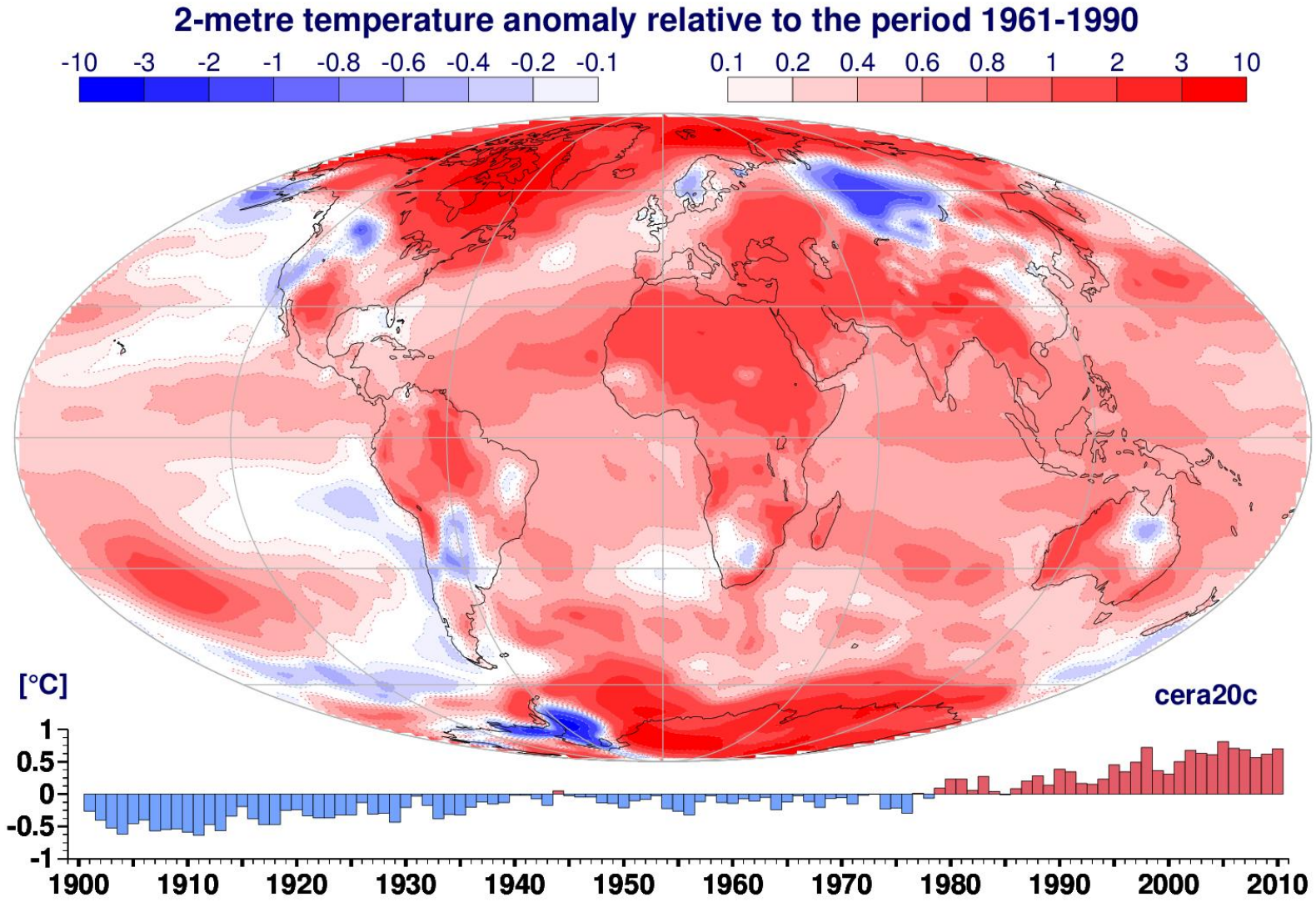
# Climate Reanalyses and Services for Society

*Stefan Brönnimann and Roberto Buizza*

ERA-CLIM2 Symposium
University of Bern, 14 December 2017

# A reanalysis is a 4-dimensional dataset

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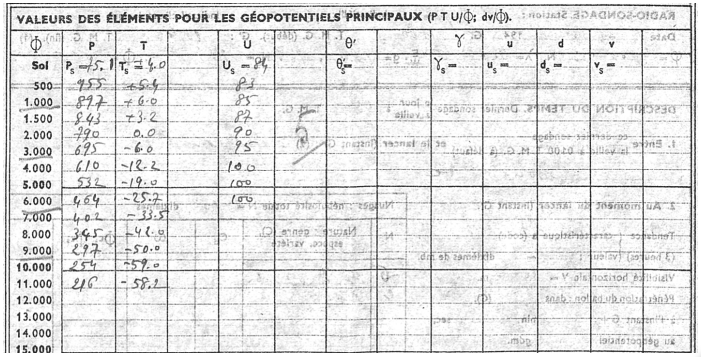
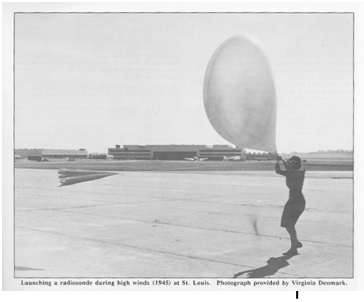
# Observations


VALEURS DES ÉLÉMENTS POUR LES GÉOPOTENTIELS PRINCIPAUX (P T U/Φ; dv/Φ).

| Φ | P | T | U | θv | γ | u | d | v |
|---|---|---|---|---|---|---|---|---|
| Sol | $P_s$ = 975.1 | $T_s$ = 4.0 | $U_s$ = 84 | $\theta_{vs}$ = | $\gamma_s$ = | $u_s$ = | $d_s$ = | $v_s$ = |
| 500 | 955 | +5.4 | 83 | | | | | |
| 1.000 | 897 | +6.0 | 85 | | | | | |
| 1.500 | 843 | +3.2 | 87 | | | | | |
| 2.000 | 790 | 0.0 | 90 | | | | | |
| 3.000 | 695 | -6.0 | 95 | | | | | |
| 4.000 | 610 | -12.2 | 100 | | | | | |
| 5.000 | 532 | -19.0 | 100 | | | | | |
| 6.000 | 464 | -25.7 | 100 | | | | | |
| 7.000 | 402 | -33.5 | | | | | | |
| 8.000 | 345 | -42.0 | | | | | | |
| 9.000 | 297 | -50.0 | | | | | | |
| 10.000 | 254 | -59.0 | | | | | | |
| 11.000 | 216 | -58.2 | | | | | | |
| 12.000 | | | | | | | | |
| 13.000 | | | | | | | | |
| 14.000 | | | | | | | | |
| 15.000 | | | | | | | | |


Launching a radiosonde during high winds (1945) at St. Louis. Photograph provided by Virginia Denmark.





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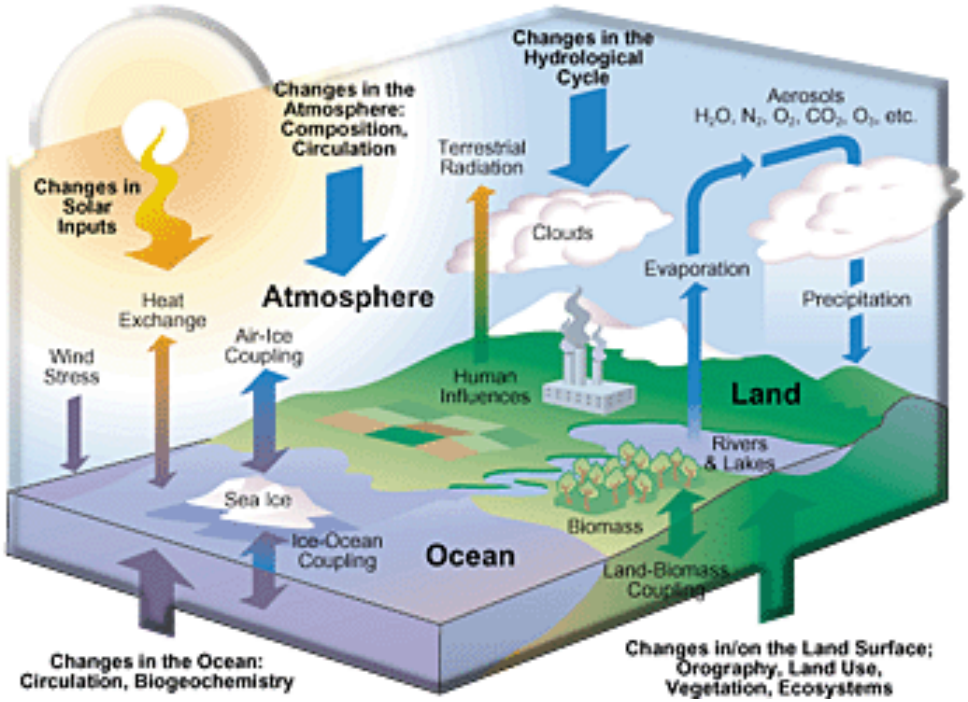
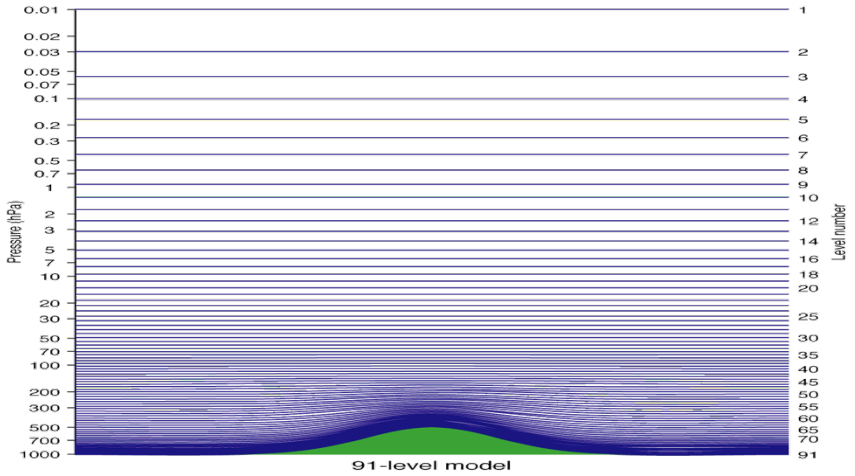
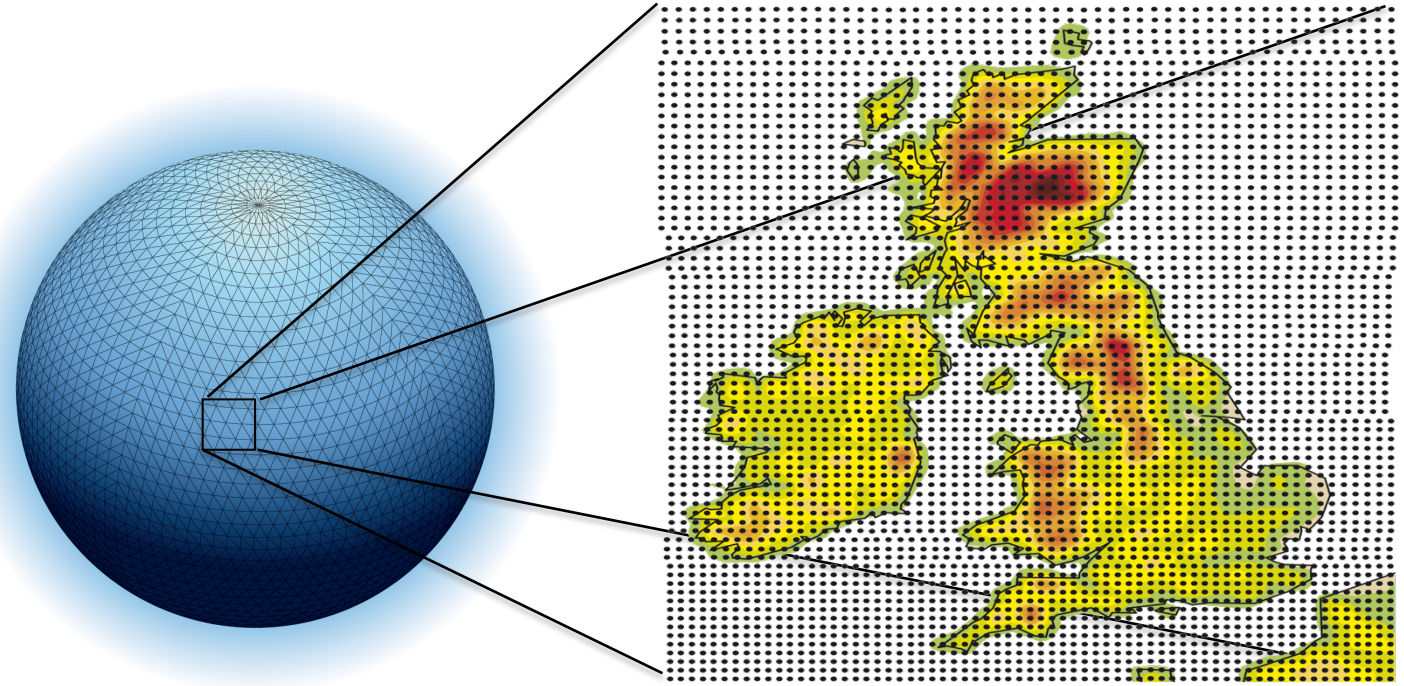
# Model


Changes in the Hydrological Cycle
Changes in the Atmosphere: Composition, Circulation
Aerosols
$H_2O$, $N_2$, $O_2$, $CO_2$, $O_3$, etc.
Terrestrial Radiation
Changes in Solar Inputs
Clouds
Evaporation
Precipitation
Heat Exchange
Atmosphere
Air-Ice Coupling
Wind Stress
Human Influences
Land
Rivers & Lakes
Sea Ice
Biomass
Ice-Ocean Coupling
Ocean
Land-Biomass Coupling
Changes in the Ocean: Circulation, Biogeochemistry
Changes in/on the Land Surface; Orography, Land Use, Vegetation, Ecosystems


Pressure (hPa)
0.01
0.02
0.03
0.05
0.07
0.1
0.2
0.3
0.5
0.7
1
2
3
5
7
10
20
30
50
70
100
200
300
500
700
1000
Level number
1
2
3
4
5
6
7
8
9
10
12
14
16
18
20
25
30
35
40
45
50
55
60
65
70
91
91-level model



# Data assimilation (DA) procedure

Aproximately 20 million observations

DA

Data assimilation

First guess

Initial conditions

Model next step

Intermediate results

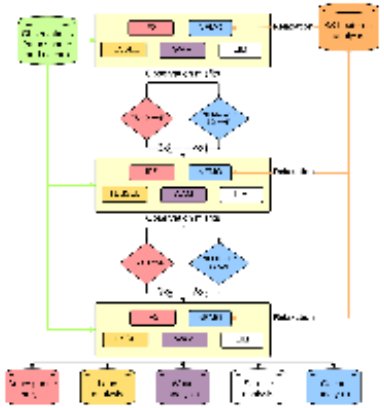
Archive

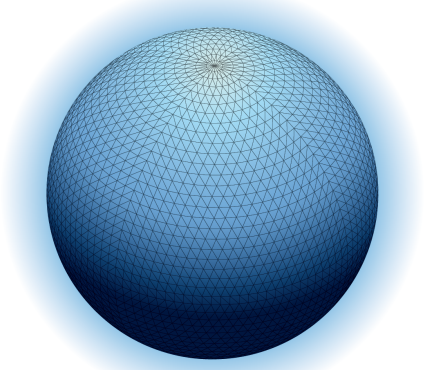
Forecast

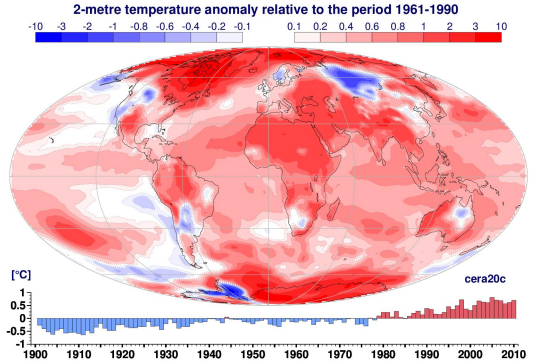
Laws of physics

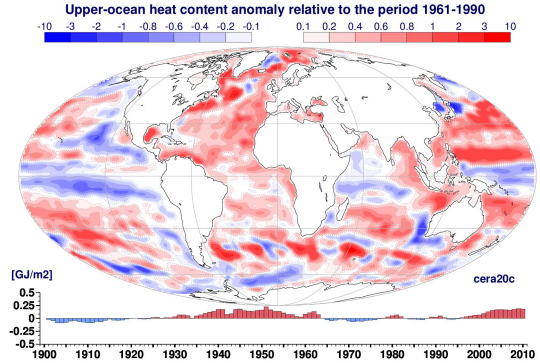
The atmosphere is divided into about one billion cells each having associated parameters such as temperature, pressure, and wind direction.

# Obs + model + DA + HPC = reanalysis

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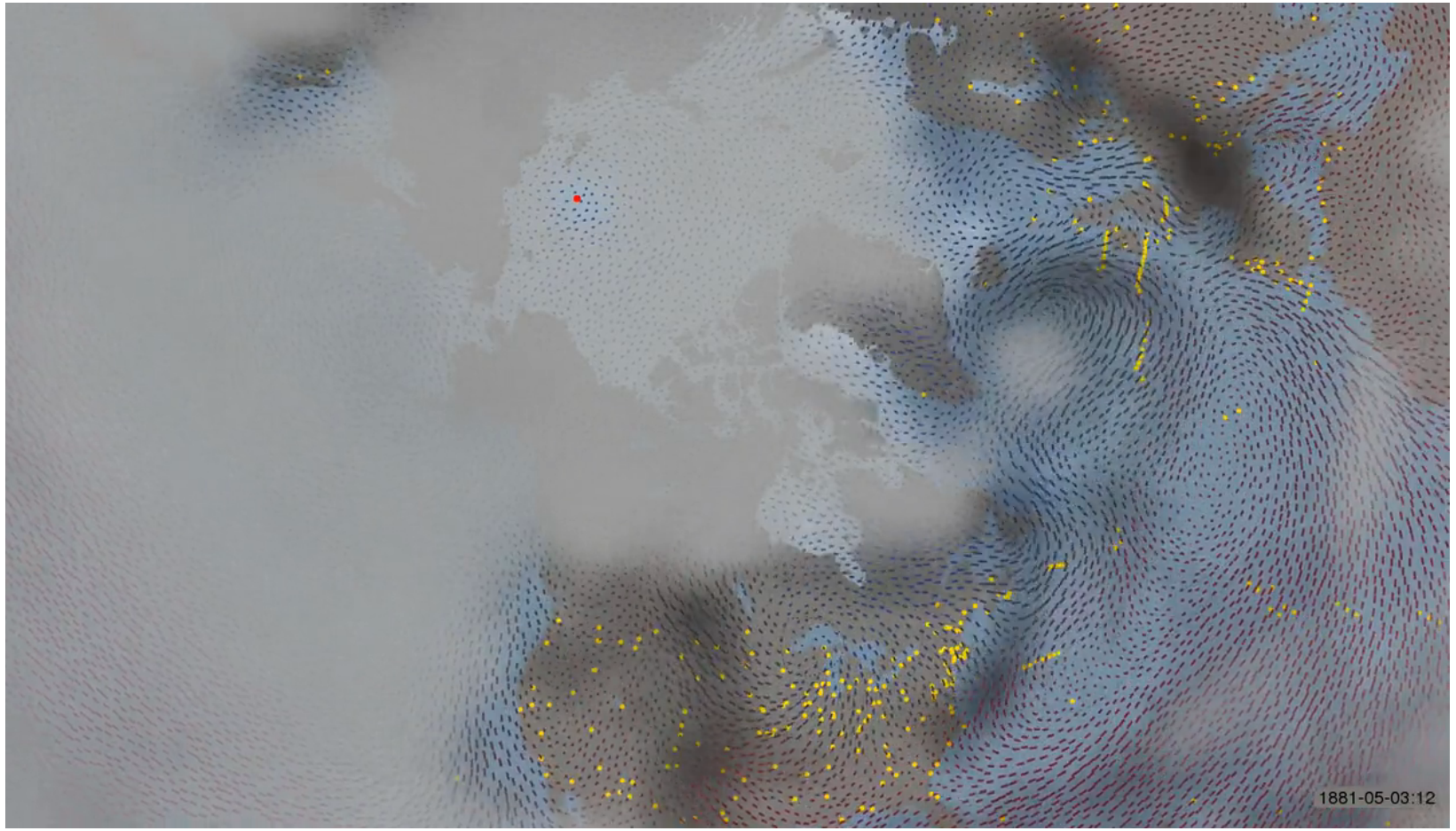
# Reanalyses provides extra knowledge

20CRv3 – May-Sep 1881 with new Oldweather.org obs (red dots) https://vimeo.com/128684414

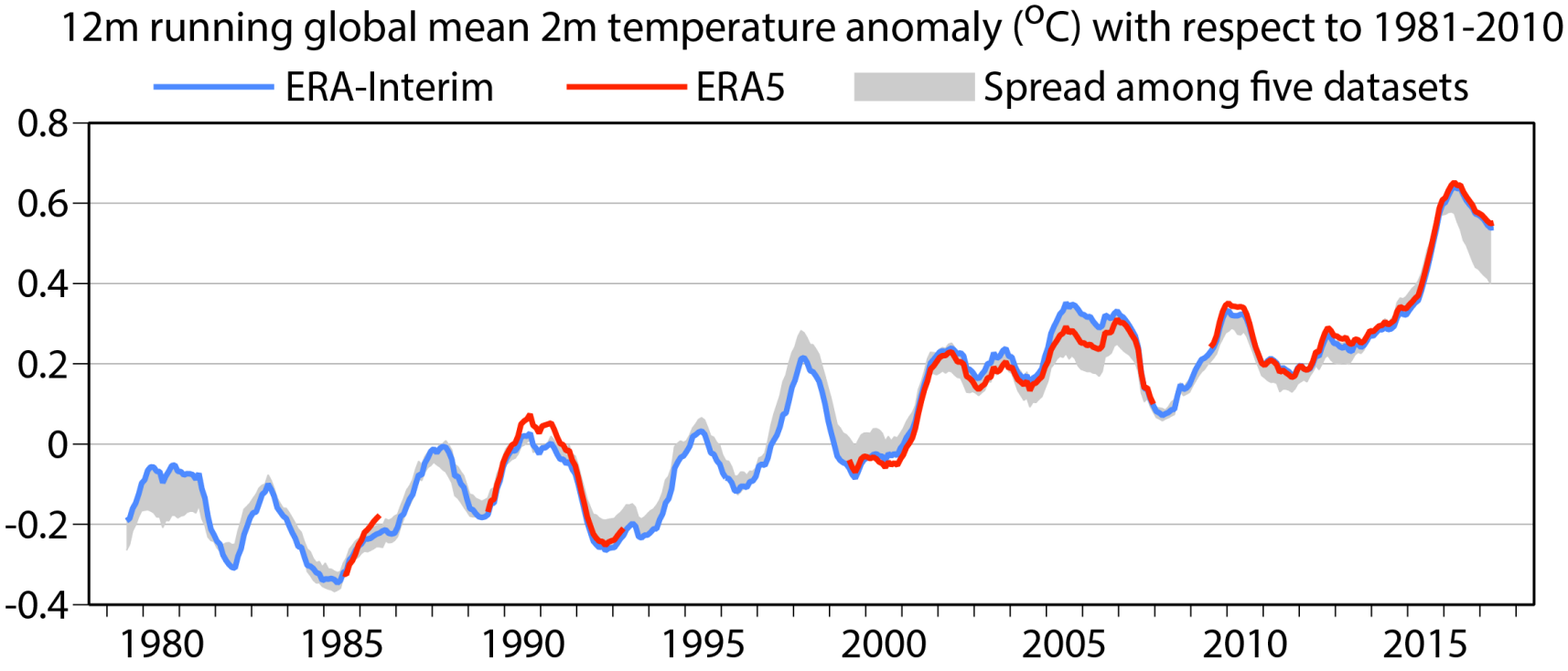



- Colors = temperature
- Vector = wind
- Contours = Sea Level Pressure
- Dark Grey=precipitation
- Gold dots = location of pressure observations used
- Grey fog = indicator of uncertainty

*(From Gil Compo, NOAA, and Phil Brohan, Met Office)*

# Reanalyses provides extra knowledge

Reanalyses 2-meter temperature trends are consistent with observations' trends. Reanalyses bring an extra full 3-dimensional view of the changes, and coupled (ocean, sea-ice, land and atmosphere) reanalyses can help understanding the Earth-system climate evolution.



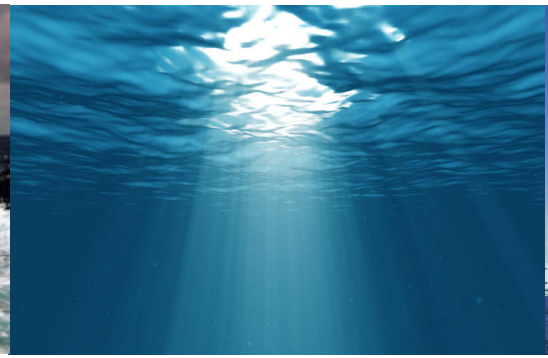

*This graph shows ERA-Interim (blue), ERA5 (red), and the spread of five datasets - ERA-Interim, JRA-55 and the conventional GISTEMP, HadCRUT4 and NOAAGlobalTemp datasets (grey).*

*(From Adrian Simmons)*

# During this meeting we will discuss …

- Observations and methods for reanalyses
- Reanalyses and climate change monitoring
- How reanalyses can be used to understand past events
- Climate Services at three levels: ….

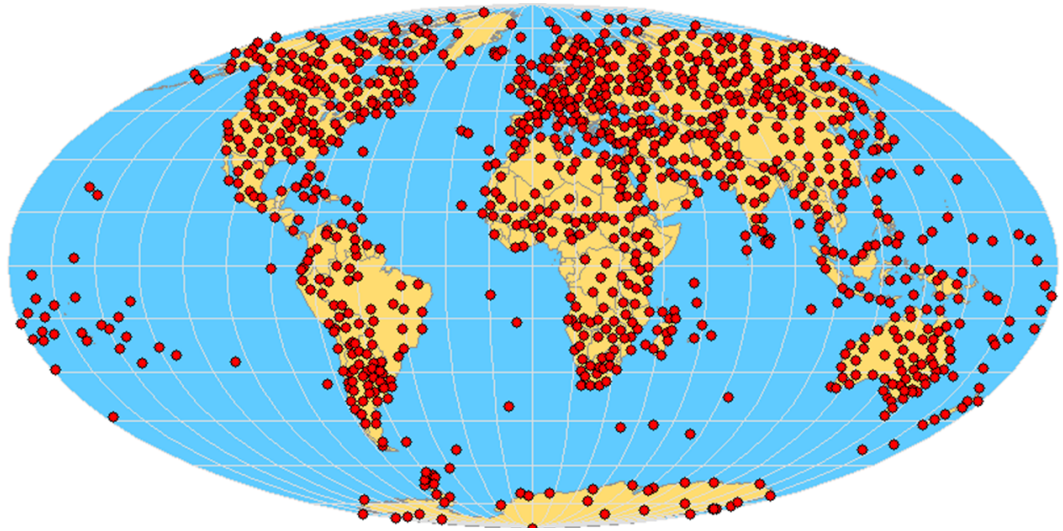



# Climate services at the global level, …

GFCS GLOBAL FRAMEWORK FOR CLIMATE SERVICES


GCOS GLOBAL CLIMATE OBSERVING SYSTEM



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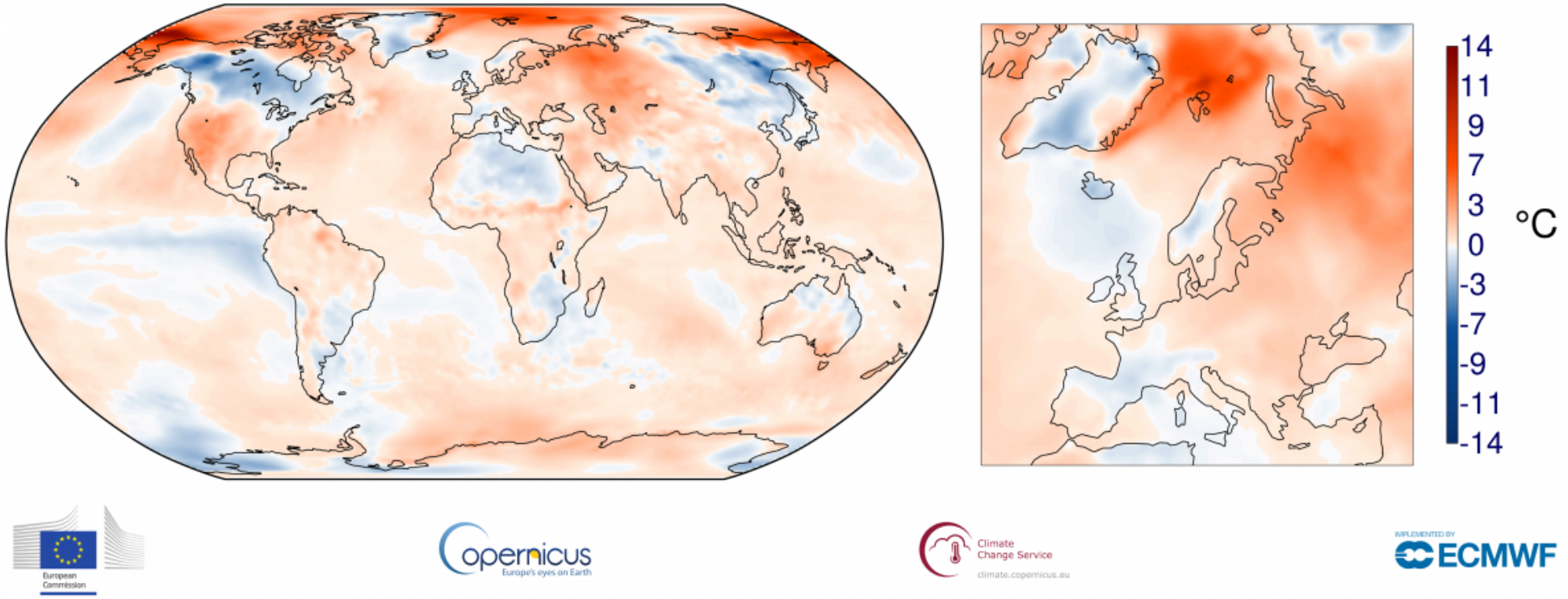
# at the EU level (Copernicus C3S), and …

2mT monthly anomaly map: November 2017



# at the national level (NCCS Switzerland)