The GAIA-CLIM Virtual Observatory

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 640276.

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1 Objectives

- Unearth potential of and enhance exploitation of ground-based and in-situ reference data for satellite sensor and product validation by systematically organising access to data and comparison results including the respective uncertainties;
- Integrate non-satellite reference data with existing satellite-satellite comparisons and observation feedback from NWP/reanalysis model and eventually climate model outputs;
- Increase awareness among scientist and other users on the concept of traceable uncertainty estimates;
- Develop a sustainable facility that supports Copernicus Services and science to analyse product quality in routine mode;
- Address current shortcomings as laid out in the GAIA-CLIM Gaps Assessment and Impacts Document (GAID).

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1 Initial Application Areas of the VO

- Assessment of satellite retrieval quality, e.g., EUMETSAT IASI L2 (T, q, trace gases);
- Assessment of long term stability of satellite retrievals at specific locations using homogeneous ground-based series including uncertainty estimates;
- Assessment of radiance data quality for sensors with frequent sampling such as geostationary radiometer and polar orbiter - May support cal/val of new satellite mission in future;
- Assessment of reference data quality by satellite data, e.g., space based Radio Occultation has demonstrated this for conventional sondes;
- Could have a role in general satellite product assessments, e.g., GEWEX water vapour assessment currently running;

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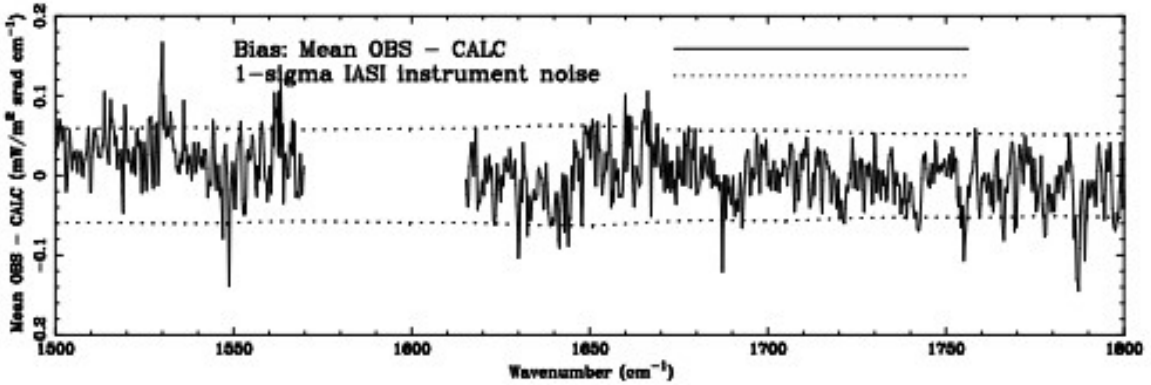
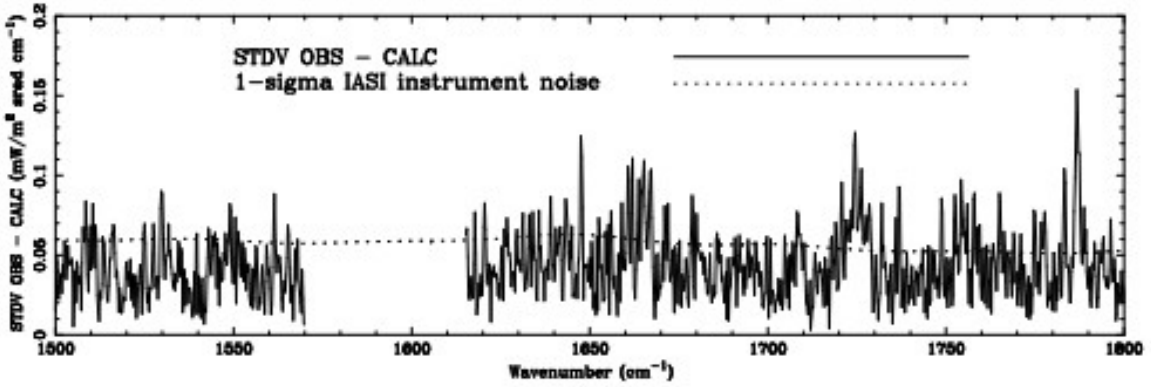
1 Example: IASI Cal/Val Activities

- Observed IASI radiances (OBS) are compared to calculated radiances (CALC) using GRUAN;
- Sonde profile + Radiative Transfer Model (LBLRTM 12.2);
- OBS-CALC should fall within —3 σ IASI instrument noise: is this even possible?



Calbet et al. AMT 2011.



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2 Indications from the User Survey and Current Plan for the Virtual Observatory

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2 Indications from User Survey

- The most frequent intended applications are model evaluation, climate analysis and quality assessment of satellite and ground-based data;
- Uncertainties: Will be included but representation needs to be reviewed.
- Online sub-setting by variable, time and location, but also by observing system and by surface type.
- Online data post-processing (on identified subsets): Re-gridding to a specified resolution and or time step and average data in space and/or time. At a later stage possibly vertical smoothing.
- Flexible forward radiative transfer modelling capability will be included.
- Easy online data extraction: Comparison of collocated data files/specified subsets. At a later stage trend and step-change analysis, stability tests, and anomaly calculations.
- Online visualisation: Graphical maps and time series. Add plots with comparison statistics at a later stage.
- Timeliness: Offline or delayed fine for now. However, the design needs to foresee an eventual operational near real time capability.
- Meta data: Large agreement for using CF standard
- Data format: Large agreement for NetCDF4.
- Concise documentation needed, in particular on the meaning of provided uncertainty information.

2 ECV Priorities

- Temperature profiles , IR+MW sounding with GRUAN, possibly ARSA radiosondes (always together with humidity)
- Humidity – 3 distinct and complementing products (GCOS ECVs):
  - Total column water vapour (TCWV), passive microwave, IR, VIS, Radio Occultation versus GRUAN and ARSA radiosonde data base, lidar, GPS, etc.
  - Profiles of abs. Humidity (kg/kg), IR+MW sounding, Radio Occultation versus GRUAN
  - Upper troposphere humidity: relative humidity, microwave sounders (183 GHz) and IR from polar and geostationary orbit e.g., 30 years of METEOSAT data

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2 ECV Priorities

- Aerosols, AOD at 550nm from space with reference data from AERONET and possibly LIDAR
- GCOS Greenhouse gases, in particular Ozone. Reference data from ground-based Dobson/Brewer measurements. Others reference data (TCCON, NDACC, etc.) to be added depending on level of completeness of traceability within given timeframes (the more the merrier) .
- All ECVs will be augmented with information from NWP/reanalysis systems and eventually CMIP-5 data could be integrated if feasible;
- Forward radiative transfer will be implemented where feasible.

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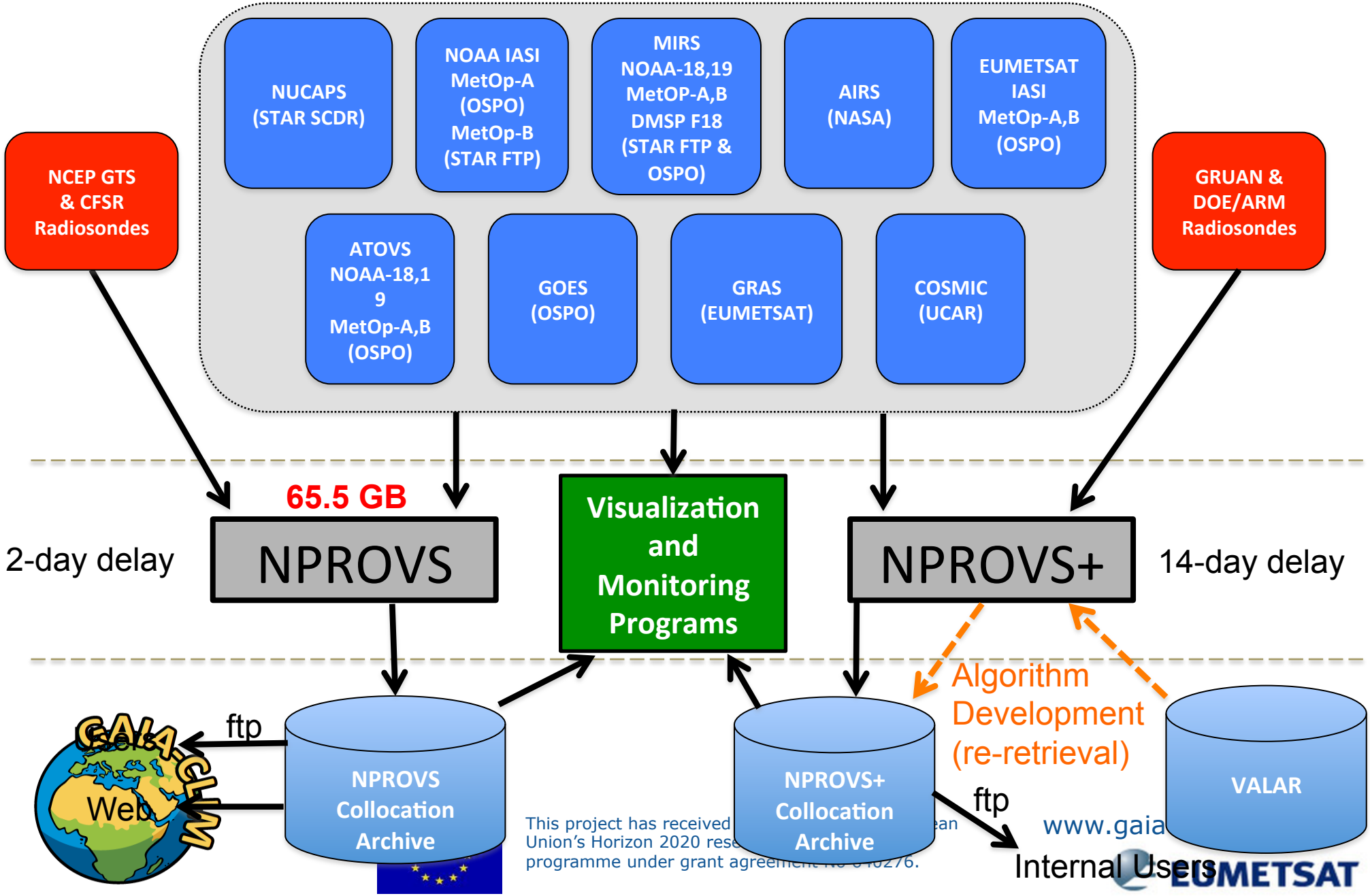

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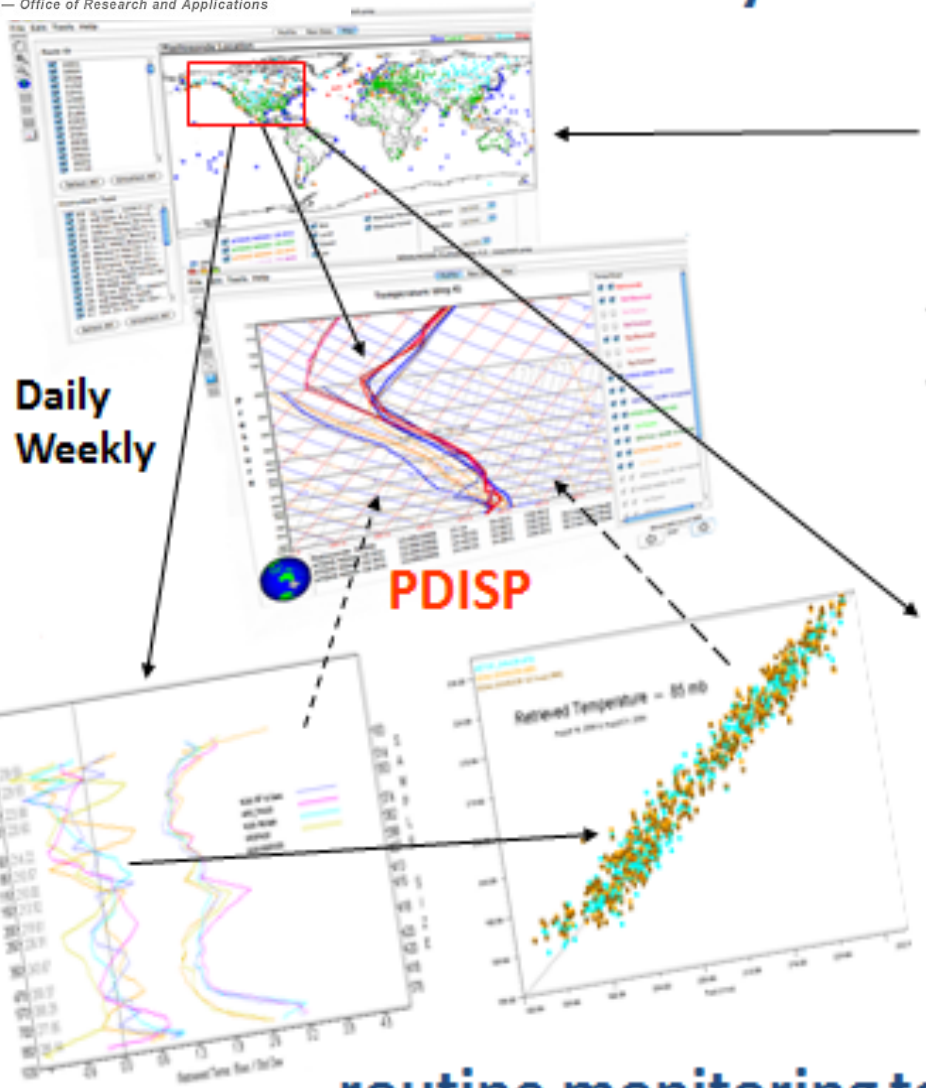
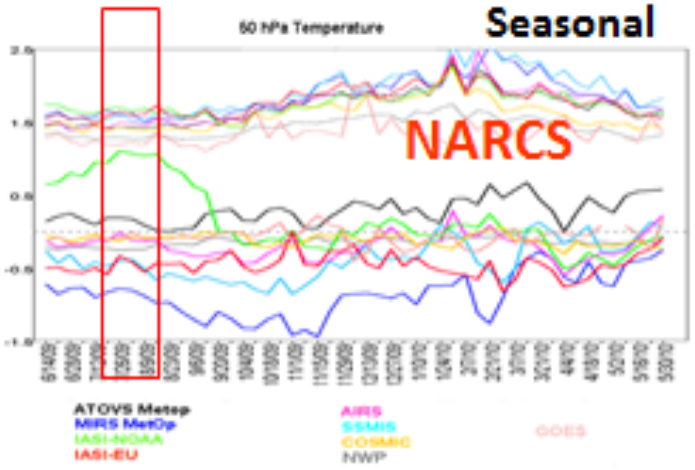
STAR Center for Satellite Applications and Research
formerly ORA — Office of Research and Applications

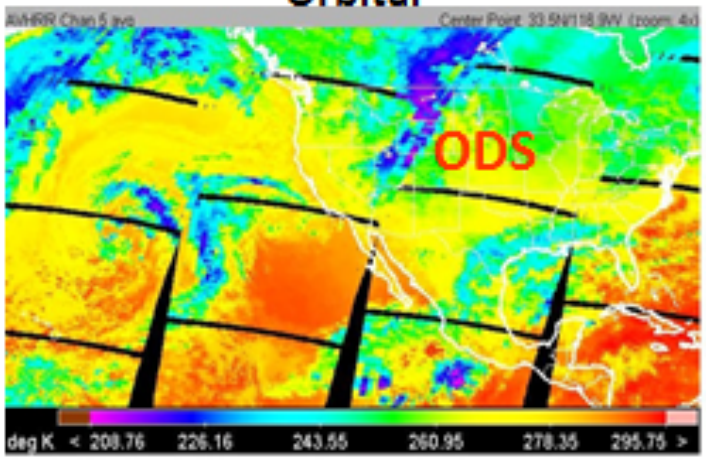
EDGE Analytical Interface …



Seasonal



Orbital



… routine monitoring to deep dive

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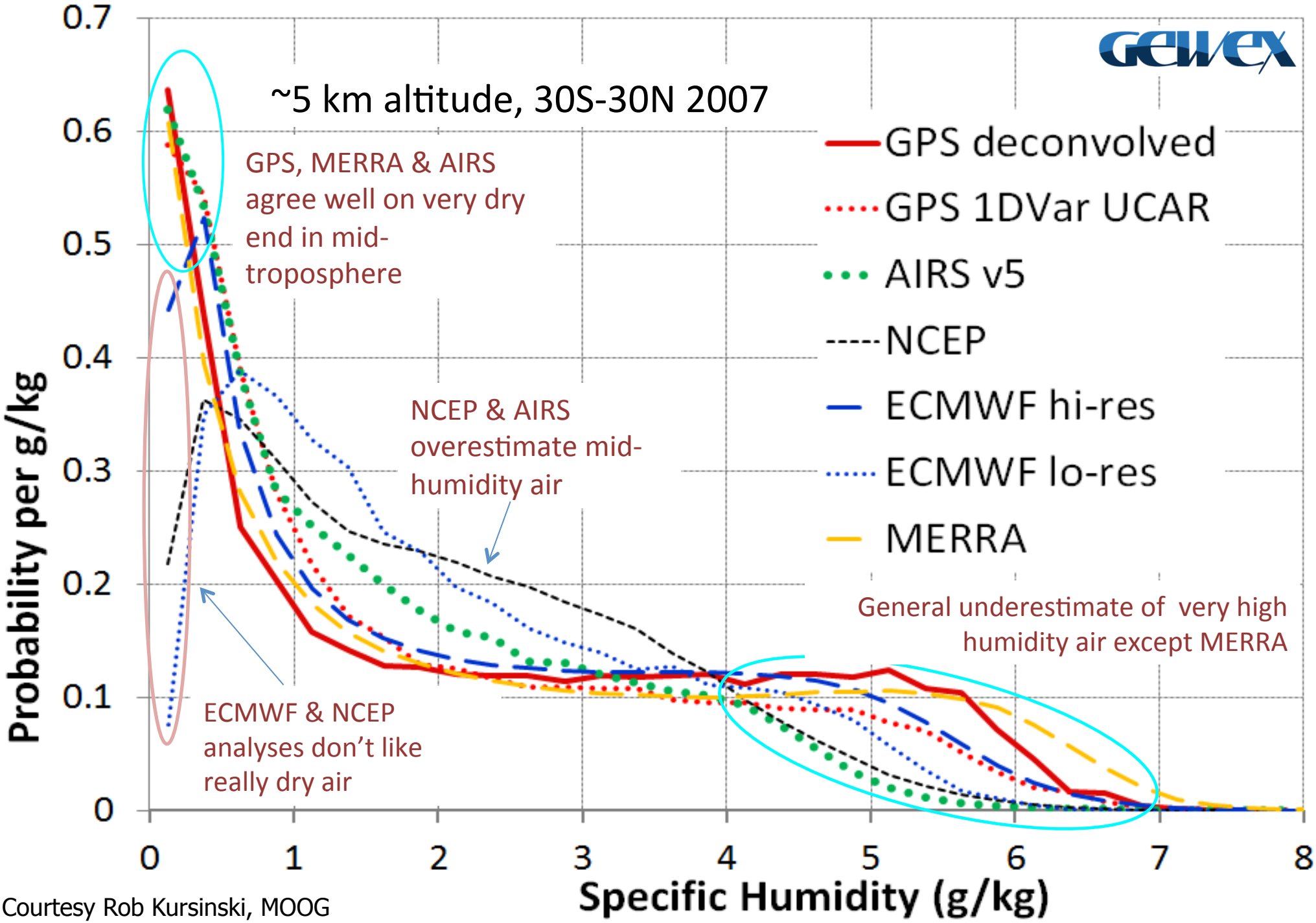

Courtesy Rob Kursinski, MOOG

2 Virtual Observatory Design

- Design based on user requirements derived from user survey and potential further input from this user workshop;
- Benefit from existing tools, e.g. for co-location and sub-setting (STAMP, ICARE, NPROVS+, EUM CM SAF, ESA CCI, Felyx, …);
- Benefit from ongoing GEWEX water vapour assessment;
- Benefit from FIDUCEO, EUMETSAT and ESA CCI satellite data records;
- Benefit from NWP/reanalysis capability on radiative transfer;
- Compliance with C3S standard (Copernicus Services) and EUMETSAT standards for operational software;
- Take only data that we can redistribute without constraints;
- VO will be extendable in terms of reference data, satellite missions and ECVs (covering other domains);
- Agile (iterative) development with strong user interaction is envisioned.

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3 Next Steps and Interaction with Users

- Start with 4 ECVs (temperature, humidity, ozone, aerosol);
- Implement core functionality based on user survey and eventual input at this workshop;
- Would like to include users in development of the VO in particular diagnostic measures and associated graphical displays;
- Development cycles including tests performed by users;
- First test round most likely to start Q3/2016;
- Next User Workshop could offer first practical exercise.

-> Indicate interest to me or arndt.meier@eumetsat.int.

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SPARES

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ECVs Envisaged

Instruments / programme	T	q	CO_2	CH_4	O_3	Aerosols	CO	HCHO	NO_2
Pre-existing / already in process on GAIA-CLIM timescales									
Radiosondes (RS92 and various others)	■	■							
Frostpoint hygrometer sondes		■							
Ozonesondes					■				
QA4ECV project (various instruments)							■	■	■
Planned in GAIA-CLIM									
Lidars	■	■			■	■			
Microwave radiometers	■	■							
FTIR / FTS		■	■	■	■				
UV/visible spectroscopy					■				
MAX-DOAS/Pandora					■				
GNSS-PW		■							

- Selecting satellite products is ongoing and input from the WS encouraged.

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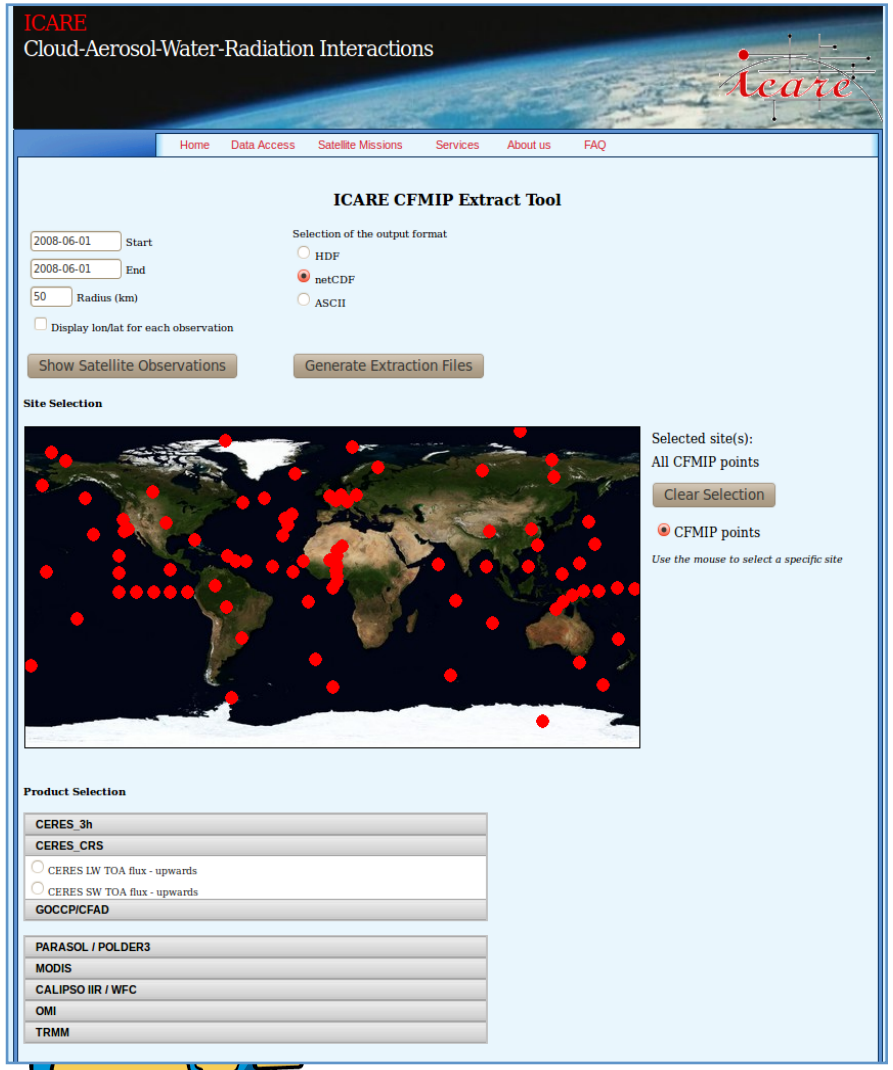
Satellite-to-site collocation (2/2)



Extract tool http://www.icare.univ-lille1.fr/extract

User-specified parameters:

- Time range of sat. observations
- Extract radius around sites
- Extract site or network of sites

Output: all satellite observations within the specified vicinity of any site of the selected network over the selected time period

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Global Gridded Products (1/2)

- ICARE generates many global gridded products from original data sets
- Suitable for satellite-to-satellite or satellite-to-model comparisons
- Pros:
  - Products are very straightforward to use
  - Circumvents complexity of sensor geometry and overpass schedule
  - Each product can be regridded independently
  - Supported by interoperability tools
  - Geographic subsetting is straightforward
  - Product intercomparison is straightforward (direct pixel-to-pixel comparison)
  - Temporal collocation can be handled separately by users
- Data integrity can be somewhat preserved if regridding is done correctly and products are used appropriately

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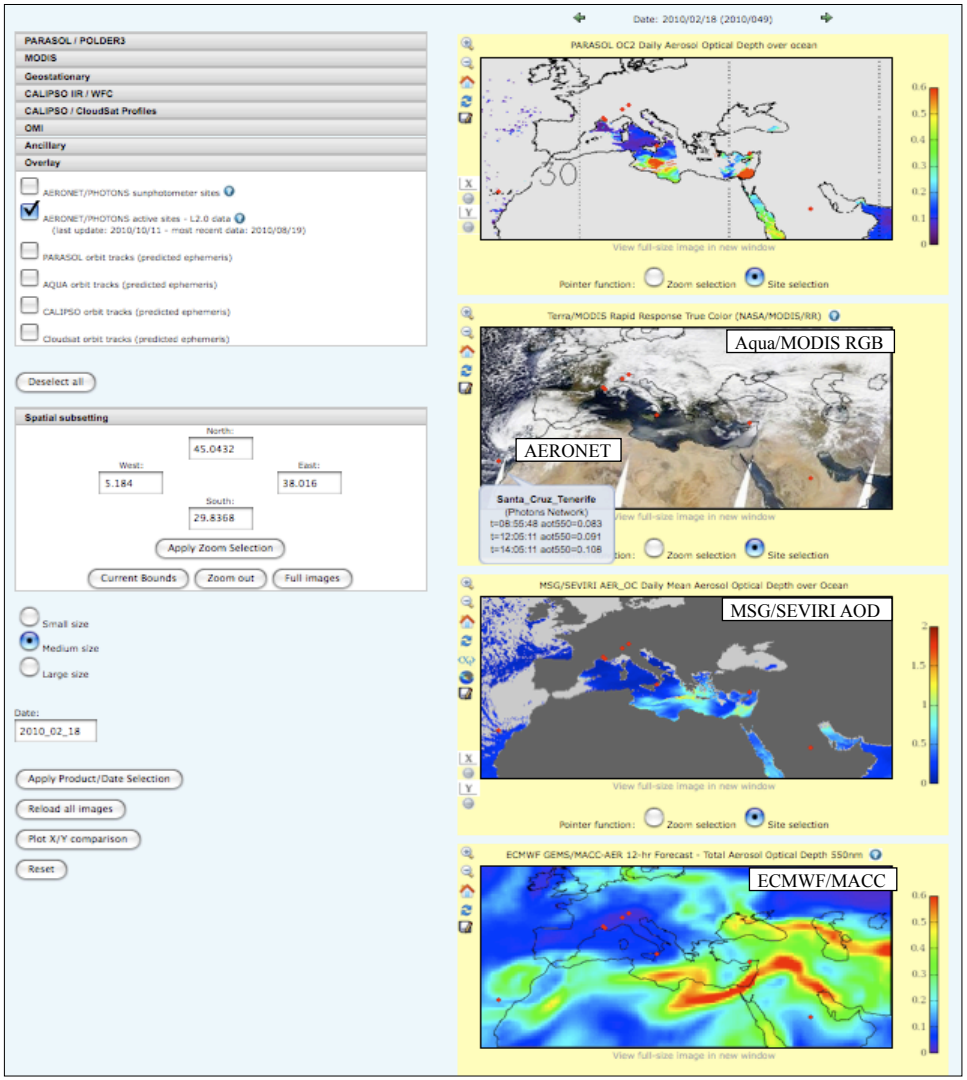
Global Gridded Products (2/2)

Multi-sensor browse interface
http://www.icare.univ-lille1.fr/browse

- A user-friendly interface where multiple products can be displayed over the user-defined region of interest
- Top-down selection (Product>Date>Region) coupled with transverse selection (i.e., modify date or product or region selection)
- Orbit tracks overlay available
- X/Y comparison plot available
- Link to AERONET sunphotometer database
- Some models and analyses are available (e.g., MACC aerosol forecast)



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Intercomparison Selection

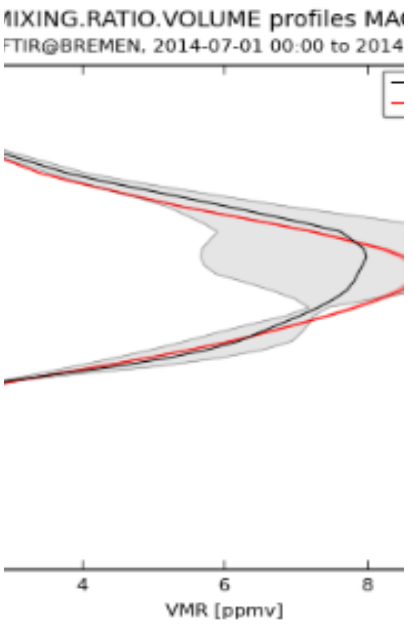
PARAMETER	
AEROSOL	2
CH2O	4
CH4	1
CO	2
NO2	3
O3	10

MODEL TYPE	
fnyp	9
g4e2	13

INSTRUMENT TYPE	
FTIR	8
LIDAR	2
MWR	2
UVVIS.DOAS.DIRECTSUN	2
UVVIS.DOAS.OFFAXIS	5
UVVIS.DOAS.ZENITH	3

2 3 4 5 6 7 8 9

MEN: 2014-07



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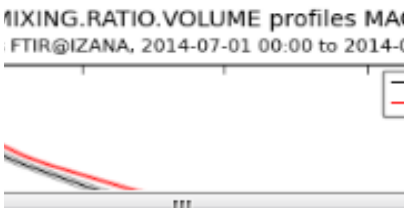

Filter Options

LOCATION	
[ALL]	99
BERN	26
BREMEN	29
BUJUMBURA	15
EUREKA	2
HARESTUA	21
HAUTE.PROVENCE	44
IZANA	78
JUNGFRAUJOCH	72
LA.REUNION.MAIDO	58
LA.REUNION.STDENIS	19
LAUDER	15
MAUNA.LOA.HI	16
NY.ALESUND	49
RIO.GALLEGOS	12
THULE	14
UCCLE	9
XIANGHE	43
ZUGSPITZE	29

Full report with traceability, statistics, and download options

Currently viewing

REPORT PROPERTIES

Intercomparison	O3-fnyp-MWR
Period	MONTHS
Start	01 Jul 2014
End	31 Jul 2014
Location	[ALL]
Affiliation	[ALL]
Generated	04 Oct 2014, 05:31h

Report actions

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previous month

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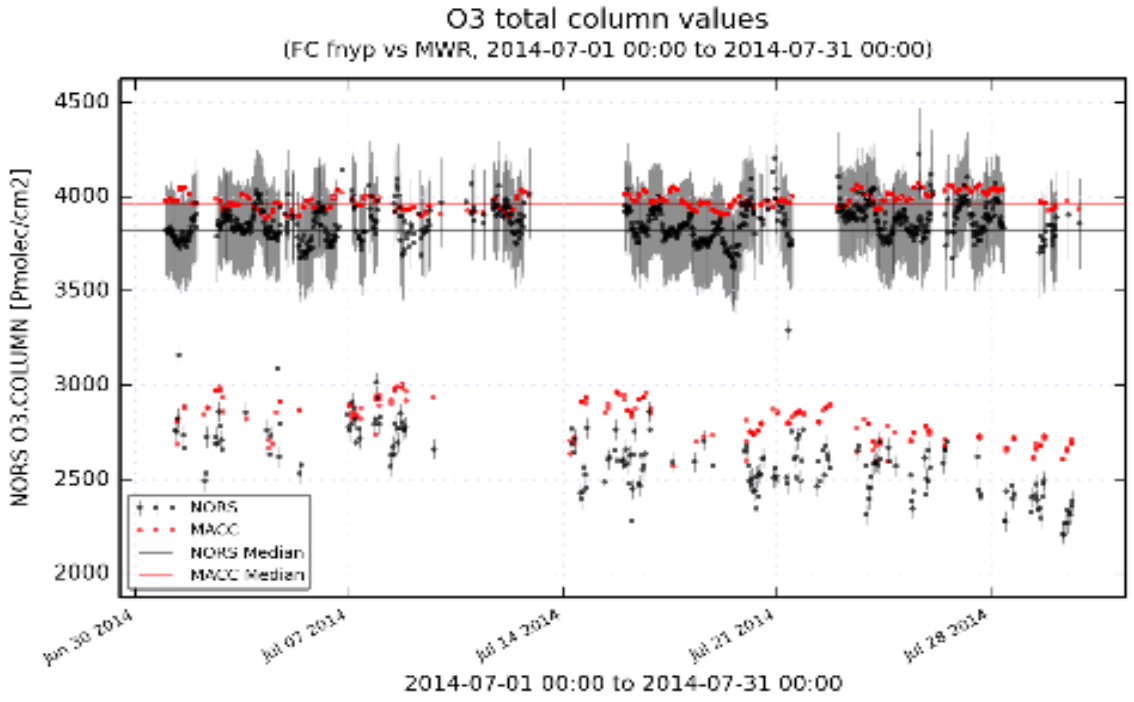
Intercomparison Report

NORS Report: MACC fnyp vs NORS MWR - O3

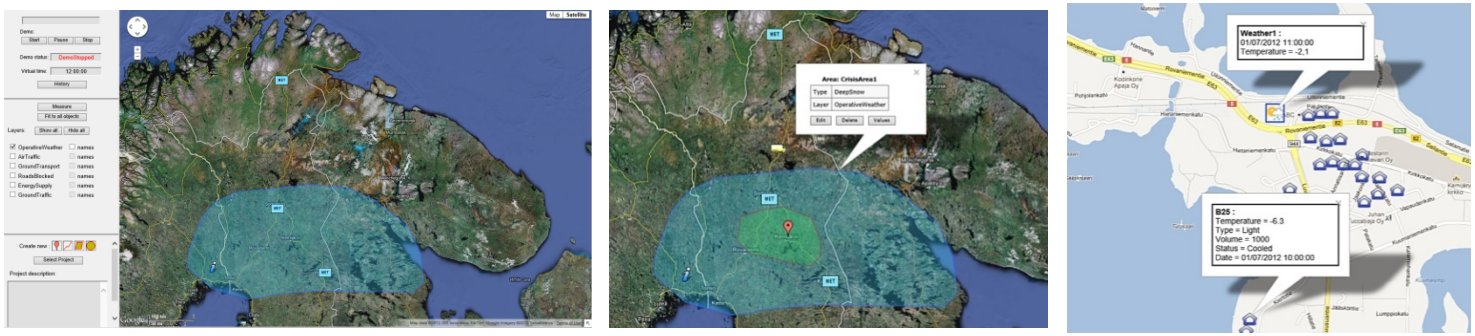
MACC vs NORS O3 - Intercomparison Statistics

f (predicted variable)	MACC O3.COLUMN [Pmolec/cm2]
o (observed variable)	NORS O3.COLUMN [Pmolec/cm2]
# measurements	1035
median bias	137.581
B (mean bias)	138.883
RMSE (root mean square error)	115.996
MNMB (modified normalized mean bias)	0.0405263
FGE (fractional gross error)	0.0439414
R (correlation coefficient)	0.975414
RS (Spearman rank correlation coefficient)	0.486943



User interface examples from CRISMA

DynMap client-server application with GUI, programmed in Google Maps API:



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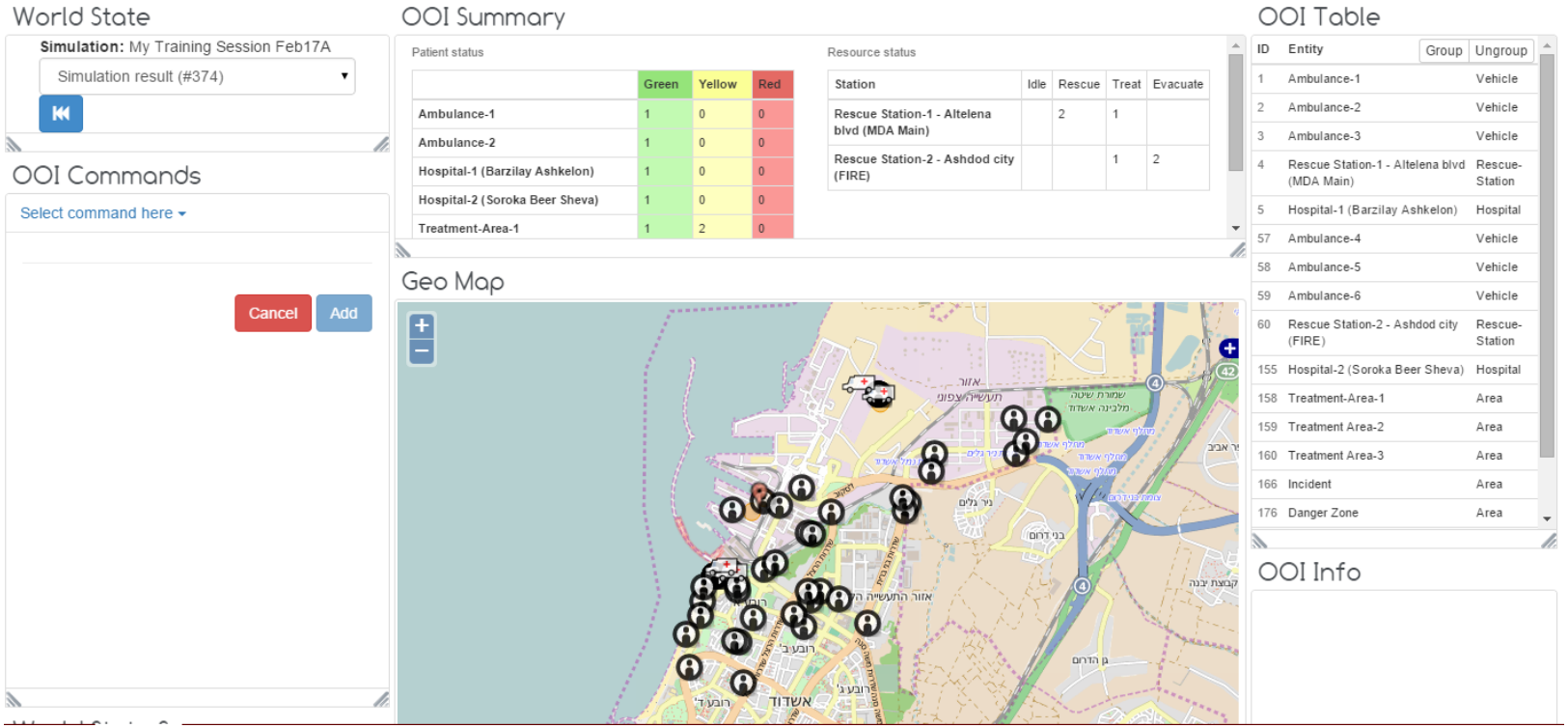
User interface examples from CRISMA

GUI from integrated widgets (in Wirecloud):

World State
OOI Summary
Resource Status
OOI Table



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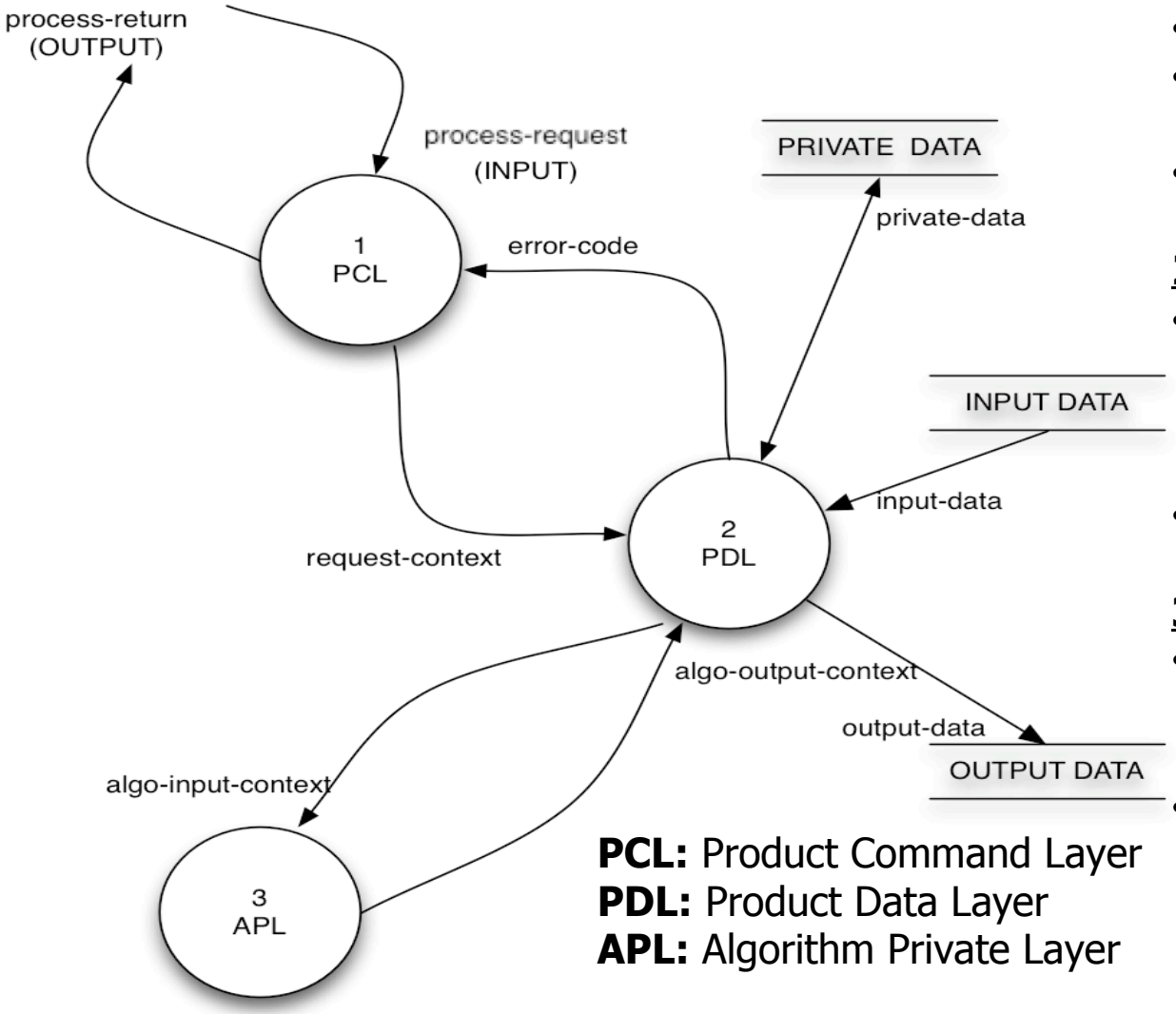
❷ Technical Design



PCL: Product Command Layer
PDL: Product Data Layer
APL: Algorithm Private Layer

3-Layers algorithm approach:

1st Layer: PCL

- Handles the reading of input and writing of output.
- It is modular with defined interfaces.
- One plug-in per data format.
- It is the only interface to an external system framework (plug & play feel)
- Visualization would be just another form of output.

2nd Layer: PDL

- Exclusive I/O and memory management – where the data is after it has been read in or before it is written out – independent of how it was read in.
- Provides the scientific core of the algorithm with all relevant input data

3rd Layer: APL

- Contains the scientific part of the algorithm, e.g. all the procedures for defining the co-locations
- It is completely independent from both the external framework and the format of the input data.

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