DWD: Expertise, achievements and interest in EURRA

Jörg Schulz and Franz Berger, Deutscher Wetterdienst

with contributions from:

Klaus Behrens, Michael Baldauf, Frank Beyrich, Gerrit Campell, Dirk Engelbart, Ulrich Leiterer, Detlev Majewski, Gerd Vogel

Fields of expertise

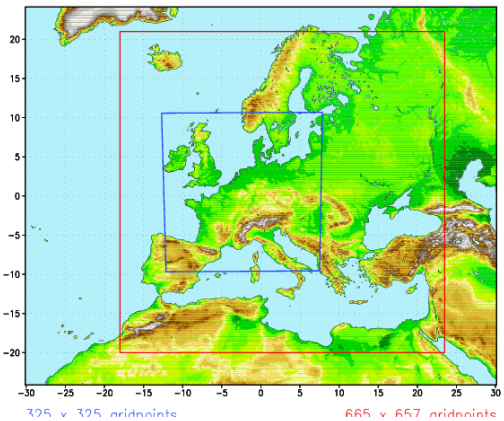
- Regional modelling – The Lokalmodell;
- High quality in situ and ground based remote sensing measurements – The Lindenberg observatory;
- Satellite climatology – The Satellite Application Facility on Climate Monitoring.

European Regional Reanalysis Workshop, 21 - 22 November 2005, Reading, U.K.

LME: LM Europe

- **Model Configuration**
  Grid spacing: 0.0625° (~ 7 km)
  665 x 657 grid points per layer
  40 vertical layers
  Timestep: 40 sec
  Daily runs at 00, 12, 18 UTC, +78h
  Progn. Vars.: u, v, w, T, p', q_v, q_c, q_i, q_r, q_s, TKE
- **Boundary Conditions**
  Interpolated GME forecasts with ds ~ 40 km and 40 layers (hourly)
- **Data Assimilation**
  Nudging analysis scheme
  Variational soil moisture analysis
  SST analysis at 00 UTC
  Snow depth analysis every 6 hrs

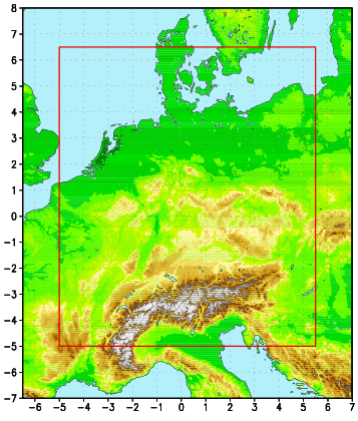
Model Domain of LME (red frame)



LMK-Configuration I

- grid length: **dx = 2.8 km**
  - direct simulation of the coarser parts of deep convection
  - interactions with fine scale topography
- about **50 vertical layers**,
  lowest layer in 22 m (new: 10 m) above ground
- center of the domain 10° E, 50° N
- 421 x 461 grid points
- boundary values from LM (LME) (Δx = 7 km)
- LAF-ensemble (model run every 3 h, 18h-forecasts)
- planned operational use: end of 2006

Tentative Model Domain of LMK



LMK- Numerics

red = new in LMK

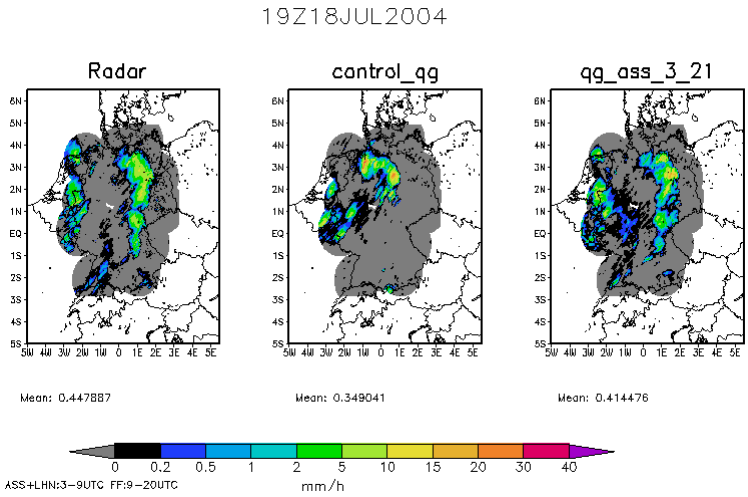
- grid structure: horizontal: Arakawa C;
  vertical: Lorenz
- time integrations: time-splitting between fast and slow modes:
  3-time levels: Leapfrog (+centered diff.)
  (Klemp, Wilhelmson, 1978)
  2-time levels: Runge-Kutta: 2. order, 3. order, 3. order
  TVD (Wicker, Skamarock, 2002)
- advection: for u,v,w,p',T:
  horizontal adv.: upwind 3., 4., 5., 6. order
  vertical adv.: implicit 2. order
  for q_v, q_c, q_i, q_r, q_s, q_g, TKE:
  Courant-number-independent (CNI)-advection:
  Motivation: no constraint for w (deep convection!)
  Euler-schemes:
  CNI with PPM advection
  Bott-scheme (2., 4. order)
  Semi-Lagrange (trilinear, triquadratic, tricubic)
- smoothing: 3D divergence damping; horizontal diffusion 4. order

LMK- Physics

- turbulence: 1D, 1-equation model (prognostic TKE)
  3D, 1-equation-model, full coordinate transformations
  'moist turbulence' (buoyancy production of TKE altered by condensation processes)
- cloud microphysics: 6-class-scheme (qv, qc, qi, qr, qs, new: graupel qg)
  6-class/2-moments-scheme
  (Seifert, Beheng, 2002; for research/benchmark purposes)
- radiation: 2-flux-scheme (Ritter, Geleyn, 1992) update frequency?
- soil-vegetation-model: 7 levels (extension of Jacobsen, Heise, 1982)
- convection: no cumulus convection parameterization !
  ‚simple' shallow convection:
  apply only shallow convection part (Tiedtke, 1989)
  only for cloud 'heights' < 250 hPa

red = new in LMK

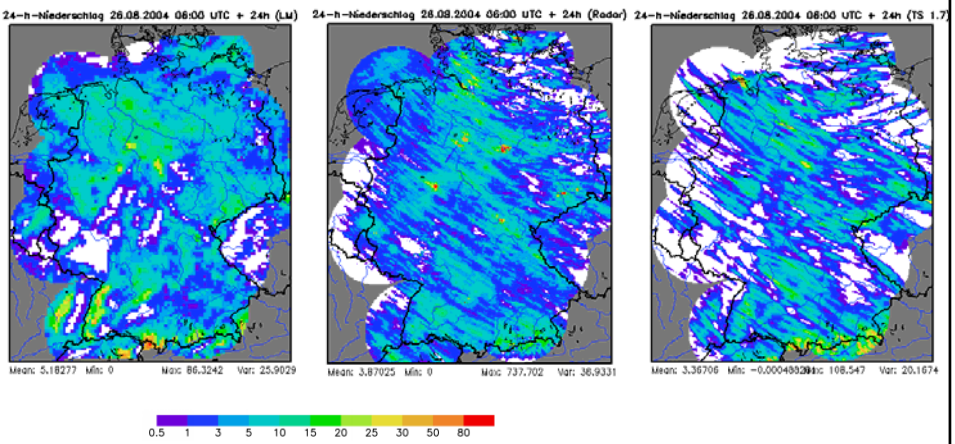
Assimilation of radar data in LMK



Explicitly resolved convection in LMK

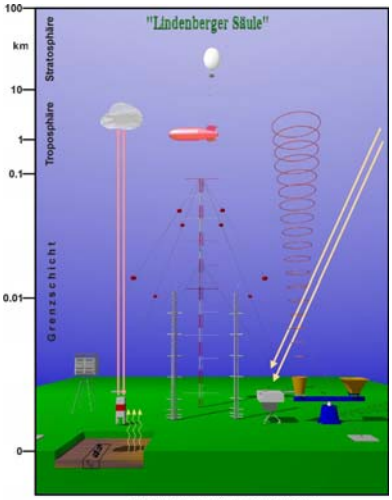
(case study '26.08.2004')

LM | Radar | LMK, Testsuite 1.7



1905-2005
100 Jahre Meteorologisches Observatorium Lindenberg
Deutscher Wetterdienst

3D/4D Lindenberg Column



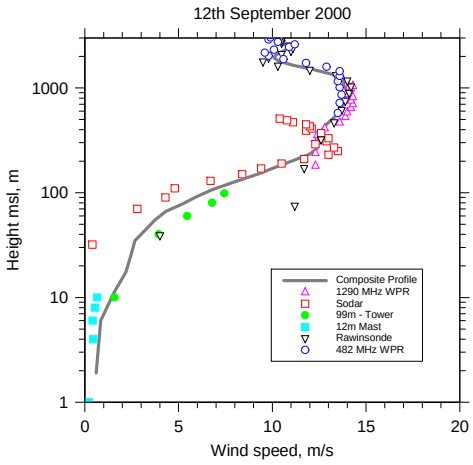
Lindenberger Säule - Meßsystem
bestehend aus : Bodenbeobachtungen, aerologischen Messungen, aktiven und passiven Fernerkundungsmethoden

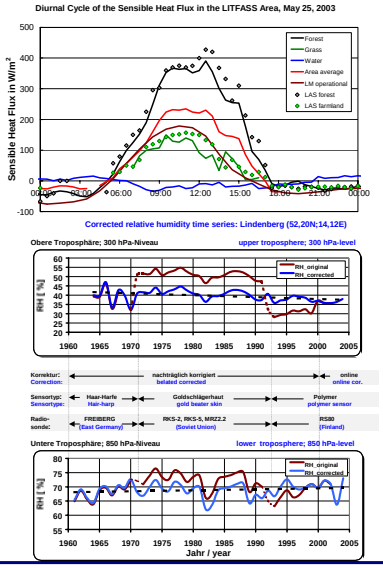
24 different measuring systems

- active and passive, ground based remote (wind profiler, cloud radar, Raman-lidar, microwave radiometer, …) – GVaP reference site
- ABL measuring sites (incl. different measuring towers in a regional network, local Eddy-Covariance network, scintillometer, …) – CEOP / GABLS reference site
- routinely operating radiosounding (every 6 hours, incl. humidity calibration) – GUAN reference site
- surface broadband and spectral radiance & flux measurements – BSRN reference site

1905-2005
100 Jahre Meteorologisches Observatorium Lindenberg
Deutscher Wetterdienst

3D/4D Lindenberg Column





1905-2005
100 Jahre Meteorologisches Observatorium Lindenberg
Deutscher Wetterdienst

3D/4D Lindenberg Column

Measuring Systems I

Active ground based remote sensing

- 2 wind profiler/RASS (+ MN-2000)
- Sodar/RASS
- LIDAR (since Aug. 2005)
- Ka-Band cloudradar
- micro-rainradar
- 3 Laser-Ceilometer

Passive ground based remote sensing

- microwave profiler / radiometer
- FTIR- spectrometer
- GPS- receiver (cooperat. BKG + GFZ)

Validationsystems

- 4 - rawinsonden / day (8 Profiles)
- 6-sonde-thetered balloonsystem (ff,dd,T,q, p, z)
- sun- and starphotometer
- [*99m Mast (dx = 5km)*]







1905-2005
100 Jahre Meteorologisches Observatorium Lindenberg
Deutscher Wetterdienst

3D/4D Lindenberg Column

Measuring Systems II

- ABL measuring site Falkenberg
- regional network (precipitation, radiation, micrometeorol. parameter)
- turbulence measuring systems
- scintillometers
- further monitoring instruments incl. testing of new instruments



European Regional Reanalysis Workshop, 21 - 22 November 2005, Reading, U.K.

1905-2005 100 Jahre Meteorologisches Observatorium Lindenberg
Deutscher Wetterdienst

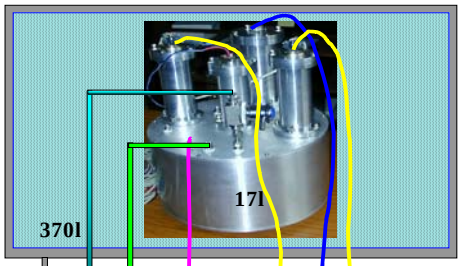
3D/4D Lindenberg Column

Measuring Systems III

- radiosounding system (every 6 hours) incl. humidity calibration
- O_3-sonde (every week) since 1975
- research radiosonde – every week

Simulationchamber

Temperature - Humidity - Pressure - Ventilation
(+40 to -78°C); (0% to saturation); (1030 to 10hPa); (5 m/s)



FEUTRON - Thermo - Chamber +40 to -80°C

supply with air, H2O, dry N2

vacuum pump and regulator 1030 - 10 hPa
Baratron 690A (DKD control 2004)

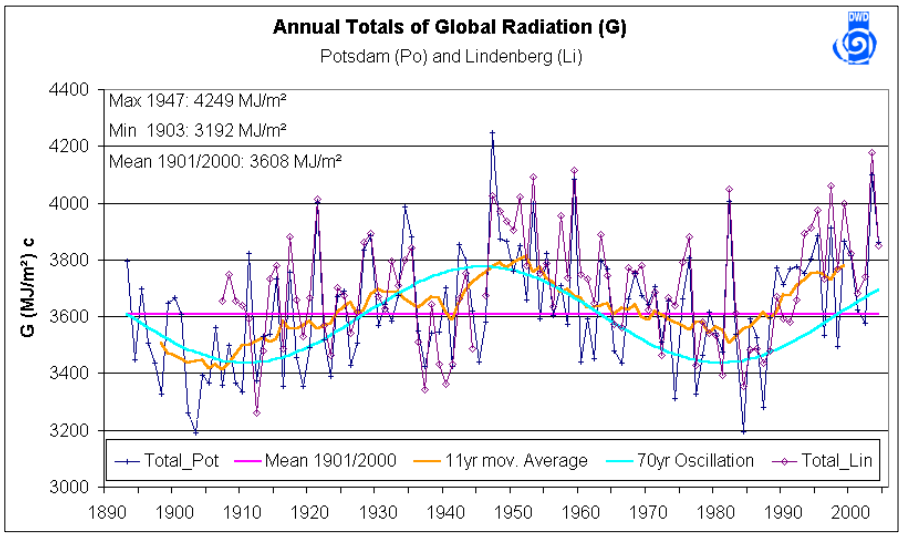
control of temperature PT100 (PTB control 2001)

Frostpoint - Hygrometer (TOROS, CR2)

radiosonde PTU- signal (sensor 1 and 2)

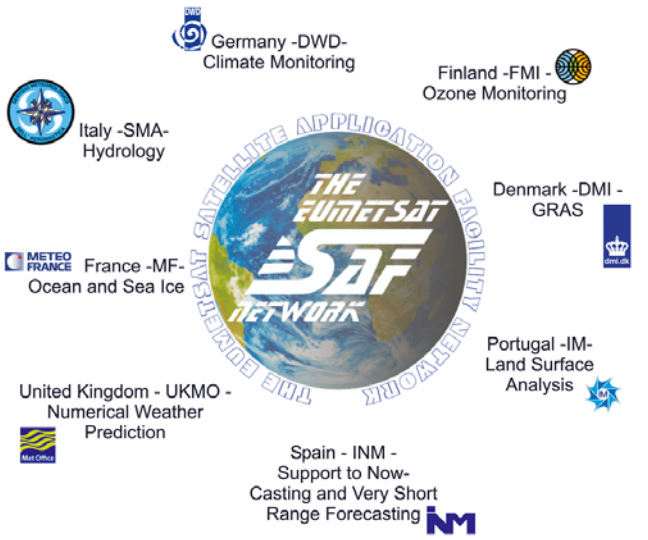
1905-2005 100 Jahre Meteorologisches Observatorium Lindenberg
Deutscher Wetterdienst

3D/4D Lindenberg Column



European Regional Reanalysis Workshop, 21 - 22 November 2005, Reading, U.K.

EUMETSAT's SAF network

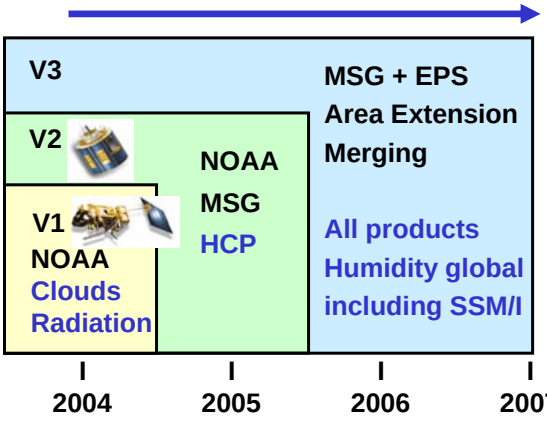


CM-SAF targets

- Exploit satellite measurements at different parts of the electromagnetic spectrum to derive information about key climate variables of the Earth system;
- Establish long time series with known error characteristic and temporal stability of those quantities from different instruments and perform climate analysis;
- Assure high traceability through operational environment with full reprocessing capability and adoption of GCOS principles;
- Support the user community using the products for climate monitoring and climate research.

CM-SAF: Schedule & Versioning

CM-SAF has the mandate to generate thematic climate data records in an operational off - line environment. It requires calibrated and cross calibrated radiance data sets from different satellite operators.



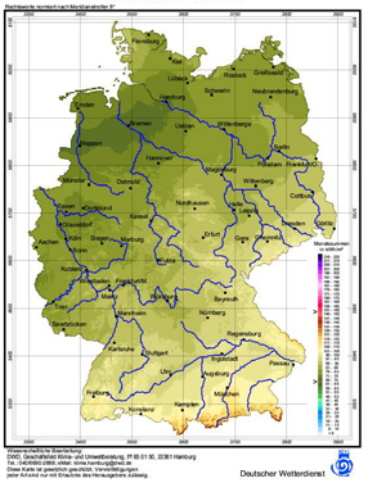
Initial Operations Phase

Example Product Applications - solar energy -

METEOSAT-7 data based product

Globalstrahlung in der Bundesrepublik Deutschland

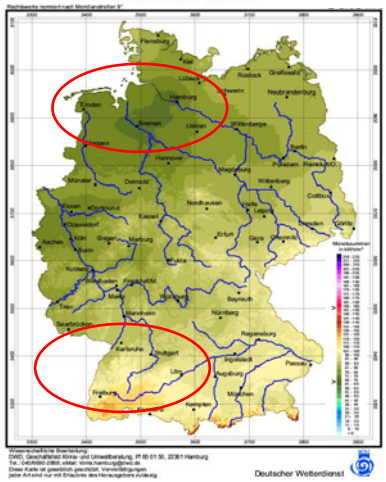
Monatssummen - März 2005



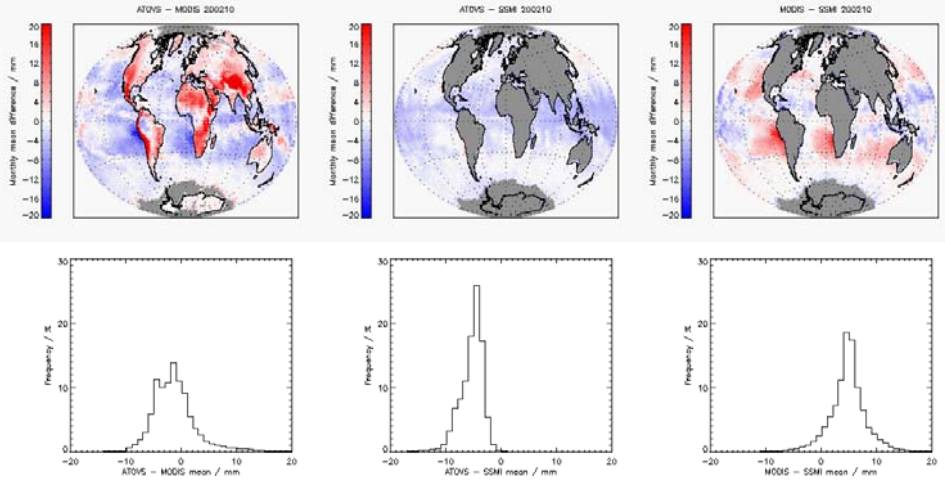
CM-SAF data based product

Globalstrahlung in der Bundesrepublik Deutschland

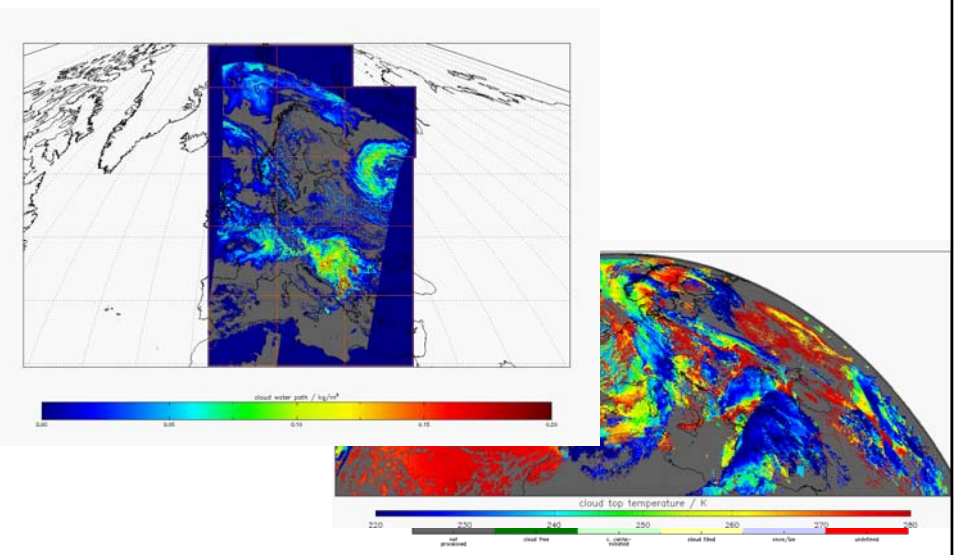
Monatssummen - März 2005



HCP - Global Demonstrator (Monthly fields, mean difference)



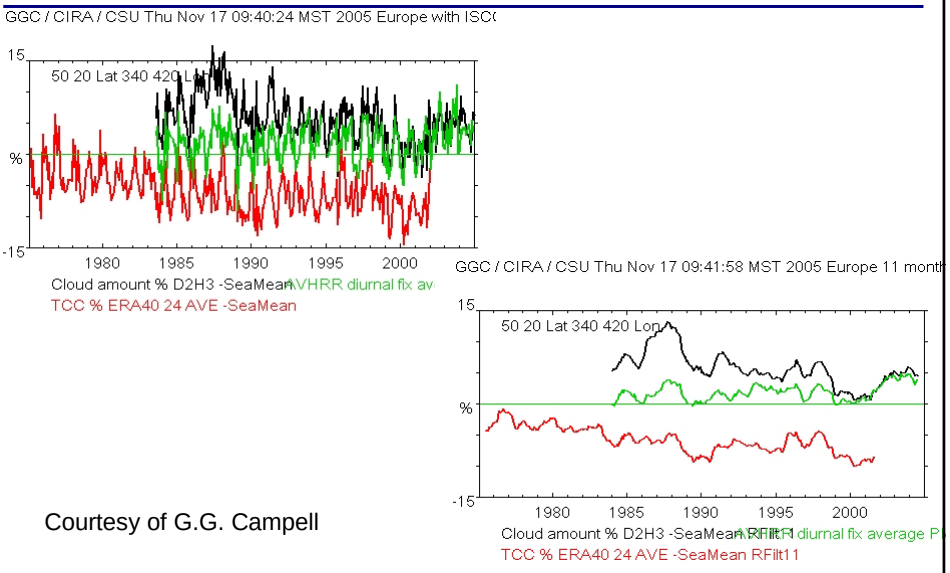
CM-SAF: Cloud products today



CM-SAF: Products in 2007-2012

- high resolution (~(3km)^2) cloud and surface radiation products from AVHRR and SEVIRI imagers;
- medium resolution water vapour profile (~(25km)^2)and total integrated water vapour information from MetOp instruments (IASI, ATOVS, GRAS, GOME-2); [planned as federation activity between CM-, GRAS, and O3M-SAF];
- medium resolution upper tropospheric humidity available as ~30 years series from all Meteosat platforms (MVIRI and SEVIRI instruments); [collaborative effort of CM-SAF and LMD];
- high resolution water vapour information at radiance level and integrated water vapour content from SEVIRI.
- there is an option for a precipitation product for SEVIRI coverage but depend on available funding.

ERA40 vs. satellite cloud climatology



Courtesy of G.G. Campell

Concluding remarks

- DWD has strong experience in regional modelling, high quality in situ measurements, and satellite climatology.
- Potential contributions to EURRA can be on the fields of model development, validation of reanalysis, and possibly in the provision of homogeneous level 1 satellite data.
- The CDOP (2007-2012) of EUMETSAT Satellite Application Facilities will run in parallel to the EURRA project, i.e. a structural frame to support EURRA is existing.
- CM-SAF may take lead of integration of SAF network products related to climate, e.g. assure same grids.
- Radar data for assimilation ???

CM-SAF Web - access

CM-SAF homepage:

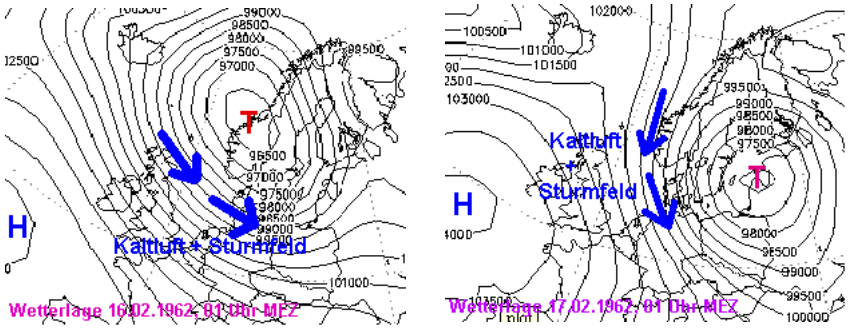
www.cmsaf.dwd.de

CM-SAF Web User Interface

SPARE SLIDES

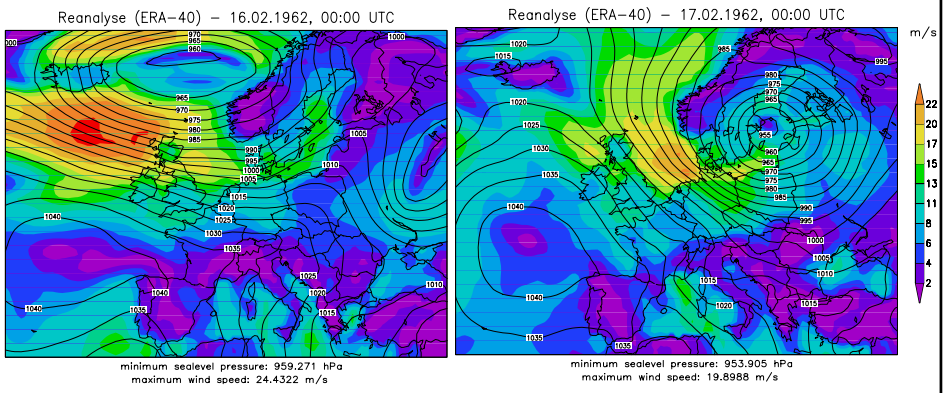
Hamburg storm surge 1962

Surface analyis 16/17 February 1962, 00:00 UTC



Hamburg storm surge 1962

ERA 40 16/17 February 1962, 00:00 UTC



Hamburg storm surge 1962

LM simulation
16/17 February 1962, 00:00 UTC