IOMASA
UAG2

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Goals for IOMASA Sea Ice

Overall Goal:

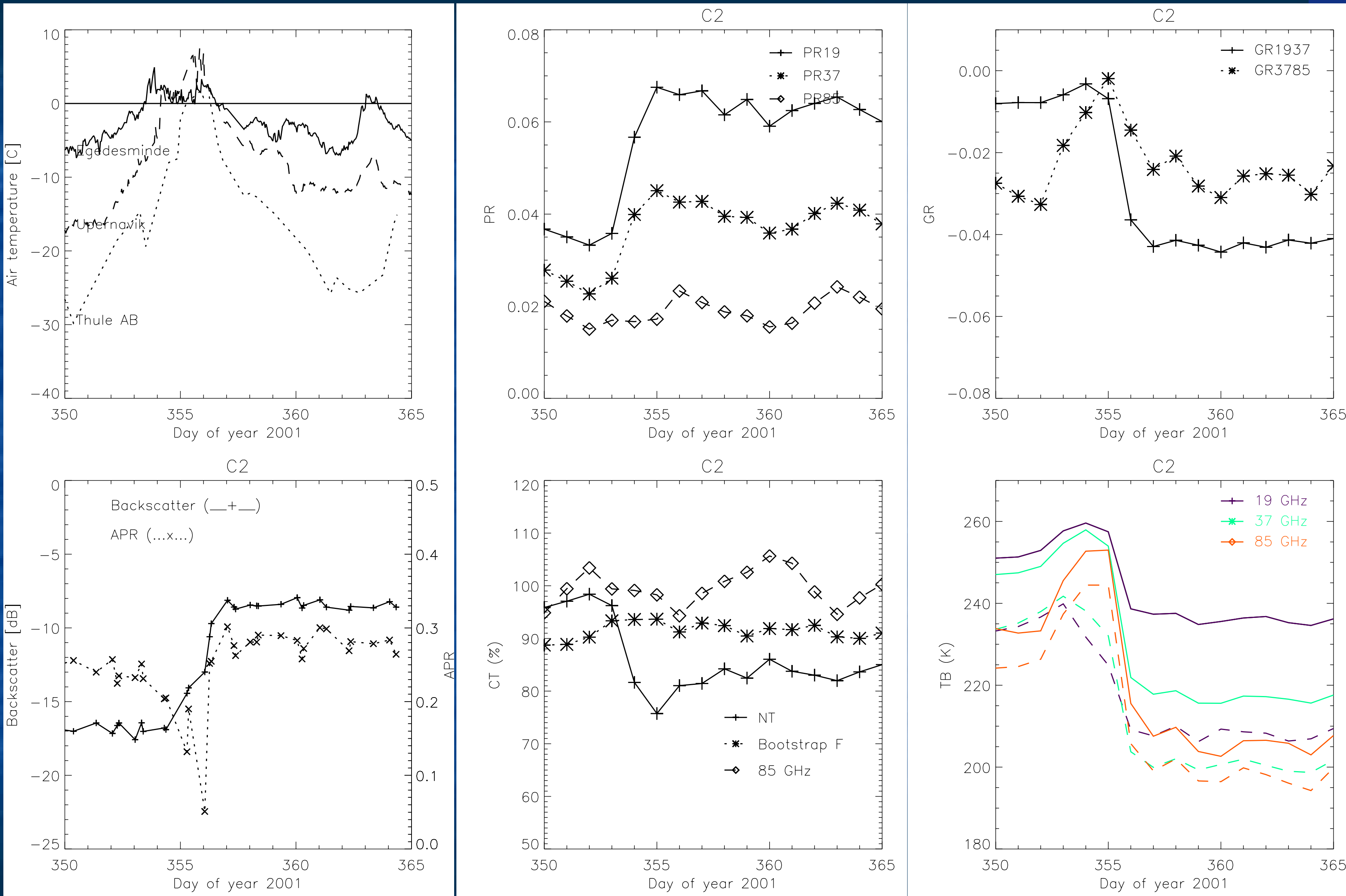
- Improve description and quantification of leads and polynias in daily hemispheric analyses.
- Benefits are expected also in the low concentration ranges/ice edge area due to improved description of ice properties (e.g. thin ice).

- Better accounting for sea ice/snow properties.
- Improved use of multiple sensors for concentration retrieval.
- Improved use of and better atmospheric fields over consolidated sea ice.
- Improved use of high resolution information/channels.
- Extensive validation/testing

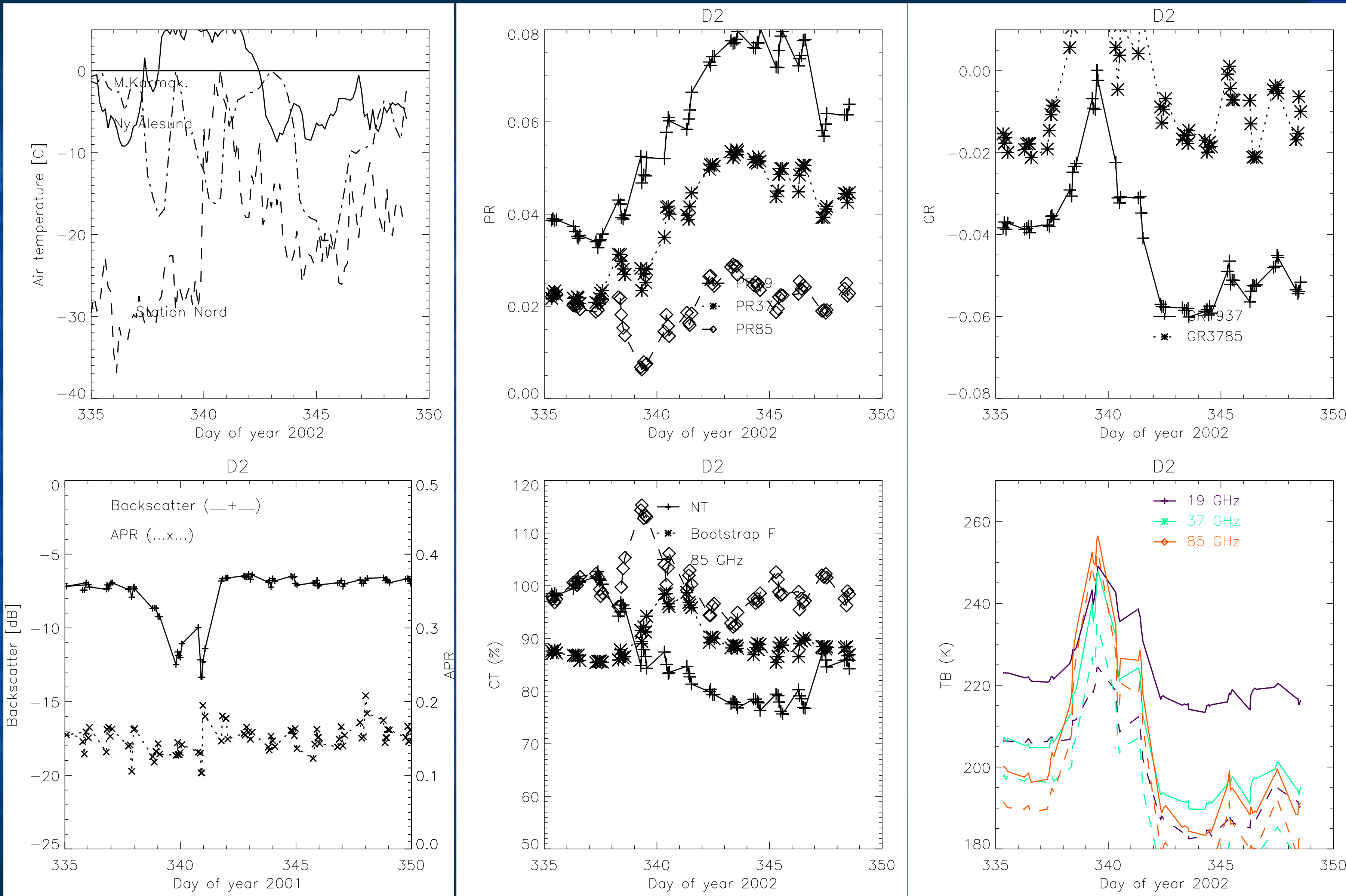
Status

- Results likely to enter operations soon
  - Ice/snow emission modelling
  - Concentration algorithm evaluation
  - AMSR processing
  - Routine SAR classification for validation
- Longer operational scope
  - Book-keeping
  - Thermodynamic model
  - Ice concentration system

Temporary melt in Baffin Bay December 2001

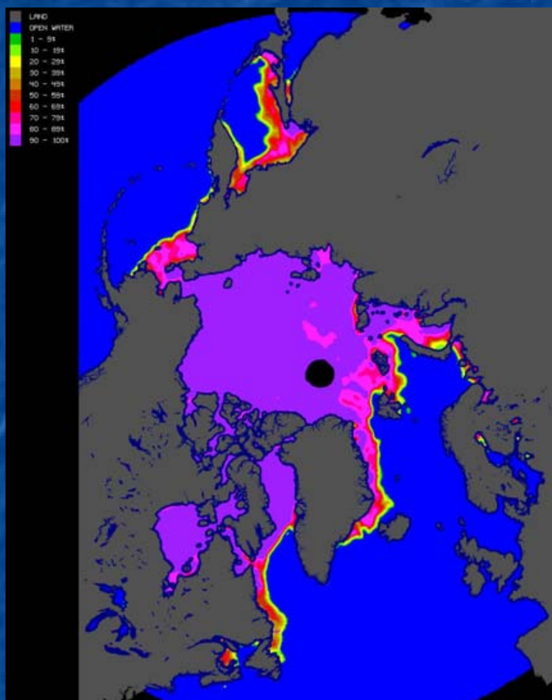


Temporary melt in the Arctic Ocean December 2002

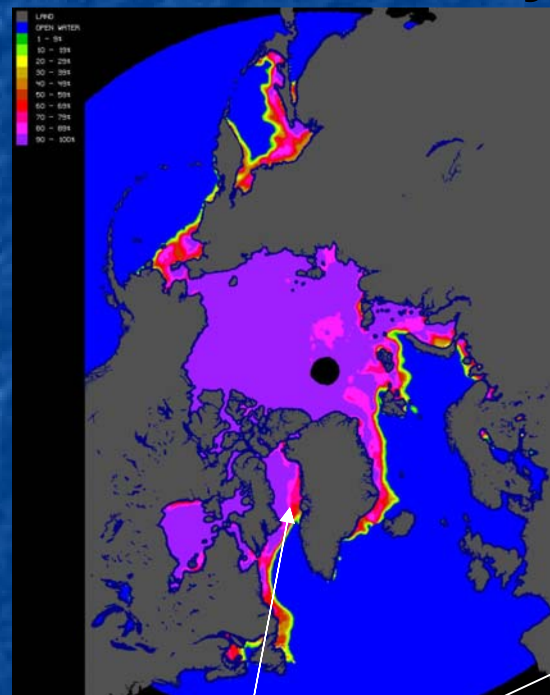


A recent example

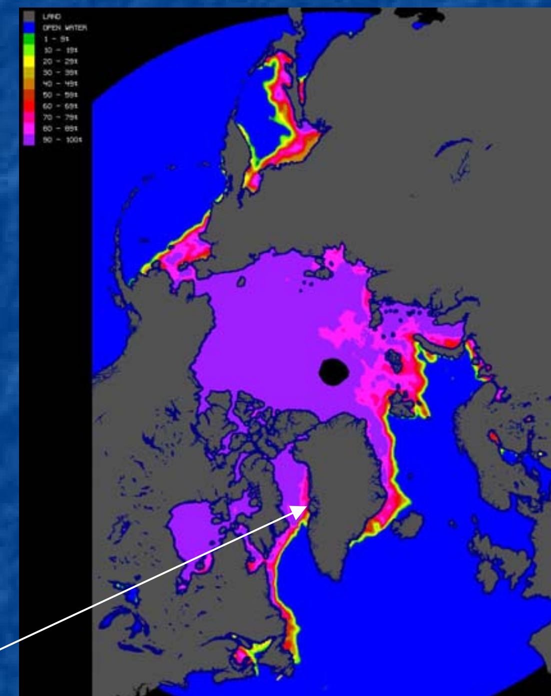
OSI-SAF NH analyses



Feb 18



Feb 20

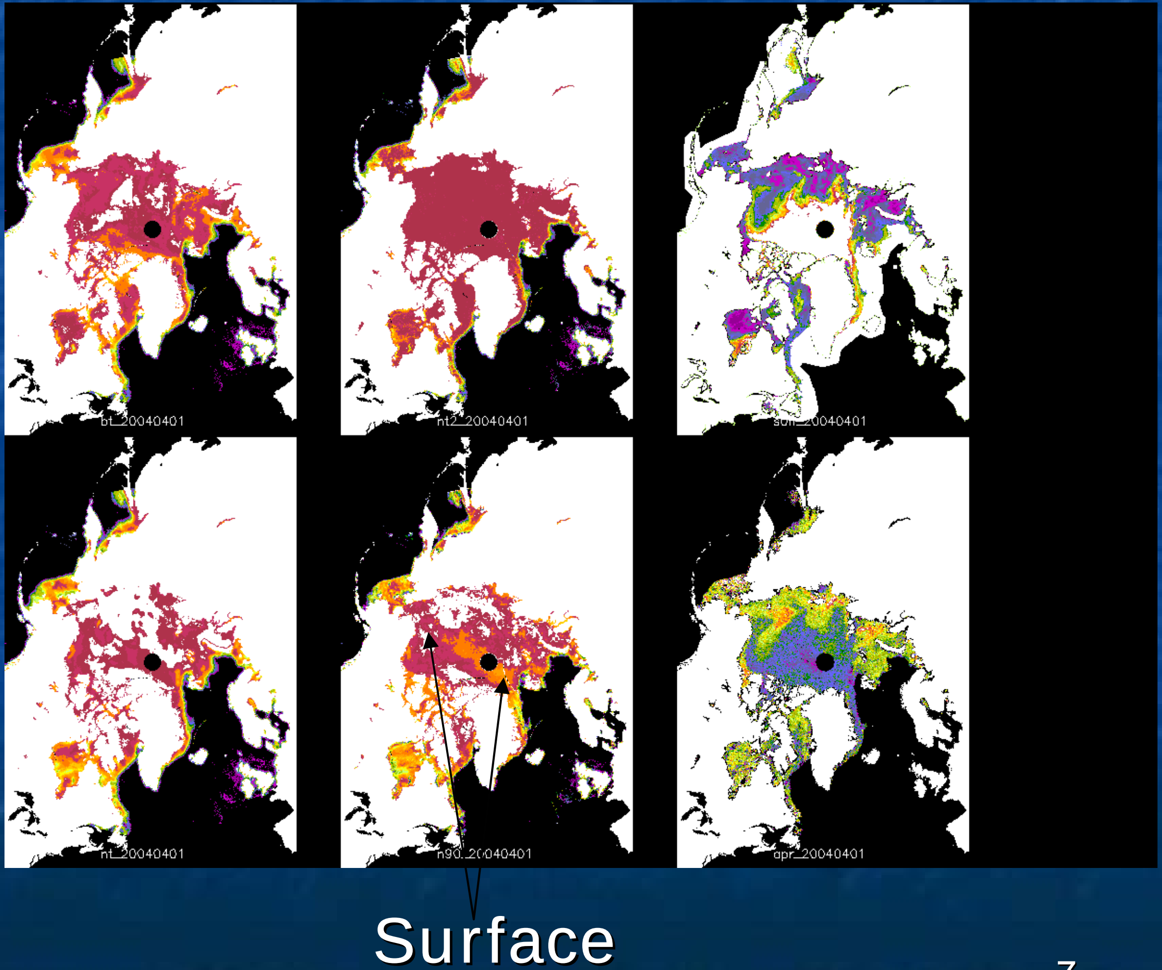


Feb 28

No such changes are found in available SAR imagery for the period

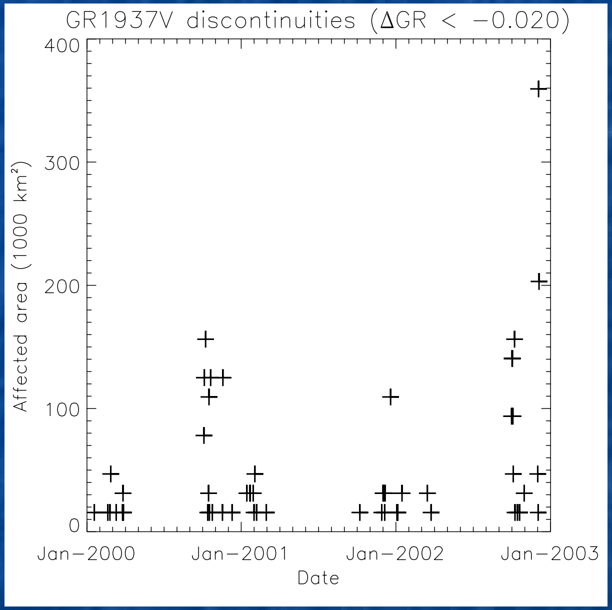
Observations April 2004

- NT2 is very stable
- Some long lasting 85 GHz depressions not noticed earlier



Melt detection

- Ice surface melt is common in in winter especially along the ice edge
- The ice emissivity and backscatter changes are long lived (< 3 months)



Emission modelling

- MEMLS obtained from C. Mätzler
  - Added sea ice module (->MEMLSI)
- In-situ ice profiles from Polarstern March 2003 and collocated AMSR Tbs through DTU
  - Grain sizes poorly defined
  - Snow described qualitatively at best
  - Lacks snow/ice density data for many stations
  - Representativeness/varying spatial scales?
- Initial sensitivity study
  - Draft report in progress

First-try, simulating AMSR measurements using MEMLSI and *in situ* observations, 23.03.2003 near 76.26˚N, 23.28˚E

Thick snow (36cm) profile on FY ice:

14 cm soft wind slab

0.1 cm thin icy layer

16 cm hard wind slab

6 cm depth hoar

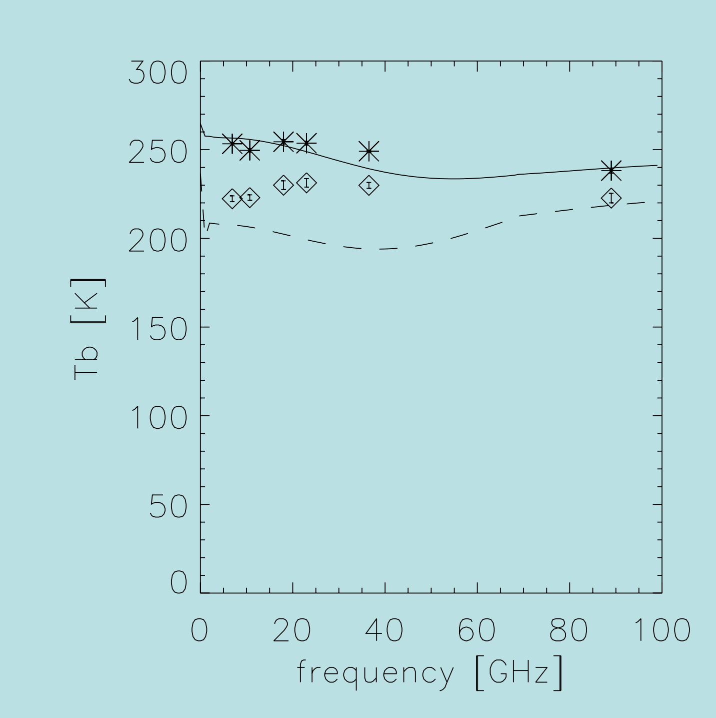
First year ice, S: 4-13.6 psu.

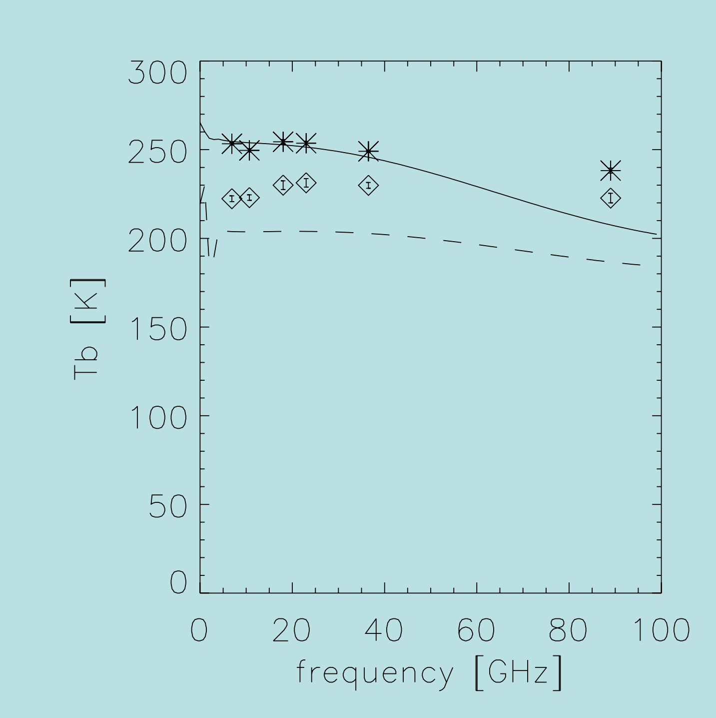
Thin snow (7cm) profile on FY ice:

4 cm hard wind slab

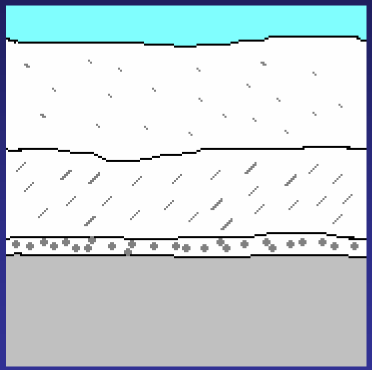
3 cm depth hoar

First year ice, S: 4.4-13.5 psu.

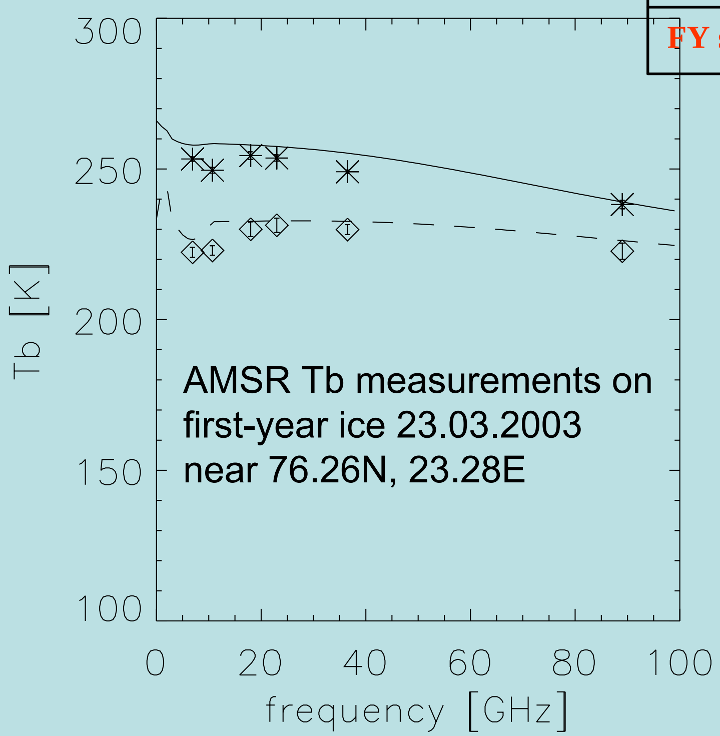




Profile used to initialise MEMLSI in sensitivity studies



Type	T[K]	Density [kg/m3]	Thickness [cm]	PCI [mm]	S [psu]	Snow/ice
Nearly new snow	253.0	260	7.0	0.05	0	Snow
Hard densified slap	257.0	410	5.0	0.08	0	Snow
Coarse grains	261.0	320	1.0	0.14	0	Snow
FY sea ice	262.0	920	2.0	0.18	7.0	Ice
FY sea ice	262.5	920	100.0	0.15	5.0	Ice

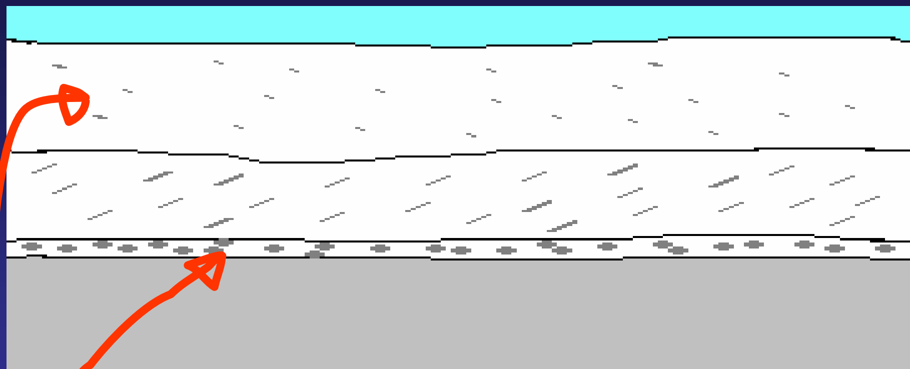


Important snow parameters:

•Density contrast between layers

•Correlation length (grain size)

MEMLSI simulations of ice concentration



NASA Team: sensitive to layer contrast.

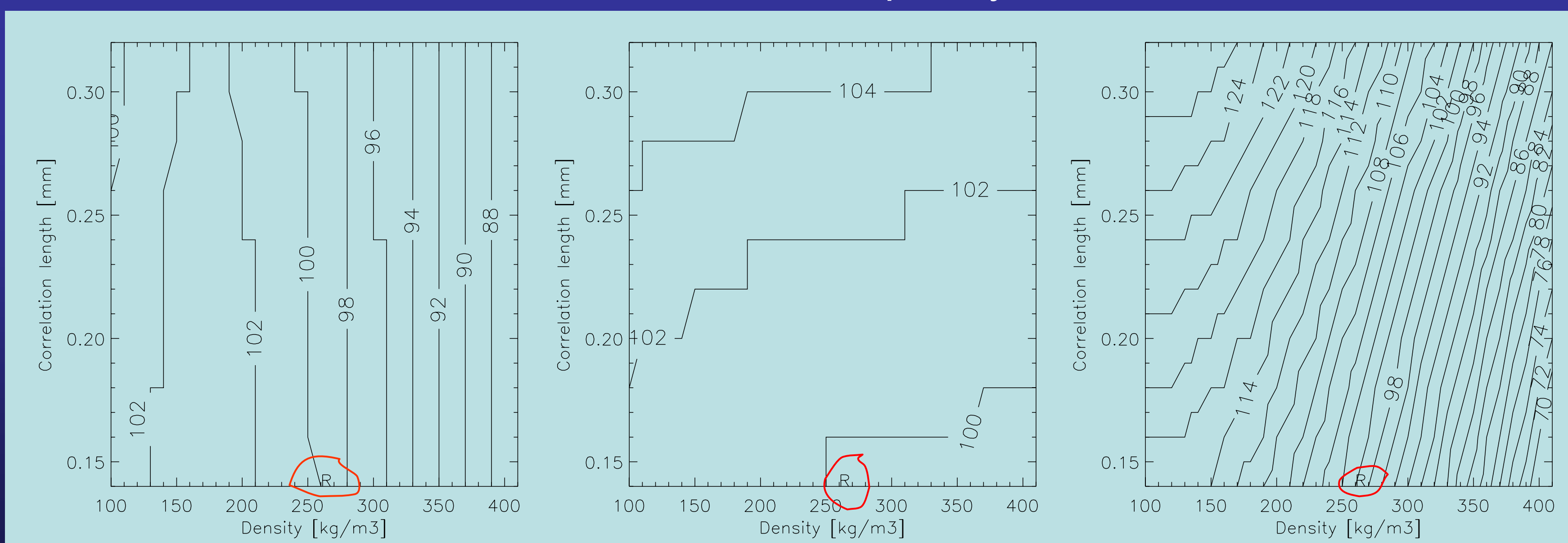
Comiso frequency: moderately sensitive to scattering.

Near 90 GHz: moderately sensitive to deep scattering, sensitive to layer contrast.

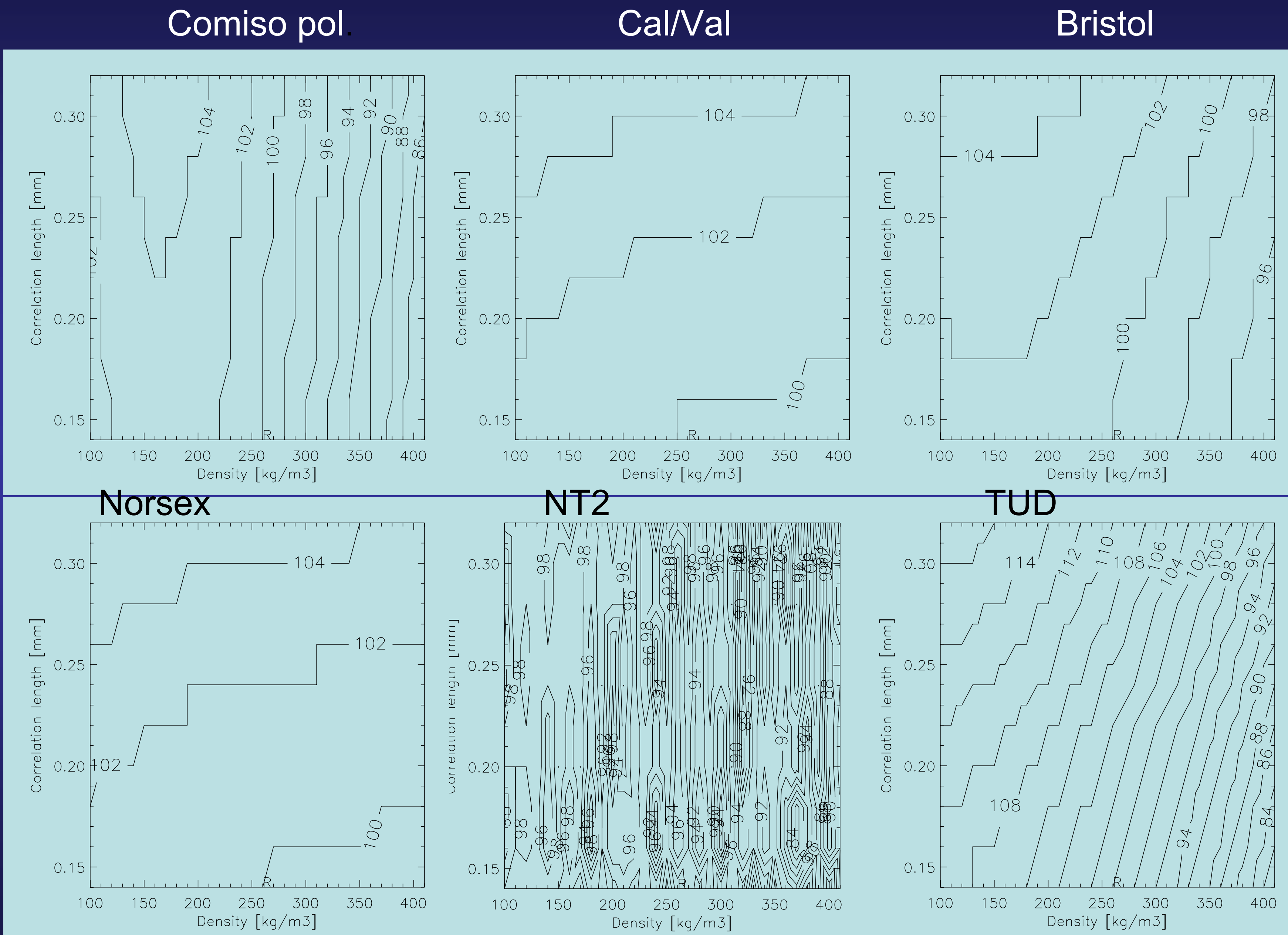
Upper snow-layer density 100-410kg/m3

Above ice correlation length 0.14-0.32mm

NASA Team Comiso frequency Near 90GHz

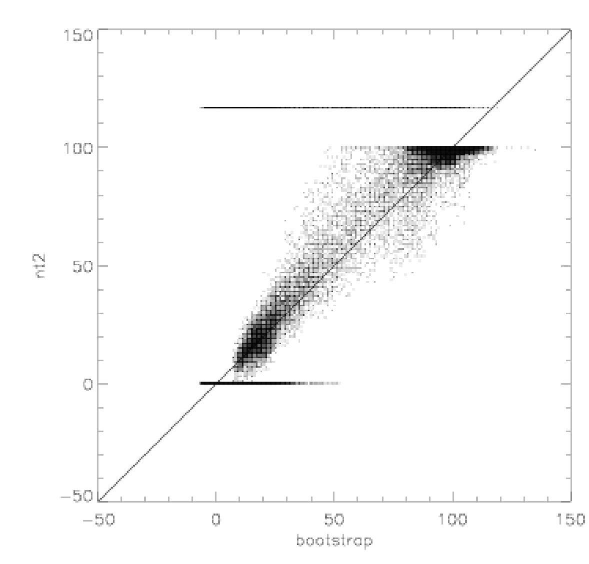


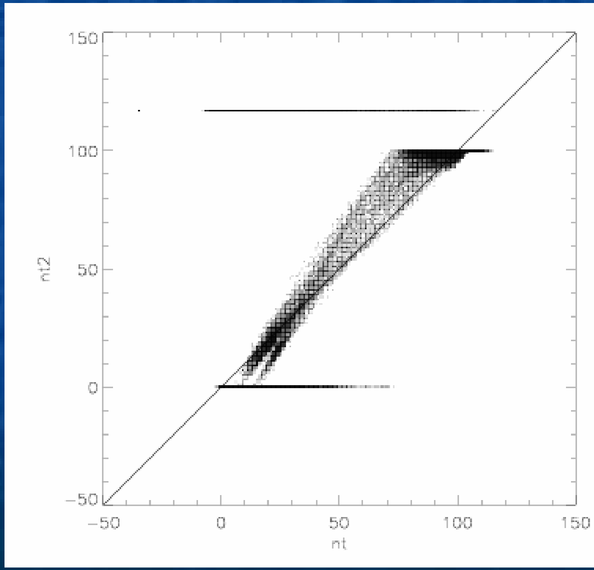
MEMLSI simulations of ice concentration

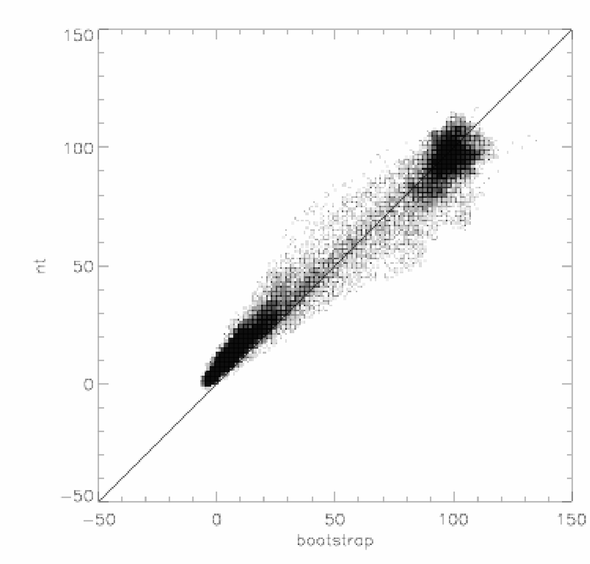


A closer look at NT2

- Meier (accepted TGRS 2004) found good agreement with AVHRR data

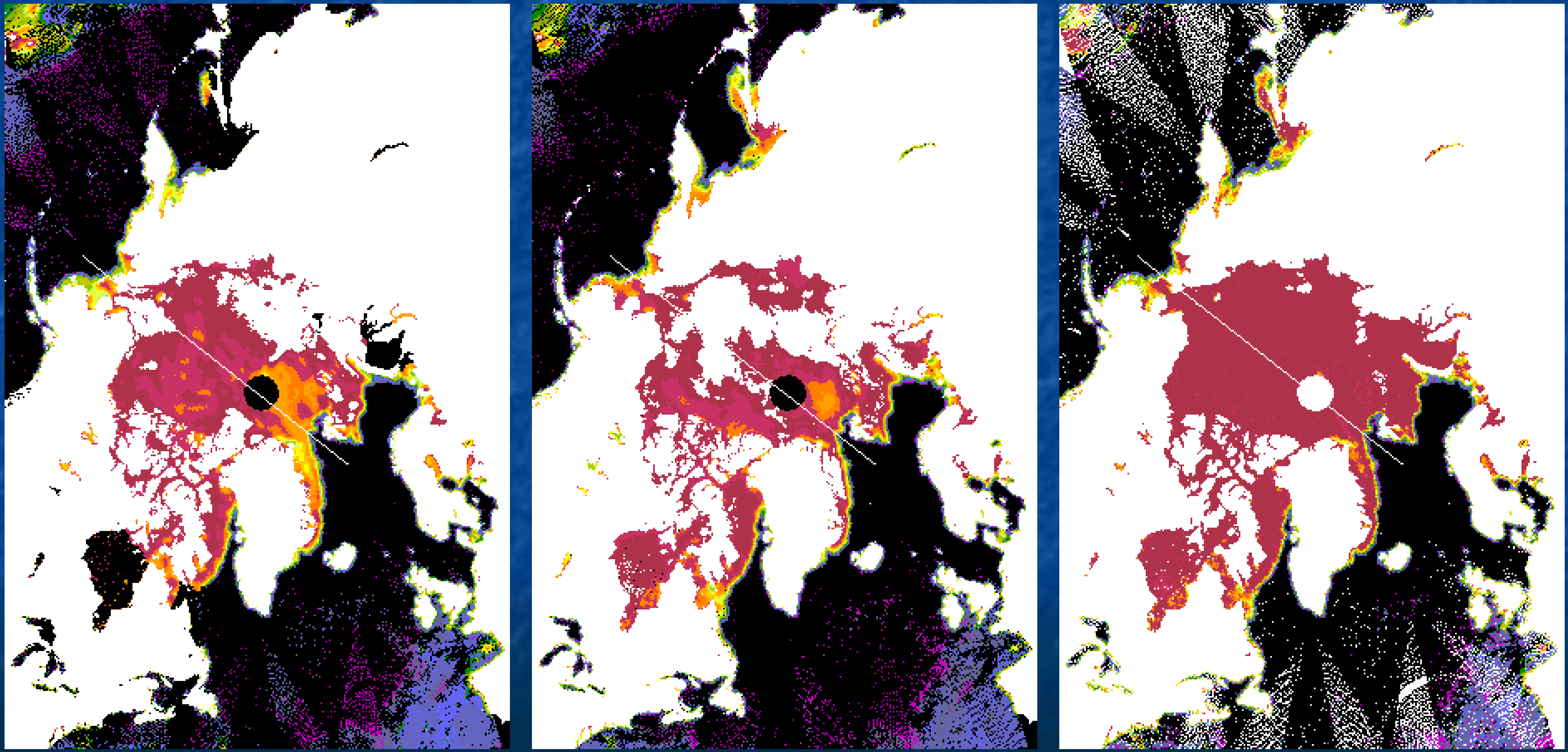




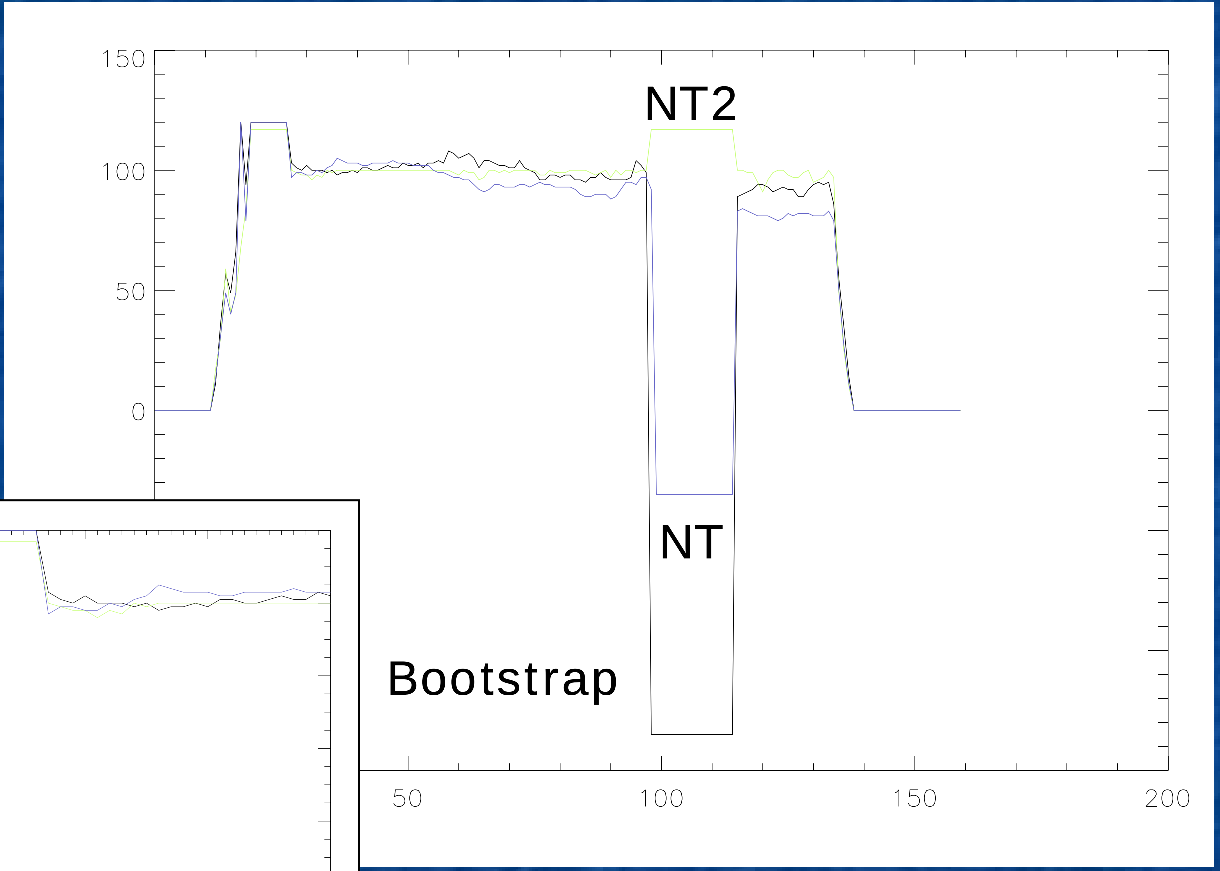


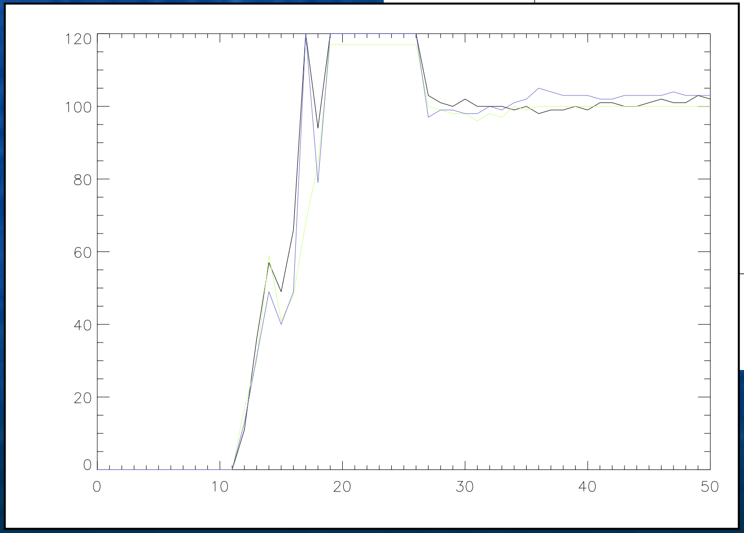
January 2004

NT | Bootstrap | NT2



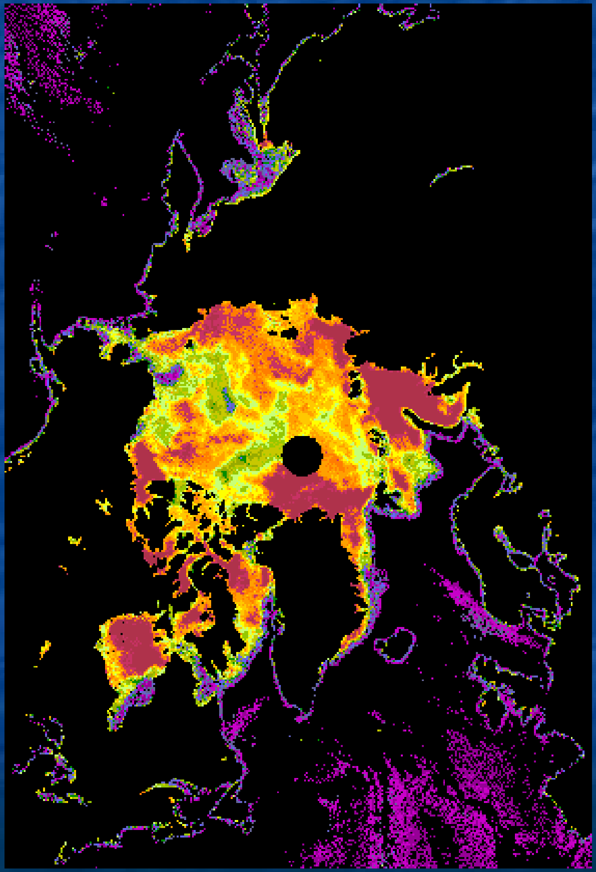
Arctic section



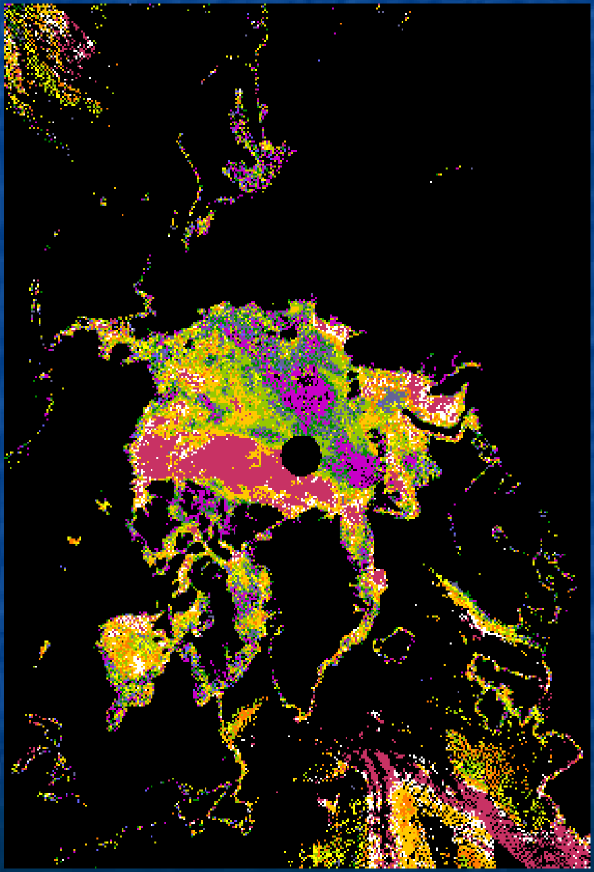


NT2 atm. and partial conc.

Type A/B conc.



Atm. number



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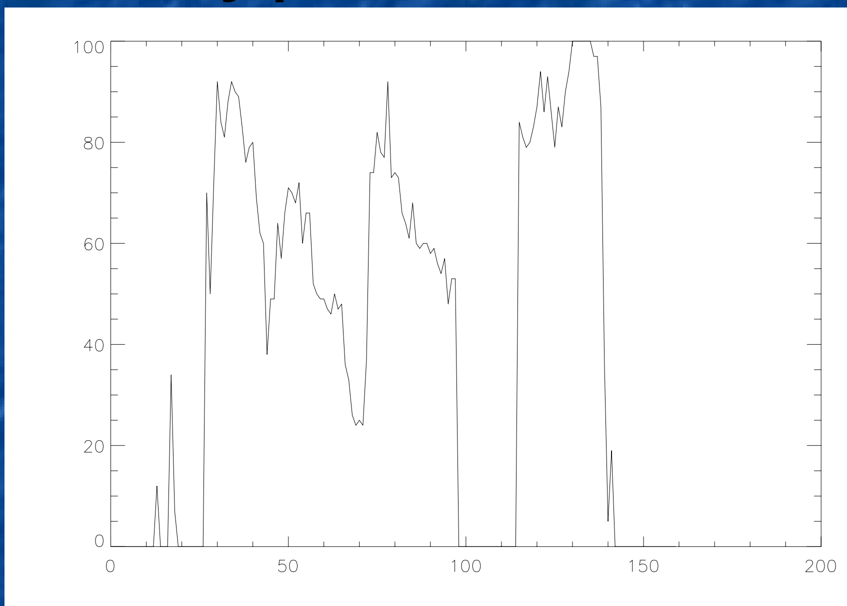
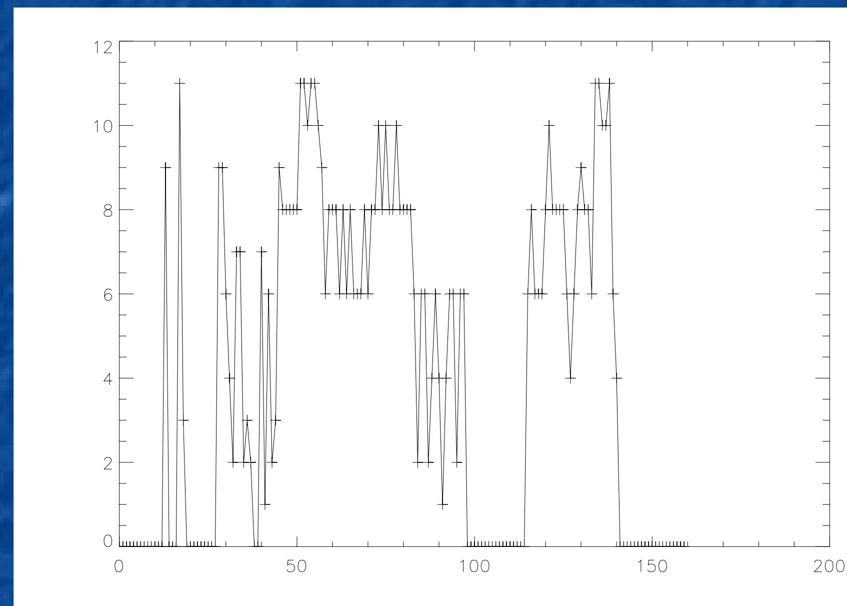


Atm. number



LWC

250

125

75

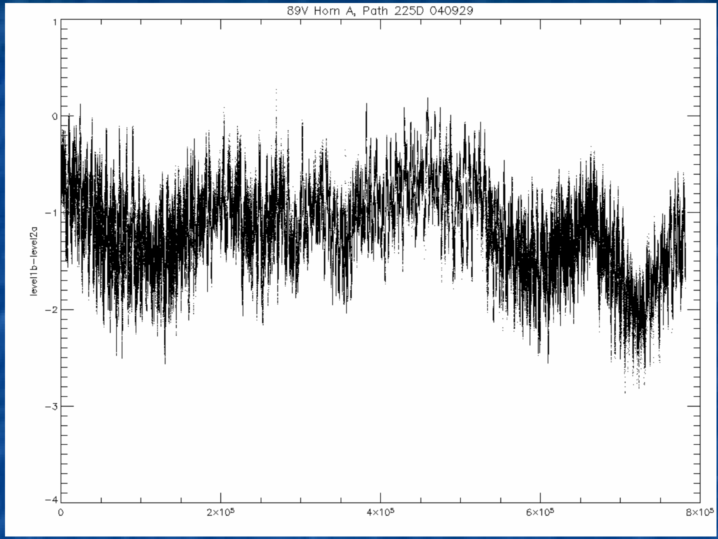
15

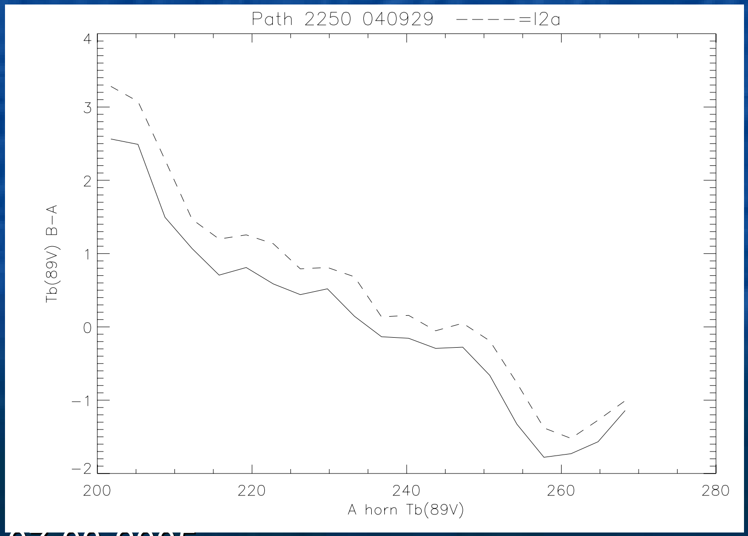
50

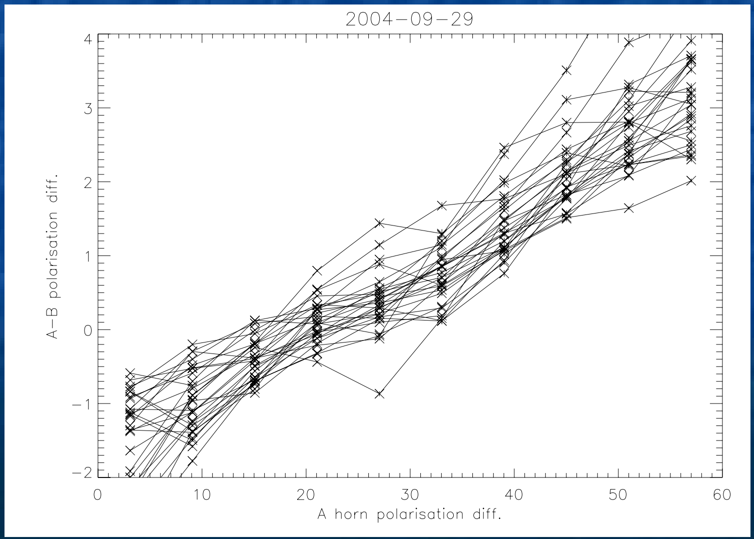
0

AMSR-E 89 GHz

- BUFR data available from NESDIS (2-3h delay)
- BUFR and HDF L1 data match within 0.5 K (max deviation)
- L1 and L2 differ more -> RSS is doing something to data
- Calibration mismatch between A and B horn in level 1 **and** 2
- Low pol. obs. match better
- Bias may be adjusted against SSMI

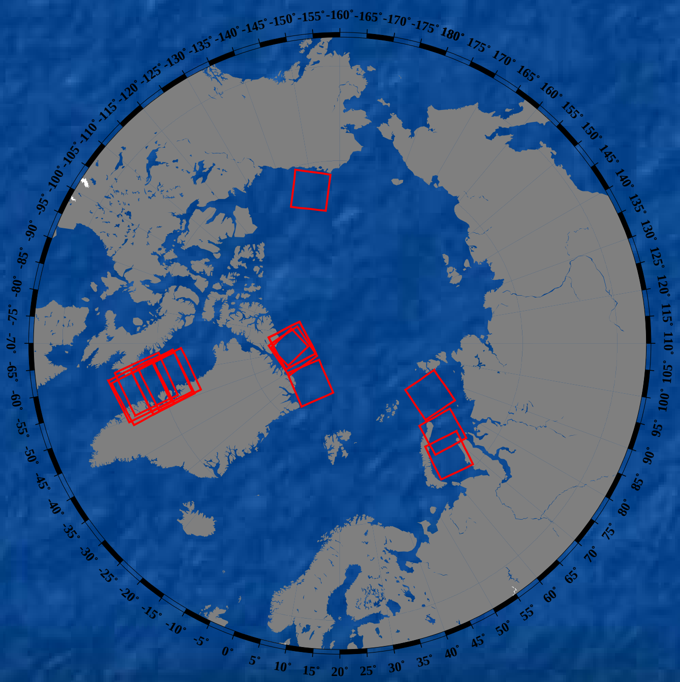






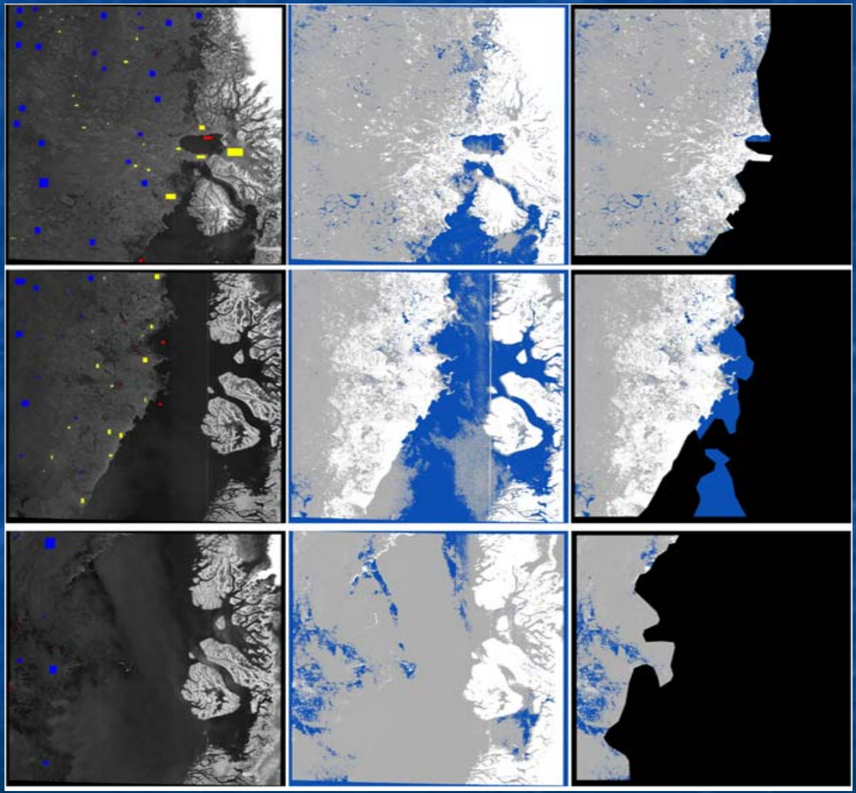
Validation

- Validation is to use classified SAR data
- 30 scenes completed, 20 to be completed through April
- Matchup with SSM/I or AMSR data relatively simple
- Result will help in final algorithm selection



SAR validation data

- Examples of results:
  - Original data with training areas
  - Resulting classification
  - Masking of unreliable areas
- Accuracy test
  - Two independent operators:
    - Ice/water 2.1 %
    - Ice/ice 3.1 %



Basic conclusions

- The following findings can be directly transferred to operations after validation:
  - OSI-SAF algorithm needs maintenance
    - Bootstrap and/or NT2
    - Possibly Near 90 GHz with SSMIS (not really an iomasa finding)
    - To be confirmed in validation against SAR data
  - Algorithm pros and cons so far:

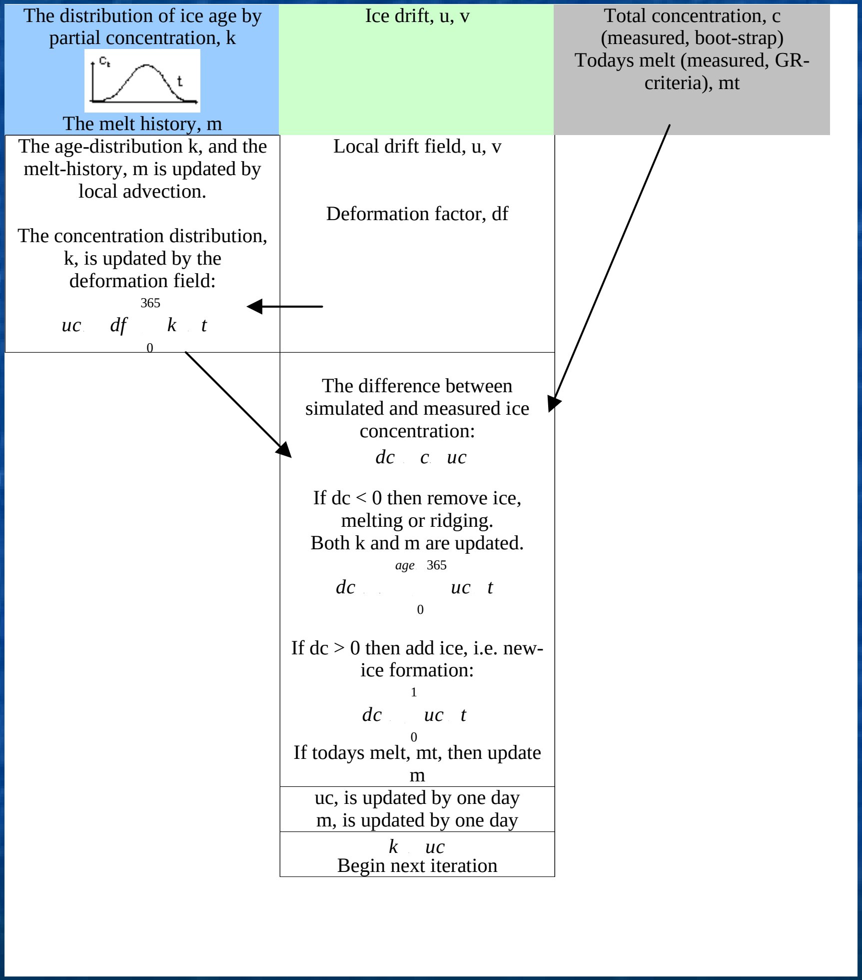
90 GHz pol	Bootstrap	NT	NT2
Resolution	Weather insensitive	Temperature insensitive	Surface insensitive (seemingly)
Weather, Surface/snow	Temperature	Surface/snow	Some weather, surface-atmosphere confusion

Advanced developments

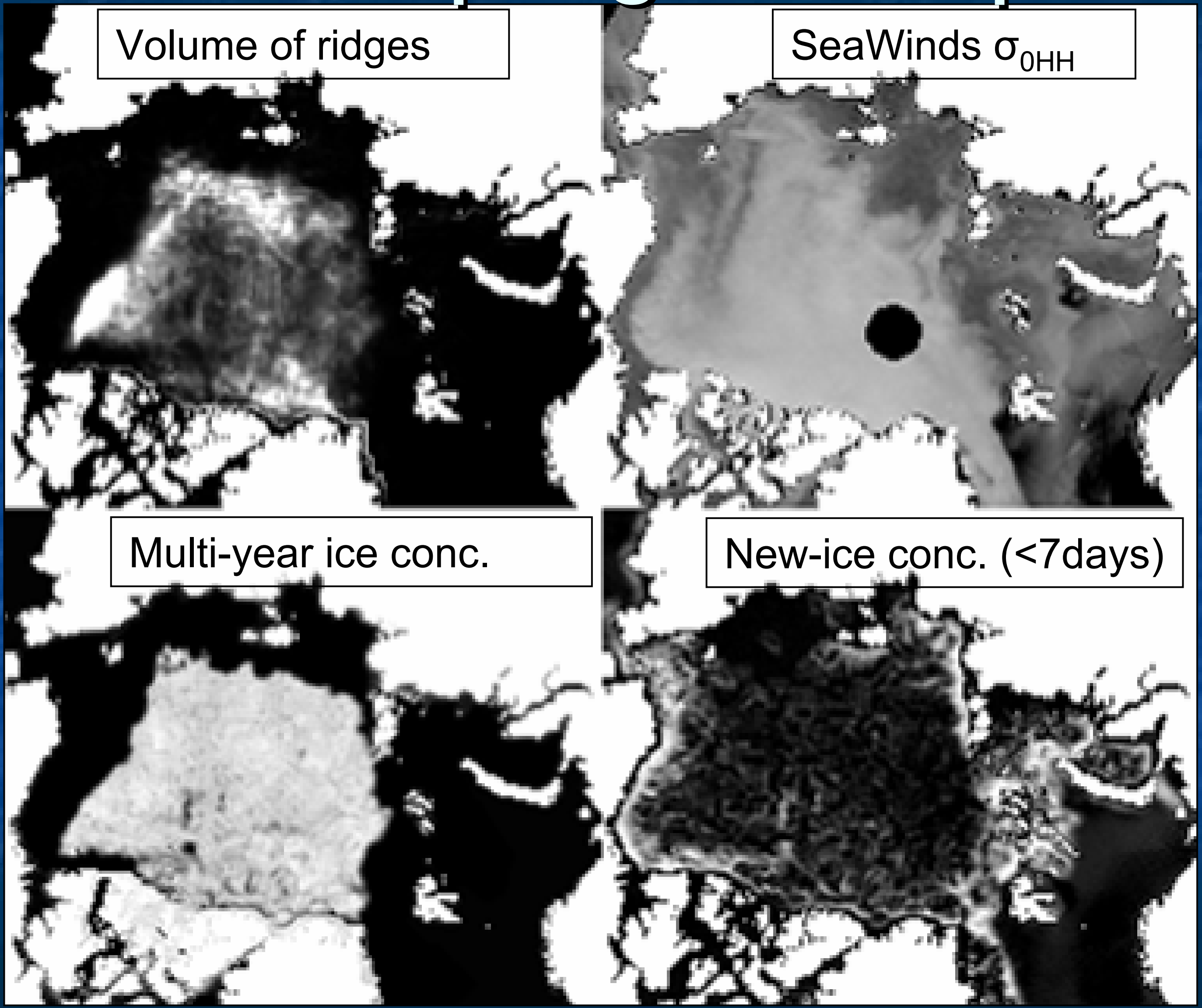
- More experimental developments with uncertain operational scope :
  - Book-keeping model
  - Thermo-dynamic model
  - Ice concentration system
- Could be considered e.g. in next phase of OSI-SAF

Sea-ice book-keeping model

- Todays ice conc. is measured by satellite: ***c***
- Yesterdays ice is updated by satellite drift: ***uc***
- The measured (***c***) and simulated (***uc***) ice are compared to keep track of new-ice formation and ice melt/ridging
- The model can track:
  - -ice age distribution
  - -surface melt history
  - -deformation/ridging



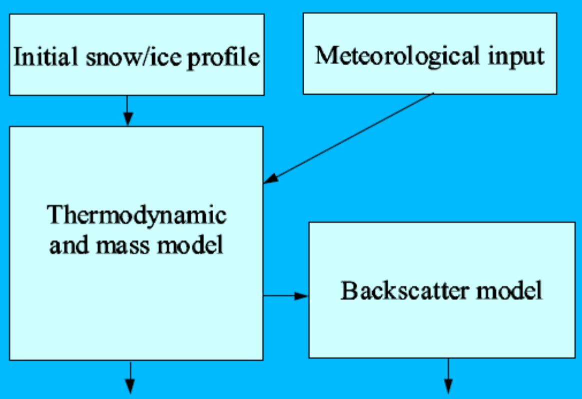
Book-keeping example



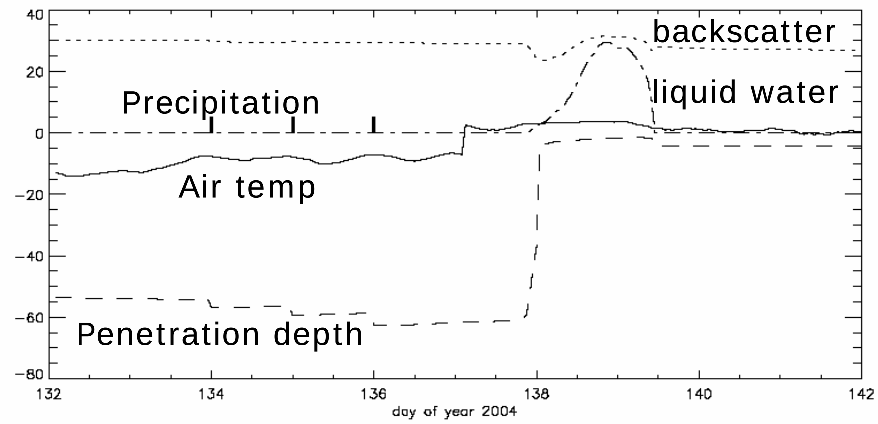
Oct. 1 - Dec. 31, 2000

Thermodynamic model

- Application example using a backscatter model



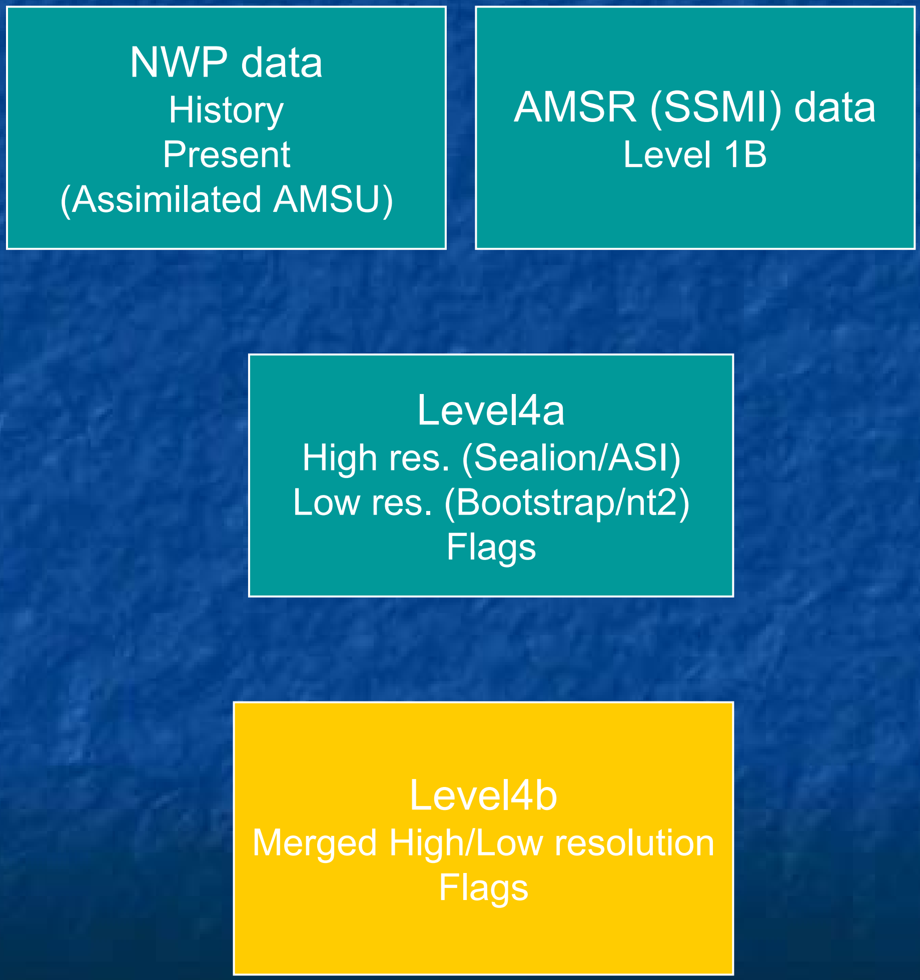
The meteorological record from the GreenIce camp in the Lincoln Sea 2004 is used in the coupled thermodynamic mass and backscatter model. The thermodynamic mass model ensures a realistic description of the snow/ ice profile under different meteorological forcing.



The simulated backscatter coefficient [dB](dotted line), liquid water content of the upper snow layer [%](dash-dotted line) and penetration depth [cm](dashed line) using a modified meteorological record from the GreenIce camp in the Lincoln Sea May 2004 and the multiyear ice profile in Appendix I. The air temperature [°C] is marked by the solid line and precipitation events on day 134, 135 and 136 of 5kg/m^2 are marked by vertical pins. The original meteorological record had persistent cold (about -10°C) conditions during the entire 10 day period and both backscatter and snow/ice parameters variability was small. In order to study the effect of different meteorological conditions the three precipitation events were added and 10°C and 20w/m^2 were added to the air temperature and incoming long-wave radiation respectively after day 137.

Ice concentration system

- Combine virtues of 89 GHz and low resolution Algorithms
- Atmospheric data from other space platforms should be integrated via assimilation in NWP model
- Flags to describe surface and/or atmospheric conditions such as:
  - R-factor
  - History from book-keeping and/or
  - Emissivity anomaly from thermodynamic model
- No general merging method exists for all applications:
  - Make an optimal level4a dataset based on comparison to SAR data
  - do our best with level4b
- All green blocks exist but need to be integrated



Overall results

- Likely impacts on OSI-SAF operations
  - Revised OSI-SAF algorithm
  - Higher resolution
  - Use of 85/89 GHz
- Improved understanding of surface radiative processes
  - Better sea ice retrieval
  - Foundation for improving a range of parameters retrieved over sea ice

Thank you!