esa
Workshop on Cold Regions Hydrology
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# Role of wetlands in the seasonal distribution of discharge of the Poluy, Nadym, Pur and Taz rivers (Northern part of the Western Siberia)

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LEGOS

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# Context: active national/international cooperation

**Cooperation CNRS-Russia: GDRI CAR-WET-SIB (Biogeochemical cycle of carbon in wetlands of Western Siberia)**

**French ANR Project “Impact-BOREAL”,**

**FP7 “MONARCH-A”**

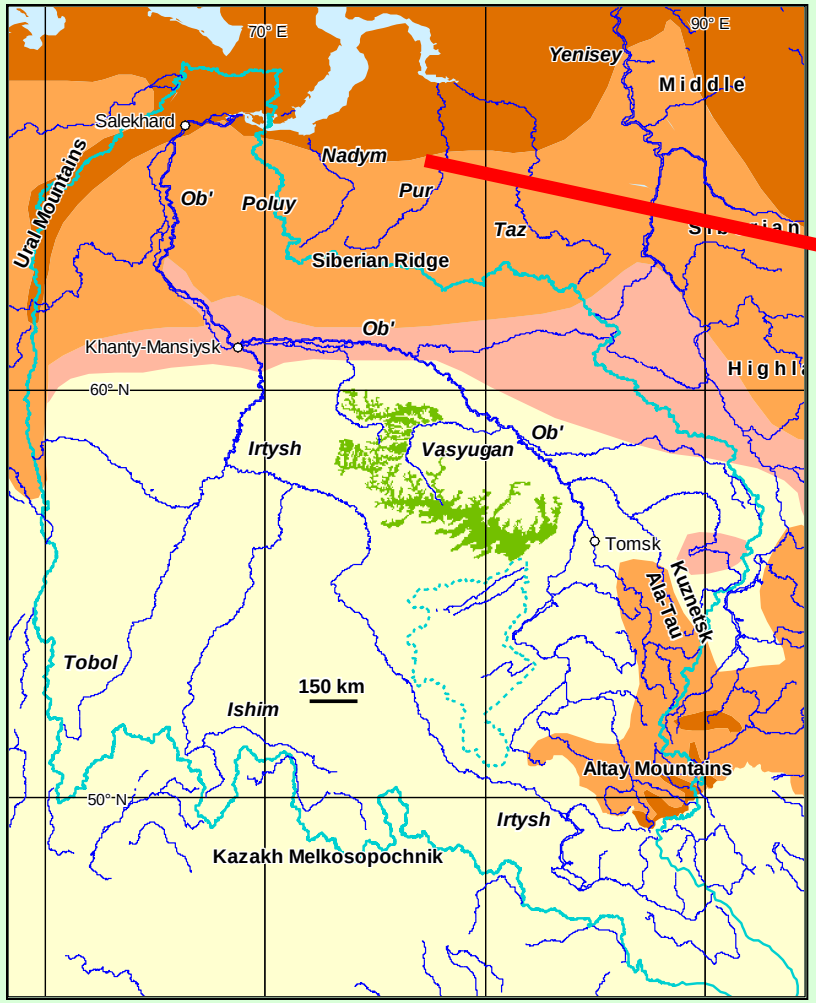
**Field studies in the Noviy Urengoy region (summers of 2008 and 2009) and in the Altai mountains (summer 2009)**

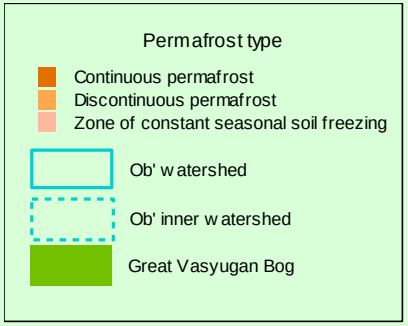
**Int. J. of Environmental Studies August 2009 - special issue on Western Siberia with several our publications on this subject**

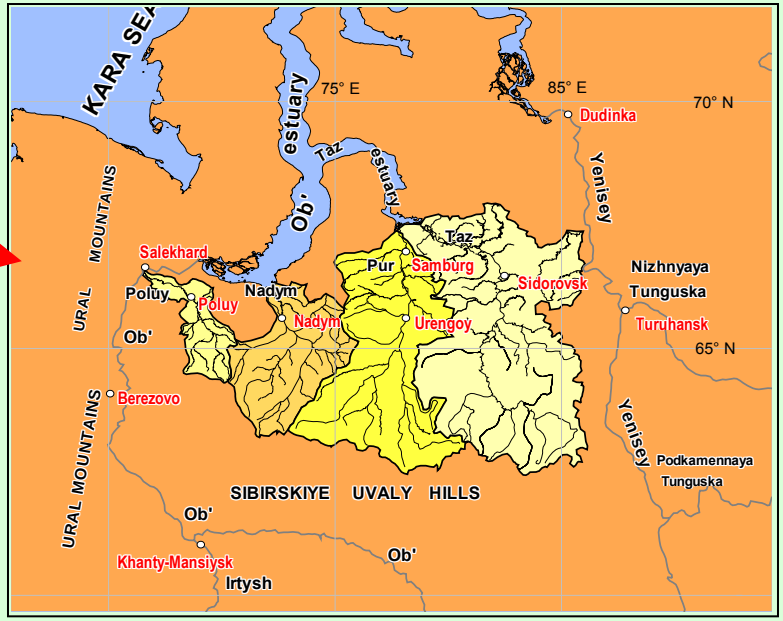
# Western Siberia: an unique region

**Ob' + Yenisey+ PNPT : 1250 km3 /year (greatest input among all other Arctic seas)**

**Flat relief - multitude of natural objects (large and small rivers and streams, extensive floodplains, lakes, mires, etc).**



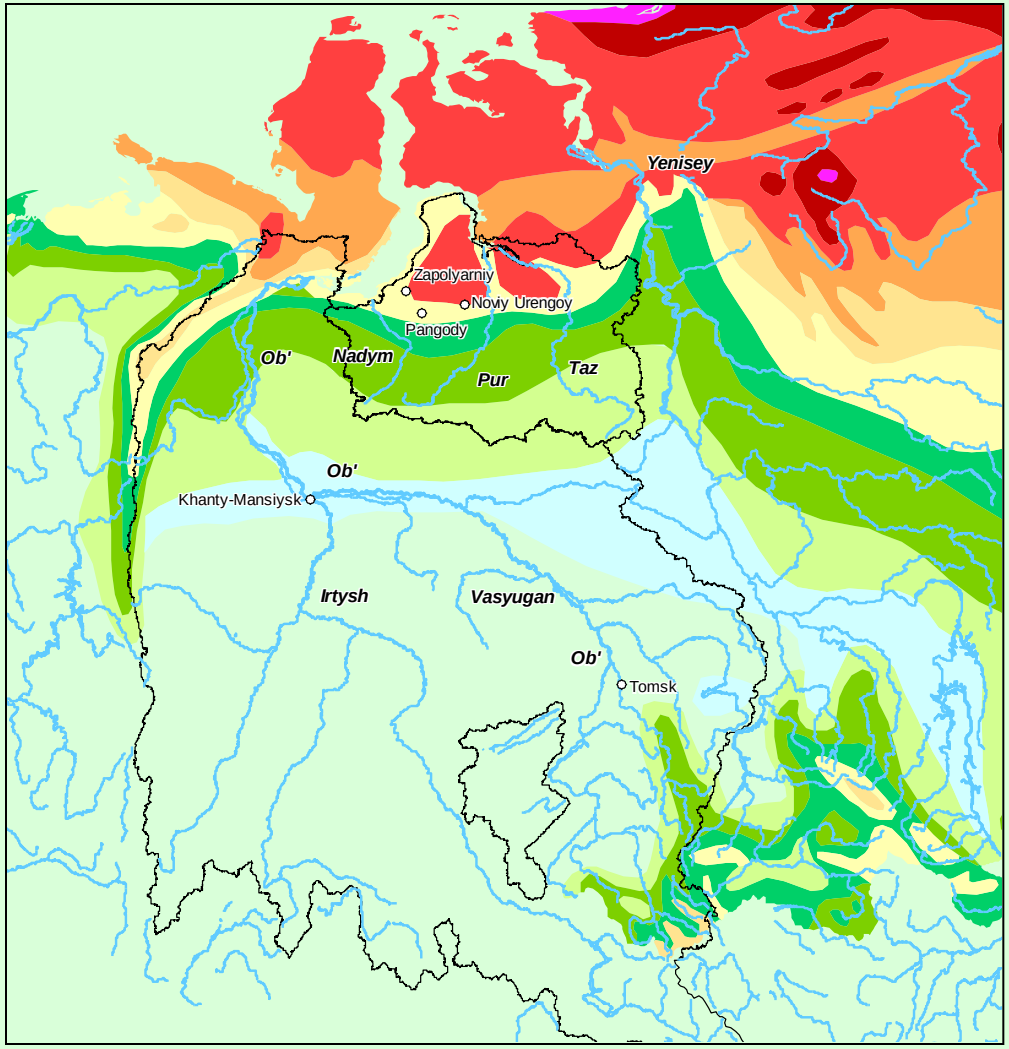




**Poluy, Nadym, Pur and Taz (PNPT)**

**Homogeneous conditions, good climate indicator**

# Permafrost conditions

**Influence of permafrost. Active layer depth in tundra 20-25 cm N to 80-90 cm S, taiga - up to 2m.**




Permafrost types of Russian Federation
(after K.A.Kondratyev and V.A.Kudryavtsev classification)

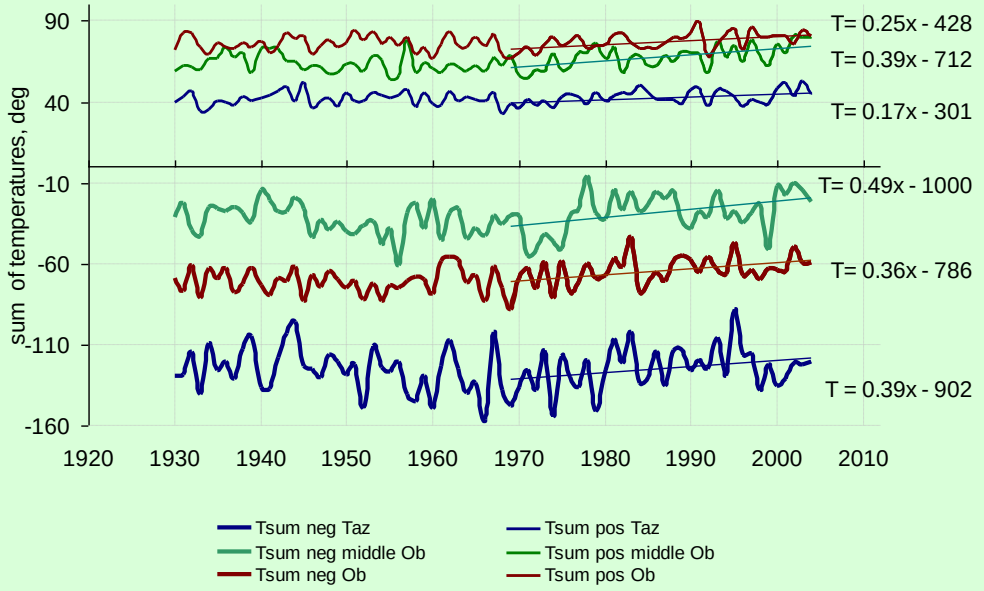
3
4
5
6
7
8
9
10
11
12
14

| Type | Percent of coverage , % | Average temperature, deg Celcius | Depth of permafrost, m |
|---|---|---|---|
| **Continuous permafrost** | | | |
| **3** | 100 | less than -13 | M >800 m |
| **4** | 100 | -11 to -13 | M 500-700 m |
| **5** | 100 | -9 to -11 | M 400-600 m, in mountain ridges 1000 m or more |
| **6** | 100 | -7 to -9 | M 300-500 m, in mountain ridges up to 500_900 m |
| **7** | 100 | -5 to -7 | M 200-400 m, in mountain ridges 300-500 |
| **8** | 100 | -3 to -5 | M 200-400 m, |
| **9** | 100 | -1 to -3 | M 100-300 m |
| **Discontinuous permafrost** | | | |
| **10** | 70-80 | 0 to -2, thaw soils - +1 to 0 | M up to 100 m, rarely 200-300 m |
| **11** | 40-60 | 0 to -1, thaw soils - +2 to 0 | M 50-70 m, rarely 100-200 m |
| **12** | 5-10 | 0 to -0.5, thaw soils +2 to 0 | M 15-20 m, rarely up to 50 m |
| **Zones of constant seasonal freezing of soils** | | | |
| **14** | up to 5% | 0 to -0.5 | M up to 10-20 m |

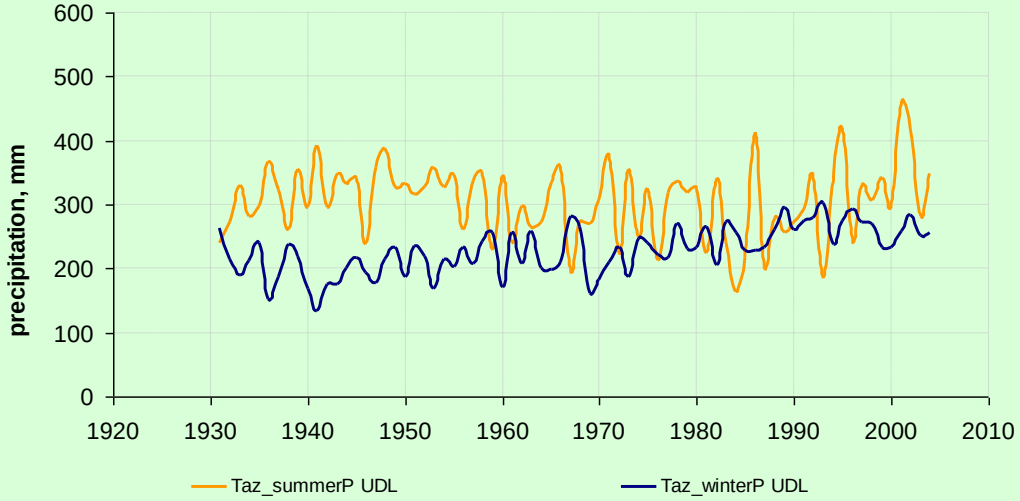
**Note the depth: several hundreds of meters !**

# Climate conditions

**General increase of winter and summer air temperatures**

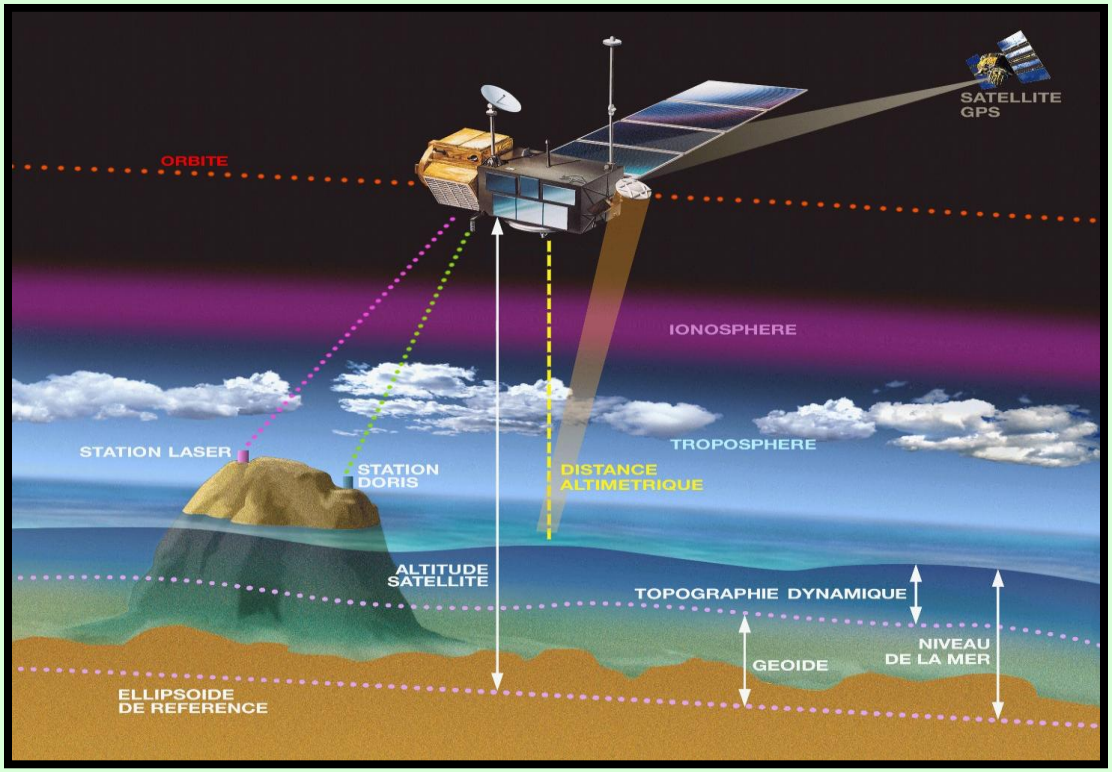



**Increase of precipitation in the northern regions**



# Satellite Earth observations: focus on radar altimetry

# Radar altimetry measurements




**T/P (Oct 1992- Aug 2002, new orbit - Aug 2002-2005)**
**Jason-1 (since Feb 2002)**
**GFO (since Jan 2000)**
**ENVISAT (since Nov 2002)**
**Jason-2 since June 2008**
***+ ERS-1 (Jul 1991 - Mar 2000), ERS-2 (since Apr 1995)***

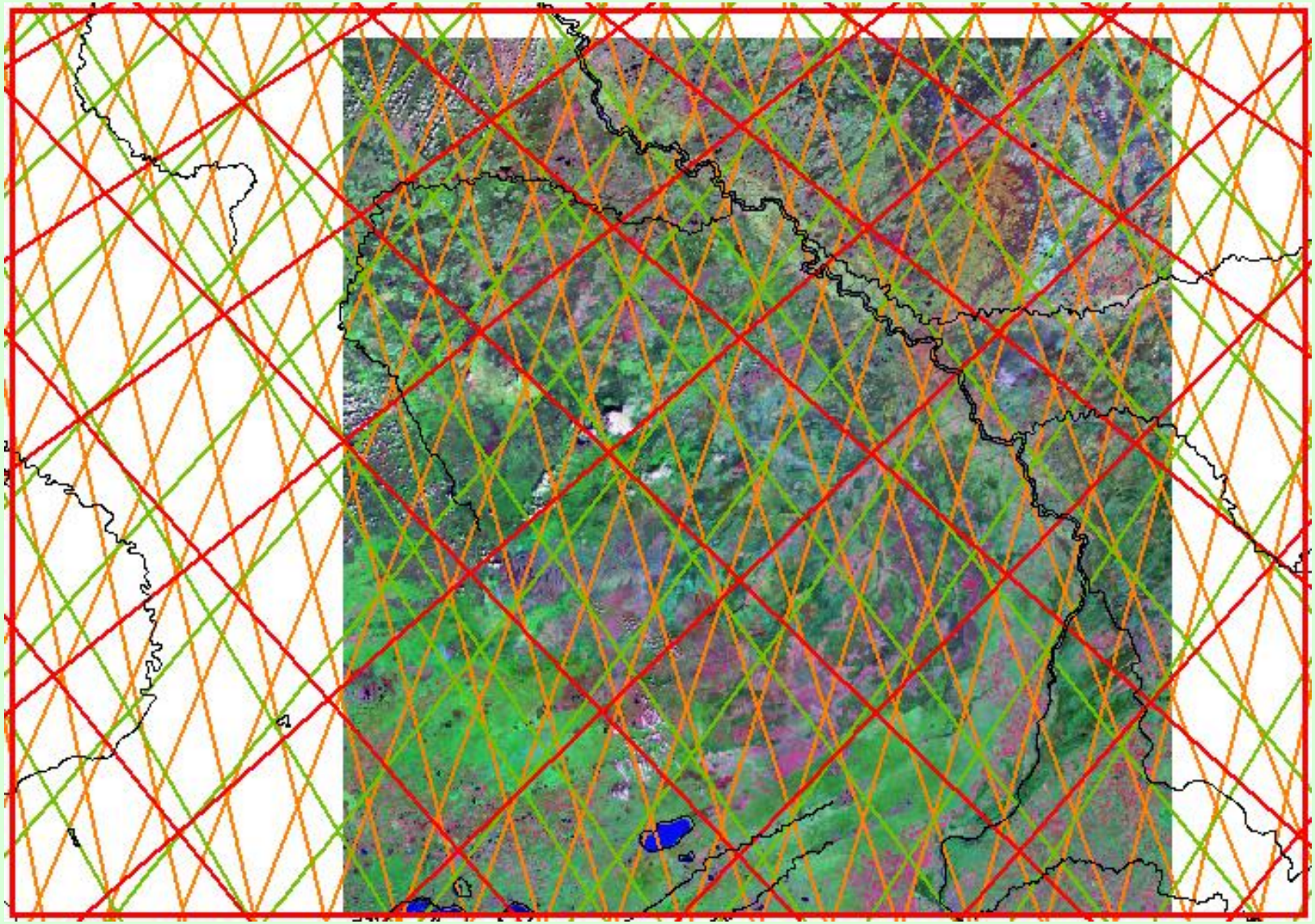
**Main instruments: radar altimeter, radiometer**

**Footprint: radar - 12 km (ocean), radiometer - 22 - 42 km**

**Repeat period: 10 days (T/P, jason), 17 days (GFO) and 35 (ENVISAT)**

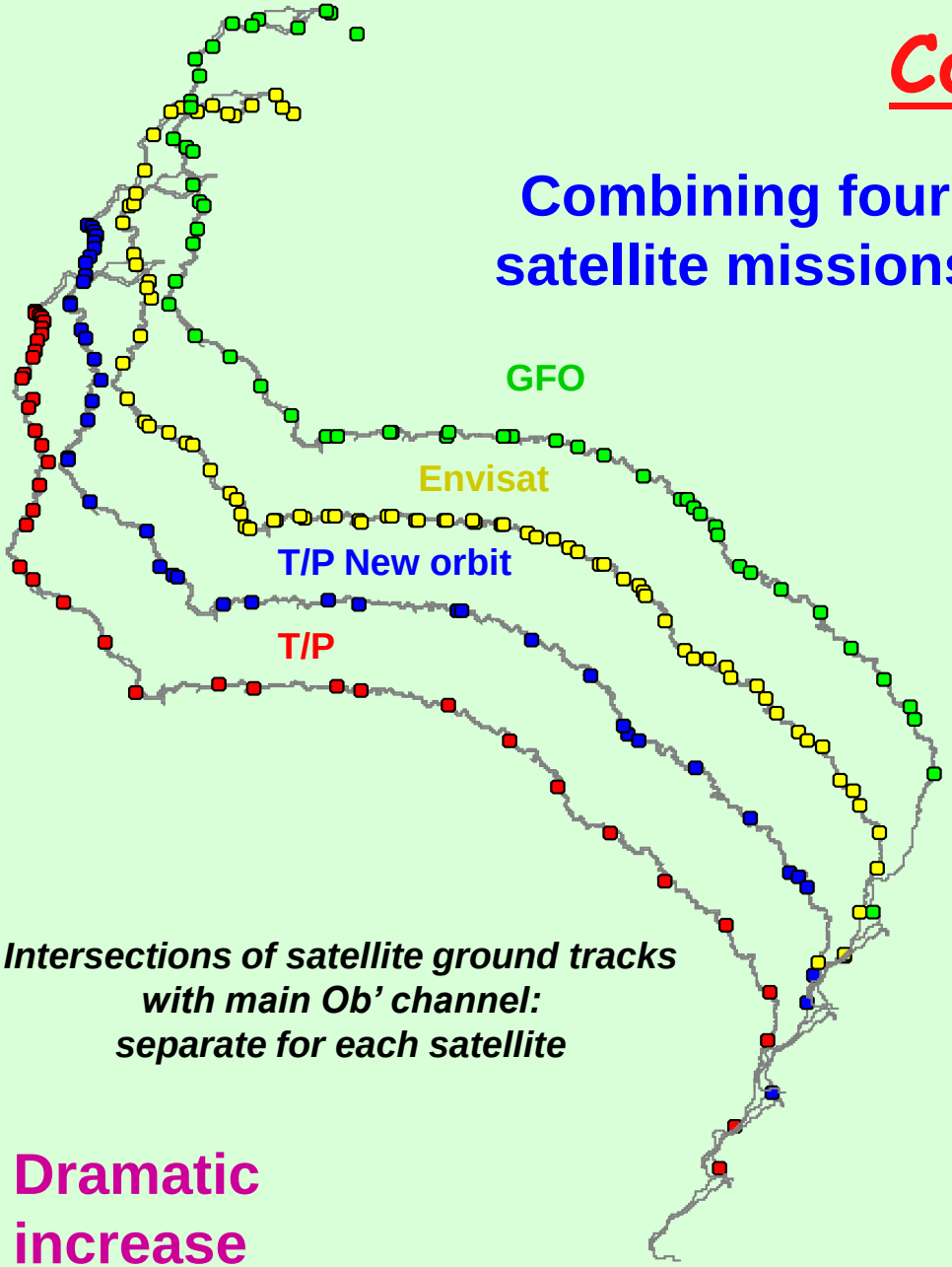
# Satellite coverage

***Altimetric coverage (red - T/P, green - GFO, orange - ENVISAT)***



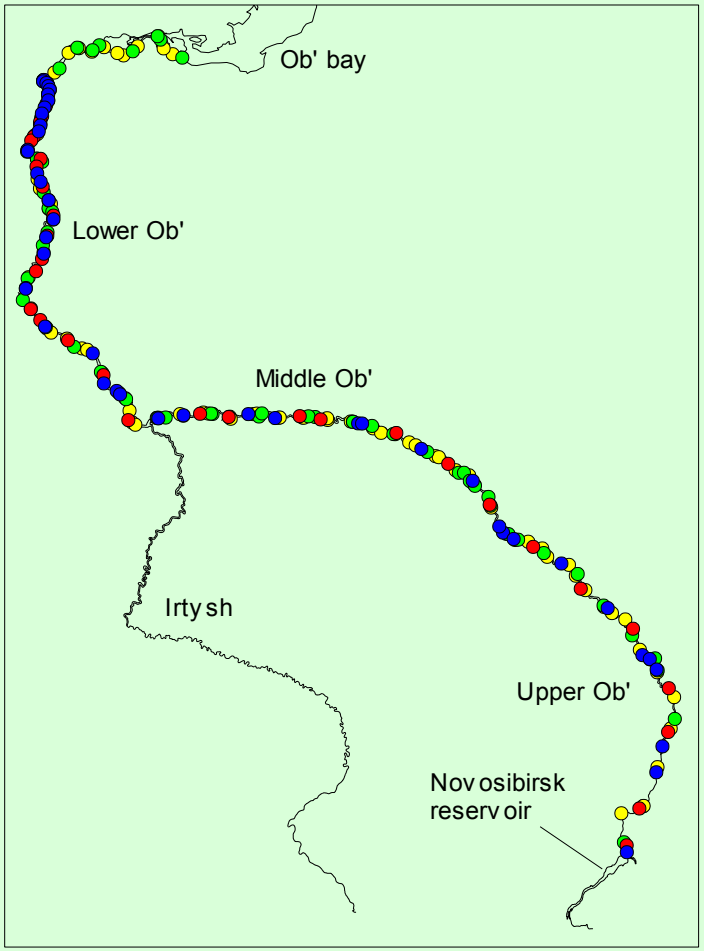
# Coverage by four satellites

## Combining four satellite missions



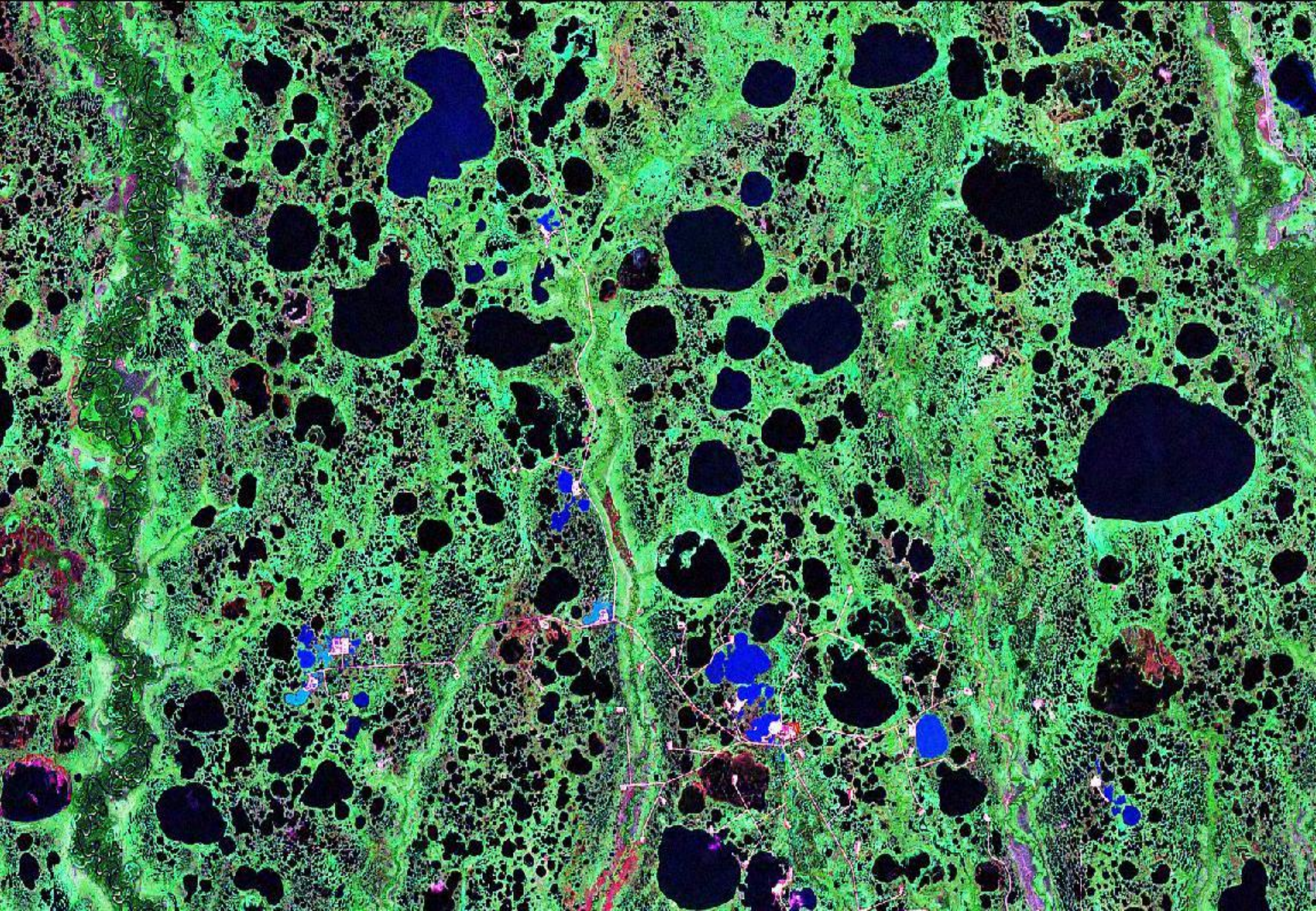

***Intersections of satellite ground tracks with main Ob' channel: separate for each satellite***

**Dramatic increase of spatial coverage**




***Intersections of satellite ground tracks with main Ob' channel: all four satellites***

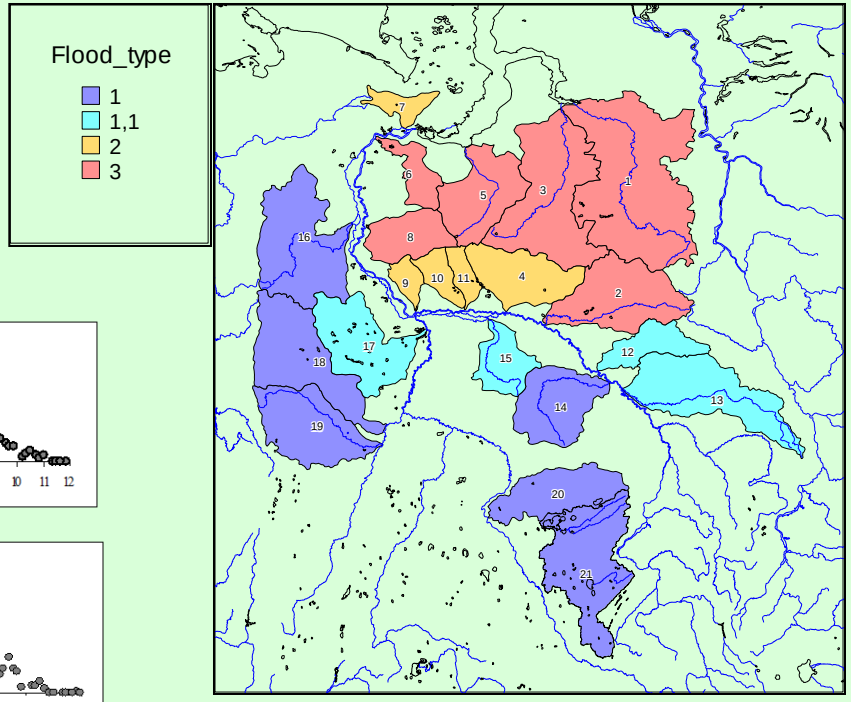
# Wet zones extent



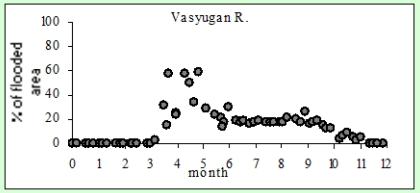
# What do we see from backscatter in Siberia?

# Wet zones: one- and two-humped camels

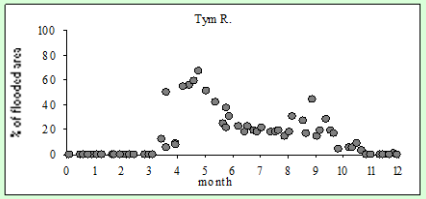
**Using ENVISAT data we estimate the extent (%) of wet zones within 21 mid-size watershed of the Ob' river system. Basing on the difference in seasonal signal we grouped the watersheds into the 3 main types (and one subtype)**



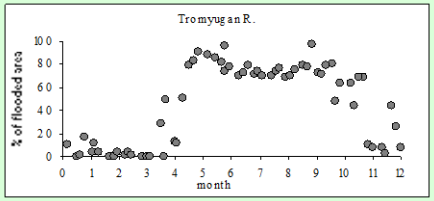

**Type 1: Small permanent flooding (one peak) and well pronounced draining**



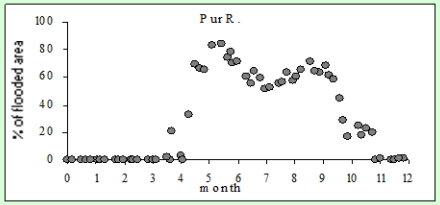

**Type 1a: Same as 1 but with two peaks**




**Type 2: High permanent flooding with insignificant draining**



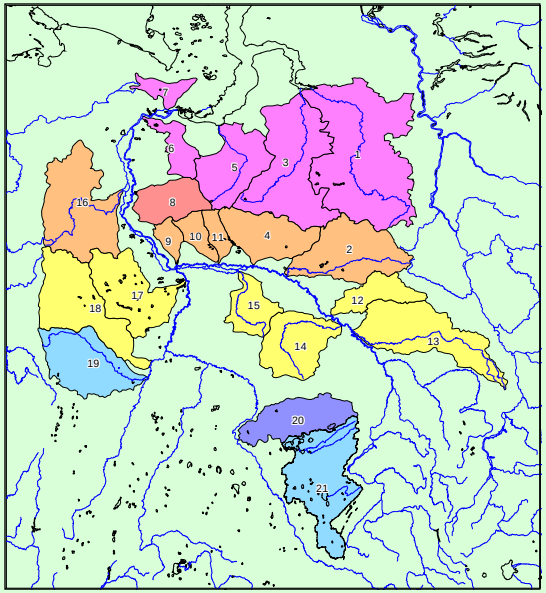

**Type 3: Medium permanent flooding with two peaks and well pronounced draining**



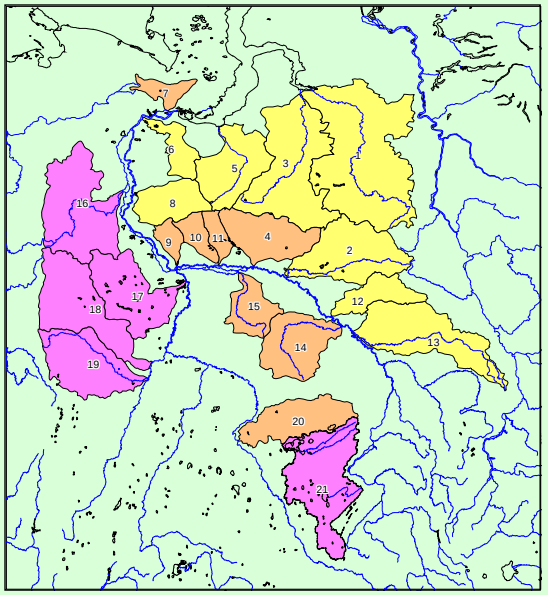

| No | River name |
|---|---|
| 1 | Taz |
| 2 | Vakh |
| 3 | Pur |
| 4 | Trom Yugan |
| 5 | Nadym |
| 6 | Poluy |
| 7 | Schuchya |
| 8 | Kazym |
| 9 | Nazym |
| 10 | Lyamin |
| 11 | Pim |
| 12 | Tym |
| 13 | Ket |
| 14 | Vasyugan |
| 15 | Big Yugan |
| 16 | Severnaya Sosva |
| 17 | Konda |
| 18 | Tavda |
| 19 | Tura |
| 20 | Om |
| 21 | Inner watershed |

# Wet zones: timing of seasonal variations

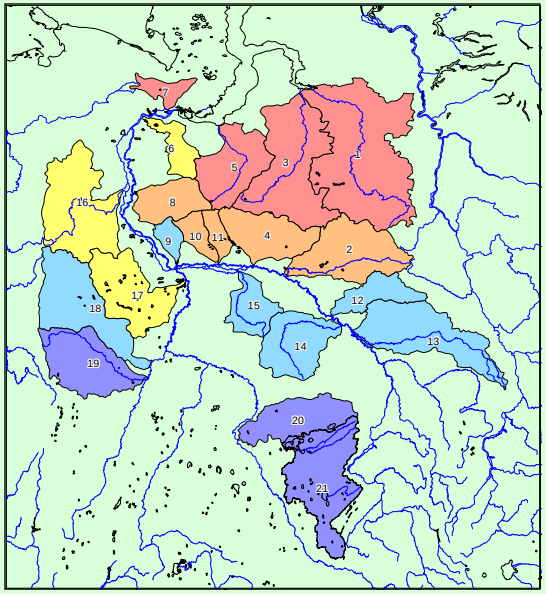
## Beginning of flood




## Beginning of freeze-up

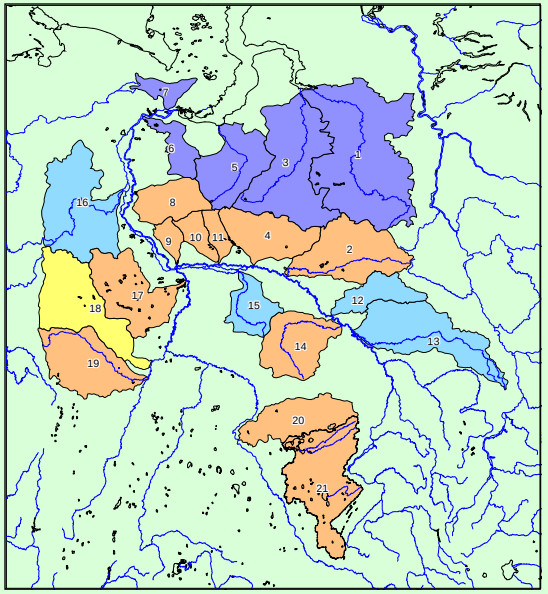



## Maximal flood




## Full freeze-up

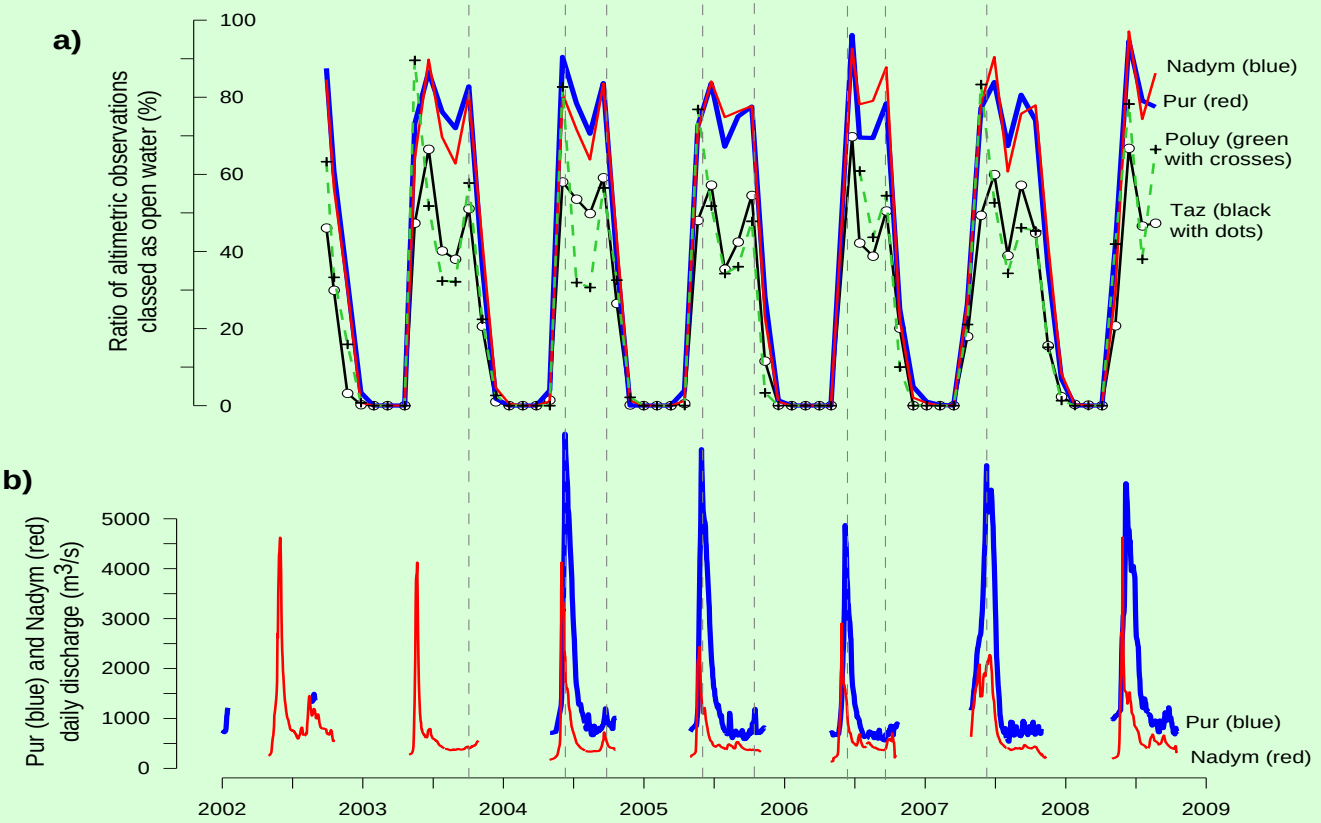
**Generally N to S, but some specific orographic/drainage features**



# Wet zones: interannuall variations

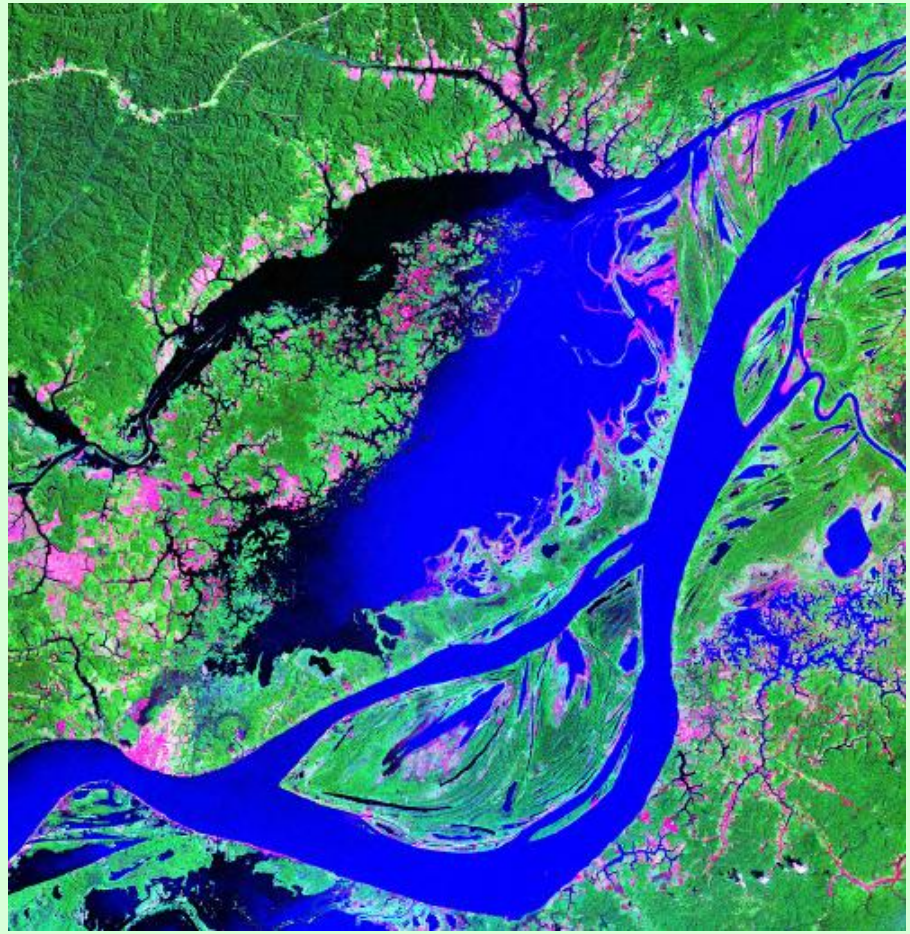
**Wet zones extent (%) (PNPT)**

**Discharge (NP)**

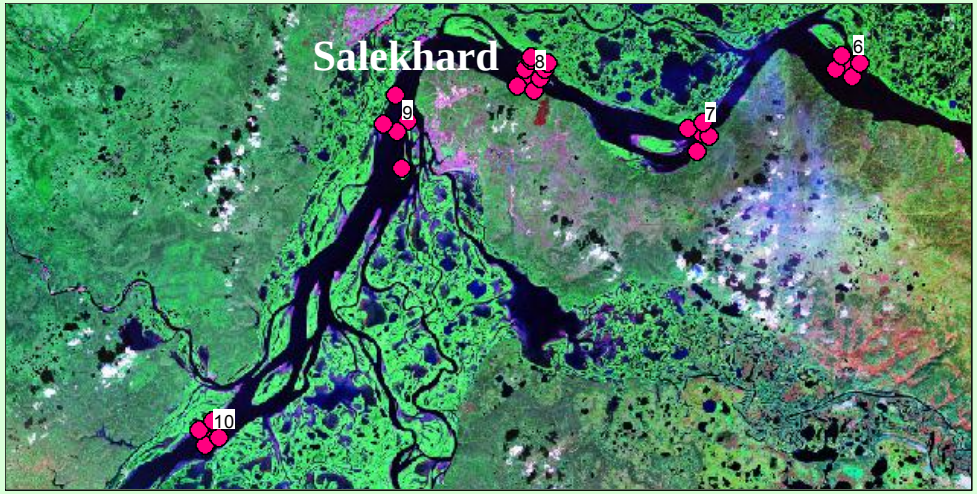


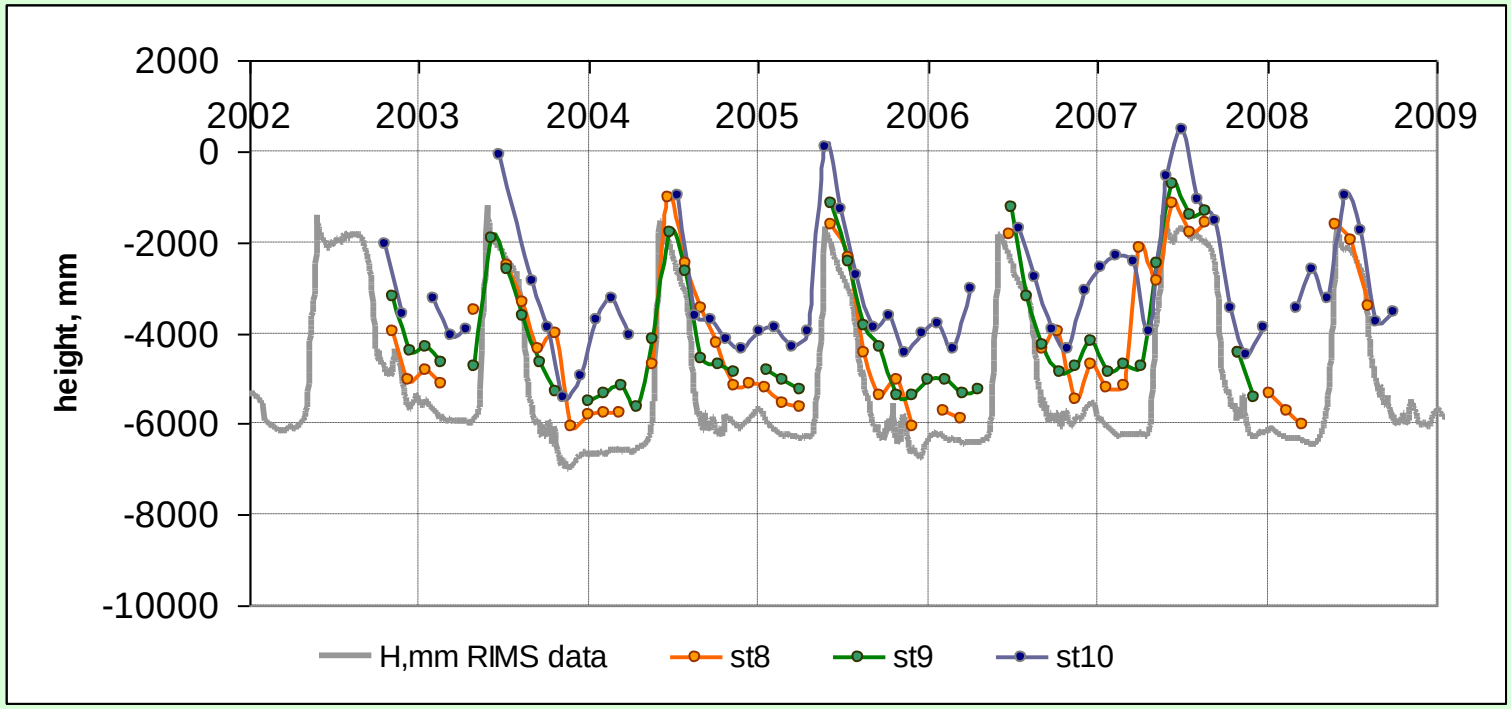

**Significant variability from year to year.**
**Wet zones extent (%) similar in spring and autumn, though in volume it is very different**
**=> need to study water level changes**

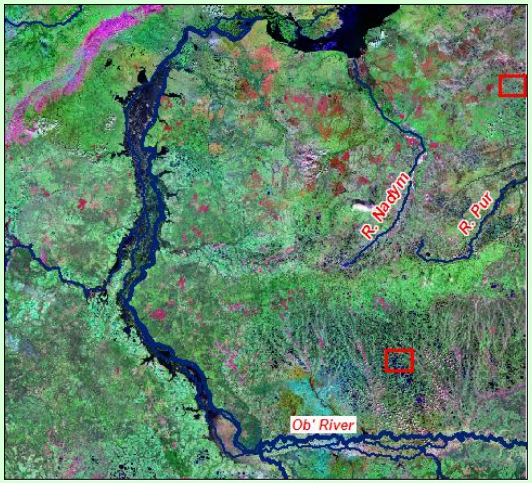
# River level from satellite altimetry



# Ob River : water level validation





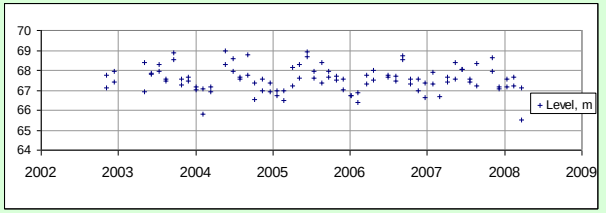

# Water level from altimetry

**Variability is highest (1-1.5 m) for lakes, much less (50-70 cm) for flat mires and drained lakes.**

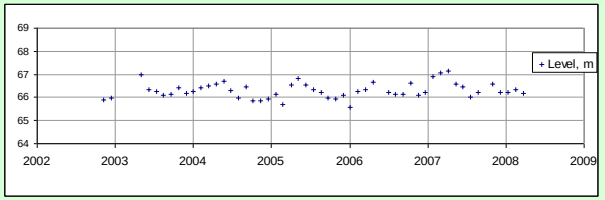
**Wetlands have regulating (dampening) affect on water level**

**Northern Ob': Nadym swamps**

**Lake**

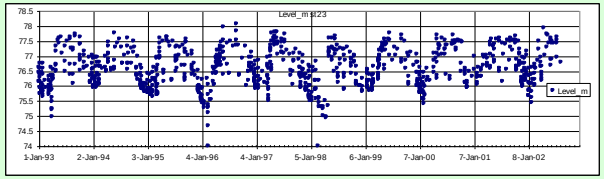



**Draned lake**

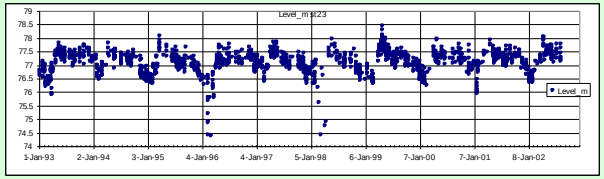



**Middle Ob': Surgut swamp region**

**Lake**

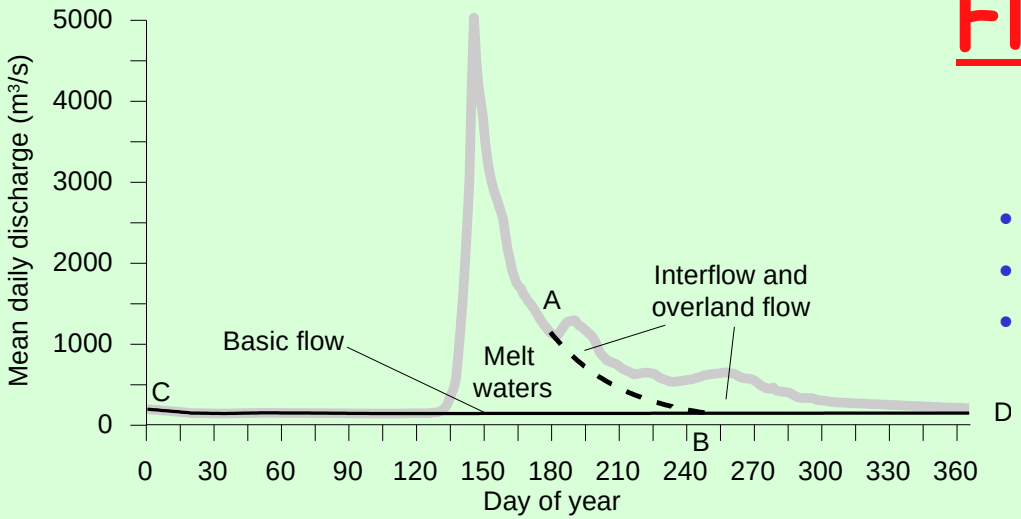



**Flat bog**



# Discharge and its relation with snow cover

# Flow components estimates




Data on daily discharges are used for the estimates of the flow components parts

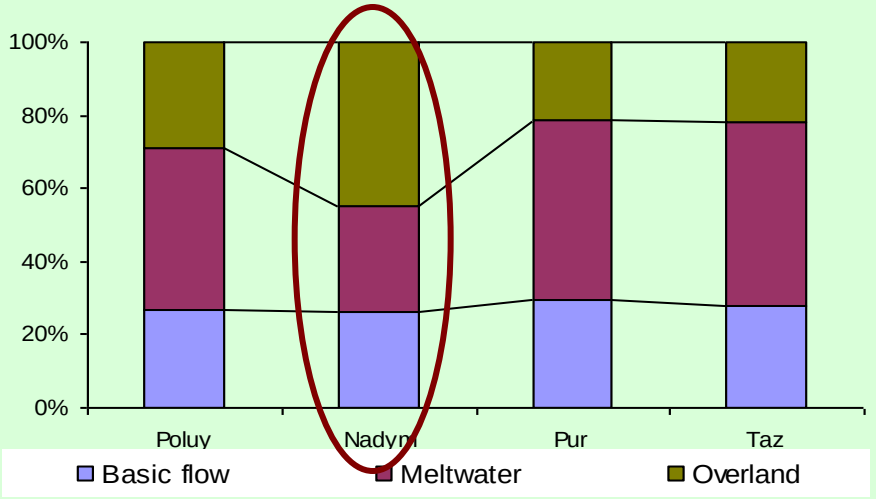
**Three main sources of water flow :**

- **melt waters**
- **ground waters (basic flow)**
- **rain waters (interflow and overland flow during ice free period)**

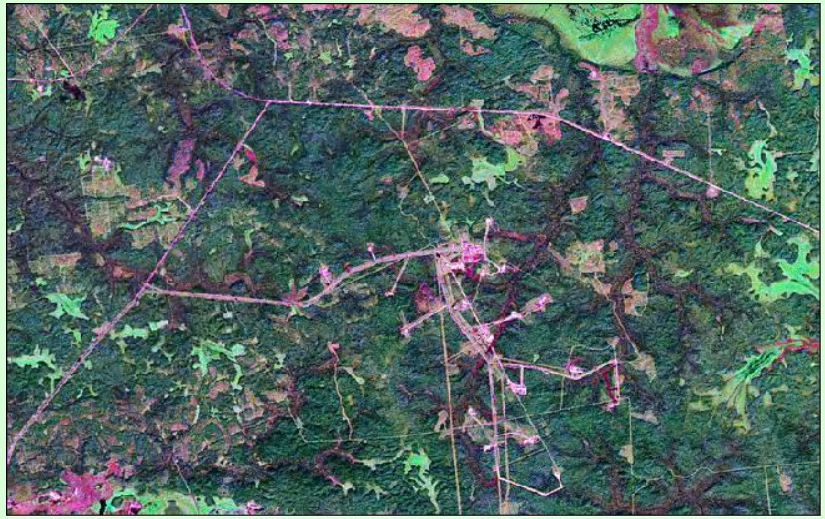
**Nadym river: low impact of melt water (29%) and high impact of overland/interflow (45%)**

**Changes in a watershed properties as a result of intense human impact related with gas exploration**

Mean of the flow components input for 4 Arctic rivers



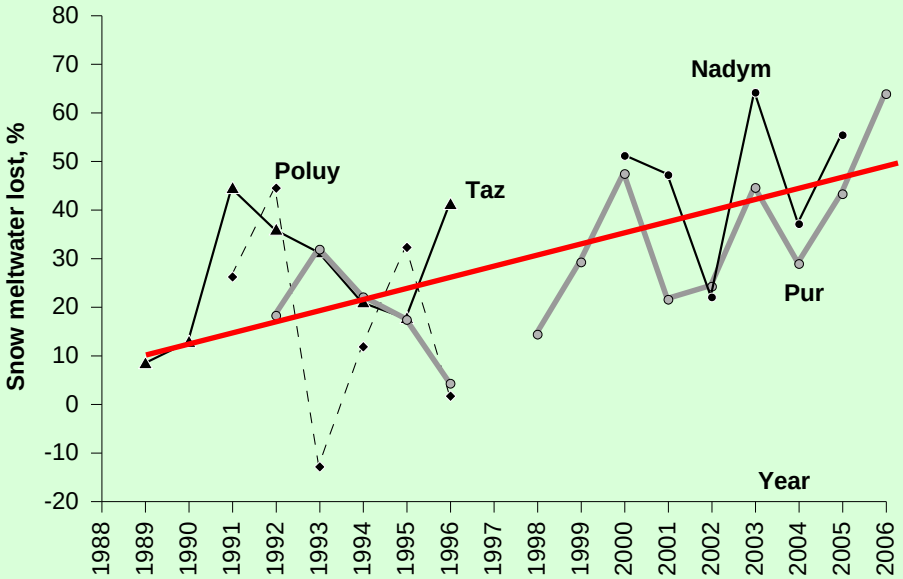
# Anthropogenic impact



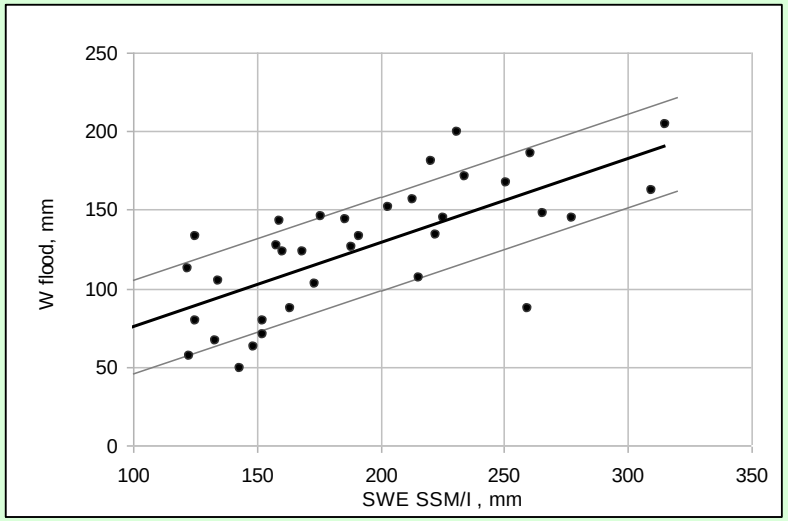

# Snow cover and flood flow

**Estimation of spring flood volume (using in situ daily data on discharge and hydrograph graphical separation) - Zakharova et al., IJES 2009**

**Very good relation => possibility to quantify role of snow in seasonal water redistribution**




***Temporal evolution of difference between snow volume and spring flood (I.e. % of snow lost)***




***Snow water equivalent from SSM/I and in situ data versus spring flood volume***

**However we lose about 20-60% of snowmelt water for evaporation + retention for later release**

**The ratio of water lost is increasing for PNPT - climate change or anthropogenic impact?**