Highlights of CREW-4 and the Plans for ICWG

IWWG-12 2014, Copenhagen

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Thanks to

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Outline

- Introduction & History
- Highlights from CREW-4 Workshop Report
- Ideas for IWWG Collaboration with ICWG

History of Cloud Retrieval Evaluation Workshop (CREW)

CREWs started 2006 and were organised 3 times since. The workshops are being attended by developers cloud parameters and users of from **Asia**, **USA** and **Europe**.

The CREWs aim to enhance our knowledge on state-of-art cloud parameter retrievals from passive imager observations and pave the path towards optimising these retrievals for now casting, weather forecasting, climate monitoring, as well for the analysis of weather and climate models.

Level-2 and Level-3 cloud parameter assessment studies are facilitated by a common database of passive imager retrievals (from geostationary and polar satellites) and reference observations from active instruments (e.g. from the A-Train).

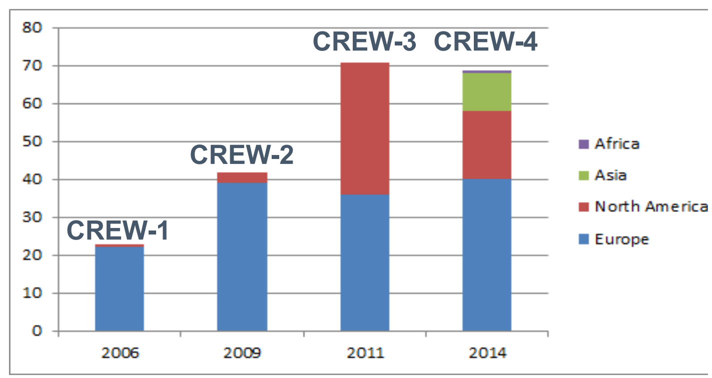


Fig.: *CREW participants distribution*

CREW-4: Workshop Topics

- **Topic 1: Cloud parameter retrieval methods**
  (retrieval parameterizations, optimal estimation, combined retrievals, error estimates)

- **Topic 2: Cloud parameter retrieval evaluations**
  (validation, inter-comparisons, uncertainty estimate assessments, and sensitivity analysis)

- **Topic 3: Cloud parameters for nowcasting and forecasting applications**
  (severe weather, aviation, early warning, and data assimilation)

- **Topic 4: Cloud parameter datasets for climate and weather research**
  (aggregation methods, dataset stability and trend analysis, reanalysis verification, evaluation of model parameterizations, and satellite simulators)

SEVIRI Cloud Height Retrieval Methods in CREW

Acronym	Method	Channels (mm)	Aux Data	Institute
AWG	Optimal Estimation	6.7, 8.5, 11, 12, 13.3	NCEP	NOAA/NESDIS & CIMSS
CMS	IRW, H_2O Intercept, CO_2 Slicing	6.2, 7.3, 10.8, 13.3	ERA Interim	Climate SAF
DLR	IRW + CO_2 Slicing	10.8, 13.3	ECMWF	German Aerospace
EUM	IRW, H_2O Intercept, CO_2 Slicing	6.2, 7.3, 10.8, 12.0, 13.3	ECMWF	EUMETSAT
GSF	IRW + CO_2 Slicing	10.8, 13.3	NCEP GDAS	NASA Goddard
LAR	IRW, H_2O Intercept, CO_2 Slicing	6.2, 10.8, 12.0, 13.3	NCEP	NASA Langley
MFR	IRW, H_2O Intercept, CO_2 Slicing	6.2, 7.3, 10.8, 12.0, 13.3	ECMWF	MeteoFrance
MPF	IRW, H_2O Intercept, CO_2 Slicing	6.2, 7.3, 10.8, 12.0, 13.3	ECMWF	EUMETSAT
OCA	Optimal Estimation	all, but 3.9, 9.6	ECMWF	EUMETSAT
UKM	IRW, CO_2 Slicing	11, 12, 13.3	MetOffice	UK MetOffice

CREW database also includes AVHRR, MODIS, VIIRS and AMSR products.

Cloud parameter retrieval
Evaluation

(all figures and data are available from the CREW wiki)

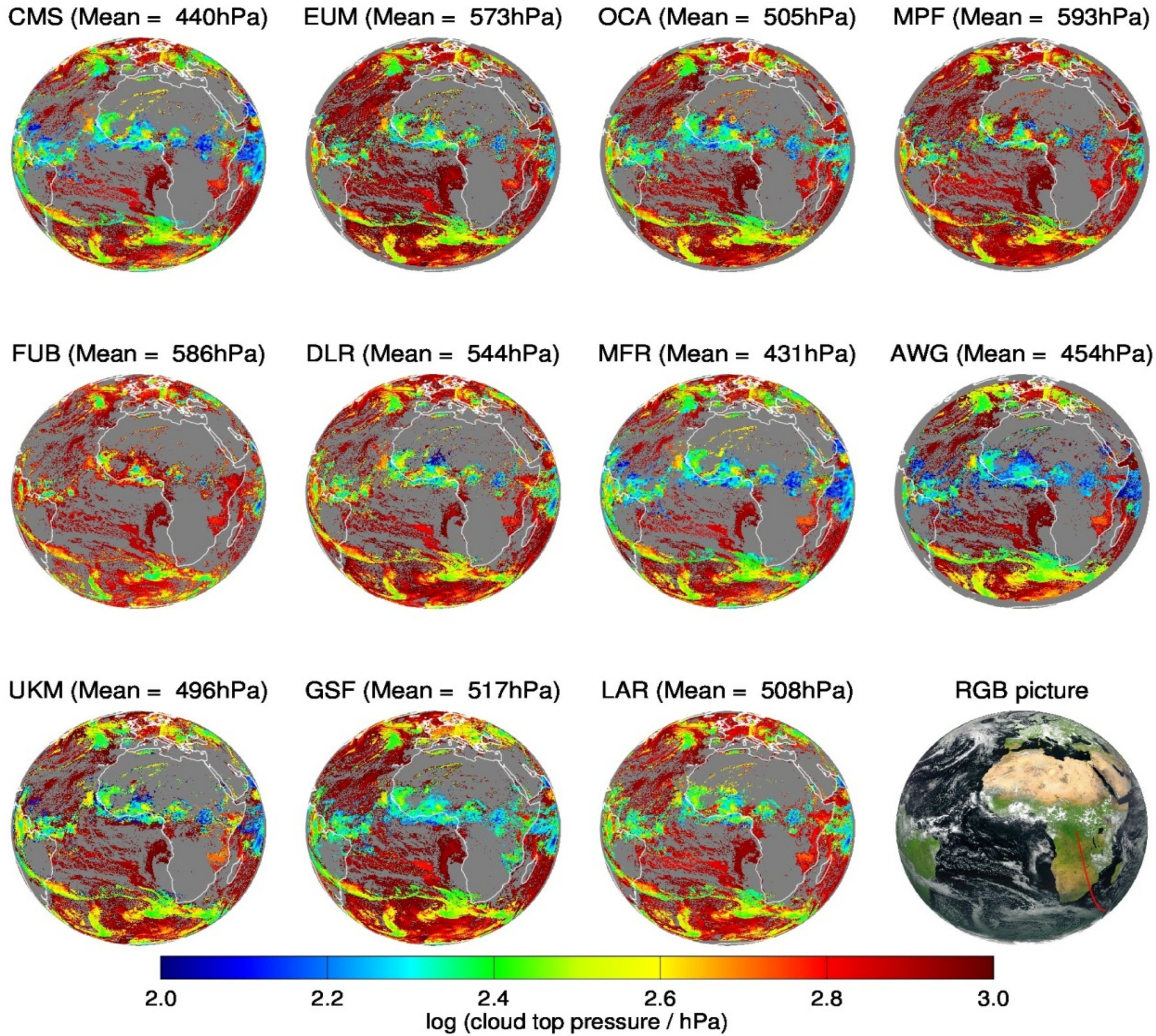
Retrieval inter-comparison: Cloud Pressure

2008-06-13
12:00 UTC

- **11 retrievals**
- **Different cloud masks**
- **Different CTP retrievals**

- **Range in mean is 431 – 593 hPA**

- **OCA = 505 hPa**
- **NOAA/AWG = 454 hPa**
- **MFR = 431 hPa**



Inter-algorithm consistency Geostationary satellites

CTP assessment from SEVIRI

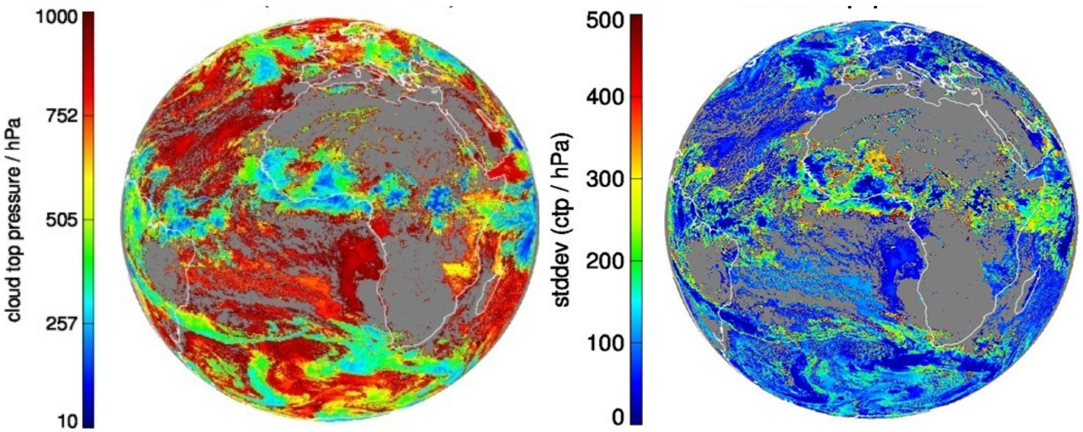


***Fig. :** Mean CTP (left) and standard deviation of CTP (right) both calculated from 11 retrieval algorithms*

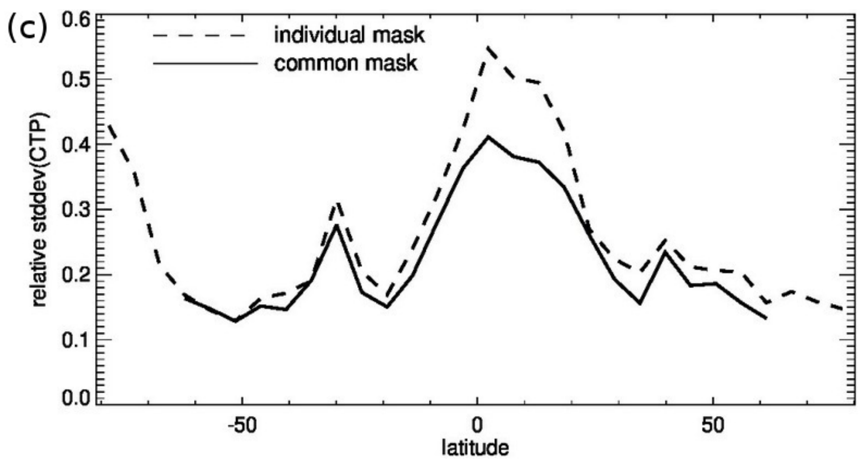


***Fig. :** Latitudinal distribution of the relatives standard deviation of CTPs (%) from 11 retrieval algorithms using individual or common cloud mask.*

Summary

Tropics:

- Large differences between the algorithms (30% < rel. std < 55%).
- Using a common cloud mask leads to 5-15% improvement.

Extratropics:

- Smaller differences between the algorithms (15% < rel. std < 30%).
- Using a common cloud mask leads to 2-5% improvement .

Courtesy of Ulriich Hamann, MeteoSwiss

Validation against A-train reference:
SEVIRI Cloud Top Height validation

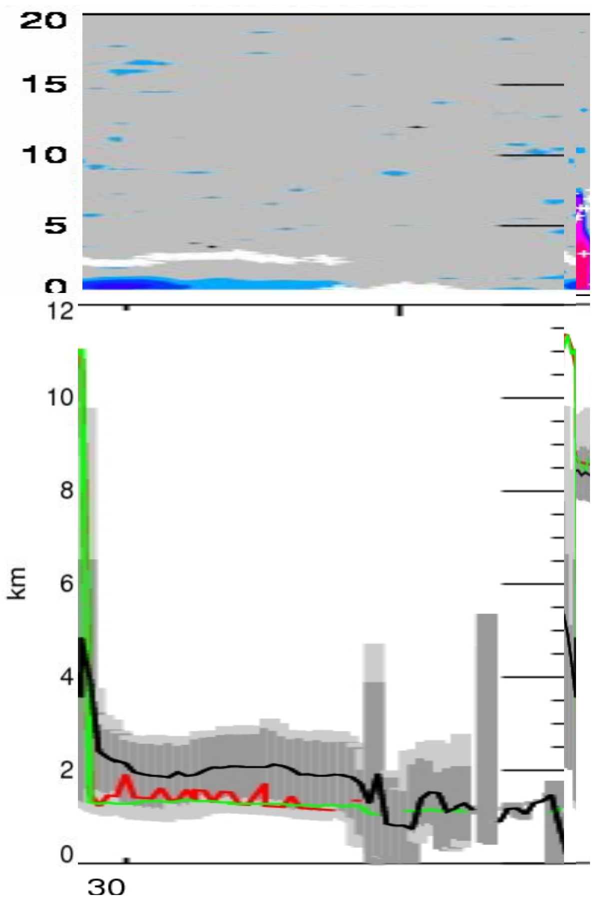


Fig. : Calipso*, *Cloudsat* and *SEVIRI mean *cloud top heights.*

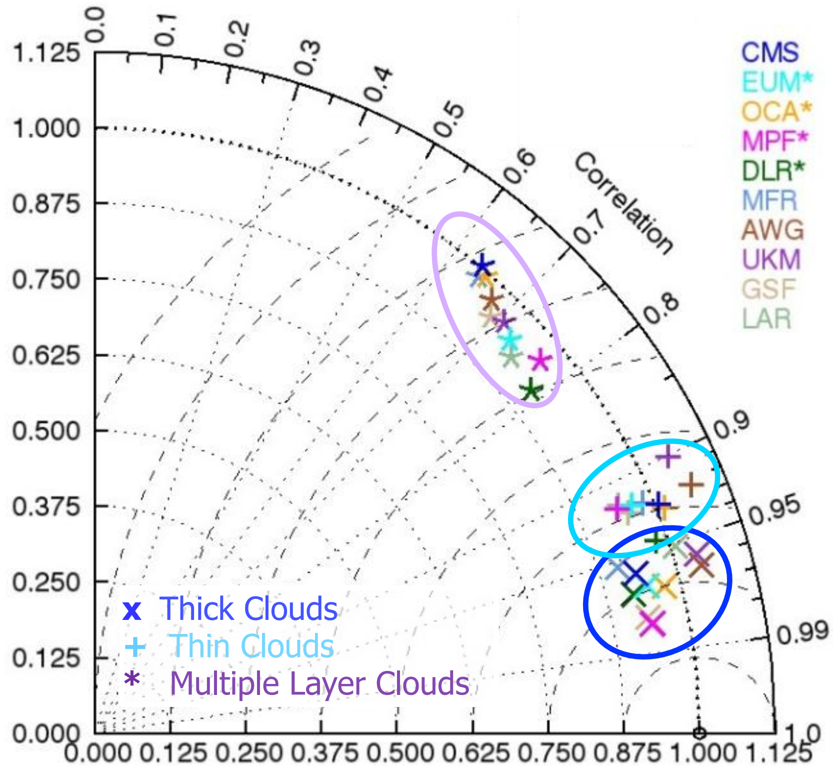


Fig. : *Taylor plot of **CPR** CTH vs. 10 passive imager retrievals*

Courtesy of Ulrich Hamann, MeteoSwiss, Switzerland

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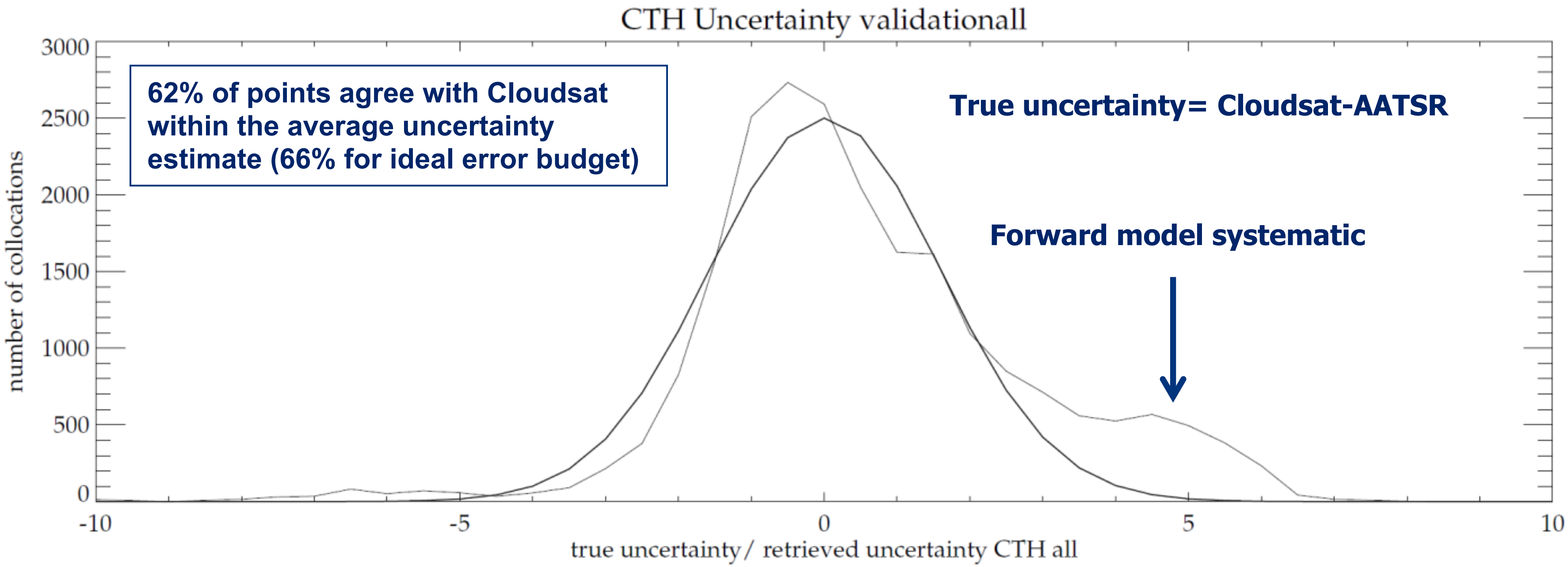
Validation of uncertainty
RAL Optimal Estimation (OE) retrievals



Summary

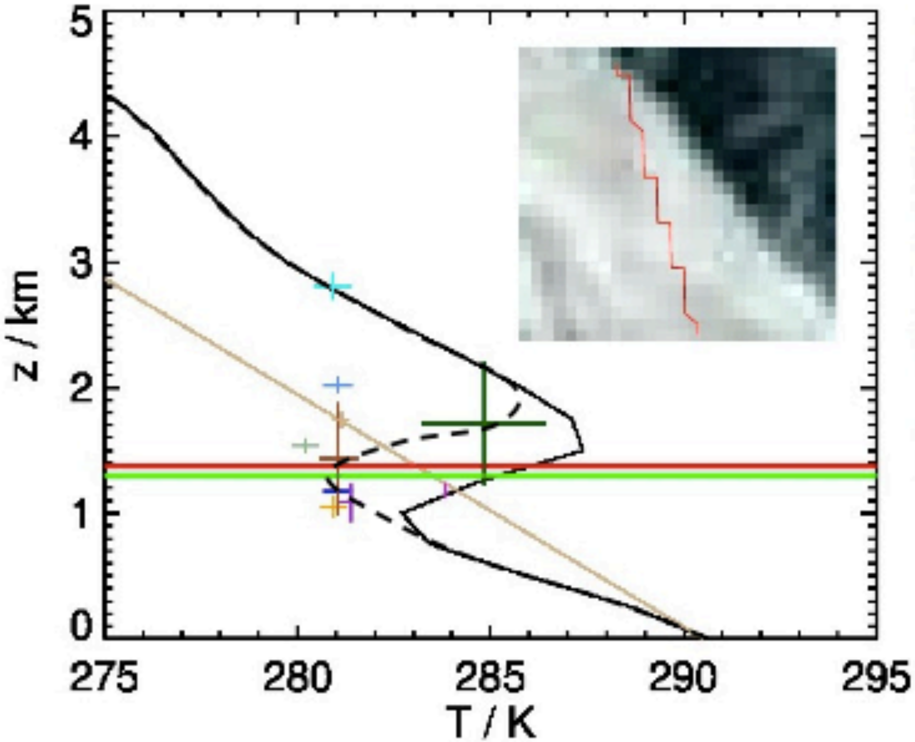
- OE uncertainty is random
- OE propagates measurement, co-registration, homogeneity and surface uncertainties
- Cost indicates good fit to the model - often identifies Multiple Layer clouds

  >>1 OE uncertainty too low
  <<1 OE uncertainty too high

Courtesy of Caroline Poulsen, Rutherford Appleton Laboratory, UK

Boundary layer challenges

This examples explores the impact of the handling of inversions on cloud height. Each algorithm slightly different choices.

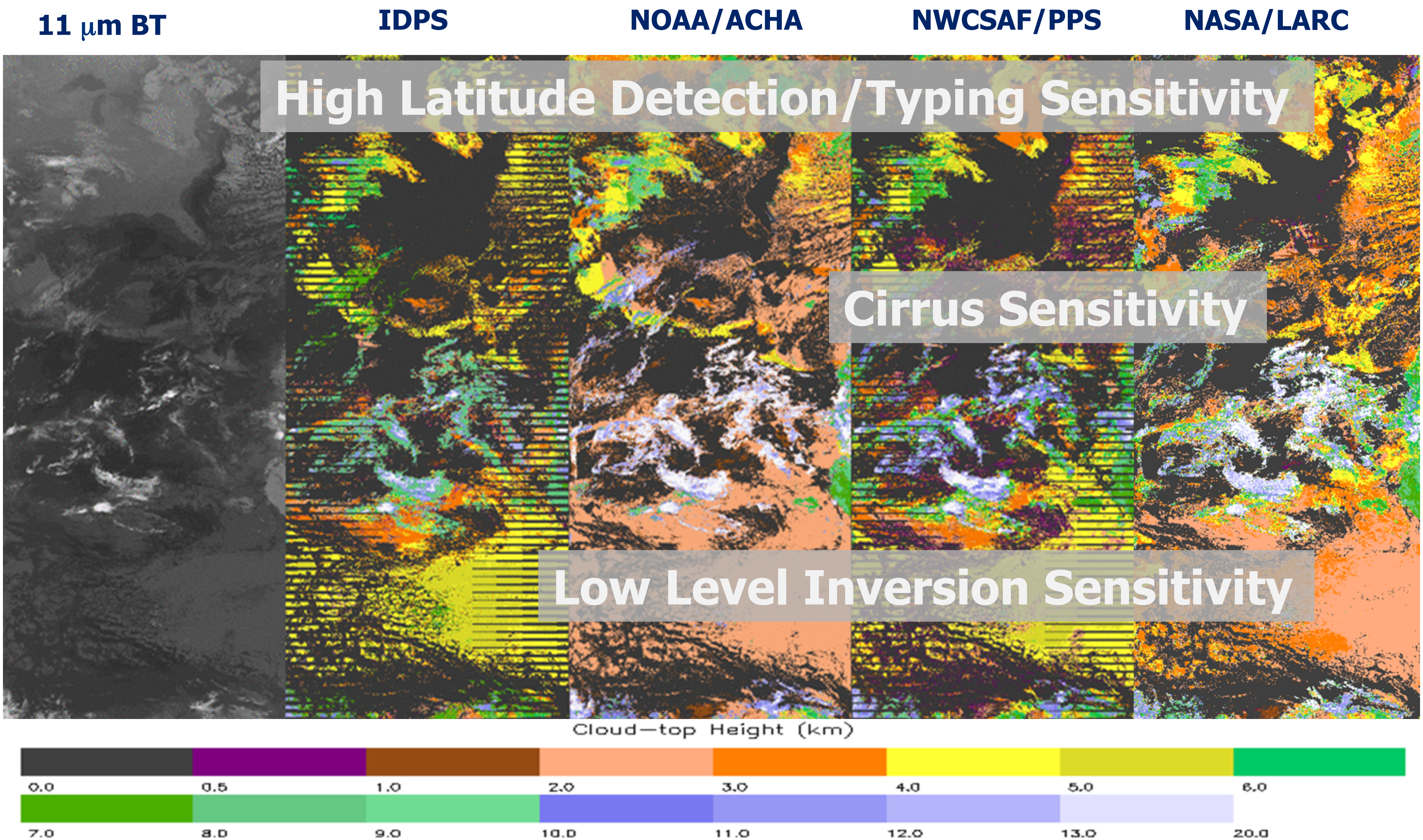


CALIPSO
CPR
CMS
EUM*
OCA*
MPF*
DLR*
MFR
AWG
UKM
GSF
LAR

CMS inversion correction
EUM no correction
OCA no correction, but usage of WV channels
MPF CTH inversion correction with CTT modification
MFR inversion correction
UKM inversion correction
GSF assuming constant temperature gradient
LAR constant lapse rate

Inter-algorithm Consistency Polar satellites

VIIRS Cloud Height 29 March 2014



Courtesy of Andrew Heidinger, NOAA, USA

Cloud Top Height Issues Relevant to AMVs

- **Cloud Height Algorithms often fail (Optimal Estimation) or performance poorly (IRW, H_2O Intercept, CO_2 Slicing) at cloud edges.**
- **Spatial processing techniques offer promise of improving edge performance for cirrus clouds (where vertical layer distributions are smooth).**
- **No CREW algorithm exploits temporal consistency in the cloud height but this is also an issue.**

Recommendations

CGMS-ICWG: Recommendations

- **To improve on level-2 cloud retrievals methods;** *(e.g. multi-instrument retrievals)*
- **To work towards characterizing product errors;**
- **To improve on level-3 aggregation methods;** *(e.g. define essential filtering rules)*
- **To use common databases and validation procedures;** *(level-2 and level-3)*
- **To explore the use of M**ultiple **A**lgorithm **E**nsembles **for uncertainty analysis;**
- **To explore the production of a long-term datasets aimed at stability;**

✔ • **To establish CREW as CGMS I**nternational **C**louds **W**orking **G**roup **(CGMS-ICWG);**

- **To establish sub-working groups addressing specific research topics;**

- **To encourage GSICS to provide VIS, NIR, and IR calibrations for present and past passive imagers;**
- **To encourage the establishment of sites operating several reference networks,** ***C****limate* ***A****nchor* ***R****eference* ***S****ites* ***(CARSs)***

My Ideas for ICWG and IWWG Collaboration

- ***We don't really know how to determine which pixels matter most to AMVs. If we did, our ICWG analysis could be more relevant to IWWG.***
  - *Recommend that IWWG provide a test case where the ICWG can explore the cloud height performance for relevant features.*

- ***ICWG cloud height algorithms are exploring spatial and temporal methods to improve performance.***
  - *Recommend IWWG collaboration in ICWG cloud height working group to leverage AMV experience and optimize information (i.e. QF) coming out of cloud height algorithms. ICWG experience is mainly radiative transfer, not spatial and temporal processing.*

Where to get the data?

More information on Wiki site ->

http://www.icare.univ-lille1.fr/crew/

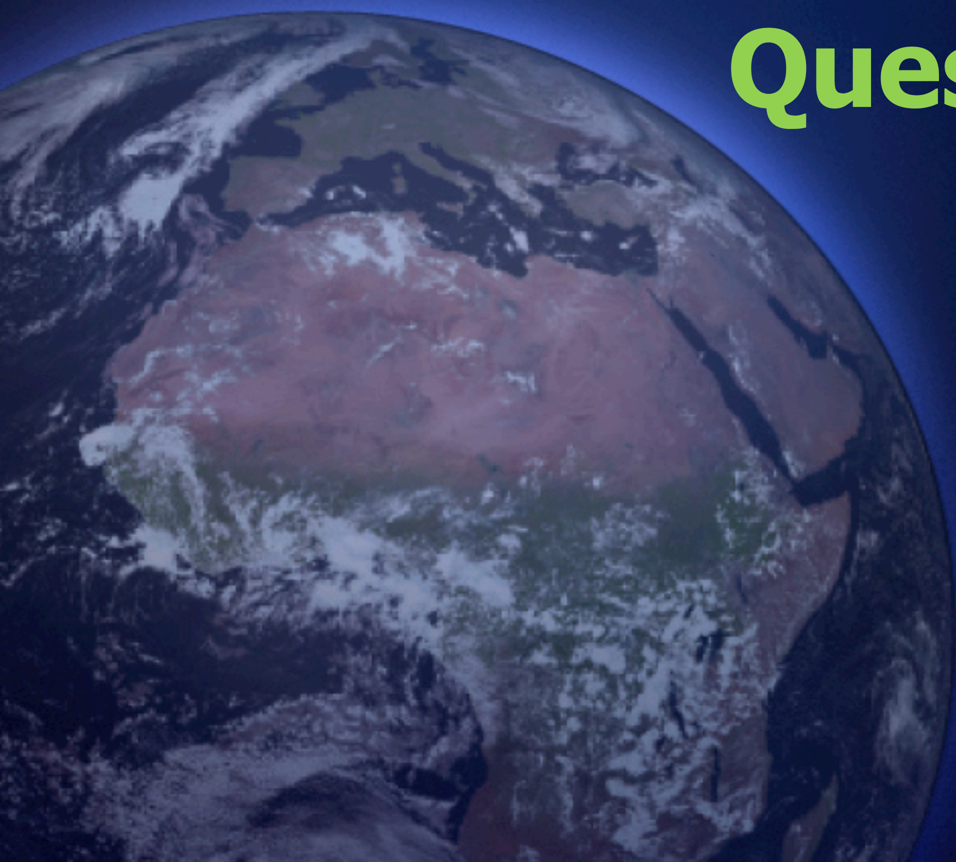
Common Database on FTP site ->

ftp://ftpush.icare.univ-lille1.fr/crew/

Next workshop: Lille, France in 2016

*CREW acknowledges **Jerome Riedi** (Univ. Lille, France) for providing infrastructure for website and common database*

Thank You



Questions ?

Cloud Detection Impact on Cloud Height

Individual masks

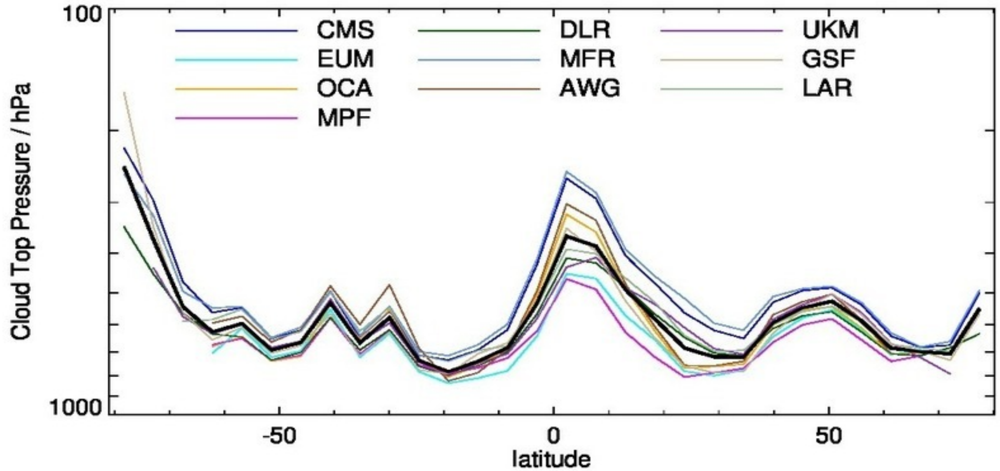
Differences caused by

- **CTH retrievals and**
- **Cloud detection**

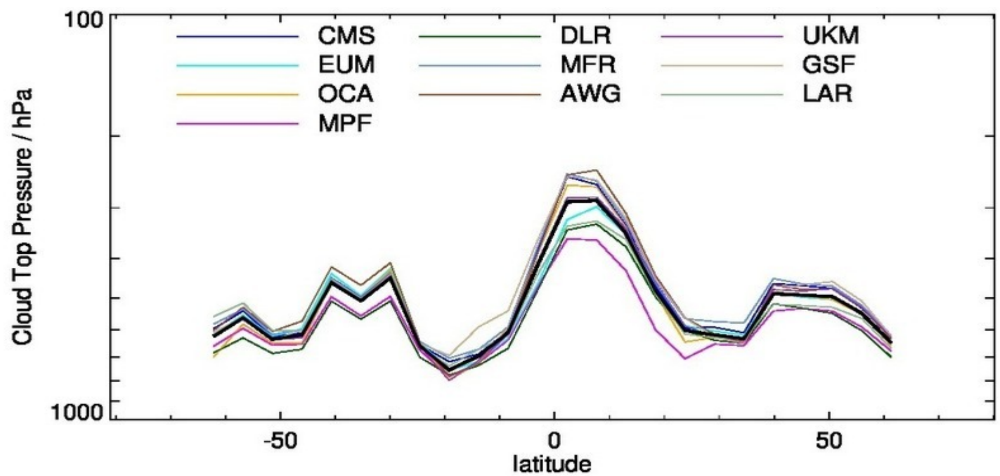
Common mask

- **Use common pixels only**
- **No cloud mask effect**
- **THIS THROWS AWAY EDGES.**

individual masks

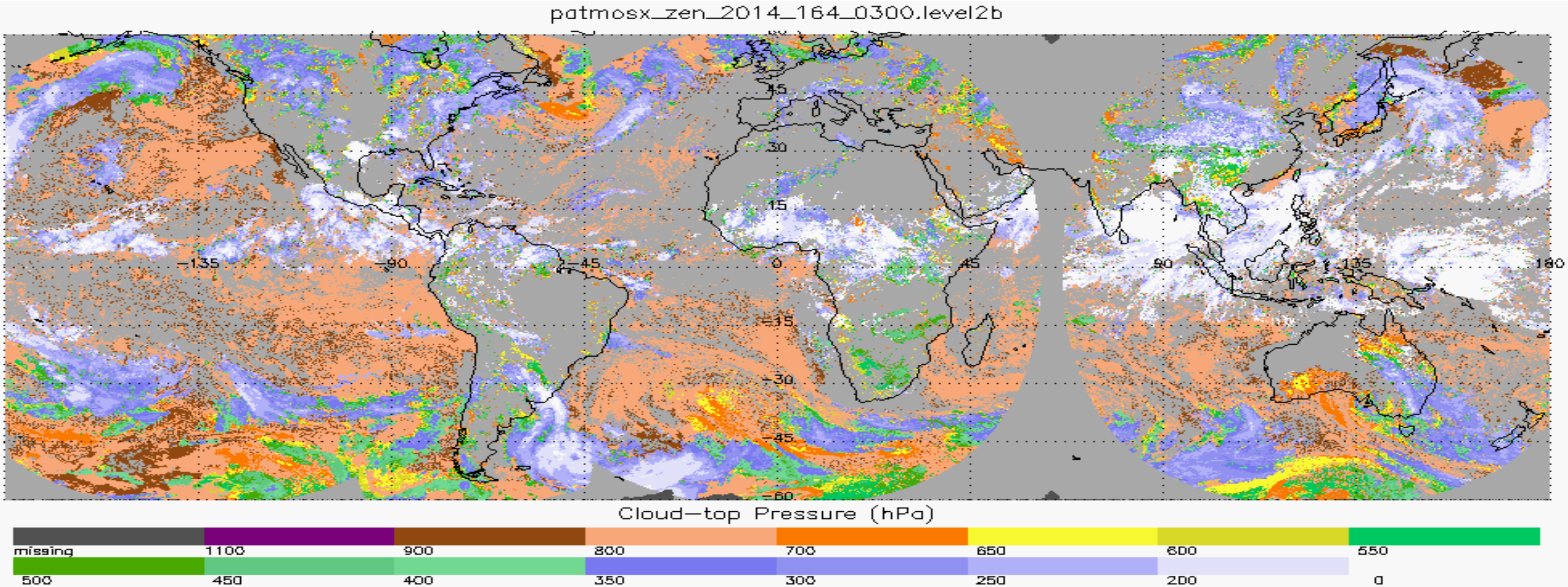


common mask



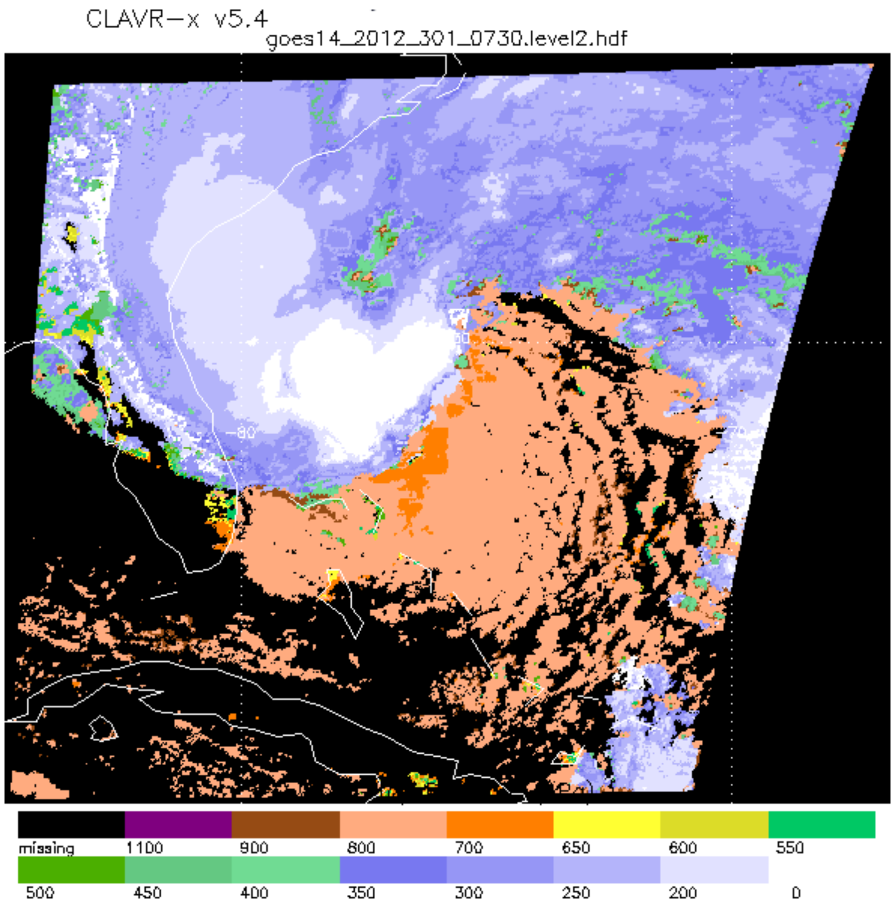
Global Geo Cloud Pressure from a Common Algorithm

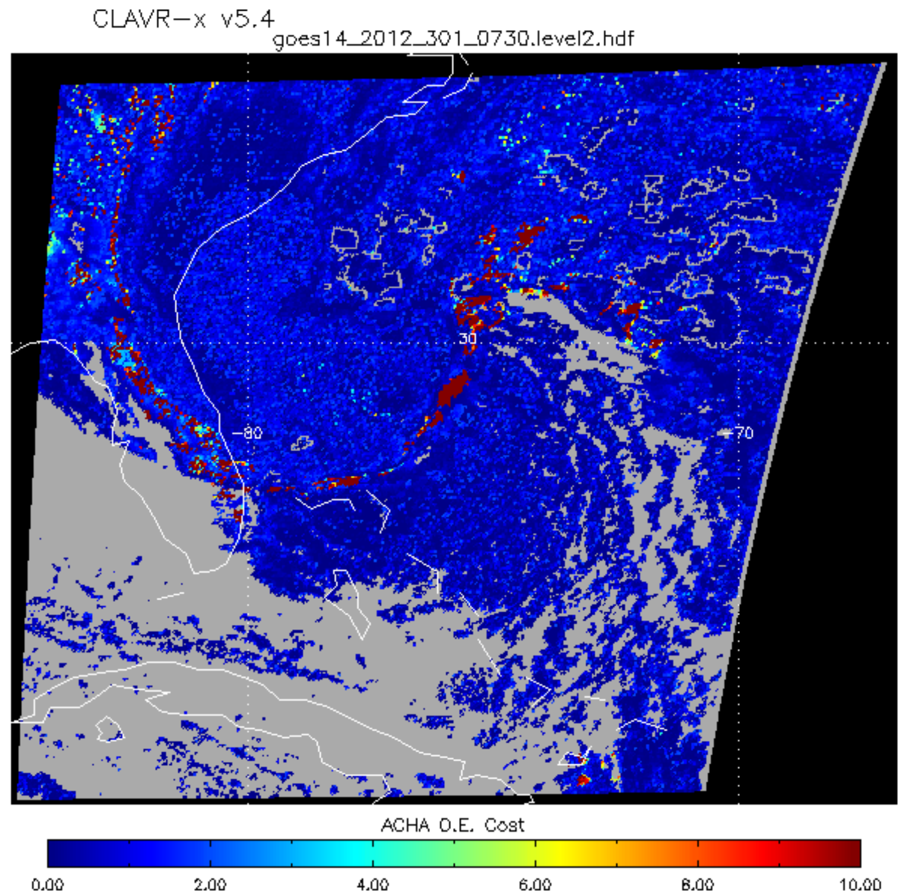
- The CREW/ICWG groups are not attempting to make a common algorithm. Our approach has been to share techniques and make **Multiple Algorithm Ensembles** to detect discrepancies.
- Current geostationary constellation (NOAA, EUMETSAT, JMA and KMA) only provide 6.7 and 11 micron common basis.
- For this reason, CREW analysis has continued to use SEVIRI.
- Image below shows the NOAA Cloud Height Algorithm applied to global geo imagers using the common channels.
- Once geostationary imagers are updated, ICWG will expand to global analysis.



Cloud Height Retrievals Near Edges Often Fail.

Our physical algorithms tend to fail near cloud edge, which is where AMV applications need them





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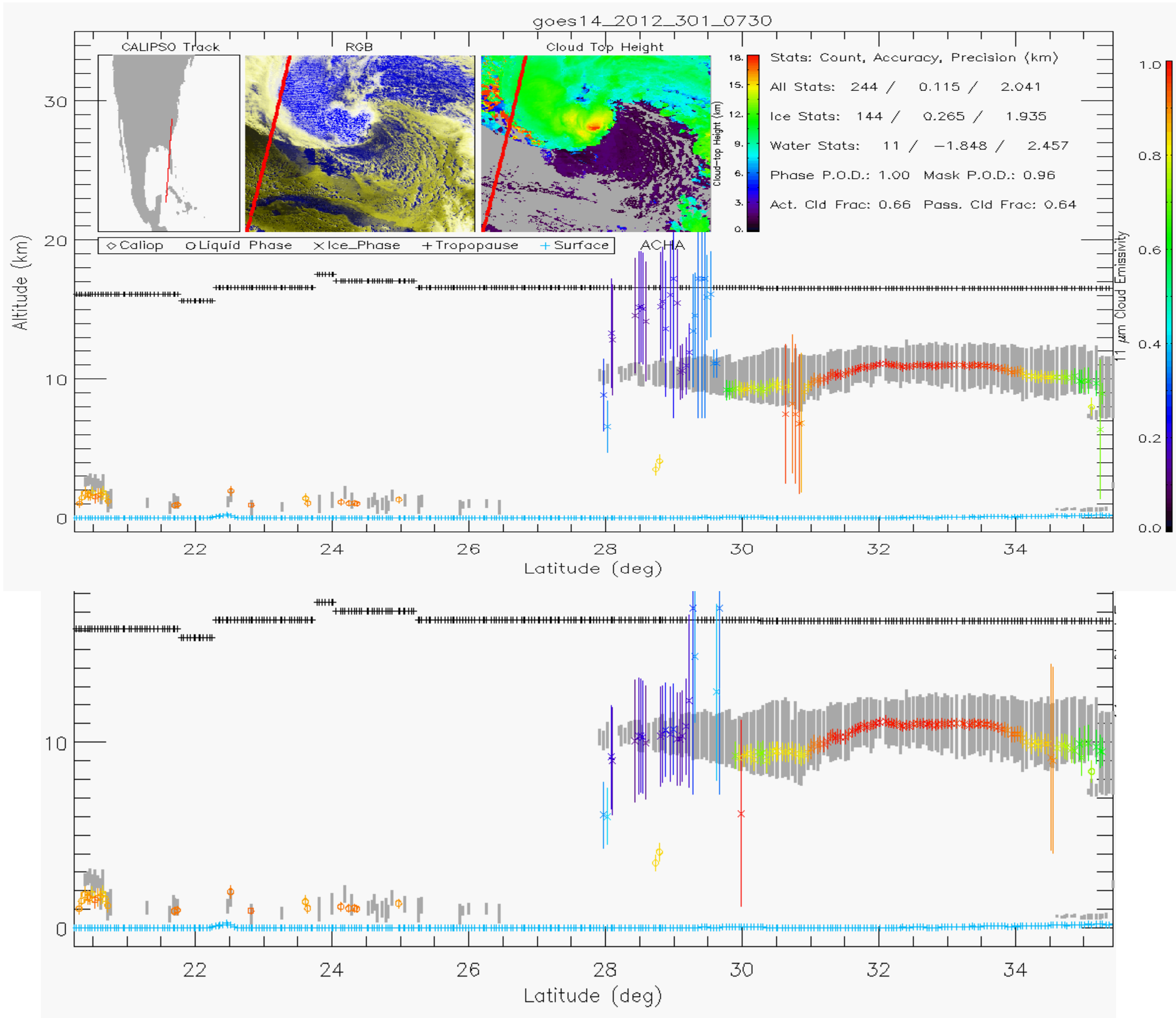
Improving Edge Performance with Spatial Constraints

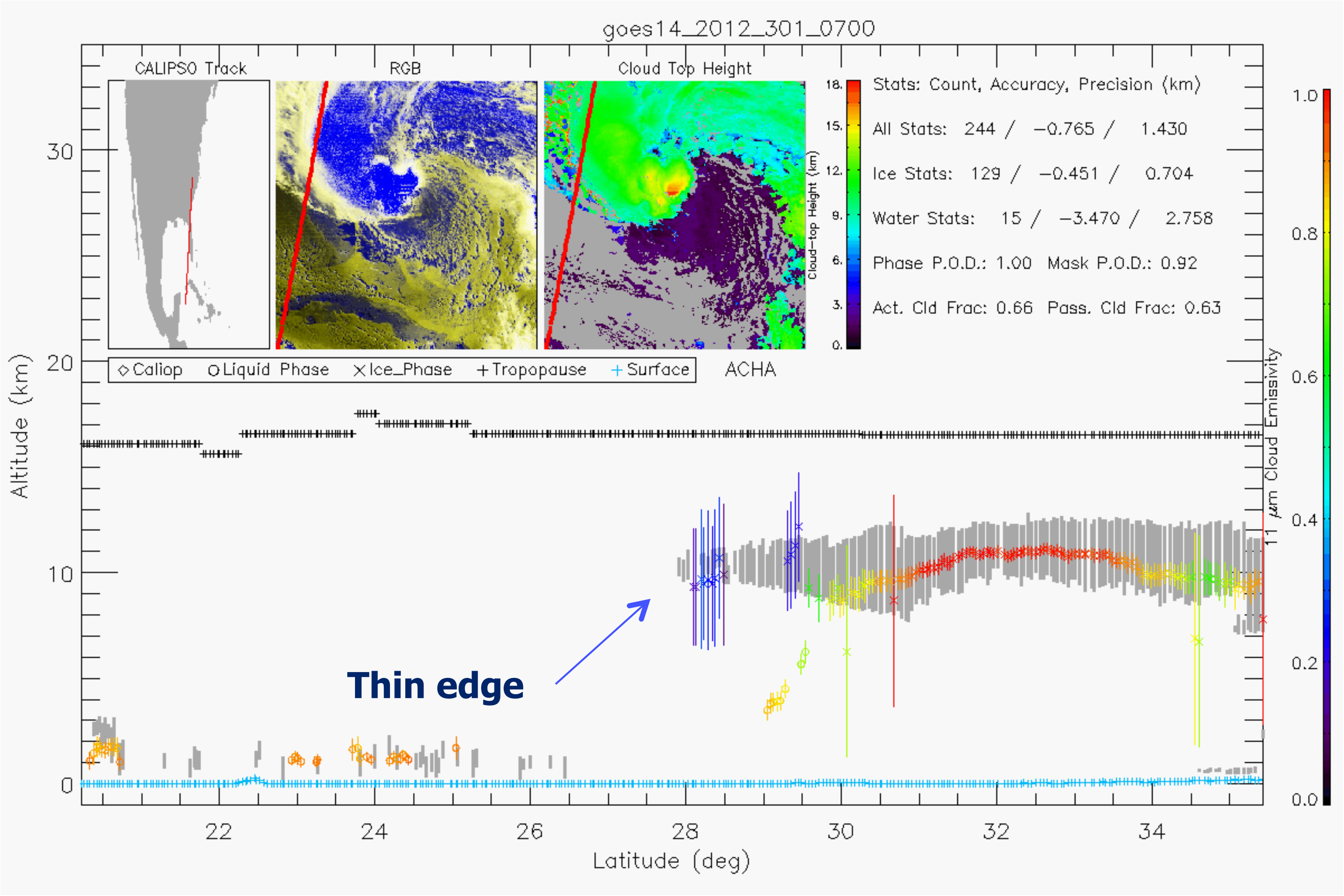
- **Cirrus cloud heights vary little over large spatial scales.**
- **One can use the cirrus height retrievals for thicker clouds to constrain heights of thinner clouds in the same region.**
- **Upper panel shows ACHA results using a global cirrus height first guess that is too high for this case. Impact is seen on edge of cirrus.**
- **Lower panel shows the impact of a first guess from preprocessing the opaque regions first and applying them to the semitransparent regions.**



Temporal Stability of Cloud Edge Retrievals

- **Currently, no ICWG cloud height algorithm uses temporal information to improve consistency of height retrievals.**
- **The AMV retrievals rely on feature tracking n features in 2 or 3 images.**
- **The cloud community could benefit from temporal and spatial filtering used in the AMV community.**

Comparison of CALIPSO/CALIPSO to GOES-14 Cloud Heights.



CALIPSO Data Is from 07:30 UTC. GOES-14 is from 07:00 to 07:45 UTC

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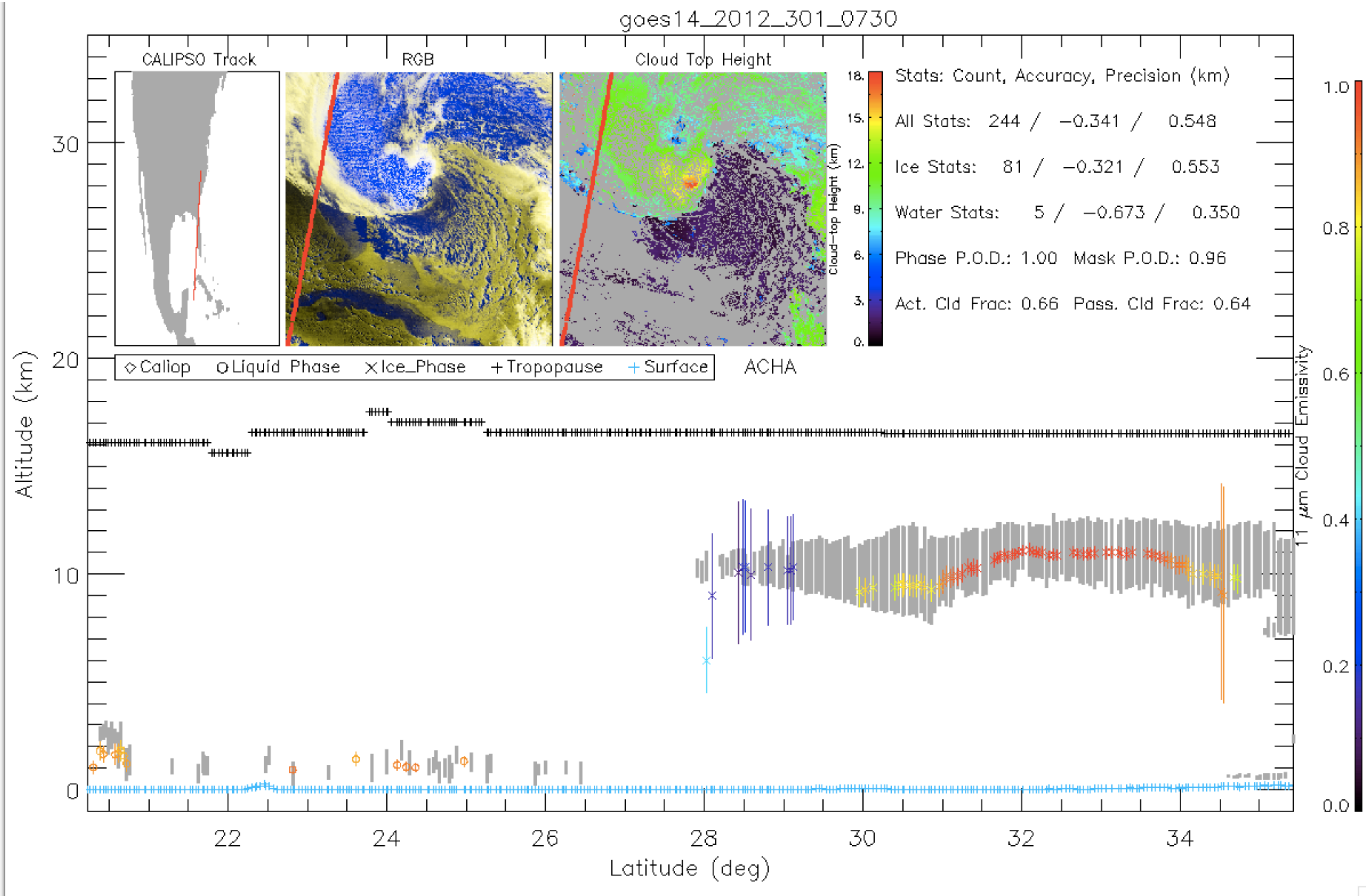
goes14_2012_301_0730
CALIPSO Track
RGB
Cloud Top Height
Cloud-top Height (km)
Stats: Count, Accuracy, Precision (km)
All Stats: 244 / −0.341 / 0.548
Ice Stats: 81 / −0.321 / 0.553
Water Stats: 5 / −0.673 / 0.350
Phase P.O.D.: 1.00 Mask P.O.D.: 0.96
Act. Cld Frac: 0.66 Pass. Cld Frac: 0.64
◇Caliop ○Liquid Phase ×Ice_Phase +Tropopause +Surface
ACHA
Altitude (km)
Latitude (deg)
11 μm Cloud Emissivity

Multiple Algorithm Ensembles for Uncertainty Analysis

We are not pursuing common algorithms. Instead we have made multiple algorithm ensembles and studied regions of variability.

2008-06-13
12:00 UTC

- **11 retrievals**
- **Different cloud masks**
- **Different CTP retrievals**
- **Uncertainties**