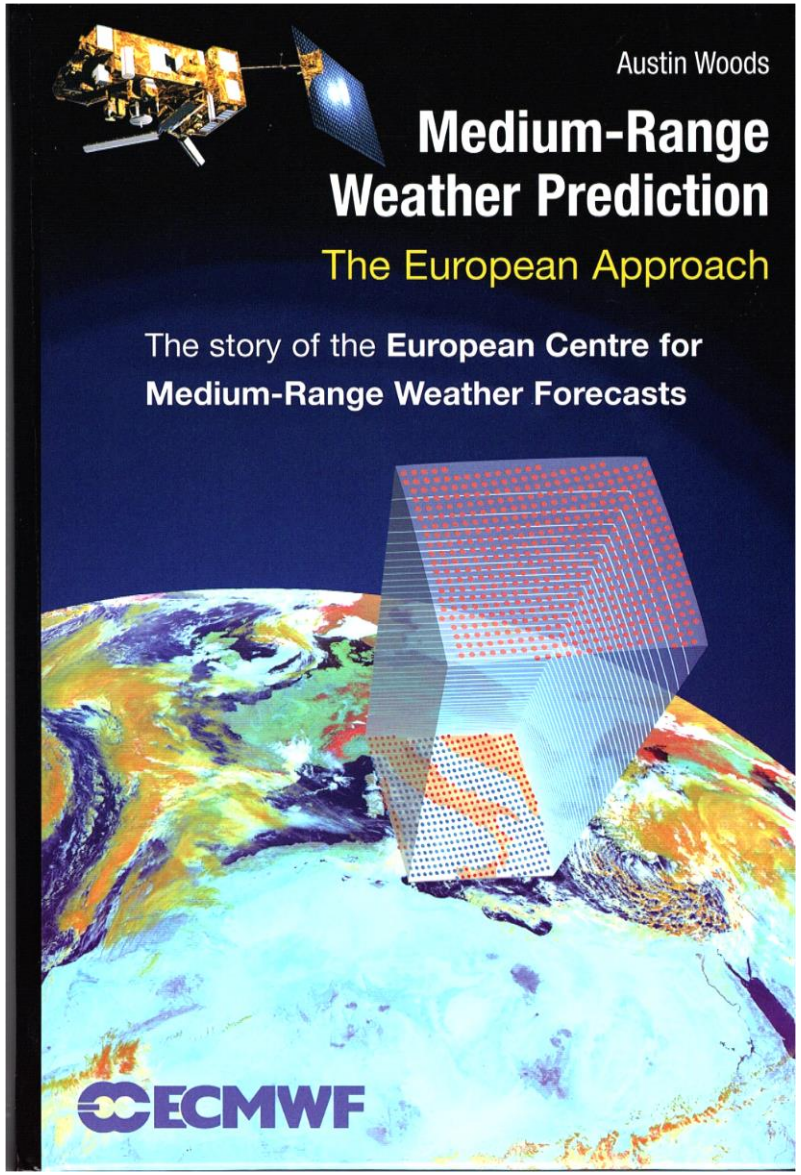
What has ECMWF done for us?

David Burridge (ghost of the past)

- Inspired by Monty Python's sketch "What have the Romans done from us"?

- REG: All right, but apart from the sanitation, the medicine, education, wine, public order, irrigation, roads, a fresh water system, and public health, what have the Romans ever done for us?
- XERXES: Brought peace.
- REG: Oh. Peace? Shut up!

The “Story” of the Centre has been told in …



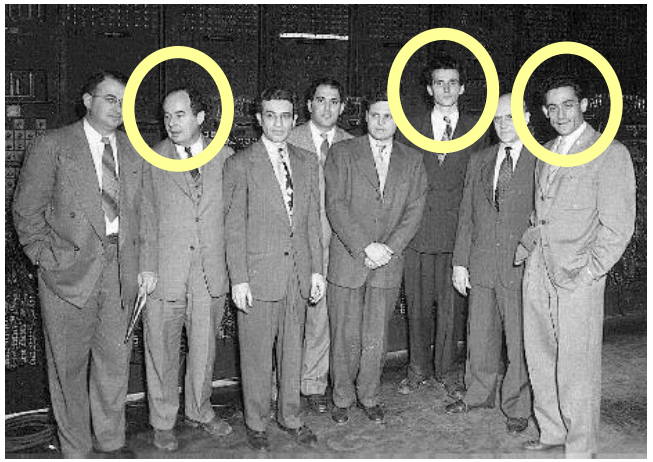
and in The ECMWF 40th Anniversary presentation “The Origin and early days of the ECMWF” by Lennart Bengtsson

- Coals to Newcastle
- Wood to the forest
- Water to the river

Our fathers fathers/heroes

Vilhelm Bjerknes laid out the principles of NWP in 1904

L F Richardson's 1922 book "WEATHER PREDICTION BY NUMERICAL PROCESS" contains his first integration which was contaminated by large amplitude gravity waves but this showed the way

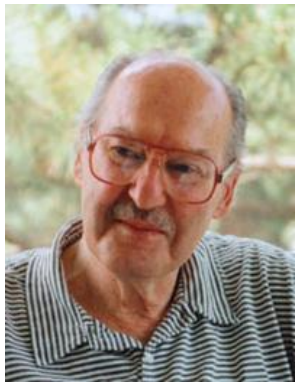


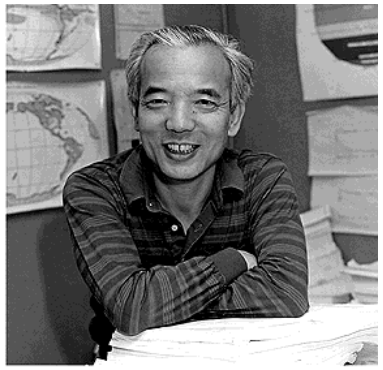
Charney, Fjörtoft and von Neumann (1950): Numerical integration of the barotropic vorticity equation Tellus, 2, 237-254;

1954 – NWP operational (for two weeks) in Sweden

In addition to his underpinning contributions to dynamics and weather prediction, C.G. Rossby anticipated the establishment of a Centre like ECMWF

Our fathers/heroes





Norman Phillips (1956) – The first general circulation experiment

Joe Smagorinsky (1963) – Hemispheric primitive-equation general circulation model (hydrostatic)

Yale Mintz (1965) – Global primitive-equation model

Syukuro Manabe et al. (1965) – Inclusion of moist processes

Kiku Miyakoda et al. (1972) – Hemispheric medium-range forecasts

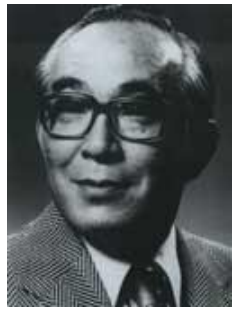
Contribution of GFDL

1 November 1975

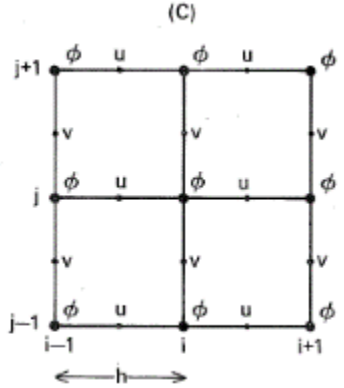
The first model?

Tower of Babel - Pieter Brueghel the Elder

Inspiration for the first models and data assimilation system



Akio Arakawa: c-grid



Lev Gandin

Andre Robert: Implicit time-stepping – Gravity Waves

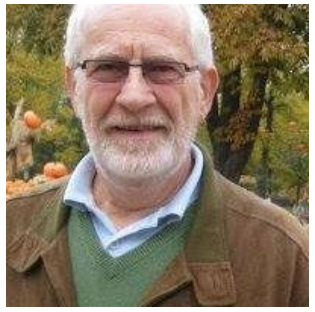
Spectral representation

$$\Phi(\lambda, \mu, t) = \sum_{m=-M}^{M} \sum_{n=|m|}^{J} \{\Phi_{m,n} Y_{m,n}(\lambda, \mu)$$

Optimum interpolation

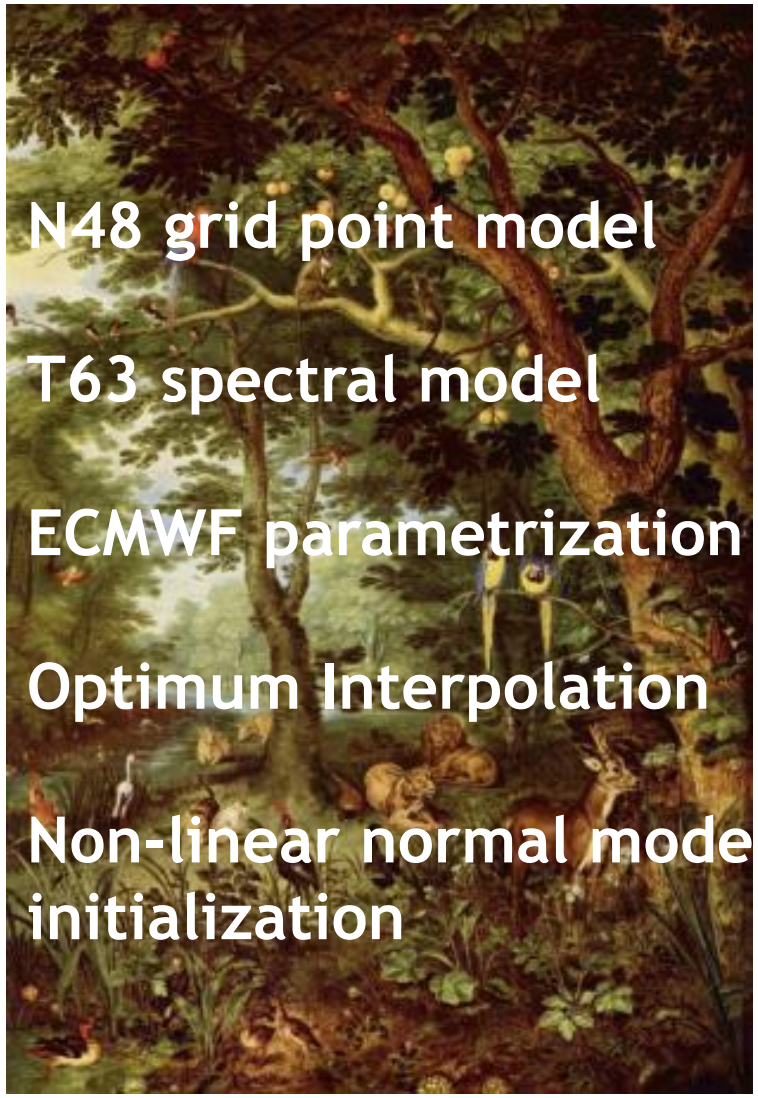
$$J[\boldsymbol{x}] = \frac{1}{2}(\boldsymbol{x}_B - \boldsymbol{x})^T \mathbf{B}^{-1}(\boldsymbol{x}_B - \boldsymbol{x}) +$$

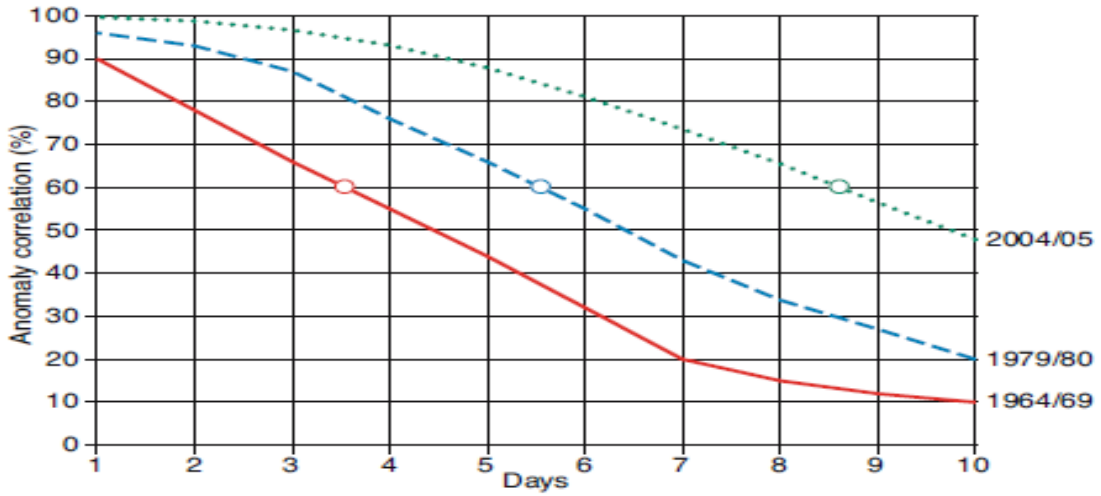
$$\frac{1}{2}\sum_{t=0}^{\Delta t}(\boldsymbol{y}(t) - \boldsymbol{H}_t^o[\boldsymbol{x}(t)])^T \mathbf{E}^{-1}(\boldsymbol{y}(t) - \boldsymbol{H}_t^o[\boldsymbol{x}(t)])$$



Bennert Machenhauer: Non-linear normal mode initialization

The First Generation Forecasting Systems





A step change in global numerical weather prediction achieved in under four years with help from visitors and other institutions

Den lilla readingtösen sover fridfullt inunder sitt regnskydd...

Mitt i vädret

Reading, England, i november.

Att befinna sig i Reading, det är att befinna sig i vädrets centrum.

Här, cirka sex mil väster om London, i grevskapet Berkshires välmående huvudstad, kan man lukta sig till ett annalkande oväder över småländska höglandet. Nog drar det ihop sig till snö i Tomtabacken fram emot fredan...

Sedan ganska precis ett år ligger här det europeiska vädercentret. Sjutton länders flaggor vajar stillsamt i novembervinden, en för vardera av de nationer som ingår i verksamheten. Forskare från tretton av dem — plus gästforskare från skilda hörn av jorden — arbetar sida vid sida. Vädret är en global angelägenhet.

Reading skulle ju alls inte behöva den här ståtliga, internationella anläggningen. Man har redan gått till historien — för sitt goda öl, sina delikata kex och för Oscar Wildes sorgesamma ballad om fängelset: "I Readings borg i Readings stad, där finns en skammens bädd..." Nu kröner man alltså berömmelsen med vädercentret. Som till råga på allt har världens största datoranläggning, inrymd i en hall som ser ut som en ordinär hangar.

Flickan i receptionen frågar artigt hur vädret är i Sverige och ryser förtjust vid en lägesbeskrivning. Really, so very bad — och träden redan utan löv! Arma svenska folk.

Aristoteles står i entrén som marmorbyst, en gåva från medlemslandet Grekland. Några hundra år före Kr. skrev han den första meteorologiska uppsatsen — lite väl metafysisk för att duga i dag, men ändå... Sverige har också bidragit till utsmyckningen: med ett verk av meteorologen Curry Melin, en orkan med devisen "Formen är bara en yttring av det inre innehållet".

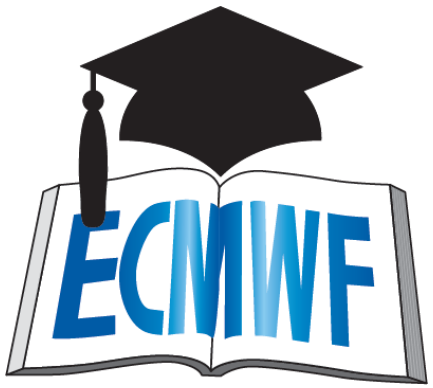
Som svensk känner man hjärtat dunka av stolthet här i de verkligt stora vädersammanhangen. Var det inte en svensk, C-G Rossby, som var banbrytare för den moderna prognosmetoden? Är det inte vi som har det genuina, djupborrande väderintresset (nåja, jämsides med amerikanerna)?

Engelsmännen pratar vissерligen ständigt om vädret, men saknar helt vårt faktaintresse för molnskärmar, fronter och

Den svenska meteorologtrion på "soffan" runt huvuddatorn Cray — världens snabbaste. Fr. v. Erland Källén, Lennart Bengtsson och Per Källberg.

6

Rösten i Radio och TV, nr 48, 27-29 Nov. 1979
(Swedish television magazine)

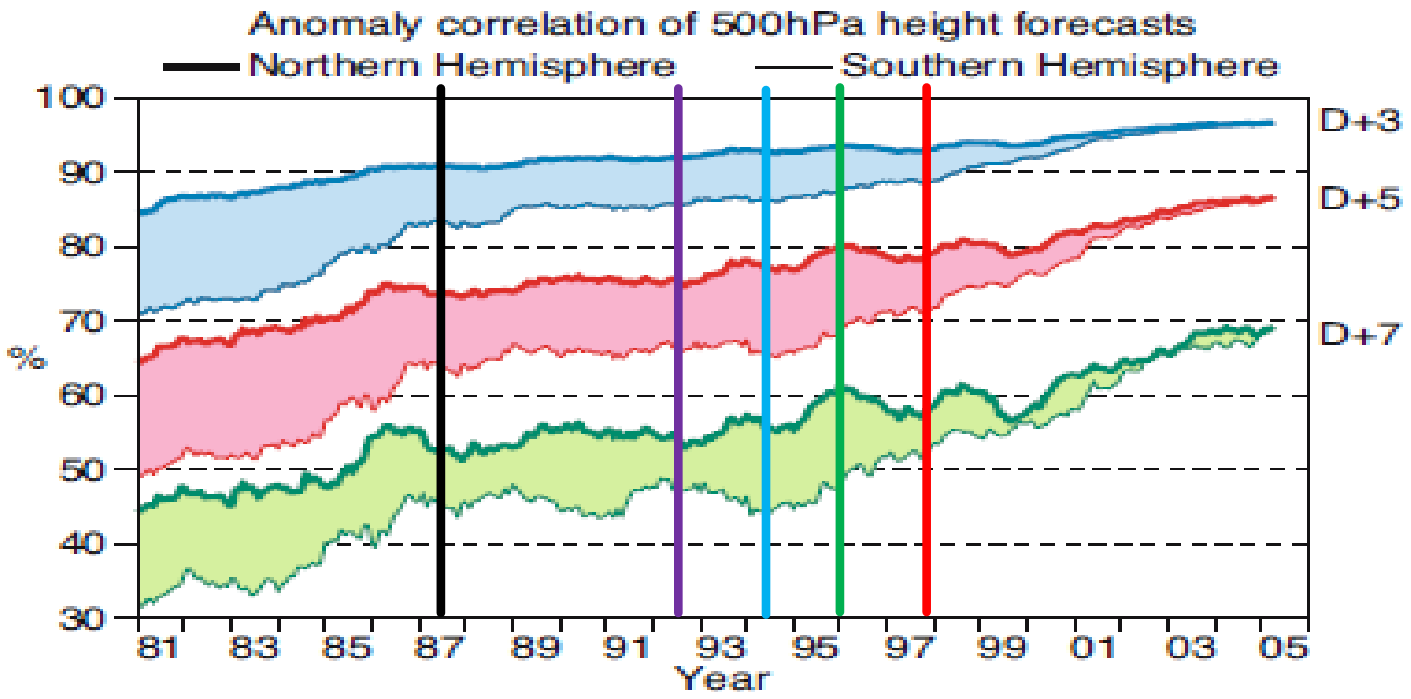


1/5/1979 – 31/3/1982

Prince Charles opens the Centre 15/6/1979

"Second Coming"
Head of Research
"Use of Satellite Observations in NWP"

Second Generation - Integrated Forecasting System



Use of satellite radiances

The Verne Suomi approach
To unscramble an egg
"feed it to chickens"

Radiances

"Model"

Temperatures

IFS

Variational Data Assimilation

1DVar (ipod)

3DVar (iphone)

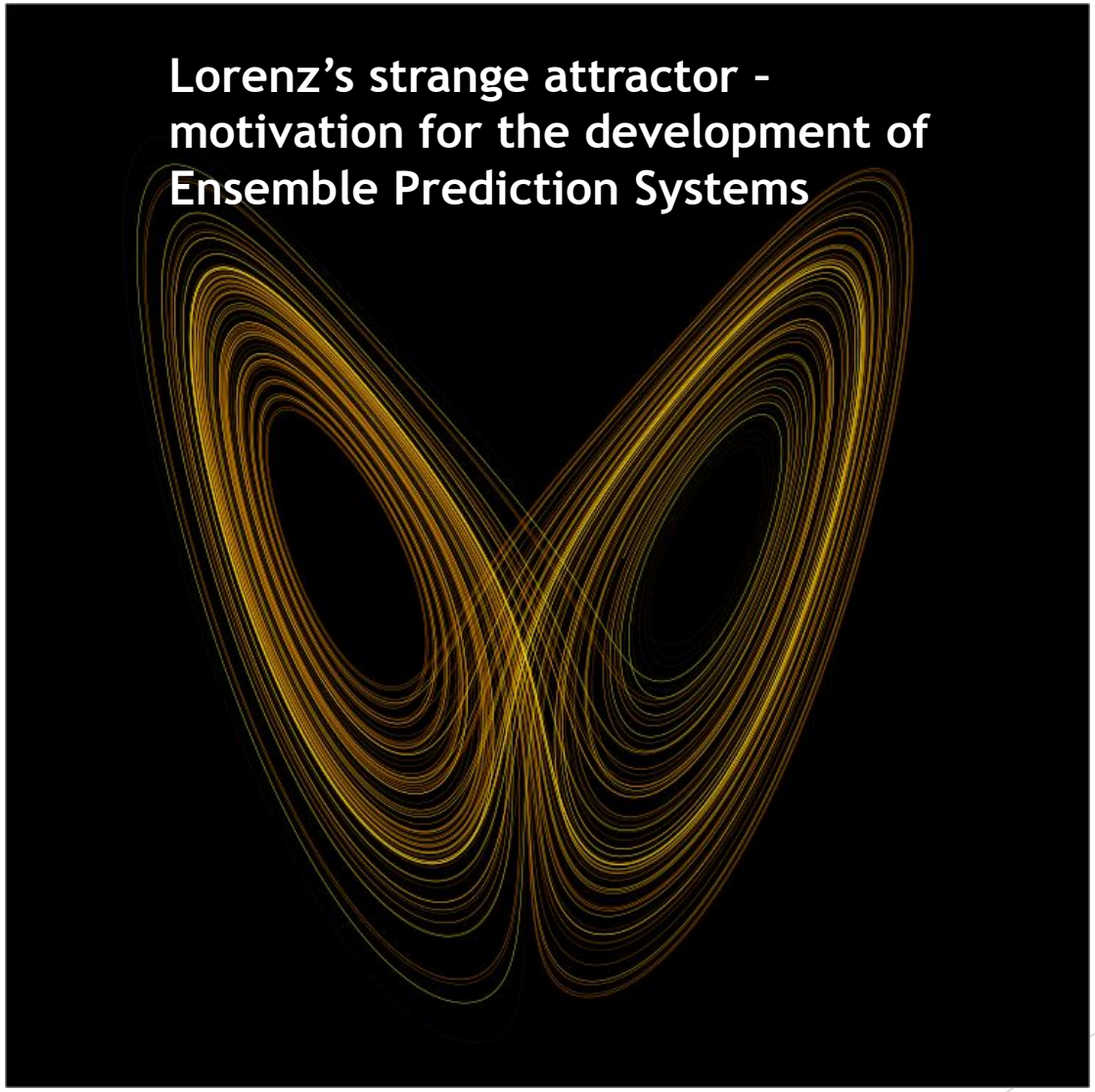
4DVar (ipad)

$$J[x] = \frac{1}{2}(x_B - x)^T \mathbf{B}^{-1}(x_B - x) +$$

$$\frac{1}{2}\sum_{t=0}^{\Delta t}(y(t) - H_t^o[x(t)])^T \mathbf{E}^{-1}(y(t) - H_t^o[x(t)])$$

Edward Lorenz – understanding predictability
1917 - 2008

A frequent visitor scientist
Who also loved gossip

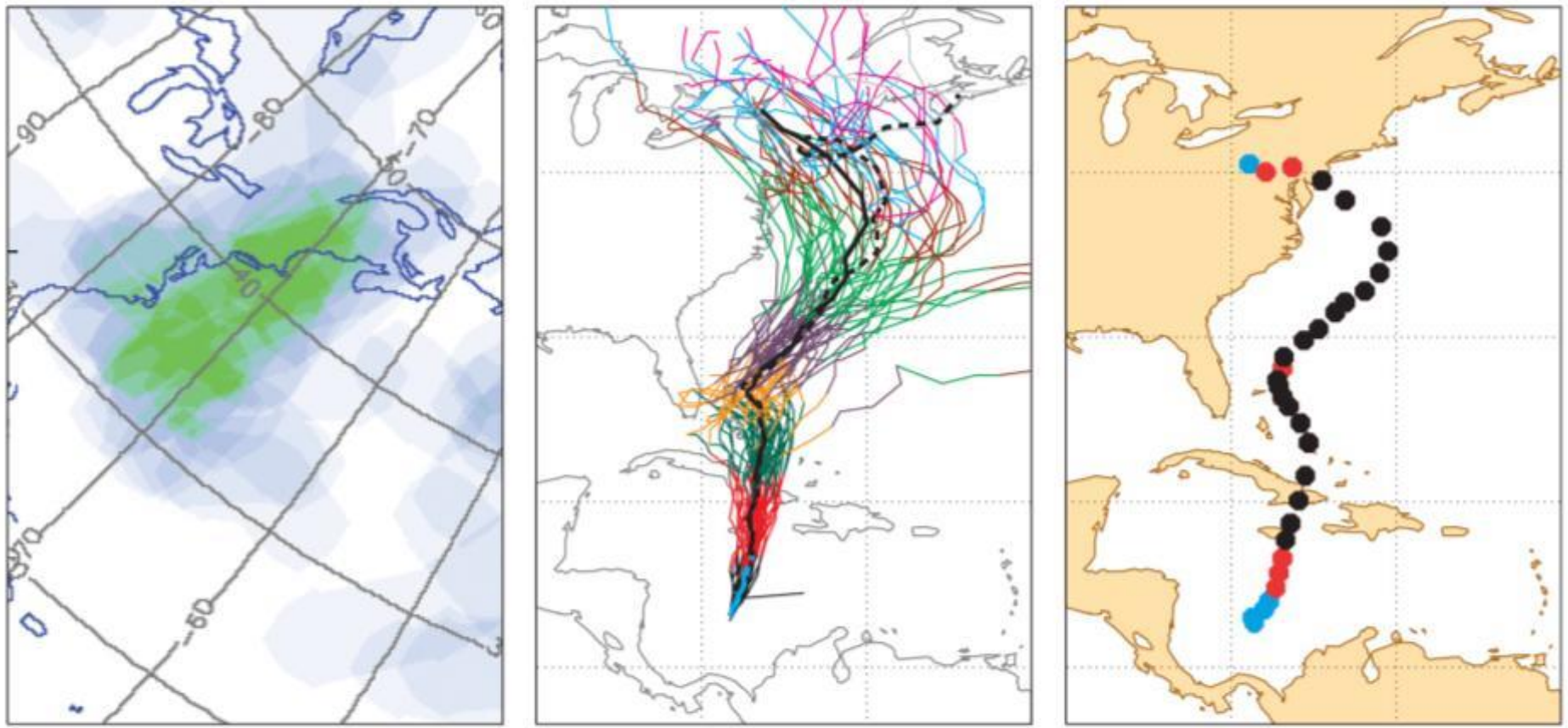


Superstorm Sandy

Probability of a wind storm
9.5 days before landfall

Track forecasts
6.5 days before landfall

Observed track of Sandy



Two days before Sandy formed (9.5 days before landfall in New Jersey) there was already a significant probability (25%) of a severe wind storm affecting the North-Eastern USA.

Narrowing the scenarios

Ensemble mean

The multi-model approach has again been extended

Reanalysis

FGGE analyses (1978/79)

ERA 15 (1979/93) - getting started

Reanalysis

We are developing new reanalysis products

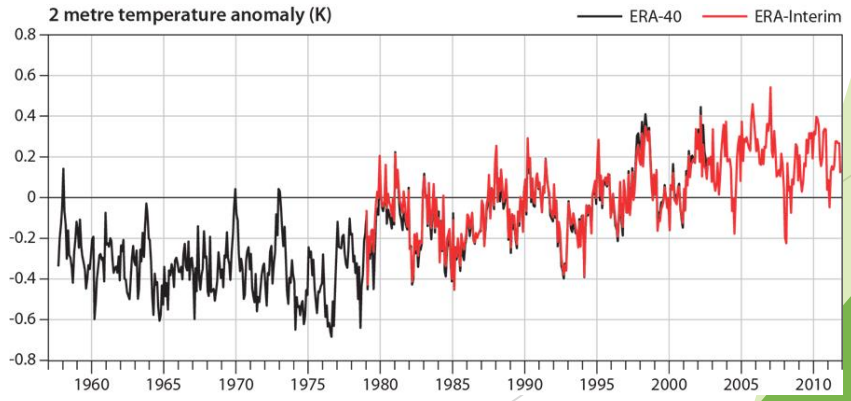
CERA [/en/research/projects/cera]

Core-Climax [/en/research/projects/core-climax]

ERA-CLIM [/en/research/projects/era-clim]

ERA-CLIM2 [/en/research/projects/era-clim2]

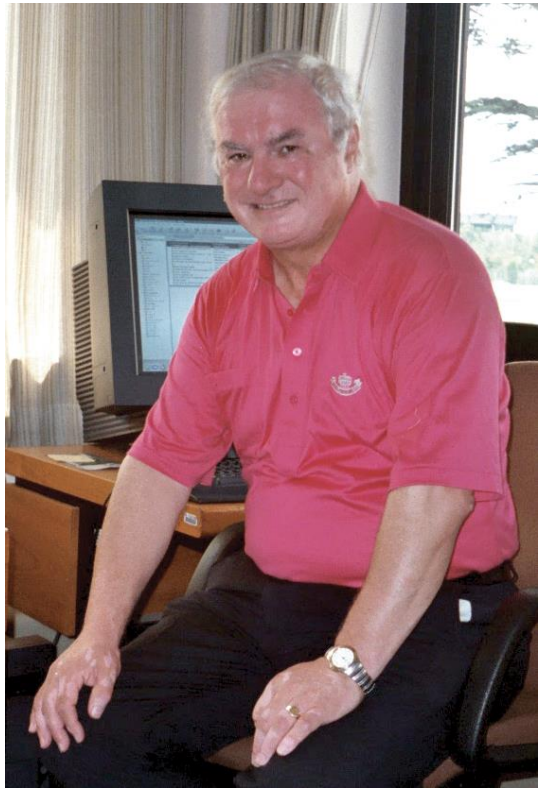
UERRA [/en/research/projects/uerra]



Data handling/archives

Project Objectives

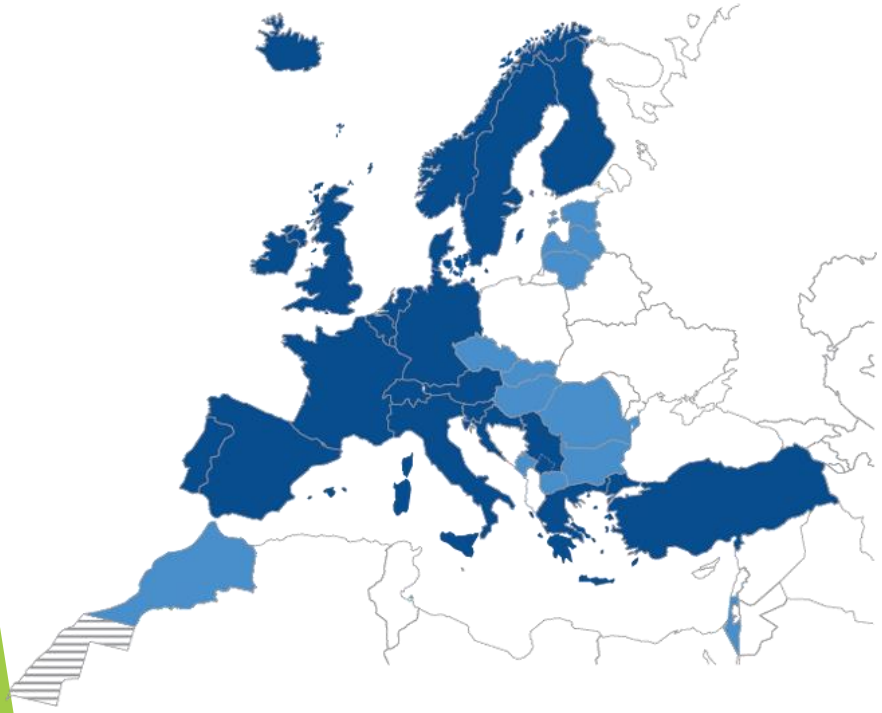
The EU-funded GEMS project has developed comprehensive data analysis and modelling systems for monitoring the global distributions of atmospheric constituents important for climate, air quality and UV radiation, with a focus on Europe. The project concluded on 31 May 2009. Operation and improvement of the systems developed during GEMS is continuing in a new EU-funded Copernicus Atmospheric Monitoring Service (CAMS)



Tony Hollingsworth

Monitoring atmospheric composition & climate

Monitoring atmospheric composition & climate



- What has ECMWF done for Europe and the rest of the world for that matter:

  The best global weather predictions,
  Ocean wave predictions,
  Monthly forecasts,
  Seasonal forecasts
  Operational services
  Research support
  IFS
  Climate services
  Computing
  ……


Celebrating CY43r1
November 2016
Good luck with
the New Strategy
David Burridge