

# ***Grand European and Asian-Pacific Multi-Model Seasonal Forecasts: Maximization of Skill and of Potential Economical Value to End-Users***

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Contributors:

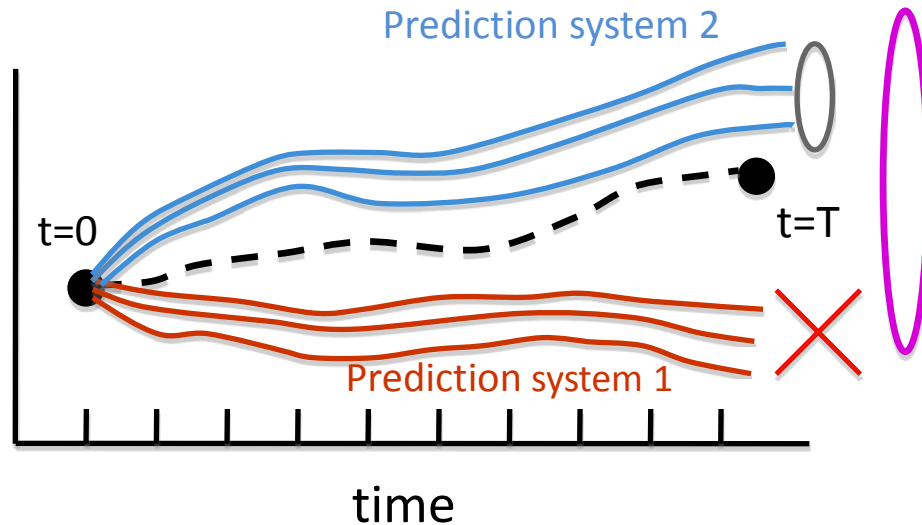
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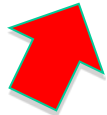
- Motivation and Method
  - Combining Asian-Pacific (CliPAS/APCC) and European (ENSEMBLES) MMEs
  - Development of the grand ENSEMBLES-CliPAS/APCC MME
- Maximum level of skill attainable by combining ENSEMBLES and CliPAS/APCC models
- Potential Economic value to end users: case study for energy sector in Italy
- Discussion and Conclusions

# The rationale behind use of Multi-Models



*MME can improve by:*

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



- *Degree of over-confidence*
- *Independence of the contributing Prediction Systems*

*(Hagedorn et al., 2005 ; Weigel et al., 2009; Alessandri et al., 2011)*

## Development of the Grand ENSEMBLES-CliPAS/APCC Multi-Model by combining Asian-Pacific (CliPAS/APCC) and European (ENSEMBLES) MMEs

Performance and usefulness of CLimate predictions: Beyond  
current liMITationS (<http://tinyurl.com/fp7-iof-climits>)

Supported by European Union (FP7 programme) Marie Curie IOF

# The Grand ENSEMBLES-CIIPAS/APCC MME

Two independent MME:

**11** Prediction Systems  
from **CIIPAS/APCC** and  
**5** from EU **ENSEMBLES**

## CIIPAS/APCC (Wang et al., 2009)

**APCC**, Asia-Pacific Economic Cooperation  
Climate Center, S. Korea.

**NCEP**, National Center for Environmental  
Prediction, USA

**BMRC**, Bureau of Meteorology Research  
Center, Australia

**PNU**, Pusan National University, S. Korea.

**MSC**, Meteorological Service of Canada,  
Canada (CANCM3, CANCM4)

**NASA**, National Aeronautics and Space  
Administration, USA

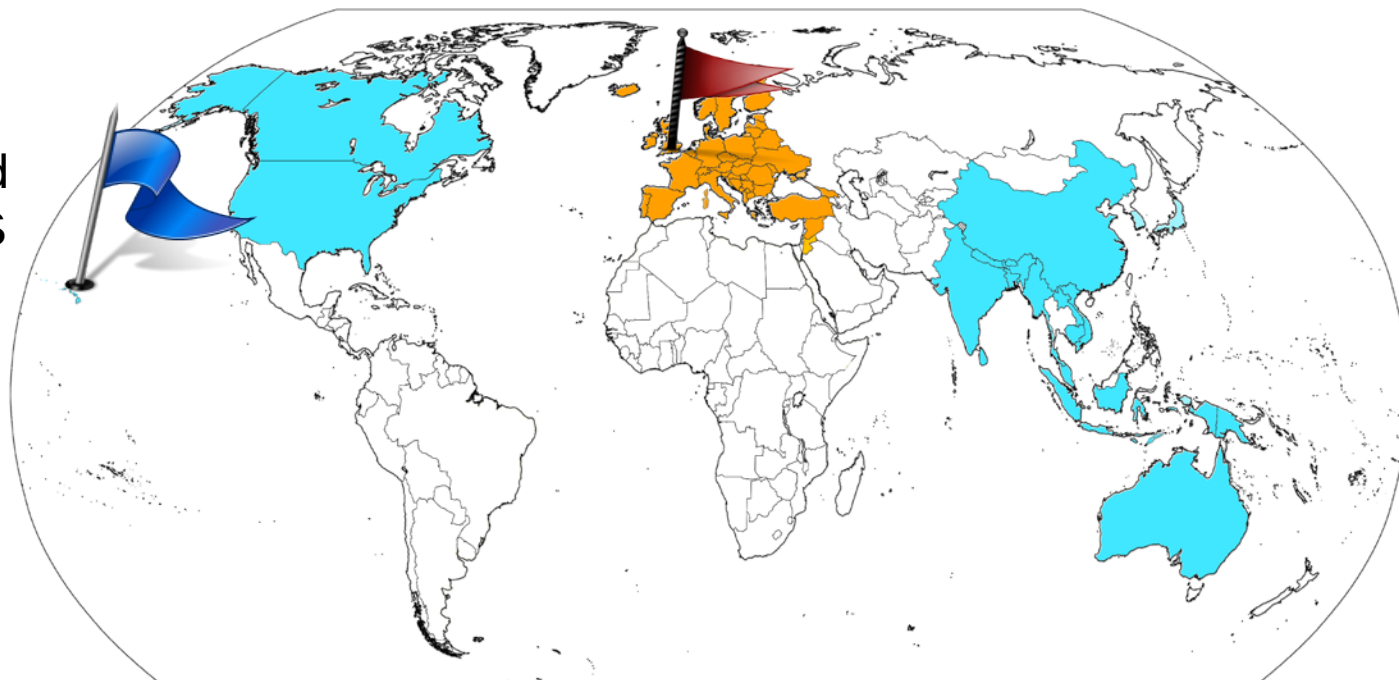
**SNU**, Seoul National University, S. Korea

**UH**, University of Hawaii, USA

**GFDL**, The Geophysical Fluid Dynamics  
Laboratory, USA

**FRCGC**, Frontier Research Center for  
Global Change, Japan

Climate Prediction and its  
Application to Society project  
(**CIIPAS**; Wang et al., 2009)  
sponsored by **APCC**



## ENSEMBLES (Weisheimer et al, 2010; Alessandri et al, 2011)

**ECMWF**, European Centre for Medium-  
Range Weather Forecasts, United Kingdom

**UKMO**, UK-Met Office Met Office, United  
Kingdom

**MF**, Meteo France. France

**INGV-CMCC**, Centro Euro-Mediterraneo  
per i Cambiamenti Climatici, Italy

**IFM-GEOMAR**, Leibnitz Institute of  
Marine Sciences at Kiel University, Germany

ENSEMBLE-based predictions of  
climate changes and their impacts  
(**ENSEMBLES**) supported by EU  
FP6 programme

common hindcast period 1983-2005  
1 May and 1 Nov start dates

## How does CliPAS/APCC compare with ENSEMBLES?

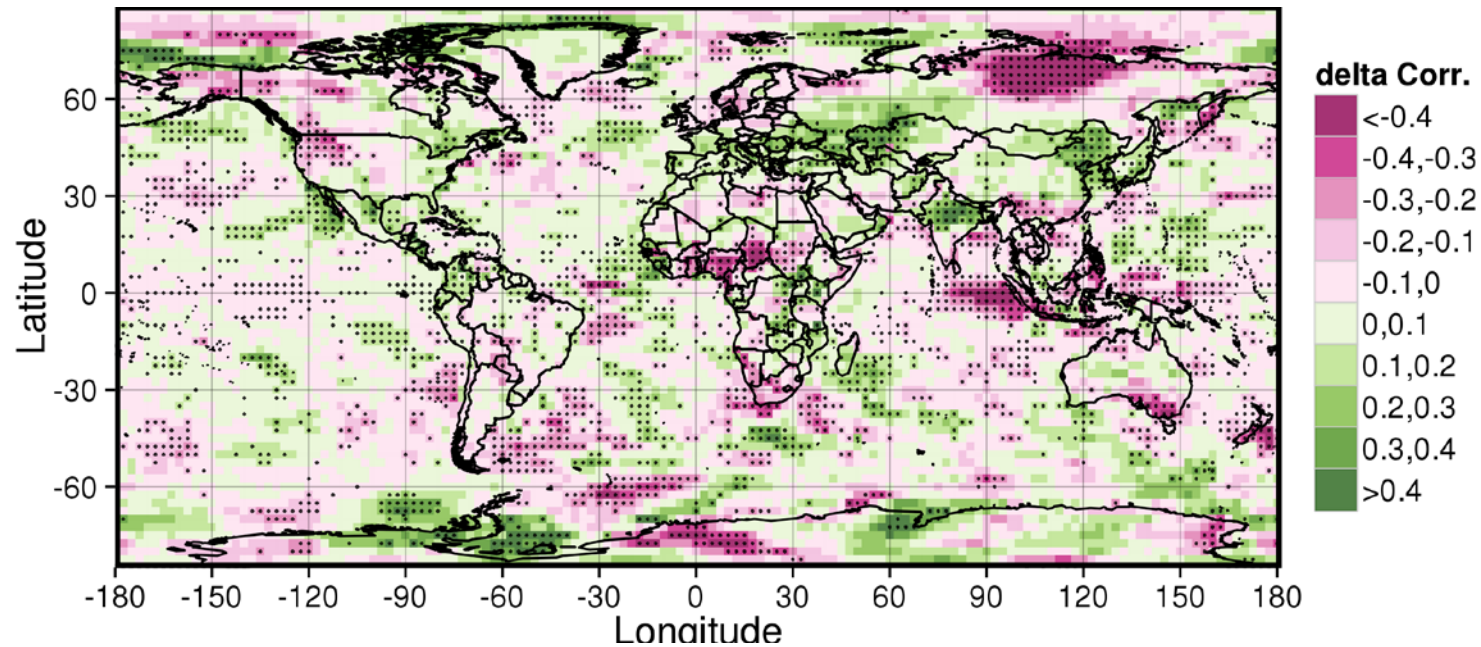
Performance and usefulness of CLImate predictions: Beyond current liMiTationS (<http://tinyurl.com/fp7-iof-climits>)

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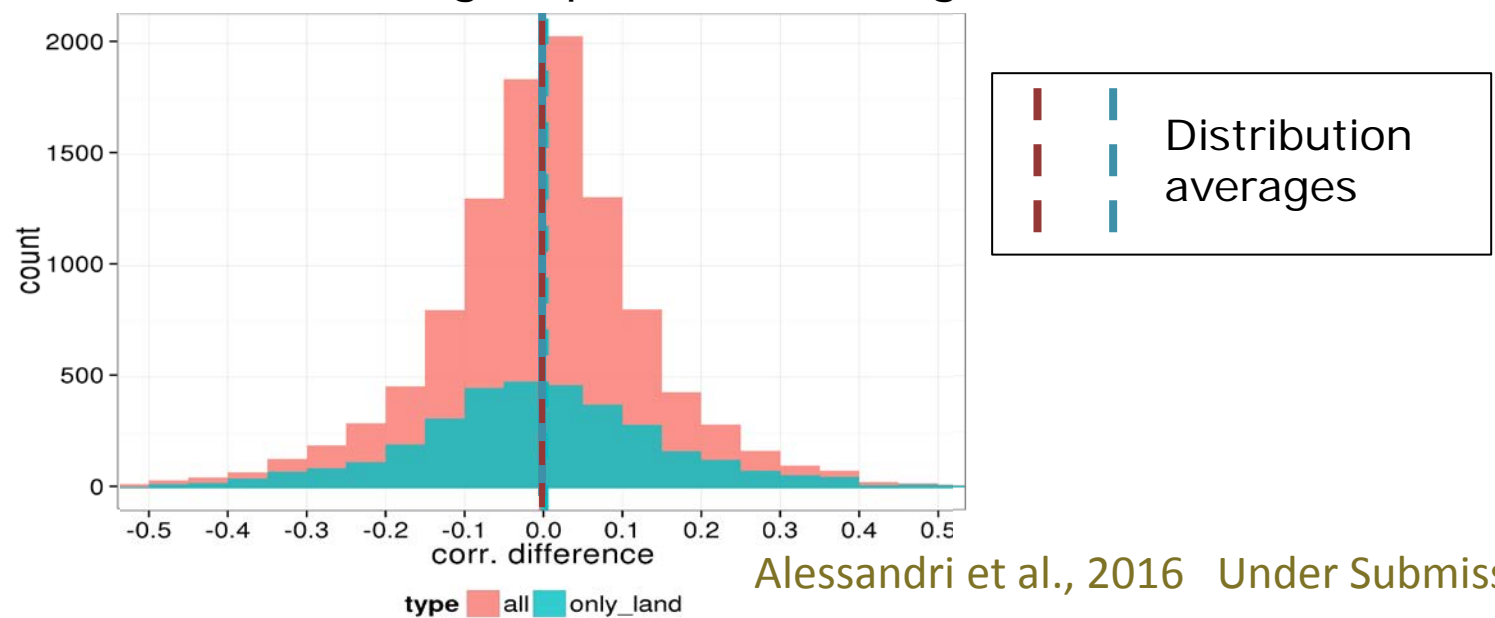


# CLIPAS/APCC vs ENSEMBLES - correlations of MME means with OBS 2m-Temperature - Boreal Summer (JJA)

## ENSEMBLES minus CLIPAS/APCC JJA



## Distribution of grid-point skill changes



## Maximum level of skill attainable by combining ENSEMBLES and CliPAS/APCC models

Performance and usefulness of CLImate predictions: Beyond  
current liMiTationS (<http://tinyurl.com/fp7-iof-climits>)

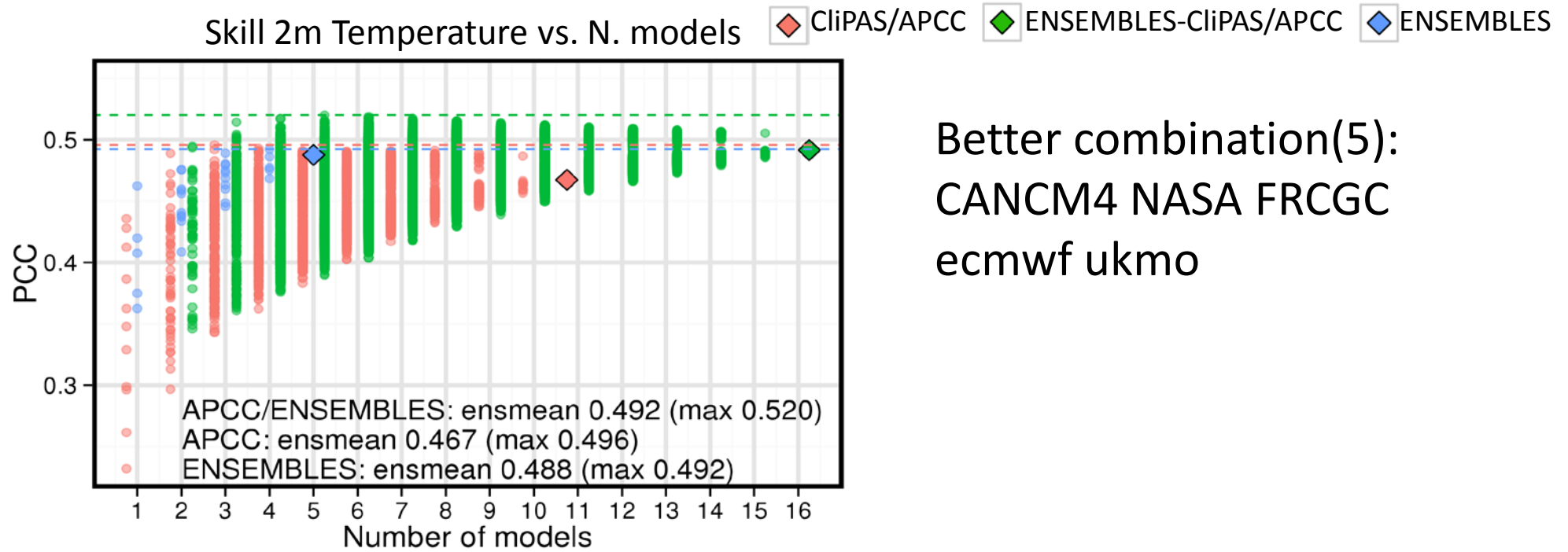
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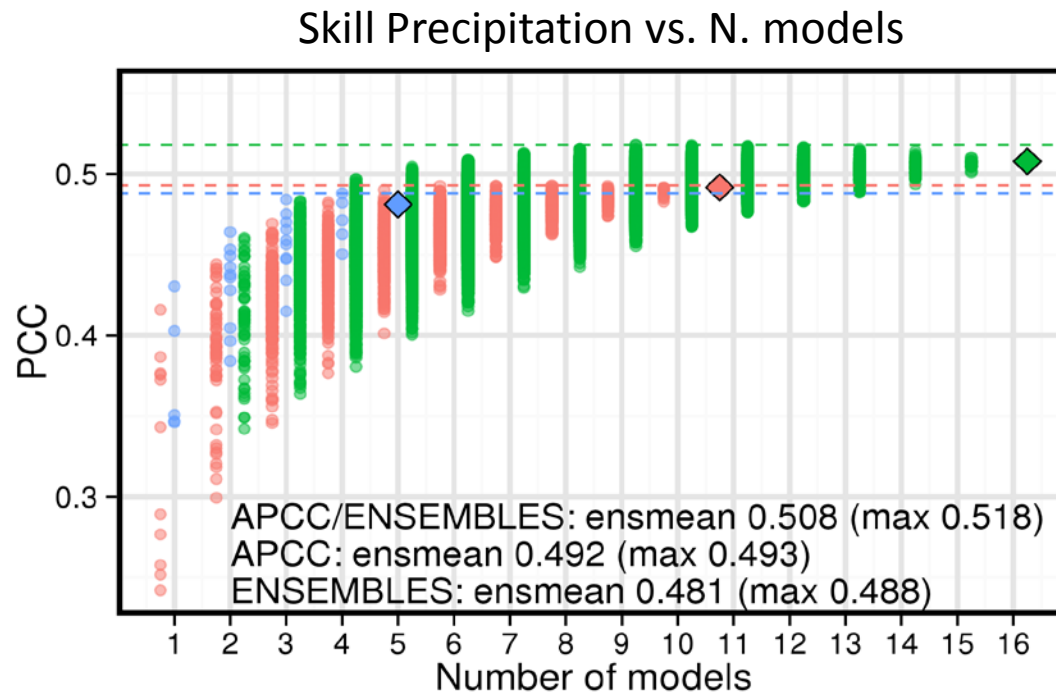
# All combinations - Grand ENSEMBLES-CliPAS/APCC MME – Tropics

Pattern Correlation (PCC) – JJA Tropics

(25S-25N)



Better combination(5):  
CANCM4 NASA FRCGC  
ecmwf ukmo

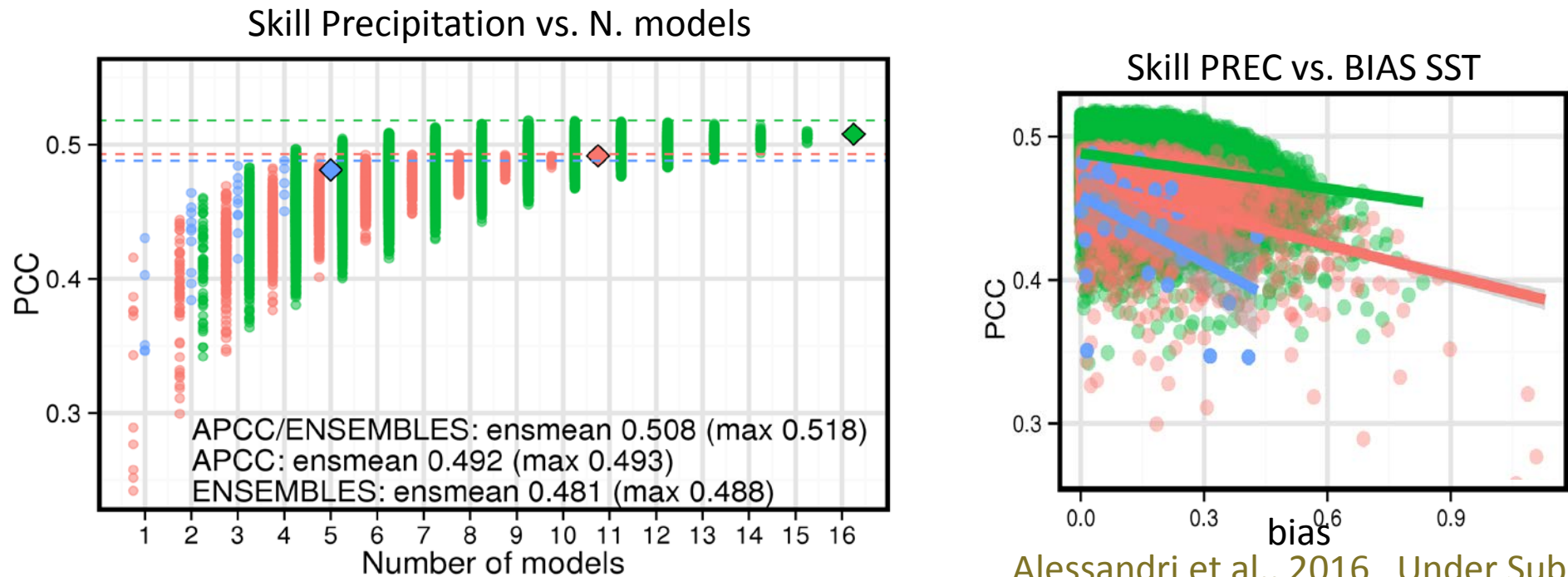
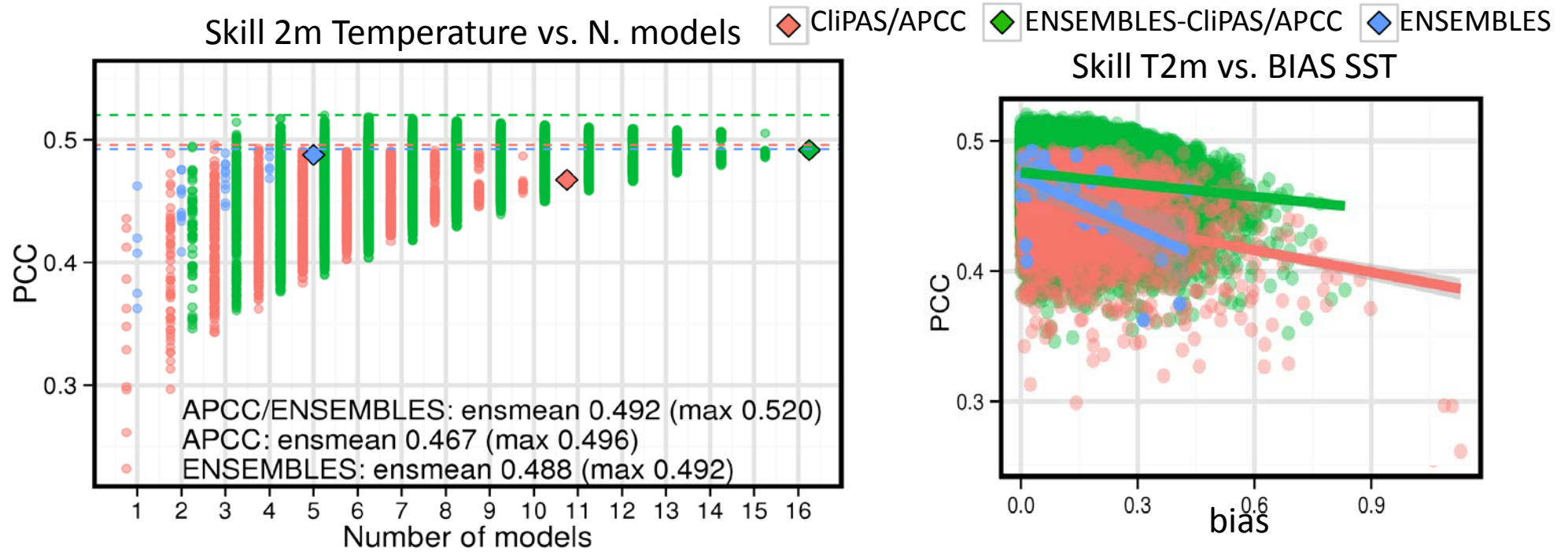


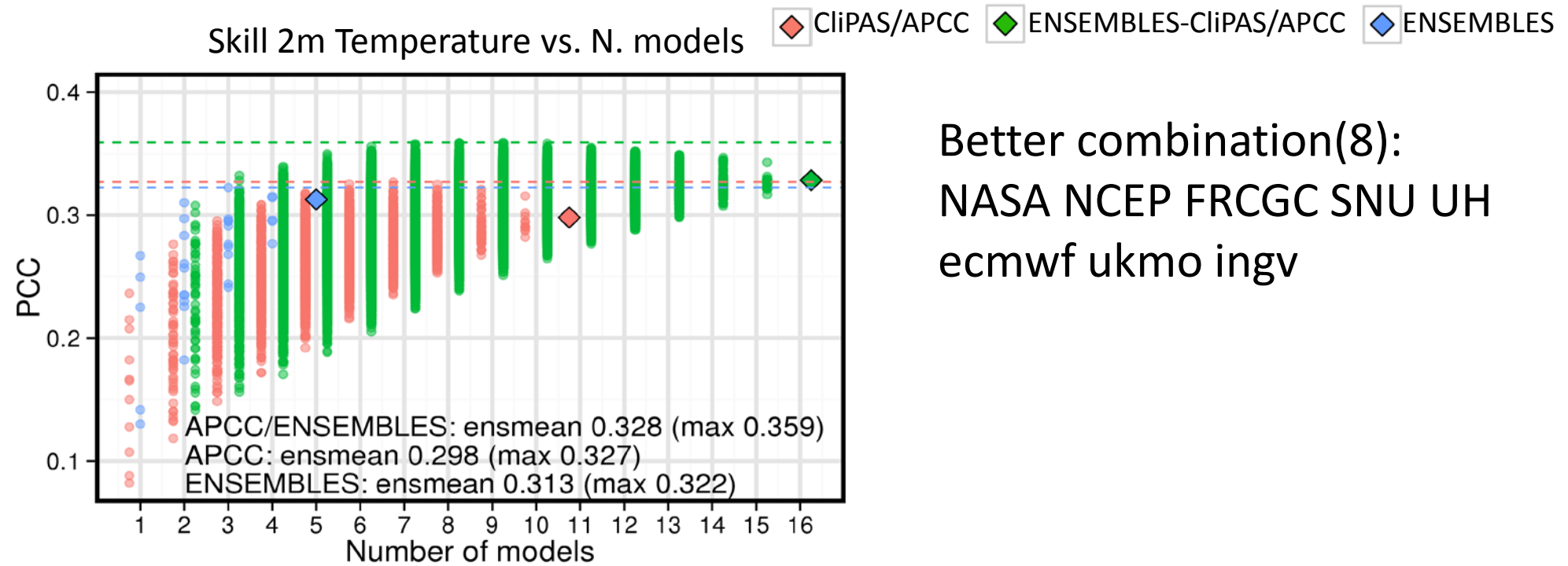
Better combination(9):  
CANCM3 CANCM4 NASA FRCGC NCEP  
ecmwf ukmo mf ifm

# All combinations - Grand ENSEMBLES-CliPAS/APCC MME – Tropics

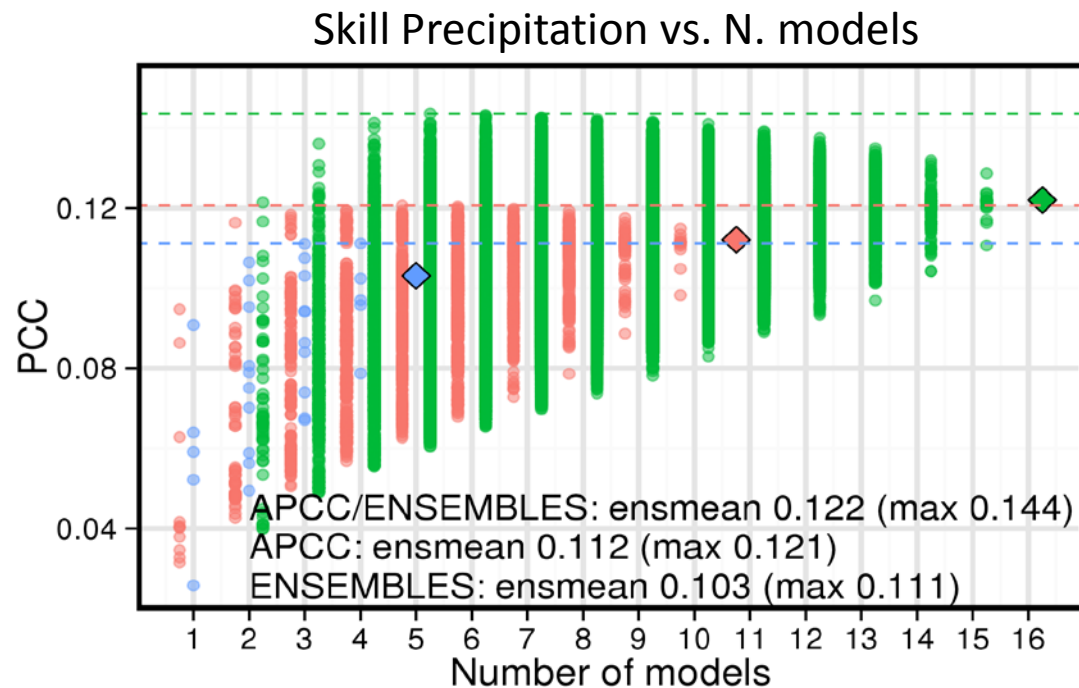
Pattern Correlation (PCC) – JJA Tropics

(25S-25N)





Better combination(8):  
 NASA NCEP FRCGC SNU UH  
 ecmwf ukmo ingv

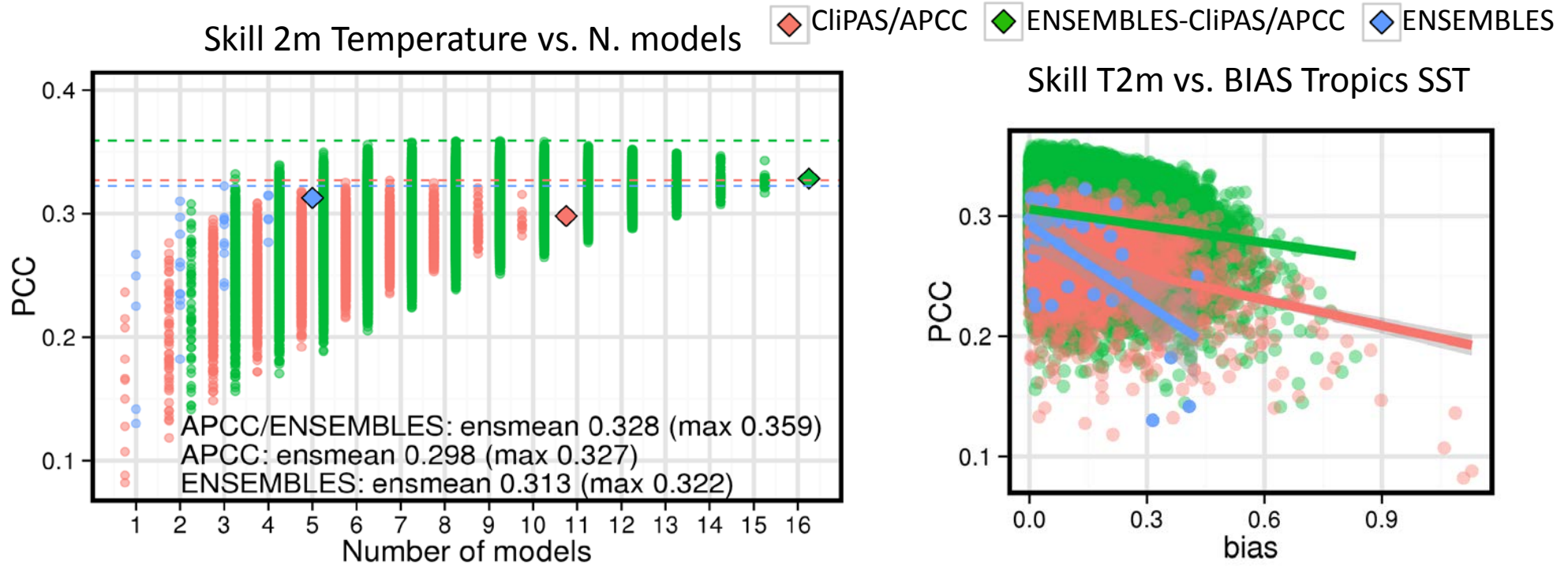


Better combination(5):  
 NCEP GFDL  
 ecmwf ifm ingv

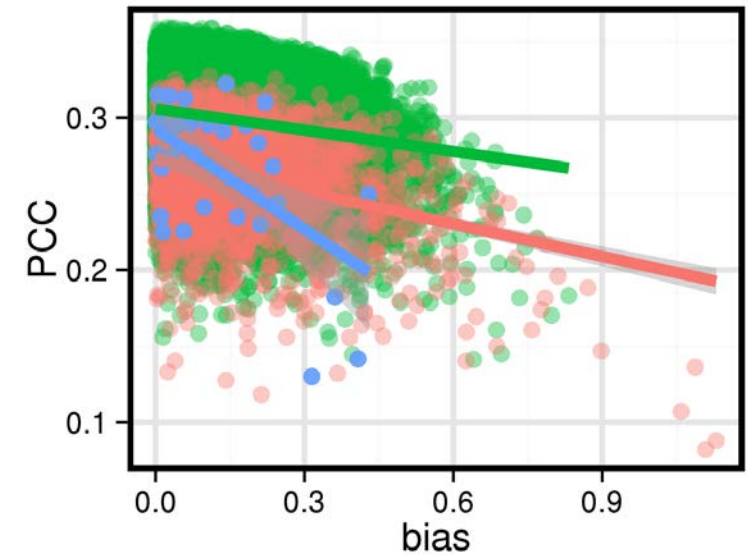
Pattern Correlation (PCC) – JJA North Mid Latitudes

(25N-75N)

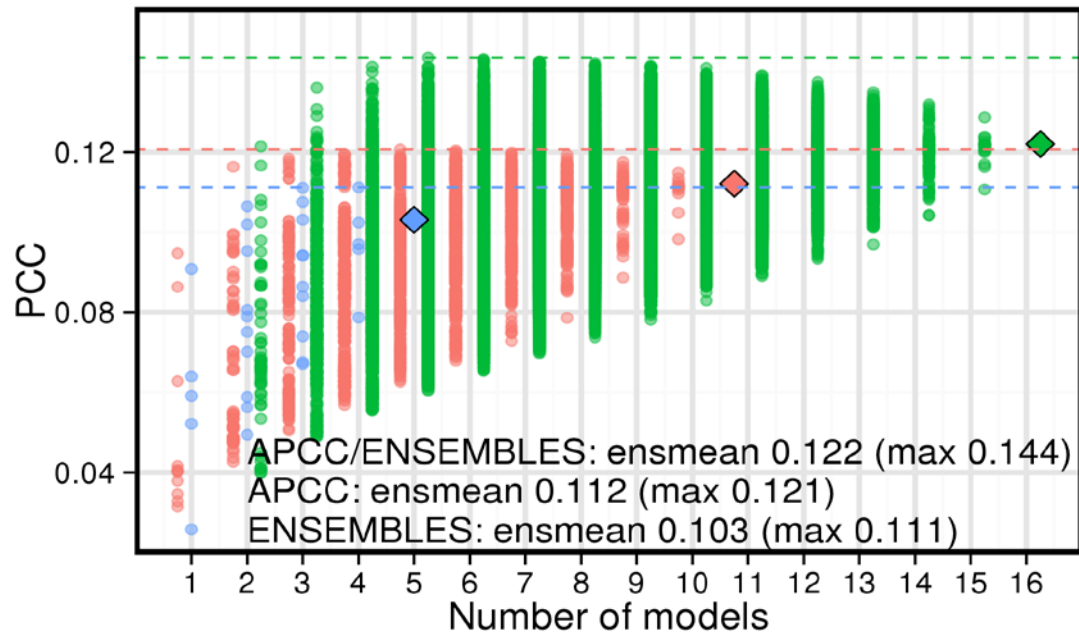
Skill 2m Temperature vs. N. models



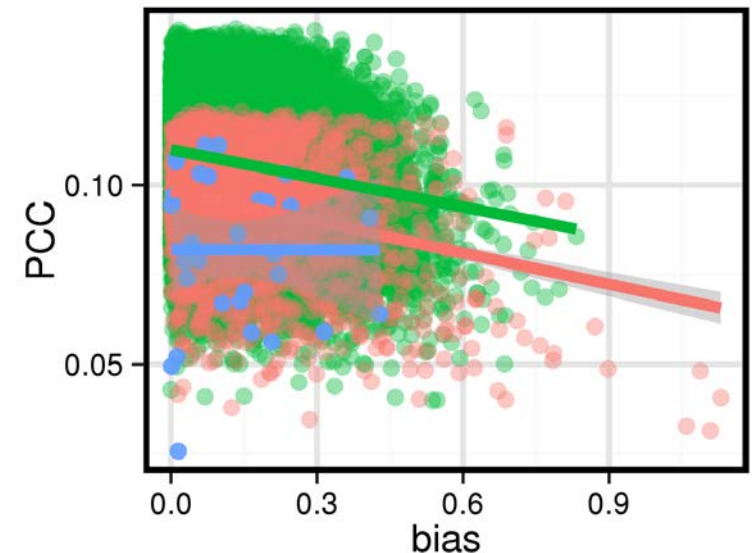
Skill T2m vs. BIAS Tropics SST



Skill Precipitation vs. N. models



Skill PREC vs. BIAS Tropics SST



# Maximization of probabilistic seasonal forecasts performance at each grid point by combining ENSEMBLES and CliPAS/APCC models

Performance and usefulness of CLImate predictions: Beyond current liMiTationS (<http://tinyurl.com/fp7-iof-climits>)

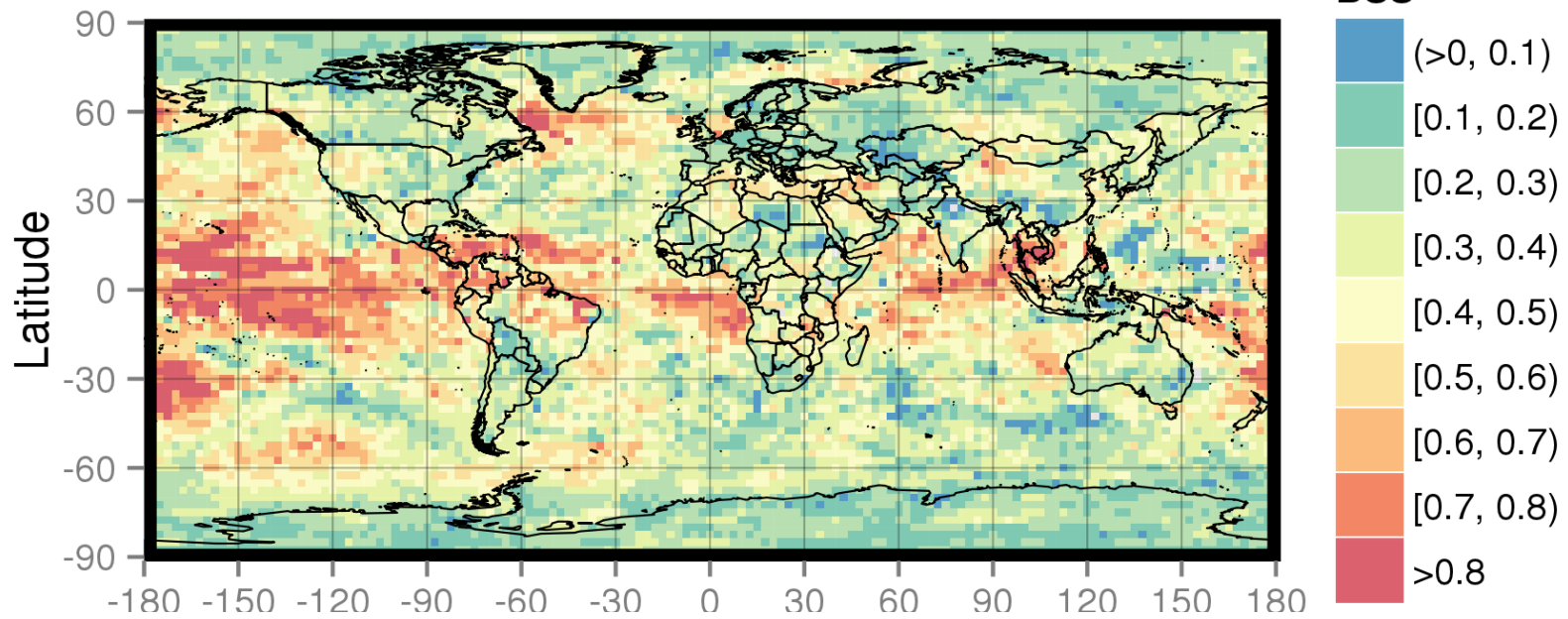
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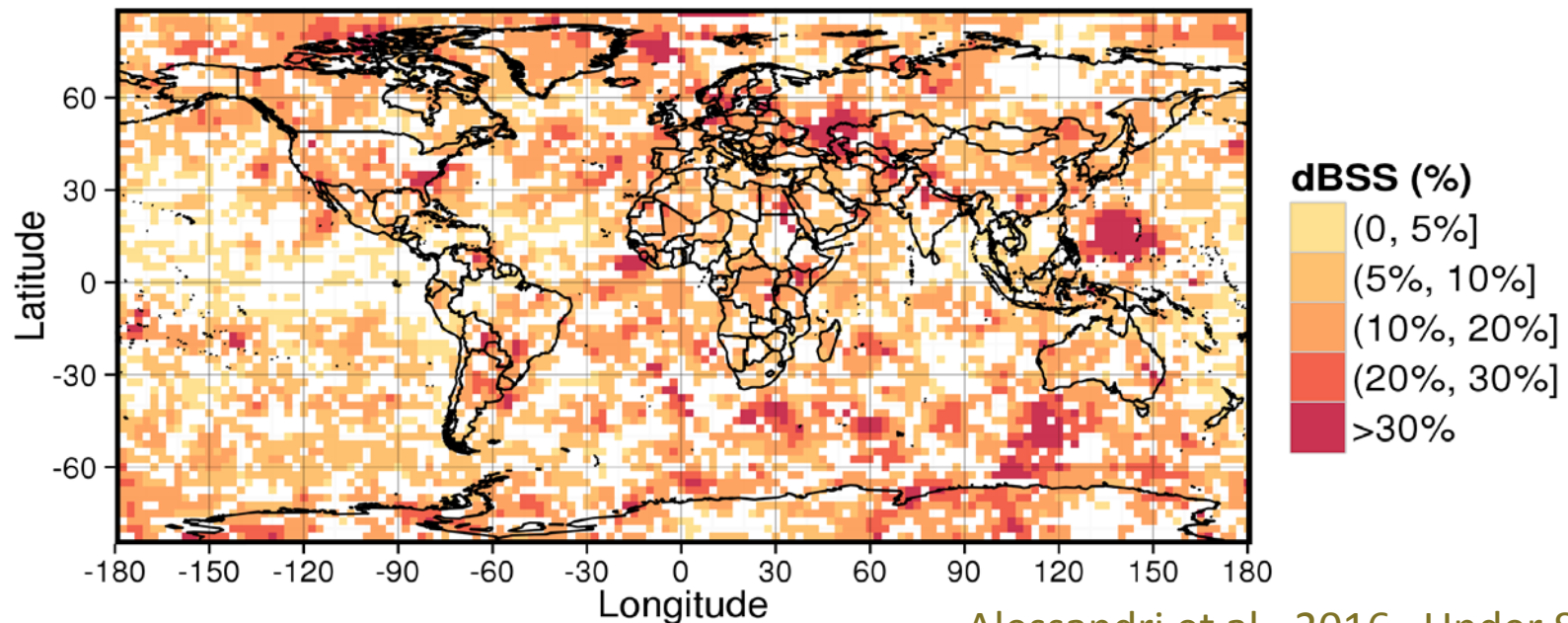
# Max [Grand MME] vs Max [ENSEMBLES or CliPAS/APCC]

Brier Skill score - above upper tercile T2m JJA

Max [Grand MME]



Max [Grand MME] minus Max [ENSEMBLES or CliPAS/APCC] JJA

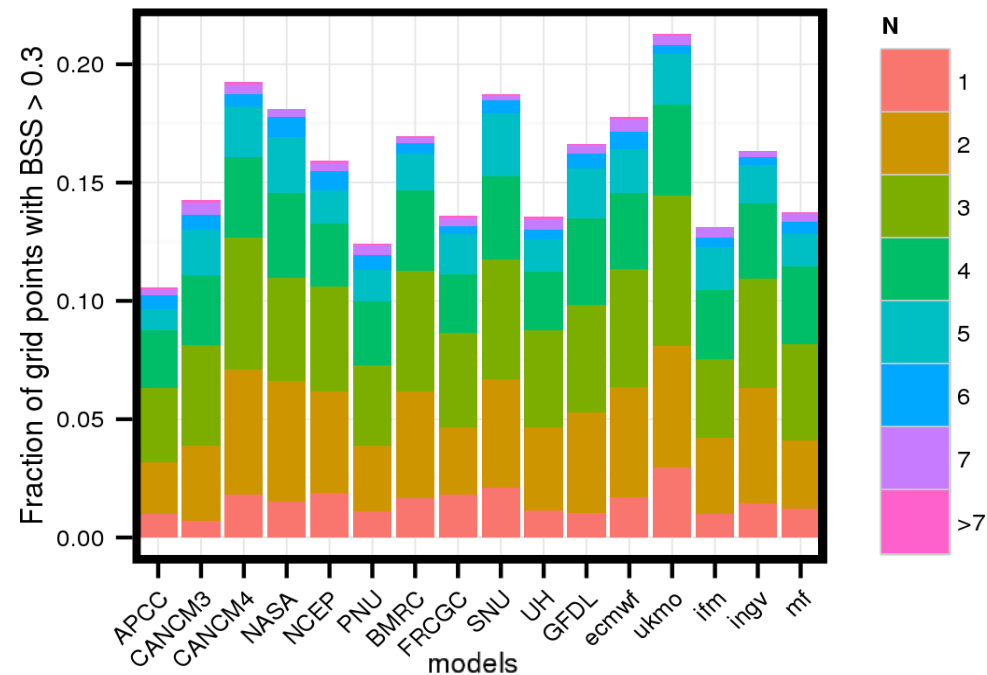


# Usefulness of the contributing models

## Brier Skill score - above upper tercile T2m JJA

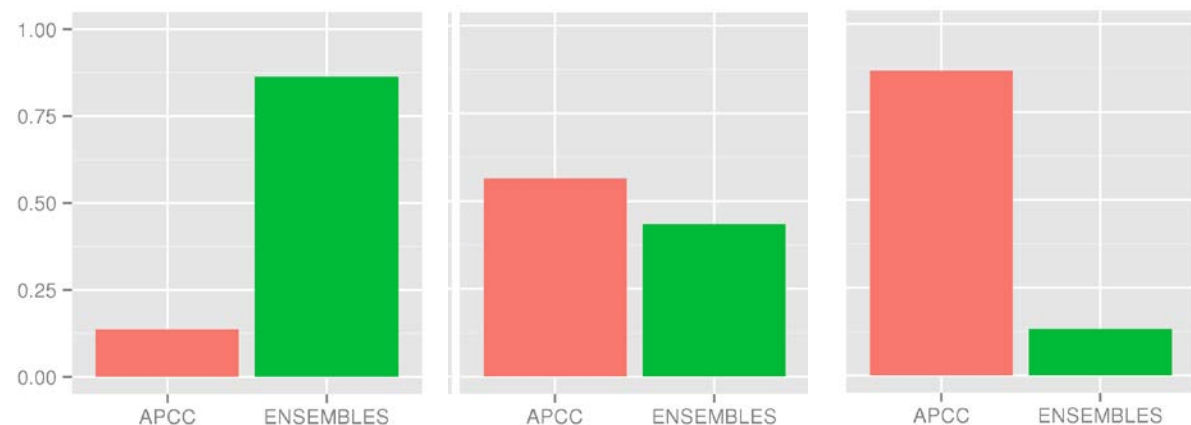
All models contribute to the improved performance of the Grand MME

Fraction of grid-points each model is needed to maximize performance



The improvements are larger when adding independent models to the MMEs

Mixed  
CliPAS/APCC only APCC/ENSEMBLES ENSEMBLES only



Normalized marginal contribution of adding APCC or ENSEMBLES models to combinations of APCC only, ENSEMBLES only and mixed MMEs



# Prediction of Electricity demand over Italy using seasonal climate forecasts



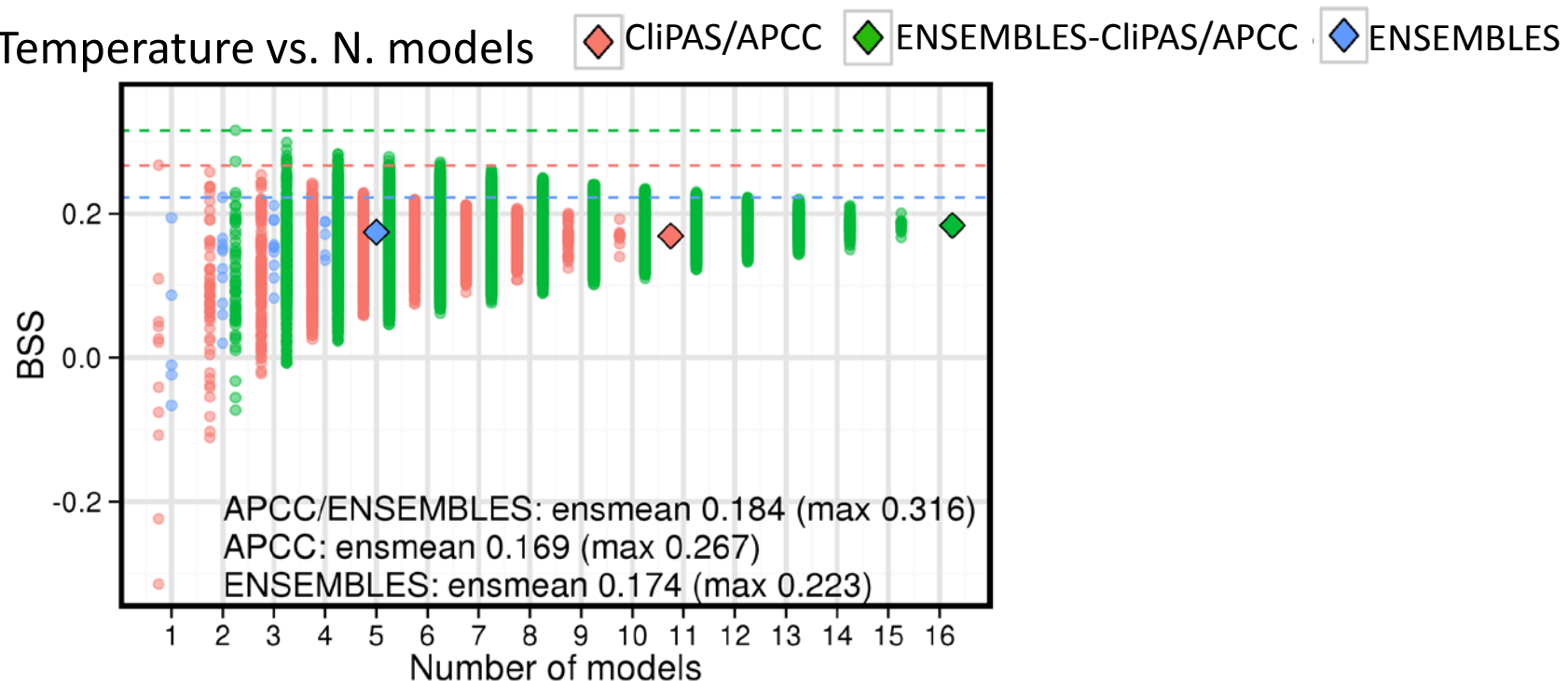
- Forecasting of anomalous summer Temperature at the seasonal time-scale over “hot-spot” land areas such as Euro-Mediterranean has been recently shown to have the potential to drive predictions of electricity demand anomalies due to increased summer refrigeration and air conditioning.

De Felice M, A Alessandri and F Catalano, 2015 (Appl. Energy)

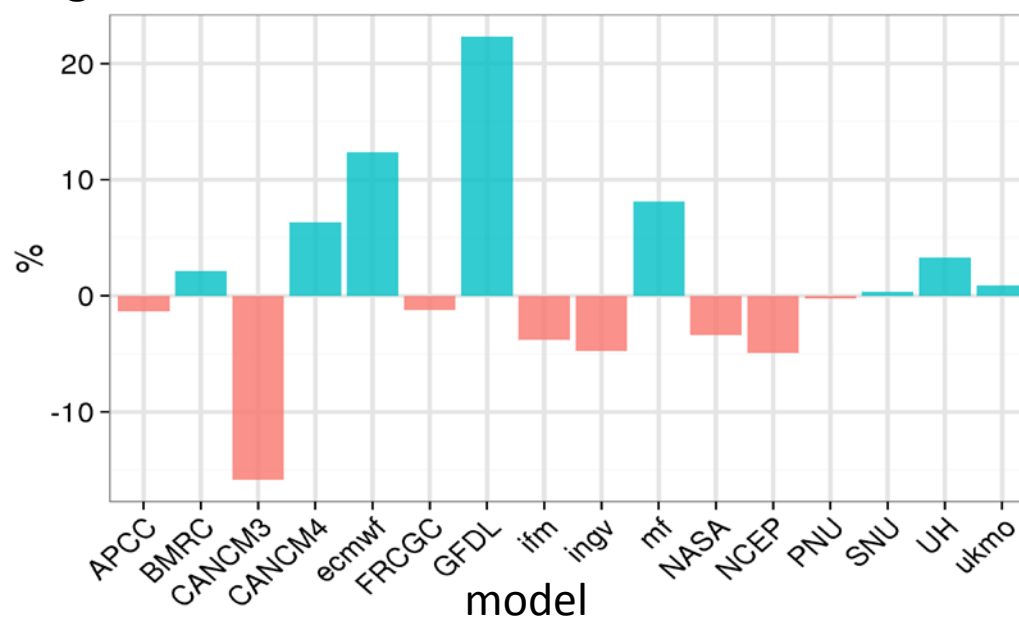
# Seasonal forecast skill for Temperature prediction over Italy

## Brier Skill score - above upper tercile T2m JJA

Skill 2m Temperature vs. N. models



Avg. marginal skill contribution of each model



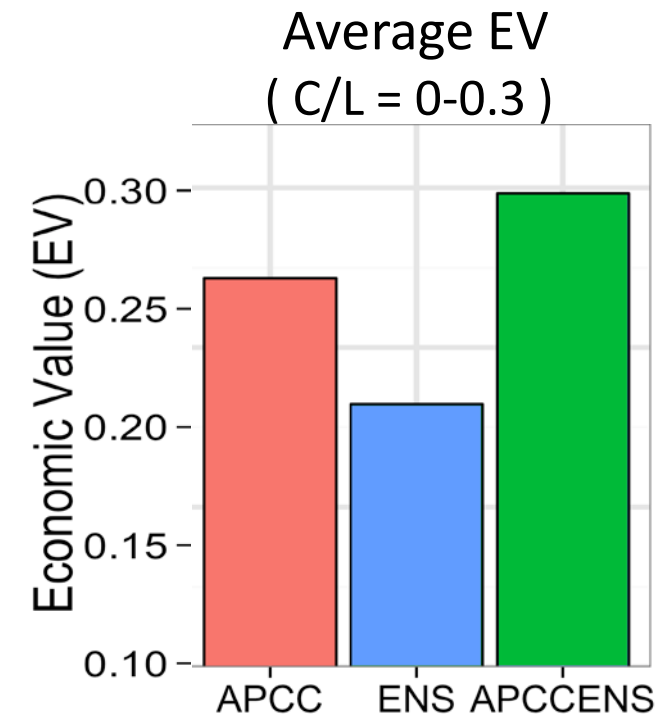
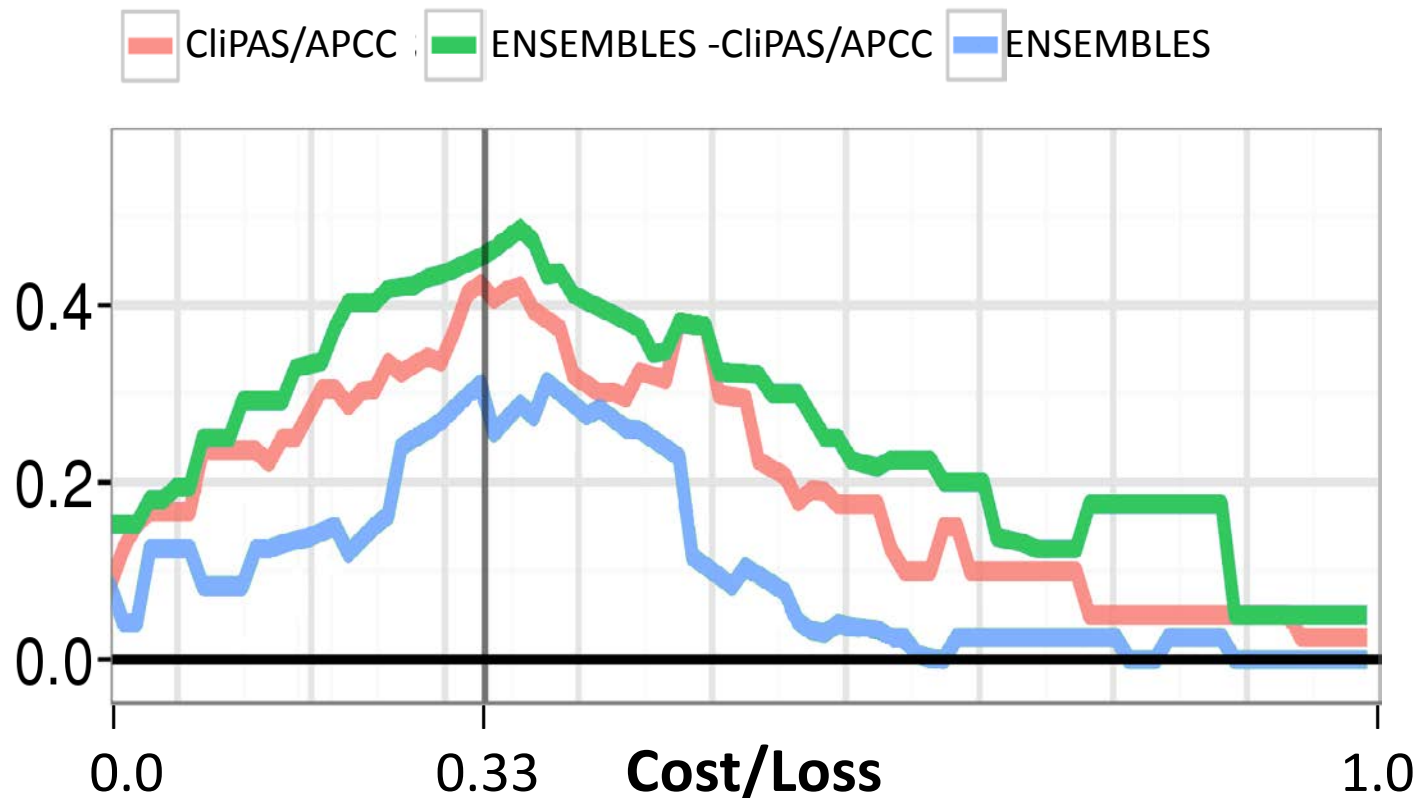
# Prediction of Electricity demand over Italy using seasonal climate forecasts

Prediction of above upper tercile Electricity demand over Italy [E+]

Potential Economic Value

(**Cost-Loss** decision model; Richardson, 2003)

[E+] implies financial **Loss** if no preventive action is taken at a financial **Cost**



(Electricity demand data for 1990-2007 from Italian TSO TERNA SpA)

- ❑ The CliPAS/APCC and ENSEMBLES MMEs display high degree of independence, even though having similar averaged performance.
- ❑ The collection of all models into a Grand MME improves significantly the maximum skill by ~10-20% over both Tropics and NML.
  - More skill is gained by combining independent models compared to using models from CliPAS/APCC and ENSEMBLES only.
  - All models are useful in improving the performance of the Grand MME. Each model has its own distinction and provides added value for some variable, region and season.
- ❑ The Grand MME improves PEV of Temperature forecasts over Euro-MED:
  - Mixing models from CliPAS/APCC and ENSEMBLES can maximize probabilistic performance for the prediction of temperature in summer.
  - Electricity demand forecasting over Italy is improved significantly with increased PEV for end users in the Energy industry.