

An aerial photograph of a coastal city, likely Barcelona, Spain. The image shows a dense urban area with a mix of colorful buildings and a prominent tall, modern skyscraper. A wide, sandy beach runs along the coast, with a clear blue sea. The sky is a deep blue with some light clouds. The text is overlaid on the upper part of the image.

Research Activities of the Climate Forecasting Unit of the IC³

Louis-Philippe Caron
Montréal, March 31st 2015

Catalan Institute of Climate Sciences (IC³)

- Composed of 3 research groups:

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 - Focus on health impact

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NEWS

Health

Brazil 2014: World Cup dengue fever risk predicted

© 17 May 2014 | Health



Tropospheric winds from northeastern China carry the etiologic agent of Kawasaki disease from its source to Japan

Xavier Rodó^{a,b,1}, Roger Curcoll^b, Marguerite Robinson^b, Joan Ballester^{b,c}, Jane C. Burns^d, Daniel R. Cayan^{e,f}, W. Ian Lipkin^g, Brent L. Williams^g, Mara Couto-Rodriguez^g, Yosikazu Nakamura^h, Ritei Ueharaⁱ, Hiroshi Tanimotoⁱ, and Josep-Anton Morgui^b

^aInstitució Catalana de Recerca i Estudis Avançats, 08010 Barcelona, Catalonia, Spain; ^bUnitat de Dinàmica i Impacte Climàtic (UDIC), Institut Català de Ciències del Clima, 08005 Barcelona, Catalonia, Spain; ^cGeological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125; ^dDepartment of Pediatrics, Rady Children's Hospital-San Diego and University of California, San Diego, La Jolla, CA 92093; ^e Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92037; ^fUS Geological Survey, La Jolla, CA 92037; ^gCenter for Infection and Immunity, Mailman School of Public Health of Columbia University, New York, NY 10032; ^hDepartment of Public Health, Jichi Medical Hospital, Tochigi 331-8639, Japan; and ⁱCenter for Global Environmental Research, National Institute for Environmental Studies, Tsukuba 305-8506, Japan

Edited* by Mark H. Thieme, University of California, San Diego, La Jolla, CA, and approved April 4, 2014 (received for review January 9, 2014)



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 - Climate Forecasting Unit (CFU)



Climate Prediction

- Improvement of climate prediction systems at s2d scale
- Forecast quality assessment: attribution (source of predictability), diagnosis of climate forecast weaknesses

Atmospheric Composition

- Development of air quality forecast model (chemical-aerosol/weather) for urban areas
- Investigate atmospheric composition processes and their effects on weather, climate, air quality

4 groups


Software Development and IT

- EC-Earth
- s2dverification R package
- Auto-submit
- Code optimization, ...

Climate Services

- Orient research
- Development products in partnership with industry
- Develop platforms to disseminate knowledge
- 2 projects: TC predictions. Wind power production

Tools we use...

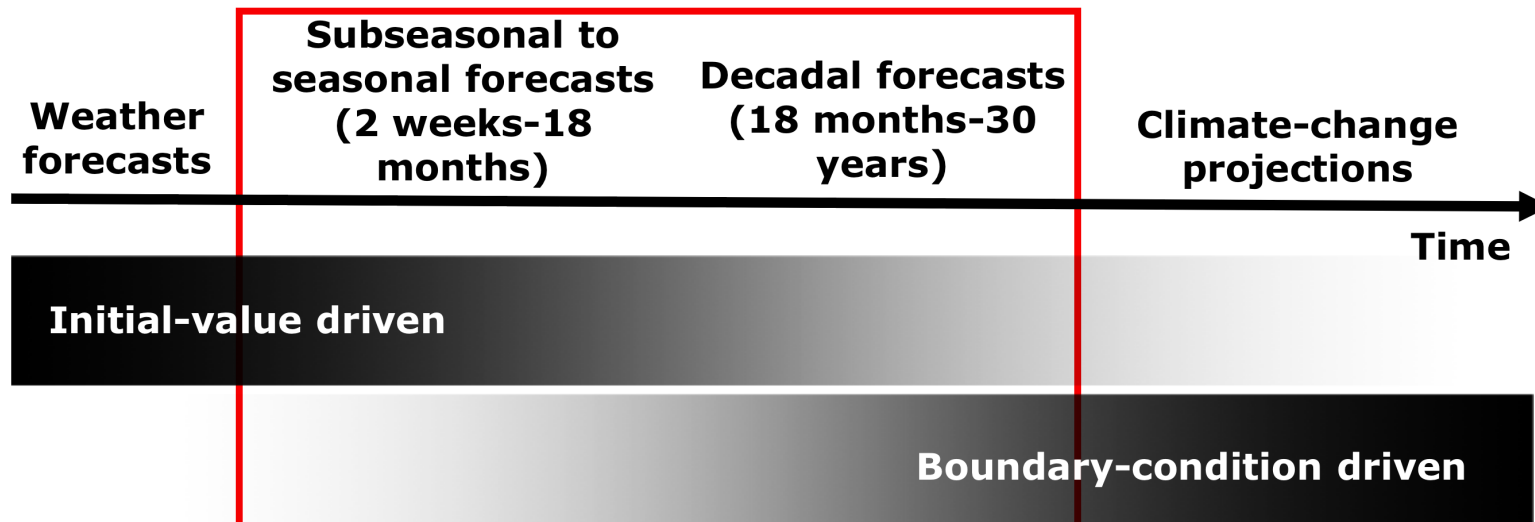
- Global Climate models: 
 - Combination of IFS, NEMO, OASIS coupler
 - New standard resolution: T511, ORCA0.25
- Freeware only (we're poor) : bash, python, R, ...
 - We maintain a R package: s2dverification
- Git, GitLab for software development
- Hardware:
 - local cluster (384 cores)
 - 0.5PB of storage



Climate prediction



Progression from initial-value problems with weather forecasting at one end and multi-decadal to century projections as a forced boundary condition problem at the other, with climate prediction (**sub-seasonal, seasonal and decadal**) in the middle. Prediction involves initialization and systematic comparison with a **simultaneous** reference.



Adapted from Meehl et al. (2009)

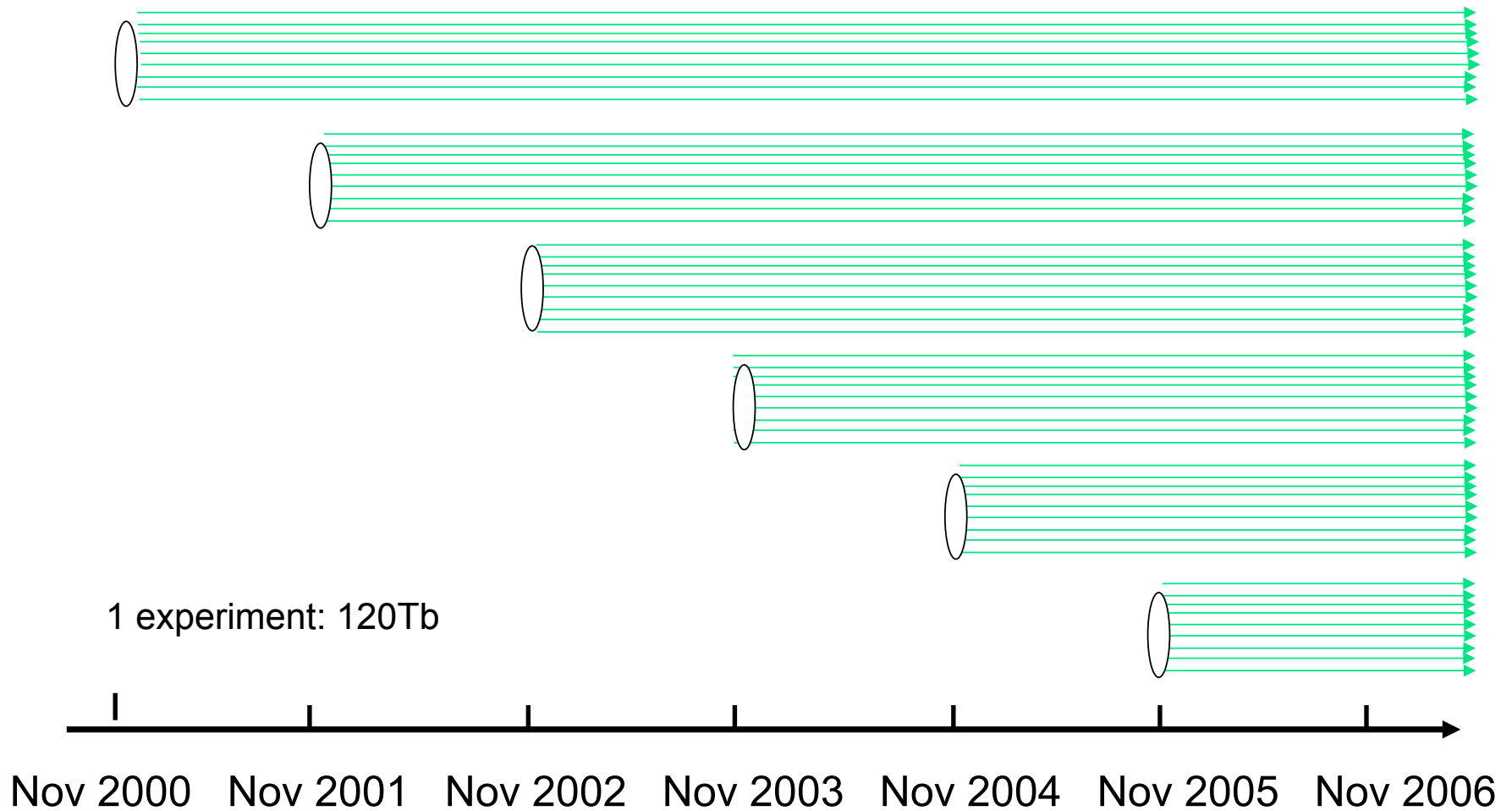
Climate system predictability

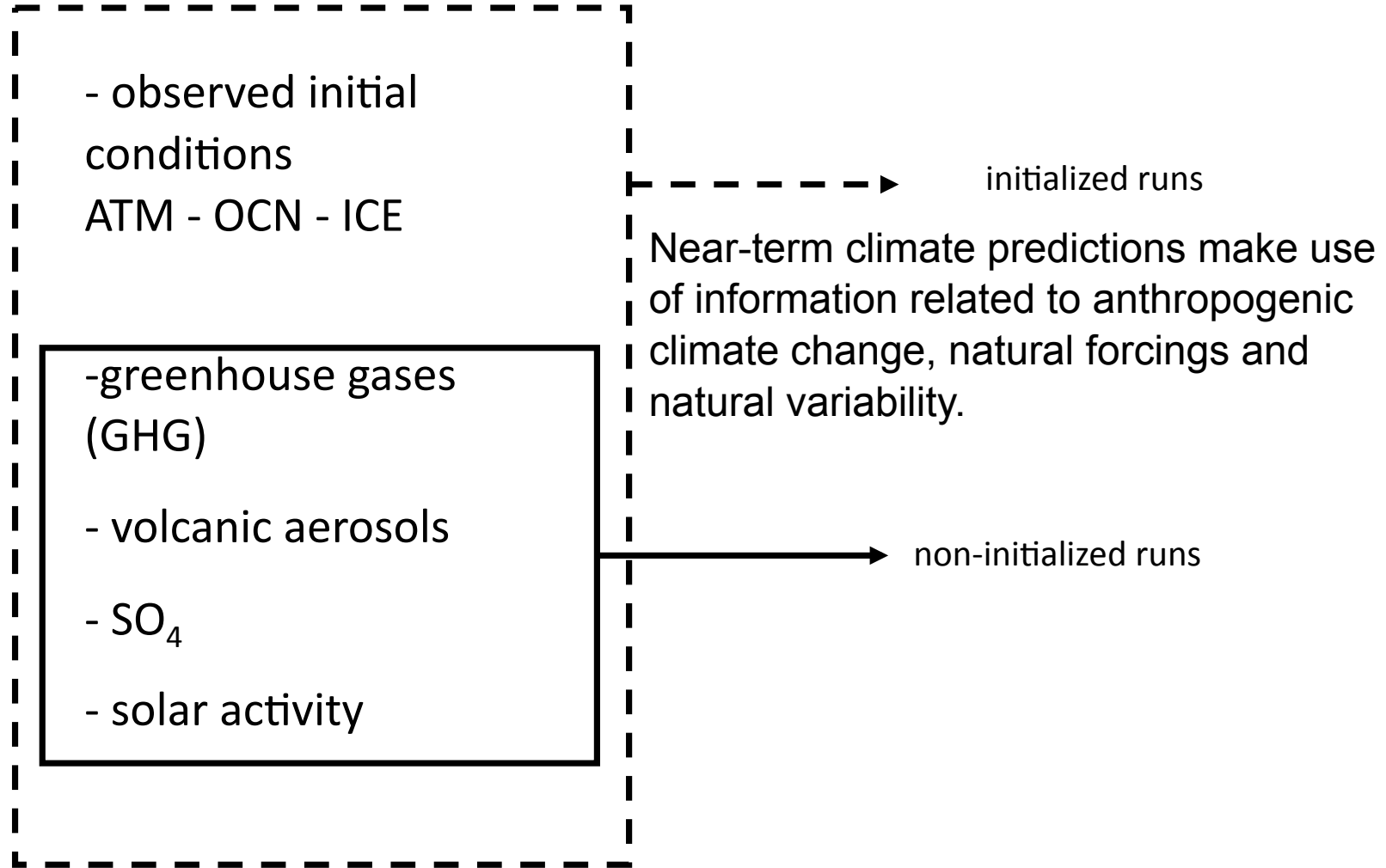
- Memory on interannual to centennial timescales in the **ocean**
- Memory on seasonal to interannual timescales in the **sea ice** and **land surface**
- External radiative forcings (solar activity, greenhouse gases, aerosols)



Ensemble initialized near-term predictions

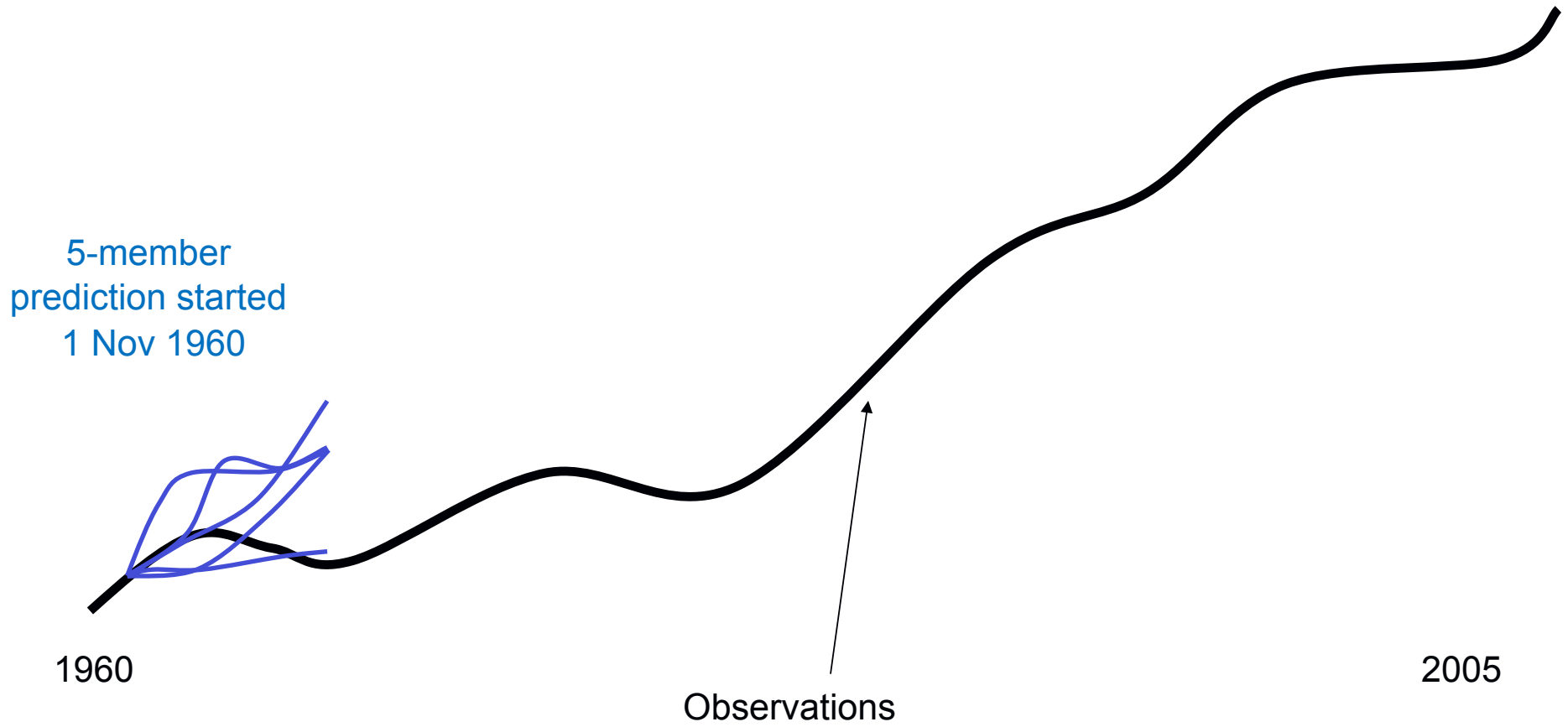
CMIP5: ensemble forecast systems using an initialized ESM







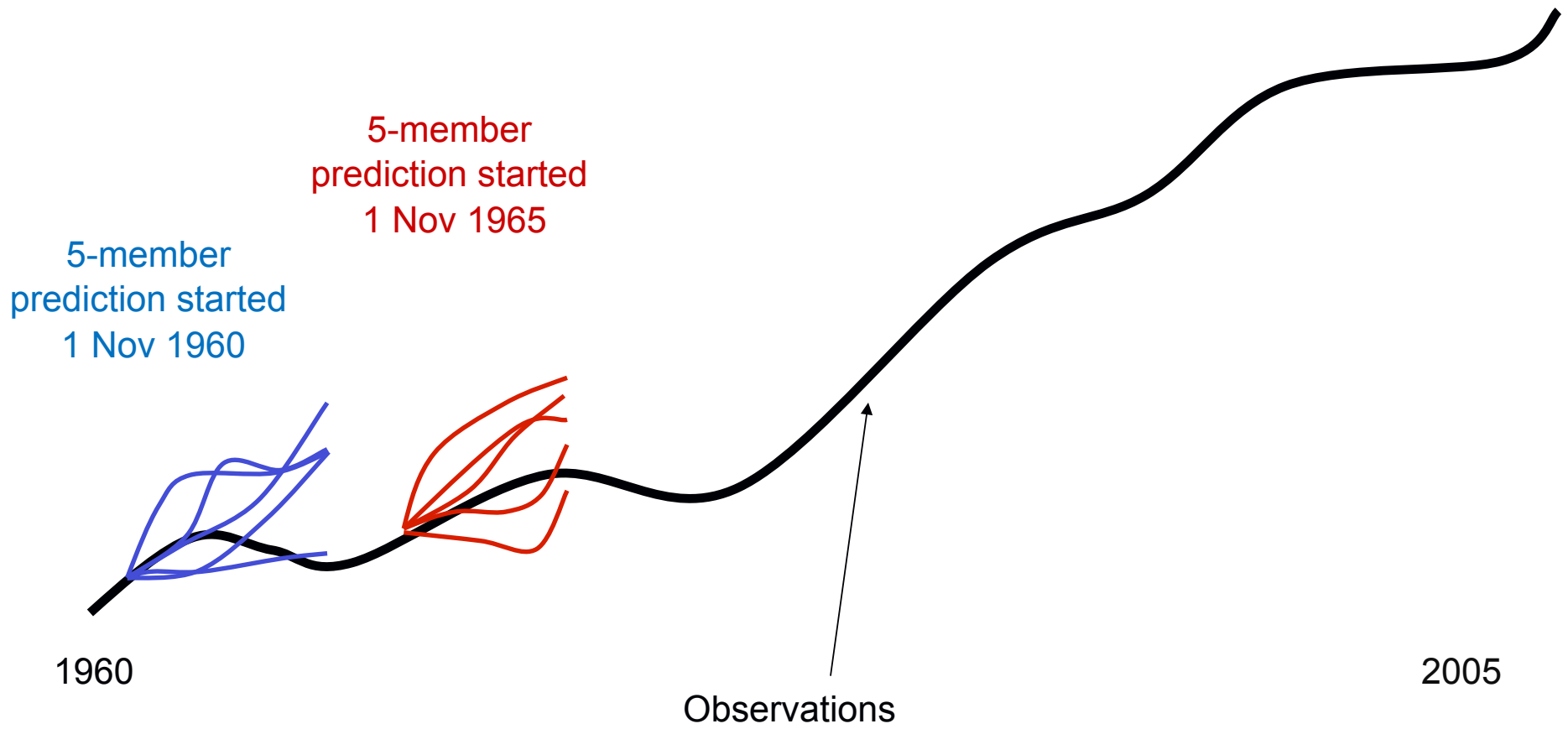
Experimental setup : 1 grid-point





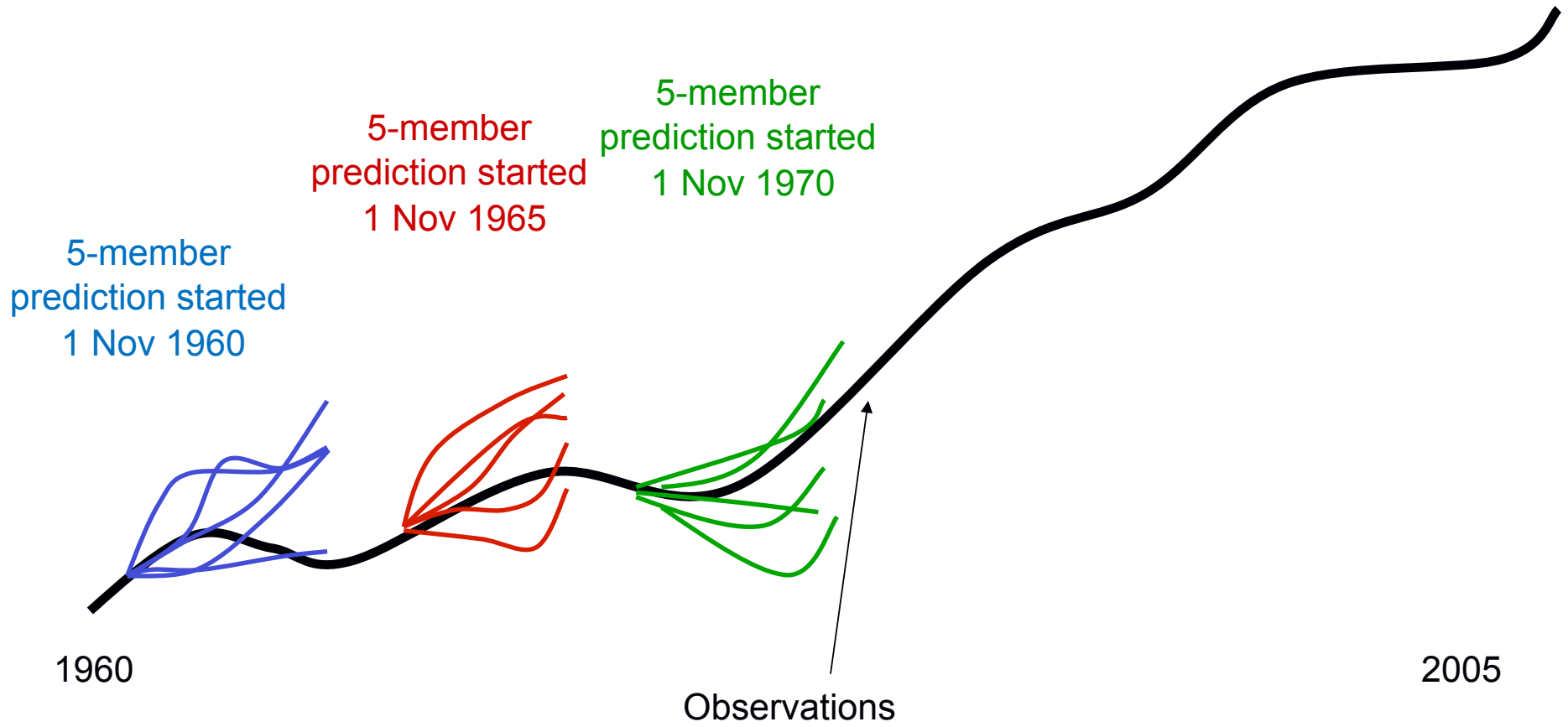
Climate Forecasting Unit

Experimental setup : 1 grid-point



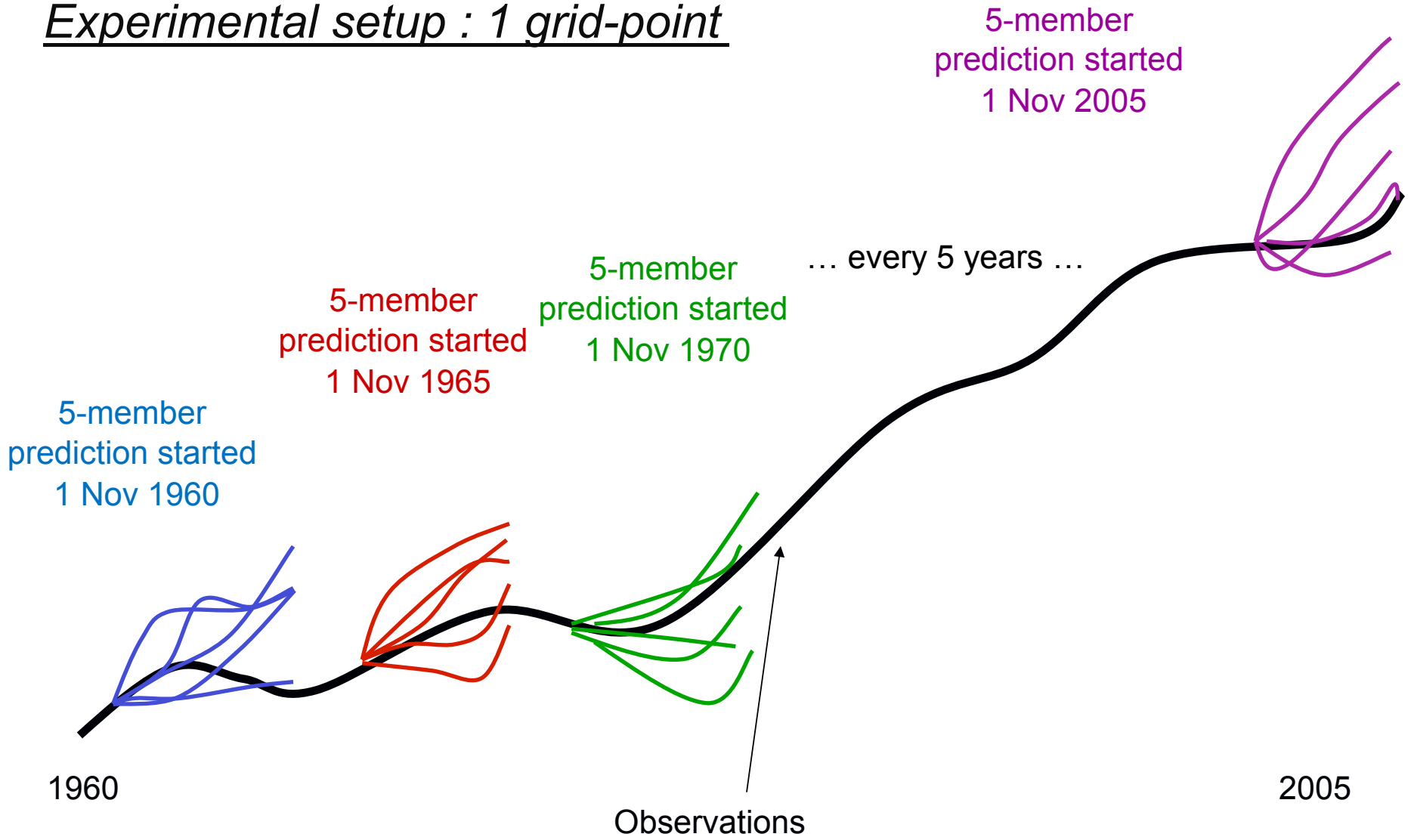


Experimental setup : 1 grid-point



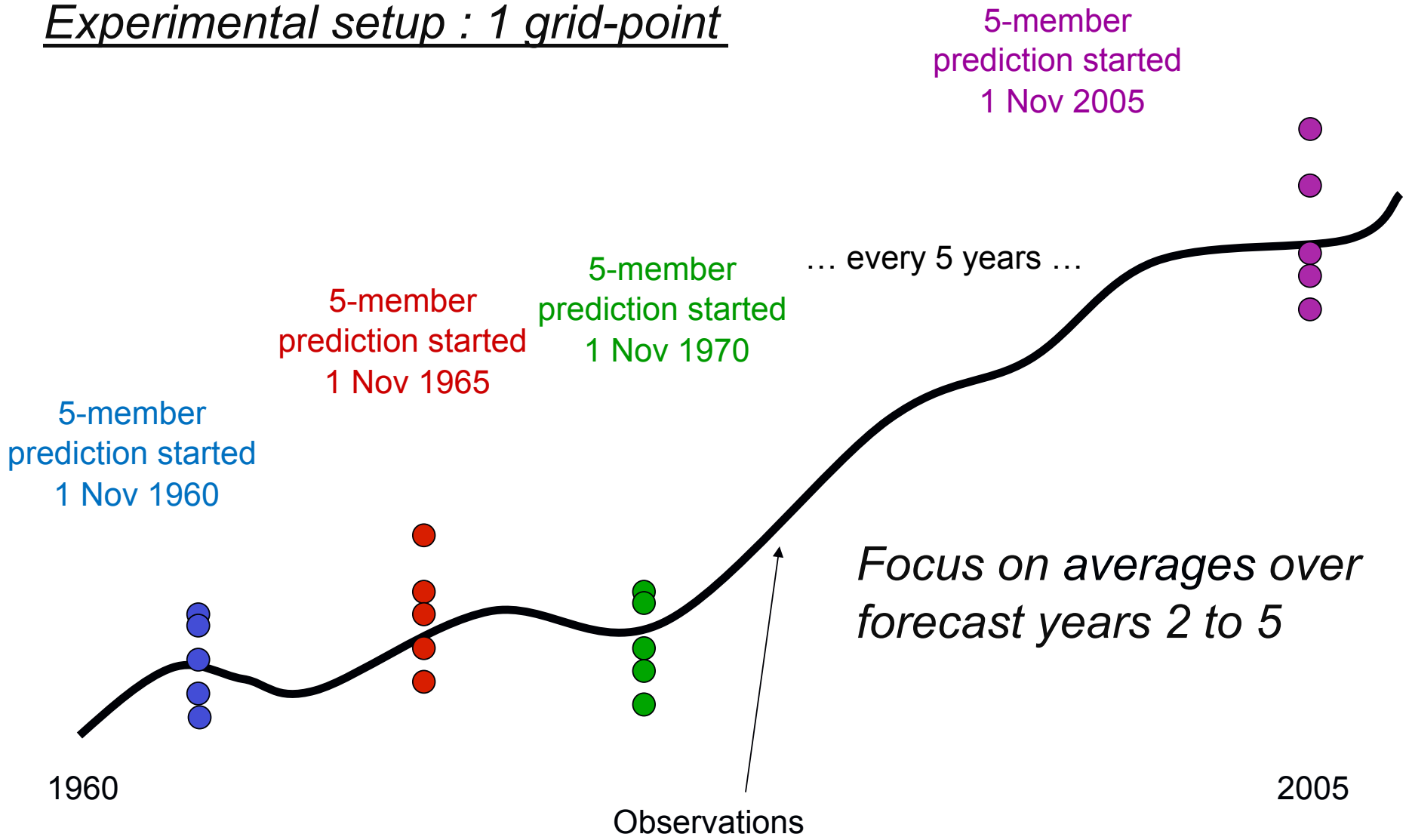


Experimental setup : 1 grid-point



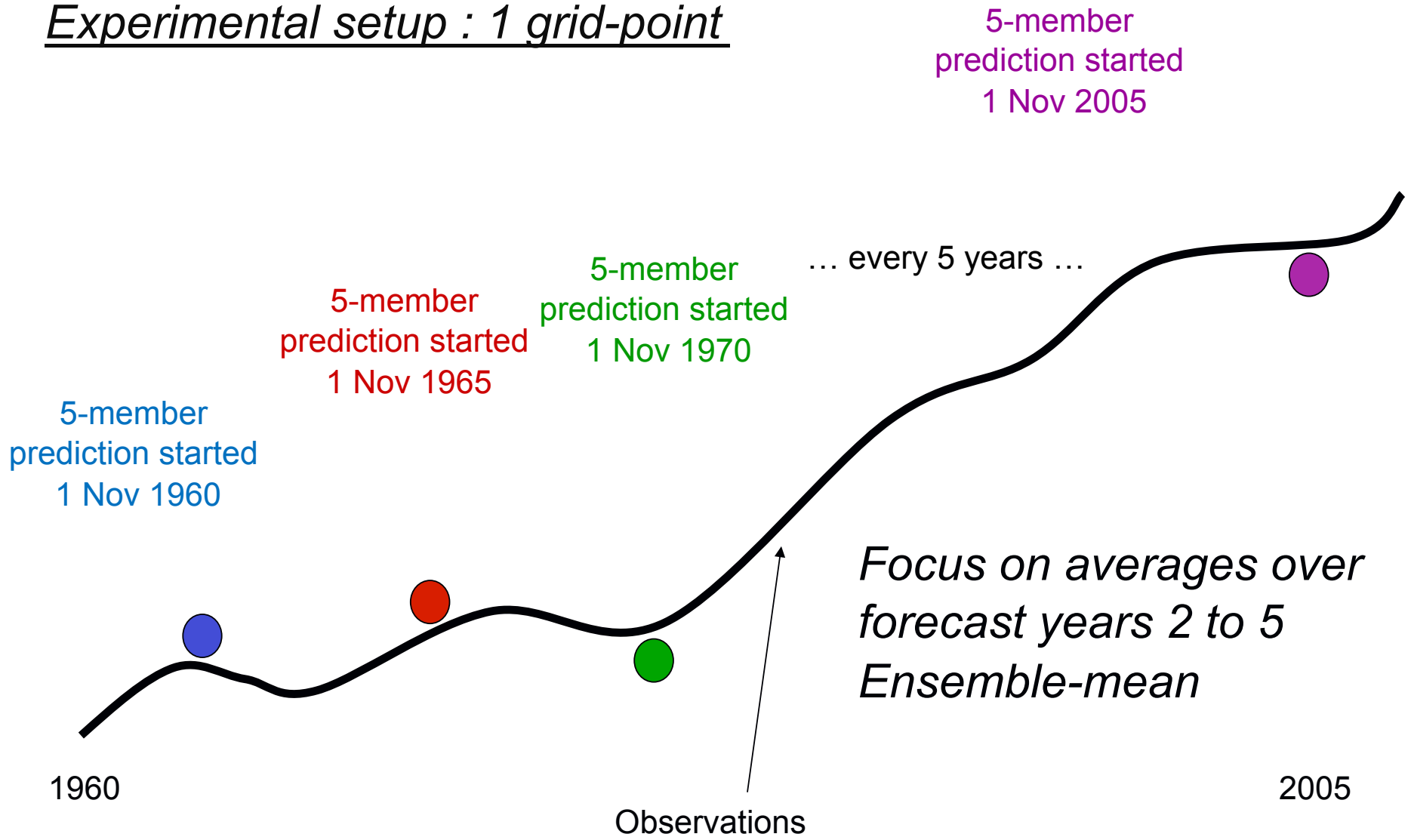


Experimental setup : 1 grid-point



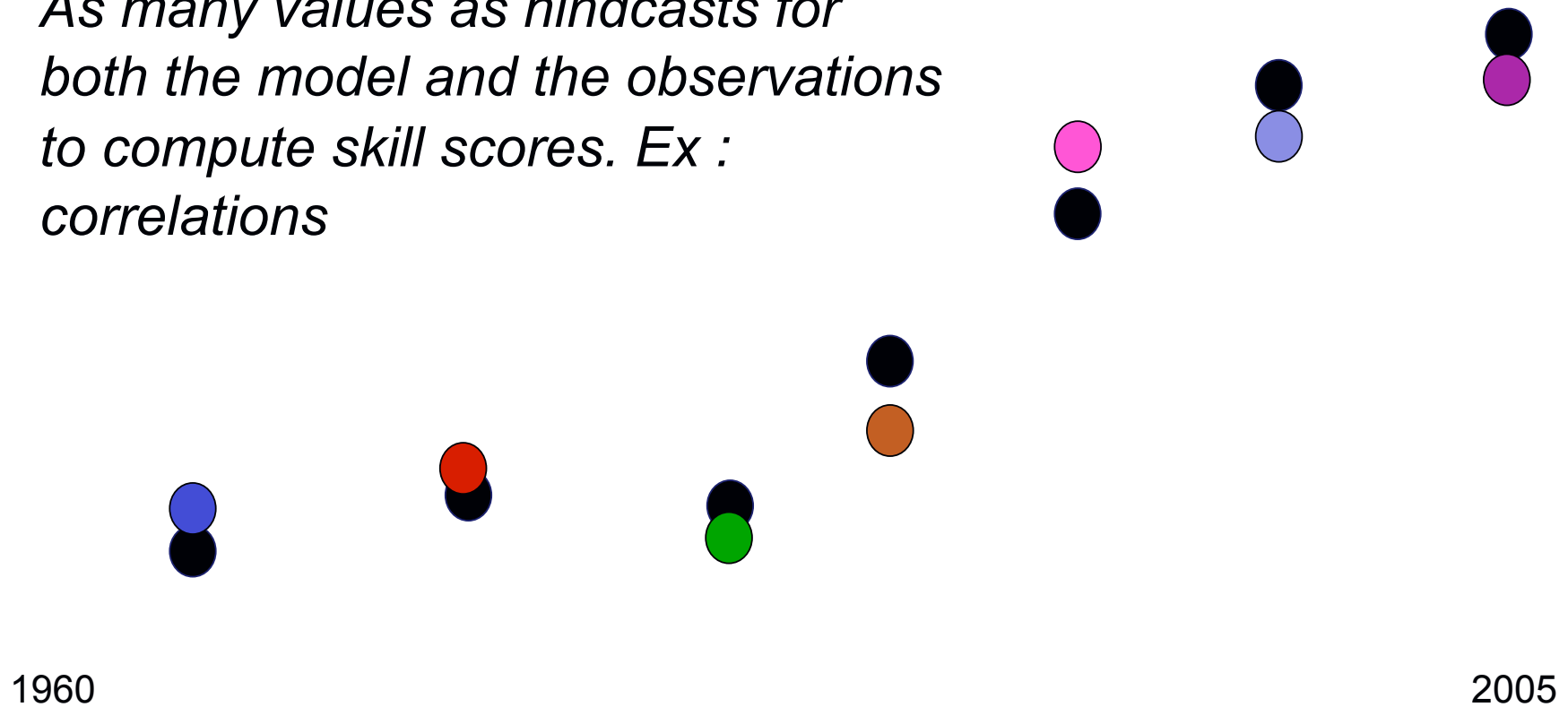


Experimental setup : 1 grid-point



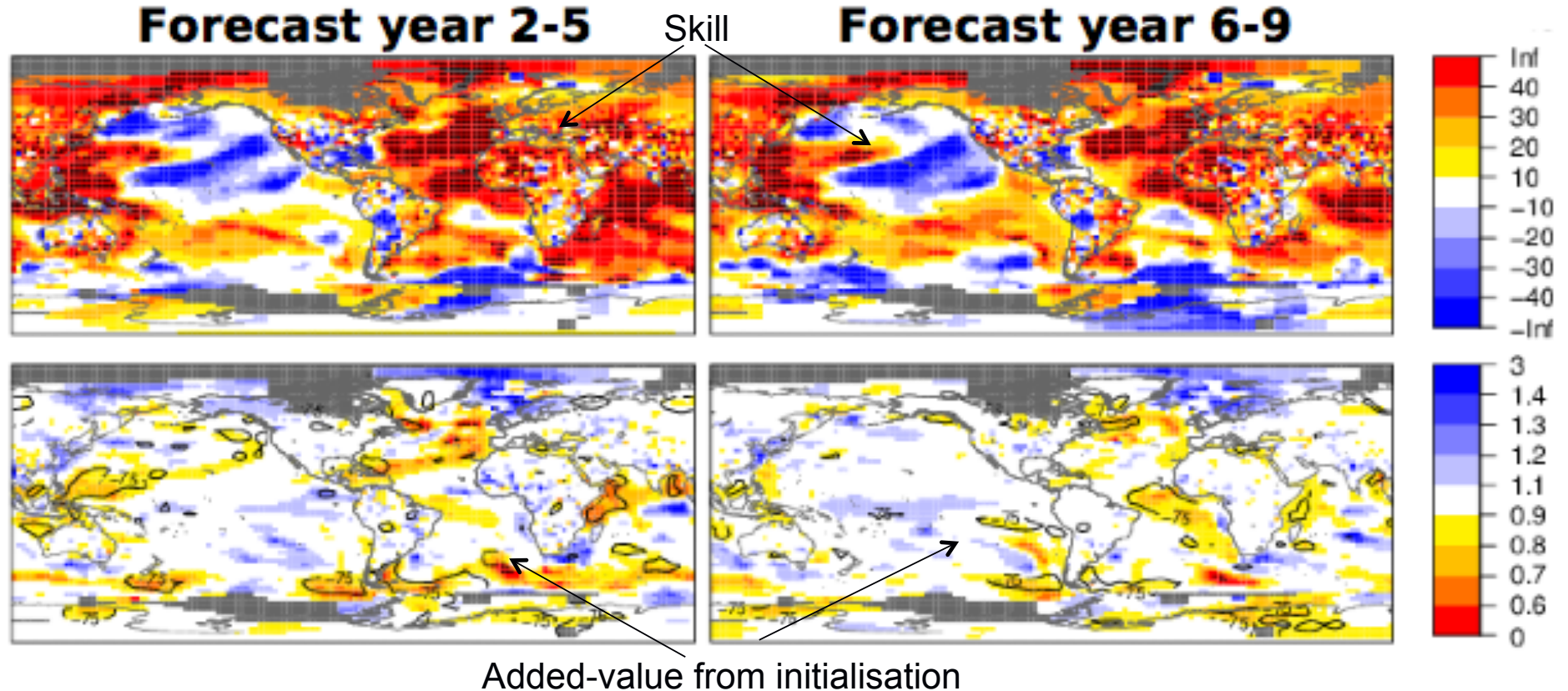
Experimental setup : 1 grid-point

As many values as hindcasts for both the model and the observations to compute skill scores. Ex : correlations



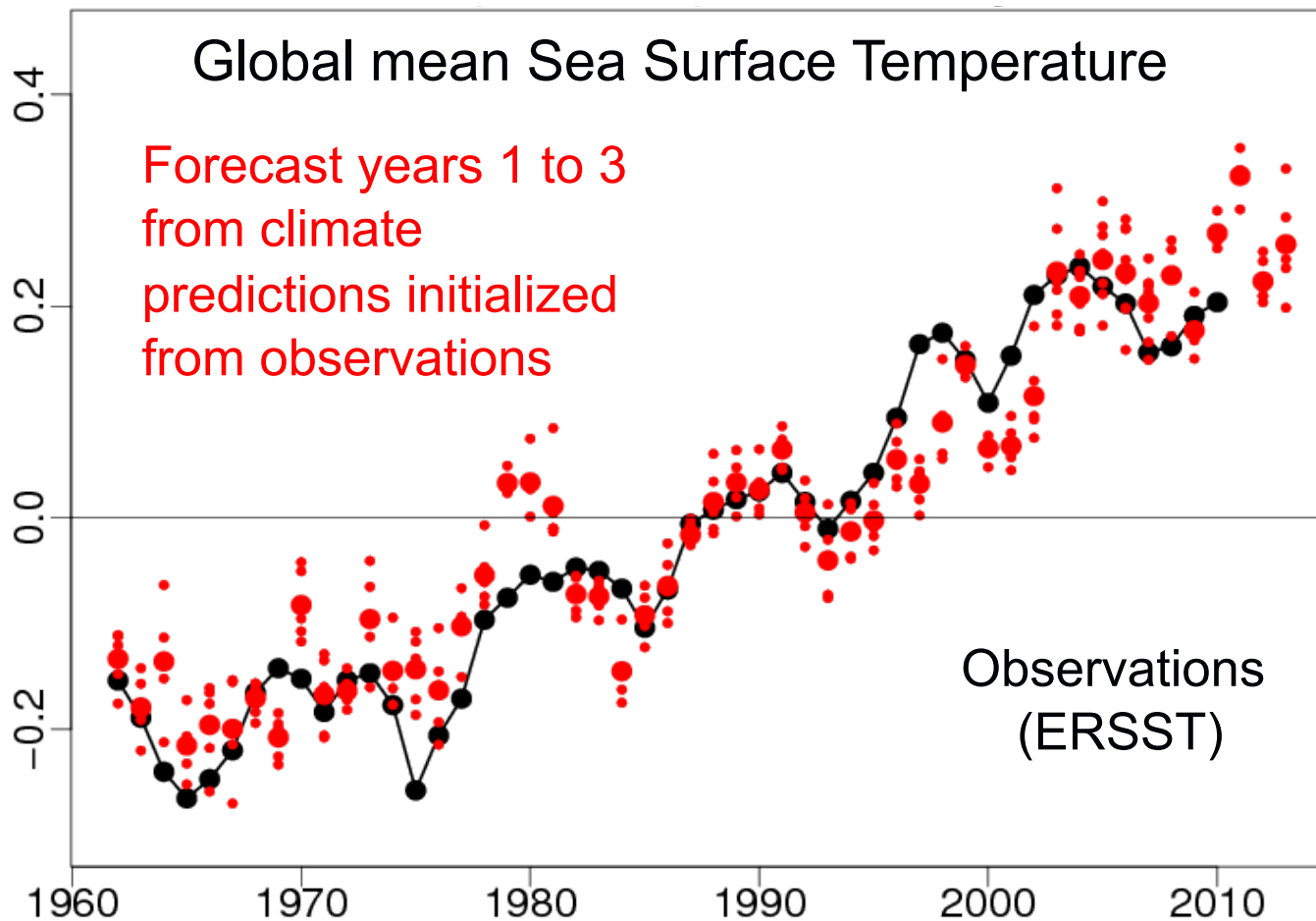
Typical decadal forecast skill – IPCC AR5

(Top row) Root mean square skill score (RMSSS) of the ensemble mean of the initialised predictions and (bottom row) ratio of the root mean square error (RMSE) of the initialised and uninitialised predictions for the near-surface temperature from the multi-model CMIP5 experiment (1960-2005) for (left) 2-5 and (right) 6-9 forecast years. Five-year start date interval.



Predictions of the XXIst century hiatus

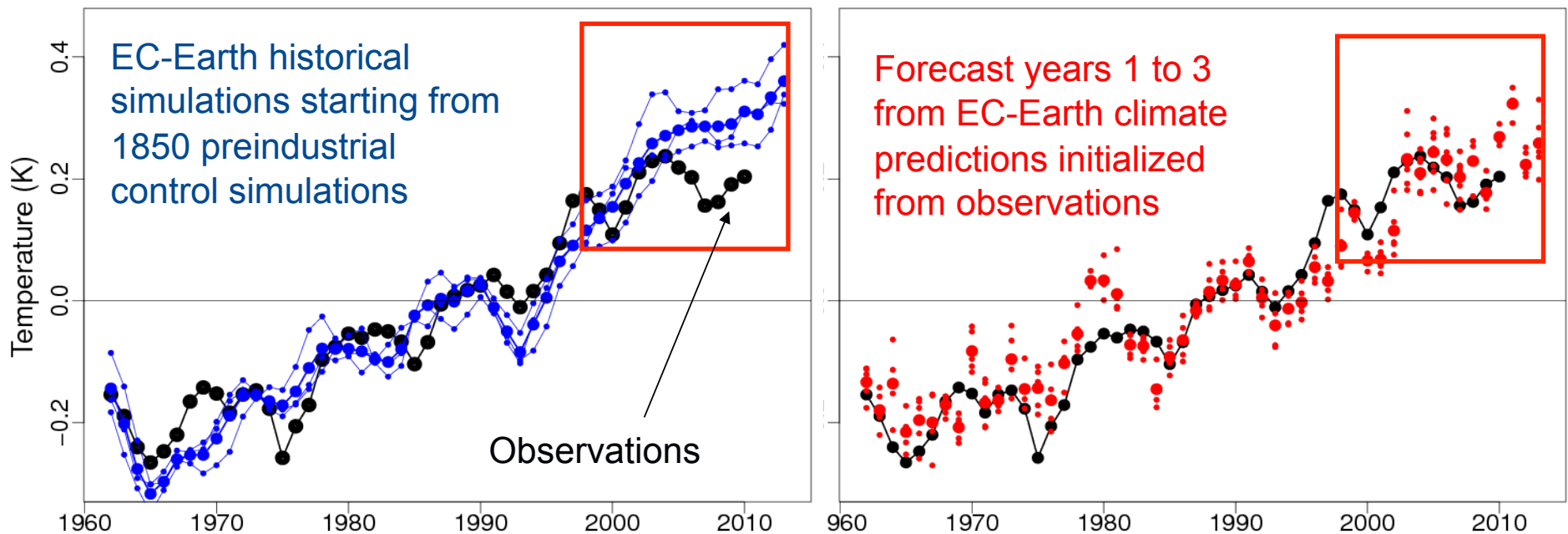
EC-Earth2.3 CMIP5 decadal climate predictions capture the hiatus



Guemas et al (2013) Nature Climate Change

Predictions of the XXIst century hiatus

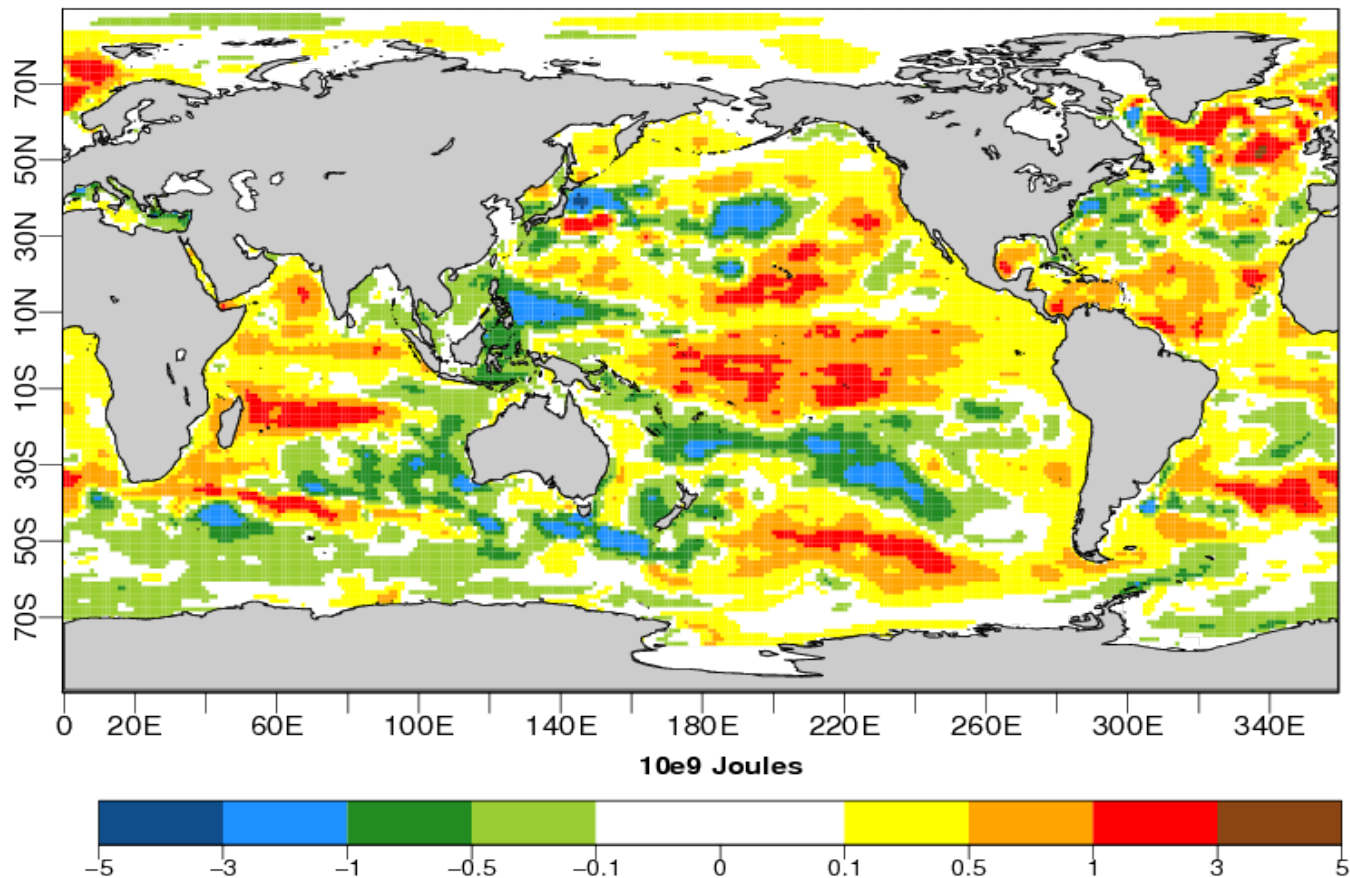
Crucial role of initialization from observations in capturing the plateau



Predictions of the XXIst century hiatus

Plateau explained by increased ocean heat uptake

Ocean heat uptake (0-800m excluding the mixed layer) at the onset of the plateau



Guemas et al (2013) Nature Climate Change

National and international projects



European Commission:

1. QWeCI : Climate and Health over Africa
2. CLIM-RUN : Climate information - Mediterranean region
3. DENFREE : Dengue
4. SPECS : Seasonal-to-Decadal predictions
5. EUPORIAS : Climate services
6. IS-ENES2 : Infrastructure for Earth System Modelling
7. PREFACE : Tropical Atlantic climate and fisheries
8. EUCLEIA : Attribution of extreme events

Spanish Government:

1. PICA-ICE : sea ice reconstruction and prediction
2. RESILIENCE : climate services – renewable energy
3. RUCSS : seasonal-to-decadal predictions

Others:

1. Private: RPI, MAPFRE, Banca Cívica
2. Agence Nationale de la Recherche (France).
3. German Academic Exchange Service
4. VERITAS (European Space Agency)

SPECS: Seasonal-to-decadal climate Prediction for the improvement of European Climate Services

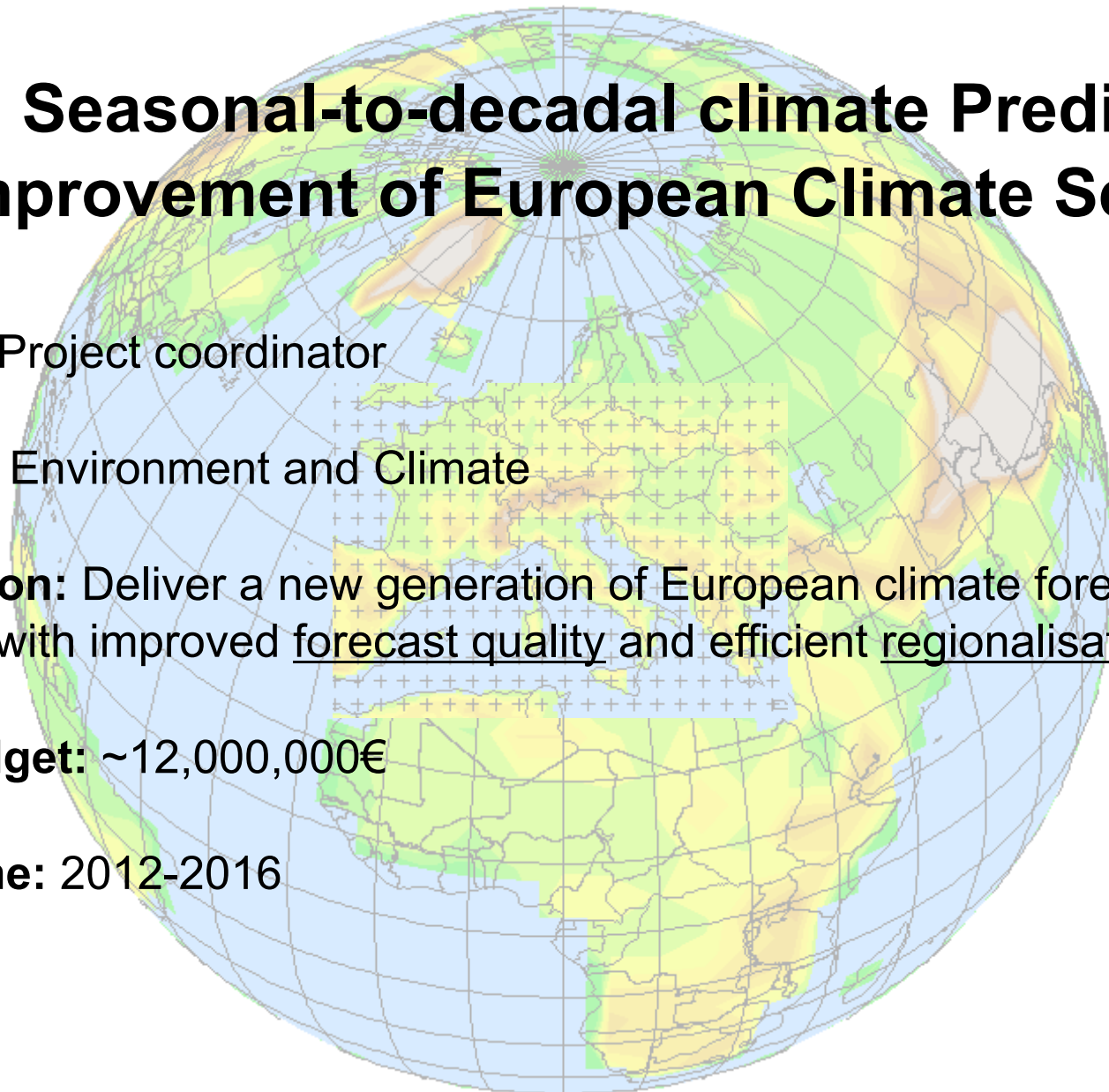
IC3 role: Project coordinator

Call: FP7 Environment and Climate

Description: Deliver a new generation of European climate forecast systems, with improved forecast quality and efficient regionalisation tools.

Total budget: ~12,000,000€

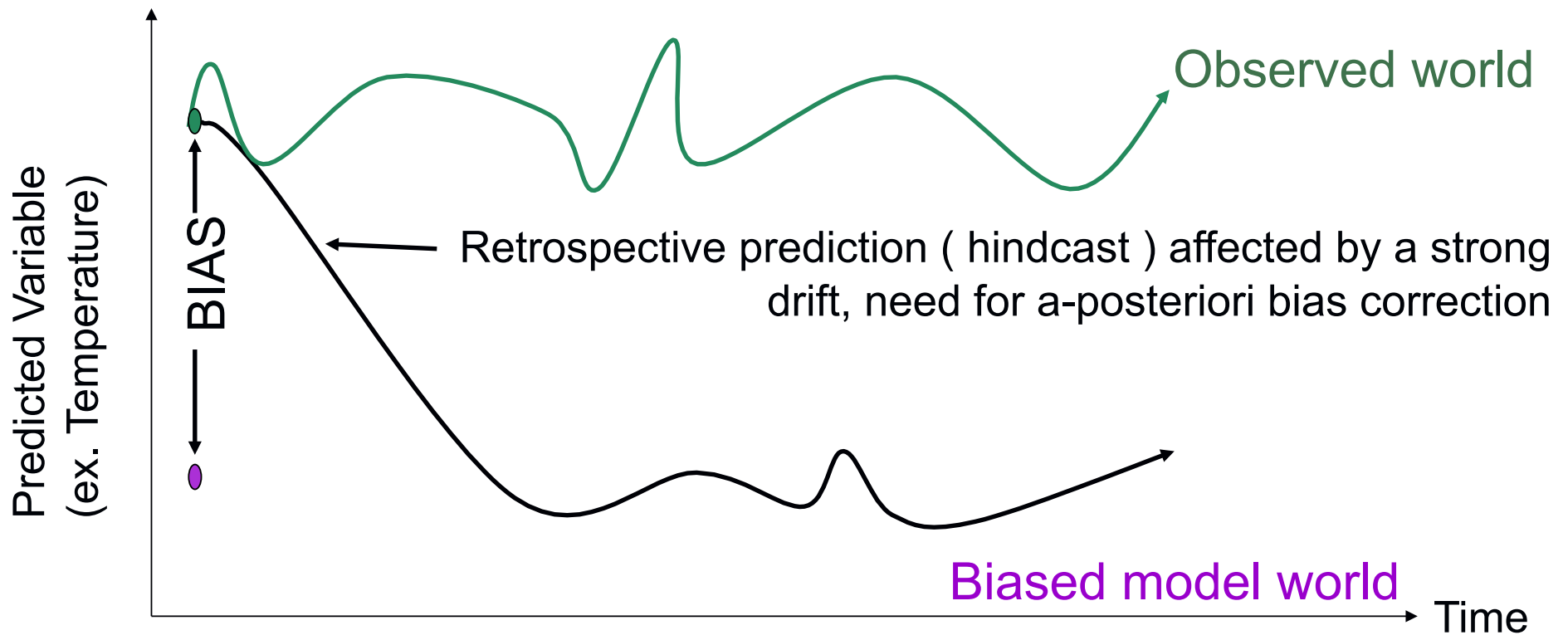
Timeframe: 2012-2016



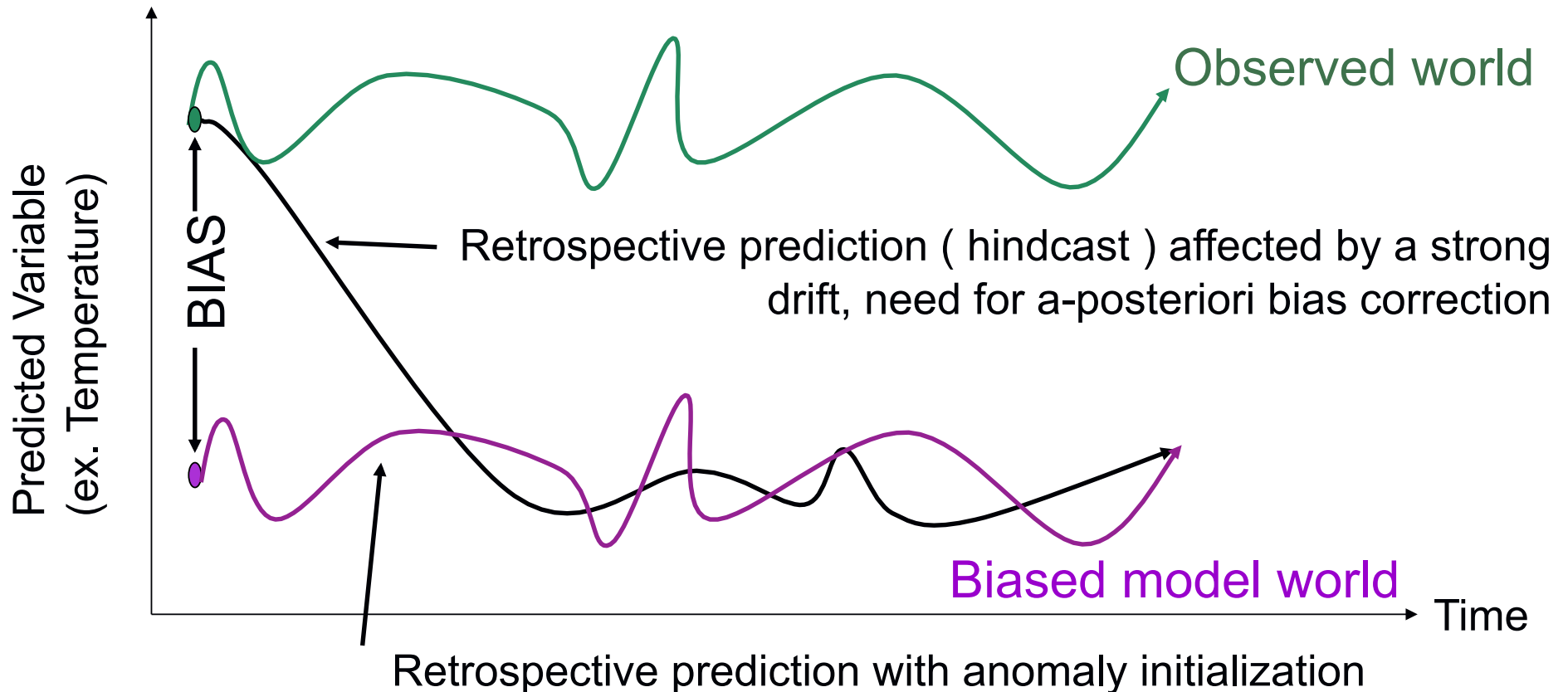
Some open fronts

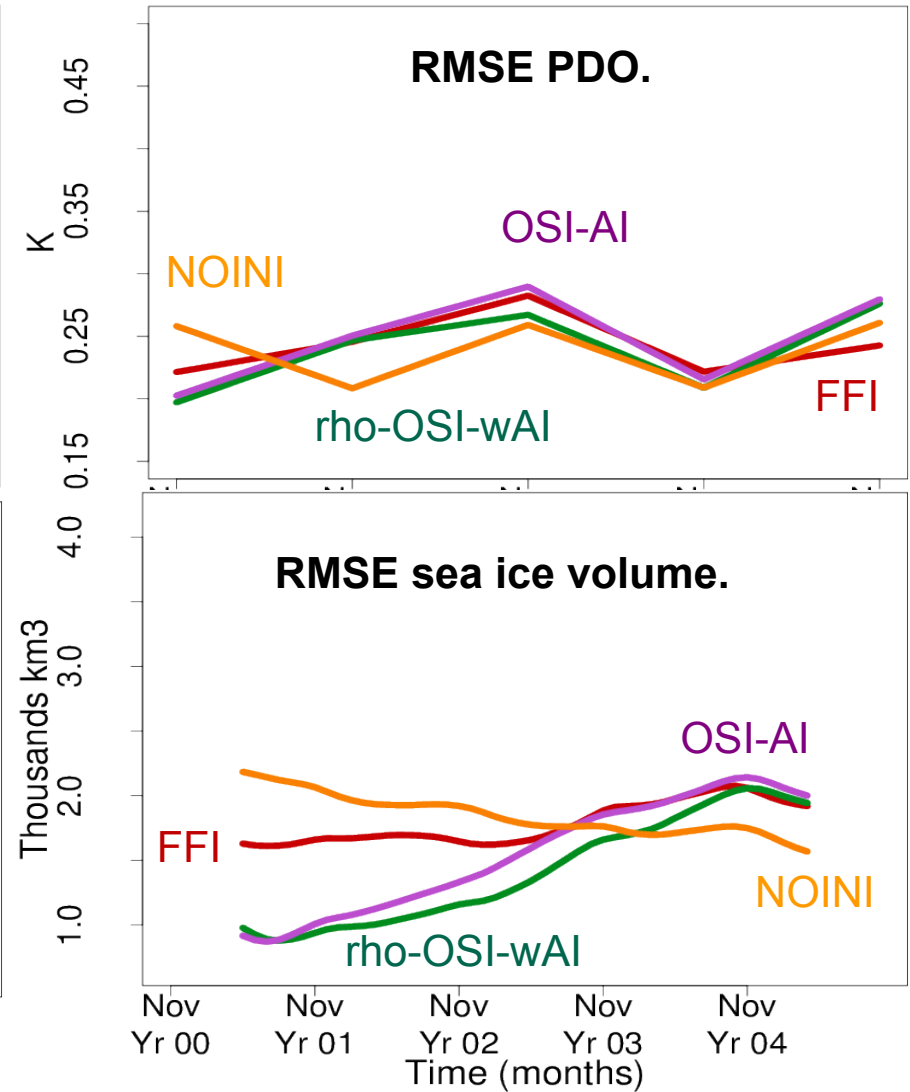
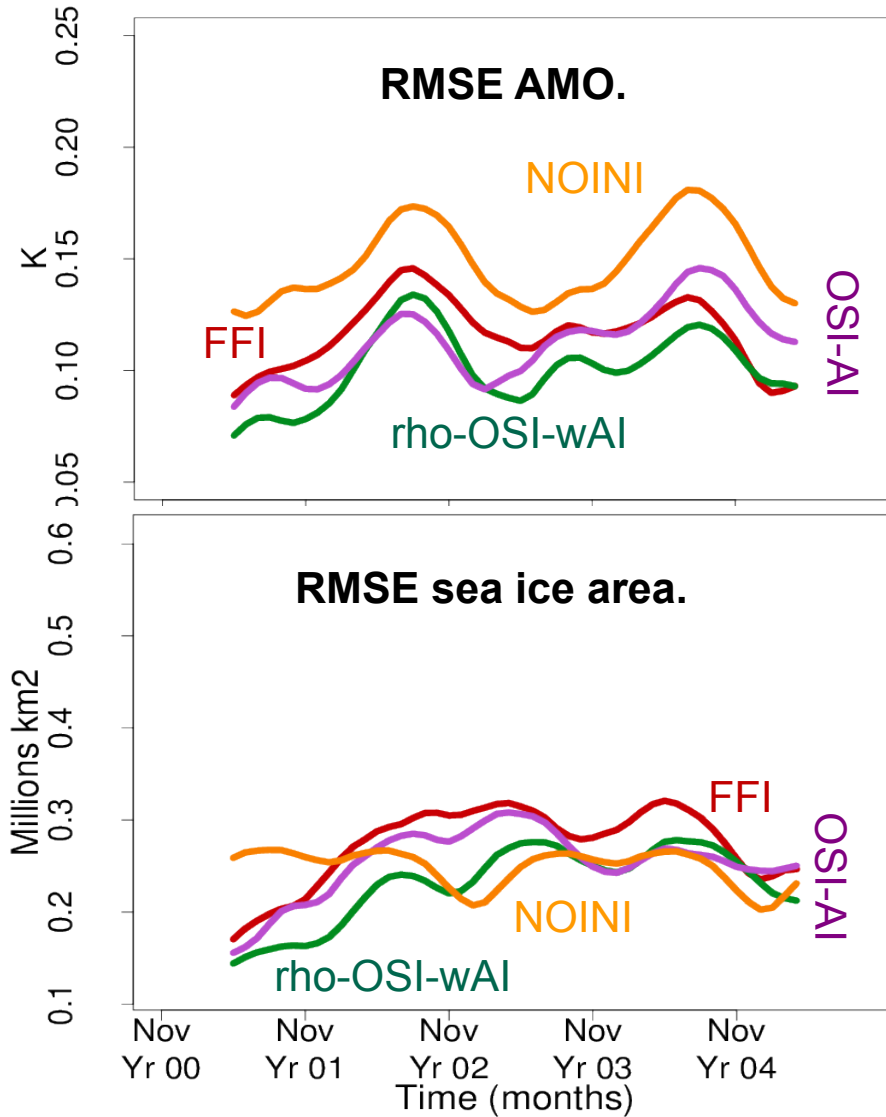
- **Work on initialisation:** generate initial conditions (e.g. for sea ice, ocean). Compare different initialisation techniques (e.g. full field versus anomaly initialisation), better ensemble generation.
- **Improving model processes:** Inclusion and/or testing of model components (biogeochemistry, vegetation, land, aerosols, sea ice) or new parameterizations, model parameter calibration, increase in resolution. More efficient codes and adequate computing resources.
- **Calibration and combination:** empirical prediction (better use of current benchmarks), local knowledge.
- **Forecast quality assessment:** scores closer to the user, reliability as a main target, process-based verification, attribution of climate events with successful predictions, diagnostics of model weaknesses with failing predictions
- **More sensitivity to the users' needs:** going beyond downscaling, better documentation (e.g. use the IPCC language), demonstration of value and outreach.

The climate prediction drift issue



The climate prediction drift issue





Anomaly versus full-field initialization

Volpi et al (2015) *Climate Dynamics*



Climate Forecasting Unit

EUPORIAS: EUropean Provision Of Regional Impact Assessment on a Seasonal-to-decadal timescale

IC3 role: Partner, WP leader and energy case study representative

Call: FP7 Environment and Climate

Description: Develop prototypes (6) of climate impact prediction services on seasonal to decadal timescale. Increase the ability of businesses and government in making decision in climate sensitive sector.

Total budget: ~12,000,0€

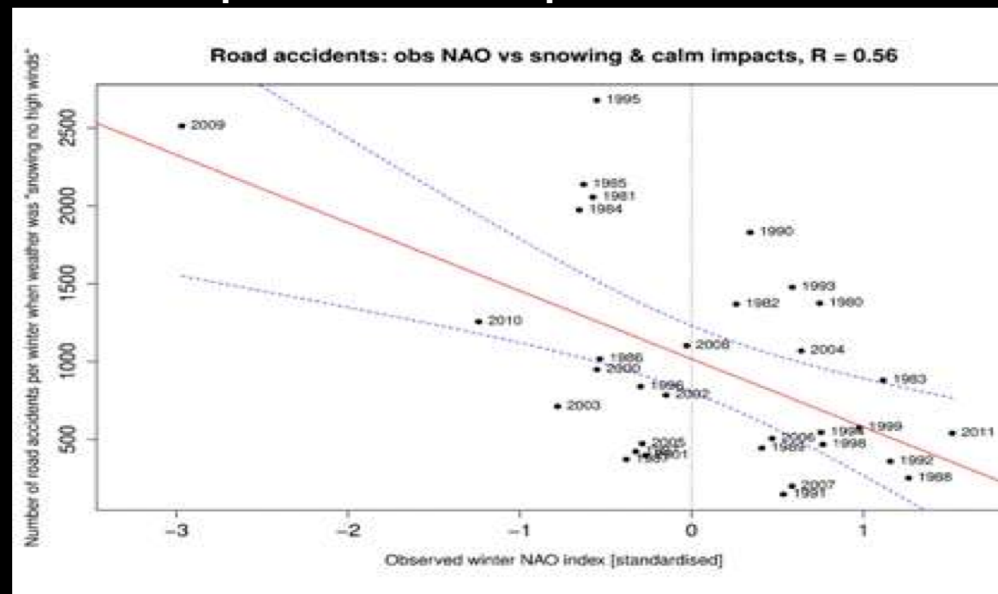
Timeframe: 2012-2016

Winter conditions for UK Transport

EUPORIAS

Objective: to assess the potential skill for transport impacts forecasts using GloSea5 and UK transport data

- *Stakeholder:* UK Dept for Transport



More info:
and

Erika Palin (Erika.Palin@metoffice.gov.uk)
Adam Scaife (Adam.Scaife@metoffice.gov.uk)

Land management tool

EUPORIAS

Objective: Enable land managers to make more weather-resilient decisions.

- *Stakeholder:* Clinton Devon Estates
www.clintondevon.com
- The aim is to develop a specific working tool for one application which can later be extended to other uses, while also serving as a blueprint for a weather-decision making tool for land managers and farmers in general. The specific decision is cover crop planting.
- More info: Pete Falloon
(pete.falloon@metoffice.gov.uk)



Image retrieved online from:
http://goingtoseed.files.wordpress.com/2010/05/img_2781.jpg
On 27/05/2014

LEAP- Ethiopia's National Food Security Early Warning System

EUPORIAS

- *Objectives:* The prototype will enable the integration of seasonal weather forecasts into Ethiopia's existing national food security early warning system, known as LEAP (Livelihoods, Early Assessment and Protection), to enable earlier and more accurate estimates of the people in need of food assistance in the coming months.
- *Stakeholders:* World Food Programme (WFP)
<http://www.wfp.org/disaster-risk-reduction/leap>
- More info: Anna Law (anna.law@wfp.org) and Sandro Calmanti (sandro.calmanti@enea.it)

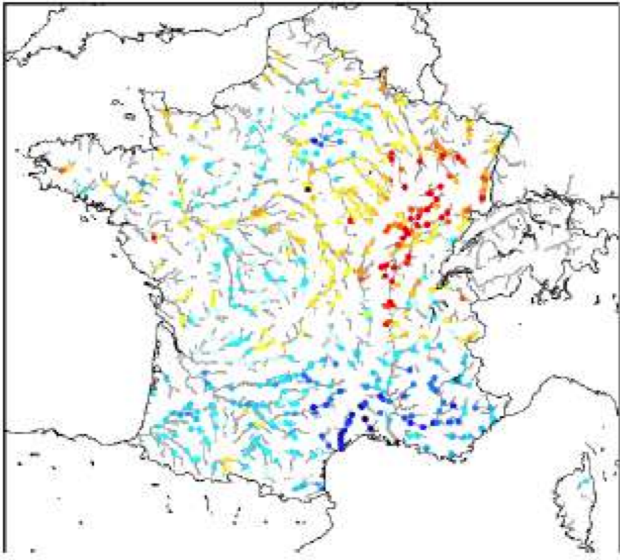
Seasonal discharge multi-model forecast system

EUPORIAS

- *Objective:* The objective of this prototype is to provide the hydropower industry with high quality discharge forecasts at the seasonal scale of to assist them in decision making and planning of operations.
- *Stakeholder:* ELFORSK (www.elforsk.se)
- This prototype is a multi-model seasonal forecast system for making ensemble stream flow predictions. The system will be implemented for the Ångerman River in northern Sweden. The basin is Sweden's third largest by area, 31864 km², and the second largest by hydropower production with an average annual production of 6900 GWh.

Water resource management in France

EUPORIAS



Objective: to provide relevant and tailored information leading to an effective decision for the water stock management for both the refilling and low-flow periods.

- *Stakeholder:* EPTB Seine Grands Lacs www.seinegrandslacs.fr DREAI Midi-Pyrénées www.midi-pyrenees.developpement-durable.gouv.fr
- The main stakes to be managed in this prototype are related to fresh water supply, power station cooling, summer irrigation and reservoir refilling in France.
- More info: jean-pierre.ceron@meteo.fr



RESILIENCE: Strengthening the European Energy Network with Climate Services

IC3 role: Project leader

Call: National – Spanish Ministry of Industry

Description: Strengthen the efficiency and security of the European energy network using the state-of-the-art from subseasonal-to-seasonal climate predictions of wind power supply and temperature-related demand, developed in co-production with end users.

Special focus on the Iberian Peninsula and the North Sea region where wind power supply has significant impact.

Timeframe: 2014-2016

If I could provide **more information** of
wind power generation
for the next **one to three months**,
could you **improve your business operations?**

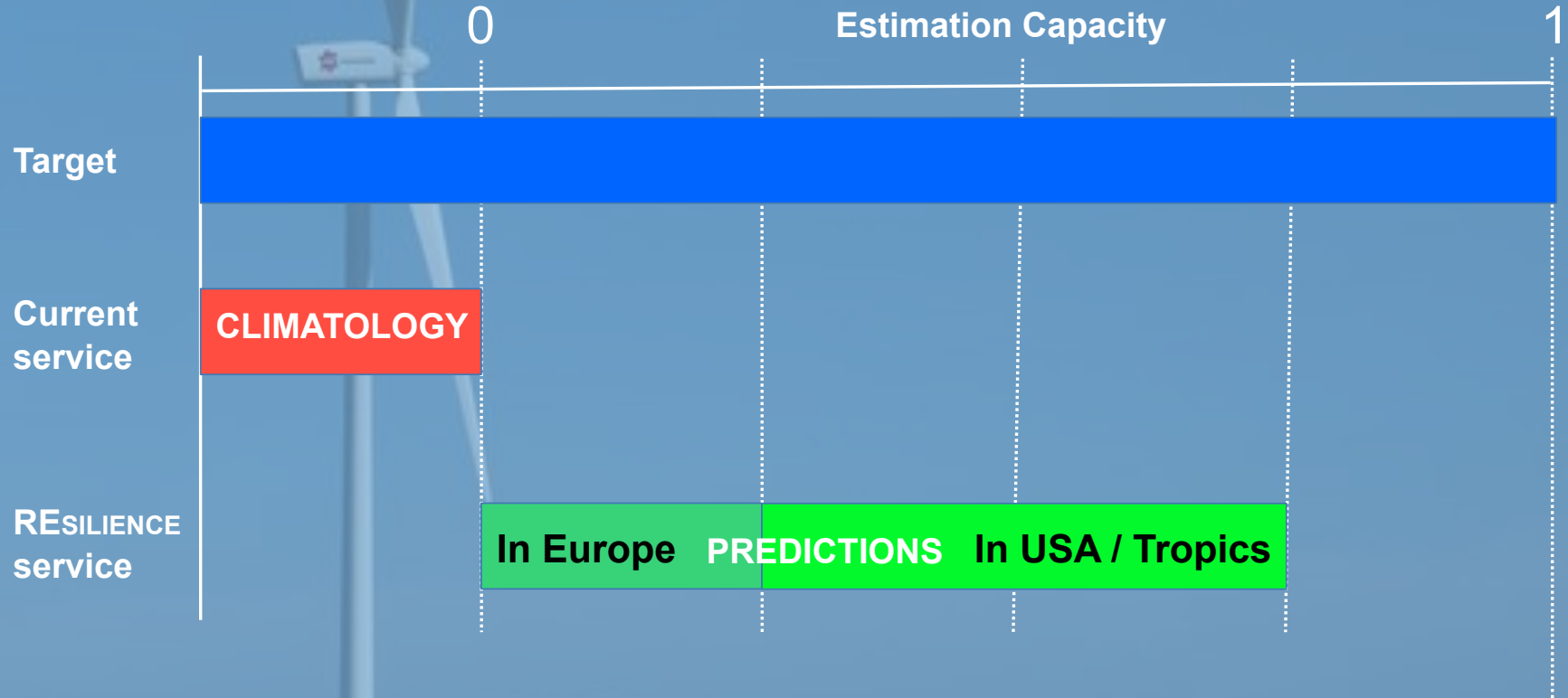
A hand is shown in the bottom right corner, holding a single white feather. The feather is long and wispy, extending towards the top left of the frame. The background is a clear blue sky with some light, wispy clouds. The overall image conveys a sense of lightness and the power of wind.

If I could provide **more information** of
wind power generation
for the next **one to three months**,
could you **improve your business operations?**

A hand is shown in the bottom right corner, holding a single white feather. The feather is positioned vertically, with its base near the hand and its long, delicate barbs extending upwards and slightly to the left. The background is a clear, bright blue sky filled with soft, white, wispy clouds. The overall scene is bright and airy, suggesting a sense of lightness and possibility.



INDEX: Wind Power Information



If I could provide **more information** of
wind power generation
for the next **one to three months**,
could **you** improve your business operations?



EDF, energy producers; RTE, grid operators:

Wind resource management for improved grid operations

Marexspectron, energy traders:

Wind power resource effects on financial markets

Alstom/GE, wind farm developers and operators:

Optimise planning for maintenance works

GE/EDPR, wind farm investors:

Optimise return on investments, manage risk of low return periods

If I could provide **more information** of
wind power generation
for the next **one to three months**,
could you **improve your business operations?**



Anticipate and Identify Vulnerabilities and Risks

Facilitate strategic climate adaptation action

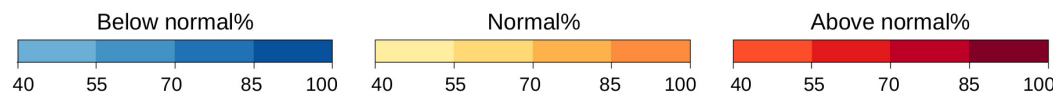
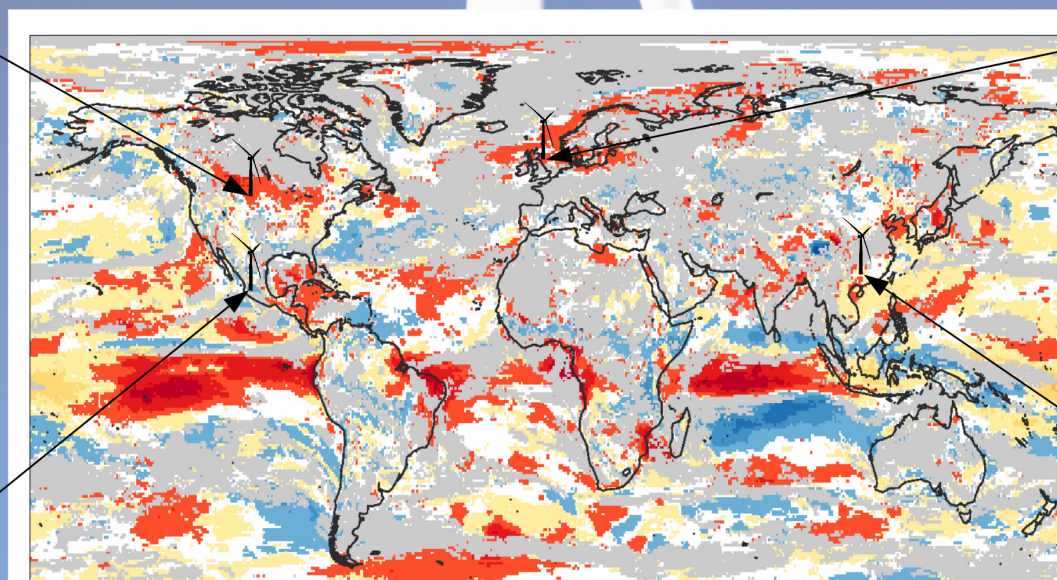
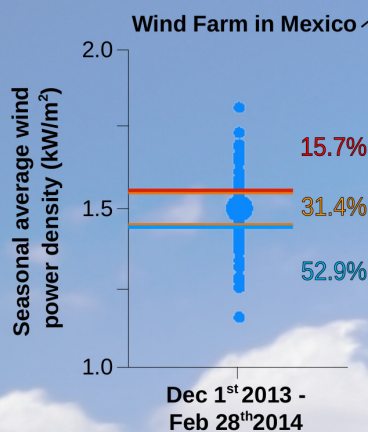
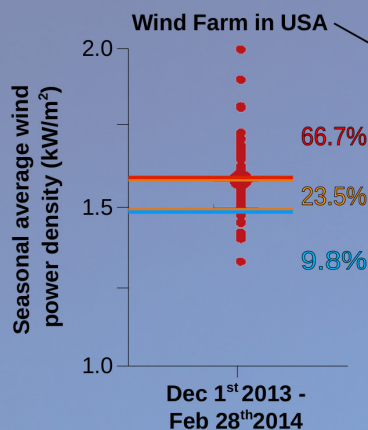
Ability to make decisions earlier

Avoid subjective decision making

Take calculated precautionary action

Potential cost saving

Illustrative examples of seasonal wind power predictions

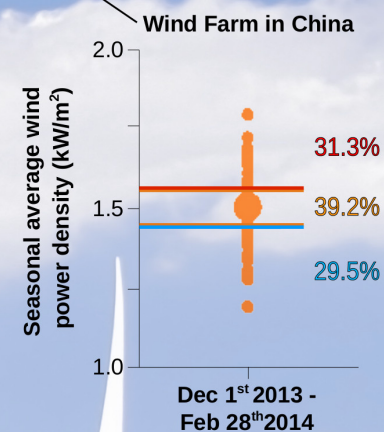
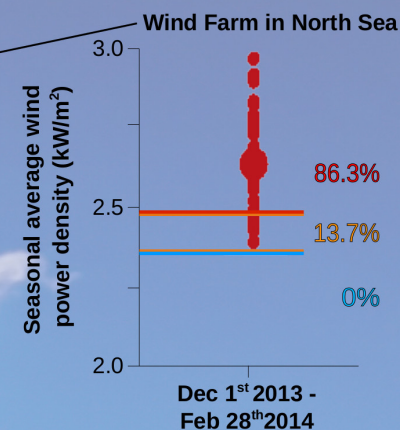


Wind power prediction for December 1st 2013 - February 28th 2014, issued on November 1st 2013.

The most likely wind power category (**below normal**, **normal** or **above normal**), and its percentage probability to occur is shown. "Normal" represents the average of the past 30 years.

White areas demonstrate where the probability is <40% and approximately equal for all three categories.

Grey areas show where the climate prediction model does not improve upon the standard and current approach, which projects past climate data into the future.



EUPORIAS

RESILIENCE PROTOTYPE

1.2.6

764 elements rendered

Map shows only cells with RPSS skill values above zero
opacity = RPSS score
width = avg. predicted wind speed
tilt = avg predicted wind speed compared to historic mean (up = higher, down = lower)

HISTORIC OBSERVATIONS

PREDICTIONS

SKILL

<http://clients.stefaner.eu/euporias/1.2.6/>



Decision Support Tools

Environment Agency
FIM Decision Support Tool
Halcrow

Date 24/06/2011 **Time** 13:29:05
Team Anglian FF Team **User** Joe Bloggs

Site/Community Colne Barrier

Potential FIM action D2. Operate active structures as necessary (e.g. close barrier)

Action cost £4,000
Forecast benefit £101,144
Initial recommendation Take action

Soft factors influencing the decision include:

1. Do you want to use this event as a practice or training event or as a PR exercise? [could change]
2. Is the community at risk in danger of being desensitised (i.e. too many false alarms?) [could change]
3. Is this a highly sensitive location with recent flooding? [could change a 'No' into 'Yes']
4. Have there been any missed flooding events (not forecast) at this site? [could change a 'No' into 'Yes']

Final action decision Close Barrier

Justification
 B-C ratio is very high, softer factors considered

¹ Forecast benefit comprises monetised impact of reduction in risk to life/serious injury, social impact, residential business/agriculture damage and infrastructure disruption.

Environment Agency
FIM Decision Support Tool
Halcrow

Probabilistic Forecast Data

	Level (mAOD)	Flood impact avoided by action (£)	Exceeding threshold?
Ensemble 1	3.297	£0	0
Ensemble 2	3.296	£0	0
Ensemble 3	3.264	£0	0
Ensemble 4	3.277	£0	0
Ensemble 5	3.317	£208,981	1
Ensemble 6	3.318	£224,816	1
Ensemble 7	3.285	£0	0
Ensemble 8	3.331	£386,912	1
Ensemble 9	3.330	£376,332	1
Ensemble 10	3.288	£0	0
Ensemble 11	3.291	£0	0
Ensemble 12	3.336	£442,730	1
Ensemble 13	3.297	£0	0
Ensemble 14	3.296	£0	0
Ensemble 15	3.264	£0	0
Ensemble 16	3.292	£0	0
Ensemble 17	3.302	£25,561	1
Ensemble 18	3.342	£513,820	1
Ensemble 19	3.292	£0	0
Ensemble 20	3.288	£0	0
Ensemble 21	3.310	£124,276	1
Ensemble 22	3.310	£124,032	1
Ensemble 23	3.272	£0	0
Ensemble 24	3.284	£0	0
Expected Action Benefit (£)		£101,144	
Action Level Threshold (mAOD)			3.3
Exceeding probability			38%

Halcrow Water, 2013.
 UK Environment Agency.

Application of Probabilistic Forecasting
 in Flood Incident Management.