Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Statistics on snow reporting practice in Europe

Martin Lange, Gerhard Paul, DWD

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Snapshot on snow reporting practice in Europe

Martin Lange, Gerhard Paul, DWD

Outline

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Snapshot of present reporting practice for selected dates

Investigation of snow depth reports in database wrt

- Recent changes
- Report type / Station type, data format
- Reporting frequency / reporting times
- Reporting practice in case of no snow /
  - multiple reports per station

Big improvement in snow data aquisition

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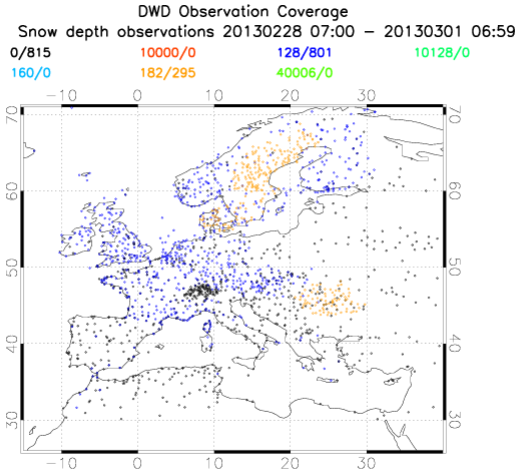
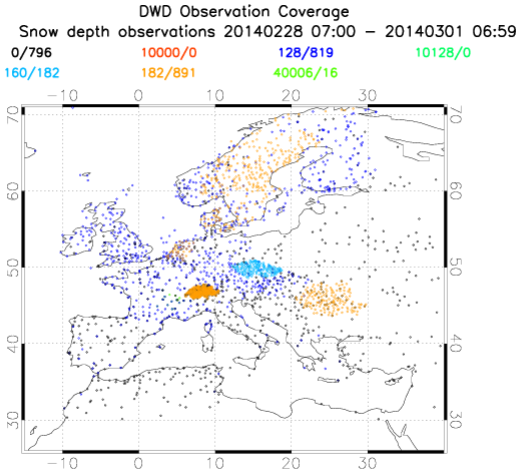
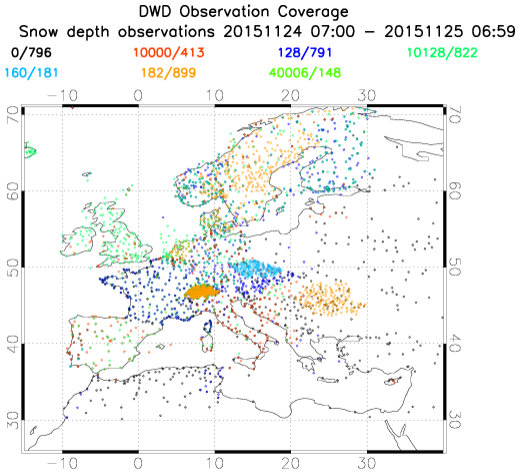
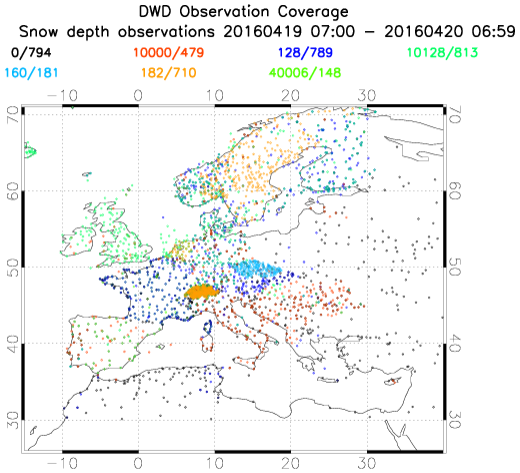
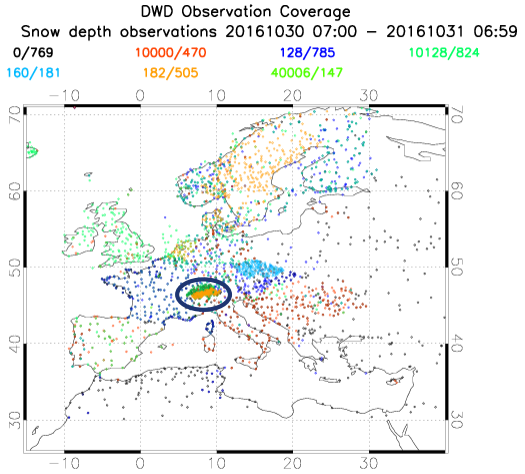




additional obs for Suisse,
Sweden, Czech., Romania







switch to new bufr format in
several countries

numerous reports in TAC format
still
Less reports from suisse (?)

Snow obs sorted by internal ID

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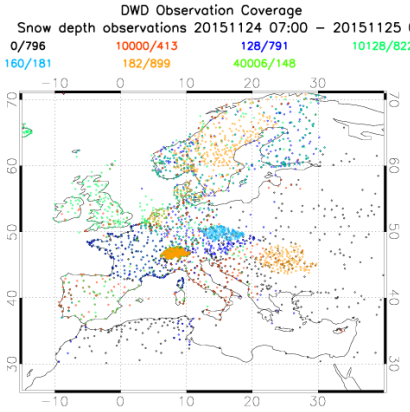

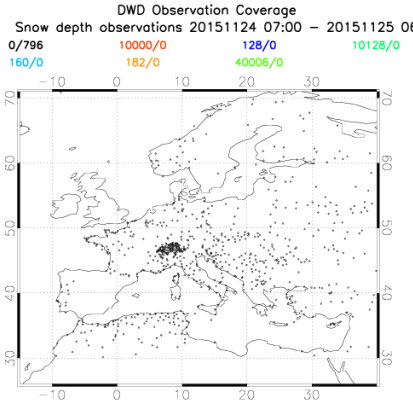

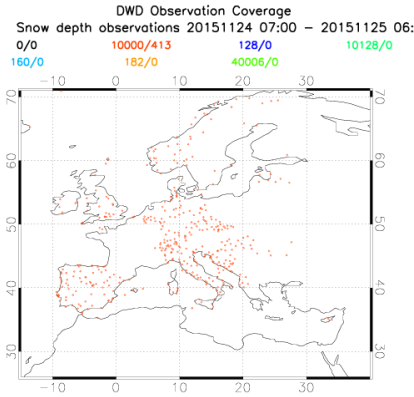

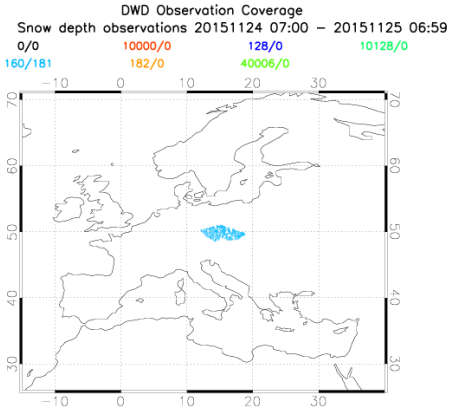

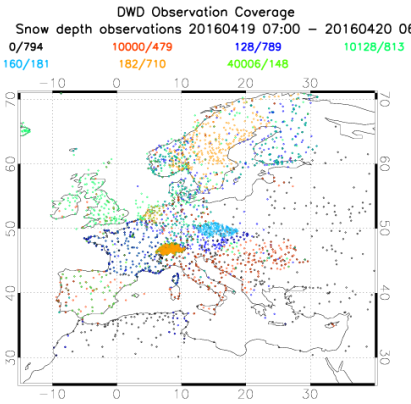

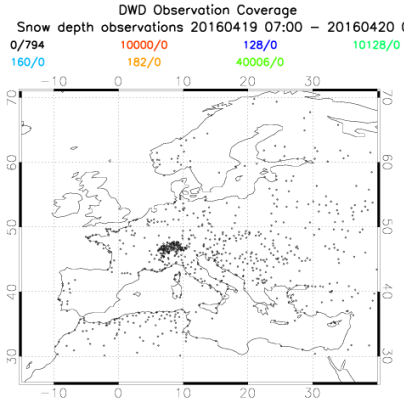

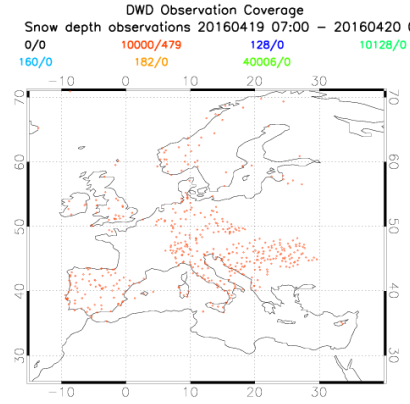

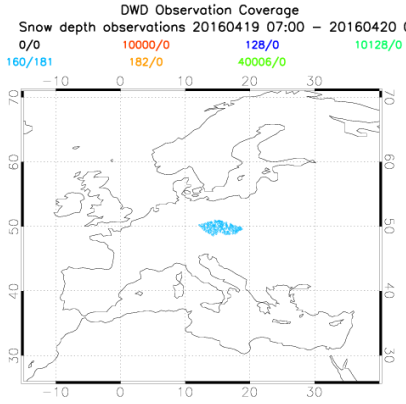

Snow obs sorted by internal ID

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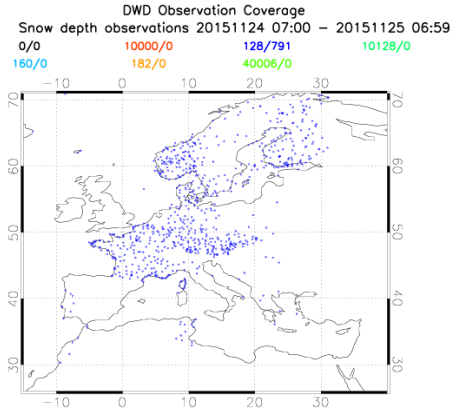

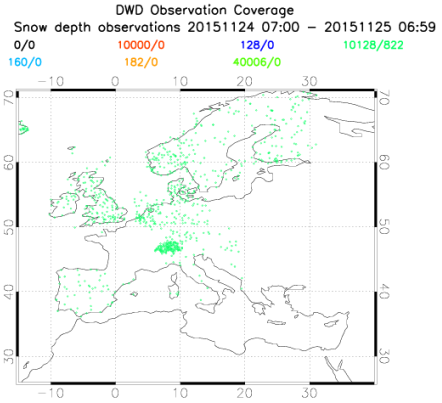

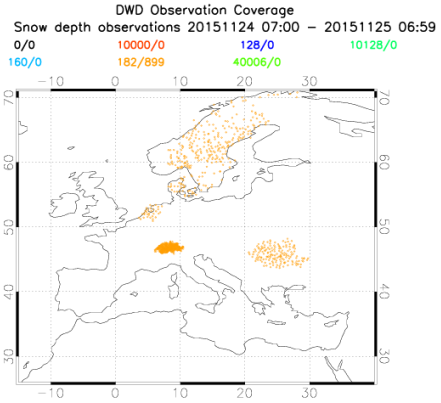

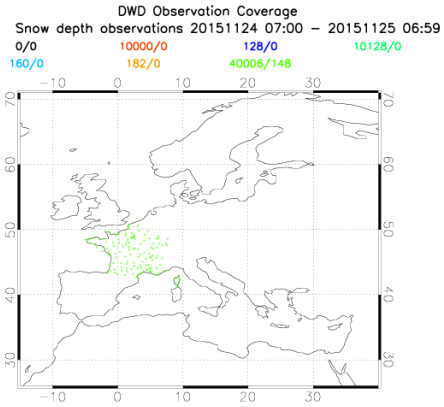

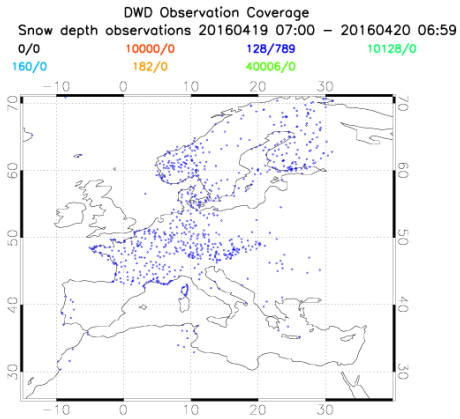

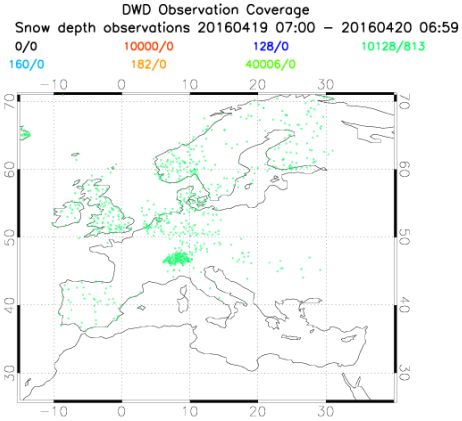

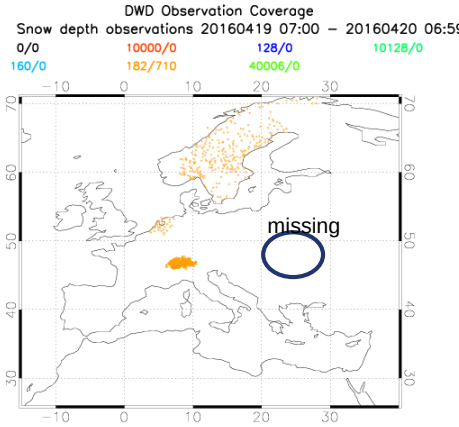

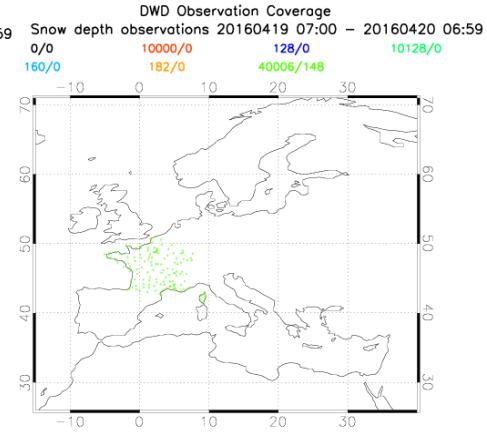

Temporal frequency in snow reports

Hourly snow reports over 24 hour period

Change of reporting in winter 2016

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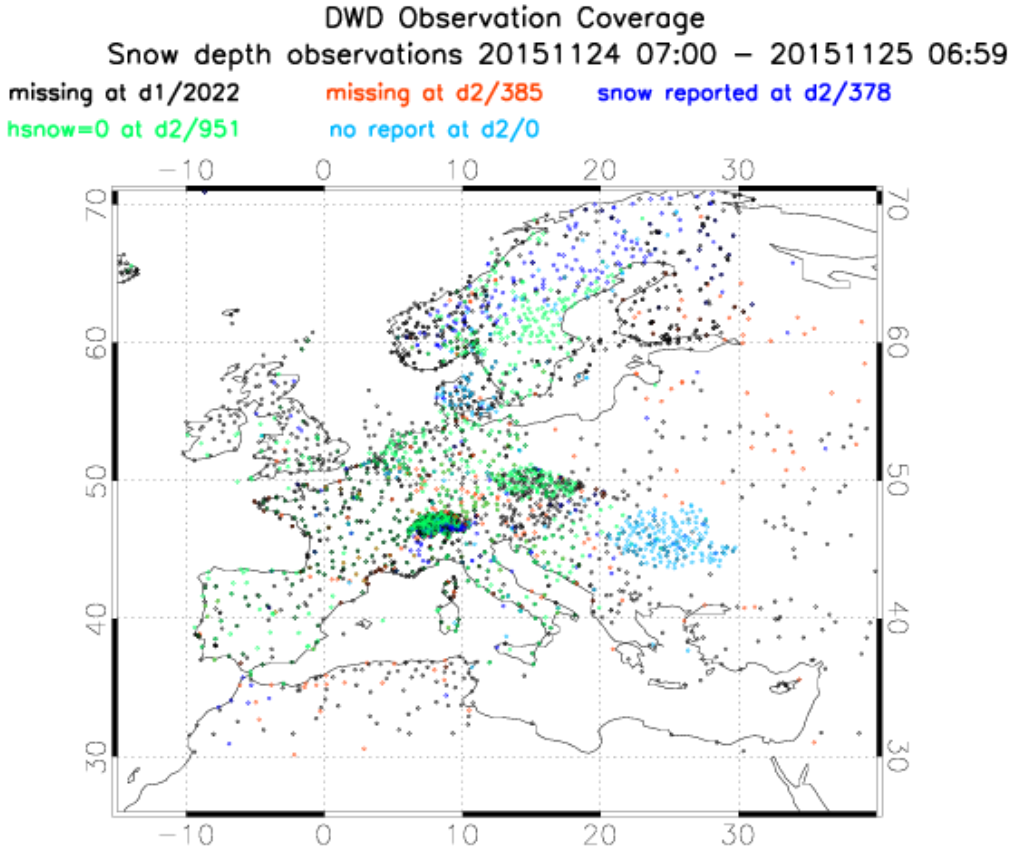
24 hour snow depth data 20151125 vs 20160420



Multiple reportings

Does missing value at second day mean that there is no valid report?

Reports for one station with different reporting type

Conclusions

- Big improvements in snow data aquisition in Europe
- Some of new report types occur once daily at 6:00.
  Single reporting in SE Europe vanished in last winter, therefore hourly regular manual reports increased.
- Further activities to get more zero snowdepth reports

How to further improve the snow database in the analysis?

- Investigation of „state of ground“ as complementary information
- Generate list of stations which still do not report zero snow depth
- bufr format should contain information on instrument type

Thank you for your attention

Conclusion / todo

How to further improve the
- Investigation of „state of ground“ as complementary information
- bufr format should contain information on instrument type
- Generate list of stations which still

Cooperation in use of satellite data ?
- review of existing and future available products
- share investigations / knowledge

Cooperation in DA methods?
- Any plans for new developments / Ensemble methods
- How to assimilate satellite information (snow cover / snow depth)

For discussion
- how to handle different observations if both are present? (automated vs manual, priorisation, higher weight to less frequent obs)
- Future activities on observation processing e.g. satellite data?
- Future discussion on observation errors / uncertainties
- How to best use information on snow cover? (orog

Temporal frequency in snow reports

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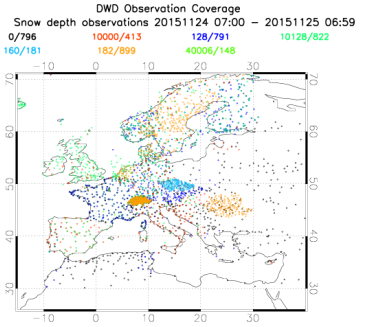
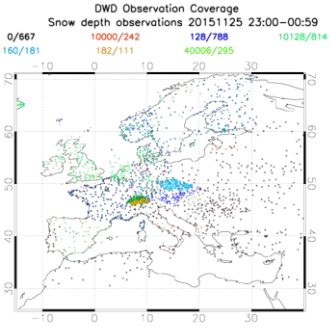
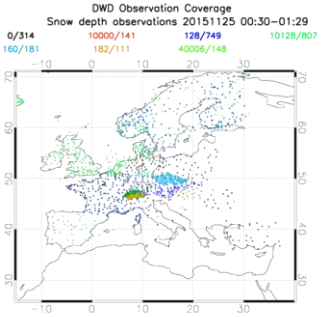
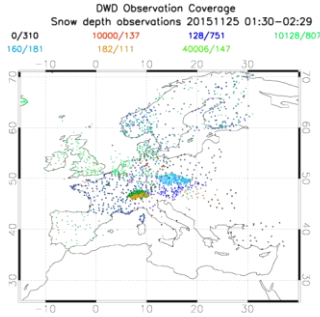
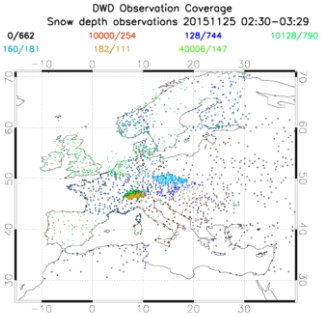


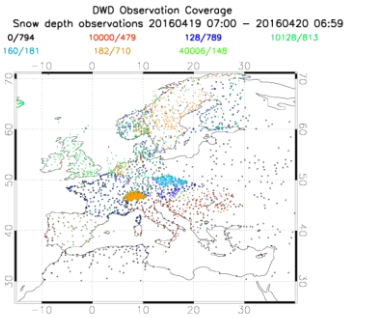


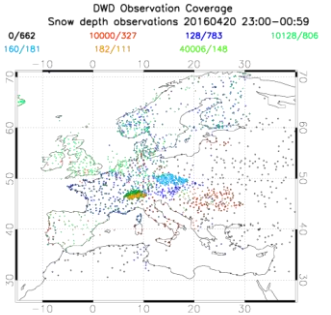


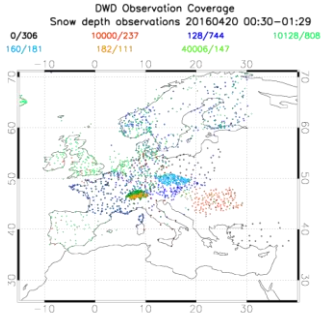


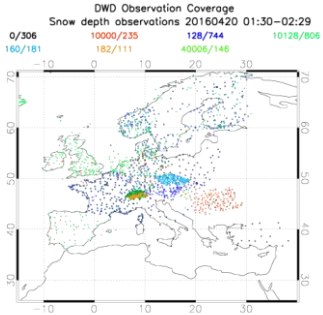


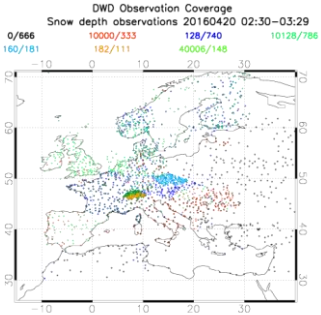
Hourly snow reports over 24 hour period











Snow obs sorted by observation time

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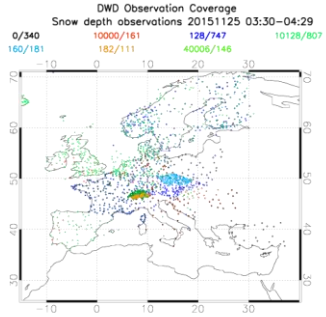

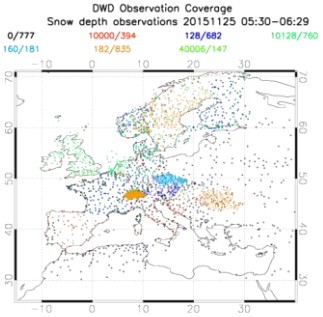

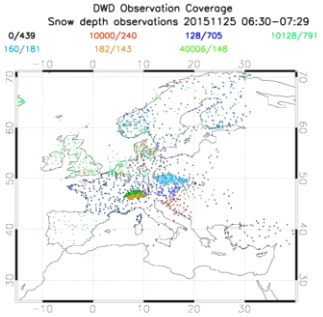

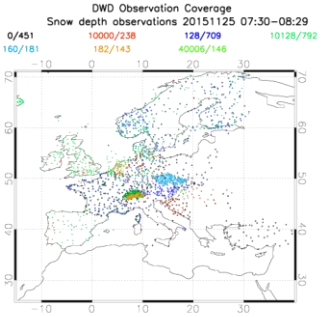

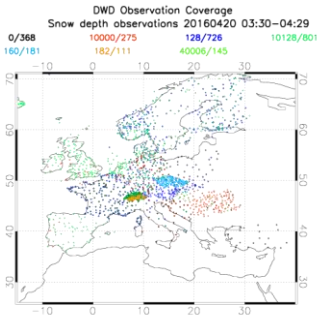

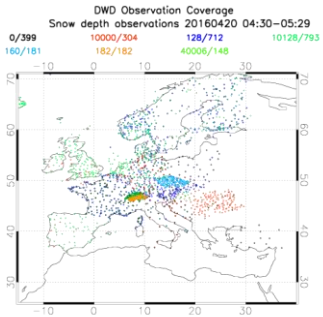

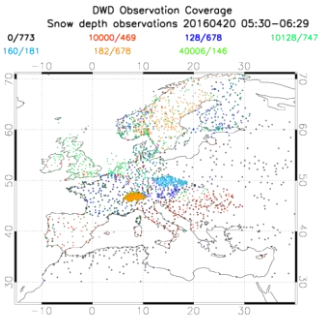

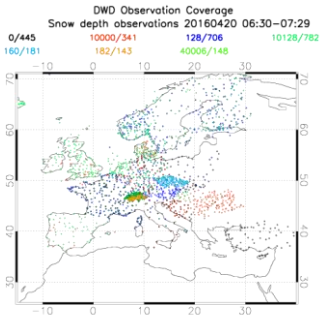

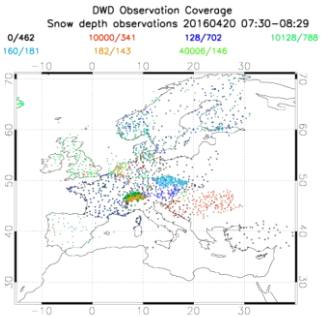

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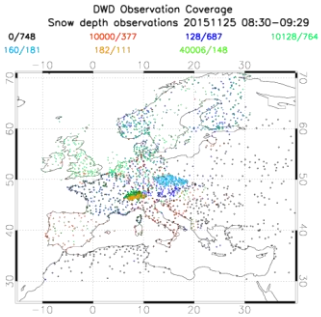

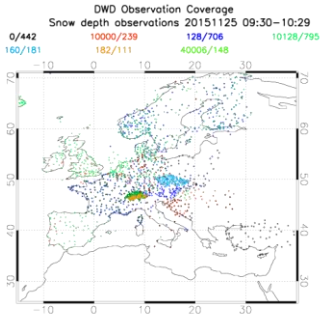

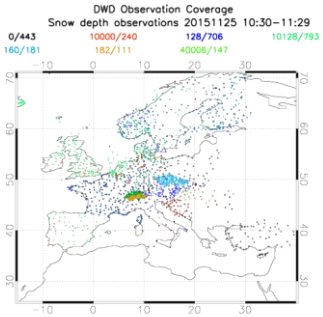

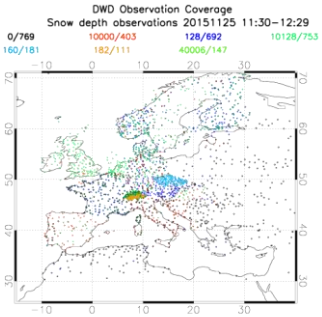

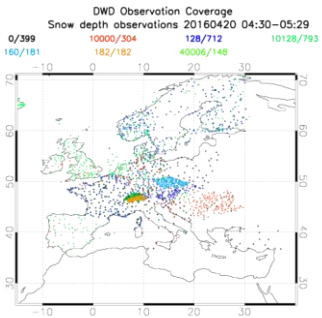

Big achievements in snow data aquisition

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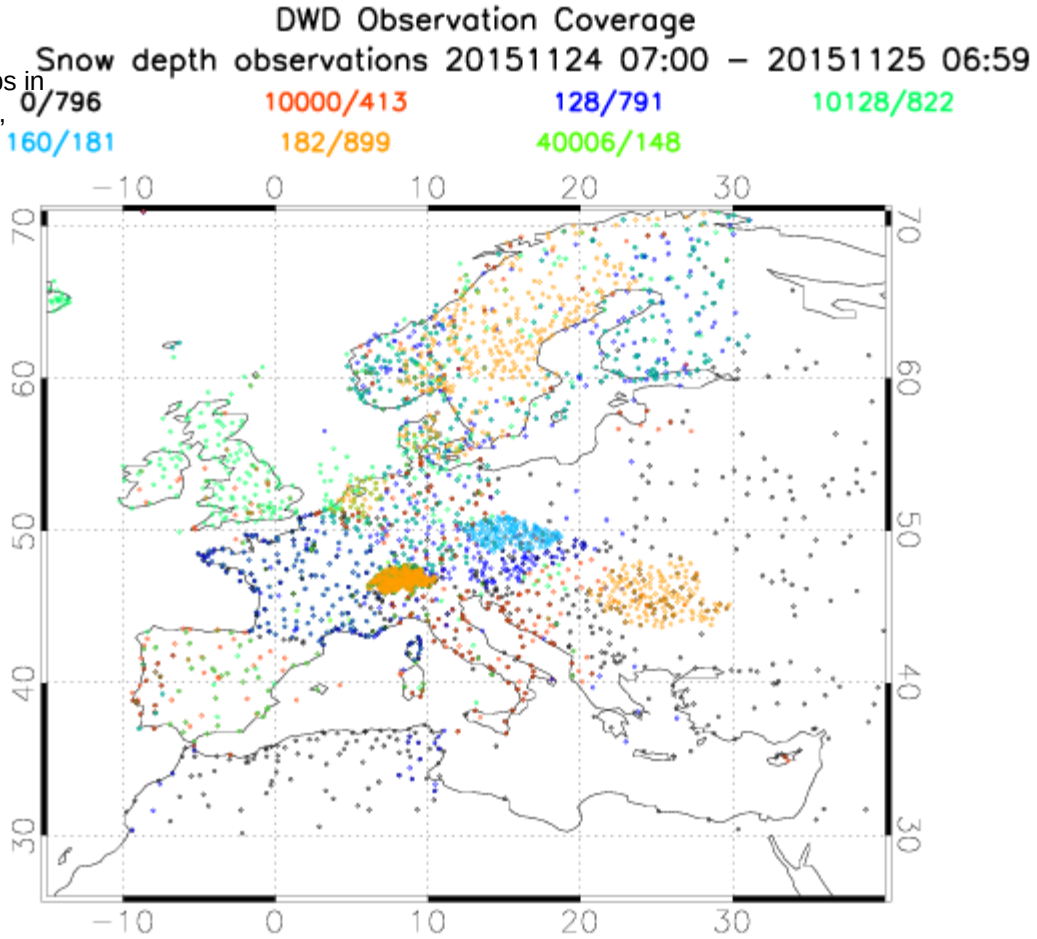
more reports from manual obs in new bufr format in se europe, more frequently
-> 1 hourly obs 20151125 / 20160420



Motivation to take part in es 1404

Old fashioned snow analysis package

➔ Cressman method, indirect use of satellite data in regions of sparse obs coverage through NOAA snow depth analysis.

Opportunity to get appropriate background for improvement/revision of the system.

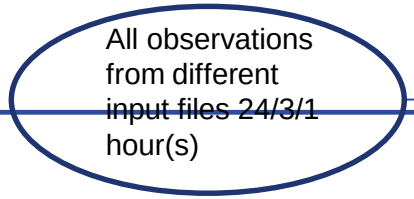
➔ Get an overview over present analysis practice, w.r.t. assimilation methods and best use of different types of observations (assimilation window, use of satellite data, SWE measurements)

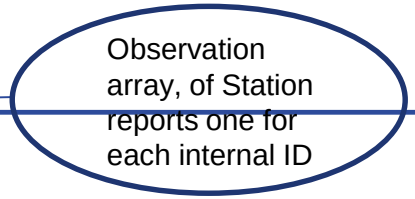
➔ Getting info about further data sources, getting in touch with experienced colleagues on interdisciplinary base and potential future data providers.

➔ Bringing own ideas into the community

Snow analysis scheme

- 3 hourly cycled Cressman analysis 
- Observation driven, bg from pre-analysis
- Analysis of H_SNOW, Diagnostics of Freshsnow factor a measure for albedo change from old to new snow, i.e. 5 cm of new snow increase the factor from 0 to 1.





Datatype for Station reports

Recent changes

- Location
- Internal ID
- Array with index of station report (One for each internal ID)

frequent measurements >=1/hour
regular measurements 1-4/day
low frequent climatological measurements 1/week

tac – traditional alphanumeric codes (int.id=0-manual/128-automated)
bufr- int.id=10000-manual/10128-automated international bufr templates contain more station specific information than earlier tac‘s which needed additional tables to be decoded and transformed to

Snow analysis scheme

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Cressman Method, Successive Correction

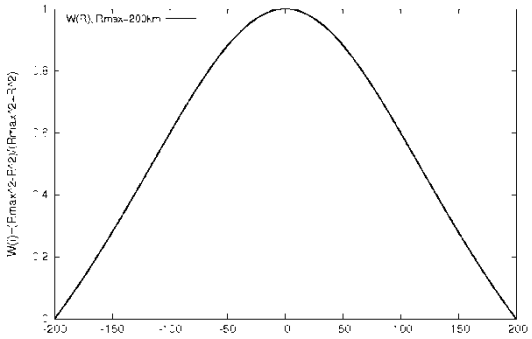
$$f_i^A = f_i^B + \sum_k w_k h_k D_k$$

$$D_k = f_k^O - f_k^B$$

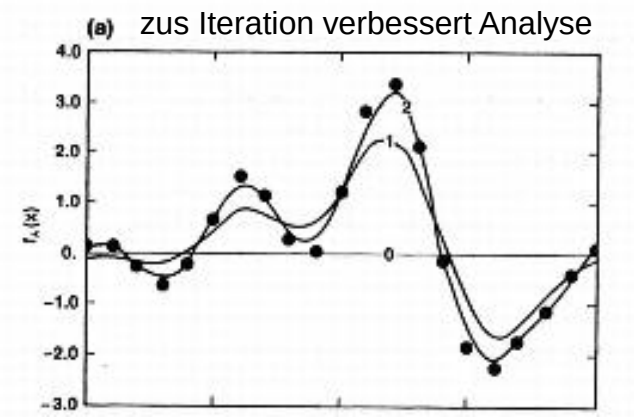
$$w_k = \max\left(0, \frac{(R_{\max}^2 - R_k^2)}{(R_{\max}^2 + R_k^2)}\right)$$

$$h_k = \max\left(0, \frac{(Z_{\max}^2 - Z_k^2)}{(Z_{\max}^2 + Z_k^2)}\right)$$

Weight function in successive correction method



zus Iteration verbessert Analyse



External data input

- Snow height reports from synop stations, if not available 3-6 hourly precipitation sums in combination with screen level temperature, if not reported information from ww are extracted and converted to snow depth obs.
- Indirect use of satellite information through NOAA snow cover and snow depth over data sparse areas in northern hemisphere.
- Fixed snow depth of 40 m over permanent glaciers, snow density 200kg/m2.
- ERA 40 monthly climatology elsewhere

Modification of the scheme

- Tile approach
- Multilayer snow model
- Using more conventional data if available
- Update external data (Era interim, NOAA IMS snowcover)
- Direct use of satellite data
- New assimilation scheme

Summary

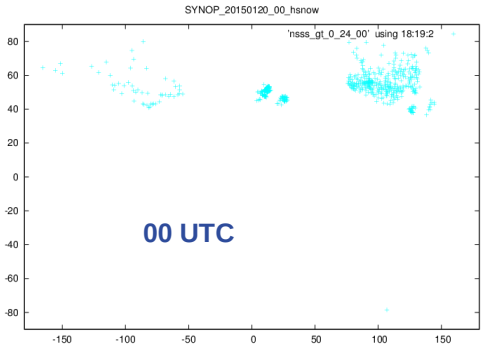
- Present analysis scheme needs revision, to be done in the next middleterm period. The atmospheric DA system is migrating to hybrid VarEnKF on global and LETKF on km scale (KENDA), surface analysis is not decided upon yet.
- COST ES 1404 is a perfect action to gain knowledge on methodologies for data assimilation and to get an overview over snow data which are presently existing or available in future.
- It is also an ideal platform to bring ideas into the comunity.

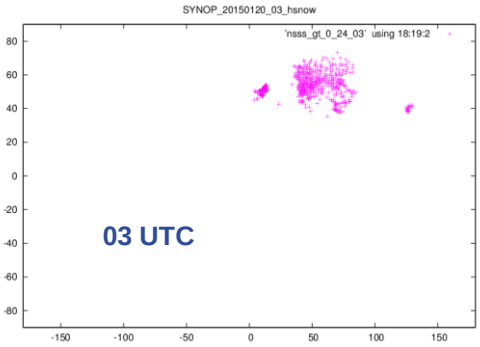
Main interests

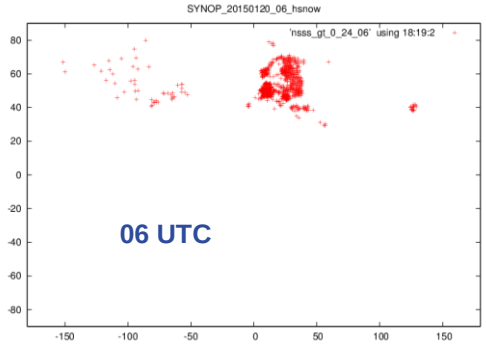
- ➔ New data sources: Making measurements from regional networks available through GTS
- ➔ DA methods, experiences with EnKF?
- ➔ Promoting derivation of snow fraction.
  - Interesting for initialisation of snow tiles, snow free area has strong impact on surface fluxes.
  - In NWP even more important than exact knowledge about snow height.
- ➔ Promoting measurements or derivation of SWE (multilayer analysis).
- ➔ Testbed for Intercomparisons between different model outputs

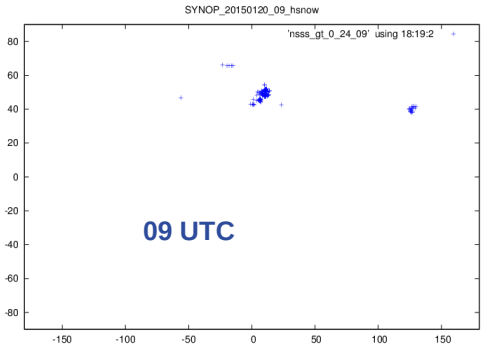
Obs H_SNOW at different times

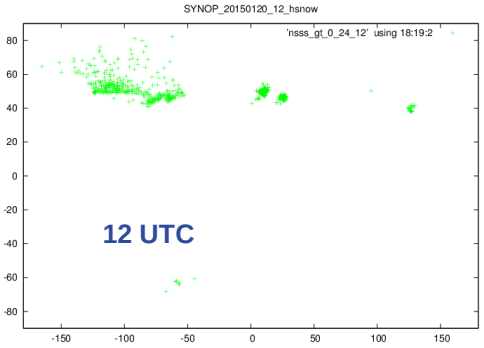
Deutscher Wetterdienst
Wetter und Klima aus einer Hand

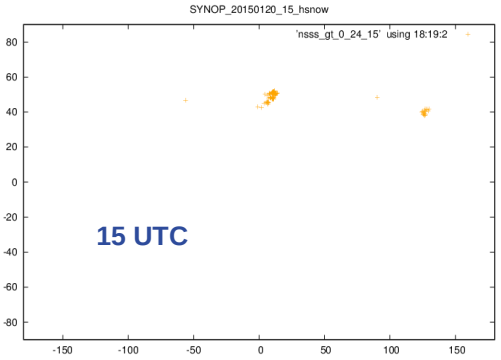


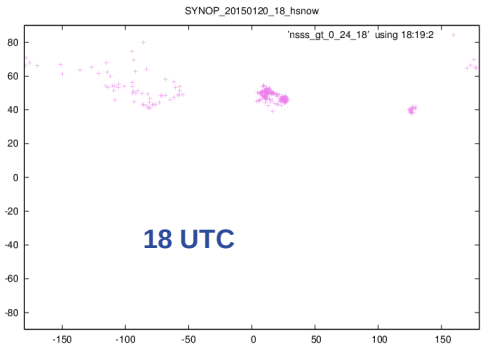


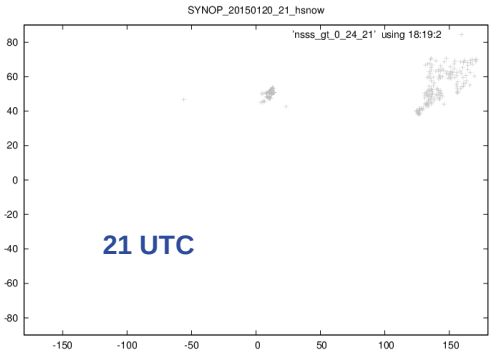












Global EDA (VarEnKF) Development

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Current State

3dVar → Det. Analysis → Det Forecast

Level 1

VarEnKF → EnKF Ensemble
VarEnKF → Det. Analysis → Det Forecast

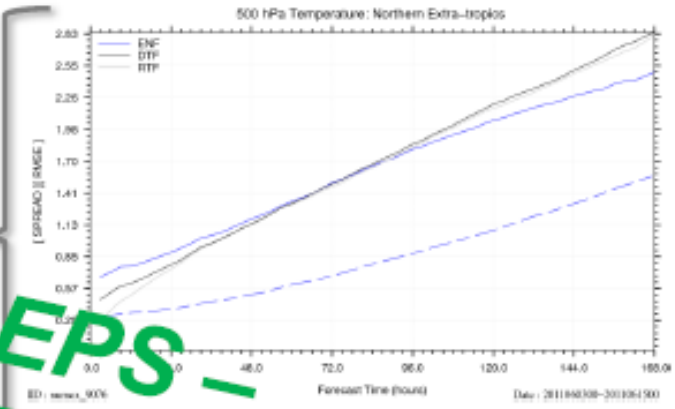
Level 2

VarEnKF → EnKF Ensemble → GlobalEPS
VarEnKF → Det. Analysis → Det Forecast

Level 3

VarEnKF → Additional Perturbations, EnKF Ensemble → Integrated Ensemble → GlobalEPS
VarEnKF → Det. Analysis → Det Forecast

Deterministic Forecast

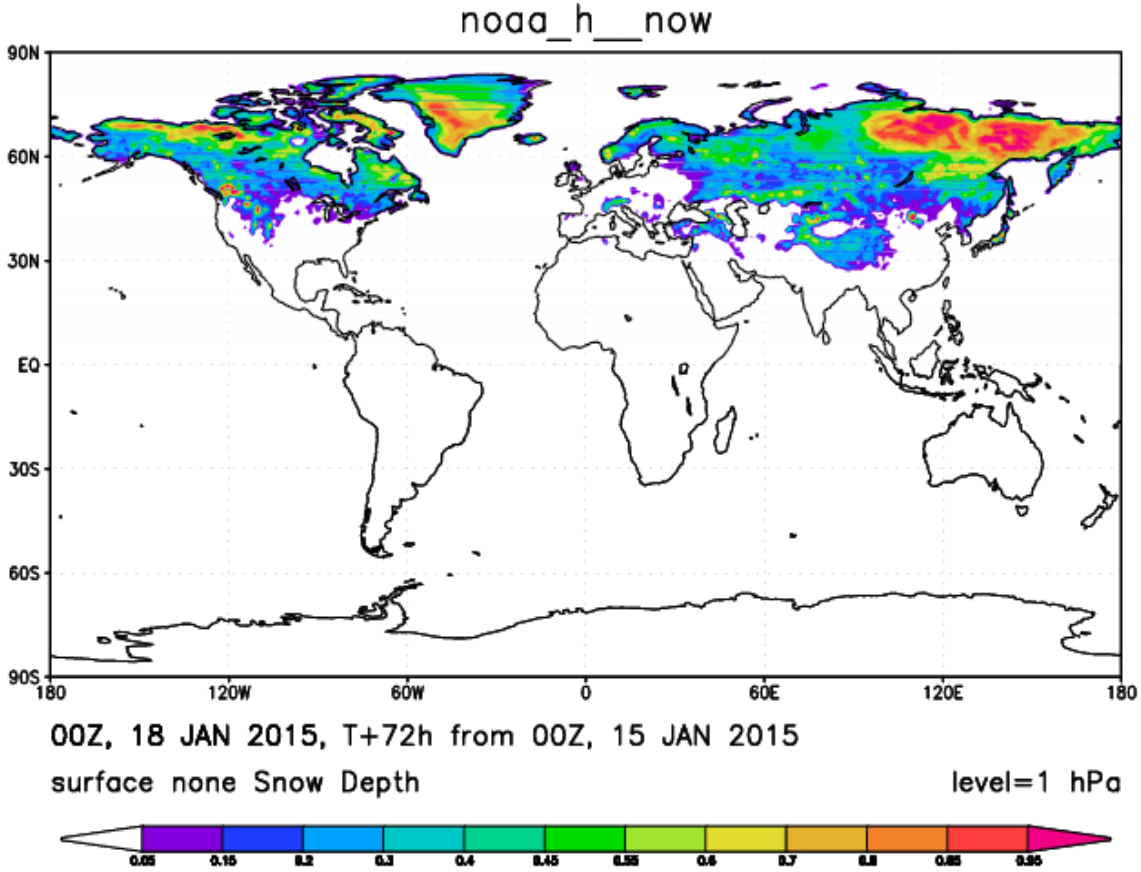


EPS – Ensemble Prediction

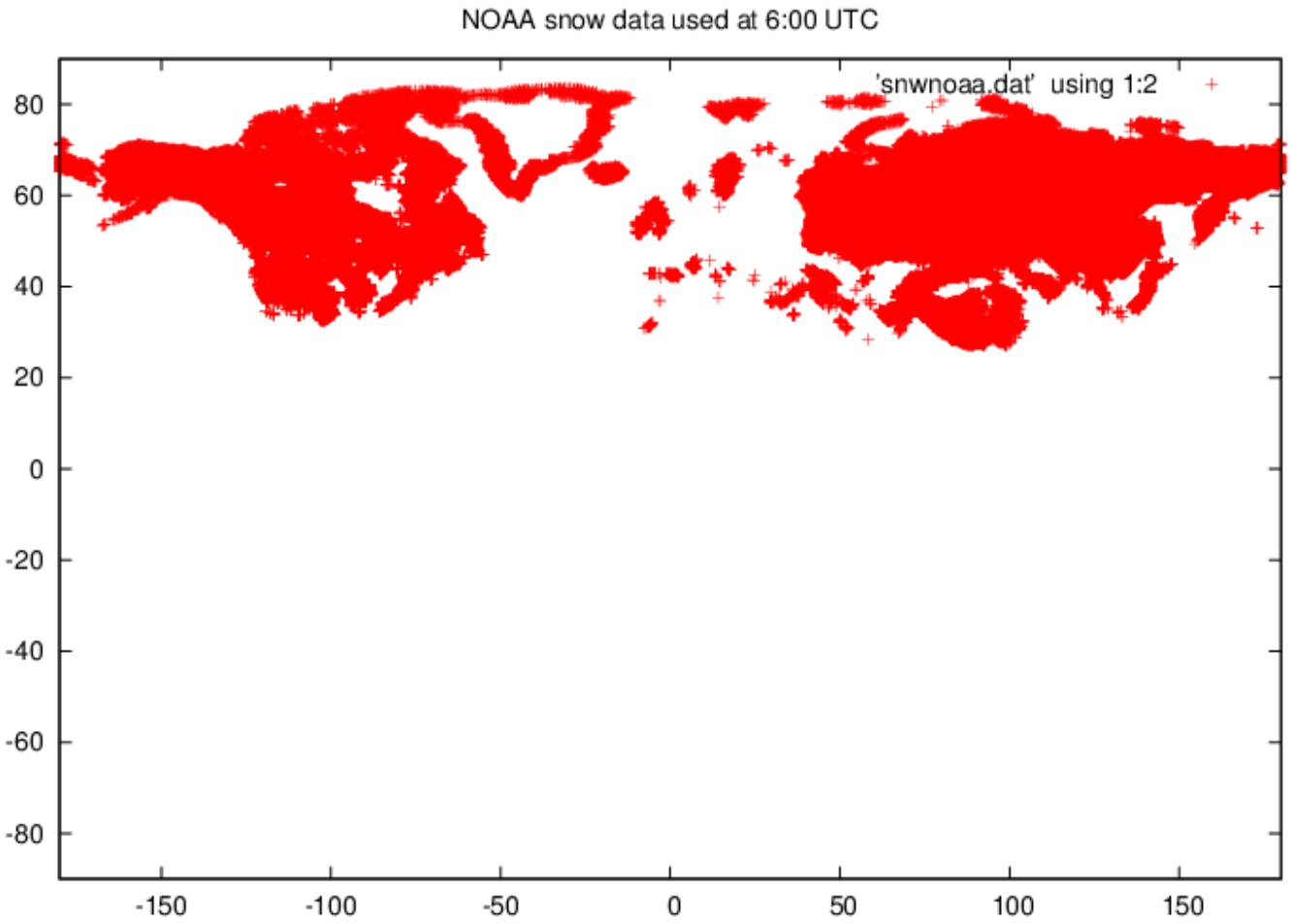
Project related issues

- ➔ Main interests
  - Making measurements from regional networks available through GTS
  - DA methods, experiences with EnKF?
  - Testbed for Intercomparisons between different model outputs
- ➔ New data sources
  - potential additional measurement networks in russia

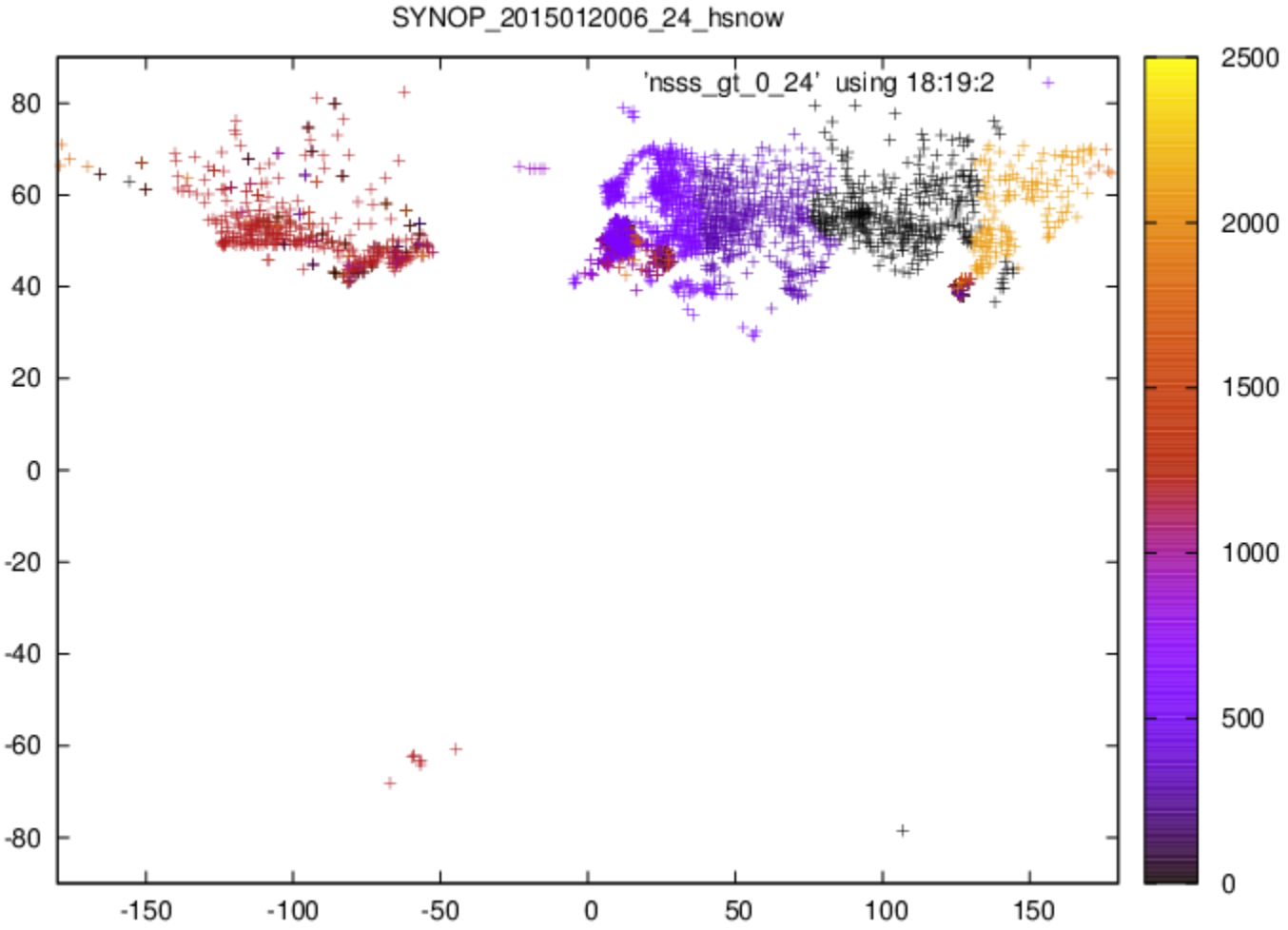
NCEP snow depth analysis, northern hemisphere



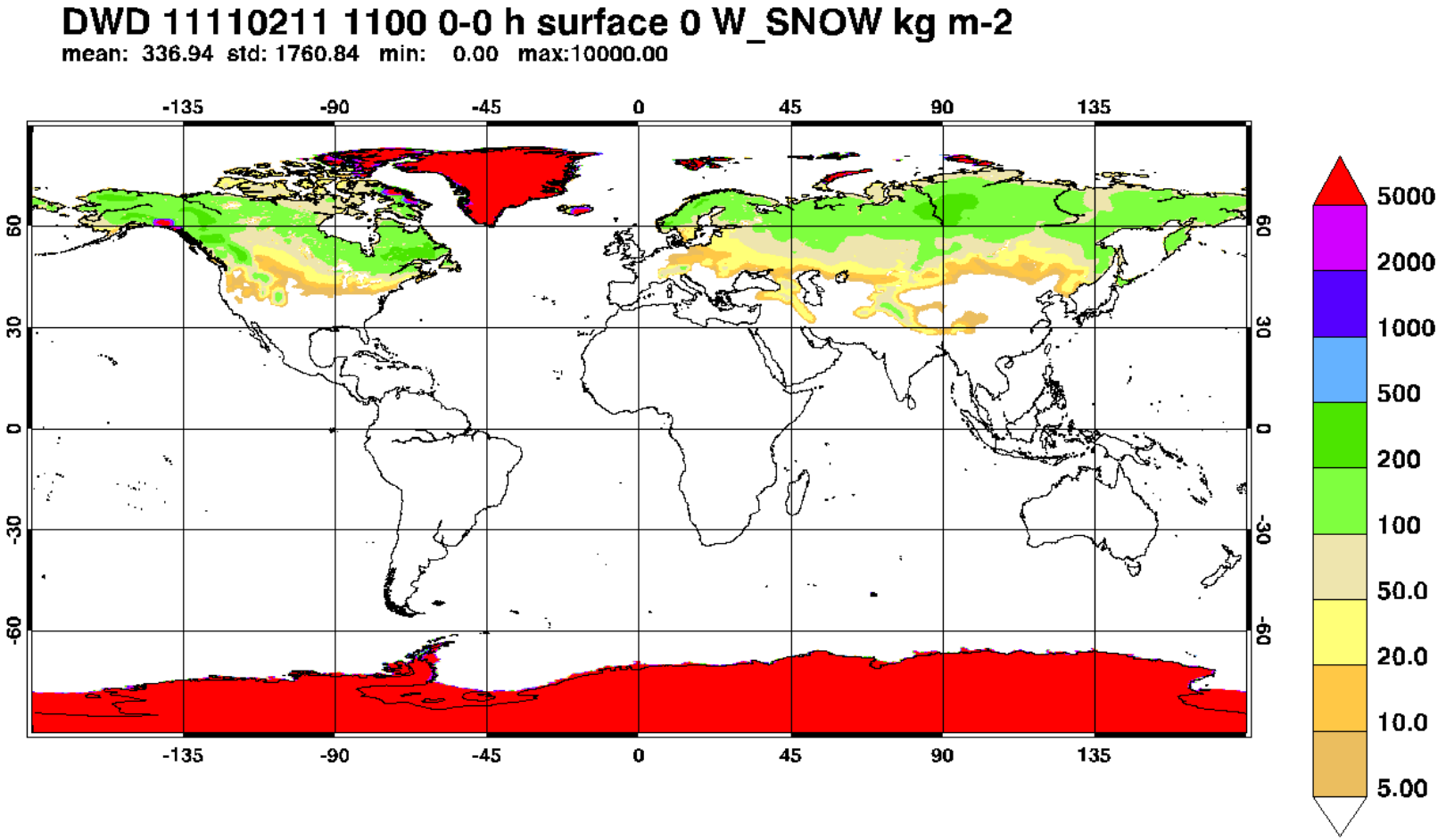
NCEP snow used in 06 UTC ICON snow analysis



Snow height Observations at different report times



Climatology from ERA 40



Cressman method

Successive correction

- ➔ Calc weight with obs for a given search radius, start second scan with shorter radius if enough obs available.
- ➔ snow height observations, if not enough then
- ➔ Precipitation in combination with temperature
- ➔ synop reports
- ➔ Ncep snow data over data sparse areas which use satellite based information

limit ncep snow increment

no positive adaptation if model decrease dz_snow < -50mm/6hrs

use derived snow depth increment from ww, precip. to adjust snow depth increment.:

Limiter and adjustments

Use derived snow depth increment from ww, precip. to adjust snow depth increment.:

- If weight(h_snow) < threshold and weight(ww,precip)>threshold

  if no snowfall is observed in precip,ww, snow increment=0

  if derived snow depth incremen >5mm and T<0.5°C
  no negative increment is allowed

```
C     FUNKTION ZUR BESTIMMUNG DES SCHNEEHOEHENZUWACHSES AUS WW
C     DSS IN MM/6h
      DSS(A0,A1,A2,B1,B2,T0,T) = A0 + A1 * EXP(B1*(T-T0)) + A2*EXP(B2*(T-T0))

      4.3.5 SCHNEEHOEHENZUWACHS AUS W1
        ZRRW    = DSS(-5.,18.,0.,.03,0.,-5.,ZT) + DSS( 0., 1.,0.,.13,0., 0.,ZT)
        IF (ZRRW.LT.0.) ZRRW = 0.     ZRRWW   = ZRRWW + ZRRW
        ZWGWW   = ZWGWW + 1.
```

Snow analysis data input

Observation driven analysis, fg from pre-analysis

- ➔ Verfahren analog zu Icon Analyse, Besonderheiten des begrenzten Gebietes, I/O, Beobachtungsverarbeitung anpassen, G. Paul hier involviert,
- ➔ Ncep snow data over data sparse areas which use satellite based information

future modifications, partly input from the Cost forum is hoped for

- ➔ Modification of the scheme
  Switch to model fg as bg instead of preanalysis

- ➔ Using more conventional data if available
  Satellite data

Bodenanalysen für Icon NEST

- **Step 3:** (April 2015) **Bodenanalysen für ICON NEST**
  Implementation läuft, viel Kleinkram und bisher Unterschiede zwischen COSMO und Globalmodell, wird homogenisiert und vereinfacht.

SST, Schnee-Analyse

- - nun analog zu globaler Analyse, statt zu regionaler Analyse wie ursprünglich geplant.
- - Vorteil: gleiche Felder im Input (NCEP SST; SEAICE) -> keine großen Inhomogenitäten z.B. durch unterschiedliche Eisverteilung (BSH in regionaler Analyse), weniger Aufwand zum Umbau der Programme (Anpassung des Analysegitters (keine zyklischen Rb‘s, Obs ausserhalb der Ränder berücksichtigen (?).
- Bis Experimentierversion verfügbar, Interpolation von globaler Ana via ICON-Remap