L’attività di previsione su scala “subseasonal” del CNR-ISAC

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Bologna

1ª Conferenza Nazionale sulle Previsioni Meteorologiche e Climatiche

Bologna, 17–18 giugno 2019

Why subseasonal forecasting?

scientific and technical improvements

- model formulation
- observational data
- data analysis and assimilation
- ensemble forecasting
- seamless prediction
- computing capacity

predictive signal potentially available at all the atmospheric space-time scales

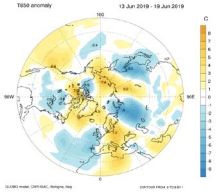
- modes of intraseasonal variability (MJO)
- anomalous initial conditions in ocean, soil, snow cover, sea ice
- stratosphere-troposphere interaction

weather prediction
(predictability 1st kind)

climate prediction
(predictability 2nd kind)

subseasonal to seasonal (S2S)

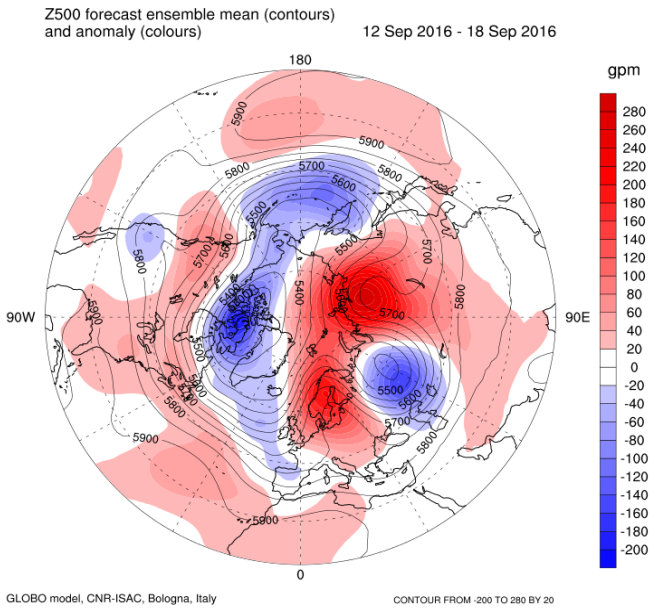
two weeks <



< season

Subseasonal forecasting with the GLOBO model

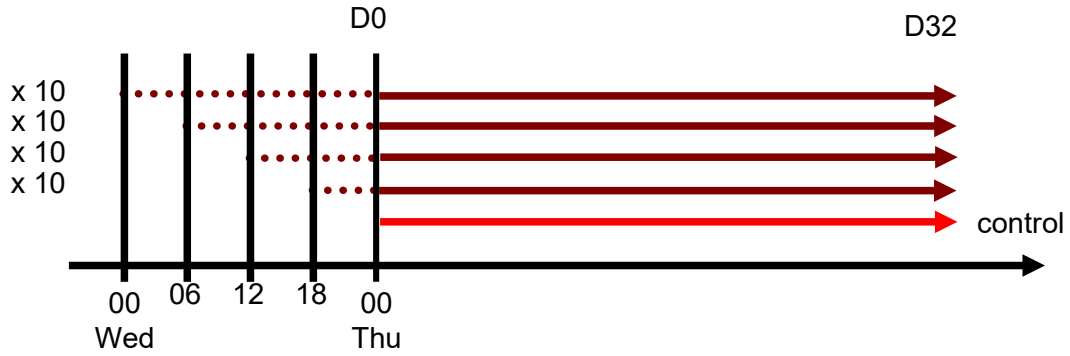
- experimental activity started in 2009 in the framework of a cooperation with the National Civil Protection Department
- ensemble forecasting system based on the atmospheric general circulation model **GLOBO**, a global, grid-point spherical domain, hydrostatic model (Malguzzi et al., WAF, 2011)
- regular latitude-longitude grid with horizontal grid spacing of 0.56 deg lat x 0.8 deg lon with output (grib2 files) on 1.5 x 1.5 grid
- 54 vertical hybrid levels, 7 soil layers
- time step of 360 s
- slab ocean model for sea-surface temperature (SST) evolution
- sea-ice cover fixed if > (<) than climatology in the fall-winter (spring-summer) season, relaxed to climatology otherwise
- SST and sea-ice cover climatological values computed from ECMWF ERA-Interim reanalyses as 5-day averages over the 30-year period 1981-2010



Forecasting strategy

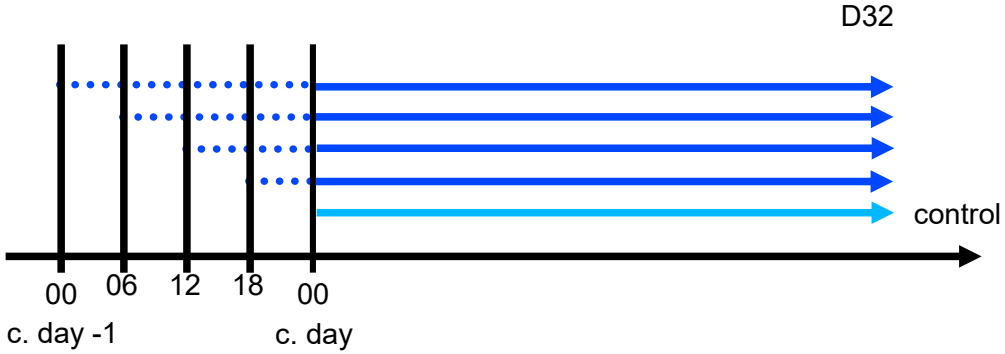
Forecast

- mixed lagged-perturbed ensemble of 41 members
- (up to) 32-day runs initialized every Wednesday -> 4 forecasts each month
- 10 runs at 00, 06, 12, 18 UTC of Wednesday + 1 “control” run at 00 UTC of Thursday
- initial conditions from NOAA-NCEP GEFS forecasts at 0-h lead time (analyses)



Reforecast

- 5-member ensemble simulations every 5 days on 73 calendar days over the 30-year period 1981-2010 → 10950 reforecasts
- initial conditions from ECMWF ERA-Interim



Forecasting strategy - calibration

Reforecasts are combined to perform a bias-removal forecast calibration.

A running average with Gaussian weights is used over the subset of 73 calendar days closest to initialization date

The weighting averaging technique accomplishes two goals:

- it defines a model mean climatological field for any initialization day;
- it filters out the shorter-scale.

The resulting climatology is used to compute the bias *b* for the selected initialization day *d*

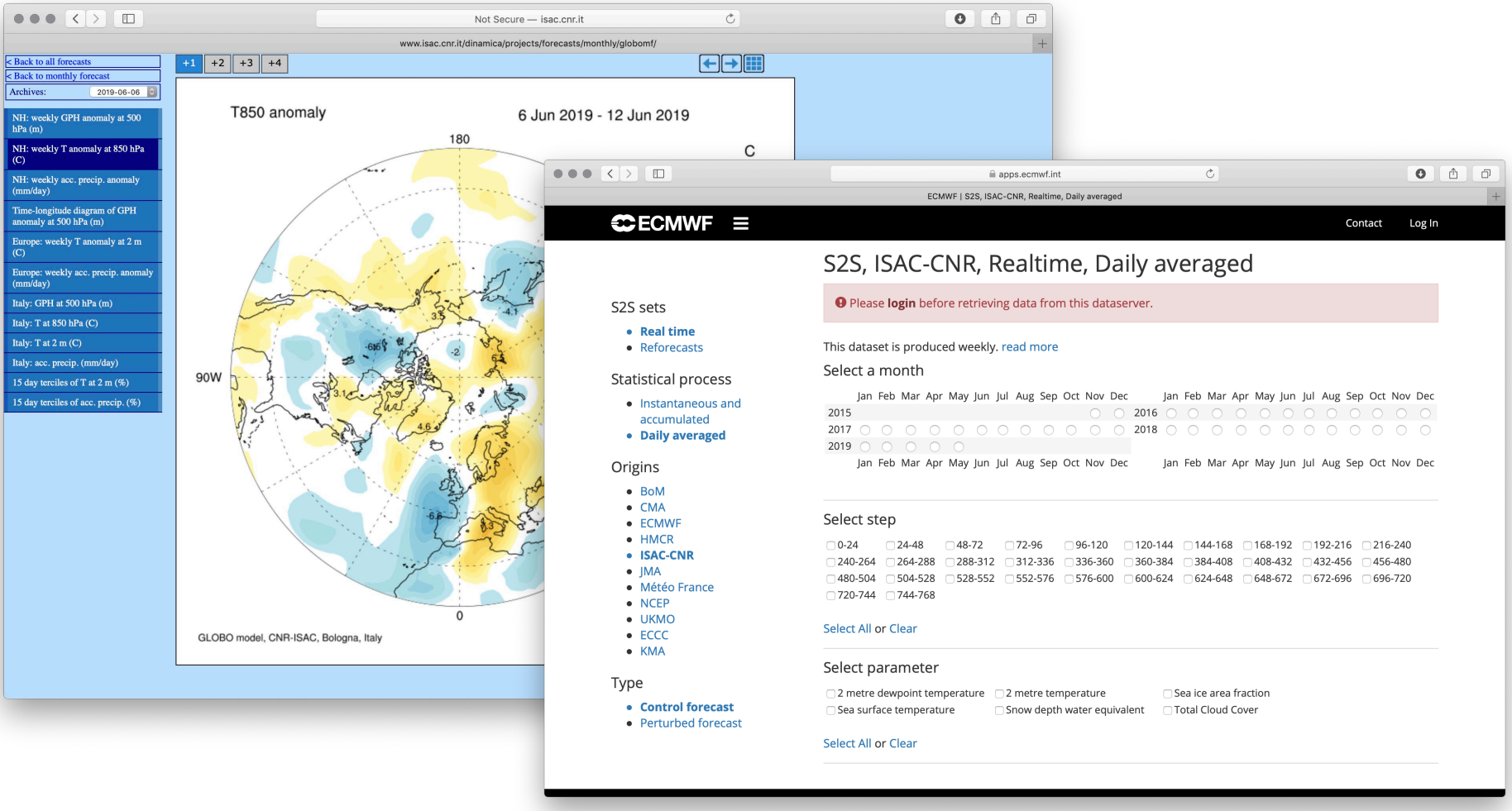
b is used to calibrate the forecast ensemble mean anomaly.

$$b(\lambda, \vartheta, v, d) = \frac{1}{W}\sum_{i=1}^{73} B_i(\lambda, \vartheta, v)\, e^{-\left(|d-D_i|/\Lambda\right)^2}$$

The weights W_i also represent the normalized frequency of each reforecast in the resulting climatological distribution, which provides threshold values for probabilistic forecasts.

Subseasonal forecasting at CNR-ISAC - operational activity

http://www.isac.cnr.it/dinamica/projects/forecasts/monthly/monthly.htm



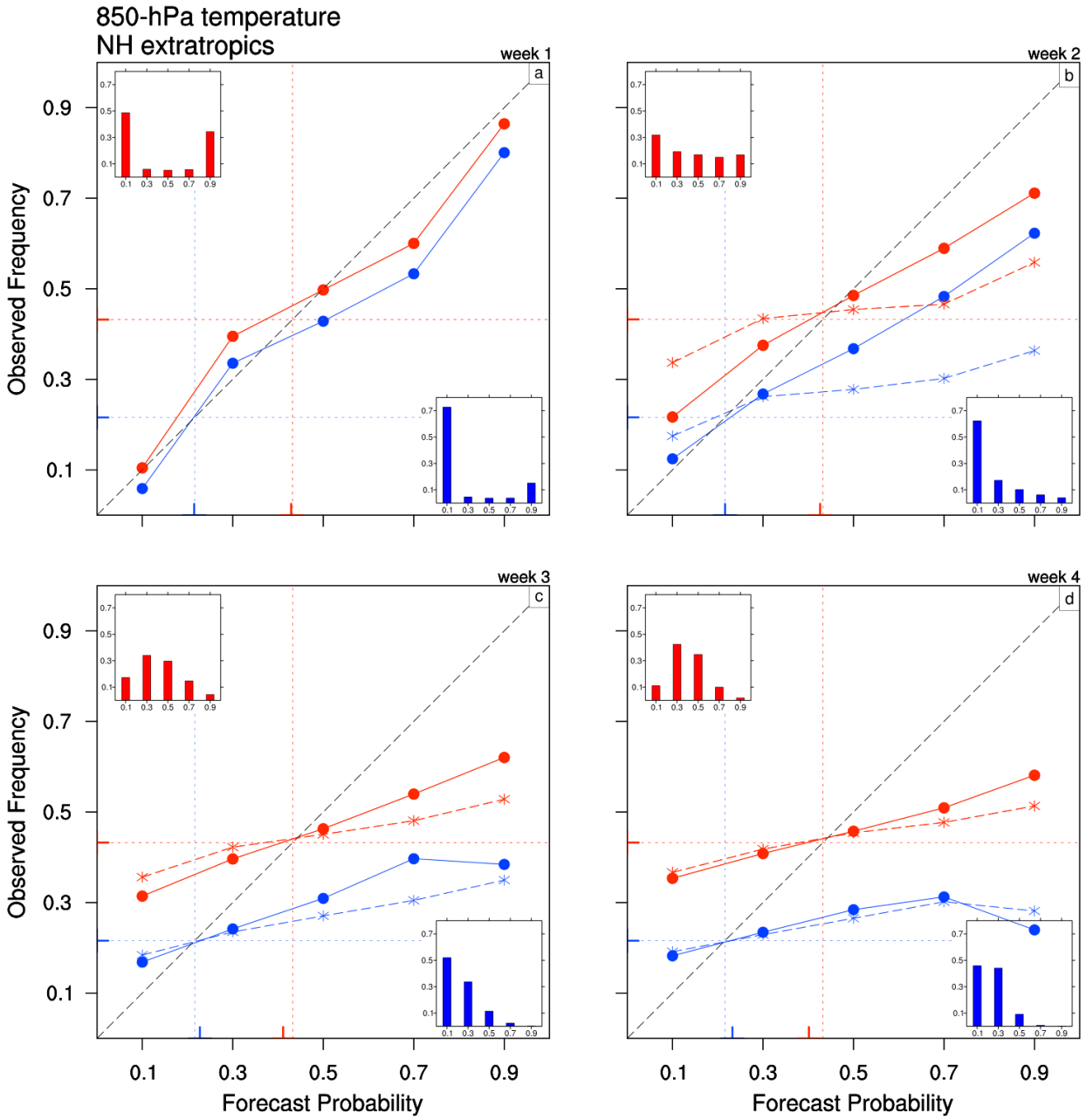
Subseasonal-to-Seasonal (S2S) Prediction Project, is a WWRP/THORPEX-WCRP joint research project established to improve forecast skill and understanding on the sub-seasonal to seasonal time scale, and promote its uptake by operational centers and exploitation by the applications community.

Verification

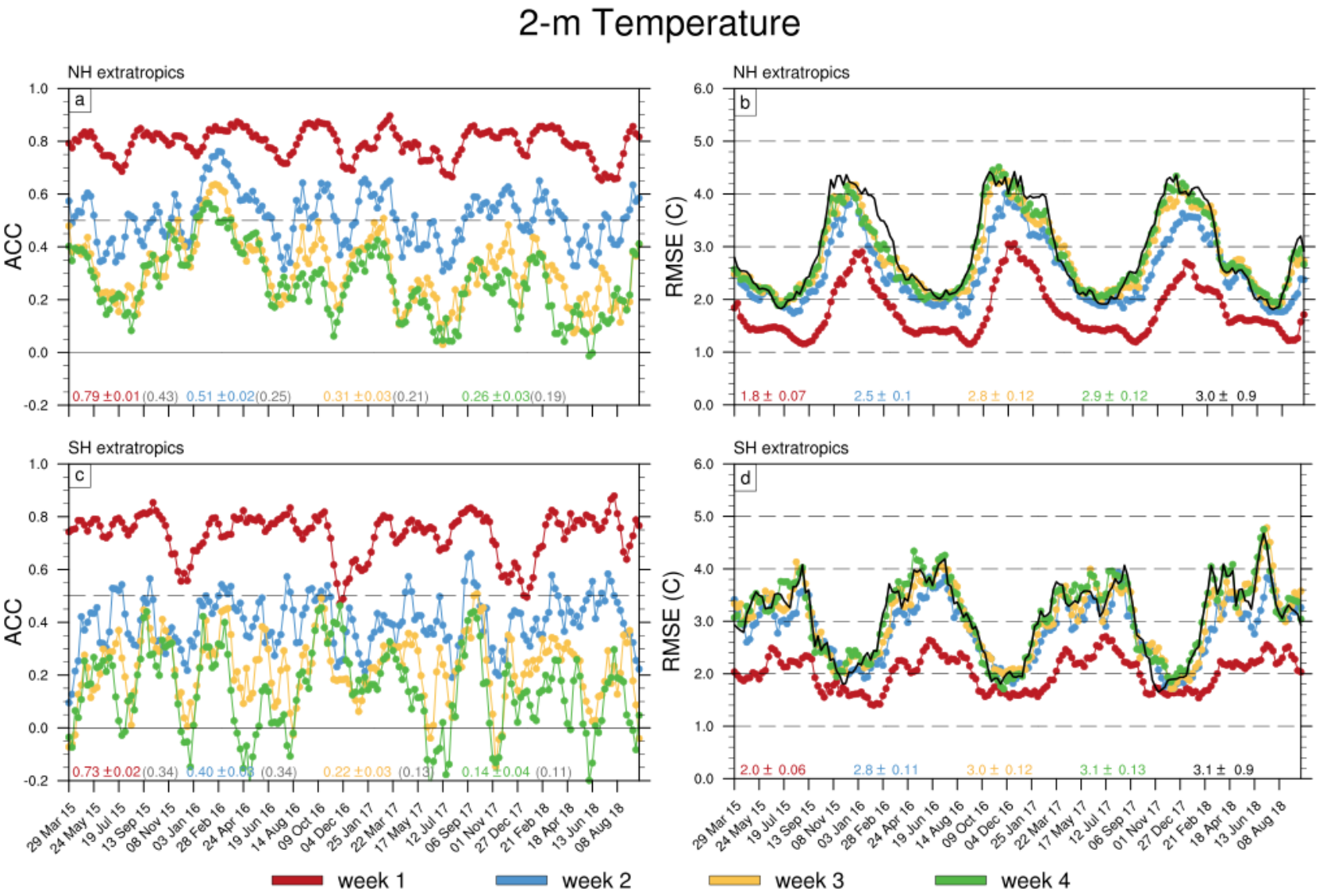
- verification based on 184 cases (41-member forecasts), ranging from 29 Mar 2015 to 26 Set 2018
- all forecasts are obtained with the “S2S version” of GLOBO and are evaluated as weekly means
- bilinearly interpolated to a 1.5 x 1.5 lat-lon grid
- verifying against ERA5 reanalysis
- verifying anomalies and climatological distributions referred to the 1981-2010 climate
- probabilistic verification based on reliability diagrams
- non probabilistic scores based on uncentered anomaly correlation (ACC), root mean square error (RMSE)

Mastrangelo, D. and P. Malguzzi, 2019: Verification of two years of CNR-ISAC subseasonal forecasts. Wea. Forecasting, 34, 331–344, https://doi.org/10.1175/WAF-D-18-0091.1.

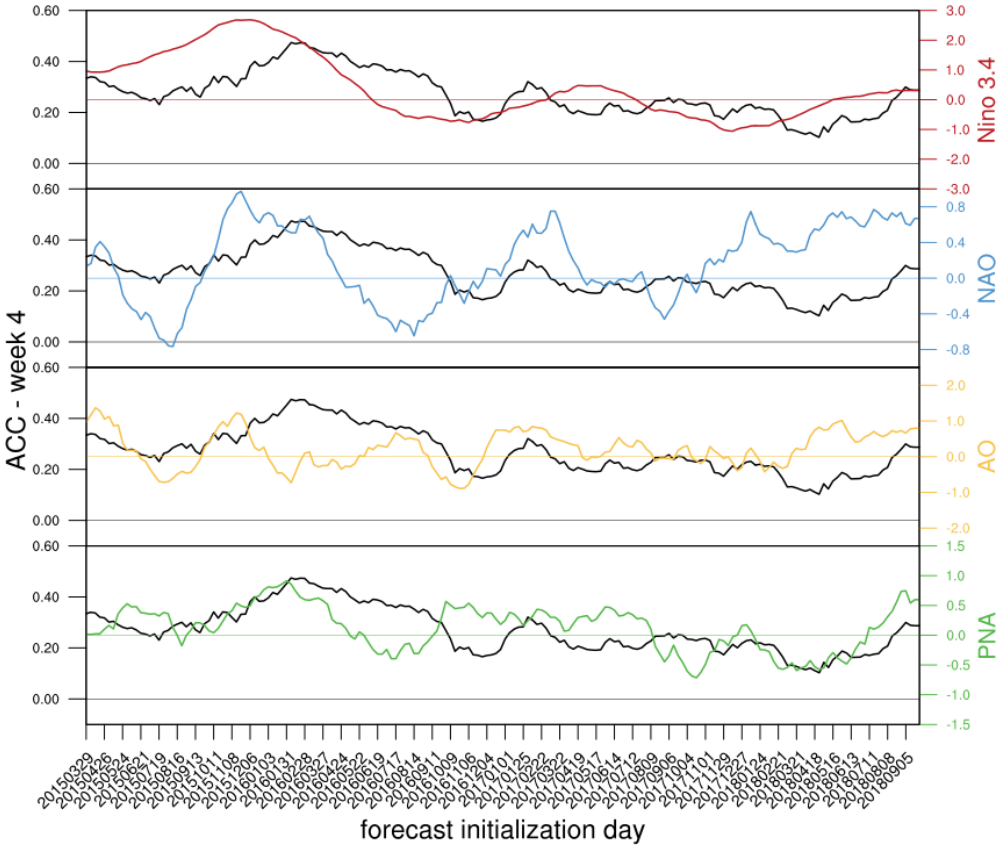
Verification - reliability diagram

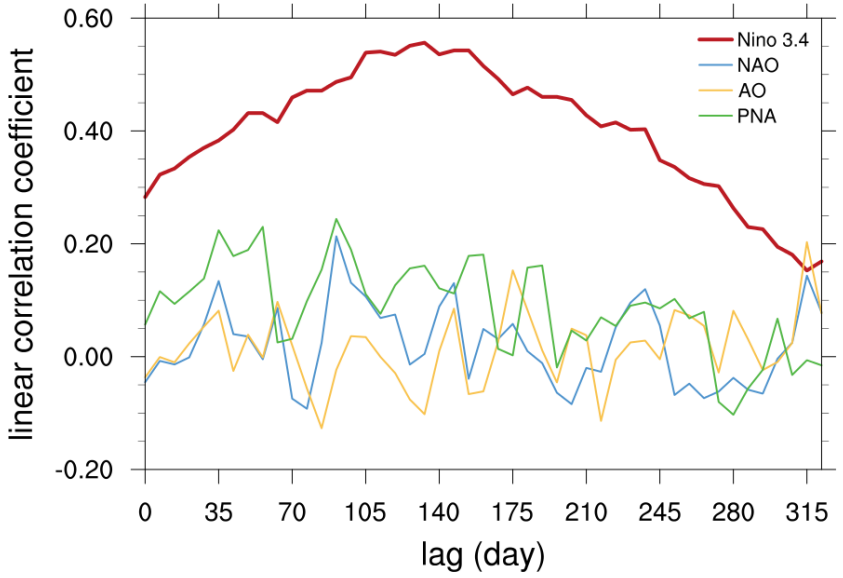


Verification - deterministic scores



Subseasonal forecasting - predictability sources





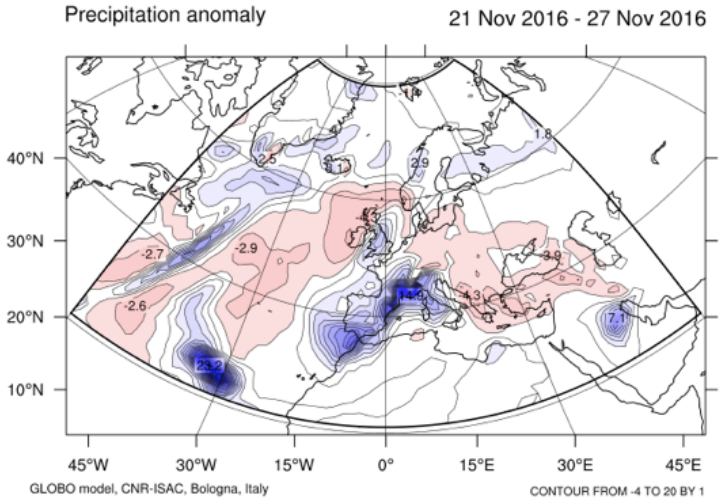
ACC NH	Nino 3.4	NAO	AO	PNA
week 3	0.15	0.07	0.02	0.07
week 4	0.29	-0.05	-0.04	0.06

- greatest correlation coefficient for Nino 3.4, peaking at at ~4 month lag
- correlation at w4 > w3 - statistically significant at the 95% level (two-tailed Student-t test)
- El Nino 2015/16 -> window of opportunity

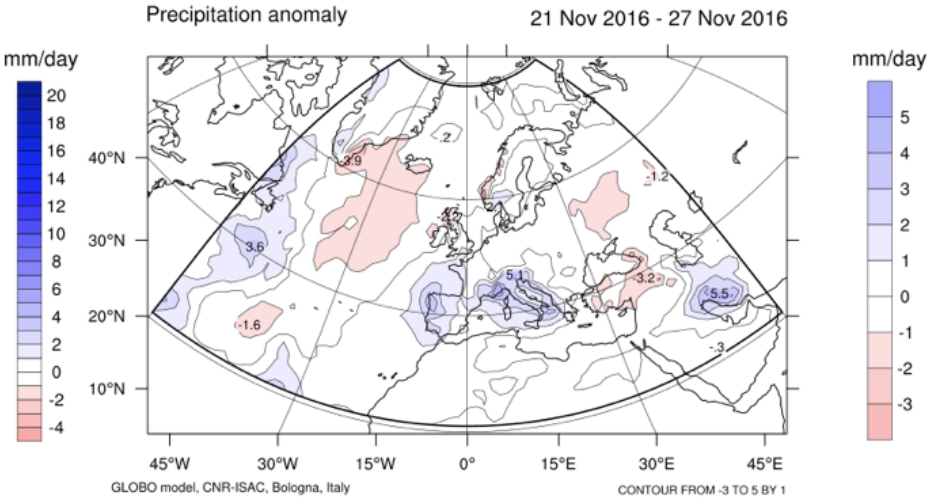
Subseasonal forecasting - extreme events

GLOBO

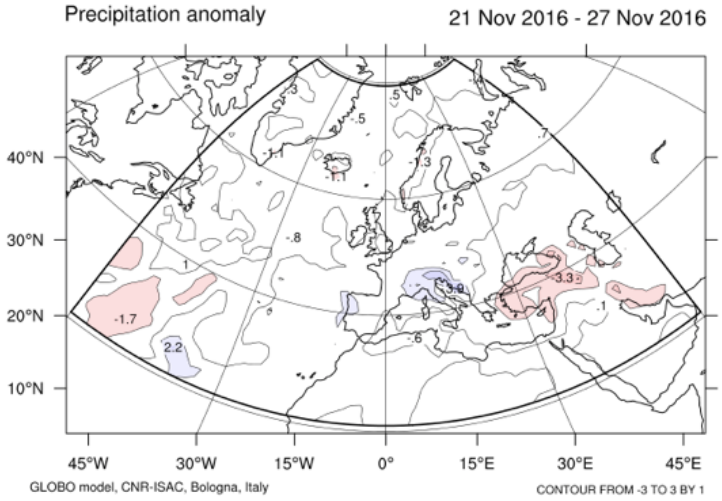
IC 20 Nov, day 1-7



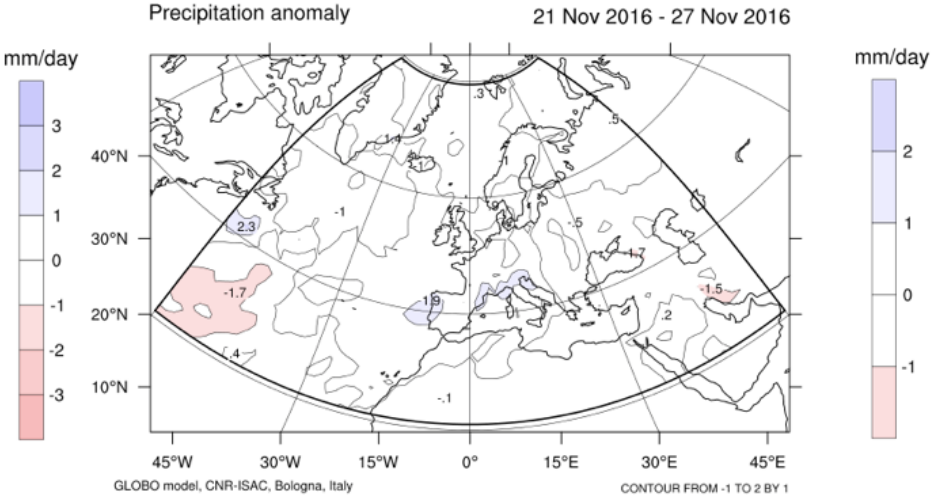
IC 13 Nov, day 8-14



IC 6 Nov, day 15-21



IC 31 Oct, day 22-28



Subseasonal forecasting - extreme events

GLOBO

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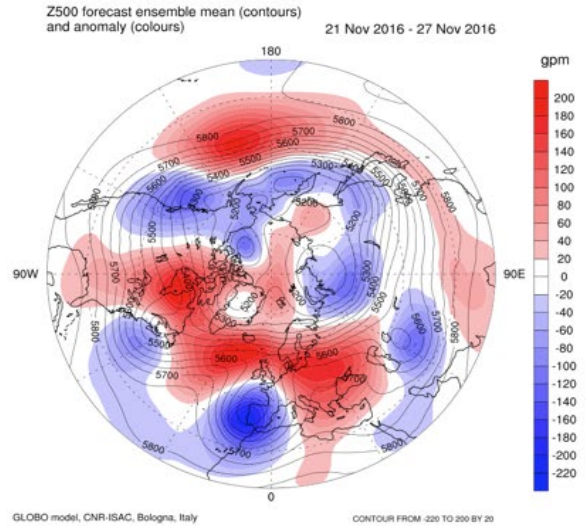

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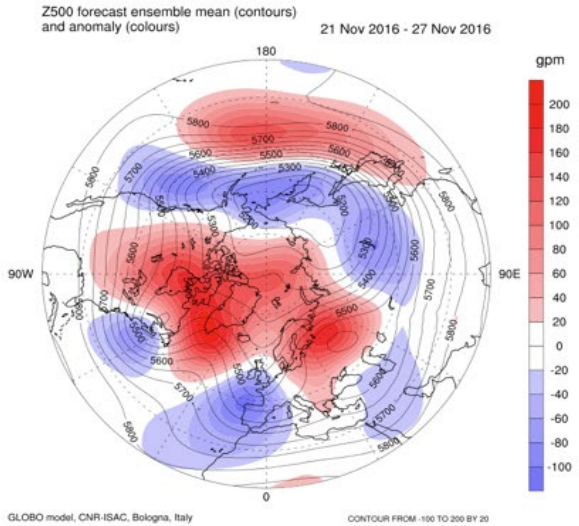

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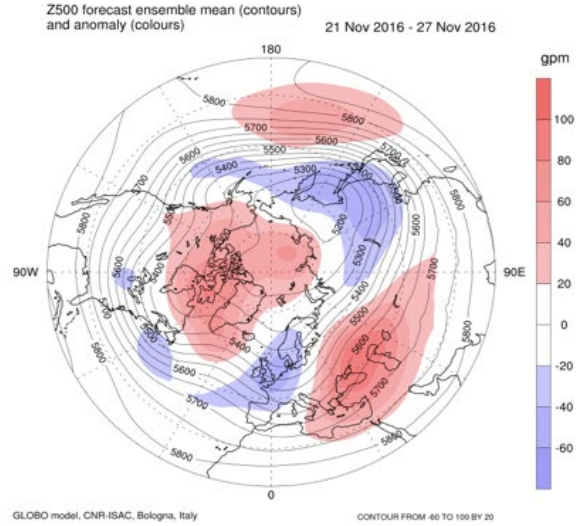

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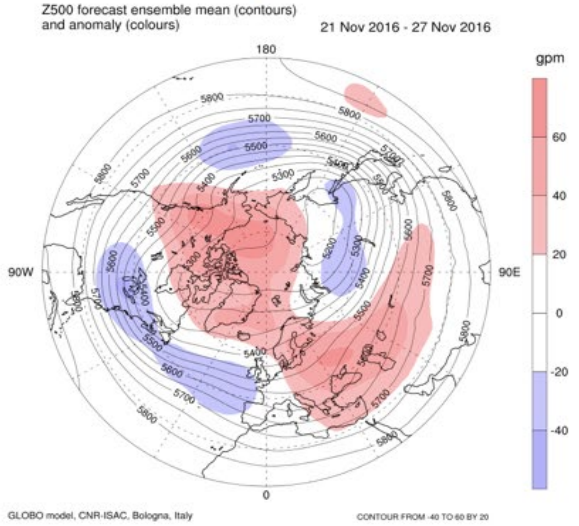
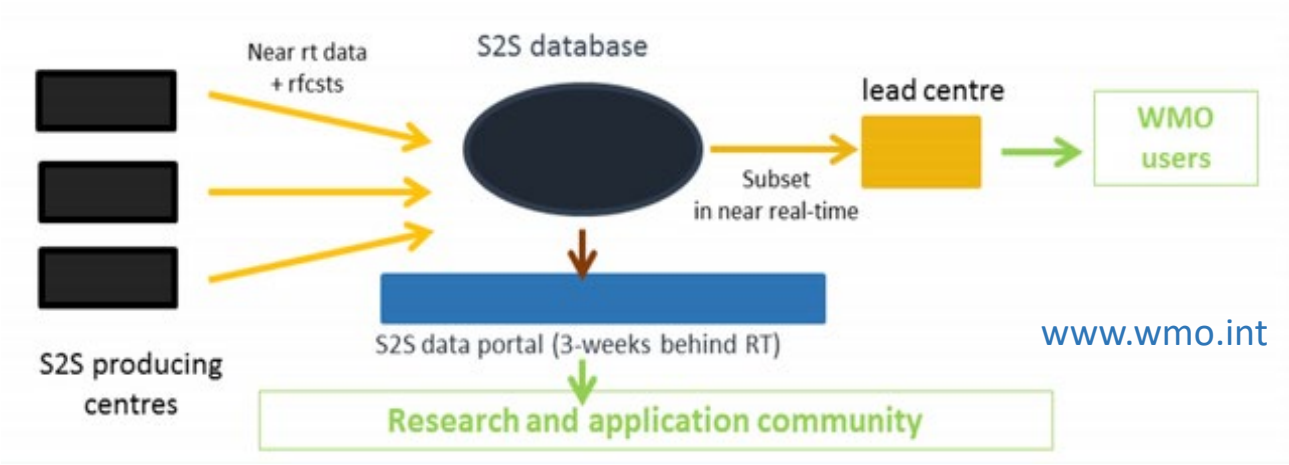


Subseasonal forecasting at CNR-ISAC

- Convenzione DPC/CNR-ISAC
- model update: increased resolution, new soil scheme (?), ocean coupling (??)
- new reforecast dataset initialized on ERA5 -> larger ensemble
  - calibration
  - verification on a longer dataset
- subseasonal sources of predictability, subseasonal prediction of “extreme” events, multi-model prediction and comparison
- S2S, phase II (2019-2023)



participation in the S2S-subproject “Real time pilot initiative”: make some derived variables available in real-time for a limited period of time and for selected projects, in partnership with the Italian Civil Protection Department