The Added Value of Seasonal Climate Forecasting for Integrated Risk Assessment

Stakeholder Workshop

15 June 2020 – 9:00-11:00 UTC and 12:00-14:00 UTC

Prof. Alberto Troccoli, and the SECLI-FIRM team
University of East Anglia, Norwich, UK

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Agenda Session 1
9:00-11:00 UTC

SECLI FIRM

Seasonal climate forecasts - calibration, downscaling and multi-models

9:00-9:20	SECLI-FIRM overview and industry case studies	Alberto Troccoli (UEA/WEMC) and Case Study Leads
9:20-9:50	Seasonal climate forecasts: • Downscaling and bias correction • Skill, probabilistic forecasts and bias correction • Multi-models	Alice Crespi (EURAC) and Marcello Petitta (ENEA) Phil Bett (Met Office) Kristian Nielsen (AWST/UL)
9:50-10:50	Seasonal climate forecast multi-models discussion	Discussion – Chair: Kristian Nielsen (AWST/UL)
10:50-11:00	Summary and take home messages	Alberto Troccoli (UEA/WEMC)

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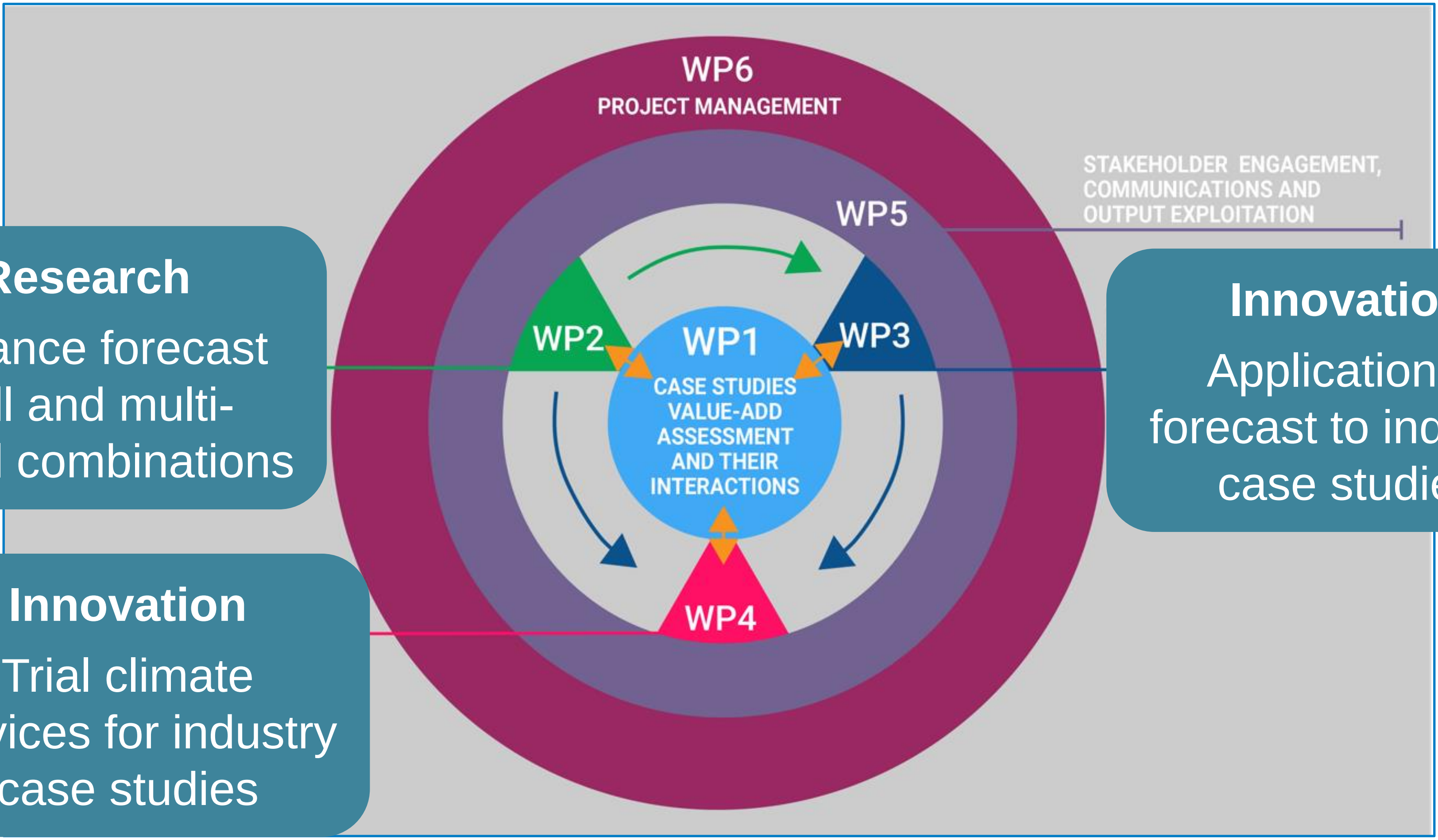
Project Structure

Research

Enhance forecast skill and multi-model combinations

Innovation

Trial climate services for industry case studies



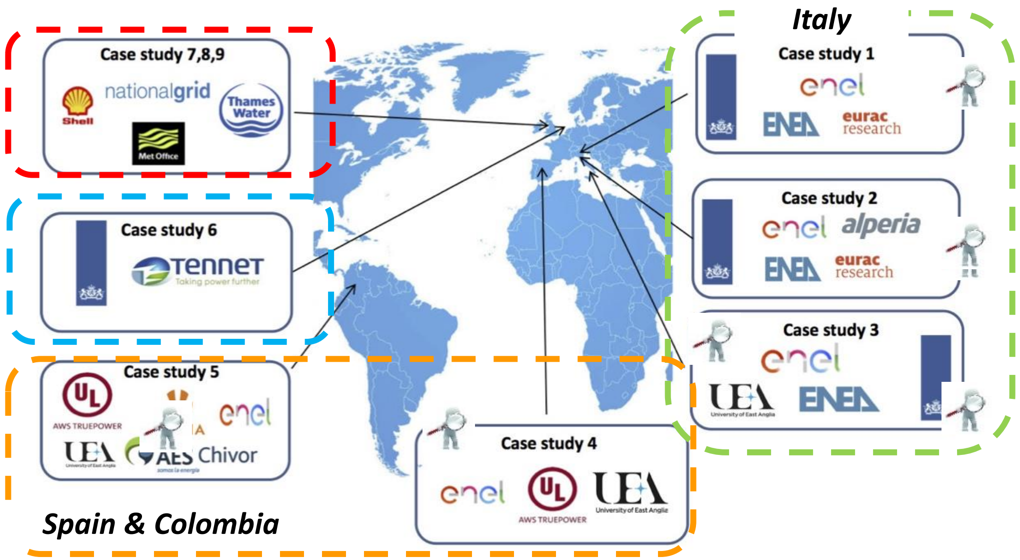
Innovation

Application of forecast to industry case studies

Case Studies

Case Study	Climate events	Geography	Sectoral impact	Co-designers
CS1	Heat Wave 2015, and other similar extremes	Southern Europe	Energy –Thermal electricity plant cooling, demand model uncertainty	**ENEL**, ENEA, EURAC, KNMI
CS2	Dry Winter 2015-16 and other similar extremes	Northern Italy	Energy –Hydroelectric power production	**ENEL**, KNMI, ENEA, EURAC, Alperia
CS3	Strong Winds March 2016 and other similar extreme	Southern Italy	Energy – Wind power production	**ENEL**, ENEA, KNMI, UEA
CS4	Extreme Winds 2014-15 and other similar extremes	Spain	Energy – Wind power production and balancing	**AWS**, MO, ENEL
CS5	Strong El Niños	South America	Energy – Hydroelectric power production and other RE	**AWS**, UEA, AES Chivor, Celsia, ENEL
CS6	Low Winds	North Sea	Energy – Offshore operations and maintenance planning	**TenneT**, KNMI

Italy: CS1–CS3. *Spain & Colombia*: CS4–CS5.



Case Study	Climate events	Geography	Sectoral impact	Co-designers
CS7	Severe climate events in 'shoulder' months	North Sea	Energy – Offshore operations and maintenance planning	**Shell**, MO
CS8	Anomalous winter conditions	UK	Energy – Winter electricity demand	**National Grid**, MO
CS9	Dry Spring and Summers	UK	Water – Water use restrictions	**Thames Water**, MO

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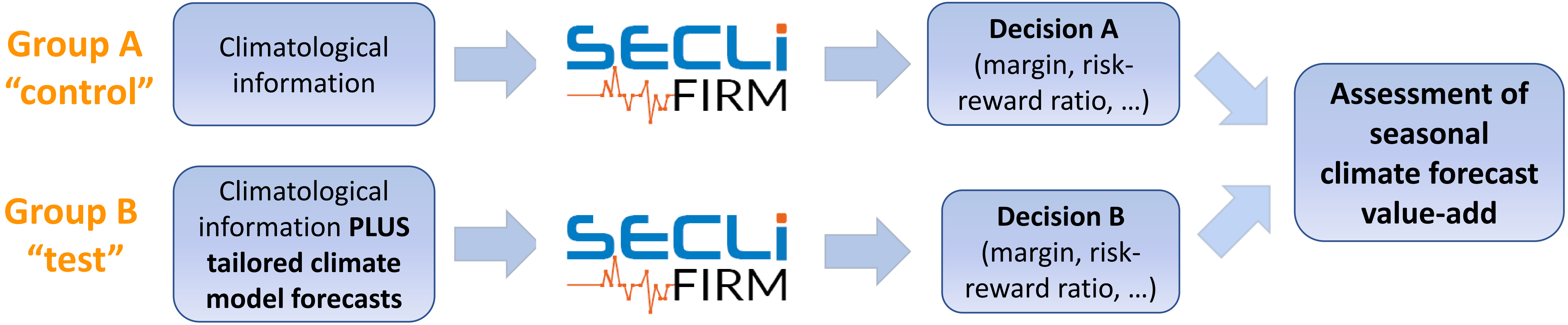
Value Assessment



A control case only utilises climatological conditions based on historical averages, while a test case also considers individually optimised and tailored state-of-the-art probabilistic seasonal forecasts

Modelling Options for Value-Add Assessment

MENU

MENU OF ECONOMIC ASSESSMENT METHODS

- **DECISION THEORY MODELS**
- **AVOIDED COSTS**
- **ECONOMETRIC MODELS**
- *CONTINGENT VALUATION APPROACHES*
- PARTIAL AND GENERAL EQUILIBRIUM MODELS
- ALTERNATIVE METHODS

*How are weather-related **decisions** currently made in our project **Case Studies**?*

*Which **Economic Assessment methods** are used, or could be used, to assess and support those **decisions**?*

*How can we use those methods to **quantify the potential benefits** of using **seasonal forecasts?***

*What can we **learn** from each other across **Case Studies**, **Areas** and **Sectors**?*

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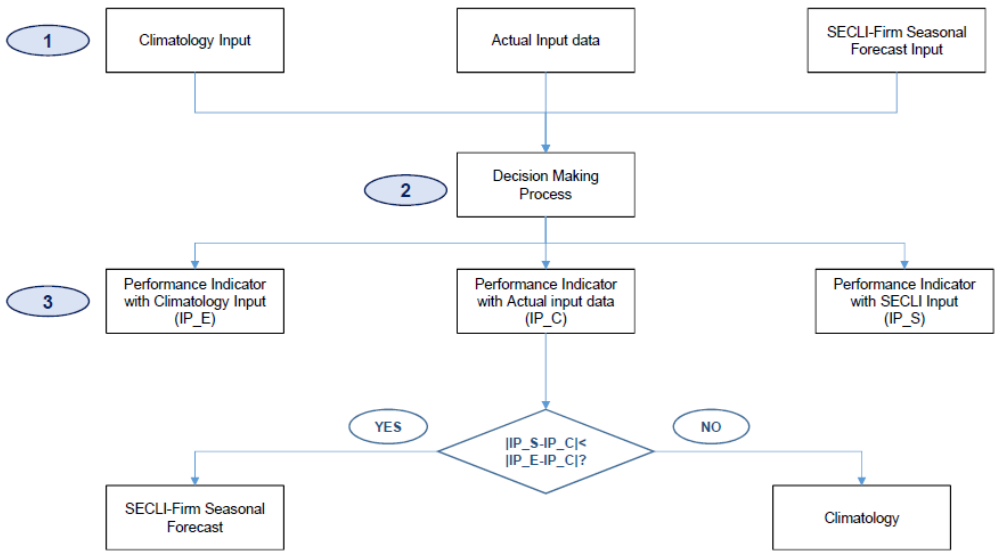
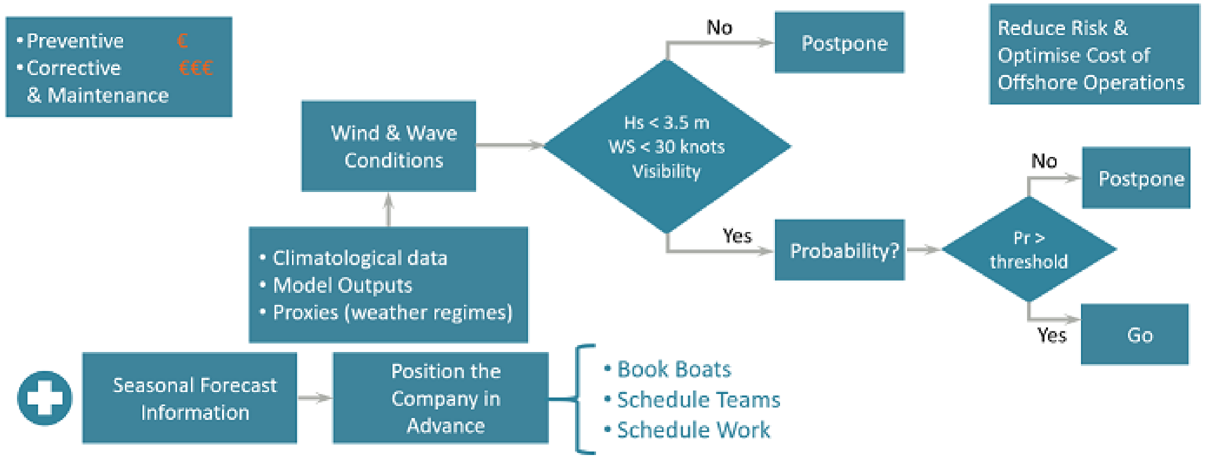
Decision Trees





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Seasonal climate forecast multi-model dataset

Multi-model

Center	C3S-CMCC	C3S - ECMWF	C3S - DWD	C3S - MF
Dates	1993-2016	1993-2016	1993-2016	1993-201
Variable				
Total precipitation	X	X	X	X
2m Temperature	X	X	X	X
Maximum Temperature at 2 Meters	X	X	X	X
Minimum Temperature at 2 Meters	X	X	X	X
10m u-component of wind	X	X	X	X
10m v-component of wind	X	X	X	X
10m wind speed	X	X	X	X
Mean sea level pressure	X	X	X	X
Solar irradiance downward	X	X	X	X
Snowdepth		X	X	X
Sea Surface Temperature	X	X	X	X
Latent Heat Flux		X		
Latent Heat Flux Land				
Sensible Heat Flux		X		
Sensible Heat Flux Land				
Temperature at 500 hPa			X	
Geopotential at 200 hPa				
Geopotential at 500 hPa	X	X	X	X
500hPa u-component of wind		X	X	X
500hPa v-component of wind		X	X	X
500hPa w-component of wind				

ERA5 | SEAS-Gl-Mon | SEAS-Gl-HF

- Gathered and homogenized unprecedented data set from 15 different model/model versions in one place and format

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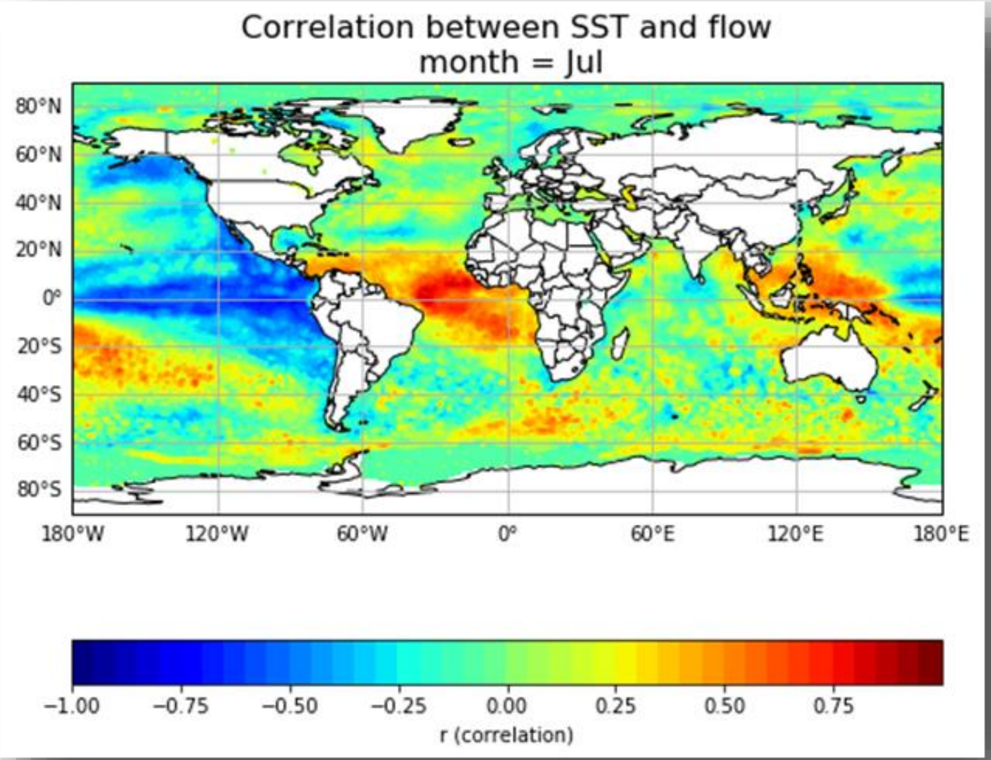
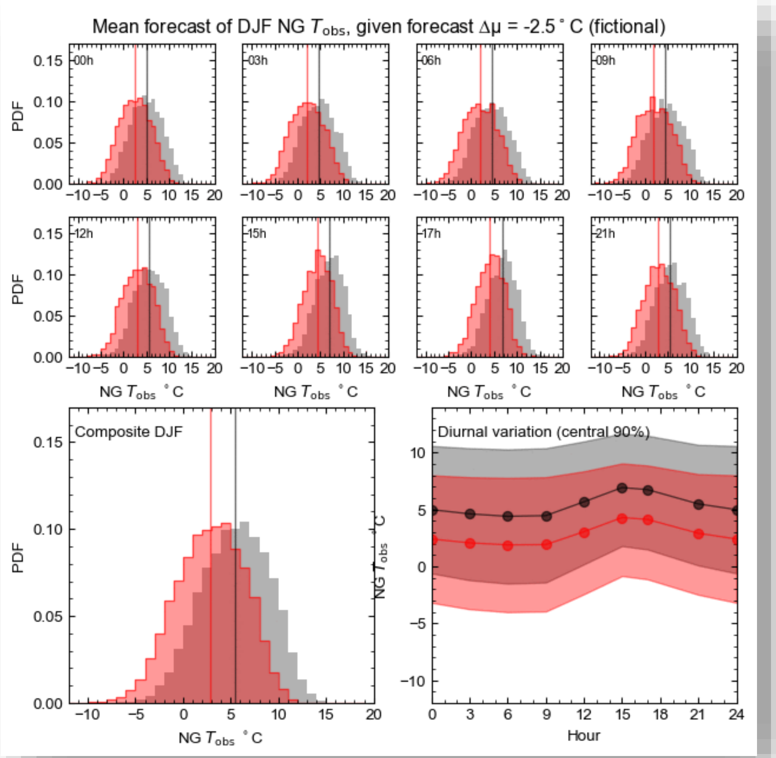
Exploiting tele-connections to improve forecast skill



- Using teleconnection indexes as the predictand instead of the variable itself provides a better forecast

Exploiting weather regimes to improve forecast skill

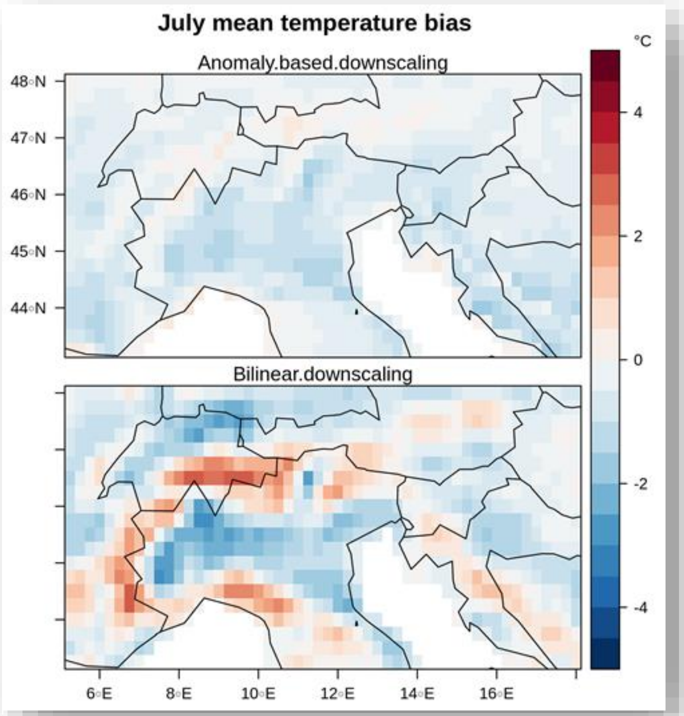
Weather regimes



- Improve the forecasts by shifting the distribution according to forecast seasonal mean

Exploiting statistical methods to improve forecast skill

Statistical downscaling



- Anomaly-based downscaling of seasonal forecasts of temperature and precipitation in complex terrain has a lower forecast error than bilinear interpolation.

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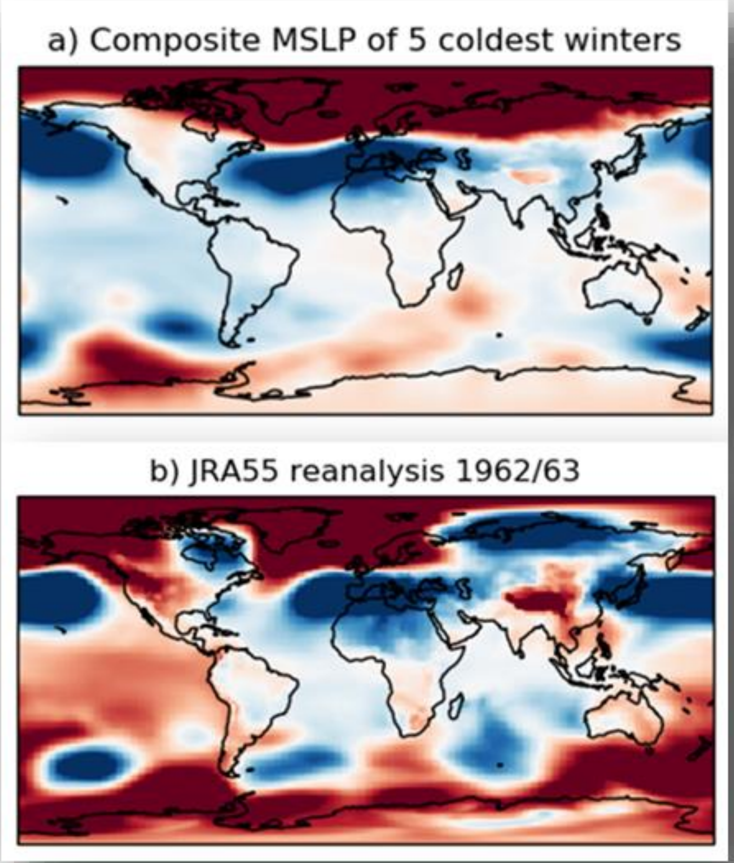
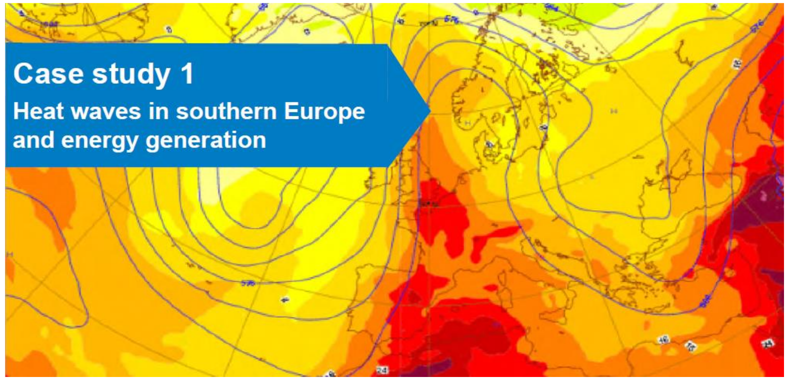
Assessment of extremes for management decisions

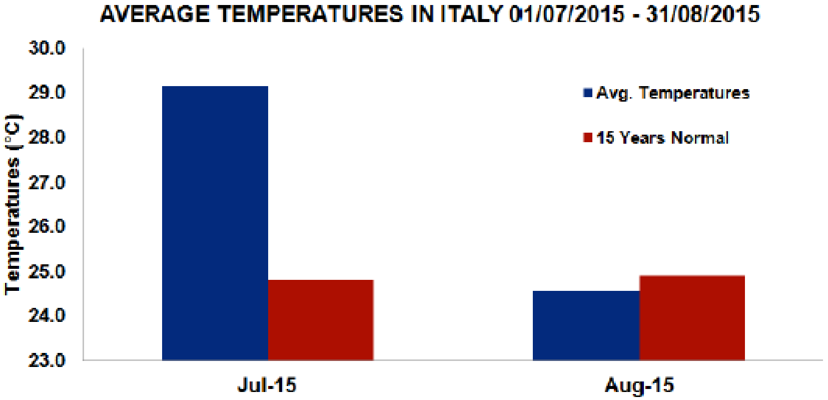


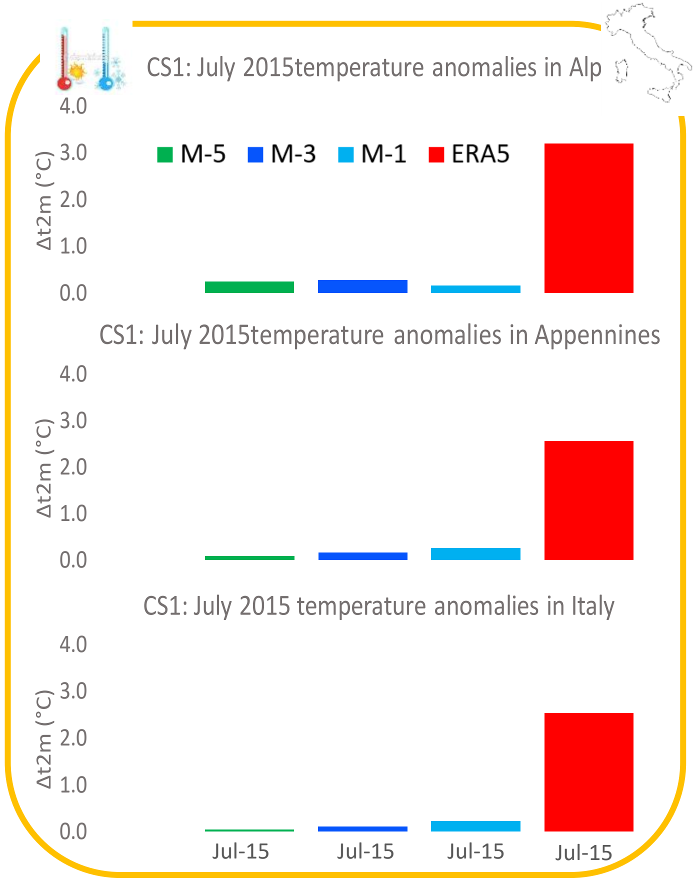
- The use of all the ensemble members provides a way to estimate the probability of unprecendented cold/warm winters

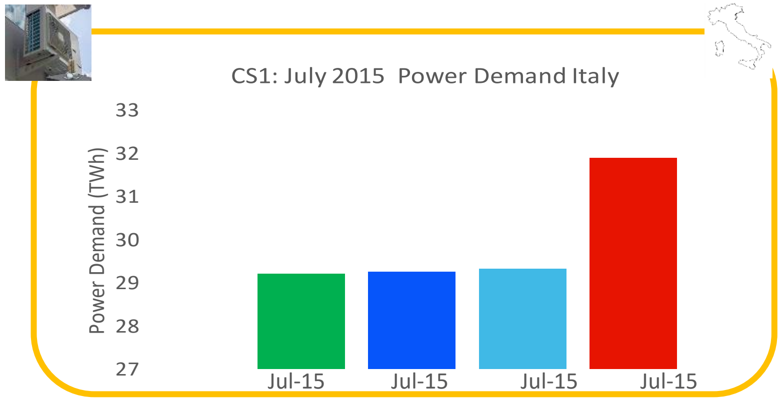
Case Study 1

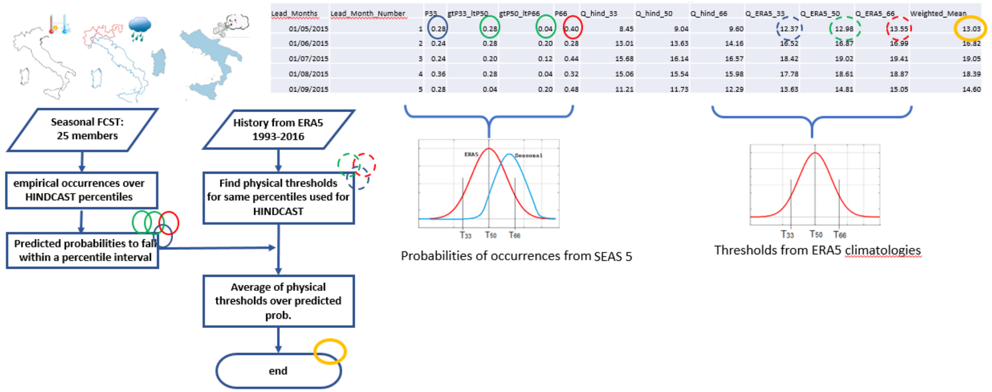
Case study 1 ENEL: Heat Wave in Italy: results from SEAS5





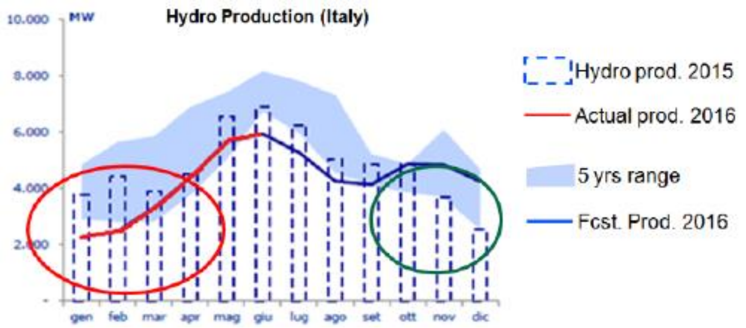


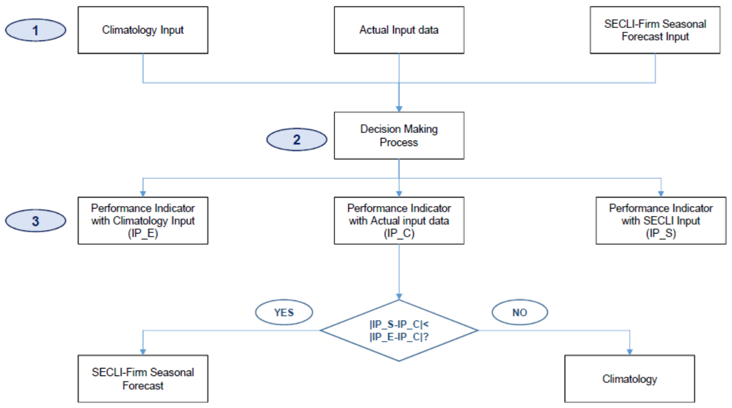


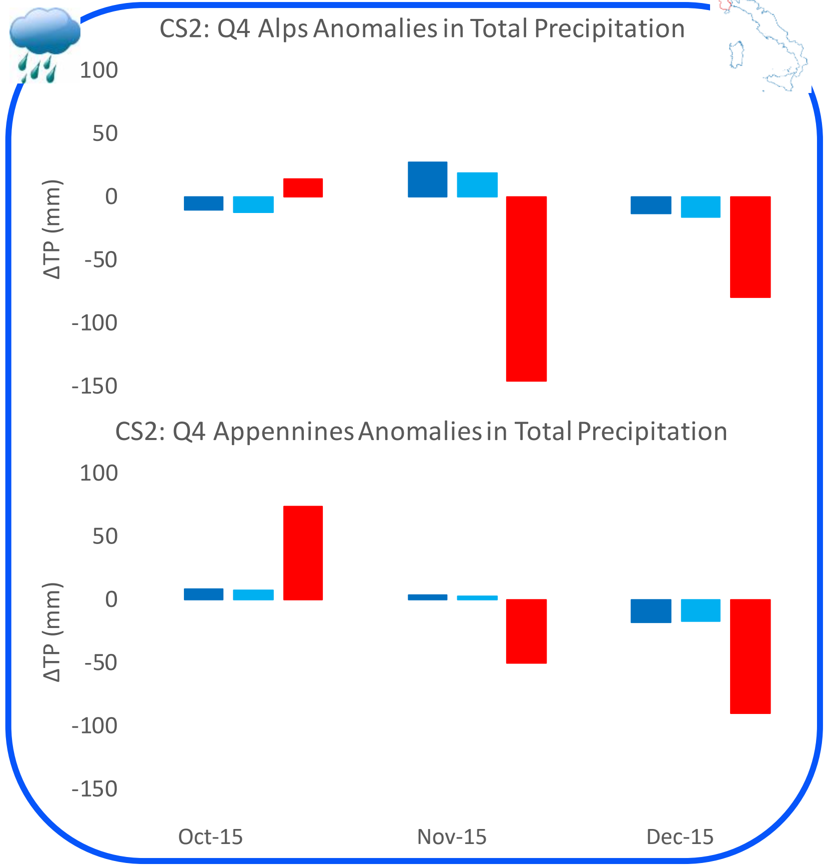


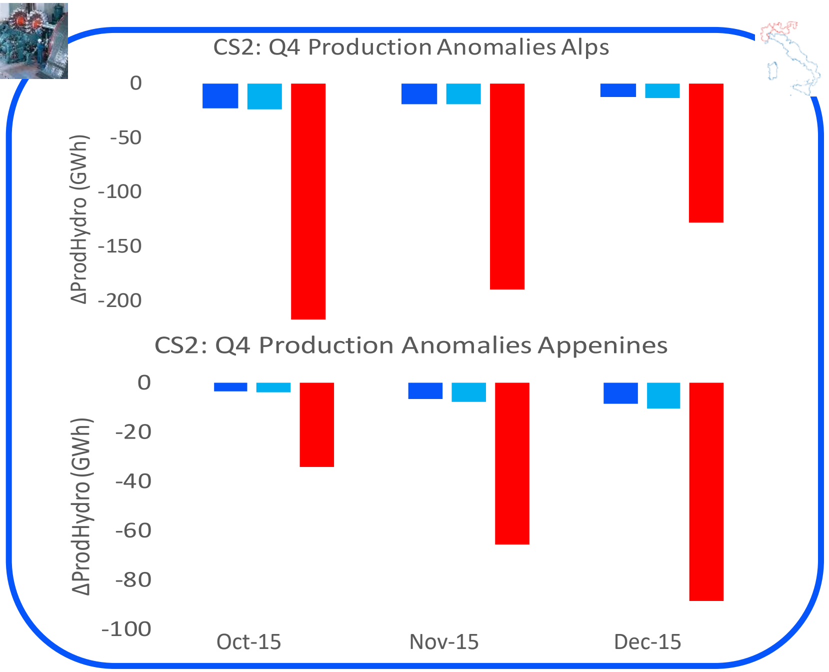
Case Study 2A

Case study 2 ENEL: Drought in Italy: results for Q4 2015 October-November-December from SEAS5









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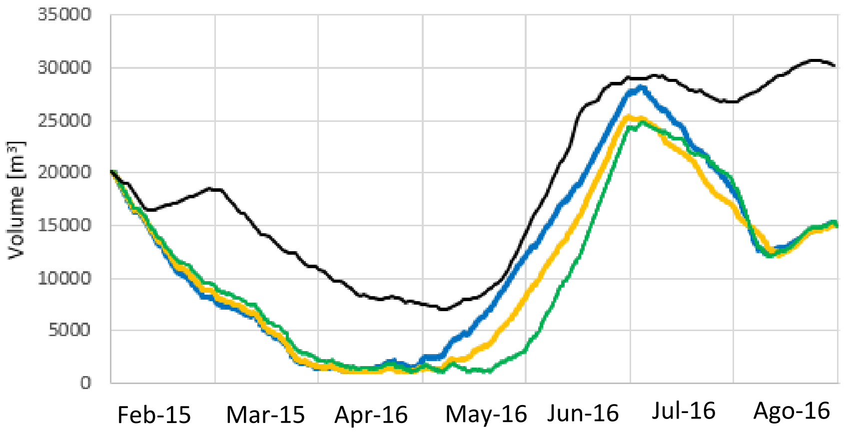
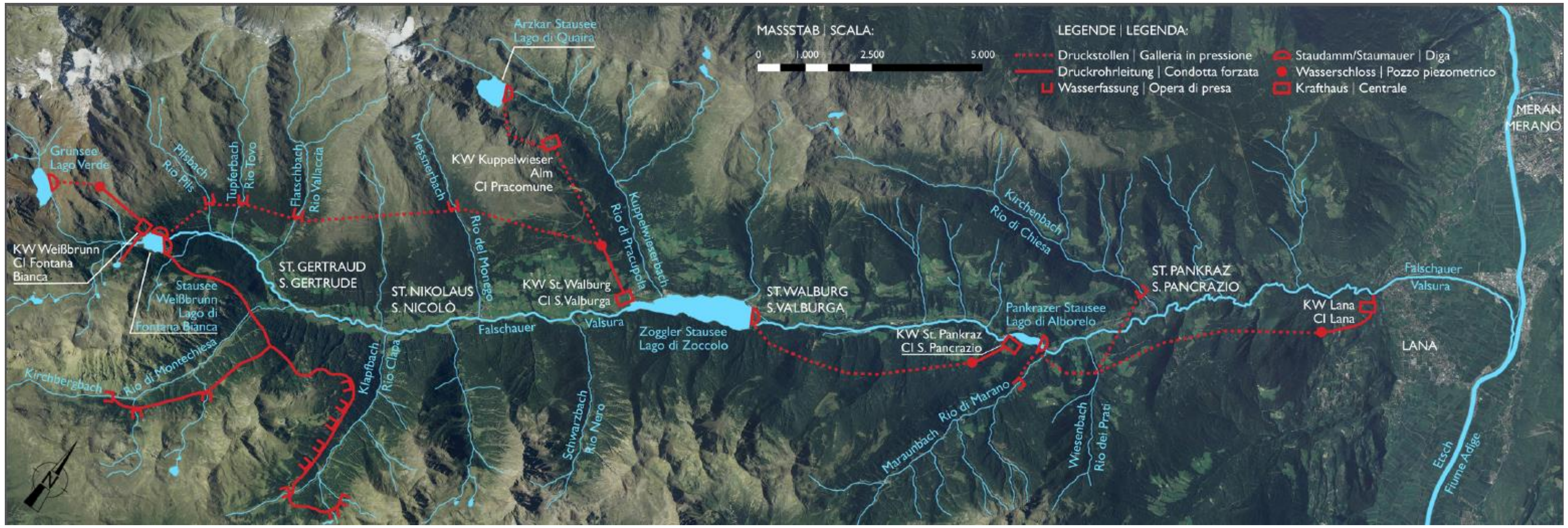
Case Study 2B

Case Study 2 Alperia: Mild/dry winter in Ulten Valley (2015-2016)





using historical mean runoff as model input

using estimated runoff as model input

using runoff forecast as model input

Measured water volume

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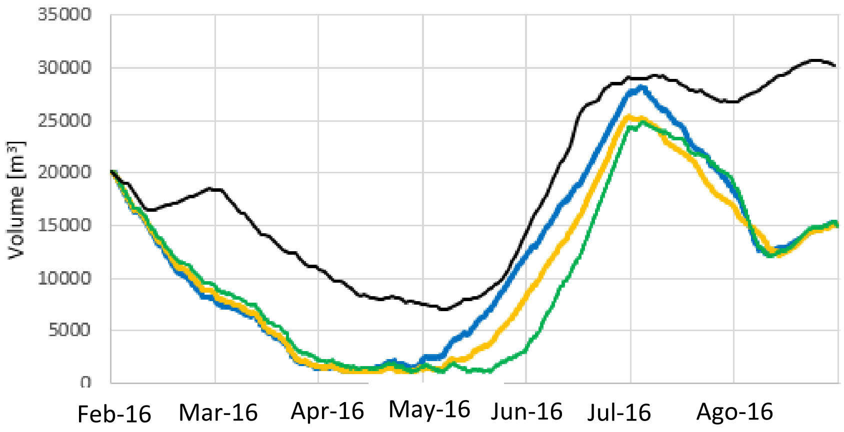
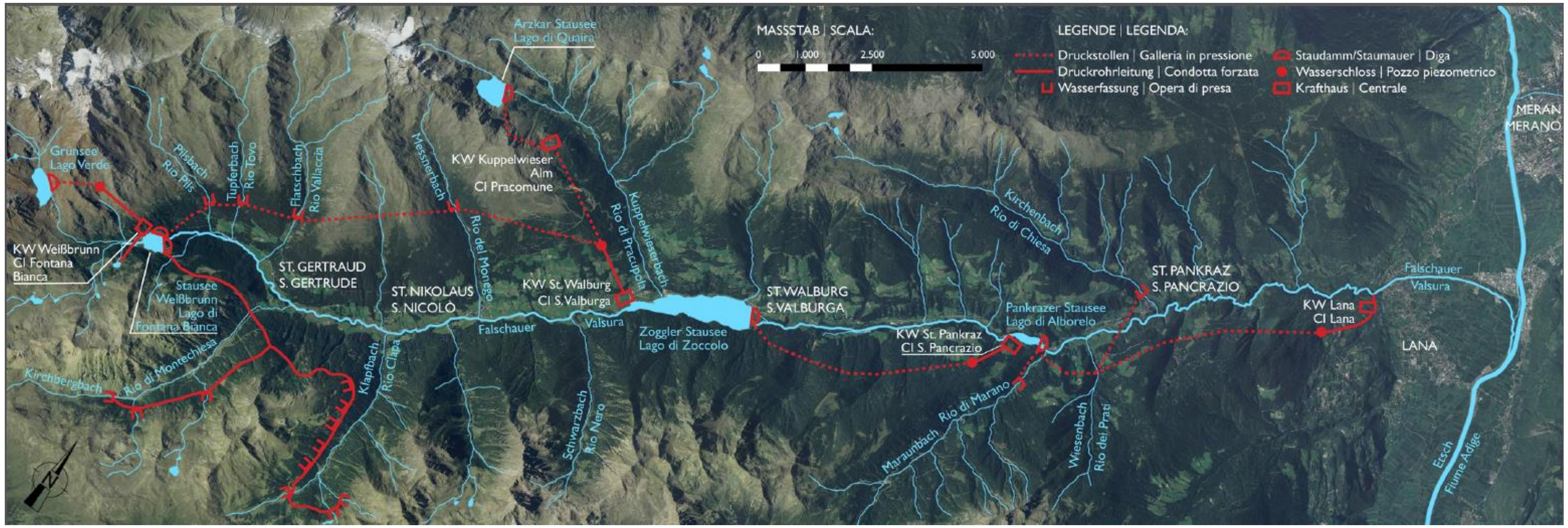
Case Study 2B

Case Study 2 Alperia: Mild/dry winter in Ulten Valley (2015-2016)

- using historical mean runoff as model input
- using estimated runoff as model input
- using runoff forecast as model input
- Measured water volume





The case study 2 is applied by Alperia to a system of 6 hydropower plants in series in a valley (the Ulten Valley) that is 40 km long. Alperia is comparing the results obtained by means its management model by using as input the climatology data and the new EURAC forecast model.

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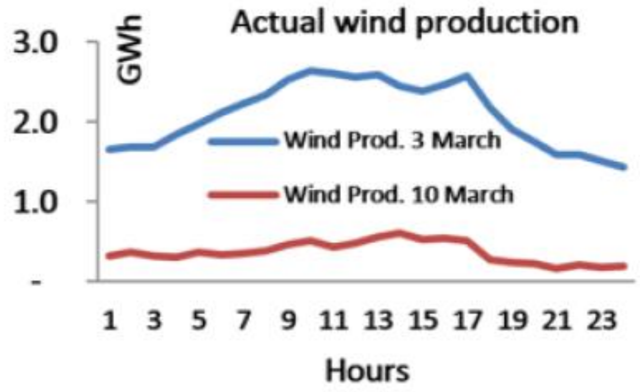
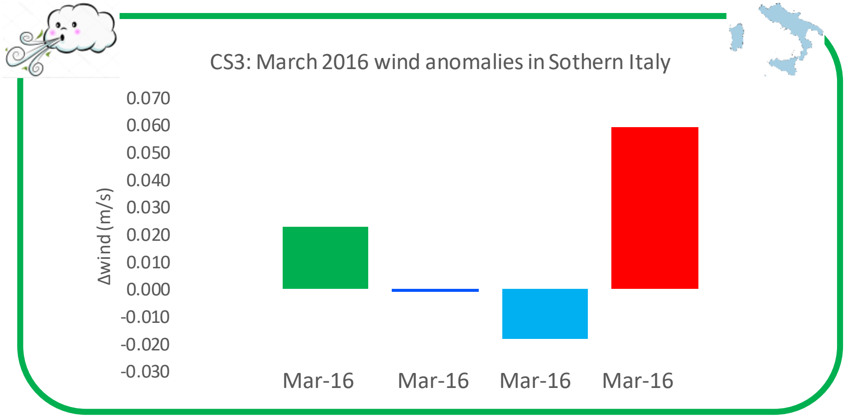
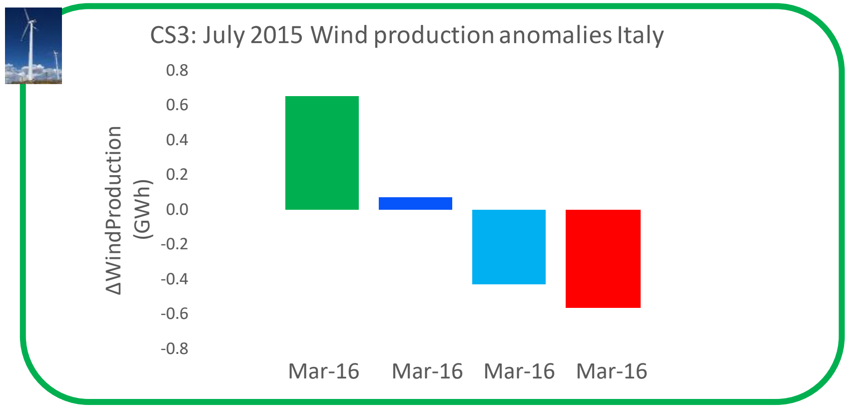
Case study 3 ENEL: Wind variability in Southern Italy: results







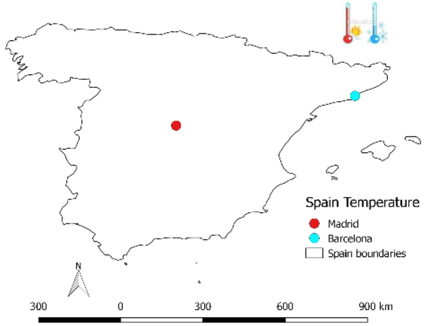
Case Study 4

Case study 4 ENEL: High/low winds in Spain and energy generation: approach

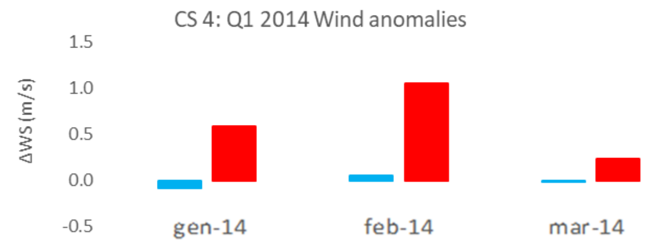
A. January 2014 – march 2014: High production from wind.

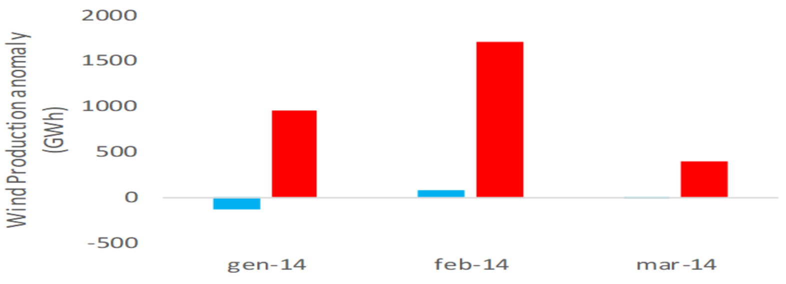
B. December 2014 – January 2015: Low wind production

We are working on the downscaling of the SEAS5 data to the ERA5 grid.

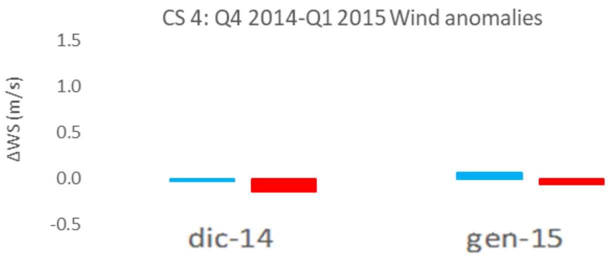


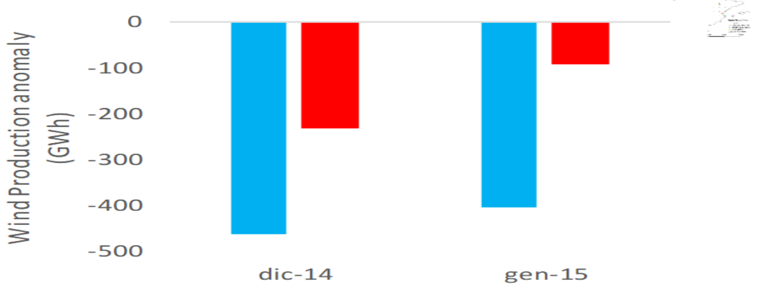
Case A: January 2014 – march 2014: High production from wind.

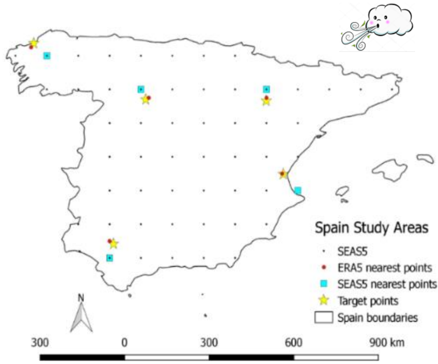




Case B: December 2014 – January 2015: Low production from wind.







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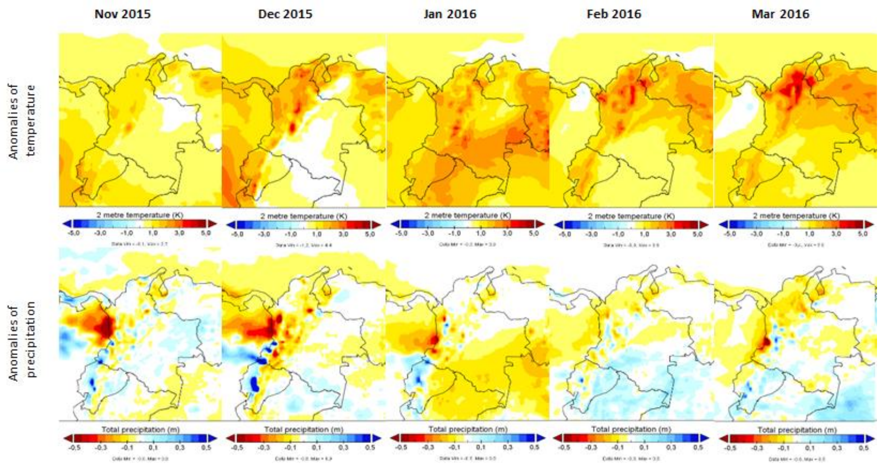
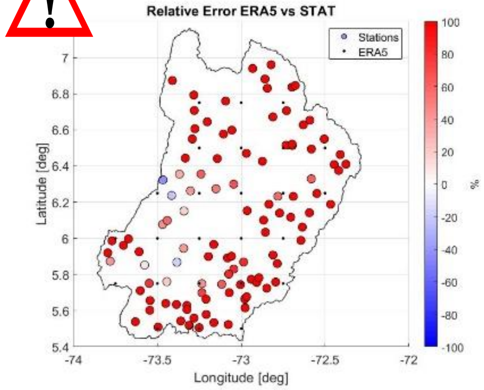
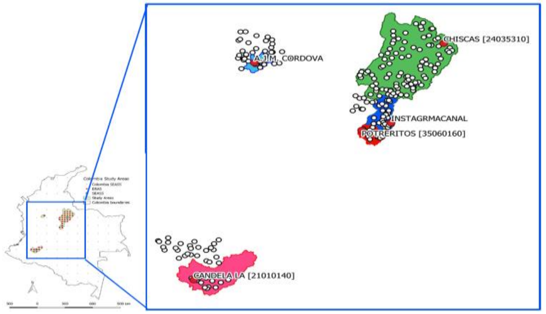
Case Study 5A

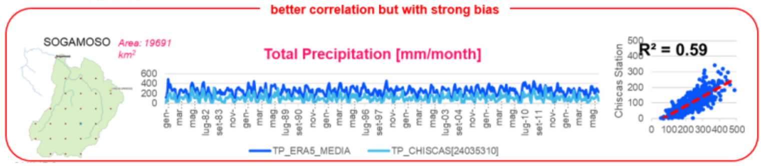
Case study 5 ENEL: Strong El Niños and energy mix planning: approach

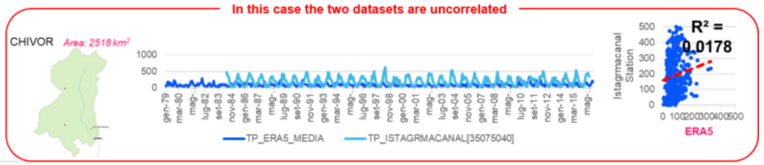
We used the best weather station inside each basin from IDEAM* dataset.

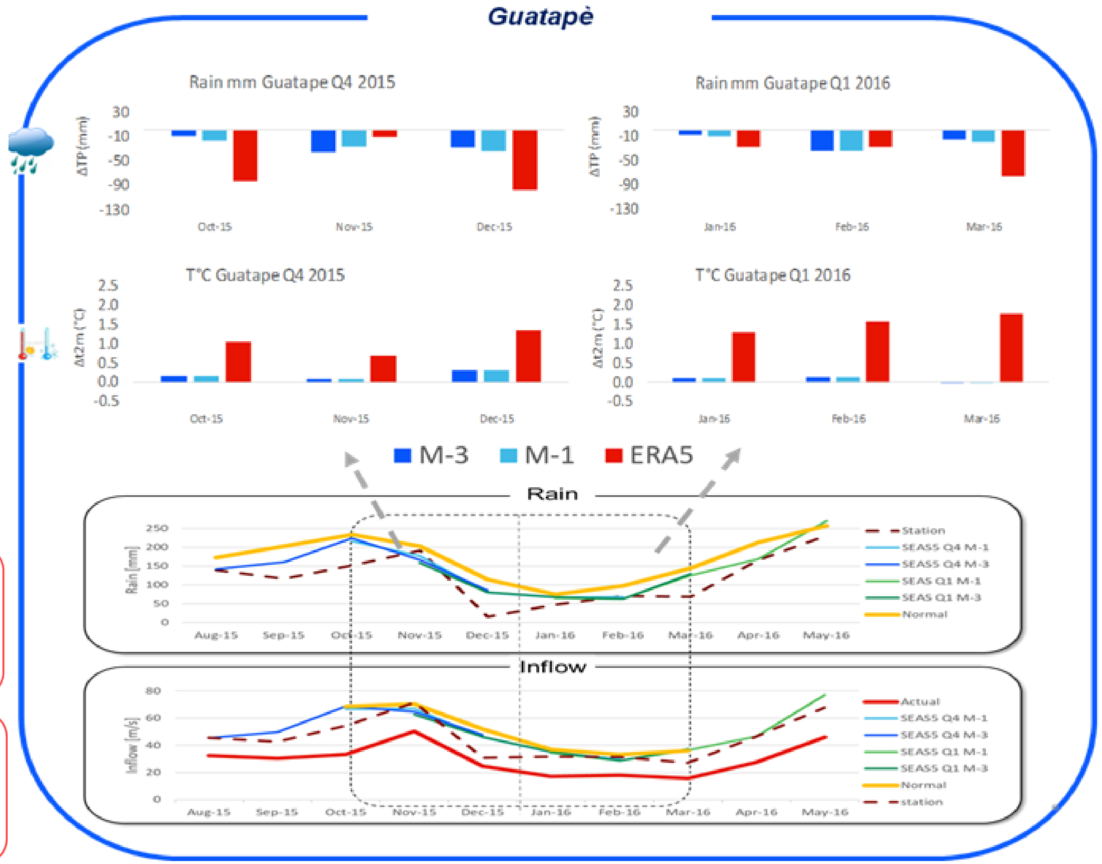












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Case Study 5B

Case study 5 UL AWS: Strong El Niños and energy mix planning: approach

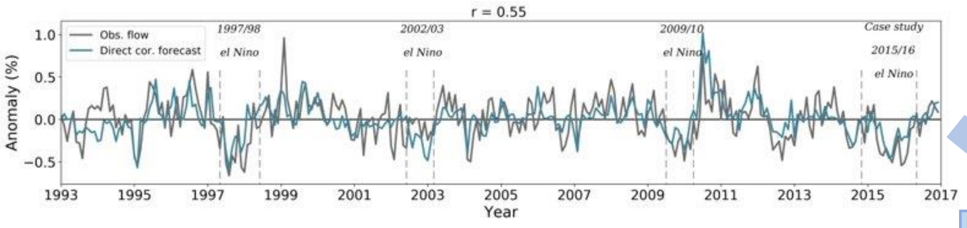
UKMOsys14...
ECMWFsys5
Seasonal forecast and reanalysis data

"Direct" forecast of river flow from relation with precipitation over catchment area

Quantile mapping used for downscaling data

Finding best MME combination with relation to precipitation

Corelating precipitation with river flow to predict the later

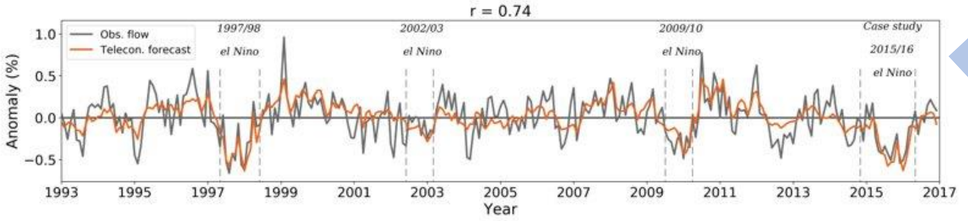


Teleconnection forecast of river flow from utilization of teleconnection patters for SST

Estimation of teleconnection between SST (ERA5) and flow

Estimating of best combination for global SST predictions.

Exploiting this "MME" to forecast river flow



Selection of method and comparison with Celsia's internal model and first estimation of added value

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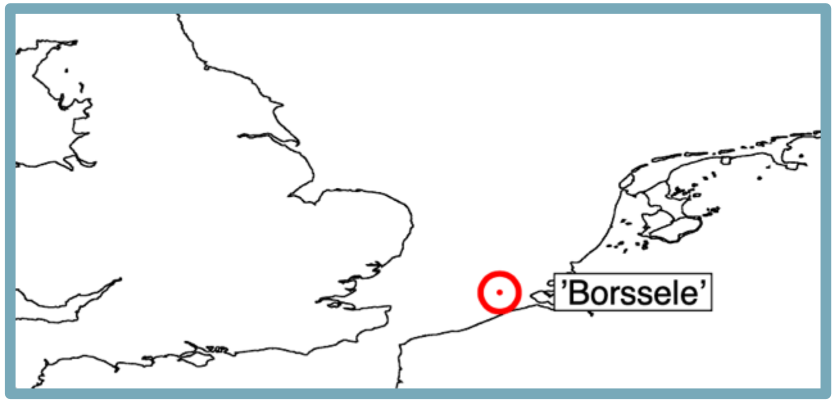
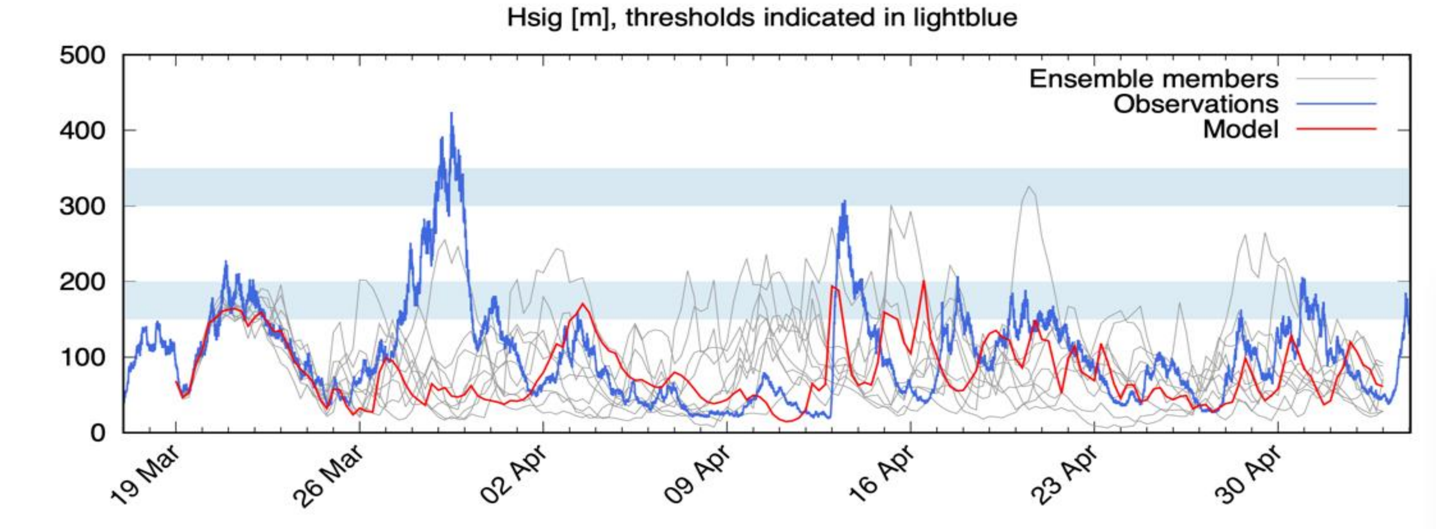
Case Study 6

Case study 6: North Sea waves and winds





Borssele March-April 2020:
Blue the observations,
Red the reference model forecast,
Grey 10 ensemble members.

Overlap is quite good, except for 26 March – 02 April, though one of these members shows a good overlap also in this period.

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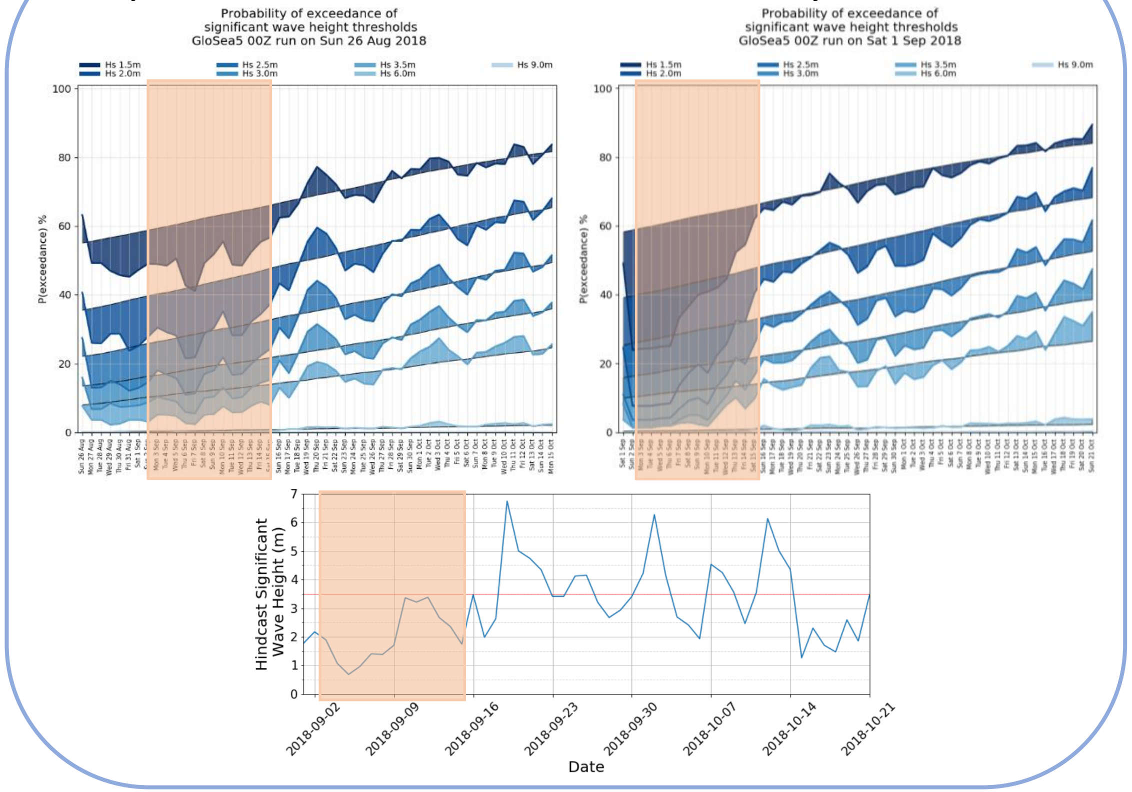
Case Study 7

Case study 7: North Sea weather windows in seasonal shoulder months

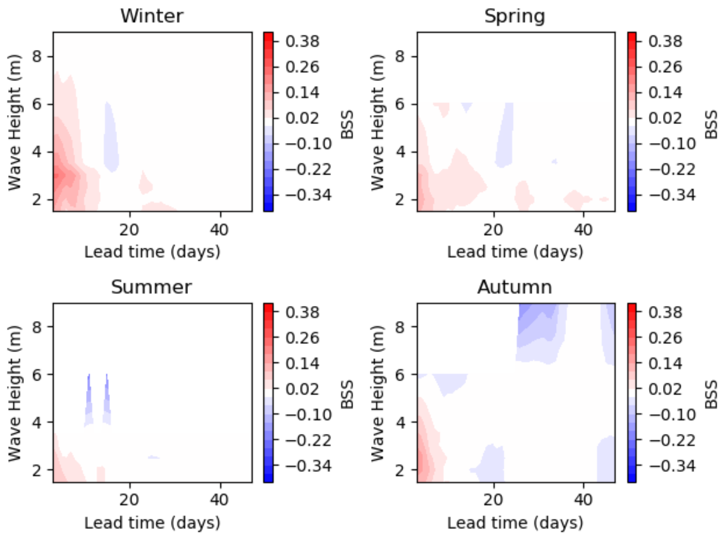
- Ensemble forecast (MSLP)
- Weather pattern forecast
- Downscaling using 101-day wave climatology centred on each day
- Probability of (non-) exceedance of operational limits
- Local climatology modified by predicted weather

September 2018 downtime case study



Long-term verification

- **e.g. Brier Score, Brier Skill Score**



+ comparisons of weather pattern verification with direct simulation verification (to link to CS6)

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Case Study 8

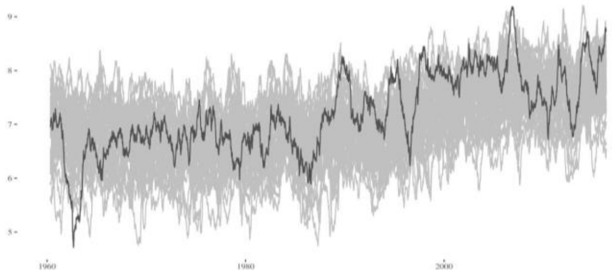
Case study 8: - Anomalous winter conditions on energy demand in the UK as assessed by National Grid (NG).

Feedback from industry partners includes:

- Importance of being able to easily integrate any new data into NG's current processes.
- Focus on integrating seasonal forecast data into NG's standard methodology for forecasting the risk of peak demand in the winter.

Tailoring of data

1. Tailoring and evaluation of new dataset for the improvement of current risk management calculation (ACS)



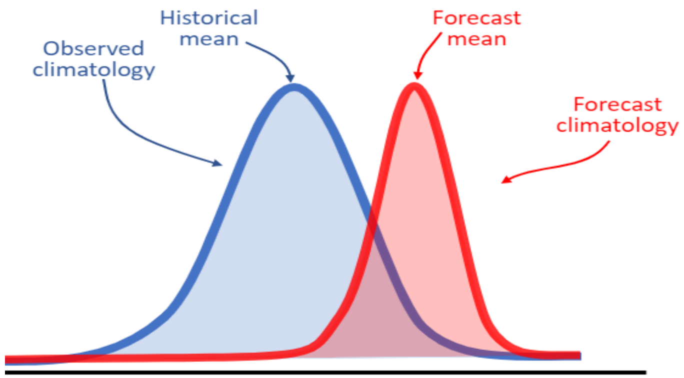
2. Tailoring of seasonal forecast input to generate weekly peak demand forecast

To allow NG to use a seasonal forecast,

With only minimal changes to their current methodology,

We propose shifting the current observed climatology

According to the forecast seasonal mean



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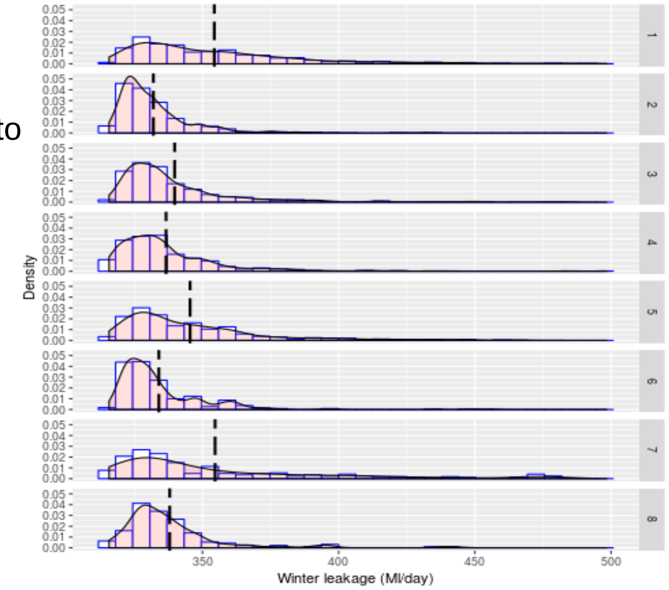
Case Study 9

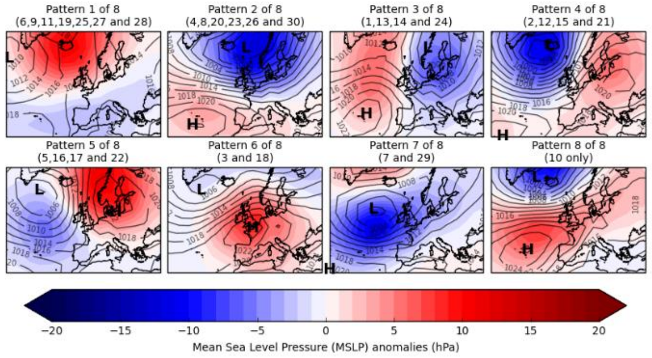
Case study 9: Managing the water supply and demand balance including Summer fluctuations in demand e.g. June/July 2017

Feedback from industry partners :

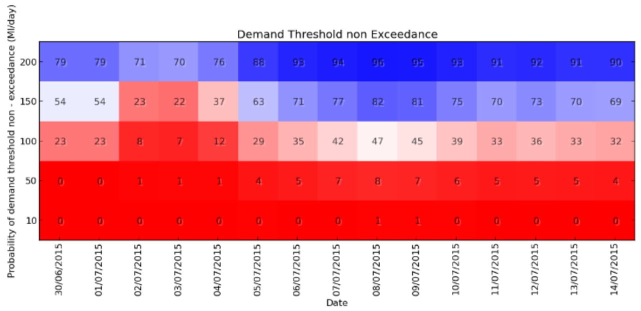
- seamless approach to integrating seasonal forecast information into the water industries decision processes - Focus on extending current 10 day ahead demand forecast.
- Need to understand feature of the weather causing changes in demand

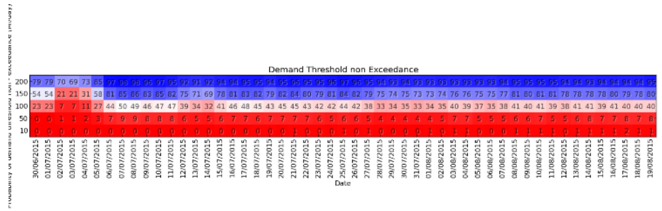
Tailoring data –Understanding the relationship between broad scale circulation patterns and demand





Extended probabilistic demand forecast using forecasts of Weather patterns





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Planning the Trial Climate Services

- Agreement on the use of '**trial climate service**'
- The climate service delivery methods for the case studies decided in consultation with industry users
- Detailing the co-design of the trial climate services
  - Documenting the engagement and interactions with industry partners
  - Sharing ideas with other project partners
  - How the industry decision making processes are being incorporated into the co-design
- Considering the approach to evaluation of trial climate services
- Understanding the wider opportunities presented by the case studies

	Delivery methods					
	Demonstrator	Visualisation	Briefing document	Teleconference / webinar	Post-processed data (relevant indicators)	Training (with WP5)
CS1	✓	✓			✓	✓
CS2	✓	✓			✓	✓
CS3	✓	✓			✓	✓
CS4	✓	✓			✓	✓
CS5	✓	✓			✓	✓
CS6		✓			✓	✓
CS7		✓			✓	✓
CS8			✓	✓	✓	✓
CS9		✓		✓	✓	✓

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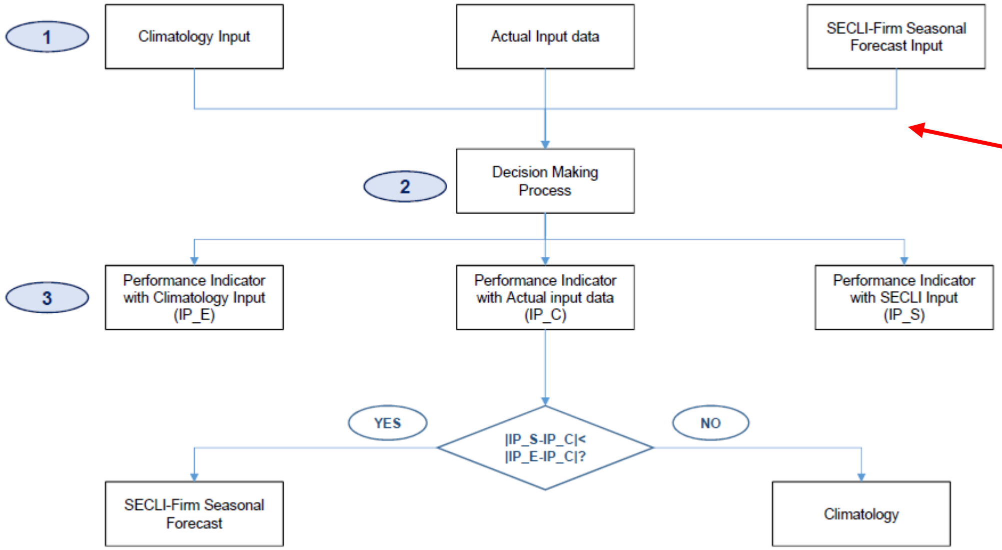
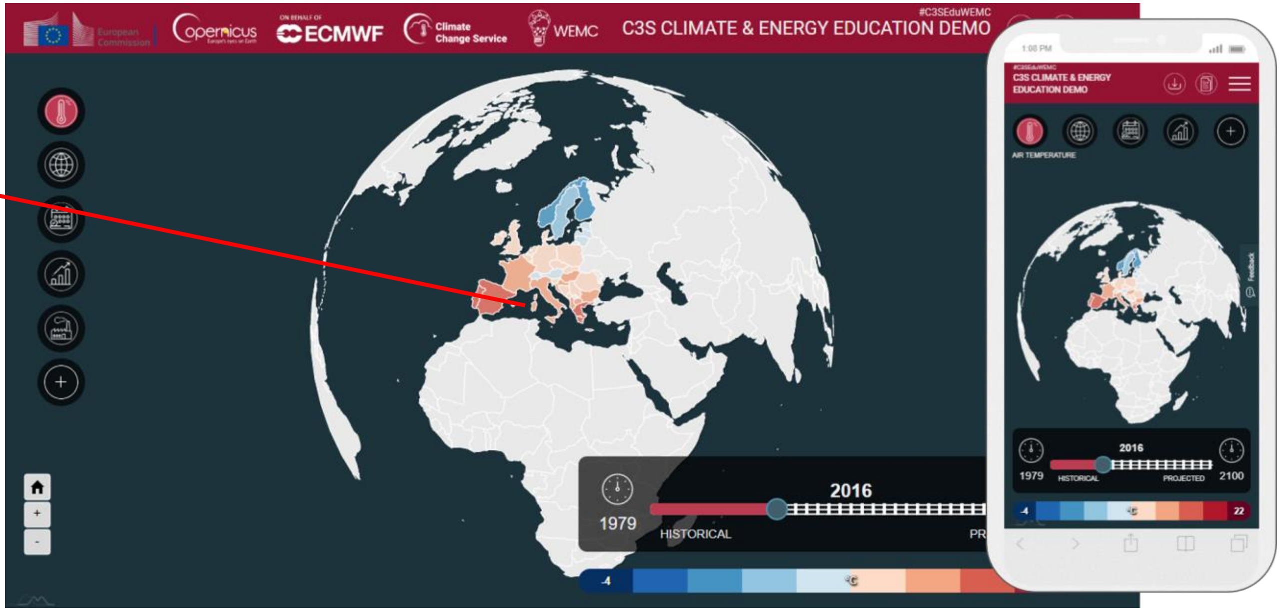
Trial Climate Service example
Case studies 1-5

SECLI-FIRM will deliver trail climate services to demonstrate how the use of improved seasonal climate forecasts can be used in management decisions





https://c3s-edu.wemcouncil.org/

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WEMC World Energy & Meteorology Council
eurac research
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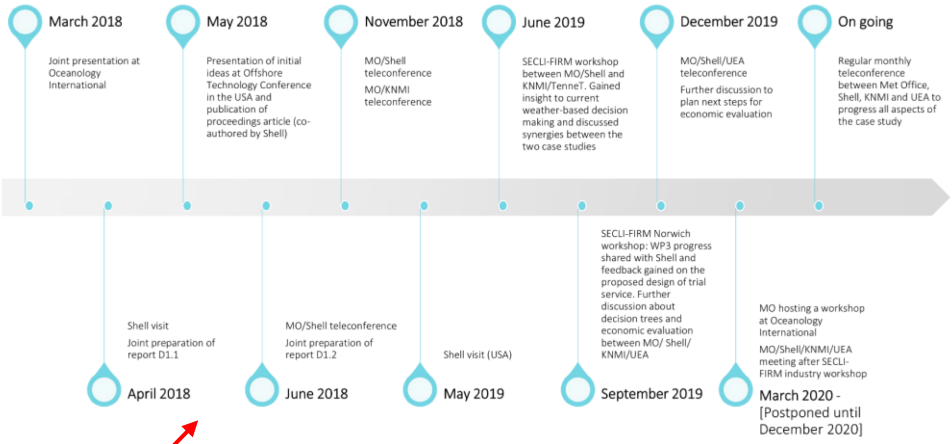
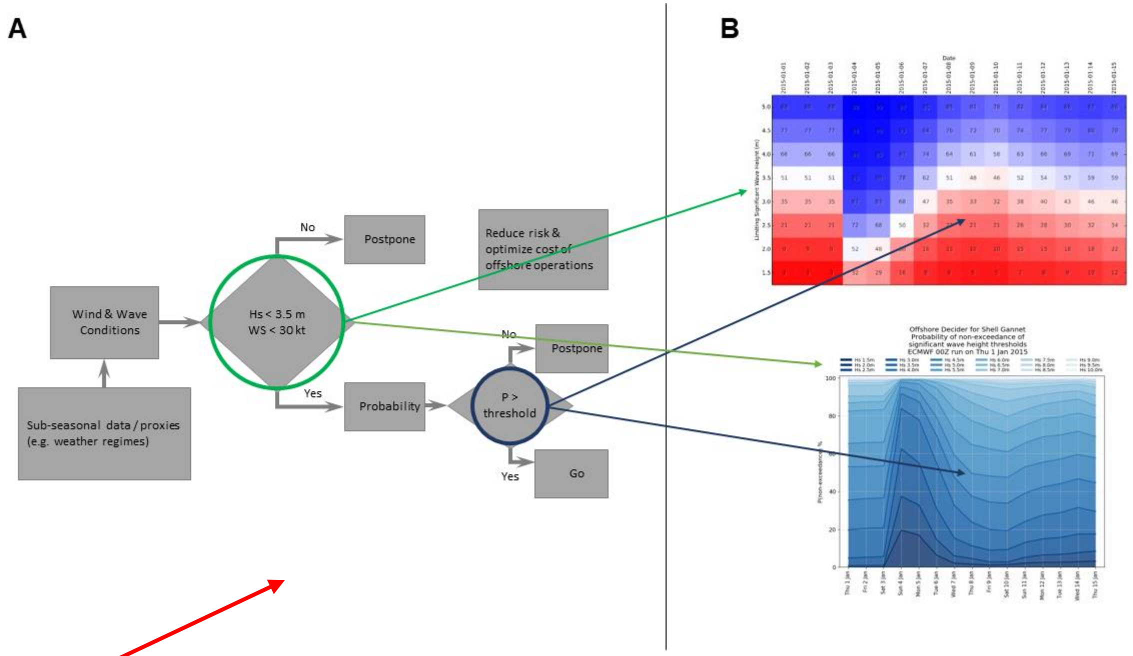
Trial Climate Service example Case study 7



- Case study 7 has benefitted from extensive knowledge sharing (via frequent e-mail, face-to-face meetings and user workshops)
- The iterative nature of the developments has been documented, which charts the evolution of the proposed visualisation, from a simple table of the probability of non-exceedance to a plot of the deviation of probability of exceedance for key industry thresholds
- The latest visualisation supports the decisions defined in a typical offshore industry decision tree



Case Study Flyers

http://www.secli-firm.eu/case-studies/

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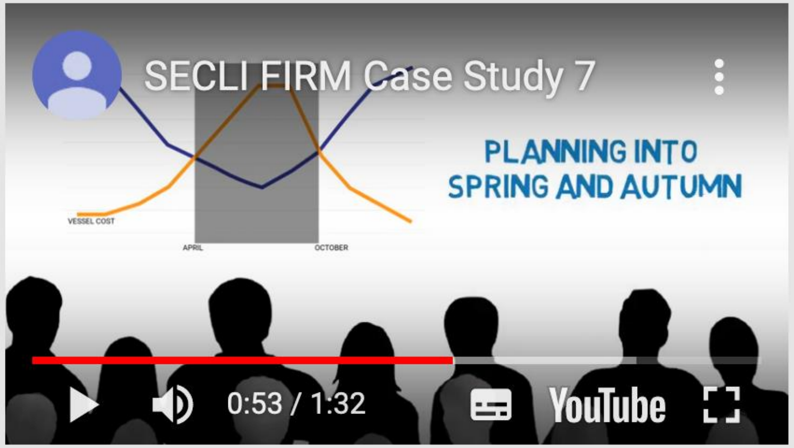
Videos

Find out what SECLI-FIRM is all about

Discover SECLI-FIRM Case Study 7



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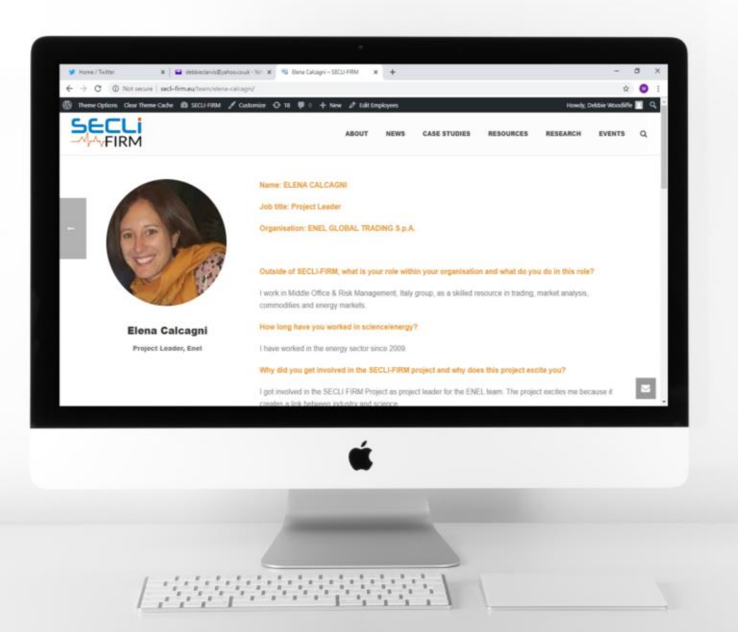
In conversation

- Stakeholder workshops: www.secli-firm.eu/events/
- News items and newsletters: www.secli-firm.eu/news/
- Social media: @SECLI_FIRM #SECLIFIRM
  SECLI-FIRM
- Partners interviews:
  www.secli-firm.eu/team-members/



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