Performance of a Future Spaceborne Water Vapour Lidar

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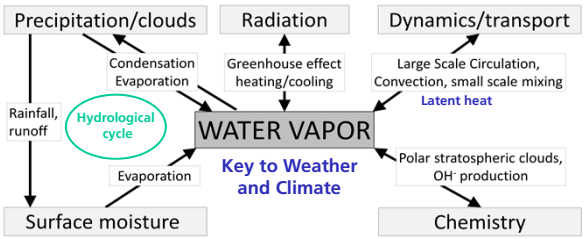
Water Vapour: Why We Need More and Global Data

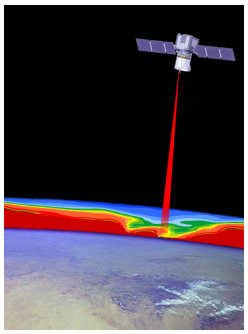


Ref.: U. Schumann (ed.), ***Atmospheric Physics****, Research Topics in Aerospace, Springer 2012*

WALES: Water Vapour Lidar Experiment in Space

Issues with Actual Instruments

- Sparse vertical profiling network.
- Passive spaceborne remote sensors:
  - coarse spatial resolution,
  - biases by aerosols and clouds,
  - bad coverage in lower troposphere.



Water Vapour Lidar

- active remote sensing
- 3 online wavelengths at 935 nm
- low polar orbit, 500 km height
- 1 km vertical resolution
- 100 km horizontal resolution
- 0 – 15 km height range
- 6000 profiles / day
- aerosol profiles, cloud tops, cirrus
- Candidate for ESA Earth Explorer Core Mission (2001)

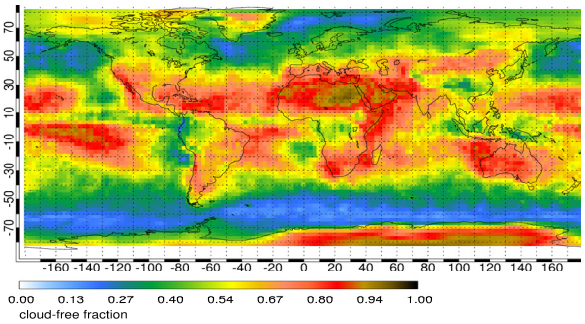
Advantages of Lidar

- **penetrates thin cirrus clouds and aerosol layers without bias**
- **measures above clouds decks and in cloud gaps**
- **spatial resolution can be adapted to the required precision**
- **bias and noise uncertainties are uncorrelated and quantifiable**

	Requirement	WALES Expected Performance
Dynamic Range [g/kg]	0.01-15	0.005-16
Precision (1σ) [%]	20	5-18%
BIAS [%]	5	<4%

Ref.: ***WALES*** *– ESA Report for Mission Selection, ESA SP-1279 (3), 2004*

WALES: Expected Coverage in the Lower Troposphere

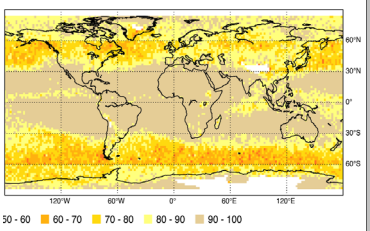


Source: NASA CALIPSO profiles, 5-km res., full 2007, cut-off cloud optical depth of 1

CALIPSO cloud-free fractions:

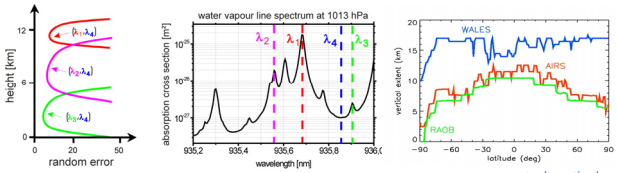
Cut-off optical depth	Jan/Feb/Mar 2007	Jul/Aug/Sep 2007	whole 2007
0.0	31.7 %	30.4 %	**30.7 %**
0.5	49.7 %	48.5 %	**48.8 %**
1.0	54.2 %	53.4 %	**53.5 %**
number of obs.	1×10^7	1×10^7	4×10^7

WALES coverage above 3 km (mean = 85 %):



Ref.: Kiemle, Ehret, Kawa, Browell: Global Distribution of Cloud Gaps in CALIPSO Data, JQSRT 2014

WALES: Simulation Results, Expected Performance



3 H_2O absorption lines are needed to cover the full troposphere and meet the WMO accuracy requirements.

expected vertical extent of lidar data, compared to AIRS and radiosondes

Resolution can be adapted to particular observational and scientific aims; automated adaptive averaging can be used to circumvent clouds.

Surface return signals can provide humidity of the lowest layer.

Refs.: Gérard et al.: Major advances foreseen in WALES humidity profiling, BAMS 2004
Di Girolamo et al.: Simulation of satellite water vapour lidar, Rem. Sens. Env., 2008

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