



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

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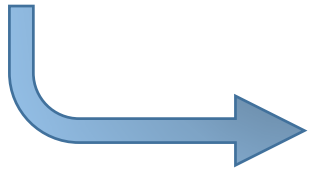
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Bologna

Why subseasonal forecasting?

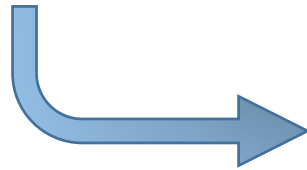
scientific and technical improvements

- 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

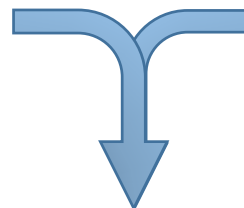


weather prediction

(predictability 1st kind)

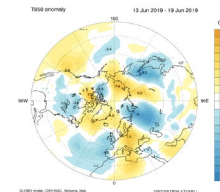
climate prediction

(predictability 2nd kind)



subseasonal to seasonal (S2S)

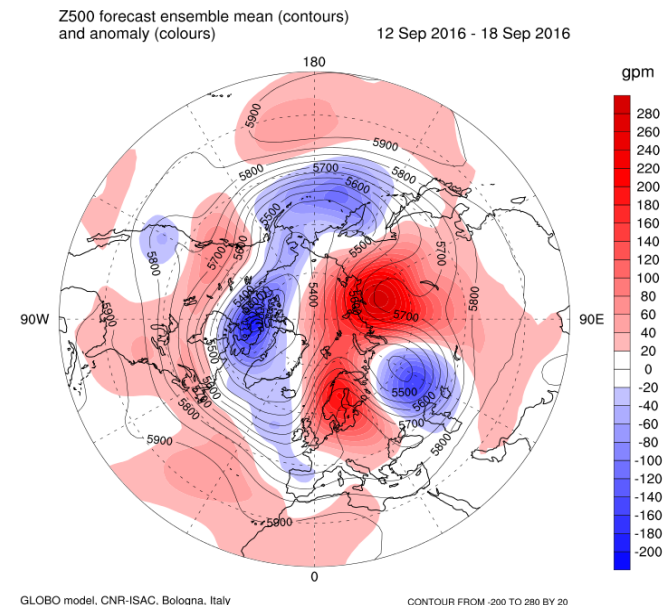
two weeks <



< season

Subseasonal forecasting with the GLOBO model

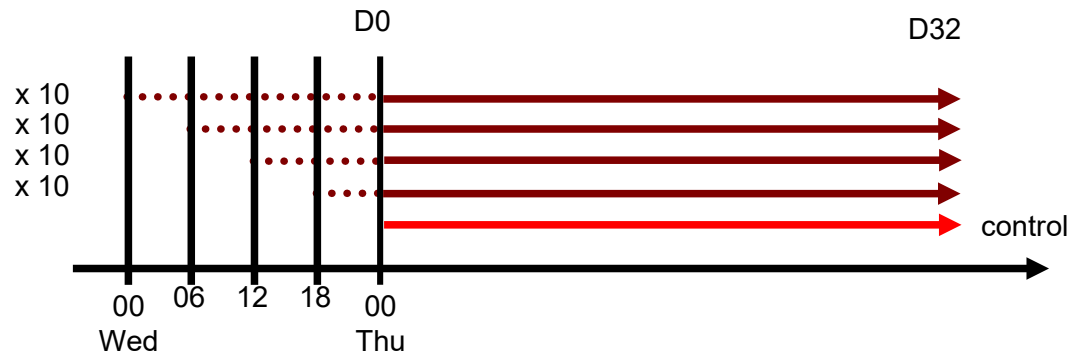
- experimental activity started in 2009 in the framework of a cooperation with the National Civil Protection Department
- ensemble forecasting system based on the atmospheric general circulation model **GLOBO**, a global, grid-point spherical domain, hydrostatic model (Malguzzi et al., WAF, 2011)
- regular 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

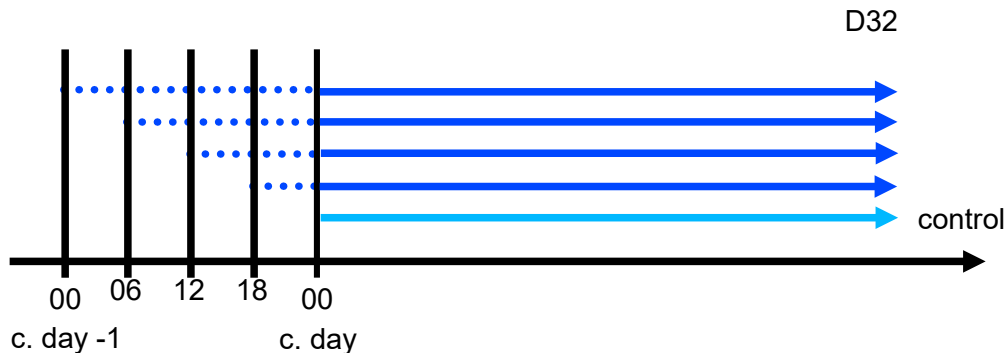
Forecast

- 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.

$$b(\lambda, \mathcal{G}, \nu, d) = \frac{1}{W} \sum_{i=1}^{73} B_i(\lambda, \mathcal{G}, \nu) e^{-(|d-D_i|/\Delta)^2}$$

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>

The image shows a web browser window displaying a subseasonal forecasting interface. The browser address bar shows `www.isac.cnr.it/dinamica/projects/forecasts/monthly/globomf/`. The main content area features a map titled "T850 anomaly" for the period "6 Jun 2019 - 12 Jun 2019". The map shows a color-coded anomaly field over the North Atlantic and Europe, with values ranging from -6 to 6. The map is labeled "GLOBO model, CNR-ISAC, Bologna, Italy".

On the left side of the browser window, there is a navigation menu with the following items:

- Back to all forecasts
- Back to monthly forecast
- Archives: 2019-06-06
- NH: weekly GPH anomaly at 500 hPa (m)
- NH: weekly T anomaly at 850 hPa (C)
- NH: weekly acc. precip. anomaly (mm/day)
- Time-longitude diagram of GPH anomaly at 500 hPa (m)
- Europe: weekly T anomaly at 2 m (C)
- Europe: weekly acc. precip. anomaly (mm/day)
- Italy: GPH at 500 hPa (m)
- Italy: T at 850 hPa (C)
- Italy: T at 2 m (C)
- Italy: acc. precip. (mm/day)
- 15 day terciles of T at 2 m (%)
- 15 day terciles of acc. precip. (%)

The right side of the browser window shows the ECMWF S2S, ISAC-CNR, Realtime, Daily averaged interface. The page title is "S2S, ISAC-CNR, Realtime, Daily averaged". A red banner at the top right says "Please login before retrieving data from this dataserver." Below this, there is a section for "Select a month" with a calendar grid for the years 2015, 2017, and 2019. The "Daily averaged" option is selected. Other sections include "Select step" with various time intervals (e.g., 0-24, 24-48, etc.), "Select parameter" with options like "2 metre dewpoint temperature" and "Sea ice area fraction", and "Select All or Clear" buttons.

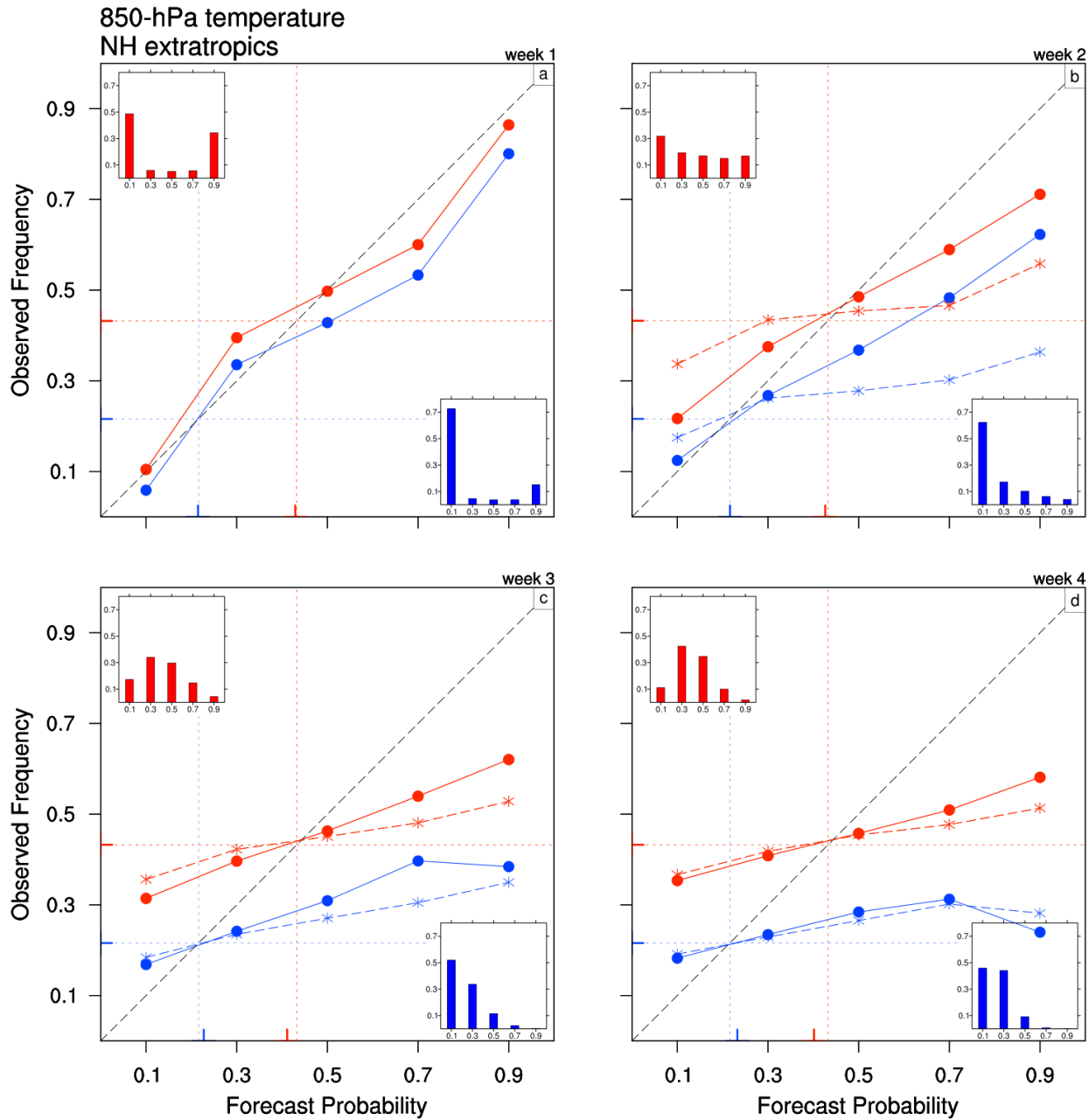
Subseasonal-to-Seasonal (S2S) Prediction Project, is a WWRP/THORPEX-WCRP joint research project established to improve forecast skill and understanding on the sub-seasonal to seasonal time scale, and promote its uptake by operational centers and exploitation by the applications community.

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)

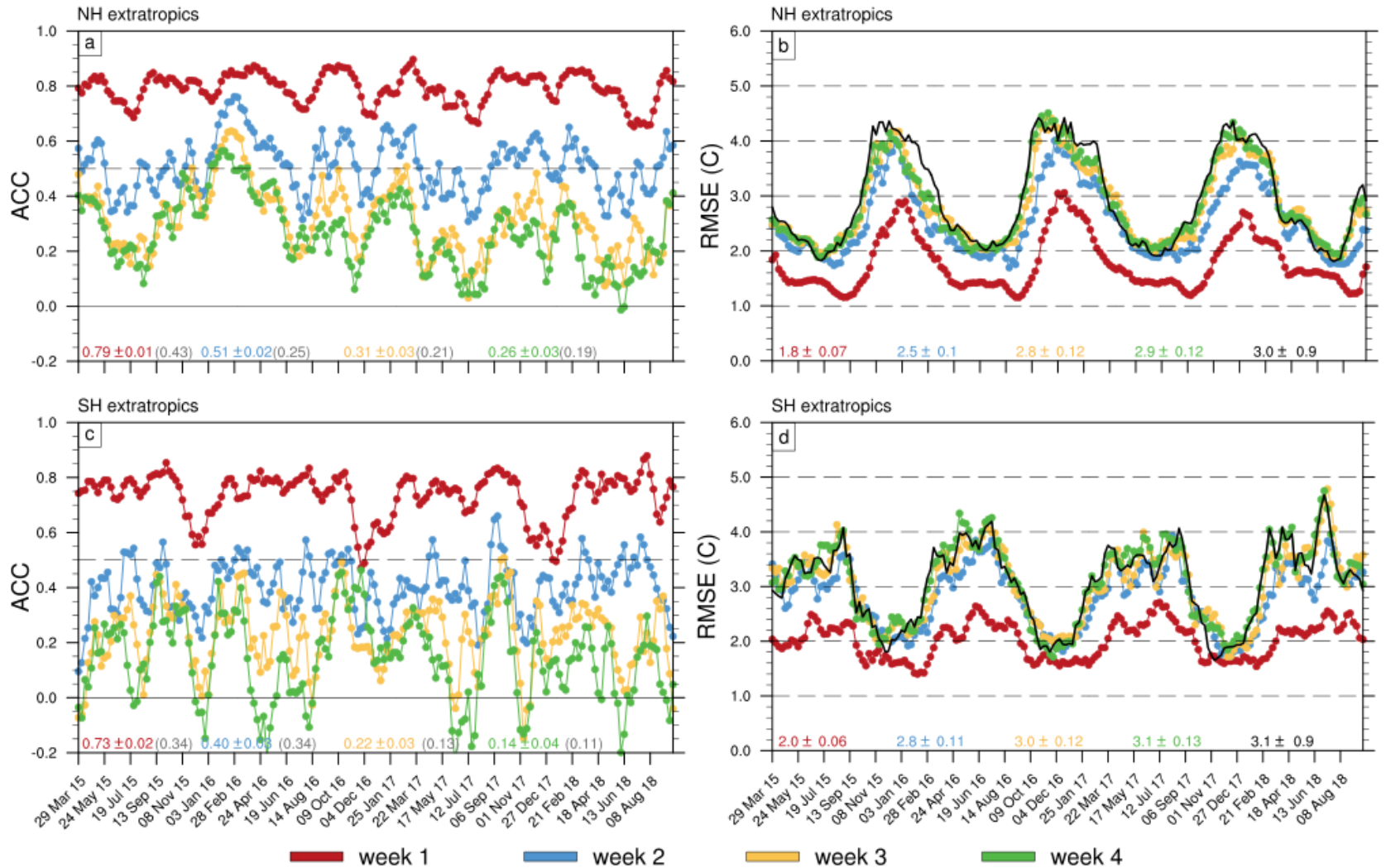
Mastrangelo, D. and P. Malguzzi, 2019: Verification of two years of CNR-ISAC subseasonal forecasts. *Wea. Forecasting*, 34, 331–344, <https://doi.org/10.1175/WAF-D-18-0091.1>.

Verification - reliability diagram

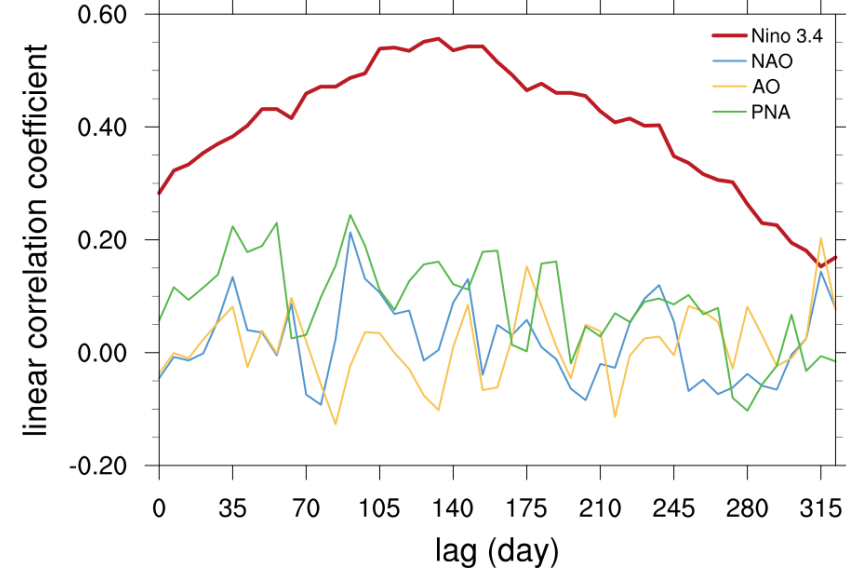
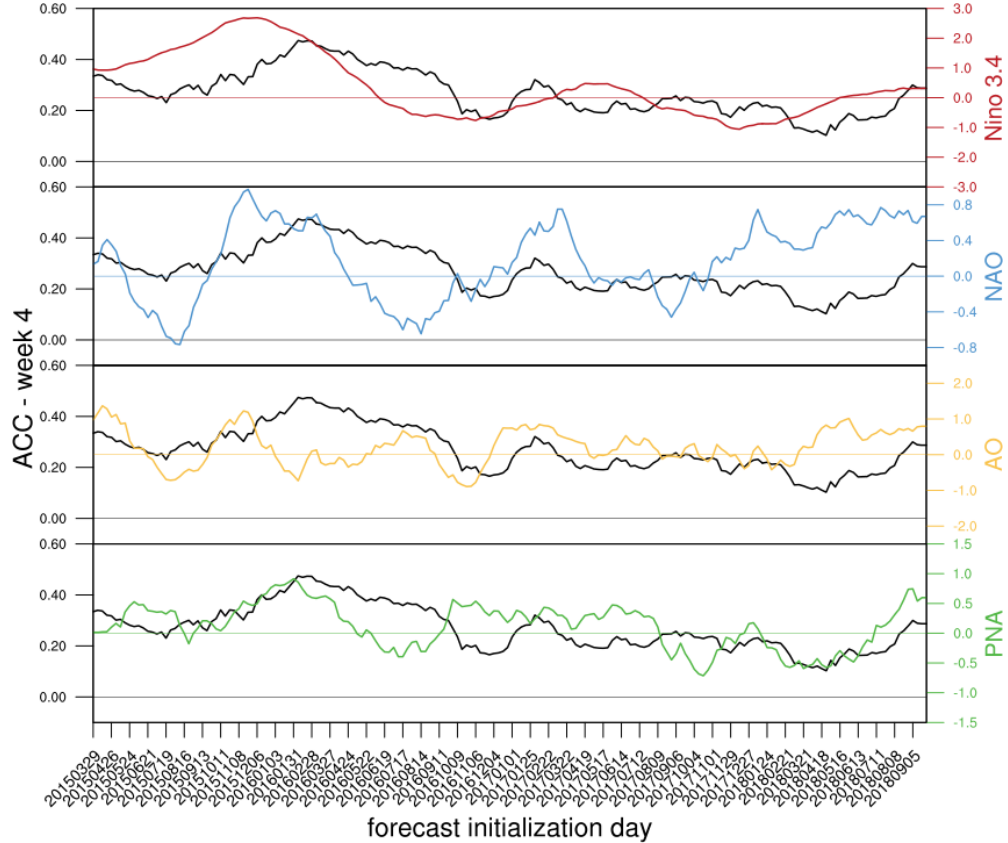


Verification - deterministic scores

2-m Temperature



Subseasonal forecasting - predictability sources



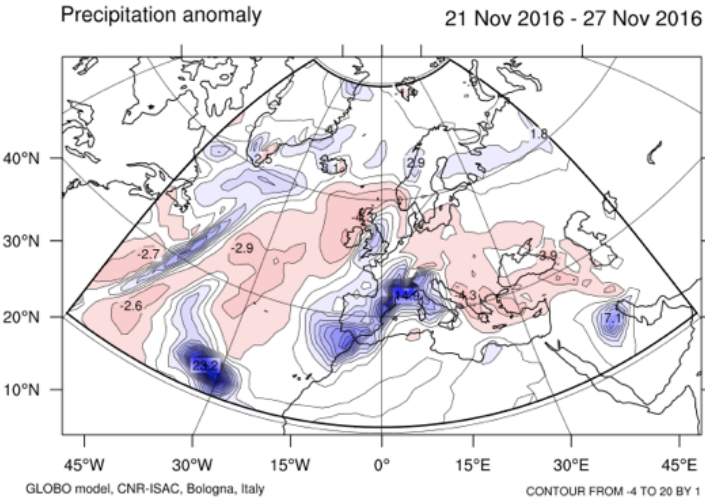
ACC NH	Nino 3.4	NAO	AO	PNA
week 3	0.15	0.07	0.02	0.07
week 4	0.29	-0.05	-0.04	0.06

- 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

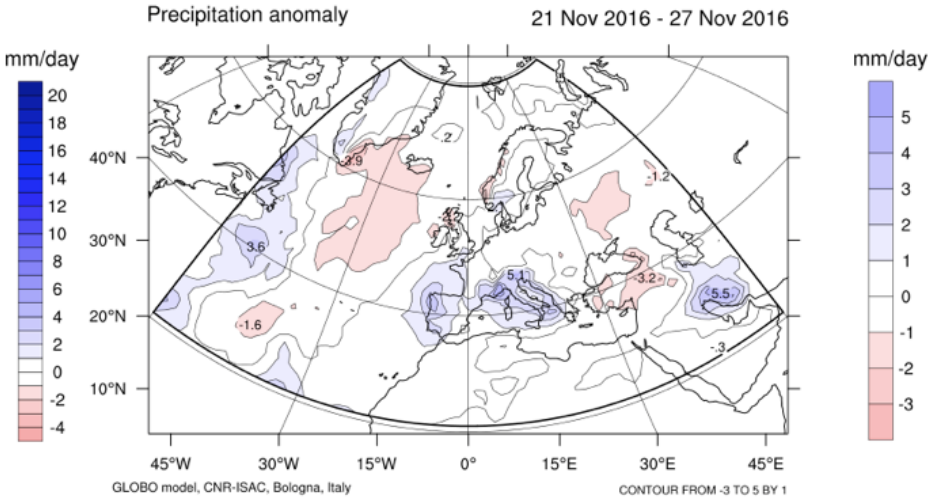
Subseasonal forecasting - extreme events

GLOBO

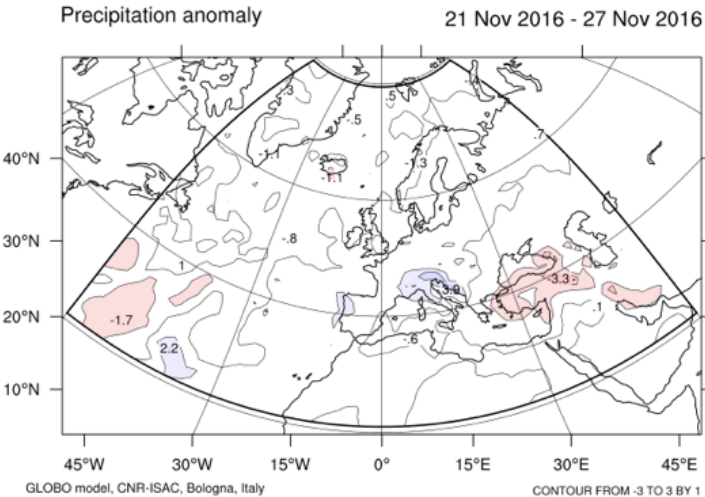
IC 20 Nov, day 1-7



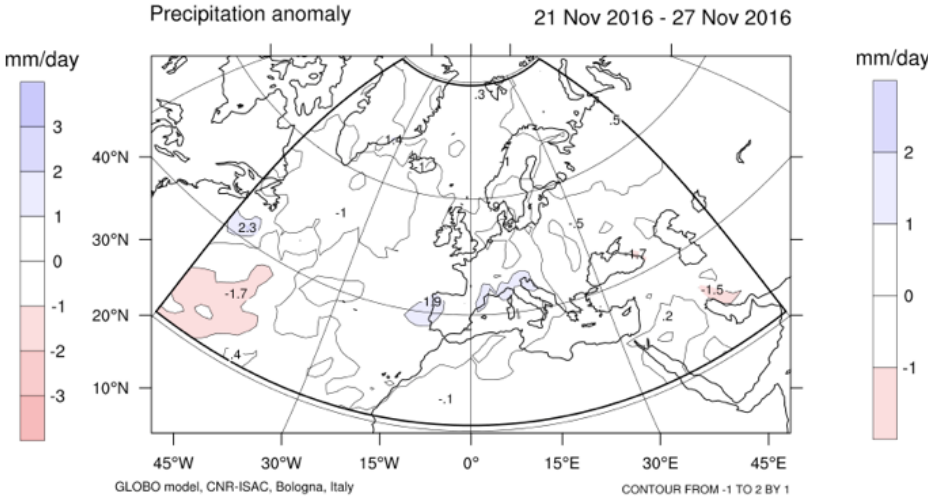
IC 13 Nov, day 8-14



IC 6 Nov, day 15-21



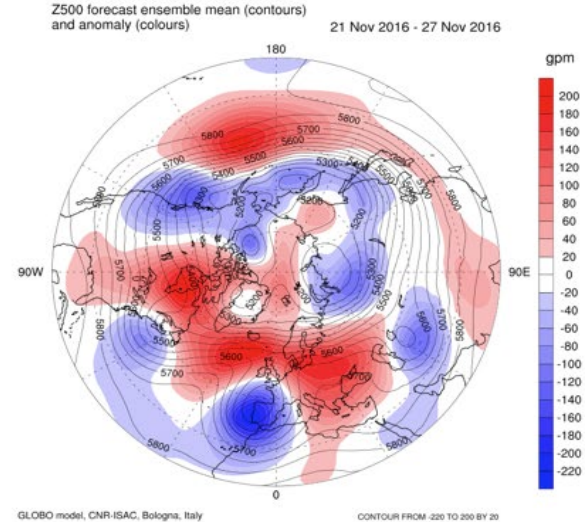
IC 31 Oct, day 22-28



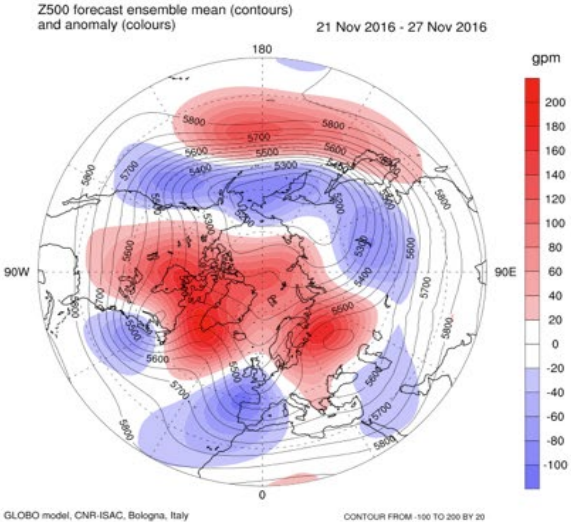
Subseasonal forecasting - extreme events

GLOBO

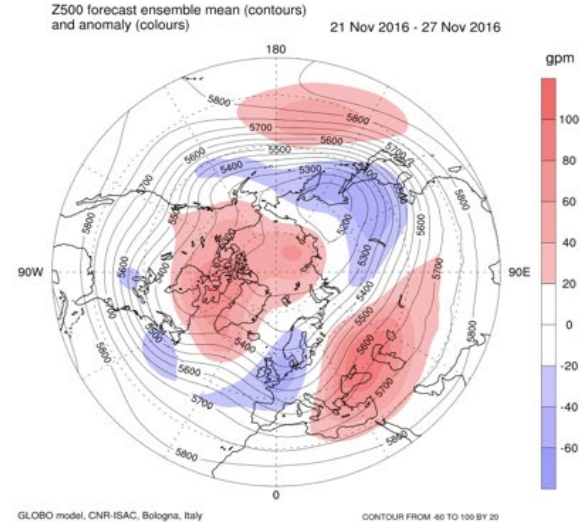
IC 20 Nov, day 1-7



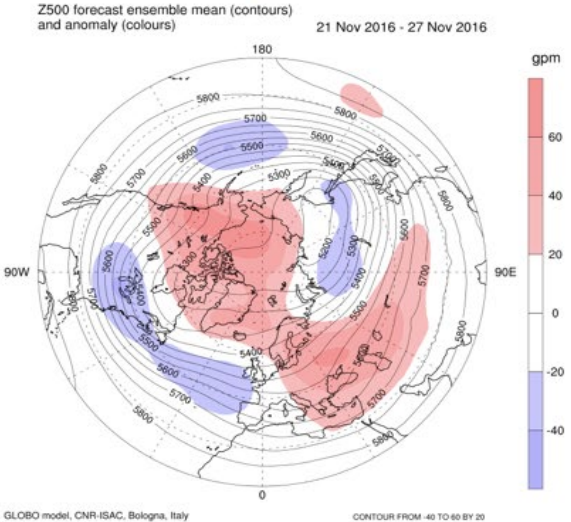
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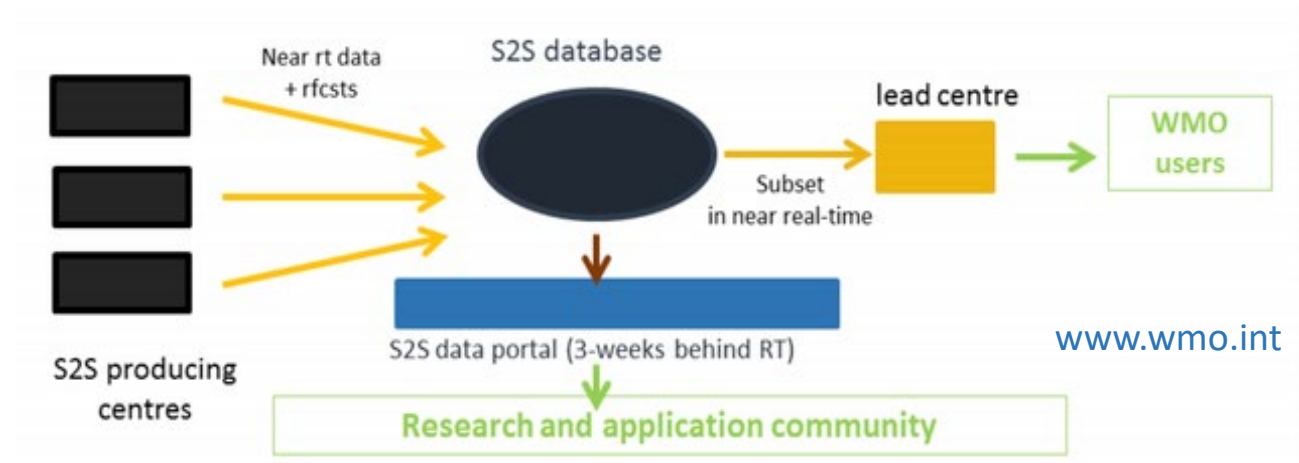


IC 31 Oct, day 22-28



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