Subseasonal to Seasonal (S2S) Prediction Databases

S2S Databases

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1. TIGGE Global, Medium-Range Operational Ensembles

- THORPEX Interactive Grand Global Ensemble (TIGGE) is a WMO project starting from October 2006
- TIGGE focuses on the short-range and medium-range forecasts
  - In summer 2021, the forecasts were produced by 13 models, with a horizontal resolution ranging from 12 km to 139 km, and most centers produce forecast up to 10-15 days.
- Please see the current status of the TIGGE models at https://confluence.ecmwf.int/display/TIGGE/Models

1. TIGGE: NCEP

- In summer 2017, the NCEP-ENS consisted of four runs a day (at 00, 06, 12, and 18 UTC), with a 25-km horizontal resolution. Each run included 1 unperturbed and 30 perturbed forecasts, up to 16 days.
- The forecast model included only the land and atmospheric components (no wave or ocean model component used).
- Model uncertainties are represented using the Stochastic Total Tendency Perturbation (STTP) scheme (Hou et al., 2008), which represents model uncertainty by adding a stochastic forcing term to the total tendency from all physical parametrization schemes.

1. TIGGE: ECMWF

- In summer 2021, the ECMWF-ENS comprised 51 members (1 unperturbed and 50 perturbed).
- It includes coupling of the 3-dimensional ocean and atmosphere
- Forecasts are run twice a day, with initial times at 00 and 12 UTC, up to 15 days; at 00 UTC on Mondays and Thursdays, the forecasts are extended to 46 days
- Forecasts are run with a variable resolution (Buizza et al., 2007):
    - Tco639L91 (~18 km spacing in the horizontal dimension and 91 vertical levels) during the first 15 days, and Tco319L91 (~35 km horizontal grid spacing) thereafter.

2. S2S Prediction Project

- The Subseasonal-to-Seasonal (S2S) Prediction Project is a WMO core project to improve forecast skill and understanding on the subseasonal to seasonal time scale.
- The first 5-year phase of the project began in Nov 2013. Phase II of S2S began in January 2019 and will conclude in December 2023.
- In summer 2021, the S2S datasets were produced by 11 centers with different horizontal resolution and forecast length (see the table).
- A total of 7 of the 11 ensembles use an atmosphere/land/ocean coupled model, with some of them with an interactive sea ice model.
- Different centers have different initialization frequency.

http://www.s2sprediction.net/

TABLE 3 Key Characteristics of the 11 S2S Monthly Operational Ensembles

Center	Initial Perturbation Method	Model Uncertainty	Horizontal Resolution (km)—Vertical Levels (TOA, hPa)	Dynamical Ocean (model)	Forecast Length	No. of Me (Perturbed + Unpertu
BMRC, monthly	BV (globe)	Yes	T42 (250 km)—L17 (10.0)	Yes (ACOM2)	62 days	33 + 1
CMA-BCC, monthly	LAF method	No	T106 (110 km)—L40 (0.5)	Yes (MOM4)	60 days	4 + 1
ECCC, monthly	EnKF (globe)	Yes	0.45° × 0.45°—L40 (2.0)	No	32 days	20 + 1
ECMWF ENS, monthly extension	SV (NH, SH, TC) + EDA (globe)	Yes	Tco639 (0.14°; 16 km)—L91 (0.01) Tco319 (0.28°; 32 km)—L91 (0.01)	Yes (NEMO)	0–15 days 46 days	50 + 1
HMCR, monthly	BV (globe)	No	1.1° × 1.4° (120 km)—L28 (5.0)	No	61 days	20 + 1
ISAC-CNR, monthly	LAF method + BV (globe)	No	0.8° × 0.56° (80 km)—L54 (6.8)	No	31 days	40 + 1
JMA, monthly	LAF method + BV (globe)	Yes	TL319 (0.70°; 60 km)—L60 (0.1)	No	34 days	24 + 1
KMA	LAF + ETKF (globe)	Yes	N216 (0.8° × 0.56°; 60 km)—L85 (0.1)	Yes (NEMO)	60 days	4 + 1
MF, monthly	No	Yes	TL255 (80 km)—L91 (0.01)	Yes (NEMO)	32 days	50 + 1
NCEP	LAF + BV (globe)	No	T126 (100 km)—L64 (0.02)	Yes (MOM4P0)	45 days	16
UKMO	LAF + ETKF (globe)	Yes	N216 (0.8° × 0.56°; 60 km)—L85 (0.1)	Yes (NEMO)	60 days	4

Note: Listed in alphabetical order (column 1): initial uncertainty method (column 2), model uncertainty simulation (column 3), horizontal res (including the top of the atmosphere, in hPa; column 4), coupling to a dynamical ocean (with model name; column 5), forecast length in day each run (column 7), and frequency (number of runs per week; column 8). For columns 3–5, blue (brown) color identifies the ensemble wit NH, Northern Hemisphere; SH, Southern Hemisphere.

Table credit: Buizza et al. 2019, https://doi.org/10.1016/B978-0-12-811714-9.00013-9

3. North American Multi-Model Ensemble (NMME)

- The North American Multi-Model Ensemble (NMME) is a multi-model, seasonal forecasting system consisting of coupled models from North American modeling centers.
- This data contains global, 12-month forecasts of 13 key variables, including precipitation rate, daily maximum and minimum surface air temperatures, SLP, 850 hPa UV, and 200 hPa UV.
- NMME data are available at daily or 6-hourly intervals with a 1º by 1º spatial resolution.

Model	Grid/Scale	Period of Record	Model Cycle	Output Timestep	Data Access Links
CCSM4	Global, 1º	01Jan2011 - Present	1/day	Daily	HTTPS TDS ERDDAP
CFSV2-2011	Global, 1º	01Jan2011 - Present	1/day	6-hourly	HTTPS TDS ERDDAP
CanCM3	Global, 1º	01Jan2011 - Present	1/day	Daily	HTTPS TDS
CanCM4	Global, 1º	01Jan2011 - Present	1/day	Daily	HTTPS TDS
GEOS-5	Global, 1º	01Jan2011 - Present	1/day	Daily	HTTPS TDS
GEM/NEMO	Global, 1º	01Nov2019 - Present	1/day	Daily	HTTPS TDS

https://www.ncei.noaa.gov/products/weather-climate-models/north-american-multi-model

4. The NOAA SubX Project

- The Subseasonal Experiment (SubX) is a NOAA/Climate Testbed project focused on subseasonal predictability and predictions.
- It includes seven global models, which produced seventeen years of ensemble retrospecive forecasts initialized weekly. Additionally, one-year of real-time predictions were produced and provided to the NOAA/NWS Climate Prediction Center as additional guidance for their week-3/4 outlooks.
- Data are output on a 1x1 grid. Reforecasts cover the period of 1999-2015, and additional years are available for some models.
- More information about the models: http://cola.gmu.edu/subx/data/modelinfo.html

http://cola.gmu.edu/subx/about.html

5. Seasonal forecasts at the Copernicus Climate Change Service (C3S)

- The C3S seasonal forecasts consist of the products from several seasonal prediction systems: ECMWF, The Met Office, Météo-France, Deutscher Wetterdienst (DWD), Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), National Centers for Environmental Prediction (NCEP), and Japan Meteorological Agency (JMA)
- Multi-system combinations, as well as predictions from the individual participating systems, are available.
- The C3S seasonal service provides graphical forecast products (https://climate.copernicus.eu/charts/c3s_seasonal/) and public access to the forecast data via the C3S Climate Data Store (https://confluence.ecmwf.int/display/CKB/Climate+Data+Store+%28CDS%29+infrastructure+and+API).
- A summary of the C3S modeling systems: https://confluence.ecmwf.int/display/CKB/Description+of+the+C3S+seasonal+multi-system
- A summary of the data (Real-time forecasts + hindcasts) can be found at https://confluence.ecmwf.int/display/CKB/Summary+of+available+data

Hindcasts

- All prediction products come with hindcasts.
- *Why do we need hindcasts?*
  - Bias correction: Systematic errors or biases must be corrected in model forecasts to extract the useful information. Hindcasts are necessary for determining and correcting systematic errors.
  - Skill assessment: Hindcasts are also used to assess the model prediction skill, which provides important information for decision making.

Fixed vs. on-the-fly hindcasts

- Fixed hindcasts: the model version is frozen for a few years and the reforecasts are created once and for all.
  - Advantage: The hindcast dataset is available well in advance of real-time forecasts being issued, and its biases and skill can be quantified once for repeated use.
  - Disadvantage: It is very expensive exercise and cannot be repeated too often. The system remains fixed for a long period of time.
- On-the-fly hindcasts: the full hindcast set is run every time a new real-time forecast is produced, slightly in advance (a few weeks) of the real-time forecast and using exactly the same version of the forecasting system. This also offers the advantage of balancing the requirement for computing resources, but the compromise is the regular change of the model climatology.

https://confluence.ecmwf.int/display/CKB/Seasonal+forecasts+and+the+Copernicus+Climate+Change+Service

How do seasonal forecasting systems build their ensembles?

- "Burst" mode: all the members are initialized at the same start time, but from slightly different (perturbed) initial conditions.
  - For example, all members initialized at 00Z 1st March 2017. This is the case for ECMWF's system.
- "Lagged" mode: members are initialized on “slightly” different start dates (the differences are sufficiently small compared to the forecast lead time).
  - For example, members are initialized on consecutive days, and members with different initialization times are grouped together to build ensembles. This is the case for Met Office system and the CPC.

https://confluence.ecmwf.int/display/CKB/Seasonal+forecasts+and+the+Copernicus+Climate+Change+Service

References

- TIGGE: https://confluence.ecmwf.int/display/TIGGE
- S2S: http://s2sprediction.net/
- SubX: http://cola.gmu.edu/subx/about.html
- NMME: https://www.ncdc.noaa.gov/data-access/model-data/model-datasets/north-american-multi-model-ensemble