Report from the Decadal Climate Prediction Panel (DCPP)

- evolution
- activities
  - volcanoes
  - survey
  - Aspen workshop
  - bias correction
  - recommendations for CMIP5 decadal predictions and data
- analysis
- members
- future

First WCRP Workshop on *Seasonal Prediction*
Barcelona, Spain - June 4-7 2007

Working Group on Seasonal to Interannual Prediction 11th Session.

Decadal prediction is an agenda item

- WGSIP interest

Barcelona, 7-8 June 2007

International scientific interest

WORLD CLIMATE RESEARCH PROGRAMME

JOINT SCIENTIFIC COMMITTEE

TWENTY-EIGHTH SESSION

ZANZIBAR, TANZANIA, 26-30 MARCH 2007

JSC-XXVIII/Doc. 2.4
(13.II.2007)

Item 2

Cross-Cutting Topic: Decadal Prediction


ASPEN GLOBAL CHANGE INSTITUTE
CLIMATE PREDICTION TO 2030:
Is it possible, what are the scientific issues,
and how would those predictions be used?
22-28 June 2008 in Aspen, Colorado

What are the Prospects for Decadal Prediction?

G.J.Boer

Canadian Centre for Climate Modelling and Analysis (CCCma)

(in future CCCmap…?)

Decadal prediction motivations

- Existence of “long timescale” processes
- Results of predictability studies
- Demonstrations of forecast skill
- Scientific interest
- Societal importance of modestly skillful decadal prediction

Prospects are good for decadal prediction

- Existence of "long timescale" processes - ☑
- Results of predictability studies - ☑
- Scientific interest - ☑
- Demonstrations of forecast skill - ☑
- Societal importance of modestly skillful decadal prediction – ☑

DHFP

The Decadal Historical Forecasting Project

Based on the Aspen Protocol

Evolution

INTERNATIONAL COUNCIL FOR SCIENCE | INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION | WORLD METEOROLOGICAL ORGANIZATION

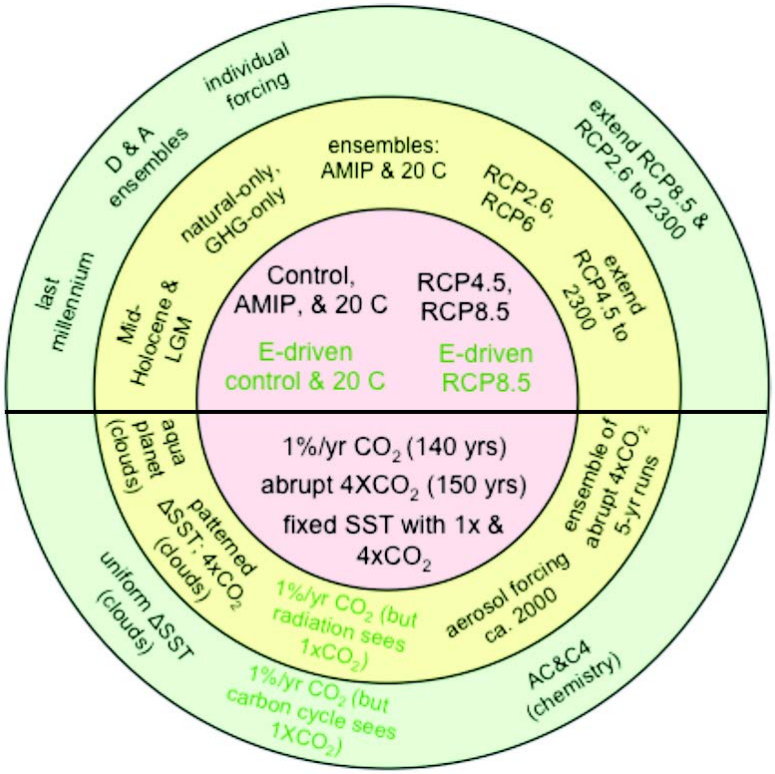
WORLD CLIMATE RESEARCH PROGRAMME

Report of the 12th Session of the JSC/CLIVAR Working Group on Coupled Modelling (WGCM)

Paris, France – 22-24 September 2008

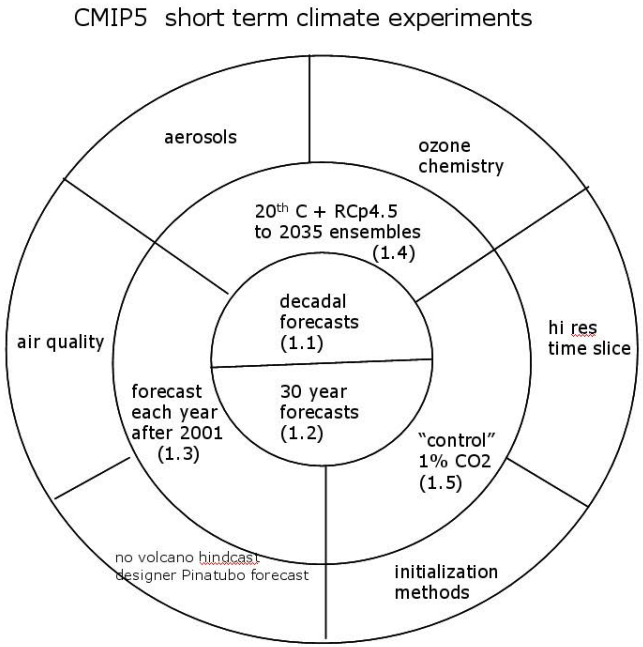
- WGCM Paris
  - meeting focused on CMIP5 design and participation
  - featured core and tier 1 and 2 *simulation* experiments
  - additionally included *decadal prediction* experiments

- WGCM Paris (September 22-24,2008):
  - Featured core and tier 1 and 2 *simulation* experiments (including early version of bulls eye diagram)



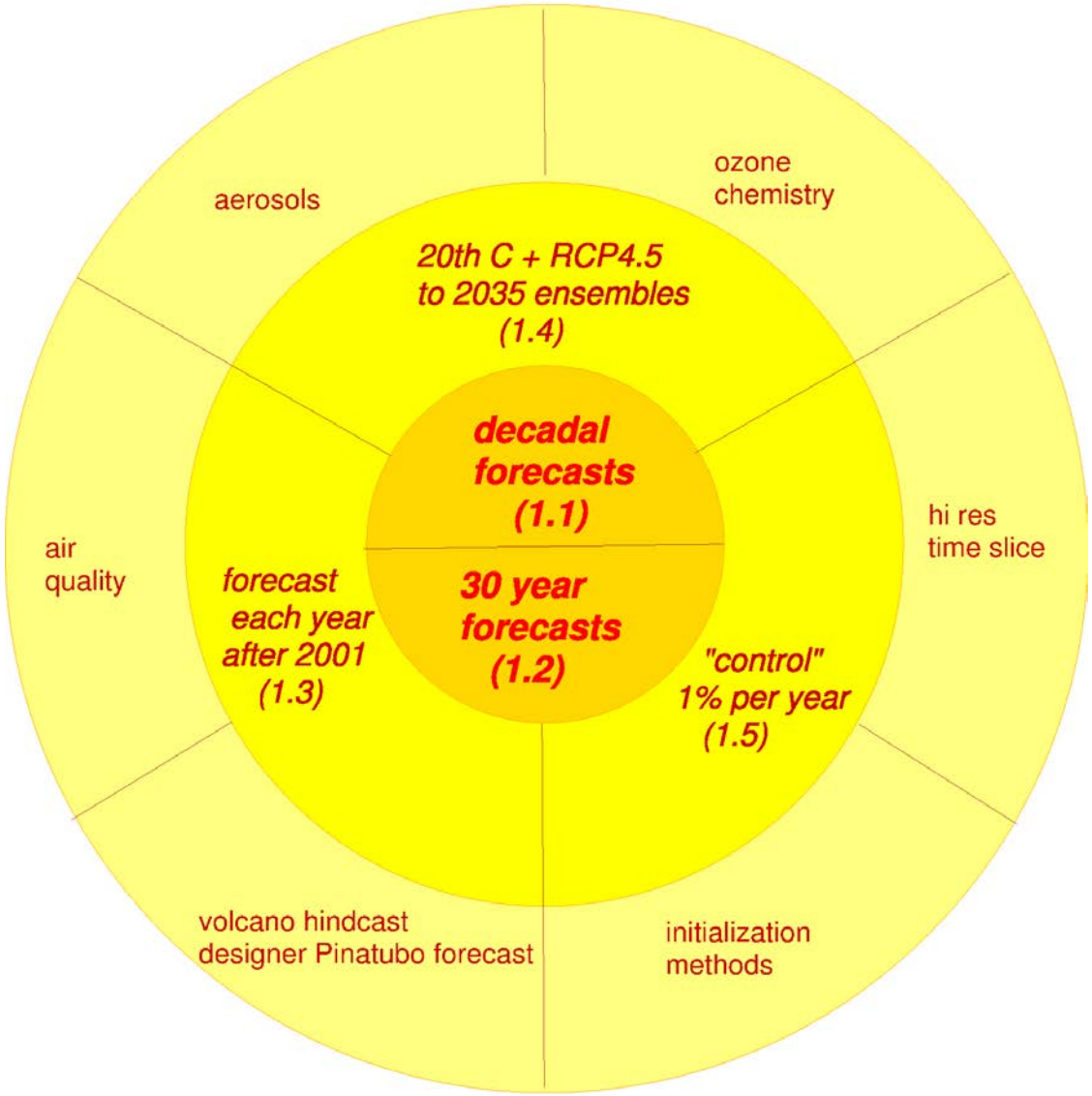
Evolution

- WGCM Paris (2008):
  - WGSIP's interest in *decadal prediction* as natural extension of seasonal-interannual prediction
    - Attempted decadal prediction diagram to match simulation diagram

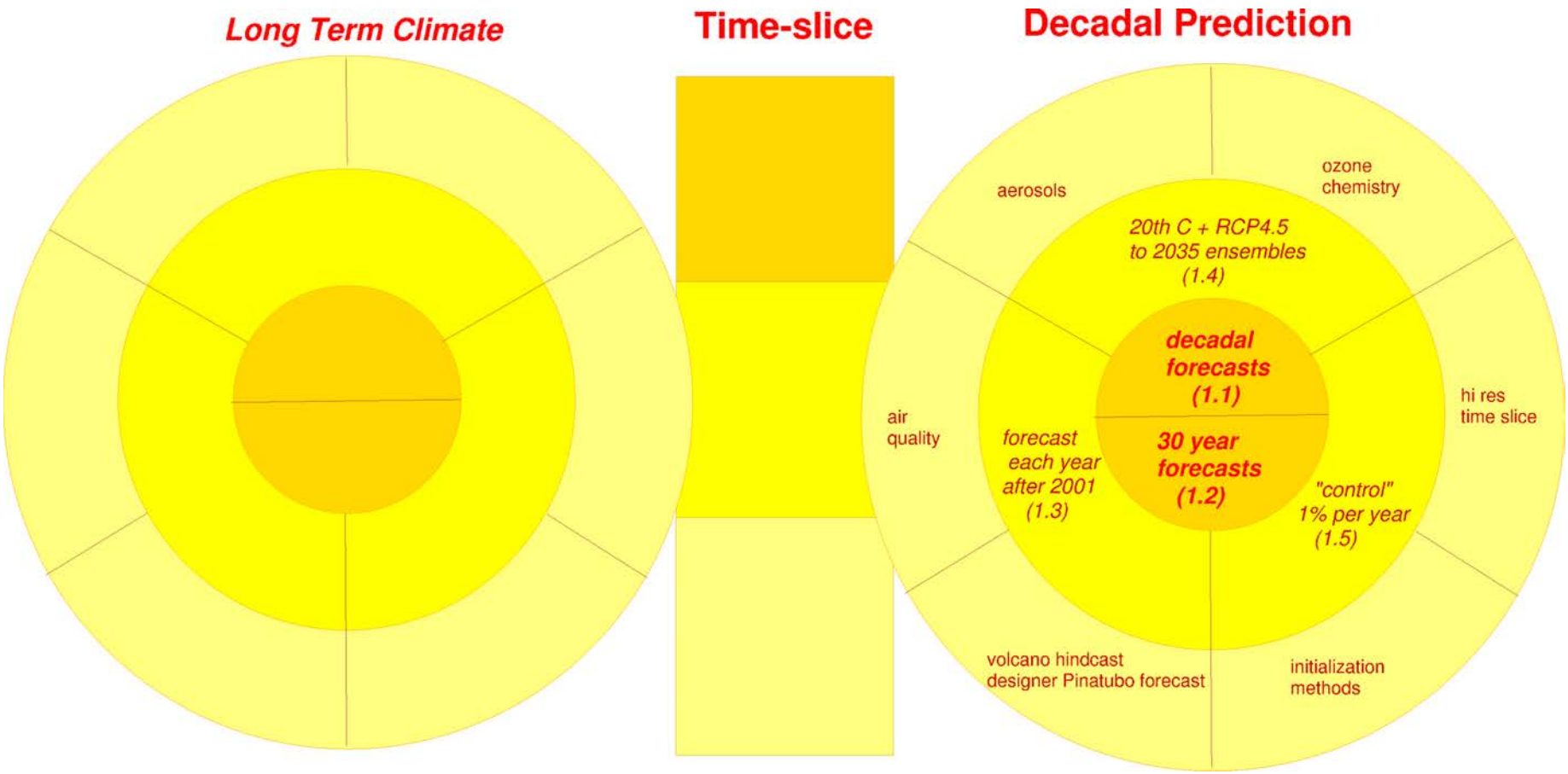


Original attempt

CMIP 5 near term climate



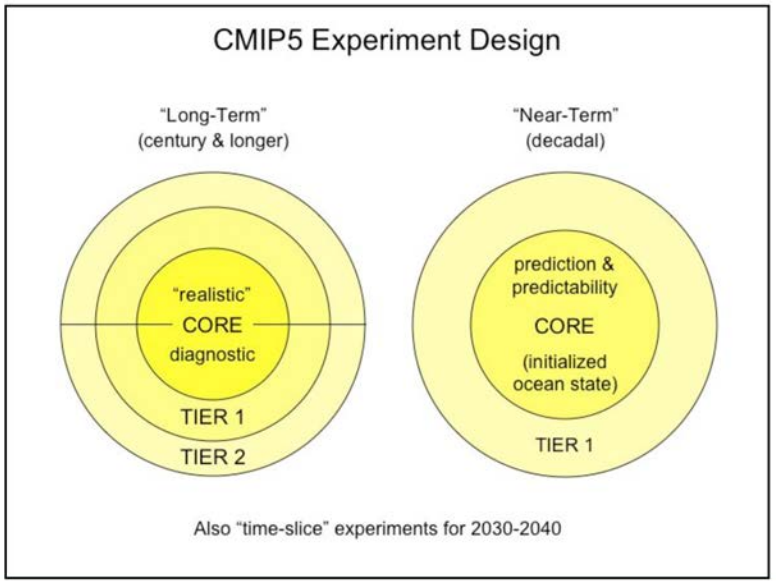
artistic attempt

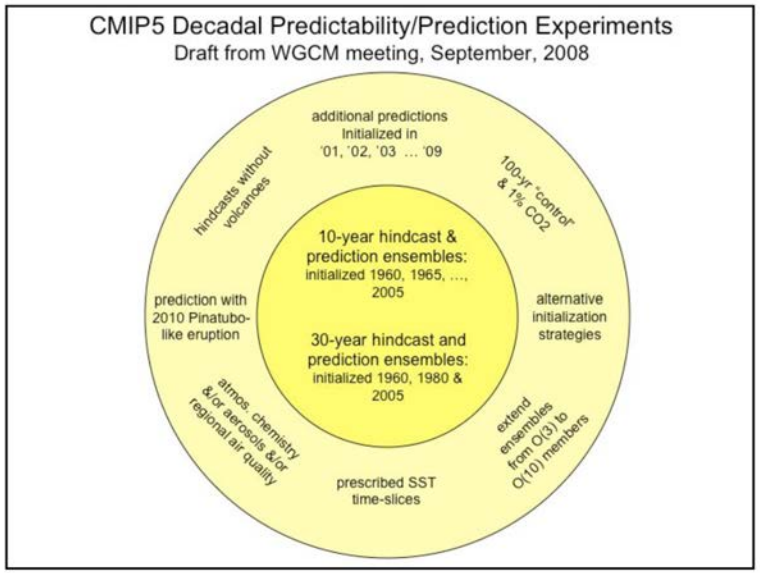


The timeslice problem

Evolution

- WGCM Paris (2008):
  - WGSIP's interest in *decadal prediction* as natural extension of seasonal-interannual prediction
    - decadal prediction "target" parallels \ simulation "target"
    - formation of a "Joint WGCM-WGSIP Contact Group on Decadal Predictability/Prediction" consisting of Tim Stockdale and/or GJB (WGSIP), M. Latif, R. Stouffer (CMIP), G. Meehl (WGCM)
    - initial question concerning volcanoes





- WGSIP Miami (2009):
  - action items included
    - *confirmation* T. Stockdale and G. Boer as WGSIP members of the CMIP-WGCM-WGSIP group coordinating the CMIP5 near term experiments.
    - *determination* the interest within the WGSIP community in participating in the CMIP5 near term experiments and diagnostics analysis
      - resulting survey
    - *interfacing* between US CLIVAR WG on decadal prediction and the CMIP-WGCM-WGSIP group (A. Kumar, T. Stockdale, G. Boer).

Organizational aspects of decadal prediction: Survey

- SIP community natural participants
- Experience/ability in most needed aspects
  - IPCC-class models
  - initialization, ensemble generation
  - retrospective forecast methodology
  - forecast combination, calibration, skill measures …
  - (external forcing)
- Survey of intended participation in CHFP and CMIP5 decadal prediction

Survey

International CLIVAR Project Office
World Climate Research Programme

Subject: Survey of Current and Planned Participation in the:

- **Climate-system Historical Forecasting Project (CHFP)**
- **CMIP5 Decadal Climate Prediction component**

From: G.J. Boer, B. Kirtman, A. Scaife (WGSIP)
G. Meehl, S. Bony (WGCM)

.....

The Working Group on Seasonal to Interannual Prediction (WGSIP) has interests in prediction on timescales from seasons to decades. As such it is sponsoring the

Climate-system Historical Forecast Project (CHFP)

Details at: *http://www.clivar.org/organization/wgsip/chfp/chfp.php*

and supporting, together with the Working Group on Coupled Modelling (WGCM), the

Decadal Climate Prediction component of CMIP5

Details at: http*://cmip-pcmdi.llnl.gov/cmip5/index.html*

These are multi-model and multi-institutional experiments aimed at improving our understanding of the physical climate system and our ability to predict its evolution on timescales from seasons to decades.

Many groups have, are, or soon will be undertaking the experiments involved. This Survey of Current and Planned Participation will aid the coordination between WGSIP, WGCM and PCMDI in support of WCRP and IPCC in furthering Studies and Workshops in these areas.

We would appreciate your completing the survey below in as brief or extensive a manner as you would care to.

THANK YOU in anticipation of your returning the survey by 24 September to Anna Pirani at anna.pirani@noc.soton.ac.uk

Survey of Current and Planned Participation

Please return to Anna Pirani at anna.pirani@noc.soton.ac.uk by 24 September, 2010.

CHFP: Climate-system Historical Forecast Project

Name of Group:
Contact/email:
Will you participate in CHFP:

Model designator and resolution:
Status of integrations:
Where data is/will be available:

Comments or other information:

Please note that if you intend to store your data (as is highly desirable) at CIMA (http://chfp.cima.fcen.uba.ar/index.html):

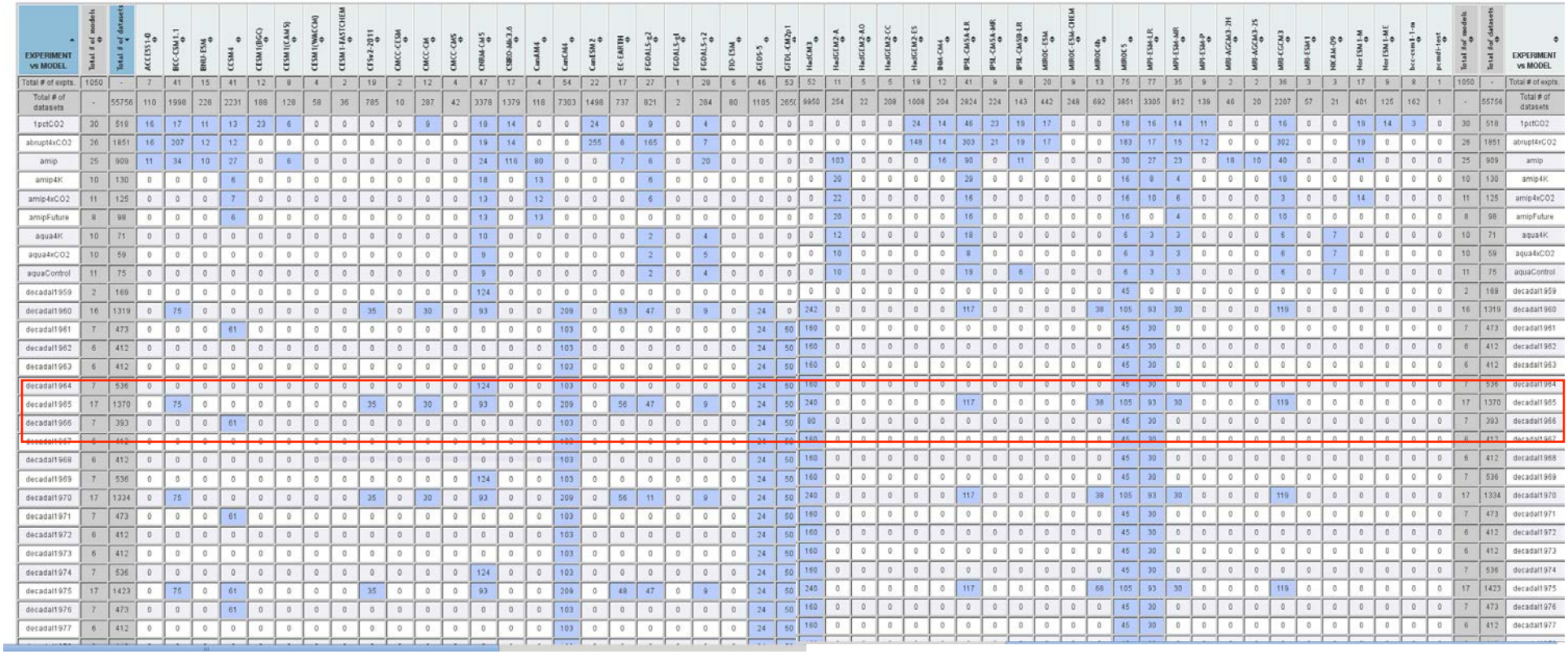
- the target date for CHFP data to be received at CIMA is 31 January 2011
- it is important that you send a test file to CIMA as soon as possible, that is by 17 September 2010, to enable technical aspects to be addressed. See the website for details (to appear shortly).

CMIP5 near-term decadal climate prediction

Groups planning to participate in the near-term decadal climate prediction component of CMIP5 are asked to consult the web page (http://pcmdi-cmip.llnl.gov/cmip5/index.html) under the Modeling Info/Getting Started links and to follow the "Guide for Modeling Groups Participating in CMIP5: Stage 1". If they have not already done so, groups are asked to provide information on their planned participation.

An email updating this information request will be forthcoming in the next week from PCMDI/CMIP5.

CMIP5 website – decadal prediction data



EXPERIMENT vs MODEL	Total # of models	Total # of datasets	ACCESS1-0	BCC-CSM1.1	BNU-ESM	CCSM4	CESM1(BGC)	CESM1(CAM5)	CESM1(WACCM)	CESM1-FASTCHEM	CFSv2-2011	CMCC-CESM	CMCC-CM	CMCC-CMS	CNRM-CM5	CSIRO-Mk3.6	CanAM4	CanCM4	CanESM2	EC-EARTH	FGOALS-g2	FGOALS-s1	FGOALS-s2	FIO-ESM	GEOS-5	GFDL-CM2p1	HadCM3	HadGEM2-A	HadGEM2-AO	HadGEM2-CC	HadGEM2-ES	INM-CM4	IPSL-CM5A-LR	IPSL-CM5A-MR	IPSL-CM5B-LR	MIROC-ESM	MIROC-ESM-CHEM	MIROC-4h	MIROC5	MPI-ESM-LR	MPI-ESM-MR	MPI-ESM-P	MRI-AGCM3-2H	MRI-AGCM3-2S	MRI-CGCM3	MRI-ESM1	NICAM-09	NorESM1-M	NorESM1-ME	bcc-csm1-1-m	prmdi-test	Total #of_models	Total #of_datasets	EXPERIMENT vs MODEL
Total # of expts.	1050	-	7	41	15	41	12	8	4	2	19	2	12	4	47	17	4	54	22	17	27	1	28	6	46	52	52	11	5	5	19	12	41	9	8	20	9	13	75	77	35	9	2	2	36	3	3	17	9	8	1	1050	-	Total # of expts.
Total # of datasets	-	55756	110	1998	228	2231	188	128	58	36	785	10	287	42	3378	1379	118	7303	1498	737	821	2	284	80	1105	2651	9950	254	22	208	1008	204	2824	224	143	442	248	692	3851	3305	812	139	46	20	2207	57	21	401	125	162	1	-	55756	Total # of datasets
1pctCO2	30	518	16	17	11	13	23	6	0	0	0	0	9	0	18	14	0	0	24	0	9	0	4	0	0	0	0	0	0	0	24	14	46	23	19	17	0	0	18	16	14	11	0	0	16	0	0	19	14	3	0	30	518	1pctCO2
abrupt4xCO2	26	1851	16	207	12	12	0	0	0	0	0	0	0	0	19	14	0	0	255	6	165	0	7	0	0	0	0	0	0	0	148	14	303	21	19	17	0	0	183	17	15	12	0	0	302	0	0	19	0	0	0	26	1851	abrupt4xCO2
amip	25	909	11	34	10	27	0	6	0	0	0	0	0	0	24	116	80	0	0	7	6	0	20	0	0	0	0	103	0	0	0	16	90	0	11	0	0	0	30	27	23	0	18	10	40	0	0	41	0	0	0	25	909	amip
amip4K	10	130	0	0	0	6	0	0	0	0	0	0	0	0	18	0	13	0	0	0	6	0	0	0	0	0	0	20	0	0	0	0	29	0	0	0	0	0	16	9	4	0	0	0	10	0	0	0	0	0	0	10	130	amip4K
amip4xCO2	11	125	0	0	0	7	0	0	0	0	0	0	0	0	13	0	12	0	0	0	6	0	0	0	0	0	0	20	0	0	0	0	16	0	0	0	0	0	16	10	6	0	0	0	3	0	0	14	0	0	0	11	125	amip4xCO2
amipFuture	8	98	0	0	0	6	0	0	0	0	0	0	0	0	13	0	13	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	16	0	0	0	0	0	16	0	4	0	0	0	10	0	0	0	0	0	0	8	98	amipFuture
aqua4K	10	71	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	2	0	4	0	0	0	0	12	0	0	0	0	18	0	0	0	0	0	6	3	3	0	0	0	6	0	7	0	0	0	0	10	71	aqua4K
aqua4xCO2	10	59	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	2	0	5	0	0	0	0	10	0	0	0	0	8	0	0	0	0	0	6	3	3	0	0	0	6	0	7	0	0	0	0	10	59	aqua4xCO2
aquaControl	11	75	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	2	0	4	0	0	0	0	10	0	0	0	0	19	0	6	0	0	0	6	3	3	0	0	0	6	0	7	0	0	0	0	11	75	aquaControl
decadal1959	2	169	0	0	0	0	0	0	0	0	0	0	0	0	124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	2	169	decadal1959
decadal1960	16	1319	0	75	0	0	0	0	0	0	35	0	30	0	93	0	0	209	0	53	47	0	9	0	24	0	242	0	0	0	0	0	117	0	0	0	0	38	105	93	30	0	0	0	119	0	0	0	0	0	0	16	1319	decadal1960
decadal1961	7	473	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	473	decadal1961
decadal1962	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1962
decadal1963	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1963
decadal1964	7	536	0	0	0	0	0	0	0	0	0	0	0	0	124	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	536	decadal1964
decadal1965	17	1370	0	75	0	0	0	0	0	0	35	0	30	0	93	0	0	209	0	56	47	0	9	0	24	50	240	0	0	0	0	0	117	0	0	0	0	38	105	93	30	0	0	0	119	0	0	0	0	0	0	17	1370	decadal1965
decadal1966	7	393	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	80	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	393	decadal1966
decadal1967	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1967
decadal1968	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1968
decadal1969	7	536	0	0	0	0	0	0	0	0	0	0	0	0	124	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	536	decadal1969
decadal1970	17	1334	0	75	0	0	0	0	0	0	35	0	30	0	93	0	0	209	0	56	11	0	9	0	24	50	240	0	0	0	0	0	117	0	0	0	0	38	105	93	30	0	0	0	119	0	0	0	0	0	0	17	1334	decadal1970
decadal1971	7	473	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	473	decadal1971
decadal1972	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1972
decadal1973	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1973
decadal1974	7	536	0	0	0	0	0	0	0	0	0	0	0	0	124	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	536	decadal1974
decadal1975	17	1423	0	75	0	61	0	0	0	0	35	0	0	0	93	0	0	209	0	49	47	0	9	0	24	50	240	0	0	0	0	0	117	0	0	0	0	68	105	93	30	0	0	0	119	0	0	0	0	0	0	17	1423	decadal1975
decadal1976	7	473	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	473	decadal1976
decadal1977	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1977

- decadal prediction data becoming available
- multi-model analyses for Chapter 11 AR5 active

- WGCM Exeter (2009): action items include
  - WGCM-WGSIP Decadal Climate Prediction Panel (DCPP)
    - G. Boer (lead), B. Kirtman, R. Stouffer, G. Meehl, K. Taylor, M. Latif, D. Smith and S. Power
  - encourage panel support the organization of the 2011 *Aspen Global Change Institute Workshop* on decadal prediction
  - WGSIP and the Decadal Climate Prediction Panel should consider providing recommendations/guidance on
    - *bias correction* (common in SIP but not for climate)
    - if *bias corrected* decadal prediction *data* should be submitted to the CMIP5 archive

    with recommendations circulated to WGCM so that they can be passed on to modeling groups as soon as possible (G. Boer, D. Smith)

Bias correction/adjustment report

Data and bias correction for decadal climate predictions

January 2011

Secret authors: GJB and Doug Smith

Initialization

There are two main approaches to forecast initialization referred to as "full field" and "anomaly" initialization. Bias correction and verification can depend on which initialization method is used.

Full field initialization constrains the model initial conditions to be close to the observed values with

Data and bias correction for decadal climate predictions

$$Y_{j\tau=0} \approx X_{j\tau=0}$$

while *anomaly initialization* adds the observed anomaly to the model climatology of the variable in question as

$$Y_{j\tau=0} \approx < Y > + (X_{j\tau=0} - < X >)$$

In the case of an ensemble of forecasts the initial conditions are not all the same although "close" to one another. The nature of the perturbations around the value at $\tau = 0$ will depend on the approach taken by a particular modelling group.

Basic bias correction/adjustment

a. For full field initialization

The bias correction is calculated from the collection of hindcasts and the corresponding observations. The model drift is estimated as the difference between *ensemble mean* forecasts and the observations averaged over all cases as

$$d_\tau = \overline{Y}_\tau - \overline{X}_\tau$$

and the *bias corrected* forecast $\hat{Y}_{j\tau}$ is obtained by subtracting this drift from each ensemble member as

$$\hat{Y}_{j\tau} = Y_{j\tau} - d_\tau = \overline{X}_\tau + (Y_{j\tau} - \overline{Y}_\tau) = \overline{X}_\tau + Y'_{j\tau}$$

Here $Y'_{j\tau} = Y_{j\tau} - \overline{Y}_\tau$ is the *anomaly* of the raw forecast with respect to the *forecast average*. It is generally considered to be best practice to calculate the bias correction in a "cross-validated" manner where the particular forecast to be corrected does not contribute to the forecast average.

b. For anomaly initialization

In this case the bias has been at least partially removed by the initialization method. The drift is characterized as the difference between the modelled and observed climates as

$$D = < Y > - < X >$$

and the bias corrected forecast is

$$\hat{Y}_{j\tau} = Y_{j\tau} - D = < X > + (Y_{j\tau} - < Y >) = < X > + Y''_{j\tau}$$

Note: that the "full field" version of bias correction can also be applied to anomaly initialized forecasts but may not be optimum.

Data aspects

Data and bias correction for decadal climate predictions

5. CMIP5 decadal climate prediction data submission and data use

a. Raw data

Raw decadal prediction data sets as specified in documentation available from the CMIP5 website (http://cmip-pcmdi.llnl.gov/index.html) should be submitted in all cases. Users should regard these data as the basis for analysis.

b. Bias correction

Bias correction can be undertaken in order to use the decadal prediction results. The methods outlined in Sections 4a or 4b are recommended. In every case it is important to specify clearly what has been done when reporting results.

c. Bias corrected data

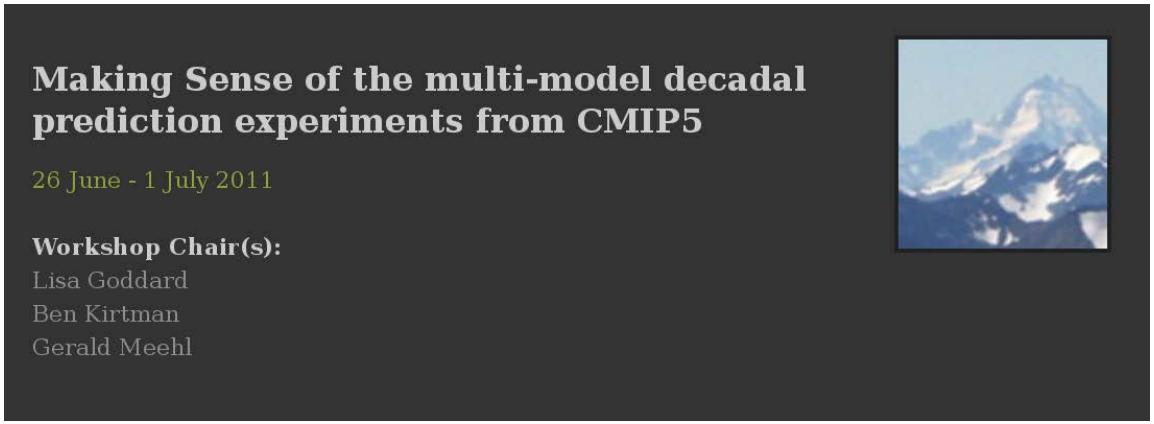
Data providers may also contribute a set of *bias corrected* CMIP5 data but this is limited by practicalities to basic climatological parameters. These comprise *monthly means* of bias corrected

- near-surface air temperature (tas)
- surface temperature (ts)
- precipitation rate (pr)
- sea level pressure (psl)

on the atmospheric grid.

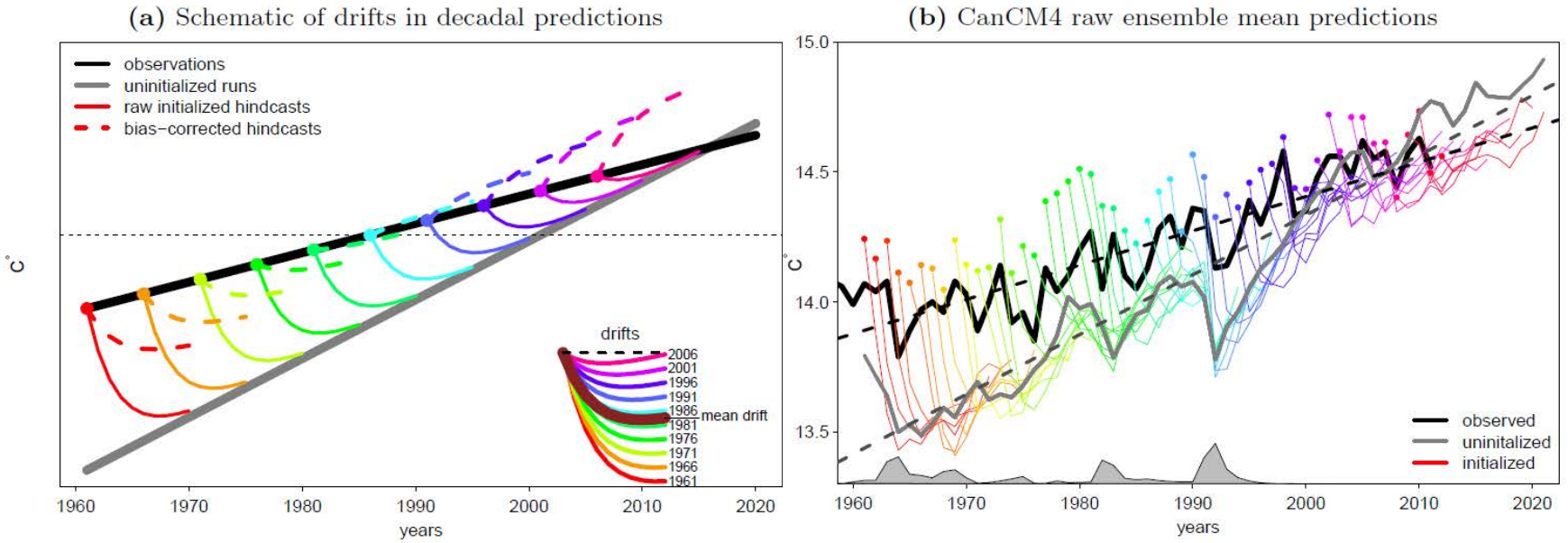
- stress that raw data is basic
- reluctantly allow for some bias-adjusted fields
- limit number of fields

Aspen



- successful Workshop and early results
- further sensitized researchers to questions of:
  - bias adjustment including trend adjustment
  - statistical aspects and number of start dates
  - priority of sub-daily data for CMIP5

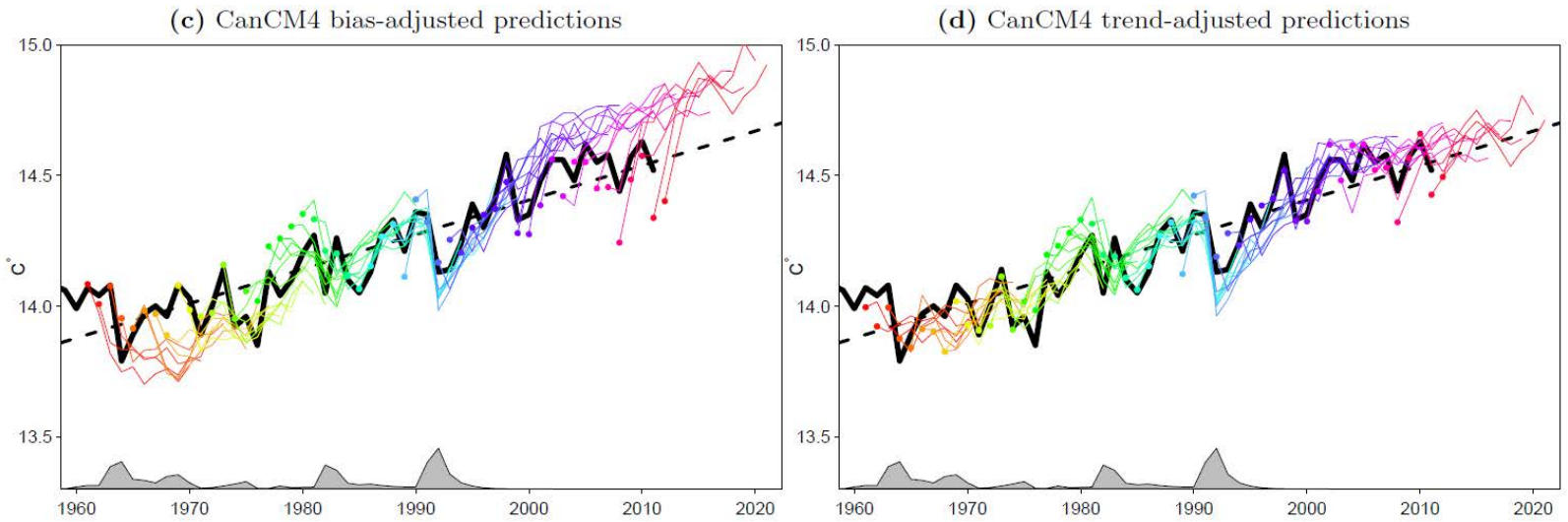
Bias correction/adjustment



- model's which are initialized from observations *X* subsequently "drift" toward the model climate thereby introducing a "bias" into the forecast *Y*
- the simplest adjustment obtains the drift $D(\tau) = Y(\tau) - X(\tau)$ averaged over all forecasts for each forecast range τ and subtracts it from the forecast, i.e. $Y(\tau)$ $Y'(\tau) = Y(\tau) - D(\tau)$
- presumes drift is the same for all forecasts, more difficult if model's forced component differs appreciably from observed

(Kharin et al. 2012)

Bias correction/adjustment



- *first order* bias adjustment improves forecast considerably
- if trends differ may be useful to attempt a *second order* adjustment
- question of the stability of the statistics involved

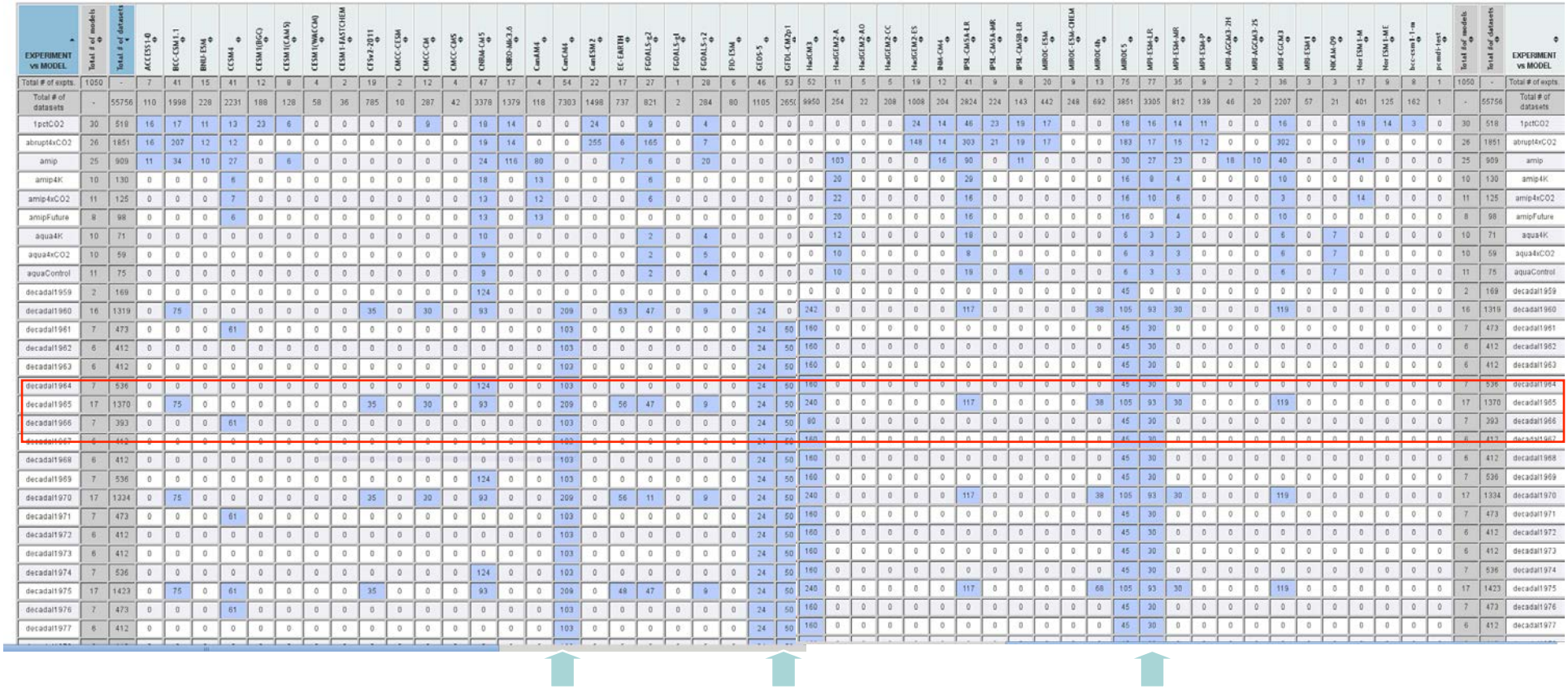
Statistical aspects

- The DCPP also considered the importance of *stable estimates* of bias adjustment values and of other statistics
  - CMIP5 protocol calls for forecasts initialized every 5 years from 1960 to 2005 with a minimum of 3 ensemble members
  - for annual means one needs to estimate 10 values of $D(\tau)$, one for each forecast range τ = 1….10 years
    - result is 30 values with which to estimate the 10 values of $D(\tau)$
  - can also be sampling problems with semi-regular and/ or large variations in climate (e.g. El Nino, volcanoes)
    - applies to bias adjustment and other statistics including scores

Recommendations

- DCPP, in consultation with WGSIP, WGCM, PCMDI recommended
  - *producing* forecasts initialized *every year* over the period to enhance statistical stability
  - *adding* the historical climate simulations made with the model used for decadal predictions as part of CMIP5 (i.e. uninitialized simulations)
    - in order to quantify the utility of the initialization of the forecasts
  - *reducing* the priority of "high frequency" decadal prediction data (3 and 6-hourly) in the archive

CMIP5 website – decadal prediction data



EXPERIMENT vs MODEL	Total # of models	Total # of datasets	ACCESS1-0	BCC-CSM1.1	BNU-ESM	CCSM4	CESM1(BGC)	CESM1(CAM5)	CESM1(WACCM)	CESM1-FASTCHEM	CFSv2-2011	CMCC-CESM	CMCC-CM	CMCC-CMS	CNRM-CM5	CSIRO-Mk3.6	CanAM4	CanCM4	CanESM2	EC-EARTH	FGOALS-g2	FGOALS-s1	FGOALS-s2	FIO-ESM	GEOS-5	GFDL-CM2p1	HadCM3	HadGEM2-A	HadGEM2-AO	HadGEM2-CC	HadGEM2-ES	INM-CM4	IPSL-CM5A-LR	IPSL-CM5A-MR	IPSL-CM5B-LR	MIROC-ESM	MIROC-ESM-CHEM	MIROC4h	MIROC5	MPI-ESM-LR	MPI-ESM-MR	MPI-ESM-P	MRI-AGCM3-2H	MRI-AGCM3-2S	MRI-CGCM3	MRI-ESM1	NICAM-09	NorESM1-M	NorESM1-ME	bcc-csm1-1-m	prmdi-test	Total #of_models	Total #of_datasets	EXPERIMENT vs MODEL
Total # of expts.	1050	-	7	41	15	41	12	8	4	2	19	2	12	4	47	17	4	54	22	17	27	1	28	6	46	52	52	11	5	5	19	12	41	9	8	20	9	13	75	77	35	9	2	2	36	3	3	17	9	8	1	1050	-	Total # of expts.
Total # of datasets	-	55756	110	1998	228	2231	188	128	58	36	785	10	287	42	3378	1379	118	7303	1498	737	821	2	284	80	1105	2655	9950	254	22	208	1008	204	2824	224	143	442	248	692	3851	3305	812	139	46	20	2207	57	21	401	125	162	1	-	55756	Total # of datasets
1pctCO2	30	518	16	17	11	13	23	6	0	0	0	0	9	0	18	14	0	0	24	0	9	0	4	0	0	0	0	0	0	0	24	14	46	23	19	17	0	0	18	16	14	11	0	0	16	0	0	19	14	3	0	30	518	1pctCO2
abrupt4xCO2	26	1851	16	207	12	12	0	0	0	0	0	0	0	0	19	14	0	0	255	6	165	0	7	0	0	0	0	0	0	0	148	14	303	21	19	17	0	0	183	17	15	12	0	0	302	0	0	19	0	0	0	26	1851	abrupt4xCO2
amip	25	909	11	34	10	27	0	6	0	0	0	0	0	0	24	116	80	0	0	7	6	0	20	0	0	0	0	103	0	0	0	16	90	0	11	0	0	0	30	27	23	0	18	10	40	0	0	41	0	0	0	25	909	amip
amip4K	10	130	0	0	0	6	0	0	0	0	0	0	0	0	18	0	13	0	0	0	6	0	0	0	0	0	0	20	0	0	0	0	29	0	0	0	0	0	16	9	4	0	0	0	10	0	0	0	0	0	0	10	130	amip4K
amip4xCO2	11	125	0	0	0	7	0	0	0	0	0	0	0	0	13	0	12	0	0	0	6	0	0	0	0	0	0	20	0	0	0	0	16	0	0	0	0	0	16	10	6	0	0	0	3	0	0	14	0	0	0	11	125	amip4xCO2
amipFuture	8	98	0	0	0	6	0	0	0	0	0	0	0	0	13	0	13	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	16	0	0	0	0	0	16	0	4	0	0	0	10	0	0	0	0	0	0	8	98	amipFuture
aqua4K	10	71	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	2	0	4	0	0	0	0	12	0	0	0	0	18	0	0	0	0	0	6	3	3	0	0	0	6	0	7	0	0	0	0	10	71	aqua4K
aqua4xCO2	10	59	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	2	0	5	0	0	0	0	10	0	0	0	0	8	0	0	0	0	0	6	3	3	0	0	0	6	0	7	0	0	0	0	10	59	aqua4xCO2
aquaControl	11	75	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	2	0	4	0	0	0	0	10	0	0	0	0	19	0	6	0	0	0	6	3	3	0	0	0	6	0	7	0	0	0	0	11	75	aquaControl
decadal1959	2	169	0	0	0	0	0	0	0	0	0	0	0	0	124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	0	0	2	169	decadal1959
decadal1960	16	1319	0	75	0	0	0	0	0	0	35	0	30	0	93	0	0	209	0	53	47	0	9	0	24	0	242	0	0	0	0	0	117	0	0	0	0	38	105	93	30	0	0	0	119	0	0	0	0	0	0	16	1319	decadal1960
decadal1961	7	473	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	473	decadal1961
decadal1962	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1962
decadal1963	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1963
decadal1964	7	536	0	0	0	0	0	0	0	0	0	0	0	0	124	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	536	decadal1964
decadal1965	17	1370	0	75	0	0	0	0	0	0	35	0	30	0	93	0	0	209	0	56	47	0	9	0	24	50	240	0	0	0	0	0	117	0	0	0	0	38	105	93	30	0	0	0	119	0	0	0	0	0	0	17	1370	decadal1965
decadal1966	7	393	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	80	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	393	decadal1966
decadal1967	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1967
decadal1968	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1968
decadal1969	7	536	0	0	0	0	0	0	0	0	0	0	0	0	124	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	536	decadal1969
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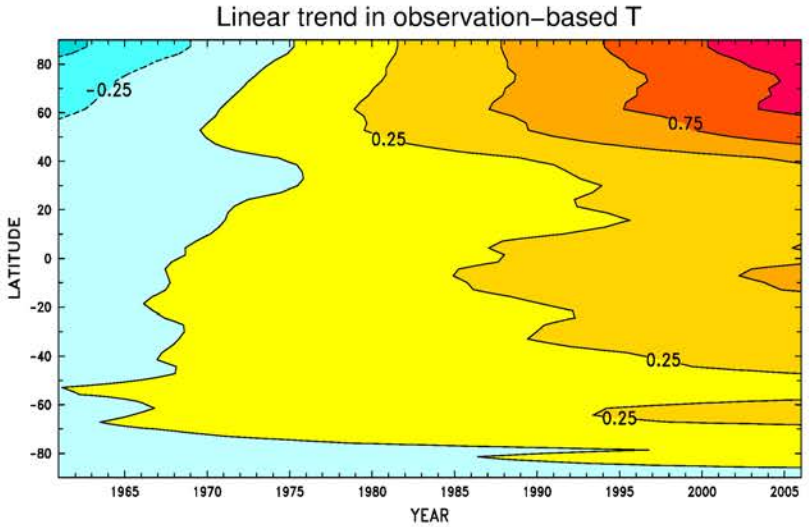
decadal1971	7	473	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	473	decadal1971
decadal1972	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1972
decadal1973	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1973
decadal1974	7	536	0	0	0	0	0	0	0	0	0	0	0	0	124	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	536	decadal1974
decadal1975	17	1423	0	75	0	61	0	0	0	0	35	0	0	0	93	0	0	209	0	48	47	0	9	0	24	50	240	0	0	0	0	0	117	0	0	0	0	68	105	93	30	0	0	0	119	0	0	0	0	0	0	17	1423	decadal1975
decadal1976	7	473	0	0	0	61	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	7	473	decadal1976
decadal1977	6	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103	0	0	0	0	0	0	24	50	160	0	0	0	0	0	0	0	0	0	0	0	45	30	0	0	0	0	0	0	0	0	0	0	0	6	412	decadal1977

- mainly 5-year start times (~18 models)
- every-year start times (~ 6 models)
- a number of groups are “filling in” remaining years

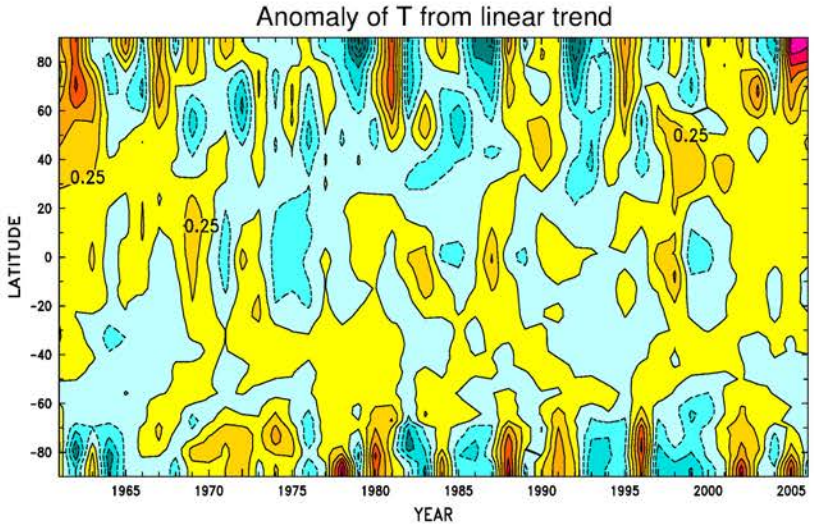
Analysis

- active analysis of CMIP5 decadal predictions
- WCRP workshop
- individual model results
- multi-model results (e.g. Paco's analysis for Chapter 11 of the AR5)

Schematic of forced and internally generated components

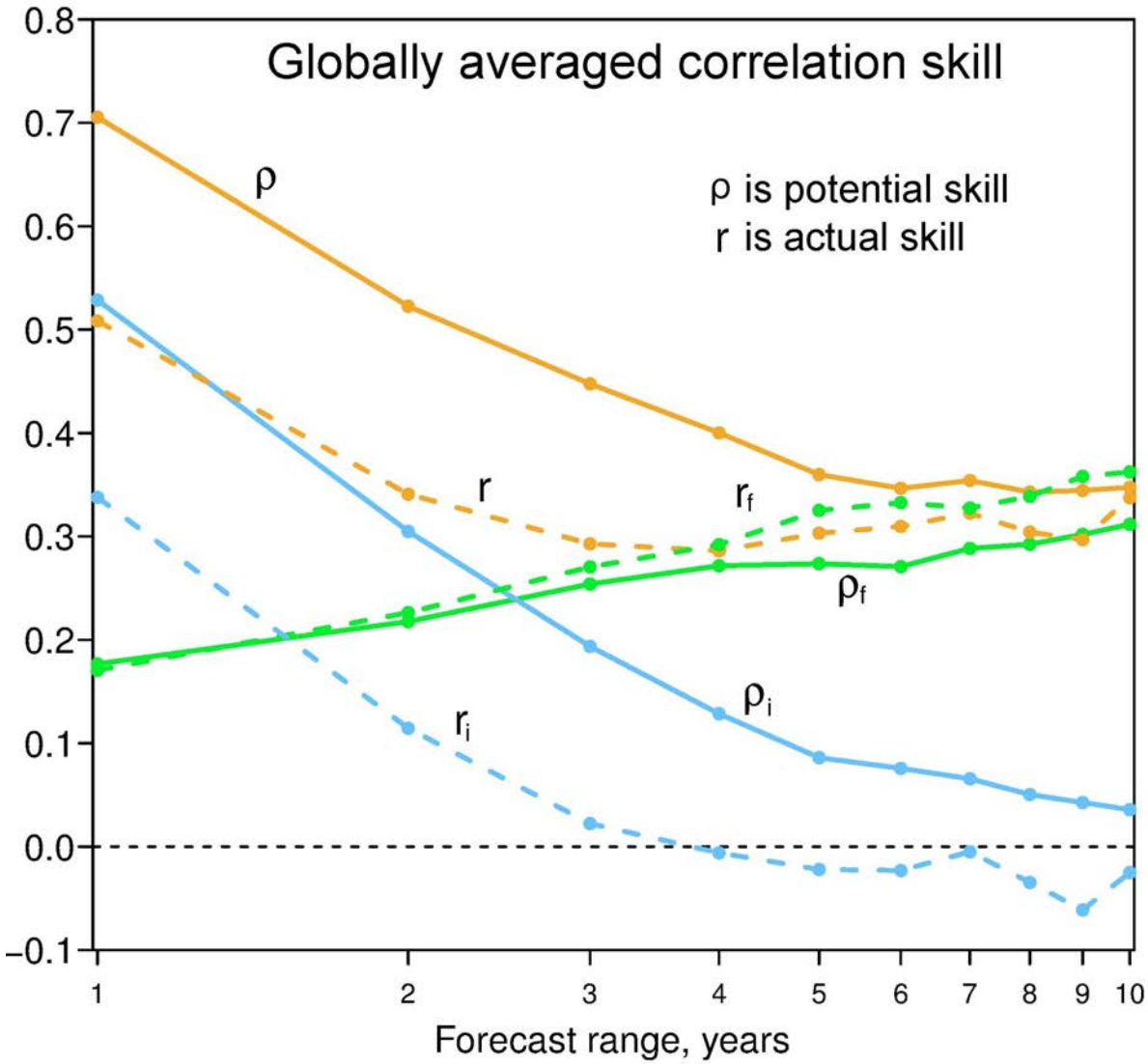


~forced



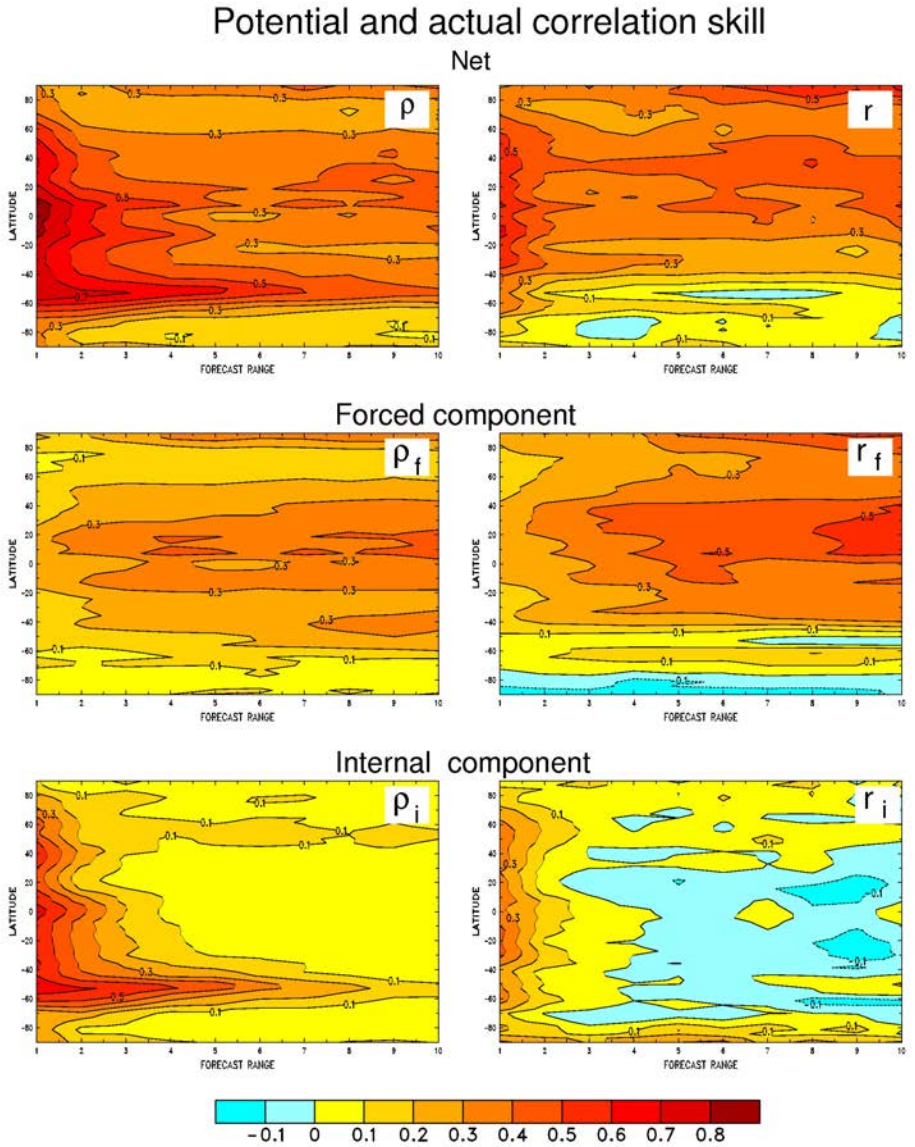
~internally generated

Potential and actual correlation skill



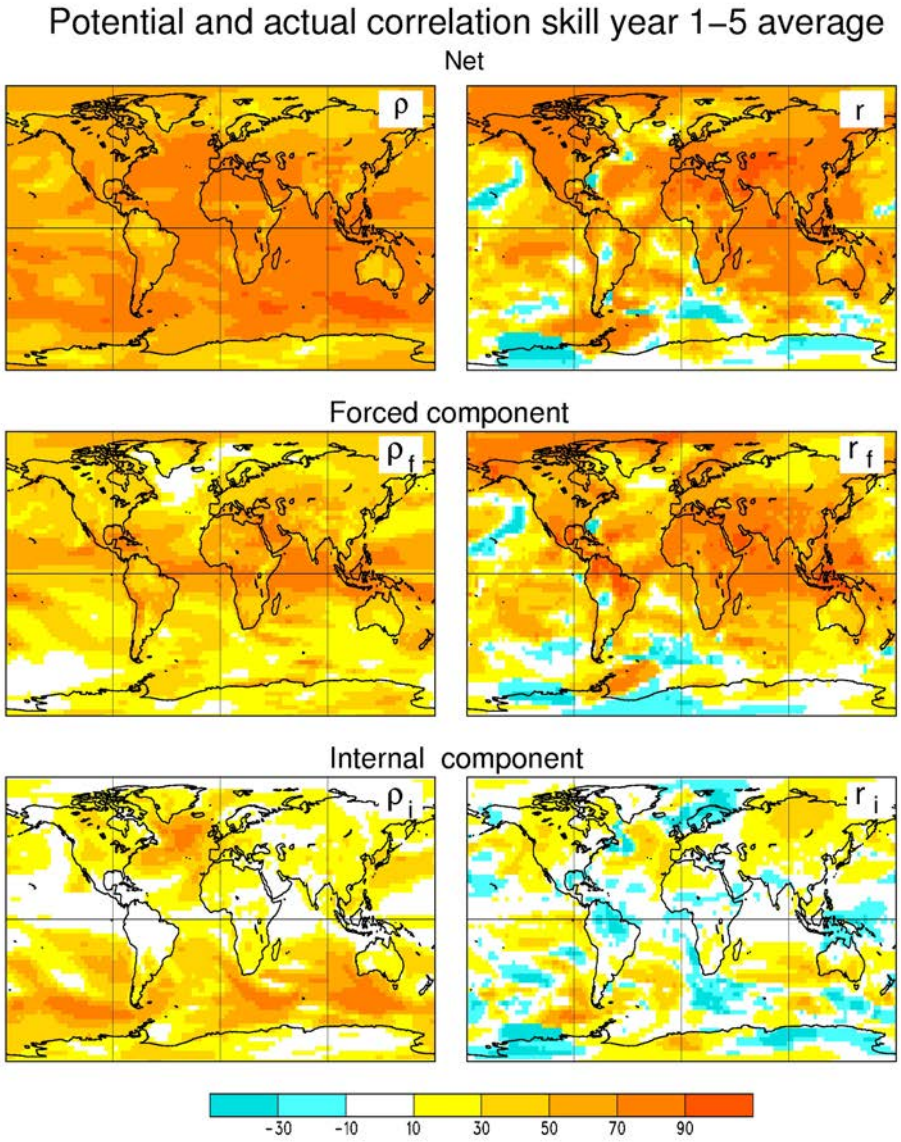
Potential and actual correlation skill

potential skill

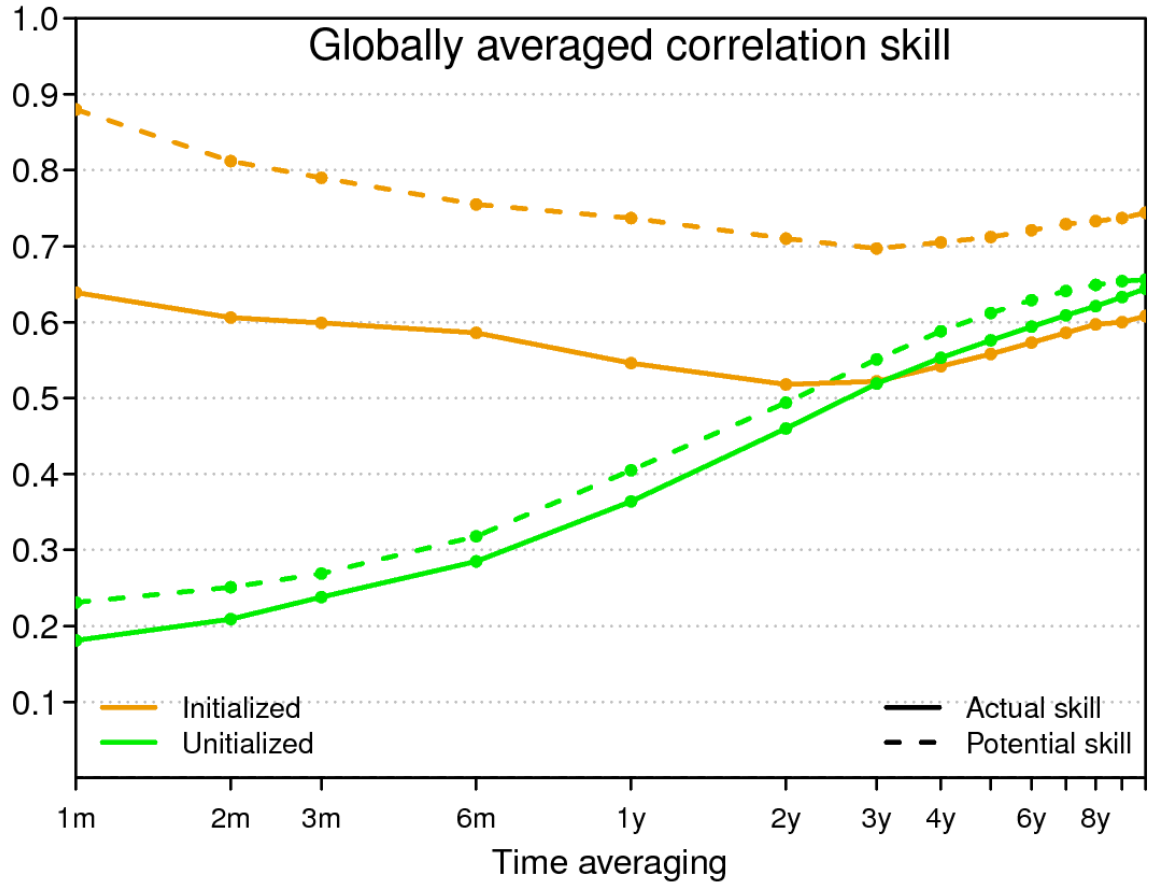


actual skill

Potential and actual correlation skill



Skill as a function of averaging time



Summary

- reasonably early days wrt analysis of decadal predictions although very active
- most analyses are for temperature
- considerable attention to prediction and predictability of AMV and PDV “modes”
- some attention hurricanes, extremes
- less attention paid to precipitation, so far, and less skill
- not yet much attention to other variables

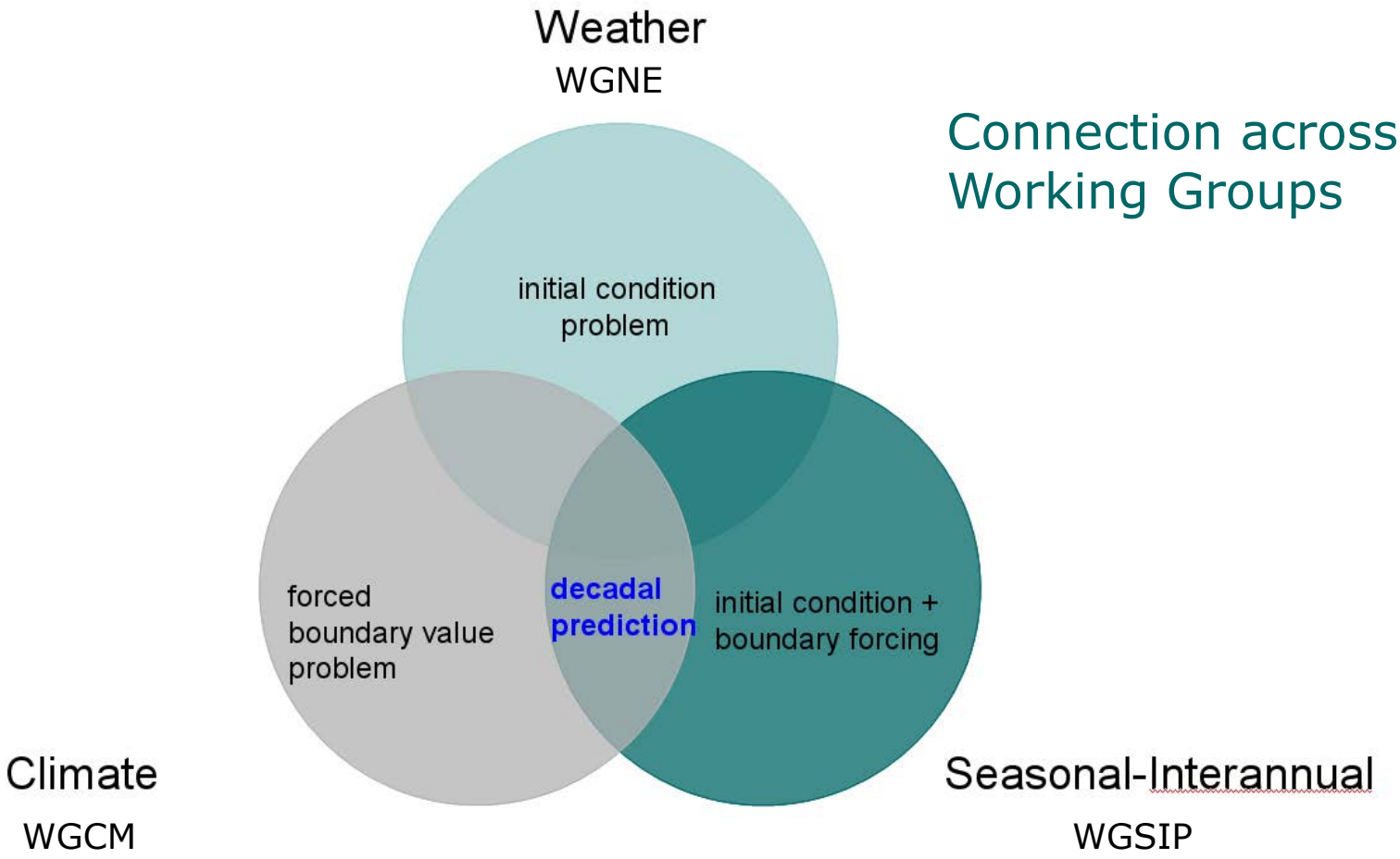
Potential s2d Workshop

- Workshop spanning seasonal to decadal timescale
- planning underway
- s2d with concentration on
  - CHFP results
  - CMIP5 decadal results
- target next spring

Decadal Climate Prediction Panel (DCPP) members

- Current members include
  - George Boer <george.boer@ec.gc.ca>
  - Karl Taylor <taylor13@llnl.gov>
  - Doug Smith <doug.smith@metoffice.gov.uk>
  - Ben Kirtman <bkirtman@rsmas.miami.edu>,
  - Jerry Meehl <meehl@ucar.edu>
  - Ronald Stouffer <ronald.stouffer@noaa.gov>
  - Mojib Latif <mlatif@ifm-geomar.de>
  - Scott Power <S.Power@bom.gov.au>

Where does the DCPP fit



Connection across Working Groups

Future DCPP activities(?)

- continue as focus for *practical questions* regarding decadal prediction as appropriate
- *promote common interests* across Working Groups, presumably through membership/attendance at meetings
  - models
  - initialization
  - mechanisms
  - analysis
- *support*
  - continued research into decadal forecasts and applications
  - "operalization" of multi-year forecasting (?)
- *aid in organizing and promoting*
  - proposed s2d Workshop
  - decadal prediction sessions in other scientific meetings
- *contribute* to the decadal prediction aspects of CMIP6 and other intercomparison studies
- …..

end of presentation