Grand Multi-Model Seasonal Forecasts in the SECLI-FIRM project

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European Geosciences Union General Assembly 2020, Vienna, Austria, 04-08 May 2020
The SECLI-FIRM project has received funding from European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 776868.

The Added Value of Seasonal Climate Forecasting for Integrated Risk Management

Outline

✓ SECLI-FIRM innovative approach: bridging the gap between climate forecasters and end-users decisions

✓ Optimization of climate prediction performance in SECLI-FIRM

➢ The benefit of using Grand-MME seasonal forecasts

Prediction of rainfall over Italy not an “hopeless case”

✓ Summary and Discussion
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Bridging the gap between climate forecasters and end-users decisions

Case study applications
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SECLI-FIRM case studies

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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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<tr>
<td>CS3</td>
<td>Strong Winds March 2016 and other similar extreme</td>
<td>Southern Italy</td>
<td>Energy – Wind power production</td>
<td>ENEL, ENEA, KNMI, UEA</td>
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<tr>
<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, ENE</td>
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<tr>
<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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<tr>
<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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More info at followin link: http://www.secli-firm.eu/
Bridging the gap between climate forecasters and end-users decisions

• Development of tools to produce tailored data.

• Formalisation of the business processes: Decision Trees.

• Introduction of calibrated probabilistic forecasts of suitable dichotomous events in business decision processes.

More info at following link: http://www.secli-firm.eu/
Optimization of Seasonal Climate prediction in SECLI-FIRM

The use of Grand-MME seasonal forecasts
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WP2

Optimization of climate prediction performance

Exploit teleconnected vs. locally-forced signal (Task 2.2)

Predictability of weather regimes (Task 2.3)

Engage International prediction community (Task 2.6)

Prediction of high-risk events (Task 2.5)

Statistical downscaling (Task 2.4)

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We are collecting a selection of prediction systems independently developed by (i) the European community (Copernicus C3S dataset; https://climate.copernicus.eu/seasonal-forecasts), (ii) the North American community (NMME dataset; http://www.cpc.ncep.noaa.gov/products/NMME) and (iii) the Asian-Pacific community (APCC dataset; http://www.apcc21.org/abt/model.do?lang=en).

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<td>Daily/Monthly</td>
<td>25/51</td>
<td>1993-2016</td>
<td>Burst</td>
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<td>Daily/Monthly</td>
<td>15/51</td>
<td>1993-2016</td>
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<td>Daily/Monthly</td>
<td>30/51</td>
<td>1993-2016</td>
<td>Burst</td>
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<td>CMCC</td>
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<td>1° x 1°</td>
<td>Daily/Monthly</td>
<td>40/50</td>
<td>1993-2016</td>
<td>Burst</td>
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<tr>
<td>NASA</td>
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<td>1° x 1°</td>
<td>Monthly</td>
<td>4/10</td>
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<tr>
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<td>Monthly</td>
<td>10/10</td>
<td>1981-2018</td>
<td>Burst</td>
</tr>
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<td>Daily/Monthly</td>
<td>10/10</td>
<td>1982-2016</td>
<td>Burst</td>
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<tr>
<td>NCEP</td>
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<td>1° x 1°</td>
<td>Daily/Monthly</td>
<td>28/28</td>
<td>1982-2018</td>
<td>Lagged</td>
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<tr>
<td>GFDL</td>
<td>B1</td>
<td>1° x 1°</td>
<td>Monthly</td>
<td>12/12</td>
<td>1980-2018</td>
<td>Burst</td>
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<tr>
<td>JMA</td>
<td>5</td>
<td>1° x 1°</td>
<td>Daily/Monthly</td>
<td>10/10</td>
<td>1993-2016</td>
<td>Burst</td>
</tr>
</tbody>
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The benefit of using Grand-MME seasonal forecasts
Exploitation of independent prediction systems
The rationale behind use of Multi-Models

**MME can improve by:**

- Combining the skill from the single models
- Improve ensembles dispersion and uncertainty consideration

- Independence of the Single models systems
- Degree of over-confidence

(Hagedorn et al., 2005; Weigel et al., 2009; Alessandri et al., 2011)
How to measure independence among seasonal prediction systems?

**Newly developed Indenpendency metrics**

**One example is Brier score covariance (Bscov)**

Starting from the definition of the Brier score (BS; Wilks, 2011) a new metric has been developed, named the Brier score covariance (BScov), which estimates the relative independence of prediction systems 1 and 2:

\[
BS = \frac{1}{n} \sum_{i=1}^{n} (y_i - o_i)^2
\]

\[
BScov = \frac{1}{n} \sum_{i=1}^{n} (y_i^1 - o_i)(y_i^2 - o_i) \sqrt{BS^1 \cdot BS^2}
\]

Alessandri et al., 2020 (In Preparation)

Catalano et al., 2020 (In Preparation)

See Display D3421 (EGU2020-18283) By Catalano et al in this session

For a discussion of the results using indepndency metrics
Maximization of prediction skill using Grand-MME
Case study over Italy: Water availability and drought for
Energy Sector

Seasonal prediction of rainfall over Italy not an “hopeless case”
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Seasonal hindcasts - 1° May start date - JJA Precipitation vs. ERA-5

All combinations – SECLI-FIRM Grand MME – Italy

Binary weighting model combinations, Corelation coefficient (r) with ERA5
Best combination: ‘[CMCC ‘MF ‘GEMN]’ with r = 0.56
Best European comb.: ‘[CMCC ‘MF]’ with r = 0.5
Best other models comb.: ‘[GEMN]’ with r = 0.376
Best single model: ‘[MF]’ with r = 0.402
All models with r = 0.154
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The Added Value of Seasonal Climate Forecasting for Integrated Risk Management

Seasonal hindcasts - 1° November start date - DJF Precipitation vs. ERA-5

All combinations – SECLI-FIRM Grand MME – Italy

Binary weighting model combinations, Corelation coefficient (r) with ERA5

Best combination: ['CMCC' 'CCSM' 'DWD' 'JMA'] with r = 0.64

Best European comb.: ['CMCC' 'ECMF' 'DWD'] with r = 0.538

Best other models comb.: ['GEMN' 'JMA'] with r = 0.558

Best single model: ['DWD'] with r = 0.498

All models with r = 0.353
Summary and Discussion

- SECLI-FIRM innovative approach: bridging the gap between seasonal climate forecasters and end-users decisions in the energy sector by employing a comprehensive set of techniques.
  - The use of Grand-MME is key strategy for the optimization of forecasts

- The SECLI-FIRM Grand MME can improve significantly the maximum skill.
  - More skill is gained by combining independent systems
  - No need to be democratic to optimize skill: a limited number of systems is generally required for a given predictand (variable, region, season)
  - All prediction system are useful. Each model has its own distinction and provides added skill for some variable, region and season.
  - Seasonal prediction of rainfall over Italy is not an “hopeless case”

- Next/Ongoing: use Grand-MME for the optimization of tailored probabilistic forecasts of the dichotomous events identified as key predictands by end-users for the study cases.