HOAPS

Thematic Climate Data Records

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Satellite Application Facility on Climate Monitoring

Content

- Motivation
- HOAPS algorithms
- Products
- Validation
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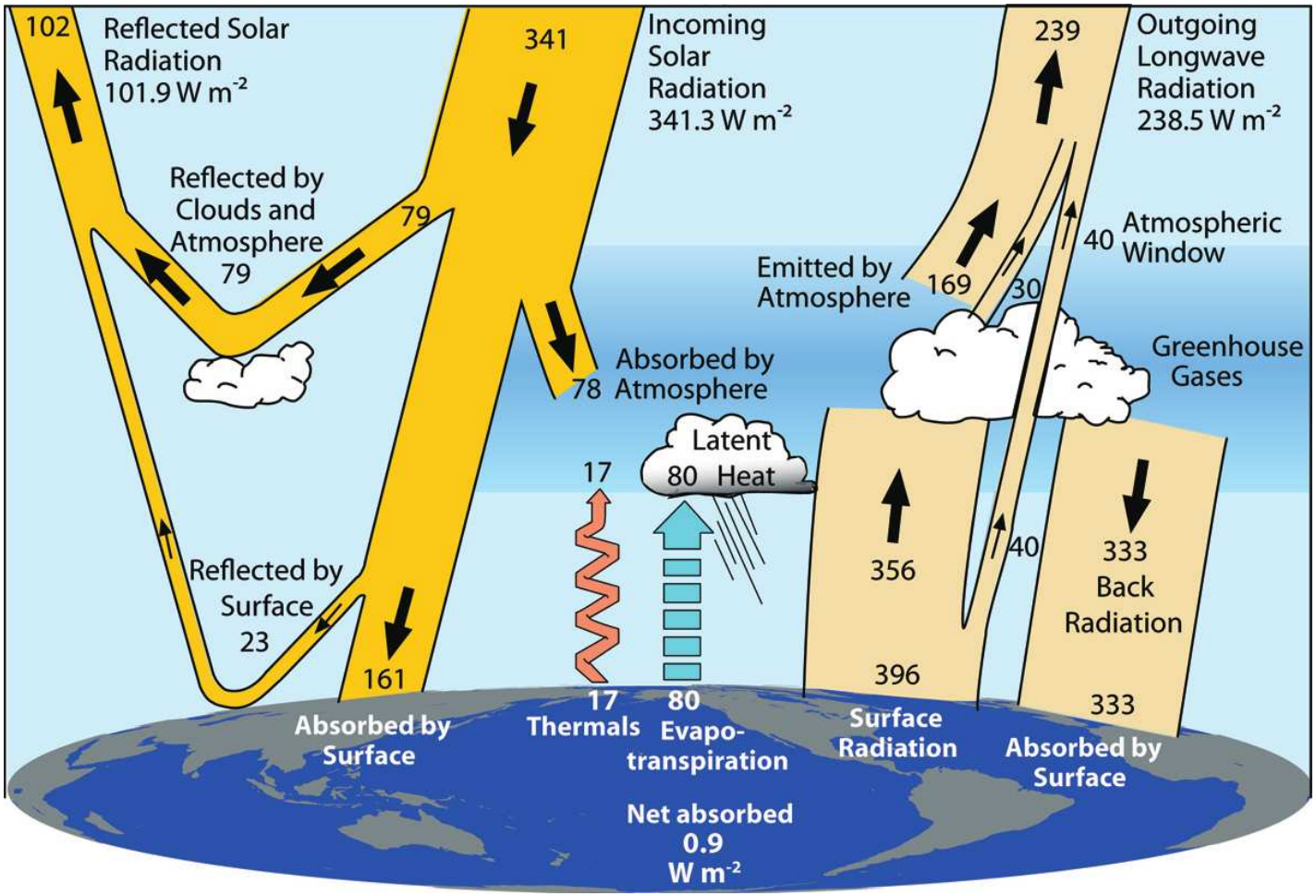
- Summary / Outlook

Global energy budget

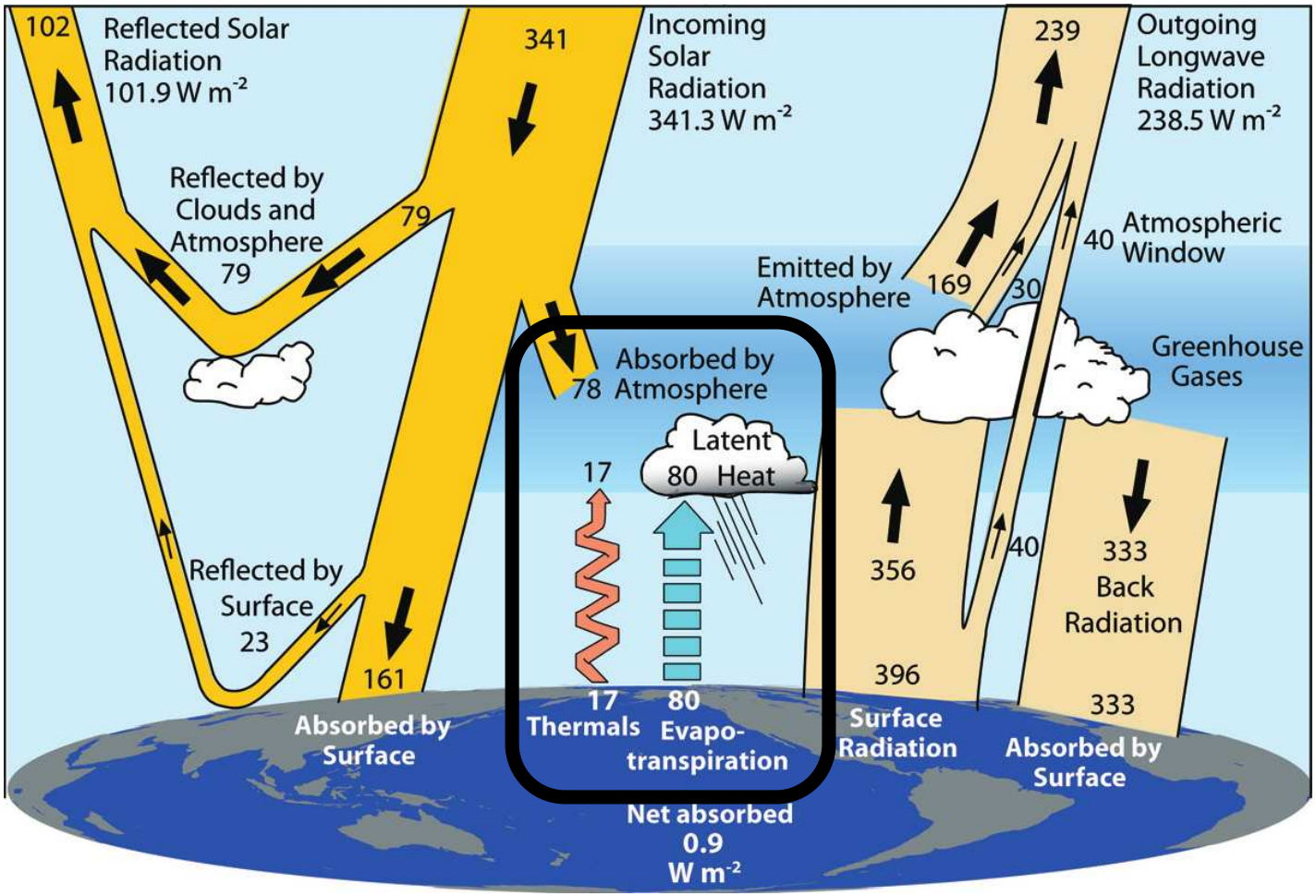
(2000-2004) W/m^2



Trenberth et. al., 2009: Earth's global energy budget, BAMS

Global energy budget

(2000-2004) W/m^2



Trenberth et. al., 2009: Earth's global energy budget, BAMS

Global Water Cycle

- The knowledge of the global water cycle is crucial for a successful understanding and modelling of the climate system
- An important component of the water cycle is the surface fresh water flux over global oceans and its components evaporation and precipitation
  → significant energy transport in form of latent heat
- Over global oceans, the total precipitation is smaller than the total evaporation and the difference should be balanced mainly by continental run-off
- Current evaporation & precipitation satellite time series cover about 20 years
- Combination of evaporation & precipitation data sets is possible to assess global energy and water cycle
- **H**amburg **O**cean **A**tmosphere **P**arameters and Fluxes from **S**atellite data HOAPS :: evaporation and precipitation available from common source (SSM/I plus AVHRR)

HOAPS algorithms

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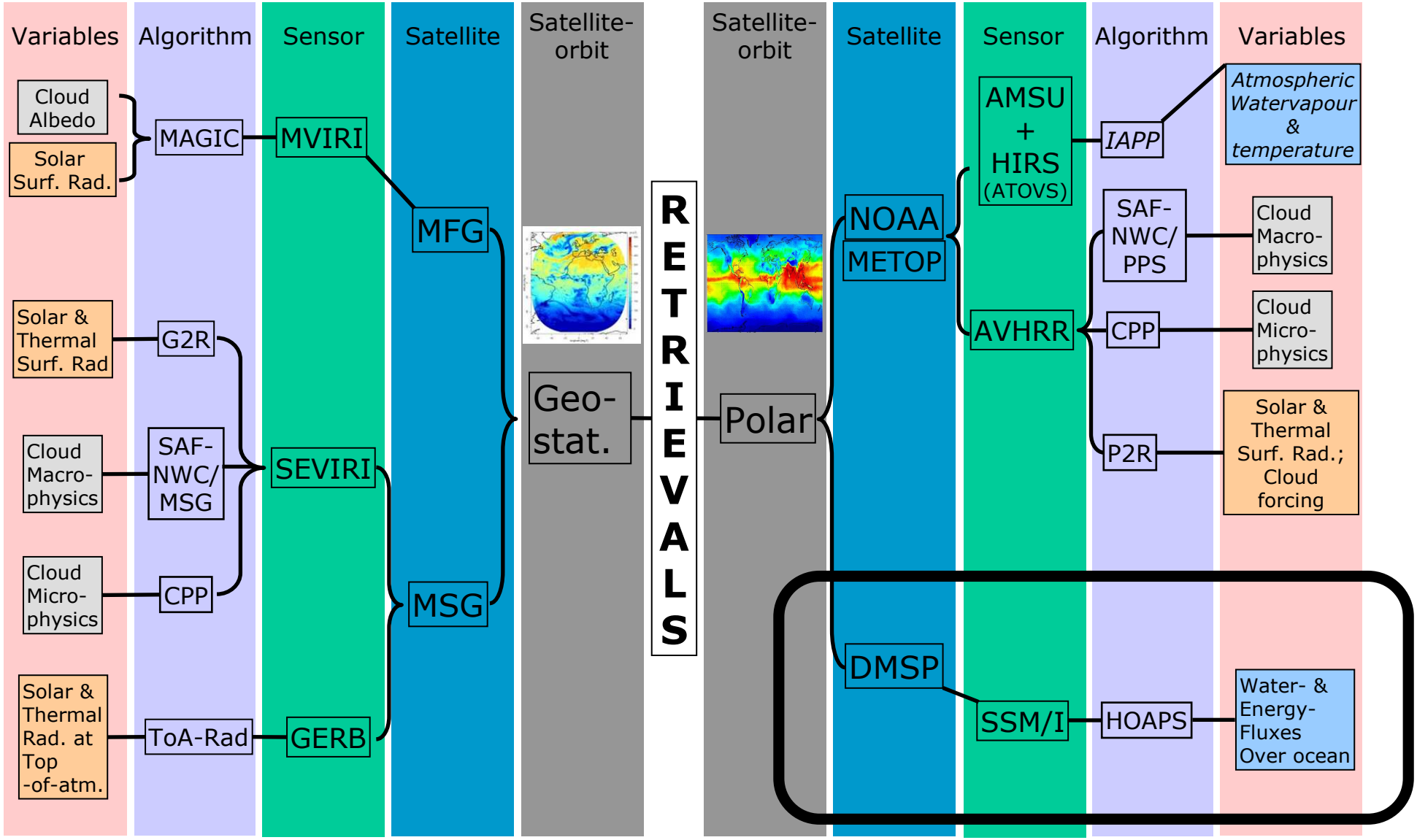
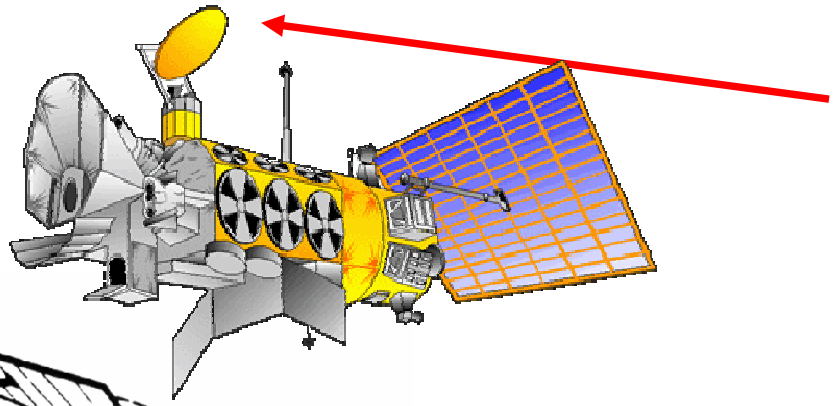
HOAPS climatology

- Climatology of freshwater flux over the ice free global ocean derived from satellite data
- Developed at University of Hamburg / MPI Hamburg
- 15 parameters: precipitation, evaporation and related surface and atmospheric state parameters
- Radiometers on board polar orbiting satellites:
  - SSM/I (passive microwave)
  - AVHRR (infrared; Pathfinder V5 SST)
- homogeneous time series:
  - Multi satellite averages containing all SSM/I operating at the same time
  - incidence angle normalisation (Furhop, 1996)
  - inter-sensor calibration (Andersson et al., 2010)

CM SAF Retrieval Overview



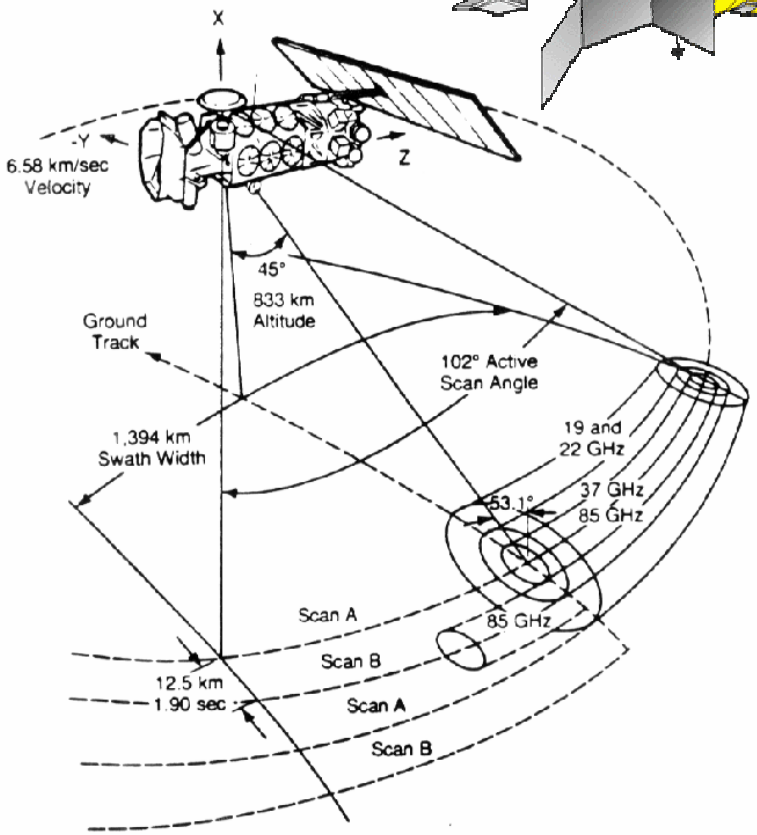
Measuring water cycle components

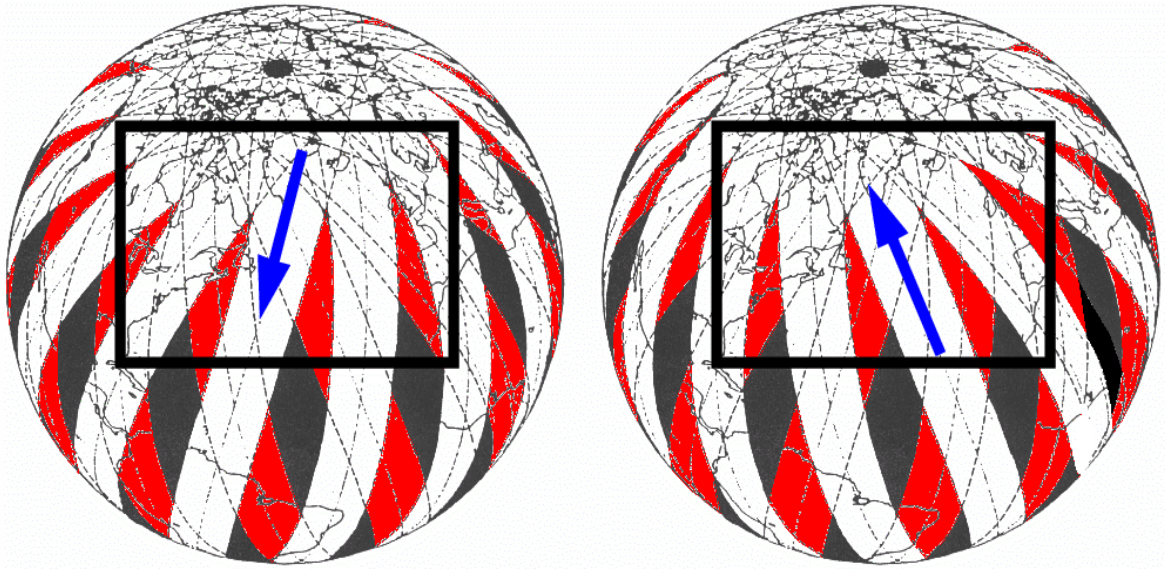


SSM/I

First launch:

F08 - 19 June 1987



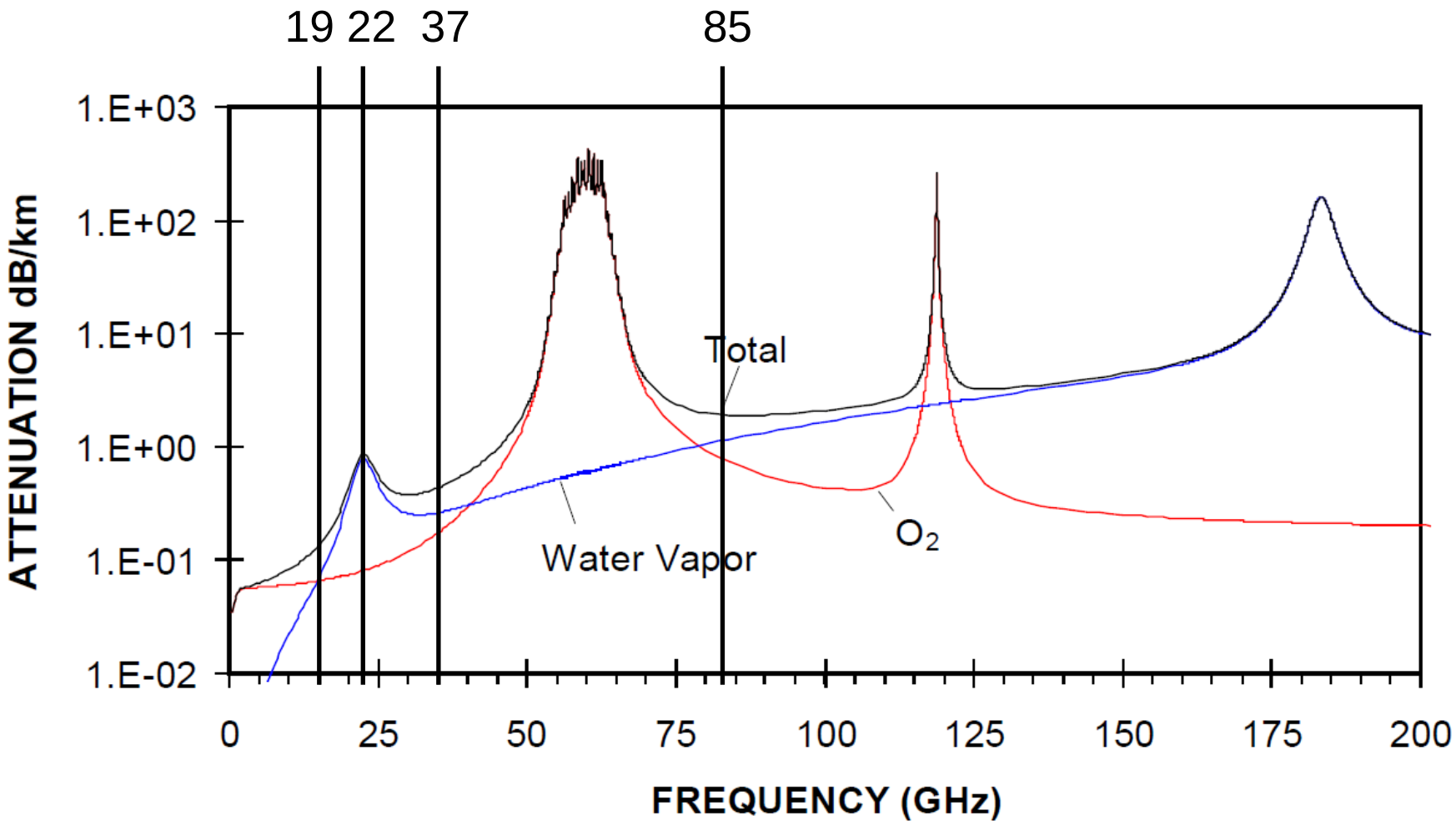


HOAPS algorithms

- Precipitation (P)
  - neuronal net (Andersson et al., 2010)
  - training data: radiative transfer calculations (ECMWF, P. Bauer)
- Evaporation (E)
  - Bulk formula

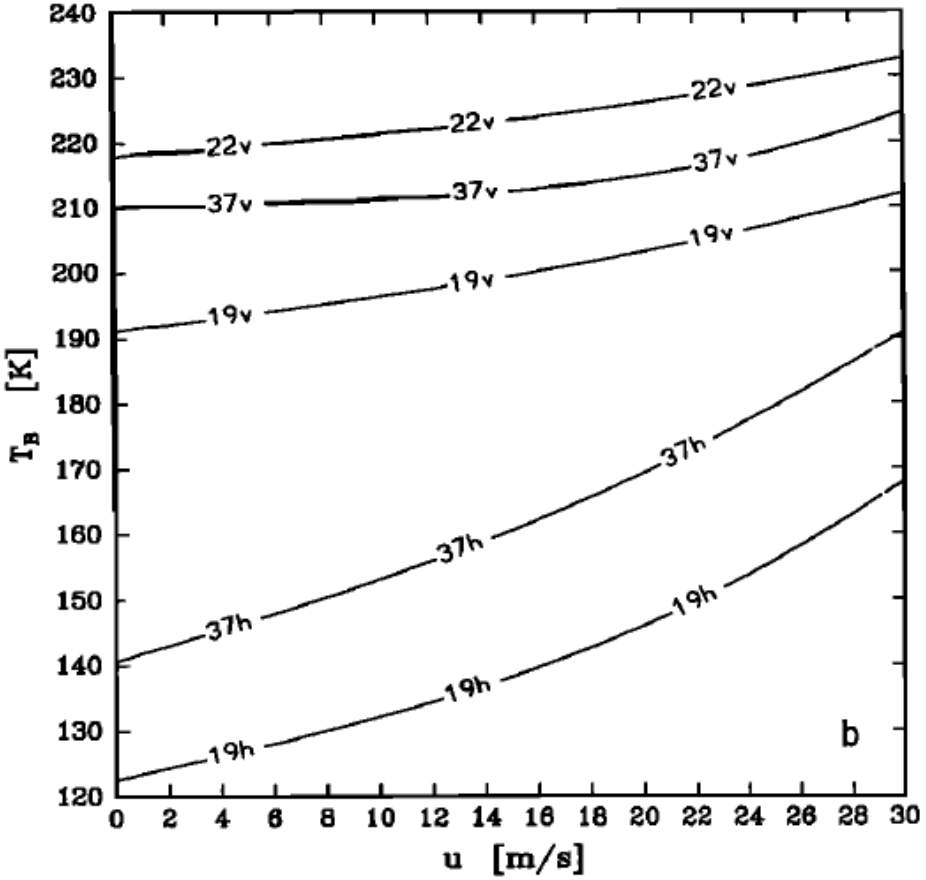
    $E = (\rho_a/\rho_w)\, C_E\, U\, (q_s - q_a)$
- Wind speed (U)
  - neuronal net (Andersson et al., 2010)
  - training data: radiative transfer calculations plus buoy observations
- Near surface specific humidity (q_a) (Bentamy et al., 2003)
- Sea surface saturation specific humidity (q_s) (Pathfinder SST)
- Latent heat transfer coefficient (Dalton number) (C_E) (Fairall, 1996)
- Freshwater Flux: E-P

HOAPS algorithms

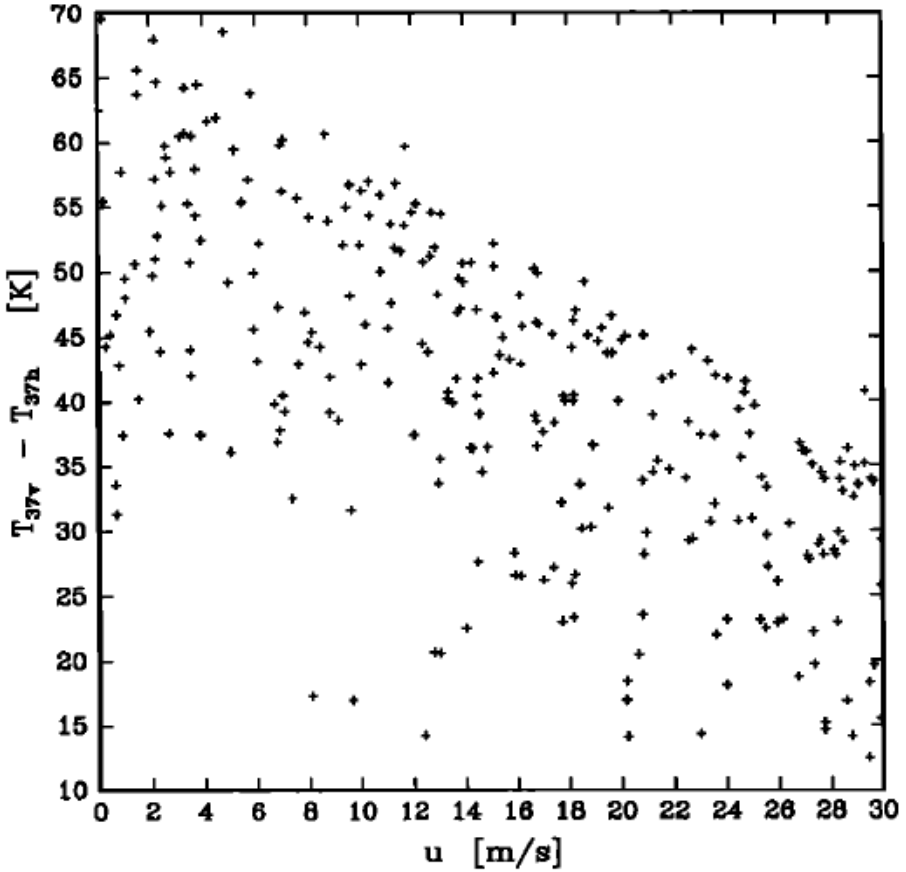


Atmospheric absorption in the microwave region
(from SSM/I User's Interpretation Guide)

HOAPS algorithms
Near Surface Wind Speed

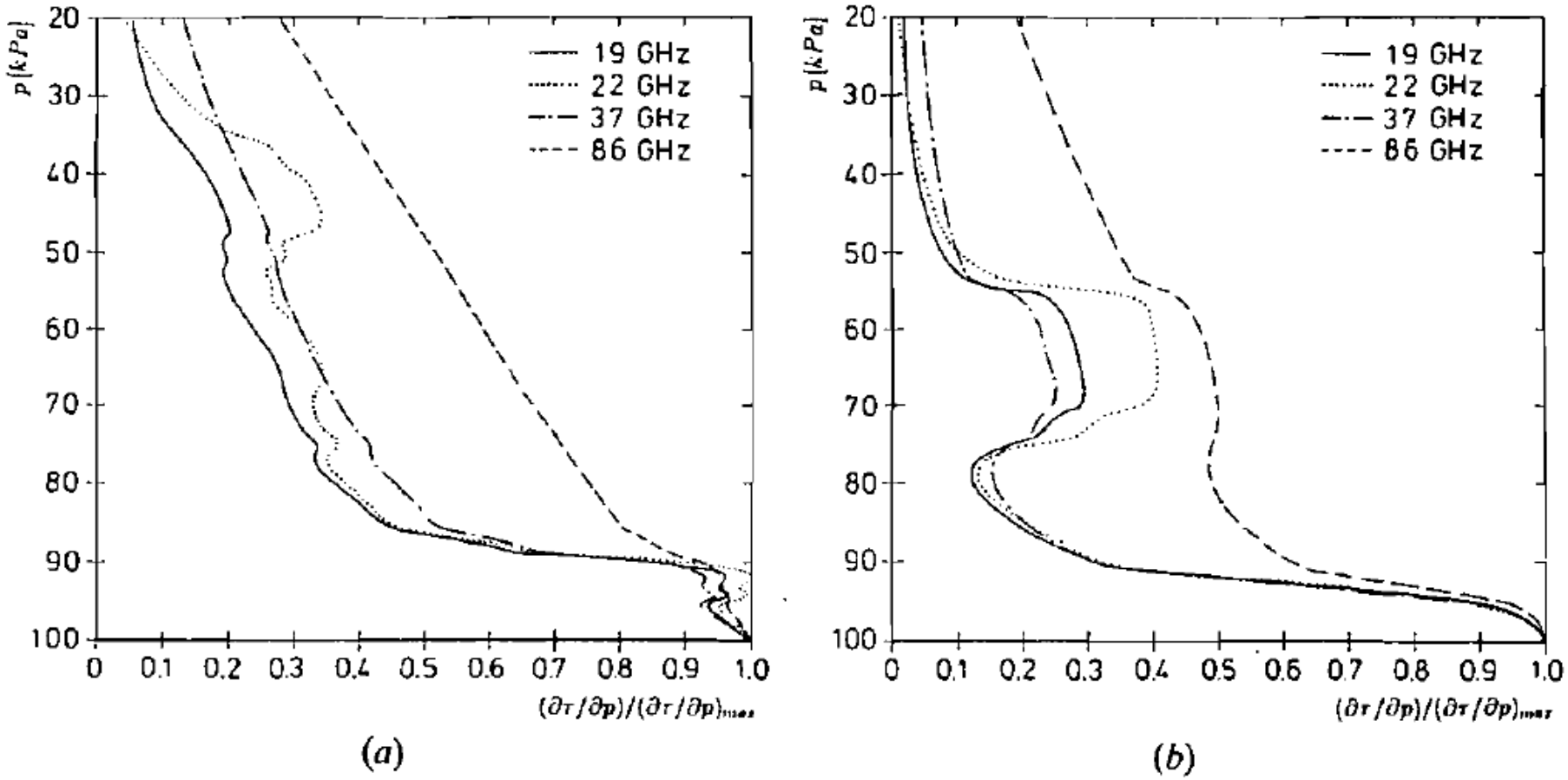


Simulated variation of SSM/I brightness temperatures with wind speed
(from Schlüssel and Luthardt, 1991)



Simulated brightness temperature differences $T_{37v} - T_{37h}$ for 281 radiosonde profiles
(from Schlüssel and Luthardt, 1991)

HOAPS algorithms
Near Surface Humidity



Normalised weighting functions for (a) a mid-latitude atmosphere, and (b) a tropical atmosphere for the SSM/I frequencies. (from Schulz et al., 1993)

Products

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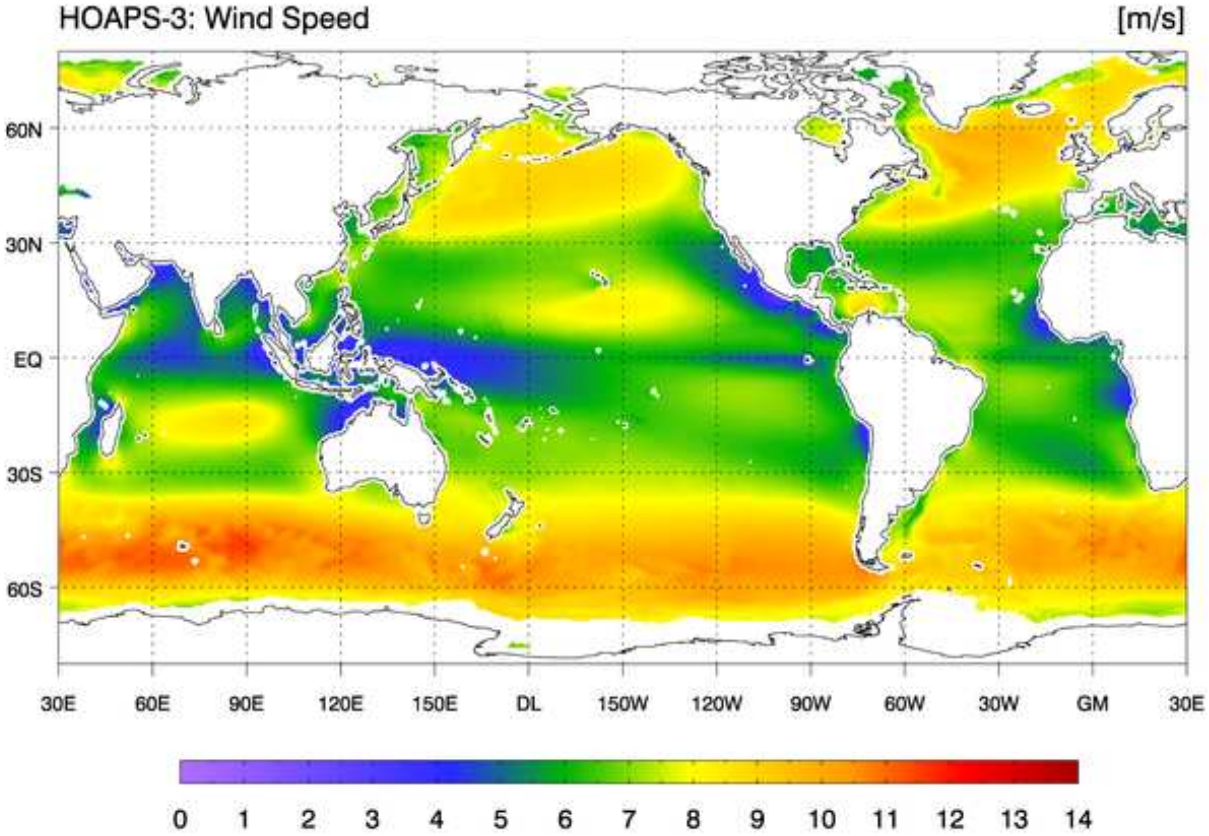
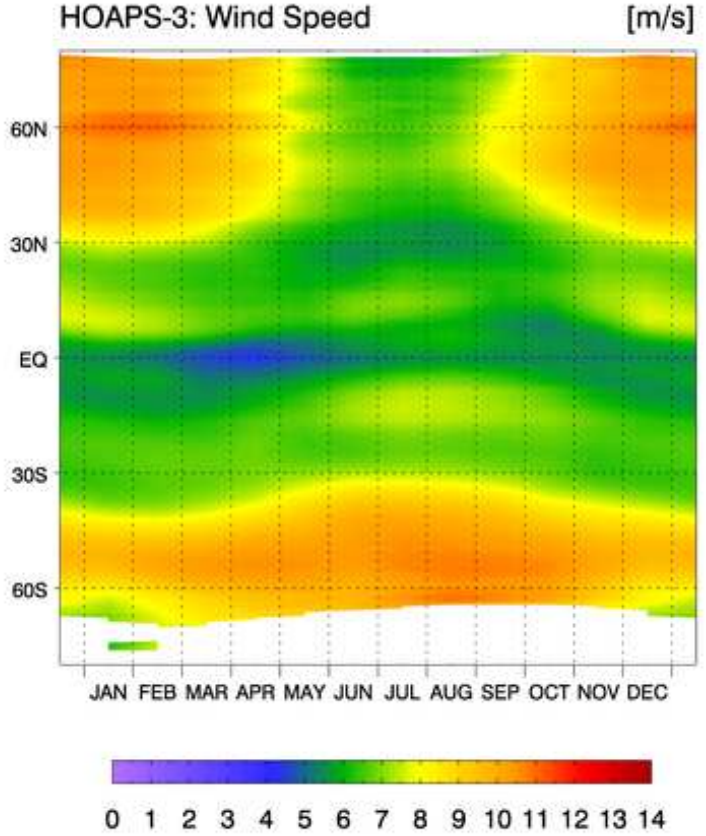
CM SAF HOAPS Release

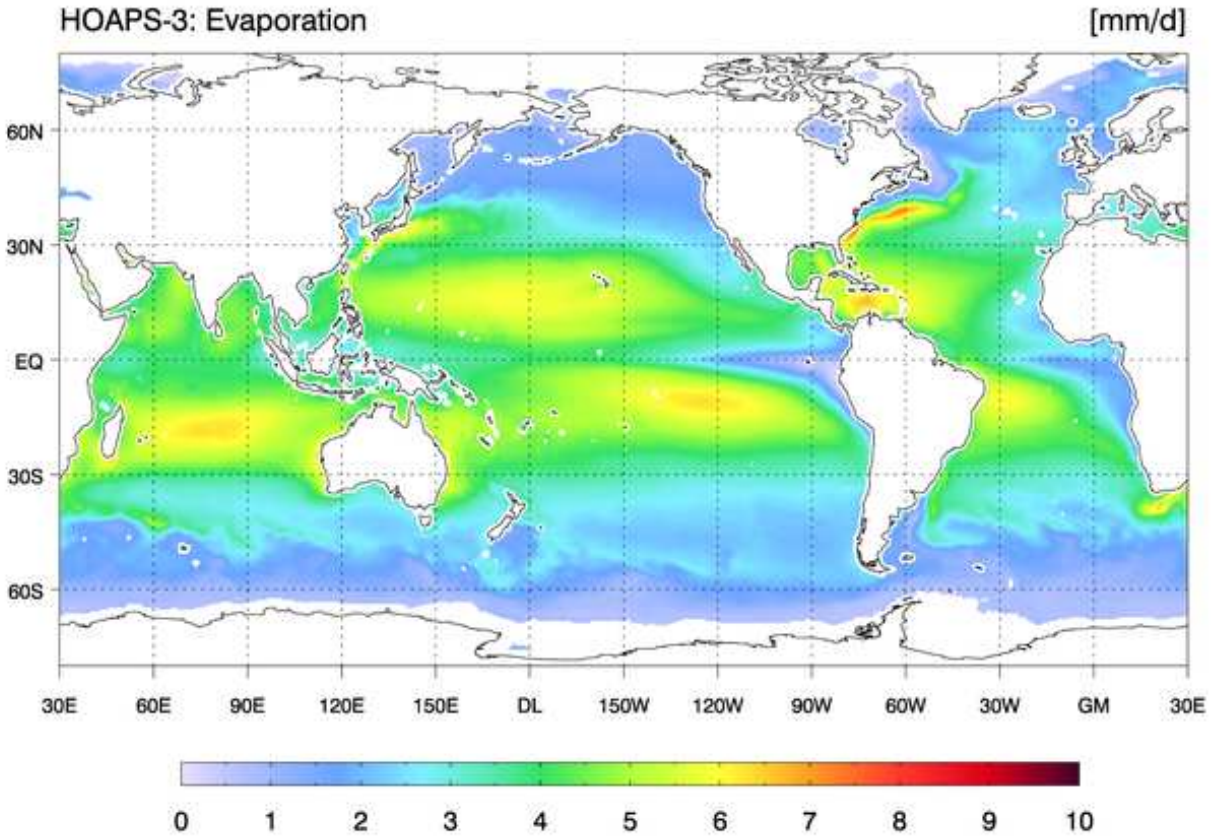
- Transition of HOAPS (Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite data; http://www.hoaps.org/) into CM SAF
- 20-year Thematic Climate Data Record (TCDR) of total column integrated water vapour derived from SSM/I has been released in 2009
- Release 3.2 of HOAPS parameters within the CM SAF framework:
  - Near surface humidity, CM SAF Data Set CM-141 (NSH_HOAPS)
  - Near surface wind speed, CM SAF Data Set CM-142 (SWS_HOAPS)
  - Latent heat flux, CM SAF Data Set CM-143 (LHF_HOAPS)
  - Precipitation, CM SAF Data Set CM-144 (PRE_HOAPS)
  - Evaporation, CM SAF Data Set CM-145 (EVA_HOAPS)
  - Freshwater flux, CM SAF Data Set CM-146 (EMP_HOAPS)
- Successful DRI December 2010 and close-out April 2011.
- All HOAPS parameter via CM SAF Web User Interface http://wui.cmsaf.eu/

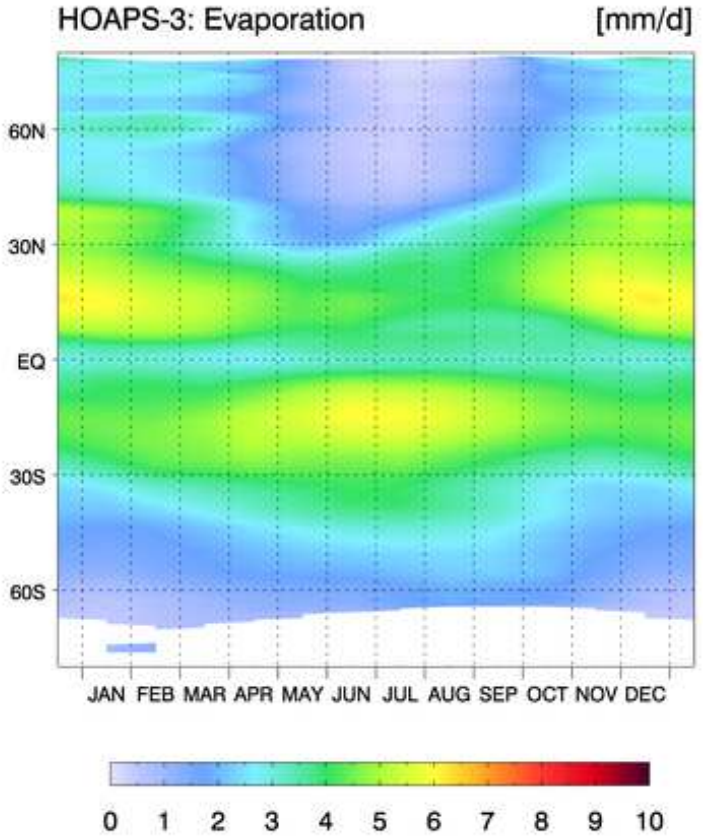
Water Cycle Products
Near Surface Wind Speed



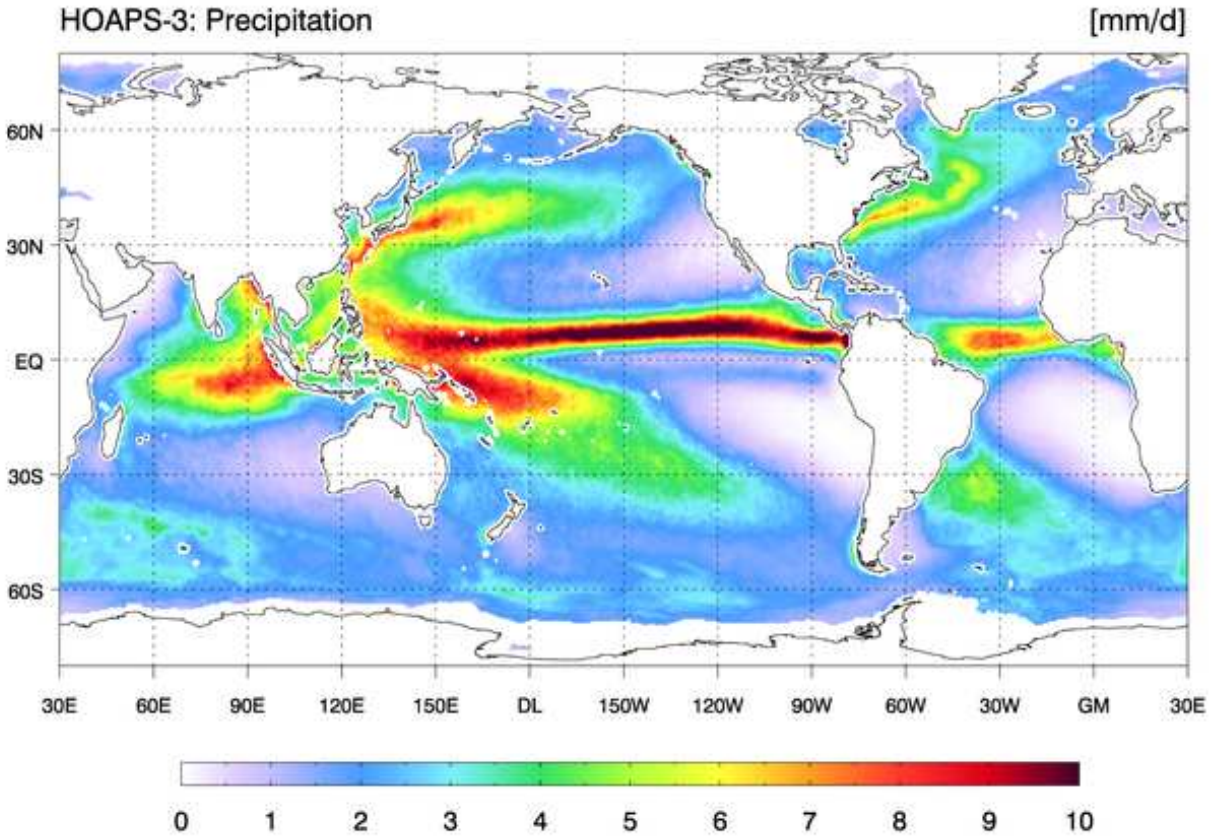


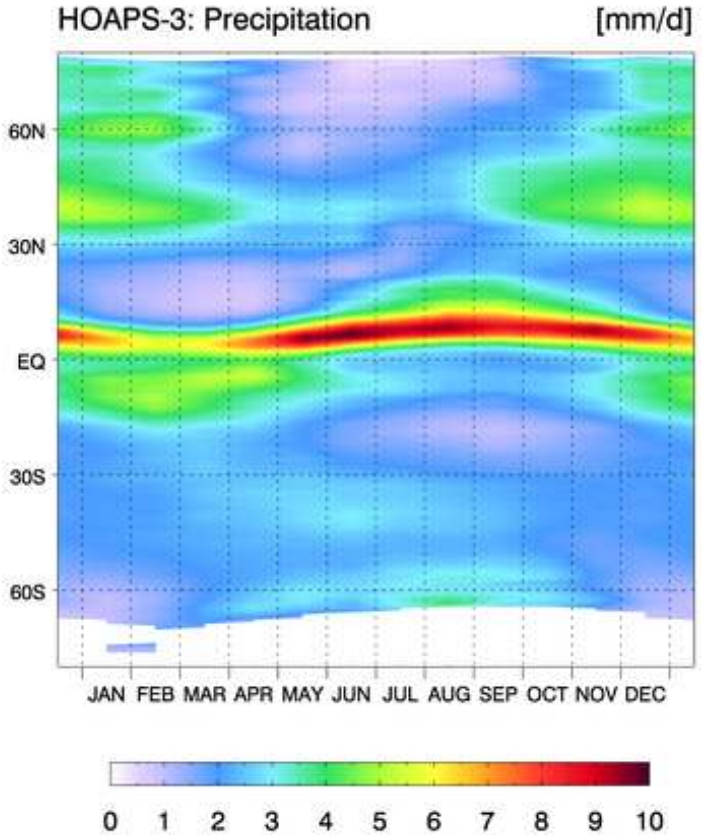
Water Cycle Products
Evaporation



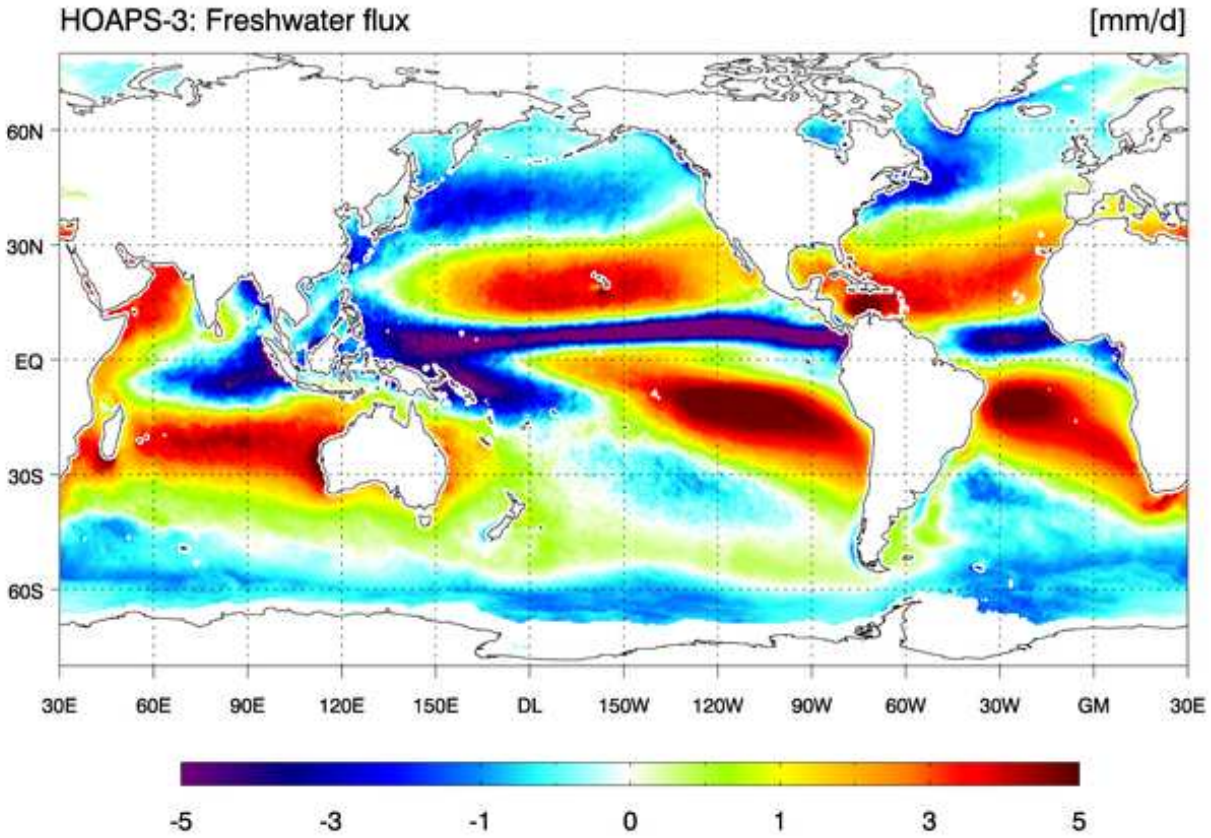


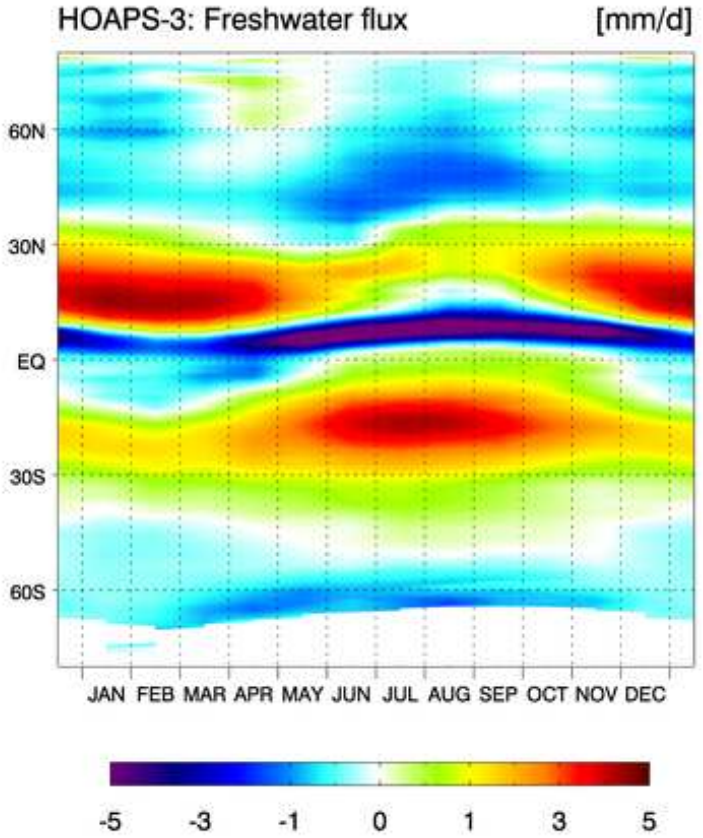
Water Cycle Products Precipitation





Water cycle Products
Freshwater flux





Validation

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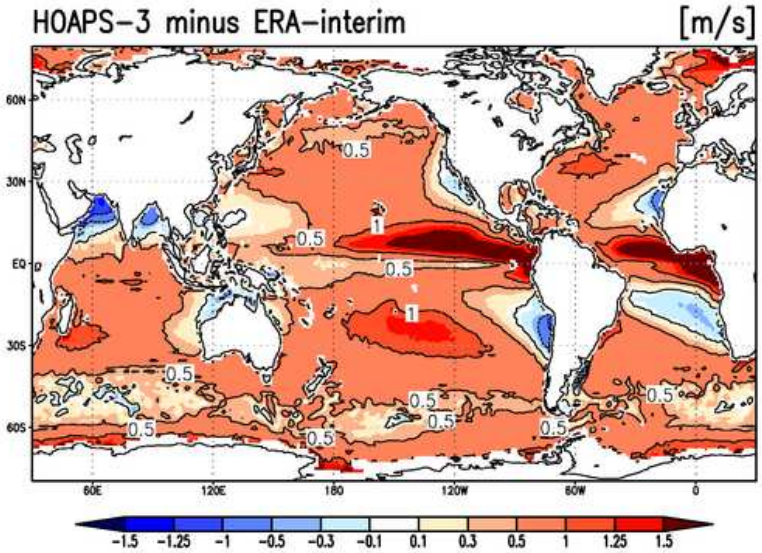
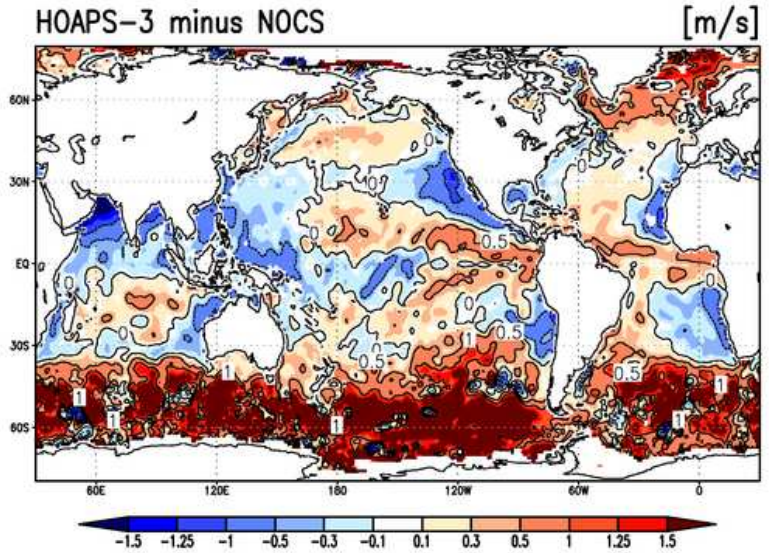
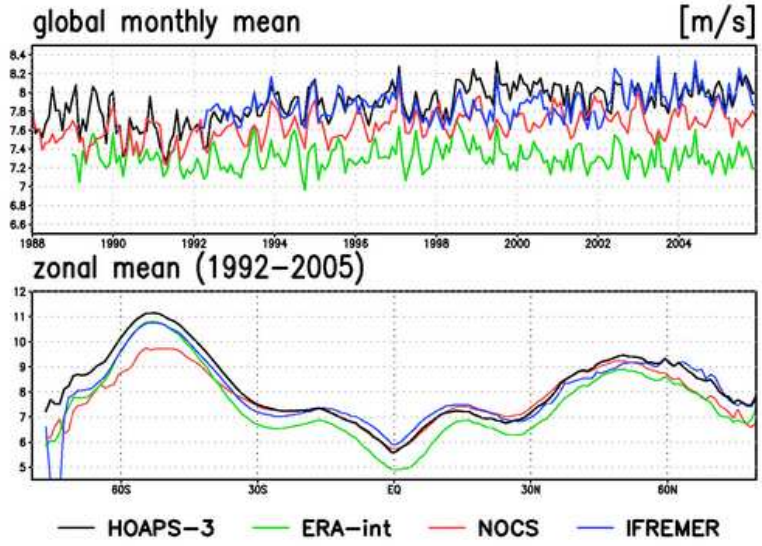
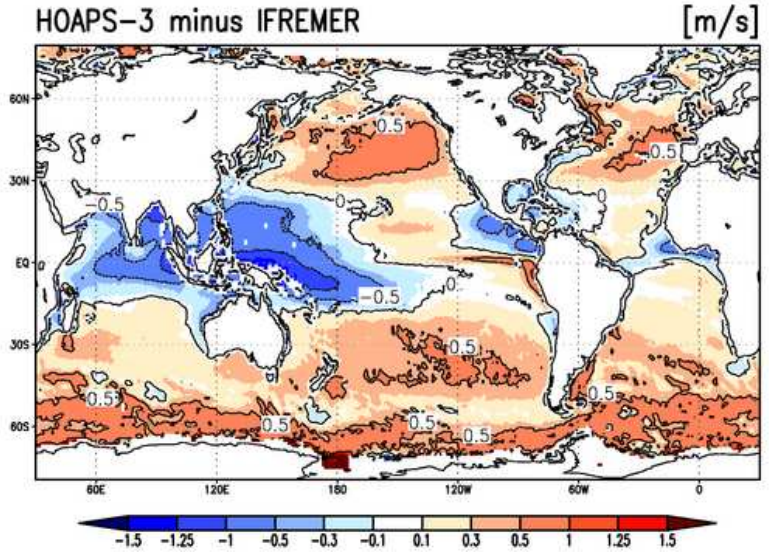
Validation
Near Surface Wind Speed

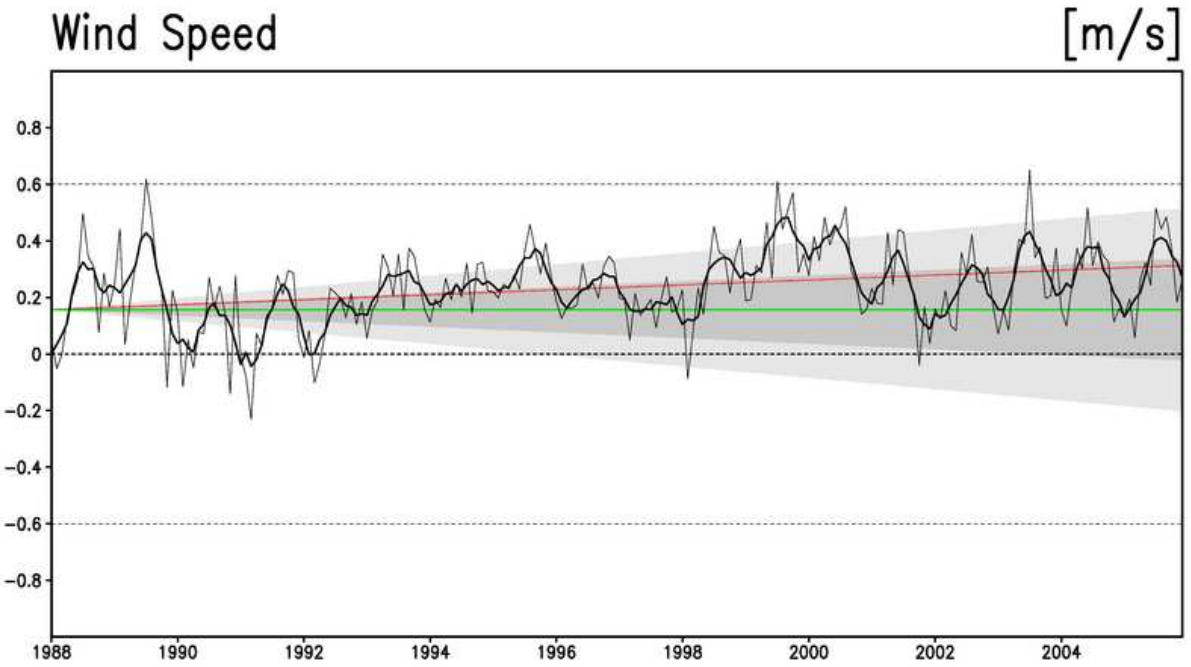








Validation
Near surface wind speed

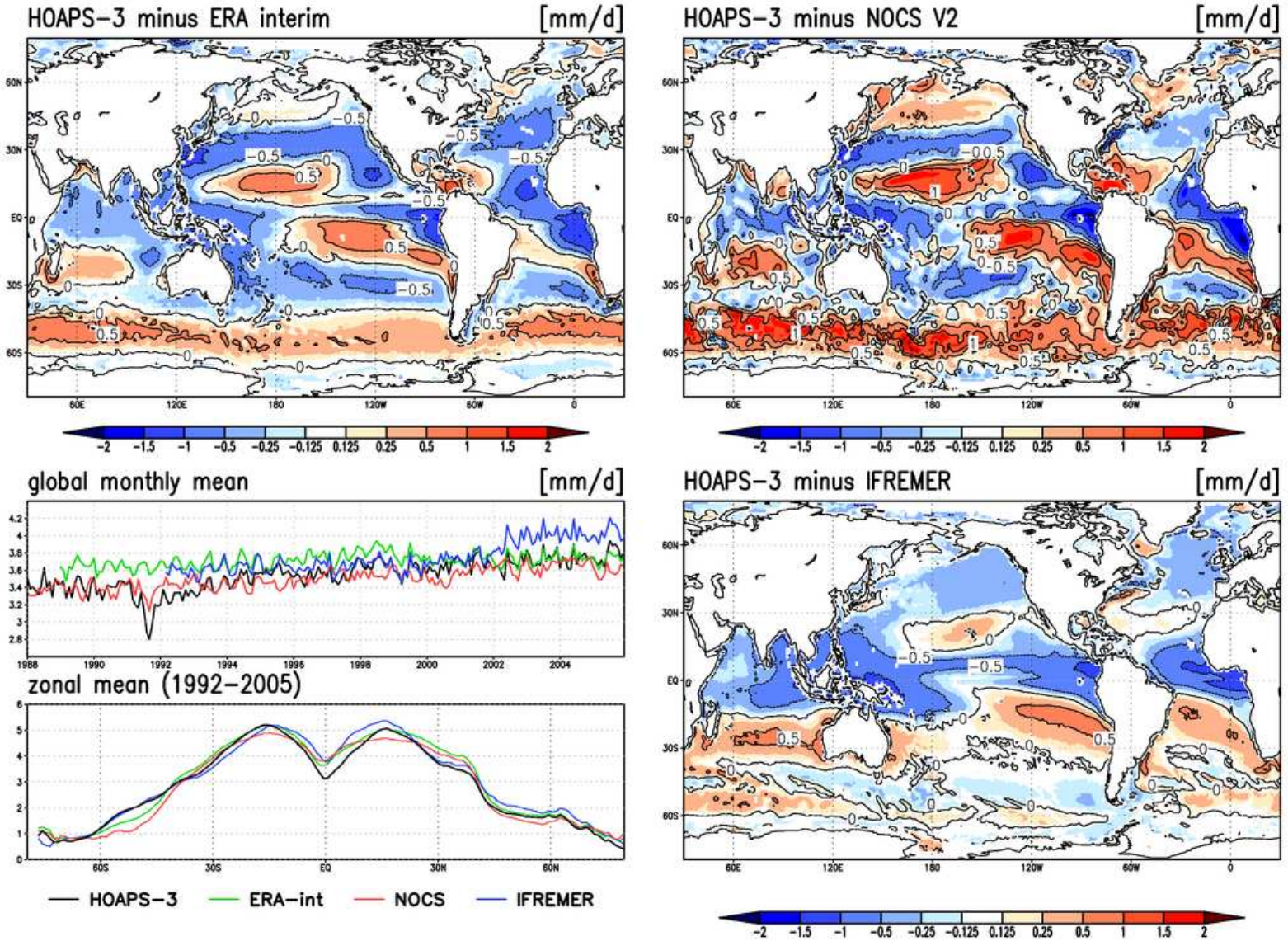


Global monthly mean
Near surface wind speed
anomalies

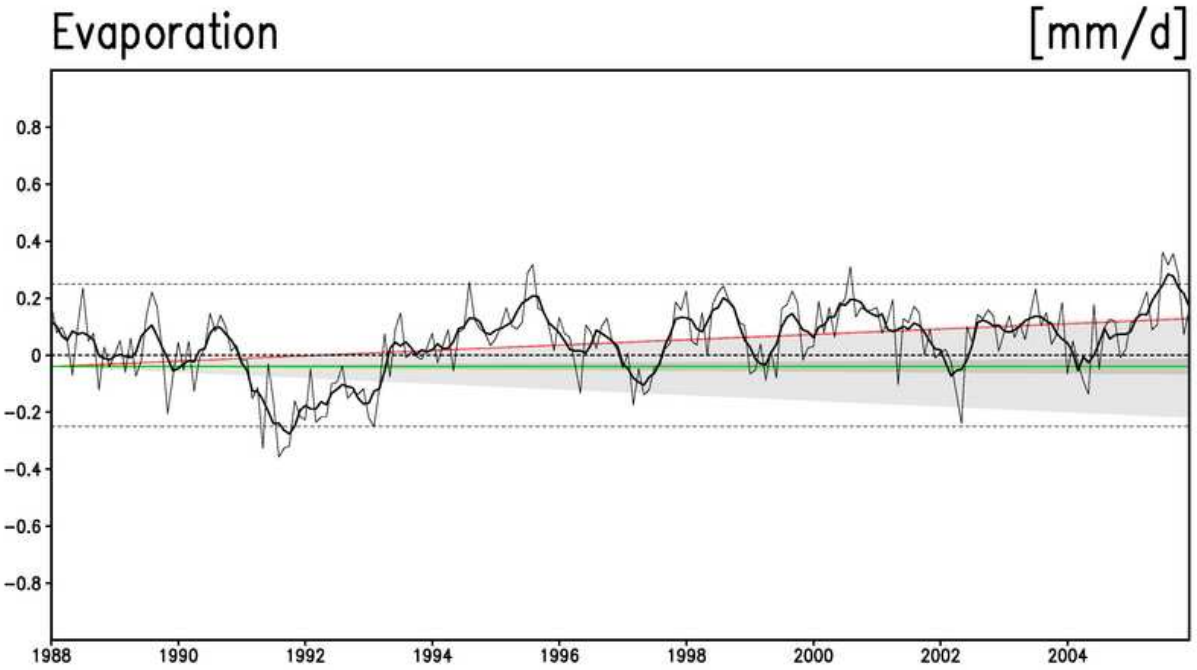
HOAPS minus NOCS

	Threshold	Target	Optimal	HOAPS
Bias	1.0 m/s	0.6 m/s	0.5 m/s	0.24 m/s
RMS	2.8 m/s	2.0 m/s	0.5 m/s	0.15 m/s
Decadal stability	0.2 m/s	0.1 m/s	0.04 m/s	0.09 m/s

Validation Evaporation



Validation Evaporation

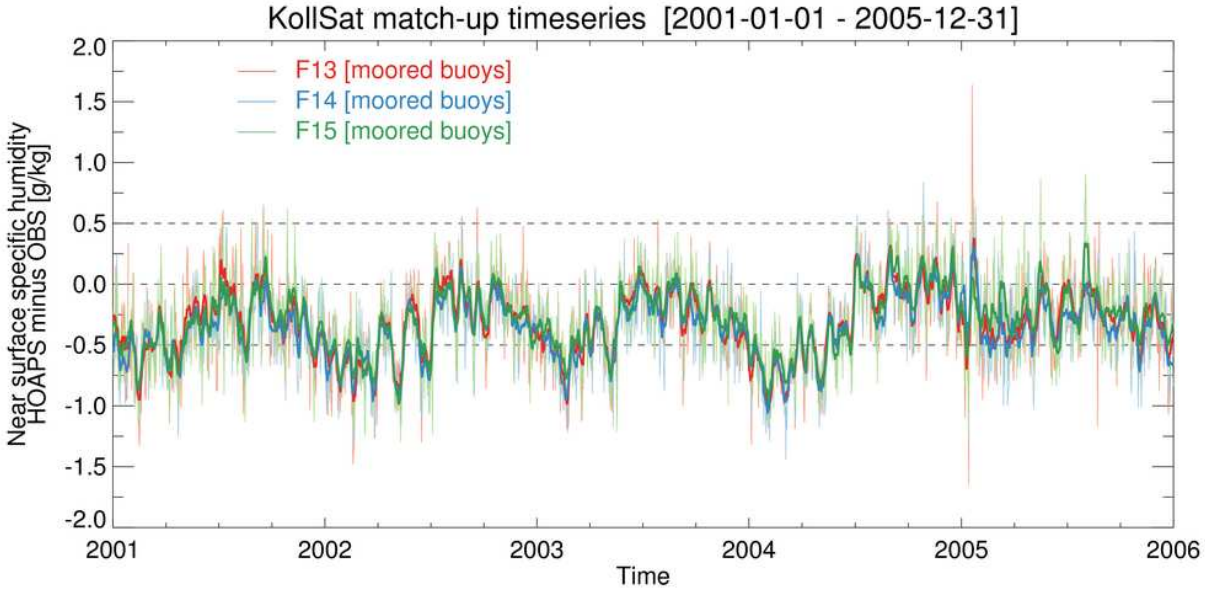


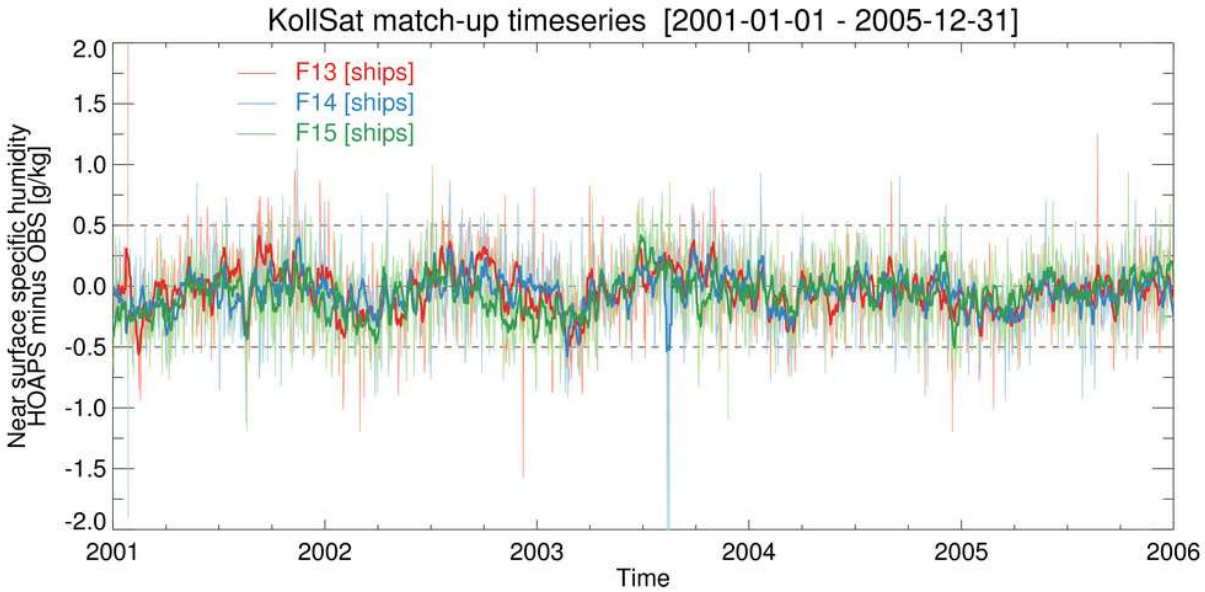
Global monthly mean Evaporation anomalies

HOAPS minus NOCS

	Threshold	Target	Optimal	HOAPS
Bias	1.0 mm/d	0.25 mm/d	0.15 mm/d	0.05 mm/d
RMS	1.4 mm/d	0.50 mm/d	0.30 mm/d	0.13 mm/d
Decadal stability	0.1 mm/d	0.015 mm/d	0.002 mm/d	0.09 mm/d

Statistical analysis Near Surface Humidity





Moored buoys

	Bias [g/kg]	RSD [g/kg]
F13	-0.33	1.57
F14	-0.37	1.55
F15	-0.31	1.55
All	-0.34	1.55

Ships

	Bias [g/kg]	RSD [g/kg]
F13	-0.04	1.47
F14	-0.05	1.51
F15	-0.07	1.57
All	-0.05	1.52

Applications

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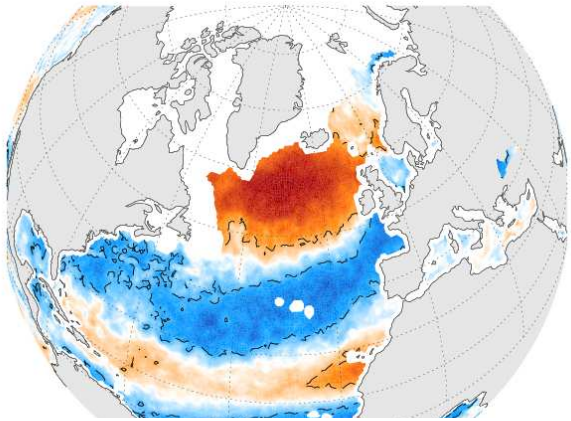
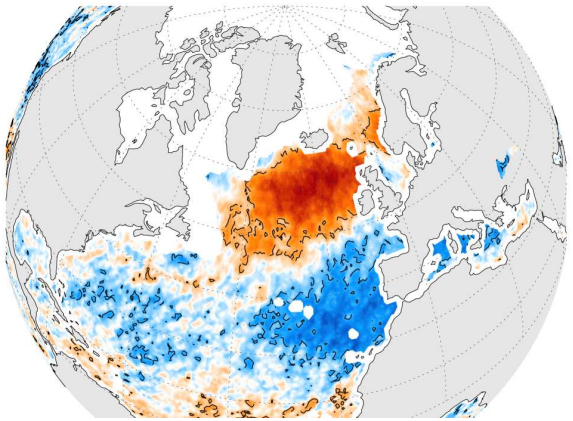
Application
Variability of Freshwater Flux

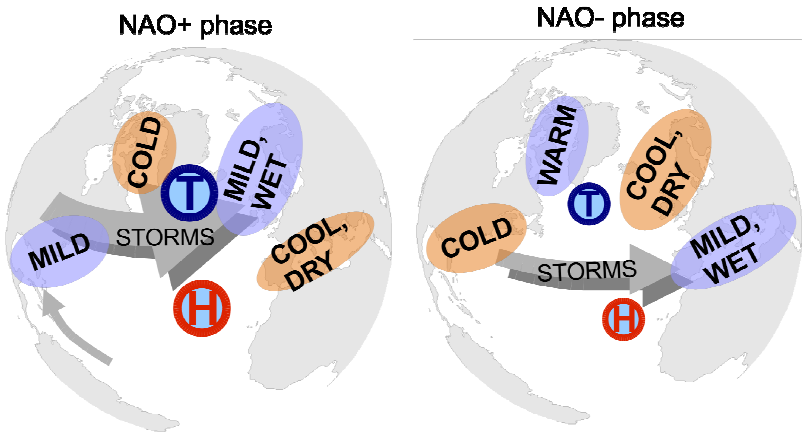
Correlation with NAO Index

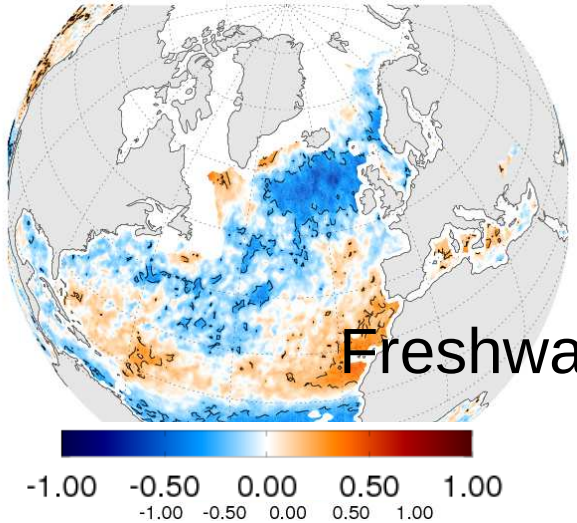
EVAP (E)



RAIN (P)







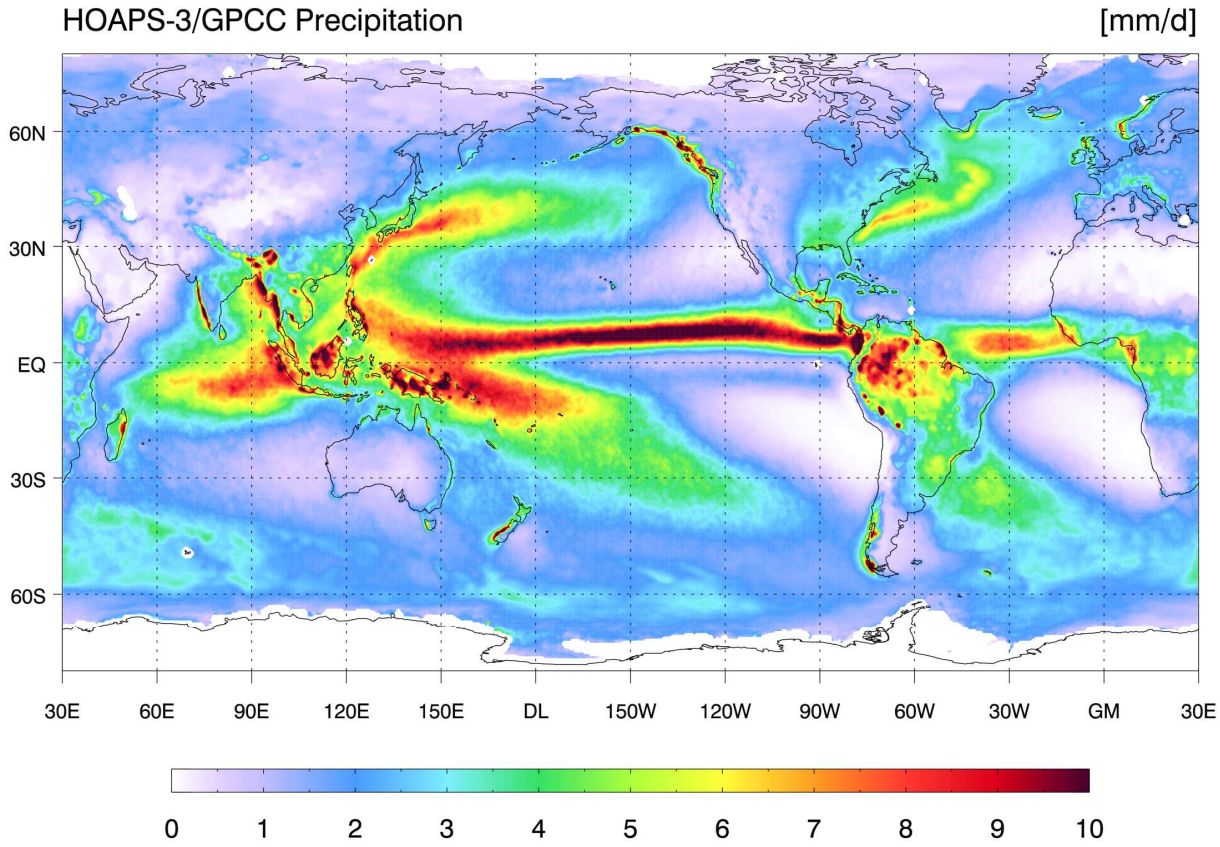
Freshwater Flux (E-P)

A. Andersson, S. Bakan, H. Graßl, Satellite derived precipitation and freshwater flux variability and its dependence on the North Atlantic Oscillation, Tellus, 62A, 2010

Applications

Quasi-global precipitation coverage by combination of HOAPS-3 + GPCC precipitation

- Ocean: HOAPS-3 over ocean precipitation
- Land: GPCC „Full Reanalysis V4“ based on rain gauge data



Summary

- HOAPS is a climatology of freshwater flux over the global ocean entirely derived from satellite data
    - Developed at MPI/Uni Hamburg and now at CM SAF
    - Current version HOAPS-3.2 (1987-2008)
- Extensive evaluation, application, validation of HOAPS
    - Intercomparison studies
    - In-situ validation of precipitation on board of ships
    - Variability analysis of North Atlantic freshwater fluxes
- Two gridded products are distributed: monthly means (HOAPS-G) and 6-hourly composites (HOAPS-C)
- The scan-oriented product HOAPS-S is available on request.
- HOAPS provides consistent fields of evaporation, precipitation, and the resulting freshwater flux that are well suited for further studies of the freshwater flux and related parameters on climatological and monthly scale.

Outlook

- New version of HOAPS is based on improved record of SSM/I brightness temperatures, which will be released as an FCDR in autumn 2012.
- Extension over Land (MPI-M, HOLAPS)
- Combination of HOAPS precipitation over ocean and GPCP over land on monthly time scale (EURO4M)
- Combination of HOAPS precipitation over ocean and GPCP/SYNOP over land on daily time scale (MIKLIP, DAPACLIP)
- Daily climatology of precipitation with error estimates (MIKLIP, DAPACLIP)
- Full error analysis for monthly products (DFG project in preparation)
- Update of statistical algorithms to 1D-VAR (CDOP-2)
- Extension of time series using SSMIS (CDOP-2)