Earth Sciences Department

Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Avoiding too good to be true:

Guiding decision makers toward more meaningful climate information

Sam Pickard*, Dragana Bojovic, Alba Llabrés Brustenga, Núria Pérez-Zanón, Ángel G. Muñoz Solórzano, Carmen Gonzalez Romero, Eren Duzenli, Aleksander Lacima-Nadolnik, Yohan Ruprich Robert, Paloma Trascasa-Castro, Diana Urquiza, Josep Cos, Asun Lera St Clair, and Francisco J. Doblas-Reyes

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EMS 2024, Session 2.2

Supported by: IMPETUS 4CHANGE, adaptation Agora

SCREEN CAPTURE WELCOME

Barcelona Supercomputing Center
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BSC

Earth Sciences

Services

Knowledge Integration Team (KIT)

Engagement & knowledge co-production

Dissemination

Operationalisation

Science communication & outreach

Policy engagement

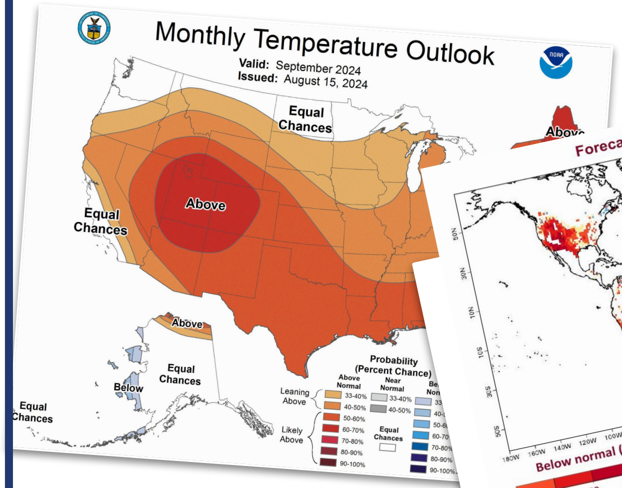
Services evaluation

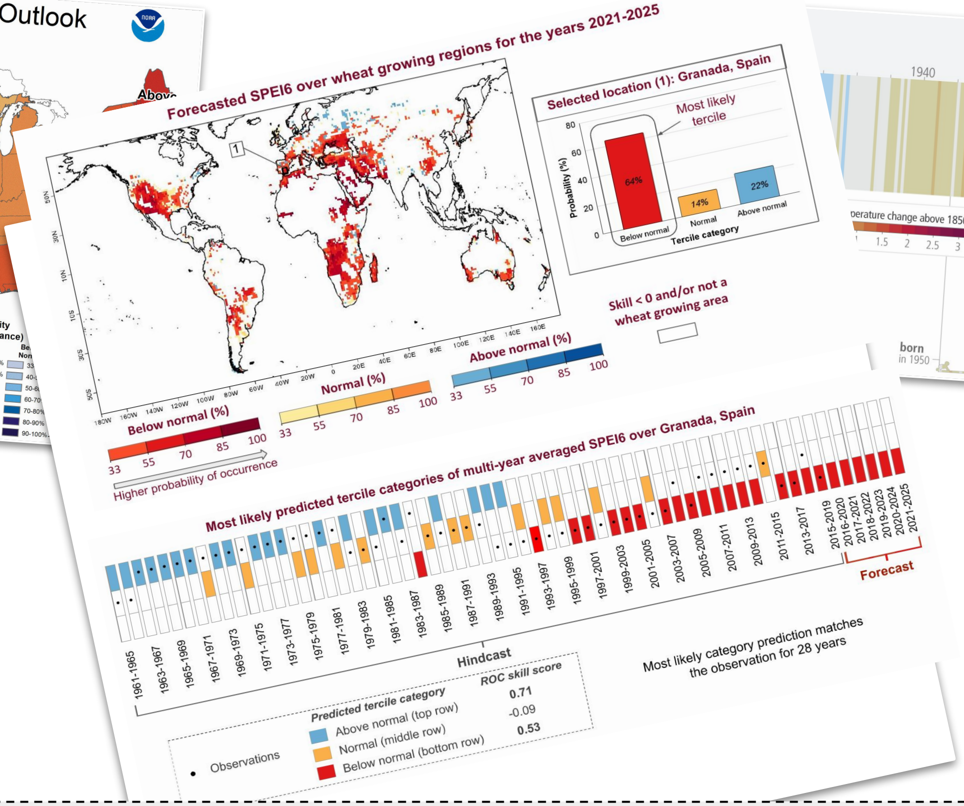
User experience & product design

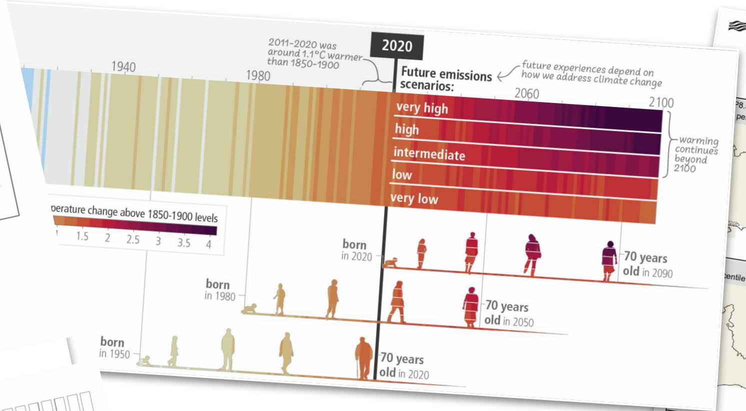
What do we do?

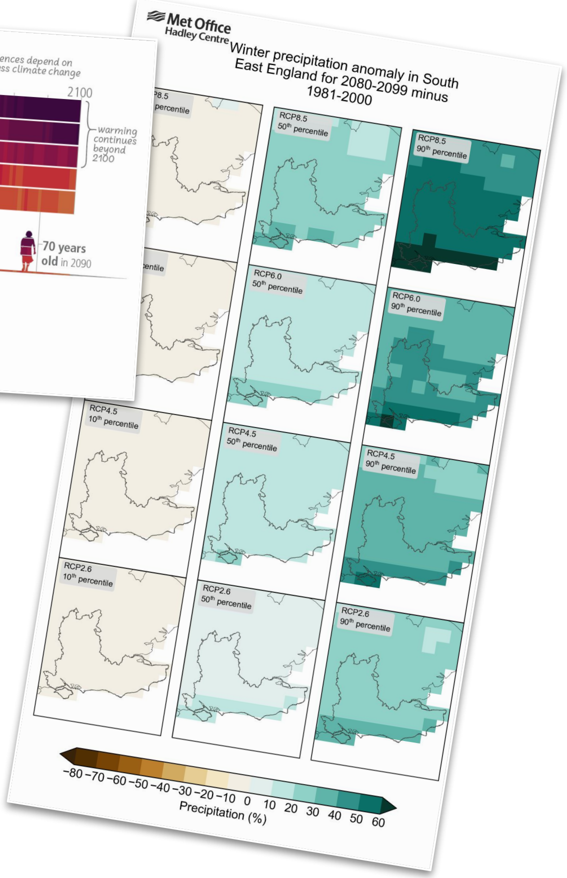
We co-design climate, air quality and health resilience services, while facilitating knowledge exchange and technology transfer of state-of-the-art research at local, national, and international levels.

Climate services come in different shapes and sizes…









“High quality” climate services are based on “high quality” climate information…but what does “quality” mean?

Image sources: NOAA, Copernicus, IPCC: Met Office

Quality throughout the CS production process

Climate services components

Image source: [Climateurope2]

Quality of the climate **information**

Quality of the climate **service**

Climate Data → **Climate Information** → **Climate Knowledge / Climate Action**

Climate Data

Essential climate variables produced by global or regional climate models, or climatological observation datasets, e.g.:

- surface temperature
- precipitation
- ice sheet extent
- soil moisture

Climate Information

Climate data that has been transformed to make it more relevant to society. For example, it may have been:

- downscaled or bias-corrected
- processed to yield climate indices
- merged with non-climate data

Climate Knowledge / Climate Action

Climate information that is used by decision makers to support climate-informed real-world decisions, e.g.,

- preparedness planning for disaster risk reduction
- evaluating competing business cases
- avoiding maladaptive infrastructure

Efforts to improve quality

Three main types of resources that vary depending on:

- What part of the CS value chain
    - Before or after climate information is produced
- Who are the target audience
    - “Producers” or “Users” of climate information

Outside of co-production, there is little (no?) focus on helping those procuring climate services shape the climate information

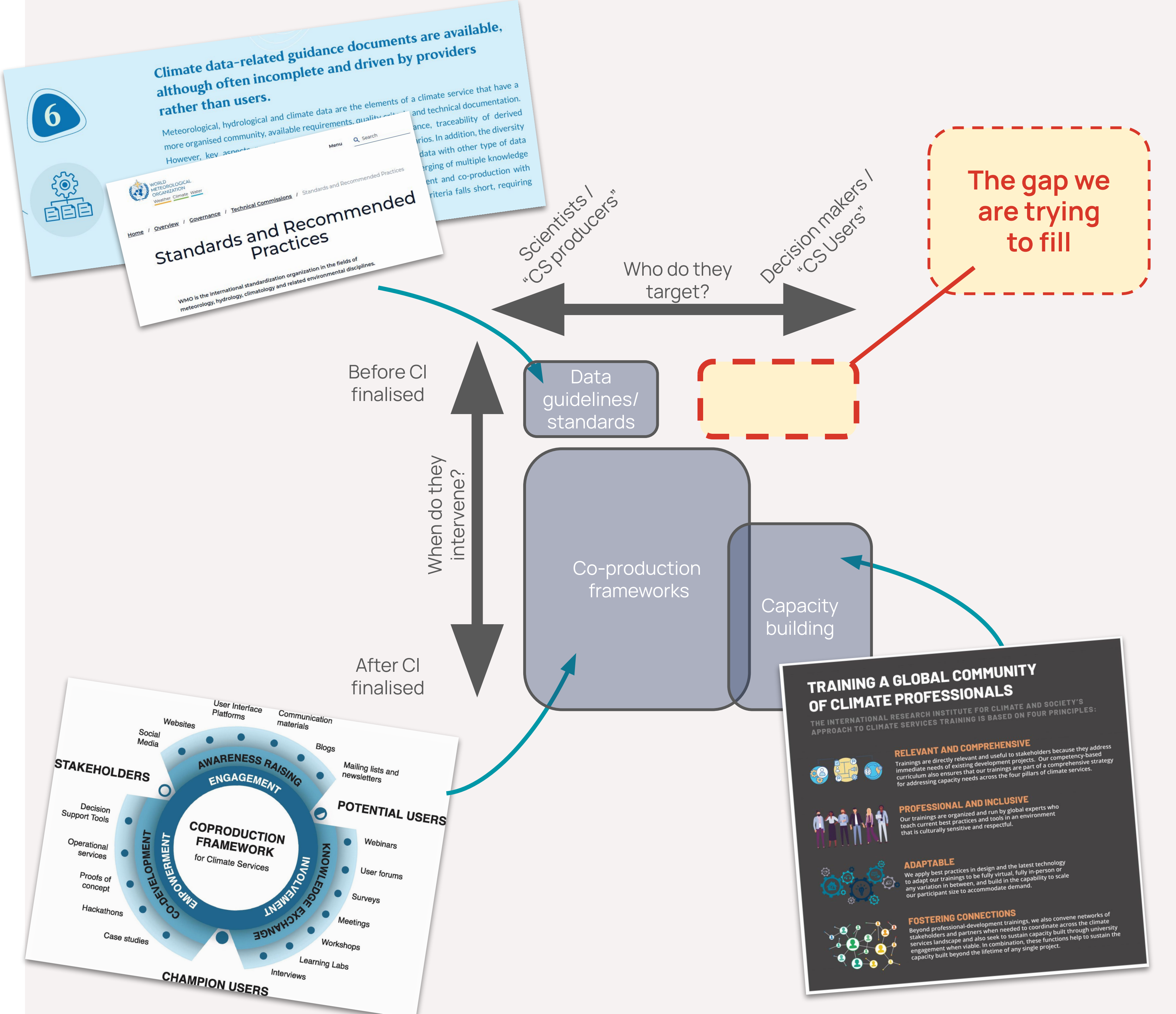


Image sources: Climateurope2, WMO, Bojovic et al., (2021), IRI

Let's think of climate services as composites of interlocking pieces, each chosen following (invisible) decisions

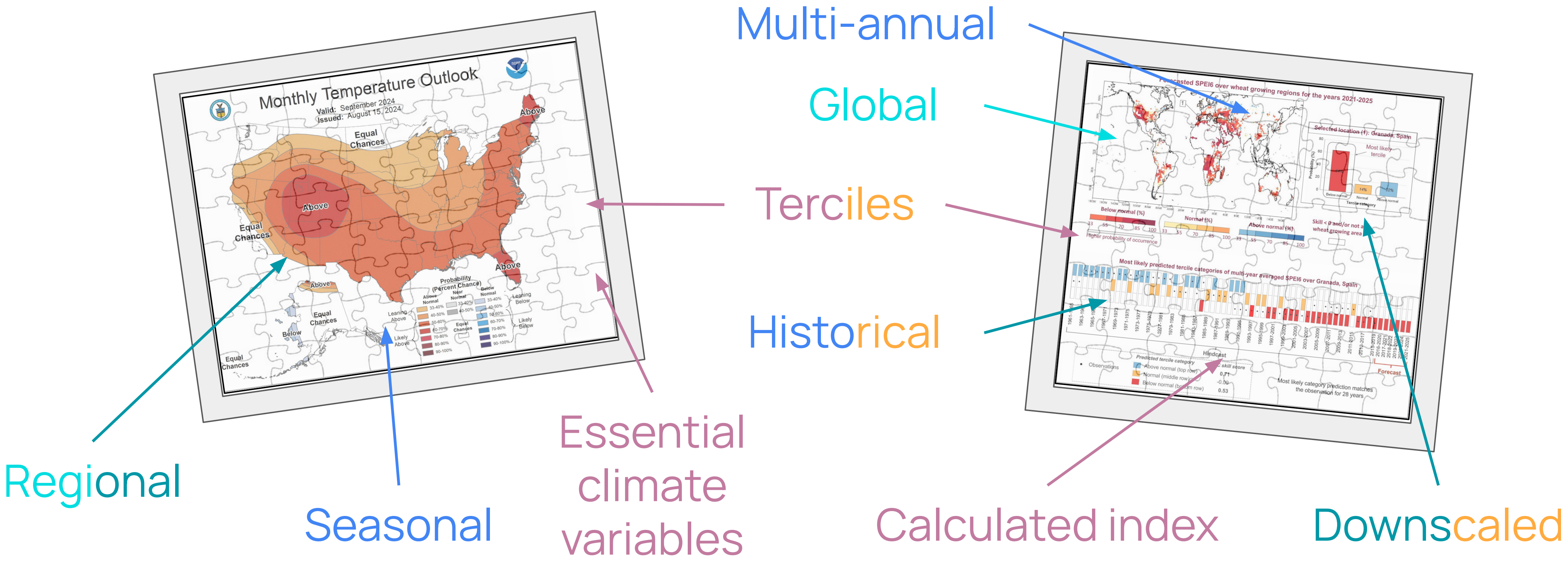


Image sources: NOAA, Copernicus,

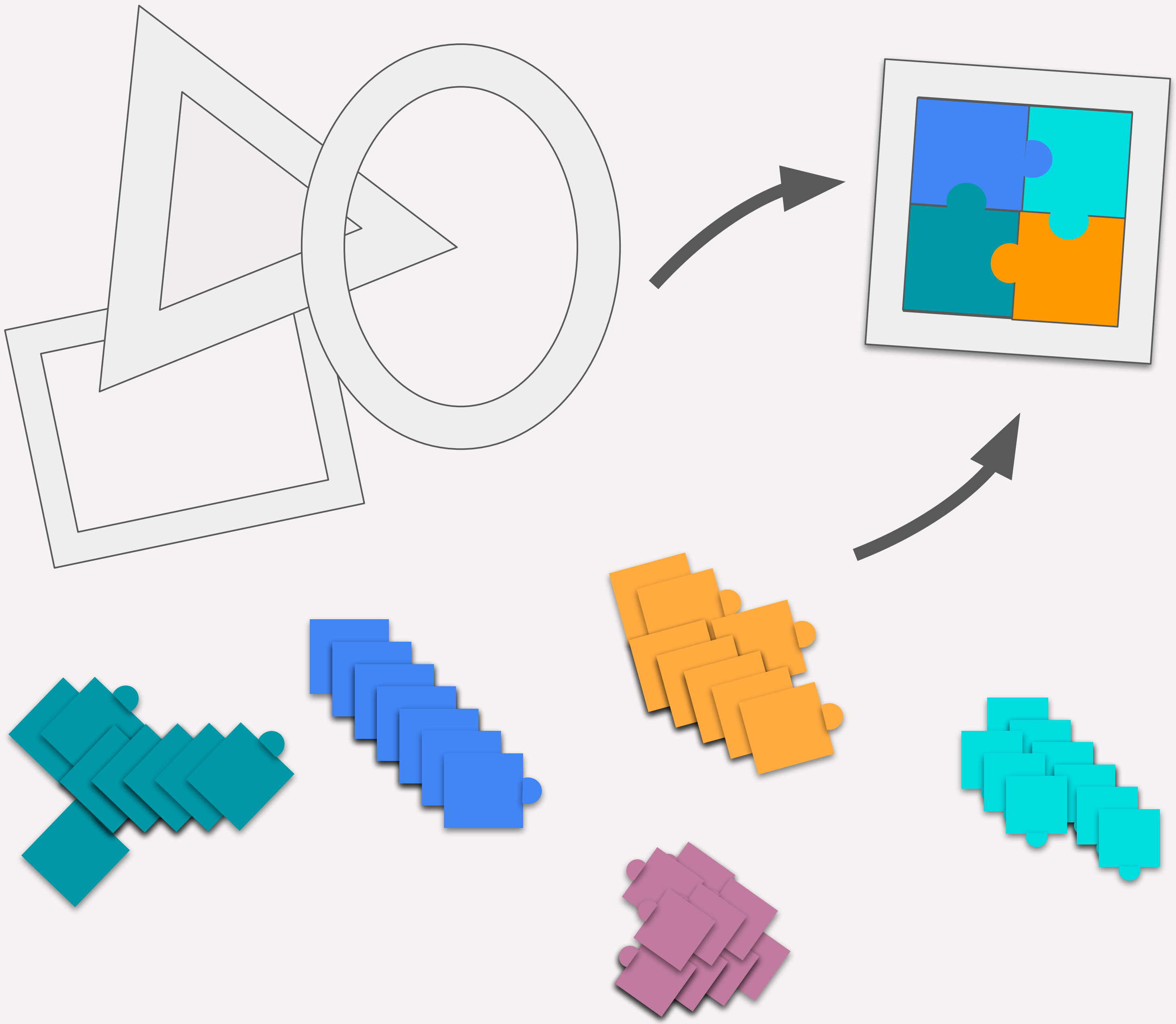
Assembling the puzzle

The overall shape
(the frame)

- the purpose

The key aspects
(the inner pieces)

- spatial resolution
- timescale
- reference dataset
- underlying climate models
- outputs
- ...+ others



Step 1: The purpose

What will the climate information be used for?

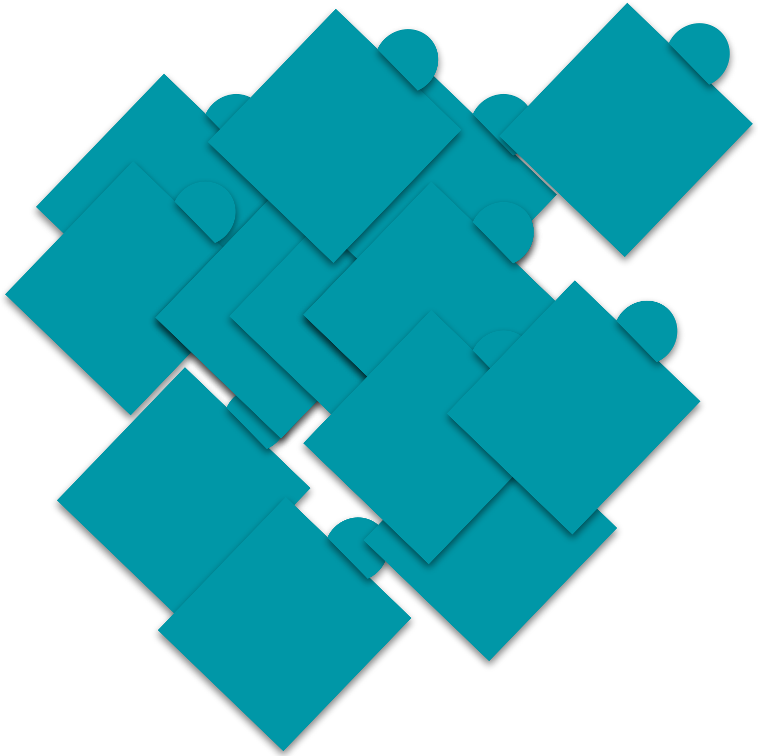
As specifically as possible:

- **Who…?**
  - the agricultural sector → farmers in Country A → sorghum farmers in the southwest (CS-1) and in X, Y and Z regions (CS-2)
- **…needs what information…?**
  - precipitation → spring rainfall → number of dry days (CS-i)) + minimum soil moisture content (CS-ii)
- **…for when…?**
  - the future → immediate (CS-a), short-term (CS-b) and medium-term (CS-c) → next month (CS-a), next spring (CS-b) + spring in 5-10 years time (CS-c)
- **…for what?**
  - Agricultural planning → crop planting strategies → contracting labour (CS-I), estimating water costs (CS-II) + deciding whether to change crops (CS-III)

Image source: Climateurope

Step 2: The key aspects

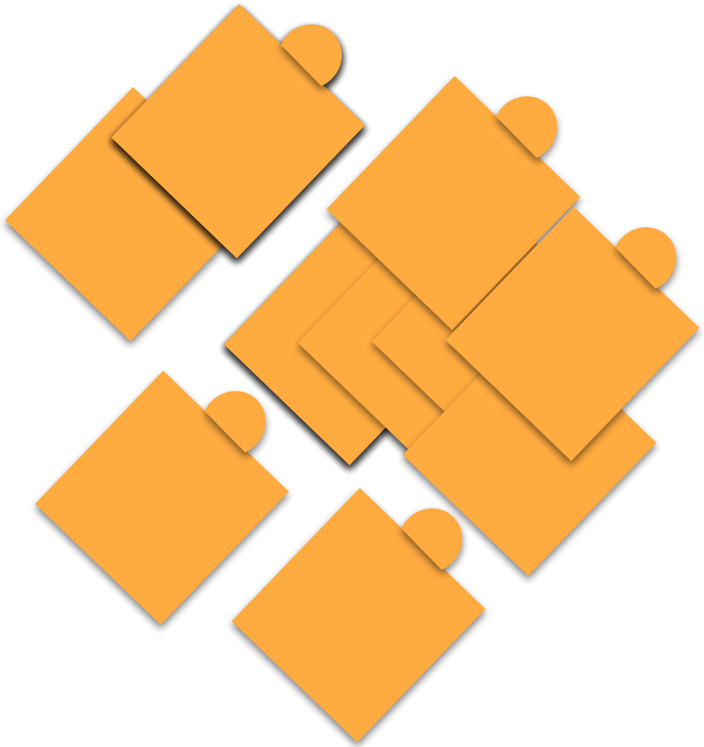
E.g. What spatial resolution is relevant and appropriate?



Why is this important Brief explainer for how this aspect contributes to the final climate data/information produced.	• Global climate models (GCMs) simulate large-scale physical processes • Historically, computational efficiency has required GCMs to run at a resolution of approx 100 km square • Too coarse to resolve many local (regional) phenomena: requires linking the GCM and the target output
How climate modellers address this Highlight key principles that govern the choices associated with this aspect and the potential pitfalls/importance of getting it right.	• Statistical downscaling: observations link GCM outputs to local impacts • Dynamical downscaling: GCM outputs → inputs for regional climate models • Higher resolution GCMs can resolve some, but not all, localised processes
Climate science limits and advances. Explain historical developments where we are today, what should be possible tomorrow, and what might be in the future (and when).	• Downscaling adds extra complexity to interpreting the predictions • Which downscaling technique to use in each situation remains a subject of active research • Very high-resolution (km-scale) earth system models are on the cusp of becoming available (e.g. DestinE)
Key choices to make **after the demand has been identified** What should users consider for this aspect, why, and how might they ask for it.	• Which downscaling methods will be used and what are their limitations? • What sensitivity study / pre-analysis has been conducted? • How does the skill vary depending on the location/timestep/variable?

Step 2: The key aspects

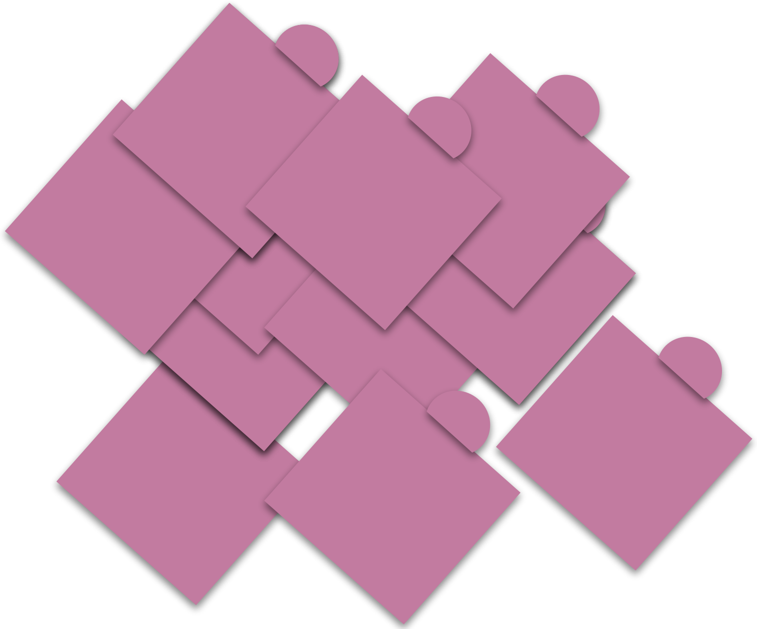
E.g. What reference datasets are relevant and appropriate?



Why is this important Brief explainer for how this aspect contributes to the final climate data/information produced.	• We need real data to anchor the climate dynamics in our models to reality, e.g.:. ○ calibration (e.g. bias correction), ○ downscaling, and ○ evaluating predictive skill.
How climate modellers address this Highlight key principles that govern the choices associated with this aspect and the potential pitfalls/importance of getting it right.	• Each of the main types of dataset (gridded and in-situ observations, satellite, reanalysis) supports different climate models & post-processing • Not all are universally available across space/time/variables • Seek to balance availability/applicability to select dataset(s) that are most appropriate to the final climate product
Climate science limits and advances. Explain historical developments where we are today, what should be possible tomorrow, and what might be in the future (and when).	• Gridded measurements for GCMs are universally available • Long-running in-situ observations only available in some parts of the world • Automatic measurements, digitisation of hand-written records, and synthetic datasets are working to fill these gaps
Key choices to make **after the demand has been identified** What should users consider for this aspect, why, and how might they ask for it.	• Do the reference datasets cover a sufficient time period to account for the dominant source of climate variability? • (For GCMs/RCMs) Is the gridded data set well sampled in the target region? • (For localised data) what steps have been taken to homogenise the data?

Step 2: The key aspects

E.g. How should the climate service outputs be presented and interpreted



Why is this important Brief explainer for how this aspect contributes to the final climate data/information produced.	• Variables are directly produced by climate models, but might not have direct societal relevance • Indicators are computed from one or more variables to present values that can directly support decisions.
How climate modellers address this Highlight key principles that govern the choices associated with this aspect and the potential pitfalls/importance of getting it right.	• Understanding user needs and the decision context is key. • For example, the same drought indicator (SPI / SPEI) has different uses depending on the length of the data that is accumulated (e.g. impacts on soil moisture or on reservoir levels)
Climate science limits and advances. Explain historical developments where we are today, what should be possible tomorrow, and what might be in the future (and when).	• Most (but not all, e.g. UTCI!) indicators are straightforward to calculate, but it remains challenging to ensure they have some predictive skill. • Key challenges include reducing and better communicating uncertainties created by combining different data types from different sources.
Key choices to make **after the demand has been identified** What should users consider for this aspect, why, and how might they ask for it.	• How should we choose the most appropriate indicator for our case? • How skillful is the indicator for the spatial resolution / timescale? • Can you show the skill of the underlying variables? • How do you measure this?

Questions for assembly

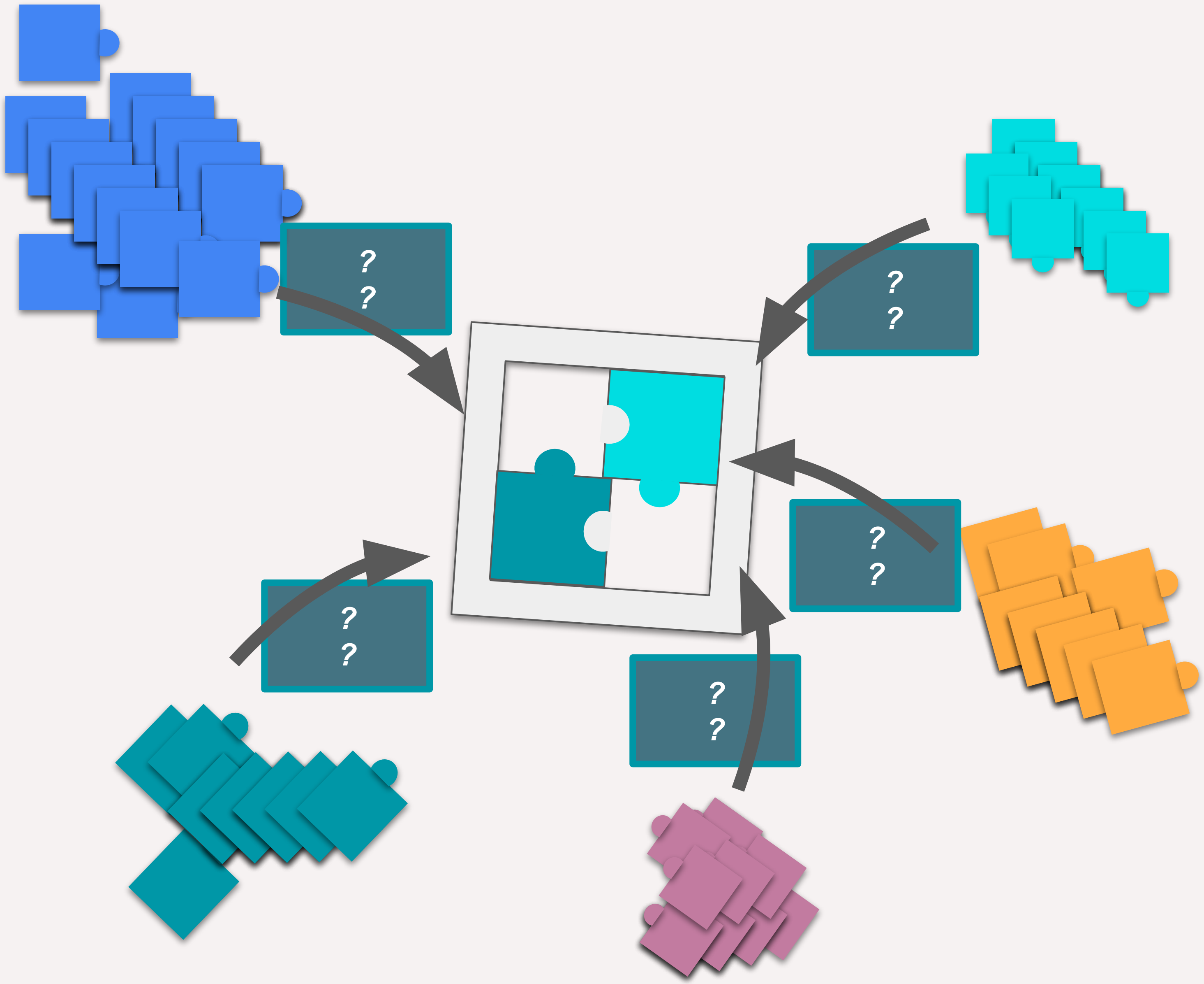
- the purpose

  User provided

The key aspects
(the inner pieces)

- spatial resolution
- timescale
- reference datasets
- underlying climate models
- outputs
- ...+ others

  Informed user questions



Our next steps

As this is (albeit fairly advanced) work in progress, we are still looking for input.

Do you have:

- comments or questions about what you've seen; or
- ideas for any of the next steps →

???

Let us know!

Ongoing

Have we included the most important categories?

Have we explored and explained the key points of these categories?

Coming up

How to communicate this to users?

Can we test the approach?

How can we integrate this with other quality-building efforts?

...?

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Thank you for your attention!

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Abstract

Climate services are on the cusp of becoming mainstream decision support tools. Many present accurate climate information within the bounds of scientific knowledge and technological development, yet some present climate information of limited “quality”, that is often “too good to be true”: i.e., scientific and technological constraints render it impossible to be as precise or as confident as suggested. This fidelity is rarely apparent when climate services are used to support decision making.

Alongside pursuing academic and technological advances, traditional efforts to counter this disconnect (between what climate scientists know to be the boundaries of what their work shows, and the way in which climate information is used in some decision making situations) has focussed on two groups of actors at two different moments in the production of climate services. Most established is training users how to interpret the climate information, occurring after it has been produced. More recently, climate scientists have begun to articulate guidelines of how to produce “high-quality” information, for other climate scientists to follow during the production of climate information.

We fear that demand for climate services will outpace the dissemination and use of good-practice standards. More positively, we believe the decisions taken to produce the data that underlies climate services could be made understandable for decision makers, making them active interrogators and providing a complementary route to counter the spread of meaningless climate information.

For the production of climate information, we use the metaphor of a jigsaw puzzle consisting of distinct, interlocking pieces. We illustrate the importance of user context in framing the puzzle, and for each of the constituent parts (e.g. timescales, spatial resolution, indicators) explain the production process and suggest guiding questions those commissioning climate services should ask to probe the fidelity of information presented in climate services.