Climate and Oceans Support
Program in the Pacific

ACCESS-S Workshop

MODULE: MME vs ACCESS-S

Topics in this module

- Recap – What is ACCESS-S?
- Other dynamical models
- What is a multi-model ensemble (MME)? Who produces MMEs?
- Examples of MME outlooks. Other centres producing MME outlooks
- MME vs individual model skill
- Comparing ACCESS-S and MME forecasts
- Specific reasons for using BOM produced products and services

Expected learning outcomes

- Understanding of how ACCESS-S differs to a multi-model ensemble
- Understanding of the advantages and disadvantages of ACCESS-S compared to a multi-model ensemble

These outcomes are important for understanding which seasonal prediction products are most appropriate for each NMS

Recap: What is ACCESS-S?

- ACCESS-S: BOM model. BOM also WMO Global Prediction Centre (GPC) for Long-Range Forecasts (LRF). See WMO GPC LRF for more information
- Physics-based dynamical forecast modelling system
- ACCESS-S outlooks based on a 99-member ensemble. Model run 99 times with slightly different initial conditions to capture a range of scenarios
- Forecasts based on ensemble of 99 forecasts (or scenarios). Outlook variability among the 99 ensemble members provides range of possible future scenarios. For instance, if 80 of the 99 ensemble members suggest drier conditions are likely, we can say there is ~80% chance of drier conditions in the upcoming month/season

Other dynamical models

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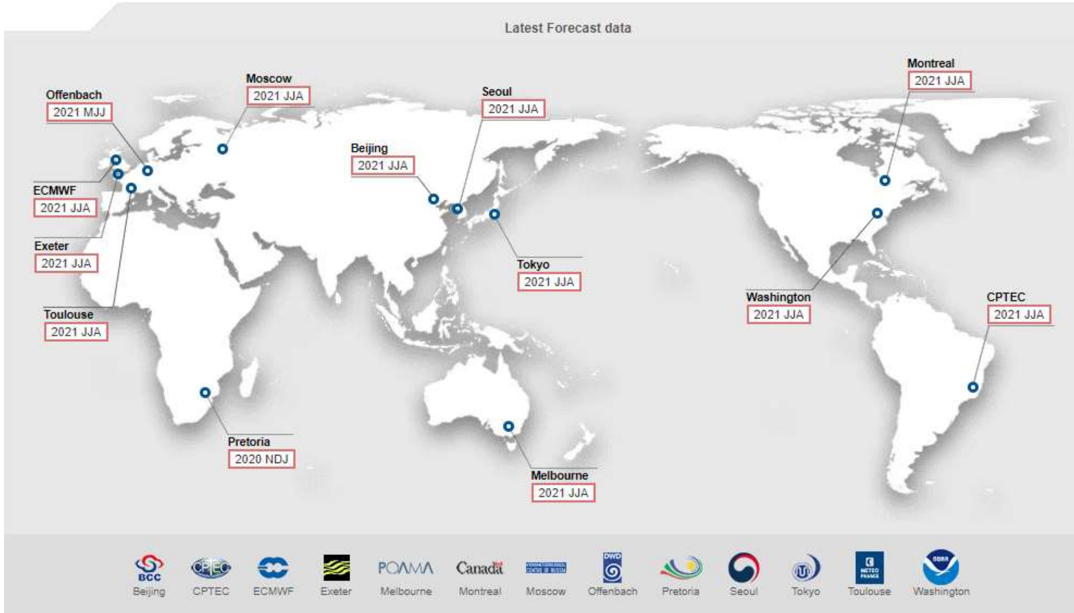
- Twelve GPC LRF. Each have their own model with a range of abilities.
- Many other national and research models in existence.
- Forecasting skill varies significantly from model to model depending on a range of factors, such as model physics, initial conditions, length of hindcast, number of ensemble members etc.



Other dynamical models

- Two best are ECMWF (European model) and UKMO (United Kingdom model)
- Model constantly changing as GPC LRFs invest further in their models. BOM for example will be releasing ACCESS-S2 later this year.

Future Versions: ACCESS-S2/S3

Compared to ACCESS-S1, ACCESS-S2 will have a locally developed data assimilation system for the ocean and will improve on the land surface initialisation for soil moisture. It will also have a longer hindcast period (38 years) and forecasts will run out to lead times of several years to facilitate an investigation of multi-year prediction.

ACCESS-S3 will improve the data assimilation (new variables assimilated e.g., altimeter data) and ensemble generation (weakly coupled Ensemble Kalman Filter) and will use an upgraded coupled model version, including utilising locally developed model physics parameterisations improvements.

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What is a multi-model ensemble?

- A number of global centres gather dynamical model data and combine them to produce a multi-model ensemble (MME). This becomes a 'super-ensemble' of several hundred ensembles.
- By combining model forecasts, effects of single model errors are averaged out, giving a better estimate of the most likely outcome.
- Differences between models provide a measure of system-related uncertainty in the forecast.
- Multi-model systems are not perfect e.g. some errors are common to all models.
- There is typically a smaller climatology in MME's due to the need to have common years amongst all models.
- Nonetheless, MME tend provide forecasts which are both more accurate and more reliable than individual model forecasts.

Who produces MME forecasts?

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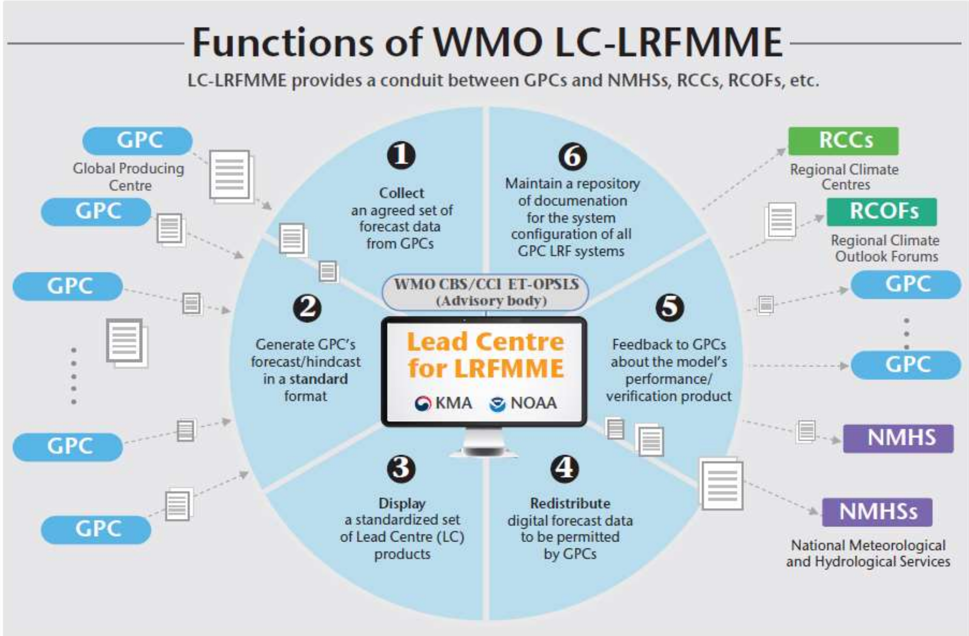
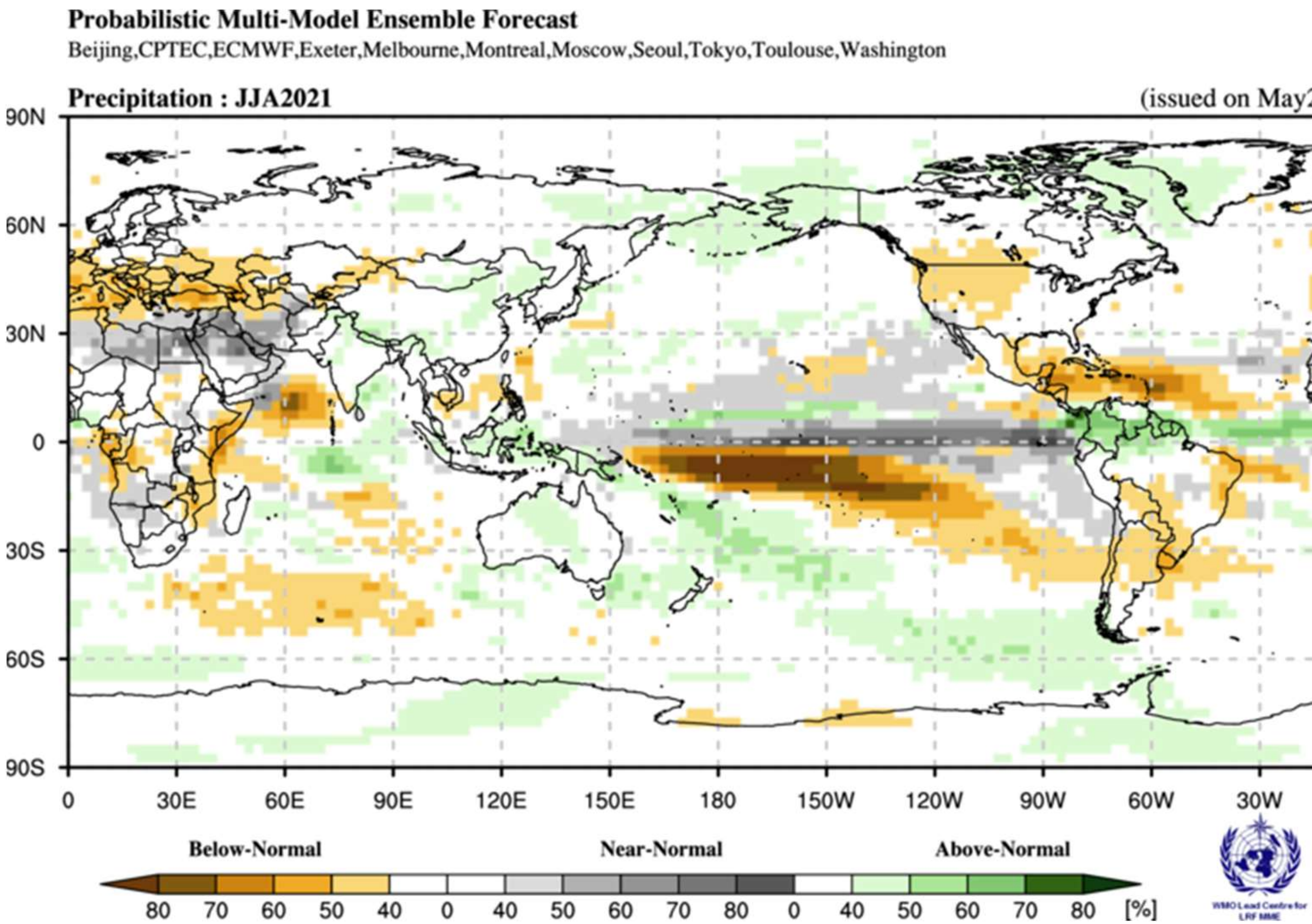
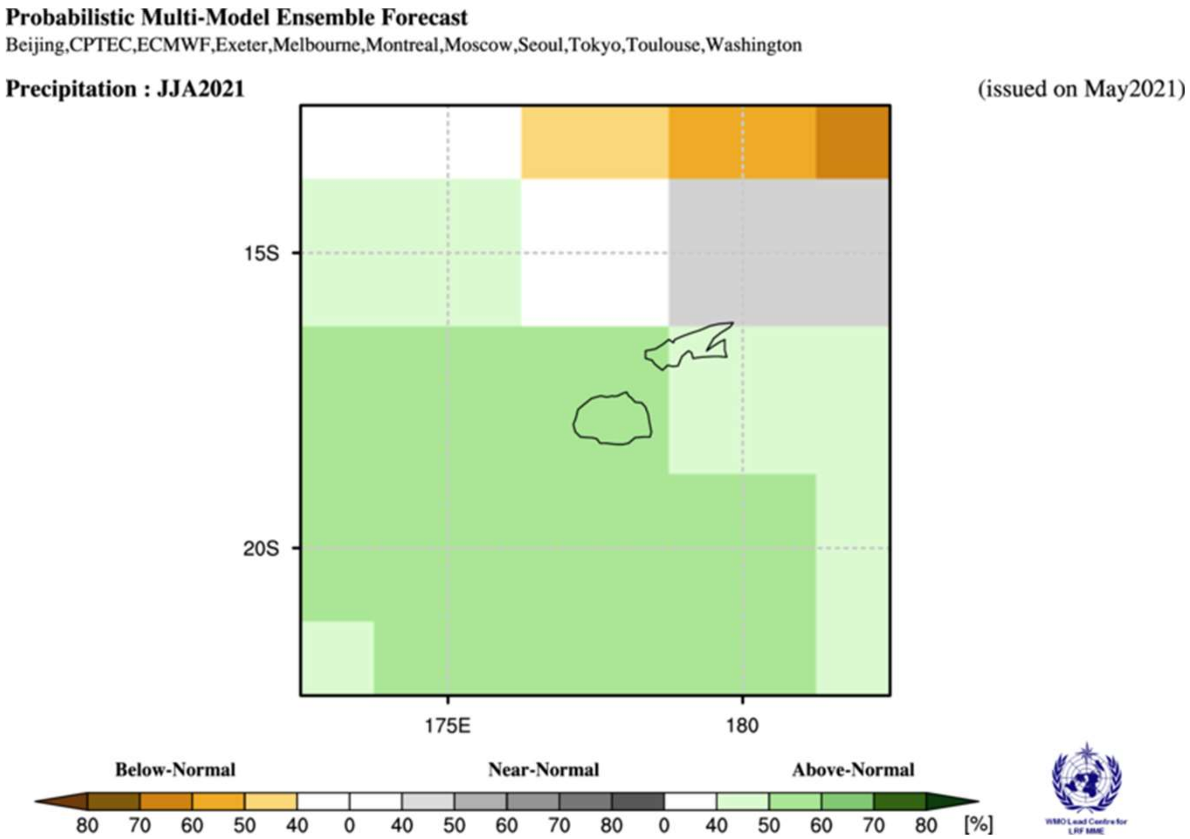
- WMO Lead Centre for Long-Range Forecast Multi-Model Ensemble – based in South Korea (joint KMA – NOAA effort)
- WMO LC LRF MME forecast used during the April 2021 PICOF as WMO encouraging Regional Climate Centres to use objective forecasting methods – not take a subjective model average as we have in the past
- Subject to data availability, WMO LC LRF MME provides up to individual 13 model and MME forecasts
- Forecasts available for 1 to 6 month periods for monthly and seasonal timescale. Lead time 1-6 months (No. of models decreases with lead time. Four available for lead-6)



Example of WMO LC LRF MME global forecast



Example of WMO LC LRF MME national forecast



Other centres producing MME forecasts?

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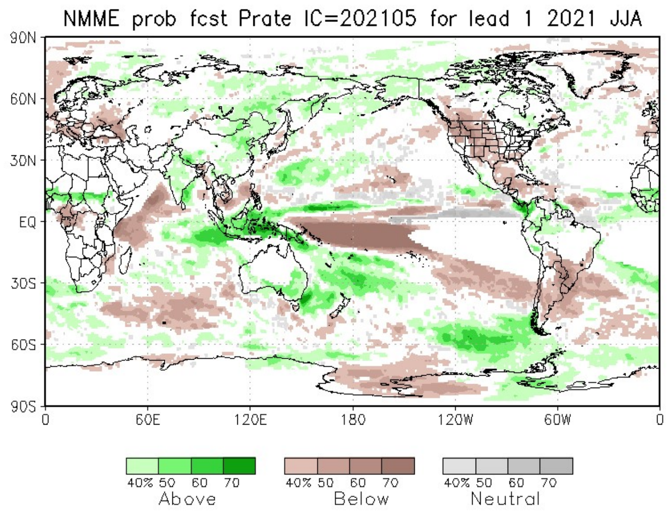
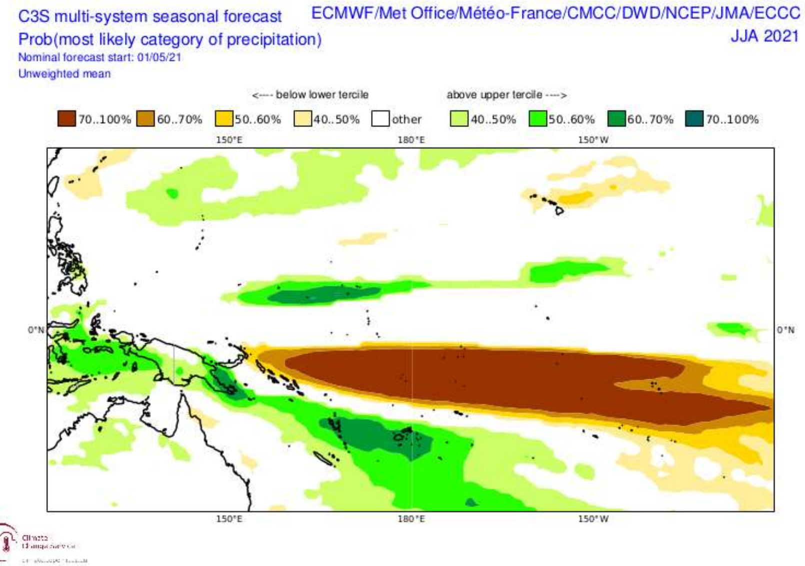
- North American MME
  http://www.cpc.ncep.noaa.gov/products/NMME/
- Copernicus Climate Change Service
  https://climate.copernicus.eu/seasonal-forecasts

  (will include ACCESS-S2 in the future)
- APEC Climate Centre
  https://www.apcc21.org/ser/outlook.do?lang=en

APCC web-based tool (CLimate Information toolKit, CLIK), allows users to construct own MME forecast comparing hindcast performances when selecting different model combinations. Also provides a statistical downscaling function (PICASO) to convert large-scale forecast information into pointwise information for selected Pacific locations





MME vs individual model skill – for the Pacific Basin

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	Beijing	Montreal	Tokyo	CPTEC	Moscow	Toulouse
DJF	0.254	0.507	0.481	0.254	0.243	0.418
JFM	0.043	0.514	0.446	0.043	0.321	0.450
FMA	0.322	0.482		0.322	0.310	0.369
MAM	0.360	0.437	0.376	0.360	0.280	0.354
AMJ	0.258	0.429	0.349	0.258	0.195	0.356
MJJ	0.367	0.397	0.420	0.237	0.127	0.367
JJA	0.298	0.385	0.417	0.277	0.244	0.298
JAS	0.347	0.416	0.431	0.316	0.231	0.347
ASO	0.400	0.446	0.477	0.400	0.304	0.400
SON	0.265	0.494	0.480	0.265	0.252	0.490
OND	0.243	0.461	0.454	0.243	0.256	0.467
NDJ	0.249	0.453	0.422	0.249	0.261	0.408
All season mean	0.284	**0.452**	**0.432**	0.269	0.252	**0.394**

	ECMWF	Offenbach	Washington	Exeter	Pretoria	Melbourne	Seoul	MME
DJF	0.531	0.491	0.392	0.513	0.384	0.498	0.504	0.543
JFM	0.511	0.463	0.426	0.520	0.366	0.505	0.498	0.551
FMA	0.497	0.425	0.352	0.494	0.260	0.472	0.444	0.507
MAM	0.470	0.384	0.382	0.465	0.360	0.429	0.446	0.492
AMJ	0.435	0.321	0.284	0.455	0.258	0.407	0.429	0.453
MJJ	0.449	0.330	0.310	0.478	0.337	0.389	0.450	0.468
JJA	0.476	0.321	0.378	0.463	0.313	0.363	0.449	0.493
JAS	0.489	0.376	0.421	0.496	0.326	0.413	0.486	0.532
ASO	0.558	0.511	0.460	0.503	0.259	0.422	0.489	0.575
SON	0.536	0.498	0.433	0.511	0.269	0.428	0.468	0.550
OND	0.501	0.467	0.400	0.488	0.321	0.422	0.464	0.519
NDJ	0.467	0.461	0.377	0.509	0.249	0.435	0.473	0.508
All season mean	**0.493**	**0.421**	**0.385**	**0.491**	0.309	**0.432**	**0.467**	0.516

Parameter: 3-month rain, Anomaly Correlation Coefficient (values from -1 to 1), Lead-1, 1993-2009, GPCP monthly

MME vs individual model skill – for the Pacific Basin

But note skill scores vary significantly

- Subject to skill measure (LEPS, ACC etc.)
- Dataset used to verify predictions

Comparing ACCESS-S (left) and MME (right) features

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- Subseasonal to seasonal outlooks
- Global to island scales (site specific possible too)
- Multiple parameters. Obtaining these from a single model means the is less chance of conflicting outlooks. Only the ECMWF and Melbourne offer multi-week TC outlooks.
- Forecasts available at multiple lead times
- Forecasts updated daily
- Skill for the Pacific basin is among the better half of GPC LRF models but less than the MME

- Monthly and seasonal global scale outlooks
- Global to site specific scale (e.g. PICASO). Some MME producers don't have the Pacific region or countries as output options (only C3S and APCC). Where available forecast resolution poor (as shown) at country and divisional scales.
- Multiple parameters but tends to be less than ACCESS-S e.g. for WMO LC not TCs or sea level
- Forecasts available at multiple lead times
- Updated monthly (takes a while to collate data from multiple models)
- Higher skill than individual models but poor models included may reduce MME skill

Comparing ACCESS-S (left) and MME (right) features

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- Among the 13 GPCs-LRF, there is non-uniformity with respect to hindcast periods, some span 30+ years and others < 30 years (ACCESS-S1:1990-2012, S2 will have 38 years)

30 years considered adequate for skill estimation and systematic error correction. Long hindcast period needed for adequate statistical sample of the influences of climate variability, especially for noisier variables such as rainfall – WMO No. 1246

- Near-real time verification (on to do list)
- Most skillful forecasts tend to have the shortest lead time. e.g. forecast for MAM from 25 February model run likely to be more skillful than forecast issued on 10 February.

- Even shorter hindcast period (for WMO LC, 1993-2009). MME uses hindcast period that is common across the models.
- Limited hindcast verification information. WMO LC only have lead-1 option.
- Near-real time verification not available
- Short lead-time forecasts not possible, as data gathering stage for MME production takes about a fortnight.

Comparing ACCESS-S (left) and MME (right) features

- Possible to produce tailored and specialised products e.g. MJO, EAR Watch forecasts
- Downscaled/calibrated forecasts

- Limited to no specialised tailored and specialised products
- Downscaled/calibrated forecasts available but computational expensive

Specific reasons for using BOM associated products and services

- ACCESS-S among the best models skill-wise, but not the best. Not better than most MMEs

BUT forecast skill shouldn't be the only reason to select a model/MME.

Need to consider:

- Potential for future development S2, S3 etc.
- Ability to capture major Pacific climate drivers accurately in all seasons (in BOM's interest to have MJO presented correctly in ACCESS-S as MJO also affects northern Australia)
- Research based understanding of ACCESS-S shortfalls, e.g. SPCZ is too zonal
- Associated services and capacity building e.g. short to long-term climate and ocean monitoring, communications and capacity building, climate projections.
- Sectoral, tailored and specialised products (e.g. Malaclim, Afulilo dam model, EAR Watch).

Specific reasons for using BOM associated products and services

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Need to consider:

- Duration of commitment. BOM ongoing efforts in the region since early 2000s.
- Consistency between different products by using a single model, e.g. the fortnightly forecasts will not be inconsistent with the monthly forecast.

Specific reasons for using BOM associated products and services

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Further discussion on skill: ACCESS-S among the best models skill-wise, but not the best. Not better than most MMEs

BUT does this really matter. Let's review in detail.

If we use the ACC skill measure the difference between

ACCESS-S and MME: 0.08

ACCESS-S and ECMWF: 0.06

ACCESS-S and UKMO: 0.06

Difference in regionally averaged skill – small.

Specific reasons for using BOM associated products and services

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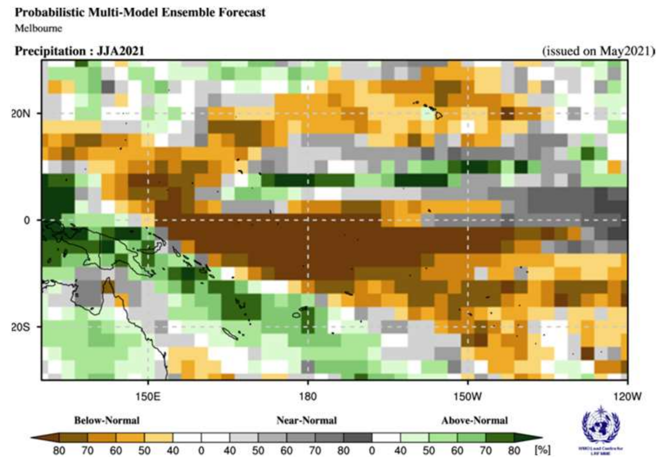

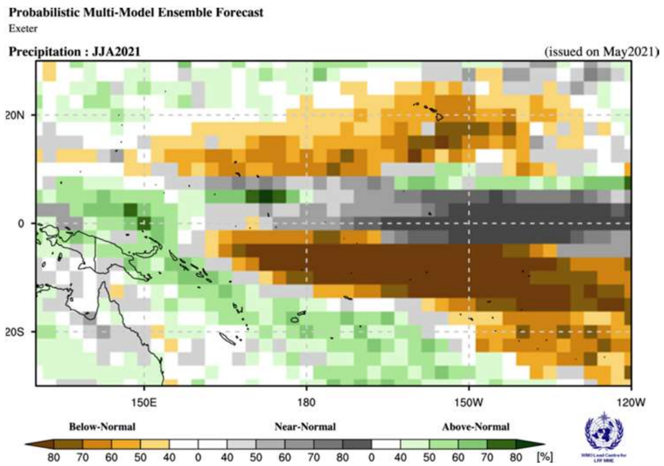

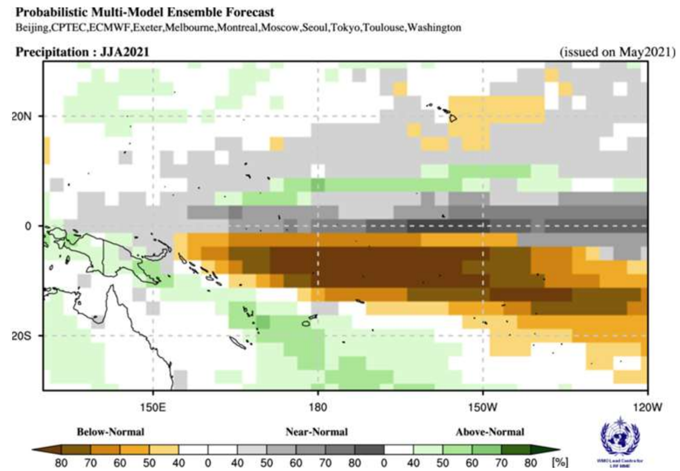

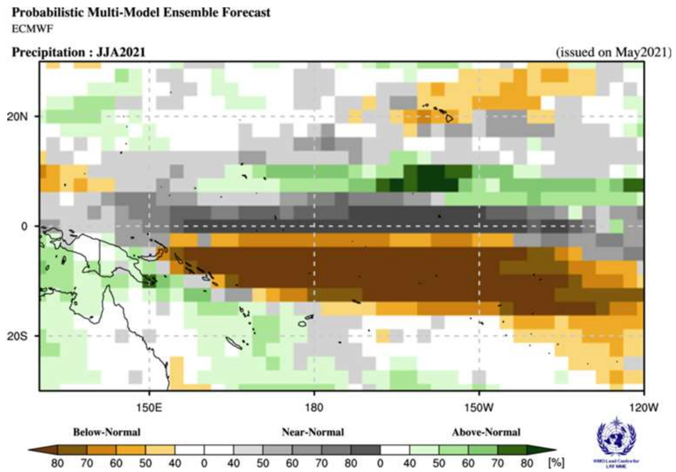

Let's examine how the forecast varies across the Pacific:

Select: Pacific region, June to August 2021 rainfall

While probabilities might be different the message communicated to communities are similar

Note: UKMO and ACCESS-S model broadly similar outlook

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Summary

- A number of global centres gather dynamical model data and combine them to produce a multi-model ensemble (MME). This becomes a 'super-ensemble' of several hundred ensembles
- By combining model forecasts, effects of single model errors are averaged out, giving a better estimate of the most likely outcome
- Using the ACC skill score MME slightly better than ACCESS-S. ACCESS-S is among the better half of WMO GPC LRF models
- BUT skill score not the only aspect to consider. Subseasonal to seasonal seamless prediction, lag times, specialist products, communication and capacity building etc. also important.

Discussion question: When is it best to use an MME and when it is best to use ACCESS-S?

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https://media0.giphy.com/media/3ornk03njkdi5mNKJG/giphy.gif

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My turn for questions

1. Is the WMO LC LRFMME 3-month outlook for a country or location a simple average of individual model outlooks? Yes or No
2. I want to present a forecast that takes into account as many model forecasts as possible. Can I average CliKP, ACCESS-S and SCOPIC outlooks? Yes or No
3. Question 2. Why?
4. What are some of the advantages of MME outlooks over ACCESS-S?
5. What are some of the advantages of ACCESS-S over MME outlooks?