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
## 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)
The SECLI-FIRM project has received funding from European Union’s Horizon 2020 Research and Innovation Program under Grant Agreement 776868.

**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
<table>
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<tr>
<th>Case Study</th>
<th>Climate events</th>
<th>Geography</th>
<th>Sectoral impact</th>
<th>Co-designers</th>
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<tr>
<td>CS1</td>
<td>Heat Wave 2015, and other similar extremes</td>
<td>Southern Europe</td>
<td>Energy – Thermal electricity plant cooling, demand model uncertainty</td>
<td>ENEL, ENEA, EURAC, KNMI</td>
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<tr>
<td>CS2</td>
<td>Dry Winter 2015-16 and other similar extremes</td>
<td>Northern Italy</td>
<td>Energy – Hydroelectric power production</td>
<td>ENEL, KNMI, ENEA, EURAC, Alperia</td>
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<td>CS3</td>
<td>Strong Winds March 2016 and other similar extreme</td>
<td>Southern Italy</td>
<td>Energy – Wind power production</td>
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<td>CS4</td>
<td>Extreme Winds 2014-15 and other similar extremes</td>
<td>Spain</td>
<td>Energy – Wind power production and balancing</td>
<td>AWS, MO, ENEL</td>
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<td>CS5</td>
<td>Strong El Niños</td>
<td>South America</td>
<td>Energy – Hydroelectric power production and other RE</td>
<td>AWS, UEA, AES Chivor, Celsia, ENEL</td>
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<td>CS6</td>
<td>Low Winds</td>
<td>North Sea</td>
<td>Energy – Offshore operations and maintenance planning</td>
<td>TenneT, KNMI</td>
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<td>CS7</td>
<td>Severe climate events in ‘shoulder’ months</td>
<td>North Sea</td>
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<td>Shell, MO</td>
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<td>CS8</td>
<td>Anomalous winter conditions</td>
<td>UK</td>
<td>Energy – Winter electricity demand</td>
<td>National Grid, MO</td>
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<td>CS9</td>
<td>Dry Spring and Summers</td>
<td>UK</td>
<td>Water – Water use restrictions</td>
<td>Thames Water, MO</td>
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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.
The SECLI-FIRM project has received funding from European Union’s Horizon 2020 Research and Innovation Program under Grant Agreement 776868.

Modelling Options for Value-Add Assessment

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**

**Decision Making Process**

1. **Performance Indicator with Climatology Input (IP, C)**
   - YES: SECLI-FIRM Seasonal Forecast
   - NO: Climatology

2. **Decision Making Process**
   - YES: SECLI-Firm Seasonal Forecast Input
   - NO: Actual Input data

3. **Performance Indicator with Actual Input data (IP, Ci)**
   - YES: SECLI-Firm Seasonal Forecast Input
   - NO: Actual Input data

**Wind & Wave Conditions**

- $H < 3.5$ m
- $WS < 30$ knots
- Visibility

**Probability?**

- YES: Go
- NO: Postpone

**Reduce Risk & Optimise Cost of Offshore Operations**

- YES: Postpone
- NO: Reduce Risk & Optimise Cost of Offshore Operations

**Seasonal Forecast Information**

- YES: Position the Company in Advance
  - Book Boats
  - Schedule Teams
  - Schedule Work
- NO: Postpone

**Preventive**

- YES: Corrective & Maintenance
- NO: Postpone

**Performance Indicator with SECLI Input (IP, Si)**

**Climatological data**

**Model Outputs**

**Proxies (weather regimes)**
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- 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

- Improve the forecasts by shifting the distribution according to forecast seasonal mean
• 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 unprecedented cold/warm winters.
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Case Study 1 Video
Case study 1 ENEL: Heat Wave in Italy: results from SEAS5

AVERAGE TEMPERATURES IN ITALY 01/07/2015 - 31/08/2015

CS1: July 2015 temperature anomalies in Alps

CS1: July 2015 temperature anomalies in Appennines

CS1: July 2015 temperature anomalies in Italy

CS1: July 2015 Power Demand Italy
Case Study 2 ENEL: Drought in Italy: results for Q4 2015 October-November-December from SEAS5

CS2: Q4 Alps Anomalies in Total Precipitation

CS2: Q4 Appennines Anomalies in Total Precipitation

CS2: Q4 Production Anomalies Alps

CS2: Q4 Production Anomalies Appenines

Grant Agreement n. 776868
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
Case Study 2 Alperia: Mild/dry winter in Ulten Valley (2015-2016)

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.
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

B. December 2014 – January 2015: Low wind production

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

Case B: December 2014 – January 2015: Low production from wind.
Case study 5 ENEL: Strong El Niños and energy mix planning: approach

We used the best weather station inside each basin from IDEAM* dataset.
Case study 5 UL AWS: Strong El Niños and energy mix planning: approach

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

- Quantile mapping used for downscaling data
- Correlating precipitation with river flow to predict the later
- Finding best MME combination with relation to precipitation

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

- Estimation of teleconnection between SST (ERA5) and flow
- Exploiting this "MME" to forecast river flow
- Estimating of best combination for global SST predictions.

Selection of method and comparison with Celsia's internal model and first estimation of added value
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**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.
Case Study 7: North Sea weather windows in seasonal shoulder months

September 2018 downtime case study

- 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

Long-term verification
- e.g. Brier Score, Brier Skill Score

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

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<th>Demonstrator</th>
<th>Visualisation</th>
<th>Briefing document</th>
<th>Teleconference / webinar</th>
<th>Post-processed data (relevant indicators)</th>
<th>Training (with WP5)</th>
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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/
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 1: Heat waves in southern Europe for energy generation and demand

Case study 2: Single-chamber small power plants in the Italian electricity system

Case study 3: Wind energy variability in Italy and energy generation

Case study 4: High-latitude wind in Spain and energy generation

Case study 5: Strong El Niño in a South America planning

Case study 6: High and low wind energy generation in high-penetration wind power systems

Case study 7: Strong wind and wave conditions during a month in the North Sea and energy logistics

Case study 8: Winter weather and energy system balance

Case study 9: Winter weather and energy system balance

Focus: Heat waves in southern Europe for energy generation and demand

Booting decision making

The temperature indicator is driven by weather patterns and the wind speed in the area.

The seasonal forecasting context

- The seasonal forecast is based on historical data and current weather patterns.
- Wind power production in the area.

Sectoral challenges and opportunities

- Managing energy and power production in rural areas.
- Managing energy and power production in rural areas.

Focus: A mild, dry winter 2015/16 due pressure system over the Mediterranean

France - the impact on energy generation

Booting decision making

The seasonal forecast is based on historical patterns and current weather patterns.

The seasonal forecasting context

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- Managing energy and power production in rural areas.

Sectoral challenges and opportunities

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Focus: During the month of March 2016 variability in the wind regime over Italy

Hydropower systems over the Mediterranean

Implications for supply-demand balance

Booting decision making

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The seasonal forecasting context

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Sectoral challenges and opportunities

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Focus: Sustained high and low wind energy generation in high-penetration wind power systems

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Focus: The use of seasonal forecasts for water management to identify periods of stress to the supply-demand balance

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Find out what SECLI-FIRM is all about

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