australian, national, city, siberia, canada, oregon, northwest, peninsula, northern, arizona, portland, southeast, town, idaho, regions, place, seattle, france, coast, russia, eastern, portugal, siberian, sydney, united, land, located, earth, germany, cities, pacific, victoria, africa, hemisphere, planet, sahara, ground, capital, madrid, saharan, america

Temperature

ALL ARTICLES



temperatures, heat, hot, temperature, cold, warm, degrees, 40°, tropical, °c, warming, cool, hottest, thermal, °c

CLIMATE-CHANGE-CITING



heat, temperatures, temperature, hot, warming, degrees, warm, cold, warmest, known, tropical, °c, cool, hottest, warmer, temp, celsius, cooling, heatrelated, °c

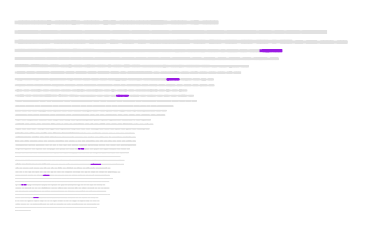
Natural environment

ALL ARTICLES



water, sea, forest, animals, river, reservoirs, mountain, mountains, koalas, environment, basin

CLIMATE-CHANGE-CITING



water, river, forest, ice, environment, natural, sea, lake

Science

ALL ARTICLES



according, miles, maximum, recorded, values, data, maximum, known, know, study, minimum, report, information

CLIMATE-CHANGE-CITING



according, miles, average, maximum, recorded, study, scientists, data, research, values, university, know, information, amount, researchers, reports, studies, experts, resources

Media

ALL ARTICLES



said, told, reported, video, news, say, tell, press, episode, media

CLIMATE-CHANGE-CITING



said, told, reported, news, services, weathercom, press, update, media, episodes, says, show

People

ALL ARTICLES



people, homes, residents, health, community, communities, home, man

CLIMATE-CHANGE-CITING



people, homes, residents, health, community, home, human

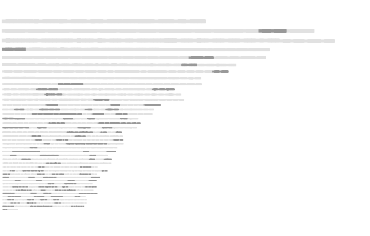
Others

ALL ARTICLES



due, associated, caused, issued, affect, cause, affected, department

CLIMATE-CHANGE-CITING



due, associated, emissions, fueled, cause, greenhouse, gas, caused, affected, linked, consequences, influence, attribution, lead, result

CATEGORIES AND SUBCATEGORIES WITH THEIR EXPLANATIONS

- WEATHER**
 - Forecasts** → words referring to weather and weather forecasting (*e.g. meteorological*);
 - Phenomena** → words referring to weather phenomena and events (*e.g. rain*);
- CAUSES**
 - General** → words generally related to causation (*e.g. due*);
 - Climate change** → words referring to specific causes of climate change (*e.g. greenhouse*);
- SOLUTIONS**
 - Action** → words conveying the general idea of action/reaction (*e.g. fight*);
 - Institutions** → words related to institutions or governments, supposed to act against climate change (*e.g. intergovernmental*);
 - Climate change** → words related to specific behaviours connected with climate change savviness (*e.g. sustainability*);
- IMPACTS**
 - Extreme** → words conveying a sense of out of the ordinary (*e.g. extreme*);
 - Effects** → words generally related to effects (*e.g. impacts*);
 - Threats** → words related to clearly negative effects (*e.g. disasters*);
- TIME**
 - Time** → words expressing general time periods and intervals (*e.g. winter*);
- PAST AND PRESENT**
 - Past** → words expressing specific moments in the past, specifically before the moment when the data was collected (*e.g. 2019*);
 - Present** → words generally addressing the present moment (*e.g. now*);
- FUTURE**
 - General** → words generally related to future (*e.g. projections*);
 - Specific moment** → words expressing specific moments in future time (*e.g. 2050*);
- ANTICIPATION**
 - Uncertainty** → words expressing uncertainty or doubt (*e.g. might*);
 - Certainty** → words expressing certainty or confident expectancy (*e.g. sure*);
- LOCATIONS**
 - General** → general geographical terms (*e.g. longitude*);
 - Global** → words related to earth as a whole (*e.g. global*);
 - Local** → words referring to specific locations (*e.g. greenland*);
- TEMPERATURE**
 - Temperature** → words related to temperature (*e.g. heat*);
- NATURAL ENVIRONMENT**
 - Natural environment** → words related to natural environments, ecosystems and/or their elements (*e.g. mountain*);
- SCIENCE**
 - Institutions** → words related to scientists and scientific institutions (*e.g. ipcc*);
 - Studies** → words related to scientific studies and measurements (*e.g. data*);
 - Information** → words related to scientific communications (*e.g. report*);
- MEDIA**
 - Media** → words generally related to formats and channels (*e.g. photo*);
- PEOPLE**
 - People** → words connected with humanity as a group (*e.g. human*);
- OTHERS**
 - Others** → everything else;

Tag clouds - subcategories

The last textual analysis focused on climate-change-citing articles only: its purpose was to inquire deeper the representation of climate change made by weather forecast websites in connection with extreme weather events. To do that, words from the tag cloud were rearranged according to second-level categories.

CLIMATE-CHANGE-CITING

Finally, only the tag cloud regarding climate-change-citing articles was taken into consideration. Previous analysis had already provided a satisfying comparison between news in general and articles which explicitly reference the climate crisis. The focus shifted then to a more detailed exploration of textual representations of the climate crisis in the extreme weather events articles.

CATEGORISATION

The focus shifted on subcategories (second-level categorisation) from the ones previously listed and defined (complete list available on the right, subcategories highlighted in orange).

CLUSTERING

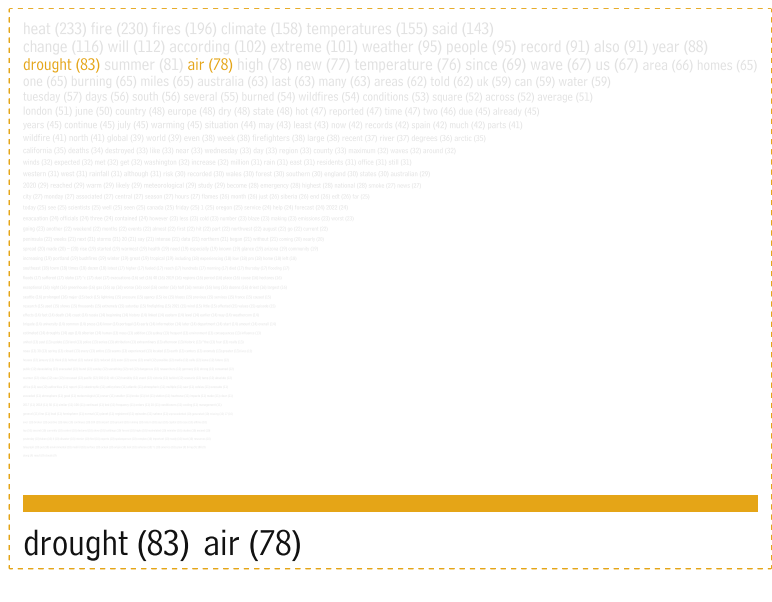
The tag cloud was broken into single words, which were then positioned according to the subcategory they belong to. The information available through this kind of display is:

- variety → how many words for each subcategory;
- frequency → size of words for each subcategory.

◆ P3 → TEXTS → TAG CLOUDS → VIZ 04

The visualisation on the right shows the words from the tag cloud grouped according to the category and subcategory they belong to. Words are readable, and their size is linked to their frequency as in the original tag cloud. Furthermore, each word is followed by its absolute frequency (in brackets).

The colour coding previously established is maintained in order to strengthen the visual clustering of subcategories in higher-level groups.



Weather

FORECASTS

climate (158)
change (116) air (78)

meteorological (29) forecast (24) pressure (15) atmosphere (11)

meteorologist (1)

Causes

GENERAL

due (45) associated (27) emissions (23) fueled (17) cause (14)

caused (15) affected (15) linked (14) consequences (13) influence (13) attribution (12)

heat (11) heat (8)

Solutions

ACTIONS

management (11) control (10) roads (10) heat (10)

INSTITUTIONS

firefighters (38) officials (24)

agency (15) firefighting (15) brigades (14)

department (14) police (13) news (13) aft (13)

authorities (11) media (10)

CLIMATE CHANGE

greenhouse (14) gas (14)

Impacts

EXTREME

extreme (101)
record (91)

high (78)

new (77)

many (63)

several (55)

already (45) least (43)

records (42) much (42)

even (38) large (38)

increase (32) reached (29)

highest (28) end (26) worst (23)

first (22) hit (22) intense (21) rise (19)

increasing (19) great (19) low (18)

higher (17) reach (17) exceptional (16)

worst (14) largest (14) major (13) idleness (13)

land (14) frequent (13) extraordinary (13) historic (13)

really (13) anomaly (13) greater (13) strong (13)

increased (12) reached (12) hit (11) frequency (11)

represented (10) over (10) after (10) to (10) second (10)

reported (10)

GENERAL

year (88) summer (81) tuesday (57) days (56) june (50) time (47)

years (45) july (45) may (43) week (38) wednesday (33) day (33) monday (27) month (26) hours (27)

month (26) friday (25) weekend (22) months (22) august (22) weeks (21) winter (19) times (18) morning (17) thursday (17) period (16) night (16)

prolonged (16) saturday (15) earlier (14) early (14) later (14) afternoon (13) spring (13) century (13) january (12) sunday (12) yesterday (10)

Past & present

PAST

since (69) last (63) recent (37)

recent (37) 2020 (29) 2021 (29) 2022 (24) latest (17)

2019 (14) previous (15) 2021 (15) ago (14) past (13) 2017 (12) 2018 (12)

continued (11)

EFFECTS

wave (67)

conditions (53)

situation (44) waves (32)

events (22) effects (19) experienced (13) event (12)

events (12)

THREATS

deaths (34)

destroyed (33)

risk (30)

emergency (28) help (24)

evacuation (24) need (19) died (17)

suffered (17) evacuations (16) death (14)

evacuating (12) evacuated (12) damaged (12)

catastrophic (12) evacuee (12) forced (10) disaster (10)

Future

GENERAL

will (112)

next (21) soon (12) more (12) several (12)

Anticipation

UNCERTAINTY

can (59)

around (32) estimated (14) seems (13) rise (13)

possible (12)

Locations

GENERAL

area (66)

areas (62)

south (56)

across (52) state (48)

north (41) region (33)

county (33) east (31)

western (31) west (31)

southern (30) states (30)

national (28) city (27) northwest (22)

peninsula (22) northern (21) southeast (18)

town (18) regions (14) place (14) coast (14)

eastern (14) land (13) located (13) other (12)

hemisphere (11) green (10) north (10)

Temperature

GENERAL

heat (233) temperatures (155) temperature (76) hot (47)

warming (45) degrees (36) warm (29) cold (23) warmest (19) known (19) tropical (19) °c (17) cool (16) hottest (12) here (12) unless (12)

coldest (12) hottest (12) °f (10)

SPECIFIC MOMENT

CERTAINTY

expected (32) likely (29)

GLOBAL

world (39)

global (39)

earth (12) planet (11)

LOCAL

us (67)

australia (63)

uk (59) london (51)

country (48)

europe (48) spain (42)

arctic (35) california (35)

washington (32) wales (30)

england (30) australian (29)

siberia (26) canada (25) oregon (25)

arizona (19) portland (19) idaho (17)

seattle (14) france (13) russia (14) portugal (14)

iberian (14) sweden (13) united (13) germany (12)

pacific (12) vietnam (12) africa (12) sahra (11) north (10)

alaska (10) antarctica (10)

Natural environment

GENERAL

water (59)

river (37)

forest (30)

ice (15) environment (13)

natural (12) sea (12) sea (12)

WHO

scientists (25)

university (14) researchers (12)

people (10)

WHAT

Media

GENERAL

said (143) told (62) reported (47)

news (27) services (15) weathercom (14) press (14) update (12) media (12) updates (11)

was (12) news (12)

People

GENERAL

people (95) homes (65)

residents (31) health (19) community (19) home (18) human (15)

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Network

Images were arranged into a network based on AI image captioning. The network provided the base for mapping the visual representations of climate change in the websites.

VISUAL SIMILARITY

The 3,538 images were fed to Yale DHLab's PixPlot in order to get an interactive image network based on similarity: each picture is captioned from a previously trained neural network model, then all pictures are arranged in the space according to their content similarity.

The network can be explored through panning and zooming in the space or jumping to hotspots (image clusters). PixPlot automatically identifies some default hotspots, but they can also be created and curated by the user.

TAGGING

A static screenshot of the network was taken and manually tagged according to groups and clusters visually identified while exploring the interactive model and with the help of automatically identified hotspots.

P3 → IMAGES → NETWORK → VIZ 00

The visualisation on the right shows the 3,538 images (resulting from the scraping as previously described) displayed in the space on the basis of similarity (according to PixPlot's process of image captioning and positioning through a pre-trained convolutional neural network model).

Areas characterised by the predominance of a specific subject are outlined and tagged, even if subject clusters are often more spread around and less localised than they appear.

CLUSTERING

The network mapping was expanded into a detailed clustering of the images through the creation of a hierarchy of manually curated hotspots. The categorisation process kept into consideration the actual images' features and subjects as well as the evaluation criteria previously set. The hierarchy of (not exclusive) image clusters is visible on the opposite page.

INTERACTIVE NETWORK



PixPlot P3
Interactive network including all the 3,538 images, displayed according to image similarity and with hotspots based on images' subjects.

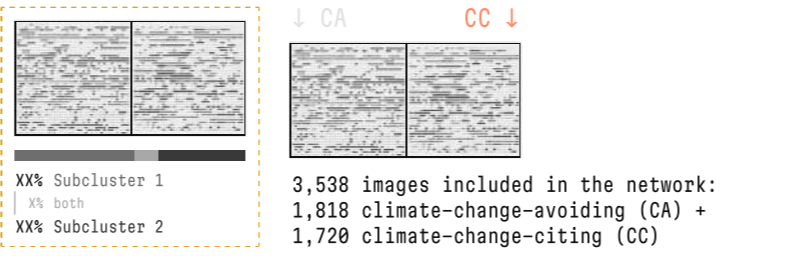


P3 → IMAGES → NETWORK → VIZ 01

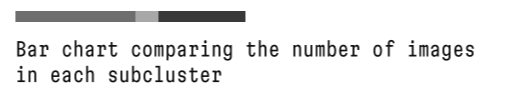
The visualisation on the right displays the cluster hierarchy and the quantity of images for each cluster and subcluster. It builds on the metadata display provided by PixPlot: images from climate-change-citing (CC) and climate-change-avoiding (CA) articles are organised in two distinct grids, colour is used to distinguish one category from the others as well as for highlighting the links in the hierarchy.

Clusters are ordered from the most populated to the least populated. Quantities are always expressed as percentages, since the most interesting comparison in that sense is that between child clusters belonging to the same parent cluster (or that of parent clusters between each other).

A single cluster is visualised as follows:

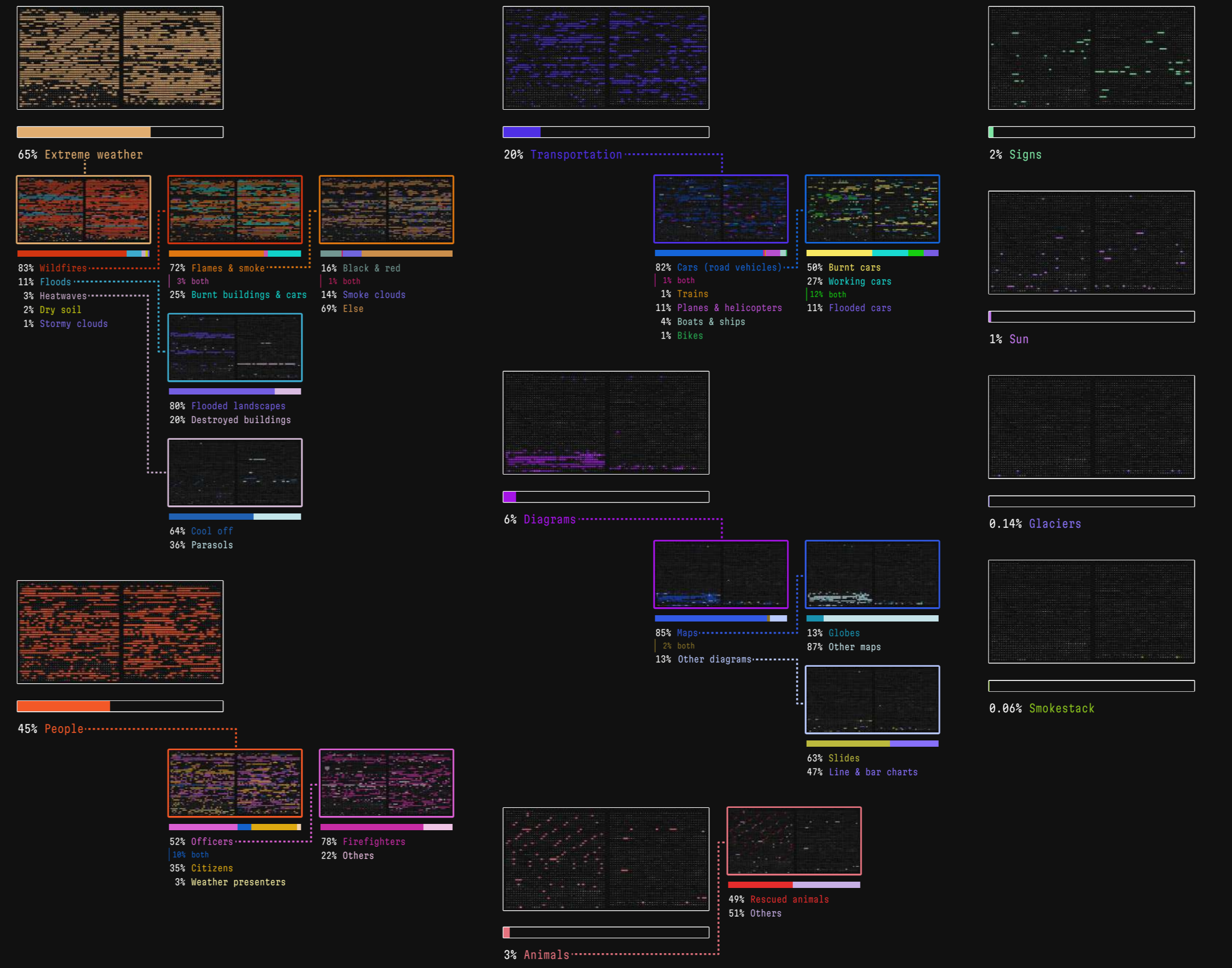
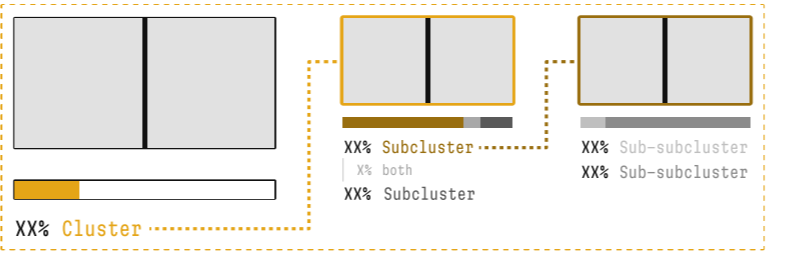


- Image not belonging to the cluster
- Image belonging to subcluster 1
- Image belonging to subcluster 2
- Image belonging to both subclusters



XX% Subcluster 1
X% both
XX% Subcluster 2
List of subclusters with respective percentages (relative to the total number of images in the parent cluster)

A family of clusters is visualised as a series of cluster visualisations connected through dashed lines and colour coding according to their hierarchy.



HIERARCHY OF IMAGE CLUSTERS

- EXTREME WEATHER ----- Wildfires ----- Flames & smoke ----- Black & red
 - Smoke clouds
 - Else
- Floods ----- Flooded landscapes
 - Destroyed buildings
 - Burnt buildings & cars
- Heatwave ----- Cool off
- Parasols
- Dry soil
- Stormy clouds
- PEOPLE ----- Officers ----- Firefighters
 - Others
- Citizens
- Weather presenters
- TRANSPORTATION ----- Cars ----- Burnt cars
 - Working cars
 - Flooded cars
- Trains
- Planes & helicopters
- Boats & ships
- Bikes
- DIAGRAMS ----- Maps ----- Globes
 - Other maps
 - Slides
 - Line & bar charts
- Other diagrams
- ANIMALS ----- Rescued animals
 - Others
- SIGNS
- SUN
- GLACIERS
- SMOKESTACK

Network - images

Clustered images were reconnected with their visual appearance through cluster-specific wall of images based on the grouping hierarchy.

CHILD CLUSTER

All images in each low-level-cluster (clusters which don't contain other clusters) were downloaded and arranged together in creating cluster-specific image walls. The purpose of this operation was to connect the abstraction of the network with the qualitative appearance of the images, providing samples of the distinctive visual qualities in each image group.

The complete hierarchy of clusters with all low-level-clusters highlighted in orange is available on the right.

P3 -> IMAGES -> NETWORK -> VIZ 02

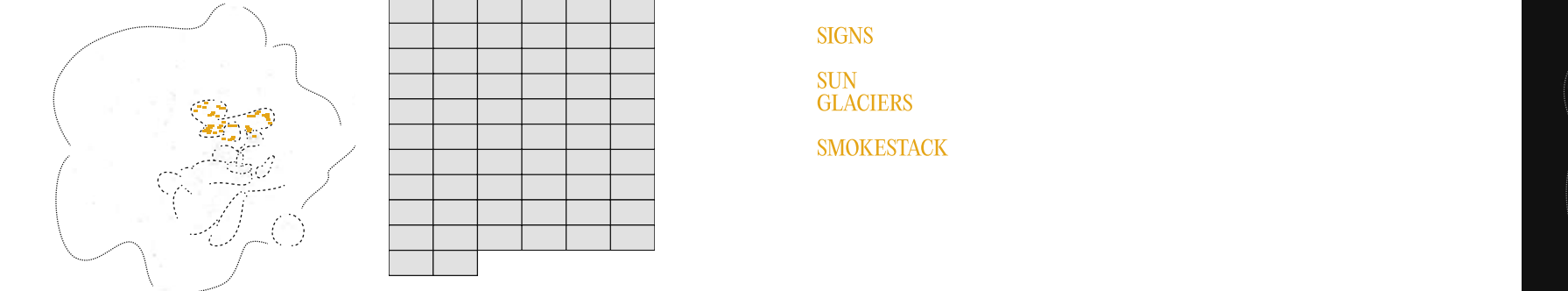
The visualisation on the right covers all low-level-clusters in the previously defined hierarchy. For each cluster are shown:

- the hierarchy of its parent clusters (if any);
- the number of images in the cluster;
- the position of the images in the network;
- a sample of images from the cluster (image wall).

Colours are maintained from the previous visualisation (P3 -> images -> network -> viz 01). A single cluster is visualised as follows:

CLUSTER HIERARCHY

Cluster	Subcluster	Sub-subcluster	NUMBER OF IMAGES
			XX IMAGES



↑ IMAGES IN THE NETWORK WALL OF IMAGES ↑

The sequence of low-level-clusters' displays is followed by a miniature of the tagged network (P3 -> images -> network -> viz 00), in order to provide an easy-to-consult map of the network areas.

EXTREME WEATHER

- Wildfires
- Flames & smoke
 - Black & red
 - Smoke clouds
 - Else
- Floods
 - Burnt buildings & cars
 - Flooded landscapes
 - Destroyed buildings
 - Parasols
- Heatwave
 - Cool off
 - Parasols
- Dry soil
- Stormy clouds

PEOPLE

- Officers
 - Firefighters
 - Others
- Citizens
- Weather presenters

TRANSPORTATION

- Cars
 - Burnt cars
 - Working cars
 - Flooded cars
- Trains
- Planes & helicopters
- Boats & ships
- Bikes

DIAGRAMS

- Maps
 - Globes
 - Other maps
 - Slides
 - Line & bar charts
- Other diagrams

ANIMALS

- Rescued animals
- Others

SIGNS

SUN

GLACIERS

SMOKESTACK

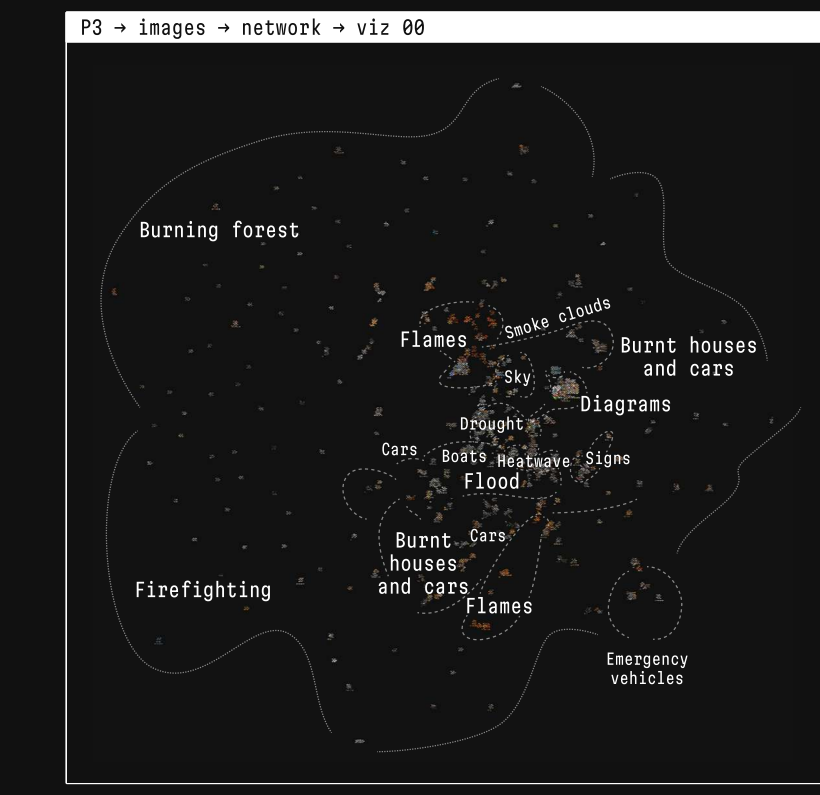


Image plot

The visual space of the articles was also examined in regard to hue and brightness values in the pictures, to detect trends and tendencies in the use of colours of climate crisis' representations.

IMAGE MEASURING

Colour values in each of the 3'538 images were measured through *ImageMeasure* for ImageJ. In particular, the process returned for each picture:

- median of brightness values;
- standard deviation of brightness values;
- median of saturation values;
- standard deviation of saturation values;
- median of hue values;
- standard deviation of hue values.

PLOT DIMENSIONS

The measures of brightness and hue were used to build a plot of images through *ImagePlot* for ImageJ. The axis of the plot were mapped as below:

- X axis → median of hue values (*hue_median*);
- Y axis → standard deviation of brightness values (*brightness_stddev*).

Each image was positioned in the plot according to its measured values.

PLOT EVALUATION

The distribution in the plot was analysed mainly in regard to the hue values, considering image density as well as recurring subjects across the x axis.

◆ P3 → IMAGES → IMAGE PLOT → VIZ 01

The visualisation on the right shows the each of the 3,538 images positioned into one of two plots: the first for images scraped from climate-change-avoiding articles, the other for images scraped from climate-change-citing articles. Inside each plot the pictures are distributed in the space according to their hue values (median mapped on X axis) and brightness values (standard deviation mapped on Y axis), as previously explained.

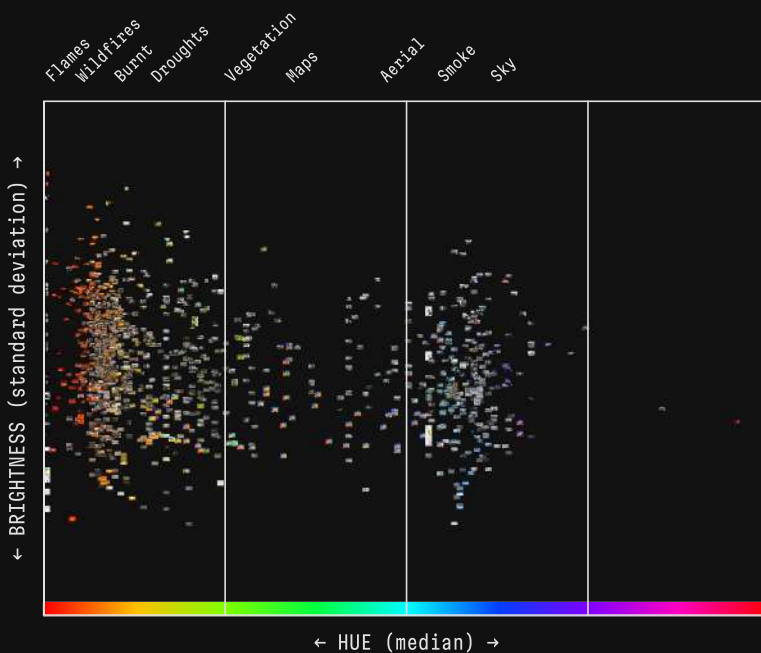
The plot is split vertically into 4 portions of equal width, according to hue values:

1. red to green (X1);
2. green to light blue (X2);
3. light blue to purple (X3);
4. purple to red (X4).

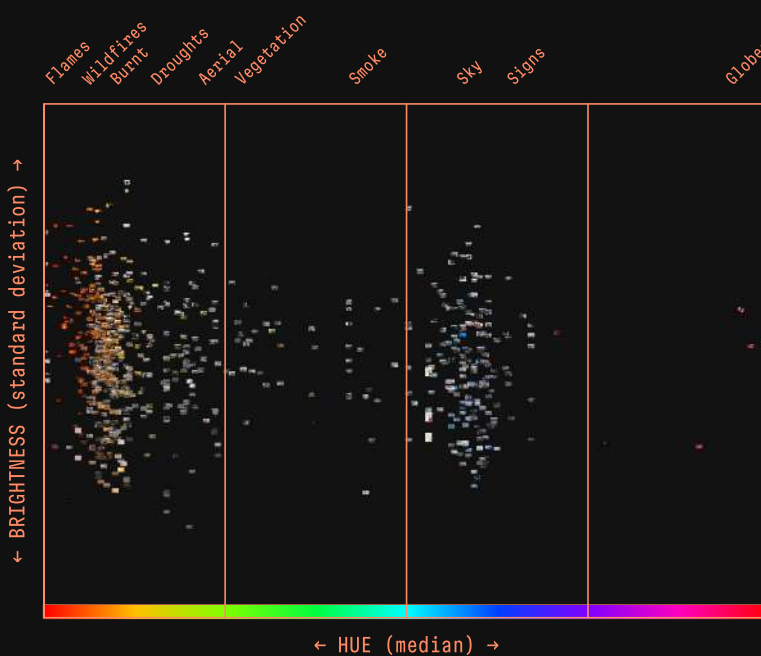
The purpose of those portions is to facilitate the evaluation of image density in relation to hue values.

Recurring subjects for specific hue areas are noted above the plot.

IMAGES FROM CLIMATE-CHANGE-AVOIDING ARTICLES

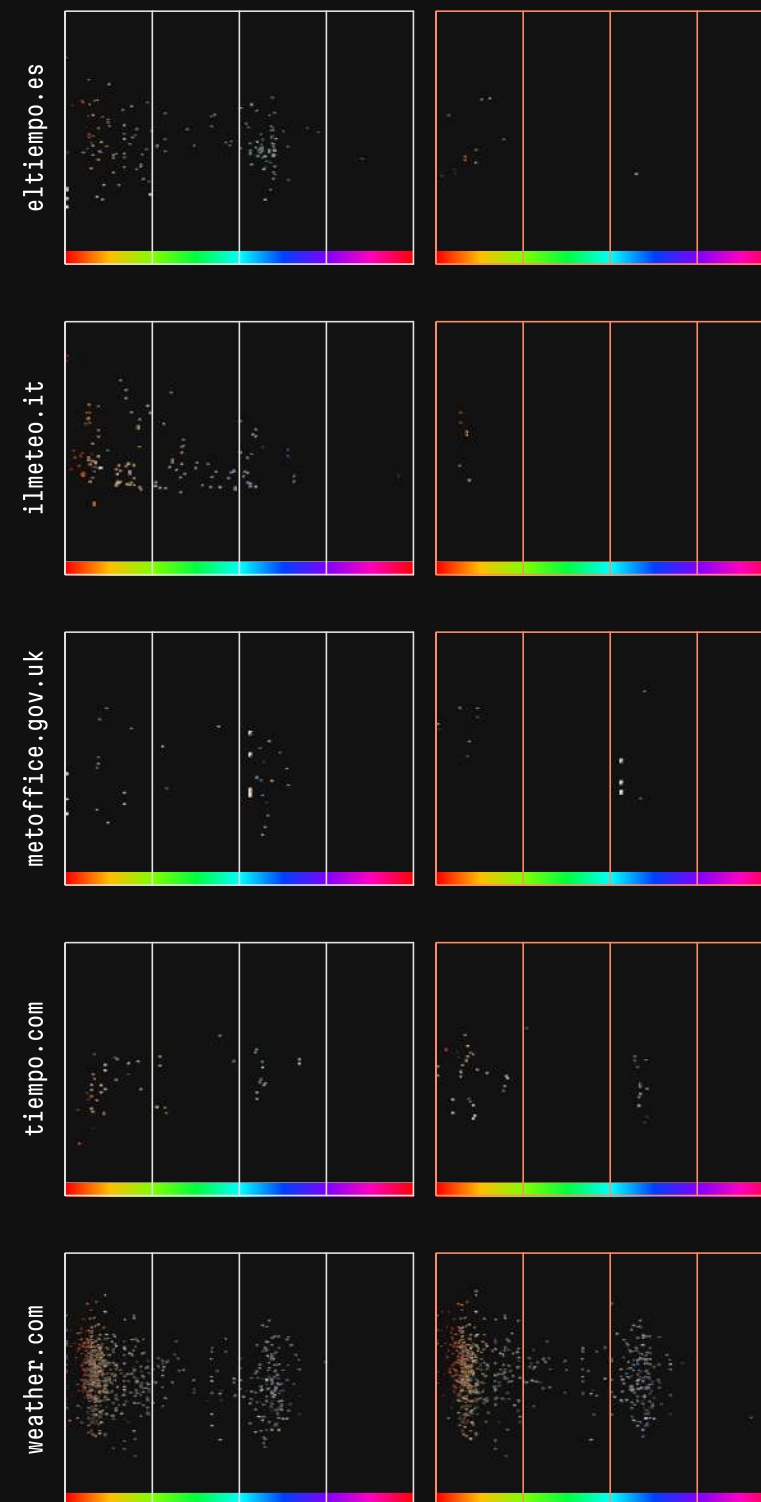


IMAGES FROM CLIMATE-CHANGE-CITING ARTICLES



CLIMATE-CHANGE-AVOIDING

CLIMATE-CHANGE-CITING



weather.com

WEBSITE-BASED

Website-specific image plots were also built with *ImageMeasure* and *ImagePlot* for ImageJ. Each website includes two plots: the first for images scraped from climate-change-avoiding articles, the other for images scraped from climate-change-citing articles. The axis of the plots were mapped as below:

- X axis → median of hue values (*hue_median*);
- Y axis → standard deviation of brightness values (*brightness_stddev*).

Each image was positioned in the respective plot according to its measured values.

The axis of every individual plot include the same range of values, in order to make them comparable. The evaluation of website-based plots in relations to the global plots is also encouraged, in order to detect cross-website tendencies as well as website-specific features in the use of colours.

CLIMATE-CHANGE-AVOIDING ↔ CLIMATE-CHANGE-CITING

The classification based on climate change relation (according to whether the source article explicitly referred climate change or not) remains. The plots provide another opportunity of comparison between the visual spaces of climate-change-citing and climate-change-avoiding articles.

◆ P3 → IMAGES → IMAGE PLOT → VIZ 02

The visualisation on the left shows the image plots at the intersection of websites and climate change reference. As in previous visualisation (P3 → images → image plot → viz 01), images are distributed in the space according to their hue values (median mapped on X axis) and brightness values (standard deviation on Y axis).

Each plot is split vertically into 4 portions of equal width, according to hue values:

1. red to green (X1);
2. green to light blue (X2);
3. light blue to purple (X3);
4. purple to red (X4).

The purpose of those portions is to facilitate the evaluation of image density in relation to hue values for visual spaces connected to specific websites.

