CAM, DA and the IPCC

Damon McDougall

Mathematics Institute, University of Warwick, United Kingdom

15th November 2011

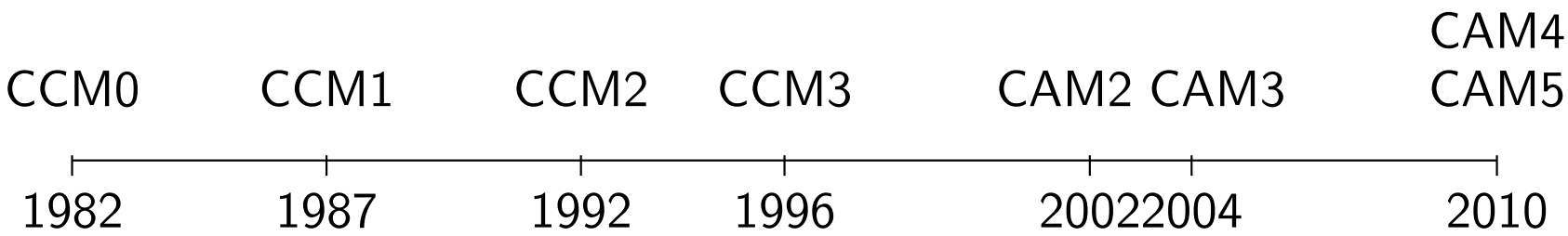
Overview

- What is CAM?
- What does it do?
- How is it used?
- What is DA?
- Does CAM use DA?
- Does there exist a DA package that comes with CAM?
- Is CAM (with DA) used in 4th Assessment Report?

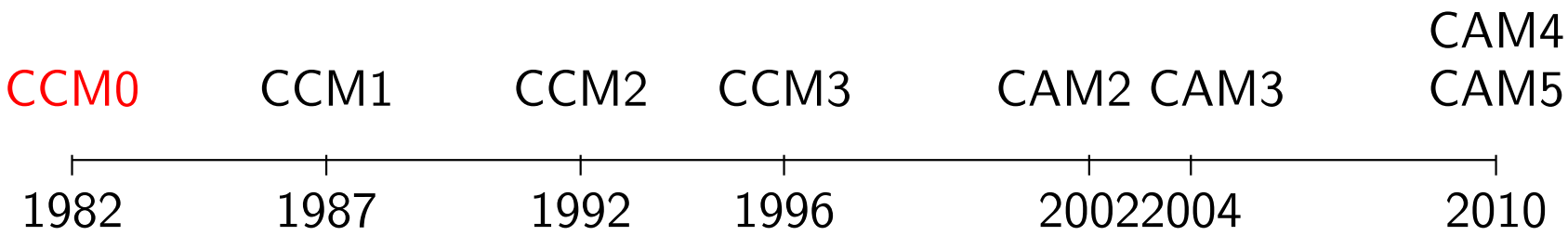
What is CAM?

- Community Atmosphere Model
- Global atmosphere model
- Serves as the atmosphere part of the Community Climate System Model (CCSM). Now called Community Earth System Model (CESM).
- Can be run as a standalone model, or as part of CESM.

CAM

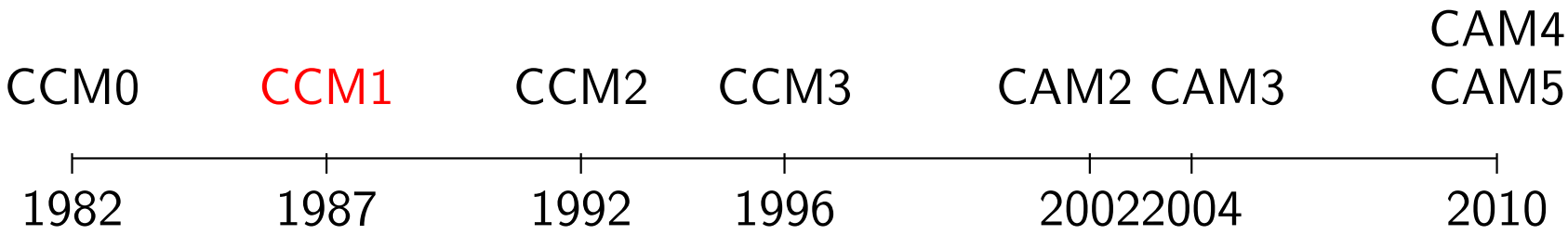

CCM0
CCM1
CCM2
CCM3
CAM2 CAM3
CAM4
CAM5
1982
1987
1992
1996
20022004
2010

CCM0



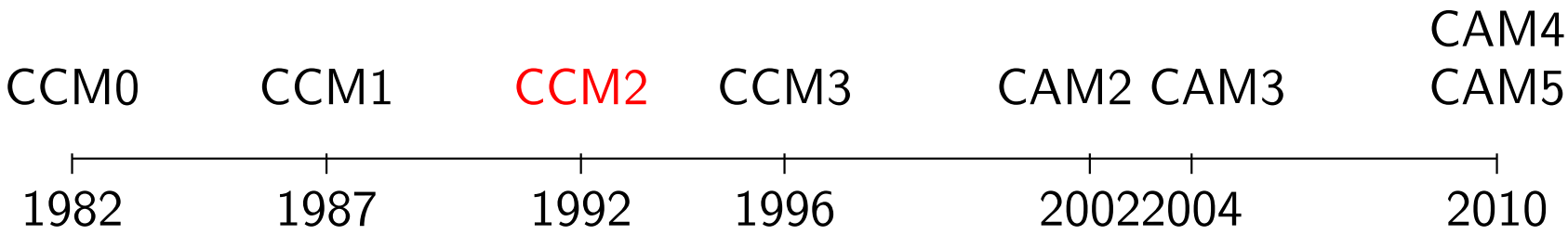
- Called CCM because it was used widespread in the community.
- Based on an Australian model, and an adiabatic, inviscid version of the ECMWF model.
- Provides a flexible infrastructure for medium- and long-range global forecast studies.

CCM1



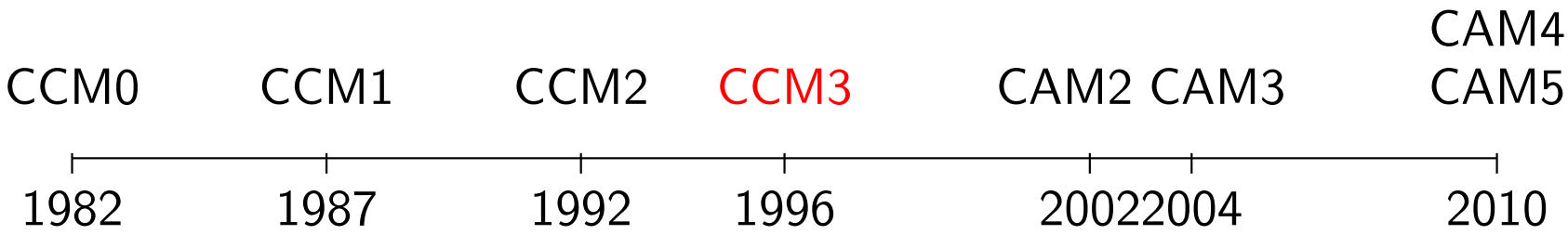
- Changes to radiation parametrisation.
- Revised vertical finite-differencing technique.
- Modifications to diffusion processes.
- Modifications to formulation of surface energy exchange.
- New modelling capabilities introduced:
  - Seasonal mode: specified surface conditions time-dependent
  - An optional interactive surface hydrology

CCM2



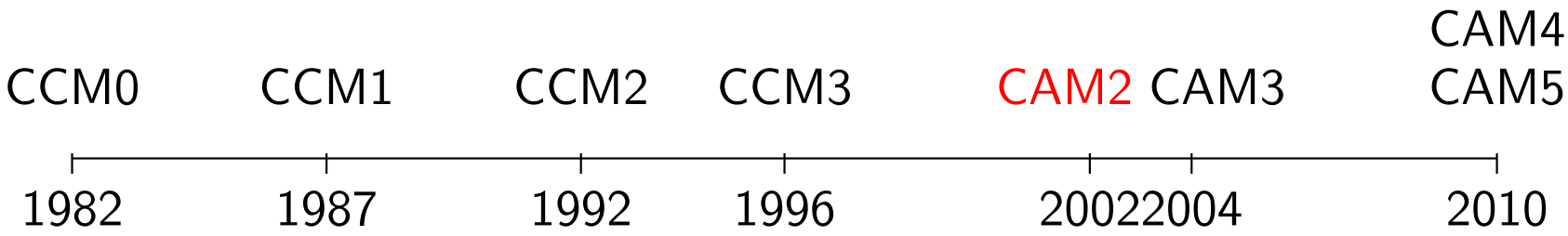
- Improved physical representation of: clouds and radiation, moist convection, the planetary boundary layer and transport.
- Much greater portability across computational platforms.
- Incorporation of single-job multitasking capabilities.
- Horizontal T42 spectral resolution (2.8 x 2.8 degree transform grid).
- 18 vertical levels and a rigid lid at 2.917 mb.
- Semi-implicit, leap frog time integration scheme.
- Spectral transform method for dry dynamics.
- Bi-harmonic horizontal diffusion operator.
- Incorporates a finite heat capacity soil/sea ice model.

CCM3



- Addresses errors in CCM2.
- Changes:
  - Representation of radiative transfer through clear and cloudy atmospheric columns (trace gases CH_4, N_2O, CFC, aerosol);
  - Hydrological processes (atmospheric boundary layer, moist convection, and surface energy exchange);
  - Sophisticated land surface model;
  - Optional slab mixed-layer ocean/thermodynamic sea-ice component.
  - Incorporates Land Surface Model for land surface processes. 1D model of energy, momentum, water and CO_2 exchange between atmosphere and land. Replaces prescribed parameters in CCM2.

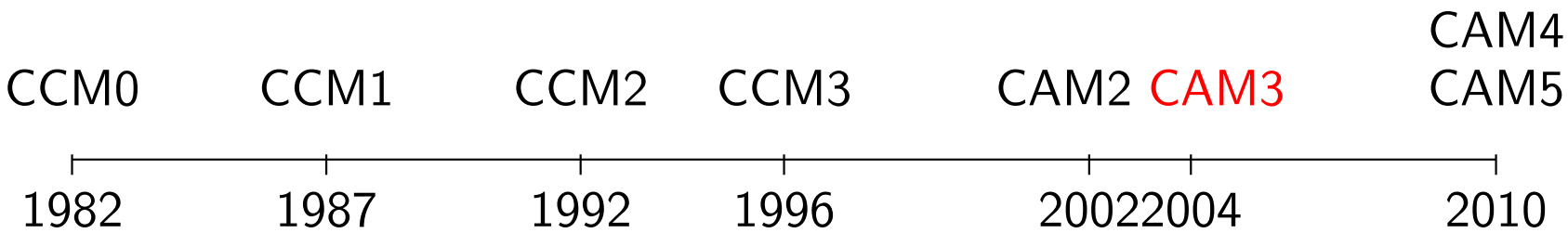
CAM2



Name change reflects role in fully coupled model. Changes:

- Treatment of cloud condensed water.
- A new thermodynamic package for sea-ice.
- Explicit representation of fraction land and sea-ice coverage.
- A more general treatment of cloud overlap in radiation calculations.
- A new parametrisation of long wave absorptivity and emissivity of water vapour.
- Evaporation of convective precipitation.
- Careful formulation of vertical diffusion of dry static energy.

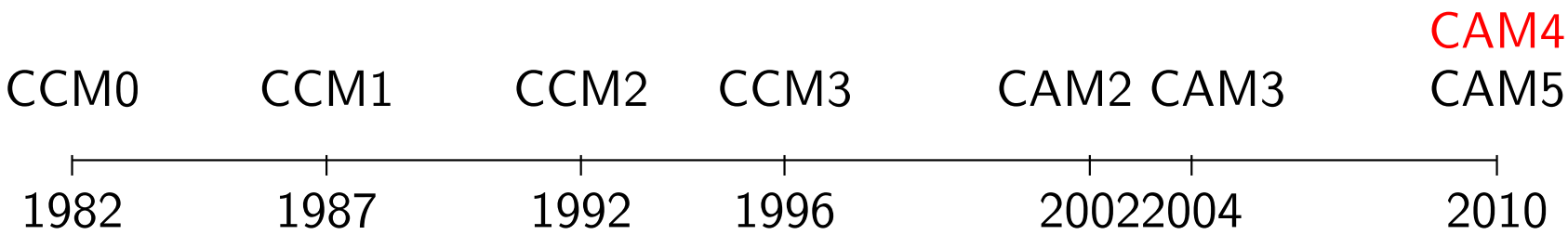
CAM3



Changes:

- Near-infrared absorption by water vapour.
- Uniform background aerosol replaced with present-day sulphate, sea-salt, carbonaceous and soil-dust aerosols.

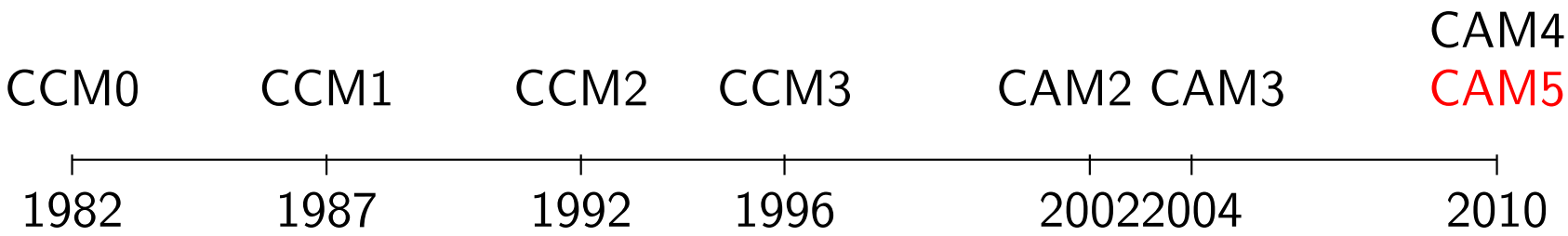
CAM4



Changes:

- Calculation of Convective Available Potential Energy (CAPE).
- Sub-grid scale Convective Momentum Transports added to deep convection scheme. CMT affects tropospheric climate.
- Cloud fraction calculation.
- Finite Volume scheme now default.

CAM5



- Changes enable full simulations of aerosol cloud interactions.
- New shallow convection scheme.
- Revised cloud macrophysics scheme.
- New 3-mode modal aerosol scheme.

Embedded into CESM.

DA

Data Assimilation is the act of incorporating observed data into a Mathematical model to obtain an estimate of the state of a system.

> *"The Democrat machine: A solar powered mechanical device that turns hope into disappointment." – Jon Stewart*

A search for 'assimilat' in the scientific model description yields:

> *The uniform background aerosol was replaced with a present-day climatology of sulfate, sea-salt, carbonaceous, and soil-dust aerosols. The climatology was obtained from a chemical transport model forced with meteorological analysis and constrained by assimilation of satellite aerosol retrievals.*

Interpretation: DA is overwhelmingly, and unsurprisingly, ignored.

All is not lost: CAM is well integrated into DART (Kevin Raeder).

IPCC

AR4 contains output runs from CCSM.

AR4 contains no DA.

Models ‘tuned’ to fit present day observations.

CAM5 runs to appear in AR5.