WGSIP's Long-Range Forecast Transient Intercomparison Project (LRFTIP)

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WCRP World Climate Research Programme
Environment and Climate Change Canada / Environnement et Changement climatique Canada
BSC Barcelona Supercomputing Center / Centro Nacional de Supercomputación
HYDROMETEOROLOGICAL CENTRE OF RUSSIA
気象庁 Japan Meteorological Agency

Introduction

LRFTIP is an initiative of WCRP's Working Group on Subseasonal to Interdecadal Prediction (WGSIP). Its purpose is to enable multi-model inter-comparison studies of the transient behavior of coupled long-range forecast models evolving from observation-based initial conditions. (*WMO defines long-range forecasting as from 30 days up to years.*)

LRFTIP Objectives

1) Developing a **multi-model online archive** of hindcast climatologies and related diagnostics including systems contributing to S2S, CHFP, DCPP
2) Developing **standard set of diagnostics** characterizing forecast shock/drift
3) **Addressing science questions**, including
   - influence of different initialization methods on transient behavior of climate model components
   - identification of any impacts (likely negative) on climate forecast quality
4) Of particular interest: **hindcast initialization experiments** (same model, different initialization methods) that contribute to (1)-(2) and inform (3)

Approach

- For a particular model and start date, hindcasts are averaged over available years and ensemble members to form a *hindcast climatology*
- When available, climatologies for the same model are also constructed for
  ➤ Freely running model (ideally CMIP **historical simulations**, averaging over multiple ensemble members)
  ➤ Hindcast initial conditions represented by assimilating model run, **analysis** used for initialization, or other observation-based reference
- These represent "endpoints" of hindcast drifts, characterizing evolution of hindcast climatology away from initial conditions, toward model's own climate:

initial condition climatology (analysis)
hindcast climatology
model climatology (historical simulation)

- Community input is welcome (and indeed sought), including
  ➤ Suggestions for shock/drift diagnostics
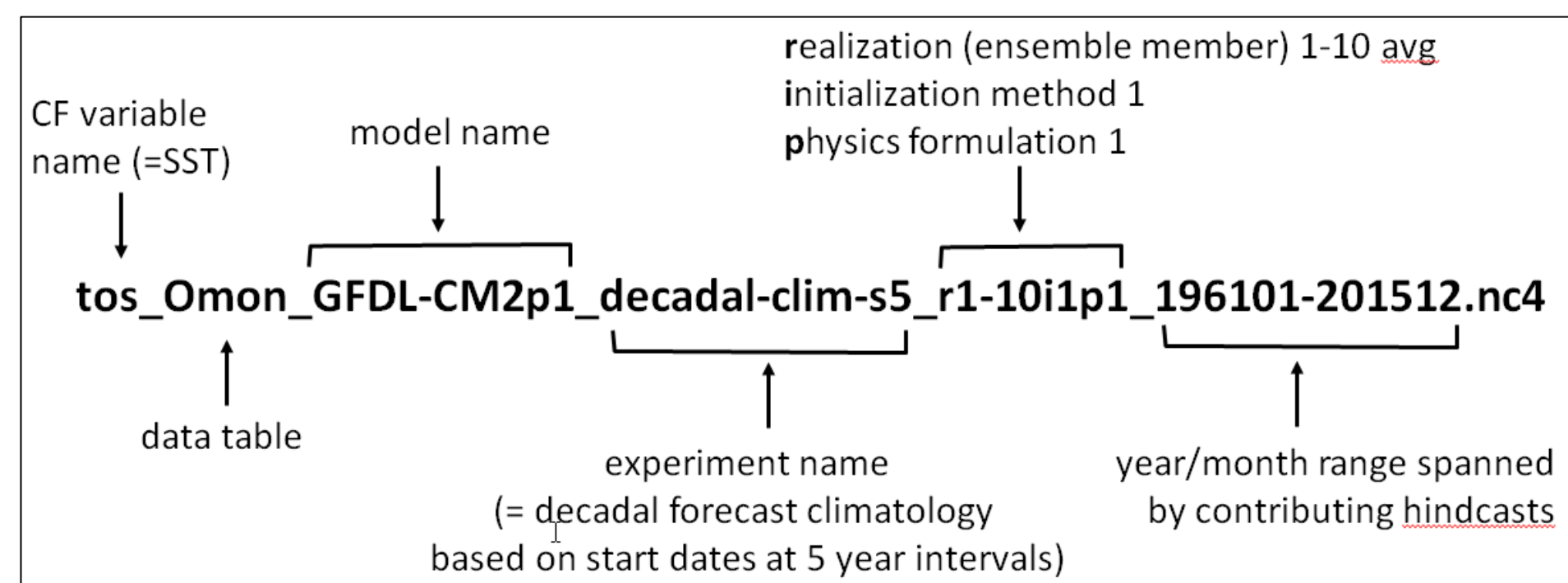 ➤ Data contributions for models and/or initialization methods not in archive

Data Archive

Time scales represented for different forecast types
- Subseasonal: daily to 30/60 days
- Seasonal: daily to 30/60 days + monthly through forecast range
- Decadal: daily to 30/60 days + monthly/annual through forecast range

Data format
- CF-compliant **NetCDF4**
- Time variable=**leadtime**
- File names, directory tree guided by **CMIP/ESGF conventions** →

CF variable name (=SST)
model name
realization (ensemble member) 1-10 avg
initialization method 1
physics formulation 1

tos_Omon_GFDL-CM2p1_decadal-clim-s5_r1-10i1p1_196101-201512.nc4

data table
experiment name (= decadal forecast climatology based on start dates at 5 year intervals)
year/month range spanned by contributing hindcasts

Data location: ftp://dapp2p.cccma.ec.gc.ca/pub/goapp/LRFTIP/
- Can be accessed from https://www.wcrp-climate.org/wgsip-projects/lrftip (web search "LRFTIP"), includes data specification document

Current Status

Models: The LRFTIP archive currently includes **6 subseasonal forecast models (S2S)**, **19 seasonal forecast models (CHFP, ENSEMBLES)**, and **15 decadal models (CMIP5, ENSEMBLES)**

Tables show **numbers of variables** for each model, climate system component, and averaging interval, for analysis (observation based), forecasts, and historical simulations as available

Legend: Analysis / Reference | Forecasts | Historical Simulations

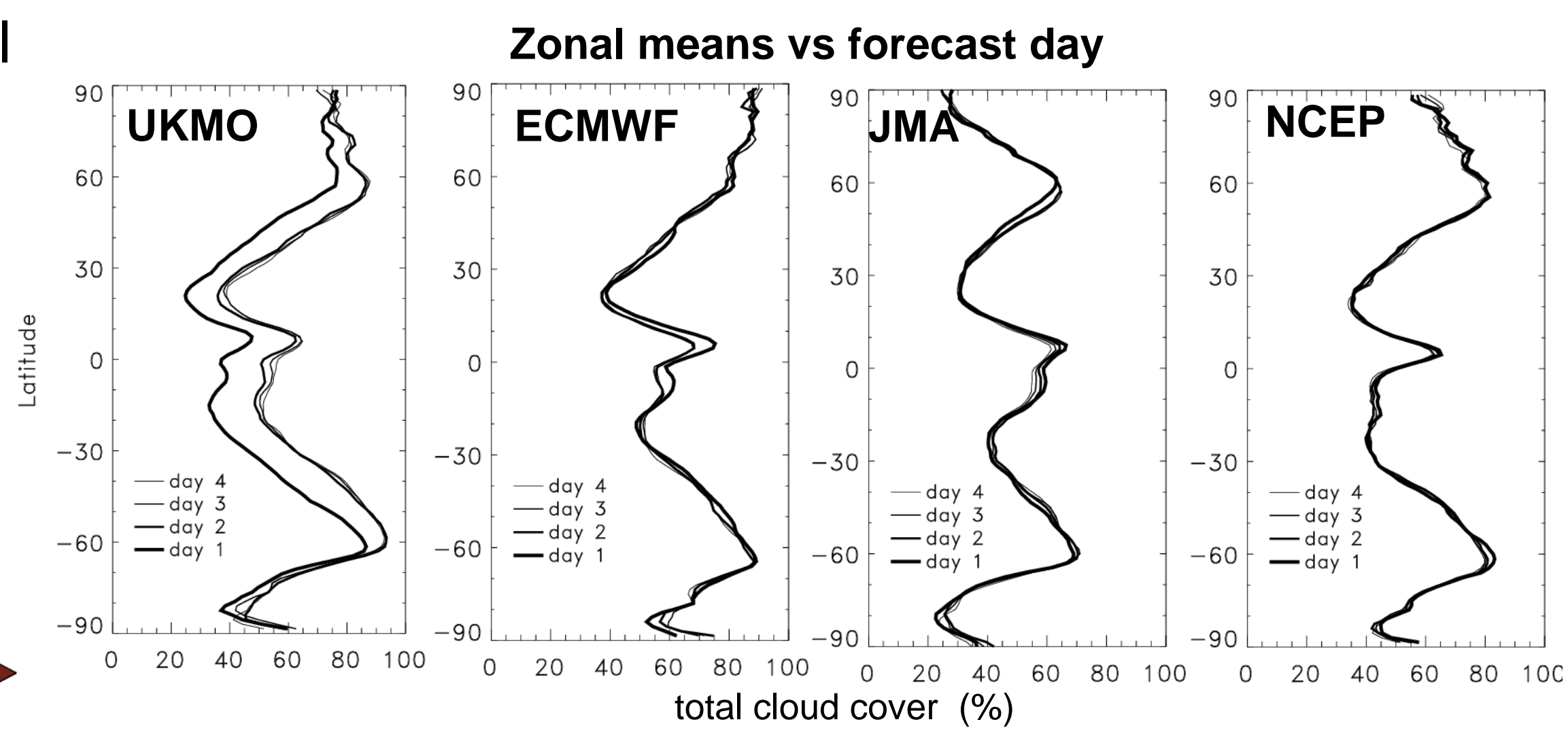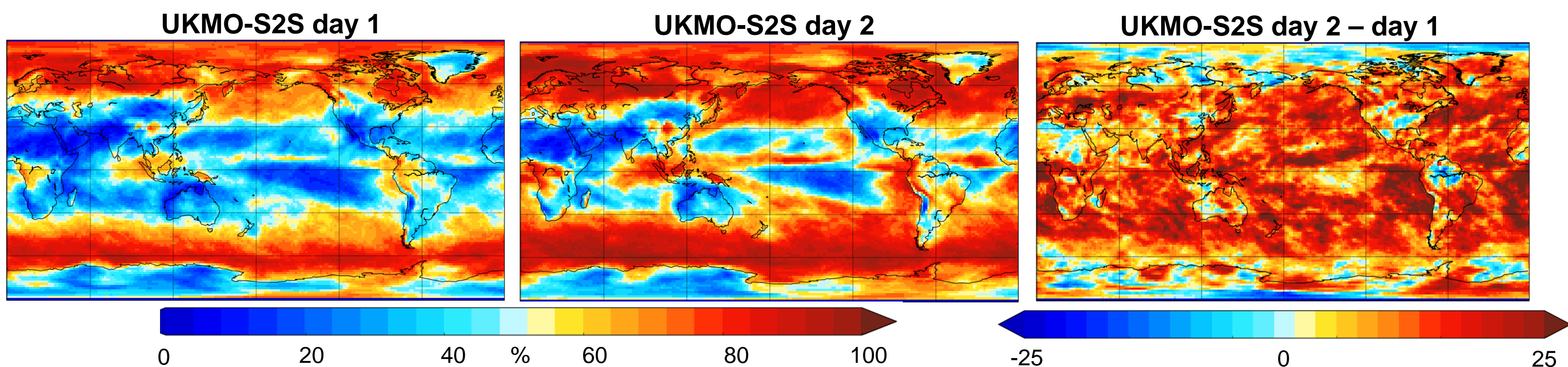| Subseasonal Model	Atmosphere Daily		Ocean Daily	
ECCC-S2S	7	7	1	1
ECMWF-S2S	7	7	1	1
JMA-S2S	2	2	1	1
Météo-France-S2S	7	7	1	1
NCEP-S2S	7	7	1	1
UKMO-S2S	4	4	1	1

* Multiple initialization methods

Seasonal Model	Atmosphere Daily		Atmosphere Monthly		Ocean Monthly		Land Monthly	Sea Ice Monthly	
CanCM3	18		22	22	12	12	4	1	2
CanCM4	18	22	22	22	12	12	4	1	2
ECMWF-S4			18	20			1		
JMAMRI-CGCM1	12	16	20	20	6	7			
JMAMRI-CGCM2			19	21	6	6			
MIROC5_v1.0	12	18	16	18	6	7			
MPI-ESM-LR			20	22					
POAMA p24a/b/c			12	14					
ARPEGE			7	7					
CFS_SHFP	3	3	8	8					
CMAM	3	5	7	7					
GloSea4			1	7	7				
GloSea5			1	7	7				
ENSEMBLES (CMCC-INGV, ECMWF-S3, IFM-GEOMAR, MF, DePreSys, HadGEM2)	16	20	20	20			1		

Decadal Model	Atmosphere Daily		Atmosphere Monthly		Atmosphere Yearly		Ocean Monthly		Ocean Yearly		Land Month/yearly		Sealce Month/Yearly	
CCSM4 (i1,i2) *			24	24	24	24	8	9	8	9	3	3	2	2
MF-ENSEMBLES			26		11		11		1					
CFSv2(i1,i2) *			26		26		7		7		1		2	
CanCM4 (i1,i2) *	25	16	6	25	26	17	25	26	17	13	13	13	13	13	13	4	3	2	2
CNRM-CM5			6	5	26		26		10	10	10	10	3		2	
ECMWF-ENSEMBLES			20		20		11		11		1			
GFDL-CM2p1			18	18	18	18	11	11	11	11	2	2	2	2
HadCM3	9	9	25	25	25	25	6	6	6	6	3	3	2	2
IFM-ENSEMBLES			20		20		11		11		1			
MIROC5	20	20	26	26	26	26	7		7		3	3	2	2
MRI-CGCM3			6		26		26		10		10		1		
UKMO-DePreSys-ENS			20		20									
UKMO-HadGEM2-ENS			20		20									
EC-EARTH			19	17	19	17	7	3	7	3			2	2
BCC-CSM1.1			6	6	26	26	26	26	7	7	7	7			2	2

Sample diagnostics

Subseasonal: **Total cloud cover** in first days of hindcasts initialized near 1 Nov → UKMO model shows large transient relative to other models due to initialization from ECMWF reanalysis
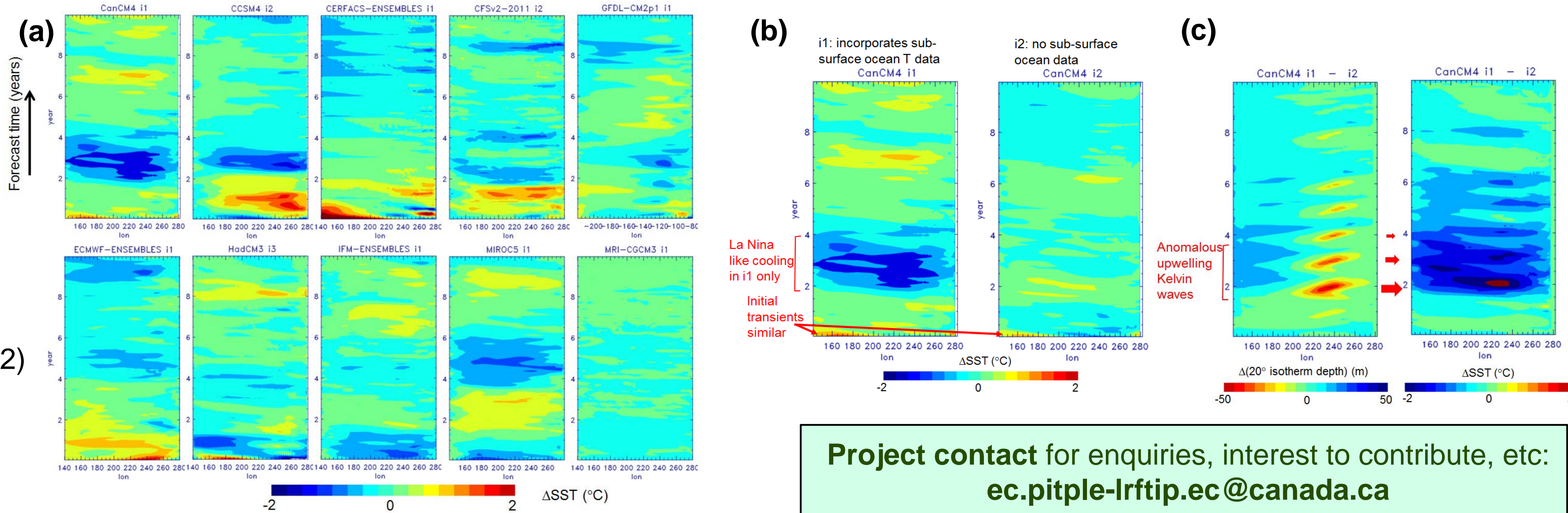

UKMO-S2S day 1   UKMO-S2S day 2   UKMO-S2S day 2 – day 1

Zonal means vs forecast day
UKMO ECMWF JMA NCEP
total cloud cover (%)

Seasonal: **SST biases** developing in forecasts initialized 1 May in two models having same ocean, different atmospheric components

ΔSST (°C)
month 1 (May)   CanCM3 CanCM4
month 5 (Sep)   CanCM3 CanCM4
month 9 (Jan)   CanCM3 CanCM4
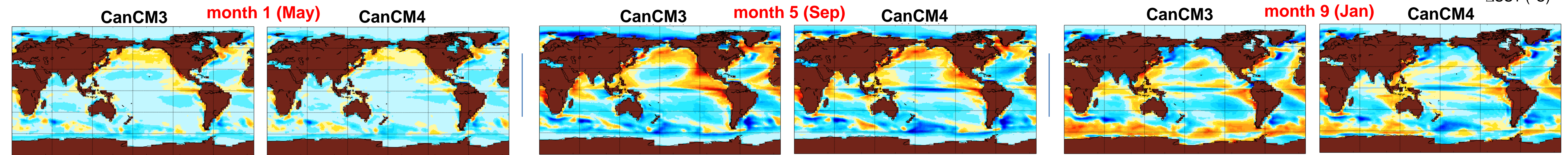
Decadal:
(a) Evolution of **SST drift across equatorial Pacific** in 10 decadal prediction models, showing El Niño and La Niña-like transients
(b) As in (a), except for a single model CanCM4 using two different ocean initialization methods: i1, including subsurface data, and i2, with surface initialization only
(c) As in (b), except *differences* (i1–i2) in SST (right) and 20°C isotherm depth (left), showing La Niña-like transient excited by anomalous upwelling Kelvin waves

(a) CanCM4 i1 CCSM4 i2 CERFACS-ENSEMBLES i1 CFSv2-2011 i2 GFDL-CM2p1 i1
ECMWF-ENSEMBLES i1 HadCM3 i3 IFM-ENSEMBLES i1 MIROC5 i1 MRI-CGCM3 i1
ΔSST (°C)

(b) i1: incorporates sub-surface ocean T data CanCM4 i1   i2: no sub-surface ocean data CanCM4 i2
La Nina like cooling in i1 only
Initial transients similar
ΔSST (°C)

(c) CanCM4 i1 – i2   CanCM4 i1 – i2
Anomalous upwelling Kelvin waves
Δ(20° isotherm depth) (m)   ΔSST (°C)