IRI Forecast Systems update

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21st Session of WGSIP

INM RAS, Moscow, May 29th 2019

International Research Institute
for Climate and Society
Earth Institute | Columbia University

Outline

1. Seasonal
   A. New Forecast System (2017; so this is a refresher)
   B. Skill Maps

2. Sub-seasonal
   A. New Forecast System (2018)
   B. Skill Maps

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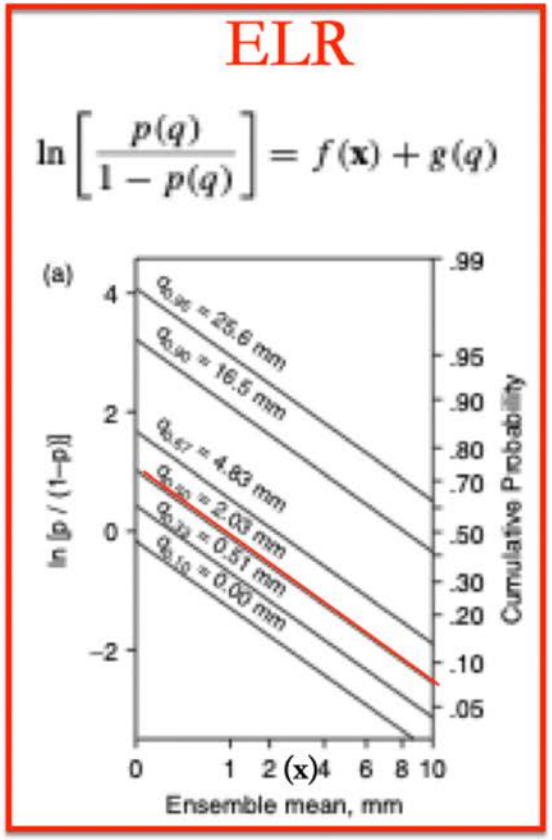
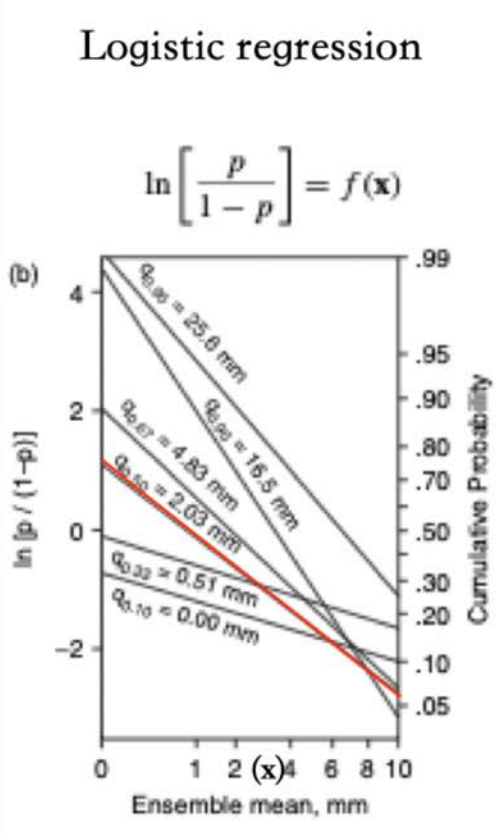
New Seasonal Forecast System

Re-calibration using Extended Logistic Regression

GFS Day 6 – 10
Precip Forecast for
Minneapolis
28 Nov – 2 Dec
2001
Wilks (2009)

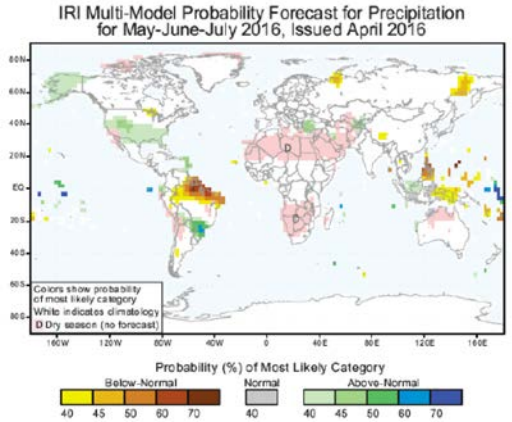




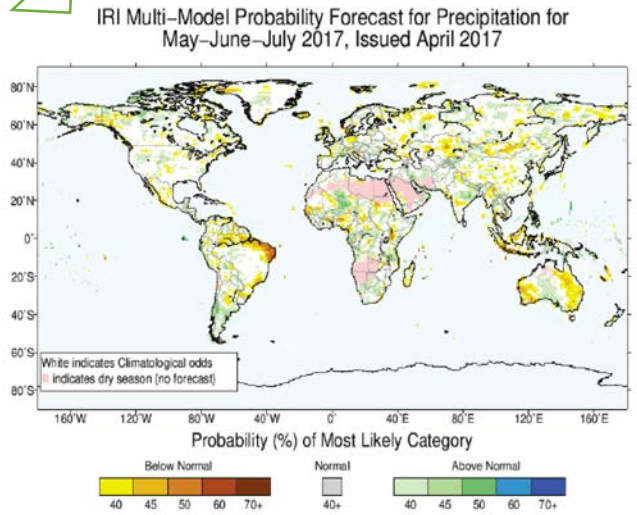
Applied at each grid point, using forecast ensemble mean

Seasonal Forecast Systems

Old system



New system



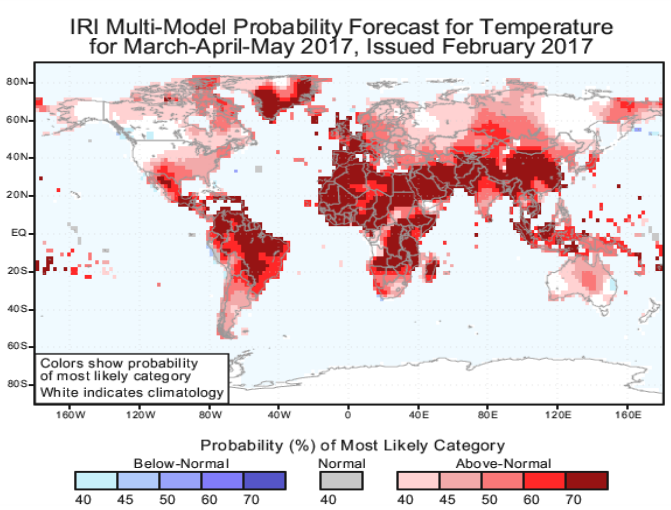
Courtesy of N. Acharya and the SCF team @ IRI

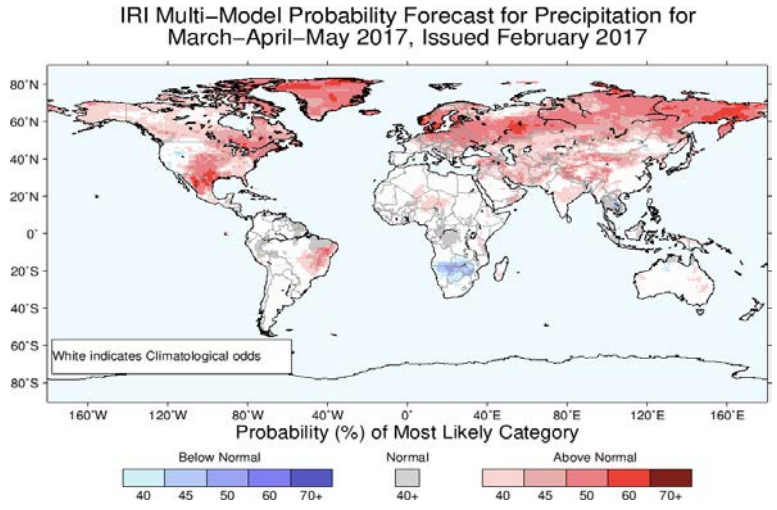
	Existing IRI forecast	New IRI forecast
GCM used (Predictors)	2-tier (uncoupled) ECHAM 4.5, CCM3.6, COLA, GFDL,CFSv2	1-tier (coupled) NMME models
Observed data used (Predictand)	Precip: CMAP Temp: CAMS	Precip: CPC-CMAP Temp: GCHN updated
Forecast Resolution	2.5 degree grid	1 degree grid
Calibration method	• Pattern-based correction of ensemble means - PC Regression based on tropical precip EOFs - Spread estimate from historical forecasts with forecast SST • Equal weighting of corrected models • Parametric forecast probabilities (T - Gaussian, P - transformed Gaussian)	Extended Logistic Regression (Non-Gaussian) at grid point level.
Dry mask	Forecast are only produced when the climatology being more than 30 mm precipitation in any given season	Forecast are only produced when the at least 10% of the training sample are non-zero.
Making Flexible forecast	Used mean and SD of the forecast, then use parametric approach	Integrated part of the ELR method

Old system

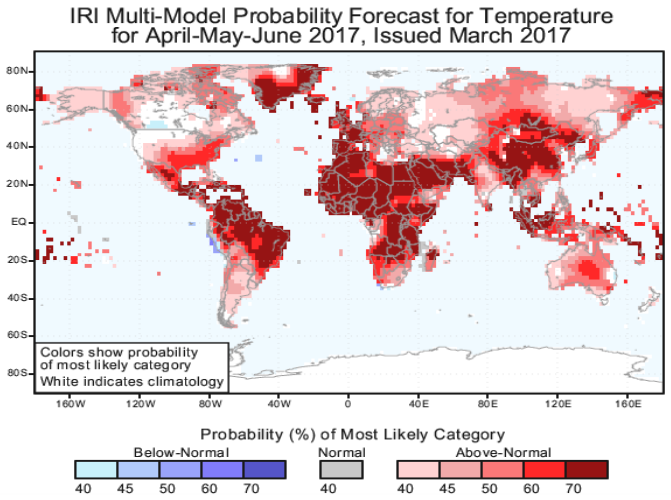
New system

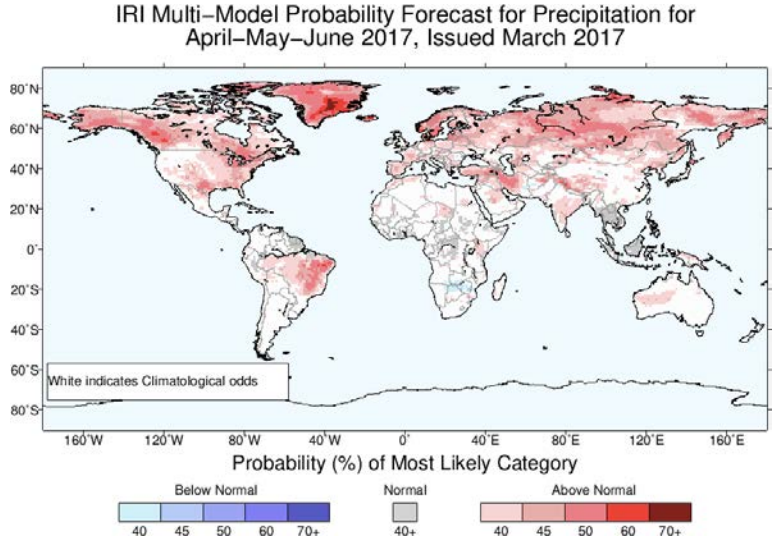
Feb forecast,2017



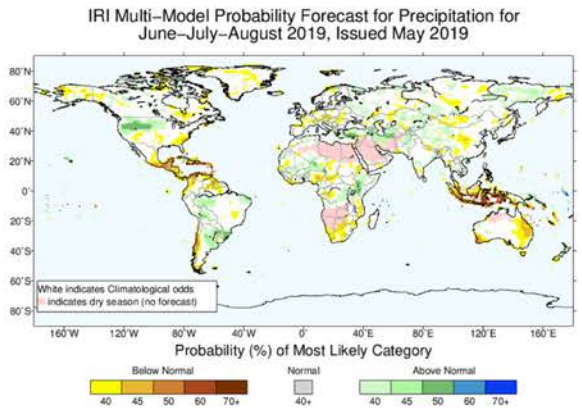


Mar forecast,2017

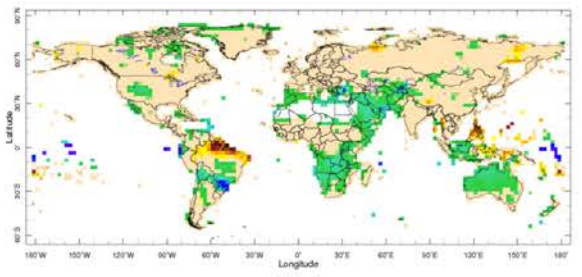




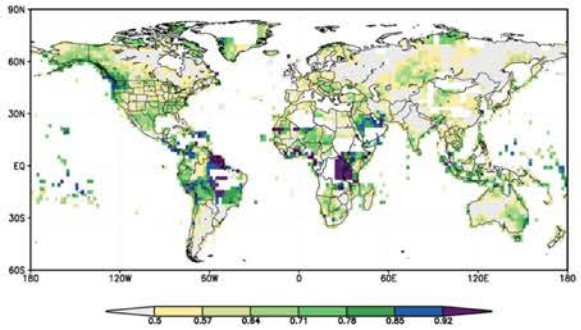
Seasonal Climate Forecasts



IRI's Seasonal Climate Forecasts (*Net Assessments*) are updated every month for the next 6 months into the future. They give probabilistic outlooks for temperature and precipitation to be in the above-normal, near-normal, or below-normal tercile categories, which are defined from the previous 30 years.



Flexible Format Seasonal Climate Forecasts are based on the same forecast information as the *Net Assessments*. They give probabilistic outlooks for temperature and precipation based on categories or thresholds chosen by the user.



The Seasonal Forecast Verifications page provides skill assessment of IRI's Net Assessment forecasts 1997-present.

The IRI probabilistic seasonal climate forecast product is based on a re-calibration of model output from the U.S. National Oceanographic and Atmospheric Administration (NOAA)'s North American Multi-Model Ensemble Project (NMME). This includes the ensemble seasonal prediction systems of NOAA's National Centers for Environmental Prediction, Environment and Climate Change Canada, NOAA/Geophysical Fluid Dynamics Laboratory, NASA, NCAR and COLA/University of Miami. The output from each NMME model is re-calibrated prior to multi-model ensembling to form reliable probability forecasts. The forecasts are now presented on a 1-degree latitude-longitude grid.

Details of the forecast system, post-processing, and recommended references for citation can be found here. Forecasts from the individual NMME models are shown on NOAA CPC's website. Verifications of IRI's real-time forecasts issued since 1998 can be found on the Seasonal Climate Verifications pages.

https://iri.columbia.edu/our-expertise/climate/forecasts/#Seasonal_Climate_Forecasts

Climate Forecasts | Flexible Forecasts: Precipitation Flexible Seasonal Forecast | Region: Global | Target Time: Jun-Aug 2019 | Probability: exceeding | Percentile | 35.0 | %-ile

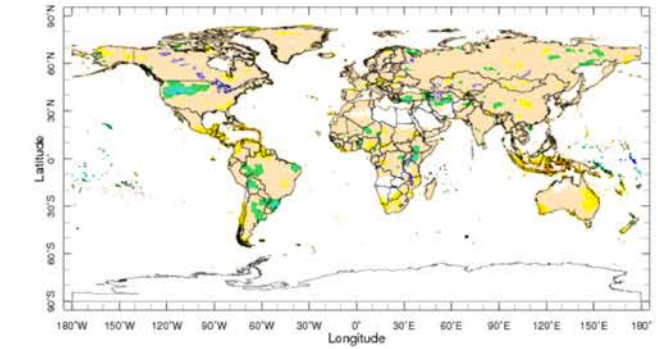
25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0

Description | Dataset Documentation | Instructions | Contact Us

Precipitation Flexible Seasonal Forecast

This seasonal forecasting system consists of probabilistic precipitation seasonal forecasts based on the full estimate of the probability distribution.

Please refer to our licensing agreement for permission to use any IRI forecast material.



Probabilistic seasonal forecasts from multi-model ensembles through the use of *statistical recalibration*, based on the historical performance of those models, provide reliable information to a wide range of climate risk and decision making communities, as well as the forecast community. The flexibility of the full probability distributions allows to deliver interactive maps and point-wise distributions that become relevant to user-determined needs.

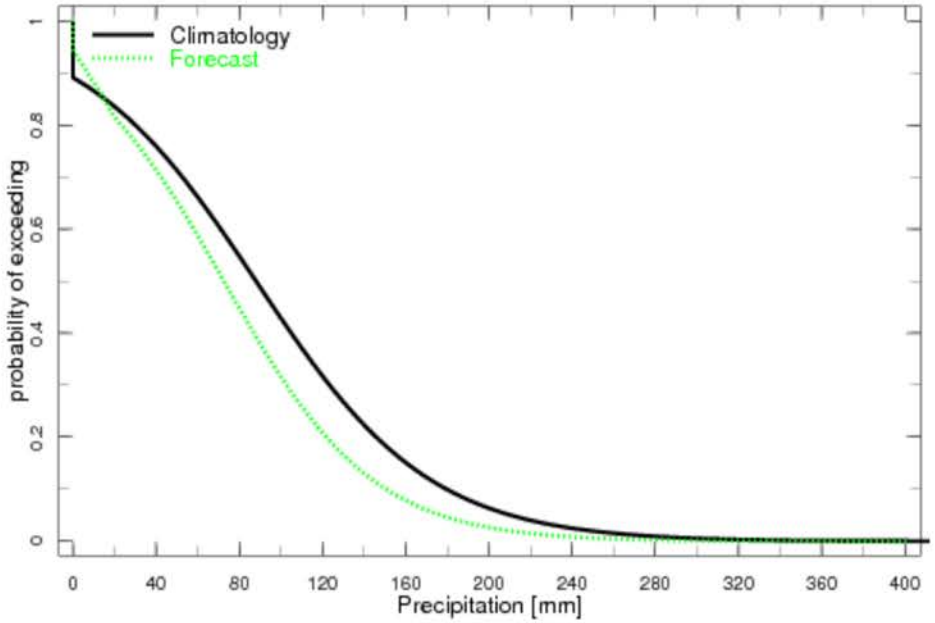
The default map shows globally the seasonal precipitation forecast probability (colors between 0 and 1) of exceeding the 50th percentile of the distribution from historical 1982-2010 climatology. The forecast shown is the latest forecast made (e.g. Dec 2017) for the next season to come (e.g. Jan-Mar 2018). Four different seasons are forecasted and it is also possible to consult forecasts made previously. The forecasts are directly computed from the extended logistic regression model as probabilities of exceeding (or non-exceeding) of every 5th percentile of the climatological distribution. The specific quantile (in steps of 5 percentile points) can then be selected. The user can also specify a quantitative value in physical units (here seasonal total precipitation in mm) for probability of exceeding or non-exceeding. The final probability maps are smoothed spatially with a 9×9 point Gaussian smoother.

Clicking on a point on the map will show the local probability of exceeding and probability distribution of the forecast (green) together with the climatological distribution (black).

Target Date	Issue Date	Lead Tin
Jun-Aug 2019 0000	1 May 2019	2.5

Forecast made for **[148E-149E, 29.5S-28.5S]**
located in or near **Goondiwindi (R), Queensland, Australia**

Probability of Exceeding



Jun-Aug 2019 Flexible seasonal Precipitation forecast issued May 2019

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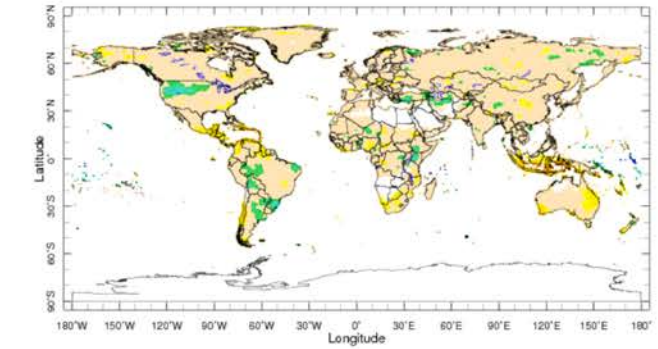

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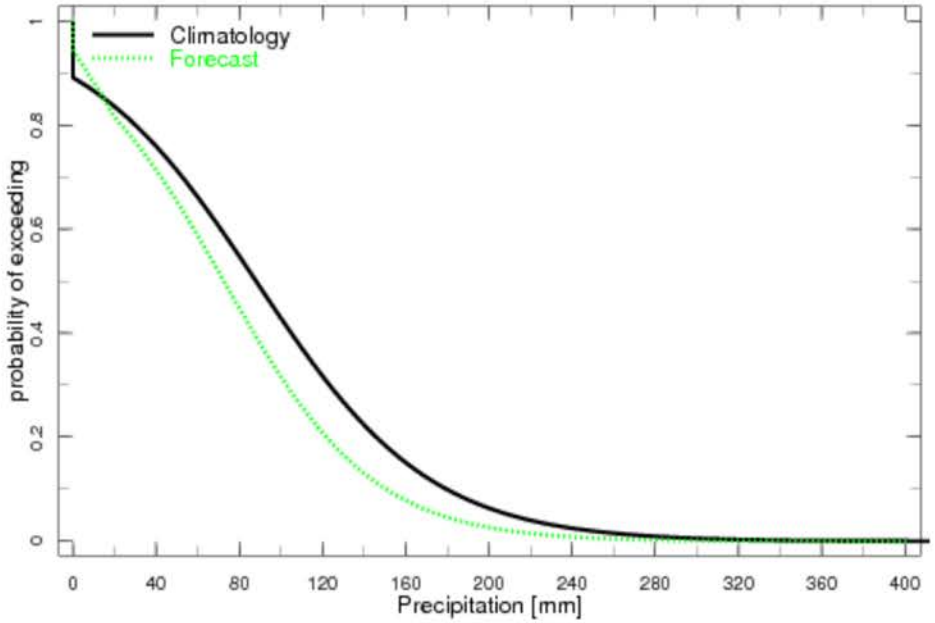

Jun-Aug 2019 Flexible seasonal Precipitation forecast issued May 2019

Data Library

home nachiketa ELR_seasonal_RPSS_hindcast_1982_2010 precip rpss_precip_ELR.nc rpss

Language: english

Description | Expert Mode | Options | Instructions

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  longitude -180 180 RANGEEDGES
  startcolormap DATA
    -0.1 0.2 RANGE
    white DodgerBlue DodgerBlue
      -0.05 bandmax
      cyan cyan
        -0.0125 bandmax
        gray gray
          0.0125 bandmax
          yellow yellow
            0.025 bandmax
            gold gold
              0.05 bandmax
              orange orange
                0.075 bandmax
                DarkOrange DarkOrange
                  0.1 bandmax
                  tomato tomato 0.125
                    bandmax
                    OrangeRed OrangeRed 0.15
                    bandmax
                    red red 0.175
                    bandmax
                    magenta magenta 0.2
                    bandmax
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fig
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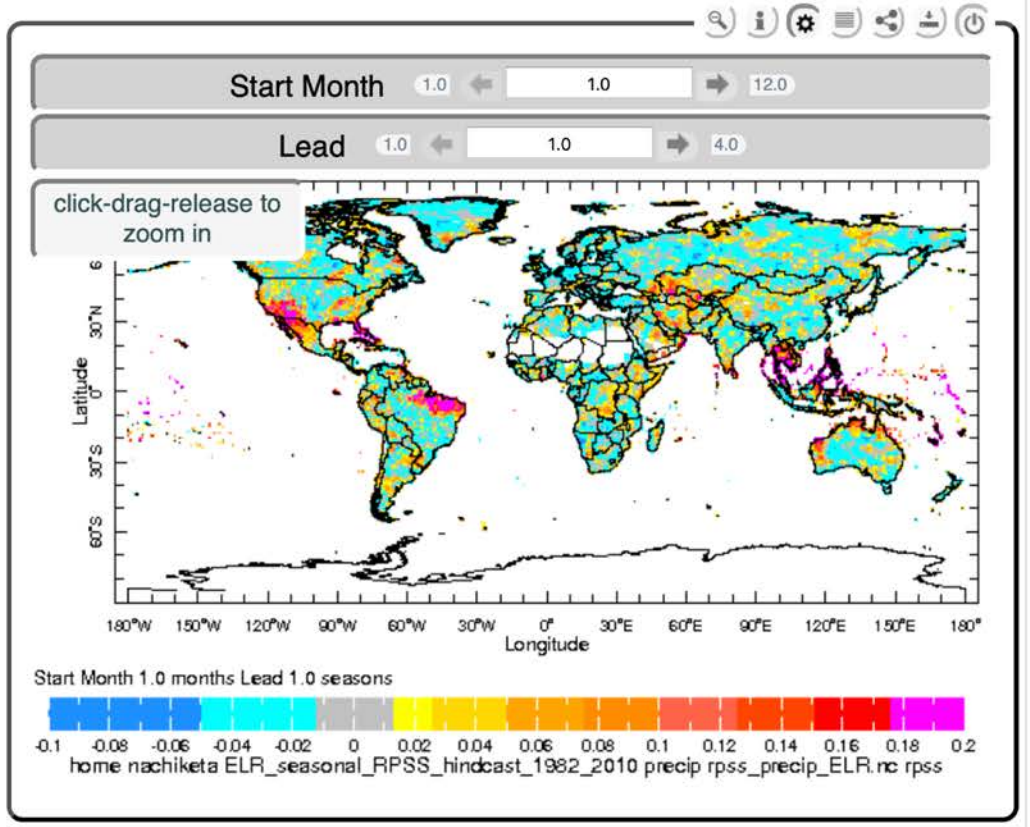
OK reset



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EPSG:4326

http://wiki.iri.columbia.edu/index.php?n=Climate.SeasForecastDev

Outline

1. Seasonal
   A. New Forecast System (2017; so this is a refresher)
   B. Skill Maps

2. Sub-seasonal
   A. New Forecast System (2018)
   B. Skill Maps

Climate: Subseasonal Forecasts | SubX Forecasts: Precipitation Probability Forecast | Region: Global | Forecast Issued: 0000 24 May 2019 | Target Period: 1-14 Jun 2019, 8-21 Jun 2019

Description | Dataset Documentation | Instructions | Contact Us

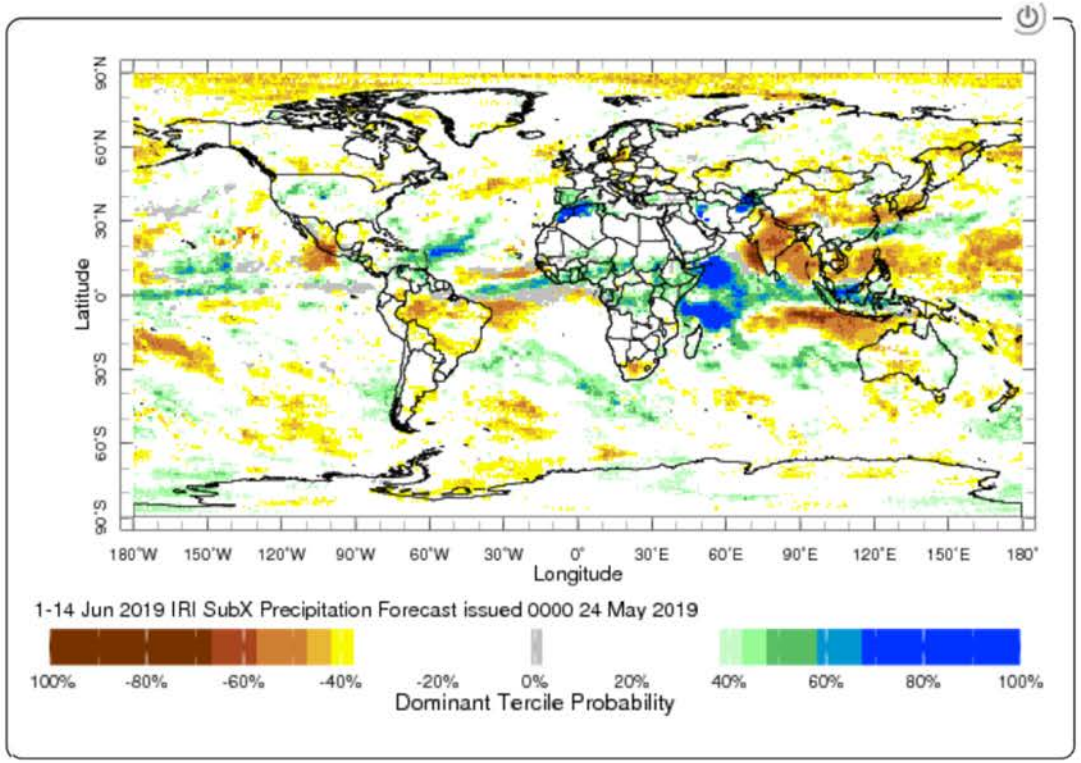
Precipitation Probability Forecast

Calibrated Subseasonal Tercile categories precipitation real-time forecasts from the Subseasonal eXperiment (SubX)

The default map shows the latest forecast for weeks 2-3 ahead (i.e. the 14-day Saturday-Friday target period, 9 to 22 days after the forecast is issued), as probability of the dominant tercile category. Previous forecasts can be viewed through the control bar menu.The weeks 3-4 forecast (i.e. the 14-day target period, 16 to 29 days after the forecast is issued) is also available. New forecasts are issued weekly on Fridays.

When navigating to a forecast of which Target Period is in the past, a smaller side map shows a verification of the forecast as the observed tercile values according to the 1999-2014 training period of the calibration of the forecast.

Clicking on the forecast map will show, for the clicked grid box, the probabilities for the 3 forecasts categories (Below-, Near- and Above- Normal).



The probabilistic forecasts shown here are obtained from the statistical calibration of three models (NCEP CFSv2, NCEP GEFS, and NOAA/ESRL FIM HYCOM, each run on Wednesdays) from the SubX database which are combined with equal weight to form multi-model ensemble precipitation tercile probabilities forecasts. Individual model forecasts are calibrated separately for each point, start and lead using Extended Logistic Regressions (ELR; Vigaud et al, 2017) based on the historical performance of each model, and thus provide reliable intra-seasonal climate information in regards to a wide range of climate risk of concerns to the decision making communities and for which subseasonal forecasts are particularly well suited.

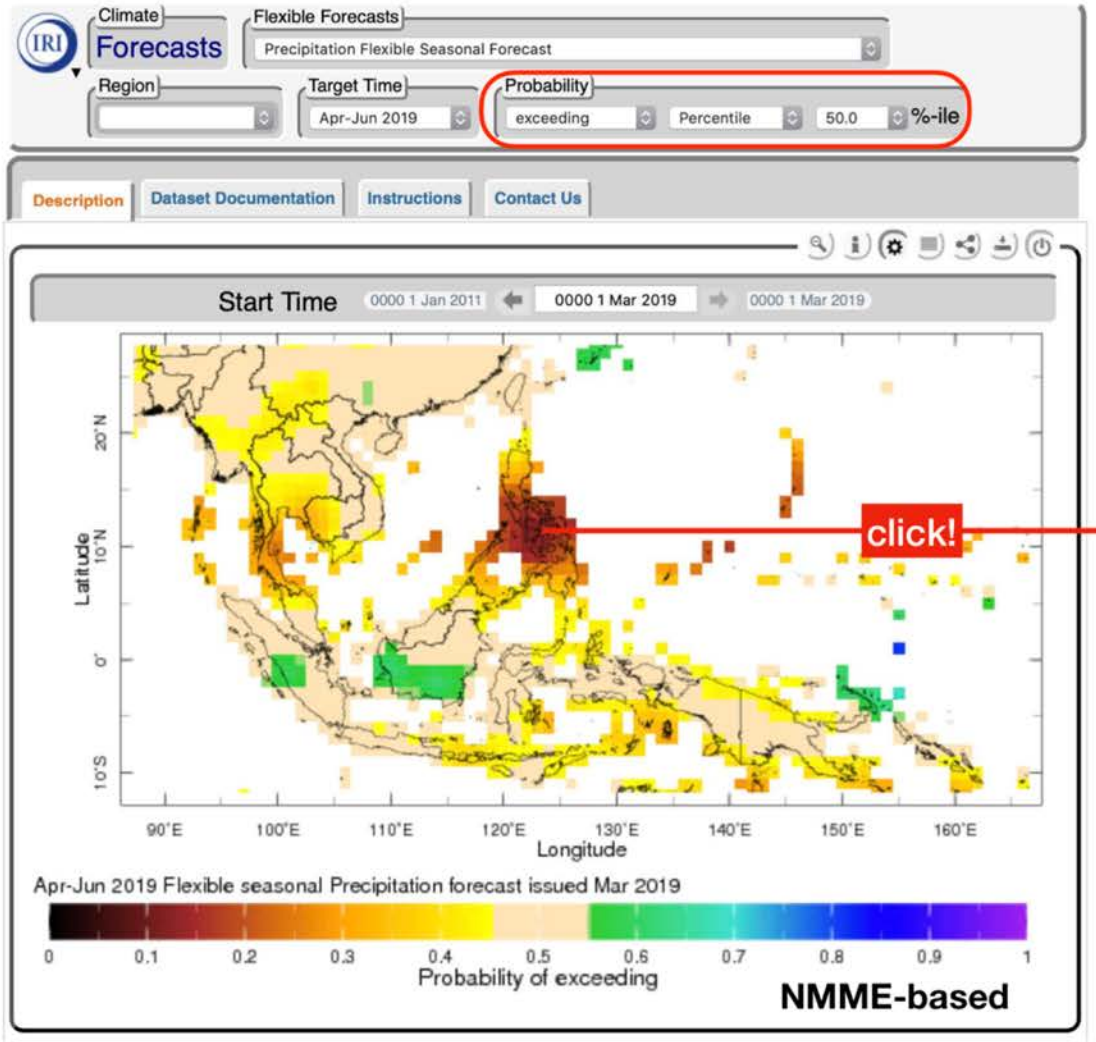
Subseasonal-to-seasonal forecasting techniques are still under development. This Maproom shows the type of experimental forecast information currently being created at these time scales in real time.

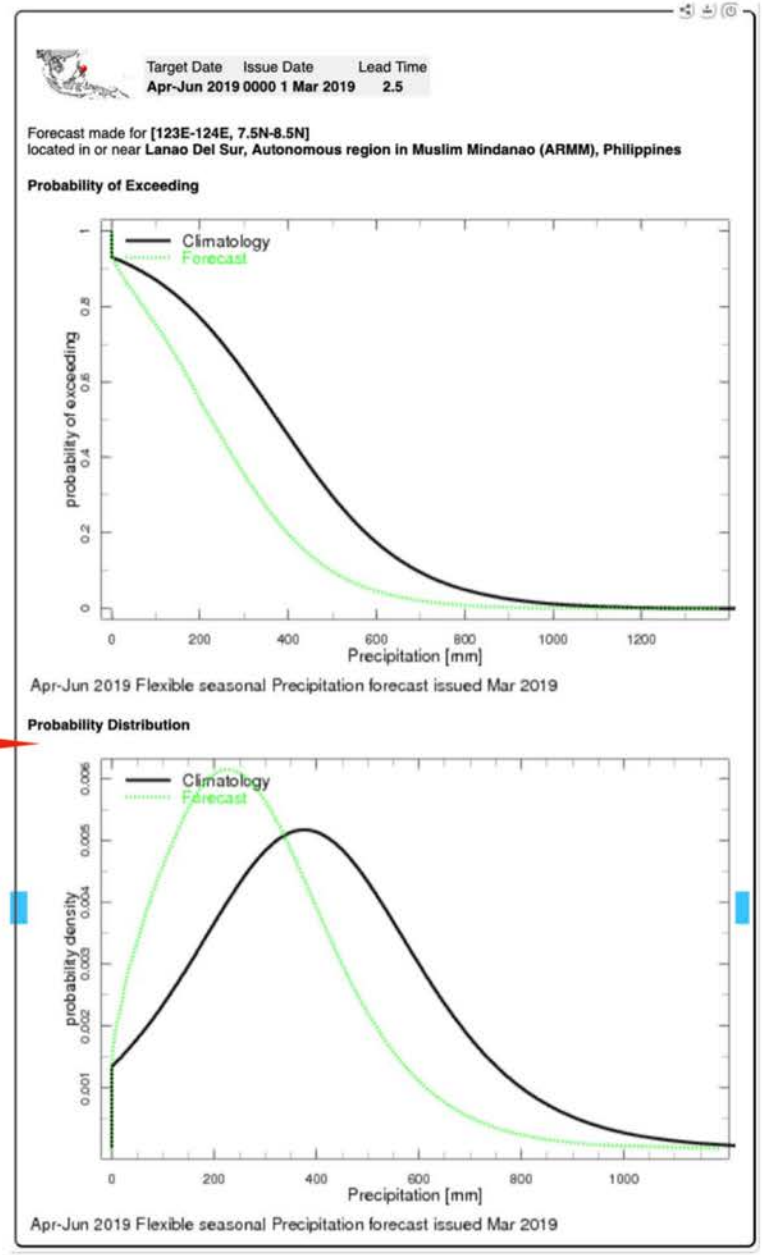
http://iridl.ldeo.columbia.edu/maproom/Global/ForecastsS2S/precip_subx.html

References:

- Pegion, K. et al. 2018: The Subseasonal Experiment (SubX): A multi-model subseasonal prediction experiment submitted to Bull. Amer. Meteor.
- Vigaud, N., A.W. Robertson, and M.K. Tippett, 2017: Multimodel Ensembling of Subseasonal Precipitation Forecasts over North America. Mon. Wea. Rev., 145, 3913–3928

Flexible Format Seasonal Forecast Maprooms





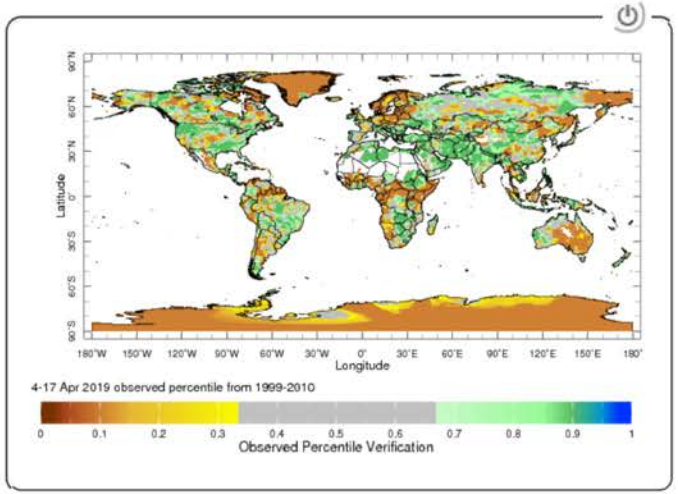
Climate: Subseasonal Forecasts | S2S Lagged Forecasts: Precipitation Probability Forecast | Region: Global | Forecast Issued: 0000 28 Mar 2019 | Target Period: 4-17 Apr 2019

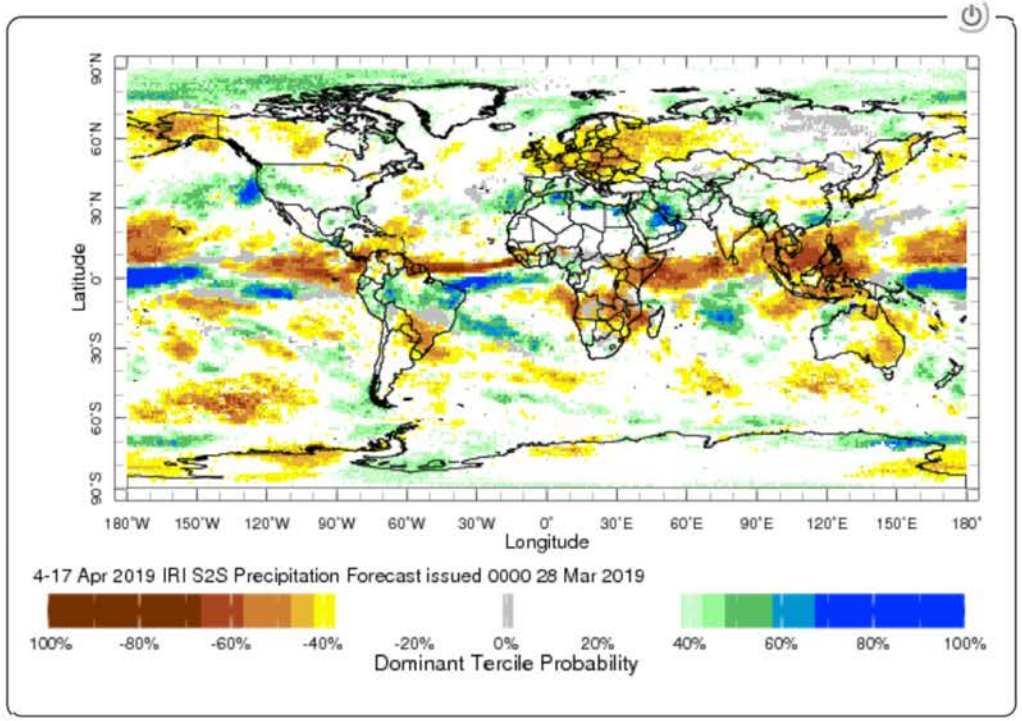
Description | Dataset Documentation | Instructions | Contact Us

Precipitation Probability Forecast

Calibrated Subseasonal Tercile categories precipitation forecasts lagged behind real time from the S2S database.

The default map shows the latest forecast for weeks 2-3 ahead (i.e. the 14-day Thursday-Wednesday target period, 8 to 21 days after the forecast is issued), as probability of the dominant tercile category. Previous forecasts can be viewed through the control bar menu. The weeks 3-4 forecast (i.e. the 14-day target period, 15 to 28 days after the forecast is issued) is also available. The smaller side map shows a verification of the forecast in current view as the observed tercile values according to the 1999-2010 training period of the calibration of the forecast. New forecasts are issued weekly on Thursdays but are released on a monthly basis. Please note that these forecasts are "lagged", i.e. they are not available in real time.





Clicking on the map will show, for the clicked grid box, the probabilities for the 3 forecasts categories (Below-, Near- and Above- Normal).

The probabilistic forecasts shown here are obtained from the statistical calibration of three models (ECMWF, NCEP CFSv2 and CMA, each run on Thursdays) from the Subseasonal to Seasonal (S2S) Prediction Project database (Vitart et al, 2017) which are combined with equal weight to form multi-model ensemble precipitation tercile probabilities forecasts. Individual model forecasts are calibrated separately for each point, start and lead using Extended Logistic Regressions (ELR; Vigaud et al, 2017) based on the historical performance of each model, and thus provide reliable intra-seasonal climate information in regards to a wide range of climate risk of concerns to the decision making communities and for which subseasonal forecasts are particularly well suited.

As subseasonal-to-seasonal (S2S) forecasting techniques are being developped, and more and more models are made available in (near) real-time, this Maproom shows the type of forecast information that can be currently delivered at these time scales.

http://iridl.ldeo.columbia.edu/maproom/Global/ForecastsS2S/precip_s2s.html

Climate: Subseasonal Forecasts | S2S Lagged Forecasts: Precipitation Hindcast Skill | Region: Global | Lead Time: week2-3 | Model: MME | Skill Score: RPSS

Description | Dataset Documentation | Instructions | Contact Us

Precipitation Hindcast Skill

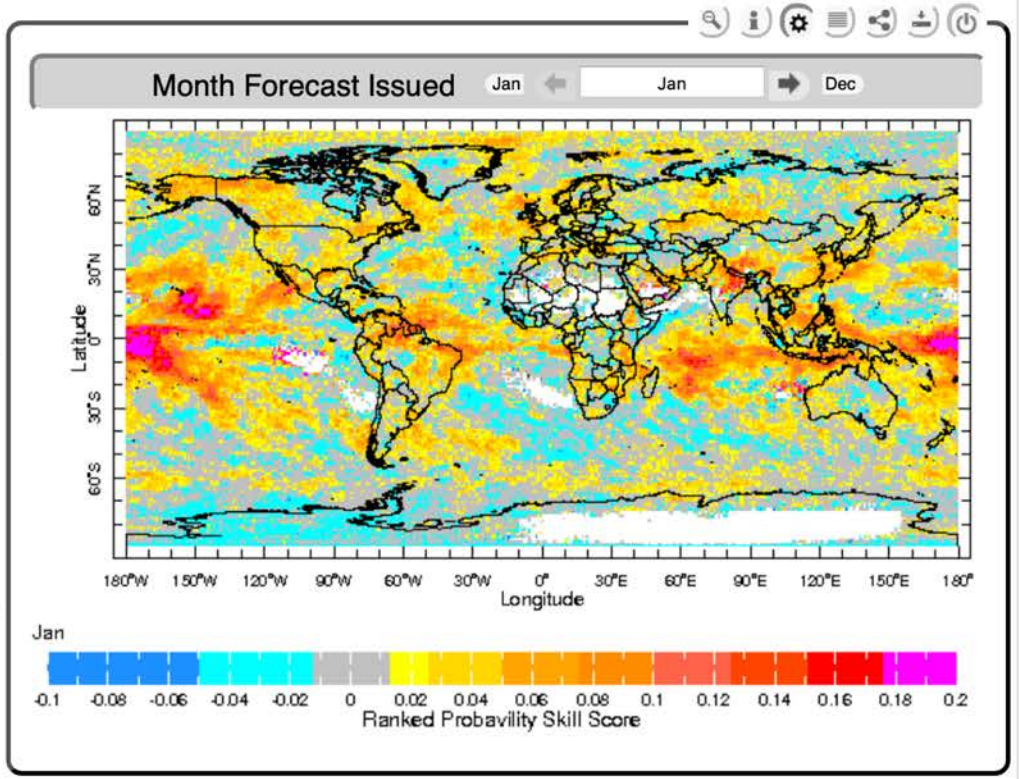
Subseasonal skill score based on the historical performance of each model and their multi-model ensemble.

The different skill scores are mapped by calendar month. The forecasts lead times are combined over the weeks 2-3 and the weeks 3-4 from the forecast start time (i.e., 14-day long periods respectively 8 to 21 days and 15 to 28 days after the forecast is issued). Forecasts skill scores combine start times by calendar month and across years 1999 to 2010.

The probabilistic forecasts shown here are obtained from the statistical calibration of three models (ECMWF, NCEP CFSv2 and CMA) from the Subseasonal to Seasonal (S2S) Prediction Project database (Vitart et al, 2017) which are combined with equal weight to form multi-model ensemble precipitation tercile probabilities forecasts. Individual model forecasts are calibrated separately for each point, start and lead using Extended Logistic Regressions (ELR; Vigaud et al, 2017) based on the historical performance of each model, and thus provide reliable intra-seasonal climate information in regards to a wide range of climate risk of concerns to the decision making communities and for which subseasonal forecasts are particularly well suited.

These skill scores diagnostics maps give a sense of where and when (issued which months of the year and for which weekly lead times) subseasonal forecasts may have the potential to provide useful information.

The actual forecasts, of which these skill scores are measuring the historical performance, are to be found in the Experimental Precipitation Subseasonal Forecast Maproom.



Skill scores definitions:

- **RPSS**: Ranked Probability Skill Scores (RPSS; Epstein (1969); Murphy (1969, 1971); Weigel et al. (2007)) are used to quantify the extent to which the calibrated predictions are improved compared to climatological frequencies. RPSS values tend to be small, even for skillful forecasts. The approximate relationship between RPSS and correlation being such that a RPSS value of 0.1 corresponds to a correlation of about 0.44 (Tippett et al. 2010).
- **Spearman Ranked Correlation**: the Spearman Anomalies Correlation Coefficient corresponds to the ranked correlation between MME forecasts and observed anomalies, which is particularly appropriate to verify probabilistic forecast
- **ACC**: the Anomalies Correlation Coefficient is the correlation between MME forecasts and observed anomalies.

http://iridl.ldeo.columbia.edu/maproom/Global/ForecastsS2S/s2sskill.html

How do IRI's Subseasonal and Seasonal forecast skills compare?

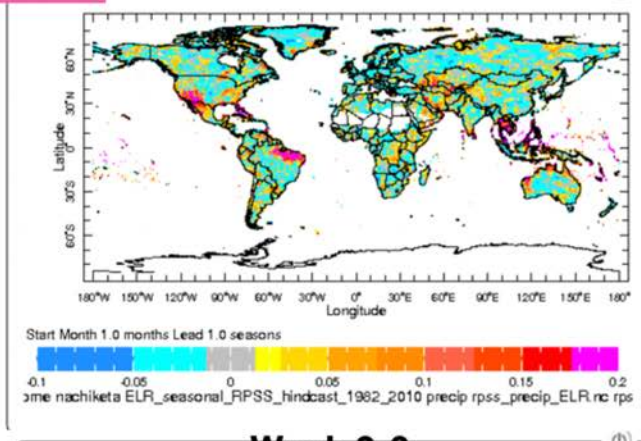
Precipitation Forecasts issue in Jan Hindcasts

Seasonal Skill

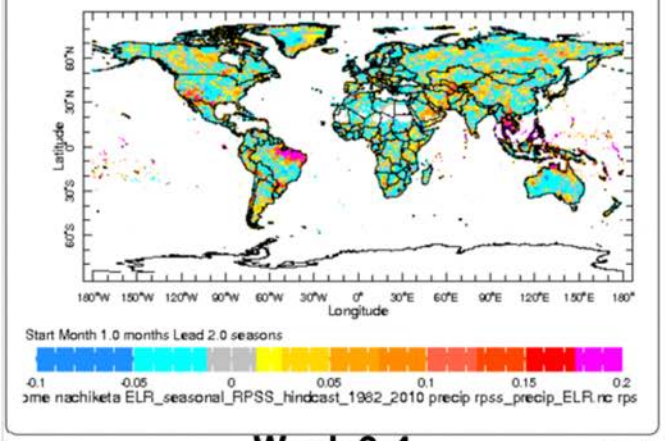
Subseasonal forecasts are skillful over broader areas than seasonal ones, but skill-maxima are lower

Subseasonal Skill

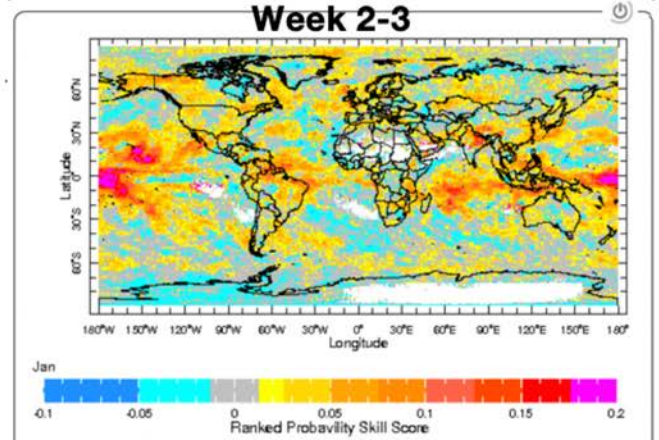
FMA from Jan



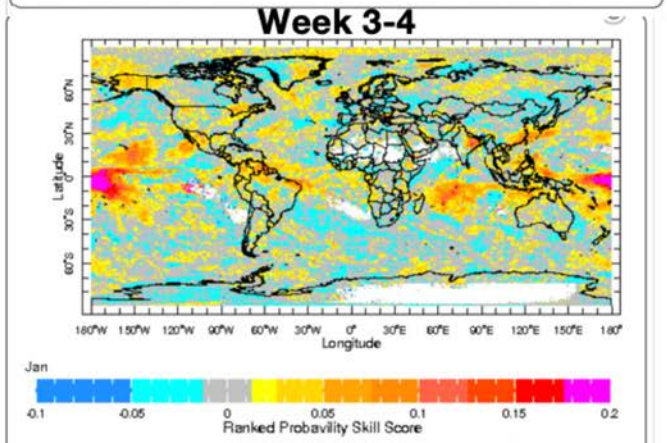
MAM from Jan



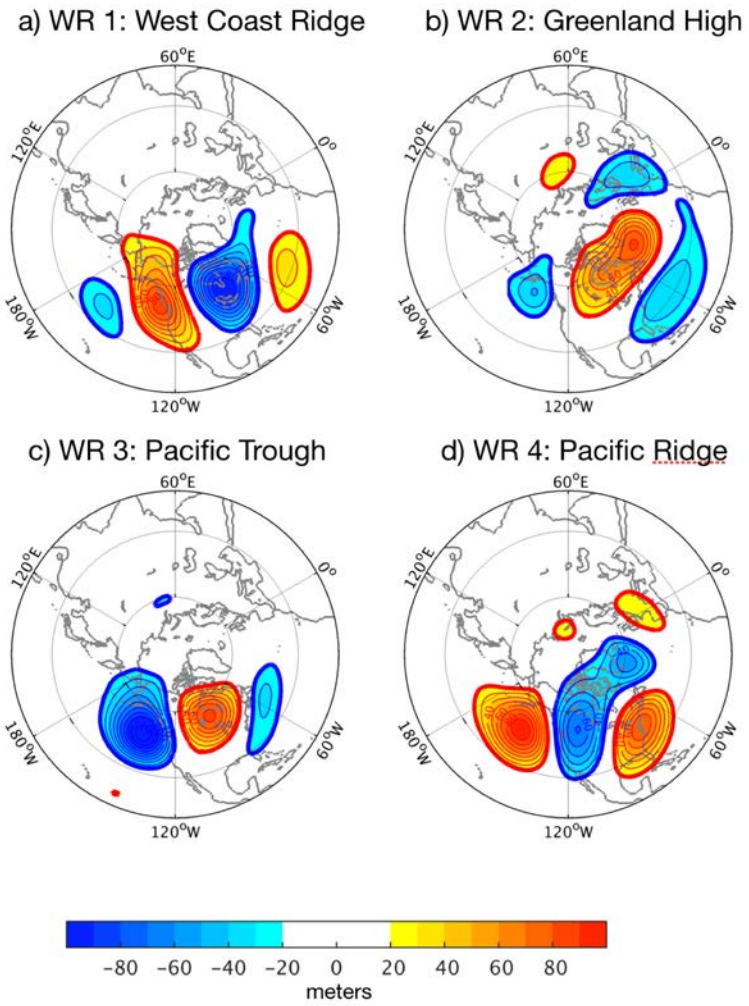
Week 2-3

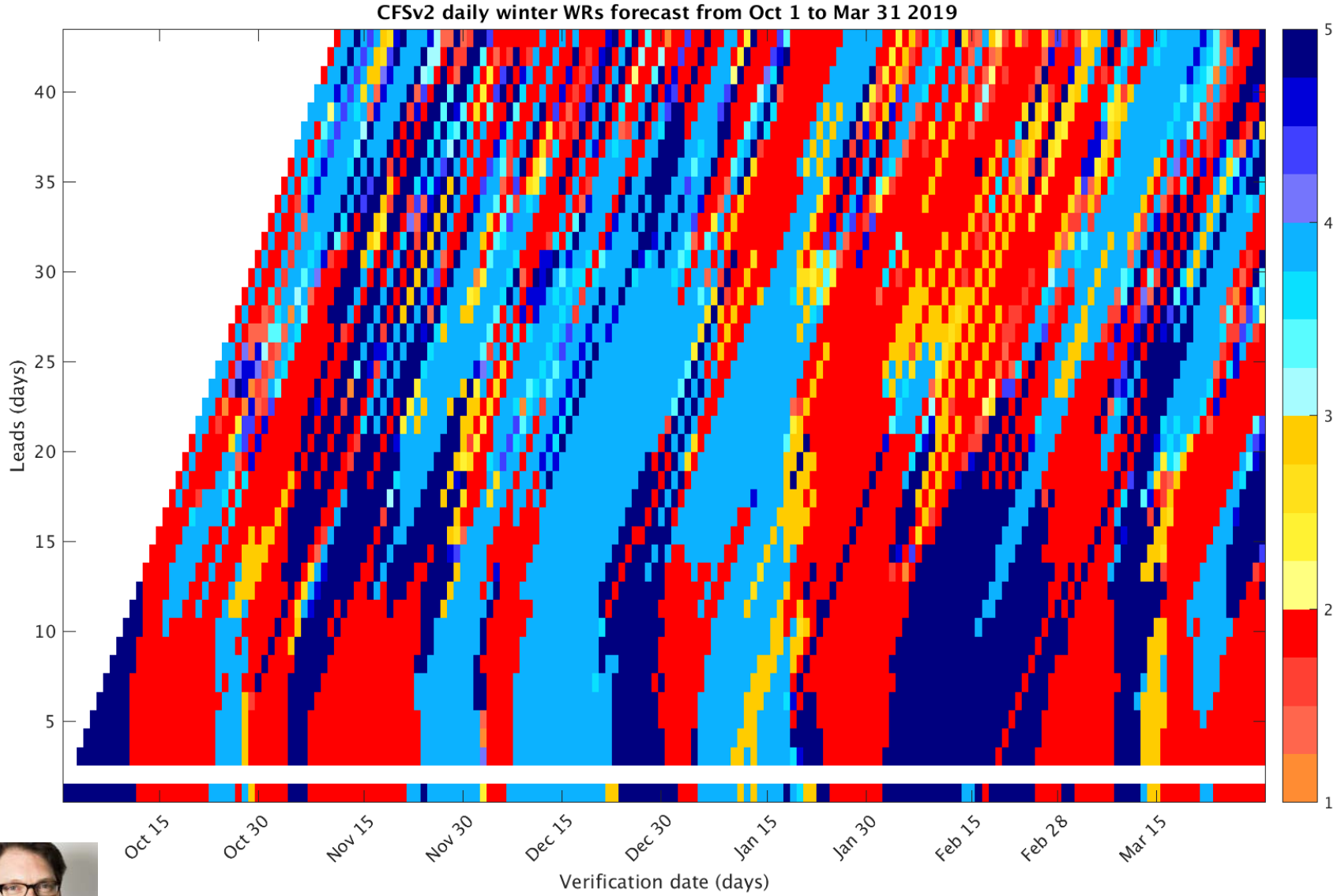


Week 3-4



Skill is expressed here in Ranked Probability Skill Score which is a multi-category generalization of the Brier Skill Score





Vigaud, Robertson, Tippet (2018)

Special thanks to Jing Yuan!!

http://wiki.iri.columbia.edu/index.php?n=Climate.S2S-WRs

IRI Forecast Systems update

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21st Session of WGSIP

INM RAS, Moscow, May 29th 2019

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