From EMERAUDE/PERIDOT projects towards ARPEGE

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PLAN

- NWP context at Meteo-France around 1983
- The **EMERAUDE** spectral model for synoptic forecasts
- Quality control of the EMERAUDE model
- The **PERIDOT** fine mesh Limited Area Model
- Evolution of the PERIDOT Model (domain extension)
- Quality control of the PERIDOT Model
- Emerging ideas leading to **ARPEGE** and **ALADIN** projects
- From the stones to the harmony
- References
NWP context at Meteo-France around year 1983

- Lessons from AMETHYSTE and SISYPHE: Advantage to the spectral for synoptic scales in terms of accuracy and efficiency.

- Availability of the Non Linear Normal Mode Initialization (NLNMI): Allows to fully utilize wind data issued from the multivariate Optimum Interpolation SAPHIR (Système d'Analyse Presque Hémisphérique par Interpolation des Résidus).

- Availability of a new computer: The CRAY-1 at the CCVR.

- Beginning of testing EMERAUDE and PERIDOT models.

- Arrival of Jean-François Geleyn to the Dynamical Meteorology Research Centre (CRMD).
EMERAUDE - A spectral model for synoptic forecasts up to 3 or 4 days

- T79 spectral model (T79 # 150 km) – 15-level progressive hybrid vertical coordinate
- Domain: hémispherical and evolution towards global
- Semi implicit treatment (adaptation terms, vorticity and specific humidity by zonal wind)
- Vertical interpolation of increments (obs - guess).
- Non linear Normal Mode initialization.
- Special treatment of the tropical belt for the hemispheric symmetrical version
- Comprehensive physical parameterizations (radiation, boundary layer and surface interactions, precipitation, convection).
- Zonal mean diagnostics
Quality control of the EMERAUDE forecasts

- 1984 - Testing the EMERAUDE model
- 1985 (January, 29) - EMERAUDE operational on the CRAY-1 at CCVR
- 1987 - Improvements: Taking into account the diurnal and semi-diurnal waves; physical parameterizations
- 1987 (June) - The CRAY-2 operational at CCVR
- 1988 (June, 29) - EMERAUDE becomes global (assimilation and model)
- 1992 (September, 29) - The unstretched ARPEGE model replaces EMERAUDE
PERIDOT (Prévision à Echéance Rapprochée Intégrant des Données Observées et Télédétectées)
A grid point limited area model over France using teledetected satellite data

- Fine mesh limited area model: staggered C-grid; 35 km mesh size; 15 levels
- Square domain centered over France, initially 1750 x 1750 km²
- Multivariate optimal interpolation taking into account radiances from the 19 channels of HIRS-2 and MSU of TOVS instrument aboard the NOAA satellites
- NLM Initialization over the limited area
- Continuous insertion of lateral boundary conditions from EMERAUDE outputs model every 6 hours
- Comprehensive physical parameterizations (radiation, boundary layer and surface interactions, precipitation, convection)
The successive PERIDOT developments

- 51 x 51: Forecast area from February 1985 to June 1987
- 95 x 95: Forecast area from June 1987 to February 1991
- 119 x 119: Forecast area from February 1991 to October 1993

1984 - Tests and daily runs during 1984

1985 - (February, 23) the PERIDOT model becomes operational

1986 - Two runs a day (60 h at 00 UTC et 48 h at 12 UTC.

1990 - Portable PERIDOT.

1991 - Tests with 10 km mesh size (research) and 3.5 km (Super-Péridot)

1992 - Use of 3.5 km Super peridot over the Alps during Winter Albertville Olympic Games

1984-1992 – Use of Peridot in the framework of test field experiments (ALPEX, Fronts 84, PYREX)
Improvement with the PERIDOT model

Statistics for the 2 m temperature, June 1986

Forecasts for fine mesh (left) and large scale (right) models. Bias (solid line), mean absolute error (dashed line), standard deviation (dotted line).

Forecasts on 7 October 1985
Large scale (a) - Fine mesh (b)

90% and above relative humidity (solid line and dotted area)
70% relative humidity (dashed line).
Radar rainfall observation (hatched area)
During its stay at CRMD, the work of Jean-François Geleyn has been essential in the design and improvement at various levels of the parameterization of the physical processes in the EMERAUDE and PERIDOT models.
Emerging techniques in NWP

- Semi-Lagrangian treatment of the advection together with semi-implicit time integration (Robert, Yee and Ritchie, 1985)

- Spectral method on limited area (Machenhauer and Haugen, 1987)

- Variational methods for analysis and data assimilation (Talagrand and Courtier, 1987)

- Variable mesh grid and spectral method as an alternative to coupled models (Geleyn and Courtier, 1988)

- Use of digital filters for initialization (Lynch and Huang, 1992)
From variable mesh to ARPEGE

Large scale + Small Scale
Grande Échelle + Petite Échelle => GEPE ?

PEGE better ; by adding AR for « Action de Recherche » (Research action)
From the Stones to the Harmony

Améthyste

Emeraude

Peridot

Caillou (Peeble)

Météo-France is getting out the stone age
Thank you for your attention
Useful references - 1

• EMERAUDE


Useful references - 2

PERIDOT


Durand, Y., 1985: The use of satellite data in French high resolution analysis. Workshop on high resolution analysis. ECMWF Reading UK. 89-127.


Useful references - 3

**EMERGING TECHNIQUES**


