WGCM/WGSIP decadal prediction proposal

A brief introduction
Outline

- Lessons from seasonal prediction
  - Starting from close to an observed state is OK
  - Clean initial states need some care
  - Model errors dominate
  - Models can be tested

- Outline of decadal prediction proposal
Lessons (?) from seasonal prediction

• Lesson 1: starting from obs. state is OK
  - To the extent that things are linear, subtract an estimate of the drift
  - Non-linearities mean that errors do hurt; but a simple argument states that the integrated effect of the problem is less if we start close to reality
  - “Equilibrium” start or well sampled hindcast set both need many years of integration.

• Lesson 2: clean initial states need some care
  - Forced ocean model can “fight” data, and in this case a close fit to the ocean data can introduce a lot of noise.
  - Might be an argument not to correct the mean state of the forced ocean model – or at least, only correct slowly varying part of system (eg large scale water mass properties)
Lessons (?) from seasonal prediction

• Lesson 3: model errors dominate
  - In most cases, model error rather than initial error dominates ENSO forecast performance. This is also true in the pre-TAO era.
  - For teleconnections, circulation changes, changes over land (ie, mapping SST anomalies to parameters of societal interest), the performance of the model is even more critical.
Forecast errors 1960-2007

NINO3.4 SST absolute error scores
ECMWF forecasts (mean during 6 months, plotted at centre of verification period)
Ensemble size is 11  SST obs: HadISST1/OIv2

- Obs. anom.
- MAE S3
- BAE S3

NINO3.4 SST rms errors
192 start dates from 19600201 to 20071101
Ensemble size is 11

- Fcast S3
- Persistence
- Ensemble sd

MAGICS 6.11 cressida - net
Fri Jun 20 10:05:43 2008
Lessons (?) from seasonal prediction

● Lesson 3: model errors dominate
  ❏ In most cases, model error rather than initial error dominates ENSO forecast performance. This is also true in the pre-TAO era.
  ❏ For teleconnections, circulation changes, changes over land (ie, mapping SST anomalies to parameters of societal interest), the performance of the model is even more critical.

● Lesson 4: models can be tested
  ❏ Making initialized forecasts is a good way of testing a coupled model, and allows estimation of future performance
  ❏ Even if model errors dominate, attention to initialization can help

● Additional comment
  ❏ Decadal trends matter a lot in seasonal prediction
NATL SST forecast anomalies
ECMWF forecasts, mean for months 1-3, plotted at centre of verification period
Ensemble size is 11  SST obs: HadISST1/OIv2

Ensemble size is 11  SST obs: HadISST1/OIv2

Some trends are handled well …
GLOBAL T50 forecast anomalies
ECMWF forecasts, mean for months 5-7, plotted at centre of verification period
Ensemble size is 11  T50 obs: ERA40/ops

... other trends are poorly handled
WGCM/WGSIP decadal prediction proposal

- **Origin**: WGCM meeting in Hamburg, Sep 2007

- **Input 1**:  
  - JSC request for WGSIP and WGCM to help coordinate a preliminary decadal prediction experiment

- **Input 2**:  
  - WGCM/IPCC requirement to define initialization for short-term climate runs (to 2030) (Aspen document)
Basic concept

- Put everything in a common framework
  (Note: Not quite the same as “do everything”)

Objective 1

- Short term prediction of climate to 2030 (or 30 years)
- Some groups/governments want to do this with high resolution models

Objective 2

- Developing the science of multi-decadal prediction in the context of a changing climate
- Study sensitivity to initialization method
- Characterize errors and uncertainties in multi-decadal predictions
- Will use affordable models

*High res: up to T318; _ deg ocean
Framework

● Objective 1:
  - Initial dates 1\textsuperscript{st} Nov 1960, 1980, 2005 (or 1970 and 2000)
  - 25 or 30 year integrations, 3-10 ensemble members
  - Initial conditions to represent “observed” anomalies in some way
  - All observed forcings (future: specified single scenario without volcanoes)
  - Will look at the DIFFERENCE in climate between different periods
  - Large ensemble size/high resolution -&gt; look at statistics of windstorms etc
  - Does not require elimination of model drift

● Objective 2 runs:
  - 1. Same runs as Objective 1
  - 2. 10 year integrations, dates 1965, 1970, 1975 etc (as ENSEMBLES)
  - 3. “Control” runs, extended CMIP5 C20th runs (no initial conditions)
  - 4, 5 and 6: Additional studies and sensitivity runs
Simple comments on initial conditions ...

For a 25 year forecast, initial conditions matter

- At least, relative to pre-industrial initialization and 150 year trajectory
- *Which* aspects matter most is poorly known:
  - Global ocean heat content
  - Arctic ice thickness
  - North Atlantic thermohaline circulation – T/S fields in N Atlantic
  - *(Only N Atlantic?)*
  - Wind driven ocean circulation - gyres, Pacific decadal state, ..

- How well do we know each of these initial conditions?
  - Relative to pre-industrial spin-up
  - Most interested in the difference between the start of different forecasts
  - *i.e.* relative changes over 1980-present (or 1960-present or …)
Possible options

- Keep the proposal
  - But modify aspects of it as required

- Split the proposal
  - Objective 1: for AR5 only, include eg experiments 2.1 and 2.2
  - Objective 2: 2.2-2.5 as a separate decadal prediction study, building on European ENSEMBLES project
  - (Maybe still a common framework, but two proposals)

- Re-write from scratch ....