# Impact of initial conditions with respect to external forcing in the decadal predictions: a sensitivity experiment

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Wilko Hazeleger Bert Wouters Sybren Drijfhout Dough Smith Nick Dunstone
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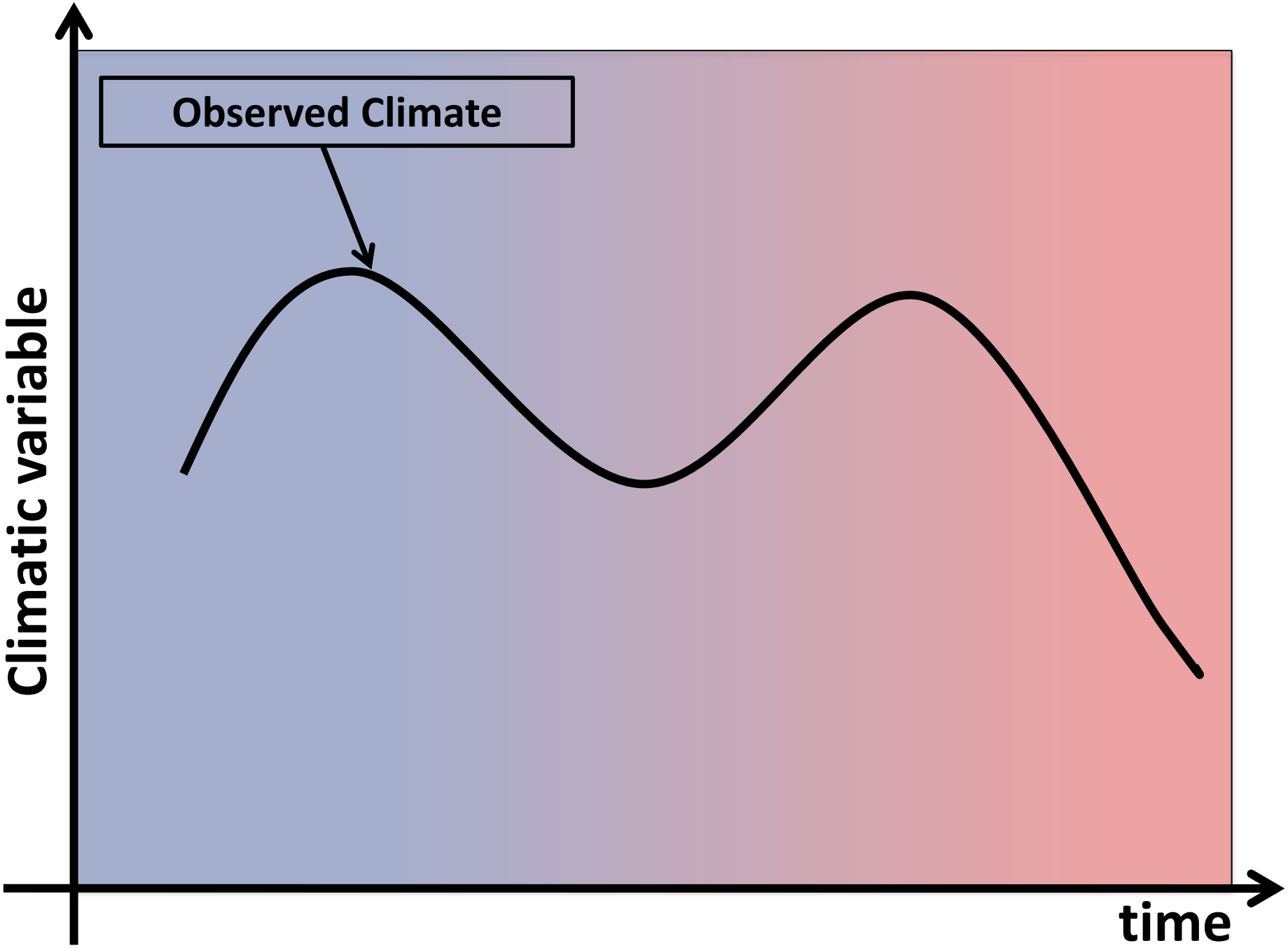
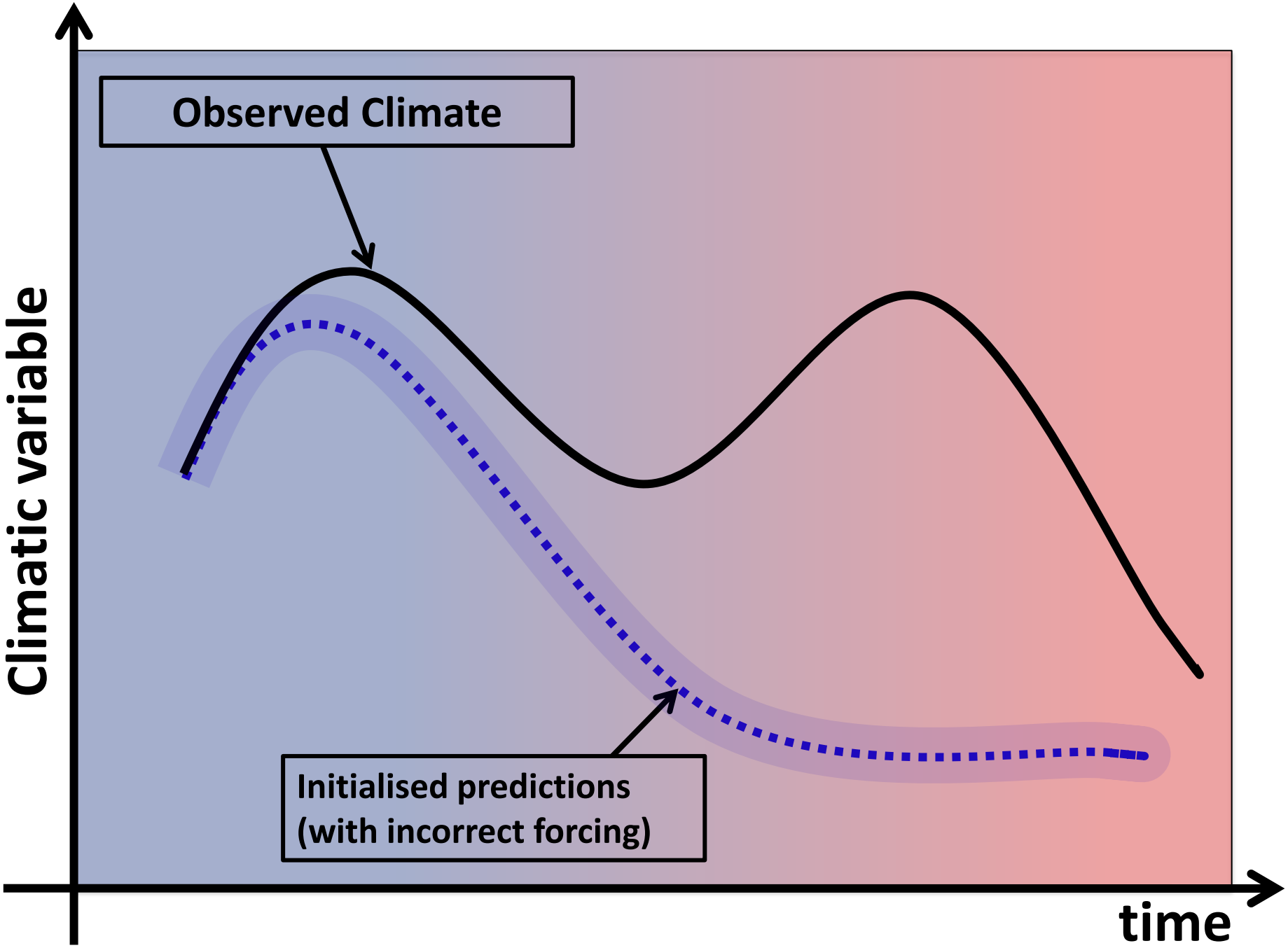
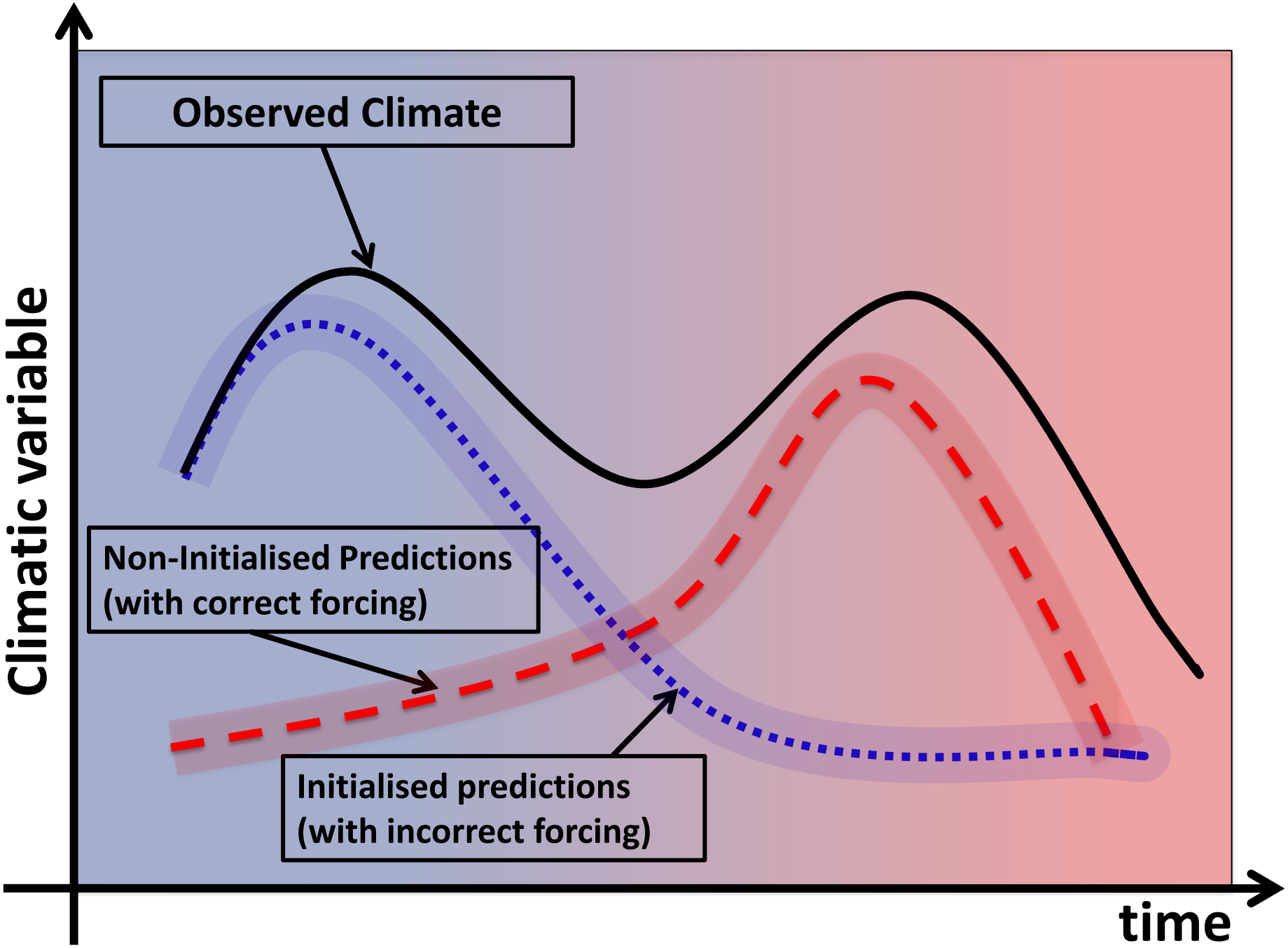
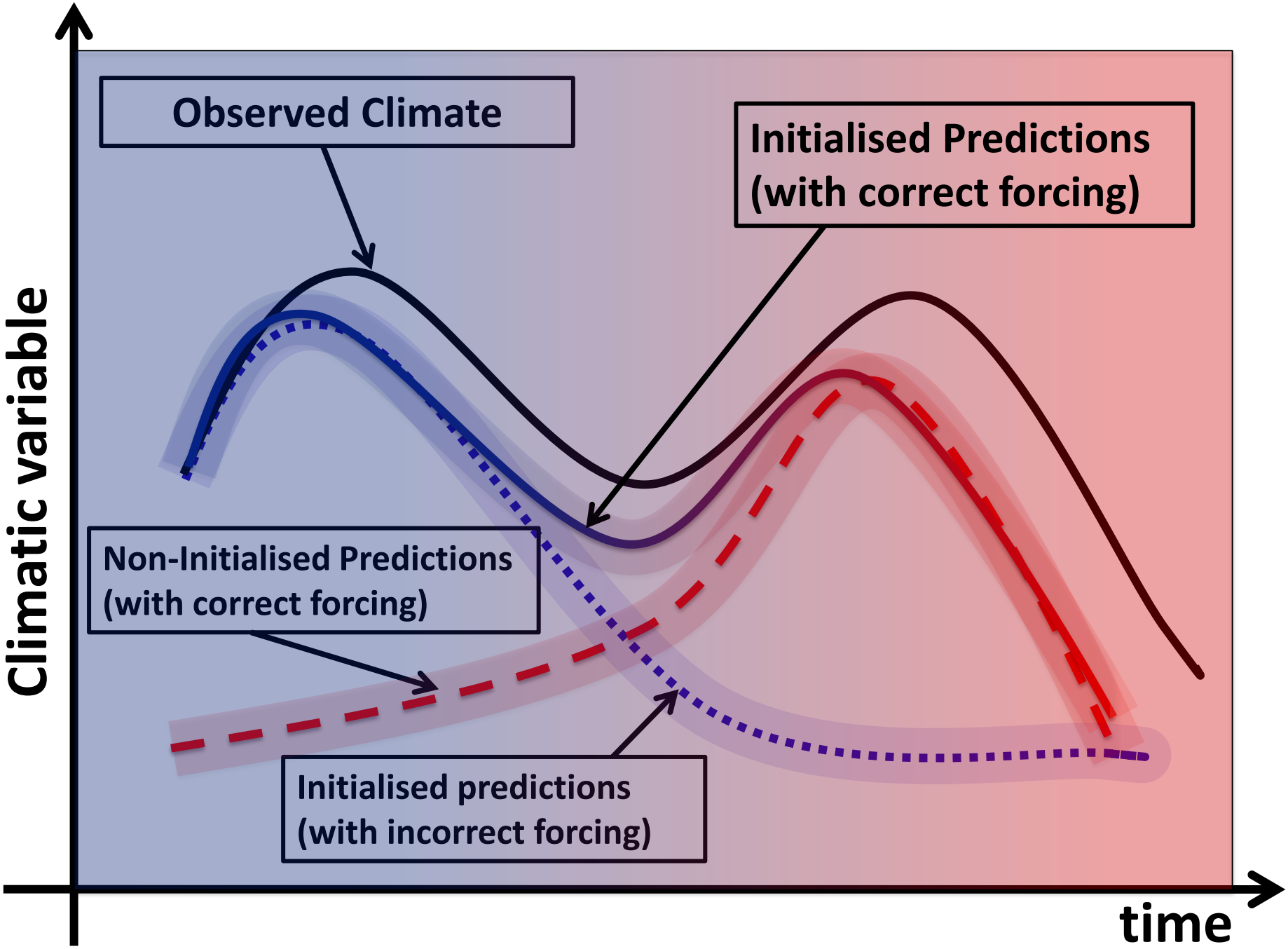
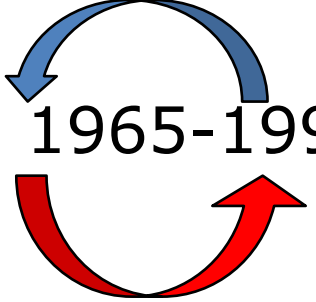

Observed Climate
Climatic variable
time


Observed Climate
Initialised predictions
(with incorrect forcing)
Climatic variable
time


Observed Climate
Non-Initialised Predictions
(with correct forcing)
Initialised predictions
(with incorrect forcing)
Climatic variable
time


Observed Climate
Initialised Predictions
(with correct forcing)
Non-Initialised Predictions
(with correct forcing)
Initialised predictions
(with incorrect forcing)
Climatic variable
time

# SWAP Experiment - 1965-1995



10-year integrations from:

A 1965 initial conditions, observed forcing (GHG & aerosols) from 1965 (control1)

B 1995 initial conditions, observed forcing (GHG & aerosols) from 1995 (control2)

C 1965 initial conditions, observed forcing from 1995

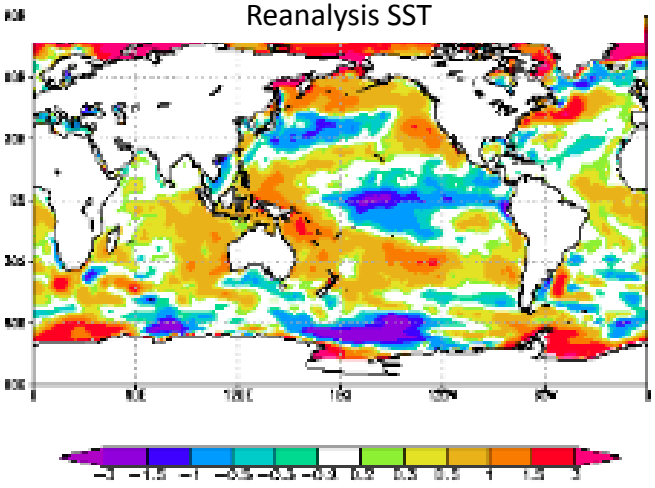
D 1995 initial conditions, observed forcing from 1965

By comparing A with D, and B with C, we have two estimates of decadal predictability (arising from having different initial conditions and the same GHG forcing).

By comparing A with C, and B with D, we have two estimates of the impact of GHG forcings (since initial conditions are the same).

# Models

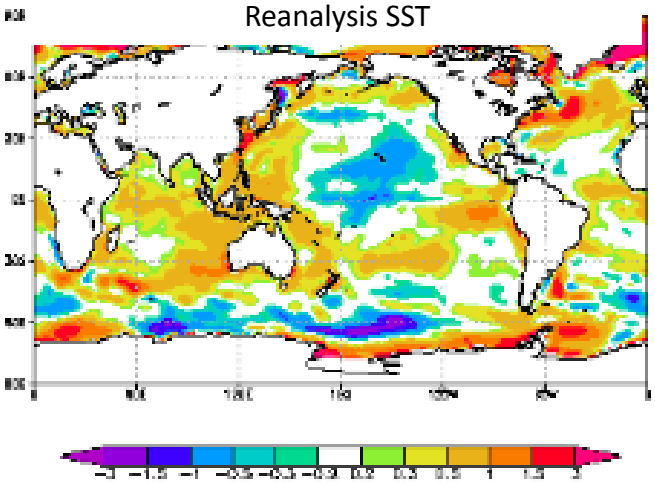
1995/96 minus 1965/1966
Reanalysis SST



ECMWF coup
(5 ensemble r

KNI
(3 e

1995/00 minus 1965/1970
Reanalysis SST



MP
(5 e

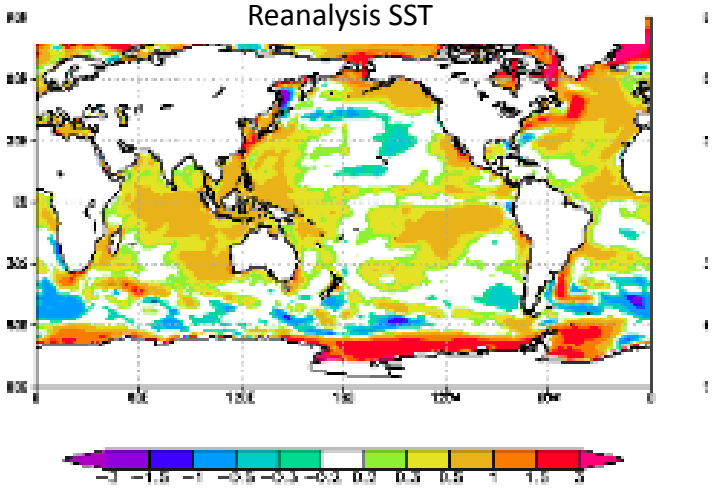
Me
(3 ensemble members)

**Boundary conditions (forcing)**

| Initial conditions | 1965 | 1995 |
|---|---|---|
| 1965 | A | C |
| 1995 | D | B |

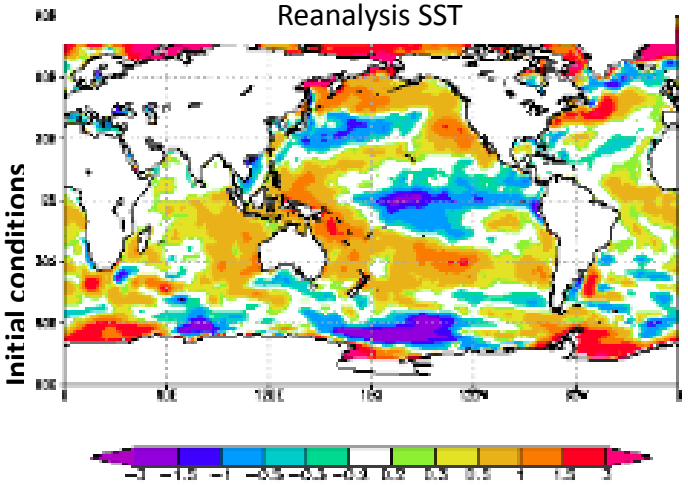
B mi
B mi
D mi
C mi
B mi

Decade 1995-05 minus decade 1965/1975
Reanalysis SST



# Impact of boundary (**forcing**) versus **initial** conditions

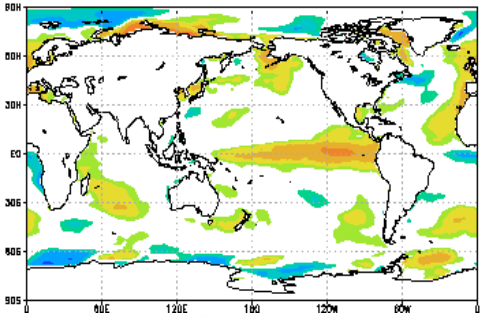
1995/96 minus 1965/1966
Reanalysis SST



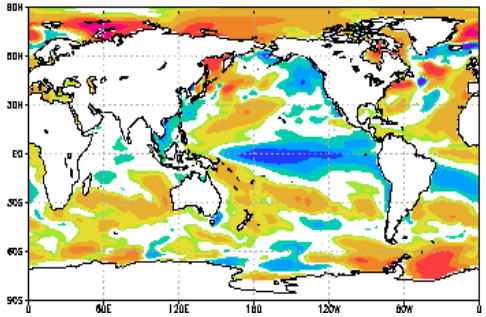

**Impact of boundary (forcing) versus initial conditions in decadal prediction experiments** with the ECMWF system by swapping ICs and BCs for two different decades

First year

**B minus D**

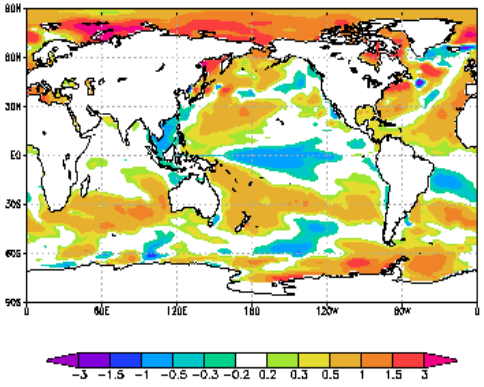


**B minus C**

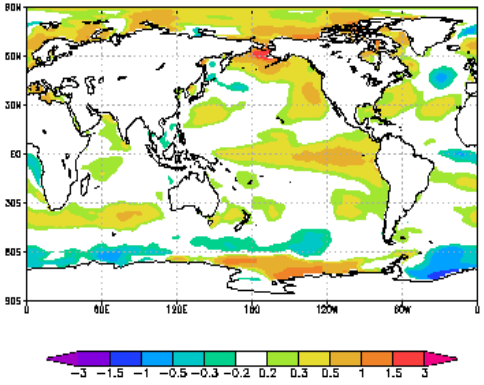


**B minus A**

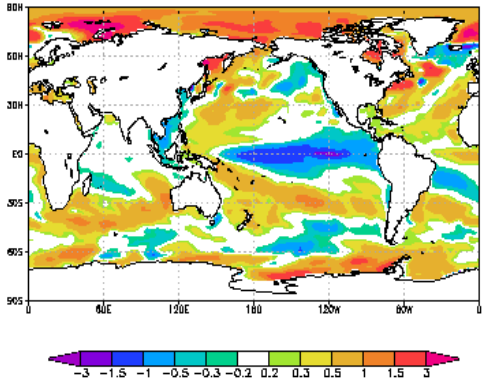
1995to1996 minus 1965to1966



**C minus A**

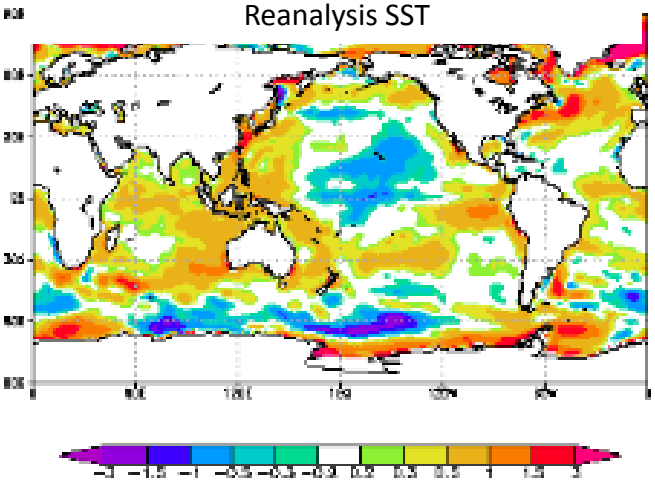


**D minus A**



# Impact of boundary (forcing)

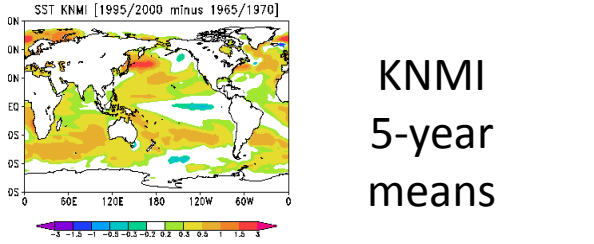
1995/00 minus 1965/1970
Reanalysis SST

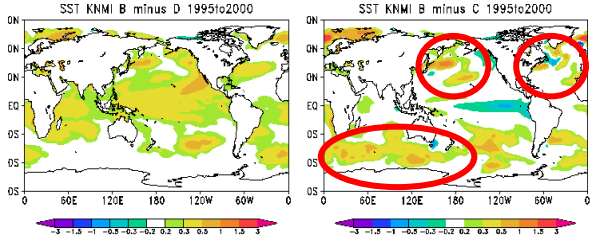


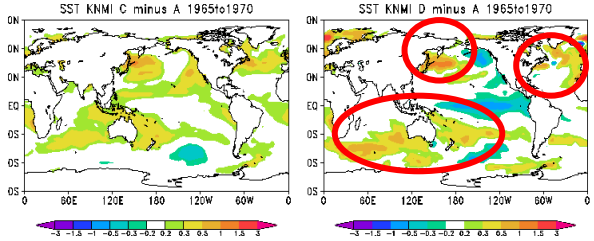
g)

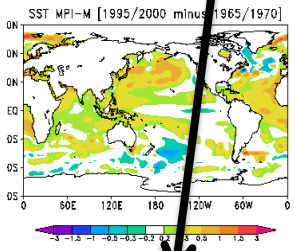
| 1995 |
|---|
| C |
| B |

KNMI
5-year
means

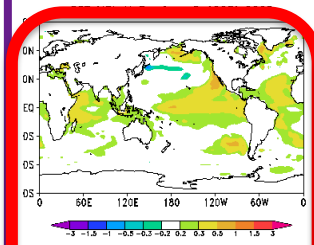


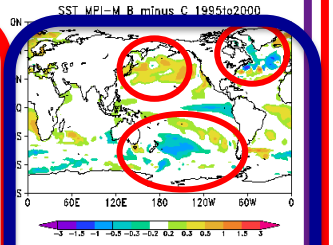



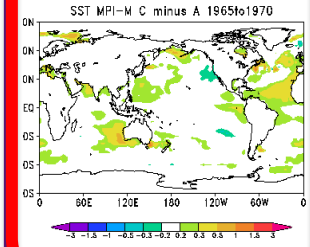



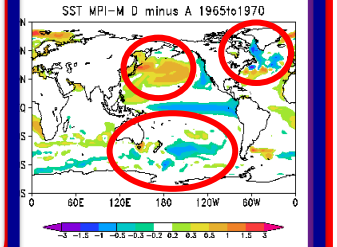



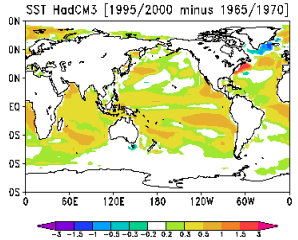

5y-year
means



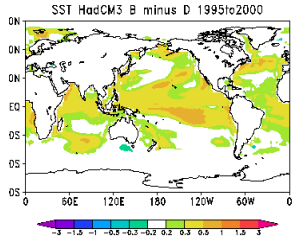


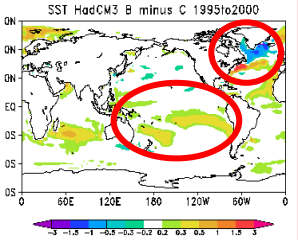



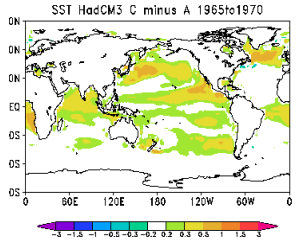



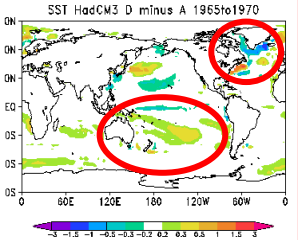




HadCM3
5yrs

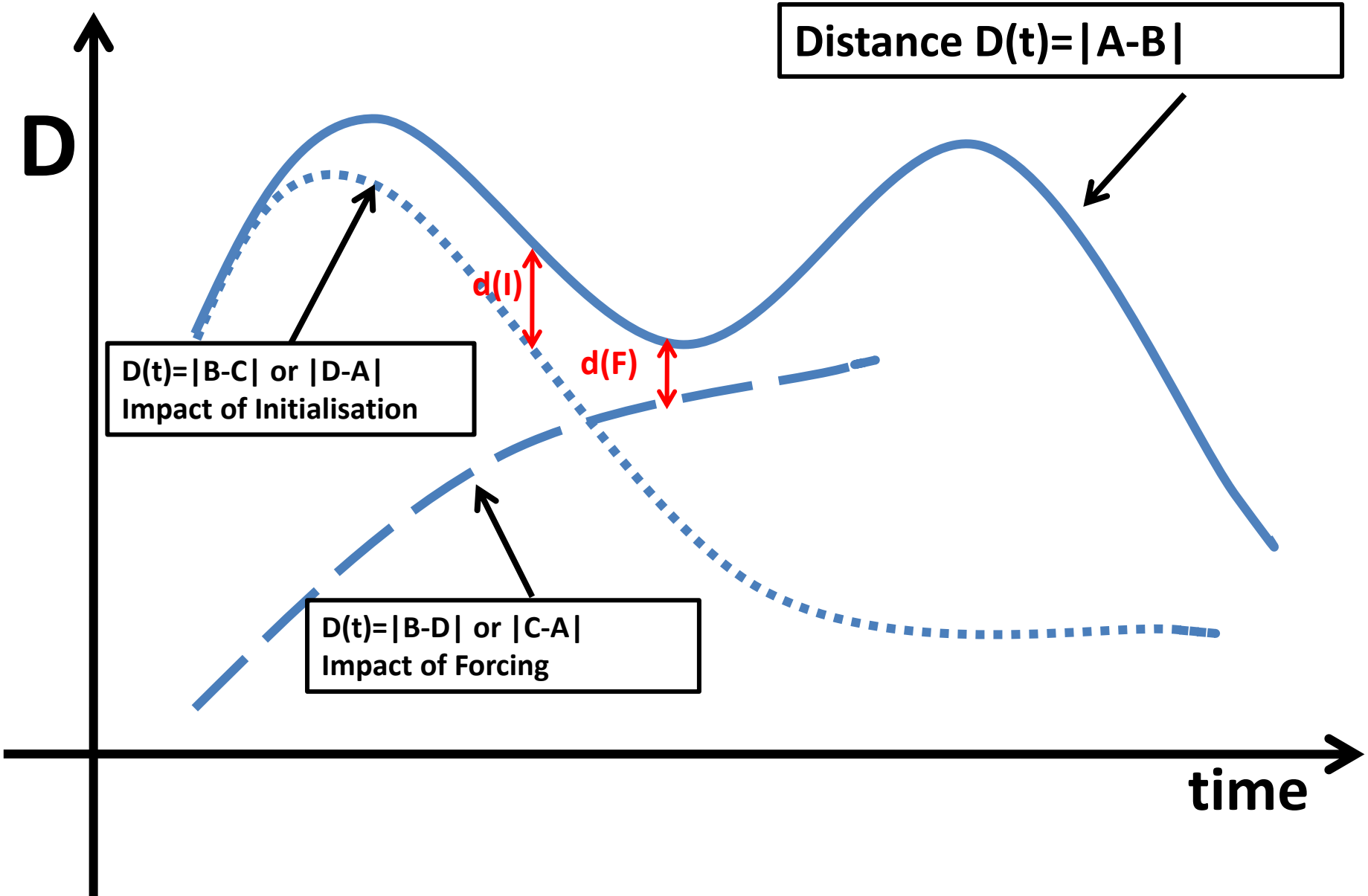


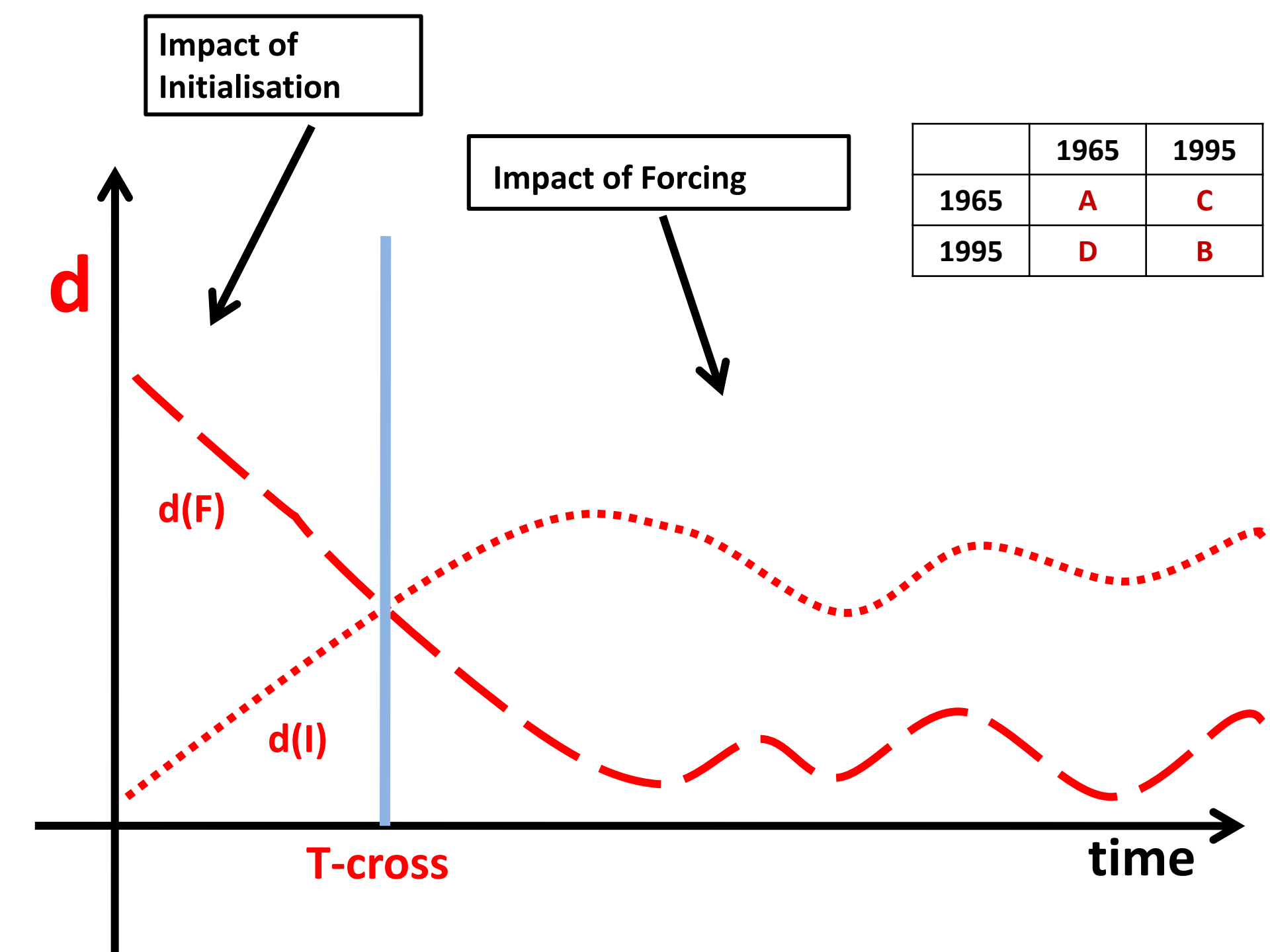



| | 1965 | 1995 |
|---|---|---|
| 1965 | A | C |
| 1995 | D | B |

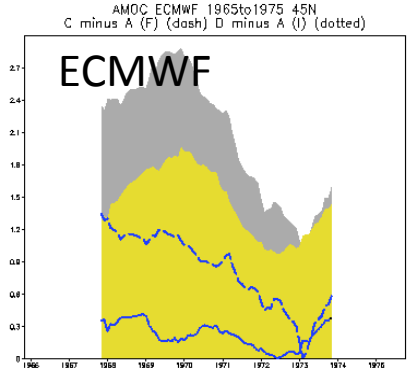


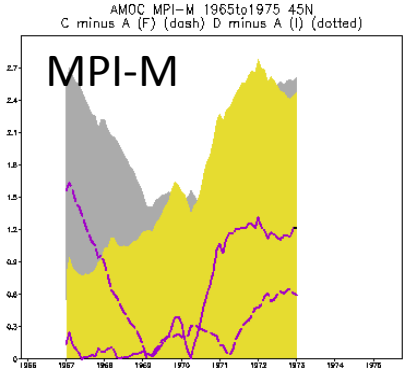


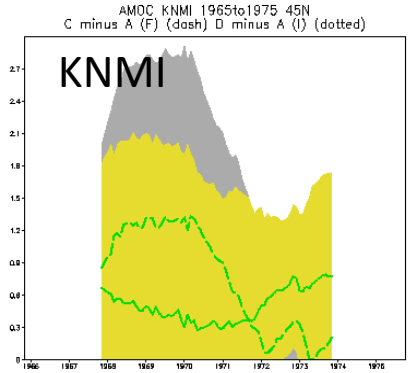

| | 1965 | 1995 |
|---|---|---|
| 1965 | A | C |
| 1995 | D | B |

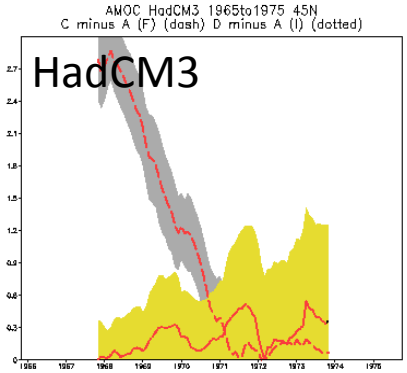
# AMOC 1000m 45N Forcing vs. Initial Conditions all models

## D minus A & C minus A



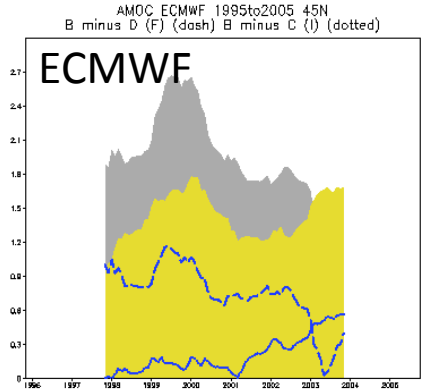



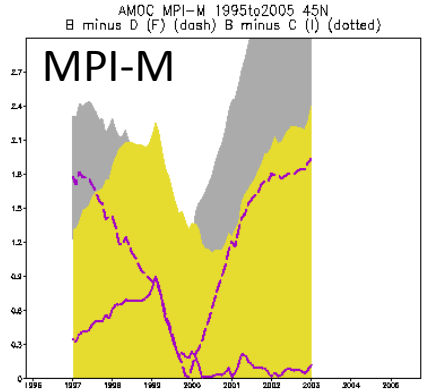

**1965**

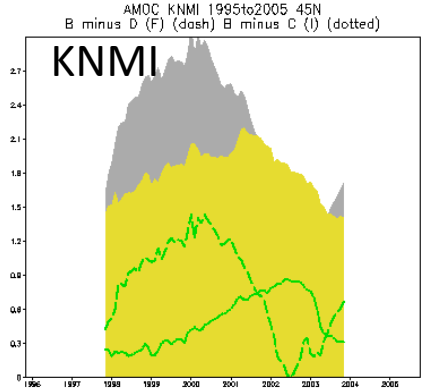
**Boundary conditions (forcing)**

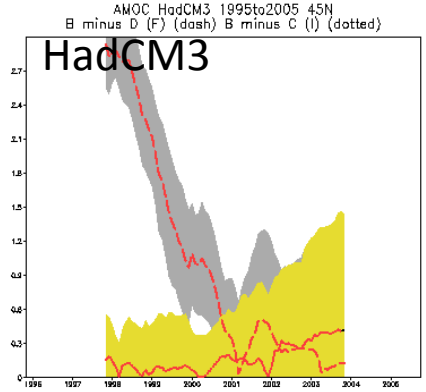
| Initial conditions | 1965 | 1995 |
|---|---|---|
| 1965 | A | C |
| 1995 | D | B |

## B minus D & B minus C



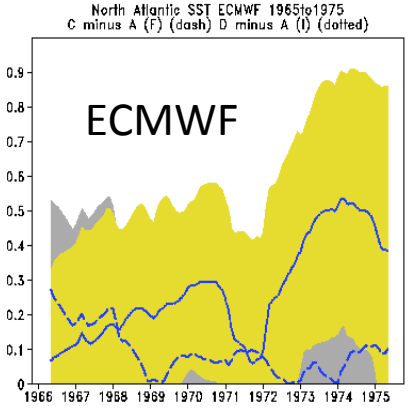



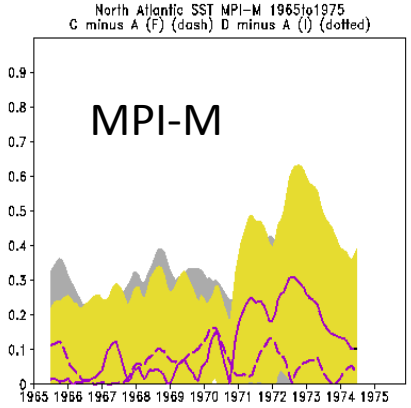



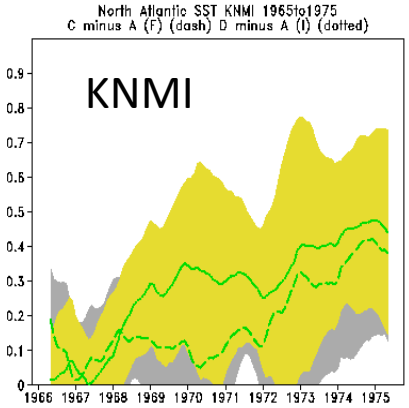

**1995**

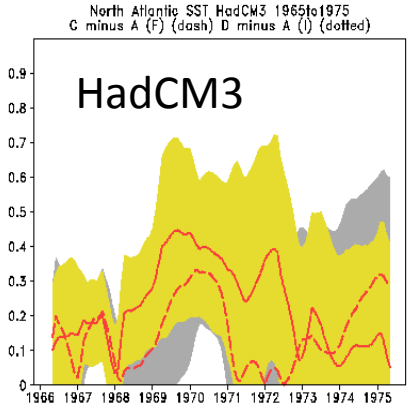
# NORTH ATLANTIC SSTs

## D minus A & C minus A



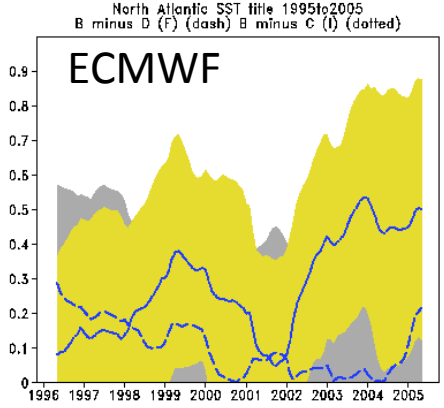



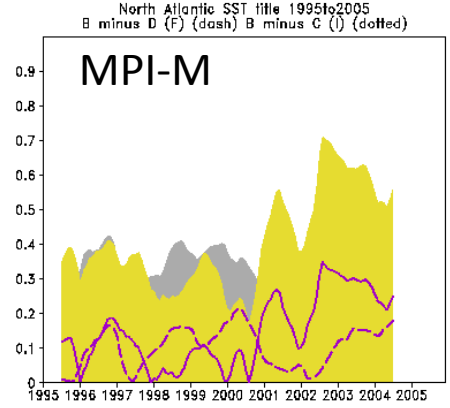

**1965**

**Boundary conditions (forcing)**

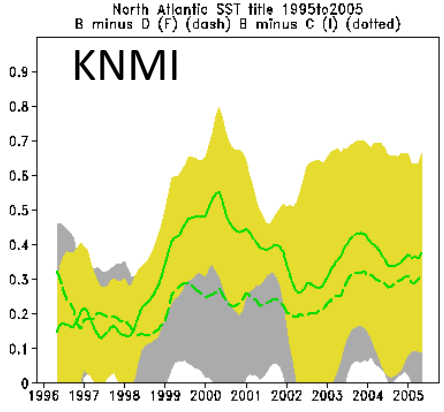
| Initial conditions | 1965 | 1995 |
|---|---|---|
| 1965 | A | C |
| 1995 | D | B |

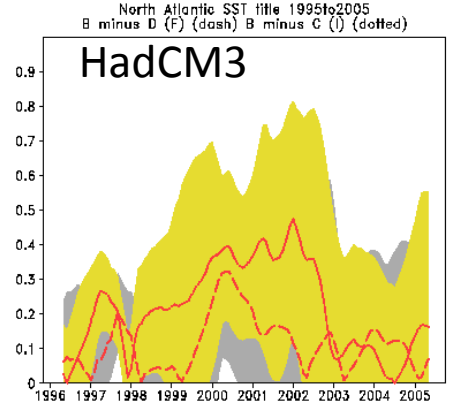
## B minus D & B minus C



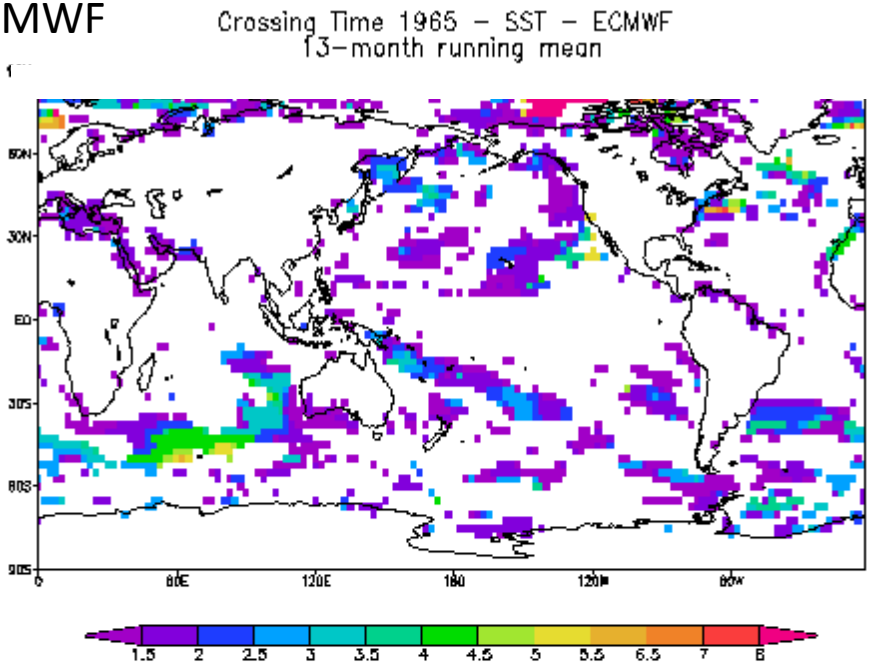

**1995**



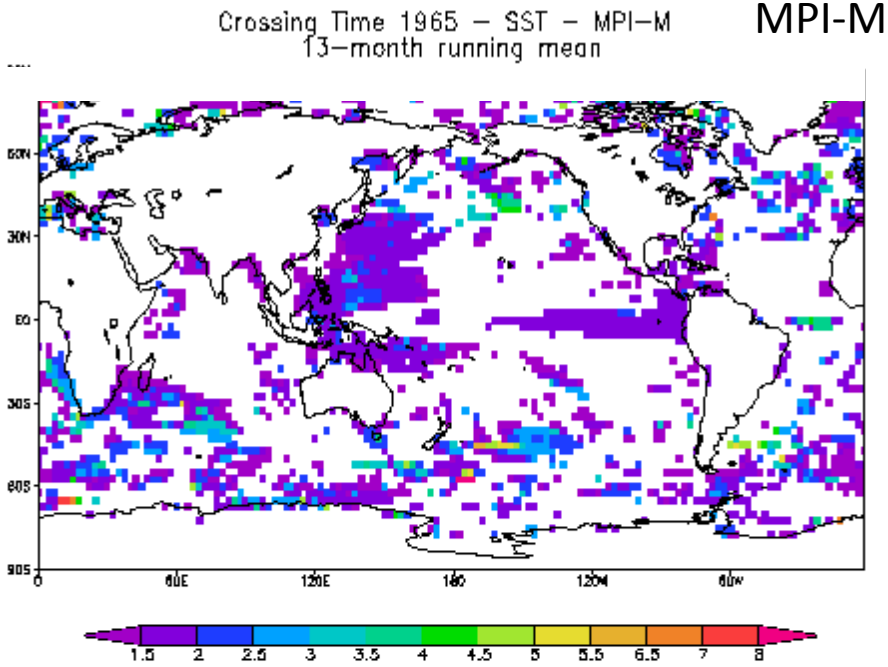



# Crossing times for SST- ensemble means

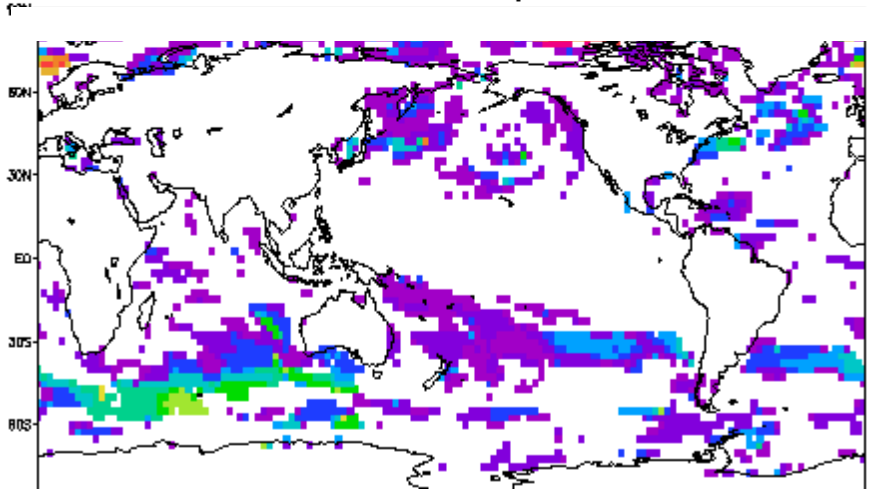
ECMWF



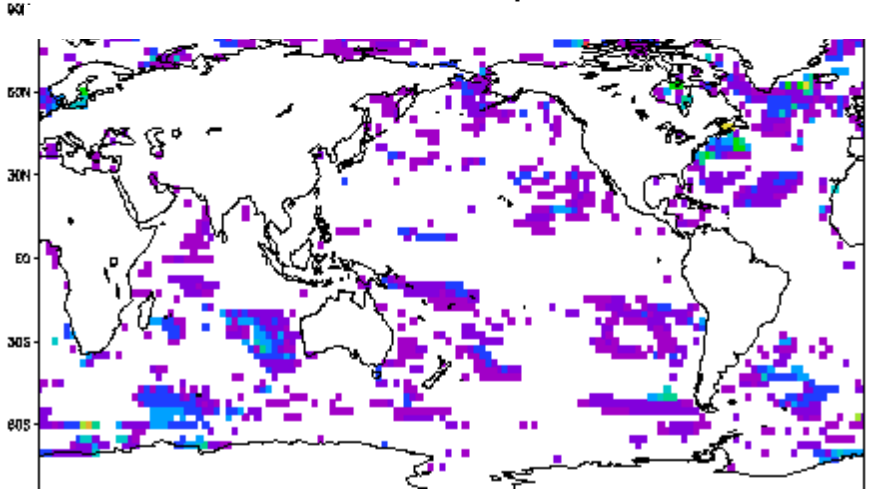

MPI-M




KNMI

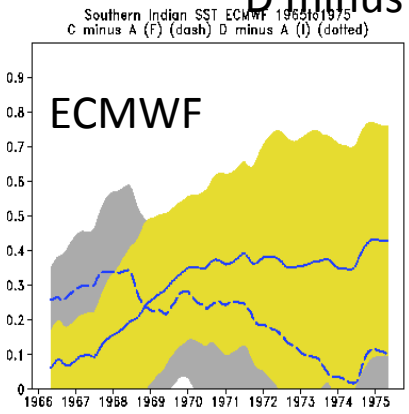


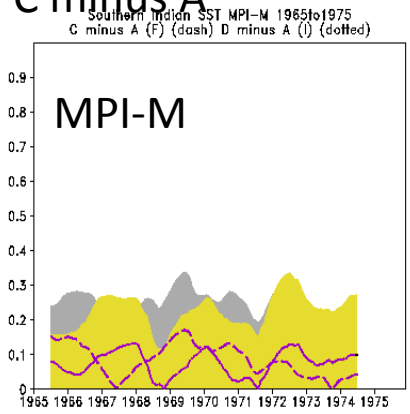

HadCM3

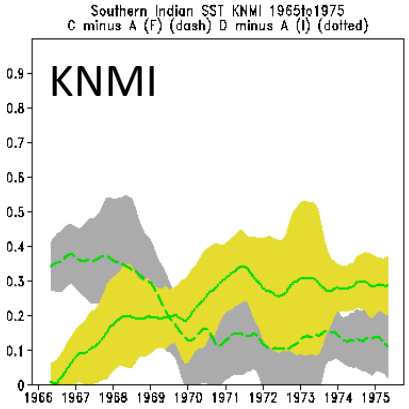


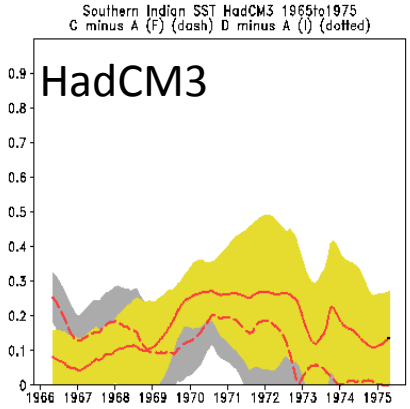
# Southern Indian Ocean SSTs

## D minus A & C minus A



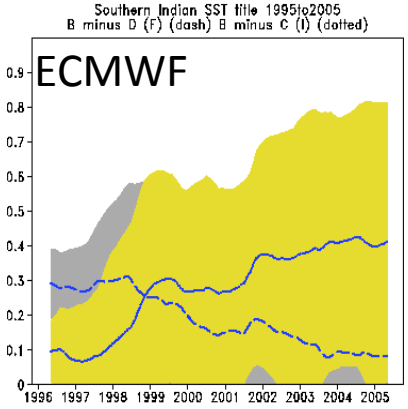



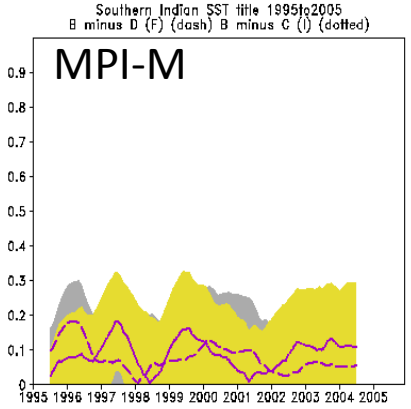

**1965**

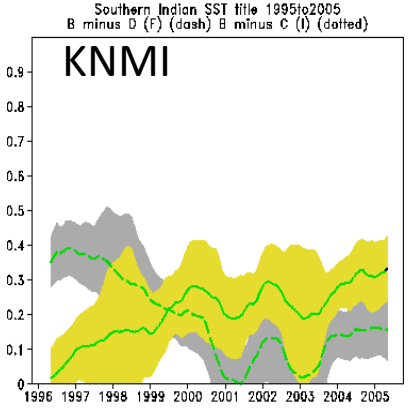
**Boundary conditions (forcing)**

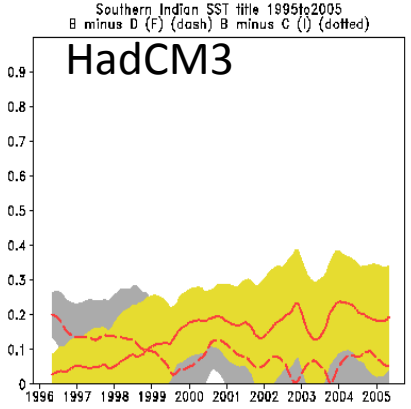
| Initial conditions | 1965 | 1995 |
|---|---|---|
| 1965 | A | C |
| 1995 | D | B |

## B minus D & B minus C



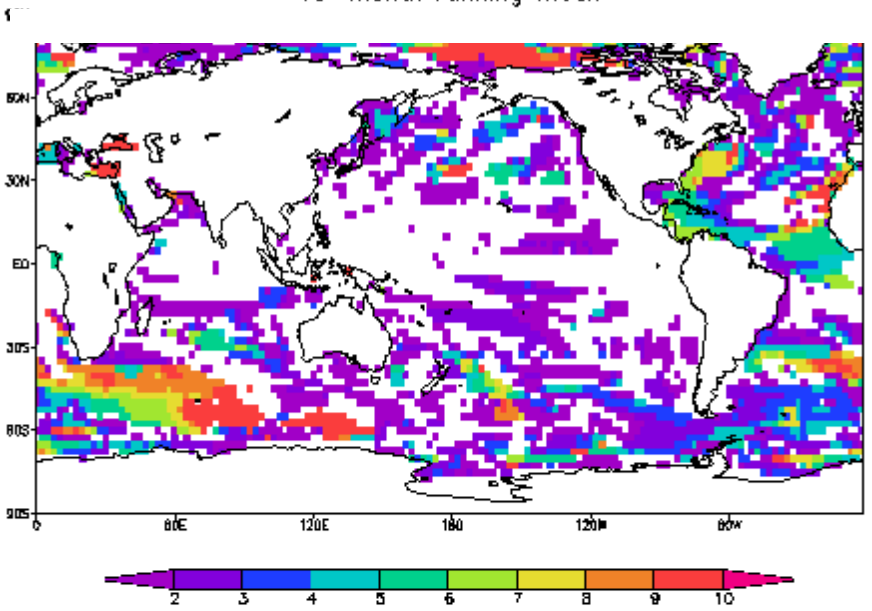



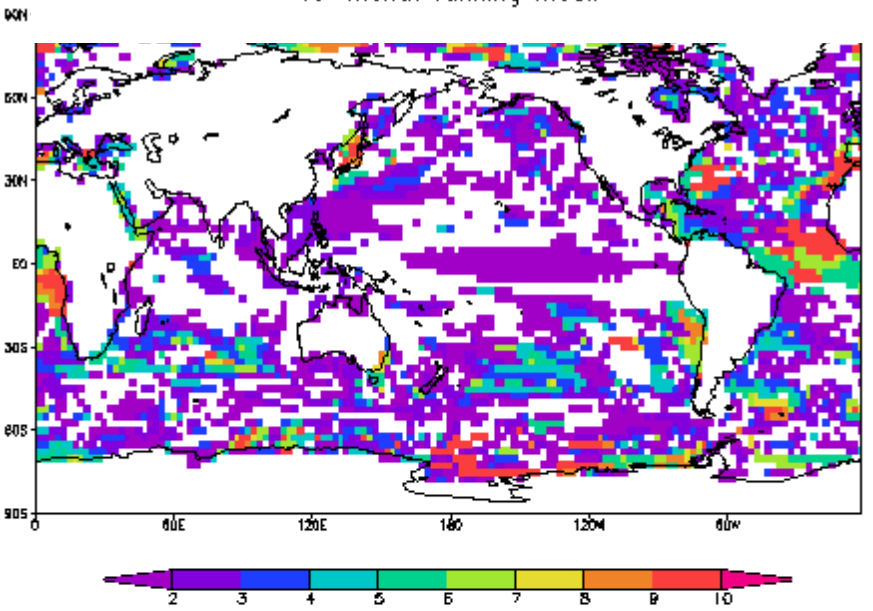

**1995**

# Crossing times for Heat Content 0-700m – ensemble means

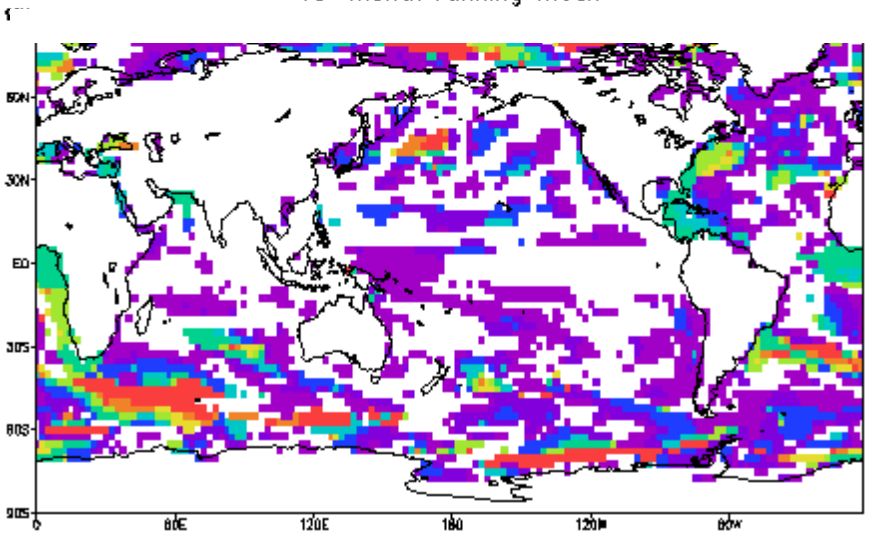
ECMWF



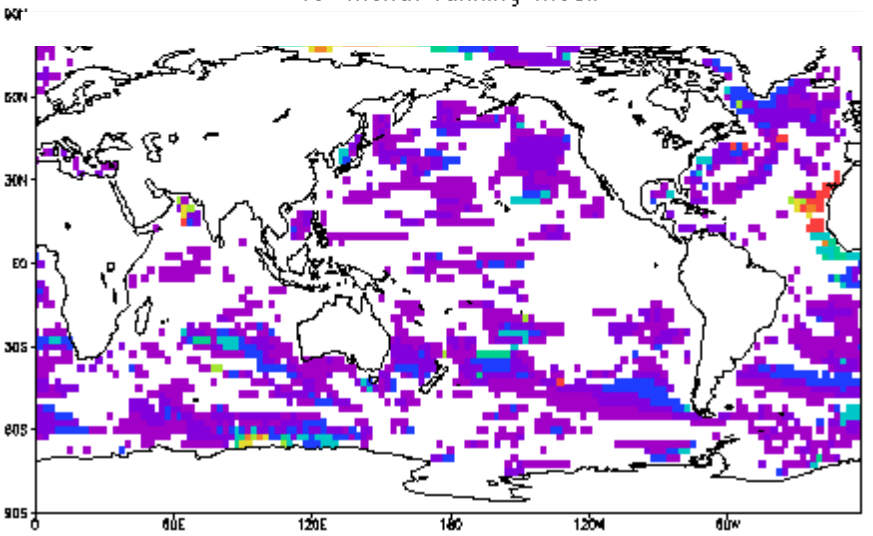

MPI-M




KNMI

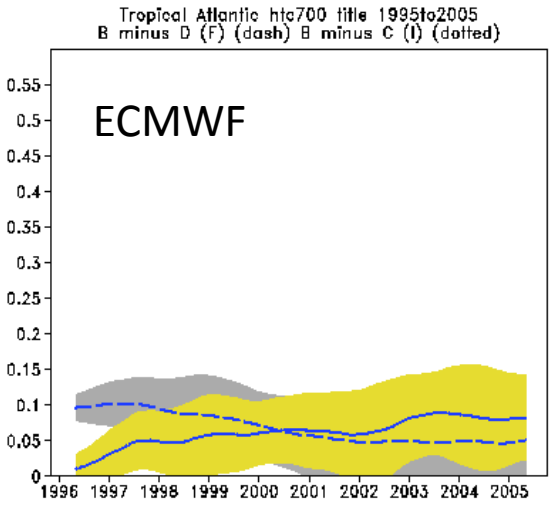


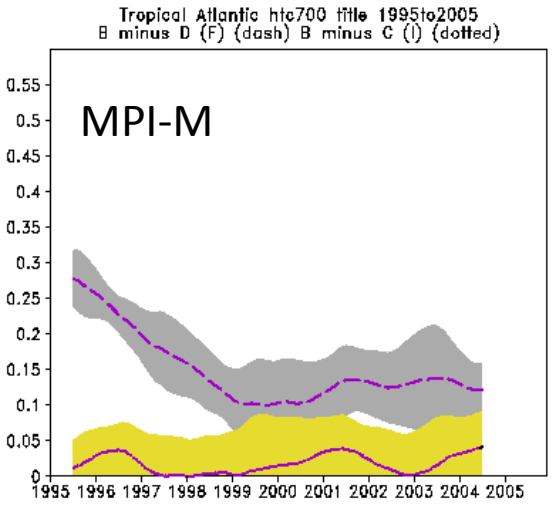

HadCM3

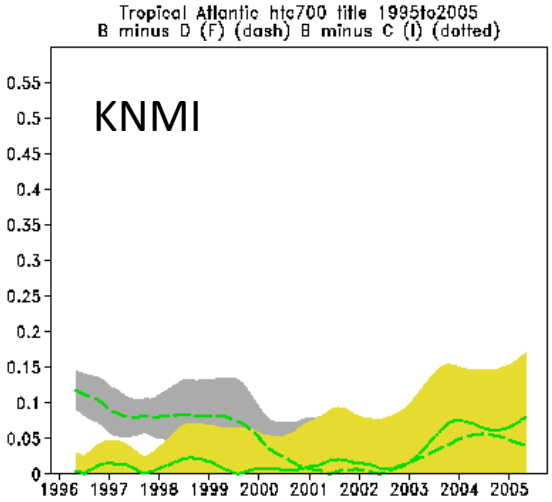


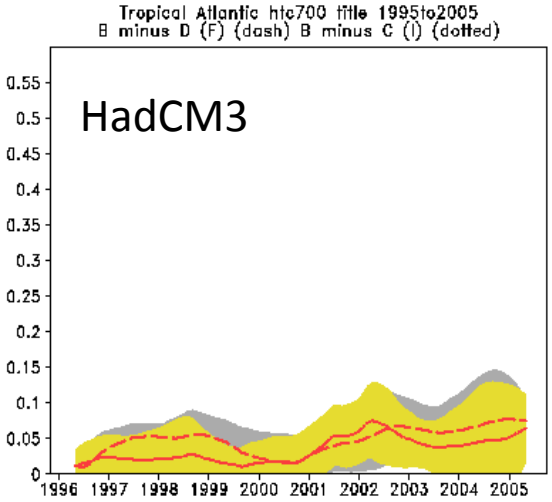
# Tropical Atlantic Ocean Heat Content 0-700m

## B minus D & B minus C




**Boundary conditions (forcing)**

| Initial conditions | 1965 | 1995 |
|---|---|---|
| 1965 | A | C |
| 1995 | D | B |

## Summary

- Results from the 1965-1995 SWAP sensitivity experiment indicate that over time scales longer than about 1 year predictability of SSTs on a global domain arises mainly from the forcing.

- The correct initialisation seems to have a longer impact on SST predictability over selected regions such as the North Atlantic, the North-West Pacific and the Southern Ocean .

- The impact of initialisation is longer and extends to wider regions when under-surface ocean variables are considered.

- Over the Tropical Atlantic the impact of initialisation for the 700 m heat content extends to as much as 10 years for one of the models considered.

- In all models considered the impact of initial conditions on the predictability of the AMOC is dominant for the first 5 years. In some models the influence of initial conditions is apparent up to 9-year lead time.

- These results have to be tempered by the fact that the band of uncertainty associated with the natural variability is wide.