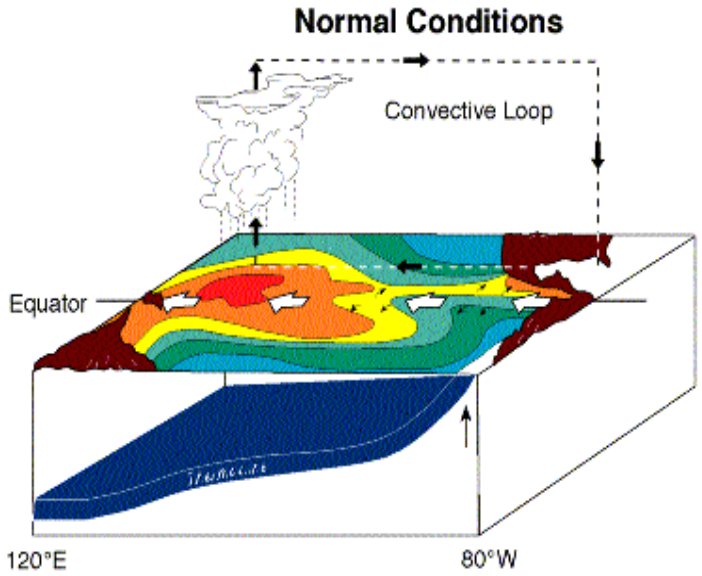
Previsioni a scala stagionale e annuale: progressi e aree di sviluppo

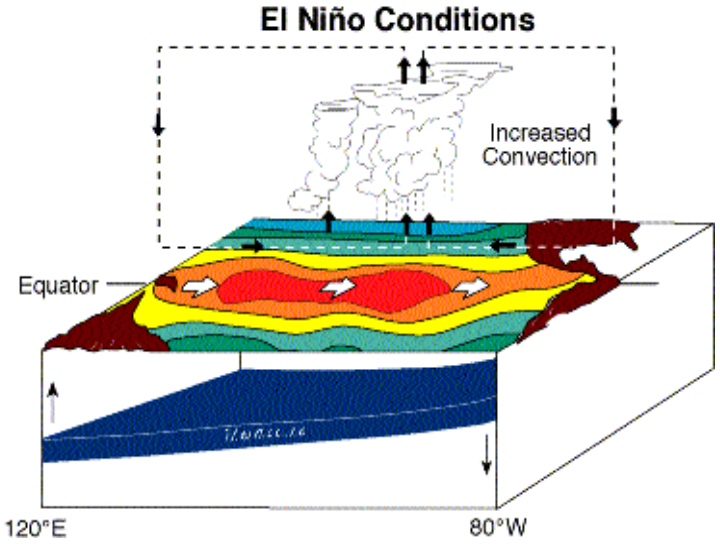
Franco Molteni

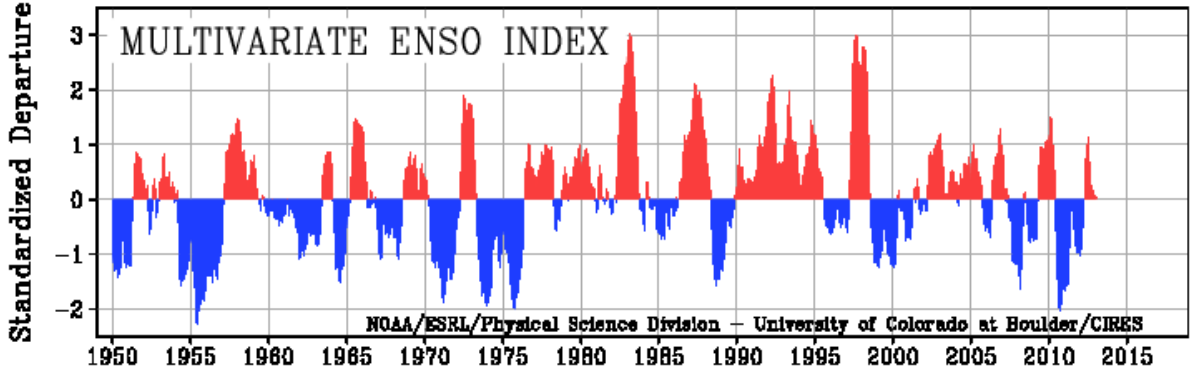
ECMWF, Reading, U.K.

ECMWF

ENSO: the main source of seasonal predictability







Prediction of the 1997 El Niño at ECMWF (Newsletter Autumn 1997)

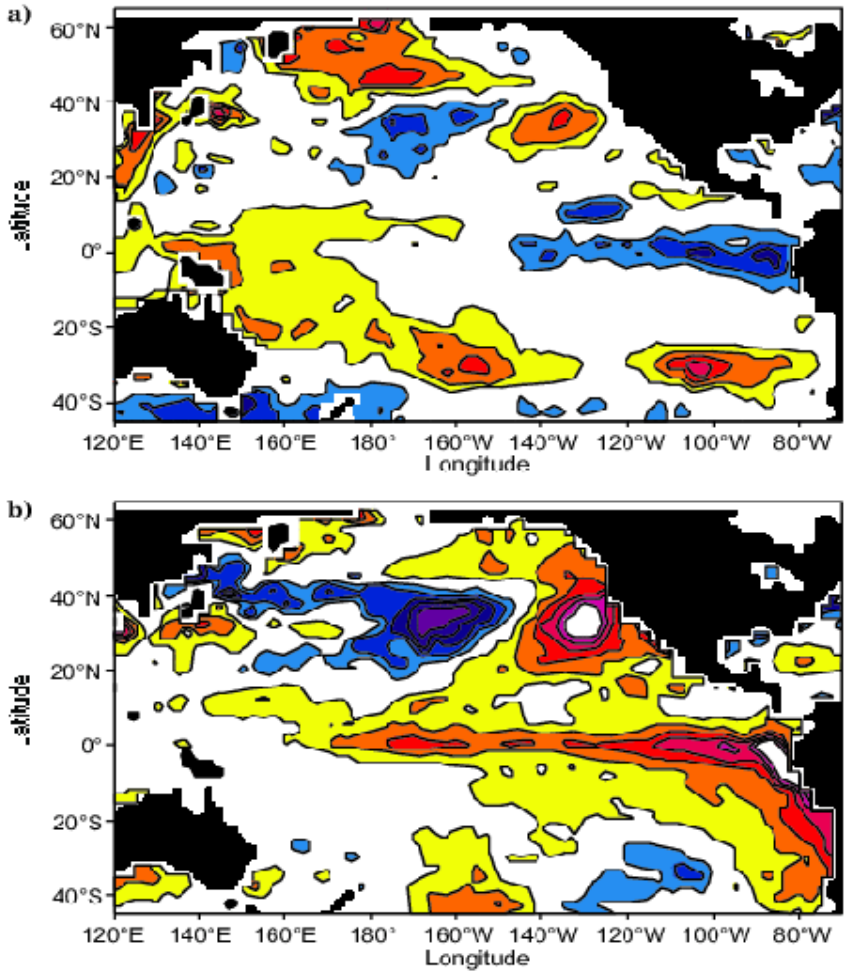
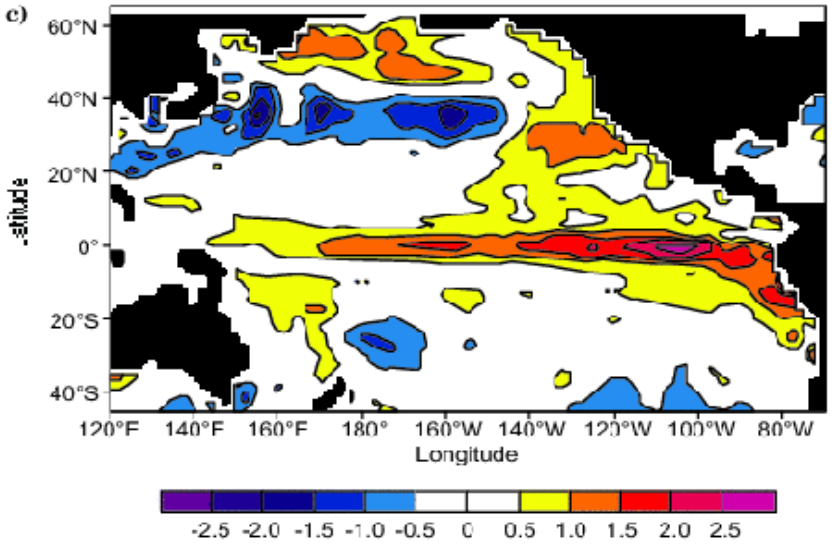
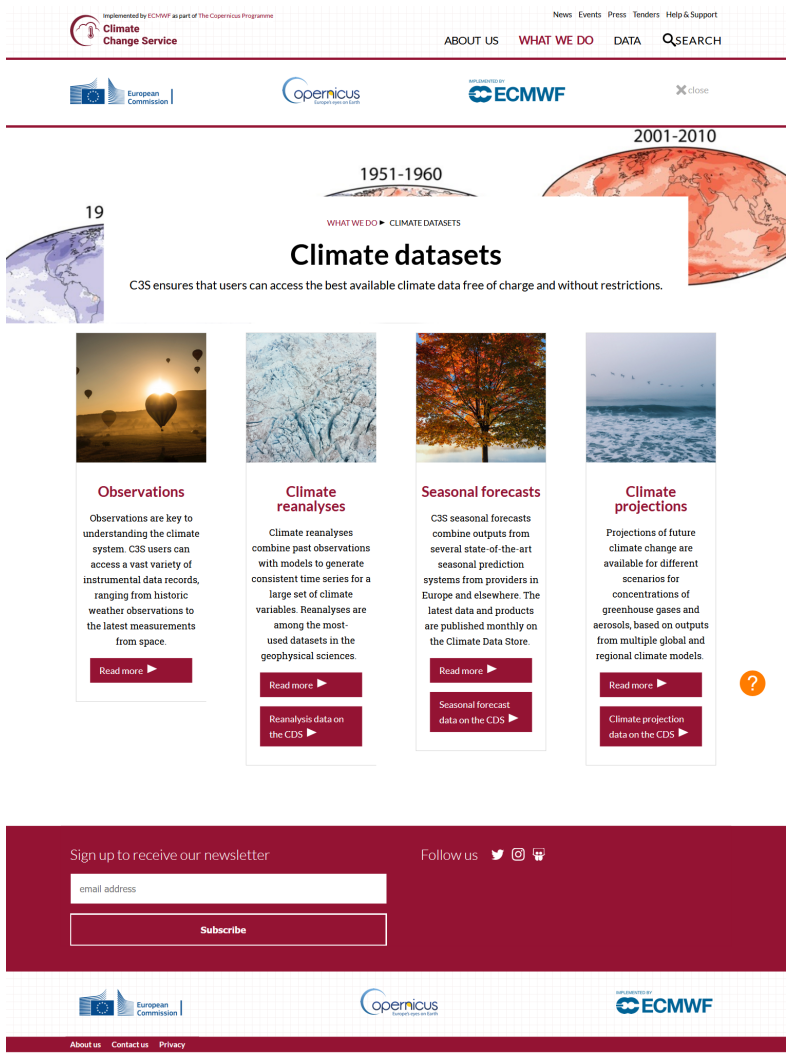


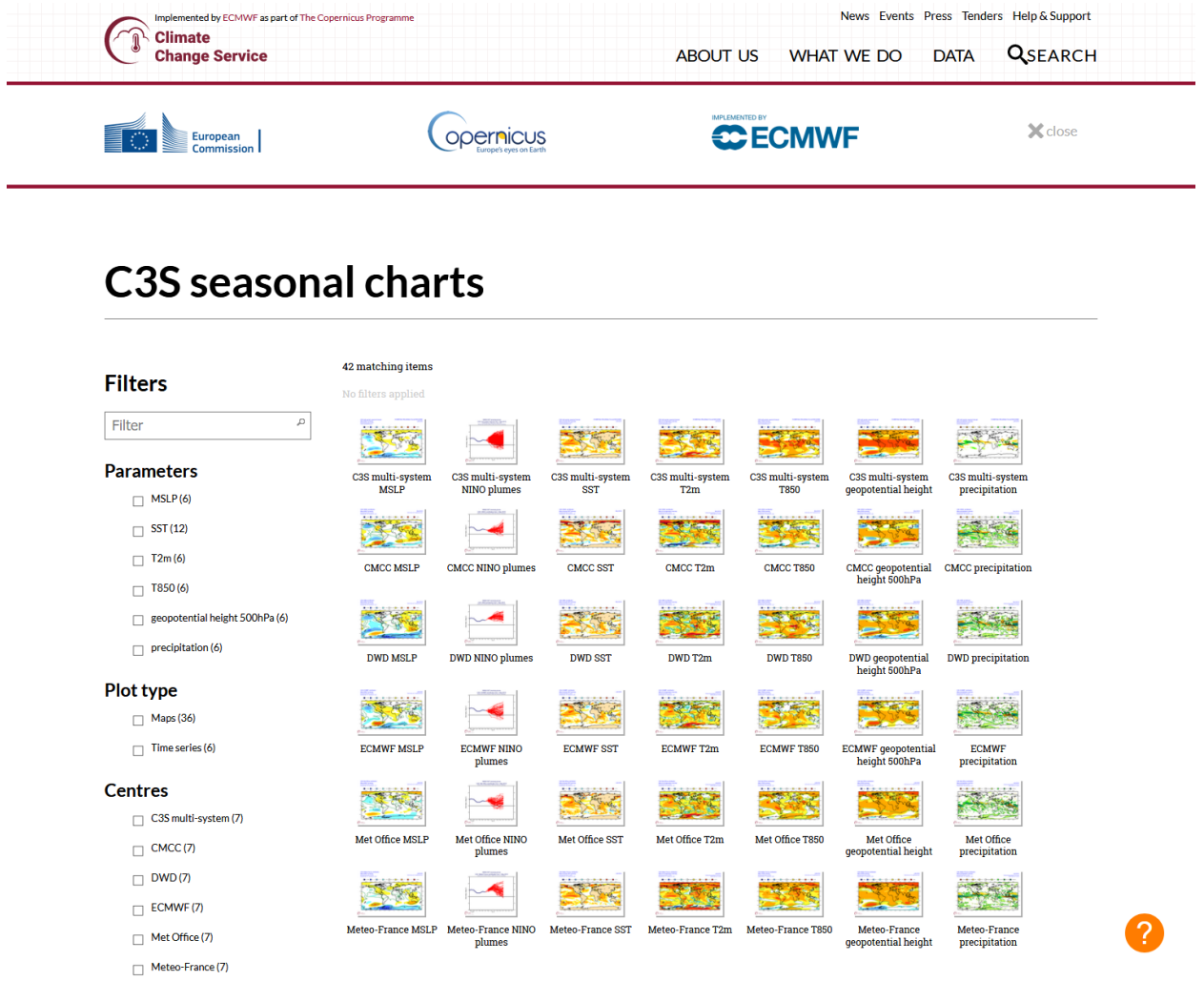
Fig 2: Plot of SST anomalies in the Pacific sector. a) Observed anomaly in December 1996; b) Observed anomaly in May 1997; c) Predicted SST anomaly for May 1997 from forecasts initiated during December 1996. Contour interval is 0.5°C. The change in equatorial SST was predicted quite well.

a) **Obs. SST anomaly, December 1996**
b) **Obs. SST anomaly, May1997**
c) **Predicted SST anomaly in May 1997 with i.c. in Dec. 1996**

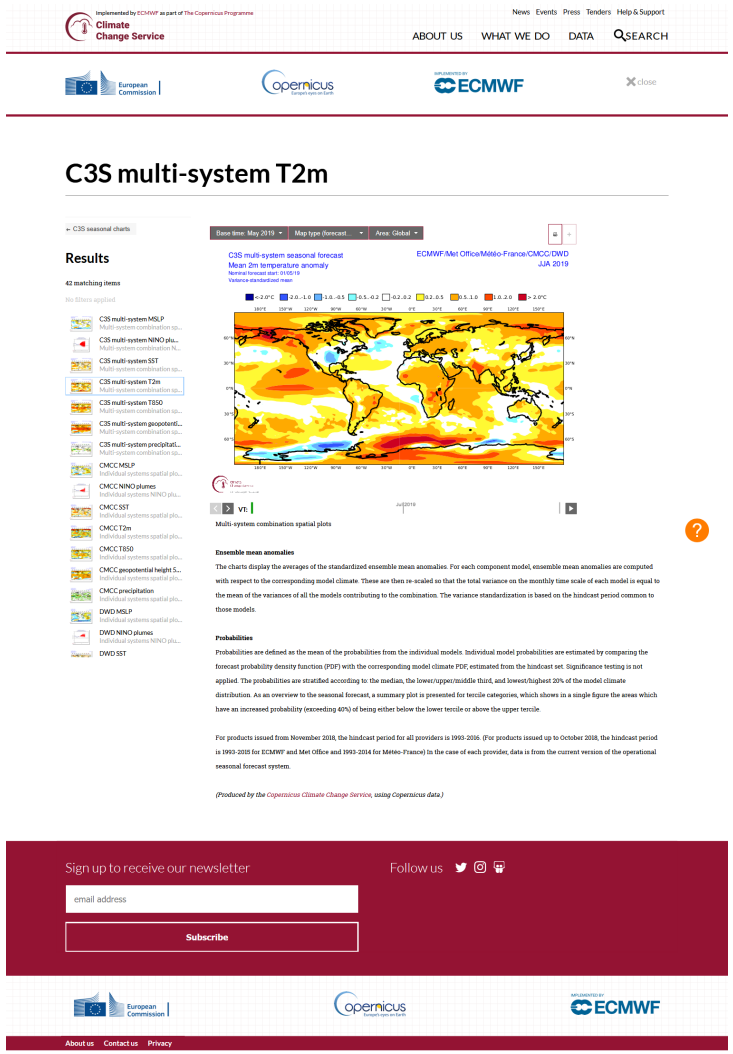


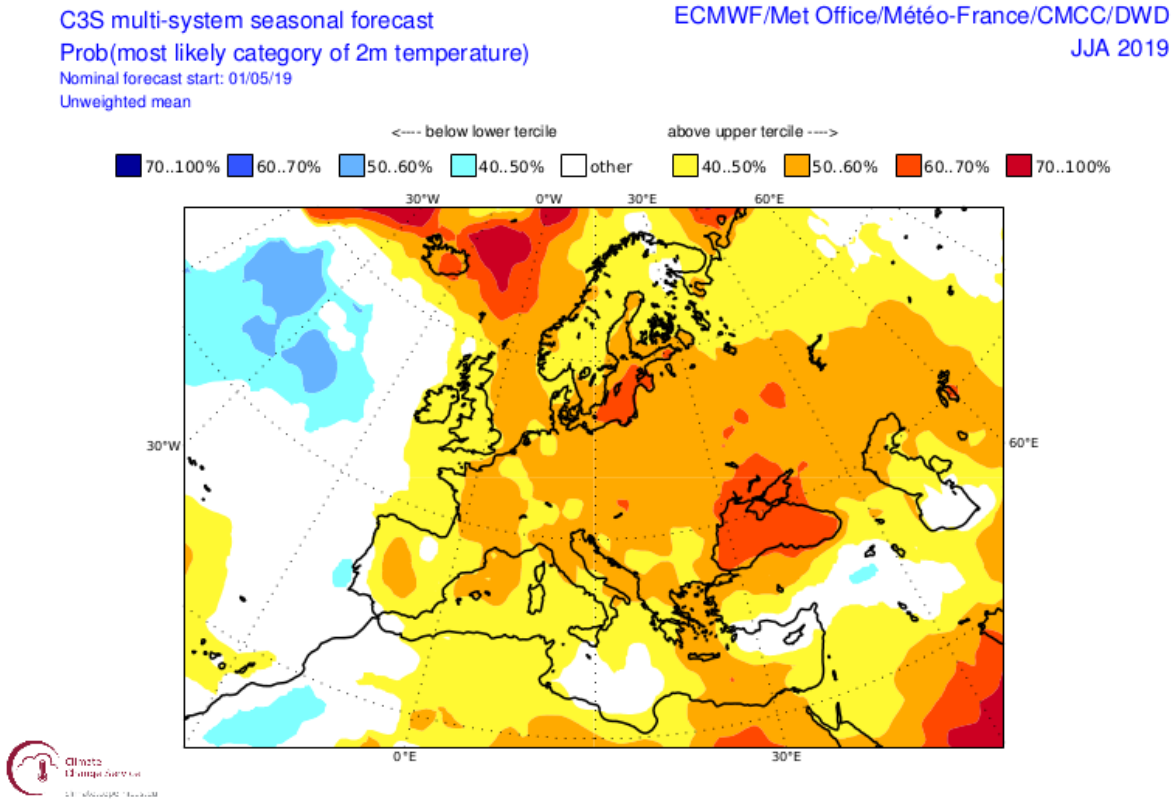
Seasonal forecasts in the Copernicus Climate Change Service (C3S)





Multi-model seasonal forecasts in C3S: graphical products

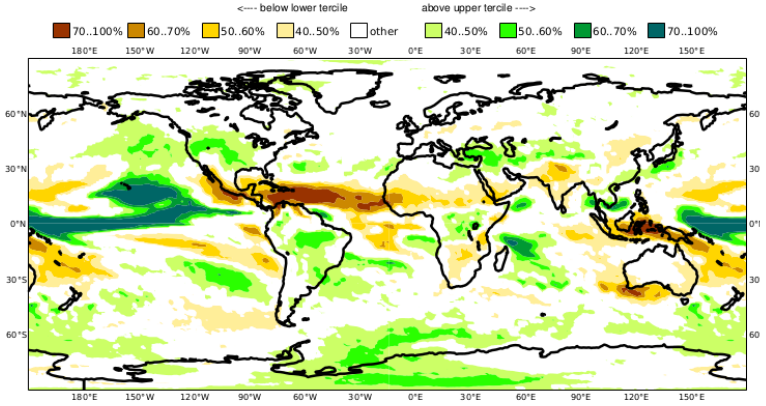




C3S predictions for JJA 2019 from 1 May: multi- and single-model forecasts

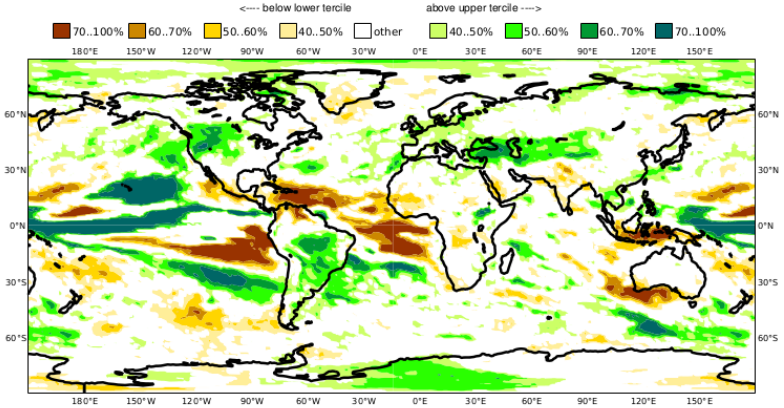
C3S multi-system seasonal forecast
Prob(most likely category of precipitation)
Nominal forecast start: 01/05/19
Unweighted mean

ECMWF/Met Office/Météo-France/CMCC/DWD
JJA 2019



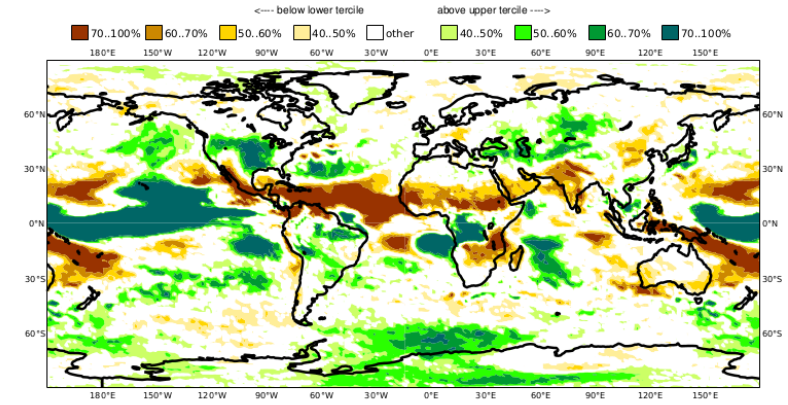
C3S: CMCC contribution
Prob(most likely category of precipitation)
Nominal forecast start: 01/05/19
Ensemble size = 50, climate size = 960

JJA 2019



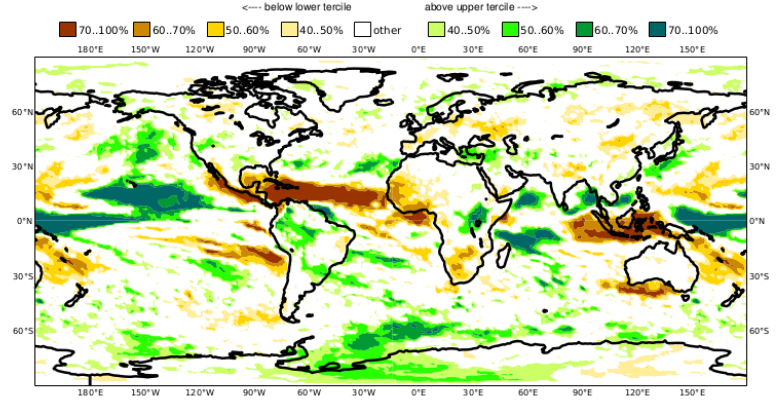
C3S: DWD contribution
Prob(most likely category of precipitation)
Nominal forecast start: 01/05/19
Ensemble size = 50, climate size = 720

JJA 2019



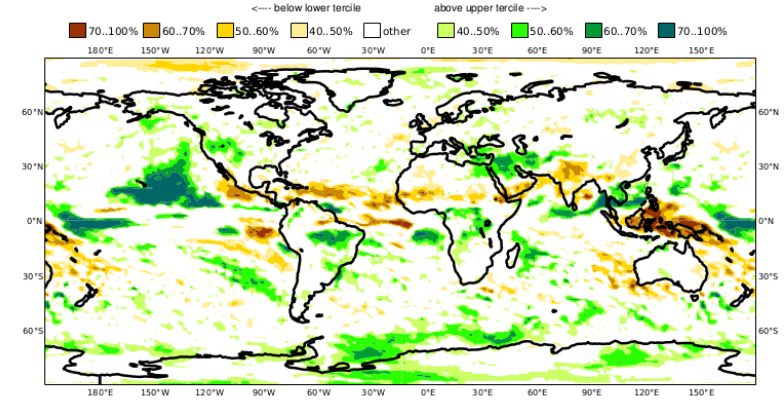
C3S: ECMWF contribution
Prob(most likely category of precipitation)
Nominal forecast start: 01/05/19
Ensemble size = 51, climate size = 600

JJA 2019



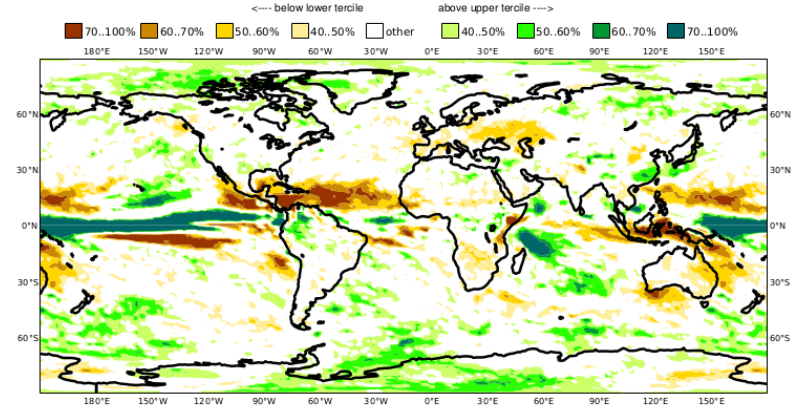
C3S: Met Office contribution
Prob(most likely category of precipitation)
Nominal forecast start: 01/05/19
Ensemble size = 50, climate size = 672

JJA 2019

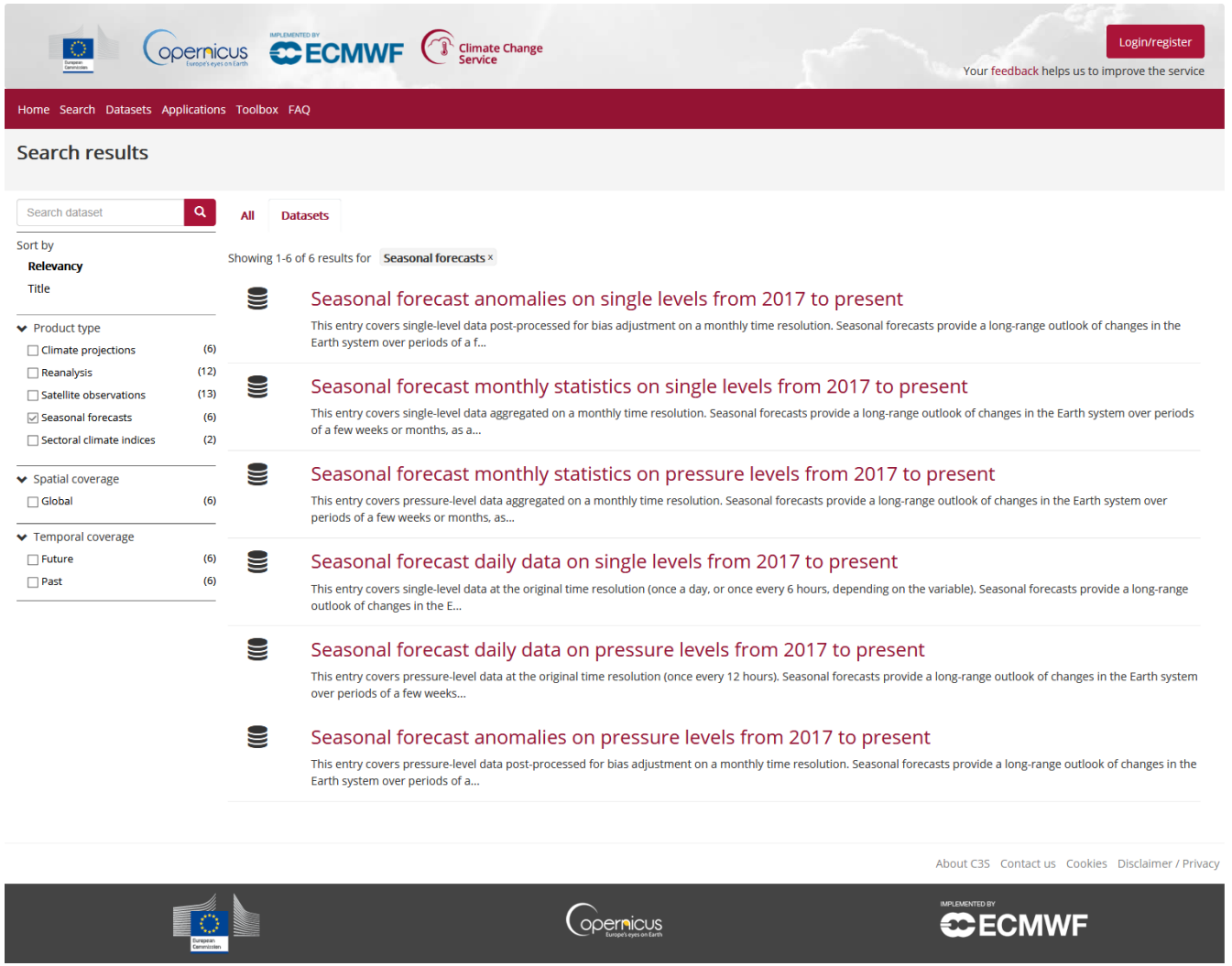


C3S: Météo-France contribution
Prob(most likely category of precipitation)
Nominal forecast start: 01/05/19
Ensemble size = 51, climate size = 600

JJA 2019

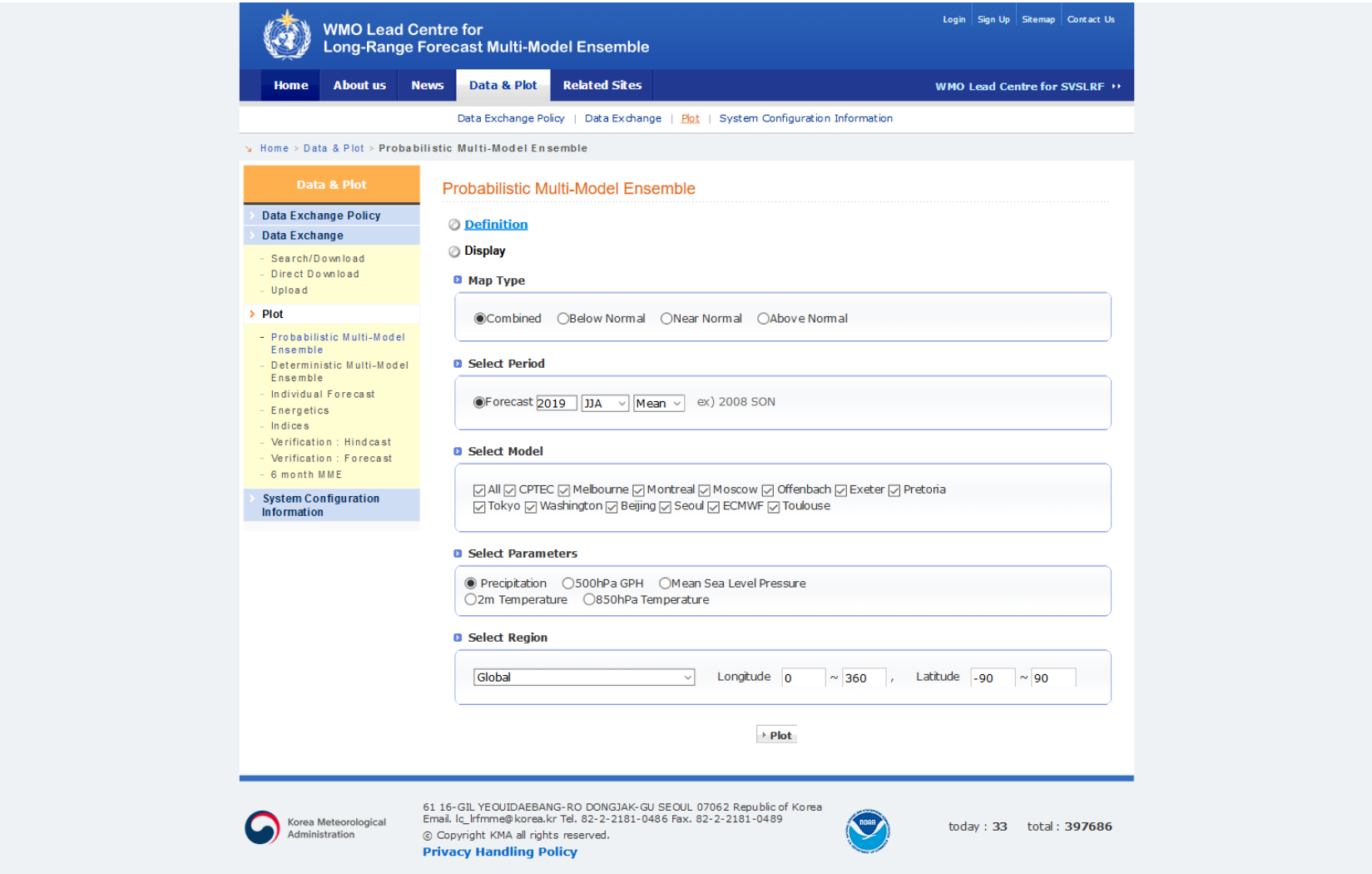


Seasonal forecast data on the C3S Climate Data Store

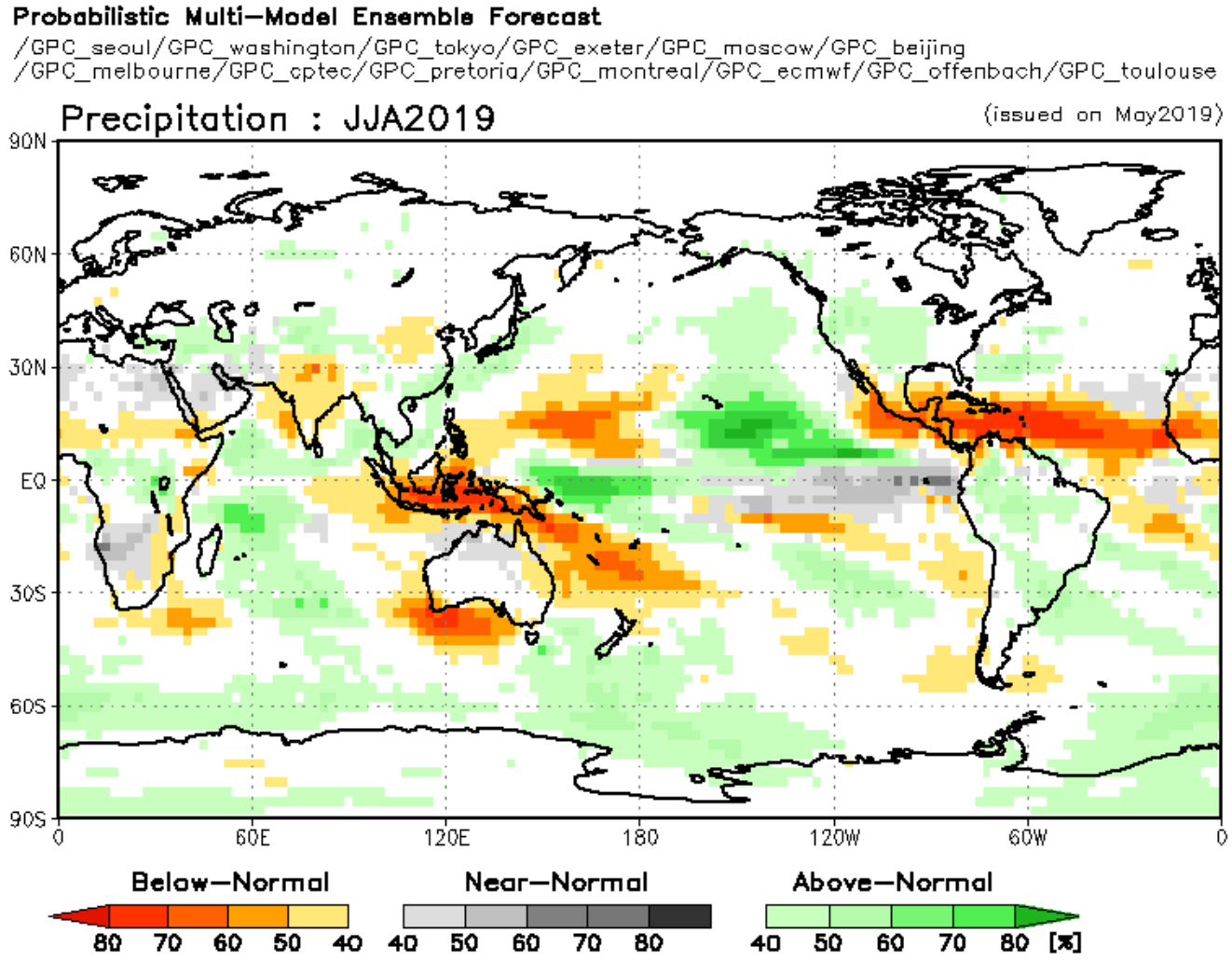


WMO Lead Centre for Long-Range Forecasts (KMA/NOAA)

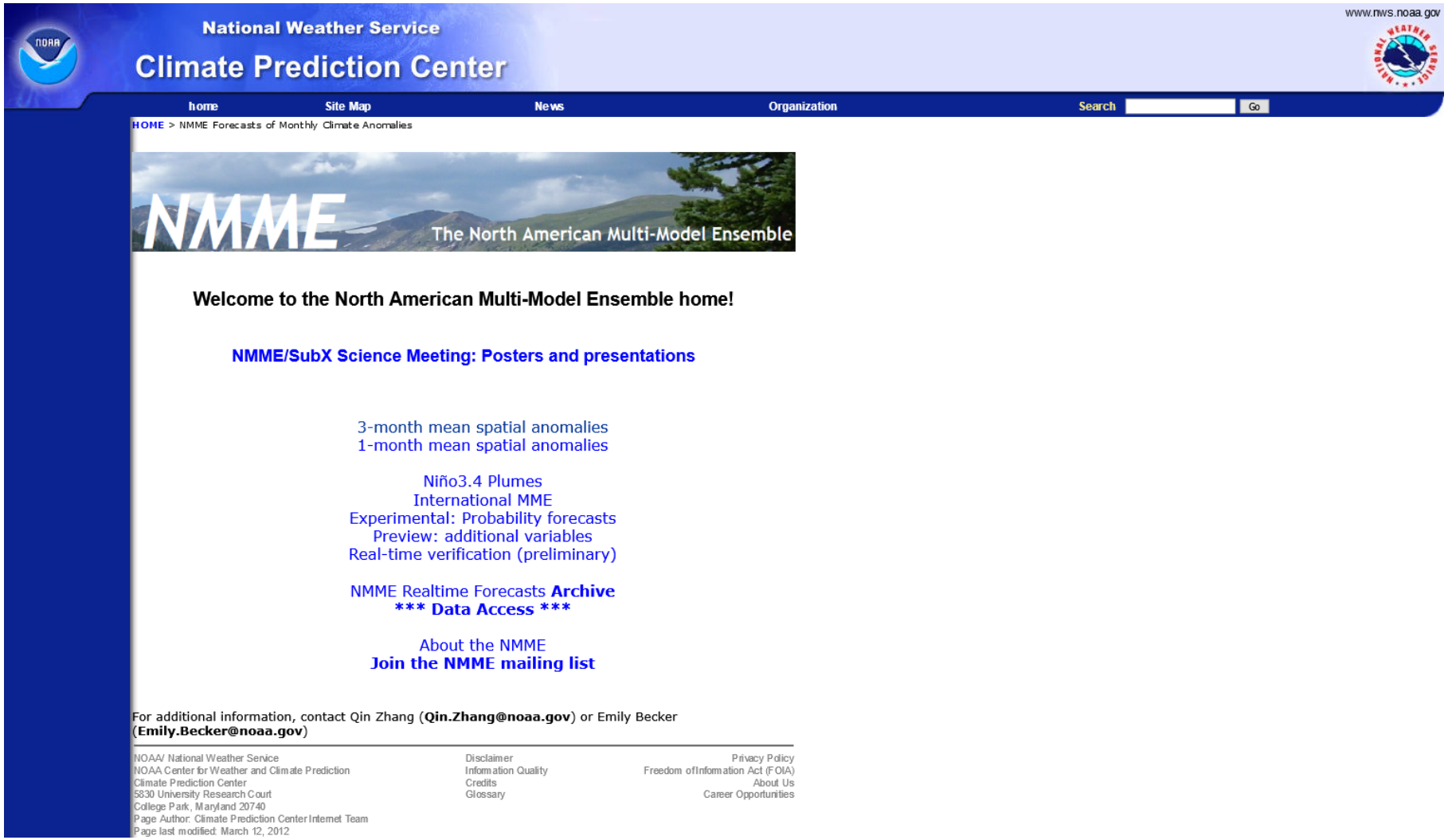
Graphical products on the WMO Lead Centre web site



Multi-model ensemble fc. for JJA 2019 from the WMO Lead Centre

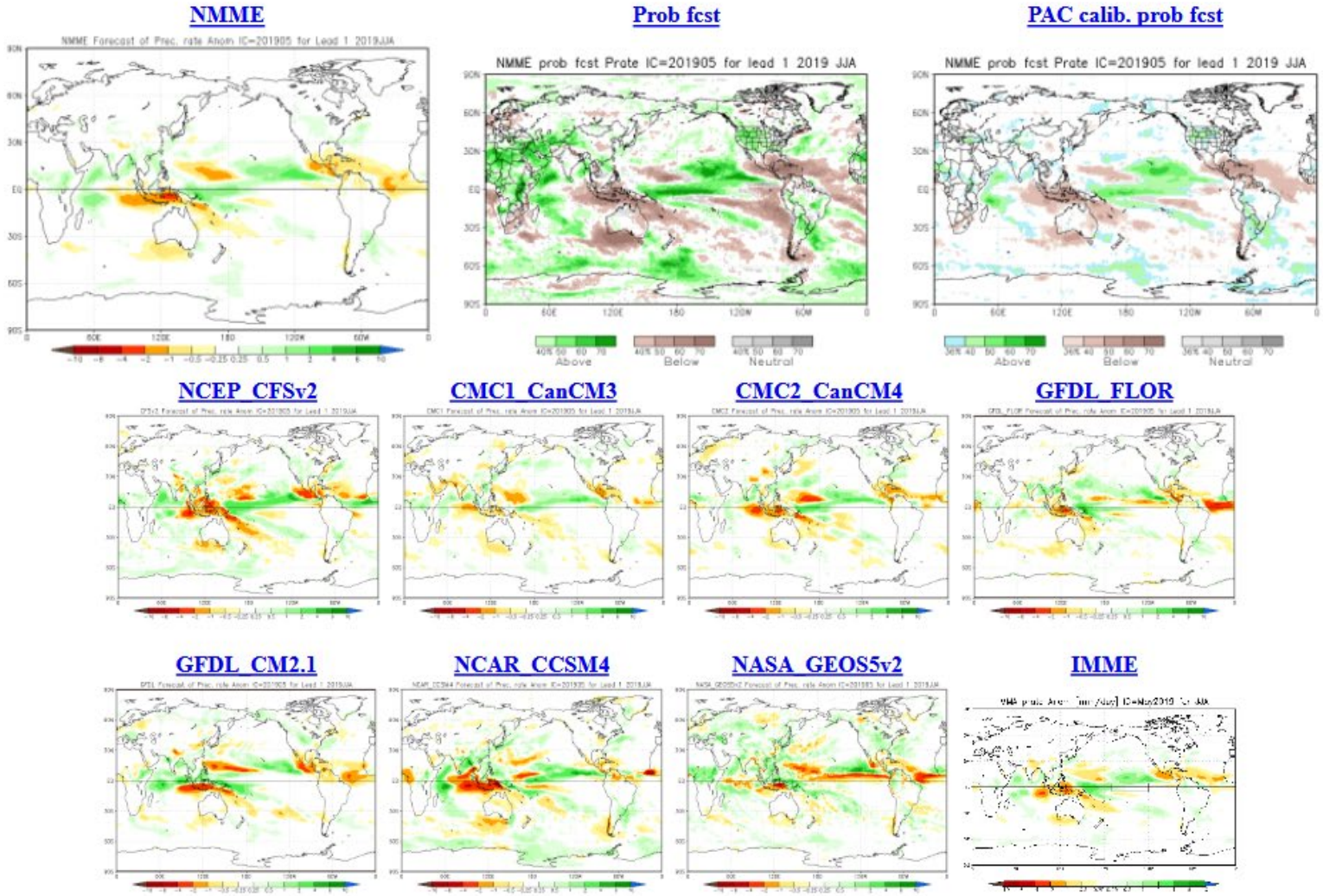


The North-American Multi-Model Ensemble (NMME) web site (@ NOAA/CPC)



The North-American Multi-Model Ensemble (NMME): fc. for JJA 2019

Season 1 prate forecast



Seasonal forecasts at the Asia-Pacific Climate Centre (APCC, S. Korea)

APCC Multi-Model Ensemble forecast for JJA 2019

APCC
APEC CLIMATE CENTER

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Outlook

2019 | JJASON | search

Our seasonal forecasts are issued on the 25th of each month. In the case that the 25th falls on a weekend or national holiday, they are issued on the closest workday.

Outlook	Deterministic MME Forecast	Probabilistic MME Forecast	Deterministic Forecast

• Outlook

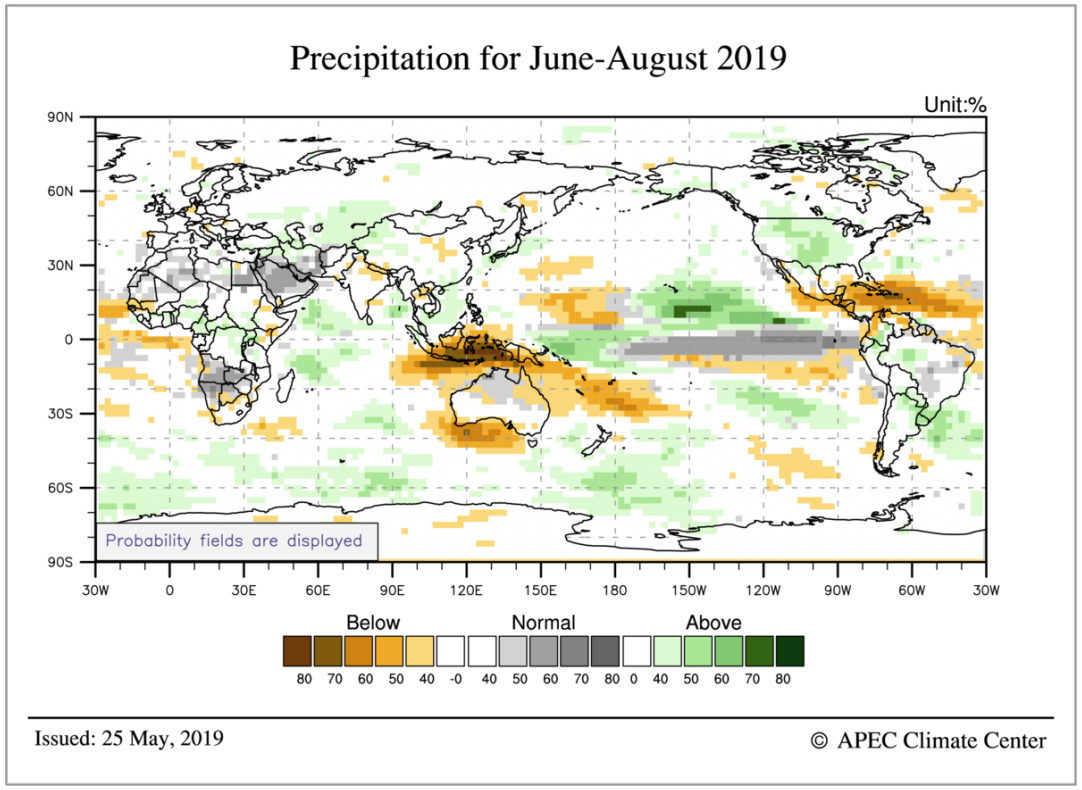
Climate Outlook for June - November 2019

(Issued: 25 May, 2019)

○ During April 2019, El Niño conditions persisted with positive sea surface temperature anomalies across the equatorial Pacific Ocean.
○ The latest APCC ENSO outlook suggests about a 35% probability for weak El Niño conditions during June – August 2019 and the conditions are likely to persist through September – November 2019.
○ Positive temperature anomalies are likely to prevail over the Arctic, Eurasia (excluding Central Asia), the tropical Pacific, southwestern South Pacific, maritime continent, tropical Atlantic, Indian Ocean except the eastern part, and Africa for June – November 2019.
○ Below normal precipitation anomalies are expected for the maritime continent, Great Australian Bight, and the Caribbean Sea, whereas near normal precipitation anomalies are predicted for the central equatorial Pacific for June – November 2019.

Temperature and Precipitation Outlook:

1. Forecast for June – August 2019



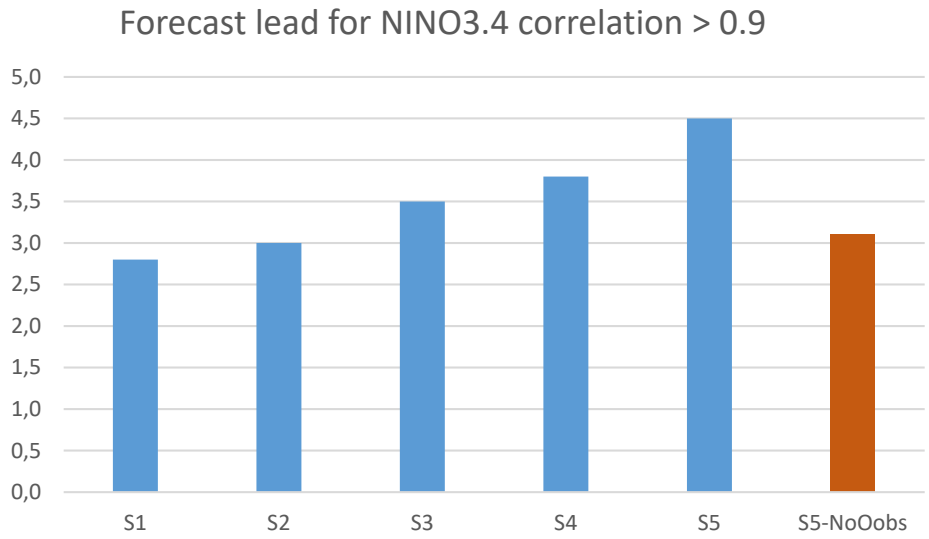
Seasonal forecasts and multi-decadal historical simulations at ECMWF

- **a)** Seasonal fc. System 5 **(Seas5)**
  - IFS cy43r1 Tco 319 (~32 km grid) L91 + NEMO v3.4 ORCA 0.25 deg. Z75+ LIM2 sea-ice
  - 7-month forecasts, 13-month fc. From Feb/May/Aug/Nov
  - Ensemble size: operational fc.: 51 members, re-forecasts: 25 members
  - Re-forecast period: Jan 1981 – Dec 2016 (36 years), IC from ERA-interim + ORA-S5

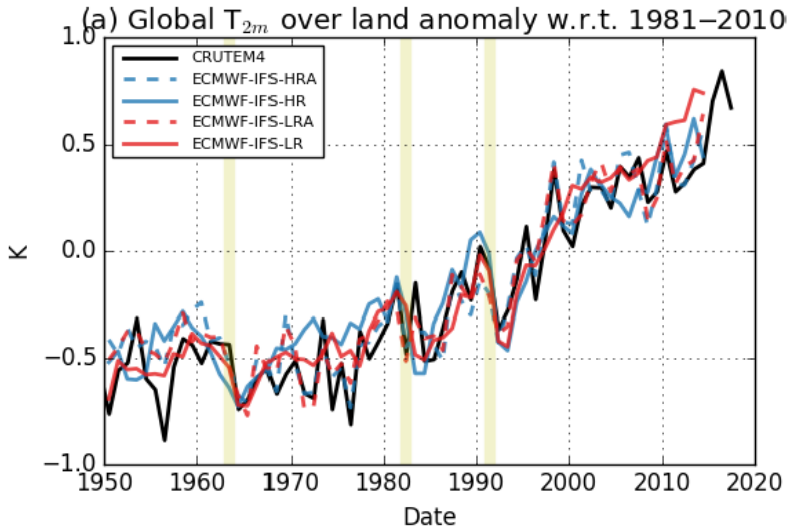
- **b)** Multi-decadal historical simulations for the EU PRIMAVERA project, following HighResMIP **(ECM-hist)**
  - High res.: IFS cy43r1 Tco 399 (~25 km grid) L91 + NEMO v3.4 ORCA 0.25 deg. Z75 + LIM2 sea-ice
  - Low res.: IFS cy43r1 Tco 199 (~50 km grid) L91 + NEMO v3.4 ORCA 1.0 deg. Z75 + LIM2 sea-ice
  - CMIP6 forcing fields (GHG, aerosol, ozone, …)
  - 1950-2014 started from 50-yr spin-up (1950 forcings)
  - Additional runs: AMIP integrations using HadISST2 data (SST + sea-ice conc.), 1950-forcing control

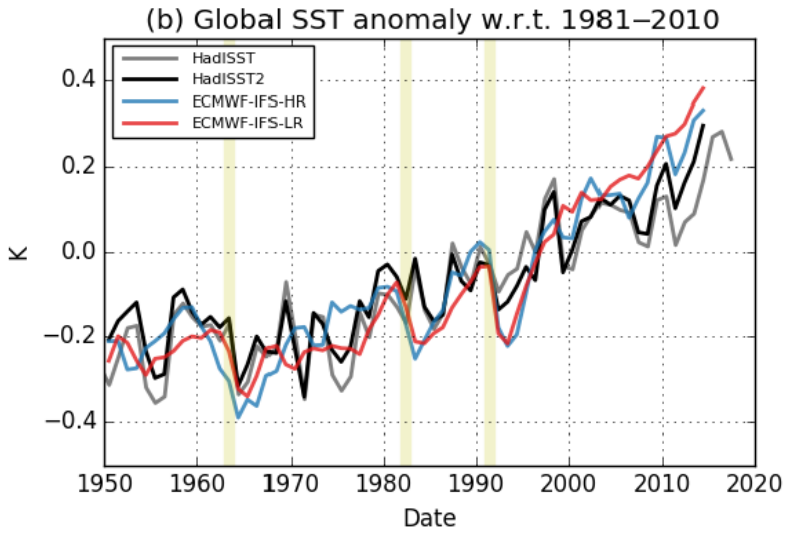
Good news: ENSO forecasts, surface temperature trend

Seas5 ENSO predictions



Sfc. T anomaly in PRIMAVERA hist. simulations

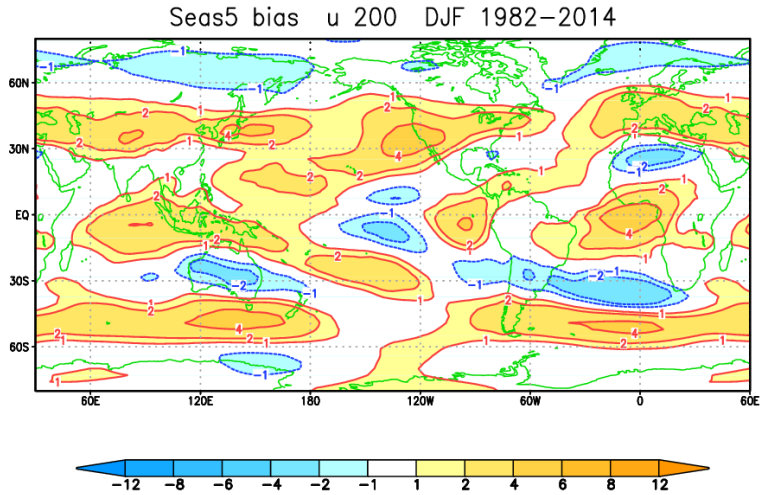


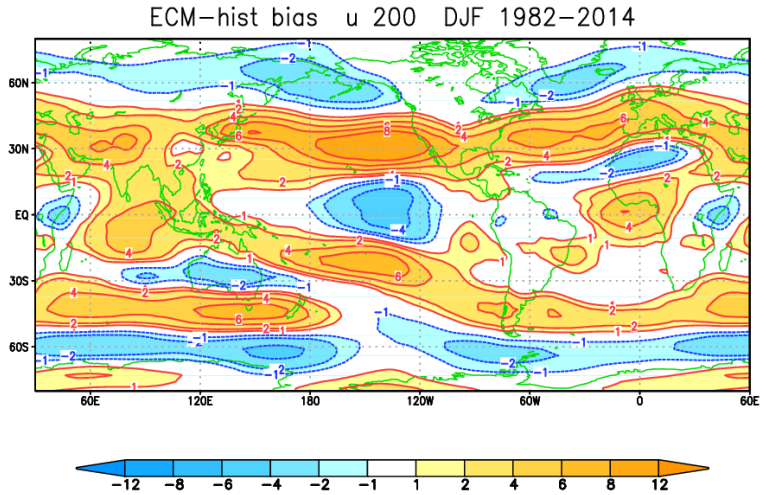


More info in:

- Johnson S. et al.: SEAS5: The new ECMWF seasonal forecast system. *Geosci. Model Dev.*, 12, 1087-1117, 2019, doi:10.5194/gmd-12-1087-2019
- Roberts C. et al.: Climate model configurations of the ECMWF Integrated Forecast System (ECMWF-IFS cycle 43r1) for HighResMIP. *Geosci. Model Dev.* 2018, doi:10.5194/gmd-11-3681-2018

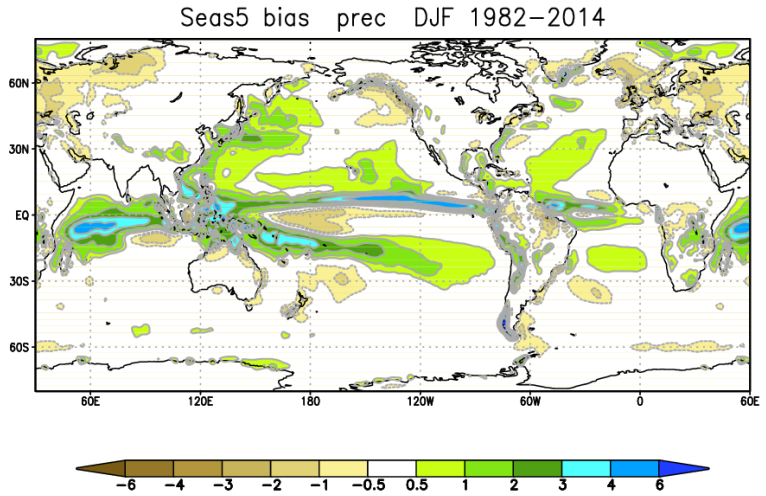
DJF model biases in U 200-hPa and precipitation

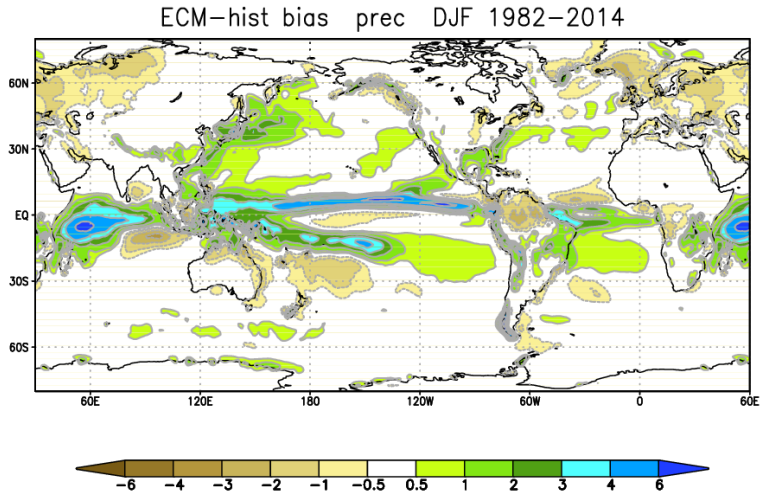




Seas5

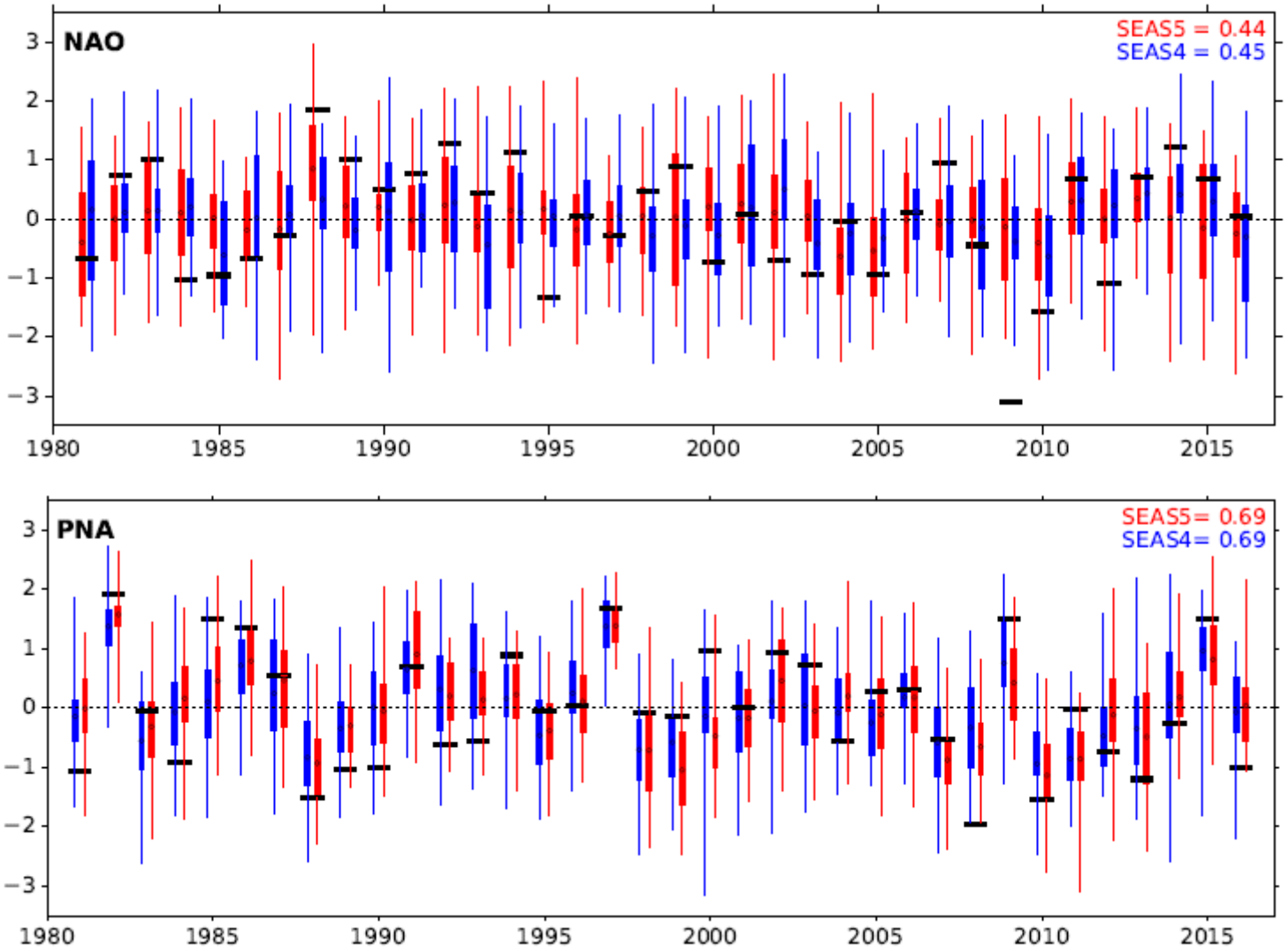
ECM-hist





Anomaly correlation of ensemble-mean NAO and PNA indices

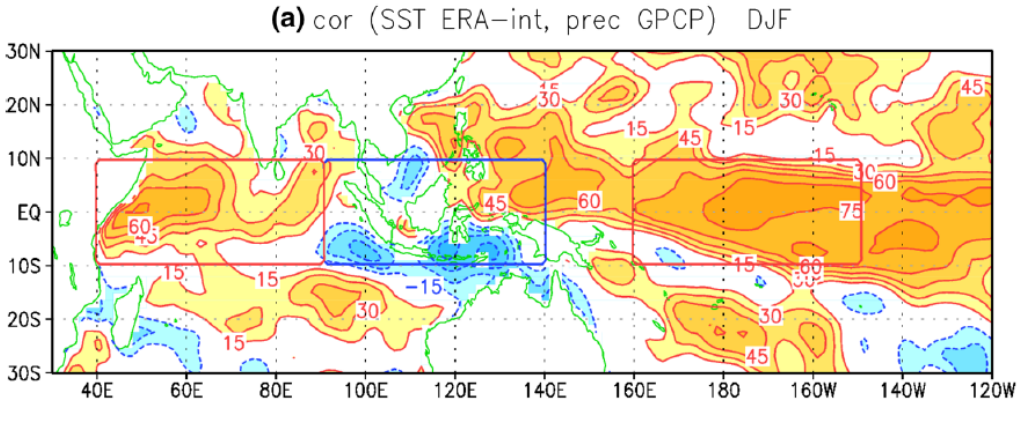
Predictive skill for NHem teleconnection patterns is almost identical in System-4 and System-5

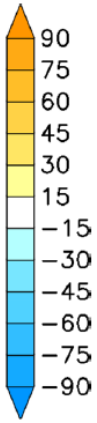


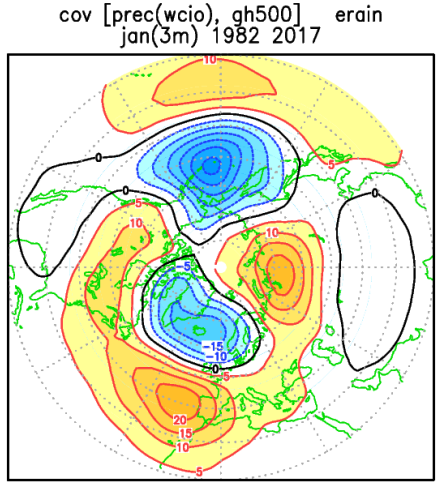
Seas5: teleconnections from DJF tropical rainfall in Pacific and Indian Oceans

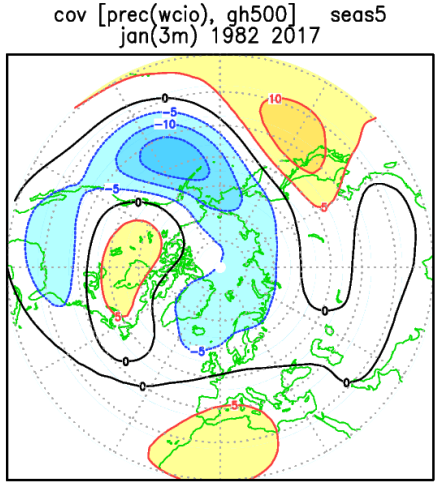
Local correlation between rainfall and SST

(Molteni et al., Climate Dyn 2015)



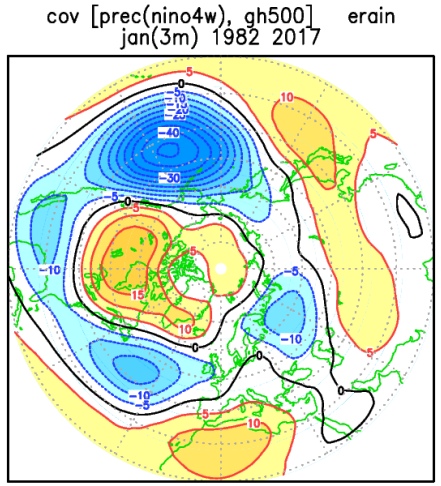


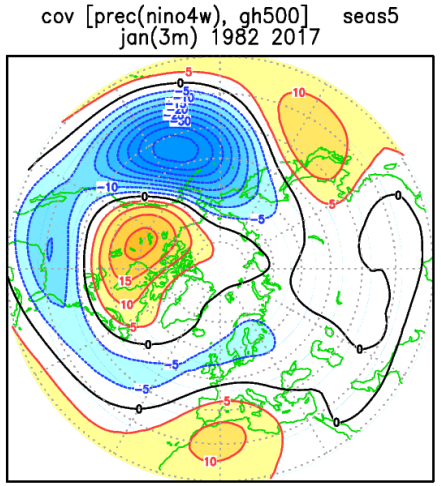




WCIO

40E-90E
10S-10N





Nino4w

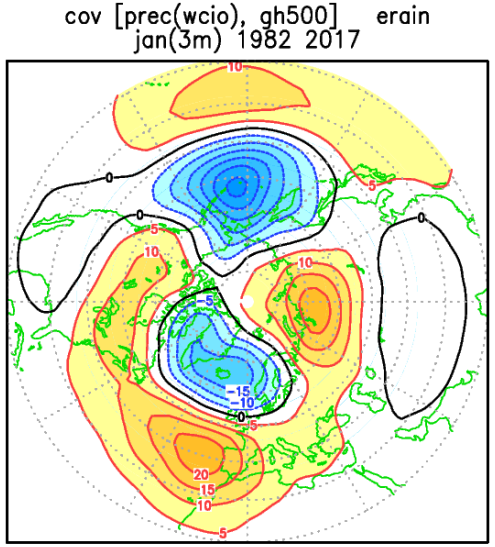
160E-150W
10S-10N

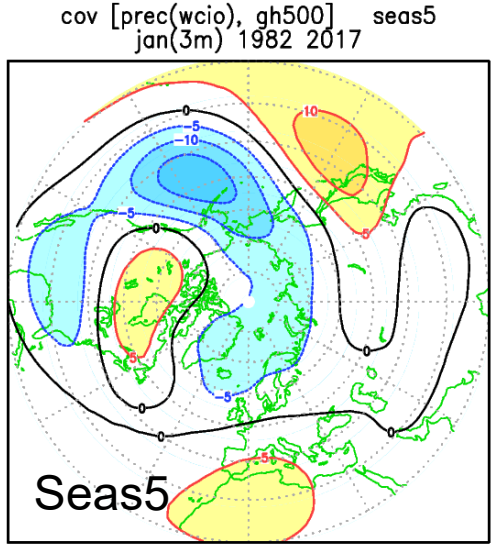
ERA-Int

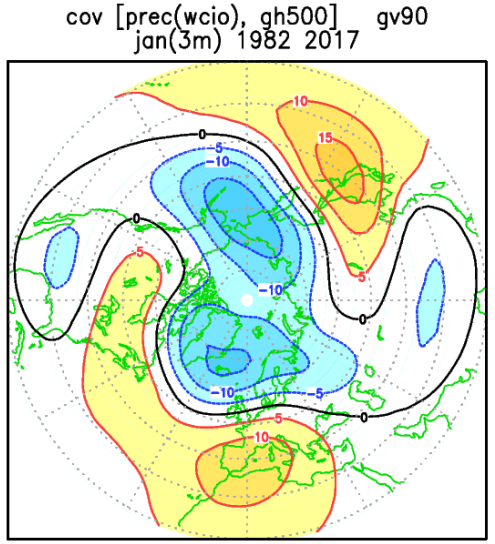
Seas5

Indian Ocean teleconnections: coupled vs. obs SST experiments

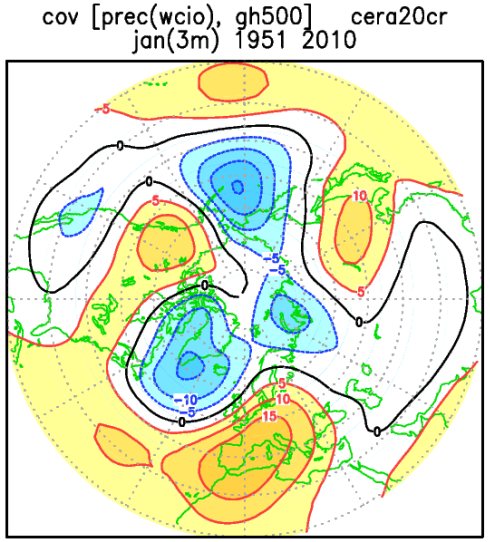
ERA Int

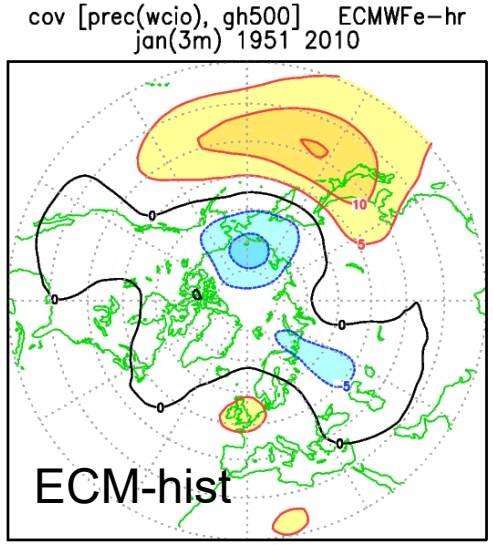


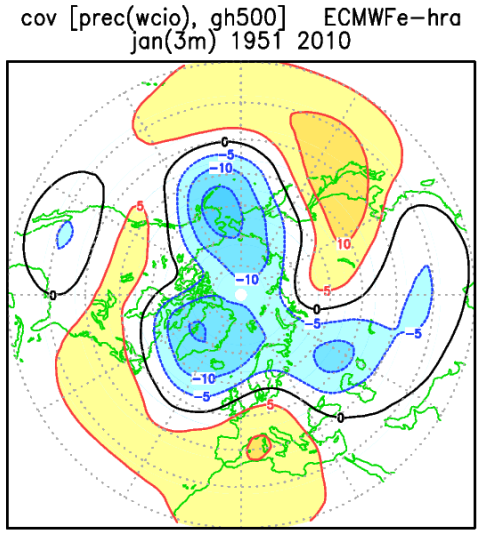




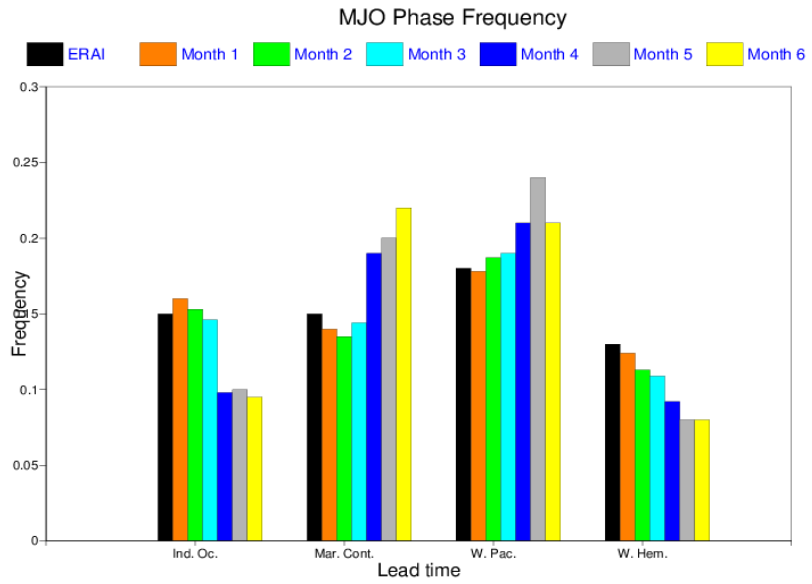
CERA20C







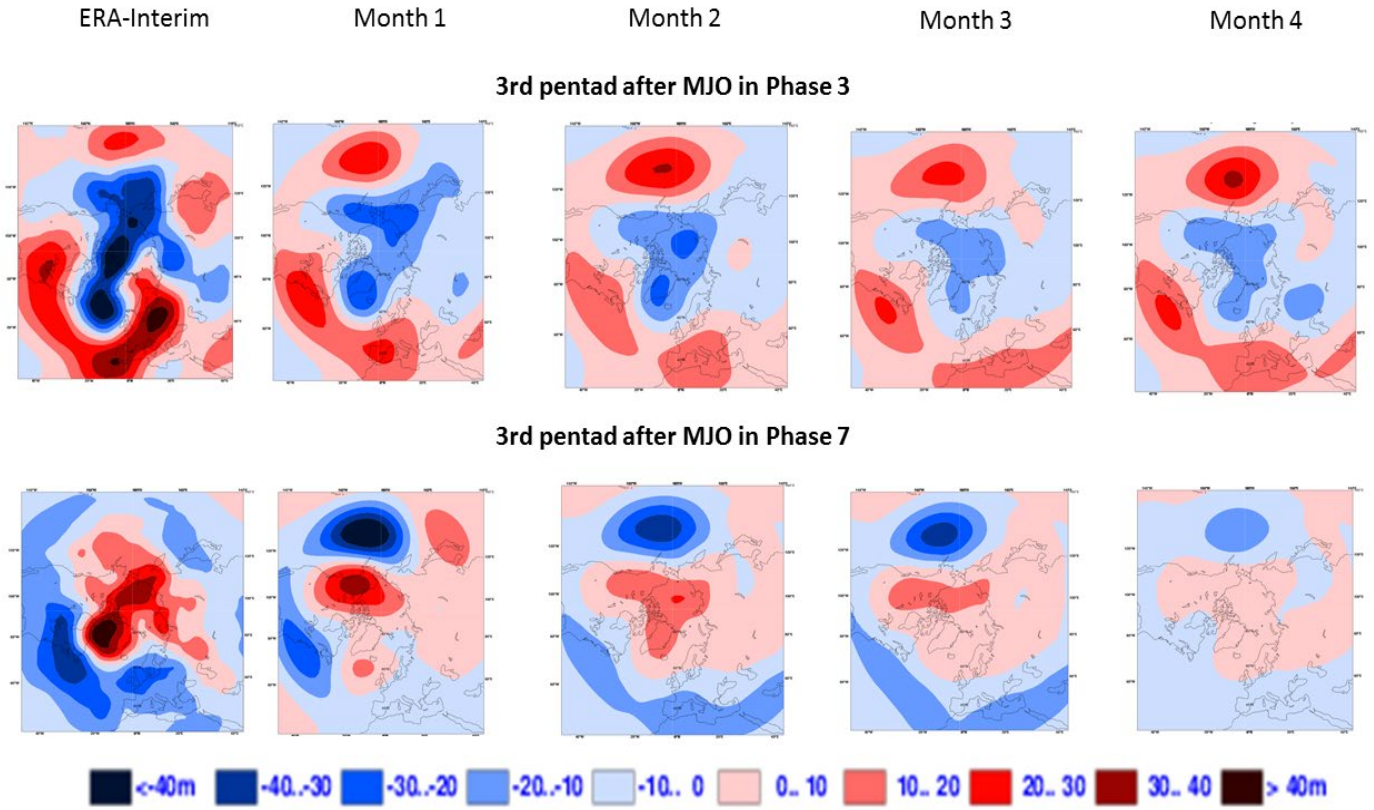
Errors in MJO phase frequency and Z500 teleconnections in SEAS5



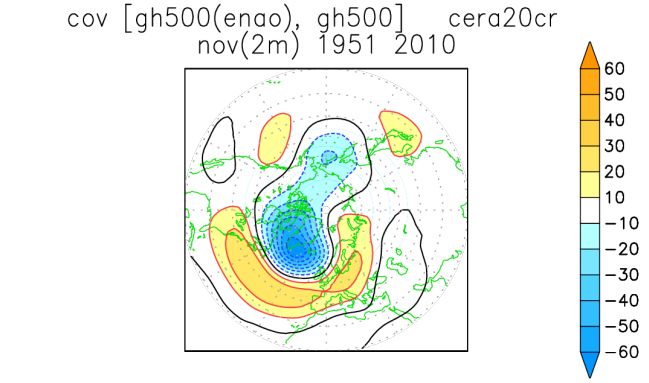
From F. Vitart (SAC 2018

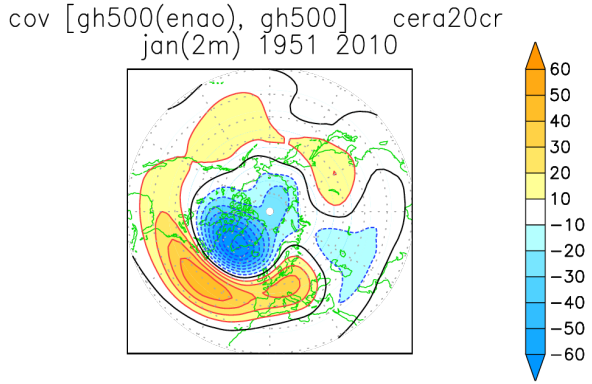
Special Topic paper on SEAS5)

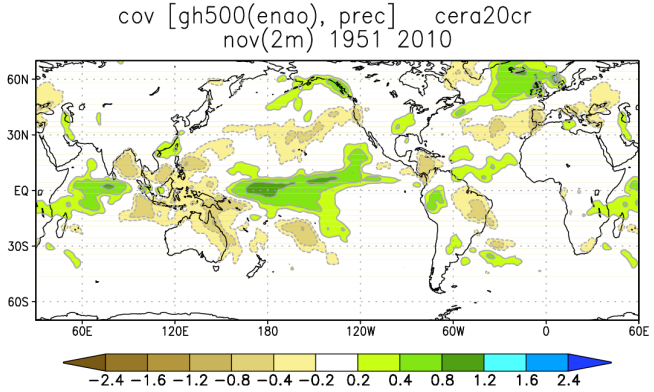
MJO phases as in
Wheeler & Hendon 2004

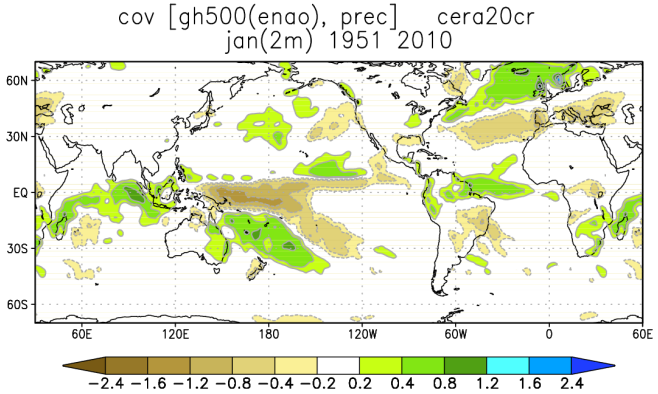


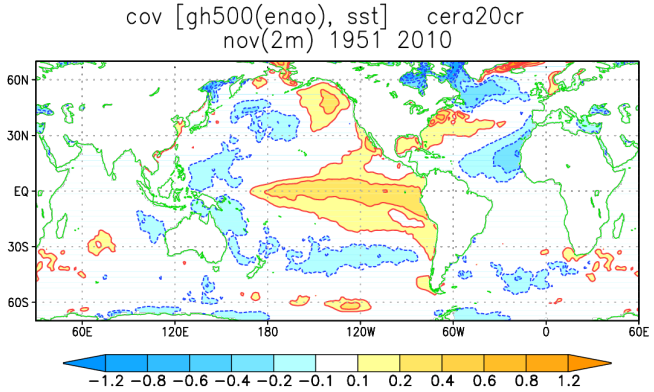
Covariance with NAO index based on 500 hPa height in Nov-Dec and Jan-Feb

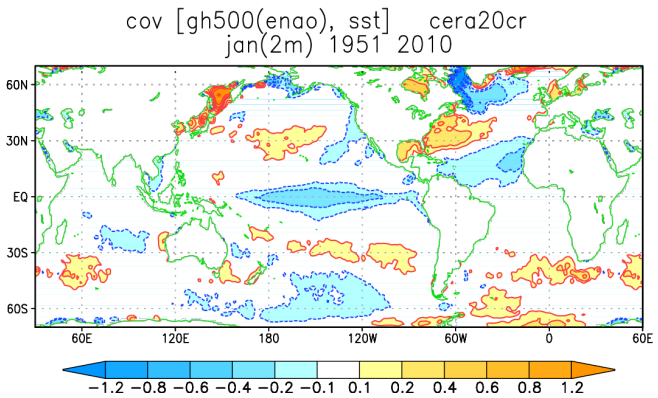












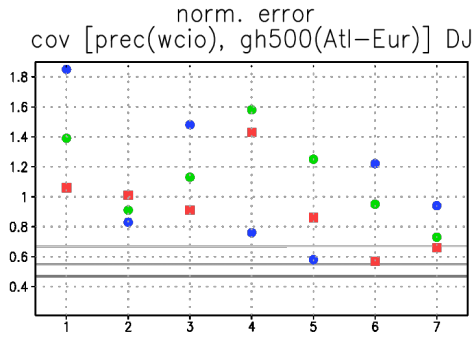
Norm. error of teleconnections in AMIP/coupled PRIMAVERA runs 1950-2010

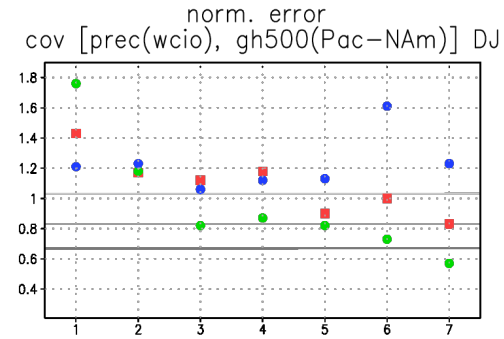
Models:

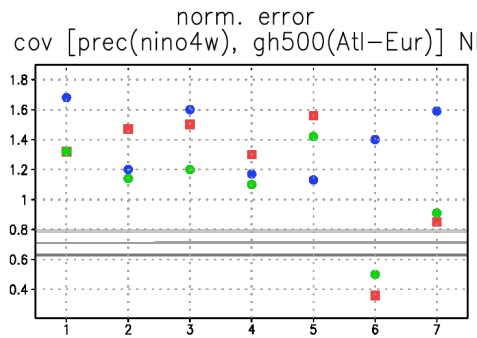
1. CMCC-CM2
2. CNRM-CM6
3. EC-Earth 3
4. HadGEM3 GC3.1
5. MPI-ESM 1-2
6. ECMWF-IFS

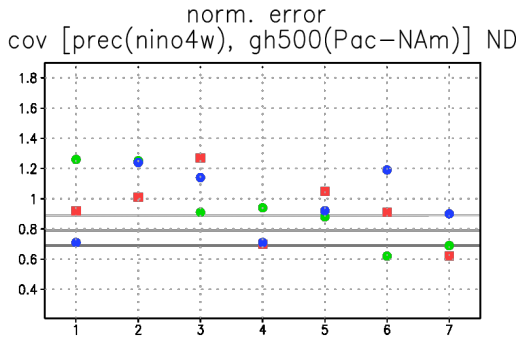
7. ECMWF ens.
   6 members low res.
   4 members high res.

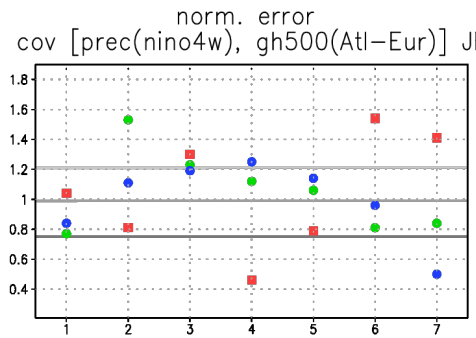
AMIP Low resol. ≈ 100 km
AMIP High resol: 20 - 40km
Coupled High-res:
atmos: 20-40km,
ocean: ~1/4 degree

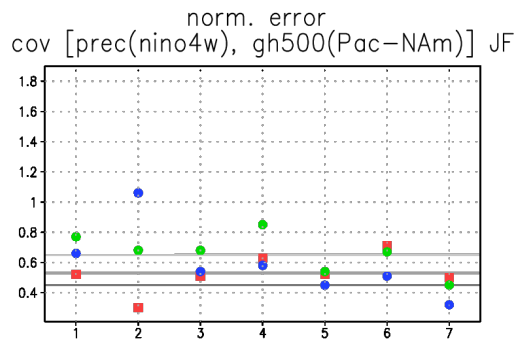












Conclusioni e commenti

- Prodotti di previsioni stagionali basate su multi-model ensembles sono oggi disponibili sui siti di diversi centri in Europa, Nord America e Asia.
- Il contributo di C3S ha permesso di uniformare le procedure di produzione e rendere pubbliche le previsioni stagionali di 5 centri/servizi europei, in forma sia grafica che numerica.
- Il numero di prodotti grafici presenti sul sito di C3S e' ancora limitato, e non sono ancora presenti indici dello skill delle previsioni basati sui re-forecasts.
- Negli ultimi 10 anni c'e stata una convergenza nella qualita' dei modelli usati per previsioni stagionali; in generale, i maggiori progressi sono visibili ai tropici.
- L'Europa e il Nord Atlantico rimangono regioni critiche per le previsioni stagionali, sia per ragioni "intrinseche" (basso rapporto segnale/rumore), ma anche per la difficolta' dei modelli a riprodurre correttamente teleconnessioni tra tropici ed extratropici (con l'eccezione della classica risposta a ENSO nel tardo inverno).
- Esistono chiare sinergie tra lo studio di errori sistematici (nello stato medio e nella variabilita') dei modelli climatici in previsioni stagionali e in simulazioni "storiche" multidecadali.
- Un approccio "seamless" alle previsioni stagionali puo' essere un'arma a doppio taglio: gli errori nelle previsioni a breve/medio termine sono dominate da processi diversi da quelli rilevanti a scala inter-annuale e decadale.