C3S_51 Lot 3:
EQC for Seasonal Forecasts

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Challenges of the EQC for seasonal forecasts

- **Adaptation**: provide information for all kind of services.
- **Consistency**: build trust, ensuring a high degree of coherence across products.
- **Innovation**: transfer recent developments from research to operations.
- **Efficiency**: information should respond to users' queries with a delay as short as possible.
- **Targets**: define data, products, verification, guidance, etc.

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C3S_51 Lot 3: What

C3S_51 Lot 3 aims at **developing a strategy for the evaluation and quality control (EQC) of the multi-model seasonal forecasts provided by the Copernicus Climate Change Service (C3S) to respond to the needs identified among a wide range of stakeholders**.

Some important elements:

- Users are consulted to identify needs in terms of products and EQC information
- Forecast data are quality controlled and forecast products (not forecast systems) are verified
- A quality assurance template is required to summarise the information
- A framework is designed that serves as a reference to the community

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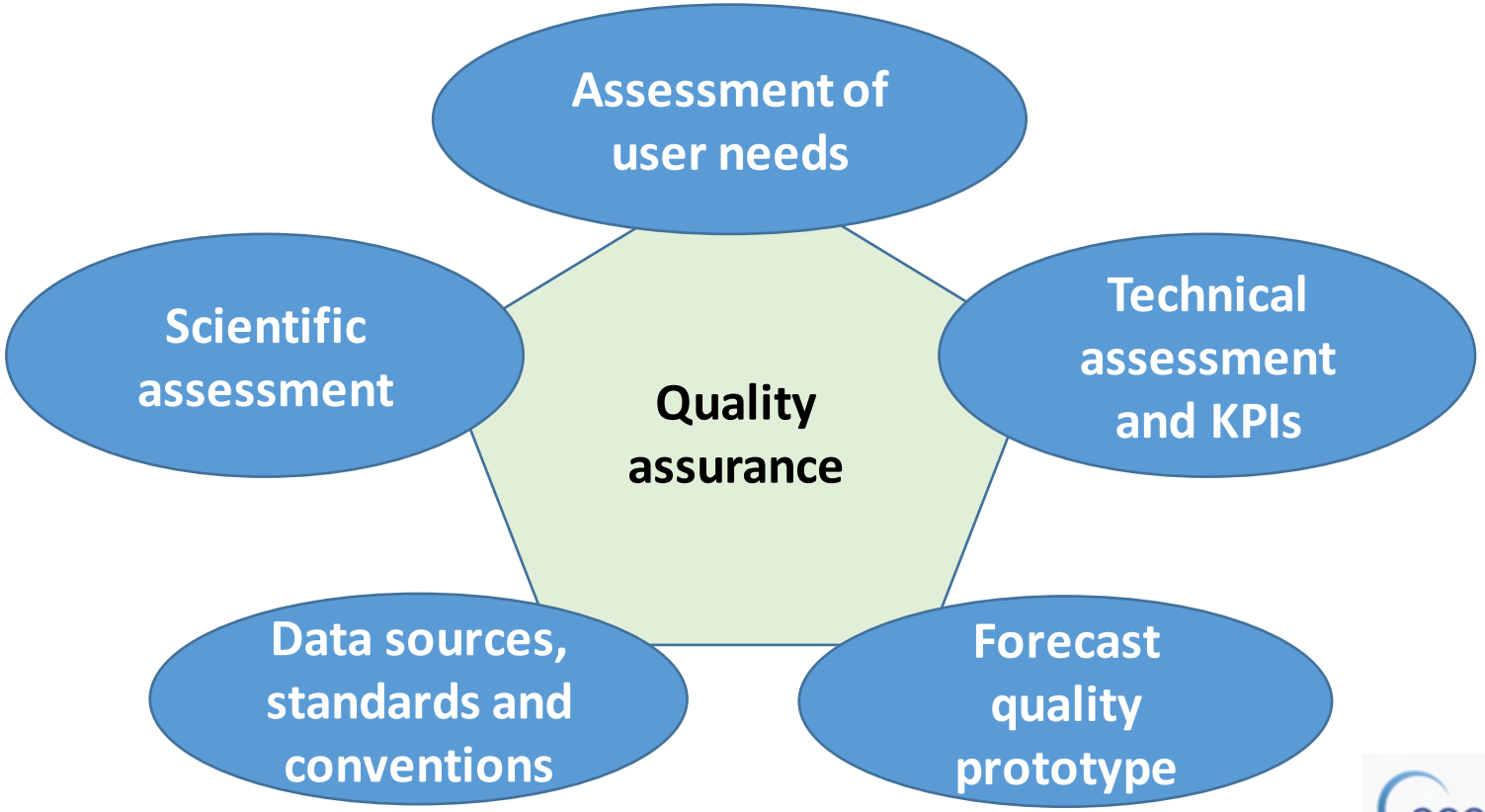
C3S_51 Lot 3: The strategy

C3S_51 Lot 3 aims at **developing a strategy for the evaluation and quality control (EQC) of the multi-model seasonal forecasts provided by the Copernicus Climate Change Service (C3S) to respond to the needs identified among a wide range of stakeholders.**



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C3S_51 Lot 3: Who

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Partner	Nature	Role
BSC-CNS (ES)	Main contractor	Coordination, data inventory and EQC framework and prototype
Univ. Leeds (UK)	Subcontractor	Assess user requirements
Meteoswiss (CH)	Subcontractor	Scientific quality assessment and gap analysis
Predictia (ES)	Subcontractor	CDS requirements and development of the prototype
Univ. Exeter (UK)	Subcontractor	Expert statistical advice
IFCA-CSIC (ES)	Subcontractor	Downscaling

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C3S_51 Lot 3: The users

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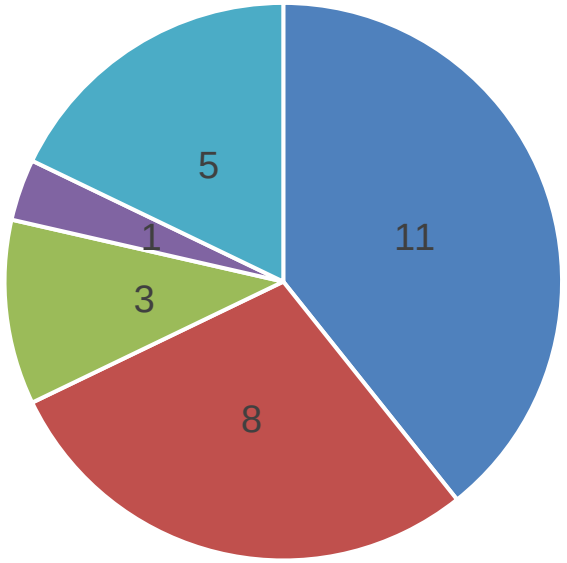
Assessing forecast quality



- Yes, both qualitatively and quantitatively
- Yes, quantitatively (e.g. compute objective f… quality measures) based on the hindcasts available from t… forecast system
- Yes, qualitatively (e.g. visual ins… based on past forecasts
- Yes, using other app…
- No, I don't … myself

Preferences for forecast quality format

- Separate from the forecast product (i.e. information about forecast performance is presented separately):
- Integrated into the forecast product (e.g. as strippling, contours, shading, text added to the forecast):
- Masking (i.e. forecasts are only shown where they are skillful):
- I'm not sure

Beware of user fatigue

M. Soares (Univ. of Leeds)

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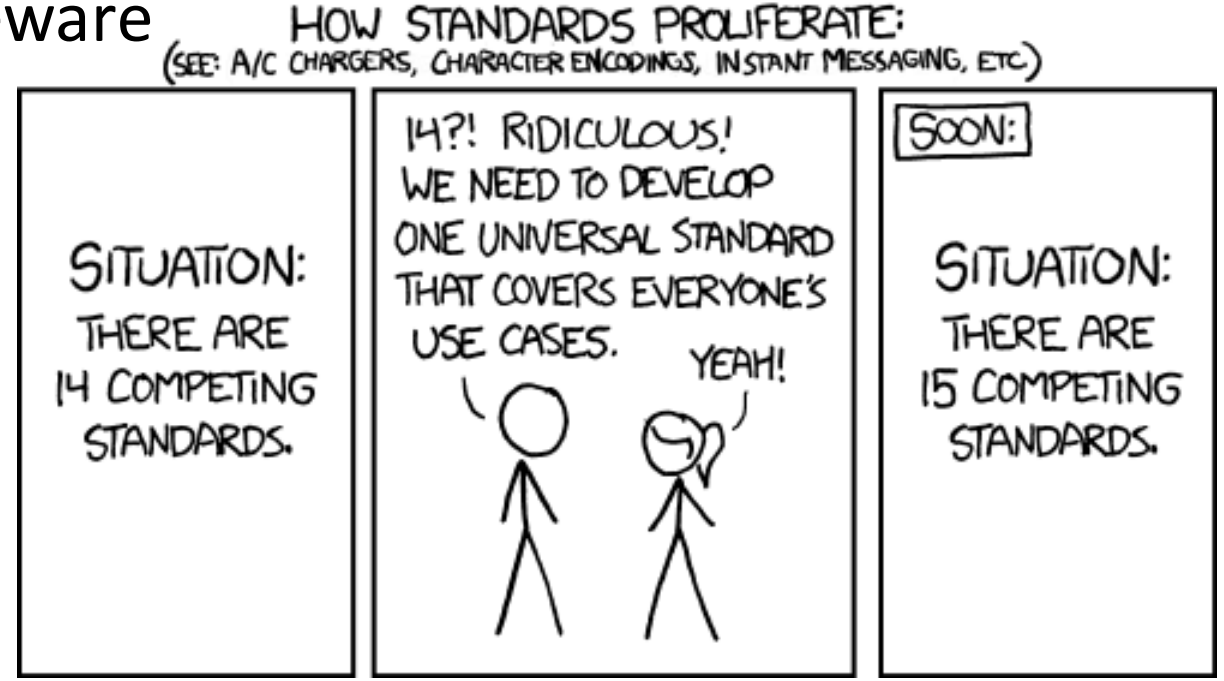
C3S_51 Lot 3: Standards and metadata

- All necessary **metadata** have been defined for the seasonal forecasts using all standards available (CHFP, SPECS).
- Similar standards could not be found for the reference observations.
- But beware



xkcd.com

- Additional checks still necessary (data checker).

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C3S_51 Lot 3: Scientific assessment

1. Forecast quality assessment
   - Verification procedure of existing forecast systems based on scoring rules (e.g. RPS for multi-category probabilities, CRPS for ensembles)
   - Products, and not data, are verified; forecast products are scrutinised
   - Impact of lagged ensembles and adequate product generation
2. Calibration
   - All bias correction and recalibration methods effectively remove bias
   - Added value of sophisticated methods (e.g. EMOS) small to inexistent due to limited hindcast length (and low skill)
3. Multi-model combination
   - No forecast system consistently outperforms others
   - Multi-model combination is beneficial
   - Avoid the temptation of identifying inadequate data sources to e.g. discard “bad” forecast systems.

These points address questions raised by users that lead to new products

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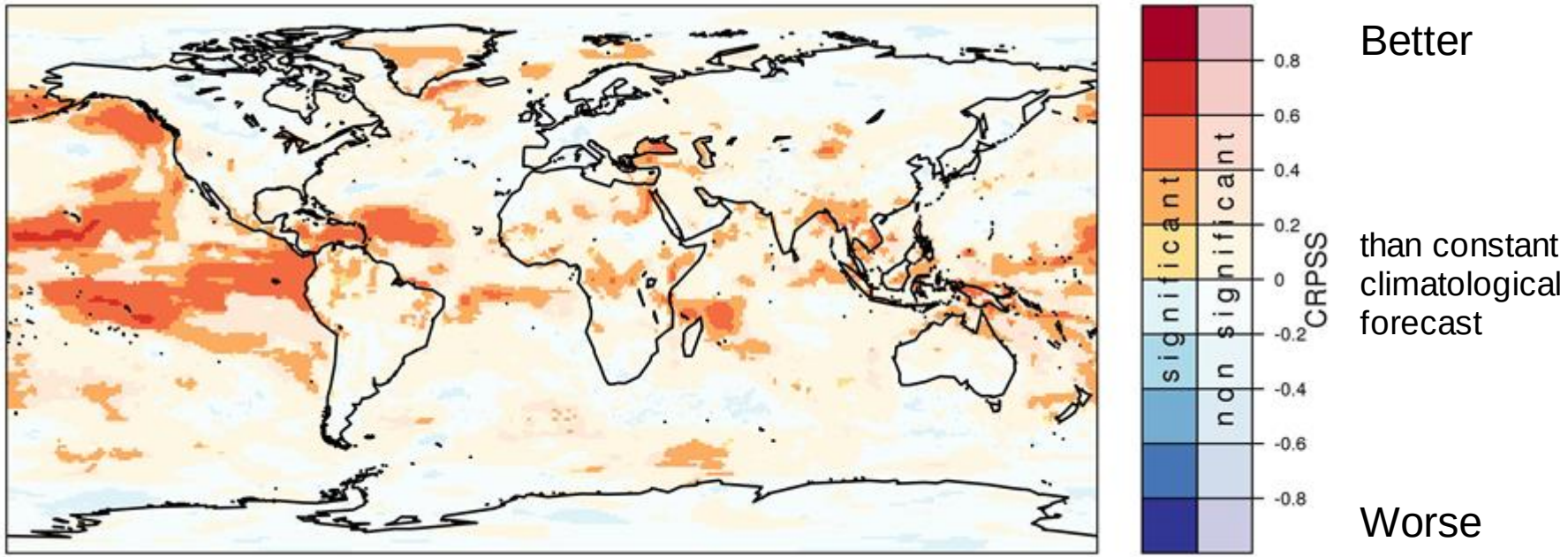
C3S_51 Lot 3: Forecast quality assessment and calibration

Skill of JJA temperature from ECMWF SEAS5 + recalibration*



Better

than constant climatological forecast

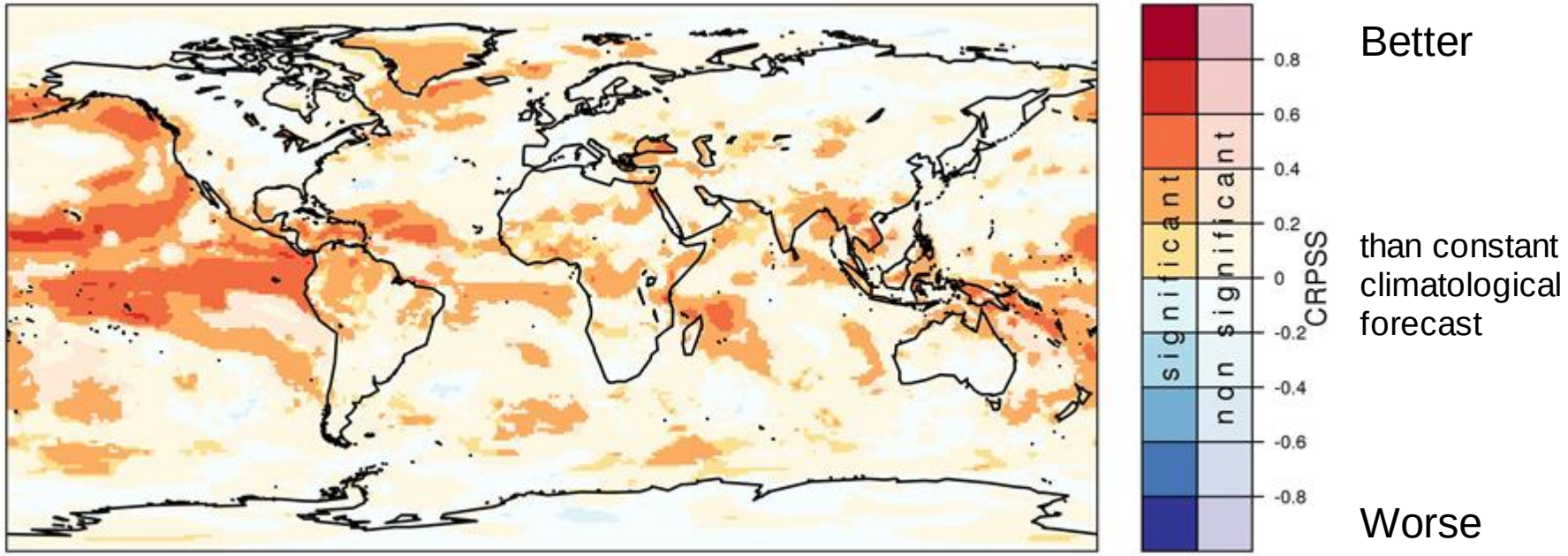
Worse

* CRPS of JJA near-surface temperature from ECMWF SEAS 5 initialized in May calibrated with the climate-conserving recalibration (CCR) and verified against ERA Interim for 1993-2014

S. Hemri (Meteoswiss)

C3S_51 Lot 3: Forecast quality assessment and multi-model

Skill of JJA temperature from C3S multi-model*



* CRPS of JJA near-surface temperature from ECMWF SEAS 5, Meteo France System 5, MetOffice GloSea5 initialized in May
CCR + weighted (RMSE) averaging of forecast PDF and verified against ERA Interim for 1993-2014

S. Hemri (Meteoswiss)

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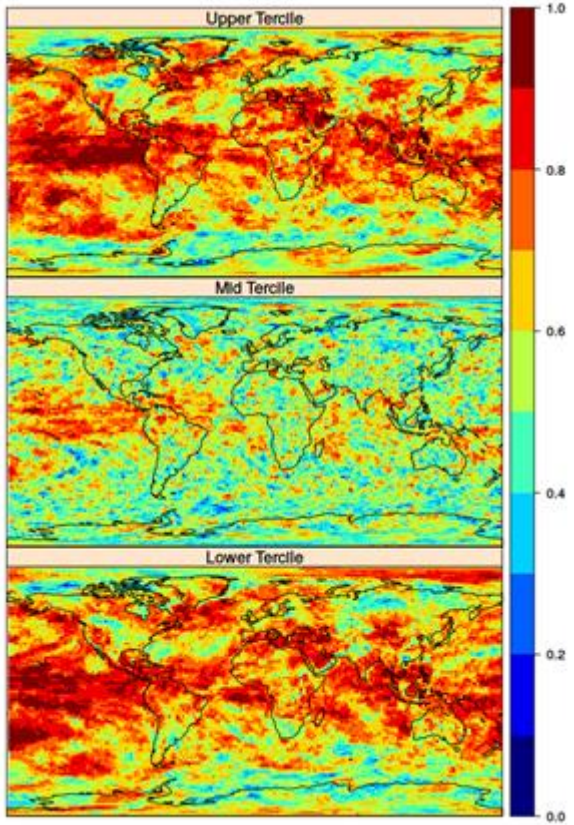
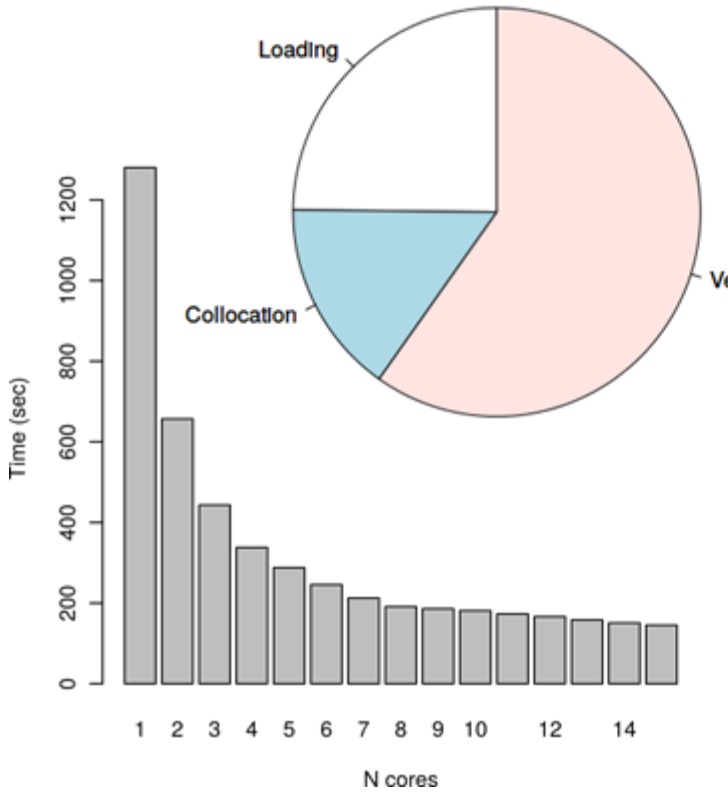
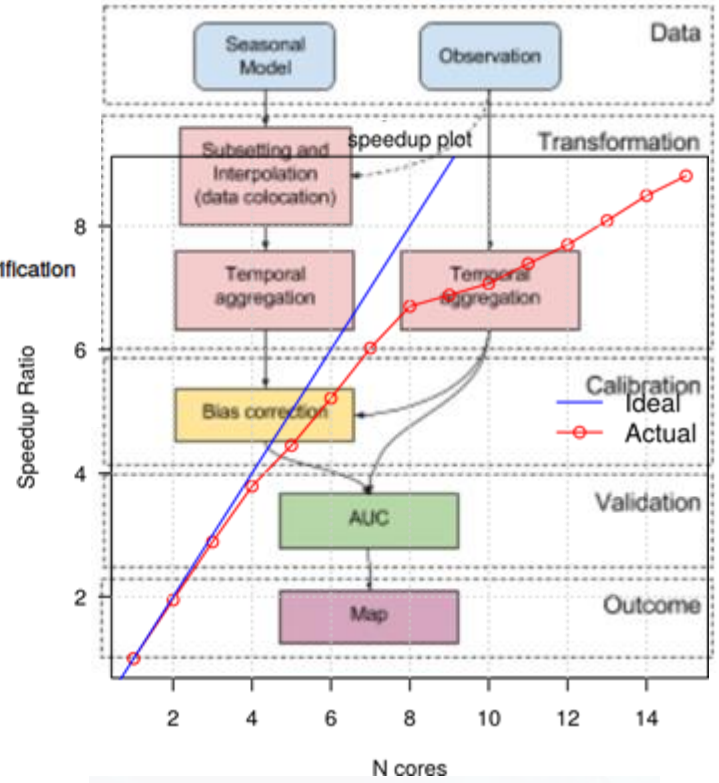
C3S_51 Lot 3: Timeliness and provenance

Computing performance and product provenance are key. Forecast verification (ROC area) with performance analysis and workflow definition using SpecsVerification and easyVerification.





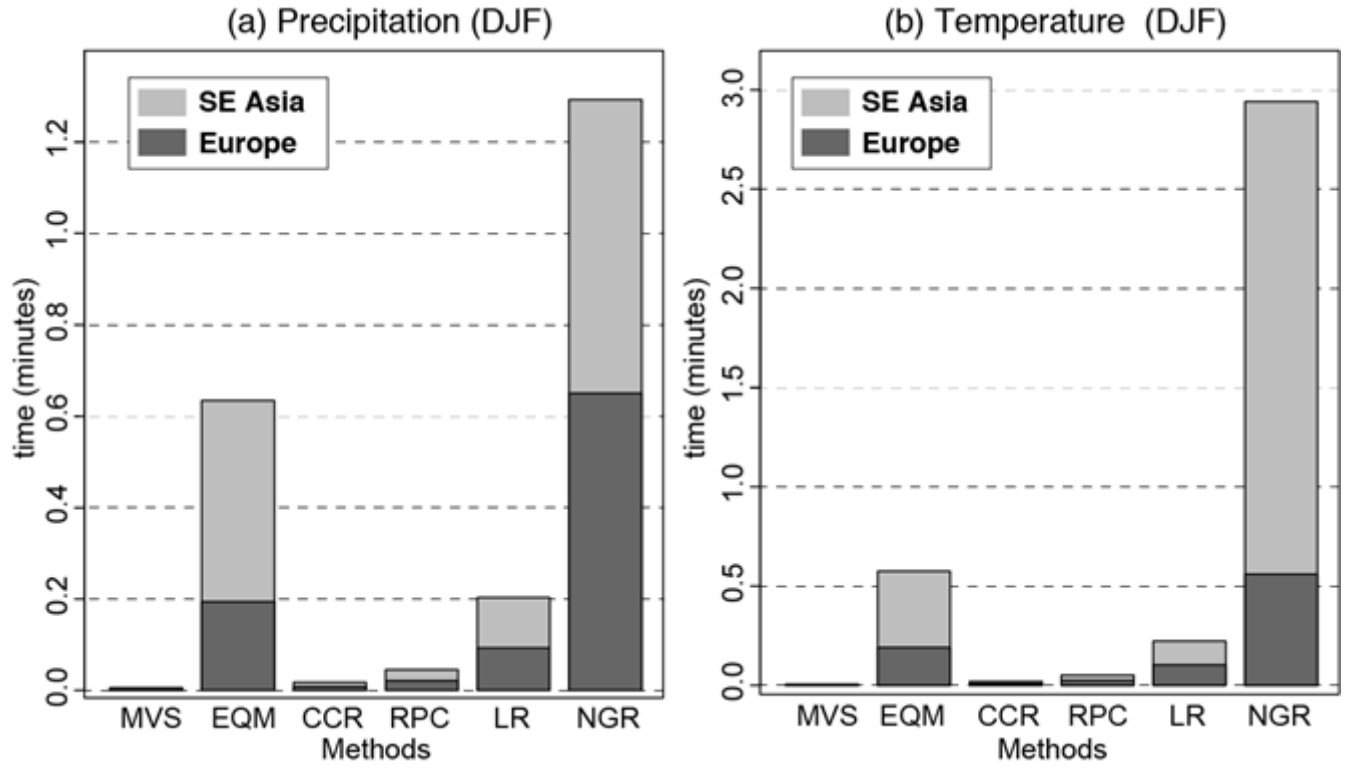


J. Bedia, D. San Martín (Predictia)

C3S_51 Lot 3: Timeliness and provenance

Computing performance and product provenance are key.

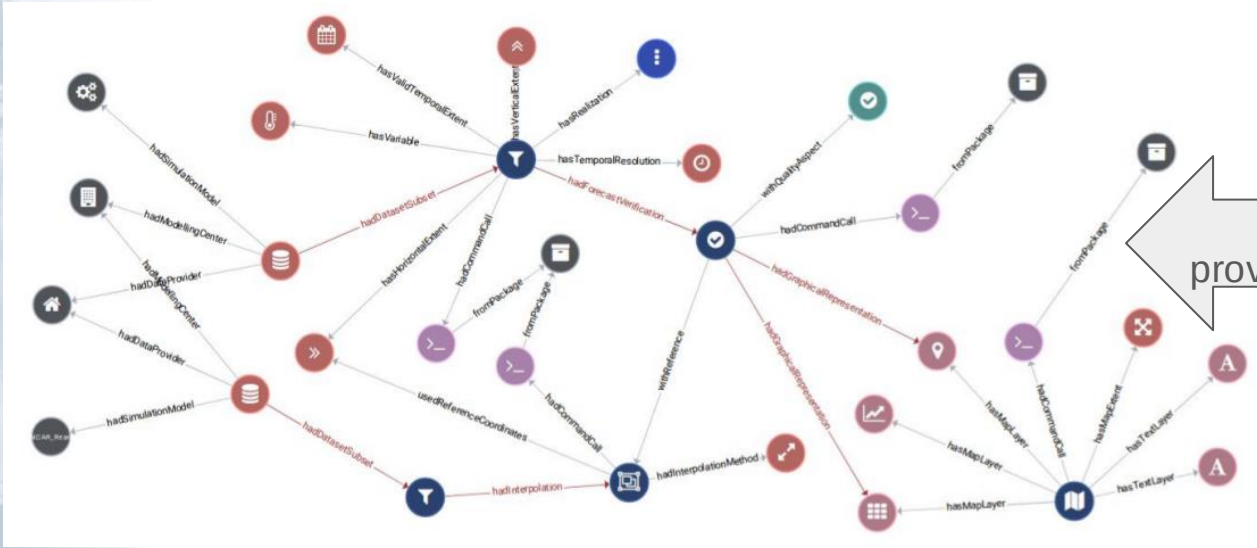
- Users need to generate products from the forecasts.
- Users require bias adjustment.
- Computational cost estimates are fundamental for user satisfaction.



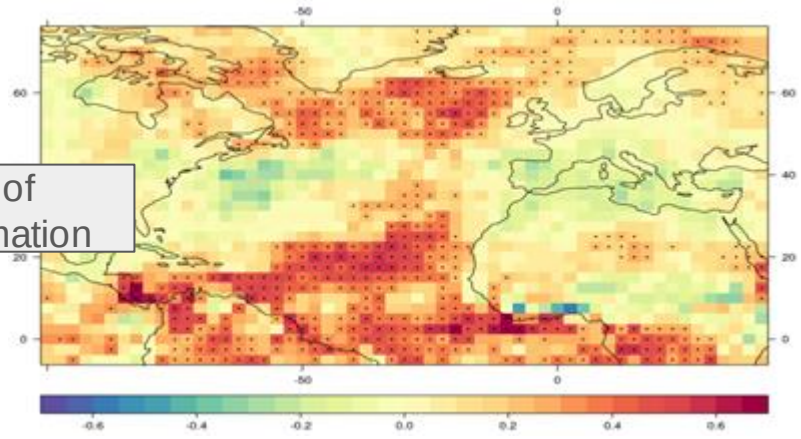
C3S_51 Lot 3: Timeliness and provenance

Prepare products for reproducibility, traceability, reuse and context

- METACLIP ensures the reproducibility of objects (NetCDF file, image) with human and machine-readable solution http://metaclip.org.
- It uses an RDF-based **semantic metadata model** that builds the vocabularies on existing initiatives (e.g. VALUE, PROV) and stores information in JSON files.
- “De facto” the IPCC WGI standard for AR6.



Visualisation of provenance information



J. Bedia, D. San Martín (PREDICTIA)

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Quality assurance template and reports

- The quality information of the climate forecast datasets should be input into a quality assurance template to produce reports that are made available along with the datasets in the CDS.
- Reports include dataset documentation, quality flags and an independent assessment.

PRODUCT DATA			
HINDCAST			
Ensemble Members*		Number	
Start date*		Date	
End date*		Date	
Time resolution*			
Simulation length			
FORECAST			
Ensemble Members*		Number	
Start date*		Date	
End date*		Date	
Time resolution*			
Simulation length			
UNCERTAINTY			
Is there a uncertainty provided? *		YES/NO	
If no ->	Is it attached any other numeri quantification of the uncertainty?*	Y/N	
If no ->	If no -> Justify	Free text field	

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- The contract has
  - documented a metadata standard to feed the common data model and created a provenance solution for products
  - provided comprehensive forecast quality assessment of products
  - illustrated the benefits of bias adjustment and multi-model solutions
  - demonstrated that scalability and computational efficiency of the solutions should be taken into account to ensure timeliness
  - identified relevant user requirements
- Relevant gaps: 1) guidance and context for forecast products, 2) metadata, vocabularies and provenance governance, 3) observational uncertainty, 4) criteria to identify relevant forecast products …

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