Extraction of 3D Wind Profiles from IASI Level2 products

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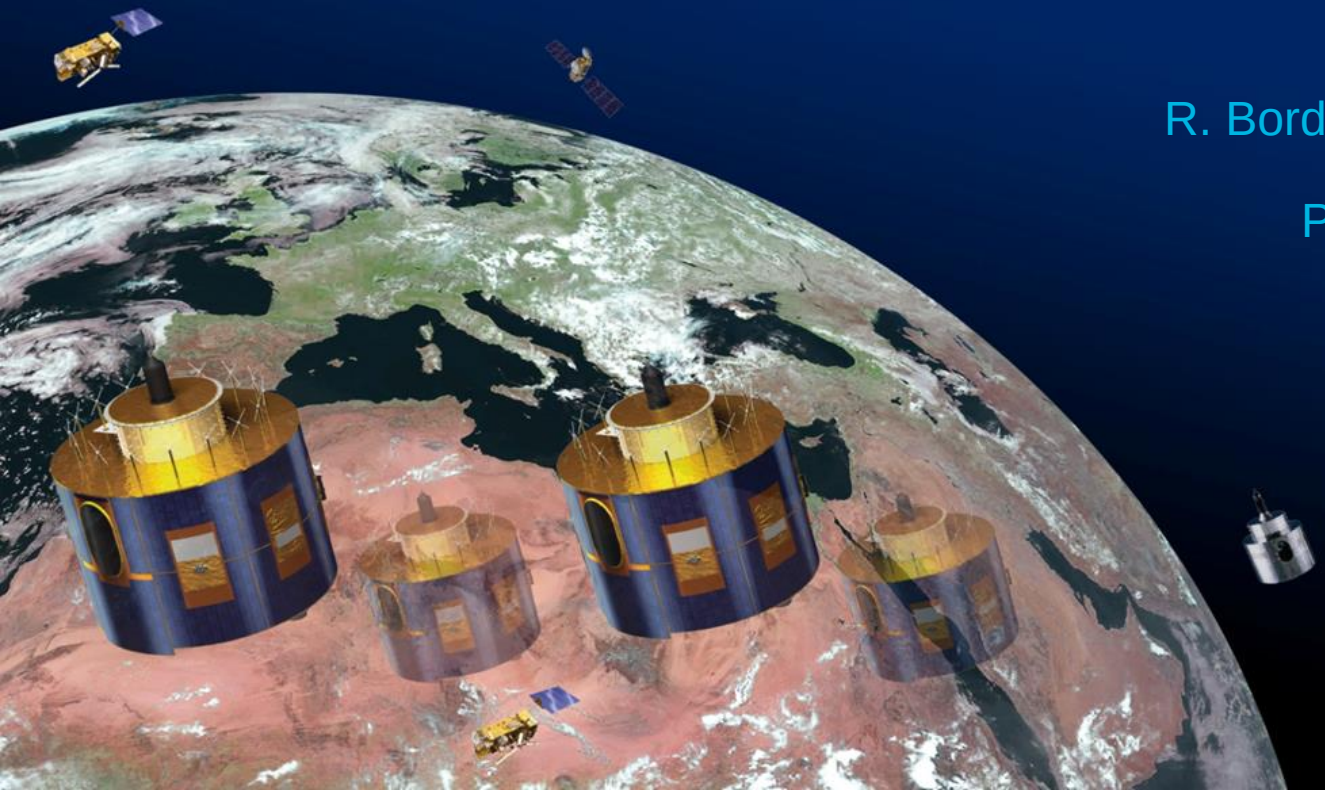
P. Héas; INRIA (Rennes, France)



Outline

- General Context of AMVs derivation at EUMETSAT
- AMVs extraction from IR sounders
  - ✓ Status of the art and strategy
  - ✓ Very first results
- Future work

EUMETSAT Atmospheric Motion Vectors

- ✓Extracted from Geostationary satellites (MFG and MSG) and Low orbit satellites (Metop AVHRR) following clouds or WV features in consecutives images

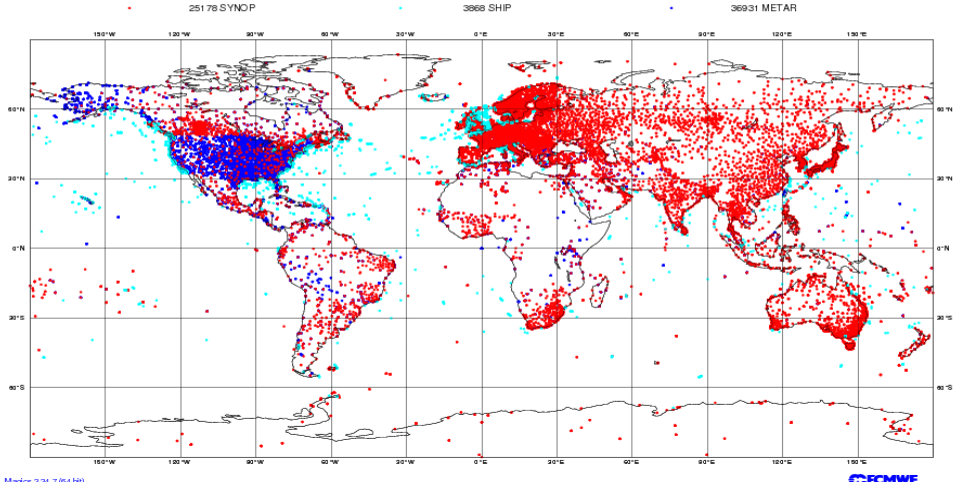
- ✓Using the channels
  - VIS0.8 during daytime, HRV during daytime for low clouds
  - IR10.8, WV6.2. WV7.3

- ✓Wind product consists of
  - Speed, Direction, Altitude
  - Quality indicator

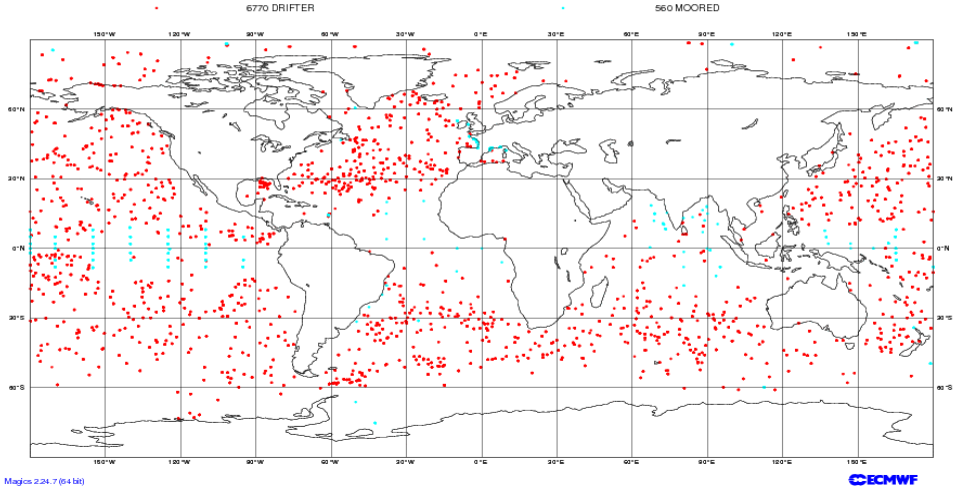
- ✓Verification against reliable insitu measurements (RO, aircraft)

Why do we care about AMVs ?

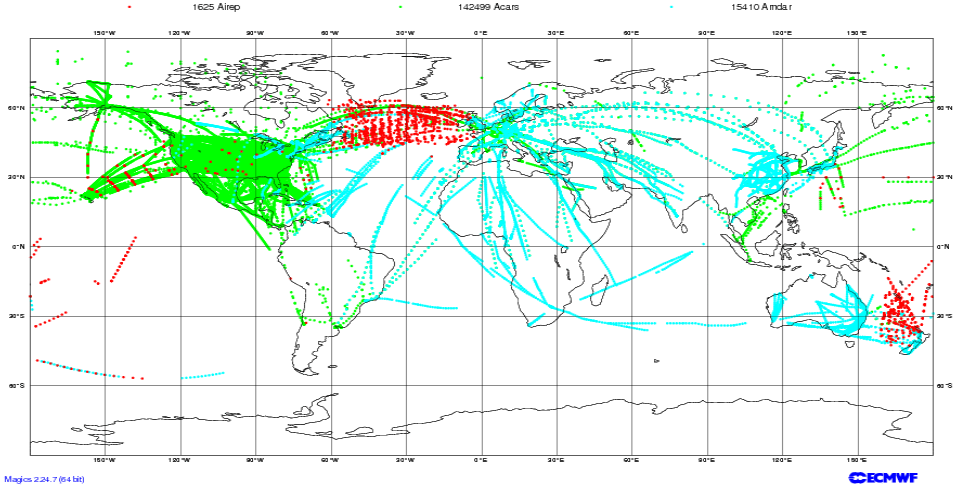
ECMWF Data Coverage (All obs DA) - Synop-Ship-Metar
16/Feb/2016; 00 UTC
Total number of obs = 65977



ECMWF Data Coverage (All obs DA) - Buoy
16/Feb/2016; 00 UTC
Total number of obs = 7330



ECMWF Data Coverage (All obs DA) - Aircraft
16/Feb/2016; 00 UTC
Total number of obs = 159534



For best results, NWP models require information on both the mass field and the wind field.

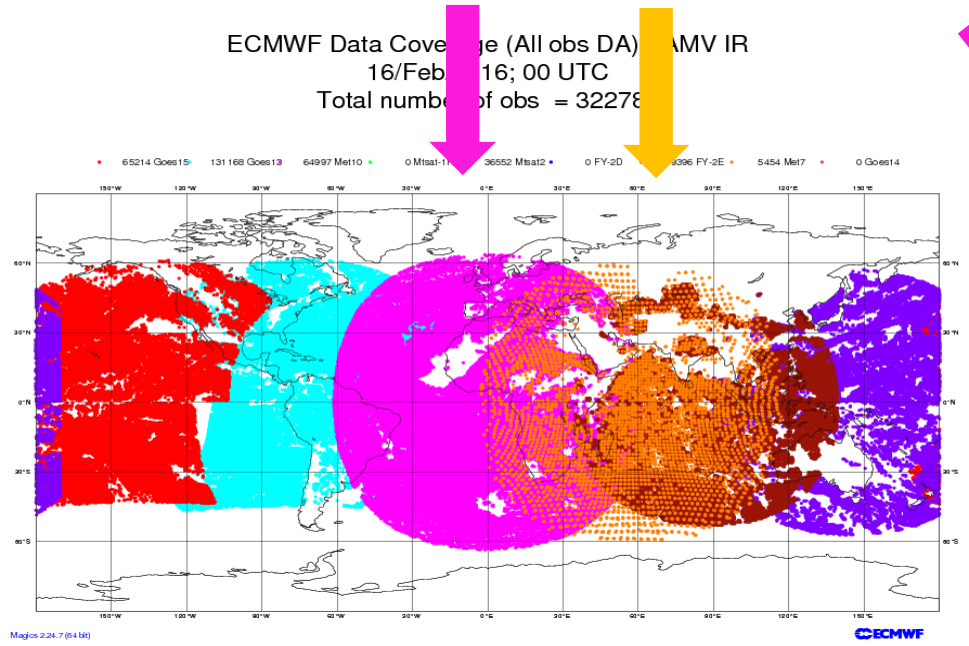
Examples of in situ measurements assimilated in ECMWF forecast model,16 Feb 2016 at 00:00 UTC

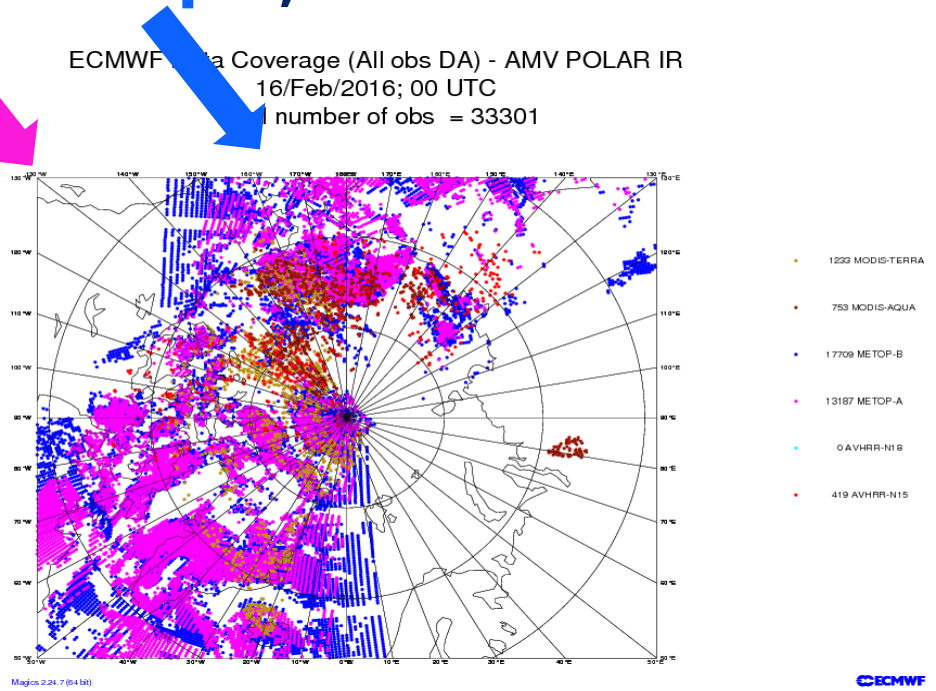
In situ observations are mainly concentrated over land in Northern Hemisphere. Oceans and polar regions are not or sparsly covered.

Why do we care about AMVs ?

EUMETSAT Contribution

Met10, Met7, Metop A, Metop B, Global AVHRR



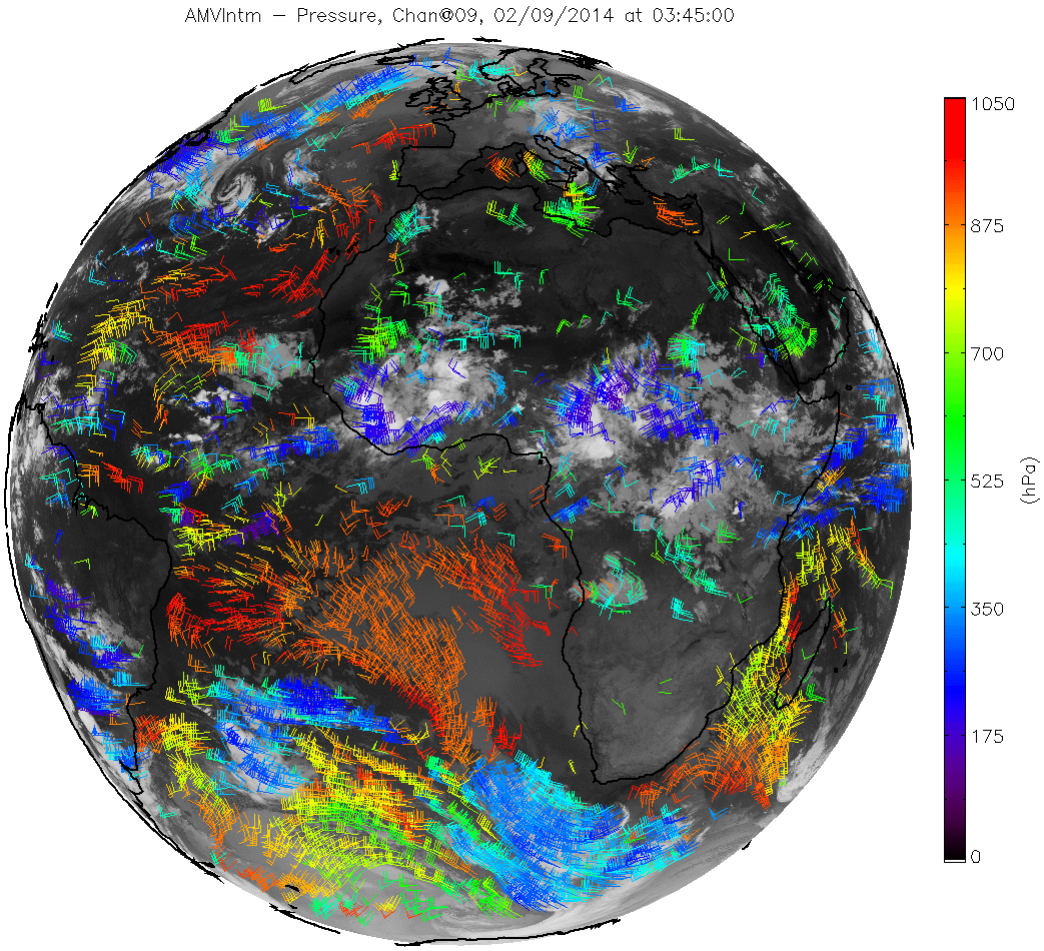


AMVs assimilated in ECMWF forecast model,16 Feb 2016 at 00:00 UTC.

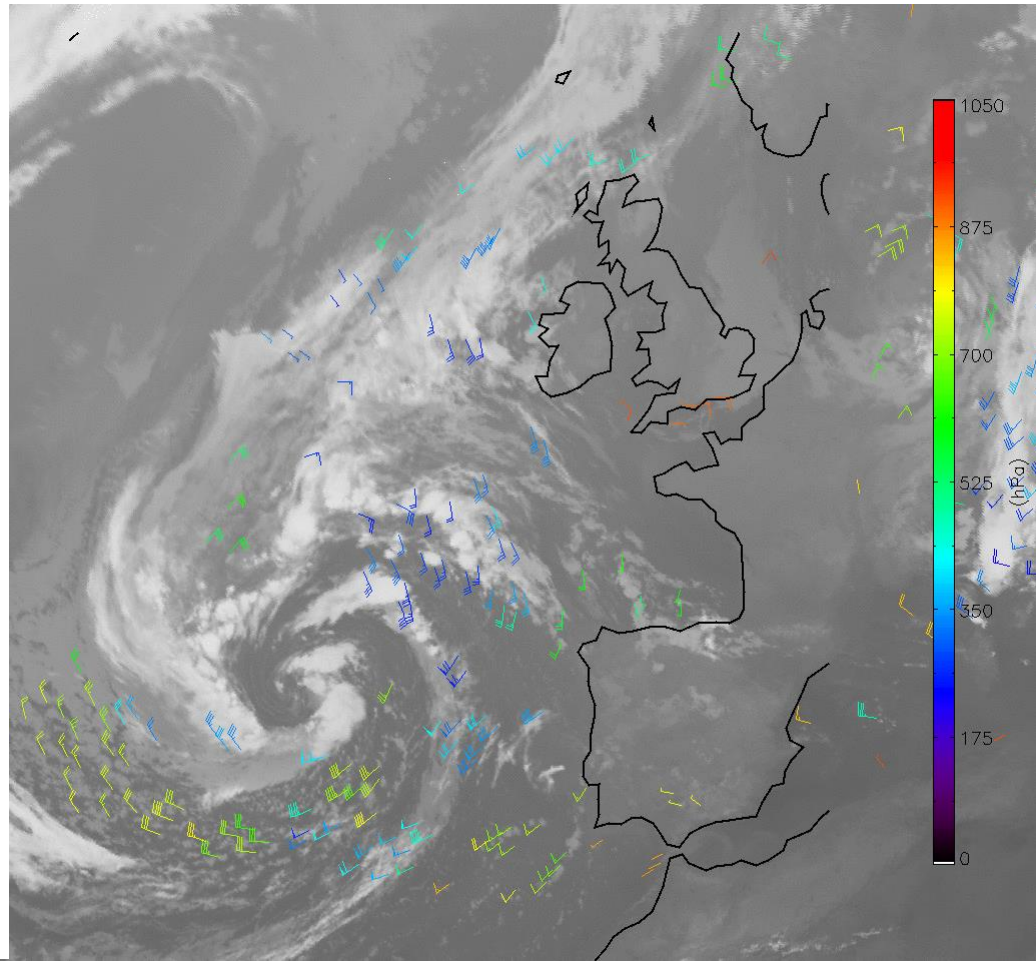
AMVs are the only observation type to provide good coverage of upper tropospheric wind data over large oceans areas and polar regions.

MSG– AMVs Examples

FES, 02/09/2014, 20:45 – 03/09/2014, 19:45



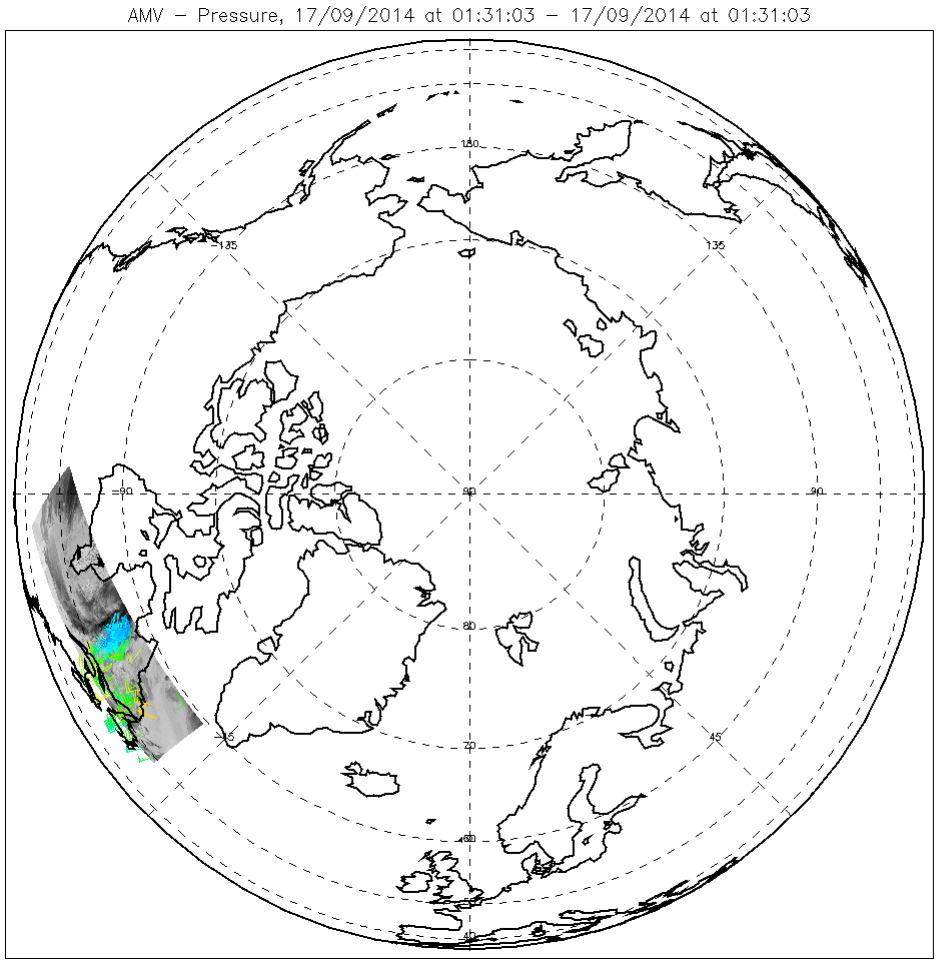
RSS, 11/09/2014, 6:30 – 12/09/2014, 5:30



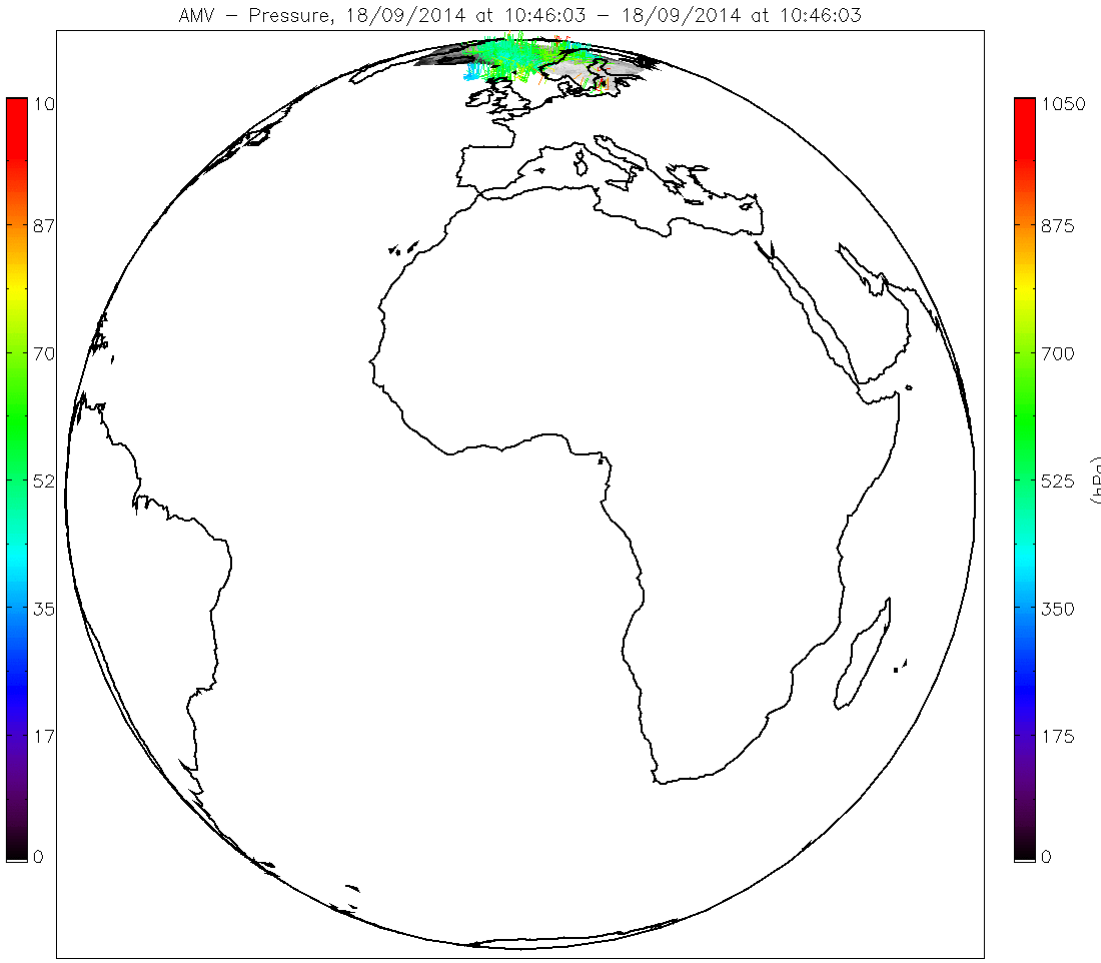
Borde, R., M. Doutriaux-Boucher, G. Dew, M. Carranza, 2014: A Direct Link between Feature Tracking and Height Assignment of Operational EUMETSAT Atmospheric Motion Vectors. J. Atmos. Oceanic Technol., 31, 33–46. doi: ***http://dx.doi.org/10.1175/JTECH-D-13-00126.1***

AVHRR winds Examples

Single Metop polar, 17/09/2014, 1:31-1:52



Global AVHRR , 18/09/2014, 9:04-9:46



Hautecoeur, O., and R. Borde, 2015, Derivation of wind vectors from AVHRR Metop at EUMETSAT, submitted to JTECH
Borde, R., O. Hautecoeur, and M. Carranza, 2015, EUMETSAT Global AVHRR winds product', J. Atmos. Oceanic Technol, 33, 429-438.
DOI: http://dx.doi.org/10.1175/JTECH-D-15-0155.1

So, why extracting winds from IR sounders ?

- Current AMVs limitations:

✓AMVs give an information at a single level of the troposphere.

✓Height assignment is known to be an important problem.

✓Recurrent AMV problems in tropics area (fast speed biases) where important mesoscale phenomena impact the medium range forecast.

- IR sounder AMVs expectations:

✓Vertical wind profiles from IR sounder temperature/humidity fields.

✓HA less a problem.

✓Better information in Tropics (MTG IRS)

State of the art extracting winds from IR sounders

- GOAL

✓Estimate the feasibility of vertical wind profiles extraction from IR sounder temperature/humidity fields.

✓At EUMETSAT it concerns future MTG/IRS and Metop/IASI

- BACKGROUND

✓Tests done in US with AIRS, product recently developed at CIMSS. (See D. Santek poster S9-66).

✓Fellow at Met Office, L. Stewart, study done using simulated spectra generated by Met Office UKV 1.5km model.

✓External study done by DLR for EUMETSAT in 2006. Humidity fields mimicked from Lokall-Modell LM from DWD.

Which strategy ?

- Known difficulties

✓Cross correlation tracking methods not very efficient considering smooth temperature/humidity fields. Not enough contrast/entropy for good matching.

✓Really difficult to deal with convection.

✓Each layer is considered separately.

- Present strategy

✓Test a 3D optical flow software developed by INRIA (France)

- http://www.irisa.fr/vista/Papers/2007_IEEEGRS_HeasMemin.pdf

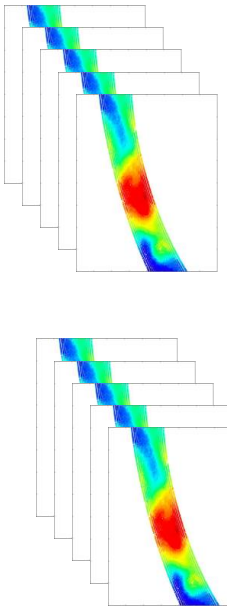
✓Collaboration with P. Héas (INRIA) started in June 2015.

3D optical flow software

Temperature/humidity fields from IR sounders

t

t+1



Parameters

Geophysical Model in 3D optical flow algorithm

Regularization (Vorticity & Divergence)

3D wind fields f(u,v,w) is reconstructed from the observations

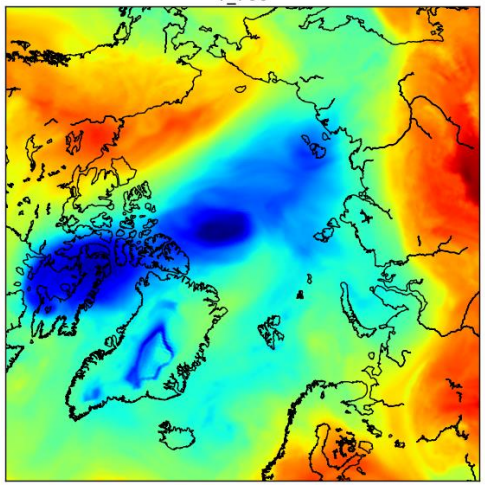
Work Plan to test the feasibility

- ✓ Use IASI L2 v6.0 Product (Thomas and others presentations)
- ✓ Adapt 3D optical flow software to IASI temperature/humidity fields.
- ✓ Adapt 3D optical flow software to ECMWF temperature/humidity fields.
- ✓ Project the data on a fixed grid
- ✓ IASI data and ECMWF fields sorted in 16 standard vertical levels:
  - 1000 / 950 / 925 / 900/ 850 / 800 / 700 / 600 / 500 / 400 / 300 / 250 / 200 / 150 / 100 / 70 hPa
- ✓ Modify the Geophysical model in the software to optimise the use of the input data in the relationships between the layers.
- ✓ Extract 3D wind fields from ECMWF data
- ✓ Extract 3D wind fields from IASI L2 data
- ✓ Compare 3D wind fields extracted from software against the 'true wind fields'.

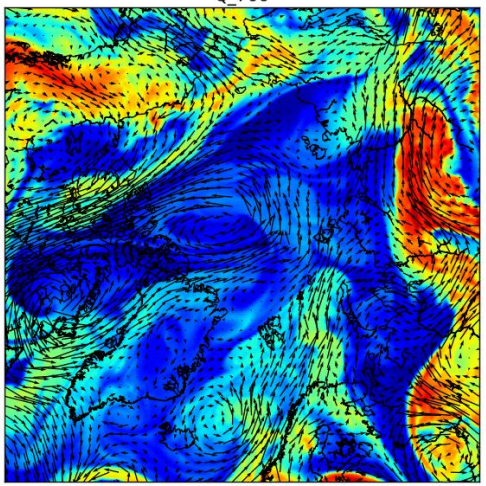
Exemples using FC fields

20 June 2013, 12:00 UTC
ECMWF fields

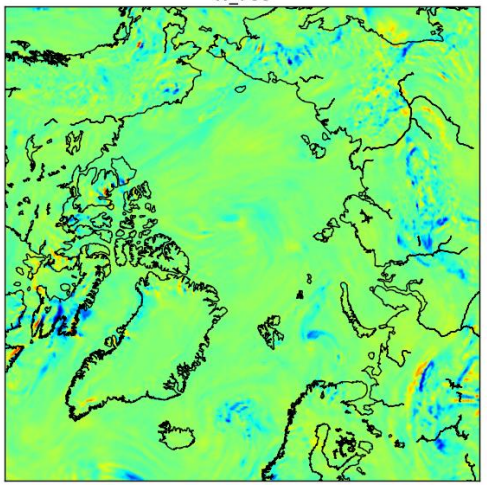
T_700



Q_700

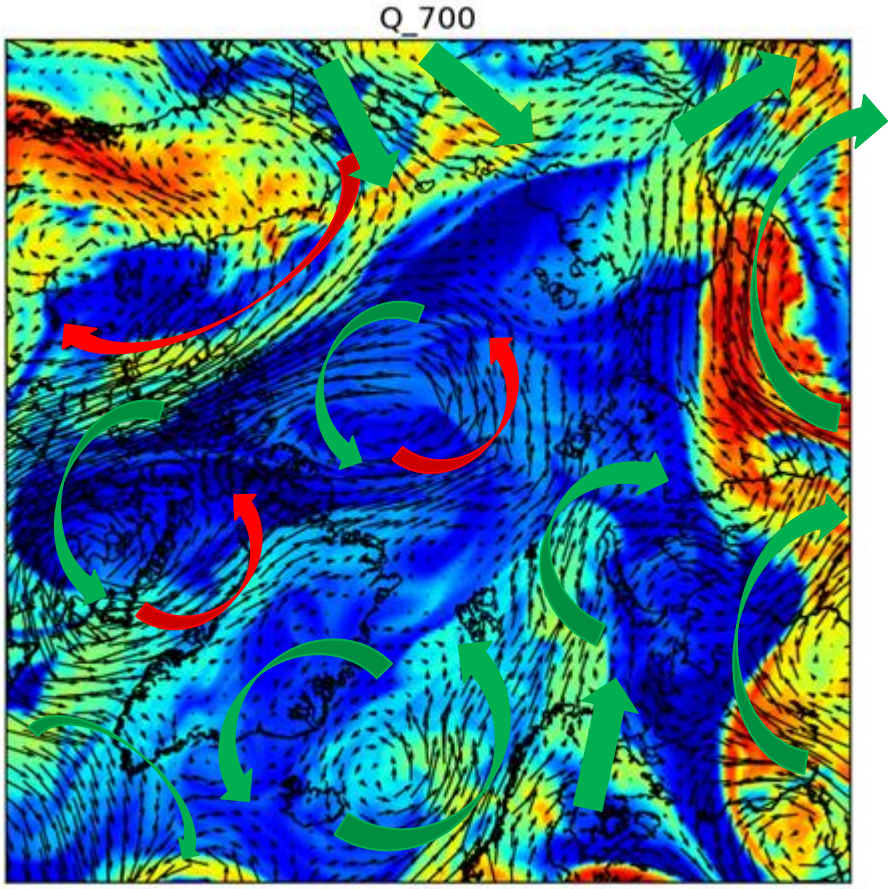


W_700

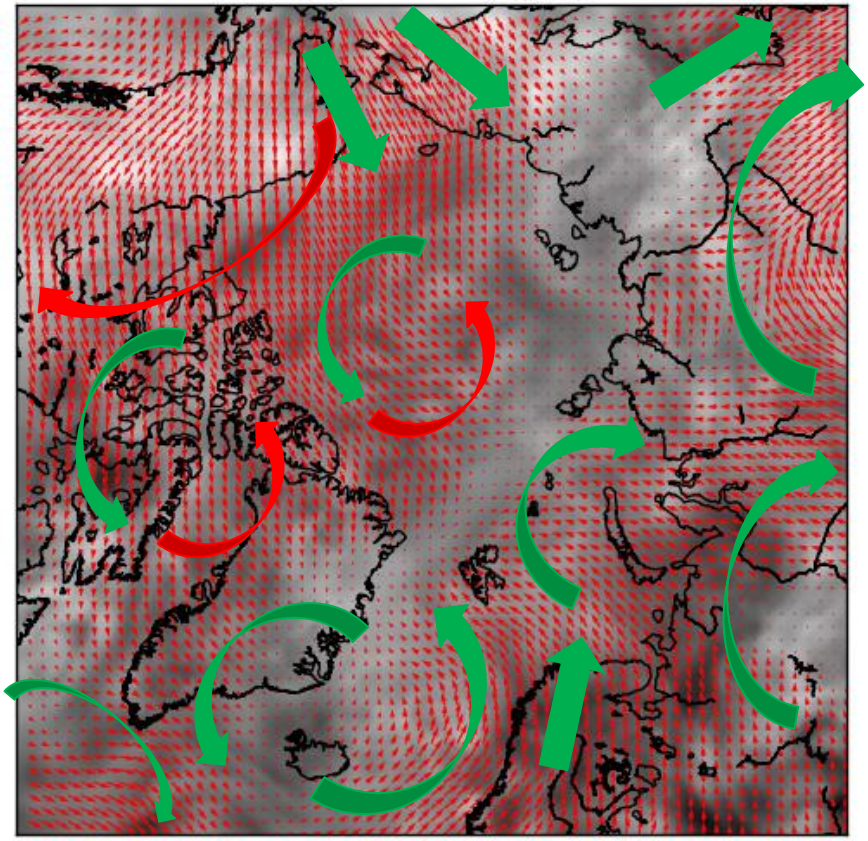


Exemple of 3D winds using FC fields
20 June 2013, 12:00 UTC at 700 hPa

ECMWF, 700 hPa

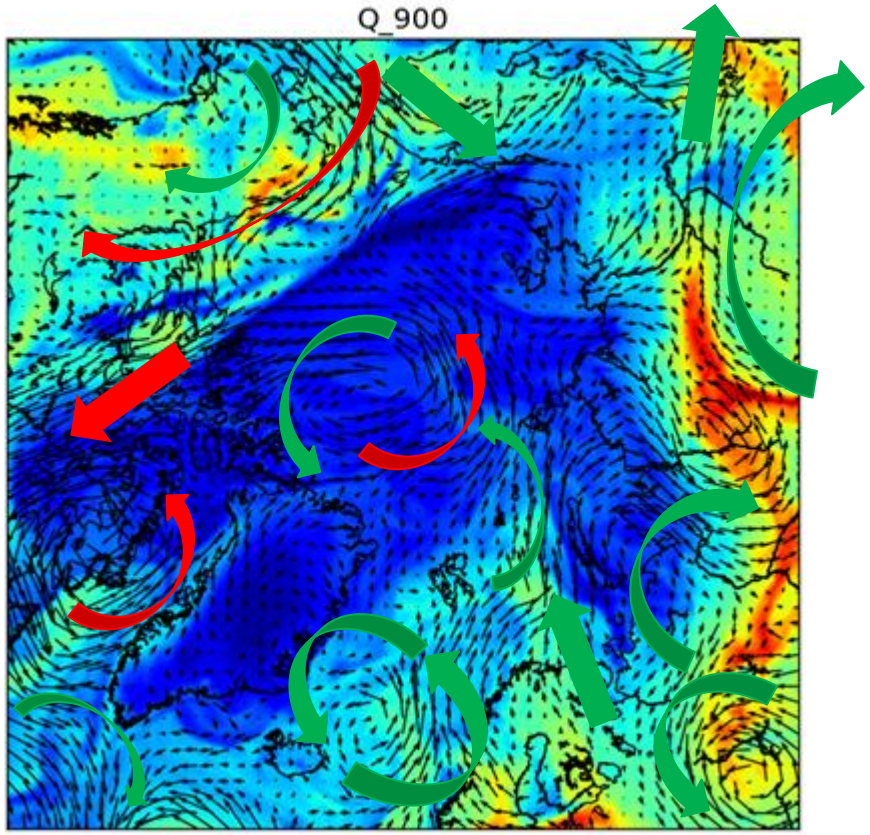


3D winds, 700 hPa (Background image : w)

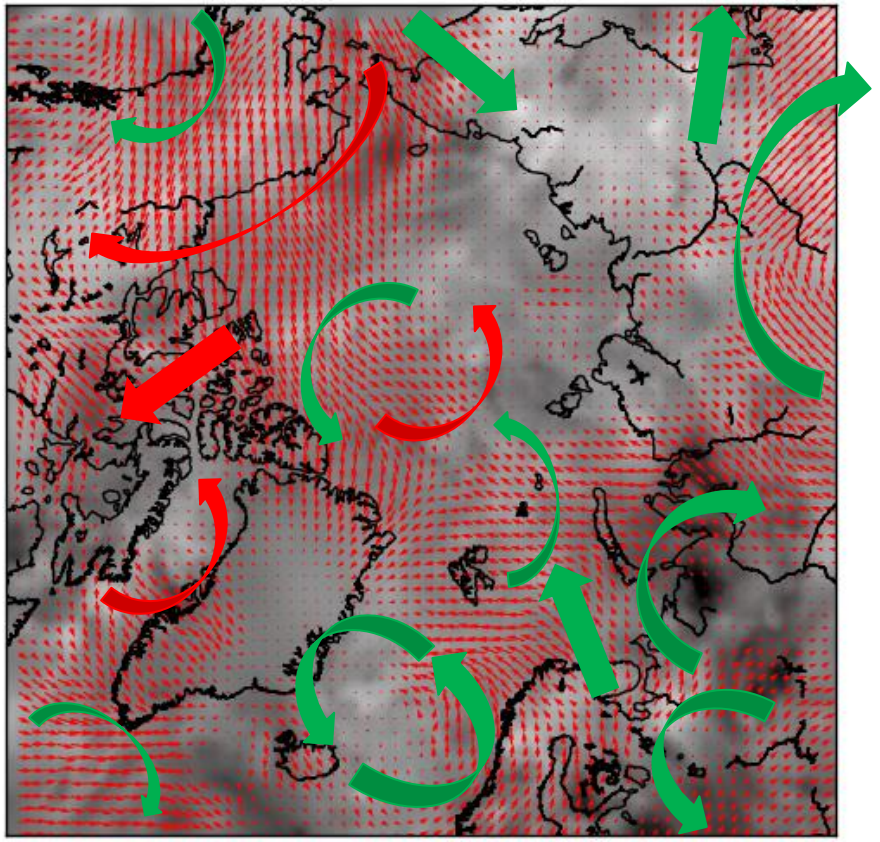


Exemple of 3D winds using FC fields
20 June 2013, 12:00 UTC at 900 hPa

ECMWF, 900 hPa



3D winds, 900 hPa (Background image : w)



What can we expect with IASI?

Temporal gap

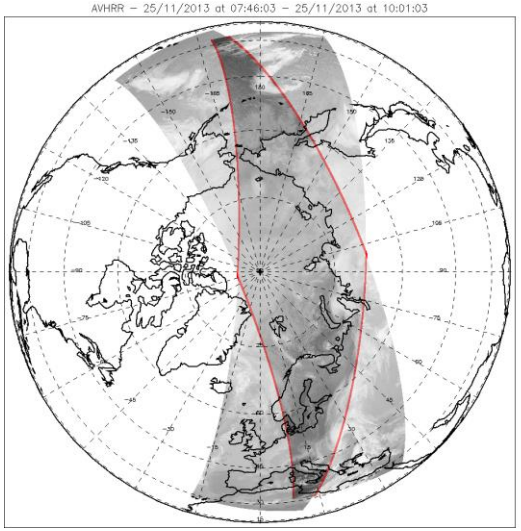
✓~100 min using single satellite

✓~50 min using two satellites

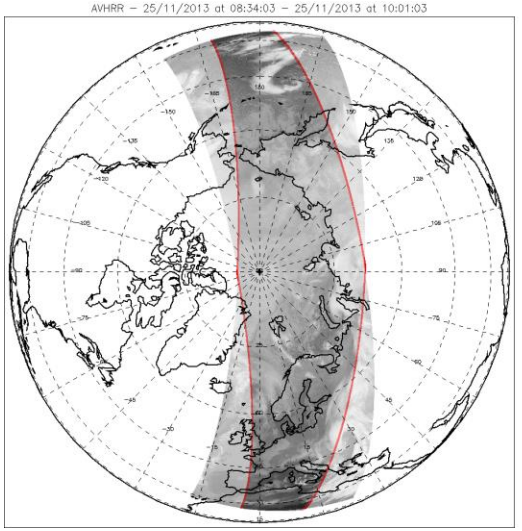
Coverage

✓High latitudes

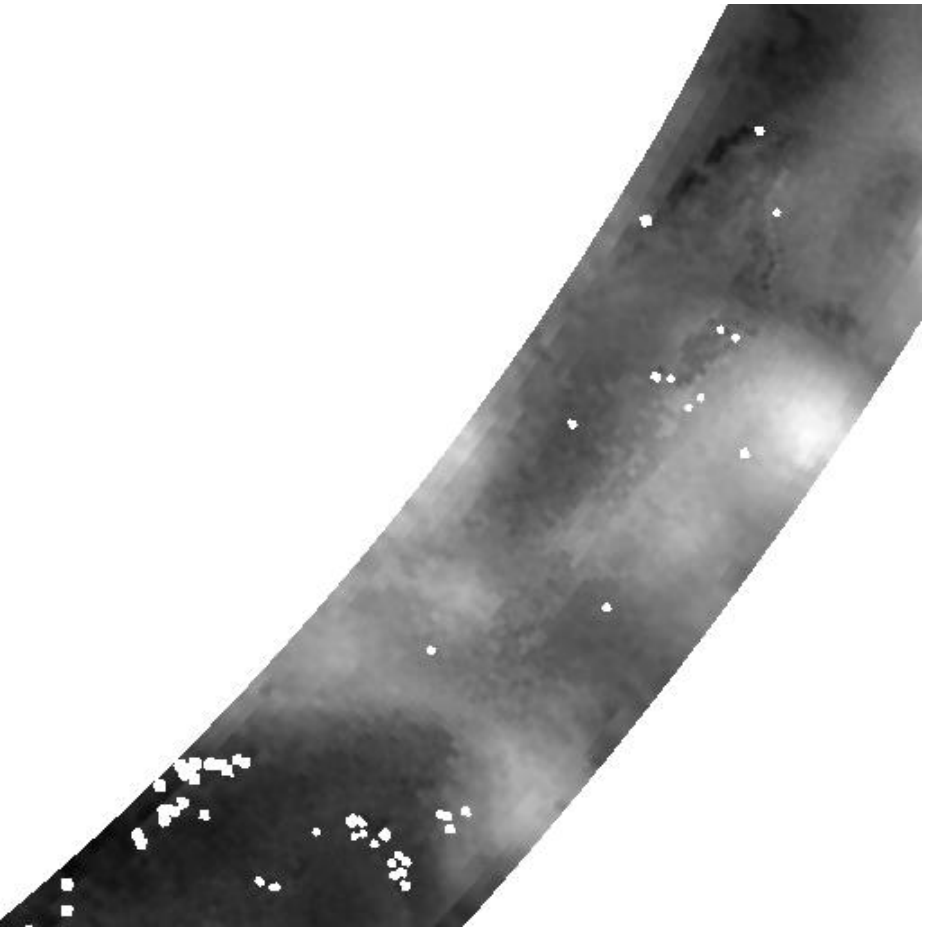
Single Metop



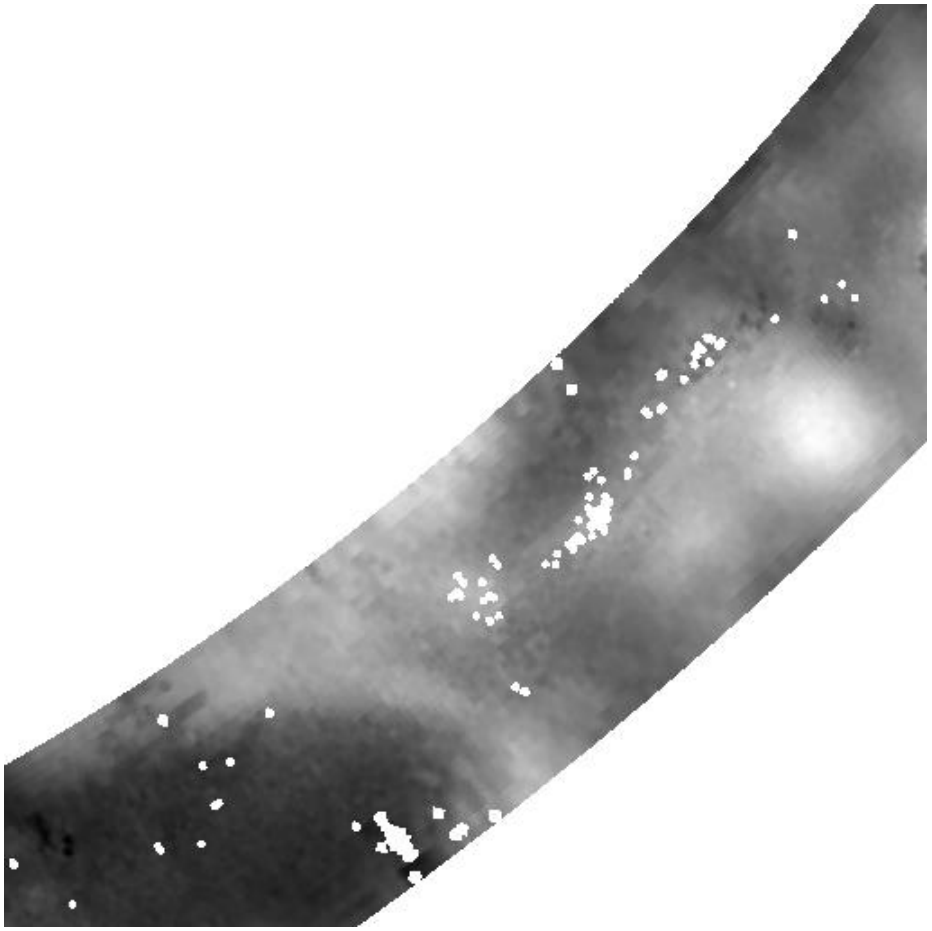
Dual Metop



Exemple using IASI Level 2 Temperature Product from both Metop A and Metop B



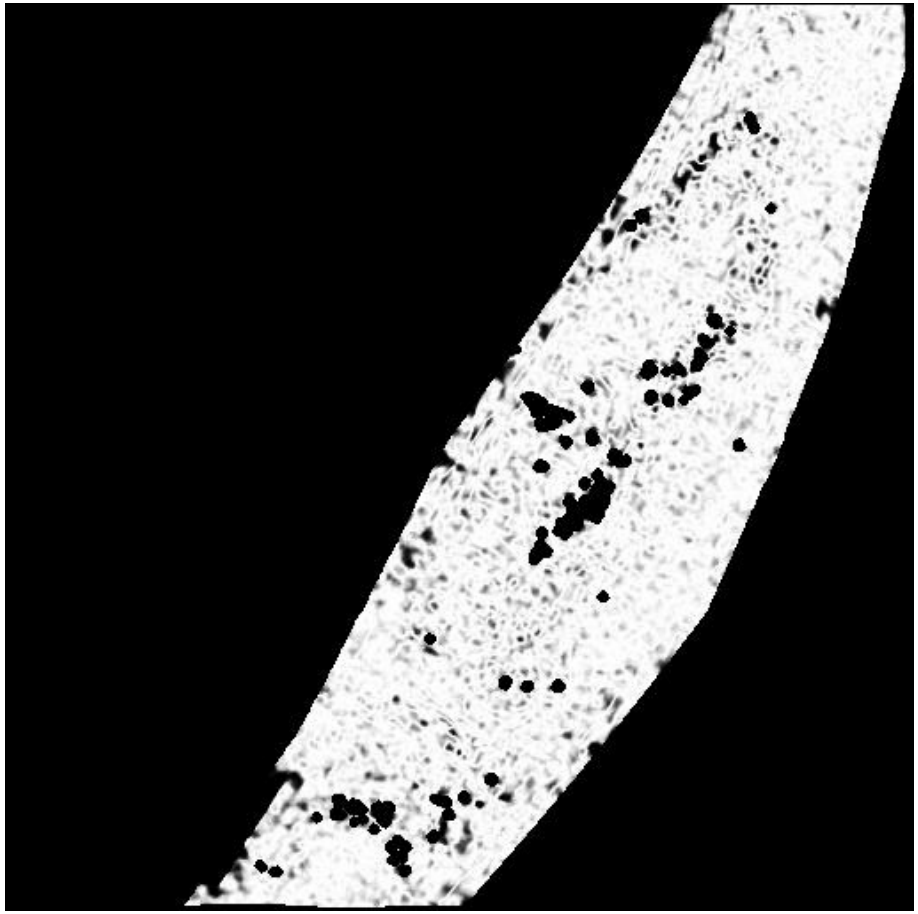
Metop B, orbit :3933,
sensingTime: 2013-06-21T11 :48 :33Z



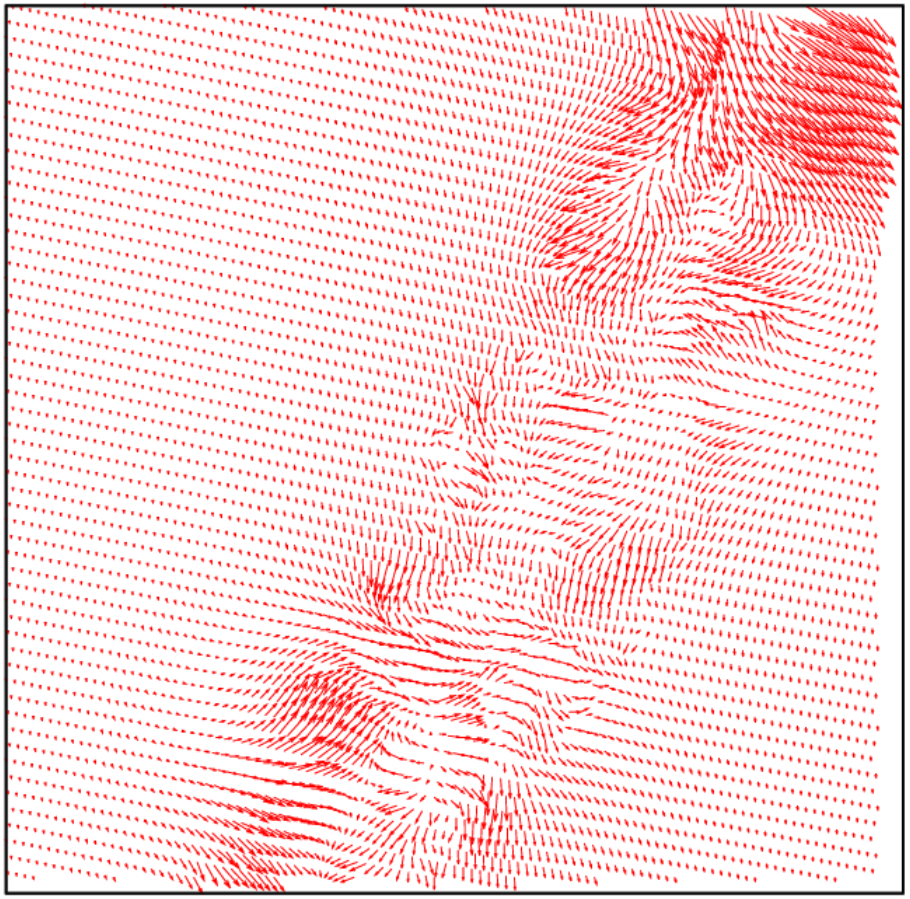
Metop A, orbit :34620,
sensingTime: 2013-06-21T12 :34 :31Z

Exemples using IASI Level 2 Temperature Product

Mask used for the retrieval



Retrieved wind vectors

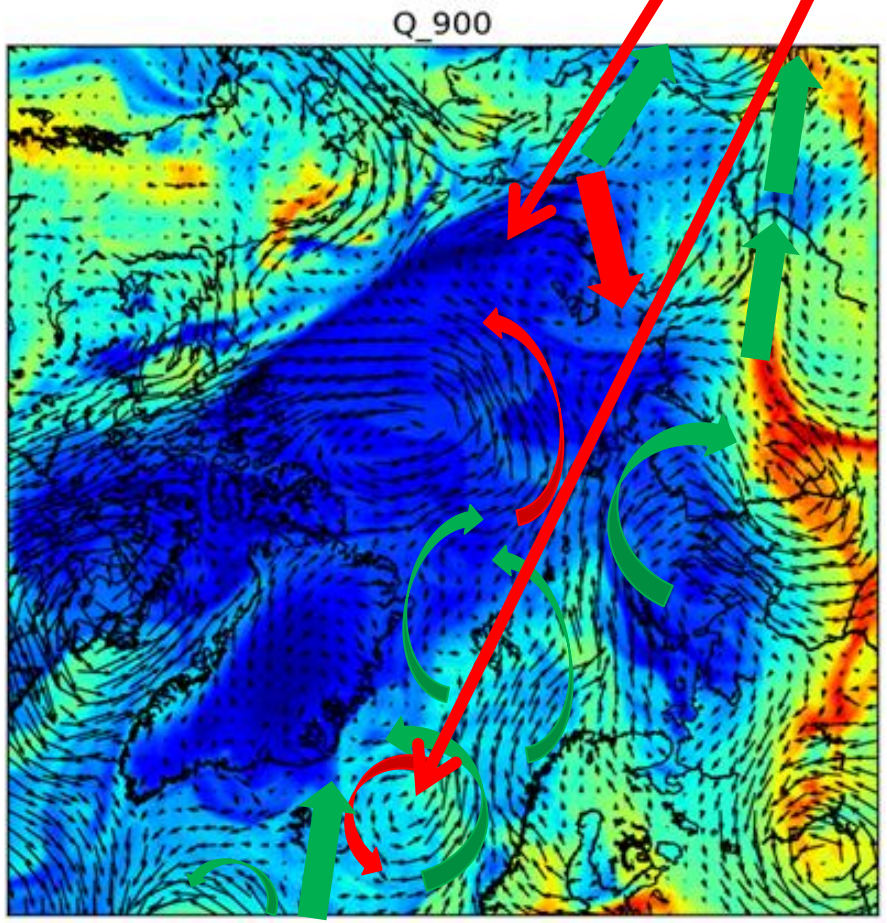


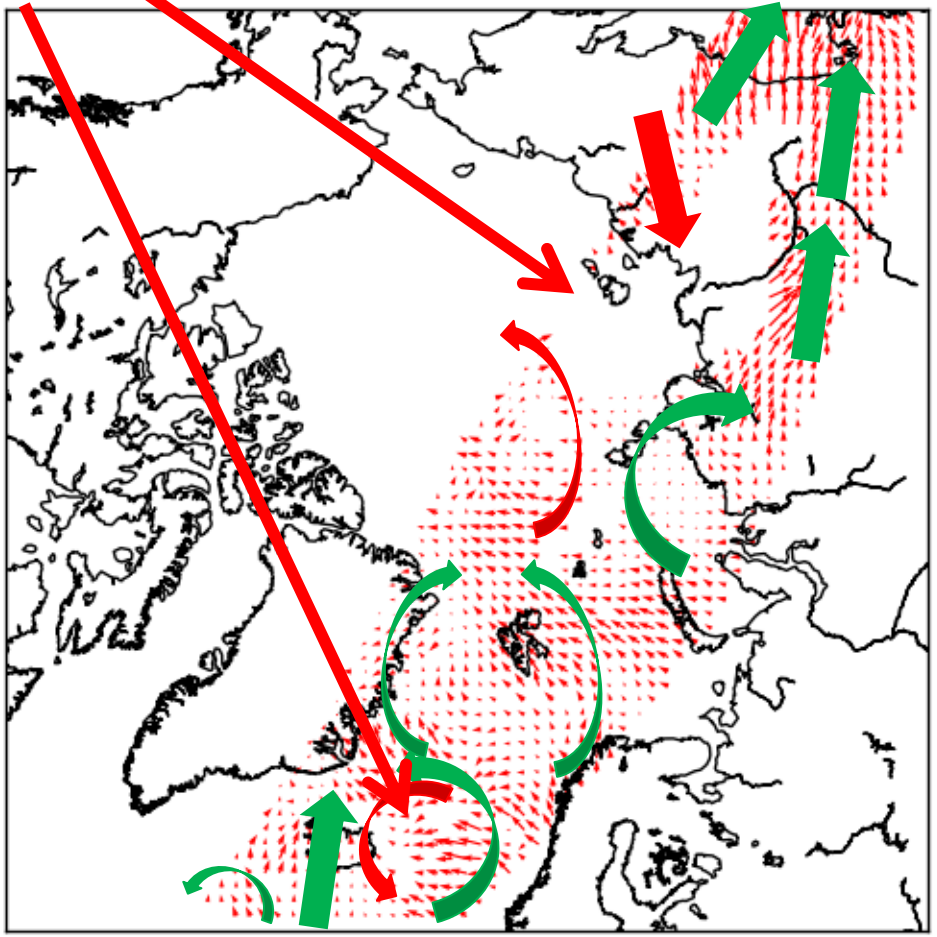
Exemple of 3D winds using FC fields
21 June 2013, 12:00 UTC at 900 hPa

ECMWF, 900 hPa

Too strong Regularization?

3D winds, 925 hPa





Conclusions & future work

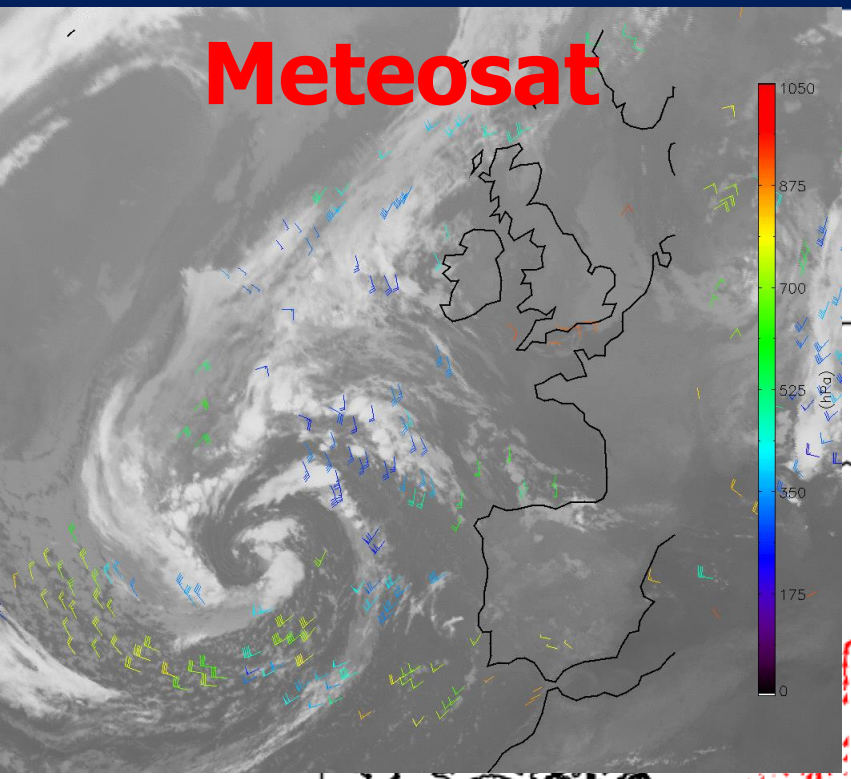
Summary

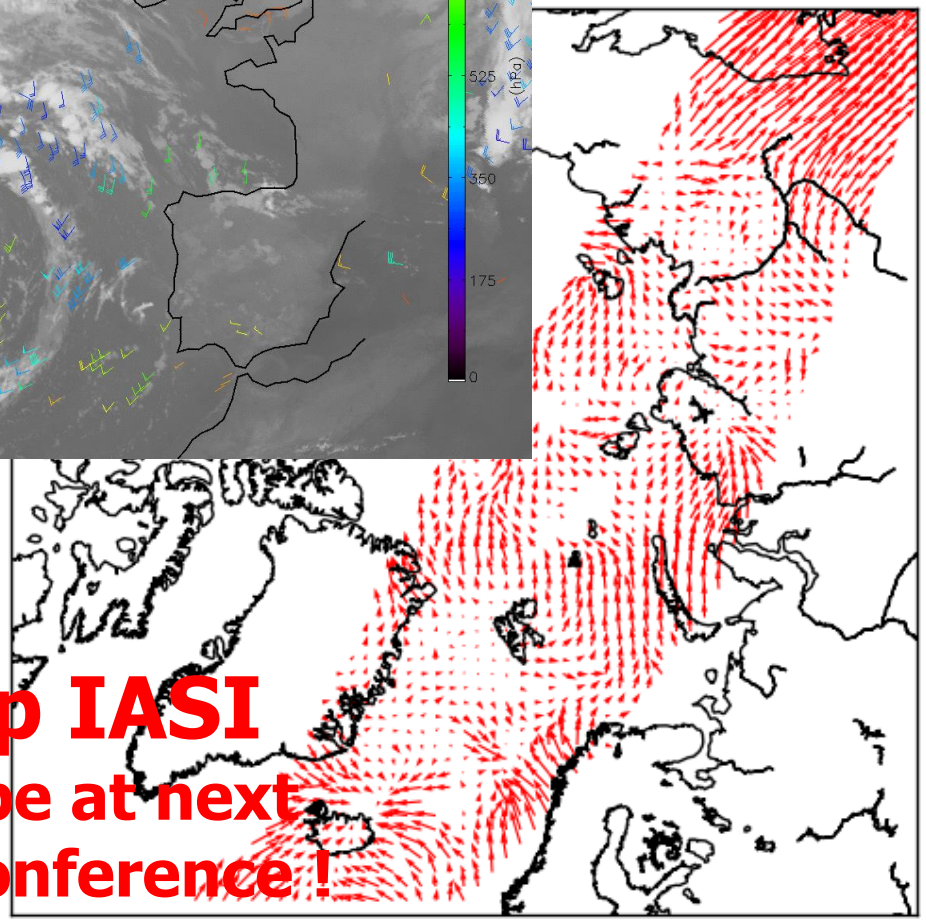
- ✓Initial goal was to demonstrate the feasibility
- ✓First results look promising using IASI L2 product (and exciting !)
- ✓Need to check the quality of the retrievals.

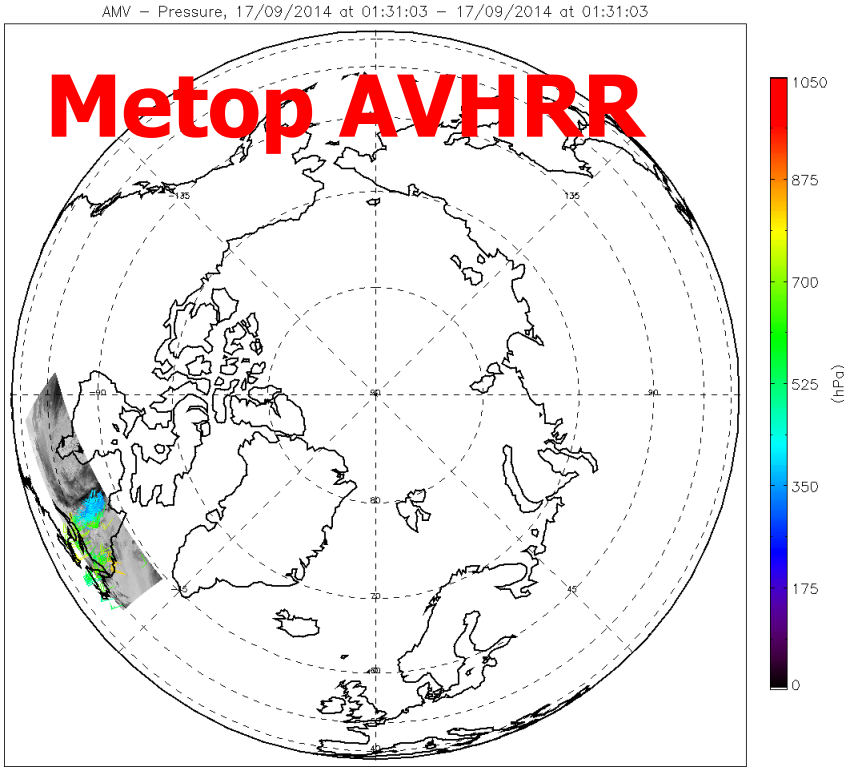
Next step

- ✓Use Temperature and Humidity fields together.
- ✓Build a new geophysical model adapted to the inputs.
  - →Regularization based on vorticity, Divergence, Diabatic heating…
- ✓New mathematical minimization algorithm.
- ✓Learn how to play with regularization methods

Thanks, all comments are welcome !







Metop IASI
…maybe at next IASI conference !
☺

Special thanks to Olivier !!!

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Olivier.hautecoeur@eumetsat.int

EUMETSAT