GNSS-RO Data Processing for Climate Applications:

Assessing the performance of the next-generation obs4mips atmospheric products

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IROWG-7

Jet Propulsion Laboratory
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Why here, why now?

Climate change threatens food security in S Asia

Says ADB study

UN Photo/Mark Garten

In visit to hurricane-ravaged Bahamas, UN chief calls for greater action to address climate change

13 September 2019 | Americas

World leaders attending the upcoming UN Climate Action Summit are being urged to show up armed not with speeches but with plans to achieve carbon neutrality, reduce emissions and improve adaptation.

The New York Times

Major Climate Report Describes a Strong Risk of Crisis as Early as 2040

NASA Facts!

Shrinking Ice Sheets: The rate of Antarctica ice mass loss has tripled in the last decade

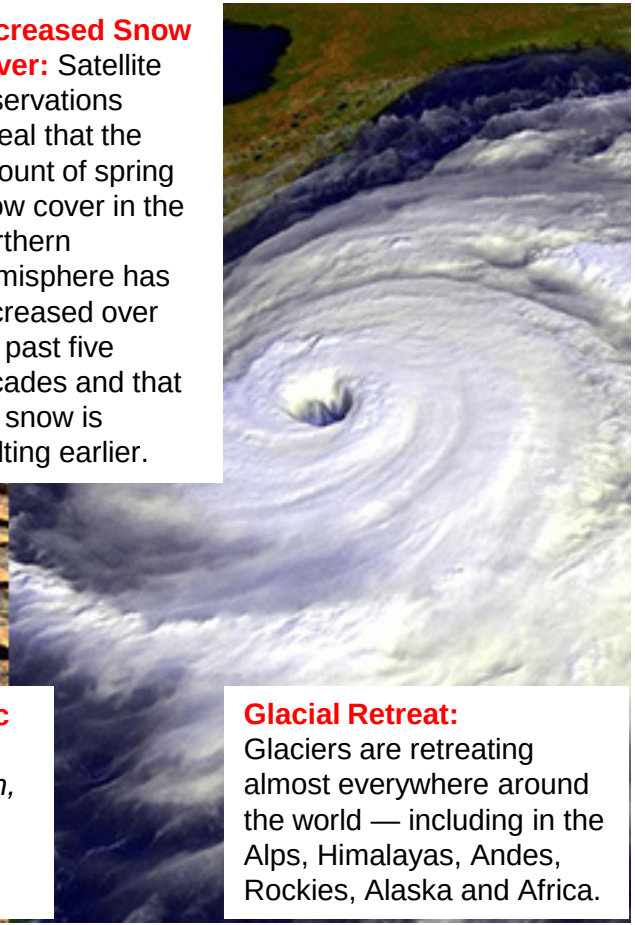
Global Temperature Rise: The planet's average surface temperature has risen about 1.62 degrees Fahrenheit (0.9 degrees Celsius) since the late 19th century,

Rising Temperatures: The number of record high temperature events in the United States has been increasing, while the number of record low temperature events has been decreasing.

Warming Oceans: Warming of more than 0.4 degrees Fahrenheit since 1969

Declining Arctic Sea Ice: *Arctic sea ice minimum, the lowest on record*

Decreased Snow Cover: Satellite observations reveal that the amount of spring snow cover in the Northern Hemisphere has decreased over the past five decades and that the snow is melting earlier.

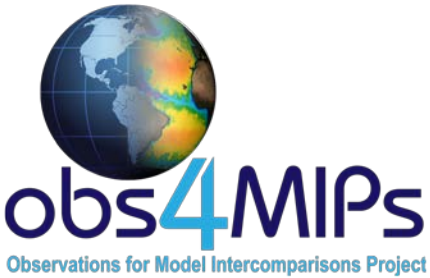


Glacial Retreat: Glaciers are retreating almost everywhere around the world — including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.

Instrument	Pros	Cons
Wx Stations	Accurate measurements	Poor spatial resolution
Radionsondes	High vertical resolution	Spatio-temporal resolutions
LIDAR	Accurate vertical and temporal resolution	Cost/Spatial resolution
IR Satellites	Good Coverage	Sensitive to aerosols/clouds. Limited vertical resolution
MW Sensors	Can penetrate clouds	Vertical resolution is poor i.e 2-3km

We need accurate, high resolution instruments (and products!), that are not biased by clouds/aerosols and can sample globally!

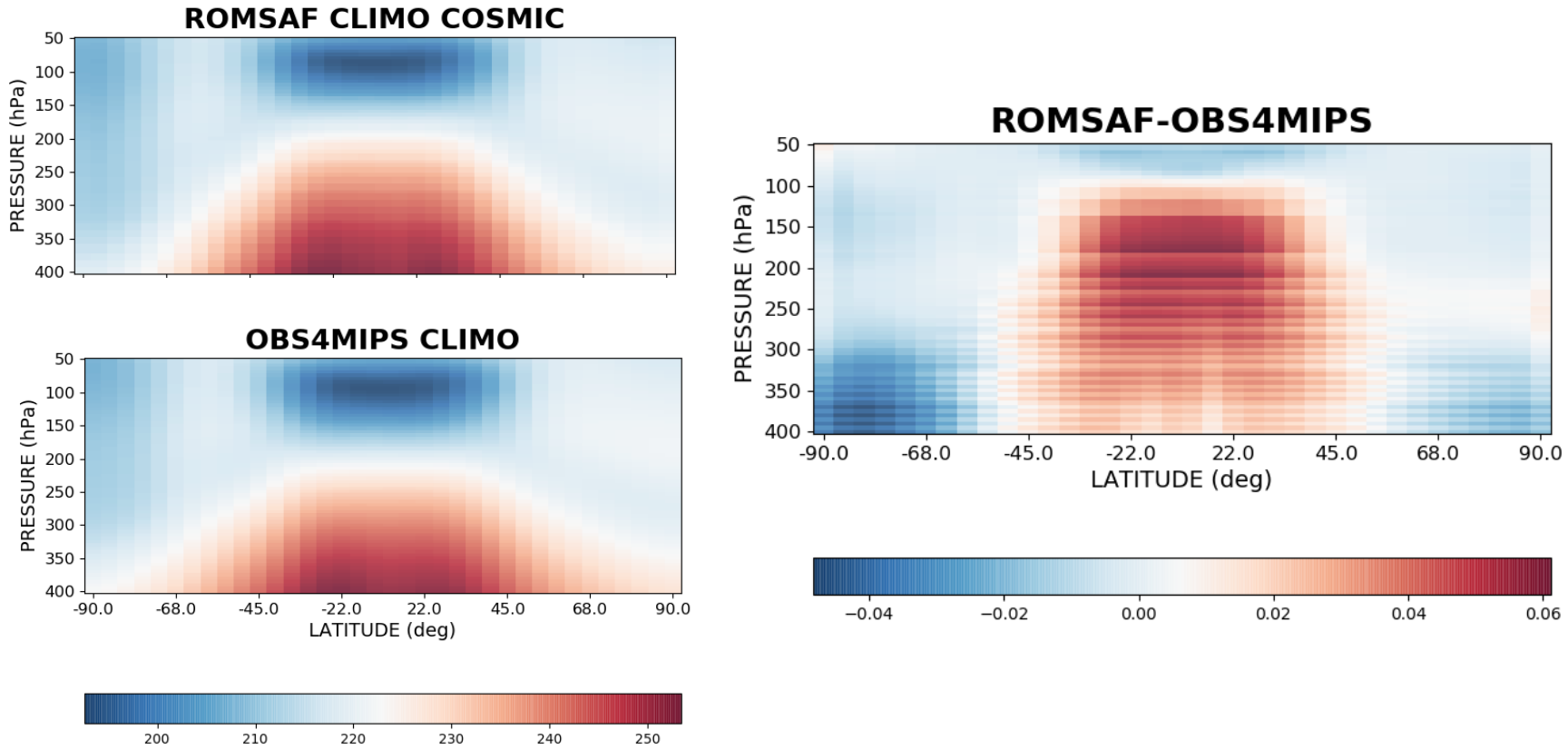
OBS4MIPS



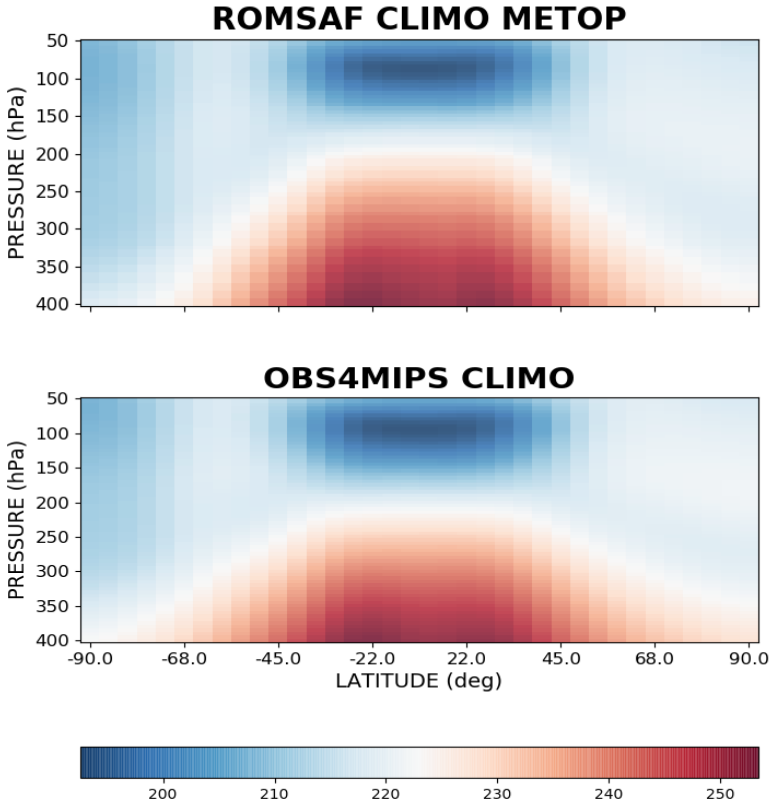
- Gridded ”Climate Record” of observations targeted at Climate/Model Intercomparison.
- Combines various RO missions (Champ, Cosmic, Grace, Champ, etc.).
- Monthly averaged gridded GPH at different pressure levels were produced using the Bayesian interpolation method with spherical harmonic basis functions [*Leroy et al.*, 2012].
- Dry and Wet Pressure/Temperature Products Available.
- Products: gridded GPH (Level 3) data in 5° zonal means and 5°×5° latitude-longitude grids used here can be downloaded from http://genesis.jpl.nasa.gov.

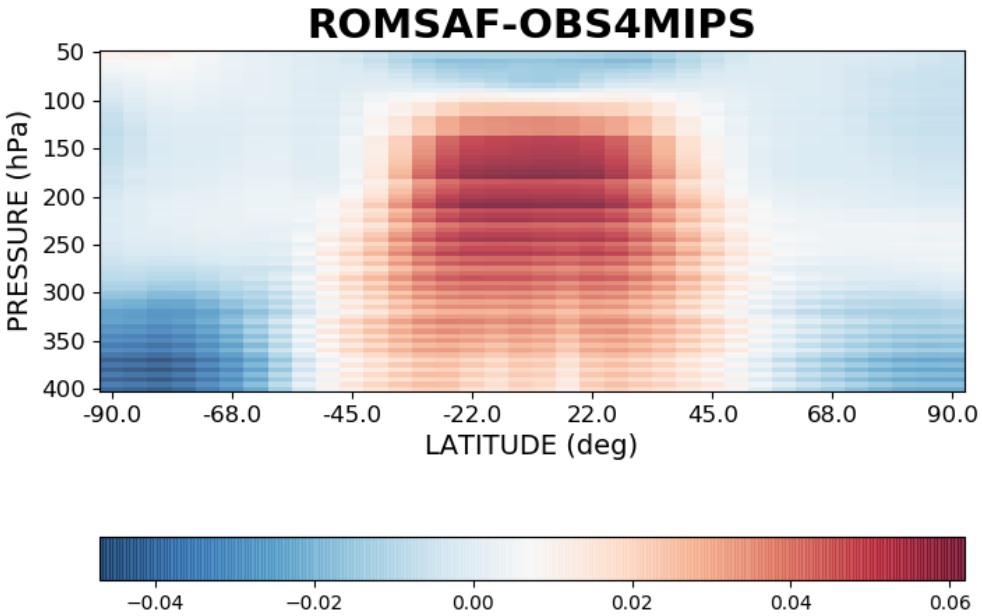
Dry Temperature Retrievals

OBS4MIPS vs. COSMIC-1

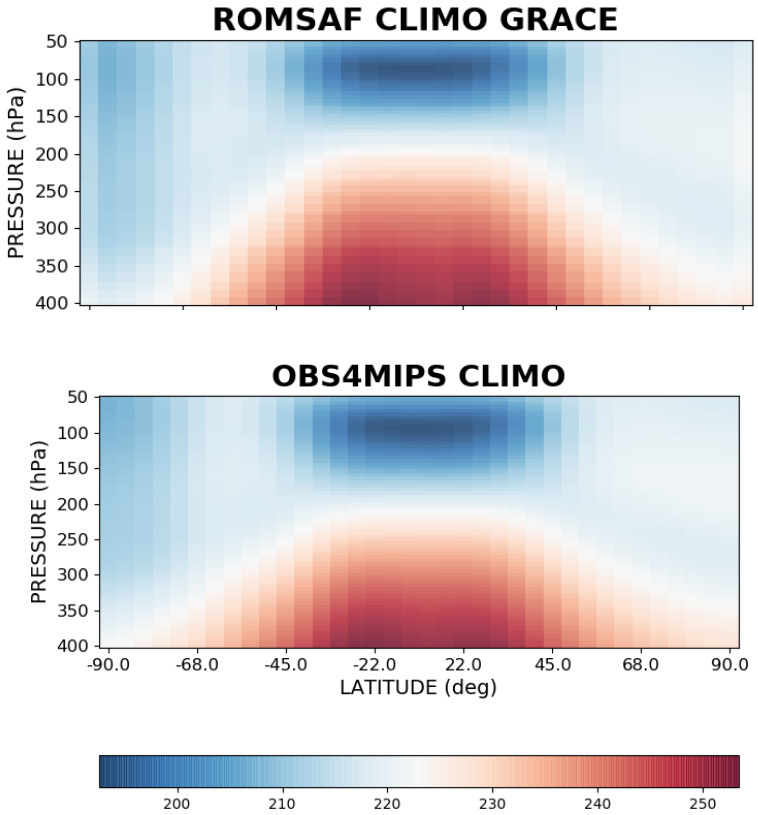


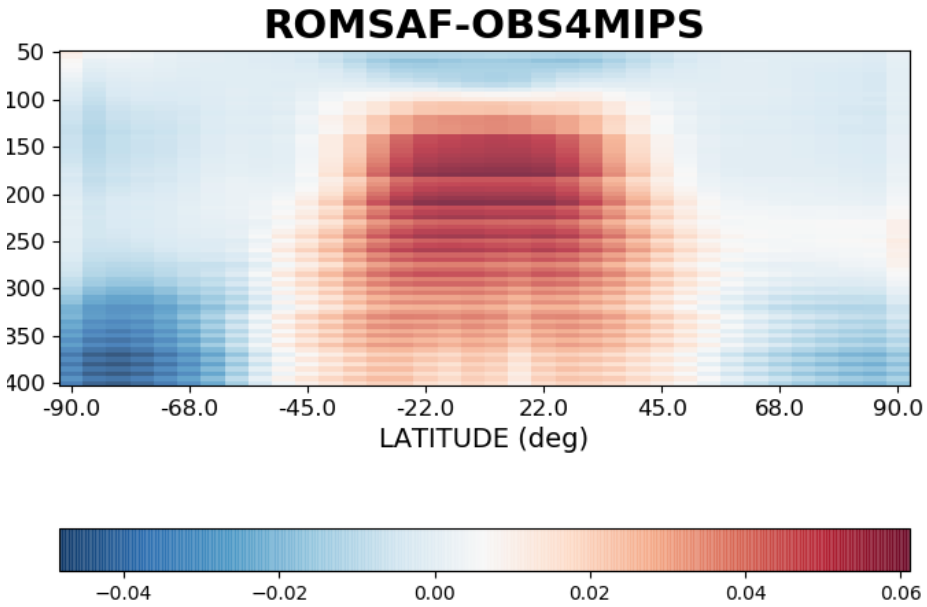
OBS4MIPS vs. METOP





OBS4MIPS vs. GRACE





Wet Retrievals

nasa.gov

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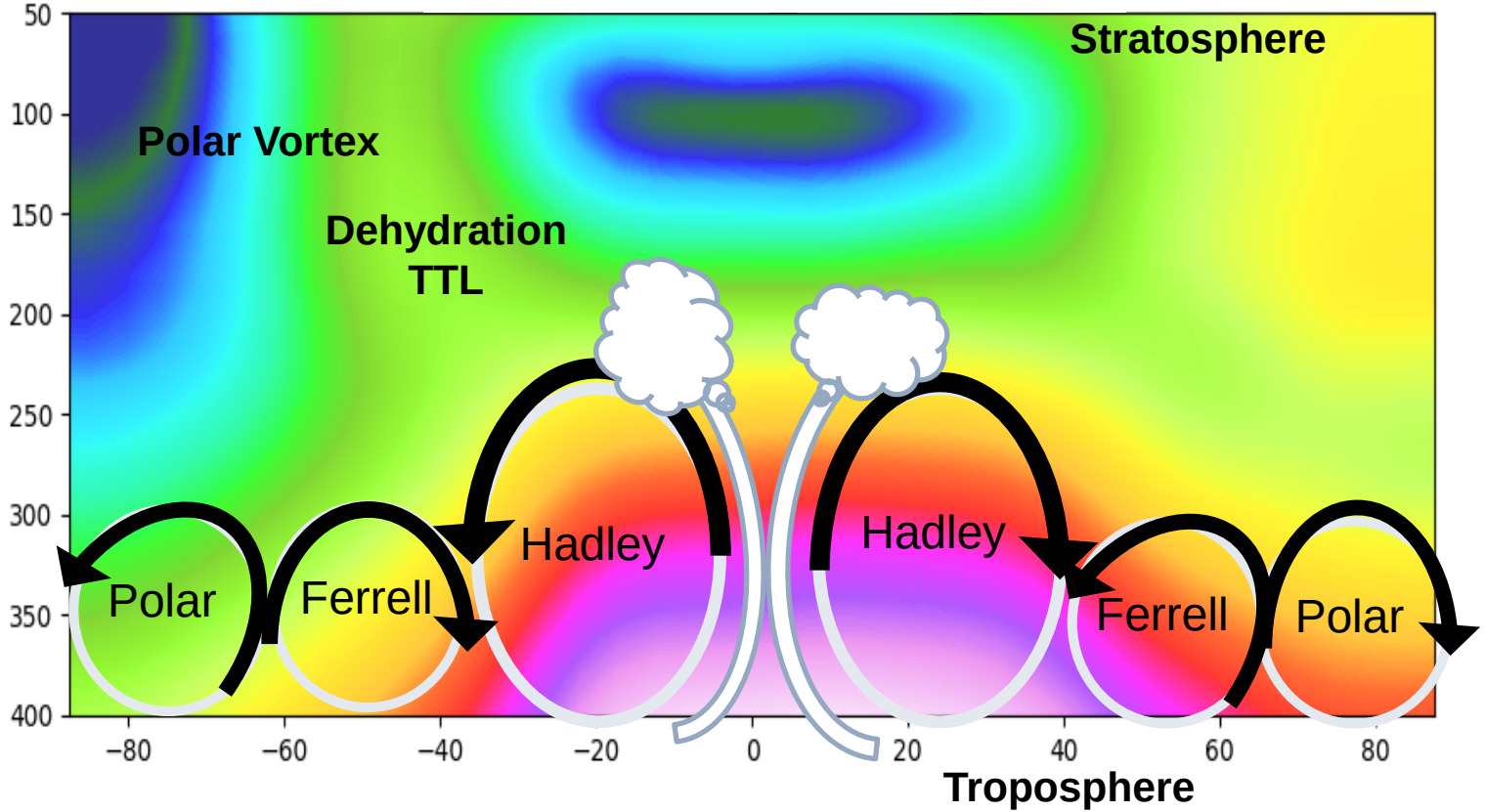
Temperature Trends

Brewer-Dobson Circulation



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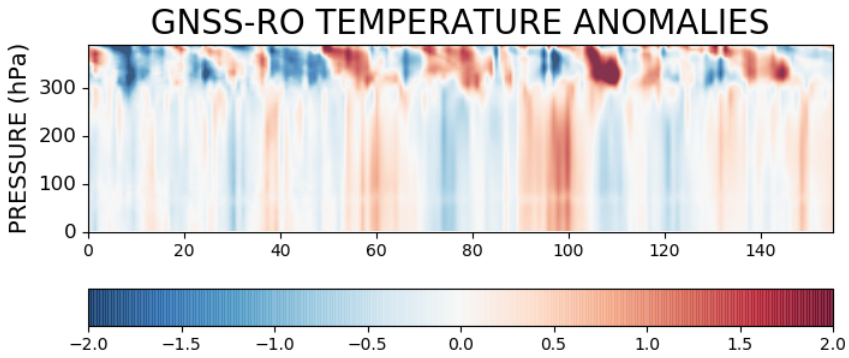
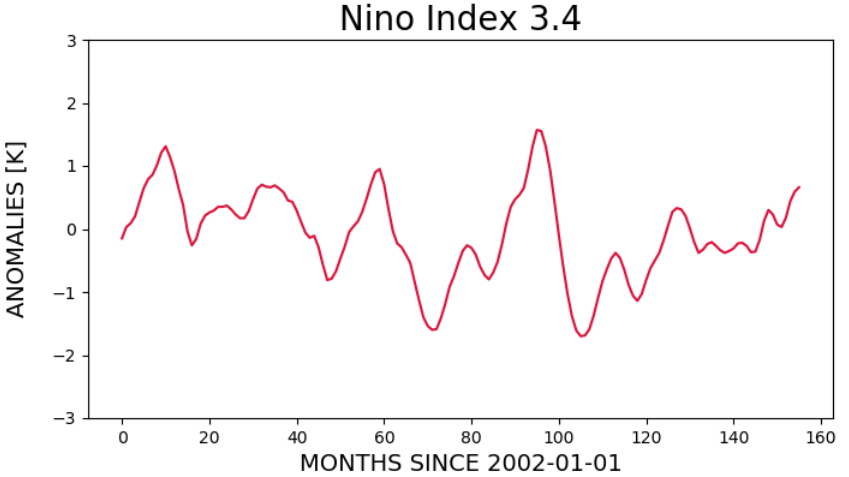
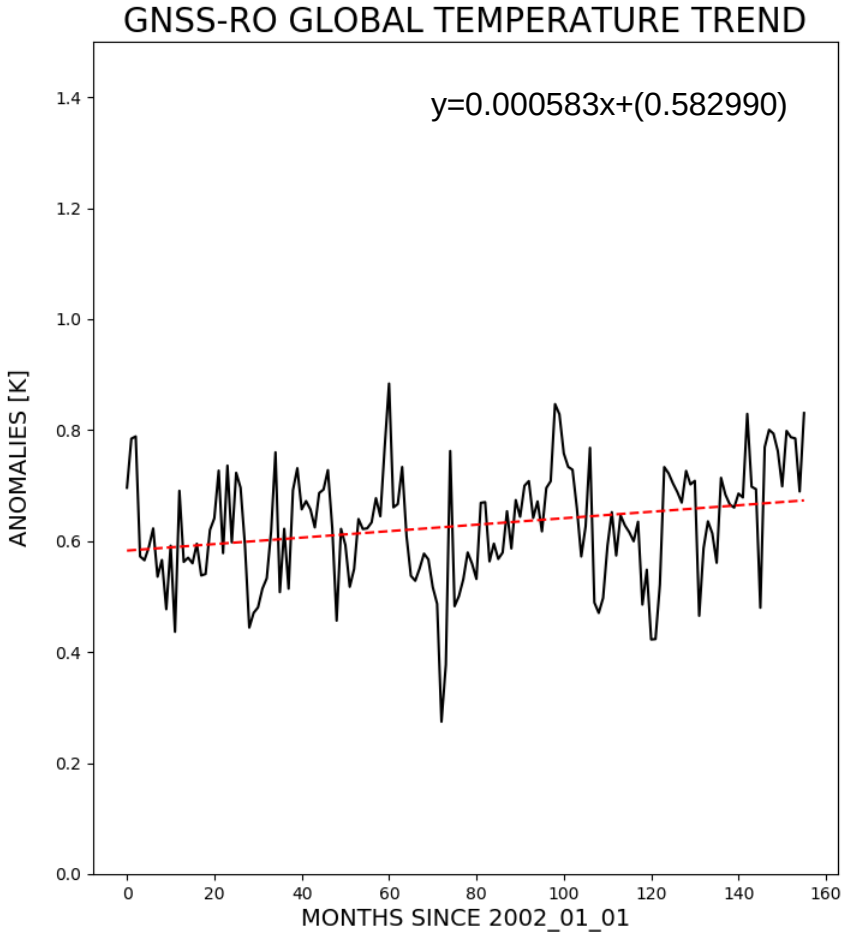
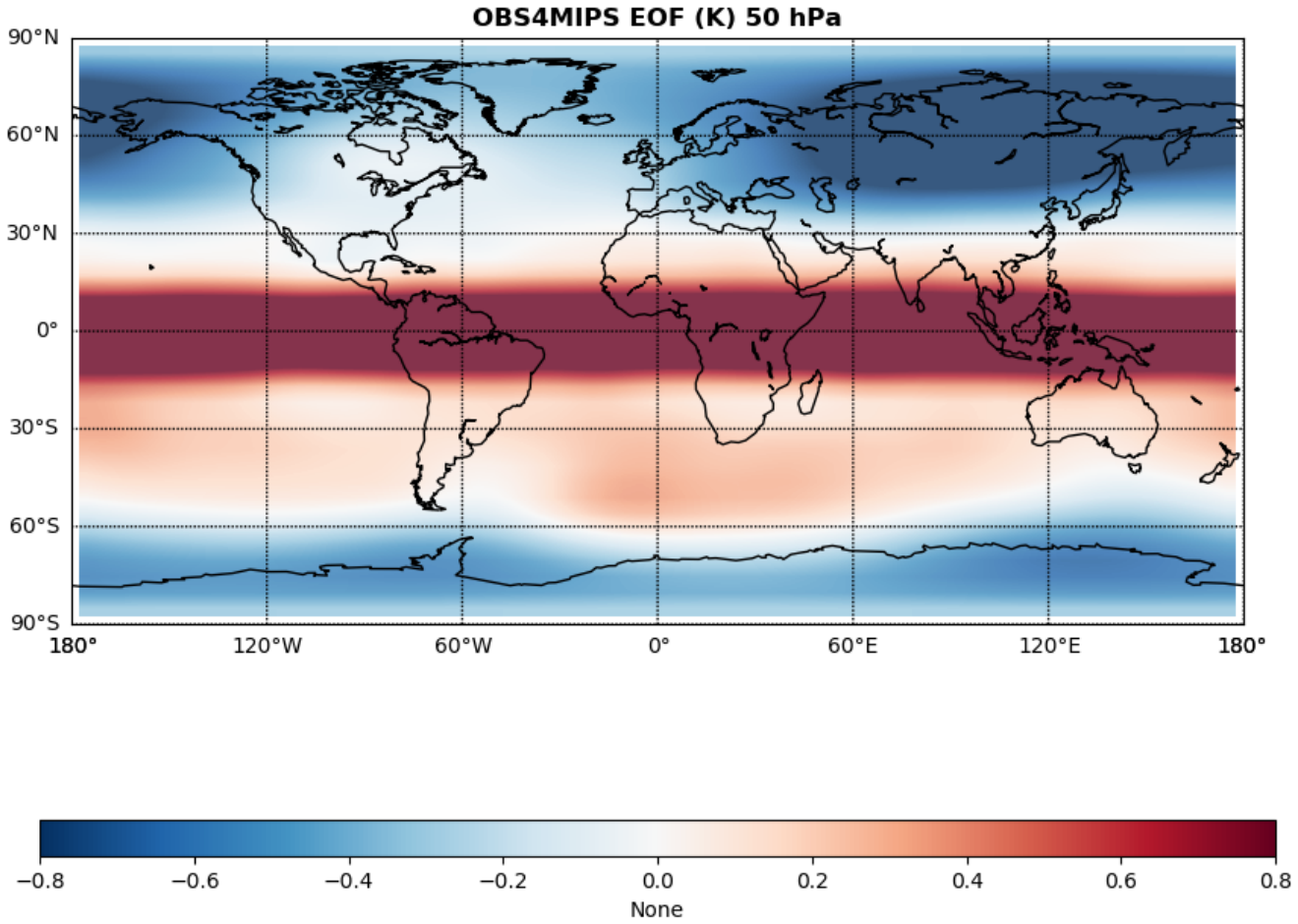
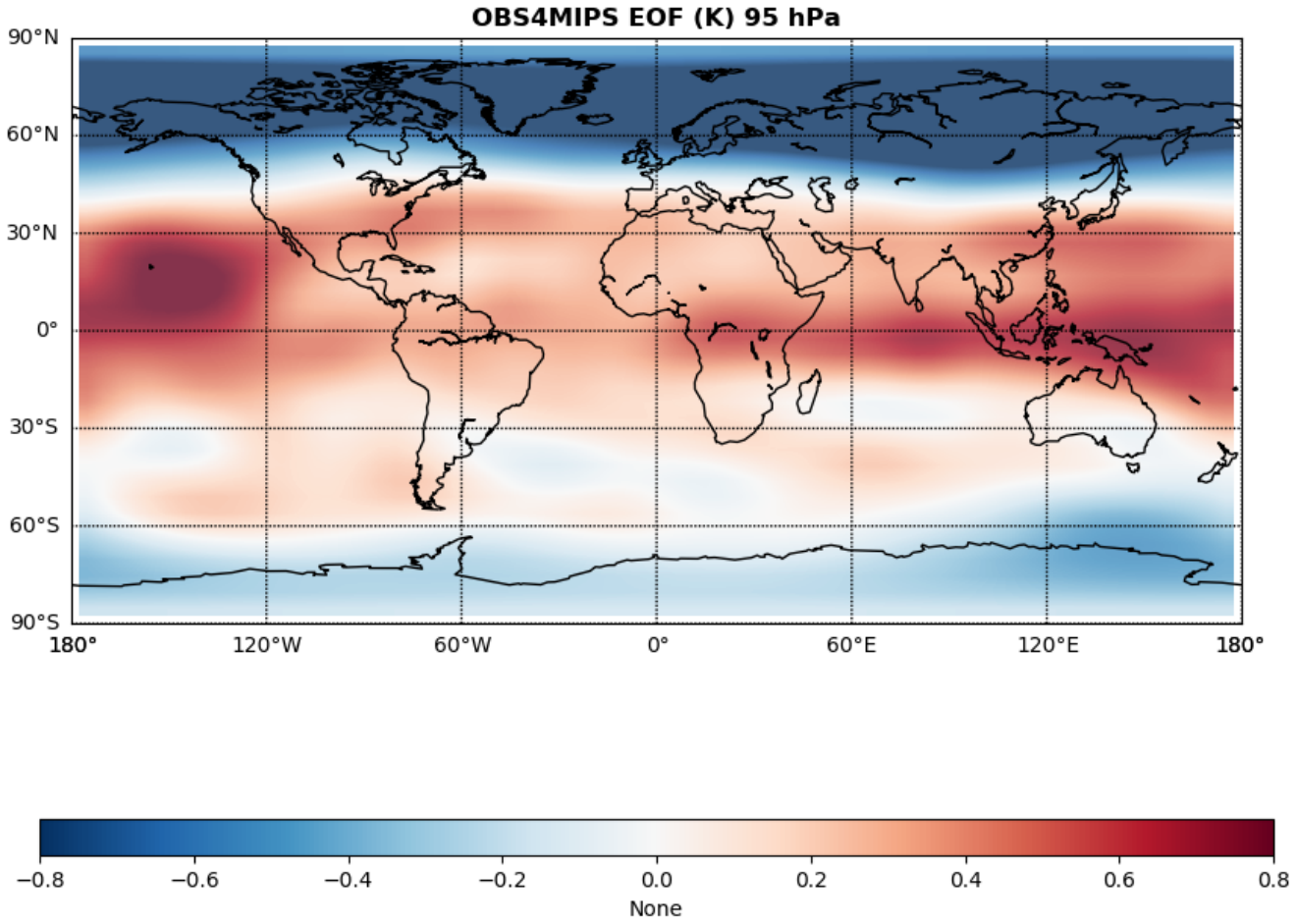

GNSS-RO TEMPERATURE ANOMALIES
PRESSURE (hPa)
0
100
200
300
0
20
40
60
80
100
120
140
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0


Nino Index 3.4
ANOMALIES [K]
3
2
1
0
−1
−2
−3
0
20
40
60
80
100
120
140
160
MONTHS SINCE 2002-01-01

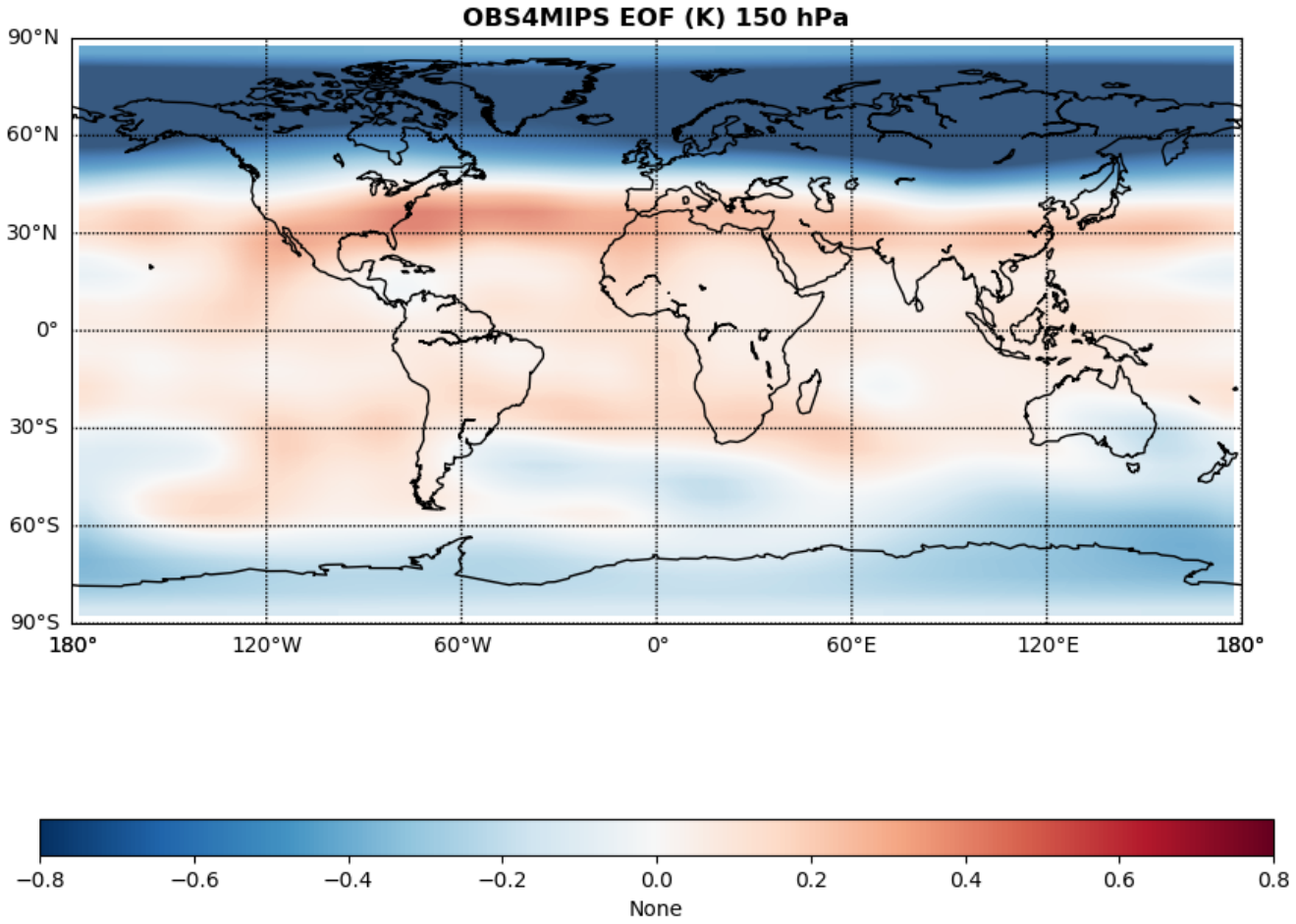

GNSS-RO GLOBAL TEMPERATURE TREND
y=0.000583x+(0.582990)
ANOMALIES [K]
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
140
160
MONTHS SINCE 2002_01_01


OBS4MIPS EOF (K) 50 hPa
90°N
60°N
30°N
0°
30°S
60°S
90°S
180°
120°W
60°W
0°
60°E
120°E
180°
−0.8
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
None

asa.gov


OBS4MIPS EOF (K) 95 hPa
90°N
60°N
30°N
0°
30°S
60°S
90°S
180°
120°W
60°W
0°
60°E
120°E
180°
−0.8
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
None

asa.gov


OBS4MIPS EOF (K) 150 hPa
90°N
60°N
30°N
0°
30°S
60°S
90°S
180°
120°W
60°W
0°
60°E
120°E
180°
−0.8
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
None

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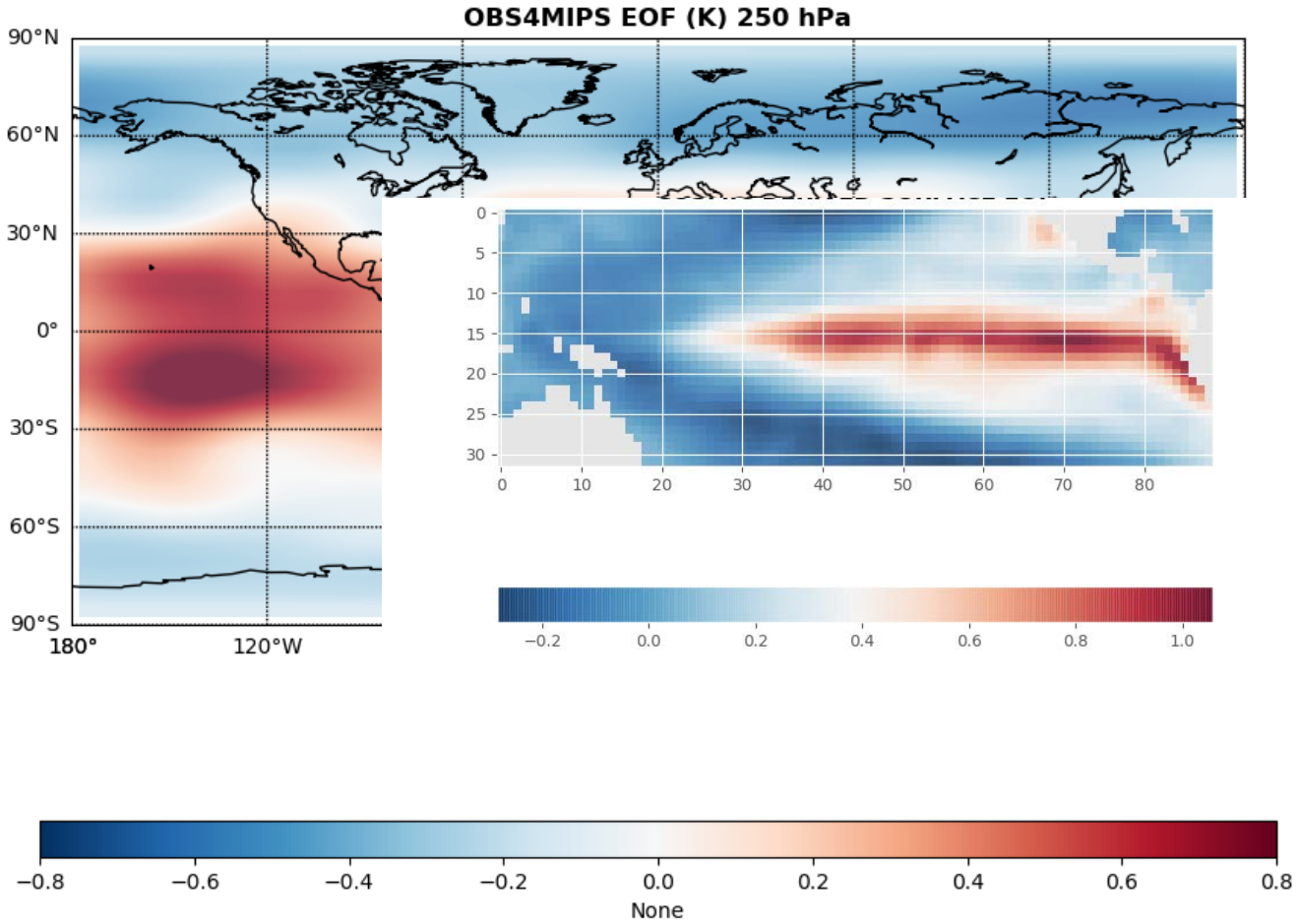
OBS4MIPS EOF (K) 250 hPa
90°N
60°N
30°N
0°
30°S
60°S
90°S
180°
120°W
0
5
10
15
20
25
30
0
10
20
30
40
50
60
70
80
−0.2
0.0
0.2
0.4
0.6
0.8
1.0
−0.8
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
None

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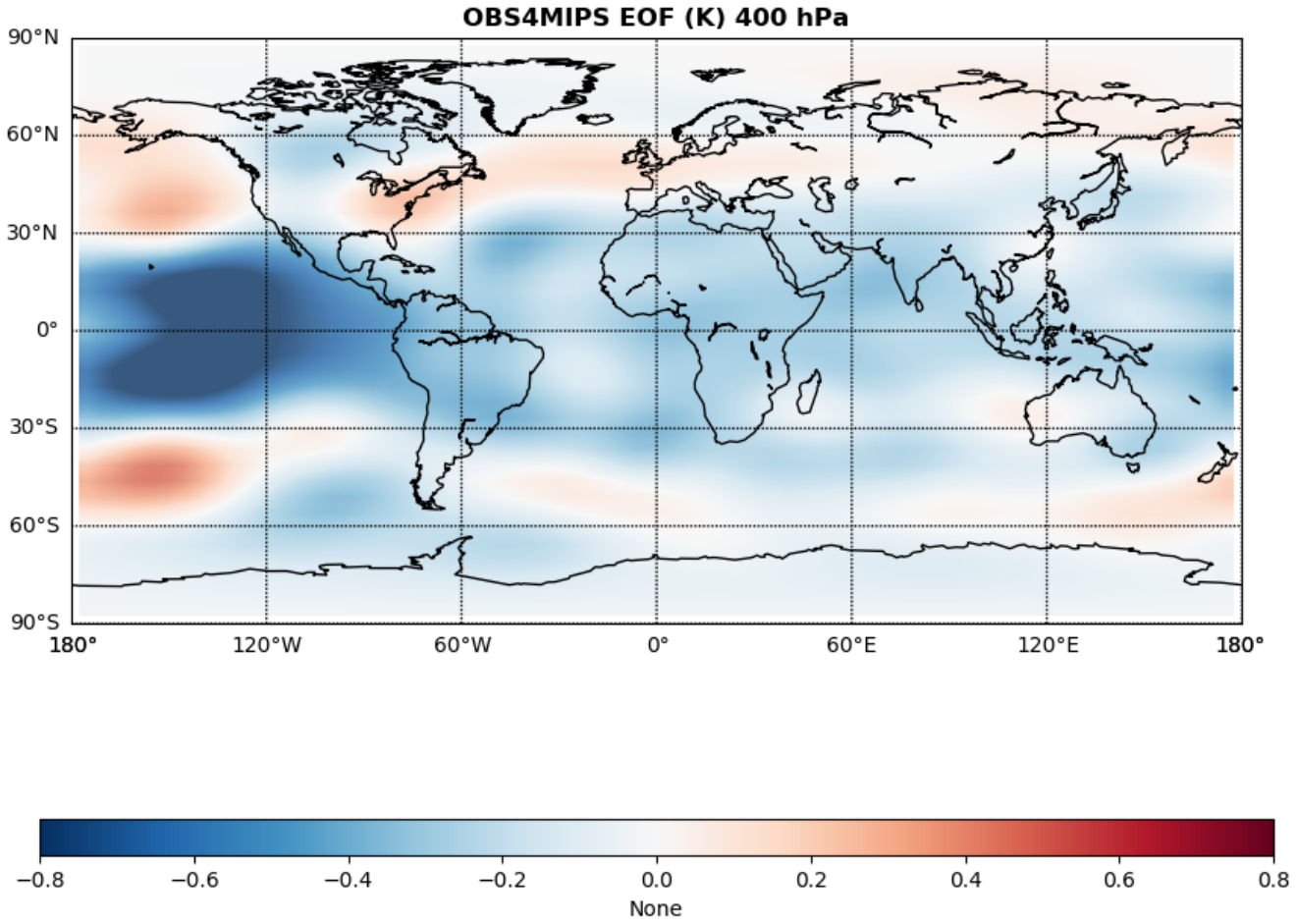

OBS4MIPS EOF (K) 400 hPa
90°N
60°N
30°N
0°
30°S
60°S
90°S
180°
120°W
60°W
0°
60°E
120°E
180°
−0.8
−0.6
−0.4
−0.2
0.0
0.2
0.4
0.6
0.8
None

asa.gov

The IGS at a Glance

- A voluntary federation of over 142 self-funding agencies, universities, and research institutions in more than 45 countries
- Working together to provide the highest precision GPS satellite orbits in the world
- Providing free and open access to the highest precision products available for scientific advancement and public benefit

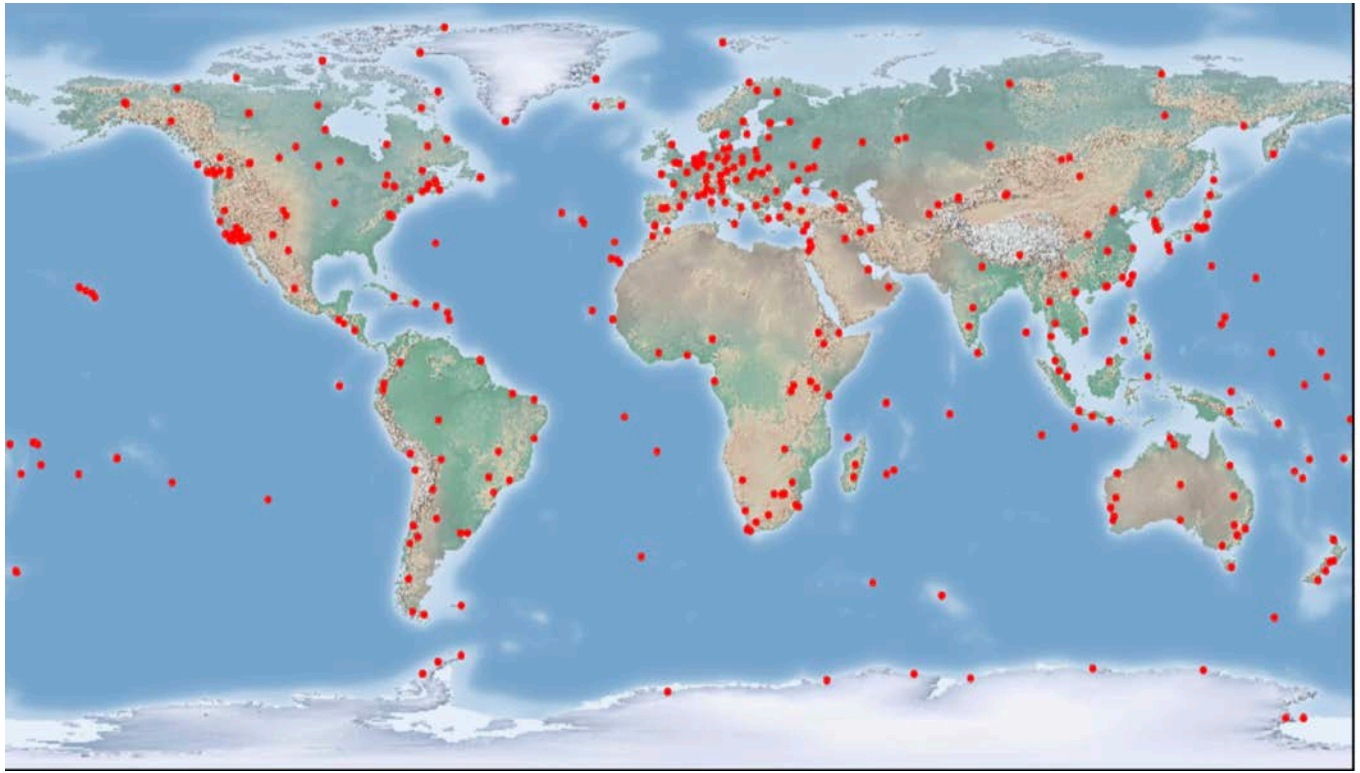
- Producing products that support realization of the International Terrestrial Reference Frame (ITRF) while providing access to tracking data from over 500 worldwide reference stations
- Supporting geodetic research and scholarly publications
- Functioning as a component of the Global Geodetic Observing System (GGOS

IGS INTERNATIONAL GNSS SERVICE

Ground Station Network

509 sites
142 organizations
45 countries

www.igs.org/network



IGS INTERNATIONAL GNSS SERVICE

Third Associate Member & Working Group Open Meeting

"AMs in the AM"

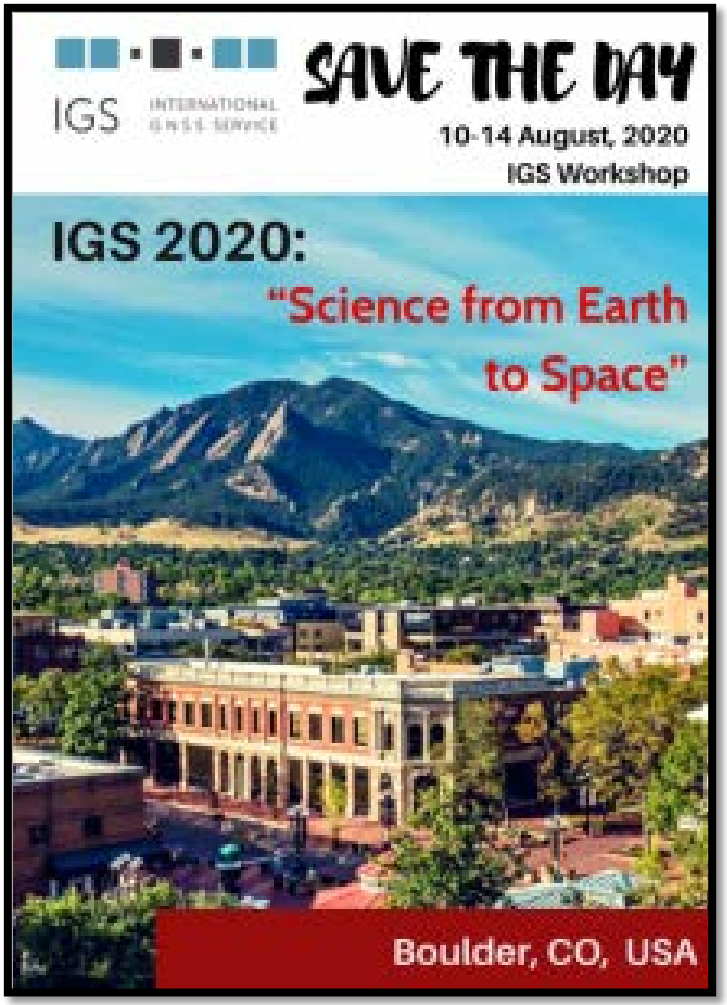
8 December 2019 - 9:00 AM

(Sunday prior to the AGU Fall Meeting in San Francisco)

IGS INTERNATIONAL GNSS SERVICE

IGS Workshop 2020
“Science From Earth to Space”

- 10-14 August 2020
- Boulder, Colorado, USA
- Additional information will be announced soon via:
  - IGSmail mailing list
  - IGS.org website
  - @IGSorg



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