SECLI FIRM

The Added Value of Seasonal Climate Forecasting for Integrated Risk Management

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

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University of East Anglia

Italian national agency for new technologies, energy and sustainable economic development

Met Office

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# 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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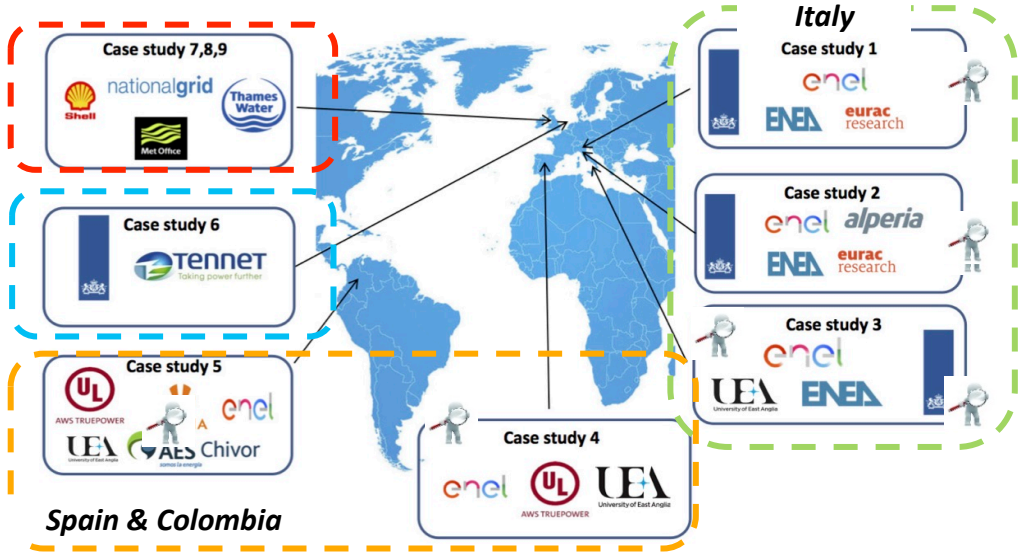
## SECLI-FIRM case studies

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




| 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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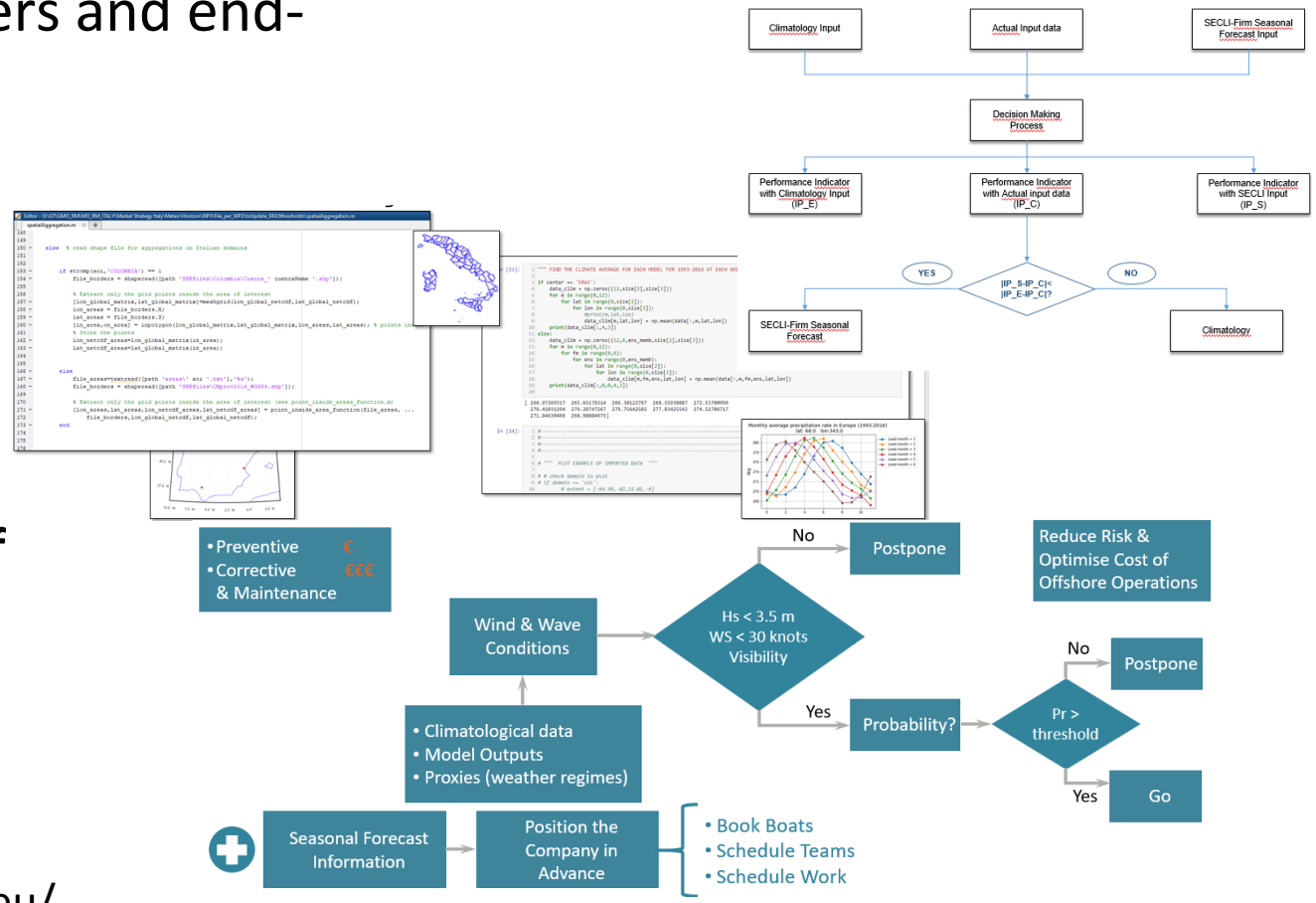
# The Added Value of Seasonal Climate Forecasting for Integrated Risk Management

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.**

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# Optimization of Seasonal Climate prediction in SECLI-FIRM

## The use of Grand-MME seasonal forecasts

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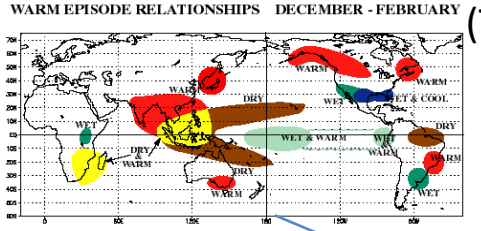
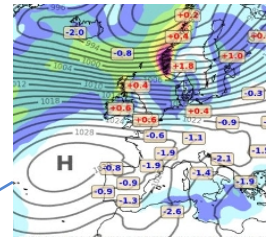
# Optimization of Seasonal Climate prediction in SECLI-FIRM (WP2)

Grand-MME FORECASTS

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




Predictability of weather regimes (Task 2.3)



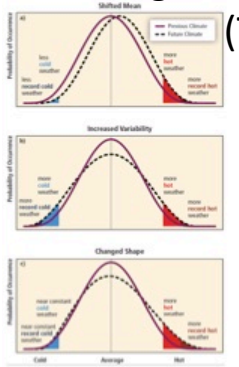
Task 2.1

WP2

Optimization of climate prediction performance

Engage International prediction community (Task 2.6)

Prediction of high-risk events (Task 2.5)



Statistical downscaling (Task 2.4)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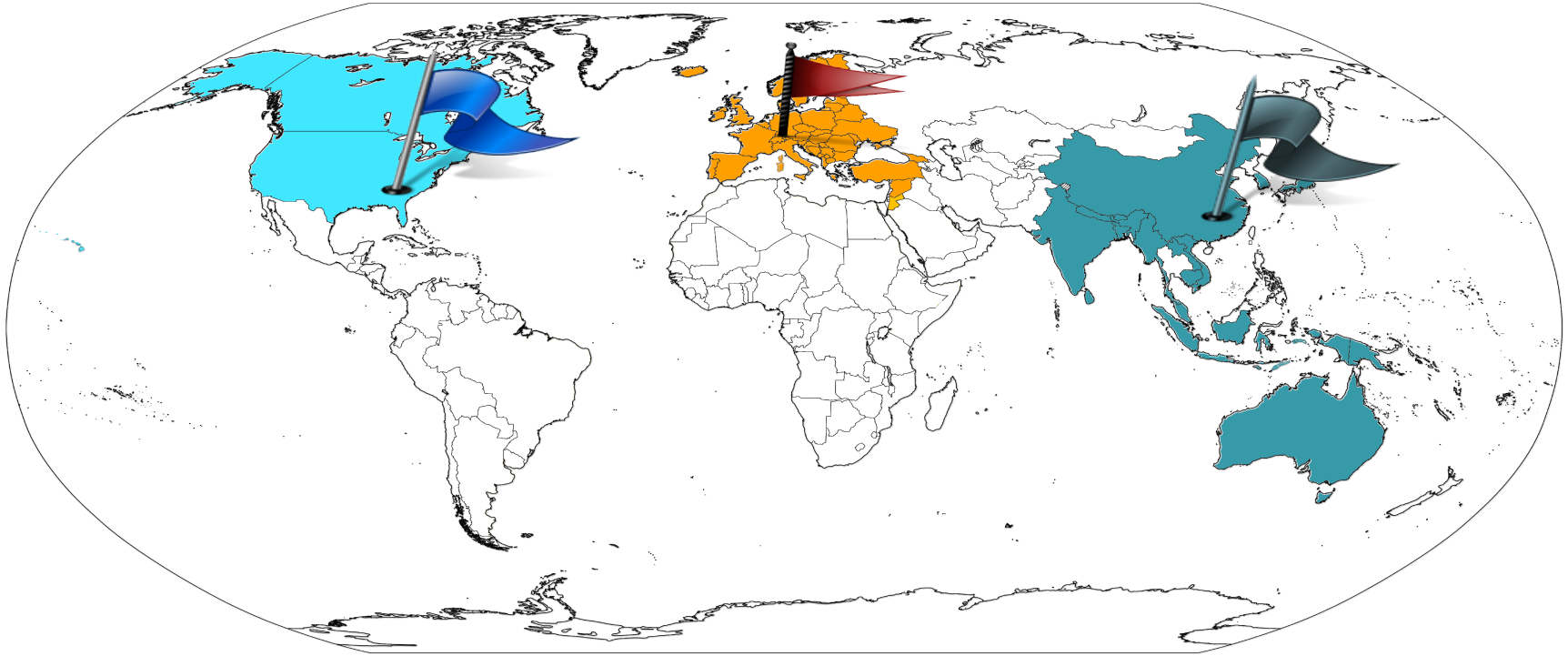
# Grand MME in SECLI-FIRM



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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| Model | Latest System | Horiz. Res. | Temporal Res. | # Ens. members: hindcast/forecasts | Hindcast Period | Ensemble Generation |
|---|---|---|---|---|---|---|
| ECMWF | 5 | 1º x 1º | Daily/Monthly | 25/51 | 1993-2016 | Burst |
| UKMO | 14 | 1º x 1º | Daily/Monthly | 28/60 | 1993-2016 | Lagged |
| MF | 6 | 1º x 1º | Daily/Monthly | 15/51 | 1993-2016 | Mixed |
| DWD | 2 | 1º x 1º | Daily/Monthly | 30/50 | 1993-2016 | Burst |
| CMCC | 3 | 1º x 1º | Daily/Monthly | 40/50 | 1993-2016 | Burst |
| NASA | 2 | 1º x 1º | Monthly | 4/10 | 1981-2016 | Lagged |
| CCMA | 2 | 1º x 1º | Monthly | 10/10 | 1981-2018 | Burst |
| CCSM4 | 4 | 1º x 1º | Daily/Monthly | 10/10 | 1982-2016 | Burst |
| NCEP | 2 | 1º x 1º | Daily/Monthly | 28/28 | 1982-2018 | Lagged |
| GFDL | B1 | 1º x 1º | Monthly | 12/12 | 1980-2018 | Burst |
| JMA | 5 | 1º x 1º | Daily/Monthly | 10/10 | 1993-2016 | Burst |

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# The Added Value of Seasonal Climate Forecasting for Integrated Risk Management

## The benefit of using Grand-MME seasonal forecasts

## Exploitation of independent prediction systems

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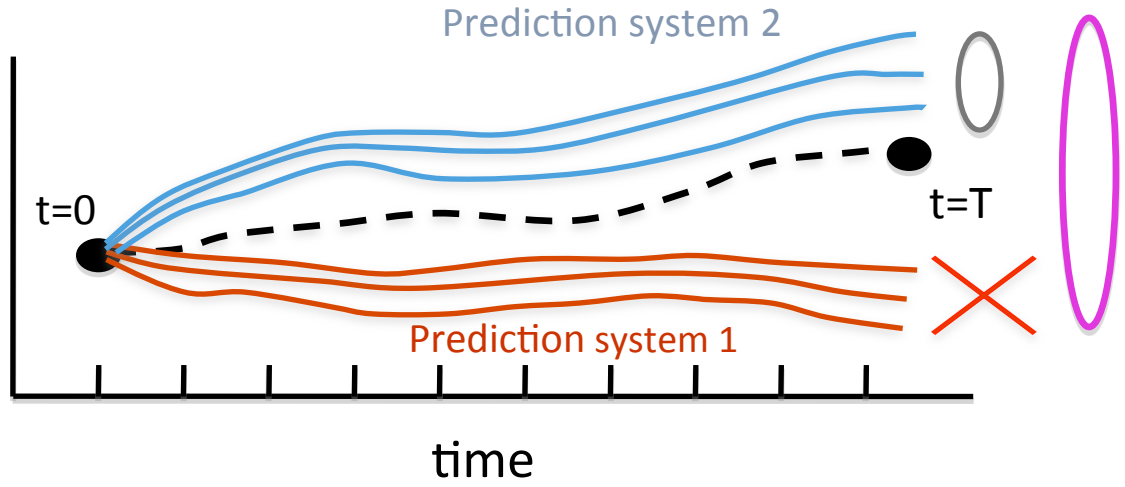
# The rationale behind use of Multi-Models




*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)*



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# How to measure independence among seasonal prediction systems?

**Newly developed Independency 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:

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

$$BS_{cov} = \frac{\frac{1}{n}\sum_{i=1}^{n}(y_i^1 - o_i)(y_i^2 - o_i)}{\sqrt{BS^1 \cdot BS^2}}$$

*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 independency metrics***

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# 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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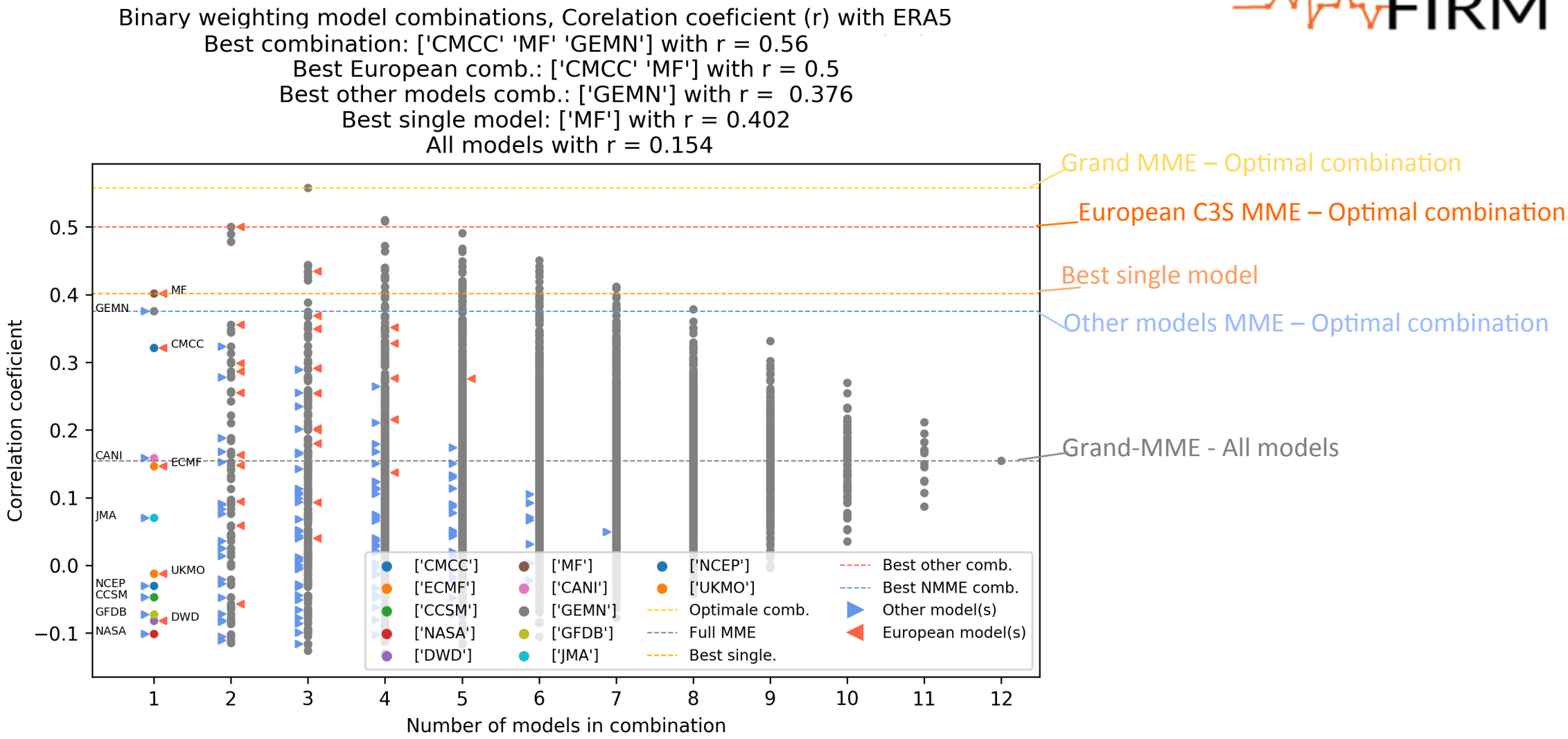
# All combinations – SECLI-FIRM Grand MME – Italy

## Seasonal hindcasts - 1° May start date - JJA Precipitation vs. ERA-5



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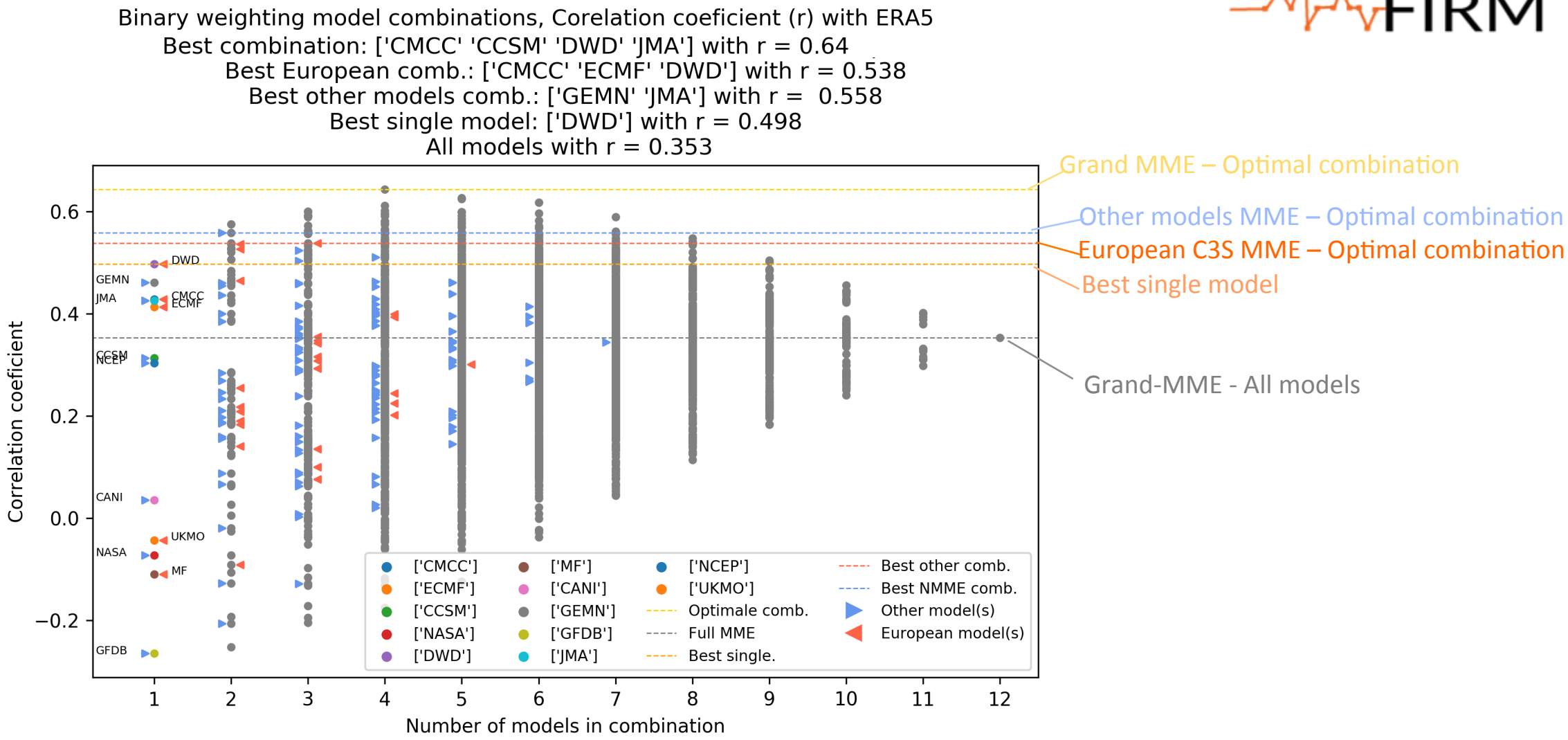
# All combinations – SECLI-FIRM Grand MME – Italy

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



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# 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.


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