CURRENT ACTIVITIES OF THE INTERNATIONAL PRECIPITATION WORKING GROUP (IPWG)

Joe Turk[1] and Peter Bauer[2] (IPWG Co-Chairpersons)

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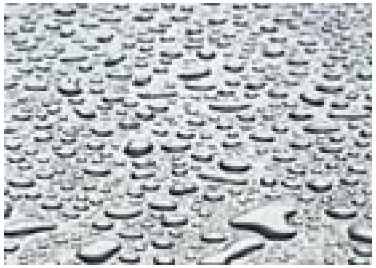
http://www.isac.cnr.it/~ipwg



CGMS IPWG

IPWG Objectives

Endorsed during the 52nd session of the WMO Executive Council (June 2000)
WMO encouraged the Coordination Group for Meteorological Satellites (CGMS) to participate in the formation of the IPWG with active participation by WMO and GPCP

Endorsed by the CGMS 29th session (July 2001)

Precipitation “equivalent” of the longstanding ITWG (TOVS Working Group)

First Co-Chairs were Vincenzo Levizzani (CNR) and Arnold Gruber (NESDIS)
IPWG-1: September 2002, INM, Madrid, Spain

- **Development of better measurements, and improvement of their utilization**
- **Improvement of scientific understanding**
- **Development of international partnerships**

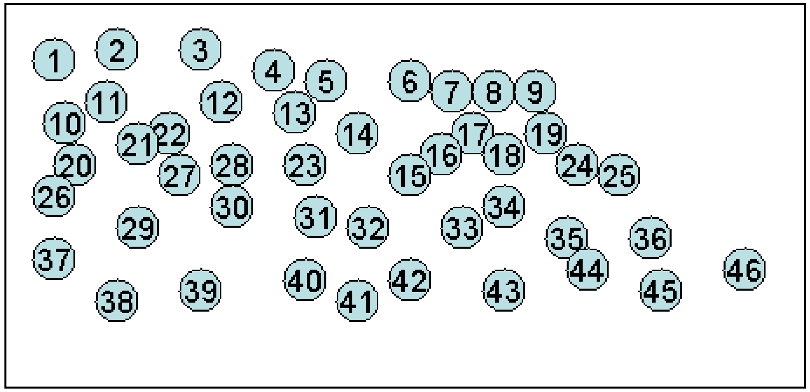
IPWG-2004: 25-28 October 2004, Monterey, California

19 countries represented

2 ½ days presentations
1 day working groups

Productive!

Workshop proceedings in press (email me for a copy)
turk@nrlmry.navy.mil



1-Robert Kuligowski 2-Thomas Nauss 3-Christian Klepp 4-George Huffman 5-Chris Kidd 6-Ralf Bennartz 7-Kyle Hilburn 8-Alessandro Battaglia 9-Joerg Schulz 10-Shannon Brown 11-Tomoo Ushio 12-John Janowiak 13-Ralph Ferraro 14-Daniel Vila 15-Francisco Tapiador 16-Toshio Inoue 17-Deborah Smith 18-Cristian Mitrescu 19-Vincenzo Levizzani 20-Anke Thoss 21-Jason Nachamkin 22-João Teixeira 23-Amy Doherty 24-Thomas Smith 25-Peter Bauer 26-Ben Jong-Dao Jou 27-Geoff Pegram 28-Una O'Keeffe 29-Michael Goodman 30-Joe Turk 31-Clara Oria Rojas 32-Rosario Alfaro 33-Bizzarro Bizzarri 34-Elizabeth Ebert 35-Arthur Hou 36-Chris Kummerow 37-Yang Hong 38-Donald Hinsman 39-Carlos Frederico Angelis 40-Thomas Nauss 41-Robert Joyce 42-Arnold Gruber 43-Philip Arkin 44-James Purdom 45-Bruno Rudolf 46-Eric Smith

How far have we come?

- 25 Years Ago:
  - Oceanic climatologies; gauge-based analyses over land
  - Qualitative indices of tropical convection
- Now:
  - Time series of global gridded monthly, pentad precipitation (GPCP, CMAP)
  - Powerful new observations (TRMM, SSM/I, AMSR-E, AMSU-B, SSMI/S, high resolution geostationary)
  - New algorithms for high resolution products (CMORPH, PERSIANN, TRMM-RT, NRL, numerous others)
  - Improved gauge-based analyses over land; oceanic reconstruction
  - See Climate Research Data Center (CRDC) at CSU

(slide courtesy of Phil Arkin)

IPWG Research: Increasing Refresh and Coverage with Multi-Dataset Techniques

Multiple LEO (Microwave) Satellite Merging

$\sum$  + $\sum$  + $\sum$  + ...

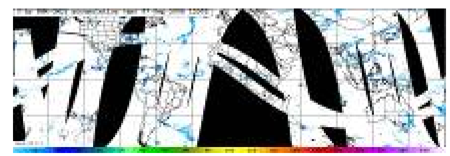
DMSP orbits

Aqua (AMSR)

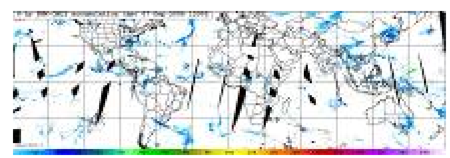
TRMM (TMI+PR)

Characteristics

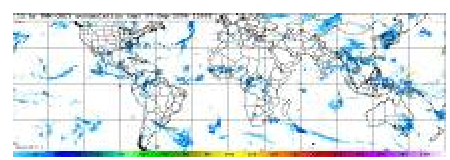
- Only a few obs per point per day
- Intermittently spaced in time
- Inter-sensor differences (resolution, calibration, algorithm)
- Open issues: high latitudes, snow, cold/variable surfaces, drizzle



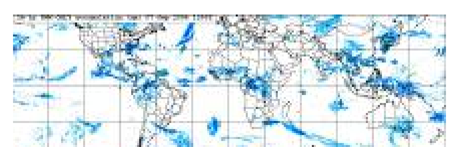
3-hour



6-hour



12-hour

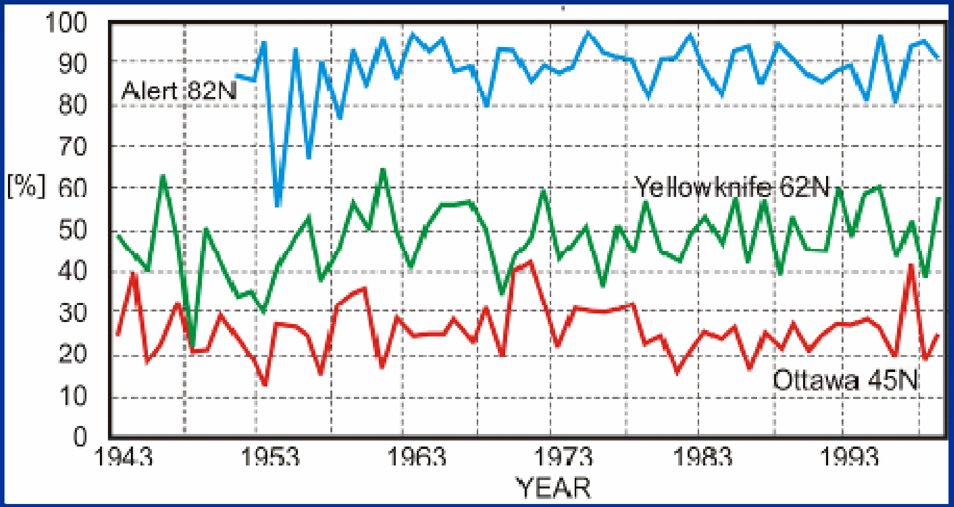


24-hour
etc.…

SNOW AT MID-TO-HIGH LATITUDES

(Figures from P. Yoe, J. Koistinen)

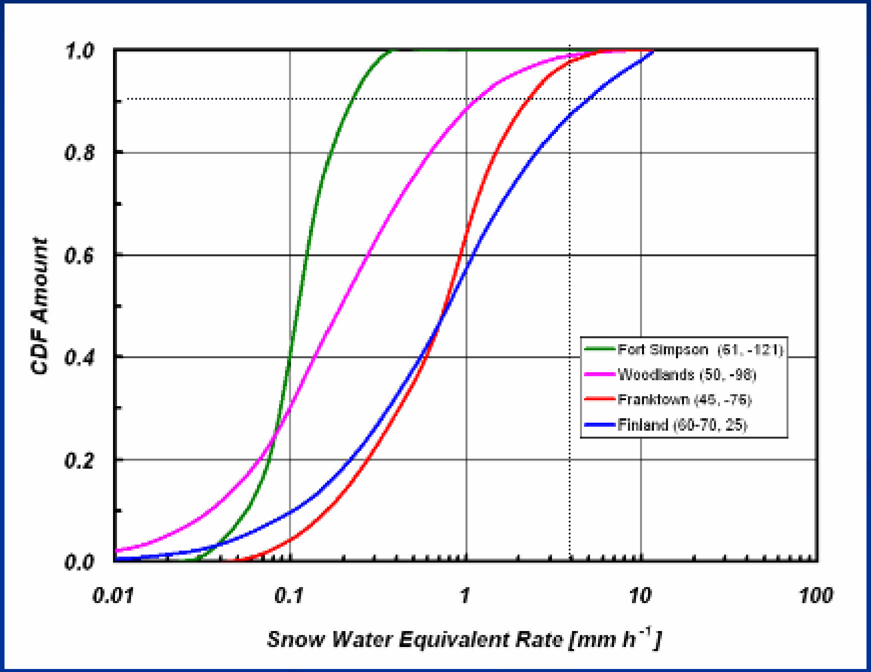
Snow to Total Precipitation Ratio



At mid-to-high latitudes, snowfall represents a substantial portion of the precipitation.

(Slide courtesy of Ralf Bennartz)

Snowfall Accumulation



From higher latitudes at least 90% of the precipitation occurs at rates less than 3 mm/hr and 60 % at less than 1 mm/h

CGMS IPWG International Precipitation Working Group

IPWG/GPM/GRP Workshop on global microwave modeling and retrieval of snowfall

Date | Venue | Co-Organizers | Objective | Agenda | Registration | Contact Information | Accommodations | Visitor Information | Workshop format | Outline

Date: 11-13 October 2005

Venue: Pyle Center
University of Wisconsin – Madison

Workshop Co-Organizers

Ralph Ferraro (NOAA/NESDIS)
Ralf Bennartz (University of Wisconsin)

Objective

The International Precipitation Working Group (IPWG), the GEWEX Radiation Panel (GRP) and NASA's Global Precipitation Measurement Program (GPM) co-sponsor a workshop on passive microwave modeling and retrieval of snowfall. The aim of this workshop is to review the state of the art in passive microwave modeling and retrieval of falling snow over both land and ocean and to develop future directions and requirements for algorithm development, implementation and validation of applications ranging from short-term weather forecasting to climate data set generation.

Agenda

Draft agenda (posted: 28 April 2005)

Registration

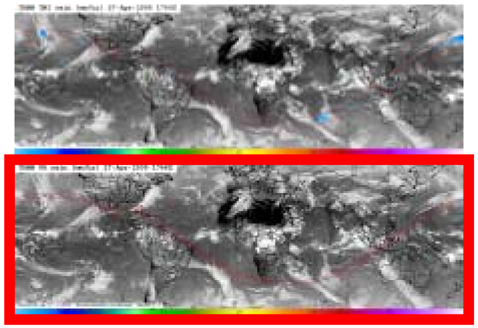
Online registration form. Registration fee will be $200 US dollars.

Contact Information

CIMSS

IPWG Research: Increasing Refresh and Coverage with Multi-Dataset Techniques

LEO + GEO (High Refresh VIS/SW/LW) Satellite Merging

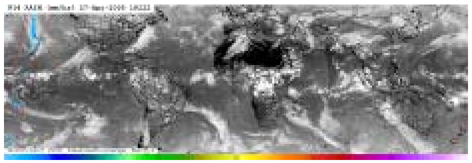


TRMM (TMI+PR)

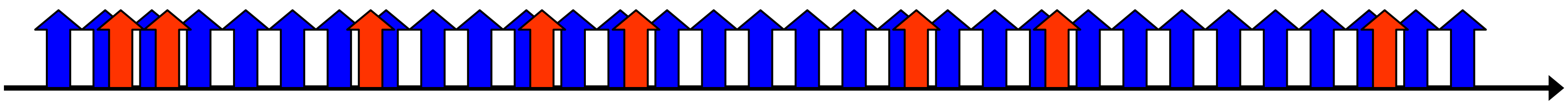
time gap

Aqua (AMSR)

time gap



F-14 SSMI

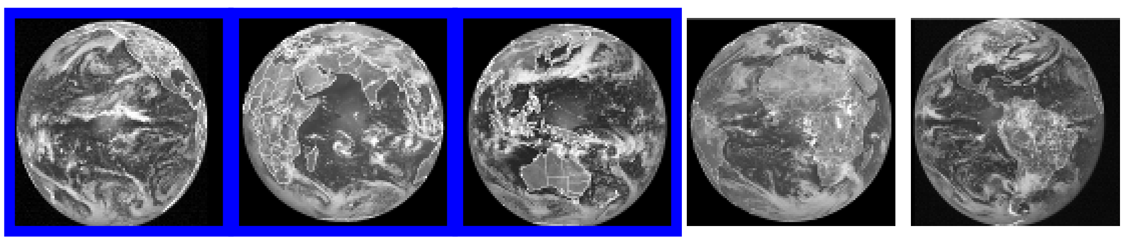


time

Characteristics

- Quantitative use of GEO
- Sequential use of GEO
- "In Microwave We Trust"
- TMI+PR only non-sun-synch PMW observation

Operational Geostationary Constellation



GOES-10/12: 30-min ENH, 3-hr disk
GOES-9 (MTSAT-1R) 1-hr disk
MSG-1: 15-min disk (9 thermal bands)
Meteo-5: 30-min disk

Other IPWG Research: Data Assimilation

Presentations and Articles from IPWG-2004

NASA GEOS-3/TRMM Re-Analysis: Capturing Observed Tropical Rainfall Variability in Global Analysis for Climate Research (Arthur Hou, NASA)

Evaluation of RTTOVSCATT at AMSU Frequencies by Comparison to Observation and ARTS (Una O’Keeffe, UKMO)

Radiometer Channel Optimization for Precipitation Remote Sensing (Peter Bauer, Sabatino DiMichele, ECMWF)

IPWG Validation: Satellite Precipitation Algorithm Validation and Intercomparison Project

- Conducted by The International Precipitation Working Group (IPWG)
- Co-sponsored by the Global Precipitation Climatology Project (GPCP)

- Routine daily validation of several satellite precipitation algorithms against daily rain gauge analyses was begun in February 2003 at the Australian Bureau of Meteorology

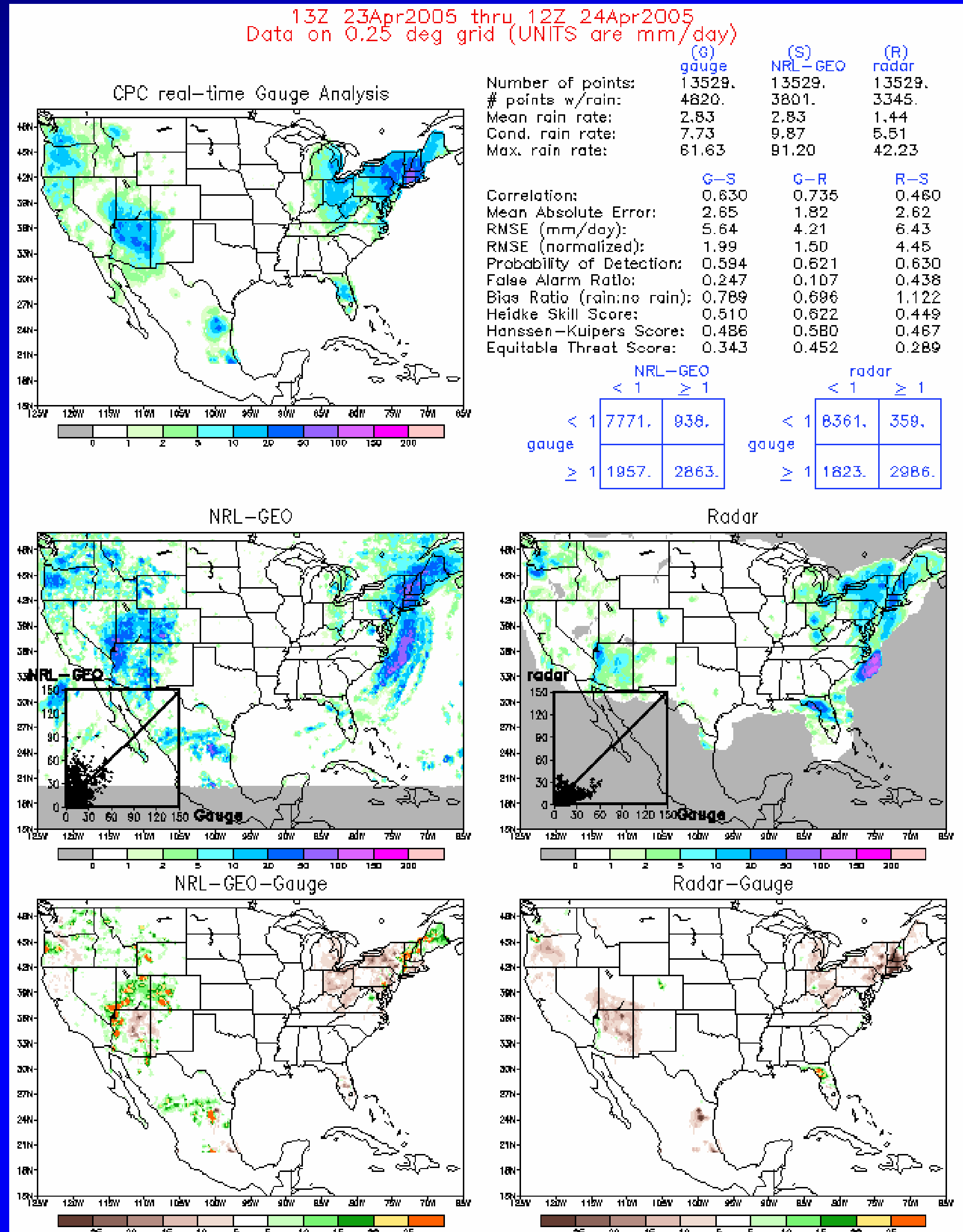
- The NOAA Climate Prediction Center (CPC) began a similar validation of algorithms over the United States starting in May 2003, followed by a European validation in mid 2004

- Most of the algorithms currently being validated are "operational" or "semi-operational", meaning that they are run routinely in near-real time and their estimates are available to the public via the web or FTP

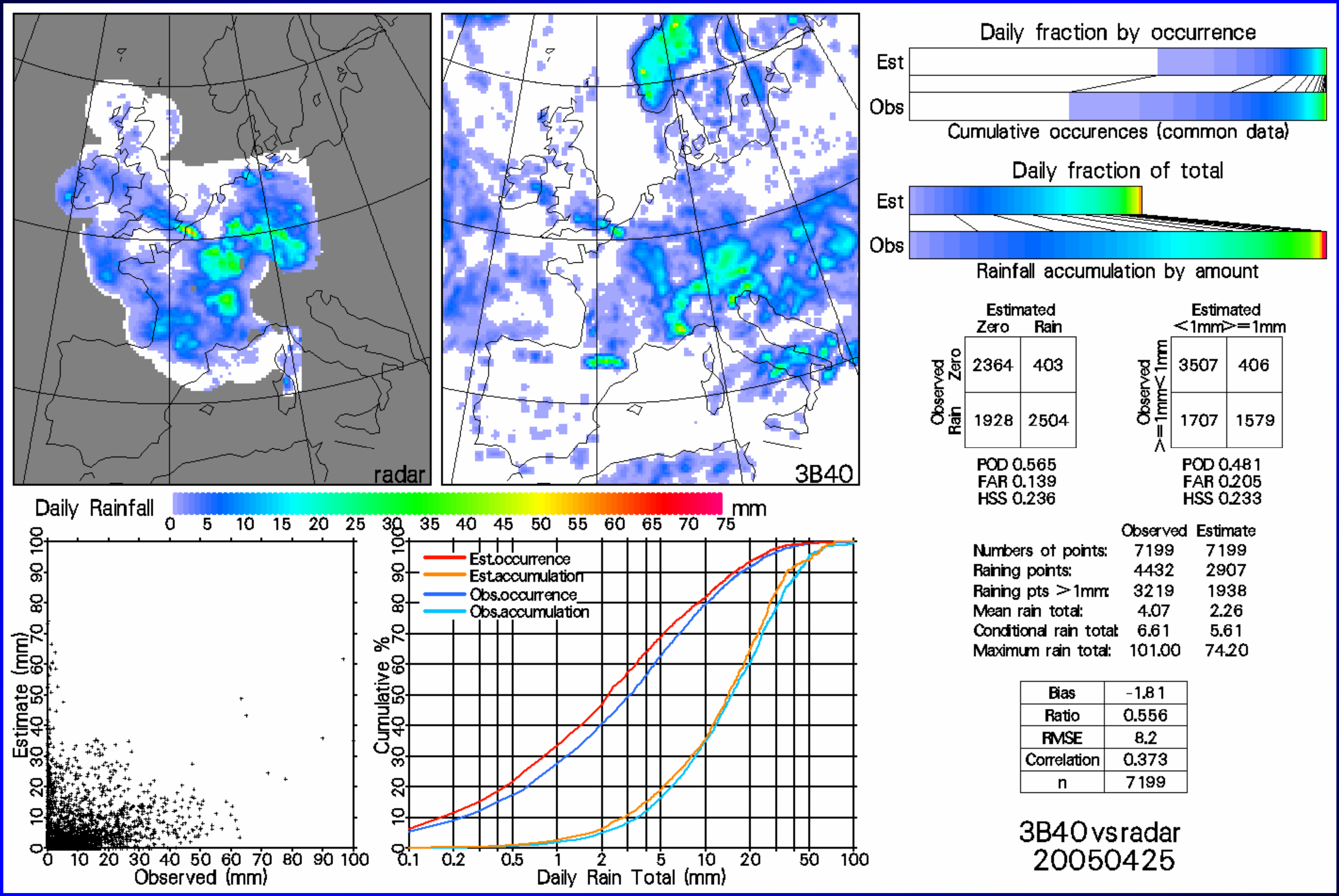
- Short-term rain forecasts from a small number of numerical weather prediction (NWP) models are also verified for comparison

http://www.bom.gov.au/bmrc/SatRainVal/validation-intercomparison.html

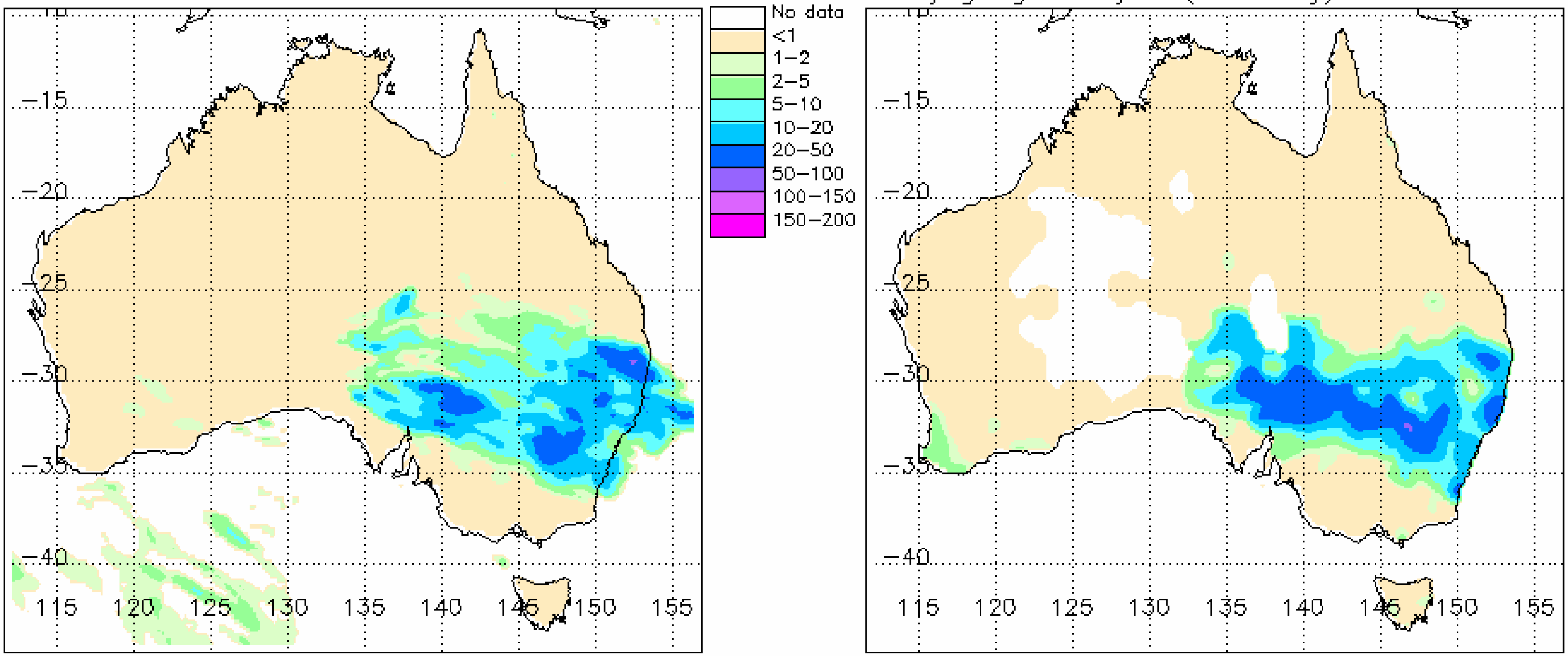
Example Validation Product from the USA Validation

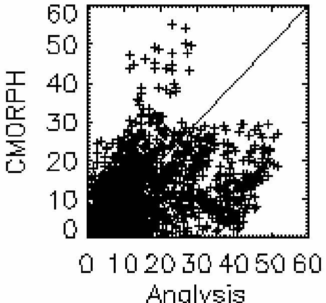


Example Validation Product from the EUROPEAN Validation



Example Validation Product from the AUSTRALIAN Validation





		CMORPH <1	CMORPH ≥1
Observed	<1	6947	385
Observed	≥1	516	1987

Verification statistics for 20040930 n=9835 Verif. grid=0.25° Units=mm/d

	Analysed	CMORPH
# gridpoints raining	2503	2372
Average rain	3.3	2.3
Conditional rain	12.8	9.6
Rain volume ($mm*km^2x10^6$)	22.0	15.7
Maximum rain	51.9	55.0

Mean abs error = 2.0
RMS error = 5.5
Correlation coeff = 0.724
Frequency bias = 0.948
Probability of detection = 0.794
False alarm ratio = 0.162
Hanssen & Kuipers score = 0.741
Equitable threat score= 0.606

The IPWG Satellite Precipitation Archive

Updated daily with 24-hour rainfall estimates from 16 operational and semi operational algorithms, as well as some NWP model forecasts, gauge and radar analyses

Encourage the validation and intercomparison of satellite precipitation estimates in additional regions of the globe using high quality and/or national rainfall reference data

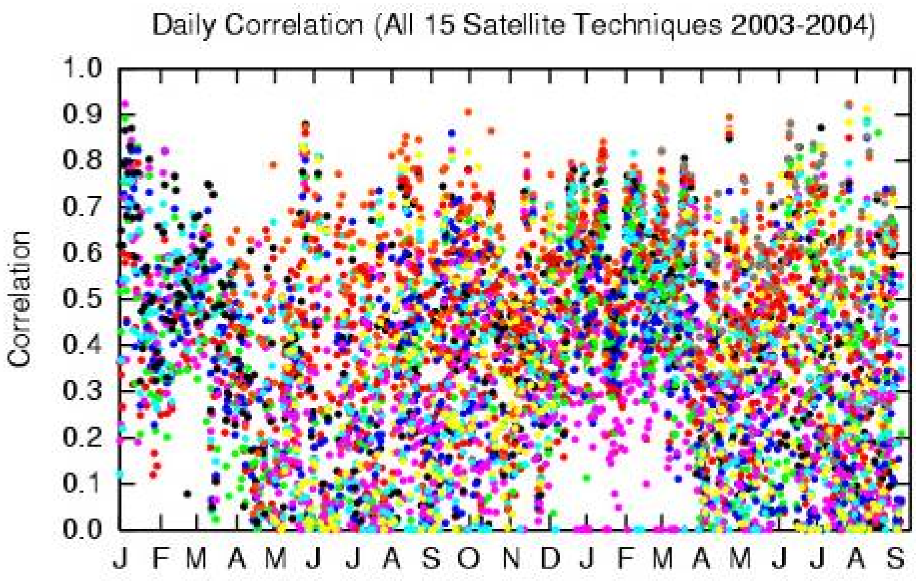
IPWG is interested in the evaluation of these satellite precipitation estimates as input to weather, climate, hydrological, and agricultural models and other applications

Located at the Cooperative Institute for Climate Studies (CICS) at the University of Maryland (updated daily):
ftp://cics.umd.edu/pub/DATA/Validation

See also the IPWG Satellite Precipitation Archive web site:
http://www.bom.gov.au/bmrc/SatRainVal/IPWG_precip_archive.html

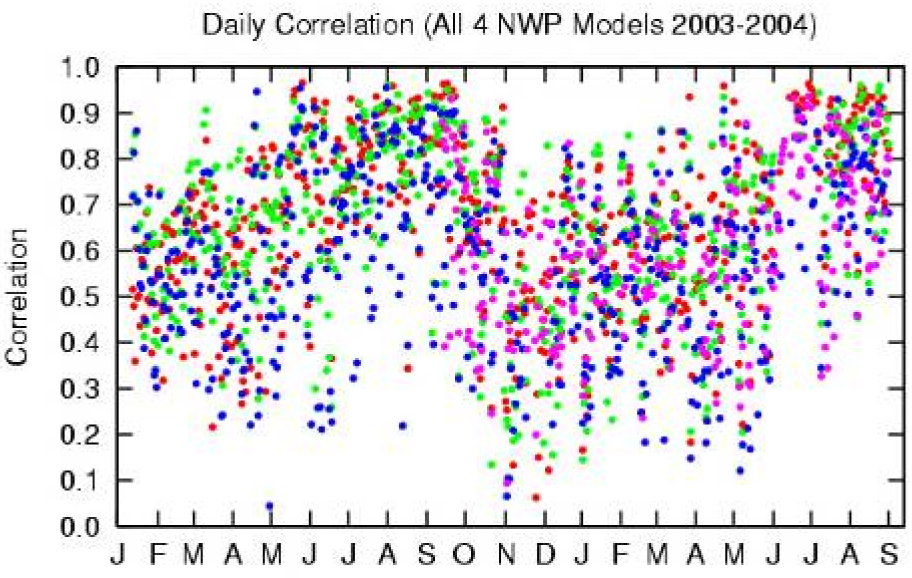
Continental Australia including Tasmania
All Latitude Regimes   Jan 2003-Sept 2004
Daily Correlation between Gauge Analysis and Estimates

15 Satellite Algorithms (blended PMW-IR, PMW-only, Multi-Precip, IR-only)



summer winter summer winter

4 NWP Models (AVN, ECMWF, NOGAPS, mesoLAPS)

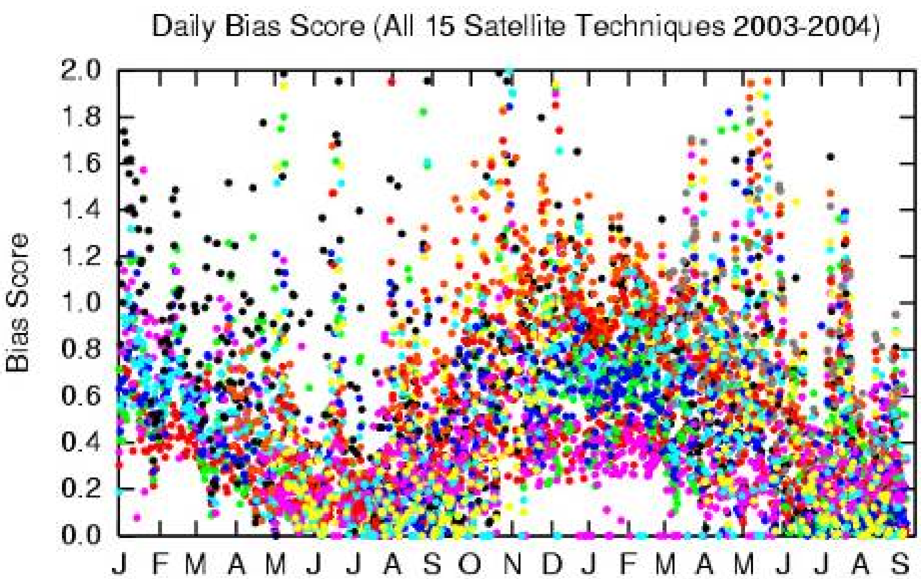


summer winter summer winter

- **Wide variety in performance of satellite techniques**
- **NWP model performance is superior for winter season**
- **Similar performance in summer season**

Continental Australia including Tasmania
All Latitude Regimes   Jan 2003-Sept 2004
Bias Score* *between Gauge Analysis and Estimates*

15 Satellite Algorithms (blended PMW-IR, PMW-only, Multi-Precip, IR-only)



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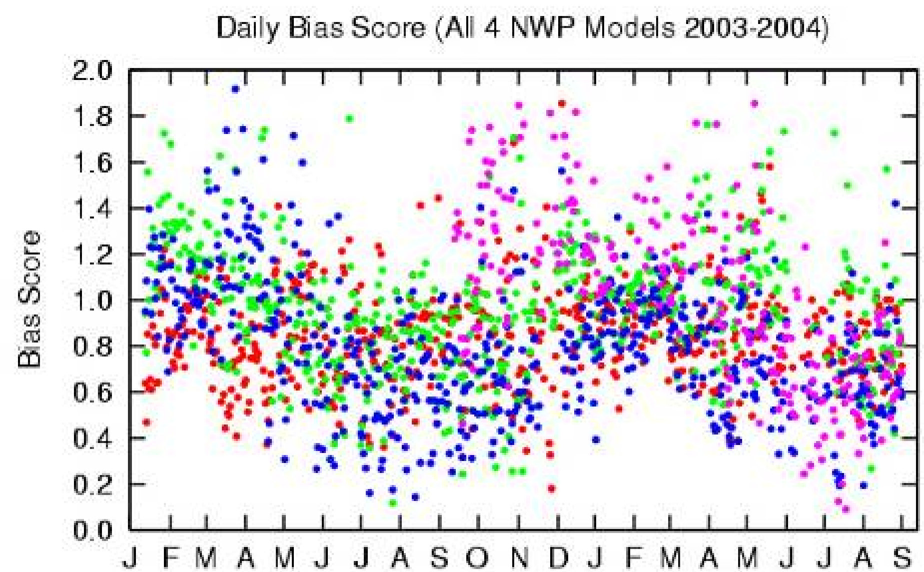


summer winter summer winter

***Bias Score = (hits + false alarms)/(hits + misses)   Range= 0 to infinity**
Indicates whether the system has a tendency to underforecast (*bias* < 1) or overforecast (*bias* > 1)

IPWG Validation Results So Far (Still Ongoing….)

No Ocean Validation

Microwave algorithms are expected to have better performance over ocean because emission signal is used

Therefore microwave+IR algorithms should also perform better over ocean

NWP QPFs perform better over land than over ocean since more observations used in model initialization

Upcoming Snowfall Workshop !

IPWG/GPM/GRP Workshop on global microwave modeling and retrieval of snowfall 11-13 October 2005, UW-Madison (Organized by Ralf Bennartz)

Program for the Evaluation of High Resolution Precipitation Products (PEHRPP)

- Recommended by IPWG (Working Group of CGMS)
- Process:
  - Recruit participants; identify/collect necessary data
  - Compare with dense gauge networks via Ebert, Janowiak, Kidd efforts
  - Use CEOP time series to extend spatial coverage
  - Apply coordinated diagnoses with other datasets, circulation data
- Outcomes:
  - Reach consensus on necessary development steps
  - Recommend algorithm(s) to be used for IGWCP IPP
  - Recommend actions by space agencies to provide data sets necessary to extend products back to early 1990s
- Timeline:
  - Initial discussions ongoing; side meeting during GEWEX Conference possible (25 June 2005 planning meeting at UC-Irvine)
  - Data collection and analysis efforts: Jan 2005 – June 2006
  - Concluding workshop: June or July 2006 during IPWG-2006

IPWG Validation Results So Far (Still Ongoing….)

1. **Merging PMW & IR estimates (i.e., GEO and LEO satellites) provides more accurate estimates of precipitation than the separate components can**

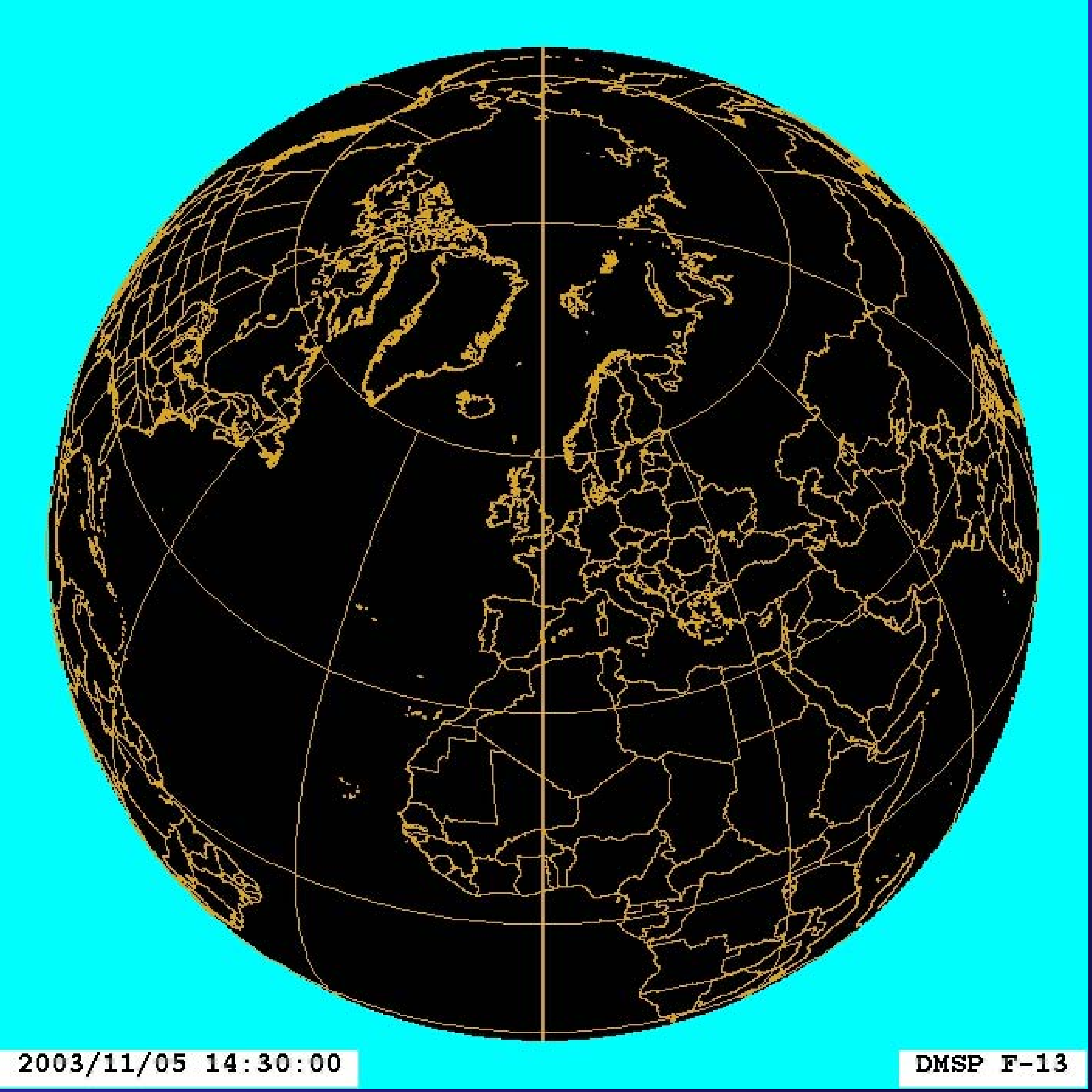
2. **Two major systematic biases are apparent in the satellite estimates:**
   - **a. OVER-estimation over snow-covered regions**
   - **b. OVER-estimation in semi-arid regions during the warm season**

3. **When merging PMW & IR data, more accurate results obtained when using IR to transport & morph precipitation than to use IR to estimate precipitation directly**

4. **NWP forecasts generally outperform satellite estimates and radar during the winter season over the U.S.**

5. **Satellite estimates compare better with radar than gauge: point estimates vs. less-direct / spatially complete**

   gauges ***radar***



Current (10-Satellite) LEO Satellite Constellation

Revisit Time

Color Codes:

SSMI
DMSP F-13/14/15
AMSR-E
Aqua
AMSU-B
NOAA-15/16/17
TMI
TRMM
Coriolis
Windsat
SSMIS
F-16

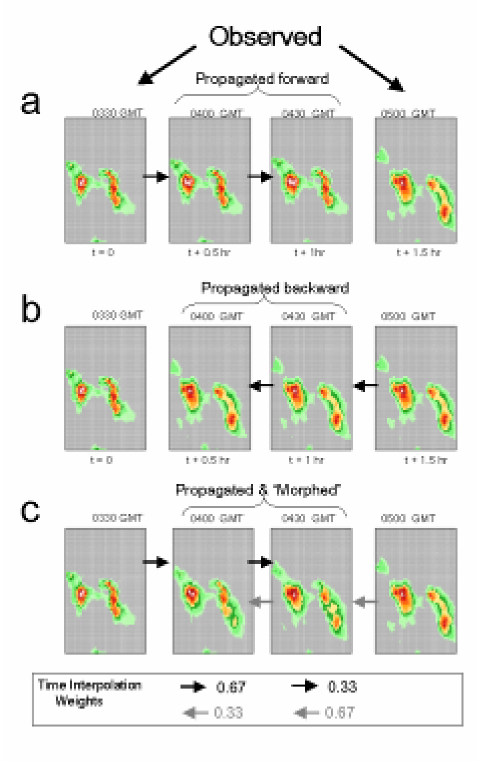
Revisit Scale: White= 0 hours   Black= 6+ hours (shaded boxes represent 15-minute coverage)

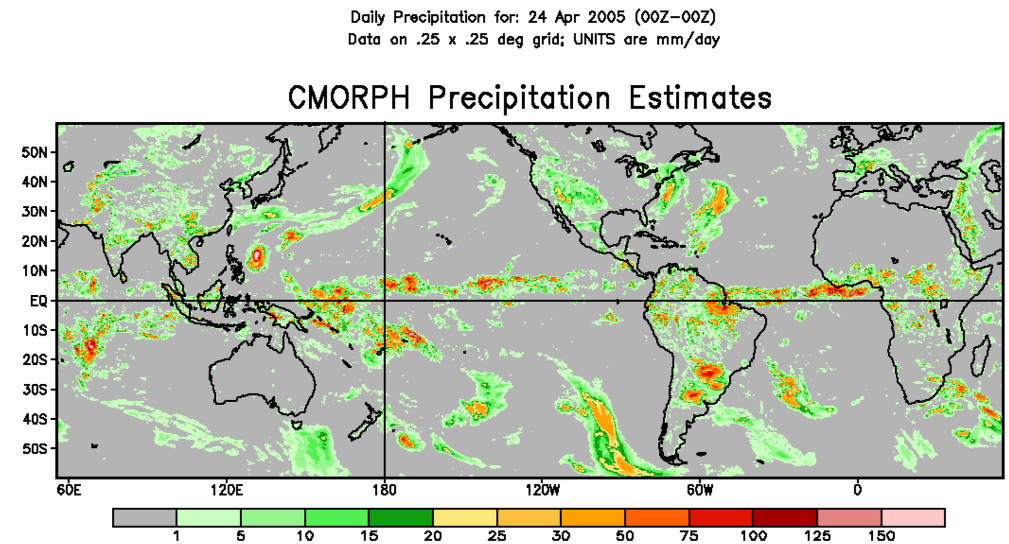
IPWG Research: Increasing Refresh and Coverage with Multi-Dataset Techniques

LEO + GEO Satellite Merging - *Examples*

CMORPH (R. Joyce, J. Janowiak, P. Arkin)

GEO-IR data are used as a means to *transport* the microwave-derived precipitation features during periods when microwave data are not available at a location. Propagation vector matrices are produced by computing spatial lag correlations on successive images of geostationary satellite IR which are then used to propagate the microwave derived precipitation estimates.





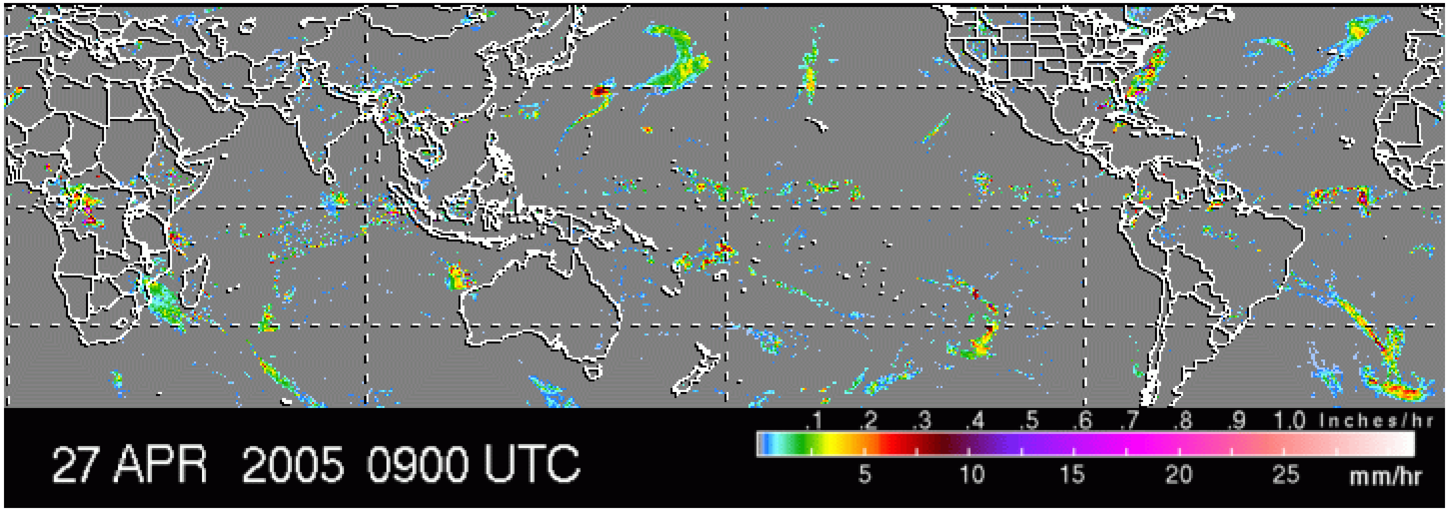
http://www.cpc.ncep.noaa.gov/products/janowiak/MW-precip_index.html

IPWG Research: Increasing Refresh and Coverage with Multi-Dataset Techniques

LEO + GEO Satellite Merging - *Examples*

NASA 3B42RT or MPA (George Huffman, Robert Adler)

This algorithm provides a combination of the TRMM real-time merged passive microwave (HQ; 3B40RT) and microwave-calibrated IR (VAR; 3B41RT). The current scheme is simple replacement - for each gridbox the HQ value is used if available, and otherwise the VAR value is used.



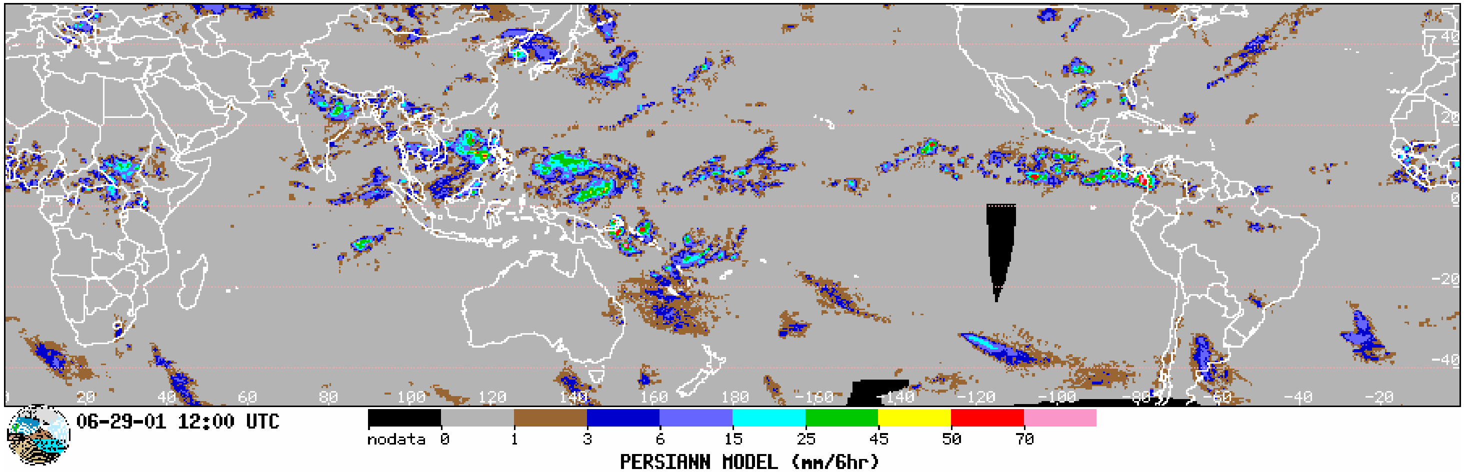
http://trmm.gsfc.nasa.gov (images and animations)
ftp://aeolus.nascom.nasa.gov/pub/merged/mergeIRMicro (data)

IPWG Research: Increasing Refresh and Coverage with Multi-Dataset Techniques

LEO + GEO Satellite Merging - *Examples*

PERSIANN (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks) (Kuo-Lin Hsu)

This system uses neural network function classification/approximation procedures to compute an estimate of rainfall rate at each 0.25° x 0.25° pixel of the infrared brightness temperature image provided by geostationary satellites. An adaptive training feature facilitates updating of the network parameters whenever independent estimates of rainfall are available.



http://hydis8.eng.uci.edu/persiann

IPWG Research: Increasing Refresh and Coverage with Multi-Dataset Techniques

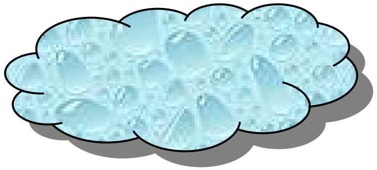
LEO + GEO Satellite Merging - *Examples*

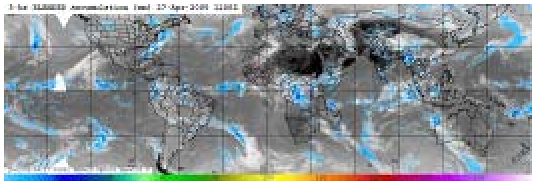
NRL-Blend (Joe Turk)

The NRL blended satellite technique is based upon area-dependent statistical relationships derived from a precise, near realtime ensemble of colocated passive microwave (PMW) and infrared (IR) pixels from any or all low Earth-orbiting (LEO) and geostationary satellites, respectively, as their individual orbits and sensor scan patterns continuously intersect in space and observation time.

http://www.nrlmry.navy.mil/sat-bin/rain.cgi (images)
ftp://ftp.nrlmry.navy.mil/pub/receive/turk/global_rain (data)

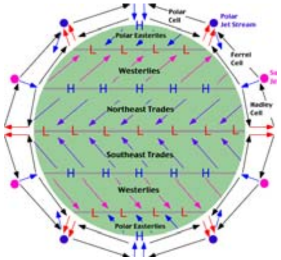
Orographic Adjustments and No-Rain Screening





Final Blended Analysis

+



Global NWP

identify moist low-level flow

adjust upslope and downslope rain